AD-A210 576

WHOI-87-1, Appendices
(1)

Woods Hole Oceanographic Institution

Sea Duct: A Deep-Sea Computer-Controlled Recirculating Flume for the Study of Sea Floor Stability

— Appendices —

by

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JUL 24 1989
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August 1987

Technical Report

Prepared for the Office of Naval Research, Environmental Sciences Directorate, under contract Numbers N00014-85-C-0001 and N00014-87-K-007.

Approved for public release; distribution unlimited.

89 7 24 043

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-87-1, Appendices	2.	3. Recipient's Accession No.

4. Title and Subtitle
Sea Duct: A Deep-Sea Computer-Controlled Recirculating Flume for the Study of Sea Floor Stability - Appendices

5. Report Date August 1987

6.

7. Author(s) Clifford L. Winget, Arthur R. M. Nowell, William E. Terry, Allan G. Gordon

8. Performing Organization Rept. No. WHOI-87-1, Appendices

9. Performing Organization Name and Address
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C) N00014-85-C-0001
(G) N00014-87-K-007

12. Sponsoring Organization Name and Address
Office of Naval Research
Environmental Sciences Directorate

13. Type of Report & Period Covered Technical

14.

15. Supplementary Notes
This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-87-1, Appendices.

16. Abstract (Limit: 200 words)

The Sea Duct Ocean-Bottom Laboratory is a computer controlled recirculating inverted flume for the *in-situ* study of sediment transport. It is designed to measure the sea floor response to controlled currents analogous to those generated by surface waves, tidal, or deep ocean storms.

The external support frame is an equilateral triangle with sixteen foot sides. It is 12 feet high, has an air weight of 12,500 lbs., and a 2800 lb. submerged weight. Three lead acid battery packs located at the vertex of the triangle legs provide power for the recirculating water pumps, hydraulic power, and ancillary equipment.

The inner rotatable structure consists of a 4 foot long by 2 foot wide open bottom windowed test section that is 9 inches high. It is connected to 30 feet of 8 inch tube configured as an elongated toroid. Above the test section is a traverse carriage with stereo camera, flash, and a laser Doppler velocimeter to measure fluid stresses.

Internal flow velocities are controlled and can be ramped up to approximately 2 ft/sec providing shear stress sufficient to scour sand, silts, and fine clays. Water and sediment sampling devices obtain specimens from inside and outside the test section. These appendices include sample programs, flow charts, file formats, electronics drawings, listing of electronics manufacturers, etc. Keywords: Ocean bottom sediment transport; Underwater oceano-graphic equipment.

17. Document Analysis a. Descriptors
1. recirculating flumes;
2. sediment transport
3. sediment stress. (e dc)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement:	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages
Approved for publication; distribution unlimited.	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Appendix A

Sea Duct Sequencer
Program Generation and Sample Program

Sea Duct sequencer programs are written in a high level language designed specifically for the Sea Duct. An example of a sequencer program is found in this appendix. The specific commands are described in the electrical section of this text. The commands may be put in a text file (source code) using using a word processor in the non-document mode. The file is given a ".MAC" extent and then assembled and linked using Syscon's M18 and L18. An example of typical commands to the assembler and linker are given on the first page of the following sequencer listing. The output listing is given a ".PRN" extent. The output file (object code) may be loaded into RAM or EPROM for use in Sea Duct. Details of the assembly / link procedure may be found in Appendix A and in the Syscon Manual.

When read by the assemblier, each high level command is converted into a string of sequencer Pseudo Program Codes (PPCs). Each high level command is called a macro-instruction. During assembly, an "INCLUDE" file labeled ISDEQ.MAC is added to the source file and is used to translate from the macros to the PPCs. See line 45 of this example. Although the actual file listing is inhibited in this example, a copy of the file is present at the end of the listing. It is possible to use higher level macros to call other macros and to create macro subroutines. Several examples of these may be found in the file ISDSUB.MAC which is also included at the end of this appendix.

Accession For	
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By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

```
                        ;       SEA DUCT SEQUENCER PROGRAM
                        ;
                        ;       KNORR Cruise # 127      SEPT 86
                        ;       SEA DUCT DEPLOYMENT - EXP #
                        ;
                        .       SUBTTL          4KNR127 28 SEP 86
                        ;
                        ;       PREV. VERSION   3KNR127 27 SEP 86
                        ;       PREV. VERSION   2KNR127 26 SEP 86
                        ;       PREV. VERSION   1KNR127 25 SEP 86
                        ;       PREV. VERSION   8KNR126 23 SEP 86
                        ;       PREV. VERSION   6KNR126 18 SEP 86
                        ;       PREV. VERSION   1KNR126 08 SEP 86
                        ;
                        ;
                        ;       W. E. TERRY
                        ;
                        ;   INCLUDE FILES REQUIRED:
                        ;       ISDSEQ.MAC      ; Sea Duct PPC Macros
                        ;       ISDDAT7.MAC     ; Sea Duct Data series subroutine
                        ;       ISDSUB.MAC      ; Sea Duct Sequencer Macro subroutines
                        ;
                        ;   Note: Radix is set to base 16 in ISDSEQ.MAC - All parameters passed to
                        ;       the macro calls (ie. all parameters) must be HEX (ie. 10D not allowed).
                        ;
                        ;*******************************************************************************
                        ;
                        ;       Assemble using M18 SDDEEPn,=SDDEEPn/R/C
                        ;
                        ;       Link Using   L18 /P:3000/D:3700,SDDEEPn,SDDEEPn/N/X/E
                        ;          for ".HEX" file.  Use MBASIC HXRCA to get ".RCA" file.
                        ;
                        ;       Link Using   L18 /P:3000/D:3700,SDDEEPn,SDDEEPn/N/E
                        ;          for ".COM" file.  Use BURN to burn a prom.
                        ;
                        ; Form is:  M18 Source,=Relocatable/R/C
                        ;           CREF 80 Relocatable=Print file      (then erase .CRF file)
                        ;           L18 /P:Prog start addr/D:Data start addr,Relocatable,Object/Options
                        ;     File extents can be omitted. See Syscon Manual for details.
                        ;
                        ;*******************************************************************************
                        ;
C                       INCLUDE ISDSEQ.MAC
C
C       ;       SEA DUCT SEQUENCER PPC MACROS
C       ;
C       ;       ISDSEQ.MAC      15 JUL 1986
C       ;
C       ;       W. E. TERRY
C       ;
C       ;       (Listing Supressed)
C               .LIST
                ;
                ;       .SALL   ; Use for generation of object code only.
```

```
                                .XALL   ; Use for generation of object code with source code
                        ;       .LALL   ; Use for generation of complete macro text.
                        ;
                        PAGE
```

```
                        ;*******************************************************************************
                        ;
                        ;                    SEA DUCT  PINGER CODES
                        ;
                        ;
                        ;       0   Program Start,              8  Off the bottom
                        ;           Znd Transmiss. Test,
                        ;
                        ;       1   Start Transmiss. Test,      9  OK to lift and move to
                        ;           Beginning Rotation,             a new position
                        ;           On Bottom,
                        ;
                        ;       2   End of Rotation             A   XYZ Position Error
                        ;
                        ;       3   Start of Insertion          B   Rotation Error
                        ;
                        ;       4   Insertion "OK"              C   Tilt "OK"
                        ;
                        ;       5   Insertion "Bad"             D   Tilt "Bad"
                        ;
                        ;       6    Start Core                 E
                        ;
                        ;       7   Start of Velocity           F  Ready to drop weight
                        ;             Measuerment Series
                        ;
                        ;*******************************************************************************
                        PAGE
```

```
                                ;*************** SEA DUCT SEQUENCER PSUEDO PROGRAM BEGINS HERE ***************
                                ;
                                ;
                                ;       While on deck we record individual system batteries.  Time is
                                ; included to block the transmissometer beam as a check.
                                ;
0000'                           START:  INITC           ;INITIALISE, CLEAR COUNTERS
0000'   4D              +               DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
                                ;
                                        ADON            ;A/D, TRANSMISSOMETER, RECORDER ON
0001'   E031            +              DW 0E031H       ;A/D ON
                                        TRON
0003'   E041            +              DW 0E041H       ;Transmissometer ON
                                        SDON
0005'   E051            +              DW 0E051H       ;Sea Data Recorder ON
                                ;
                                        SEND 0          ;SEND PINGER CODE 0
0007'   3000            +              DW (3000H + 0)  ;Push Pinger Code on ASTK
0009'   E024            +              DW 0E024H       ;Send Pinger Code (on ASTK)
                                        CAMERA          ;CHECK THE CAMERA
000B'   E0C0            +              DW 0E0C0H       ;Take a Picture
                                ;
                                ;
                                        BAT 1           ;RECORD BATTERY #1 VOLTAGE
000D'   E011            +               DW (0E010H + 1) ;Pulse Main Battery Relay #n
                                        WAIT20          ;  BAT. #1 ON FOR 20 SEC, OFF FOR 20 SEC.
000F'   60              +               DB 60H          ;Go to Sequencer Subroutine
0010'   0409'           +              DW W20
                                        BAT 1
0012'   E011            +              DW (0E010H + 1) ;Pulse Main Battery Relay #n
                                        WAIT20
0014'   60              +               DB 60H          ;Go to Sequencer Subroutine
0015'   0409'           +              DW W20
                                ;
                                ;
                                        BAT 2           ;RECORD BATTERY #2 VOLTAGE
0017'   E012            +               DW (0E010H + 2) ;Pulse Main Battery Relay #n
                                        WAIT20          ;  BAT. #2 ON FOR 20 SEC, OFF FOR 20 SEC.
0019'   60              +               DB 60H          ;Go to Sequencer Subroutine
001A'   0409'           +               DW W20
                                        BAT 2
001C'   E012            +               DW (0E010H + 2) ;Pulse Main Battery Relay #n
                                        WAIT20
001E'   60              +               DB 60H          ;Go to Sequencer Subroutine
001F'   0409'           +               DW W20
                                ;
                                ;
                                        BAT 3           ;RECORD BATTERY #3 VOLTAGE
0021'   E013            +               DW (0E010H + 3) ;Pulse Main Battery Relay #n
                                        WAIT20          ;  BAT. #3 ON FOR 20 SEC, OFF FOR 20 SEC.
0023'   60              +               DB 60H          ;Go to Sequencer Subroutine
0024'   0409'           +               DW W20
                                        BAT 3
0026'   E013            +               DW (0E010H + 3) ;Pulse Main Battery Relay #n
```

```
                                        WAIT20
                                                DB 60H          ;Go to Sequencer Subroutine
                                                DW W20

                                ;
                                ;
                                        BAT 1           ;TURN ON ALL SYSTEM BATTERIES
                                                DW (0E010H + 1) ;Pulse Main Battery Relay #n
                                        BAT 2
                                                DW (0E010H + 2) ;Pulse Main Battery Relay #n
                                        BAT 3
                                                DW (0E010H + 3) ;Pulse Main Battery Relay #n
                                ;
                                ;
                                        CAMERA
                                                DW 0E0C0H       ;Take a Picture
                                ;
                                        SEND 1          ;SEND CODE "1" TO SIGNAL TRANSMISSOMETER TEST;
                                                DW (3000H + 1)  ;Push Pinger Code on ASTK
                                                DW 0E024H       ;Send Pinger Code (on ASTK)
                                ;
                                ;                       ;WAIT FOR 2 MINUTES TO ALLOW FOR
                                        WAIT2M          ; TRANSMISSOMETER CHECK
                                                DB 60H          ;Go to Sequencer Subroutine
                                                DW W2M
                                ;
                                        SEND 0          ;SEND PINGER CODE 0
                                                DW (3000H + 0)  ;Push Pinger Code on ASTK
                                                DW 0E024H       ;Send Pinger Code (on ASTK)
                                ;
                                ;
                                ;*****************************************************************************
                                ;
                                ;       At this point we launch the instrument.  The bottom sense switch
                                ; is NOT enabled for 20 Min. in order not to false trigger during launch.
                                ; The transmissometer is tested after the 20 min. wait to get a clear water
                                ; transmission sample.
                                ;
                                ;
003E'                           DIVE:   PUSH 1,0AH      ;REST FOR 08 Min. DURING LAUNCH
003E'   30              +                               DB (2FH + 1)    ;Push Data on ASTK
003F'   0A              +                               DB 0AH
                                        WAITF MIN
0040'   82              +                               DB 82H          ;Wait for interval of Min on ASTK
                                ;
0041'                           TCHK1:  SDON
0041'   E051          +                               DW 0E051H       ;Sea Data Recorder ON
                                        ADON
0043'   E031          +                               DW 0E031H       ;A/D ON
                                        TRON
0045'   E041          +                               DW 0E041H       ;Transmissometer ON
                                ;
                                ;
0047'                           ONBOT?: NOOP            ;WAIT TILL WE ARE ON THE BOTTOM
0047'   C4              +                               DB 0C4H         ;No Operation
                                        BRBOT ONBOT
0048'   E0F0            +                               DW 0E0F0H       ;Branch if Bottom Sw to
```

```
 200     004A'   004F'       +                       DW ONBOT                ;Address
 201                                 JUMP ONBOT?
 202     004C'   28          +                       DB 28H          ;Jump To PPC at
 203     004D'   0047'       +                       DW ONBOT?               ;Address
 204                         ;
 205                         ;
 206                         ;*****************************************************************************
 207                         ;
 208                         ;       We are on the bottom.  We send signal 1 and then see if we are level.
 209                         ;
 210                         ;
 211     004F'               ONBOT:  SEND 1          ;SEND PINGER CODE 1
 212     004F'   3001        +                       DW (3000H + 1)  ;Push Pinger Code on ASTK
 213     0051'   E024        +                       DW 0E024H       ;Send Pinger Code (on ASTK)
 214                         ;
 215                                 ADON            ;TURN ON A/D AND RECORD
 216     0053'   E031        +                       DW 0E031H       ;A/D ON
 217                                 SDON
 218     0055'   E051        +                       DW 0E051H       ;Sea Data Recorder ON
 219                                 TRON
 220     0057'   E041        +                       DW 0E041H       ;Transmissometer ON
 221                         ;
 222                                 CAMERA          ;TAKE A PICTURE
 223     0059'   E0C0        +                       DW 0E0C0H       ;Take a Picture
 224                                 WAIT20          ;WAIT 20 SEC TO GET TILTS RECORDED
 225     005B'   60          +                       DB 60H          ;Go to Sequencer Subroutine
 226     005C'   0409'       +                       DW W20
 227                         ;
 228     005E'               TLTIN:  CHKTLT          ;CHECK TILTS, SEND SIGNAL TO SURFACE (C=OK, D=BAD)
 229     005E'   E070        +                       DW 0E070H       ;Check Roll, Pitch; Send Signal
 230                         ;
 231                         ;
 232                         ;                       ;SET COUNTER "A" FOR DEFAULT CONTINUATION AT ROTATE
 233                         ;                       ;IF SURFACE COMMAND IN NOT RECEIVED IN 2 MIN.
 234                                 SETCTA 078H, INSERT
 235     0060'   A1          +                       DB 0A1H
 236     0061'   0078        +                       DW 078H         ;Set Counter A (Hex Seconds)
 237     0063'   0084'       +                       DW INSERT               ; Counter A Vector (When count = 0000
 238
 239                         ;
 240                         ;                       ;WAIT FOR SURFACE SIGNAL
 241     0065'               RPLY1?: BRCMD1 INSERT   ; CMD "1" = GO TO INSERT
 242     0065'   E0F8        +                       DW 0E0F8H       ;Branch if XPONDR CMD. 1 Received to
 243     0067'   0084'       +                       DW INSERT               ;Address
 244                                 BRCMD2 LIFT1    ; CMD "2" = GO TO B
 245     0069'   E0F9        +                       DW 0E0F9H       ;Branch if XPONDR CMD. 2 Received to
 246     006B'   0070'       +                       DW LIFT1                ;Address
 247                                 JUMP RPLY1?
 248     006D'   28          +                       DB 28H          ;Jump To PPC at
 249     006E'   0065'       +                       DW RPLY1?               ;Address
 250                         ;
 251                         ;
 252     0070'               LIFT1:  INITC
 253     0070'   4D          +                       DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
 254                                 SEND 9          ;HERE WE LIFT THE SEA DUCT AND MOVE TO A NEW POSITION
 255     0071'   3009        +                       DW (3000H + 9)  ;Push Pinger Code on ASTK
```

```
                                        DW 0E024H       ;Send Pinger Code (on ASTK)
OFFBOT: NOOP
                                        DB 0C4H         ;No Operation
        BRBOT OFFBOT
                                        DW 0E0F0H       ;Branch if Bottom Sw to
                                        DW OFFBOT               ;Address
        SEND 8          ;SEND OFF BOTTOM SIGNAL
                                        DW (3000H + 8)  ;Push Pinger Code on ASTK
                                        DW 0E024H       ;Send Pinger Code (on ASTK)
        WAIT60
                                        DB 60H          ;Go to Sequencer Subroutine
                                        DW W60
        JUMP ONBOT?     ;GO TO ONBOT?
                                        DB 28H          ;Jump To PPC at
                                        DW ONBOT?               ;Address
;
;
;
;*****************************************************************************
;
;       We are ready to insert the flume.  Signal "3" is sent to the
; surface. Then the insertion attempt is made.  When the four insertion
; sense switches are closed, Signal "3" is sent and insertion is stopped.
;       If insertion is not achieved within 5 Min., the "insertion bad
; (Sig. "5")" is sent.  We then wait for a surface reply.  Surface
; command "1" will continue the program and go to the "RUN1" routine.
; Surface command "2" will continue insertion.
;
;
;
INSERT: INITC           ;INITIALIZE - JUST IN CASE
                                        DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
;
        LDVRST
                                        DW 0E0D0H       ;Reset the LDV
;
        CAMERA
                                        DW 0E0C0H       ;Take a Picture
        SEND 3          ;SEND SIGNAL "3" - START OF INSERTION
                                        DW (3000H + 3)  ;Push Pinger Code on ASTK
                                        DW 0E024H       ;Send Pinger Code (on ASTK)
;
        HYDRA           ;START THE HYDRAULIC PUMP
                                        DW 0E0A8H       ;Pulse Hydraulic Pump Relay
        FLUMIN          ;START THE FLUME INSERTION
                                        DW 0E0ACH       ;Insert Flume
;
        SETCTA 01A4H, INBAD     ;SET TIME OUT COUNTER FOR 7 MIN.
                                        DB 0A1H
                                        DW 01A4H                ;Set Counter A (Hex Seconds)
                                        DW INBAD                ; Counter A Vector (When count = 0)
;
IN?:    BRINS INOK      ;WAIT FOR INSERTION SWITCHES TO CLOSE
                                        DW 0E0F1H       ;Branch if Flume Inserted to
                                        DW INOK         ;Address
        JUMP IN?
```

```
 312     00??'   28              +                       DB 28H          ;Jump To PPC at
 313     009B'   0096'           +                       DW IN?          ;Address
 314
 315     009D'                   INOK:   CLRCTA          ;CLEAR COUNTER A
 316     009D'   A0              +                       DB 0A0H         ;Clear Counter A
 317                                     FLUMIN          ;STOP THE INSERTION
 318     009E'   E0AC            +                       DW 0E0ACH       ;Insert Flume
 319                                     HYDRA           ;HYDRAULIC PUMP OFF
 320     00A0'   E0A8            +                       DW 0E0A8H       ;Pulse Hydraulic Pump Relay
 321                                     SEND 4          ;SEND SIGNAL "4"  (INSERTION OK)
 322     00A2'   3004            +                       DW (3000H + 4)  ;Push Pinger Code on ASTK
 323     00A4'   E024            +                       DW 0E024H       ;Send Pinger Code (on ASTK)
 324                                     JUMP RUN1       ;GO TO "RUN1"
 325     00A6'   28              +                       DB 28H          ;Jump To PPC at
 326     00A7'   00C5'           +                       DW RUN1         ;Address
 327                             ;
 328                             ;
 329                             ;
 330     00A9'                   INBAD:  FLUMIN          ;STOP THE INSERTION
 331     00A9'   E0AC            +                       DW 0E0ACH       ;Insert Flume
 332                                     BRINS INOK+3    ;JUST IN CASE
 333     00AB'   E0F1            +                       DW 0E0F1H       ;Branch if Flume Inserted to
 334     00AD'   00A0'           +                       DW INOK+3               ;Address
 335                             ;
 336                                     HYDRA           ;STOP THE HYDRAULIC PUMP
 337     00AF'   E0A8            +                       DW 0E0A8H       ;Pulse Hydraulic Pump Relay
 338                                     SEND 5          ;SEND SIGNAL "5"  (INSERTION BAD)
 339     00B1'   3005            +                       DW (3000H + 5)  ;Push Pinger Code on ASTK
 340     00B3'   E024            +                       DW 0E024H       ;Send Pinger Code (on ASTK)
 341                             ;
 342                             ;                       ;SET COUNTER 'A' FOR DEFAULT CONTINUATION IF
 343                             ;                       ;SURFACE COMMAND IS NOT RECEIVED WITHIN 5 MIN.
 344                                     SETCTA  012CH, RUN1
 345     00B5'   A1              +                       DB 0A1H
 346     00B6'   012C            +                       DW 012CH                ;Set Counter A (Hex Seconds)
 347     00B8'   00C5'           +                       DW RUN1         ; Counter A Vector (When count = 0000)
 348                             ;
 349                             ;                       ;WAIT FOR SURFACE SIGNAL
 350     00BA'                   RPLY3?: BRCMD1 RUN1     ; CMD "1" = GO TO RUN1
 351     00BA'   E0F8            +                       DW 0E0F8H       ;Branch if XPONDR CMD. 1 Received to
 352     00BC'   00C5'           +                       DW RUN1         ;Address
 353                                     BRCMD2 INSERT   ; CMD "2" = GO TO INSERT TO TRY AGAIN
 354     00BE'   E0F9            +                       DW 0E0F9H       ;Branch if XPONDR CMD. 2 Received to
 355     00C0'   0084'           +                       DW INSERT               ;Address
 356                                     JUMP RPLY3?
 357     00C2'   28              +                       DB 28H          ;Jump To PPC at
 358     00C3'   00BA'           +                       DW RPLY3?               ;Address
 359                             ;
 360                             ;
 361                             ;
 362                             ;*****************************************************************************
 363                             ;
 364                             ;       We are now ready to start the experiment.
 365                             ;
 366                             ;
 367     00C5'                   RUN1:   INITC           ;INITIALIZE
```

```
00C5'  4D            +                          DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
                                        ADON    ;A/D, TRANS, RECORDER ON
00C6'  E031          +                          DW 0E031H       ;A/D ON
                                        TRON
00C8'  E041          +                          DW 0E041H       ;Transmissometer ON
                                        SDON
00CA'  E051          +                          DW 0E051H       ;Sea Data Recorder ON
                                ;
                                ;
                                        WAIT5M  ;MEASURE ZERO VELOCITY FOR 5 MORE MIN.
00CC'  60            +                          DB 60H          ;Go to Sequencer Subroutine
00CD'  0448'         +                          DW W5M
                                ;
                                        CAMERA
00CF'  E0C0          +                          DW 0E0C0H       ;Take a Picture
                                ;
                                        PMPRLY  ;TURN ON PLUME PUMP POWER
00D1'  E0AE          +                          DW 0E0AEH       ;Pulse Water Pump Power Relay
                                ;
                                        PMP1 040H       ;SET PUMP1 = 40H (25%)
00D3'  D2            +                          DB 0D2H         ;Send Data On SAIL Loop 2
00D4'  00D9'         +                          DW ..0000       ;Data List Address
00D6'  28            +                          DB 28H          ;Jump To PPC at
00D7'  00E5'         +                          DW ..0001               ;Address
00D9'  23 50 43 21   +            ..0000:       DB "#PC!P1"
00DD'  50 31         +
00DF'  30 34 30 48   +                  DB '040H'
00E3'  20            +                  DB ' '
00E4'  FF            +                  DB DONE
00E5'                +          ..0001:   L20FF
00E5'  D0            +                          DB 0D0H         ;SAIL Loop 2 Power Off
00E6'  E061          +                          DW 0E061H       ;Set PUMP1 on SPAGE = M1
00E8'  40            +                          DB 040H
                                ;
                                        GOSUB DATRUN    ;DO A DATA SERIES
00E9'  60            +                          DB 60H          ;Go to Sequencer Subroutine
00EA'  0300'         +                          DW DATRUN
                                ;                       ;DATRUN SUB. RETURNS WITH NO CHANGE IN M.V.P. POSITION
                                ;
                                ;
                                ;*****************************************************************************
                                ;
                                ; This marks the end of the first velocity measurement series.
                                ; The second run is started.
                                ;
                                ;*****************************************************************************
                                ;
00EC'                           RUN2:   INITC           ;INITIALIZE
00EC'  4D            +                          DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
                                ;
                                        PMP1 073H       ;SET PUMP1 = 73H (45%)
00ED'  D2            +                          DB 0D2H         ;Send Data On SAIL Loop 2
00EE'  00F3'         +                          DW ..0002       ;Data List Address
00F0'  28            +                          DB 28H          ;Jump To PPC at
00F1'  00FF'         +                          DW ..0003               ;Address
00F3'  23 50 43 21   +            ..0002:       DB "#PC!P1"
```

```
00F7'  50 31          +
00F9'  30 37 33 48    +                DB '073H'
00FD'  20             +                DB ' '
00FE'  FF             +                DB DONE
00FF'                 +        ..0003:   L20FF
00FF'  D0             +                      DB 0D0H          ;SAIL Loop 2 Power Off
0100'  E061           +                      DW 0E061H        ;Set PUMP1 on GPAGE = N1
0102'  73             +                      DB 073H
                                ;
                              GOSUB DATRUN    ;DO A DATA SERIES
0103'  60             +                      DB 60H           ;Go to Sequencer Subroutine
0104'  0300'          +                      DW DATRUN
                                ;             ;DATRUN SUB. RETURNS WITH NO CHANGE IN X,Y,Z POSITION
                                ;
                                ;*****************************************************************************
                                ;
                                ; This marks the end of the second velocity measurement series.
                                ; The third run is started.
                                ;
                                ;*****************************************************************************
                                ;
0106'                           RUN3:   INITC           ;INITIALIZE
0106'  4D             +                      DB 4DH           ;Clear stacks, modes, PPCCNT, Counters
                                ;
                              PMP1 08DH       ;SET PUMP1 = 8DH (55%)
0107'  D2             +                      DB 0D2H          ;Send Data On SAIL Loop 2
0108'  010D'          +                      DW ..0004        ;Data List Address
010A'  28             +                      DB 28H           ;Jump To PPC at
010B'  0119'          +                      DW ..0005                ;Address
010D'  23 50 43 21    +          ..0004:     DB "#PC!P1"
0111'  50 31          +
0113'  30 38 44 48    +                DB '08DH'
0117'  20             +                DB ' '
0118'  FF             +                DB DONE
0119'                 +        ..0005:   L20FF
0119'  D0             +                      DB 0D0H          ;SAIL Loop 2 Power Off
011A'  E061           +                      DW 0E061H        ;Set PUMP1 on GPAGE = N1
011C'  8D             +                      DB 08DH
                                ;
                              GOSUB DATRUN    ;DO A DATA SERIES
011D'  60             +                      DB 60H           ;Go to Sequencer Subroutine
011E'  0300'          +                      DW DATRUN
                                ;             ;DATRUN SUB. RETURNS WITH NO CHANGE IN X,Y,Z POSITION
                                ;
                                ;*****************************************************************************
                                ;
                                ; This marks the end of the third velocity measurement series.
                                ; The fourth run is started.
                                ;
                                ;*****************************************************************************
                                ;
0120'                           RUN4:   INITC           ;INITIALIZE
0120'  4D             +                      DB 4DH           ;Clear stacks, modes, PPCCNT, Counters
                                ;
```

```
                                        PMP1 040H       ;SET PUMP2 = 40H (25%)
0121'  D2               +                               DB 0D2H         ;Send Data On SAIL Loop 2
0122'  0127'            +                               DW ..0006       ;Data List Address
0124'  28               +                               DB 28H          ;Jump To PPC at
0125'  0133'            +                               DW ..0007               ;Address
0127'  23 50 43 21      +                 ..0006:       DB "#PC!P1"
012B'  50 31            +
012D'  30 34 30 48      +                       DB '040H'
0131'  20               +                       DB ' '
0132'  FF               +                       DB DONE
0133'                   +                 ..0007:     L2OFF
0133'  D0               +                               DB 0D0H         ;SAIL Loop 2 Power Off
0134'  E061             +                               DW 0E061H       ;Set PUMP1 on GPAGE = N1
0136'  40               +                               DB 040H
                                        GOSUB DRUNY     ;DO A DATA SERIES
0137'  60               +                               DB 60H          ;Go to Sequencer Subroutine
0138'  0368'            +                               DW DRUNY
                                                        ;DATRUN SUB. RETURNS WITH CHANGE IN Y POSITION
                                ;
                                ;
                                ;*******************************************************************************
                                ;
                                ; This marks the end of the last velocity measurement series.
                                ;
                                ;*******************************************************************************
                                ;
                                        INITC           ;INITIALIZE
013A'  4D               +                               DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
                                        PMPOFF          ;TURN OFF BOTH PUMPS
013B'  D2               +                               DB 0D2H         ;Send Data On SAIL Loop 2
013C'  0141'            +                               DW ..0008       ;Data List Address
013E'  28               +                               DB 28H          ;Jump To PPC at
013F'  0146'            +                               DW ..0009               ;Address
0141'  23 50 43 58      +                 ..0008:       DB "#PCX"
0145'  FF               +                       DB DONE
0146'                   +                 ..0009:  L2OFF
0146'  D0               +                               DB 0D0H         ;SAIL Loop 2 Power Off
0147'  E060             +                               DW 0E060H       ;Set PUMP1,2 on GPAGE = 00
                                        PMPRLY          ;TURN OFF PUMP POWER RELAY
0149'  E0AE             +                               DW 0E0AEH       ;Pulse Water Pump Power Relay
                                ;
                                ;
                                ;*******************************************************************************
                                ;
                                        PUSH 1, 01EH    ;WAIT 30 MIN
014B'  30               +                               DB (2FH + 1)    ;Push Data on ASTK
014C'  1E               +                               DB 01EH
                                        WAITF MIN
014D'  82               +                               DB 82H          ;Wait for interval of Min on ASTK
                                ;
                                        CAMERA
014E'  E0C0             +                               DW 0E0C0H       ;Take a Picture
                                ;
                                ;       Velocity data series is now done.  We are ready to take both cores.
                                ;
```

```
                                        ;
                                SEND 6          ;SIGNAL START OF CORE
0150'  3006             +               DW (3000H + 6)  ;Push Pinger Code on ASTK
0152'  E024             +               DW 0E024H       ;Send Pinger Code (on ASTK)
                                        ;
                                HYDRA           ;START THE HYDRAULIC PUMP
0154'  E0A8             +               DW 0E0A8H       ;Pulse Hydraulic Pump Relay
                                        ;
                                SEDINS 1        ;START SEDIMENT 1 INSERT
0156'  E0A1             +               DW 0E0A1H       ;Insert Sediment Sampler #1
                                WAIT20
0158'  60               +               DB 60H          ;Go to Sequencer Subroutine
0159'  0409'            +               DW W20
                                WAIT30          ;WAIT 30 SEC
015B'  60               +               DB 60H          ;Go to Sequencer Subroutine
015C'  041B'            +               DW W30
                                SEDINS 1        ;STOP SEDIMENT 1 INSERT
015E'  E0A1             +               DW 0E0A1H       ;Insert Sediment Sampler #1
                                        ;
                                SEDUNL 1        ;UNLATCH CLOSES THE CORE BOX AND TAKES A WATER SAMPLE
0160'  E0A3             +               DW 0E0A3H       ;Unlatch Sed. Sampler #1, Sample H2O-1
                                WAIT30          ;WAIT 30 TO LET HYDRAULIC PRES. BUILD
0162'  60               +               DB 60H          ;Go to Sequencer Subroutine
0163'  041B'            +               DW W30
                                SEDUNL 1        ;2nd UNLATCH TURNS OFF THE UNLATCH POWER
0165'  E0A3             +               DW 0E0A3H       ;Unlatch Sed. Sampler #1, Sample H2O-1
                                        ;
                                SEDRET 1        ;START SEDIMENT 1 RETRACT
0167'  E0A2             +               DW 0E0A2H       ;Retract Sediment Sampler #1
                                WAIT20
0169'  60               +               DB 60H          ;Go to Sequencer Subroutine
016A'  0409'            +               DW W20
                                WAIT30          ;WAIT 30 SEC
016C'  60               +               DB 60H          ;Go to Sequencer Subroutine
016D'  041B'            +               DW W30
                                SEDRET 1        ;STOP SEDIMENT 1 RETRACT
016F'  E0A2             +               DW 0E0A2H       ;Retract Sediment Sampler #1
                                        ;
                                        ;
                                        ;
                                SEDINS 2        ;START SEDIMENT 2 INSERT
0171'  E0A5             +               DW 0E0A5H       ;Insert Sediment Sampler #2
                                WAIT20
0173'  60               +               DB 60H          ;Go to Sequencer Subroutine
0174'  0409'            +               DW W20
                                WAIT30          ;WAIT 30 SEC
0176'  60               +               DB 60H          ;Go to Sequencer Subroutine
0177'  041B'            +               DW W30
                                SEDINS 2        ;STOP SEDIMENT 2 INSERT
0179'  E0A5             +               DW 0E0A5H       ;Insert Sediment Sampler #2
                                        ;
                                SEDUNL 2        ;UNLATCH CLOSES THE CORE BOX AND TAKES A WATER SAMPLE
017B'  E0A7             +               DW 0E0A7H       ;Unlatch Sed. Sampler #2, Sample H2O-2
                                WAIT30          ;WAIT 30 TO LET HYDRAULIC PRES. BUILD
017D'  60               +               DB 60H          ;Go to Sequencer Subroutine
017E'  041B'            +               DW W30
```

```
                                        SEDUNL 2        ;2nd UNLATCH TURNS OFF THE UNLATCH POWER
0180'   E0A7            +                               DW 0E0A7H       ;Unlatch Sed. Sampler #2, Sample H20-2
                                ;
                                        SEDRET 2        ;START SEDIMENT 2 RETRACT
0182'   E0A6            +                               DW 0E0A6H       ;Retract Sediment Sampler #2
                                        WAIT20
0184'   60              +                               DB 60H          ;Go to Sequencer Subroutine
0185'   0409'            +                               DW W20
                                        WAIT30          ;WAIT 30 SEC
0187'   60              +                               DB 60H          ;Go to Sequencer Subroutine
0188'   041B'           +                               DW W30
                                        SEDRET 2        ;STOP SEDIMENT 2 RETRACT
018A'   E0A6            +                               DW 0E0A6H       ;Retract Sediment Sampler #2
                                ;
                                        HYDRA           ;STOP THE HYDRAULIC PUMP
018C'   E0A8            +                               DW 0E0A8H       ;Pulse Hydraulic Pump Relay
                                ;
                                ;
                                ;*******************************************************************************
                                ;
                                ;       Move X near to Xo.
                                ;
                                        HYDRA           ;START THE HYDRAULIC PUMP
018E'   E0A8            +                               DW 0E0A8H       ;Pulse Hydraulic Pump Relay
0190'   E091                    DW 0E091H       ;MOVE X-
                                        WAIT30
0192'   60              +                               DB 60H          ;Go to Sequencer Subroutine
0193'   041B'           +                               DW W30
                                        WAIT10
0195'   60              +                               DB 60H          ;Go to Sequencer Subroutine
0196'   0400'           +                               DW W10
0198'   E091                    DW 0E091H       ;MOVE X-
                                        HYDRA           ;STOP THE HYDRAULIC PUMP
019A'   E0A8            +                               DW 0E0A8H       ;Pulse Hydraulic Pump Relay
                                ;
                                        CAMERA
019C'   E0C0            +                               DW 0E0C0H       ;Take a Picture
                                ;
                                ;
                                ;       We are ready to retract the flume.  Signal "3" is sent to the
                                ; surface. Then the retraction attempt is made.  When the flume retracted
                                ; sense switch is closed, Signal "3" is sent and retraction is stopped.
                                ;       If retraction is not achieved within 6 Min., the "retraction bad
                                ; (Sig. "5")" is sent.  We then wait for a surface reply.  CMD "1" will
                                ; direct the program to the "FINI" routine;  CMD"2" will continue retraction.
                                ;
                                ;
                                ;
019E'                           RETRCT: INITC
019E'   4D              +                               DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
                                        SEND 3          ;SEND SIGNAL "3" - START OF RETRACTION
019F'   3003            +                               DW (3000H + 3)  ;Push Pinger Code on ASTK
01A1'   E024            +                               DW 0E024H       ;Send Pinger Code (on ASTK)
                                        HYDRA           ;START THE HYDRAULIC PUMP
01A3'   E0A8            +                               DW 0E0A8H       ;Pulse Hydraulic Pump Relay
                                        FLUMOUT         ;RETRACT THE FLUME
```

```
 648    01A5'   E0AD        +                       DW 0E0ADH       ;Retract Flume
 649                        ;
 650                                SETCTA 01E0H, RETBAD    ;SET TIME OUT COUNTER FOR 8 MIN.
 651    01A7'   A1          +                       DB 0A1H
 652    01A8'   01E0        +                       DW 01E0H                ;Set Counter A (Hex Seconds)
 653    01AA'   01BF'       +                       DW RETBAD               ; Counter A Vector (When count = 0000
 654                        ;
 655    01AC'               RET?:   BRRET   RETOK
 656    01AC'   E0F2        +                       DW 0E0F2H       ;Branch if Flume Retracted to
 657    01AE'   01B3'       +                       DW RETOK                ;Address
 658                                JUMP    RET?
 659    01B0'   28          +                       DB 28H          ;Jump To PPC at
 660    01B1'   01AC'       +                       DW RET?         ;Address
 661                        ;
 662    01B3'               RETOK:  CLRCTA          ;CLEAR THE TIME OUT COUNTER
 663    01B3'   A0          +                       DB 0A0H         ;Clear Counter A
 664                                FLUMOUT         ;STOP THE RETRACTION
 665    01B4'   E0AD        +                       DW 0E0ADH       ;Retract Flume
 666                                HYDRA           ;STOP THE HYDRAULIC PUMP
 667    01B6'   E0A8        +                       DW 0E0A8H       ;Pulse Hydraulic Pump Relay
 668                                SEND 4          ;SEND SIGNAL "4" - RETRACTION OK
 669    01B8'   3004        +                       DW (3000H + 4)  ;Push Pinger Code on ASTK
 670    01BA'   E024        +                       DW 0E024H       ;Send Pinger Code (on ASTK)
 671                                JUMP SETTLE
 672    01BC'   28          +                       DB 28H          ;Jump To PPC at
 673    01BD'   01DB'       +                       DW SETTLE               ;Address
 674                        ;
 675                        ;
 676    01BF'               RETBAD: FLUMOUT         ;STOP THE RETRACTION
 677    01BF'   E0AD        +                       DW 0E0ADH       ;Retract Flume
 678                                BRRET RETOK+3   ;JUST IN CASE
 679    01C1'   E0F2        +                       DW 0E0F2H       ;Branch if Flume Retracted to
 680    01C3'   01B6'       +                       DW RETOK+3              ;Address
 681                        ;
 682                                HYDRA           ;STOP THE HYDRAULIC PUMP
 683    01C5'   E0A8        +                       DW 0E0A8H       ;Pulse Hydraulic Pump Relay
 684                                SEND 5          ;SEND SIGNAL "5"  (RETRACTION BAD)
 685    01C7'   3005        +                       DW (3000H + 5)  ;Push Pinger Code on ASTK
 686    01C9'   E024        +                       DW 0E024H       ;Send Pinger Code (on ASTK)
 687                        ;
 688                        ;                       ;SET COUNTER 'A' FOR DEFAULT CONTINUATION IF
 689                        ;                       ;SURFACE COMMAND IS NOT RECEIVED WITHIN 6 MIN.
 690                                SETCTA  0168H, SETTLE
 691    01CB'   A1          +                       DB 0A1H
 692    01CC'   0168        +                       DW 0168H                ;Set Counter A (Hex Seconds)
 693    01CE'   01DB'       +                       DW SETTLE               ; Counter A Vector (When count = 0000
 694                        ;
 695                        ;
 696                        ;                       ;WAIT FOR SURFACE SIGNAL
 697    01D0'               RPLY4?: BRCMD1 SETTLE   ; CMD "1" = GO SETTLE
 698    01D0'   E0F8        +                       DW 0E0F8H       ;Branch if XPONDR CMD. 1 Received to
 699    01D2'   01DB'       +                       DW SETTLE               ;Address
 700                                BRCMD2 RETRCT   ; CMD "2" = GO TO RETRACT AGAIN
 701    01D4'   E0F9        +                       DW 0E0F9H       ;Branch if XPONDR CMD. 2 Received to
 702    01D6'   019E'       +                       DW RETRCT               ;Address
 703                                JUMP RPLY4?
```

```
 704    01D8'  28          +                       DB 28H          ;Jump To PPC at
 705    01D9'  01D0'       +                       DW RPLY4?               ;Address
 706                             ;
 707                             ;
 708                             ;
 709                             ;*******************************************************************************
 710                             ;
 711                             ;       At this point the flume is retracted.  Now we will wait 3 min. for
 712                             ;the water to clear.
 713                             ;
 714    01DB'                    SETTLE: INITC
 715    01DB'  4D          +                       DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
 716                                    CAMERA          ;TAKE A PICTURE
 717    01DC'  E0C0        +                       DW 0E0C0H       ;Take a Picture
 718                             ;
 719                                    WAIT59          ;WAIT FOR 1 MIN.
 720    01DE'  60          +                       DB 60H          ;Go to Sequencer Subroutine
 721    01DF'  0424'       +                       DW W59
 722                                    CAMERA          ;TAKE A PICTURE
 723    01E1'  E0C0        +                       DW 0E0C0H       ;Take a Picture
 724                             ;
 725                                    WAIT59          ;WAIT FOR 1 MIN.
 726    01E3'  60          +                       DB 60H          ;Go to Sequencer Subroutine
 727    01E4'  0424'       +                       DW W59
 728                                    CAMERA          ;TAKE A PICTURE
 729    01E6'  E0C0        +                       DW 0E0C0H       ;Take a Picture
 730                             ;
 731                                    WAIT59          ;WAIT FOR 1 MIN.
 732    01E8'  60          +                       DB 60H          ;Go to Sequencer Subroutine
 733    01E9'  0424'       +                       DW W59
 734                                    CAMERA          ;TAKE A PICTURE
 735    01EB'  E0C0        +                       DW 0E0C0H       ;Take a Picture
 736                             ;
 737                             ;
 738                             ;
 739                             ;*******************************************************************************
 740                             ;
 741                             ;       Here we return to the surface. Haul it up.
 742                             ;
 743                             ;
 744    01ED'                    FINI:   INITC           ;INITIALIZE JUST IN CASE
 745    01ED'  4D          +                       DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
 746                                    SEND F          ;SEND SIGNAL "F" - HAUL IT UP
 747    01EE'  300F        +                       DW (3000H + F)  ;Push Pinger Code on ASTK
 748    01F0'  E024        +                       DW 0E024H       ;Send Pinger Code (on ASTK)
 749                             ;
 750                             ;
 751    01F2'                    GOHOME: NOOP
 752    01F2'  C4          +                       DB 0C4H         ;No Operation
 753                                    BRBOT   GOHOME
 754    01F3'  E0F0        +                       DW 0E0F0H       ;Branch if Bottom Sw to
 755    01F5'  01F2'       +                       DW GOHOME               ;Address
 756                             ;
 757                             ;
 758    01F7'                    MOVING: SEND 8          ;On the way up!
 759    01F7'  3008        +                       DW (3000H + 8)  ;Push Pinger Code on ASTK
```

```
 760    01F9'  E024          +                          DW 0E024H       ;Send Pinger Code (on ASTK)
 761                         ;
 762                         ;*******************************************************************************
 763                         ;
 764                         ;
 765                         ;
 766                         ;
 767    01FB'                STOP:   NOOP               ;END OF DIVE IDLE LOOP
 768    01FB'  C4            +                          DB 0C4H         ;No Operation
 769                                 JUMP STOP
 770    01FC'  28            +                          DB 28H          ;Jump To FPC at
 771    01FD'  01FB'         +                          DW STOP         ;Address
 772                         ;
 773                         ;
 774                         ;
 775                         ;
 776                         ;********************** END OF SEQUENCER MAIN PROGRAM **********************
 777                         ;
 778                         PAGE
```

```
                        ;*************************** Sequencer Subroutines ****************************
                        ;
01FF'                   CSEG
                                ORG (START + 0300H)
                        ;
                        ;******************************************************************************
                        ;
                    C           INCLUDE ISDDAT7.MAC     ;Include Sea Duct Data series subroutine
                    C   ;
                    C   ;********************** DATA SERIES SUBROUTINE *********************************
                    C   ;
                    C   ;ISDDAT7.MAC   19 SEP 86
                    C   ;
                    C   ;
0300'               C   DATRUM: WAIT60          ;TAKE DATA WITH FLUME PUMP ON FOR 25 MIN.
0300'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0301'   042D'       C+                          DW W60
                    C           WAIT59          ;2
0303'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0304'   0424'       C+                          DW W59
                    C           CAMERA
0306'   E0C0        C+                          DW 0E0C0H       ;Take a Picture
                    C   ;
                    C           WAIT60
0308'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0309'   042D'       C+                          DW W60
                    C           WAIT59          ;4
030B'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
030C'   0424'       C+                          DW W59
                    C           CAMERA
030E'   E0C0        C+                          DW 0E0C0H       ;Take a Picture
                    C   ;
                    C           WAIT60
0310'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0311'   042D'       C+                          DW W60
                    C           WAIT59          ;6
0313'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0314'   0424'       C+                          DW W59
                    C           CAMERA
0316'   E0C0        C+                          DW 0E0C0H       ;Take a Picture
                    C   ;
                    C           WAIT60
0318'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0319'   042D'       C+                          DW W60
                    C           WAIT59          ;8
031B'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
031C'   0424'       C+                          DW W59
                    C           CAMERA
031E'   E0C0        C+                          DW 0E0C0H       ;Take a Picture
                    C   ;
                    C           WAIT60
0320'   60          C+                          DB 60H          ;Go to Sequencer Subroutine
0321'   042D'       C+                          DW W60
```

```
                                C
                                C+
                                C+
                                C
                                C+
                                C       ;
                                C
                                C+
                                C+
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                                C+
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                                C+
                                C       ;
                                C
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                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0323'  60                       C+
0324'  0424'                    C+
                                C
                                C+
0326'  E0C0                     C+
                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0328'  60                       C+
0329'  042D'                    C+
                                C
                                C+
032B'  60                       C+
032C'  0424'                    C+
                                C
                                C+
032E'  E0C0                     C+
                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0330'  60                       C+
0331'  042D'                    C+
                                C
                                C+
0333'  60                       C+
0334'  0424'                    C+
                                C
                                C+
0336'  E0C0                     C+
                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0338'  60                       C+
0339'  042D'                    C+
                                C
                                C+
033B'  60                       C+
033C'  0424'                    C+
                                C
                                C+
033E'  E0C0                     C+
                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0340'  60                       C+
0341'  042D'                    C+
                                C
                                C+
0343'  60                       C+
0344'  0424'                    C+
                                C
                                C+
0346'  E0C0                     C+
                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0348'  60                       C+
0349'  042D'                    C+
                                C
                                C+
034B'  60                       C+
034C'  0424'                    C+
                                C
                                C+
034E'  E0C0                     C+
                                C       ;
                                C
                                C+
                                C+
                                C
                                C+
0350'  60                       C+
0351'  042D'                    C+
                                C
                                C+
0353'  60                       C+

WAIT59          ;10
                DB 60H          ;Go to Sequencer Subroutine
                DW W59

CAMERA
                DW 0E0C0H       ;Take a Picture

WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60

WAIT59          ;12
                DB 60H          ;Go to Sequencer Subroutine
                DW W59

CAMERA
                DW 0E0C0H       ;Take a Picture

WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60

WAIT59          ;14
                DB 60H          ;Go to Sequencer Subroutine
                DW W59

CAMERA
                DW 0E0C0H       ;Take a Picture

WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60

WAIT59          ;16
                DB 60H          ;Go to Sequencer Subroutine
                DW W59

CAMERA
                DW 0E0C0H       ;Take a Picture

WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60

WAIT59          ;18
                DB 60H          ;Go to Sequencer Subroutine
                DW W59

CAMERA
                DW 0E0C0H       ;Take a Picture

WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60

WAIT59          ;20d
                DB 60H          ;Go to Sequencer Subroutine
                DW W59

CAMERA
                DW 0E0C0H       ;Take a Picture

WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60

WAIT59          ;22
                DB 60H          ;Go to Sequencer Subroutine
```

```
 890     0354'   0424'          C+                              DW W59
 891                            C               CAMERA
 892     0356'   E0C0           C+                              DW 0E0C0H       ;Take a Picture
 893                            C       ;
 894                            C               WAIT60
 895     0358'   60             C+                              DB 60H          ;Go to Sequencer Subroutine
 896     0359'   042D'           C+                              DW W60
 897                            C               WAIT59          ;24d Min.
 898     035B'   60             C+                              DB 60H          ;Go to Sequencer Subroutine
 899     035C'   0424'          C+                              DW W59
 900                            C               CAMERA
 901     035E'   E0C0           C+                              DW 0E0C0H       ;Take a Picture
 902                            C       ;
 903                            C               WAIT30          ;25 Min.
 904     0360'   60             C+                              DB 60H          ;Go to Sequencer Subroutine
 905     0361'   041B'           C+                              DW W30
 906                            C       ;
 907                            C               SEND 7          ;SEND SIG. 7 END OF VELOCITY RUN
 908     0363'   3007           C+                              DW (3000H + 7)  ;Push Pinger Code on ASTK
 909     0365'   E024           C+                              DW 0E024H       ;Send Pinger Code (on ASTK)
 910                            C       ;
 911                            C               RETURN
 912     0367'   58             C+                              DB 58H          ;Return from Sequencer Subroutine
 913                            C       ;
 914                                    ;
 915                                    ;*******************************************************************************
 916                                    ;
 917                                    ;
 918     0368'                          DRUNY:  WAIT60
 919     0368'   60              +                              DB 60H          ;Go to Sequencer Subroutine
 920     0369'   042D'           +                              DW W60
 921                                            WAIT59
 922     036B'   60              +                              DB 60H          ;Go to Sequencer Subroutine
 923     036C'   0424'           +                              DW W59
 924                                            CAMERA
 925     036E'   E0C0            +                              DW 0E0C0H       ;Take a Picture
 926                                    ;2
 927                                            WAIT60
 928     0370'   60              +                              DB 60H          ;Go to Sequencer Subroutine
 929     0371'   042D'           +                              DW W60
 930                                            WAIT59
 931     0373'   60              +                              DB 60H          ;Go to Sequencer Subroutine
 932     0374'   0424'           +                              DW W59
 933                                            CAMERA
 934     0376'   E0C0            +                              DW 0E0C0H       ;Take a Picture
 935                                    ;4
 936                                            WAIT60
 937     0378'   60              +                              DB 60H          ;Go to Sequencer Subroutine
 938     0379'   042D'           +                              DW W60
 939                                            WAIT59
 940     037B'   60              +                              DB 60H          ;Go to Sequencer Subroutine
 941     037C'   0424'           +                              DW W59
 942                                            CAMERA
 943     037E'   E0C0            +                              DW 0E0C0H       ;Take a Picture
 944                                    ;6
 945                                            WAIT60
```

```
946     0380'   60          +
947     0381'   042D'        +
948
949     0383'   60          +
950     0384'   0424'        +
951
952     0386'   E0C0        +
953                                 ;8
954
955     0388'   E0A8        +
956     038A'   E093
957
958     038C'   60          +
959     038D'   0409'        +
960     038F'   E093
961
962     0391'   E0A8        +
963                                 ;
964
965     0393'   60          +
966     0394'   042D'        +
967
968     0396'   60          +
969     0397'   0424'        +
970
971     0399'   E0C0        +
972                                 ;2
973
974     039B'   60          +
975     039C'   042D'        +
976
977     039E'   60          +
978     039F'   0424'        +
979
980     03A1'   E0C0        +
981                                 ;4
982
983     03A3'   60          +
984     03A4'   042D'        +
985
986     03A6'   60          +
987     03A7'   0424'        +
988
989     03A9'   E0C0        +
990                                 ;6
991
992     03AB'   60          +
993     03AC'   042D'        +
994
995     03AE'   60          +
996     03AF'   0424'        +
997
998     03B1'   E0C0        +
999                                 ;8
1000
1001    03B3'   E0A8        +
```

```
                DB 60H          ;Go to Sequencer Subroutine
                DW W60
WAIT59
                DB 60H          ;Go to Sequencer Subroutine
                DW W59
CAMERA
                DW 0E0C0H       ;Take a Picture
HYDRA           ;MOVE TO Y ZERO
                DW 0E0A8H       ;Pulse Hydraulic Pump Relay
DW 0E093H
WAIT20
                DB 60H          ;Go to Sequencer Subroutine
                DW W20
DW 0E093H
HYDRA
                DW 0E0A8H       ;Pulse Hydraulic Pump Relay
WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60
WAIT59
                DB 60H          ;Go to Sequencer Subroutine
                DW W59
CAMERA
                DW 0E0C0H       ;Take a Picture
WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60
WAIT59
                DB 60H          ;Go to Sequencer Subroutine
                DW W59
CAMERA
                DW 0E0C0H       ;Take a Picture
WAIT60
                DB 60H          ;Go to Sequencer Subroutine
                DW W60
WAIT59
                DB 60H          ;Go to Sequencer Subroutine
                DW W59
CAMERA
                DW 0E0C0H       ;Take a Picture
HYDRA           ;MOVE TO Y3
                DW 0E0A8H       ;Pulse Hydraulic Pump Relay
```

```
1002    03B5'  E092                    DW 0E092H
1003                                   WAIT20
1004    03B7'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1005    03B8'  0409'       +                   DW W20
1006    03BA'  E092                    DW 0E092H
1007                                   HYDRA
1008    03BC'  E0A8        +                   DW 0E0A8H       ;Pulse Hydraulic Pump Relay
1009                               ;
1010                                   WAIT60
1011    03BE'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1012    03BF'  042D'       +                   DW W60
1013                                   WAIT59
1014    03C1'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1015    03C2'  0424'       +                   DW W59
1016                                   CAMERA
1017    03C4'  E0C0        +                   DW 0E0C0H       ;Take a Picture
1018                               ;2
1019                                   WAIT60
1020    03C6'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1021    03C7'  042D'       +                   DW W60
1022                                   WAIT59
1023    03C9'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1024    03CA'  0424'       +                   DW W59
1025                                   CAMERA
1026    03CC'  E0C0        +                   DW 0E0C0H       ;Take a Picture
1027                               ;4
1028                                   WAIT60
1029    03CE'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1030    03CF'  042D'       +                   DW W60
1031                                   WAIT59
1032    03D1'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1033    03D2'  0424'       +                   DW W59
1034                                   CAMERA
1035    03D4'  E0C0        +                   DW 0E0C0H       ;Take a Picture
1036                               ;6
1037                                   WAIT60
1038    03D6'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1039    03D7'  042D'       +                   DW W60
1040                                   WAIT59
1041    03D9'  60          +                   DB 60H          ;Go to Sequencer Subroutine
1042    03DA'  0424'       +                   DW W59
1043                                   CAMERA
1044    03DC'  E0C0        +                   DW 0E0C0H       ;Take a Picture
1045                               ;8
1046                               ;
1047                                   RETURN
1048    03DE'  58          +                   DB 58H          ;Return from Sequencer Subroutine
1049                               ;
1050                               ;
1051                               ;
1052                               PAGE
```

```
1053
1054                                    ;
1055                                    ;********** SEQUENCER MACRO SUBROUTINES **********************************
1056                                    ;
1057    03DF'                           CSEG
1058                                            ORG (START + 0400H)
1059                                    ;
1060                            C               INCLUDE ISDSUB.MAC      ;Include Sea Duct Macro Subroutines
1061                            C
1062                            C       ;*******************************************************************************
1063                            C       ;
1064                            C       ;       SEQUENCER MACRO SUBROUTINES
1065                            C       ;
1066                            C               SUBTTL ISDSUB 15 JUL 86
1067                            C       ;
1068                            C       ;       This file must be included at the end of a Sequencer Macro Program
1069                            C       ;         Use "INCLUDE ISDSUB.MAC"
1070                            C       ;
1071                            C       ;*******************************************************************************
1072                            C       ;
1073    0400'                   C               CSEG    ; Change to Code Segment
1074                            C       ;
1075                            C       ; Note: W10 - W60 allow for the call and return times.
1076                            C       ;    ie. W10 is set for 8 sec.
1077                            C       ;
1078    0400'                   C       W10:    SETCTC 0008, $+5        ;Wait for 10 Sec.
1079    0400'   C1              C+                                      DB 0C1H
1080    0401'   0008            C+                                      DW 0008         ;Set Counter C (Hex Seconds)
1081    0403'   0408'           C+                                      DW $+5          ; Counter C Vector (When count = 0000)
1082                            C               JUMP $-1
1083    0405'   28              C+                                      DB 28H          ;Jump To PPC at
1084    0406'   0405'           C+                                      DW $-1          ;Address
1085                            C               RETURN
1086    0408'   58              C+                                      DB 58H          ;Return from Sequencer Subroutine
1087                            C       ;
1088                            C       ;
1089    0409'                   C       W20:    SETCTC 0012, $+5        ;Wait for 20 Sec.
1090    0409'   C1              C+                                      DB 0C1H
1091    040A'   0012            C+                                      DW 0012         ;Set Counter C (Hex Seconds)
1092    040C'   0411'           C+                                      DW $+5          ; Counter C Vector (When count = 0000)
1093                            C               JUMP $-1
1094    040E'   28              C+                                      DB 28H          ;Jump To PPC at
1095    040F'   040E'           C+                                      DW $-1          ;Address
1096                            C               RETURN
1097    0411'   58              C+                                      DB 58H          ;Return from Sequencer Subroutine
1098                            C       ;
1099                            C       ;
1100    0412'                   C       W29:    SETCTC 001B, $+5        ;Wait for 29 Sec.
1101    0412'   C1              C+                                      DB 0C1H
1102    0413'   001B            C+                                      DW 001B         ;Set Counter C (Hex Seconds)
1103    0415'   041A'           C+                                      DW $+5          ; Counter C Vector (When count = 0000)
1104                            C               JUMP $-1
1105    0417'   28              C+                                      DB 28H          ;Jump To PPC at
1106    0418'   0417'           C+                                      DW $-1          ;Address
1107                            C               RETURN
```

```
1108    041A'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1109                       C       ;
1110                       C       ;
1111    041B'              C       W30:    SETCTC 001C, $+5        ;Wait for 30 Sec.
1112    041B'  C1          C+                          DB 0C1H
1113    041C'  001C        C+                          DW 001C         ;Set Counter C (Hex Seconds)
1114    041E'  0423'       C+                          DW $+5          ; Counter C Vector (When count = 0000)
1115                       C               JUMP $-1
1116    0420'  28          C+                          DB 28H          ;Jump To PPC at
1117    0421'  0420'       C+                          DW $-1          ;Address
1118                       C               RETURN
1119    0423'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1120                       C       ;
1121                       C       ;
1122    0424'              C       W59:    SETCTC 0039, $+5        ;Wait for 59 Sec.
1123    0424'  C1          C+                          DB 0C1H
1124    0425'  0039        C+                          DW 0039         ;Set Counter C (Hex Seconds)
1125    0427'  042C'       C+                          DW $+5          ; Counter C Vector (When count = 0000
1126                       C               JUMP $-1
1127    0429'  28          C+                          DB 28H          ;Jump To PPC at
1128    042A'  0429'       C+                          DW $-1          ;Address
1129                       C               RETURN
1130    042C'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1131                       C       ;
1132                       C       ;
1133    042D'              C       W60:    SETCTC 003A, $+5        ;Wait for 60 Sec.
1134    042D'  C1          C+                          DB 0C1H
1135    042E'  003A        C+                          DW 003A         ;Set Counter C (Hex Seconds)
1136    0430'  0435'       C+                          DW $+5          ; Counter C Vector  When count = 0000
1137                       C               JUMP $-1
1138    0432'  28          C+                          DB 28H          ;Jump To PPC at
1139    0433'  0432'       C+                          DW $-1          ;Address
1140                       C               RETURN
1141    0435'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1142                       C       ;
1143                       C       ;
1144                       C       ;
1145    0436'              C       W1M:    SETCTC 003A, $+5        ;Wait for 1 MIN.
1146    0436'  C1          C+                          DB 0C1H
1147    0437'  003A        C+                          DW 003A         ;Set Counter C  Hex Seconds)
1148    0439'  043E'       C+                          DW $+5          ; Counter C Vector  When count = 0000
1149                       C               JUMP $-1
1150    043B'  28          C+                          DB 28H          ;Jump To PPC at
1151    043C'  043B'       C+                          DW $-1          ;Address
1152                       C               RETURN
1153    043E'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1154                       C       ;
1155                       C       ;
1156    043F'              C       W2M:    SETCTC 0076, $+5        ;Wait for 2 MIN.
1157    043F'  C1          C+                          DB 0C1H
1158    0440'  0076        C+                          DW 0076         ;Set Counter C (Hex Seconds)
1159    0442'  0447'       C+                          DW $+5          ; Counter C Vector (When count = 0000)
1160                       C               JUMP $-1
1161    0444'  28          C+                          DB 28H          ;Jump To PPC at
1162    0445'  0444'       C+                          DW $-1          ;Address
1163                       C               RETURN
```

```
1164  0447'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1165                     C     ;
1166                     C     ;
1167  0448'              C     W5M:   SETCTC 012A, $+5        ;Wait for 5 MIN.
1168  0448'  C1          C+                          DB 0C1H
1169  0449'  012A        C+                          DW 012A         ;Set Counter C (Hex Seconds)
1170  044B'  0450'       C+                          DW $+5          ; Counter C Vector (When count = 0000)
1171                     C             JUMP $-1
1172  044D'  28          C+                          DB 28H          ;Jump To PPC at
1173  044E'  044D'       C+                          DW $-1          ;Address
1174                     C             RETURN
1175  0450'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1176                     C     ;
1177                     C     ;
1178  0451'              C     W7M:   SETCTC 01A2, $+5        ;Wait for 7 MIN.
1179  0451'  C1          C+                          DB 0C1H
1180  0452'  01A2        C+                          DW 01A2         ;Set Counter C (Hex Seconds)
1181  0454'  0459'       C+                          DW $+5          ; Counter C Vector (When count = 0000)
1182                     C             JUMP $-1
1183  0456'  28          C+                          DB 28H          ;Jump To PPC at
1184  0457'  0456'       C+                          DW $-1          ;Address
1185                     C             RETURN
1186  0459'  58          C+                          DB 58H          ;Return from Sequencer Subroutine
1187                     C     ;
1188                     C     ;
1189                     C     ;
1190                     C     ;************** END OF SUBROUTINE INCLUDE FILE - ISDSUB ************************
1191                     C     ;
1192                     C     ;*******************************************************************************
1193                     C     ;
1194                     C     ;
1195                           ;
1196                           ;*******************************************************************************
1197                           ;
1198                           ;************************ END OF SEQUENCER PSUEDO PROGRAM ************************
1199                           ;
1200                                 END
```

MACROS:

ADOFF	ADON	BAT	BRBOT	BRCMD1	BRCMD2	BRCMD3	BRINS
BRRET	CAMERA	CHKTLT	CLRABC	CLRCTA	CLRCTB	CLRCTC	FLUMIN
FLUMOU	GOSUB	HYDRA	INCX	INCY	INCZ	INITC	INITS
JUMP	L2OFF	L2ON	L2SEND	LDVRST	NOOP	PING	PMP1
PMP2	PMPOFF	PMPRLY	POP	PUSH	RETURN	ROTCCW	ROTCW
ROTHDG	ROTRTN	SDOFF	SDON	SEDINS	SEDRET	SEDUNL	SEND
SETCTA	SETCTB	SETCTC	SPMP0	SPMP1	SPMP2	TROFF	TRON
WAIT10	WAIT1M	WAIT20	WAIT29	WAIT2M	WAIT30	WAIT59	WAIT5M
WAIT60	WAIT7M	WAITF	WAITT	XYZ0	ZEROX	ZEROY	ZEROZ

SYMBOLS:

..0000	00D9'	..0001	00E5'	..0002	00F3'	..0003	00FF'
..0004	010D'	..0005	0119'	..0006	0127'	..0007	0133'
..0008	0141'	..0009	0146'	A	000A	B	000B
C	000C	D	000D	DATRUN	0300'	DAYS	0001
DIVE	003E'	DONE	00FF	DRUNY	0368'	E	000E
F	000F	FINI	01ED'	GOHOME	01F2'	HOURS	0002
HRS	0002	IN?	0096'	INBAD	00A9'	INOK	009D'
INSERT	0084'	LIFT1	0070'	MIN	0003	MOVING	01F7'
OFFBOT	0075'	ONBOT	004F'	ONBOT?	0047'	RET?	01AC'
RETBAD	01BF'	RETOK	01B3'	RETRCT	019E'	RPLY1?	0065'
RPLY3?	00BA'	RPLY4?	01D0'	RUN1	00C5'	RUN2	00EC'
RUN3	0106'	RUN4	0120'	SEC	0004	SETTLE	01DB'
START	0000'	STOP	01FB'	TCHK1	0041'	TLTIN	005E'
W10	0400'	W1M	0436'	W20	0409'	W29	0412'
W2M	043F'	W30	041B'	W59	0424'	W5M	0448'
W60	042D'	W7M	0451'				

NO FATAL ERROR(S)

..0000 389 392#
..0001 391 397#
..0002 420 423#
..0003 422 428#
..0004 451 454#
..0005 453 459#
..0006 482 485#
..0007 484 490#
..0008 510 513#
..0009 512 515#
A 54#
ADOFF 54#
ADON 54# 99 190 215 369
B 54#
BAT 54# 113 118 125 130 137 142 149 151 153
BRBOT 54# 198 259 753
BRCMD1 54# 241 350 697
BRCMD2 54# 244 353 700
BRCMD3 54#
BRINS 54# 308 332
BRRZT 54# 655 678
C 54#
CAMERA 54# 109 157 222 292 381 531 627 716 722 728 734
801 810 819 828 837 846 855 864 873 882 891 900
924 933 942 951 970 979 988 997 1016 1025 1034 1043
CHKTLT 54# 228
CLRABC 54#
CLRCTA 54# 315 662
CLRCTB 54#
CLRCTC 54#
D 54#
DATRUN 404 435 466 795#
DAYS 54# 186 529
DIVE 182#
DONE 54# 396 427 458 489 514
DRUNY 496 918#
E 54#
F 54# 747 747 747
FINI 744#
FLUMIN 54# 300 317 330
FLUMOU 54# 647 664 676
GOHOME 751# 755
GOSUB 54# 116 121 128 133 140 145 166 225 266 378 402
433 464 494 547 550 558 566 569 579 582 590 598
601 618 621 720 726 732 796 799 805 808 814 817
823 826 832 835 841 844 850 853 859 862 868 871
877 880 886 889 895 898 904 919 922 928 931 937
940 946 949 958 965 968 974 977 983 986 992 995

	1004	1011	1014	1020	1023	1029	1032	1038	1041			
HOURS	54#	186	529									
HRS	54#	54										
HYDRA	54#	298	319	336	541	606	614	624	645	666	682	954
	961	1000	1007									
IN?	308#	313										
INBAD	306	330#										
INCX	54#											
INCY	54#											
INCZ	54#											
INITC	54#	96	252	286	367	415	446	477	506	640	714	744
INITS	54#											
INOK	310	315#	334									
INSERT	237	243	286#	355								
JUMP	54#	201	247	268	311	324	356	390	421	452	483	511
	658	671	703	769	1082	1093	1104	1115	1126	1137	1149	1160
	1171	1182										
L2OFF	54#	397	428	459	490	515						
L2ON	54#											
L2SEND	54#	388	419	450	481	509						
LDVRST	54#	289										
LIFT1	246	252#										
MIN	54#	186	186	186	186	529	529	529	529			
MOVING	758#											
NOOP	54#	196	257	751	767							
OFFBOT	257#	261										
ONBOT	200	211#										
ONBOT?	196#	203	270									
PING	54#	108	162	171	213	256	264	296	323	340	539	644
	670	686	748	760	909							
PMP1	54#	387	418	449	480							
PMP2	54#											
PMPOFF	54#	508										
PMPRLY	54#	384	518									
POP	54#											
PUSH	54#	182	525									
RET?	655#	660										
RETBAD	653	676#										
RETOK	657	662#	680									
RETRCT	640#	702										
RETURN	54#	911	1047	1085	1096	1107	1118	1129	1140	1152	1163	1174
	1185											
ROTCCW	54#											
ROTCW	54#											
ROTHDG	54#											
ROTRTN	54#											
RPLY1?	241#	249										
RPLY3?	350#	358										
RPLY4?	697#	705										

```
RUN1      326     347     352     367#
RUN2      415#
RUN3      446#
RUN4      477#
SDOFF      54#
SDON       54#    103     188     217     373
SEC        54#
SEDINS     54#    544     552     576     584
SEDRET     54#    563     571     595     603
SEDUNL     54#    555     560     587     592
SEND       54#    106     160     169     211     254     262     294     321     338     537     642
          668     684     746     758     907
SETCTA     54#    234     303     344     650     690
SETCTB     54#
SETCTC     54#   1078    1089    1100    1111    1122    1133    1145    1156    1167    1178
SETTLE    673     693     699     714#
SPMP0      54#    517
SPMP1      54#    399     430     461     492
SPMP2      54#
START      96#    783    1058
STOP      767#    771
TCHK1     188#
TLTIN     228#
TROFF      54#
TRON       54#    101     192     219     371
W10       622    1078#
W1M      1145#
W20       117     122     129     134     141     146     226     548     567     580     599     959
         1005    1089#
W29      1100#
W2M       167    1156#
W30       551     559     570     583     591     602     619     905    1111#
W59       721     727     733     800     809     818     827     836     845     854     863     872
          881     890     899     923     932     941     950     969     978     987     996    1015
         1024    1033    1042    1122#
W5M       379    1167#
W60       267     797     806     815     824     833     842     851     860     869     878     887
          896     920     929     938     947     966     975     984     993    1012    1021    1030
         1039    1133#
W7M      1178#
WAIT10     54#    620
WAIT1M     54#
WAIT20     54#    115     120     127     132     139     144     224     546     565     578     597
          957    1003
WAIT29     54#
WAIT2M     54#    165
WAIT30     54#    549     557     568     581     589     600     617     903
WAIT59     54#    719     725     731     798     807     816     825     834     843     852     861
          870     879     888     897     921     930     939     948     967     976     985     994
```

```
        1013    1022    1031    1040
WAIT5M   54#    377
WAIT60   54#    265     795     804     813     822     831     840     849     858     867     876
         885    894     918     927     936     945     964     973     982     991     1010    1019
        1028    1037
WAIT7M   54#
WAITF    54#    185     528
WAITT    54#
XYZ0     54#
ZEROX    54#
ZEROY    54#
ZEROZ    54#
```

```
;       SEA DUCT SEQUENCER PPC MACROS
;
;       ISDSEQ.MAC      15 JUL 1986
;
;       W. E. TERRY
;
;       (Listing Supressed)
        .XLIST
;
;       PREVIOUS VERS.  16 JUN 1986
;       PREVIOUS VERS.  26 MAR 1986
;       PREVIOUS VERS.  25 MAR 1986
;       PREVIOUS VERS.  11 DEC 1985
;       PREVIOUS VERS.  21 NOV 1985
;
;       Earlier versions exist.
;
;
;*****  USED ONLY FOR ASSEMBLY OF SEQUENCER PSUEDO PROGRAM CODES *****
;
;       USE "INCLUDE ISDSEQ.MAC" IN SEQUENCER SOURCE
;
;
;*******************************************************************************
;
;********* BASIC FUNCTIONS ***********************
;
;
JUMP    MACRO P1
                        DB 28H          ;Jump To PPC at
                        DW P1           ;Address
        ENDM
;
;
PUSH    MACRO P0,P1,P2,P3,P4
                        DB (2FH + P0)   ;Push Data on ASTK
           IF P0 EQ 1
                        DB P1
           ELSE
            IF P0 EQ 2
                        DB P1
                        DB P2
            ELSE
             IF P0 EQ 3
               DB P1
               DB P2
               DB P3
             ELSE
              IF P0 EQ 4
               DB P1
               DB P2
               DB P3
                        DB P4
              ELSE
                        DB FQ   ;***** PUSH PARAMETER ERROR *****!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
            ENDIF
           ENDIF
          ENDIF
         ENDIF
        ENDM
;
;
POP     MACRO P0
                DB (3FH + P0)   ;Pop data from ASTK
        IF  (P0 GT 4) OR (P0 LT 1)
                DB FQ   ;***** POP PARAMETER ERROR *****!!!!!!!!!!!!!!!!!!!!!!!!!
        ENDIF
        ENDM
;
;
INITS   MACRO
                DB 4CH          ;Clear stacks, modes, PPCCNT
        ENDM
;
;
INITC   MACRO
                DB 4DH          ;Clear stacks, modes, PPCCNT, Counters
        ENDM
;
;
CLRABC  MACRO
                DB 4EH          ;Clear Counters A, B, C
        ENDM
;
;
RETURN  MACRO
                DB 58H          ;Return from Sequencer Subroutine
        ENDM
;
;
GOSUB   MACRO P1
                DB 60H          ;Go to Sequencer Subroutine
                DW P1
        ENDM
;
;
NOOP    MACRO
                DB 0C4H         ;No Operation
        ENDM
;
;
;********** RTC Macros **********************
;
DAYS    EQU 01
HRS     EQU 02
HOURS   EQU HRS
MIN     EQU 03
SEC     EQU 04
;
WAITT   MACRO P1
```

```
        IF P1 EQ DAYS
                        DB 70H          ;Wait Till Days = ASTK
        ELSE
         IF P1 EQ HOURS
                        DB 71H          ;Wait Till Hours = ASTK
         ELSE
          IF P1 EQ MIN
                        DB 72H          ;Wait Till Min = ASTK
          ELSE
           IF P1 EQ SEC
                        DB 73H          ;Wait Till Sec = ASTK
           ELSE
                        DB 0FQ  ;**** WAIT TILL ERROR ****!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
           ENDIF
          ENDIF
         ENDIF
        ENDIF
        ENDM
;
;
WAITF   MACRO P1
        IF P1 EQ DAYS
                        DB 80H          ;Wait for interval of Days on ASTK
        ELSE
          IF P1 EQ HOURS
                        DB 81H          ;Wait for interval of Hours on ASTK
          ELSE
            IF P1 EQ MIN
                        DB 82H          ;Wait for interval of Min on ASTK
            ELSE
                        DB 0FQ  ;**** WAIT TILL ERROR ****!!!!!!!!!!!!!!!!!!!!!!!!
            ENDIF
          ENDIF
        ENDIF
        ENDM
;
;
;***************** Sequencer Counter Macros **********
;
;*** Note: see INITC  (PPC = 4D)
;            CLRABC (PPC = 4E) above for other clear counter instructions.
;
;
CLRCTA  MACRO
                        DB 0A0H         ;Clear Counter A
        ENDM
;
;
CLRCTB  MACRO
                        DB 0B0H         ;Clear Counter B
        ENDM
;
;
CLRCTC  MACRO
                        DB 0C0H         ;Clear Counter C
```

```
        ENDM
;
;
SETCTA  MACRO P0, P1
                        DB 0A1H
                        DW P0           ;Set Counter A (Hex Seconds)
                        DW P1           ; Counter A Vector (When count = 0000)
        ENDM
;
;
SETCTB  MACRO P0, P1
                        DB 0B1H
                        DW P0           ;Set Counter B (Hex Seconds)
                        DW P1           ; Counter B Vector (When count = 0000)
        ENDM
;
;
SETCTC  MACRO P0, P1
                        DB 0C1H
                        DW P0           ;Set Counter C (Hex Seconds)
                        DW P1           ; Counter C Vector (When count = 0000)
        ENDM
;
;
;
;
;************************* SAIL Loop # 2 Macros *******************************
;
L2OFF   MACRO
                        DB 0D0H         ;SAIL Loop 2 Power Off
        ENDM
;
;
L2ON    MACRO
                        DB 0D1H         ;SAIL Loop 2 Power On
        ENDM
;
;
L2SEND  MACRO P0
                        DB 0D2H         ;Send Data On SAIL Loop 2
                        DW P0           ;Data List Address
        ENDM
;
;
;
;
;******************* EXTENDED SEQUENCER FUNCTIONS ( E0 PREFIX ) ******************
;
;
BAT     MACRO P0
         IF (P0 EQ 1) OR (P0 EQ 2) OR (P0 EQ 3)
                        DW (0E010H + P0)        ;Pulse Main Battery Relay #n
         ELSE
                        DW 0FFFFQ  ; *** Battery Relay Error ***!!!!!!!!!!!!!!!!!!!!!!!!!
         ENDIF
```

```
        ENDM
;
;
ADOFF   MACRO
                        DW 0E030H       ;A/D OFF
        ENDM
;
;
ADON    MACRO
                        DW 0E031H       ;A/D ON
        ENDM
;
;
TROFF   MACRO
                        DW 0E040H       ;Transmissometer OFF
        ENDM
;
;
TRON    MACRO
                        DW 0E041H       ;Transmissometer ON
        ENDM
;
;
SDOFF   MACRO
                        DW 0E050H       ;Sea Data Recorder OFF
        ENDM
;
;
SDON    MACRO
                        DW 0E051H       ;Sea Data Recorder ON
        ENDM
;
;
SPMP0   MACRO
                        DW 0E060H       ;Set PUMP1,2 on GPAGE = 00
        ENDM
;
;
SPMP1   MACRO N1
                        DW 0E061H       ;Set PUMP1 on GPAGE = N1
                        DB N1
        ENDM
;
;
SPMP2   MACRO N1
                        DW 0E062H       ;Set PUMP2 on GPAGE = N1
                        DB N1
        ENDM
;
;
CHKTLT  MACRO
                        DW 0E070H       ;Check Roll, Pitch; Send Signal
                                        ;  "C" = Ok, "D" = Bad
                                        ;   (+/- TLIMIT Deg)(See Equate Table)
        ENDM
```

```
;
;
;**************** Rotation Macros ********************
;
ROTCW   MACRO
                        DW 0E080H       ;Pulse Rotate CW Relay
        ENDM
;
;
ROTCCW MACRO
                        DW 0E081        ;Pulse Rotate CCW Relay
        ENDM
;
;
ROTRTN  MACRO
                        DW 0E082H       ;Rotate Flume to Transport Position
                                        ;  Send Signal "B" if error
        ENDM
;
;
ROTHDG  MACRO
                        DW 0E083H       ;Rotate Flume to Experiment Position
                                        ;  Send Signal "B" if error
        ENDM
;
;
;****************** X Y Z Traverse Macros *********
;
ZEROX   MACRO
                        DW 0E09AH       ;Zero X Position
                                        ;  Send Signal "A" if error
        ENDM
;
;
INCX    MACRO
                        DW 0E09BH       ;Increment X Position
                                        ;  Send Signal "A" if error
        ENDM
;
;
ZEROY   MACRO
                        DW 0E09CH       ;Zero Y Position
                                        ;  Send Signal "A" if error
        ENDM
;
;
INCY    MACRO
                        DW 0E09DH       ;Increment Y Position
                                        ;  Send Signal "A" if error
        ENDM
;
;
ZEROZ   MACRO
                        DW 0E09EH       ;Zero Z Position
                                        ;  Send Signal "A" if error
```

```
        ENDM
;
;
INCZ    MACRO
                        DW 0E09FH       ;Increment Z Position
                                        ;  Send Signal "A" if error
        ENDM
;
;
XYZO    MACRO
         HYDRA
         ZEROX
         ZEROY
         ZEROZ
         HYDRA
        ENDM
;
;
;****************** Sampler Macros *********************
;
;
SEDINS  MACRO P0
         IF P0 EQ 1
                        DW 0E0A1H       ;Insert Sediment Sampler #1
         ELSE
           IF P0 EQ 2
                        DW 0E0A5H       ;Insert Sediment Sampler #2
           ELSE
                        DW 0FFFFQ       ;***** SEDIMENT INSERT ERROR ***!!!!!!!!!!!!!!!!!
           ENDIF
         ENDIF
        ENDM
;
;
SEDRET  MACRO P0
         IF P0 EQ 1
                        DW 0E0A2H       ;Retract Sediment Sampler #1
         ELSE
           IF P0 EQ 2
                        DW 0E0A6H       ;Retract Sediment Sampler #2
           ELSE
                        DW 0FFFFQ       ;*** SEDIMENT RETRACT ERROR ***!!!!!!!!!!!!!!!!!
           ENDIF
         ENDIF
        ENDM
;
;
SEDUNL  MACRO P0
         IF P0 EQ 1
                        DW 0E0A3H       ;Unlatch Sed. Sampler #1, Sample H2O-1
         ELSE
           IF P0 EQ 2
                        DW 0E0A7H       ;Unlatch Sed. Sampler #2, Sample H2O-2
           ELSE
                        DW 0FFFFQ       ;*** SEDIMENT UNLATCH ERROR ***!!!!!!!!!!!!!!!!!
```

```
          ENDIF
        ENDIF
        ENDM
;
;
;*******************************************************
;
HYDRA   MACRO
                        DW 0E0A8H       ;Pulse Hydraulic Pump Relay
        ENDM
;
;
FLUMIN  MACRO
                        DW 0E0ACH       ;Insert Flume
        ENDM
;
;
FLUMOUT MACRO
                        DW 0E0ADH       ;Retract Flume
        ENDM
;
;
PMPRLY  MACRO
                        DW 0E0AEH       ;Pulse Water Pump Power Relay
        ENDM
;
;
;PUMP1  MACRO
;                       DW 0E0AEH       ;Pulse Water Pump #1 Relay
;       ENDM
;
;
;PUMP2  MACRO
;                       DW 0E0AFH       ;Pulse Water Pump #2 Relay
;       ENDM
;
;
LDVRST  MACRO
                        DW 0E0D0H       ;Reset the LDV
        ENDM
;
;
CAMERA  MACRO
                        DW 0E0C0H       ;Take a Picture
        ENDM
;
;
;*************** Pump Control Macros ******************
;
DONE EQU 0FFH
;
;
PMPOFF  MACRO
        LOCAL D,J
          L2SEND D
```

```
          JUMP J
          D:     DB "#PCX"
                 DB DONE
      J:  L2OFF
          SPMP0
          ENDM
;
;
PMP1    MACRO A
          LOCAL D,J
          L2SEND D
          JUMP J
          D:     DB "#PC!P1"
                 DB '&A'
                 DB ' '
                 DB DONE
      J:   L2OFF
          SPMP1 A
          ENDM
;
;
PMP2    MACRO A
          LOCAL D,J
          L2SEND D
          JUMP J
          D:     DB "#PC!P2"
                 DB '&A'
                 DB ' '
                 DB DONE
      J:   L2OFF
          SPMP2 A
          ENDM
;
;
;
;
;*************** "Branch" Macros ******************
;
BRBOT   MACRO P0
                        DW 0E0F0H       ;Branch if Bottom Sw to
                        DW P0           ;Address
        ENDM
;
;
BRINS   MACRO P0
                        DW 0E0F1H       ;Branch if Flume Inserted to
                        DW P0           ;Address
        ENDM
;
;
BRRET   MACRO P0
                        DW 0E0F2H       ;Branch if Flume Retracted to
                        DW P0           ;Address
        ENDM
;
```

```
;
BRCMD1  MACRO P0
                        DW 0E0F8H       ;Branch if XPONDR CMD. 1 Received to
                        DW P0           ;Address
        ENDM
;
;
BRCMD2  MACRO P0
                        DW 0E0F9H       ;Branch if XPONDR CMD. 2 Received to
                        DW P0           ;Address
        ENDM
;
;
BRCMD3  MACRO P0
                        DW 0E0FAH       ;Branch if XPONDR CMD. 3 Received to
                        DW P0           ;Address
        ENDM
;
;
;
;*****************************************************************************
;
;************************ COMBINED FUNCTION MACROS ****************************
;
;
;***************** SEND ACOUSTIC CODE - MACRO ********************
;
        A EQU 0AH
        B EQU 0BH
        C EQU 0CH
        D EQU 0DH
        E EQU 0EH
        F EQU 0FH
;
;
PING    MACRO
                        DW 0E024H       ;Send Pinger Code (on ASTK)
        ENDM
;
;
SEND    MACRO P0
         IF (P0 GT 0FH) OR (P0 LT 0)
                        DB FQ ;********************** PINGER CODE ERROR ***********!!!!!!!!!!!!!!!!!
         ELSE
                        DW (3000H + P0) ;Push Pinger Code on ASTK
         ENDIF
        PING
        ENDM
;
;
;********************** SPECIFIC "WAIT FOR" MACROS *****************
;
; ***** Wait for 10 Sec. *****
;
WAIT10  MACRO
```

```
                    GOSUB W10       ; Wait for 10 Sec.
        ENDM
;
;
; ***** Wait for 20 Sec. *****
;
WAIT20  MACRO
                    GOSUB W20       ; Wait for 20 Sec.
        ENDM
;
;
; ***** Wait for 29 Sec. *****
;
WAIT29  MACRO
                    GOSUB W29       ; Wait for 29 Sec.
        ENDM
;
;
; ***** Wait for 30 Sec. *****
;
WAIT30  MACRO
                    GOSUB W30       ; Wait for 30 Sec.
        ENDM
;
;
; ***** Wait for 59 Sec. *****
;
WAIT59  MACRO
                    GOSUB W59       ; Wait for 59 Sec.
        ENDM
;
;
; ***** Wait for 60 Sec. *****
;
WAIT60  MACRO
                    GOSUB W60       ; Wait for 60 Sec.
        ENDM
;
;
;
; ***** Wait for 1 Min. *****
;
WAIT1M  MACRO
                    GOSUB W1M       ; Wait for 1 Min.
        ENDM
;
;
; ***** Wait for 2 Min. *****
;
WAIT2M  MACRO
                    GOSUB W2M       ; Wait for 2 Min.
        ENDM
;
;
; ***** Wait for 5 Min. *****
```

```
;
WAIT5M  MACRO
                        GOSUB W5M       ; Wait for 5 Min.
        ENDM
;
;
; ***** Wait for 7 Min. *****
;
WAIT7M  MACRO
                        GOSUB W7M       ; Wait for 7 Min.
        ENDM
;
;
;
        .LIST
```

```
;
;********************* DATA SERIES SUBROUTINE *********************************
;
;ISDDAT7.MAC   19 SEP 86
;
;
;
DATRUN: WAIT60          ;TAKE DATA WITH FLUME PUMP ON FOR 25 MIN.
        WAIT59          ;2
        CAMERA
;
        WAIT60
        WAIT59          ;4
        CAMERA
;
        WAIT60
        WAIT59          ;6
        CAMERA
;
        WAIT60
        WAIT59          ;8
        CAMERA
;
        WAIT60
        WAIT59          ;10
        CAMERA
;
        WAIT60
        WAIT59          ;12
        CAMERA
;
        WAIT60
        WAIT59          ;14
        CAMERA
;
        WAIT60
        WAIT59          ;16
        CAMERA
;
        WAIT60
        WAIT59          ;18
        CAMERA
;
        WAIT60
        WAIT59          ;20d
        CAMERA
;
        WAIT60
        WAIT59          ;22
        CAMERA
;
        WAIT60
        WAIT59          ;24d Min.
        CAMERA
;
```

```
        WAIT30          ;25 Min.
;
        SEND 7          ;SEND SIG. 7 END OF VELOCITY RUN
;
        RETURN
;
```

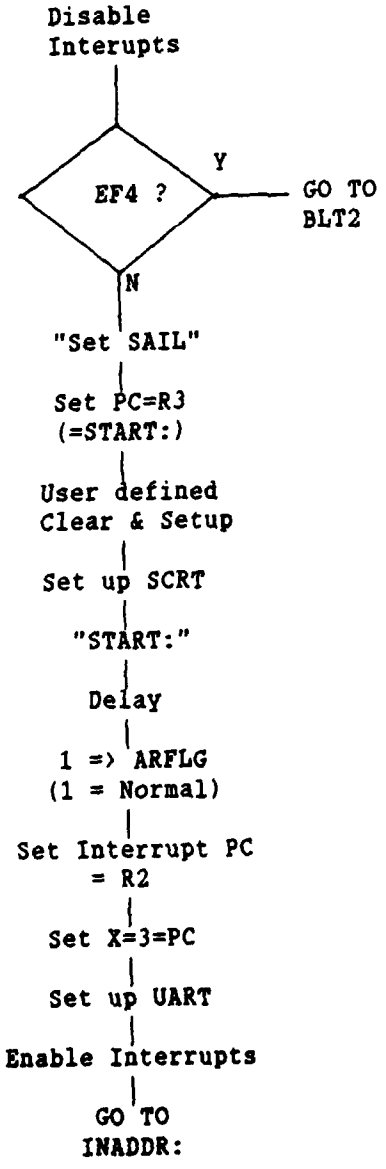
```
;*******************************************************************************
;
;       SEQUENCER MACRO SUBROUTINES
;
        SUBTTL ISDSUB 15 JUL 86
;
;       This file must be included at the end of a Sequencer Macro Program
;         Use "INCLUDE ISDSUB.MAC"
;
;*******************************************************************************
;
        CSEG    ; Change to Code Segment
;
; Note! W10 - W60 allow for the call and return times.
;    ie. W10 is set for 8 sec.
;
W10:    SETCTC 0008, $+5        ;Wait for 10 Sec.
        JUMP $-1
        RETURN
;
;
W20:    SETCTC 0012, $+5        ;Wait for 20 Sec.
        JUMP $-1
        RETURN
;
;
W29:    SETCTC 0013, $+5        ;Wait for 29 Sec.
        JUMP $-1
        RETURN
;
;
W30:    SETCTC 001C, $+5        ;Wait for 30 Sec.
        JUMP $-1
        RETURN
;
;
W59:    SETCTC 0039, $+5        ;Wait for 59 Sec.
        JUMP $-1
        RETURN
;
;
W60:    SETCTC 003A, $+5        ;Wait for 60 Sec.
        JUMP $-1
        RETURN
;
;
;
W1M:    SETCTC 003A, $+5        ;Wait for 1 MIN.
        JUMP $-1
        RETURN
;
;
W2M:    SETCTC 0076, $+5        ;Wait for 2 MIN.
        JUMP $-1
        RETURN
```

```
;
;
W5M:    SETCTC 012A, $+5        ;Wait for 5 MIN.
        JUMP $-1
        RETURN
;
;
W7M:    SETCTC 01A2, $+5        ;Wait for 7 MIN.
        JUMP $-1
        RETURN
;
;
;
;************** END OF SUBROUTINE INCLUDE FILE - ISDSUB ************************
;
;*******************************************************************************
;
;
```

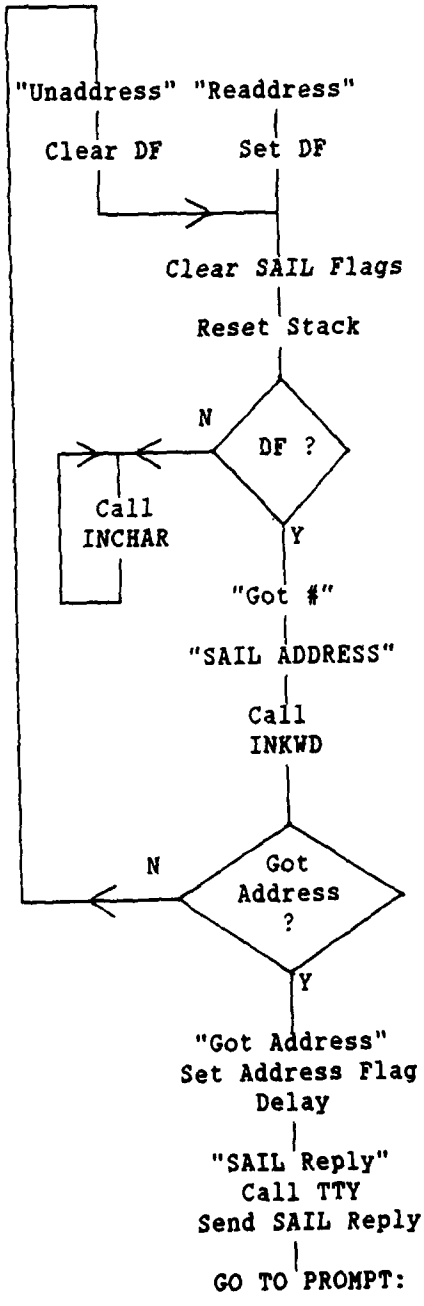
Appendix B

Sea Duct Monitor Program
Block Diagrams

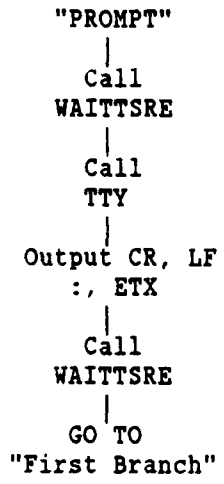
HARDSTART



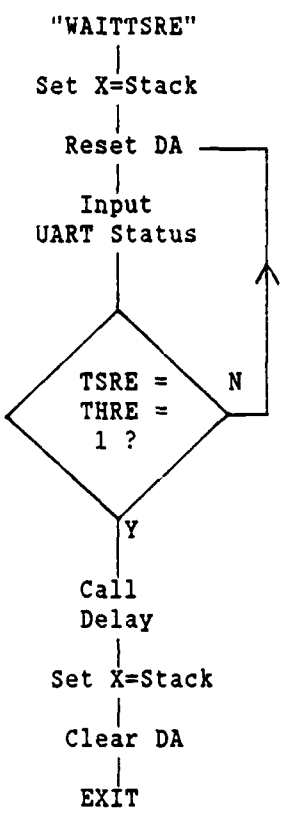
UNADDRESS and READDRESS



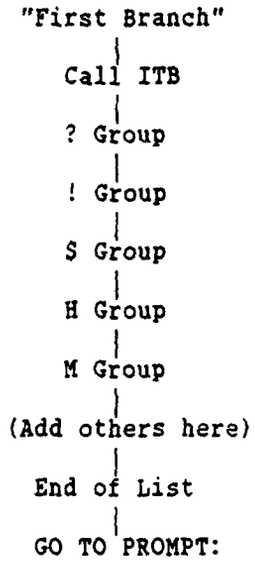
PROMPT



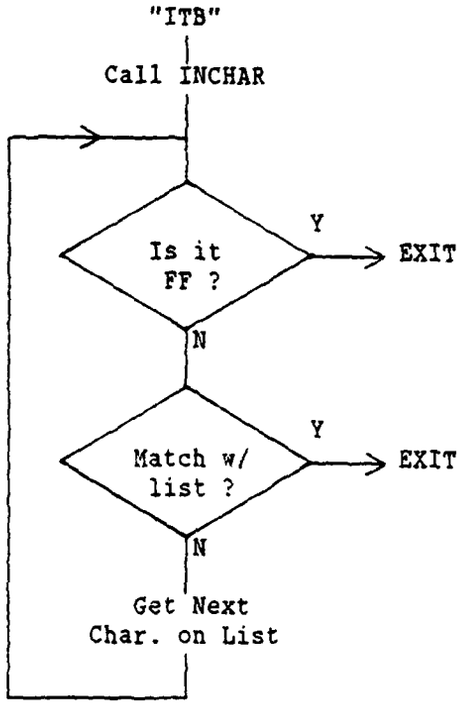
WAITTSRE
(Wait for Trans. Ser. Shift Reg. Ready)

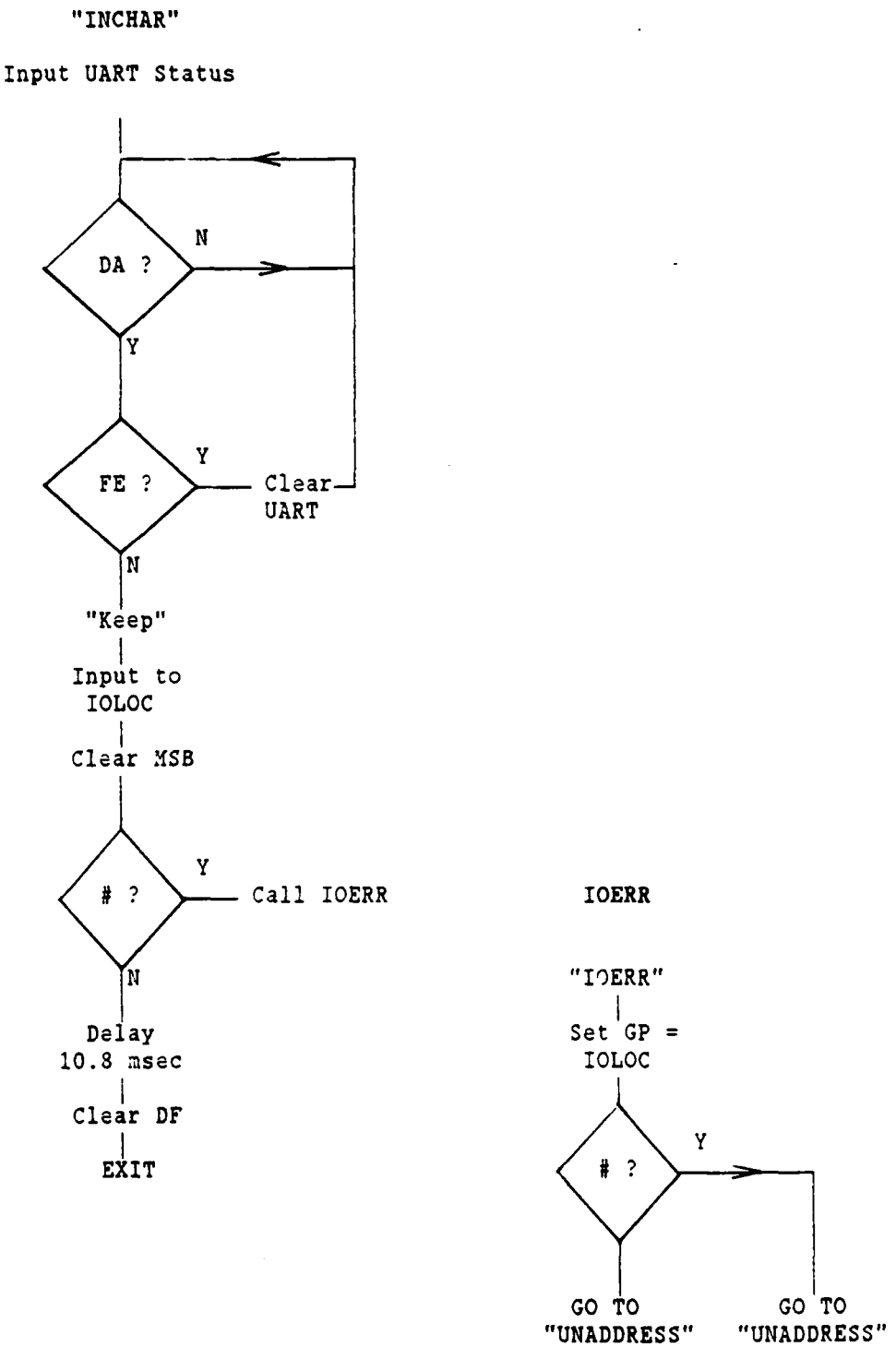


First Branch

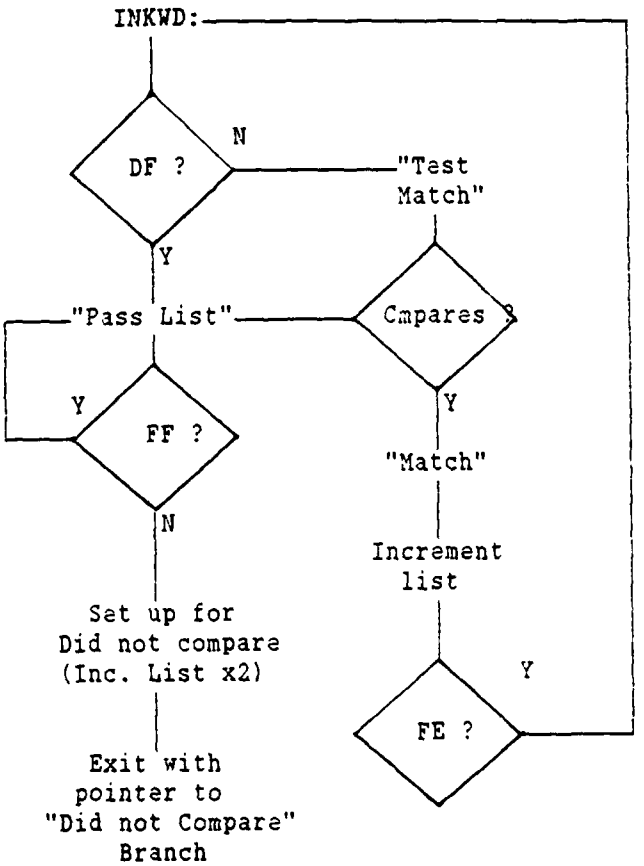


ITB
(Input Test and Branch)

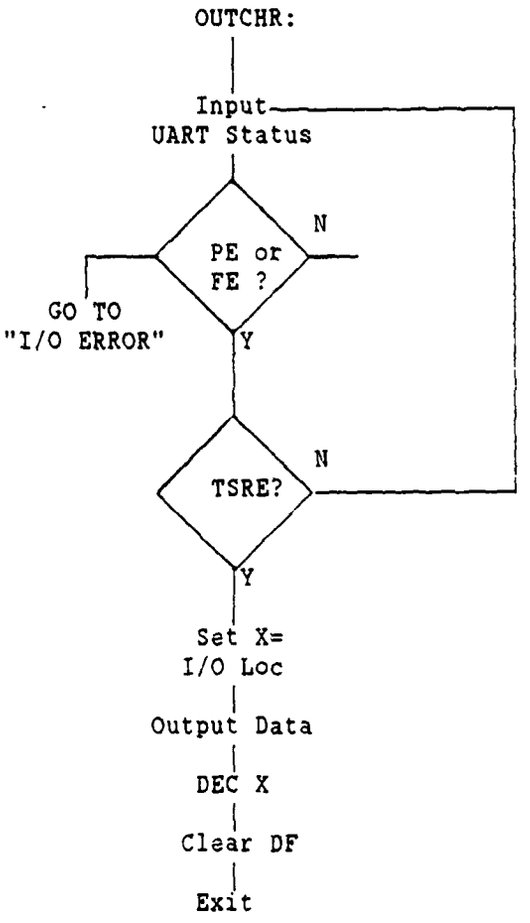



"INCHAR"
Input UART Status
DA ?
N
Y
FE ?
Y
Clear UART
N
"Keep"
Input to IOLOC
Clear MSB
?
Y
Call IOERR
N
Delay 10.8 msec
Clear DF
EXIT
IOERR
"IOERR"
Set GP = IOLOC
?
Y
GO TO "UNADDRESS"
GO TO "UNADDRESS"

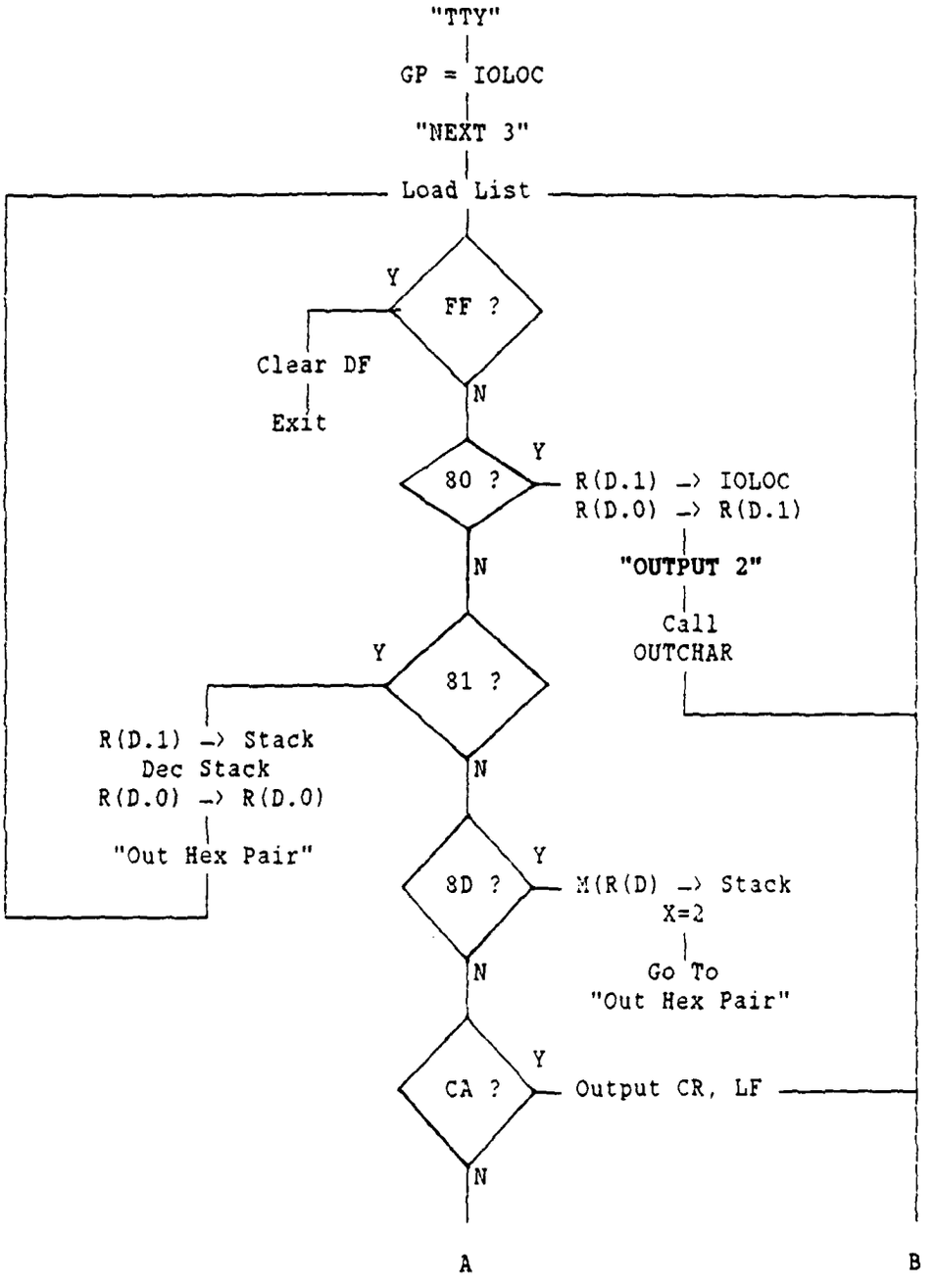
IN KEY WORD


INKWD:
DF ?
N
Y
"Test Match"
"Pass List"
Cmpares
Y
Y
FF ?
"Match"
N
Increment list
Set up for Did not compare (Inc. List x2)
Y
FE ?
Exit with pointer to "Did not Compare" Branch

OUT CHARACTER

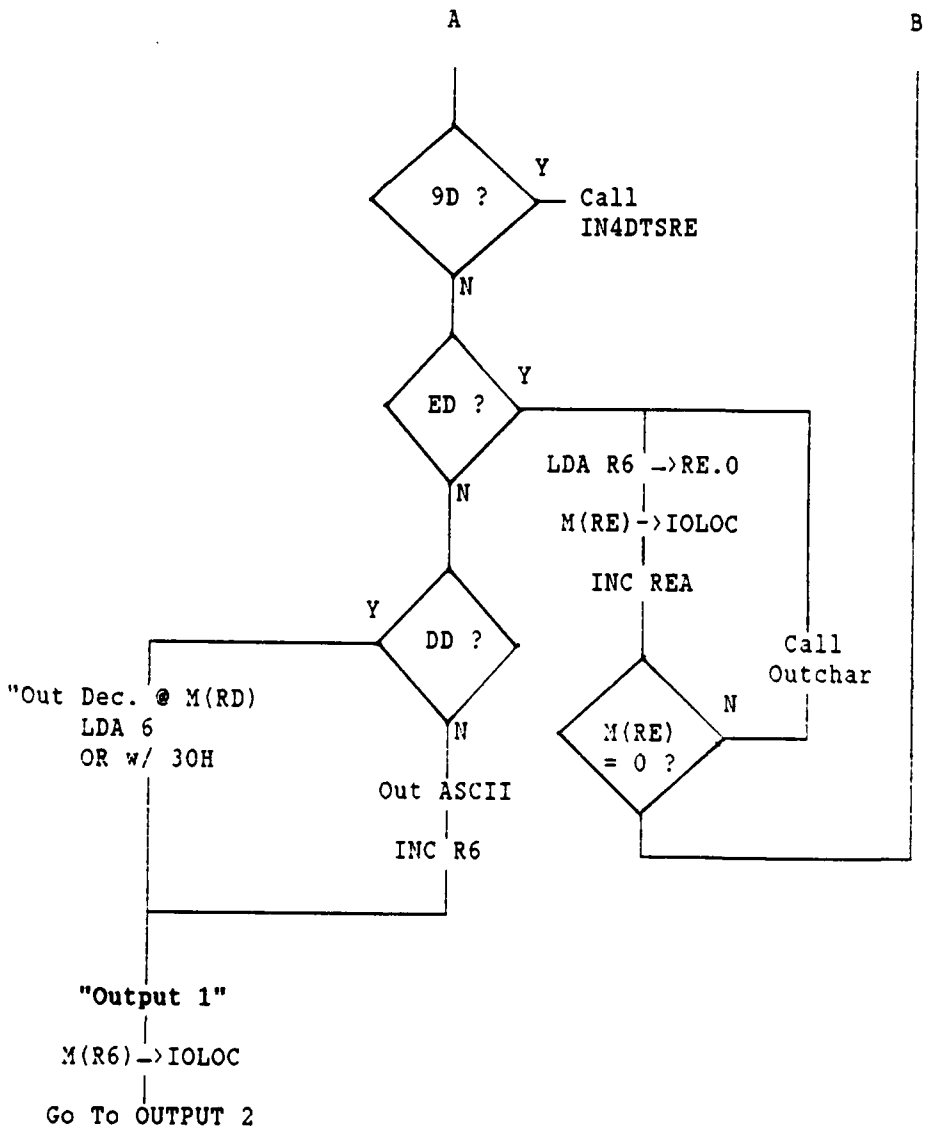


TTY

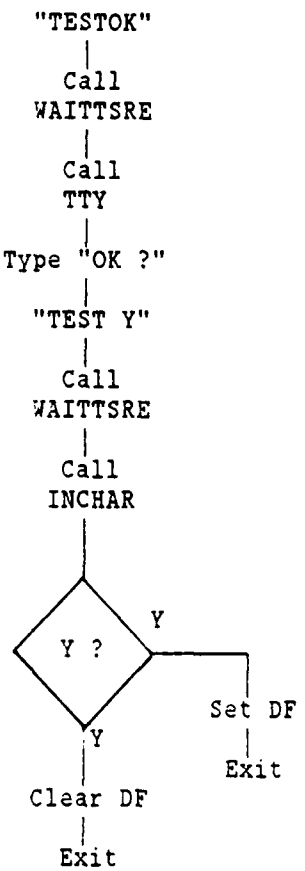


Continued next page

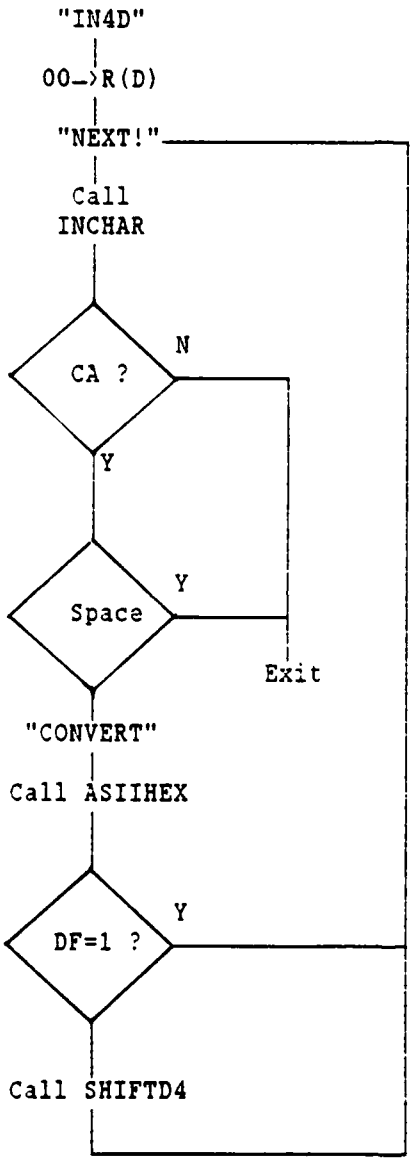
TTY contd.


A
B
9D ?
Y
Call
IN4DTSRE
N
ED ?
Y
LDA R6 –>RE.0
M(RE)–>IOLOC
INC REA
N
DD ?
Y
Call
Outchar
"Out Dec. @ M(RD)
LDA 6
OR w/ 30H
N
M(RE)
= 0 ?
N
Out ASCII
INC R6
"Output 1"
M(R6)–>IOLOC
Go To OUTPUT 2

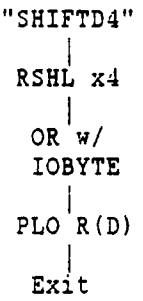
TEST OK


"TESTOK"
Call
WAITTSRE
Call
TTY
Type "OK ?"
"TEST Y"
Call
WAITTSRE
Call
INCHAR
Y ?
Y
Set DF
Exit
Y
Clear DF
Exit

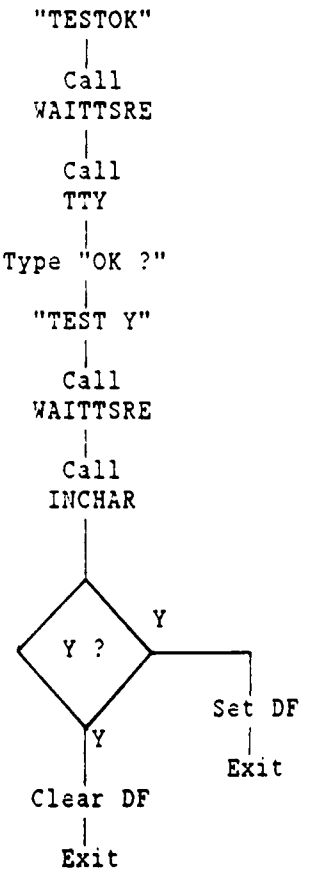
IN4D - Input 4
Digits to R(D)



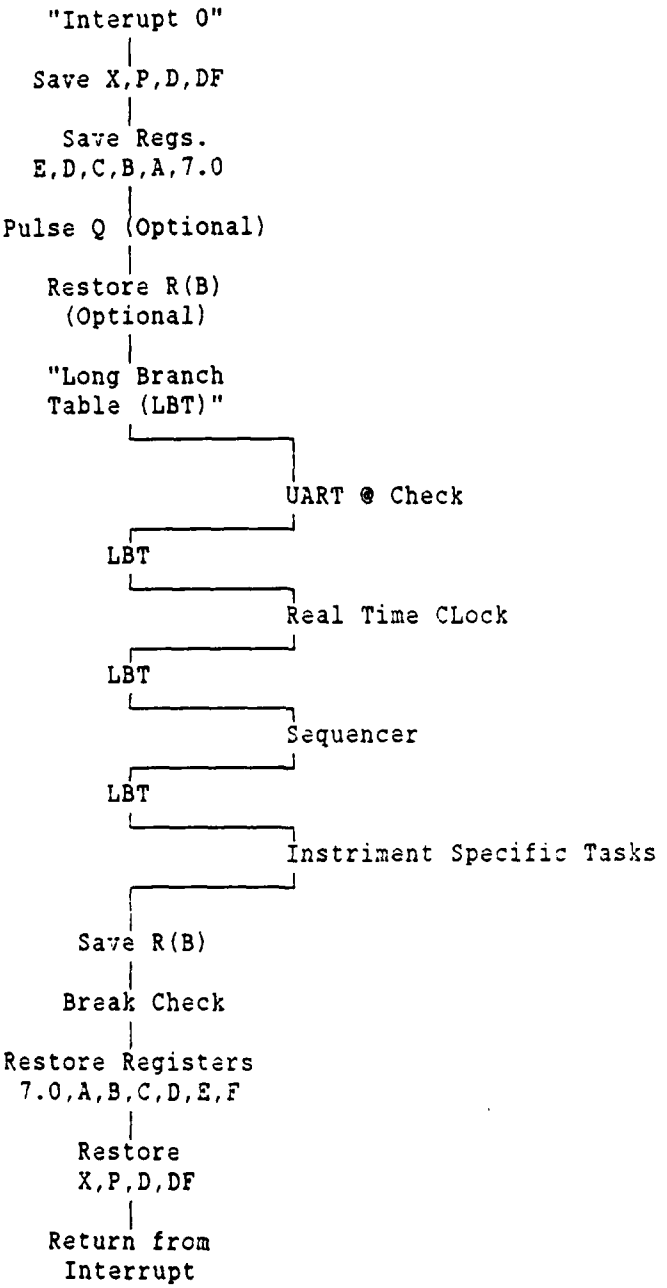
IN4D



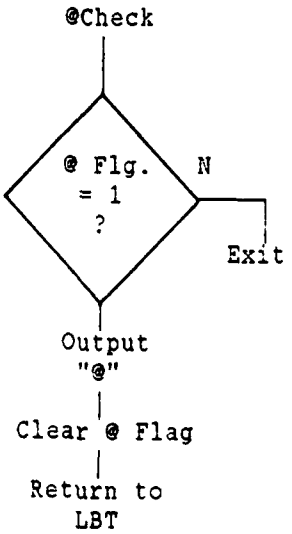
TEST OK



Interrupt Service Routine



"UART @ Check"



Appendix C

Sea Duct Main Program
Program Generation and Listing

SEA DUCT PROGRAM GENERATION

Software used in the Sea Duct System was developed on a CompuPro 816A Computer. The CompuPro 816A uses a modified version of CP/M and CP/M-86 to run 8 and 16 bit programs. All software purchased for the system was designed for eight bit CP/M systems.

The current version of the Sea Duct Main Program, SDSYS5n, is made from two files: SD05Rn and SDE5Rn. These are assembled using the Syscon M18 assemblier (for RCA 1802 series) and are linked using L18.

SD05Rn is linked using the command /P:800/D:5000, and SDE5Rn is linked using /P:2000/D:5000; the combined version is called SDSYS5n.HEX. This can be converted to RCA format (file type ".RCA") using the command MBASIC_HXRCA. Appendix D contains a listing of the Hex to RCA format conversion program. The resulting .RCA file can be loaded into Sea Duct system RAM using a version of MCALL named SAIL via the BTU Monitor which resides in PROM at 0000 in the SEA DUCT System. RAM versions are usually used for testing only. At the present time the program is burned into EPROMs which are then installed in the system. Four proms (2716) are needed. They are inserted into prom locations 0800, 1000, 1800, and 2000. For the prom version, a ".COM" version of the program is made using the L18 linker. CP/M Submit files L18COM and L18HEX exist for linking the main program. See the Syscon manual as well as information at the top of each source file for further information. These files exist on disks labeled "Sea Duct Main Prog. - Working Copy" and "1802 Development System". This text and other text files are on the "Sea Duct Text Files". The "1802 Development System" disk is the disk used for assembly, etc. Backup copies of these disks exist.

The proms for the system are programmed using "BURN" and the system object file SDSYSn.COM. "Burn" is a renamed version of PROMPROG, the Optimal Technology prom programming package.

The Sea Duct Sequencer Macro Programs are the ones used to control the Sea Duct does during an actual deployment. These macro programs are on a disk labled "Sea Duct Sequencer Progs." These are also assembled using Syscon's M18 and are linked using L18. These programs are also made into ".RCA" files using the MBASIC program HXRCA. The sequencer programs are loaded into battery backed ram memory at location 3000 hx. using the a version of MCALL renamed SAIL.COM. SAIL.COM resides on the "1802 Development System" disk. The command "SAIL -Z:SAIL." is used. This connects the Sea Duct computer to the CompuPro computer via the lab SAIL system.

```
                        ;PAGE 60
                        SUBTTL  SEA DUCT: SD05R9.MAC  16 SEP 86
                        ;
0035                    VERS    EQU "5"         ;VERSION 5.9
0039                    REV     EQU "9"
                        ;
                        ;
                        ; PREVIOUS VERS.: SD05R8.MAC  06 SEP 86
                        ; PREVIOUS VERS.: SD05R7.MAC  26 AUG 86
                        ; PREVIOUS VERS.: SD05R6.MAC  08 AUG 86
                        ; PREVIOUS VERS.: SD05R5.MAC  21 JUN 86
                        ;
                        ; Other older versions exist - no longer used.
                        ;
                        ;
                        ;SAIL SEA DUCT PROGRAM
                        ;
                        ;FOR RCA 1806 WITH:
                        ;
                        ;       1877 VECTORED INTERRUPT
                        ;       MEMORY PROTECT.
                        ;       REAL TIME CLOCK.
                        ;       BASIC SEQUENCER
                        ;       PASS THRU MODE W/ LOOP2 PWR CONTROL
                        ;       FAST SEQUENCER W/ LOOP2
                        ;       SEQUENCER TIMEOUT COUNTER
                        ;       EXTENDED SQUENCER POINTER (E0)
                        ;       A/D. MUX CONTROL
                        ;
                        ;
                C       INCLUDE I1806A.MAC
                C       ;       I1806A.MAC - Macro Definitions for RCA 1805A/6A Opcodes
                C       ;
                C       ;
                C       ;       20 FEB 1986
                C       ;       W. E. TERRY
                C       ;
                C       ;       (LISTING SUPRESSED)
                C       ;
                C       ;       With some Level II codes
                C       ;
                C               .LIST
                        ;       Macro Definitions for RCA 1805A/1806A Opcodes
                        ;
                C       INCLUDE ISDEQU.MAC
                C       ;       SEA DUCT EQUATE TABLE - ISDEQU.MAC
```

```
                        C       ;
                        C       ;       26 AUG 86 - SD05R7
                        C       ;
                        C       ;       W. E. TERRY
                        C       ;
                        C       ;       INCLUDING:
                        C       ;               REGISTER ALLOCATION
                        C       ;               GLOBAL PAGE REFERENCES
                        C       ;               I/O EQUATES
                        C       ;               DEFAULT VALUES
                        C       ;
                        C       ;       (LISTING SUPRESSED)
                        C               .LIST
                        C       ;
                                ;       Sea Duct Equate Table
                                ;
                                ;*******************************************************************************
                                ;
                                ;*** NOTE : EXTENDED SEQUENCER FUNCTIONS ARE NOT ON THIS FILE
                                ;       SEE FILE TYPES SDEvRr.MAC
                                ;       PUBLIC REFERENCES ARE MADE TO THE EXTENDED FILES
                                ;
                                ;       Assemble using:  M18 SD0vRn.=SD0vRr/R/C  then use
                                ;
                                ;       CREF80 SD0vRr=SD0vRr  to get a .PRN file.
                                ;
                                ;       Link using:
                                ;       L18 /P:800/D:5000.SD0vRr./P:2000/D:5000.SDEvRr.SDSYSvr/M/E/E
                                ;       where v = Vers. . r = Rev.
                                ;       to link both this file and the extended sequencer file.
                                ;
                                ;*******************************************************************************
                                ;
                                ;************************ PROGRAM BEGINS HERE ********************************
                                ;
                                ;
0000' 71                        HDSTRT: DIS
0001' 00                                DB 00           ;DISABLE INTERRUPTS
                                ;
0002' 30 19'                            BR SETSL        ;CAN BE BR4 TO SETSL
0004' FFFF                              DW 0FFFFH       ;3 BYTE SPACE FOR LBR TO BLT
0006' FF                                DB 0FFH
                                ;
0007' 53 45 41 20                       DB "SEA DUCT VERS."
000B' 44 55 43 54
000F' 20 56 45 52
```

```
                                        DB VERS
                                        DB '.'
                                        DB REV
                                        DB ' '
                                ;
                SETSL:  GHI R0
                                        PHI PC          ;SET PC TO STARTING ADDRESS
                                        LDI LOW(START1)
                                        PLO PC
                                ;
                SETSTK: LDI STKPG
                                        PHI STACK       ;PUT STACK LOCATION IN R2
                                        LDI LOW STKEND
                                        PLO STACK
                                        SEP PC          ;PROGRAM BEGINS TO RUN w/ PC = R3
                                ;
                                ;
                START1: SEX STACK
                                        SCAL R6. MEMSUB :CALL MEMORY ENABLE SUBROUTINE
                                +
                                +
                                        DB 01           ; ENABLE
                                        DB 00           ; START PAGE = 00
                                        DB 0FFH         ; # OF PAGES = FF
                                ;
                                        SCAL R6. SETUP  :CALL FOR USER DEFINED CLEAR &
                                +
                                +
                                ;                       ;   INITIALIZE ROUTINE
                                ;
                DLY20:  LDI 20H
                                        PHI RE          :20 = ARBITRARY DELAY WHICH
                WAIT:   DEC RE          ; INSURES UART WILL RESET
                                        GHI RE
                                        BNZ WAIT
                                        NOP
                                        LDI ARFLG       ;SET RTC A/R FLAG
                                        PLO GPAGE
                                        LDI 01
                                        STR GPAGE       ;1 -> A/R FLAG => NORMAL
                                ;
                                ;
                RESTRT: LDI HIGH(INTVEC)
                                        PHI INTPC               ;SET R1 = INTERRUPT VECTOR PAGE
                                        LDI LOW(INTVEC)
```

```
 139    0044'  A1                      PLO INTPC
 140    0045'  F8 50                   LDI GLOPG           ;SET GPAGE.1
 141    0047'  B7                      PHI GPAGE
 142                           ;
 143    0048'  F8 0A           SETURT: LDI GRPSAV          ;SELECT UART I/O GROUP
 144    004A'  A7                      PLO GPAGE           ; AND STORE ON GLOBAL PAGE
 145    004B'  F8 06                   LDI UARTS
 146    004D'  57                      STR GPAGE
 147    004E'  E7                      SEX GPAGE
 148    004F'  61                      OUT GROUP
 149    0050'  E3                      SEX PC
 150    0051'  63                      OUT CNTRL1          ;SET UART1 AS SHOWN IN THE I/O GROUP
 151    0052'  12                      DB FORMT1           ; ALLOCATION SETUP
 152                           ;
 153    0053'  65                      OUT CNTRL2          ;THIS BLOCK:
 154    0054'  12                      DB FORMT1           ;
 155                           ;                          ;CHANGED V5.8 - V5.9
 156                           ;       SEX STACK          ;
 157                           ;       SCAL R6, INTBR2    ;BREAK LOOP 2 AND SETUP UART 2
 158                           ;                          ;SHOULD BE USED ONLY AT START AND NOT RESTART
 159    0055'  E3                      SEX PC
 160    0056'  70                      RET
 161    0057'  33                      DB 33H              ;ENABLE INTERRUPTS
 162    0058'  30 84'                  BR UNADDR           ;GO TO UNADDRESS
 163                           ;                          ;INITALIZATION IS DONE AT THIS POINT
 164                           ;                          ; THE PROGRAM IS UP AND RUNNING
 165                           ;
 166                           ;*************************************************************************
 167                           ;
 168                           ;********************** CLEAR AND INITIALIZE ROUTINE **************************
 169                           ;
 170                           ;
 171    005A'  F8 50           SETUP:  LDI GLOPG       ;GLOBAL PAGE SETUP
 172    005C'  B7                      PHI GPAGE       ;SETS R7.1 TO GLOPG
 173                           ;
 174    005D'  F8 FF                   LDI 0FFH        ;CLEAR 5000 TO 5BFF WITH 00'S
 175    005F'  AA                      PLO RA          ;CONFIGURE THIS SECTION TO
 176    0060'  F8 5B                   LDI BUFPG       ;SUIT THE NEEDS OF YOUR SYSTEM
 177    0062'  BA                      PHI RA
 178    0063'  F8 00           AGAIN:  LDI 00H
 179    0065'  5A                      STR RA
 180    0066'  2A                      DEC RA
 181    0067'  8A                      GLO RA
 182    0068'  32 6C'                  BZ CLRPG
 183    006A'  30 63'                  BR AGAIN
 184    006C'  9A              CLRPG:  GHI RA
```

```
                006D' FB 50                     XRI GLOPG
                006F' 32 73'                    BZ SEQRST
                0071' 30 63'                    BR AGAIN
                                        ;
                                        ;
                0073' F8 60             SEQRST: LDI PPCHI       ;INITIALIZE SEQUENCER
                0075' A7                        PLO GPAGE
                0076' F8 07'                    LDI HIGH(IDLLOC)
                0078' 57                        STR GPAGE
                0079' 17                        INC GPAGE
                007A' F8 00'                    LDI LOW(IDLLOC)
                007C' 57                        STR GPAGE
                007D' 17                        INC GPAGE
                007E' F8 52                     LDI HIGH(RSTKTP)
                0080' 57                        STR GPAGE
                0081' 17                        INC GPAGE       ;GPAGE AT RSTK POINTER
                0082' F8 3F                     LDI LOW(RSTKTP)
                0084' 57                        STR GPAGE
                0085' 17                        INC GPAGE
                0086' F8 52                     LDI HIGH(ASTKTP)
                0088' 57                        STR GPAGE
                0089' 17                        INC GPAGE
                008A' F8 7F                     LDI LOW(ASTKTP)
                008C' 57                        STR GPAGE
                                        ;
                                        ;
                008D' F8 F8                     LDI INTPG
                008F' BA                        PHI RA                  ;SET UP PROG. INTERRUPT CONTROLLER
                0090' F8 00                     LDI LOW(INTMSK)
                0092' AA                        PLO RA                  ;SET INTERRUPT MASK FOR ONLY INT. 0
                0093' F8 FE                     LDI 0FEH
                0095' 5A                        STR RA
                0096' F8 40                     LDI LOW(INTCRL)
                0098' AA                        PLO RA                  ;SET PIC CONTROL REG.
                0099' F8 05                     LDI 05
                009B' 5A                        STR RA
                009C' F8 80                     LDI LOW(INTVEC)
                009E' AA                        PLO RA                  ;SET PIC VECTOR PAGE REG
                009F' F8 08'                    LDI HIGH(INTPGM)
                00A1' 5A                        STR RA
                                        ;
                00A2' F8 3F                     LDI HDGEXP              ;SET DEFAULT VALUE FOR THE PLUME HEADING
                00A4' A7                        PLO GPAGE               ;  FOR THE EXPERIMENT
                00A5' F8 20                     LDI HDGVAL
                00A7' 57                        STR GPAGE
```

```
                                ;
                                ;*** THIS SPACE MAY BE USED FOR FURTHER SETUP ROUTINES ***
                                ;
                                ;
00A8'  E2                       SEX STACK
                                SRET R6
00A9'  68 96            +
                                ;
                                ;
                                ;*****************************************************************************
                                ;
                                ;************************* I / O ERROR RECOVER *******************************
                                ;
00AB'  E2                       IOERR:  SEX STACK
                                ;
                                ;       SCAL R6, IMTBR2 ; REMOVED VERS. 5.8 - 5.9
                                ;
00AC'  F8 FE                    LDI IOLOC
00AE'  A7                       PLO GPAGE       ;SAIL ENTERS HERE IF
00AF'  07                       LDN GPAGE       ;       1. UART GOT #
00B0'  FB 23                    XRI 023H        ;       2. XMIT ECHOED ERROR
00B2'  32 B7'                   BZ READDR       ;IS INPUT CHARACTER '#' ?
                                ;
                                ;
00B4'  FC 00                    UNADDR: ADI 00H         ;CLEAR DF
00B6'  C8                       LSKP
00B7'  FF 00                    READDR: SMI 00H         ;SET DF
00B9'  F8 03                    LDI SYSFLG
00BB'  A7                       PLO GPAGE       ;DF = 1 MEANS IT GOT '#'
00BC'  E7                       SEX GPAGE
00BD'  F8 00                    LDI 00H
00BF'  73                       STXD
00C0'  73                       STXD
00C1'  73                       STXD            ;CLEAR SAIL FLAGS AT
00C2'  57                       STR GPAGE       ;GLOBAL PAGE 00 THRU 03
                                ;
                                ;
                                ;*****
                                ;       LDI SYSFLG      ;REMOVE THE BEGINNING ';' FOR
                                ;       PLO GPAGE       ;  PERMANENT OPEN SYSTEM
                                ;       LDI 60H         ;MAKE THESE STATEMENTS COMMENTS FOR
                                ;       STR GPAGE       ;  NORMAL SYSTEM OPERATION
                                ;******
                                ;
                                ;
00C3'  F8 DF                    LDI LOW STKEND
```

```
00C5'  A2                      PLO STACK       ;RESET STACK
00C6'  33 CF'                  BDF GOTNUM
00C8'  E2                  POUND?: SEX STACK
                               SCAL R6, INCHAR
00C9'  68 86           +
00CB'  0181'           +
00CD'  30 C8'                  BR POUND?
00CF'  30 D1'              GOTNUM: BR ADDR?
                           ;
                           ;
                           ;***************************** SAIL ADDRESS ***********************************
                           ;
                           ;
00D1'  E2                  ADDR?:  SEX STACK
                               SCAL R6, INKWD  ;LOOK FOR  NOTE: SAIL ADDRESS
00D2'  68 86           +
00D4'  0208'           +
00D6'  53 44                   DB 'SD'         ;  IS INSTRUMENT SPECIFIC
00D8'  FF                      DB DONE         ;  DONE
00D9'  00DE'                   DW ADDR
00DB'  C0 00B4'                LBR UNADDR
                           ;
                           ;
                           ;************************** GOT SAIL ADDRESS ******************************
                           ;
                           ;
00DE'  F8 03               ADDR:   LDI SYSFLG
00E0'  A7                      PLO GPAGE       ;ENTERS FROM SAIL ADDRESS
00E1'  07                      LDN GPAGE
00E2'  F9 80                   ORI 080H
00E4'  57                      STR GPAGE
00E5'  E2                      SEX STACK
                               SCAL R6, DELAY2 ;2 BIT DELAY
00E6'  68 86           +
00E8'  019B'           +
00EA'  30 EC'                  BR RPLY
                           ;
                           ;
                           ;************************* INSTRUMENT SAIL REPLY ***************************
                           ;
                           ;
00EC'                      RPLY:   SCAL R6, TTY    ;TYPE:
00EC'  68 86           +
00EE'  024E'           +
00F0'  CA                      DB 0CAH
00F1'  53 65 61 20             DB 'Sea Duct'   ;  REPLY
```

```
00F5'  44 75 63 74
00F9'  20 20 56 65              DB '  Vers. '
00FD'  72 73 2E 20
0101'  35                       DB VERS
0102'  2E                       DB '.'
0103'  39                       DB REV
0104'  FF                       DB DONE         ;  DONE
0105'  30 07'                   BR PROMPT
                        ;
                        ;
                        ;********************************** PROMPT **********************************
                        ;
                        ;
0107'  E2               PROMPT: SEX STACK
                                SCAL R6. TSRE?          ;WAIT FOR TRANS. SER. REG. EMPTY
0108'  68 86            +
010A'  02F0'            +
                                SCAL R6. TTY            ;TYPE:
010C'  68 86            +
010E'  024E'            +
0110'  CA                       DB 0CAH                 ;       CR. LF
0111'  3A                       DB PNTCHR               ;       PROMPT CHAR
0112'  03                       DB ETX                  ;       ETX
0113'  FF                       DB DONE                 ;       DONE
                                SCAL R6. TSRE?          ;WAIT FOR TRANS. SER. REG. EMPTY
0114'  68 86            +
0116'  02F0'            +
0118'  30 1A'                   BR BRIST                ;GO TO FIRST BRANCH
                        ;
                        ;
                        ;****************** FIRST BRANCH ****************************
                        ;
                        ;
011A'                   BRIST:  SCAL R6. ITB    ;TEST FOR:      ;ADD OR DELETE
011A'  68 86            +
011C'  022E'            +
011E'  3F                       DB '?'          ;? GROUP        ; AS NECESSARY
011F'  0133'                    DW QUESGR                       ; FOR YOUR SYSTEM
0121'  21                       DB '!'          ;! GROUP
0122'  014F'                    DW BANGGR
0124'  24                       DB '$'          ;$ GROUP
0125'  0472'                    DW TESTS
0127'  48                       DB 'H'          ;HELP FILE
0128'  1000'                    DW HELP
012A'  4D                       DB 'M'          ;MEMORY PROTECT
012B'  0734'                    DW MEMSAV
```

```
 369    012D'  25                       DB '%'          ;PASS THRU GROUP
 370    012E'  0171'                    DW PASSGR
 371    0130'  FF                       DB DONE         ;DONE           ;EXPANSION CAN BE
 372    0131'  30 07'                   BR PROMPT                       ;ADDED HERE
 373                                ;
 374                                ;
 375                                ;****************** ? GROUP ************************
 376                                ;
 377                                ;
 378    0133'                       QUESGR: SCAL R6. ITB    ;LOOK FOR:      ;ADD OR DELETE
 379    0133'  58 86            +
 380    0135'  022E'            +
 381    0137'  4D                       DB 'M'                          ; AS NECESSARY
 382    0138'  0396'                    DW QUESTM       ;? M
 383    013A'  43                       DB 'C'
 384    013B'  04A2'                    DW CRC          ;? CRC
 385    013D'  54                       DB 'T'
 386    013E'  05C2'                    DW QUESTT       ;? TIME
 387    0140'  53                       DB 'S'
 388    0141'  0684'                    DW SEQ?         ;? SEQUENCER
 389    0143'  42                       DB 'B'
 390    0144'  1178'                    DW QUEBUF       ;? Buffer
 391    0146'  48                       DB 'H'
 392    0147'  129D'                    DW HDG?         ;? Heading
 393    0149'  45                       DB 'E'
 394    014A'  12DC'                    DW EXP?         ;? Experiment #
 395    014C'  FF                       DB DONE         ;DONE           ;EXPANSION CAN BE
 396    014D'  30 07'                   BR PROMPT                       ; ADDED HERE
 397                                ;
 398                                ;
 399                                ;****************** ! GROUP ************************
 400                                ;
 401                                ;
 402    014F'                       BANGGR: SCAL R6. ITB    ;LOOK FOR:      ;ADD OR DELETE
 403    014F'  58 86            +
 404    0151'  022E'            +
 405    0153'  4C                       DB 'L'                          ; AS NECESARY
 406    0154'  0331'                    DW LOCK         ;! LOCK
 407    0156'  55                       DB 'U'
 408    0157'  0315'                    DW UNLOCK       ;! UNLOCK
 409    0159'  4F                       DB 'O'
 410    015A'  0348'                    DW OPEN?        ;! OPEN SYS
 411    015C'  4D                       DB 'M'
 412    015D'  03F5'                    DW WRITEM       ;! MEMORY
 413    015F'  54                       DB 'T'
 414    0160'  0535'                    DW TIMEST       ;! TIME
```

```
                        DB 'S'
                        DW SEQSET       ;! SEQUENCER
                        DB 'F'
                        DW FPCSHO       ;! FOLLOW PPC
                        DB 'H'
                        DW HDGSET       ;! SET HEADING
                        DB 'E'
                        DW EXPSET       ;! SET EXPERIMENT #
                        DB DONE         ;DONE           ;EXPANSION CAN BE
                        BR PROMPT                       ; ADDED HERE
                    ;
                    ;
                    ;********************** PASS THRU GROUP **********************
                    ;
                    ;
PASSGR: SCAL R6, ITB
                        DB 'P'          ;START PASS THRU MODE
                        DW PTHRU        ;                               ***
                        DB 'B'          ;SEND BREAK                       * BOTH SEND A
                        DW PASSBR       ;                                 * BREAK UNLESS
                        DB 'X'          ;ESCAPE ( DROP ONE LEVEL )        * %P MODE HAS
                        DW PASSBR       ;                               *** BEEN ENTERED
                        DB DONE         ;DONE   EXPANSION CAN BE
                        BR PROMPT       ;       ADDED HERE
                    ;
                    ;
                    ;***************************** SAIL IN CHARACTER *********************************
                    ;
INCHAR: INP STAT1
                        SHR             ;CHECK FOR DA (DATA AVAILABLE)
                        BNF INCHAR      ;IF NOT TRY AGAIN
                        ANI 06H         ;MASK FOR:
                        BZ KEEP2        ;   FRAME AND PARITY ERROR
                        INP DATA1       ;CLEAR BAD DATA
                        BR INCHAR
KEEP2:  LDI IOLOC       ;PUT GOOD DATA AT GP = I/O LOCATION
                        PLO GPAGE
                        SEX GPAGE
                        INP DATA1
                        ANI 07FH        ;CLEAR MSB
                        STR GPAGE       ;STORE AT GP I/O LOCATION
                        XRI '#'         ;IS IT '#' ?
                        LBZ IOERR
                        BR DELAY2       ;2 BIT DELAY
```

```
                                ;
                                ;
                                ;************************** 2 BIT DELAY ****************************
                                ;
                                ;                       ;INSTRUMENT SPECIFIC:
019B'  F8 80                    DELAY2: LDI 80H         ;       80H = 10.8 mSec FOR
019D'  FF 01                    WAIT3:  SMI 01H         ;       1.2288 MHz SYSTEM CPU CLOCK
019F'  C4                               NOP
01A0'  C4                               NOP
01A1'  C4                               NOP
01A2'  3A 9D'                           BNZ WAIT3
01A4'  FC 00                            ADI 00H         ;CLEAR DF
01A6'  E2                               SEX STACK
                                        SRET R6
01A7'  68 96                +
                                ;
                                ;
                                ;********************** INPUT 4 DIGITS TO R(D) - (IN4D) **************************
                                ;
                                ;
01A9'  F8 00                    IN4D:   LDI 00
01AB'  BD                               PHI RD          ;SET R(D) = 0000
01AC'  AD                               PLO RD
01AD'                           NEXT1:  SCAL R6. INCHAR
01AD'  68 86                +
01AF'  0181'                +
01B1'  07                               LDN GPAGE
01B2'  FB 0D                            XRI 0DH         ;INCHAR XOR CR  IS IT 'CR' ?
01B4'  32 BA'                           BZ IN4DIT       ;GP -> I/O LOC.
01B6'  FB 2D                            XRI 2DH         ;"SPACE" XOR CR IS IT ' ' ?
01B8'  3A BC'                           BNZ CNVRT
01BA'                           IN4DIT: SRET R6
01BA'  68 96                +
                                ;
                                ;
01BC'                           CNVRT:  SCAL R6. ASCHEX
01BC'  68 86                +
01BE'  01C8'                +
01C0'  33 AD'                           BDF NEXT1
                                        SCAL R6. SHFTD4
01C2'  68 86                +
01C4'  01EF'                +
01C6'  30 AD'                           BR NEXT1
                                ;
                                ;                       ;ASCII TO HEX CONVERSION
01C8'  07                       ASCHEX: LDN GPAGE
```

```
 507  01C9'  FC B0                    ADI 0D0H        ;CALLED BY CNVRT AND ! MEMORY
 508  01CB'  CB 01EB'                 LBNF NOTHEX
 509  01CE'  07                       LDN GPAGE
 510  01CF'  FD 39                    SDI 039H
 511  01D1'  C3 01E3'                 LBDF NUMBER
 512  01D4'  07                       LDN GPAGE
 513  01D5'  FC BF                    ADI 0BFH
 514  01D7'  CB 01EB'                 LBNF NOTHEX
 515  01DA'  07                       LDN GPAGE
 516  01DB'  FD 46                    SDI 046H
 517  01DD'  3B EB'                   BNF NOTHEX
 518  01DF'  07                       LDN GPAGE
 519  01E0'  FC C9                    ADI 0C9H
 520  01E2'  38                       SKP
 521  01E3'  07                NUMBER: LDN GPAGE
 522  01E4'  FA 0F                    ANI 00FH
 523  01E6'  57                       STR GPAGE
 524  01E7'  FC 00                    ADI 00H         ;CLEAR DF
 525                                  SRET R6
 526  01E9'  68 96             +
 527  01EB'  FF 00             NOTHEX: SMI 00H         ;SET DF
 528                                  SRET R6
 529  01ED'  68 96             +
 530                           ;
 531                           ;
 532  01EF'  8C                SHFTD4: GLO RC
 533  01F0'  52                       STR STACK
 534  01F1'  F8 04                    LDI 04H
 535  01F3'  AC                       PLO RC
 536  01F4'  8D                SHIFT:  GLO RD
 537  01F5'  FE                       SHL
 538  01F6'  AD                       PLO RD
 539  01F7'  9D                       GHI RD
 540  01F8'  7E                       SHLC
 541  01F9'  BD                       PHI RD
 542  01FA'  2C                       DEC RC
 543  01FB'  8C                       GLO RC
 544  01FC'  CA 01F4'                 LBNZ SHIFT
 545  01FF'  02                       LDN STACK
 546  0200'  AC                       PLO RC
 547  0201'  E7                       SEX GPAGE
 548  0202'  8D                       GLO RD
 549  0203'  F1                       OR
 550  0204'  AD                       PLO RD
 551  0205'  E2                       SEX STACK
 552                                  SRET R6
```

```
                                        +
                                ;
                                ;
                                ;********************************* IN KEY WORD ***********************************
                                ;
0208'  E2                       INKWD:  SEX STACK
                                        SCAL R6, INCHAR
0209'  68 96                    +
020B'  0181'                    +
020D'  3B 19'                           BNF MATCH?
020F'  46                       PLIST:  LDA LIST
0210'  FB FF                           XRI 0FFH        ;IS IT FF ? FF = LIST END
0212'  3A 0F'                          BNZ PLIST
0214'  16                               INC LIST
0215'  16                               INC LIST
0216'  E2                              SEX STACK
                                        SRET R6         ;GOES TO LBR AT END OF LIST
0217'  68 96                    +
                                ;
0219'  07                       MATCH?: LDN GPAGE       ;GPAGE = I/O LOC.
021A'  E6                               SEX RTNPTR
021B'  F3                               XOR             ;DOES I/O LOC = LIST ?
021C'  3A 0F'                          BNZ PLIST
021E'  16                       MATCH:  INC LIST
021F'  06                               LDN LIST
0220'  FB FF                            XRI 0FFH
0222'  3A 08'                          BNZ INKWD
0224'  16                               INC LIST
0225'  46                               LDA RTNPTR
0226'  52                               STR STACK
0227'  46                               LDA RTNPTR
0228'  A6                              PLO RTNPTR
0229'  02                               LDN STACK
022A'  B6                               PHI RTNPTR
022B'  E2                              SEX STACK
                                        SRET R6         ;GOES RETURN INDICATED AT LIST END
022C'  68 95                    +
                                ;
                                ;
                                ;************************** INPUT TEST AND BRANCH ****************************
                                ;
                                ;
022E'  E2                       ITB:    SEX STACK
                                        SCAL R6, INCHAR
022F'  68 86                    +
0231'  0181'                    +
```

```
 599  0233'  E7                      SEX GPAGE
 600  0234'  46              NEXT2:  LDA LIST
 601  0235'  FB FF                   XRI 0FFH        ;IS LIST FF ?
 602  0237'  3A 3C'                  BNZ TEST
 603  0239'  E2                      SEX STACK
 604                                 SRET R6
 605  023A'  68 96           +
 606  023C'  FB FF           TEST:   XRI 0FFH
 607  023E'  F3                      XOR
 608  023F'  32 45'                  BZ MATCH2       ;DOES CHAR = LIST ?
 609  0241'  16                      INC LIST
 610  0242'  16                      INC LIST
 611  0243'  30 34'                  BR NEXT2
 612  0245'  46              MATCH2: LDA R6
 613  0246'  52                      STR STACK
 614  0247'  46                      LDA R6
 615  0248'  A6                      PLO R6
 616  0249'  02                      LDN STACK
 617  024A'  B6                      PHI R6
 618  024B'  E2                      SEX STACK
 619                                 SRET R6
 620  024C'  68 96           +
 621                         ;
 622                         ;
 623                         ;********************************* TTY ***************************************
 624                         ;
 625                         ;
 626  024E'  F8 FE           TTY:    LDI IOLOC
 627  0250'  A7                      PLO GPAGE       ;TTY CHECKS FOR THE FOLLOWING PSUEDO OPS IN LIST:
 628  0251'  46              NEXT3:  LDA R6                      ;*************************************
 629  0252'  FB FF                   XRI 0FFH        ;IS IT FF?  ; ASCII CHAR -> TYPES IT
 630  0254'  3A 5A'                  BNZ TEST80                  ; 80 = TYPES ASCII @ RD.1
 631  0256'  FC 00                   ADI 00H         ;CLEAR DF   ; 81 = HEX PAIR @ RD.1
 632                                 SRET R6                     ;     2nd CALL SENDS HX PR @ RD.0
 633  0258'  68 96           +
 634                         ;                                   ; 8D = HEX PAIR @ M(RD). INC RD
 635  025A'  FB 7F           TEST80: XRI (80H XOR 0FFH)          ; CA = TYPES CR, LF
 636  025C'  3A 68'                  BNZ TEST81      ;IS IT 80?  ; 9D = CALLS IN4D
 637  025E'  9D              ASCRD1: GHI RD                      ; DD = DECIMAL @ M(RD)(00-99). INC RD
 638  025F'  57                      STR GPAGE                   ; A1 = SEND HI HX NIBBLE @ M(RD)
 639  0260'  8D                      GLO RD                      ; A2 = SEND LO HX NIBBLE @ M(RD).INC RD
 640  0261'  BD                      PHI RD                      ; FF = DONE (END OF LIST)
 641  0262'                  OUTPT2: SCAL R6, OUTCHR             ;*************************************
 642  0262'  68 86           +
 643  0264'  0300'           +
 644  0266'  30 51'                  BR NEXT3
```

```
                                ;
0268' FB 01                     TEST81: XRI (81H XOR 80H)       ;81 XOR 80
026A' 3A 88'                            BNZ TEST8D              ;IS IT 81?
026C' 9D                        HEXRD1: GHI RD
026D' E2                                SEX STACK
026E' 73                                STXD
026F' 8D                                GLO RD
0270' BD                                PHI RD
0271' 12                        OUTHEX: INC STACK
0272' 02                                LDN STACK
0273' 22                                DEC STACK
0274' F6                                SHR
0275' F6                                SHR
0276' F6                                SHR
0277' F6                                SHR
0278' 57                                STR GPAGE
                                        SCAL R6, HXCONV
0279' 68 86                 +
027B' 02D4'                 +
027D' 12                                INC STACK
027E' 02                                LDN STACK
027F' FA 0F                             ANI 0FH
0281' 57                                STR GPAGE
                                        SCAL R6, HXCONV
0282' 68 86                 +
0284' 02D4'                 +
0286' 30 51'                            BR NEXT3
                                ;
                                ;
0288' FB 0C                     TEST8D: XRI (8DH XOR 81H)
028A' 3A 91'                            BNZ TESTCA              ;IS IT 8D ?
028C' 4D                                LDA RD
028D' E2                                SEX STACK
028E' 73                                STXD
028F' 30 71'                            BR OUTHEX
                                ;
0291' FB 47                     TESTCA: XRI (0CAH XOR 8DH)
0293' 3A 9E'                            BNZ TEST9D              ;IS IT CA ?
0295'                           OUTCA:  SCAL R6, TTY            ;OUTPUT CR, LF
0295' 68 86                 +
0297' 024E'                 +
0299' 0D0A                              DW 0D0AH
029B' FF                                DB DONE                 ;DONE
029C' 30 51'                            BR NEXT3
                                ;
029E' FB 57                     TEST9D: XRI (9DH XOR 0CAH)
```

```
 691    02A0'  3A A8'                BNZ TESTDD             ;IS IT 9D ?
 692                                 SCAL R6, IN4DT?        ;ONLY CALL OF IN4DT?
 693    02A2'  68 86          +
 694    02A4'  02E9'          +
 695    02A6'  30 51'                BR NEXT3
 696                                 ;
 697    02A8'  FB 40          TESTDD: XRI (0DDH XOR 09DH)   ;IS TI DD ?
 698    02AA'  3A B1'                BNZ TESTA1             ;EXTEND TTY W/ BRANCH FROM HERE
 699    02AC'  4D                    LDA RD
 700    02AD'  F9 30                 ORI 030H
 701    02AF'  30 D1'                BR OUTPT1
 702                                 ;
 703    02B1'  FB 7C          TESTA1: XRI (0A1H XOR 0DDH)   ;IS IT A1 ?
 704    02B3'  3A C1'                BNZ TESTA2
 705    02B5'  0D                    LDN RD
 706    02B6'  F6                    SHR
 707    02B7'  F6                    SHR
 708    02B8'  F6                    SHR
 709    02B9'  F6                    SHR
 710    02BA'  57                    STR GPAGE
 711                                 SCAL R6, HXCONV
 712    02BC'  58 86          +
 713    02BE'  02D4'          +
 714    02C0'  30 51'                BR NEXT3
 715                                 ;
 716    02C2'  FB 03          TESTA2: XRI (0A2H XOR 0A1H)   ;IS TI A2 ?
 717    02C4'  3A CF'                BNZ OUTASC
 718    02C6'  4D                    LDA RD                 ;R(D)=R(D)+1
 719    02C7'  FA 0F                 ANI 0FH
 720    02C9'  57                    STR GPAGE
 721                                 SCAL R6, HXCONV
 722    02CB'  68 86          +
 723    02CD'  02D4'          +
 724    02CF'  30 51'                BR NEXT3
 725                                 ;
 726    02D1'  26             OUTASC: DEC R6
 727    02D2'  46                    LDA R6
 728    02D3'  57             OUTPT1: STR GPAGE
 729    02D4'  30 62'                BR OUTPT2
 730                                 ;
 731    02D6'  07             HXCONV: LDN GPAGE             ;ONLY USED BY TTY
 732    02D7'  FC F6                 ADI 0F6H
 733    02D9'  C3 02E4'              LBDF GTR9
 734    02DC'  07                    LDN GPAGE
 735    02DD'  F9 30                 ORI 030H
 736    02DF'  57             STORE:  STR GPAGE
```

```
                                        SCAL R6, OUTCHR
02DE'  68 86          +
02E0'  0300'          +
                                        SRET R6
02E2'  68 96          +
                        ;
02E4'  FC 41            GTR9:   ADI 041H
02E6'  C0 02DD'                 LBR STORE
                        ;
                        ;
                        ;********************************** IN4D TSRE ************************************
                        ;
                        ;
02E9'                   IN4DT?: SCAL R6, TSRE?
02E9'  68 86          +
02EB'  02F0'          +
02ED'  C0 01A9'                 LBR IN4D
                        ;
                        ;
                        ;*************** WAIT FOR TRANS. SER. REG. EMPTY ******************
                        ;                       ( LOOP 1 )
                        ;
                        ;                       ;CALLED BY PROMPT, TEST OK.
02F0'  E2               TSRE?:  SEX STACK       ;       AND IND4TSRE, AND PASSTHRU
02F1'  6A               WAIT4:  INP DATA1       ;CLEAR DA (DATA AVAILABLE)
02F2'  6B                       INP STAT1
02F3'  FA C0                    ANI 0C0H        ;MASK FOR TSRE & THRE
02F5'  FB C0                    XRI 0C0H        ;TSRE = THRE = 1 ?
02F7'  3A F1'                   BNZ WAIT4
                                SCAL R6, DELAY2 ;2 BIT DELAY
02F9'  68 86          +
02FB'  019B'          +
02FD'  6A                       INP DATA1       ;CLEAR ECHO DA
                                SRET R6
02FE'  68 96          +
                        ;
                        ;
                        ;************************** SAIL OUT CHARACTER ********************************
                        ;                               ( LOOP 1 )
                        ;
0300'  6B               OUTCHR: INP STAT1
0301'  FA 0C                    ANI 0CH         ;CHECK PREVIOUS I/O ERROR
0303'  CA 00AB'                 LBNZ IOERR
0306'  02               THRE?:  LDN STACK
0307'  FE                      SHL             ;CHECK THRE
0308'  3B 00'                   BNF OUTCHR      ;WAIT FOR UART READY
```

```
 783  030A'  E7                        SEX GPAGE
 784  030B'  F8 FE                     LDI IOLOC
 785  030D'  A7                        PLO GPAGE
 786  030E'  62                        OUT DATA1       ;LOAD UART FROM I/O LOCATION
 787  030F'  27                        DEC GPAGE
 788  0310'  FC 00                     ADI 00H         ;CLEAR DF
 789  0312'  E2                        SEX STACK
 790                                   SRET R6
 791  0313'  68 96          +
 792                         ;
 793                         ;
 794                         ;********************************* ! UNLOCK ************************************
 795                         ;
 796                         ;
 797  0315'                  UNLOCK: SCAL R6, INKWD  ;LOOK FOR:
 798  0315'  68 86          +
 799  0317'  0208'          +
 800  0319'  4E 4C 4F 43              DB 'NLOCK'      ;       NLOCK
 801  031D'  4B
 802  031E'  FF                        DB DONE         ;       DONE
 803  031F'  0324'                     DW NOLOCK       ;BR TO NOLOCK
 804  0321'  C0 035D'                  LBR SAYNO
 805  0324'  F8 40           NOLOCK: LDI 40H
 806  0326'  52                        STR STACK
 807  0327'  E2              SETFLG: SEX STACK
 808  0328'  F8 03                     LDI SYSFLG
 809  032A'  A7                        PLO GPAGE
 810  032B'  07                        LDN GPAGE
 811  032C'  F1                        OR              ;STORE WRITE FLAG
 812  032D'  57              MODFLG: STR GPAGE
 813  032E'  C0 0107'                  LBR PROMPT
 814                         ;
 815                         ;
 816                         ;****************************** ! LOCK *************************************
 817                         ;
 818                         ;
 819                         ;
 820  0331'                  LOCK:   SCAL R6, INKWD
 821  0331'  68 86          +
 822  0333'  0208'          +
 823  0335'  4F 43 4B                  DB 'OCK'
 824  0338'  FF                        DB DONE
 825  0339'  033D'                     DW LOCKUP
 826  033B'  30 5D'                    BR SAYNO
 827  033D'  F8 9F           LOCKUP: LDI 9FH
 828  033F'  52                        STR STACK
```

```
 829  0340'  E2                CLRFLG: SEX STACK
 830  0341'  F8 03                     LDI SYSFLG
 831  0343'  A7                        PLO GPAGE
 832  0344'  07                        LDN GPAGE
 833  0345'  F2                        AND             ;CLEAR WRITE AND SYS FLAGS
 834  0346'  30 2D'                    BR MODFLG
 835                                 ;
 836                                 ;
 837                                 ;********************** !OPEN SYS **********************
 838                                 ;
 839                                 ;
 840  0348'                          OPEN?:  SCAL R6. INKWD
 841  0348'  68 86          +
 842  034A'  0208'          +
 843  034C'  50 45 4E                 DB 'PEN'        ;LOOK FOR:
 844  034F'  20 53 59 53               DB ' SYS'       ;       PEN SYS
 845  0353'  FF                        DB DONE         ;       DONE
 846  0354'  0358'                     DW OPEN
 847  0356'  30 5D'                    BR SAYNO
 848  0358'  F8 20                   OPEN:   LDI 20H
 849  035A'  52                        STR STACK
 850  035B'  30 27'                    BR SETFLG       ;SET SYS FLAG
 851                                 ;
 852                                 ;
 853                                 ;********************** SAY NO ! ***************************
 854                                 ;
 855  035D'  E2                      SAYNO:  SEX STACK
 856                                        SCAL R6. DELAY2
 857  035E'  68 86          +
 858  0360'  019B'          +
 859                                        SCAL R6. TTY
 860  0362'  68 86          +
 861  0364'  024E'          +
 862  0366'  204E                      DW 204EH              ;TYPE: SPACE No !
 863  0368'  6F20                      DW 6F20H              ;       DONE
 864  036A'  21FF                      DW 21FFH
 865  036C'  C0 0107'                  LBR PROMPT
 866                                 ;
 867                                 ;
 868                                 ;********************** TEST OK ? **************************
 869                                 ;
 870  036F'  E2                      TESTOK: SEX STACK
 871                                        SCAL R6. TSRE?
 872  0370'  68 86          +
 873  0372'  02F0'          +
 874                                        SCAL R6. TTY    ;TYPE: Ok ? .
```

```
 875  0374'  68 86        +
 876  0376'  024E'        +
 877  0378'  20 4F 6B 20           DB ' Ok ? '
 878  037C'  3F 20
 879  037E'  03                    DB ETX          ;       ETX
 880  037F'  FF                    DB DONE         ;       DONE
 881  0380'  E2              TESTY: SEX STACK
 882                               SCAL R6, TSRE?
 883  0381'  68 86        +
 884  0383'  02F0'        +
 885                               SCAL R6, INCHAR
 886  0385'  68 86        +
 887  0387'  0181'        +
 888  0389'  07                    LDN GPAGE
 889  038A'  FB 59                 XRI 059H        ;XOR 'Y'        IS IT YES ?
 890  038C'  3A 92'                BNZ NOYRTN
 891  038E'  FF 00            YRTN: SHI 00H         ;SET DF
 892                               SRET R6
 893  0390'  68 96        +
 894  0392'  FC 00            NOYRTN: ADI 00H       ;CLEAR DF
 895                               SRET R6
 896  0394'  68 96        +
 897                          ;
 898                          ;
 899                          ;************************** ? Memory routine *********************************
 900                          ;
 901  0396'                   QUESTN: SCAL R6, IN4D
 902  0396'  68 86        +
 903  0398'  01A9'        +
 904  039A'  8D                    GLO RD
 905  039B'  73                    STXD
 906  039C'  9D                    GHI RD
 907  039D'  73                    STXD
 908                               SCAL R6, IN4D
 909  039E'  68 86        +
 910  03A0'  01A9'        +
 911  03A2'  9D                    GHI RD
 912  03A3'  BE                    PHI RE
 913  03A4'  8D                    GLO RD
 914  03A5'  AE                    PLO RE
 915  03A6'  12                    INC STACK
 916  03A7'  42                    LDA STACK
 917  03A8'  BD                    PHI RD
 918  03A9'  02                    LDN STACK
 919  03AA'  AD                    PLO RD
 920                               SCAL R6, DELAY2
```

```
 921    03AB'  68 86        +
 922    03AD'  019B'        +
 923    03AF'  E2                OUTADR: SEX STACK
 924    03B0'  8D                        GLO RD
 925    03B1'  73                        STXD
 926    03B2'  9D                        GHI RD
 927    03B3'  73                        STXD
 928                                     SCAL R6, TTY
 929    03B4'  68 86        +
 930    03B6'  024E'        +
 931    03B8'  CA                        DB 0CAH
 932    03B9'  81                        DB 081H        ;TYPE: CR.LF
 933    03BA'  81                        DB 081H
 934    03BB'  20                        DB 020H        ;       OUT HEX PR 12. SPACE
 935    03BC'  FF                        DB 0FFH        ;       DONE
 936    03BD'  12                        INC STACK
 937    03BE'  42                        LDA STACK
 938    03BF'  BD                        PHI RD
 939    03C0'  02                        LDN STACK
 940    03C1'  AD                        PLO RD
 941    03C2'  8E                HEXBYT: GLO RE
 942    03C3'  3A C9'                    BNZ DECCNT
 943    03C5'  9E                        GHI RE
 944    03C6'  C2 0107'                  LBZ PROMPT
 945    03C9'  2E                DECCNT: DEC RE
 946                                     SCAL R6, TTY
 947    03CA'  68 86        +
 948    03CC'  024E'        +
 949    03CE'  80FF                      DW 80FFH       ;TYPE: OUT HEX RD. DONE
 950    03D0'  8D                        GLO RD
 951    03D1'  FA 0F                     ANI 00FH       ;MASK FOR LINE LENGTH
 952    03D3'  C2 03E3'                  LBZ LNTEST     ;       07 = 08H / LINE
 953    03D6'  FA 01                     ANI 01H        ;       0F = 10H / LINE
 954    03D8'  3A C2'                    BNZ HEXBYT
 955                                     SCAL R6, TTY
 956    03DA'  68 86        +
 957    03DC'  024E'        +
 958    03DE'  20FF                      DW 20FFH       ;TYPE: SPACE, DONE
 959    03E0'  C0 03C2'                  LBR HEXBYT
 960                            ;
 961    03E3'  8E                LNTEST: GLO RE         ;TEST FOR END OF LINE
 962    03E4'  3A EC'                    BNZ LNEND
 963    03E6'  9E                        GHI RE
 964    03E7'  3A EC'                    BNZ LNEND
 965    03E9'  C0 0107'                  LBR PROMPT
 966                            ;
```

```
 967    03EC'                        LMEND:  SCAL R6. TTY    ;TYPE: ';'. DONE
 968    03EC'  68 86          +
 969    03EE'  024E'          +
 970    03F0'  3BFF                   DW 3BFFH
 971    03F2'  C0 03AF'               LBR OUTADR
 972                                  ;
 973                                  ;
 974                                  ;************************** ! Memory routine ***********************************
 975                                  ;
 976    03F5'  F8 03                  WRITEM: LDI SYSPLG
 977    03F7'  A7                             PLO GPAGE
 978    03F8'  07                             LDN GPAGE
 979    03F9'  FA 40                          ANI 40H         ;CHECK FOR INLOCK FLAG
 980    03FB'  C2 035D'                       LBZ SAVNO
 981    03FE'                        INADDR: SCAL R5. IN4D
 982    03FE'  68 86          +
 983    0400'  01A9'          +
 984    0402'  9D                             GHI RD
 985    0403'  BE                             PHI RE
 986    0404'  8D                             GLO RD
 987    0405'  AE                             PLO RE
 988    0406'                        INIST:  SCAL R6. INCHAR
 989    0406'  68 86          +
 990    0408'  0181'          +
 991    040A'  07                             LDN GPAGE
 992    040B'  32 36'                         BZ INIST        ;IGNORE NULLS
 993                                          SCAL R5. ASCHEX
 994    040D'  68 86          +
 995    040F'  01C8'          +
 996    0411'  C2 0437'                       LBDF TESTSP     ;DF = NOT HEX
 997    0414'  07                             LDN GPAGE
 998    0415'  AD                             PLO RD          ;SAVE LO DIGIT
 999    0416'                        INEND:  SCAL R6. INCHAR
1000    0416'  68 86          +
1001    0418'  0181'          +
1002                                          SCAL R6. ASCHEX
1003    041A'  68 86          +
1004    041C'  01C8'          +
1005    041E'  33 29'                         BDF ERROR1
1006                                          SCAL R6. SBFTD4
1007    0420'  68 86          +
1008    0422'  01EF'          +
1009    0424'  8D                             GLO RD
1010    0425'  5E                             STR RE          ;WRITE INTO RAM
1011    0426'  1E                             INC RE
1012    0427'  30 36'                         BR INIST
```

```
1013  0429'                       ERROR1: SCAL R6, DELAY2
1014  0429'  68 86          +
1015  042B'  019B'          +
1016                                  SCAL R6, TTY    ;TYPE:
1017  042D'  68 86          +
1018  042F'  024E'          +
1019  0431'  3F3F                    DW 3F3FH        ;       ?, ?
1020  0433'  FF                      DB DONE         ;       DONE
1021  0434'  C0 0107'                LBR PROMPT
1022  0437'  07                  TESTSP: LDN GPAGE
1023  0438'  FB 20                   XRI 20H         ;' ' XOR 'SPACE'        IS IT 'SPACE' ?
1024  043A'  C2 0406'                LBZ INIST
1025  043D'  FB 0C                   XRI 0CH         ; '.' XOR SPACE         IS IT '.' ?
1026  043F'  CA 0449'                LBNZ SEMI?
1027                                  SCAL R6, PASSCA
1028  0442'  68 86          +
1029  0444'  045E'          +
1030  0446'  C0 0406'                LBR INIST
1031  0449'  FB 17              SEMI?: XRI 017H        ; ':' XOR '.'   IS IT ':' ?
1032  044B'  3A 54'                  BNZ TESTCR
1033                                  SCAL R6, PASSCA
1034  044D'  68 86          +
1035  044F'  045E'          +
1036  0451'  C0 03FE'                LBR INADDR
1037                              ;
1038  0454'  FB 36               TESTCR: XRI 036H        ;'CR' XOR ':'   IS IT 'CR' ?
1039  0456'  CA 0429'                LBNZ ERROR1
1040  0459'  FC 00                   ADI 00H         ;CLEAR DF
1041  045B'  C0 0107'                LBR PROMPT
1042                              ;
1043  045E'                       PASSCA: SCAL R6, INCHAR ;ONLY USED BY .M
1044  045E'  68 86          +
1045  0460'  0181'          +
1046  0462'  07                       LDN GPAGE
1047  0463'  FB 0D                   XRI 0DH         ;IS IT 'CR' ?
1048  0465'  3A 5E'                  BNZ PASSCA
1049  0467'                      INLP:  SCAL R6, INCHAR
1050  0467'  68 86          +
1051  0469'  0181'          +
1052  046B'  07                       LDN GPAGE
1053  046C'  FB 0A                   XRI 0AH         ;IS IT 'LF' ?
1054  046E'  3A 67'                  BNZ INLP
1055                                  SRET R6
1056  0470'  68 96          +
1057                              ;
1058                              ;
```

```
1059                                ;********************* $ P (RUNS PROGRAM AT AAAA ******************************
1060                                ;                        WITH PC = R3. X = R2)
1061                                ;
1062    0472'  F8 03                TESTS:  LDI SYSFLG
1063    0474'  A7                           PLO GPAGE
1064    0475'  07                           LDN GPAGE
1065    0476'  FA E0                        ANI 0E0H        ;MASK FOR ADDR, WRITE, SYS FLAGS
1066    0478'  FB E0                        XRI 0E0H        ;ADDR = WRITE = SYS = 1 ?
1067    047A'  CA 035D'                     LBNZ SAYNO
1068    047D'                       DOLIN:  SCAL R6. IN4D
1069    047D'  58 86                +
1070    047F'  01A9'                +
1071    0481'  9D                           GHI RD
1072    0482'  BE                           PHI RE
1073    0483'  8D                           GLO RD
1074    0484'  AE                           PLO RE
1075                                        SCAL R6. TTY
1076    0485'  58 86                +
1077    0487'  024E'                +
1078    0489'  CA81                         DW 0CA81H       ;TYPE: SPACE.
1079    048B'  812C                         DW 812CH        ;       OUT HEX PR ','
1080    048D'  FF                           DB DONE         ;       DONE
1081                                        SCAL R6. TESTCK
1082    048E'  58 86                +
1083    0490'  036F'                +
1084    0492'  CB 0107'                     LBNF PROMPT
1085    0495'  E2                           SEX STACK       ;X => R2
1086    0496'  86                           GLO R6
1087    0497'  73                           STXD
1088    0498'  96                           GHI R6
1089    0499'  73                           STXD
1090    049A'  9E                           GHI RE
1091    049B'  B6                           PHI R6
1092    049C'  8E                           GLO RE
1093    049D'  A6                           PLO R6
1094    049E'  FC 00                        ADI 00          ;CLEAR DF
1095                                        SRET R6
1096    04A0'  58 96                +
1097                                ;
1098                                ;
1099                                ;********************** CRC CALCULATION ***************************************
1100                                ;
1101    04A2'                       CRC:    SCAL R6. TTY    ;TYPE:
1102    04A2'  58 86                +
1103    04A4'  024E'                +
1104    04A6'  52 43 20                     DB 'RC '        ;       RC from.
```

```
1105    04A9'  66 72 6F 6D              DB 'from '      ;       ETX.
1106    04AD'  20
1107    04AE'  03                       DB ETX          ;       IN4D.
1108    04AF'  9DFF                     DW 9DFFH        ;       DONE
1109    04B1'  9D                       GHI RD
1110    04B2'  BE                       PHI RE
1111    04B3'  8D                       GLO RD
1112    04B4'  AE                       PLO RE
1113                                    SCAL R6. TTY    ;TYPE:
1114    04B5'  68 86            +
1115    04B7'  024E'            +
1116    04B9'  6F 76 65 72              DB 'over '      ;       over.
1117    04BD'  20
1118    04BE'  03                       DB ETX          ;       ETX.
1119    04BF'  9D                       DB 09DH         ;       IN4D.
1120    04C0'  FF                       DB DONE         ;       DONE
1121    04C1'  F8 07                    LDI CRCLO
1122    04C3'  A7                       PLO GPAGE
1123    04C4'  F8 00                    LDI 00H
1124    04C6'  BC                       PHI RC          ;CLEAR "ALL FF'S" FLAG
1125    04C7'  57                       STR GPAGE
1126    04C8'  27                       DEC GPAGE       ;SET CRC HI & LO = 0000
1127    04C9'  57                       STR GPAGE
1128    04CA'  0E               CLOOP1: LDN RE
1129    04CB'  FB FF                    XRI 0FFH
1130    04CD'  CE                       LSZ
1131    04CE'  BC                       PHI RC
1132    04CF'  E2                       SEX STACK       ;A NOP
1133                                    SCAL R6. CRCSUB
1134    04D0'  68 86            +
1135    04D2'  050E'            +
1136    04D4'  2D                       DEC RD
1137    04D5'  8D                       GLO RD
1138    04D6'  3A CA'                   BNZ CLOOP1
1139    04D8'  9D                       GHI RD
1140    04D9'  CA 04CA'                 LBNZ CLOOP1
1141    04DC'  9C                       GHI RC
1142    04DD'  C2 04F5'                 LBZ SAYCLR      ;IS MEMORY SPACE EMPTY ?
1143    04E0'  97                       GHI GPAGE
1144    04E1'  BD                       PHI RD
1145    04E2'  87                       GLO GPAGE
1146    04E3'  AD                       PLO RD  ;
1147                                    SCAL R6. TTY    ;IF NOT. TYPE:
1148    04E4'  68 86            +
1149    04E6'  024E'            +
1150    04E8'  CA                       DB 0CAH         ;       CR. LF
```

```
1151    04E9'  43 52 43 20              DB 'CRC = '     ;       CRC =
1152    04ED'  3D 20
1153    04EF'  8D8D                     DW 8D8DH        ;       OUT VID RD I2
1154    04F1'  FF                       DB DONE         ;       DONE
1155    04F2'  C0 0107'                 LBR PROMPT
1156    04F5'                   SAYCLR: SCAL P5. TTY    ;IF CLEAR. TYPE: CR. LF. NULL X6
1157    04F5'  58 86            +
1158    04F7'  024E'            +
1159    04F9'  CA                       DB 0CAH         ;       Memory is clear
1160    04FA'  4D 65 6D 6F              DB 'Memory '
1161    04FE'  72 79 20
1162    0501'  69 73 20 63              DB 'is clear.'
1163    0505'  6C 65 61 72
1164    0509'  2E
1165    050A'  FF                       DB DONE         ;       DONE
1166    050B'  C0 0107'                 LBR PROMPT      ;GO TO PROMPT
1167                            ;
1168                            ;
1169    050E'  E7               CRCSUB: SEX GPAGE       ;CRC CALCULATION SUBROUTINE
1170    050F'  4E                       LDA RE          ;SEE BRADLEY CRC WRITEUP
1171    0510'  F3                       XOR
1172    0511'  27                       DEC GPAGE
1173    0512'  57                       STR GPAGE
1174    0513'  F6                       SHR
1175    0514'  F6                       SHR
1176    0515'  F6                       SHR
1177    0516'  F6                       SHR
1178    0517'  F3                       XOR
1179    0518'  57                       STR GPAGE
1180    0519'  FE                       SHL
1181    051A'  FE                       SHL
1182    051B'  FE                       SHL
1183    051C'  FE                       SHL
1184    051D'  60                       IRX
1185    051E'  60                       IRX
1186    051F'  F3                       XOR
1187    0520'  27                       DEC GPAGE
1188    0521'  73                       STXD
1189    0522'  72                       LDXA
1190    0523'  F6                       SHR
1191    0524'  F6                       SHR
1192    0525'  F6                       SHR
1193    0526'  F3                       XOR
1194    0527'  73                       STXD
1195    0528'  F0                       LDX
1196    0529'  FE                       SHL
```

```
1197    052A'  FE                      SHL
1198    052B'  FE                      SHL
1199    052C'  FE                      SHL
1200    052D'  FE                      SHL
1201    052E'  F3                      XOR
1202    052F'  60                      IRX
1203    0530'  60                      IRX
1204    0531'  73                      STXD
1205    0532'  E2                      SEX STACK
1206                                   SRET R6
1207    0533'  68 96          +
1208                           ;
1209                           ;
1210                           ;************************ ! TIME ******************************
1211                           ;
1212                           ;
1213    0535'                  TIMEST: SCAL R6, INKWD  ;LOOK FOR:
1214    0535'  68 86          +
1215    0537'  0208'          +
1216    0539'  49 4D 45                DB 'IME'        ;       IME
1217    053C'  FF                      DB DONE         ;       DONE
1218    053D'  0542'                   DW CLRBUF
1219    053F'  C0 0107'                LBR PROMPT
1220    0542'  97                      CLRBUF: GHI GPAGE
1221    0543'  BE                              PHI RE
1222    0544'  F8 20                          LDI BUF9        ;GPAGE = 9 DIGIT INPUT BUFFER
1223    0546'  52                              STR STACK
1224    0547'  AE                              PLO RE
1225    0548'  F8 00                  CLR:    LDI 00H         ;CLEAR 9 DIGIT BUFFER
1226    054A'  5E                              STR RE
1227    054B'  1E                              INC RE
1228    054C'  8E                              GLO RE
1229    054D'  FF 09                           SMI 09H
1230    054F'  E2                              SEX STACK
1231    0550'  F3                              XOR             ;9 PAST END ?
1232    0551'  CA 0548'                        LBNZ CLR
1233    0554'  02                      SETTOP: LDN STACK
1234    0555'  AE                              PLO RE
1235    0556'  22                      INPUT:  DEC STACK
1236                                           SCAL R6, INTIME
1237    0557'  68 86          +
1238    0559'  05AC'          +
1239    055B'  12                              INC STACK
1240    055C'  07                              LDN GPAGE
1241    055D'  FB 40                           XRI 40H         ;XOR '0'        IS IT AN 0 ?
1242    055F'  32 7B'                          BZ TIMEJM
```

```
1243    0561'  07                LDN GPAGE
1244    0562'  FF 30              SMI 030H        ;IGNORE NON-DECIMAL
1245    0564'  CB 0556'           LBNF INPUT
1246    0567'  FF 0A              SMI 0AH
1247    0569'  C3 0556'           LBDF INPUT
1248    056C'  FC 0A        KEEP1: ADI 0AH
1249    056E'  5E                 STR RE
1250    056F'  1E                 INC RE
1251    0570'  8E                 GLO RE
1252    0571'  FF 09              SMI 09H
1253    0573'  E2                 SEX STACK
1254    0574'  F3                 XOR
1255    0575'  C2 0554'           LBZ SETTOP
1256    0578'  C0 0556'           LBR INPUT
1257                        ;
1258                        ;
1259    057B'  E3           TIMEJM: SEX PC          ;DISABLE INTERRUPTS
1260    057C'  71                 DIS
1261    057D'  33                 DB 33H
1262    057E'  02                 LDN STACK
1263    057F'  FF 10              SMI 10H
1264    0581'  A7                 PLO GPAGE       ;NOW AT DAYS X100
1265    0582'  8E           TIMEIN: GLO RE          ; PREVIOUSLY CALLED COPYLOOP
1266    0583'  FF 09              SMI 09H
1267    0585'  E2                 SEX STACK
1268    0586'  F3                 XOR
1269    0587'  3A 8B'             BNZ COPY
1270    0589'  02                 LDN STACK
1271    058A'  AE                 PLO RE
1272    058B'  4E           COPY:  LDA RE
1273    058C'  57                 STR GPAGE
1274    058D'  17                 INC GPAGE
1275    058E'  87                 GLO GPAGE
1276    058F'  FC 07              ADI 07H
1277    0591'  F3                 XOR
1278    0592'  3A 82'             BNZ TIMEIN
1279    0594'  F8 01              LDI 01          ;TIME CORRECTION FOR LOADING
1280    0596'  57                 STR GPAGE
1281    0597'  02                 LDN STACK
1282    0598'  FC 02              ADI 02
1283    059A'  A7                 PLO GPAGE
1284    059B'  F8 00              LDI 00
1285    059D'  B7                 SEX GPAGE
1286    059E'  73                 STXD
1287    059F'  73                 STXD
1288    05A0'  F8 01              LDI 01
```

```
1289    05A2'  57                      STR GPAGE
1290    05A3'  C8                      LSKP            ;LBR TO FINETRIM CAN BE /INSERTED HERE
1291    05A4'  FFFF                    DW 0FFFFH
1292    05A6'  E3              START2: SEX PC          ;IS NOT INCLUDED IN THIS SYSTEM
1293    05A7'  70                      RET
1294    05A8'  33                      DB 33H          ;ENABLE INTERRUPT
1295    05A9'  C0 00B4'                LBR UNADDR
1296                           ;
1297                           ;
1298                           ;****************************** INPUT TIME ***********************************
1299                           ;
1300    05AC'  6B              INTIME: INP STAT1       ;CHECK FOR DA
1301    05AD'  F6                      SHR
1302    05AE'  3B AC'                  BNF INTIME      ;WAIT FOR DA
1303    05B0'  FA 06                   ANI 06H         ;CHECK FOR FE AND PE
1304    05B2'  32 B7'                  BZ KEEPT
1305    05B4'  6A                      INP DATA1       ;CLEAR BAD DATA
1306    05B5'  30 AC'                  BR INTIME
1307    05B7'  F8 FE           KEEPT:  LDI IOLOC
1308    05B9'  A7                      PLO GPAGE
1309    05BA'  E7                      SEX GPAGE
1310    05BB'  6A                      INP DATA1
1311    05BC'  FA 7F                   ANI 07FH        ;MASK MSB
1312    05BE'  57                      STR GPAGE
1313    05BF'  C0 019B'                LBR DELAY2
1314                           ;
1315                           ;
1316                           ;****************************** ? TIME ***************************************
1317                           ;
1318                           ;
1319    05C2'                  QUESTT: SCAL R6, TTY    ;TYPE:
1320    05C2'  68 86           +
1321    05C4'  024E'           +
1322    05C6'  2E 2E 2E 20             DB '... '       ;       ... DONE
1323    05CA'  FF                      DB DONE
1324    05CB'  F8 18                   LDI SEC1
1325    05CD'  A7                      PLO GPAGE
1326    05CE'  07              WAIT1:  LDN GPAGE       ;WAIT FOR SEC = 00
1327    05CF'  3A CE'                  BNZ WAIT1
1328    05D1'  87                      GLO GPAGE
1329    05D2'  FF 08                   SMI 08H         ;MOVE GPAGE TO D X 100
1330    05D4'  AD                      PLO RD
1331    05D5'  97                      GHI GPAGE
1332    05D6'  BD                      PHI RD          ;SET R(D) = GPAGE DX100
1333                                   SCAL R6, TTY    ;TYPE:
1334    05D7'  68 86           +
```

```
1335    05D9'  024E'        +
1336    05DB'  20DD                 DW 020DDH       ;       DDD HH MM SS Z
1337    05DD'  DDDD                 DW 0DDDDH       ;       ...
1338    05DF'  20DD                 DW 020DDH
1339    05E1'  DD                   DB 0DDH
1340    05E2'  3ADD                 DW 03ADDH
1341    05E4'  DD20                 DW 0DD20H
1342    05E6'  DD                   DB 0DDH
1343    05E7'  35 20 5A 2E          DB '5 Z... '
1344    05EB'  2E 2E 20
1345    05EE'  FF                   DB DONE
1346    05EF'  8D                   GLO RD
1347    05F0'  FC 06                ADI 06H
1348    05F2'  AD                   PLO RD
1349    05F3'  5D                   STR RD
1350    05F4'  FF 06                SMI 06H
1351    05F6'  A7                   PLO GPAGE
1352    05F7'  07               WAIT2:  LDN GPAGE
1353    05F8'  FB 06                XRI 06H
1354    05FA'  CA 05F7'             LBNZ WAIT2
1355    05FD'  FC 00                ADI 00H         ;CLEAR DF
1356    05FF'  C0 0107'             LBR PROMPT
1357                            ;
1358                            ;
1359                            ;****************************** : SEQUENCER ************************************
1360                            ;
1361    0602'                   SEQSET: SCAL R6. TTY            ;TYPE:
1362    0602'  68 86        +
1363    0604'  024E'        +
1364    0606'  65 71 75 65          DB 'equencer'           ;       equencer On ?
1365    060A'  6E 63 65 72
1366    060E'  20 4F 6E 20          DB ' On ? '             ;       ETX
1367    0612'  3F 20
1368    0614'  03FF                 DW 03FFH                ;       DONE
1369                                SCAL R6. TESTY
1370    0616'  68 86        +
1371    0618'  0380'        +
1372    061A'  33 32'               BDF SETPC               ;IS IT Yes ?
1373    061C'  F8 07'               LDI HIGH(IDLLOC)        ;IF NOT GO TO IDLE LOOP
1374    061E'  BD                   PHI RD
1375    061F'  F8 00'               LDI LOW(IDLLOC)
1376    0621'  AD                   PLO RD
1377    0622'  F8 60            SETPPC: LDI PPCHI       ;START PSUEDO PROGRAM
1378    0624'  A7                   PLO GPAGE
1379    0625'  E3                   SEX PC
1380    0626'  71                   DIS
```

```
1381    0627'  33                      DB 33H          ;DISABLE INTERRUPT
1382    0628'  9D                      GHI RD
1383    0629'  57                      STR GPAGE
1384    062A'  17                      INC GPAGE
1385    062B'  8D                      GLO RD
1386    062C'  57                      STR GPAGE
1387    062D'  70                      RET
1388    062E'  33                      DB 33H          ;ENABLE INTERRUPT
1389    062F'  C0 0107'                LBR PROMPT
1390                                ;
1391                                ;
1392    0632'                       SETPC:  SCAL R6. TTY            ;TYPE:
1393    0632'  68 86          +
1394    0634'  024E'          +
1395    0636'  20 61 74 20              DB ' at PPC = '         ; at PPC =
1396    063A'  50 50 43 20
1397    063E'  3D 20
1398    0640'  03                      DB ETX                  ; ETX
1399    0641'  9DFF                    DW 9DFFH                ; IN4D, DONE
1400    0643'  8D                      GLO RD
1401    0644'  AE                      PLO RE
1402    0645'  9D                      GHI RD
1403    0646'  BE                      PHI RE
1404                                ;
1405    0647'  32 60'                  BZ PCSAME       ;If the entered PPC = SPACE or 00xx.
1406                                ;                   ; the current PPC will continue.
1407                                ;
1408                                   SCAL R6. TTY
1409    0649'  68 86          +
1410    064B'  024E'          +
1411    064D'  CA81                    DW 0CA81H       ;TYPE: SPACE.
1412    064F'  812C                    DW 812CH        ;       OUT HEX PR ','
1413    0651'  FF                      DB DONE         ;       DONE
1414                                   SCAL R6. TESTOK
1415    0652'  68 86          +
1416    0654'  036F'          +
1417    0656'  3B 7B'                  BNF SET2ND
1418    0658'  9E                      GHI RE
1419    0659'  BD                      PHI RD
1420    065A'  8E                      GLO RE
1421    065B'  AD                      PLO RD
1422    065C'  FC 00                   ADI 00          ;CLEAR DF
1423    065E'  30 22'                  BR SETPPC
1424                                ;
1425    0660'                       PCSAME: SCAL R6. TTY    ;TYPE:
1426    0660'  68 86          +
```

```
1427  0662'  024E'        +
1428  0664'  CA                    DB 0CAH         ; CR.LF
1429  0665'  43 6F 6E 74           DB 'Continue ? '; Continue
1430  0669'  69 6E 75 65
1431  066D'  20 3F 20
1432  0670'  03                    DB ETX
1433  0671'  FF                    DB DONE
1434                               SCAL R6, TESTY  ;IS THE RESPONSE 'Y'?
1435  0672'  58 86        +
1436  0674'  0380'        +
1437  0676'  3B 7B'                BNF SET2ND      ;If not 'Y', try again
1438  0678'  C0 0107'              LBR PROMPT      ;IF 'Y' (Continue w/ same PPC), go to Prompt
1439                          ;
1440  067B'                   SET2ND: SCAL R6, TTY
1441  067B'  58 86        +
1442  067D'  024E'        +
1443  067F'  CA53                  DW 0CA53H       ;TYPE: CR.LF.'S'
1444  0681'  FF                    DB DONE         ;      DONE
1445  0682'  30 02'                BR SEQSET
1446                          ;
1447                          ;
1448                          ;****************************** ? SEQUENCER *********************************
1449                          ;
1450  0684'  97                SEQ?:  GHI GPAGE
1451  0685'  BD                       PHI RD
1452  0686'  F8 60                    LDI PPCHI
1453  0688'  AD                       PLO RD
1454                                   SCAL R6, TTY           ;TYPE:
1455  0689'  58 86        +
1456  068B'  024E'        +
1457  068D'  65 71 75 65           DB 'equencer '          ;      equencer
1458  0691'  6E 63 65 72
1459  0695'  20
1460  0696'  50 50 43 20           DB 'PPC = '             ;      PPC =
1461  069A'  3D 20
1462  069C'  8D8D                  DW 8D8DH                ;      OUT HX PR M(RD) I2
1463  069E'  20 20 52 73           DB '  Rstk = '          ;      Rstk =
1464  06A2'  74 6B 20 3D
1465  06A6'  20
1466  06A7'  8D8D                  DW 8D8DH                ;      OUT HX PR M(RD) I2
1467  06A9'  20 20 41 73           DB '  Astk = '          ;      Astk =
1468  06AD'  74 6B 20 3D
1469  06B1'  20
1470  06B2'  8D8D                  DW 8D8DH                ;      OUT HX PR M(RD) I2
1471  06B4'  20 20                 DB '  '
1472  06B6'  FF                    DB DONE                 ;DONE
```

```
1473  06B7'  F8 54                    LDI ASTXHI
1474  06B9'  A7                       PLO GPAGE
1475  06BA'  47                       LDA GPAGE
1476  06BB'  BD                       PHI RD
1477  06BC'  07                       LDN GPAGE
1478  06BD'  AD                       PLO RD
1479  06BE'  8D                SEQ?EX: GLO RD
1480  06BF'  FA 0F                    ANI 0FH
1481  06C1'  FB 0F                    XRI 0FH
1482  06C3'  C2 0107'                 LBZ PROMPT
1483                                   SCAL R6, TTY    ;TYPE:
1484  06C6'  58 86          +
1485  06C8'  024E'          +
1486  06CA'  8D20                      DW 8D20H        ;       OUT HX PR M(RD)
1487  06CC'  FF                        DB DONE         ;DONE
1488  06CD'  30 BE'                    BR SEQ?EX
1489                                ;
1490                                ;*******************************************************************************
1491                                ;
1492                                ;***************************** SEQUENCER IDLE LOOP ******************************
1493                                ;
1494                                ;
1495                                      ORG (HDSTRT + 700H)     ; DO NOT MOVE !
1496                                ;
1497                                ;***** SEQUENCER IDLE LOOP (PSUEDO OP CODES - NOT 1806 CODE ..
1498                                ;
1499  0700'  4D28                   IDLLOC: DW 4D28H              ;INITIALIZE SEQUENCER   4D = INIT STK & CTRS
1500  0702'  0700'                          DW IDLLOC             ;GO TO IDLLOC           28 = GOTO
1501                                ;
1502                                ;
1503                                ;*******************************************************************************
1504                                ;
1505                                ;
1506                                ;************************** ! FOLLOW PPC (PPCSHO) ****************************
1507                                ;
1508                                ;       ;FOLLOW PPC CAN ONLY BE STOPPED
1509                                ;       ;BY BREAKING THE LOOP AND READDRESSING
1510                                ;
1511  0704'                         PPCSHO: SCAL R6, TTY    ;TYPE:
1512  0704'  58 86          +
1513  0706'  024E'          +
1514  0708'  6F 6C 6C 6F                   DB 'ollow'      ;       ollow PPC
1515  070C'  77
1516  070D'  20 50 50 43                    DB ' PPC'       ;
1517  0711'  CAFF                          DW 0CAFFH       ;       CR. LF. DONE
1518  0713'  F8 60                  REPORT: LDI PPCHI
```

```
1519    0715'  AD                      PLO RD
1520    0716'  97                      GHI GPAGE
1521    0717'  BD                      PHI RD
1522    0718'  E2                      SEX STACK
1523                                   SCAL R6. TTY    ;TYPE:
1524    0719'  68 86          +
1525    071B'  024E'          +
1526    071D'  8D8D                    DW 8D8DH        ;       OUT VIA M(R(D)) I 2
1527    071F'  20                      DB ' '
1528    0720'  FF                      DB DONE         ;       . .     DONE
1529    0721'  2D                      DEC RD
1530    0722'  2D                      DEC RD          ;POINT TO PPCHI
1531    0723'  4D                      LDA RD
1532    0724'  BC                      PHI RC
1533    0725'  0D                      LDN RD
1534    0726'  AC                      PLO RC
1535    0727'  ED                  PPCCMP: SEX RD      ;COMPARE WITH OLD PPC
1536    0728'  2D                      DEC RD          ;TYPE NEW PPC WHEN IT APPEARS
1537    0729'  9C                      GHI RC
1538    072A'  F3                      XOR
1539    072B'  3A 13'                  BNZ REPORT
1540    072D'  1D                      INC RD
1541    072E'  8C                      GLO RC
1542    072F'  F3                      XOR
1543    0730'  3A 13'                  BNZ REPORT
1544    0732'  30 27'                  BR PPCCMP
1545                               ;
1546                               ;
1547                               ;*******************************************************************************
1548                               ;
1549                               ;********************** MEMORY PROTECT AND ENABLE ******************************
1550                               ;
1551    0734'                      MEMSAV: SCAL R6. TTY            ;TYPE: 'text)
1552    0734'  68 86          +
1553    0736'  024E'          +
1554    0738'  65 6D 6F 72             DB 'emory - '
1555    073C'  79 20 2D 20
1556    0740'  50 72 6F 74             DB 'Protect or Enable'
1557    0744'  65 63 74 20
1558    0748'  6F 72 20 45
1559    074C'  6E 61 62 6C
1560    0750'  65
1561    0751'  20 28 50 20             DB ' (P or E) ? '
1562    0755'  6F 72 20 45
1563    0759'  29 20 3F 20
1564    075D'  03                      DB ETX
```

```
1565    075E'  FF                      DB DONE
1566                                ;
1567                                    SCAL R6, TSRE?
1568    075F'  68 86          +
1569    0761'  02F0'          +
1570                                    SCAL R6, ITB            ;CALL INPUT TEST AND BRANCH
1571    0763'  68 86          +
1572    0765'  022E'          +
1573    0767'  50                       DB 'P'                  ;       IF P, GO TO PTECT
1574    0768'  0779'                    DW PTECT
1575    076A'  45                       DB 'E'                  ;       IF E, GO TO ENABLE
1576    076B'  0771'                    DW ENABLE
1577    076D'  FF                       DB DONE
1578    076E'  C0 0107'                 LBR PROMPT              ;GO TO PROMPT IF NOT P OR E
1579                                ;
1580    0771'  F8 00            ENABLE: LDI 00
1581    0773'  BB                       PHI RB
1582    0774'  F8 01                    LDI 01
1583    0776'  AB                       PLO RB                  ;SET PROTECT FLAG
1584    0777'  30 7D'                   BR SETPG
1585    0779'  F8 00            PTECT:  LDI 00
1586    077B'  AB                       PLO RB
1587    077C'  BB                       PHI RB                  ;SET ENABLE
1588    077D'                   SETPG:  SCAL R6, TTY            ;TYPE: CR, LF, 'text'
1589    077D'  68 86          +
1590    077F'  024E'          +
1591    0781'  CA                       DB 0CAH
1592    0782'  46 72 6F 6D              DB 'from page '
1593    0786'  20 70 61 67
1594    078A'  65 20
1595    078C'  03                       DB ETX                  ; ETX
1596    078D'  9DFF                     DW 9DFFH                ; IN4D, DONE
1597    078F'  8D                       GLO RD
1598    0790'  BE                       PHI RE                  ;SET CURRENT PAGE
1599                                    SCAL R6, TTY
1600    0791'  68 86          +
1601    0793'  024E'          +
1602    0795'  6F 76 65 72              DB 'over '              ;TYPE: (text)
1603    0799'  20
1604    079A'  03                       DB ETX                  ;       ETX
1605    079B'  9D                       DB 09DH                 ;       IN4D,
1606    079C'  20 70 61 67              DB ' pages.'            ;       pages..
1607    07A0'  65 73 2E
1608    07A3'  00FF                     DW DONE                 ;       DONE
1609    07A5'  8D                       GLO RD
1610    07A6'  AC                       PLO RC
```

```
1611  07A7'  C5                      LSNZ
1612  07A8'  FC 01                   ADI 01
1613  07AA'  AC                      PLO RC
1614                                  SCAL R6, MEMCHG
1615  07AB'  68 86          +
1616  07AD'  07B8'          +
1617  07AF'  C0 0107'               LBR PROMPT
1618                          ;
1619                          ;
1620                          ;************ MEMORY PROTECT OR ENABLE SUBROUTINE ***************
1621                          ;
1622                          ;
1623  07B2'  46               MEMSUB: LDA LIST      ;PASS ENABLE BIT
1624  07B3'  AB                       PLO RB
1625  07B4'  46                       LDA LIST      ;PASS START PAGE
1626  07B5'  BE                       PHI RE
1627  07B6'  46                       LDA LIST      ;PASS # OF PAGES
1628  07B7'  AC                       PLO RC
1629                          ;
1630  07B8'  F8 0A            MEMCHG: LDI GRPSAV    ;SELECT SYSTEM I/O GROUP
1631  07BA'  A7                       PLO GPAGE     ;       AND STORE ON GLOBAL PAGE
1632  07BB'  F8 07                    LDI SYSTEM
1633  07BD'  57                       STR GPAGE
1634  07BE'  E7                       SEX GPAGE
1635  07BF'  61                       OUT GROUP
1636                          ;
1637  07C0'  EE                       SEX RE
1638  07C1'  8C               NEXTPG: GLO RC
1639  07C2'  32 EF'                   BZ MDONE
1640                          ;
1641  07C4'  9E                       GHI RE        ;ALWAYS ENABLE:
1642  07C5'  FB 50                    XRI GLOPG     ;       GLOBAL PAGE
1643  07C7'  32 E2'                   BZ SETQ
1644                          ;
1645  07C9'  9E                       GHI RE
1646  07CA'  FB 52                    XRI SSTKPG    ;       SEQUENCER STACK PAGE
1647  07CC'  32 E2'                   BZ SETQ
1648                          ;
1649  07CE'  9E                       GHI RE
1650  07CF'  FB 53                    XRI STKPG     ;       STACK PAGE
1651  07D1'  32 E2'                   BZ SETQ
1652                          ;
1653  07D3'  9E                       GHI RE
1654  07D4'  FB 5B                    XRI BUFPG     ;       BUFFER PAGE
1655  07D6'  32 E2'                   BZ SETQ
1656                          ;
```

```
1657    07D8'  9E                       GHI RE
1658    07D9'  FB F8                    XRI INTPG       ;       INTERRUPT CONTROLLER PAGE
1659    07DB'  32 E2'                   BZ SETQ
1660    07DD'  8B                       GLO RB
1661    07DE'  3A E2'                   BNZ SETQ        ;PROTECT OR ENABLE ?
1662    07E0'  7A                       REQ             ;       PROTECT -> Q = 0
1663    07E1'  38                       SKP
1664    07E2'  7B               SETQ:   SEQ             ;       ENABLE  -> Q = 1
1665    07E3'  67                       OUT MEMORY      ;I/O = MEM. PROTECT
1666    07E4'  7A                       REQ
1667    07E5'  9E                       GHI RE
1668    07E6'  FC 01                    ADI 01
1669    07E8'  BE                       PHI RE
1670    07E9'  8C                       GLO RC
1671    07EA'  FF 01                    SMI 01
1672    07EC'  AC                       PLO RC
1673    07ED'  30 C1'                   BR NEXTPG
1674                           ;
1675    07EF'  F8 0A            NDONE:  LDI GRPSAV      ;SELECT UART I/O GROUP
1676    07F1'  A7                       PLO GPAGE       ;       AND STORE ON GLOBAL PAGE
1677    07F2'  F8 06                    LDI UARTS
1678    07F4'  57                       STR GPAGE
1679    07F5'  E7                       SEX GPAGE
1680    07F6'  61                       OUT GROUP
1681    07F7'  E2                       SEX STACK
1682                                    SRET R6
1683    07F8'  68 95            +
1684                           ;
1685                           ;
1686                           ;
1687                           ;*******************************************************************************
1688                           ;*******************************************************************************
1689                           ;
1690                                   ORG HDSTRT + 800H
1691                           ;
1692                           ;************************** 2ND. PROM STARTS HERE ******************************
1693                           ;
1694                           ;THIS SECTION INCLUDES:
1695                           ;
1696                           ;       INTERRUPT HANDLING
1697                           ;       REAL TIME CLOCK
1698                           ;       BASIC SEQUENCER
1699                           ;       LONG BRANCH TABLE
1700                           ;       PASS THRU MODE
1701                           ;       SEA DUCT SPECIFIC CODE
1702                           ;
```

```
1703                                    ;
1704                                    ;****************************** INTERRUPT VECTORS ******************************
1705                                    ;
1706                                    ;
1707    0800'  C0 083F'                 INTPGM: LBR INTRP0              ;INTERRUPT     0 VECTOR
1708    0803'  C8                               LSKP                    ;***
1709    0804'  FFFF                             DW 0FFFFH               ;      *
1710    0806'  C8                               LSKP                    ;      *
1711    0807'  FFFF                             DW 0FFFFH               ;      *
1712    0809'  C8                               LSKP                    ;      *
1713    080A'  FFFF                             DW 0FFFFH               ;      *
1714    080C'  C8                               LSKP                    ;      * FOR FUTURE VECTORS
1715    080D'  FFFF                             DW 0FFFFH               ;      *
1716    080F'  C8                               LSKP                    ;      *
1717    0810'  FFFF                             DW 0FFFFH               ;      *
1718    0812'  C8                               LSKP                    ;      *
1719    0813'  FFFF                             DW 0FFFFH               ;      *
1720    0815'  C8                               LSKP                    ;      *
1721    0816'  FFFF                             DW 0FFFFH               ;***
1722                                    ;
1723                                    ;
1724                                    ;
1725                                    ;****************** RESTORE FROM INTERRUPT 0 ***********************
1726                                    ;
1727                                    ;******** NOTE! - MUST DIRECTLY PRECEED INTERRUPT 0 **************
1728                                    ;
1729    0818'  F8 50                    RESTR0: LDI GLOPG       ;RESET GPAGE(HI) JUST IN CASE
1730    081A'  B7                               PHI GPAGE
1731    081B'  F8 0A                            LDI GRPSAV      ;RESTORE I/O GROUP
1732    081D'  A7                               PLO GPAGE
1733    081E'  E7                               SEX GPAGE
1734    081F'  61                               OUT GROUP
1735    0820'  E2                               SEX STACK       ;SET X TO STACK = R2
1736    0821'  12                               INC STACK
1737    0822'  72                               LDXA
1738    0823'  A7                               PLO GPAGE       ;RESTORE GLOBAL PAGE   R7.0
1739    0824'  72                               LDXA
1740    0825'  BA                               PHI RA          ;RESTORE RA
1741    0826'  72                               LDXA
1742    0827'  AA                               PLO RA
1743    0828'  72                               LDXA
1744    0829'  BB                               PHI RB          ;RESTORE RB
1745    082A'  72                               LDXA
1746    082B'  AB                               PLO RB
1747    082C'  72                               LDXA
1748    082D'  BC                               PHI RC          ;RESTORE RC
```

```
1749    082E'  72                       LDXA
1750    082F'  AC                       PLO RC
1751    0830'  72                       LDXA
1752    0831'  BD                       PHI RD          ;RESTORE RD
1753    0832'  72                       LDXA
1754    0833'  AD                       PLO RD
1755    0834'  72                       LDXA
1756    0835'  BE                       PHI RE          ;RESTORE RE
1757    0836'  72                       LDXA
1758    0837'  AE                       PLO RE
1759    0838'  72                       LDXA
1760    0839'  FE                       SHL             ;RESTORE DF
1761    083A'  72                       LDXA            ;RESTORE D
1762    083B'  70                       RET             ;RETURN
1763    083C'  C0 F880                  LBR INTVEC
1764                            ;
1765                            ;***************************** INTERRUPT 0 *********************************
1766                            ;
1767    083F'  22               INTRP0: DEC STACK
1768    0840'  78                       SAV             ;SAVE X.P
1769    0841'  22                       DEC STACK
1770    0842'  73                       STXD            ;SAVE D
1771    0843'  76                       SHRC
1772    0844'  73                       STXD            ;SAVE DF
1773    0845'  8E                       GLO RE
1774    0846'  73                       STXD            ;SAVE RE
1775    0847'  9E                       GHI RE
1776    0848'  73                       STXD
1777    0849'  8D                       GLO RD
1778    084A'  73                       STXD            ;SAVE RD
1779    084B'  9D                       GHI RD
1780    084C'  73                       STXD
1781    084D'  8C                       GLO RC
1782    084E'  73                       STXD            ;SAVE RC
1783    084F'  9C                       GHI RC
1784    0850'  73                       STXD
1785    0851'  8B                       GLO RB
1786    0852'  73                       STXD            ;SAVE RB
1787    0853'  9B                       GHI RB
1788    0854'  73                       STXD
1789    0855'  8A                       GLO RA
1790    0856'  73                       STXD            ;SAVE RA
1791    0857'  9A                       GHI RA
1792    0858'  73                       STXD
1793    0859'  87                       GLO GPAGE
1794    085A'  73                       STXD            ;SAVE GPAGE LOC. (R7.0)
```

```
1795    085B'  7B                       SEQ
1796    085C'  7A                       REQ             ;PLUSE Q
1797                                    ;
1798                                    ;
1799    085D'  F8 08            RBRET:  LDI RBHI        ;RESTORES RB USED IN THE LAST INTERRUPT
1800    085F'  A7                       PLO GPAGE
1801    0860'  47                       LDA GPAGE
1802    0861'  BB                       PHI RB
1803    0862'  07                       LDN GPAGE
1804    0863'  AB                       PLO RB
1805                                    ;
1806                                    ;
1807                                    ;************************ LONG BRANCH TABLE ******************************
1808                                    ;
1809    0864'  C0 08B1'         LBT:    LBR ATCHK       ;@ CHECK
1810    0867'  C0 0900'         ATRTN:  LBR RTC         ;RUN REAL TIME CLOCK
1811    086A'  C0 09CA'         RTCRTN: LBR SEQCYC      ;RUN SEQUENCER THIS CYCLE ?     CYCLE > 0
1812                                    ;
1813    086D'  C0 0A32'         SEQRTN: LBR TTY2        ;SEND DATA ON LOOP 2 IF REQUIRED
1814    0870'  C0 0A7D'         TY2RTN: LBR BR2         ;BREAK LOOP 2 IF REQUIRED
1815    0873'  C0 0A97'         BR2RTN: LBR CTRCHK      ;SEQUENCER CNTR(n) TIMEOUT?     CYCLE = 26H
1816                                    ;
1817    0876'  C0 12F0'         CTRRTN: LBR CMPSRD      ;READ COMPASS           SEC. = X1; CYC = 0A,0B
1818    0879'  C0 131A'         CMPRTN: LBR SWRD        ;READ SWITCHES          SEC. =ALL; CYC = 24,25
1819    087C'  C0 133F'         SWRTN:  LBR AD          ;A/D, MUX CONTROL
1820    087F'  C0 13BA'         ADRTN:  LBR TR          ;TRANSMISSOMETER A/D CONTROL
1821                                    ;
1822    0882'  C0 143B'         TRRTN:  LBR PDCHK       ;RELAY PODS / ACOUSTIC LINK  SEC = ALL, CYC = 27H
1823    0885'  C0 1478'         PDRTN:  LBR HDGCHK      ;HEADING INDICATOR                      CYC = 0B,0C
1824    0888'  C0 14CA'         HDGRTN: LBR PULCHK      ;PULSE RELAY DRIVER?
1825                                    ;
1826    088B'  C0 1500'         PULRTN: LBR XYZCHK      ;XYZ OPTO INTERUPTERS  FLG:  00=CYC 24,25
1827                                    ;                                            AC=OPTO PWR. ON
1828    088E'  C0 0DAD'         XYZRTN: LBR SD          ;SEA DATA BUFFER SETUP AND RECORD SEC. = 0; CYC = 1A
1829    0891'  C8                SDRET:  LSKP
1830    0892'  FFFF                    DW 0FFFFH
1831                                    ;
1832                                    ;
1833    0894'  E2                RBSAVE: SEX STACK
1834    0895'  F8 08                    LDI RBHI        ;SAVE RB FOR NEXT INTERRUPT
1835    0897'  A7                       PLO GPAGE
1836    0898'  9B                       GHI RB
1837    0899'  57                       STR GPAGE
1838    089A'  17                       INC GPAGE
1839    089B'  8B                       GLO RB
1840    089C'  57                       STR GPAGE
```

```
                                        ;
                                        ;
089D' E1                    BRCHK:  SEX INTPC       ;CHECK FOR SAIL BREAKS
089E' 61                            OUT GROUP
089F' 06                            DB UARTS        ;UART GROUP     X = INTERRUPT PC
08A0' E2                            SEX STACK       ;CKECK FOR SAIL BREAK LOOP 2
08A1' 6B                            INP STAT1       ;UART EXT STATUS LOOP 1 ?
08A2' FA 10                         ANI 10H
08A4' 3A A8'                        BNZ BROKE
08A6' 30 18'                        BR RESTR0
                                    ;
08A8' F8 3F'                BROKE:  LDI LOW(RESTRT) ;SET PC = RESTRT
08AA' A3                            PLO PC
08AB' F8 00'                        LDI HIGH(RESTRT)
08AD' B3                            PHI PC
08AE' C0 001E'                      LBR SETSTK      ;RESET STACK
                                    ;
                                    ;
                                    ;********************** UART @ CHECK ************************
                                    ;
08B1' F8 03                 ATCHK:  LDI SYSFLG      ;CHECKS TO TYPE @ FOR ?TIME
08B3' A7                            PLO GPAGE
08B4' 07                            LDN GPAGE
08B5' F6                            SHR
08B6' 3B 67'                        BNF ATRTN       ;@ FLAG SET ?
08B8' E1                            SEX INTPC
08B9' 61                            OUT GROUP
08BA' 06                            DB UARTS        ;UART GROUP
08BB' 62                            OUT DATA1
08BC' 40                            DB '@'          ;TYPE '@'
08BD' 07                            LDN GPAGE
08BE' FA FE                         ANI 0FEH
08C0' 57                            STR GPAGE       ;CLEAR @ FLAG
08C1' 30 67'                        BR ATRTN        ;RETURN TO LBT
                                    ;
                                    ;
                                        ORG (INTPGM + 100H)
                                    ;
                                    ;******************* REAL TIME CLOCK ************************
                                    ;
                                    ;
0900' F8 1D                 RTC:    LDI ARFLG
0902' 52                            STR STACK
0903' A7                            PLO GPAGE
0904' 07                            LDN GPAGE
0905' 3A 2D'                        BNZ INCRTC
```

```
1887    0907'  F8 03            DECAR:  LDI 03H         ;03 = 3 DIGIT LOOP COUNT
1888    0909'  A8                       PLO CYCCNT
1889    090A'  FC 00                    ADI 00          ;SET DF TO BORROW
1890    090C'  27               DECNEX: DEC GPAGE
1891    090D'  07                       LDN GPAGE
1892    090E'  7F 00                    SMBI 00
1893    0910'  33 14'                   BDF NOBRRW
1894    0912'  F8 09            BORROW: LDI 09
1895    0914'  57               NOBRRW: STR GPAGE
1896    0915'  28                       DEC CYCCNT
1897    0916'  88                       GLO CYCCNT
1898    0917'  3A 0C'                   BNZ DECNEX
1899    0919'  F8 03            TEST0:  LDI 03          ;03 = 3 DIGIT LOOP COUNT
1900    091B'  A8                       PLO CYCCNT
1901    091C'  47               TSTNEX: LDA GPAGE
1902    091D'  CA 086A'                 LBNZ RTCRTN
1903    0920'  28                       DEC CYCCNT
1904    0921'  88                       GLO CYCCNT
1905    0922'  3A 1C'                   BNZ TSTNEX
1906    0924'  F8 1D            CLRAR:  LDI ARFLG       ;SET A-R FLG. = NORM.
1907    0926'  A7                       PLO GPAGE
1908    0927'  F8 01                    LDI 01
1909    0929'  57                       STR GPAGE
1910    092A'  C0 086A'                 LBR RTCRTN
1911    092D'  F8 19            INCRTC: LDI CYCLES      ;INCREMENT CYCLE COUNT
1912    092F'  A7                       PLO GPAGE
1913    0930'  07                       LDN GPAGE
1914    0931'  FC 01                    ADI 01
1915    0933'  57                       STR GPAGE
1916    0934'  FF 28                    SMI HZ          ;HZ = INTERRUPT RATE
1917    0936'  3B B4'                   BNF TSTADV
1918    0938'  F8 00                    LDI 00          ;CARRY CYCLES
1919    093A'  E7                       SEX GPAGE
1920    093B'  73                       STXD
1921    093C'  07                       LDN GPAGE
1922    093D'  FC 01                    ADI 01          ;INCREMENT SECONDS
1923    093F'  57                       STR GPAGE
1924    0940'  FF 0A                    SMI 0AH
1925    0942'  33 5B'                   BDF INC10
1926    0944'  07               TEST5:  LDN GPAGE
1927    0945'  FB 05                    XRI 05          ;SECONDS = 5 ?
1928    0947'  3A B4'                   BNZ TSTADV
1929    0949'  F8 1E                    LDI ATFLG
1930    094B'  A7                       PLO GPAGE
1931    094C'  07                       LDN GPAGE
1932    094D'  32 B4'                   BZ TSTADV       ;RTC @ FLAG = 0 ?
```

```
1933    094F'  F8 00            SETAT:  LDI 00
1934    0951'  57                       STR GPAGE       ;CLEAR RTC @ FLAG
1935    0952'  F8 03                    LDI SYSFLG
1936    0954'  A7                       PLO GPAGE       ;SET SAIL @ FLAG
1937    0955'  07                       LDN GPAGE
1938    0956'  F9 01                    ORI 01
1939    0958'  57                       STR GPAGE
1940    0959'  30 B4'                   BR TSTADV
1941                           ;
1942    095B'  F8 00            INC10:  LDI 00          ;SET SEC X1 = 0
1943    095D'  73                       STXD            ;X = GPAGE HERE
1944    095E'  07                       LDN GPAGE       ;INC. SEC X 10
1945    095F'  FC 01                    ADI 01
1946    0961'  57                       STR GPAGE
1947    0962'  FF 06                    SMI 06          ;SEC X 10 = 6 ?
1948    0964'  3B B4'                   BNF TSTADV
1949    0966'  F8 00            INCMIN: LDI 00
1950    0968'  E7                       SEX GPAGE
1951    0969'  73                       STXD            ;CLEAR SEC X 10
1952    096A'  07                       LDN GPAGE
1953    096B'  FC 01                    ADI 01          ;INCREMENT MIN. X 1
1954    096D'  57                       STR GPAGE
1955    096E'  FF 0A                    SMI 0AH
1956    0970'  3B B4'                   BNF TSTADV
1957    0972'  F8 00                    LDI 00
1958    0974'  73                       STXD
1959    0975'  07                       LDN GPAGE       ;MIN X 1 = 0, INC MIN X 10
1960    0976'  FC 01                    ADI 01
1961    0978'  57                       STR GPAGE
1962    0979'  FF 06                    SMI 06          ;HOUR UP ?
1963    097B'  3B B4'                   BNF TSTADV
1964    097D'  F8 00            HOURUP: LDI 00          ;CLEAR MIN X 10
1965    097F'  73                       STXD
1966    0980'  07                       LDN GPAGE
1967    0981'  FC 01                    ADI 01          ;INCREMENT HOURS
1968    0983'  73                       STXD
1969    0984'  FF 04                    SMI 04          ;HOURS X1 = 4 ?
1970    0986'  3B B4'                   BNF TSTADV
1971    0988'  07                       LDN GPAGE
1972    0989'  FF 02                    SMI 02          ;DAY UP ?
1973    098B'  33 9C'                   BDF DAYUP
1974    098D'  17               CHK10:  INC GPAGE
1975    098E'  07                       LDN GPAGE
1976    098F'  FF 0A                    SMI 0AH
1977    0991'  3B B4'                   BNF TSTADV
1978    0993'  F8 00                    LDI 00
```

```
1979    0995'  73                      STXD
1980    0996'  07                      LDN GPAGE
1981    0997'  FC 01                   ADI 01          ;INC HOURS X 10
1982    0999'  57                      STR GPAGE
1983    099A'  30 B4'                  BR TSTADV
1984                                ;
1985    099C'  F8 00                DAYUP:  LDI 00
1986    099E'  57                      STR GPAGE
1987    099F'  17                      INC GPAGE       ;CLEAR HOURS
1988    09A0'  73                      STXD
1989    09A1'  27                      DEC GPAGE
1990    09A2'  F8 03                   LDI 03
1991    09A4'  A8                      PLO R8
1992    09A5'  07                   DAYCAR: LDN GPAGE       ;CARRY DAYS AS REQUIRED
1993    09A6'  FC 01                   ADI 01
1994    09A8'  57                      STR GPAGE
1995    09A9'  FF 0A                   SMI 0AH
1996    09AB'  3B B4'                  BNF TSTADV
1997    09AD'  F8 00                   LDI 00
1998    09AF'  73                      STXD
1999    09B0'  28                      DEC R8
2000    09B1'  88                      GLO R8
2001    09B2'  3A A5'                  BNZ DAYCAR
2002                                ;
2003    09B4'  F8 1D                TSTADV: LDI ARFLG
2004    09B6'  A7                      PLO GPAGE
2005    09B7'  07                      LDN GPAGE
2006    09B8'  FB 02                   XRI 02
2007    09BA'  3A C1'                  BNZ TST2ND
2008    09BC'  F8 03                   LDI 03
2009    09BE'  57                      STR GPAGE
2010    09BF'  30 2D'                  BR INCRTC
2011    09C1'  FB 01                TST2ND: XRI 01          ;01 = 02 OR 03
2012    09C3'  3A 24'                  BNZ CLRAR
2013    09C5'  F8 02                   LDI 02
2014    09C7'  57                      STR GPAGE
2015    09C8'  30 07'                  BR DECAR
2016                                ;
2017                                ;
2018                                ;********************************* SEQUENCE CYCLE ? *********************************
2019                                ;
2020    09CA'  F8 67                SEQCYC: LDI SEQRAT      ;SPECIAL SEQUENCER RATE NEEDED? (SEQRAT .NE. 00 ?)
2021    09CC'  A7                      PLO GPAGE
2022    09CD'  07                      LDN GPAGE
2023    09CE'  32 EE'                  BZ SEQ01        ;   IF NOT RUN ONLY ON CYCLE #1
2024                                ;
```

```
2025  09D0'  FA 80                    ANI 80H         ;SEQRAT MSB = 1? (1XXX XXXX)
2026  09D2'  C2 0A22'                 LBZ CYXXNN      ;   IF NOT, WAIT FOR CYCLE #NN OR #01 (GO TO CYXXNN)
2027                                  ;
2028  09D5'  07                       LDN GPAGE       ;IF MSB = 1 (8X), CHECK LOW NIBBLE
2029  09D6'  FB 80                    XRI 80H         ;       (1000 0000) = EVERY CYCLE
2030  09D8'  C2 0B00'                 LBZ SEQNCR      ;       (1000 0001) = EVERY OTHER CYCLE
2031  09DB'  FB 01                    XRI 01          ;       (1000 0010) = EVERY FOURTH CYCLE
2032  09DD'  32 FA'                   BZ CYXXX1       ;       (1000 0100) = EVERY EIGHT CYCLE
2033  09DF'  FB 03                    XRI 03          ;
2034  09E1'  C2 0A06'                 LBZ CYXX01      ;       (1000 1111) = EVERY FOURTH CYCLE
2035  09E4'  FB 06                    XRI 06          ;                       (PINGER CONTROL ONLY)
2036  09E6'  C2 0A14'                 LBZ CYX001      ;
2037  09E9'  FB 0B                    XRI 0BH         ;IF NONE OF THE ABOVE,
2038  09EB'  C2 0A06'                 LBZ CYXX01      ;       RUN ONLY ON CYCLE #01
2039                                  ;
2040  09EE'  F8 19            SEQ01:  LDI CYCLES      ;CHECK CYCLE #
2041  09F0'  A7                       PLO GPAGE
2042  09F1'  07                       LDN GPAGE
2043  09F2'  FB 01                    XRI 01          ;RUN SEQUENCER ONLY ON CYCLE 01
2044  09F4'  C2 0B00'                 LBZ SEQNCR
2045  09F7'  C0 086D'                 LBR SEQRTN
2046                                  ;
2047  09FA'  F8 19            CYXXX1: LDI CYCLES      ;RUN EVERY OTHER CYCLE
2048  09FC'  A7                       PLO GPAGE
2049  09FD'  07                       LDN GPAGE
2050  09FE'  FA 01                    ANI 01
2051  0A00'  CA 0B00'                 LBNZ SEQNCR
2052  0A03'  C0 086D'                 LBR SEQRTN
2053                                  ;
2054  0A06'  F8 19            CYXX01: LDI CYCLES      ;RUN EVERY FOURTH CYCLE
2055  0A08'  A7                       PLO GPAGE
2056  0A09'  07                       LDN GPAGE
2057  0A0A'  FA 03                    ANI 03
2058  0A0C'  FB 01                    XRI 01
2059  0A0E'  C2 0B00'                 LBZ SEQNCR
2060  0A11'  C0 086D'                 LBR SEQRTN
2061                                  ;
2062  0A14'  F8 19            CYX001: LDI CYCLES      ;RUN EVERY EIGHT CYCLE
2063  0A16'  A7                       PLO GPAGE
2064  0A17'  07                       LDN GPAGE
2065  0A18'  FA 07                    ANI 07
2066  0A1A'  FB 01                    XRI 01
2067  0A1C'  C2 0B00'                 LBZ SEQNCR
2068  0A1F'  C0 086D'                 LBR SEQRTN
2069                                  ;
2070  0A22'  07               CYXXNN: LDN GPAGE       ;RUN ON ONLY CYCLES = NN OR 01
```

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2071    0A23'  FA 7F                    ANI 7FH
2072    0A25'  AD                       PLO RD
2073    0A26'  F8 19                    LDI CYCLES
2074    0A28'  A7                       PLO GPAGE
2075    0A29'  E7                       SEX GPAGE
2076    0A2A'  8D                       GLO RD
2077    0A2B'  F3                       XOR
2078    0A2C'  C2 0B00'                 LBZ SEQNCR      ;ON CYCLES = NN, RUN SEQUENCER
2079    0A2F'  C0 09F1'                 LBR (SEQ01 + 3) ;CHECK FOR CYCLES = 01
2080                            ;
2081                            ;
2082                            ;****************************** TTY2 ************************
2083                            ;
2084    0A32'  F8 7E            TTY3:   LDI TTY2HI      ;CHECK LOOP 2 OUTPUT LIST PNTR
2085    0A34'  A7                       PLO GPAGE
2086    0A35'  07                       LDN GPAGE
2087    0A36'  C2 0870'                 LBZ TY2RTN      ;IF CLEAR (=00), RETURN TO LBT
2088    0A39'  E7                       SEX GPAGE
2089                                    RLXA RTTY2      ;LOAD TTY2 POINTER (REG RTTY2)
2090    0A3A'  68 6F            +
2091    0A3C'  27                       DEC GPAGE
2092    0A3D'  0F                       LDN RTTY2               ;GET M(RTTY2)
2093    0A3E'  FB FF                    XRI 0FFH                ;IS IT FF ?
2094    0A40'  C2 0870'                 LBZ TY2RTN              ;       IF SO RETURN TO LBT
2095    0A43'  FB 6F                    XRI (0FFH XOR 090H)     ;IS IT 90 ?
2096    0A45'  32 5C'                   BZ TY2ETX               ;       IF SO GO TO TTY2-ETX
2097                            ;
2098    0A47'  E1               TY2OUT: SEX INTPC               ;TYPE ON LOOP2
2099    0A48'  61                       OUT GROUP
2100    0A49'  06                       DB UARTS                ;       SET UART GROUP
2101    0A4A'  E2                       SEX STACK
2102    0A4B'  6D                       INP STAT2               ;       CHECK STATUS
2103    0A4C'  FB C0                    XRI 0C0H                ;       INVERT
2104    0A4E'  FA C0                    ANI 0C0H                ;       MASK FOR THRE AND TSRE
2105    0A50'  CA 0870'                 LBNZ TY2RTN
2106    0A53'  6C                       INP DATA2               ;       CLEAR ECHO DA
2107    0A54'  EF                       SEX RTTY2
2108    0A55'  64                       OUT DATA2               ;       SEND DATA ON LOOP 2
2109    0A56'  E7                       SEX GPAGE
2110                                    RSXD RTTY2              ;       SET DATA POINTER ON GLOBAL PAGE
2111    0A57'  68 AF            +
2112    0A59'  C0 0870'                 LBR TY2RTN
2113                            ;
2114    0A5C'  E1               TY2ETX: SEX INTPC               ;WAIT FOR ETX
2115    0A5D'  61                       OUT GROUP               ;       SET UART GROUP
2116    0A5E'  06                       DB UARTS
```

```
2117    0A5F'  E2                       SEX STACK
2118    0A60'  6D                       INP STAT2               ;       CHECK STATUS
2119    0A61'  FB C0                    XRI 0C0H                ;       INVERT
2120    0A63'  FA C0                    ANI 0C0H                ;       MASK FOR THRE AND TSRE
2121    0A65'  CA 0870'                 LBNZ TY2RTN             ;       RETURN TO LBT IF REGS. NOT EMPTY
2122    0A68'  E2                       SEX STACK
2123    0A69'  6D                       INP STAT2               ;       DA?
2124    0A6A'  F6                       SHR
2125    0A6B'  CB 0870'                 LBNF TY2RTN             ;       IF NOT RETURN TO LBT
2126    0A6E'  6C                       INP DATA2               ;       IF DA2
2127    0A6F'  FA 7F                    ANI 07FH                ;       MASK MSB
2128    0A71'  FB 03                    XRI 03                  ;       IS IT ETX ?
2129    0A73'  CA 0870'                 LBNZ TY2RTN             ;       IF NOT ETX, RETURN TO LBT
2130    0A76'  1F                       INC RTTY2               ;       IF ETX, INC. TTY2 LIST POINTER
2131    0A77'  E7                       SEX GPAGE
2132                                    RSXD RTTY2              ;       AND RESTORE
2133    0A78'  68 AF            +
2134    0A7A'  C0 0870'                 LBR TY2RTN              ;RTN TO LBT
2135                            ;
2136                            ;
2137                            ;********************** BREAK LOOP 2 ? ***************************
2138                            ;
2139                            ;
2140    0A7D'  F8 7D            BR2:    LDI BR2CNT              ;GET BREAK COUNT FROM GPAGE
2141    0A7F'  A7                       PLO GPAGE
2142    0A80'  07                       LDN GPAGE
2143    0A81'  FB 00                    XRI 00
2144    0A83'  C2 0873'                 LBZ BR2RTN              ;IF 0, RETURN TO LBT
2145    0A86'  07                       LDN GPAGE               ;IF NOT, DECREMENT COUNT
2146    0A87'  FF 01                    SMI 01
2147    0A89'  57                       STR GPAGE
2148    0A8A'  CA 0873'                 LBNZ BR2RTN             ;IF NOT 0, RETURN TO LBT
2149    0A8D'  E1               BR2CLR: SEX INTPC               ;IF NOW 0, RESET UART 2
2150    0A8E'  61                       OUT GROUP
2151    0A8F'  06                       DB UARTS
2152    0A90'  65                       OUT CNTRL2
2153    0A91'  12                       DB FORMT1
2154    0A92'  64                       OUT DATA2               ;SEND NULL TO RESET UART 2
2155    0A93'  00                       DB 00
2156    0A94'  C0 0873'                 LBR BR2RTN              ;RETUTN TO LBT
2157                            ;
2158                            ;
2159                            ;
2160                            ;******************** TIME OUT COUNTER FUNCTIONS **********************
2161                            ;                       *** RUNS ON CYCLES = 26H ONLY ***
2162                            ;
```

```
2163    0A97'  F8 19            CTRCHK: LDI CYCLES      ;RUN ONLY ON CYCLE 26H (NEXT TO LAST CYCLE)
2164    0A99'  A7                       PLO GPAGE
2165    0A9A'  07                       LDN GPAGE
2166    0A9B'  FB 26                    XRI 26H
2167    0A9D'  CA 0876'                 LBNZ CTRRTN     ;RETURN TO LBT IF CYCLE NOT = 26H
2168                                    ;
2169    0AA0'  E2               CTCHK:  SEX STACK
2170                                    SCAL R6, CTNCHK
2171    0AA1'  68 36            +
2172    0AA3'  0AB6'            +
2173    0AA5'  6C                       DB CTAHI
2174    0AA6'  6E                       DB CTAVHI
2175                                    ;
2176                                    SCAL R6, CTNCHK
2177    0AA7'  68 36            +
2178    0AA9'  0AB6'            +
2179    0AAB'  70                       DB CTBHI
2180    0AAC'  72                       DB CTBVHI
2181                                    ;
2182                                    SCAL R6, CTNCHK
2183    0AAD'  68 36            +
2184    0AAF'  0AB6'            +
2185    0AB1'  74                       DB CTCHI
2186    0AB2'  76                       DB CTCVHI
2187                                    ;
2188    0AB3'  C0 0876'                 LBR CTRRTN      ;RETURN TO LBT
2189                                    ;
2190                                    ;
2191    0AB6'  46               CTNCHK: LDA LIST
2192    0AB7'  A7                       PLO GPAGE       ;EXIT IF CNTR A = 0
2193    0AB8'  E7                       SEX GPAGE
2194                                    RLXA RA         ;PUT CNT(n) IN RA
2195    0AB9'  68 6A            +
2196    0ABB'  9A                       GHI RA          ;  Is it =0 ?
2197    0ABC'  3A C1'                   BNZ CTNDEC
2198    0ABE'  8A                       GLO RA
2199    0ABF'  32 E1'                   BZ (CTNRTN-1)   ;SKIP VECTOR POINTER IN PASSLIST AND RETURN
2200                                    ;
2201    0AC1'  2A               CTNDEC: DEC RA          ;DECREMENT CNTR N AND
2202    0AC2'  9A                       GHI RA          ;BRANCH TO CTNSTR IF NOT =0
2203    0AC3'  3A DE'                   BNZ CTNSTR
2204    0AC5'  8A                       GLO RA
2205    0AC6'  3A DE'                   BNZ CTNSTR      ;IF CNTR N = 0, STORE 0 COUNT
2206    0AC8'  27                       DEC GPAGE
2207                                    RSXD RA
2208    0AC9'  68 AA            +
```

```
2209    0ACB'  46                       LDA LIST        ;GET CT(n)VHI FROM PASSLIST
2210    0ACC'  A7                       PLO GPAGE       ;  and put it in RA
2211                                    RLXA RA
2212    0ACD'  68 6A            +
2213    0ACF'  F8 61                    LDI PPCLO       ;Put the new PPC in the
2214    0AD1'  A7                       PLO GPAGE       ; PPC pointer
2215    0AD2'  E7                       SEX GPAGE
2216                                    RSXD RA
2217    0AD3'  68 AA            +
2218    0AD5'  F8 68                    LDI PPCCNT      ;SET =00:
2219    0AD7'  A7                       PLO GPAGE
2220    0AD8'  F8 00                    LDI 00          ;   PPCCNT
2221    0ADA'  73                       STXD            ;   SEQRAT
2222    0ADB'  73                       STXD
2223    0ADC'  30 E2'                   BR CTNRTN       ;GO TO CNTRTN
2224                                ;
2225    0ADE'  27                   CTNSTR: DEC GPAGE   ;STORE COUNTER N
2226                                    RSXD RA
2227    0ADF'  68 AA            +
2228    0AE1'  16                       INC LIST        ;SKIP VECTOR POINTER IN PASSLIST
2229                                ;
2230    0AE2'  E2                   CTNRTN: SEX STACK   ;RETURN
2231                                    SRET R6
2232    0AE3'  68 96            +
2233                                ;
2234                                ;
2235                                ;
2236                                ;********************** SEQUENCER ************************
2237                                ;
2238                                    ORG (INTPGM + 300H)
2239                                ;
2240                                ;*** LOCATION OF VARIOUS ELEMENTS IN THIS SECTION ARE ***
2241                                ;*** EXTREMELY CRITICAL !       MUST START AT A PAGE START ***
2242                                ;
2243                                ;
2244    0B00'  F8 60                SEQNCR: LDI PPCHI
2245    0B02'  A7                       PLO GPAGE
2246    0B03'  47                       LDA GPAGE
2247    0B04'  BC                       PHI PPC         ;SET UP PPC
2248    0B05'  47                       LDA GPAGE
2249    0B06'  AC                       PLO PPC
2250    0B07'  47                       LDA GPAGE
2251    0B08'  BD                       PHI RSTK        ;SET UP R STACK
2252    0B09'  47                       LDA GPAGE
2253    0B0A'  AD                       PLO RSTK
2254    0B0B'  47                       LDA GPAGE
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2255    0B0C'  BE                       PHI ASTK        ;SET UP A STACK
2256    0B0D'  47                       LDA GPAGE
2257    0B0E'  AE                       PLO ASTK
2258    0B0F'  0C                       LDN PPC         ;GET NEXT PPC
2259    0B10'  FA FC                    ANI 0FCH        ;MASK TO DECODE PPC
2260    0B12'  A1                       PLO INTPC       ;REDIRECT INTERRUPT PC TO PPC
2261                                    ;
2262                                    ;
2263    0B13'  1C                       INCPPC::INC PPC         ;SET UP FOR NEXT PPC
2264    0B14'  C0 0C00'                 SAVE::  LBR SAVPPC
2265                                    ;
2266    0B17'  2C                       DECPPC::DEC PPC         ;SET UP FOR PREVIOUS PPC
2267    0B18'  30 14'                   BR SAVE         ; USED BY EXT. SEQUENCER FUNCTIONS
2268                                    ;
2269                                    ;
2270                                    ;
2271                                    ;********************** PPC's START HERE ****************************
2272                                    ;
2273                                    ;
2274                                    ORG (SEQNCR + 28H)
2275    0B28'  1C                       JUMP::  INC PPC         ;JUMP TO PPC AT AAAA
2276    0B29'  30 66'                   BR JMPEXC
2277                                    ;
2278                                    ;
2279                                    ORG (SEQNCR + 30H)
2280    0B30'  4C                       PUSH:   LDA PPC         ;PUSH N BYTES TO A STACK
2281    0B31'  FA 03                    ANI 03
2282    0B33'  A9                       PLO R9
2283    0B34'  2E                       PUSH1:  DEC ASTK
2284    0B35'  4C                       LDA PPC         ;LOAD IMMEDIATE PPC BYTE
2285    0B36'  5E                       STR ASTK
2286    0B37'  89                       GLO R9
2287    0B38'  32 14'                   BZ SAVE         ;ANOTHER BYTE ?
2288    0B3A'  29                       DEC R9
2289    0B3B'  30 34'                   BR PUSH1
2290                                    ;
2291                                    ;
2292                                    ORG (SEQNCR + 40H)
2293    0B40'  4C                       POP:    LDA PPC         ;POP N BYTES FROM A STACK
2294    0B41'  FA 03                    ANI 03
2295    0B43'  A9                       PLO R9
2296    0B44'  1E                       POP1:   INC ASTK
2297    0B45'  89                       GLO R9
2298    0B46'  32 14'                   BZ SAVE
2299    0B48'  29                       DEC R9
2300    0B49'  30 44'                   BR POP1
```

```
2301                                    ;
2302                                    ;
2303                                            ORG (SEQNCR + 4CH)
2304    0B4C'   C0 0C22'                INIT:   LBR INITX
2305                                    ;
2306                                    ;
2307                                            ORG (SEQNCR + 58H)
2308    0B58'   1D                      RETURN: INC RSTK
2309    0B59'   4D                              LDA RSTK        ;RETURN FROM PCC SUBROUTINE
2310    0B5A'   BC                              PHI PPC
2311    0B5B'   0D                              LDN RSTK
2312    0B5C'   AC                              PLO PPC
2313    0B5D'   1C                              INC PPC
2314    0B5E'   30 13'                          BR INCPPC
2315                                    ;
2316                                    ;
2317                                            ORG (SEQNCR + 60H)
2318    0B60'   1C                      GOSUB:  INC PPC         ;GOTO PPC SUBROUTINE
2319    0B61'   ED                              SEX RSTK
2320    0B62'   8C                              GLO PPC
2321    0B63'   73                              STXD
2322    0B64'   9C                              GHI PPC
2323    0B65'   73                              STXD
2324    0B66'   4C                      JMPEXC: LDA PPC
2325    0B67'   A9                              PLO R9
2326    0B68'   0C                              LDN PPC
2327    0B69'   AC                              PLO PPC
2328    0B6A'   89                              GLO R9
2329    0B6B'   BC                              PHI PPC
2330    0B6C'   30 14'                          BR SAVE
2331                                    ;
2332                                    ;
2333                                            ORG (SEQNCR + 70H)
2334    0B70'   0C                      WTTILL: LDN PPC         ;WAIT TILL DAYS, HOURS,
2335    0B71'   FA 03                           ANI 03          ;MIN, SEC ON RTC
2336    0B73'   FE                              SHL
2337    0B74'   FC 11                           ADI D10
2338    0B76'   A7                              PLO GPAGE
2339    0B77'   E2                              SEX STACK
2340                                            SCAL R6, CMPARE
2341    0B78'   68 86           +
2342    0B7A'   0C9C'           +
2343    0B7C'   33 13'                          BDF INCPPC
2344    0B7E'   30 14'                          BR SAVE
2345                                    ;
2346                                    ;
```

```
                                        ORG (SEQNCR + 80H)
0B80'   C0 0C6F'            WTFOR:  LBR WTFORX
                            ;
                            ;
                                        ORG (SEQNCR + 0A0H)
0BA0'   C0 0D3A'            CTA:    LBR CTAX
                            ;
                            ;
                                        ORG (SEQNCR + 0B0H)
0BB0'   C0 0D57'            CTB:    LBR CTBX
                            ;
                            ;
                                        ORG (SEQNCR + 0C0H)
0BC0'   C0 0D74'            CTC:    LBR CTCX
                            ;
                            ;
                                        ORG (SEQNCR + 0C4H)
0BC4'   30 13'              NOOP:   BR INCPPC       ;PPC NO OP
                            ;
                            ;
                                        ORG (SEQNCR + 0C8H)
                            ;*** ADDITIONAL PSEUDO CODES CAN BE INSERTED HERE ***
                            ;
                            ;
                                        ORG (SEQNCR + 0D0H)
0BD0'   C0 0CB9'            LOOP2:  LBR LOOP2X      ;START OUTPUT LIST ON LOOP 2
                            ;                       ;       AND PWR ON/OFF LOOP 2
                            ;
                            ;
                                        ORG (SEQNCR + 0E0H)
0BE0'   C0 1800'            SEQXT1: LBR HELP + 800H         ;SEA DUCT EXTENDED SEQUENCER
                            ;                               ;       FUNCTION PREFIX
                            ;
                            ;*** MORE PSEUDO CODES CAN BE INSERTED HERE ***
                            ;
                            ;
                            ;
                                        ORG (SEQNCR + 100H)
                            ;
                            ;****** BASIC SEQUENCER IN THIS SECTION ARE CALLED BY THE
                            ;       PREVIOUS PROGRAM PAGE ******
                            ;
                            ;
0C00'   F8 65               SAVPPC::LDI ASTKLO      ;SAVE PPC AND STACKS ON GPAGE
0C02'   A7                          PLO GPAGE
0C03'   E7                          SEX GPAGE
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```
2393    0C04'  8E                       GLO ASTK
2394    0C05'  73                       STXD
2395    0C06'  9E                       GHI ASTK
2396    0C07'  73                       STXD
2397    0C08'  8D                       GLO RSTK
2398    0C09'  73                       STXD
2399    0C0A'  9D                       GHI RSTK
2400    0C0B'  73                       STXD
2401    0C0C'  8C                       GLO PPC
2402    0C0D'  73                       STXD
2403    0C0E'  9C                       GHI PPC
2404    0C0F'  57                       STR GPAGE             ;GPAGE -> PPCHI
2405                                ;
2406                                ;
2407    0C10'  E1                   FLAGCK: SEX INTPC         ;THIS SECTION COULD CHECK INSTRUMENT
2408                                ;*** DO FLAG CKECKS       ;       SPECIFIC FLAGS ( ON / OFF )
2409                                ;       AS NECESSARY      ;       AND PERFORM THE INDICATED
2410                                ;       THEN ...    ***   ;       OPERATION WHEN SEQUENCER
2411                                ;                         ;       EXITS TO LBT
2412                                ;
2413    0C11'  C0 086D'                 LBR SEQRTN      ;RETURN TO LBT
2414                                ;
2415                                ;
2416                                ;
2417                                ;
2418                                ;
2419    0C14'  A7                   SETCLR::PLO GPAGE       ;SET OR CLR FLAG ON GPAGE
2420    0C15'  4C                       LDA PPC
2421    0C16'  F6                       SHR
2422    0C17'  33 1C'                   BDF SETAC
2423    0C19'  F8 00                    LDI 00
2424    0C1B'  C8                       LSKP
2425    0C1C'  F8 AC                SETAC:  LDI 0ACH
2426    0C1E'  57                       STR GPAGE
2427    0C1F'  C0 0B14'                 LBR SAVE
2428                                ;
2429                                ;
2430                                ;*************** INITIALIZE STACKS AND COUNTERS - 4C, 4D, 4E ***************
2431                                ;
2432    0C22'  0C                   INITX:  LDN PPC
2433    0C23'  FA 03                    ANI 03
2434    0C25'  32 37'                   BZ INITS        ;4C = INITIALIZE ONLY SEQ. STACKS, PPCCNT,
2435    0C27'  FB 01                    XRI 01          ;       FASTMODE, ETC.
2436    0C29'  32 32'                   BZ INITB        ;4D = INITIALIZE BOTH
2437    0C2B'  FB 03                    XRI (01 XOR 02)
2438    0C2D'  32 3F'                   BZ INITC        ;4E = INITIALIZE ONLY  SEQ. COUNTERS
```

```
2439    0C2F'  C0 0B13'                 LBR INCPPC
2440                                    ;
2441    0C32'  E2                       INITB:  SEX STACK
2442                                            SCAL R6, CNTCLR
2443    0C33'  68 86            +
2444    0C35'  0C47'            +
2445                                    ;
2446    0C37'  E2                       INITS:  SEX STACK
2447                                            SCAL R6, STKCLR
2448    0C38'  68 86            +
2449    0C3A'  0C59'            +
2450    0C3C'  C0 0B13'                 LBR INCPPC
2451                                    ;
2452    0C3F'  E2                       INITC:  SEX STACK
2453                                            SCAL R6, CNTCLR
2454    0C40'  68 86            +
2455    0C42'  0C47'            +
2456    0C44'  C0 0B13'                 LBR INCPPC
2457                                    ;
2458                                    ;
2459                                    ;*** SUBROUTINES FOR INITIALIZE ***
2460                                    ;
2461    0C47'  E2                       CNTCLR: SEX STACK               ;CLEAR COUNTERS A, B, C
2462                                            SCAL R6, CTNCLR
2463    0C48'  68 86            +
2464    0C4A'  0DA3'            +
2465    0C4C'  6D                       DB CTALO
2466                                    SCAL R6, CTNCLR
2467    0C4D'  68 86            +
2468    0C4F'  0DA3'            +
2469    0C51'  71                       DB CTBLO
2470                                    SCAL R6, CTNCLR
2471    0C52'  68 86            +
2472    0C54'  0DA3'            +
2473    0C56'  75                       DB CTCLO
2474                                    SRET R6                 ;RETURN
2475    0C57'  68 96            +
2476                                    ;
2477                                    ;
2478    0C59'  F8 52                    STKCLR: LDI SSTKPG      ;INITIALISE STACKS
2479    0C5B'  BD                               PHI RSTK
2480    0C5C'  BE                               PHI ASTK
2481    0C5D'  F8 3F                            LDI LOW(RSTKTP)
2482    0C5F'  AD                               PLO RSTK        ;       R STACK
2483    0C60'  F8 7F                            LDI LOW(ASTKTP)
2484    0C62'  AE                               PLO ASTK        ;       A STACK
```

```
2485    0C63'  F8 68                    LDI PPCCNT
2486    0C65'  A7                       PLO GPAGE
2487    0C66'  E7                       SEX GPAGE
2488    0C67'  F8 00                    LDI 00
2489    0C69'  73                       STXD            ;CLEAR PPC COUNT
2490    0C6A'  73                       STXD            ;SET SEQUENCER RATE TO CYCLE 1 ONLY
2491    0C6B'  73                       STXD            ;CLEAR FAST SEQUENCER MODE
2492    0C6C'  E2                       SEX STACK
2493                                    SRET R6         ;RETURN
2494    0C6D'  68 96            +
2495                            ;
2496                            ;
2497                            ;******************** 'Wait For' Sequencer Code ************************
2498                            ;
2499    0C6F'  0C               WTFORX: LDN PPC         ;WAIT FOR DAYS, HOURS, MIN
2500    0C70'  FA 03                    ANI 03          ;GET LOW NIBBLE
2501    0C72'  FE                       SHL
2502    0C73'  FC 13                    ADI H10
2503    0C75'  A7                       PLO GPAGE
2504    0C76'  C4                       NOP
2505    0C77'  2E               PUSH00: DEC ASTK
2506    0C78'  F8 00                    LDI 00
2507    0C7A'  5E                       STR ASTK
2508    0C7B'  E2                       SEX STACK
2509                                    SCAL R6, CMPARE
2510    0C7C'  68 86            +
2511    0C7E'  0C9C'            +
2512    0C80'  33 88'                   BDF MATCH3
2513    0C82'  1E                       INC ASTK
2514    0C83'  C0 0B14'                 LBR SAVE
2515    0C86'  C4                       NOP
2516    0C87'  C4                       NOP
2517                            ;
2518    0C88'  87               MATCH3: GLO GPAGE
2519    0C89'  F3 19                    XRI CYCLES
2520    0C8B'  3A 77'                   BNZ PUSH00
2521    0C8D'  C4                       NOP
2522    0C8E'  C4                       NOP
2523    0C8F'  0E                       LDN ASTK
2524    0C90'  32 98'                   BZ STKERR
2525    0C92'  FF 01                    SMI 01          ;DEC. COUNT
2526    0C94'  5E                       STR ASTK
2527    0C95'  CA 0B14'                 LBNZ SAVE
2528    0C98'  1E               STKERR: INC ASTK
2529    0C99'  C0 0B13'                 LBR INCPPC
2530                            ;
```

```
2531                                    ;
2532                                    ;********************* COMPARE TIME SUBROUTINE ******************
2533                                    ;***************** Used by Wait Till and Wait For ***************
2534                                    ;
2535    0C9C'  47                       CMPARE: LDA GPAGE       ;GET X 10 DIGIT
2536    0C9D'  FE                               SHL
2537    0C9E'  FE                               SHL
2538    0C9F'  FE                               SHL
2539    0CA0'  FE                               SHL
2540    0CA1'  EE                               SEX ASTK
2541    0CA2'  F3                               XOR
2542    0CA3'  FA F0                            ANI 0F0H        ;CONSIDER HI DIGIT
2543    0CA5'  32 AD'                           BZ CHK1
2544    0CA7'  FC 00                    NOMTCH: ADI 00          ;CLEAR DF
2545    0CA9'  27                               DEC GPAGE
2546    0CAA'  E2                               SEX STACK
2547                                            SRET R6
2548    0CAB'  68 96            +
2549    0CAD'  47                       CHK1:   LDA GPAGE
2550    0CAE'  F3                               XOR
2551    0CAF'  FA 0F                            ANI 0FH         ;CONSIDER LO DIGIT
2552    0CB1'  3A A7'                           BNZ NOMTCH
2553    0CB3'  FF 00                            SMI 00          ;SET DF
2554    0CB5'  1E                               INC ASTK
2555    0CB6'  E2                               SEX STACK
2556                                            SRET R6
2557    0CB7'  68 96            +
2558                                    ;
2559                                    ;
2560                                    ;*** LOOP 2 -- PWR ON; OFF; ON AND SEND DATA ON LOOP 2 *********************
2561                                    ;****** D0= PWR OFF, D1= PWR ON, D2nnnn = PWR ON AND SEND DATA LOOP 2 ******
2562                                    ;
2563                                    ;
2564    0CB9'  0C                       LOOP2X: LDN PPC                 ;IS PPC D0, D1, OR D2?
2565    0CBA'  FA 03                            ANI 03                  ;       MASK FOR 2 LSB's
2566    0CBC'  32 C9'                           BZ LP2OFF               ;  IF D0, LOOP 2 PWR OFF
2567    0CBE'  FB 01                            XRI 01
2568    0CC0'  32 D1'                           BZ LP2ON                ;  IF D1, LOOP 2 PWR ON
2569    0CC2'  FB 03                            XRI 01 XOR 02
2570    0CC4'  32 D9'                           BZ LP2XMT               ;  IF D2, LOOP 2 PWR ON AND SEND DATA
2571    0CC6'  C0 0D2D'                         LBR LP2XIT              ;IF NOT 1, 2, OR 3, GO TO NEXT PPC
2572                                    ;
2573    0CC9'  E1                       LP2OFF: SEX INTPC       ;D0 = LOOP2 PWR OFF
2574    0CCA'  61                               OUT GROUP
2575    0CCB'  02                               DB 02
2576    0CCC'  67                               OUT RELAYS
```

```
2577    0CCD'  00                       DB 00
2578    0CCE'  C0 0B13'                 LBR INCPPC
2579                                    ;
2580    0CD1'  E1                       LP2ON:  SEX INTPC       ;D1 = LOOP 2 PWR ON
2581    0CD2'  61                               OUT GROUP
2582    0CD3'  02                               DB 02
2583    0CD4'  67                               OUT RELAYS
2584    0CD5'  40                               DB 100Q
2585    0CD6'  C0 0B13'                 LBR INCPPC
2586                                    ;
2587    0CD9'  F8 68                    LP2XMT: LDI PPCCNT      ;D2 = LOOP2 PWR ON, SEND LIST ON LOOP2 VIA TTY2
2588    0CDB'  A7                               PLO GPAGE       ; CHECK IF 1st TIME THRU THIS PPC
2589    0CDC'  07                               LDN GPAGE       ; *** NOTE: 60 SEC. TIMEOUT
2590    0CDD'  32 FF'                           BZ LP20TH       ;       ON THIS PART OF PPC! ***
2591    0CDF'  FB 01                            XRI 01
2592    0CE1'  C2 0D11'                 LBZ LP21ST
2593                                    ;
2594    0CE4'  F8 7E                    LP2NTH: LDI TTY2HI      ;NEXT TIME THRU:
2595    0CE6'  A7                               PLO GPAGE       ; LOOK AT TTY2 CHARACTER
2596    0CE7'  E7                               SEX GPAGE
2597                                            RLXA R9         ;LOAD TTY2 POINTER INTO R9
2598    0CE8'  68 69            +
2599    0CEA'  09                               LDN R9          ;LOOK AT TTY2 DATA
2600    0CEB'  FB FF                            XRI 0FFH        ; IS IT FF ?
2601    0CED'  C6                               LSNZ            ;       IF SO, GO TO LP2XIT
2602    0CEE'  C0 0D2D'                 LBR LP2XIT      ;       IF NOT, CONTINUE
2603    0CF1'  EE                               SEX ASTK
2604    0CF2'  0E                               LDN ASTK
2605    0CF3'  FB 3C                            XRI 03CH        ; 60 SEC. UP ?
2606    0CF5'  C2 0D26'                 LBZ LP2ERR      ;       IF SO, GO TO LP2ERR ROUTINE
2607    0CF8'  F8 01                            LDI 01          ;       IF NOT, CONTINUE THIS PPC
2608    0CFA'  F4                               ADD             ;ADD 01 TO ASTK
2609    0CFB'  5E                               STR ASTK
2610    0CFC'  C0 0C00'                 LBR SAVPPC
2611
2612                                    ;
2613    0CFF'  F8 01                    LP20TH: LDI 01          ;FIRST TIME THRU:
2614    0D01'  57                               STR GPAGE       ; SET PPC COUNT = 01
2615                                    ;
2616    0D02'  E1                               SEX INTPC       ;SELECT I/O GROUP 02
2617    0D03'  61                               OUT GROUP
2618    0D04'  02                               DB 02
2619    0D05'  67                               OUT RELAYS      ;LOOP 2 PWR ON
2620    0D06'  40                               DB 100Q
2621                                    ;
2622    0D07'  F8 80                            LDI ERROR       ;CLEAR LOOP 2 ERROR BITS (0,1) IF PRESENT
```

```
2623    0D09'  A7                       PLO GPAGE
2624    0D0A'  07                       LDN GPAGE
2625    0D0B'  FA FC                    ANI 0FCH
2626    0D0D'  57                       STR GPAGE
2627    0D0E'  C0 0C00'                 LBR SAVPPC
2628                                ;
2629                                ;
2630    0D11'  F8 02                LP21ST: LDI 02          ;2nd TIME THRU:
2631    0D13'  57                       STR GPAGE       ; SET PPC COUNT = 02
2632                                ;
2633    0D14'  1C                       INC PPC         ;SEND DATA ON LOOP 2
2634    0D15'  F8 7E                    LDI TTY2HI      ;       UNDER SEQUENCER CONTROL
2635    0D17'  A7                       PLO GPAGE       ;       BY PUTTING SEND-LIST POINTER
2636    0D18'  4C                       LDA PPC         ;       IN TTYHI AND TTYLO FOR TTY2
2637    0D19'  57                       STR GPAGE
2638    0D1A'  17                       INC GPAGE
2639    0D1B'  0C                       LDN PPC
2640    0D1C'  57                       STR GPAGE
2641    0D1D'  2E                       DEC ASTK
2642    0D1E'  F8 00                    LDI 00          ;SET ASTK TO 00 TO START
2643    0D20'  5E                       STR ASTK        ;   TIME OUT LOOP
2644    0D21'  2C                       DEC PPC         ;DECREMENT PPC TWICE TO RUN
2645    0D22'  2C                       DEC PPC         ;   AGAIN ON NEXT PASS
2646    0D23'  C0 0C00'                 LBR SAVPPC
2647                                ;
2648                                ;
2649    0D26'  F8 80                LP2ERR: LDI ERROR       ;SET LOOP 2 ERROR BIT (01)
2650    0D28'  A7                       PLO GPAGE       ;ERROR SET BY TIME OUT
2651    0D29'  07                       LDN GPAGE
2652    0D2A'  F9 02                    ORI 02
2653    0D2C'  57                       STR GPAGE
2654                                ;
2655                                ;
2656    0D2D'  1C                   LP2XIT: INC PPC         ;MOVE TO NEXT PPC
2657    0D2E'  1C                       INC PPC
2658    0D2F'  1C                       INC PPC
2659    0D30'  1E                       INC ASTK
2660    0D31'  F8 68                    LDI PPCCNT      ;CLEAR PPC COUNT
2661    0D33'  A7                       PLO GPAGE
2662    0D34'  F8 00                    LDI 00
2663    0D36'  57                       STR GPAGE
2664    0D37'  C0 0C00'                 LBR SAVPPC
2665                                ;
2666                                ;
2667                                ;
2668                                ;***************** SEQUENCER COUNTER A CONTROL ******************
```

```
2669                                    ;
2670    0D3A'  0C                       CTAX:   LDN PPC         ;SET OR CLEAR CNTR A
2671    0D3B'  FA 03                            ANI 03          ; A0 = CLEAR
2672    0D3D'  32 45'                           BZ CTACLR       ; A1 = SET (B1 CCCC AAAA)
2673    0D3F'  F6                               SHR             ; A2 = A3 = IGNORED
2674    0D40'  33 4E'                           BDF CTASET      ;       WHERE CCCC = COUNT IN SECONDS
2675    0D42'  C0 0B13'                         LBR INCPPC      ;       AND AAAA = VECTOR ADDR AT CNT = 0000
2676                                    ;
2677    0D45'  E2                       CTACLR: SEX STACK
2678                                            SCAL R6, CTNCLR         ;CLEAR COUNTER A
2679    0D46'  68 86            +
2680    0D48'  0DA3'            +
2681    0D4A'  6B                               DB CTALO
2682    0D4B'  C0 0B13'                         LBR INCPPC
2683                                    ;
2684    0D4E'  E2                       CTASET: SEX STACK               ;SET COUNTER B
2685                                            SCAL R6, CTNSET
2686    0D4F'  68 86            +
2687    0D51'  0D91'            +
2688    0D53'  6C                               DB CTAHI
2689    0D54'  C0 0C00'                         LBR SAVPPC              ;GO TO SAVE PPC
2690                                    ;
2691                                    ;
2692                                    ;***************** SEQUENCER COUNTER B CONTROL ******************
2693                                    ;
2694    0D57'  0C                       CTBX:   LDN PPC         ;SET OR CLEAR CNTR B
2695    0D58'  FA 03                            ANI 03          ; B0 = CLEAR
2696    0D5A'  32 62'                           BZ CTBCLR       ; B1 = SET (B1 CCCC AAAA)
2697    0D5C'  F6                               SHR             ; B2 = B3 = IGNORED
2698    0D5D'  33 6B'                           BDF CTBSET      ;       WHERE CCCC = COUNT IN SECONDS
2699    0D5F'  C0 0B13'                         LBR INCPPC      ;       AND AAAA = VECTOR ADDR AT CNT = 0000
2700                                    ;
2701    0D62'  E2                       CTBCLR: SEX STACK
2702                                            SCAL R6, CTNCLR         ;CLEAR COUNTER B
2703    0D63'  68 86            +
2704    0D65'  0DA3'            +
2705    0D67'  71                               DB CTBLO
2706    0D68'  C0 0B13'                         LBR INCPPC
2707                                    ;
2708    0D6B'  E2                       CTBSET: SEX STACK               ;SET COUNTER B
2709                                            SCAL R6, CTNSET
2710    0D6C'  68 86            +
2711    0D6E'  0D91'            +
2712    0D70'  7C                               DB CTBHI
2713    0D71'  C0 0C00'                         LBR SAVPPC              ;GO TO SAVE PPC
2714                                    ;
```

```
                                        ;
                                        ;***************** SEQUENCER COUNTER C CONTROL ******************
                                        ;
0D74'  0C                       CTCX:   LDN PPC         ;SET OR CLEAR CNTR C
0D75'  FA 03                            ANI 03          ; C0 = CLEAR
0D77'  32 7F'                           BZ CTCCLR       ; C1 = SET (C1 CCCC AAAA)
0D79'  F6                               SHR             ; C2 = C3 = IGNORED
0D7A'  33 88'                           BDF CTCSET      ;       WHERE CCCC = COUNT IN SECONDS
0D7C'  C0 0B13'                         LBR INCPPC      ;       AND AAAA = VECTOR ADDR AT CNT = 0000
                                        ;
0D7F'  E2                       CTCCLR: SEX STACK
                                        SCAL R6, CTNCLR         ;CLEAR COUNTER C
0D80'  68 86                +
0D82'  0DA3'                +
0D84'  75                               DB CTCLO
0D85'  C0 0B13'                         LBR INCPPC
                                        ;
0D88'  E2                       CTCSET: SEX STACK               ;SET COUNTER C
                                        SCAL R6, CTNSET
0D89'  68 86                +
0D8B'  0D91'                +
0D8D'  74                               DB CTCHI
0D8E'  C0 0C00'                         LBR SAVPPC              ;GO TO SAVE PPC
                                        ;
                                        ;
                                        ;******************** SET COUNTER (N) SUBROUTINE ***************
                                        ;
0D91'  1C                       CTNSET: INC PPC         ;INCREMENT PPC
0D92'  46                               LDA LIST        ;GET CTA(N) HI
0D93'  A7                               PLO GPAGE
0D94'  EC                               SEX PPC
0D95'  72                               LDXA            ;STORE CT(N) HI
0D96'  57                               STR GPAGE
0D97'  17                               INC GPAGE
0D98'  72                               LDXA            ;STORE CT(N) LO
0D99'  57                               STR GPAGE
0D9A'  17                               INC GPAGE
0D9B'  72                               LDXA            ;STORE CT(N) VECT HI
0D9C'  57                               STR GPAGE
0D9D'  17                               INC GPAGE
0D9E'  72                               LDXA            ;STORE CT(N) VECT LO
0D9F'  57                               STR GPAGE
0DA0'  E2                               SEX STACK
                                        SRET R6         ;RETURN
0DA1'  68 96                +
                                        ;
```

```
2761                                    ;
2762                                    ;*************** CLEAR COUNTER #N (SUBROUTINE) ******************
2763                                    ;***************** Called by CTAX, CTBX, CTCX ********************
2764                                    ;
2765    0DA3'   46                      CTNCLR: LDA LIST        ;GET CT(N) LO ADDRESS
2766    0DA4'   A7                              PLO GPAGE       ;CLEAR COUNT OF CNT(N)
2767    0DA5'   E7                              SEX GPAGE
2768    0DA6'   F8 00                           LDI 00
2769    0DA8'   73                              STXD
2770    0DA9'   73                              STXD
2771    0DAA'   E2                              SEX STACK
2772                                            SRET R6         ;RETURN FROM SUB
2773    0DAB'   68 96           +
2774                                    ;
2775                                    ;
2776                                    ;
2777                                    ;*****************************************************************
2778                                    ;
2779                                    ;*************** SET UP SEA DATA BUFFER AND RECORD *************
2780                                    ;
2781    0DAD'   F8 18                   SD:     LDI SEC1                ;SEC. = X0?
2782    0DAF'   A7                              PLO GPAGE
2783    0DB0'   07                              LDN GPAGE               ;       IF NOT, RETURN TO LBT
2784    0DB1'   CA 0891'                        LBNZ SDRET
2785    0DB4'   17                              INC GPAGE               ;CYCLES = 1A?
2786    0DB5'   07                              LDN GPAGE
2787    0DB6'   FB 1A                           XRI 1AH                 ;       IF NOT, RETURN TO LBT
2788    0DB8'   CA 0891'                        LBNZ SDRET
2789                                    ;
2790                                            RLDI DMA, BUFFER        ;SET UP BUFFER  R0 = DMA = 5B00
2791    0DBB'   68 C0           +
2792    0DBD'   5B00            +
2793                                    ;
2794                                    ;
2795                                    ;  TRANSFER DATA FROM GLOBAL PAGE TO DMA BUFFER
2796                                    ;  DATA IS PACKED DURING TRANSFER
2797                                    ;
2798                                    ;  DO EXP. # AND TIME WORDS FIRST
2799                                    ;
2800                                    ;
2801    0DBF'   F8 0F                           LDI EXPNUM              ;GP TO EXPNUM (GP = 0F)
2802    0DC1'   A7                              PLO GPAGE
2803    0DC2'   E7                              SEX GPAGE
2804    0DC3'   72                              LDXA                    ;LD EXPNUM; GP TO D100 (GP=10)
2805    0DC4'   FE                              SHL
2806    0DC5'   FE                              SHL
```

```
2807    0DC6'  FE                       SHL
2808    0DC7'  FE                       SHL
2809    0DC8'  F1                       OR
2810    0DC9'  50                       STR DMA             ;       EXPNUM/D100 TO DMA BUFFER 00
2811    0DCA'  10                       INC DMA             ;       DMA BUFFER TO 01
2812    0DCB'  17                       INC GPAGE           ;       GP -> D11
2813    0DCC'  72                       LDXA                ;LD D10; GP TO D1 (GP=12)
2814    0DCD'  FE                       SHL
2815    0DCE'  FE                       SHL
2816    0DCF'  FE                       SHL
2817    0DD0'  FE                       SHL
2818    0DD1'  F1                       OR
2819    0DD2'  50                       STR DMA             ;       D10/D1 TO DMA BUFFER 01
2820    0DD3'  10                       INC DMA             ;       DMA BUFFER TO 02
2821    0DD4'  17                       INC GPAGE           ;       GP -> D13
2822                                    ;
2823    0DD5'  72                       LDXA                ;LD H10;GP TO H1 (GP=14)
2824    0DD6'  FE                       SHL
2825    0DD7'  FE                       SHL
2826    0DD8'  FE                       SHL
2827    0DD9'  FE                       SHL
2828    0DDA'  F1                       OR
2829    0DDB'  50                       STR DMA             ;       HH TO DMA BUFFER 02
2830    0DDC'  10                       INC DMA             ;       DMA BUFFER TO 03
2831    0DDD'  17                       INC GPAGE           ;       GP->M10
2832    0DDE'  72                       LDXA                ;LD M10;GP TO M1 (GP=16)
2833    0DDF'  FE                       SHL
2834    0DE0'  FE                       SHL
2835    0DE1'  FE                       SHL
2836    0DE2'  FE                       SHL
2837    0DE3'  F1                       OR
2838    0DE4'  50                       STR DMA             ;       MM TO BUFFER 03
2839    0DE5'  10                       INC DMA             ;       DMA BUFFER TO 04
2840    0DE6'  17                       INC GPAGE           ;       GP -> S10
2841    0DE7'  72                       LDXA                ;LD S10;GP TO S1 (GP=18)
2842    0DE8'  FE                       SHL
2843    0DE9'  FE                       SHL
2844    0DEA'  FE                       SHL
2845    0DEB'  FE                       SHL
2846    0DEC'  F1                       OR
2847    0DED'  50                       STR DMA             ;SS TO DMA BUFFER 04
2848                                    ;
2849                                    ;
2850    0DEE'  10                       INC DMA         ;       DMA BUFFER TO 05
2851    0DEF'  F8 60                    LDI PPCHI
2852    0DF1'  A7                       PLO GPAGE
```

```
2853    0DF2'  72                       LDXA            ; LOAD PPCHI (GP=60); GP TO PPCLO (GP=61)
2854    0DF3'  50                       STR DMA         ; PPCHI TO DMA BUFFER 05
2855    0DF4'  10                       INC DMA         ;       DMA BUFFER TO 06
2856    0DF5'  F0                       LDX             ; LOAD PPCLO (GP=61); GP STAYS AT GP=61
2857    0DF6'  50                       STR DMA         ; PPCLO TO DMA BUFFER 06
2858    0DF7'  10                       INC DMA         ;       DMA BUFFER TO 07
2859                            ;
2860                            ;
2861                            ; PUT STATUS BYTES IN BUFFER
2862                            ;
2863    0DF8'  F8 80                    LDI ERROR       ; SET GLOBAL PAGE TO ERROR (GP=80)
2864    0DFA'  A7                       PLO GPAGE
2865    0DFB'  72                       LDXA            ; LOAD ERROR (GP=80); GP -> 81
2866    0DFC'  50                       STR DMA         ; ERROR WORD TO DMA BUFFER 07
2867    0DFD'  10                       INC DMA         ;       DMA BUFFER TO 08
2868                            ;
2869    0DFE'  72                       LDXA            ;LOAD ACSTAT (GP=81); GP -> 82
2870    0DFF'  50                       STR DMA         ; ACOUSTIC STATUS TO DMA BUFFER 08
2871    0E00'  10                       INC DMA         ;       DMA BUFFER TO 09
2872                            ;
2873    0E01'  72                       LDXA            ;LOAD SWSTAT (GP=82); GP -> 83
2874    0E02'  50                       STR DMA         ; SWSTAT TO DMA BUFFER 09
2875    0E03'  10                       INC DMA         ;       DMA BUFFER TO 0A
2876                            ;
2877    0E04'  72                       LDXA            ;LOAD PODSTAT (GP=83); GP -> 84
2878    0E05'  50                       STR DMA         ; PODSTAT TO DMA BUFFER 0A
2879    0E06'  10                       INC DMA         ;       DMA BUFFER TO 0B
2880                            ;
2881    0E07'  72                       LDXA            ;LOAD CMPSS (GP=84); GP -> 85
2882    0E08'  50                       STR DMA         ; COMPASS TO DMA BUFFER 0B
2883    0E09'  10                       INC DMA         ;       DMA BUFFER TO 0C
2884                            ;
2885    0E0A'  72                       LDXA            ;LOAD HDG (GP=85); GP -> 86
2886    0E0B'  50                       STR DMA         ; HEADING TO DMA BUFFER 0C
2887    0E0C'  10                       INC DMA         ;       DMA BUFFER TO 0D
2888                            ;
2889    0E0D'  72                       LDXA            ;LOAD PUMP1 (GP=86); GP -> 87
2890    0E0E'  50                       STR DMA         ; PUMP 1 SPEED TO DMA BUFFER 0D
2891    0E0F'  10                       INC DMA         ;       DMA BUFFER TO 0E
2892                            ;
2893    0E10'  72                       LDXA            ;LOAD PUMP2 (GP=87); GP -> 88
2894    0E11'  50                       STR DMA         ; PUMP 2 SPEED TO DMA BUFFER 0E
2895    0E12'  10                       INC DMA         ;       DMA BUFFER TO 0F
2896                            ;
2897    0E13'  72                       LDXA            ;LOAD CAMCNT (GP=88); GP -> 98
2898    0E14'  50                       STR DMA         ; CAMERA FRAME COUNT TO DMA BUFFER 0F
```

```
2899    0E15'  10                       INC DMA         ;       DMA BUFFER TO 10
2900                                ;
2901    0E16'  72                       LDXA            ; LOAD PITCH (GP=89); GP -> 8A
2902    0E17'  50                       STR DMA         ; PITCH TO DMA BUFFER 10
2903    0E18'  10                       INC DMA         ;       DMA BUFFER TO 11
2904                                ;
2905    0E19'  72                       LDXA            ;LOAD ROLL (GP=8A); GP -> 8B
2906    0E1A'  50                       STR DMA         ; ROLL TO DMA BUFFER 11
2907    0E1B'  10                       INC DMA         ;       DMA BUFFER TO 12
2908                                ;
2909    0E1C'  72                       LDXA            ;LOAD BATTUP (GP=8B); GP -> 8C
2910    0E1D'  50                       STR DMA         ; uP BATTERY TO DMA BUFFER 12
2911    0E1E'  10                       INC DMA         ;       DMA BUFFER TO 13
2912                                ;
2913    0E1F'  72                       LDXA            ;LOAD BATTSY (GP=8C); GP -> 8D
2914    0E20'  50                       STR DMA         ; SYSTEM BATTERY TO DMA BUFFER 13
2915    0E21'  10                       INC DMA         ;       DMA BUFFER TO 14
2916                                ;
2917                                ;
2918    0E22'  E0                       SEX DMA         ;START STORING A/D STRING
2919                                ;
2920                                ;
2921    0E23'  47                       LDA GPAGE       ;LOAD ADGH8 (GP=8D); GP -> 8E
2922    0E24'  50                       STR DMA         ;       ADGH8 TO DMA BUFFER 14
2923    0E25'  10                       INC DMA         ;       DMA BUFFER TO 15
2924    0E26'  47                       LDA GPAGE       ;LOAD ADGL4 (GP=8E); GP -> 8F
2925    0E27'  FE                       SHL
2926    0E28'  FE                       SHL
2927    0E29'  FE                       SHL
2928    0E2A'  FE                       SHL
2929    0E2B'  50                       STR DMA         ;       ADGL4/XXXX TO DMA BUFFER 15
2930    0E2C'  07                       LDN GPAGE       ;LOAD ADRH8 (GP=8F)
2931    0E2D'  F6                       SHR
2932    0E2E'  F6                       SHR
2933    0E2F'  F6                       SHR
2934    0E30'  F6                       SHR
2935    0E31'  F1                       OR
2936    0E32'  50                       STR DMA         ;       ADGL4/ADRH4 TO DMA BUFFER 15
2937    0E33'  10                       INC DMA         ;       DMA BUFFER TO 16
2938    0E34'  47                       LDA GPAGE       ;LOAD ADRH8 (GP=8F); GP -> ADRL4 (GP=90)
2939    0E35'  FE                       SHL
2940    0E36'  FE                       SHL
2941    0E37'  FE                       SHL
2942    0E38'  FE                       SHL
2943    0E39'  50                       STR DMA         ;       ADRM4 TO DMA BUFFER 16
2944                                ;
```

```
2945    0E3A'  47                       LDA GPAGE       ;LOAD ADRL4 (GP=90); GP -> AD5H8 (GP=91)
2946    0E3B'  FA 0F                    ANI 0FH
2947    0E3D'  F1                       OR
2948    0E3E'  50                       STR DMA         ;       ADRL8 TO DMA BUFFER 16
2949    0E3F'  10                       INC DMA         ;       DMA BUFFER TO 17
2950                                ;
2951                                ;DMA = 17 (AD5H8)       ;GP = 91 (AD5H8)
2952                                ;
2953    0E40'  47                       LDA GPAGE       ;LOAD AD5H8 (GP=91); GP -> AD5L4 (GP=92)
2954    0E41'  50                       STR DMA         ;AD5H8 TO DMA BUFFER 17
2955    0E42'  10                       INC DMA         ;       DMA BUFFER TO 18
2956    0E43'  47                       LDA GPAGE       ;LOAD AD5L4 (GP=92); GP -> XPOS (GP=93)
2957    0E44'  FE                       SHL
2958    0E45'  FE                       SHL
2959    0E46'  FE                       SHL
2960    0E47'  FE                       SHL
2961    0E48'  50                       STR DMA         ;AD5L4/XXXX TO DMA BUFFER 18
2962    0E49'  47                       LDA GPAGE       ;LOAD XPOS (GP=93); GP -> YZPOS (GP=94)
2963    0E4A'  FA 0F                    ANI 0FH
2964    0E4C'  F1                       OR
2965    0E4D'  50                       STR DMA         ;AD5L4/XPOS TO DMA BUFFER 18
2966    0E4E'  10                       INC DMA         ;       DMA BUFFER TO 19
2967    0E4F'  47                       LDA GPAGE       ;LOAD YZPOS (GP=94); GP TO ADT1H8 (GP=95)
2968    0E50'  50                       STR DMA         ;YZPOS TO DMA BUFFER 19
2969    0E51'  10                       INC DMA         ;       DMA BUFFER TO 1A
2970                                ;
2971                                ;DO TRANSMISSOMETER STRING: DMA = BUF + 1AH ;GP = 95H
2972                                ;
2973    0E52'  47                       LDA GPAGE       ;LOAD ADT1H8 (GP=95); GP -> ADT1L4 (GP=96)
2974    0E53'  50                       STR DMA         ;ADT1H8 TO DMA BUFFER 1A
2975    0E54'  10                       INC DMA         ;       DMA BUFFER TO 1B
2976    0E55'  47                       LDA GPAGE       ;LOAD ADT1L4 GP=96); GP -> ADT2H8 (GP=97)
2977    0E56'  FE                       SHL
2978    0E57'  FE                       SHL
2979    0E58'  FE                       SHL
2980    0E59'  FE                       SHL
2981    0E5A'  50                       STR DMA         ;ADT1L4/XXXX TO DMA BUFFER 1B
2982    0E5B'  07                       LDN GPAGE       ;LOAD ADT2H8 (GP=97)
2983    0E5C'  F6                       SHR
2984    0E5D'  F6                       SHR
2985    0E5E'  F6                       SHR
2986    0E5F'  F6                       SHR
2987    0E60'  F1                       OR
2988    0E61'  50                       STR DMA         ;ADT1L4/ADT2H4 TO DMA BUFFER 1B
2989    0E62'  10                       INC DMA         ;       DMA BUFFER TO 1C
2990    0E63'  47                       LDA GPAGE       ;LOAD ADT2H8 (GP=97); GP -> ADT2L4 (GP=98)
```

```
2991    0E64'  FE                       SHL
2992    0E65'  FE                       SHL
2993    0E66'  FE                       SHL
2994    0E67'  FE                       SHL
2995    0E68'  50                       STR DMA         ;ADT2M4  TO DMA BUFFER 1C
2996    0E69'  47                       LDA GPAGE       ;LOAD ADT2L4 (GP=98); GP TO ADT3H8 (GP=99)
2997    0E6A'  FA 0F                    ANI 0FH
2998    0E6C'  F1                       OR
2999    0E6D'  50                       STR DMA         ;ADT2L8 TO DMA BUFFER 1C
3000    0E6E'  10                       INC DMA         ;       DMA BUFFER TO 1D
3001                                    ;
3002    0E6F'  47                       LDA GPAGE       ;LOAD ADT3H8 (GP=99); GP TO ADT3L4 (GP=9A)
3003    0E70'  50                       STR DMA         ;ADT3H8 TO DMA BUFFER 1D
3004    0E71'  10                       INC DMA         ;       DMA BUFFER TO 1E
3005    0E72'  47                       LDA GPAGE       ;LOAD ADT3L4 (GP=9A); GP TO ADT4H8 (GP=9B)
3006    0E73'  FE                       SHL
3007    0E74'  FE                       SHL
3008    0E75'  FE                       SHL
3009    0E76'  FE                       SHL
3010    0E77'  50                       STR DMA         ;ADT3L4/XXXX TO DMA BUFFER 1E
3011    0E78'  07                       LDN GPAGE       ;LOAD ADT4H8 GP=9B
3012    0E79'  F6                       SHR
3013    0E7A'  F6                       SHR
3014    0E7B'  F6                       SHR
3015    0E7C'  F6                       SHR
3016    0E7D'  F1                       OR
3017    0E7E'  50                       STR DMA         ;ADT3L4/ADT4H4 TO DMA BUFFER 1E
3018    0E7F'  10                       INC DMA         ;       DMA BUFFER TO 1F
3019    0E80'  47                       LDA GPAGE       ;LOAD ADT4H8 (GP=9B); GP TO ADT4L8 (GP=9C)
3020    0E81'  FE                       SHL
3021    0E82'  FE                       SHL
3022    0E83'  FE                       SHL
3023    0E84'  FE                       SHL
3024    0E85'  50                       STR DMA         ;ADT4M4/XXXX TO DMA BUFFER 1F
3025    0E86'  47                       LDA GPAGE       ;LOAD ADT4L8 (GP=9C); GP TO ADT5H8 (GP=9D)
3026    0E87'  FA 0F                    ANI 0FH
3027    0E89'  F1                       OR
3028    0E8A'  50                       STR DMA         ;ADT4L8 TO DMA BUFFER 1F
3029    0E8B'  10                       INC DMA         ;       DMA BUFFER TO 20
3030                                    ;
3031    0E8C'  47                       LDA GPAGE       ;LOAD ADT5H8 (GP=9D); GP TO ADT5L4 (GP=9E)
3032    0E8D'  50                       STR DMA         ;ADT5H8 TO DMA BUFFER 20
3033    0E8E'  10                       INC DMA         ;       DMA BUFFER TO 21
3034    0E8F'  47                       LDA GPAGE       ;LOAD ADT5L4 (GP=9E); GP TO ADT6H8 (GP=9F)
3035    0E90'  FE                       SHL
3036    0E91'  FE                       SHL
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```
3037    0E92'  FE                       SHL
3038    0E93'  FE                       SHL
3039    0E94'  50                       STR DMA         ;ADT5L4/XXXX TO DMA BUFFER 21
3040    0E95'  07                       LDN GPAGE       ;LOAD ADT6H8 (GP=9F)
3041    0E96'  F6                       SHR
3042    0E97'  F6                       SHR
3043    0E98'  F6                       SHR
3044    0E99'  F6                       SHR
3045    0E9A'  F1                       OR
3046    0E9B'  50                       STR DMA         ;ADT5L4/ADT6H4 TO DMA BUFFER 21
3047    0E9C'  10                       INC DMA         ;       DMA BUFFER TO 22
3048    0E9D'  47                       LDA GPAGE       ;LOAD ADT6H8 (GP=9F); GP TO ADT6L4 (GP=A0)
3049    0E9E'  FE                       SHL
3050    0E9F'  FE                       SHL
3051    0EA0'  FE                       SHL
3052    0EA1'  FE                       SHL
3053    0EA2'  50                       STR DMA         ;ADT6M4/XXXX TO DMA BUFFER 22
3054    0EA3'  47                       LDA GPAGE       ;LOAD ADT6L4 (GP=A0); GP TO ADT7H8 (GP=A1)
3055    0EA4'  FA 0F                    ANI 0FH
3056    0EA6'  F1                       OR
3057    0EA7'  50                       STR DMA         ;ADT6L8 TO DMA BUFFER 22
3058    0EA8'  10                       INC DMA         ;       DMA BUFFER TO 23
3059                                    ;
3060                                    ;GP = A1 (ADT7H8); DMA = BUF + 23 (ADT7H8)
3061                                    ;
3062    0EA9'  47                       LDA GPAGE       ;LOAD ADT7H8 (GP=A1); GP TO ADT7L4 (GP=A2)
3063    0EAA'  50                       STR DMA         ;ADT7H8 TO DMA BUFFER 23
3064    0EAB'  10                       INC DMA         ;       DMA BUFFER TO 24
3065    0EAC'  47                       LDA GPAGE       ;LOAD ADT7L4 (GP=A2); GP TO ADT8H8 (GP=A3)
3066    0EAD'  FE                       SHL
3067    0EAE'  FE                       SHL
3068    0EAF'  FE                       SHL
3069    0EB0'  FE                       SHL
3070    0EB1'  50                       STR DMA         ;ADT7L4/XXXX  TO DMA BUFFER 24
3071    0EB2'  07                       LDN GPAGE       ;LOAD ADT8H8 (GP=A3)
3072    0EB3'  F6                       SHR
3073    0EB4'  F6                       SHR
3074    0EB5'  F6                       SHR
3075    0EB6'  F6                       SHR
3076    0EB7'  F1                       OR
3077    0EB8'  50                       STR DMA         ;ADT7L4/ADT8H4 TO DMA BUFFER 24
3078    0EB9'  10                       INC DMA         ;       DMA BUFFER TO 25
3079    0EBA'  47                       LDA GPAGE       ;LOAD ADT8H8 (GP=A3);  GP TO ADT8L4 (GP=A4)
3080    0EBB'  FE                       SHL
3081    0EBC'  FE                       SHL
3082    0EBD'  FE                       SHL
```

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3083    0EBE'  FE                       SHL
3084    0EBF'  50                       STR DMA         ;ADT8M4/XXXX TO DMA BUFFER 25
3085    0EC0'  47                       LDA GPAGE       ;LOAD ADT8L4 (GP=A4); GP TO ADT9H8 (GP=A5)
3086    0EC1'  FA 0F                    ANI 0FH
3087    0EC3'  F1                       OR
3088    0EC4'  50                       STR DMA         ;ADT8L8 TO DMA BUFFER 25
3089    0EC5'  10                       INC DMA         ;       DMA BUFFER TO 26
3090                                    ;
3091    0EC6'  47                       LDA GPAGE       ;LOAD ADT9H8 (GP=A5); GP TO ADT9L4 (GP=A6)
3092    0EC7'  50                       STR DMA         ;ADT9H8 TO DMA BUFFER 26
3093    0EC8'  10                       INC DMA         ;       DMA BUFFER TO 27
3094    0EC9'  47                       LDA GPAGE       ;LOAD ADT9L4 (GP=A6); GP TO ADT0H8 (GP=A7)
3095    0ECA'  FE                       SHL
3096    0ECB'  FE                       SHL
3097    0ECC'  FE                       SHL
3098    0ECD'  FE                       SHL
3099    0ECE'  50                       STR DMA         ;ADT9L4/XXXX TO DMA BUFFER 27
3100    0ECF'  07                       LDN GPAGE       ;LOAD ADT0H8 (GP=A7)
3101    0ED0'  F6                       SHR
3102    0ED1'  F6                       SHR
3103    0ED2'  F6                       SHR
3104    0ED3'  F6                       SHR
3105    0ED4'  F1                       OR
3106    0ED5'  50                       STR DMA         ;ADT9L4/ADT0H4 TO DMA BUFFER 27
3107    0ED6'  10                       INC DMA         ;       DMA BUFFER TO 28
3108    0ED7'  47                       LDA GPAGE       ;LOAD ADT0H8 (GP=A7); GP TO ADT0L4 (GP=A8)
3109    0ED8'  FE                       SHL
3110    0ED9'  FE                       SHL
3111    0EDA'  FE                       SHL
3112    0EDB'  FE                       SHL
3113    0EDC'  50                       STR DMA         ;ADT0M4/XXXX TO DMA BUFFER 28
3114    0EDD'  07                       LDN GPAGE       ;LD ADT0L4 (GP=A8)
3115    0EDE'  FA 0F                    ANI 0FH
3116    0EE0'  F1                       OR
3117    0EE1'  50                       STR DMA         ;ADT0L8 TO DMA BUFFER 28
3118                                    ;
3119                                    ;
3120                                    ;DATA IS NOW LOADED INTO DMA BUFFER
3121                                    ;START RECORDER IF REC. FLG. = AC
3122                                    ;
3123    0EE2'  F8 00                    LDI 00          ;SET DMA TO START OF BUFFER
3124    0EE4'  A0                       PLO DMA
3125    0EE5'  F8 B2                    LDI RECFLG      ;RECORD IF RECFLG = AC
3126    0EE7'  A7                       PLO GPAGE
3127    0EE8'  07                       LDN GPAGE
3128    0EE9'  FB AC                    XRI 0ACH
```

```
3129    0EEB'  32 F3'                    BZ SDREC
3130    0EED'  F8 00                     LDI 00          ;IF NOT = AC, SET TO 00
3131    0EEF'  57                        STR GPAGE
3132    0EF0'  C0 0891'                  LBR SDRET       ;       AND RETURN TO LBT
3133                                ;
3134    0EF3'  E1                   SDREC:  SEX INTPC    ;START RECORDING AFTER
3135    0EF4'  61                        OUT GROUP
3136    0EF5'  02                        DB 02
3137    0EF6'  63                        OUT SDREQ       ;       SENDING RECORD LENGTH
3138    0EF7'  29                        DB SDLNGT
3139    0EF8'  C0 0891'                  LBR SDRET       ;RETURN TO LBT
3140                                ;
3141                                ;
3142                                ;*******************************************************************************
3143                                ;
3144                                ;******************************** PROM 3 ***************************************
3145                                ;
3146                                ;
3147                                     ORG (HDSTRT + 1000H)
3148                                ;
3149                                ;
3150                                ;***************************** HELP FILE ***************************************
3151                                ;
3152    1000'                       HELP:   SCAL R6, TTY
3153    1000'  68 86           +
3154    1002'  024E'           +
3155    1004'  65 6C 70 3A               DB 'elp:'
3156    1008'  CA                        DB 0CAH
3157    1009'  53 65 61 20               DB 'Sea Duct '
3158    100D'  44 75 63 74
3159    1011'  20
3160    1012'  56 65 72 73               DB 'Vers. '
3161    1016'  2E 20
3162    1018'  35                        DB VERS
3163    1019'  2E                        DB '.'
3164    101A'  39                        DB REV
3165    101B'  00CA                      DW 0CAH
3166                                ;
3167    101D'  53 79 73 74               DB 'System Cmds:'
3168    1021'  65 6D 20 43
3169    1025'  6D 64 73 3A
3170    1029'  20 21 55 4E               DB ' !UNLOCK; !LOCK'
3171    102D'  4C 4F 43 4B
3172    1031'  3B 20 21 4C
3173    1035'  4F 43 4B
3174    1038'  CA                        DB 0CAH
```

```
3175    1039'  4D 65 6D 6F              DB 'Memory Commands:'
3176    103D'  72 79 20 43
3177    1041'  6F 6D 6D 61
3178    1045'  6E 64 73 3A
3179    1049'  CA                       DB 0CAH
3180    104A'  20 20 21 4D              DB '  !Maaaa dd...;'
3181    104E'  61 61 61 61
3182    1052'  20 64 64 2E
3183    1056'  2E 2E 3B
3184    1059'  20 3F 4D 61              DB ' ?Maaaa nnnn;'
3185    105D'  61 61 61 20
3186    1061'  6E 6E 6E 6E
3187    1065'  3B
3188    1066'  20 3F 43 20              DB ' ?C (CRC)'
3189    106A'  28 43 52 43
3190    106E'  29
3191    106F'  CA                       DB 0CAH
3192    1070'  20 20 4D 20              DB '  M (Memory protect)'
3193    1074'  28 4D 65 6D
3194    1078'  6F 72 79 20
3195    107C'  70 72 6F 74
3196    1080'  65 63 74 29
3197    1084'  CA                       DB 0CAH
3198                                    ;
3199    1085'  43 6C 6F 63              DB 'Clock Commands:'
3200    1089'  6B 20 43 6F
3201    108D'  6D 6D 61 6E
3202    1091'  64 73 3A
3203    1094'  20 3F 54 3B              DB ' ?T; '
3204    1098'  20
3205    1099'  21 54 49 4D              DB '!TIME DDDHHMMSS @'
3206    109D'  45 20 44 44
3207    10A1'  44 48 48 4D
3208    10A5'  4D 53 53 20
3209    10A9'  40
3210    10AA'  CA                       DB 0CAH
3211                                    ;
3212    10AB'  50 61 73 73              DB 'Pass Thru Mode:'
3213    10AF'  20 54 68 72
3214    10B3'  75 20 4D 6F
3215    10B7'  64 65 3A
3216    10BA'  20 25 50 3B              DB ' %P; %R; %X; %B'
3217    10BE'  20 25 52 3B
3218    10C2'  20 25 58 3B
3219    10C6'  20 25 42
3220    10C9'  CA                       DB 0CAH
```

```
3221                                    ;
3222    10CA'   53 65 71 75             DB 'Sequencer Cmds:'
3223    10CE'   65 6E 63 65
3224    10D2'   72 20 43 6D
3225    10D6'   64 73 3A
3226    10D9'   CA                      DB 0CAH
3227    10DA'   20 20 3F 53             DB '  ?S; !S; !F (Follow PPC)'
3228    10DE'   3B 20 21 53
3229    10E2'   3B 20 21 46
3230    10E6'   20 28 46 6F
3231    10EA'   6C 6C 6F 77
3232    10EE'   20 50 50 43
3233    10F2'   29
3234    10F3'   CA                      DB 0CAH
3235                                    ;
3236    10F4'   20 20 4D 61             DB '  Main Sequencer PPC Starts at 3000'
3237    10F8'   69 6E 20 53
3238    10FC'   65 71 75 65
3239    1100'   6E 63 65 72
3240    1104'   20 50 50 43
3241    1108'   20 53 74 61
3242    110C'   72 74 73 20
3243    1110'   61 74 20 33
3244    1114'   30 30 30
3245    1117'   CA                      DB 0CAH
3246                                    ;
3247    1118'   53 65 61 20             DB 'Sea Duct Cmds:'
3248    111C'   44 75 63 74
3249    1120'   20 43 6D 64
3250    1124'   73 3A
3251    1126'   CA                      DB 0CAH
3252    1127'   20 20 3F 48             DB '  ?H; !H (Read or Set Exp. Hdg.)'
3253    112B'   3B 20 21 48
3254    112F'   20 28 52 65
3255    1133'   61 64 20 6F
3256    1137'   72 20 53 65
3257    113B'   74 20 45 78
3258    113F'   70 2E 20 48
3259    1143'   64 67 2E 29
3260    1147'   CA                      DB 0CAH
3261    1148'   20 20 3F 45             DB '  ?E; !E (Read or Set Exp. #)'
3262    114C'   3B 20 21 45
3263    1150'   20 28 52 65
3264    1154'   61 64 20 6F
3265    1158'   72 20 53 65
3266    115C'   74 20 45 78
```

```
3267    1160'  70 2E 20 23
3268    1164'  29
3269    1165'  CA                          DB 0CAH
3270    1166'  20 20 3F 42                 DB '  ?B (?Buffer)'
3271    116A'  20 28 3F 42
3272    116E'  75 66 66 65
3273    1172'  72 29
3274                                ;
3275    1174'  FF                          DB DONE
3276    1175'  C0 0107'                    LBR PROMPT
3277                                ;
3278                                ;
3279                                ;********************** ? BUFFER (INSTRUMENT SPECIFIC) ************************
3280                                ;
3281    1178'                       QUEBUF: SCAL R6, TTY    ;TYPE "uffer CR,LF
3282    1178'  68 86          +
3283    117A'  024E'          +
3284    117C'  20 20 57 41                 DB '  WAIT...'
3285    1180'  49 54 2E 2E
3286    1184'  2E
3287    1185'  CAFF                        DW 0CAFFH
3288                                ;
3289    1187'  F8 18                       LDI SEC1        ;       WAIT FOR SEC = 0
3290    1189'  A7                          PLO GPAGE
3291                                       ;
3292    118A'  07                          LDN GPAGE
3293    118B'  FA 0F                       ANI 0FH
3294    118D'  3A 8A'                      BNZ $-03
3295                                ;
3296    118F'  17                          INC GPAGE       ;SET GP = CYCLES
3297    1190'  07                          LDN GPAGE       ;       WAIT FOR CYCLES = 1B
3298    1191'  FB 1B                       XRI 1BH
3299    1193'  3A 90'                      BNZ $-03
3300                                       RLDI RD, BUFFER ;SET UP RD TO START OF
3301    1195'  68 CD          +
3302    1197'  5B00          +
3303                                       ;               ;       SEA DATA BUFFER
3304                                       ;
3305                                       SCAL R6, TTY    ;TYPE: (FIRST LINE)
3306    1199'  68 86          +
3307    119B'  024E'          +
3308    119D'  CA                          DB 0CAH
3309    119E'  42 75 66 66                 DB 'Buffer:'
3310    11A2'  65 72 3A
3311    11A5'  CA                          DB 0CAH
3312    11A6'  45 58 50 23                 DB 'EXP# '      ;FIRST LINE:
```

```
3313    11AA'  20
3314    11AB'  A1                       DB 0A1H         ;  OUTPUT 4 BIT EXPERIMENT #
3315    11AC'  20 20                    DB '  '
3316    11AE'  A2                       DB 0A2H         ;  OUTPUT 3 DIGIT DAYS
3317    11AF'  8D                       DB 08DH
3318    11B0'  2F                       DB '/'
3319                                ;
3320    11B1'  8D                       DB 08DH         ;OUTPUT TIME
3321    11B2'  3A                       DB ':'
3322    11B3'  8D                       DB 08DH
3323    11B4'  3A                       DB ':'
3324    11B5'  8D                       DB 08DH
3325                                ;
3326    11B6'  20 20 20 50              DB '   PPC='    ;OUTPUT SEQUENCER PPC
3327    11BA'  50 43 3D
3328    11BD'  8D                       DB 08DH
3329    11BE'  8D                       DB 08DH
3330                                ;
3331    11BF'  CA                       DB 0CAH
3332                                    ;
3333                                    ;               ;SECOND LINE:
3334    11C0'  45 52 52 3D              DB 'ERR='       ;   ERROR WORD
3335    11C4'  8D                       DB 08DH
3336    11C5'  20 20 41 43              DB '  ACU='     ;   ACOUSTIC STATUS
3337    11C9'  55 3D
3338    11CB'  8D                       DB 08DH
3339    11CC'  20 20 53 57              DB '  SW='      ;   SWITCH STATUS
3340    11D0'  3D
3341    11D1'  8D                       DB 08DH
3342    11D2'  20 20 50 4F              DB '  POD='
3343    11D6'  44 3D
3344    11D8'  8D                       DB 08DH         ;   RELAY POD STATUS
3345    11D9'  20 20 43 4D              DB '  CMPS='
3346    11DD'  50 53 3D
3347    11E0'  8DCA                     DW 08DCAH       ;   COMPASS, CR, LF
3348                                    ;
3349                                    ;               ;THIRD LINE:
3350    11E2'  48 44 47 3D              DB 'HDG='
3351    11E6'  8D                       DB 08DH         ;   HEADING
3352    11E7'  20 20 20 50              DB '   P1='
3353    11EB'  31 3D
3354    11ED'  8D                       DB 08DH         ;   PUMP 1 SPEED
3355    11EE'  20 20 50 32              DB '  P2='
3356    11F2'  3D
3357    11F3'  8D                       DB 08DH         ;   PUMP 2 SPEED
3358    11F4'  20 20 43 41              DB '  CAM='
```

```
3359    11F8'  4D 3D
3360    11FA'  8DCA                    DW 08DCAH       ; CAMERA FRAME COUNT, CR, LF
3361                                   ;
3362                                   ;               ;FOURTH LINE:
3363    11FC'  50 49 54 43            DB 'PITCH='
3364    1200'  48 3D
3365    1202'  8D                      DB 08DH         ;  PITCH
3366    1203'  20 20 52 4F            DB '  ROLL='
3367    1207'  4C 4C 3D
3368    120A'  008D                    DW 08DH         ;  ROLL
3369    120C'  20 20 75 50            DB '  uP Bat='
3370    1210'  20 42 61 74
3371    1214'  3D
3372    1215'  8D                      DB 08DH         ;  COMPUTER BATTERY
3373    1216'  20 20 53 79            DB '  SysBat='
3374    121A'  73 42 61 74
3375    121E'  3D
3376    121F'  8DCA                    DW 08DCAH       ;  SYSTEM BATTERY, CR, LF
3377                                   ;
3378                                   ;               ;FIFTH LINE:
3379    1221'  47 4E 44 3D            DB 'GND='
3380    1225'  8DA1                    DW 08DA1H       ;  A/D GND REF (12BIT)
3381    1227'  20 20 52 45            DB '  REF='
3382    122B'  46 3D
3383    122D'  A28D                    DW 0A28DH       ;  A/D REF (12 BIT)
3384    122F'  20 20 2B 35            DB '  +5V='
3385    1233'  56 3D
3386    1235'  8DA1                    DW 08DA1H       ;  A/D +5V (12 BIT)
3387    1237'  CA                      DB 0CAH         ;  CR, LF
3388                                ;
3389                                ;                  ;SIXTH LINE:
3390    1238'  58 50 4F 53            DB 'XPOS='
3391    123C'  3D
3392    123D'  A2                      DB 0A2H         ;  XPOS (4 BIT)
3393    123E'  20 20 20 59            DB '   YPOS='
3394    1242'  50 4F 53 3D
3395    1246'  A1                      DB 0A1H         ;  YPOS (4 BIT)
3396    1247'  20 20 20 5A            DB '   ZPOS='
3397    124B'  50 4F 53 3D
3398    124F'  A2CA                    DW 0A2CAH       ;  ZPOS (4 BIT), CR, LF
3399                                ;
3400                                ;                  ;SEVENTH LINE:
3401    1251'  8DA1                    DW 08DA1H       ;  T1
3402    1253'  20                      DB ' '
3403    1254'  A28D                    DW 0A28DH       ;  T2
3404    1256'  20                      DB ' '
```

```
3405    1257'  8DA1                    DW 08DA1H       ;  T3
3406    1259'  20                      DB ' '
3407    125A'  A28D                    DW 0A28DH       ;  T4
3408    125C'  20                      DB ' '
3409    125D'  8DA1                    DW 08DA1H       ;  T5
3410                            ;
3411    125F'  2F                      DB '/'          ;  /
3412                            ;
3413    1260'  A28D                    DW 0A28DH       ;  T6
3414    1262'  20                      DB ' '
3415    1263'  8DA1                    DW 08DA1H       ;  T7
3416    1265'  20                      DB ' '
3417    1266'  A28D                    DW 0A28DH       ;  T8
3418    1268'  20                      DB ' '
3419    1269'  8DA1                    DW 08DA1H       ;  T9
3420    126B'  20                      DB ' '
3421    126C'  A28D                    DW 0A28DH       ;  T10
3422                            ;
3423    126E'  00FF                    DW DONE         ;  DONE
3424                            ;
3425    1270'  C0 0107'                LBR PROMPT
3426                            ;
3427                            ;
3428                            ;********************* SET EXPERIMENT HEADING VALUE ***************************
3429                            ;
3430    1273'                   HDGSET: SCAL R6, TTY
3431    1273'  68 86            +
3432    1275'  024E'            +
3433    1277'  65 61 64 69             DB 'eading (HX)  Flow from = ? '
3434    127B'  6E 67 20 28
3435    127F'  48 58 29 20
3436    1283'  20 46 6C 6F
3437    1287'  77 20 66 72
3438    128B'  6F 6D 20 3D
3439    128F'  20 3F 20
3440    1292'  03                      DB 03H          ;ETX
3441    1293'  9D                      DB 9DH          ;IN4D
3442    1294'  FF                      DB DONE         ;DONE
3443                            ;
3444    1295'  F8 3F                    LDI HDGEXP      ;SET GPAGE TO HEADING LOACTION
3445    1297'  A7                      PLO GPAGE
3446    1298'  8D                      GLO RD
3447    1299'  57                      STR GPAGE
3448    129A'  C0 0107'                LBR PROMPT      ;RETURN TO PROMPT
3449                            ;
3450                            ;
```

```
3451                                    ;********************** READ EXPERIMENT HEADING VALUE ************************
3452                                    ;
3453    129D'   F8 BF                   HDG?:   LDI HDGEXP      ;SET RD = HDGEXP LOCATION
3454    129F'   AD                              PLO RD
3455    12A0'   97                              GHI GPAGE
3456    12A1'   BD                              PHI RD
3457                                    ;
3458                                            SCAL R6, TTY
3459    12A2'   68 86           +
3460    12A4'   024E'           +
3461    12A6'   65 61 64 69                     DB 'eading = '
3462    12AA'   6E 67 20 3D
3463    12AE'   20
3464    12AF'   8D                              DB 8DH          ;OUT HX PR
3465    12B0'   20 28 48 58                     DB ' (HX)'
3466    12B4'   29
3467    12B5'   FF                              DB DONE         ;DONE
3468    12B6'   C0 0107'                        LBR PROMPT
3469                                    ;
3470                                    ;
3471                                    ;************************** SET EXPERIMENT NUMBER ****************************
3472                                    ;
3473    12B9'                           EXPSET: SCAL R6, TTY
3474    12B9'   68 86           +
3475    12BB'   024E'           +
3476    12BD'   78 70 2E 20                     DB 'xp. # (1 Char.) = ? '
3477    12C1'   23 20 28 31
3478    12C5'   20 43 68 61
3479    12C9'   72 2E 29 20
3480    12CD'   3D 20 3F 20
3481    12D1'   03                              DB 03H          ;ETX
3482    12D2'   9D                              DB 9DH          ;IN4D
3483    12D3'   FF                              DB DONE         ;DONE
3484                                    ;
3485    12D4'   F8 0F                           LDI EXPNUM      ;SET GPAGE TO EXPERIMENT NUMBER LOCATION
3486    12D6'   A7                              PLO GPAGE
3487    12D7'   8D                              GLO RD
3488    12D8'   57                              STR GPAGE
3489    12D9'   C0 0107'                        LBR PROMPT      ;RETURN TO PROMPT
3490                                    ;
3491                                    ;
3492                                    ;********************** READ EXPERIMENT NUMBER (4 BIT) ************************
3493                                    ;
3494    12DC'   F8 0F                   EXP?:   LDI EXPNUM      ;SET RD = EXPNUM LOCATION
3495    12DE'   AD                              PLO RD
3496    12DF'   97                              GHI GPAGE
```

```
3497    12E0'  BD                        PHI RD
3498                                ;
3499                                     SCAL R6, TTY
3500    12E1'  68 86          +
3501    12E3'  024E'          +
3502    12E5'  78 70 2E 20               DB 'xp. # '
3503    12E9'  23 20
3504    12EB'  A2                        DB 0A2H          ;OUT LOW NIBBLE OF EXPNUM
3505    12EC'  FF                        DB DONE          ;DONE
3506    12ED'  C0 0107'                  LBR PROMPT
3507                                ;
3508                                ;
3509                                ;****************************** COMPASS ROUTINE ******************************
3510                                ;                        ENTERS FROM LONG BRANCH TABLE
3511                                ;
3512    12F0'  F8 18                CMPSRD: LDI SEC1         ;RUN ONLY ON SEC = X1
3513    12F2'  A7                        PLO GPAGE
3514    12F3'  07                        LDN GPAGE
3515    12F4'  FA 0F                     ANI 0FH
3516    12F6'  FB 01                     XRI 01
3517    12F8'  CA 0879'                  LBNZ CMPRTN
3518    12FB'  17                        INC GPAGE        ;SET GPAGE = CYCLES
3519    12FC'  07                        LDN GPAGE        ;START ONLY IF CYCLES = 0A
3520    12FD'  FB 0A                     XRI 0AH
3521    12FF'  C2 1312'                  LBZ CMPPWR
3522    1302'  FB 01                     XRI (0BH XOR 0AH)       ;READ IF CYCLES = 0B
3523    1304'  CA 0879'                  LBNZ CMPRTN
3524                                ;
3525    1307'  E1                        SEX INTPC        ;READ THE COMPASS
3526    1308'  61                        OUT GROUP
3527    1309'  01                        DB 01
3528    130A'  F8 84                     LDI CMPSS
3529    130C'  A7                        PLO GPAGE
3530    130D'  E7                        SEX GPAGE
3531    130E'  6A                        INP CMPASS
3532    130F'  C0 0879'                  LBR CMPRTN              ;RETURN TO LBT
3533                                ;
3534    1312'  E1                   CMPPWR: SEX INTPC            ;FIRE UP THE COMPASS
3535    1313'  61                        OUT GROUP
3536    1314'  01                        DB 01
3537    1315'  62                        OUT CMPASS
3538    1316'  00                        DB 00
3539    1317'  C0 0879'                  LBR CMPRTN              ;RETURN TO LBT
3540                                ;
3541                                ;
3542                                ;
```

```
3543                                ;************************ READ SWITCH ROUTINE ********************************
3544                                ;                       ENTERS FROM LONG BRANCH TABLE
3545                                ;
3546                                ;
3547    131A'  F8 19                SWRD:   LDI CYCLES      ;RUNS EVERY SEC.
3548    131C'  A7                           PLO GPAGE
3549    131D'  07                           LDN GPAGE       ;START ONLY IF CYCLES = 24H
3550    131E'  FB 24                        XRI 024H
3551    1320'  32 37'                       BZ SWPWR
3552    1322'  FB 01                        XRI (024H XOR 025H)     ;READ ONLY IF CYCLES = 24H
3553    1324'  CA 087C'                     LBNZ SWRTN
3554                                ;
3555    1327'  E1                           SEX INTPC
3556    1328'  61                           OUT GROUP
3557    1329'  00                           DB 00
3558    132A'  F8 82                        LDI SWSTAT      ;INPUT SWITCH STATUS TO
3559    132C'  A7                           PLO GPAGE       ;  GLOBAL PAGE AT SWSTAT
3560    132D'  E7                           SEX GPAGE
3561    132E'  6A                           INP SWITCH      ;| Bot |   |   |Ins0 || Ins4 | Ins3 | Ins2 | Ins1 |
3562                                ;
3563    132F'  E1                           SEX INTPC
3564    1330'  61                           OUT GROUP
3565    1331'  02                           DB 02           ;TURN OFF BOTTOM SW. DRIVE PWR.
3566    1332'  67                           OUT RELAYS
3567    1333'  0D                           DB 015Q
3568    1334'  C0 087C'                     LBR SWRTN       ;RETURN TO LBT
3569                                ;
3570    1337'  E1                   SWPWR:  SEX INTPC
3571    1338'  61                           OUT GROUP       ;TURN ON BOTTOM SW. DRIVE PWR.
3572    1339'  02                           DB 02
3573    133A'  67                           OUT RELAYS
3574    133B'  4D                           DB 115Q
3575    133C'  C0 087C'                     LBR SWRTN       ;RETURN TO LBT
3576                                ;
3577                                ;
3578                                ;
3579                                ;************************** A/D CONTROL **********************************
3580                                ;                       ENTERS FROM LONG BRANCH TABLE
3581                                ;
3582                                ;
3583    133F'  F8 18                AD:     LDI SEC1        ;RUNS ONLY ON SEC = 0
3584    1341'  A7                           PLO GPAGE
3585    1342'  07                           LDN GPAGE
3586    1343'  FA 0F                        ANI 0FH         ;MASK FOR LO BYTE
3587    1345'  CA 087F'                     LBNZ ADRTN      ;       IF NOT = 0, RETURN TO LBT
3588    1348'  F8 B0                        LDI ADFLG       ;A/D FLAG = AC?
```

```
3589    134A'  A7                      PLO GPAGE
3590    134B'  07                      LDN GPAGE
3591    134C'  FB AC                   XRI 0ACH
3592    134E'  C2 1367'                LBZ ADGO
3593                                ;
3594    1351'  F8 00                   LDI 00          ; IF NOT AC, SET FLAG = 00
3595    1353'  57                      STR GPAGE
3596    1354'  F8 92                   LDI AD5L4       ;       AND CLEAR A/D STORAGE
3597    1356'  A7                      PLO GPAGE       ;       LOCATIONS ON GPAGE
3598    1357'  E7                      SEX GPAGE
3599    1358'  F8 00                   LDI 00
3600    135A'  73                      STXD
3601    135B'  73                      STXD
3602    135C'  73                      STXD
3603    135D'  73                      STXD
3604    135E'  73                      STXD
3605    135F'  73                      STXD
3606    1360'  73                      STXD
3607    1361'  73                      STXD
3608    1362'  73                      STXD
3609    1363'  57                      STR GPAGE
3610    1364'  C0 087F'                LBR ADRTN       ;RETURN TO LBT
3611                                ;
3612    1367'  F8 19            ADGO:  LDI CYCLES      ;IF AC, CONTINUE
3613    1369'  A7                      PLO GPAGE       ;IF CYCLES NOT = 0,
3614    136A'  07                      LDN GPAGE       ;       DO NOT RESET POINTERS
3615    136B'  3A 7B'                  BNZ $+10H       ;IF = 0:
3616    136D'  F8 AD                   LDI MUXPTR      ;       RESET MUX LIST POINTER
3617    136F'  A7                      PLO GPAGE
3618    1370'  F8 00'                  LDI LOW(MUXLST)
3619    1372'  57                      STR GPAGE
3620    1373'  17                      INC GPAGE       ;       RESET MEM LIST POINTER
3621    1374'  F8 80'                  LDI LOW(MEMLST)
3622    1376'  57                      STR GPAGE
3623    1377'  F8 19                   LDI CYCLES
3624    1379'  A7                      PLO GPAGE
3625    137A'  07                      LDN GPAGE
3626                                ;
3627    137B'  FF 16                   SMI 16H         ;IF CYCLES > 15H,
3628    137D'  3B 84'                  BNF $+07H       ;       ( BORROW => DF = 0)
3629    137F'  FC 00                   ADI 00          ;       CLR DF
3630    1381'  C0 087F'                LBR ADRTN       ;       RETURN TO LBT
3631                                ;
3632    1384'  E1                      SEX INTPC       ;IF CYCLES < 16 :
3633    1385'  61                      OUT GROUP       ;       SELECT MUX GROUP
3634    1386'  02                      DB 02           ;       CONTROL MUX
```

```
3635    1387'  F8 AD                    LDI MUXPTR      ;       WITH MUX LIST
3636    1389'  A7                       PLO GPAGE
3637    138A'  07                       LDN GPAGE
3638    138B'  AA                       PLO RA
3639    138C'  F8 17'                   LDI HIGH(MUXLST)
3640    138E'  BA                       PHI RA
3641    138F'  EA                       SEX RA
3642    1390'  62                       OUT MUX         ;       (OUT MUX INCREMENTS RA)
3643    1391'  62                       OUT MUX
3644    1392'  8A                       GLO RA          ;       STORE MUX LIST ADDR
3645    1393'  57                       STR GPAGE       ;       AT GP = MUXPTR
3646                           ;
3647    1394'  F8 19                    LDI CYCLES      ;IF CYCLES < 9 :
3648    1396'  A7                       PLO GPAGE       ;       RETURN TO LBT
3649    1397'  07                       LDN GPAGE
3650    1398'  FF 08                    SMI 08H
3651    139A'  CB 087F'                 LBNF ADRTN
3652                           ;
3653    139D'  07                       LDN GPAGE       ;IF CYCLES > 8 :
3654    139E'  F6                       SHR
3655    139F'  33 A4'                   BDF $+5
3656    13A1'  C0 087F'                 LBR ADRTN       ;       RETURN TO LBT ON EVEN CYCLES
3657                           ;
3658    13A4'  F8 AE                    LDI MEMPTR      ; ON ODD CYCLES :
3659    13A6'  A7                       PLO GPAGE       ;       READ A/D AND STORE AT
3660    13A7'  07                       LDN GPAGE       ;       GPAGE LOCATION REFERENCED
3661    13A8'  AA                       PLO RA          ;       BY MEMLST
3662    13A9'  0A                       LDN RA
3663    13AA'  A7                       PLO GPAGE
3664    13AB'  E7                       SEX GPAGE
3665    13AC'  6B                       INP ADHI8       ; X=GPAGE; HI 8 BITS TO
3666    13AD'  1A                       INC RA          ;   GPAGE STORAGE
3667    13AE'  0A                       LDN RA
3668    13AF'  A7                       PLO GPAGE
3669    13B0'  6A                       INP ADLO4       ; LO 8 BITS TO NULL LOCATION
3670    13B1'  1A                       INC RA
3671    13B2'  F8 AE                    LDI MEMPTR      ;STORE MEM LIST POINTER
3672    13B4'  A7                       PLO GPAGE       ;       ON GPAGE AT MEMPTR
3673    13B5'  8A                       GLO RA
3674    13B6'  57                       STR GPAGE
3675    13B7'  C0 087F'                 LBR ADRTN       ;RETURN TO LBT
3676                           ;
3677                           ;
3678                           ;************************* TRANSMISSOMETER CONTROL ****************************
3679                           ;                       ENTERS FROM LONG BRANCH TABLE
3680                           ;
```

```
3681    13BA'  E1                TR:    SEX INTPC       ;TR FLAG = AC?
3682    13BB'  F8 B1                    LDI TRFLG
3683    13BD'  A7                       PLO GPAGE
3684    13BE'  07                       LDN GPAGE
3685    13BF'  FB AC                    XRI 0ACH        ;IF = AC, GO TO TRCY02
3686    13C1'  C2 13EF'                 LBZ TRCY02
3687                           ;                        ;IF NOT = AC:
3688    13C4'  F8 18                    LDI SEC1
3689    13C6'  A7                       PLO GPAGE       ;       SEC =1 ?
3690    13C7'  07                       LDN GPAGE
3691    13C8'  FA 0F                    ANI 0FH
3692    13CA'  FB 01                    XRI 01          ;       IF SEC NOT = X1
3693    13CC'  CA 0882'                 LBNZ TRRTN      ;       RETURN TO LBT
3694                           ;
3695    13CF'  17                       INC GPAGE       ;       CYCLES = 03 ?
3696    13D0'  07                       LDN GPAGE
3697    13D1'  FB 03                    XRI 03H         ;       IF CYCLES NOT = 03
3698    13D3'  CA 0882'                 LBNZ TRRTN      ;       RETURN TO LBT
3699                           ;
3700    13D6'  61                       OUT GROUP       ;       SELECT RELAYS GROUP
3701    13D7'  02                       DB 02
3702    13D8'  67                       OUT RELAYS
3703    13D9'  04                       DB 04H          ;       TRANSMISSOMTER PWR OFF
3704    13DA'  F8 B1                    LDI TRFLG
3705    13DC'  A7                       PLO GPAGE       ;       SET TRFLG = 00
3706    13DD'  F8 00                    LDI 00
3707    13DF'  57                       STR GPAGE
3708                           ;
3709    13E0'  F8 A8                    LDI ADT0L4      ;       CLEAR TRANSMISSOMETER
3710    13E2'  A7                       PLO GPAGE       ;         A/D LOCATIONS ON GPAGE
3711    13E3'  E7                       SEX GPAGE
3712    13E4'  F8 00                    LDI 00
3713    13E6'  73                       STXD
3714    13E7'  87                       GLO GPAGE
3715    13E8'  FF 95                    SMI ADT1H8
3716    13EA'  33 E4'                   BDF $-06H
3717    13EC'  C0 0882'                 LBR TRRTN       ;       RETURN TO LBT
3718                           ;
3719    13EF'  F8 19           TRCY02: LDI CYCLES      ;CYCLES = 2?
3720    13F1'  A7                       PLO GPAGE
3721    13F2'  07                       LDN GPAGE
3722    13F3'  FB 02                    XRI 02H
3723    13F5'  CA 13FF'                 LBNZ TRCY17     ; IF NOT = 2, GO TO TRCY17
3724    13F8'  61                       OUT GROUP       ; IF = 2:
3725    13F9'  02                       DB 02           ;       SELECT RELAYS GROUP
3726    13FA'  67                       OUT RELAYS
```

```
3727    13FB'  44                       DB 104Q         ;       TRANSMISSOMETER PWR ON
3728    13FC'  C0 0882'                 LBR TRRTN       ;       RETURN TO LBT
3729                                    ;
3730    13FF'  FB 15                    TRCY17: XRI (02H XOR 17H)       ;CYCLES = 17?;IF NO GO TO TRCY18
3731    1401'  3A 0A'                   BNZ TRCY18                      ; IF = 17:
3732    1403'  61                       OUT GROUP                       ;       SELECT MUX GROUP
3733    1404'  02                       DB 02H                          ;       ( R(X)= INTPC )
3734    1405'  62                       OUT MUX                         ;       A/D = PWR ON
3735    1406'  72                       DB 72H                          ;       MUX = TRANSMISSOMETER
3736    1407'  C0 0882'                 LBR TRRTN                       ;       RETURN TO LBT
3737                                    ;
3738    140A'  FB 0F                    TRCY18: XRI (17H XOR 18H)       ;CYCLES = 19?
3739    140C'  CA 1418'                 LBNZ TRCY19                     ; IF NOT, GO TO TRCY19
3740    140F'  61                       OUT GROUP                       ; IF CYCLES = 18
3741    1410'  02                       DB 02H                          ;       SELECT MUX GROUP
3742    1411'  62                       OUT MUX                         ;       A/D = START CNVRT
3743    1412'  73                       DB 73H                          ;       MUX = TRANSMISSOMETER
3744    1413'  62                       OUT MUX
3745    1414'  72                       DB 72H                          ;       A/D = PWR ON
3746    1415'  C0 0882'                 LBR TRRTN                       ; GO TO LBT
3747                                    ;
3748    1418'  FB 01                    TRCY19: XRI (18H XOR 19H)       ;CYCLES = 19H?
3749    141A'  CA 0882'                 LBNZ TRRTN                      ; IF NOT RETURN TO LBT
3750    141D'  27                       DEC GPAGE                       ; IF = 19:      SET GP-> SEC1
3751    141E'  07                       LDN GPAGE                       ; LOOK AT SEC1
3752    141F'  FA 0F                    ANI 0FH                         ;   IF 0, STORE A/D AT GP = ADT0H8, ADT0L4
3753    1421'  3A 27'                   BNZ $+06
3754    1423'  F8 A7                    LDI ADT0H8
3755    1425'  30 2B'                   BR $+06H
3756    1427'  07                       LDN GPAGE                       ;IF SEC1 NOT = 0;  LOAD SEC.
3757    1428'  FE                       SHL                             ; SEC. * 2
3758    1429'  FC 93                    ADI (ADT1H8)-02H                ; STORE A/D HI 8 BITS AT
3759    142B'  A7                       PLO GPAGE                       ; GP= 2(SEC1) + ADT1H8 - 02H
3760    142C'  21                       SEX INTPC
3761    142D'  61                       OUT GROUP
3762    142E'  02                       DB 02
3763    142F'  E7                       SEX GPAGE
3764    1430'  6B                       INP ADHI8
3765    1431'  60                       IRX                             ;       STORE A/D LO 4 BITS AT
3766    1432'  6A                       INP ADLO4                       ;       GP= 2(SEC1) + ADT1H8 - 01H
3767    1433'  E1                       SEX INTPC
3768    1434'  61                       OUT GROUP                       ;SELECT MUX GROUP
3769    1435'  02                       DB 02                           ;       A/D = ON
3770    1436'  62                       OUT MUX                         ;       MUX = PENDULUM 1
3771    1437'  00                       DB 00
3772    1438'  C0 0882'                 LBR TRRTN                       ;RETURN TO LBT
```

```
3773                                    ;
3774                                    ;
3775                                    ; ******************* RELAY POD AND ACOUSTIC LINK CHECK ********************
3776                                    ;                  **** RUNS EACH SEC. ON CYCLE = 27H ****
3777                                    ;
3778    143B'  F8 19                    PDCHK:  LDI CYCLES      ;RUN ONLY ON CYCLE 27H 39 dec. (Last cycle)
3779    143D'  A7                               PLO GPAGE
3780    143E'  07                               LDN GPAGE
3781    143F'  FB 27                            XRI 27H
3782    1441'  CA 0885'                        LBNZ PDRTN      ;RETURN TO LBT IF CYCLE NOT = 27H
3783                                    ;
3784    1444'  F8 18                           LDI SEC1        ;IF Sec = n0, reset PDSTAT, ACSTAT
3785    1446'  A7                               PLO GPAGE
3786    1447'  07                               LDN GPAGE
3787    1448'  FA 0F                           ANI 0FH
3788    144A'  CA 145F'                        LBNZ PDSTR      ; If SEC. not = n0, GO TO PDSTR
3789                                    ;
3790    144D'  E1                       PDCLR:  SEX INTPC
3791    144E'  61                               OUT GROUP       ;  SET RELAY GROUP
3792    144F'  02                               DB 02           ;      GROUP 2
3793    1450'  F8 83                            LDI PDSTAT      ;CLEAR POD STATUS (Sec.=n9)
3794    1452'  A7                               PLO GPAGE
3795    1453'  F8 00                           LDI 00
3796    1455'  57                               STR GPAGE
3797                                    ;
3798    1456'  E1                       ACUCLR: SEX INTPC
3799    1457'  61                               OUT GROUP       ;  SET GROUP 0
3800    1458'  00                               DB 00
3801    1459'  F8 81                            LDI ACSTAT      ;CLEAR ACOUSTIC STATUS (Sec.=n9)
3802    145B'  A7                               PLO GPAGE
3803    145C'  F8 00                           LDI 00
3804    145E'  57                               STR GPAGE
3805                                    ;
3806    145F'  E1                       PDSTR:  SEX INTPC       ;CHECK RELAY PODS FOR ACTIVE RELAYS
3807    1460'  61                               OUT GROUP       ;  SET RELAY GROUP
3808    1461'  02                               DB 02           ;      GROUP 2
3809                                    ;
3810    1462'  F8 83                           LDI PDSTAT
3811    1464'  A7                               PLO GPAGE
3812    1465'  E2                               SEX STACK       ;Input PoD STATUS
3813    1466'  6F                               INP RELAYS
3814    1467'  E7                               SEX GPAGE
3815    1468'  F1                               OR              ;OR with existing data
3816    1469'  57                               STR GPAGE       ;store in PDSTAT on GPAGE
3817                                    ;
3818                                    ;
```

```
3819    146A'  E1              ACSTR:  SEX INTPC       ;CHECK ACOUSTIC LINK FOR ACTIVE INPUT
3820    146B'  61                      OUT GROUP       ;  SET GROUP 0
3821    146C'  00                      DB 00
3822                           ;
3823    146D'  F8 81                   LDI ACSTAT
3824    146F'  A7                      PLO GPAGE
3825    1470'  E2                      SEX STACK       ;INPUT ACOUSTIC LINK
3826    1471'  6F                      INP PING
3827    1472'  E7                      SEX GPAGE
3828    1473'  F1                      OR              ;OR W/ EXISTING DATA
3829    1474'  57                      STR GPAGE       ;STORE IN ACSTAT ON GPAGE
3830                           ;
3831                           ;
3832    1475'  C0 0885'                LBR PDRTN       ;RETURN TO LBT
3833                           ;
3834                           ;
3835                           ;********************************* READ HEADING *********************************
3836                           ;                       ENTERS FROM LONG BRANCH TABLE
3837                           ;
3838    1478'  F8 B3           HDGCHK: LDI HDGFLG      ;CHECK HDG FLAG STATUS:
3839    147A'  A7                      PLO GPAGE       ;  AC = TURN ON HEADING INDICATOR PWR
3840    147B'  07                      LDN GPAGE       ;       ( USED BY SEQUENCER FOR FAST READ
3841    147C'  FB AC                   XRI 0ACH        ;         DURING ROTATION )
3842    147E'  C2 149C'                LBZ HDG1B
3843                                                   ;  ELSE = TURN ON PWR AT CYC=1B  (SEC = x9)
3844                                                   ;         READ XYZ AT CYC=1C AND TURN OFF PWR
3845                                                   ;         SET XYZ FLG = 00
3846                           ;
3847    1481'  F8 00                   LDI 00          ;Force HDG Flag = 00
3848    1483'  57                      STR GPAGE
3849    1484'  F8 18                   LDI SEC1        ;Run Slow only on Sec =9
3850    1486'  A7                      PLO GPAGE
3851    1487'  07                      LDN GPAGE
3852    1488'  FB 09                   XRI 09H
3853    148A'  CA 14A1'                LBNZ HDGXT
3854                           ;
3855    148D'  F8 19           HDGSLO: LDI CYCLES      ;Check cycle
3856    148F'  A7                      PLO GPAGE
3857    1490'  07                      LDN GPAGE
3858    1491'  FB 1B                   XRI 1BH
3859    1493'  C2 149C'                LBZ HDG1B       ;  If CYC = 1B go to HDG1B
3860    1496'  FB 07                   XRI (1BH XOR 1CH)
3861    1498'  32 A4'                  BZ HDG1C        ;  If CYC = 1C go to HDG1C
3862    149A'  30 A1'                  BR HDGXT        ;  If not 1B or 1C return to LBT
3863                           ;
3864                           ;
```

```
3865    149C'  E1                HDG1B:  SEX INTPC       ;SET GROUP 02
3866    149D'  61                        OUT GROUP
3867    149E'  02                        DB 02
3868    149F'  67                        OUT RELAYS      ;TURN ON HEADING INDICATOR PWR
3869    14A0'  41                        DB 101Q
3870    14A1'  C0 0888'          HDGXT:  LBR HDGRTN
3871                             ;
3872                             ;
3873    14A4'  E2                HDG1C:  SEX STACK
3874                                     SCAL R6, HDGIN  ;READ IN THE HEADING
3875    14A5'  68 86          +
3876    14A7'  14B1'          +
3877                             ;
3878    14A9'  E1                        SEX INTPC       ;SET GROUP 02
3879    14AA'  61                        OUT GROUP
3880    14AB'  02                        DB 02
3881    14AC'  67                        OUT RELAYS      ;TURN OFF HEADING INDICATOR PWR
3882    14AD'  01                        DB 01Q
3883    14AE'  C0 14A1'                  LBR HDGXT
3884                             ;
3885                             ;
3886                             ;*** SUBROUTINE - INPUT HEADING ***
3887                             ;
3888                             ; ** CALLED BY THIS ROUTINE AND EXT. SEQUENCER ROTATION ROUTINE **
3889                             ;
3890    14B1'  E1                HDGIN:: SEX INTPC
3891    14B2'  61                        OUT GROUP
3892    14B3'  01                        DB 01
3893    14B4'  63                        OUT HLATCH      ;LATCH DATA IN ENCODER
3894    14B5'  00                        DB 00           ;NULL DATA
3895                                     RLDI RA ,0008H  ;SHIFT IN DATA TO I/O BOARD
3896    14B6'  68 CA          +
3897    14B8'  0008           +
3898                             ;
3899    14BA'  64                HDGAGN: OUT HSHIFT      ;SEND SHIFT PULSE
3900    14BB'  00                        DB 00
3901    14BC'  C4                        NOP             ;SMALL DELAY
3902    14BD'  C4                        NOP
3903    14BE'  2A                        DEC RA
3904    14BF'  8A                        GLO RA
3905    14C0'  3A BA'                    BNZ HDGAGN      ;ANOTHER SHIFT PULSE?
3906                             ;
3907    14C2'  F8 85                     LDI HDG         ;INPUT HEADING
3908    14C4'  A7                        PLO GPAGE
3909    14C5'  E7                        SEX GPAGE
3910    14C6'  6C                        INP HEADNG
```

```
3911                                    ;
3912    14C7'   E2                      SEX STACK
3913                                    SRET R6
3914    14C8'   68 96           +
3915                                    ;
3916                                    ;
3917                                    ;
3918                                    ;************************ RELAY DRIVER PULSE ROUTINE ***************************
3919                                    ;
3920    14CA'   F8 40                   PULCHK: LDI PULFLG
3921    14CC'   A7                              PLO GPAGE
3922    14CD'   07                              LDN GPAGE       ;Pulse flag = AC
3923    14CE'   FB AC                           XRI 0ACH
3924    14D0'   3A E8'                          BNZ PSET00      ;If not, set to 00
3925    14D2'   17                              INC GPAGE       ; SET GPAGE = PULCNT
3926    14D3'   07                              LDN GPAGE
3927    14D4'   32 E8'                          BZ PSET00
3928    14D6'   FF 01                           SMI 01          ;DECREMENT THE PULSE COUNTER
3929    14D8'   57                              STR GPAGE       ;   AND STORE IT
3930    14D9'   E1                              SEX INTPC
3931    14DA'   61                              OUT GROUP       ;SET RELAYS GROUP
3932    14DB'   02                              DB 02
3933    14DC'   17                              INC GPAGE
3934    14DD'   E7                              SEX GPAGE
3935    14DE'   07                              LDN GPAGE
3936    14DF'   FA 3F                           ANI 077Q        ;Mask Relay #
3937    14E1'   F9 40                           ORI 100Q        ; Set Relay Data Bit = ON
3938    14E3'   57                              STR GPAGE
3939    14E4'   67                              OUT RELAYS      ; Turn on the Relay driver
3940    14E5'   C0 14FD'                        LBR PULXT       ;EXIT THE ROUTINE
3941                                    ;
3942    14E8'   E1                      PSET00: SEX INTPC
3943    14E9'   61                              OUT GROUP       ;SET RELAYS GROUP
3944    14EA'   02                              DB 02
3945    14EB'   F8 42                           LDI PULNUM
3946    14ED'   A7                              PLO GPAGE
3947    14EE'   E7                              SEX GPAGE
3948    14EF'   07                              LDN GPAGE
3949    14F0'   FA 3F                           ANI 077Q        ;Set Relay Data Bit = OFF
3950    14F2'   57                              STR GPAGE
3951    14F3'   67                              OUT RELAYS      ;Turn Off the Relay Driver
3952                                    ;
3953    14F4'   27                              DEC GPAGE       ;SET GPAGE = PULNUM
3954    14F5'   F8 FF                           LDI 0FFH
3955    14F7'   E7                              SEX GPAGE
3956    14F8'   73                              STXD            ;Set PULNUM = FF (FF IS NOT USED)
```

```
3957    14F9'  F8 00                    LDI 00
3958    14FB'  73                       STXD            ;Set PULCNT = 00
3959    14FC'  57                       STR GPAGE       ;Set PULFLG = 00
3960    14FD'  C0 088B'          PULXT: LBR PULRTN      ;EXIT THE ROUTINE
3961                             ;
3962                             ;
3963                             ;****************************** READ XYZ POSITION *******************************
3964                             ;                       ENTERS FROM LONG BRANCH TABLE
3965                             ;
3966    1500'  F8 B4             XYZCHK: LDI XYZFLG     ;CHECK XYZ FLAG STATUS
3967    1502'  A7                       PLO GPAGE       ;  AC = TURN ON OPTO INTERRUPTER PWR
3968    1503'  07                       LDN GPAGE       ;       ( USED BY SEQUENCER FOR FAST READ
3969    1504'  FB AC                    XRI 0ACH        ;         DURING XYZ POSITIONING)
3970    1506'  C2 1525'                 LBZ XYZON       ;  ELSE = TURN ON PWR AT CYC=24 (SEC = x9)
3971                             ;                       ;         READ XYZ AT CYC=25 AND TURN OFF PWR
3972                             ;                       ;         SET XYZ FLG = 00
3973                             ;                       ;***!!! NOTE:
3974                             ;                       ; **** CYCLE 25 CURRENTLY MUST LEAVE PWR ON
3975                             ;                       ;       DUE TO HDWR. BUG ***********************
3976                             ;
3977    1509'  F8 00                    LDI 00          ;FORCE XYZFLG = 00
3978    150B'  57                       STR GPAGE
3979    150C'  F8 18                    LDI SEC1        ;CHECK FOR SEC = x9
3980    150E'  A7                       PLO GPAGE
3981    150F'  07                       LDN GPAGE
3982    1510'  FB 09                    XRI 09H
3983    1512'  CA 1522'                 LBNZ XYZXT      ;IF NOT = x9, EXIT
3984    1515'  F8 19                    LDI CYCLES
3985    1517'  A7                       PLO GPAGE
3986    1518'  07                       LDN GPAGE
3987    1519'  FB 24                    XRI 24H
3988    151B'  C2 1525'                 LBZ XYZON
3989    151E'  FB 01                    XRI (24H XOR 25H)
3990    1520'  32 2C'                   BZ XYZIN
3991    1522'  C0 088E'          XYZXT: LBR XYZRTN
3992                             ;
3993    1525'  E1                XYZON: SEX INTPC
3994    1526'  61                       OUT GROUP
3995    1527'  02                       DB 02
3996    1528'  67                       OUT RELAYS
3997    1529'  4C                       DB 114Q         ;TURN ON OPTO INTERRUPTER PWR
3998    152A'  30 22'                   BR XYZXT
3999                             ;
4000    152C'  E1                XYZIN: SEX INTPC
4001    152D'  61                       OUT GROUP
4002    152E'  00                       DB 00
```

```
4003    152F'  E7                       SEX GPAGE
4004    1530'  F8 93                    LDI XPOS
4005    1532'  A7                       PLO GPAGE
4006    1533'  6B                       INP X          ;INPUT X POSITION
4007    1534'  FA 0F                    ANI 0FH        ;MASK UNUSED BITS
4008    1536'  57                       STR GPAGE
4009    1537'  17                       INC GPAGE      ;GPAGE => YX POSITION
4010    1538'  6C                       INP YZ
4011                            ;
4012    1539'  E1                       SEX INTPC
4013    153A'  61                       OUT GROUP
4014    153B'  02                       DB 02
4015    153C'  67                       OUT RELAYS
4016    153D'  4C                       DB 114Q        ;TURN OFF OPTO INTERRUPTER PWR
4017                            ;              ;*** NOTE !!!  PWR IS KEPT ON -- DUE TO HDWR. BUG ***
4018    153E'  30 22'                   BR XYZXT
4019                            ;
4020                            ;
4021                            ;
4022                            ;****************************** PASS THRU MODE *********************************
4023                            ;
4024                            ;
4025    1540'  F8 0A            PTHRU:  LDI GRPSAV     ;PWR UP LOOP 2
4026    1542'  A7                       PLO GPAGE
4027    1543'  F8 02                    LDI 02         ;  STORE NEW I/O GROUP
4028    1545'  57                       STR GPAGE
4029    1546'  E7                       SEX GPAGE
4030    1547'  61                       OUT GROUP
4031    1548'  E3                       SEX PC
4032    1549'  67                       OUT RELAYS     ;POWER UP LOOP2
4033    154A'  40                       DB 100Q
4034    154B'  27                       DEC GPAGE
4035    154C'  F8 06                    LDI UARTS
4036    154E'  57                       STR GPAGE
4037    154F'  E7                       SEX GPAGE
4038    1550'  61                       OUT GROUP      ;RESET UART I/O GROUP
4039                            ;
4040    1551'  F8 02                    LDI PLEVEL     ;SET PASS LEVEL = 01
4041    1553'  A7                       PLO GPAGE
4042    1554'  F8 01                    LDI 01
4043    1556'  57                       STR GPAGE
4044                            ;
4045    1557'  E2                       SEX STACK
4046                                    SCAL R6, DELAY2 ;WAIT FOR LOOP 2 POWER TO SETTLE
4047    1558'  68 86            +
4048    155A'  0198'            +
```

```
4049                                    SCAL R6, DELAY2 ; AND UARTS TO CLEAR BREAK
4050    155C'  68 86          +
4051    155E'  019B'          +
4052                                    SCAL R6, DELAY2
4053    1560'  68 86          +
4054    1562'  019B'          +
4055                            ;
4056    1564'  E2               RADDR2: SEX STACK       ;CLEAR ANY DATA FROM LOOP 2
4057    1565'  6C                       INP DATA2
4058    1566'  F8 FE                    LDI IOLOC       ;XMIT '#' ON LOOP 2
4059    1568'  A7                       PLO GPAGE
4060    1569'  F8 23                    LDI '#'
4061    156B'  57                       STR GPAGE
4062                                    SCAL R6, XMTLP2
4063    156C'  68 86          +
4064    156E'  167D'          +
4065    1570'  E2               DA1:    SEX STACK
4066    1571'  6B                       INP STAT1       ;CHECK FOR DA1
4067    1572'  F6                       SHR             ;DA1?
4068    1573'  3B 93'                    BNF DA2         ;IF NOT GO TO DA2
4069    1575'  FA 06                    ANI 06H         ;IF DA1, MASK AND CHECK FE,OE
4070    1577'  32 7C'                    BZ KEEP3
4071    1579'  6A                       INP DATA1       ;CLEAR BAD DATA
4072    157A'  30 93'                    BR DA2
4073                            ;
4074    157C'  F8 FE            KEEP3:  LDI IOLOC
4075    157E'  A7                       PLO GPAGE
4076    157F'  E7                       SEX GPAGE
4077    1580'  6A                       INP DATA1
4078    1581'  FA 7F                    ANI 7FH         ;MASK MSB
4079    1583'  57                       STR GPAGE
4080    1584'  FB 23                    XRI '#'         ;IS IT # ?
4081    1586'  C2 00AB'                 LBZ IOERR
4082    1589'  FB 06                    XRI ('%' XOR '#')       ;IS IT % ?
4083    158B'  C2 160A'                 LBZ PMODE
4084    158E'  E2               PMODEX: SEX STACK
4085                                    SCAL R6, XMTLP2
4086    1590'  68 86          +
4087    1591'  167D'          +
4088                            ;
4089                            ;
4090    1593'  6D               DA2:    INP STAT2
4091    1594'  F6                       SHR             ;DA2 ?
4092    1595'  C3 15B8'                 LBDF DA2YES     ;IF NOT, CHECK ES LOOP 2
4093    1598'  FB 08                    XRI 08H         ;IF ES LOOP 2,
4094    159A'  C2 163E'                 LBZ PASSBR      ;       GO TO PASS BREAK
```

```
4095    159D'  30 70'                    BR DA1          ;IF NOT GO TO DA1
4096                                     ;
4097    159F'  6D                        DA2MOR: INP STAT2
4098    15A0'  F6                                SHR             ;DA2?
4099    15A1'  C3 15B8'                          LBDF DA2YES     ;IF NOT, CHECK ES LOOP 2
4100    15A4'  FB 08                             XRI 08H         ;IF ES LOOP 2,
4101    15A6'  C2 163E'                          LBZ PASSBR      ;       GO TO PASS BREAK
4102    15A9'  1C                                INC RC          ;IF NOT, INC TIME OUT LOOP
4103    15AA'  9C                                GHI RC
4104    15AB'  FB 02                             XRI 02          ;IF NOT 512 LOOPS (2 CHAR),
4105    15AD'  CA 159F'                          LBNZ DA2MOR     ;LOOK FOR MORE DATA ON 2
4106    15B0'  52                                SEX STACK
4107                                             SCAL R6, TSRE?  ;IF 512, WAIT FOR TSRE AND
4108    15B1'  68 86            +
4109    15B3'  02F0'            +
4110    15B5'  C0 1570'                          LBR DA1         ;       GO TO DA1
4111                                     ;
4112    15B8'  FA 06                     DA2YES: ANI 06H         ;MASK FOR FE, PE
4113    15BA'  CA 163E'                          LBNZ PASSBR     ;IF FE OR PE, GO TO PASS BREAK
4114    15BD'  F8 00                             LDI 00
4115    15BF'  BC                                PHI RC
4116    15C0'  AC                                PLO RC
4117    15C1'  F8 FE                             LDI IOLOC       ;IF DATA IS OK, INPUT DATA
4118    15C3'  A7                                PLO GPAGE       ;       ON LOOP 2       TO I/O LOCTION
4119    15C4'  E7                                SEX GPAGE
4120    15C5'  6C                                INP DATA2
4121    15C6'  FA 7F                             ANI 7FH         ;MASK MSB
4122    15C8'  57                                STR GPAGE
4123    15C9'  FB 03                             XRI 03          ;IS IT ETX ?
4124    15CB'  C2 15E2'                          LBZ PMT2        ;IF ETX, ADD A PROMPT
4125                                     ;
4126    15CE'  E2                        NOTETX: SEX STACK       ;IF DATA LOOP 2 IS NOT ETX:
4127    15CF'  6B                                INP STAT1       ;CHECK FE, PE ON LOOP 1
4128    15D0'  FA 0C                             ANI 0CH
4129    15D2'  CA 00AB'                          LBNZ IOERR      ;BRANCH IF ERROR
4130    15D5'  02                                LDN STACK
4131    15D6'  FE                                SHL             ;WAIT FOR THRE LOOP 1
4132    15D7'  CB 15CE'                          LBNF NOTETX
4133    15DA'  E7                                SEX GPAGE
4134    15DB'  62                                OUT DATA1       ;IN LOOP 2 -> OUT LOOP 1
4135    15DC'  27                                DEC GPAGE
4136    15DD'  FC 00                             ADI 00          ;CLEAR DF
4137    15DF'  C0 159F'                          LBR DA2MOR      ;GO TO DA2MOR
4138                                     ;
4139    15E2'  E2                        PMT2:   SEX STACK       ;IF DATA LOOP 2 = ETX:
4140    15E3'  6B                                INP STAT1       ;CHECK FE, PE ON LOOP 1
```

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4141    15E4'  FA 0C                    ANI 0CH
4142    15E6'  CA 00AB'                 LBNZ IOERR      ;BRANCH IF ERROR
4143    15E9'  02                       LDN STACK
4144    15EA'  FE                       SHL             ;WAIT FOR THRE LOOP 1
4145    15EB'  3B E2'                   BNF PMT2
4146    15ED'  E3                       SEX PC
4147    15EE'  62                       OUT DATA1       ;OUTPUT PROMPT CHAR. ON LOOP 1
4148    15EF'  3A                       DB PMTCHR
4149    15F0'  FC 00                    ADI 00H         ;CLEAR DF
4150    15F2'  E2                       SEX STACK
4151    15F3'  6B                XMTETX: INP STAT1       ;CHECK FE, PE ON LOOP 1
4152    15F4'  FA 0C                    ANI 0CH
4153    15F6'  CA 00AB'                 LBNZ IOERR      ;BRANCH IF ERROR
4154    15F9'  02                       LDN STACK
4155    15FA'  FE                       SHL             ;WAIT FOR THRE LOOP 1
4156    15FB'  3B F3'                   BNF XMTETX
4157    15FD'  E7                       SEX GPAGE
4158    15FE'  62                       OUT DATA1       ;IN LOOP 2 -> OUT LOOP 1
4159    15FF'  27                       DEC GPAGE
4160    1600'  FC 00                    ADI 00          ;CLEAR DF
4161    1602'  E2                       SEX STACK
4162                                    SCAL R6, TSRE?  ;WAIT TSRE1 AND CLEAR ECHO 1
4163    1603'  68 86            +
4164    1605'  02F0'            +
4165    1607'  C0 1570'                 LBR DA1         ;GO TO DA1
4166                            ;
4167                            ;
4168                            ;
4169    160A'  E2                PMODE: SEX STACK
4170                                    SCAL R6, ITB    ;PMODE ENTERED WHEN LOOP 1 = '%'
4171    160B'  68 86            +
4172    160D'  022E'            +
4173    160F'  50                       DB 'P'
4174    1610'  161F'                    DW PINC         ;OPEN THE NEXT LOWER LEVEL
4175    1612'  52                       DB 'R'
4176    1613'  1564'                   DW RADDR2       ;READDRESS THE CURRENT LEVEL
4177    1615'  42                       DB 'B'
4178    1616'  163E'                   DW PASSBR       ;SEND BREAK ON LOOP 2
4179    1618'  58                       DB 'X'
4180    1619'  1658'                   DW PDEC         ;DROP THE LOWEST LEVEL
4181    161B'  FF                       DB DONE
4182    161C'  C0 158E'                 LBR PMODEX
4183                            ;
4184                            ;
4185    161F'  F8 02             PINC:  LDI PLEVEL      ;INCREMENT PASS LEVEL
4186    1621'  A7                       PLO GPAGE
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4187    1622'  07                          LDN GPAGE
4188    1623'  FC 01                       ADI 01H
4189    1625'  57                          STR GPAGE
4190    1626'  F8 FE                       LDI IOLOC
4191    1628'  A7                          PLO GPAGE
4192    1629'  F8 25                       LDI '%'
4193    162B'  57                          STR GPAGE
4194    162C'  E2                          SEX STACK
4195                                       SCAL R6, XMTLP2
4196    162D'  68 86          +
4197    162F'  167D'          +
4198    1631'  F8 FE                       LDI IOLOC
4199    1633'  A7                          PLO GPAGE
4200    1634'  F8 50                       LDI 'P'
4201    1636'  57                          STR GPAGE
4202                                       SCAL R6, XMTLP2
4203    1637'  68 86          +
4204    1639'  167D'          +
4205    163B'  C0 1593'                    LBR DA2
4206                                ;
4207                                ;
4208    163E'  F8 02                PASSBR: LDI PLEVEL      ;CLEAR PASS LEVEL
4209    1640'  A7                          PLO GPAGE
4210    1641'  F8 00                       LDI 00
4211    1643'  57                          STR GPAGE
4212                                ;      SEX STACK        ;
4213                                ;      SCAL R6, XMTBR2  ;BREAK LOOP 2 (NOT USED WITH LOOP2
4214                                ;                       ;     PWR CONTROL SYSTEM)
4215    1644'  F8 0A                       LDI GRPSAV
4216    1646'  A7                          PLO GPAGE
4217    1647'  F8 02                       LDI 02
4218    1649'  57                          STR GPAGE
4219    164A'  E7                          SEX GPAGE
4220    164B'  61                          OUT GROUP
4221    164C'  E3                          SEX PC
4222    164D'  67                          OUT RELAYS      ;LOOP2 POWER OFF
4223    164E'  00                          DB 00
4224    164F'  27                          DEC GPAGE       ;RESET UART GROUP
4225    1650'  E7                          SEX GPAGE
4226    1651'  F8 06                       LDI UARTS
4227    1653'  57                          STR GPAGE
4228    1654'  61                          OUT GROUP
4229    1655'  C0 0107'                    LBR PROMPT      ;EXIT PASS THRU MODE TO PROMPT
4230                                ;
4231                                ;
4232    1658'  F8 02                PDEC:   LDI PLEVEL
```

```
4233  165A'  A7                        PLO GPAGE
4234  165B'  07                        LDN GPAGE
4235  165C'  FB 01                     XRI 01          ;IS P LEVEL 01 ?
4236  165E'  C0 163E'                  LBR PASSBR      ;       IF SO, BREAK LOOP 2
4237  1661'  07                        LDN GPAGE
4238  1662'  FF 01                     SMI 01          ;       IF NOT, DECREMENT PASS LEVEL
4239  1664'  57                        STR GPAGE
4240  1665'  F8 FE                     LDI IOLOC
4241  1667'  A7                        PLO GPAGE
4242  1668'  F8 25                     LDI '%'         ;OUTPUT % ON LOOP 2
4243  166A'  57                        STR GPAGE
4244  166B'  E2                        SEX STACK
4245                                   SCAL R6, XMTLP2
4246  166C'  68 86          +
4247  166E'  167D'          +
4248  1670'  F8 FE                     LDI IOLOC
4249  1672'  A7                        PLO GPAGE       ;OUTPUT X ON LOOP 2
4250  1673'  F8 58          +         LDI 'X'
4251  1675'  57                        STR GPAGE
4252                                   SCAL R6, XMTLP2
4253  1676'  68 86          +
4254  1678'  167D'          +
4255  167A'  C0 1593'                  LBR DA2         ;GO TO DA2
4256                                ;
4257                                ;
4258                                ;************************** XMIT LOOP 2 ************************************
4259                                ;
4260  167D'  F8 FE                  XMTLP2: LDI IOLOC
4261  167F'  A7                        PLO GPAGE
4262  1680'  E7                        SEX GPAGE
4263  1681'  F0                        LDX
4264  1682'  AA                        PLO RA          ;ALSO PUT IT IN RA
4265  1683'  64                        OUT DATA2       ;OUTPUT CHARACTER LOOP 2
4266  1684'  27                        DEC GPAGE
4267  1685'  E2                        SEX STACK
4268  1686'  6C                        INP DATA2       ;CLEAR DA
4269  1687'  6D                     WAIT6:  INP STAT2
4270  1688'  FA C0                     ANI 0C0H        ;MASK FOR THRE & TSRE
4271  168A'  FB C0                     XRI 0C0H
4272  168C'  3A 87'                    BNZ WAIT6
4273                                   SCAL R6, DELAY2 ;2 BIT DELAY
4274  168E'  68 86          +
4275  1690'  019B'          +
4276  1692'  E7                        SEX GPAGE
4277  1693'  6C                        INP DATA2       ;INPUT ECHOED CHAR
4278  1694'  FA 7F                     ANI 07FH        ;MASK MSB
```

```
4279    1696'  57                       STR GPAGE
4280    1697'  8A                       GLO RA          ;COMPARE WITH XMIT CHAR
4281    1698'  F3                       XOR
4282    1699'  CA 163E'                 LBNZ PASSBR     ;BREAK IF ECHO WAS BAD
4283    169C'  E2                       SEX STACK
4284                                    SRET R6
4285    169D'  68 96          +
4286                           ;
4287                           ;
4288                           ;
4289                           ;************************** XMITBR2 ****************************************
4290                           ;                       ( BREAK LOOP 2)
4291                           ;
4292    169F'  F8 0A           XMTBR2: LDI GRPSAV      ;SELECT UART I/O GROUP
4293    16A1'  A7                      PLO GPAGE       ;       AND STORE ON GLOBAL PAGE
4294    16A2'  F8 06                   LDI UARTS
4295    16A4'  57                      STR GPAGE
4296    16A5'  E7                      SEX GPAGE
4297    16A6'  61                      OUT GROUP
4298    16A7'  E3                      SEX PC
4299    16A8'  65                      OUT CNTRL2              ;BREAK LOOP 2
4300    16A9'  52                      DB (40H  OR  FORMT1)
4301    16AA'  F8 7D                   LDI BR2CNT
4302    16AC'  A7                      PLO GPAGE
4303    16AD'  F8 0A                   LDI 0AH         ;0A = 250 mSEC. (10 INTERRUPT CYCLES)
4304    16AF'  57                      STR GPAGE
4305    16B0'  E2                      SEX STACK
4306                                   SRET R6
4307    16B1'  68 96          +
4308                           ;
4309                           ;
4310                           ;
4311                           ;*****************************************************************************
4312                                   ORG (HELP + 700H)
4313                           ;                       ;  MUX AND A/D CONTROL
4314                           ;
4315    1700'  0000            MUXLST: DW 0000H        ;CYCLE 00       A/D OFF         MUX PITCH
4316    1702'  0000                    DW 0000H        ;CYCLE 01
4317    1704'  0000                    DW 0000H        ;CYCLE 02
4318    1706'  0000                    DW 0000H        ;CYCLE 03
4319    1708'  0000                    DW 0000H        ;CYCLE 04
4320    170A'  0000                    DW 0000H        ;CYCLE 05
4321    170C'  0000                    DW 0000H        ;CYCLE 06
4322    170E'  0202                    DW 0202H        ;CYCLE 07       A/D ON          MUX PITCH
4323    1710'  0302                    DW 0302H        ;CYCLE 08       A/D START PULSE,MUX PITCH
4324    1712'  1212                    DW 1212H        ;CYCLE 09       A/D ON          MUX ROLL
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4325  1714'  1312                    DW 1312H        ;CYCLE 0A       A/D START PULSE,MUX ROLL
4326  1716'  2222                    DW 2222H        ;CYCLE 0B       A/D ON          MUX uP BAT
4327  1718'  2322                    DW 2322H        ;CYCLE 0C       A/D START PULSE MUX uP BAT
4328  171A'  3232                    DW 3232H        ;CYCLE 0D       A/D ON          MUX SYSBAT
4329  171C'  3332                    DW 3332H        ;CYCLE 0E       A/D START PULSE MUX SYSBAT
4330  171E'  4242                    DW 4242H        ;CYCLE 0F       A/D ON          MUX A/D GND
4331  1720'  4342                    DW 4342H        ;CYCLE 10       A/D START PLUSE MUX A/D GND
4332  1722'  5252                    DW 5252H        ;CYCLE 11       A/D ON          MUX A/D REF
4333  1724'  5352                    DW 5352H        ;CYCLE 12       A/D START PULSE MUX A/D REF
4334  1726'  6262                    DW 6262H        ;CYCLE 13       A/D ON          MUX A/D +5V
4335  1728'  6362                    DW 6362H        ;CYCLE 14       A/D START PULSE MUX A/D +5V
4336  172A'  7070                    DW 7070H        ;CYCLE 15       A/D OFF         MUX TRANSMISSOMETER
4337                          ;
4338                          ;
4339                                  ORG (HELP + 780H)
4340                          ;                       ;  A/D STORAGE LOCATIONS
4341                          ;
4342  1780'  89               MEMLST: DB PITCH        ;PITCH (PENDULUM 1)
4343  1781'  AF                       DB (NULL)
4344  1782'  8A                       DB ROLL         ;ROLL  (PENDULUM 2)
4345  1783'  AF                       DB (NULL)
4346  1784'  8B                       DB BATTUP       ;uP BATTERY
4347  1785'  AF                       DB (NULL)
4348  1786'  8C                       DB BATTSY       ;SYS BATTERY
4349  1787'  AF                       DB (NULL)
4350  1788'  8D                       DB ADGH8        ;GND HI 8 BITS
4351  1789'  8E                       DB ADGL4        ;GND LOW 4 BITS
4352  178A'  8F                       DB ADRH8        ;REF HI 8 BITS
4353  178B'  90                       DB ADRL4        ;REF LOW 4 BITS
4354  178C'  91                       DB AD5H8        ;+5V HI 8 BITS
4355  178D'  92                       DB AD5L4        ;+5V LOW 4 BITS
4356                          ;
4357                          ;
4358                          ;*******************************************************************************
4359                          ;
4360                          ;
4361                          ;
4362                          ;
4363                          ;
4364                                  END
```

MACROS:

BCI	BXI	CALL	CID	CIS	DACI	DADC	DADD
DADI	DBNZ	DSAV	DSBI	DSM	DSMB	DSMI	DTC
ETQ	EXIT	GEC	IDLE	LDC	POP	PPAGE	PUSH
RLDI	RLXA	RNX	RSXD	SCAL	SCM1	SCM2	SPM1
SPM2	SRET	STM	STPC	TCAL	TRET	XID	XIE

SYMBOLS:

ACSTAT	0081	ACSTR	146A'	ACUCLR	1456'	AD	133F'
AD5H8	0091	AD5L4	0092	ADDR	00DE'	ADDR?	00D1'
ADFLG	00B0	ADGH8	008D	ADGL4	008E	ADGO	1367'
ADHI8	0003	ADLO4	0002	ADRH8	008F	ADRL4	0090
ADRTN	087F'	ADT0H8	00A7	ADT0L4	00A8	ADT1H8	0095
ADT1L4	0096	ADT2H8	0097	ADT2L4	0098	ADT3H8	0099
ADT3L4	009A	ADT4H8	009B	ADT4L4	009C	ADT5H8	009D
ADT5L4	009E	ADT6H8	009F	ADT6L4	00A0	ADT7H8	00A1
ADT7L4	00A2	ADT8H8	00A3	ADT8L4	00A4	ADT9H8	00A5
ADT9L4	00A6	AGAIN	0063'	AR1	001C	AR10	001B
AR100	001A	ARFLG	001D	ASCHEX	01C8'	ASCRD1	025E'
ASTK	000E	ASTKHI	0064	ASTKLO	0065	ASTKTP	527F
ATCHK	08B1'	ATFLG	001E	ATMFLG	001F	ATRTN	0867'
BANGGR	014F'	BAT1	0002	BAT2	0003	BAT3	0004
BATTSY	008C	BATTUP	008B	BLT	0000	BORROW	0912'
BR1ST	011A'	BR2	0A7D'	BR2CLR	0A8D'	BR2CNT	007D
BR2RTN	0873'	BRCHK	089D'	BROKE	08A8'	BUF9	0020
BUFFER	5B00	BUFPG	005B	CAMCNT	0088	CAMERA	0006
CHK1	0CAD'	CHK10	098D'	CLOOP1	04CA'	CLR	0548'
CLRAR	0924'	CLRBUF	0542'	CLRFLG	0340'	CLRPG	006C'
CMPARE	0C9C'	CMPASS	0002	CMPPWR	1312'	CMPRTN	0879'
CMPSRD	12F0'	CMPSS	0004	CNTCLR	0C47'	CNTRL1	0003
CNTRL2	0005	CNTRL3	0007	CNVRT	01BC'	COPY	058B'
CRC	04A2'	CRCHI	0006	CRCLO	0007	CRCRAM	0005
CRCSUB	050E'	CTA	0BA0'	CTACLR	0D45'	CTAHI	006C
CTALO	006D	CTASET	0D4E'	CTAVHI	006E	CTAVLO	006F
CTAX	0D3A'	CTB	0BB0'	CTBCLR	0D62'	CTBHI	0070
CTBLO	0071	CTBSET	0D6B'	CTBVHI	0072	CTBVLO	0073
CTBX	0D57'	CTC	0BC0'	CTCCLR	0D7F'	CTCHI	0074
CTCHK	0AA0'	CTCLO	0075	CTCSET	0D88'	CTCVHI	0076
CTCVLO	0077	CTCX	0D74'	CTNCHK	0AB6'	CTNCLR	0DA3'
CTNDEC	0AC1'	CTNRTN	0AE2'	CTNSET	0D91'	CTNSTR	0ADE'
CTRCHK	0A97'	CTRRTN	0876'	CYCCNT	0008	CYCLES	0019
CYX001	0A14'	CYXX01	0A06'	CYXXNN	0A22'	CYXXX1	09FA'
D1	0012	D10	0D11	D100	0010	DA1	1570'
DA2	1593'	DA2MOR	159F'	DA2YES	15B8'	DATA1	0002
DATA2	0004	DATA3	0006	DAYCAR	09A5'	DAYUP	099C'
DECAR	0907'	DECCNT	03C9'	DECNEX	090C'	DECPPC	0B17I'
DELAY2	019B'	DLY20	0031'	DMA	0000	DOLIN	047D'
DONE	00FF	ENABLE	0771'	ERROR	0080	ERROR1	0429'
ETX	0003	EXP?	12DC'	EXPNUM	000F	EXPSET	12B9'

FLAGA	0069	FLAGB	006A	FLAGC	006B	FLAGCK	0C10'
FORMT1	0012	GLOPG	0050	GOSUB	0B60'	GOTNUM	00CF'
GP	5000	GPAGE	0007	GROUP	0001	GRPSAV	000A
GTR9	02E4'	H1	0014	H10	0013	HALT	0006
HDG	0085	HDG1B	149C'	HDG1C	14A4'	HDG?	129D'
HDGAGN	14BA'	HDGCHK	1478'	HDGEXP	00BF	HDGFLG	00B3
HDGIN	14B1I'	HDGPWR	0005	HDGRTN	0888'	HDGSET	1273'
HDGSLO	148D'	HDGVAL	0020	HDGXT	14A1'	HDSTRT	0000'
HEADNG	0004	HELP	1000'	HEXRD1	026C'	HLATCH	0003
HOURUP	097D'	HSHIFT	0004	HXCONV	02D4'	HZ	0028
IDLLOC	0700'	IN1ST	0406'	IN2ND	0416'	IN4D	01A9'
IN4DT?	02E9'	IN4DXT	01BA'	INADDR	03FE'	INC10	095B'
INCHAR	0181'	INCMIN	0966'	INCPPC	0B13I'	INCRTC	092D'
INIT	0B4C'	INITB	0C32'	INITC	0C3F'	INITS	0C37'
INITX	0C22'	INKWD	0208'	INLF	0467'	INPUT	0556'
INTCRL	F840	INTIME	05AC'	INTMSK	F800	INTPC	0001
INTPG	00F8	INTPGM	0800'	INTPOL	F840	INTRP0	083F'
INTSTA	F800	INTVEC	F880	IOA	0006	IOCLR	0004
IOCTEL	0005	IOERR	00AB'	IOLOC	00FE	IOSTAT	0005
ITB	022E'	JMPEXC	0B66'	JUMP	0B28I'	KEEP1	056C'
KEEP2	018C'	KEEP3	157C'	KEEPT	05B7'	L2BUF	00C0
LBT	0864'	LDVRST	0005	LIST	0006	LNEND	03EC'
LNTEST	03E3'	LOCK	0331'	LOCKUP	033D'	LOOP2	0BD0'
LOOP2X	0CB9'	LP20TH	0CFF'	LP21ST	0D11'	LP2ERR	0D26'
LP2NTH	0CE4'	LP2OFF	0CC9'	LP2ON	0CD1'	LP2XIT	0D2D'
LP2XNT	0CD9'	M1	0016	M10	0015	MATCH	021E'
MATCH2	0245'	MATCH3	0C88'	MATCH?	0219'	MDONE	07EF'
MEMCHG	07B8'	MEMLST	1780'	MEMORY	0007	MEMPTR	00AE
MEMSAV	0734'	MEMSUB	07B2'	MODFLG	032D'	MUX	0C02
MUXLST	1700'	MUXPTR	00AD	NEXBYT	03C2'	NEXT1	01AD'
NEXT2	0234'	NEXT3	0251'	NEXTPG	07C1'	NOBRRW	0914'
NOLOCK	0324'	NOMTCH	0CA7'	NOOP	0BC4'	NOTETX	15CE'
NOTHEX	01EB'	NOYRTN	0392'	NULL	00AF	NUMBER	01E3'
OKRTN	038E'	OPEN	0358'	OPEN?	0348'	OUTADR	03AF'
OUTASC	02CF'	OUTCA	0295'	OUTCHR	0300'	OUTHEX	0271'
OUTPT1	02D1'	OUTPT2	0262'	PASSBR	163E'	PASSCA	045E'
PASSGR	0171'	PC	0003	PCSAME	0660'	PDCHK	143B'
PDCLR	144D'	PDEC	1658'	PDRTN	0885'	PDSTAT	0083
PDSTR	145F'	PINC	161F'	PING	0007	PITCH	0089
PLEVEL	0002	PLIST	020F'	PMODE	160A'	PMODEX	158E'
PMPSPD	0006	PMT2	15E2'	PMTCHR	003A	POP	0B40'
POP1	0B44'	PORTB	0007	POUND?	00C8'	PPC	000C
PPCCMP	0727'	PPCCNT	0068	PPCHI	0060	PPCLO	0061
PPCSHO	0704'	PROMPT	0107'	PSET00	14E8'	PTECT	0779'
PTHRU	1540'	PULCHK	14CA'	PULCNT	0041	PULFLG	0040
PULNUM	0042	PULRTN	088B'	PULXT	14FD'	PUMP1	0086

PUMP2	0087	PUSH	0B30'	PUSH00	0C77'	PUSH1	0B34'
QUEBUF	1178'	QUESGR	0133'	QUESTM	0396'	QUESTT	05C2'
RADDR2	1564'	RBHI	0008	RBLO	0009	RBRET	085D'
RBSAVE	0894'	READDR	00B7'	RECFLG	00B2	RELAYS	0007
REPORT	0713'	RESTR0	0818'	RESTRT	003F'	RETURN	0B58'
REV	0039	ROLL	008A	RPLY	00EC'	RSTK	000D
RSTKHI	0062	RSTKLO	0063	RSTKTP	523F	RTC	0900'
RTCRTN	086A'	RTNPTR	0006	RTTY2	000F	SAVE	0B14I'
SAVPPC	0C00I'	SAYCLR	04F5'	SAYNO	035D'	SD	0DAD'
SDLNGT	0029	SDREC	0EF3'	SDREQ	0003	SDRET	0891'
SEC1	0018	SEC10	0017	SEMI?	0449'	SEQ01	09EE'
SEQ?	0684'	SEQ?EX	06BE'	SEQCYC	09CA'	SEQFAS	0066
SEQNCR	0B00'	SEQRAT	0067	SEQRST	0073'	SEQRTN	086D'
SEQSET	0602'	SEQXT1	0BE0'	SET2ND	067B'	SETAC	0C1C'
SETAT	094F'	SETCLR	0C14I'	SETFLG	0327'	SETPC	0632'
SETPG	077D'	SETPPC	0622'	SETQ	07E2'	SETSL	0019'
SETSTK	001E'	SETTOP	0554'	SETUP	005A'	SETURT	0048'
SHFTD4	01EF'	SHIFT	01F4'	SSTKPG	0052	STACK	0002
START1	0025'	START2	05A6'	STAT1	0003	STAT2	0005
STAT3	0007	STKCLR	0C59'	STKEND	53DF	STKERR	0C98'
STKPG	0053	STORE	02DD'	SWITCH	0002	SWPWR	1337'
SWRD	131A'	SWRTN	087C'	SWSTAT	0082	SYSFLG	0003
SYSTEM	0007	TEST	023C'	TEST$	0472'	TEST0	0919'
TEST5	0944'	TEST80	025A'	TEST81	0268'	TEST8D	0288'
TEST9D	029E'	TESTA1	02B1'	TESTA2	02C1'	TESTCA	0291'
TESTCR	0454'	TESTDD	02A8'	TESTOK	036F'	TESTSP	0437'
TESTY	0380'	THRE?	0306'	TIME01	003C	TIME02	00F0
TIMEIN	0582'	TIMEJM	057B'	TIMEST	0535'	TLEVEL	005A
TLIMIT	0006	TR	13BA'	TRCY02	13EF'	TRCY17	13FF'
TRCY18	140A'	TRCY19	1413'	TRFLG	00B1	TRRTN	0882'
TSRE?	02F0'	TST2ND	09C1'	TSTADV	09B4'	TSTNEX	091C'
TTY	024E'	TTY2	0A32'	TTY2HI	007E	TTY2LO	007F
TY2ETX	0A5C'	TY2OUT	0A47'	TY2RTN	0870'	UARTS	0006
UNADDR	00B4'	UNLOCK	0315'	VERS	0035	WAIT	0034'
WAIT1	05CE'	WAIT2	05F7'	WAIT3	019D'	WAIT4	02F1'
WAIT6	1687'	WRITEM	03F5'	WTFOR	0B80'	WTFORX	0C6F'
WTTILL	0B70'	X	0003	XMTBR2	169F'	XMTETX	15F3'
XMTLP2	167D'	XPOS	0093	XYZCHK	1500'	XYZFLG	00B4
XYZIN	152C'	XYZON	1525'	XYZRTN	088E'	XYZXT	1522'
YZ	0004	YZPOS	0094				

NO FATAL ERROR(S)

ACSTAT 59# 3801 3823
ACSTR 3819#
ACUCLR 3798#
AD 1819 3583#
AD5H8 59# 4354
AD5L4 59# 3596 4355
ADDR 296 303#
ADDR? 284 290#
ADFLG 59# 3588
ADGH8 59# 4350
ADGL4 59# 4351
ADGO 3592 3612#
ADHI8 59# 3665 3764
ADLO4 59# 3669 3766
ADRH8 59# 4352
ADRL4 59# 4353
ADRTN 1820# 3587 3610 3630 3651 3656 3675
ADT0H8 59# 3754
ADT0L4 59# 3709
ADT1H8 59# 3715 3758
ADT1L4 59#
ADT2H8 59#
ADT2L4 59#
ADT3H8 59#
ADT3L4 59#
ADT4H8 59#
ADT4L4 59#
ADT5H8 59#
ADT5L4 59#
ADT6H8 59#
ADT6L4 59#
ADT7H8 59#
ADT7L4 59#
ADT8H8 59#
ADT8L4 59#
ADT9H8 59#
ADT9L4 59#
AGAIN 178# 183 187
AR1 59#
AR10 59#
AR100 59#
ARFLG 59# 130 1882 1906 2003
ASCHEX 498 506# 995 1004
ASCRD1 637#
ASTK 59# 2255 2257 2283 2285 2296 2393 2395 2480 2484 2505 2507
2513 2523 2526 2528 2540 2554 2603 2604 2609 2641 2643 2659
ASTKHI 59# 1473
ASTKLO 59# 2390

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ASTXTP     59#    204     207    2483
ATCHK    1809    1861#
ATFLG      59#   1929
ATMFLG     59#
ATRTN    1810#   1865    1874
BANGGR    362     402#
BAT1       59#
BAT2       59#
BAT3       59#
BATTSY     59#   4348
BATTUP     59#   4346
BCI        42#
BLT        59#
BORROW   1894#
BR1ST     350     356#
BR2      1814    2140#
BR2CLR   2149#
BR2CNT     59#   2140    4301
BR2RTN   1815#   2144    2148    2156
BRCHK    1843#
BROKE    1849    1852#
BUF9       59#   1222
BUFFER     59#   2792    3302
BUFPG      59#     59     176    1654
BXI        42#
CALL       42#
CAMCNT     59#
CAMERA     59#
CHK1     2543    2549#
CHK10    1974#
CID        42#
CIE        42#
CLOOP1   1128#   1138    1140
CLR      1225#   1232
CLRAR    1906#   2012
CLRBUF   1218    1220#
CLRFLG    829#
CLRPG     182     184#
CMPARE   2342    2511    2535#
CMPASS     59#   3531    3537
CMPPWR   3521    3534#
CMPRTN   1818#   3517    3523    3532    3539
CMPSRD   1817    3512#
CMPSS      59#   3528
CNTCLR   2444    2455    2461#
CNTRL1     59#    150
CNTRL2     59#    153    2152    4299
CNTRL3     59#
CNVRT     491     496#
```

COPY 1269 1272#
CRC 384 1101#
CRCHI 59#
CRCLO 59# 1121
CRCRAM 59#
CRCSUB 1135 1169#
CTA 2352#
CTACLR 2672 2677#
CTAHI 59# 2173 2688
CTALO 59# 2465 2681
CTASET 2674 2684#
CTAVHI 59# 2174
CTAVLO 59#
CTAX 2352 2670#
CTB 2356#
CTBCLR 2696 2701#
CTBHI 59# 2179 2712
CTBLO 59# 2469 2705
CTBSET 2698 2708#
CTBVHI 59# 2180
CTBVLO 59#
CTBX 2356 2694#
CTC 2360#
CTCCLR 2720 2725#
CTCHI 59# 2185 2736
CTCHK 2169#
CTCLO 59# 2473 2729
CTCSET 2722 2732#
CTCVHI 59# 2186
CTCVLO 59#
CTCX 2360 2718#
CTNCHK 2172 2178 2184 2191#
CTNCLR 2464 2468 2472 2680 2704 2728 2765#
CTNDEC 2197 2201#
CTNRTN 2199 2223 2230#
CTNSET 2687 2711 2735 2742#
CTNSTR 2203 2205 2225#
CTRCHK 1815 2163#
CTRRTN 1817# 2167 2188
CYCCNT 59# 1888 1896 1897 1900 1903 1904
CYCLES 59# 1911 2040 2047 2054 2062 2073 2163 2519 3547 3612 3623
3647 3719 3778 3855 3984
CYX001 2036 2062#
CYXX01 2034 2038 2054#
CYXXNN 2026 2070#
CYXXX1 2032 2047#
D1 59#
D10 59# 2337
D100 59#

DA1 4065# 4095 4110 4165
DA2 4068 4072 4090# 4205 4255
DA2NOR 4097# 4105 4137
DA2YES 4092 4099 4112#
DACI 42#
DADC 42#
DADD 42#
DADI 42#
DATA1 59# 450 455 761 769 786 1305 1310 1869 4071 4077 4134
4147 4158
DATA2 59# 2106 2108 2126 2154 4057 4120 4265 4268 4277
DATA3 59#
DAYCAR 1992# 2001
DAYUP 1973 1985#
DBNZ 42#
DECAR 1887# 2015
DECCNT 942 945#
DECNEX 1890# 1898
DECPPC 2266#
DELAY2 311 460 466# 768 858 922 1015 1313 4048 4051 4054 4275
DLY20 124#
DNA 59# 2791 2810 2811 2819 2820 2829 2830 2838 2839 2847 2850
2854 2855 2857 2858 2866 2867 2870 2871 2874 2875 2878 2879
2882 2883 2886 2887 2890 2891 2894 2895 2898 2899 2902 2903
2906 2907 2910 2911 2914 2915 2918 2922 2923 2929 2936 2937
2943 2948 2949 2954 2955 2961 2965 2966 2968 2969 2974 2975
2981 2988 2989 2995 2999 3000 3003 3004 3010 3017 3018 3024
3028 3029 3032 3033 3039 3046 3047 3053 3057 3058 3063 3064
3070 3077 3078 3084 3088 3089 3092 3093 3099 3106 3107 3113
3117 3124
DOLIN 1068#
DONE 59# 295 329 346 371 395 423 439 687 802 824 845
880 935 1020 1080 1120 1154 1165 1217 1323 1345 1413 1433
1444 1472 1487 1528 1565 1577 1608 3275 3423 3442 3467 3483
3505 4181
DSAV 42#
DSBI 42#
DSM 42#
DSMB 42#
DSMI 42#
DTC 42#
ENABLE 1576 1580#
ERROR 59# 2622 2649 2863
ERROR1 1005 1013# 1039
ETQ 42#
ETX 59# 345 879 1107 1118 1398 1432 1564 1595 1604
EXIT 42#
EXP? 394 3494#
EXPNUM 59# 2801 3485 3494

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EXPSET    422    3473#
FLAGA      59#
FLAGB      59#
FLAGC      59#
FLAGCK    2407#
FORMT1     59#    151    154    2153    4300
GEC        42#
GLOPG      59#     59    140     171     185    1642    1729
GOSUB    2318#
GOTNUM    278    284#
GP         59#
GPAGE      59#    131    133     141     144     146     147     172     191     193     194     196
          197    199    200     202     203     205     206     208     227     229     249     250
          259    260    265     304     305     307     453     454     457     487     506     509
          512    515    518     521     523     547     572     599     627     638     660     667
          710    720    728     731     734     736     783     785     787     809     810     812
          831    832    888     977     978     991     997    1022    1046    1052    1063    1064
         1122   1125   1126    1127    1143    1145    1169    1172    1173    1179    1187    1220
         1240   1243   1264    1273    1274    1275    1280    1283    1285    1289    1308    1309
         1312   1325   1326    1328    1331    1351    1352    1378    1383    1384    1386    1450
         1474   1475   1477    1520    1631    1633    1634    1676    1678    1679    1730    1732
         1733   1738   1793    1800    1801    1803    1835    1837    1838    1840    1862    1863
         1871   1873   1884    1885    1890    1891    1895    1901    1907    1909    1912    1913
         1915   1919   1921    1923    1926    1930    1931    1934    1936    1937    1939    1944
         1946   1950   1952    1954    1959    1961    1966    1971    1974    1975    1980    1982
         1986   1987   1989    1992    1994    2004    2005    2009    2014    2021    2022    2028
         2041   2042   2048    2049    2055    2056    2063    2064    2070    2074    2075    2085
         2086   2088   2091    2109    2131    2141    2142    2145    2147    2164    2165    2192
         2193   2206   2210    2214    2215    2219    2225    2245    2246    2248    2250    2252
         2254   2256   2338    2391    2392    2404    2419    2426    2496    2487    2503    2518
         2535   2545   2549    2588    2589    2595    2596    2614    2623    2624    2626    2631
         2635   2637   2638    2640    2650    2651    2653    2661    2663    2744    2747    2748
         2750   2751   2753    2754    2756    2766    2767    2782    2783    2785    2786    2802
         2803   2812   2821    2831    2840    2852    2864    2921    2924    2930    2938    2945
         2953   2956   2962    2967    2973    2976    2982    2990    2996    3002    3005    3011
         3019   3025   3031    3034    3040    3048    3054    3062    3065    3071    3079    3085
         3091   3094   3100    3108    3114    3126    3127    3131    3290    3292    3296    3297
         3445   3447   3455    3486    3488    3496    3513    3514    3518    3519    3529    3530
         3548   3549   3559    3560    3584    3585    3589    3590    3595    3597    3598    3609
         3613   3614   3617    3619    3620    3622    3624    3625    3636    3637    3645    3648
         3649   3653   3659    3660    3663    3664    3668    3672    3674    3683    3684    3689
         3690   3695   3696    3705    3707    3710    3711    3714    3720    3721    3750    3751
         3756   3759   3763    3779    3780    3785    3786    3794    3796    3802    3804    3811
         3814   3816   3824    3827    3829    3839    3840    3848    3850    3851    3856    3857
         3908   3909   3921    3922    3925    3926    3929    3933    3934    3935    3938    3946
         3947   3948   3950    3953    3955    3959    3967    3968    3978    3980    3981    3985
         3986   4003   4005    4008    4009    4026    4028    4029    4034    4036    4037    4041
         4043   4059   4061    4075    4076    4079    4118    4119    4122    4133    4135    4157
         4159   4186   4187    4189    4191    4193    4199    4201    4209    4211    4216    4218
```

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         4219   4224   4225   4227   4233   4234   4237   4239   4241   4243   4249   4251
         4261   4262   4266   4276   4279   4293   4295   4296   4302   4304
GROUP     59#    148   1635   1680   1734   1344   1867   2099   2115   2150   2574   2581
         2617   3135   3526   3535   3556   3564   3571   3633   3700   3724   3732   3740
         3761   3768   3791   3799   3807   3820   3866   3879   3891   3931   3943   3994
         4001   4013   4030   4038   4220   4228   4297
GRPSAV    59#    143   1630   1675   1731   4025   4215   4292
GTR9      733    743#
H1         59#
H10        59#   2502
HALT       59#
HDG        59#   3907
HDG1B     3842   3859   3865#
HDG1C     3861   3873#
HDG?       392   3453#
HDGAGN    3899#  3905
HDGCHK    1823   3838#
HDGEXP     59#    226   3444   3453
HDGFLG     59#   3838
HDGIN     3876   3890#
HDGPWR     59#
HDGRTN    1824#  3870
HDGSET     420   3430#
HDGSLO    3855#
HDGVAL     59#    228
HDGXT     3853   3862   3870#  3883
HDSTRT     33#   1495   1690   3147
HEADNG     59#   3910
HELP       366   2377   3152#  4312   4339
HEXRD1     648#
HLATCH     59#   3893
HOURUP    1964#
HSHIFT     59#   3899
HXCONV     663    670    713    723    731#
HZ         59#   1916
IDLE       42#
IDLLOC     132    135   1373   1375   1499#  1500
IN1ST      988#   992   1012   1024   1030
IN2ND      999#
IN4D       481#   753    903    910    983   1070
IN4DT?     694    750#
IN4DXT     489    492#
INADDR     981#  1036
INC10     1925   1942#
INCHAR     282    445#   447    451    486    561    598    887    990   1001   1045   1051
INCMIN    1949#
INCPPC    2263#  2314   2343   2364   2439   2450   2456   2529   2578   2585   2675   2682
         2699   2706   2723   2730
INCRTC    1886   1911#  2010
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INIT 2304#
INITB 2436 2441#
INITC 2438 2452#
INITS 2434 2446#
INITX 2304 2432#
INKWD 293 558# 579 799 822 842 1215
INLF 1049# 1054
INPUT 1235# 1245 1247 1256
INTCRL 59# 217
INTIME 1238 1300# 1302 1306
INTMSK 59# 213
INTPC 59# 137 139 .843 1866 2098 2114 2149 2260 2407 3573 3580
2616 3134 3525 3534 3555 3563 3570 3632 3681 3760 3767 3790
3798 3806 3819 3865 3878 3890 3930 3942 3993 4000 4012
INTPG 59# 59 59 59 59 59 211 1658
INTPGM 223 1707# 1877 2238
INTPOL 59#
INTRP0 1707 1767#
INTSTA 59#
INTVEC 59# 136 138 221 1763
IOA 59#
IOCLR 59#
IOCTEL 59#
IOERR 244# 459 779 4081 4129 4142 4153
IOLOC 59# 248 452 626 784 1307 4058 4074 4117 4190 4198 4240
4248 4260
IOSTAT 59#
ITB 358 380 404 432 595# 1572 4172
JMPEXC 2276 2324#
JUMP 2275#
KEEP1 1248#
KEEP2 449 452#
KEEP3 4070 4074#
KEEPT 1304 1307#
L2BUF 59#
LBT 1809#
LDC 42#
LDVRST 59#
LIST 59# 563 566 567 576 577 580 600 609 610 1623 1635
1627 2191 2209 2228 2743 2765
LNEND 962 964 967#
LNTEST 952 961#
LOCK 406 820#
LOCKUP 825 827#
LOOP2 2372#
LOOP2X 2372 2564#
LP20TH 2590 2613#
LP21ST 2592 2630#
LP2ERR 2606 2649#

LP2NTH 2594#
LP2OFF 2566 2573#
LP2ON 2568 2580#
LP2XIT 2571 2602 2656#
LP2XMT 2570 2587#
M1 59#
M10 59#
MATCH 576#
MATCH2 608 612#
MATCH3 2512 2518#
MATCH? 562 572#
MDONE 1639 1675#
MEMCHG 1616 1630#
MEMLST 3621 4342#
MEMORY 59# 1665
MEMPTR 59# 3658 3671
MEMSAV 368 1551#
MEMSUB 114 1623#
MODFLG 812# 834
MUX 59# 3642 3643 3734 3742 3744 3770
MUXLST 3618 3639 4315#
MUXPTR 59# 3616 3635
NEXBYT 941# 954 959
NEXT1 484# 499 503
NEXT2 600# 611
NEXT3 628# 644 671 688 695 714 724
NEXTPG 1638# 1673
NOBRRW 1893 1895#
NOLOCK 803 805#
NOMTCH 2544# 2552
NOOP 2364#
NOTETX 4126# 4132
NOTHEX 508 514 517 527#
NOYRTN 890 894#
NULL 59# 4343 4345 4347 4349
NUMBER 511 521#
OKRTN 891#
OPEN 846 848#
OPEN? 410 840#
OUTADR 923# 971
OUTASC 717 726#
OUTCA 583#
OUTCHR 643 739 777# 782
OUTHEX 653# 679
OUTPT1 701 728#
OUTPT2 641# 729
PASSBR 436 438 4094 4101 4113 4178 4208# 4236 4282
PASSCA 1029 1035 1043# 1048
PASSGR 370 430#

PC 59# 100 102 108 149 159 1259 1292 1379 1853 1855
4031 4146 4221 4298
PCSAME 1405 1425#
PDCHK 1822 3778#
PDCLR 3790#
PDEC 4180 4232#
PDRTN 1823# 3782 3832
PDSTAT 59# 3793 3810
PDSTR 3788 3806#
PINC 4174 4185#
PING 59# 3826
PITCH 59# 4342
PLEVEL 59# 4040 4185 4208 4232
PLIST 563# 565 575
PMODE 4083 4169#
PMODEX 4084# 4182
PMPSPD 59#
PMT2 4124 4139# 4145
PMTCHR 59# 344 4148
POP 42# 2293#
POP1 2296# 2300
PORTB 59#
POUND? 279# 283
PPAGE 42#
PPC 59# 2247 2249 2258 2263 2266 2275 2280 2284 2293 2310 2312
2313 2318 2320 2322 2324 2326 2327 2329 2334 2401 2403 2420
2432 2499 2564 2633 2636 2639 2644 2645 2656 2657 2658 2670
2694 2718 2742 2745
PPCCMP 1535# 1544
PPCCNT 59# 2218 2485 2587 2660
PPCHI 59# 190 1377 1452 1518 2244 2851
PPCLO 59# 2213
PPCSHO 418 1511#
PROMPT 330 336# 372 396 424 440 813 865 944 965 1021 1041
1084 1155 1166 1219 1356 1389 1438 1482 1578 1617 3276 3425
3448 3468 3489 3506 4229
PSET00 3924 3927 3942#
PTEST 1574 1585#
PTHRU 434 4025#
PULCHK 1824 3920#
PULCNT 59#
PULFLG 59# 3920
PULNUM 59# 3945
PULRTN 1826# 3960
PULXT 3940 3960#
PUMP1 59#
PUMP2 59#
PUSH 42# 2280#
PUSH00 2505# 2520

PUSH1 2283# 2289
QUEBUF 390 3281#
QUESGR 360 378#
QUESTN 382 901#
QUESTT 386 1319#
RADDR2 4056# 4176
RBHI 59# 1799 1834
RBLO 59#
RBRET 1799#
RBSAVE 1833#
READDR 252 257#
RECFLG 59# 3125
RELAYS 59# 2576 2583 2619 3566 3573 3702 3726 3813 3868 3881 3939
3951 3996 4015 4032 4222
REPORT 1518# 1539 1543
RESTR0 1729# 1850
RESTRT 136# 1852 1854
RETURN 2308#
REV 5# 96 328 3164
RLDI 42# 2790 3300 3895
RLXA 42# 2089 2194 2211 2597
RNX 42#
ROLL 59# 4344
RPLY 312 318#
RSTK 59# 2251 2253 2308 2309 2311 2319 2397 2399 2479 2488
RSTKHI 59#
RSTKLO 59#
RSTKTP 59# 198 201 2481
RSXD 42# 2110 2132 2207 2216 2226
RTC 1810 1882#
RTCRTN 1811# 1902 1910
RTNPTR 59# 573 581 583 584 586
RTTY2 59# 2090 2092 2107 2111 2130 2133
SAVE 2264# 2267 2287 2298 2330 2344 2427 2514 2527
SAVPPC 2264 2390# 2610 2627 2646 2664 2689 2713 2737
SAYCLR 1142 1156#
SAYNO 304 326 347 355# 980 1067
SCAL 42# 112 119 280 291 309 318 337 340 347 356 378
402 430 484 496 500 559 596 641 661 668 683 692
711 721 737 750 766 797 820 840 856 859 871 874
882 885 901 908 920 928 946 955 967 981 988 993
999 1002 1006 1013 1016 1027 1033 1043 1049 1068 1075 1081
1101 1113 1133 1147 1156 1213 1236 1319 1333 1361 1369 1392
1408 1414 1425 1434 1440 1454 1483 1511 1523 1551 1567 1570
1588 1599 1614 2170 2176 2182 2340 2442 2447 2453 2462 2466
2470 2509 2678 2685 2702 2709 2726 2733 3152 3281 3305 3430
3458 3473 3499 3874 4046 4049 4052 4062 4085 4107 4162 4170
4195 4202 4245 4252 4273
SCM1 42#

SCM2 42#
SD 1828 2781#
SDLNGT 59# 3138
SDREC 3129 3134#
SDREQ 59# 3137
SDRET 1829# 2784 2788 3132 3139
SEC1 59# 1324 2781 3289 3512 3583 3688 3784 3849 3979
SEC10 59#
SEMI? 1026 1031#
SEQ01 2023 2040# 2079
SEQ? 388 1450#
SEQ?EX 1479# 1488
SEQCYC 1811 2020#
SEQFAS 59#
SEQNCR 2030 2044 2051 2059 2067 2078 2244# 2274 2279 2292 2303 2307
2317 2333 2347 2351 2355 2359 2363 2367 2371 2376 2384
SEQRAT 59# 2020
SEQRST 186 190#
SEQRTN 1813# 2045 2052 2060 2068 2413
SEQSET 416 1361# 1445
SEQXT1 2377#
SET2ND 1417 1437 1440#
SETAC 2422 2425#
SETAT 1933#
SETCLR 2419#
SETFLG 307# 850
SETPC 1372 1392#
SETPG 1584 1588#
SETPPC 1377# 1423
SETQ 1643 1647 1651 1655 1659 1661 1664#
SETSL 86 99#
SETSTK 104# 1856
SETTOP 1233# 1255
SETUP 121 171#
SETURT 143#
SHFTD4 502 532# 1008
SHIFT 536# 544
SPM1 42#
SPM2 42#
SRET 42# 236 474 492 525 528 552 569 588 604 619 632
740 770 790 892 895 1055 1095 1206 1682 2231 2474 2493
2547 2556 2758 2772 3913 4284 4306
SSTKPG 59# 59 59 1646 2478
STACK 59# 105 107 111 235 244 277 279 290 308 336 473
533 545 551 558 568 582 585 587 595 603 613 626
618 649 653 654 655 664 665 677 760 780 789 806
807 828 829 849 855 870 881 915 916 918 923 936
937 939 1085 1132 1205 1223 1230 1233 1235 1239 1253 1262
1267 1270 1281 1522 1681 1735 1736 1767 1769 1833 1846 1883

	2101	2117	2122	2169	2230	2339	2441	2446	2452	2461	2492	2508
	2546	2555	2677	2684	2701	2708	2725	2732	2757	2771	3812	3825
	3873	3912	4045	4056	4065	4084	4106	4126	4130	4139	4143	4150
	4154	4161	4169	4194	4244	4267	4283	4305				
START1	101	111#										
START2	1292#											
STAT1	59#	445	762	777	1300	1847	4066	4127	4140	4151		
STAT2	59#	2102	2118	2123	4090	4097	4269					
STAT3	59#											
STKCLR	2449	2478#										
STKEND	59#	106	276									
STKERR	2524	2528#										
STKPG	59#	59	104	1650								
STM	42#											
STORE	736#	744										
STPC	42#											
SWITCH	59#	3561										
SWPWR	3551	3570#										
SWRD	1818	3547#										
SWRTN	1819#	3553	3568	3575								
SWSTAT	59#	3558										
SYSFLG	59#	258	303	808	830	976	1062	1861	1935			
SYSTEM	59#	1632										
TCAL	42#											
TEST	602	606#										
TEST$	364	1062#										
TEST0	1899#											
TEST5	1926#											
TEST80	630	635#										
TEST81	636	646#										
TEST8D	647	674#										
TEST9D	682	690#										
TESTA1	698	703#										
TESTA2	704	716#										
TESTCA	675	681#										
TESTCR	1032	1038#										
TESTDD	691	697#										
TESTOX	870#	1083	1416									
TESTSP	996	1022#										
TESTY	881#	1371	1436									
THRE?	780#											
TIME01	59#											
TIME02	59#											
TIMEIN	1265#	1278										
TIMEJM	1242	1259#										
TIMEST	414	1213#										
TLEVEL	59#											
TLIMIT	59#											
TR	1820	3681#										

TRCY02 3686 3719#
TRCY17 3723 3730#
TRCY18 3731 3738#
TRCY19 3739 3748#
TRET 42#
TRFLG 59# 3682 3704
TRRTN 1822# 3693 3698 3717 3728 3736 3746 3749 3772
TSRE? 339 349 752 760# 873 884 1569 4109 4164
TST2ND 2007 2011#
TSTADV 1917 1928 1932 1940 1948 1956 1963 1970 1977 1983 1996 2003#
TSTNEX 1901# 1905
TTY 320 342 626# 685 861 876 930 948 957 969 1018 1077
1103 1115 1149 1158 1321 1335 1363 1394 1410 1427 1442 1456
1485 1513 1525 1553 1590 1601 3154 3283 3307 3432 3460 3475
3501
TTY2 1813 2084#
TTY2HI 59# 2084 2594 2634
TTY2LO 59#
TY2ETX 2096 2114#
TY2OUT 2098#
TY2RTN 1814# 2087 2094 2105 2112 2121 2125 2129 2134
UARTS 59# 145 1677 1845 1868 2100 2216 2151 4035 4226 4294
UNADDR 162 255# 297 1295
UNLOCK 408 797#
VERS 4# 94 326 3162
WAIT 126# 128
WAIT1 1326# 1327
WAIT2 1352# 1354
WAIT3 467# 471
WAIT4 761# 765
WAIT6 4269# 4272
WRITEM 412 976#
WTFOR 2348#
WTFORX 2348 2499#
WTTILL 2334#
X 59# 4006
XID 42#
XIE 42#
XMTBR2 4292#
XMTETX 4151# 4156
XMTLP2 4064 4087 4197 4204 4247 4254 4260#
XPOS 59# 4004
XYZCHK 1826 3966#
XYZFLG 59# 3966
XYZIN 3990 4000#
XYZON 3970 3988 3993#
XYZRTN 1828# 3991
XYZXT 3983 3991# 3998 4018
YZ 59# 4010

YZPOS 59#

```
                        ;       I1806A.MAC - Macro Definitions for RCA 1805A/6A Opcodes
                        ;
                        ;
                        ;       20 FEB 1986
                        ;       W. E. TERRY
                        ;
                        ;       (LISTING SUPRESSED)
                        ;
                        ;       With some Level II codes
                        ;
                                .XLIST                  ;TURN OFF LISTING
                                .SALL                   ;INHIBIT SOURCE LISTING
                        ;
                        ;
                        ;*****************************************************************************
                        ;
                        ;       For use with Syscon M18 assembler -- adds:
                        ;                       1805A/6A capability
                        ;                       some RCA LEVEL II CODES
                        ;                       some WET MACROS
                        ;
                        ;       Include this file into source program using
                        ;                       INCLUDE I1806A.MAC
                        ;
                        ;
                        ;*****************************************************************************
                        ;
                        ;
                        ;------------------------------------------------ COUNTER CONTROL ---- -
                        ;
                        ;
                                STPC MACRO              ;STOP COUNTER
                                DB 68H,00H
                                ENDM
                        ;
                                DTC MACRO               ;DECREMENT COUNTER
                                DB 68H,01H
                                ENDM
                        ;
                                SPM2 MACRO              ;SET PULSE MODE 2
                                DB 68H,02H
                                ENDM
                        ;
                                SPM1 MACRO              ;SET PULSE MODE 1
                                DB 68H,04H
                                ENDM
```

```
                        ;
                        SCM2 MACRO              ;SET COUNTER MODE 2
                        DB 68H,03H
                        ENDM
                        ;
                        SCM1 MACRO              ;SET COUNTER MODE 1
                        DB 68H,05H
                        ENDM
                        ;
                        LDC MACRO               ;LOAD COUNTER
                        DB 68H,06H
                        ENDM
                        ;
                        STM MACRO               ;SET TIMER MODE
                        DB 68H,07H
                        ENDM
                        ;
                        GEC MACRO               ;GET COUNTER
                        DB 68H,08H
                        ENDM
                        ;
                        ETQ MACRO               ;ENABLE TOGGLE Q
                        DB 68H,09H
                        ENDM
                        ;
                        ;
                        ;-------------------------------------------------- REGISTER OPS --------
                        ;
                        ;
                        RNX MACRO P1            ;RN TO RX COPY
                        DB 68H,(0B0H + P1)
                        ENDM
                        ;
                        RLDI MACRO P1,P2        ;REGISTER LOAD IMMEDIATE
                        DB 68H,(0C0H + P1)
                        DW P2
                        ENDM
                        ;
                        ;
                        ;-------------------------------------------------- MEMORY OPS ----------
                        ;
                        ;
                        RLXA MACRO P1           ;REGISTER LOAD VIA X AND ADVANCE
                        DB 68H,(060H + P1)
                        ENDM
                        ;
```

```
                        RSXD MACRO P1           ;REGISTER STORE VIA X AND DECREMENT
                        DB 68H,(0A0H + P1)
                        ENDM
                ;
                ;
                ;-------------------------------------------------- BRANCHES -------- --
                ;
                ;
                        BCI MACRO P1            ;BRANCH ON COUNTER INTERRUPT
                        DB 68H,3EH
                        DB LOW (P1)
                        ENDM
                ;
                        BXI MACRO P1            ;BRANCH ON EXTERNAL INTERRUPT
                        DB 68H,3FH
                        DB P1
                        ENDM
                ;
                        DBNZ MACRO P1,P2        ;DECREMENT AND BRANCH IF NOT ZERO
                        DB 68H,(020H + P1)
                        DW P2
                        ENDM
                ;
                ;
                ;------------------------------------------- INTERRUPT CONTROL -------- --
                ;
                ;
                        XIE MACRO               ;EXTERNAL INTERRUPT ENABLE
                        DB 68H,0AH
                        ENDM
                ;
                        XID MACRO               ;EXTERNAL INTERRUPT DISABLE
                        DB 68H,0BH
                        ENDM
                ;
                        CIE MACRO               ;COUNTER INTERRUPT ENABLE
                        DB 68H,0CH
                        ENDM
                ;
                        CID MACRO               ;COUNTER INTERRUPT DISABLE
                        DB 68H,0DH
                        ENDM
                ;
                        DSAV MACRO              ;SAVE D
                        DB 68H,76H
                        ENDM
```

```
                        ;
                        ;
                        ;---------------------------------------------- BCD ARITHMETIC ----------
                        ;
                        ;
                        ;
                DADC    MACRO                   ;ADD WITH CARRY
                        DB 68H,74H
                        ENDM
                        ;
                DSMB    MACRO                   ;SUBTRACT MEMORY WITH BORROW
                        DB 68H,77H
                        ENDM
                        ;
                DACI    MACRO P1                ;ADD WITH CARRY, IMMEDIATE
                        DB 68H,7CH
                        DB P1
                        ENDM
                        ;
                DSBI    MACRO P1                ;SUBTRACT MEMORY WITH BORROW, IMMEDIATE
                        DB 68H,7FH
                        DB P1
                        ENDM
                        ;
                DADD    MACRO                   ;ADDITION
                        DB 68H, 0F4H
                        ENDM
                        ;
                DSM     MACRO                   ;SUBTRACT MEMORY
                        DB 68H,0F7H
                        ENDM
                        ;
                DADI    MACRO P1                ;ADD IMMEDIATE
                        DB 68H,0FCH
                        DB P1
                        ENDM
                        ;
                DSMI    MACRO P1
                        DB 68H,0FFH
                        DB P1
                        ENDM
                        ;
                        ;
                        ;---------------------- SUBROUTINE CONTROL ------------------------------
                        ;
```

```
185                             ;
186                                     SCAL MACRO P1,P2        ;RCA SCAL
187                                     DB 68H,(80H + P1)
188                                     DW P2
189                                     ENDM
190                             ;
191                                     SRET MACRO P1           ;RCA SRET
192                                     DB 68H,(90H + P1)
193                                     ENDM
194                             ;
195                                     TCAL MACRO P1           ;TERRY SCAL USING
196                                     SEX STACK                       ;X=R2=STACK
197                                     DB 68H,86H                      ;RN=R6=RTNPTR
198                                     DW P1
199                                     ENDM
200                             ;
201                                     TRET MACRO              ;TERRY SRET USING:
202                                     SEX STACK
203                                     DB 68H,96H                      ;X=R2=STACK
204                                     ENDM                                    ;RN=R6=RTNPTR
205                             ;
206                             ;---------- RCA LEVEL II MACROS ----------
207                             ;
208                                     CALL MACRO P1
209                                     SEP R4
210                                     DW P1
211                                     ENDM
212                             ;
213                                     EXIT MACRO
214                                     SEP R5
215                                     ENDM
216                             ;
217                                     PUSH MACRO
218                                     STXD
219                                     ENDM
220                             ;
221                                     POP MACRO
222                                     LDXA
223                                     ENDM
224                             ;
225                                     IDLE MACRO
226                                     IDL
227                                     ENDM
228                             ;
229                                     PPAGE MACRO
230                                     ORG HDSTRT+($-LOW($))+100H
```

```
                                        ENDM
                                    ;
                                        .LIST
```

MACROS:

BCI	BXI	CALL	CID	CIE	DACI	DADC	DADD
DADI	DBNZ	DSAV	DSBI	DSM	DSMB	DSMI	DTC
ETQ	EXIT	GEC	IDLE	LDC	POP	PPAGE	PUSH
RLDI	RLXA	RNX	RSXD	SCAL	SCM1	SCM2	SPM1
SPM2	SRET	STM	STPC	TCAL	TRET	XID	XIE

SYMBOLS:

NO FATAL ERROR(S)

BCI	101#
BXI	106#
CALL	208#
CID	132#
CIE	128#
DACI	154#
DADC	146#
DADD	164#
DADI	172#
DBNZ	111#
DSAV	136#
DSBI	159#
DSM	168#
DSMB	150#
DSMI	177#
DTC	36#
ETQ	68#
EXIT	213#
GEC	64#
IDLE	225#
LDC	56#
POP	221#
PPAGE	229#
PUSH	217#
RLDI	80#
RLXA	89#
RNX	76#
RSXD	93#
SCAL	186#
SCM1	52#
SCM2	48#
SPM1	44#
SPM2	40#
SRET	191#
STM	60#
STPC	32#
TCAL	195#
TRET	201#
XID	124#
XIE	120#

```
                        :       SEA DUCT EQUATE TABLE - ISDEQU.MAC
                        :
                        :       26 AUG 86 - SD05R9
                        :
                        :       W. E. TERRY
                        :
                        :       INCLUDING:
                        :               REGISTER ALLOCATION
                        :               GLOBAL PAGE REFERENCES
                        :               I/O EQUATES
                        :               DEFAULT VALUES
                        :
                        :       (LISTING SUPRESSED)
                        :       .XLIST
                        ;
                        : PREVIOUS VERSION:  08 AUG 86  - SD05R6
                        : PREVIOUS VERSION:  20 JUN 86  - SD05R5
                        : PREVIOUS VERSION:  21 MAR 86  - SD05R2 thru 5R4
                        :
                        :
                        :*************************************************************************
                        :
                        :**** THIS FILE MUST BE INCLUDED IN ALL
                        :       SEA DUCT PROGRAM SOURCE (".MAC") FILES
                        :
                        :       USE "INCLUDE ISDEQU.MAC"
                        :
                        :**** THIS FILE MUST NOT BE INCLUDED IN SEA DUCT SEQUENCER
                        :       MACRO PROGRAM SOURCE (".MAC") FILES
                        :
                        :
                        :********************** REGISTER ALLOCATION ********************************
                        :
                        :******* SAIL REGISTERS *******
                        ;
0000                    DMA     EQU R0  :DMA IN/OUT  -  ALSO START
0001                    INTPC   EQU R1  :INTERRUPT PROGRAM COUNTER
0002                    STACK   EQU R2  :UTILITY STACK
0003                    PC      EQU R3  :MAIN PROGRAM COUNTER
                        :           R4  :SCRT CALL     * SCRT NOT USED BY *
                        :           R5  :SCRT RETURN   *  THIS PROGRAM    *
0006                    RTNPTR  EQU R6  :POINTER FOR RETURN & IMMEDIATE BYTES
0006                    LIST    EQU R6  :   *     *     *       *       *
0007                    GPAGE   EQU R7  :GLOBAL PAGE    S & R  R7.0 (R7.1 REMAINS CONSTANT)
0008                    CYCCNT  EQU R8  :REAL TIME CLOCK CYCLE COUNT, OTHER MISC.
                        :
```

```
                        ;****   NOTE:   S & R => SAVED AND RESTORED BY INTERRUPT   ****
                        ;                       FOR USE OUTSIDE INTERRUPT
                        ;
                        ;       REGISTERS A - F, 7.0 ARE S & R
                        ;
                        ;
                        ;******* INTERRUPT REGISTERS *******
                        ;
                        ;       INTERRUPT PC = R1
                        ;
000C                    PPC     EQU RC  ;SEQUENCER PSEUDO PROGRAM COUNTER
000D                    RSTK    EQU RD  ;SEQUENCER RETURN STACK
000E                    ASTK    EQU RE  ;SEQUENCER STACK
                        ;
000F                    RTTY2   EQU RF  ;TTY2 OUTPUT POINTER
                        ;
                        ;****   REGISTER B IS ALSO SAVED AND RESTORED
                        ;         FROM INSIDE INTERRUPT TO INTERRUPT
                        ;
                        ;
                        ;************************** MISC. ALLOCATION ***********************************
                        ;
                        ;Q      UT4 (BLT.2):INTERRUPT PULSE:MEM. PROTECT
                        ;SF1    INTERRUPT       ( FUTURE OPTION )
                        ;SF2
                        ;SF3    SEA DATA RECORDER
                        ;SF4    UT4 (BLT.2)
                        ;
                        ;
                        ;************************** I/O SELECT *****************************************
                        ;
0001                    GROUP   EQU 01  ;SELECT = OUT 01; READ = INP 01 - GROUP SELECT
                        ;
                        ;
                        ;********* GROUP 0 ********
                        ;
                        ;< INPUT >
                        ;
0002                    SWITCH  EQU 02  ;BOTTOM AND INSERTION SWITCHES
0003                    X       EQU 03  ;X  POSITION
0004                    YZ      EQU 04  ;YX POSITIONS
                        ;PING   EQU 07  ;ACOUSTIC TRANSPONDER
                        ;
                        ;< OUTPUT >
                        ;
0002                    BAT1    EQU 02  ;BATTERY 1 RELAY
```

```
93     0003                    BAT2    EQU 03  :BATTERY 2 RELAY
94     0004                    BAT3    EQU 04  :BATTERY 3 RELAY
95     0005                    LDVRST  EQU 05  :RESET THE LDV
96     0006                    CAMERA  EQU 06  :TAKE A PICTURE
97     0007                    PING    EQU 07  :PINGER
98                             :
99                             :
100                            :********* GROUP 1 ********
101                            :
102                            :( INPUT )
103                            :
104    0002                    CMPASS  EQU 02  :INPUT COMPASS
105    0004                    HEADNG  EQU 04  :INPUT HEADING
106                            :
107                            :( OUTPUT )
108                            :
109                            :CMPASS EQU 02  :COMPASS PWR. AND LATCH
110    0003                    HLATCH  EQU 03  :LATCH HEADING
111    0004                    HSHIFT  EQU 04  :HEADING SER. SHIFT IN
112    0005                    HDGPWR  EQU 05  :HEADING POWER
113                            :
114                            :
115                            :********* GROUP 2 ********
116                            :
117                            :( INPUT )
118                            :
119    0002                    ADLO4   EQU 02  :A/D    FOUR LSB's
120    0003                    ADHI8   EQU 03  :A/D    EIGHT MSB's
121    0007                    RELAYS  EQU 07  :RELAY CONTROLS
122                            :
123                            :( OUTPUT )
124                            :
125    0002                    MUX     EQU 02  :MUX AND A/D CONTROL
126    0003                    SDREQ   EQU 03  :SEA DATA RECORD REQUEST
127    0006                    PMPSPD  EQU 06  :CIRCULATION PUMP SPEED
128                            :RELAYS EQU 07  :RELAY SENSE LINES
129                            :
130                            :
131                            :******** GROUP 3 ********
132                            :
133                            :
134                            :******** GROUP 4 ********
135                            :
136                            :*** GROUP 5 - 1851 BIT I/O ***
137                            :
138                            :( INPUT )
```

```
                                ;
0005                            IOSTAT  EQU 05  ;1851 PORT STATUS
                                ;IOA    = 06    ;READ PORT A
                                ;IOB    = 07    ;READ PORT B
                                ;
                                ;( OUTPUT )
                                ;
0004                            IOCLR   EQU 04  ;CLEAR 1851
0005                            IOCTEL  EQU 05  ;1851 PORT CONTROL
0006                            IOA     EQU 06  ;LOAD PORT A
0007                            PORTB   EQU 07  ;LOAD PORT B
                                ;
                                ;
                                ;******** GROUP 6 - UARTS ********
                                ;
0006                            UARTS   EQU 06  ;UART GROUP
0012                            FORMT1  EQU 12H ;7 DATA BITS, 1 STOP BIT, EVEN PARITY
                                ;
                                ;(INPUT)
                                ;
0002                            DATA1   EQU 02  ;LEVEL 1 SAIL UART
0003                            STAT1   EQU 03  ;LEVEL 1 SAIL UART
0004                            DATA2   EQU 04  ;LEVEL 2 SAIL UART
0005                            STAT2   EQU 05  ;LEVEL 2 SAIL UART
0006                            DATA3   EQU 06  ;NOT USED
0007                            STAT3   EQU 07  ;NOT USED
                                ;
                                ;( OUTPUT )
                                ;
0003                            CNTRL1  EQU 03  ;LEVEL 01 SAIL UART CONTROL
0005                            CNTRL2  EQU 05  ;LEVEL 02 SAIL UART CONTROL
0007                            CNTRL3  EQU 07  ;NOT USED
                                ;
                                ;
                                ;******** GROUP 7 ********
                                ;
0007                            SYSTEM  EQU 07
                                ;
                                ;( INPUT )
                                ;
                                ;( OUTPUT )
                                ;
0006                            HALT    EQU 06  ;SUICIDE FUNCTION
0007                            MEMORY  EQU 07  ;MEMORY PAGE PROTECT OR ENABLE
                                ;
                                ;
```

```
                        ;********************* DEFINITIONS AND REFERENCES ******************************
                        ;
                        ;
                        ;*** SAIL PROM LOCATIONS (2716'S) AND PAGE REFERENCES ***
                        ;
0000                    BLT     EQU 00H         ;*** BLT MONITOR PROM BASE PAGE ***
0050                    GLOPG   EQU 050H        ;*** GLOBAL PAGE
0052                    SSTKPG  EQU 052H        ;*** SEQUENCER STACK PAGE ***
0053                    STKPG   EQU 053H        ;*** MAIN STACK BASE PAGE ***
005B                    BUFPG   EQU 05BH        ;*** SEA DATA OUTPUT BUFFER PAGE ***
00F8                    INTPG   EQU 0F8H        ;*** INTERRUPT CONTROLER BASE PAGE
                        ;                       ;    ( CDP1877 ) ***
                        ;
                        ;       BLT.2 MONITOR RAM PAGE = 5700:STACK END = 57DF
                        ;
                        ;
                        ;*** OTHER REFERENCES ***
                        ;
                        ;
53DF                    STKEND  EQU (STKPG * 100H) + 0DFH       ;*** MAIN STACK END = STKPG+DF
                        ;
523F                    RSTKTP  EQU (SSTKPG * 100H) + 3FH       ;SEQ R STACK TOP - RSTK = 5200 - 523F
527F                    ASTKTP  EQU (SSTKPG * 100H) + 7FH       ;SEQ A STACK TOP - ASTK = 5240 - 527F
                        ;
F800                    INTMSK  EQU (INTPG * 100H) + 00H        ;INTERRUPT MASK - WRITE ONLY
F840                    INTCRL  EQU (INTPG * 100H) + 40H        ;INTERRUPT CONTROL - WRITE ONLY
F880                    INTVEC  EQU (INTPG * 100H) + 80H        ;INTERRUPT PAGE REGISTER - WRITE ONLY
F800                    INTSTA  EQU (INTPG * 100H) + 00H        ;INTERRUPT STATUS REG. - READ ONLY
F840                    INTPOL  EQU (INTPG * 100H) + 40H        ;INTERRUPT POLLING REG. - READ ONLY
                        ;
5B00                    BUFFER  EQU (BUFPG * 100H)              ;SEADATA BUFFER 0 LOCATION
                        ;
                        ;
                        ;
                        ;********************** GLOBAL PAGE REFERENCES *******************************
                        ;
5000                    GP      EQU (GLOPG * 100H)
                        ;
0002                    PLEVEL  EQU 02H         ;PASS THRU LEVEL
0003                    SYSFLG  EQU 03H         ;SYSTEM FLAG      |ADDR|WRITE|SYS|
0005                    CRCRAM  EQU 05H         ;CRC CALC. SCRATCH
0006                    CRCHI   EQU 06H         ;CRC HI BYTE RESULT
0007                    CRCLO   EQU 07H         ;CRC LO BYTE RESULT
0008                    RBHI    EQU 08H         ;RB.1 SAVE FROM LAST INTERRUPT
0009                    RBLO    EQU 09H         ;RB.0 SAVE FROM LAST INTERRUPT
000A                    GRPSAV  EQU 0AH         ;CURRENT I/O GROUP (OUTSIDE INTERRUPT)
```

```
                        ;
000F                    EXPNUM  EQU 0FH         ;EXPERIMENT NUMBER (LOW NIBBLE ONLY)
                        ;
00FE                    IOLOC   EQU 0FEH        ;I/O BYTE
                        ;
                        ;
                        ;****** REAL TIME CLOCK LOCATIONS ******
                        ;
0028                    HZ      EQU 40          ;40 Hz INTERRUPT RATE
                        ;
0010                    D100    EQU 10H         ;DAYS   X 100
0011                    D10     EQU 11H         ;DAYS   X 10
0012                    D1      EQU 12H         ;DAYS   X 1
0013                    H10     EQU 13H         ;HOURS  X 10
0014                    H1      EQU 14H         ;HOURS  X 1
0015                    M10     EQU 15H         ;MIN.   X 10
0016                    M1      EQU 16H         ;MIN.   X 1
0017                    SEC10   EQU 17H         ;SEC.   X 10
0018                    SEC1    EQU 18H         ;SEC.   X 1
0019                    CYCLES  EQU 19H         ;RTC CYCLE COUNT
001A                    AR100   EQU 1AH         ;ADV.-RET. CNT X 100
001B                    AR10    EQU 1BH         ;ADV.-RET. CNT X 10
001C                    AR1     EQU 1CH         ;ADV.-RET. CNT X 1
001D                    ARFLG   EQU 1DH         ;00= RETARD, 01= NORM., 02= ADVANCE: RTC REF. LOC.
001E                    ATFLG   EQU 1EH         ;@ FLAG
001F                    ATMFLG  EQU 1FH         ;@ MINUTE FLAG
0020                    BUF9    EQU 20H         ;START OF 9 DIGIT INPUT BUFFER
                        ;
                        ;
                        ;****** INSRUMENT SPECIFIC FLAGS ******
                        ;
0040                    PULFLG  EQU 40H         ;RELAY DRIVER PULSE FLAG (AC = ON)
0041                    PULCNT  EQU 41H         ;RELAY DRIVER PULSE COUNTER (00=DONE)
0042                    PULNUM  EQU 42H         ;RELAY DRIVER NUMBER (= FF when inactive)
                        ;
                        ;
                        ;****** SEQUENCER ******
                        ;
0060                    PPCHI   EQU 60H         ;SEQ PSUEDO PC HI BYTE POINTER
0061                    PPCLO   EQU 61H         ;"      "   PC LO BYTE POINTER
0062                    RSTKHI  EQU 62H         ;SEQ R STACK LO BYTE POINTER
0063                    RSTKLO  EQU 63H         ;SEQ R STACK HI BYTE POINTER
0064                    ASTKHI  EQU 64H         ;SEQ A STACK LO BYTE POINTER
0065                    ASTKLO  EQU 65H         ;SEQ A STACK HI BYTE POINTER
                        ;
                        ;
```

```
277   0066                    SEQFAS  EQU 66H         ;SEQ CTR FOR FAST CYCLE MODE
278   0067                    SEQRAT  EQU 67H         ;SEQ CYCLE RATE FOR INDIV. SEQ. INST.
279                           ;                       ;  if SEQRAT MSB=1 (ie. 8x), check lo nibble:
280                           ;                       ;       (1000 0000) EVERY CYCLE
281                           ;                       ;       (1000 0001) EVERY OTHER CYCLE
282                           ;                       ;       (1000 0010) EVERY FOURTH CYCLE
283                           ;                       ;       (1000 0100) EVERY EIGHT CYCLE
284                           ;                       ;  if MSB = 0 (ie. 0x) run on cycle #NN and #01
285                           ;                       ;  if SEQRAT = 00, run only on cycle #01
286                           ;
287                           ;
288   0068                    PPCCNT  EQU 68H         ;# TIMES THRU CURRENT PPC
289                           ;
290   0069                    FLAGA   EQU 69H         ;FLAG A LOCATION
291   006A                    FLAGB   EQU 6AH         ;FLAG B LOC.
292   006B                    FLAGC   EQU 6BH         ;FLAG C LOC.
293                           ;
294                           ;
295   006C                    CTAHI   EQU 6CH         ;COUNTER A, HI CNT.
296   006D                    CTALO   EQU 6DH         ;COUNTER A, LO CNT.
297   006E                    CTAVHI  EQU 6EH         ;COUNTER A, HI VECTOR
298   006F                    CTAVLO  EQU 6FH         ;COUNTER A, LO VECTOR
299                           ;
300   0070                    CTBHI   EQU 70H         ;COUNTER B, HI CNT.
301   0071                    CTBLO   EQU 71H         ;COUNTER B, LO CNT.
302   0072                    CTBVHI  EQU 72H         ;COUNTER B, HI VECTOR
303   0073                    CTBVLO  EQU 73H         ;COUNTER B, LO VECTOR
304                           ;
305   0074                    CTCHI   EQU 74H         ;COUNTER C, HI CNT.
306   0075                    CTCLO   EQU 75H         ;COUNTER C, LO CNT.
307   0076                    CTCVHI  EQU 76H         ;COUNTER C, HI VECTOR
308   0077                    CTCVLO  EQU 77H         ;COUNTER C, LO VECTOR
309                           ;
310                           ;
311                           ;****** PASS THRU LOOP FLAGS ******
312                           ;
313   007D                    BR2CNT  EQU 7DH         ;COUNTER FOR BREAK LOOP 2
314   007E                    TTY2HI  EQU 7EH         ;TTY2 OUTPUT LIST POINTER
315   007F                    TTY2LO  EQU 7FH         ;"      "       "       "
316                           ;
317                           ;
318                           ;****** INSTRUMENT SPECIFIC ******
319                           ;
320   0080                    ERROR   EQU 80H         ;ERROR WORD     ;XY2;ROT;TLT; -- ; ; -- ; -- ;L2TI;L2UR;
321   0081                    ACSTAT  EQU 81H         ;XPNDER STATUS  ;Signl.to Surface; -- ;Cmd3;Cmd2;Cmd1;
322   0082                    SWSTAT  EQU 82H         ;SWITCH STATUS  ;Bot; - ; - ;Ins0;Ins4;Ins3;Ins2;Ins1;
```

```
323  0083                    PDSTAT  EQU 83H         :RELAY POD STATUS
324                          :
325  0084                    CMPSS   EQU 84H         :COMPASS VALUE
326  0085                    HDG     EQU 85H         :HEADING VALUE
327  0086                    PUMP1   EQU 86H         :FLUME PUMP 1 SPEED
328  0087                    PUMP2   EQU 87H         :FLUME PUMP 2 SPEED
329                          :
330  0088                    CAMCNT  EQU 88H         :CAMERA FRAME COUNTER
331  0089                    PITCH   EQU 89H         :PITCH - PENDULUM 1 (OLD TILT1)
332  008A                    ROLL    EQU 8AH         :ROLL  - PENDULUM 2 (OLD TILT2)
333  008B                    BATTUP  EQU 8BH         ;uP  BATTERY VOLTAGE * (1/6)
334                          :
335  008C                    BATTSY  EQU 8CH         :SYS BATTERY VOLTAGE * (1/6)
336  008D                    ADGH8   EQU 8DH         :A/D GROUND VALUE       HI 8 BITS
337  008E                    ADGL4   EQU 8EH         :A/D GROUND VALUE       LO 4 BITS
338  008F                    ADRH8   EQU 8FH         :A/D REFERENCE VALUE    HI 8 BITS
339                          :
340  0090                    ADRL4   EQU 90H         :A/D REFERENCE VALUE    LO 4 BITS
341  0091                    AD5H8   EQU 91H         :A/D +5V VALUE          HI 8 BITS
342  0092                    AD5L4   EQU 92H         :A/D +5 VALUE           LO 4 BITS
343  0093                    XPOS    EQU 93H         :CARRAGE X POSITON
344                          :
345  0094                    YZPOS   EQU 94H         :CARRAGE Y,Z POSITION
346  0095                    ADT1H8  EQU 95H         :1st SEC. TRANSMISSOMETER HI 8 BITS (BA98:7654)
347  0096                    ADT1L4  EQU 96H         :1st SEC. TRANSMISSOMETER LO 4 BITS (FFFF:3210)
348  0097                    ADT2H8  EQU 97H         :2nd SEC. TRANS HI 8 BITS (BA98:7654)
349                          :
350  0098                    ADT2L4  EQU 98H         :2nd SEC. TRANS LO 4 BITS (FFFF:3210)
351  0099                    ADT3H8  EQU 99H         :3rd SEC. TRANS HI 8 BITS
352  009A                    ADT3L4  EQU 9AH         :3rd SEC. TRANS LO 4 BITS
353  009B                    ADT4H8  EQU 9BH         :4th SEC. TRANS HI 8 BITS
354                          :
355  009C                    ADT4L4  EQU 9CH         :4th SEC. TRANS LO 4 BITS
356  009D                    ADT5H8  EQU 9DH         :5th SEC. TRANS HI 8 BITS
357  009E                    ADT5L4  EQU 9EH         ;5th SEC. TRANS LO 4 BITS
358  009F                    ADT6H8  EQU 9FH         :6th SEC. TRANS HI 8 BITS
359                          :
360  00A0                    ADT6L4  EQU 0A0H        :6th SEC. TRANS LO 4 BITS
361  00A1                    ADT7H8  EQU 0A1H        ;7th SEC. TRANS HI 8 BITS
362  00A2                    ADT7L4  EQU 0A2H        :7th SEC. TRANS LO 4 BITS
363  00A3                    ADT8H8  EQU 0A3H        :8th SEC. TRANS HI 8 BITS
364                          :
365  00A4                    ADT8L4  EQU 0A4H        :8th SEC. TRANS LO 4 BITS
366  00A5                    ADT9H8  EQU 0A5H        :9th SEC. TRANS HI 8 BITS
367  00A6                    ADT9L4  EQU 0A6H        :9th SEC. TRANS LO 4 BITS
368  00A7                    ADT0H8  EQU 0A7H        :10thSEC. TRANS HI 8 BITS (BA98:7654)
```

```
00A8                    ADTOL4  EQU 0A8H        ;10thSEC. TRANS LO 4 BITS (FFFF!3210)
                        ;
                        ;
00AD                    MUXPTR  EQU 0ADH        ;MUX LIST POINTER FOR A/D
00AE                    MEMPTR  EQU 0AEH        ;MEM LIST POINTER FOR A/D
00AF                    NULL    EQU 0AFH        ;NULL STROAGE LOC. FOR UNUSED
                        :                       :A/D LO4 BITS
                        ;
                        ;
00B0                    ADFLG   EQU 0B0H        ;A/D 'ON' FLAG, AC = ON
00B1                    TRFLG   EQU 0B1H        ;TRANSMISSOMETER A/D 'ON' FLAG, AC = ON
00B2                    RECFLG  EQU 0B2H        ;SEA DATA RECORDER 'ON' FLAG, AC = ON
                        ;
00B3                    HDGFLG  EQU 0B3H        ;HEADING (ROTATION) FLAG:
                        :                       ;  AC = TURN ON ROTATION ENCODER PWR
                        :                       ;       ( USED BY SEQUENCER FOR FAST READ
                        :                       ;         DURING ROTATION)
                        :                       ;  ELSE = TURN ON PWR AT CYC=1B (SEC = x9)
                        :                       ;         READ HEADING AT CYC=1C AND TURN OFF PWR
                        :                       ;         SET HEADING FLG = 00
                        ;
00B4                    XYZFLG  EQU 0B4H        ;XYZ POSITIONS FLAG:
                        :                       ;  AC = TURN ON OPTO INTERRUPTER PWR
                        ;                       ;       ( USED BY SEQUENCER FOR FAST READ
                        ;                       ;         DURING XYZ POSITIONING)
                        :                       ;  ELSE = TURN ON PWR AT CYC=24 (SEC = x9)
                        :                       ;         READ XYZ AT CYC=25 AND TURN OFF PWR
                        :                       ;         SET XYZ FLG = 00
                        ;
00BF                    HDGEXP  EQU 0BFH        ;FLUME HEADING VALUE FOR THE EXPERIMENT
                        ;
00C0                    L2BUF   EQU 0C0H        ;LOOP 2 RECEIVE BUFFER (USED BY TTY2)
                        ;
                        ;
                        ;********************** INSTRUMENT SPECIFIC EQUATES ***************************
                        ;
003A                    PMTCHR  EQU ':'         ;PROMPT CHARACTER = :
                        ;
0003                    ETX     EQU 03H         ;ASCII ETX = 03
00FF                    DONE    EQU 0FFH        ;USED BY TTY CALLS
                        ;
0029                    SDLNGT  EQU 41D         ;SEA DATA RECORD LENGTH (BYTES)
                        ;
0020                    HDGVAL  EQU 020H        ;FLUME HEADING DEFAULT VALUE
                        :                       ;NOTE! - WATER FLOWS FROM HDGVAL
                        ;
```

```
                                TIME01  EQU 60D         :TIME OUT CONST. FOR XYZ POSITION MOVEMENT
                                :
                                TIME02  EQU 0F0H        :TIME OUT CONST. FOR ROTATION MOVEMENT
                                :                       :  TIME02 X 2 = TIME OUT VALUE FOR ROTATION MOVEMENT
                                :                       :  ie. F0 = 480 Sec.
                                :
                                TLEVEL  EQU 05AH        :PENDULUM TILT ZERO VALUE
                                TLIMIT  EQU 06D         :EXPERIMENT TILT LIMITS (IN DEGREES)
                                :
                                ;
                                :2 BIT DELAY ROUTINE
                                :SAIL ADDRESS AND REPLY
                                :DELAY 250      ( 250 mSEC DELAY)
                                :DELAY 20       ( INITIAL SETUP DELAY)
                                :
                                :
                                        .LIST
                                :
```

```
                        ;PAGE 60
                        ;
                               SUBTTL SEADUCT EXT SEQUENCER: SDE5R9.MAC  22 SEP 86
                        ;
                        ;
                        ;      PREVIOUS VERSION: SDE5R7.MAC  20 AUG 86
                        ;      PREVIOUS VERSION: SDE5R6.MAC  14 AUG 86
                        ;      PREVIOUS VERSION: SDE5R5.MAC  21 JUN 86
                        ;
                        ;          PREVIOUS VERSIONS EXIST
                        ;
                        ;      W. E. TERRY
                        ;
                        ;      SEA DUCT EXTENDED SEQUENCER FUNCTIONS
                        ;             (SEQUENCER PREFIX EC)
                        ;
                C       INCLUDE I1806A.MAC
                C       ;      I1806A.MAC - Macro Definitions for RCA 1806A/6A Opcodes
                C       ;
                C       ;
                C       ;      20 FEB 1986
                C       ;      W. E. TERRY
                C       ;
                C       ;      .LISTING SUPRESSED.
                C       ;
                C       ;      With some Level II codes
                C       ;
                C              .LIST
                        ;
                C       INCLUDE ISDEQU.MAC
                C       ;      SEA DUCT EQUATE TABLE - ISDEQU.MAC
                C       ;
                C       ;      26 AUG 86 - SDDER
                C       ;
                C       ;      W. E. TERRY
                C       ;
                C       ;      INCLUDING:
                C       ;             REGISTER ALLOCATION
                C       ;             GLOBAL PAGE REFERENCES
                C       ;             I/O EQUATES
                C       ;             DEFAULT VALUES
                C       ;
                C       ;      .LISTING SUPRESSED.
                C              .LIST
                C       ;
                        ;
```

```
                                ;***** ; NOTE: . ***************************************************************
                                ;
                                :       ASSEMBLY OF THIS EXTENDED PROGRAM REQUIRES LINKING
                                ; THIS PROGRAM SEGMENT WITH THE MAIN SEA DUCT SEGMENT VIA L18.
                                ;
                                ; USE: L18 /P:800/D:5000,SD0nRn,/P:2000/D:5000,SDEnRn,SDSYSn/N/X/E
                                ;       for generation of ".HEX" file.  Use MBASIC HXRCA to get ".RCA" file.
                                ;
                                ; USE: L18 /P:800/D:5000,SD0nRn,/P:2000/D:5000,SDEnRn,SDSYSn/N/E
                                ;       for generation of ".COM" file.  Use BURN to burn the PROMS.
                                ;
                                ;*******************************************************************************
                                ;
                                        EXTRN   DECPPC, INCPPC, JUMP,   SAVPPC, SETCLR
                                        EXTRN   HDGIN
                                ;
                                ;
                                ; THIS PAGE (100H LOCATIONS) ACTS AS A POINTER TO THE ACTUAL
                                :       EXTENDED SEQUENCER FUNCTIONS (PREFIX "E0") ON THE NEXT PAGE.
                                ;
                                ;
0000'  1C                       EXTE0:  INC PPC                 ; DECODE EXTENDED FUNCTION
0001'  0C                               LDN PPC
0002'  FA FC                            ANI 0FCH
0004'  AC                               PLO INTPC
                                ;
                                ;
                                        ORG (EXTE0 + 10H)
0010'  C0 0100'                 BATTRY: LBR BATT                ; PULSE MAIN BATTERY RELAYS  (E0 1n
                                ;                               ;   10 = Do Nothing
                                ;                               ;   11 = Relay 1
                                ;                               ;   12 = Relay 2
                                ;                               ;   13 = Relay 3
                                ;
                                ;
                                        ORG (EXTE0 + 24H)
0024'  C0 0123'                 PINGR:  LBR PINGRX              ; KEY TELEMETRY PINGER  (E0 2n)
                                ;                               ;   n = Telemetry Code ,where
                                ;                               ;   n = 0-F
                                ;
                                ;
                                        ORG (EXTE0 + 30H)
0030'  F8 B0                    ADON:   LDI ADFLG               ; A/D ON/OFF  (E0 3n)
0032'  C0 0000*                         LBR SETCLR              ;   30=A/D OFF -- 31=A/D ON
                                ;
                                ;
```

```
                                        ORG (EXTE0 + 40H)
0040'  F8 31            TRON:   LDI TRFLG           ; TRANSMISSOMETER ON/OFF  (E0 4n)
0042'  C0 0000*                 LBR SETCLR          ;   40=TRANS OFF -- 41=TRANS ON
                        ;
                        ;
                                        ORG (EXTE0 + 50H)
0050'  F8 32            SDON:   LDI RECFLG          ; RECORDER ON/OFF  (E0 5n)
0052'  C0 0000*                 LBR SETCLR          ;   50=REC OFF -- 51=REC ON
                        ;
                        ;
                                        ORG (EXTE0 + 60H)
0060'  C0 019B'         PMPS:   LBR PMPSX           ; STORE PUMP SPEED VALUES ON SPARE
                        ;
                        ;
                                        ORG (EXTE0 + 70H)
0070'  C0 013D'         TILT:   LBR TILTX           ;PITCH - ROLL CHECK (E0 70)
                        ;
                        ;
                                        ORG (EXTE0 + 80H)       ; E0 80-83
0080'  C0 01FD'         ROT:    LBR ROTX            ;   PLUME ROTATION CONTROLS
                        ;
                        ;
                                        ORG (EXTE0 + 84H)       ; E0 84-87
0084'  C0 01FD'                 LBR ROTX            ;   PLUME ROTATION CONTROLS
                        ;
                        ;
                                        ORG (EXTE0 + 90H)       ; E0 90-93
0090'  C0 0342'         XY:     LBR POSX            ;   PULSE X+, X-, Y+, Y- TRAVERSE PWR
                        ;
                        ;
                                        ORG (EXTE0 + 94H)       ; E0 94-97
0094'  C0 0342'         Z:      LBR POSX            ;   PULSE Z+, Z- TRAVERSE PWR
                        ;
                        ;
                                        ORG (EXTE0 + 98H)       ; E0 98-9B
0093'  C0 0342'         POSXY:  LBR POSX            ;   POSITION X OR Y TRAVERSE
                        ;
                        ;
                                        ORG (EXTE0 + 9CH)       ; E0 9C-9F
009C'  C0 0342'         POSZ:   LBR POSX            ;   POSITION Z TRAVERSE
                        ;
                        ;
                                        ORG (EXTE0 + 0A0H)      ; E0 A0-A3
00A0'  C0 0660'         SAM1:   LBR SAM1X           ;   WATER AND SEDIMENT SAMPLER #1
                        ;
                        ;
```

```
                                        ORG (EXTE0 + 0A4H)      ; E0 A4-A7
00A4'  C0 0691'                 SAM2:   LBR SAM2X               ;   WATER AND SEDIMENT SAMPLER #2
                                ;
                                ;
                                        ORG (EXTE0 + 0A8H)      ; E0 A8-AB
00A8'  C0 06C4'                 PUMP:   LBR PUMPX               ;   HYDRAULIC AND SUCTION PUMPS
                                ;                               ;   VEIW PORT CLEAN
                                ;
                                        ORG (EXTE0 + 0ACH)      ; E0 AC-AF
00AC'  C0 0701'                 FLUM:   LBR FLUMX               ;   FLUME INSERT AND WITHDRAW
                                ;                               ;   RECIRCULATE PUMPS
                                ;
                                        ORG (EXTE0 + 0C0H)      ; E0 C0
00C0'  C0 0730'                 FLASH:  LBR FLASHX              ;   TAKE A PICTURE
                                ;
                                ;
                                        ORG (EXTE0 + 0D0H)      ; E0 D0
00D0'  C0 0745'                 RLDV:   LBR RLDVX               ;   RESET LDV
                                ;
                                ;
                                        ORG (EXTE0 + 0F0H)
00F0'  C0 0753'                 IFSW:   LBR IFSWX               ; BRANCH IF SWITCH  (E0 Fn aaaa)
                                ;                               ;   n=switch  F0=Bottom contact switch
                                ;                               ;             F1=Flume insertion switches
                                ;                               ;             F2=Flume retracted switch
                                ;                               ;   aaaa = branch address
                                ;
                                ;
                                        ORG (EXTE0 + 0F8H)
00F8'  C0 0738'                 IFACU:  LBR IFACUX              ; BRANCH IF ACOUSTIC SIGNAL
                                ;
                                ;
                                ;
                                ; ***************************************************************
                                ;
                                        ORG EXTE0 + 100H
                                ;
                                ; THIS PAGE CONTAINS THE EXTENDED SEQUENCER FUNCTIONS PREFIXED
                                ;       WITH "E0".
                                ;
                                ;
                                ; ******************** E0 1n - PULSE BATTERY RELAYS ********************
                                ;
                                ;
0100'  E1                       BATT:   SEX INTPC
0101'  61                               OUT GROUP       ; SET I/O GROUP = 0
```

```
                0102'  00                       DB 00
                0103'  0C                       LDN PPC
                0104'  FA 03                    ANI 03          ; DECIDE IF BATTERY 1,2,OR 3
                0106'  FB 01                    XRI 01          ;       E0 10 = Do Nothing
                0108'  32 14'                   BZ BATT1        ;       E0 11 = BATTERY 1
                010A'  FB 03                    XRI (01 XOR 02)
                010C'  32 18'                   BZ BATT2        ;       E0 12 = BATTERY 2
                010E'  FB 01                    XRI (02 XOR 03)
                0110'  32 1C'                   BZ BATT3        ;       E0 13 = BATTERY 3
                0112'  30 20'                   BR BATTXT       ;       EXIT IF NOT 1,2, OR 3
                                        ;
                0114'  62               BATT1:  OUT BAT1        ; BATTERY RELAY 1
                0115'  00                       DB 00           ;   Conn. M - Pin 3
                0116'  30 20'                   BR BATTXT       ;   Relay Pod 1
                                        ;
                0118'  63               BATT2:  OUT BAT2        ; BATTERY RELAY 2
                0119'  00                       DB 00           ;   Conn. M - Pin 4
                011A'  30 20'                   BR BATTXT       ;   Relay Pod 1
                                        ;
                011C'  64               BATT3:  OUT BAT3        ; BATTERY RELAY 3
                011D'  00                       DB 00           ;   Conn. M - Pin 5
                011E'  30 20'                   BR BATTXT       ;   Relay Pod 1
                                        ;
                0120'  C0 0000*         BATTXT: LBR INCPPC
                                        ;
                                        ;
                                        ;
                                        ; ***************** E0 24 - TELEMETRY PINGER CONTROL ******************
                                        ;
                                        ;
                0123'  F8 68            PINGRX: LDI PPCCNT      ; PING CODE nn (nn = 00-0F) MUST BE ON ASTK
                0125'  A7                       PLO GPAGE       ;   CYCLES FOR 30 SEC. (Conn. M - Pin 8)
                0126'  07                       LDN GPAGE
                0127'  3A 37'                   BNZ PNGAGN      ; IF FIRST TIME, SET CNTR
                0129'  F8 1E                    LDI 30          ;   FOR 30 PING CYCLES
                012B'  57                       STR GPAGE
                                        ;
                012C'  F8 81                    LDI ACSTAT      ;STORE PING CODE IN HI NIBBLE ACSTAT
                012E'  A7                       PLO GPAGE
                012F'  E7                       SEX GPAGE
                0130'  0E                       LDN ASTK
                0131'  FE                       SHL
                0132'  FE                       SHL
                0133'  FE                       SHL
                0134'  FE                       SHL
                0135'  F1                       OR
```

```
 231    0136'  57                        STR GPAGE
 232                                    ;
 233    0137'  E1                       PNGAGN: SEX INTPC       ; SET GROUP 00
 234    0138'  61                              OUT GROUP
 235    0139'  00                              DB 00
 236    013A'  F8 19                           LDI CYCLES
 237    013C'  A7                              PLO GPAGE
 238    013D'  07                              LDN GPAGE
 239    013E'  FB 01                           XRI 01                  ; CYCLES = 1 ?
 240    0140'  32 64'                          BZ PNGCY1
 241    0142'  FB 04                           XRI (01 XOR 05)         ;       = 5 ?
 242    0144'  32 80'                          BZ PNGCY2
 243    0146'  FB 0C                           XRI (05 XOR 09)         ;       = 9 ?
 244    0148'  32 89'                          BZ PNGCY3
 245    014A'  FB 04                           XRI (09 XOR 0DH)        ;       = D ?
 246    014C'  32 92'                          BZ PNGCY4
 247    014E'  FB 1C                           XRI (0DH XOR 11H)       ;       = 11?
 248    0150'  3A 6C'                          BNZ PNGXT1              ; IF NOT GO TO PINGER EXIT !
 249                                    ;
 250    0152'  0E                       PNGCY5: LDN ASTR        ; LAST PING IN GROUP
 251    0153'  FA 01                           ANI 01
 252    0155'  32 59'                          BZ $+4          ; 'TO PING OR NOT TO PING?'
 253    0157'  67                              OUT PING
 254    0158'  00                              DB 00
 255                                    ;
 256    0159'  F8 68                           LDI PPCONT
 257    015B'  A7                              PLO GPAGE
 258    015C'  07                              LDN GPAGE
 259    015D'  FF 01                           SMI 01          ; DECREMENT PING CYCLE COUNT
 260    015F'  57                              STR GPAGE       ;       GO TO NEXT PPC IF DONE
 261    0160'  32 6F'                          BZ PNGXT2       ;       IF NOT, DO ANOTHER PING CYCLE
 262    0162'  30 6C'                          BR PNGXT1
 263                                    ;
 264    0164'  67                       PNGCY1: OUT PING        ; 1st. PING CYCLE ALWAYS PINGS
 265    0165'  00                              DB 00
 266    0166'  F8 67                           LDI SEQRATE     ; SET SEQ RATE TO EVERY 4 CYC
 267    0168'  A7                              PLO GPAGE
 268    0169'  F8 3F                           LDI 3FH         ;   (3FH = EVERY 4th CYC)
 269    016B'  57                              STR GPAGE
 270                                    ;
 271                                    ;
 272    016C'  C0 0000*                 PNGXT1: LBR DECPPC      ; POINT PPC TO RUN AGAIN
 273                                            ;       AND EXIT SEQUENCER
 274                                    ;
 275                                    ;
 276    016F'  F8 67                    PNGXT2: LDI SEQRATE     ; SET SEQ. RATE TO ONLY CYCLE #1
```

```
                                        PLO GPAGE
                                        LDI 00
                                        STR GPAGE
                                ;
                                        LDI ACSTAT      ; CLEAR HI NIBBLE OF ACSTAT
                                        PLO GPAGE
                                        LDN GPAGE
                                        ANI 0FH
                                        STR GPAGE
                                ;
                                        INC ASTK        ; CLEAR PING CODE FROM SEQUENCER ASTK
                                        LBR INCPPC      ;       AND EXIT SEQUENCER
                                ;
                                ;
                                PNGCY2: LDN ASTK        ; PING?
                                        ANI 08
                                        BZ $+4
                                        OUT PING
                                        DB 00
                                        BR PNGXT1       ; EXIT SEQ. FOR 100mSEC.
                                ;
                                PNGCY3: LDN ASTK        ; PING?
                                        ANI 04
                                        BZ $+4
                                        OUT PING
                                        DB 00
                                        BR PNGXT1       ; EXIT FOR 100mSEC.
                                ;
                                PNGCY4: LDN ASTK        ; PING?
                                        ANI 02
                                        BZ $+4
                                        OUT PING
                                        DB 00
                                        BR PNGXT1       ; EXIT FOR 100mSEC.
                                ;
                                ;
                                ;***************** ED 60 - STORE PUMP VALUES ON GOBAL PAGE ********************
                                ;
                                PMPSX:  LDI PUMP1       ;SET GPAGE TO PUMP1
                                        PLO GPAGE
                                        LDN PPC
                                        ANI 03
                                        BZ PMPS0
                                        XRI 01
                                        BZ PMPS1
                                        XRI (01 XOR 02)
```

```
 323   01A9'  32 AE'                    BZ PMPS2
 324   01AB'  C0 0000*                  LBR INCPPC
 325                                    ;
 326   01AE'  17                        PMPS2:  INC GPAGE       ;SET GPAGE TO PUMP2
 327                                    ;
 328   01AF'  1C                        PMPS1:  INC PPC         ;STORE PUMP SPEED VALUE
 329   01B0'  0C                                LDN PPC
 330   01B1'  57                                STR GPAGE
 331   01B2'  C0 0000*                          LBR INCPPC
 332                                    ;
 333   01B5'  F8 00                     PMPS0:  LDI 00          ;SET PUMP1,2 = 00
 334   01B7'  57                                STR GPAGE
 335   01B8'  17                                INC GPAGE
 336   01B9'  57                                STR GPAGE
 337   01BA'  C0 0000*                          LBR INCPPC
 338                                    ;
 339                                    ;
 340                                    ;********************** SO 70 - PITCH AND ROLL CHECK **************************
 341                                    ;
 342   01BD'  0C                        TILTX:  LDN PPC         ;READ PPC
 343   01BE'  FA 03                             ANI 03          ;MASK FOR LO 3 BITS
 344   01C0'  CA 0000*                          LBNZ INCPPC     ;RETURN IF NOT = 70
 345                                    ;
 346   01C3'  F8 67                             LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
 347   01C5'  A7                                PLO GPAGE       ;   ACOUSTIC ERROR MESSAGE GENERATED
 348   01C6'  07                                LDN GPAGE       ;   BY THIS PPC (SEQRAT = 8FH)
 349   01C7'  FB 8F                             XRI 08FH
 350   01C9'  C2 0123'                          LBZ PINGRX      ;   IF SO, GO TO THE PINGER ROUTINE
 351                                    ;
 352   01CC'  2E                                DEC ASTX        ;DEC ASTX (USED TO SEND PINGER CODE)
 353                                    ;
 354   01CD'  F8 89                             LDI PITCH                       ;CHECK PITCH (1BIT = .50 DEG)
 355   01CF'  A7                                PLO GPAGE                       ;TLEVEL = VERTICAL = 8A
 356   01D0'  07                                LDN GPAGE                       ;TLIMIT = TILT LIMIT IN DEG.
 357   01D1'  FF 4E                             SMI (TLEVEL-(TLIMIT * 2))       ;CHECK FOR UNDER LIMIT
 358   01D3'  3B F0'                            BNF TILERR
 359   01D5'  FF 18                             SMI (TLIMIT * 4)                ;CHECK FOR OVER LIMIT
 360   01D7'  33 F0'                            BDF TILERR
 361                                    ;
 362   01D9'  17                                INC GPAGE                       ;SET GPAGE = ROLL
 363   01DA'  07                                LDN GPAGE                       ;CHECK ROLL
 364   01DB'  FF 4E                             SMI (TLEVEL-(TLIMIT * 2))       ;CHECK FOR UNDER LIMIT
 365   01DD'  3B F0'                            BNF TILERR
 366   01DF'  FF 18                             SMI (TLIMIT * 4)                ;CHECK FOR OVER LIMIT
 367   01E1'  33 F0'                            BDF TILERR
 368                                    ;
```

```
                                TILTOK: LDI ERROR       ;SET TILT BIT OF ERROR WORD = 0
01E3'  F8 80                            PLO GPAGE
01E5'  A7                               LDN GPAGE
01E6'  07                               ANI 0DFH                ;TILT BIT = BIT 5
01E7'  FA DF                            STR GPAGE
01E9'  57                       ;
                                        LDI 0CH         ;LOAD ASTK WITH "TILT OK" CODE
01EA'  F8 0C                            STR ASTK
01EC'  5E                               LBR PINGRX      ;SEND "TILT OK" ("C")
01ED'  C0 0123'                 ;
                                TILERR: LDI ERROR       ;SET TILT BIT OF ERROR WORD = 1
01F0'  F8 80                            PLO GPAGE
01F2'  A7                               LDN GPAGE
01F3'  07                               ORI 20H         ;TILT BIT = BIT 5
01F4'  F9 20                            STR GPAGE
01F6'  57                       ;
                                        LDI 0DH         ;LOAD ASTK WITH "TILT BAD" CODE
01F7'  F8 0D                            STR ASTK
01F9'  5E                               LBR PINGRX      ;SEND "TILT BAD" ("D")
01FA'  C0 0123'                 ;
                                ;
                                ;
                                ;
                                ;********************** 80 8n - PLUME ROTATION CONTROL ************************
                                ;
01FD'  F8 67                    ROTX:   LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
01FF'  A7                               PLO GPAGE       ;   ACOUSTIC ERROR MESSAGE GENERATED
0200'  07                               LDN GPAGE       ;   BY THIS PPC (SEQRAT = 8FH)
0201'  F3 8F                            XRI 08FH
0203'  C2 0123'                         LBZ PINGRX      ;   IF SO, GO TO THE PINGER ROUTINE
                                ;
0206'  0C                               LDN PPC
0207'  FA 03                            ANI 03
0209'  C2 0223'                         LBZ RCW         ;E0 80  ROTATE CW
020C'  FB 01                            XRI 01
020E'  C2 022B'                         LBZ RCCW        ;E0 81  ROTATE CCW
0211'  FB 03                            XRI (01 XOR 02)
0213'  C2 0233'                         LBZ ROTRTN      ;E0 82  ROTATE TO TRANSPORT POSITION
0216'  FB 01                            XRI (02 XOR 03)
0218'  C2 027D'                         LBZ ROTHDG      ;E0 83  ROTATE TO EXPERIMENT POSITION
0213'  FB 07                            XRI (03 XOR 04)
021D'  C2 02D1'                         LBZ ROTCOR      ;E0 84  ROTATE TO CORE POSITION
0220'  C0 0000*                 ROTXT:  LBR INCPPC
                                ;
                                ;
0223'                           RCW:    SCAL R6, PULSE  ;PULSE ROTATE CW RELAY
```

```
 415    0223'  68 36        +
 416    0225'  07B6'        +
 417    0227'  14                   DB 24Q
 418    0228'  08                   DB 08H          ;3 CYCLES = 200 mSec. Pulse
 419    0229'  30 20'               BR ROTXT
 420                        ;
 421                        ;
 422    022B'               RCCW:   SCAL R6, PULSE  ;PULSE ROTATE CCW RELAY
 423    022B'  68 36        +
 424    022D'  07B6'        +
 425    022F'  15                   DB 25Q
 426    0230'  08                   DB 08H          ;3 CYCLES = 200 mSec. Pulse
 427    0231'  30 20'               BR ROTXT
 428                        ;
 429                        ;
 430                        ;****************** ROTATE TO "TRANSPORT" POSITION - E0 82 ********************
 431                        ;
 432    0233'  F8 68        ROTRTN: LDI PPCCNT      ;1st TIME THRU THE PPC ?
 433    0235'  A7                   PLO GPAGE
 434    0236'  07                   LDN GPAGE
 435    0237'  CA 0254'             LBNZ ROTON      ;  IF NOT;  GO TO XON
 436                        ;
 437                        ;                       ;ELSE:
 438    023A'  F8 35        ROT00:  LDI HDG         ; GET CURRENT HEADING
 439    023C'  A7                   PLO GPAGE
 440    023D'  07                   LDN GPAGE
 441                        ;
 442    023E'  2E                   DEC ASTK        ;STORE CURRENT HEADING IN ASTK
 443    023F'  5E                   STR ASTK        ;   (NOT USED BUT THE ASTK GETS INCREMENTED
 444                        ;                       ;   LATER AND MUST BE DECREMENTED HERE)
 445    0240'  FF FD                SMI 0FDH        ;TRANSPORT POS. = FD, FE, FF    SMI=> D-M(R(P))->DF,D
 446    0242'  C3 02E4'             LBDF ROTXT2
 447                        ;
 448    0245'  E2                   SEX STACK       ; SET UP INITIAL PARAMETERS
 449                                SCAL R6, ROT0
 450    0246'  68 36        -
 451    0248'  02FD'        +
 452                        ;
 453    024A'  E2                   SEX STACK
 454                                SCAL R6, PULSE  ; PULSE ROTATION-CW RELAY TO START ROTATION
 455    024B'  68 36        +
 456    024D'  07B6'        +
 457    024F'  14                   DB 24Q          ;  24Q = ROT-CW Relay
 458    0250'  04                   DB 04H          ;  100 mSec. Pulse
 459                        ;
 460    0251'  C0 02E8'             LBR ROTXT1      ; EXIT THE ROUTINE
```

```
                                ;
                                ;
0254'  E2                       ROTON:  SEX STACK
                                        SCAL R6, HDGIN  ; READ THE CURRENT HEADING ,STORE AT GP = HDG
0255'  68 86            +
0257'  0000*            +
                                ;
0259'  F8 85                            LDI HDG
025B'  A7                               PLO GPAGE
025C'  07                               LDN GPAGE       ;TRANSPORT POS. = FD, FE, FF
025D'  FF FD                            SMI 0FDH        ;                               SMI=> D-M(R(P))->DF,D
025F'  33 73'                           BDF ROTOOK      ;IF AT TRANSPORT POSITION, GO TO ROTOOK
                                ;
                                ;                       ;IF NOT:
0261'  E2                               SEX STACK       ;   GO TO ROTATION TIMEOUT SUBROUTINE
                                        SCAL R6, RCNT
0262'  68 86            +
0264'  0326'            +
                                ;                       ;TIMEOUT ROUTINE USUALLY RETURNS HERE
0266'  C0 02E3'                        LBR ROTXT1
                                ;                       ;TIMEOUT ROUTINE RETURNS HERE IF TIME OUT IS REACHED
                                ;
0269'  E2                       ROTOER: SEX STACK       ;PULSE ROT-CW RELAY TO STOP ROTATION
                                        SCAL R6, PULSE
026A'  68 86            +
026C'  0736'            +
026E'  14                               DB 24Q
026F'  08                               DB 08H
0270'  C0 02EB'                        LBR ROTERR      ;GO TO ROTATION ERROR ROUTINE
                                ;
                                ;
0273'  E2                       ROTOOK: SEX STACK       ;PULSE ROT-CW RELAY TO STOP ROTATION
                                        SCAL R6, PULSE
0274'  68 86            +
0276'  0736'            +
0278'  14                               DB 24Q
0279'  08                               DB 08H
027A'  C0 02DF'                         LBR ROTOK       ;GO TO ROTATION OK ROUTINE
                                ;
                                ;
                                ;
                                ;****************** ROTATE TO POSITION FOR EXPERIMENT - E0 83 ******************
                                ;
027D'  F8 68                    ROTHDG: LDI PPCCNT      ;1st TIME THRU THE PPC ?
027F'  A7                               PLO GPAGE
0280'  07                               LDN GPAGE
```

```
 307    0281'  3A A7'                    BNZ ROTHN       ;  IF NOT;  GO TO ROTHN
 308                                    ;
 309                                    ;                ;ELSE:
 310    0283'  F8 84                    ROTH0:  LDI CMPSS       ; GET CURRENT COMPASS READING
 311    0285'  A7                               PLO GPAGE
 312    0286'  07                               LDN GPAGE
 313    0287'  AA                               PLO RA          ; STORE CMPSS READING IN R(A.0)
 314    0288'  E7                               SEX GPAGE
 315    0289'  F8 BF                            LDI HDGEXP      ; GET THE HEADING FOR THE EXPERIMENT
 316    028B'  A7                               PLO GPAGE       ;       HEADING = DIRECTION FLOW COMES FROM
 317    028C'  8A                               GLO RA
 318    028D'  F5                               SD              ; SD=> M(R(X)) - D -> DF,D
 319                                    ;                       ;       HDGEXP - CMPS = -> HDGFINAL
 320                                    ;
 321    028E'  2E                       ROTH?:  DEC ASTK
 322    028F'  5E                               STR ASTK        ; STORE FINAL HEADING (H final) ON SEQUENCER ASTK
 323                                    ;
 324    0290'  FF 33                            SMI 33H         ;                               SMI=> D-M R.P(X)->DF.D
 325    0292'  3B B4'                           BNF ROTXT2      ; EXIT IF NEW HEADING < 2H  4.0 DEG
 326                                    ;
 327    0294'  FF FA                            SMI 0FAH        ;                               SMI=> D-M(R.P  )->DF.D
 328    0296'  C3 02E4'                         LBDF ROTXT2     ; EXIT IF NEW HEADING > FOH
 329                                    ;
 330                                    ;
 331    0299'  E2                               SEX STACK       ; SET UP INITIAL PARAMETERS
 332                                            SCAL R6, ROTO
 333    029A'  68 36            -
 334    029C'  02ED'            -
 335                                    ;
 336    029E'  E2                               SEX STACK
 337                                            SCAL R6, PULSE  ; PULSE ROT-CCW RELAY TO START ROTATION
 338    029F'  68 36            -
 339    02A1'  07B6'            -
 340    02A3'  15                               DB 15Q          ;  15Q = CCW Rotation Relay
 341    02A4'  04                               DB 04H          ;  100 mSec. Pulse
 342    02A5'  30 E8'                           BR ROTXT1       ; EXIT THE ROUTINE
 343                                    ;
 344                                    ;
 345    02A7'  E2                       ROTHN:  SEX STACK
 346                                            SCAL R6, HDGIN  ; READ CURRENT HEADING  H now , STORE AT SP = HDG
 347    02A8'  68 36            -
 348    02AA'  0030*            -
 349                                    ;
 350    02AC'  F8 85                            LDI HDG
 351    02AE'  A7                               PLO GPAGE
 352    02AF'  07                               LDN GPAGE       ;    H now -> D
```

```
                                ;
02B0'  EE                       SEX ASTK        ;   H final -> ASTK
                                ;
                                ;               ;COMPARE H final WITH H now
02B1'  F5                       SD              ;   (H final - (H now) -> D
                                ;
02B2'  C3 02C7'                 LBDF ROTHOK     ;IF AT PROPER POSITION, GO TO ROTHOK
                                ;
                                ;               ;IF NOT:
02B5'  E2                       SEX STACK       ;   GO TO ROTATION TIMEOUT SUBROUTINE
                                SCAL R6, RCNT
02B6'  68 86            -
02B8'  0326'            -
                                ;               ;TIMEOUT ROUTINE USUALLY RETURNS HERE
02BA'  C0 02E8'                 LBR ROTXT1
                                ;               ;TIMEOUT ROUTINE RETURNS HERE IF TIME OUT IS REACHED
                                ;
02BD'  E2               ROTHER: SEX STACK       ;PULSE ROT-CCW RELAY TO STOP ROTATION
                                SCAL R6, PULSE
02BE'  68 86            -
02C0'  07B6'            -
02C2'  19                       DB 25Q
02C3'  08                       DB 08H
02C4'  C0 02EB'                 LBR ROTERR
                                ;
02C7'  E2               ROTHOK: SEX STACK       ;PULSE ROT-CCW RELAY TO STOP ROTATION
                                SCAL R6, PULSE
02C8'  68 86            -
02CA'  07B6'            -
02CC'  19                       DB 25Q
02CD'  08                       DB 08H
02CE'  C0 02DF'                 LBR ROTOK       ;GO TO ROTATION OK ROUTINE
                                ;
                                ;
                                ;****************** ROTATE TO "CORE" POSITION - ED 40 **********************
                                ;
02D1'  F8 68            ROTCOR: LDI PPCCNT      ;1st TIME THRU THE PPC ?
02D3'  A7                       PLO GPAGE
02D4'  07                       LDN GPAGE
02D5'  3A A7'                   BNZ ROTHN       ;  IF NOT;  GO TO ROTHN
                                ;
                                ;               ;ELSE:
02D7'  F8 85            ROTCO:  LDI HDG         ; GET CURRENT HEADING
02D9'  A7                       PLO GPAGE
02DA'  07                       LDN GPAGE
02DB'  FF 20                    SMI 20H         ; FIND CORE HEADING
```

```
                                        ;                       ;       HDGNOW - 20H = -) HDGCORE
                                        ;
02DD'   30 3E'                          BR ROTH?        ; GO TO ROTH?
                                        ;
                                        ;
                                        ;
                                        ;******** ROTATION - COMMON EXIT POINTS ********
                                        ;
02DF'   E2                              ROTOK:  SEX STACK
                                                SCAL R6, ROT1   ;CLEAR PARAMETERS
02E0'   68 36           +
02E2'   0316'           +
                                        ;
02E4'   1E                              ROTXT2: INC ASTK
02E5'   C0 0000*                                LBR INCPPC
                                        ;
                                        ;
02E8'   C0 0000*                        ROTXT1: LBR DECPPC
                                        ;
02EB'   F8 80                           ROTERR: LDI ERROR       ;SET ROTATION ERROR CODE IN ERROR WORD
02ED'   A7                                      PLO GPAGE
02EE'   07                                      LDN GPAGE
02EF'   F9 40                                   ORI 40H         ;ROTATION ERROR CODE = BIT 6
02F1'   57                                      STR GPAGE
                                        ;
02F2'   E2                                      SEX STACK       ;CLEAR PARAMETERS
                                                SCAL R6, ROT1
02F3'   68 36           +
02F5'   0316'           +
                                        ;
02F7'   F8 0B                                   LDI 0BH         ;LOAD ASTK WITH ERROR CODE (Stk position is
02F9'   5E                                      STR ASTK        ; not changed; pinger will clear and increment)
02FA'   C0 0123'                                LBR PINGRX      ;SEND PINGER ROTATION ERROR CODE ("3")
                                        ;
                                        ;
                                        ;
                                        ;******** ROTATION SUBROUTINES ********
                                        ;
02FD'   F8 B3                           ROT0:   LDI HDGFLG      ; SET HDG FLAG = AC FOR THIS SEQUENCE
02FF'   A7                                      PLO GPAGE       ;   (TURNS ON ROTATION ENCODER PWR)
0300'   F8 AC                                  LDI 0ACH
0302'   57                                      STR GPAGE
                                        ;
0303'   F8 80                                   LDI ERROR       ; SET ERROR WORD BIT 6 = 0
0305'   A7                                      PLO GPAGE
0306'   07                                      LDN GPAGE
```

```
                0307'  FA 3F                    ANI 0BFH
                0309'  57                       STR GPAGE
                                        ;
                030A'  F8 68                    LDI PPCCNT      ; SET PPCCNT TO 01
                030C'  A7                       PLO GPAGE
                030D'  F8 01                    LDI 01
                030F'  57                       STR GPAGE
                                        ;
                0310'  27                       DEC GPAGE       ; SET SEQRAT TO RUN EVERY FORTH CYCLE
                0311'  F8 82                    LDI 82H         ;  (EVERY 100 mSEC.)
                0313'  57                       STR GPAGE
                                        ;
                                        ;
                0314'  68 96            +       SRET R6         ;RETURN FROM SUBROUTINE
                                        ;
                                        ;
                0316'  F8 68            ROT1:   LDI PPCCNT      ;CLEAR PPC COUNT
                0318'  A7                       PLO GPAGE
                0319'  F8 00                    LDI 00
                031B'  57                       STR GPAGE
                                        ;
                031C'  27                       DEC GPAGE       ;CLEAR SEQUENCER RATE
                031D'  57                       STR GPAGE
                                        ;
                031E'  F8 33                    LDI HDGFLG      ;RESET HDG FLAG = 00
                0320'  A7                       PLO GPAGE
                0321'  F8 00                    LDI 00
                0323'  57                       STR GPAGE
                                        ;
                0324'  68 96            +       SRET R6         ;RETURN FROM SUBROUTINE
                                        ;
                                        ;
                                        ;
                                        ;******** ROTATION - TIMEOUT CHECK SUBROUTINE ********
                                        ;
                0326'  F8 19            RCNT:   LDI CYCLES      ;INCREMENT PPC COUNT ONCE PER SEC.
                0328'  A7                       PLO GPAGE       ;   AT CYCLES = 01
                0329'  07                       LDN GPAGE
                032A'  FB 01                    XRI 01
                032C'  3A 3B'                   BNZ RCNTX1      ; EXIT IF CYCLES NOT 01
                                        ;                       ; IF CYCLES = 01
                032E'  27                       DEC GPAGE       ; LOOK AT SEC1
                032F'  F6                       SHR
```

```
                                BDF RCNTX1      ;  EXIT IF SEC = ODD
                        ;
                                LDI PPCCNT      ;  INC PPCCNT IF SEC = EVEN
                                PLO GPAGE
                                LDN GPAGE
                                STR GPAGE
                                SMI TIME02      ;  EXIT IF PPC COUNT IS LESS THAN TIME02 LIMIT
                                BDF RCNTX2      ;  GO TO RCNTX2 IF PPC COUNT = OR GREATER THAN TIME02
                        ;
RCNTX1: SRET R6         ;RETURN FROM SUBROUTINE
                        ;
RCNTX2: INC R6          ;IF PPC COUNT = TIME LIMIT,
                                INC R6
                                INC R6
                                SRET R6         ;RETURN TO ROTATION ERROR SETUP
                        ;
                        ;
                        ;********************** E0 9n - X, Y, Z, TRAVERSE CONTROL ******************
                        ;
POSX:   SEX STACK               ;E0 90-9F
                                LDN PPC
                                ANI 0FH
                                LBZ PULXP               ;E0 90  Pulse X+ Relay
                                XRI 01
                                LBZ PULXN               ;E0 91  Pulse X- Relay
                                XRI (01 XOR 02)
                                LBZ PULYP               ;E0 92  Pulse Y+ Relay
                                XRI (02 XOR 03)
                                LBZ PULYN               ;E0 93  Pulse Y- Relay
                                XRI (03 XOR 04)
                                LBZ PULZP               ;E0 94  Pulse Z+ Relay
                                XRI (04 XOR 05)
                                LBZ PULZN               ;E0 95  Pulse Z- Relay
                                XRI (05 XOR 0AH)
                                LBZ X0                  ;E0 9A = Zero X Position
                                XRI (0AH XOR 0BH)
                                LBZ XINC                ;E0 9B = Increment X Position
                                XRI (0BH XOR 0CH)
                                LBZ Y0                  ;E0 9C = Zero Y Position
                                XRI (0CH XOR 0DH)
                                LBZ YINC                ;E0 9D = Increment Y Position
                                XRI (0DH XOR 0EH)
                                LBZ Z0                  ;E0 9E = Zero Z Position
                                XRI (0EH XOR 0FH)
```

```
 737    037D'  C2 05B4'                    LBZ ZINC              ;50 9F = Increment Y Position
 738    0380'  C0 0000*                    LBR INCPPC
 739                                ;
 740    0383'                       PULXP: SCAL R6, PULSE
 741    0383'  68 86          +
 742    0385'  07B6'          +
 743    0387'  18                          DB 30Q                ; Relay Driver 30Q = 18H = 24D
 744    0388'  08                          DB 08H                ; 8 CYCLES = 200mSec.
 745    0389'  C0 0000*                    LBR INCPPC
 746                                ;
 747    038C'                       PULXN: SCAL R6, PULSE
 748    038C'  68 86          +
 749    038E'  07B6'          +
 750    0390'  19                          DB 31Q
 751    0391'  08                          DB 08H
 752    0392'  C0 0000*                    LBR INCPPC
 753                                ;
 754    0395'                       PULYP: SCAL R6, PULSE
 755    0395'  68 86          +
 756    0397'  07B6'          +
 757    0399'  1A                          DB 32Q
 758    039A'  08                          DB 08H
 759    039B'  C0 0000*                    LBR INCPPC
 760                                ;
 761    039E'                       PULYN: SCAL R6, PULSE
 762    039E'  68 86          +
 763    03A0'  07B6'          -
 764    03A2'  1B                          DB 33Q
 765    03A3'  08                          DB 08H
 766    03A4'  C0 0000*                    LBR INCPPC
 767                                ;
 768    03A7'                       PULZP: SCAL R6, PULSE
 769    03A7'  68 86          +
 770    03A9'  07B6'          -
 771    03AB'  1C                          DB 34Q
 772    03AC'  08                          DB 08H
 773    03AD'  C0 0000*                    LBR INCPPC
 774                                ;
 775    03B0'                       PULZN: SCAL R6, PULSE
 776    03B0'  68 86          +
 777    03B2'  07B6'          +
 778    03B4'  1D                          DB 35Q
 779    03B5'  08                          DB 08H
 780    03B6'  C0 0000*                    LBR INCPPC
 781                                ;
 782                                ;
```

```
                                        ;
                                        ;****** ZERO THE X POSITION: SEQUENCER CODE = E0 9A ******
                                        ;
03B9'  F8 67                    X0:     LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
03BB'  A7                               PLO GPAGE       ;   ACOUSTIC ERROR MESSAGE GENERATED
03BC'  07                               LDN GPAGE       ;   BY THIS PPC (SEQRAT = 8FH)
03BD'  FB 8F                            XRI 08FH
03BF'  C2 0123'                         LBZ PINGRX      ;   IF SO, GO TO THE PINGER ROUTINE
                                        ;
03C2'  F8 68                            LDI PPCCNT      ;1st TIME THRU THE PPC ?
03C4'  A7                               PLO GPAGE
03C5'  07                               LDN GPAGE
03C6'  3A E4'                           BNZ X0N         ;  IF NOT;  GO TO X0N
                                        ;
                                        ;                       ;ELSE:
03C8'  F8 93                    X00:    LDI XPOS        ; CHECK CURRENT X POSITION
03CA'  A7                               PLO GPAGE
03CB'  07                               LDN GPAGE
03CC'  2E                               DEC ASTK        ; STORE CURRENT VALUE OF X POS. ON ASTK
03CD'  FA 0F                            ANI 0FH         ;     (NOT USED BUT THE ASTK GETS INCREMENTED
03CF'  5E                               STR ASTK        ;     LATER AND MUST BE DECREMENTED HERE)
03D0'  FA 08                            ANI 08H         ;CHECK ZERO POSITION BIT (MSB OF LO NIBBLE)
03D2'  CA 061E'                         LBNZ POSXT2     ; IGNORE AND EXIT IF ZERO POSITION BIT= 0
                                        ;
03D5'  E2                               SEX STACK       ; SET UP INITIAL PARAMETERS
                                        SCAL R6, POS0
03D6'  68 86            +
03D8'  0637'            +
                                        ;
03DA'  E2                               SEX STACK       ; PULSE X- RELAY to start
                                        SCAL R6, PULSE  ; the traverse
03DB'  68 86            +
03DD'  07B6'            +
03DF'  19                               DB 31Q          ;  31Q = X- Relay
03E0'  34                               DB 34H          ;  100 mSec. Pulse
                                        ;
03E1'  C0 0622'                         LBR POSXT1      ; EXIT THE ROUTINE
                                        ;
                                        ;
03E4'  E1                       X0N:    SEX INTPC       ;READ X POSITION OPTO INTERRUPTERS
03E5'  61                               OUT GROUP       ;GROUP 00
03E6'  00                               DB 00
03E7'  F8 93                            LDI XPOS
03E9'  A7                               PLO GPAGE
03EA'  E7                               SEX GPAGE
03EB'  6B                               INP X           ;INPUT X POSITION
```

```
 829    03EC'  FA 08                    ANI 08H         ;CHECK X ZERO POSITION BIT
 830    03EE'  CA 0410'                 LBNZ X00K       ;IF AT ZERO POSITION, GO TO X00K
 831                                    ;               ;IF NOT:
 832    03F1'  F8 19                    LDI CYCLES      ;   INCREMENT PPC COUNT ONCE PER SEC.
 833    03F3'  A7                       PLO GPAGE       ;   AT CYCLES= 01
 834    03F4'  07                       LDN GPAGE
 835    03F5'  FB 01                    XRI 01
 836    03F7'  CA 0622'                 LBNZ POSXT1     ;  EXIT IF CYCLES NOT 01
 837    03FA'  F8 68                    LDI PPCCNT      ;   INC PPCCNT
 838    03FC'  A7                       PLO GPAGE
 839    03FD'  07                       LDN GPAGE
 840    03FE'  FC 01                    ADI 01
 841    0400'  57                       STR GPAGE
 842    0401'  FB 78                    XRI (TIME01 * 2);  IF PPC COUNT NOT = (TIME01 * 2) LIMIT
 843    0403'  CA 0622'                 LBNZ POSXT1     ;   THEN EXIT
 844                                    ;
 845                                    ;
 846    0406'  E2                       X0ERR:  SEX STACK       ;PULSE X- RELAY TO STOP TRAVERSE
 847                                            SCAL R6, PULSE
 848    0407'  68 86            +
 849    0409'  07B6'            +
 850    040B'  19                               DB 31Q
 851    040C'  08                               DB 08H
 852    040D'  C0 0625'                         LBR POSERR      ;GO TO POSITION ERROR ROUTINE
 853                                    ;
 854                                    ;
 855    0410'  E2                       X00K:   SEX STACK       ;PULSE X- RELAY TO STOP TRAVERSE
 856                                            SCAL R6, PULSE
 857    0411'  68 86            +
 858    0413'  07B6'            +
 859    0415'  19                               DB 31Q
 860    0416'  08                               DB 08H
 861                                    ;
 862    0417'  C0 0619'                         LBR POSOK
 863                                    ;
 864                                    ;
 865                                    ;
 866                                    ;******** INCREMENT X POSITION: SEQUENCER CODE = 20 9B ********
 867                                    ;
 868    041A'  F8 67                    XINC:   LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
 869    041C'  A7                               PLO GPAGE       ;   ACOUSTIC ERROR MESSAGE GENERATED
 870    041D'  07                               LDN GPAGE       ;   BY THIS PPC (SEQRAT = 8FH)
 871    041E'  FB 8F                            XRI 08FH
 872    0420'  C2 0123'                         LBZ PINGRX      ;   IF SO, GO TO THE PINGER ROUTINE
 873                                    ;
 874    0423'  F8 68                            LDI PPCCNT      ;1st TIME THRU THE PPC ?
```

```
 875    0425'  A7                          PLO GPAGE
 876    0426'  07                          LDN GPAGE
 877    0427'  CA 0446'                    LBNZ XINCN      ;  IF NOT;  GO TO XINCN
 878                                ;
 879                                ;                      ;ELSE:
 880    042A'  F8 93                XINC0: LDI XPOS        ; CHECK CURRENT POSITION
 881    042C'  A7                          PLO GPAGE
 882    042D'  07                          LDN GPAGE
 883    042E'  2E                          DEC ASTK
 884    042F'  FA 07                       ANI 07          ; MASK OUT UNUSED HI NIBBLE AND ZERO (RESET) BIT
 885    0431'  5E                          STR ASTK        ; STORE ON SEQUENCER ASTK
 886    0432'  FF 07                       SMI 07
 887    0434'  C3 061E'                    LBDF POSXT2     ; IGNORE AND EXIT IF POSITION >= 7
 888                                ;
 889    0437'  E2                          SEX STACK       ; SET UP INITIAL PARAMETERS
 890                                       SCAL R6, POS0
 891    0438'  68 86           +
 892    043A'  0637'           +
 893                                ;
 894    043C'  E2                          SEX STACK       ; PULSE X+ RELAY to start
 895                                       SCAL R6, PULSE  ; the traverse
 896    043D'  68 36           +
 897    043F'  07B6'           +
 898    0441'  18                          DB 30Q          ;  30Q = X+ Relay
 899    0442'  04                          DB 04H          ;  100 mSec. Pulse
 900                                ;
 901    0443'  C0 0622'                    LBR POSXT1      ; EXIT THE ROUTINE
 902                                ;
 903                                ;
 904    0446'  E1                  XINCN:  SEX INTPC       ;READ X POSITION OPTO INTERRUPTERS
 905    0447'  61                          OUT GROUP       ;GROUP 00
 906    0448'  00                          DB 00
 907    0449'  F8 93                       LDI XPOS
 908    044B'  A7                          PLO GPAGE
 909    044C'  E7                          SEX GPAGE
 910    044D'  6B                          INP X           ;INPUT X POSITION
 911    044E'  FA 07                       ANI 07H         ;Mask null bits "0" position bit
 912    0450'  E2                          SEX STACK
 913    0451'  52                          STR STACK
 914    0452'  0E                          LDN ASTK        ;GET THE ORIGIONAL X VALUE FOR THE ASTK
 915    0453'  FC 01                       ADI 01
 916    0455'  F3                          XOR             ;(X POS) XOR (OLD POS + 1)
 917    0456'  C2 0478'                    LBZ XINCOK      ;IF AT NEXT POSITION, GO TO XINCOK
 918                                ;                      ;IF NOT:
 919    0459'  F8 19                       LDI CYCLES      ;   INCREMENT PPC COUNT ONCE PER SEC.
 920    045B'  A7                          PLO GPAGE       ;   AT CYCLES= 01
```

```
 921    045C'  07                        LDN GPAGE
 922    045D'  FB 01                     XRI 01
 923    045F'  CA 0622'                  LBNZ POSXT1     ; EXIT IF CYCLES NOT 01
 924    0462'  F8 68                     LDI PPCCNT      ;  INC PPCCNT
 925    0464'  A7                        PLO GPAGE
 926    0465'  07                        LDN GPAGE
 927    0466'  FC 01                     ADI 01
 928    0468'  57                        STR GPAGE
 929    0469'  FB 3C                     XRI TIME01      ; IF PPC COUNT NOT = TIME01 LIMIT
 930    046B'  CA 0622'                  LBNZ POSXT1     ;  THEN EXIT
 931                                  ;
 932                                  ;
 933    046E'  E2                     XINCER: SEX STACK      ;PULSE X+ RELAY TO STOP TRAVERSE
 934                                        SCAL R6, PULSE
 935    046F'  68 86          +
 936    0471'  07B6'          +
 937    0473'  18                          DB 30Q
 938    0474'  08                          DB 08H
 939    0475'  C0 0625'                    LBR POSERR
 940                                  ;
 941    0478'  E2                     XINCOK: SEX STACK      ;PULSE X+ RELAY TO STOP TRAVERSE
 942                                        SCAL R6, PULSE
 943    0479'  68 86          +
 944    047B'  07B6'          +
 945    047D'  18                          DB 30Q
 946    047E'  08                          DB 08H
 947    047F'  C0 0619'                    LBR POSOK
 948                                  ;
 949                                  ;
 950                                  ;
 951                                  ;****** ZERO THE Y POSITION: SEQUENCER CODE = E0 9C ******
 952                                  ;
 953    0482'  F8 67                  Y0:     LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
 954    0484'  A7                             PLO GPAGE       ;  ACOUSTIC ERROR MESSAGE GENERATED
 955    0485'  07                             LDN GPAGE       ;  BY THIS PPC (SEQRAT = 8FH)
 956    0486'  FB 8F                          XRI 08FH
 957    0488'  C2 0123'                       LBZ PINGRX      ;  IF SO, GO TO THE PINGER ROUTINE
 958                                  ;
 959    048B'  F8 68                          LDI PPCCNT      ;1st TIME THRU THE PPC ?
 960    048D'  A7                             PLO GPAGE
 961    048E'  07                             LDN GPAGE
 962    048F'  CA 04AD'                       LBNZ Y0N        ;  IF NOT;  GO TO YINCN
 963                                  ;
 964                                  ;                       ;ELSE:
 965    0492'  F8 94                  Y00:    LDI YZPOS       ; CHECK CURRENT POSITION
 966    0494'  A7                             PLO GPAGE
```

```
 967    0495'  07                        LDN GPAGE
 968    0496'  2E                        DEC ASTX        ; STORE CURRENT VALUE OF Y POS. ON ASTX
 969    0497'  FA F0                     ANI 0F0H        ;     (NOT USED BUT THE ASTX GETS INCREMENTED
 970    0499'  5E                        STR ASTX        ;     LATER AND MUST BE DECREMENTED HERE)
 971    049A'  FE                        SHL             ;CHECK ZERO POSITION BIT (MSB OF HI NIBBLE)
 972    049B'  C3 0615'                  LBDF POSXT2     ; IGNORE AND EXIT IF ZERO POSITION BIT= 0
 973                                ;
 974    049E'  E2                        SEX STACK       ; SET UP INITIAL PARAMETERS
 975                                     SCAL R6, POS0
 976    049F'  68 86           +
 977    04A1'  0637'           +
 978                                ;
 979    04A3'  E2                        SEX STACK       ; PULSE Y- RELAY to start
 980                                     SCAL R6, PULSE  ; the traverse
 981    04A4'  68 86           +
 982    04A6'  0736'           +
 983    04A8'  1B                        DB 33Q          ;  33Q = Y- Relay
 984    04A9'  04                        DB 04H          ;  100 mSec. Pulse
 985                                ;
 986    04AA'  C0 0622'                  LBR POSXT1      ; EXIT THE ROUTINE
 987                                ;
 988                                ;
 989    04AD'  E1                  YON:  SEX INTPC       ;READ YZ POSITION OPTO INTERRUPTERS
 990    04AE'  61                        OUT GROUP       ;GROUP 00
 991    04AF'  00                        DB 00
 992    04B0'  F8 94                     LDI YZPOS
 993    04B2'  A7                        PLO GPAGE
 994    04B3'  E7                        SEX GPAGE
 995    04B4'  6C                        INP YZ          ;INPUT YZ POSITION
 996    04B5'  FE                        SHL             ;MOVE Y ZERO POSITION BIT TO LOW NIBBLE
 997    04B6'  C3 04D8'                  LBDF YOOK       ;IF AT ZERO POSITION, GO TO YOOK
 998                                ;                    ;IF NOT:
 999    04B9'  F8 19                     LDI CYCLES      ;   INCREMENT PPC COUNT ONCE PER SEC.
1000    04BB'  A7                        PLO GPAGE       ;   AT CYCLES= 01
1001    04BC'  07                        LDN GPAGE
1002    04BD'  FB 01                     XRI 01
1003    04BF'  CA 0622'                  LBNZ POSXT1     ;  EXIT IF CYCLES NOT 01
1004    04C2'  F8 68                     LDI PPCCNT      ;   INC PPCCNT
1005    04C4'  A7                        PLO GPAGE
1006    04C5'  07                        LDN GPAGE
1007    04C6'  FC 01                     ADI 01
1008    04C8'  57                        STR GPAGE
1009    04C9'  FB 3C                     XRI TIME01      ;  IF PPC COUNT NOT = TIME01 LIMIT
1010    04CB'  CA 0622'                  LBNZ POSXT1     ;   THEN EXIT
1011                                ;
1012                                ;
```

```
1013    04CE'  E2                  YOER:  SEX STACK       ;PULSE Y- RELAY TO STOP TRAVERSE
1014                                      SCAL R6, PULSE
1015    04CF'  68 86          +
1016    04D1'  07B6'          +
1017    04D3'  1B                        DB 33Q
1018    04D4'  08                        DB 08H
1019    04D5'  C0 0625'                  LBR POSERR     ;GO TO POSITION ERROR ROUTINE
1020                               ;
1021                               ;
1022    04D8'  E2                  YOOK:  SEX STACK       ;PULSE Y- RELAY TO STOP TRAVERSE
1023                                      SCAL R6, PULSE
1024    04D9'  68 86          +
1025    04DB'  07B6'          +
1026    04DD'  1B                        DB 33Q
1027    04DE'  08                        DB 08H
1028                               ;
1029    04DF'  C0 0619'                  LBR POSOK
1030                               ;
1031                               ;
1032                               ;
1033                               ;******** INCERMENT Y POSITION:  SEQUENCER CODE = 50 9D *******
1034                               ;
1035    04E2'  F8 67               YINC:  LDI SEQRAT     ;CHECK TO SEE IF WE ARE SENDING THE
1036    04E4'  A7                        PLO GPAGE      ;   ACOUSTIC ERROR MESSAGE GENERATED
1037    04E5'  07                        LDN GPAGE      ;   BY THIS PPC (SEQRAT = 3FH)
1038    04E6'  FB 8F                     XRI 08FH
1039    04E8'  C2 0123'                  LBZ PINGRX     ;   IF SO, GO TO THE PINGER ROUTINE
1040                               ;
1041    04EB'  F8 68                     LDI PPCCNT     ;1st TIME THRU THE PPC ?
1042    04ED'  A7                        PLO GPAGE
1043    04EE'  07                        LDN GPAGE
1044    04EF'  CA 0512'                  LBNZ YINCN     ;  IF NOT;  GO TO YINCN
1045                               ;
1046                               ;                     ;ELSE:
1047    04F2'  F8 94               YINC0: LDI YZPOS      ; CHECK CURRENT POSITION
1048    04F4'  A7                        PLO GPAGE
1049    04F5'  07                        LDN GPAGE
1050    04F6'  2E                        DEC ASTX
1051    04F7'  F6                        SHR            ;MOVE Y POSITION TO LOW NIBBLE
1052    04F8'  F6                        SHR
1053    04F9'  F6                        SHR
1054    04FA'  F6                        SHR
1055    04FB'  FA 07                     ANI 07         ; MASK OUT UNUSED HI NIBBLE AND ZERO (RESET) BIT
1056    04FD'  5E                        STR ASTX       ; STORE ON SEQUENCER ASTX
1057    04FE'  FF 07                     SMI 07
1058    0500'  C3 061E'                  LBDF POSXT2    ; IGNORE AND EXIT IF POSITION >= 7
```

```
1059                                    ;
1060    0503'   E2                      SEX STACK       ; SET UP INITIAL PARAMETERS
1061                                    SCAL R6, POS0
1062    0504'   68 86           +
1063    0506'   0637'            +
1064                                    ;
1065    0508'   E2                      SEX STACK       ; PULSE Y+ RELAY to start
1066                                    SCAL R6, PULSE  ; the traverse
1067    0509'   68 86           +
1068    050B'   0736'            +
1069    050D'   1A                      DB 32Q          ;  32Q = Y+ Relay
1070    050E'   04                      DB 04H          ;  100 mSec. Pulse
1071                                    ;
1072    050F'   C0 0622'                LBR POSXT1      ; EXIT THE ROUTINE
1073                                    ;
1074                                    ;
1075    0512'   E1              YINCN:  SEX INTPC       ;READ YZ POSITION OPTO INTERRUPTERS
1076    0513'   61                      OUT GROUP       ;GROUP 00
1077    0514'   00                      DB 00
1078    0515'   F8 94                   LDI YZPOS
1079    0517'   A7                      PLO GPAGE
1080    0518'   E7                      SEX GPAGE
1081    0519'   6C                      INP YZ          ;INPUT YZ POSITION
1082    051A'   F6                      SHR             ;MOVE Y POSITION TO LOW NIBBLE
1083    051B'   F6                      SHR
1084    051C'   F6                      SHR
1085    051D'   F6                      SHR
1086    051E'   FA 07                   ANI 07H         ;Mask null bits "0" position bit
1087    0520'   52                      STR STACK
1088    0521'   E2                      SEX STACK
1089    0522'   0E                      LDN ASTK        ;GET THE ORIGIONAL Y VALUE FOR THE ASTK
1090    0523'   FC 01                   ADI 01
1091    0525'   F3                      XOR             ;(Y POS) XOR (OLD POS + 1)
1092    0526'   C2 0548'                LBZ YINCOK      ;IF AT NEXT POSITION, GO TO YINCOK
1093                                    ;                       ;IF NOT:
1094    0529'   F8 19                   LDI CYCLES      ;   INCREMENT PPC COUNT ONCE PER SEC.
1095    052B'   A7                      PLO GPAGE       ;   AT CYCLES= 01
1096    052C'   07                      LDN GPAGE
1097    052D'   FB 01                   XRI 01
1098    052F'   CA 0622'                LBNZ POSXT1     ;  EXIT IF CYCLES NOT 01
1099    0532'   F8 68                   LDI PPCCNT      ;   INC PPCCNT
1100    0534'   A7                      PLO GPAGE
1101    0535'   07                      LDN GPAGE
1102    0536'   FC 01                   ADI 01
1103    0538'   57                      STR GPAGE
1104    0539'   FB 3C                   XRI TIME01      ;  IF PPC COUNT NOT = TIME01 LIMIT
```

```
1105    0533'  CA 0622'                    LBNZ POSXT1     ;  THEN EXIT
1106                                ;
1107                                ;
1108    053E'  E2                   YINCER: SEX STACK       ;PULSE Y+ RELAY TO STOP TRAVERSE
1109                                        SCAL R6, PULSE
1110    053F'  68 86          +
1111    0541'  07B6'          +
1112    0543'  1A                           DB 32Q
1113    0544'  08                           DB 08H
1114    0545'  C0 0625'                     LBR POSERR
1115                                ;
1116    0548'  E2                   YINCOK: SEX STACK       ;PULSE Y+ RELAY TO STOP TRAVERSE
1117                                        SCAL R6, PULSE
1118    0549'  68 86          +
1119    054B'  07B6'          +
1120    054D'  1A                           DB 32Q
1121    054E'  08                           DB 08H
1122    054F'  C0 0619'                     LBR POSOK
1123                                ;
1124                                ;
1125                                ;
1126                                ;****** ZERO THE Z POSITION: SEQUENCER CODE = E0 9E ******
1127                                ;
1128    0552'  F8 67                Z0:     LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
1129    0554'  A7                           PLO GPAGE       ;   ACOUSTIC ERROR MESSAGE GENERATED
1130    0555'  07                           LDN GPAGE       ;   BY THIS PPC (SEQRAT = 8FH)
1131    0556'  FB 8F                        XRI 08FH
1132    0558'  C2 0123'                     LBZ PINGRX      ;   IF SO, GO TO THE PINGER ROUTINE
1133                                ;
1134    055B'  F8 68                        LDI PPCCNT      ;1st TIME THRU THE PPC ?
1135    055D'  A7                           PLO GPAGE
1136    055E'  07                           LDN GPAGE
1137    055F'  CA 057E'                     LBNZ Z0N        ;  IF NOT;  GO TO ZINCN
1138                                ;
1139                                ;                       ;ELSE:
1140    0562'  F8 94                Z00:    LDI YZPOS       ; CHECK CURRENT POSITION
1141    0564'  A7                           PLO GPAGE
1142    0565'  07                           LDN GPAGE
1143    0566'  2E                           DEC ASTK        ; STORE CURRENT VALUE OF Z POS. ON ASTK
1144    0567'  FA 0F                        ANI 0FH         ;     (NOT USED BUT THE ASTK GETS INCREMENTED
1145    0569'  5E                           STR ASTK        ;     LATER AND MUST BE DECREMENTED HERE)
1146    056A'  FA 08                        ANI 08H         ;CHECK ZERO POSITION BIT (MSB OF LO NIBBLE)
1147    056C'  CA 0613'                     LBNZ POSXT2     ; IGNORE AND EXIT IF ZERO POSITION BIT= 0
1148                                ;
1149    056F'  E2                           SEX STACK       ; SET UP INITIAL PARAMETERS
1150                                        SCAL R6, POS0
```

```
1151    0570'  68 86          +
1152    0572'  0637'          +
1153                        ;
1154    0574'  E2                   SEX STACK       ; PULSE Z- RELAY to start
1155                                SCAL R6, PULSE  ; the traverse
1156    0575'  68 86          +
1157    0577'  07B6'          +
1158    0579'  1D                   DB 35Q          ;  35Q = Z- Relay
1159    057A'  04                   DB 04H          ;  100 mSec. Pulse
1160                        ;
1161    057B'  C0 0622'             LBR POSXT1      ; EXIT THE ROUTINE
1162                        ;
1163                        ;
1164    057E'  E1           ZON:    SEX INTPC       ;READ YZ POSITION OPTO INTERRUPTERS
1165    057F'  61                   OUT GROUP       ;GROUP 00
1166    0580'  00                   DB 00
1167    0581'  F8 94                LDI YZPOS
1168    0583'  A7                   PLO GPAGE
1169    0584'  E7                   SEX GPAGE
1170    0585'  6C                   INP YZ          ;INPUT YZ POSITION
1171    0586'  FA 08                ANI 08H         ;CHECK Z ZERO POSITION BIT
1172    0588'  CA 05AA'             LBNZ ZOOK       ;IF AT ZERO POSITION, GO TO ZOOK
1173                        ;                       ;IF NOT:
1174    058B'  F8 19                LDI CYCLES      ;   INCREMENT PPC COUNT ONCE PER SEC.
1175    058D'  A7                   PLO GPAGE       ;   AT CYCLES= 01
1176    058E'  07                   LDN GPAGE
1177    058F'  FB 01                XRI 01
1178    0591'  CA 0622'             LBNZ POSXT1     ;  EXIT IF CYCLES NOT 01
1179    0594'  F8 68                LDI PPCCNT      ;   INC PPCCNT
1180    0596'  A7                   PLO GPAGE
1181    0597'  07                   LDN GPAGE
1182    0598'  FC 01                ADI 01
1183    059A'  57                   STR GPAGE
1184    059B'  FB 3C                XRI TIME01      ;  IF PPC COUNT NOT = TIME01 LIMIT
1185    059D'  CA 0622'             LBNZ POSXT1     ;   THEN EXIT
1186                        ;
1187                        ;
1188                        ;
1189    05A0'  E2           ZOERR:  SEX STACK       ;PULSE Z- RELAY TO STOP TRAVERSE
1190                                SCAL R6, PULSE
1191    05A2'  68 86          +
1192    05A3'  07B6'          +
1193    05A5'  1D                   DB 35Q
1194    05A6'  08                   DB 08H
1195    05A7'  C0 0625'             LBR POSERR      ;GO TO POSITION ERROR ROUTINE
1196                        ;
```

```
1197                                    ;
1198    05AA'   E2                      ZOOK:   SEX STACK       ;PULSE Z- RELAY TO STOP TRAVERSE
1199                                            SCAL R6, PULSE
1200    05AB'   68 86           +
1201    05AD'   0736'           +
1202    05AF'   1D                              DB 35Q
1203    05B0'   08                              DB 08H
1204                                    ;
1205    05B1'   C3 0619'                        LBR POSOK
1206                                    ;
1207                                    ;
1208                                    ;
1209                                    ;******* INCREMENT Z POSITION:  SEQUENCER CODE = E0 9F *******
1210                                    ;
1211    05B4'   F8 67                   ZINC:   LDI SEQRAT      ;CHECK TO SEE IF WE ARE SENDING THE
1212    05B6'   A7                              PLO GPAGE       ;   ACOUSTIC ERROR MESSAGE GENERATED
1213    05B7'   07                              LDN GPAGE       ;   BY THIS PPC (SEQRAT = 8FH)
1214    05B8'   FB 8F                           XRI 08FH
1215    05BA'   C2 0123'                        LBZ PINGRX      ;   IF SO, GO TO THE PINGER ROUTINE
1216                                    ;
1217    05BD'   F8 68                           LDI PPCCNT      ;1st TIME THRU THE PPC ?
1218    05BF'   A7                              PLO GPAGE
1219    05C0'   07                              LDN GPAGE
1220    05C1'   CA 05E0'                        LBNZ ZINCN      ;  IF NOT;  GO TO ZINCN
1221                                    ;
1222                                    ;                       ;ELSE:
1223    05C4'   F8 94                   ZINC0:  LDI YZPOS       ; CHECK CURRENT POSITION
1224    05C6'   A7                              PLO GPAGE
1225    05C7'   07                              LDN GPAGE
1226    05C8'   2E                              DEC ASTK
1227    05C9'   FA 07                           ANI 07          ; MASK OUT UNUSED HI NIBBLE AND ZERO  RESET  BIT
1228    05CB'   5E                              STR ASTK        ; STORE ON SEQUENCER ASTK
1229    05CC'   FF 07                           SMI 07
1230    05CE'   C3 061E'                        LBDF POSXT2     ; IGNORE AND EXIT IF POSITION >= 7
1231                                    ;
1232    05D1'   E2                              SEX STACK       ; SET UP INITIAL PARAMETERS
1233                                            SCAL R6, POS0
1234    05D2'   68 86           +
1235    05D4'   0637'           +
1236                                    ;
1237    05D6'   E2                              SEX STACK       ; PULSE Z+ RELAY to start
1238                                            SCAL R6, PULSE  ; the traverse
1239    05D7'   68 86           +
1240    05D9'   0736'           +
1241    05DB'   1C                              DB 34Q          ;  32Q = Z+ Relay
1242    05DC'   04                              DB 04H          ;  100 mSec. Pulse
```

```
                                        ;
05DD'  C0 0622'                         LBR POSXT1      ; EXIT THE ROUTINE
                                        ;
                                        ;
05E0'  E1                       ZINCN:  SEX INTPC       ;READ YZ POSITION OPTO INTERRUPTERS
05E1'  61                               OUT GROUP       ;GROUP 00
05E2'  00                               DB 00
05E3'  F8 94                            LDI YZPOS
05E5'  A7                               PLO GPAGE
05E6'  E7                               SEX GPAGE
05E7'  6C                               INP YZ          ;INPUT Z POSITION
05E8'  FA 07                            ANI 07H         ;Mask null bits "0" position bit
05EA'  E2                               SEX STACK
05EB'  52                               STR STACK
05EC'  0E                               LDN ASTK        ;GET THE ORIGIONAL Z VALUE FOR THE ASTK
05ED'  FC 01                            ADI 01
05EF'  F3                               XOR             ;(Z POS) XOR (OLD POS + 1)
05F0'  C2 0612'                         LBZ ZINCOK      ;IF AT NEXT POSITION, GO TO ZINCOK
                                        ;               ;IF NOT:
05F3'  F8 19                            LDI CYCLES      ;   INCREMENT PPC COUNT ONCE PER SEC.
05F5'  A7                               PLO GPAGE       ;   AT CYCLES= 01
05F6'  07                               LDN GPAGE
05F7'  FB 01                            XRI 01
05F9'  CA 0622'                         LBNZ POSXT1     ;  EXIT IF CYCLES NOT 01
05FC'  F8 68                            LDI PPCCNT      ;   INC PPCCNT
05FE'  A7                               PLO GPAGE
05FF'  07                               LDN GPAGE
0600'  FC 01                            ADI 01
0602'  57                               STR GPAGE
0603'  FB 3C                            XRI TIME01      ;  IF PPC COUNT NOT = TIME01 LIMIT
0605'  CA 0622'                         LBNZ POSXT1     ;   THEN EXIT
                                        ;
                                        ;
0608'  E2                       ZINCER: SEX STACK       ;PULSE Z+ RELAY TO STOP TRAVERSE
                                        SCAL R6, PULSE
0609'  68 86            +
0608'  07B6'            +
060D'  1C                               DB 34Q
060E'  08                               DB 08H
060F'  C0 0625'                         LBR POSERR
                                        ;
0612'  E2                       ZINCOK: SEX STACK       ;PULSE Z+ RELAY TO STOP TRAVERSE
                                        SCAL R6, PULSE
0613'  68 86            +
0615'  07B6'            +
0617'  1C                               DB 34Q
```

```
1289    0618'  08                       DB 08H
1290                                    ;
1291    0619'  E2                       POSOK:  SEX STACK
1292                                            SCAL R6, POS1   ;CLEAR PARAMETERS
1293    061A'  68 86            -
1294    061C'  0650'            +
1295                                    ;
1296    061E'  1E                       POSXT2: INC ASTK        ;CLEAR OLD ZPOS FROM ASTK
1297    061F'  C0 0000*                         LBR INCPPC      ;GO TO SET UP FOR NEXT PPC
1298                                    ;
1299                                    ;
1300    0622'  C0 0000*                 POSXT1: LBR DECPPC      ;GO TO DECREMENT PPC
1301                                    ;
1302                                    ;
1303    0625'  F8 80                    POSERR: LDI ERROR       ;SET POSITION ERROR CODE IN ERROR WORD
1304    0627'  A7                               PLO GPAGE
1305    0628'  07                               LDN GPAGE
1306    0629'  F9 80                            ORI 80H         ;POSITION ERROR = BIT 7
1307    062B'  57                               STR GPAGE
1308                                    ;
1309    062C'  E2                               SEX STACK       ;CLEAR PARAMETERS
1310                                            SCAL R6, POS1
1311    062D'  68 86            -
1312    062F'  0650'            +
1313                                    ;
1314    0631'  F8 0A                            LDI 0AH         ;LOAD ASTK WITH ERROR CODE (Stk position is
1315    0633'  5E                               STR ASTK        ; not changed; pinger will clear and increment)
1316    0634'  C0 0123'                         LBR PINGRX      ;SEND PINGER XYZ ERROR CODE ("A")
1317                                    ;
1318                                    ;
1319                                    ;
1320                                    ;*** SUBROUTINES ***
1321                                    ;
1322    0637'  F8 34                    POS0:   LDI XYZFLG      ; SET XYZ FLAG = AC FOR THIS SEQUENCE
1323    0639'  A7                               PLO GPAGE       ;   (TURNS ON OPTO INTERRUPTER PWR)
1324    063A'  F8 AC                            LDI 0ACH
1325    063C'  57                               STR GPAGE
1326                                    ;
1327    063D'  F8 80                            LDI ERROR       ; SET ERROR WORD MSB = 0
1328    063F'  A7                               PLO GPAGE
1329    0640'  07                               LDN GPAGE
1330    0641'  FA 7F                            ANI 7FH
1331    0643'  57                               STR GPAGE
1332                                    ;
1333    0644'  F8 68                            LDI PPCCNT      ; SET PPCCNT TO 01
1334    0646'  A7                               PLO GPAGE
```

```
1335    0647'  F8 01                    LDI 01
1336    0649'  57                       STR GPAGE
1337                                ;
1338    064A'  27                       DEC GPAGE       ; SET SEQRAT TO RUN EVERY CYCLE
1339    064B'  F8 10                    LDI 10H         ;  (EVERY 25 mSEC.)
1340    064D'  57                       STR GPAGE
1341                                ;
1342                                    SRET R6         ;RETURN FORM SUBROUTINE
1343    064E'  68 96          +
1344                                ;
1345                                ;
1346    0650'  F8 68            POS1:   LDI PPCCNT      ;CLEAR PPC COUNT
1347    0652'  A7                       PLO GPAGE
1348    0653'  F8 00                    LDI 00
1349    0655'  57                       STR GPAGE
1350                                ;
1351    0656'  27                       DEC GPAGE       ;CLEAR SEQUENCER RATE
1352    0657'  57                       STR GPAGE
1353                                ;
1354    0658'  F8 34                    LDI XYZFLG      ;RESET XYZ FLAG = 00
1355    065A'  A7                       PLO GPAGE
1356    065B'  F8 00                    LDI 00
1357    065D'  57                       STR GPAGE
1358                                ;
1359                                    SRET R6         ;RETURN FROM SUBROUTINE
1360    065E'  68 96          +
1361                                ;
1362                                ;
1363                                ;
1364                                ;
1365                                ;************** E0 An - SEDIMENT AND WATER SAMPLE FUNCTIONS *************
1366                                ;               where n = 0-7
1367                                ;
1368    0660'  E2               SAM1X:  SEX STACK               ;E0 A0-A3
1369    0661'  0C                       LDN PPC
1370    0662'  FA 03                    ANI 03                  ;MASK FOR LAST 2 BITS
1371    0664'  C2 0000*                 LBZ INCPPC              ;  E0 A1 = DOES NOTHING
1372    0667'  FB 01                    XRI 01
1373    0669'  32 76'                   BZ SED1I                ;  E0 A1 = SED. 1 INSERT
1374    066B'  FB 03                    XRI (01 XOR 02)
1375    066D'  32 7F'                   BZ SED1R                ;  E0 A2 = SED. 1 RETRACT
1376    066F'  FB 01                    XRI (02 XOR 03)
1377    0671'  32 88'                   BZ SED1U                ;  E0 A3 = SED. 1 UNLATCH & H2O SAMPLE 1
1378    0673'  C0 0000*                 LBR INCPPC
1379                                ;
1380                                ;
```

```
1381    0676'                       SED1I:  SCAL R6, PULSE          ;PULSE SED.1 INSERT RELAY
1382    0676'   68 86          +
1383    0678'   07B6'           +
1384    067A'   06                      DB 06Q                  ;  Conn. 2 - Pin 3
1385    067B'   08                      DB 08H                  ;  Relay Pod 2
1386    067C'   C0 0000*                LBR INCPPC
1387                                ;
1388    067F'                       SED1R:  SCAL R6, PULSE          ;PULSE SED.1 RETRACT RELAY
1389    067F'   68 86          +
1390    0681'   07B6'           +
1391    0683'   07                      DB 07Q                  ;  Conn. 2 - Pin 7
1392    0684'   08                      DB 08H                  ;  Relay Pod 2
1393    0685'   C0 0000*                LBR INCPPC
1394                                ;
1395    0688'                       SED1U:  SCAL R6, PULSE          ;PULSE SED.1 UNLATCH, H20 SAMPLE 1 RELAY
1396    0688'   68 86          +
1397    068A'   07B6'           +
1398    068C'   08                      DB 10Q                  ;  Conn. 2 - Pin 6
1399    068D'   08                      DB 08H                  ;  Relay Pod 2
1400    068E'   C0 0000*                LBR INCPPC
1401                                ;
1402                                ;
1403                                ;
1404    0691'   E2                  SAM2X:  SEX STACK               ;E0 A4-A7
1405    0692'   0C                      LDN PPC
1406    0693'   FA 03                   ANI 03                  ;MASK FOR LAST 2 BITS
1407    0695'   C2 0000*                LBZ INCPPC              ;  E0 A4 = DOES NOTHING
1408    0698'   FB 01                   XRI 01
1409    069A'   32 A9'                  BZ SED2I                ;  E0 A5 = SED. 2 INSERT
1410    069C'   FB 03                   XRI (01 XOR 02)
1411    069E'   C2 06B2'                LBZ SED2R               ;  E0 A6 = SED. 2 RETRACT
1412    06A1'   FB 01                   XRI (02 XOR 03)
1413    06A3'   C2 06BB'                LBZ SED2U               ;  E0 A7 = SED. 2 UNLATCH
1414    06A6'   C0 0000*                LBR INCPPC
1415                                ;
1416                                ;
1417    06A9'                       SED2I:  SCAL R6, PULSE          ;PULSE SED.2 INSERT RELAY
1418    06A9'   68 86          +
1419    06AB'   07B6'           +
1420    06AD'   09                      DB 11Q                  ;  Conn. 2 - Pin 5
1421    06AE'   08                      DB 08H                  ;  Relay Pod 2
1422    06AF'   C0 0000*                LBR INCPPC
1423                                ;
1424    06B2'                       SED2R:  SCAL R6, PULSE          ;PULSE SED.2 RETRACT RELAY
1425    06B2'   68 86          +
1426    06B4'   07B6'           +
```

```
1427    06B6'  0A                       DB 12Q              ;  Conn. 2 - Pin 4
1428    06B7'  08                       DB 08H              ;  Relay Pod 2
1429    06B8'  C0 0000*                 LBR INCPPC
1430                                ;
1431    06BB'                       SED2U:  SCAL R6, PULSE      ;PULSE SED.2 UNLATCH, H20 SAMPLE 2 RELAY
1432    06BB'  68 86          +
1433    06BD'  07B6'          +
1434    06BF'  0B                       DB 13Q              ;  Conn. 2 - Pin 3
1435    06C0'  08                       DB 08H              ;  Relay Pod 2
1436    06C1'  C0 0000*                 LBR INCPPC
1437                                ;
1438                                ;
1439                                ;
1440                                ;********** E0 A8-AB - HYDRAULIC, SUCTION PUMPS AND VIEW PORT CLEAN *********
1441                                ;
1442                                ;
1443    06C4'  E2                   PUMPX:  SEX STACK
1444    06C5'  0C                       LDN PPC
1445    06C6'  FA 03                    ANI 03              ;MASK FOR LOW 2 BITS
1446    06C8'  C2 06DD'                 LBZ HYDRU           ;  E0 A8 = HYDRAULIC PUMP
1447    06CB'  FB 01                    XRI 01
1448    06CD'  C2 06E6'                 LBZ SPARE1          ;  E0 A9 = SPARE #1
1449    06D0'  FB 03                    XRI (01 XOR 02)
1450    06D2'  C2 06EF'                 LBZ SUCT            ;  E0 AA = SUCTION PUMP
1451    06D5'  FB 01                    XRI (02 XOR 03)
1452    06D7'  C2 06F8'                 LBZ CLEAN           ;  E0 AB = CLEAN VIEW PORT
1453    06DA'  C0 0000*                 LBR INCPPC
1454                                ;
1455    06DD'                       HYDRU:  SCAL R6, PULSE      ;HYDRAULIC PUMP
1456    06DD'  68 86          +
1457    06DF'  07B6'          +
1458    06E1'  1E                       DB 36Q              ;  Conn. 6 - Pin 8
1459    06E2'  08                       DB 08H              ;  Relay Pod 6
1460    06E3'  C0 0000*                 LBR INCPPC
1461                                ;
1462    06E6'                       SPARE1: SCAL R6, PULSE      ;SPARE #1
1463    06E6'  68 86          +
1464    06E8'  07B6'          +
1465    06EA'  21                       DB 41Q              ;  Conn. 6 - Pin 5
1466    06EB'  08                       DB 08H              ;  Relay Pod 6
1467    06EC'  C0 0000*                 LBR INCPPC
1468                                ;
1469    06EF'                       SUCT:   SCAL R6, PULSE      ;SUCTION PUMP
1470    06EF'  68 86          +
1471    06F1'  07B6'          +
1472    06F3'  16                       DB 26Q              ;  Conn. 4 - Pin 4
```

```
1473    06F4'  08                       DB 08H              ; Relay Pod 4
1474    06F5'  C0 0000*                 LBR INCPPC
1475                                ;
1476    06F8'                       CLEAN:  SCAL R6, PULSE      ;CLEAN VIEW PORT
1477    06F8'  68 86          +
1478    06FA'  07B6'          +
1479    06FC'  17                       DB 27Q              ; Conn. 4 - Pin 3
1480    06FD'  08                       DB 08H              ; Relay Pod 4
1481    06FE'  C0 0000*                 LBR INCPPC
1482                                ;
1483                                ;
1484                                ;******** E0 AC-AF - Flume Insert and Withdraw; Recirculate Pumps *********
1485                                ;
1486    0701'  E2                   FLUMX:  SEX STACK
1487    0702'  0C                       LDN PPC
1488    0703'  FA 03                    ANI 03              ;MASK FOR LOW 2 BITS
1489    0705'  C2 0715                  LBZ INSRT           ; E0 AC = Insert Flume
1490    0708'  FB 01                    XRI 01
1491    070A'  C2 071E'                 LBZ RETRAC          ; E0 AD = Retract Flume
1492    070D'  FB 03                    XRI (01 XOR 02)
1493    070F'  C2 0727'                 LBZ PUMPR1          ; E0 AE = Recirculate Pump #1
1494                                ;       XRI (02 XOR 03)     ;***** E0 AF DISABLED *****
1495                                ;       BZ PUMPR2           ; E0 AF = Recirculate Pump #2
1496    0712'  C0 0000*                 LBR INCPPC
1497                                ;
1498    0715'                       INSRT:  SCAL R6, PULSE      ;Insert Flume
1499    0715'  68 86          +
1500    0717'  07B6'          +
1501    0719'  12                       DB 22Q              ; Conn. 4 - Pin 8
1502    071A'  08                       DB 08H              ; Relay Pod 4
1503    071B'  C0 0000*                 LBR INCPPC
1504                                ;
1505    071E'                       RETRAC: SCAL R6, PULSE      ;Retract Flume
1506    071E'  68 86          +
1507    0720'  07B6'          +
1508    0722'  13                       DB 23Q              ; Conn. 4 - Pin 7
1509    0723'  08                       DB 08H              ; Relay Pod 4
1510    0724'  C0 0000*                 LBR INCPPC
1511                                ;
1512    0727'                       PUMPR1: SCAL R6, PULSE      ;RECURCULATE PUMP #1
1513    0727'  68 86          +
1514    0729'  07B6'          +
1515    072B'  1F                       DB 37Q              ; Conn. 6 - Pin 7
1516    072C'  08                       DB 08H              ; Relay Pod 6
1517    072D'  C0 0000*                 LBR INCPPC
1518                                ;
```

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1519                                    ;PUMPR2:        SCAL R6, PULSE          ;RECURCULATE PUMP #2
1520                                    ;       DB 40Q                  ; Conn. 6 - Pin 6
1521                                    ;       DB 08H                  ; Relay Pod 6
1522                                    ;       LBR INCPPC
1523                                    ;
1524                                    ;
1525                                    ;
1526                                    ;****************** E0 C0 - TAKE A PICTURE ************************************
1527                                    ;
1528    0730'   0C                      FLASHX: LDN PPC         ;DECODE PPC
1529    0731'   FA 03                           ANI 03
1530    0733'   CA 0000*                       LBNZ INCPPC     ;RETURN IF NOT C0
1531                                    ;
1532    0736'   E1                              SEX INTPC
1533    0737'   61                              OUT GROUP       ; SELECT I/O GROUP 0
1534    0738'   00                              DB 00
1535                                    ;
1536    0739'   66                              OUT CAMERA      ; I/O 6
1537    073A'   00                              DB 00           ;   NULL DATA
1538                                    ;
1539    073B'   F8 88                           LDI CAMCNT      ;INCREMENT CAMERA FRAME COUNTER
1540    073D'   A7                              PLO GPAGE
1541    073E'   07                              LDN GPAGE
1542    073F'   FC 01                           ADI 01H
1543    0741'   57                              STR GPAGE
1544                                    ;
1545    0742'   C0 0000*                       LBR INCPPC
1546                                    ;
1547                                    ;
1548                                    ;
1549                                    ;****************** E0 D0 - RESET THE LDV *************************************
1550                                    ;
1551    0745'   0C                      RLDVX:  LDN PPC         ;DECODE PPC
1552    0746'   FA 03                           ANI 03
1553    0748'   CA 0000*                       LBNZ INCPPC     ;RETURN IF NOT D0
1554                                    ;
1555    074B'   E1                              SEX INTPC       ;SELECT I/O GROUP 0
1556    074C'   61                              OUT GROUP
1557    074D'   00                              DB 00
1558                                    ;
1559    074E'   65                              OUT LDVRST      ;RESET LDV (I/O 5)
1560    074F'   00                              DB 00           ;  NULL DATA
1561
1562                                    ;
1563    0750'   C0 0000*                       LBR INCPPC
1564                                    ;
```

```
1565                                    ;
1566                                    ;
1567                                    ;****************** E0 Fn aaaa - SEQUENCER BRANCH ON SWITCH *********************
1568                                    ; ****** n = 0-3,  aaaa = Branch address
1569                                    ; ****** F0 = Bottom Switch, F1 = Flume Insertion Switches,
1570                                    ; ****** F2 = Flume Retracted Switch, F3 = IGNORED (Spare)
1571                                    ;
1572                                    ; ****** SWSTAT = | Bot |__|__| Ins0 || Ins4 | Ins3 | Ins2 | Ins1 | *****
1573                                    ;
1574                                    ;
1575    0753'   F8 82                   IFSWX:  LDI SWSTAT      ; IF SWITCH nn  FUNCTIONS
1576    0755'   A7                              PLO GPAGE       ;       LOAD SWITCH STATUS
1577    0756'   0C                              LDN PPC
1578    0757'   FA 03                          ANI 03          ; DO: IF PPC =
1579    0759'   C2 076C'                       LBZ IFBOT       ;       E0 F0, GO TO BOTTOM SW. ROUTINE
1580    075C'   FB 01                          XRI 01          ;
1581    075E'   C2 0774'                       LBZ IFINS       ;       E0 F1, GO TO FLUME INSERTION SW ROUTINE
1582    0761'   FB 03                          XRI (01 XOR 02) ;
1583    0763'   C2 077F'                       LBZ IFRETR      ;       E0 F2, GO TO FLUME RETRACTED SW ROUTINE (Ins0)
1584                                    ;
1585    0766'   1C                      IFSWXT: INC PPC         ; OTHERWISE, EXIT
1586    0767'   1C                              INC PPC
1587    0768'   1C                              INC PPC
1588    0769'   C0 0000*                       LBR SAVPPC
1589                                    ;
1590    076C'   07                      IFBOT:  LDN GPAGE       ; IF BOTTOM SW, JUMP TO AAAA
1591    076D'   FE                              SHL             ; ELSE, EXIT
1592    076E'   CB 0766'                       LBNF IFSWXT
1593    0771'   C0 0000*                       LBR JUMP
1594                                    ;
1595    0774'   07                      IFINS:  LDN GPAGE       ; IF ALL 4 INSERTION SWITCHES, JUMP TO AAAA
1596    0775'   FA 0F                          ANI 0FH         ; ELSE, EXIT
1597    0777'   FB 0F                          XRI 0FH
1598    0779'   C2 0000*                       LBZ JUMP
1599    077C'   C0 0766'                       LBR IFSWXT
1600                                    ;
1601    077F'   07                      IFRETR: LDN GPAGE       ; IF FLUME IS RETRACTED, JUMP TO AAAA
1602    0780'   FA 10                          ANI 10H
1603    0782'   C2 0766'                       LBZ IFSWXT
1604    0785'   C0 0000*                       LBR JUMP
1605                                    ;
1606                                    ;
1607                                    ;
1608                                    ; ****** E0 Fn aaaa - SEQUENCER BRANCH ON ACOUSTIC SIGNAL ******************
1609                                    ; ****** n = 8-B,  aaaa = Branch address
1610                                    ; ****** F8 = Sig. A, F9 = Sig. B, FA = Sig. C, F3 = IGNORED *****
```

```
1611                                    ;
1612                                    ; ****** ACSTAT =  |  |  |  |  | Sig.C | Sig.B | Sig.A |  ******
1613                                    ;
1614                                    ;
1615    0788'   F8 81                   IFACUX: LDI ACSTAT
1616    078A'   A7                              PLO GPAGE
1617    078B'   0C                              LDN PPC
1618    078C'   FA 03                           ANI 03
1619    078E'   C2 07A1'                        LBZ IFACA               ;E0 F8
1620    0791'   FB 01                           XRI 01
1621    0793'   C2 07A6'                        LBZ IFACB               ;E0 F9
1622    0796'   FB 03                           XRI (01 XOR 02)
1623    0798'   C2 07AB'                        LBZ IFACC               ;E0 FA
1624                                    ;
1625    079B'   1C                      IFACXT: INC PPC         ;IF NO SIGNAL, CONTINUE W/O JUMP
1626    079C'   1C                              INC PPC
1627    079D'   1C                              INC PPC
1628    079E'   C0 0000*                        LBR SAVPPC
1629                                    ;
1630    07A1'   07                      IFACA:  LDN GPAGE       ;IF SIGNAL A
1631    07A2'   FA 01                           ANI 01
1632    07A4'   30 B0'                          BR IFAC?
1633                                    ;
1634    07A6'   07                      IFACB:  LDN GPAGE       ;IF SIGNAL B
1635    07A7'   FA 02                           ANI 02
1636    07A9'   30 B0'                          BR IFAC?
1637                                    ;
1638    07AB'   07                      IFACC:  LDN GPAGE       ;IF SIGNAL C
1639    07AC'   FA 04                           ANI 04
1640    07AE'   30 B0'                          BR IFAC?
1641                                    ;
1642    07B0'   CA 0000*                IFAC?:  LBNZ JUMP       ;JUMP TO aaaa IF SIGNAL
1643    07B3'   C0 079B'                        LBR IFACXT      ;IF NOT, GO TO NEXT PPC
1644                                    ;
1645                                    ;
1646                                    ;
1647                                    ;*************** 200 mSEC. RELAY PULSE SUBROUTINE ***************************
1648                                    ;
1649    07B6'   F8 42                   PULSE:  LDI PULNUM
1650    07B8'   A7                              PLO GPAGE
1651    07B9'   46                              LDA LIST        ;Get Relay Driver # from LIST
1652    07BA'   E7                              SEX GPAGE
1653    07BB'   73                              STXD            ;Store Relay Driver # at GPAGE = PULNUM
1654    07BC'   46                              LDA LIST        ;Get Pulse time from LIST (time = 25mSec X LIST)
1655    07BD'   73                              STXD            ;Set Pulse time counter
1656    07BE'   F8 AC                           LDI 0ACH
```

```
1657    07C0'  57                       STR GPAGE       ;Set Pulse Flag = AC (active)
1658    07C1'  E2                       SEX STACK
1659                                    SRET R6         ;Return from this routine
1660    07C2'  68 96            +
1661                            ;
1662                            ;
1663                            ;
1664                            ; ****************** END OF EXTENDED SEQUENCER FUNCTIONS ********************
1665                            ;
1666                            ; ********************************************************************************
1667                            ;
1668                                    END
```

MACROS:

BCI	BXI	CALL	CID	CIE	DACI	DADC	DADD
DADI	DBNZ	DSAV	DSBI	DSM	DSMB	DSMI	DTC
ETQ	EXIT	GEC	IDLE	LDC	POP	PPAGE	PUSH
RLDI	RLXA	RNX	RSXD	SCAL	SCM1	SCM2	SPM1
SPM2	SRET	STM	STPC	TCAL	TRET	XID	XIE

SYMBOLS:

ACSTAT	0081	AD5H8	0091	AD5L4	0092	ADFLG	00B0
ADGH8	008D	ADGL4	008E	ADHI8	0003	ADLO4	0002
ADON	0030'	ADRH8	008F	ADRL4	0090	ADT0H8	00A7
ADT0L4	00A8	ADT1H8	0095	ADT1L4	0096	ADT2H8	0097
ADT2L4	0098	ADT3H8	0099	ADT3L4	009A	ADT4H8	009B
ADT4L4	009C	ADT5H8	009D	ADT5L4	009E	ADT6H8	009F
ADT6L4	00A0	ADT7H8	00A1	ADT7L4	00A2	ADT8H8	00A3
ADT8L4	00A4	ADT9H8	00A5	ADT9L4	00A6	AR1	001C
AR10	001B	AR100	001A	ARFLG	001D	ASTK	000E
ASTKHI	0064	ASTKLO	0065	ASTKTP	527F	ATFLG	001E
ATMFLG	001F	BAT1	0002	BAT2	0003	BAT3	0004
BATT	0100'	BATT1	0114'	BATT2	0118'	BATT3	011C'
BATTRY	0019'	BATTSY	008C	BATTUP	008B	BATTXT	0120'
BLT	0000	BR2CNT	007D	BUF9	0020	BUFFER	5B00
BUFPG	005B	CAMCNT	0088	CAMERA	0006	CLEAN	06F8'
CMPASS	0002	CMPSS	0084	CNTRL1	0003	CNTRL2	0005
CNTRL3	0007	CRCHI	0006	CRCLO	0007	CRCRAM	0005
CTAHI	006C	CTALO	006D	CTAVHI	006E	CTAVLO	006F
CTBHI	0070	CTBLO	0071	CTBVHI	0072	CTBVLO	0073
CTCHI	0074	CTCLO	0075	CTCVHI	0076	CTCVLO	0077
CYCCNT	0008	CYCLES	0019	D1	0012	D10	0011
D100	0010	DATA1	0002	DATA2	0004	DATA3	0006
DECPPC	0623*	DMA	0000	DONE	00FF	ERROR	0080
ETX	0003	EXPNUM	000F	EXTE0	0000'	FLAGA	0069
FLAGB	006A	FLAGC	006B	FLASH	00C0'	FLASHX	0730'
FLUM	00AC'	FLUMX	0701'	FORMT1	0012	GLOPG	0050
GP	5000	GPAGE	0007	GROUP	0001	GRPSAV	000A
H1	0014	H10	0013	HALT	0006	HDG	0085
HDGEXP	00BF	HDGFLG	00B3	HDGIN	02AA*	HDGPWR	0005
HDGVAL	0020	HEADNG	0004	HLATCH	0003	HSHIFT	0004
HYDRU	06DD'	HZ	0028	IFAC?	0730'	IFACA	07A1'
IFACB	07A6'	IFACC	07AB'	IFACU	00F8'	IFACUX	0788'
IFACXT	079B'	IFBOT	076C'	IFINS	0774'	IFRETR	077F'
IFSW	00F0'	IFSWX	0753'	IFSWXT	0766'	INCPPC	0751*
INSRT	0715'	INTCRL	F840	INTMSK	F800	INTPC	0001
INTPG	00F8	INTPOL	F840	INTSTA	F800	INTVEC	F880
IOA	0006	IOCLR	0004	IOCTEL	0005	IOLOC	00FE
IOSTAT	0005	JUMP	07B1*	L2BUF	00C0	LDVRST	0005
LIST	0006	M1	0016	M10	0018	MEMORY	0007
MEMPTR	00AE	MUX	0002	MUXPTR	00AD	NULL	00AF
PC	0003	PDSTAT	0083	PING	0007	PINGR	0024'

```
PINGRX  0123'   PITCH   0089    PLEVEL  0002    PMPS    0060'
PMPS0   01B5'   PMPS1   01AF'   PMPS2   01AE'   PMPSPD  0006
PMPSX   019B'   PMTCHR  003A    PNGAGN  0137'   PNGCY1  0164'
PNGCY2  0130'   PNGCY3  0189'   PNGCY4  0192'   PNGCY5  0152'
PNGXT1  016C'   PNGXT2  016F'   PORTB   0007    POS0    0637'
POS1    0650'   POSERR  0625'   POSOK   0619'   POSX    0342'
POSXT1  0622'   POSXT2  061E'   POSXY   0098'   POSZ    009C'
PPC     000C    PPCCNT  0068    PPCHI   0060    PPCLO   0061
PULCNT  0041    PULFLG  0040    PULNUM  0042    PULSE   07B6'
PULXN   038C'   PULXP   0383'   PULYN   039E'   PULYP   0395'
PULZN   03B0'   PULZP   03A7'   PUMP    00A8'   PUMP1   0086
PUMP2   0087    PUMPR1  0727'   PUMPX   06C4'   RBHI    0008
RBLO    0009    RCCW    022B'   RCNT    0326'   RCNTX1  033B'
RCNTX2  033D'   RCW     0223'   RECFLG  00B2    RELAYS  0007
RETRAC  071E'   RLDV    00D0'   RLDVX   0745'   ROLL    008A
ROT     0080'   ROT0    02FD'   ROT00   023A'   ROT0ER  0269'
ROT0N   0254'   ROT0OK  0273'   ROT1    0316'   ROTC0   02D7'
ROTCOR  02D1'   ROTERR  02EB'   ROTH0   0283'   ROTH?   028E'
ROTHDG  027D'   ROTHER  02BD'   ROTHN   02A7'   ROTHOK  02C7'
ROTOK   02DF'   ROTRTN  0233'   ROTX    01FD'   ROTXT   0220'
ROTXT1  02E8'   ROTXT2  02E4'   RSTK    000D    RSTKHI  0062
RSTKLO  0063    RSTKTP  523F    RTNPTR  0006    RTTY2   000F
SAM1    00A0'   SAM1X   0660'   SAM2    00A4'   SAM2X   0691'
SAVPPC  079F*   SDLNGT  0029    SDON    0050'   SDREQ   0003
SEC1    0018    SEC10   0017    SED1I   0676'   SED1R   067F'
SED1U   0688'   SED2I   06A9'   SED2R   06B2'   SED2U   06BB'
SEQFAS  0066    SEQRAT  0067    SETCLR  0053*   SPARE1  06E6'
SSTKPG  0052    STACK   0002    STAT1   0003    STAT2   0005
STAT3   0007    STKEND  53DF    STKPG   0053    SUCT    06EF'
SWITCH  0002    SWSTAT  0082    SYSFLG  0003    SYSTEM  0007
TILERR  01F0'   TILT    0070'   TILTOK  01E3'   TILTX   01BD'
TIME01  003C    TIME02  00F0    TLEVEL  005A    TLIMIT  0006
TRFLG   00B1    TRON    0040'   TTY2HI  007E    TTY2LO  007F
UARTS   0006    X       0003    X0      03B9'   X00     03C8'
X0ERR   0406'   X0N     03E4'   X0OK    0410'   XINC    041A'
XINC0   042A'   XINCER  0463'   XINCN   0446'   XINCOK  0473'
XPOS    0093    XY      0090'   XYZFLG  00B4    Y0      0482'
Y00     0492'   Y0ER    04CE'   Y0N     04AD'   Y0OK    04D8'
YINC    04E2'   YINC0   04F2'   YINCER  053E'   YINCN   0512'
YINCOK  0548'   YZ      0004    YZPOS   0094    Z       0094'
Z0      0552'   Z00     0562'   Z0ERR   05A0'   Z0N     057E'
Z0OK    05AA'   ZINC    05B4'   ZINC0   05C4'   ZINCER  0608'
ZINCN   05E0'   ZINCOK  0612'
```

NO FATAL ERROR(S)

ACSTAT 44# 222 281 1615
AD5H8 44#
AD5L4 44#
ADFLG 44# 89
ADGH8 44#
ADGL4 44#
ADHI8 44#
ADLO4 44#
ADON 89#
ADRH8 44#
ADRL4 44#
ADT0H8 44#
ADT0L4 44#
ADT1H8 44#
ADT1L4 44#
ADT2H8 44#
ADT2L4 44#
ADT3H8 44#
ADT3L4 44#
ADT4H8 44#
ADT4L4 44#
ADT5H8 44#
ADT5L4 44#
ADT6H8 44#
ADT6L4 44#
ADT7H8 44#
ADT7L4 44#
ADT8H8 44#
ADT8L4 44#
ADT9H8 44#
ADT9L4 44#
AR1 44#
AR10 44#
AR100 44#
ARFLG 44#
ASTK 44# 225 250 237 291 298 305 352 376 386 442 443
521 522 554 612 630 631 803 833 885 914 968 970
1050 1056 1089 1143 1145 1226 1228 1257 1296 1315
ASTKHI 44#
ASTKLO 44#
ASTKTP 44#
ATFLG 44#
ATMFLG 44#
BAT1 44# 196
BAT2 44# 200
BAT3 44# 204
BATT 75 183#
BATT1 189 196#

```
BATT2     191     200#
BATT3     193     204#
BATTRY     75#
BATTSY     44#
BATTUP     44#
BATTXT    194     198     202     206     208#
BCI        28#
BLT        44#
BR2CNT     44#
BUF9       44#
BUFFER     44#
BUFPG      44#      44
BXI        28#
CALL       28#
CAMCNT     44#    1539
CAMERA     44#    1536
CID        28#
CIE        28#
CLEAN    1452    1476#
CMPASS     44#
CMPSS      44#     510
CNTRL1     44#
CNTRL2     44#
CNTRL3     44#
CRCHI      44#
CRCLO      44#
CRCRAM     44#
CTAHI      44#
CTALO      44#
CTAVHI     44#
CTAVLO     44#
CTBHI      44#
CTBLO      44#
CTBVHI     44#
CTBVLO     44#
CTCHI      44#
CTCLO      44#
CTCVHI     44#
CTCVLO     44#
CYCCNT     44#
CYCLES     44#     236     682     832     919     999    1094    1174    1262
DI         44#
DIO        44#
DIOO       44#
DACI       28#
DADC       28#
DADD       28#
DADI       28#
DATAI      44#
```

DATA2 44#
DATA3 44#
DBN2 28#
DECPPC 60# 272 616 1300
DMA 44#
DONE 44#
DSAV 28#
DSBI 28#
DSM 28#
DSMB 28#
DSMI 28#
DTC 28#
ERROR 44# 369 379 618 642 1303 1327
ETQ 28#
ETX 44#
EXIT 28#
EXPNUM 44#
EXTSO 68# 74 82 88 93 98 103 107 111 115 119 123
127 131 135 139 143 147 151 155 159 167 174
FLAGA 44#
FLAGB 44#
FLAGC 44#
FLASH 152#
FLASHX 152 1528#
FLUM 148#
FLUMX 148 1486#
FORMII 44#
GEC 28#
GLOPG 44# 44
GP 44#
GPAGE 44# 216 217 220 223 224 231 237 238 257 258 260
267 269 277 279 282 283 285 316 326 330 334 335
336 347 348 355 356 362 363 370 371 373 380 381
383 395 396 433 434 439 440 469 470 505 506 511
512 514 516 551 552 590 591 596 597 619 620 622
638 640 643 644 646 649 651 653 655 662 666 667
668 671 673 683 684 689 694 695 696 737 738 793
794 799 800 826 827 833 834 838 839 841 869 870
875 876 881 882 908 909 920 921 925 926 928 954
955 960 961 966 967 993 994 1000 1001 1005 1006 1008
1036 1037 1042 1043 1048 1049 1079 1080 1095 1096 1130 1131
1203 1129 1130 1135 1136 1141 1142 1168 1169 1175 1176 1180
1181 1183 1212 1213 1218 1219 1224 1225 1251 1252 1263 1264
1268 1269 1271 1304 1305 1307 1323 1325 1328 1329 1331 1334
1336 1338 1340 1347 1349 1351 1352 1355 1357 1540 1541 1543
1576 1590 1595 1601 1616 1630 1634 1638 1650 1652 1657
GROUP 44# 184 234 823 905 990 1076 1165 1248 1533 1536
GRPSAV 44#
H1 44#

H10 44#
HALT 44#
HDG 44# 438 468 550 595
HDG2XP 44# 515
HDGFLG 44# 637 670
HDGIN 61# 466 548
HDGPWR 44#
HDGVAL 44#
HEADNG 44#
HLATCH 44#
HSHIFT 44#
HYDRU 1446 1455#
HZ 44#
IDLE 28#
IFAC? 1632 1636 1640 1642#
IFACA 1619 1630#
IFACB 1621 1634#
IFACC 1623 1638#
IFACU 168#
IFACUX 168 1615#
IFACXT 1625# 1643
IFBGT 1579 1590#
IFINS 1581 1595#
IFRETR 1583 1601#
IFSW 160#
IFSWX 160 1575#
IFSWXT 1585# 1592 1599 1603
INCPPC 60# 208 288 324 331 337 344 411 613 738 745 752
759 766 773 780 1297 1371 1378 1386 1393 1400 1407 1414
1422 1429 1436 1453 1460 1467 1474 1481 1496 1503 1510 1517
1530 1545 1553 1563
INSRT 1489 1498#
INTCRL 44#
INTMSK 44#
INTPC 44# 71 183 233 822 904 989 1075 1164 1247 1532 1555
INTPG 44# 44 44 44 44 44
INTPOL 44#
INTSTA 44#
INTVEC 44#
IOA 44#
IOCLR 44#
IOCTEL 44#
IOLOC 44#
IOSTAT 44#
JUMP 60# 1593 1598 1604 1642
L2BUF 44#
LDC 28#
LDVRST 44# 1559
LIST 44# 1651 1654

M1 44#
M10 44#
MEMORY 44#
MEMPTR 44#
MUX 44#
MUXPTR 44#
NULL 44#
PC 44#
PDSTAT 44#
PING 44# 253 264 294 301 308
PINGR 83#
PINGRX 83 215# 350 377 387 398 631 790 872 957 1039 1132
1215 1316
PITCH 44# 354
PLEVEL 44#
PMPS 104#
PMPS0 319 333#
PMPS1 321 328#
PMPS2 323 326#
PMPSPD 44#
PMPSX 104 315#
PMTCHR 44#
PNGAGN 218 233#
PNGCY1 240 264#
PNGCY2 242 291#
PNGCY3 244 298#
PNGCY4 246 305#
PNGCY5 250#
PNGXT1 248 262 272# 296 303 310
PNGXT2 261 276#
POP 28#
PORTB 44#
POS0 810 892 977 1063 1152 1235 1322#
POS1 1294 1312 1346#
POSERR 852 939 1019 1114 1195 1282 1303#
POSOK 862 947 1029 1122 1205 1291#
POSX 120 124 128 132 712#
POSXT1 819 836 843 901 923 930 986 1303 1310 1072 1098 1105
1161 1178 1185 1244 1266 1273 1300#
POSXT2 805 887 972 1058 1147 1230 1296#
POSXY 128#
POSZ 132#
PPAGE 28#
PPC 44# 68 69 186 317 328 329 342 400 713 1369 1405
1444 1487 1528 1551 1577 1585 1586 1587 1617 1625 1626 1627
PPCCNT 44# 215 256 432 504 589 648 661 693 792 837 874
924 959 1004 1041 1099 1134 1179 1217 1267 1333 1346
PPCHI 44#
PPCLO 44#

PULCNT 44#
PULFLG 44#
PULNUM 44# 1649
PULSE 416 424 456 486 495 539 573 581 742 749 756 763
770 777 815 849 858 897 936 944 982 1016 1025 1068
1111 1119 1157 1192 1201 1240 1279 1287 1383 1390 1397 1419
1426 1433 1457 1464 1471 1478 1500 1507 1514 1649#
PULXN 717 747#
PULXP 715 740#
PULYN 721 761#
PULYP 719 754#
PULZN 725 775#
PULZP 723 768#
PUMP 144#
PUMP1 44# 315
PUMP2 44#
PUMPR1 1493 1512#
PUMPX 144 1443#
PUSH 28#
RBHI 44#
RBLO 44#
RCCW 404 422#
RCNT 478 565 682#
RCNTX1 686 691 700#
RCNTX2 698 703#
RCW 402 414#
RECFLG 44# 99
RELAYS 44#
RETRAC 1491 1505#
RLDI 28#
RLDV 156#
RLDVX 156 1551#
RLXA 28#
RNX 28#
ROLL 44#
ROT 112#
ROT0 451 534 637#
ROT00 438#
ROT0ER 483#
ROT0N 435 463#
ROT0OK 472 492#
ROT1 610 627 661#
ROTC0 595#
ROTCOR 410 589#
ROTERR 489 576 618#
ROTH0 510#
ROTH? 521# 601
ROTHDG 498 504#
ROTHER 570#

ROTHN 507 545# 592
ROTHOK 559 578#
ROTOK 498 584 607#
ROTRTN 406 432#
ROTX 112 116 394#
ROTXT 411# 419 427
ROTXT1 460 480 542 567 616#
ROTXT2 446 525 528 612#
RSTK 44#
RSTKHI 44#
RSTKLO 44#
RSTKTP 44#
RSXD 28#
RTNPTR 44#
RTTY2 44#
SAM1 136#
SAM1X 136 1368#
SAM2 140#
SAM2X 140 1404#
SAVPPC 60# 1588 1628
SCAL 28# 414 422 449 454 464 476 484 493 532 537 546
563 571 579 608 625 740 747 754 761 768 775 808
813 847 856 890 895 934 942 975 980 1014 1023 1061
1066 1109 1117 1150 1155 1190 1199 1233 1238 1277 1285 1292
1310 1381 1388 1395 1417 1424 1431 1455 1462 1469 1476 1498
1505 1512
SCM1 28#
SCM2 28#
SDLNGT 44#
SDON 99#
SDREQ 44#
SEC1 44#
SEC10 44#
SED1I 1373 1381#
SED1R 1375 1388#
SED1U 1377 1395#
SED2I 1409 1417#
SED2R 1411 1424#
SED2U 1413 1431#
SEQFAS 44#
SEQRAT 44# 266 276 346 394 786 868 953 1035 1128 1211
SETCLR 60# 90 95 100
SPARE1 1448 1462#
SPM1 28#
SPM2 28#
SRET 28# 657 675 700 706 1342 1359 1659
SSTKPG 44# 44 44
STACK 44# 448 453 463 475 483 492 531 536 545 562 570
578 607 624 712 807 812 846 885 889 894 912 913

	933	941	974	979	1013	1022	1060	1065	1087	1088	1108	1116
	1149	1154	1189	1198	1232	1237	1255	1256	1276	1284	1291	1309
	1368	1404	1443	1486	1658							
STAT1	44#											
STAT2	44#											
STAT3	44#											
STKEND	44#											
STKPG	44#	44										
STM	28#											
STPC	28#											
SUCT	1450	1469#										
SWITCH	44#											
SWSTAT	44#	1575										
SYSFLG	44#											
SYSTEM	44#											
TCAL	28#											
TILERR	358	360	365	367	379#							
TILT	108#											
TILTOK	369#											
TILTX	108	342#										
TIME01	44#	842	929	1009	1104	1184	1272					
TIME02	44#	697										
TLEVEL	44#	357	364									
TLIMIT	44#	357	359	364	366							
TRET	28#											
TRFLG	44#	94										
TRON	94#											
TTY2HI	44#											
TTY2LO	44#											
UARTS	44#											
X	44#	828	910									
XO	727	786#										
XOO	798#											
XOERR	846#											
XON	795	822#										
XOOK	830	855#										
XID	28#											
XIE	28#											
XINC	729	868#										
XINCO	880#											
XINCER	933#											
XINCN	877	904#										
XINCOK	917	941#										
XPOS	44#	798	825	880	907							
XY	120#											
XYZFLG	44#	1322	1354									
YO	731	953#										
YOO	965#											
YOER	1013#											

YON 962 989#
YOOK 997 1022#
YINC 733 1035#
YINCO 1047#
YINCER 1108#
YINCN 1044 1075#
YINCOK 1092 1116#
YZ 44# 995 1081 1170 1253
YZPOS 44# 965 992 1047 1078 1140 1167 1223 1250
Z 124#
ZO 735 1128#
ZOO 1140#
ZOERR 1189#
ZON 1137 1164#
ZOOK 1172 1198#
ZINC 737 1211#
ZINCO 1223#
ZINCER 1276#
ZINCN 1220 1247#
ZINCOK 1260 1284#

APPENDIX D

HXRCA - Intel .HEX file format to .RCA file format conversion.

The following BASIC program converts Intel HEX format object code files created by the Syscon assemblier - linker to RCA file format. In this version, the HEX file resides on a ram disk called drive M. This must be changed for use in other systems. The M drive is specified on lines 40 and 80 of the program.

```
10 'Program to read .HEX file from the M: drive and write a .RCA file.
20 'W. Terry, A. Bradley - 1986
30 'This section selects input file
40 G$="M:*.*"
50 FILES G$
60 PRINT"FILE TO READ? (must be M:nnnnnn.HEX, just input without extension)"
70 INPUT F$
80 F$="M:"+F$
90 PRINT F$+".HEX";" OK?";:INPUT Y$
100 IF Y$<>"Y" GOTO 60
110 '
120 'Now open the .HEX and .RCA files
130 OPEN "I",#1,F$+".HEX"
140 OPEN "O",#2,F$+".RCA"
150 R$="!M "
160 '
170 'Read a line at a time and translate
180 INPUT#1, L$ 'get Intel line
190 L=LEN(L$)
200 N$=MID$(L$,2,2) 'get length in hex
210 H$=N$:GOSUB 500 'convert HEX byte to DEC
220 IF H=0 GOTO 280
230 PRINT#2, R$+";"
240 A$=MID$(L$,4,4)
250 D$=MID$(L$,10,2*H)
260 R$=A$+" "+D$
270 GOTO 170
280 ' Print final line
290 PRINT#2, R$
300 RESET 'close disk files
310 SYSTEM
320 STOP
330 '
500 ' Convert H$ in hex to H in dec.
510 ' Convert H$ in hex to H in dec
520 H=ASC(RIGHT$(H$,1))-48
530 IF H>9 THEN H=H-7
540 H1=ASC(LEFT$(H$,1))-48
550 IF H1>9 THEN H1=H1-7
560 H=H+16*H1
570 RETURN
```

Appendix E

Sea Duct Monitor Cyclic Redundancy Check (CRC)

Calculation of a CRC checksum over a block of memory is reputed to be the remainder from a division. The entire data block is divided by a special 16 bit constant and the CRC is the remainder. The constant is chosen such that the probability of a random change in the data block giving the same CRC value is minimal.

The procedure is as follows:

1. Set the 16 bit CRC variable to zero.

2. Call the CRC subroutine and give it the first byte of the data block. The subroutine will modify the CRC.

3. Call the CRC subroutine again, this time passing it the next data byte. Repeat this until you have given it all the bytes in the block.

4. The final CRC is now valid for the data block.

The CRC subroutine

Variable use:

```
B  = data byte passed in the call
CH = high byte of the 16 bit CRC
CL = low byte of the 16 bit CRC
S  = a scratch byte
```

```
1.  S = B XOR CH                      :Constants shown base 16
2.  S = (S/16) XOR S                  :Integer arithmetic
3.  CH= CL XOR ((S*16) mod 256)       :mod 256 arithmetic
4.  CH= CH XOR (S/8)
5.  CL= S XOR ((S*32) mod 256)
R.  Return from subroutine
```

Notice that this can be done easily in 8 bit machine code using logical shifts and XOR.

Debug Test: The CRC over a string of 0 bytes stays 0. The CRC over the four bytes 11 22 33 44 is DD33. The CRC over the string 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F is 513D.

Appendix F

Radio Shack TRS-80 Model 100 Communication with SAIL and MCALL

To use the Radio Shack Mod.100 with MCall:

Set MCALL to:
Echoplex, 2400 Baud, X-ON/X-OFF,
7 Data, Even Parity, 1 Stop bit

For two way communication:
Get the M-100 running in TELCOM,
M-100 status = 67E1D, Half Duplex

To send a file to the M-100:
Set the M-100 to half duplex (see above)
Enter the text mode for a new file and name the new file.
To replace an existing file, enter the text mode by running the file name, then clear the file.

MCALL - Use (esc.)F to name the file to send.
M100 - Use "LOAD" - Load from COM:67E1D
MCALL - Use (esc.)T to send

To send a file to MCALL:
Set the M-100 to half duplex (see above)
Enter the text mode by running the file name.
MCALL - Use (esc.)F name the file to receive.
MCALL - Use (esc.)R to receive the file.
M100 - Use "SAVE" - Save to COM:67E1D

To use the Radio Shack M-100 with SAIL:

(Assumes 300 Baud, 7 data, Even Par., 1 Stop, RCA format):

For two way communication:
Get the M-100 running in TELCOM,
M-100 status = 37E1D, Full Duplex

To send a file to a SAIL instrument:
Set the M-100 to full duplex (see above)
Enter the text mode by running the file name.
M100 - Use "SAVE" - Save to COM:67E1D
(Assumes a !M; at the start of the file.)

Appendix G

Electrochem Lithium Battery Warning

The page copied below is included with the Lithium batteries supplied by Electrochem Industries, Inc. These batteries are used in the microprocessor and emergency hydrostatic release systems.

Electrochem Industries Inc
9990 Wehrle Drive
Clarence, New York 14031
716-759-2828

TLX 91-386

LITHIUM BATTERY

WARNING: FIRE, EXPLOSION AND SEVERE BURN HAZARD.

DO NOT SHORT CIRCUIT, CHARGE, FORCE OVER-DISCHARGE,

DISASSEMBLE, CRUSH, PENETRATE, INCINERATE, HEAT

ABOVE 72° C (162° F), OR BATTERY MAY LEAK OR EXPLODE

CELLS MAY BECOME SHORT CIRCUITED BY ALLOWING A CONDUCTIVE

(METALLIC, ETC.) MATERIAL TO COME IN CONTACT WITH THE LEADS.

CELLS MAY SWELL AND LEAK WHEN OPERATED AT BOTH MAXIMUM

RATED CURRENT AND MAXIMUM RATED TEMPERATURE.

FORM NO. 3-3000/0683
REV. B

Appendix H

Sea Duct Pump Controller Program Listing

```
2500 A.D. 6301 CROSS ASSEMBLER   -   VERSION 3.31g
-----------------------------------------------

        INPUT  FILENAME :  SDPUMP1.ASM
        OUTPUT FILENAME :  SDPUMP1.OBJ


 1                              TITLE SDPUMP1.ASM - SEA DUCT - 6301 SAIL PUMP CONTROLLER
 2                              SUBTITLE
 3                      :
 4                      :       A. Bradley, W. Terry
 5                      :
 6                      : Rev.  24 MAR 86  X COMMAND CLEARS REGISTERS.
 7                      :       06 MAR 86  First version.
 8
 9                      :       SAIL portion interrupt driven by SCI
10                      :       PARITY SEEMS TO WORK, BUT THE ?MF000 1000 SEEMS TO
11                      :       HANG WITH THE MAC AT 9600, GET BETTER TERMINAL?
12                      :
13                      :
14                              RADIX   H       :SET HEX DEFAULT
15  0000                        CODE
16                              ABSOLUTE
17                      :
18                      :-------------------------------------------------------------------
19                      :
20          00 00       DDR1:           EQU     0
21          00 01       DDR2:           EQU     1
22          00 02       PORT1:          EQU     2       : |brk.x.x.x|x.x.P2 . P1|
23                      :                               : |flg.         .ebl.ebl|
24                      :
25          00 03       PORT2:          EQU     3       : |X.X.X|SDO.SDI.SCK|TOUT.TIN|
26                      :                               : |mode | serial     | timer  |
27          00 04       DDR3:           EQU     4
28          00 05       DDR4:           EQU     5
29          00 06       PORT3:          EQU     6       : pump 1 power control
30          00 07       PORT4:          EQU     7       : pump 2 power control
31          00 08       TCSR:           EQU     $8      : |ICF.OCF.TOF|EICI.EOCI.ETOI|EDG.OLVL|
32                      :                               : | int flags | int masks     . in   out|
33          00 09       COUNTHI:        EQU     $9      : Counter HI (1st)
34          00 0A       COUNTLO:        EQU     $A      :         LO (2nd)
35          00 0B       COMPARHI:       EQU     $B      : Out compare HI
36          00 0C       COMPARLO:       EQU     $C      :            LO
37          00 0D       CAPTURHI:       EQU     $D      : Input Capture HI
38          00 0E       CAPTURLO:       EQU     $E      :              LO
39          00 0F       P3CSR:          EQU     $F      :PORT3 C/S REG
40          00 10       TRMCR:          EQU     $10     :XFR RATE & MODE CONTROL
41                      :                               : |x.x.x.x|CC1.CC0.SS1.SS0|
42          00 11       TRCSR:          EQU     $11     :T/R CONTROL & STATUS REG
43                      :                               : |RDRF.ORFE.TDRE.RIE.RE.TIE.TE.WU|
44          00 12       RECD:           EQU     $12     :REC'D DATA
45          00 13       XDATA:          EQU     $13     :XMIT DATA
46          00 14       RAMCON:         EQU     $14     : |STDBY PWR.RAME.x.x.x.x.x|
47                      :-------------------------------------------------------------
48                      : SAIL inteface RAM workspace
```

```
                                00 80           RJUMP:          EQU     $80     :JUMP INST GOES HERE..
                                00 81           RVECT:          EQU     $81     :       HI
                                                :               EQU     $82     :       LO
                                00 83           XJUMP:          EQU     $83     :XMIT JUMP INST
                                00 84           XVECT:          EQU     $84     :       HI
                                                :               EQU     $85     :       LO
                                00 86           JUMP2:          EQU     $86     :2ND  JUMP INST
                                00 87           VECT2:          EQU     $87     :       HI
                                                :               EQU     $88     :       LO
                                00 89           SCRTCH1:        EQU     $89     :SCRATCH LOC 1
                                00 8A           SCRTCH2:        EQU     $8A     :SCRATCH LOC 2
                                00 8B           SCRTCH3:        EQU     $8B     :SCRATCH LOC 3
                                00 8C           SCRTCH4:        EQU     $8C     :SCRATCH LOC 4
                                00 8D           SCRTCH5:        EQU     $8D     :SCRATCH LOC 5
                                                :
                                00 8E           BMODE:          EQU     $8E     :SAIL BREAK MODE
                                                :                               ;brk.x.x.x!x.x.x.x;
                                                :                                 ;flg.           ;
                                00 8F           STATUS:         EQU     $8F     :REPLY STATUS
                                                ;-------------------------------------------------------------
                                                ; general workspace
                                                :
                                00 90           PUMP:           EQU     $90     :PUMP ADDRESS
                                                :               EQU     $91     :       "
                                                :
                                                ;*************************************************************
                                                :
F000                                                    ORG     $F000   :ASSUME 32K EPROM
                                                ;  SAIL Address stored here..
F000  23 50 43                  ADDR:   DB      '#PC'   :SAIL ADDRESS
F003  00                                DB      $00     :TERMINATOR
F004  00 00 00 00                       DB      $00,$00,$00,$00 :SPACE FOR LONG ADDRESS..
                                                :
                                                ;-------------------------------------------
F008  8E 00 FF                  START:  LDS     #$00FF  :SET STACK POINTER
F00B  86 7F                             LDAA    #$7F    :PREPARE PORT 1
F00D  97 00                             STAA    DDR1    :AS OUTPUT WITH MSB AS BREAK DETECT
F00F  86 00                             LDAA    #$00    : AND DISABLE PUMPS
F011  86 12                             LDAA    #$12    :PREPARE PORT 2
F013  97 01                             STAA    DDR2    :FOR FUTURE TIMER USE
F015  86 FF                             LDAA    #$FF    :PREPARE PORT 3
F017  97 04                             STAA    DDR3    :AS PUMP 1 CONTROL
F019  7F 00 06                          CLR     PORT3   : AND CLEAR
F01C  86 FF                             LDAA    #$FF    :PREP PORT 4
F01E  97 05                             STAA    DDR4    :AS PUMP 2 CONTROL
F020  7F 00 07                          CLR     PORT4   : AND CLEAR
                                                :
F023  7F 00 89                          CLR     SCRTCH1 :USE AS SAIL MODE FLAG & ADDR POINTER
F026  86 7E                             LDAA    #$7E    :MUST WRITE JMP INSTS.
F028  97 80                             STAA    RJUMP   :FOR SAIL DRIVER
F02A  97 83                             STAA    XJUMP
F02C  97 86                             STAA    JUMP2
F02E  CC F9 78                          LDD     #SETUMAD        :SET VECTORS TO INITIAL VALUES
F031  DD 81                             STD     RVECT
F033  DD 84                             STD     XVECT
                                                :
F035  86 04                             LDAA    #$04    :ENABLE ETOI (TIMER OVERFLOW INTERRUPT)
```

```
106  F037  97 08              STAA   TCSR
107  F039  86 0C              LDAA   #$0C     :EXTERNAL CLOCK
108  F03B  97 10              STAA   TRMCR
109  F03D  86 1A              LDAA   #$1A     : SET RE TE RIE TO INIT SERIAL &
110  F03F  97 11              STAA   TRCSR    :ALLOW SERIAL INTERRUPTS FOR REC NOW
111                           :
112  F041  86 2A              LDAA   #'*'
113  F043  97 8F              STAA   STATUS   :INITIALIZE STATUS
114  F045  7F 00 8E           CLR    BMODE    :AND MODE FLAG
115                           :
116  F048  0E                 CLI             :AND ALLOW INTERRUPTS
117  F049  1A           DOZE: SLP             :SLEEP BETWEEN INTERRUPTS
118  F04A  20 FD              BRA    DOZE     :TO MINAMIZE POWER DRAIN
119                           :
120                           :*************************************************************
121                           :  HELP FILE
122                                  LIST ON
123  F800                     ORG    $F800
124  F800  6C 70 0D 0A  HELPFIL:DB    'lp',$0D,$0A
125  F804  4D 6F 6E 69        DB     'Monitor Commands (enter via _ or ? or !)',$0D,$0A
     F808  74 6F 72 20
     F80C  43 6F 6D 6D
     F810  61 6E 64 73
     F814  20 28 65 6E
     F818  74 65 72 20
     F81C  76 69 61 20
     F820  5F 20 6F 72
     F824  20 3F 20 6F
     F828  72 20 21 29
     F82C  0D 0A
126  F82E  20 5F 20 28        DB     ' _ (space) enter monitor*',$0D,$0A
     F832  73 70 61 63
     F836  65 29 20 65
     F83A  6E 74 65 72
     F83E  20 6D 6F 6E
     F842  69 74 6F 72
     F846  2A 0D 0A
127  F849  20 3F 4D 61        DB     ' ?Maaaa_llllcr *',$0D,$0A
     F84D  61 61 61 5F
     F851  6C 6C 6C 6C
     F855  63 72 20 2A
     F859  0D 0A
128  F85B  20 21 4D 61        DB     ' !Maaaa_dd...cr *',$0D,$0A
     F85F  61 61 61 5F
     F863  64 64 2E 2E
     F867  2E 63 72 20
     F86B  2A 0D 0A
129  F86E  20 20 77 69        DB     '  with all RCA UT4 conventions',$0D,$0A
     F872  74 68 20 61
     F876  6C 6C 20 52
     F87A  43 41 20 55
     F87E  54 34 20 63
     F882  6F 6E 76 65
     F886  6E 74 69 6F
     F88A  6E 73 0D 0A
130  F88E  43 6F 6E 74        DB     'Control Commands',$0D,$0A
     F892  72 6F 6C 20
```

```
     F896  43 6F 6D 6D
     F89A  61 6E 64 73
     F89E  0D 0A
131  F8A0  20 21 50 31          DB      ' !P1hh_ ,!P2hh_ set pump power to hh *',$0D,$0A
     F8A4  68 68 5F 20
     F8A8  2C 21 50 32
     F8AC  68 68 5F 20
     F8B0  73 65 74 20
     F8B4  70 75 6D 70
     F8B8  20 70 6F 77
     F8BC  65 72 20 74
     F8C0  6F 20 68 68
     F8C4  20 2A 0D 0A
132  F8C8  20 3F 50 31          DB      ' ?P1 , ?P2 shows current pump setting *',$0D,$0A
     F8CC  20 2C 20 3F
     F8D0  50 32 20 73
     F8D4  68 6F 77 73
     F8D8  20 63 75 72
     F8DC  72 65 6E 74
     F8E0  20 70 75 6D
     F8E4  70 20 73 65
     F8E8  74 74 69 6E
     F8EC  67 20 2A 0D
     F8F0  0A
133  F8F1  20 58 20 28          DB      ' X (may be 'PCX only) Immeadiate Shutdown',$0D,$0A
     F8F5  6D 61 79 20
     F8F9  62 65 20 7E
     F8FD  50 43 58 20
     F901  6F 6E 6C 79
     F905  29 20 49 6D
     F909  6D 65 61 64
     F90D  69 61 74 65
     F911  20 53 68 75
     F915  74 64 6F 77
     F919  6E 0D 0A
134  F91C  0D 0A                DB      $0D,$0A
135  F91E  20 2A 20 72          DB      ' * returns prompt '
     F922  65 74 75 72
     F926  6E 73 20 70
     F92A  72 6F 6D 70
     F92E  74 20
136  F930  00 00                DB      $00,$00         :TERMINATOR
137                        ;*************************************************************
138                        :  SCI INTERRUPT HANDLER (SAIL DRIVER)
139  F932  7B 40 11        SCISTRT:TIM     #$40,TRCSR      :TEST ORFE
140  F935  27 03                BEQ     CKCHAR
141                             LIST OFF
142  F937  96 12                LDAA    RECD            :READ BAD CHAR TO CLEAR?
143  F939  3B              SCIXIT: RTI                     : & EXIT
144                        :
145  F93A  7B 80 11        CKCHAR: TIM     #$80,TRCSR      :TEST DA
146  F93D  26 03                BNE     READD           :IF NOT, XMIT
147  F93F  7E FC 10             JMP     CHECKX
148                        :
149  F942  96 12           READD:  LDAA    RECD            :READ DATA TO A..
150  F944  16                   TAB                     :AND COPY TO B
151  F945  CE FD 66             LDX     #PARITY         :POINT PARITY TABLE
```

```
F948  3A                  ABX                 :POINT INTO PARITY TABLE
F949  E6 00               LDAB   0,X          :GET PARITY WORD
F94B  26 EC               BNE    SCIXIT       :REJECT IF NOT EVEN PARITY
F94D  84 7F               ANDA   #$7F         :ELSE REMOVE PARITY FOR SUBSEQUENT TESTS
F94F  16                  TAB                 :(ALSO COPY TO B)
F950  C8 23               EORB   #'#'         :IS IT '#'?
F952  27 03               BEQ    GOTNUM
F954  7E 00 80            JMP    RJUMP        :ELSE GO THRU VECTOR
                          :
                          : SAIL ADDRESS RECOGNIZE SECTION
F957  C6 01               GOTNUM: LDAB   #01          : GOT # CODE
F959  D7 89               STAB   SCRTCH1      :SET SAIL FLAG TO 01
F95B  71 FB 11            AIM    #$FB,TRCSR   :OFF XMIT IF REQ'D?
F95E  CC F9 66            LDD    #READAD      :POINT READ ADDRESS
F961  DD 81               STD    RVECT
F963  7E F9 39            JMP    SCIXIT       :AND EXIT
                          :
F966  D6 89               READAD: LDAB   SCRTCH1      :GET SMODE COUNT
F968  C1 01               CMPB   #$01         :IS THIS THE FIRST CHAR?
F96A  26 04               BNE    TRYADD
F96C  81 30               CMPA   #'0'         :IF FIRST, IS IT '0'?
F96E  27 2E               BEQ    TSTBAUD      :IF SO, MAY BE BAUD SWITCH
                          :                   :CONTINUE ON BELOW...
F970  CE F0 00            TRYADD: LDX    #ADDR        :ELSE POINT X TO ADDR
F973  3A                  ABX                 :ADD TO X
F974  A1 00               CMPA   0,X          :COMPARE NEW CHAR TO A
F976  27 13               BEQ    NEXTAD       :IF MATCH, LOOK FOR NEXT CHAR
                          :
F978  CC F9 7D            SETUNAD:LDD    #UNADDR      :ELSE SET UNADDRESS STATE
F97B  DD 81               STD    RVECT
                          ;
F97D  7F 00 89            UNADDR: CLR    SCRTCH1      :CLEAR SAIL MODE TO 00
F980  71 FB 11            AIM    #$FB,TRCSR   :STOP XMIT INTRPTS
F983  CC FC 19            LDD    #XPASS       :SET XMIT VECTOR TO PASS
F986  DD 84               STD    XVECT
F988  7E F9 39            JMP    SCIXIT
                          :
                NEXTAD: INX                 :POINT NEXT ADD CHAR
F98C  7C 00 89            INC    SCRTCH1      :(& INC COUNTER)
F98F  6D 00               TST    0,X          :TEST IT,
F991  27 03               BEQ    GOTADDR      : TERMINATOR?
F993  7E F9 39            JMP    SCIXIT       :ELSE SAME VECTOR
                          :
F996  CC FA 1B            GOTADDR:LDD    #CONCHAR     :REC CONTROL CHAR NEXT..
F999  DD 81               STD    RVECT
F99B  7E F9 39            JMP    SCIXIT
                          :
                          :  TEST FOR BAUD CHANGE COMMAND
F99E  CC F9 A6            TSTBAUD:LDD    #BAUD2
F9A1  DD 81               STD    RVECT
F9A3  7E F9 39            JMP    SCIXIT
                          :
F9A6  81 30               BAUD2:  CMPA   #'0'         :GOT SECOND 0?
F9A8  27 03               BEQ    BAUD3
F9AA  7E F9 78            JMP    SETUNAD
                          :
F9AD  CC F9 BA            BAUD3:  LDD    #BAUD4       :HERE IF GOT #00 (BAUD CHANGE)
```

```
F9B0  DD 81           STD   RVECT
F9B2  CE 00 89        LDX   #SCRTCH1      :POINT TO 5 CHAR BUFFER
F9B5  DF 87           STX   VECT2         :SAVE AT VECT2
F9B7  7E F9 39        JMP   SCIXIT
                      :
F9BA  DE 87     BAUD4: LDX  VECT2         :GET POINTER
F9BC  81 20           CMPA  #' '          :IS IT SPACE?
F9BE  26 02           BNE   BAUD5
F9C0  86 30           LDAA  #'0'          :..CHAO 0'S
F9C2  A7 00     BAUD5: STAA 0,X           :STORE CHAR
F9C4  08              INX                 :ADVANCE POINTER
F9C5  8C 00 8E        CPX   #SCRTCH1+5    :PAST END OF 5 CHAR BUFFER?
F9C8  27 05           BEQ   BAUD6
F9CA  DF 87           STX   VECT2         :IF NOT DONE, SAVE POINTER
F9CC  7E F9 39        JMP   SCIXIT        :AND GET MORE
                      :
F9CF  DE 8C     BAUD6: LDX  SCRTCH1+3     :GET LAST TWO CHARS
F9D1  8C 30 30        CPX   #$3030        :ARE LAST TWO CHARS BOTH 0?
F9D4  26 31           BNE   WAITBRK       :IF NOT VALID, SET UP TO WAIT FOR BREAK
                      :
                      : IF LAST TWO CHARS ARE 00, CHECK BUFFER AGAINST DATA TABLES FOR A MATCH
F9D6  CC FA 0E        LDD   #BAUDTBL      :SET UP TABLE POINTER
F9D9  DD 87           STD   VECT2         :AND STORE IN JUMP2 VECTOR
                      :
                      :  TRY EACH TABLE SEPARATELY, 00 AS 1ST CHAR SIGNALS END OF TABLE
F9DB  DE 87     BTRY:  LDX  VECT2         :GET TABLE POINTER
F9DD  A6 00           LDAA  0,X           : AND TABLE ELEMENT
F9DF  27 26           BEQ   WAITBRK       : IF=00, WAS NO MATCH, WAIT FOR BREAK
                      :
                      :  COMPARE BUFFER WITH ONE TABLE ENTRY
F9E1  CE 00 89        LDX   #SCRTCH1      :INIT BUFFER POINTER TO TOP
F9E4  DF 84           STX   XVECT         : & SAVE IN XMIT JUMP VECTOR
                      :  COMPARE EACH CHARACTER
F9E6  DE 84     COMPARE:LDX XVECT         :GET BUFFER POINTER
F9E8  A6 00           LDAA  0,X           : TO GET BUFFER CHAR TO A
F9EA  08              INX                 : INX BUF POINT WHILE WE'RE HERE
F9EB  DF 84           STX   XVECT         :  & SAVE..
F9ED  DE 87           LDX   VECT2         :NOW GET TABLE POINTER
F9EF  A1 00           CMPA  0,X           : & USE TO COMPARE CHARS
F9F1  26 09           BNE   NOMATCH
F9F3  08        CMATCH: INX               :IF MATCH, MOVE AHEAD TABLE POINTER
F9F4  A6 00           LDAA  0,X           :LOOK AT NEXT TABLE ELEMENT
F9F6  27 1C           BEQ   MATCH         : IF IT'S 00, FULL MATCH!
F9F8  DF 87           STX   VECT2         : ELSE SAVE TABLE POINTER
F9FA  20 EA           BRA   COMPARE       : AND TRY NEXT CHAR
                      :
F9FC  08        NOMATCH:INX               :INC TABLE POINTER
F9FD  A6 00           LDAA  0,X           :AND LOOK FOR 00
F9FF  26 FB           BNE   NOMATCH       :LOOP TILL IT'S FOUND
FA01  08              INX                 :INC OVER NULL
FA02  08              INX                 : & BAUD SET BYTE
FA03  DF 87           STX   VECT2         :AND REPLACE TO HOLDING LOCATION
FA05  20 D4           BRA   BTRY          :GO BACK TO CHECK NEXT TABLE
                      :
FA07  86 0A     WAITBRK:LDAA  #$0A        :TURN OFF SCI INTERRUPTS
FA09  97 11           STAA  TRCSR         : (REQUIRES TOF INTERRUPT TO RESTART)
FA0B  7E F9 78        JMP   SETUMAD       :AND SET VECTORS FOR NEW ADDRESS..
```

```
                                ;
                                :  MATCH TABLE FOR BAUD RATE SWITCH
FA0E  30 30 33 00       BAUDTBL:DB      '003',$00,$01   :  300 baud is only rate allowed
FA12  01
FA13  00                        DB      $00             :DONE
                                ;
FA14  08                MATCH:  INX                     :PASS 00 TERMINATOR
FA15  A6 00                     LDAA    0,X             :GET BAUD BYTE
FA17  16                        TAB                     :SAVE IN B
                                : This unit has no baud change hardware, these lines are kept here
                                : to allow it to be added later.
                                ;       ORAA    PORT1           :SET BITS ON BAUD CONTROL PORT
                                :       STAA    PORT1
                                :       ORAB    #$F8            :CLEAN UP MASK SO OTHERS DON'T CHANGE
                                :       ANDB    PORT1           : WHEN CLEAR BITS..
                                :       STAB    PORT1           : IN PORT1 (BAUD SET PORT)
FA18  7E F9 78                  JMP     SETUNAD         :AND PREPARE FOR NEW ADDRESSING
                                ;
                                :  AFTER VALID ADDRESS, RECEIVE CONTROL CHAR..
FA1B  01                CONCHAR:NOP
FA1C  81 21                     CMPA    #'!'            :IS IT '!'
FA1E  27 13                     BEQ     BANG
FA20  81 3F                     CMPA    #'?'            :OR IS IT '?'
FA22  27 22                     BEQ     QUERY
FA24  81 20                     CMPA    #' '            : SPACE TO ENTER MONITOR?
FA26  27 3D                     BEQ     GOMON
FA28  81 48                     CMPA    #'H'            :HELP?
FA2A  27 48                     BEQ     SAYHELP
FA2C  81 58                     CMPA    #'X'            : IMMIATE STOP?
FA2E  27 38                     BEQ     XSTOP
FA30  7E F9 78                  JMP     SETUNAD         :UNADDRESS IF NOT VALID..
                                ;
                                ;
FA33  CC FA 3B          BANG:   LDD     #GOTBANG        :GOT ! PREFIX
FA36  DD 81                     STD     RVECT
FA38  7E F9 39                  JMP     SCIXIT
                                ;
FA3B  81 4D             GOTBANG:CMPA    #'M'            :!M COMMAND?
FA3D  27 20                     BEQ     BANGML
FA3F  81 50                     CMPA    #'P'            :!P COMMAND?
FA41  27 1F                     BEQ     BANGPL
FA43  7E F9 78                  JMP     SETUNAD
                                ;
FA46  CC FA 4E          QUERY:  LDD     #GOTQURY
FA49  DD 81                     STD     RVECT
FA4B  7E F9 39                  JMP     SCIXIT
                                ;
FA4E  81 4D             GOTQURY:CMPA    #'M'            :?M COMMAND?
FA50  27 07                     BEQ     QUERYML
FA52  81 50                     CMPA    #'P'            :?P COMMAND
FA54  27 06                     BEQ     QUERYPL
FA56  7E F9 78                  JMP     SETUNAD
                                ;
FA59  7E FA 92          QUERYML:JMP     QUERYM          :LINK TO ?M
FA5C  7E FB 32          QUERYPL:JMP     QUERYP          :LINK TO ?P
FA5F  7E FA B4          BANGML: JMP     BANGM           :LINK TO !M
FA62  7E FB 6F          BANGPL: JMP     BANGP           :LINK TO !P
```

```
322  FA65  7E FC BA      GOMON:  JMP     PROMPT          :LINK INTO MONITOR
323                      :-----------------------------------------
324                      :  IMMEADIATE STOP
325  FA68  71 FC 02      XSTOP:  AIM     #$FC,PORT1      :DROP BOTH ENABLE BITS
326  FA6B  86 00                  LDAA    #$00            :AND SET PORTS TO 00
327  FA6D  97 06                  STAA    PORT3
328  FA6F  97 07                  STAA    PORT4
329  FA71  7E F9 78               JMP     SETUNAD
330                      :-------------------------------------------------------
331                      :  HELP FILE DUMP
332  FA74  CC FA 83      SAYHELP:LDD     #OUTHELP
333  FA77  DD 84                  STD     XVECT
334  FA79  CC F8 00               LDD     #HELPFIL        :SET POINTER
335  FA7C  DD 89                  STD     SCRTCH1
336  FA7E  86 65                  LDAA    #'e'            :SEND FIRST LETTER OF REPLY
337  FA80  7E FC C1               JMP     SETOUT
338                      :
339  FA83  DE 89         OUTHELP:LDX     SCRTCH1         :GET POINTER
340  FA85  A6 00                  LDAA    0,X             :GET CHAR ->A
341  FA87  27 06                  BEQ     HELPDUN         :NUL IS TERMINATOR
342  FA89  08                     INX                     :MEANWHILE, INC POINTER
343  FA8A  DF 89                  STX     SCRTCH1         :AND SAVE
344  FA8C  7E FC C1               JMP     SETOUT          :FINALLY SEND THE CHAR IN A..
345                      :
346  FA8F  7E FC BA      HELPDUN:JMP     PROMPT
347
348                      :-------------------------------------------------------
349                      :  ?M COMMAND - DATA INPUT SECTION
350  FA92  CC FA 98      QUERYM: LDD     #SAVEADD        :NOW INPUT ADDRESS
351  FA95  7E FB BB               JMP     IN4
352                      :
353  FA98  DC 89         SAVEADD:LDD     SCRTCH1         :GET ADDRESS,
354  FA9A  DD 8B                  STD     SCRTCH3     ADDRESS POINTER
355  FA9C  CC FA A2               LDD     #STARTL
356  FA9F  7E FB BB               JMP     IN4             :THEN GET LENGTH
357                      :
358  FAA2  DC 89         STARTL: LDD     SCRTCH1         :IF LENGTH NE 0000
359  FAA4  26 03                  BNE     STARTL2         : CARRY ON..
360  FAA6  7E FC BA               JMP     PROMPT          :ELSE QUIT
361                      :
362  FAA9  CC FB B5      STARTL2:LDD     #ECHO           :PREPARE TO IGNORE ECHO CHARS
363  FAAC  DD 81                  STD     RVECT
364  FAAE  72 04 11               OIM     #$04,TRCSR      :START XMIT INTERRUPTS
365  FAB1  7E FC 1F               JMP     OUTLINE         :& SEND A LINE..
366                      :
367                      : ..THE ?M DUMP IS STORED IN THE XMIT SERVICE SECTION BELOW
368                      :
369                      :-------------------------------------------------------
370                      :  !M SECTION
371  FAB4  CC FA BA      BANGM:  LDD     #KEEPADD        :INPUT STARTING ADDRESS
372  FAB7  7E FB BB               JMP     IN4
373                      :
374  FABA  CC FA C2      KEEPADD:LDD     #HIHEX          :WAIT FOR HIGH HEX CHAR
375  FABD  DD 81                  STD     RVECT
376  FABF  7E F9 39               JMP     SCIXIT
377                      :
378  FAC2  BD FD 16      HIHEX:  JSR     ASCHEX          :ATTEMPT CONVERT TO HEX
```

```
379  FAC5  25 27              BCS     TERMIN          :CHECK TERMINATOR IF NOT..
380  FAC7  48                 ASLA
381  FAC8  48                 ASLA                    :MOVE OVER NIBBLE
382  FAC9  48               FACA  48                      ASLA
384  FACB  97 8D              STAA    SCRTCH5
385  FACD  CC FA D5           LDD     #LOWHEX
386  FAD0  DD 81              STD     RVECT
387  FAD2  7E F9 39           JMP     SCIXIT
388                       :
389  FAD5  BD FD 16       LOWHEX: JSR     ASCHEX          :CONVERT LOW
390  FAD8  24 03              BCC     STASH
391  FADA  7E FC BA           JMP     PROMPT          :PROMPT IF BAD SECOND CHAR
392  FADD  DE 89          STASH:  LDX     SCRTCH1         :GET POINTER
393  FADF  9A 8D              ORAA    SCRTCH5         :COMBINE NIBBLES
394  FAE1  A7 00              STAA    0,X             :STORE IT..
395  FAE3  08                 INX                     :INC &
396  FAE4  DF 89              STX     SCRTCH1         :RESTORE POINTER
397  FAE6  CC FA C2           LDD     #HIHEX
398  FAE9  DD 81              STD     RVECT           :&PREP FOR MORE
399  FAEB  7E F9 39           JMP     SCIXIT
400                       :
401  FAEE  84 7F          TERMIN: ANDA    #$7F            ;MASK OFF FLAG BIT
402  FAF0  81 0D              CMPA    #$0D            :IS IT CR?
403  FAF2  26 03              BNE     TERMIN2
404  FAF4  7E FC BA           JMP     PROMPT
405                       :
406  FAF7  81 20          TERMIN2:CMPA    #' '            :IS IT SPACE?
407  FAF9  26 08              BNE     TERMIN3
408  FAFB  CC FA C2           LDD     #HIHEX
409  FAFE  DD 81              STD     RVECT
410  FB00  7E F9 39           JMP     SCIXIT
411                       :
412  FB03  81 3B          TERMIN3:CMPA    #':'            :OR ':' ?
413  FB05  26 05              BNE     TERMIN4
414  FB07  CC FA B4           LDD     #BANGM
415  FB0A  20 07              BRA     PASSLF
416                       :
417  FB0C  81 2C          TERMIN4:CMPA    #','            :OR ',' ?
418  FB0E  26 1F              BNE     TERMIN5
419  FB10  CC FB 27           LDD     #SETHIHX
420  FB13  DD 87          PASSLF: STD     VECT2
421  FB15  CC FB 1D           LDD     #PASSLF2
422  FB18  DD 81              STD     RVECT
423  FB1A  7E F9 39           JMP     SCIXIT
424                       :
425  FB1D  81 0A          PASSLF2:CMPA    #$0A            :GOT LF YET?
426  FB1F  26 03              BNE     PXIT
427  FB21  7E 00 86           JMP     JUMP2           :IF YES, EXIT THRU JMP2
428  FB24  7E F9 39       PXIT:   JMP     SCIXIT          :ELSE WAIT FOR MORE CHARS..
429                       :
430  FB27  CC FA C2       SETHIHX:LDD     #HIHEX          :IF ',' THEN PREP FOR MORE HEX
431  FB2A  DD 81              STD     RVECT
432  FB2C  7E F9 39           JMP     SCIXIT
433                       :
434  FB2F  7E FC BA       TERMIN5:JMP     PROMPT          :TO PROMPT IF NOT VALID CHAR
435                       ;-------------------------------------------------------
```

```
                        ;  QUERY PUMP COMMAND (?Pn, N=1,2)
FB32  CC FB 3A          QUERYP: LDD     #QP2
FB35  DD 81                     STD     RVECT
FB37  7E F9 39                  JMP     SCIXIT
                        ;
FB3A  81 31             QP2:    CMPA    #'1'            :PUMP 1?
FB3C  26 04                     BNE     QP3
FB3E  C6 06                     LDAB    #PORT3          :PORT 3 ADDRESS TO B
FB40  20 09                     BRA     QP5             :AND GO FIND VALUE
                        ;
FB42  81 32             QP3:    CMPA    #'2'            :PUMP 2?
FB44  27 03                     BEQ     QP4
FB46  7E F9 78                  JMP     SETUNAD
                        ;
FB49  C6 07             QP4:    LDAB    #PORT4          :IF 2, POINT PORT 4
FB4B  CE 00 00          QP5:    LDX     #0000           :CLEAR INDEX REGISTER
FB4E  3A                        ABX                     :AND PUT B IN IT
FB4F  A6 00                     LDAA    0,X             :FETCH VALUE FROM PORT
FB51  97 89                     STAA    SCRTCH1         :AND SAVE
FB53  CC FB 5D                  LDD     #QP6
FB56  DD 84                     STD     XVECT           :PREP FOR NEXT
FB58  86 3D                     LDAA    #'='            :SEND =
FB5A  7E FC C1                  JMP     SETOUT
                        ;
FB5D  CC FB 67          QP6:    LDD     #QP7            :PREP FOR PROMPT
FB60  DD 87                     STD     VECT2
FB62  96 89                     LDAA    SCRTCH1         :GET PUMP CONTROL VALUE,
FB64  7E FC 9D                  JMP     OUTBYTE
                        ;
FB67  CC FC BA          QP7:    LDD     #PROMPT
FB6A  DD 84                     STD     XVECT
FB6C  7E F9 39                  JMP     SCIXIT
                        ;
                        ;-------------------------------------------------------
                        ;  SET PUMP SPEED COMMAND (!Pnhh n=1,2 hh=value)

FB6F  CC FB 77          BANGP:  LDD     #BP1            :IMMEADIATELY AFTER !P,
FB72  DD 81                     STD     RVECT           :PREPARE FOR N
FB74  7E F9 39                  JMP     SCIXIT
                        ;
FB77  CE 00 06          BP1:    LDX     #PORT3          :SET ADDRESS OF PUMP1
FB7A  81 31                     CMPA    #'1' PUMP 1 ?
FB7C  27 0A                     BEQ     BP2
FB7E  CE 00 07                  LDX     #PORT4          :NEXT SET ADDRESS OF PUMP2
FB81  81 32                     CMPA    #'2'            :PUMP 2 ?
FB83  27 03                     BEQ     BP2
FB85  7E FC BA                  JMP     PROMPT          :PROMPT IF NOT 1 OR 2
                        ;
FB88  DF 90             BP2:    STX     PUMP            :SAVE PUMP ADDRESS
FB8A  CC FB 90                  LDD     #BP3            :SET EXIT VECTOR
FB8D  7E FB BB                  JMP     IN4             :AND GO READ NEW PUMP VALUE
                        ;
FB90  DE 90             BP3:    LDX     PUMP            :RETRIEVE PUMP ADDRESS
FB92  C6 01                     LDAB    #01             :SET PUMP1 FLAG
FB94  8C 00 06                  CPX     #PORT3
FB97  27 0A                     BEQ     BP4
FB99  C6 02                     LDAB    #02             :ELSE SET PUMP2 FLAG
```

```
493  FB9B  8C 00 07          CPX    #PORT4
494  FB9E  27 03             BEQ    BP4
495  FBA0  7E F9 78          JMP    SETUNAD        :ERROR IF NOT VALID ADDRESS!
496                     :
497  FBA3  96 8A        BP4: LDAA   SCRTCH2        :RETRIEVE NEW VALUE
498  FBA5  A7 00             STAA   0,X            :AND STORE IN PUMP PORT
499  FBA7  26 08             BNE    BP6            :IS IT NOT 00?
500  FBA9  53                COMB                  :INVERT B TO CLEAR ENABLE BIT
501  FBAA  D4 02             ANDB   PORT1          :AND WITH ENABLE PORT
502  FBAC  D7 02        BP5: STAB   PORT1          :AND MODIFY THE BIT.
503  FBAE  7E FC 8A          JMP    PROMPT
504                     :
505  FBB1  DA 02        BP6: ORAB   PORT1          :ELSE ENABLE THE CORRECT BIT
506  FBB3  20 F7             BRA    BP5            :AND CARRY ON...
507                     :
508                     :-------------------------------------------------------
509                     :  RECEIVE AN ECHO CHARACTER (& IGNORE!)
510  FBB5  01           ECHO: NOP                  :ROOM FOR JUMP...
511  FBB6  01                 NOP
512  FBB7  01                 NOP
513  FBB8  7E F9 39           JMP    SCIXIT
514                     :
515                     :-------------------------------------------------------
516                     :  IN4 HEX DIGITS
517                     :       INPUTS HEX DIGITS TILL TERMINATED BY A SPACE OR
518                     :       BY A CR. (OR BY UNADDRESS). RESULT LEFT AT SCRTCH1,2
519                     :       EXITS THRU JUMP2 WHEN DONE (TARGET IN D ON ENTRY)
520                     :
521  FBBB  DD 87        IN4: STD    VECT2          :STORE EXIT VECTOR
522  FBBD  7F 00 89          CLR    SCRTCH1        :CLEAR INPUT BUFFER
523  FBC0  7F 00 8A          CLR    SCRTCH2
524  FBC3  CC FB CB          LDD    #IN4HEX        :POINT CHAR RECEIVER
525  FBC6  DD 81             STD    RVECT
526  FBC8  7E F9 39          JMP    SCIXIT
527                     :
528  FBCB  BD FD 16     IN4HEX: JSR  ASCHEX        :CONVERT TO HEX
529  FBCE  25 15             BCS    CKEND          :IF NOT HEX, CHECK FOR END
530  FBD0  36                PSHA                  :SAVE..
531  FBD1  96 89             LDAA   SCRTCH1        :HI TO A
532  FBD3  D6 8A             LDAB   SCRTCH2
533  FBD5  05                ASLD                  :SHIFT OVER FOUR
534  FBD6  05                ASLD
535  FBD7  05                ASLD
536  FBD8  05                ASLD
537  FBD9  97 89             STAA   SCRTCH1        :RETURN HIGH
538  FBDB  D7 8A             STAB   SCRTCH2        :AND B
539  FBDD  32                PULA                  :RETRIEVE NEW NIBBLE
540  FBDE  9A 8A             ORAA   SCRTCH2        :ADD NEW NIBBLE
541  FBE0  97 8A             STAA   SCRTCH2        : & UPDATE
542  FBE2  7E F9 39          JMP    SCIXIT
543                     :
544  FBE5  84 7F        CKEND: ANDA  #$7F          :CLEAN OFF MS FLAG BIT
545  FBE7  81 20             CMPA   #' '           :IS IT SPACE?
546  FBE9  27 07             BEQ    INEXIT
547  FBEB  81 0D             CMPA   #$0D           :IS IT CR?
548  FBED  27 03             BEQ    INEXIT
549  FBEF  7E F9 39          JMP    SCIXIT         :ELSE, GET ANOTHER CHAR
```

```
550                             :
551   FBF2  7E 00 86            INEXIT: JMP     JUMP2           :IF DONE, CARRY ON THRU VECTOR..
552                             :
553                             :
554                             :-------------------------------------------------------
555                             :  INPUT ONE HEX BYTE AND CONTINUE THRU JUMP2
556   FBF5  48                  INBYTE: ASLA                    :MOVE OVER
557   FBF6  48                          ASLA
558   FBF7  48                          ASLA
559   FBF8  48                          ASLA
560   FBF9  97 8D                       STAA    SCRTCH5         :SAVE
561   FBFB  CC FC 03                    LDD     #INBYTE2        :POINT TO NEXT SEGMENT
562   FBFE  DD 81                       STD     RVECT
563   FC00  7E F9 39                    JMP     SCIXIT
564                             :
565   FC03  BD FD 16            INBYTE2:JSR     ASCHEX          :CONVERT LOW NIBBLE
566   FC06  24 03                       BCC     SAVEDAT
567   FC08  7E F9 78                    JMP     SETUNAD         :UNADDRESS IF ERROR
568                             :
569   FC0B  9A 8D               SAVEDAT:ORAA    SCRTCH5         :COMBINE
570   FC0D  7E 00 86                    JMP     JUMP2           :AND CARRY ON THRU VECTOR2
571                             :
572   FC10                      ---------------------------------------------------
573                             :  NOW CHECK THE TRANSMIT SITUATION
574   FC10  7B 20 11            CHECKX: TIM     #$20,TRCSR      :TEST TDRE
575   FC13  27 03                       BEQ     XERROR
576   FC15  7E 00 83                    JMP     XJUMP           :GO THRU XMIT VECTOR
577                             :
578                             : THESE SEGMENTS ARE ENTERED THRU XJUMP AND XVECTOR..
579   FC18  01                  XERROR: NOP                     :TRIG LOC FOR DIAGNOSTICS
580                             :
581                             :  XJUMP TARGETS..
582   FC19  71 FB 11            XPASS:  AIM     #$FB,TRCSR      :TURN OFF XMIT INTERRUPTS
583   FC1C  7E F9 39                    JMP     SCIXIT
584                             :
585                             : OUTPUT A LINE OF DATA (FROM ?M DUMP)
586   FC1F  CC FC 29            OUTLINE:LDD     #OUTLF          :& SET UP TO XMIT
587   FC22  DD 84                       STD     XVECT
588   FC24  86 0D                       LDAA    #$0D            :SEND CR
589   FC26  7E FC C1                    JMP     SETOUT
590                             :
591   FC29  CC FC 33            OUTLF:  LDD     #OUTADDR
592   FC2C  DD 84                       STD     XVECT
593   FC2E  86 0A                       LDAA    #$0A            :SEND LF
594   FC30  7E FC C1                    JMP     SETOUT
595                             :
596   FC33  CC FC 3D            OUTADDR:LDD     #LOWADDR        :PREP OUTBYTE XIT
597   FC36  DD 87                       STD     VECT2
598   FC38  96 8B                       LDAA    SCRTCH3         :GET HIGH ADDRESS
599   FC3A  7E FC 9D                    JMP     OUTBYTE
600                             :
601   FC3D  CC FC 45            LOWADDR:LDD     #LOWADD2        :EXIT FROM 2ND OUTBYTE..
602   FC40  DD 84                       STD     XVECT
603   FC42  7E F9 39                    JMP     SCIXIT
604                             :
605   FC45  CC FC 4F            LOWADD2:LDD     #ADDRSP
606   FC48  DD 87                       STD     VECT2
```

```
607  FC4A  96 8C              LDAA   SCRTCH4        :NOW LOW ADDRESS
608  FC4C  7E FC 9D           JMP    OUTBYTE
609                    :
610  FC4F  CC FC 57    ADDRSP: LDD    #SENDSP        :EXIT FROM 2ND OUTBYTE...
611  FC52  DD 84              STD    XVECT
612  FC54  7E F9 39           JMP    SCIXIT
613                    :
614  FC57  CC FC 61    SENDSP: LDD    #OUTDATA
615  FC5A  DD 84              STD    XVECT
616  FC5C  86 20              LDAA   #$20           :SEND SPACE
617  FC5E  7E FC C1           JMP    SETOUT
618                    :
619  FC61  DE 8B       OUTDATA:LDX    SCRTCH3        :GET ADDR POINTER
620  FC63  A6 00              LDAA   0,X            :TO GET DATA BYTE
621  FC65  36                 PSHA                  :SAVE
622  FC66  CC FC 6F           LDD    #DECLEN
623  FC69  DD 87              STD    VECT2          :PREP XIT VECTOR
624  FC6B  32        PULA                          :RETRIEVE DATA BYTE
625  FC6C  7E FC 9D           JMP    OUTBYTE        :& SEND IT
626                    :
627  FC6F  CC FC 77    DECLEN: LDD    #DECLEN2       :EXIT FROM OUTBYTE2..
628  FC72  DD 84              STD    XVECT
629  FC74  7E F9 39           JMP    SCIXIT
630                    :
631  FC77  DE 89       DECLEN2:LDX    SCRTCH1        :GET LENGTH
632  FC79  09                 DEX                   :DECREMENT
633  FC7A  DF 89              STX    SCRTCH1        :& RETURN
634  FC7C  26 03              BNE    SAYMORE        : MORE DATA?
635  FC7E  7E FC BA           JMP    PROMPT         :PROMPT IF DONE
636                    :
637  FC81  DE 8B       SAYMORE:LDX    SCRTCH3        :GET ADDR
638  FC83  08                 INX                   :INCREMENT
639  FC84  DF 8B              STX    SCRTCH3        :REPLACE
640  FC86  18                 XGDX                  :X REG TO ACCD
641  FC87  04                 LSRD                  :LSB TO C
642  FC88  25 D7              BCS    OUTDATA        :NEXT BYTE NOW IF ODD
643  FC8A  C4 07              ANDB   #$07           :CHECK FOR XXX0 (LINE END)
644  FC8C  26 C9              BNE    SENDSP         :IF ONLY EVEN, SEND SP
645                    :
646  FC8E  86 3B              LDAA   #':'           :IF NEW LINE, SEND CONTINUATION
647  FC90  BD FD 33           JSR    GENPAR
648  FC93  97 13              STAA   XDATA
649  FC95  CC FC 1F           LDD    #OUTLINE       :& PREP FOR NEW LINE..
650  FC98  DD 84              STD    XVECT
651  FC9A  7E F9 39           JMP    SCIXIT
652                    :
653                    :-------------------------------------------------------------
654         :  OUTPUTS A BYTE IN A AS TWO HEX CHARS, EXITS VIA VECT2..
655  FC9D  97 8D       OUTBYTE:STAA   SCRTCH5        :STASH FOR LATER
656  FC9F  44                 LSRA
657  FCA0  44                 LSRA                  :MOVE OVER
658  FCA1  44                 LSRA
659  FCA2  44                 LSRA
660  FCA3  BD FD 0B           JSR    HEXASC         :CONVERT
661  FCA6  36                 PSHA                  :AND SAVE..
662  FCA7  CC FC B0           LDD    #OUTBYT2
663  FCAA  DD 84              STD    XVECT
```

```
664  FCAC  32          PULA                    :RECOVER CHARACTER
665  FCAD  7E FC C1    JMP     SETOUT
666                    :
667  FCB0  96 8D       OUTBYT2:LDAA    SCRTCH5
668  FCB2  84 0F       ANDA    #$0F            :CLEAN UP
669  FCB4  BD FD 0B    JSR     HEXASC
670  FCB7  7E FD 03    JMP     OUTJMP          :CONVERT, SEND & JUMP THRU VECT2
671                    :
672                    :---------------------------------------------------------------
673                    ;  SEND A PROMPT FROM THE MONITOR, THEN WAIT FOR CHARS
674  FCBA  CC FC D1    PROMPT: LDD     #PROMPT1
675  FCBD  DD 84       STD     XVECT
676  FCBF  86 0D       LDAA    #$0D            :SEND CR FIRST
677                    :
678                    :  INITIATE A OUTPUT SEQUENCE
679  FCC1  BD FD 33    SETOUT: JSR     GENPAR
680  FCC4  97 13       STAA    XDATA           :SEND FIRST CHAR
681  FCC6  72 04 11    OIM     #$04,TRCSR      :TURN ON INTERRUPTS IF REQ'D
682  FCC9  CC FB B5    LDD     #ECHO
683  FCCC  DD 81       STD     RVECT           :& PREPARE TO ECHO
684  FCCE  7E F9 39    JMP     SCIXIT
685                    :
686  FCD1  CC FC DA    PROMPT1:LDD     #PROMPT2
687  FCD4  DD 84       STD     XVECT
688  FCD6  86 0A       LDAA    #$0A            :SEND LF
689  FCD8  20 E7       BRA     SETOUT
690                    :
691  FCDA  CC FC E3    PROMPT2:LDD     #PROMPT3
692  FCDD  DD 84       STD     XVECT
693  FCDF  86 3A       LDAA    #':'
694  FCE1  20 DE       BRA     SETOUT
695                    :
696  FCE3  86 03       PROMPT3:LDAA    #$03            :FINALLY ETX
697  FCE5  BD FD 33    JSR     GENPAR
698  FCE8  97 13       STAA    XDATA           :DRAGON HERE?
699  FCEA  71 FB 11    AIM     #$FB,TRCSR      :NOW TURN OFF XMIT INTERRUPTS
700  FCED  CC FC F5    LDD     #WAITPR1
701  FCF0  DD 81       STD     RVECT           :WAIT FOR ETX ECHO
702  FCF2  7E F9 39    JMP     SCIXIT
703                    :
704                    : WAIT FOR THE ETX TO ECHO BACK..
705  FCF5  81 03       WAITPR1:CMPA    #$03            :IS IT THE ETX YET?
706  FCF7  26 05       BNE     WXIT            :IF NOT, WAIT FOR NEXT CHAR
707  FCF9  CC FA 1B    LDD     #CONCHAR
708  FCFC  DD 81       STD     RVECT           :IF SO, CONTROL CHAR WILL BE NEXT
709  FCFE  7E F9 39    WXIT:   JMP     SCIXIT
710                    :
711                    :---------------------------------------------------------------
712                    :  SENDS ETX & CARRIES ON THRU VECT2
713  FD01  86 03       XETX:   LDAA    #$03            :SEND ETX
714  FD03  BD FD 33    OUTJMP: JSR     GENPAR          :MAY ENTER HERE...
715  FD06  97 13       STAA    XDATA           :DRAGON AGAIN?
716  FD08  7E 00 86    JMP     JUMP2           :NOW THRU JUMP2
717                    :
718                    :
719                    :***************************************************************
720                    : SUBROUTINES.....
```

```
                        ;----------------
                        :  Converts low nibble in A to ASCII char in A
FD0B  84 0F             HEXASC: ANDA    #$0F            :CLEAN IT UP
FD0D  8B F6                     ADDA    #$F6
FD0F  24 02                     BCC     HNUMBER
FD11  8B 07                     ADDA    #$07            :CONVERT
FD13  8B 3A             HNUMBER:ADDA    #$3A            : TO ASCII
FD15  39                        RTS
                        :
                        :---------------------------------------------------
                        :  Converts ASCII char in A to nibble in A if it is HEX &sets C bit.
                        :       Otherwise, returns origional char with C bit set.
FD16  36                ASCHEX: PSHA            :SAVE CHAR
FD17  80 30                     SUBA    #$30
FD19  25 15                     BCS     NOTHEX
FD1B  80 0A                     SUBA    #$0A
FD1D  2C 04                     BGE     TSTALPH
FD1F  8B 0A                     ADDA    #$0A    :REPAIR NUMB
FD21  20 0A                     BRA     AXIT
FD23  80 07             TSTALPH:SUBA    #$07    :41->00 ?
FD25  2D 09                     BLT     NOTHEX
FD27  80 06                    SUBA    #$06
FD29  2C 05                     BGE     NOTHEX
FD2B  8B 10                     ADDA    #$10    :REPAIR ALPH
FD2D  31                AXIT:   INS             :POP OFF SAVED CHAR
FD2E  0C                        CLC             :AND CLEAR CARRY BIT
FD2F  39                        RTS
                        :
FD30  32                NOTHEX: PULA            :GET CHAR
FD31  0D                        SEC             :SET CARRY
FD32  39                        RTS
                        :---------------------------------------------------
                        :  GENERATE PARITY- Char is passed in and out thru A
FD33  37                GENPAR: PSHB            :SAVE SOME STUFF..
FD34  3C                        PSHX
FD35  16                        TAB             :COPY CHAR TO B
FD36  CE FD 66                  LDX     #PARITY :POINT TO PARITY TABLE TOP
FD39  3A                        ABX             :ADD OFFSET TO POINT X TO CHAR
FD3A  AA 00                     ORAA    0,X     :ADD PARITY BIT
FD3C  38                        PULX            :..RESTORE
FD3D  33                        PULB
FD3E  39                        RTS
                        :
                        :*********************************************************
                        : TIMER INTERRUPT PROCESSING SECTIONS
                        :---------------------------------------------------------
                        : TIMER OVERFLOW INTERRUPT, WATCHES FOR SAIL BREAK EXIT
                        :
FD3F  96 08             TOF:    LDAA    TCSR    :READ COUNTER STATUS REG
FD41  96 09                     LDAA    COUNTHI ; AND COUNTER TO CLEAR INTERRUPT
FD43  7B 80 02                  TIM     #$80,PORT1      :TEST BREAK SENSE BIT
FD46  27 11             EQ      SETBRK  ;IF LOW, SET BREAK FLAG
                        : IF NOT LOW, JUST RISEN?
FD48  96 8E                     LDAA    BMODE
FD4A  2A 13                     BPL     TOFXIT  :IF WAS NO BREAK, CARRY ON..
                        : IF JUST CAME OUT OF BREAK...
FD4C  71 7F 8E                  AIM     #$7F,BMODE      :CLEAR BREAK FLAG
```

```
778  FD4F  72 10 11          OIM    #$10,TRCSR      :ENABLE SCI INTERRUPTS
779  FD52  CC F9 7D          LDD    #UNADDR
780  FD55  DD 81             STD    RVECT           :AND PRESET JUMP VECTOR..
781  FD57  20 06             BRA    TOFXIT
782                       :
783  FD59  72 80 8E       SETBRK: OIM    #$80,BMODE      :SET BREAK FLAG
784  FD5C  71 EB 11          AIM    #$EB,TRCSR      :TURN OFF BOTH SCI INTERRUPTS
785  FD5F  3B              TOFXIT: RTI
786                       :
787                       ;-----------------------------------------------------------
788                       :  OUTPUT COMPARE INTERRUPT
789                       :
790  FD60  7B 40 08        OCI:    TIM    #40,TCSR
791  FD63  27 00                   BEQ    OXIT    :EXIT IF NOT OCFlag
792                       :       DUMMY FOR INSTRUCTIONAL PURPOSES ONLY
793  FD65  3B              OXIT:   RTI            :AND EXIT..
794                       ;***********************************************************
795                       :  PARITY TABLE
796  FD66  00 80 80 00     PARITY: DB 00,80,80,00,80,00,00,80      :A
     FD6A  80 00 00 80
797  FD6E  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FD72  00 80 80 00
798  FD76  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FD7A  00 80 80 00
799  FD7E  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FD82  80 00 00 80
800                       : XX20
801  FD86  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FD8A  00 80 80 00
802  FD8E  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FD92  80 00 00 80
803  FD96  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FD9A  80 00 00 80
804  FD9E  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FDA2  00 80 80 00
805                       : XX40
806  FDA6  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FDAA  00 80 80 00
807  FDAE  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FDB2  80 00 00 80
808  FDB6  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FDBA  80 00 00 80
809  FDBE  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FDC2  00 80 80 00
810                       : XX60
811  FDC6  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FDCA  80 00 00 80
812  FDCE  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FDD2  00 80 80 00
813  FDD6  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FDDA  00 80 80 00
814  FDDE  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
     FDE2  80 00 00 80
815                       : XX80
816  FDE6  80 00 00 80             DB 80,00,00,80,00,80,80,00      :B
     FDEA  00 80 80 00
817  FDEE  00 80 80 00             DB 00,80,80,00,80,00,00,80      :A
```

```
     FDF2   80 00 00 80
818  FDF6   00 80 80 00            DB 00,80,80,00,80,00,00,80      :A
     FDFA   80 00 00 80
819  FDFE   80 00 00 80            DB 80,00,00,80,00,80,80,00      :B
     FE02   00 80 80 00
820                           : XXA0
821  FE06   00 80 80 00            DB 00,80,80,00,80,00,00,80      :A
     FE0A   80 00 00 80
822  FE0E   80 00 00 80            DB 80,00,00,80,00,80,80,00      :B
     FE12   00 80 80 00
823  FE16   80 00 00 80            DB 80,00,00,80,00,80,80,00      :B
     FE1A   00 80 80 00
824  FE1E   00 80 80 00            DB 00,80,80,00,80,00,00,80      :A
     FE22   80 00 00 80
825                           : XXC0
826  FE26   00 80 80 00            DB 00,80,80,00,80,00,00,80      :A
     FE2A   80 00 00 80
827  FE2E   80 00 00 80            DB 80,00,00,80,00,80,80,00      :B
     FE32   00 80 80 00
828  FE36   80 00 00 80            DB 80,00,00,80,00,80,80,00      :B
     FE3A   00 80 80 00
829  FE3E   00 80 80 00            DB 00,80,80,00,80,00,00,80      :A
     FE42   80 00 00 80
830                           : XXE0
831  FE46   80 00 00 80            DB 80,00,00,80,00,80,80,00      :A
     FE4A   00 80 80 00
832  FE4E   00 80 80 00            DB 00,80,80,00,80,00,00,80      :B
     FE52   80 00 00 80
833  FE56   00 80 80 00            DB 00,80,80,00,80,00,00,80      :B
     FE5A   80 00 00 80
834  FE5E   80 00 00 80            DB 80,00,00,80,00,80,80,00      :A
     FE62   00 80 80 00
835                           :
836                           :***************************************************************
837                           : DEFINE INTERRUPT AND RESET VECTORS
838         F0 08             TRAP:   EQU     START
839                           :       TOF:    EQU     START
840                           :       OCF:    EQU     START
841         F0 08             ICF:    EQU     START
842         F0 08             IRQ1:   EQU     START
843         F0 08             SWI:    EQU     START
844         F0 08             NMI:    EQU     START
845         F0 08             RESET:  EQU     START
846                           :
847  FFEE                             ORG     $FFEE   : SET HARDWARE VECTORS
848  FFEE   F0 08                     DW      TRAP
849  FFF0   F9 32                     DW      SCISTRT
850  FFF2   FD 3F                     DW      TOF
851  FFF4   FD 60                     DW      OCI     :OUTPUT COMPARE INTERRUPT
852  FFF6   F0 08                     DW      ICF
853  FFF8   F0 08                     DW      IRQ1
854  FFFA   F0 08                     DW      SWI
855  FFFC   F0 08                     DW      NMI
856  FFFE   F0 08                     DW      RESET
857                           :
858  0000                             END
```

********** C R O S S R E F E R E N C E T A B L E **********

----------	FC10	:				
ADDR	F000	:	175			
ADDRSP	FC4F	:	605			
ASCHEX	FD16	:	378	389	528	565
AXIT	FD2D	:	739			
BANG	FA33	:	286			
BANGM	FAB4	:	320	414		
BANGML	FA5F	:	303			
BANGP	FB6F	:	321			
BANGPL	FA62	:	305			
BAUD2	F9A6	:	200			
BAUD3	F9AD	:	205			
BAUD4	F9BA	:	208			
BAUD5	F9C2	:	216			
BAUD6	F9CF	:	221			
BAUDTBL	FA0E	:	230			
BMODE	= 008E	:	114	774	777	783
BP1	FB77	:	472			
BP2	FB88	:	478	481		
BP3	FB90	:	485			
BP4	FBA3	:	491	494		
BP5	FBAC	:	506			
BP6	FBB1	:	499			
BTRY	F9DB	:	261			
CAPTURHI	= 000D	:				
CAPTURLO	= 000E	:				
CHECKX	FC10	:	147			
CKCHAR	F93A	:	140			
CKEND	FBE5	:	529			
CMATCH	F9F3	:				
COMPARE	F9E6	:	253			
COMPARHI	= 000B	:				
COMPARLO	= 000C	:				
CONCHAR	FA1B	:	195	707		
COUNTHI	= 0009	:	770			
COUNTLO	= 000A	:				
DDR1	= 0000	:	85			
DDR2	= 0001	:	88			
DDR3	= 0004	:	90			
DDR4	= 0005	:	93			
DECLEN	FC6F	:	622			
DECLEN2	FC77	:	627			
DOZE	F049	:	118			
ECHO	FBB5	:	362	682		
GENPAR	FD33	:	647	679	697	714
GOMON	FA65	:	290			
GOTADDR	F996	:	192			
GOTBANG	FA3B	:	298			
GOTNUM	F957	:	158			
GOTQURY	FA4E	:	308			
HELPDUM	FA8F	:	341			
HELPFIL	F800	:	334			
HEXASC	FD0B	:	660	669		
HIHEX	FAC2	:	374	397	408	430

Appendix I
SEA DUCT - ELECTRONIC DRAWINGS

Dwg. #	Size	Title	Rev. Date.
SD-B001	B	Computer System Connection List	20 Nov. 84
SD-B002	B	Computer System Connections	20 Nov. 84
SD-B003	B	U/W Connectors (CPU System)	24 Nov. 86
SD-B004	B	I/O Decode	24 Nov. 86
SD-B005	B	Output Driver Decoding	24 Nov. 86
SD-B006	B	Pulse Driver Decoding, A/D, Mux. Decoding	23 Apr. 86
SD-B007	B	Software Timing	24 Nov. 86
SD-B008	B	Computer Ribbon Conn. Pin / Funct. Cross Ref.	04 Nov. 83
SD-B009	B	uP, System Battery	24 Mar. 87
SD-B010	B	SAIL, Camera, Transmissometer - External Conn.	02 Dec. 86
SD-0011	B	Bottom Sw., Opto. Int., Xponder - Ext. Conn.	23 Apr. 86
SD-B012	B	Buffer Board - Main Section	23 Apr. 86
SD-0013	B	Buffer Board - SAIL and Reset	12 Jun. 86
SD-B014	B	Buffer Board - Circulation Pump Control	24 Nov. 86
SD-0015	B	Buffer Board - Parts Layout	24 Nov. 86
SD-B016	B	Output Driver Board	24 Nov. 86
SD-0017	B	Output Driver Board - Parts Layout	24 Nov. 86
SD-B018	B	Interface Board - A/D, Voltage Convertor	24 Nov. 86
SD-0019	B	Interface Board - Compass Interface	15 Oct. 84
SD-B020	B	Interface Board - Rotation Encoder Interface	24 Nov. 86
SD-0021	B	Interface Board - Parts Layout	28 Sep. 83
SD-B022	B	Rotation Encoder Interface (Encoder Housing)	20 Nov. 84
SD-B023	B	LITTON Rotation Encoder	20 Nov. 84
SD-B024	B	Rotation Encoder Interface - Parts Layout	20 Nov. 84
SD-B025	B	Auxillary Board	24 Nov. 86
SD-B026	B	Auxillary Board - Parts Layout	05 Dec. 85
SD-B027	B	Manual Control Box (Connections)	24 Nov. 86
SD-B028	B	HP 1630D Analyzer Interface Box	02 Feb. 84
SD-B029	B	HP 1630D Analyzer Interface Box - Layout	18 Oct. 83
SD-B030	B	HP 1630D/HP 1610 Analyzer Interface Box	12 Jul. 84
SD-B031	B	Main Wiring Harness	28 Mar. 87
SD-B032	B	CPU Endcap - Electrical Connections	13 Dec. 85
SD-B033	B	Pump Controller - Control Circuit	26 Nov. 86
SD-B034	B	Pump Controller - Power Circuit	26 Nov. 86
SD-B035	B	Pump Controller - Board Layout	26 Nov. 86
SD-B036	B	Pump Controller - Block Diagram	26 Nov. 86
SD-B037	B	CMOS - RS232 Interface	24 Nov. 86
SD-B038	B	OIS Acoustic Command Xcvr. - Modifications	30 Dec. 86
SD-B039	B	OIS Acoustic Command Rcvr. - Modifications	30 Dec. 86
SD-B040	B	Photosea Camera Cable	28 Mar. 87
SD-C001	C	CPU BOARD (2 Sheets)	19 Dec. 85
SD-C002	C	Main Junction Box Wiring	18 Dec. 85
SD-D001	D	Electrical Master	31 Jul. 85

SP 11208A

CONN	BOARD	PINS	SOCKET	TO	FOR
A	INTERFACE	34	AMP LATCH	N	BUFFERED I/O BUS
B	"	8	AMP HEADER	BB	Pendulums
C	"	6	"	A/D INPUTS	
D	"	8	"	I/O E	Position Encoder (Rotation)
E	"	14	AMP HEADER	CC	Compass
F	"	6	AMP HEADER	L	
G	OUTPUT DRV.	—	"	I/O A	Sys. PWR
H	"	34	AMP LATCH	K, U	BUFFERED I/O BUS
J	"	8	AMP POWER	F, G	Sail Pwr, Rot Pos Pwr, Trans Pwr
2	"	8	"	I/O 2	Relay Cam 2 Sed. Sample
3	"	8	"	Y	Pwr. for Bot. SW, opto Interruptors
4	"	8	"	I/O 4	Relay Cam 4 Insert, Rotate, Suct., Clean
5	"	8	"	I/O 5	Relay Cam 5 XYZ Position
6	"	8	"	I/O 6	Relay Cam 6 Pumps & H_2O Samples
7	"	8	"	N.C.	} Not currently in Use
8	"	8	"	N.C.	
I	BUFFER	26	AMP LATCH	SEA DATA	BUFFERED I/O BUS Sea Data Recorder
J1	CPU	50	AMP LATCH	Q	CPU BUS
J2	"	26	AMP HEADER	U	UARTS (LDV SAIL)
J3	"	26	"	EXTERNAL	BOTTOM SWITCHES
J4	"	8	"	S	SAIL/RESET
K	BUFFER	34	AMP LATCH	H, W	BUFFERED I/O BUS
L	"	6	AMP POWER	F	POWER
M	"	8	"	I/O(A, I, D, L)	BATT. RELAYS, ACOUSTIC LINK, CAMERA; LDV RST
N	"	34	AMP LATCH	A	BUFFERED I/O BUS
O	NONE	—	—	—	—
P	BUFFER	50	AMP LATCH	EXT	BUFFERED CPU BUS FOR LOGIC ANALYZER
Q	BUFFER	50	AMP LATCH	J1	CPU BUS
R	"	8	AMP POWER	G	LDV Sail Pwr, Misc.
S	"	8	AMP HEADER	J4, T	UW S.W. #, (Control) Sail
T	"	8	"	I/O C, S	CONTROL UART For Sail Loop 1
U	"	8	"	J2	UW SAIL #2, LDV
V	"	8	"	I/O D	UW SAIL #2 (LDV) + LDV RESET (H)
W	AUX	34	AMP LATCH	K, H	BUFFERED I/O BUS
X	"	8	AMP POWER	I/O, J	OPTO-INTERRUPTERS
Y	"	3	"	J	POWER FOR BOT. SW. & OPTO-INT.
Z	"	10	"	I/O K	BOTTOM SENSE SWITCHES
PWR	BUFFER	4	AMP HEADER	I/O B	PWR SUPPLY IN
AA	AUX	6	"	I/O I	Acoustic Signals (from XPONDR)
BB	Pendulum	9	Cable D	B, Pendulum	Pendulums

20 Nov 84 we
27 Oct 84 W
REV 24 Oct 84 W

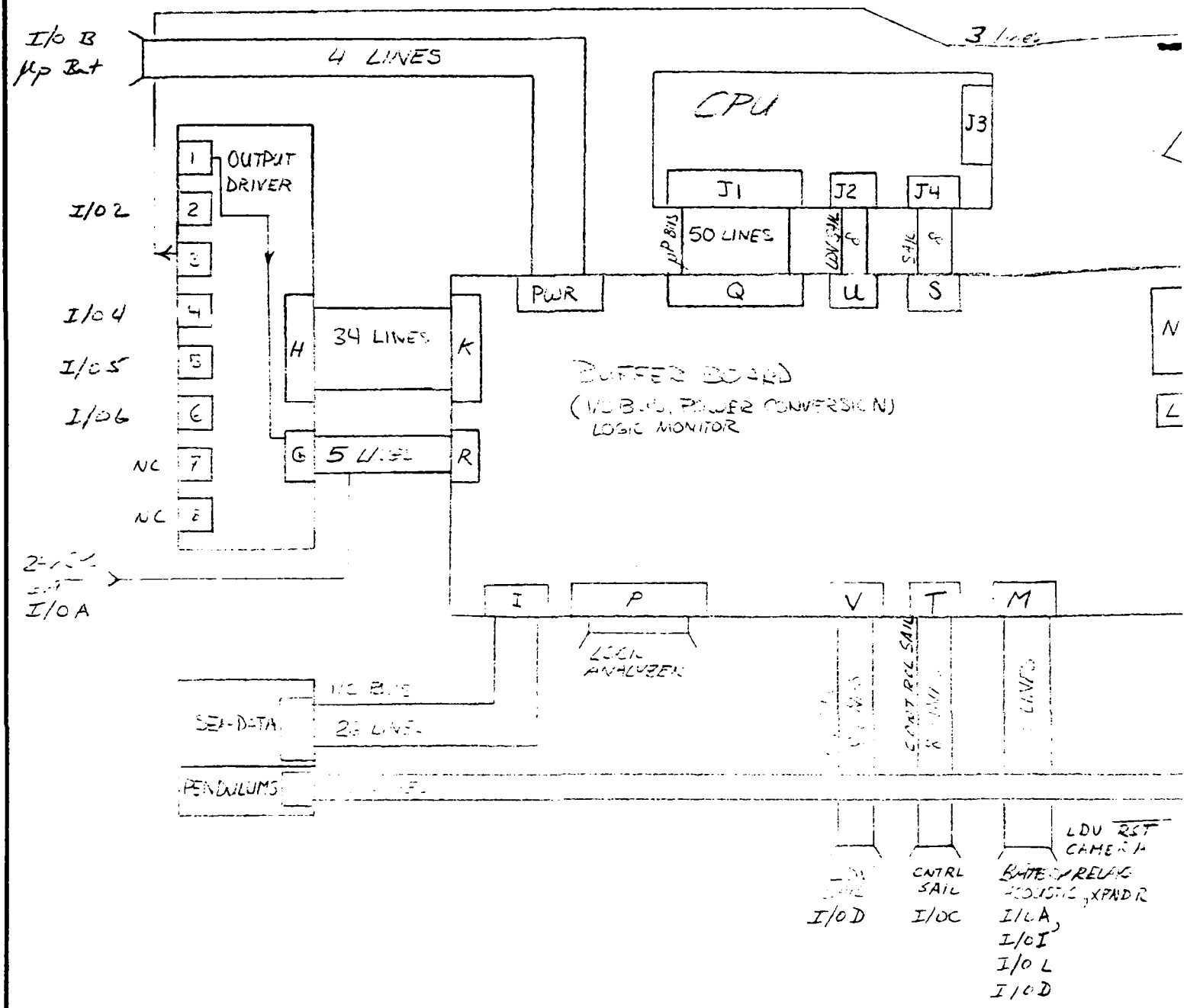
	Y	"	3	"	I/O I	POWER FOR BOT. SW. & OPTO-INT.
	Z	"	10	"	I/O K	BOTTOM SENSE SWITCHES
	PWR	BUFFER	4	[illegible]	I/O B	PWR SUPPLY IN
	AA	Aux	6	"	I/O I	Acoustic Signals (from XPONDR)
	BB	Pendulum	9	Cannon D	B, Pendulum	Pendulums
	CC	Compass	14	Augat Dip		Compass
	I/O A	To End Cap	9	Red Molex	U/W A, G	Sys. Batt. + Relays
	I/O B		4	Red Sq Molex	U/W B, PWR	µP Batt.
	I/O C		4	Grn Sq Molex	U/W C, T	Control Sail
	I/O D		4	Grn Molex	U/W D, V	LDV Sail
	I/O E		9	Grn Molex	U/W E, D	Rotation Position
	I/O F		4	Blu Sq Molex	U/W F, C, 1	Transmissometer
	I/O 2		9	Blu Molex	U/W 2, 2	Relay Can 2 Sediment Sampler
	I/O 4		9	Blu Molex	U/W 4, 4	Relay Can 4 Insert, Rotate, Suct, Clean
	I/O 5		9	Blu Molex	U/W 5, 5	Relay Can 5 XYZ Position
	I/O 6		9	Blu Molex	U/W 6, L	Relay Can 6 Hydraulic Pump, Flow Pump
	I/O I		6	Wht Molex	U/W I, AA	Acoustic Link
	I/O J		9	Yel Molex	U/W J, X	Opto Encoders (XYZ)
	I/O K		9	Wht Molex	U/W K, Z	Bottom Switches
	I/O L		2	Wht Molex	U/W L, M	Camera
		To End Cap				
	U/W A	END CAP	8	XSK-8-BCL	I/O A	Sys. Bat. + Bat Relays
	U/W B		4	XSG-4-BCL	I/O B	µP. Bat
	U/W C		4	"	I/O C	Control SAIL
	U/W D		4	"	I/O D	LDV SAIL
	U/W E		8	XSK-8-BCL	I/O E	Rotation Position
	U/W F		4	XSG-4-BCL	I/O F	Transmissometer
	U/W 2		8	XSK-8-BCL	I/O 2	Relay Can 2
	U/W 4			"	I/O 4	" 4
	U/W 5			"	I/O 5	" 5
	U/W 6			"	I/O 6	" 6
	U/W I		8	XSK-8-BCL	I/O I	Acoustic Link
	U/W J		8	"	I/O J	Opto Encoders
	U/W K		8	"	I/O K	Bottom Switches
	U/W L	END CAP	4	XSG-4-BCL	I/O L	Camera

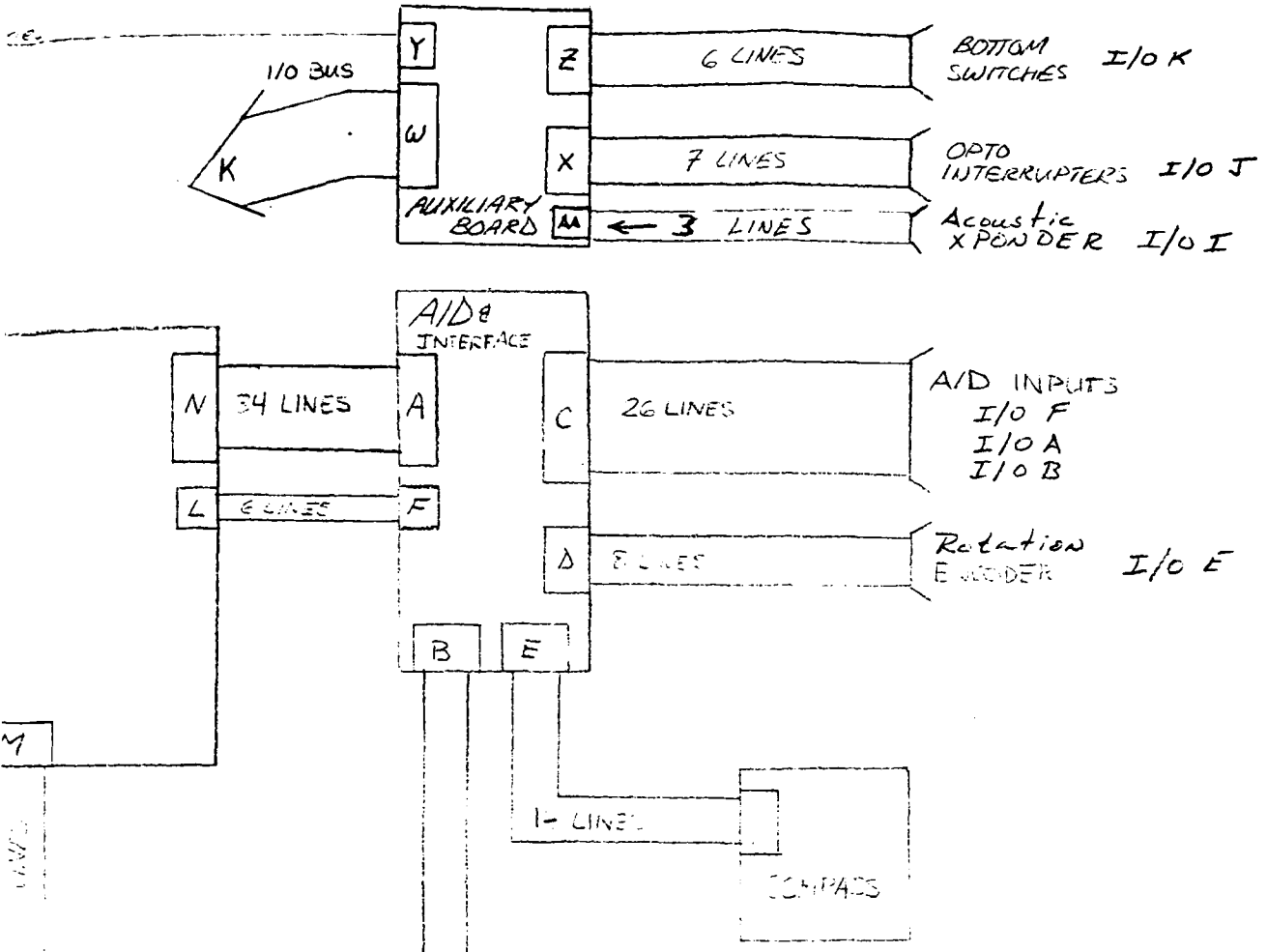
Nov 84 WET
Oct 84 WET

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543
PROJ. 10/82.69 BY ARD
SHEET 1 OF 1 DATE 7 NOV 84

TITLE
Computer System - Connector List

SD-B-001 SEE DWG LIST


I/O B
μp Bat
4 LINES
3 Lines
CPU
J3
J1
J2
J4
OUTPUT DRIVER
I/O 2
I/O 4
I/O 5
I/O 6
NC
NC
μP BUS
50 LINES
LOW SPK
SPK
PWR
Q
U
S
H
34 LINES
K
G
5 LINES
R
BUFFER BOARD
(I/O B.D., POWER CONVERSION)
LOGIC MONITOR
I
P
V
T
M
LOGIC ANALYZER
SEA-DATA
PENDULUMS
CNTRL SAIL
I/O D
I/O C
I/O A
I/O I
I/O L
I/O D



LDU RST
CAMERA
WITH PREVAC
CONTROL, XPNDR
I/O A,
I/O I
I/O L
I/O D

REV. 20 Nov 84 WET

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 1782.69 BY ARD SHEET 2 OF 2 DATE 4 NOV 82	TITLE Computer System Connectors SD-B-002 SEA DUCT

CPU Pressure Housing Connectors

Function	Conn.	Mates With	Wire	Other End	Connector	
I/O A Main Battery (Relay Pod #1) x3	XSK-8-BCL 8pins	RMK-8-FS w/K-FLS-P	30' 18/8 SO	Danco		
I/O E Position Encoder #6	XSK-8-BCL	RMK-8-FS w/K-FLS-P	18/8 SO	RMK-8-FS w/K-FLS-P	XSK-8-BCL	
Sail to Control 4	4pins each XSG-4-BCL	RMG-4-FS	Two Shielded Pair in oil tube	BARE for SAIL CONTROL	RMG-4-FSD (dummy)	also G-FLS-P
I/O D to LDV #8	XSG-4-BCL	RMG-4-FS		RMG-4-FS	XSG-4BCL	also (2) G-FLS-
Acoustic Link I/O-I (XPONDER) 1 3	6 Pins XSK-8-BCL	RMK-8-FS w/K-FLS-P	30' 18/8 SO to WINDIV	Mecca Female (6)	Mecca (6)	also to pump con
I/O-F Transmissometer #7	4PIN XSG-4-BCL	RMG-4-FS w/G-FLS-P	2 Shielded Pair in oil tube	VMG-4-FS w/G-FLS-P	VSG-4BCL	
XYZ Opto Encoder x3 I/O J	XSK-8-BCL	RMK-8-FS w/ -FLS-P	18/8 SO to 30'	DANCO		
Bottom + Sense x3 I/O-K Switches	XSK-8-BCL	RMK-8-FS w/ -FLS-P	18/8 SO to 30'	DANCO		
I/O-L Camera 4	XSG-4BCL	RMG-4-FS w/G-FLS-P	18/4 SO	51F2F (Electro)	51F2M (Electro)	See Note 3
I/O-2 Relay Pod #2 x3	XSK-8-BCL	RMK-8-FS K-FLS-P	18/8 SO	DANCO	—	
I/O-4 Relay Pod #4 x3	XSK-8-BCL	RMK-8-FS K-FLS-P	18/8 SO	DANCO	—	
I/O-5 Relay Pod #5 x3	XSK-8-BCL	RMK-8-FS K-FLS-P	18/8 SO	DANCO	—	
I/O-6 Relay Pod #6 x3	XSK-8-BCL	RMK-8-FS K-FLS-P	18/8 SO	DANCO	—	
I/O-B µP Battery 4	XSG-4-BCL	RMG-4-FS G-FLS-P	30' 18/4 SO to Mecca	Mecca Female (4) or (2)	Mecca Male	
Pump Controller (Recirculate Pumps)	3 ea XSK 6B BCL 1 ea XSG 4BCL ALSO SEE SAIL LDV	RMK-6B-FS RMG-4-FS G-FLS-P K-FLS-P	10/2 SO	Danco on Pumps + Box B	—	See Note 2
Emergency Battery to Emergency Acoustic Link	Mecca Male (2)		?	Mecca Female (6)	Mecca Male	* Not connected to

9223L-078

FOTOBEAM/BROOKSIDE 0232-B

WC

CONTRA

BY

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

G-FLS-P
(2 @ G-FLS-P)
to pump control

Note:

1. 9 ea XSK-8-BCL } ON CPU
   5 ea XSG-4-BCL } Pressure Case

2. Current Configuration uses seperate SAIL Controller IN seperate U/W Housing
   See Dwgs. SD-B010, B036

3. [illegible] PhotoSea Systems – Dwg 100467 (1/52)
   "Cable Diagram – 10000 Ft. – Wireless Hole Sonar System", or SD-BØ37

te 3

te 2

onnected to CPU housing

REV. 24 Nov 86

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543	TITLE U/W Connectors (μP System) SEA DUCT	
CONTRACT NO. 10182.69 / CODE NO.		
BY W.E.T. / DATE 11 July 84 / SIZE B	DWG. NO. SD-B-003 / OF / REV. 31 Jul 85	

Group Ø

	Input	Output
1	Read Grp. Sel.	Set Grp. Sel.
2	Contact Switches	Bat. 1 Relay
3	X Position	Bat. 2 Relay
4	Y Z Position	Bat. 3 Relay
5	—	LDV Reset
6	—	Camera
7	Acoustic Xpond	Acoustic Xpond

Group 1

	Input	Output
1	Read G. S.	Set G. S.
2	Compass	Compass
3	—	
4	Heading	Heading Latch
5	—	Heading Shift Clk.
6	—	Heading PWR.
7	—	—

Group 2

	Input	Output
1	Read G. S.	Set G. S.
2	A/D Low 4 bits	Mux + A/D Control
3	A/D High 8 bits	Sea Data Request
4	—	—
5	—	—
6	—	Circ. Pump Control (PWR)
7	Relay Sense	Relay Control

Group 3

	Input	Output
1	Read Grp. Sel.	Set Grp. Sel.
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—

Group 4

	Input	Output
1	Read Grp. Sel.	Set Grp. Sel.
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—

Group 5 (1851)

	Input	Output	
1	Read G. S.	Set G. S.	
2	—	—	
3	—	—	
4	CLR	CLR	
5	Port Status	Port Control	
6	Port A	Port A	Not Use
7	Port B	Port B	Not Use

Group 6 (Harts)

	Input	Output	
1	Read G.S.	Set G.S	
2	Data 1 in	Data 1 out	]
3	Status 1	Control 1	]
4	Data 2 in	Data 2 out	]
5	Status 2	Control 2	]
6	Data 3 in	Data 3 out	]
7	Status 3	Control 3	]

Group 7

	Input	Output
1	Read Grp. Sel	Set Grp. Sel.
2	—	—
3	—	—
4	—	—
5	—	—
6	—	Halt (Suicide)
7	—	Memory Protect

Input Output

WOODS

CONTRACT NO

BY N. E.

2 | 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

tput

t Grp. Sal.

Other 1806 'I/O'

EF1 —
EF2 Compass + A/D
EF3 Sea Data Recorder
EF4 UT4

Q UT4, Mem. Protect, Interrupt Pulse

t G.S.

Control
A
B
] Not Used

s)

t G.S
ta 1 out
trol 1
] Control SAIL

ta 2 out
itrol 2
] LDV, PUMP SAIL

'a 3 out
trol 3
] UNUSED

Grp. Sal,

(Suicide) Not Used
ry Protect

24 Nov 86 WET
16 Oct 84 WET
27 July 84 WET
REV 7 Nov 83 ARD

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE 1806A CPU I/O DECODING SEA DUCT	
CONTRACT NO. 10/82.69	CODE NO.		
BY W. E. TERRY	DATE	SIZE B	DWG. NO. SD-B004 OF REV.

2 | 1

GS2-I/07

MR	D	G G G	A A A
MASTER RESET	DATA	Chip Sel.	ADDR

USE OCTAL →
- 2 XX = RESET
- 1 NN = Set Function
- 0 NN = CLR Function

I.C. Pin	Logical Device #	HEX	Octal #	Function	Conn. #	Pin
4	0	0	00	LDU Sail Loop	* 1	8
5	1	1	1	HEADING INDICATOR	* 1	7
6	2	2	2	—	* 1	6
7	3	3	3	—	* 1	5
(IC 5) 9	4	4	4	TRANSMISSOMETER PWR	* 1	4
10	5	5	5	—	* 1	3
11	6	6	6	Sed 1 insert	2	8
12	7	7	7	Sed 1 retract	2	7
4	8	8	10	Sed 1 unlatch – H_2O Sample 1	2	6
5	9	9	11	Sed 2 insert	2	5
6	10	A	12	Sed 2 retract	2	4
7	11	B	13	Sed 2 unlatch – H_2O Sample 2	2	3
(IC 7) 9	12	C	14	Opto Interrupter Drive	3	8
10	13	D	15	Bottom Switch Drive	3	7
11	14	E	16	—	3	6
12	15	F	17	—	3	5
4	16	10	20	—	3	4
5	17	11	21	—	3	3
6	18	12	22	Flume insert	4	8
7	19	13	23	Flume retract	4	7
(IC 9) 9	20	14	24	Rotate CW	4	6
10	21	15	25	Rotate CCW	4	5
11	22	16	26	Suction Pump (Spare)	4	4
12	23	17	27	View Port Clean (Spare)	4	3
4	24	18	30	X+	5	8
5	25	19	31	X−	5	7
6	26	1A	32	Y+	5	6
7	27	1B	33	Y−	5	5
(IC 11) 9	28	1C	34	Z+	5	4
10	29	1D	35	Z−	5	3
11	30	1E	36	Hydraulic Pump	6	8
12	31	1F	37	Recirculate Pump Pwr	6	7

Relay Card #6

Not Installed

I.C. Pin #	DEC	H
4	32	
5	33	
6	34	
(IC 13) 7	35	
9	36	
10	37	
11	38	
12	39	
4	40	
5	41	
6	42	
(IC 15) 7	43	
9	44	
10	45	
11	46	
12	47	

* Supplied by μP Battery —
All others are System Battery

WOOD
PROJ.
SHEET.

I.C. Pin #	DEC	HEX	OCTAL	Function	Conn. #	Pin #	
4	32	20	40	Spare (was Recirculate Pump #2)	6	6	
5	33	21	41	Spare	6	5	Relay Card #6 con't
6	34	22	42	Spare (was H_2O sample 1)	6	4	
7	35	23	43	Spare (was H_2O sample 2)	6	3	
8	36	24	44		7	8	
9	37	25	45		7	7	
10	38	26	46		7	6	
11	39	27	47		7	5	
4	40	28	50		7	4	
5	41	29	51		7	3	
6	42	2A	52		8	8	
7	43	2B	53		8	7	
8	44	2C	54		8	6	
9	45	2D	55		8	5	
10	46	2E	56		8	4	
11	47	2F	57		8	3	
12							

Not Installed

24 Nov 86 WET
16 Oct 84 WET
27 July 84 WET
REV 17 July 84 KAW

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543
PROJ. 10/82.69 BY W.E.T.
SHEET 3 OF 3 DATE 4 NOV 83

TITLE
Output Driver Decoding
SEA DUCT

SD-8-005

SEA DUCT–BUFFER BOARD PULSE DRIVERS

						Conn/Pin
1	Compass	GS 1	I/O 2	10. mSec	24V	L1
2	Spare	–		–	24V	L2
3	Bat.1 RELAY	GSØ	I/O 2	160 m Sec	24V	M3
4	Bat 2 RELAY	GSØ	I/O 3	160 m Sec	24V	M4
5	Bat.3 Relay	GSØ	I/O 4	160 m Sec	24V	M5
6	LDV RESET	GSØ	I/O 5	200 m Sec.	O.C	M6
7	Camera	GSØ	I/O 6	150 m Sec	O.C	M7
8	Acoustic XPONDER ("SEND")	GSØ	I/O 7	35 m Sec	O.C	M8

SEA D

Hi Byte (N 4)		
Ø	×	Pe
1	×	Pe
2	×	μ
3	×	S
4	×	A
5	×	A
6	×	A
7	×	T
8	×	
9	×	
A	×	
B	×	
C	×	
D	×	
E	×	
F	×	

WOODS HOLE

W

CONTRACT NO. 10

BY W. E. T.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

SEA DUCT - A/D + MUX DECODING

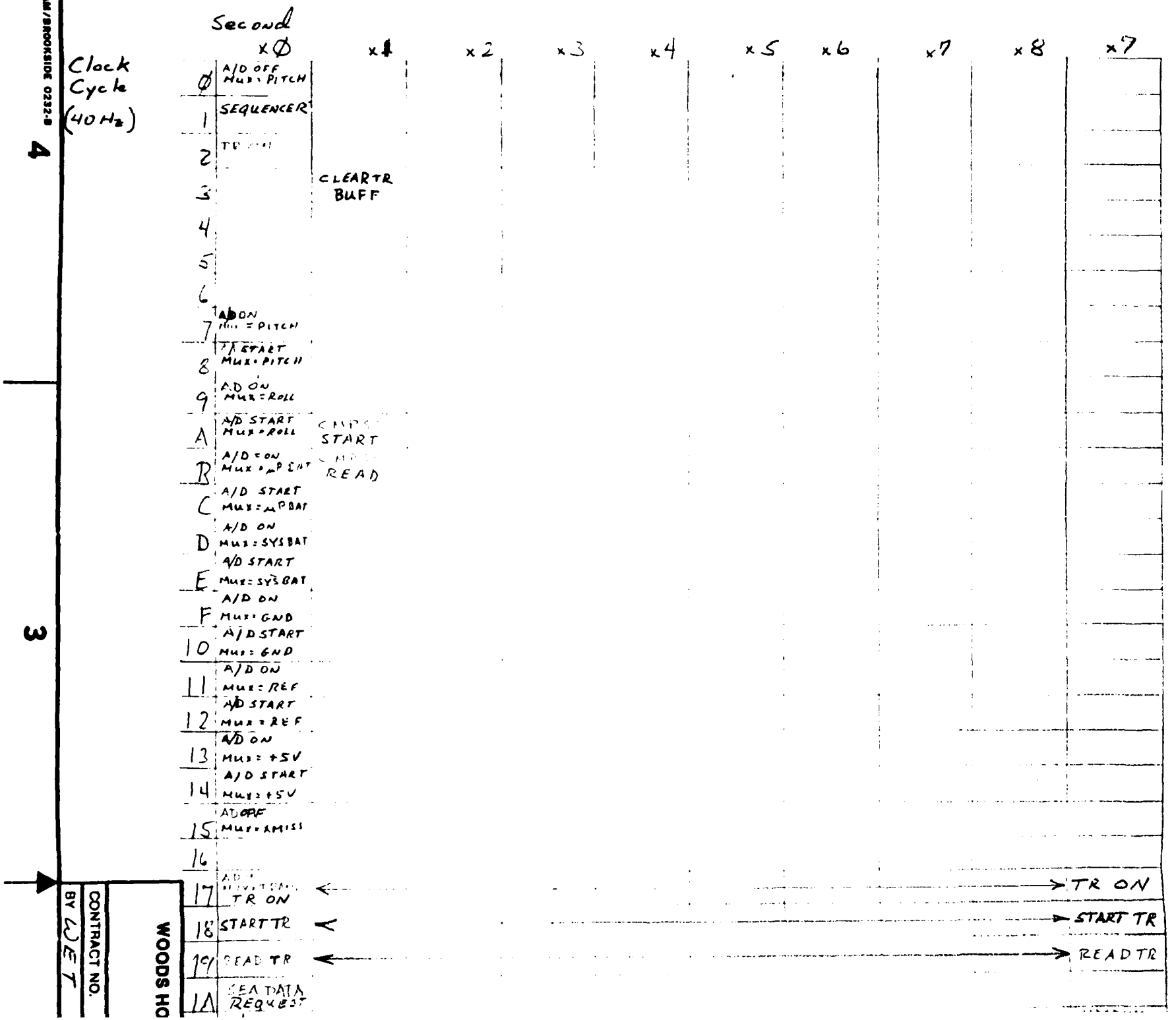
Hi Byte (N Y)			Lo Byte Y N	
0	x	Pendulum 1-Pitch (8 bit)	x 0	A/D OFF
1	x	Pendulum 2-Roll (8 bit)	x	
2	x	µP 24V Bat (8 bit)	x 2	A/D Pwr ON
3	x	Sys 24V Bat (8 bit)	x 3	A/D Start Convert
4	x	A/D GND (12 bit)	x	
5	x	A/D REF (12 bit)		
6	x	A/D +5V (12 bit)		
7	x	Transmissometer (12 bit)		
8	x			
9	x			
A	x			
B	x			
C	x			
D	x			
E	x			
F	x			

GS = 2 I/O = 2

(Use GP = X Rec)

Rev 23 Apr 86

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE Pulse Driver Decoding A/D, Mux Decoding SEA DUCT	
CONTRACT NO. 10182.69	CODE NO.		
BY W. E. T.	DATE 20 Nov 84 SIZE B	DWG. NO. SD-B-006	OF REV.



WOODS HO

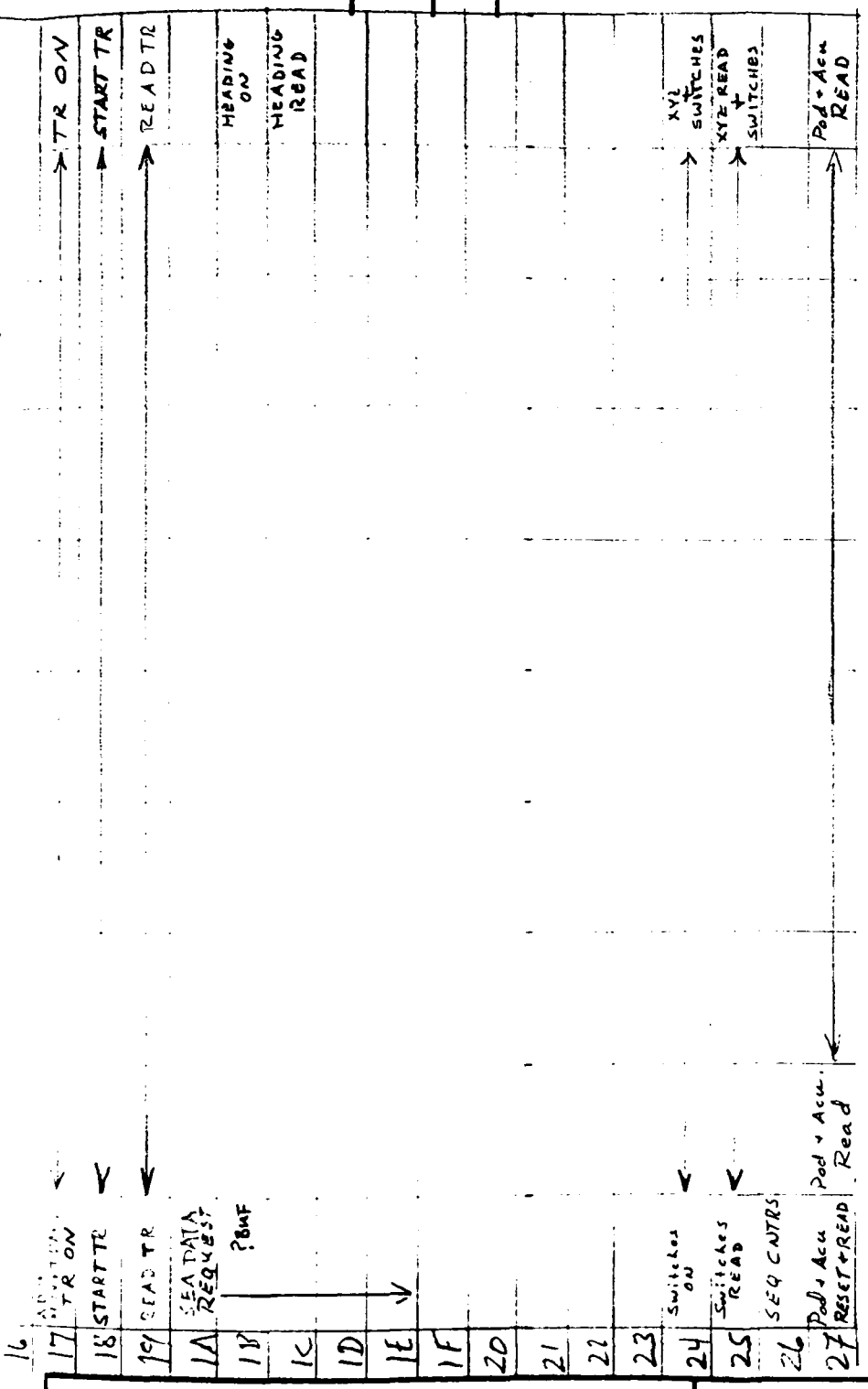
CONTRACT NO.

BY WET

FOTOBEAM/BROOKSIDE 0232-8

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

Note
This chart is a general reference. It does not represent everything done by the CPU.



REV 24 Nov. 86

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543	TITLE Software Timing SEA DUCT
CONTRACT NO. 10/82.69 / CODE NO.	
BY WET / DATE 9/9/84 / SIZE B	DWG. NO. SD-B-007 / OF / REV.

PIN #	50 PIN CPU	34 PIN I/O BUS	26 PIN SEADATA
1	I/O 4	I/O 4°	EF 2
2	I/O 7	I/O 7°	EF 3
3	I/O 3	I/O 3°	EF 1
4	I/O 6	I/O 6°	EF 4
5	I/O 2	I/O 2°	GND
6	I/O 5	I/O 5°	NC
7	GND	GND	GS2°
8	GND	GND	B0L
9	5v	5v	I/O 3°
10	5v	5v	B1L
11	$\overline{EF4}$	$\overline{EF4}$	NC
12	NC KEY	GS 3°	B2L
13	$\overline{MWR}$	GS2°	SC 0
14	$\overline{EF3}$	$\overline{EF3}$	B3L
15	A7	GS1°	TPB°
16	$\overline{EF2}$	$\overline{EF2}$	B4L
17	A6	GS0°	DMA OUT
18	$\overline{EF1}$	$\overline{EF1}$	B5L
19	A5	B7°	$\overline{MRD}$°
20	N2	N.C. KEY	B6L
21	A4	B6°	SC 1
22	N1	CLK	B7L
23	A3	B5°	GND
24	N0	N.C. KEY	V Mode
25	A2	B4°	5v
26	GS2	NC	V I/O
27	A1	B3°	
28	GS1	NC	
29	A0	B2°	
30	GS0	$\overline{MRD}$°	
31	B7	B1°	
32	WAIT	TPB°	

FUNCTION	50 PIN CPU	34 PIN I/O BUS	26 PIN SEADATA
B0(°,L,)	45	33	8
1 "	43	31	10
2 "	41	29	12
3 "	39	27	14
4 "	37	25	16
5 "	35	23	18
6 "	33	21	20
B7 (°,L,)	31	19	22
N0	24	NC	NC
N1	22	NC	NC
N2	20	NC	NC
$\overline{EF1}$	18	18	3
$\overline{EF2}$	16	16	1
$\overline{EF3}$	14	14	2
$\overline{EF4}$	11	11	4
0	40	NC	NC
TPA	49	34	NC
TPB (0)	47	32	15
SC 0	38	NC	13
SC 1	36	NC	21
DMA OUT	48	NC	17
$\overline{DMA\ IN}$	50	NC	NC
$\overline{MRD}$ (0)	42	30	19
$\overline{MWR}$	13	NC	NC
$\overline{INT}$	44	NC	NC
CLK	NC	NC	NC
I/O	29	NC	NC
A1	27	NC	NC
A2	25	NC	NC
A3	23	NC	NC
A4	21	NC	NC
A5	19	NC	NC

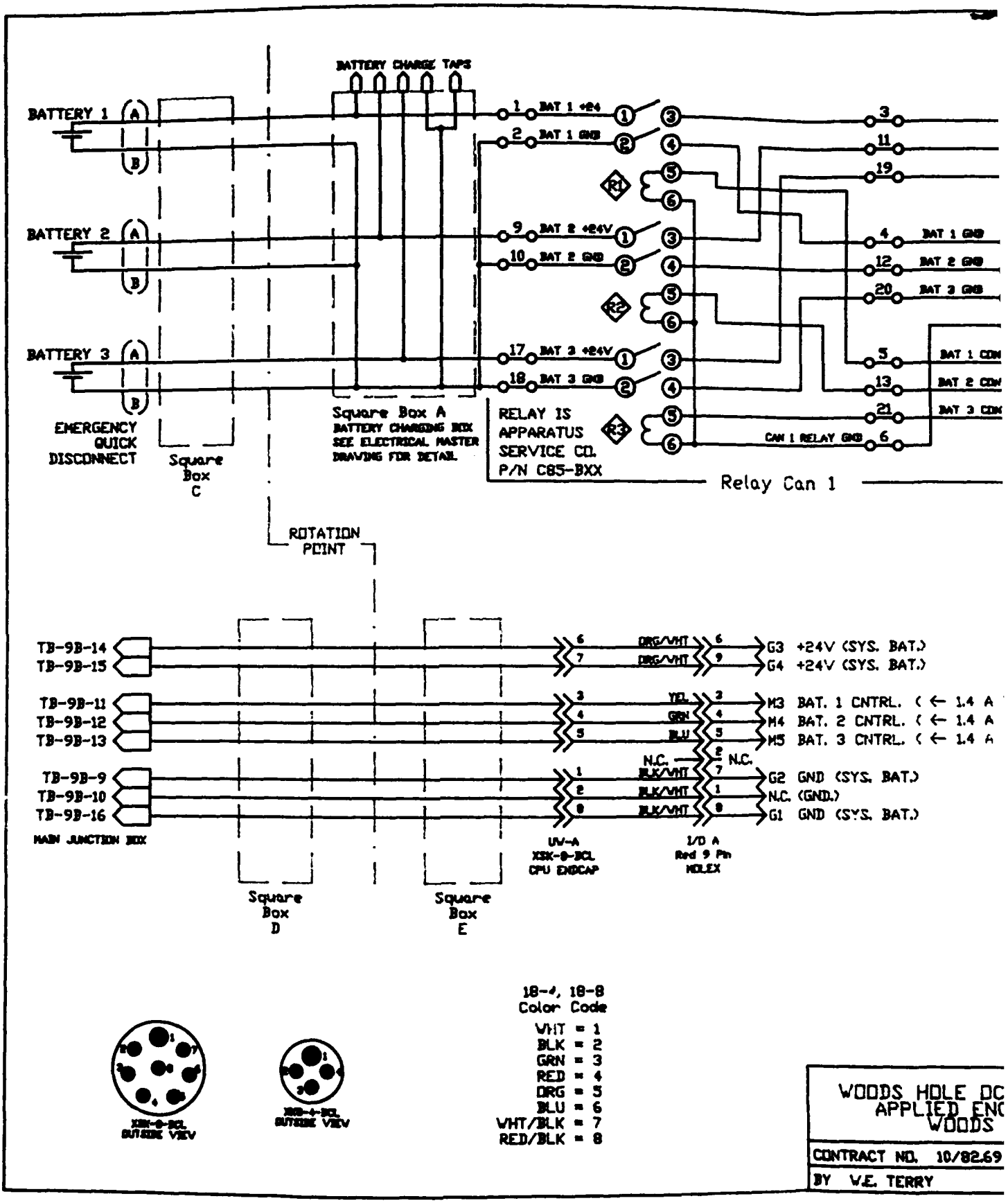
28	GS1	NC
29	A0	A2
30	GS0	MRD
31	B7	B1
32	WAIT	TPB
33	B6	B0
34	CLR	TPA
35	B5	
36	SCI	
37	B4	
38	SCO	
39	B3	
40	Q	
41	B2	
42	MRD	
43	B1	
44	INT	
45	B0	
46	GS3	
47	TPB	
48	DMA OUT	
49	TPA	
50	DMA IN	

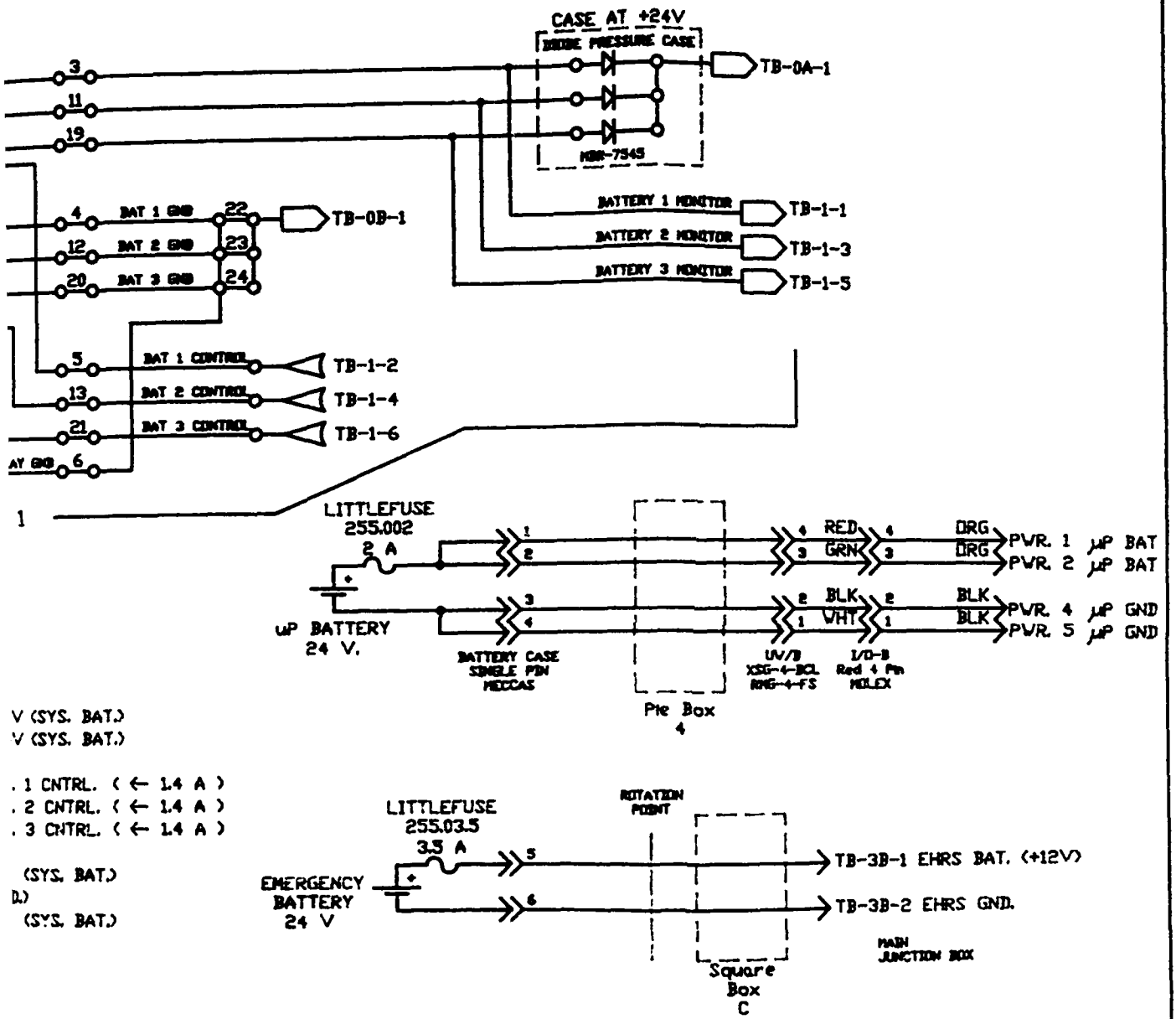
A1	27	NC	NC
A2	25	NC	NC
A3	23	NC	NC
A4	21	NC	NC
A5	19	NC	NC
A6	17	NC	NC
A7	15	NC	NC
V_{DD} (5V)	9, 10	9, 10	25
V_{SS} (GND)	7, 8	7, 8	23
$V_{REF}+$	NC	NC	26
$V_{REF}-$	7, 8	NC	24
CLR	34	22	NC
WAIT	32	NC	NC
GS0	30	17	NC
GS1	28	15	NC
GS2	26	13	7
GS3	46	12	NC
I/O 2	5	5	NC
I/O 3	3	3	9
I/O 4	1	1	NC
I/O 5	6	6	NC
I/O 6	4	4	NC
I/O 7	2	2	NC
N C	NONE	26, 28	6, 11
NC KEY	12	20, 24	NONE

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543
PROJ. 10/82.69 BY MRD
SHEET 1 OF 1 DATE 4 NOV 82

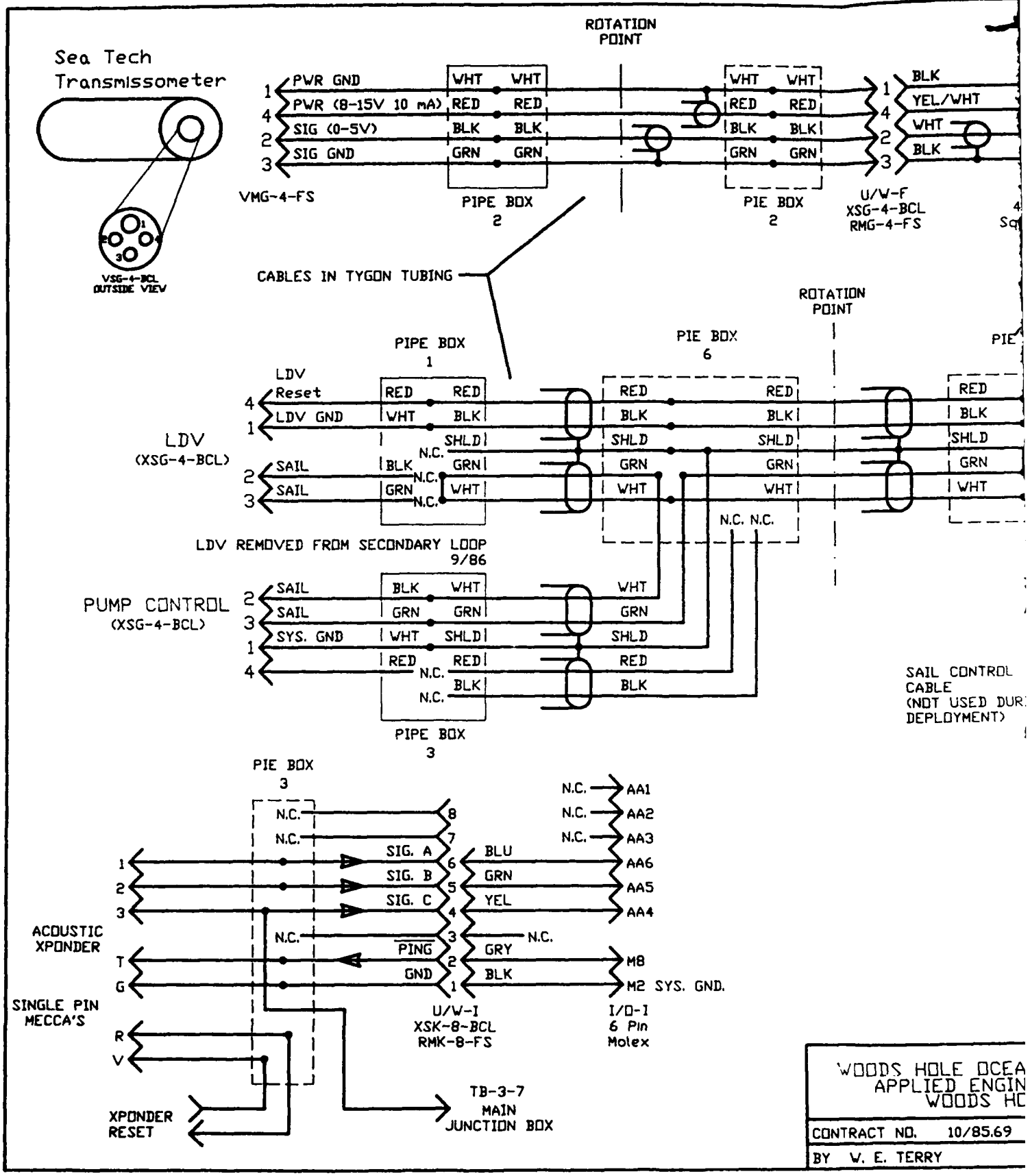
TITLE
Computer Ribbon Conn.
Pin/Funct. Cross Ref. SEA DUCT

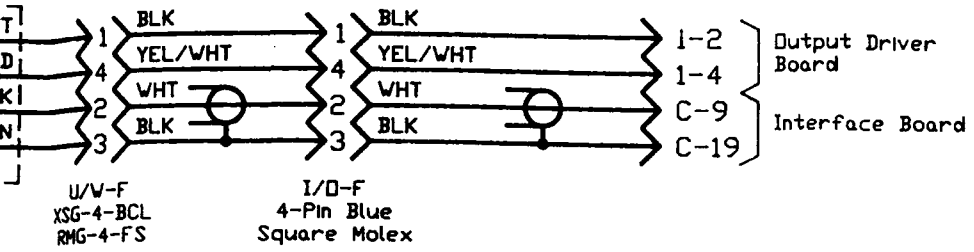
SD-P-228

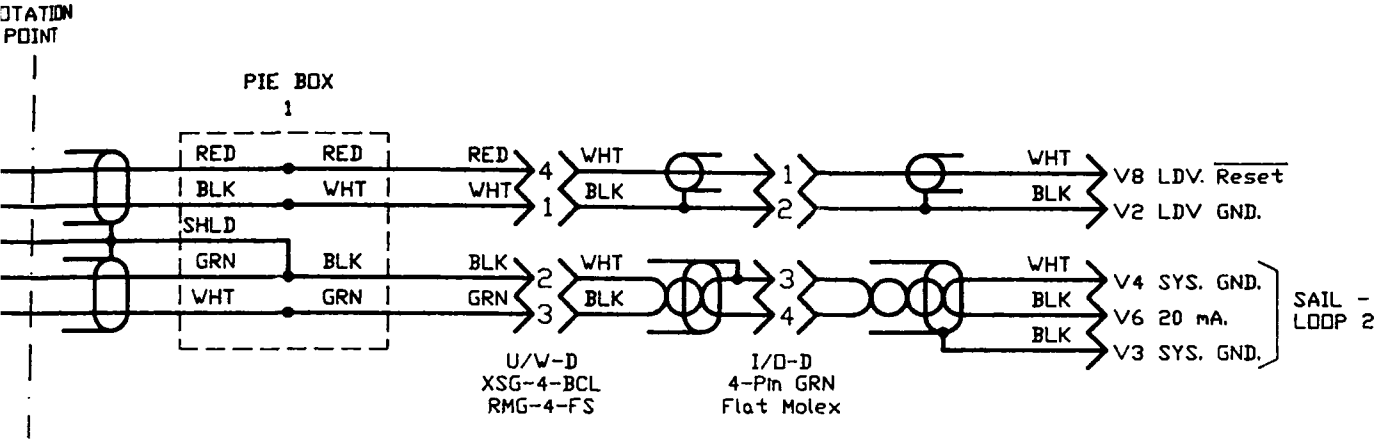

BATTERY CHARGE TAPS
BATTERY 1
BATTERY 2
BATTERY 3
A
B
1 BAT 1 +24
2 BAT 1 GND
9 BAT 2 +24V
10 BAT 2 GND
17 BAT 3 +24V
18 BAT 3 GND
R1
R2
R3
3
11
19
4 BAT 1 GND
12 BAT 2 GND
20 BAT 3 GND
5 BAT 1 CON
13 BAT 2 CON
21 BAT 3 CON
CAN 1 RELAY GND 6
EMERGENCY QUICK DISCONNECT
Square Box C
Square Box A
BATTERY CHARGING BOX
SEE ELECTRICAL MASTER DRAWING FOR DETAIL
RELAY IS APPARATUS SERVICE CO. P/N C85-BXX
Relay Can 1
ROTATION POINT
TB-9B-14
TB-9B-15
TB-9B-11
TB-9B-12
TB-9B-13
TB-9B-9
TB-9B-10
TB-9B-16
MAIN JUNCTION BOX
ORG/WHT
YEL.
GRN
BLU
N.C.
BLK/WHT
G3 +24V (SYS. BAT.)
G4 +24V (SYS. BAT.)
M3 BAT. 1 CNTRL. (← 1.4 A
M4 BAT. 2 CNTRL. (← 1.4 A
M5 BAT. 3 CNTRL. (← 1.4 A
G2 GND (SYS. BAT.)
N.C. (GND.)
G1 GND (SYS. BAT.)
UV-A
XSK-8-BCL
CPU ENDCAP
I/O A
Red 9 Pin
MOLEX
Square Box D
Square Box E
XSK-8-BCL OUTSIDE VIEW
XSB-4-BCL OUTSIDE VIEW
18-4, 18-8
Color Code
WHT = 1
BLK = 2
GRN = 3
RED = 4
ORG = 5
BLU = 6
WHT/BLK = 7
RED/BLK = 8
WOODS HOLE OC
APPLIED ENG
WOODS
CONTRACT NO. 10/82.69
BY W.E. TERRY

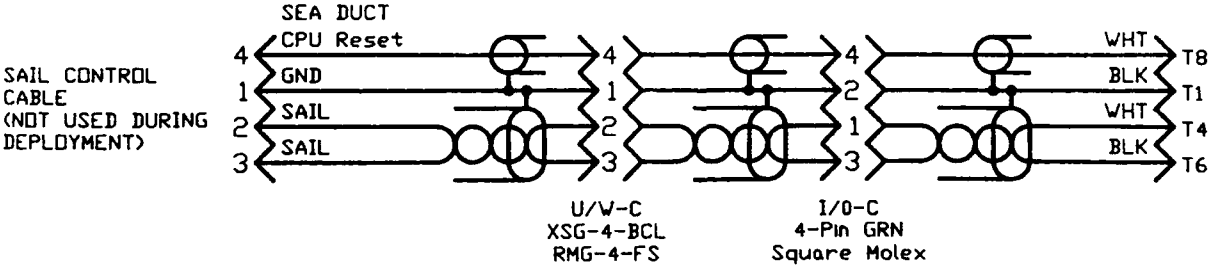


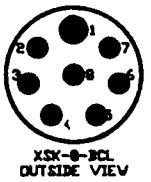
WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED ENGINEERING LABORATORY WOODS HOLE, MA. 02543				TITLE uP BATTERY, SYSTEM BATTERY AND, EMERGENCY BATTERY SYSTEMS		
INTRACT NO. 10/82.69	CODE NO.					SEA DUCT
V.E. TERRY	DATE 1 AUG. 84	SIZE B	DWG. NO. SD-B009		DF	REV. 24 MAR 87


Sea Tech
Transmissometer
VSG-4-BCL
OUTSIDE VIEW
ROTATION
POINT
1 PWR GND
4 PWR (8-15V 10 mA)
2 SIG (0-5V)
3 SIG GND
WHT WHT
RED RED
BLK BLK
GRN GRN
VMG-4-FS
PIPE BOX
2
PIE BOX
2
U/W-F
XSG-4-BCL
RMG-4-FS
BLK
YEL/WHT
WHT
BLK
CABLES IN TYGON TUBING
ROTATION
POINT
PIPE BOX
1
PIE BOX
6
LDV
(XSG-4-BCL)
4 LDV Reset
1 LDV GND
2 SAIL
3 SAIL
RED RED
WHT BLK
SHLD
BLK N.C. GRN
GRN N.C. WHT
N.C.
LDV REMOVED FROM SECONDARY LOOP
9/86
PUMP CONTROL
(XSG-4-BCL)
2 SAIL
3 SAIL
1 SYS. GND
4
BLK WHT
GRN GRN
WHT SHLD
RED RED
N.C.
BLK
N.C.
N.C. N.C.
SAIL CONTROL
CABLE
(NOT USED DUR
DEPLOYMENT)
PIPE BOX
3
PIE BOX
3
ACOUSTIC
XPONDER
1
2
3
T
G
N.C.
N.C.
SIG. A
SIG. B
SIG. C
N.C.
PING
GND
8
7
6
5
4
3
2
1
BLU
GRN
YEL
GRY
BLK
N.C.
N.C.
N.C.
AA1
AA2
AA3
AA6
AA5
AA4
M8
M2 SYS. GND.
U/W-I
XSK-8-BCL
RMK-8-FS
I/O-1
6 Pin
Molex
SINGLE PIN
MECCA'S
R
V
XPONDER
RESET
TB-3-7
MAIN
JUNCTION BOX
WOODS HOLE OCEA
APPLIED ENGIN
WOODS HO
CONTRACT NO. 10/85.69
BY W. E. TERRY





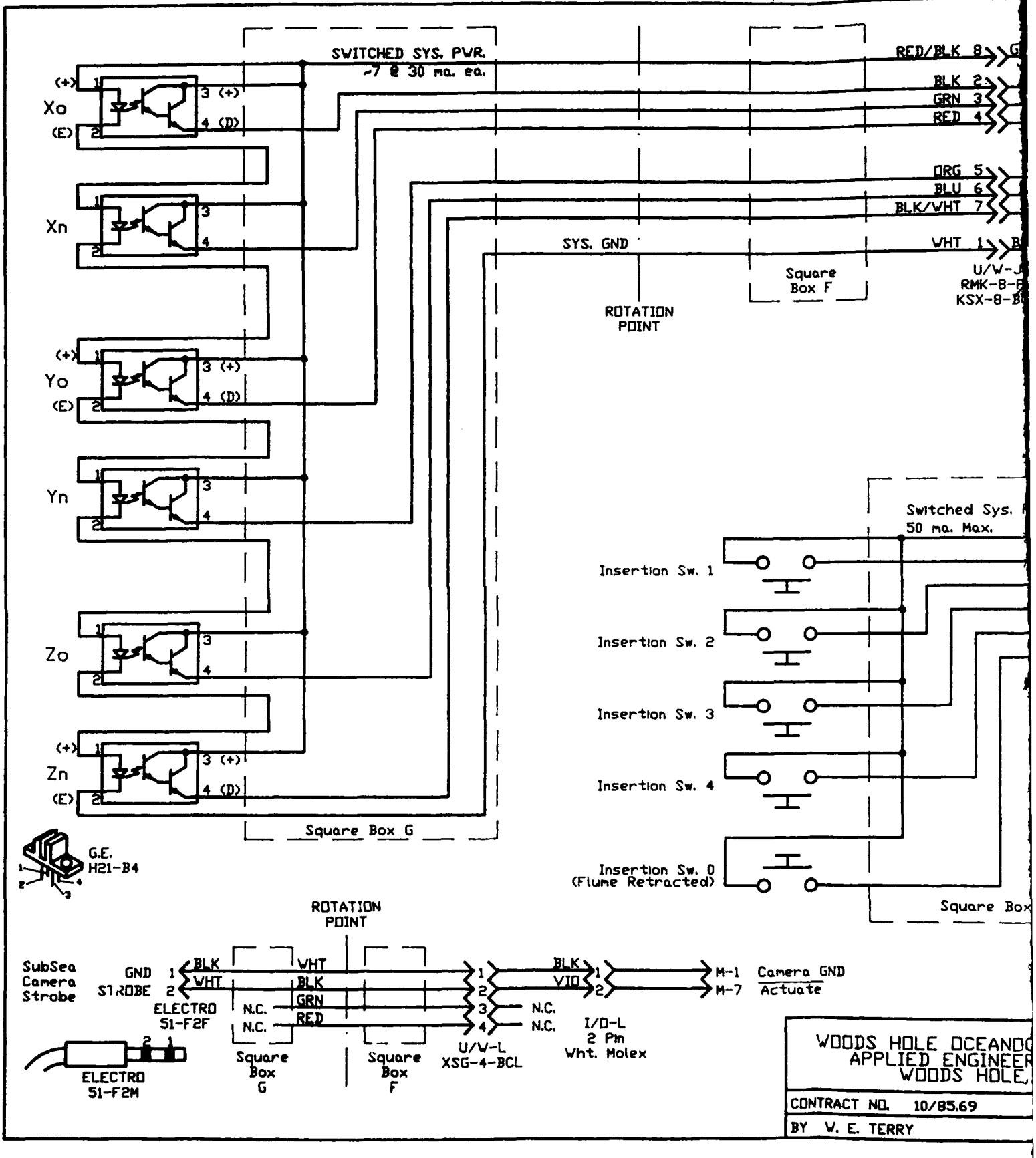




18-4, 18-8 Color Code

WHT = 1
BLK = 2
GRN = 3
RED = 4
ORG = 5
BLU = 6
WHT/BLK = 7
RED/BLK = 8

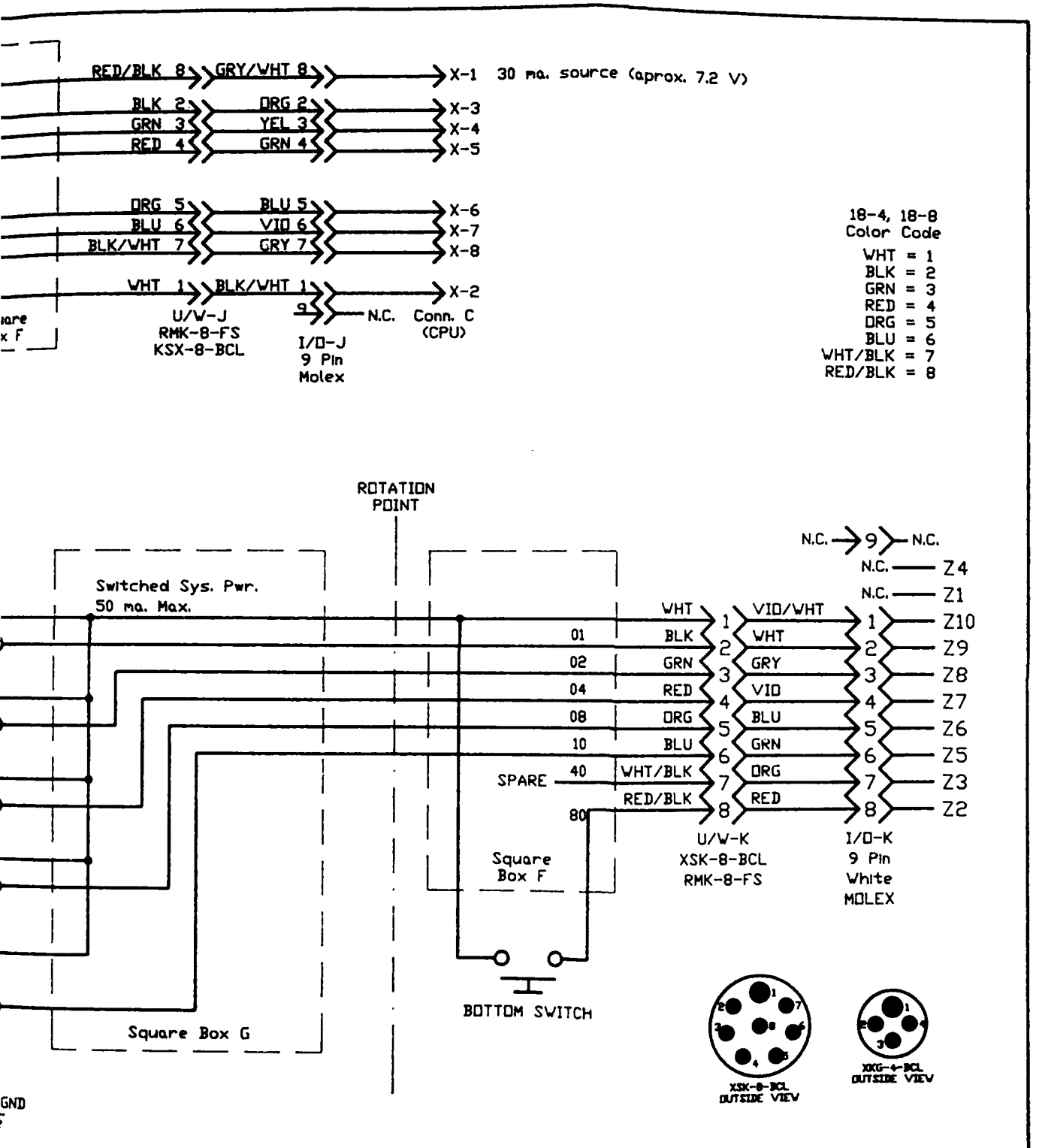
WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED ENGINEERING LABORATORY WOODS HOLE, MA. 02543			TITLE SAIL, TRANSPONDER, AND TRANSMISSOMETER --- EXTERNAL CONNECTIONS SEA DUCT		
JNTRACT NO. 10/85.69	CODE NO.				
W. E. TERRY	DATE 26 JUL 85	SIZE B	DWG. NO. SD-B-010	OF	REV. 02 DEC 86



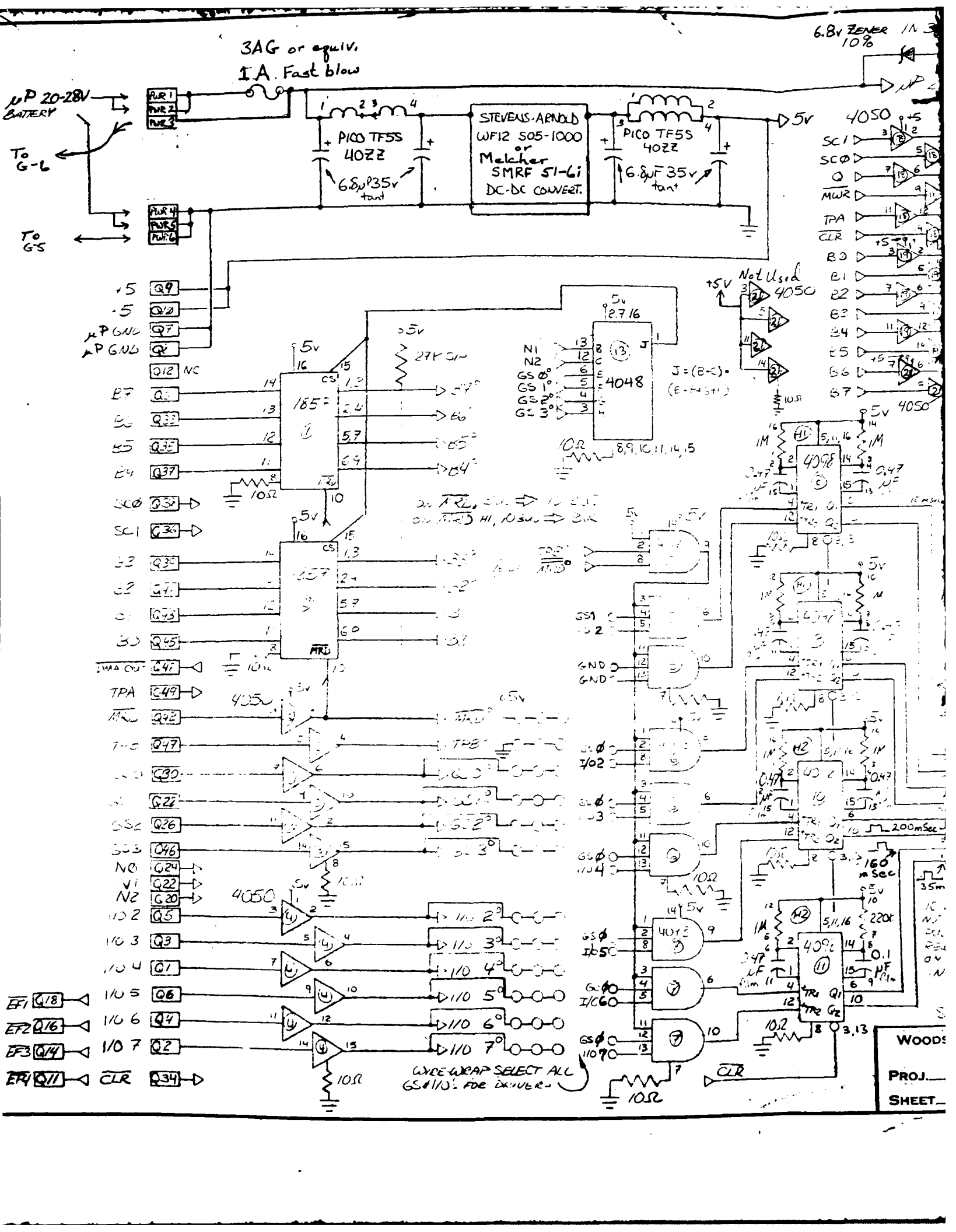
WOODS HOLE OCEANOG
APPLIED ENGINEER
WOODS HOLE,

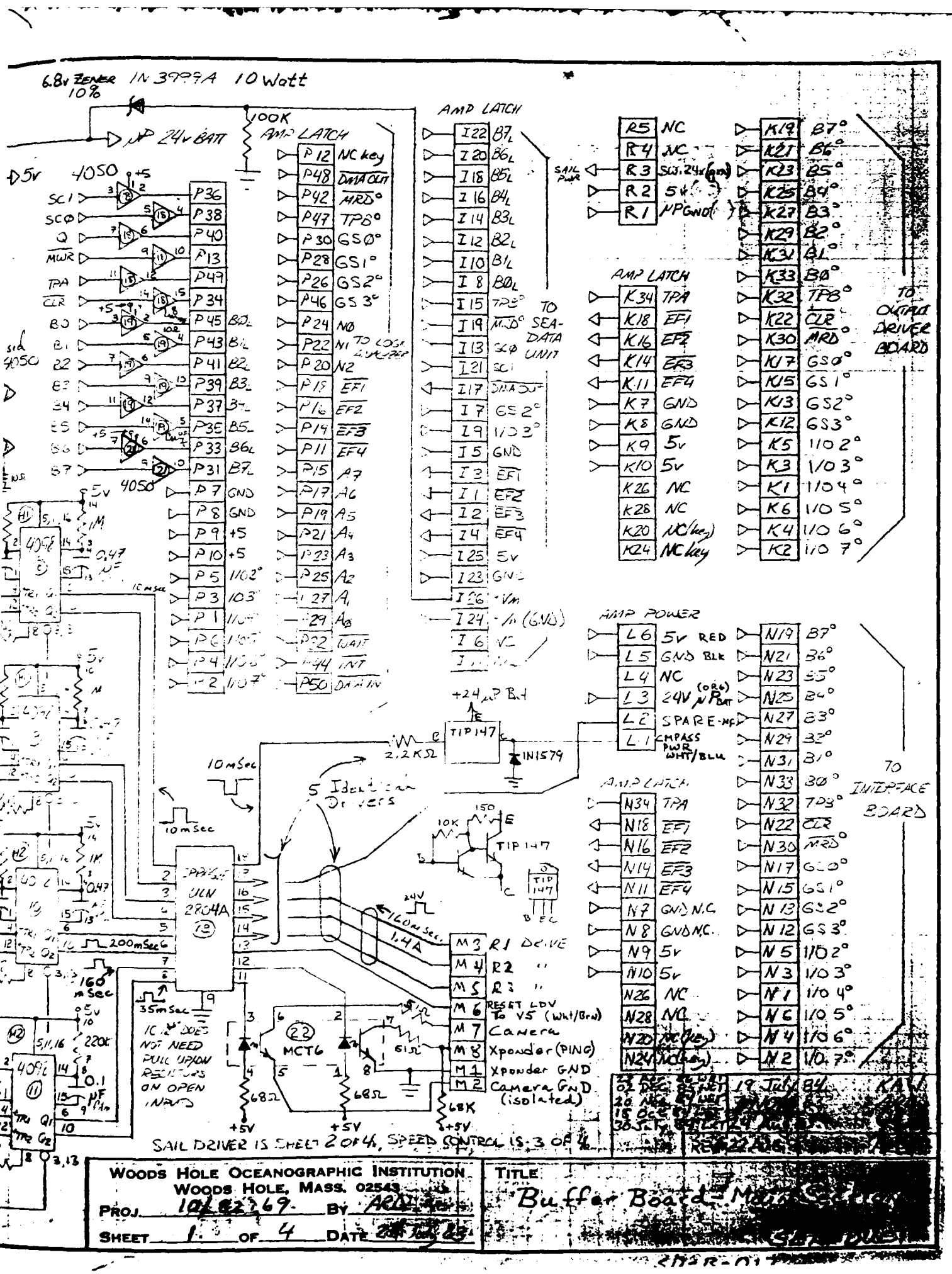
CONTRACT NO. 10/85.69

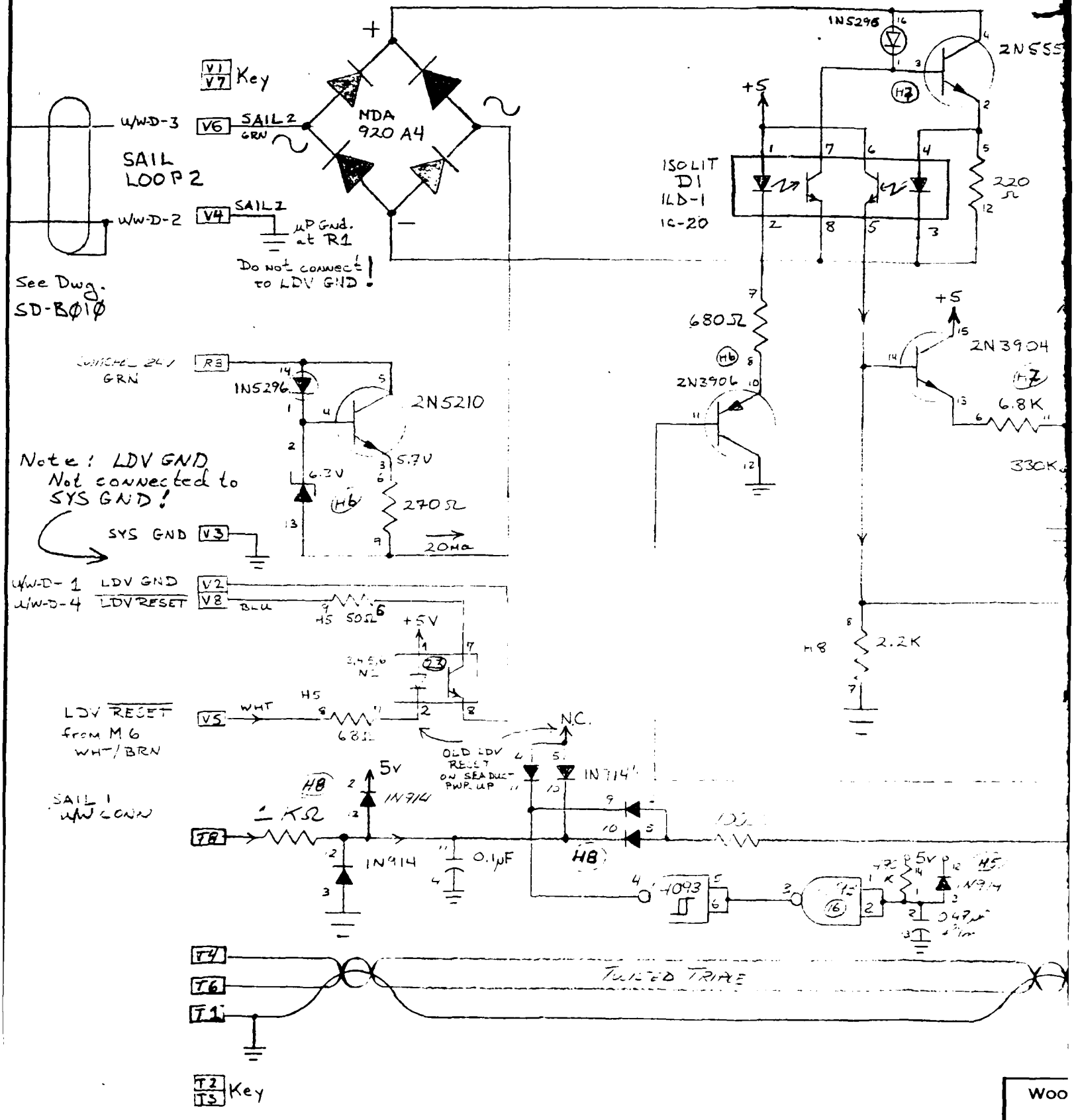
BY W. E. TERRY



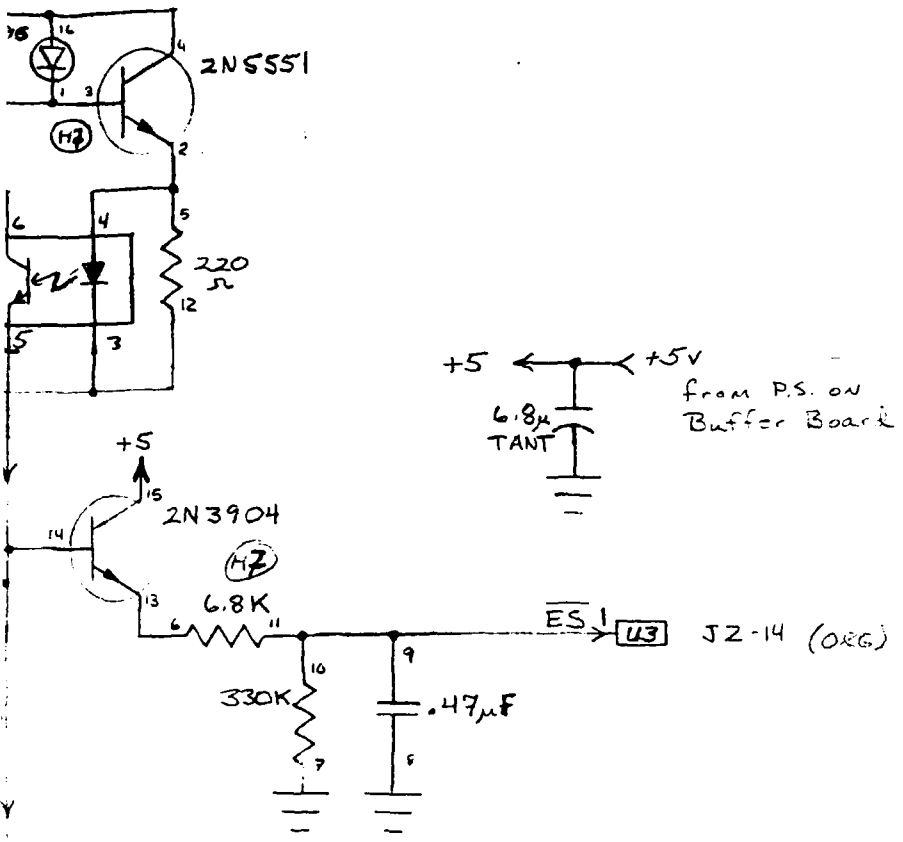
WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED ENGINEERING LABORATORY WOODS HOLE, MA. 02543			TITLE	OPTO INTERRUPTERS, CAMERA SENSE SWITCHES --- EXTERNAL WIRING	SEA DUCT
TRACT NO. 10/85.69	CODE NO.				
V. E. TERRY	DATE 1 NOV. 83	SIZE B	DWG. NO. SD-B011	OF	REV.23 APR 86


3AG or equiv.
1A. Fast blow
6.8v ZENER 1N
10%
μP 20-28V BATTERY
To G-6
To G-5
PWR 1
PWR 2
PWR 3
PWR 4
PWR 5
PWR 6
PICO TF5S 4022
6.8μF 35v tant
STEVENS-ARNOLD WF12 S05-1000 or Melcher SMRF 5I-6i DC-DC CONVERT.
PICO TF5S 4022
6.8μF 35v tant
5v
4050
SC1
SCØ
Q
MWR
TPA
CLR
B0
B1
B2
B3
B4
B5
B6
B7
+5
+5
μP GND
μP GND
Q9
Q10
Q7
Q8
Q12 NC
B7 Q31
B6 Q33
B5 Q35
B4 Q37
SCØ Q32
SC1 Q34
B3 Q39
B2 Q41
B1 Q43
B0 Q45
DMA OUT C47
TPA C49
MRD Q42
Q44
Q47
Q30
Q28
Q26
Q46
N0 Q24
N1 Q22
N2 Q20
I/O 2 Q5
I/O 3 Q3
I/O 4 Q1
I/O 5 Q6
I/O 6 Q4
I/O 7 Q2
EF1 Q18
EF2 Q16
EF3 Q14
EF4 Q11
CLR Q34
185
27K 5%
4048
N1
N2
GS Ø
GS 1
GS 2
GS 3
J=(B+C)•(E+F+G+H)
8,9,10,11,14,15
10Ω
Not Used
4050
1M
0.47 μF
4098
200mSec
160 m Sec
35m
220K
0.1 μF
10Ω
WRAP SELECT ALL GS#I/O's FOR DRIVERS
WOODS
PROJ.
SHEET


6.8v Zener 1N3999A 10 Watt
10%
100K
+24v BATT
AMP LATCH
4050
5v
SC1
SCØ
Q
MWR
TPA
CLR
B0
B1
B2
B3
B4
B5
B6
B7
P36
P38
P40
P13
P49
P34
P45
P43
P41
P39
P37
P35
P33
P31
P7
P8
P9
P10
P5
P3
P1
P6
P4
P2
P12 NC key
P48 DATA OUT
P42 MRD°
P47 TP8°
P30 GSØ°
P28 GS1°
P26 GS2°
P46 GS3°
P24 NØ
P22 N1
P20 N2
P18 EF1
P16 EF2
P14 EF3
P11 EF4
P15 A7
P17 A6
P19 A5
P21 A4
P23 A3
P25 A2
P27 A1
P29 AØ
P22 WAIT
P44 INT
P50 DATA IN
TO LOCAL DRIVER
I22 B7L
I20 B6L
I18 B5L
I16 B4L
I14 B3L
I12 B2L
I10 B1L
I 8 BØL
I15 TP2°
I19 MJD°
I13 SCØ
I21 SC1
I17 DATA OUT
I 7 GS2°
I 9 I/O 3°
I 5 GND
I 3 EF1
I 1 EF2
I 2 EF3
I 4 EF4
I25 5v
I23 GND
I26 Vm
I24 Vm (GND)
I 6 NC
TO SEA-DATA UNIT
R5 NC
R4 NC
R3 SW. 24v (gm)
R2 5v
R1 µP GND
SAIL PWR
K19 B7°
K21 B6°
K23 B5°
K25 B4°
K27 B3°
K29 B2°
K31 B1°
K33 BØ°
K32 TP8°
K22 CLR
K30 MRD°
K17 GSØ°
K15 GS1°
K13 GS2°
K12 GS3°
K5 I/O 2°
K3 I/O 3°
K1 I/O 4°
K6 I/O 5°
K4 I/O 6°
K2 I/O 7°
TO OUTPUT DRIVER BOARD
K34 TPA
K18 EF1
K16 EF2
K14 EF3
K11 EF4
K7 GND
K8 GND
K9 5v
K10 5v
K26 NC
K28 NC
K20 NC (key)
K24 NC key
AMP LATCH
AMP POWER
L6 5v RED
L5 GND BLK
L4 NC
L3 24V (ORN) µP BAT
L2 SPARE-NC
L1 CMPASS PWR WHT/BLU
N19 B7°
N21 B6°
N23 B5°
N25 B4°
N27 B3°
N29 B2°
N31 B1°
N33 BØ°
TO INTERFACE BOARD
N34 TPA
N18 EF1
N16 EF2
N14 EF3
N11 EF4
N7 GND N.C.
N8 GND N.C.
N9 5v
N10 5v
N26 NC
N28 NC
N20 NC (key)
N24 NC (key)
N32 TP8°
N22 CLR
N30 MRD°
N17 GSØ°
N15 GS1°
N13 GS2°
N12 GS3°
N5 I/O 2°
N3 I/O 3°
N1 I/O 4°
N6 I/O 5°
N4 I/O 6°
N2 I/O 7°
+24µP Bat
TIP 147
2.2KΩ
IN1579
10mSec
5 Identical Drivers
10K
150
TIP 147
TIP 147
24V
160mSec
1.4A
ULN 2804A
200mSec
160 mSec
35mSec
IC DOES NOT NEED PULL UPON RESISTORS ON OPEN INPUTS
MCT6
68Ω
68Ω
68K
+5V
M3 R1 DRIVE
M4 R2 "
M5 R3 "
M6 RESET LDV To V5 (WHT/Brn)
M7 Camera
M8 Xponder (PING)
M1 Xponder GND
M2 Camera GND (isolated)
1M
0.47 µF
0.1 µF
220K
SAIL DRIVER IS SHEET 2 OF 4, SPEED CONTROL IS 3 OF 4
19 JULY 84
WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543
PROJ. 10692369 BY ARL
SHEET 1 OF 4 DATE 28 JULY 83
TITLE Buffer Board - Main
SAIL DRIVER



WOO	
PROJ.	
SHEET	



REV			
REV.	20 Nov	84	WET
	15 Oct	84	WET
	31 July	84	KAW
	30 Sept	83	WET

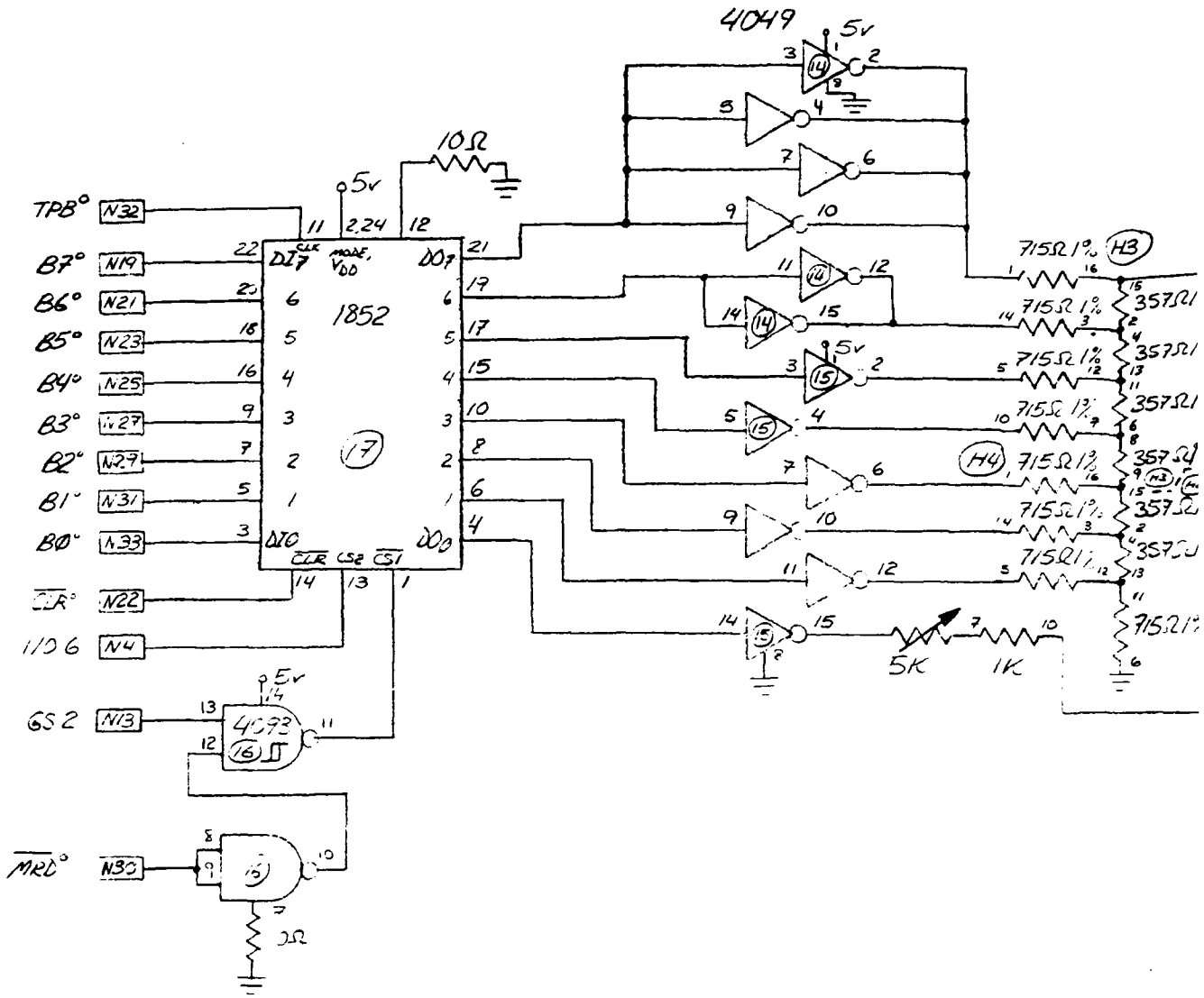
WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543

PROJ. 10/82.69 BY WET

SHEET 2 OF 4 DATE 11 Apr 83

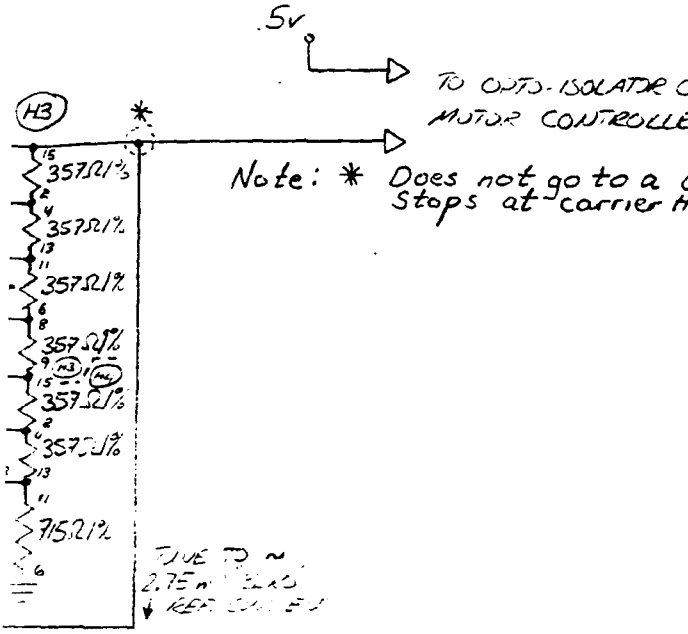
TITLE Buffer Board SAIL [redacted]

SD-B013


4049
5v
10Ω
5v
2.24
TPB°
N32
B7°
N19
B6°
N21
B5°
N23
B4°
N25
B3°
N27
B2°
N29
B1°
N31
B0°
N33
CLR°
N22
1/0 6
N4
1852
17
DI7
DI0
DO7
DO0
CLR
CS2
CS1
MODE
VDD
GS 2
N13
4072
16
MRD°
N30
15
2Ω
715Ω 1%
H3
357Ω
H4
5K
1K

2.75 ma = Ø Motor Speed

? ma = F.S. Motor Speed (trim on motor control)

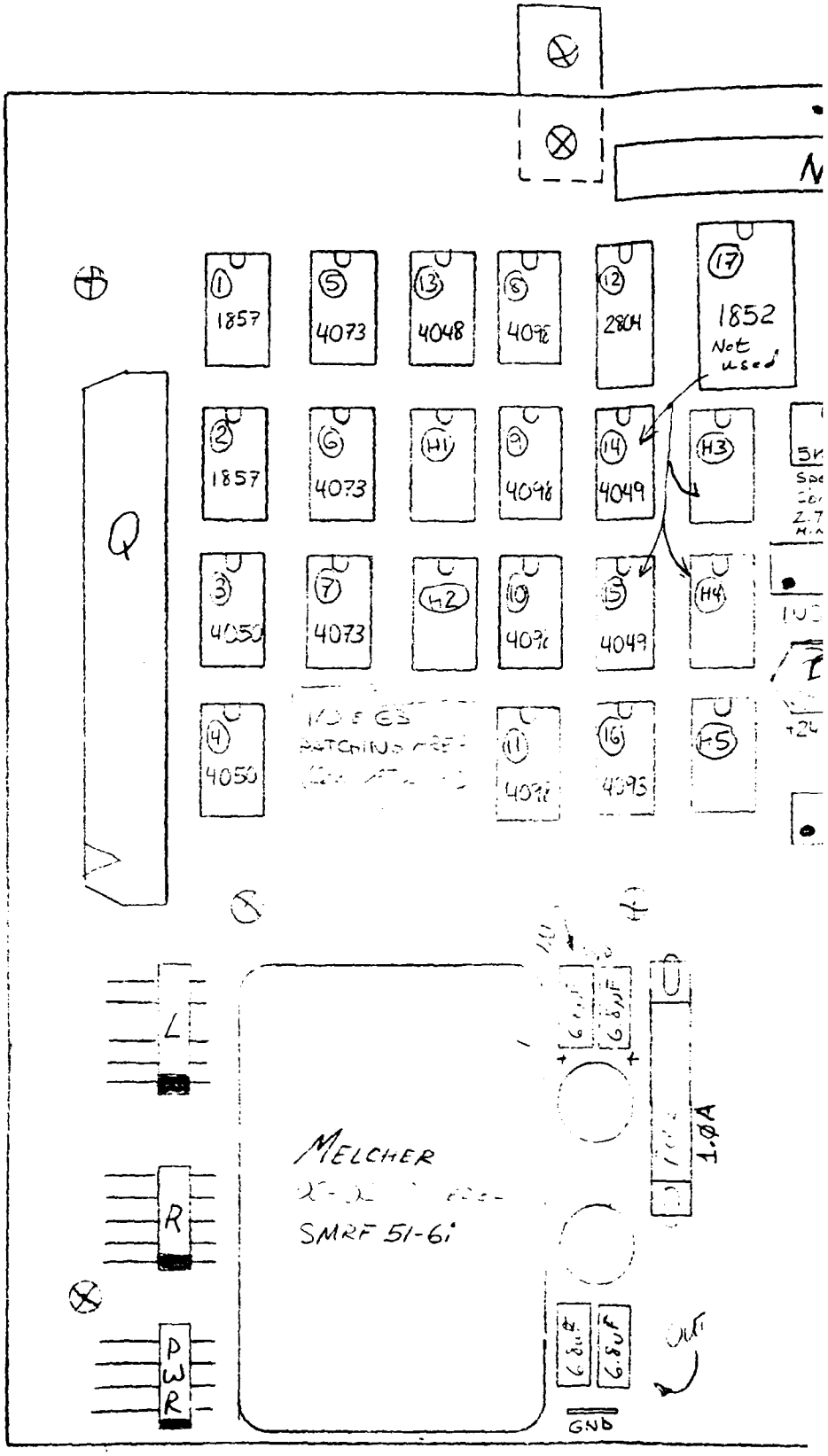


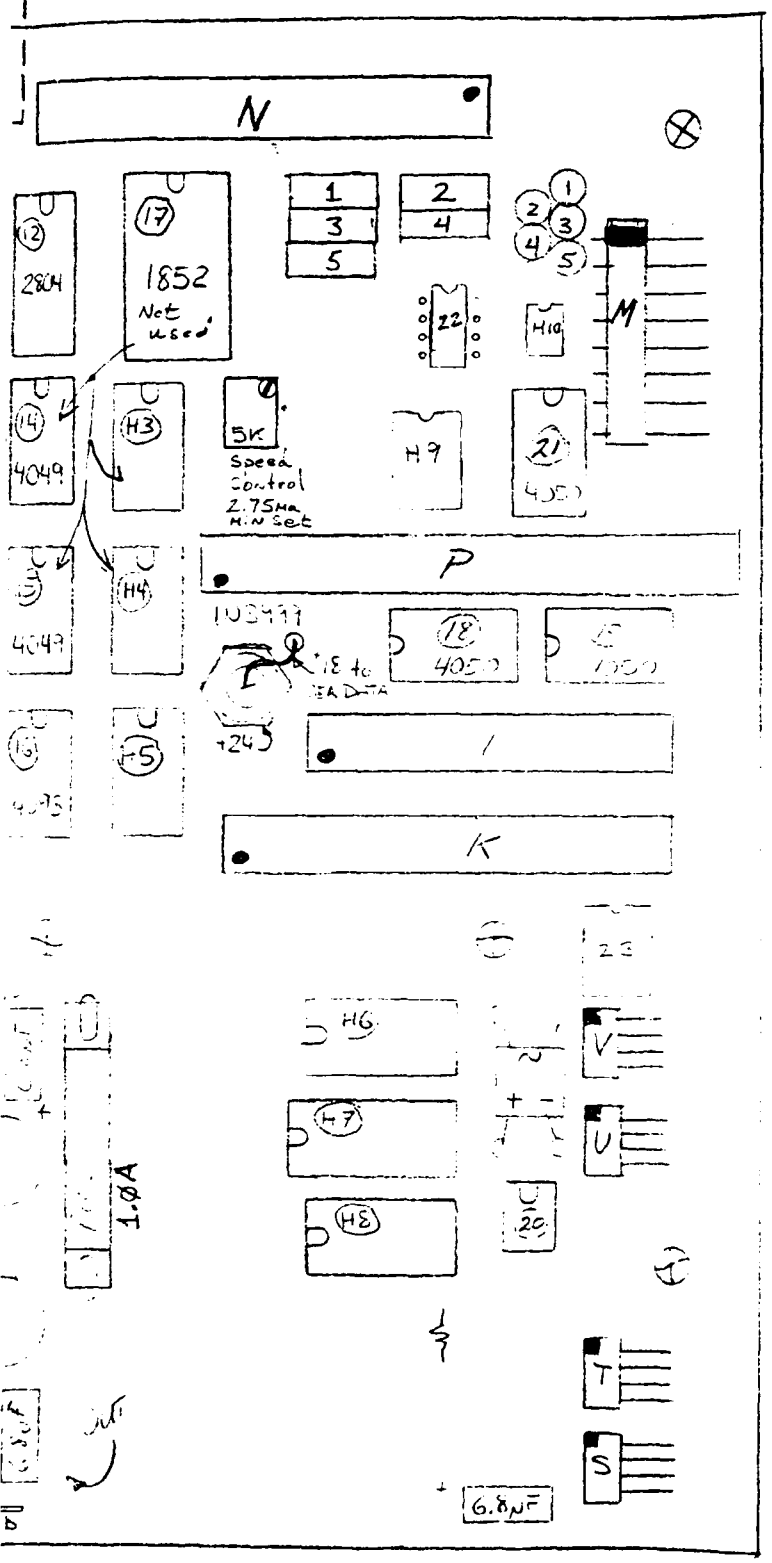
Note: * Does not go to a connector. Stops at carrier H3 pin 16.

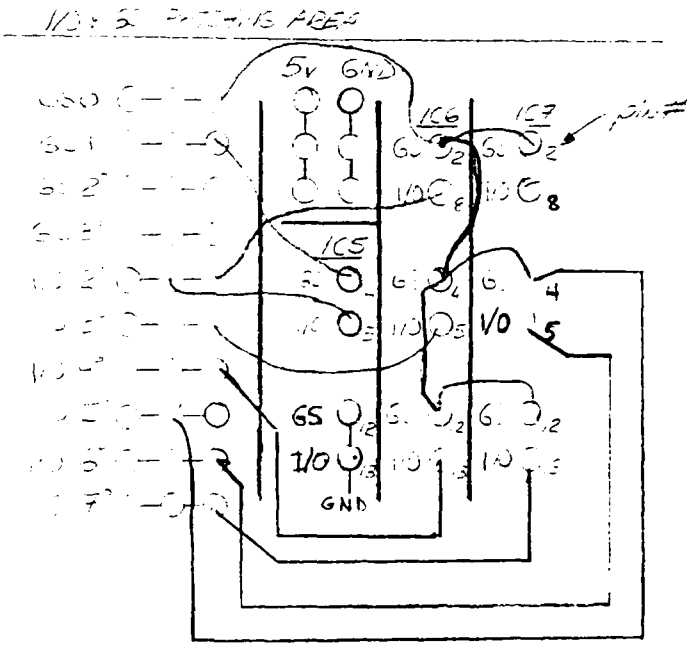
Note: Circuit no longer used, but wiring still in place!
IC's 14, 15, 17 and parts carriers H3, H4 have been removed.
Speed control PWR via Output Driver Board
Speed control in seperate SAIL controlled housing.

24 Nov 86 WET
REV 1 Mar 85 WET
REV 12 July 84 KAV
REV 23 AUG 83 [redacted]

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10187.67 BY AGD SHEET 3 OF 4 DATE 4 AUG 83	TITLE Buffer Board - Circ. Pump Control SEA DUCT

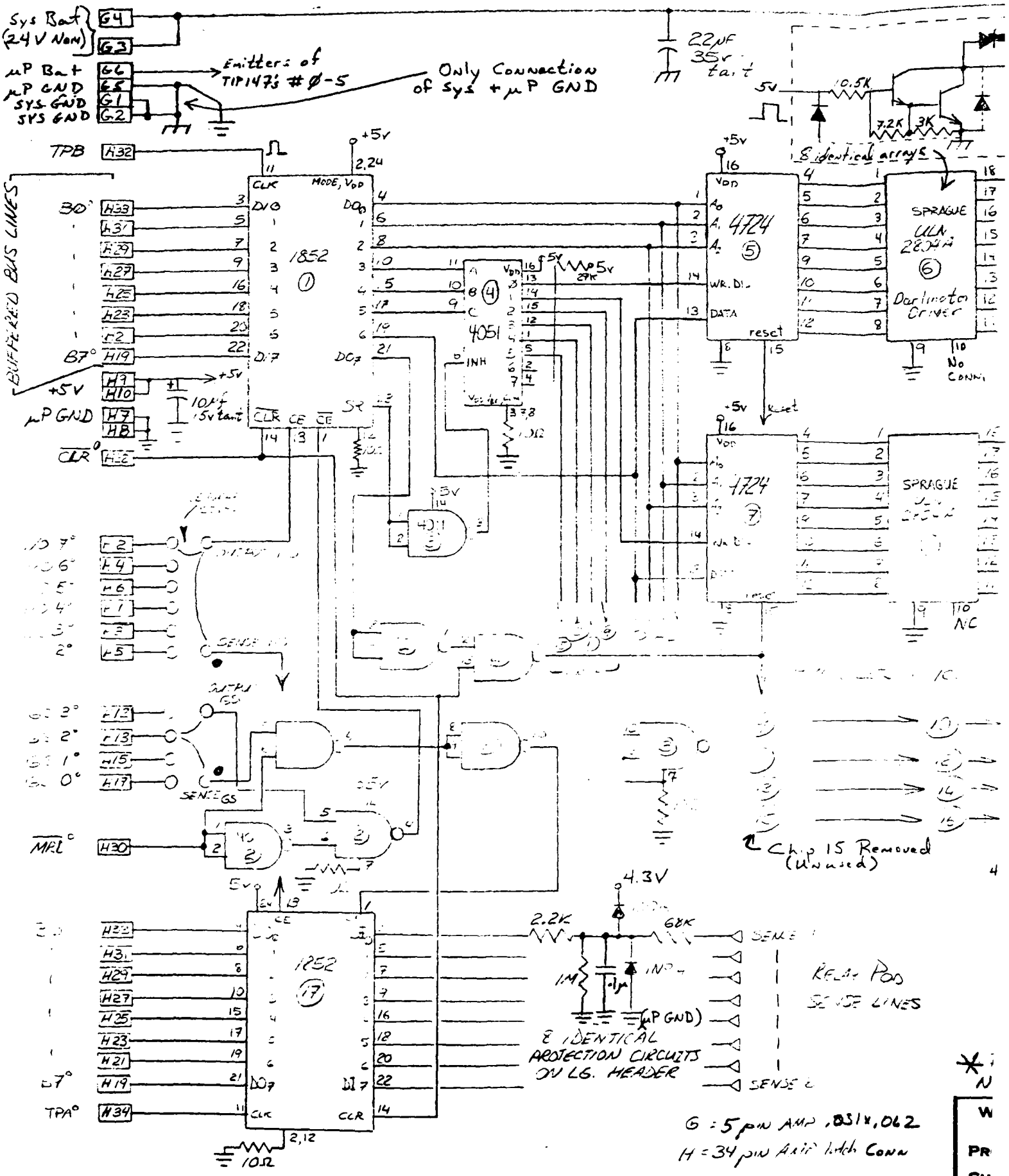

1 1857
5 4073
13 4048
8 4076
12 2804
17 1852 Not used
2 1857
6 4073
H1
9 4096
14 4049
H3
3 4050
7 4073
H2
10 4076
15 4049
H4
4 4050
11 4076
16 4093
+5
Q
L
R
PWR
MELCHER
SMRF 51-6
1.0A
GND

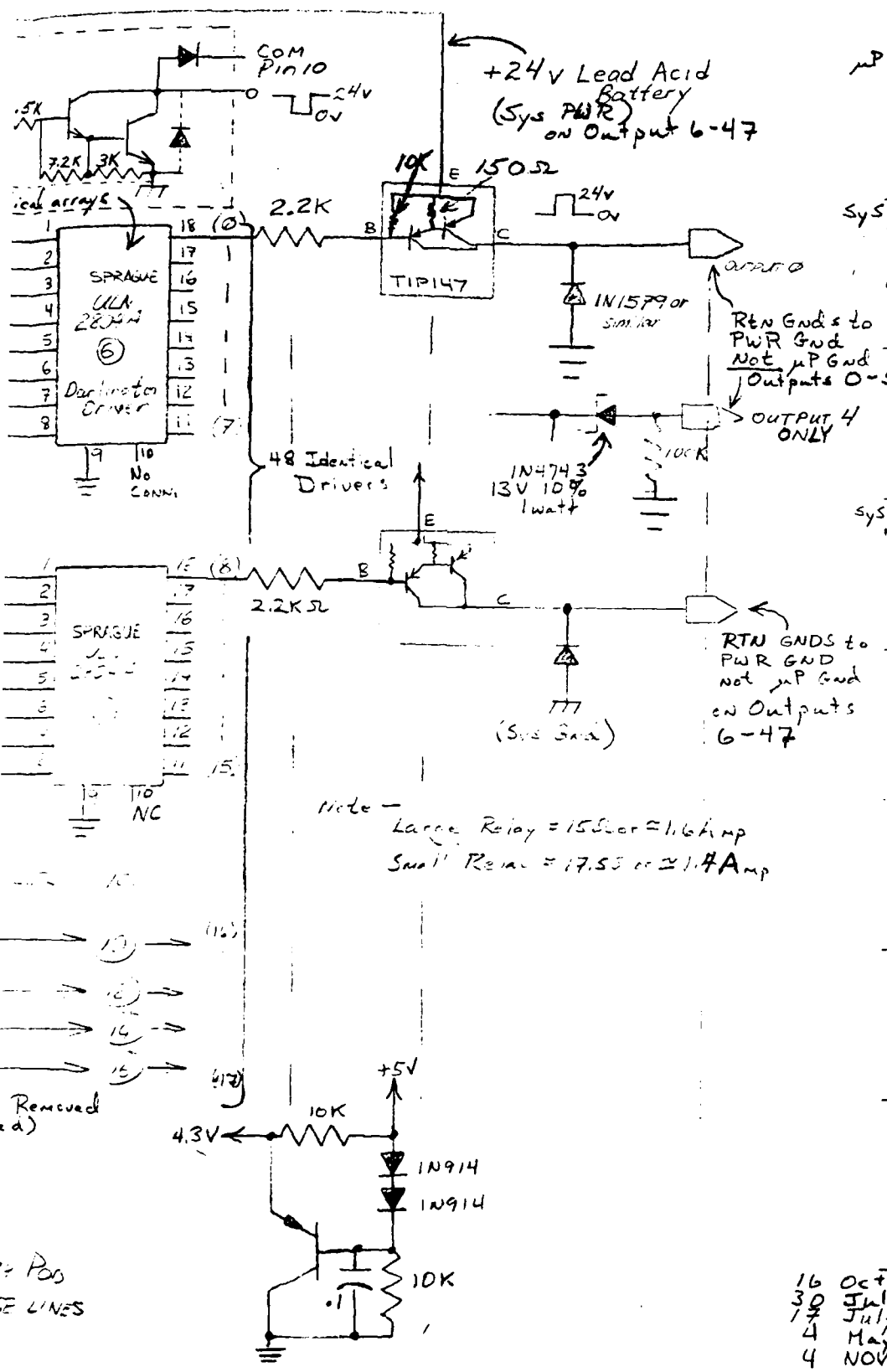




24 Nov 86 WET
02 DEC 85 WET
15 Oct 84 WET
30 July WET
Rev 19 July WET

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10182.67 BY ARD SHEET 4 OF 4 DATE 26 Sep 83	TITLE Buffer Board - Parts Layout SEA DUCT SD-B015


Sys Bat (24 V Nom) G4 G3
μP Bat+ G6
μP GND G5
SYS GND G1
SYS GND G2
Emitters of TIP147's #0-5
Only Connection of Sys + μP GND
22μF 35v tant
5V
10.5K
7.2K
3K
8 identical arrays
TPB H32
+5V
2.2μ
CLK
MODE, VDD
DI0
DO0
1852 (1)
DI7
DO7
CLR CE CE
SR
BUFFERED BUS LINES
30° H33 H31 H29 H27 H25 H23 H21
B7° H19
+5V H9 H10
μP GND H7 H8
10μf 15v tant
CLR° H32
4051 (4)
INH
5V
27K
1.0Ω
4724 (5)
VDD
A0 A1 A2
WR. DIS.
DATA
reset
SPRAGUE ULN 2803A (6)
Darlington Driver
No Conn
4724 (7)
SPRAGUE
NC
10° H2
9° H4
8° H6
7° H1
6° H3
5° H5
SENSE HI
3° H13
2° H11
1° H15
0° H17
SENSE GS
MRL° H30
1852 (17)
TPA° H34
2,12
10Ω
4.3V
2.2K
68K
1M
.1μ
μP GND
8 IDENTICAL PROJECTION CIRCUITS ON LG. HEADER
SENSE 1
SENSE 2
REAR PCB SENSE LINES
Chip 15 Removed (Unused)
G = 5 pin AMP .031 x .062
H = 34 pin Axial Inch Conn



Output #	Pin #	Connector #
µP Bat 0 (Low Sail)	8	1
" / (HDG)	7	
" 2	6	
" 3	5	
" 4 (Trans)	4	
" 5	3	
GND	2	
SENSE 1	1	
Sys Bat 6	8	2
" 7	7	
" 8	6	
" 9	5	
" 10	4	
" 11	3	
GND	2	
SENSE 2	1	
12 Opto	8	3
13 Bat	7	
14	6	
15	5	
16	4	
17	3	
GND	2	
SENSE 3	1	
Sys Bat 18 (Sens. 19 Withdrew)	8	4
" 20 CW	7	
" 21 CCW	6	
" 22 Spare	5	(Swat)
" 23 Spare	4	(Wipe)
GND	3	
SENSE 4	2	
24 X+	1	5
25 X-	8	
26 Y+	7	
27 Y-	6	
28 Z+	5	
29 Z-	4	
GND	3	
SENSE 5	2	
30 Hydro	1	6
31 Pump 1	8	
32 Pump 2	7	
33	6	
34	5	(H_2O1)
35	4	(H_2O2)
GND	3	
SENSE 6	2	
36	1	7
37	8	
38	7	
39	6	
40	5	
41	4	
GND	3	
SENSE 7	2	
42	1	8
43	8	
44	7	
45	6	
46	5	
47	4	
GND	3	
SENSE 8	2	

16	Oct	84	WET
30	July	84	WET
17	July	84	KAW
4	May	84	WET
4	NOV	83	ARD
4	AUG	83	WET

REV 24 NOV 83 WET

REV 3 AUG 83 ARD

* POWER 24v comes from POWER BATTERIES, Not µP BATTERIES — BE WARNED

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543

PROJ. 10182.69 BY ARD

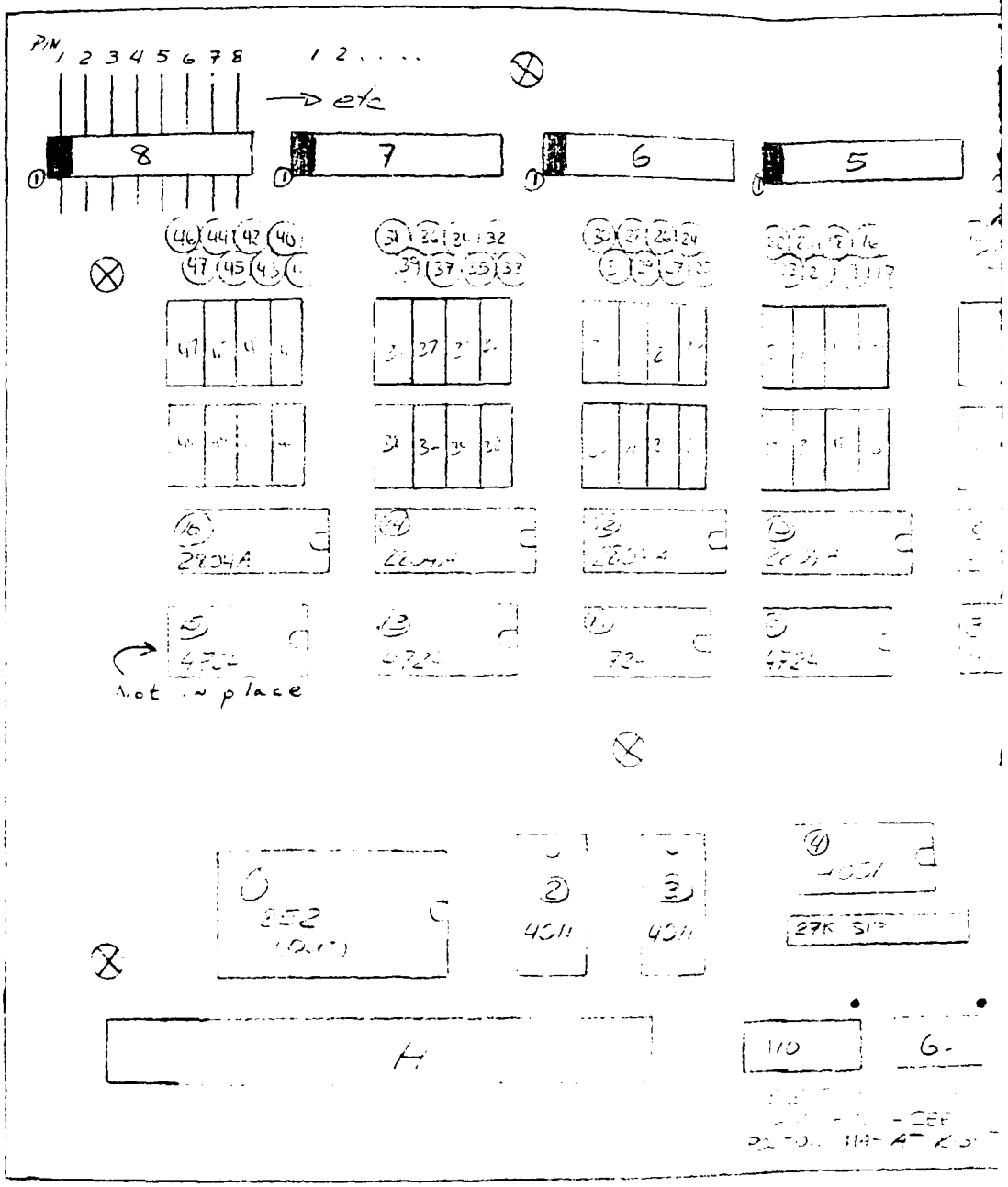
SHEET 1 OF 3 DATE 17 Feb 83

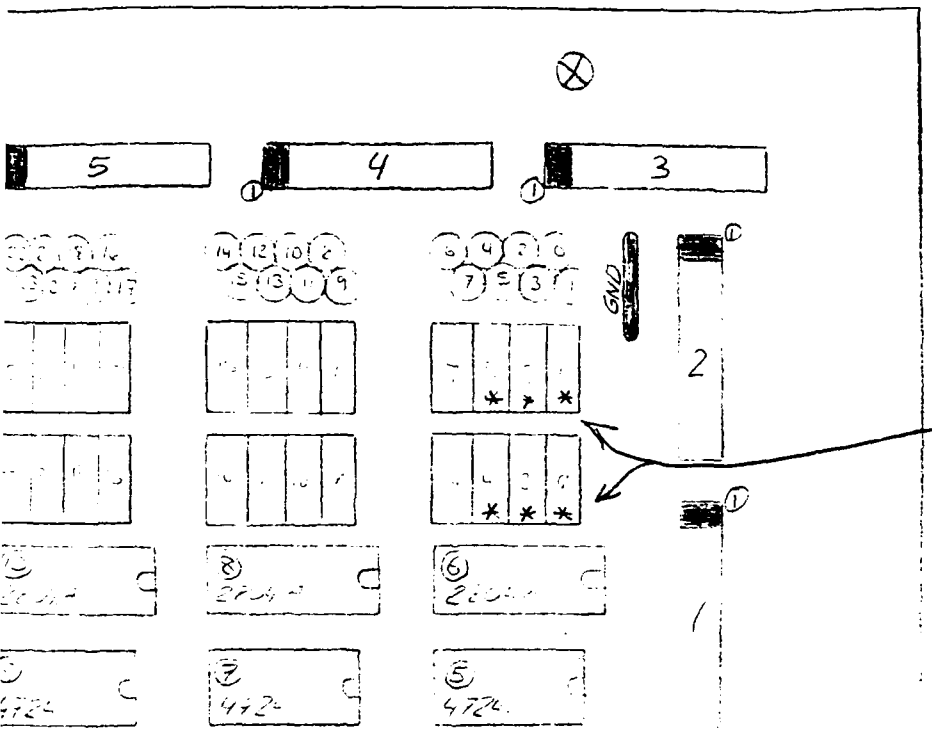
TITLE

OUTPUT DRIVER BOARD

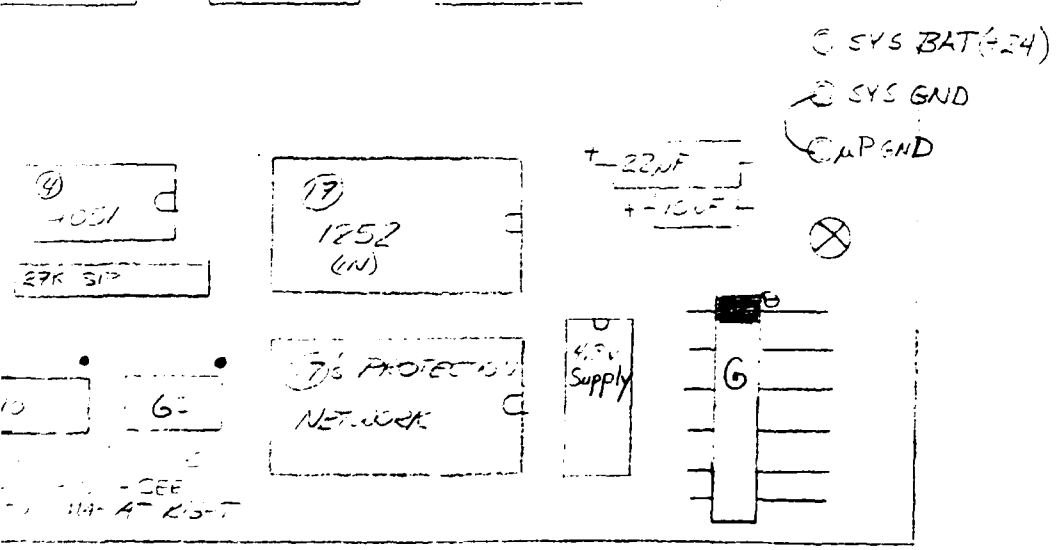
SEA DUCT

SD-B016


PIN 1 2 3 4 5 6 7 8
1 2 . . . .
etc
8
7
6
5
FREE-WHEELING DIODES
TIP 147
Not in place
H
110
6-

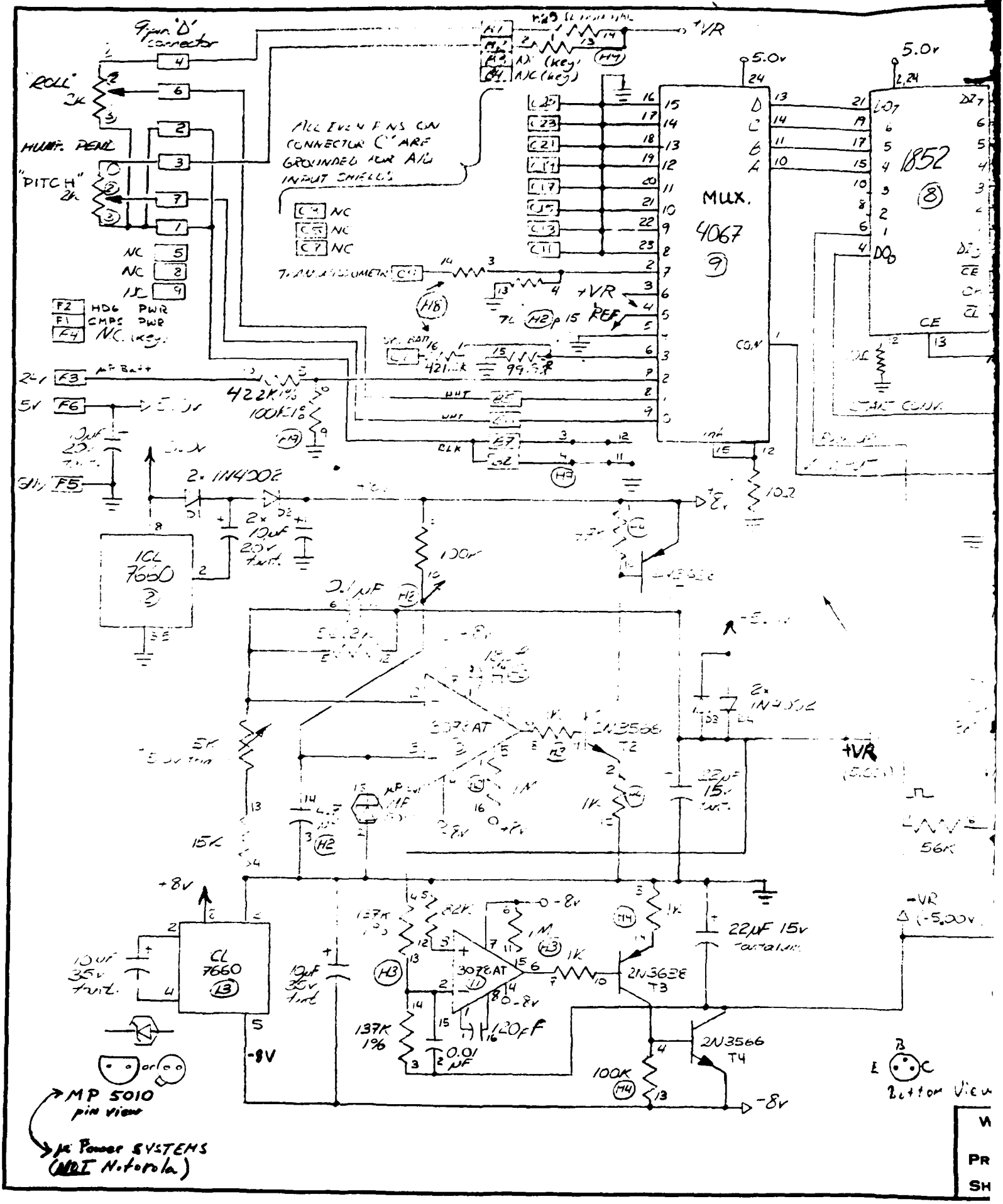


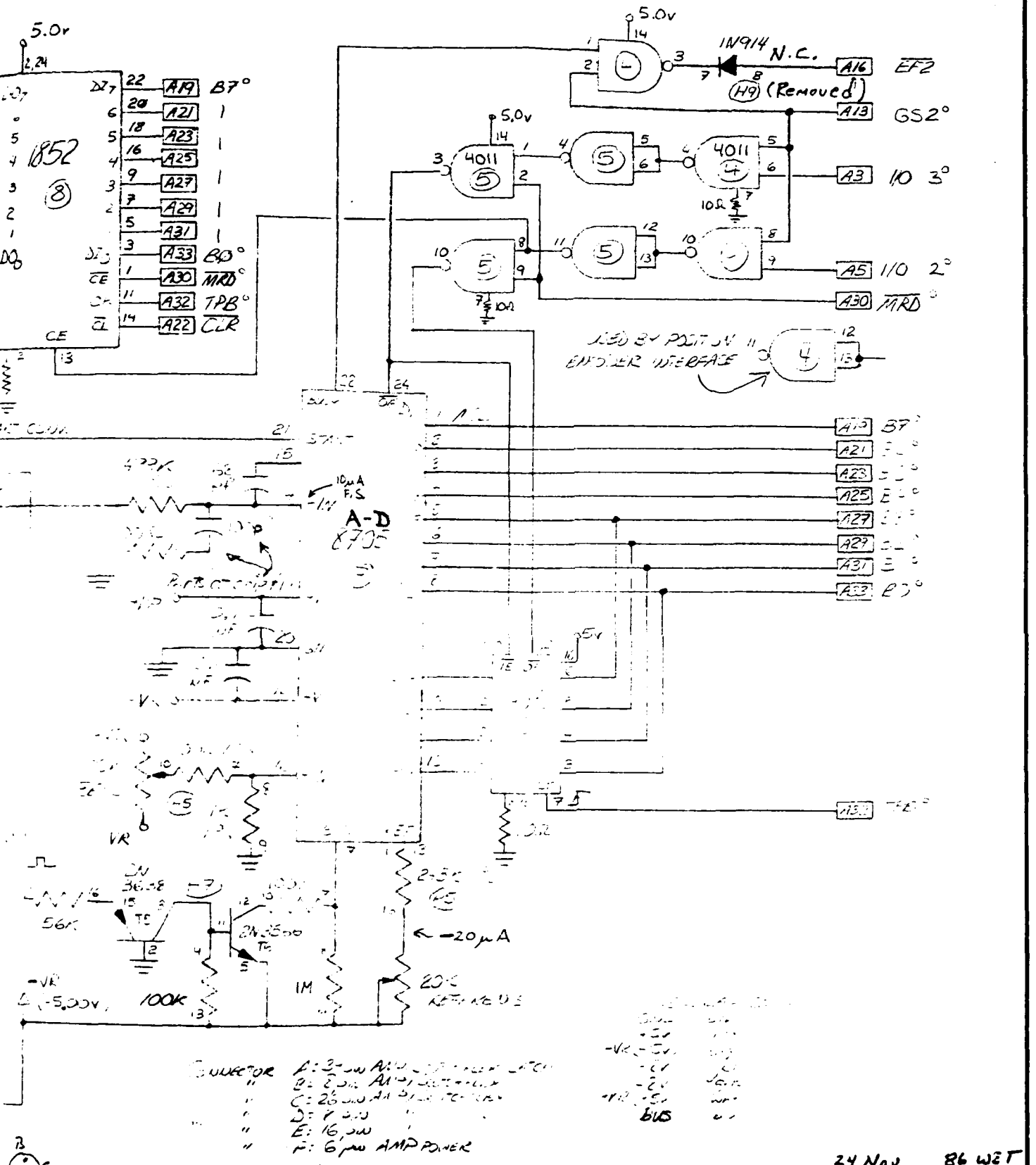
Note:
O-6 Connected to
µP Bat. Source
All others to Sys Bat.



REV	24 Nov 86	WET
	19 July 84	WET
REV	12 July 84	KAW
REV	21 OCT 83	ARI

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543	TITLE Output Drivers Board - Parts Layout SEA DUCT
PROJ. 1269 BY ARI SHEET 2 OF 3 DATE 26 SEP 83	SD-B-017


9 pin 'D' connector
"ROLL" 2K
HUMP. PEDAL
"PITCH" 2K
NC
NC
NC
F2 HDG PWR
F1 CMPS PWR
F4 NC (key)
F3
F6
F5
5V
2x IN4002
ICL 7660
100K
2.1 MF
5K
15K
56K
1K
22MF 15V
+8V
-8V
+VR
-VR
5.0V
MUX. 4067
1852
2N3566 T2
2N3566 T3
2N3566 T4
137K 1%
422K 1%
100K 1%
MP 5010
pin view
Bottom View
Power SYSTEMS (MRI Motorola)



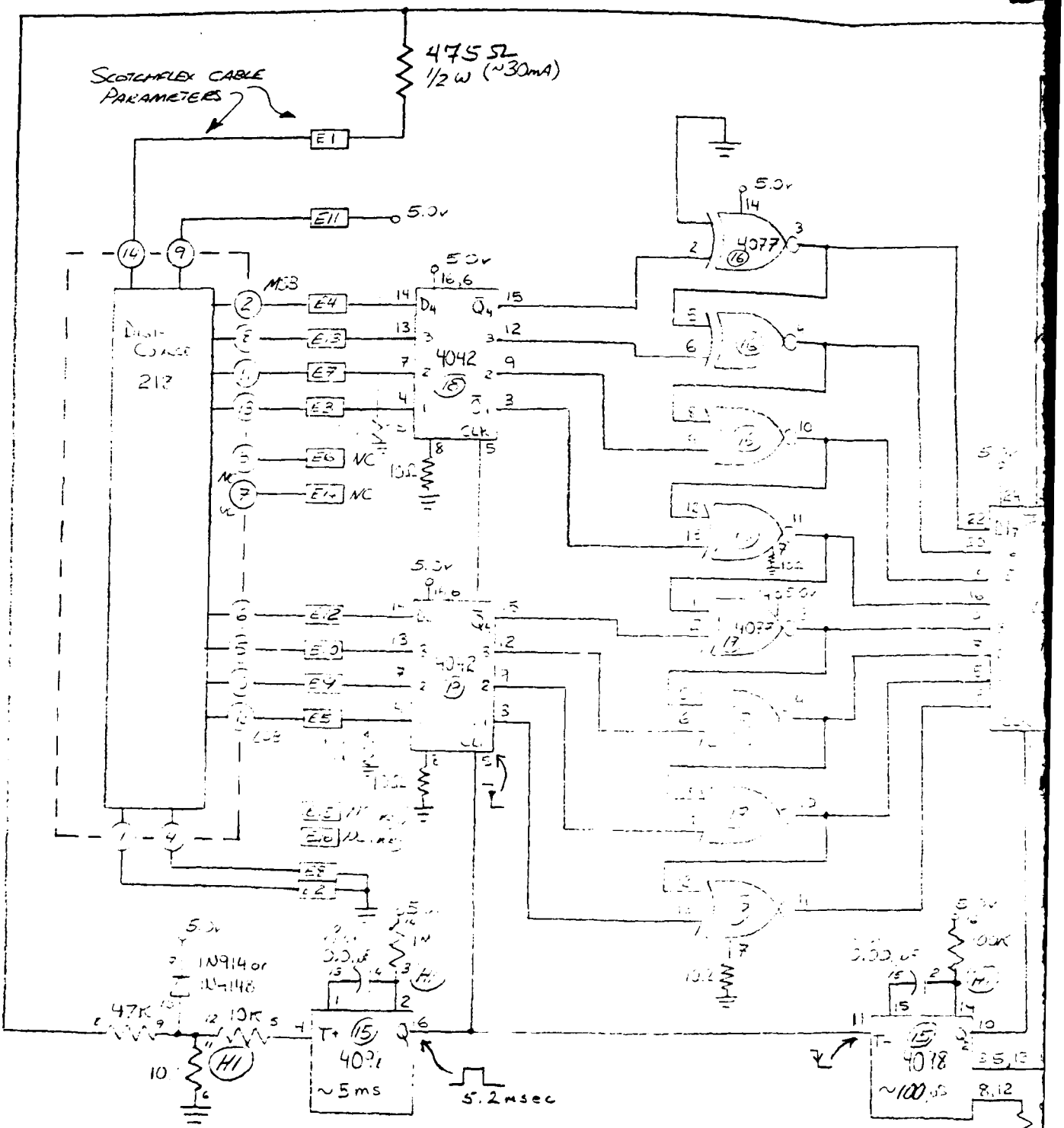
WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543

PROJ. 10182.64 BY ARD

SHEET 1 OF 4 DATE 24 Feb 83

TITLE Interface Board
A/D, Voltage Convertor
SEA DUCT

SD-B-018



DIGITIZER RETRO SATURATE IN ~2ms WITH 30mA LED DRIVE

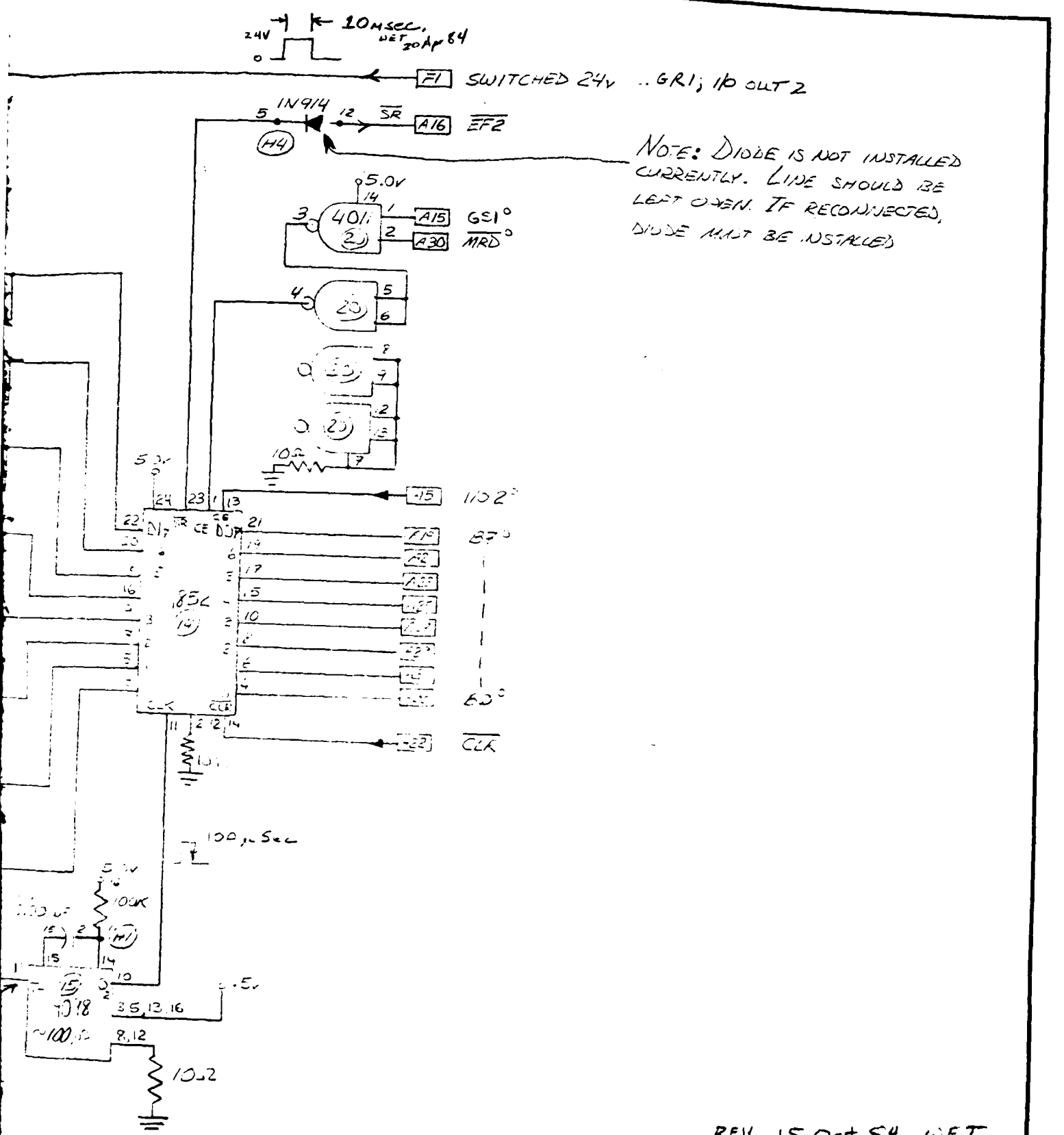
Note:

WOO

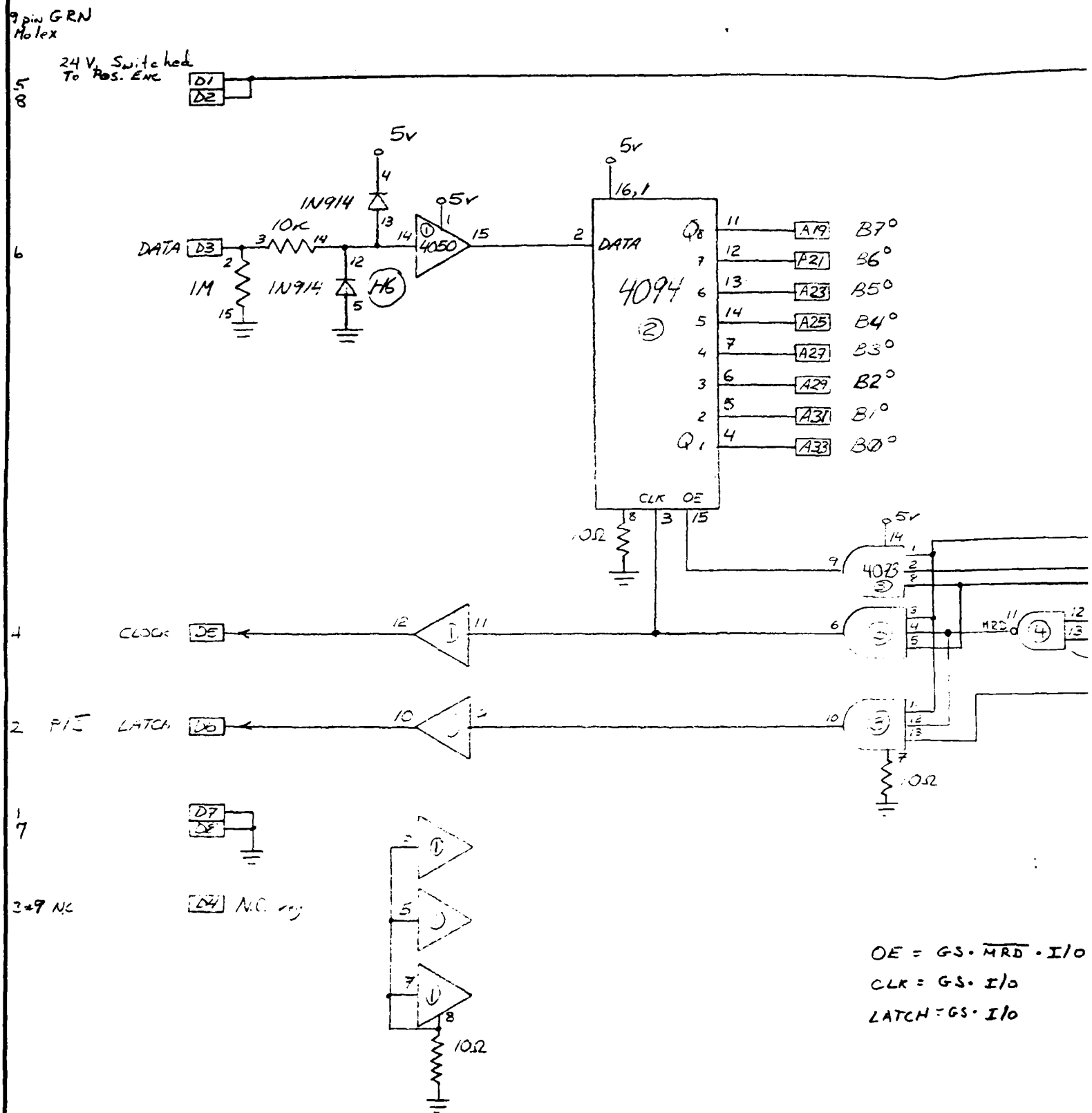
PROJ.

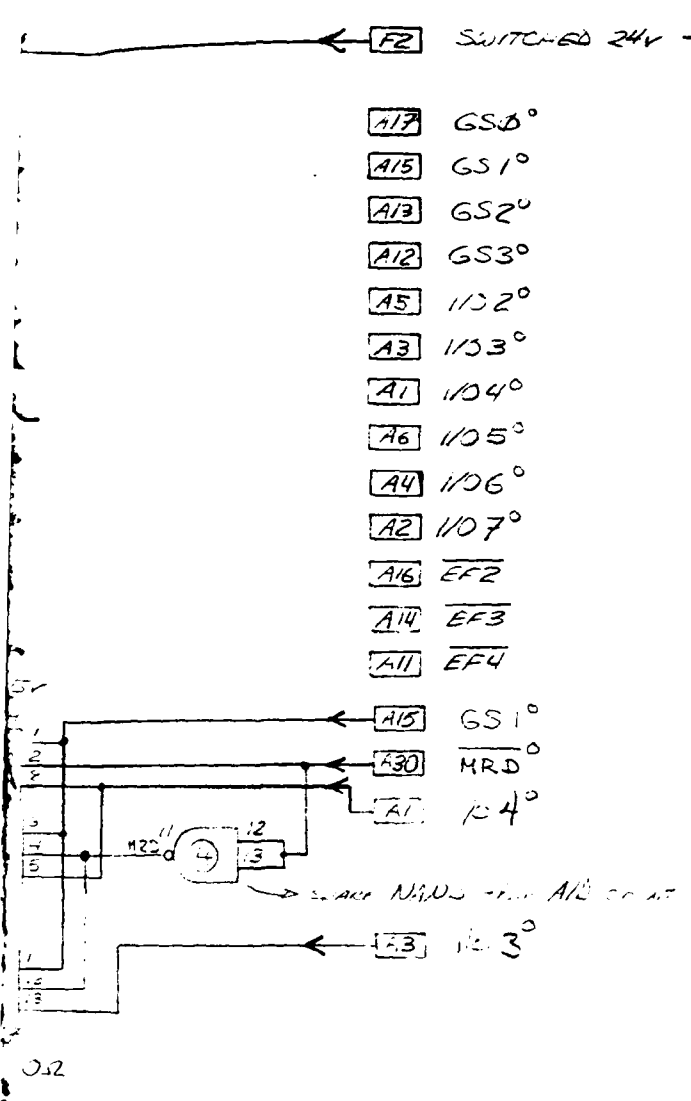
SHEE

SP 11208A



WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543	TITLE INTERFACE BOARD COMPASS INTERFACE
PROJ. 10182.69 BY ARD	SEA DUCT
SHEET 2 OF 4 DATE 22 Feb 83	SD-B019


9 pin GRN Molex
24 V Switched To Pos. Enc
D1
D2
5v
IN914
10K
DATA
D3
1M
IN914
H6
4050
4094
DATA
CLK
OE
Q8
Q1
A19
A21
A23
A25
A27
A29
A31
A33
B7°
B6°
B5°
B4°
B3°
B2°
B1°
B0°
10Ω
4075
CLOCK
D6
P/L
LATCH
D5
D7
D4
N.C.
3+9 N.C.
OE = GS · MRD · I/O
CLK = GS · I/O
LATCH = GS · I/O



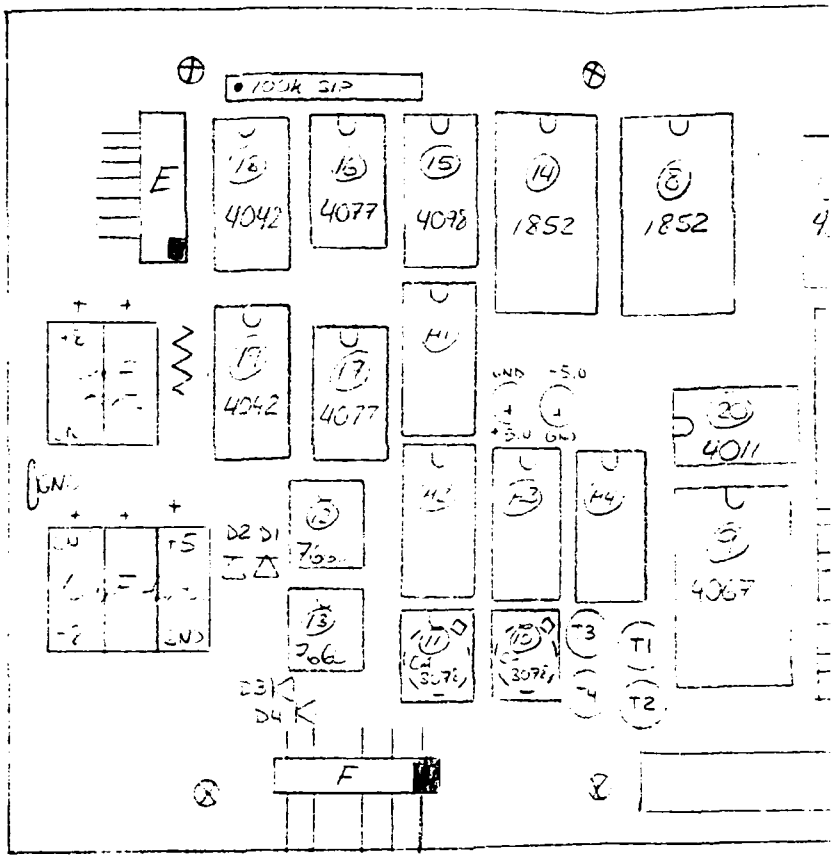
= GS · MRD · I/O = GS 1 · INP 4

= GS · I/O = GS 1 · OUT 4

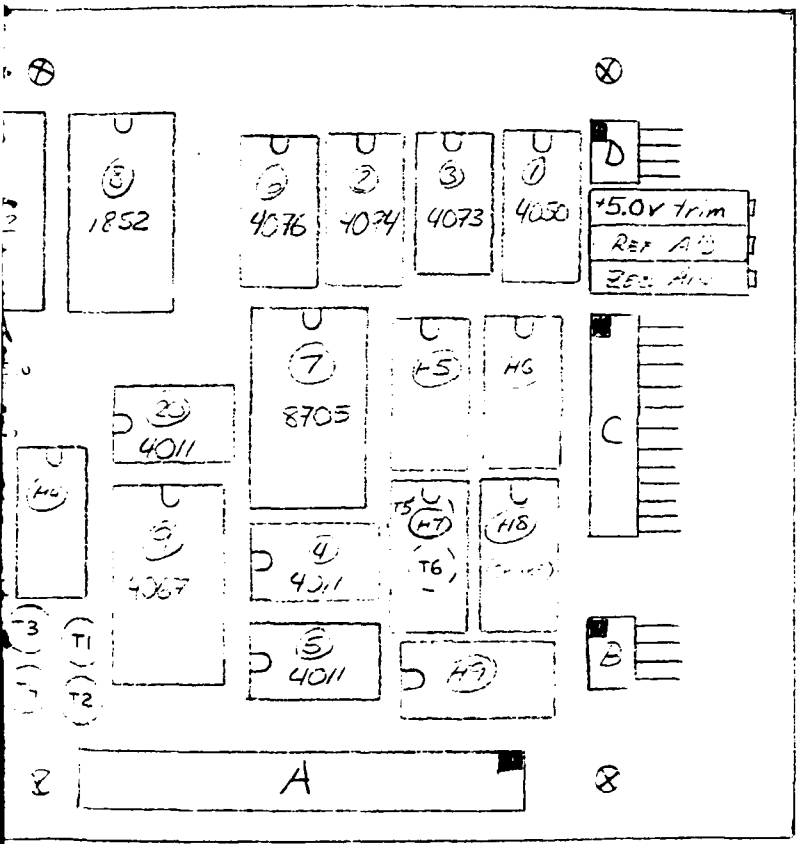
TCH = GS · I/O = GS 1 · OUT 3

REV 24 Nov 86 WET
16 Oct 84 WET
REV. 27 July 83 ARD

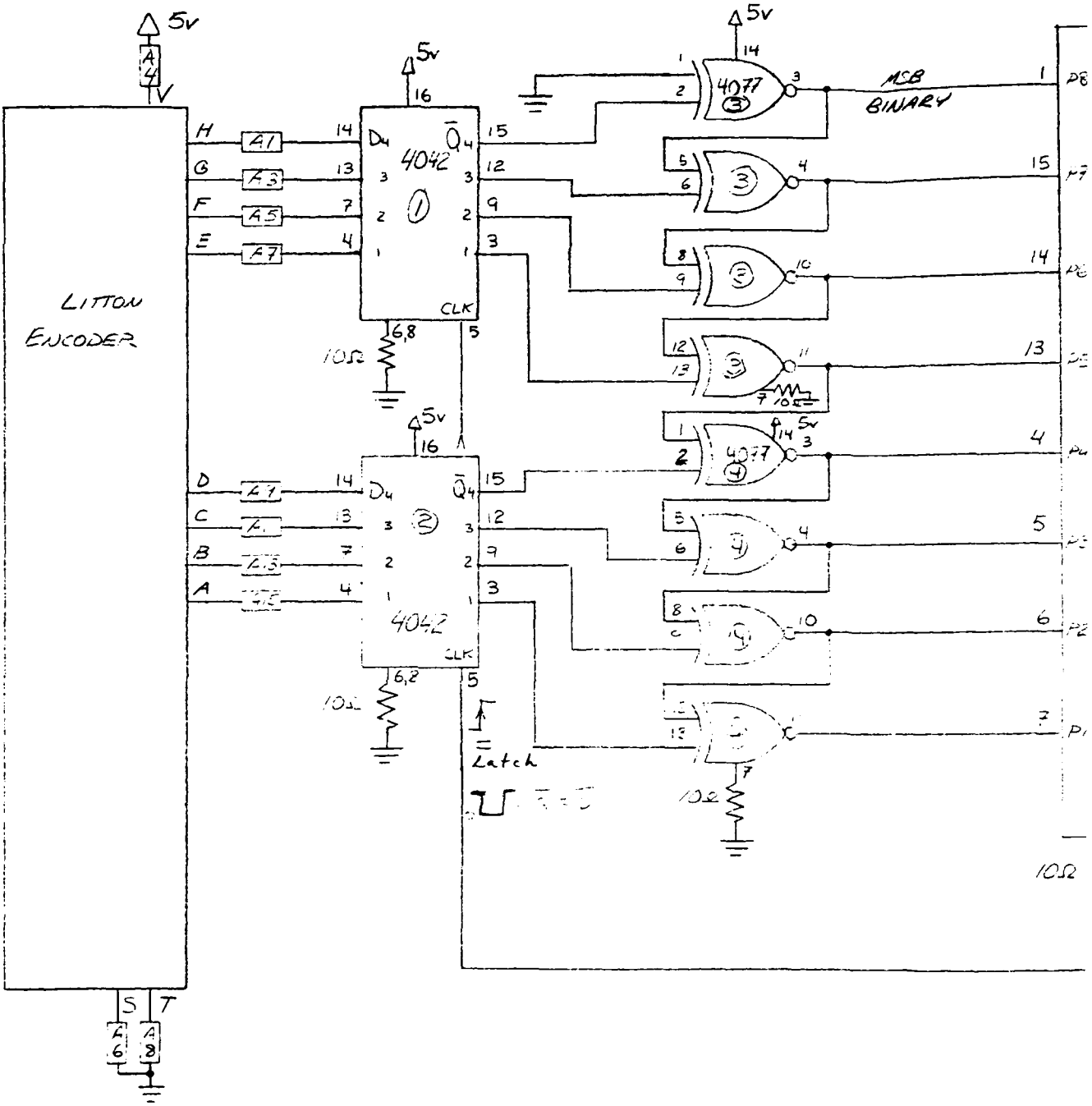
WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10182.69 BY ARD SHEET 3 OF 4 DATE 14 MAR 83	TITLE Interface Board Rotation Encoder Interface SEA DUCT SD-B-020

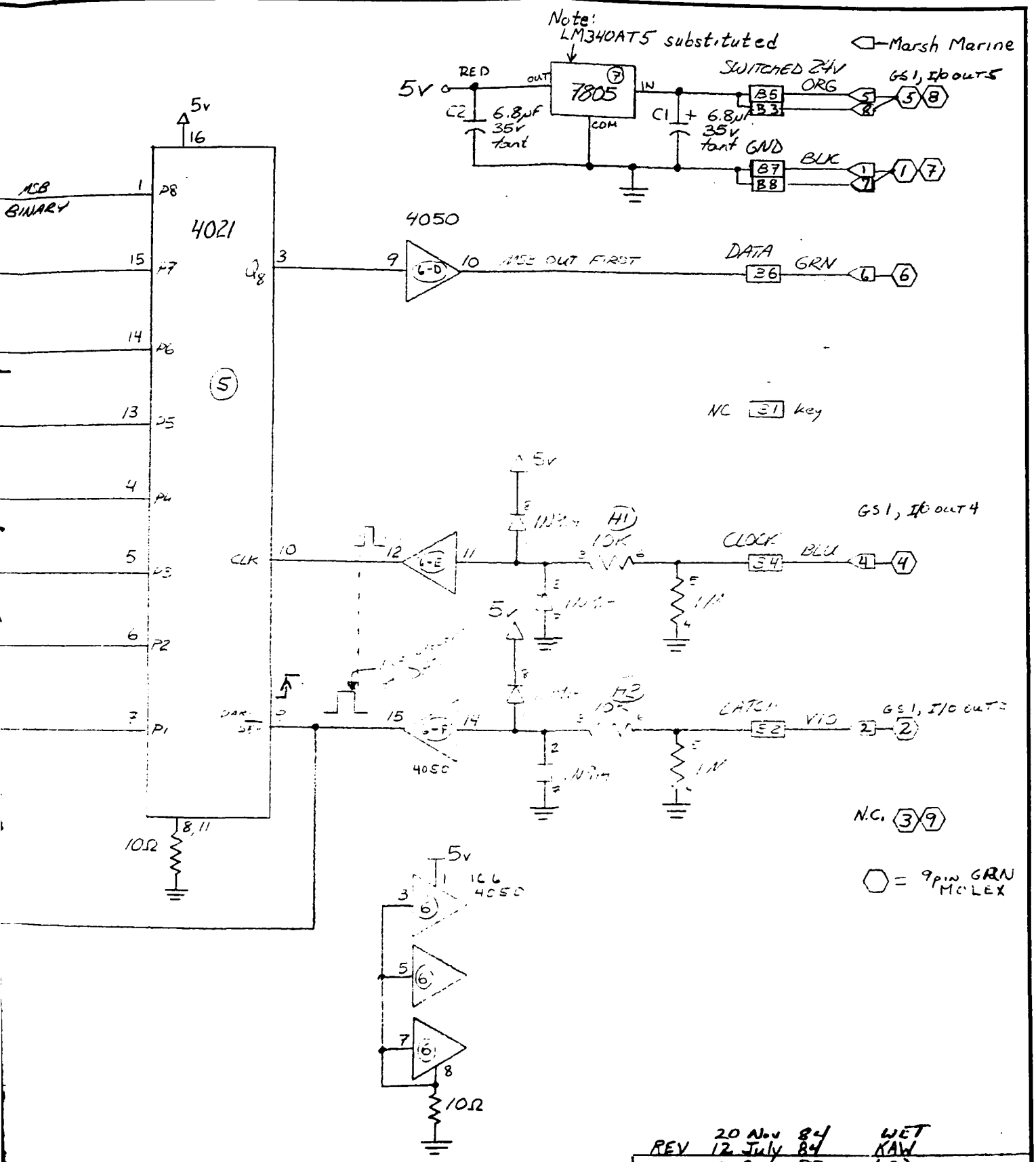

100k SIP
E
16
4042
15
4077
14
4078
13
1852
12
1852
18
4042
17
4077
H1
H3
H4
20
4011
9
4067
5
7
13
7
11
(74
10
(3078)
T1
T2
F

SP 11781



WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543	TITLE Interface Board Parts Layout
PROJ. 1082.69 BY ARD	SEADUCT
SHEET 4 OF 4 DATE 28 SEP 83	SD-B-021


5v
LITTON
ENCODER
H
G
F
E
D
C
B
A
A1
A3
A5
A7
A2
A4
A6
A8
S
T
4042
4077
CLK
Latch
MSB
BINARY
10Ω
6,8
6,2



REV	20 Nov 84	WET
REV.	12 July 84	KAW
	19 Oct. 83	ARD

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543

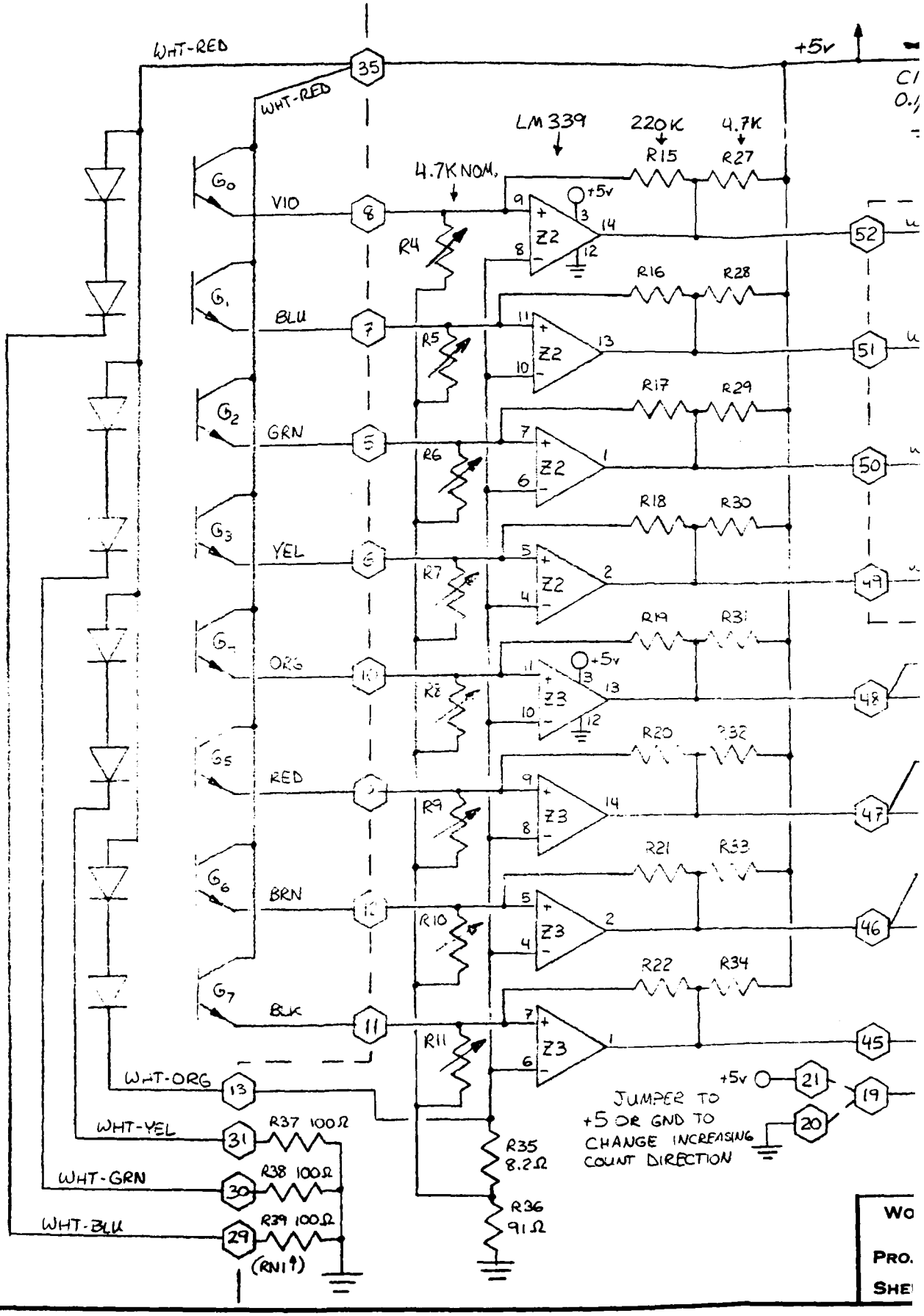
PROJ. 10/82 67 BY ARD

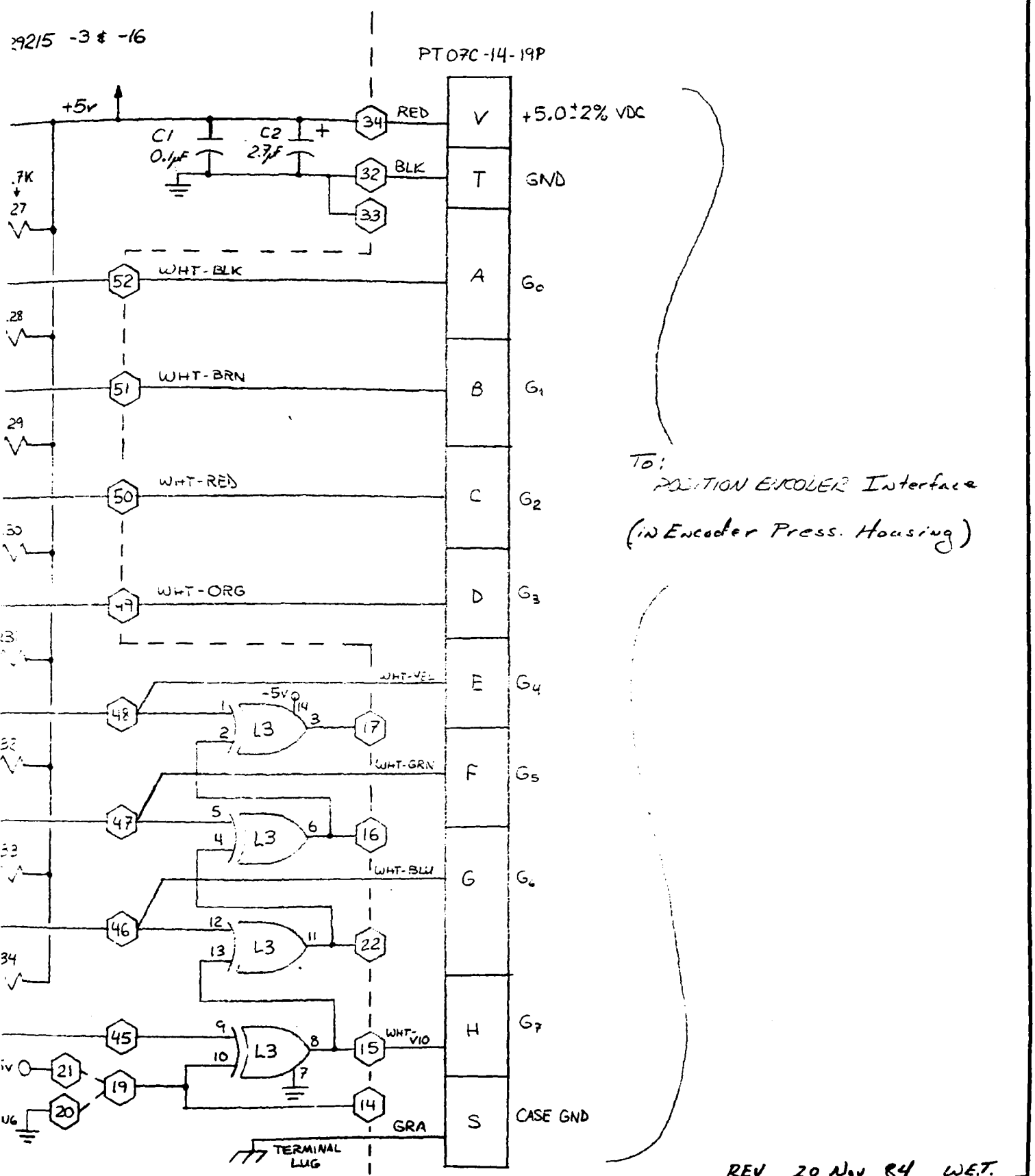
SHEET 1 OF 3 DATE 14 MARCH 83

TITLE
Rotation Encoder Interface
(Encoder Housing)
SEA DUCT

SD-B-022

AMPLIFIER BOARD ASSY PIN 29215 -3 & -16

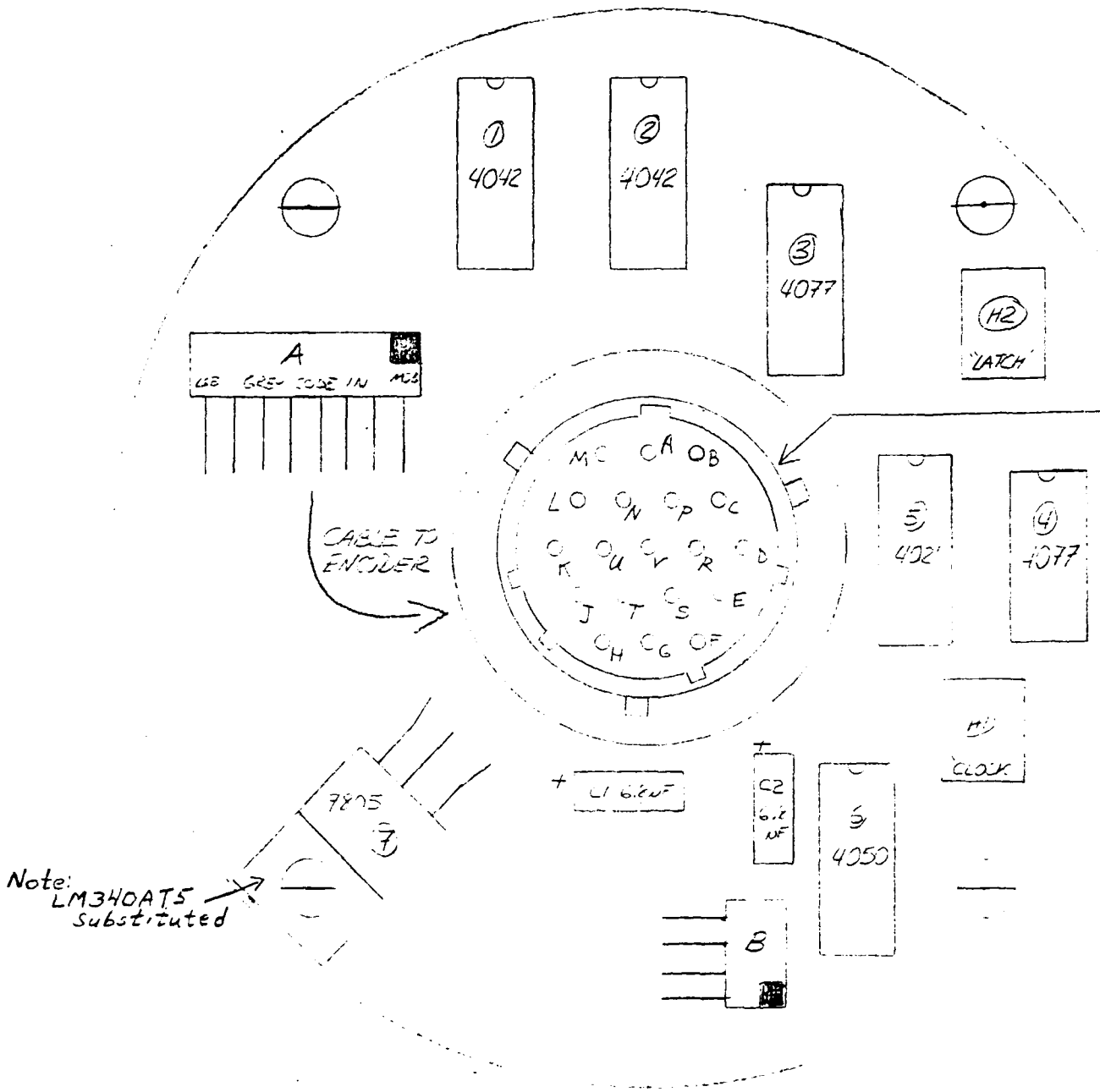




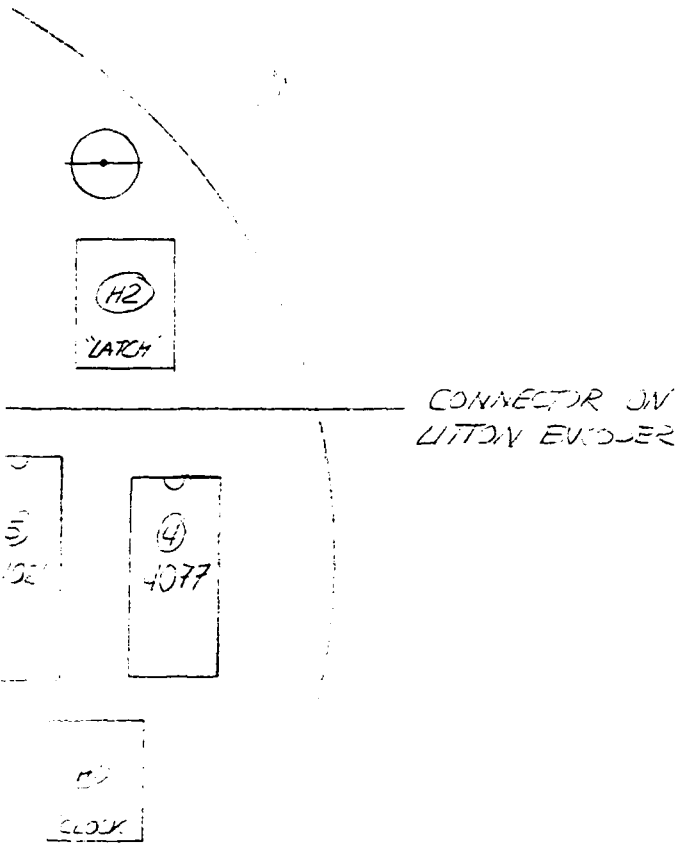
REV 20 Nov 84 W.E.T.

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543	TITLE LITTON Rotation Encoder SEA DUCT
PROJ. 10182.69 BY ARD	
SHEET 2 OF 3 DATE 15 FEB 83	

SD-B-023


1
4042
2
4042
3
4077
H2
LATCH
A
GE GREY CODE IN MCB
CABLE TO ENCODER
M C A B
L O N P C
K U V R D
J T S E
H G F
5
4027
4
4077
H1
CLOCK
7805
7
+ C1 6.8nF
C2
6.8 nF
9
4050
8
Note:
LM340AT5
Substituted

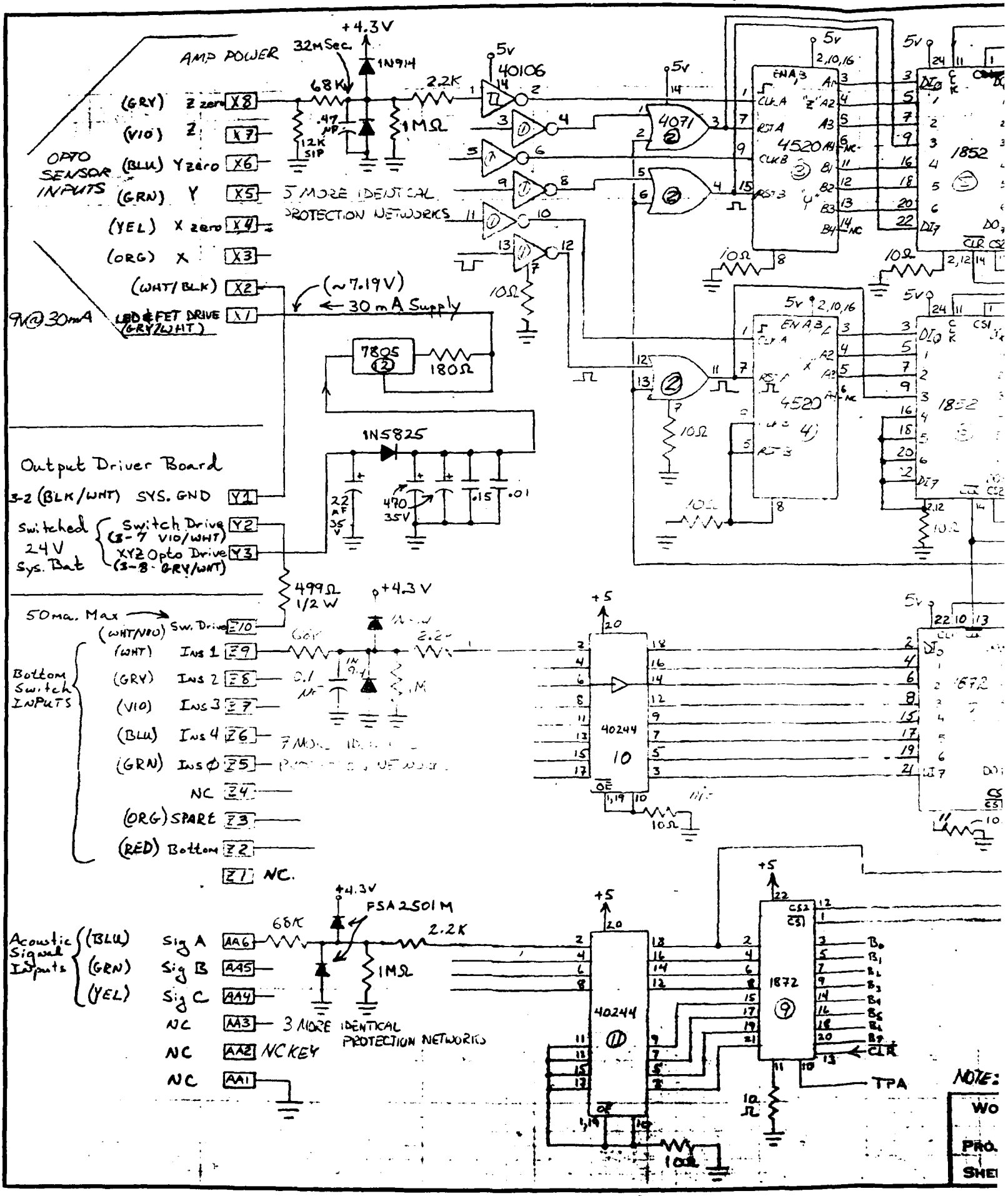
SP 11284A

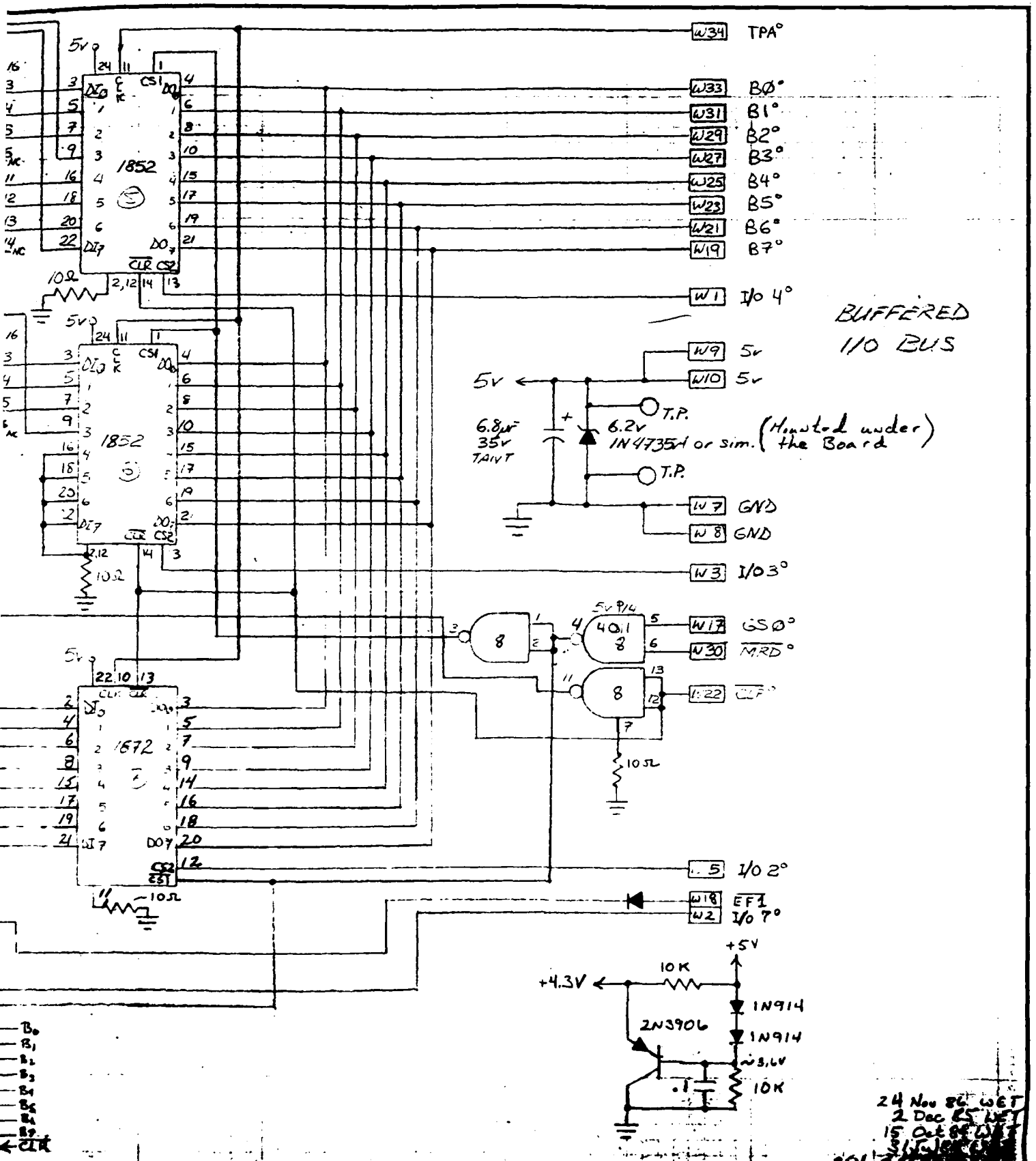


20 Nov 84 WET
REV 12 July 84 KAW

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10182.69 BY ARD SHEET 3 OF 3 DATE 19 Oct 83	TITLE Rotation Encoder Interface Parts Layout (Encoder Housing) SEA DUCT

SD-B-024

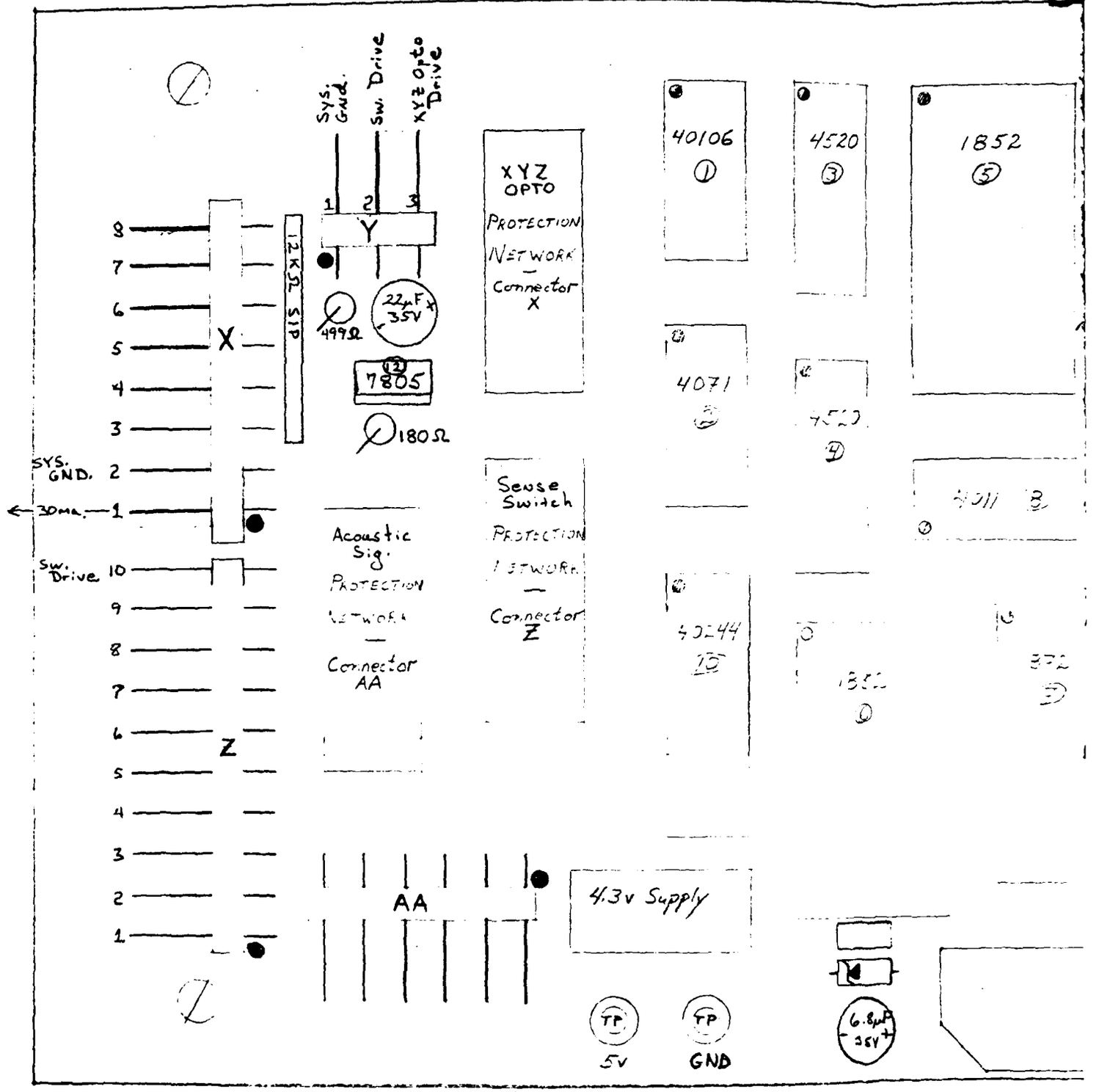

AMP POWER
+4.3V
32m Sec.
1N914
68K
2.2K
1MΩ
.47 MFD
12K SIP
5V
40106
4071
4520
1852
10Ω
OPTO SENSOR INPUTS
(GRY) Z zero X8
(VIO) Z X7
(BLU) Y zero X6
(GRN) Y X5
(YEL) X zero X4
(ORG) X X3
(WHT/BLK) X2
LED & FET DRIVE (GRY/VIO/WHT) X1
9V@30mA
5 MORE IDENTICAL PROTECTION NETWORKS
(~7.19V)
30 mA Supply
7805
180Ω
1N5825
22 MF 35V
490 35V
.15
.01
Output Driver Board
3-2 (BLK/WHT) SYS. GND Y1
Switched 24V Sys. Bat
Switch Drive (3-7 VIO/WHT) Y2
XYZ Opto Drive (3-8 GRY/WHT) Y3
499Ω 1/2 W
50ma. Max
(WHT/RED) Sw. Drive Z10
Bottom Switch INPUTS
(WHT) Ins 1 Z9
(GRY) Ins 2 Z8
(VIO) Ins 3 Z7
(BLU) Ins 4 Z6
(GRN) Ins Ø Z5
NC Z4
(ORG) SPARE Z3
(RED) Bottom Z2
Z1 NC.
0.1 MF
7 MORE IDENTICAL PROTECTION NETWORKS
40244
+5
Acoustic Signal Inputs
(BLU) Sig A AA6
(GRN) Sig B AA5
(YEL) Sig C AA4
NC AA3
NC AA2
NC AA1
+4.3V
FSA2501M
68K
2.2K
1MΩ
3 MORE IDENTICAL PROTECTION NETWORKS
NC KEY
1872
TPA
NOTE:
WO
PRO
SHE



NOTE: COUNTERS INCREMENT ON LEADING EDGE OF OPTICAL INTERRUPTOR

24 Nov 85 WET
2 Dec 85 WET
15 Oct 85 WET
REV 3
REV 2

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543	TITLE: Auxillary Board
PROJ 1078267 BY ARD	SEA D[redacted]
SHEET 1 OF 2 DATE 27 Oct 83	

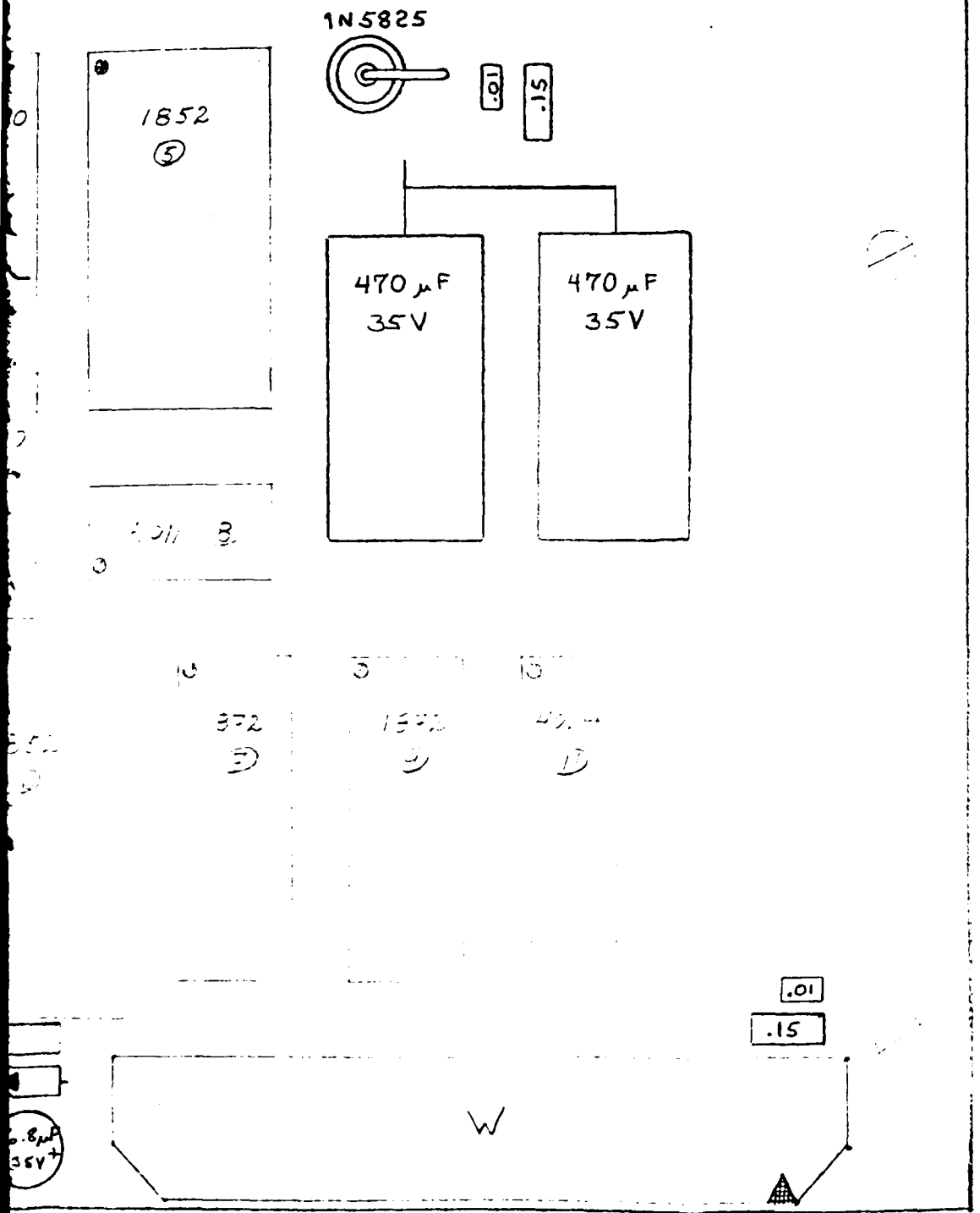


WOOD

PROJ. /

SHEET

1



REV	12 July 84	KAW
	20 Nov 84	WET
	05 Dec 85	WET

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543

PROJ. 10/82.69 BY KAW

SHEET 2 OF 2 DATE 26 June 84

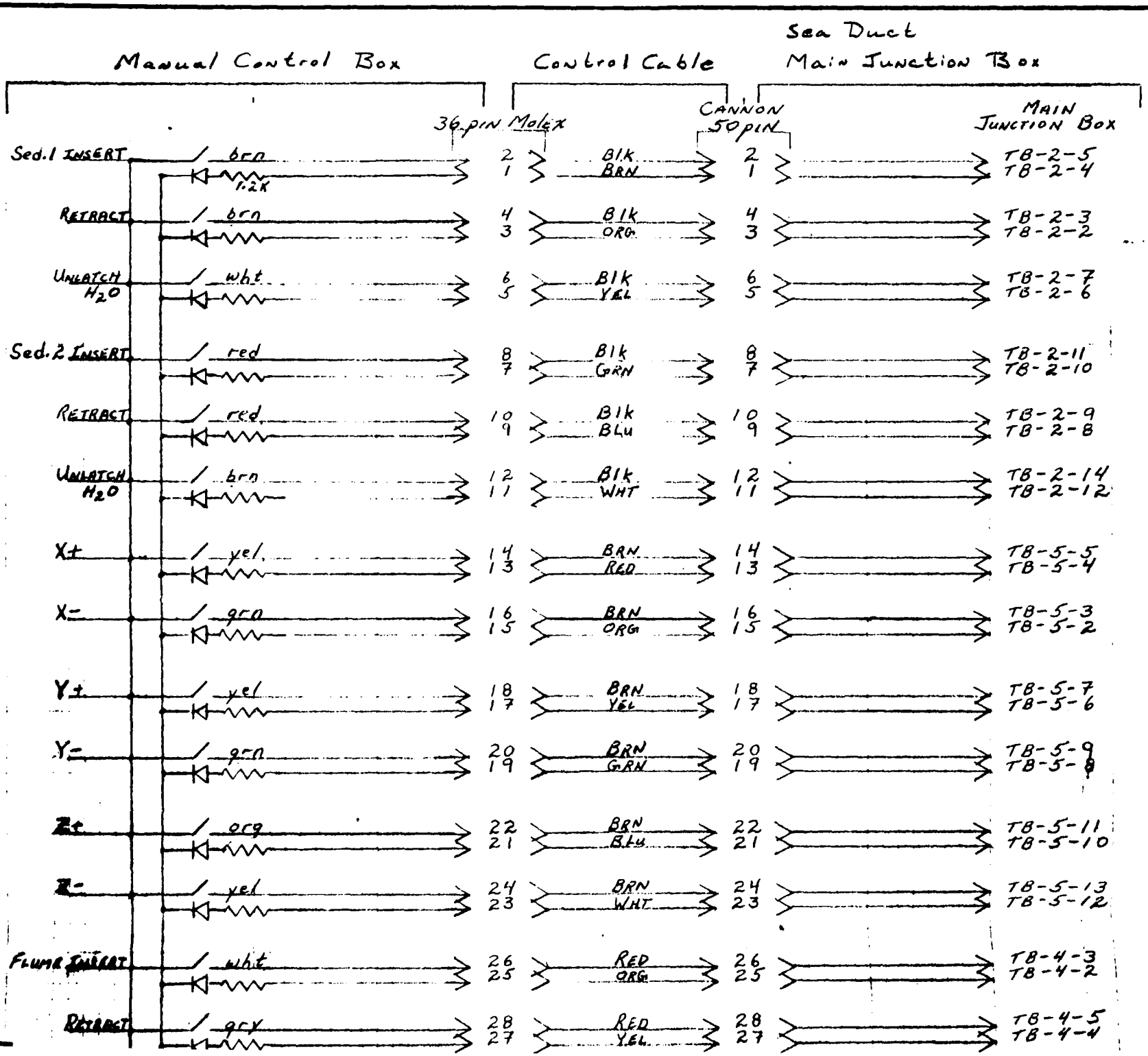
TITLE

Auxillary Board - Parts Layout

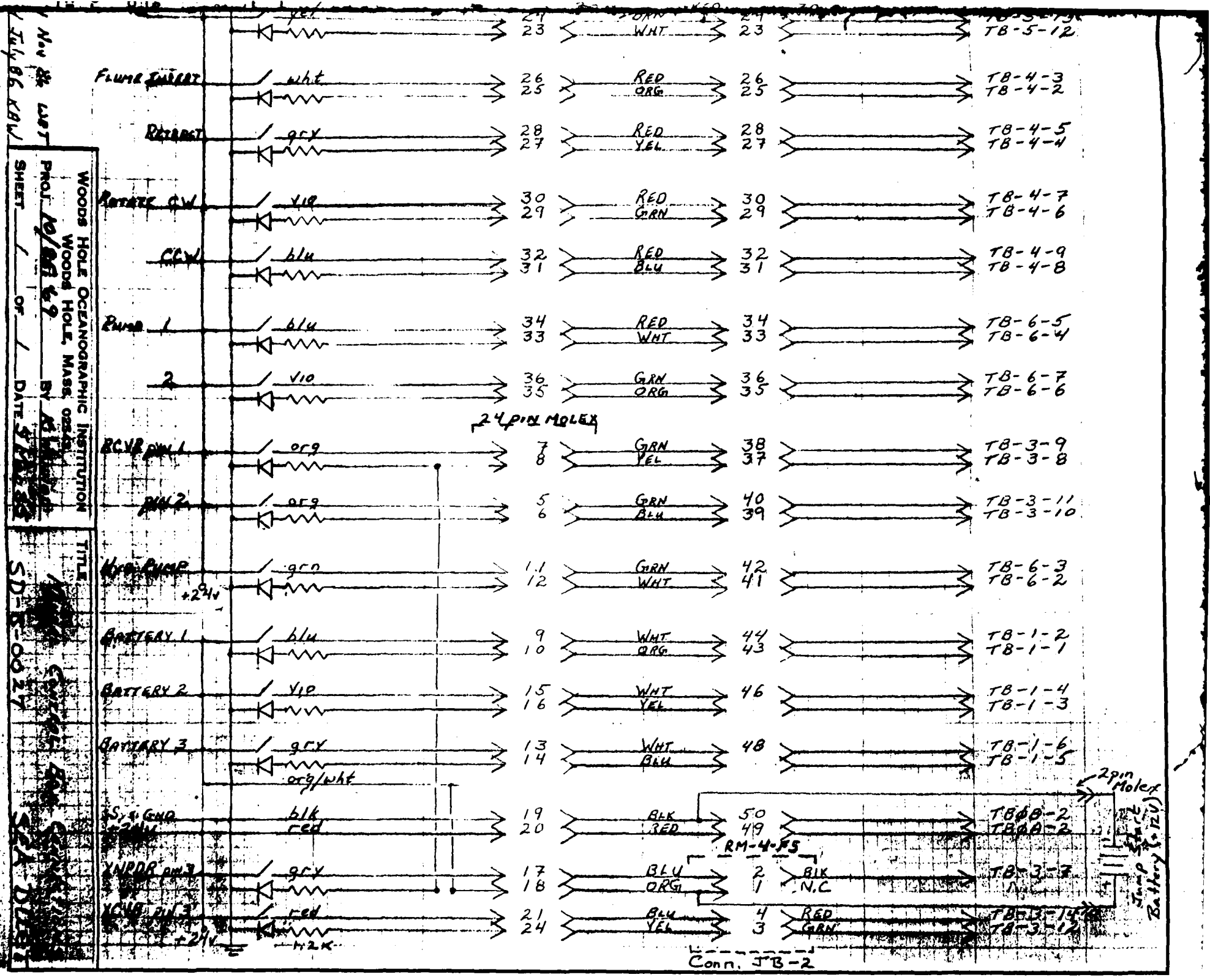
SEA DUCT

SD-R-0212

SP 11209A



Rev 24 Nov 86 WPT
Rev 24 July 86 KAW


WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, MASS. 02543
PROJ
SHEET
DATE
BY
TITLE
SD-R-00247
24 PIN MOLEX
2pin Molex
RM-4-FS
Conn. JB-2
TB-4-3
TB-4-2
TB-4-5
TB-4-4
TB-4-7
TB-4-6
TB-4-9
TB-4-8
TB-6-5
TB-6-4
TB-6-7
TB-6-6
TB-3-9
TB-3-8
TB-3-11
TB-3-10
TB-6-3
TB-6-2
TB-1-2
TB-1-1
TB-1-4
TB-1-3
TB-1-6
TB-1-5
TB-3-7
TB-3-14
TB-3-13

J4

50 pin Amp

1	I/O 4° TP 3	37	B4°
2	I/O 7° TP6	38	SCØ
3	I/O 3° TP 2	39	B3°
4	I/O 6° TP5	40	Q° TP 18
5	I/O 2° - TP 1	41	B2°
6	I/O 5° TP4	42	$\overline{MRD}$ TP14
7	GND TPØ	43	B1°
8	GND TP27	44	$\overline{INT}$ TP25
9	$+V_{DD}$ TP26	45	BØ°
10	$+V_{DD}$	46	GS3° TP 10
11	$\overline{EF4}$ TP 24	47	TPB° TP29
12	N.C. (KEY)	48	DMA OUT - TP16
13	$\overline{HWR}$° - TP15	49	TPA° TP 28
14	$\overline{EF3}$ TP23	50	DMA IN - TP17
15	A7'		
16	$\overline{EF2}$ TP 22		
17	A6'		
18	$\overline{EF1}$ TP 21		
19	A5'		
20	N2 TP13		
21	A4'		
22	N1 TP12		
23	A3'		
24	NØ TP 11		
25	A2'		
26	GS 2° TP9		
27	A1'		
28	GS 1° TP8		
29	AØ		
30	GSØ° TP7		
31	B7°		
32	$\overline{WAIT}$ TP 19		
33	B6°		
34	$\overline{CLR}$ TP 20		
35	B5°		
36	SC1		

To Connector 'P' Sea Duct Buffer Board

V_{DD} ← → V_{DD} (+5v)

+ 22μf 35v TANT

← AØ'
← A1'
← A2'
← A3

TO CONNECTOR P OF SEA DUCT BUFFER BOARD

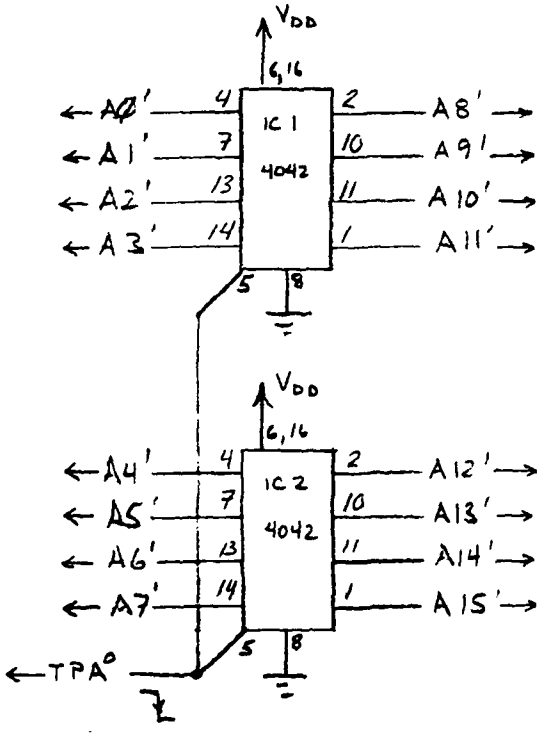
← A4
← A5
← A6
← A7

← TPA° -

SP 11288A

V_{DD} (+5v)

2 µf 35v
ANT



J2 — 26 Pin AMP — POD 3

A9'	J2-1	0
A10'	J2-2	1
A11'	J2-3	2
A12'	J2-4	3
A13'	J2-5	4
A14'	J2-6	5
A15'	J2-7	6
N.C.	J2-8	7
	J2-9	8
⏚	J2-10	GND
J3-8	J2-11	K Clk

J2-12 = KEY

POD 4

$\overline{MWR}$	J2-13	0 ✓
$\overline{MRD}$	J2-14	1 ✓
SCØ	J2-15	2 ✓
SC1	J2-16	3
J3-2	J2-17	4
J3-3	J2-18	5
J3-4	J2-19	6
J3-5	J2-20	7
J3-6	J2-21	8
⏚	J2-22	GND
TPB	J2-23	J Clk
	J2-24	KEY

Buses

J1 — 26 Pin AMP — POD 1

BØ°	J1-1	0
B1°	J1-2	1
B2°	J1-3	2
B3°	J1-4	3
B4°	J1-5	4
B5°	J1-6	5
B6°	J1-7	6
B7°	J1-8	7
⏚	J1-10	GND
	J1-9	= KEY

POD 2

AØ'	J1-13	0
A1'	J1-14	1
A2'	J1-15	2
A3'	J1-16	3
A4'	J1-17	4
A5'	J1-18	5
A6'	J1-19	6
A7'	J1-20	7
A8'	J1-21	8
⏚	J1-22	GND
J3-9	J1-23	L Clk
	J1-24	Key

J3 — 9 Pin 'D'

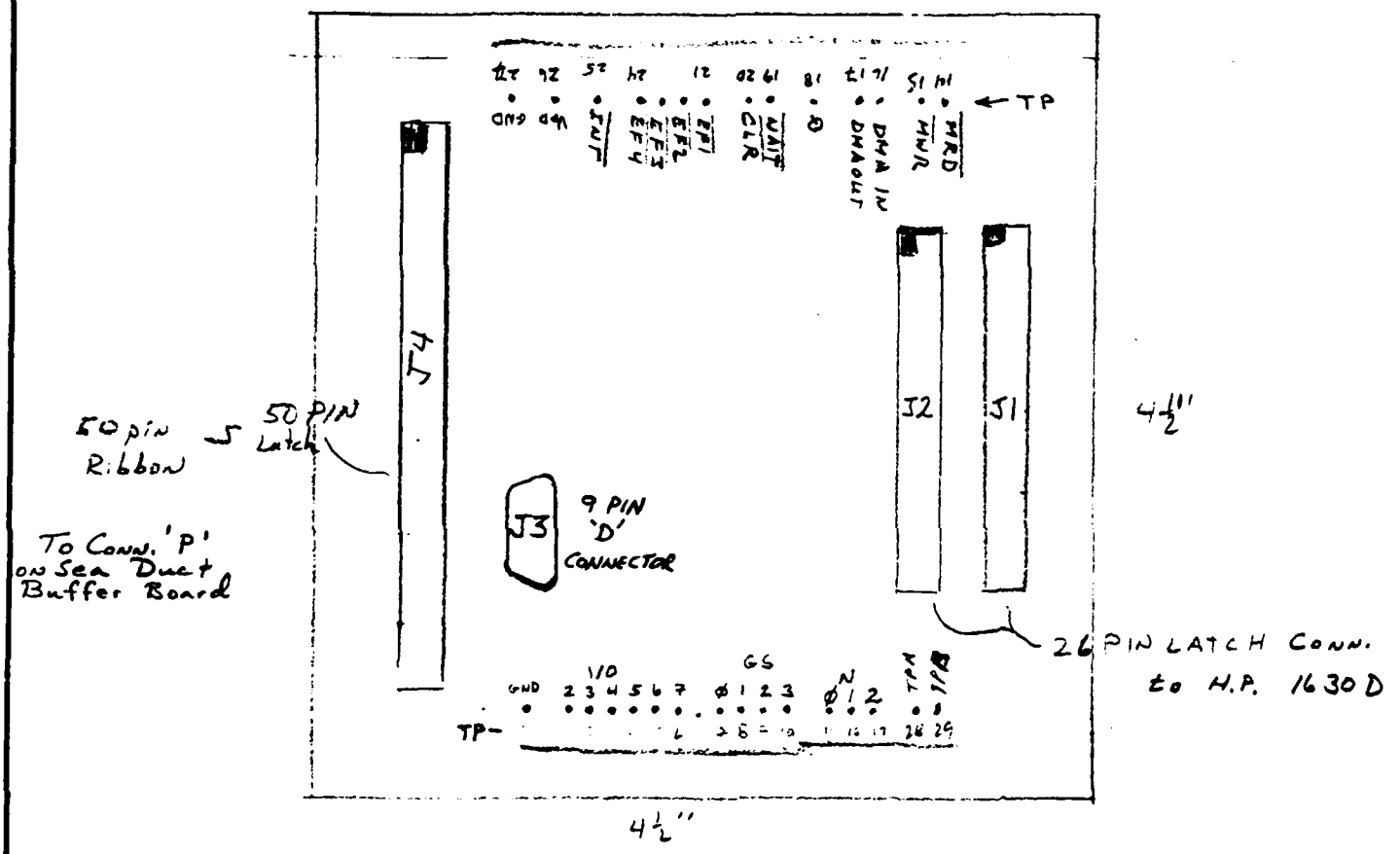
1	GND	BLK	Bus
2	POD 4-4	BRN	
3	POD 4-5	RED	
4	POD 4-6	ORG	
5	POD 4-7	YEL	
6	POD 4-8	GRN	
7			
8	K Clk		
9	L Clk		

REV 2 Feb 84 ~~WET~~

REV 31 OCT 83 ~~ARD~~

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10/82.69 BY WET SHEET 1 OF 2 DATE 18 Oct 83	TITLE SEA DUCT — HP 1630 D Analyzer Interface Box SEA DUCT

SD-B-028



J3

1	BLK	Bongo w/GRY
2	BRN	Bongo w/GRY WIRE
3	RED	" "
4	ORG	" "
5	YEL	" "
6	GRN	" "
7	BLU	" "
8	NC	
9	NC	

CONN.
1630 D

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10/82.69 BY WET SHEET 2 OF 2 DATE 18 Oct 83	TITLE SEA DUCT – HP 1630 D Logic Analyzer Interface Box – Layout SEA DUCT

SD-R-0029

JA-Pins:

1 — B_0
2 — B_1
3 — B_2
4 — B_3
5 — B_4
6 — B_5
7 — B_6
8 — B_7
9 — N.C (KEY)
10 — GND
11 — [illegible]
12 — NC
13 — [illegible]
14 — [illegible]
15 — [illegible]
16 — [illegible]
17 — [illegible]
18 — [illegible]
19 — [illegible]
20 — [illegible]
21 — [illegible]
22 — GND
23 —
24 — NC (KEY)
25 — NC
26 — NC

TO [illegible] OR
[illegible] DUCT — HP, 1630 D
[illegible] CONNECTOR
[illegible] INTERFACE

JB-Pins:

1 — A_9
2 — A_{10}
3 — A_{11}
4 — A_{12}
5 — A_{13}
6 — A_{14}
7 — A_{15}
8 — NC
9 — [illegible]
10 — GND
11 —
12 — NC (KEY)
13 — [illegible]
14 — $\overline{MRD}$
15 — SCC
16 — SCL
17 — [illegible] (NC)
18 — [illegible]
19 — [illegible]
20 — [illegible]
21 —
22 — [illegible]
23 — [illegible]
24 — NC (KEY)
25 —
26 — NC

TO [illegible]
[illegible] DUCT — HP 1630 D
[illegible] CONNECTOR
[illegible] INTERFACE

WOODS HO

CONTRACT NO. /

BY W E T

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

J2-PIN:

D_0	1	
B_1	3	
B_2	5	
B_3	7	Pod 1
B_4	9	
B_5	11	
B_6	13	
B_7	15	
A_0	2	
A_1	4	
A_2	6	
A_3	8	Pod 2
A_4	10	
A_5	12	
A_6	14	
A_7	16	
GND	17	
GND	20	

J3-PIN:

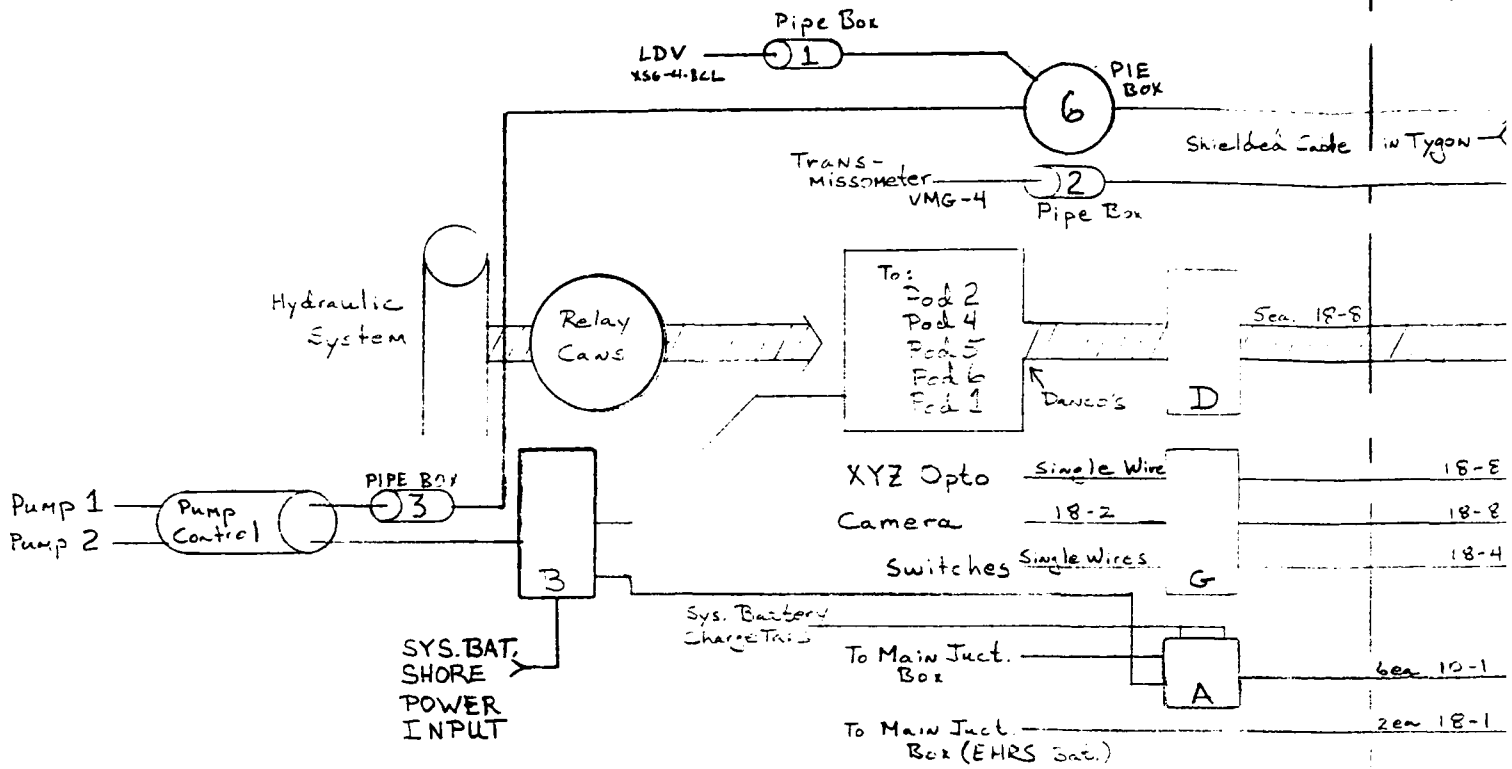
A_0	1	
A_1	3	
A_2	5	
A_3	7	Pod 3
A_4	9	
A_5	11	
A_6	13	
A_7	15	
SCA	2	
SCL	4	
$\overline{MRD}$	6	
$\overline{MWR}$	8	Pod 4
[illegible]	15	
[illegible]	12	
[illegible]	14	
[illegible]	16	
GND	17	
GND	20	

To: HP 1610 Logic Analyzer

Note:
HP 1610 Clock Pod GND = GND
KCLK = TPE

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543			TITLE HP 1630 C/ HP 1610 Analyzer Interface Box CER DUCT	
CONTRACT NO. 10/82.69	CODE NO.			
BY WET	DATE 12 July 88	SIZE B	DWG. NO. SD-B-030	OF REV

SD-B-030



EHRS = Emergency Hydrostatic Release System

Rotation Side

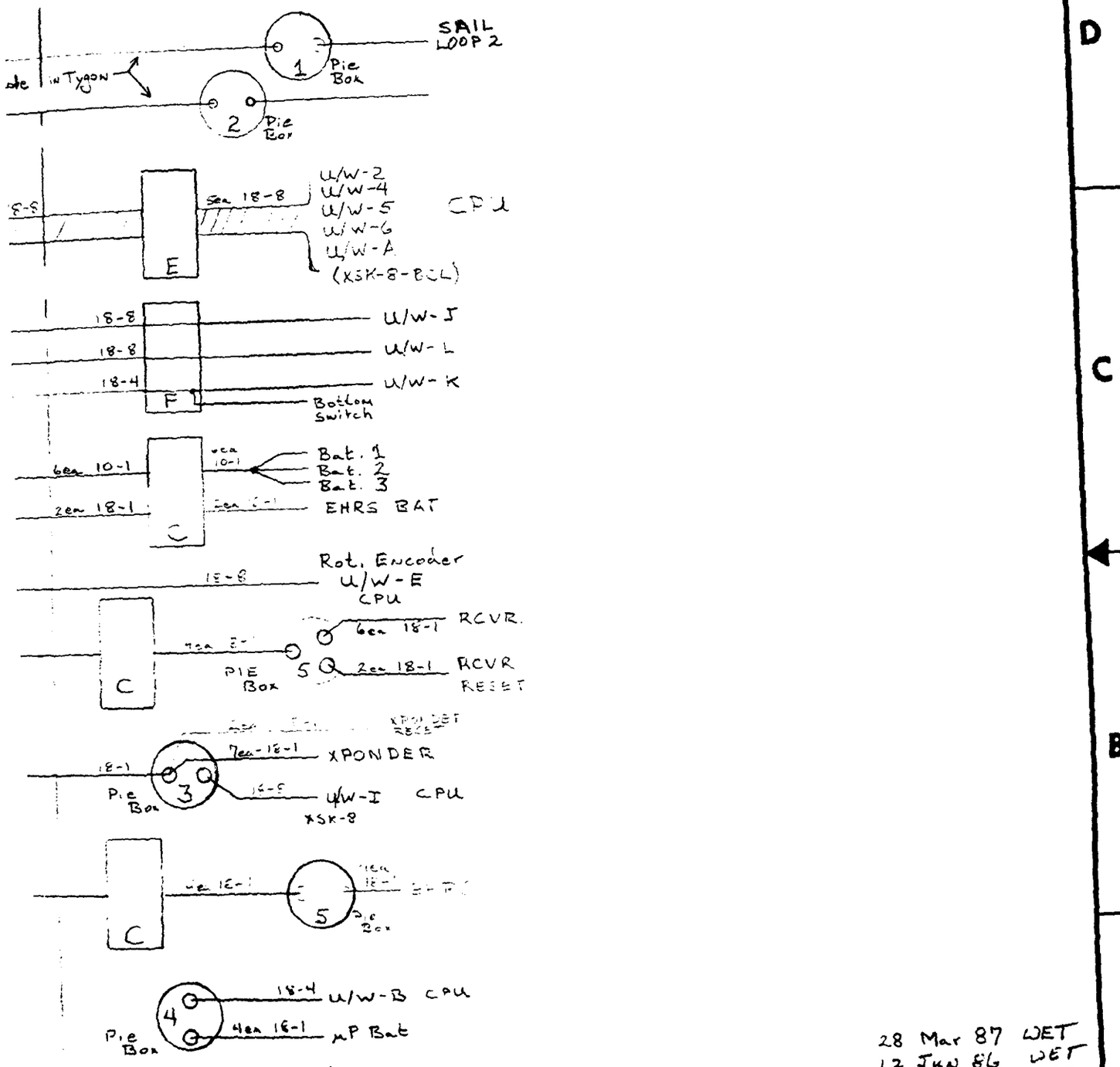
9223L-078

FOTOBEAM/BROOKSIDE 0232-B

2 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

Rotation Point

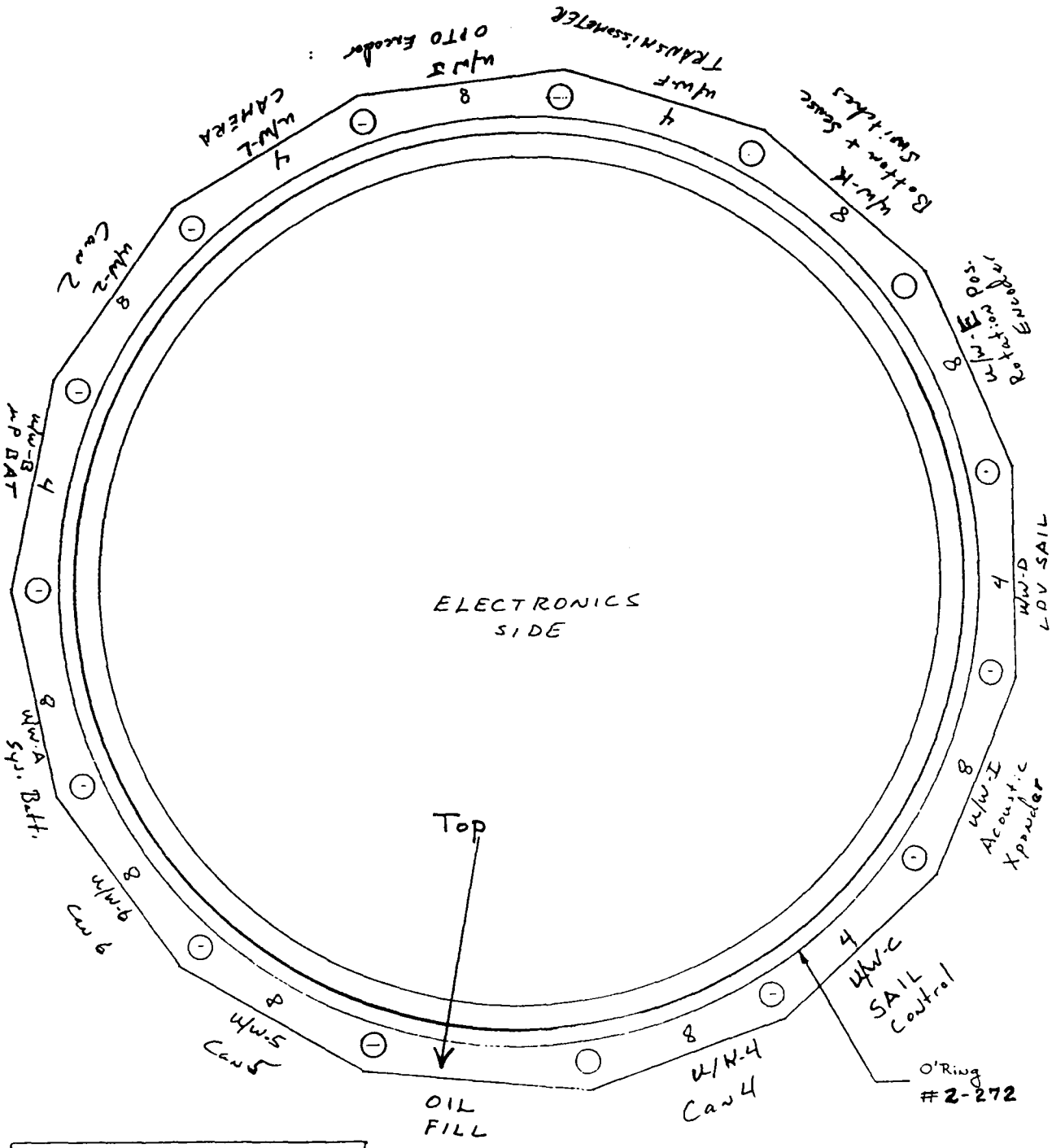


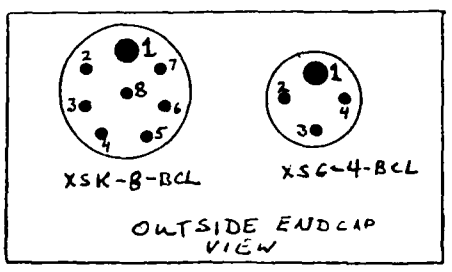
Leg Side

28 Mar 87 WET
12 JUN 86 WET
Rev. 23 Apr 86 WET

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE Main Wiring Harness SEA DUCT	
CONTRACT NO. 10/85.69	CODE NO.		
BY W. E. Terry	DATE 3 Dec 85 SIZE B	DWG. NO. SD-B Ø31	OF REV.

2 1





O'Rings:
XSG-4-BCL = 9ea.
2-213
XSK-8-BCL = 5ea
2-217

SEA DUCT ENDCAP CONNECTORS

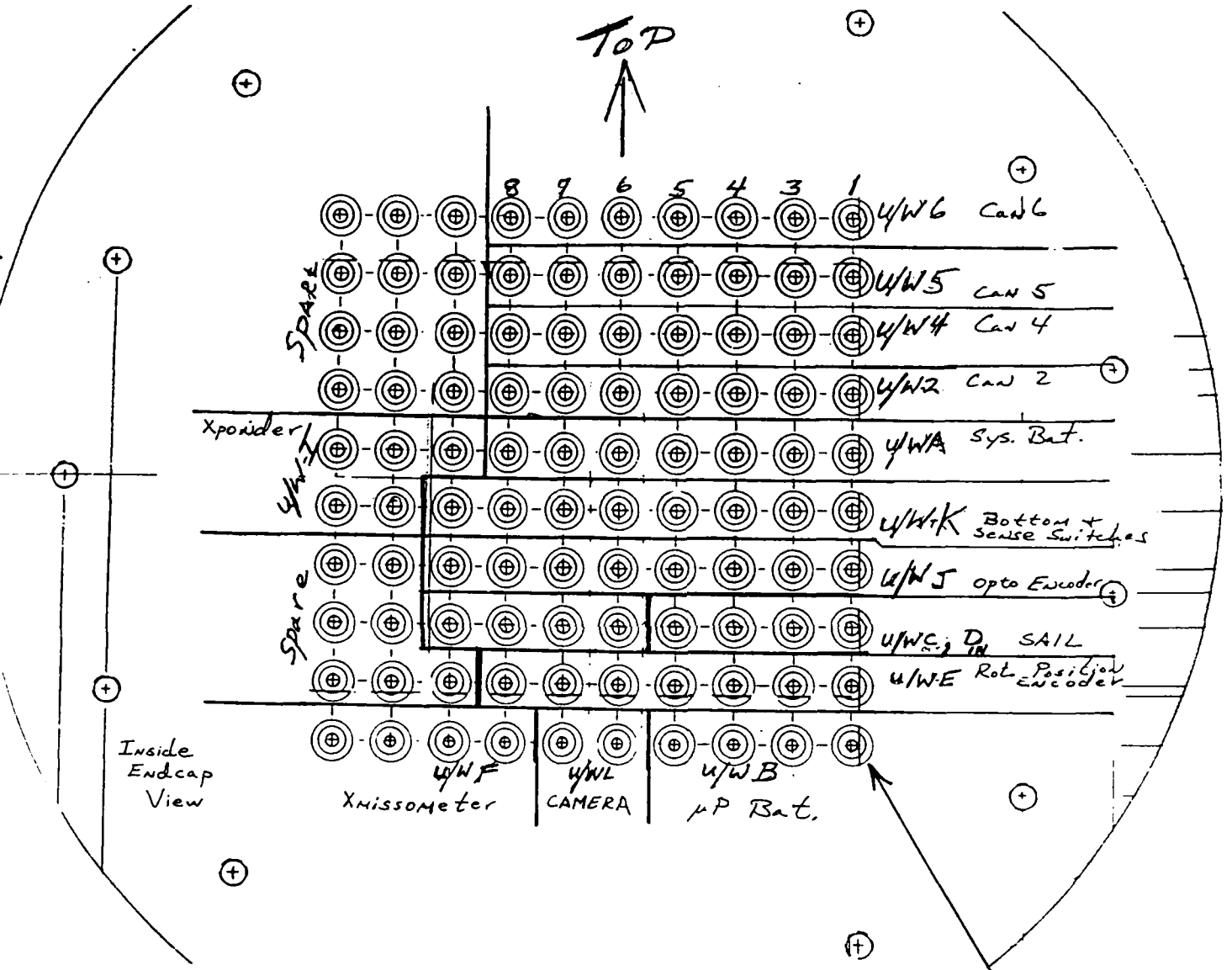
O'Rings:
2ea. 2-
2ea. 2-
1ea 2-
2ea 2-

WO
CONTRAC
BY W.

92231-078

FOTOBEAM/BROOKSIDE 0232-B

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



O'Rings:

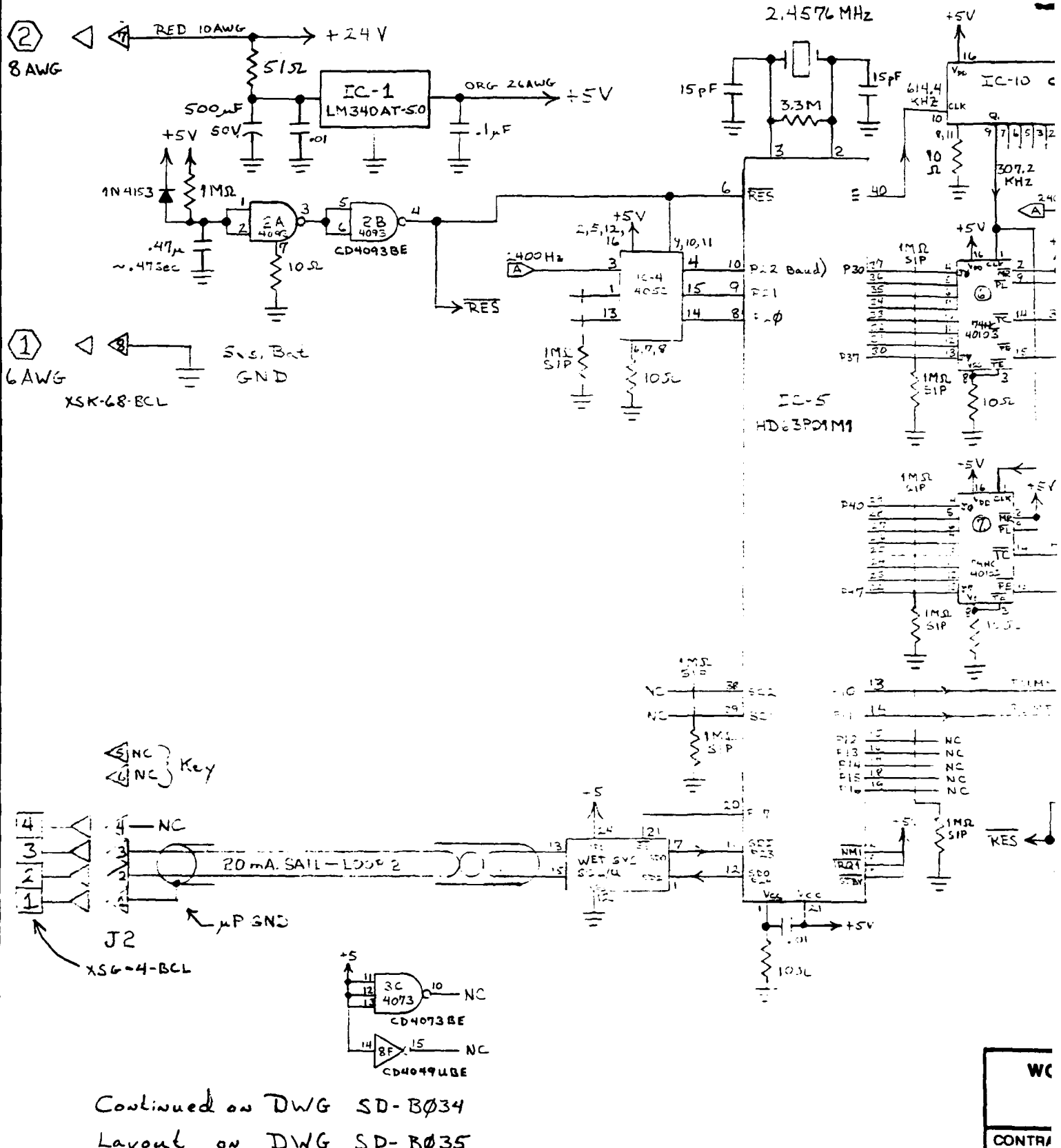
2ea. 2-273 } Endcaps to
2ea. 2-276 } Pressure Housing

1ea 2-272 – Endcap to Oil filled Connector Housing

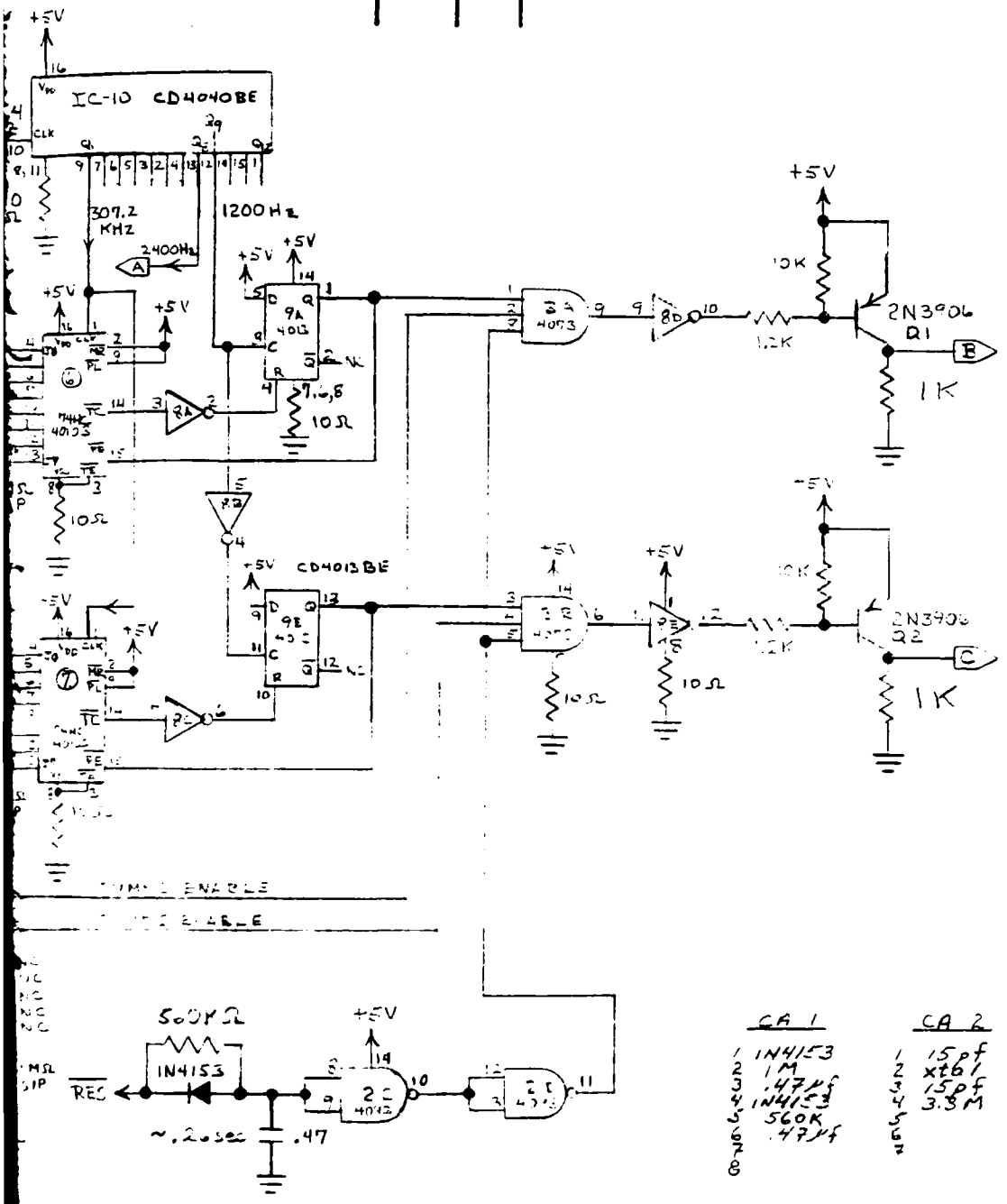
2ea 2-112 - Endcap purge plugs

100 ea.
Sinclair Mfg. Co.
TBTHSW605SS
Glass to metal feed-thru.

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543			TITLE CPU Endcap – Electrical Connections Sea Duct		
CONTRACT NO. 10/85.69	CODE NO.				
BY W. Terry	DATE 13 Dec 85	SIZE B	DWG. NO. SD-B-032	OF	REV.


2.4576 MHz
RED 10AWG
+24 V
8 AWG
IC-1
LM340AT-5.0
ORG 26AWG
+5V
IC-10
IC-5
HD63P01M1
CD4093BE
CD4073BE
CD4049UBE
XSK-68-BCL
XSG-4-BCL
6 AWG
GND
20 mA. SAIL — LOOP 2
μP GND
J2
Key
NC
RES
2400 Hz
614.4 KHz
307.2 KHz
1MΩ SIP
10Ω
.47μ
~.47sec
1N4153
500μF 50V
.01
.1μF
15pF
3.3M
WET SYS
Continued on DWG SD-BØ34
Layout on DWG SD-BØ35

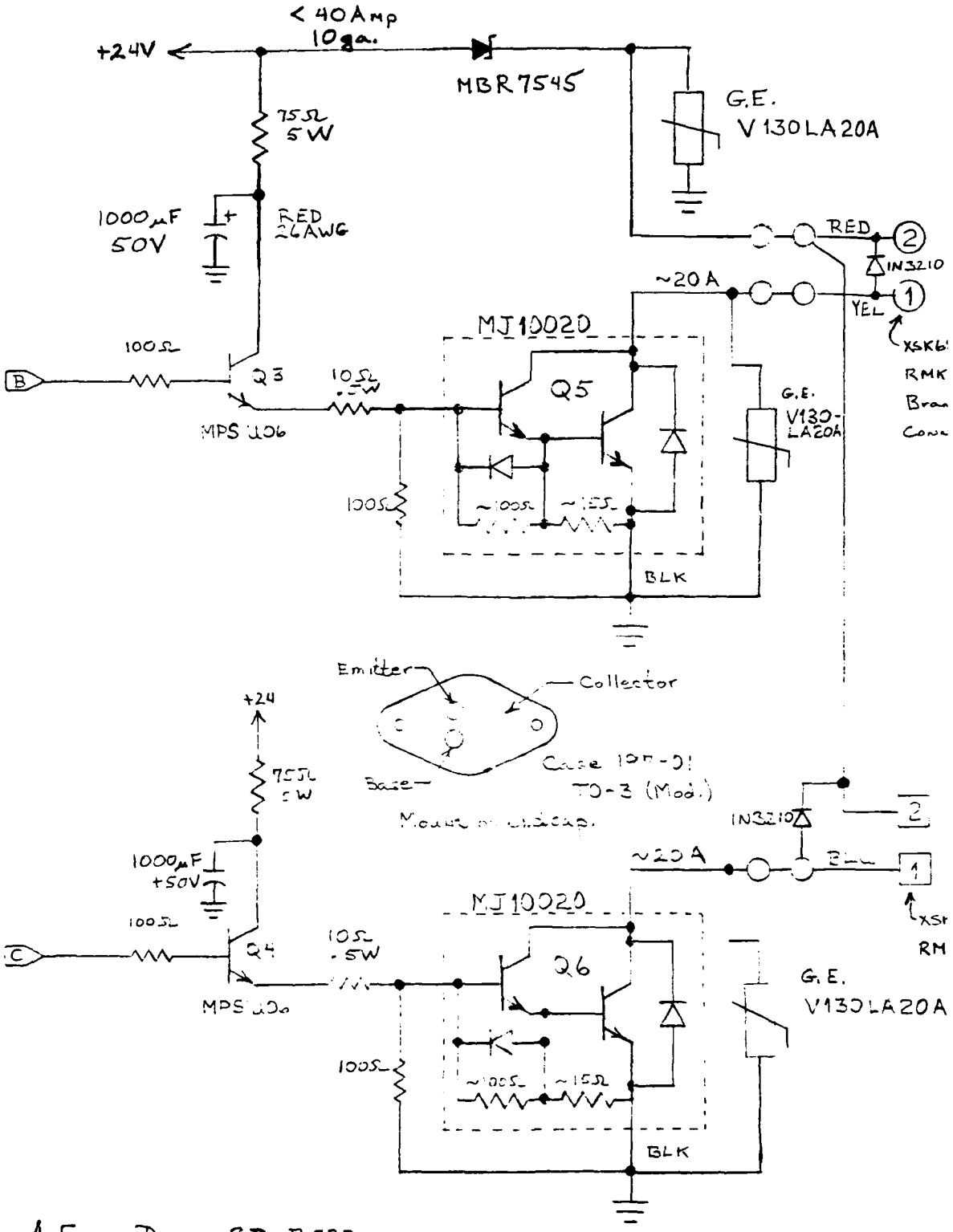
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



CA 1		CA 2		CA 3		CA 4	
1	IN4153	1	15pf	1	1.2K	1	51Ω
2	1M	2	xtal	2	10K	2	
3	.47μf	3	15pf	3	E 2N3906	3	.01μf
4	IN4153	4	3.3M	4	B C	4	.1μf
5	560K	5		5	1.0K	5	
6	.47μf	6		6	1.2K	6	
7		7		7	10K	7	
8				8	C		
9				9	2N3906 B		
10				10	1.0K E		

REV 26 Nov. 86 W.E.T.
REV. 23 Apr 87 W.E.T.

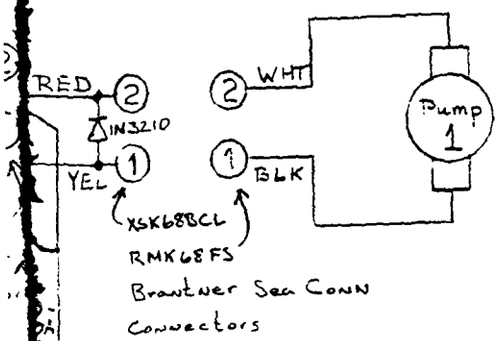
WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE Pump Controller (Control Circuit) Sea Duct	
CONTRACT NO. 10/85.69	CODE NO.		
BY W. TERRY	DATE 27 Feb 86 SIZE B	DWG. NO. SD-B-033	1 OF 3 REV.

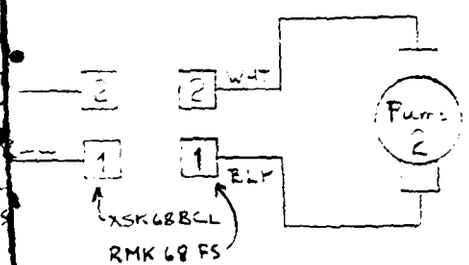


Continued From Dwg. SD-B033

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

A 20A

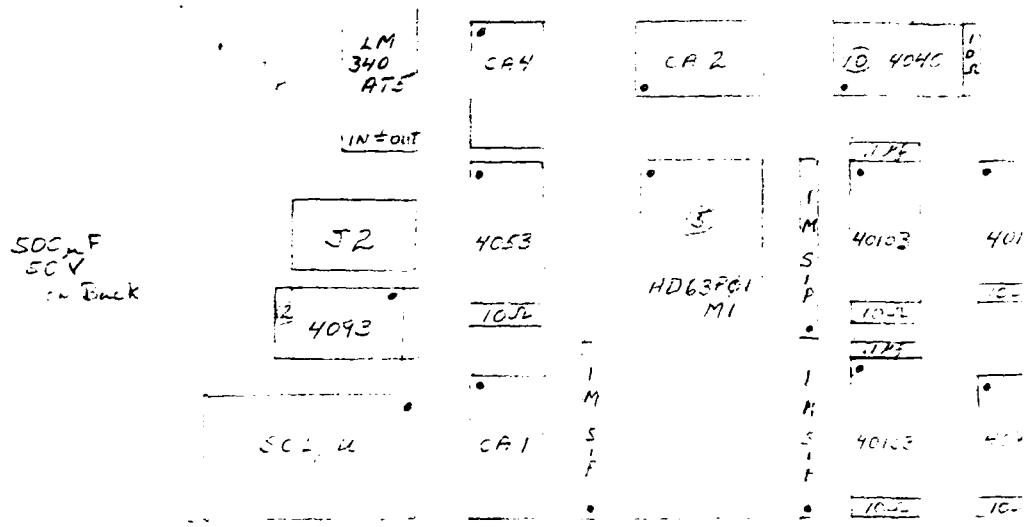




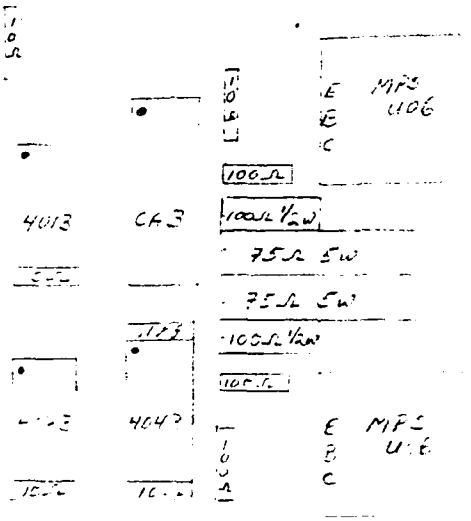
OLA 20A

REV 26 Nov 86 W.E.T.
REV 23 Apr 86 W.E.T.

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE Pump Controller (Power Circuitry) Sea Duct	
CONTRACT NO. 10/85.69	CODE NO.	DWG. NO. SD-B-034	2 OF 3 REV.
BY W. Terry	DATE 27 Feb 86 SIZE B		


LM
340
AT5
IN ± OUT
J2
4093
SOC u
CA4
4053
10JL
CA1
CA 2
HD63FC1
M1
10. 4040
40103
40103
.1MF
10JL
10-
SOC u F
5C V
on Back

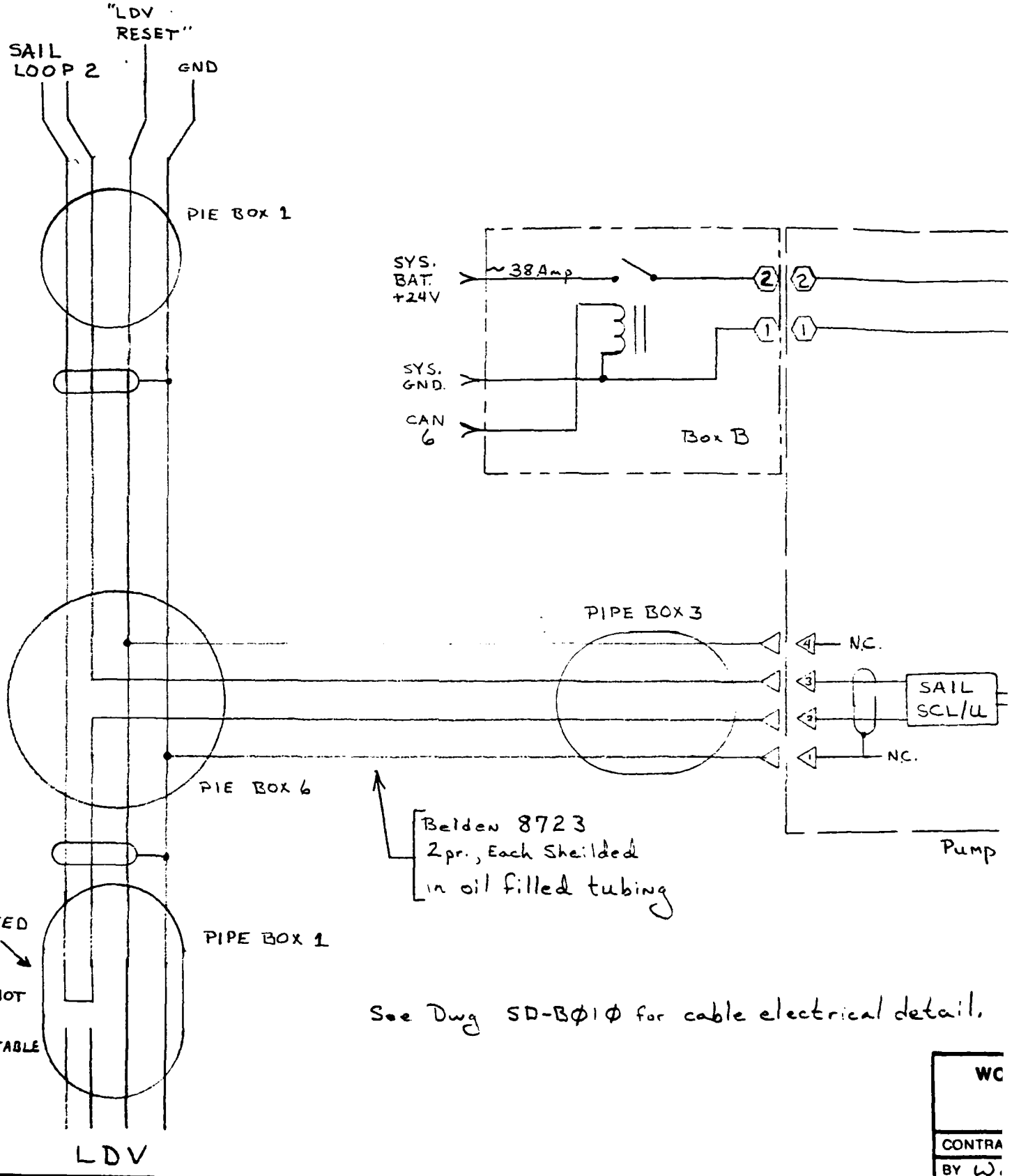
SP 11288A



2 on:
1000 mF
50 V
in Rack

REV 26 Nov 86 W.E.T.
REV 23 Apr 86 W.E.T.

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543	TITLE Pump Controller (Layout)
PROJ. 10/P5.69 BY KAWannop	
SHEET 3 OF 3 DATE 6 March 86	SD-E-035 Sea Duct



See Dwg SD-BØ1Ø for cable electrical detail.

WC

CONTRA

BY W.

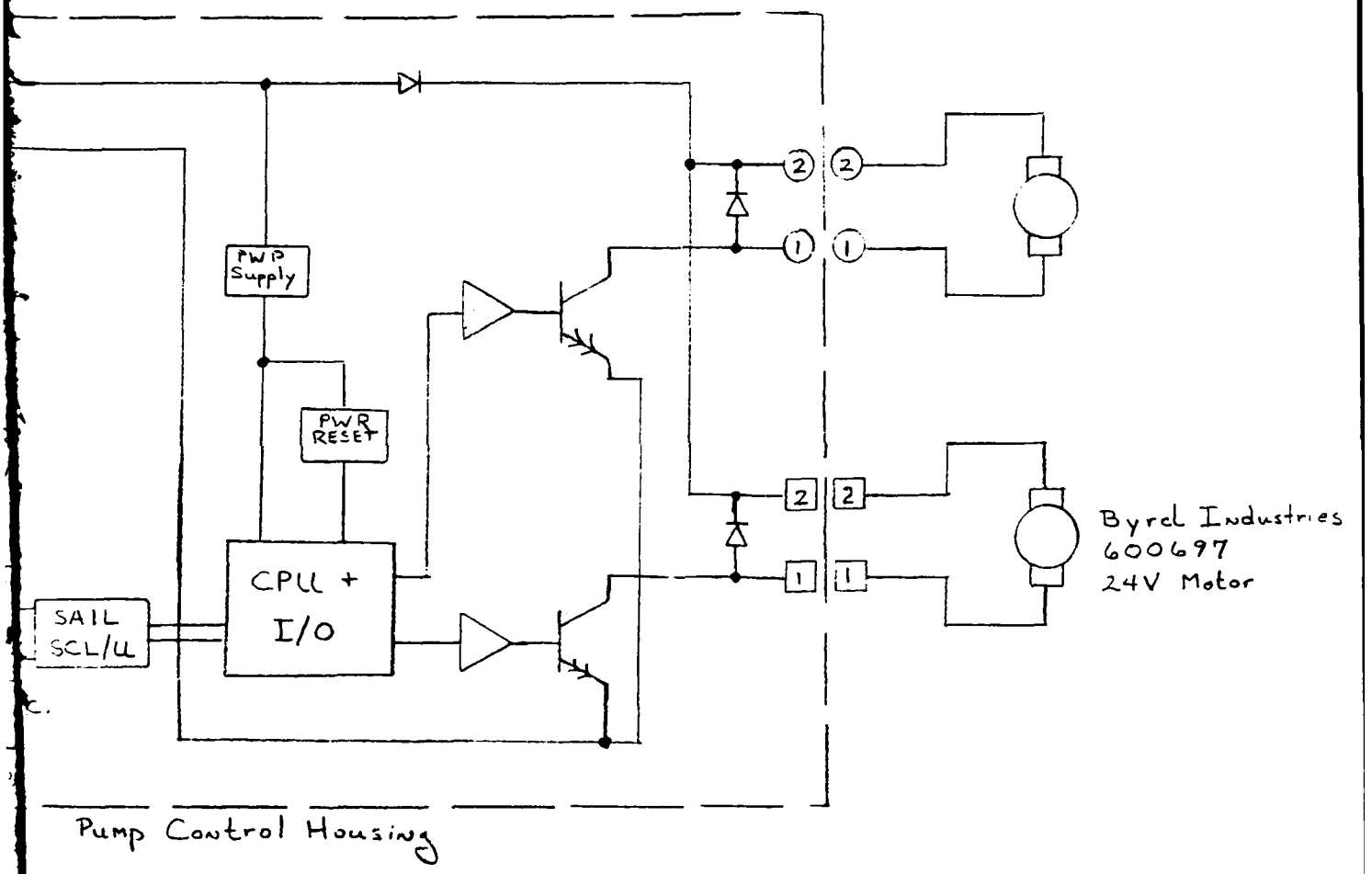
9223L078

FOTOBEAM/BROOKSIDE 0232-B

4

3

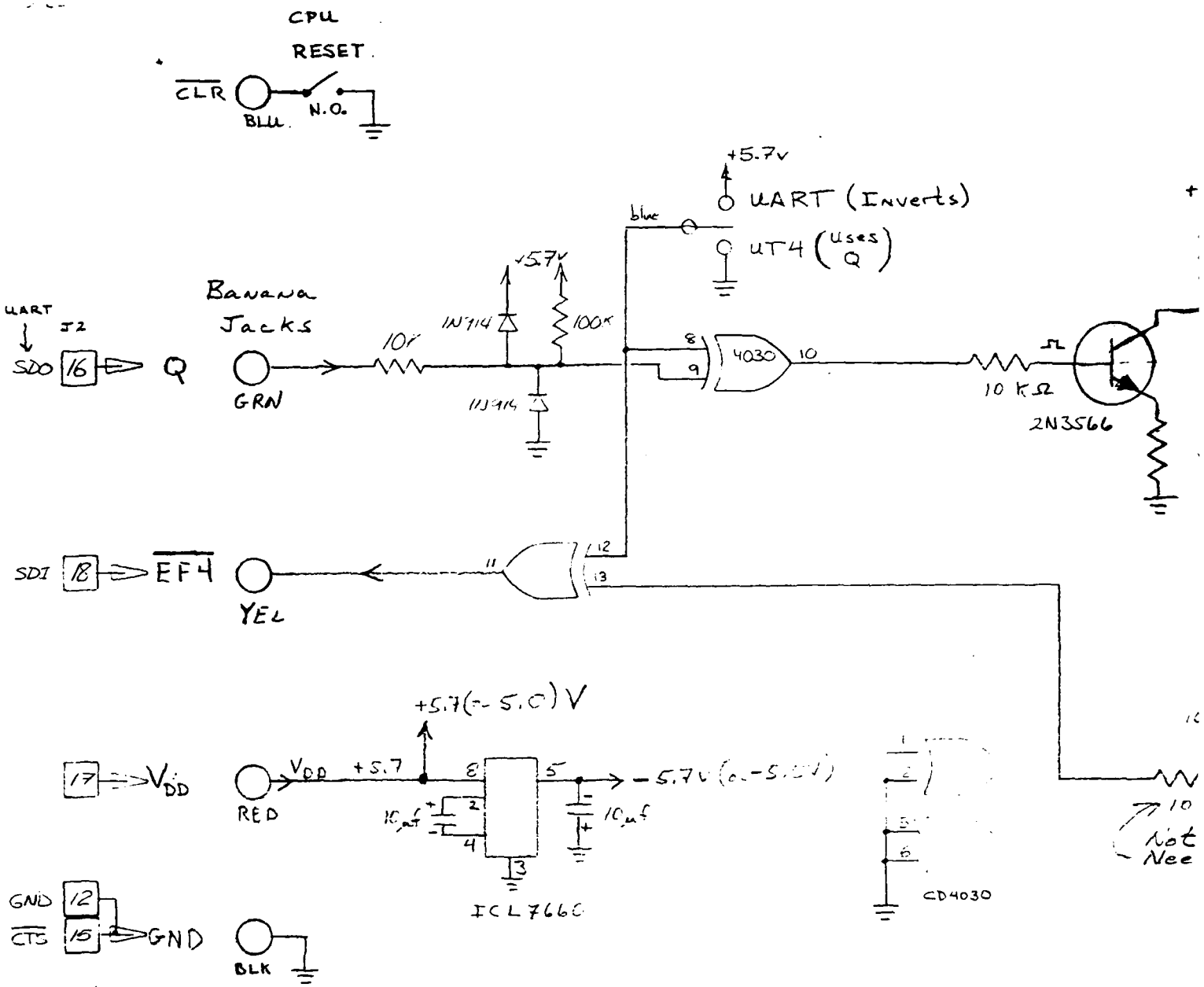
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

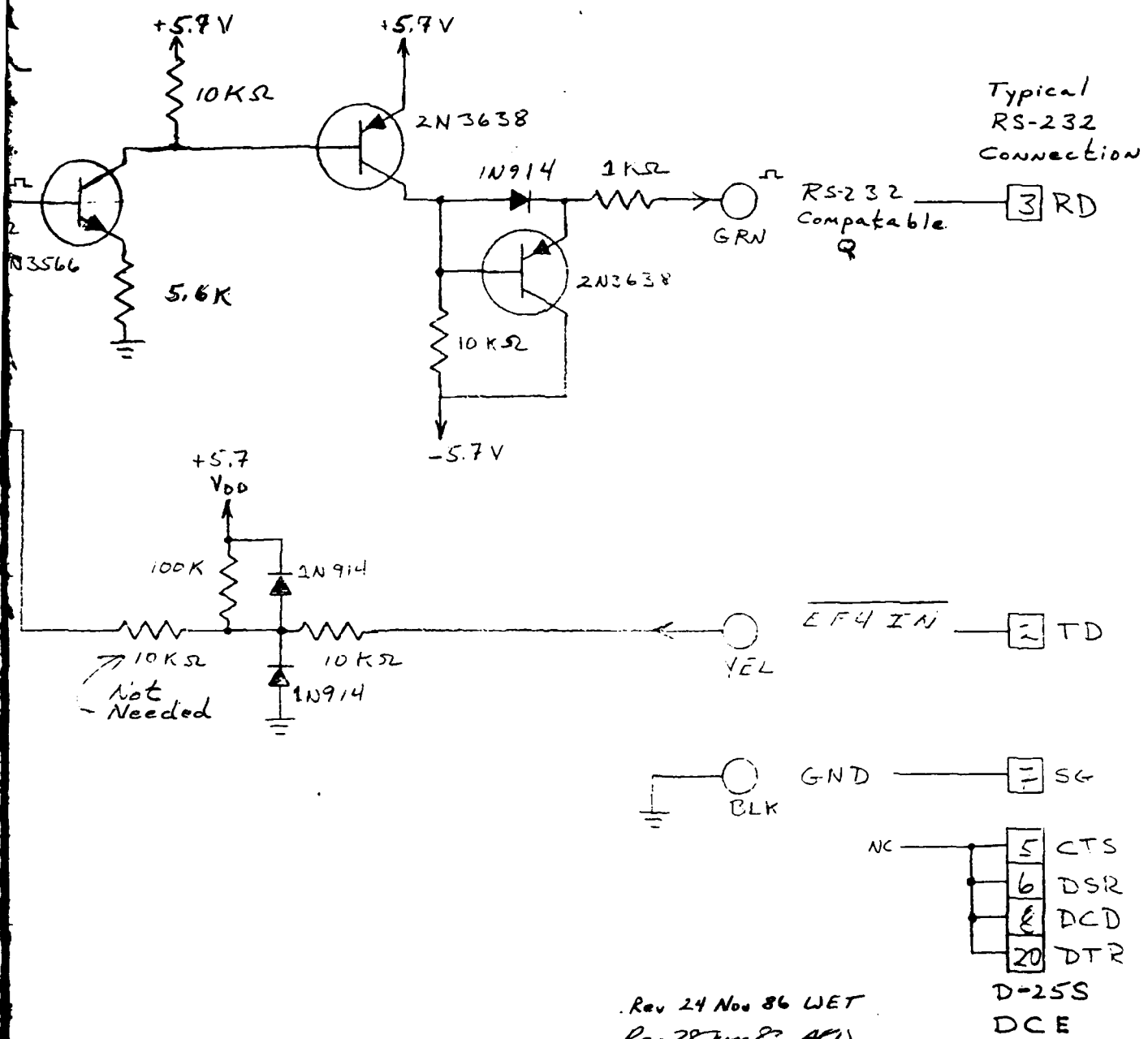


etail.

Rev 26 Nov 86 WET
REV 12 Jun 86 WET

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543			TITLE Pump Control Block Diagram Sea Duct		
CONTRACT NO. 10/85.69	CODE NO.				
BY W. TERRY	DATE 4 Mar 86	SIZE B	DWG. NO. SD-B036	OF	REV. 26 Nov 86


CPU
RESET
CLR
BLU
N.O.
+5.7v
UART (Inverts)
blue
UT4 (uses Q)
+5.7v
Banana Jacks
UART
J2
SDO
16
Q
GRN
10K
IN914
100K
IN914
8
9
4030
10
10 KΩ
2N3566
SDI
18
EF4
YEL
11
12
13
+5.7(-5.0)V
17
VDD
RED
VDD
+5.7
8
5
-5.7v (or -5.0V)
10 μf
10 μf
2
4
3
ICL7660
1
2
5
6
CD4030
10
Not Nee
GND
12
CTS
15
GND
BLK
Connections for Sea Duct Cable to J2
Note:
GND not connected to Chassis



Rev 24 Nov 86 WET

Rev 28 June 88 AKS

WOODS HOLE OCEANOGRAPHIC INSTITUTION WOODS HOLE, MASS. 02543 PROJ. 10/82.69 BY W. TERRY SHEET 1 OF 1 DATE	TITLE CMOS – RS-232 Interface Sea Duct SD-BØ37

Note — Pressure Housing is isolated from ground.

Case Gnd. (N.C.

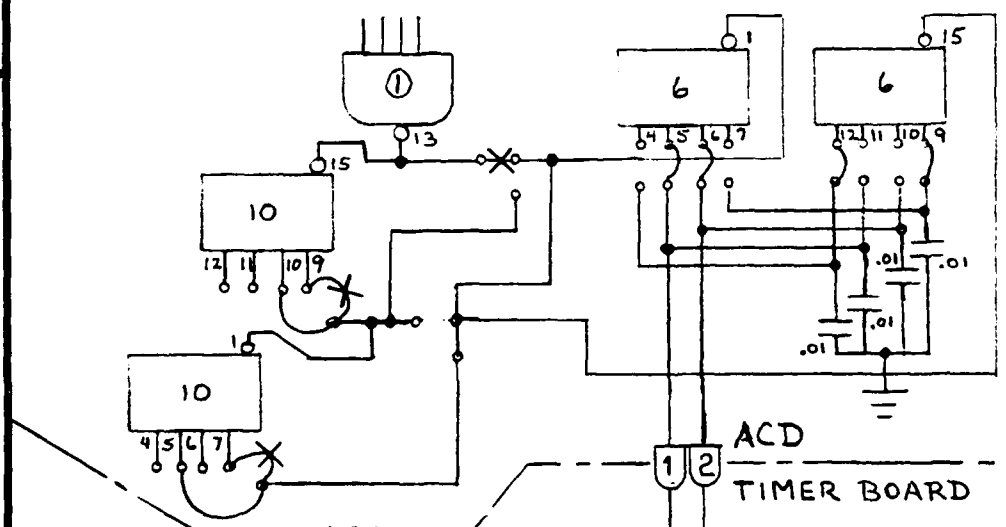
V+

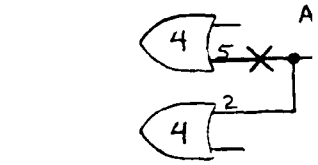
PIN R "Reset"

GND (Isolated from Case)

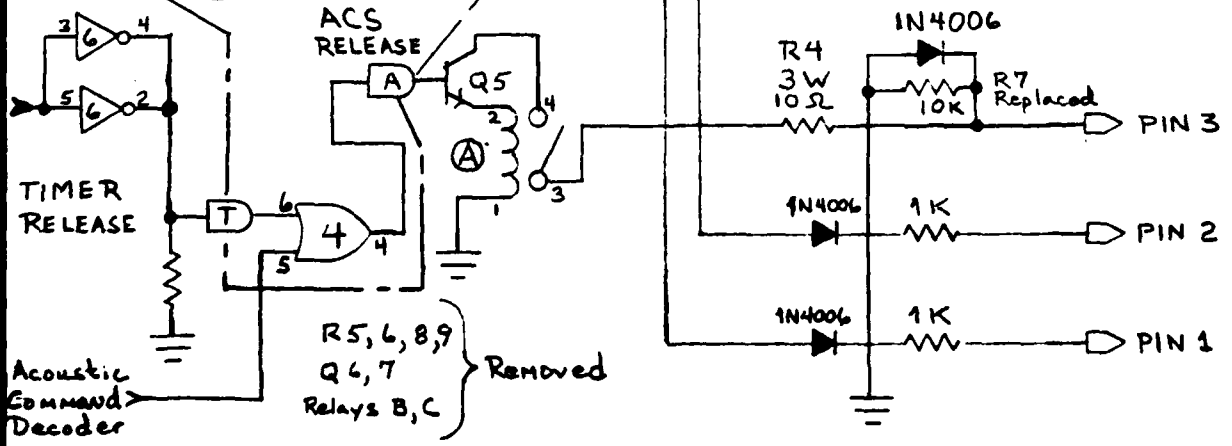
PIN T "PING"

Acoustic Command Decoder Board (ACD)





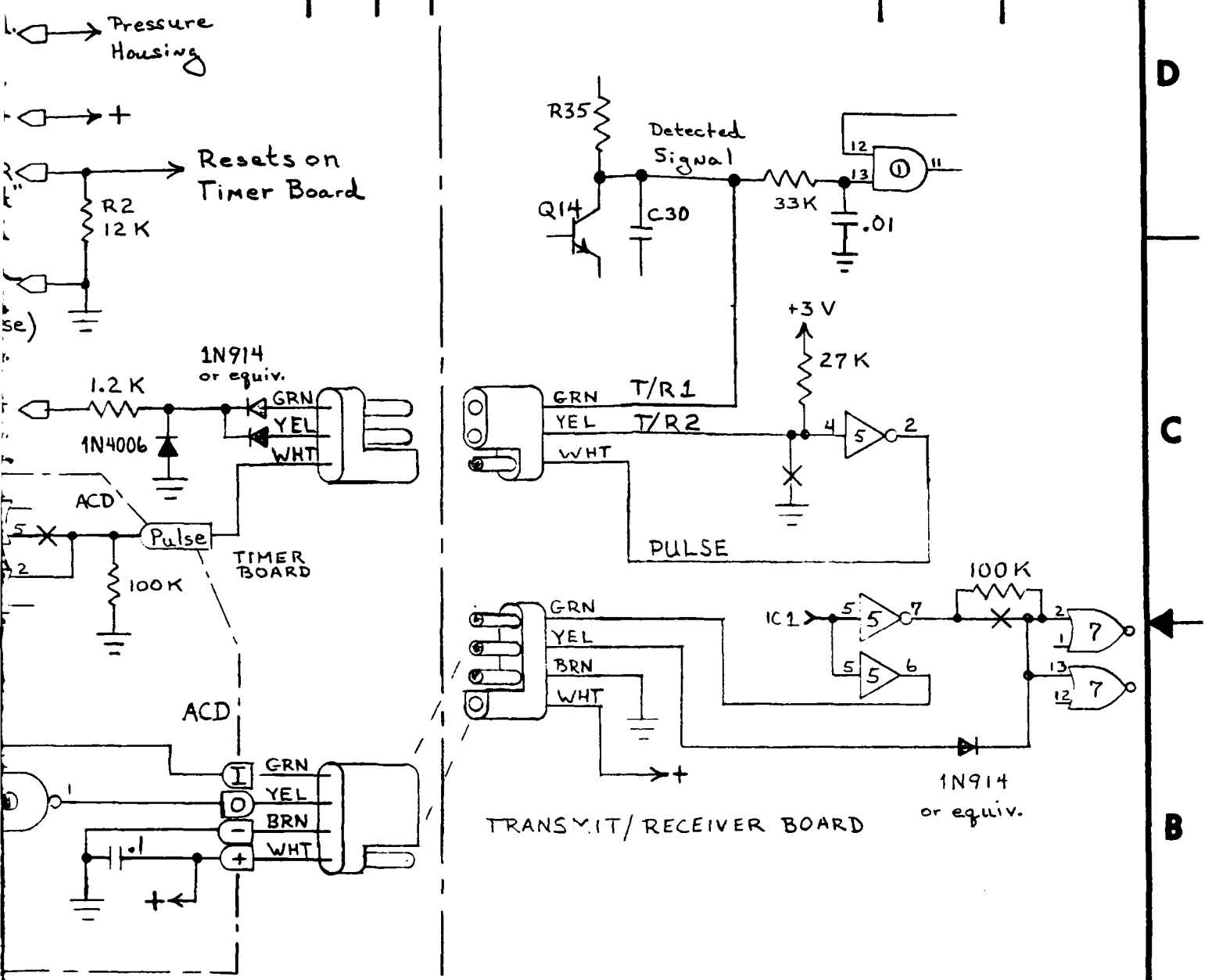
Received Pulse



9223L-078

FOTOBEAM/BROOKSIDE 0232-B

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



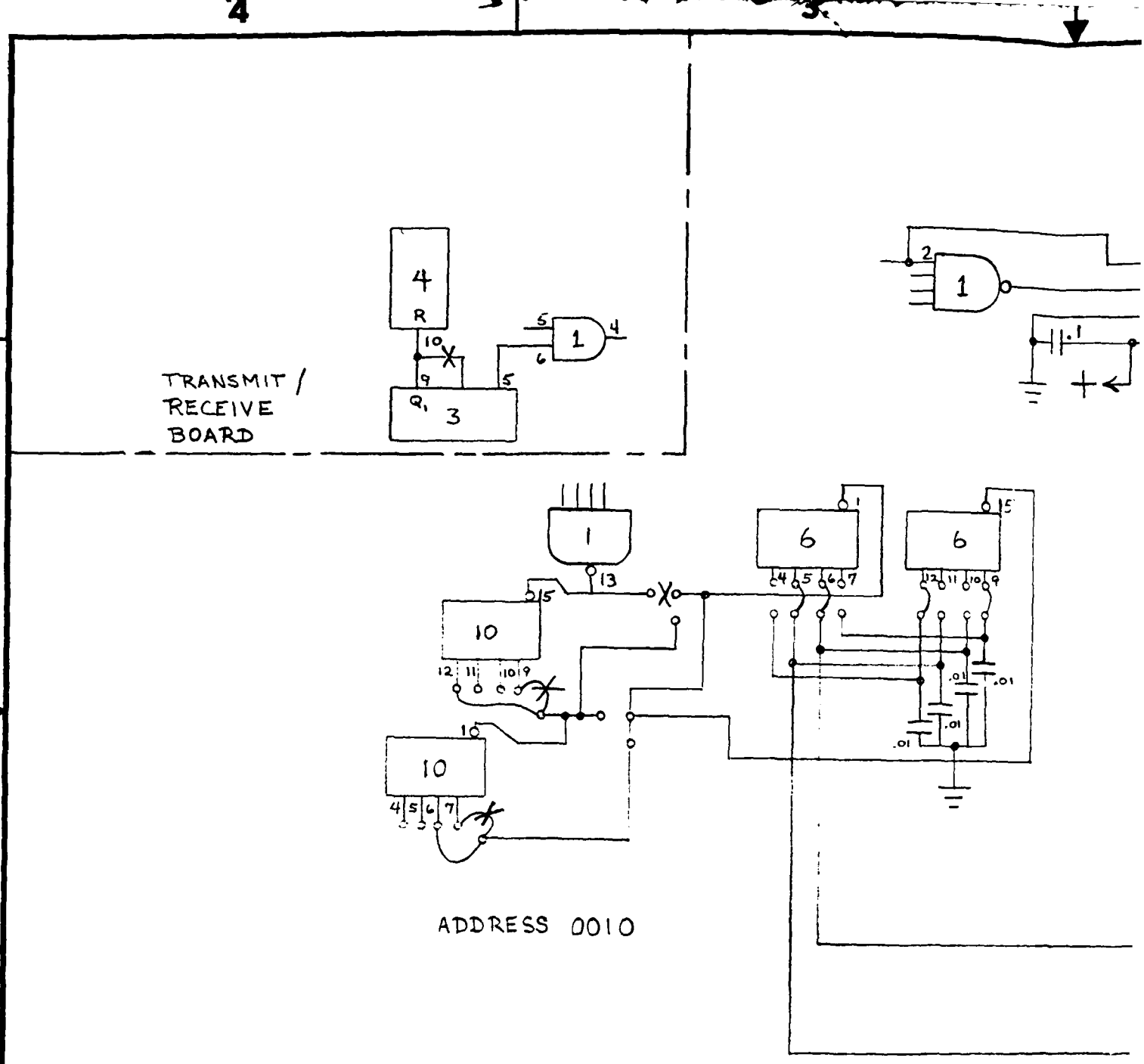
X = Cut Trace

▷ = End Cap Mecca Conn.

▷ = Transition between boards (Solder Connection)

ACD = Acoustic Command Decoder (Board)

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE QIS. Acoustic Command Xcvr. Modifications Sea Duct	
CONTRACT NO.	CODE NO.		
BY W. Terry	DATE 30 Dec. 84 SIZE B	DWG. NO. SD-B038	OF REV.



X = Cut Trace

▷ = End Cap Mecca Conn.

▷ = Transition between boards (Solder Connection)

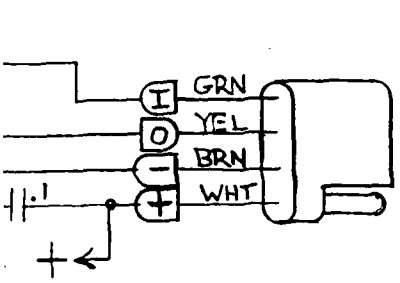
9223L-078

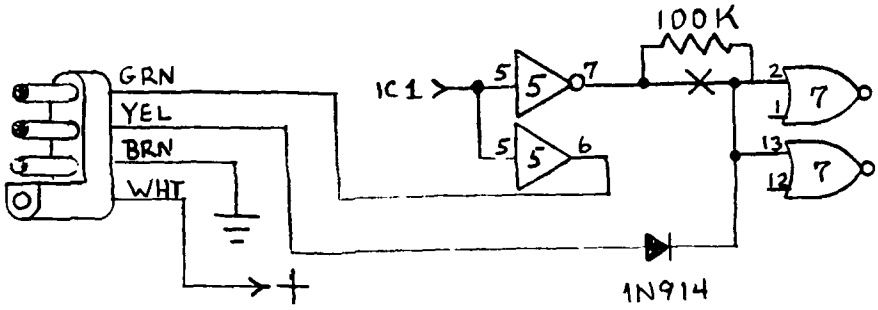
FOTOBEAM/BROOKSIDE 0232-B

CON

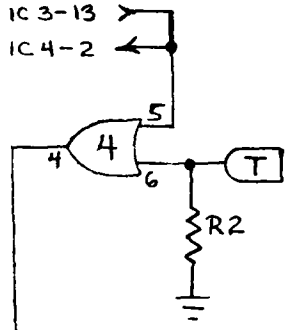
BY

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

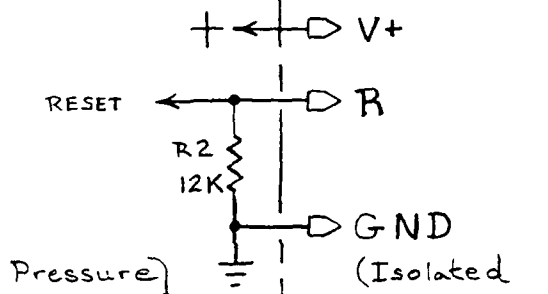


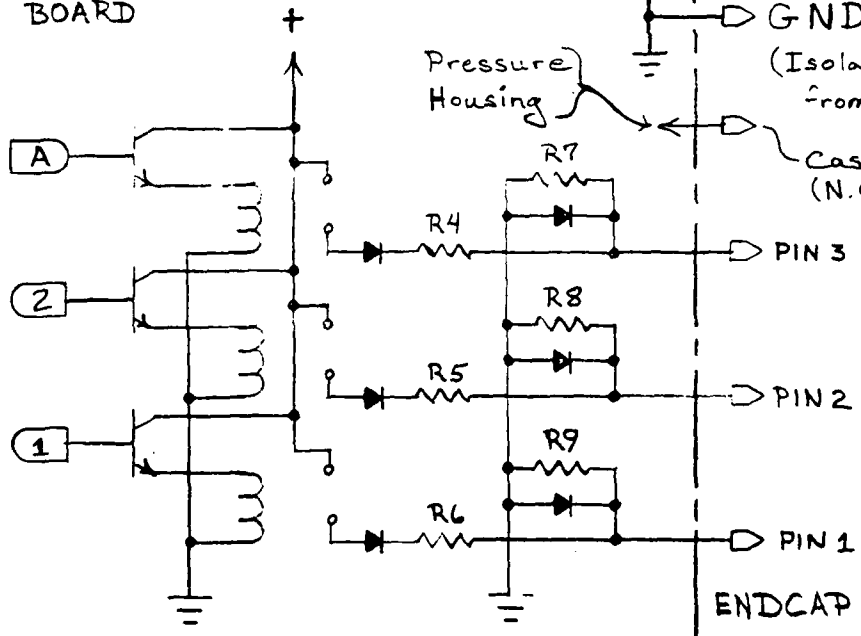


TRANSMIT/RECEIVE BOARD



TIMER BOARD



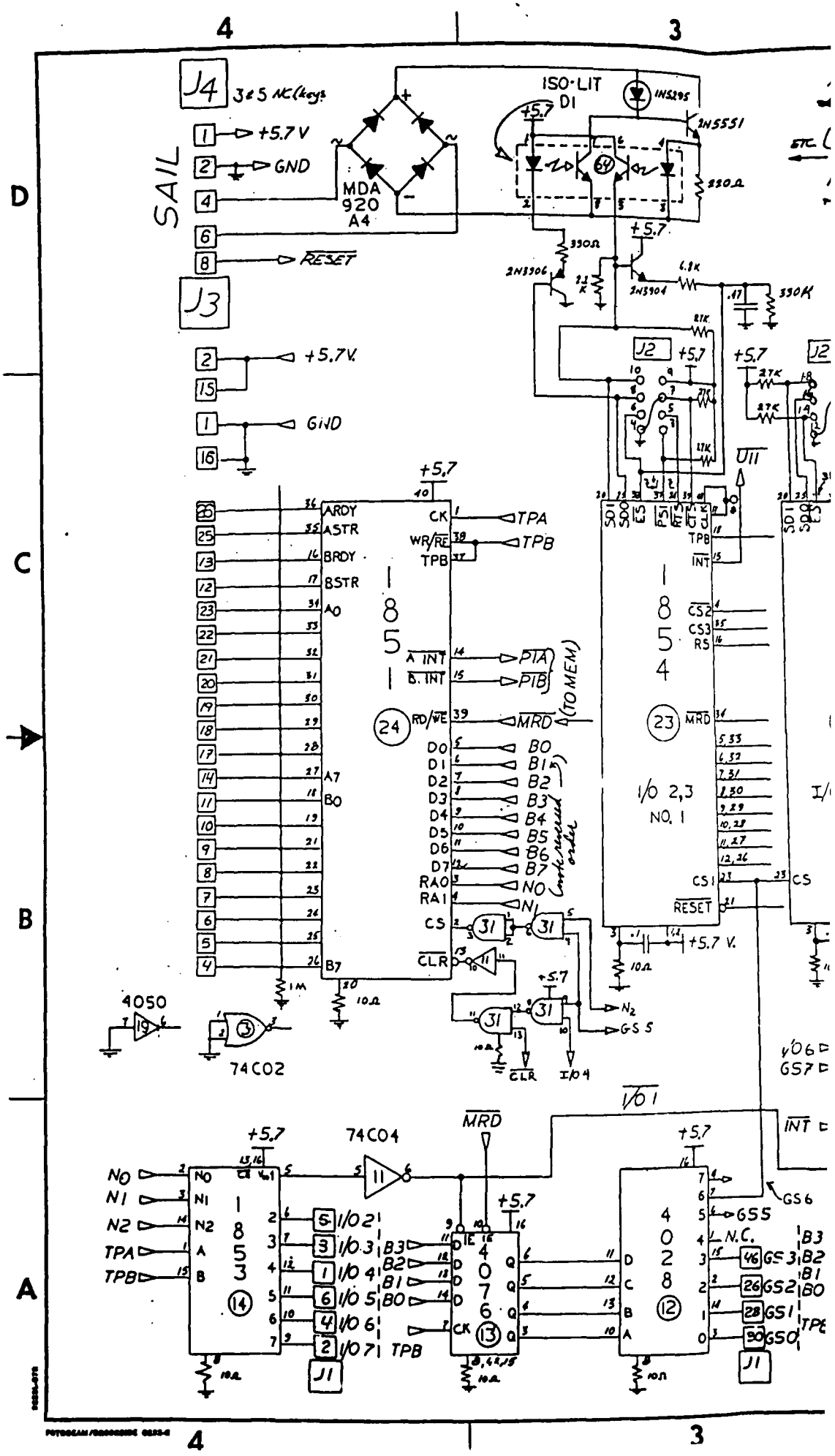


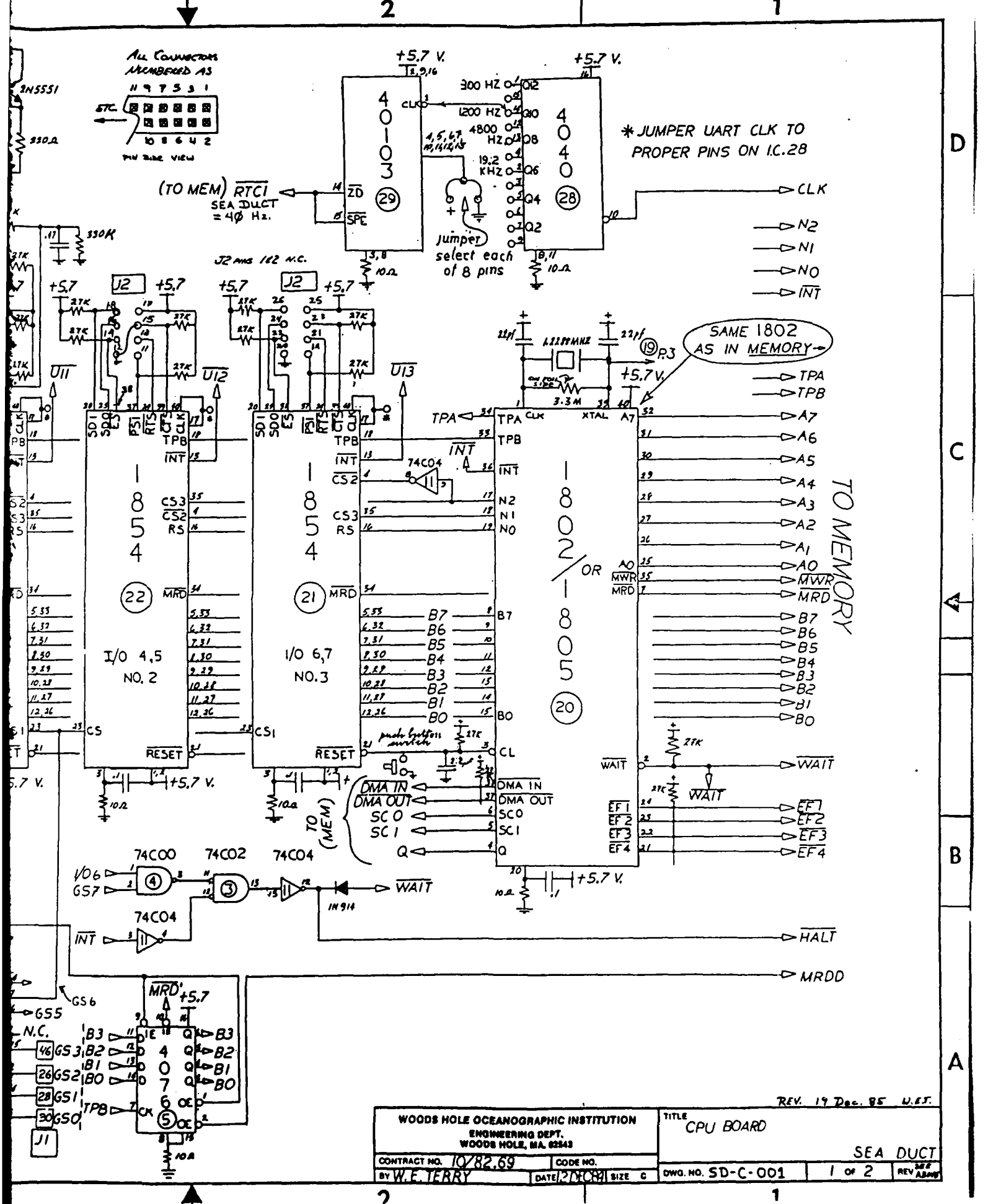
ACOUSTIC CMD. DECODER BOARD

Set for 1/10 day

ENDCAP

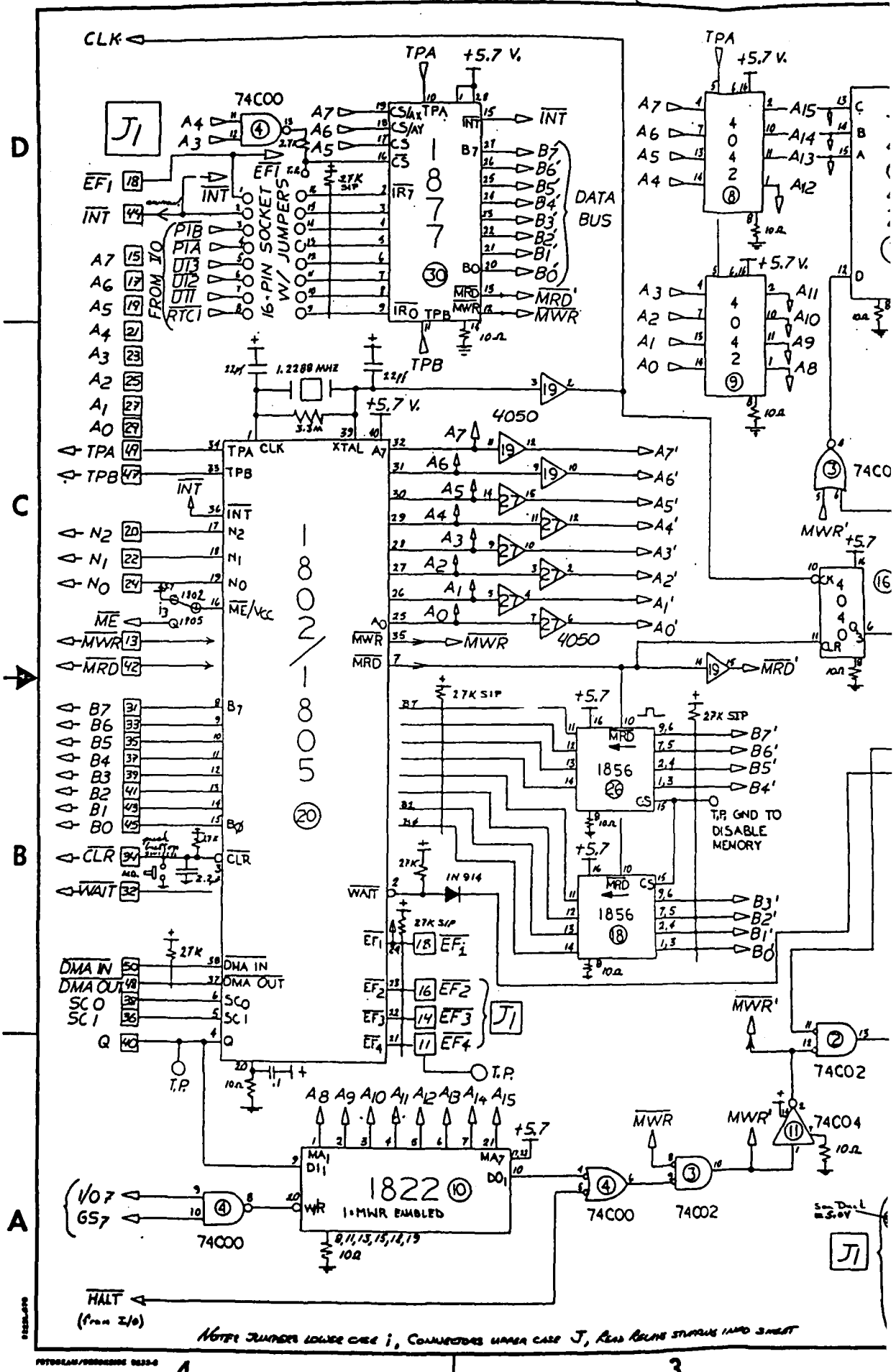
WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE O.I.S. Acoustic Command Rcvr. Modifications Sea Duct		
CONTRACT NO.	CODE NO.			
BY W. Terry	DATE 30 Dec. 84 SIZE B	DWG. NO. SD-BØ39	OF	REV.

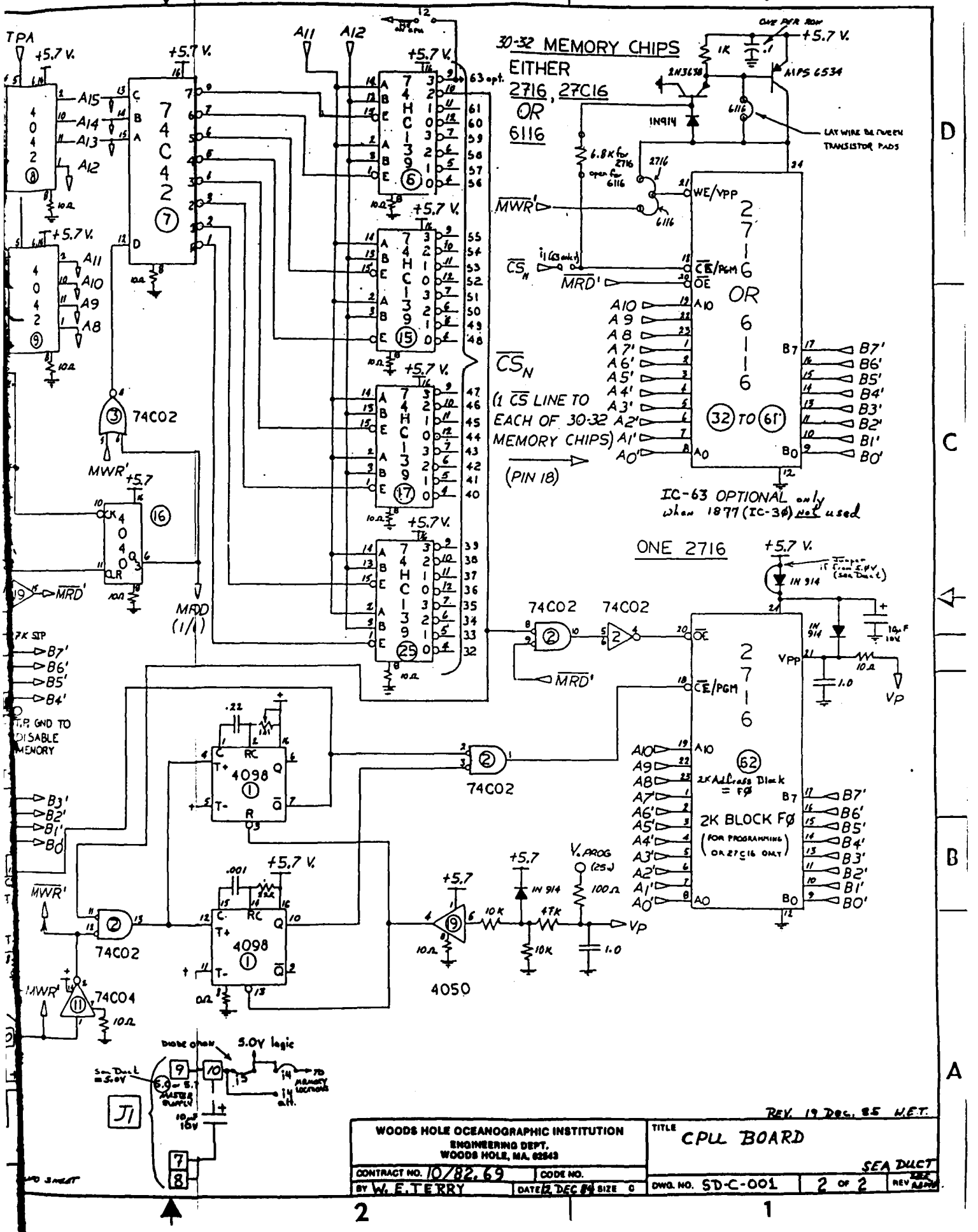

J4
3 & 5 NC (keys)
+5.7 V
GND
RESET
J3
SAIL
MDA 920 A4
ISO-LIT D1
1N5295
2N5551
330Ω
2N3906
2N3904
6.8K
.47
330K
8.2K
27K
47K
J2
U11
+5.7
+5.7 V.
GND
8154
ARDY
ASTR
BRDY
BSTR
A0
A7
B0
B7
CK
WR/RE
TPB
A INT
B. INT
PIA
PIB
RD/WE
MRD
(TO MEM)
D0
D1
D2
D3
D4
D5
D6
D7
RA0
RA1
CS
CLR
B0
B1
B2
B3
B4
B5
B6
B7
N0
N1
N2
(Continued on next)
8154
CS2
CS3
RS
I/O 2,3
NO. 1
CS1
RESET
INT
SDI
SDO
ES
PSI
RST
CLK
4050
74C02
74C04
74C153
74C42
74C86
74C76
74C02
N0
N1
N2
TPA
TPB
I/O 2
I/O 3
I/O 4
I/O 5
I/O 6
I/O 7
J1
MRD
I/O 1
INT
GS 5
GS 6
GS 7
GS 3
GS 2
GS 1
GS 0
N.C.
CLR
I/O 4
10Ω
1M
4.7K
.1
.01

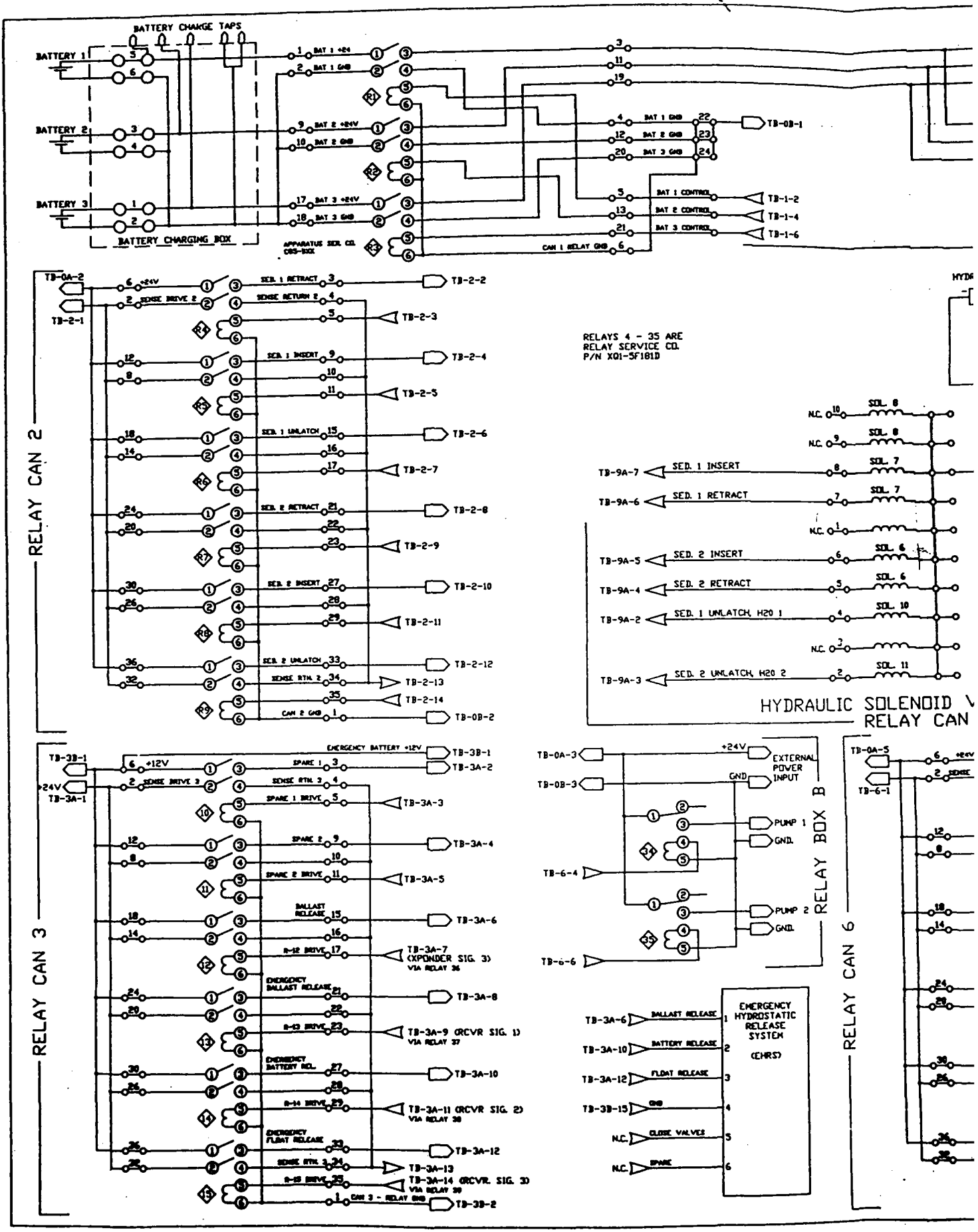


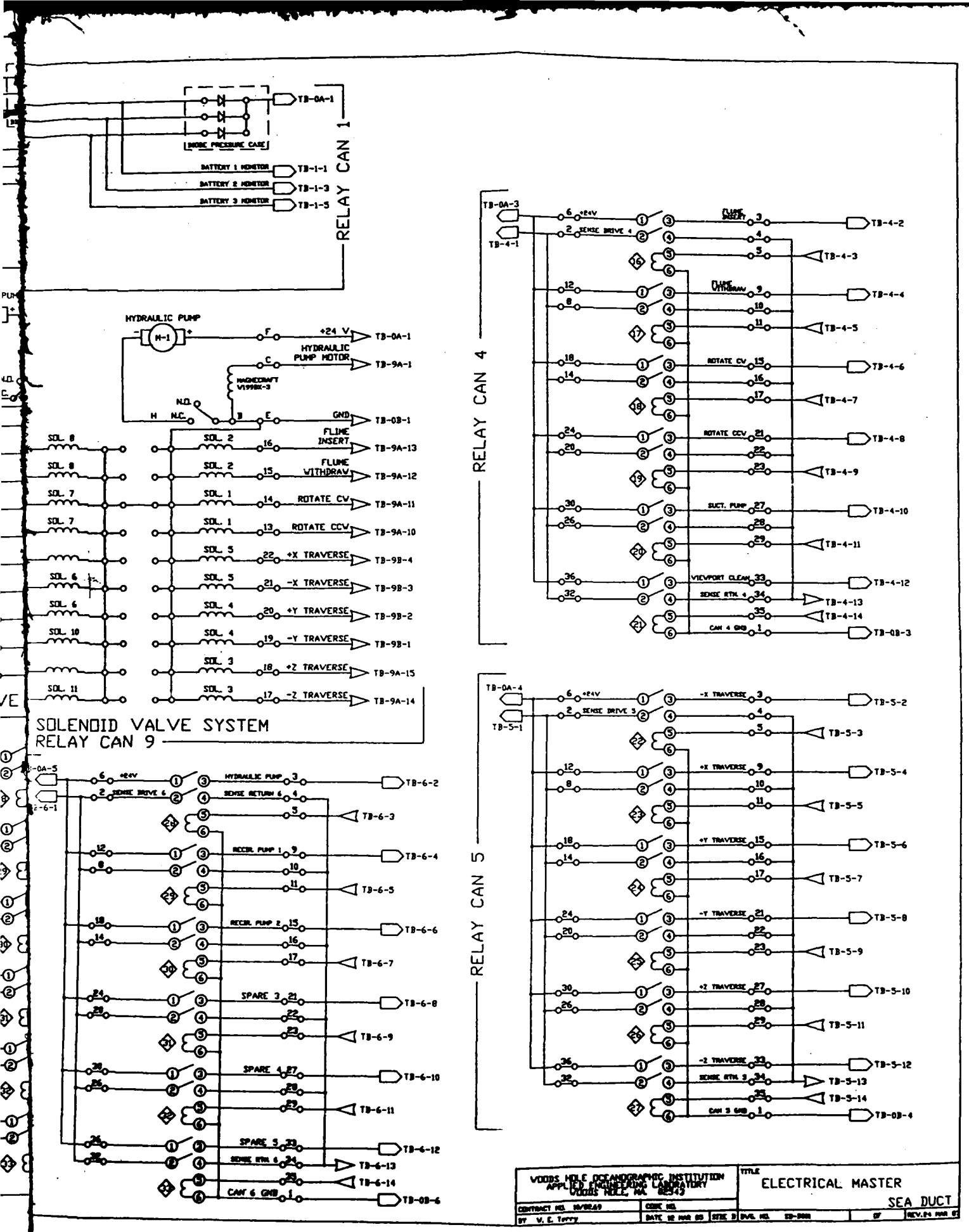
REV. 19 Dec. 85 W.E.T.

WOODS HOLE OCEANOGRAPHIC INSTITUTION ENGINEERING DEPT. WOODS HOLE, MA. 02543		TITLE CPU BOARD SEA DUCT	
CONTRACT NO. 10/82.69	CODE NO.		
BY W.E. TERRY	DATE 27 OCT 81 SIZE C	DWG. NO. SD-C-001	1 OF 2 REV SEE ABOVE


CLK
TPA
+5.7 V.
74C00
J1
A4
A3
EF1
INT
PIB
PIA
UI3
UI2
UI1
RTCI
FROM I/O
16-PIN SOCKET W/ JUMPERS
1877
DATA BUS
B7'
B6'
B5'
B4'
B3'
B2'
B1'
B0'
MRD'
MWR'
TPB
1.2288 MHz
4050
A7'
A6'
A5'
A4'
A3'
A2'
A1'
A0'
N2
N1
N0
ME
MWR
MRD
1802/1805
CLR
WAIT
DMA IN
DMA OUT
SC0
SC1
Q
T.P.
IN 914
1856
T.P. GND TO DISABLE MEMORY
74C02
74C04
74C00
74C02
74C00
1822
I=MWR ENABLED
HALT
(from I/O)
Notes: Jumper lower case i, Connectors upper case J, Pull Relay straps into sheet


30-32 MEMORY CHIPS
EITHER
2716, 27C16
OR
6116
ONE 2716
IC-63 OPTIONAL only when 1877 (IC-38) not used
$\overline{CS}_N$
(1 $\overline{CS}$ LINE TO EACH OF 30-32 MEMORY CHIPS)
(PIN 18)
MWR'
MRD'
MRD (1/1)
74C02
74C04
74C42
4050
4098
2716
6116
2K BLOCK FØ
(FOR PROGRAMMING ON 27C16 ONLY)
2K Address Block = FØ
LAY WIRE BETWEEN TRANSISTOR PADS
7K SIP
T.P. GND TO DISABLE MEMORY
V. PROG (25V)
Vp
+5.7 V.
5.0V logic
J1
WOODS HOLE OCEANOGRAPHIC INSTITUTION
ENGINEERING DEPT.
WOODS HOLE, MA. 02543
TITLE CPU BOARD
SEA DUCT
CONTRACT NO. 10/82.69
BY W. E. TERRY
DATE 12 DEC 84
SIZE C
DWG. NO. SD-C-001
2 OF 2
REV 19 Dec. 85 W.E.T.


BATTERY CHARGE TAPS
BATTERY 1
BATTERY 2
BATTERY 3
BATTERY CHARGING BOX
BAT 1 +24
BAT 1 GND
BAT 2 +24V
BAT 2 GND
BAT 3 +24V
BAT 3 GND
APPARATUS SER. CO. CBS-BOX
BAT 1 GND
BAT 2 GND
BAT 3 GND
TB-0B-1
BAT 1 CONTROL
BAT 2 CONTROL
BAT 3 CONTROL
TB-1-2
TB-1-4
TB-1-6
CAN 1 RELAY GND
RELAY CAN 2
TB-0A-2
TB-2-1
+24V
SENSE DRIVE 2
SEN. 1 RETRACT
SENSE RETURN 2
SEN. 1 INSERT
SEN. 1 UNLATCH
SEN. 2 RETRACT
SEN. 2 INSERT
SEN. 2 UNLATCH
SENSE RTN. 2
CAN 2 GND
TB-2-2
TB-2-3
TB-2-4
TB-2-5
TB-2-6
TB-2-7
TB-2-8
TB-2-9
TB-2-10
TB-2-11
TB-2-12
TB-2-13
TB-2-14
TB-0B-2
RELAYS 4 - 35 ARE
RELAY SERVICE CO.
P/N X01-5F181D
HYDRAULIC SOLENOID V
RELAY CAN
N.C.
SOL. 8
SOL. 7
SOL. 6
SOL. 10
SOL. 11
TB-9A-7
SEN. 1 INSERT
TB-9A-6
SEN. 1 RETRACT
TB-9A-5
SEN. 2 INSERT
TB-9A-4
SEN. 2 RETRACT
TB-9A-2
SEN. 1 UNLATCH, H20 1
TB-9A-3
SEN. 2 UNLATCH, H20 2
RELAY CAN 3
TB-3B-1
+24V
TB-3A-1
+12V
SENSE DRIVE 3
EMERGENCY BATTERY +12V
SPARE 1
SENSE RTN. 3
SPARE 1 DRIVE
SPARE 2
SPARE 2 DRIVE
BALLAST RELEASE
EMERGENCY BALLAST RELEASE
EMERGENCY BATTERY REL.
EMERGENCY FLOAT RELEASE
SENSE RTN. 3
CAN 3 - RELAY GND
TB-3B-1
TB-3A-2
TB-3A-3
TB-3A-4
TB-3A-5
TB-3A-6
TB-3A-7
(XPONDER SIG. 3)
VIA RELAY 36
TB-3A-8
TB-3A-9 (RCVR SIG. 1)
VIA RELAY 37
TB-3A-10
TB-3A-11 (RCVR SIG. 2)
VIA RELAY 38
TB-3A-12
TB-3A-13
TB-3A-14 (RCVR SIG. 3)
VIA RELAY 39
TB-3B-2
TB-0A-3
TB-0B-3
TB-6-4
TB-6-6
+24V
GND
EXTERNAL POWER INPUT
PUMP 1
GND
PUMP 2
GND
RELAY BOX B
TB-3A-6
BALLAST RELEASE
TB-3A-10
BATTERY RELEASE
TB-3A-12
FLOAT RELEASE
TB-3B-15
GND
N.C.
CLOSE VALVES
N.C.
SPARE
EMERGENCY HYDROSTATIC RELEASE SYSTEM
(EHRS)
TB-0A-5
TB-6-1
RELAY CAN 6


RELAY CAN 1
TB-0A-1
DIODE PRESSURE CASE
BATTERY 1 MONITOR
TB-1-1
BATTERY 2 MONITOR
TB-1-3
BATTERY 3 MONITOR
TB-1-5
HYDRAULIC PUMP
M-1
+24 V
TB-0A-1
HYDRAULIC PUMP MOTOR
TB-9A-1
MAGNECRAFT V1998K-3
N.O.
N.C.
GND
TB-0B-1
SOL. 8
SOL. 2
FLUME INSERT
TB-9A-13
FLUME WITHDRAW
TB-9A-12
SOL. 7
SOL. 1
ROTATE CW
TB-9A-11
ROTATE CCW
TB-9A-10
SOL. 5
+X TRAVERSE
TB-9B-4
SOL. 6
SOL. 4
-X TRAVERSE
TB-9B-3
+Y TRAVERSE
TB-9B-2
SOL. 10
-Y TRAVERSE
TB-9B-1
SOL. 3
+Z TRAVERSE
TB-9A-15
SOL. 11
-Z TRAVERSE
TB-9A-14
SOLENOID VALVE SYSTEM
RELAY CAN 9
RELAY CAN 4
TB-0A-3
TB-4-1
+24V
SENSE DRIVE 4
FLUME INSERT
TB-4-2
TB-4-3
FLUME WITHDRAW
TB-4-4
TB-4-5
ROTATE CW
TB-4-6
TB-4-7
ROTATE CCW
TB-4-8
TB-4-9
SUCT. PUMP
TB-4-10
TB-4-11
VIEWPORT CLEAN
TB-4-12
SENSE RTN 4
TB-4-13
TB-4-14
CAN 4 GND
TB-0B-3
RELAY CAN 5
TB-0A-4
TB-5-1
SENSE DRIVE 5
-X TRAVERSE
TB-5-2
TB-5-3
+X TRAVERSE
TB-5-4
TB-5-5
+Y TRAVERSE
TB-5-6
TB-5-7
-Y TRAVERSE
TB-5-8
TB-5-9
+Z TRAVERSE
TB-5-10
TB-5-11
-Z TRAVERSE
TB-5-12
SENSE RTN 5
TB-5-13
TB-5-14
CAN 5 GND
TB-0B-4
TB-0A-5
TB-6-1
SENSE DRIVE 6
HYDRAULIC PUMP
TB-6-2
SENSE RETURN 6
TB-6-3
RECIR. PUMP 1
TB-6-4
TB-6-5
RECIR. PUMP 2
TB-6-6
TB-6-7
SPARE 3
TB-6-8
TB-6-9
SPARE 4
TB-6-10
TB-6-11
SPARE 5
TB-6-12
SENSE RTN 6
TB-6-13
TB-6-14
CAN 6 GND
TB-0B-6
WOODS HOLE OCEANOGRAPHIC INSTITUTION
APPLIED ENGINEERING LABORATORY
WOODS HOLE, MA. 02543
TITLE
ELECTRICAL MASTER
SEA DUCT
CONTRACT NO.
CODE NO.
BY V. E. TOTTY
SIZE D
DWG. NO.
SD-0000
SHT.
REV.

APPENDIX J

Electronics Manufacturers

Apparatus Service Co.
5 Henshaw St.
Woburn, MA 01801
617-933-5999

Belden - Electronic Wire
and Cable Division
P.O. Box 1980
Richmond IN, 47375
317-983-5200

Brantner & Associates
1240 Vernon Way
El Cajon, CA 92020
619-562-7070
800-854-2552

Byrd Industries
P.O. Box 278
Industrial Park
Shelbyville, KY 40065
502-633-1338

Carrol Cable Company, Inc.
Pawtucket, RI 02862
401-728-7000

CompuPro
3506 Breakwater Court
Hayward, CA 94545
415-786-0909

Digicourse, Inc.
P.O. Box 50699
New Orleans, LA 70150
504-733-6061

Electrochem Industries
10,000 Wehrle Dr.
Clarence, NY 14031
716-759-6901

Humphrey, Inc.
9212 Balboa Ave.
San Diego, CA 92123
714-656-6631

Littlefuse, Inc.
800 E. Northwest Hwy.
Des Plains, IL 60016
312-433-2050

Litton Systems, Inc.
Encoder Divison
20745 Nordhoff St.
Chattsworth, CA 91311
213-341-6161

Magnacraft Electric Co.
1910 Techny Road
Northbrook IL 60062-5376
312-282-5500

Melcher elektronische Gerate AG
Ackerstrasse 56
Postfach
CH-8610 Uster
Switzerland
Telex 57154 MEUS CH
Telephone 01 941 37 37

Molex,Inc.
2222 Wellington Court
Lisle, Illinois 60532
312-969-4550

Micro Power Systems
3100 Alfred St.
Santa Clara, CA 95054
408-727-5350

Oceanographic Instrument Systems
Box 766
N. Falmouth, MA 02556

Optimal Technology, Inc.
Blue Wood 127
Earlysville, VA 22936

Photosea Systems, Inc.
11120 Roselle St.
San Diego, CA 92121
619-452-8903

Potter & Brumfield
P.O. Box 322
Princeton, Indiana 47671-0001
812-386-1000

Relay Service Co.
1310 North Pulaski Rd.
Chicago, Ill. 60651
312-252-2700

Sea Data Corporation
One Bridge St.
Newton, MA 02158
716-244-3203

Sea Tech, Inc.
P.O. Box 779
Corvallis, OR 97330
503-757-9716

Stevens Arnold
7 Elkins St.
South Boston, MA 02127
617-268-1170

Sinclair Manufacturing Co.
Chartley, MA. 02712
617-222-7440

Sprague Electric Co.
87 Marshall St.
North Adams, MA 02147-2484
413-664-4411

Syscon Corp.
5015 Hancock St.
San Diego, CA 92110

Teledyne - Mecca
P.O. Box 36393
Houston, Texas 77236
(713) 772-2811

WET Instrument Systems
P.O. Box 517
Woods Hole, MA 02543

Appendix K

BLT.2 Mini-Monitor Program

BLT, (Bradley-Liberatore-Terry) is an extension and modification of RCA's UT4 monitor. The only I/O used are Q and EF4*. The baud rate if fixed, and an entry at location 0000 (cold start) will give a prompt without typing CR. Some of the extended functions require a modest amount of RAM but BLT checks before using it and will refuse these functions if it can't write in the assigned area.

To install BLT:

1. Find the timing constant and write it into the PROM at M(0108).

300 Baud 1.0000 Mhz. = 14	300 Baud 1.6000 Mhz. = 18
300 Baud 1.2288 Mhz. = 1E	300 Baud 2.0000 Mhz. = 26

2. Select one page of RAM for BLT's use if you need either the subroutine call or CRC functions. BLT will use E0-FF on this page with a stack extending back from DF. The page selected is specified at M(001F).

3. BLT.2 is page relocatable and may be moved if required. Two long branches must be changed in the UT4 part. The bytes to be changed are 01 at M(00D0) and 00 at M(01FD). These are the values for the version that starts at 0000. Add to these values to move to a higher location in memory. If you need to use the $P entry method with RAMTEST (see section on modification of BLT), you may wish to change the LBR at M(0010) as well.

4. Select the user branch at bytes 0005 and 0006. If EF4* is not held low (true) on entry by an RS232 device, the monitor will jump to the user program via a LBR at 0004. This is usually set to 0800 but can be any value.

5. If the terminal you are using has a narrow screen (H.P. 85) you can shorten the memory dump line length (set to 16 bytes normally) by changing the 0F at M(009D) to 07, giving a format of 8 bytes per line.

6. If you can't use EF4*, the monitor can be switched to any other flag by changing the 37's (BF4) at M(0002), M(0153), and M(0161) and the 3F (BN4) at M(0173) and M(014D).

Features of the BLT.2 Mini-Monitor

BLT contains the !M, ?M and $P commands of UT4. Read the RCA documentation for details. Notice that, although RCA doesn't list it in the register use table, the TYPE routines use an additional scratch location. RCA selected RD.0 but this interferes with alternating calls to TYPE and READH which is occasionally useful. BLT.2 therefore substitutes R8.0 which is "scratched" by all calls to TYPE.

All the BLT added commands are accessed by typing "." (the monitor echos "...") then typing a single letter to select the command. The commands prompt the user for the necessary arguments which are usually addresses or byte counts. The argument rules are similar to those for UT4. When the monitor expects a constant, all non-hex entries are ignored except space and CR, either of which terminate the entry. (Don't use CR since the subsequent reply will overwrite the beginning of the line.) Leading zeros are provided and excess hex digits may be added to correct an entry error since only the last valid hex digits are used. Examples of valid entries are 0001, 20, 3WE5 (=35), ABC34EF2 (=4EF2).

1. .M, block move. Format, "...Move from AAAA to BBBB length CCCC ok?Y" where AAAA, BBBB, CCCC are source start address, sink start address and length to copy. If the reply to "ok?" is not "Y", no move will occur. "Move" copies from low to high address and can get into trouble if the source and sink overlap.

2. .V, Verify. Format, "...Verify AAAA with BBBB length CCCC". This command compares two blocks of memory and list the differences. The format of non equal data is AAAA BB CC DDDD where BB is the byte at AAAA and CC is the byte at DDDD and BB<>CC.

3. .C CRC calculation. Format "...CRC from AAAA over BBBB =CCCC". This calculates a 16 bit CRC check character over the block of memory starting at AAAA of length BBBB. It takes about 15 seconds to do all 65K. It is based on some European standard polynomial for generating CRC's. This command will refuse if there is no RAM in the system.

4. .S Subroutine. Format "...Subroutine AAAA DD DD X". This command invokes a SCRT call to a routine at AAAA, passes it in-line data, DDDD, and expects the subroutine to return via a D5 instruction (standard RCA call and return using R3=pc, R4=call, R5=return, R6=immediate bytes pointer and R2-stack pointer). The in-line-data is optional but will run out of buffer if longer than 28 bytes. For this one command, spaces are allowed between bytes hence the terminator "X" must be used to invoke the command. Any other non-hex entry will abort the command and return to the prompt. After the return from the user subroutine, the monitor re-initializes all it's registers so there are no restrictions on register use (other than those used by SCRT itself.) The stack is set up on the ram page starting at location DF. This command will abort if no RAM is present in the system.

5. .R Ramtest. Format "...Ram test start at AAAA over BBBB". Ramtest tests an area of RAM starting at AAAA by writing a psudo-random sequence BBBB bytes long, then checking the entire area on a second pass. It is very good at finding obscure "connected cell" errors. Every good pass causes an "*" on the terminal. Each subsequent pass uses the sequence shifted over one bit so several are required to catch all bit locations. When RAMTEST finds an error, it lists the XDR of the data it wrote and read along with the address where the error occurred.

Modifications to BLT.2

There are several attractive alternative configurations of BLT. First, if memory is at a premium, the first two pages alone can be used to give a self-starting version of UT4 which can be re-entered at 0000 with X=P=0 or 0007 with only P=0 to elicit an immediate prompt. Similarly, RAMTEST is totally contained on the third page and will work with UT4 as a 3 page package. To enter RAMTEST without the rest of the monitor, use $P10. If you use either of these truncated versions, you should delete the extended command test branch added to UT4. The easiest way to do this is to change the 3A (BNZ) at M(001C) to 30 (BR).

It's easy to add more functions to BLT.2 as well. Study the code at 0592-059A then add more tests by changing the jump at 059A. Notice that the letter entered as a response to the "..." extended prompt is stored at RF.1 and that the "no match" return is through 0522. Notice also that P=R4 at this time. If your routine is used, return through the "warm start" location, 0007, with P=0 to re-initialize the registers required for the monitor's use. There is a small text handling subroutine included with BLT (called QTTY) that runs in R5 and starts at 04A1 which may be handy if you need some prompting for your extension. Read the source file for details. Remember the bit about all TYPE calls (QTTY calls TYPE) scratching R8.0.

RCA Format listing for BLT2

```
!M ;
0000 7100 3707 C008 06F8 02BE 2E9E 3A0A 3029;     User Branch
0010 C002 F6FF FFFF FFFF FFFF FB11 3A42 F857;     LBR for Ram Test
0020 B295 FC03 B4F8 06A4 D490 B5B3 F830 A5D5;     Ram page select
0030 E571 55C4 C4F8 FEA3 D3F8 9CA3 D30D D30A;          Sea Duct = 57
0040 D32B F800 ADBD F83B A3D3 FB24 32D6 FB05;
0050 A1CE FB1E 3A1A D3FB 4D3A CAD3 3B5B D333;
0060 5EFB 203A CA9D B08D A081 32B4 F800 ADBD;
0070 D333 70FB 0D3A CAF8 9CA3 8DA1 9DB1 D30A;
0080 90BF F8AE A3D3 80BF F8AE A3D3 D320 40BF;
0090 F8AE A3D3 2181 3A9B 9132 3980 FA0F 3AA6;     ?M line length
00A0 D33B D30D 307E F633 8E30 8CD3 3BAB D33B;          0F=16 Bytes
00B0 CA8D 5010 D333 AEFB 0D32 39FB 2132 ABFB;          07=08 Bytes
00C0 173A B4D3 FB0D 3AC3 305B F89C A3D3 0DC0;
00D0 01F8 0000 0000 D3FB 503A CAD3 33DB FB0D;     Page dependent
00E0 3ACA 9DB0 8DA0 F89C A3D3 0AE5 7100 D39E;     $P exit
00F0 F6AE 2E43 FF01 3AF4 8E32 EE23 30F2 93BC;
0100 F800 AEAF F8EF ACF8 18BE F839 A530 2EFF;     Baud Rate Select
0110 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF;
0120 FFFF FFFF FFFF FFFF FFFF FFFF FFFF D5FC;
0130 0733 37FC 0A33 87FC 009F D5F8 0038 83C8;
0140 F801 AFF8 80BF E38F F63B 4D38 803F 4D37;     BF4, BN4
0150 4FDC 0237 4F8F F63B 5B38 40E2 C49E F633;
0160 6837 667B 3068 7AC4 DC07 C4C4 9FF6 BF33;
0170 78F9 803F 5BBF 305D 7A32 438F 3A39 9FFF;
0180 413B 2FFF 0633 37FE FEFE FEFC 08FE AE8D;
0190 7EAD 9D7E BD8E FE3A 8E30 3900 DC17 38D5;
01A0 4538 4638 9FAE FB0A 3ABF F88B 30C1 9FF6;
01B0 F6F6 F6FC F63B B9FC 07FF C6AE F81B C8F8;
01C0 0BAF 7B8E A8DC 072F F588 76A8 33D1 7B30;     R8.0 scratched by 'type'
01D0 D37A C48F FA0F C4C4 3AC5 8FFC FBAF 3B9F;
01E0 FF1B 329F 3BEA F800 30F5 9FFA 0FFC F63B;
01F0 F3FC 07FF C6AE 30C2 D30A D33F C000 3947;     Page Dependent
-------------------------------------------------------------------
0200 90B5 F8BB A5D5 0000 0000 0000 0000 0061;     Ram Test Routine
0210 6D20 7465 7374 2073 7461 7274 2061 7420;      * Page independent
0220 9DFF 9DBB 8DAB D56F 7665 7220 9DFF C4C4;      * Enter $P 2F6 from UT4
0230 97B8 9BB9 8BA9 9DBA 8DAA F898 A5D5 98C4;      * Enter ...R from BLT2
0240 5919 2A8A 3A3D 9A3A 3DC4 97B8 9BB9 8BA9;
0250 9DBA 8DAA D5E9 98F3 3A70 192A 8A3A 549A;
0260 3A54 97B8 D598 B7F8 BBA5 D52A FF30 30FF;
0270 A8F8 BBA5 D50D 0A00 0000 0000 FF88 BFD5;
0280 8120 6174 20FF 99BF D581 FF89 BFD5 81FF;
0290 F898 A530 5AFF FFD0 F800 A898 3AA1 F8FF;
02A0 B8F6 3BA5 18F6 F63B AA18 F63B AE18 F63B;
02B0 B218 88F6 9876 B830 97FF D040 A7FA 803A;
02C0 C9F8 A4A3 87BF D330 BB87 FBFF 32BA 87FB;
02D0 813A D8F8 AEA3 30C6 87FB 9D3A C130 EDFF;
02E0 D39F FB20 3AE0 F89C A3D3 2030 BBF8 00AD;
02F0 BDF8 3BA3 30E0 F810 BA2A 9A3A F930 002F;     Ram Test entry point
-------------------------------------------------------------------
                                                  BLT additions to UT4
```

```
0300 B4FF FFFF FFFF 94FC 01B5 F8A1 A5C4 D5DD;
0310 2E2E 9ADD 00C4 9FFB 4D32 30FB 0E32 70C4;
0320 FB15 32C2 30FE 94FF 03B0 F807 A0E0 D0FF;
0330 D5DD 6F76 6520 6672 6F6D 209D 00C8 FFFF;
0340 9DBA 8DAA D574 6F20 9D00 9DBB 8DAB D56C;
0350 656E 6774 6820 9D6F 6B3F 9A00 9FFB 59C4;
0360 3A26 4A5B 1B2D 9D3A 628D 3A62 30EA FFFF;
0370 D5DD 7263 2066 726F 6D20 9D00 9DBA 8DAA;
0380 FFFF D56F 7665 7220 9D00 F8E2 A2F8 6DA5;
0390 D533 26F8 00BB 7352 FFFF 0AFB FFCE BBC4;
03A0 D52D 9D3A 9A8D 3A9A F8A1 A59B 32B9 92BD;
03B0 82AD D53D 8D8D 0030 26D5 436C 6561 7200;
03C0 3026 D5DD 6572 6966 7920 9D00 9DBA 8DAA;
03D0 D5DD 7769 7468 209D 009D BB8D ABD5 DD6C;
03E0 656E 6774 6820 9D00 30FF D5DD 0700 3026;
03F0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF 38C8;
0400 30FE 9D3A 148D 3A14 D5DD 2064 6F6E 6500;
0410 3022 FFFF EB0A F33A 261A 1B2D 3002 FFFF;
0420 FFFF 94FF 01B4 D50D 0A00 F84B A5FC 009A;
0430 D58A D5F6 D50A D5F6 D50B D5F6 D59B D58B;
0440 D5F8 A1A5 3019 FFF8 02F6 D433 54BF F8AE;
0450 A3D3 3047 F820 BFF8 A430 50FF FFFF FFFF;
0460 FFFF FFFF FFFF FFFF FFFF FFFF FFF8 7352;
0470 E2F3 3277 FF00 C8FC 00D4 E24A F322 52F6;
0480 F6F6 F6F3 52FE FEFE FE60 60F3 2273 72F6;
0490 F6F6 F373 F0FE FEFE FEFE F360 6073 3079;
04A0 D404 3AA7 1430 A0FB 8A3A B4F8 A4A3 D314;
04B0 30A1 FFFF FB07 3AC0 4DBF F8AE A330 AEFF;
04C0 FB02 3AD0 30BA FB40 32EC FBDD BF30 ABFF;
04D0 FB15 3ADA F83E A330 AEFF FB07 3AC6 F800;
04E0 BDAD F83B A3D3 9FFB 203A E5C4 9EFE FEAE;
04F0 8E32 AF2E C430 F0FF FFFF FFFF FFFF 38C8;
0500 3092 FFFF FFFF D5DD 7562 726F 7574 696E;
0510 6520 00C4 F86D A5D5 3322 94B5 F87C A5C4;
0520 3028 94FF 02B4 FFFF F8E0 A2F8 D452 12D5;
0530 9FFB 583A 22F8 D552 C4C4 F8DF A294 B6C4;
0540 F870 A692 B3F8 E0A3 94B5 F861 A5C8 FFFF;
0550 D3E2 8673 9673 93B6 83A6 46B3 46A3 3050;
0560 D396 B386 A3E2 1272 B6F0 A630 60FF FFFF;
0570 93FF 05B0 F807 A0E3 7100 FFD4 F83B A3D3;
0580 3B8A D33B 8A8D 5212 307F 9FFB 2032 7C30;
0590 7BFF 9FFB 5332 06FB 013A 2294 FF03 B0C4;
05A0 F8F6 A0E0 D0FF FFFF FFFF FFFF FFFF FFFF;
05B0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF;
05C0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF;
05D0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF;
05E0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF;
05F0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
```

Locations 0600 - 07FF are also empty.

Appendix L

BTU Monitor Program Listing

The BTU Monitor program runs automatically when the CPU is reset. A description of this monitor may be found in the software section.

```
                                ;
                                ;SAIL BASIC MONITOR PROGRAM
                                ;
                                ;
                                        SUBTTL  BTU SAIL MONITOR        20 FEB 1986     BTU2.MAC
                                ;
                                ;       PREVIOUS VERSION:       13 FEB 1985     BTU2.MAC
                                ;
                                ;*******************************************************************************
                                ;
                                ;SEA DUCT VERSION  - Easily adaptable for other 1805A/6A SAIL systems
                                ;
                                ;*** UNLOCKED SYSTEM VERSION !!! ***
                                ;
                                ;*** DOES NOT USE INTERRUPTS !!! ***
                                ;
                        C               INCLUDE I1806A   ;include file for 1806A opcodes
                        C       ;       I1806A.MAC - Macro Definitions for RCA 1805A/6A Opcodes
                        C       ;
                        C       ;
                        C       ;       20 FEB 1986
                        C       ;       W. E. TERRY
                        C       ;
                        C       ;       (LISTING SUPRESSED)
                        C       ;
                        C       ;       With some Level II codes
                        C       ;
                        C               .LIST
                                ;
                                ;       FOR RCA 1805A/6A
                                ;
                                ;       W. E. TERRY
                                ;
                                ;
                                ;*************************** REGISTER ALLOCATION ******************************
                                ;
                                ;               ******* SAIL *******
                                ;
0000                            DMA     EQU 0   ;DMA IN/OUT     -       ALSO START
0001                            INTPC   EQU 1   ;INTERRUPT PROGRAM COUNTER
0002                            STACK   EQU 2   ;UTILITY STACK
0003                            PC      EQU 3   ;MAIN PROGRAM COUNTER
                                ;           4   ;SCRT CALL
                                ;           5   ;SCRT RETURN
0006                            RTNPTR  EQU 6   ;POINTER FOR RETURN & IMMEDIATE BYTES
0006                            LIST    EQU 6   ;       "       "       "       "
0007                            GPAGE   EQU 7   ;GLOBAL PAGE            S.0 & R.0
0008                            CYCCNT  EQU 8   ;REAL TIME CLOCK CYCLE COUNT
                                ;
                                ;
                                ;****************************** I/O SELECT ************************************
                                ;
0001                            GROUP   EQU 01  ; SELECT = OUT 01
                                ;               ; READ = INP 01
```

```
                                ;
                                ;
                                ; ******** GROUP 6 - UARTS ********
                                ;
0006                            UARTS   EQU 06  ; UART GROUP
0012                            FORMT1  EQU 12H ; 7 DATA BITS, 1 STOP BIT, EVEN PARITY
                                ;
                                ;
                                ; (INPUT)
                                ;
0002                            DATA1   EQU 02  ; LEVEL 1 SAIL UART
0003                            STAT1   EQU 03  ; LEVEL 1 SAIL UART
0004                            DATA2   EQU 04  ; LEVEL 2 SAIL UART
0005                            STAT2   EQU 05  ; LEVEL 2 SAIL UART
0006                            DATA3   EQU 06  ; NOT USED
0007                            STAT3   EQU 07  ; NOT USED
                                ;
                                ; ( OUTPUT )
0003                            CTRL1   EQU 03  ; LEVEL 01 SAIL UART CONTROL
0005                            CTRL2   EQU 05  ; LEVEL 02 SAIL UART CONTROL
0007                            CTRL3   EQU 07  ; NOT USED
                                ;
                                ;
                                ; ******** GROUP 7 ********
                                ;
0007                            SYSTEM  EQU 07
                                ;
                                ; ( INPUT )
                                ;
                                ; ( OUTPUT )
                                ;
0006                            HALT    EQU 06  ; SUICIDE FUNCTION
0007                            MEMORY  EQU 07  ; MEMORY PAGE PROTECT OR ENABLE
                                ;
                                ; ******************************************
                                ;
                                ;       Q = UT4 (BLT.2)
                                ;       INTERRUPT PULSE
                                ;       MEM. PROTECT
                                ;
                                ; EF1 =
                                ; EF2 =
                                ; EF3 =
                                ; EF4 =
                                ;
                                ;*************** DEFINITIONS ****************
                                ;
                                ;*** SAIL PROM LOCATIONS - 2716'S ***
                                ;
0000                            BTU     EQU 00H         ;*** BTU MONITOR PROM BASE PAGE ***
0008                            PROM1   EQU 08H         ;*** TARGET PROGRAM BASE PAGE ***
                                ;
                                ;************* PAGE REFERENCES ***************
                                ;
0056                            GLOPG   EQU 056H        ;*** BTU2 GLOBAL PAGE ***
0057                            STKPG   EQU 057H        ;*** BTU STACK BASE PAGE ***
```

```
                                ;
                                ;
                                ;       SEA DUCT GLOBAL PAGE = 5000
                                ;       SEA DUCT STACK PAGE = 5300
                                ;       SEA DUCT SEQUENCER STACK PAGE = 5200
                                ;
                                ;       BLT.2 MONITOR STACK PAGE = 5700
                                ;       STACK END = 57FF
                                ;
                                ;
                                ;*** OTHER REFERENCES ***
                                ;
57DF                            STKEND  EQU (STKPG * 100H) + 0DFH       ;*** STACK END = STKPG+DF
                                ;
                                ;
                                ;*** SAIL FLAGS, ETC. ***
                                ;
5600                            GP      EQU (GLOPG * 100H)
                                ;
5602                            PLEVEL  EQU (GP + 02H)  ; PASS THRU LEVEL
5603                            SYSFLG  EQU (GP + 03H)  ; <ADDR:WRITE:SYS:      ::      :       :       :8>
5605                            CRCRAM  EQU (GP + 05H)  ; CRC CALC. SCRATCH
5606                            CRCHI   EQU (GP + 06H)  ; CRC HI BYTE RESULT
5607                            CRCLO   EQU (GP + 07H)  ; CRC LO BYTE RESULT
5608                            RBHI    EQU (GP + 08H)  ; RB.1 SAVE FROM LAST INTERRUPT
5609                            RBLO    EQU (GP + 09H)  ; RB.0 SAVE FROM LAST INTERRUPT
560A                            GRPSAV  EQU (GP + 0AH)  ; CURRENT I/O GROUP (OUTSIDE INTERRUPT)
                                ;
56FE                            IOLOC   EQU (GP +0FEH)  ; I/O BYTE
                                ;
0003                            ETX     EQU 03H         ;ASCII ETX = 03
00FF                            DONE    EQU 0FFH        ;USED BY TTY CALLS
                                ;
081F                            TARADR  EQU 081FH       ;TARGET SYSTEM ADDRESS - USED BY .R
                                ;
003B                            PMTCHR  EQU ';' ; PROMPT CHARACTER = :
                                ;       2 BIT DLY ROUTINE
                                ;       SAIL ADDRESS AND REPLY
                                ;       DLY 250 ( 250 mSEC DLY)
                                ;       DLY 20  ( INITIAL SETUP DLY)
                                ;
                                ;*******************************************************************************
                                ;
                                ;************************** PROGRAM BEGINS HERE ********************************
                                ;
                                ;
0000'                           HDSTRT: ORG (BTU * 100H)
0000'  71                               DIS
0001'  00                               DB 00           ; DISABLE INTERRUPTS
0002'  30 07'                           BR SETSL
0004'  FFFF                             DW 0FFFFH
0006'  FF                               DB 0FFH
0007'  90                       SETSL:  GHI R0
0008'  B3                              PHI PC          ; SET PC TO STARTING ADDRESS
0009'  F8 0E'                           LDI LOW(START1)
000B'  A3                               PLO PC
```

```
  169     000C'   30 56'                BR SCRTST       ; BRANCH TO SCRT SET UP
  170                                 ;
  171     000E'   F8 01               START1: LDI 01
  172     0010'   AB                          PLO RB
  173     0011'   F8 00                       LDI 00
  174     0013'   AE                          PLO RE
  175     0014'   F8 FF                       LDI 0FFH
  176     0016'   AC                          PLO RC
  177                                 ;
  178     0017'   B3                  MENAB:  SEX PC          ;SELECT SYSTEM I/O GROUP
  179     0018'   61                          OUT GROUP
  180     0019'   07                          DB SYSTEM
  181                                 ;
  182     001A'   EE                          SEX RE
  183     001B'   8C                  NEWPG:  GLO RC
  184     001C'   32 3A'                      BZ FINIS
  185     001E'   9E                          GHI RE          ;ALWAYS ENABLE:
  186     001F'   FB 57                       XRI STKPG       ;       STACKPAGE
  187     0021'   32 2D'                      BZ SETQ1
  188     0023'   9E                          GHI RE
  189     0024'   FB 56                       XRI GLOPG       ;       GLOBAL PAGE
  190     0026'   32 2D'                      BZ SETQ1
  191     0028'   8B                          GLO RB
  192     0029'   3A 2D'                      BNZ SETQ1       ;PROTECT OR ENABLE ?
  193     002B'   7A                          REQ             ;       PROTECT -> Q = 0
  194     002C'   38                          SKP
  195     002D'   7B                  SETQ1:  SEQ             ;       ENABLE  -> Q = 1
  196     002E'   67                          OUT MEMORY      ;I/O = MEM. PROTECT
  197     002F'   7A                          REQ
  198     0030'   9E                          GHI RE
  199     0031'   FC 01                       ADI 01
  200     0033'   BE                          PHI RE
  201     0034'   8C                          GLO RC
  202     0035'   FF 01                       SMI 01
  203     0037'   AC                          PLO RC
  204     0038'   30 1B'                      BR NEWPG
  205                                 ;
  206     003A'   E3                  FINIS:  SEX PC
  207     003B'   61                          OUT GROUP
  208     003C'   06                          DB UARTS
  209                                 ;
  210                                 ;
  211     003D'   F8 56               SETUP:  LDI GLOPG       ; GLOBAL PAGE SETUP
  212     003F'   B7                          PHI GPAGE       ; SETS R7.1 TO GLOPG
  213                                 ;
  214                                 ;
  215                                 ; NO MEMORY IS CLEARED IN CASE WE WOULD LIKE TO SEE WHAT FORCED
  216                                 ;       US TO RESET THE SYSTEM
  217                                 ;
  218                                 ;
  219                                 ;
  220                                 ; *** THIS SPACE MAY BE USED FOR FURTHER SETUP ROUTINES ***
  221                                 ;
  222                                 ;
  223                                 ;
  224     0040'   F8 20               DLY00:  LDI 20H
```

```
                                        PHI RE          ; 20 = ARBITRARY DELAY WHICH
0042'  BE                       WAIT:   DEC RE          ;   INSURES UART WILL RESET
0043'  2E                               GHI RE
0044'  9E                               BNZ WAIT
0045'  3A 43'                   ;
                                ;
                                SETURT: LDI LOW GRPSAV  ; SELECT UART I/O GROUP
0047'  F8 0A                            PLO GPAGE       ; AND STORE ON GLOBAL PAGE
0049'  A7                               LDI LOW UARTS
004A'  F8 06                            STR GPAGE
004C'  57                               SEX GPAGE
004D'  E7                               OUT GROUP
004E'  61                               SEX PC
004F'  E3                               OUT CTRL1       ; SET UART1 AS SHOWN IN THE I/O GROUP
0050'  63                               DB FORMT1       ; ALLOCATION SETUP
0051'  12                       ;
                                        SEX PC
0052'  E3                               LBR UNADDR      ; GO TO UNADDRESS
0053'  C0 0084'                 ;
                                ;
                                ;*******************************************************************************
                                ;
                                ;********************** STANDARD CALL AND RETURN ********************************
                                ;
0056'  90                       SCRTST: GHI R0          ; GET PROM #1 BASE PAGE
0057'  B4                       SCRT:   PHI R4
0058'  B5                               PHI R5          ; AND PUT IN R4.1 & R5.1
0059'  F8 57                            LDI LOW STKPG
005B'  B2                               PHI STACK       ; PUT STACK LOCATION IN R2
005C'  F8 DF                            LDI LOW STKEND
005E'  A2                               PLO STACK
005F'  F8 66'                           LDI LOW CALL
0061'  A4                               PLO R4          ; SET UP SCAL RTNPTR
0062'  F8 76'                           LDI LOW(RTN)
0064'  A5                               PLO R5          ; AND RETURN
                                ;
                                ; *** STANANDARD CALL ***
                                ;
0065'  D3                       CTOP:   SEP PC
0066'  E2                       CALL:   SEX STACK
0067'  36                               GLO RTNPTR
0068'  73                               STXD
0069'  96                               GHI RTNPTR
006A'  73                               STXD
006B'  93                               GHI PC
006C'  B6                               PHI RTNPTR
006D'  83                               GLO PC
006E'  A6                               PLO RTNPTR
006F'  46                               LDA RTNPTR
0070'  B3                               PHI PC
0071'  46                               LDA RTNPTR
0072'  A3                               PLO PC
0073'  30 65'                           BR CTOP
                                ;
                                ; *** STANDARD RETURN ***
                                ;
```

```
 281  0075'  D3                  RTOP:   SEP PC          ; SET P = PROGRAM COUNTER
 282  0076'  96                  RTN:    GHI RTNPTR
 283  0077'  B3                          PHI PC          ; RETURN ROUTINE
 284  0078'  86                          GLO RTNPTR
 285  0079'  A3                          PLO PC
 286  007A'  E2                          SEX STACK
 287  007B'  12                          INC STACK
 288  007C'  72                          LDXA
 289  007D'  B6                          PHI RTNPTR
 290  007E'  F0                          LDX
 291  007F'  A6                          PLO RTNPTR
 292  0080'  30 75'                      BR RTOP
 293                                 ;
 294                                 ;*******************************************************************************
 295                                 ;
 296                                 ;************************** I / O ERROR RECOVER ********************************
 297                                 ;
 298  0082'  32 85'               IOERR:  BZ READDR
 299                                 ;
 300                                 ;
 301  0084'  C4                   UNADDR: NOP
 302  0085'  F8 03                READDR: LDI LOW SYSFLG  ; FORCE OPEN SYSTEM
 303  0087'  A7                          PLO GPAGE
 304  0088'  F8 E0                       LDI 0E0H
 305  008A'  57                          STR GPAGE
 306                                 ;
 307  008B'  F8 DF                       LDI LOW STKEND
 308  008D'  A2                          PLO STACK       ; RESET STACK
 309                                 ;
 310                                 ;******************************** PROMPT ***************************************
 311                                 ;
 312                                 ;
 313  008E'                          PROMPT: CALL TSRE?      ;(TRANS. SER. REG. EMPTY)
 314  008E'  D4            +
 315  008F'  023A'         +
 316                                         CALL TTY        ;TYPE:
 317  0091'  D4            +
 318  0092'  013D'         +
 319  0094'  CA                              DB 0CAH
 320  0095'  3B                              DB PMTCHR
 321  0096'  03                              DB 003H
 322  0097'  FF                              DB 0FFH         ;       CR, LF, NULL X6,
 323                                         CALL TSRE?      ;       PROMPT CHAR., ETX
 324  0098'  D4            +
 325  0099'  023A'         +
 326  009B'  C0 009E'                        LBR BR1ST       ; GO TO FIRST BRANCH
 327                                 ;
 328                                 ;
 329                                 ;************************** FIRST BRANCH *************************************
 330                                 ;
 331                                 ;
 332  009E'                          BR1ST:  CALL ITB        ; TEST FOR:     ; ADD OR DELETE
 333  009E'  D4            +
 334  009F'  0180'         +
 335  00A1'  3F                              DB '?'          ; ? GROUP       ;       AS NECESSARY
 336  00A2'  00C7'                           DW QUESGR                       ;       FOR YOUR SYSTEM
```

```
00A4' 21                        DB '!'          ; ! GROUP
00A5' 00D4'                     DW BANGGR
00A7' 24                        DB '$'          ; $ GROUP
00A8' 0427'                     DW TEST$
00AA' 48                        DB 'H'           ; HELP FILE
00AB' 04E0'                     DW HELP
00AD' 4D                        DB 'M'          ; MEMORY PROTECT
00AE' 0598'                     DW MEMSAV
00B0' 2E                        DB '.'          ; DOT COMMAND EXTENSION
00B1' 00B7'                     DW DOTGR
00B3' FF                        DB 0FFH         ;DONE           ; EXPANSION CAN BE
00B4' C0 008E'                  LBR PROMPT                      ;       ADDED HERE
                        ;
                        ;
                        ;****************************** DOT GROUP ***************************************
                        ;
00B7'                   DOTGR:  CALL ITB
00B7' D4            +
00B8' 0180'         +
00BA' 4D                        DB 'M'          ; .MOVE
00BB' 0336'                     DW MOVE
00BD' 56                        DB 'V'          ; .VERIFY
00BE' 037B'                     DW VERFY
00C0' 52                        DB 'R'          ; .RAMTEST
00C1' 0642'                     DW RAMTST
00C3' FF                        DB 0FFH
00C4' C0 008E'                  LBR PROMPT
                        ;
                        ;
                        ;****************************** ? GROUP ***************************************
                        ;
                        ;
00C7'                   QUESGR: CALL ITB        ; LOOK FOR:
00C7' D4            +
00C8' 0180'         +
                                                        ; ADD OR DELETE
00CA' 4D                        DB 'M'                  ; AS NECESSARY
00CB' 025D'                     DW QUESTM       ; ? M
00CD' 43                        DB 'C'
00CE' 0453'                     DW CRC          ; ? CRC
00D0' FF                        DB 0FFH         ; DONE          ; EXPANSION CAN BE
00D1' C0 008E'                  LBR PROMPT                      ; ADDED HERE
                        ;
                        ;
                        ;****************************** ! GROUP ***************************************
                        ;
                        ;
00D4'                   BANGGR: CALL ITB        ; LOOK FOR:
00D4' D4            +
00D5' 0180'         +
00D7' 4D                        DB 'M'
00D8' 02B7'                     DW WRITEM       ; ! MEMORY
00DA' 52                        DB 'R'
00DB' 03F5'                     DW RUN          ; ! Run target system
00DD' FF                        DB 0FFH         ; DONE          ; EXPANSION CAN BE
00DE' C0 008E'                  LBR PROMPT                      ;       ADDED HERE
```

```
                                        ;
                                        ;
                                        ;************************ SAIL IN CHARACTER ***********************************
                                        ;
00E1'  6B                               INCHAR: INP STAT1
00E2'  F6                                       SHR             ; CHECK FOR DA (DATA AVAILABLE)
00E3'  3B E1'                                   BNF INCHAR      ; IF NOT TRY CLRBIT
00E5'  FA 06                                    ANI 06H         ; MASK FOR:
00E7'  32 ED'                                   BZ KEEP2        ;       FRAME AND PARITY ERROR
00E9'  6A                                       INP DATA1       ; CLEAR BAD DATA
                                        ;
                                        ;*****
00EA'  C0 0082'                                 LBR IOERR  ;****** USUALLY "BR INCHAR"
                                        ;       BR INCHAR  ;IS USED HERE ***************
                                        ;*****
                                        ;
00ED'  F8 FE                            KEEP2:  LDI LOW IOLOC   ; PUT GOOD DATA AT GP = I/O LOCATION
00EF'  A7                                       PLO GPAGE
00F0'  E7                                       SEX GPAGE
00F1'  6A                                       INP DATA1
00F2'  FA 7F                                    ANI 07FH        ; CLEAR MSB
00F4'  57                                       STR GPAGE       ; STORE AT GP I/O LOCATION
00F5'  FB 23                                    XRI '#'         ; IS IT '#' ?
00F7'  C2 0082'                                 LBZ IOERR
00FA'  C0 0150'                                 LBR DELAY2      ; 2 BIT DELAY
                                        ;
                                        ;
                                        ;********************* INPUT 4 DIGITS TO R(D)  (IN4D) ***************************
                                        ;
00FD'  F8 00                            IN4D:   LDI LOW 00
00FF'  BD                                       PHI RD          ; SET R(D) = 0000
0100'  AD                                       PLO RD
0101'                                   IN4D2:  CALL INCHAR
0101'  D4                               +
0102'  00E1'                            +
0104'  07                                       LDN GPAGE
0105'  FB 0D                                   XRI 0DH         ;INCHAR XOR CR          IS IT 'CR' ?
0107'  32 0D'                                  BZ IN4RET       ; GP -> I/O LOC.
0109'  FB 2D                                   XRI 2DH         :"SPACE" XOR CR         IS IT ' ' ?
010B'  3A 0E'                                   BNZ CNVRT
010D'                                   IN4RET: EXIT
010D'  D5                               +
                                        ;
                                        ;
010E'                                   CNVRT:  CALL ASCHEX
010E'  D4                               +
010F'  0118'                            +
0111'  33 01'                                   BDF IN4D2
                                                CALL SHFTD4
0113'  D4                               +
0114'  013A'                            +
0116'  30 01'                                   BR IN4D2
                                        ;
                                        ;
0118'  07                               ASCHEX: LDN GPAGE
0119'  FC D0                                   ADI 0D0H        ; CALLED BY CNVRT AND ! MEMORY
```

```
 449    011B'  3B 37'                BNF NOTHEX
 450    011D'  07                    LDN GPAGE
 451    011E'  FD 39                 SDI 039H
 452    0120'  33 30'                BDF NUMBER
 453    0122'  07                    LDN GPAGE
 454    0123'  FC BF                 ADI 0BFH
 455    0125'  3B 37'                BNF NOTHEX
 456    0127'  07                    LDN GPAGE
 457    0128'  FD 46                 SDI 046H
 458    012A'  3B 37'                BNF NOTHEX
 459    012C'  07                    LDN GPAGE
 460    012D'  FC C9                 ADI 0C9H
 461    012F'  38                    SKP
 462    0130'  07              NUMBER: LDN GPAGE
 463    0131'  FA 0F                 ANI 00FH
 464    0133'  57                    STR GPAGE
 465    0134'  FC 00                 ADI 000H        ; CLEAR DF
 466                                 EXIT
 467    0136'  D5            +
 468    0137'  FF 00           NOTHEX: SMI 000H        ; SET DF
 469                                 EXIT
 470    0139'  D5            +
 471                          ;
 472                          ;
 473    013A'  8C              SHFTD4: GLO RC
 474    013B'  52                    STR STACK
 475    013C'  F8 04                 LDI LOW 04H
 476    013E'  AC                    PLO RC
 477    013F'  8D              SHIFT:  GLO RD
 478    0140'  FE                    SHL
 479    0141'  AD                    PLO RD
 480    0142'  9D                    GHI RD
 481    0143'  7E                    SHLC
 482    0144'  BD                    PHI RD
 483    0145'  2C                    DEC RC
 484    0146'  8C                    GLO RC
 485    0147'  3A 3F'                BNZ SHIFT
 486    0149'  02                    LDN R2
 487    014A'  AC                    PLO RC
 488    014B'  E7                    SEX GPAGE
 489    014C'  8D                    GLO RD
 490    014D'  F1                    OR
 491    014E'  AD                    PLO RD
 492                                 EXIT
 493    014F'  D5            +
 494                          ;
 495                          ;
 496                          ;************************** 2 BIT DELAY ********************************
 497                          ;
 498                          ;                       ; INSTRUMENT SPECIFIC:
 499    0150'  F8 80           DELAY2: LDI LOW 80H     ;       80H = 10.8 mSec FOR
 500    0152'  FF 01           WAIT3:  SMI 01H         ;       1.2288 MHz SYSTEM CPU CLOCK
 501    0154'  C4                      NOP
 502    0155'  C4                      NOP
 503    0156'  C4                      NOP
 504    0157'  3A 52'                  BNZ WAIT3
```

```
505     0159'   FC 00                   ADI 00H         ; CLEAR DF
506                                     EXIT
507     015B'   D5              +
508                             ;
509                             ;
510                             ; ************************ IN KEY WORD ***************************
511                             ;
512     015C'                   INKWD:  CALL INCHAR
513     015C'   D4              +
514     015D'   00E1'           +
515     015F'   CB 016B'                LBNF TMATCH
516     0162'   46              PLIST:  LDA LIST
517     0163'   FB FF                  XRI 0FFH        ; IS IT FF ?
518     0165'   CA 0162'                LBNZ PLIST
519     0168'   16                      INC LIST
520     0169'   16                      INC LIST
521                                     EXIT            ; GOES TO LBR AT END OF LIST
522     016A'   D5              +
523                             ;
524     016B'   07              TMATCH: LDN GPAGE       ; GPAGE = I/O LOC.
525     016C'   E6                      SEX RTNPTR
526     016D'   F3                      XOR             ; I/OLOC = LIST ?
527     016E'   CA 0162'                LBNZ PLIST
528     0171'   16              MATCH:  INC LIST
529     0172'   06                      LDN LIST
530     0173'   FB FF                  XRI 0FFH
531     0175'   CA 015C'                LBNZ INKWD
532     0178'   16                      INC LIST
533     0179'   46                      LDA RTNPTR
534     017A'   52                      STR STACK
535     017B'   46                      LDA RTNPTR
536     017C'   A6                      PLO RTNPTR
537     017D'   02                      LDN STACK
538     017E'   B6                      PHI RTNPTR
539                                     EXIT            ; GOES RETURN INDICATED AT LIST END
540     017F'   D5              +
541                             ;
542                             ;
543                             ; ********************** INPUT TEST AND BRANCH ***********************
544                             ;
545                             ;
546     0180'                   ITB:    CALL INCHAR
547     0180'   D4              +
548     0181'   00E1'           +
549     0183'   E7                      SEX GPAGE
550     0184'   46              NEXT2:  LDA LIST
551     0185'   FB FF                  XRI 0FFH        ; IS LIST FF ?
552     0187'   CA 018B'                LBNZ TEST
553                                     EXIT
554     018A'   D5              +
555                             ;
556     018B'   FB FF           TEST:   XRI 0FFH
557     018D'   F3                      XOR
558     018E'   C2 0196'                LBZ MATCH2      ; DOES CHAR = LIST ?
559     0191'   16                      INC LIST
560     0192'   16                      INC LIST
```

```
 561    0193'  C0 0184'              LBR NEXT2
 562    0196'  46                 MATCH2: LDA RTNPTR              ;
 563    0197'  52                         STR STACK
 564    0198'  46                         LDA RTNPTR
 565    0199'  A6                         PLO RTNPTR
 566    019A'  02                         LDN STACK
 567    019B'  B6                         PHI RTNPTR
 568                                      EXIT
 569    019C'  D5                +
 570                                ;
 571                                ;
 572                                ;********************************** TTY ****************************************
 573                                ;
 574                                ;
 575    019D'  F8 FE               TTY:    LDI LOW IOLOC
 576    019F'  A7                          PLO GPAGE       ;TTY CHECKS FOR THE FOLLOWING PSUEDO OPS IN LIST:
 577    01A0'  46                  NEXT3:  LDA RTNPTR                  ;************************************
 578    01A1'  FB FF                       XRI 0FFH        ;IS IT FF?      ; ASCII CHAR -> TYPES IT
 579    01A3'  3A A8'                      BNZ TEST80                      ; 80 = ASCII @ RD.1
 580    01A5'  FC 00                       ADI 00H         ;CLEAR DF       ; 81 = HEX PAIR @ RD.1
 581                                       EXIT                            ;      2nd CALL SENDS HXPR @ RD.0
 582    01A7'  D5                +
 583    01A8'  FB 7F               TEST80: XRI 07FH        ;80 XOR FF      ; 8D = HEX PAIR @ M(RD), INC RD
 584    01AA'  3A B5'                      BNZ TEST81      ;IS IT 80?      ; CA = TYPES CR, LF
 585    01AC'  9D                  ASCRD1: GHI RD                          ; 9D = CALLS IN4D
 586    01AD'  57                          STR GPAGE                       ; DD = DECIMAL @ M(RD) (00-99)
 587    01AE'  8D                          GLO RD                          ; A1 = SEND HI HX NIBBLE @ M(RD)
 588    01AF'  BD                          PHI RD                          ; A2 = SEND LO HX NIBBLE @ M(RD),INC RD
 589    01B0'                      OUTPT2: CALL OUTCHR                     ; FF = DONE (END OF LIST)
 590    01B0'  D4                +
 591    01B1'  0249'             +
 592    01B3'  30 A0'                      BR NEXT3                    ;************************************
 593                                ;
 594    01B5'  FB 01               TEST81: XRI (81H XOR 80H)       ;81 XOR 80
 595    01B7'  CA 01D4'                    LBNZ TEST8D             ;IS IT 81?
 596    01BA'  9D                  HEXRD1: GHI RD
 597    01BB'  E2                          SEX STACK
 598    01BC'  73                          STXD
 599    01BD'  8D                          GLO RD
 600    01BE'  BD                          PHI RD
 601    01BF'  12                  OUTHEX: INC STACK
 602    01C0'  02                          LDN STACK
 603    01C1'  22                          DEC STACK
 604    01C2'  F6                          SHR
 605    01C3'  F6                          SHR
 606    01C4'  F6                          SHR
 607    01C5'  F6                          SHR
 608    01C6'  57                          STR GPAGE
 609                                       CALL HXCONV
 610    01C7'  D4                +
 611    01C8'  0222'             +
 612    01CA'  12                          INC STACK
 613    01CB'  02                          LDN STACK
 614    01CC'  FA 0F                       ANI 0FH
 615    01CE'  57                          STR GPAGE
 616                                       CALL HXCONV
```

```
 617    01CF'  D4            +
 618    01D0'  0222'         +
 619    01D2'  30 A0'                BR NEXT3
 620                         ;
 621    01D4'  FB 3C         TEST8D: XRI (8DH XOR 81H)      ;8D XOR 81
 622    01D6'  3A DD'                BNZ TESTCA                ;IS IT 8D ?
 623    01D8'  4D                    LDA RD
 624    01D9'  E2                    SEX STACK
 625    01DA'  73                    STXD
 626    01DB'  30 BF'                BR OUTHEX
 627                         ;
 628    01DD'  FB 47         TESTCA: XRI (0CAH XOR 8DH)     ;CA XOR 8D
 629    01DF'  3A E9'                BNZ TEST9D              ;IS IT CA ?
 630    01E1'                OUTCA:  CALL TTY
 631    01E1'  D4            +
 632    01E2'  019D'         +
 633    01E4'  0D0A                  DW 0D0AH        ;CR,LF
 634    01E6'  FF                    DB DONE         ;DONE
 635    01E7'  30 A0'                BR NEXT3
 636                         ;
 637    01E9'  FB 57         TEST9D: XRI (9DH XOR 0CAH)     ;9D XOR CA
 638    01EB'  3A F2'                BNZ TESTDD              ;IS IT 9D ?
 639                                 CALL IN4DT?             ; ONLY CALL OF IN4DT?
 640    01ED'  D4            +
 641    01EE'  0234'         +
 642    01F0'  30 A0'                BR NEXT3
 643                         ;
 644    01F2'  FB 40         TESTDD: XRI (0DDH XOR 9DH)     ;DD XOR 5D      IS IT DD ?
 645    01F4'  CA 01FD'              LBNZ TESTA1
 646    01F7'  4D                    LDA RD
 647    01F8'  F9 30                 ORI 030H
 648    01FA'  C0 021E'              LBR OUTPT1
 649                         ;
 650    01FD'  FB 3C         TESTA1: XRI (0A1H XOR 09DH)    ;IS IT A1?
 651    01FF'  CA 020E'              LBNZ TESTA2
 652    0202'  0D                    LDN RD
 653    0203'  F6                    SHR
 654    0204'  F6                    SHR
 655    0205'  F6                    SHR
 656    0206'  F6                    SHR
 657    0207'  57                    STR GPAGE
 658                                 CALL HXCONV
 659    0208'  D4            +
 660    0209'  0222'         +
 661    020B'  C0 01A0'              LBR NEXT3
 662                         ;
 663    020E'  FB 03         TESTA2: XRI (0A2H XOR 0A1H)    ;IS IT A2?
 664    0210'  3A 1C'                BNZ OUTASC              ;EXTEND TTY W/ BRANCH FROM HERE
 665    0212'  4D                    LDA RD
 666    0213'  FA 0F                 ANI 0FH
 667    0215'  57                    STR GPAGE
 668                                 CALL HXCONV
 669    0216'  D4            +
 670    0217'  0222'         +
 671    0219'  C0 01A0'              LBR NEXT3
 672                         ;
```

```
673  021C'  26              OUTASC: DEC RTNPTR
674  021D'  46                      LDA RTNPTR
675  021E'  57              OUTPT1: STR GPAGE
676  021F'  C0 0130'                LBR OUTPT2
677                         ;
678                         ;
679  0222'  07              HXCONV: LDN GPAGE       ;ONLY USED BY TTY
680  0223'  FC F6                   ADI 0F6H
681  0225'  C3 0230'                LBDF GTR9
682  0228'  07                      LDN GPAGE
683  0229'  F9 30                   ORI 030H
684  022B'  57              STORE:  STR GPAGE
685                                 CALL OUTCHR
686  022C'  D4                +
687  022D'  0249'             +
688                                 EXIT
689  022F'  D5                +
690                         ;
691  0230'  FC 41           GTR9:   ADI 041H
692  0232'  30 2B'                  BR STORE
693                         ;
694                         ;
695                         ;***************************** IN4D TSRE ***************************************
696                         ;
697                         ;
698  0234'                  IN4DT?: CALL TSRE?
699  0234'  D4                +
700  0235'  023A'             +
701  0237'  C0 00FD'                LBR IN4D
702                         ;
703                         ;******************** WAIT FOR TRANS. SER. REG. EMPTY ***************************
704                         ;                               ( LOOP 1 )
705                         ;
706                         ;                       ; CALLED BY PROMPT, TEST OK,
707  023A'  E2              TSRE?:  SEX STACK       ;       AND IND4TSRE, AND PASSTHRU
708  023B'  6A              WAIT4:  INP DATA1       ; CLEAR DA (DATA AVAILABLE)
709  023C'  6B                      INP STAT1
710  023D'  FA C0                   ANI 0C0H        ; MASK FOR TSRE & THRE
711  023F'  FB C0                   XRI 0C0H        ; TSRE = THRE = 1 ?
712  0241'  3A 3B'                  BNZ WAIT4
713                                 CALL DELAY2     ; 2 BIT DLY
714  0243'  D4                +
715  0244'  0150'             +
716  0246'  E2                      SEX STACK
717  0247'  6A                      INP DATA1       ; CLEAR ECHO DA
718                                 EXIT
719  0248'  D5                +
720                         ;
721                         ;
722                         ;************************** SAIL OUT CHARACTER *********************************
723                         ;                               ( LOOP 1 )
724                         ;
725  0249'  6B              OUTCHR: INP STAT1
726  024A'  FA 0C            .       ANI 0CH         ; CHECK PREVIOUS I/O ERROR
727  024C'  CA 0082'                 LBNZ IOERR
728  024F'  02              THRE?:  LDN STACK
```

```
 729    0250'  FE                          SHL             ; CHECK THRE
 730    0251'  CB 0249'                    LBNF OUTCHR     ; WAIT FOR UART READY
 731    0254'  E7                          SEX GPAGE
 732    0255'  F8 FE                       LDI LOW IOLOC
 733    0257'  A7                          PLO GPAGE
 734    0258'  62                          OUT DATA1       ; LOAD UART FROM I/O LOCATION
 735    0259'  27                          DEC GPAGE
 736    025A'  FC 00                       ADI 00H         ; CLEAR DF
 737                                       EXIT
 738    025C'  D5               +
 739                                ;
 740                                ;
 741                                ;************************** ? Memory routine **********************************
 742                                ;
 743                                ;
 744    025D'                       QUESTM: CALL IN4D
 745    025D'  D4               +
 746    025E'  00FD'            +
 747    0260'  E2                          SEX STACK
 748    0261'  8D                          GLO RD
 749    0262'  73                          STXD
 750    0263'  9D                          GHI RD
 751    0264'  73                          STXD
 752                                       CALL IN4D
 753    0265'  D4               +
 754    0266'  00FD'            +
 755    0268'  9D                          GHI RD
 756    0269'  BE                          PHI RE
 757    026A'  8D                          GLO RD
 758    026B'  AE                          PLO RE
 759    026C'  12                          INC STACK
 760    026D'  42                          LDA STACK
 761    026E'  BD                          PHI RD
 762    026F'  02                          LDN STACK
 763    0270'  AD                          PLO RD
 764                                       CALL DELAY2
 765    0271'  D4               +
 766    0272'  0150'            +
 767    0274'  E2                   OUTADR: SEX STACK
 768    0275'  8D                          GLO RD
 769    0276'  73                          STXD
 770    0277'  9D                          GHI RD
 771    0278'  73                          STXD
 772                                       CALL TTY
 773    0279'  D4               +
 774    027A'  019D'            +
 775    027C'  CA                          DB 0CAH
 776    027D'  81                          DB 081H         ; TYPE: CR,     LF, NULL X 6, R
 777    027E'  81                          DB 081H
 778    027F'  20                          DB 020H         ;       OUT HEX PR X2, SPACE
 779    0280'  FF                          DB 0FFH         ;       DONE
 780    0281'  12                          INC STACK
 781    0282'  42                          LDA STACK
 782    0283'  BD                          PHI RD
 783    0284'  02                          LDN STACK
 784    0285'  AD                          PLO RD
```

```
 785    0286'  8E                NEXBYT: GLO RE
 786    0287'  3A 8D'                    BNZ DECCNT
 787    0289'  9E                        GHI RE
 788    028A'  C2 008E'                  LBZ PROMPT
 789    028D'  2E                DECCNT: DEC RE
 790                                     CALL TTY
 791    028E'  D4           +
 792    028F'  019D'        +
 793    0291'  8DFF                      DW 8DFFH        ; TYPE: OUT HEX RD, DONE
 794    0293'  8D                        GLO RD
 795    0294'  FA 0F                     ANI 00FH        ; MASK FOR LINE LENGTH
 796    0296'  C2 02A6'                  LBZ LNTEST      ;       07 = 08H / LINE
 797    0299'  FA 01                     ANI 01H         ;       0F = 10H / LINE
 798    029B'  CA 0286'                  LBNZ NEXBYT
 799                                     CALL TTY
 800    029E'  D4           +
 801    029F'  019D'        +
 802    02A1'  20FF                      DW 20FFH        ; TYPE: SPACE, DONE
 803    02A3'  C0 0286'                  LBR NEXBYT
 804    02A6'  8E                LNTEST: GLO RE          ; TEST FOR END OF LINE
 805    02A7'  3A AF'                    BNZ LNEND
 806    02A9'  9E                        GHI RE
 807    02AA'  3A AF'                    BNZ LNEND
 808    02AC'  C0 008E'                  LBR PROMPT
 809    02AF'                    LNEND:  CALL TTY        ; TYPE: '       ', DONE
 810    02AF'  D4           +
 811    02B0'  019D'        +
 812    02B2'  3BFF                      DW 3BFFH
 813    02B4'  C0 0274'                  LBR OUTADR
 814                                     ;
 815                                     ;
 816                                     ;********************** ! Memory Routine ************************************
 817                                     ;
 818                                     ;
 819    02B7'  F8 03             WRITEM: LDI LOW SYSFLG
 820    02B9'  A7                        PLO GPAGE
 821    02BA'  07                        LDN GPAGE       ; CHECK FOR UNLOCK FLAG
 822    02BB'  FA 40                     ANI 40H         ;       GO TO SAY NO IF LOCKED
 823    02BD'  C2 03F8'                  LBZ SAYNO
 824    02C0'                    INADDR: RLDI RD, 0000   ; WAIT FOR NUMERIC INPUT
 825    02C0'  68 CD        +
 826    02C2'  0000         +
 827                                     CALL INCHAR
 828    02C4'  D4           +
 829    02C5'  00E1'        +
 830                                     CALL ASCHEX
 831    02C7'  D4           +
 832    02C8'  0118'        +
 833    02CA'  33 C0'                    BDF INADDR
 834                                     CALL SHFTD4     ; PUT ADDRESS POINTER IN R(B)
 835    02CC'  D4           +
 836    02CD'  013A'        +
 837                                     CALL IN4D2
 838    02CF'  D4           +
 839    02D0'  0101'        +
 840    02D2'  9D                        GHI RD
```

```
 841    02D3' BE                        PHI RE
 842    02D4' 8D                        GLO RD
 843    02D5' AE                        PLO RE
 844    02D6'                   IN1ST:  CALL INCHAR
 845    02D6' D4                +
 846    02D7' 00E1'             +
 847    02D9' 07                        LDN GPAGE
 848    02DA' 32 D6'                    BZ IN1ST        ; IGNORE NULLS (NULL =00)
 849                                    CALL ASCHEX
 850    02DC' D4                +
 851    02DD' 0118'             +
 852    02DF' 33 FF'                    BDF TESTSP      ; DF = NOT HEX
 853    02E1' 07                        LDN GPAGE
 854    02E2' AD                        PLO RD          ; SAVE LO DIGIT
 855    02E3'                   IN2ND:  CALL INCHAR
 856    02E3  D4                +
 857    02E4' 00E1'             +
 858                                    CALL ASCHEX
 859    02E6' D4                +
 860    02E7' 0118'             +
 861    02E9' 33 F3'                    BDF ERROR
 862                                    CALL SHFTD4
 863    02EB' D4                +
 864    02EC' 013A'             +
 865    02EE' 8D                        GLO RD
 866    02EF' 5E                        STR RE          ; WRITE INTO RAM
 867    02F0' 1E                        INC RE
 868    02F1' 30 D6'                    BR IN1ST
 869                            ;
 870    02F3'                   ERROR:  CALL DELAY2
 871    02F3' D4                +
 872    02F4' 0150'             +
 873                                    CALL TTY        ; TYPE:
 874    02F6' D4                +
 875    02F7' 019D'             +
 876    02F9' 3F3F                      DW 3F3FH        ;       ? ?
 877    02FB' FF                        DB DONE         ; DONE
 878    02FC' C0 003E'                  LBR PROMPT
 879                            ;
 880    02FF' 07                TESTSP: LDN GPAGE       ; TEST FOR DELIMITORS
 881    0300' FB 20                     XRI 20H         ; XOR 'SPACE'           IS IT 'SPACE' ?
 882    0302' CB 02D6'                  LBZ IN1ST
 883    0305' FB 0C                     XRI 0CH         ; (0C XOR 'SPACE'       IS IT 'L' ?
 884    0307' CA 0310'                  LBNZ SEMI?
 885                                    CALL PASSCA
 886    030A' D4                +
 887    030B' 0124'             +
 888    030D' C0 02D6'                  LBR IN1ST
 889    0310' FB 17             SEMI?:  XRI 017H        ; (3B XOR 2C            IS IT ';' ?
 890    0312' 3A 1A'                    BNZ TESTCR
 891                                    CALL PASSCA
 892    0314' D4                +
 893    0315' 0124'             +
 894    0317' C0 02C0'                  LBR INADDR
 895    031A' FB 36             TESTCR: XRI 036H        ; 'CR' XOR ';'          IS IT 'CR' ?
 896    031C' CA 02F3'                  LBNZ ERROR
```

```
 897    031F'  FC 00                    ADI 00H         ; IF NO ERROR, CLEAR DF
 898    0321'  C0 008E'                 LBR PROMPT      ;       GO TO PROMPT
 899                                    ;
 900    0324'                           PASSCA: CALL INCHAR     ; ONLY USED BY XM
 901    0324'  D4              +
 902    0325'  00E1'           +
 903    0327'  07                       LDN GPAGE
 904    0328'  FB 0D                    XRI 0DH         ; IS IT 'CR' ?
 905    032A'  CA 0324'                 LBNZ PASSCA
 906    032D'                           INLF:   CALL INCHAR
 907    032D'  D4              +
 908    032E'  00E1'           +
 909    0330'  07                       LDN GPAGE
 910    0331'  FB 0A                    XRI 0AH         ; IS IT 'LF' ?
 911    0333'  3A 2D'                   BNZ INLF
 912                                    EXIT
 913    0335'  D5              +
 914                                    ;
 915                                    ;
 916                                    ;****************************** MOVE ****************************************
 917                                    ;
 918    0336'                           MOVE:   CALL TTY
 919    0336'  D4              +
 920    0337'  019D'           +
 921    0339'  6F 76 65 20              DB 'ove from '
 922    033D'  66 72 6F 6D
 923    0341'  20
 924    0342'  03                       DB ETX
 925    0343'  9DFF                     DW 09DFFH
 926    0345'  9D                       GHI RD
 927    0346'  BA                       PHI RA
 928    0347'  8D                       GLO RD
 929    0348'  AA                       PLO RA
 930                                    CALL TTY
 931    0349'  D4              +
 932    034A'  019D'           +
 933    034C'  74 6F 20                 DB   o '
 934    034F'  03                       DB ETX
 935    0350'  9DFF                     DW 09DFFH
 936    0352'  9D                       GHI RD
 937    0353'  BB                       PHI RB
 938    0354'  8D                       GLO RD
 939    0355'  AB                       PLO RB
 940                                    CALL TTY
 941    0356'  D4              +
 942    0357'  019D'           +
 943    0359'  6C 65 6E 67              DB 'length '
 944    035D'  74 68 20
 945    0360'  03                       DB ETX
 946    0361'  9DFF                     DW 09DFFH
 947                                    CALL OK?
 948    0363'  D4              +
 949    0364'  0407'           +
 950    0366'  CB 008E'                 LBNF PROMPT     ;return to prompt if no flag
 951                                    ;
 952    0369'  4A                       MOV:    LDA RA
```

```
  953    036A'  5B                        STR RB
  954    036B'  1B                        INC RB
  955    036C'  2D                        DEC RD
  956    036D'  9D                        GHI RD
  957    036E'  3A 69'                    BNZ MOV
  958    0370'  8D                        GLO RD
  959    0371'  3A 69'                    BNZ MOV
  960                                     CALL TTY
  961    0373'  D4            +
  962    0374'  019D'         +
  963    0376'  07FF                      DW 07FFH
  964    0378'  C0 008E'                  MOVRTN: LBR PROMPT
  965                                     ;
  966                                     ;
  967                                     ;****************************** VERIFY ************************************
  968                                     ;
  969                                     ;
  970    037B'                            VERFY:  CALL TTY
  971    037B'  D4            +
  972    037C'  019D'         +
  973    037E'  65 72 69 66               DB 'erify '
  974    0382'  79 20
  975    0384'  03                        DB ETX
  976    0385'  9DFF                      DW 09DFFH
  977    0387'  9D                        GHI RD          ;STORE 'VERIFY' GROUP ADDR IN RA
  978    0388'  BA                        PHI RA
  979    0389'  8D                        GLO RD
  980    038A'  AA                        PLO RA
  981                                     CALL TTY
  982    038B'  D4            +
  983    038C'  019D'         +
  984    038E'  77 69 74 68               DB 'with '
  985    0392'  20
  986    0393'  03                        DB ETX
  987    0394'  9DFF                      DW 09DFFH
  988    0396'  9D                        GHI RD          ;STORE 'WITH' group in RB
  989    0397'  BB                        PHI RB
  990    0398'  8D                        GLO RD
  991    0399'  AB                        PLO RB
  992                                     CALL TTY
  993    039A'  D4            +
  994    039B'  019D'         +
  995    039D'  6C 65 6E 67               DB 'length '
  996    03A1'  74 68 20
  997    03A4'  03                        DB ETX
  998    03A5'  9DFF                      DW 09DFFH
  999    03A7'  9D                        GHI RD          ;STORE LENGTH IN RC
 1000    03A8'  BC                        PHI RC
 1001    03A9'  8D                        GLO RD
 1002    03AA'  AC                        PLO RC
 1003                                     ;
 1004    03AB'  9C                        VNEXT:  GHI RC
 1005    03AC'  3A 3D'                    BNZ VMORE
 1006    03AE'  8C                        GLO RC
 1007    03AF'  3A 3D'                    BNZ VMORE
 1008                                     CALL TTY
```

```
1009    03B1'  D4            +
1010    03B2'  019D'         +
1011    03B4'  20 44 4F 4E           DB ' DONE'
1012    03B8'  45
1013    03B9'  FF                    DB DONE
1014    03BA'  C0 008E'              LBR PROMPT
1015                         ;
1016    03BD'  EB            VMORE:  SEX RB
1017    03BE'  0A                    LDN RA
1018    03BF'  F3                    XOR
1019    03C0'  3A C7'                BNZ VBAD
1020    03C2'  1A            VCONT:  INC RA
1021    03C3'  1B                    INC RB
1022    03C4'  2C                    DEC RC
1023    03C5'  30 AB'                BR VNEXT
1024                         ;
1025    03C7'  E2            VBAD:   SEX STACK       ; OUTPUT BAD LOCATIONS AND CONTENTS
1026    03C8'  9A                    GHI RA
1027    03C9'  BD                    PHI RD
1028    03CA'  8A                    GLO RA
1029    03CB'  AD                    PLO RD
1030                                 CALL TTY
1031    03CC'  D4            +
1032    03CD'  019D'         +
1033    03CF'  CA81                  DW 0CA81H       ; REG A ADDRESS
1034    03D1'  8120                  DW 08120H
1035    03D3'  FF                    DB 0FFH
1036    03D4'  9A                    GHI RA
1037    03D5'  BD                    PHI RD
1038    03D6'  8A                    GLO RA
1039    03D7'  AD                    PLO RD
1040                                 CALL TTY
1041    03D8'  D4            +
1042    03D9'  019D'         +
1043    03DB'  8D20                  DW 08D20H       ; REG A CONTENTS
1044    03DD'  20FF                  DW 020FFH
1045    03DF'  9B                    GHI RB
1046    03E0'  BD                    PHI RD
1047    03E1'  8B                    GLO RB
1048    03E2'  AD                    PLO RD
1049                                 CALL TTY
1050    03E3'  D4            +
1051    03E4'  019D'         +
1052    03E6'  8D20                  DW 08D20H       ; REG B CONTENTS
1053    03E8'  FF                    DB 0FFH
1054    03E9'  9B                    GHI RB
1055    03EA'  BD                    PHI RD
1056    03EB'  8B                    GLO RB
1057    03EC'  AD                    PLO RD
1058                                 CALL TTY
1059    03ED'  D4            +
1060    03EE'  019D'         +
1061    03F0'  8181                  DW 08181H       ; REG B ADDRESS
1062    03F2'  FF                    DB 0FFH
1063    03F3'  30 C2'                BR VCONT
1064                         ;
```

```
1065                                    ;
1066                                    ;************************** RUN TARGET SYSTEM **********************************
1067                                    ;
1068    03F5'   C0 981F                 RUN:    LBR TARADR
1069                                    ;
1070                                    ;
1071                                    ;
1072                                    ;****************************** SAY NO ! ***************************************
1073                                    ;
1074    03F8'                           SAYNO:  CALL DELAY2
1075    03F8'   D4              +
1076    03F9'   0150'           +
1077                                            CALL TTY
1078    03FB'   D4              +
1079    03FC'   019D'           +
1080    03FE'   204E                            DW 204EH                ; TYPE: SPACE No !
1081    0400'   6F20                            DW 6F20H                ;       DONE
1082    0402'   21FF                            DW 21FFH
1083    0404'   C0 808E'                        LBR PROMPT
1084                                    ;
1085                                    ;
1086                                    ;
1087                                    ; ********************* TEST OK ? ***************************
1088                                    ;
1089    0407'                           OK?:    CALL TSRE?
1090    0407'   D4              +
1091    0408'   023A'           +
1092                                            CALL TTY        ;TYPE:  Ok ? ,
1093    040A'   D4              +
1094    040B'   019D'           +
1095    040D'   20 4F 6B 20                     DB ' Ok ? '
1096    0411'   3F 20
1097    0413'   03                              DB ETX
1098    0414'   FF                              DB DONE         ;       DONE
1099                                    ;
1100    0415'                           YES?:   CALL TSRE?
1101    0415'   D4              +
1102    0416'   023A'           +
1103                                            CALL INCHAR
1104    0418'   D4              +
1105    0419'   00E1'           +
1106    041B'   07                              LDN SPAGE
1107    041C'   FB 59                          XRI 059H        ; XOR 'Y'       IS IT YES ?
1108    041E'   CA 0424'                       LBNZ NO
1109                                    ;
1110    0421'   FF 00                  OKRTN:  SMI 00H         ; SET DF
1111                                            EXIT
1112    0423'   D5              +
1113    0424'   FC 00                  NO:     ADI 00H         ; CLEAR DF
1114                                            EXIT
1115    0426'   D5              +
1116                                    ;
1117                                    ;
1118                                    ;
1119                                    ;******************** $ P (RUNS PROGRAM AT AAAA ****************************
1120                                    ;                       WITH PC = R3, X = R2)
```

```
1121                                    ;
1122    0427'   F8 03                  TEST$:  LDI LOW SYSFLG
1123    0429'   A7                             PLO GPAGE
1124    042A'   07                             LDN GPAGE
1125    042B'   FA E0                          ANI 0E0H        ; MASK FOR ADDR, WRITE, SYS FLAGS
1126    042D'   FB E0                          XRI 0E0H        ; ADDR = WRITE = SYS = 1 ?
1127    042F'   CA 03F8'                       LBNZ SAYNO
1128    0432'                           IN$:    CALL IN4D
1129    0432'   D4              +
1130    0433'   00FD'           +
1131    0435'   9D                             GHI RD
1132    0436'   BE                             PHI RE
1133    0437'   8D                             GLO RD
1134    0438'   AE                             PLO RE
1135                                           CALL TTY
1136    0439'   D4              +
1137    043A'   019D'           +
1138    043C'   2081                           DW 2081H        ; TYPE: SPACE,
1139    043E'   812C                           DW 812CH        ;       OUT HEX PR ','
1140    0440'   FF                             DB 0FFH         ;       DONE
1141                                           CALL OK?
1142    0441'   D4              +
1143    0442'   0407'           +
1144    0444'   CB 008E'                       LBNF PROMPT
1145    0447'   E2                             SEX STACK       ; X => R2
1146    0448'   86                             GLO RTNPTR
1147    0449'   73                             STXD
1148    044A'   96                             GHI RTNPTR
1149    044B'   73                             STXD
1150    044C'   9E                             GHI RE
1151    044D'   B6                             PHI RTNPTR
1152    044E'   8E                             GLO RE
1153    044F'   A6                             PLO RTNPTR
1154    0450'   FC 00                          ADI 00          ; CLEAR DF
1155                                           EXIT
1156    0452'   D5              +
1157                                    ;
1158                                    ;
1159                                    ;
1160                                    ;************************ CRC CALCULATION ***********************************
1161                                    ;
1162                                    ;
1163    0453'                           CRC:    CALL TTY        ;TYPE:
1164    0453'   D4              +
1165    0454'   019D'           +
1166    0456'   52 43 20                       DB 'RC '        ;       RC from,
1167    0459'   66 72 6F 6D                    DB 'from '      ;       ETX,
1168    045D'   20
1169    045E'   03                             DB 03H          ;       IN4D,
1170    045F'   9DFF                           DW 9DFFH        ;       DONE
1171    0461'   9D                             GHI RD
1172    0462'   BE                             PHI RE
1173    0463'   8D                             GLO RD
1174    0464'   AE                             PLO RE
1175                                           CALL TTY        ;TYPE:
1176    0465'   D4              +
```

```
1177    0466' 019D'          +
1178    0468' 6F 76 65 72            DB 'over '      ;       over,
1179    046C' 20
1180    046D' 03                     DB 03H          ;       ETX,
1181    046E' 9D                     DB 09DH         ;       IN4D,
1182    046F' FF                     DB 0FFH         ;       DONE
1183    0470' F8 07                  LDI LOW CRCLO
1184    0472' A7                     PLO GPAGE
1185    0473' F8 00                  LDI LOW 00H
1186    0475' BC                     PHI RC          ; CLEAR "ALL FF'S" FLAG
1187    0476' 57                     STR GPAGE
1188    0477' 27                     DEC GPAGE       ; SET CRC HI & LO = 0000
1189    0478' 57                     STR GPAGE
1190    0479' 0E                CLOOP1: LDN RE
1191    047A' FB FF                  XRI 0FFH
1192    047C' CE                     LSZ
1193    047D' BC                     PHI RC
1194    047E' E2                     SEX STACK       ;A NOP
1195                                 CALL CRCSUB
1196    047F' D4             +
1197    0480' 04BB'          +
1198    0482' 2D                     DEC RD
1199    0483' 8D                     GLO RD
1200    0484' CA 0479'               LBNZ CLOOP1
1201    0487' 9D                     GHI RD
1202    0488' CA 0479'               LBNZ CLOOP1
1203    048B' BC                     GHI RC
1204    048C' C2 04A3'               LBZ SAYCLR      ; IS MEMORY SPACE EMPTY ?
1205    048F' 97                     GHI GPAGE
1206    0490' BD                     PHI RD
1207    0491' 87                     GLO GPAGE
1208    0492' AD                     PLO RD
1209                                 CALL TTY        ; IF NOT, TYPE:
1210    0493' D4             +
1211    0494' 019D'          +
1212    0496' CA                     DB 0CAH         ;       CR, LF
1213    0497' 43 52 43 20            DB 'CRC = '     ;       CRC =
1214    049B' 3D 20
1215    049D' 8D8D                   DW 8D8DH        ;       OUT VID RD X2
1216    049F' FF                     DB 0FFH         ;       DONE
1217    04A0' C0 008E'               LBR PROMPT
1218    04A3'                SAYCLR: CALL TTY        ; IF CLEAR, TYPE:       CR, LF, NULL X6
1219    04A3' D4             +
1220    04A4' 019D'          +
1221    04A6' CA                     DB 0CAH         ;       Memory is clear
1222    04A7' 4D 65 6D 6F            DB 'Memory '
1223    04AB' 72 79 20
1224    04AE' 69 73 20 63            DB 'is clear.'
1225    04B2' 6C 65 61 72
1226    04B6' 2E
1227    04B7' FF                     DB 0FFH         ;       DONE
1228    04B8' C0 008E'               LBR PROMPT      ; GO TO PROMPT
1229                             ;
1230                             ;
1231    04BB' E7                 CRCSUB: SEX GPAGE   ; CRC CALCULATION SUBROUTINE
1232    04BC' 4E                     LDA RE
```

```
1233    04BD'  F3                       XOR
1234    04BE'  27                       DEC GPAGE
1235    04BF'  57                       STR GPAGE
1236    04C0'  F6                       SHR
1237    04C1'  F6                       SHR
1238    04C2'  F6                       SHR
1239    04C3'  F6                       SHR
1240    04C4'  F3                       XOR
1241    04C5'  57                       STR GPAGE
1242    04C6'  FE                       SHL
1243    04C7'  FE                       SHL
1244    04C8'  FE                       SHL
1245    04C9'  FE                       SHL
1246    04CA'  60                       IRX
1247    04CB'  60                       IRX
1248    04CC'  F3                       XOR
1249    04CD'  27                       DEC GPAGE
1250    04CE'  73                       STXD
1251    04CF'  72                       LDXA
1252    04D0'  F6                       SHR
1253    04D1'  F6                       SHR
1254    04D2'  F6                       SHR
1255    04D3'  F3                       XOR
1256    04D4'  73                       STXD
1257    04D5'  F0                       LDX
1258    04D6'  FE                       SHL
1259    04D7'  FE                       SHL
1260    04D8'  FE                       SHL
1261    04D9'  FE                       SHL
1262    04DA'  FE                       SHL
1263    04DB'  F3                       XOR
1264    04DC'  60                       IRX
1265    04DD'  60                       IRX
1266    04DE'  73                       STXD
1267                                    EXIT
1268    04DF'  D5               +
1269                                ;
1270                                ;
1271                                ;****************************** HELP FILE ************************************
1272                                ;
1273                                ;
1274    04E0'                       HELP:   CALL TTY
1275    04E0'  D4               +
1276    04E1'  019D'            -
1277    04E3'  65 6C 70                 DB 'elp'
1278    04E6'  CA                       DB 0CAH
1279    04E7'  42 54 55 20              DB 'BTU MONITOR'
1280    04EB'  4D 4F 4E 49
1281    04EF'  54 4F 52
1282    04F2'  CACA                     DW 0CACAH
1283    04F4'  53 79 73 74              DB 'System Commands:'
1284    04F8'  65 6D 20 43
1285    04FC'  6F 6D 6D 61
1286    0500'  6E 64 73 3A
1287    0504'  CA                       DB 0CAH
1288    0505'  20 24 61 61              DB ' $aaaa (Run @ aaaa)'
```

```
1289    0509'  61 61 20 28
1290    050D'  52 75 6E 20
1291    0511'  40 20 61 61
1292    0515'  61 61 29
1293    0518'  CA                       DB 0CAH
1294    0519'  20 21 52 75              DB ' !Run target system ('
1295    051D'  6E 20 74 61
1296    0521'  72 67 65 74
1297    0525'  20 73 79 73
1298    0529'  74 65 6D 20
1299    052D'  28
1300    052E'  081F                     DW TARADR
1301    0530'  29                       DB ')'
1302    0531'  CACA                     DW 0CACAH
1303    0533'  4D 65 6D 6F              DB 'Memory Commands:'
1304    0537'  72 79 20 43
1305    053B'  6F 6D 6D 61
1306    053F'  6E 64 73 3A
1307    0543'  CA                       DB 0CAH
1308    0544'  20 2E 4D 6F              DB ' .Move; .Verify; .Ram Test'
1309    0548'  76 65 3B 20
1310    054C'  2E 56 65 72
1311    0550'  69 66 79 3B
1312    0554'  20 2E 52 61
1313    0558'  6D 20 54 65
1314    055C'  73 74
1315    055E'  CA                       DB 0CAH
1316    055F'  20 21 4D 61              DB ' !Maaaa dd;  '
1317    0563'  61 61 61 20
1318    0567'  64 64 3B 20
1319    056B'  20
1320    056C'  20 3F 4D 61              DB ' ?Maaaa nnnn'
1321    0570'  61 61 61 20
1322    0574'  6E 6E 6E 6E
1323    0578'  CA                       DB 0CAH
1324    0579'  20 4D 65 6D              DB ' Memory protect'
1325    057D'  6F 72 79 20
1326    0581'  70 72 6F 74
1327    0585'  65 63 74
1328    0588'  CA                       DB 0CAH
1329    0589'  20 3F 43 72              DB ' ?Crc calc'
1330    058D'  63 20 63 61
1331    0591'  6C 63
1332    0593'  CAFF                     DW 0CAFFH
1333    0595'  C0 008E'                 LBR PROMPT
1334                                ;
1335                                ;
1336                                ;*****************************************************************
1337                                ;
1338                                ;****************** MEMORY PROTECT AND ENABLE ******************
1339                                ;
1340    0598'                       MEMSAV: CALL TTY              ;TYPE: (text)
1341    0598'  D4                +
1342    0599'  019D'             +
1343    059B'  65 6D 6F 72              DB 'emory - '
1344    059F'  79 20 2D 20
```

```
1345    05A3'  50 72 6F 74              DB 'Protect or Enable'
1346    05A7'  65 63 74 20
1347    05AB'  6F 72 20 45
1348    05AF'  6E 61 62 6C
1349    05B3'  65
1350    05B4'  20 28 50 20              DB ' (P or E) ? '
1351    05B8'  6F 72 20 45
1352    05BC'  29 20 3F 20
1353    05C0'  03FF                     DW 03FFH            ;       ETX, DONE
1354                                    CALL TSRE?
1355    05C2'  D4              +
1356    05C3'  023A'           +
1357                                    CALL ITB            ;CALL INPUT TEST AND BRANCH
1358    05C5'  D4              +
1359    05C6'  0180'           +
1360    05C8'  50                       DB 'P'              ;       IF P, GO TO PTECT
1361    05C9'  05DA'                    DW PTECT
1362    05CB'  45                       DB 'E'              :       IF E, GO TO ENABLE
1363    05CC'  05D2'                    DW ENABLE
1364    05CE'  FF                       DB 0FFH
1365    05CF'  C0 008E'                 LBR PROMPT          ;GO TO PROMPT IF NOT P OR E
1366                                ;
1367    05D2'  F8 00                ENABLE: LDI 00
1368    05D4'  BB                       PHI RB
1369    05D5'  F8 01                    LDI 01
1370    05D7'  AB                       PLO RB              ;SET PROTECT FLAG
1371    05D8'  30 DE'                   BR SETPG
1372    05DA'  F8 00                PTECT:  LDI 00
1373    05DC'  AB                       PLO RB
1374    05DD'  BB                       PHI RB              ;SET ENABLE
1375    05DE'                       SETPG:  CALL TTY        ;TYPE: CR, LF, (text)
1376    05DE'  D4              +
1377    05DF'  019D'           +
1378    05E1'  CA                       DB 0CAH
1379    05E2'  46 72 6F 6D              DB 'From page '
1380    05E6'  20 70 61 67
1381    05EA'  65 20
1382    05EC'  03                       DB ETX
1383    05ED'  9DFF                     DW 9DFFH            ;       IN4D, DONE
1384    05EF'  8D                       GLO RD
1385    05F0'  BE                       PHI RE              :SET CURRENT PAGE
1386                                    CALL TTY
1387    05F2'  D4              +
1388    05F3'  019D'           +
1389    05F5'  6F 76 65 72              DB 'over '          ;TYPE:  (text)
1390    05F9'  20
1391    05FA'  03                       DB ETX              ;       ETX
1392    05FB'  9D                       DB 09DH             ;       IN4D,
1393    05FC'  20 70 61 67              DB ' pages.'        ;       pages.,
1394    0600'  65 73 2E
1395    0603'  03FF                     DW 03FFH            ;       ETX, DONE
1396    0605'  8D                       GLO RD
1397    0606'  AC                       PLO RC
1398    0607'  C6                       LSNZ
1399    0608'  FC 01                    ADI 01
1400    060A'  AC                       PLO RC
```

```
1401                                            CALL MEMCHG
1402    060A'   D4              +
1403    060B'   0615'            +
1404    060D'   C0 008E'                        LBR PROMPT
1405                                    ;
1406                                    ;
1407                                    ;********** MEMORY PROTECT OR ENABLE SUBROUTINE **************
1408                                    ;
1409                                    ;
1410    0610'   46                      MEMSUB: LDA LIST        ;PASS ENABLE BIT
1411    0611'   AB                              PLO RB
1412    0612'   46                              LDA LIST        ;PASS START PAGE
1413    0613'   BE                              PHI RE
1414    0614'   46                              LDA LIST        ;PASS # OF PAGES
1415    0615'   AC                              PLO RC
1416                                    ;
1417    0616'   E3                      MEMCHG: SEX PC          ;SELECT SYSTEM I/O GROUP
1418    0617'   61                              OUT GROUP
1419    0618'   07                              DB SYSTEM
1420                                    ;
1421    0619'   EE                              SEX RE
1422    061A'   8C                      NEXPG:  GLO RC
1423    061B'   32 39'                          BZ MDONE
1424    061D'   9E                              GHI RE          ;ALWAYS ENABLE:
1425    061E'   FB 57                           XRI STKPG       ;       STACKPAGE
1426    0620'   32 2C'                          BZ SETQ
1427    0622'   9E                              GHI RE
1428    0623'   FB 56                           XRI GLOPG       ;       GLOBAL PAGE
1429    0625'   32 2C'                          BZ SETQ
1430    0627'   8B                              GLO RB
1431    0628'   3A 2C'                          BNZ SETQ        ;PROTECT OR ENABLE ?
1432    062A'   7A                              REQ             ;       PROTECT -> Q = 0
1433    062B'   38                              SKP
1434    062C'   7B                      SETQ:   SEQ             ;       ENABLE  -> Q = 1
1435    062D'   67                              OUT MEMORY      ;I/O = MEM. PROTECT
1436    062E'   7A                              REQ
1437    062F'   9E                              GHI RE
1438    0630'   FC 01                           ADI 01
1439    0632'   BE                              PHI RE
1440    0633'   8C                              GLO RC
1441    0634'   FF 01                           SMI 01
1442    0636'   AC                              PLO RC
1443    0637'   30 1A'                          BR NEXPG
1444                                    ;
1445    0639'   F8 0A                    MDONE:  LDI LOW GRPSAV  ;SELECT UART I/O GROUP
1446    063B'   A7                              PLO GPAGE       ;       AND STORE ON GLOBAL PAGE
1447    063C'   F8 06                           LDI UARTS
1448    063E'   57                              STR GPAGE
1449    063F'   E7                              SEX GPAGE
1450    0640'   61                              OUT GROUP
1451                                            EXIT
1452    0641'   D5              +
1453                                    ;
1454                                    ;
1455                                    ;************************** RAM TEST ROUTINE ****************************
1456                                    ;
```

```
1457    0642'                       RAMTST: CALL TTY
1458    0642'  D4            +
1459    0643'  019D'          +
1460    0645'  CA                          DB 0CAH
1461    0646'  52 61 6D 20                 DB 'Ram test - start at '
1462    064A'  74 65 73 74
1463    064E'  20 2D 20 73
1464    0652'  74 61 72 74
1465    0656'  20 61 74 20
1466    065A'  03                          DB ETX
1467    065B'  9DFF                        DW 9DFFH
1468    065D'  9D                          GHI RD          ;Start address to RB
1469    065E'  BB                          PHI RB
1470    065F'  8D                          GLO RD
1471    0660'  AB                          PLO RB
1472                                ;
1473                                       CALL TTY
1474    0661'  D4            +
1475    0662'  019D'          +
1476    0664'  20 4F 56 45                 DB ' OVER '
1477    0668'  52 20
1478    066A'  03                          DB ETX
1479    066B'  9DFF                        DW 9DFFH
1480                                ;
1481    066D'  9F                   LDSET: GHI RF          ;Get rand key from RF
1482    066E'  B8                          PHI R8
1483                                ;
1484    066F'  9B                          GHI RB          ;Start address to RB
1485    0670'  B9                          PHI R9
1486    0671'  8B                          GLO RB
1487    0672'  A9                          PLO R9
1488                                ;
1489    0673'  9D                          GHI RD          ;Length to RA
1490    0674'  BA                          PHI RA
1491    0675'  8D                          GLO RD
1492    0676'  AA                          PLO RA
1493                                ;
1494    0677'                       LDLOOP: CALL RAND
1495    0677'  D4            +
1496    0678'  06CA'          +
1497                                ;
1498    067A'  98                          GHI R8
1499    067B'  59                          STR R9
1500    067C'  19                          INC R9
1501    067D'  2A                          DEC RA
1502    067E'  8A                          GLO RA
1503    067F'  3A 77'                      BNZ LDLOOP
1504    0681'  9A                          GHI RA
1505    0682'  3A 77'                      BNZ LDLOOP
1506                                ;
1507                                ;
1508    0684'  9F                   CHKSET: GHI RF
1509    0685'  B8                          PHI R8
1510    0686'  9B                          GHI RB
1511    0687'  B9                          PHI R9
1512    0688'  8B                          GLO RB
```

```
1513    0689'  A9                          PLO R9
1514    068A'  9D                          GHI RD
1515    068B'  BA                          PHI RA
1516    068C'  8D                          GLO RD
1517    068D'  AA                          PLO RA
1518    068E'                      CHK:    CALL RAND
1519    068E'  D4           -
1520    068F'  06CA'        +
1521    0691'  E9                          SEX R9
1522    0692'  98                          GHI R8
1523    0693'  F3                          XOR
1524    0694'  3A AD'                      BNZ ERRLST
1525    0696'  19                  CONT1:  INC R9
1526    0697'  2A                          DEC RA
1527    0698'  8A                          GLO RA
1528    0699'  3A 8E'                      BNZ CHK
1529    069B'  9A                          GHI RA
1530    069C'  3A 8E'                      BNZ CHK
1531                               ;
1532    069E'  9F                  PASSDN: GHI RF
1533    069F'  B8                          PHI R8
1534                                       CALL RAND
1535    06A0'  D4           -
1536    06A1'  06CA'        -
1537    06A3'  98                          GHI R8
1538    06A4'  BF                          PHI RF
1539                                       CALL TTY
1540    06A5'  D4           -
1541    06A6'  019D'        -
1542    06A8'  2A                          DB '*'
1543    06A9'  00FF                        DW DONE
1544    06AB'  30 6D'                      BR LDSET
1545                               ;
1546    06AD'  A8                  ERRLST: PLO R8
1547                                       CALL TTY
1548    06AE'  D4           -
1549    06AF'  019D'        -
1550    06B1'  CAFF                        DW 0CAFFH
1551    06B3'  88                          GLO R8
1552    06B4'  BD                          PHI RD
1553                                       CALL TTY
1554    06B5'  D4           -
1555    06B6'  019D'        -
1556    06B8'  81                          DB 081H
1557    06B9'  20 61 74 20                 DB ' at '
1558    06BD'  FF                          DB 0FFH
1559    06BE'  99                          GHI R9
1560    06BF'  BD                          PHI RD
1561    06C0'  89                          GLO R9
1562    06C1'  AD                          PLO RD
1563                                       CALL TTY
1564    06C2'  D4           +
1565    06C3'  019D'        +
1566    06C5'  8181                        DW 8181H
1567    06C7'  FF                          DB 0FFH
1568    06C8'  30 96'                      BR CONT1
```

```
1569                                    ;
1570                                    ;
1571    06CA'  F8 00            RAND:   LDI 00
1572    06CC'  A8                       PLO R8
1573    06CD'  98                       GHI R8
1574    06CE'  3A D3'                   BNZ ON0
1575    06D0'  F8 FF                    LDI 0FFH
1576    06D2'  B8                       PHI R8
1577    06D3'  F6               ON0:    SHR
1578    06D4'  3B D7'                   BNF ON1
1579    06D6'  18                       INC R8
1580    06D7'  F6               ON1:    SHR
1581    06D8'  F6                       SHR
1582    06D9'  3B DC'                   BNF ON2
1583    06DB'  18                       INC R8
1584    06DC'  F6               ON2:    SHR
1585    06DD'  3B E0'                   BNF ON3
1586    06DF'  18                       INC R8
1587    06E0'  F6               ON3:    SHR
1588    06E1'  3B E4'                   BNF ON4
1589    06E3'  18                       INC R8
1590    06E4'  88               ON4:    GLO R8
1591    06E5'  F6                       SHR
1592    06E6'  98                       GHI R8
1593    06E7'  76                       RSHR
1594    06E8'  B8                       PHI R8
1595                                    EXIT
1596    06E9'  D5
1597                                ;
1598                                ;
1599                                .LIST
1600                                ;
1601                                    END
```

MACROS:

BCI	BXI	CALL	CID	CIE	DACI	DADC	DADD
DADI	DBNZ	DSAV	DSBI	DSM	DSMB	DSMI	DTC
ETQ	EXIT	GEC	IDLE	LDC	POP	PPAGE	PUSH
RLDI	RLXA	RNX	RSXD	SCAL	SCM1	SCM2	SPM1
SPM2	SRET	STM	STPC	TCAL	TRET	XID	XIE

SYMBOLS:

ASCHEX	0118'	ASCRD1	01AC'	BANGGR	00D4'	BR1ST	009E'
BTU	0000	CALL	0066'	CHK	068E'	CHKSET	0684'
CLOOP1	0479'	CNVRT	010E'	CONT1	0696'	CRC	0453'
CRCHI	5606	CRCLO	5607	CRCRAM	5605	CRCSUB	04BB'
CTOP	0065'	CTRL1	0003	CTRL2	0005	CTRL3	0007
CYCCNT	0008	DATA1	0002	DATA2	0004	DATA3	0006
DECCNT	028D'	DELAY2	0150'	DLY00	0040'	DMA	0000
DONE	00FF	DOTGR	00B7'	ENABLE	05D2'	ERRLST	06AD'
ERROR	02F3'	ETX	0003	FINIS	003A'	FORMT1	0012
GLOPG	0056	GP	5600	GPAGE	0007	GROUP	0001
GRPSAV	560A	GTR9	0230'	HALT	0006	HDSTRT	0000'
HELP	04E0'	HEXRD1	01BA'	HXCONV	0222'	IN$	0432'
IN1ST	02D6'	IN2ND	02E3'	IN4D	00FD'	IN4D2	0101'
IN4DT?	0234'	IN4RET	010D'	INADDR	02C0'	INCHAR	00B1'
INKWD	015C'	INLF	032D'	INTPC	0001	IOERR	0082'
IOLOC	56FE	IT3	0180'	KEEP2	00ED'	LDLOOP	0677'
LDSET	066D'	LIST	0006	LNEND	02AF'	LNTEST	02A6'
MATCH	0171'	MATCH2	0196'	MDONE	0639'	MEMCHG	0616'
MEMORY	0007	MEMSAV	0598'	MEMSUB	0610'	MENAB	0017'
MOV	0369'	MOVE	0336'	MOVRTN	0378'	NEWPG	001B'
NEXBYT	0286'	NEXPG	061A'	NEXT2	0184'	NEXT3	01A0'
NO	0424'	NOTHEX	0137'	NUMBER	0130'	OK?	0407'
OKRTN	0421'	ON0	06D3'	ON1	06D7'	ON2	06DC'
ON3	06E0'	ON4	06E4'	OUTADR	0274'	OUTASC	021C'
OUTCA	01E1'	OUTCHR	0249'	OUTHEX	01BF'	OUTPT1	021E'
OUTPT2	01B0'	PASSCA	0324'	PASSDN	069E'	PC	0003
PLEVEL	5602	PLIST	0162'	PMTCHR	003B	PROM1	0008
PROMPT	008E'	PTECT	05DA'	QUESGR	00C7'	QUESTN	025D'
RAMTST	0642'	RAND	06CA'	RBHI	5608	RBLO	5609
READDR	0085'	RTN	0076'	RTNPTR	0006	RTOP	0075'
RUN	03F5'	SAYCLR	04A3'	SAYNO	03F8'	SCRT	0057'
SCRTST	0056'	SEMI?	0310'	SETPG	05DE'	SETQ	062C'
SETQ1	002D'	SETSL	0007'	SETUP	003D'	SETURT	0047'
SHFTD4	013A'	SHIFT	013F'	STACK	0002	START1	000E'
STAT1	0003	STAT2	0005	STAT3	0007	STKEND	57DF
STKPG	0057	STORE	022B'	SYSFLG	5603	SYSTEM	0007
TARADR	081F	TEST	018B'	TEST$	0427'	TEST90	01A8'
TEST81	01B5'	TEST8D	01D4'	TEST9D	01E9'	TESTA1	01FD'
TESTA2	020E'	TESTCA	01DD'	TESTCR	031A'	TESTDD	01F2'
TESTSP	02FF'	THRE?	024F'	TMATCH	016B'	TSRE?	023A'
TTY	019D'	UARTS	0006	UNADDR	0084'	VBAD	03C7'
VCONT	03C2'	VERFY	037B'	VMORE	03BD'	VNEXT	03AB'
WAIT	0043'	WAIT3	0152'	WAIT4	023B'	WRITEM	02B7'
YES?	0415'						

NO FATAL ERROR(S)

ASCHEX 439 447# 832 851 860
ASCRD1 585#
BANGGR 338 384#
BCI 30#
BRIST 326 332#
BTU 106# 159
BXI 30#
CALL 30# 256 264# 313 316 323 332 353 369 384 425 437
441 512 546 589 609 616 630 639 658 668 685 698
713 744 752 764 772 790 799 809 827 830 834 837
844 849 855 858 862 870 873 885 891 900 906 918
930 940 947 960 970 981 992 1008 1030 1040 1049 1058
1074 1077 1089 1092 1100 1103 1128 1135 1141 1163 1175 1195
1209 1218 1274 1340 1354 1357 1375 1386 1401 1457 1473 1494
1518 1534 1539 1547 1553 1563
CHK 1518# 1528 1530
CHKSET 1508#
CID 30#
CIE 30#
CLOOP1 1190# 1200 1202
CNVRT 432 437#
CONT1 1525# 1568
CRC 376 1163#
CRCHI 135#
CRCLO 136# 1183
CRCRAM 134#
CRCSUB 1197 1231#
CTOP 263# 277
CTRL1 75# 238
CTRL2 76#
CTRL3 77#
CYCCNT 50#
DACI 30#
DADC 30#
DADD 30#
DADI 30#
DATA1 67# 402 412 708 717 734
DATA2 69#
DATA3 71#
DBNZ 30#
DECCNT 786 789#
DELAY2 417 499# 715 766 872 1076
DLY00 224#
DMA 41#
DONE 144# 634 877 1013 1098 1543
DOTGR 346 353#
DSAV 30#
DSBI 30#

DSM 30#
DSMB 30#
DSMI 30#
DTC 30#
ENABLE 1363 1367#
ERRLST 1524 1546#
ERROR 861 870# 896
ETQ 30#
ETX 143# 924 934 945 975 986 997 1097 1382 1391 1466 1478
EXIT 30# 433 466 469 492 506 521 539 553 568 581 688
718 737 912 1111 1114 1155 1267 1451 1595
FINIS 184 206#
FORMT1 62# 239
GEC 30#
GLOPG 111# 130 189 211 1428
GP 130# 132 133 134 135 136 137 138 139 141
GPAGE 49# 212 232 234 235 303 305 410 411 414 428 447
450 453 456 459 462 464 488 524 549 576 586 608
615 657 667 675 679 682 684 731 733 735 820 821
847 853 880 903 909 1106 1123 1124 1184 1187 1188 1139
1205 1207 1231 1234 1235 1241 1249 1446 1448 1449
GROUP 55# 179 207 236 1418 1450
GRPSAV 139# 231 1445
GTR9 681 691#
HALT 88#
HDSTRT 159# 1599
HELP 342 1274#
HEXRD1 596#
HXCONV 611 618 660 670 679#
IDLE 30#
INS 1128#
IN1ST 844# 848 868 882 888
IN2ND 855#
IN4D 422# 701 746 754 1130
IN4D2 425# 440 444 839
IN4DT? 641 698#
IN4RET 430 433#
INADDR 824# 833 894
INCHAR 397# 399 427 514 548 829 846 857 902 908 1105
INKWD 512# 531
INLF 906# 911
INTPC 42#
IOERR 298# 405 416 727
IOLOC 141# 409 575 732
ITB 334 355 371 386 546# 1359
KEEP2 401 409#
LDC 30#
LDLOOP 1494# 1503 1505
LDSET 1481# 1544

LIST 48# 516 519 520 528 529 532 550 559 560 1410
1412 1414
LNEND 805 807 809#
LNTEST 796 804#
MATCH 528#
MATCH2 558 562#
MDONE 1423 1445#
MEMCHG 1403 1417#
MEMORY 89# 196 1435
MEMSAV 344 1340#
MEMSUB 1410#
MENAB 178#
MOV 952# 957 959
MOVE 357 918#
MOVRTN 964#
NEWPG 183# 204
NEXBYT 785# 798 803
NEXPG 1422# 1443
NEXT2 550# 561
NEXT3 577# 592 619 635 642 661 671
NO 1108 1113#
NOTHEX 449 455 458 468#
NUMBER 452 462#
OK? 949 1089# 1143
OKRTN 1110#
ON0 1574 1577#
ON1 1578 1580#
ON2 1582 1584#
ON3 1585 1587#
ON4 1588 1590#
OUTADR 767# 813
OUTASC 664 673#
OUTCA 630#
OUTCHR 591 687 725# 730
OUTHEX 601# 626
OUTPT1 648 675#
OUTPT2 589# 676
PASSCA 887 893 900# 905
PASSDN 1532#
PC 44# 166 168 178 206 237 241 263 269 271 274 276
281 283 285 1417
PLEVEL 132#
PLIST 516# 518 527
PNTCHR 148# 320
POP 30#
PPAGE 30#
PROM1 107#
PROMPT 313# 348 363 378 392 788 808 878 898 950 964 1014
1083 1144 1217 1228 1333 1365 1404

PTECT 1361 1372#
PUSH 30#
QUESGR 336 369#
QUESTN 374 744#
RANTST 361 1457#
RAND 1496 1520 1536 1571#
RBHI 137#
RBLO 138#
READDR 298 302#
RLDI 30# 824
RLXA 30#
RNX 30#
RSXD 30#
RTN 258 282#
RTNPTR 47# 265 267 270 272 273 275 282 284 289 291 525
533 535 536 538 562 564 565 567 577 673 674 1146
1148 1151 1153
RTOP 281# 292
RUN 390 1068#
SAYCLR 1204 1218#
SAYNO 823 1074# 1127
SCAL 30#
SCM1 30#
SCM2 30#
SCRT 250#
SCRTST 169 249#
SEMI? 884 889#
SETPG 1371 1375#
SETQ 1426 1429 1431 1434#
SETQ1 187 190 192 195#
SETSL 162 165#
SETUP 211#
SETURT 231#
SHFTD4 443 473# 836 864
SHIFT 477# 485
SPM1 30#
SPM2 30#
SRET 30#
STACK 43# 253 255 264 286 287 308 474 534 537 563 566
597 601 602 603 612 613 624 707 716 728 747 759
760 762 767 780 781 783 1025 1145 1194
START1 167 171#
STAT1 68# 397 709 725
STAT2 70#
STAT3 72#
STKEND 125# 254 307
STKPG 112# 125 186 252 1425
STM 30#
STORE 684# 692

STPC 30#
SYSFLG 133# 302 819 1122
SYSTEM 82# 180 1419
TARADR 146# 1068 1300
TCAL 30#
TEST 552 556#
TEST$ 340 1122#
TEST80 579 583#
TEST81 584 594#
TEST8D 595 621#
TEST9D 629 637#
TESTA1 645 650#
TESTA2 651 663#
TESTCA 622 628#
TESTCR 890 895#
TESTDD 638 644#
TESTSP 852 880#
THRE? 728#
TMATCH 515 524#
TRET 30#
TSRE? 315 325 700 707# 1091 1102 1356
TTY 318 575# 632 774 792 801 811 875 920 932 942 962
972 983 994 1010 1032 1042 1051 1060 1079 1094 1137 1165
1177 1211 1220 1276 1342 1377 1388 1459 1475 1541 1549 1555
1565
UARTS 61# 208 233 1447
UNADDR 242 301#
VBAD 1019 1025#
VCONT 1020# 1063
VERFY 359 970#
VMORE 1005 1007 1016#
VNEXT 1004# 1023
WAIT 226# 228
WAIT3 500# 504
WAIT4 708# 712
WRITEM 388 819#
XID 30#
XIE 30#
YES? 1100#

Appendix M

The following program was written for a Hewlett - Packard HP-16C calculator. It is used to convert data in the Sea Duct buffer to engineering units. Before running the program, Calculator Register .0 must contain the A/D GND value and Register F must contain the A/D +5V value. The calculator must be placed in the HEX mode before each conversion.

Calculator subroutines A, B, C and D are run to give the following conversions:

A = A/D conversion (12 bit)
B = Battery conversion (8 bit)
C = Compass conversion
D = Pendulum conversion

For example to convert an A/D value of 3F8 to engineering units, (assume A/D GND = 009 [R.0] and A/D +5V = FE1 [R F.])

1. Press HEX
2. Enter 3F8 - There is no need to hit ENTER
3. Press GSB A
4. Read the answer in the appropiate units (1.24063 Volts for this example).

To convert a compass value of 2C to degrees,

1. Press HEX
2. Enter 2C - There is no need to hit ENTER
3. Press GSB C
4. Read the answer in the appropriate units (61.88 degrees for this example).

HP 16C - Sea Duct Programs

A = A/D conversion (12 Bit)	HEX to Volts
B = Battery conversion (8 bit)	HEX to Volts
C = Compass	HEX to Degrees
D = Pendulum	HEX to Degrees

Note: First store A/d GND in R0, A/D +5V in RF in HEX mode

```
001      43,22, A          LBL-A        A/D Program
002         21, 8          GSB 8
003             4              4
004            48              .
005             9              9
006             9              9
007             7              7
008            20              X
009         43,21          g RTN
```

```
010     43,22, B        LBL-B          Battery Program
011        21, 9        GBS 9
012        21, 8        GBS 8
013           3             3
014           0             0
015          20             X
016       43,21        g RTN

017     43,22, C        LBL-C          Compass Program
018        42, 3       f UNSGN
019          36         Enter
020           0             0
021     42,45, 2       f float 2
022           3             3
023           6             6
024           0             0
025          20             X
026           2             2
027           5             5
028           6             6
029          10             ÷
030       43,21        g RTN

031     43,22, D        LBL-D          Pendulum Program
032          36         Enter
033           0             0
034     42,45, 2       f float 2
035           2             2
036          20             X
037           4             4
038           5             5
039          30             -
040     43,   21        g RTN

041     43,22, 8        LBL-8  Scale 12 bit #(HEX) to Decimal Routine
042        42, 3       f UNSGN
043          36         Enter
044       45,.0         Rcl.0 (Recall A/D Gnd)
045          30           -
046          36         Enter
047           0             0
048     42,45, 2       f float 2
049       44,.1        Store .1
050          23          HEX
051       45, F         Rcl F. (Recall A/D +5V)
052          36         Enter
```

```
053        45,.0          Rcl.0
054           30            -
055            0              0
056     42,45, 2       f float 2
057        45,.1       Recall .1
058           34             XY
059           10              ÷
060     42,45, 5       f float 5
061        43,21          g RTN

062     43,22, 9          LBL-9    8 bit to 12 bit conversion routine
063        42, A          f SL
064        42, A          f SL
065        42, A          f SL
066        42, A          F SL
067        43,21          g RTN
```

APPENDIX N

SEA DUCT PRE-LAUNCH CHECK LIST

Deployment Date _____

Location _____

Depth _____

1. MAIN BATTERY PACKS

Pack #1		Initial
A.	Safety Chain On _____ Off_____	_____
B.	Top of Compensation Oil (Marcol)	_____
C.	Check water sump drain plugs for security	_____
D.	Tie wrap any loose hoses or electrical cables	_____
E.	Check microprocessor for security in cradle	_____
F.	Check microprocessor compensation diaphragm for top off (Marcol)	_____
G.	Check microprocessor electrical plugs for full seating, milk air from connector if necessary	_____
H.	Check microprocessor electrical cables; tie wrap if necessary	_____
I.	Check all tea cup diaphragms for leakage at wires and seals. Top off as required (5 places) White (Marcol) Red (Mil H5606 Hyd. fluid)	_____ _____ _____ _____ _____
J.	Back fill battery disconnect with (Marcol) Use disconnect at base of battery to force all air thru plastic check valve. Reconnect to drain fitting	_____
K.	Remove battery gas vent line	_____
L.	Install disconnect plug in battery gas vent fitting	_____
M.	Remove overflow can	_____
N.	Check pinger battery voltage	_____
O.	Reset pinger and reinstall dummy plugs	_____

Pack #2		Initial
A.	Safety Chain On _____ Off_____	_____
B.	Top of Compensation Oil (Marcol)	_____
C.	Check water sump drain plugs for security	_____
D.	Tie wrap any loose hoses or electrical cables	_____
E.	Check emergency battery pack for security in cradle	_____
F.	Check EHRS battery voltage Check MP battery voltage	_____ _____
G.	Check emergency battery wiring and plugs for proper seating, milk air if necessary, cap unused plugs and wires	_____
H.	Check all tea cup diaphragms for leakage at wires and seals, top off as required (3 places) white (Marcol) red (Mil H5606 Hyd. fluid)	_____ _____ _____
I.	Back fill battery disconnect with (Marcol) Use disconnct at base of battery to force all air thru plastic check valve. Reconnect at drain fitting	_____
J.	Remove battery gas vent line	_____
K.	Install disconnect plug in battery gas vent fitting	_____
L.	Remove overflow can	_____

Pack #3		Initial
A.	Safety Chain On _____ Off_____	_____
B.	Top of Compensation Oil (Marcol)	_____
C.	Check water sump drain plugs for security	_____
D.	Tie wrap any loose hoses or electrical cables	_____
E.	Check emergency release control canister for security in cradle	_____
F.	Check emergency release wiring and plugs for proper seating, milk air if necessary, cap unused plugs and wires	_____
G.	Check cylindrical vertical reservoir for security in cradle	_____
H.	Check all 1/8 inch st/sl tube and gland nuts for tightness	_____
I.	Back fill relief valve vent tube loop with oil (Marcol)	_____
J.	Check all electrical cables for security, tie wrap if necessary	_____
K.	Check all tea cup diaphragms for leakage at wires and seals. Top off as required (4 places) white (Marcol) red (Mil H5606 Hyd fluid)	_____ _____ _____ _____
L.	Back fill battery disconnect with (Marcol) Use disconnect at base of battery to force all air thru plastic check valve. Reconnect at drain fitting	_____
M.	Remove battery gas vent line	_____
N.	Install disconnect plug in battery gas vent fitting	_____
O.	Remove overflow can	_____
P.	Check pinger battery voltage	_____
Q.	Reset pinger and reinstall dummy plugs	_____

Hydraulic Canister		Initial
A.	Top off canister with (Marcol)	____
B.	Check all seals and fittings for leakage	____
C.	Check all electrical cables for leakage at Dancos	____
D.	Check all electrical cable for security; tie wrap as necessary	____
E.	Back fill relief valve hose loop with (Marcol)	____
F.	Remove top vent line from over flow can; plug male disconnect into female disconnect on PVC relief valve mounting block	____
G.	Disconnect compensation regulator sense line at canister base, plug in free flow male disconnect fitting to assure regulator feels ambient sea water pressure	____
H.	Install dead ended female disconnect into sump sense line male fitting	____
I.	Open valve at N_2 compensation accumulator. 1/2 to 3/4 turn is sufficient. Do not open further; a stem leak could occur.	

Relay Canisters		
A.	Check all seals and fittings for leakage	____
B.	Check all electrical cables for leakage at Dancos	____
C.	Check all electrical cables for security; tie wrap as required	____
D.	Top off all canisters as necessary (use Marcol)	____

Main Junction Box — Initial

A. Check all seals and fittings for leakage ____

B. Check all electrical cables for leakage at Dancos ____

C. Check all electrical cables for security; tie wrap as required ____

D. Top off all canisters as necessary (use Marcol) ____

E. Insure all functions are "off" on external manual control. Remove external test box plug. Clean `O` ring and install test plug cap. Be sure `T` handle plug is centered; a leak will occur if the plug is not centered in the step machined in the cap ring. Install dummy plug on 4-bin Brantner connector. ____

N_2 Compensation Systems

A. Pressurize recirculating pump motor accumulators with 3,000+ psi N_2 ____

B. Pressurize hydraulic pump motor with 3,000+ PSI N_2 ____

C. Check all lines and valves for leakage ____

D. Back fill accumulator diaphragms with water base hydraulic fluid as required ____

Insert/Retract System

A. Check hydraulic cylinders and hoses for leaks ____

B. Check cable and turnbuckler for security and freedom of motion ____

C. Check cable to assure they do not hang slack; adjust if necessary ____

D. Remove 3 lock clamps ____

Interface Junction Boxes (5" x 9")

A. Check for fluid leakage at seals, wires and dancos ____

B. Back fill with (Marcol)
Four located on rotary frame A____ B____ D____ G____
Three located on main structure C____ E____ F____

Bottom Contact Switches — Initial

A. Check for freedom of motion and smooth operation

1. One bottom contact switch with contact weight ____
2. One rotary frame retract switch ____
3. Four test section insert switches ____

Hydraulic System Accumlators

A. Check accumulators for leakage at fittings and diaphragms ____

B. Cylindrical accumulator has piston with (Red Mil H5606) on system side, (water base hydraulic fluid in flexible diaphragm) ____

C. Flexible accordion diaphragm assembly has (red Mil H5606 hydraulic fluid only). Replacable filters are located in the upper PVC cap. ____

Water Vent Flapper Tees

A. Check flapper valve freedom of motion (8 flappers) ____

Window and Lens Cleaning

A. Clean camera lens ____

B. Clean transmissometer glass ____

C. Remove plywood safety covers from test section top ____

D. Clean upper test section glass ____

E. Clean side ports in test section ____

F. Clean photo flash port ____

Rotary Mechanism

A. Check hydraulic cylinders and hoses for leakage ____

B. Check drive chains for lubricant ____

C. Check F/G cover cap for security ____

Camera System — Initial

A. Charge camera battery pack ____

B. Install film, set data chamber ____

C. Charge photo flash battery pack ____

D. Install assemblies on x-y-z traverse mechanism ____

E. Install control cables; tie wrap as required ____

F. Turn on switch ____

Water Samplers

A. Hydro products butter-fly

1. Install bag ____

2. Cock mechanism ____

3. Hook up sample tube at test section port ____

4. Remove safety clamp ____

B. Hydro products chop-stik baggie

1. Install bag ____

2. Wind up spring mechanism ____

3. Cock latch mechanism ____

Sediment Samples (two)

1. Retract hydraulic cylinder until it bottoms out ____

2. Retract closure doors; install safety lock link (two) ____
CAUTION—*Do not put hands or fingers into opening at base of sampler.*

3. Install release cable loop eyes on release pins ____

4. Rotate release pin mechanism until cable eyes are secure ____

5. Carefully remove safety lock link ____

Battery Charge Junction Box (A) — Initial

1. Check penetrator caps (4) for full seating; milk air from connector cap if necessary (4 places) ____

Shore Power Junction Box (B)

1. Check penetrator cap (1) for full seating; milk air if necessary; check Danco connectors ____

Recirculating Pump Motors (two)

1. Check Danco electrical plugs for security ____
2. Check plastic N_2 compensation line for collapse water tie wraps; correct if required ____
3. Check plastic N_2 compensation line for cracks at inlet fitting to motor ____
4. Open valve at N_2 compensation accumulator, 1/2 to 3/4 turn is sufficient. Do not open further; a stem leak could occur. ____

Hydraulic Flow Dividers (two at center line of structure)

1. Visually inspect cylindrical PVC housings and large top hat bladder for leakage ____
2. Check tube fittings at top of both assemblies for leakage ____
3. Top off compensation fluid in both assemblies; use Mil-H-5606 (Red) ____

Recirculating Pump Motor Controller

1. Check electrical plugs for proper seating; milk air from caps if necessary ____
2. Check mechanical security of pressure housing ____