NORDA Technical Note 60

Operation and Maintenance Manual for the XBT Data Acquisition System

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DISCLAIMER NOTICE

EXECUTIVE SUMMARY

The Ocean Programs Office (Code 500) of the Naval Ocean Research and Development Activity (NORDA) provided funds in the fall of 1978 to the Ocean Science and Technology Laboratory (Code 350) for the development of a versatile XBT Data Acquisition System. The expendable bathythermograph (XBT) device is used extensively to obtain ocean temperature profiles at selected locations. Relatively recent interest in the mixing and energy propagation mechanisms of the upper mixed layers of the ocean requires the collection of thermal data at rates and accuracies greatly exceeding the capability of commercially available XBT equipment. The purpose, then, of this development was the creation of a very flexible system that could be software programmed to collect XBT data from one to four probes falling simultaneously or in rapid succession at data rates of up to 20 samples per second per probe. The system resolution is 0.01°C.

This manual describes the functional operation, interconnections for system set-up, calibration procedures, and library operating programs of the developed system. The system is quite flexible in that the user can easily modify any of the library programs or develop new programs which tailor the system performance to his specific needs. Considerable redundancy has been provided in the design so that failures can be quickly bypassed; and the electronics are modularly constructed so that repairs can be effected by rapid replacement. In addition to collection and storage of raw data, the system has the ability to make off-line conversions to engineering units and presentation of the converted data in numerous printed and plotted formats for assessment of quality and completeness. These "data looks" can also be used to fine tune an experiment scenario on site in order to maximize results.

Immediately after completion of the system, it was utilized aboard USNS KANE to support an internal wave study's portion of HYDRO 79. The result of this and other data collection and analysis efforts is reported in NORDA Technical Note 58 entitled, "Oceanic Environmental Background Observations in the Sargasso Sea During September 1979". The system has also been used aboard the USNS LYNCH during the ATOM I experiment in December 1979 and January 1980. The results of this experiment should be published in a NORDA report in late FY 80. During these two at-sea operations, the XBT Data Acquisition System demonstrated extremely reliable operation with the only failure occurring in the backup tape recording unit.

This system is available to ocean researchers. Those having an interest in making use of this system should contact the Ocean Programs Office at NORDA.

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1.0 Introduction

1.1 System Purpose

The XBT Data Acquisition System has been designed to facilitate rapid collection of ocean thermal data from one to four vertically descending sensor probes. The system is capable of operating in a number of modes and is sufficiently general purpose to permit interfacing with other oceanographic sensors if such should become desirable in the future.

1.2 System Features

The System accepts XBT data from up to four launch stations as shown in Figure 1. The Launch Stations contain signal conditioning circuitry which amplifies the weak temperature sensor signal and sends it over an interconnecting cable to the Data Interface Unit. Circuitry is also provided at the Launch Station to audibly notify the operator when to load and launch an XBT probe.

The Data Interface Unit accepts the analog signals from each of the Launch Stations and performs additional signal conditioning prior to conversion to digitized values. This conditioning consists of signal biasing and further amplification so that selected portions of the temperature range can be recorded with maximum resolution. In the present configuration, the temperature range is 10°C to 30°C with a maximum resolution of 10 millidegrees (0.01°C). Circuitry is also

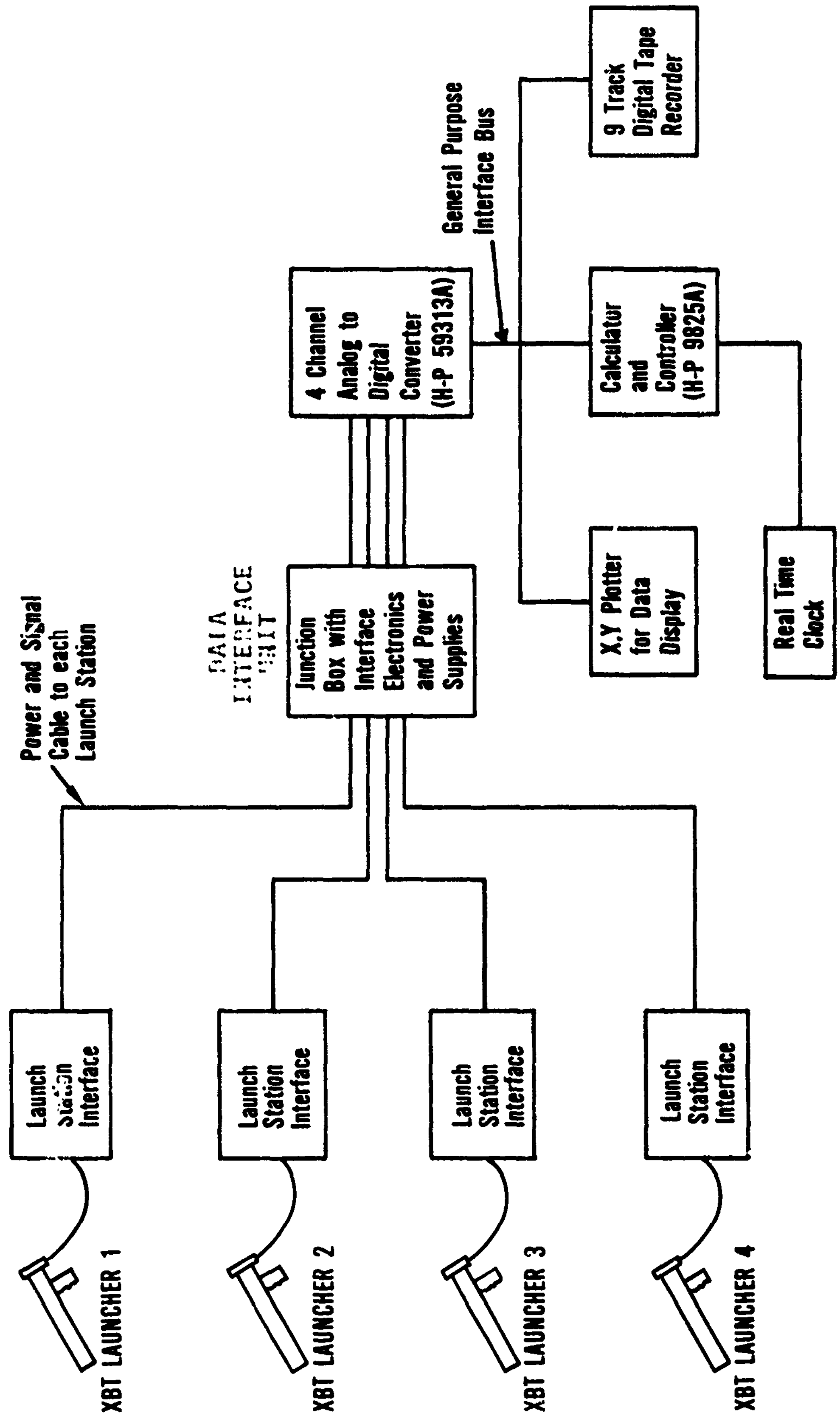


FIGURE 1 - XBT SYSTEM BLOCK DIAGRAM

provided in the Data Interface Unit for generation of the load/launch commands and for powering of Launch Station and Data Interface components.

The Data Interface Unit sends the conditioned signal from each launch station to a channel of the four channel analog-to-digital (A/D) converter. The four channel A/D operates under program control of the HP9825 calculator and converts the analog signal from each active launch station into digitally coded values at the programmed sample rate of 20 samples per second per channel.

Each digital output from the A/D converter is transferred via the data bus into the HP9825 calculator for examination and storage. During the various data collection modes, the calculator determines when to take data, what channels are active, what data is valid, and where the data should be stored until it is needed for quality assurance inspection. Details of the programs written for collection of XBT data are contained in section 3.0 System Operation. During a data collection operation, valid data is stored on cassette tape within the HP9825 and on 9-track digital tape.

Once a data collection period has been completed (for example,a leg of data stations) the stored data can be recalled for formatting, calculation, and plotting on the X-Y plotter. Plotting routines have been supplied (see section 3.3) which permit graphing of the data in two ways. The first allows each temperature data point to be plotted as a function of depth for a given probe and for successive probes to be plotted with an off-set so that the time series of temperature profiles can be examined. The second routine permits plotting of the temperature deviations about mean temperature values thus yielding plots of temperature variability as a function of depth. Successive plots are also made by the second routine for inspection of the time series.

1.3 Performance Characteristics

The XBT Data Acquisition System in the present hardware/software configuration performs with the following characteristics. It should be noted, however, that these characteristics are not fixed and can be widely varied to suit other data collection requirements.

1) The system has four identical launch stations, each capable of being connected to a hand-held launcher. The launchers and launch stations are capable of handling any of the Sippican T series probes; however, software programs have been provided only for T 7 and T 11 types.

2) Each of the four launch station channels is calibrated to accept temperature data between +10°C and +30°C with a resolution of 1 part in 2000 (0.05%).

3) The sample rate is approximately 20/second, with each sample being time related to any other sample of that particular probe profile to within ± 50 milliseconds.

4) Launch Stations (data channels) #1 and #2 are designated for launch of T 7 probes, with one and only one T7 probe allowed in the water at a time. Launch Station #3 is designated for T11 probes only. Launch Station #4 is a spare.

5) A T7 probe can be launched at any time (see Section 3.0 for

details). The next T7 can be launched as soon as the calculator records the previous probe data and so alerts the operator.

6) A T11 probe can be launched at any time,provided it is synchronized with a T7 launch and the system operator has activated this special mode (see Section 3.2).

7) Collected temperature data is recorded on the calculator's cassette tape and on an external 9 track digital tape in raw form and scaled engineering units. During some modes of data collection, small gaps of a few seconds duration will occur in the recorded data; each data point recorded can be time positioned to within ±0.05 seconds, however, for each profile.

8) Data quality assurance programs have been provided which permit graphical plotting and inspection of the temperature profiles and the variations about profile means (see Section 3.3 for details).

2.0 System Configuration

2.1 System Interconnections

Figure 2 illustrates the cable interconnections that need to be made between each of the functional units. The following considerations will assist in properly configuring the system:

1) The Launch Station to Data Station cables are identical with the cable ends having three color coded wires with spade lugs. The cable end connected to the Launch Station must have these wires connected to the terminal strip on the box such that each color is matched to a like color on the handheld launcher cable, except that the black wire is not connected; i.e., only the red and green wires are connected to the handheld launcher red and green wires. For any Launch Station not

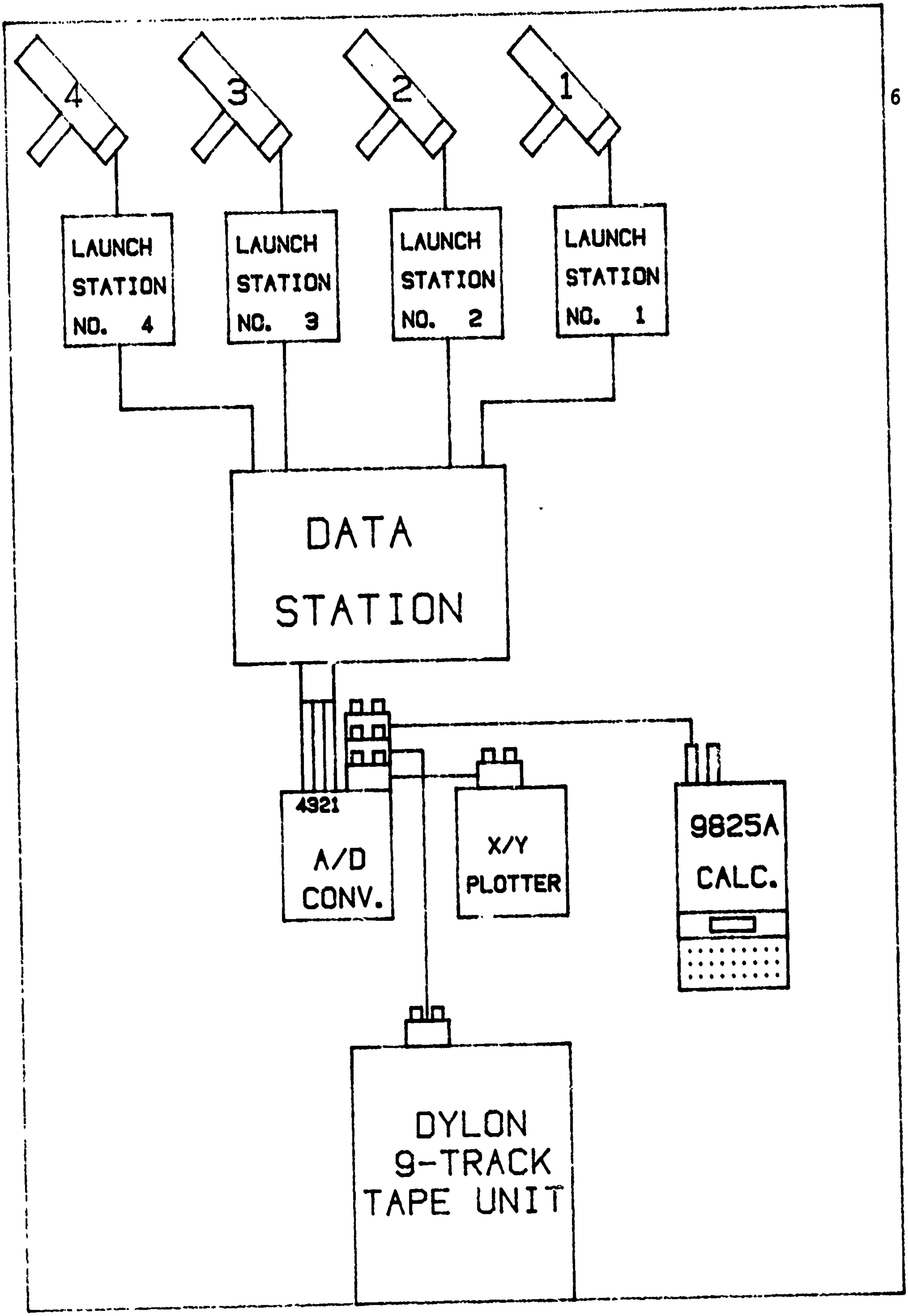


FIGURE 2--XBT SYSTEM CABLE INTERCONNECTIONS

connected to a handheld launcher, connect a calibration resistor selected from Table 1 Section 3.2 across the red and green wires. For each Launch Station connected to a handheld launcher, insure that an XBT probe is loaded prior to conducting any calibration checks.

2) Remember that whichever Launch Station is connected to Data Station #1 connector becomes Launch Station #1.

3) Connection between the Data Station and the A/D converter is via four individual cables and phono plugs. Each plug is numbered as to the channel it must be plugged into on the rear of the A/D converter. Swapping of these phono plugs between A/D channel inputs should only be done to work around hardware faults in the Data Station as discussed in Section 4.1.

4) Connections between the HP9825 calculator and the various peripherals (A/D converter, plotter, and 9 track digital tape recorder) can be made "daisy chain" or "star". The HPIB interface plugs into any one of the three slots at the rear of the 9825 and the other end connects to any one of the peripherals. HPIB interconnect cables are simply stacked on top of the interface cable end connector and routed to the other peripherals for their connection to the bus.

5) For the HP9825 calculator to function properly it must have a real time clock module plugged into one of the three slots at the rear of the unit and the following Read Only Memories (ROMs) plugged into slots at the front of the machine just below the keyboard: String-Advanced Programming and 9872A Plotter-General I-O - Extended I/O.

6) In making power connections to each of the electronic enclosures it is very important to connect each unit to the same phase of

the 115VAC 60HZ power system to prevent troublesome AC power ground loops. It is recommended that all units be plugged into a power strip and the strip be plugged into a single power source outlet. If this measure does not completely remove power ground loops, it is recommended that an isolation transformer of 500 VA rating or greater be placed between the power strip and the power source outlet.

7) Grounding is very important to proper operation of the XBT Data Acquisition System. Signal and power grounds and shields have been carefully carried through the system to a single point on the chassis of the Data Station. The ground post located near the power socket should be connected via a ground wire of AWG #14 or #16 to a bright clean hull (ship) ground. CAUTION: The importance of this hull ground being of high quality cannot be overemphasized.

2.2 Location of Launch Stations

The four identical Launch Stations are completely portable and can be located anywhere desired. The present system is supplied with 100 foot cables for each Launch Station but longer cables could be used if desired. In locating the Launch Stations, the following considerations will be helpful:

1) The Launch Station operator is alerted for "load" and "launch" operations audibly, therefore, the Launch Station should not be located next to loud sources of extraneous noise.

2) The Launch Station is moisture resistant and relatively splash

proof; however, because of the connections required for the hand held XBT probe launcher the connection terminal strip is exposed. Once connections are made, the strip should be coated with a layer of RTV for waterproofing. In addition, it would be wise to place the box at a location protected from sea spray, rain, and direct sunshine.

3) The Launch Station enclosure is part of the system electrostatic shield and should not be permitted to touch the metallic hull; otherwise ground loops may result. Rubber insulating feet have been provided on the enclosure bottom to prevent contact with the hull and an insulating coating applied to the top and sides, but care should be taken to insure that objects do not touch or rest against the box.

2.3 Power and Cooling Considerations

All necessary Launch Station power is provided by the Data Station through the interconnecting cabling. The Data Station is powered from the same internal supplies that power each of the Launch Stations. All other units in the system contain their own internal supplies. The Data Station, Calculator, and peripherals are in turn supplied by 115VAC 60HZ 1Ø power. The 115VAC supply should be clean of transients and reasonably well regulated. This 115VAC source should be suitable for operation of computer equipment.

Cooling will not be a problem for those items located in air conditioned spaces such as the Data Station, Calculator, and peripherals. Some care needs to be exercised for the Launch Station, however. The

Launch Station is sealed rather tightly to inhibit moisture penetration, and therefore also inhibits the escape of heated air. The Launch Station box should be kept in a shaded area if at all possible where ambient air is free to circulate around the enclosure.

2.4 Cautions Concerning Grounds

XBT operating environments are usually quite noisy electrically. This electrical noise can cause significant signal errors and even failure of equipment operation. Because the XBT probes require a return signal through the seawater and ship's hull, considerable attention must be paid to shielding and the prevention of ground loop currents. The following cautions are advised:

1) The Launch Stations should be insulated from any metallic surface by resting only on its rubber feet. No metallics should touch any portion of the housing (box).

2) The Data Station should be grounded to the hull at one point only and the quality of this ground should be very good.

3) All 115VAC power connections should be made to a single power strip and the strip plugged into a source of computer grade power. If ground loops do appear to occur, then an isolation transformer should be used between the strip and the computer grade power source.

4) Peripheral units may have to be insulated from conducting surfaces. Particular attention should be paid to the potential need to insulate the 9 track tape recorder from hull ground.

3.0 System Operation

CAUTION - Before attempting to load programs into the calculator or perform any system operations, be sure that the system interconnections specified in Section 2.1 have been made.

3.1 Loading Programs

Prior to actual loading of software programs into the calculator's memory, it will be necessary to perform the following set-up steps:

1) Place the POWER switch on the Dylon Model 1015A Magnetic Tape Formatter into the ON position.

2) Push the red POWER button on the DYLON/CIPHER Tape Drive Unit so that it lights up.

3) Load a blank 9-track data tape onto the bottom spool of the Tape Drive Unit and thread the tape onto the upper spool by following the arrows painted on the Tape Drive Unit. (NOTE: Make sure that the WRITE ENABLE ring is attached to the tape).

4) Push the LOAD button on the Drive Unit and the tape should tension itself. If it does not, try pushing the button again. The tape should proceed to the load point after the next step, and only then will the LOAD botton light up.

5) After the tape has tensioned, push the LOAD button again. The tape should proceed to the LOAD point and stop; then the LOAD button should light up. (NOTE: If the tape refuses to stop within about 15 seconds, press the REWIND button while the tape

is still moving and the same effects will be achieved).

6) Now press the ON LINE button so that it lights up. The 9-track digital tape recorder is now ready to receive or send data.

7) Next place the POWER switch on the A/D Converter into ON position.

8) Place the AC LINE switch on the right side of the calculator into the LINE (ON) position. The "lazy T" (⊢) should appear on the left-hand side of the small display screen.

9) Type the following on the calculator and press EXECUTE: (NOTE: Do not type the slash marks. Slash marks will be used to bracket items which must be typed into the calculator exactly as written).

/wrt 704, "QY"/ The tape should move and the FILE MARK DETECTED light should come on. (If this does not work, power down the tape unit and start the procedure again.)

10) Insert the PROGRAM TAPE (with RECORD tab in the RECORD position) into the slot to the left of the display screen. The writing on the label of the cassette should be readable (not upside-down). The cassette will click into place almost flush with the surface surrounding the slot.

11) Type in the following and press the EXECUTE key after each one:

/erase a/

/ldk 0/ (that is a zero, not an "O")

12) Whenever a new tape is being used for the first time on the

9-track Dylon/Cipher tape recorder the following must be entered along with the commands of step 11:

/1→Y/ (That is a one, not an "L")

Now press special function key f10

The System is now ready for a program load. The next command should be /ldf A/, where A is the file number of one of the programs listed in Section 5.2.

3.2 Performing System Tests

In a normal start-up sequence where the System has just been installed aboard a ship and is being configured for XBT data collection, the following sequence of activities should be used:

1) /ldf 5/ This loads the address check program which tests each peripheral for proper connection to the BUS and for proper address setting.

When using this test program or any other of the programs, it is a general rule that if the program has obviously stopped, as indicated by the absence of a RUN light in the upper left-hand corner of the display screen, the operator should press the CONTINUE key to start the next segment of the program. Now, press RUN to start the program that checks the address settings on the different peripherals. If any part of this program fails to respond properly, consult the checklist that follows:

GENERAL:

a. Are all connections in the right places and solidly connected and anchored?

b. Is the HP-IB interface bus fully inserted into the rear of the calculator?

c. Was the plotter power off during the address checks on the other peripherals?

DYLON:

a. Is the cable connecting the rear of the Magnetic Tape Formatter and the Tape Drive Unit connected properly?

b. Are the POWER and READY lights on the Formatter lit?

c. Are the POWER, ON LINE, and WRT EN lights on the Tape Drive Unit lit?

A/D CONVERTER:

a. Is the power light lit?

PLOTTER:

a. Is the LINE light on the plotter lit?

b. Is the CHART LOAD button on the plotter unlit?

If all of the above conditions have not been met, then one or more of the peripherals probably has the wrong address. Check for the following addresses:

HP-IB Interface Bus---------------------7

Plotter---------------------------------7

A/D Converter---------------------------6 (Set internally)

Dylon Magnetic Tape Formatter-----------4

Dylon Tape Drive Unit-------------------5

2) With the addresses all checked and properly set next push the ERASE and EXECUTE keys thereby clearing the calculator.

3) Now type in /ldf6/ and press EXECUTE thereby loading the Real-time clock setting program. Press RUN, CONTINUE, and answer the question "Want to change date and time?" with a /y/. Set the clock to the current date and time according to the program directions. If you wish to sync the clock to some time standard, enter the time including seconds but do not push the last CONTINUE until the instant that set time occurs on the standard. After you enter the seconds and push CONTINUE, the calculator will pause for a short time (10 to 25 seconds) and will then display the time just entered until it is stopped using the STOP key.

4) Make sure that the plotter is turned off for the next series of tests.

5) Push the ERASE and EXECUTE keys.

6) Type in /ldf7/ and press the EXECUTE key thereby loading the calibration program. This program is divided into two parts. The first part permits a calibration check of the analog to digital converter using its internal calibrator. A small-tipped, flat-bladed screwdriver will be needed and all four signal plugs from the Data Station must be removed for this test prior to pressing CONTINUE. The program will automatically step through each channel after RUN is pushed and check the setting, with about 30 seconds permitted for adjustment. With the calibrate switch on the back of the A/D set to zero each channel can be checked and set to zero. After the zero check, the calibrate switch should be set to -500 and CONTINUE pressed. The program will now sequence through all

channels again pausing about 30 seconds to permit adjustment of gain so that the calculator screen displays -500 for each channel tested. After the A/D calibration section of the program is finished, the message, "Test Complete" will appear on the screen; just press the CONTINUE key to use the second half of this system testing program. (Replace signal plugs and apply power to the Data Station.) The second half of this File 7 program permits a total system calibration from the probe output (a thermistor resistance) to the calculator input by using known resistance values as inputs and then setting the Bias and Gain adjustments on the Data Station Channel Cards for the correct calculator display. The procedure is somewhat involved and is described in step-by-step detail in Section 4.2.4. A simple but very accurate check can be made of the need to calibrate any specific channel by using the fixed resistors listed in Table 1. With power applied to the Data Station operate all LOAD/LAUNCH red paddle switches as specified in the Caution and Warning statements under Step 3 of Section 3.3 to minimize calibration errors. Now connect one of the resistors selected from Table 1 across the red and green wires of the Launch Station. No other connection should be made to the Launch Station red wire except one end of the selected resistor; no other connection should be made to the green wire except for the other end of the selected resistor. A clip lead should now be used to connect the Launch Station black wire to the green wire. Once these connections are complete, answer the program questions concerning channel number, display type, display mode, and display speed. NOTE: As to display type be sure to select TEMPERATURE and not counts. When all questions have been answered, the calculator should display the temperature value shown in Table 1 corresponding to the calibration resistor selected ±0.010°C. If a temperature reading of more than 10 millidegrees error is found, the calibration procedure of Section 4.2.4 must be followed for each channel requiring calibration.

TABLE 1--Calibration Resistors and Equivalent Temperatures

Resistor Marking	Resistor Value	Equiv. Temp.
Black Back	5K ohms	24.993°C
"	6.32K ohms	19.740°C
"	8.1K ohms	14.340°C
Red Back	5K ohms	24.998°C
"	6.32K ohms	19.735°C
"	8.1K ohms	14.337°C
Red Top	6.32K ohms	19.760°C

The System Tests have now been completed and the System is ready to collect data using one of the data collection programs provided.

3.3 Collecting Data From Probes

Three separate programs have been supplied for collecting data from the XBT Probes; they are: The main program (see Section 5.9 for details); the main program without the use of the 9-track tape recorder (see Section 5.10); and the main program with only 3 available Launch Stations or channels (see Section 5.11).

The utilization and operator interaction with each of these three programs is quite similar and will normally proceed as follows:

1) With the System properly installed aboard ship, interconnected, and tested, the operator will select and load the desired

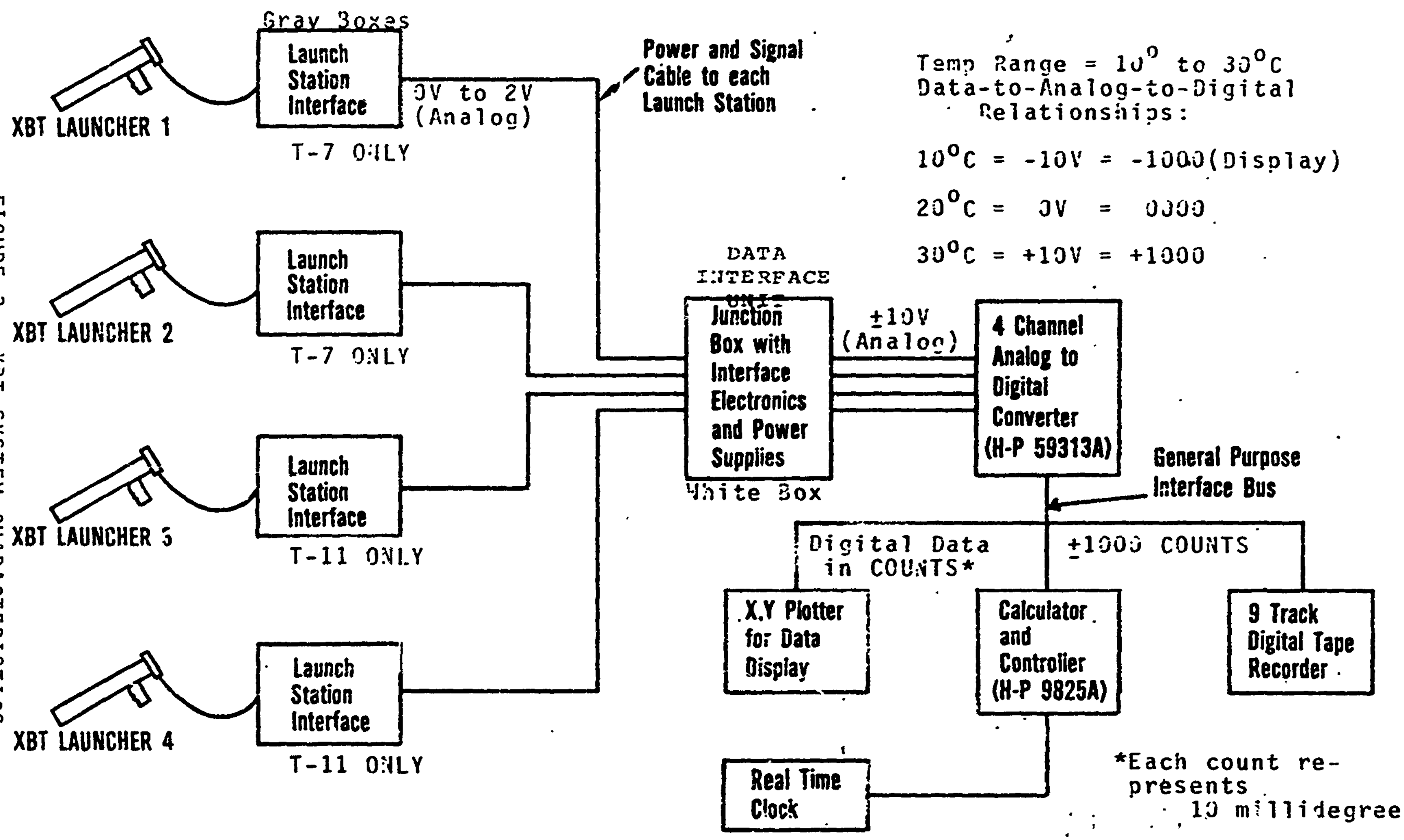


FIGURE 3 - XBT SYSTEM CHARACTERISTICS

operating program from the Program Tape, usually File 8 (see Section 3.1 for steps in loading programs).

2) With the selected operating program loaded into the calculator's memory and the run mode initiated, the program will initialize all necessary conditions and then display a "PRESS CONTINUE TO INITIATE TEST" message to the operator. At this point the system is fully ready to collect data and will begin such collection as soon as the CONTINUE key on the calculator keyboard is pressed.

3) It is now necessary to set up the Launch Stations for the loading and then launching of the proper probes. Launch Stations 1 and 2 (channels 1 and 2) are reserved for T7 type probes while Launch Stations 3 and 4 (Channels 3 and 4) are for T11 probes. At program initiation Launch Station 1 is automatically selected for the first T7 launch and Launch Station 3 for the first T11 launch. There are four red paddle switches on the front of the Data Station which permit the System operator to send LOAD and LAUNCH commands to the individual Launch Station operators. To send a LOAD command to each Launch Station, the System operator pushes the paddle switch handle for that Station to the LOAD side. This action generates a slow on-off tone at the Launch Station signaling the operator to load an XBT and standby for launch. When the Launch Station operator has loaded his hand-held launcher, he presses the reset button next to the tone generator on his Launch Station to signal the System operator that a probe is loaded and ready for launch. The pressing of the reset button turns off the small light next to the paddle

switch which was actuated thereby giving the System operator positive indication that the LOAD message was received and executed. At the beginning of a data collection period, both Launch Stations of the type probe to be launched (T7 or T11) should be loaded so that if the first probe fails a backup probe can be quickly launched. If T7 and T11 probes are to be launched simultaneously then all four launchers must be loaded.

CAUTION: To insure that LOAD and LAUNCH signals sequence properly it will be necessary to initially set all paddle switches to LOAD and have each Launch Station reset; then switch all to LAUNCH and obtain resets; then return all paddles to the center off position. This initial check will synchronize the signals and provide a complete check of their operation.

WARNING: During the generation of LOAD and LAUNCH signals, additional noise is introduced onto the data signal lines thereby degrading System resolution. LOAD and LAUNCH signals should be generated when data is <u>not</u> being collected to the maximum extent possible and once confirmation of the command has been received by the system operator, the paddle switch should be returned to the center off position. <u>If a T7 and T11 launch is to be performed, be sure to read "NOTE:" on the following page.</u>

4) With the appropriate Launch Stations loaded and ready for launch, the System operator need only decide when to launch the desired probe(s). The CONTINUE key on the calculator shoul causing the calculator to begin "looking" for valid data.

5) Next the LAUNCH command should be sent to the appropriate Launch

Station. As soon as acknowledgement is received the paddle switch should be returned to the center off position.

6) At approximately the same time that launch is acknowledged, the calculator should print the start time of the probe data collection sequence. No printed start time means that valid data was not achieved after the commanded launch signifying that either the probe was not launched as commanded or the probe failed prior to generating any valid data. In this case we assume a failed probe and press the calculator STOP key followed by the Special Function Key f4 if a T7 only probe was launched or f12 STOP f5 if both a T7 and T11 probe were launched.

NOTE: If a T7 and T11 probe were to be launched, Special Function Key f3 had to be pressed immediately before the CONTINUE key at the beginning of the data collection sequence (just before the commanded launches). When in the dual probe mode (f3) two probe start times must be printed to verify that both launches are good. If none or only one start time is printed, press f12 STOP then f5.

7) Pressing the appropriate special function keys just discussed (see Section 5.1 for detailed explanation of Special Function Keys) in general returns the program to the beginning, tells the operator which channel (Launch Station) to command for launch of the backup probe(s), and either waits for the CONTINUE key to be pressed or continues taking data (if there is a probe still in the water).

8) During the probe drop the calculator will automatically collect data, test each point for validity, and store the data in memory and on the 9-track tape recorder. The run light will be illuminated on the calculator screen indicating that the program is in operation and the 9-track tape recorder will occasionally advance the tape a small amount indicating the recording of a data block.

9) The program will collect data for the time specified for each type probe (120 seconds for T7 and 269 seconds for T11). At the end of a data collection period (one complete probe drop), the data stored in calculator memory will be recorded on the calculator cassette.

10) When all data has been stored, the program alerts the System operator that it is standing by for the next probe launch and advises the operator to push the CONTINUE key when ready to proceed.

11) If no more probes are to be launched at this time, but the presently mounted 9-track digital tape will be used to store more data at a later time, press Special Function Key f10 (see Section 5.1 for details).

3.3.1 Data Collection Differences Between Programs

The Main program (Program File 8) consists of two parts as mentioned previously; the T7 probe-only launch and the combination T7/T11 launch. For the T7-only launches data is collected for 120 seconds at 20 samples per second and each point is stored in memory and sent to the 9-track tape recorder. At the end of the 120 seconds, the 2400 data points in memory are read onto the cassette tape requiring about 4 or 5 seconds for this recording. The program then cycles back to the start of the T7 only mode and waits.

For the T7/T11 dual launches, the T7 and T11 probes should be launched at the same time (within a couple of seconds). The program (File 8, key f3) will collect data on each probe at 20 samples per second (40 samples per second total). Each T7 data point will be stored in calculator memory and sent to the 9-track tape recorder just like the T7 only mode. Each T11 data point is stored only in calculator memory at this stage. The T11 fall time is 269 seconds or about 2 1/4 times a T7 fall time. At the end of the first T7 all the T7 data in memory is stored on the calculator cassette tape which requires approximately 4-5 seconds. During this storage period no data can be taken on the T11 probe and so there will be a gap or missing data piece. This delay time in collection of T11 data is remembered by the System and used later to calculate accurate T11 data point times. After the first T7 probe's data is recorded on cassette, the System resumes taking data on the still falling T11 probe and alerts the system operator that a second (or next) T7 probe may be launched. If a T7 probe is launched prior to completion of the remaining T11 drop, data will again be collected on the T7 and T11 at 20 samples per second each with each T7 data point being recorded on 9-track tape as well as stored in memory. If the T7 drop is completed prior to the remaining T11, cassette recording of the T7 will again occur with a corresponding gap in the T11 data. If, however, the T11 finishes prior to completion of the present falling T7, the program will continue collecting T7 data until it is complete. Both T7 and T11 data will be recorded on cassette tape and the T11 data will also be recorded on the 9-track digital tape recorder. With all probes complete, the program will return to the T7 only mode of operation and so alert the System operator.

The NO DYLON program (Program File 9) operates in the same manner as the main program (File 8) except that data is not written to the 9-track tape recorder. This program option has been provided to allow system operation in the event of a 9-track tape recorder failure. The connecting cables between the 9-track tape unit and the HPIB should be removed for this mode of operation (File 9).

The THREE (3) CHANNELS ONLY program (Program file 10) operates in the same manner as the main program (File 8) except that no alternate launch channel (channel 4) is available for launch of a second T11 probe should the first probe prove to be a failure. It must be carefully noted that the three active stations must be channels 1,2, and 3 even if this requires shifting connections on the Data Station or swapping plug in boards (see Section 4.1 for details). The reason for this is that the THREE (3) CHANNELS ONLY program expects the first three channels to be operative. This program was provided in case one channel was lost and sufficient spares did not exist to make repairs. Since spare cards are being provided for the Launch Stations and Data Stations, it is extremely unlikely that this specific program will be needed.

3.3.2 Marking Data Tapes

Before any specific data collection program is selected and loaded into the calculator, it will be necessary to mark files on the cassette tapes that will be used to record the collected raw data and the converted data that will follow later (see Section 3.4).

Each data tape has two tracks and each track has room for twenty (20) files of T7 data and four (4) files of T11 data. To mark a tape, insert a blank cassette into the 9825 calculator and type in the following commands (note: follow each line with an EXECUTE command):

```
/trkl;ert0/
/trk0;ert0/
/trkl;fdf0/
/mrk 20,4900/
/fdf20/
/mrk 4, 10900/
/trk0;fdf0/
/mrk 20,4900/
/fdf20/
/mrk 4,10900/
/rew/
```

It is recommended that as many tapes be marked as will be needed for a single test leg instead of marking all the tapes needed for the whole test since marked tapes are not readily identifiable as new and unused.

3.4 Converting Data To Engineering Units

Because of the rate at which data are being collected during a probe (T7) or probes (T7/T11) drop, insufficient time is available for conversion to engineering units. Actually two conversions need to be made The first takes the binary count output of the A/D converter and converts it to a voltage in accordance with the System calibrations. The second conversion changes the voltage into a corresponding temperature value in accordance with a non-linear conversion equation supplied by the Sippican Corporation for their XBT bridge circuit output. To perform these conversions, files 11 and 12 (see Sections 5.12 and 5.13) have been provided on the program tape. The conversion of stored raw data (A/D binary counts) to converted data (temperature in °C) must occur off-line and can be performed at the end of a set of data drops or at the completion of all data drops. The conversion programs are divided into two types; conversion of T7 only data and conversion of T11 only data.

To convert T7 data it is only necessary to load file 11 from the Program Tape and follow the calculator prompted instructions. The program has been designed to prompt the operator at each decision point (see Section 5.12 for a detailed explanation of the program). When the cassette data tapes where initially recorded, raw data was stored on every other file. The converted T7 data will be stored in the blank file immediately following the corresponding raw data file.

To convert T11 data, load file 12 from the Program Tape and again follow the calculator prompts (see Section 5.13 for program details). As was the case for T7 data, the converted T11 data is stored on tape in the file which immediately follows the corresponding raw data file.

3.5 Plotting Data For Quality Assurance

Two programs have been provided for the plotting and inspection of collected XBT data; they are located in files 13 and 14 of the Program Tape.

3.5.1 Temperature Profile Plotting

File 13 of the Program Tape (see Section 5.14 for program details) enables plotting of temperature versus calculated depth profiles for up to five (5) probes on a single X-Y plot. The program prompts the operator with a series of questions asking for the desired start time at which the first probe was taken and the type, T7 or T11, data to be plotted. The program permits plotting of T7 and T11 data mixed by asking the operator for the start time of the first of each of the two probe types. The operator is also asked for the order in which he desires to have the probe data plotted. While it is necessary to plot a given probe type data in chronological order, each of the probe types being plotted (T7 or T11) do not have to be in chronological order. Each plot is off-set by an amount specified by the operator as one of the answered questions. Each plot has scale markings at the end points and a calibrated temperature scale is drawn at the edge of the plot to facilitate scaling of temperature values for each plot as a function of calculated depth. The depth of each plotted temperature is calculated from the Sippican Corp. fall rate equations specified for each probe type, a knowledge of the start time of each probe drop and a very accurate sample rate during each drop.

3.5.2 Deviation Plotting

File 14 of the Program Tape (see Section 5.15 for program details) enables the plotting of any single temperature profile and the deviation between any given data point and the mean of a group of data points which contain the given point at the center. This calculation and plotting routine allows inspection of the degree of variability (higher frequency fluctuation) in the data over the entire profile. Once the program has been loaded and the run mode initiated, the program asks the operator a number of questions the answers to which decide the probe type, start time, and deviation amplitude sensitivity.

4.0 What If Things Go Wrong?

The XBT Data Acquisition System has been designed with considerable redundancy in mind. Sufficient spare circuit cards and functional subunits have been provided to permit 100% backup for all functions as described in the following sections.

4.1 Hardware Considerations

4.1.1 Launch Station Repairs

Launch Stations are identical and any unit can be substituted for any other Launch Station unit. If Launch Stations are interchanged, the launch station designations, #1, #2, etc., also change; i.e., if stations #1 and #4 are swapped (because #1 failed) then the original station #4 becomes station #1 and must be treated accordingly. Anticipated use should see two stations in use at any one time, therefore, a 100% backup exists.

Each Launch Station is connected to a separate printed circuit card in the Data Station Unit. These printed circuit cards are also identical and can be interchanged if one should fail. It will usually be easier, however, to interchange analog signal connectors at the A/D converter. If such an interchange is made, it should be noted in a log to prevent later confusion as to the true interconnection arrangement.

4.1.2 Data Station Repairs

There are two ± 15VDC power supplies in the Data Station Unit; one supplying all Data Station electronics, the other supplying all Launch Station electronics. If either supply should fail, it must be replaced before continuing operations; or the bad supply can be disconnected and the remaining good supply connected to carry the full load of all four channels.

CAUTION: When swapping or doubling connections on any power supply pay very close attention to polarity and color codes.

4.1.3 Calculator and Peripherals Repair

The HP9825 calculator, HP59313 analog to digital converter, HPIB interface, cable, and realtime clock are all backed up by substitute units which can be directly inserted or interconnected in place of the malfunctioning unit. Since each calculator contains a cassette tape recording unit, 100% redundancy is provided for recording data. Printed circuit boards are also easily exchangeable between calculators should one calculator fail but its cassette recorder remain good while the other calculator suffers a tape unit failure. Simply follow the HP calculator manual for directions in changing out printed circuit cards.

An additional tape recorder (9 track, incremental, digital) and HPIB interface have been provided so that XBT data can be stored in computer compatible format for later merging with other test data on a large capacity computer. If this unit should fail, data will still be stored on the calculator cassette(s). This cassette data can later be transcribed onto 9 track tape if the 9 track unit fails in the field.

An X-Y plotter is also provided for plotting of data as an aid in assessing its quality and completeness. Should the X-Y plotter fail, data can be listed on the calculator printer on a probe by probe basis using the special off-line programs provided. While printer listing of the data does not provide the nice graphical presentation of the X-Y plotter, it does provide an assessment of data completeness and a means for hand plotting of the data if desired.

4.2 Software Considerations

A fairly large number of documented programs (see Section 5.0) have been written to aid in the diagnosis of system trouble or to operate "around" such troubles as illustrated by the following considerations.

4.2.1 Special Function Keys

During program operation, a number of possibilities exist for the occurrence of recoverable errors. These errors are detected by the HP9825 calculator and would normally be displayed as an error message except that additional programming has been supplied which prompts the System operator to press a specified Special Function Key thereby eliminating the error. The Special Function Keys which are computer prompted are fØ, f1, f2, f6, f7, f8, f9, f10, f11, f13, and f14; the function of each is defined in Section 5.1.

Additional Special Function Keys have been provided to permit operator recovery from errors that are undetected by the System or to change modes of data collection. The f3 Key allows the operator to shift from the main program which permits collection of T7 data only to a subsection of the main program which permits collection of T7 and T11 data simultaneously.

A detailed discussion of the main data collection program is contained in Section 5.9.

The f4 Key (see Section 5.1) permits a system restart in the event that a launched XBT T7 probe fails prior to the generation of any good data. The main operating program "looks" at the probe data whenever the program is in run mode. Prior to the probe launch, the data values are out of range and declared invalid by the program. Once launch has been commanded, the probe values should come in range immediately upon water entry. If this does not happen, no launch time will be printed and the operator will know that the computer is still waiting for launch. Since launch has occurred, the probe must have failed and a substitute probe should be launched. Depressing "STOP" and then the f4 Key resets the system and provides automatic prompts to the operator concerning launch of the substitute T7 probe.

The f12 STOP f5 Key sequence provides the same recovery capability as the f4 Key except that it is used for the combination T7/T11 mode of operation. If two print times (one for each launched probe) are not seen by the operator shortly after the commanded dual-launch, then f12 STOP is pressed followed by the f5 Key resulting in System prompts which tell the operator which probe failed and which channel to command for launch of the backup probe.

The f15 Key provides for the same mode selection capability as the f3 Key (T7 only mode or T7/T11 dual mode) for that situation in which the Dylon 9-track tape recorder is not available (see Section 5.10).

NOTE: The execution (depressing) of any Special Function Key normally occurs when the calculator is not in run mode; i.e. the run light is off. If the run light is on, the STOP key normally must be pressed first, followed by the Special Function Key desired (an exception to this general rule is key f12.).

4.2.2 Address Checks For Peripherals

This program (see Section 5.6 for details) permits checking of each of the peripherals connect to the HPIB to insure proper electrical connections and interchange of TALK/LISTEN commands. The program carries the operator step by step with prompts and upon completion has insured that all peripherals are connected, properly addressed, and functioning with the Bus. It is helpful to utilize this test once the System interconnections specified in Section 2.1 have been made.

4.2.3 Real Time Clock Check

A program has been provided for reading or setting the Real Time Clock plugged into the rear of the HP9825 Calculator (see Section 5.7 for details). The clock can be read or set by loading this program (File 6) and following the prompts. Comparison to an independent time source will indicate the functioning status of the Clock (on time or error).

4.2.4 System Calibration Check

This program provides for System calibration prior to collection of a data set or a System calibration check at any time System malfunction or error is suspected (see Section 5.8 for details). The calibration program consists of two parts: part one permits alignment of the A/D Converter using its internal calibrator; part two permits alignment of the Data Station and Launch Stations using known resistances to simulate specific temperature values. To calibrate the A/D simply load the program (File 7) and answer each of the computer prompts. The specific procedure is described in Step 6 of Section 3.2 and should be referred to if the A/D requires calibration.

To calibrate the Data Station and Launch Stations, it will first be necessary to calibrate the A/D Converter. With the A/D calibrated, the calibration program next permits reading of temperature (resistance) values from a selected Launch Station (channel number). Assume that we wish to calibrate channel one (Launch Station 1) from the XBT probe input to the A/D output (calculator input).

NOTE: Calibration of any other channel is identical to the procedure for channel one.

1) Utilizing one of the precision resistance substitution boxes selected from Table 2, set the resistance value for 6247 ohms and connect the resistance box to the Launch Station terminal strip as shown in figure 3. The resistance setting of 6247 ohms corresponds to a probe temperature of exactly 20.00°C and is the mid-scale point for the calibrated measurement range.

TABLE 2--Resistance Substitution Box Resistance Settings

Box 236 A-1

Required Launch Station Value	Box One Setting
10.00°C -- 9948 ohms	9968
20.00°C -- 6247 ohms	6247
30.00°C -- 4024 ohms	4024

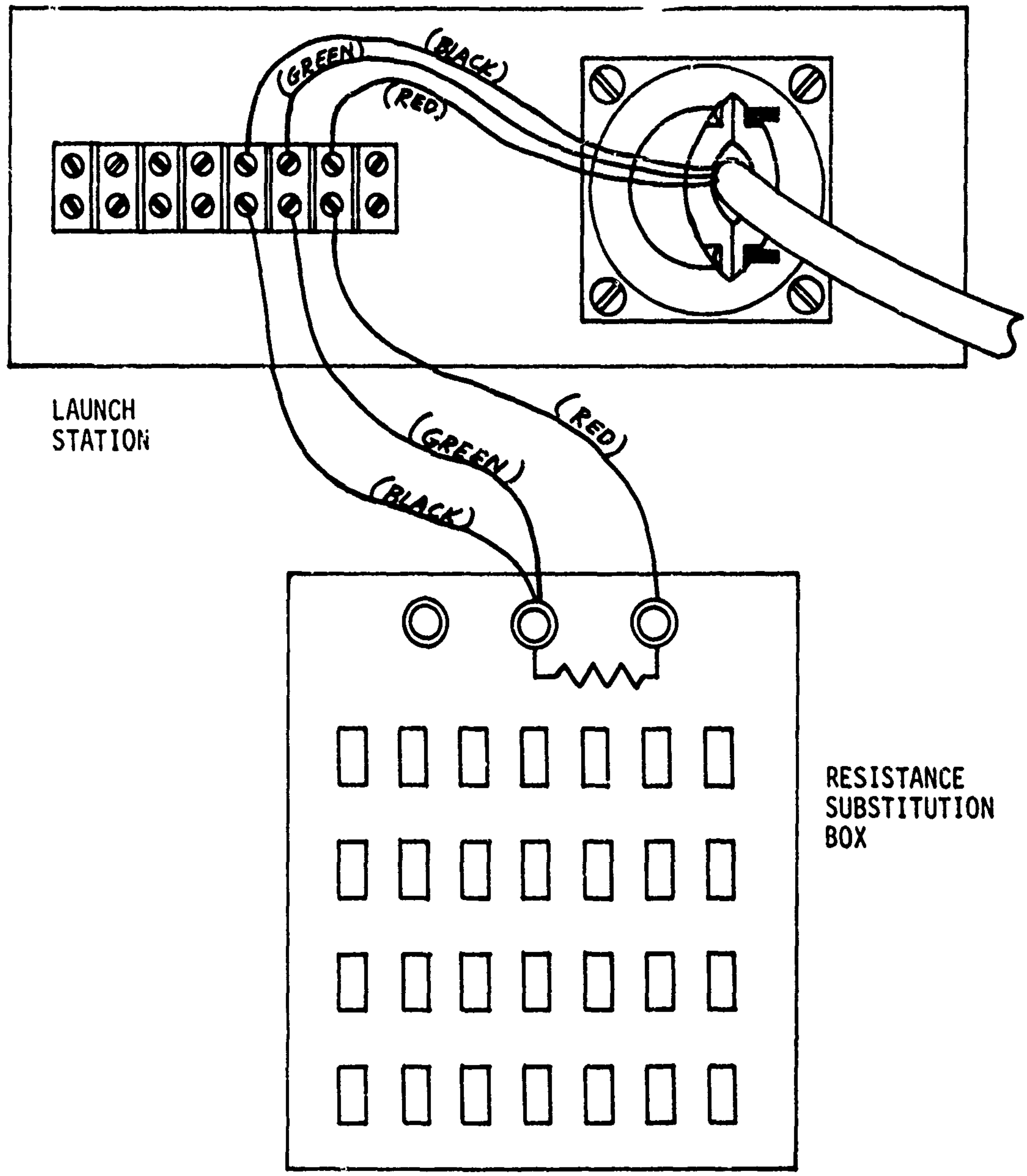


FIGURE 4- RESISTANCE BOX
CONNECTION DIAGRAM

Box 236 A-2

Required Launch Station Value	Box Two Setting
10.00°C -- 9948 ohms	9961
20.00°C -- 6247 ohms	6250
30.00°C -- 4024 ohms	4023

2) Connect 6.32K ohm calibration resistors (see Table 1 Section 3.2) across the red and green wires of each of the other Launch Stations; do not make any connections to the black wire and be sure that all handheld launcher wires have been removed. These 6.32K ohm resistors place a finite resistance across the input differential amplifier in the Launch Station bridge circuit and act to balance all Stations with respect to each other to minimize offset errors.

3) Carefully remove the white cover of the Data Station by removing the four black rubber feet (a medium straight blade screwdriver will be required). Locate the channel BIAS and GAIN controls by comparing the inside of the Data Station to Figures 4 and 5. Access ports have been provided for these adjustments on the rear panel of the Data Station lid. With the cover reinstalled, apply power by pressing the power switch. Actuate the LOAD/LAUNCH red paddle switches as specified in the Caution and Warning statements under Step 3 of Section 3.3 to minimize induced noise.

4) Now load the Special Function Keys and File 7 into the calculator (if this has not already been accomplished as a result of following Sections 3.1 and 3.2). It is assumed that the A/D has just been calibrated; if not, use Step 6 of Section 3.2 to accomplish this. With the Special Function Keys and File 7 loaded, press key f6 and then f7; this jumps the calibration program to the beginning of a series of questions which will ask for a channel selection (select one to be calibrated); display type (select TEMPERATURE); display mode (select display); and display speed (select 3).

5) If everything has been accomplished correctly up to this point, the calculator display will show approximately 20°C. Now adjust the BIAS potentiometer shown in Figure 4 (using a very small straight blade screwdriver) for the channel to be calibrated (one in this case) until the calculator display indicates as close to 20.00°C as possible. This step sets the midpoint of the calibrated 10°C to 30°C measurement scale.

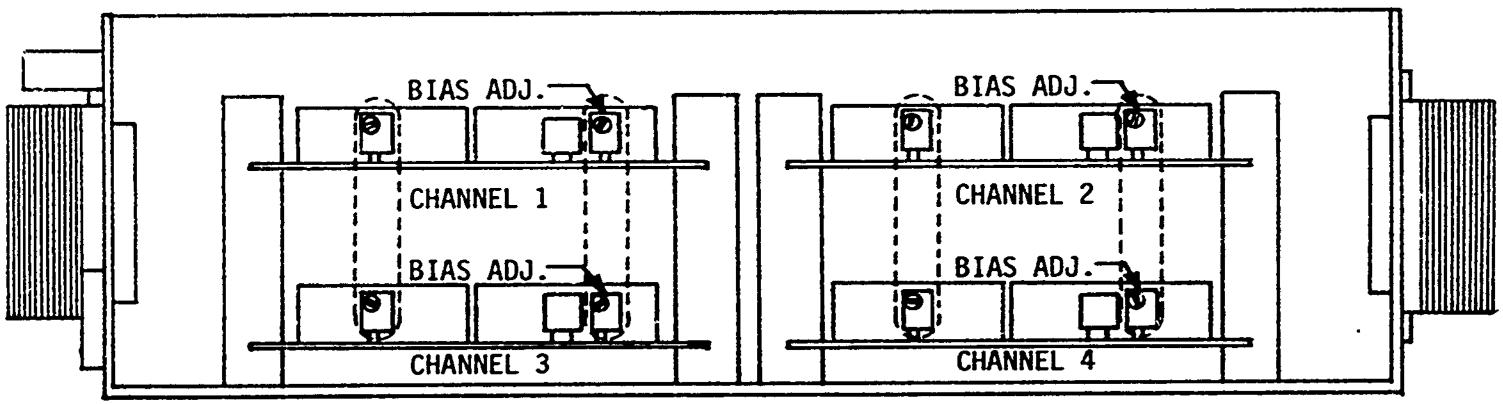
6) Now change the setting on the resistance substitution box to 4024 ohms. The calculator should indicate very nearly 30°C. Adjust the GAIN potentiometer shown in Figure 5 for the selected channel until the calculator display indicates as close to 30.00°C as possible. This step sets the highpoint of the calibrated 10°C to 30°C range.

7) Now alternate between steps 5 and 6 until you have achieved the best settings possible. Next set the resistance box for 9948 ohms; the calculator should indicate exactly 10.00°C ±0.01°C. If close but not within specs, adjust BIAS and GAIN slightly rechecking the 10°C, 20°C, and 30°C points until each point is within ±0.01°C. If this accuracy is not achievable, refer to Section 4.1 for trouble-shooting help.

8) Once the 10°C, 20°C, and 30°C points have been set using Steps 5, 6, and 7 so that each falls within ±0.01°C of the nominal value when the corresponding resistance shown in Table 2 is switched in, the channel is completely calibrated and the resistance substitution box can be moved to the next channel. Note: a 6.32K ohm calibration resistor (for Station balance purposes) must be connected across the red and green wires of each Launch Station not connected to the substitution box.

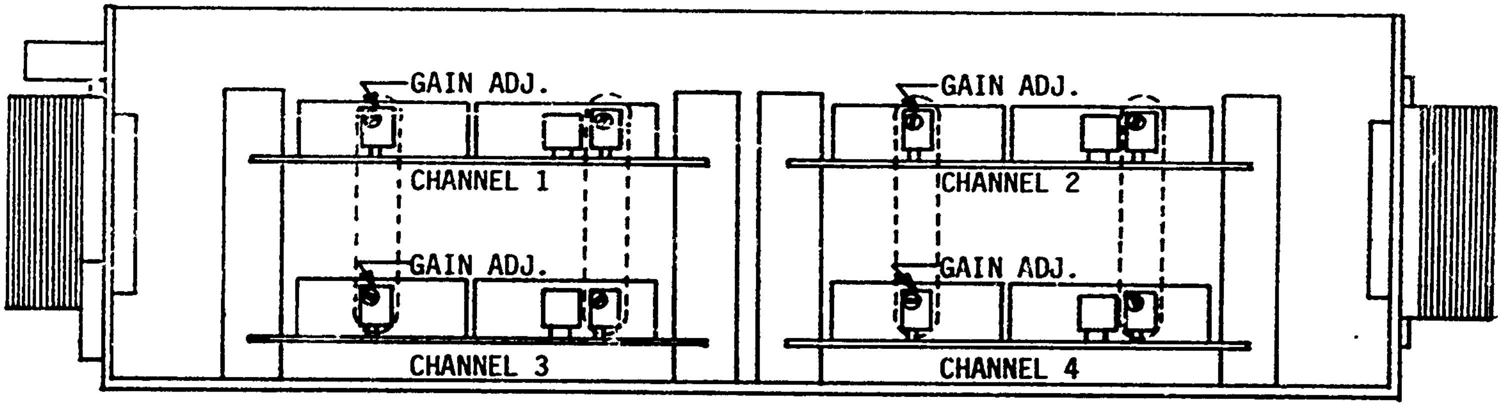
9) When the last channel has been calibrated using the resistance substitution box, a final confidence test can be performed if desired. This confidence test can also be performed at any time the calibration accuracy of any channel is questioned. Remove the substitution box and connect a resistor selected from Table 1 Section 3.2 across the red and green wires of the Launch Station. At this time, all Launch Stations should have calibration resistors, from Table 1, connected across the red and green wires (all handheld launcher connections removed). If a jumper (clip lead) is now connected between the black and green wire of each Launch Station, a signal will be generated which corresponds to the temperature listed in Table 1 for each calibration resistor used. If the channel being confidence tested is properly calibrated, the calculator will display the corresponding temperature $\pm 0.01^{o}C$ when using the second part of the calibration program (File 7).

CAUTION: In order to maintain the system calibration accuracy in operation, a resistance between 3K ohms and 16K ohms must be connected across the red and green wires of each Launch Station at all times that data are being collected. Use of the 6.32K ohm calibration resistors will satisfy this requirement for each Launch Station not being used to launch XBT probes. For Stations used to launch XBT probes insure that a probe is loaded at all times that data is being collected from any Station.



DATA STATION WITH COVER REMOVED (REAR VIEW)

FIGURE 5--CHANNEL BIAS VOLTAGE
ADJUSTMENT LOCATION



DATA STATION WITH COVER REMOVED (REAR VIEW)

FIGURE 6--CHANNEL GAIN ADJUSTMENT LOCATION

The XBT Data Acquisition System has a measurement resolution of 10 millidegrees. In order to maintain a system accuracy commensurate with the resolution, extreme care must be exercised in the calibration of each channel. If the calibration is ever doubted, the particular channel or channels should be checked using the above confidence test procedures. Check and recheck until it is optimum; don't attempt shortcuts!

PROGRAM LISTINGS

FILE 0

SPECIAL FUNCTION KEYS

FILE Ø
SPECIAL FUNCTION KEYS

There are 24 special function keys on the 9825A Programmable Calculator. These keys are in the upper right-hand corner of the keyboard and are numbered from fØ to f11 (that takes care of 12 keys; the other 12 are the shifted versions of fØ through f11. Thus, shifted f5 is really f17). The special function keys which are defined and explained below are used in various different programs within the XBT Data Acquisition System. These programs and various lines contained within them will be referenced in the explanations of the keys. *NOTE: Before each of the special function keys is the character "*". This asterisk before each of the commands indicates to the calculator that it is not merely to display that command and await an EXECUTE from the operator. It tells the calculator to execute that command immediately.

fØ: *erase v -----Since an error 39, S6, S7, or S8 must have occurred to warrant the use of fØ, this key is used to remedy problems caused in the program when one of these errors has occurred. All of those errors have in common an indication of errors in dimensioning variables. The erase v command erases all variables in the calculator in preparation for use of either the f1 or f2 keys.

f1: *cont 5 -----After the erase v command has been executed using the fØ key, this key restarts the program at line 5, which will redimension the T7 probe variables since the error subroutine has shown that the error occurred during a T7 probe drop. This command is used for both the Main and 3-Channel-Only data acquisition programs (files 8 and 1Ø).

f2: *cont 39 -----This key performs the same function that f1 performed, except that it restarts the program and redimensions variables for the second half of the program in the T7/T11 mode.

f3: *cont 4Ø-----This key is used to go from the T7-Only mode of either the Main or 3-Channel-Only data acquisition programs to the T7/T11 mode of those same programs.

f4: *cont "defect" -----The calculator has no way of knowing that a probe is defective unless at least one valid data point has been taken. If the operator does not see the probe start time printed within 2 seconds of the launch of a T7 probe, he knows that the calculator has not taken and probably will not ever take any valid data. He therefore pushes STOP and f4, in effect telling the program that the probe is defective. f4 then sends the program down to the defective probe subroutine "defect" to take appropriate action. This key is also used for the Main and 3-Channel-Only and the No-Dylon data acquisition programs.

f5: *cont "defectb" -----This key performs the same function as f4 for the same programs, except that it is for the second half of the program; the T7/T11 mode. It must, however, be preceded by both f12 and a STOP. See f12 documentation for details.

f6: *cont 65 -----This key is used in the System Calibration program to skip the A/D Converter Calibration section of that program (file 7). It is explained at the start of the program.

f7: *cont 72 -----This key is also used with file 7. It is used to change channels, output speed, or devices for the values being output from the A/D Converter. It is explained in the program.

f8: *cont 43 -----f8 is used in the T7 Engineering Conversions program (file 11). It continues the program at line 43 if the operator is through with all T7 data conversions and is explained in the program as to when it is to be used.

f9: *cont 23 -----This key is used in the T11 Engineering Conversions program (file 12). It continues the program at line 23 if the operator has finished with all T11 data conversions. It is also used only when instructions to do so are given to the operator within the program.

f1Ø: *trk1;rcf 2,Y;trkØ;rcf 2,Y -----This key is used in both the Main and 3-Channel-Only data acquisition programs (files 8 and 1Ø) After an error in dimensioning has occurred, the user is told to press f1Ø, fØ, and several other keys. f1Ø must be used before fØ because f1Ø records the value of the Dylon tape file counter onto the program tape so that it will not be lost when fØ is pressed and all variables are erased.

f11: *trkØ;ldf 2,Y -----This key is used to retrieve the value of the number of files written onto the Dylon tape so far. It is used with files 8 and 1Ø and is explained as to its usage in the programs.

f12: *wrt 9,"U2C,U2G" -----This key must be pressed before the STOP and f5 keys are pressed. It is the ONLY key in this listing which may be pressed while the program is running. It starts a timer which will be read later to ascertain the data gap created in one probe while the program is telling the operator that the other probe is defective and what he should do about it. It is shifted fØ. See f5 documentation for further details.

f13: *cont 2 -----(shifted f1)
f14: *cont 35 ----(shifted f2)
f15: *cont 36 ----(shifted f3)

These three keys are used by the data acquisition program with no Dylon unit. They perform the same as f1, f2, and f3.

*NOTE: Special Function Key Listing on next page--------------→

```
f0: *erase v

f1: *cont 5

f2: *cont 39

f3: *cont 40

f4: *cont "defec
 t"

f5: *cont "defec
 tb"

f6: *cont 65

f7: *cont 72

f8: *cont 43

f9: *cont 23

f10: *trk1;rcf 2
 ,Y;trk0;rcf 2,Y

f11: *trk0;ldf 2
 ,Y

f12: *wrt 9,"U2C
 ,U2G"

f13: *cont 2

f14: *cont 35

f15: *cont 36
```

FILE 1

MENU FILE

FILE 1
MENU FILE

The menu file is a listing of the contents of the program tape for the XBT Data Acquisition System. Just as the contents of a book list the Chapter numbers and sometimes tell something about what occurs in that chapter, the menu file lists the files on the program tape by number and follows those numbers with a descriptive phrase or sentence regarding the contents of that file. What follows is a more detailed listing of the program tape contents:

File 0:
SPECIAL FUNCTION KEYS

File 1:
MENU FILE

File 2:
DATA FILE COUNTER FOR DYLON; USED BY DATA ACQUISITION PROGRAMS

File 3:
DATA FILE COUNTER FOR DYLON; USED BY T7 ENGINEERING CONVERSION PROGRAM

File 4:
DATA FILE COUNTER FOR DYLON; USED BY T11 ENGINEERING CONVERSION PROGRAM

FILE Ø: File Ø is a data file containing the special function keys for use with the various programs on the rest of the tape. These keys are loaded into memory with the command ldkØ . The special function keys are used primarily for two things:

(a) To skip a part of a program and continue the program again at some later point. For example, the special function key f3 may be pressed when the main data acquisition program (FILE 8) is stopped and waiting for another T7 probe to be launched. This key will send the program down to continue in the T7/T11 mode, thereby skipping approximately 3Ø program lines.

(b) To recover from program or operator errors. For example, if the main data acquisition program is running and the operator commands a T7 launch, he should see the start time of that probe printed within 2 seconds of launch. If he does not see that start time printed, he presses STOP and f4. This sends the program down to the subroutine called "defect" and tells the operator on which channel the defective probe occurred and on which channel to launch a new probe.

FILE 1: File 1 is the menu file and may be accessed by pressing LOAD, 1, and EXECUTE. It is being fully documented here.

FILE 2: File 2 is used by the three data acquisition programs (FILES 8,9, and 1Ø). File 2 is a data file which contains one integer. This integer represents the number of files which have been stored on the Dylon 9-track tape (the actual number on the cassette in FILE 2 is one more than the number of files which have been written onto the Dylon tape. (Continued on next page).

Each time one of the main data acquisition programs is used, the number of files written onto the Dylon tape by that program is counted and stored into the variable Y. Y is actually one more than the number of files already written. When the operator has finished using one of those programs, he pushes special function key f1Ø. This key records the value of Y into FILE 2. When the operator restarts the program, the Dylon tape is rewound and then spaced forward that number of files. That way, if 1ØØ files have been recorded on the Dylon tape, the tape is then positioned at the start of the one hundred and first file and is ready to be written on.

FILE 3: File 3 performs the exact same function that FILE 2 performed with one exception. FILE 3 stores the counter for the number of files written onto the Dylon tape by the T7 Engineering Conversions program (FILE 11). The number of files is recorded onto FILE 3 within the T7 Conversions program and is automatically reloaded whenever the program is run again.

FILE 4: File 4 is identical to FILE 3 except that it is used by the T11 Engineering Conversion program. Again, the value of the number of files already recorded onto the T11 converted data Dylon tape is stored into FILE 4 within the T11 Conversions program and is automatically reloaded whenever the program is run again.

FILE 5: File 5 is a program to check the address settings on the various peripherals involved in the system. The program is largely self-explanatory. It sends commands to the different peripherals (data listen, untalk, etc.) while explaining each command to the operator and telling him what should happen each time if the peripheral being addressed has the correct address setting and is working properly. The documentation of FILE 5 informs the operator as to what he needs to check for if any of the peripherals do not respond properly as dictated in the program. FILE 5 may be accessed by pressing LOAD, 5, and EXECUTE.

FILE 6: File 6 is accessed by pressing LOAD, 6, and EXECUTE. This program is used to set the Real Time Clock (if desired) and to read the clock. If the operator chooses to set the clock, he is directed to do so and then must wait for approximately 2Ø to 25 seconds for the clock to reset itself to the new date and time. Then the date and time will be displayed continuously until the STOP key is pressed. If the operator chooses not to set the clock, the date and time are displayed immediately and then continuously displayed until the STOP key is pressed.

File 5:
ADDRESS CHECK

File 6:
REAL TIME CLOCK
SET AND/OR READ

File 7:
SYSTEM
CALIBRATION

File 8:
OPERATING PROG.
XBT DATA
ACQUISITION

File 9:
OPERATING PROG.
XBT DATA
ACQUISITION
(NO DYLON)

File 10:
OPERATING PROG.
XBT DATA
ACQUISITION
3 CHANNELS ONLY

FILE 7: File 7 is accessed by pressing LOAD, 7, and EXECUTE. This is a program designed to do two things:
(a) Calibrate the A/D Converter using the internal signal generated within the A/D Converter.
(b) Read into the computer values from the A/D Converter and either print or display them for use in system calibration.

At the start of the program, the operator is given a choice to press special function key f6, which will take him directly down to the system calibration section of the program; or he may press the CONTINUE key and calibrate the A/D Converter first. The first half of the program which calibrates the A/D Converter is self-explanatory. The second half of the program will read in values which have been input into the A/D Converter. These values are in the form of counts coming from the Converter, and on the scale being used by this system; each count represents 1Ø millivolts. Thus, a known resistance may be applied at a launch station and the value which is read from the A/D Converter should agree with that resistance. This information may be used to calibrate the system. Further, the counts coming in from the A/D Converter may be printed or displayed. If display mode is chosen, the operator has a choice of 6 different display speeds to aid him in calibration. The counts from the A/D Converter are output to the calculator as integers, so they are displayed and printed as integers also. The program will read the channel selected by the operator until he pushes STOP. From that point he may continue to another program or press special function key f7 and change the channel, display speed, or print/display mode (or any combination of the above).

FILE 8: File 8 may be accessed by pressing LOAD, 8, and EXECUTE. This is the main data acquisition program. It is the most important program and the focal point of the software for the system. This program has the following capabilities:

(a) Take in data from T7 probes dropped one after another at 2Ø samples per second accurate to within 5Ø milliseconds between any two data points in a probe drop.
(b) Store a full probe drop (12Ø seconds worth) of data onto an HP cassette and onto 9-track tape using a Dylon 9-track model 1Ø15A Magnetic tape formatter.
(c) Collect data from T7 and T11 probes simultaneously at a sample rate of 2Ø samples per second per probe also accurate to within 5Ø milliseconds between any two data points in a probe drop.
(d) Store a full probe drop (269 seconds worth) of data onto an HP cassette and onto 9-track tape using a Dylon 9-track model 1Ø15A Magnetic tape formatter. (T11 probe drop).
(e) Test data as it comes in for validity and inform the operator if the probe is defective (broken wire, etc.). Then tell the operator on which channel the defective probe is at the time and on which channel to launch a replacement or back-up probe.
(f) Inform the operator when a data cassette is full so that it may be replaced with a blank one for further recording of probe data.
(g) For most of the probable errors, the program will not only inform the operator what error has occurred and in which program line; but it will usually also inform him as to the peripheral in which the problem has occurred and/or tell him exactly what actions he needs to take to remedy the difficulty.

This program is also very flexible in that it allows fairly easy changes to be made in the sample duration on either type of probe, the sample rate, etc. Also, for ease of access to the files later, the program records the start time (month, day, hour, minute, and second) and the probe type (T7 or T11) and also records the fact that the data in that data file is either raw (raw) or converted to engineering units in terms of degrees Centigrade (con).

FILE 9: File 9 is accessed by pressing LOAD, 9, and EXECUTE. It has the same capabilities as FILE 8 with one exception; it is designed to run without the Dylon tape unit. If the Dylon should not work for any reason, the operator could load this program and go on taking data from probes with the only loss being that the data would not be stored on the Dylon; only on the cassettes. In all other respects the program is identical to FILE 8 (except possibly that the line numbers are different).

FILE 1Ø: File 1Ø is another modified version of FILE 8. In FILE 8 during the T7/T11 sampling mode, if a T11 probe is found to be defective, another T11 probe may be launched as a replacement or back-up probe on channel 4 (T11 probes are normally only launched on channel 3). Since channels 1 and 2 are used alternately for T7 probes, all four channels have a possibility of being used. This program in FILE 1Ø is designed to work with only 3 channels on the assumption that one channel has failed. If a T11 probe fails during this program, a message is printed to the effect that the T11 probe on channel 3 has failed, but no back-up may be launched for this probe. T7 probes remain unaffected.

File 11:
ENGINEERING
CONVERSIONS
(T7 PROBES)

File 12:
ENGINEERING
CONVERSIONS
(T11 PROBES)

File 13:
TEMP. PROFILE
OFFSET PLOTTING
ROUTINE

File 14:
DEVIATION PLOTTING ROUTINE

FILE 11: File 11 may be accessed by pressing LOAD, 11, and EXECUTE. FILE 11 contains the program used to convert the data taken from T7 probe drops and convert the start time and probe type to reflect that conversion. Explanation follows:

First, the start time is stored both on a special Dylon tape and on cassette on the file directly following the raw data file which is being converted. In this manner a data cassette will contain files of raw data, converted data, raw, etc. Next, the probe type of the raw data (rawT7) is changed to conT7 to reflect the fact that this file now being stored is converted data ("con"). This new probe type is also stored on Dylon and cassette. Then, the raw data is put through a conversion equation and the converted data (in the form of degrees Centigrade between 10° and 30°) is stored on cassette and on Dylon.
(Continued on next page.)

This program also tells the operator when the data cassette on which it is working has been fully converted and gives him a choice:
He may insert another tape and convert that data or he may continue on to the T11 Engineering Conversions program (FILE 12). He may, of course, stop altogether if he so desires. If he chooses to go on to the T11 Conversions program, this program will set up the T11 program almost entirely and then actually load and start the program for the operator. The operator is given minimal instructions concerning which tapes to load and which special function keys to push; the program does the rest internally. It is necessary that FILE 11 set up as much as possible of FILE 12 before actually loading that file because memory space in the program in FILE 12 is critical.

FILE 12: FILE 12 performs the same functions as FILE 11 except that FILE 12 deals with T11 probes. Also, FILE 12 does not give the operator the choice of going back to the T7 Engineering Conversions program after a data cassette has been converted. Although this file is usually accessed through FILE 11, it may also be reached by pressing LOAD, 12, and EXECUTE.

FILE 13: File 13 may be accessed by pressing LOAD, 13, and EXECUTE. This is the T7/T11 Offset plotting routine. The operator is given a choice of plotting from the Dylon tape (Converted Engineering units only) or from cassette. This program will plot up to five T7 and/or T11 probes. Although all probes of the same type must be plotted in chronological order, the probe types may be plotted in any order selected by the operator. For example, the operator may decide to plot 1 T11, 2 T7's, 1 T11, and another T7. Each plot is offset from the others; this amount of offset is also operator controlled. The operator may also decide whether or not he wishes to have the plotter stop after the plot of each probe to allow him to change pen colors. Each probe is labeled as to start time, location on the graph, and probe type. The program is also fully automatic in setting the upper right and lower left limits on the plotting surface; the only necessary operator function regarding the plotter is the changing of pens (if so desired) and the loading of paper.

```
0: beep;dsp "MEN
 U FILE (Press
 Continue)";stp
1: ent "No. of
 file? (For all;
  type 100)",J
2: if J#100;jmp
 J+1
3: prt "File
 0:","SPECIAL
 FUNCTION","
   KEYS";gsb
 "all"
4: prt "File
 1:","MENU FILE"
 ;gsb "all"
5: prt "File
 2:","DATA FILE"
 ,"COUNTER FOR",
 "DYLON; USED
 BY","DATA ACQUI
 SI-"
6: prt "TION
 PROGRAMS";gsb
 "all"
7: prt "File
 3:","DATA FILE"
 ,"COUNTER FOR",
 "DYLON; USED
 BY","T7 ENGINEE
 RING"
8: prt "CONVERSI
 ON","PROGRAM";
 gsb "all"
9: prt "File
 4:","DATA FILE"
 ,"COUNTER FOR",
 "DYLON; USED
 BY","T11 ENGINE
 ER-"
```

```
10: prt "ING
 CONVERSION",
 "PROGRAM";gsb
 "all"
11: prt "File
 5:","ADDRESS
 CHECK";gsb "all
 "
12: prt "File
 6:","REAL TIME
 CLOCK","SET
 AND/OR RE'D";
 gsb "all"
13: prt "File
 7:","SYSTEM",
 "CALIBRATION";
 gsb "all"
14: prt "File
 8:","OPERATING
 PROG.","XBT
 DATA","ACQUISIT
 ION";gsb "all"
15: prt "File
 9:","OPERATING
 PROG.","XBT
 DATA","ACQUISIT
 ION"
16: prt "(NO
 DYLON)";gsb
 "all"
17: prt "File
 10:","OPERATING
  PROG.","XBT
 DATA","ACQUISIT
 ION"
18: prt "3 CHANN
 ELS ONLY";gsb
 "all"
19: prt "File
 11:","ENGINEERI
 NG","CONVERSION
 S","(T7 PROBES)
 ";gsb "all"
```

FILE 14: File 14 is accessed by pressing LOAD, 14, and EXECUTE. This program is the T7 or T11 Deviation plotting routine. This program will, like the Offset plotting routine, plot from either the cassette or Dylon tape, and the operato may change pen colors during plotting if so desired. But this routine plots the normal probe profile on the left-hand side of the paper first Then on the right-hand side, a grid of identical size to the left-hand grid is drawn and a line i drawn vertically down the middle of this grid. This vertical dotted line represents the Mean. The Mean is not any set number. It is merely a standard used for plotting purposes in this manner:

The first 49 data points are read into an array. This array is multiplied, point for point, with another array of the same size containing weighting factors in the shape of a cosine bell curve. The end points of the data point array have a weight of Ø and the mid-point has a weight of 1. These new values are now used to obtain a weighted average of those 49 data points. This weighted average now becomes the Mean over the specified interval of data points. The value of the mid-point of the interval is subtracted from this Mean value, and the result is plotted on the right-hand (Deviation) grid parallel with the mid-point in a vertical direction and the value of the result away from the dotted Mean line (plus or minus). The operator may select the scale of the Deviation grid. Full scale may be anywhere from ± 5°C down to (in effect) ±Ø°C. In this manner, the operator has total control over the amount of definition that the plot will show him regarding the amount of Deviation from the Mean line.

FILE 2

DATA FILE COUNTER FOR DYLON; USED BY

T7 ENGINEERING CONVERSION PROGRAM

FILE 3

DATA FILE COUNTER FOR DYLON; USED BY

T11 ENGINEERING CONVERSION PROGRAM

FILE 4

DATA FILE COUNTER FOR DYLON; USED BY

DATA ACQUISITION PROGRAMS (FILES 8 AND 10)

FILE 2
DATA FILE COUNTER FOR DYLON
(Data Acquisition Programs)

File 2 is used primarily by the data acquisition programs in FILE 8 and FILE 1Ø. It is a data file which only contains one integer. This integer represents the number of files which have been stored on the Dylon 9-track tape (the actual number on the cassette in FILE 2 is one more than the number of files which have been written onto the Dylon tape. Each time one of the main data acquisition programs is used, the number of files written onto the Dylon tape by that program is counted and stored into the variable Y. Y is actually one more than the number of files already written. When the operator has finished using one of those programs, he pushes special function key f1Ø. This key records the value of Y into FILE 2. When the operator restarts the program, the Dylon tape is rewound and then spaced forward that (Y) number of files. That way, if 1ØØ files have already been recorded on the Dylon tape, the tape is then positioned at the start of the one hundred and first file and is ready to be written on from that point.

FILE 3
DATA FILE COUNTER FOR DYLON
(T7 Engineering Conversions Program)

File 3 performs the same function that FILE 2 performs with one exception. FILE 3 stores the counter for the number of files written onto the Dylon tape by the T7 Engineering Units Conversion program (FILE 11).

FILE 4
DATA FILE COUNTER FOR DYLON
(T11 Engineering Conversions Program)

File 4 performs the same function that FILE 2 and FILE 3 perform with one exception. FILE 4 stores the counter for the number of files written onto the Dylon tape by the T11 Engineering Conversions program (FILE 12).

FILE 5

ADDRESS CHECKS FOR PERIPHERALS

```
0: beep;dsp "Add
 ress checks
 for peripherals
 .";stp
1: prt "Each
 time the","run
 light is","not
 on, you","shoul
 d press the"
2: prt "CONTINUE
 key."
3: prt "See disp
 lay for","posit
 ion of run",
 "light.";spc 2;
 beep
4: dsp "Run ligh
 t is";wait 4000
5: beep;dsp "↑
 here.";wait
 3000;beep
6: prt "Each
 time you","pres
 s the","CONTINU
 E key,","a diff
 erent"
7: prt "aspect
 of the","periph
 eral ad-","dres
 s will be","che
 cked.";spc 2
8: beep;dsp "CHE
 CK:ALL PERIPHER
 ALS CONNECTED?"
 ;stp
9: beep;dsp "Tur
 n plotter power
  OFF.";stp
10: prt "A/D
 CONVERTER:",
 "When you press
 ","CONTINUE,"
11: prt "the
 talker light",
 "should come
 on.";spc 2;stp
12: cmd 7,"F";
 stp
13: prt "Now
 the light","sho
 uld go off.";
 spc 2;wait 2000
14: wrt 706,"&";
 stp
```

FILE 5

ADDRESS CHECKS FOR PERIPHERALS

0: thru 7: Lines 0 thru 7 describe what the program is and what it will do. The program is designed to write commands to each peripheral in turn to make sure (a) that all connections are in order and (b) that all peripherals have the proper addresses. Lines 0 thru 7 also tell the operator to push the CONTINUE key each time the program has stopped.

8: and 9: These two lines tell the operator to check and be sure that all peripherals are connected through the bus into the calculator and then tell him to turn the plotter power OFF so that the plotter will not be affected by bus commands used to test the A/D Converter and Dylon Tape Unit.

10: thru 14: Lines 10 through 14 write the Data Talk command designed for the A/D Converter over the HP-IB bus. When the light (Data Talk Light) comes on, the program then tells the operator to look and see if the light goes off and line 14 outputs the Data Untalk command which shuts off the light. The program is then stopped to wait a CONTINUE from the operator.

15: thru 24: Lines 15 through 24 do the following: (telling the operator what to look for each time)------ write the Data Listen command to the Dylon to light up the Data Listen Light; write the Data Talk command to extinguish the Data Listen Light and light up the Data Talk light; and write data onto the tape so that the tape moves and therefore showing that not only the Tape Formatter but the Tape Drive as well is working. The program is again stopped to await a CONTINUE.

25: thru 32: Lines 25 through 32 direct the operator to position the plotter pen in the center of the platen and in the DOWN position after turning the plotter power on. The plotter is then cleared and given the PEN command (raises the pen) and the IN command (places the pen back into the initial chart-load position. The test is now completed, so the computer displays the message TEST COMPLETE and stops the program.

*NEXT PAGE FOR FURTHER PROGRAM LISTING--------→

```
15: prt "DYLON
 TAPE UNIT:",
 "When you press
 ","CONTINUE,",
 "the Data Liste
 n"
16: prt "light
 should","come
 on.";spc 2;stp
17: cmd 7,"%";
 stp
18: prt "When
 you press","CON
 TINUE this",
 "time, the Data
 ","Listen light
 "
19: prt "should
 go off;","the
 Data","Talk
 light","should
 come on.";spc
 2;stp
20: cmd 7,"E";
 stp
21: prt "Now
 when you","pres
 s CONTINUE",
 "the Data Liste
 n","light shoul
 d"
22: prt "come
 on and","the
 tape should",
 "move forward"
23: prt "about
 3 inches.";spc
 2;stp
24: wrt 704,"B10
 W10";cmd 7,"%";
 wrt 705,A;stp
25: prt "PLOTTER
 :","Turn plotte
 r","power on.";
 spc 2;stp
26: prt "Using
 the front","pan
 el controls,",
 "position the
 pen"
27: prt "near
 the center",
 "of the paper",
 "and press the"
 ,"PEN DOWN butt
 on"
28: prt "on the
 front","panel."
 ;spc 2;stp
29: prt "When
 you press","CON
 TINUE,","the
 pen should",
 "come up and"
30: prt "return
 to the","initia
 l chart-","load
 position";spc
 2;stp
31: psc 707;wait
 100;psc 707;
 wait 100;psc
 707;pen;wrt
 707,"IN"
32: wait 3500;
 beep;dsp "Test
 Complete";stp
```

FILE 6

REAL TIME CLOCK SET AND/OR READ

```
0: beep;dsp "Rea
 l Time Clock
 Set and/or Read
 ";beep;stp
1: dim C$[14];
 ent "Want to
 change date
 and time?",C$
2: if C$#"yes";
 if C$#"y";gto
 12
3: dim A$[14];"
 "→A$[1,14]
4: dsp "Enter
 date and time";
 wait 1000
5: dsp "as two-
 digit numbers";
 wait 1000
6: ent "Month?(C
 C)",A$[1,2]
7: ent "Day?(DD)
 ",A$[4,5]
8: ent "Hour?(HH
 )",A$[7,8]
9: ent "Minute?(
 MM)",A$[10,11]
10: ent "Seconds
 ?(SS)",A$[13,
 14]
11: wrt 9,"S",
 A$;wrt 9,"B"
12: dim B$[30]
13: wrt 9,"R";
 red 9,C$
14: "DATE:  "→B$
 [1,7];C$[1,2]→B
 $[8,9];"/"→B$[1
 0,10];C$[4,5]→B
 $[11,12]
15: "   TIME:
 "→B$[13,22];
 C$[7,14]→B$[23,
 30]
16: dsp B$
17: gto 13
```

FILE 6
REAL TIME CLOCK SET AND/OR READ

Ø: and 1: These two lines give the title of the program and ask the operator whether he would like to change the date and time (reset the clock)

2: If the answer to the question in line 1 was yes, the program continues to line 3. If the answer was anything but yes, the program is sent directly down to line 12 to read the clock.

3: thru 1Ø: Lines 3 through 1Ø dimension the string variable A$ for the time (and date) and input the values for the Month, Day, Hour, Minute, and Second into the string as the operator enters them into the computer upon command.

11: Line 11 inputs the value of A$ into the real time clock using the "S" command. The "B" command used next is a command to clear the real time clock in preparation for a read statement.

*NOTE: This clear command to the clock may take up to 25 seconds to execute, so it is suggested that the operator wait a minimum of 30 seconds after pressing the last continue to allow the clock to enter the new time and clear itself.

12: thru 17: Lines 12 through 17 are reached either by answering no to the "Want to change date and time?" question in line 1 or after the clock has fully cleared itself in line 11. These lines display the date and time as fast as the computer can read it, display it, and go back to read it again. They are displayed in the format:

DATE: Ø7:18 TIME: Ø8:12:34

*NOTE: To stop the program, simply press the STOP key.

FILE 7

SYSTEM CALIBRATION

```
0: prt "To calib
 rate the","A/D,
  press","CONTIN
 UE";spc 3;prt
 "System Test:"
1: prt "To read
 A/D","values
 (counts","or
 degrees C)",
 "press f6";spc
 2;stp
2: dsp "This
 program allows
 A/D zero and"
3: wait 2000;
 dsp "gain adjus
 tments to be
 made.";wait
 2000
4: dsp "The valu
 e displayed
 represents";
 wait 2000
5: dsp "the actu
 al binary count
  from";wait
 2000
6: dsp "the 5931
 3A A/D,";wait
 2000
7: dsp "Place
 the CAL switch
 in the 0 ";wait
  2000
8: dsp "position
  and ensure
 that input ";
 wait 2000
9: dsp "plugs
 have been remov
 ed.";wait 2000
10: dsp "Adjust
 the zero set
 for 0.0L ";wait
  2000
11: dsp "o_ disp
 la.ed on the
 9825A.";wait
 2000
12: dsp "NOTE:
 If the A/D Conv
 erter is";wait
 2000
```

FILE 7
A/D CONVERTER AND SYSTEM CALIBRATION

Ø: and 1: Lines Ø and 1 give the operator a choice of whether to calibrate the A/D Converter and then calibrate the system or to go straight to the system calibration. If the operator goes straight to the system calibration he must press f6 (see special function key listing). To go on to the A/D calibration first, he need only press the CONTINUE key.

2: thru 16: These lines are self-explanatory in that they are merely statements designed to make the computer either print or display messages to the operator to tell him how to set up the system for calibration of the A/D Converter and what to expect in the upcoming calibration tests.

17 thru 37: These lines test each channel from 1 to 4 on the A/D Converter to see if the Ø set is equal to Ø. If the number read is not equal to Ø then it is displayed until the operator calibrates the Ø set back to Ø; the program then continues on to the next channel.

38: thru 47: These lines inform the operator as to the nature of the next calibrations to be performed. They tell the operator to adjust the gain set on the A/D Converter to match the proper reading as set forth on page 3-16 of the 59313A operating and programming manual. These proper gain sets are as follows:

SWITCH POSITION (IN BACK OF A/D):	READING:
Ø	Ø
-1	-1ØØ
-5	-5ØØ

48: thru 63: These lines display the count from each channel in turn for a short time so that gain adjustments may be made.

64: thru 68: Line 64 displays the message TEST COMPLETE and then the next 4 lines tell the operator to press the CONTINUE key to initiate the system test. The message SYSTEM TEST is displayed and the program is stopped.

*NEXT PAGE FOR FURTHER PROGRAM LISTING AND EXPLANATIONS-->

```
13: dsp "already
 calibrated to
 zero,";wait
 2000
14: dsp "no valu
 e will be displ
 a ed and";wait
 2000
15: dsp "the
 program will
 continue to
 the";wait 2000
16: dsp "next
 channel automat
 ically.";wait
 2000
17: beep;dsp
 "Channel 1";
 wait 2000
18: fmt 1,z,f.0
19: wrt 706.1,
 "H11AJ"
20: ior(shf(rdb(
 706),-8),rdb(70
 6))→A
21: if A=0;B+
 1→B;if B=100;
 gto 23
22: dsp A;gto 19
23: beep;dsp
 "Channel 2";
 wait 2000
24: wrt 706.1,
 "H22AJ"
25: ior(shf(rdb(
 706),-8),rdb(70
 6))→A
26: if A=0;C+
 1→C;if C=100;
 gto 28
27: dsp A;gto 24
28: beep;dsp
 "Channel 3";
 wait 2000
29: wrt 706.1,
 "H44AJ"
30: ior(shf(rdb(
 706),-8),rdb(70
 6))→A
31: if A=0;D+
 1→D;if D=100;
 gto 33
32: dsp A;gto 29
33: beep;dsp
 "Channel 4";
 wait 2000
34: wrt 706.1,
 "H88AJ"
35: ior(shf(rdb(
 706),-8),rdb(70
 6))→A
36: if A=0;E+
 1→E;if E=100;
 gto 38
37: dsp A;gto 34
38: dsp "Adjust
 the gain set
 for the ";wait
 2000
39: dsp "proper
 reading as show
 n on page ";
 wait 2000
40: dsp "3-16
 of the 59313A
 operation ";
 wait 2000
41: dsp "and
 programming
 manual.";wait
 2000
42: dsp "The
 count from each
 channel ";wait
 2000
43: dsp "is disp
 layed for a
 short time ";
 wait 2000
44: dsp "so that
 gain adjustmen
 ts can ";wait
 2000
45: dsp "be made
 and then the
 next ";wait
 2000
46: dsp "channel
 is displayed
 in sequence";
 wait 2000
47: dsp "Press
 CONTINUE to
 begin test";
 stp
48: beep;dsp
 "Channel 1 gain
 adj.";wait
 2000;0→N
49: N+1→N;wrt
 706.1,"H11AJ"
50: if N=1500;
 gto 52
51: dsp ior(shf(
 rdb(706),-8),
 rdb(706));gto
 49
52: beep;dsp
 "Channel 2 gain
 adj.";wait
 2000;0→N
```

```
53: N+1→N;wrt
 706.1,"H22AJ"
54: if N=1500;
 gto 56
55: dsp ior(shf(
 rdb(706),-8),
 rdb(706));gto
 53
56: beep;dsp
 "Channel 3 gain
  adj.";wait
 2000;0→N
57: N+1→N;wrt
 706.1,"H44AJ"
58: if N=1500;
 gto 60
59: dsp ior(shf(
 rdb(706),-8),
 rdb(706));gto
 57
60: beep;dsp
 "Channel 4 gain
  adj.";wait
 2000;0→N
61: N+1→N;wrt
 706.1,"H88AJ'
62: if N=1500;
 gto 64
63: dsp ior(shf(
 rdb(706),-8),
 rdb(706));gto
 61
64: dsp "Test
 complete";beep;
 wait 2000
65: prt "Press
 Continue","to
 read in","A/D
 values and",
 "display or
 print"
66: prt "them.
 What","follows
 is a","set of
 questions","to
 set up that"
67: prt "display
  or print";spc
 2
68: dsp "
    System Test"
 ;stp
```

69: thru 71: Lines 69 through 71 inform the operator that; "To change channel number, output speed, or to change the print/display option; press STOP and f7." (See special function key listing for f7).

72: thru 79: These lines allow the operator to enter into the calculator the number of channel to be read, whether he wants the counts from the A/D Converter to be printed or displayed. If he chooses to display the values, he may choose from any one of six display speeds from Ø (slow) to 5 (fast).

80: thru 94: These lines input the selected values for the channel and speed into the proper variables and continue to read and display values from the A/D Converter until the stop button is pushed.

95: Line 95 is only reached if the operator chooses to print the A/D values rather than to display them. This line reads in A/D values and prints them. (The display statements are skipped in the segment just preceding this line by the stipulation that line 94 may not be executed unless flag 2 has been set, which indicates that the operator had chosen the display option.)

```
69: prt "To chan
 ge","channel
 number,","outpu
 t speed,"
70: prt "or to
 change the",
 "print/display"
 ,"option; press
 "
71: prt "STOP
 and f7.";spc 2
72: cfg ;ent
 "Number of chan
 nel to be read?
 ",F
73: fxd 0;ent
 "Counts (0) or
 Temperature
 (1)?",H
74: if H=1;gsb
 'Constants"
75: ent "Print
 data(1) or disp
 lay(0)?",U
76: if U=1;gto
 "select"
77: sfg 2;dsp
 "Select desired
  display speed
 by";wait 2000
78: dsp "typing
 in a number
 from 0 to 5";
 wait 2000
79: ent "where
 0 is the slowes
 t speed",T
80: if T=0;750→T
81: if T=1;600→T
82: if T=2;450→T
83: if T=3;300→T
84: if T=4;150→T
85: if T=5;0→T
86: "select":if
 F<3;F→G;gto
 "read"
87: if F=3;4→G;
 gto "read"
88: 8→G
89: "read":fmt
 1,z,f.0;wrt 9,
 "A,U2=I3,U2C,
 U2G"
```

```
90: wrt 706.1,
 "H",G,G,"AJ";
 if flg10;fxd 11
91: ior(shf(rdb(
 706),-8),rdb(70
 6))→A
92: if flg10;A/
 100→A;I+AJ+KA↑2
 +LA↑3+MA↑4+OA↑5
 →A
93: if flg10;
 fxd 3
94: if flg2;dsp
 A;wait T;gto 90
95: prt A;gto 90
96: "Constants":
 fxd 11;19.85325
 88513→I;.984312
 236498→J;1.2810
 326104e-3→K
97: 1.4481456272
 2e-4→L;1.771491
 8524e-6→M;1.327
 07601597e-7→O;
 sfg 10
98: ret
*29569
```

FILE 8

OPERATING PROGRAM, XBT DATA ACQUISITION

FILE 8
MAIN DATA ACQUISITION PROGRAM

```
0: ldf 2,Y;beep;
 prt "JUST befor
 e","erasing
 this","program,
  be sure"
1: prt "to inser
 t the","program
  tape and","pre
 ss f10.";spc 3;
 beep;stp
2: wrt 704,"Q";
 prt "When Dylon
  stops","press
 CONTINUE";spc
 2;avd;fxd 0;
 stp
3: wrt 704,"YQK"
 ,Y;on err "erro
 r"
4: time 2000;
 wrt 9,"A,U2=I3
 ;prt "Insert
 data tape";spc
 2;stp
```

Ø: and 1: Lines Ø and 1 load the value of the number of files already written onto the current Dylon 9-track tape from the program tape into the variable Y. This value will be used later in the program to position the Dylon tape to the first blank file on the tape. The programmer is then informed, via the internal printer of the calculator, "Before erasing this program, be sure to insert the program tape and press f1Ø." Pressing f1Ø with the program tape inserted will record the new value of Y (Dylon tape file counter) back into file 2 to be used the next time the program is loaded and run. The program is now stopped to make sure that the operator reads the message and to await his CONTINUE.

2: Line 2 rewinds the Dylon tape and prints: "When the Dylon stops, press CONTINUE". The avd command is the automatic verify disable command and saves time in recording data to lessen the gaps created in T11 probes during the recording of T7 data. fxdØ sets a fixed decimal point with zero digits following that decimal point for any number in the calculator. The program is now stopped to await a CONTINUE from the operator.

3: In this line, a file mark is written at load point on the Dylon tape and it is then rewound and spaced forward the number of files represented by Y. This positions the Dylon tape at the file after the last recorded data file. This is accomplished because the value of Y is initialized at a value of 1. Therefore, if one data file has been recorded, the value of Y will be 2 and the tape will be spaced forward to the start of the second file on the tape. The on err statement sets up an error condition in the calculator which searches for errors and sends the program down to a subroutine called "error" when one occurs. This subroutine starts at line 144 and will be explained later.

4: The first command sets a time limit of 2 seconds for any peripheral being addressed by the calculator to respond. If the peripheral does not respond within that 2 seconds, an error E4 condition is set in the calculator. The second command resets the Real Time Clock and sets up unit 2 as a timer to be used later in the program. The operator is then told to "Insert Data Tape".

```
5: dim T$[14],
 P$[9],A$[4810],
 E$[14],F$[9],
 G$[10800];fmt
 1,z,f.0;fmt 2,
 z,f4.0
6: 1→T;20→J;0→F;
 0→G;0→K;1100→Q;
 fdf F
7: on err "error
 ";prt "Press
 CONTINUE","just
  before","probe
  launch";spc 2
8: 1→I;beep;dsp
 "Ready to conti
 nue?";beep;stp
9: wrt 705.1,
 "H",T,T,"AJ"
10: ior(shf(rdb(
 706),-8),rdb(70
 6))→A
```

5: In this line, the variables for the probe start time, probe type, and main data storage for each of the probe types are dimensioned. (See variable cross-reference for explanations as to which string serves what purpose). The first format statement is the format for writing to the A/D Converter, the second format is a 4-character integer field for writing data to the Dylon tape.

6: Line 6 initializes several variables. For a full listing of all variables and their uses in the program, see the variable cross-reference and explanation immediately following this program documentation. The <u>fdf F</u> statement finds file F, (F is the file counter for the T7 probes on the cassette tape) which is set to Ø at this point. This will save time later when the first T7 probe is to be recorded.

7: In line 7 the on err condition is reset. This must be done periodically throughout the program because the error subroutine "error" can only be reached if the on err condition is set, and each time "error" is referenced the on err condition is "unset". So it is reset at strategic points in case "error" has been referenced. The operator is then told to "Press CONTINUE just before probe launch".

8: After each probe (T7) is finished, the program is sent back to line 7. In this line, which immediately follows line 7, the valid data point counter (I) is reset to one and the message "Ready to continue?" is displayed. The program is then stopped to await a CONTINUE from the operator which will start the data collection procedure.

9: Due to the nature of the A/D Converter, it must be reset each time it is read from in the one-conversion-only mode used by this program. This line resets the A/D to the channel selected by the channel selector variable T. It is then reset to the one-conversion-only mode and it is given the output command (J). (NOTE: Because the A/D Converter achieves channel selection through bit shifting, T=4 for ch. 3 and T=8 for ch.4. Channels 1 and 2 are T=1 and T=2).

1Ø: Line 1Ø reads in an 8-bit byte from the A/D, shifts the memory location 8 bits to the left, reads another 8-bit byte, and stores the calculator-combined 16-bit word into the variable A.

```
11: if abs(A)>10
 00;gto "invalid
 "
12: if I=1;gto
 "time"
13: fti (A)→A$[I
 ,I+1];wrt 705.2
 ,A;wait 27
14: if I>2400+
 2400;for I=1
 to 200;wrt 705.
 2,P;next I;gto
 "finish"
15: I+2+0→I;gto
 9
16: "invalid":if
 I=1;gto 9
```

11: This program reads in values from the A/D Converter, which has a maximum and minimum count of ± 1Ø24 counts. The program only considers a data value valid, however, if it lies within the range of ± 1ØØØ counts. Since the A/D Converter is set up for an output of ± 1Ø volts, each count represents 1Ø millivolts. Line 11 tests the value of A to see if it is within the proper range. If A fails the test, the program is sent down to the subroutine "invalid".

12: Each data file for any probe starts with the probe start time and probe type and then continues with all data for that probe. If I=1, indicating the first valid data point, the program is sent down to subroutine "time" to record the start time and probe type in memory and on the Dylon tape.

13: Line 13 is reached only by valid data points. This line stores that valid data point into the data string A$ in integer precision format. This format uses two ASCII characters (2 bytes) as opposed to normal full precision storage (8 bytes) This same data value is then stored on the Dylon tape in the format described in line 2. The program then waits for 27 milliseconds to achieve the desired 2Ø sample per second data sampling rate.

14: Line 14 tests to see if all data points have been taken for the given probe (I greater than 48ØØ). 48ØØ is expressed as 24ØØ+24ØØ to slow the program down less than one millisecond to achieve a much greater accuracy to the desired sample rate. If all data points have been taken, the program is sent down to subroutine "finish".

15: If all data points have not been taken, the valid data point counter (I) is incremented by 2 and the program is sent back up to line 9 to read another value. The +Ø addition is another timing factor to slow the program down to the desired sample rate.

16: Line 16 is the first line of the subroutine "invalid". A launch is registered by the computer only when the first valid data point is found. If I=1, indicating that the first valid data point has not yet been found, the program is sent back up to line 9 to read in another data value and test it for validity.

```
17: C+1→C;fti
 (1100)→A$[I,I+
 1];I+2→I;wrt
 705.2,Q;if C<40
 ;gto 9
18: trk G;rcf F,
 T$,P$,A$;fdf F+
 2;F+2→F;wrt
 734,"Y";Y+1→Y;
 0→C;1→I
19: if F>19;if
 G=0;1→G;0→F;
 gto 21
20: if F>19;0→G;
 0→F;0→K;20→J;
 beep;prt "Chang
 e Data Tape",
 "Immediately!!"
 ;beep
21: beep;prt
 "Bad Probe",T;
 beep
```

17: Line 17 is reached only if an invalid data point has been taken after probe launch. The invalid data point counter (C) is incremented by 1 and a value of 11ØØ is input into the data string to show up later in the data analysis as an invalid point. The value of the variable Q is then output to the Dylon tape (Q=11ØØ) for the same purpose. If less than 4Ø invalid data points have been taken, the program is sent back to line 9 to read in another data value. The program is allowed to read in 4Ø invalid points before telling the operator that a probe is defective because probes are likely to bounce from one rail to another when they first hit the water before the values coming from the probe's thermistor become valid.

18: If the invalid data point counter fails the 4Ø points or less test in line 17, all data taken from the probe so far is recorded on the current file in the current track since it is known by now that the probe is defective. Then the data cassette is positioned to the next file to be recorded. (Raw data is recorded on every other file on the data cassette and will be converted to temperature values later and stored on the files in between). The file counter is then incremented, a file mark is written to the Dylon tape to end the current Dylon data file, the Dylon file counter is incremented, and both the valid and invalid data point counters are reset.

19: There are 2Ø T7 probe files and 4 T11 probe files on each track. Files Ø,2,4,etc., are reserved for raw data, and files 1,3,5,etc., are reserved for converted data. Line 19 tests to see if the end of a track has been reached. If the end of a track has been reached and the tape is on track Ø, the track indicator is set to 1 and the file counter is reset to Ø. The program is then sent down to line 21.

2Ø: If the end of a track has been reached but the finished track is track 1, the program prints the message "Change Data Tape Immediately!!" and continues to line 21.

21: Regardless of what has occurred in lines 19 and 2Ø, line 21 prints "Bad Probe T"; where T is the channel number on which the defective probe was being sampled. Since only channels 1 and 2 are being used to sample T7 probes, it is not necessary to change the value of T because of the bit shifting method of channel selection in the A/D.

22: and 23: Lines 22 and 23 change the value of T on which the defective probe was being sampled to the other channel so that a new or back-up probe may be launched immediately without having to wait to reload the old channel with another probe.

```
22: if T=2;1→T;
 gto 24
23: 2→T
24: beep;prt
 "Launch T7 on",
 "Channel",T;
 beep;spc 2;gto
 7
25: "finish":trk
  G;rcf F,T$,P$,
 A$;wrt 704,"Y";
 Y+1→Y;fdf F+2;
 F+2→F;0→C;1→I
26: if F>19;if
 G=0;1→G;0→F;
 gto 28
27: if F>19;0→G;
 0→F;0→K;20→J;
 beep;prt "Chang
 e Data Tape",
 "Immediately!!"
 ;beep
28: if T=2;1→T;
 gto 30
29: 2→T
30: beep;prt
 "Launch T7 on",
 "Channel",T;
 beep;spc 2;gto
 7
31: "time":wrt
 9,"R";"rawT7
  "→P$
32: red 9,T$;
 prt T$;on err
 "error";cmd 7,
 "?";wrt 704,
 "B14H1";cmd 7,
 "%"
```

24: Line 24 prints the message "Launch T7 on Channel T" where T is now the new channel number selected in lines 22 and 23. The program is now sent back to line 7 to ask the operator if he is ready to continue with the next probe.

25: Line 25 is the first line of the subroutine "finish" and is reached when all 4800 data points have been taken from a T7 probe. This line records the data on cassette on the proper file and track, ends the Dylon data file with a file mark, increments the Dylon file counter, the data cassette is positioned to the next blank data file, the cassette file counter is incremented, and both valid and invalid data point counters are reset.

26: and 27: Lines 26 and 27 perform the same functions as lines 19 and 20.

28: thru 30: These lines are identical to lines 22 through 24.

31: Line 31 is the first line of the subroutine "time" which is reached just before the first valid data point of a probe (indicating probe launch) has been reached. The two commands in this line recover the current month, date, and time from the real time clock and input the string rawT7 into the T7 probe type variable P$. The raw is tacked onto the first of the probe type to indicate to persons analyzing the data that this is raw data and has not been converted into temperature units yet.

32: Line 32 inputs the month, date, and start time read from the real time clock into the start time string (T$) in the form of MO:DA:HR:MN:SC. Then the start time is printed. This is to show the operator that the probe now in the water has found at least one valid data point. If the operator commands a probe launch and does not see the start time printed within 2 seconds after the probe hits the water, then he knows the probe is defective and can signal the program to that effect. (cont. on next page)

32: The on error condition is reset. Then, the bus is given the unlisten command, a block size of 14 characters is set up in the Dylon Tape Formatter, the Dylon is told that it will write one block of this size, and the data listen command is output on the bus.

```
33: wrt 705,T$;
 wrt 704,"B9W1";
 cmd 7,"%";wrt
 705,P$;wrt 704,
 "B1000W32000"
34: cmd 7,"%";
 gto 13
35: "defect":if
 T=2;1→T;gto 37
36: 2→T
37: beep;prt
 "Launch T7 on",
 "Channel",T;
 beep
38: 1→I;0→C;gto
 7
39: dim T$[14],
 P$[9],A$[4810],
 E$[14],F$[9],
 G$[10800];fmt
 1,z,f.0
40: beep;prt
 "Launch T11
 on","Channel
 3","whenever
 ready";spc 2;
 fmt 2,z,f4.0
```

33: In line 33, the start time of the probe is written out to the Dylon tape to start the data file. Then a block size of 6 characters is set up and the probe type stored in line 31 is written into this block. The Dylon is then set up for a block size of 1ØØØ characters and set up to write as many as 32ØØØ blocks.

34: Line 34 puts the Dylon into the data listen mode and sends the program back to line 13 to store that first valid data point which sent the program down to this subroutine in the first place.

35: thru 37: It was mentioned that the operator had to tell the program if a probe was launched and never received valid data (indicated by the absence of a printed start time for that probe). These are the first three lines of subroutine "defect", which is reached only by the operator pressing the STOP key and special function key f4. These lines perform the same functions that lines 22 through 24 performed.

38: Line 38 resets both valid and invalid data point counters and sends the program back up to line 7 to ask the operator if he is ready to look at the next probe on a different channel.

39: Line 39 is reached only when an error in string dimensioning occurs. The operator is told to press a special function key to reach this line. This will be explained further during the documentation of the subroutine "error".

4Ø: Line 4Ø is also reached only through a special function key, f3, which may be pressed any time that a T7 probe has just finished and the "Ready to continue?" message is apparent on the display screen. It informs the operator that he may launch a T11 probe on channel 3 whenever ready. The format statement merely restates the format used for writing data onto the Dylon tape.

```
41: on err "erro
 r";prt "Press
 Continue","just
  before","probe
  launch";spc 2
42: if T=0;1→T
43: beep;dsp
 "Ready to conti
 nue?";beep;stp
44: 1→B;4→L;269→
 D;0→H;0→M;0→C;
 1→I;1100→Q;if
 J=0;20→J
45: wrt 706.1,
 "H",T,T,"AJ";
 wait 4
46: ior(shf(rdb(
 706),-8),rdb(70
 6))→A;2r0→V
47: if T<3;T→E;
 gto 54
48: if abs(A)<10
 00;gto 50
49: if M=0;gto
 "invalidy"
```

41: Line 41 resets an on err condition in the calculator and then duplicates the message printed by line 7.

42: At this point in the program, T should have a value of either 1 or 2; but just in case, this line sets it equal to 1 if it is equal to zero.

43: Line 43 displays the "Ready to continue?" message and stops the program awaiting a CONTINUE from the operator. At this point in the program, the operator should launch a T7 and a T11 probe at nearly the same time. He may, however, only launch one or the other.

44: Line 44 initializes all variables and resets the T11 probe file counter for the cassette to its initial value of 2Ø if for some reason it is equal to Ø. See the variable cross reference at the end of this program documentation for details.

45: and 46: These lines perform the same functions as lines 9 and 1Ø. The wait 4 and 2 Ø-V are timing factors and have no other use in the program.

47: Sampling in this program mode is achieved by alternating between the T7 and T11 channels. A sample rate of 2Ø samples per second per probe is maintained throughout and made more precise due to various timing factors thrown in throughout the program to slow it down to the precise speed needed to guarantee that sample rate to an acceptable degree of accuracy. This line sends the program down to line 54 if T is less than 3 (indicating to the program that the current probe channel contains a T7 probe). The value of T (either 1 or 2) is stored in the variable E for later use before the program is sent to line 54.

48: If the probe in question is on channel 3 or 4, the program continues on to line 48, where the data point in question is tested for validity.

49: If the data point in question failed the validity test in line 48, and if the T11 probe in question is not finished recording all data (M=Ø), the program is sent down to "invalidy". If a T11 probe finished during a T7 probe drop, it is indicated to the program that the T11 probe has finished through the variable M, but the T11 data is not recorded until the T7 finishes to avoid data gaps in the T7 probe.

50: Line 5Ø performs for a T11 probe the same function performed by line 12.

51: Line 51 tests to see if a full 538Ø data points have been taken by a T11 probe. If they have been taken, the value of 2 is input into the variable M to indicate to the program from that point on that the T11 probe has finished. The invalid data point counter for the T11 probes is reset to Ø (H). The stored value of E, representing the number of the channel on which the current T7 probe is being sampled, is input into T. The program is then sent back to line 45 to read another value from the T7 probe. The following: 4ØD rather than 1Ø76Ø; Ø Ø-M; and wait 1 are timing factors. It will be noted that the value of B has not been reset and is still greater than 4ØD. This is to prevent more data from being taken from the T11 probe.

```
50: if B=1;gto
 "timeb"
51: if B>400;
 0r0→M;2→M;0→H;
 E→T;wait 1;gto
 45
52: fti (A)→G$[B
 ,B+1]
53: B+2→B;E→T;
 gto 45
54: if abs(A)<10
 00;gto 56
55: gto "invalid
 x"
56: if I=1;gto
 "timea"
57: fti (A)→A$[I
 ,I+1];wrt 705.2
 ,A
58: I+2→I;L→T
59: if I>4800;
 gto "finish1"
```

52: If all data has not yet been taken from the T11 probe, line 52 stores the valid data point into the T11 memory string. These data values will be later dumped onto cassette and Dylon.

53: In this line, the valid data point counter for the T11 probes (B) is incremented, the value of E (T7 probe channel number) is input into the channel selector variable T, and the program is sent back up to line 45 to read in another value from the T7 probe channel.

54: through 56: These lines perform for the T7 probe the same functions performed by lines 48 through 5Ø for the T11 probe.

57: If the data point in question has passed all tests so far, it is recorded in memory and onto the Dylon tape by line 57.

58: In line 58, the T7 valid data point counter (I) is incremented and the value of L is input into T. L stores the number of the selector for the channel of the T11 probe. It is normally 4 for channel 3 unless a T11 probe becomes defective, in which case channel 4 is used as a backup and L=8 for channel 4.

59: Line 59 sends the program down to "finish1" if a full 24ØØ data points have been taken for the T7 probe. The timing factors used in line 51 are not necessary due to the extra time used to write the valid data point to the Dylon tape.

```
60: gto 45
61: "invalidx":i
 f I=1;L→T;wait
 7;gto 45
62: C+1→C;fti
 (1100)→A$[I,I+
 1];I+2→I;wrt
 705.2,Q;if C<40
 ;L→T;gto 45
63: if M=0;if
 B#1;wrt 9,"U2C,
 U2G"
64: trk G;rcf F,
 T$,P$,A$;fdf F+
 2;F+2→F;wrt
 704,"Y";Y+1→Y;
 0→C;1→I
65: if E=1;2→E;
 gto 67
66: 1→E
67: if M=2;trk
 F;rcf J,E$,F$,
 G$;cmd 7,"?";
 wrt 704,"S14N1"
 ;cmd 7,"%"
```

6∅: Line 6∅ sends the program back to line 45 to read in another value from the T11 probe.

61: Line 61 is the first line of subroutine "invalidx"; the invalid subroutine for the T7 probes. As in line 16, if I=1 (indicating to the program that the T7 probe has not yet been launched), the program is sent back to line 45 to read in another value. The difference in this case is that the value of the T11 probe channel (L) is input into the channel selector (T) and the program is paused for 7 milliseconds as a timing factor before going to line 45.

62: Line 62 performs the same functions that line 17 performed with the addition that the channel selector (T) is changed to the T11 channel value of L.

63: If the program reaches line 63, that signifies that the current T7 probe has been found to be defective. If the current T11 probe is still sampling (M=∅), and if it has been launched (B not equal to 1), then the timer set up in line 4 is cleared and started. This timer will time to the nearest millisecond the gap created in the T11 probe while the partial data from the T7 defective probe is being recorded. This time will be used later to calculate the number of data points lost by the T11 probe and to show that gap as invalid data.

64: Line 64 is identical to line 18.

65: and 66: Lines 65 and 66 perform the same functions that lines 22 and 23 performed. The value of E is changed rather than the value of T because the program is about to input the value of L into T, so it is useless to use T to change the number of the T7 channel.

67: Line 67 is executed only if the T11 probe is finished. It records all T11 data (start time, etc.) onto cassette in the proper file on the proper track. Then the Dylon is unlistened, a block size of 14 characters (for the start time) is set up, and the Dylon is put into the data listen mode in preparation for recording of the T11 probe data onto the Dylon tape.

```
68: if M=2;wrt
 705,E$;wrt 704,
 "B9W1";wrt 705,
 F$;wrt 704,"B10
 00W32000"
69: if M=2;for
 I=1 to 10759
 by 2;itf(G$[I,
 I+1])→A;wrt
 705.2,A;next I
70: if M=2;wrt
 704,"Y";Y+1→Y;
 fdf F;J+2→J
71: if F>19;if
 G=0;1→G;0→F;
 gto 73
72: if F>19;0→G;
 0→F;0→K;20→J;
 beep;prt "Chang
 e Data Tape",
 "Immediately!!"
 ;beep
73: if J>23;if
 K=0;1→K;20→J;
 gto 75
74: if J>23;0→K;
 20→J;0→G;0→F;
 beep;prt "Chang
 e Data Tape",
 "Immediately!!"
 ;beep
75: beep;prt
 "Bad Probe",T;
 beep
76: if M=2;E→T;
 beep;prt "*T7
 PROBES ONLY*";
 beep
77: beep;prt
 "Launch T7 on",
 "Channel",E;
 beep;spc 2
78: if M=2;gto 7
```

68: Line 68 is only executed if M=2 (T11 probe) has finished. The start time is written to the Dylon unit, a 6-character block is set up for the probe type, the probe type is written to the Dylon tape, and the data block of 1ØØØ characters is set up in preparation for dumping the T11 raw data onto the Dylon tape.

69: Again, if the T11 probe has finished, this line retrieves each data value from memory string G$ and writes it to the Dylon using format 2.

7Ø: If M=2; a file mark is written to the Dylon tape to end the current data file, the Dylon file counter variable (Y) is incremented to show that another file has been fully recorded, the tape is positioned back to the next T7 file to save recording time later, and the T11 cassette file counter is incremented.

71: and 72: These lines perform the same func- as lines 19 and 2Ø.

73: and 74: Since the T11 cassette file counter has just been incremented, the cassette must also be checked to see if the T11 files on the current T11 track are at an end. These lines perform the same functions that lines 19 and 2Ø perform for T7 probes.

75: Line 75 prints the "Bad Probe" message.

76: Line 76 is executed only if M=2, meaning that the current T11 probe is finished and therefore that all data from that T11 probe has been recorded on cassette and Dylon. It inputs the value of the T7 channel (E) which was selected in lines 65 and 66 into the channel selector variable (T). Then, the message "*T7 PROBES ONLY*" is printed since the program is about to be sent back to the T7 only mode of the program.

77: Regardless of whether the T11 probe is finished or not, another T7 probe needs to be launched on the channel designated by the variable E. The "Launch T7 on Channel E", where E is 1 or 2, is printed.

78: If the T11 probe is finished (M=2), the program is sent back up to display the "Ready to continue?" message in the T7 probe only mode that starts with line 7.

```
79: if B#1;wrt
 9,"U2V";red 9,
 N;int(N/1000*
 20)→O;B+2O+4→V;
 L→T
80: if B#1;for
 W=B to V by 2;
 fti (1100)→G$[W
 ,W+1];next W
81: if B#1;V→B;
 gto 45
82: L→T;gto 45
```

79: Line 79 is reached only if the current T11 probe is not yet finished. If it has been launched (B not equal to 1) then the timer that was started in line 63 is stopped and the time placed into an output port in the clock waiting to be read. The time is read into the variable N. Then, N/1ØØØ converts the time to seconds fr' its current value of milliseconds. This n value is multiplied by the sample rate of 2Ø samples per second to get a number which represents the number of samples which would normally have been taken by the T11 probe during this time lag. This value is converted to an integer and stored in the variable O. Then B (T11 valid data point counter used also to position data values in the memory string), 2*O (because of integer precision), and 4 are added together and stored in the variable V. This number represents the current position of the memory string plus the number of points which were lost during T7 recording plus another 4 data points to account for the time that it will take to record data into this data gap. Then the value of L is input into the channel selector (T).

8Ø: Again, if the current T11 probe is not yet finished, this line is executed. Into each memory location between B, the current location, and V, the location at the end of the gap, the value of 11ØØ is written into memory. This value will be recognized later as invalid data.

81: Line 81 is executed if the T11 probe has been launched. (Not yet finished). It inputs the value of V into B which will prepare for storage of a data value the next memory location after th' gap created by the T7 recording. The program is then sent back up to line 45 to read in another data point from the T11 probe.

82: If the probe is not yet finished and has not been launched, either; the value of L is input into T and the program is sent back to look at another data value from the T11 probe and test it for validity.

```
83: "invalidy":i
 f B=1;0r0→T;
 E→f;wait 2;gto
 45
84: H+1→H;fti
 (1100)→G$[B,B+
 1];B+2→B;if
 H<60;E→T;gto 45
85: if I#1;wrt
 9,"U2C,U2G"
86: trk K;rcf J,
 E$,F$,G$;J+2→J;
 0→H;1→B;0→M
87: if J>23;if
 M=0;1→K;20→J;
 gto 89
88: if J>23;0→K;
 20→J;0→G;0→F;
 beep;prt "Chang
 e Data Tape",
 "Immediately!!"
 ;beep
89: if T=8;4→S;
 gto 91
90: 3→S
91: beep;prt
 "Bad Probe",S;
 beep
92: if S=4;4→L;
 3→S;gto 94
93: 8→L;4→S
```

83: Line 83 is identical to line 61 in function, except that line 83 is used for T11 probes and the timing factors are different.

84: Line 84 is identical to line 62 in function, except that line 84 is used for T11 probes and those T11 probes are allowed 6∅ invalid data points before being declared defective due to their longer fall time and consequently larger number of data points total.

85: Line 85 starts the timer if a T7 probe has been launched. Unlike the subroutine "invalidx", there is no need to test the T7 probe to see if it is finished or not because all T7 probes are sent immediately down to a subroutine called "finishl" after they finish.

86: Line 86 records all T11 data taken before the probe was registered as defective into the proper file on the proper track on the cassette. The T11 file counter is then incremented, the valid and invalid data point counters for the T11 probes are reset, and M is reset to ∅ to indicate to the program that this T11 probe is not finished yet. (This is merely a safety measure; M should already be equal to zero.)

87: and 88: Lines 87 and 88 are identical to lines 73 and 74.

89: and 9∅: Lines 89 and 9∅ decide whether T=4 or T=8. If T=4 (Channel 3) then the value of 3 is input into the variable S. If T=8 (Channel 4) then the value of 4 is input into the variable S.

91: Line 91 prints the message "Bad Probe S", where S was defined in lines 89 and 9∅ and represents the number of the channel on which the now-defective T11 probe was being sampled.

92: and 93: Lines 92 and 93 take the value of S (the current T11 probe channel on which the T11 probe was just discovered to be defective) and switches the value of L to the other channel. Therefore, if S=3, 4 is input into L; if S=4, 8 is input into L. Also, the value of S is changed to the other channel. Thus, if S was 3, it is changed to 4; and vice versa. These two values will be used later in the program.

```
94: beep;prt
 "Launch T11
 on","Channel",
 S;beep;spc 2
95: if I#1;wrt
 9,"U2V";red 9,
 N;int(N/1000*
 20)→O;I+20+10→V
 ;E→T
96: if I#1;for
 W=I to V by 2;
 fti (1100)→A$[W
 ,W+1];wrt 705.2
 ,Q;next W
97: if I#1;V→I;
 gto 45
98: E→T;gto 45
99: "finish1":if
  M=0;if B#1;
 wrt 9,"U2C,U2G"
 ;for I=1 to
 200;wrt 705.2,
 P;next I
100: trk G;rcf
 F,T$,P$,A$;wrt
 704,"Y";Y+1→Y;
 fdf F+2;F+2→F;
 1→I;0→C
101: if M=2;trk
 l;rcf J,E$,F$,
 G$;cmd 7,"?";
 wrt 704,"B14W1"
 ;cmd 7,"%"
102: if M=2;wrt
 705,E$;wrt 704,
 "B9W1";wrt 705,
 F$;wrt 704,"B10
 03W32000"
103: if M=2;for
 I=1 to 10759
 by 2;itf(G$[I,
 I+1])→A;wrt
 705.2,A;next I
104: if M=2;for
 I=1 to 200;wrt
 705.2,P;next I;
 wrt 704,"Y";Y+
 1→Y;fdf F;J+2→J
105: if F>19;if
 G=0;1→G;0→F;
 gto 107
```

94: Line 94 informs the operator via the calculator's internal printer that he may "Launch T11 on Channel S", where S is either 3 or 4.

95: thru 98: Lines 95 through 98 are used to record invalid data in the gap created by recording of T11 partial data. They are practically identical to lines 79 through 82, except that in line 96, the value of 11ØØ is written to the memory locations and Q is written to the Dylon tape, since T7 probes write each value to the Dylon tape as it is taken. (Q is equal to 11ØØ).

99: Line 99 is reached only if a T7 probe has finished. It is identical to line 63.

1ØØ: Line 1ØØ records all T7 data onto cassette. Then a file mark is written onto the Dylon tape to mark the end of that data file, the Dylon file counter is incremented, the cassette is positioned to the next file to be recorded, the T7 cassette file counter is incremented, and both the valid and invalid data point counters for the T7 probes are reset.

1Ø1: thru 1Ø8: These lines are identical to lines 67 through 74.

1Ø9: and 11Ø: These two lines are identical to lines 65 and 66.

111: thru 117: These lines are identical to lines 76 through 82.

118: thru 121: This is the subroutine "timea" which records the time and probe type for the T7 probes in the T7/T11 half of the program. It is identical in content to subroutine "time" in lines 31 through 34.

122: thru 124: Lines 122 through 124 comprise the subroutine "timeb". This subroutine is basically the same as subroutine "time" and subroutine "timea", except that the start time and probe type are not yet written out to the Dylon unit. The start time is read from the clock and stored in E$, the probe type "rawT11" is stored in F$, the on err condition is reset once again, and the block size for writing data onto the Dylon tape is set up. Then the Dylon is put into data listen mode and the program is sent back up to line 51 to record the first valid data point from the T11 probe which sent the program down to this subroutine originally.

```
106: if F>19;
 0→G;0→F;0→K;
 20→J;beep;prt
 "Change Data
 Tape","Immediat
 ely!!";beep
107: if J>23;if
 K=0;1→K;20→J;
 gto 109
108. if J>23;
 0→K;20→J;0→G;
 0→F;beep;prt
 "Change Data
 Tape","Immediat
 ely!!";beep
109: if E=1;2→E;
 gto 111
110: 1→E
111: if M=2;E→T;
 beep;prt "*T7
 PROBES ONLY*";
 beep
112: beep;prt
 "Launch T7 on",
 "Channel",E;
 spc 2
113: if M=2;gto
 7
114: if B#1;wrt
 9,"U2V";red 9,
 N;int(N/1000*
 20)→O;B+20+4→V;
 L→T
115: if B#1;for
 W=B to V by 2;
 fti (1100)→G$[W
 ,W+1];next W
116: if B#1;V→B;
 gto 45
117: L→T;gto 45
118: "tinea":wrt
 9,"R";"rawT7
 "→P$
119: red 9,T$;
 prt T$;on err
 "error";cmd 7,
 "?";wrt 704,
 "E14W1";cmd 7,
 ":"
```

125: This is the first line of the subroutine "defectb". This defective probe subroutine is for the T7/T11 half of the program and is very similar to subroutine "defect" except that it is more complex in that it must determine which of the two probes being sampled is defective and act accordingly. This subroutine is also reached only through the keyboard via the special function keys f12 and f5. This first line clears all flags in the calculator and if I=1 (indicating that the defective probe is the T7 probe) the program is sent down to line 136.

126: and 127: These two lines are executed only if the T11 probe in question at the moment is not finished and has not yet registered a launch. They input the number (not the selector) of the current T11 channel into the variable S.

128: Again, this line is executed only if the T11 probe has not finished and has not registered a launch yet. It prints the "Bad Probe S" message and sets flag 2 (when a flag is set its value is one, when it is not set its value is Ø).

129: and 13Ø: These two lines change the channel number (S) to the other T11 channel and change the channel selector storage variable (L) to the selection number for the other T11 channel.

131: Line 131 tells the operator to "Launch T11 on Channel S", where S has been changed to the new channel number in lines 129 and 13Ø.

132: thru 134: These lines are identical to lines 95 through 97, except that they include the stipulation that flag 2 must be set before they can be executed. Flag 2 is set only if line 128 has been executed, which indicates that the defective probe is a T11.

135: If the program was not sent down to line 136 during the execution of line 125 (indicating that the defective probe was not the T7) and if flag 2 is not set (indicating that the defective probe was not the T11 either), then this line is executed which prints the message "Program error; Both probes look valid." and the program is stopped to await operator analysis of the problem.

```
120: wrt 705,T$;
 wrt 704,"B9W1";
 cmd 7,"%";wrt
 705,P$;wrt 704,
 "B1000W32000"
121: cmd 7,"%";
 gto 57
122: "timeb":wrt
  9,"R";"rawT11
   "→F$
123: red 9,E$;
 prt E$;on err
 "error"
124: wrt 704,
 "B1000W32000";
 cmd 7,"%";gto
 51
125: "defectb":c
 fg ;if I=1;gto
 136
126: if M=0;if
 B=1;if L=4;3→S;
 gto 128
127: if M=0;if
 B=1;4→S
128: if M=0;if
 B=1;beep;prt
 "Bad Probe",S;
 beep;stp 2
129: if M=0;if
 B=1;if I=3;4→S;
 8→L;gto 131
130: if M=0;if
 B=1;3→S;4→L
131: if M=0;if
 B=1;prt "Launch
  T11 on","Chann
 el",S;spc 2
132: if I#1;if
 flg2;wrt 9,"U2V
 ";red 9,H;int(H
 /1000-20)→O;I+
 20+4→V;E→T
133: if I#1;if
 flg2;for N=I
 to V by 2;fti
 (1100)→A$[N,N+
 1];wrt 705.2,O;
 next N
134: if I#1;if
 flg2;N-I;gto 45
```

136: Line 136 is reached only if the program has decided that the defective probe is the T7 probe. It prints the "Bad Probe E" message.

137: and 138: These two lines are duplicates of lines 65 and 66.

139: This line is identical to line 113 in function.

14Ø: thru 142: These lines are identical to lines 115 through 117, with the additional stipulation that M=Ø before any of the lines may be executed. If M is not equal to Ø, then the T11 probe is finished and there is no data gap to account for at this time. So, the program would continue down to line 143.

143: This is the last line of the subroutine "defectb" and it sends the program back up to line 45 to read in a value from the new T7 channel. This line is reached only if the T7 probe was defective and the T11 probe was already finished.

144: Line 144 is the first line of the subroutine called "error". If the on-err condition is set in the calculator and an error occurs, the program bounces down to this subroutine. The decimal value of the ROM letter in which the error occurred is input into the variable rom. The number of the error is input into the variable ern. The number of the program line in which the error occurred is input into the variable erl. Thus, an error E4 might occur in line 9 if the A/D Converter did not respond to the reset command in line 9 within the required 2 second time limit set in line 3. This error E4 in line 3 would be stored as: rom=69 (the decimal value of the ASCII character E), ern=4, erl=3. An error in the mainframe sets rom=Ø. A mainframe error is one which involves no particular ROM. In this line, P is reset to Ø and will be used later in the error subroutine.

145: thru 148: If an error E4, G8, G4, or G9 has occurred in any program line, these lines send the program down to line 165. All these errors have in common an indication that one or more of the peripherals or that the HP-IB itself is down. Sending the program down to line 165 will start the program checking to see which line stopped the program with an error, and therefore which peripheral is down.

```
135: if flg2=0;
 prt "Program
 error!","Both
 probes","look
 valid.";spc 2;
 stp
136: beep;prt
 "Bad Probe",E;
 beep
137: if E=1;2→E;
 gto 139
138: 1→E
139: prt "Launch
  T7 on","Channe
 l",E;spc 2
140: if M=0;if
 B#1;wrt 9,"U2V"
 ;red 9,N;int(N/
 1000*20)→O;B+
 20+10→V;L→T
141: if M=0;if
 B#1;for W=B to
 V by 2;fti (110
 0)→G$[W,W+1];
 next W
142: if M=0;if
 B#1;V→B;gto 45
143: E→T;gto 45
144: "error":0→P
145: if rom=69
 and ern=4;gto
 165
146: if rom=71
 and ern=8;gto
 165
147: if rom=71
 and ern=4;gto
 165
148: if rom=71
 and ern=9;gto
 165
149: if rom=0
 and ern=39;1→P
150: if P=1;prt
 "Insert prograr
 ","cassette
 and","press
 f10."
```

149: Line 149 sets P=1 if an error 39 has occurred in the program. Error 39 indicates an error involving insufficient memory for variable allocation. This P=1 will be used in the next program lines as an indicator that this error has occurred.

15Ø: thru 154: These lines print a message to the operator if an error in dimensioning or variable allocation has occurred. They print the message "Insert program cassette and press f1Ø. When the tape stops, press fØ and f11. Insert NEW data cassette and" Then, if erl (number of the line in which the error occurred is less than or equal to 38, indicating the T7-only mode of the program; the message is finished with "press f1." If erl is greater than 39, indicating the T7/T11 mode of the program, then the message is completed with "press f2." Analyzing this message, the operator will insert the program tape and f1Ø will record the value of the Dylon file counter (Y) into file 2 on the cassette. Then, fØ will erase all variables and f11 will then retrieve the value of Y from file 2 of the cassette. The operator then inserts a new data cassette (because the track and file indicators for the old one have all been erased) and hits either f1 or f2. These two keys send the program back to redimension and reinitialize all program variables for either the T7-only or T7/T11 mode of the program. At this point, the T7 channel is channel 1 and the T11 channel is channel 3.

155: thru 157: These three lines also set P=1 if an error S7,S8, or S6 have occurred. They then send the program back up to line 15Ø to print the operator message. These errors all involve problems in string dimensioning.

158: thru 16Ø: These three lines are executed if an error 42 in the mainframe has occurred. This error indicates to the program that the RECORD tab on the data cassette is in the wrong position for recording. In the section of the program in which this error might occur, it is highly possible that a data gap is occurring in the T11 probe, so the message printed is "Quickly eject cassette and slide RECORD tab over, then replace tape and type cont erl", where erl is the number of the line in which the error occurred.

```
151: if P=1;prt
 "When the tape"
 ,"stops, press"
 ,"f0 and f11."
152: if P=1;prt
 "Insert NEW
 data","cassette
  and"
153: if P=1;if
 erl<=38;prt
 "press f1.";
 spc 3;beep;0→P;
 stp
154: if P=1;if
 erl>38;prt "pre
 ss f2.";spc 3;
 beep;0→P;stp
155: if rom=83
 and ern=7;1→P;
 gto 150
156: if rom=83
 and ern=8;1→P;
 gto 150
157: if rom=83
 and ern=6;1→P;
 gto 150
158: if rom=0
 and ern=42;prt
 "Quickly eject"
 ,"cassette and"
 ,"slide RECORD"
159: if rom=0
 and ern=42;prt
 "tab over,",
 "Then replace",
 "tape and type"
160: if rom=0
 and ern=42;prt
 "             cont"
 ,erl;beep;spc
 3;stp
161: if rom=0
 and ern=30;prt
 "Insert program
 ","tape and
 type in","ldk
 0."
```

161: thru 163: These lines are executed if an error 3Ø occurs in the mainframe. This error indicates that a special function key has been pressed by the operator, but that key was not defined. The program assumes that the operator has pressed the correct key, but that the keys are not yet defined. Therefore, the message "Insert program tape and type in ldk Ø. Then re-insert Data Tape and Press special function key again." is printed.

164: If the program has come this far without being sent down to line 165, then it is evident that the error that has occurred is not covered in this error subroutine. In that case, the operator will want to see the error message, which looks something like this: error 15 in 3Ø. This tells the programmer that the printer either ran out of paper or failed while the printer was attempting to print the message in line 3Ø of the program. Therefore, line 164 tells the calculator to jump 164-erl lines backward in the program. This, in effect, tells the program to execute the line in which the error occurred another time, but this time the on-err condition will not be set since the error subroutine was just used. If the error occurs again , which it should, the error message is displayed and the program is stopped to await operator action.

165: thru 168: These lines decide, as mentioned, which peripheral is down. If the error occurred in lines 9, 1Ø, or 46, the program is told to go down to "A/D" to print a message to the operator. If the error occurred in line 45, there is a possibility that either the clock or the A/D is down. The program is then sent to "Cl/A2D."

169: thru 171: These three lines are reached through lines 165 through 168. They print messages to the operator telling him that the Real Time Clock, the A/D Converter, or that either of the two is down. The program is then stopped to await operator action. *NOTE: If an error occured to send the program down to lines 165 through 168, but the erl does not match any of the line numbers checked by those lines, the program will tell the operator that the Real Time Clock is down, since that is the first message reached by the program flow after the check in line 168.

```
162: if rom=0
 and ern=30;prt
 "Then re-insert
 ","Data Tape
 and","Press
 special"
163: if rom=0
 and ern=30;prt
 "function key",
 "again.";beep;
 stp
164: jmp -(164-
 erl)
165: if erl=9;
 gto "A/D"
166: if erl=10;
 gto "A/D"
167: if erl=45;
 gto "Cl/A2D"
168: if erl=46;
 gto "A/D"
169: "Clock":prt
  "Real Time
 Clock","Is Down
 ;","See Manual.
 ";beep;spc 3;
 stp
170: "A/D":prt
 "A/D Converter"
 ,"Is Down;",
 "See Manual.";
 beep;spc 3;stp
171: "Cl/A2D":pr
 t "Either Clock
  or","A/D is
 down;","See
 Manual.";spc 3;
 stp
*25495
```

FILE 8
VARIABLE CROSS-REFERENCE AND DESCRIPTION

```
A    10   11   13
13   46   48   52
54   57   57   69
69   103  103

B    44   50   51
52   52   53   53
63   79   79   80
80   81   81   83
84   84   84   84
86   99   114  114
115  115  116  116
126  127  128  129
130  131  140  140
141  141  142  142

C    17   17   17
18   25   38   44
62   62   62   64
100

D    44   51

E    47   51   53
65   65   66   76
77   83   84   95
98   109  109  110
111  112  132  136
137  137  138  139
143

F    6    6    18
18   18   18   19
19   20   20   25
25   25   25   26
26   27   27   64
64   64   64   70
71   71   72   72
74   86   100  100
100  100  104  105
105  106  106  108

G    6    18   19
19   20   25   26
26   27   64   71
71   72   74   88
100  105  105  106
108

H    44   51   84
84   84   86
```

NOTE: In this variable listing and description, each variable will be listed on the left, followed by the program line numbers in which they occur. To the right will be a description of what the variable is used for in the program. After each description will follow either an *, a ⁑, or nothing. An asterisk following a description indicates that the variable is used only in the T7-Only mode of the program. A⁑ indicates the T7/T11 mode, and nothing indicates both. NOTE: These character descriptors are used to indicate in which program modes a variable is used, and do not necessarily mean that the variable does not occur in the other half of program. They simply mean that the variable may be initialized or dimensioned in another part of the program, but that it is only used in the specified program section.

A: A is used to store the 16-bit data word made from the two combined 8-bit words read into the calculator from the A/D Converter.

B: B is the valid data point counter for the T11 probes. Since B is actually twice the actual number of valid data points taken minus one, it is also used to position data values in the main data storage string for the T11 probes. This is necessary due to the integer precision method of data storage being used.⁑

C: C is the invalid data point counter for the T7 probes.

D: D is the sample duration in seconds for the T11 probes and is always equal to 269.⁑

E: E is used to store the number of the T7 channel so that it can be input into T (channel selector variable) when it is time to read in a value from a T7 probe.⁑

F: F is the file counter for T7 probes on the cassette. T7 raw data is recorded on the even numbered files from Ø to 18 on both tracks.

```
I    8    12   13
13   14   14   14
15   15   16   17
17   17   17   18
25   38   44   56
57   57   58   58
59   61   62   62
62   62   64   69
69   69   69   85
95   95   96   96
97   97   99   99
100  103  103  103
103  104  104  125
132  132  133  133
134  134

J    6    20   27
44   44   67   70
70   72   73   73
74   74   86   86
86   87   87   88
88   101  104  104
106  107  107  108
108

K    6    20   27
67   72   73   73
74   86   87   87
88   101  106  107
107  108

L    44   58   61
62   79   82   92
93   114  117  126
129  130  140

M    44   49   51
51   63   67   68
69   70   76   78
86   99   101  102
103  104  111  113
126  127  128  129
130  131  140  141
142

N    79   79   95
95   114  114  132
132  140  140

O    79   79   95
95   114  114  132
132  140  140
```

G: G is the track indicator for the T7 probes on the cassette. It is always either Ø or 1.

H: H is the invalid data point counter for the T11 probes.*

I: I is the valid data point counter for the T7 probes and is the counterpart of B. See the documentation of the variable B for details.

J: J is the file counter for the T11 probes on the cassette. It is always either 2Ø or 22.

K: K is the track indicator for the T11 probes * on the cassette. It is also always either Ø or 1.

L: L is used to store the number of the T11 channel so that it can be input into T (channel selector variable) when it is time to read in a value from a T11 probe. It is the counterpart of E.*

M: M is the indicator which tells the program whether or not a T11 probe is finished. It is Ø when the probe is not finished and 2 when it is finished.*

N: N is the variable used to store the time read from the unit 2 timer in the Real Time Clock that is used at various points in the program.*

O: O is used to store the value of the number of lost data points during the recording of data on another probe. It is always the value of N/1ØØØ times 2Ø and rounded to the nearest integer.*

P: P is used as an indicator in the error subroutine called "error". It indicates to lines 15Ø through 154 whether or not an error in dimensioning or allocation of variables has occurred and, consequently, tells the program whether to execute these lines. Thus, P=Ø if a dimensioning or allocation error has not occurred and P=1 if such an error has occurred.

Q: Q is used to write out to the Dylon unit to register invalid data for a data gap. Q is always equal to 11ØØ.

```
P    14   99   104
144  149  150  151
152  153  153  154
154  155  156  157

Q    6    17   44
62   96   133

S    89   90   91
92   92   93   94
126  127  128  129
129  130  131

T    6    9    9
21   22   22   23
24   28   28   29
30   35   35   36
37   42   42   45
45   47   47   51
53   58   61   62
75   76   79   82
83   83   84   89
95   98   111  114
117  132  140  143

V    46   79   80
81   95   96   97
114  115  116  132
133  134  140  141
142

W    80   80   80
80   96   96   96
96   115  115  115
115  133  133  133
133  141  141  141
141

Y    0    3    18
18   25   25   64
64   70   70   100
100  104  104

A$   5    13   17
18   25   35   57
62   64   96   100
133

E$   5    39   67
68   86   101  102
123  123
```

S: S is used to store the value of the number of a T11 channel on the A/D Converter. It is used primarily when messages concerning the T11 probes have to be printed to the operator. Since the channel selectors for channels 3 and 4 are T=4 and T=8, S is used to store the numbers 3 or 4 so that it is easier for the operator to know which channel is being talked about in a message.*

T: T is the channel selector variable for the A/D Converter. It is either 1,2,4, or 8 depending on whether the operator is looking at channel 1,2,3, or 4.

V: V is used to store the memory location of the end of a data gap so that that gap may be filled with the exact amount of data points with value 11ØØ (invalid data).*

W: W is the counter in the for/next loop which is used to write invalid data into memory to take care of a data gap. W ranges from the current memory location from where the gap started (B) to the ending location of the data gap (W).

Y: Y is the counter for the number of files already written onto the current Dylon tape. It is actually one more than the number of files already written and is stored in file 2 of the program tape. Whenever the program is loaded and run, the Dylon tape is rewound and spaced forward Y files, so the tape ends up at the beginning of the file immediately following the last recorded data file on the tape.

A$: A$ is the string used to store the T7 probe data. The data is stored in integer precision format, which takes only 2 ASCII characters (2 bytes) to store a data word.

E$: E$ is used to store the probe start time for the T11 probes.*

F$: F$ is used to store the probe type for the T11 probes.*

G$: G$ is used to store the T11 probe data. It is the counterpart of A$.*

P$ and T$: These are the probe type and start time strings, respectively, for the T7 probes.

```
F$  5   39  67
68  86  101 102
122

G$  5   39  52
67  69  80  84
86  101 103 115
141

P$  5   18  25
31  33  39  64
100 118 120

T$  5   18  25
22  32  33  39
64  100 119 119
120
```

FILE 9

OPERATING PROGRAM, XBT DATA ACQUISITION (NO DYLON)

FILE 9
DATA ACQUISITION PROGRAM (NO DYLON UNIT)

FILE 9 is exactly the same as FILE 8, except that all references, variables, messages, program lines etc., regarding the Dylon unit have been deleted. The programmer is informed at the first of the program to turn the Dylon power OFF. CAUTION: If the Dylon unit is left powered up during the running of this program, the sample rate of the probes will be severely affected!!

The only difference in FILE 8 and FILE 9 is the line numbers and hence the spacing of command statements in the program.

FILE 1Ø
DATA ACQUISITION PROGRAM (3 CHANNELS ONLY)

FILE 1Ø is exactly the same as FILE 8 except that there is no backup channel for T11 probes. If a channel becomes defective (any channel, since hardware changes can easily be made in the system to make any launch station go to any channel), this program launches T11 probes on channel 3 as usual but will only print the Bad Probe message for T11 probes which are found to be defective.

Listings of these two programs, along with variable cross references (unexplained), follow in the next few pages.

FILE 9

```
0: on err "error";time 2000;avd;dsp "Turn Sylon power OFF";beep;stp
1: fxd 0;wrt 9,"A,U2=I3";prt "Insert data tape";spc 2;stp
2: dim T$[14],P$[6],A$[4810],E$[14],F$[6],G$[10800];fmt 1,z,f.0;fmt 2,z,f4.0
3: 1 T;20→J;0→F;0→G;0→K;fdf F
4: on err "error";prt "Press Continue","just before","probe launch";spc 2
5: 1→I;beep;dsp "Ready to continue?";beep;stp
6: wrt 706.1,"H",T,T,"AJ"
7: ior(shf(rdb(706),-8),rdb(706))→A;wait 32;T.81+0→V
8: if abs(A)>1000;gto "invalid"
9: if I=1;gto "time"
10: fti (A)→A$[I,I+1]
11: if I>4800;gto "finish"
12: I+2→I;gto 6
13: "invalid":if I=1;gto 6
14: C+1→C;fti (1100)→A$[I,I+1];I-2→I;if C<40;gto 6
15: trk G;rcf F,T$,P$,A$;fdf F-2;F+2→F;C→C;1→I
16: if F>19;if G=0;1→G;0→F;gto 16
17: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
18: beep;prt "Bad Probe",T;beep
19: if T=2;1→T;gto 21
20: 2→T
21: beep;prt "Launch T7 on","Channel",T;beep;spc 2;gto 4
22: "finish":trk G;rcf F,T$,P$,A$;fdf F-2;F+2→F;0→C;1→I
23: if F>19;if G=0;1→G;0→F;gto 25
24: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
25: if T=2;1→T;gto 27
26: 2→T
27: beep;prt "Launch T7 on","Channel",T;beep;spc 2;gto 4
28: "time":wrt 9,"R";"ewT7 "→P$
29: red 9,T$;prt T$;on err "error"
30: gto 10
31: "defect":if T=2;1→T;gto 33
32: 2→T
33: beep;prt "Launch T7 on","Channel",T;beep
34: 1→I;0→C;gto 4
35: dim T$[14],P$[6],A$[4810],E$[14],F$[6],G$[10800];fmt 1,z,f.0
36: beep;prt "Launch T11 on","Channel 3","whenever ready";spc 2;fmt 2,z,f4.0
37: on err "error";prt "Press Continue","just before","probe launch";spc 2
38: if T=0;1→T
39: beep;dsp "Ready to continue?";beep;stp
40: 1 B;4→L;269→D;0→H;0→M;0→C;1→I;if J=0;20→J
41: wrt 706.1,"H",T,T,"AJ";wait 8
42: ior(shf(rdb(706),-8),rdb(706))→A;ff0+0→V
43: if T<3;T→E;gto 50
44: if abs(A)<1000;gto 46
45: if M=0;gto "invalidy"
46: if B=1;gto "timeb"
47: if B>400;2→M;50→H;E+0→T;wait 1;gto 41
48: fti (A)→G$[B,B+1]
49: B+2→B;E→T;gto 41
50: if abs(A)<1000;gto 51
51: gto "invalidx"
52: if I=1;gto "timee"
53: fti (A)→A$[I,I+1]
54: I+2→I;L→T
55: if I>4800;gto "finish1"
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56: gto 41
57: "invalidx":if I=1;L+√0→T;wait 2;gto 41
58: C+1→C;fti (1100)→A$[I,I+1];I+C→I;if C<40;L→T;gto 41
59: if M=0;if B≠1;wrt 9,"U2C,U2G"
60: trk G;rcf F,T$,P$,A$;fdf F+2;F+2→F;0→C;1→I
61: if E=1;2→E;gto 63
62: 1→E
63: if M=2;trk K;rcf J,E$,F$,G$;0→H;1→B
64: fdf F;J+2→J
65: if F>19;if G=0;1→G;0→F;gto 67
66: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
67: if J>23;if K=0;1→K;20→J;gto 69
68: if J>23;0→K;20→J;0→G;0→F;beep;prt "Change Data Tape","Immediately!!";beep
69: beep;prt "Bad Probe",T;beep
70: if M=2;E→T;beep;prt "*T7 PROBES ONLY*";beep
71: beep;prt "Launch T7 on","Channel",E;beep;spc 2
72: if M=2;gto 4
73: if B≠1;wrt 9,"U2V";red 9,N;int(N/1000*20)→O;B+20+4→V;L→T
74: if B≠1;for W=B to V by 2;fti (1100)→G$[W,W+1];next W
75: if B≠1;V→B;gto 41
76: L→T;gto 41
77: "invalidy":if B=1;E→T;√0→P;wait 2;gto 41
78: H+1→H;fti (1100)→G$[B,B+1];B+2→B;if H<60;E→T;gto 41
79: if I≠1;wrt 9,"U2C,U2G"
80: trk K;rcf J,E$,F$,G$;J+2→J;0→H;1→B;0→M
81: if J>23;if K=0;1→K;20→J;gto 83
82: if J>23;0→K;20→J;0→G;0→F;beep;prt "Change Data Tape","Immediately!!";beep
83: if T=8;4→S;gto 85
84: 3→S
85: beep;prt "Bad Probe",S;beep
86: if S=4;4→L;3→S;gto 88
87: 3→L;4→S
88: beep;prt "Launch T11 on","Channel",S;beep;spc 2
89: if I≠1;wrt 9,"U2V";red 9,N;int(N/1000*20)→O;I+20+10→V;E→T
90: if I≠1;for W=I to V by 2;fti (1100)→A$[W,W+1];next W
91: if I≠1;V→I;gto 41
92: E→T;gto 41
93: "finish1":if M=0;if B≠1;wrt 9,"U2C,U2G"
94: trk G;rcf F,T$,P$,A$;fdf F+2;F+2→F;1→I;0→C
95: if M=2;trk K;rcf J,E$,F$,G$
96: fdf F;if M=2;J+2→J
97: if F>19;if G=0;1→G;0→F;gto 99
98: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
99: if J>23;if K=0;1→K;20→J;gto 101
100: if J>23;0→K;20→J;0→G;0→F;beep;prt "Change Data Tape","Immediately!!";beep
101: if E=1;2→E;gto 103
102: 1→E
103: if M=2;E→T;beep;prt "*T7 PROBES ONLY*";beep
104: beep;prt "Launch T7 on","Channel",E;spc 2
105: if M=2;gto 4
106: if B≠1;wrt 9,"U2V";red 9,N;int(N/1000*20)→O;B+20+4→V;L→T
107: if B≠1;for W=B to V by 2;fti (1100)→G$[W,W+1];next W
108: if B≠1;V→B;gto 41
109: L→T;gto 41
110: "timea":wrt 9,"R";"newT7 "→P$
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111: red 9,T$;prt T$;on err "error"
112: gto 53
113: "timeb":wrt 9,"P";"rawT11"+F$
114: red 9,E$;prt E$;on err "error"
115: gto 47
116: "defectb":cfg ;if I=1;gto 127
117: if M=0;if B=1;if L=4;3→S;gto 119
118: if M=0;if B=1;4→S
119: if M=0;if B=1;beep;prt "Bad Probe",S;beep;sfg 2
120: if M=0;if B=1;if S=3;4→S;3→L;gto 122
121: if M=0;if B=1;3→S;4→L
122: if M=0;if B=1;prt "Launch T11 on","Channel",S;spc 2
123: if I#1;if flg2;wrt 9,"U2V";red 9,N;int(N/1000*20)+0→I+20+4→V;E→T
124: if I#1;if flg2;for W=I to V by 2;ftl (1100)→A$[W,W+1];next W
125: if I#1;if flg2;V→I;gto 41
126: if flg2=0;prt "Program error;","Both probes","look valid.";spc 2;stp
127: beep;prt "Bad Probe",E;beep
128: if E=1;2→E;gto 130
129: 1→E
130: prt "Launch T7 on","Channel",E;spc 2
131: if M=0;if B#1;wrt 9,"U2V";red 9,N;int(N/1000*20)→G;B+20+10→V;L→T
132: if M=0;if B#1;for W=B to V by 2;ftl (1100)→G$[W,W+1];next W
133: if M=0;if B#1;V→B;gto 41
134: "error":0→P
135: if rom=69 and ern=4;gto 153
136: if rom=71 and ern=8;gto 153
137: if rom=71 and ern=4;gto 153
138: if rom=71 and ern=9;gto 153
139: if rom=0 and ern=39;1→P
140: if P=1;prt "Insert NEW data","cassette; press"
141: if P=1;if erl<=34;prt "f0 and f1.";0→P;spc 3;beep;stp
142: if P=1;if erl>34;prt "f0 and f2.";0→P;spc 3;beep;stp
143: if rom=83 and ern=7;1→P;gto 149
144: if rom=83 and ern=8;1→P;gto 149
145: if rom=83 and ern=6;1→P;gto 149
146: if rom=0 and ern=42;prt "Quickly eject","cassette and","slide RECORD"
147: if rom=0 and ern=42;prt "tab over,","Then replace","tape and type"
148: if rom=0 and ern=42;prt "         cont",erl;beep;spc 3;stp
149: if rom=0 and ern=30;prt "Insert program","tape and type in","ldf 0."
150: if rom=0 and ern=30;prt "Then re-insert","Data Tape and","Press special"
151: if rom=0 and ern=30;prt "function key","again ";beep;stp
152: jmp -(152-erl)
153: if erl=6;gto "A/D"
154: if erl=7;gto "Cl/A2D"
155: if erl=41;gto "Cl/A2D"
156: if erl=42;gto "A/D"
157: "Clock":prt "Real Time Clock","Is Down;","See Manual.";beep;spc 3;stp
158: "A/D":prt "A/D Converter","Is Down;","See Manual.";beep;spc 3;stp
159: "Cl/A2D":prt "Either Clock or","A/D is down.","See Manual.";spc 3;stp
```

Cross Reference for Variables for File 9

A	7	8	10
42	44	48	50
53			

B	40	46	47
48	48	49	49
59	63	73	73
74	74	75	75
77	78	78	78
78	80	93	106
106	107	107	108
108	117	118	119
120	121	122	131
131	132	132	133
133			

C	14	14	14
15	22	34	40
58	58	58	60
94			

D	40	47	

E	43	47	49
61	61	62	70
71	77	78	89
92	101	101	102
103	104	123	127
128	128	129	130

F	3	3	15
15	15	15	16
16	17	17	22
22	22	22	23
23	24	24	60
60	60	60	64
65	65	66	66
68	82	94	94
94	94	96	97
97	98	98	100

G	3	15	16
16	17	22	23
23	24	60	65
65	66	68	82
94	97	97	98
100			

H	40	47	63
78	78	78	80

I	5	9	10
10	11	12	12
13	14	14	14
14	15	22	34
40	52	53	53
54	54	55	57
58	58	58	58
60	79	89	89
90	90	91	91
94	116	123	123
124	124	125	125

J	3	17	24
40	40	63	64
64	66	67	67
68	68	80	80
80	81	81	82
82	95	96	96
98	99	99	100
100			

K	3	17	24
63	66	67	67
68	80	81	81
82	95	98	99
99	100		

L	40	54	57
58	73	76	86
87	106	109	117
120	121	131	

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M    40   45   47
59   63   70   72
80   93   95   96
103  105  117  118
119  120  121  122
131  132  133

N    73   73   89
89   106  106  123
123  131  131

O    73   73   89
89   106  106  123
123  131  131

P    77   134  139
140  141  141  142
142  143  144  145

S    83   84   85
86   86   87   88
117  118  119  120
120  121  122

T    3    6    6
18   19   19   20
21   25   [illegible] 26
27   31   31   32
33   38   38   41
41   43   43   47
49   54   57   58
69   70   73   76
77   78   83   89
92   103  106  109
123  131

V    7    42   73
74   75   89   90
91   106  107  108
123  124  125  131
132  133

W    74   74   74
74   90   90   90
90   107  107  107
107  124  124  124
124  132  132  132
132

A$   2    10   14
15   22   35   53
58   60   90   94
124

E$   2    35   63
80   95   114  114

F$   2    35   63
80   95   113

G$   2    35   48
63   74   78   80
95   107  132

P$   2    15   22
28   35   60   94
110

T$   2    15   22
29   29   35   60
94   111  111
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FILE 10

OPERATING PROGRAM, XBT DATA ACQUISITION

(3 CHANNELS ONLY)

FILE 10

```
0: ldf 2,Y;prt "JUST before","erasing this","program, be sure"
1: prt "to insert the","program tape and","press f10.";spc 3;beep;stp
2: wrt 704,"Q";prt "When Dylon stops","press CONTINUE";spc 2;avd;fxd 0;stp
3: wrt 704,"YQK",Y;on err "error"
4: time 2000;wrt 9,"A,U2=I3";prt "Insert data tape";spc 2;stp
5: dim T$[14],P$[6],A$[4810],E$[14],F$[6],G$[10800];fmt 1,z,f.0;fmt 2,z,f4.0
6: 1→T;20→J;0→F;0→G;0→K;1100→G;fdf F
7: on err "error";prt "Press Continue","just before","probe launch";spc 2
8: 1→I;beep;dsp "Ready to continue?";beep;stp
9: wrt 706.1;"H",T,T,"AJ"
10: ior(shf(rdb(706),-8),rdb(706))→A
11: if abs(A)>1000;gto "invalid"
12: if I=1;gto "time"
13: fti (A)→A$[I,I+1];wrt 705.2,A;wait 27
14: if I>2400+2400;gto "finish"
15: I+2+0→I;gto 9
16: "invalid":if I=1;gto 9
17: C+1→C;fti (1100)→A$[I,I+1];I+2→I;wrt 705.2,Q;if C<40;gto 9
18: trk G;rcf F,T$,P$,A$;fdf F+2;F+2→F;wrt 704,"Y";Y+1→Y;0→C;1→I
19: if F>19;if G=0;1→G;0→F;gto 21
20: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
21: beep;prt "Bad Probe",T;beep
22: if T=2;1→T;gto 24
23: 2→T
24: beep;prt "Launch T7 on","Channel",T;beep;spc 2;gto 7
25: "finish":trk G;rcf F,T$,P$,A$;wrt 704,"Y";Y+1→Y;fdf F+2;F+2→F;0→C;1→I
26: if F>19;if G=0;1→G;0→F;gto 28
27: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
28: if T=2;1→T;gto 30
29: 2→T
30: beep;prt "Launch T7 on","Channel",T;beep;spc 2;gto 7
31: "time":wrt 9,"R";"rawT7 "→P$
32: red 9,T$;prt T$;on err "error";cmd 7,"?";wrt 704,"B14N1";cmd 7,"%"
33: wrt 705,T$;wrt 704,"B6W1";cmd 7,"%";wrt 705,P$;wrt 704,"B1000W32000"
34: cmd 7,"%";gto 13
35: "defect":if T=2;1→T;gto 37
36: 2→T
37: beep;prt "Launch T7 on","Channel",T;beep
38: 1→I;0→C;gto 7
39: dim T$[14],P$[6],A$[4310],E$[14],F$[6],G$[10800];fmt 1,z,f.0;fmt 2,z,f4.
40: beep;prt "Launch T11 on","Channel 3","whenever ready";spc 2;fmt 2,z,f4.0
41: on err "error";prt "Press Continue","just before","probe launch";spc 2
42: if T=0;1→T
43: beep;dsp "Ready to continue?";beep;stp
44: 1→B;4→L;269→D;0→H;0→M;0→C;1→I;1100→Q;if J=0;20→J
45: wrt 706.1,"H",T,T,"AJ";wait 4
46: ior(shf(rdb(706),-8),rdb(706))→A;2T0→V
47: if T<3;T→E;gto 54
48: if abs(A)<1000;gto 50
49: if M=0;gto "invalidy"
50: if B=1;gto "timeb"
51: if B>40D;0J0→M;2-M;0→H;E→T;wait 1;gto 45
52: fti (A)→G$[B,B+1]
53: B+2→B;E→T;gto 45
54: if abs(A)<1000;gto 56
55: gto "invalidx"
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56: if I=1;gto "timea"
57: fti (A)→A$[I,I+1];wrt 705.2,A
58: I+2→I;L→T
59: if I>4800;gto "finish1"
60: gto 45
61: "invalidx":if I=1;L→T;wait 7;gto 45
62: C+1→C;fti (1100)→A$[I,I+1];I+2→I;wrt 705.2,0;if C<40;L→T;gto 45
63: if M=0;if B#1;wrt 9,"U2C,U2G"
64: trk G;rcf F,T$,P$,A$;fdf F+2;F+2→F;wrt 704,"Y";Y+1→Y;0→C;1→I
65: if E=1;2→E;gto 67
66: 1→E
67: if M=2;trk K;rcf J,E$,F$,G$;cmd 7,"?";wrt 704,"B14W1";cmd 7,"%"
68: if M=2;wrt 705,E$;wrt 704,"B6W1";wrt 705,F$;wrt 704,"B1000W32000"
69: if M=2;for I=1 to 10759 by 2;itf(G$[I,I+1])→A;wrt 705.2,A;next I
70: if M=2;wrt 704,"Y";Y+1→Y;fdf F;J+2→J
71: if F>19;if G=0;1→G;0→F;gto 73
72: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
73: if J>23;if K=0;1→K;20→J;gto 75
74: if J>23;0→K;20→J;0→G;0→F;beep;prt "Change Data Tape","Immediately!!";beep
75: beep;prt "Bad Probe",T;beep
76: if M=2;E→T;beep;prt "*T7 PROBES ONLY*";beep
77: beep;prt "Launch T7 on","Channel",E;beep;spc 2
78: if M=2;gto 7
79: if B#1;wrt 9,"U2V";red 9,N;int(N/1000*20)→0;B+20+4→V;L→T
80: if B#1;for W=B to V by 2;fti (1100)→G$[W,W+1];next W
81: if B#1;V→B;gto 45
82: L→T;gto 45
83: "invalidy":if B=1;0/0→T;E→T;wait 2;gto 45
84: H+1→H;fti (1100)→G$[B,B+1];B+2→B;if H<60;E→T;gto 45
85: if I#1;wrt 9,"U2C,U2G"
86: trk K;rcf J,E$,F$,G$;J+2→J;0→H;0→M
87: if J>23;if K=0;1→K;20→J;gto 89
88: if J>23;0→K;20→J;0→G;0→F;beep;prt "Change Data Tape","Immediately" ;beep
89: if T=8;4→S;gto 91
90: 3→S
91: beep;prt "Bad Probe",S;beep
92: if I#1;wrt 9,"U2V";red 9,N;int(N/1000*20)→0;I+20+10→V;E→T
93: if I#1;for W=I to V by 2;fti (1100)→A$[W,W+1];wrt 705.2,0;next W
94: if I#1;V→I;20000→B;gto 45
95: E→T;20000→B;gto 45
96: "finish1":if M=0;if B#1;wrt 9,"U2C,U2G"
97: trk G;rcf F,T$,P$,A$;wrt 704 "Y";Y+1→Y;fdf F+2;F+2→F;1→I;0→C
98: if M=2;if B<15000;trk K;rcf   E$,F$,G$;cmd 7,"?";wrt 704,"B14W1"
99: if M=2;if B<15000;cmd 7,"%";wrt 705,E$;wrt 704,"B6W1";wrt 705,F$
100: if M=2;if B<15000;wrt 704,"B1000W32000";for I=1 to 10759 by 2
101: if M=2;if B<15000;itf(G$[I,I+1])→A;wrt 705.2,A;next I
102: if M=2;if B<15000;wrt 704,"Y";Y+1→Y;fdf F;J+2→J
103: if F>19;if G=0;1→G;0→F;gto 105
104: if F>19;0→G;0→F;0→K;20→J;beep;prt "Change Data Tape","Immediately!!";beep
105: if J>23;if K=0;1→K;20→J;gto 107
106: if J>23;0→K;20→J;0→G;0→F;beep;prt "Change Data Tape","Immediately!!";beep
107: if E=1;2→E;gto 109
108: 1→E
109: if M=2;E→T;beep;prt "*T7 PROBES ONLY*",beep
110: beep;prt "Launch T7 on","Channel",E;spc 2
```

```
111: if M=2;gto 7
112: if B#1;wrt 9,"U2V";red 9,N;int(N/1000*20)+O;B+20+4+V;L+T
113: if B#1;for W=B to V by 2;fti (1100)+G$[W,W+1];next W
114: if B#1;V+B;gto 45
115: L+T;gto 45
116: "timea":wrt 9,"R";"rawT7 "+P$
117: red 9,T$;prt T$;on err "error";cmd 7,"?";wrt 704,"B14W1";cmd 7,"%"
118: wrt 705,T$;wrt 704,"B6W1";cmd 7,"%";wrt 705,P$;wrt 704,"B1000W32000"
119: cmd 7,"%";gto 57
120: "timeb":wrt 9,"R";"rawT11"+F$
121: red 9,E$;prt E$;on err "error"
122: wrt 704,"B1000W32000";cmd 7,"%";gto 51
123: "defectb":cfg ;if I=1;gto 134
124: if M=0;if B=1;if L=4;3+S;gto 126
125: if M=0;if B=1;4+S
126: if M=0;if B=1;beep;prt "Bad Probe",S;beep;sfg 2
127: if M=0;if B=1;if S=3;4+S;8+L;gto 129
128: if M=0;if B=1;3+S;4+L
129: if M=0;if B=1;prt "Launch T11 on","Channel",S;spc 2
130: if I#1;if flg2;wrt 9,"U2V";red 9,N;int(N/1000*20)+O;I+20+4+V;E+T
131: if I#1;if flg2;for W=I to V by 2;fti (1100)+A$[W,W+1];wrt 705.2,Q;next W
132: if I#1;if flg2;V+I;gto 45
133: if flg2=0;prt "Program errors","Both probes","look valid.";spc 2;stp
134: beep;prt "Bad Probe",E;beep
135: if E=1;2+E;gto 137
136: 1+E
137: prt "Launch T7 on","Channel",E;spc 2
138: if M=0;if B#1;wrt 9,"U2V";red 9,N;int(N/1000*20)+O;B+20+10+V;L+T
139: if M=0;if B#1;for W=B to V by 2;fti (1100)+G$[W,W+1];next W
140: if M=0;if B#1;V+B;gto 45
141: "error":0+P
142: if rom=69 and ern=4;gto 162
143: if rom=71 and ern=8;gto 162
144: if rom=71 and ern=4;gto 162
145: if rom=71 and ern=9;gto 162
146: if rom=0 and ern=39;1+P
147: if P=1;prt "Insert program","cassette and","press f10."
148: if P=1;prt "When the tape" "stops, press","f0 and f11."
149: if P=1;prt "Insert NEW data","cassette and"
150: if P=1;if erl<=38;prt "press f1.";spc 3;beep;0+P;stp
151: if P=1;if erl>38;prt "press f2.";spc 3;beep;0+P;stp
152: if rom=83 and ern=7;1+P;gto 147
153: if rom=83 and ern=8;1+P;gto 147
154: if rom=83 and ern=6;1+P;gto 147
155: if rom=0 and ern=42;prt "Quickly eject","cassette and","slide RECORD"
156: if rom=0 and ern=42;prt "tab over,","Then replace","tape and type"
157: if rom=0 and ern=42;prt "          cont",erl;beep;spc 3;stp
158: if rom=0 and ern=30;prt "Insert program","tape and type in","ldk 0."
159: if rom=0 and ern=30;prt "Then re-insert","Data Tape and","Press special"
160: if rom=0 and ern=30;prt "function key","again.";beep;stp
161: jmp -(161-erl)
162: if erl=9;gto "A/D"
163: if erl=10;gto "A/D"
164: if erl=45;gto "Cl/A2D"
165: if erl=46;gto "A/D"
166: "Clock":prt "Real Time Clock","Is Down;","See Manual.";beep;spc 3;stp
167: "A/D":prt "A/D Converter","Is Down;","See Manual.";beep;spc 3;stp
168: "Cl/A2D":prt "Either Clock or","A/D is down;","See Manual.";spc 3;stp
```

Cross Reference for Variables for File 10

```
A    10   11   13
13   46   48   52
54   57   57   69
69   101  101

B    44   50   51
52   52   53   53
63   79   79   80
80   81   81   83
84   84   84   84
94   95   96   98
99   100  101  102
112  112  113  113
114  114  124  125
126  127  128  129
138  138  139  139
140  140

C    17   17   17
18   25   38   44
62   62   62   64
97

D    44   51

E    47   51   53
65   65   66   76
77   83   84   92
95   107  107  108
109  110  130  134
135  135  136  137

F    6    6    18
18   18   18   19
19   20   20   25
25   25   25   26
26   27   27   64
64   64   64   70
71   71   72   72
74   88   97   97
97   97   103  103
103  104  104  106

G    6    18   19
19   20   25   26
26   27   64   71
71   72   74   88
97   103  103  104
106

H    44   51   84
84   84   86

I    8    12   13
13   14   14   14
15   15   16   17
17   17   17   18
25   38   44   56
57   57   58   58
59   61   62   62
62   62   64   69
69   69   69   85
92   92   93   93
94   94   96   96
97   100  101  101
101  101  102  123
130  130  131  131
132  132

J    6    20   27
44   44   67   70
70   72   73   73
74   74   86   86
86   87   87   88
88   98   102  102
104  105  105  106
106

K    6    20   27
67   72   73   73
74   86   87   87
88   98   104  105
105  106

L    44   58   61
62   79   82   112
115  124  127  128
138
```

```
M    44   49   51
51   63   67   68
69   70   76   78
86   96   98   99
100  101  102  109
111  124  125  126
127  128  129  138
139  140

N    79   79   92
92   112  112  130
130  138  138

O    79   79   92
92   112  112  130
130  138  138

P    14   96   102
141  146  147  148
149  150  150  151
151  152  153  154

Q    6    17   44
62   93   131

S    89   90   91
124  125  126  127
127  128  129

T    6    9    9
21   22   22   23
24   28   28   29
30   35   35   36
37   42   42   45
45   47   47   51
53   58   61   62
75   76   79   82
83   83   84   89
92   95   109  112
115  130  138

V    46   79   80
81   92   93   94
112  113  114  130
131  132  138  139
140

W    80   80   80
80   93   93   93
93   113  113  113
113  131  131  131
131  139  139  139
139

Y    0    3    18
18   25   25   64
64   70   70   97
97   102  102

A$   5    13   17
18   25   39   57
62   64   93   97
131

E$   5    39   67
68   86   98   99
121  121

F$   5    39   67
68   86   98   99
120

G$   5    39   52
67   69   80   84
86   98   101  113
139

P$   5    18   25
31   33   39   64
97   116  118

T$   5    18   25
32   32   33   39
64   97   117  117
118
```

FILE 11

ENGINEERING CONVERSIONS (T7 PROBES)

FILE 11
T7 ENGINEERING CONVERSIONS

```
0: beep;dsp "T7
 Engineering
 Units Conversio
 n";beep;stp
1: ldk 0;ldf 3,Y
2: prt "INSTRUCT
 IONS FOR","CONV
 ERSION OF","DAT
 A INTO ENGIN-",
 "EERING UNITS:"
3: spc 2;prt
 "Load Engineeri
 ng","Units tape
 into","Dylon."
 ;spc 2
4: prt "To load,
 thread","the
 tape into","the
 machine as",
 "shown by the"
5: prt "arrows
 and","press
 the LOAD","butt
 on twice.";spc
 2
6: prt "The LOAD
 button","shoul
 d light up;",
 "if it does
 not,"
7: prt "Try push
 ing it","again.
 ";spc 2
8: prt "When
 you have","fini
 shed loading",
 "the tape, pres
 s","Continue."
9: spc 2;stp
10: prt "Now
 press the","ON
 LINE button",
 "and make sure
 it","lights
 up."
11: prt "Then
 press","Continu
 e";spc 2;stp
12: wrt 704,"QYQ
 K",Y;beep;wait
 500;beep
```

Ø: and 1: Lines Ø and 1 give the title of the program and load the special function keys from file Ø of the program tape. Line 1 also loads the value of the number of files already written onto the T11 Engineering Units Dylon Tape into the variable Y for later use.

2: thru 11: Lines 2 through 11 tell the operator to set up the Dylon for use and give him step-by-step instructions for loading the tape.

12: Line 12 uses the value of Y which was read from file 3 of the program tape to position the Dylon tape after the last previously recorded data file.

13: thru 16: These lines give more set-up information to the operator, telling him to insert the Data Tape (indicating that Data Tape means the cassette rather than the Dylon) and to press CONTINUE to initiate the Data Conversion Program.

17: thru 22: Lines 17 through 22 set up the program for operation by setting the error condition to send any error down to a subroutine to be evaluated for possible computer action before the operator sees the error message. Then, the internal number format for the calculator is set; all variables are dimensioned and initialized, including the file counter variable, track indicator variable, and the coefficients for the data conversion equation in line 3Ø.

23: and 24: Lines 23 and 24 reset the error condition, increment the file counter F, and decide whether the tape has reached the end of track Ø or the end of the entire tape. Line 24 prints an appropriate message if the end of the data cassette has been reached and sends the program down to line 35 to print another message to the operator.

25: and 26: These lines load the raw data from the current file on the current track into the specified memory strings. The program is then sent down to the subroutine "write" to write the start time and probe type onto the Dylon tape. (The probe type is stored into F$ as "conT7 " to indicate to persons analyzing the data from the Dylon tape that this is <u>con</u>verted data).

```
13: beep;prt
 "Insert Data
 Tape";beep;spc
 2
14: prt "Note:",
 "In this progra
 m"
15: beep;prt
 "Data Tape mean
 s","the cassett
 e,","not the
 Dylon.";spc 2
16: beep;dsp
 "To initiate,
 press Continue"
 ;beep;stp
17: on err "erro
 r"
18: fxd 11;dim
 T$[14],P$[9],
 A$[4810];-2→F;
 0→G

19: dim E$[14],
 F$[9],G$[4810]
20: 19.853258851
 3→A;.9843122364
 98→B;1.28103261
 04e-3→C
21: 1.4481456272
 2e-4→D
22: 1.7714918524
 e-6→E;1.3270760
 1597e-7→H
23: 0→P;165→J;
 on err "error";
 2+F→F;if F>19;
 if G=0;1→G;0→F;
 gto 25
24: if F>19;beep
 ;prt "Change
 Data Tape","&
 Press Continue"
 ;spc 2;gto 35
25: trk G;ldf F,
 T$,P$,A$
26: T$→E$;"conT7
 "→F$;gsb
 "write"
27: wrt 704,"B10
 00W32000";cmd
 7,"%"
```

27: Line 27 sets up the 1ØØØ-character block size for writing to the Dylon, and places the Dylon into the Data Listen mode.

28: thru 32: Lines 28 through 32 perform the following functions for each raw data point:
(a) Read the raw data value into the variable Z.
(b) Divide Z by 1ØØ and store the result into K.
(c) Place K into the conversion equation and store the result of that calculation back into K.
(d) Round K to the nearest 3 places past the decimal point, and store the result back into K.
(e) Multiply K by 1ØØØ to make it an integer, even though it is still followed by .ØØØØØØØØ
(f) Integer K to get rid of the following zeroes.
(g) Write K onto the Dylon tape using the format set up in the write subroutine called "write".
(h) Store K into the string set up in line 19 using integer precision.

33: and 34: These lines record the start time, probe type, and converted data into the file immediately following the raw data file from which the data was read earlier in the program. Then, a file mark is written on the Dylon tape to mark the end of the file, and the file counter for the Dylon tape is incremented. Then the program is sent back to line 23 to read in another raw data file and data conversion begins.

35: and 36: These lines are reached after a raw data tape has been fully converted to engineering units. The message "If finished with T7 Data Conversions, insert Program Tape & press f8."

37: Line 37 is reached if the operator presses CONTINUE after the message printed in lines 35 and 36. This indicates to the program that the operator has inserted another raw data tape to be converted. This line resets the file and track indicators and sends the program up to line 23 to begin data conversions on that tape.

38: Line 38 is the first line of the error subroutine "error". It sends the program back to line 33 with an illegal value for the file counter if an error 6Ø has occurred. This means that there are no more data files on the current track, so the program will either change to track 1 or display the "Change Data Tape" message.

```
28: for I=1 to
 4799 by 2
29: itf(A$[I,I+
 1])→Z
30: Z/100→K;A+
 BK+CK↑2+DK↑3+
 EK↑4+HK↑5→K
31: prnd(K,-3)→K
 ;1000K→K;int(K)
 →K;wrt 705.1,K;
 fti (K)→G$[I,I+
 1]
32: next I
33: trk→G;rcf F+
 1,E$,F$,G$;for
 I=1 to J;wrt
 705.1,P;next I
34: wrt 704,"Y";
 Y+1→Y;gto 23
35: prt "If fini
 shed","with T7
 Data","Conversi
 ons,","insert
 Program"
36: prt "Tape,
 then press",
 "f8.";spc 2;
 stp
37: -2→F;0→G;
 gto 23
38: "error":if
 rom=65 and ern=
 7;1100→P;2565-
 (I-1)/2→J;gto
 33
39: if rom=0
 and ern=60;25→F
 ;gto 23
40: if rom=0
 and ern=42;prt
 "Remove Tape
 and","Slide
 RECORD tab",
 "over; then"
41: if rom=0
 and ern=42;prt
 "re-insert tape
 ","and type",
 "cont",erl;spc
 2;stp
42: jmp -(42-
 erl)
43: prt "T11
 Engineering",
 "Conversions"
```

39: thru 41: If the RECORD tab on a data cassette is not in the RECORD position when the calculator tries to dump data onto the cassette, an error 42 occurs. Lines 39 through 41 are executed only if an error 42 condition is present. They print the message "Remove Data Cassette and Slide RECORD tab over, then reinsert tape and type cont erl". In this message, erl will be printed as the number of the line in which the error 42 occurred. The program is stopped at this point to await operator action.

42: If an error has occurred to send the program down to the subroutine "error", but that error is not present in the subroutine, line 42 sends the program back up to the same line in which the error existed without clearing the on err condition. In this way the error message is displayed to the operator and the program is stopped so that he may take appropriate action.

43: thru 48: Lines 43 through 48 tell the operator how to set up for T11 data conversions. It is necessary to do this in the T7 data conversion program because memory positions in the T11 program are critical, so the more that can be done before that program is loaded, the better. They tell the operator to load the T11 Conversions Tape onto the Dylon, insert the program tape, record the value of the number of files used so far on the T7 Data Conversions tape in file 3 of the program tape, and then direct him to erase all variables and load program 12 (T11 Engineering Conversions).

49: thru 51: Lines 49 through 51 comprise the "write" subroutine used to write the start time and probe type onto the T7 engineering units tape on the Dylon. They write the unlisten command to the Dylon, set a 14-character block size, write the start time into that block, set a 6-character block size, write the "conT7 " probe type into that block, set the format for writing the converted data onto the Dylon, and return the program to line 27.

*NOTE: It will be noted that 2 separate strings were used to bring the raw data into memory and store the converted data. Due to the nature of the string variable, it is impossible to read a raw data value, convert it, and restore it in its new form to the original string position.

```
44: beep;dsp
 "Insert Program
  Tape";stp
45: trk 1;rcf 3,
 Y;trk 0;rcf 3,Y
46: prt "Press",
 "ERASE","v",
 "EXECUTE","ERAS
 E","k","EXECUTE
 "
47: prt "Type
 in:","","ldp12"
 ,"","and press"
 ,"EXECUTE";spc
 2;stp
48: "write":cmd
 7,"?";wrt 704,
 "B14W1";cmd 7,
 "%";wrt 705,E$
49: wrt 704,"B9W
 1";cmd 7,"%";
 wrt 705,F$
50: fmt 1,z,f6.0
 ;ret
*24065
```

Cross Reference for Variables in File 11

```
A    20  30
B    20  30
C    20  30
D    21  30
E    22  30
F    18  23  23
23   23  24  25
33   37  39
G    18  23  23
25   33  37
H    22  30
I    28  29  29
31   31  32  33
33   38
J    23  33  38

K    30  30  30
30   30  30  30
31   31  31  31
31   31  31  31
P    23  33  38
Y    1   12  34
34   45  45
Z    29  30
A$   18  25  29
E$   19  26  33
48
F$   19  26  33
49
G$   19  31  33
P$   18  25
T$   18  25  26
```

FILE 12

ENGINEERING CONVERSIONS (T11 PROBES)

T11 ENGINEERING CONVERSIONS

```
0: ldf 3,Y;wrt
 704,"QYQK",Y;
 ldk 15
1: prt "Insert
 Data Tape";spc
 2;stp
2: fxd 11;dim
 T$[14],P$[9],
 A$[10800],E$[14
 ],F$[6],G$[1080
 0];18→J;0→K
3: 19.8532588513
 →A;.98431223649
 8→B;1.281032610
 4e-3→C
4: 1.44814562722
 e-4→D
5: 1.7714918524e
 -6→E;1.32707601
 597e-7→H
6: 0→P;165→Q;on
 err "error";J+
 2→J;if J>23;if
 K=0;1→K;20→J;
 gto 8
7: if J>23;prt
 "Insert New
 Tape;";spc 2;
 gto 18
8: trk K;ldf J,
 T$,P$,A$
9: T$→E$;"conT11
 "→F$;gsb
 "write"
10: wrt 704,"B10
 00W32000";cmd
 7,"%"
```

Ø: Line Ø loads the value of the number of files written onto the Dylon Engineering Conversions tape so far into the variable Y, and then sets up the Dylon to the file immediately following the last file written.

1: Line 1 tells the operator to insert the data cassette and stops the program to await a CONTINUE from the operator.

2: thru 5: Lines 2 through 5 initialize and dimension all needed variables, including the file counter variable, the track indicator variable, and the coefficients for the data conversion equation.

6: and 7: These two lines set the on error condition to send any error down to a subroutine called "error" so that the computer may possibly take action on the error without making the operator look up the error and decide what to do. Then, the file counter variable J is incremented and tests are performed to make sure that the end of a track has not been reached. If the end of track Ø is reached, the computer changes itself to track 1 and starts again. If the end of track 1 has been reached, the message "Change Data Tape' is printed and the program is sent down to line 18 so that a further message may be printed to the operator.

8: and 9: Lines 8 and 9 load the raw data from the current file on the current track into memory strings. The probe type and start time are then put into the strings used for the converted data, with the probe type being changed to "con T11" to indicate to persons analyzing the data from the Dylon tape that this is converted data. The program is then sent down to the subroutine called "write" to write the start time and new probe type onto the Dylon tape.

10: Line 10 sets up the block size for writing the converted data onto the Dylon tape and puts the Dylon into data listen mode.

```
11: for I=1 to
 10759 by 2
12: itf(A$[I,I+
 1])→Z
13: Z/100→X;A+
 BX+CX↑2+DX↑3+
 EX↑4+HX↑5→X
14: prnd(X,-3)→X
 ;1000X→X;int(X)
 →X;wrt 705.1,X;
 fti (X)→G$[I,I+
 1]
15: next I
16: trk K;rcf J+
 1,E$,F$,G$;for
 I=1 to Q;wrt
 705.1,P;next I
17: wrt 704,"Y";
 Y+1→Y;gto 6
18: prt "If fini
 shed","insert",
 "Program tape",
 "and press f9."
 ;stp
19: 18→J;0→K;
 gto 6
20: "error":if
 rom=0 and ern=6
 0;25→J;gto 6
```

11: thru 15: Lines 11 through 15 perform the following functions for each raw data point:
(a) Read the raw data value into the variable Z.
(b) Divide Z by 1ØØ and store the result into X.
(c) Place X into the conversion equation and store the result of that calculation back into X.
(d) Round X to the nearest 3 places past the decimal point and store the result back into X.
(e) Multiply X by 1ØØØ to make it an integer, even though it is still followed by .ØØØØØØØØ.
(f) Integer X to get rid of the following zeroes.
(g) Write X onto the Dylon tape using the format set up in the write subroutine called "write".
(h) Store X into the string set up in line 18 using integer precision storage.

16: and 17: These lines record the start time, new probe type, and converted data into the file immediately following the raw data file from which the original data was read earlier in the program. Then, a file mark is written on the Dylon tape to mark the end of that data file and the file counter for the Dylon tape is incremented. Then the program is sent back to line 6 to read in anothe raw data file and start converting it.

18: Line 18 is reached after a raw data tape has been fully converted to engineering units. The message "If finished with T11 Data Conversions, press f9." is printed.

19: Line 19 is reached if the operator presses CONTINUE after the message printed in lines 7 and 18. This indicates to the program that the operator has inserted another raw data tape to be converted. This line resets the file and track indicators and sends the program up to line 6 to begin data conversions on the new tape.

20: Line 20 is the first line of the error subroutine "error". It sends the program back to line 7 with an illegal value for the file counter if an error 6Ø has occurred. This means that no more data files are on the current track...... so the program will either change to track 1 or display the "Change Data Tape" message.

```
21: if rom=65
 and ern=7;1100→
 P;5545-(I-1)/
 2→Q;gto 16
22: jmp -(22-
 erl)
23: trk 1;rcf 3,
 Y;trk 0;rcf 3,
 Y;end
24: "write":cmd
 7,"?";wrt 704,
 "B14W1";cmd 7,
 "%";wrt 705,E$
25: wrt 704,"B9W
 1";cmd 7,"%";
 wrt 705,F$
26: fmt 1,z,f6.0
 ;ret
*9079
```

21: Line 21 is the line which ends the subroutine called "error". Subroutine "error" checks the error number, ROM, and error line indicators and performs operations for those errors covered in the subroutine which match the current error condition in the calculator. If none of the error conditions covered in the subroutine match the current error condition in the calculator, line 21 sends the program back up to the line where the error existed without clearing the on error condition. In this way the error message is displayed to the operator and the program is stopped so that he may take appropriate action.

22: Line 22 records the value of the number of T11 converted data files which have been written onto the Dylon tape into file 4 on the program tape. The program is then stopped and ended.

23: thru 26: Lines 23 through 26 comprise the "write" subroutine used to write the start time and probe type onto the T7 engineering units tape on the Dylon. They write the unlisten command to the Dylon, set a 14-character block size, write the data listen command to the Dylon, write the start time into the 14-character block, set a 6-character block size, write the "conT7 " probe type into that block, set the format for writing the converted data onto the Dylon, and return the program to line 10.

*NOTE: It will be noted that 2 separate strings were used to bring the raw data into memory and store the converted data. Due to the nature of the string variable as it exists in the 9825A Calculator, it is impossible to read a raw data value, convert it, and restore it in its new form in the original string position.

FILE 13

TEMPERATURE PROFILE OFFSET PLOTTING ROUTINE

FILE 13

T7/T11 OFFSET PLOTTING ROUTINE

```
0: beep;dsp "Ins
 ert Data Casset
 te";stp
1: fxd 0;cfg ;
 0→H;0→I;0→J;
 50→M;-50→N;10→P
 ;0→Q;1→R;21→X;
 sfg 8;sfg 10;
 sfg 11
2: dim A$[14],
 B$[3],F$[1],
 J$[14],K$[3],
 L$[1],M$[3];
 psc 707;wrt
 707,"VA"
3: dim C$[14],
 D$[9],E$[4810],
 G$[14],H$[9],
 I$[10800];"*
 "→F$
4: psc 707;pclr;
 wrt 707,"ip1000
 ,700,10300,8100
 ";fmt 1,z,f6.0
```

Ø: Line Ø displays the title of the program and stops the program to await a CONTINUE.

1: Line 1 uses the fxdØ command to set the calculator up into an integer format; cfg clears all flags in the calculator. The rest of the line initializes various variables and flags.*

2: Line 2 dimensions all strings used in the program except those strings to be used in loading the data to be plotted from the cassette or Dylon. The psc7Ø7 command tells the calculator that it may talk to a plotter on the address 7Ø7; the command also partially clears the plotter in that it assures that the plotter will accept commands. The wrt 7Ø7,"VA" writes a command to the plotter using the 7Ø7 address. The VA stands for Velocity Adapt and tells the plotter to adapt its pen velocity to the approximate output speed of the calculator. This assures maximum efficiency in plotting.*

3: Line 3 dimensions the strings into which the data to be plotted from the cassette or Dylon will be loaded. The line also inputs the initial character * into the string variable F$, which will be used later in the program to delineate the exact range of any given probe along the Y or temperature axis of the plot.*

4: Line 4 writes the psc7Ø7 command described in the documentation of line 2; writes the pclr command to fully clear the plotter; and then writes the ip... command. The ip command sets up the absolute plotting area for scaling purposes.

*NOTE: Immediately following the documentation of this plotting routine is a cross-reference listing all variables used in the program and the line numbers in which they occur. Also included is a list of each variable and string variable and what each is used for in the program. Each flag in the program is then documented in a similar manner. These listings are provided for ease of alteration should the program need to be changed to fit the individual user's needs.

```
5: ent "Plot
 from Dylon(0)
 or cass.(1)?",O
6: if O=0;gto
 "Dylon"
7: dsp "Start
 time of first
 T7 probe to";
 wait 3000
8: prt "If not
 appli-","cable,
  type in 0";
 spc 2
9: ent "be plott
 ed?(i.e.→09:02:
 14:35:28)",A$
10: dsp "Start
 time of first
 T11 probe to";
 wait 2000
11: ent "be plot
 ted?  (Start
 time or 0)",J$
12: ent "Total
 no. of T7's to
 be plotted?",A
13: ent "Total
 no. of T11's
 to be plotted":
 B
14: if A+B>5;
 beep;dsp "Only
 5 probes may
 be plotted.";
 beep;wait 2000;
 gto 7
15: if A+B=1;if
 A=0;gto "T11"
16: if A+B=1;
 gto "T7"
17: if B=0 or
 A=0;gto "grid"
18: beep;dsp
 "ORDER OF PLOTT
 ING";beep;wait
 2000;sfg 2
```

5: and 6: Line 5 asks the operator to enter a Ø if he wishes to plot from the Dylon Tape or a 1 if he wishes to plot from the cassette. The number that he enters is placed into the variable O. Line 6 sends the program down to the subroutine called "Dylon" if the operator entered a Ø.

7: thru 11: Lines 7 through 11 ask the operator to enter the start times of the first T7 and the first T11 probes to be plotted. Line 8 prints a message telling him that if either of the two questions is inapplicable (meaning that he is only going to plot one type of probe), he should enter a zero for the start time of the inapplicable probe. The start time of each probe is recorded in a string.

12: and 13: Lines 12 and 13 ask the operator to enter the total number of T7 and T11 probes, respectively, which he wishes to plot.

14: Line 14 sends the program back to ask the same questions asked in lines 12 and 13 again if the total number of probes to be plotted is over 5. Since the program is only designed to plot 5 probes on one plot, the message "Only 5 probes may be plotted." is also printed.

15: and 16: Lines 15 and 16 decide whether or not the total number of probes to be plotted is equal to one. If it is, the program is sent directly down to either the T7 or T11 routines which search the cassette for the proper probe. This bypasses a large amount of the program which has no meaning on a single-probe plot.

17: Since the operator may want to plot only one type of probe, but still want to plot more than one probe of that type, line 17 bypasses the ORDER OF PLOTTING routine and sends the program directly down to plot the scaling grid, which will be explained later.

18: Line 18 displays the ORDER OF PLOTTING message and sets flag 2 to indicate later in the program that more than one type of probe is to be plotted.

```
19: ent "Is firs
 t probe a T7
 or T11?",B$
20: if B$="T11";
 sfg 6;gto 22
21: ent "Plot
 how many T7
 probes?",C
22: ent "Plot
 how many T11
 probes?",D
23: if C+D=A+B;
 gto "grid"
24: sfg 3;ent
 "Then how many
 T7 probes?",E
25: if C+D+E=A+
 B;gto "grid"
26: sfg 4;ent
 "Then how many
 T11 probes?",F
27: if C+D+E+
 F=A+B;gto "grid
 "
28: sfg 5;ent
 "Then how many
 T7 probes next?
 ",K
29: "grid":beep;
 dsp "TEMPERATUR
 E SCALE (Scaled
 down)";wait
 2000;beep
30: psc 707;pclr
 ;wrt 707,"ip100
 0,700,10300,
 8100"
31: scl 0,100,0,
 10;csiz 1.5;pen
32: plt -4,3,-2;
 iplt -1,0;iplt
 2,0;pen
33: plt -4,4,-2;
 iplt -1,0;iplt
 2,0;pen
34: plt -4,5,-2;
 iplt -1,0;iplt
 2,0;pen
```

19: and 2Ø: Lines 19 and 2Ø ask the operator if the first probe to be plotted is a T7 or a T11. The operator's answer is input into the string variable B$. If B$=T11, flag 6 is set and the program is sent down to line 22 to ask the operator <u>how many</u> T11 probes he wishes to plot first.

21: thru 28: These lines ask the operator how many of each probe type he wishes to plot and in what order. After each entry by the operator, the program tests to see if the total number of probes that he has so far described in this section is equal to the total number of probes that he specified in lines 12 and 13. If the total number of probes described in this section does equal the overall total, the program is immediately sent down to the subroutine entitled "grid".

29: Line 29 displays the message TEMPERATURE SCALE (Scaled down) while that temperature scale is being drawn by the next several program lines.

3Ø: Line 3Ø is identical in content and function to line 4.

31: This line sets up a scale on the absolute plotting area defined in line 3Ø. This scale runs from Ø to 1ØØ on the X-axis and from Ø to 1Ø on the Y-axis. The character size is set with the <u>csiz 1.5</u> statement at 1.5% of the total height of the scaling area. The <u>pen</u> command lifts the plotter pen.

32: thru 43: Lines 32 through 43, without going into detail on each command, plot a scaled-down Y-axis labeled from 1Ø to 3Ø degrees Centigrade. This Y-axis is drawn on the extreme left-hand edge of the plotting area (the paper).

44: and 45: Lines 44 and 45 label the Y-axis just drawn with a °C, showing that this scale ranged from 1Ø to 3Ø degrees Centigrade.

46: Line 46 plots a point to the far right of the paper (lifting the pen beforehand), then the <u>pen</u> command raises the pen in preparation for the next program line. If there is only one probe to be plotted, this scaled-down Y-axis will not appear on the plot. The purpose of this line is to give the operator a clear view of the scaled-down axis so that it may be used to answer the question put forth to him in the next program line.

```
35: plt -4,6,-2;
 iplt -1,0;iplt
 2,0;pen
36: plt -4,7,-2;
 iplt -1,0;iplt
 2,0;pen
37: plt -4,3,1
38: plt -4,7,2;
 pen
39: plt -9,3,1;
 lbl "10"
40: plt -9,4,1;
 lbl "15"
41: plt -9,5,1;
 lbl "20"
42: plt -9,6,1;
 lbl "25"
43: plt -9,7,1;
 lbl "30"
44: plt -7,2.7,
 1;lbl "o"
45: plt -5.6,
 2.55,1;lbl "C"
46: plt 90,10,1;
 pen
47: beep;ent
 "Offset between
  plots in degre
 es?",G
48: A+B→W;if
 G>1/(W-1)*20;
 prt "Too much
 offset,","max.
 offsets:";gto
 "max"
49: if O=0;gto
 "decide"
50: gto "T7";if
 flg6;gto "T11"
51: scl 0,750,0,
 110;csiz 1.5
```

47: Line 47 asks the operator how much he wishes to offset each plot of a probe from the next plot. This number is given in degrees Centigrade and is an offset along the Y-axis only.

48: There are necessarily some limitations on the amount of offset allowed between plots. But the offset allowable is different, depending upon the number of probes to be plotted. If the maximum offset allowed is exceeded by the operator's entry in line 47, the message "Too much offset, max. offsets:" is printed and the program is sent down to a subroutine called "max" which lists the maximum offsets allowed for 1,2,3,4, or 5 probes. The maximum offset is determined by the equation: 1/(W-1)*2Ø, where W is the total number of probes to be plotted.

49: If the operator chose to plot from the Dylon tape, the program was sent down much earlier to the subroutine called "Dylon". The subroutine "Dylon" in turn sends the program back up to plot the scaled-down Y-axis, or "grid". In line 49, if the operator's original choice was to plot from the Dylon tape, (indicated by O=Ø), the program is sent down to the subroutine called "decide".

5Ø: If the operator is plotting from the cassette, line 5Ø is reached. It sends the program down to subroutine "T7", assuming that the first probe to be plotted is a T7 probe, unless flag 6 has been set. In that case, the program is sent down to subroutine "T11", since flag 6 indicates that the first probe to be plotted is a T11 probe (see documentation of line 2Ø).

51: Line 51 is reached through subroutines "T7" and "T11" only after the correct probe to be plotted has been found on the tape. (Line 51 is reached through the subroutines "T7Dy" and "T11-DY" if the operator is plotting from the Dylon). It sets a new scaling factor from Ø to 75Ø on the X-axis and from Ø to 11Ø on the Y-axis. The character size is reset to the value of 1.5% of the total scaling area.

```
52: if J<4;105→L
 ;gto 54
53: 100→L
54: plt N,L,1
55: lbl "Probe
 ",F$,"→→→",C$,
 "  ",D$[4,6]
56: if J<3;N+
 275→N
57: if J=3;100→N
58: if J=4;450→N
59: if J=1;"X"→F
 $
60: if J=2;"+
 "→F$
61: if J=3;"H"→F
 $
62: if J=4;"$"→F
 $
63: if J=1;dsp
 "Change pens
 and press Conti
 nue.";stp
```

52: and 53: Lines 52 and 53 determine the Y value of the start point of the probe labeling statement. Since up to five probes may be plotted on a single sheet of paper, each of them must be labeled as to probe type and start time. The labeling follows this format:
<u>PROBE X---Ø7:24:15:45:29 TY</u>, where <u>X</u> is a character (either <u>*</u>, <u>X</u>, <u>+</u>, <u>H</u>, or <u>$</u>); <u>Ø7:24:15:45:29</u> is the probe start time by month, day, hour, minute, and second; <u>T</u> remains T; and <u>Y</u> is either 7 or 11 depending upon the type of that particular probe. The characters which X represents will be discussed during the documentation of the subroutine called "offset". Only 3 of these probe labels may be placed across the paper, so lines 52 and 53 decide whether to put the current label on the first upper row (J is less than 4) or the lower row (J is greater than 3). Thus, the Y value of the probe label is either 1Ø5 or 1ØØ. This Y value is represented by L in the program.

54: Line 54 positions the plotter pen to the correct coordinates for labeling the probe type and start time for the current probe.

55: Line 55 labels the probe type and start time as described in the documentation of lines 52 and 53. The information for the labeling of the probe has already been stored in memory strings and is retrieved from those strings for labeling purposes.

56: thru 58: These lines determine the new X value for the probe label start point using the variable J (number of probes already plotted) just as the value of the new Y coordinate of the probe label start point was determined in lines 52 and 53. This X value goes into the variable N.

59: thru 62: Lines 59 through 62 determine the character represented by X in the documentation of lines 52 and 53. (See documentation of subroutine "offset" for full details on these characters and their usage in this program).

63: If J=1 (indicating the first probe), line 63 tells the operator to "Change pens and press CONTINUE", it stops program operation to allow him to change the pen if he so desires. The reason for the J=1 restriction is that the main grid used for plotting will be plotted at this time if J=1; if the main grid has already been plotted, there is no need for the operator to change pens since the probe label and plot are the same color.

```
64: psc 707;pclr
 ;wrt 707,"ip100
 0,700,10300,
 8100"
65: scl 0,750,
 10,55;fxd 0;
 csiz 2;if flg7;
 gto 82
66: xax 10,50,0,
 750,1
67: plt -74,7.6,
 1;lbl "Depth"
68: plt -74,6.5,
 1;lbl "(meters)
 "
69: yax 0,0,10,
 50
70: plt 0,50,1
71: plt 750,50,2
72: plt 750,10,-
 1
73: dsp "Change
 pens and press
 Continue.";stp
74: line 2,2
75: plt M,10,1
76: plt M,50,2
77: M+50→M;if
 M<750;gto 75
```

64: Line 64 is identical to lines 4 and 3Ø.

65: Line 65 sets up a scale from Ø to 75Ø on the X-axis and from 1Ø to 55 on the Y-axis. fxdØ sets a fixed decimal point in the calculator with Ø digits past that decimal. (NOTE: All internal calculations will still be done to the highest number of digits available in the calculator). The current character size statement is now csiz2, which sets the character size at 2% of the total scaling area. If flag 7 is set, the program is sent down to line 82. Flag 7 will be set later in the program and is an indicator to the program that the main plotting grid has already been drawn.

66: Line 66 is reached if flag 7 has not been set, indicating that the main axes and grid have not yet been drawn. This line draws an X-axis ranging from Ø to 75Ø, crossing the Y-axis at a Y value of 1Ø, with tic marks every 5Ø units, and each of those tic marks labeled with a number.

67: and 68: These lines label the X-axis just drawn with the label: Depth
(meters)

69: Line 69 draws the Y-axis. It crosses the X-axis at an X value of Ø, has no tic marks, and ranges from 1Ø to 5Ø with no points numbered. The Y-axis cannot be numbered, since the offset will make it a sliding scale.

7Ø: thru 72: These 3 lines draw the opposite sides of the rectangle started by the X and Y axes. The pen is then picked up off the paper.

73: Line 73 displays the "Change pen..." message and stops program execution to await a CONTINUE from the operator.

74: Line 74 sets a line type of 2 (dashed line) in the plotter and also sets a pattern length (the length of one dash and the space after it) of 2% of the diagonal distance between the bottom left and upper right points of the scaling area.

75: thru 77: These lines draw dotted lines upward from each tic mark to the top of the grid. Again, lines are not drawn horizontally to crosshatch this grid because of the sliding scale on the Y-axis.

```
78: line ;plt 0,
 10,1
79: beep;dsp
 "Change pen
 and press Conti
 nue.";beep;stp
 ;if flg7;gto 82
80: beep;dsp
 "Do you wish
 to stop after
 the";wait 2500
81: ent "plot
 of each probe?
  (yes or no)",
 M$;if M$="yes";
 sfg 12
82: if flg7;if
 J>1;ofs 0,(J-
 1)*G
83: if flg7;if
 O=1;gto "T7plt"
 ;if D$="conT11
   ";gto "T11plt
 "
84: if flg7;if
 O=0;gto "T7Dypl
 t";if D$="conT1
 1";gto "T11Dypl
 t"
85: "offset":sfg
  7
86: if A+B#5;
 gto "four"
```

78: The line command with no parameters following it resets the line condition back to a normal line (no dots or dashes). The plt Ø,1Ø,1 statement positions the pen at the origin of the plotting axes.

79: Line 79 once again allows the operator to change pens.

8Ø: and 81: These lines ask the operator "Do you wish to change pens after each probe? (yes or no)". If the operator answers yes, flag 12 is set for use later in the program.

82: Line 82 is the offset statement and is carried out only if the grid has already been drawn, and if the probe about to be plotted is at least the second probe (J greater than 1). The scale is offset from the origin Ø units on the X-axis and J-1 times G(the offset which the operator entered in line 47)units along the Y-axis.

83: Line 83 sends the program down to either the subroutine "T7plt" or "T11plt" depending upon the probe type of the current probe. However, two conditions must first be met; flag 7 must be set showing that the main grid has been drawn, and O must equal 1 showing that the operator has chosen to plot from the cassette rather than the Dylon.

84: Line 84 has the same function as line 83 except that line 84 checks to see if O=Ø, indicating that the operator has chosen to plot from the Dylon tape. The program is then sent down to either subroutine "T7Dyplt" or "T11Dyplt".

85: Line 85 is the first line of subroutine "offset". It sets flag 7 (indicating to the program that the main grid has been drawn), since after the completion of this subroutine the grid will have been completed.

86: Line 86 tests to see if the total number of probes to be plotted is equal to 5. If it is not the program is sent down to subroutine "four" to be tested there.

87: Line 87 first uses the probe labeling character mentioned in the documentation of lines 52 and 53. Please refer to the sample offset plot at the end of this program documentation for general reference and answers to any questions which may arise about the method of probe labeling used here. Notice that the first probe is labeled Probe *. Look down at the plot and see that there are two** on the Y-axis; one at the origin and one approximately half-way up. If you look horizontally across the graph from these two ** you will see two more which are parallel to the first two and are resting on the line which runs parallel to the Y-axis. These 4 *'s form a rectangle which encloses the graph of the probe which is labeled Probe * at the top of the page. A scale is already drawn from Ø to 75Ø m on the long side of the rectangle which represents depth. The short side ranges from 1Ø°C (lower asterisks) to 3Ø°C (higher asterisks). The second probe is labeled Probe X. Probe X has the same rectangle as Probe * except that it is labeled with X's and has been offset from the first rectangle by the number of degrees input by the operator earlier in the program. Notice that the probes are offset from each other only in the Y direction, so the scale along the bottom of the graph (depth) remains the same for all probes.

Line 87 uses the wrt 7Ø7,"sm*" command to tell the plotter to write an * at each point it is told to plot. The program is then sent down to subroutine "plot" which plots the four aster- This subroutine will be explained more fully later.

```
87: wrt 707,"sm*
 ";gsb "plot"
88: wrt 707,"smX
 ";P+G→P;gsb
 "plot"
89: wrt 707,"sm+
 ";P+G→P;gsb
 "plot"
90: wrt 707,"smH
 ";P+G→P;gsb
 "plot"
91: wrt 707,"sm$
 ";P+G→P;if G<4.
 5;gsb "plot'
```

88: Line 88 changes the symbol mode set in line 87 to X. P+G→P offsets the axes used for plotting G° along the Y-axis. (G is the operator-entered offset in degrees). The program is then sent down to subroutine "plot", again to draw the X's in their proper place.

89: and 9Ø: Lines 89 and 9Ø perform the same function as line 88 using the characters + and H.

91: Line 91 uses the character $ for the fifth probe to be plotted and sends the program down to subroutine "Plot" only if the operator-specified offset is less than 4.5°C. This is used to prevent the upper * of the first probe from being written over by the lower $ of the fifth probe.

```
92: if G>=4.5;
 plt -15,P,-1;
 plt -15,P+20,-
 1;plt 765,P,-1;
 plt 765,P+20,-1
93: wrt 707,"sm"
 ;gto 79
94: "four":if A+
 B#4;gto "three"
95: wrt 707,"sm*
 ";gsb "plot"
96: wrt 707,"smX
 ";P+G→P;gsb
 "plot"
97: wrt 707,"sm+
 ";P+G→P;gsb
 "plot"
98: wrt 707,"smH
 ";P+G→P;gsb
 "plot"
99: wrt 707,"sm"
 ;gto 79
100: "three":if
 A+B#3;gto "two"
101: wrt 707,
 "sm*";gsb "plot
 "
102: wrt 707,
 "smX";P+G→P;
 gsb "plot"
103: wrt 707,
 "sm+";P+G→P;if
 G<9;gsb "plot"
104: if G>=9;
 plt -15,P,-1;
 plt -15,P+20,-
 1;plt 765,P,-1;
 plt 765,P+20,-1
105: wrt 707,
 "sm";gto 79
106: "two":if A+
 B#2;gto "one"
107: wrt 707,
 "sm*";gsb "plot
 "
108: wrt 707,
 "smX";P+G→P;if
 G<18;gsb "plot"
109: if G>=18;
 plt -15,P,-1;
 plt -15,P+20,-
 1;plt 765,P,-1;
 plt 765,P+20,-1
```

92: If the offset specified by the operator is less than 4.5°C, this line is never reached. If it is greater than or equal to 4.5°C, line 92 writes the four dollar signs used to bracket the graph of the fifth probe as usual except that the dollar signs are written slightly away from the Y-axis and the line parallel to it so as not to superimpose over the other characters already written on the axis.

93: Line 93 resets the symbol mode in the plotter so that only a point will be plotted at each point rather than some character. The program is then sent back to line 79, which decides what subroutine to send the program to for plotting purposes.

94: thru 99: If the total number of probes to be plotted is equal to 4, subroutine "four" in lines 94 through 99 performs the same functions which subroutine "offset" (lines 86 through 93) performed. The probe-labeling characters follow the same order (*,X,+, and H). The $ is omitted since only four probes are being plotted.*

100: thru 105: If the total number of probes to be plotted is equal to 3, subroutine "three" in lines 100 through 105 performs the same funtions as subroutine "offset" (lines 86 through 93).+

106: thru 110: If the total number of probes to be plotted is equal to 2, subroutine "two" performs the same functions that subroutine "offset" (lines 86 through 93) performed.

111: and 112: If the total number of probes to be plotted is only 1, subroutine "one" in lines 111 and 112 performs the same functions as lines 87 and 99.

*NOTE: The offset from the axes,if the operator-entered offset for the probes is above a certain amount, is not needed here since no overlap is possible.

+NOTE: The amount of offset necessary to make the program set the last probe-labeling character away from the axes will vary with a different number of total probes.

```
110: wrt 707,
 "sm";gto 79
111: "one":wrt
 707,"sm*";gsb
 "plot"
112: wrt 707,
 "sm";gto 79
113: "plot":plt
 0,P,-1;plt 0,P+
 20,-1;plt 750,
 P,-1;plt 750,P+
 20,-1
114: ret
115: "max":prt
 "Number of prob
 es","is on left
 ;"
116: prt "Maximu
 m offset","allo
 wed is on","the
  right.";spc 2
117: prt "1-----
 -No offset","2-
 ----20 degrees"
118: prt "3-----
 10 degrees","4-
 -----6 degrees"
 ,"5------5 degr
 ees";spc 2;gto
 47
119: gto 47
120: "T7":if
 flg2;if flg6=0;
 if I=C;0→I;cmf
 2;sfg 9;gto
 "T11"
```

113: This is subroutine "plot", which plots the probe-labeling characters on the Y-axis and on the line parallel to the Y-axis. P is the Y value of the lower two characters to be plotted, and it is incremented by the operator-entered offset (G) before each new set of four characters is drawn. The two upper characters are arrived at by adding 2Ø (the full range of a probe in degrees is from 1Ø to 3Ø°C) to P and plotting the new point as the upper asterisk, dollar sign, etc.

114: Line 114 is the return statement for subroutine "plot".

115: thru 118: Lines 115 through 118 comprise the subroutine "max" and are reached if the operator enters an offset between each probe which is too large for the total number of probes which he has elected to plot. The message "Too much offset, max. offsets:" has already printed in line 48 just before this subroutine is reached. These lines add onto that message the following: "Number of probes is on left; Maximum offset allowed is on the right."

1------No offset
2-----2Ø degrees
3-----1Ø degrees
4------6 degrees
5------5 degrees

119: Line 119 is used to return the subroutine to line 47 in order to ask the operator to enter another offset within the bounds specified above.

120: Line 12Ø starts the subroutine "T7". This subroutine uses the information entered by the operator in the first part of the program to find the proper probe files on the cassette and send the program to the subroutine "T7plt" (indirectly) to be plotted. This subroutine ("T7") also sends the program down to its T11 sister subroutine when it is time to plot a T11 probe. In this first line, if flag 2 is set and flag 6 is not set and if I=C, then I is reset to Ø, flag 2 is complemented (reset to Ø), flag 9 is set, and the program is sent down to the subroutine "T11". The meaning of this logic sequence is partially explained on the next page.

The logic sequences expressed in the lines of this subroutine are basically to decide if the correct order of plotting is being followed. See the variable cross reference and special flag reference sections at the end of this program documentation.

```
121: if flg3;if
 flg9;if I=E;
 0→I;cmf 3;gto
 "T11"
122: if R<20;
 trk Q;ldf R,C$,
 D$,E$;gto 125
123: gsb "overfl
 ow"
124: gto 122
125: R+2→R;if
 flg8;if C$[1,
 11]=A$[1,11];I+
 1→I;J+1→J;cmf
 8;gto 51
```

121: Line 121 makes decisions very similar to those made in line 12Ø for the second T7 probe(s) to be plotted.

122: If the file counter for the cassette (R) is less than 2Ø, the current converted data file from the current track is loaded into the memory strings dimensioned at the first of the program. The program then skips lines 123 and 124 to continue at line 125.

123: If the file counter for the cassette (R) is greater than 2Ø (indicating the end of the track), the program is sent down to the subroutine called "overflow", which tests to see which track has just been completed and takes action accordingly.

124: When the program returns from completion of subroutine "overflow" reached through line 123, this program line sends the program back to line 122 to read in another data file from the new track (track 1; if track 1 has just ended the subroutine,"overflow" will inform the operator of this fact and the program will not return).

125: The operator is required by the program to enter the start time of the first T7 probe which will be read. After that first probe's data file has been located, all subsequent T7 probes will be plotted in chronological order after the initial probe. Therefore, flag 8 (indicating that the first T7 probe has not yet been plotted) must be set in order for this line to be executed. Since it is known that a probe will be either plotted or the next file will be read from the data cassette, the file counter (R) is incremented. Then, if the start time (to the nearest minute) matches the start time entered by the operator (to the nearest minute), the current probe type counter (I) is incremented and the total number of probes plotted (J) is incremented. Then, since the first T7 probe is about to be plotted, flag 8 is complemented and the program is sent up to line 51 to plot the main grid (if necessary) and to plot the probe.

126: If flag 8 was not set, and therefore line 125 was not executed, then the probe now in question should be one of the probes immediately following the first probe which matched the operator-entered start time. The command which asks if J is greater than 1 before executing the line is checking to see if one probe (at least) has indeed been plotted. If so, both probe counters are incremented and the program is sent up to line 51 to check and make sure that the main grid has been plotted first before plotting the probe itself.

127: If neither of the conditions stipulated in lines 125 and 126 were met, then obviously the first T7 probe for which the program is now searching in the data cassette has not been found. This line sends the program back up to line 122 to be read & tested in the next data file to see if it is the desired probe file prior to plotting.

```
126: if J>0;I+
 1→I;J+1→J;gto
 51
127: gto 122
128: "T7plt":-
 .05→U;for S=1
 to 4799 by 2
129: U+.05→U;
 6.472U-.00216U↑
 2→V
130: itf(E$[S,S+
 1])→T;T/1000→T
```

128: Line 128 is the first line of the subroutine "T7plt" which does the actual plotting of all T7 probes in the program. The sample rate of the probes in the data acquisition programs is 2Ø per second per probe. Therefore, a data point should be placed every .Ø5 seconds. The counter used for this placement (U) is initialized to -.Ø5 in this line. Then the "for" statement for the plotting loop is stated.

129: For each data point in the loop, this line increments the time counter (U) and inputs the current value of U into the depth equation for the T7 probe. The value which emerges from this equation is the value of the probe depth in the water at the point in time from launch specified by U and is expressed in meters. This value is stored into the variable V for later use.

13Ø: Line 13Ø brings in the next temperature value from the data string and stores it into the variable T. Then, since the temperature values were stored in the form 16435 for the temperature 16.435°C, T is divided by 1000 and placed back into T.

```
131: if T<30;
 plt V,T;gto 133
132: pen
133: next S
134: if J=A+B;
 gto "finish"
135: pen;if flg1
 2;beep;dsp "Cha
 nge pen and
 press Continue.
 ";beep;stp
136: gto "T7"
137: "T11":if
 flg11;if I=D;
 0→I;cmf 11;sfg
 9;gto "T7"
138: if flg4;if
 flg9;if I=F;
 0→I;cmf 4;gto
 "T7"
139: if X<24;
 trk H;ldf X,G$,
 H$,I$;G$→C$;
 H$→D$;gto 142
140: gsb "overfl
 ow"
141: gto 139
142: X+2→X;if
      0;if G$[1,
 11]=A$[1,11];I+
 1→I;J+1→J;cmf
 10;gto 51
143: if J>0;I+
 1→I;J+1→J;gto
 51

144: gto 139
```

131: Since a 12ØØ is written for each invalid data point in the raw data, this converts to a temperature of over 32°C on the converted data cassette. Since the full range of temperatures of the probes is supposed to be 1Ø° to 3Ø°C, this is out of range. Therefore, the point V,T (depth and temperature) is only plotted if the temperature is less than 3Ø°C. The program then skips down to line 133.

132: Line 132 is reached only if the temperature value to be plotted was out of range on the high side. The pen is lifted and will not go down again until a valid point is plotted. Therefore, a string of invalid temperature values will show up on the plot as a space or gap in the plot.

133: Line 133 is the end of the plotting loop; it sends the program back up to plot another point if the maximum value of the counter (S) has not yet been reached.

134: After all data points from a given probe have been plotted, this line tests to see if the total number of probes which have been plotted by this program is equal to the total number of probes which the operator has indicated that he wants to plot. If this is true, the program is sent down to the subroutine called "finish" to wind up the program execution and inform the operator that it is finished.

135: In line 135, the pen is lifted in preparation for the next probe plot. If flag 12 has been set, meaning that the operator has elected to have the program stopped after full plotting of each probe to allow him time to change the pen, then the message "Change pen and press CONTINUE" is displayed and the program is stopped.

136: Line 136 sends the program back up to the subroutine "T7" to start looking for the next probe to plot.

137: thru 144: These lines comprise the subroutine "T11" and perform either very similar or identical functions to those in lines 12Ø through 127. The main exception is that these lines deal with T11 probes. Also, in line 139, it is necessary to input the values for the start time and probe type into C$ and D$ because the probe labeling lines (lines 51 through 62) label the probes using C$ and D$.

```
145: "overflow":
 if R<20;gto 148
146: if Q=0;1→Q;
 1→R;gto 153
147: gto 149
148: if H=0;1→H;
 21→X;gto 152
149: beep;prt
 "Please insert"
 ,"next data
 tape","before
 plotting"
150: prt "this
 probe;","then
 press","CONTINUE";spc 2;stp
151: if X<24;
 0→Q;0→R;gto 153
152: 0→H;21→X
153: ret
```

145: thru 153: These lines comprise the subroutine "overflow", which is reached through either subroutine "T7" or subroutine "T11" if the end of a track on a data cassette has been reached. Lines 145 through 148 decide which track has ended and from which subroutine ("T7" or "T11") the program was sent. These lines also reset variables and change to track 1 if the finished track was track Ø. Lines 149 and 15Ø are reached if the entire data tape has been looked at and the current file for which the program is searching has not yet been found. These lines print the message "Please insert next data tape before plotting this probe; then press CONTINUE". The program is then stopped to await operator action. Lines 151 and 152 decide which variables to reset in the case of a finished data tape. They are reached only if the current data tape has been finished and the operator message from lines 149 and 15Ø has already been printed. Line 153 returns the subroutine to the appropriate place in the program.

```
154: "T11plt":-
 .05→U;for S=1
 to 10759 by 2
155: U+.05→U;
 1.7779U-.000255
 7U↑2→V
156: itf(I$[S,S+
 1])→T;T/1000→T
157: if T<30;
 plt V,T;gto 159
158: pen
159: next S
160: if J=A+B;
 gto "finish"
161: pen;if flg1
 2;beep;dsp "Cha
 nge pen and
 press CONTINUE"
 ;beep;stp
162: gto "T11"
```

154: thru 162: Lines 154 through 162 perform the same functions that lines 128 through 136 performed, except that these lines perform the plotting for the T11 probes. They also comprise the subroutine "T11plt".

```
163: "Dylon":cmd
 7,"?";ent "Rew
 ind Dylon tape?
 (y or n)?",L$
```

163: Line 163 is the first line of the subroutine called "Dylon". As soon as the operator enters the fact that he wishes to plot from the Dylon rather than from the cassette, the program is bounced down to this subroutine. In preparation for addressing the Dylon, the unlisten command is sent over the bus. Then, since a person may wish to plot several probes in a row from the same part of the Dylon tape, the operator is given the choice of whether to rewind the Dylon tape. In this manner, if the operator knows that the next probe to be plotted is farther ahead on the tape, he can skip the time-consuming process of rewinding the tape and searching all the way through it again.

```
164: if L$="y";
 wrt 704,"QK1";
 wait 2000
```

164: If the operator elected to rewind the Dylon tape in line 163, the Dylon is rewound and positioned at the first file on the tape.

```
165: ent "Will
 plotted probes
 be T7 or T11",
 K$
```

165: Line 165 asks if the plotted probes will be T7 probes or T11 probes. (Since the converted data from T7 and T11 probes are on separate tapes, both may not be plotted on the same graph from the Dylon unit.

166: Line 166 asks the operator how many of the types of probes he selected in line 165 he wishes to plot.

167: Line 167 finishes the question asked in line 166 and enters it into memory for later use.

168: and 169: These lines ask the operator the start time of the first probe that he wishes to plot.

```
166: dsp "Total
 number of ",K$,
 " probes to";
 wait 2000
167: ent "be
 plotted on this
  graph?",W
168: dsp "Start
 time of first",
 K$,"probe";wait
  2000
169: ent "to be
 plotted?(i.e.→0
 7:10:15:42)",A$
170: if W=1;gto
 172
171: W→A;0→B;
 gto "grid"
172: "decide":if
  K$="T11";gto
 "T11Dy"
173: "T7Dy":wrt
 704,"S0";cmd 7,
 "?_";wrt 704,
 "R1V14"
174: red 705,C$;
 wrt 704,"R1V9";
 red 705,D$
175: if flg8;if
 C$[1,11]=A$[1,
 11];J+1→J;cmf
 8;gto 51
176: if J>0;J+
 1→J;gto 51
```

170: Line 170 effectively skips the drawing of a sample grid (Y-axis) if there is only one probe to be plotted, meaning that there is no need for the operator to enter an offset.

171: Line 171 inputs the values of W and 0 into the variables A and B for use in the offset evaluation to take place in line 48. The program is then sent up to the subroutine "grid" to draw a sample scaled-down Y-axis and let the operator enter an offset in °C based upon that grid.

172: Line 172 decides, based upon previous operator input, whether to let the program continue to subroutine "T7Dy" or to send it down to subroutine "T11Dy".

173: and 174: These two lines read in the start time and probe type from the current Dylon tape file.

175: Flag 8 is set at the beginning of the program to indicate that the first Dylon probe file to be plotted (the probe which must match the operator-entered start time) has not yet been plotted. If flag 8 is still set, this line is executed and it checks to see if the start time entered by the operator is matched by the start time read by the calculator from the Dylon tape. (Times need only match to the nearest minute.) If the times do match, the probes-plotted counter is incremented, flag 8 is complemented, and the program is sent up to plot the main grid and then to plot the probe itself.

176: If flag 8 is not set, ther line 175 is not executed. But the start time and probe type now in memory should be correct if the first probe has been plotted. Therefore, if J is greater than 1, J is incremented and the program is sent up to plot the grid if necessary and to plot the probe.

```
177: wrt 704,
 "K1";gto "T7Dy"
178: "T7Dyplt":w
 rt 704,"S1";
 wrt 704,"R32000
 V1000";-.05→U;
 for S=1 to 2400
179: U+.05→U;
 6.472U-.00216U↑
 2→V;fmt 1,z,
 f6.0
180: red 705.1,
 T;T/1000→T
181: if T<30;
 plt V,T;gto 183
182: pen
183: next S
184: if J=W;gto
 "finish"
185: pen;if flg1
 2;beep;dsp "Cha
 nge pen and
 press Continue.
 ";beep;stp
186: gto "T7Dy"
187: "T11Dy":wrt
  704,"S0";cmd
 7,"?";wrt 704,
 "R1V14"
188: red 705,C$;
 wrt 704,"R1V9";
 red 705,D$
189: if flg8;if
 C$[1,11]=A$[1,
 11];J+1→J;cmf
 8;gto 51
190: if J>0;J+
 1→J;gto 51
191: wrt 704,
 "K1";gto "T11Dy
192: "T11Dyplt":
 wrt 704,"S1";
 wrt 704,"R32000
 V1000";-.05→U;
 for S=1 to 5380
193: U+.05→U;
 1.7779U-.000255
 7U↑2→V
194: red 705.1,
 T;T/1000→T
195: if T<30;
 plt V,T;gto 197
```

177: If neither of the conditions for execution of lines 175 and 176 were satisfied, the first probe has not yet been found. So the Dylon tape is spaced forward to the next file and the program is sent back to the start of the subroutine to test the new file and see if it contains the desired probe data.

178: Line 178 is the first line of the subroutine "T7Dyplt". The first two commands enable the Service Request Interrupt from the Dylon unit (this has the function, among others, of stopping program execution if the program goes too far and tries to read a file mark) and sets up the block size for reading in the probe data.

179: thru 186: This subroutine ("T7Dyplt") is almost identical to the subroutine ("T7plt") in lines 128 through 136. The only differences are in line 178 above, line 186 sends the program back to the subroutine "T7Dy" rather than to its sister subroutine in the cassette section ("T7"). And the data points are read in differently in that they are read in directly from the Dylon tape instead of from an internal memory string.

187: thru 191: These lines comprise the subroutine "T11Dy" which is the T11 probe version of the subroutine "T7Dy" in lines 173 through 177.

192: thru 2ØØ: These lines comprise the subroutine "T11Dyplt" which is the T11 probe version of the subroutine "T7Dyplt" in lines 178 through 186.

2Ø1: and 2Ø2: These two lines comprise the subroutine "finish" which is reached after all probes have been plotted. It prints the message "If you wish to plot more data, press RUN". The paper is spaced up to allow the operator easy view of the message and the plotter is given the IN command, which places the pen in the initial position and erases all scaling, line types, etc. The program is then stopped and ended.

```
196: pen
197: next S
198: if J=W;gto
 "finish"
199: pen;if flg1
 2;beep;dsp "Cha
 nge pen and
 press CONTINUE.
 ";beep;stp
200: gto "T11Dy"
201: "finish":pr
 t "If you wish
 to","plot more
 data,","press
 RUN"
202: spc 2;wrt
 707,"IN";stp ;
 end
*8884
```

```
A   12  14  15
15  16  17  23
25  27  48  86
94  100 106 134
160 171

B   13  14  15
16  17  23  25
27  48  86  94
100 106 134 160
171

C   21  23  25
27  120

D   22  23  25
27  137

E   24  25  27
121

F   26  27  138

G   47  48  82
88  89  90  91
91  92  96  97
98  102 103 103
104 108 108 109

H   1   139 148
148 152

I   1   120 120
121 121 125 125
126 126 137 137
138 138 142 142
143 143

J   1   52  56
57  58  59  60
61  62  63  82
82  125 125 126
126 126 134 142
142 143 143 143
160 175 175 176
176 176 184 189
189 190 190 190
198

K   28

L   52  53  54

M   1   75  76
77  77  77
```

FILE 13

VARIABLE CROSS-REFERENCE AND DESCRIPTION

FLAG LISTING AND DESCRIPTION

At left and continued on the next page is a listing of all variables used in the offset plotting routine (FILE 13) and in what program lines they occur. Following that is a listing of all flags in the program and in what lines they occur. To the right of the page is a listing of the same variables and flags and their uses in the program.

A: Total number of T7 probes to be plotted on a given piece of paper (graph) in the cassette mode*.

*NOTE: From this point on, an * at the end of a variable or flag description indicates that it is used by the cassette mode of the program. A ⁑ at the end of a description indicates the Dylon mode of the program. If there is nothing following a description, the variable or flag may be used in both sections.

B: Total number of T11 probes to be plotted on a graph.*

C: Used only if the first probe to be plotted is a T7 probe. Stores the number of T7 probes to be plotted in the first set.*

D: Used to determine how many T11 probes will be plotted in the first set of T11 probes notwithstanding the fact that some T7 probes may or may not have plotted already.*

E: How many T7 probes will be plotted in the next T7 set.*

F: Number of T11 probes to be plotted in the next set.*

G: Operator-entered amount of offset between probes. Expressed in °C.

H: Track indicator variable for T11 probes.*

I: Counter for the number of probes plotted,thus far in any given set, is used to compare with set counters such as C,D,etc.*

```
N   1   54  56
56  57  58

O   5   6   49
83  84

P   1   88  88
89  89  90  90
91  91  92  92
92  92  96  96
97  97  98  98
102 102 103 103
104 104 104 104
108 108 109 109
109 109 113 113
113 113

Q   1   122 146
146 151

R   1   122 122
125 125 145 146
151

S   128 130 130
133 154 156 156
159 178 183 192
197

T   130 130 130
131 131 156 156
156 157 157 180
180 180 181 181
194 194 194 195
195

U   128 129 129
129 129 154 155
155 155 155 178
179 179 179 179
192 193 193 193
193

V   129 131 155
157 179 181 193
195

W   48  48  167
170 171 184 198

X   1   139 139
142 142 148 151
152
```

J: Counter for the total number of probes plotted so far.

K: Number of probes to be plotted in the last T7 probe set.*

L: Y value of the start point of probe labels.

M: X value of the start point of dotted lines coming upward from each tic mark on the X axis.

N: X value of the start point of probe labels.

O: Indicator to the program whether the operator has chosen to plot from the cassette mode or the Dylon mode.

P: Y value of the position of the probe labeling characters.

Q: Track indicator for T7 probes.*

R: File number counter for T7 probes.*

S: Counter used to count the number of data points to be plotted.

T: Temperature values which make up the Y coordinates of points to be plotted.

U: Counter for the number of elapsed seconds since probe launch, used to input into depth equations for different probes.

V: Value which represents the depth of the probe at the time at which a given temperature value was taken. It is the result of the standard depth equation for its probe type and is a function of the time variable (U).

W: Total number of probes to be plotted.

X: File counter for T11 probes.*

A$: Start time of the first T7 probe to be plotted (if applicable).*

B$: Probe type of first probe to be plotted.*

A$	2	9 125 142 169 175 189
B$	2	19 20
C$	3	55 122 125 139 174 175 188 189
D$	3	55 83 84 122 139 174 188
E$	3	122 130
F$	2	3 55 59 60 61 62
G$	3	139 139 142
H$	3	139 139
I$	3	139 156
J$	2	11
K$	2	165 166 168 172
L$	2	163 164
M$	2	81 81

C$: Start time string used in plotting. This string is loaded with the value of the probe start time from either tape. (Dylon or cassette).

D$: Probe type string used in plotting. This string is loaded with the value of the probe type from the cassette or the Dylon.

E$: Main data string for T7 probes.*

F$: A 1-character string used to store the probe labeling characters (i.e.; *,$,H,X, etc.).

G$: Start time string not used in plotting. This string is loaded with the value of the T11 start time and that value is then transferred into C$ to be used in the plotting routine.*

H$: Probe type string not used in plotting. This string is loaded with the value of the probe type and that value is then transferred to D$ for plotting purposes.*

I$: Main data string for T11 probes.*

J$: Start time of first T11 probe to be plotted (if applicable).*

K$: Probe type of probes to be plotted from Dylon tape.*

L$: Stores the operator-entered answer to the question "Rewind Dylon tape?".*

M$: Stores the operator-entered answer to the question "Do you wish to stop after the plot of each probe?".

(Flag listing follows on next page).

FLAG 2: Flag 2 is used to indicate to the program that more than one type of probe is to be plotted. It is only used with the cassette mode.

FLAG 3: Flag 3 is used to indicate to the program that at least one set (a set is one or more) of T7 probes is to be plotted. The setting of flag 6 determines if at least two sets of T7 probes will be plotted. Again, this flag is used only in the cassette mode.*

FLAG 4: Flag 4 is used to indicate to the program that at least two sets of T11 probes will be plotted. Used only in cassette mode.

FLAG 5: Flag 5 is used to indicate to the program that at least two sets of T7 probes will be plotted. The setting of flag 6 determines if at least 3 sets of T7 probes are to be plotted. As in the previous flags, this flag is used only in the cassette mode of plotting.*

FLAG 6: Flag 6 indicates to the program that the first probe to be plotted (cassette mode only) is a T11 probe. This flag is used to determine what probe to plot next. If flag 3 is set and flag 6 is set too, then flag 3 indicates to the program that at least one set of T7 probes will be plotted. This is unnecessary due to the fact that flag 2 is set and the program already knows that at least one set of each probe type will be plotted. But, if flag 3 and flag 6 are changed so that flag 3 is still set but flag 6 is not set, then the fact that flag 3 is set indicates to the program that at least two sets of T7 probes are to be plotted.

FLAG 7: Flag 7 is set to indicate to the program that the main grid has been drawn.

FLAG 8: Flag 8 in the cassette mode indicates to the program that the first T7 probe has not yet been plotted so that the program will continue to search for the proper start time for the first T7 probe. In the Dylon mode, flag 8 indicates that the first probe (either type) has not yet been plotted for the same reason. After the first probe has been plotted, flag 8 is complemented.

FLAG 9: Flag 9 is an indicator that the first set of probes in the cassette mode has been completely plotted. It is used to decide which probes should be plotted next.

FLAG 1Ø: Flag 1Ø is used in the cassette mode to indicate to the program that the first T11 probe has not yet been plotted so that the program will continue to search for the correct probe start time until it is found. At that time, flag 1Ø is complemented.

FLAG 11: Flag 11 is used to indicate that the first set of T11 probes has not yet been plotted. (Cassette mode only).

FLAG 12: Flag 12 is set if the operator decides in the program that he wishes to have the program stop after the plot of each probe to allow him time to examine the plot and change pens if he so desires.

FILE 14

DEVIATION PLOTTING ROUTINE

FILE 14
T7/T11 DEVIATION PLOTTING ROUTINE

```
0: .fxd 0;1→B;
 0→C;1→D;1→F;
 97→G;0→K;1→M;
 25→N;0→O;21→P;
 1→Q;cfg ;sfg 4
1: psc 707;pclr;
 wrt 707,"ip2000
 ,700,5212,8100"
 ;wrt 707,"VA";
 fmt 1,z,f6.0
2: dim A[400],
 B[50],D[-24:24]
 ,A$[3],B$[14],
 F$[1]
3: ent "Using
 Dylon(0) or
 cassette(1)?",A
4: ent "Is probe
  a T7 or T11?",
 A$
5: ent "Probe
 start time(ex→0
 7:24:12:38)",B$
6: beep;dsp "Do
 you wish to
 have the progra
 m";wait 2500
7: beep;ent "sto
 p for pe: chang
 es? (y or n)",
 F$

8: if F$="y";
 sfg 3
9: if A=1;beep;
 dsp "Insert
 Data Tape;press
  CONTINUE";stp
10: scl 10,30,
 750,-45;csiz
 3.5,1
```

Ø: Line Ø sets a fixed decimal point in the calculator with zero digits following that decimal. Then, various variables to be used in the program are initialized, all flags in the calculator are cleared (set to Ø), and flag 4 is set (set to a value of 1). Flag 4 will be used later in the program.*

1: Line 1 selects plotter address 7 on the HP-IB bus (also address 7ØØ), clears the plotter, then writes the ip... command. The ip command sets up the absolute plotting area to be used for scaling purposes. The VA command adapts the velocity of the plotter pen to the approximate rate at which the calculator is sending out values to be plotted. The format statement at the end of the line is used in reading from the Dylon tape.

2: In line 2, more variables are dimensioned.*

3: thru 7: These lines ask the operator to enter the device (Dylon or cassette), probe type, start time (to the nearest minute), and stop for possible pen changes.

8: Line 8 sets flag 3 if the operator elected to have the pen stop during the plotting of the probe.

9: If the operator has elected to plot from the cassette (which is usually the case), then the program displays the message "Insert Data Tape and press CONTINUE". The program is then stopped to await operator action.

1Ø: Line 1Ø sets up the scale for plotting the main probe profile, sets a character size of 3.5% of the total scaling area, and sets an aspect ratio of 1 (letters just as wide as they are high, but conforming to the shape of the scaling area).

*NOTE: Immediately following the documentation of this plotting routine is a listing of all variables used in the program and the line numbers in which they occur. Also included is an explanation of the use of each variable. Each flag in the program is then documented in a similar manner. These listings are provided for ease of alteration should the program need to be changed to fit the individual user's needs.

```
11: xax 750,5,
 10,30,1
12: fxd 5;wrt
 707,"SL",tan(30
 );plt 33,779,1;
 lbl "o";plt 34,
 796,1;lbl "C"
13: fxd 0;wrt
 707,"SL";yax
 10,-50,750,0,3;
 fxd 5
14: wrt 707,"SL"
 ,tan(20);plt 2,
 350,1;lbl "Dept
 h";plt 1,390,1;
 lbl "(meters)"
15: plt 10,0,-2;
 plt 30,0;plt
 30,750,-1;wrt
 707,"SL"
16: plt 10,150,
 1;line 1,1.5
17: plt 59.8,
 150B,2;B+1→B;
 plt 59.8,150B,
 1;plt 10,150B,2
18: B+1→B;plt
 10,150B,1;if
 B<5;gto 17
19: plt 15,750,
 1;plt 15,0,2;
 plt 20,0,1;plt
 20,750,2;plt
 25,750,1;plt
 25,0,2
20: pen;if flg3;
 dsp "Change
 pens and press
 CONTINUE.";beep
 ;stp
21: if A$="T11";
 dim C$[14],D$[9
 ],E$[10800];
 gto 23
22: dim C$[14],
 D$[9],E$[4810];
 sfg 5
```

11: Line 11 draws the X-axis for the plot of the main probe profile.

12: Line 12 labels the X-axis with the label °C written at a 3Ø° slant.

13: and 14: These lines draw the Y-axis for the main probe profile and label it Depth (meters) at a 2Ø° slant.

15: Line 15 outlines the plotting area and resets the slant parameter to Ø°.

16: thru 19: These lines cross-hatch the plotting area with dotted lines.

2Ø: Line 2Ø displays the Change pen message and stops the program if the operator elected earlier to have the program stop to allow pen changes.

21: and 22: These lines dimension the variables which will hold the data read from tape. The variables must be dimensioned differently for different probe types.

23: If the operator elected earlier to plot from the Dylon tape unit, the program is sent down to subroutine "Dylon" at this point.

24: Line 24 is the first line of subroutine "T7". This line loads the data from the first T7 file from the cassette into the proper string variable.

25: Line 25 sends the program down to subroutine "T7plt" if the start time of the probe data which was just read from cassette matches the desired start time of the probe to be plotted by the operator in line 5.

26: Line 26 sends the program back up to load another file of data from the cassette and tests the start time to see if it matches the operator-entered start time from line 5.

27: Line 27 is executed if the end of track Ø on the cassette has been reached. It changes the track and file counters to the first file on track 1 and sends the program back up to read in the data from that file.

```
23: if A=0;gto
 "Dylon"
24: "T7":trk C;
 ldf D,C$,D$,E$
25: if C$[1,11]=
 B$[1,11];gto
 "T7plt"
26: if D<18;D+
 2→D;gto "T7"
27: if C=0;1→C;
 1→D;gto "T7"
28: prt "Designa
 ted probe","not
  found on","thi
 s data tape.";
 stp
29: "T7plt":csiz
  2.5,1;plt 13,-
 15,1;lbl C$,"
  ",D$[4,6];line

30: fxd 11;-.05→
 U;for I=1 to
 4799 by 2
31: U+.05→U;6.47
 2U-.00216U↑2→V
32: itf(E$[I,I+
 1])→T;T/1000→T
33: if T<=30;if
 T>=10;plt T,V;
 gto 35
34: V→A[Q];Q+
 1→Q;pen
35: next I
36: psc 707;pclr
 ;wrt 707,"ip650
 0,700,10000,
 8100";wrt 707,
 "VA"
```

28: Line 28 is reached if the whole tape has been searched and the desired probe has not yet been found. The calculator then prints the message "Designated probe not found on this data tape." and stops the program.

29: Line 29 is the first line of the subroutine "T7plt" which actually plots the data. This line sets a slightly smaller character size and labels the grid used to plot the main probe profile with the start time and probe type.. The line command resets the line parameter from the dotted line to a continuous line.

3Ø: Line 3Ø sets a fixed decimal point with 11 digits following. Then, the value of U (counter for the seconds since probe launch) is initialized. The rest of the line is the "for" statement of the plotting loop.

31: Line 31 increments U and places the new value of U into the depth equation for the T7 probes and stores the result into the variable V.

32: Line 32 brings in a temperature value from the storage string E$ and stores it into the variable T. This value is then divided by 1ØØØ to put the decimal place in the right position and the result of this calculation is then put back into the variable T.

33: Line 33 plots the point (T,V) if it is within the range of 1Ø° to 3Ø°C. The program is then sen to line 35.

34: Line 34 is reached only if the point to be plotted in line 33 was out of range. It stores the point into an array (A), the array counter i incremented (Q), and the pen is raised. In this way, if several invalid data point occur, the pe will not sit on the paper and make an ink spot which could cloud part of the graph.

35: Line 35 is the "next" statement for the plotting loop.

36: Line 36 clears the plotter and uses the ip command to set the absolute plotting area for the deviation plot.

```
37: scl -10,10,
 750,-45;line 1,
 .75;1.15→U
38: plt 0,7.4399
 434,-2;plt 0,
 742.5600566,-1
39: line ;plt -
 10,750,-2;plt -
 10,0;plt 10,0;
 plt 10,750;plt
 -10,750
40: line 2,1.5;
 plt 10,738.6865
 034,1;plt -10,
 738.6865034,2;
 pen
41: plt -10,7.43
 99434,-2;plt
 10,7.4399434,-
 1;line ;csiz 2,
 1
42: plt -1,-26,
 1;lbl "MEAN";
 plt 0,-20;plt
 0,0,2;plt .5,-
 9;plt -.5,-9;
 plt 0,0
43: gsb "deg"
44: for I=F to
 G by 2;itf(E$[I
 ,I+1])→B[M];
 B[M]/1000→B[M];
 M+1→M;next I
45: 1→I;for J=-
 (N-1) to N-1;
 D[J]*B[I]→H;H+
 K→K;I+1→I;next
 J
46: U+.05→U;6.47
 2U-.00216U↑2→V
47: B[25]-K→L;
 if abs(L)<=E;
 plt L,V;gto 49
48: pen
49: if U=118.8;
 gto "finish"
50: F+2→F;G+2→G;
 U+.05→U;1→M;
 0→K;gto 44
51: "T11":trk 0;
 ldf P,C$,D$,E$
52: if C$[1,11]=
 B$[1,11];gto
 "T11plt"
```

37: Line 37 sets up the scale for the deviation plot grid. A very close-packed dotted line mode is then initialized in the plotter with the <u>line</u> statement. Then U is re-initialized.

38: thru 42: This deviation plotting routine uses 24 points on either side of a certain mid-point in a segment to calculate a weighted average over that segment and then compares that weighted average with the actual value of the mid-point of the segment to find the deviation of the midpoint from the calculated mean. The first 24 points can be used to calculate the mean for the 25th; but no means may be calculated for the first or last 24 points. Therefore, these lines plot a dotted line down the center of the grid to represent the mean. Then, two dashed lines are plotted perpendicular to that mean line. (They represent the endpoints or the deviation plot.) The grid is then labeled at the top with the word MEAN followed by an arrow pointing down to the dotted line representing the mean.

43: Line 43 sends the program down to subroutine degree at this point.

44: Line 44 reads in the desired segment of data points into the array B after multiplying each of them by 1000 to position the decimal point properly.

45: Line 45 multiplies each value of array B by its corresponding weighting value (weighting values are calculated in subroutine "degree"). All the resulting values are added together and stored in the variable K. After the execution of this program line, K represents the weighted average of the points in the segment being considered.

46: Line 46 performs the depth calculation upon the value of U and stores it into the variable V.

47: Line 47 plots the value of B[25] (midpoint of the segment) minus K (calculated mean) as the X value and V as the Y value. Only this point is plotted, and only the program is sent to line 49 if this value is within the X range of the deviation plotting grid.

48: Line 48 lifts the pen to avoid an ink flow on the paper if a point outside the plotting range is discovered.

```
53: if O<22;O+
 2→O;gto "T11"
54: if P=0;1→P;
 21→O;gto "T11"
55: gto 28
56: "T11plt":csi
 z 2.5,1;plt 13,
 -15,1;lbl C$,"
   ",D$[4,6];
 line ;cmf 4
57: fxd 11;-.05→
 U;for I=1 to
 10759 by 2
58: U+.05→U;1.77
 79U-.0002557U↑2
 →V
59: itf(E$[I,I+
 1])→T;T/1000→T
60: if T<=30;if
 T>=10;plt T,V;
 gto 62
61: V→A[Q];Q+
 1→Q;pen
62: next I
63: psc 707;pclr
 ;wrt 707,"ip650
 0,700,10000,
 8100";wrt 707,
 "VA"
64: scl -10,10,
 750,-45;line 1,
 .75;1.15→U
65: plt 0,0,-2;
 plt 0,750,-1
66: line ;plt -
 10,750,-2;plt
 10,0;plt 10,0;
 plt 10,750;plt
 -10,750
67: line 2,1.5;
 plt 10,457.8656
 70727,1;plt -
 10,457.86567072
 7,2;pen
68: plt -10,2.04
 424683675,-2;
 plt 10,2.044246
 83675,-1;line ;
 csiz 2,1
```

49: The program is sent down to subroutine "finish" if the U value of 118.8 (24th point from the end of the probe drop) is reached.

5Ø: If the full deviation plot is not yet finished, the segment is moved one point ahead, the value of U is incremented by .Ø5, variables are reset and the program is sent back to repeat the previously described process for another segment of data points.

51: thru 54: These lines are identical to lines 24 through 27, except that the program is sent down to "T11plt" rather than "T7plt".

55: Line 55 sends the program back to line 28 to inform the operator that the desired probe was not found on this cassette.

56: thru 69: These lines are practically identical to lines 29 through 42. The two major exceptions are that flag 4 is complemented in line 56; and the depth equation for the T11 probes (line 58) is different from the T7 probe depth equation (line 31.)

7Ø: and 71: Lines 7Ø and 71 are the first two lines of the subroutine "deg". They ask the operator to enter the amount of deviation which the plot will cover in degrees C on either side of the mean line. This number can be anything between Ø°C and 5°C.

72: thru 77: These lines use the value of E (entered in line 71) to scale the deviation plotting area to agree with that value and to set up the X- and Y-axes for the plot.

78: Line 78 calculates the 49 weighting values used to obtain a weighted average of each data segment studied by the program.

79: Line 79 returns the program to line 44 if the probe to be plotted is a T7.

8Ø: thru 86: These lines are practically identical to lines 44 through 5Ø. The main differences are in the equations in lines 82 and 46 and also in the finish times in lines 85 and 49.

```
69: plt -1,-26,
 1;lbl "MEAN";
 plt 0,-20;plt
 0,0,2;plt .5,-
 9;plt -.5,-9;
 plt 0,0
70: "deg":pen;
 beep;dsp "No.
 of degrees dev.
  on each side";
 wait 2500;beep
71: ent "of MEAN
  (Number betwee
 n 0 and 5)",E
72: scl -E,E,
 750,-45
73: if E=1;fxd
 2;xax 750,.25,-
 1,1,1;gto 77
74: if E=2;fxd
 2;xax 750,.5,-
 2,2,1;gto 77
75: if frc(E)=0;
 fxd 0;xax 750,
 1,-E,E,1;gto 77
76: fxd 2;xax
 750,.25E,-E,E,1
77: yax 0,0,0,0
78: fxd 11;for
 J=-(N-1) to N-
 1;(1+cos(180J/
 N))/2N→D[J];
 next J
79: if flg4;ret
80: for I=F to
 G by 2;itf(E$[I
 ,I+1])→B[M];
 B[M]/1000→B[M];
 M+1→M;next I
```

87: and 88: Lines 87 and 88 are the first two lines of subroutine "Dylon". In line 87, the Dylon unit is unlistened. Then the operator is asked if he wishes the Dylon unit to be rewound. If an operator is plotting files in chronological order, then there is no need for him to rewind the Dylon tape and search the entire tape for his desired file each time. Line 88 rewinds the Dylon tape if the operator chose to do so in line 87.

89: and 90: Lines 89 and 90 enable the service request on the Dylon unit so that the plotting routine will not try to read and plot file marks. Then the start time and probe type are read into memory strings from the Dylon tape.

91: Line 91 spaces the Dylon tape forward to the next file and sends the program back to look at the start time of that file if the current start time does not match the operator-entered start time for the desired probe.

92: and 93: These two lines read in either all T7 data from the correct probe or all T11 data depending upon the operator-selected probe type.

94: and 95: These two lines send the program back to either subroutine "T7plt" or "T11plt" depending upon the previously entered probe type.

96: Line 96 comprises the "finish" routine of the program and is reach only when the program has finished execution. It writes the "IN" command to the plotter, which returns the pen to the chart load position. Then, the calculator prints the message, "To plot another probe press RUN." The program then ends.

```
81: 1→I;for J=-
 (N-1) to N-1;
 D[J]*B[I]→H;H+
 K→K;I+1→I;next
 J
82: U+.05→U;1.77
 79U-.000255*U↑2
 →V
83: B[25]-K→L;
 if abs(L)<=E;
 plt L,V;gto 85
84: pen
85: if U=267.8;
 gto "finish"
86: F+2→F;G+2→G;
 U+.05→U;1→M;
 0→K;gto 80
87: "Dylon":cmd
 7,"?";ent "Rewi
 nd Dylon tape?
    (y or n)?",
 F$
88: if F$="y";
 wrt 704,"QK1";
 wait 2000
89: wrt 704,"S0"
 ;cmd 7,"?";wrt
 704,"R1V14"
90: red 705,C$;
 wrt 704,"R1V9";
 red 705,D$;wrt
 704,"R32000V100
 0"
91: if C$[1,11]#
 B$[1,11];wrt
 704,"K1";gto 89
92: if flg5;for
 I=1 to 4799 by
 2;red 705.1,R;
 fti (R)→E$[I,I+
 1];next I;gto
 94
```

```
93: for I=1 to
 10759 by 2;red
 705.1,R;fti
 (R)→E$[I,I+1];
 next I;gto 95
94: gto "T7plt"
95: gto "T11plt"
96: "finish":wrt
  707,"IN";prt
 "To plot anothe
 r","probe","pre
 ss RUN";spc 2;
 end
*57
```

```
A    3    9    23

B    0    17   17
17   17   17   18
18   18   18

C    0    24   27
27

D    0    24   26
26   26   27

E    47   71   72
72   73   74   75
75   75   76   76
76   83

F    0    44   50
50   80   86   86

G    0    44   50
50   80   86   86

H    45   45   81
81

I    30   32   32
35   44   44   44
44   45   45   45
45   57   59   59
62   80   80   80
80   81   81   81
81   92   92   92
92   93   93   93
93

J    45   45   45
78   78   78   78
81   81   81

K    0    45   45
47   50   81   81
83   86

L    47   47   47
83   83   83

M    0    44   44
44   44   44   50
80   80   80   80
80   86

N    0    45   45
78   78   78   78
81   81
```

FILE 14

VARIABLE CROSS-REFERENCE AND DESCRIPTION

FLAG LISTING AND DESCRIPTION

A: Indicator to the program whether the operator has chosen to plot from the cassette tape or the Dylon tape.

B: Variable used as a plotting aid in an equation for plotting the dashed lines which cross-hatch the plotting grids.

C: Track indicator variable for T7 probes.

D: File number indicator variable for T7 probes.

E: Operator-entered scaling factor for the deviation plotting grid. This number is in degrees Centigrade and ranges from Ø°C to 5°C.

F: Used to indicate the starting point of the current segment of data which is being plotted.

G: Used to indicate the ending point of the current segment of data which is being plotted.

H: As each point is multiplied by its corresponding weighting value, the result of that multiplication is stored into the variable H.

I: I is used as a counter for the "for,next" loops (similar to FORTRAN DO loops) in the program.

J: J is used as a counter for the "for,next" loop used to multiply each data value by its corresponding weighting value.

K: K represents the weighted average of the current data segment being plotted.

L: L represents the deviation of the midpoint of the current data segment from the value of K.

M: M is used to position each data value into its proper place in the array B[*] as it is called in from memory.

N: N is used to indicate to the program the exact positioning of each weighting value in array D[*].

Variable	Lines	Description
O	0 0 51 53 53 53 54	O: Track indicator variable for T11 probes.
P	0 51 54 54	P: File number indicator for T11 probes.
Q	0 34 34 34 61 61 61	Q: Used to position each invalid data value into the invalid data point storage array A[*].
R	92 92 93 93	R: Each data value read from the Dylon unit is temporarily stored in the variable R before being converted to integer precision for more permanent storage in calculator memory.
T	32 32 32 33 33 33 59 59 59 60 60 60	T: Used to store and plot each data (temperature) value. T is the X coordinate of each plotted point on the main probe profile half of the plot.
U	30 31 31 31 31 37 46 46 46 46 49 50 50 57 58 58 58 58 64 82 82 82 82 85 86 86	U: U represents the elapsed time since the first valid data point of any probe. V: V is used to store the result of the depth equations for either probe type. V is the Y coordinate of all points on the main probe profile and the deviation curve halves of the program.
V	31 33 34 46 47 58 60 61 82 83	A[*]: Array A[*] is used to store any points which do not fall within the range of 1Ø°C to 3Ø°C in the main probe profile.
A[*]	2 34 61	B[*]: Used to store the 49 data points of each segment of data which is averaged and then tested for deviation.
B[*]	2 44 44 44 45 47 80 80 80 81 83	D[*]: Used to store the 49 weighting values derived from a cosine bell curve which correspond point-for-point with the current 49 data values which have to be average in accordance with these weighting values.
D[*]	2 45 78 81	
A$	2 4 21	A$: Probe type of probe to be plotted.
B$	2 5 25 52 91	B$: Probe start time (to the nearest minute).
C$	21 22 24 25 29 51 52 56 90 91	C$: Start time of probe which is read from tape. (B$ is the operator-entered start time of the desired probe).
D$	21 22 24 29 51 56 90	D$: Probe type of probe which is read from tape. (A$ is the operator-entered probe type of the desired probe).
E$	21 22 24 32 44 51 59 80 92 93	E$: Main data string for probe.

F$ 2 7 8
87 88

F$: Stores the operator-entered answer to the question "Do you wish to have the program stop for pen changes? (y or n)".

FLAG 3: Flag 3 is used to indicate to the program that the operator does desire a colored plot and has elected to have the program stop for pen changes.

flag 3:
8 20

flag 4:
0 56 79

flag 5:
22 32

FLAG 4: Flag 4 is used to indicate to subroutine "deg" where the program should be sent after the end of the subroutine has been reached. If flag 4 is set, then the subroutine returns to the T7 section of the program from which it was sent in the first place. If flag 4 is not set, the program simply continues with the next line after the subroutine itself. This subroutine is nested inside the T11 section of the program so the program would then continue with T11 plotting operations.

FLAG 5: Flag 5 is used to indicate to the program whether the probe to be plotted is a T7 probe. If flag 5 is set, then the probe is a T7, if it is not set then the probe is a T11.