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OPERATING INSTRUCTIONS MANUAL FOR MICROPROCESSOR  
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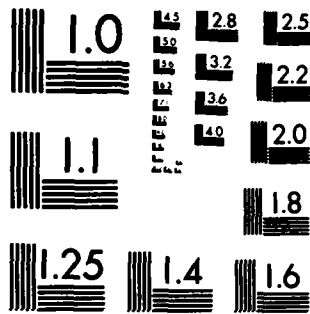
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Aerodynamics Technical Memorandum 347

OPERATING INSTRUCTIONS MANUAL FOR MICROPROCESSOR  
AIRBORNE DATA ACQUISITION & REPLAY (MADAR) MODULE

J.F. HARVEY, C.W. SUTTON and I.M. KERTON

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AIRBORNE DATA ACQUISITION & REPLAY (MADAR) MODULE

by

J.F. HARVEY, C.W. SUTTON and I.M. KERTON

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SUMMARY

This user's manual details the operating instructions for MADAR which is a 16 channel analogue input, digital cassette recording system with programmable facilities. Selected data are able to be scaled and periodically displayed on liquid crystal displays.



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## 1 INTRODUCTION

The Microprocessor Airborne Data Acquisition & Replay (MADAR) module is a 16 channel analogue input digital recording system with programmable facilities. Selected data are able to be scaled and displayed on liquid crystal displays.

This manual details the user aspects of MADAR and should be used in conjunction with the circuit folder and data booklets supplied with each MADAR module. The design description of MADAR is covered in Ref#1 The specification is given in APPENDIX 1.

## 2 MODES OF OPERATION

### 2.1 General

The 3 modes of MADAR operation are:

- (1) Program
- (2) Record
- (3) Replay

All 3 modes of operation require that the MADAR module be powered from 115 volts 50-400 Hz. Pin connections for the power lead connectors are given in Section 9.1. (The internal fan must be powered from 115V 400 Hz only but the fan is not required for ambient temperatures between 10°C and 25°C).

Detail description of the labelled switches, indicator lights and connectors is given in Sections 7 and 8.

### 2.2 Program Mode

There are 3 levels of communication:

- (1) Keypad (if no other device is connected to MADAR)
- (2) Keyboard/printer (if connected to PORT 2)
- (3) An RS232 terminal (if connected to TERMINAL connection)

- Steps
- 1 Connect communication device as required.
  - 2 Place RAM BATT S/W to 'ON'.
  - 3 Place PROG/RUN S/W to 'PROG'.
  - 4 Connect remote control unit &/or monitor unit.
  - 5 Press the circuit breaker 'IN'. Apply 115 volt power with POWER S/W located at top of remote control unit or with the POWER S/W on the front panel of the monitor unit (Section 9.2).
  - 6 Enter commands. For keypad use -see Section 3.1.  
For keyboard/printer or terminal use  
-see Sections 3.2 & 3.3.
  - 7 To load an application program refer to Section 3.3.7.

---

#1Reference 1.  
Sutton C.W. & Harvey J.F.  
Microprocessor Airborne Data Acquisition & Replay (MADAR) System  
ARL Publication in preparation 1983

8 To retain program entries RAM BATT S/W must remain 'ON'.

### 2.3 Record Mode

There are two choices of control in the record mode:

- (1) remote control unit
- (2) keypad

- Steps
- 1 Connect remote control unit if required.
  - 2 Ensure RAM BATT S/W is 'ON'. (In general the RECORD MODE follows the PROGRAM MODE and this switch will have remained 'ON').
  - 3 Place PROG/RUN S/W to 'RUN' and apply power.
  - 4 Load a cassette into the recorder (Side "A" down against door). Ensure that the "WRITE" tabs are not in the "WRITE" protected position. If a new cassette is being used check that the clear leader & not tape is across the head.
  - 5 If using the remote control unit check that the REC S/W is in the central (OFF) position.
  - 6 On closing the recorder door check that the red WRITE PROTECT indicator is extinguished and that the two green indicators SIDE CORRECT and CASSETTE PRESENT are lit. The TAPE MOTION indicator should light for about 6 seconds as the tape automatically drives past the Beginning Of Tape (BOT) leader & hole. Tape time remaining should then display as 5.3 minutes.

If the BOT clear leader does not automatically drive past the recording head then momentarily depress the CPU INITIALISE switch with the PROG/RUN S/W in the 'RUN' position. (If the cassette is inserted at step 4 without exposed clear leader there will be no automatic motion).

- 7 If using the remote control unit displace the REC S/W from the central position for a few seconds and return switch to the central position. Check that the TAPE MOTION indicator light extinguishes and that the TAPE TIME REMAINING display is nominally 5.3 for a new cassette.

If the remote control unit is not connected then control is through the keypad. Press the 'RUN' pad, wait a few seconds and press the 'STOP' pad. Check that the TAPE MOTION indicator lights and then extinguishes.

Input data is in three forms:

- a. Channels 1 to 13 - analogue signals only, range  $\pm 5V$ .
- b. Channels 14 to 16 - 3 phase synchro-resolvers, line to line 11.8 volts, reference 26 volts at 400 Hz RMS.
- c. Two 16 bit digital input/output ports (TTL Logic levels).

Two types of low-pass plug-in filter cards are provided. One card type contains dual active 4th order Butterworth low-pass filters with cut-off frequencies of either 0.8 or 5 Hz and D.C. gain of 0.5 or unity. The other card type accommodates passive resistor/capacitor networks and is user defined. Two special plug-in cards, are available. One card contains a peak detector circuit for channel 11 only and the other card has high gain



amplifier (max. gain of 300). Pin connections and initial allocation of filter cards to channels is given in APPENDIX 2.

A 16 channel multiplexer (Fig 1) connects each channel in turn to an analogue to digital converter for processing by the microprocessor. The microprocessor controls a digital cassette recorder for the storage of data.

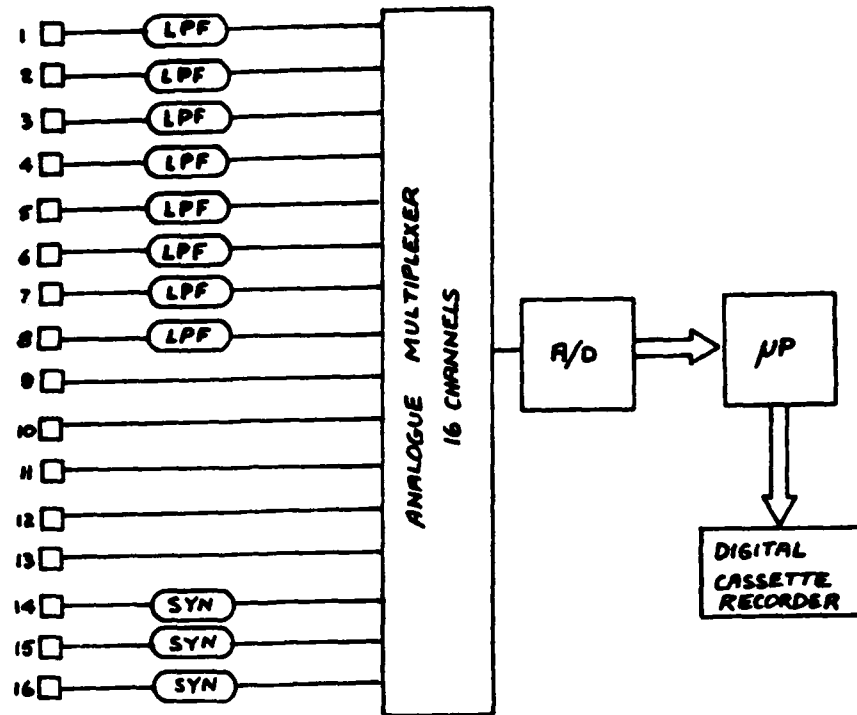


Fig 1 RECORD SCHEMATIC

#### 2.4 Replay Mode

In the replay mode MADAR reads data back off tape and transfers that data to an external output peripheral (Fig 2).

Three external output peripherals may be used:

1. A RS232 device. May be either a Minicomputer (HP9845B) or a Visual Display Unit (VDU). The rate of transmission of data is either 1200 or 300 Baud, selectable by an internal switch, which is normally set at the higher rate of 1200 Baud.
2. A 20 character width metallized paper, printer. The microprocessor sends 8 bit parallel ASCII characters to the printer along with the appropriate print commands.

Note: If both 1 & 2 devices are simultaneously connected, MADAR selects the device with the highest data transfer rate. The RS232 device has higher priority than the printer.

3. An analogue X-Y Recorder. MADAR controls pen lift for the plotting of data from a single program selectable channel VS a time increment in the X direction.

WARNING

REMOVE CASSETTE FROM RECORDER BEFORE SWITCHING POWER 'ON' OR 'OFF'

- Steps
1. Place PROG/RUN S/W to 'PROG' position.
  2. Connect desired output device(s).  
For computer or computer terminal communication, check that Baud setting of MADAR and the device are compatible.
  3. Apply 115V power.
  4. Ensure that the write tabs are in the write protect position.
  5. Insert cassette in recorder with side "A" down against door. Check that the red WRITE PROTECT indicator is lit when the recorder door is closed.
  6. Momently depress TAPE REWIND switch.  
When TAPE MOTION indicator extinguishes the tape is rewound.
  7. Enter commands R, D, Z or O and respond to the prompts as given in Sections 3.3.1, 3.3.2, 3.3.5 & 3.3.6.

NOTE. To replay data to the desk top computer (Hewlett Packard 9845B) requires that an accept program be executed by the computer. The program (named "MADAR") as developed by Aeronautical Research Laboratories Computer Center also sorts the data by Channel No and hand-shakes with the MADAR module.

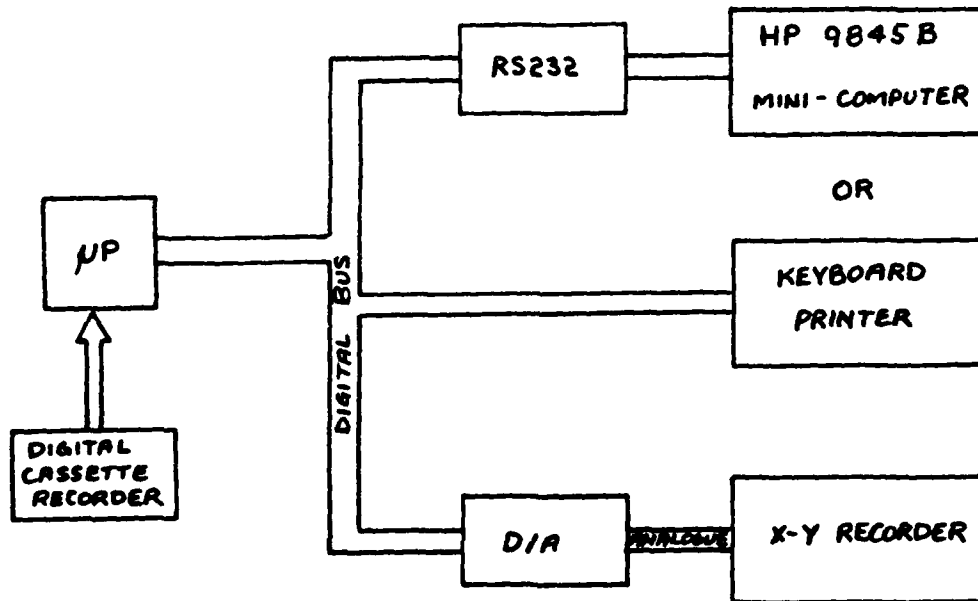


Fig 2 REPLAY SCHEMATIC

### 3 COMMUNICATION

#### 3.1 Control Via Keypad of MADAR

To gain control by keypad.

- a. Place PROG/RUN S/W into 'RUN' position.
- b. Press INITIALISE switch.  
Control is now transferred to keypad.
- c. Place PROG/RUN S/W to 'PROG' position.  
MADAR now ready for program entry via keypad.

The 16 keys are shown in Fig 3 and commands listed in Fig 4. The colon (:) key serves as a delimiter and the digit key enables codes, channel numbers (NN) and values (xxx) to be entered. The minus (-) key is intended for entry use of calibration constants in applications where MADAR is to perform real time calculations. The Display (DIS) & Alter (ALT) keys define the type of command. The Run & Stop keys allow the operator to control data gathering (with the PROG/RUN S/W in the 'RUN' position) in lieu of the hand held remote control unit.

As entries are made on the keypad, the entered digits move from right to left on the 6 digit liquid crystal display located above the keypad.

0	1	2	3
4	5	6	7
8	9	:	-
DIS	ALT	RUN	STOP

Fig 3 KEYPAD LABELLING

NN (:)	00 (ALT)	Change channel NN select Status to Skip
NN (:)	11 (ALT)	" " " Low sample Low gain
NN (:)	22 (ALT)	" " " High " High "
NN (:)	12 (ALT)	" " " Low " High "
NN (:)	21 (ALT)	" " " High " Low "
30 (:)	xx (ALT)	Change Run number to xx xx Range 00 to 99
40 (:)	xx (ALT)	Change Tape Time Remaining to xx xx Range 00 to 54
NN (:)	33 (ALT)	Selects Channel NN for Audio Alert NN any channel 01 to 16
NN (:)	44 (ALT)	Deactivates Audio Alert
60 (:)	xxx (ALT)	Set minimum trip of Audio Alert to xxx
70 (:)	xxx (ALT)	" maximum " " xxx range 000 to 999 refer graph of Audio Alert values in APPENDIX 3
NN (DIS)		Displays channel NN signal voltage NN Range 01 to 16
20 (DIS)		Displays internal Real Time Clock in seconds
30 (DIS)		Displays Run Number Range 00 to 99
40 (DIS)		Displays Tape Time Remaining in minutes. Range 5.4 to 0.0
50 (DIS)		Cycles Channel Status on internal display

Note: When using MADAR to display input channels, the range is  $\pm 4.90$  volts. For positive values the : and . remain steady. For negative values the : and . flash at a rate of approximately once per second.

Fig 4 KEYPAD CODE LISTING

### 3.2 Control Via Remote Terminal

An RS232 type computer peripheral terminal such as a VDU at 1200 Baud or a KSR 43 at 300 Baud may be connected to the input connector labelled TERMINAL. The Baud rate is selected by an internal switch next to the fan. Data transmission is in ASCII 11 bit serial. With the printer connected to I/O Port 2 on the front panel both the Input & Output connectors are used & data transmission is in ASCII 8 bit parallel.

### 3.3 Commands

On initialization (by pressing the INITIALIZE switch on the front panel or by automatic initialization on power-up) the MADAR terminal displays MADAR CONTROL (H)

H indicates HELP and by typing H the following commands are listed:

H		
T	XX: YY	Type Memory from XX to YY, 1/line
A	XX, DD, DD, —	Store Data From xx
G	XX	Execute at XX
P	XX:YY	Print Memory From XX to YY, Z/line
R		Replay from Tape into Data Buffer
D		Print Data Buffer
C		Change Status
L		List Status
Z		Plots Data 1 Channel V Time
Q		Continuous Replay
X		Program from tape

MADAR CONTROL (H)

The T,A,G, and P commands are useful for programming MADAR to perform additional functions or for fault finding.

### 3.3.1 R Replay from Tape into Data Buffer

Data buffer is RAM (Random Access Memory) starting at X 0100. (X stands for HEX).

#### EXAMPLES OF PROMPT AND ERROR MESSAGES

R  
No Cassette?                    Indicates no cassette  
MADAR Control (H)            in recorder

R  
Tape side B                    MADAR at this stage does not  
Type Run no:                   use side B, reverse cassette

R  
Tape side A                    (Range of Run No 00-99) MADAR  
Type Run No:                   initiates search of tape for data  
071                              block with Run No 71. When found  
                                 the data in the block are transferred  
                                 to the Data Buffer (starting at X 0100).

COMPLETED                    Data block found and transferred to Data  
MADAR CONTROL (H)            Buffer

R  
Tape Side A  
Type Run No:  
077

Faulty Preamble  
MADAR Control (H)      A preamble, recorded ahead of the required data block, has been incorrectly written or read and the replay clock is unable to synchronise with the recorded clock. The preamble value read may be examined in memory location HEX 22 (use T command). Value should be HEX 5555.

R  
Tape Side A  
Type Run No:  
ABBA  
COMPLETED  
MADAR Control (H)      Initiates a search for the next available data block on the tape regardless of Run No.

### 3.3.2 D Print Data Buffer

Print data currently in the Data Buffer to highest priority connected terminal.

D  
Print Data Channels      (a maximum of 10 channels may be typed)  
Type 1 to 16  
For all type Y  
  
2,4,6,8      Channels 2,4,6,8 will be sorted from Data Buffer and the HEX values printed as signed decimal voltages

+1.19 - 2.76 - 3.51 + 4.09    ) All data in buffer  
+1.10 - 2.76 - 2.99 + 4.05    )  
"                                    )  
+1.01 - 1.11 - 2.01 + 3.33    )

Y  
0071 7FFF 1110 . . . . .      All channels are printed in HEX preceded by the 8 CODE words  
A014 B117 C198 DDE1 E001

### 3.3.3 C Change Status

This enables the individual channels to be selected along with the gain of the input amplifier (either 0.5. or 1) and the sample rate (either 5 or 20) samples/second. Selection is by "L" or "H" (Low or High).

C  
Enter Channel No, (1-16)      enter required channel  
l,                                    then (,) if single digit  
L or H Sets freq cut off      (no comma required for double digit channel No.)  
0 Cancel Channel  
L or H sets gain  
H  
Enter Channel No, (1-16)      Ready for next channel

(To regain control either enter Channel No. greater than 16 or press INITIALIZE switch)

MADAR CONTROL (H)

### 3.3.4 L Lists Status of Channel Selection

L

CURRENT STATUS			
CHAN	IN	GAIN	SAMP
01	YES	HIGH	LOW
02	NO		
03	YES	HIGH	HIGH
04	YES	HIGH	HIGH
05	YES	LOW	LOW
06	YES	HIGH	HIGH
07	YES	HIGH	HIGH
08	YES	LOW	HIGH
09	NO		
10	NO		
11	NO		
12	YES	HIGH	HIGH
13	NO		
14	NO		
15	NO		
16	NO		

MADAR CONTROL (H)

### 3.3.5 Z Plots Data

This command provides an analogue output from MADAR via the ANALOGUE o/p connector on the front panel.

The output range is:

HEX 000	+5V
HEX 7FF	+0V
HEX 800	-0V
HEX FFF	-5V

During plotting on an analogue X-Y recorder, the microprocessor controls the recorder pen lift.

Z

Tape Side A

Type Run No:

071

TYPE X inc

6

TYPE CHANNEL NO

2

071 FBAA F36E

071 FBAA F601

- Selects Run No 71 data block
- Value for scaling time in the X direction
- Channel 2 to be plotted against X time
- Tape starts finds Run No 71 Reads block, [Time H Time L in HEX for each block]

TYPE CHANNEL NO

Draws graph & rewinds tape to leading 71 block when all blocks of Run No.71 are read. Asks for next channel No which is to be plotted against same time increment.

To escape from program press 'carriage return' key (CR)

? TYPE H FOR HELP  
MADAR CONTROL (H)

### 3.3.6 Q Continuous Replay

For continuous reading of data in HEX from tape

Q  
Type Run No: - Reads all Data blocks in HEX  
ABBA regardless of Run No  
TAPE SIDE A  
0055

When block transfer complete waits for operator to type any character except carriage return (a space is suggested).

(SPACE KEY)  
0065

(SPACE KEY)  
0067

- Carriage Return terminates continuous Replay.

MADAR CONTROL (H)

If instead of ABBA a Run No (say 0055) is inserted, a search of tape for 55 is initiated. When found, is transferred replaced block by block until a different Run No. (say 0057) is encountered. The program then responds with:

COMPLETED  
MADAR CONTROL (H)

### 3.3.7 X Program from Tape

Special programs written at ARL and recorded on tape, can be read by MADAR into battery powered RAM starting at location X0400. The intended purpose of special programs is to control MADAR for specific tasks not included in the main program.

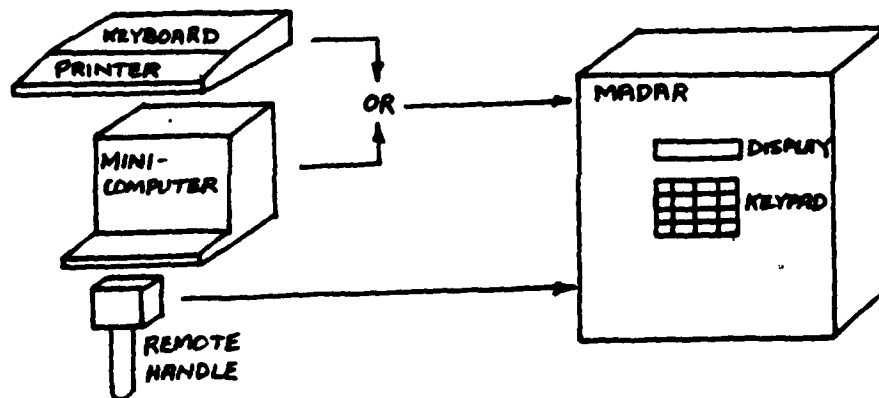


FIG 5 COMMUNICATION/CONTROL OPTIONS



#### 4 RECORDED DATA FORMAT

PREFAMBLE 5555  
 RUN No. 00 to 99  
 MARKTIME 7FFF : No Event  
 0000 to 3FFF :Event Range  
 LSB 10 millisecc.  
 Valid 14 Bits  
 CHANNEL SELECT 0 = Not Selected  
 1 = Selected  
 SAMPLE RATE 0 = 5 Samples/second  
 1 = 20 Samples/second  
 GAIN SELECT 0 = 0.5 (half gain)  
 1 = 1 (unity gain)  
 TIME HIGH Valid 12 Bits  
 TIME LOW Valid 12 Bits  
 DELIMETER 0000  
 DATA 256 16 Bit Words  
 POSTAMBLE 5555

Time to gather the above block with 1 selected channel at 5 Samples/sec is 51 sec. ie.  $256/5$

A data word contains 16 bits, the 12 low order bits represent the value of the data and the 4 remaining bits (0-F) define the Channel No.

0 Channel 1  
 F Channel 16

To determine clock time from Time H & Time L. Discard top 4 high bits of both Time words and pack as a 24 bit word. Convert to decimal and divide by 200 to give time in Seconds. Reason -LSB is 5 msec hence need 200 for 1 sec.

#### 5 EVENT TIME

By pressing EVENT switch on hand-held control handle the clock time of an event is recorded at the beginning of the data block. However, only one (the first) event / block can be recorded by this technique. The time for one block to be recorded varies between 0.7 seconds (16 selected channels at 20 samples/sec) and 51 seconds (1 selected channel at 5 samples /sec).

For more than one event mark per block the circuit shown in Fig 6 must be employed.

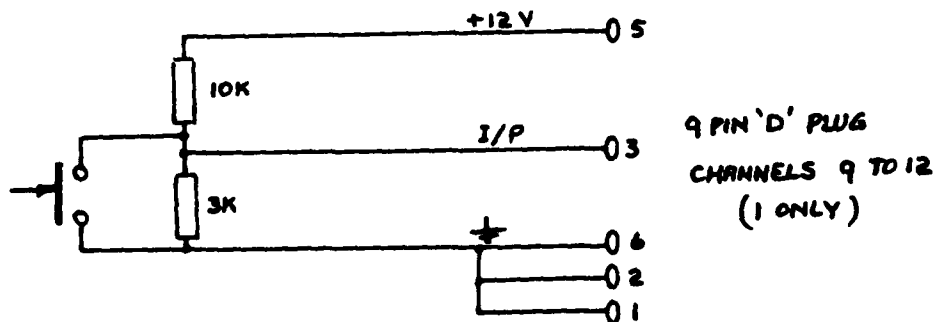


Fig 6 EXTERNAL EVENT CIRCUIT

## 6 TIMING SYNCHRONIZATION

The real time clock has a range of 0 to 23.3 hours with a resolution of 5 milliseconds. At power-on the clock may start at any value so it is important to reset the clock by depressing the front panel TIMING SYNC switch, or by joining pins 1 and 5 on the front panel TIMING SYNC 9 pin 'D' socket (Pin 5 is earth). To Sync two MADARs, requires a cable and a set of normally open contacts as shown in Fig. 7.

Note: Synchronization occurs on the re-opening of the contacts or the release of the TIMING SYNC switch.

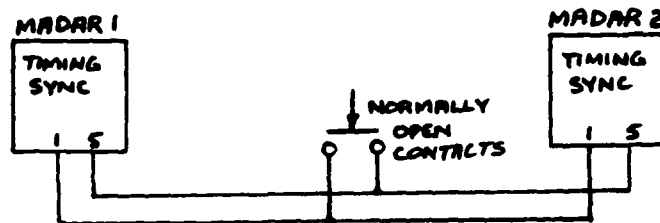


Fig 7 TIMING SYNCHRONIZATION

Note: If RAM battery S/W is 'ON' continuously, the real time clock is unaffected by Power ON/Power OFF actions. Use keypad to check time, VIZ 20 (DIS) enables real time clock to be displayed.

## 7 FRONT PANEL FACILITIES

### 7.1 Keypad

The front panel keypad provides the operator with a convenient means of field control of displays and acquisition. The 16 keys of the keypad are labelled as in Fig 3 & the commands are listed in Fig 4.

### 7.2 Internal Display

#### 7.2.1 Delimiter

A colon and a decimal point produce a visual delimiter of 3 vertical dots between the fourth & fifth digits of the internal display to separate the keypad-entered code/channel digits from digits generated on request by MADAR. In general, the code/channel digits move left and reside as the fifth and sixth digits of the display while the four right most digits refresh in response to a DISPLAY command. For an ALTER command the digits remain as entered.

#### 7.2.2 Refresh Rate

Within the main loop program there is provision for display refresh of data associated with a DISPLAY command. Typically the refresh rate is about 10 times/second but varies with the cycle time of the main loop.

When TIME is selected for display, refresh is disabled during transfer of a data block from the buffer to tape because the 2 millisecond time slot, between successive reloads of the cassette interface, is too short for a guaranteed conversion of a 23 bit binary time word to decimal. Thus TIME refresh may reduce to about twice/second and occasionally produce an apparent erratic time change in the display. Accuracy of the recorded data is unaffected and the display jump could be avoided by splitting the TIME refresh conversion into segments each of less than 2 milliseconds.

### 7.2.3 Signal Voltage

A decimal point is automatically inserted between the second & third digits when a signal voltage is displayed. The display reads directly in volts with a resolution of 0.01 volts.

For negatively applied signals the delimiter and decimal point flash.

### 7.2.4 Time

The delimiter and decimal point extinguish for a time display generated from the RTC. The display uses 5 digits and reads directly in seconds with a one second resolution.

### 7.3 CPU Halt Indicator

A red indicator fitted to the CPU INITIALISE switch lights when the microprocessor is forced to HALT. This indicates a fault condition in the MADAR system and may clear if the CPU INITIALISE switch is pressed and released.

### 7.4 CPU Initialise Switch

A red, center biased toggle switch enables the operator to electrically initialise the microprocessor and cause the resident program to restart from the instruction at address 0FFFF.

Normally, the operator should not need to use this switch other than as a convenient abort during REPLAY as the system automatically initialises at power up.

### 7.5 PROGRAM/RUN Switch

A yellow two position toggle switch which in conjunction with printer sense links at PORT 2 steers the resident program to one of the three operating modes VIZ PROGRAM, RECORD or REPLAY.

### 7.6 RAM Battery Switch

The red ON/OFF RAM BATTERY toggle switch, when in the ON position, applies internal battery power to both IK RAM cards (address 0000 to 03FF & 0400 to 07FF), the remote power-up circuit, the real time clock and the memory save circuit.

Whilst battery power is available, the memory contents of the card is retained during mains power-off periods.

### 7.7 Time Synchronise Switch

The center-biased blue toggle switch when depressed causes the RTC to reset to zero time. Counting commences when the switch is released.

Because the RTC is used by the resident control program for time delays it is important that resets be avoided while data is being recorded.

### 7.8 Time Synchronise Connector

A normally open pair of remote contact wired to this connector may be used to synchronise MADAR units to a datum event time or to each other.

### 7.9 Tape Rewind Switch

A center biased blue toggle switch to enable the operator to REWIND cassettes. Generally this function is used only during the REPLAY mode and is initiated and latched by a press & release of the switch.

Once started, the tape rewinds until automatically stopped by the opto sense of the clear leader (or hole).

### 7.10 Tape Rewind Indicator

An amber indicator mounted within the REWIND switch, lights while the tape is being rewound.

### 7.11 Tape Motion Indicator

The TAPE MOTION amber indicator lights whenever there is tape motion and is a useful check of START/STOP action of the recorder during RECORD/REPLAY operation.

### 7.12 File Protect Indicator

A red indicator which lights if the cassette inserted in the recorder is WRITE protected.

When recording data the write protect flap of the cassette must be in WRITE position but once the data is recorded the flap should be placed to the other position to minimise accidental erasure or overwrite of the recorded data.

### 7.13 Side Correct Indicator

The SIDE CORRECT green indicator lights when a cassette is correctly inserted with the A side down against the recorder door.

### 7.14 Cassette Loaded Indicator

The CASSETTE LOADED green indicator lights whenever a cassette is loaded into the recorder.

### 7.15 Supply Indicators

These indicators connect to the three regulated supplies within the MADAR module. With power applied and switched 'ON' all three indicators (+5V, +15V) must light, otherwise a fault condition exists.

### 7.16 I/O PORT 2 Connectors

This input/output port is serviced by two connectors and is addressed by the resident software for keyboard/printer operation.

### 7.17 Terminal Connector

Provides duplex RS 232-C communication for a keyboard printer, teletypewriter, VDU or support computer.

### 7.18 Analogue Output

Provides a dual channel analogue output signal during REPLAY of selected data. Intended for quick-look graphics on an analogue X-Y recorder.

### 7.19 Remote Control Connector

Accepts the wander lead from the hand held remote control unit.

### 7.20 Test Connector

Accepts the wander lead from a monitor unit which contains a meter for checking all voltage supplies within the module.

### 7.21 Power Connector

A quick release 6 pin connector for applying 115 volt power to the module. Care must be taken to ensure that power is applied to the correct pins (Section 9.1).

For 400 Hz operation the internal fan may be powered but for other frequencies down to 50 Hz the fan link must be disconnected (The link also disconnects power to the modules that provide the reference supplies to the analogue input connectors).

### 7.22 Circuit Breaker

The service approved circuit breaker is rated at 5 Amperes and is electrically 'ON' when physically pressed 'IN'.

## 8 REAR PANEL CONNECTORS

### 8.1 I/O PORT 1 Connectors

Two 37 pin connectors provide a 16 bit parallel latched input & output port. The output port is intended for use with a bank of five (extendable to a maximum of eight) external liquid crystal displays. The input port is undefined.

### 8.2 Signal Input Connectors

Sixteen 9 pin sockets provide connection for external transducers to assigned channels. For the two Navy modules wiring for channels 1 to 13 is identical but firmware requires that the peak detector, when used, be assigned to channel 11. Three synchro to analogue converters are permanently assigned to channels 14, 15 and 16 (refer to APPENDIX 2).

## 9 POWER CIRCUIT

### 9.1 General

MADAR is designed to operate from 115V at frequencies between 400 Hz and 50 Hz.

The internal cooling fan may be used with 400 Hz power ONLY.

Two power leads are provided:

1. 115V, 50 Hz operation has a 3 pin plug with 115V, round earth pin.
2. 115V, 400 Hz operation has a lead not terminated. (Brown-active, blue-neutral, green-yellow - earth). Special linking is required at the 6 pin cable-attached plug on the POWER CABLE of MADAR.

It is important not to mix the leads. Refer to circuit diagrams if in doubt. Drawing No 56291 in particular.

A circuit breaker on the front panel provides 115V isolation.

A 115V, 400 Hz power output has been provided on the rear panel of MADAR to power the AMAFTU motion platform.

### 9.2 Power Switch-ON

Two methods of power turn on.

1. MADAR TEST UNIT Plugs into front panel TEST connector With RAM BAT Switch in 'ON' position, MADAR may be powered-up by the POWER switch on the TEST UNIT. Supply indicator LED's on MADAR should light.

Red +5V  
Red +15V  
Yellow -15V

Note: TEST UNIT is needed to power MADAR when RAM battery is discharged.

2. MADAR HAND HELD CONTROL UNIT. Plugs into front panel REMOTE CONTROL connector. With RAM BAT Switch in 'ON' position, MADAR may be powered-up by the POWER switch on the top of the control unit. The toggle of this switch must be lifted before changing toggle position ;prevents accidental operation. Supply indicator LED's should light. Check that the colon (:) in the hand-held unit flashes to indicate that the main program is being executed.

### 9.3 Internal Fuses

On left side below fan. 1 Amp fuse for fan & 50 milliamp fuse for transducer power pack.

On left side, front on main power unit. 50 milliamp fuse for remote control of power circuit.

On right side, battery charger. 250 milliamp fuse for battery charger.

### 9.4 RAM Battery Supply

Two 1 K words of RAM are provided:

RAM 1	X 0000	to	X03FF	MADAR use only
RAM 2	X 0400	to	X07FF	User use

These memory cards are provided with NICAD rechargeable battery back up, so that the MADAR may be powered down and information stored in memory retained. Battery life is approx 24 hours. RAM BAT switch on the front panel of MADAR must remain 'ON'.

If MADAR is not being used in 24 hour period turn RAM BAT switch 'OFF'. Memory is lost.

A fully automatic battery charger is in-built. This charges the NICAD batteries at power-on, until charged then switches off. Yellow LED (viewed through hole on right hand side of module) indicates state of charger.

#### IMPORTANT

REMOTE HAND HELD CONTROL UNIT will not power-up MADAR if NICAD battery pack has discharged.

To power-up under these conditions the power switch of a TEST UNIT must be used.

#### 10. TRIALS USE OF MADAR

##### WARNING

Ensure Cassette removed prior to power-up and down of MADAR. False data can be written on tape, causing problems on Replay.

1. Check that all transducers and signal sources are connected to MADAR rear panel ANALOGUE INPUTS. Ref Appendix 2.
2. Ensure 115 V power is available to front panel connection.
3. Ensure that front panel circuit Breaker C/R is pushed 'IN'.
4. Ensure HAND HELD CONTROL UNIT is connected to front panel REMOTE CONTROL connector.
5. Turn PAM BAT switch to 'ON'.
6. Lift and move power switch to 'ON' at top of HAND HELD CONTROL UNIT.
7. Check front panel supply indicators.
  - +5V Red Led
  - +15V Red Led
  - 15V Yellow Led
8. Initialize by pressing INITIALIZE switch with the PROG/RUN S/W in the 'RUN' position.
9. Place PROG/RUN S/W to PROG position and key in required channels.  
If a mistake is made INITIALIZE and repeat procedure.  
(Initializing MADAR regains control for the operator).
10. Change RUN No. to required value.
11. Change Tape Time Remaining to required value.  
Should automatically set to 53 (5.3 minutes) if new tape.
12. Set Audio alert if required.
13. Check that input transducers (platform etc) are functioning by displaying channels and inducing signal.
14. Display Real Time Clock. Reset on COMMAND by either external Sync or pressing TIMING SYNC switch.

15. Place PROG/RUN switch to 'RUN' position.
16. Insert cassette with clear leader showing and SIDE A down against door.  
Depress INITIALIZE switch, close door and release switch.  
Tape runs for 6 seconds to move leader & ROT hole past head.

NOTE: While writing on tape the door locks and cassette cannot be removed until tape motion LED extinguishes.

17. Check Indicator Status:
  - a. CASS LOADED - ON
  - b. SIDE CORRECT - ON
  - c. FILE PROTECT - OFF
  - d. TAPE MOTION - OFF
18. Recording is started by large switch on handle (REC PUN switch).  
Pressing switch up for long time recording - switch stays up.  
Pressing switch down for short time recording - switch is spring loaded and turns off when pressure removed.
19. Run No. Press button switch on handle will increment the Run No. shown on handle display and recorded on tape.
20. EVENT Press button switch on handle will record event time on tape.
21. Prior to first run press RFC RUN switch 'ON' for 1 second to record dummy start file on new tape. This simplifies the replay and enables the first file to always be found.
22. When Tape Time Remaining reaches 00 remove cassette and insert new cassette, return to step 15.
23. Label removed cassette and store in safe location away from magnetic fields.

NOTE: To minimise incorrect usage of the front panel switches, particularly in the PROGRAM and RECORD modes, the operator is advised to fit the quick release front cover.

#### CAUTION

The MADAR system is not designed or constructed to MIL. specifications. It is an experimental instrumentation system with a limited useful life and requires protection from unfavourable environmental conditions. Care must be exercised in the installation and use of the MADAR system to recognise and avoid potentially hazardous situations. No specific safe operating conditions can be specified for the system but consideration needs to be given to such factors as:

Isolation of the system in the event of electrical failure or fire.

Vibration & 'g' forces stressing and fatiguing electrical connections.

Altitude changes producing pressure differentials in components.  
e.g. electrolytic capacitors.

Ambient temperature & altitude on heat dissipation.

Moisture (condensation, rain, spray or salt air) causing surface insulation leakage, electrolysis and corrosion.

Electrical interference.

APPENDIX 1

MADAR MODULE SPECIFICATION

No of Channels : Programmable 1 to 16

Sample Rate : Programmable 5 or 20 Samples/selected  
chan/sec

Low-Pass Filters : 0.8 Hz or 5 Hz (nominal) 3db cut-off.  
(Program interlocked with sample  
rate) 4th order Butterworth

Analogue Inputs : Differential

Input Impedance : 100 Kohms (minimum)

Common Mode Rejection : 60 db (typical)

Analogue Channel Gain : Programmable 1 or 0.5

Analogue Range : +5 volts (unity gain)

Analogue/Digital Conversion : 12 bits

Least Significant Bit (LSB) : 2.5 millivolts (nominal)

Digital Word Size : 16 bits (4 channel address, 12 data)

Internal Time Word : 24 bits (LSB 5 millisecc)

Range Before Recycle : 83886.08 seconds (23 h 18 m 6 sec)

Internal Display : 6 digit liquid crystal display  
(decimal point blinks for negative  
voltage)

Internal Keypad : 10 digit, sign, 1 delimiter &  
4 commands)

Memory : 2k battery powered RAM  
: 1k normal RAM (not standard fit)  
: 4k ROM

Front Panel Switches : INITIALISE  
: RAM BATTERY  
: TIMING SYNC  
: TAPE REWIND  
: PROGRAM/RUN  
: 5 Ampere circuit breaker

Front Panel Indicators : +15V, +5V  
: TAPE MOTION  
: FILE PROTECT  
: SIDE CORRECT  
: CASSETTE LOADED  
: CPU HALT

Internal Battery : 2 ampere hour nickel cadium rechargesble  
battery (4 C size cells)

Internal Charger : Charges from +15 volt internal supply



160 MA charge with auto switch-off.

Power Requirements : 115V 50 to 400 Hz 180VA max (plus  
70VA @400 Hz for internal fan)

Connectors (Rear) : 16 ANALOGUE INPUT CHANNELS (+12 volts  
reg max 300 MA pick-off)  
: I/O PORT 1 (External Displays)

(Front) : I/O PORT 2 ( external keyboard/printer)  
: ANALOGUE OUTPUT  
: TERMINAL (RS232)  
: FRONT PANEL TEST  
: REMOTE CONTROL  
: TIMING SYNC  
: INPUT POWER

Physical Size : 475 mm x 345 (370) mm x 355  
(375) mm nominal.  
[Bracketed figures refer to No 2 unit]

Weight : 33 kilograms (nominal)

#### Remote Control Unit

Internal Display : 4 digit liquid crystal display

Tape Time Remaining : 2 digit decrements in 0.1 minutes  
RUN No : 2 digit 00 to 99

RUN Switch : Push button to advance RUN No

MARK Switch : Push button to record Real Time Clock  
at instant of position

Record Switch : 3 position center off (biased OFF one  
way toggle ON other way)

Power 'ON' Switch : Lift & toggle (opto isolated from  
115V AC supply)

#### External Display SET

FIVE Liquid crystal displays intended for:

ALTITUDE	: 6 digit	)	
AIRSPEED	: 4 digit	)	DISPLAY RANGE &
TEMPERATURE	: sign &	)	FUNCTION DETERMINED
	4 digits	)	BY APPLICATION
SIDE SLIP ANGLE	: sign &	)	PROGRAM
	4 digits	)	
PITCH ANGLE	: sign &	)	
	4 digits	)	

(A maximum of 8 displays are possible)

#### Monitor Unit

Facilities : REMOTE POWER ON/OFF & TOGGLE S/W  
: SWITCHED VOLTMETER TO MONITOR SUPPLIES  
: APPLICATION PROGRAM SELECTION S/W

APPENDIX 2

CHANNEL DETAILS

INPUT CHANNEL ALLOCATION

Channel No	Madar 1	Madar 2
1	Low Pass Filter	Low Pass Filter
2	"	"
3	"	"
4	"	"
5	"	"
6	"	"
7	"	"
8	"	"
9	Direct	Direct
10	"	Direct
11	"	Direct
12	"	Direct
13	Direct	Direct
14	Synchro	Synchro
15	"	"
16	"	"

INPUT CONNECTIONS

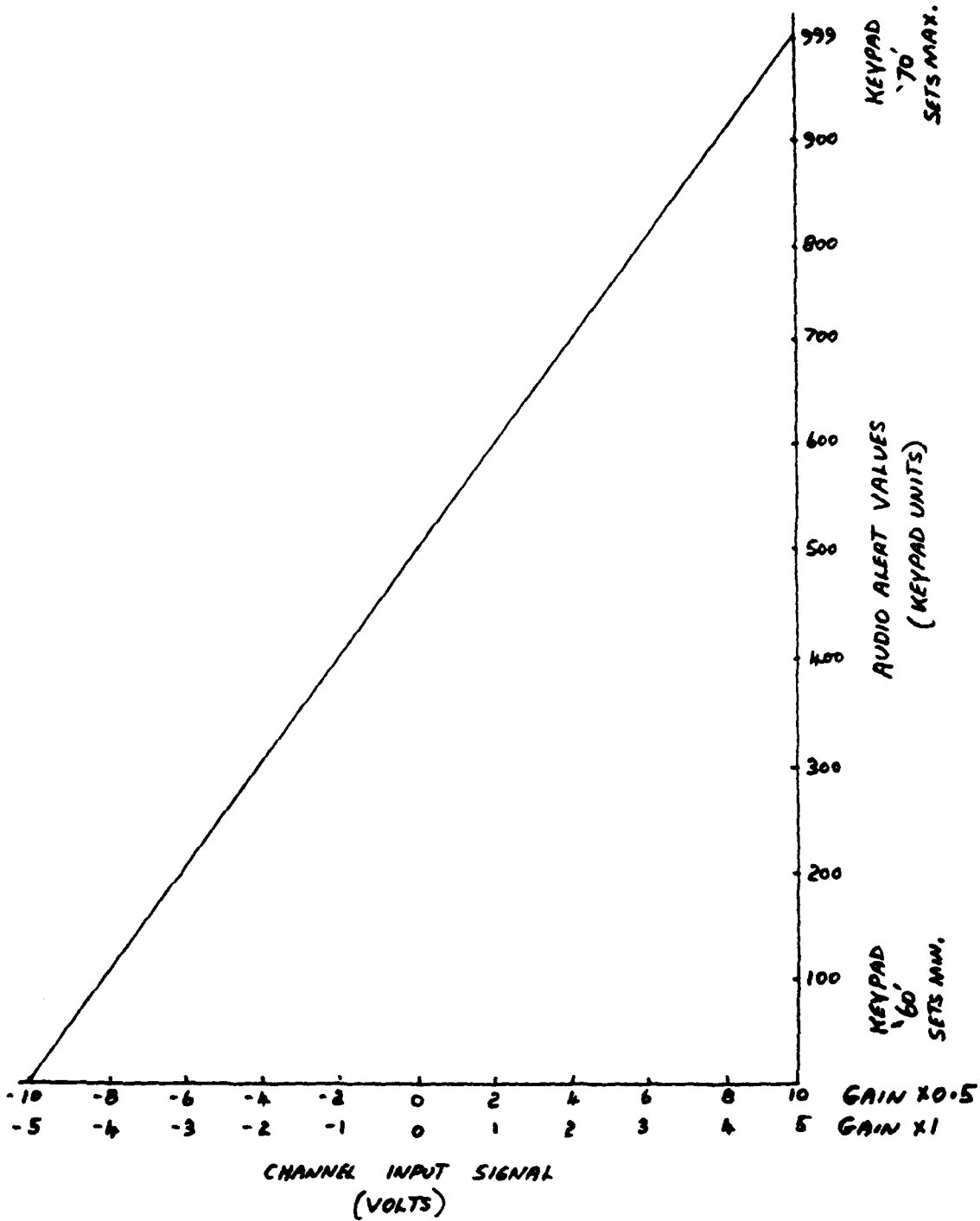
Input Connector  
9 Pin Socket

Note\* Becomes analogue ground when  
single ended filter used

Pin No	Analogue Channel 1 to 13	Synchro Channel 14 to 16
1	Inverting Input *	S1
2	Analogue Ground	S2
3	Non-Inverting Input	S3
4	Analogue Ground	Ground
5	+12V	+12V
6	Common	Common
7	-12V	-12V
8		R10
9		R11

APPENDIX 3

AUDIO ALERT GRAPH



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