8.11 How to Troubleshoot the EAI-1000 Using Diagnostic Routines

The diagnostic routines exist as a program module which can be used in a standard HCI installation. The HCI board complete with diagnostic program module is also mounted in a "diagnostic box" containing switches and indicator lamps which are extended from the HCI and replace the standard HCI LED indicators and control switches.

The diagnostic box is connected to the EAI-1000 by means of a 40 way flat strip cable. The cable plugs into the microprocessor card socket. Thus it replaces the microprocessor card and immediately seperates the two main possible areas of malfunction, viz. the microprocessor board and control board.

8.12 Use of Diagnostic Routines

This diagnostic program is most effectively used in conjunction with the preceeding descriptions of section 8.

The objective of the diagnostics is to offer a pass/fail test where possible. This is not always possible as a large portion of the functions of the microprocessor are "write" functions and there is no facility to test for successfull operation other than by operator observation either visually in tests of the display or with an oscilloscope. All such write or read diagnostics are continuous loop operations so that they can be synchronously displayed on an oscilloscope by triggering on the appropriate chip select.

The tests are arranged such that no test requires the successful operation of functions to be tested later.

Unless the operator is sure of the appropriate test, he should start from the initial test and continue through successive tests until a fault is observed.

TERMINOLOGY

The terminology relating to integrated circuits, integrated circuit pin indentification and switch nomenclator for the HCI and diagnostic box is defined on page 1 of the quick reference "EAI-1000 diagnostic" brochure.

The following 7 fault areas are covered:

8.12.1 Data Bus/Program Storage/Ram storage

8.12.2 Keyboard reading

8.12.3 Device selection for access to analog bus

8.12.4 A/D conversion

8.12.5 Display

8.12.6 Mode Control (no diagnostics - see section 8.7)

8.12.7 Overload monitoring (no diagnostics - see section 7.1)

8.13 Data Bus/Program Storage/Ram Storage Faults

If an EAI-1000 is malfunctioning because of a failure of DATA BUS peripheral/program storage or RAM storage the insertion of the diagnostic box itself may indicate the problem. The user should note that the diagnostic box will run the standard EAI-1000 program when switch [A] is set to zero. In the instance that the standard program run from the diagnostic box does not operate the machine effectively the control board ata bus may be the cause of the problem or the data bus buffers IC42 or IC38. In this case the user should start with the diagnostic box self test diagnostics, which will verify the data bus buffers IC42 and IC38. If the diagnostic routines are executed correctly, this indicates that the fault lies in the control board section of the data bus or associated chip select decoders.

The diagnostics are:

1) Test of diagnostic box data bus
[AB] = [10] or [11] or [12]

2) Diagnostic box program storage
[AB] = [13]

3) Diagnostic box ram storage
[AB] = [1E]

See diagnostic "Description of Tests" for necessary details.

In the instance that the insertion of the diagnostic box solves the problem, the original microprocessor board would seem at fault. In this case the Eproms can be pulled from the socket and tested on the diagnostic box using the appropriate ROM checksum diagnostic. In this case remember that the 2758 is a 1K byte device. Be careful to select not only the diagnostic for the correct device but also for the correct address range.

If the Eproms are giving the correct checksums then a chip replacement proceedure is recommended.

Replace chips on the microprocessor board in the following order of most probable failure and test the board after each replacement.

1. RAM chips (8111)
2. 8085 chip
3. 8212 chip
4. The three TTL chips; both 74LS138 and the 74LS04.

If the standard program is not operating successfully, try to use the control board section of the data bus. This can be done by using a "display" diagnostic such as [21] [N_1N_2] [04]. In this diagnostic the value N_1,N_2 are taken from switch pair [CD] and continuously written into the first and second seven segment display digits to the right of the decimal point.

1) CHIP SELECTS
Only the following chip selects should be enabled. (81LS95 enables are active low)
IC38/1,19
IC41/1,19
DSW 6 (active low)
NO OTHER CHIP SELECTS SHOULD MOVE OR BE ENABLING OTHER CHIPS

2) DATA BUS
If the chip selects are as above but the display is not working or is showing incorrect characters then one can assume (providing the display is not malfunctioning) that one or more tristate outputs are not in the high inpedence state when they should be, therefore, the bus drive is faulty or a data bus peripheral IC input is leaking power onto the bus. Often the failing data bus line can be detected by the difference between the data on [C] or [D] and the display and in such a case the appropriate pin on the various chip outputs driving the data bus can be snipped until the display write routine is operating correctly.

NOTE: BINARY VALUES GREATER THAN 9 WRITTEN TO THE DISPLAY CAUSE IT TO BLANK.

8.13.1 Keyboard Reading

The keyboard test [AB] = [21], [CD] = [ON], [EF] = [92] is quite self explanatory when used in conjunciton with the explanation of operation found in section 8.03. The indicator register simply registers the column which the selected row [N] contacts upon keypress e.g., when switch pair [CD] contain the ROW address "0" (that is N=O) and the key "7" is pressed the light L_0 will illuminate.

8.13.2 Device Selection for Access to Analog Bus

The following switch settings will cause the selected field and function to be written to the respective registers IC18 and IC22, 19 of the control board. The latches are independently addressed so diagnostic:

[21] [XN] [09] loads IC18 with field address "N"

[21] [N_1,N_2] [OA] loads IC22, 29 with function address. (See diagnostic definitions for values N_1,N_2).

With the field registers set and examined with an oscilloscope to ensure it holds the correct field address, the diagnostic [21] [XX] [90] can be used to examine the field valid signal (see diagnostic definition) with an invalid field address ([CD] = [OF] for example) the status register should read [49]; D3 is "ON". The switches on the diagnostic box are best changed with "RESET" on the keyboard depressed. This ensures that no spurious signals occur which may inadvertently change the registers.

If the machine continually goes into halt a failed field valid signal transistor may be giving a continuous output low. In this case the microprocessor cannot establish a maximum field number and will go into HALT mode. On the REV4 EPROM program for the standard 1000 the machine will also write [.01] on the value display of the computer display panel. All HCI installations will also write this value on the display for this fault. The HALT state of the microprocessor can be determined by examination of pins 33 and 29 of the microprocessor, both are "low" for HALT mode. On machines with RV3 program or lower the machine will execute "Reset" subroutine but then remain insensitive to all input of keyboard or serial communication channel origin commands.

8.13. 3 Analog to Digital Conversion

The Analog input to the A to D converter is supplied by two operational amplifiers which control the gain and zero of the analog conversion to digital code. The actual analog input magnitude should be about 1.175 volts for a Reference Voltage (5 Volt) Input.

The sequence of events is as follows:

As a quick test of the A/D use diagnostic [22] [XX] [XX] - see diagnostic definitions. This test ensures that the A/D converter is giving a conversion. If the test fails or the conversion value is considered incorrect the remaining diagnostics should be used.

1) Check for the presence of a "start conversion" pulse with diagnostic [21][XX][00] A/D commence conversion mono-stable (IC35) is strobed which puts out a 2.0 microsecond (approximate) pulse.

2) Confirm that the A/D busy signal goes high when conversion is commenced. Use diagnostic [22] [XX] [XX]. Refer to the diagnostic definition.

3) Confirm that the A/D busy signal goes low for conversion complete and the microprocessor initiates a read of the high byte and then a low byte (A/D converter has output of twos complement, 13 bit word). Each of the read operations can be tested using [21] [XX] [93] and [21] - [XX] [94]. the value obtained is displayed on the indicator register.

8.13.4 Display Panel

The display is a simple memory mapped output port off the data bus. It is important to note that the data bus has two buffer stages. The diagnostic definitions give sufficient information to test the display.

DIAGNOSTIC ROUTINE INDEX

The following diagnostic routines are intended for "quick reference" use in both the 'diagnostic box' (Part No. 11-045-0100) and as software support for the serial Hybrid Control Interface (HCI) Microprocessor board. Effective use of those diagnostics is made if the user reads section 8.00 of the EAI-1000 Users manual and in particular section 8.09. The diagnostic box contains an actual HCI processor board with switchpacks extended to switches as follows:

Switchpack A4 is connected to thumb wheel switchpair [AB]
Switchpack A3 is connected to thumb wheel switchpair [CD]
Switchpack A2 is connected to thumb wheel switchpair [EF]

Use of the following diagnostic routines on an HCI installation can be made with the above mentioned switch packs provided the user takes care to convert the HEX values below to binary.

TERMINOLOGY:

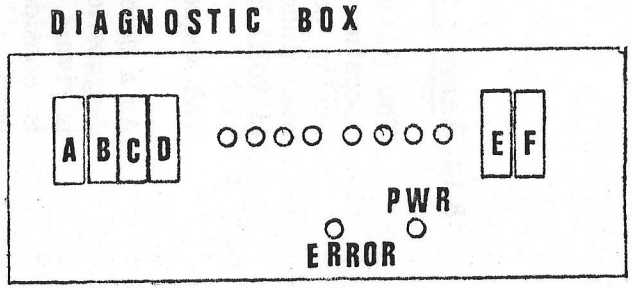
Tests of the IC33/8 means IC33 pin 8 also D6/11 means ICD6 pin 11. (X) switch value means "dont care". "N" switch value means that the definition of the diagnostic will indicate values for substitution. Tests are referenced by format [AB] [CD] [EF] = [N_1,N_2] [N_3,N_4] [N_5,N_6], and all N are HEX values.

LAMP TESTS

Tests of the Diagnostic box lamps are found in [10] [XX] [XX] for 8 bit indicator register and [21] [XX] [OF] for error lamps.

NOTE 1: Before connecting diagnostic box check logic voltage supply (+5v).
NOTE 2: It is recommended that the RESET key be pressed for input of the new parameter.

INDEX:



TEST NUMBER (HEX) [AB]	[CD]	[EF]	DESCRIPTION OF TEST	EXTRA DETAILS AND RELATED HARDWARE
1) STANDARD PROGRAM OPERATION				
[OX]	[XX]	[XX]	This allows standard EAI-1000 program operation from the diagnostic box or HCI.	The diagnostic box 'error' and 'no error' lamps should be off. "PWR" lamp should be on. For the indicator register and HCI operation see HCI manual and refer to status indicator function.
2) DIAGNOTIC BOX/HCI DATA BUS AND CONTROL SWITCH TESTS				
			The following tests can be used to check the data bus of the diagnostic board (provided control board data bus buffers IC38 and IC42 are functioning). The tests [AB]=[10],[11],[12] can be used to check the lamps, lamp drivers (ICB5) and switches of the diagnostic box or the HCI.	Refer 8.2 of EAI-1000 handbook.
[10]	[XX]	[XX]	This test reads the value on switch pair [AB] and displays this HEX value on the indicator register. Once this diagnostic has commenced, the switch value [AB] can be changed at will.	Check HCI D6/11 and B4/1 for chip select signals. If data is unable to be read from the ROM program storage even this test fails, but often the signal distortion is not sufficient to stop this diagnostic. NOTE: For diagnostic box L7 is permanently off. For the HCI board mounted on the digital tray L7 is actuated by the local/remote switch.
[11]	[N_1,N_2]	[XX]	This test puts the value of [CD] onto the indicator register.	HCI 33/1 chip select for Baud rate and echo period selection for serial interface.
[12]	[XX]	[N_1,N_2]	This puts the value of switch pair [EF] onto the indicator register.	HCI B2/1 chip select for USART mode control input for serial interface.

ROM PROGRAM SPACE CHECKSUM TESTS

[13]	[XX]	[XX]	This test initiates a checksum over the entire space of the ROMS containing the program being executed in the diagnostic box as HCI.
[14]	[XX]	[XX]	This checksum is taken over a 1K size space in the external connector on the diagnostic box. The checksum is tested against is the 0-3FF EPROM of RV2 of the standard EAI-1000 program.
[15]	[XX]	[XX]	1k byte type 2758, 400-7FF of RV2 as above.
[16]	[XX]	[XX]	1K type 2758 0-3FF of RV3.
[17]	[XX]	[XX]	1K type 2758 400-7FF of RV3.
[18]	[XX]	[XX]	2K type 2716 0-7FF of RV3.
[19]	[XX]	[XX]	2K type 2716 0-7FF of RV2A.
[1A]	[XX]	[XX]	HCI Prog 2K type 2716 0-7FF of RV2A.
[1B]	[XX]	[XX]	HCI Prog 2K type 2716 800-FFF of RV2A.
[1C]	[XX]	[XX]	HCI Prog 2K type 2716 0-7FF of RV3.
[1D]	[XX]	[XX]	HCI Prog 2K type 2716 800-FFF of RV3.

The diagnostic box has a 24 pin socket on the front panel. All checksum tests except [13] [XX] [XX] are done on the ROM inserted in this socket.

On all ROM check sum tests the "error" light goes on when the checksum is wrong and the "no error" light goes on for correct checksum.

" "

" "

" "

When there is no error the value "FF" is displayed on the indicator register, When there is an error "OF" is displayed. On HCI installations, which do not have error lamps, the above indicator register readings give the test result.

RAM TEST

[1E]	[XX]	[XX]	RAM CHECK. A pattern is written over each RAM location and then read to confirm it has been correctly retained. The pattern is complemented and the proceedure is repeated. Correct values cause [CF] to be displayed on indicator register and [FC] to be displayed if RAM test fails.

This test is usefull only as a self test for diagnostic box and hybrid control interface (HCI).

KEYBOARD TEST

[21] [o,N] [92]

This test effectively tests the operation of all keys in the keyboard.

L_6 and L_7 are never illuminated. The row is selected by the address decoding (chip select logic) and each of these rows also is OR'ed into IC32 where it is taken in a read operation. DSRO, DSR1, DSR2, DSR3 are the chip selects in question. See main control board circuit diagram.

Note, press resett key after each alteration of "N".

LAMP	L_7	L_6	L_5	L_4	L_3	L_2	L_1	L_0
N = 0	-	-	C	M	I	9	8	7
N = 1	-	-	Inc	F	S	6	5	4
N = 2	-	-	DEC	A	P	3	2	1
N = 3	-	-	FST	T	Q	CLR	SP	0

TRANSMIT - RECEIVE TESTS FOR HCI INSTALLATION

[1F] [XX] [XX]

This is a self test for the HCI transmitter. The character string [% 0 1 + 1.2345 CR] is transmitted at the appropriate baud rate.

If system digital can be put in continuous read mode then test can check communications control settings such as baud rate etc.

[20] [XX] [XX]

This takes a character off the serial interface of the HCI and displays it on the indicator register.

Care must be exercised to ensure that only one character is being transmitted to the HCI.

ANALOG BUS SWITCH CONTROL, FIELD AND FUNCTION ADDRESS LATCH TESTS

[21]	[XN]	[09]	Field address register is loaded with settings of [CD]. See section 8.40 of EAI-1000 users manual for used field address codes.	This test checks the proper operation of the field address register and allows any value on [D] to be loaded into IC18 on the control board. The value latched in the register must be checked by the operator with a C.R.O. This diagnostic can be used to check the field valued signal IC27/6 by alternately writing a correct field address and an incorrect one and each time using diagnostic [21] [XX] [90] to check field valid signal.
[21]	[N, N_2]	[0A]	Function device register for selection of analog function to drive analog bus. Address lines are marked FN4, FN3, FN1, FN0. See section 8.40 of EAI-1000 users manual for FN address codes.	See users manual. The correct setting of this latch must also be checked with an oscilloscope.

MODE, STATUS REGISTER AND MISCELLANEOUS REGISTER TESTS

[21]	[N, N_2]	[0C]	Accesses timer (8253) command register. Tests E4/14 select line on HCI only.	
[21]	[XN]	[0E]	This allows the setting of mode control latch by the HCI if the LOC/REMOTE switch is in the remote position. This diagnostic has no effect for a diagnostic box inserted on control board.	If mode control is not being effected by the setting of HCI check local remote switch by looking at control board IC9/1. LO = REMOTE CODES: N = E gives IC mode, N = D OP mode, N = B gives Rep Op mode, N = 7 gives HLD mode
[21]	[XX]	[0F]	The data on [CD] is written into the Timer control register of the HCI. This allows testing of NO error and error lamps of the diagnostic box.	Internal test of HCI and diagnostic [CD] = HCI D6. However, to check error lamps: [D] = 8, "ERROR" OFF [D] = 7, "ERROR" ON [C] = 8, "NO ERROR" OFF [C] = 7, "NO ERROR" ON
[21]	[XX]	[90]	The status register value is displayed on the indicator register.	This diagnostic is used to check the status of Field valid and conversion complete. When checking for correct field valid signal it is necessary to determine the field being addressed by the use of diagnostic [21] [XN] [09] above.
[21]	[XX]	[91]	The HCI timer status register is displayed on the indicator register.	

DISPLAY TESTS

Checks lamps, Drivers, Data Bus and Chip Selects.

[21]	[00]	[01]	This test illuminates the INTEGRATOR FN" lamp.	For tests [21][00][01] through [21][0C][01] inclusive, the data bus buffer for display board data feed (IC41) is common to the display write operation. The value of [CD] is written to the display board IC9,10,11 via decoder IC8 where it is latched with DSW3 which is transmitted via IC19 (one gate) and IC19 (one converter).
[21]	[01]	[01]	This test illuminates the "SUMMER FN" lamp.	
[21]	[02]	[01]	This test illuminates the "MULTIPLIER" lamp.	
[21]	[04]	[01]	This test illuminates the "ANALOG SWITCH" lamp.	
[21]	[05]	[01	This test illuminates the "POTENTIOMETER" lamp.	
[21]	[06]	[01]	This test illuminates the "C" lamp.	" " "
[21]	[O7]	[01]	This test illuminates the "Q POT" lamp.	
[21]	[OC]	[01]	This test illuminates the "TRUNKS" lamp.	
[21]	[XN]	[02]	Field display address, adjust [D] of SW [CD] to display field. N=1,2,3 for fields 1,2,3.	Checks DSW4 select line and IC7 on display board.
[21]	[XN]	[03]	Function number display N values 0-9	Checks DSW5 select line and IC6 on display board.
[21]	[N_1N_2]	[04]	This displays the digits [CD] on the two higher order value digits to the right of the decimal point.	Checks DSW6 and then IC4 and IC3 on display board.
[21]	[N_1N_2]	[05]	This displays the digit [N_1] on the low order digit position on the display.	Checks DSW7 and then IC2 and IC1 on display board.
[21]	[XN]	[06]	This addresses the ± 1 digit display. Different settings on [N] cause variations in the display	Setting on [D] 9 8 7 6 5 4 3 2 1 0 + display '1' +1 + -1 - 1 blanked

ANALOG/DIGITAL CONVERSION TESTS

[21]	[XX]	[00]	The start conversion pulse is operated. The test is repeated and no attempt is made to see if the A/D converter is responding with an A/D busy signal.	This diagnostic provides the driving signal IC25/1 to IC30/5 via IC26/8, IC26/9. Monostable output should be from IC 30/6 and is a positive pulse of about 2.5 microseconds duration.
[21]	[XX]	[93]	This reads the high order A/D converter value and displays it on the indicator register.	It is important to note that if the A/D converter has completed one conversion a value is stored in its O/P registers which should be constant until another conversion is initiated. Both low byte and high byte can be obtained without attachment of analog board to control board with plus or minus reference attached to buffer (IC39/12) with loose wire. The digital values can then be assessed. Remember negative analog input voltages are converted to twos complement binary.
[21]	[XX]	[94]	This reads the low order ADC vlaue and displays it on the indicator register.	
[22]	[XX]	[XX]	This is a two level test. 1) It confirms that the A/D converter gives a busy signal immediately after being strobed by conversion commence signal. 2) It tests that the A/D converter is giving a conversion complete signal. The A/D converter is immediately started on another conversion allowing synchronous viewing of buffer latches (IC36) and chip selects (IC31).	When error light goes on the A/D busy signal did not go high immediately following the start conversion strobe. When the A/D is not completing a conversion [01] remains on a CRO displayed on the indicator register. When the test is successful, neither No Error or Error are illuminnated and [08] Hexaddecimal is displayed on the indicator register and LSB light will be seen to flicker.