

1N9300921

BARC/1992/E/026

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GOVERNMENT OF INDIA  
ATOMIC ENERGY COMMISSION

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**BIBLIOGRAPHY DESCRIPTION SHEET FOR TECHNICAL REPORT**  
(as per IS : 9400 - 1980)

01	Security classification :	Unclassified
02	Distributtton	External
03	Report status :	New
04	Series :	BARC External
05	Report type :	Technical Report
06	Report No. :	BARC/1992/E/026
07	Part No. or Volume No. :	
08	Contract No. :	
10	Title and subtitle :	PC based Manual and Safety Logic Card test setup for 235 MWe PHWRs
11	Collation :	11 p., 4 figs., 1 annexure
13	Project No. :	
20	Personal author (s) :	G.M. Chandgadkar; A.K. Kohli; R.G. Agarwal; Rajesh Chandra
21	Affiliation of author (s) :	Refuelling Technology Division, Bhabha Atomic Research Centre, Bombay
22	Corporate author(s) :	Bhabha Atomic Research Centre, Bombay - 400 085
23	Originating unit :	Refuelling Technology Division, BARC Bombay
24	Sponsor(s) Name :	Department of Atomic Energy
	Type :	Government
30	Date of submission :	August 1992
31	Publication/Issue date	September 1992

contd... (ii)

(ii)

40 Publisher/Distributor : Head, Library and Information Division,  
Bhabha Atomic Research Centre, Bombay

42 Form of distribution : Hard Copy

50 Language of text : English

51 Language of summary : English

52 No. of references :

53 Given data on :

60 Abstract : Fuel handling controls for 235 MWe PHWR make use of Manual and Logic cards (MLCs) for providing safety interlocks. These cards consist of various type of logic blocks. By connecting these logic blocks all the safety interlocks required for fuel handling controls have been provided. Previously trouble shooting of these cards was done by means of logic probe. Since the method was manual, it was laborious and time consuming. PC based test setup has overcome this drawback and detects the fault at the component level within few seconds. It also gives printout of status of faulty MLC cards. Here motherboard has been designed having slots for insertion of MLC cards. The input/output connection of these cards are coming to two 50 pin FRC connectors. PC communicates through 144 line digital input/output card with MLC card under test. Software is user friendly and outputs suitable input patterns to the card under test and checks for output pattern. It compares this output pattern with compare pattern and detects the fault and displays the symptoms. This system is currently in use at test facility for fuelling machine for 235 MWe at Refuelling Technology Division, Hall-7. This test setup has been proposed for use at NAPP and future reactors.

70 Keywords/Descriptors : PHWR TYPE REACTORS; SAFETY; INTERLOCKS;  
CONTROL SYSTEMS; REACTOR FUELLING; MICROCOMPUTERS; REACTOR  
CHARGING MACHINES; COMPUTER CODES; TESTING

71 Class No. : INIS Subject Category : E3400; E2400

99 Supplementary elements :

## PC BASED MANUAL AND SAFETY LOGIC CARD

### TEST SETUP FOR 235 MWe PHWRs

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Refuelling Technology Division

**1.0 Introduction:** Manual & logic control (MLC) cards are used in fuelling machine control system of Narora reactor and also in test facility of fuelling machine at Refuelling Technology Division of BARC.

The control system of Inclined Fuel Translift Mechanism (IFTM) for Prototype Fast Breeder Reactor (PFBR) will be also having manual & safety logic which will be implemented by using similar types of cards. This test set up therefore can be easily modified to suit testing of these cards.

Manual & safety logic for entire Fuel handling controls are implemented using a set of thirteen standard printed circuit cards named as MLC-1 to MLC-13. MLC-1 to MLC-4 type cards are used for implementing logic for F/M and F/T components. MLC-1 is most extensively used in F/M logic. Out of 39 cards used for F/M, 18 cards are of MLC-1 type. MLC-1 type cards consists of filtering circuits for manual command and 2 input multiplexers for selecting auto or manual command. It also consists of logic circuitary to implement manual and safety logic. MLC-2 and MLC-3 are used where delay/pulse circuits are required. MLC-4 contains only logic gates.

MLC-6 is used for magazine position feedbacks. MLC-7 has 24 input filter circuits and five cards of this type are used for initial filtering of input signals. MLC-8 & MLC-9 are used for F/T system. MLC-12 & MLC-13 contains open collector drivers for using with solenoid driver card.

The cards of the same type can be freely interchanged within manual & safety logic except MLC-2 & MLC-3 card which have different delay times on their delay circuits.

The circuits on these cards are organised as set of circuit blocks of different types. These blocks are numbered as a set of circuit blocks of different types. These blocks are numbered on each type of card. The block numbers, card location, IC numbers and card pin numbers are shown on the elementary drawings (Refer Fig 4).

There are thirteen types of cards used in fuelling machine control system. Presently the testing of these cards is done manually by giving appropriate logic level at the input of the various gates using probe. Then the output is checked for the correct functioning of the gate.

This method of card testing is time consuming and laborious. In order to overcome this problem, Refuelling technology Division has developed a PC based system. Using this technique any card can be tested in very short time. The details of this technique is explained in following paragraphs.

**2.0 Overall Scheme :** To overcome the drawbacks of manual checking, IBM-PC based system has been developed for testing MLC Cards. Here software has been developed in "C" language and is menu driven. In this scheme a single board will be used having different slots for each MLC Card. Wiring for connecting each card to the PC is done on the same board. The test software asks card number and date of testing, checks the corresponding output pattern from the card and compares it with the corresponding compare pattern stored in PC. If there is any fault in the card then the software detects which o/p pins of card are faulty. It also displays the symptoms of each faulty pin, so the card can be easily repaired by checking for those symptoms. The facility of storing the test status of faulty card has also been provided and printout of the same can be taken at any time for record.

**3.0 Hardware Configuration:-** Fig 1 shows block diagram of PC based MLC card test setup. It consists of test rig for inserting the card under test. Each type of card has unique slot in the motherboard of the test rig. The test rig is connected to PC via 144 lines TTL I/O card (IBM Compatible).

The suitable wiring for each card is done around each slot on the motherboard. The wiring is done in such a way to group all inputs and outputs separately.

The 144 line I/O card is having 6no's of 8255 IC's (programmable peripheral device). Which can be programmed as I/P or O/P in group of 8. Each IC has 24 I/O lines.

The card is programmed to O/P, output pattern to card and I/P, input pattern coming from card under test.

**4.0 Software Configuration:-** Software for MLC card test setup is divided into 3 main modules.

- 1) Data preparation module
- 2) Card testing module
- 3) Printout module

Fig 2 shows the tree of software structure.

**4.1 Data Preparation Module:-** Data preparation module creates various data bases and provides facility of adding, editing new/old data of each MLC card.

The module is divided into following submodules.

- 1) Wiring diagram database module.
- 2) Output/Compare data pattern database module
- 3) Faulty pin database module.
- 4) Status database module
- 5) Message table database module
- 6) Database of IC used in each card.

**4.1.1 Wiring Diagram Database Module:-** This module creates database for storing wiring diagram details of each card. This wiring diagram explains how each card is communicating with PC. The module provides facility of adding/editing wiring diagram data of each card. Wiring diagrams of each MLC card are given in annexure A.

**4.1.2 Output/Compare Data Pattern Database:-** This module creates database for output & compares data patterns for each card. This database is very important as the card testing software module is using this data for testing the MLC card.

The output pattern data is used for outputting data to all the inputs of MLC card under test. For each card various combinations of output pattern are outputted so as to test the card thoroughly. Output pattern data is different for each card.

Compare data pattern is the data which is expected from MLC card O/Ps if the card is O.K. The compare data patterns are also different for different cards.

This module provides facility of adding/editing the above data for each card.

**4.1.3 Faulty Pin Database Module:-** This module creates database for storing faulty pin details of each card. This has got facility of adding/editing faulty pin details of each card.

**4.1.4 Faulty Pin Status Database Module:-** This module creates database for storing status of faulty card. Various combinations of status are stored for detecting the symptoms of faulty card. The status data is different for each card.

This module has feature of adding/editing status data for each card.

**4.1.5 Message Table Database Module:-**This module creates database for storing message tables for each card. Message tables are nothing but list of possible symptoms occurring in the faulty card.

Message table database is used by card testing software module for displaying possible symptoms in the faulty card depending on status received from each card.

This module has facility of adding/editing message tables of each card.

**4.1.6 Database Of IC Used In Each Card:-**This module creates database for storing details of ICs used in each card ie IC name, Vcc & ground Pins. It has also got feature of adding/editing this data.

**4.2 Card Testing Module:-**Basic purpose of this module is to test the cards and display/print the symptoms if the card is faulty. It is further divided into following submodules.

- 1) User initialisation module.
- 2) Data searching/storing module.
- 3) Data input/output module.
- 4) Bit processing module.
- 5) Faulty pin search module.
- 6) Faulty pin status search module.
- 7) Faulty pin symptoms display/print module.

**4.2.1 User Initialisation Module:-**This module asks user to input information like card number, card count and data of testing of card under test.

**4.2.2 Data Searches/Storing Module:-**This module searches input compare data pattern database file and stores the data retrieved from file in computer memory.

**4.2.3 Data Input/Output Module:-**This module outputs all the combinations of data pattern retrieved by search/store module to all the inputs of card under test and takes corresponding input patterns from cards and stores it into the memory.

**4.2.4 Bit Manipulation Module:-**This module compares each input pattern coming from the card under test and compares with the corresponding compare pattern. If the patterns are not matching then it will return no of bits and its position. These data will be used by faulty pin search module to display faulty pins.

**4.2.5 Faulty Pin Status Search Module:-**Since the card is tested by outputting various output patterns to the card under test, this module will form status by seeing for which combination of output patterns error is occurring. The status formed in this way is checked in status database for error identification. Then it will give information like message line no and no of lines to be displayed.

**4.2.6 Faulty Pin Symptoms Display/Print Module:-**This module makes use of information given by status search module and will display/print the possible symptoms of faulty pins by retrieving message from message table database.

Using this symptom table fault can be easily located in very short time.

**4.3 Printout Module:-**Printout module is software for taking printout of wiring diagram, compare output pattern and message tables. This module is further divided into following submodules.

- 1) Wiring diagram printout module
- 2) Output/compare pattern printout module.
- 3) Message table printout module.

All the three types of printout are taken by giving card number. This is very useful for documentation.

The basic flowchart for card testing software is given in fig 3.

#### **5.0 Conclusion:-**

This setup is under use in fuelling machine test facility at hall 7. for testing and debugging of manual and logic cards.

The commissioning of the system for NAPP fuelling machine control has been planned. This system is useful for all the future 235 MWe, 500MWe reactors and also for PFBR fuel handling system where these types of logic cards will be used.

#### **6.0 Acknowledgement:-**

Authors are thankful to Instrumentation Group ECIL, Shri Dhruva Narayana (SO/SP), Fuelling Machine Group 235 MWe NPC, Shri Umesh Chandra, Head, Computer Control Section RCnD for the co-operation rendered by them for this task. We are also thankful to Shri V.V. Kshirsagar (SA/B), Shri A.N. Das (T'man/G), Shri S.V. Kulkarni (T'man/B) for successful execution of this test setup.



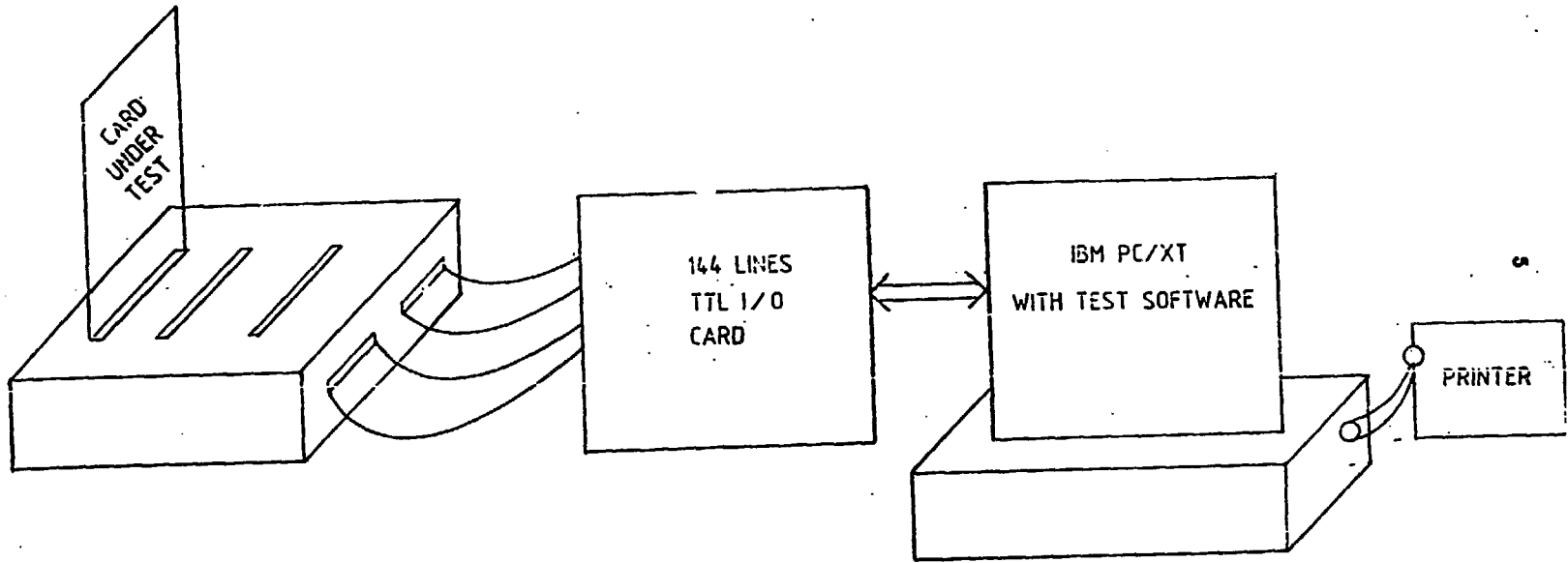


FIG. 1. BASIC BLOCK DIAGRAM OF PC BASED MLC  
CARD TEST SETUP

SOFTWARE CONFIGURATION OF PC BASED MLC CARD TEST SET-UP

DATA PREPARATION MODULE

- WIRING DIAGRAM DATABASE
- OUTPUT/COMPARE PATTERN DATABASE
- FAULTY PIN DATABASE
- FAULTY PIN STATUS DATABASE
- MESSAGE TABLE DATABASE
- DATABASE OF IC USED

CARD TESTING MODULE

- USER INITIALISATION MODULE
- OUTPUT COMPARE PATTERN READ MODULE
- DATA INPUT/OUTPUT MODULE
- BIT MANIPULATION MODULE
- FAULTY PIN SEARCH MODULE
- FAULTY PIN STATUS SEARCH MODULE
- FAULTY PIN SYMPTOMS DISPLAY/PRINT MODULE

PRINTOUT MODULE

- WIRING DIAGRAM PRINTOUT
- COMPARE/OUTPUT PATTERN PRINTOUT
- MESSAGE TABLE PRINTOUT

FIG. 2 SOFTWARE CONFIGURATION FOR PC BASED MLC CARD TEST SETUP.

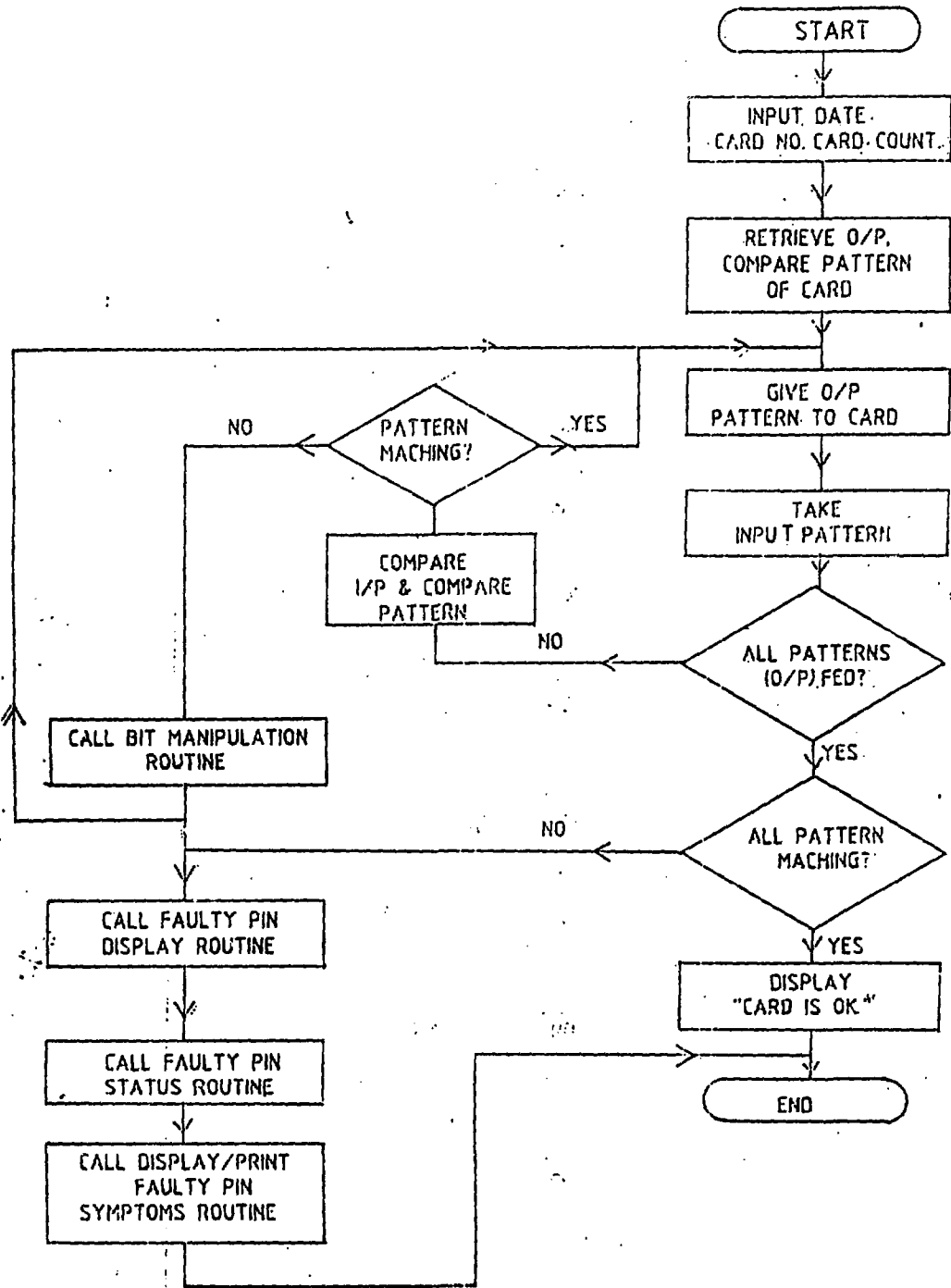


FIG. 3: BASIC FLOWCHART OF PC BASED MLC CARD TEST SETUP

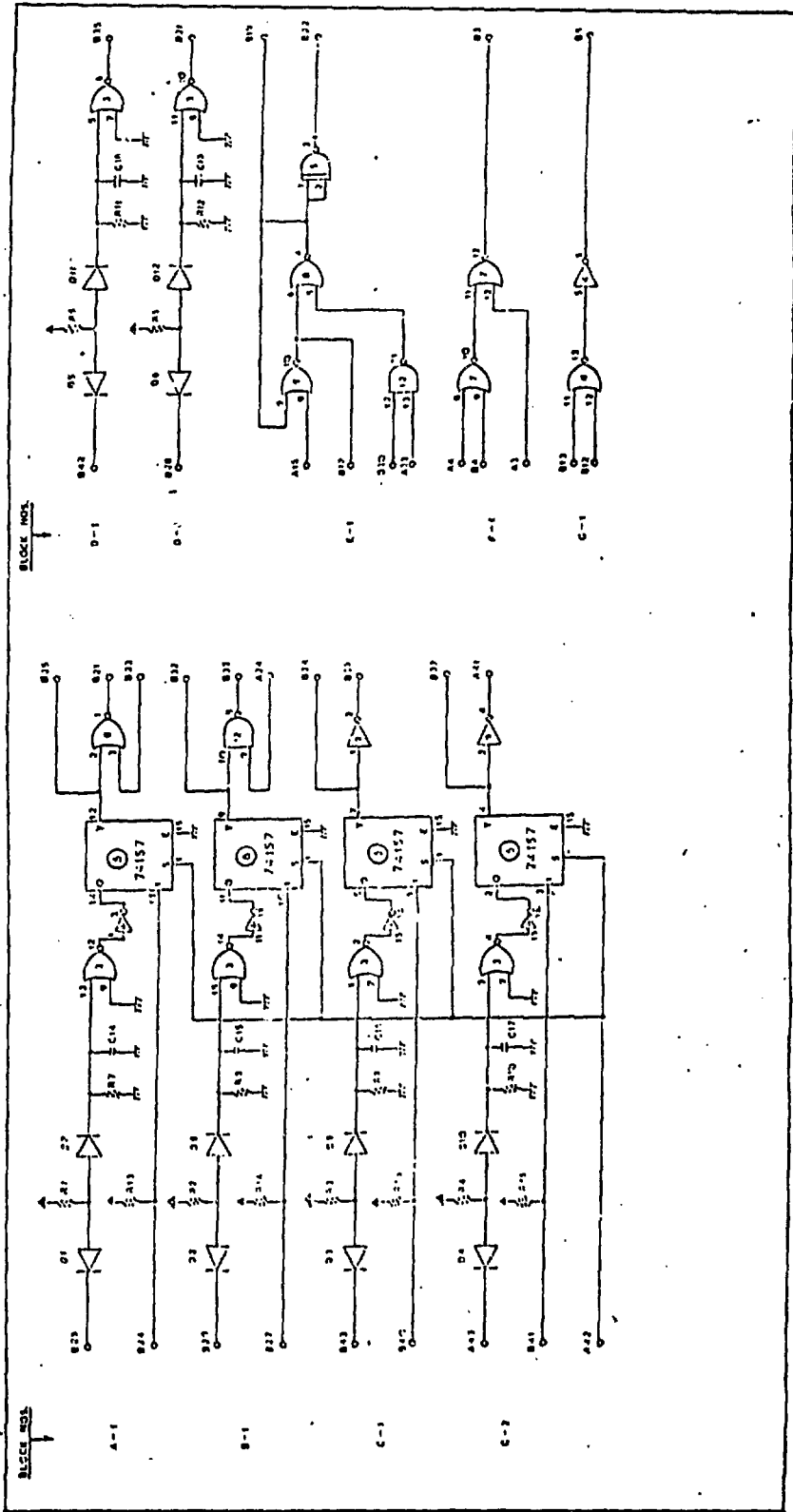


FIG. 4 ELEMENTARY DRAWING OF MLC-1

ANNEXURE

TEST STATUS OF FAULTY MLC 1

Date: 18/03/92

CARD COUNT: 1

PASS No	INPUT PATTERN							
	A1	A2	B2	C2	B3	C3	A4	
0	4	0	0	f3	0	4	0	
1	28	4a	40	f7	55	a4	2f	
2	54	b5	bf	bb	0	5d	d0	
3	7c	ff	3f	51	aa	fd	ff	

PASS No	COMP. PATTERN							
	B1	C1	A3	B4				
0	f8	c2	aa	ff				
1	67	ce	55	f				
2	87	3a	aa	cc				
3	7	39	55	0				

PASS No	OUTPUT PATTERN							
	B1	C1	A3	B4				
0	f8	c2	aa	ff				
1	67	ce	56	f				
2	87	3a	aa	cc				
3	7	39	55	0				

CONTROL WORD DATA IS:8bH, 80H, 90H, 8bH.

TEST STATUS OF FAULTY MLC 1

Date: 18/03/92

CARD COUNT: 1

PASS No	No.Of Faulty Pins	FAULTY_PINS
0	0	NO ERRORS
1	2	B25,B21,
2	0	NO ERRORS
3	0	NO ERRORS

IC USED IN MLC 1

I.C.NO.	I.C.TYPE	PIN NO.	
		VCC	GND
1,2,5	75452	8	4
3	8837	16	8
4,9	7404	14	7
6	74157	16	8
7,8,11	7402	14	7
10	7410	14	7
12	7400	14	7

TEST STATUS OF FAULTY MLC 1

Date: 18/03/92

CARD COUNT: 1

TOTAL FAULTY PINS: 2

FINAL FAULTY PIN TABLE OF MLC 1

FAULTY-PINS	SYMPTOMS
B25	i) o/p pin 5 of IC 5 is grounded
B21	i) o/p pin 3 of IC 2 is grounded

