PC Based Co-Ordinate Location of a RCMT Board

Project Report

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CERTIFICATE

This is to certify that the Project Report entitled

"PC BASED CO-ORDINATE LOCATION OF A RCMT BOARD"

has been submitted by

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in partial fulfilment for the award of the degree of
Bachelor of Engineering in Electrical and Electronics Engineering Branch
of the Bharathiar University
During the academic year 1996-97

9/4/97

Guide

Professor and Head

Date : 9/4/97

Certified that the Candidate with University Register No. __________ was examined by us in Project Work Viva-Voce Examination held on __________

Internal Examiner

External Examiner

आईटीआई लिमिटेड
पालक्काड प्लान्ट
कंजिकोड वेस्ट, पालक्काड - ६७८ ६२३, केरला
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CERTIFICATE

THIS IS TO CERTIFY THAT THE FOLLOWING STUDENTS OF KUMARAGU COLLEGE OF TECHNOLOGY,BHARATHIYAR UNIVERSITY, COIMBATORE HA COMPLETED THEIR PROJECT WORK IN **ITI LTD, PALAKKAD** AS PART OF THEIR CURRICULAM.

1. R.ARUMUGAM
2. K.SANJITH KUMAR
3. W.JOSEPH ANAND
4. P.L.SATHISH KUMAR
5. A.SHANMUGASUNDARAM

THEY HAVE DEVELOPED AN EFFICIENT SOFTWARE TO SUPPORT ACTIVITES OF MANUFACTURING DEFECT ANALYSER WORK STATION FOR BOARDS. ALSO THE SAME SOFTWARE HAS BEEN EXTENDED TO A STEP MOTOR CONTROL FACILITY TO LOCATE THE SURFACE MOUN COMPONENTS(SMD) AND CONVENTIONAL COMPONENTS,THEREBY RESULTING AN EFFICIENT TOOL FOR DEBUGGING OF OCB BOARDS.

THEY HAVE DEVELOPED A PC BASED STEPPER MOTOR CONTROL BOARD THE FIRST LEVEL INSERTION OF ALL TYPES OF CONVENTIONAL COMPONE IN OCB BOARDS.

THIS PROJECT HAS RESULTED IN DEVELOPING A VERY EFFICI SOFTWARE TOOL FOR THE SCORPION STATION AND ALSO A FAULT F SEMI-AUTOMATIC COMPONENT PLACEMENT FOR ONE TYPE OF BOARD,NAM "RCMT" USED IN OCB EXCHANGE.

12/03/97

P.SATHEESH KUMAR
DEPUTY MANAGER(QC)

PLACE : PALAKKAD
DATE : 12-03-'97

GOD IS LOVE

"WHAT LIGHT IS TO THE EYES,
WHAT AIR IS TO THE LUNGS,
WHAT LOVE IS TO THE HEART,
PARENTS IS TO THE SOUL OF HUMAN."

THIS WORK IS **DEDICATED**

TO OUR

RESPECTFUL & LOVABLE PARENTS,

FOR WHOM WE MEAN MORE...

ACKNOWLEDGEMENT

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We would be failing in our duty if we forget to mention **Mr. P.SATHEESH KUMAR,** Deputy Manager, Quality controls, ITI Palakkad, for his constant encouragement, valuable guidance and sustained motivation during the various phases of the project work..

We are indebted to the following officials for providing us immense help.

1)Mrs.V. SARASWATHI DEVI - DEPUTY PERSONAL MANAGER

2)Mr. KRISHNA PRAKASH - ADMINISTATION DEPARTMENT

Last but not the least, we like to thank all the **STAFF** of our department for providing us immense help to finish the project and to the drafting of the report.

SYNOPSIS

"It is an established fact that without a well thought-out and long term program of action, various worthwhile projects do not add up to any remarkable achievement over time"

Our project titled, "PC BASED CO-ORDINATE LOCATION OF A RCMT BOARD" is definitely the one that is well thought-out to sought-out the problems in a Printed Circuit Board. It alleviates the burden of human and also the time consuming process of component location and its first line insertion assembly of an RCMT board which plays a vital role in OCB(Control & Operation Board) exchange and add up to many achievements in the future.

The aim of this project is to develop a PC based, Coordinate locating system for an RCMT board, which can be used in multi layer PCB's used in telephone switching exchange systems. A hardware interface to the Personal Computer is designed. This provides an effective path for the control signals from the Personal Computer and the selection of an address through a address decoder.

An efficient software package in QBASIC 4.5 is developed. These programs along with the support of the stepper motor will be able to locate the co-ordinates in the RCMT board. Thus this is used in the debugging and the First Line Insertion of the board in the OCB exchange. This method has considerably decreased the time slot required for the entire testing sequence into few minutes and thereby conserves the precious of time and also reduces the fatigue of the worker and makes his work easy.

CONTENTS

Chapter 1
INTRODUCTION

With the technology moving at such a rapid stride, apart from new devices in electronics (high speed CPU, high speed MSI devices) even the packaging of the devices is undergoing massive changes. With the quest for making powerful devices being the driving force, the IC designers are forced to pack more functions in to their design. This leads to an increase in packing density as well as Input / Output pin counts, making the conventional leaded packaging more difficult to manufacture.

In conventional packages the components, both discrete as well as Integrated Circuits are leaded or equipped with the leads for insertion on to the PCB. These are soldered on the opposite of the component side.

But the surface mount components have leads which can be soldered on to the footprint of the PCB directly.

Some of the features of the SMT board designs are

* With the package size much smaller, the board size is smaller compared to a through-hole component board design.
* The package height is small so the board height is less and takes less space.
* Due to reduced lead length, the lead inductance and capacitance are less. This leads to better high frequency characteristics.

* Since the number of holes are reduced, the board becomes stronger and more reliable.
* SMT based designs enable components to be mounted on board sides, thus reducing the size of the board.
* SMT components allow automatically components to be mounted, placed and soldered, thus enabling large volume of production very easily.

This does not mean that "ALL THAT GLITTERS ARE GOLD." There are some disadvantages, not from technology but for reasons other than that.

Some of them are,

* SMT based designs calls for high precision and so manual artwork for PCB is very difficult.
* Due to same reasons, use of high precision automatic placement and soldering becomes a must. In fact, hand placement assembly of SMT board consumes more time and is prone to defects.
* The capital investment is very high and it may not be the technology for small scale operation and low volume products. But with the trend of virtual factories catching up where the company which designs a product, out-sources the product from contract manufacturing companies who have the whole assembly line and processes in place, this may become significant.

SMT devices can be differentiated among themselves on two aspects for their construction. One is the **shape** and the other is the type of **pin connection** that is provided for connectivity.

SHAPE :

Normally there are three shapes. They are rectangular shape with the pins provided on both sides of the package - on the longer side the pin count usually goes up to 28 pins. In second and third the shape of device is respectively square and rectangular with pins provided on all the sides.

PINS :

There are two most prevalent ones, one is J lead formation and the other is Gull wing formation. The third which is not prevalent is one with the Butt ends.

When we design a board three important designs should be taken to account.

Design For Manufacturability,
Design For Testability,
Design For Reliablity.

When these boards are assembled using the conventional components and SMT components it is easily prone to defects. This is also because of the 12 layer multi PCB layer available in the industry. There may be many faults like soldering faults, contact faults, short circuit faults and open faults. These defects should be analyzed and should be found out. Otherwise this may lead to rejection of the whole board. So for this purpose the nodes are injected by current and voltage and their signals are compared and the corresponding faults are found out. So a Manufacturing Defect Analyzer is used to find out a manufacturing defects, with the help of Personal Computer and the software language. The software and hardware, called as SCORPION MACHINE are used to find out manufacturing defects in Indian Telephone Industry.

The ITI industry manufacturers OCB exchanges and the Palakkad plant manufactures control racks for controlling the operation. This OCB exchange consists of many systems and one is the switching station (MCX) for connecting the incoming calls and the outgoing calls. Here comes the Function of RCMT board which is responsible for providing 64 matrix links with the subscriber at both the ends. The RCMT board has two sides, one is connected with the conventional components on one side and the SMT components on the other side. Any defects could be analyzed by a SCORPION MACHINE. But the problem is that it can give out the nail number only through which the injection logic is injected. Now the present trend of ITI is that they have an atlas containing the data base of all the boards with the the pin numbers. So far with the corresponding pin number, they find out the X and Y co-ordinates and the components. Moreover in the first line insertion stage of conventional components they refer a database, locate the components and place it. This take considerable time and leads to the fatigue of workers.

We have created a software package using QBASIC in order to support our hardware interface. This software package has datafiles corresponding for the data available for the RCMT board. For the debugging process, as hardware we have developed an Input / Output port which provides an effective path for control signals of the Personal Computer and selection of address through address decoder and then finally getting the output data. Depending upon the data from the computer, the Demultiplexer unit or the Stepper motor unit is selected. We have also a control data by which the X and Y direction of the Stepper motor is selected. The Demultiplexer unit is connected to the LEDs which are connected to the top of the boxes for indication of selection of chips from those boxes. These Integrated Chips of the same nature are put in a box. Now when we use a first line insertion, the LED at the top of the box containing the chip to be selected glows and then the the X and Y direction brings the point to the point at which the component is to be placed. The same process is done for debugging of the boards which have the defects in the conventional and SMT components.

1.1 SOFTWARE TREND

In the fast evolving trends of modernization and reduction in time - consumption, the so called artificial brain "COMPUTER" has underlined its valuable presence. So the replacement of the time consuming and error prone manual first line insertion assembly of the PCB (RCMT4), and for debugging the fault using SCORPION MACHINE, we have designed our computer sequences in the following way.

1) Creating data files containing

NAIL .DAT :

It has nail number, nodes, components, X and Y co-ordinates as data.

SMT.DAT & MAN.DAT :

It has component name , Tolerance, Code, Value, X and Y co-ordinates as data.

2) Co-ordinating this data in a main program thereby performing the debugging operation and the first line insertion assembly.

1.2 SPECIAL FEATURES:

1.2.1) <u>COST EFFECTIVE</u> :

It utilizes the same Personal Computer of the SCORPION MACHINE and it adds enhancement of the program. It costs only in thousands but when in need to change this and purchase an alternate form from FRANCE CIT it may cost lakhs of Rupees.

1.2.2) USER FRIENDLY:

The software is written in QBASIC which is the easiest language to study in a short time. More over it is easy to understand.

1.2.3) SPEEDY OPERATION:

First insertion assembly and debugging will take only 10 to 15 minutes where as manually referring the atlas, takes hours.

1.2.4) REDUCES FATIGUE:

It reduces the fatigue of the worker. This is because while doing the whole process manually it involves tedious concentration which exhausts the worker easily. But, now it can be reduced to simple take and place First line Insertion Assembly.

Chapter 2

EQUIPMENT FACILITIES

2.1 SCORPION MACHINE:

Scorpion machine is designed to find faults on assembled PCB's. MDA refers to Manufacturer Defects Analyzer, its block diagram is shown in fig.(2.1). Scorpion tests indicate components in the board, the aim being to isolate and identify the manufacturing process faults such as solder defects, insertion faults and placement errors. In addition to this, the value of the individual components can be verified.

2.2 SCORPION HARDWARE:

Scorpion machine basically consists of two parts.

1)Stimulus unit

2)Measurement unit (Self Calibrating)

2.2.1 STIMULUS UNIT:

This unit uses two types of techniques

1) Current injection technique

2) Voltage injection technique

There are values of current and voltage for the typical cases and for worst cases of the components also.

2.2.2 ENVIRONMENTAL DATA:

Mains input : 115/230 V from the tolerance +6% to -10%

Frequency	: 47-63Hertz.
Power consumption	: 400 VA excluding PC
Temperature	: +10 Centigrade to 40 centigrade.
Safety Standard	: IP 20
Safety Shielding	: Class 1
Table Dimensions	: 1740 long, 700 deep, 750 high mm

2.2.3 OVER VIEW:

Standard Scorpion tester consists of certain configuration.

1) Controller
2) Test unit
3) Table

2.2.4 CONTROLLER:

It consists of PC of a certain configuration

PC	: IBM/AT
MEMORY	: ≥ 2MB
DISK CAPACITY	: ≥ 5MB
FLOPPY DRIVE	: 1.2 MB
MONITOR	: VGA
DATA INPUT	: KEYBOARD,OPERATION KEYPAD, MOUSE, BARCODE READER

PRINTER : INTERFACE PARALLEL

CLOCK : REAL TIME

OPERATING SYSTEM :DOS >=3.3

2.2.5 TEST UNIT:

Actual test unit is housed in a 19" rack. Connections out of the fixture interface is via 64 -way VG. Euraconnectors. The test unit receives DC power (only) from the PSU located in the 19" rack. It is made up of number of sub units described below.

2.2.6 TEST POINT SWITCHING MATRIX:

ARCHITECTURE	: 4 POLE to every test point. 64 test points per board -maximum 32 boards.
MAXIMUM VOLTAGE	: 100 v
MAXIMUM CURRENT	: 0.5 A

2.2.7 TEST POINT POWER SUPPLY:

MAINS :115/230 Volts. Supply DC

+ 5 V DC / 10 A

$\pm$ 15 V DC / 3 A

+ 24 V DC / 2 A

+ 100 V DC / 20 mA

These are the tests points and they are to be contacted with the nails from the nail bed. For this purpose the bed of nails should be raised and lowered. A vacuum pressure of 40 cube-metered per hour is essential for this purpose. For releasing it, compressed air of same pressure could be used.

There are various fuses in the unit in order to protect the system from overcurrent. The company which manufactures this product calibrates for a period of two years. There are two types of self test in the system. These tests are used to detect the system performance. The tests involved are,

2.2.8 <u>SYS TEST</u>:

This test checks the memory, environment and the internal architecture of the Scorpion machine. This checks the over all performance of the system.

2.2.9 <u>SSM TEST</u>:

This tests all the test points which are present in the machine.

Basically the system maintains a matrix of zeros for every test point. If there is any element present in the row of the matrix, then that rows corresponding test point is faulty.

2.2.10 MEASUREMENT TECHNIQUES:

Basically measurement techniques are of two types viz.,

1) Two pole measurement technique
2) Four pole measurement technique

The difference between the two pole and four pole technique is that in case of four pole measurement the parasitic stray resistance effects are taken in to account.

2.2.11 GUARD AMPLIFIER:

This amplifier is responsible for maintaining same potential in both sides for a component to be measured.

By these techniques measurement of various components could be performed. Some of the components involved are,

2.2.12 RESISTANCE:

By injecting the current through the component and measuring the voltage across it, and it can be given by

$$R=V/I$$

V - Voltage drop.

I - Current injected and this value is tested against standard value given in the database.

2.2.13 CAPACITANCE:

Similarly Capacitance could be found out by

$$C = (\Delta t / \Delta V) I$$

2.2.14 INDUCTANCE:

The value of inductance can be given by

$$L = V T / I$$

2.2.15 RESISTANCE WITH PARALLEL CAPACITANCE:

$$V = IR(1 - e^{-t/RC})$$

2.2.16 RESISTANCE WITH PARALLED INDUCTANCE :

$$V = IR(1 - e^{-t/RC})$$

2.2.17 CAPACITANCE WITH PARALLEL INDUCTANCE:

This could be found out by using the above formulae.

2.3 SCORPION SOFTWARE:

SCORPION SOFTWARE could be worked under DOS environment any thing greater than or equal to 3 (Refer fig.(2.2). SCORPION banner page is the page under which we are going to work. Next is the program selection screen which used the tools from the SCORPION test unit. Program edit screen helps in editing are changing any existing format. Component screen gives the details about the components and test select screen gives the mode of test to be selected.

The type and scope of test required for a portable board type have to be set down in a test program. A SCORPION test program consists of a sequence of test steps which are operated by a operation key pad having Stop, Start and Print buttons.

2.3 <u>OPERATOR KEY BOARD:</u>

1)START	-	To enter SCORPION from DOS
2)STOP	-	Select test program from front
PRINT	-	Select from back
3)START	-	Load highlighted test program
4)START	-	Run
5)START	-	Continue the test program
6)STOP	-	Print Results
7)STOP	-	Stop test
8)STOP	-	Exit

From DOS environment the SCORPION SOFTWARE could be invoked by, SCORPION - CC:\ SCORPION \SCORPION.CFG

Now each test step has a graphical layout which forms the basis of manual test programming. At run time a measurement result is evaluated for each test step. For passive component one test step is usually sufficient, whereas for semiconductor component requires two or more.

Easy to programming, set up screens are on hand to enable the rapid generation of all commonly used components as well as the functions, for automatic generating contact and short circuit tests. In addition non-standard component tests are provided for general purpose voltage and current measurements. Equally easy to use and set up are the range of program control screens. These flexible and powerful features are designed to help and manage the logical flow of test program and include such capabilities as passing control codes to and fro external equipment, operated interactive routines, as well as the ability to hand over the program control inside the Operating System and receive and process the results from an external routine.

SCORPION SOFTWARE is highly user friendly and is virtually entirely graphically oriented being largely mouse driven.

2.4 STEPPER MOTOR:

Stepper motor is a system which indicates the point as a X Co-ordinate or Y Co-ordinate. The stepper motor is often considered as a digital device which converts electrical pulses into proportionate mechanical movements. Each revolution of the stepper motor's shaft is made up of series of discrete individual steps. Size of the step depends up on the design of the motor and can be as small as 1.5 mm and as large as 30 mm. The stepper motor shaft rotation is incremental. The basic feature of the stepper motor is that upon being energized it will move and come to rest after some number of steps in strict accordance with the digital input commands provided. The stepping motor therefore allows the control of the load's velocity, distance and direction. The motor usually provides for clockwise or anti clockwise rotation. Repeatability is very good. The only system error introduced by the stepper motor is single step error which is small percentage of one step and it is generally less than 5 percentage. Most significantly, this error is non cumulative regardless of the distance traveled or the number of times repositioning takes place. Stepper is a reliable device with bearings subject to wear.

2.4.1 CONSTRUCTIONAL FEATURES :

Construction is quite simple. It consists of a slotted stator equipped with two or more individual coils, and a rotor structure that carries no winding. The classification of stepper motor are,

1) Permanent magnet type
2) Reluctance type

Presence of permanent magnet furnishes the motor with the equivalent of DC excitation. Thus when one or more of stator coils are energized, the machine behaves as a synchronous motor.

Basic construction details of the Permanent Magnet stepper motor is illustrated in fig.(2.3) for a four pole stator and five pole rotor structure. Observe that the action of the permanent magnet on the particular orientation of the rotor structure is to magnetize each of the poles or slots at one end of the rotor with N-pole polarity and each of the poles at the other end with S-pole polarity. More over N-pole set of rotor poles is arranged to be displaced from the S-pole set of rotor poles by one half of the pole pitch and is readily evident by comparison of fig.(2.3a) & fig.(2.3b). The symmetry that exists between the stator poles and each set of rotor poles makes it apparent that each rotor pole set behaves in an identical fashion. For example, if coil A - A' is assumed to be energized to yield a north polarity at A and South pole polarity at A', then the relation between N of the Stator and S1, S2 and S5 of rotor in fig.(2.3b) corresponds exactly to that of S of the stator and N1, N2 and n% of rotor in fig.(2.3b). A similar arrangement can be made for remaining set of poles.

2.4.2 PRINCIPLE AND OPERATION:

Three types of Stepper motors are

1) Variable reluctance type
2) Permanent magnet type
3) Hybrid type

A stepper motor is based on the principle like magnetic poles repel and unlike poles attract. If the stator winding in fig.(2.4a) is energized so that stator A is in the north pole, stator B is the south pole and the permanent magnet rotor is positioned as shown in fig.(2.4b). A torque will be developed to position the rotor 180 degrees from its indicated position.

However, it would be impossible to determine the direction of rotation and in fact the rotor may not move at all if the forces are perfectly balanced as indicated in fig.(2.4b) additional stator poles C and D are added and energized. We are able to predict the direction of rotation of the rotor. As indicated in fig.(2.4b)the rotor's direction of rotation would be counter clockwise with the rotor aligning itself between the average south pole and average north pole as shown in fig.(2.4c).

The permanent magnet stepper motor operates by means of the interaction between the rotor magnet biasing flux and the magnetic Forces generating by the stator windings. The motor is made to rotate faster or slower by sending more or fewer pulses per second. Pulses can usually be sent up to a maximum rate of around 2,000 per second. The direction of the rotation of the Stepper motor can be conveniently reversed by merely reversing the sequence.

2.4.3 SPEED TORQUE CHARACTERSISTICS:

Although torque is not a major criteria of the Stepper motor involved in our project, we study it. The Stepper motor either runs at specified speed or does not run at all. In Speed Torque characteristics as speed is increased the torque falls to a very low value. Stepper motors could be run at open loop mode. Although it is energy inefficient and it is costly it is used because it is excellent position device.A typical speed, Torque characteristics is shown in fig(2.5).

2.5 OCB EXCHANGE:

2.5.1 GENERAL DESCRIPTION:

ALCATEL 1000 E10 is the digital switching system developed by ALCATEL CIT. Multi-applications, ALCATEL 1000 E10 serves the entire range of central offices, from smallest local exchanges to largest transit gateway switches. It adapts to every type of habitat. ALCATEL 1000 E10 provides all modern communication services,

Basic Telephony

ISDN Services

Centrex

Digital Cellular

Radio Telephony and

All Intelligent Network Applications.

The ALCATEL E10 system is located at the heart of the telecommunication networks concerned. It is made up of three independent functional units.

- SUBSCRIBER ACCESS SUB SYSTEM, which carries out connection analogue and digital subscriber lines.
- CONNECTION AND CONTROL, which carries out connection and processing of calls.
- OPERATION AND MAINTENANCE, which is responsible for all functions needed by the network operating authority.

Each functional unit is equipped with the Software's which are appropriate for handling the functions for which it is responsible.

Fig.(2.6) shows the functional architecture of OCB 283 exchange. The brief explanation of the block diagram is,

MR : Call Handler - Establishing and breaking of communications.

TR : Subscriber and analyses data base manager, analyses, routine circuit groups , circuit and subscriber database.

TX : Call charging and traffic measurement - Charging for communications, Observations of circuits and subscriber, charging time table and charge accounts.

MQ : Message distributor - Distribution of messages to the PCM controller and auxiliary equipment manager, configuration of the connection subsystem.

GX : Matrix system handler - processing of number 7 rotocol, management of statuses of no. 7 circuits, switching of subscriber digital access unit messages.

PC : CCS7 Controller - Management of number 7 Network, defense of CCS7 protocol handler Software machines, traffic observations.

OC : OM message router - switching of messages relating to the operation and maintenance of maintenance software.

URM : PCM CONTROLLER - Management of channel associated circuits and of PCMs of distant CSN and CSE.

ETA : Auxiliary Equipment Manager - Management of statuses of auxiliaries.

COM : Matrix switch controller - establishing, supervising and breaking of connections.

SM : Control station - System functions configuration of control stations.

CSN : Subscriber Digital Access unit - Management of statuses of subscriber, management of subscriber digital access unit machine.

CSE : Electronic satellite concentrator - management of statuses of subscriber, management of electronic satellite concentrator machine.

OM : Operation and maintenance software - Operation and maintenance functions. Archival storage

ESTABLISHMENT OF LOCAL CONNECTIONS BY AN EXCHANGE:

A Subscriber, equipped with the pulse telephone set connected to local subscriber digital access unit going to a free ordinary B subscriber.

1) New call and transmitter on hook

2) Data request of calling subscriber

3) Sending dial tone from ETA

4) First digit reception

5) Stop sending of dial tone from ETA

6) Digit analysis and reception of following digits

7) Test and ringing of call subscriber

8) Sending of ring tone by common memory to see whether available or busy tone is sent to calling party

9) Either a available ring tone or busy tone is send to calling party from ETA

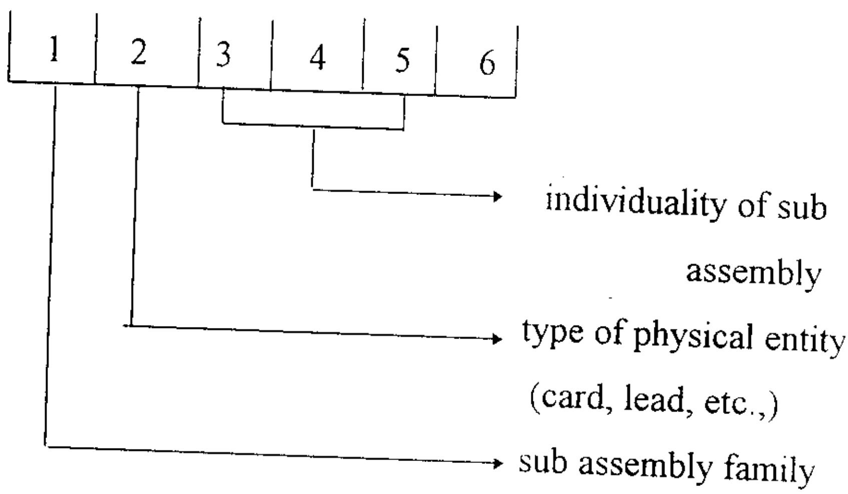
10) When the called party off - hook the phone stop the ring tone and send a message to ETA to cut

11) Physical connection is made available now by semi permanent connection

12) Now the charging and billing in transmitter takes place. Set a counter to increment

The second form of OCB exchange showing that some of the common sub systems i.e., having somewhat common are grouped together to be more compact.

These main assembly have sub assemblers which have racks of board which perform different types of functions, namely,



1st letter

A - Command Station.

I - Anything other than Subscriber Digital access Unit

R - Connection Network and time-base

T - Subscriber Digital access unit

2nd letter

A - Back plane adaptation device

B - Sub-rack

C - Electronic Card

E - Power supply

F - Back plane

L - Leads

P - Extender

R - Rack

S - Plug

As our RCMT4 comes under the category connection network MCX is discussed in depth.

2.5.2 HOST SWITCHING MATRIX:

MCX is controlled by COM function. MCX is a square connection matrix with a single time stage, T, duplicated in full, which enables up to 2048 matrix links (LRs) to be connected.

A matrix link (LR) is an internal PCM, with 16 bits per channel (32 channels).

MCX can execute the following:

1) An unidirectional connection between any incoming channel and any outgoing channel. These can be as many as simultaneous connections as there are outgoing channels. It should be remembered that a connection consists of allocating the information contained within an incoming channel to an outgoing channel.

2) Connection between any incoming channel and

any M outgoing channels (Video conferencing).

3) Connection of N incoming channels belonging to one frame structure of any multiplex on to N outgoing channels which belong to the same frame structure, abiding to the integrity and sequencing of the frame received. This function is referred to as "Connection with N X 64 bits per second".

2.5.3 SWITCHING MATRIX SYSTEM:

Role of Chaine Centrale De ConnecXion (CCX):

The switching matrix system establishes interconnections of time domain channels for local subscriber digital access units (CSNLS) and trunk control (SMT) and auxiliary equipment control stations.

Three major functions of CCX are,

1)Host switching matrix

- 16 bit switching
- Matrix of 2048 X 2048 links
- One RCMT board equal to 64 matrix storage

2) Branch selection

- selection
- Amplification
- Time distribution

3) Matrix links

- Four mega bits per second rate

2.5.4 SWITCHING MATRIX SYSTEM (CCX):

Operation of switching matrix system:

1) Connections are established in both the branches

2) Selection of active branches for a time slot is carried by comparing the outgoing time slots of each branch.

3) Three control bits permits the following function in each branch.

(a) Carrying time slot parity

(b) Setting by matrix, Selection of active link

(c) Monitoring connections on request

(d) Monitoring quality of Xmission on request

4) Five external bits are used for external utilisation.

2.5.5 HOST SWITCHING MATRIX (MCK) :

The host switching matrix is made up of two branches, A and B, and from the hardware point of view, it is made up of Matrix Control Stations (SMXs). A branch of host switching matrix contains 1 to 8

matrix control stations. ISMX station has a 2k switch. Each matrix control station receives a time signals tripled data items (8 MHz and frame synchronization) coming from the time base and following majority choice, distributes information to the exchange and to matrix link interfaces (ILRs).

Each matrix control station handles 250 incoming matrix links and 256 outgoing matrix links, within its network liason interfaces. An output from incoming side ICRs, the LCXE links of homologous numbers and multiplied on the same positions of all the matrix control stations. Each time domain matrix is capable of handling the switching of any time slot of the 2048 incoming matrix links, to any time slot of its 256 outgoing matrix links.

2.4.6 MATRIX CONTROL STATION (SMX):

Each SMX includes,

(a) A main Multiplex Coupler (CMP) which permits two-way communication on the Main Control Station Access Multiplex (MAS) and performs the "processor" function for the Matrix Switch Controller Software Machine (MLCOM).

(b) A coupler to the time-domain matrix.

(c) Matrix Link Interfaces (ILRs) for a maximum of 256 incoming matrix links and 256 outgoing matrix links.

(d) A time-domain matrix of maximum capacity of 2048 incoming matrix links and 256 outgoing matrix links.

2.5.7 COMMAND INTERFACE PART:

The role of this is to ,

- Receive via MAS coming from command stations
- Write or Read connection matrices

- Process monitoring functions
- Transmit responses to command stations
- Interfacing with general time base

2.5.8 MATRIX LINK (LR) INTERFACE PART (RCID):

This interfaces matrix links to and for from SAB.

2.5.9 CONNECTION MATRIX PART (RCMT board):

This is the part which we are going to deal about. The function of RCMT Board is to switch any incoming channel onto any outgoing channel.

Operations is based on use of two types of dual access memory:

2.5.10 BUFFER TYPE:

This memory allows storage of samples relating to two frames, with storage taking place at the strobe of the time base and even frame altering with odd frame in two buffers.

2.5.11 READ OUT IS FROM CONTROL MEMORY (RCMP):

Matrix has a maximum capacity of 2048 incoming matrix links on 256 outgoing matrix links, making up to 1024 LRE X256 LRS modules.

Thus RCMT board has 64 X 64 matrix link storage. Here RCMT are arranged in 32 columns and 4 rows, as shown in fig.(2.8) to obtain time domain matrix of matrix control station. Average time taken to go through one frame is 125 microseconds.

2.5.12 RCMT MATRIX BOARD:

Matrix board consists of 4, 64*64 matrices . It is on two board, on inter-aid. Access to these boards takes place at 4 Mbit/sec. Internal operating rate is 16Mhz. Inter-aid takes place on the front of the boards.

The host switching matrix handles 16 bit time slots:

- 8 Speech bits.
- 5 Free bits.
- 3 bits for protection of connections.

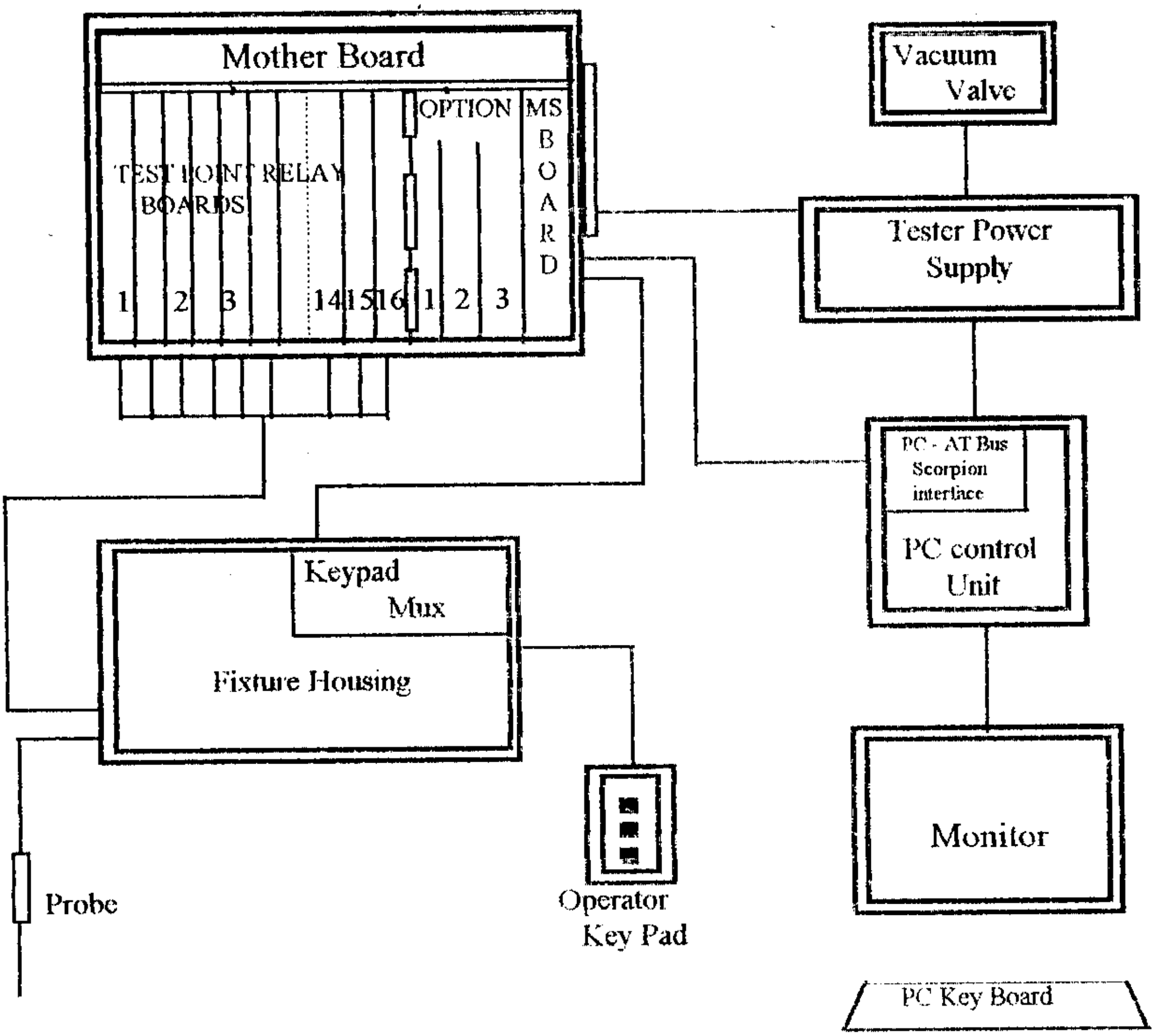


Fig.(2.1) SCORPION SYSTEM BLOCK DIAGRAM

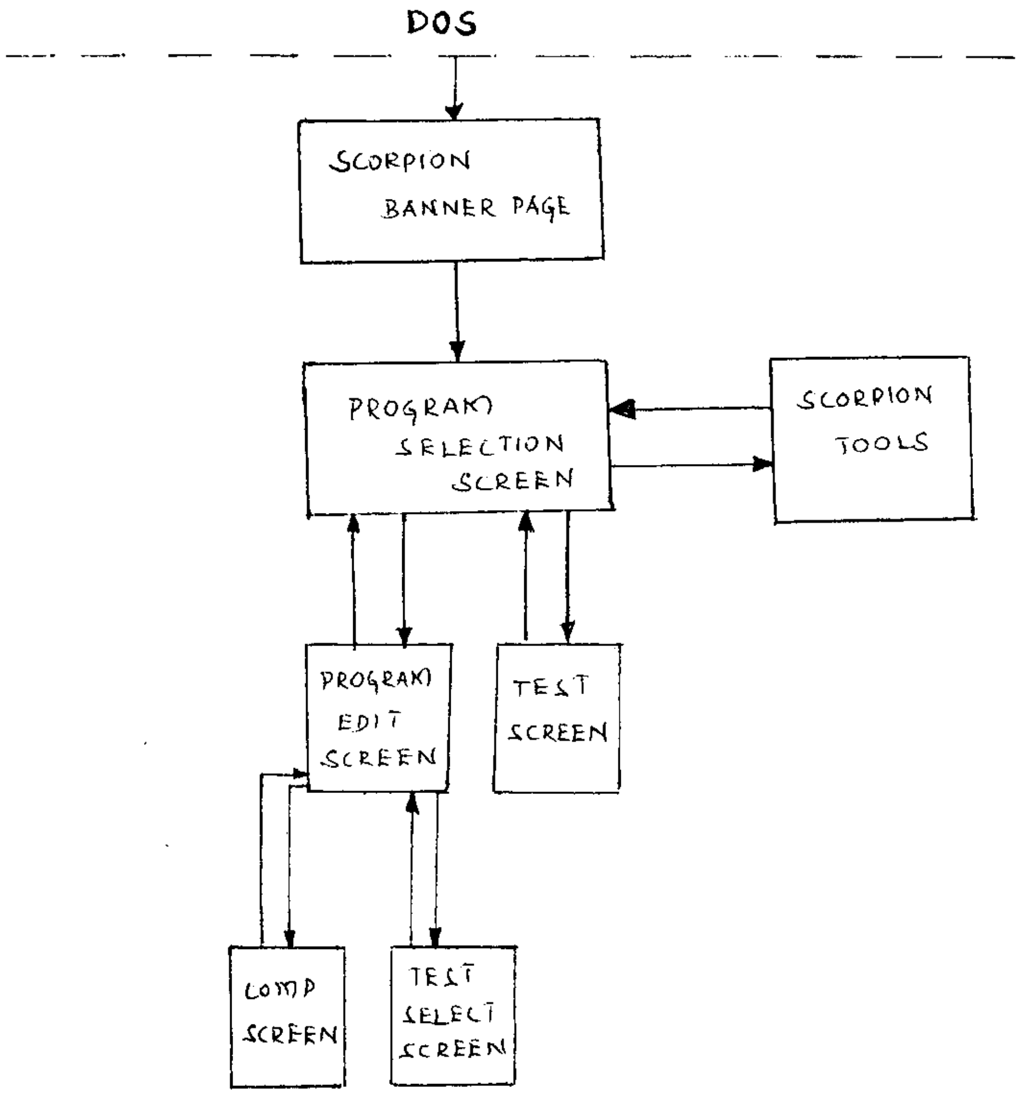


FIG. (2-2) SCORPION SOFTWARE

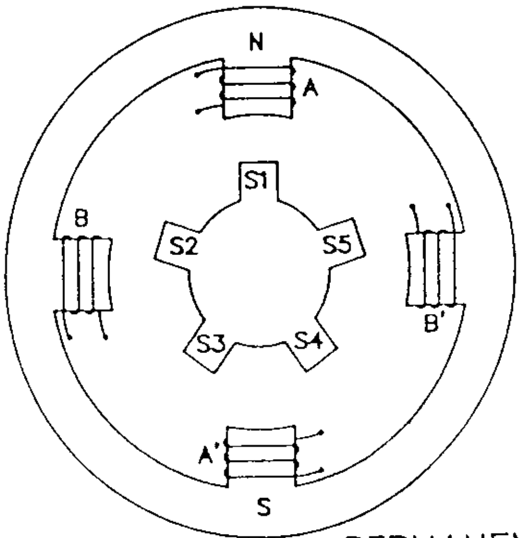


FIG.(2.3)

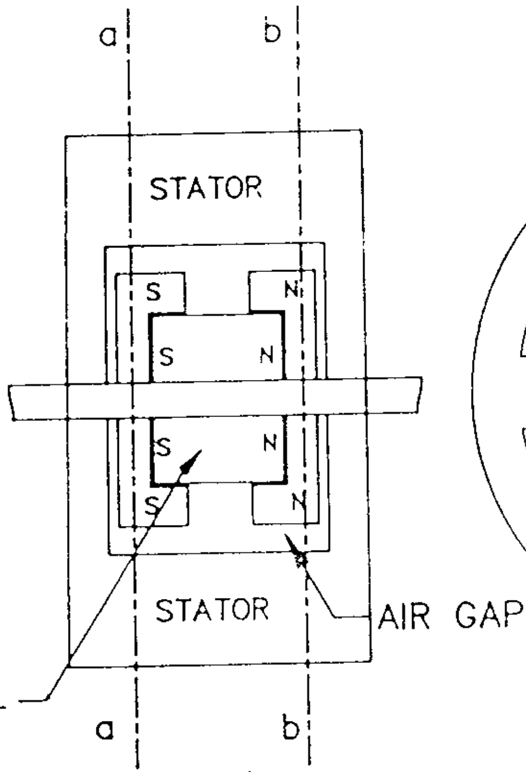


FIG (2.3a)

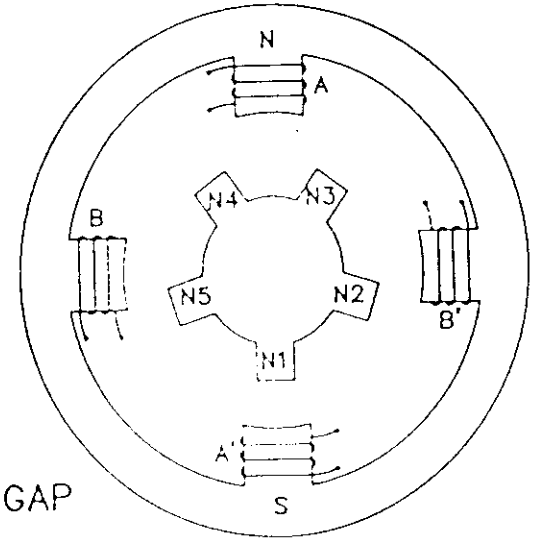
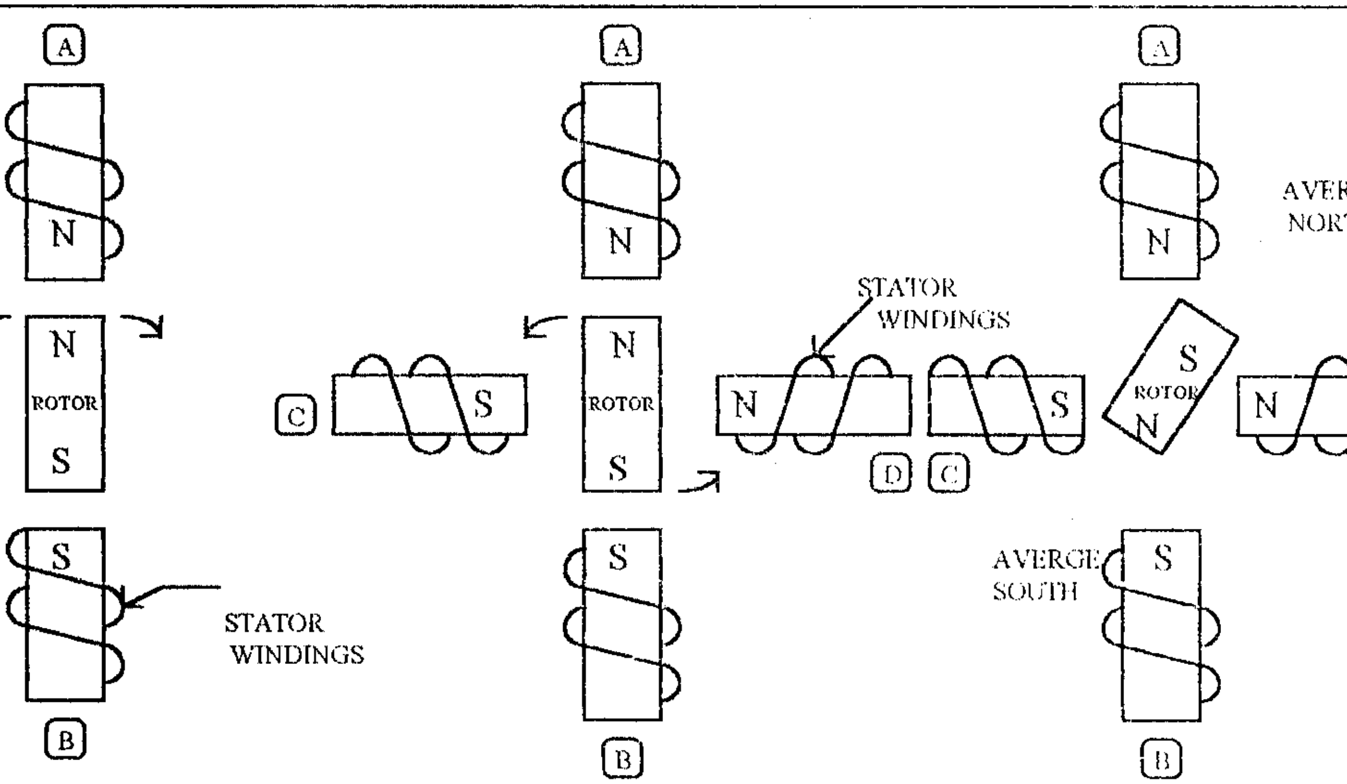


FIG (2.3b)

CONSTRUCTIONAL FEATURES OF A STEPPER MOTOR



FIG(2.4a) FIG(2.4b) FIG(2.4c)

BASIC STEPPER MOTOR ROTATION

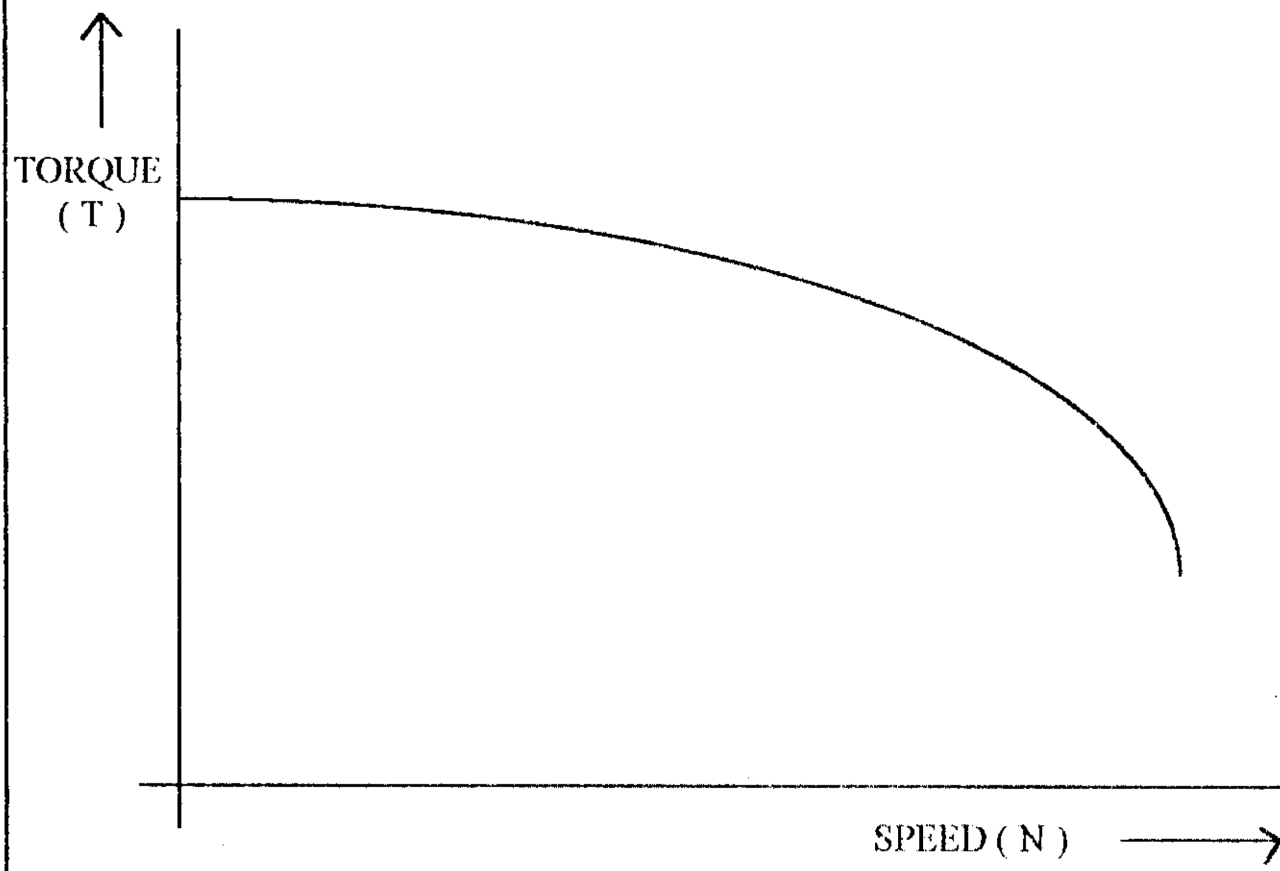


FIG.(2.5) SPEED - TORQUE CHARTERISTICS OF A STEPPER MOT

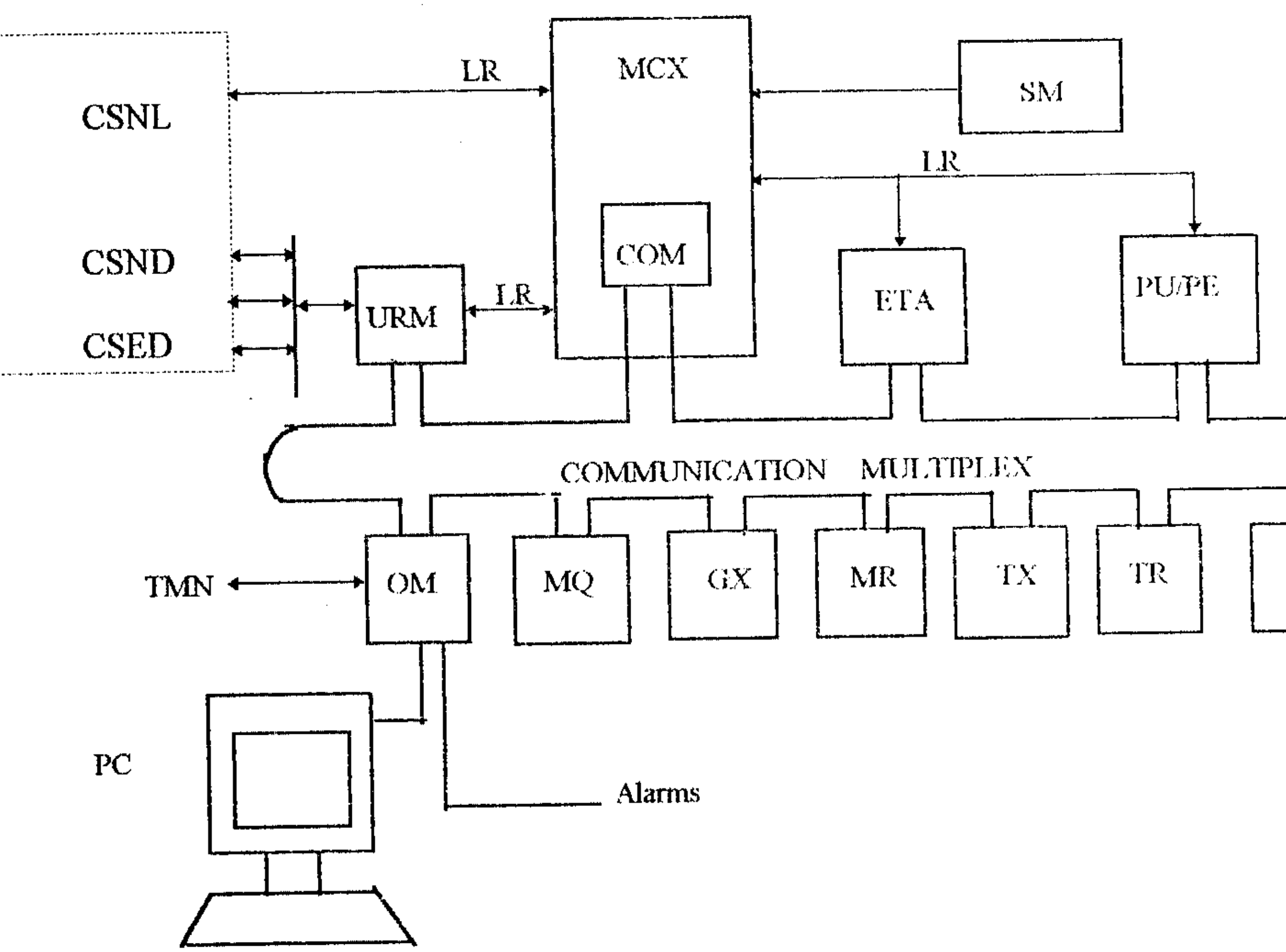


Fig.(2.6) OCB 283 F UNCTIONAL ARCHITECTURE

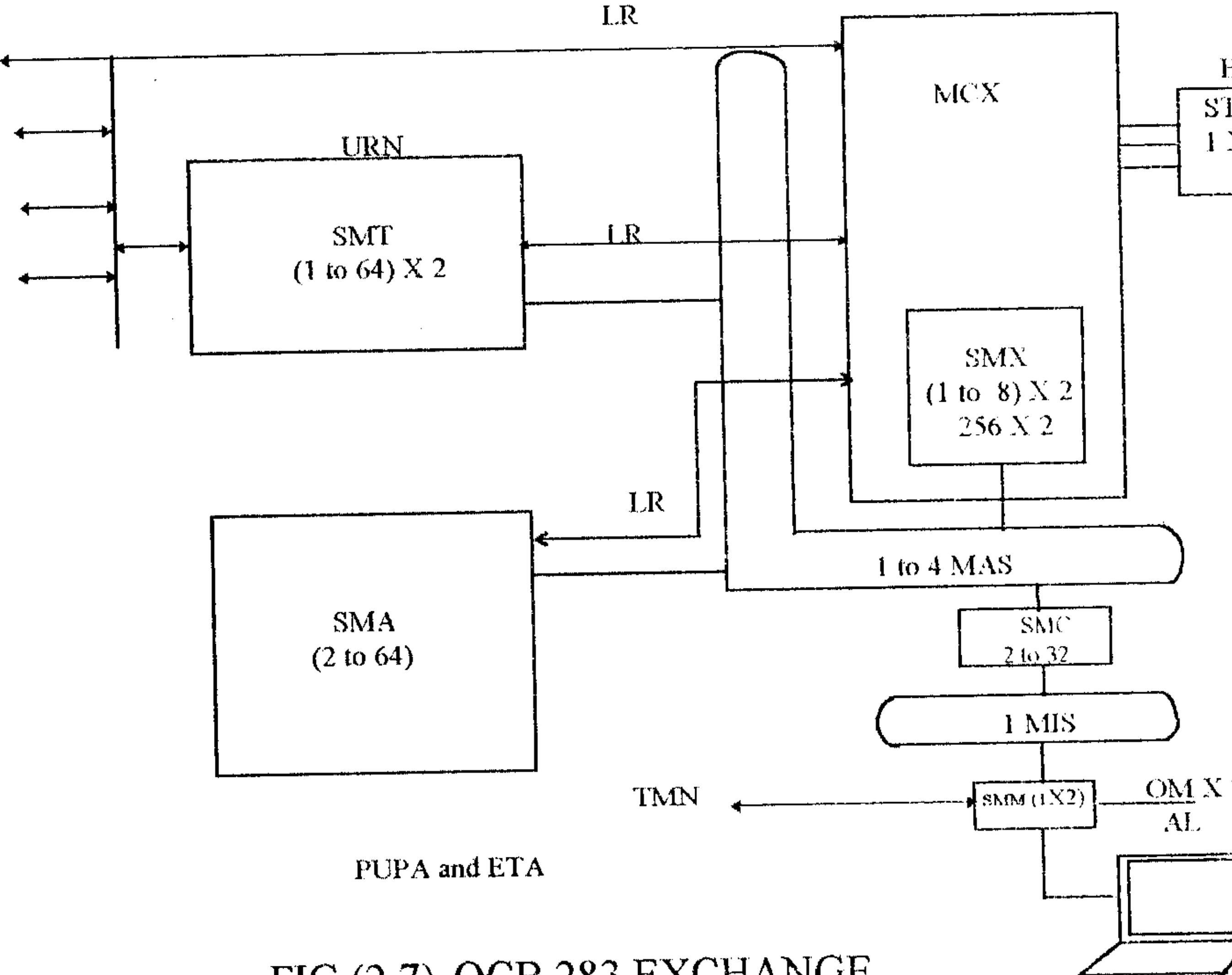


FIG.(2.7) OCB 283 EXCHANGE

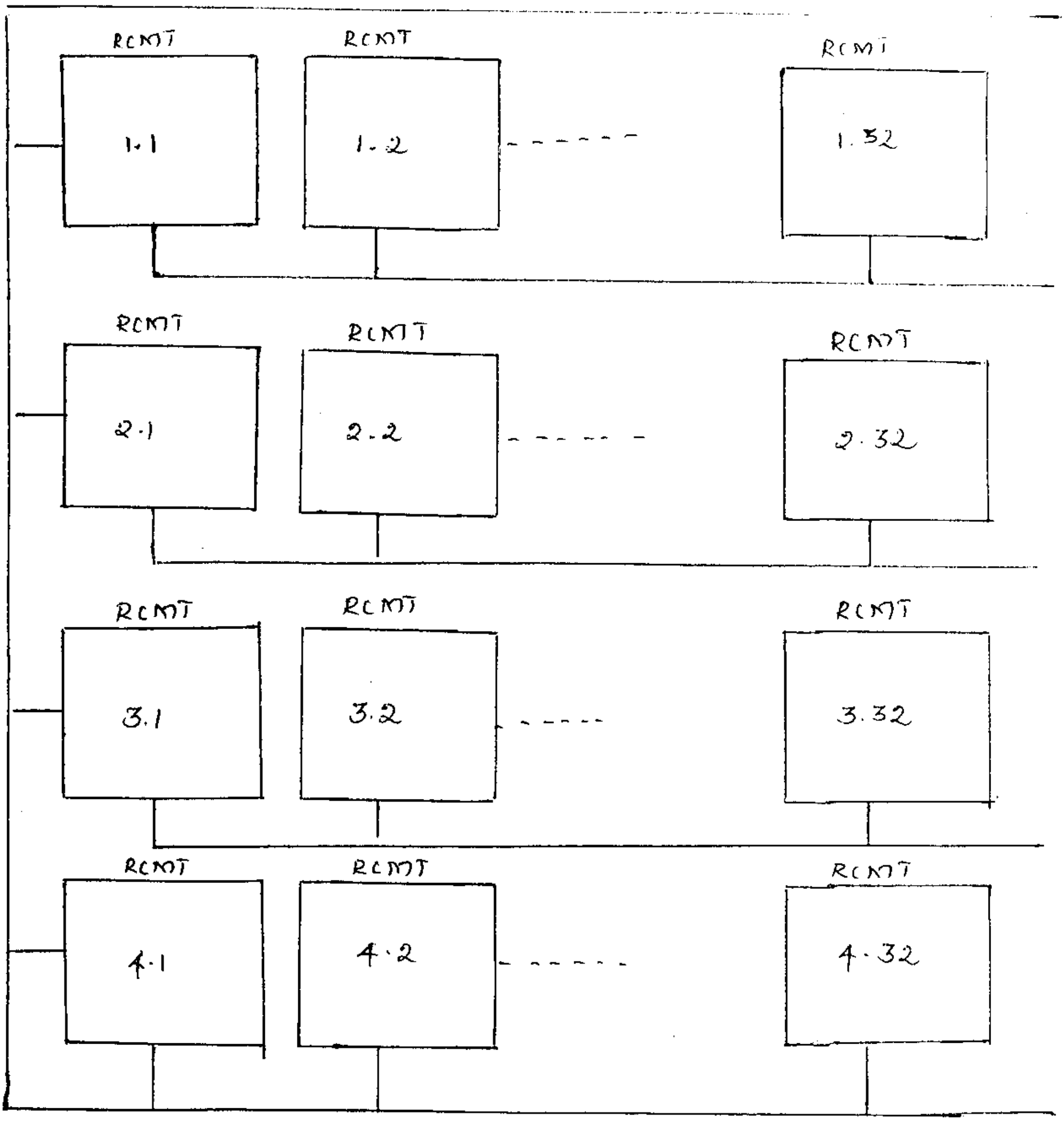


FIG.(2.8) RCMT CONTROL STATION

Chapter 3
HARD WARE

3.1 GENERAL CONFIGURATION:

The hardware is divided into two main sections. They are

1) I/O card connected to the personnel computer.
2) The multiplexed unit is responsible for selecting the components.
3) The hard ware interface of the stepper motor unit.

This software along with hardware peripherals could be run in the same SCORPION machine itself. The hardware part of the test machine has been simplified in favour of software. The program can thus choose the signals which may be transmitted at any given instant without any signal adversely affecting any other.

3.2 INPUT /OUTPUT CARD DESIGN:

The data bus and the address bus of the Personal Computer are used to establish interconnections between the stepper motor interface and the software for establishing the process. The buses are, resistor pad shown in fig.(3.1) which is connected to one side of the eight bit comparator which compares it with the fixed address. This fixed address is selected by using a port switch which can be connected to a zero level or a signal level and is pulled up using a resistor pad connected to 5V supply.

The main function of this address comparator is to select a address location in the address bus of the CPU. The CPU of our computer sweeps through various address locations meant for executing the various job cycles of the computer. The gaps of memory map which points out the address have no functions to do. Our main aim is to select such a memory space in the address map to execute our testing process. For example the address 220H is selected using the port switch and is compared with the address of the input from the address bus. So that when the address 230H is scanned by the Personnel Computer, we can execute the enable signal from the computer to reach out as a signal for enabling various Integrated circuits when the comparator selects the address 220H. The AEN signal enables the bi-directional latch which connects the data bus of the computer after an active pull up to the external circuitry. This is essential because there some needs that the total interface should be taken out without actually removing the I/O card. The enable input of the transceiver is controlled by the signals from the OR gate when the address is 220H. An octal D-type flip-flop with three state output and a hex buffer with open collector high voltage output, is used to give signals, after a pulling up using a resister pad connected to a 12 V supply, to the female connector. This connection could be taken when in future cases need to take input to the Personnel computer. An octal transceiver output is connected to a bi-directional buffer specifying the direction. Before that the D_4^{th} and D_5^{th} data lines are handed and this is given to the chip selected logic of the 74245(buffer).The other lines are passed through a D-type flip flop for a delay so that buffer selects either demuliplexer or the stepper motor interface. The demultiplexer part will be explained in details later in the chapter. Now the line D_7 determines the select logic of the buffer connected to the lines immediately. If the level in D_7 = 0 then the buffer corresponding to Y directional stepper motor interface is selected and D_7 = 1 for the buffer corresponding the X direction.

For demultiplexer logic the data should be like ,

D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
1/0	1/0	1/0	1/0	1/0	1/0	0	0

The stepper motor logic data should be :

D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
1/0	1/0	1/0	1/0	1	1	1/0	1/0

3.3 DEMULTIPLEXER UNIT:

For this unit various boxes containing Integrated circuits are connected with the LIGHT EMMITTING DIODES. The light emitting diodes show the boxes for which the components to be selected. For this data from the computer is given selecting the components. The data reaches the demultiplexer unit as shown in fig.(3.2) via the date lines through the data bus. Light Emitting diodes are placed at the top of the boxes. These are ensured to the selection of the chips from the boxes. The data lines gives the data from the computer and this gives the output to the demultiplexer unit which shows the chip to be selected. The LED's connected get a low signal and this makes it to glow. The demultiplexer unit uses the 74154 chips which has the output of 16 and when these are connected in parallel then it is possible to enhance the output number.

For example,

	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
R1	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	1
R3	0	0	0	0	0	0	1	0
R4	0	0	0	0	0	0	1	1
R5	0	0	0	0	0	1	0	0
R6	0	0	0	0	0	1	0	1
R7	0	0	0	0	0	1	1	0
						and etc.		

In our system we had used three chips and these are connected in parallel. In this system we uses 00 to select the chip number 1, 10 selects the second and the data 01 selects the third.

3.4 OPTO COUPLER:

OPTO COUPLER consists of a LIGHT EMMITTING DIODE and opto transistor. There is an isolation between the two. This acts as a physical isolation between the two systems namely the high voltage side and low voltage side. The main advantage of MCT 2E is that it acts as a coupler or isolation between the high voltage and low voltage sides. Hence this is used in the fist stage of the stepper motor interface.

3.5 INTERFACING A MICRO COMPUTER TO A STEPPER MOTOR:

A unique type of motor useful for moving things in small increments is the stepper motor. Instead of rotating smoothly around or step from one fixed position to the next. Common step sizes range from 0.9 to 30mm. Stepper motor is stepper from one position to the next by changing the currents through the fields of the motor. the two common field connections are referred to as two phase or four phase motor.

The fig.(3.3) shows a circuit which is used to interface a small four phase stepper motor. Since the IC MCT2E is used as the optocoupler. This is used because it disconnects the low voltage from the high voltage side. The fig. (3.4) shows he switching sequence to step a motor such as this clockwise, as face the motor shaft, or counter clockwise. Hence how this works. Suppose SW1 and SW2 are turned on. Turning of SW2 and turning on SW4 will use the motor to rotate one step of 1.8 degrees clockwise. Changing to SW3 and SW2 on will cause another step. After that, changing to SW2 and SW1 on again will cause another step clockwise. You can repeat the sequence until the motor has rotated as many steps clockwise, you simply work through the switch sequence in the reverse direction. In either case the motor will be held in its last position by current through the coils. The fig.(3.5) shows the switching sequence that can be used to rotate the motor half steps 0.9 degrees clockwise and anticlockwise.

A close look at the switching sequence in the fig.(3.6) shows an interesting pattern. To take the first step clockwise from SW2 and SW1 being on. The pattern of 1's and 0's are simply rotated 1 bit position around to the right. The 1 from SW1 is rotated around into bit 4. To take the next step the switch pattern is rotated one more bit position. To step anticlockwise the switch pattern is rotated left one bit position for each step desired. Suppose that initially load 00110011 though the port to the switches. Duplicating the switching pattern from 0011 0011 will make the stepping easy. To step the motor clockwise, you just rotate this pattern right one bit position and output it. After you output one step code you must wait a few milliseconds before you output another step command, because the motor can only step so fast. Maximum stepping rates for different types of steppers vary from few 100 steps per second to several thousand steps per second. To achieve high stepping rates, the stepping rate is slowly increased to the maximum, when it is decreased as the desired number of steps is approached.

As a stepper motor steps to a new position, it tends to oscillate around the new position, before settling down. A common software technique to damp out this oscillation is to first send the patterns to step the motor towards the new position. When the motor has rotated part of the way to the new position, a word to step the motor backward is output for a short time. This is like putting the brakes on the step forward word is then sent again to complete the step to next position. The timing for the damping command must be determined experimentally for each motor and load.

3.6 PC DETAILS:

Most important part of the testing process of the component location is the personal computer. Theb effective interfacing of the rack of the computer and the execution of the program is the major part of our task. So it is essential to have knowledge though not in detail about various features of the computer. The I/O band which or inserted in to the I/O parts of the computer. So we must know details abpout the I/O part specification. The memory address map which provides a fixed address space is given below,

3.6.1 PIN ASSIGNMENTS FOR 1/0 CHANNEL CONNECTORS:

I/O PIN	Sngnal name	1/0
A1	-1/0 CH CK	1
A2	SD 7	1/0
A3	SD 6	1/0
A4	SD 5	1/0

A5	SD 4	1/0
A6	SD 3	1/0
A7	SD 2	1/0
A8	SD 1	1/0
A9	SD 0	1/0
A10	-1/0 CH RDY	1
A11	AEN	0
A12	SA 19	1/0
A13	SA 18	1/0
A14	SA 17	1/0
A15	SA 16	1/0
A16	SA 15	1/0
A17	SA 14	1/0
A18	SA 13	1/0
A19	SA 12	1/0
A20	SA 11	1/0
A21	SA 10	1/0
A22	SA 9	1/0
A23	SA 8	1/0
A24	SA 7	1/0
A25	SA 6	2/0
A26	SA 5	1/0
A27	SA 4	1/0
A28	SA 3	1/0
A29	SA 2	1/0

A30	SA 1	1/0
A31	SA 0	1/0
B1	GND	ground
B2	RESET DRV	0
B3	+ 5 Vdc	Power
B4	IRQ 9	1
B5	- 5 Vdc	power
B6	DRQ 2	1
B7	- 12 Vdc	Power
B8	OWS	1
B9	+ 12 Vdc	Power
B10	GND	ground
B11	SME MW	0
B12	SME MR	0
B13	10W	1/0
B14	IOR	1/0
B15	DACK 3	0
B16	DRQ 3	1
B17	DACK 1	0
B18	DRQ 1	1
B19	Refresh	1/0
B20	CLK	0
B21	1 RQ 7	1
B22	1 RQ 6	1

B23	1 RQ 5	1
B24	1 RQ 4	1
B25	1 RQ 3	1
B26	DACK 2	0
B27	T/C	0
B28	BALE	0
B29	+ 5 Vdc	Power
B30	OSC	0
B31	GND	Ground

3.6.2 I/O CHANNEL SIGNAL DESCRIPTION

1) SA0 through SA 19 (I/O)

Address bits 0 through 19 used to address memory and I/O devices within the system. These 20 address lines allow access of 16 Mb of memory. SAO through SA 19 are gated on the system bus when 'BALE' is high and are latched and the falling edge of BALE. these signals are generated bythe microprocessor or DMA controller. They also may be driven by other microprocessors or DMA controllers that reside on the I/O channel.

2) BALE (0) (Buffered Address Latch Enable)

Address latch enable is provided by the 82288 Bus Controller and is used on the system board to latch valid addresses and memory decodes from the microprocessor. It is available to the I/O channel as an indicator of a valid micfroprocessor or DMA address. Micro processor addresses SAO- SA 19 are latched within the falling edge of "BALE". "BALE" is forced high during DMA cycles.

3) SD 0 through SD 15 (I/O) (Signal Data 0 through 15)

These signals provide bus bits through 15 for one microprocessor, memory and I/O devices. D0 is LSB and D15 is the msb. All 8-bit devices on one I/O channel should use D0 through D7 for Communication to the microprocessor. The 16 bit devices will use D0 through D15. To support 8 bit drives, the data on D8 through D15 will be gated to D0 through D7 during 8-bit transfers to these devices, 16 bit microprocessor transfers to 8 bit devices will be converted to two 8 bit transfers.

4) -IOR (I/O) (Input output Read)

"-I/O Read" instructs as I/O device to drive this data on to the data bus. It may be driven by the system microprocessor or DMA controller, or by a microprocessor or DMA controller resident on one I/O channel. This signal is active low.

5) -IOW (I/O) (Input output Write)

"-I/O Write" instructs an I/O device to read the data on the data bus. It may be driven by any microprocessor or DMA controller in the system. This signal is active low.

6) AEN (0) (Addresss Enable)

"Address Enable" is used to degate the microprocessor and other devices from the I/O channel to allow DMA transfers to take place. When this line is active, the DMA controller has control of the address bus, the data bus Read command and the Write command lines.

Hex Range	Device
000 -01F	DMA controller 1, 8237 A -5.
020 - 03F	Interupt controller1,8259A,Master.
040 - 05F	Timer, 8254.2.
060 - 06F	8042 (Key Board).
070 - 07F	Real - time clock, NMI.
080 - 09F	DMA page register, 7415612.
0A0 - 0BF	Interrupt controller 2, 82594.
0C0 - 0DF	DMA controller 2, 8237A - 5.
0F0	Clear matu coprocesssor busy.
0F1	Reset matu coprocessor.
0F8 - 0FF	Matu coprocessor.
1F0 - 1F8	Fixed disk.
200 - 207	Game I/O.
278 - 27F	Parrel printer port 2.
2F8 - 2FF	Serial port 2.
300 - 31F	Prototype card.
360 - 36F	Reserved.

378 - 37F	Parallel printer port 1.
380 - 38F	SDLC, bisynchronous.
3A0 - 3AF	Bisynchronous.
3B0 - 3BF	Monochrome display and printer adapter.
3C0 - 3CF	Reserved.
3D0 - 3DF	Colour/Graphics Monitor Adapter.
3F0 - 3F7	Diskette controller.
3F8 - 3FF	Serial port 1.

3.7 PCB FABRICATION:

3.7.1 PCB FABRICATION USING SMARTWORK:

The Printed circuit Board (PCB) making is the arrangement of components in a neat, compact way on a copper clad board with circuit connections.

The various components used in PCB fabrication assembly have standard dimensions. Based on this suitable spacing is to be provided while drawing a PCB. First the circuit diagram is thoroughly studied. The size of the different components are noted down. Approximate placing of the different components are taken in preparing a PCB layout. The layout should be a compact, arranged the components neatly, spacing is to be provided sufficiently according to the size of the components so that the leads do not break by bending or the components do not get crowded, and all the connecting lines are drawn in the board.

A rough layout for the circuit is prepared in a paper is indicating the placing of the components and lines interconnecting them. This diagram is then converted to required PCB layout with the help of SMARTWORK which is a software design producing a printout of the layout. The solder side and the component side are shown in the Figures. Then the board is fabricated by using any one of the technique used in the industry and holes are drilled to give the corresponding Printed Circuited Board. This board is then tested for the open test and the short circuit test. The Solder side and Component side layout of Input / Output card is shown in fig.(3.7) and fig.(3.8) and the same for Demultiplexer unit is shown in fig.(3.9) and fig.(3.10).

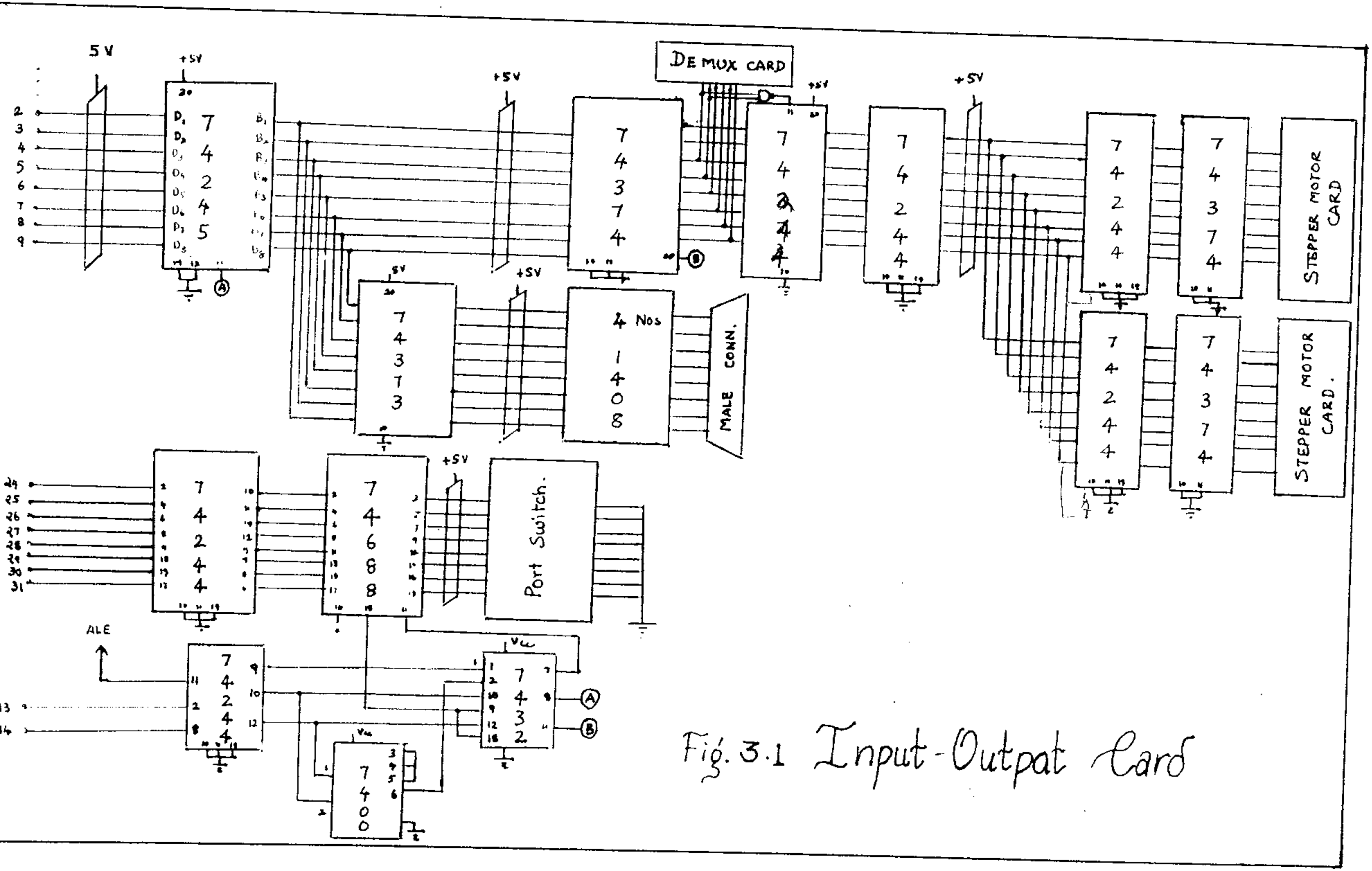


Fig. 3.1 Input-Outpat Card

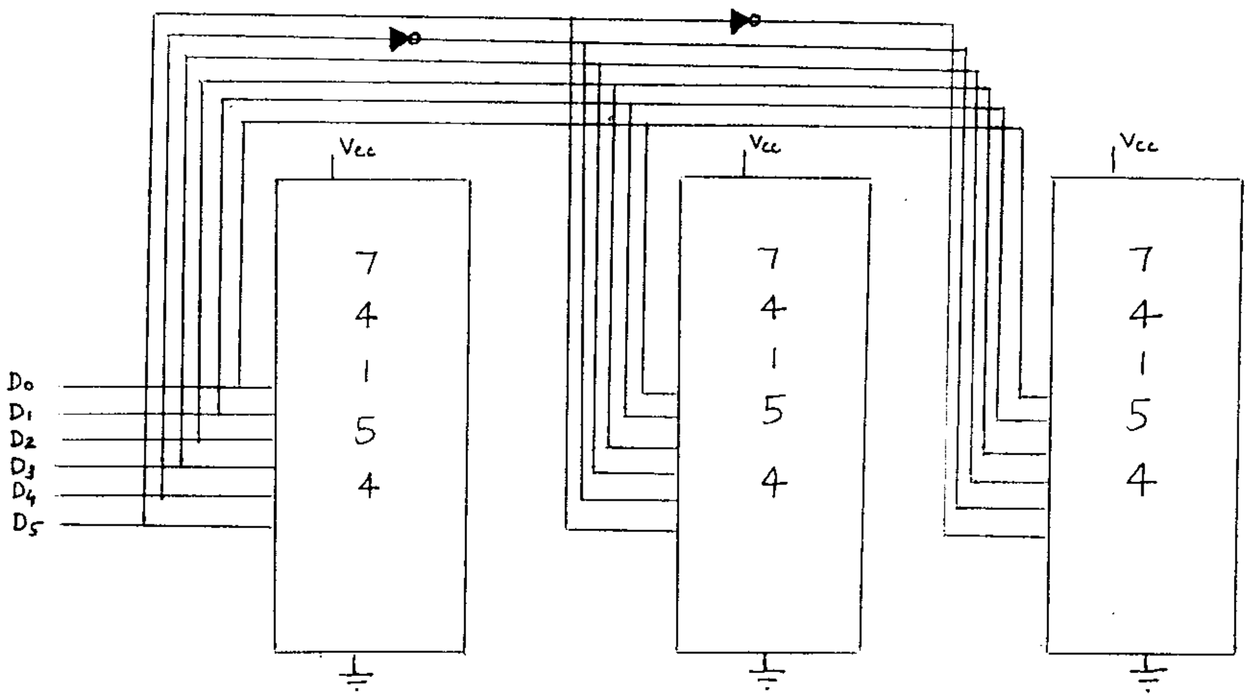


Fig 3.2 Demultiplexer Unit

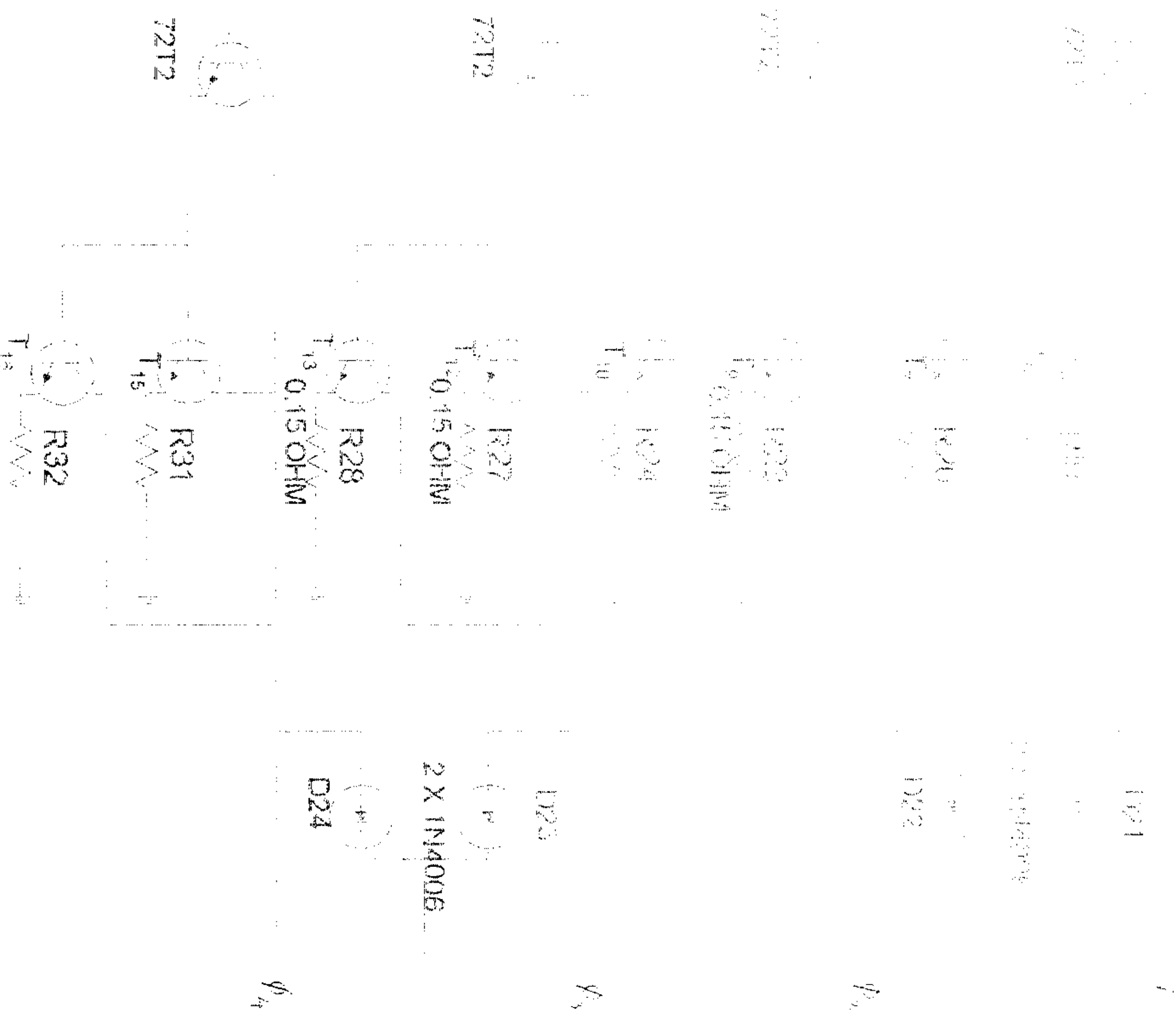


Fig (3-3) STEPPER MOTOR [illegible] CARD

STEP	SWITCH #1	SWITCH #2
1	1	5
2	1	4
3	3	4
4	3	5
1	1	5

TO REVERS DIRECTION, READ CHART UP FROM BOTTOM

(b) SWITCHING SEQUENCE.

PHASE	1 STEP	2 STEP	3 STEP	4 STEP	5 STEP
1	ON	ON	OFF	OFF	ON
2	OFF	OFF	ON	ON	OFF
3	ON	OFF	OFF	ON	ON
4	OFF	ON	ON	ON	OFF

← REV

(c) WAVEFORMS

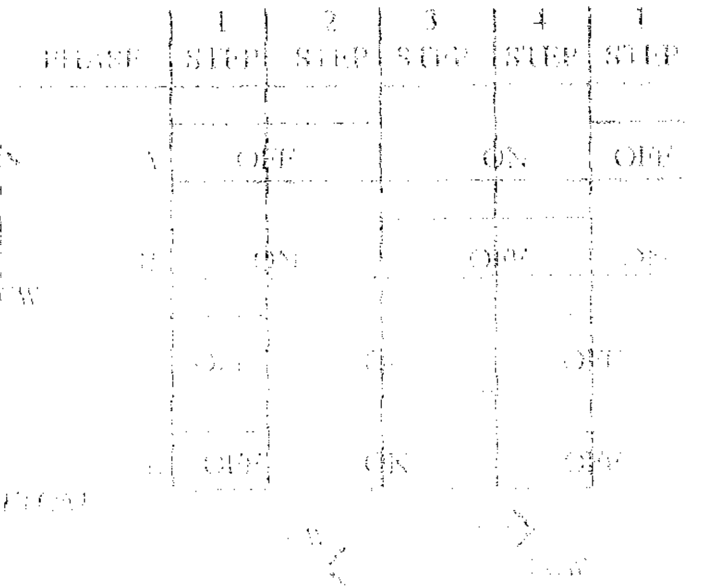
FIG (3.4)

CW ↓

STEP	S1	S2	S3	S4
1	OFF	ON	OFF	ON
2	OFF	ON	ON	OFF
3	ON	OFF	ON	OFF
4	ON	OFF	OFF	ON
1	OFF	ON	OFF	ON

↑ CCW

TO REVERSE DIRECTION READ CHART UP FROM BOTTOM



[illegible]

STEP	S1	S2	S3	S4
1	OFF	ON	OFF	ON
2	OFF	ON	OFF	OFF
3	OFF	ON	ON	OFF
4	OFF	OFF	ON	OFF
5	ON	OFF	ON	OFF
6	ON	OFF	OFF	OFF
7	ON	OFF	OFF	ON
8	OFF	OFF	OFF	ON
1	OFF	ON	OFF	ON

CW ↓   CCW ↑

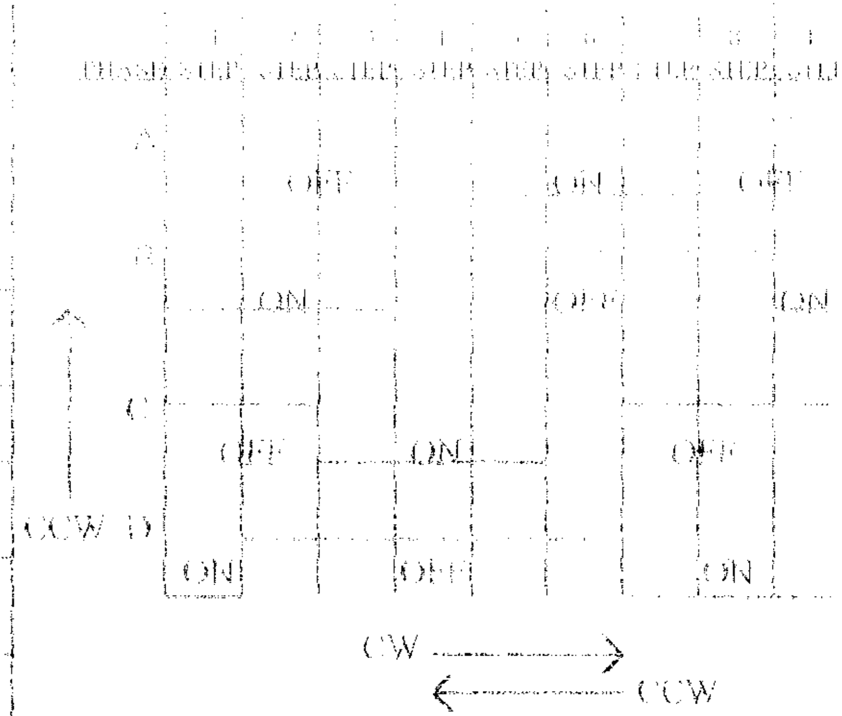


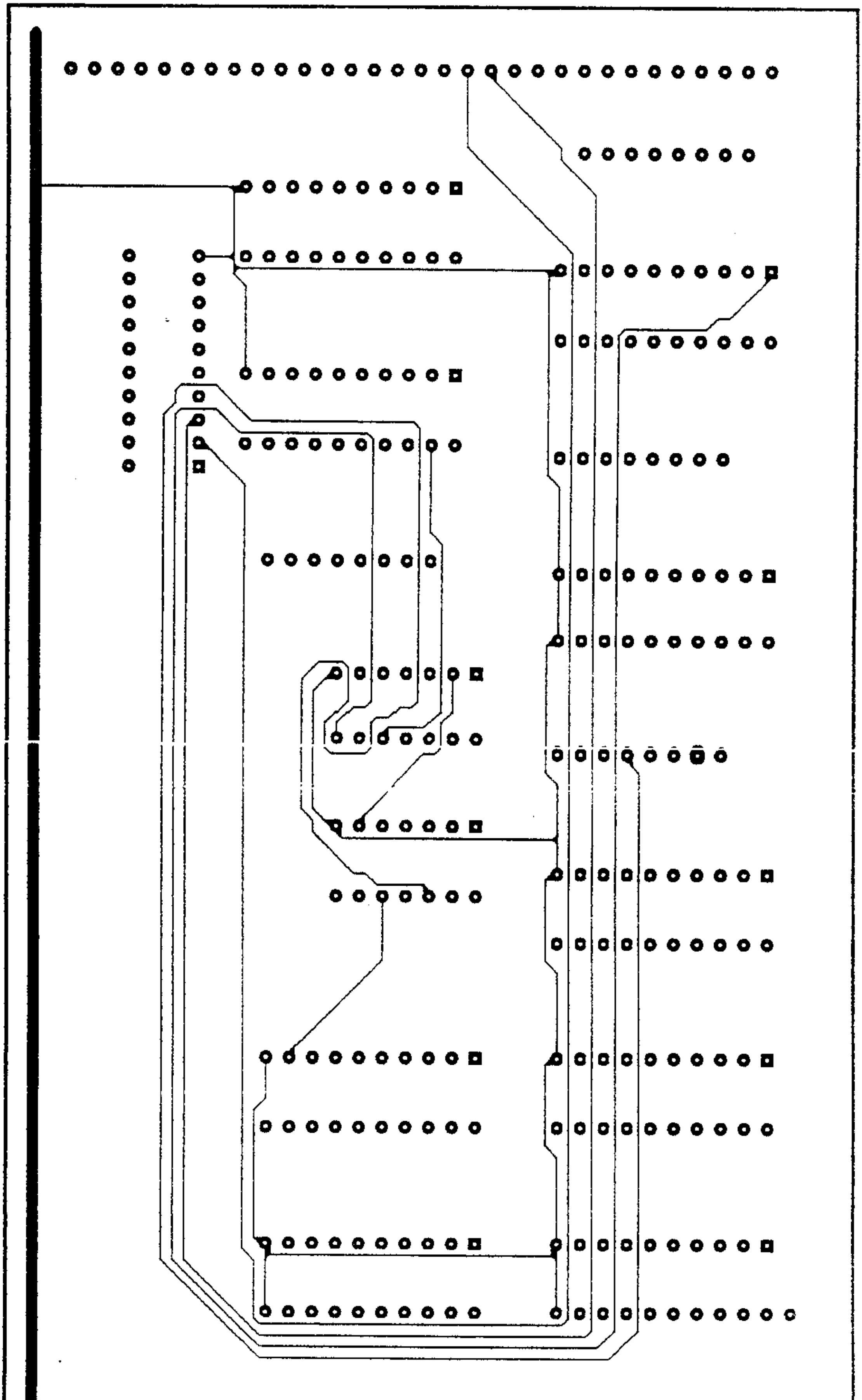
FIG.(3.?) HALF - STEP SEQUENCE AND WAVEFORMS

ZX artwork

iocard

v1.2 ... component ...

approx ... 6.05 ... 3.47

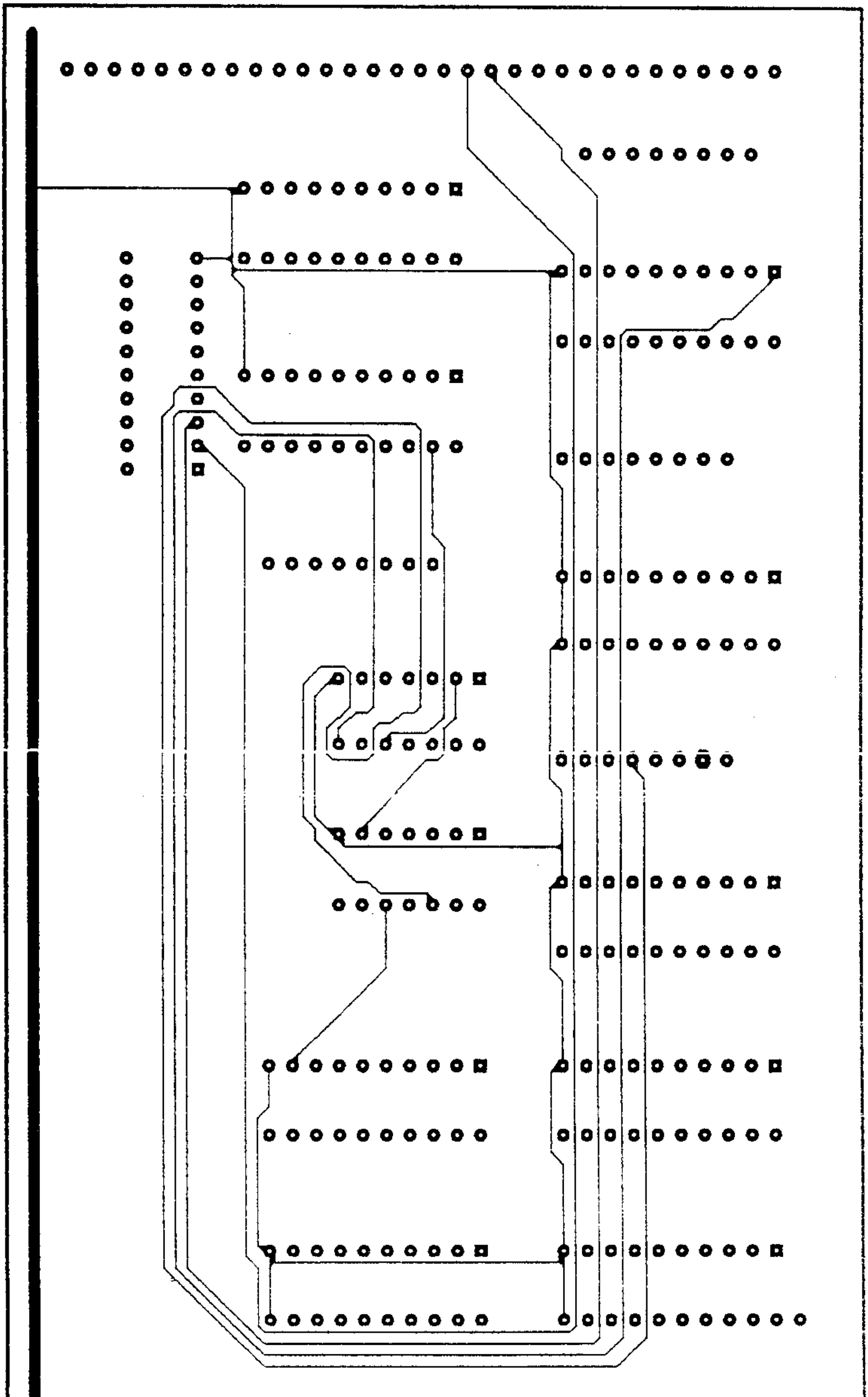


2X artw

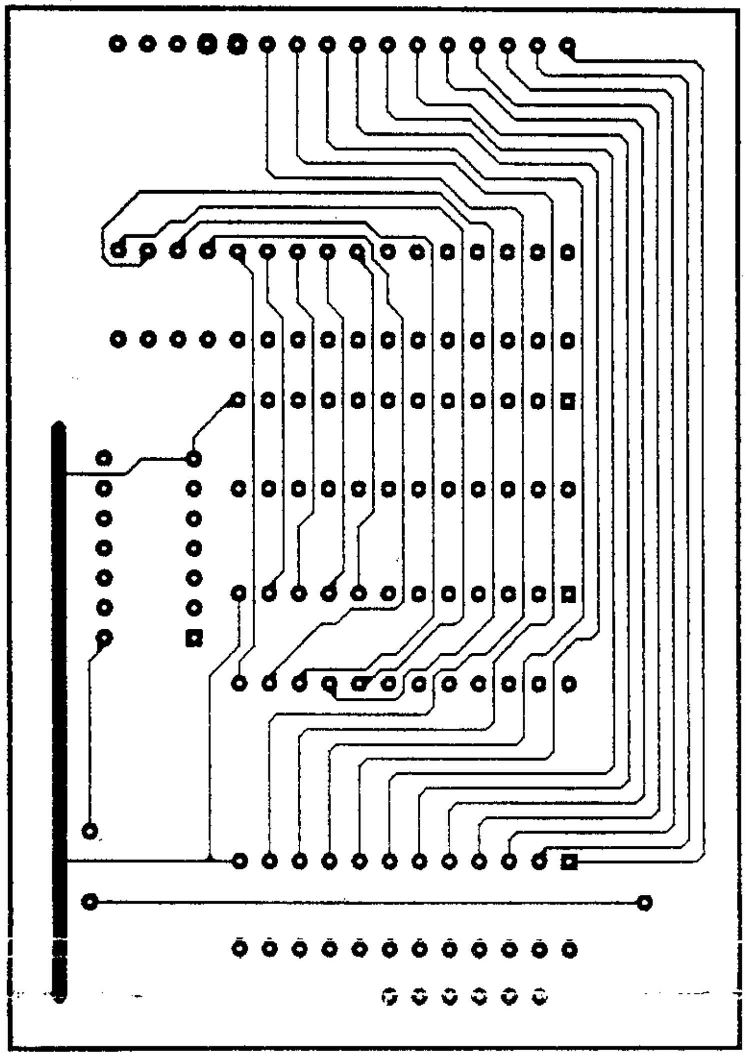
iocard

v1.2 r2

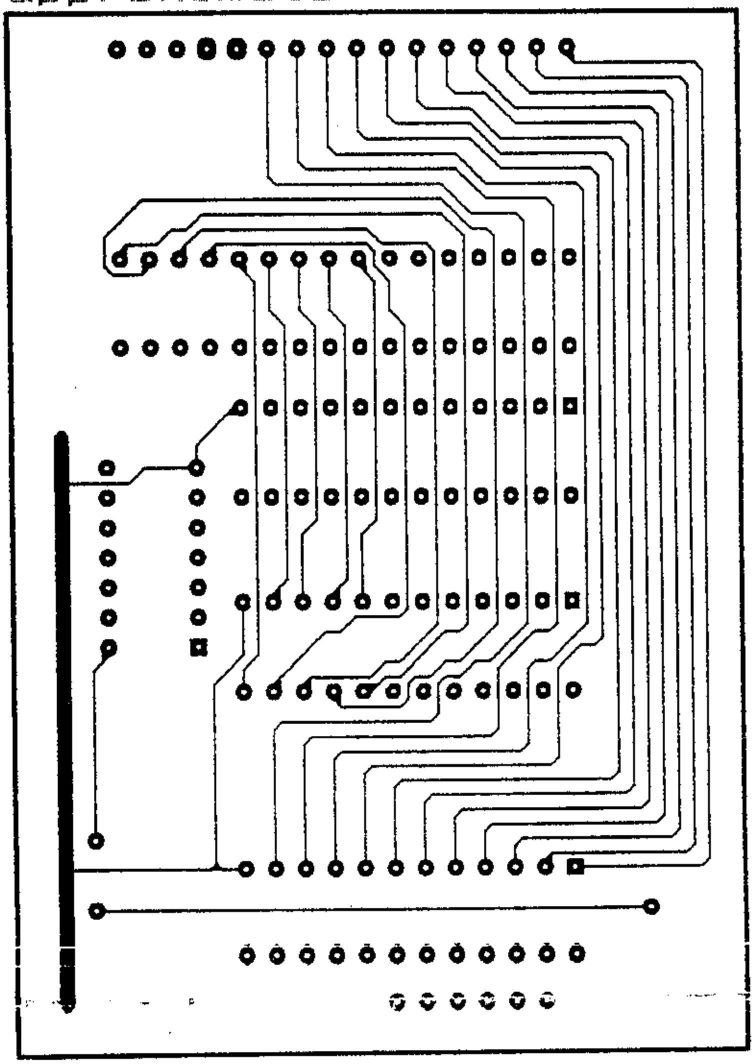
appro 6.05 3.45



2X artwork 2 Mar 1997 12:14:25
demux
v1.2 r2 holes: 143 component side
approximate size: 3.30 by 2.25 inches



2X artwork 2 Mar 1997 12:14:25
demux
v1.2 r2 holes: 145 component side
approximate size: 3.30 by 2.25 inches



Chapter 4
SOFTWARE

4.1 SOFTWARE DESCRIPTION:

The main structure that serves as a base for the software is the **"DATA SET"**. The data set includes the RCMT board components which has been again divided into SMT and the conventional components.

The SMT is "Surface Mounting Technology" which enhances the portability of the Printed Circuit Board(PCB). Conventional components are ordinary components that are manually assembled.

The data set consists of the Nail number, the component name, code, signal applied, tolerance, value of the component, X and Y co-ordinates of the RCMT board. The objective of the program is to get the X and Y co-ordinates when the Nail number is given as input.

4.2 MAIN PROGRAM:

The developed Software is given at the end of this Chapter. The flowchart of the main program is shown in fig.(4.1). The package is a "**Menu Driven Program**" which when started gives three options, viz., Help, Information and Continue. When the programmer needs any help as to how to go about with the program he may use this menu which entirely describes the operation of the program.

The entire information about who have written and guided to develop this software has been presented here. Also the title of the project has been given. When 'continue menu' is retrieved the programmer could go about with the program and he might be able to locate the co-ordinates.

4.3 PROGRAM INFORMATION:

When the continue menu is entered another set of choices could be reached to get the details of the RCMT board.

The choices that is given in software are :

1) **Display set**
2) **Search and display**
3) **Display components**
4) **Insertion assembly**
5) **Help**
6) **Quit**

4.3.1 DISPLAY SET:

The flowchart for this subprogram is shown in fig.(4.2a). When this area is reached, we will be able to scroll through the data available for the SCORPION MACHINE page by page. Also , if we need to quit after any number of pages that would also be possible. The SCORPION MACHINE atlas or data sheets gives the nail number, node x and y co-ordinates.

If we call for the display set menu it will reach the subprogram DISPLAY SET and would open a file named SANJU.DAT which consists of 1239 records and each record describes the nail number, component, signal, x coordinate and y coordinate of the RCMT board.

By this program all data could be known to us and could be displayed. As it would be running very fast it have to be read out individually. Hence, we have created a delay such that the data could be read page by page and also we can quit at any time.

4.3.2 SEARCH AND DISPLAY:

The flowchart for this subprogram is shown in fig.(4.2b). When this area is reached, we will be able to get the x and y co-ordinates of the RCMT board when the nail number or the component name is asked. This depends upon the user whether he want to get the information using the nail number or the component name. The co-ordinates could be located by means of a Stepper motor arrangement which is interfaced to the Personal Computer.

If we call for the search and display menu it will reach the subprogram SAD which is the search and display option. The x and y coordinate of a particular component is selected by means of entering the nail number or the component name. This is done by selecting any option in the menu, and those are,

1) **SELECT BY COMPONENT**
2) **SELECT BY NAIL**
3) **HELP**

4.3.3 SELECT BY NAIL:

When this is called for it will reach the subprogram SBN (Select by nail) and would open a file name SANJU.DAT. When the file opens, the nail number of reach records in that file. If both are same, displaying of co-ordinates takes place or else the data is not displayed. Unless we quit, the process of getting the co-ordinates is done.

4.3.4 SELECT BY COMPONENT:

The flowchart for this subprogram is shown in fig.(4.3a).When this program is called for, then it will reach the subprogram SBC (SELECT BY COMPONENT) and this would cause either the SMT components or the Conventional components data base would open. By entering the name of the component either SMT or Conventional it's corresponding X and Y co-ordinates could be displayed. This X and Y co-ordinates could be taken to the Stepper motor arrangement with the help of the Input / Output port via the address decoder.

4.3.5 DISPLAY COMPONENTS:

When this subprogram is called for, then it would reach the subprogram COMP (COMPONENTS) which has two options with it.

When we select, either of the option then the corresponding data base could be displayed. There is a provision for it to handle the components individually. There are two data files namely,

1) **SMT.DAT**
2) **MAN.DAT**

The first file has the data base of the Surface mounted components and the second has the data base of the Conventional components. The sub records have the name of the component, tolerance, Code used in the industry, value, X coordinate and the Y coordinate. The MAN file has also the same sub records as for the SMT components. After this, provision has been given to either continue in the same loop or to QUIT to the main program.

4.3.6 INSERTION ASSEMBLY:

The flowchart for this subprogram is shown in fig.(4.3b).When this is called for, it would reach the INST sub program and this would make the computer to open the SMT.DAT and MAN.DAT. Depending upon the application, that it whether there is a need to insert the component on the SMT side or the Conventional side the corresponding answer should be given to the program. This would cause the selection of the SMT data base or the MAN data base resulting in the insertion assembly of the component.

4.3.7 STEP X & STEP Y:

This is the subprogram which is responsible for the operation of the Stepper motor. This out ports the switching sequence of the Stepper motor and this would cause the Stepper motor to move in the X direction. The switching sequence is for the clockwise direction and the subprogram STEP Y is for the same purpose but it is the Y direction.

4.3.8 STEPA X & STEPA Y:

This is the subprogram which is responsible for the anti clockwise operation of the Stepper motor. This out ports the switching sequence of the Stepper motor and this would cause the Stepper motor to move in the X direction. The switching sequence is for the anti clockwise direction and the subprogram STEP Y is for the same purpose but it is the Y direction.

PROGRAMS

&

FLOWCHARTS

```
DECLARE SUB INFO ()
DECLARE SUB HELP ()
DECLARE SUB SBC ()
DECLARE SUB SMTDI (NA$, k%, ELE)
DECLARE SUB CONDI (MA$, k%, ELE)
DECLARE SUB COMP ()
DECLARE SUB DISCO ()
DECLARE SUB INST ()
DECLARE SUB SAD ()
DECLARE SUB SBN ()
DECLARE SUB DISPLAYSET ()
CLS
SCREEN 1
  FOR N = 1 TO 59
       pp = (N - 1) * 10
       LINE (pp, 6)-(pp * 0, 9), 2, BF
       LINE (pp, 190)-(pp * 0, 193), 2, BF
       COLOR 1
  NEXT N
 PETAL$ = " s16 BM50,100 M-2,-7 E2 F2 M-2,7"
 COLR% = 1
  FOR 1% = 0 TO 330 STEP 30
       COLR% = 3 - COLR%
       DRAW "C=" + VARPTR$(COLR%)
       DRAW "TA=" + VARPTR$(1%) + PETAL$
  NEXT 1%
 LOCATE 9, 25: PRINT "WELCOME"
 LOCATE 12, 28: PRINT "TO  "
 LOCATE 15, 24: PRINT "R C M T 4"
 LOCATE 18, 25: PRINT "DATABASE"
 LOCATE 23, 20: PRINT "WAIT!"
  FOR k = 1 TO 1000
  FOR j = 1 TO 200
    NEXT j
  NEXT k
 CLS
 COLOR 13
 PRINT "*****************************************"
 PRINT
 PRINT "         HELP        - H"
 PRINT
 PRINT "         INFO        - I"
 PRINT
 PRINT "         CONTINUE    - C"
 PRINT
 PRINT "*****************************************"
 LOCATE 20, 1: INPUT "ENTER THE MENU CODE"; Z$
 SELECT CASE UCASE$(Z$)
   CASE "H"
     CALL HELP
```

```
    CASE "I"
      CALL INFO
    CASE ELSE
  END SELECT
7 CLS
   COLOR 1
  SCREEN 1
  PRINT "****************************************"
  PRINT
  PRINT "      DISPLAY SET                      - D"
  PRINT
  PRINT
  PRINT "      SEARCH AND DISPLAY               - S"
  PRINT
  PRINT
  PRINT "      DISPLAY COMPONENTS               - C"
  PRINT
  PRINT
  PRINT "      INSERTION ASSEMBLY               - A"
  PRINT
  PRINT
  PRINT "      HELP                             - H"
  PRINT
  PRINT
  PRINT "      QUIT                             - Q"
  PRINT
  PRINT "****************************************"
  PRINT
  INPUT "ENTER THE MENU CODE"; C$
  PRINT
  PRINT
  CLS
     SELECT CASE UCASE$(C$)
       CASE "D"
         CALL DISPLAYSET
       CASE "S"
         CALL SAD
       CASE "A"
         CALL INST
       CASE "C"
         CALL COMP
```

```
      CASE "H"
        CALL HELP
      CASE "Q"
        GOTO 10
    END SELECT
 CLS
 SCREEN 1
 COLOR 1
     IF x$ = "C" THEN
        GOTO 7
     ELSE
     END IF
        GOTO 7
10 CLS
   COLOR 13
        LOCATE 12, 18: PRINT "GOOD BYE"
     DO
        BEEP
     LOOP UNTIL INKEY$ <> ""
        PRINT
   CLS
END
```

```
SUB COMP
   DO
  COLOR 13
     LOCATE 3, 15: PRINT "COMPONENTS"
     LOCATE 7, 16: PRINT "DISPLAY"
     LOCATE 12, 18: PRINT "SMT"
     LOCATE 16, 19: PRINT "&"
     LOCATE 20, 17: PRINT "MANUAL"
     LOCATE 23, 1: PRINT "Press any key to continue..."
    LOOP UNTIL INKEY$ <> ""
  CLS
2       PRINT "****************************************"
        PRINT
        PRINT "           SELECT SMT   S"
        PRINT
        PRINT "           SELECT MAN   M"
        PRINT
        PRINT "           HELP         H"
        PRINT
        PRINT "****************************************"
        PRINT
        INPUT "ENTER THE MENU CODE"; ME$
  CLS
     IF ME$ = "H" THEN
        CALL HELP
     ELSE
     END IF
     IF ME$ = "S" THEN
        ELE = 155
        k% = 1
      OPEN "smt.dat" FOR INPUT AS #k%
         PRINT "########################################"
        PRINT
        PRINT "     RESISTOR - 1 (10  K )  -  R1"
        PRINT
        PRINT "     RESISTOR - 2 (3.3 K )  -  R2"
        PRINT
        PRINT "     CAPACITOR- 1 (330 PF ) -  C1"
        PRINT
        PRINT "     CAPACITOR- 2 ( 10 NF ) -  C2"
        PRINT
        PRINT "     CAPACITOR- 3 (100 NF ) -  C3"
        PRINT
        PRINT "########################################"
    COLOR 3
     LOCATE 17, 13: INPUT "ENTER NAME"; NA$
    CLS
      SELECT CASE UCASE$(NA$)
         CASE "R1"
            CALL SMTDI(NA$, k%, ELE)
```

```
      CASE "R2"
         CALL SMTDI(NA$, k%, ELE)
      CASE "C1"
         CALL SMTDI(NA$, k%, ELE)
      CASE "C2"
         CALL SMTDI(NA$, k%, ELE)
      CASE "C3"
         CALL SMTDI(NA$, k%, ELE)
      CASE ELSE
     DO
         BEEP
         LOCATE 12, 15: PRINT "NO SUCH DATA"
         LOCATE 23, 1: PRINT "Press any key to continue..."
      LOOP UNTIL INKEY$ <> ""
   END SELECT
   CLOSE #1
   ELSEIF ME$ = "M" THEN
     ELE = 201
     k% = 2
    OPEN "man.dat" FOR INPUT AS #k%
CLS
SCREEN 1
COLOR 3
        PRINT
        PRINT "----------------------------------------"
        PRINT " RESISTOR  R1 (100K) R2 (220H)  R3 (22H)"
        PRINT " RESISTOR  R4 (10K) R5 (100H)  R6 (200O)"
        PRINT " RESISTOR  R7 (1M)   R8 (120H)"
        PRINT " DIODE     D1 (BZX55C)        D2 (IN4148)"
        PRINT " RESEAU    U1 (H29)              U2 (H05)"
        PRINT " SIL       S1                    S2 (H05)"
        PRINT " IC.LOGIQ  L1 (74AC14)       L2 (74AC374)"
        PRINT " IC.LOGIQ  L3 (74AC00)       L4 (74AC299)"
        PRINT " IC.LOGIQ                    L5 (74AC74)"
        PRINT " CI.LOGIQUE                 C1 (74AC244)"
        PRINT " CI.LOGIQUE                C2 (74ACT374)"
        PRINT " GENBENGATE                          GE"
        PRINT " COND                                CO"
        PRINT " INDUCT                              IN"
        PRINT " LARA ACTIV                          LA"
        PRINT " CI.MEM                              CI"
        PRINT " RGTR2                               RG"
        PRINT " IC.PREDIF                           IC"
        PRINT "----------------------------------------"
      LOCATE 24, 1: INPUT "ENTER THE MENU CODE  "; MA$
 CLS
        SELECT CASE UCASE$(MA$)
           CASE "R1"
              CALL CONDI(MA$, k%, ELE)
           CASE "R2"
              CALL CONDI(MA$, k%, ELE)
```

```
CASE "R3"
   CALL CONDI(MA$, k%, ELE)
CASE "R4"
   CALL CONDI(MA$, k%, ELE)
CASE "R5"
   CALL CONDI(MA$, k%, ELE)
CASE "R6"
   CALL CONDI(MA$, k%, ELE)
CASE "R7"
   CALL CONDI(MA$, k%, ELE)
CASE "D1"
   CALL CONDI(MA$, k%, ELE)
CASE "D2"
   CALL CONDI(MA$, k%, ELE)
CASE "U1"
   CALL CONDI(MA$, k%, ELE)
CASE "U2"
   CALL CONDI(MA$, k%, ELE)
CASE "S1"
   CALL CONDI(MA$, k%, ELE)
CASE "S2"
   CALL CONDI(MA$, k%, ELE)
CASE "L1"
   CALL CONDI(MA$, k%, ELE)
CASE "L2"
   CALL CONDI(MA$, k%, ELE)
CASE "L3"
   CALL CONDI(MA$, k%, ELE)
CASE "L4"
   CALL CONDI(MA$, k%, ELE)
CASE "L5"
   CALL CONDI(MA$, k%, ELE)
CASE "C1"
   CALL CONDI(MA$, k%, ELE)
CASE "C2"
   CALL CONDI(MA$, k%, ELE)
CASE "GE"
   CALL CONDI(MA$, k%, ELE)
CASE "CO"
   CALL CONDI(MA$, k%, ELE)
CASE "IN"
   CALL CONDI(MA$, k%, ELE)
CASE "LA"
   CALL CONDI(MA$, k%, ELE)
CASE "CI"
   CALL CONDI(MA$, k%, ELE)
CASE "RG"
   CALL CONDI(MA$, k%, ELE)
CASE "IC"
   CALL CONDI(MA$, k%, ELE)
CASE ELSE
```

```
SUB DISPLAYSET
  COLOR 1
  SCREEN 2
  CLS
   OPEN "sanju.dat" FOR INPUT AS #3
    FOR k = 1 TO 67
     PRINT "-----------------------------------------------------------
     PRINT "Nailno.        comp          signal        X coord         Y
     PRINT "-----------------------------------------------------------
      FOR j = 1 TO 18
       INPUT #3, N%, cn$, S$, x!, y!
       PRINT N%, cn$, S$, x!, y!
      NEXT j
     LOCATE 23, 1: INPUT "Press any key to continue and Q to QUIT ";
      IF UCASE$(sh$) = "Q" THEN
       GOTO 17
      ELSE
      END IF
  CLS
    NEXT k
     PRINT "-----------------------------------------------------------
     PRINT "Nailno.        comp          signal        X coord         Y
     PRINT "-----------------------------------------------------------
      FOR j = 1 TO 15
       INPUT #3, N%, cn$, S$, x!, y!
       PRINT N%, cn$, S$, x!, y!
      NEXT j
       LOCATE 23, 1: PRINT "Press any key to continue "
        DO
        LOOP UNTIL INKEY$ <> ""
17 CLS
   CLOSE #3
END SUB
```

```
SUB HELP
      CLS
        PRINT "1.DISPLAY SET"
        PRINT "-----------------"
        PRINT
        PRINT "     By entering this area you will be "
        PRINT
        PRINT "able  to  scroll  through  the  data "
        PRINT
        PRINT "available  for  the  SCORPION  machine"
        PRINT
        PRINT "in  groups. SCORPION  machine  gives "
        PRINT
        PRINT "nail  no., node, X & Y coordinates"
        LOCATE 23, 1: PRINT "Press any key to continue..."
       DO
       LOOP UNTIL INKEY$ <> ""
      CLS
        PRINT "2.SEARCH & DISPLAY"
        PRINT "--------------------"
        PRINT
        PRINT "    In this area you will be able to get"
        PRINT
        PRINT "X & Y coordinates  for the RCMT board by"
        PRINT
        PRINT "nailno.& also the coordinates by name of"
        PRINT
        PRINT "the components either SMT/Conventional."
        PRINT
        PRINT "The  coordinates  could  be  located  by"
        PRINT
        PRINT "means of a stepper motor arrangement."
        LOCATE 23, 1: PRINT "Press any key to continue..."
       DO
       LOOP UNTIL INKEY$ <> ""
       CLS
        PRINT "3.DISPLAY COMPONENTS"
        PRINT "---------------------"
        PRINT
        PRINT "       When entered  in this menu, SMT/"
        PRINT
        PRINT "Conventional   components  are  to  be"
        PRINT
        PRINT "selected. Depending on your option, the"
        PRINT
        PRINT "respective list of components could be "
        PRINT
        PRINT "displayed."
        LOCATE 23, 1: PRINT "Press any key to continue..."
       DO
```

```
SUB INST
  CLS
  SCREEN 1
  COLOR 4
    OPEN "smt.dat" FOR INPUT AS #1
    OPEN "man.dat" FOR INPUT AS #2
    OPEN "sanju.dat" FOR INPUT AS #3
      INPUT " SMT -S MAN -M "; y$
       IF y$ = "S" THEN
          FOR I = 1 TO 155
            INPUT #1, N$, x!, y!
             IF LEFT$(UCASE$(N$), 2) = "R1" THEN
               OUT 230, 0
             ELSEIF LEFT$(UCASE$(N$), 2) = "R2" THEN
               OUT 230, 1
             ELSEIF LEFT$(UCASE$(N$), 2) = "C1" THEN
               OUT 230, 2
             ELSEIF LEFT$(UCASE$(N$), 2) = "C2" THEN
               OUT 230, 3
             ELSEIF LEFT$(UCASE$(N$), 2) = "C3" THEN
               OUT 230, 4
             END IF
             CALL STEPX(x!)
                 FOR l = 1 TO 100
                   FOR k = 1 TO 100
                   NEXT k
                 NEXT l
             CALL STEPY(y!)
                 FOR l = 1 TO 100
                   FOR k = 1 TO 100
                   NEXT k
                 NEXT l
             CALL STEPAX(x!)
                 FOR l = 1 TO 100
                   FOR k = 1 TO 100
                   NEXT k
                 NEXT l
             CALL STEPAY(y!)
                 FOR l = 1 TO 100
                   FOR k = 1 TO 100
                   NEXT k
                 NEXT l

  CLS
      LOCATE 10, 12: PRINT "PUT YOUR COMPONENT"
     DO
     LOOP UNTIL INKEY$ <> ""
          NEXT I
       ELSE
          FOR I = 1 TO 249
```

```
   CLS
              LOCATE 12, 10: PRINT "NO SUCH DATA"
         DO
         LOOP UNTIL INKEY$ <> ""
           END SELECT
       END IF
        CLOSE #2
   CLS
              LOCATE 11, 18: PRINT "QUIT          - Y"
              LOCATE 13, 18: PRINT "CHECK AGAIN - N"
              LOCATE 20, 18: INPUT "ENTER  "; D$
          IF D$ = "N" THEN
   CLS
                 GOTO 2
          ELSE
          END IF
END SUB


SUB SAD
   COLOR 2
        PRINT "****************************************"
        PRINT
        PRINT "          SELECT BY NAIL          - N"
        PRINT
        PRINT "          SELECT BY COMP          - C"
        PRINT
        PRINT "          HELP                    - H"
        PRINT
        PRINT "****************************************"
        PRINT
        PRINT
        INPUT "INPUT MENU CODE"; MENU$
     SCREEN 2
       SELECT CASE UCASE$(MENU$)
         CASE "N"
           CALL SBN
         CASE "C"
           CALL SBC
         CASE "H"
           CALL HELP
         CASE "Q"
           END
         CASE ELSE
           BEEP
       END SELECT
 END SUB
```

```
SUB SBC
  CLS
  SCREEN 1
  COLOR 12

     INPUT " FOR SMT - S  &  FOR CON - M"; R$
  CLS
     IF R$ = "S" THEN
9         OPEN "smt.dat" FOR INPUT AS #1
           LOCATE 5, 1: INPUT "ENTER THE COMP NAME"; CO$
          FOR I = 1 TO 155
           INPUT #1, N$, C$, V$, T$, x!, y!
            IF MID$(N$, 4) = CO$ THEN
  COLOR 13
             CLS
             LOCATE 3, 2: PRINT "COMP"
             LOCATE 3, 10: PRINT MID$(N$, 4)
             LOCATE 5, 2: PRINT "CODE"
             LOCATE 5, 10: PRINT C$
             LOCATE 7, 2: PRINT "SPEC"
             LOCATE 7, 10: PRINT V$
             LOCATE 9, 2: PRINT "TOLE"
             LOCATE 9, 10: PRINT T$
             LOCATE 11, 2: PRINT "X Cord"
             LOCATE 11, 10: PRINT x!
             LOCATE 13, 2: PRINT "Y Cord"
             LOCATE 13, 10: PRINT y!
             ELSE
             END IF
          NEXT I
          CLOSE #1
             LOCATE 20, 1: PRINT "Press any key to continue...
            DO
             LOOP UNTIL INKEY$ <> ""
        CLS
             LOCATE 13, 18: PRINT "Quit  - Q"
             LOCATE 15, 18: PRINT "Check - C"
             LOCATE 20, 18: INPUT "Enter - "; FC$
               IF FC$ = "C" THEN
                  CLS
                  I = 1
                  GOTO 9
               ELSE
               END IF
        ELSE
          OPEN "man.dat" FOR INPUT AS #1
            LOCATE 5, 1: INPUT "ENTER THE COMP NAME"; CO$
           FOR I = 1 TO 248
            INPUT #1, I$, C$, N$, V$, T$, x!, y!
             IF N$ = CO$ THEN
```

```
 SUB SBN
  SCREEN 1
   COLOR 3
4 OPEN "sanju.dat" FOR INPUT AS #3
   INPUT "ENTER THE NAIL NUMBER"; A%
   IF A% <= 1239 THEN
    N% = 1221
    CLS
    PRINT
    LOCATE 1, 4: PRINT "************************************"
    PRINT
    LOCATE 3, 4: PRINT "Nail no      X coord       Y coord"
    LOCATE 5, 4: PRINT "************************************"
    PRINT
     FOR I = 1 TO N%
      INPUT #3, B%, cn$, S$, x!, y!
      IF B% = A% THEN GOTO 20
     NEXT I
 20 LOCATE 8, 5: PRINT B%: LOCATE 8, 17: PRINT x!: LOCATE 8, 3C
      ELSE
   CLS
   COLOR 3
        LOCATE 12, 13: PRINT "NO SUCH DATA...!"
      END IF
    DO
    LOOP UNTIL INKEY$ <> ""
        CLOSE #3
   CLS
        LOCATE 13, 18: PRINT "QUIT    - Q"
        LOCATE 15, 18: PRINT "CHECK   - C"
        LOCATE 20, 18: INPUT "ENTER    "; F$
     IF F$ = "C" THEN
   CLS
        I = 1
        GOTO 4
     ELSE
     END IF
        CLOSE #3
 END SUB
```

```
SUB CONDI (MA$, k%, ELE)
FOR I = 1 TO ELE
INPUT #k%, I$, N$, C$, T$, V$, x!, y!
IF MA$ = LEFT$(UCASE$(N$), 2) THEN
PRINT
PRINT "NAME    "; N$
PRINT
PRINT
PRINT "CODE    "; C$
PRINT
PRINT
PRINT "TOLERA "; T$
PRINT
PRINT
PRINT "VALUE   "; V$
PRINT
PRINT "X Cord "; x!
PRINT
PRINT
PRINT "Y Cord "; y!
LOCATE 20, 1: PRINT "Press any key to continue..."
DO
LOOP UNTIL INKEY$ <> ""
CLS
ELSE
END IF
NEXT I
END SUB
```

```
SUB STEPAY (x!)
   FO% = x% / 100 * 2.5
      FOR I = 1 TO FO%
         FOR j = 1 TO 8
            OUT 230, 246
            OUT 230, 176
            OUT 230, 252
            OUT 230, 176
            OUT 230, 249
            OUT 230, 176
            OUT 230, 243
            OUT 230, 176
         NEXT j
      NEXT I
END SUB
```

```
SUB STEPY (y!)
     FO% = y! / 100 * 2.5
        FOR I = 1 TO FO%
         FOR j = 1 TO 8
          OUT 230, 115
          OUT 230, 48
          OUT 230, 121
          OUT 230, 48
          OUT 230, 124
          OUT 230, 48
          OUT 230, 118
          OUT 230, 48
         NEXT j
        NEXT I
     DO
        LOOP UNTIL INKEY$ <> ""
END SUB


SUB STEPX (x!)
    FO% = x! / 100 * 2.5
        FOR I = 1 TO FO%
           FOR j = 1 TO 8
                OUT 230, 243
                OUT 230, 176
                OUT 230, 249
                OUT 230, 176
                OUT 230, 252
                OUT 230, 176
                OUT 230, 246
                OUT 230, 176
           NEXT j
        NEXT I
END SUB

SUB STEPAY (y!)
   FO% = y% / 100 * 2.5
      FOR I = 1 TO FO%
         FOR j = 1 TO 8
            OUT 230, 246
            OUT 230, 176
            OUT 230, 252
            OUT 230, 176
            OUT 230, 249
            OUT 230, 176
            OUT 230, 243
            OUT 230, 176
         NEXT j
      NEXT I
END SUB
```

```
SUB SMTDI (NA$, k%, ELE)
    FOR I = 1 TO ELE
   INPUT #k%, N$, C$, T$, V$, x!, y!
        IF NA$ = LEFT$(UCASE$(N$), 2) THEN
          PRINT
          PRINT "NAME              "; N$
          PRINT
          PRINT "CODE              "; C$
          PRINT
          PRINT "SIGNAL            "; S$
          PRINT
          PRINT "TOLERANCE         "; T$
          PRINT
          PRINT "VALUE             "; V$
          PRINT
          PRINT "X Coord.          "; x!
          PRINT
          PRINT "Y Coord.          "; y!
          LOCATE 20, 1: PRINT "Press any key to continue..."
        DO
          LOOP UNTIL INKEY$ <> ""
     CLS
        ELSE
        END IF
     NEXT I
 END SUB
```

```
       LOOP UNTIL INKEY$ <> ""
       CLS
        PRINT "4.INSERTION ASSEMBLY"
        PRINT "--------------------"
        PRINT
        PRINT "        When entered into this menu  you"
        PRINT
        PRINT "will  be  able  to  do  the  FIRST  LINE"
        PRINT
        PRINT "INSERTION ASSEMBLY by means of a stepper"
        PRINT
        PRINT "motor  arrangement,  which  locates  the"
        PRINT
        PRINT "X & Y  coordinates."
        LOCATE 23, 1: PRINT "Press any key to continue..."
       DO
       LOOP UNTIL INKEY$ <> ""
 END SUB


SUB INFO
  CLS
   SCREEN 1
   COLOR 13
        LOCATE 2, 15: PRINT ""
        LOCATE 4, 15
        PRINT "^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
        LOCATE 6, 10
        PRINT "PROJECT WORK DONE BY"
        LOCATE 8, 12
        PRINT "R.ARUMUGAM"
        LOCATE 10, 14
        PRINT "W.JOSEPH ANAND"
        LOCATE 12, 16
        PRINT "K.SANJITH KUMAR"
        LOCATE 14, 18
        PRINT "P.L.SATHISH KUMAR"
        LOCATE 16, 20
        PRINT "A.SHANMUGASUNDARAM"
        LOCATE 18, 14
        PRINT "EXTERNAL GUIDE - Mr.P.SATHISH KUMAR     "
        LOCATE 20, 14
        PRINT "INTERNAL GUIDE - Mrs.N.KALAIARASI B.E.,"
        LOCATE 22, 10
        PRINT "^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^"
       DO
       LOOP UNTIL INKEY$ <> ""
END SUB
```

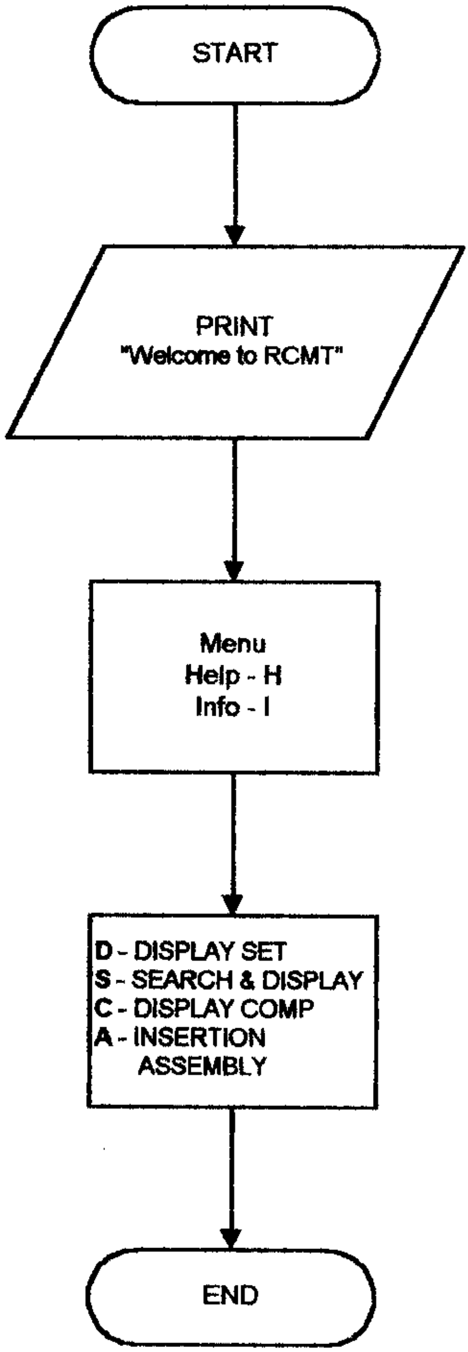
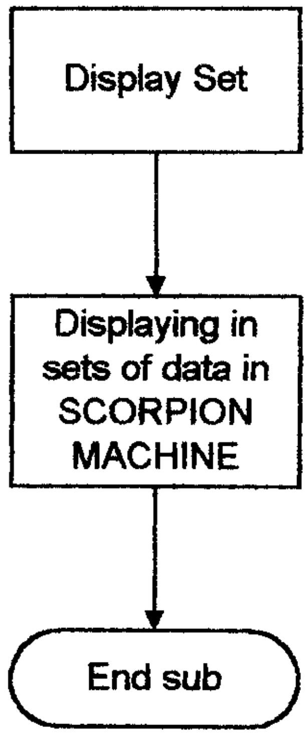


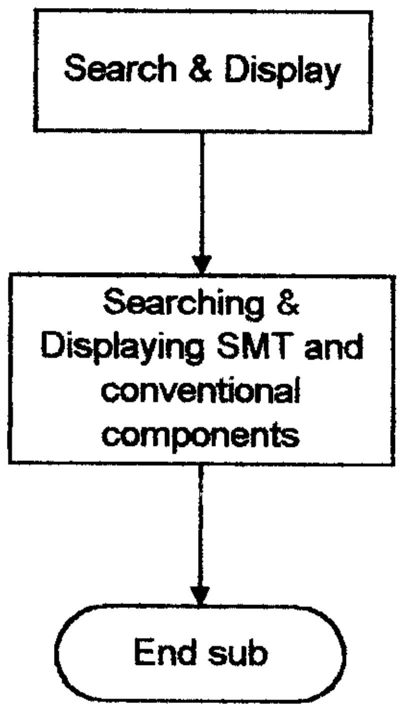
Fig.(4.1) Main program

Sub programs

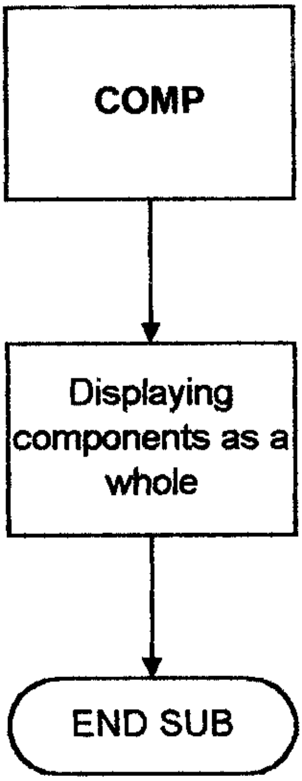
a.



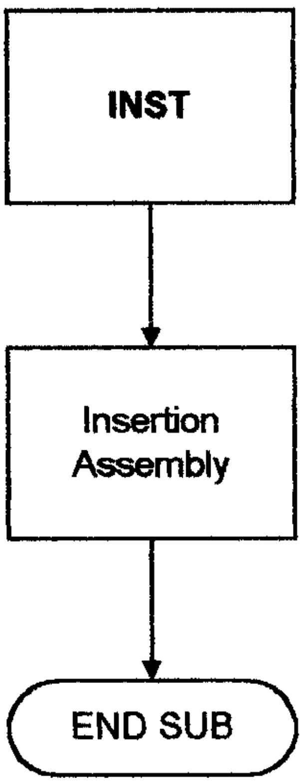
b.



a.


COMP
Displaying components as a whole
END SUB

b.


INST
Insertion Assembly
END SUB

Chapter 5
CONCLUSION

A **multipurpose test system** using Personal Computer, Input / Output card, Demultiplexer card and Stepper Motor interface card has been designed and fabricated . This system enables the location of Co-ordinates of RCMT board in OCB exchange quickly. A Software has been developed in QBASIC to control the functions of the test system.

The Multipurpose test system enables for performing Component Location and First Line Insertion Assembly. We modestly claim that the design meets Industrial Standards. The design which are based on digital Integrated Circuits is **quite flexible**.

During the course of development of the system, we reached a conclusion that the system developed is an **ideal tool** for the reduction of manual work. This process increases the usage and lifetime of Printed Circuit Boards (PCB) which are rejected when debugged manually. But, this is not the end of the road. Steps for **further development** of the system are also incorporated.

1) More user friendly, graphical oriented and **efficient package** could be developed.
2) **Full automation** by picking and placing using Robots.
3) Making testing method more simple by interfacing with the Scorpion Machine and using the **Scorpion software**.

REFERENCES

1) GAONKAR, "Microprocessor Architecture, programming and applications with the 8085/8080 A", Wiley Eastern Limited, New Delhi, 1992.

2) DOUGLAS V. HALL, "Microprocessors and Interfacing Programming and Hardware", McGraw Hill International Editions, Newyork, 1988.

3) STEVEN AND NAMEROFF, "QUICK BASIC the complete Reference", McGraw Hill International Editions, Newyork, 1989.

4) VINCENT DEL TORO, "Electrical machinery fundamentals", Prentice - Hall of India, New Delhi, 1988.

5) "Scorpion MDA manual",ALCATEL CIT, FRANCE.

6) "PC User Reference Manual",INTEL.

7) "OCB 283 Exchange Manual",ALCATEL CIT, FRANCE.

8) "PHILIPS data book", PHILIPS.

9) MORRIS MANO, "Digital logic and Computer Design",Prentice - Hall of India Private Ltd.,New Delhi,1995.

10) FLOYD, "Digital fundamentals",McGraw Hill International Editions, Newyork,1989.

APPENDIX

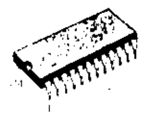
T54LS154
T74LS154

PRELIMINARY DATA

4-LINE-TO-16-LINE DECODERS/DEMULTIPLEXERS

DESCRIPTION

The T54LS/T74LS154 is a 4-line-to-16-line decoder. It provided decoding of four binary-coded inputs into one of sixteen mutually exclusive outputs when both the strobe inputs, E_1 and E_2, are in the low state. Each of the strobe input can be used as a data input to perform the demultiplexing function by using the 4 input lines to address the output line and having the other strobe input low. When either strobe input is high, all outputs are high.



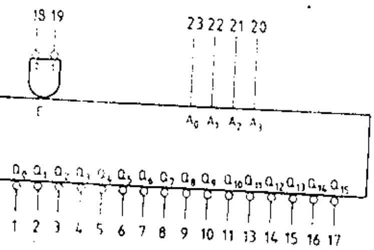
B1
Plastic Package

D1/D2
Ceramic Package

ORDERING NUMBERS:
T54LS154 D2
T74LS154 D1
T74LS154 B1

- DECODERS 4 BINARY-CODED INPUTS INTO ONE OF 16 MUTUALLY EXCLUSIVE OUTPUTS
- PERFORMS THE DEMULTIPLEXING FUNCTION BY DISTRIBUTING DATA FROM ONE INPUT LINE TO ANY ONE OF 16 OUTPUTS

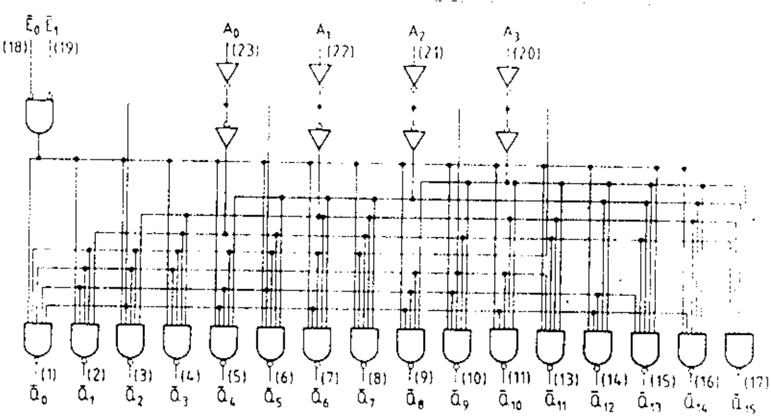
LOGIC SYMBOL



PIN CONNECTION
(top view)

DUAL IN LINE

LOGIC DIAGRAM



V_{CC} = Pin 24
GND = Pin 12
( ) = Pin numbers

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	-0.5 to 7	V
V_I	Input Voltage, Applied to Input	-0.5 to 7	V
V_O	Output Voltage, Applied to Output	0 to 5	V
I_I	Input Current, Into Inputs	30 to 1	mA
I_O	Output Current, Into Outputs	50	mA

Stresses in excess of those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions in excess of those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

GUARANTEED OPERATING RANGES

Part Numbers	Supply Voltage			Temperature
	Min	Typ	Max	
T54LS154D2	4.5 V	5.0 V	5.5 V	55°C to +125°C
T74LS154XX	4.75 V	5.0 V	5.25 V	0°C to +70°C

XX = package type.

T54LS154
T74LS154

TRUTH TABLE

INPUTS						OUTPUTS															
E_0	E_1	A_3	A_2	A_1	A_0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L

L = LOW Voltage Level
H = HIGH Voltage Level
X = Don't Care

AC WAVEFORMS

Fig. 1

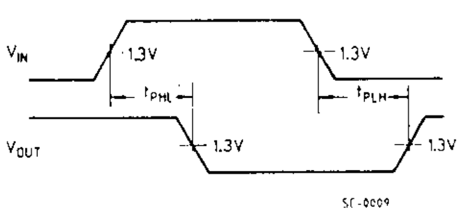
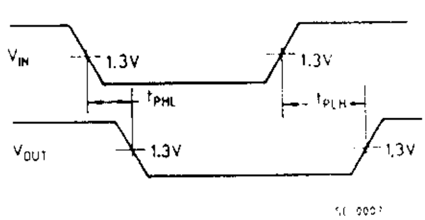


Fig. 2



DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE

Symbol	Parameter		Limits Min.	Typ.	Max.	Test Conditions (Note 1)		Units
V_{IH}	Input HIGH Voltage		2.0			Guaranteed input HIGH Voltage for all Inputs		V
V_{IL}	Input LOW Voltage	54			0.7	Guaranteed input LOW Voltage for all Inputs		V
		74			0.8			
V_{CD}	Input Clamp Diode Voltage				−1.5	V_{CC} = MIN, I_{IN} = −18mA		V
V_{OH}	Output HIGH Voltage	54	2.5	3.4		V_{CC} = MIN, I_{OH} = −400μA, V_{IN} = V_{IL}		V
		74	2.7	3.4				
V_{OL}	Output LOW Voltage	54,74		0.25	0.4	I_{OL} = 4.0mA	V_{CC} = MIN, V_{IN} = 2.0V	V
		74		0.35	0.5	I_{OL} = 8.0mA		
I_{IH}	Input HIGH Current				20 0.1	V_{CC} = MAX, V_{IN} = 2.7V V_{CC} = MAX, V_{IN} = 7.0V		μA mA
I_{IL}	Input LOW Current				−0.4	V_{CC} = MAX, V_{IN} = 0.4V		mA
I_{OS}	Output Short Circuit Current (Note 2)		−15		−100	V_{CC} = MAX		mA
I_{CC}	Power Supply Current (Note 3)				14	V_{CC} = MAX		mA

AC CHARACTERISTICS: $T_A = 25°C$

Symbol	Parameter	Limits Min.	Typ.	Max.	Test Conditions		Units
t_{PLH} t_{PHL}	Propagation Delay Address to output			36 33	Fig. 1	V_{CC} = 5.0V	ns
t_{PLH} t_{PHL}	Propagation Delay Enable to output			30 27	Fig. 2	C_L = 15pF, R_L = 2kΩ	ns

Notes:

1) For conditions shown as MIN or MAX, use the appropriate value specified under guaranteed operating ranges.
2) Not more than one output should be shorted at a time.
3) Measure I_{CC} with all inputs grounded and all output open.
4) Typical values are at V_{CC} = 5.0V, T_A = 25°C

Signetics

Logic Products

FAST 74F32
Gate

Quad Two-Input OR Gate
Product Specification

FUNCTION TABLE

INPUTS		OUTPUT
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	H

H = HIGH voltage level
L = LOW voltage level

TYPE	TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (TOTAL)
74F32	4.1ns	8.2mA

ORDERING CODE

PACKAGES	COMMERCIAL RANGE V_{CC} = 5V ± 10%; T_A = 0°C to +70°C
Plastic DIP	N74F32N
Plastic SO-14	N74F32D

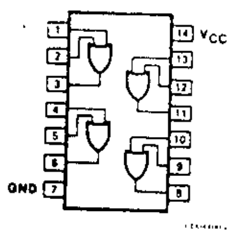
NOTES:
1. SO package is surface-mounted micro-miniature DIP.
2. For information regarding devices processed to Military Specifications, see the Signetics Military Product Data Manual.

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

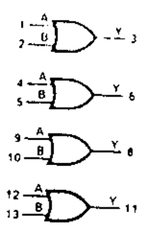
PINS	DESCRIPTION	74F(U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
A, B	Inputs	1.0/1.0	20μA/0.6mA
Y	Outputs	50/33	1.0mA/20mA

NOTE:
One (1.0) FAST Unit Load (U.L.) is defined as: 20μA in the HIGH state and 0.6mA in the LOW state.

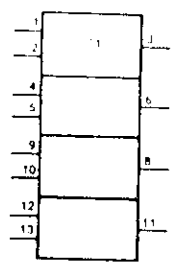
PIN CONFIGURATION



LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)



ABSOLUTE MAXIMUM RATINGS

(Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted, these limits are over the operating free-air temperature range.)

	PARAMETER	74F	UNIT
V_{CC}	Supply voltage	-0.5 to +7.0	V
V_{IN}	Input voltage	-0.5 to +7.0	V
I_{IN}	Input current	-30 to +5	mA
V_{OUT}	Voltage applied to output in HIGH output state	-0.5 to $+V_{CC}$	V
I_{OUT}	Current applied to output in LOW output state	40	mA
T_A	Operating free-air temperature range	0 to 70	°C

RECOMMENDED OPERATING CONDITIONS

	PARAMETER	74F Min	74F Nom	74F Max	UNIT
V_{CC}	Supply voltage	4.5	5.0	5.5	V
V_{IH}	HIGH-level input voltage	2.0			V
V_{IL}	LOW-level input voltage			0.8	V
I_{IK}	Input clamp current			-18	mA
I_{OH}	HIGH-level output current			-1	mA
I_{OL}	LOW-level output current			20	mA
T_A	Operating free-air temperature	0		70	°C

DC ELECTRICAL CHARACTERISTICS

(Over recommended operating free-air temperature range unless otherwise noted.)

	PARAMETER		TEST CONDITIONS[1]		74F32 Min	74F32 Typ[2]	74F32 Max	UNIT
V_{OH}	HIGH-level output voltage		V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN, I_{OH} = MAX	±10%V_{CC}	2.5			V
				±5%V_{CC}	2.7	3.4		V
V_{OL}	LOW-level output voltage		V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN, I_{OL} = MAX	±10%V_{CC}		.35	.50	V
				±5%V_{CC}		.35	.50	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = I_{IK}			-0.73	-1.2	V
I_I	Input clamp current at maximum input voltage		V_{CC} = MAX, V_I = 7.0V				100	µA
I_{IH}	HIGH-level input current		V_{CC} = MAX, V_I = 2.7V			1	20	µA
I_{IL}	LOW-level input current		V_{CC} = MAX, V_I = 0.5V			-0.4	-0.6	mA
I_{OS}	Short-circuit output current[3]		V_{CC} = MAX, V_O = 0.0V		-60	-90	-150	mA
I_{CC}	Supply current (total)	I_{CCH}	V_{CC} = MAX	V_{IN} = 4.5V		6.1	9.2	mA
		I_{CCL}		V_{IN} = GND		10.3	15.5	mA

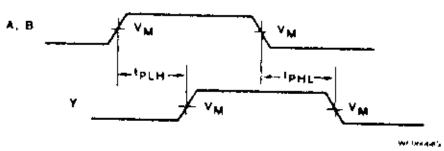
NOTES:
1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a HIGH output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

AC ELECTRICAL CHARACTERISTICS

PARAMETER		TEST CONDITIONS	74F32				
			$T_A = +25°C$ $V_{CC} = +5.0V$ $C_L = 50pF$ $R_L = 500\Omega$			$T_A = 0°C$ to $+70°C$ $V_{CC} = +5.0V \pm 10\%$ $C_L = 50pF$ $R_L = 500\Omega$	
			Min	Typ	Max	Min	Max
t_{PLH} t_{PHL}	Propagation delay A, B to Y	Waveform 1	3.0 3.0	4.2 4.0	5.6 5.3	3.0 3.0	6.6 6.3

NOTE:
Subtract 0.2ns from minimum values for SO package.

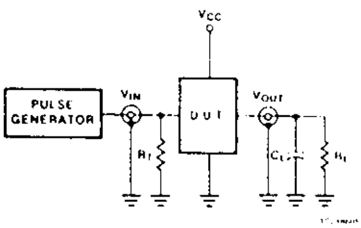
AC WAVEFORM



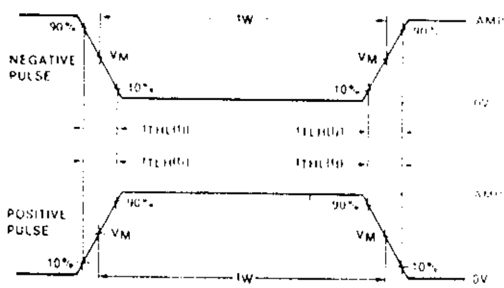
NOTE: For all waveforms, $V_M = 1.5V$.

Waveform 1. For Non-Inverting Outputs

TEST CIRCUIT AND WAVEFORMS



Test Circuit For Totem-Pole Outputs



$V_M = 1.5V$

Input Pulse Definition

DEFINITIONS
R_L = Load resistor; see AC CHARACTERISTICS for value.
C_L = Load capacitance includes jig and probe capacitance; see AC CHARACTERISTICS for value.
R_T = Termination resistance should be equal to Z_{OUT} of pulse generators

FAMILY	INPUT PULSE REQUIREMENTS			
	Amplitude	Rep. Rate	Pulse Width	t_{TLH}
74F	3.0V	1MHz	500ns	2.5ns

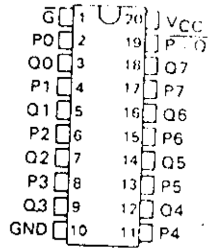
D2661, JUNE 1982 REVISED DECEMBER 1983

- Compares Two Eight-Bit Words
- Choice of Totem-Pole or Open-Collector Outputs
- Package Options Include Both Plastic and Ceramic Chip Carriers in Addition to Plastic and Ceramic DIPs
- Dependable Texas Instruments Quality and Reliability

TYPE	OUTPUT FUNCTION AND CONFIGURATION
'ALS688†	$\overline{P=Q}$ totem-pole
'ALS689	$\overline{P=Q}$ open-collector

†'ALS688 is identical to 'ALS521

SN54ALS688, SN54ALS689 . . . J PACKAGE
SN74ALS688, SN74ALS689 . . . N PACKAGE
(TOP VIEW)

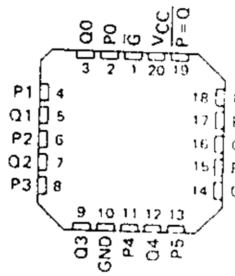


description

These identity comparators perform comparisons of two eight-bit binary or BCD words. The 'ALS688 and 'ALS689 provide $\overline{P=Q}$ outputs. The 'ALS688 has totem-pole outputs, while 'ALS689 has open-collector outputs.

The SN54ALS688 and SN54ALS689 are characterized for operation over the full military temperature range of −55 °C to 125 °C. The SN74ALS688 and SN74ALS689 are characterized for operation from 0 °C to 70 °C.

SN54ALS688, SN54ALS689 . . . FH PACKAGE
SN74ALS688, SN74ALS689 . . . FN PACKAGE
(TOP VIEW)

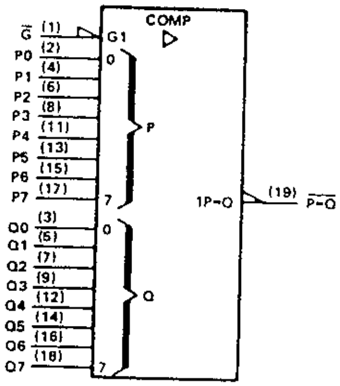


FUNCTION TABLE

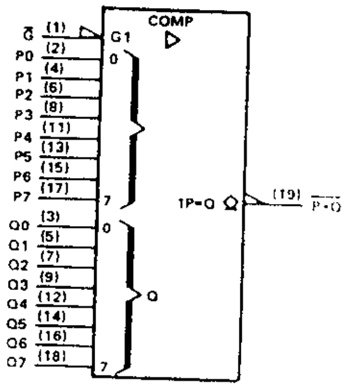
INPUTS DATA P, Q	INPUTS ENABLE $\overline{G}$	OUTPUT $\overline{P=Q}$
P = Q	L	L
P>Q	L	H
P<Q	L	H
X	H	H

logic symbols

'ALS688

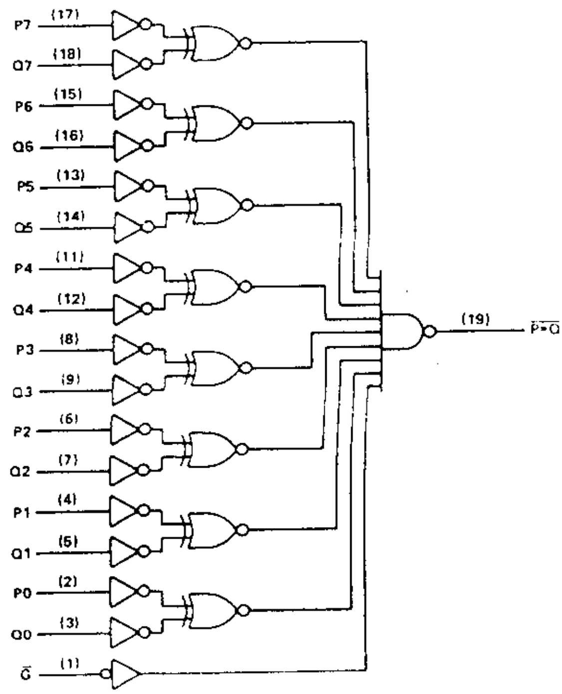


'ALS689



Pin numbers shown are for J and N packages.

logic diagram (positive logic)



Pin numbers shown are for J and N packages

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC}	7 V
Input voltage:	7 V
Off-state output voltage: 'ALS689	7 V
Operating free-air temperature range: SN54ALS688, SN54AS689	− 55 °C to 125 °C
SN74ALS688, SN74AS689	0 °C to 70 °C
Storage temperature range	− 65 °C to 150 °C

recommended operating conditions

		SN54ALS688 MIN	SN54ALS688 NOM	SN54ALS688 MAX	SN74ALS688 MIN	SN74ALS688 NOM	SN74ALS688 MAX	UNIT
V_{CC}	Supply voltage	4.5	5	5.5	[illegible]	[illegible]	[illegible]	V
V_{IH}	High-level input voltage	2			[illegible]			V
V_{IL}	Low-level input voltage			0.8			[illegible]	V
I_{OH}	High-level output current			1			[illegible]	mA
I_{OL}	Low-level output current			12			[illegible]	mA
T_A	Operating free-air temperature	55		125	[illegible]		[illegible]	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54ALS688 MIN	SN54ALS688 TYP†	SN54ALS688 MAX	SN74ALS688 MIN	SN74ALS688 TYP†	SN74ALS688 MAX	UNIT
V_{IK}	V_{CC} = 4.5 V,	I_I = 18 mA			1.5			1.5	V
V_{OH}	V_{CC} = 4.5 V to 5.5 V,	I_{OH} = 0.4 mA	V_{CC} 2			[illegible]			V
	V_{CC} = 4.5 V,	I_{OH} = 1 mA	2.4	3.3					
	V_{CC} = 4.5 V,	I_{OH} = 2.6 mA				2.4	[illegible]		
V_{OL}	V_{CC} = 4.5 V,	I_{OL} = 12 mA		0.25	0.4		0.25	[illegible]	V
	V_{CC} = 4.5 V,	I_{OL} = 24 mA					[illegible]	[illegible]	
I_I	V_{CC} = 5.5 V,	V_I = 7 V			0.1			[illegible]	mA
I_{IH}	V_{CC} = 5.5 V,	V_I = 2.7 V			20			[illegible]	μA
I_{IL}	V_{CC} = 5.5 V,	V_I = 0.4 V			0.1			[illegible]	mA
I_O‡	V_{CC} = 5.5 V,	V_O = 2.25 V	30		112	30		112	mA
I_{CC}	V_{CC} = 5.5 V	See Note 1		12	19		12	19	mA

† All typical values are at V_{CC} = 5 V, T_A = 25 °C.
‡ The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current.
NOTE 1: I_{CC} is measured with G grounded, P and Q at 4.5 V.

switching characteristics (see Note 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALS688 MIN	SN54ALS688 MAX	SN74ALS688 MIN	SN74ALS688 MAX	UNIT
			V_{CC} = 4.5 V to 5.5 V, C_L = 50 pF, R_L = 500 Ω, T_A = MIN to MAX				
t_{PLH}	P	$\overline{P=Q}$	3	16	3	12	ns
t_{PHL}			5	25	5	20	
t_{PLH}	Q	$\overline{P=Q}$	3	16	3	12	ns
t_{PHL}			5	25	5	20	
t_{PLH}	$\overline{G}$	$\overline{P=Q}$	3	15	3	12	ns
t_{PHL}			5	25	5	22	

NOTE 2: For load circuit and voltage waveforms, see page 1-12.

Signetics

FAST 74F245
Transceiver

Octal Transceiver (3-state)
Product Specification

Logic Products

FEATURES
- **Octal bidirectional bus interface**
- **3-State buffer outputs sink 64mA**
- **15mA source current**
- **Outputs are placed in Hi-Z state during power-off conditions**

DESCRIPTION
The 'F245 is an octal transceiver featuring noninverting 3-state bus compatible outputs in both send and receive directions. The B side outputs are all capable of sinking 64mA and sourcing up to 15mA, producing very good capacitive drive characteristics. The device features an Output Enable ($\overline{OE}$) input for easy cascading and a Send/Receive (T/$\overline{R}$) input for direction control. The 3-state outputs, $B_0 - B_7$, have been designed to prevent output bus loading if the power is removed from the device.

TYPE	TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (TOTAL)
74F245	3.8ns	100mA

ORDERING CODE

PACKAGES	COMMERCIAL RANGE $V_{CC} = 5V \pm 10\%; T_A = 0°C$ to $+70°C$
Plastic DIP	N74F245N
Plastic SOL-20	N74F245D

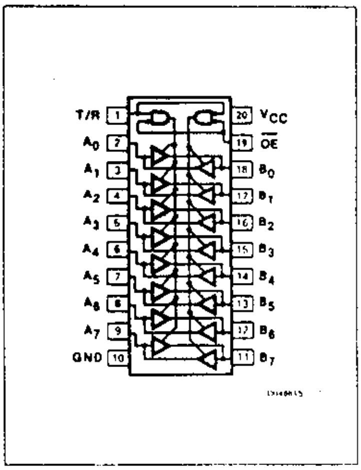
NOTES:
1. SO package is surface-mounted micro-miniature DIP.
2. For information regarding devices processed to Military Specifications, see the Signetics Military Products Data Manual.

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

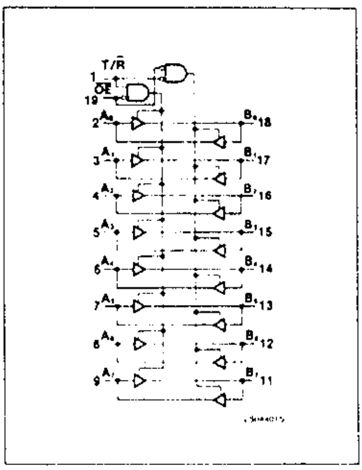
PINS	DESCRIPTION	74F(U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
$A_0 - A_7$	A Port data inputs	3.5/1.0	70μA/0.6mA
$B_0 - B_7$	B Port data inputs	3.5/1.0	70μA/0.6mA
$\overline{OE}$	Output enable input (active LOW)	2.0/2.0	40μA/1.2mA
T/$\overline{R}$	Transmit/Receive input	2.0/2.0	40μA/1.2mA
$A_0 - A_7$	A Port data outputs	150/40	3.0mA/24mA
$B_0 - B_7$	B Port data outputs	750/106.7	15mA/64mA

NOTE:
One (1.0) FAST Unit Load is defined as: 20μA in the HIGH state and 0.6mA in the LOW state.

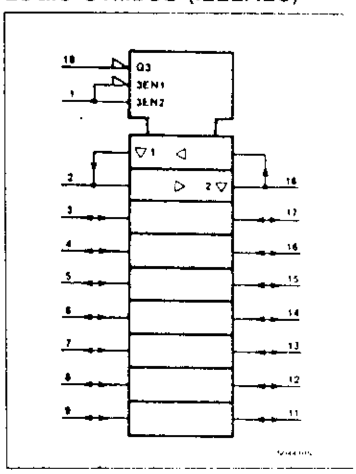
PIN CONFIGURATION



LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)



FUNCTION TABLE

INPUTS		INPUTS/OUTPUTS	
$\overline{OE}$	S/$\overline{R}$	A_n	B_n
L	L	A = B	INPUTS
L	H	INPUT	B = A
H	X	(Z)	(Z)

H = HIGH voltage level
L = LOW voltage level
X = Don't care
(Z) = HIGH impedance "off" state

ABSOLUTE MAXIMUM RATINGS

(Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted these limits are over the operating free-air temperature range.)

PARAMETER			74F	UNIT
V_{CC}	Supply voltage		−0.5 to +7.0	V
V_{IN}	Input voltage		−0.5 to +7.0	V
I_{IN}	Input current		−30 to +5	mA
V_{OUT}	Voltage applied to output in HIGH output state		−0.5 to +5.5	V
I_{OUT}	Current applied to output in LOW output state	$A_0 - A_7$	48	mA
		$B_0 - B_7$	128	mA
T_A	Operating free-air temperature range		0 to 70	°C

RECOMMENDED OPERATING CONDITIONS

PARAMETER			74F			UNIT
			Min	Nom	Max	
V_{CC}	Supply voltage		4.5	5.0	5.5	[illegible]
V_{IH}	HIGH-level input voltage		2.0			V
V_{IL}	LOW-level input voltage				[illegible]	
I_{IK}	Input clamp current				[illegible]	[illegible]
I_{OH}	HIGH-level output current	$A_0 - A_7$			[illegible]	[illegible]
		$B_0 - B_7$			[illegible]	[illegible]
I_{OL}	HIGH-level output current	$A_0 - A_7$			24	[illegible]
		$B_0 - B_7$			64	[illegible]
T_A	Operating free-air temperature		0		[illegible]	

6

DC ELECTRICAL CHARACTERISTICS (Over recommended operating free-air temperature range unless otherwise noted)

Symbol	Parameter		Test conditions[1]			74F245 Min	74F245 Typ[2]	74F245 Max	Unit
V_{OH}	HIGH-level output voltage	$A_0 - A_7$	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN	I_{OH} = −3mA	±10%V_{CC}	2.4			V
		$B_0 - B_7$			±5%V_{CC}	2.7	3.4		V
		$B_0 - B_7$		I_{OH} = −15mA	±10%V_{CC}	2.0			V
					±5%V_{CC}	2.0			V
V_{OL}	LOW-level output voltage	$A_0 - A_7$	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN	I_{OL} = 48mA	±10%V_{CC}		.35	.50	V
		$B_0 - B_7$		I_{OL} = 64mA	±5%V_{CC}		.40	.55	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, $I_I = I_{IK}$				−0.73	−1.2	V
I_I	Input current at maximum input voltage	$\overline{OE}$, T/$\overline{R}$	V_{CC} = MAX, V_I = 7.0V					100	μA
		$A_0 - A_7$, $B_0 - B_7$	V_{CC} = 5.5V, V_I = 5.5V					1.0	mA
I_{IH}	HIGH-level input current $\overline{OE}$ and T/$\overline{R}$ only		V_{CC} = MAX, V_I = 2.7V					40	μA
I_{IL}	LOW-level input current $\overline{OE}$ and T/$\overline{R}$ only		V_{CC} = MAX, V_I = 0.5V				−0.75	−1.2	mA
$I_{OZH} + I_{IH}$	Off-state current HIGH-level voltage applied		V_{CC} = MAX, $\overline{OE}$ = 2.0V, V_I = 2.7V				0	70	μA
$I_{OZL} + I_{IL}$	Off-state current LOW-level voltage applied		V_{CC} = MAX, $\overline{OE}$ = 2.0V, V_I = 0.5V					−600	μA
I_{OS}	Short-circuit output current[3]	$A_0 - A_7$	V_{CC} = MAX			−60		−150	mA
		$B_0 - B_7$				−100		−225	mA
I_{CC}	Supply current (total)	I_{CCH}	V_{CC} = MAX	V_{IN} = 4.5V			85	114	mA
		I_{CCL}		V_{IN} = GND			100	125	mA
		I_{CCZ}		V_{IN} = $\overline{OE}$ = 4.5V			110	140	mA

NOTES:

1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a HIGH output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

AC ELECTRICAL CHARACTERISTICS (When measured in accordance with the procedures outlined in Signetics LOGIC App Note 202, "Testing and Specifying FAST Logic.")

Symbol	Parameter	Test conditions	74F T_A = +25°C, V_{CC} = +5.0V, C_L = 50pF, R_L = 500Ω Min	Typ	Max	74F T_A = 0 to +70°C, V_{CC} = +5.0V ± 10%, C_L = 50pF, R_L = 500Ω Min	Max	Unit
t_{PLH} t_{PHL}	Propagation delay A_n to B_n or B_n to A_n	Waveform 1	2.5 2.5	3.5 4.0	5.5 6.0	2.5 2.5	6.5 7.0	ns
t_{PZH} t_{PZL}	Output enable time to HIGH and LOW level	Waveform 2 Waveform 3	5.0 3.5	7.0 6.5	8.5 8.0	5.0 3.5	9.5 9.0	ns
t_{PHZ} t_{PLZ}	Output disable time from HIGH and LOW level	Waveform 2 Waveform 3	3.0 2.0	4.5 4.0	6.5 6.0	3.0 2.0	7.5 7.0	ns

NOTE:

Subtract 0.2ns from minimum values for SO package.

DC ELECTRICAL CHARACTERISTICS (Over recommended operating free-air temperature range unless otherwise noted)

PARAMETER			TEST CONDITIONS[1]			74F245 Min	74F245 Typ[2]	74F245 Max	UNIT
V_{OH}	HIGH-level output voltage	$A_0 - A_7$	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN	I_{OH} = −3mA	±10%V_{CC}	2.4			V
		$B_0 - B_7$			±5%V_{CC}	2.7	3.4		V
		$B_0 - B_7$		I_{OH} = −15mA	±10%V_{CC}	2.0			V
					±5%V_{CC}	2.0			V
V_{OL}	LOW-level output voltage	$A_0 - A_7$	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN	I_{OL} = 48mA	±10%V_{CC}		.35	.50	V
		$B_0 - B_7$		I_{OL} = 64mA	±5%V_{CC}		.40	.55	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = I_{IK}				−0.73	−1.2	V
I_I	Input current at maximum input voltage	$\overline{OE}$, T/$\overline{R}$	V_{CC} = MAX, V_I = 7.0V					100	μA
		$A_0 - A_7$, $B_0 - B_7$	V_{CC} = 5.5V, V_I = 5.5V					1.0	mA
I_{IH}	HIGH-level input current $\overline{OE}$ and T/$\overline{R}$ only		V_{CC} = MAX, V_I = 2.7V					40	μA
I_{IL}	LOW-level input current $\overline{OE}$ and T/$\overline{R}$ only		V_{CC} = MAX, V_I = 0.5V				−0.75	−1.2	mA
I_{OZH} + I_{IH}	Off-state current HIGH-level voltage applied		V_{CC} = MAX, $\overline{OE}$ = 2.0V, V_I = 2.7V				0	70	μA
I_{OZL} + I_{IL}	Off-state current LOW-level voltage applied		V_{CC} = MAX, $\overline{OE}$ = 2.0V, V_I = 0.5V					−600	μA
I_{OS}	Short-circuit output current[3]	$A_0 - A_7$	V_{CC} = MAX			−60		−150	mA
		$B_0 - B_7$				−100		−225	mA
I_{CC}	Supply current (total)	I_{CCH}	V_{CC} = MAX	V_{IN} = 4.5V			85	114	mA
		I_{CCL}		V_{IN} = GND			100	125	mA
		I_{CCZ}		V_{IN} = $\overline{OE}$ = 4.5V			110	140	mA

NOTES:

1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a HIGH output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed las

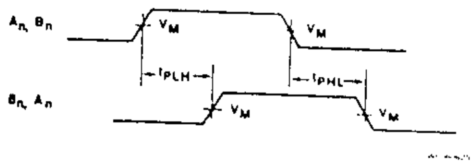
AC ELECTRICAL CHARACTERISTICS (When measured in accordance with the procedures outlined in Signetics LOGIC App Note 202, "Testing and Specifying FAST Logic.")

PARAMETER		TEST CONDITIONS	74F T_A = +25°C, V_{CC} = +5.0V, C_L = 50pF, R_L = 500Ω			74F T_A = 0 to +70°C, V_{CC} = +5.0V ±10%, C_L = 50pF, R_L = 500Ω		UNIT
			Min	Typ	Max	Min	Max	
t_{PLH} t_{PHL}	Propagation delay A_n to B_n or B_n to A_n	Waveform 1	2.5 2.5	3.5 4.0	5.5 6.0	2.5 2.5	6.5 7.0	ns
t_{PZH} t_{PZL}	Output enable time to HIGH and LOW level	Waveform 2 Waveform 3	5.0 3.5	7.0 6.5	8.5 8.0	5.0 3.5	9.5 9.0	ns
t_{PHZ} t_{PLZ}	Output disable time from HIGH and LOW level	Waveform 2 Waveform 3	3.0 2.0	4.5 4.0	6.5 6.0	3.0 2.0	7.5 7.0	ns

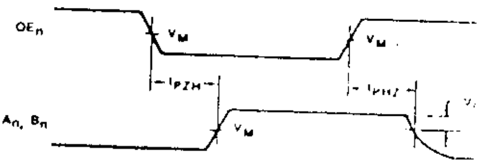
NOTE:

Subtract 0.2ns from minimum values for SO package.

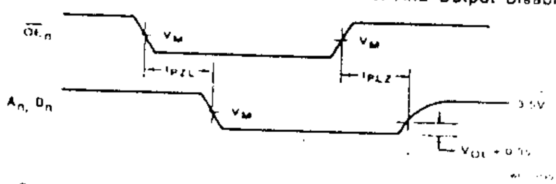
AC WAVEFORMS



Waveform 1. Propagation Delay Data To Output



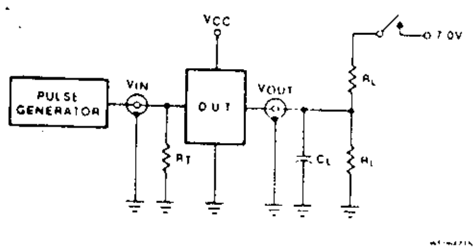
Waveform 2. 3-State Output Enable Time To HIGH Level And Output Disable Time From HIGH Level



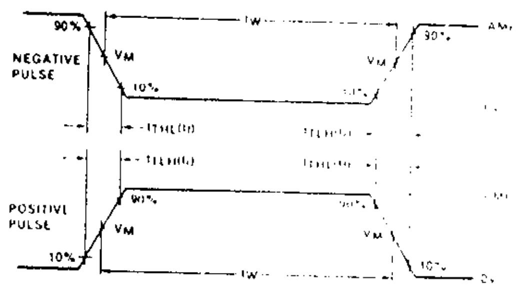
Waveform 3. 3-State Output Enable Time To LOW Level And Output Disable Time From LOW Level

NOTE: For all waveforms, V_M = 1.5V

TEST CIRCUIT AND WAVEFORMS



Test Circuit for 3-State Outputs



V_M = 1.5V

Input Pulse Definition

SWITCH POSITION

TEST	SWITCH
t_{PLZ}	closed
t_{PZL}	closed
All other	open

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

C_L = Load capacitance includes jig and probe capacitance; see AC CHARACTERISTICS for value.

R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	Pulse Width	t_r	t_f
74F	3.0V	1MHz	500ns	2.5ns	2.5ns

Signetics

FAST 74F00
Gate

Quad Two-Input NAND Gate
Product Specification

Logic Products

FUNCTION TABLE

INPUTS		OUTPUT
A	B	$\bar{Y}$
L	L	H
L	H	H
H	L	H
H	H	L

H = HIGH voltage level
L = LOW voltage level

TYPE	TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (TOTAL)
74F00	3.4ns	4.4mA

ORDERING CODE

PACKAGES	COMMERCIAL RANGE $V_{CC} = 5V \pm 10\%$; $T_A = 0°C$ to $+70°C$
Plastic DIP	N74F00N
Plastic SO-14	N74F00D

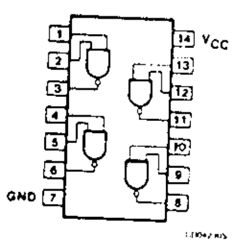
NOTES:
1. SO package is surface-mounted micro-miniature DIP.
2. For information regarding devices processed to Military Specifications, see the Signetics Military Products Data Manual.

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

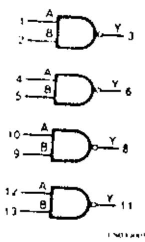
PINS	DESCRIPTION	74F(U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
A, B	Inputs	1.0/1.0	20μA/0.6mA
$\bar{Y}$	Output	50/33	1.0mA/20mA

NOTE:
One (1.0) FAST Unit Load is defined as: 20μA in the HIGH state and 0.6mA in the LOW state.

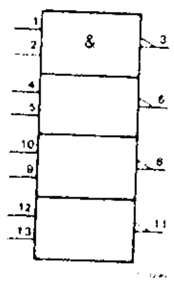
PIN CONFIGURATION



LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)



ABSOLUTE MAXIMUM RATINGS

(Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted these limits are over the operating free-air temperature range.)

	PARAMETER	74F	UNIT
V_{CC}	Supply voltage	-0.5 to +7.0	V
V_{IN}	Input voltage	-0.5 to +7.0	V
I_{IN}	Input current	-30 to +5	mA
V_{OUT}	Voltage applied to output in HIGH output state	-0.5 to $+V_{CC}$	V
I_{OUT}	Current applied to output in LOW output state	40	mA
T_A	Operating free-air temperature range	0 to 70	°C

RECOMMENDED OPERATING CONDITIONS

	PARAMETER	74F Min	74F Nom	74F Max	UNIT
V_{CC}	Supply voltage	4.5	5.0	5.5	V
V_{IH}	HIGH-level input voltage	2.0			V
V_{IL}	LOW-level input voltage			0.8	V
I_{IK}	Input clamp current			-18	mA
I_{OH}	HIGH-level output current			-1	mA
I_{OL}	LOW-level output current			20	mA
T_A	Operating free-air temperature	0		70	°C

DC ELECTRICAL CHARACTERISTICS

(Over recommended operating free-air temperature range unless otherwise noted.)

	PARAMETER	TEST CONDITIONS[1]		74F00 Min	74F00 Typ[2]	74F00 Max	UNIT
V_{OH}	HIGH-level output voltage	V_{CC} = MIN, V_{IL} = MAX, I_{OH} = MAX, V_{IH} = MIN	±10%V_{CC}	2.5			V
			±5%V_{CC}	2.7	3.4		V
V_{OL}	LOW-level output voltage	V_{CC} = MIN, V_{IL} = MAX, I_{OL} = MAX, V_{IH} = MIN	±10%V_{CC}		.35	.50	V
			±5%V_{CC}		.35	.50	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, $I_I = I_{IK}$			-0.73	-1.2	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 7.0V				100	µA
I_{IH}	HIGH-level input current	V_{CC} = MAX, V_I = 2.7V			1	20	µA
I_{IL}	LOW-level input current	V_{CC} = MAX, V_I = 0.5V			-0.4	-0.6	mA
I_{OS}	Short-circuit output current[3]	V_{CC} = MAX, V_O = 0.0V		-60	-80	-150	mA
I_{CC}	Supply current (total) I_{CCH}	V_{CC} = MAX	V_{IN} = GND		1.9	2.8	mA
	I_{CCL}		V_{IN} = 4.5V		6.8	10.2	mA

NOTES:

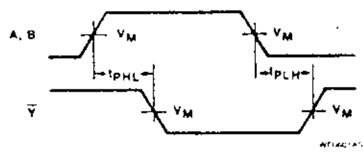
1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a HIGH output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

AC ELECTRICAL CHARACTERISTICS (When measured in accordance with the procedures outlined in Signetics LOGIC App Note 202 "Testing and Specifying FAST Logic")

PARAMETER		TEST CONDITIONS	74F00					UNIT
			$T_A = +25°C$, $V_{CC} = +5.0V$, $C_L = 50pF$, $R_L = 500\Omega$			$T_A = 0°C$ to $+70°C$, $V_{CC} = +5.0V \pm 10\%$, $C_L = 50pF$, $R_L = 500\Omega$		
			Min	Typ	Max	Min	Max	
t_{PLH} t_{PHL}	Propagation delay A, B to $\overline{Y}$	Waveform 1	2.4 2.0	3.7 3.2	5.0 4.3	2.4 2.0	6.0 5.3	ns

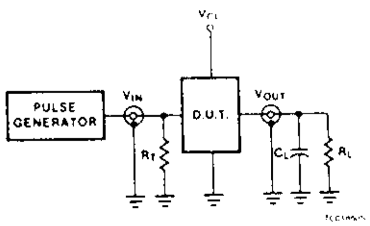
NOTE:
Subtract 0.2ns from minimum values for SO package.

AC WAVEFORM

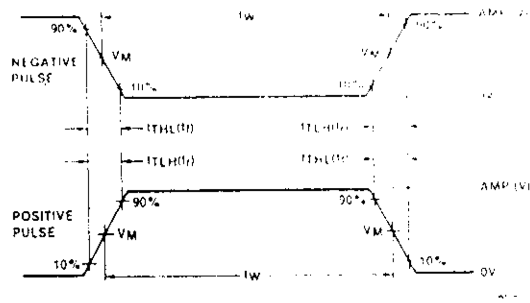


NOTE: For all waveforms, $V_M = 1.5V$.
Waveform 1. For Inverting Outputs

TEST CIRCUIT AND WAVEFORMS



Test Circuit For Totem-Pole Outputs



$V_M = 1.5V$
Input Pulse Definition

DEFINITIONS
R_L = Load resistor, see AC CHARACTERISTICS for value.
C_L = Load capacitance includes jig and probe capacitance, see AC CHARACTERISTICS for value.
R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	Pulse Width	t_{TLH}	t_{THL}
74F	3.0V	1MHz	500ns	2.5ns	2.5ns

Signetics

FAST 74F08
Gate

Quad Two-Input AND Gate
Product Specification

Logic Products

TYPE	TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (TOTAL)
74F08	4.1ns	7.1mA

ORDERING CODE

PACKAGES	COMMERCIAL RANGE $V_{CC} = 5V \pm 10\%$; $T_A = 0°C$ to $+70°C$
Plastic DIP	N74F08N
Plastic SO-14	N74F08D

NOTES:
1. SO package is surface-mounted micro-miniature DIP.
2. For information regarding devices processed to Military Specifications, see the Signetics Military Products Data Manual.

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

PINS	DESCRIPTION	74F(U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
A, B	Inputs	1.0/1.0	20μA/0.6mA
Y	Outputs	50/33	1.0mA/20mA

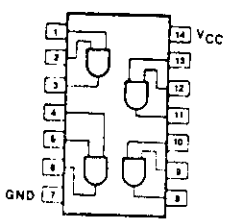
NOTE:
One (1.0) FAST Unit Load (U.L.) is defined as: 20μA in the HIGH state and 0.6mA in the LOW state.

FUNCTION TABLE

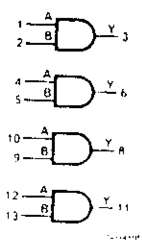
INPUTS		OUTPUT
A	B	Y
L	L	L
L	H	L
H	L	L
H	H	H

H = HIGH voltage level
L = LOW voltage level

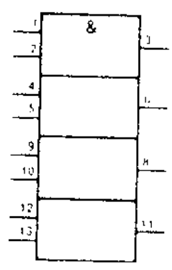
PIN CONFIGURATION



LOGIC SYMBOL



LOGIC SYMBOL (IEEE/IEC)



ABSOLUTE MAXIMUM RATINGS

(Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted, these limits are over the operating free-air temperature range.)

	PARAMETER	74F	UNIT
V_{CC}	Supply voltage	0.5 to +7.0	V
V_{IN}	Input voltage	-0.5 to +7.0	[illegible]
I_{IN}	Input current	-30 to +5	[illegible]
V_{OUT}	Voltage applied to output in HIGH output state	-0.5 to +V_{CC}	[illegible]
I_{OUT}	Current applied to output in LOW output state	40	[illegible]
T_A	Operating free-air temperature range	0 to 70	[illegible]

RECOMMENDED OPERATING CONDITIONS

	PARAMETER	74F Min	74F Nom	74F Max	UNIT
V_{CC}	Supply voltage	4.5	5.0	[illegible]	[illegible]
V_{IH}	HIGH-level input voltage	2.0			[illegible]
V_{IL}	LOW-level input voltage			0.8	[illegible]
I_{IK}	Input clamp current			-18	[illegible]
I_{OH}	HIGH-level output current			[illegible]	[illegible]
I_{OL}	LOW-level output current			20	[illegible]
T_A	Operating free-air temperature	0		70	[illegible]

DC ELECTRICAL CHARACTERISTICS

(Over recommended operating free-air temperature range unless otherwise noted.)

	PARAMETER	TEST CONDITIONS[1]		74F08 Min	74F08 Typ[2]	74F08 Max	UNIT
V_{OH}	HIGH-level output voltage	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN, I_{OH} = MAX	±10%V_{CC}	2.5			V
			±5%V_{CC}	2.7	3.4		V
V_{OL}	LOW-level output voltage	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN, I_{OL} = MAX	±10%V_{CC}		.35	[illegible]	V
			±5%V_{CC}		.35	.5	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = I_{IK}			-0.73	-1.2	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 7.0V			5	100	μA
I_{IH}	HIGH-level input current	V_{CC} = MAX, V_I = 2.7V				20	μA
I_{IL}	LOW-level input current	V_{CC} = MAX, V_I = 0.5V			0.4	0.6	mA
I_{OS}	Short-circuit output current[3]	V_{CC} = MAX, V_O = 0.0V		-60	-80	150	mA
I_{CC}	Supply current (total) I_{CCH}	V_{CC} = MAX	V_{IN} = 4.5V		5.5	8.3	mA
	I_{CCL}		V_{IN} = GND		8.6	12.9	mA

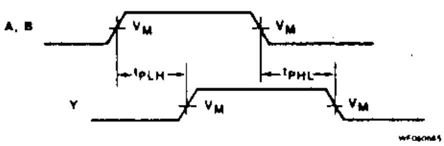
NOTES:
1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a HIGH output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, [illegible]

AC CHARACTERISTICS

PARAMETER		TEST CONDITIONS	74F08 $T_A = +25°C$, $V_{CC} = +5.0V$, $C_L = 50pF$, $R_L = 500\Omega$			74F08 $T_A = 0°C$ to $+70°C$, $V_{CC} = +5.0V \pm 10\%$, $C_L = 50pF$, $R_L = 500\Omega$		UNIT
			Min	Typ	Max	Min	Max	
t_{PLH} t_{PHL}	Propagation delay A, B to Y	Waveform 1	3.0 2.5	4.2 4.0	5.6 5.3	3.0 2.5	6.6 6.3	ns

NOTE:
Subtract 0.2ns from minimum values for SO package

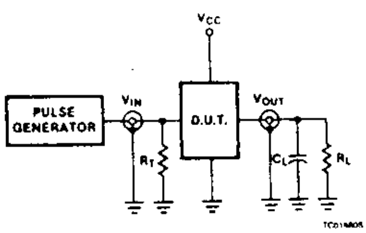
AC WAVEFORM



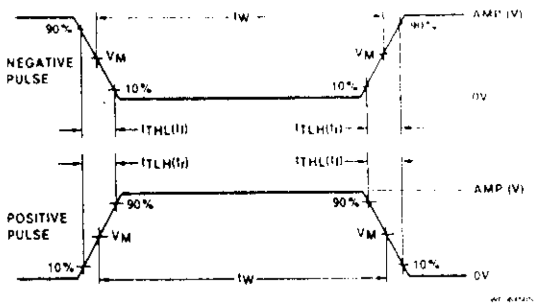
NOTE: For all waveforms, $V_M = 1.5V$

Waveform 1. For Non-Inverting Outputs

TEST CIRCUIT AND WAVEFORMS



Test Circuit For Totem-Pole Outputs



$V_M = 1.5V$

Input Pulse Definition

DEFINITIONS
R_L = Load resistor; see AC CHARACTERISTICS for value.
C_L = Load capacitance includes jig and probe capacitance; see AC CHARACTERISTICS for value.
R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	Pulse Width	t_{TLH}	t_{THL}
74F	3.0V	1MHz	500ns	2.5ns	2.5ns

Signetics

FAST 74F373, 74F374
Latches/Flip-Flops

'F373 Octal Transparent Latch (3-State)
'F374 Octal D Flip-Flop (3-State)
Product Specification

Logic Products

FEATURES

- **8-bit transparent latch – 'F373**
- **8-bit positive, edge-triggered register – 'F374**
- **3-State output buffers**
- **Common 3-State output enable**
- **Independent register and 3-state buffer operation**

DESCRIPTION

The 'F373 is an octal transparent latch coupled to eight 3-State output buffers. The two sections of the device are controlled independently by Enable (E) and Output Enable ($\overline{OE}$) control gates.

The data on the D inputs are transferred to the latch outputs when the Latch Enable (E) input is HIGH. The latch remains transparent to the data inputs while E is HIGH, and stores the data that is present one set-up time before the HIGH-to-LOW enable transition.

The 3-State output buffers are designed to drive heavily loaded 3-State buses, MOS memories, or MOS microprocessors. The active LOW Output Enable ($\overline{OE}$) controls all eight 3-State buffers independent of the latch operation.

TYPE	TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (TOTAL)
74F373	4.5ns	35mA
74F374	6.5ns	55mA

ORDERING CODE

PACKAGES	COMMERCIAL RANGE $V_{CC} = 5V \pm 10\%$; $T_A = 0°C$ to $+70°C$
Plastic DIP	N74F373N, N74F374N
Plastic SOL-20	N74F373D, N74F374D

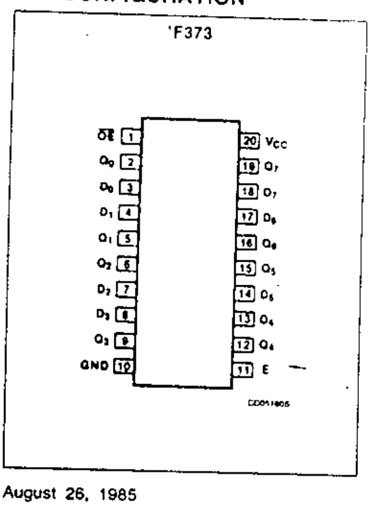
NOTES:
1. SO package is surface-mounted micro-miniature DIP.
2. For information regarding devices processed to Military Specifications, see the Signetics Military Products Data Manual.

INPUT AND OUTPUT LOADING AND FAN-OUT TABLE

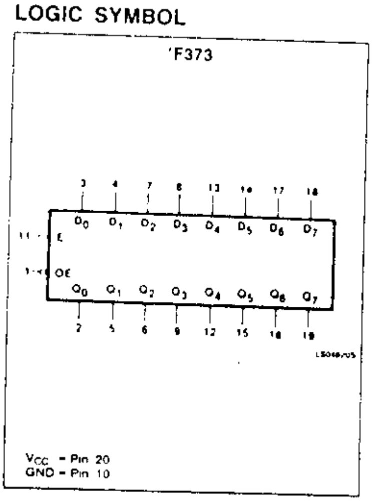
PINS	DESCRIPTION	74F(U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
$D_0 - D_7$	Data inputs	1.0/1.0	20μA/0.6mA
E ('F373)	Latch enable input (active HIGH)	1.0/1.0	20μA/0.6mA
$\overline{OE}$	Output enable input (active LOW)	1.0/1.0	20μA/0.6mA
CP ('F374)	Clock pulse input (active rising edge)	1.0/1.0	20μA/0.6mA
$Q_0 - Q_7$	3-State outputs	150/40	3mA/24mA

NOTE:
One (1.0) FAST Unit Load is defined as: 20μA in the HIGH state and 0.6mA in the LOW state.

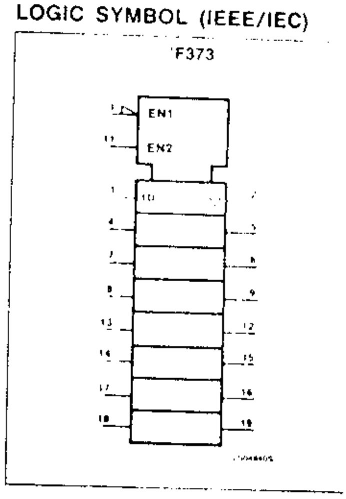
PIN CONFIGURATION



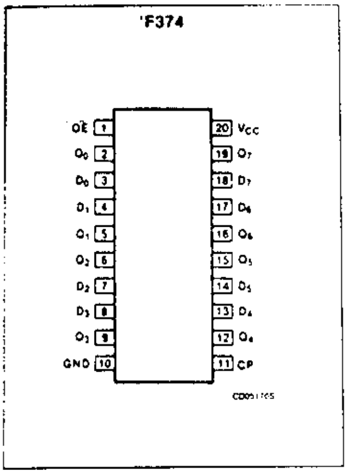
LOGIC SYMBOL



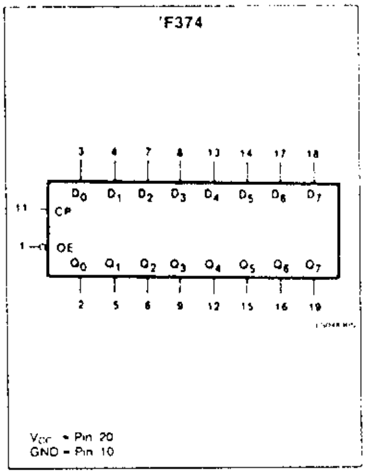
LOGIC SYMBOL (IEEE/IEC)



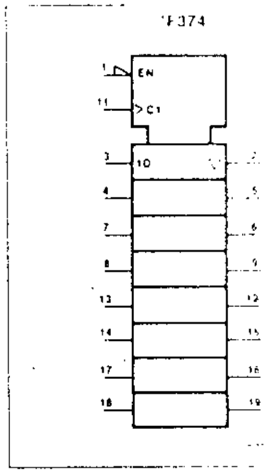
PIN CONFIGURATION



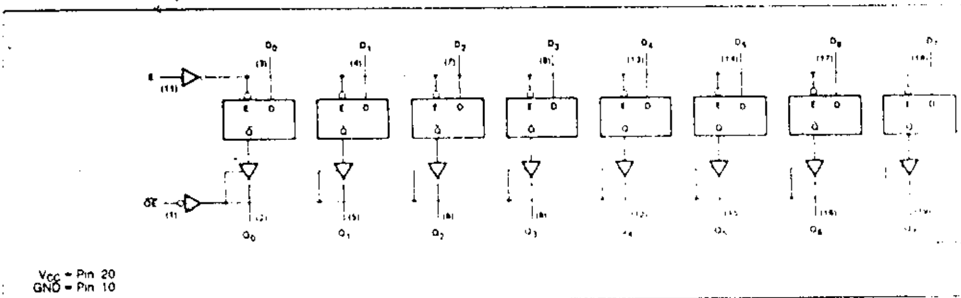
LOGIC SYMBOL



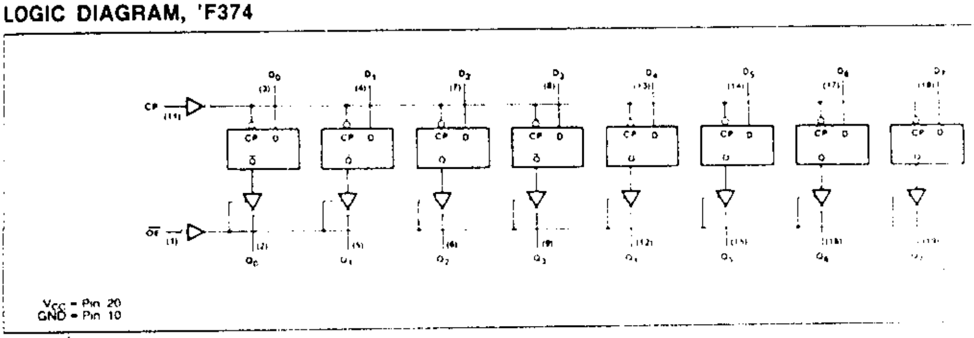
LOGIC SYMBOL (IEEE/IEC)



LOGIC DIAGRAM, 'F373



LOGIC DIAGRAM, 'F374



When $\overline{OE}$ is LOW, the latched or transparent data appears at the outputs. When $\overline{OE}$ is HIGH, the outputs are in the HIGH impedance "off" state, which means they will neither drive nor load the bus.

The 'F374 is an 8-bit, edge-triggered register coupled to eight 3-State output buffers. The two sections of the device are controlled independently by the Clock (CP) and Output Enable ($\overline{OE}$) control gates. The register is fully edge triggered. The state of each D input, one set-up time before the LOW-to-HIGH clock transition, is transferred to the corresponding flip-flop's Q output.

The 3-State output buffers are designed to drive heavily loaded 3-State buses, MOS memories, or MOS microprocessors. [illegible] tive LOW Output Enable ($\overline{OE}$) [illegible] eight 3-State buffers independent [illegible] register operation. When $\overline{OE}$ is LOW, [illegible] the register appears at the outputs. [illegible] is HIGH, the outputs are in the [illegible] ance "off" state, which [illegible] neither drive nor load the bus.

MODE SELECT — FUNCTION TABLE, 'F373

OPERATING MODES	INPUTS			INTERNAL REGISTER	OUTPUTS
	$\overline{OE}$	$\overline{E}$	D_n		$Q_0 - Q_7$
Enable and read register	L L	H H	X X	L H	L H
Latch and read register	L L	L L	l h	L H	L H
Latch register and disable outputs	H H	X X	X X	X X	(Z) (Z)

MODE SELECT — FUNCTION TABLE, 'F374

OPERATING MODES	INPUTS			INTERNAL REGISTER	OUTPUTS
	$\overline{OE}$	CP	D_n		$Q_0 - Q_7$
Load and read register	L L	↑ ↑	l h	L H	L H
Load register and disable outputs	H H	X X	X X	X X	(Z) (Z)

H = HIGH voltage level
h = HIGH voltage level one set-up time prior to the LOW-to-HIGH clock transition or HIGH-to-LOW $\overline{E}$ transition
L = LOW voltage level
X = Don't care
l = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition or HIGH-to-LOW $\overline{E}$ transition
(Z) = HIGH impedance "off" state
↑ = LOW-to-HIGH clock transition

ABSOLUTE MAXIMUM RATINGS (Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted these limits are over the operating free-air temperature range.)

	PARAMETER	74F	UNIT
V_{CC}	Supply voltage	−0.5 to +7.0	V
V_{IN}	Input voltage	−0.5 to +7.0	V
I_{IN}	Input current	−30 to +5	mA
V_{OUT}	Voltage applied to output in HIGH output state	−0.5 to +5.5	V
I_{OUT}	Current applied to output in LOW output state	40	mA
T_A	Operating free-air temperature range	0 to 70	°C

RECOMMENDED OPERATING CONDITIONS

	PARAMETER	74F Min	74F Nom	74F Max	UNIT
V_{CC}	Supply voltage	4.5	5.0	5.5	V
V_{IH}	HIGH-level input voltage	2.0			V
V_{IL}	LOW-level input voltage			0.8	V
I_{IK}	Input clamp current			−18	mA
I_{OH}	HIGH-level output current			−1	mA
I_{OL}	LOW-level output current			20	mA
T_A	Operating free-air temperature	0		70	°C

Latches/Flip-Flops

FAST 74F373, 74F374

DC ELECTRICAL CHARACTERISTICS (Over recommended operating free-air temperature range unless otherwise noted.)

	PARAMETER	TEST CONDITIONS[1]			74F373, 'F374 Min	Typ[2]	Max	UNIT
V_{OH}	HIGH-level output voltage	V_{CC} = MIN, V_{IL} = MAX, I_{OH} = MAX, V_{IH} = MIN		±10%V_{CC}	2.4			[illegible]
				±5%V_{CC}	[illegible]			[illegible]
V_{OL}	LOW-level output voltage	V_{CC} = MIN, V_{IL} = MAX, I_{OL} = MAX, V_{IH}=MIN,		±10%V_{CC}		.35	[illegible]	V
				±5%V_{CC}		.35	[illegible]	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = I_{IK}				−0.73	−1.2	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 7.0V					100	μA
I_{IH}	HIGH-level input current	V_{CC} = MAX, V_I = 2.7V					20	μA
I_{IL}	LOW-level input current	V_{CC} = MAX, V_I = 0.5V					−0.6	mA
I_{OZH}	Off-state output current, HIGH-level voltage applied	V_{CC} = MAX, V_{IH} = MIN, V_O = 2.4V					50	μA
I_{OZL}	Off-state output current, LOW-level voltage applied	V_{CC} = MAX, V_{IH} = MIN, V_O = 0.5V					−50	μA
I_{OS}	Short-circuit output current[3]	V_{CC} = MAX, V_O = 0.0V			−60		−150	mA
I_{CC}	Supply current (total) 'F373	V_{CC} = MAX	I_{CCZ}	$\overline{OE}$ = 4.5V, D inputs = E = GND		[illegible]		mA
	Supply current (total) 'F374	V_{CC} = MAX	I_{CCZ}	CP = $\overline{OE}$ = 4.5V, D inputs = GND		57	[illegible]	mA

NOTES:

1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_A = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a HIGH output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

AC ELECTRICAL CHARACTERISTICS (When measured in accordance with the procedures outlined in Signetics LOGIC App Note 202, "Testing and Specifying FAST Logic.")

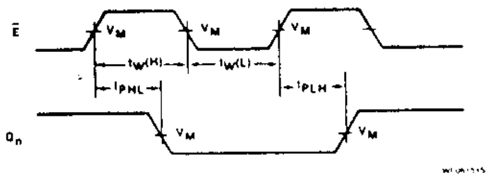
Symbol	Parameter		Test Conditions	74F373, 'F374 $T_A = +25°C$, $V_{CC} = +5.0V$, $C_L = 50pF$, $R_L = 500\Omega$ Min	Typ	Max	$T_A = 0°C$ to $+70°C$, $V_{CC} = +5.0V \pm 10\%$, $C_L = 50pF$, $R_L = 500\Omega$ Min	Max	UNIT
f_{MAX}	Maximum clock frequency	'F374	Waveform 6	100			70		MHz
t_{PLH} t_{PHL}	Propagation delay E to Q_n	'F373	Waveform 1	3.0 2.0	9.0 4.0	11.5 7.0	5.0 [illegible]	13.0 [illegible]	
t_{PLH} t_{PHL}	Propagation delay D_n to Q_n	'F373	Waveform 4	3.0 2.0	5.3 3.7	7.0 5.0	3.0 2.0	[illegible] 6.0	
t_{PLH} t_{PHL}	Propagation delay CP to Q_n	'F374	Waveform 6	4.0 4.0	6.5 6.5	8.5 8.5	4.0 4.0	10.0 10.0	ns
t_{PZH}	Output enable time to HIGH level	'F373 'F374	Waveform 2	2.0 2.0	5.0 9.0	11.0 11.5	2.0 2.0	12.0 12.5	ns
t_{PZL}	Output enable time to LOW level	'F373 'F374	Waveform 3	2.0 2.0	5.6 5.3	7.5 7.5	2.0 2.0	8.5 8.5	ns
t_{PHZ}	Output disable time from HIGH level	'F373 'F374	Waveform 2	2.0 2.0	4.5 5.3	6.5 7.0	2.0 2.0	7.5 8.0	ns
t_{PLZ}	Output disable time from LOW level	'F373 'F374	Waveform 3	2.0 2.0	3.8 4.3	5.0 5.5	2.0 2.0	6.0 6.5	ns

AC SET-UP REQUIREMENTS

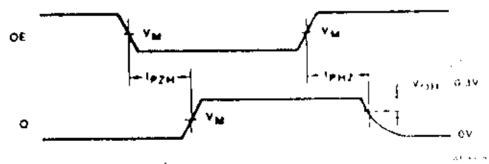
Symbol	Parameter		Test Conditions	74F373, 'F374 $T_A = +25°C$, $V_{CC} = +5.0V$, $C_L = 50pF$, $R_L = 500\Omega$ Min	Typ	Max	$T_A = 0°C$ to $+70°C$, $V_{CC} = +5.0V \pm 10\%$, $C_L = 50pF$, $R_L = 500\Omega$ Min	Max	UNIT
$t_s(H)$ $t_s(L)$	Set-up time, HIGH or LOW D_n to E	'F373	Waveform 5	2.0 2.0			2.0 2.0		ns
$t_h(H)$ $t_h(L)$	Hold time, HIGH or LOW D_n to E	'F373	Waveform 5	3.0 3.0			3.0 3.0		ns
$t_w(H)$ $t_w(L)$	Clock pulse width	'F374	Waveform 6	7.0 6.0			7.0 6.0		ns
$t_s(H)$ $t_s(L)$	Set-up time, HIGH or LOW D_n to CP	'F374	Waveform 7	2.0 2.0			2.0 2.0		
$t_h(H)$ $t_h(L)$	Hold time, HIGH or LOW D_n to CP	'F374	Waveform 7	2.0 2.0			[illegible] [illegible]		ns
$t_w(H)$	Latch enable pulse width	'F373	Waveform 1	6.0			[illegible]		ns

NOTE:
Subtract 0.2ns from minimum values for SO package

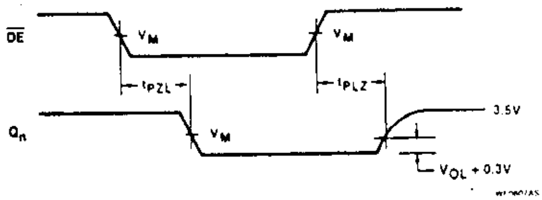
AC WAVEFORMS



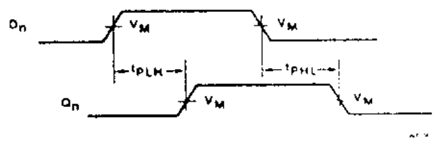
Waveform 1. Latch Enable To Output Delays And Latch Enable Pulse Width



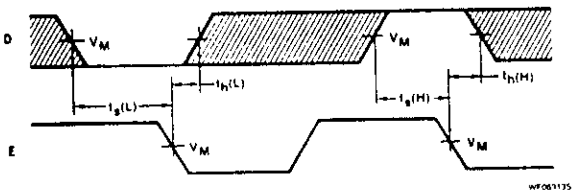
Waveform 2. 3-State Output Enable Time To HIGH Level And Output Disable Time From HIGH Level



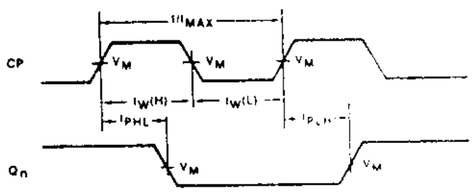
Waveform 3. 3-State Output Enable Time To LOW Level And Output Disable Time From LOW Level



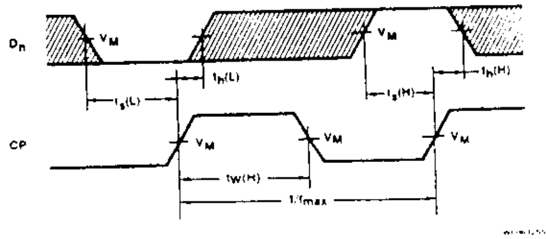
Waveform 4. Propagation Delay Data To Q Outputs



Waveform 5. Data Set-up And Hold Times



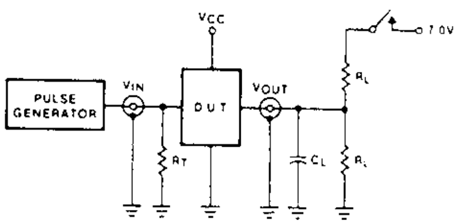
Waveform 6. Clock To Output Delays And Pulse Width



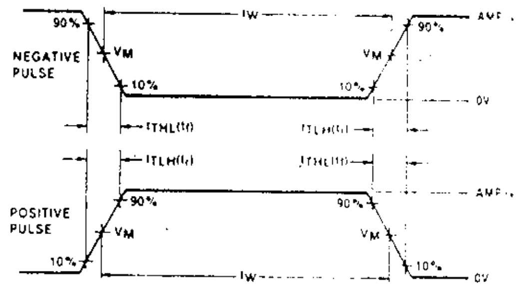
Waveform 7. Data Set-up And Hold Times

NOTE: For all waveforms, $V_M = 1.5V$
The shaded areas indicate when the input is permitted to change for predictable output performance.

TEST CIRCUIT AND WAVEFORMS



Test Circuit For 3-State Outputs



$V_M = 1.5V$

Input Pulse Definition

SWITCH POSITION

TEST	SWITCH
t_{PLZ}	closed
t_{PZL}	closed
All other	open

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

C_L = Load capacitance includes jig and probe capacitance; see AC CHARACTERISTICS for value.

R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	Pulse Width	t_{TLH}	t_{THL}
74F	3.0V	1MHz	500ns	2.5ns	2.5ns

```
"CI","SRAM2KXB","U1505","CI.MEM","2KX8EB"," - ",1.8,7.6
"CI","SRAM2KXB","U1605","CI.MEM","2KX8EB"," - ",1.4,7.6
"CI","SRAM2KXB","SRAM2KXB","CI.MEM","2KX8EB"," - ",4.85,9.25
"CI","SRAM2KXB","SRAM2KXB","CI.MEM","2KX8EB"," - ",4.4,9.25
"CI","SRAM2KXB","U0302","CI.MEM","2KX8EB"," - ",8,11.5
"CI","SRAM2KXB","U0402","CI.MEM","2KX8EB"," - ",7.6,11.5
"CI","SRAM2KXB","U0502","CI.MEM","2KX8EB"," - ",6.7,11.5
"CI","SRAM2KXB","U0602","CI.MEM","2KX8EB"," - ",6.3,11.5
"CI","SRAM2KXB","U1302","CI.MEM","2KX8EB"," - ",3,11.5
"CI","SRAM2KXB","U1402","CI.MEM","2KX8EB"," - ",2,11.5
"CI","SRAM2KXB","U1502","CI.MEM","2KX8EB"," - ",1.8,11.5
"CI","SRAM2KXB","U1602","CI.MEM","2KX8EB"," - ",1.3,11.5
"CI","SRAM2KXB","U0901","CI.MEM","2KX8EB"," - ",5.2,12.6
"CI","SRAM2KXB","U1001","CI.MEM","2KX8EB"," - ",4.8,12.6
"CI","SRAM2KXB","U0305","CI.MEM","2KX8EB"," - ",8,7.6
"CI","SRAM2KXB","U0405","CI.MEM","2KX8EB"," - ",7.6,7.6
"CI","SRAM2KXB","U0505","CI.MEM","2KX8EB"," - ",6.7,7.6
"CI","SRAM2KXB","U0605","CI.MEM","2KX8EB"," - ",6.3,7.6
"L4","AC299","U0105","IC.LOGIQ","74AC299"," - ",8.8,7.6
"L4","AC299","U0205","IC.LOGIQ","74AC299"," - ",8.4,7.6
"L1","AC14","U1805","IC.LOGIQ","74AC14"," - ",.35,7.4
"LA","LARIOP","U0705","LARA.ACTIV","30NS"," 5% ",5.9,7.4
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"C2","ACT374","U1406","CI.LOGIQUE","74ACT374"," - ",2.5,9.4
"C2","ACT374","U1506","CI.LOGIQUE","74ACT374"," - ",1.8,9.4
"C2","ACT374","U1606","CI.LOGIQUE","74ACT374"," - ",1.3,9.4
"R6","RESISTOR","R214","RESISTOR","200 O"," 5% ",.4,6.6
"R4","RESISTOR","R212","RESISTOR","10 K"," 5% ",.3,6.6
"D2","DIODE","D200","DIODE","1N4148"," - ",.2,6.6
"R3","RESISTOR","R603","RESISTOR","22H"," 5% ",3.6,8.25
"R3","RESISTOR","R602","RESISTOR","22H"," 5% ",3.6,8.15
"R3","RESISTOR","R612","RESISTOR","22H"," 5% ",3.6,8.05
"R3","RESISTOR","R611","RESISTOR","22H"," 5% ",3.6,7.95
"R3","RESISTOR","R605","RESISTOR","22H"," 5% ",3.6,7.85
"R3","RESISTOR","R604","RESISTOR","22H"," 5% ",3.6,7.75
"R3","RESISTOR","R601","RESISTOR","22H"," 5% ",3.6,7.65
"R3","RESISTOR","R600","RESISTOR","22H"," 5% ",3.6,7.55
"R3","RESISTOR","R609","RESISTOR","22H"," 5% ",3.6,7.45
"R3","RESISTOR","R607","RESISTOR","22H"," 5% ",3.6,7.35
"R3","RESISTOR","R236","RESISTOR","22H"," 5% ",3.6,7.25
"R3","RESISTOR","R235","RESISTOR","22H"," 5% ",3.6,7.15
"R3","RESISTOR","R233","RESISTOR","22H"," 5% ",5.8,8.35
"R3","RESISTOR","R234","RESISTOR","22H"," 5% ",5.8,8.25
"R3","RESISTOR","R237","RESISTOR","22H"," 5% ",5.8,8.15
"R3","RESISTOR","R226","RESISTOR","22H"," 5% ",5.8,8.05
"R8","RESISTOR","R228","RESISTOR","120H"," 5% ",.5,8.3
"R8","RESISTOR","R227","RESISTOR","120H"," 5% ",.4,8.3
"R7","RESISTOR","R213","RESISTOR","1M"," 5% ",.3,8.3
"R3","RESISTOR","R229","RESISTOR","22H"," 5% ",5.3,9.1
"R3","RESISTOR","R230","RESISTOR","22H"," 5% ",5.2,9.1
"R3","RESISTOR","R231","RESISTOR","22H"," 5% ",4.1,9.1
"R3","RESISTOR","R232","RESISTOR","22H"," 5% ",4,9.1
"R3","RESISTOR","R800","RESISTOR","22H"," 5% ",5.4,9.9
"R3","RESISTOR","R806","RESISTOR","22H"," 5% ",5.2,9.9
"R3","RESISTOR","R801","RESISTOR","22H"," 5% ",4.1,9.9
"R3","RESISTOR","R807","RESISTOR","22H"," 5% ",4,9.9
"R3","RESISTOR","R809","RESISTOR","22H"," 5% ",3.9,9.9
"R3","RESISTOR","R810","RESISTOR","22H"," 5% ",5.9,11.1
"R3","RESISTOR","R804","RESISTOR","22H"," 5% ",5.5,11.2
"R3","RESISTOR","R805","RESISTOR","22H"," 5% ",3.1,11.2
"R3","RESISTOR","R811","RESISTOR","22H"," 5% ",3.5,11.2
"R3","RESISTOR","R812","RESISTOR","22H"," 5% ",3.5,11.8
"R3","RESISTOR","R803","RESISTOR","22H"," 5% ",5.3,13
"R3","RESISTOR","R802","RESISTOR","22H"," 5% ",5.3,12.3
"R3","RESISTOR","R610","RESISTOR","22H"," 5% ",5.5,7.6
"R3","RESISTOR","R606","RESISTOR","22H"," 5% ",5.45,7
"GE","CAPACITOR","C200","GENSENGATE","63V 470NF"," - ",.4,8.75
"CI","SRAM2KXB","U1305","CI.MEM","2KX8EB"," - ",3.2,7.6
"CI","SRAM2KXB","U1405","CI.MEM","2KX8EB"," - ",2.8,7.6
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"CN","DS26C32C","U1508","CI.INTERF","DS26C32C"," - ",1.8,3.9
"CN","DS26C32C","U1608","CI.INTERF","DS26C32C"," - ",1.4,3.9
"CN","DS26C32C","U1708","CI.INTERF","DS26C32C"," - ",1,3.9
"CN","DS26C32C","U1808","CI.INTERF","DS26C32C"," - ",.6,3.9
"S1","V12","V12","SIL","3.3 KOHMS"," - ",8.95,5.4
"R5","RESISTOR","R403","RESISTOR","100H"," 5% ",.6,4.85
"RG","RGTR0","RGTR0","RGTR2"," - "," - ",8,5.1
"RG","RGTR1","RGTR1","RGTR2"," - "," - ",6.2,5.1
"R3","RESISTOR","R1103","RESISTOR","22H"," 5% ",4.95,5.65
"R3","RESISTOR","R1104","RESISTOR","22H"," 5% ",4.95,5.55
"R3","RESISTOR","R1105","RESISTOR","22H"," 5% ",4.95,5.45
"R3","RESISTOR","R1106","RESISTOR","22H"," 5% ",4.95,5.35
"R3","RESISTOR","R1020","RESISTOR","22H"," 5% ",4.95,5.25
"R3","RESISTOR","R1021","RESISTOR","22H"," 5% ",4.95,5.15
"R3","RESISTOR","R1014","RESISTOR","22H"," 5% ",4.95,5.05
"R3","RESISTOR","R1013","RESISTOR","22H"," 5% ",4.95,4.95
"R5","RESISTOR","R402","RESISTOR","100H"," 5% ",4.95,4.85
"R1","RESISTOR","R406","RESISTOR","100K"," 5% ",4.95,4.75
"R1","RESISTOR","R407","RESISTOR","100K"," 5% ",4.95,4.65
"R3","RESISTOR","R1100","RESISTOR","22H"," 5% ",4.35,5.65
"R3","RESISTOR","R702","RESISTOR","22H"," 5% ",4.35,5.55
"R3","RESISTOR","R701","RESISTOR","22H"," 5% ",4.35,5.45
"R3","RESISTOR","R1019","RESISTOR","22H"," 5% ",4.35,5.35
"R3","RESISTOR","R1016","RESISTOR","22H"," 5% ",4.35,5.25
"R3","RESISTOR","R1017","RESISTOR","22H"," 5% ",4.35,5.15
"R3","RESISTOR","R1018","RESISTOR","22H"," 5% ",4.35,5.05
"R5","RESISTOR","R400","RESISTOR","100H"," 5% ",4.35,4.85
"R1","RESISTOR","R404","RESISTOR","100K"," 5% ",4.35,4.75
"R1","RESISTOR","R405","RESISTOR","100K"," 5% ",4.35,4.65
"RG","RGTR2","RGTR2","RGTR2"," - "," - ",3.1,5.1
"RG","RGTR3","RGTR3","RGTR2"," - "," - ",1.2,5.1
"R5","RESISTOR","R401","RESISTOR","100H"," 5% ",.6,4.85
"S1","V11","V11","SIL","3.3 KOHMS"," - ",.2,5.2
"L2","AC374","U0106","CI.LOGIQ","74AC374"," - ",8.8,9.4
"L2","AC374","U0206","CI.LOGIQ","74AC374"," - ",8.4,9.4
"C2","AC374","U0306","CI.LOGIQUE","74ACT374"," - ",8,9.4
"C2","AC374","U0406","CI.LOGIQUE","74ACT374"," - ",7.6,9.4
"C2","AC374","U0506","CI.LOGIQUE","74ACT374"," - ",6.7,9.4
"C2","AC374","U0606","CI.LOGIQUE","74ACT374"," - ",6.3,9.4
"L2","AC374","U0706","CI.LOGIQ","74AC374"," - ",5.9,9.4
"L3","AC00","U0806","IC.LOGIQ","74AC00"," - ",5.5,9.2
"L3","AC00","U1106","IC.LOGIQ","74AC00"," - ",4,9.2
"C1","AC244","U0906","CI.LOGIQUE","74AC244"," - ",5.1,9.2
"C1","AC244","U1006","CI.LOGIQUE","74AC244"," - ",4.4,9.2
"L2","ACT374","U1206","CI.LOGIQ","74AC374"," - ",3.5,9.4
"C2","ACT374","U1306","CI.LOGIQUE","74ACT374"," - ",3,9.4
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"R3","RESISTOR","R1012","RESISTANCE","22H"," 5% ",.5,1.8
"R4","RESISTOR","R1005","RESISTANCE","10K"," 5% ",.5,1.2
"R4","RESISTOR","R1006","RESISTANCE","10K"," 5% ",.5,1.1
"R4","RESISTOR","R1007","RESISTANCE","10K"," 5% ",.5,1
"R4","RESISTOR","R1008","RESISTOR","10K"," 5% ",.5,.9
"CO","CAPACITOR","C1001","COND","16V 220UF"," - ",.65,.75
"CO","CAPACITOR","C1000","COND","16V 220UF"," - ",8.4,1
"IN","INDUCTOR","L100","INDUCT","14UH"," 20% ",8.3,.75
"R4","RESISTOR","R209","RESISTOR","10K"," 5% ",8.7,.9
"R4","RESISTOR","R210","RESISTOR","10K"," 5% ",8.7,1
"R4","RESISTOR","R211","RESISTOR","10K"," 5% ",8.7,1.1
"D1","DIODE","D100","DIODE","BZX55C"," - ",8.7,1.2
"C1","AC244","U0109","CI.LOGIQUE","74AC244"," - ",8.8,2.85
"L2","AC374","U0209","CI.LOGIQ","74AC374"," - ",8.4,2.85
"L2","AC374","U0309","CI.LOGIQ","74AC374"," - ",8,2.85
"L2","AC374","U0409","CI.LOGIQ","74AC374"," - ",7.6,2.85
"L2","AC374","U0509","CI.LOGIQ","74AC374"," - ",6.7,2.85
"L2","AC374","U0609","CI.LOGIQ","74AC374"," - ",6.3,2.85
"L2","AC374","U0709","CI.LOGIQ","74AC374"," - ",5.9,2.85
"L2","AC374","U0809","CI.LOGIQ","74AC374"," - ",5.5,2.85
"L2","AC374","U0909","CI.LOGIQ","74AC374"," - ",5.1,2.85
"S1","V13","V13","SIL","3.3 KOHM"," - ",4.6,2.85
"L2","AC374","U1009","CI.LOGIQUE","74AC374"," - ",4.4,2.85
"L2","AC374","U1108","CI.LOGIQUE","74AC374"," - ",4,2.85
"L2","AC374","U1309","CI.LOGIQUE","74AC374"," - ",3.2,2.85
"L2","AC374","U1209","CI.LOGIQUE","74AC374"," - ",3.6,2.85
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"L2","AC374","U1509","CI.LOGIQUE","74AC374"," - ",1.8,2.85
"L2","AC374","U1609","CI.LOGIQUE","74AC374"," - ",1.4,2.85
"L2","AC374","U1709","CI.LOGIQUE","74AC374"," - ",1,2.85
"C1","AC244","U1809","CI.LOGIQUE","74AC244"," - ",.6,2.85
"CN","DS26C32C","U0108","CI.INTERF","DS26C32C"," - ",8.8,3.9
"CN","DS26C32C","U0208","CI.INTERF","DS26C32C"," - ",8.4,3.9
"CN","DS26C32C","U0308","CI.INTERF","DS26C32C"," - ",8,3.9
"CN","DS26C32C","U0408","CI.INTERF","DS26C32C"," - ",7.6,3.9
"CN","DS26C32C","U0508","CI.INTERF","DS26C32C"," - ",6.7,3.9
"CN","DS26C32C","U0608","CI.INTERF","DS26C32C"," - ",6.3,3.9
"CN","DS26C32C","U0708","CI.INTERF","DS26C32C"," - ",5.9,3.9
"CN","DS26C32C","U0808","CI.INTERF","DS26C32C"," - ",5.5,3.9
"CN","DS26C32C","U0908","CI.INTERF","DS26C32C"," - ",5.1,3.9
"S2","V15","V15","SIL H05","8X10K"," - ",4.6,3.9
"CN","DS26C32C","U1008","CI.INTERF","DS26C32C"," - ",4.4,3.9
"CN","DS26C32C","U1108","CI.INTERF","DS26C32C"," - ",4,3.9
"CN","DS26C32C","U1208","CI.INTERF","DS26C32C"," - ",3.6,3.9
"CN","DS26C32C","U1308","CI.INTERF","DS26C32C"," - ",3.2,3.9
"CN","DS26C32C","U1408","CI.INTERF","DS26C32C"," - ",2.8,3.9
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SPECIMEN COPY OF DATA FILES OF A RCMT BOARD

```
INDEX   NAME            CODE            VALUE       TOLERANCE  X    Y

"U1","RESISTOR","RR1000","RESEAU","H29 5X0.047K"," - ",8.3,1.7
"U1","RESISTOR","RR1001","RESEAU","H29 5X0.047K"," - ",8.1,1.7
"U1","RESISTOR","RR1002","RESEAU","H29 5X0.047K"," - ",7.7,1.7
"U1","RESISTOR","RR1003","RESEAU","H29 5X0.047K"," - ",7.5,1.7
"U1","RESISTOR","RR1004","RESEAU","H29 5X0.047K"," - ",7.3,1.7
"U1","RESISTOR","RR1005","RESEAU","H29 5X0.047K"," - ",6.9,1.7
"U1","RESISTOR","RR1006","RESEAU","H29 5X0.047K"," - ",6.7,1.7
"U1","RESISTOR","RR1007","RESEAU","H29 5X0.047K"," - ",6.5,1.7
"U1","RESISTOR","RR1008","RESEAU","H29 5X0.047K"," - ",6.3,1.7
"U1","RESISTOR","RR1009","RESEAU","H29 5X0.047K"," - ",6.1,1.7
"U1","RESISTOR","RR1010","RESEAU","H29 5X0.047K"," - ",5.9,1.7
"U1","RESISTOR","RR1011","RESEAU","H29 5X0.047K"," - ",5.7,1.7
"U1","RESISTOR","RR1012","RESEAU","H29 5X0.047K"," - ",5.5,1.7
"U1","RESISTOR","RR1013","RESEAU","H29 5X0.047K"," - ",5.3,1.7
"L1","AC14","AC14","IC.LOGIQ","74AC14"," - ",4.9,1.7
"U1","RESISTOR","RR1100","RESEAU","H29 5X0.047K"," - ",3.95,1.
"U1","RESISTOR","RR1101","RESEAU","H29 5X0.047K"," - ",3.75,1.
"U1","RESISTOR","RR1102","RESEAU","H29 5X0.047K"," - ",3.55,1.
"U1","RESISTOR","RR1103","RESEAU","H29 5X0.047K"," - ",3.35,1.
"U1","RESISTOR","RR1104","RESEAU","H29 5X0.047K"," - ",3.15,1.
"U1","RESISTOR","RR1105","RESEAU","H29 5X0.047K"," - ",2.95,1.
"U1","RESISTOR","RR1106","RESEAU","H29 5X0.047K"," - ",2.75,1.
"U1","RESISTOR","RR1107","RESEAU","H29 5X0.047K"," - ",2.55,1.
"U1","RESISTOR","RR1108","RESEAU","H29 5X0.047K"," - ",2.35,1.
"U1","RESISTOR","RR1109","RESEAU","H29 5X0.047K"," - ",2,1.7
"U1","RESISTOR","RR1110","RESEAU","H29 5X0.047K"," - ",1.7,1.7
"U1","RESISTOR","RR1111","RESEAU","H29 5X0.047K"," - ",1.45,1.
"U1","RESISTOR","RR1112","RESEAU","H29 5X0.047K"," - ",1.2,1.7
"U1","RESISTOR","RR1113","RESEAU","H29 5X0.047K"," - ",1,1.7
"R3","RESISTOR","R1108","RESISTANCE","22H"," 5% ",4.4,2.1
"R3","RESISTOR","R1107","RESISTANCE","22H"," 5% ",4.4,2
"R3","RESISTOR","R1101","RESISTANCE","22H"," 5% ",4.4,1.9
"R2","RESISTOR","R202","RESISTANCE","220H"," 5% ",4.4,1.6
"R3","RESISTOR","R205","RESISTANCE","22H"," 5% ",4.4,1.5
"R4","RESISTOR","R201","RESISTANCE","10K"," 5% ",4.4,1.4
"R3","RESISTOR","R204","RESISTANCE","22H"," 5% ",4.4,1.3
"R4","RESISTOR","R200","RESISTANCE","10K"," 5% ",4.4,1.2
"R2","RESISTOR","R203","RESISTANCE","220H"," 5% ",4.4,1.1
"R3","RESISTOR","R1009","RESISTANCE","22H"," 5% ",.5,2.1
"R3","RESISTOR","R1010","RESISTANCE","22H"," 5% ",.5,2
"R3","RESISTOR","R1011","RESISTANCE","22H"," 5% ",.5,1.9
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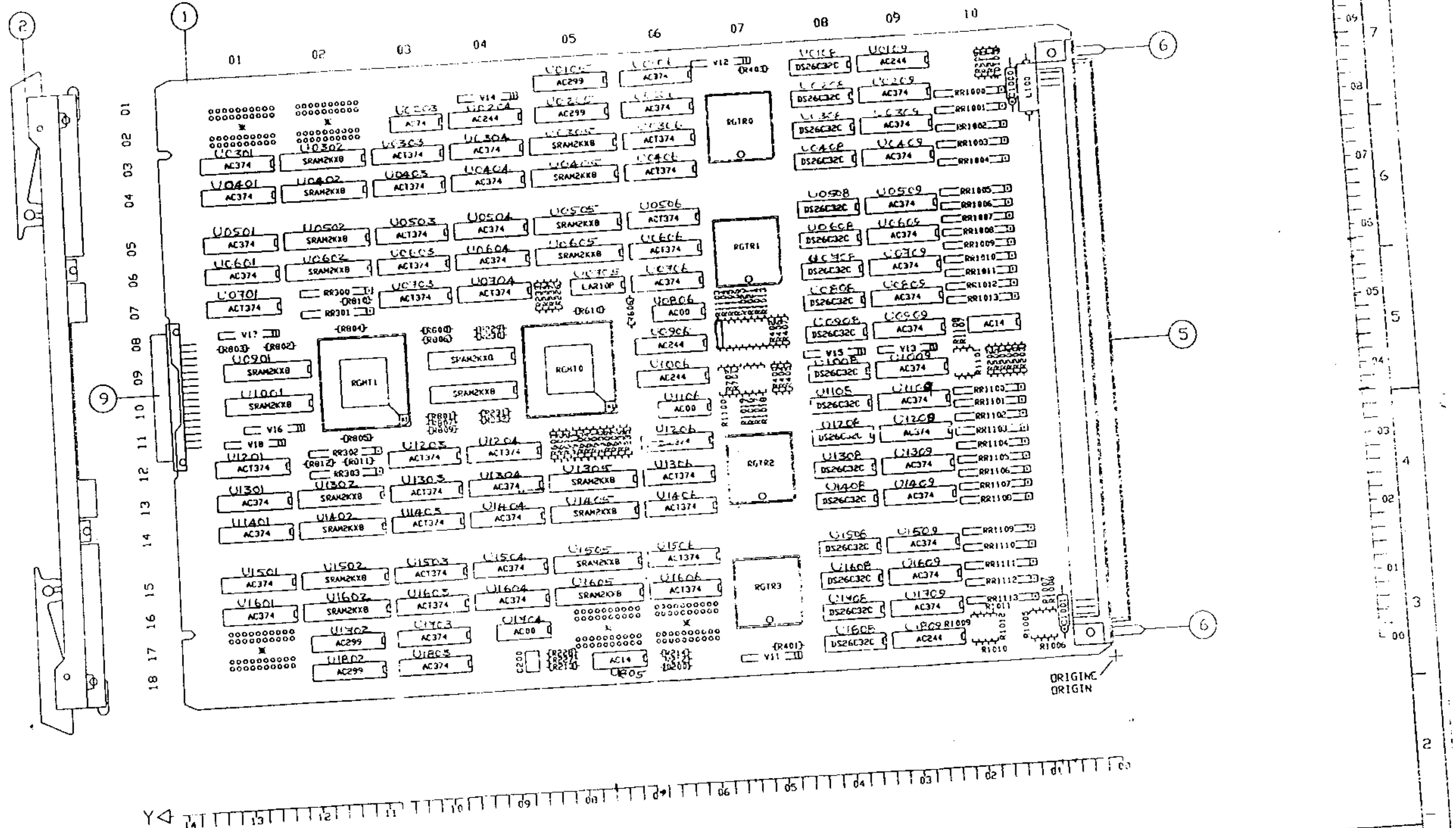

NOTA ✱ EMPLACEMENT RESERVE A NE PAS EQUIPER
NOTE ✱ SPARE PLACE TO BE KEPT EMPTY

NOTA: CODAGE DU CONNECTEUR 5 EN G3
NOTE: CONNECTOR 5 ENCODED BY G3

NOTA2:
- L'EMBASE DES TRANSISTORS SERA SURELEVEE DE 1 A 3 MM AU DESSUS DU CIRCUIT.
- LE CORPS DES RESISTANCES DE PUISSANCE SUPERIEURE A 2W DEVRA ETRE SURELEVE DE 3 A 5 MM AU DESSUS DU CIRCUIT.

NOTE 2: - THE TRANSISTOR BASE WILL BE SET 1 TO 3 MM ABOVE THE CIRCUIT.
- THE BODY OF THE RESISTOR (POWER 2W) WILL HAVE TO BE SET 3 TO 5 MM ABOVE THE CIRCUIT.

ED DATE	02	92-03-31
CHANGE NOTE		DV
APPR. AUTHO	D.VAL	
ORIGINATOR	F.LOPES	

EQUIPEMENT DE CARTE — CARD EQUIPMENT LAYOUT
RCMT4 — RCMT4

CIT

A2-BE001/01

AAC00103670 2HD EF — 1/2

[illegible]	[illegible]
5.090	1.950
8.953	3.390
8.493	3.390
8.033	3.390
7.570	3.390
6.670	3.390
6.410	3.390
5.950	3.390
5.490	3.390
5.030	3.390
4.450	3.390
3.990	3.390
3.530	3.390
3.070	3.390
2.610	3.390
1.910	3.390
1.450	3.390
0.99[illegible]	3.390
0.530	3.390
8.953	4.390
8.493	4.390
8.033	4.390
7.570	4.390
6.870	4.390
6.410	4.390
5.950	4.390
5.490	4.390
5.030	4.390
4.430	4.390
3.990	4.390
3.530	4.390
3.070	4.390
2.610	4.390
1.910	4.390
1.450	4.390
0.590	4.390
0.533	4.390
8.490	6.990
8.030	6.990
7.570	6.990
6.870	6.990
6.418	6.990
5.933	6.990
5.530	6.730
5.013	6.990
4.533	6.990
4.130	6.710
3.590	6.990
3.110	6.990
2.650	6.990
1.910	6.990
1.450	6.990
8.950	6.990
8.490	8.290
5.933	7.890
8.950	8.290
8.493	7.910
8.490	9.390
8.033	9.590
7.573	9.590
6.878	9.590
6.418	9.590
5.930	9.590
3.590	9.590
3.113	9.590
2.653	9.590
1.910	9.590
1.450	9.590
0.993	9.290
0.570	10.790
8.033	10.790
7.573	10.790
6.878	10.790
6.418	10.790
6.050	10.790
3.593	10.790
3.113	10.790
2.653	10.790
1.910	10.790
1.450	10.790
0.990	10.790
0.990	12.090
0.570	12.090
8.030	13.350
7.570	13.350
6.870	13.350
6.410	13.350
5.930	13.350
3.590	13.350
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1.450	13.350
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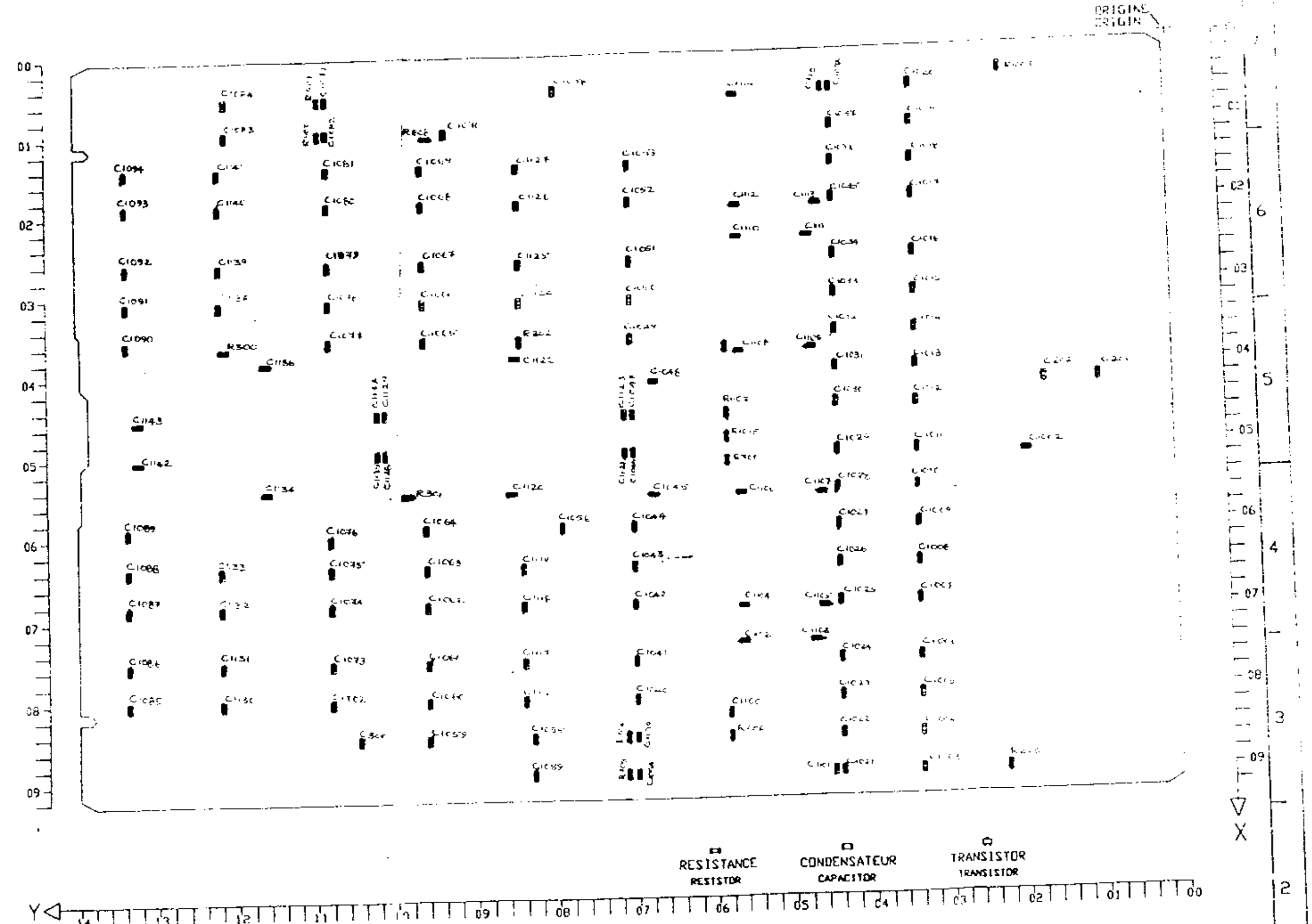
8.953	4.490
7.350	5.610
7.350	4.710
6.910	5.610
6.930	4.590
5.530	5.610
5.550	4.590
3.770	5.610
3.750	4.690
2.370	5.610
2.370	4.710
1.970	5.610
1.970	4.590
8.590	5.613
0.533	4.490
8.030	8.390
7.570	8.390
6.870	8.390
6.410	8.390
5.490	8.513
5.013	7.890
3.010	8.434
4.533	7.890
3.110	8.390
2.650	8.390
1.910	8.390
1.450	8.390
4.990	10.690
4.490	10.690
8.033	12.190

C1134	5.450	11.610
C1135	4.990	10.190
C1136	3.850	11.610
C1137	4.490	10.190
C1138	3.113	12.190
C1139	2.653	12.190
C1140	1.910	12.190
C1141	1.450	12.190
C1142	5.050	13.210
C1143	4.550	13.210
R225	8.950	2.250
R300	3.650	12.130
R301	5.490	9.807
R302	3.590	8.390
R500	3.710	5.790
R608	8.493	5.810
R700	4.530	5.790
R703	8.950	7.110
R704	8.490	7.110
R808	1.050	9.510
R900	0.990	10.890
R901	0.570	10.890
R1000	0.363	2.200
R1015	5.127	5.790
R1102	4.830	5.790



ED	DATE	02	92-03-31
CHANGE NOTE			
APPR. AUTHO.	D.VAL		
ORIGINATOR	F.LOPES		

[redacted] CIT

EQUIPEMENT DE CARTE RCMT4

CARD EQUIPMENT LAYOUT RCMT4

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A2-BE001/01

ITI PROFILE

ITI LIMITED, PALAKKAD is engaged in the production of electronic switching exchanges of capacity varying from 256 to 20,000 lines. Presently, the unit is engaged in the production of digital trunk automatic exchanges namely E10B and OCB - 283 in collaboration with ALCATEL FRANCE. The total capacity of the unit has gone up to one million lines per annum.

Quality of the product has been considerably good. The uncompromising attitude to quality has fetched ITI, PALAKKAD the coveted self certification scheme for DTAX AND ISO - 9002 certification for IRQS, Mumbai. Over this year, the unit has grown to become one of the world class manufacturing plant, with the state of art FUJI SMT assembly time. PCB plant has the capacity to produce 1,44,000 square meters of PCB's per annum.