MICROPROCESSOR BASED SCOUR MEASUREMENT

A DISSERTATION

submitted in partial fulfilment of the
requirements for the award of the degree
of
MASTER OF ENGINEERING
(SYSTEM ENGINEERING AND OPERATIONS RESEARCH)

By

N. K. SRINATH

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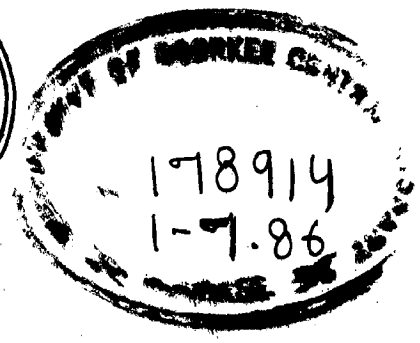
1995



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February, 1986

C E R T I F I C A T E

Certified that the dissertation entitled, ' MICRO-PROCESSOR BASED SCOUR MEASUREMENT', which is being submitted by Mr. N.K. Srinath in partial fulfilment for the award of the Degree of MASTER OF ENGINEERING in 'Systems Engineering and Operation Research' of the University of Roorkee, Roorkee, is a record of student's bonafide work carried out by him under my supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other degree or diploma.

This is to further certify that he has worked for a period of six months from August 1985 to February 1986, for preparing this dissertation at this University.

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A C K N O W L E D G E M E N T

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N.K. Srinath

(N.K. SRINATH)

C O N T E N T S

INTRODUCTION

The detachment of bed material and lowering of bed, known as scour, is being studied in hydraulics section of Civil Engineering Department. To study the rate of scour, profile indicator is being used. The data from the profile bed indicator is being recorded on graph through graphical plotter. This graphical plotter is very slow. For further calculations, this graphical value is converted into decimal value which is strenuous. Moreover many readings are necessary in the first few seconds to record scour accurately.

To avoid the sluggishness and the strain to read data from graph, an attempt is made in this dissertation to read data from profile indicator and print the decimal value upto third decimal much faster. A single channel ADC interface and a parallel printer interface have been developed for the purpose. In the continuous mode of recording data, about 7 readings/second rate has been achieved.

Chapter-1 deals with the simulated model and the instrument to convert the scour value into analog equivalent, profile indicator.

Chapter-2 deals with the VMC 85/9 micro computer which controls the operation of ADC and the parallel printer.

The details of the parallel printer and the associated selective switches are given in Chapter-3.

The hardware circuit to interface the printer and the ADC are discussed in Chapter-4. Here a method is provided for selecting the scan intervals along with indicating lamps.

Chapter-5 deals with the development of subroutines. A total of seven subroutines have been developed for reading in data conversion to decimal values, decimal to ASCII, print routine etc. The main software programme is also given in this chapter.

The last chapter as usual contains the conclusion and suggestions for further development.

CHAPTER-1

SCOUR MEASUREMENT

INTRODUCTION

The flow in an alluvial river causes detachment of the bed materials which may be carried away by the water in the form of silt. The detachment of bed material, particularly around the structures such as bridge piers etc. constructed across the river causes lowering of the bed. The lowering of river bed around such structures is called LOCAL SCOUR. For the same flow conditions lowering of river bed around the obstructions is considerably more than that for general river bed. The depth of scour depends upon -

1. Bed material characteristics
2. Flow and fluid characteristics
3. Geometry of obstruction and its orientation to flow.

The study of local scour of river bed is particularly important in design of the structures. Whenever there is obstruction to the flow in the centre of the river such as piles, there will be eddy currents around the obstructions resulting in the scouring of the river bed. Because of scouring the river bed around the structure part or whole of the structure may get exposed to flow. This may result in decrease of the structure strength. This makes the structure unsafe. Knowledge of the rate of scouring enables the designer to select a suitable factor of safety in the design of the structure. Scour studies are made by setting up simulated models of rivers in the laboratory.

1.2 EXISTING SETUP

Simulated model of the river used in the present work is a fixed bed masonry frame 30 m long, 1 m wide and 1.5 m deep. It has a slope of 6.4×10^{-4} and glass panel sides. The diagram of the simulated model is shown in Appendix A-1. Transparent flume sides enables one to note the level of water. Railings are provided with level adjusting screws to enable the mounting of a wooden plank which supports the measuring instrument of scour at different points of the model. The measurement setup can be moved on the railings along the bed length. The obstructions (piers) to flow in rivers is simulated by the use of hallow pipes in the river model.

Water is made to flow from an overhead tank. To avoid eddy currents, grids made of bricks and guide vanes are provided. This also results in damping of turbulence present in the flow. The flow of water can be regulated by the wheel valve. The level of water in the model can also be controlled by the outlet gate. The out flow from the model goes into sump tank from where the water is pumped to the overhead tank for recycling. This portion is not shown in the diagram Appendix-A1. The pumping rate is such that the overhead tank always overflows so that head is always maintained.

The scour of the river bed is studied by the use of the profile bed indicator. Electrodes from the profile bed indicator is placed near the pile, but not touching it, to measure the depth of scour. The detailed description of the profile indicator, and the working principle are given in the next section to follow.

1.3 ELECTRONIC PROFILE INDICATOR[1]

Electronic profile bed indicator is the instrument used to measure bed levels in hydraulic models continuously. This instrument converts the difference in levels into equivalent Analog voltage.

1.3.1 Description

The instrument consists of a probe, that is, a needle placed vertically in the water. A servomechanism maintains the tip of the probe at a constant distance (adjustable to 0.5 -2.5mm) above the bed. A potentiometer attached to the probe enables the position of the probe to be indicated in the form of the analog equivalent. The technical specifications of the particular profile bed indicator are given below -

Maximum depth to be measured	-	108 cm.
Minimum depth to be measured	-	3 cm.
Maximum vertical probe speed	-	50 cm/sec.
Distance from bed to tip of probe (adjustable)	-	0.5 to 2.5 mm
Sensitivity to bed level variations	-	0.2 mm
Applicable in fluids with a conductivity varying between	-	0.05 to 1 ms/cm.
Voltage	-	24 V
Current	-	2A
Frequency	-	50/60 Hz.
Read out of 10-turn potentiometer	-	2 k
Resolution	-	0.03 percent
Linearity	-	0.5 percent
Calibration	-	0.05 V/cm

1.4 PRINCIPLES OF OPERATION

PROBE - Probe is a stainless steel tube completely insulated. At a distance of approximately 15 mm from its tip a stainless steel ring interrupts the insulation. This is the compensation electrode. Fig.1.1 shows the probe of the profile bed indicator.

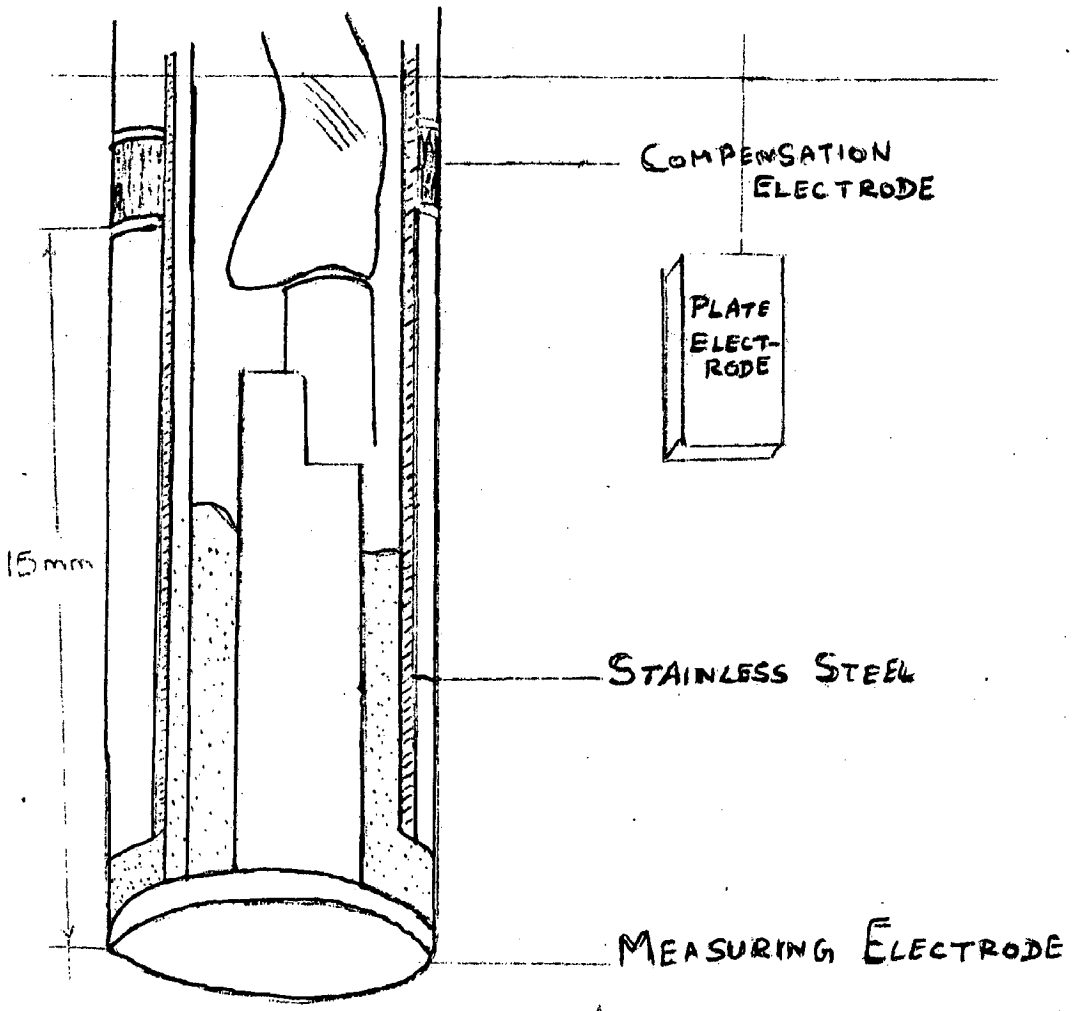


Fig. 1.1

At the tip of the tube is the measuring electrode completely insulated. The probe is placed in the fluid with the plate electrode in its vicinity. The electrical resistance between the measuring electrode or compensation electrode and the plate electrode (in the fluid) is a function of the area of the electrodes and the conductivity of the fluids. As soon

as the measuring electrode is in the vicinity of a non-conductive bed, the resistance of the measuring electrode increases rapidly. The resistance of the compensation electrode remains almost constant. The ratio of the resistance of measuring electrode to the resistance of compensation electrode appears to be independent of the specific conductivity of the fluid. Fig.1.2 shows the relation between the ratio of resistance of measuring electrode to the resistance of compensation electrode (R_m/R_c) and the distance from the bed to the pick-up h_o. The ratio R_m/R_c appears to be independent of the specific conductivity of the fluid.

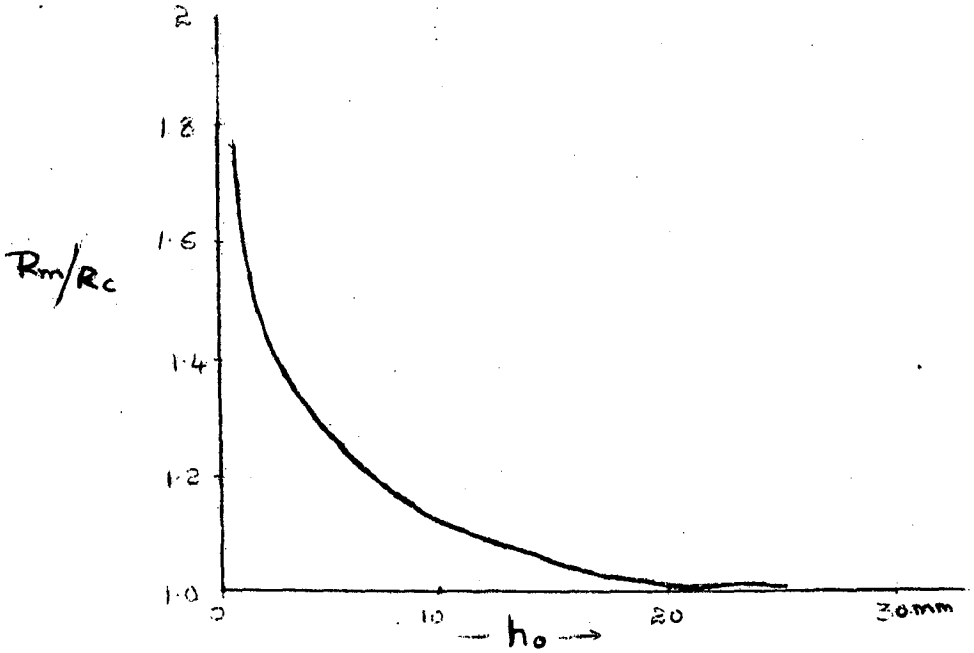


Fig. 1.2

Circuit description

The electrodes are placed in a resistance bridge, which is fed by an a.c. voltage of 9 volts and a frequency of 5 KHz as shown in Fig.1.3. The current through the compensation electrode can be adjusted within certain limits by potentiometer R_3. The resistance of R_4 and R_5 have been chosen in such a way, that for distances varying from 0.5 -2.5 mm above the bed, the voltage of the electrode can be adjusted to the same value by R_3.

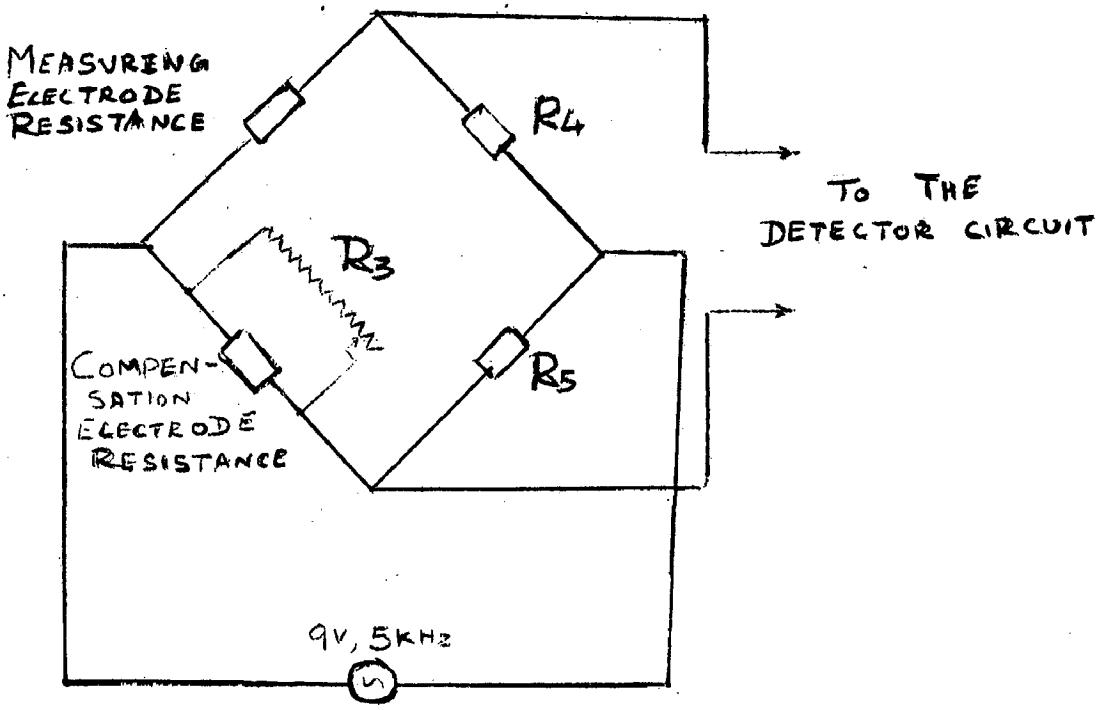
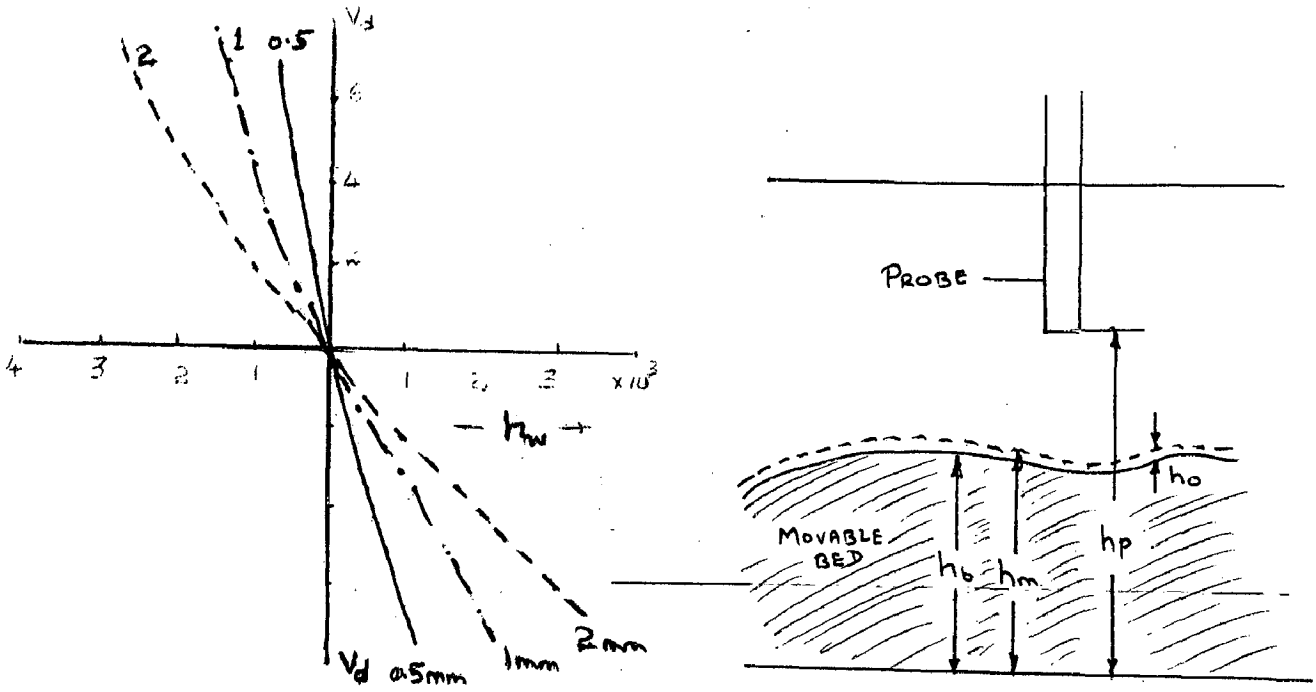


FIG 1.3

The a.c. voltage of the electrodes are rectified in the detector circuit. The difference between these two voltages is amplified about 100 times and is directed to the output attentuator.

Figure 1.4 shows the relation between the output voltage of the detector and ~~the distance~~ from the measuring electrode to the operating point.



$h_w = h_m - h_p$

V_d as a function of h_w

Fig 1.4

In this graph the potentiometer balance has 3 values, resulting in operation having values of 0.5 mm, 1 mm and 2 mm. The graph shows that sensitivity decreases from increasing operation distances. The detector signal passes the output attenuator and is directed to the input of the servo amplifier. The input circuit is such that negative voltages are amplified more than the positive voltages. This creates a correction of the non-linear behaviour of the detector.

A d.c. motor is connected to the output of the servo amplifier. The motion of the probe is governed by this motor by way of gear transmission. A tacho generator is connected directly to the motor. Voltage from this tacho generator is fed back through a resistor to the second input of the servo amplifier. This feedback creates a damping effect preventing the system to oscillate.

If a voltage occurs at the input of the servo-amplifier, due to the fact that the distance from the measuring electrode to the bed is not equal to the operation distance, the servo motor will move the probe in the direction of the operation point. The servo motor stops its action as soon as this point has been attained. A ten-turns potentiometer is connected to the probe, enabling the position of the probe to be indicated.

System Description

Figure 1.5 shows the block diagram of the profile indicator. Blocks indicate corresponding parts as well as their transfer functions. The transfer function is -

$$H(s) = \frac{h_p(s)}{h_m(s)} = \frac{1}{S^2 \dfrac{T}{A.\ K_n.K_d.K_c} + S \dfrac{1+A.Kg.Km}{A.K_n.K_d.K_c} + 1} \qquad \ldots(1)$$

In practice A, K_m, K_g appears >>> 1, so we can state -

$$H(s) = \frac{1}{S^2 \dfrac{T}{A.K_m.K_d.\ K_c} + S \dfrac{K_g}{K_d\ K_c} + 1} \qquad \ldots(2)$$

The frequency response can be derived by substituting jw for S in equation (2)

Let us state

$$w_o = \frac{A.K_m.K_d.K_c}{T} \qquad ...(3)$$

or

$$d = \frac{K_g\, w_o}{K_d.K_c.\ 2} \text{ (damping ratio)} \qquad ...(4)$$

$\therefore$ we find

$$H(jw) = \frac{1}{1 - (w/w_o)^2 + 2dj(w/w_o)} \qquad ...(5)$$

In equations (3) and (4) K_d and K_g are the only variables. This magnitudes depends on sensitivity. Moreover K_d depends on h_o in minor degree. The other factors depend on the properties of the parts used.

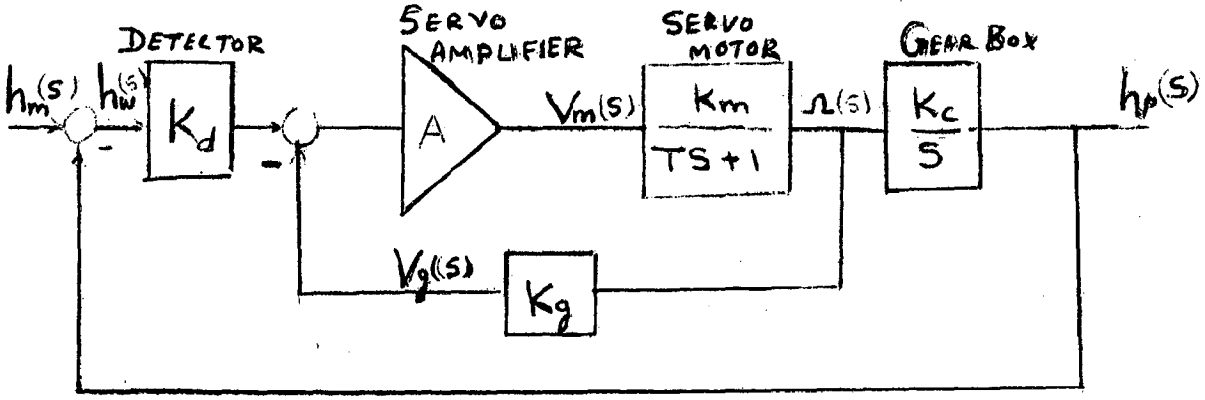


FIG 5. BLOCK DIAGRAM

$A_1 = 30$ $\quad K_m = 56$

$T = 30 \times 10^{-3}$

$K_c = 2.1 \times 10^{-3}$

$K_g = 0\text{-}10 \times 10^{-3}$

$K_d = 0 - 10^4$

Depending on sensitivity and h_o

CHAPTER-2

VMC-85/9

MICROPROCESSOR TRAINING/DEVELOPMENT KIT[2]

INTRODUCTION

VMC-85/9 is a single board microprocessor Training/ Development kit based on 8085 Microprocessor. The man machine interface is through Hex key board having 28 keys and seven segment hexadecimal display interfaced through 8279. VMC-85/9 provides 2k byte of RAM and 4k byte of EPROM. The total on board memory can be easily expanded to 64k bytes in an appropriate combination of RAM and ROM. The monitor is incorporated from 0000 Hexa to 0FFF and the necessary 2k Bytes of RAM has an address of 2000-27FF. The input/output structure of VMC-85/9 provides 24 programmable I/O lines expandable to 48 I/O on board expansion. It has got 16 bit programmable Timer/counter for generating any type of counting etc. The on board 8255 provides 8 level of interrupts. The on board battery back up for RAM retains the memory contents in case of power failure. The on board resident system monitor software is very powerful and provides various software utilities. The kit provides various powerful software commands like SEND,RECEIVE,INSERT, DELETE, BLOCK MOVE, RELOCATE, STRING, FILL and MEMORY COMPARE etc. which are helpful in debugging/developing the software. VMC-85/9 is configured around the internationally adopted STD Bus, which is the most popular bus for process control and real time applications. All the Address, Data and Control

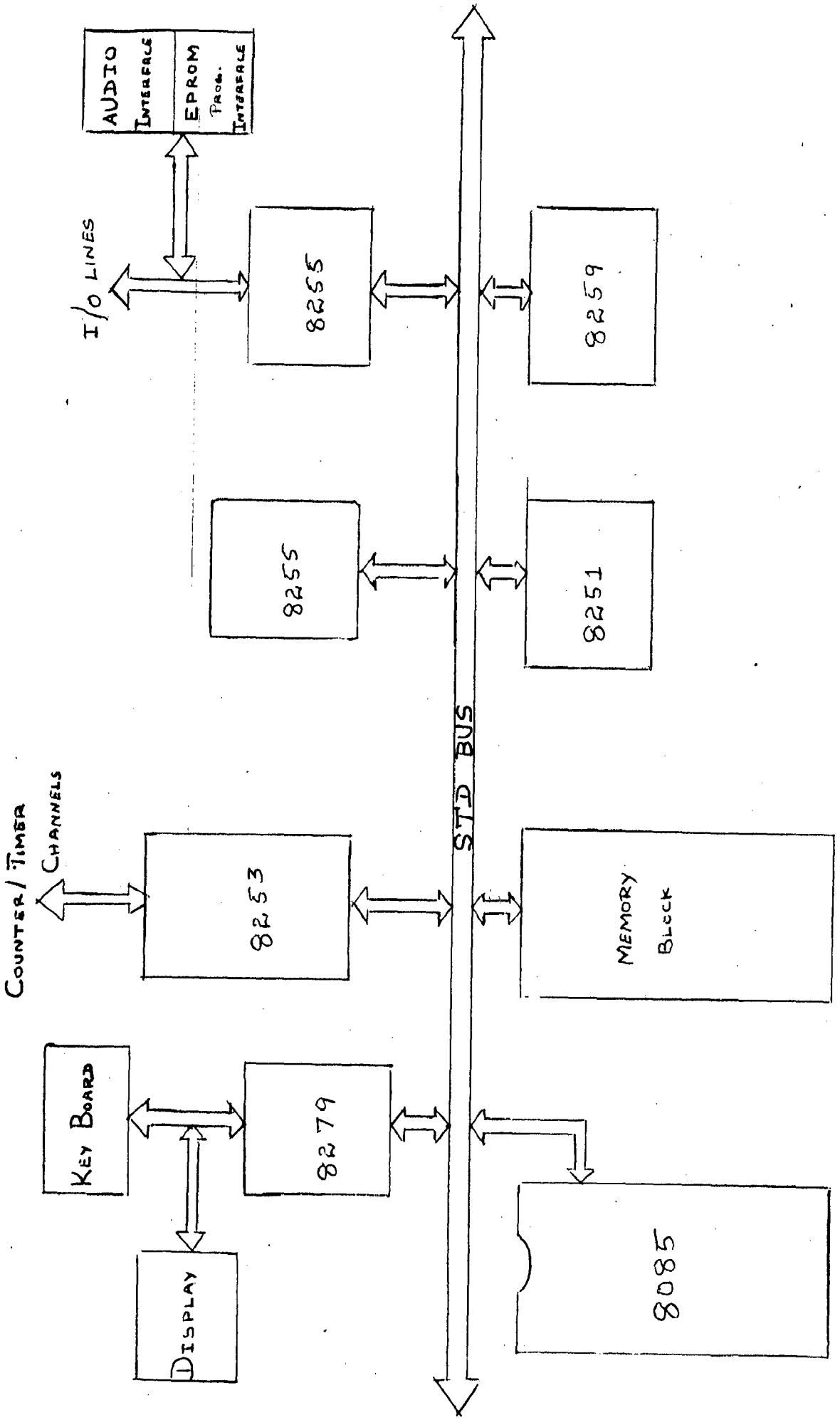


Fig. 2.1 Block Diagram Of System

lines are available at the edge connector through buffers. The kit is fully expandable for any kind of application. The System Specifications of VMC 85/9 is given in Appendix-B-1 and system capabilities is given in Appendix-B-2.

2.2 MEMORY

VMC-85/9 provides 2k bytes of CMOS RAM using 6116 chip and 4 k byte of EPROM using 2732. The total on board memory can be expanded upto 64 k bytes. The various chips which can be used are 2716, 2732, 2764, 27128 and 6116. There are six memory provided on VMC-85/9. These six spaces are divided into three blocks of two memory spaces each. Each memory space can be defined any address slots from 0000-FFFF depending upon the size of the memory chip. The memory decoding technique is explained next.

2.2.1 Memory Decoding Technique

The total memory which can be supported by 8085 is 64 k bytes. This 64 k is divided into eight blocks of 8 k bytes each by using 3 line to 8 line decoder using 74-LS-156 chip. Each slot is of 8 k each as shown in Fig.2.2.

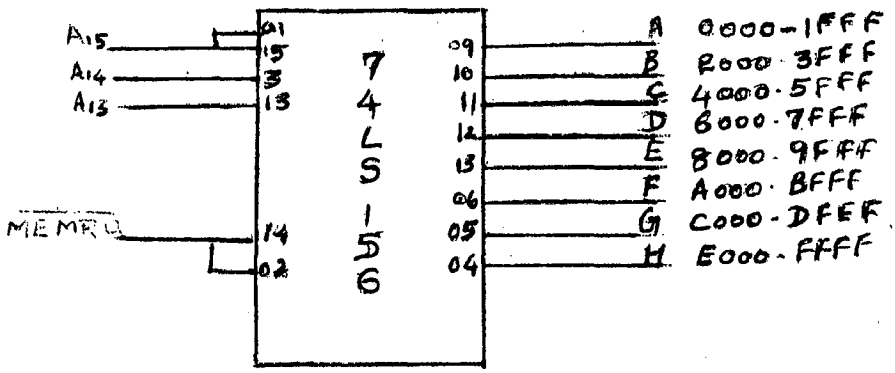


Fig.2.2

Another decoder 74-LS-156 converts a block of 8 k Byte into four blocks of 2 k each. Fig.2-3 shows that any two blocks of 8 k can be converted into blocks of 2 k byte.

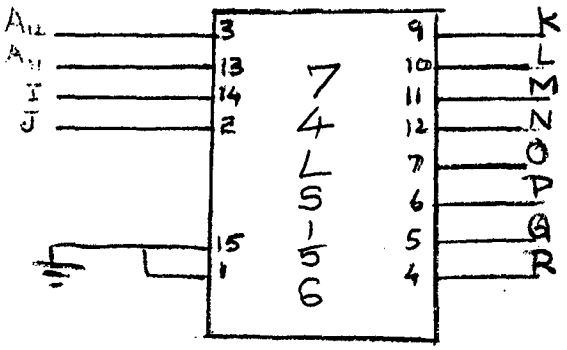


Fig.2-3

Pin named I and J can be connected to any block of 8 k each.

The chips select points of all the six sockets are connected to points CEM0 to CEM5 as shown in Fig.2-4. The signal points S to X are buffered using 74LS503 to generate CEM0 to CEM5.

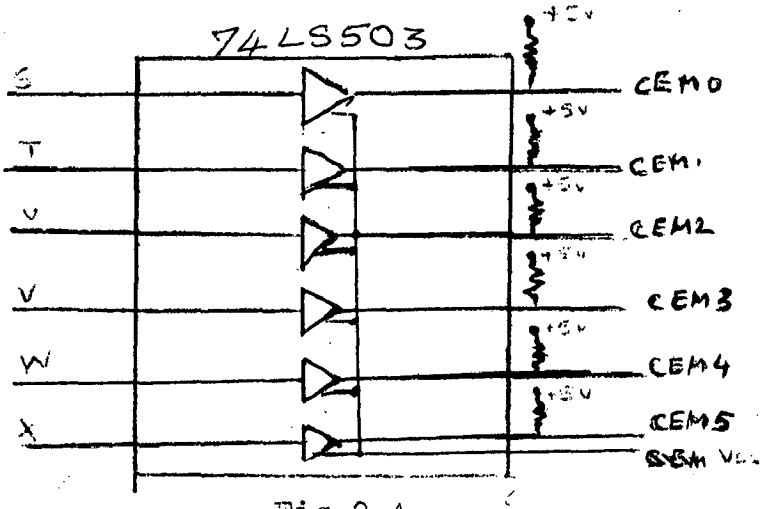


Fig.2-4

Points S to X can be connected to any of the points A to H or K to R at the black box provided depending upon the size of the memory chip selected for each socket. All these points from A to X are brought at the block box-1 for selecting the proper jumper as shown in Fig.2.5.

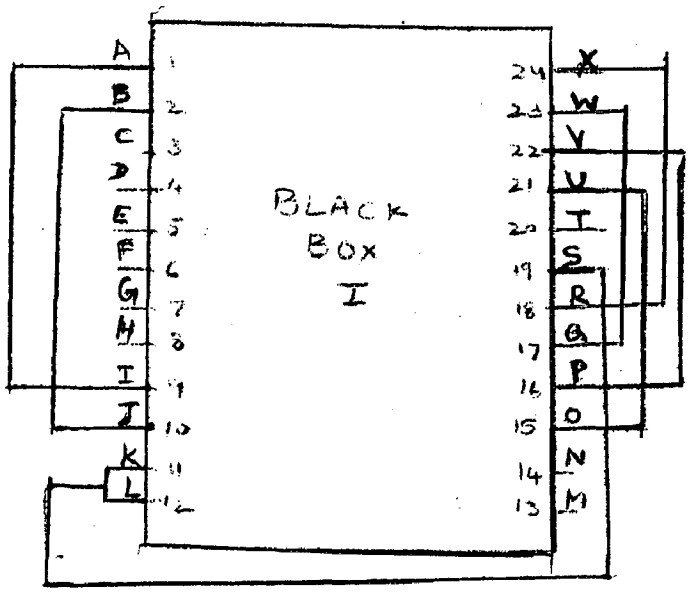


Fig.2.5

The selection of chip for any of the socket is done by proper jumper connection in block box II. ICS 2716 and 6116 requires Address lines from A0 upto A10, 2732 upto A11, 2764 upto A12 and 27128 upto A13. For 2716 Pin No.21 should be connected to +5V, for 6116 this should be connected to $\overline{WR}$ and for 2732 this pin 21 should be connected to A11. Each memory

space has a pin socket with the connections as shown in the Fig.2.6.

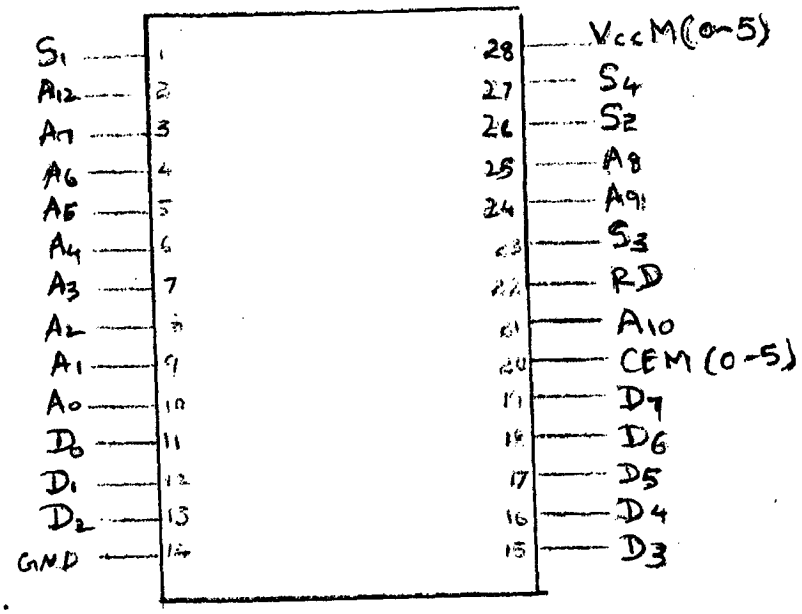


Fig.2.6

Pin No.1, 26 and 23 of memory are named S_1, S_2 and S_3. These pins are brought to black box II with the following connections. In number 1, of memory space 0 and memory space 1 are shorted, memory space 2 and 3 are shorted and memory space 4 and 3 are shorted and brought respectively to pin number 1,2 and 3 of black box-II. Pin number 26, of memory space 0 and 1, are shorted, memory space 2 and 3 are shorted and memory space 4 and 5 are shorted and brought respectively to pin no.4,5 and

6 of black box II. Pin no.23 of, memory space of 1, are shorted, memory space 2 and 3 are shorted and memory space 4 and 5 are shorted and brought respectively to pin 7,8 and 9 of black box-II. The various signals brought at black box-II are shown in Fig.2.7.

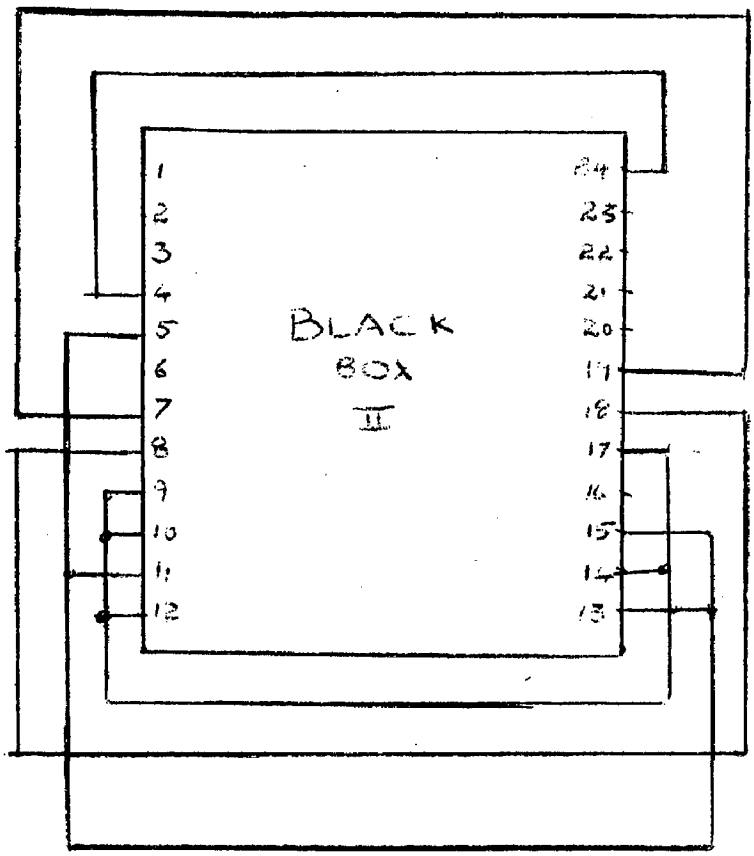


Fig.2.7

Addresses are defined to different memory spaces which is explained below. The chips connected to the memory space and the address defined are tabulated in the table 2.1.

Table 2.1

Memory space	0	1	2	3	4	5
Address defined	0000 to 0FFF	4000 to 5FFF	2000 to 27FF	2800 to 2FFF	3000 to 37FF	3800 to 3FFF
Chip to be defined	2732	—	6116	6116	2716	2716

By changing the connections in the black box I and II it is possible to change the addresses to different memory chips spaces and different chips can be used. By using certain combinations of memory chips it is possible to have a maximum of 64 k bytes.

2.2.2 Battery Back up

VMC-85/9 provides a battery back up for the on board RAM area. The battery back up circuitry is based around LM-393. It also provides a LED indication for low battery. The LED turns ON when the battery voltage goes low and needs to be replaced. Since each socket can be defined to have 6116 chip also, the VCC to each memory socket is given through black box-II. It is named as VCC Mo to VCC M5. Any RAM area to be backed up by battery, its corresponding Vcc M point must be connected to CMOS + 5V point in the black box-II.

2.3 I/O DEVICES[6,10]

The various I/O chips used in VMC-85/9 are 8279, 8255, 8253, 8251 and 8259. The functional role of all these chips is explained here under.

2.3.1 8279 - is a general purpose programmable keyboard and display I/O interface device designed for use with the 8085 uP. It provides a scanned interface to 28 contact key matrix provided in kit and scanned display interface for the six seven segment displays. Port addresses and fold back address are 18 and 1C Mode sector 19 and 1D control word.

2.3.2 8255 - is a programmable peripheral interface (PPI) designed to use with 8085 uP. This basically acts as a general purpose I/O component to interface peripheral equipments to the system bus. To interface peripheral equipment, VMC 85/9 has made use of two 8255 PPI. There three ports Port A, Port B and Port C are brought out to the connectors J_2 and J_3. The details of these ports are shown in Appendix B-3. To select 8255 PPI control word has been assigned and any input/output combinations of Port A, Port B, Port C upper and Port C lower can be defined using appropriate software commands. Various port addresses for different port numbers 8255 chips are given below.

Active range port address	Port No.	Selected devices
00 and 04	Port A	8255-I
01 and 05	Port B	-do-
02 and 06	Port C	-do-
03 and 07	Control word	-do-
08 and 0C	Port A	8255-II
09 and 0D	Port B	-do-
0A and 0E	Port C	-do-
0B and 0F	Control word	-do-

Using these port numbers 8255 PPI can be used to interface any equipment

Port A in - Mode 0, Mode 1 and Mode 2

Port B in - Mode 0, Mode 1

Port C in - Mode 0.

2.3.3 8253 - This chip is a programmable interval timer/counter and can be used for the generation of accurate time delays under software control. Various other functions that can be implemented with this chip are programmable rate generator, event counter, Binary rate multiplier, real time clock etc. This chip has got 3 independent 16 bit counters each having a count rate of upto 2 MHz. The first timer/counter (i.e. counter 0) is used for single step operation in VMC 85/9 chip. The second timer/counter (i.e. counter 1) is being used for generating programmable band rate while using 8251. Its connections are brought out at junction J_1 which is shown in Appendix-B-4. The third timer counter (counter-2) is also brought out a junction J_1. 1.535 MHz clock is available on the VMC-85/9 to the user at the socket A from pin 37 of 8085 through 74LS74 chip. To facilitate the use of timer/counter-2 of 8253, CLK-2, GATE-2 are brought out of the board of VMC-85/9 (just above 8253) along with clock-0, GATE-0 VCC and GND. The signal positions of these sockets is shown in Fig.2.8. Using jumper connection the 1.535 MHz clock can be assigned

GATE-1	GATE-2	VCC
D	E	F
0	0	0
0	0	0
A	B	C
CLO-0	CLK-2	GND

Fig.2.8

from CLO-0 to Clock-2. The port addresses and fold back addresses of 8253 are -

10 and 14 Counter 0

11 and 15 Counter 1

12 and 16 Counter 2

13 and 17 Control word

A digital clock has been implemented using this 8253 I.C. timer chip for use in the system. The program is shown in Appendix B-5. Whenever time of scanning has to be printed out this digital clock outputs can be made use of. However, in the software programme developed and discussed in Chapter-5 thus has not been included to increase the number of readings that can be taken per second.

2.3.4 8251 - It is a programmable communication interface chip used as peripheral device. This device accepts data characters from the CPU in parallel format and then converts them into a continuous serial data stream for transmission. 8251 has been utilised in VMC-85/9 for CRT terminal and TTY interface. The addresses and fold back addresses for this I/O device are -

20 and 24 Data In/Outward

21 and 25 Command/Status word

2.3.5 8259 - It is a device designed for use in real time, interrupt driven microcomputer system. It manages 8-levels of requests and has built-in features for expandability to other 8259's. The addresses and fold back addresses are -

28 and 8C Data word

29 and 2D Command word

from CLO-0 to Clock-2. The port addresses and fold back addresses of 8253 are -

10 and 14 Counter 0

11 and 15 Counter 1

12 and 16 Counter 2

13 and 17 Control word

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28 and 8C Data word

29 and 2D Command word

The connections of these I/O devices and memory interface to 8085 µP in VMC 85/9 chip is given in Appendix-B-5.

B-4 Buffers - Buffers have been provided on the VMC 85/9 for buffering the data, address and control lines. All these address, data and control lines (TTL compatible) are available to the uses at the PCB edge connector in the STD bus configuration. The buffers used in VMC-85/9 are 74LS245 and 74LS240 in order to facilitate the multi processing operation.

2.5 INTERFACE

2.5.1 Cassette Recorder Interface

VMC-85/9 provides an interface for Audio Cassette Recorder. The user can store his program into the recorder and can load back the program into the system memory as and when required. The system uses two I/O lines out of the 24 I/O lines provided by the first 8255 PPI chip on the board. Each byte of information loaded serially onto the cassette is preceeded by a start bit (low) and is followed by one and a half stop bit (High).

2.5.2 EPROM Programmer Interface

EPROM Programmer Interface is provided on the board of kit to facilitate the programming of the 2716/2732/2732-A/2764/27128 EPROMS. The on board EPROM Programmer provides the following useful commands -

(1) BLANK CHECK (2) DUPLICATE (3) VERIFY (4) UST

For each type of EPROM, a separate module is available which is to be plugged in the black box-3 position while using the EPROM + 24V/+21V is applied to the EPROM through the switch SW1, provided on the board, during programming and is switched OFF as soon as the programming is over.

The EPROM programmer is selected by pressing the 9 key. The selection is indicated by glowing of LED named PRG IND (Programming indicator). This LED remains ON as long as the EPROM Programmer (mode) remains selected. To bring VMC-85/9 to the normal mode (i.e, out of EPROM programmer mode) press the RESET key. During DUPLICATE command the programming is indicated by the blinking of the PRG IND LED.

2.5.3 Additional Serial Interface

Additional serial interface (RS-232-C) is provided through 8251. The required signals for this interface are coming at connector space J_5. The details of this connector is given in Appendix-B.6. 8251 has been used here in asynchronous mode. Any serial device like Printer, floppy drive or CRT terminal can be connected through this interface.

CHAPTER-3

PRINTER AND PRINTER INTERFACE

INTRODUCTION

Printers are used for obtaining hard copies of the outputs of the equipment to which the printers are interfaced. Printers have possibilities of giving the hard copies using different letters and numeral types. Printers may be classified into two main types, viz. (1) Serial printer and (2) Line printer. Based on the method of character generation printers may also be classified as impact printers and non impact printers. Impact printer strike the medium with the printing element to form a character. Non impact printer generally use thermal or electrostatic techniques that do not require impact. Character formation techniques provide another way of classifying printers. Character printers use fully formed characters, whereas matrix printers use combinations of either dots or lines to form complete characters.

Serial printers are also called Dot matrix printers. Print speed in case of dot matrix printers is normally specified in terms of characters per second (CPS). The common speeds are 50 to 200 cps. These printers are not preferred for use with word processors because of their poor print quality.

Line printer is the term normally used to denote a band, chain or drum printer. Here, printing is done line by line instead of character by character. These printers are faster than serial printers.

3.1 CP-80 TYPE-I PERIPHERAL PRINTER[3]

CP-80 Type-I printer is designed to operate through software control supplied from any general purpose computer. It can be used for RS-232C or 20mA neutral current loop and standard centronics parallel interface. RS-232C or 20mA neutral current loop can be used because of interface board which is housed in the printer above the mother card. This card converts the serial bits into byte and then through the parallel interface card the data is printed.

CP-80 Type I has character set of 96 in normal front, 96 in italic front and control words. All these can be accessed by a particular control code. Apart from software control codes, some hardwave facilities are provided in the form of DIP switches. Details of DIP switches are as follows -

3.2. INTERNAL DIP SWITCHES

DIP switches are mounted on the mother card. There are two sets of switches. In the first set of switches there are 8-switches and in the second set there are 4 switches. The functions of each switch is explained below.

3.2.1 First Set of Switches SW1

SW1-1 - When this switch is in the OFF position, it gives normal character width of 10.7 C.P.I. and when in ON it gives compressed characters width of 19.2 CPI. In the interfacing of printer, in this dissertation this switch is in OFF position.

SW1-2 - This switch has no function. It may be either in the ON or OFF position.

SW1-3 - This switch when in OFF position detects the absence of paper in the printer and stops printing. When the switch is in the ON position, the printer does not detect the presence or absence of the paper, but continuous to print. In this dissertation work this switch is in OFF position.

SW1-4 - When this switch is in OFF position, printer prints normal characters and Italic characters when in ON position. In this dissertation work this switch is in OFF position.

SW1-5 - When this switch is OFF, the printer prints normal characters. When ON, it prints emphasized characters. Emphasized mode has priority over compressed mode |SW1-1|. In this dissertation work this switch is in OFF position.

SW1-6 - When this switch is ON, paper out signal is indicated by a buzzer. If the switch is OFF the printer will not give an Audio buzzing sound. In this dissertation work this switch is in ON position.

SW1-7 - When this switch is ON, the ZERO is printed with a slash in the middle as it is printed on computer terminal to distinguish between letter 'O' and numeric ' ZERO'. If the switch is OFF, zero without slash is printed. In this dissertation work this switch is in OFF position.

SW1-8 - The printer can be permanently selected when this switch is in the ON position. In the OFF position the printer can be selected only when pin No.36 is made LOW by software. In this dissertation work this switch is in ON position.

3.2.2. SW2-1 and SW2-2 - are not used. These may be either in ON or OFF position.

SW2-3 - The LINE FEED and CARRIAGE RETURN can be obtained when the switch is in ON position after 80 column of data is printed. When the switch is in the OFF position, LINE FEED is possible either by software or by making $\overline{\text{AUTO FEED XT}}$ (Pin No. 14) LOW. If all 80 columns of data are space, the CARRIAGE RETURN assembly does not operate. Under this condition, if $\overline{\text{AUTO FEED XT}}$ is at LOW level, or if the DIP switch pin 2-3 on the main circuit board is ON, only paper feed is performed. In this dissertation work this switch is in the OFF position.

SW2-4 - When the switch is ON, automatic one inch skip takes place over perforation. This one inch skip enables readable program listings to be obtained. When OFF, skip is not given over performation. In this dissertation work this switch is in OFF position.

3.3 PIN ASSIGNMENT

To interface the printer, there are 36 pins connector out of which only 13 pins are used for interface. The use of each pin is given next.

PIN-1

STROBE signal is received by the printer from this pin. This signal is Active LOW. The width of the pulse must be more than 0.5μ sec. This signal is sent after the data has been sent to tell the printer to accept the data sent.

PIN 2 to 9

These 8-pins are used to receive data from the µP. These signals represent information of the Ist to 8th bits or parallel data respectively. Each signal is at HIGH level when data is logical '1' and LOW when logical 0.

PIN 10

This pin sends ACKNOLODGE SIGNAL from the printer to the computer. This signal indicates that data has been received and the printer is ready to accept other data when ACTIVE LOW signal is sent. The approximate width of the pulse is 5µ sec.

PIN 11

This pin sends BUSY signal from the printer to µP. It is active HIGH signal, which indicates that printers cannot receive data. The signal becomes 'HIGH' in the following cases -

i) During DATA entry

ii) During printing operation

iii) In OFF-LINE State

iv) During printer error status

PIN 19 to 30 - Are useful for grounding.

PIN 31

This pin receives $\overline{\text{INIT}}$ signal from the µP. When the level of this signal becomes LOW, the printer controller is reset to its initial state and the printer buffer is cleaved. This signal is normally HIGH, and its pulse width must be more than 50 µ sec.

The printer connector details are given in Appendix C-1.

3.4 SWITCHES AND INDICATORS

CP-80 Type-I has 3 switches and four indicators on the control panel and one power switch on the right side of the printer case. Power switch controls primary AC power to the printer.

i) ON LINE SWITCH

When the power switch is turned on the printer enters the On-line mode and can be utilized in conjunction with a host computer. Depressing the ON-LINE switch will set the printer in the Off-line mode and causes the green light to go out, it toggle the mode from ON-Line to Off-Line and Off-Line to ON-Line alternately. The switch does not function while the printer is actively engaged in printing. The printer is automatically placed off-line if the paper supply is exhausted or if a mechanical error occurs (blocking the movement of head) in the printer. The operation of the Line feed and form feed switches are effective only while the printer is Off-line Mode.

ii) Form Feed (FF) Switch

When this switch is depressed once, the paper is advanced vertically to the next top of form position. This switch must be depressed while the printer is off-line mode. The top of form position is initialized when the power switch is turned on, when $\overline{\text{INIT}}$ signal is applied to the interface connector, or when the ESC (a) code is input. Therefore, before turning the power switch ON to start operation, paper has to be set at the appropriate top of form position.

iii) Line-Feed(LF) Switch

The paper advances while this switch is being depressed. The line feed operation is prohibited while the printer is actively engaged in printing.

i) Power Indicator - This indicator illuminates while the AC power is ON.

ii) Ready Indicator - This indicator illuminates when the printer is ready to accept data.

iii) On Line Indicator - Illuminates when the printer is in the ON-line mode.

iv) Paper out - Illuminates when the paper supply is near its end.

3.5 SERIAL INTERFACE

RS-232/current loop interface board is an optional interface that fits inside the CP-80 TYPE-I printer. With this interface, CP-80 Type-I can be used for RS-232C or 20mA neutral current loop interfacing for asynchronous serial data transmission at speeds of 75 to 9600 band rate.

The Serial interface board is equipped with 2k-byte buffer memory. Data transmission can be received at any allowed bit rate with buffering upto its capacity.

3.5.1 Specification

The basic specification of the serial board are -

i) PRINTER - CP-80 Type-I

ii) Synchronization - Asynchronous

iii) Bit Rate - 75, 110, 134.5, 150, 200, 300, 600, 1200, 2400 and 4800.

iv) Word length - i) Start bit - 1 bit
ii) Data bits - 7 or 8 bits
iii) Parity bits - Even, odd or omission.

3.5.2 Pin Assignment

The pin assignment of the common EIA Spec. 25 pin connection is as follows -

Pin No.	Signal	Source	Function
1.	GND	-	Protective Ground
2.	Transmission Data (TxD)	Printer	Normally in mark status
3.	Receiving Data (RxD)	Host	Serial input data
6.	Data set ready (DSR)	Host	Should be space status when transmitting data is printer
7.	Signal GND	-	Common Ground
8.	Carrier Detect(DCD)	Host	Must be in space status when transmitting data to printer
11	Reverse channel	Printer	Both signals indicate the printer is in busy status.
20	Data Terminal Ready	Printer	When those are in space status (EIA level +ve) the printer can receive data

3.5.3 Operation

Before the printer is used the computer must be set for serial data transmission. If parity checking is specified and a parity error is detected, ' ? ' mark is printed instead of the expected character.

There are two sets of DIP switches on the serial board, which are used for selection of functions. The first set of DIP switches (SW1-1 to SW1-8) has 8 poles and the second set of DIP switches (SW2-1 to SW2-4) has 4 poles. These DIP switch sets are used for changing (1) Band Rate, (2) Reverse Channel Control, and (3) Word length. Table-1 shows the Band rate setting.

Table 3-1

Bit speed	SW1-1	SW1-2	SW1-3	SW1-4
75	OFF	OFF	ON	ON
110	ON	ON	OFF	ON
134.5	OFF	ON	OFF	ON
150	ON	OFF	OFF	ON
200	OFF	OFF	OFF	ON
300	ON	ON	ON	OFF
600	OFF	ON	ON	OFF
1200	ON	OFF	ON	OFF
1800	OFF	OFF	ON	OFF
2400	ON	ON	OFF	OFF
4800	OFF	ON	OFF	OFF
9600	ON	OFF	OFF	OFF

Table 3-2

Remind Space in Buffer	SW1-5	SW1-6
162	ON	ON
304	OFF	ON
583	ON	OFF
1866	OFF	OFF

Table 3-3

Pin No.	Function			
SW2-2	ON	Reverse channel at input block on RS-232C Mark TTY-TXD on current	OFF	Reverse channel at input block on RS-232-C space TTY-TTD on current loop-space.
SW2-3	OFF		ON	
SW2-4	ON	Reverse channel is active		
	OFF	Reverse channel in freeze- Free for data input		

SW2-2 and SW2-3 should not be kept in the ON position.

Table 3-4

SW1-7	ON	PARITY CHECK - NO
	OFF	PARITY CHECK - YES
SW1-8	ON	EVEN PARITY
	OFF	ODD PARITY
SW2-1	ON	WORD LENGTH - 7 BITS
	OFF	WORD LENGTH - 8 BITS

The DIP switches SW1-1,2,3,4 are used to select the band rate as shown in Table 3.1. These switches are also used for Self Test. For Self-test, all the four switches should be in the ON position. The self test, tests serial interface card and the printer data transmission. This test prints all the characters.

DIP switches SW1-5 and SW1-6 are used as timing switches for flag reset. The flags are Re-set after the buffer is full. The various capacities of buffer at different switch combinations are shown in Table 3-2. These switches enable adjustment of the buffer capacity.

DIP switches SW2-2, SW2-3 and SW2-4 show the signal polarity explained in Table 3.3 DIP switch SW1-1, SW1-8 and SW2-1 show the parity check explained in Table3-4.

In the present work serial interface is not preferred as the rate of printing is very slow. It takes data bit by bit and converts it into byte either by even parity or odd parity with 7 bits word or 8 bits words depending on the user's wish. Serial interface card can be dismounted whenever it is not used.

3.6 PRINTER INTERFACE WITH 85/9

Printer can be interfaced with 85/9 trainer kit either in serial or line mode. Because of sluggishness in serial mode, line mode is preferred. Printer can be interfaced through the I/O parts that are available for interfacing. The procedure used to interface the printer is given as follows -

8255 programmable peripheral interface is used as the I/O chip in the 85/9 kit. This chip can be used either in MODE-0 or MODE-1 for interfacing the printer. MODE-1 enables one to shorten the software program as it has the strobe hand-shaking signal. To make the printer work successfully it is necessary to include some buffers in the interfacing circuit. The figure shows the buffer 7407 used for this purpose. 7407 is a hexa open collector, high voltage output buffer. For open collectors, pull up resistors are necessary. Therefore, output of each buffer of 7407 is connected to 300 resistor in series with 5V supply, Fig.3.3 shows the circuit diagram.

The Busy signal from the printer is connected to PCo of 8255 through the buffer. PC_7 and PC_4 are connected to $\overline{STROBE}$ and $\overline{INIT}$ of printer. The remaining 8 bits PA0 to PA7 are connected to data lines of printer.

Printer prints using a software program written for the purpose. The software is written taking into view the following points.

i) To print, the printer has to receive $\overline{INIT}$ signal which is ACTIVE LOW. This pulse width has to be more than than 50mS, until this pulse is received printer will not be initialized.

ii) Data has to be sent through the 8 data lines after sending $\overline{INIT}$ signal. Each data signal is at HIGH level when data is logical 1 and LOW when logical zero.

iii) To accept the data a STROBE signal, which is active LOW, has to be sent through the pin 1.

iv) Before the next data is sent the BUSY signal is studied from Pin No.11. As soon as this signal becomes LOW, the next signal can be sent.

The time diagram in fig.3.2 explains the points mentioned above.

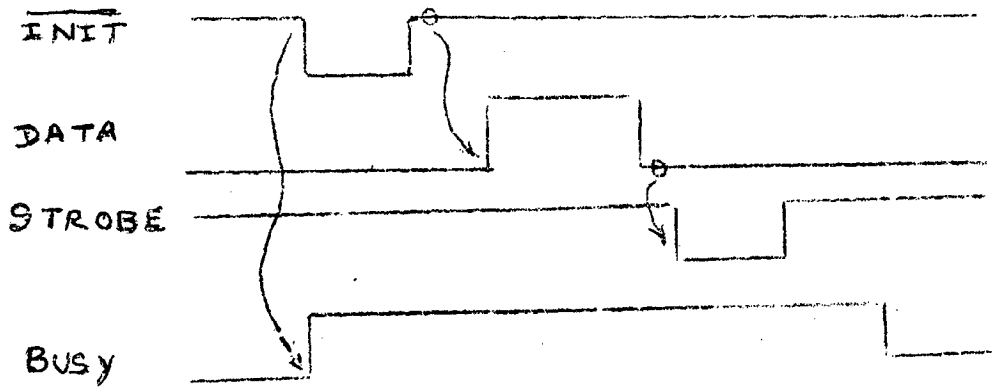


Fig - 3.2

3.7 PRINTER INTERFACE WITH AMO2 - MDS SYSTEM[4]

Printer can be interfaced with AMO2 system by parallel interfacing printer card with the bus. Printer card is housed along with other cards in the card cage. All these cards are based on the international STD Bus. All address, data and control signals are buffered and are available at the STD Bus connector. The printer card has the following chips for parallel interface along with other chips for serial and buzzer.

1. 74LS245 - 1
2. 74LS244 - 2
3. 74LS373 - 2
4. 2716 - 1

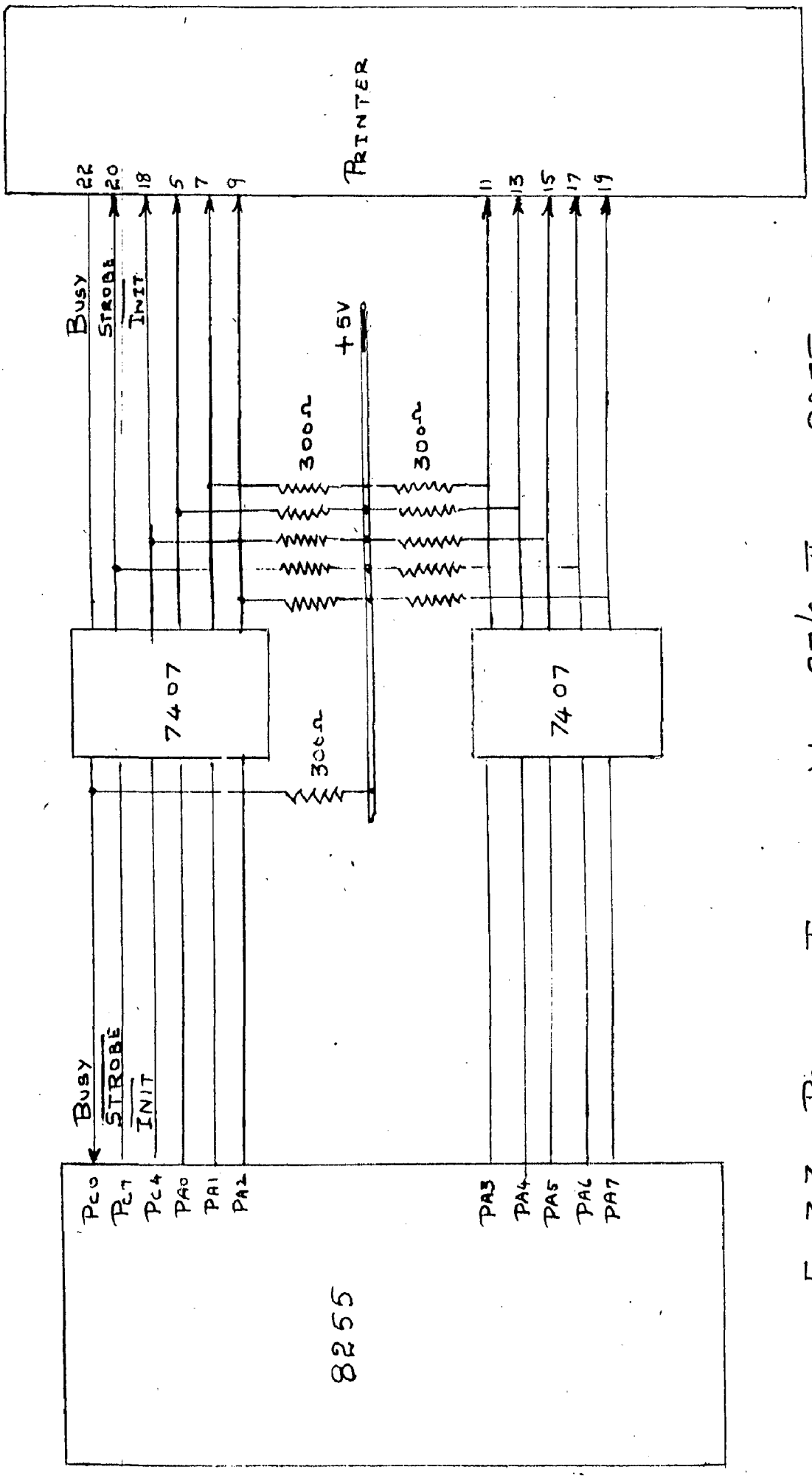


FIG. 3.3. PRINTER INTERFACE WITH 85/9 THROUGH 8255

74LS373 are Octal D-type Transparent latches and edge-triggered flip-flops. These 8-bit registers feature To-Tem-Pole 3-state outputs designed especially for driving highly capacitive or relatively low impedance loads. 74LS373-I provides a data latch for the output. 74LS373-II provides the control signals, INPUT PRIME and DATA STROBE signals.

74LS244 and Octal Buffers and line drivers with 3-state outputs. These octal buffers and line drivers are designed to improve both the performance and density of 3-state memory address drives, clock drives, and bus-oriented receivers and transmitters. These devices feature high fan-out, improved fanin, and 400 mV noise margin. 74LS244 is used to receive ACK and INPUT BUSY signal from the printer.

74LS373-1, 47LS373-2 and 74LS244 can be selected by CSI-0, CSI-1 and CSI-2. These chips are I/O mapped and can be defined in any area from 00-FF issuing PROM decoding technique.

2716 EPROM is used for the decoding.

Fig.3.4 shows the circuit diagram. To select only I/O device the particular output line should be low along with the card select line at the desired port address location. Table 3.6 shows how to arrive at a code number to select the desired I/O device.

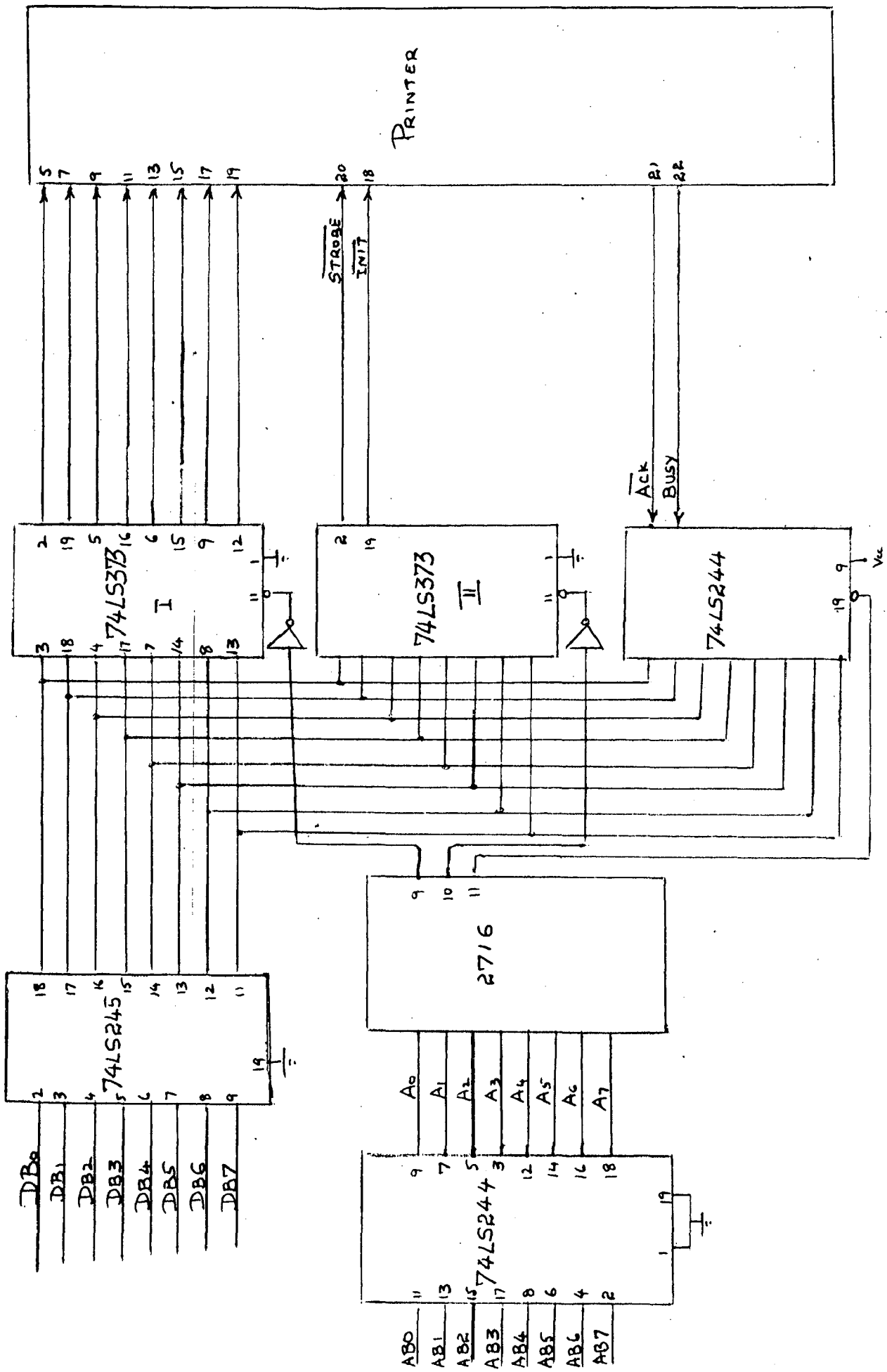


FIG. 3.4 PRINTER INTERFACE WITH AM102 - MDS SYSTEM

Table 3-6

O_7	O_6	O_5	O_4	O_3	O_2	O_1	O_o	Code for
0	1	1	1	1	1	1	0	CS0
0	1	1	1	1	1	0	1	CS1
0	1	1	1	1	0	1	1	CS2

PROM has following chip select address which is given in Table 3-7.

Table 3-7

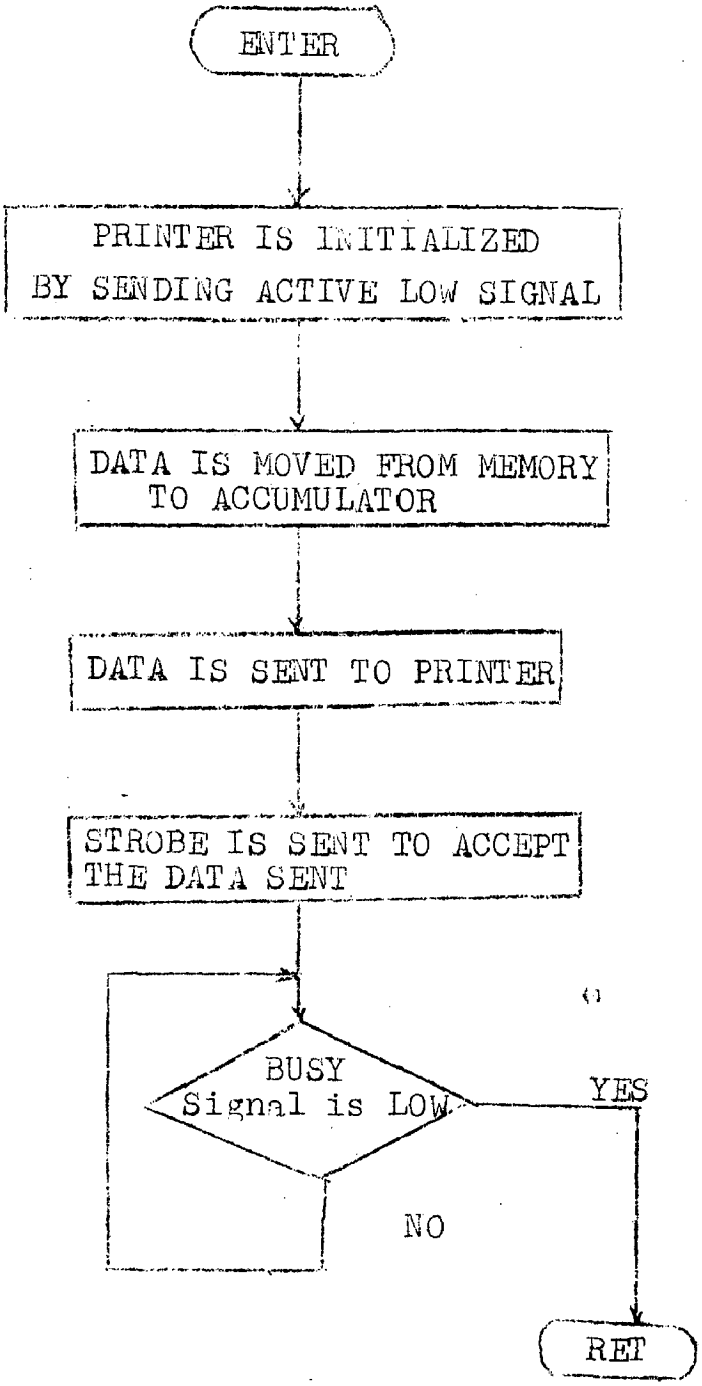
Location	Content	Code
60	7_E	C5-0
61	7_D	CS-1
62	7_B	CS-2

To make the printer work it is necessary to write software program.

3.8 SOFTWARE STD BUS BASED FOR PARALLEL INTERFACE WITH VMDS

For writing the program we assume that the Data is available in the memory location 0C200, the RAM area available is from 0C000 to $0C7_{FF}$(2k). Before running the program the printer interfacing card is placed in the cage. The required adjustments are made in the printer. After the adjustments, executing the program, the print subroutine is called and the data that is available in 0C200 memory location is printed.

This program can be modified such that the data is directly available in the accumulator and is output to port 60.


ENTER
PRINTER IS INITIALIZED BY SENDING ACTIVE LOW SIGNAL
DATA IS MOVED FROM MEMORY TO ACCUMULATOR
DATA IS SENT TO PRINTER
STROBE IS SENT TO ACCEPT THE DATA SENT
BUSY Signal is LOW
YES
NO
RET

ABEL	ADDRESS	CONTENTS	HNEMONICS AND OPERAND	COMMENTS
START	C000	21 00C2	LXI H C200	Initialize with data address
	C003	3E 12	MVI A 12	Initialization pulse is given to the printer through 74LS373-I
	C005	D3 61	OUT 61	
	C007	3D	DCR A	
	C008	D3 61	OUT 61	
	C00A	3C	INR A	
	C00B	D3 61	OUT 61	
NEXT	C00D	7E	MOV A,M	Data is moved from memory
	C00E	D3 60	OUT 60	Data is moved to the printer through 74LS373-I
	C0010	3E 01	MVI,A,01	Strobe signal (active low) is sent through 74LS373-II
	C0012	D3 61	OUT 61	
	C0014	3D	DCR A	
	C0015	D3 61	OUT 61	
	C0017	3C	INRA	
	C0018	D3 61	OUT 61	
WAIT	C01A	DB	IN 62	Busy signal is studied
	C01B	IF	RAR	Has busy signal become low
	C01C	IF	RAR	
	C01D	D2 1A C0	JNC WAIT	No - Read busy signal
	C020	C9	RET	Return

CHAPTER-4

HARDWARE DEVELOPMENT

INTRODUCTION

While in the previous chapters the associated equipment such as printer, micro computer and electronic profile indicator have been explained, in this chapter, the unit developed as part of this dissertation to link the profile bed indicator with micro computer and printer is explained.

As explained in Chapter-1, the scouring of the river bed is converted into the equivalent voltage in the profile indicator. The output of the profile indicator is further converted into its digital equivalent using an ADC 0808 chip. The output of the chip is read by the micro computer through input port-B, 8255-I and is converted into its decimal equivalent using software. The software converts the decimal values to their corresponding ASCII codes and transmits these codes to the printer for printing.

The interfacing unit developed consists of a power supply unit, analog to digital converter, buffer circuit for interfacing printer with micro processor and scan interval controller circuit. Appendix D-5 shows all these units.

4.2 POWER SUPPLY UNIT

Power supply of 5 volts is necessary to enable the I.C. chips to work effectively. The power supply unit is built for this purpose. The power supply unit consists of a transformer, 4 diodes a capacitor and a regulator. The transformer is

230V/9V, 30VA. 5402 diode is made use of rectify the a.c. voltage. Bridge circuit with 500 μF, 50 V capacitor gives satisfactory d.c. supply. To have the regulated voltage 7805 regulator, which has 4.98 V and 0.98 Amps. output is made use off. The power supply unit circuit is shown in Fig.4.1.

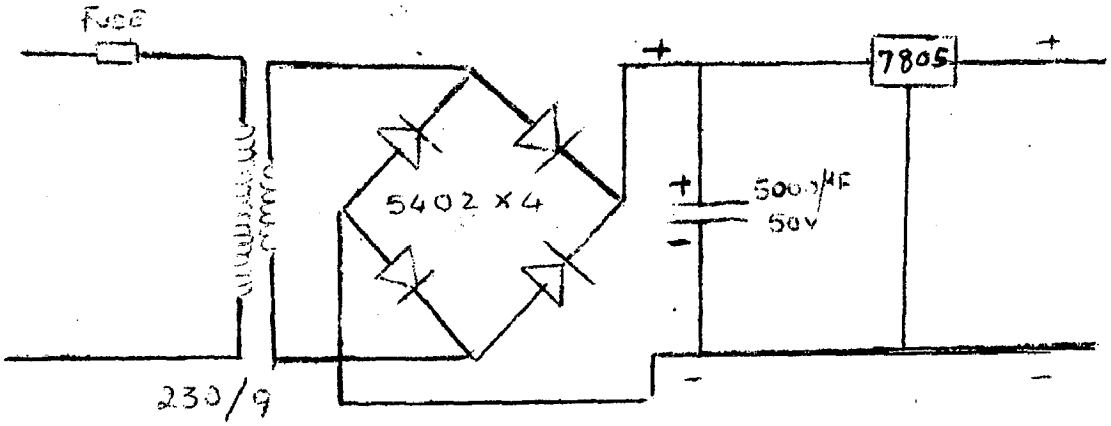
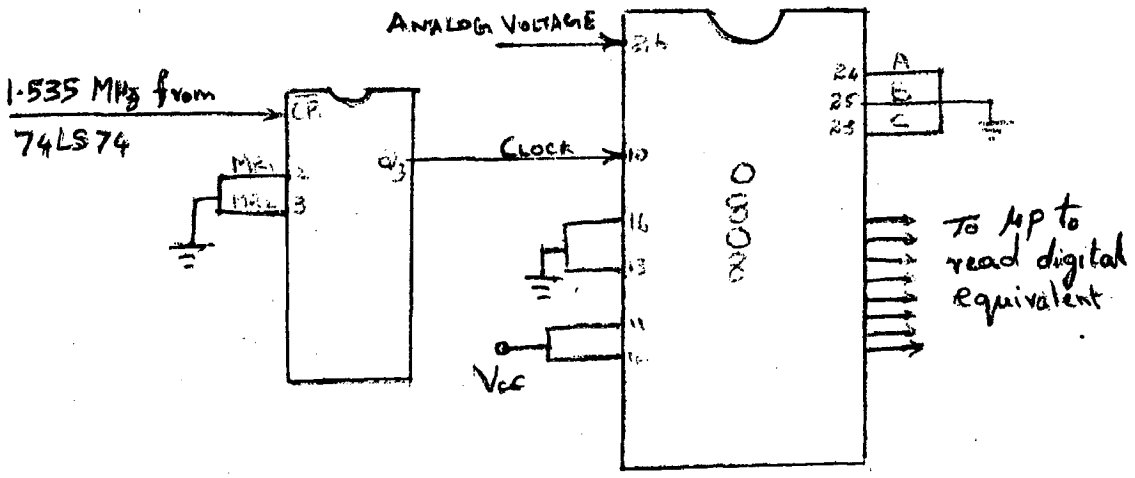


Fig. 4.1

4.3 ANALOG TO DIGITAL CONVERTER

0808 ADC chip is made use for converting the analog signal into equivalent digital value. The details of ADC 0808 is given in Appendix D-2. ADC 0808 is monolithic CMOS device with an 8-channel multiplexer, 8-bit analog to digital converter and microprocessor control logic. The 8-channel multiplexer can be controlled by a microcomputer through a 3-bit address at pin number 23,24 and 25. Only one analog signal needs to be converted to digital signal, all these 3-bits address pins 23,24 and 25 are connected to ground (address 000) select only, INPUT-0 at pin no.26 as Analog input. This 8-bit Analog

to digital converter uses the successive approximation technique. Clock signal necessary for 0808 is derived from 7493 4-bit Binary counter. The necessary circuit diagram is shown in Fig.4.2. The details of 7493 appears as Appendix D-3.



4.3.1 Operation

To start 0808 ADC, the supply and clock have to be applied and START OF CONVERSION pulse has to be applied through Pin No.6, START OF CONVERSION pulse is Active High Signal. Before this signal is applied the analog voltage must be made available at the input pin. After START OF CONVERSION, the END OF CONVERSION can be monitored from Pin 7. END OF CONVERSION signal is normally HIGH goes low when the conversion process starts, remain LOW as long as the conversion is in progress and then goes back High when the conversion is complete. This conversion period is around 100 micro seconds. As soon as this pin becomes High, it indicates that the conversion is over and the digital equivalent is available to be read. Without monitoring the END OF CONVERSION

the data can be read by giving a Delong of 100μ sec. after the START OF CONVERSION Signal has been applied. The time diagram of 0808 ADC is given in Fig.4.3.

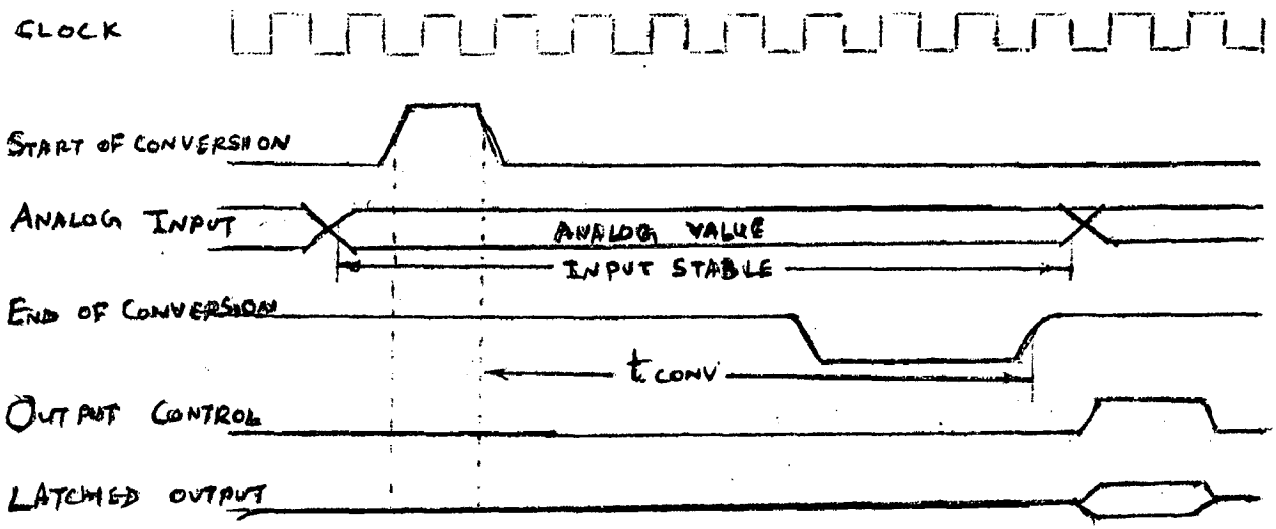


Fig. 4-3 TIMING DIAGRAM

ADC 0808 is interfaced to micro computer through 8255-I PPI. The data is read into Port-B of 8255-I. Start of conversion signal is applied to ADC 0808 from PC_2 of 8255-7. The clock of 1.535 MHz from the trainer kit which is available at jumper A is applied to clock terminal of 74LS93.

4.4 BUFFER FOR PRINTER INTERFACE

Printer is interfaced to VMC 85/9 microcomputer to print the digital data available after reading from ADC and converting to ASCII. To enable the printer to be interfaced effectively, buffers are necessary. 7407, Hex Buffers/drivers with open collector High voltage output are used, for the purpose. The details of 7407 is given in Appendix D-3. The hand shaking signals and Data lines are buffered, before they are interfaced,

through port-A of 8255-I PPI chip to the microprocessor. The port-A of 8255-I PPI chip is used as output port in Mode-1 for hand shake control. The data lines are connected to Port-A signal OBF_A from PC_7 is connected to $\overline{STROB}$ input signal of the printer. Group-B is programmed in MODE-0 with PC0, PC1 and PC2 as input lines. While PC4 and PC5 from Group-A (which is in Mode-1) is made as output port. PC4 generates the required initialization signal $\overline{INIT}$ at pin No.31 of printers. Busy signal $\overline{BUSY}$ from the printer is monitored through PC0 for polled I/O transfer.

Software program enables the printer to start printing. Before executing the program, printer is initialized by the following procedure.

1) ON-OFF OF DIP switches are adjusted as requred by the USER.
2) Paper is fixed to the printer
3) Interfacing flat cable is connected between the printer and the unit.
4) Power is switched ON
5) Printer is brought to ON-LINE mode.

For use in this dissertation the switch positions are -

SW1-1 - OFF	SW1-2 - OFF	SW1-3 - OFF
SW1-4 - OFF	SW1-5 - OFF	SW1-6 - ON
SW1-7 - OFF	SW1-8 - ON	

In the continuous mode of scanning 7 data print out per second could be achieved. To enable the user to adjust the other scan interval, three switches are provided on the

interfacing unit. These three switches can have 8 different combinations of scan intervals as given in Table 4.1.

4.5 SCAN INTERVAL CONTROL AND INDICATION[9]

Scan interval is indicated by the hard ware circuit. 74LS138 decodes one of eight lines depending on the conditions at the 3 binary select inputs. Details of 74LS138 is given in Appendix D-4.

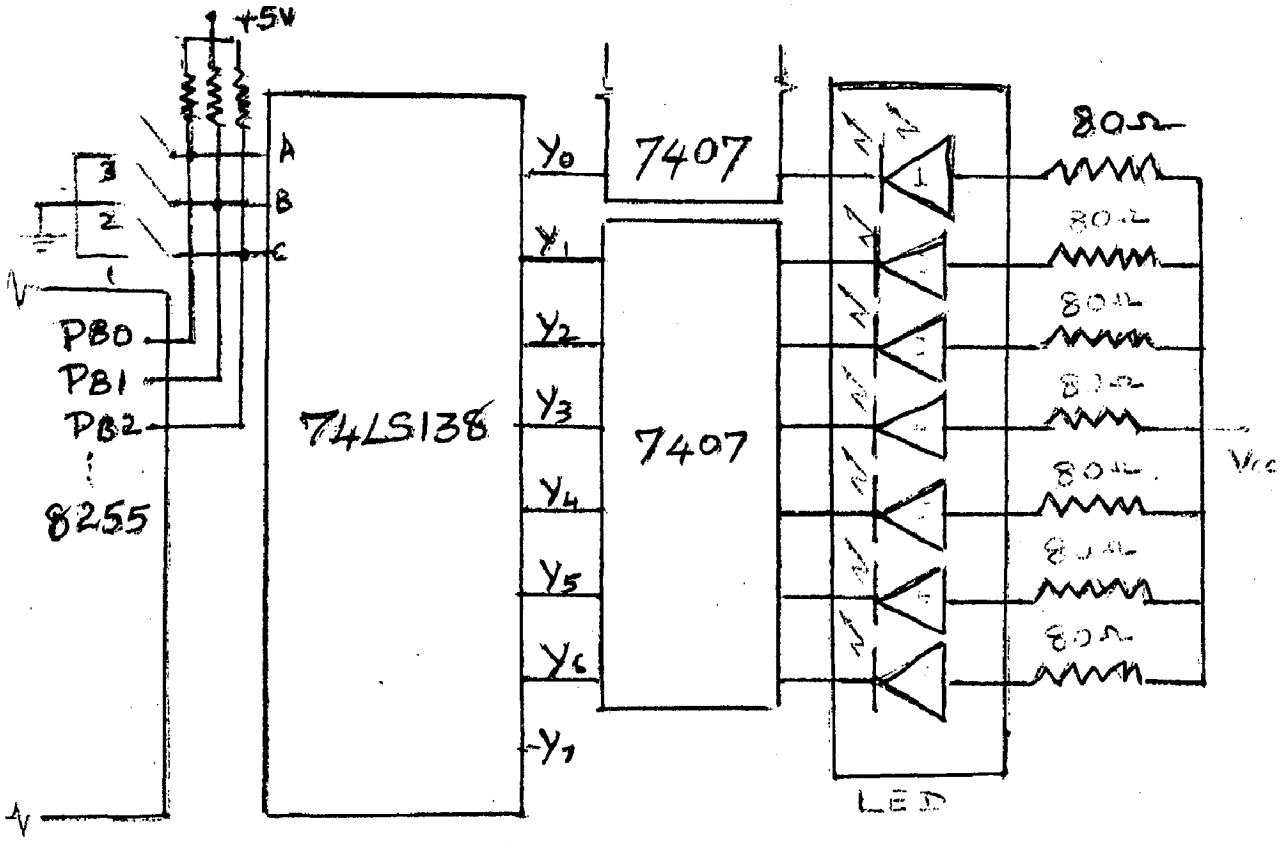


Fig. 4.4

When the switches are off all the three bits will be High and results in the y_7 line output LOW. Function Table 4-1 gives the different switch positions and the corresponding output lines.

Light emitting diodes are used to indicate the scan interval to the user. LED is a diode with a voltage drop of 1.2 to 2.4 volts depending on the type of diode. It is a device that emits a narrow wave length band of visible or infrared light. Infrared light emitting diodes are connected to the output of 74LS138 through the buffer 7407. The other end of the LED's are connected through current limitting resistors of 80 Ω to 5 volts supply. When all the switches are off, no LED glows and it indicates that the scanning interval is zero and the printer prints in continuous mode. When any one of the 3 switches is ON, the corresponding bit becomes Low and 7407 will have the capacity to sink 40 mA of current. For different combinations of switch positions, different LED glows indicating to the user, the scan interval. The different combinations of scan interval and LED glow, numbering from Right to Left is given in the Table 4.1.

Hardware circuit helps in indicating the scanning interval through LED glow. The actual scanning interval is controlled by the software. The user's wish of scan interval is read into the micro processor through port-B of 8255-II. Since the 3-switches controls the indication of interval, these 3 bits are read into PB0, PB1, and PB2 of 8255 and the rest of the bits of Port-B are grounded. This is also shown in Fig.4.4.

Table 4.1

FUNCTION TABLE

Switch			Output								Scan Interval	LED No. GLOW
1	2	3	y_0	y_1	y_2	y_3	y_4	y_5	y_6	y_7		
L	L	L	L	H	H	H	H	H	H	H	CONTINUOUS	NO GLOW
H	L	L	M	L	H	H	H	H	H	H	1 SEC/DATA	FIRST
L	H	L	H	H	L	H	H	H	H	H	2 SEC/DATA	SECOND
H	H	L	H	H	H	L	H	H	H	H	5 SEC/DATA	THIRD
L	L	H	H	H	H	H	L	H	H	H	30 SEC/DATA	FOURTH
H	L	H	H	H	H	H	H	L	H	H	1 MIN/DATA	FIFTH
L	H	H	H	H	H	H	H	H	L	H	2 MIN/DATA	SIXTH
H	H	H	H	H	H	H	H	H	H	H	5 MIN/DATA	SEVENTH

The software program is monitor the scan interval and operate according to the switch position is explained in the next chapter.

4.6 OPERATING PROCEDURE

To start the experiment the lead from the profile indicator is connected to the unit developed with correct polarity. The flat cable is connected from the interfacing unit to the printer. The two flat cables named I and II are connected to J_2 and J_3 connectors of 82/9 kit. Another wire is connected to bring the clock signal of 1.535 MHz from the microprocessor 85/9 trainer kit to the interfacing unit. This clock is available on the kit at the junction named A. After this connection the power switch in the interfacing unit is switched ON.

Paper is fixed to the printer and the printer is then switched ON and brought to the ON-line mode. Now the printer indicating green lamps should glow. If any one of the three lamps does not glow, it means that the system is in the OFF line mode or the power switch in the interfacing unit is not switched ON. When all the 3 lamps glow, it indicates that the printer is ready to print, in ON-line mode.

The wheel valve of the simulated model is rotated to make the water flow in the river model setup. As soon as you know that the scour is about to start near the profile bed indicator, programme is executed, with switch in LLL position. This results in continuous printing at a speed of 7 datas per second. The various scan interval that can be adjusted are indicated by 7 LED's placed on the interface unit. As soon as

the RESET knob is pressed the printer stops printing and micro processor stops reading the data from profile bed indicator.

4.7 TR2721A MULTI CHANNEL DIGITAL RECORDER[5]

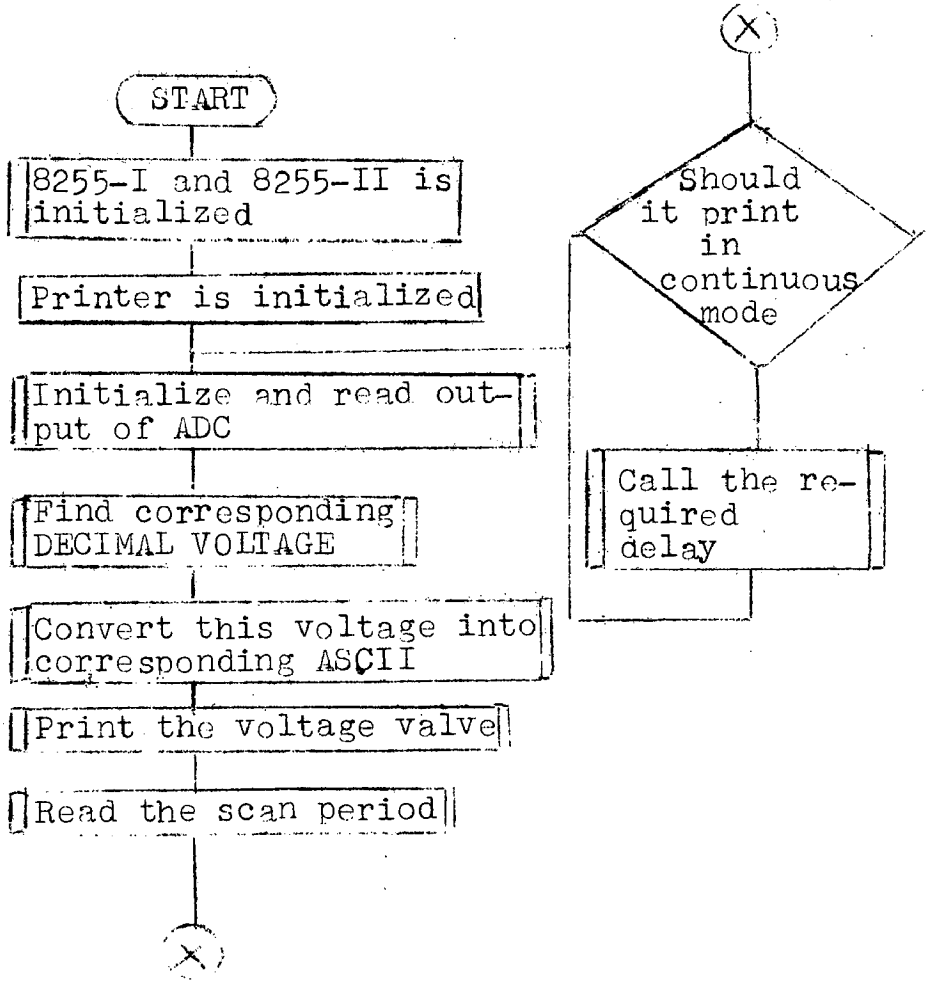
Multi channel recorder is an readily available equipment which can be used for d.c. voltage measurement, temperature measurement and record the measured result on a built in thermal printer. This unit was used in the beginning stages of this dissertation to record the profile indicator voltage at different scan intervals. This has the facility of getting the print out along with time either in normal mode or trend mode. Appendix D-5 gives the details of TR2721A multi channel digital recorder.

CHAPTER-5

SOFTWARE DEVELOPMENT

In Chapter-4 the hardware unit built for interfacing profile indicator with microprocessor and, printer with microprocessor are explained. As is very well known the inferfacing circuits along with the microcomputer unit is just a useless piece of equipment if it is not supported by the corresponding software. This chapter deals with the software subroutine to read the data from the profile indicator, convert it into a correct form to print and also to change the scan interval depending upon 3 switches. There is one main program and seven subroutines. Each subroutine has been explained with the flow chart and documented as per standard practice.

MAIN FLOW CHART



MAIN PROGRAMME

CALLS - ADC RED, CODEC, COASC, PRINT, DELAY
INPUTS -
OUTPUTS -
DESTROYS - ALL
DESCRIPTION- 8255-I is initialized with Port-A in Mode 1 and Port-B in Mode 0 and 8256-II is initialized with Port-B in Mode 0. Printer is initialized and calls subroutines for conversion and prints. The scan period is monitoried and the required delay is called.

LABEL	ADDRESS	CONTENT	MNEMONICS AND OPERANDS	COMMENTS
START	2000	3E A3	MVI A, A3	Initialize 8255-I
	2002	D3 03	OUT 03	Port A- Output in Mode 1 and Port B - Input in Mode 0 Port C -(L) - Input
	2004	3E 82	MVI A, 82	Initialize 825--II
	2006	D3 0B	OUT 0B	Port B - Input Mode 0
	2008	3E 09	MVI A,09	Printer is initialized by
	200A	D3 03	OUT 03	giving active low signal
	200C	3D	DCR A	through pin PC4
	200D	D3 03	OUT 03	
ADCIN	200F	CD 50 20	CALL ADCRED	To read the analog signal from P.I.
	2012	CD 7020	CALL CODEC	The digital value is converted into Analog equivalent
	2015	CD A1 20	CALL COASC	The value is converted into ASCII
	2018	CD E0 20	CALL PRINT	The data is printed
	201B	0E 07	MVI C,07	C register is initialized
	201D	DB09	IN 09	The required scan period is monitored
	201F	B9	CMP C	Is continuous printing reqd.
	2020	CA 0F 20	JZ ADCIN	Yes, go to read data from ADC
	2023	CD 0821	CALL DELS	No check for reqd. delay
	2026	C3 0F 20	JMP ADC IN	Continue reading next data

The software subroutines are -

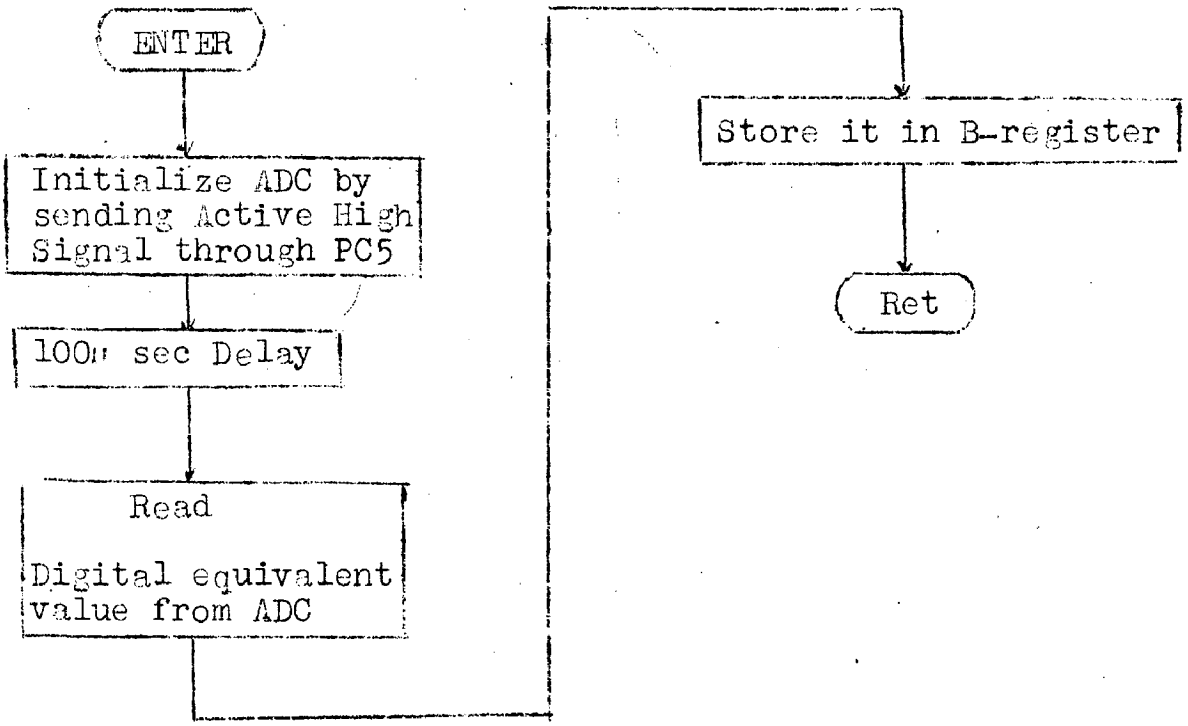
1. ADCRED Subroutine - (ADCREAD) This routine initializes the ADC 0808 by applying START CONVERSION PULSE and reads in the digital equivalent of the analog voltage from the profile bed indicator.
2. CODEEC Subroutine (Conversion into Decimal equivalent) - This subroutine converts the digital value into decimal equivalent and stores it in D.E. rp.
3. COASC Subroutine (Convert into ASCII Equivalent) - The decimal equivalent value that is available is converted into corresponding ASCII Code and is stored back in the same rp.

4. Print Subroutine - The ASCII Code is sent from the micro-processor into the printer to print after monitoring the scan period.

5. DELAY Subroutine - Delay subroutine monitors the scan period necessary and stores the number in the required register and calls Delay-1.

6. DELAY-1 Subroutine - This routine decrements the number loaded in the registers and gives needed delay.

FLOW CHART FOR ADC RED SUBROUTINE



SUBROUTINE - ADC RED

CALLS - DELAY

OUTPUTS - Digital equivalent value from B-register

INPUTS -

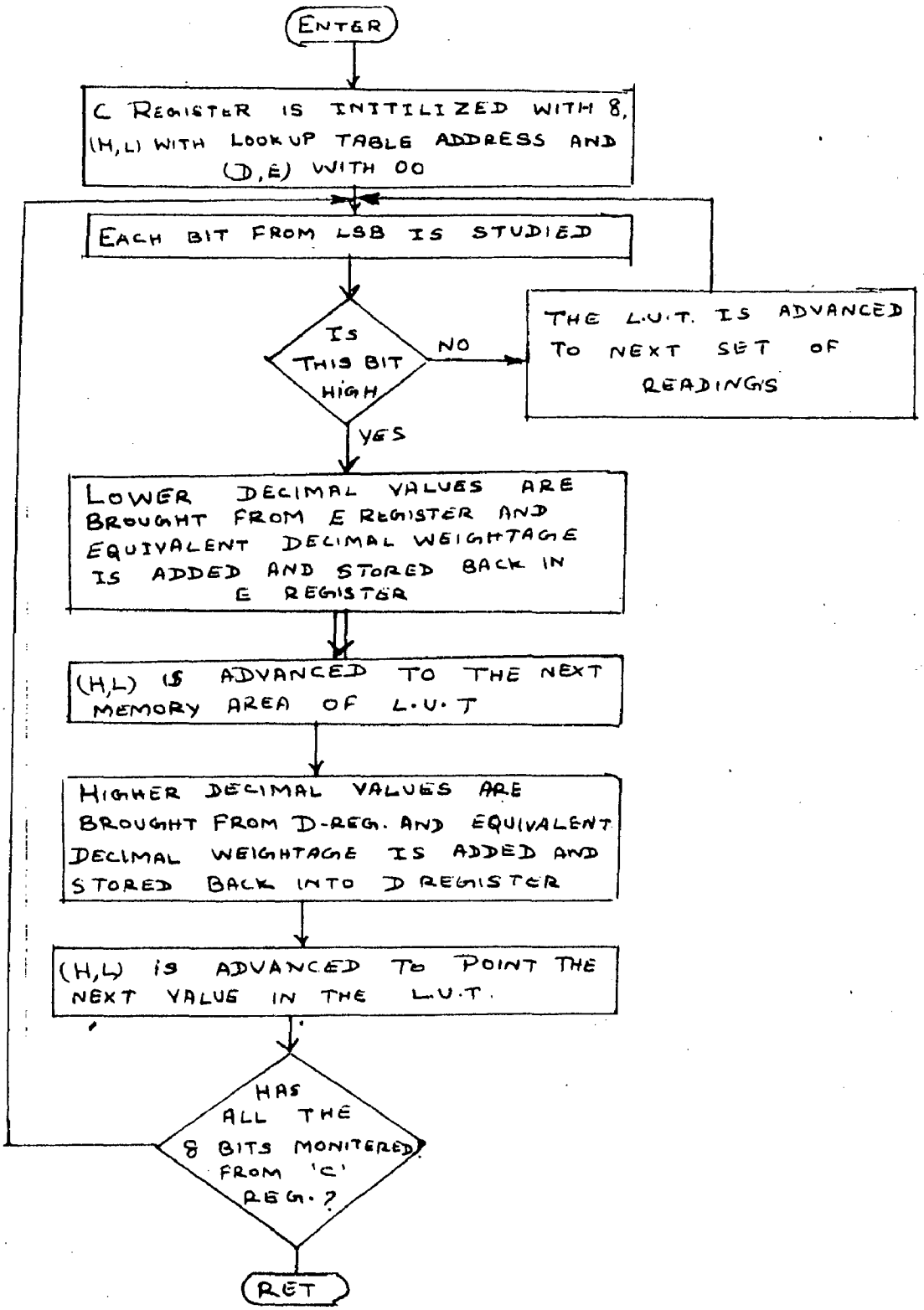
DESTROYS - A,B

DESCRIPTION - A start pulse is given through PC5 of 8255-1 to start ADC and the digital value is read and stored in B reg.

LABEL	ADDRESS	CONTENTS	MNEMONICS AND OPERANDS	COMMENTS
ADCRED	2050	3E 0A	MVI A, 0A	ADC is intialized to start conversion by giving active high signal from Pin. No. PC5 of 8255-I
	2052	D3 03	OUT 03	
	2054	3C	INR A	
	2055	D3 03	OUT 03	
	2057	3D	DCR A	
	2058	D3 03	OUT 03	
	205A	11 05 00	LXID 00 05	100 ms delay is given for the conversion
	205D	CD BC 03	CALL DELAY	
	2060	DB 01	IN 01	Digital value is red through Port-B and stored in B-register
	2062	47	MOV B,A	
	2063	C9	RET	

CONVERT DECIMAL EQUIVALENT

FLOW CHART



SUBROUTINE - CODEC(Convert Decimal Equivalent)

CALLS -

OUTPUTS - Analog equivalent in (D,E)r.p.

INPUTS - Digital value in B-register

DESTROYS - ALL

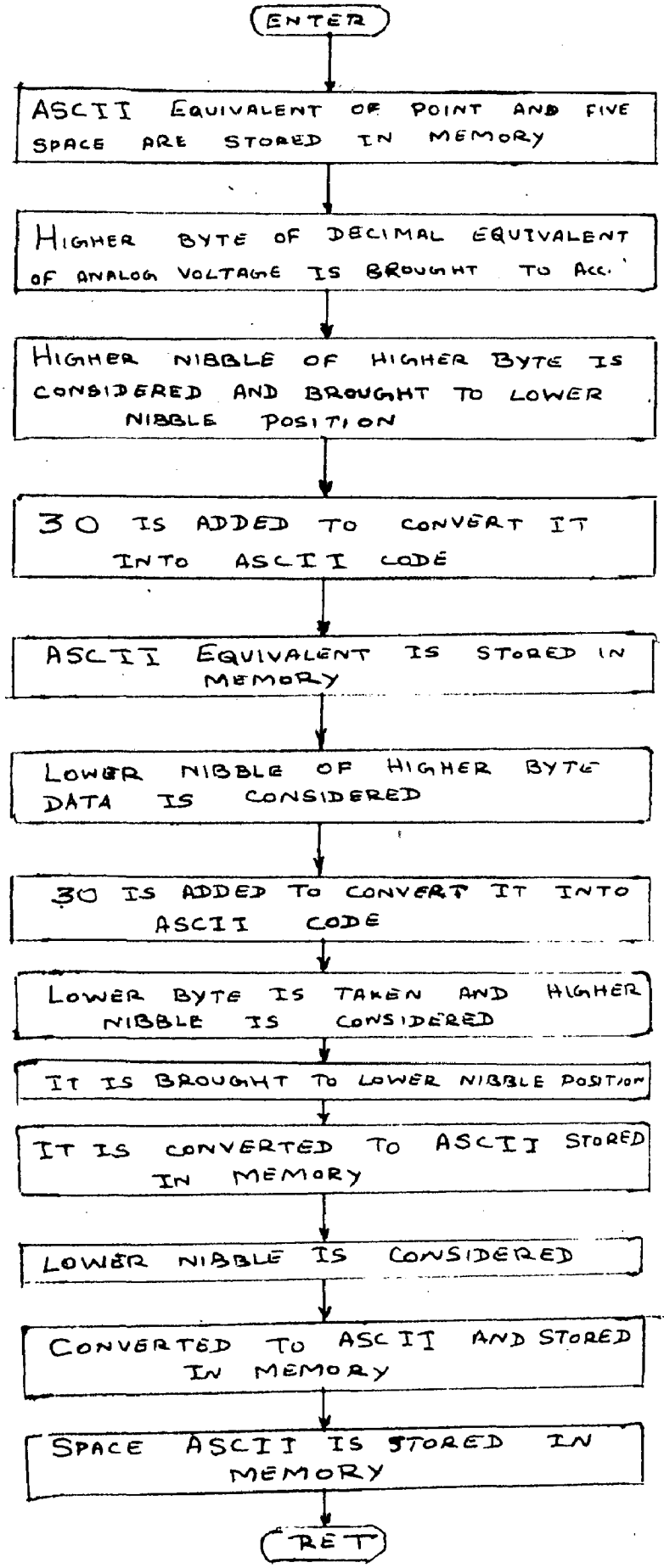
DESCRIPTION - The digital value is converted into decimal equivalent by adding the equivalent value from the Look up Table which is in the memory location.

LABEL	ADDRESS	CONTENTS	MNEMONICS AND OPERANDS	Comments
	2070	0E 08	MVI C 08	Initialize C-register to convert all the 8-bits
	2072	11 00 00	LXID 00 00	Initialize (D,E) r.p.
	2075	21 91 20	LXI H 2091	Initialize (H,L) with L.U.T. Address
LOOP	2078	78	MOV A,B	Digital value is brought to ACC.
	2079	07	RLC	Is the LSB high
	207A	47	MOV B,A	Store after rotate right
	207B	DA 82 20	JC CONT	Yes.Jmp to calculate decimal equivalent
	207E	23	INX H	No. Jump to next valve in the look up table
	207F	C3 8B 20	JMP LAST	Jump to find the next bit.
CONT	2082	7B	MOV A,E	Higher decimal values is brought to ACC.
	2083	86	ADD M	Equivalent decimal equivalent
	2084	27	DAA	Value is added and decimal adjusted
	2085	5F	MOV E,A	It is stored back in E-reg.
	2086	23	INX H	(H,L)points to lower decimal
	2087	7A	MOV A,D	Lower dec.value is brought to ACC
	2088	8E	ADC M	Equivalent decimal equivalet
	2089	27	DAA	Value is added with carry and decimal adjusted
	208A	57	MOV D,A	The value is stored back.
LAST	208B	23	INX H	(H,L)points to next memory.
	208C	0D	DCRC	Has all the 8 bits converted
	208D	C2 78 20	JNZ LOOP	No jump to study next loop
	2090	C9	RET	

LOOK UP TABLE

ADDRESS	CONTENT
2091	00
2092	25
2093	50
2094	12
2095	25
2096	06
2097	12
2098	03
2099	56
209A	01
209B	78
209C	00
209D	39
209E	00
209F	20
20A0	00

FLOW CHART FOR SUBROUTINE COASC



SUBROUTINE - COASC (CONVERT TO ASCII EQUIVALENT)
CALLS -
OUTPUTS - ASCII equivalent in memory
INPUTS - Decimal Equivalent value in (D,E) r.p.
DESTROYS - ALL
DESCRIPTION - Decimal equivalent value is converted into ASCII by taking nibble and adding 30. This value is stored in the memory location along with decimal point. At the end of the ASCII data ASCII for 5 spaces is stored.

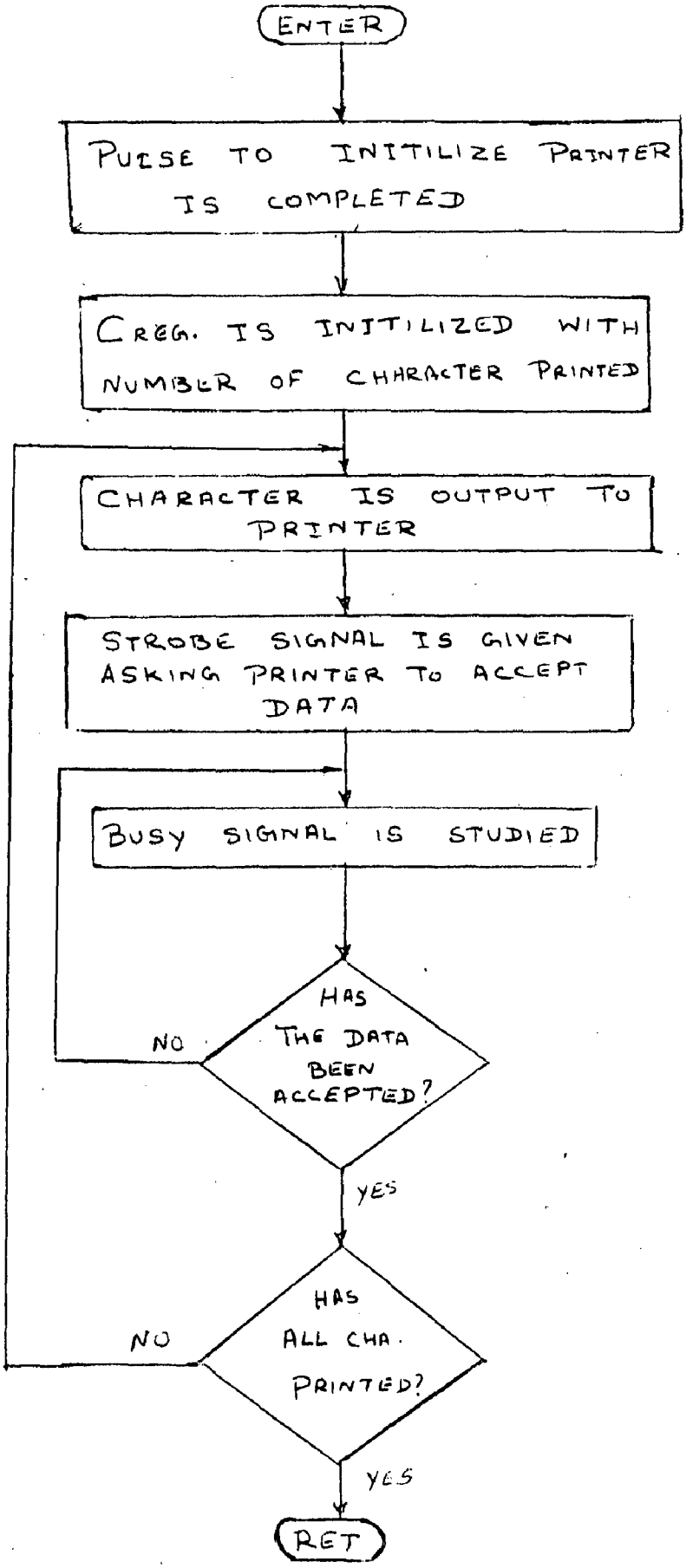
LABEL	ADDRESS	CONTENTS	MNEMONICS AND OPERANDS	COMMENTS
	20A1	01 2E 09	LXI B 09 2E	ASCII equivalent of dot and space is stored in (B,C) r.p.
	20A4	21 D0 20	LXI H ASEQDA	Memory address for ASCII equivalent
	20A7	7A	MOV A,D	Hi her byte of data is brought to ACC
	20A8	E6 F0	ANI F0	Higher nibble value is retained
	20AA	0F	RRC	Higher nibble value is protected to bring it to the lower position
	20AB	0F	RRC	
	20AC	0F	RRC	
	20AD	0F	RRC	
	20AE	C6 30	ADI 30	Converted to ASCII value
	20B0	77	MOV M,A	It is stored in memory area
	20B1	23	INX H	Decimal point is moved to the memory area
	20B2	71	MOV M,C	
	20B3	23	INX H	Lower nibble of the higher byte of the decimal equivalent data is converted to ASCII and stored in the memory
	20B4	7A	MOV A,D	
	2085	E6 0F	ANI 0F	
	20B7	C6 30	ADI 30	
	20B9	77	MOV M,A	
	20BA	23	INX H	Points to next memory location
	20BB	7B	MOV A,E	Lower decimal value brought to ACC
	20BC	E6 F0	ANI F0	Higher nibble value is choosen
	20BE	0F	RRC	It is brought to the
	20BF	0F	RRC	Lower value position
	20C0	0F	RRC	
	20C1	0F	RRC	

LABEL	ADDRESS	CONTENTS	MNEMONICS AND OPERANDS	COMMENTS
	20C2	C6 30	ADI 30	Lower nibble is converted to ASCII by adding 30 and moved to memory
	20C4	77	MOV M, A	
	20C5	23	INX H	(H,L) point next memory location
	20C6	7B	MOV A, E	Lower nibble of the data is taken
	20C7	E6 0F	ANI 0F	
	20C9	C6 30	ADI 30	Converted into ASCII
	20CB	77	MOV M, A	Stored in memory
	20CC	23	INX H	Point to next address
	20CD	70	MOV M, B	Space ASCII is moved to memory
	20CE	C9	RET	

ASCII EQUIVALENT OF DATA (ASEQDA)

ADDRESS	CONTENT
20D0	-
20D1	2E
20D2	-
20D3	-
20D4	-
20D5	09

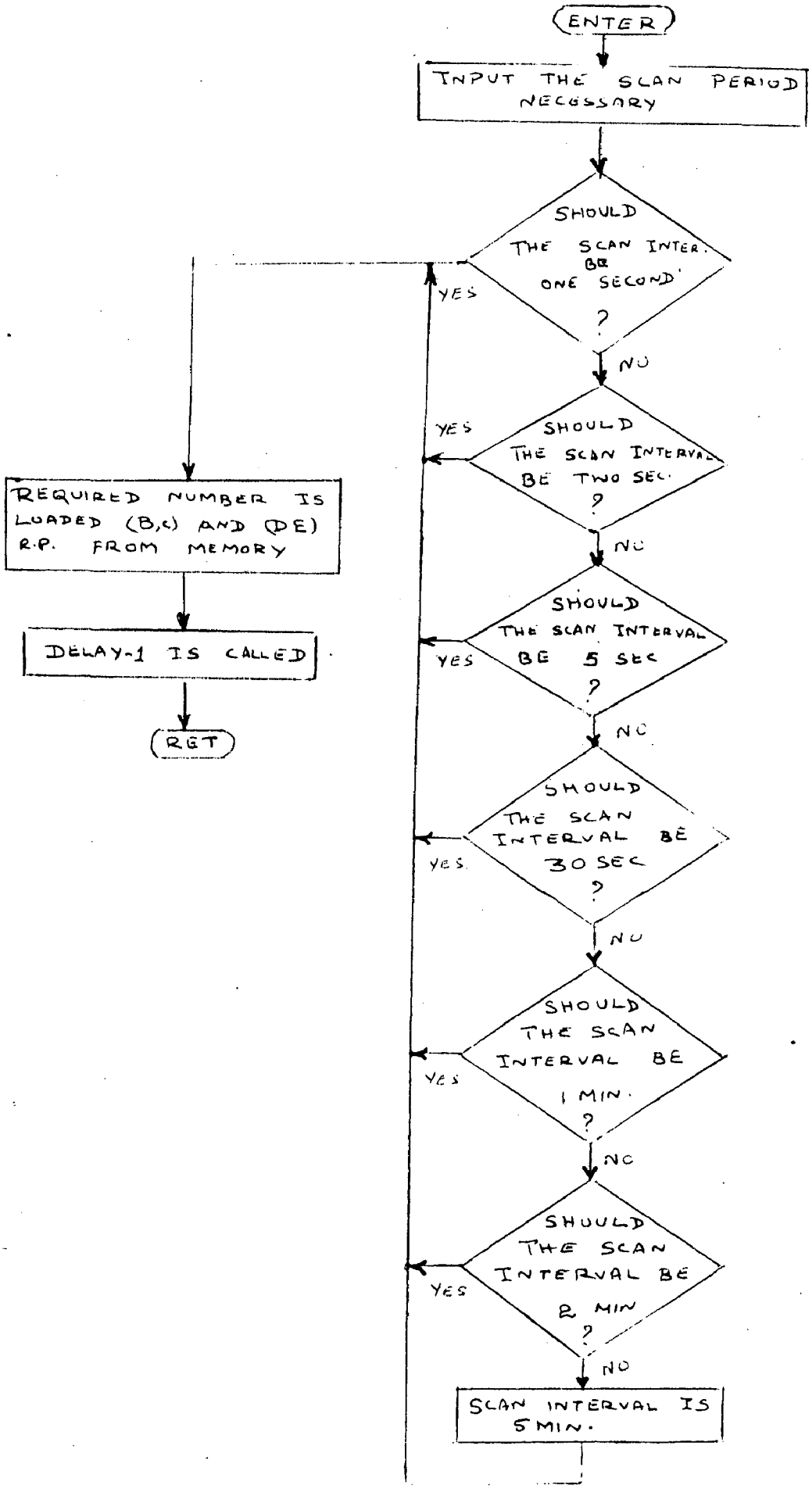
Flow chart for Subroutine Print



SUBROUTINE - PRINT
CALLS -
OUTPUTS - DATA TO PRINTER
INPUTS - ASCII value from memory
DESTROYS - H, L, A
DESCRIPTION - The ASCII data stored in memory is sent to printer and strobe signal is applied. Busy signal is monitored to send the next data

LABEL	ADDRESS	CONTENT	MNEMONICS AND OPERANDS	COMMENTS
PRINT	20E0	3E 09	MVI A, 09	To make PC4 high 09 is output to port-C
	20E2	D3 03	OUT 03	
	20E4	0E 06	MVI,C, 06	No. of characters that has to be printed
	20E6	21 D020	LXI H ASEQDA	Address of the data stored
CONT	20E9	7E	MOV A,M	Data sent to printer to print
	20EA	D3 00	OUT 00	
WAIT	20EC	DB 02	IN 02	Busy signal is monitored
	20EE	1F	RAR	Is the bit high
	20EF	DA EC 20	JC WAIT	Yes. Wait till it is low
	20F2	0D	DCRC	No. Has all be chart printed
	20F3	CA FA 20	JZ RET	Yes. Return to main program
	20F6	23	INX H	No Point to next chat
	20F7	C3 E9 20	JMP CONT	Continue to print
	20FA	C9	RET	Return

FLOW CHART FOR DELAY



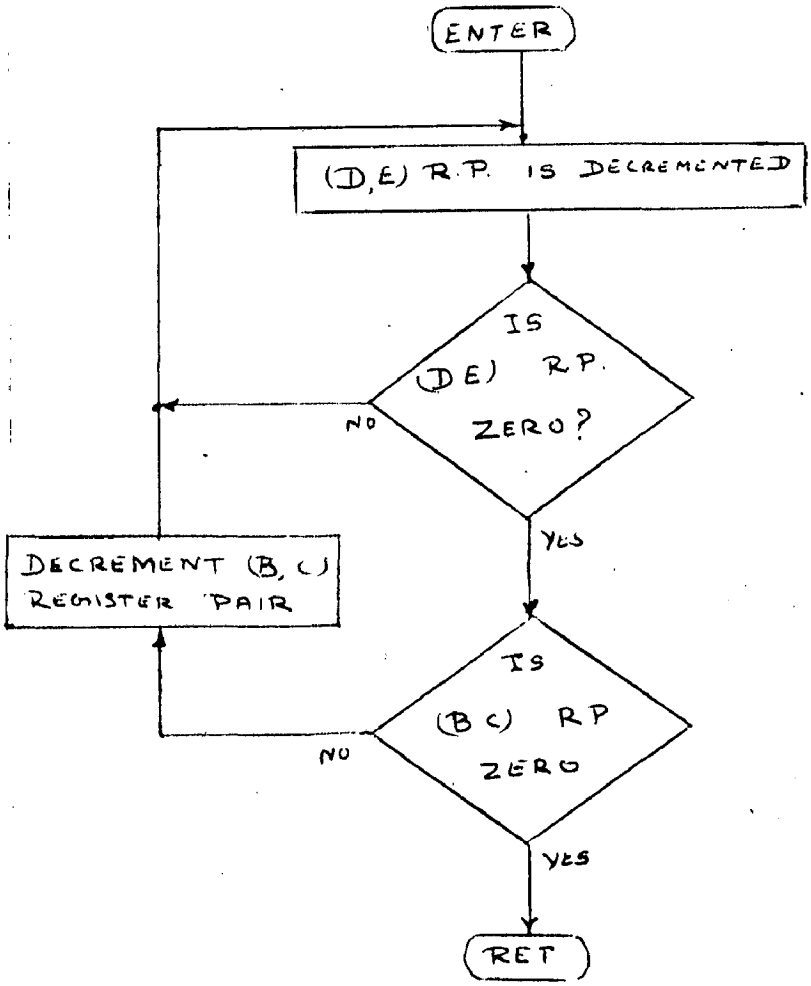
SUBROUTINE - DELAYS
CALLS - DELAY-1
OUTPUTS - Values equivalent for delays in B,C,D,E
INPUTS - The rate of printing in A-register and study from ACC
DESTROYS - B,C,D,E,A,H,L
DESCRIPTION - The required scanning interval is monitored through Port-C and the delays subroutines are called to match the required scan period. The value necessary for the delay is moved in (B,C) and (D,E) r.p. from memory and delay is called.

LABEL	ADDRESS	CONTENTS	MNEMONICS AND OPERANDS	COMMENTS
	2106	0D	DCR C	No, indicate to next scan period
	2107	B9	CMP C	Should II scan, data per sec.
	2108	CA 30 21	JZ 1SEC	Yes, jump to call one second delay
	210B	0D	DCR C	No, indicate to next scan period
	210C	B9	CMP C	Should it scan 1 data after 2 second
	210D	CA 3E 21	JZ 2 SEC	Yes, jump to call two second delay
	2110	0D	DCR C	No, indicate next scan period
	2111	B9	CMP C	Should it scan 1 data after 5 second
	2112	CA 44 21	JZ 5 SEC	Yes, jump to call 5 sec delay
	2115	0D	DCR C	No, indicate next scan period
	2116	B9	CMP C	Should it scan 1 data after 30 second
	2117	CA 44 21	JZ 30 SEC	Yes, call 30 sec. delay
	211A	0D	DCR C	No, indicate next scan period
	211B	B9	CMP C	Should it scan 1 data fter 1 minute
	211C	CA 50 21	JZ 1 MIN	Yes, call 1 min. delay
	211F	0D	DCR C	No, indicate next scan period
	2120	B9	CMP C	Should it scan on data after 2 minute
	2121	CA 56 21	JZ 2 MIN	Yes, call one min. delay
	2124	C3 58 21	JMP 5 MIN	No, call 5 min. to scan data after 5 minute

1 SEC	2130	21 70 21	LXIH LUT-1	Look up Table-1 address is loaded
LSR	2133	46	MOV B,M	B is loaded with delay no.
	2134	23	INX H	Points to next address
	2135	4E	MOV C,M	C is loaded with delay no.
	2136	23	INX H	Points to next address
	2137	56	MOV D,M	(D,E) r.p. is loaded with the required from the consecutive memory
	2138	23	INX H	
	2139	5E	MOV E,M	
	213A	CD 61 21	CALL DELAY-1	Subroutine of delay is called
	213D	C9	RET	Return to main program
2 SEC	213E	21 74 21	LXI H LUT-2	LUT-2 address is loaded
	2141	C3 33 21	JMP LSR	Jumps to load the reqd.number
5 SEC	2144	21 78 21	LXI H LUT-3	LUT-3 address is loaded
	2147	C3 33 21	JUMP LSR	Jumps to load the reqd.number
30SEC	214A	21 7A 21	LXI H LUT-4	LUT-4 address is loaded
	214D	C3 33 21	JMP LSR	Jumps to load the reqd.number
1 MIN	2150	21 7C 21	LXI H LUT-5	LUT-5 address is loaded
	2153	C3 33 21	JMP LSR	Jumps to load the reqd.number
2 MIN	2156	21 80 21	LXI H LUT-6	LUT-6 Address is loaded
	2159	C3 33 21	JMP LSR	Jumps to load the reqd.number
5 MIN	215C	21 84 21	LXI H LUT-6	LUT-6 address is loaded
	215F	C3 33 21	JMP LSR	Jumps to load the reqd.number

COMMENTS	ADDRESS	CONTENTS	COMMENTS	ADDRESS	CONTENTS
LUT-1	2170	00	LUT-4	217A	84
	2171	01		217B	20
	2172	C2	LUT-5	217C	00
	2173	10		217D	22
				217E	21
LUT-2	2174	00		217F	00
	2175	02			
	2176	3D	LUT-6	2180	00
	2177	D0		2181	44
				2182	42
LUT-3	2178	00		2183	00
	2179	06	LUT-7	2184	00
				2185	88
				2186	84
				2187	00

FLOW CHART FOR DELAY-1



SUBROUTINE - DELAY-1

CALLS -

OUTPUTS -

INPUTS - D,E,B and C values to decrement

DESTROYS - D,E,B,C, A

DESCRIPTION - D,E, r.p. is decremented for the delay and then B,C, r.p. is stucied. If further delay is required these values are decremented till the desired delay is obtained.

LABEL	ADDRESS	CONTENTS	MNEHONICS AND OPERANDS	COMMENTS
CDY	2161	1B	DCX D	(B,E) is decrement to zero
	2162	7A	MOV A,D	D is brought to ACC
	2163	B3	OR A, E	Check D and E are equalled
	2164	C2 60 21	JNZ CDY	No, continue decrementing
	2167	78	MOV A,B	Yes decrement input counter
	2168	B1	ORA,C	ACC has C-register
	2169	C8	RZ	B,C, r.p. contains zero Yes, JMP to continue decrement
	216A	0B	DCX B	No, DEC(B,C) r.p. and again
	216B	C3 60 21	JMP CDY	Decrement (D,C) r.p.

CHAPTER-6

CONCLUSION AND SUGGESTION FOR FURTHER DEVELOPMENT

The interfacing unit developed to interface printer and ADC with microcomputer and the different scanning period with the indicating lamps has been achieved. Any analog voltage upto 5 volts can be read and recorded upto the third decimal place satisfactorily. The printer paper used can be any ordinary paper. Three copies can be obtained by CP-80 Type-I printer. In continuous mode of scanning seven datas per second has been achieved. The other scanning periods are one sec/data, 2 seconds/data, 5 seconds/data, 30 seconds/data, 1 min/data, 2 minutes/data, and 5 minutes/data as required in scour measurement. The required scanning period can be controlled by the 3 switches. The data read is printed in decimal value which can be used for further calculations.

Some of the suggestions for further development are -

1. The data along with time can be printed. The time software using 8253 developed as in Appendix B-5 can be used to store the time in one memory location and output to print when necessary.

2. The rate of scanning can be increased to a very large value by storing the data in a memory location instead of printing it directly. The on-board capacity of RAM available is 10 k along with the monitor ROM of 4 k. The data once

stored can be printed whenever needed. If the on-board capacity is not sufficient then floppy disc drive can be interfaced to the system 85/9 trainer kit and store the data on the floppy disc. This will enhance the capacity of memory for storing large number of data. At a later convenient time data can be printed out from the floppy.

3. The unit can be modified to have the multiplex input. Then data from different places can then be monitored and recorded.

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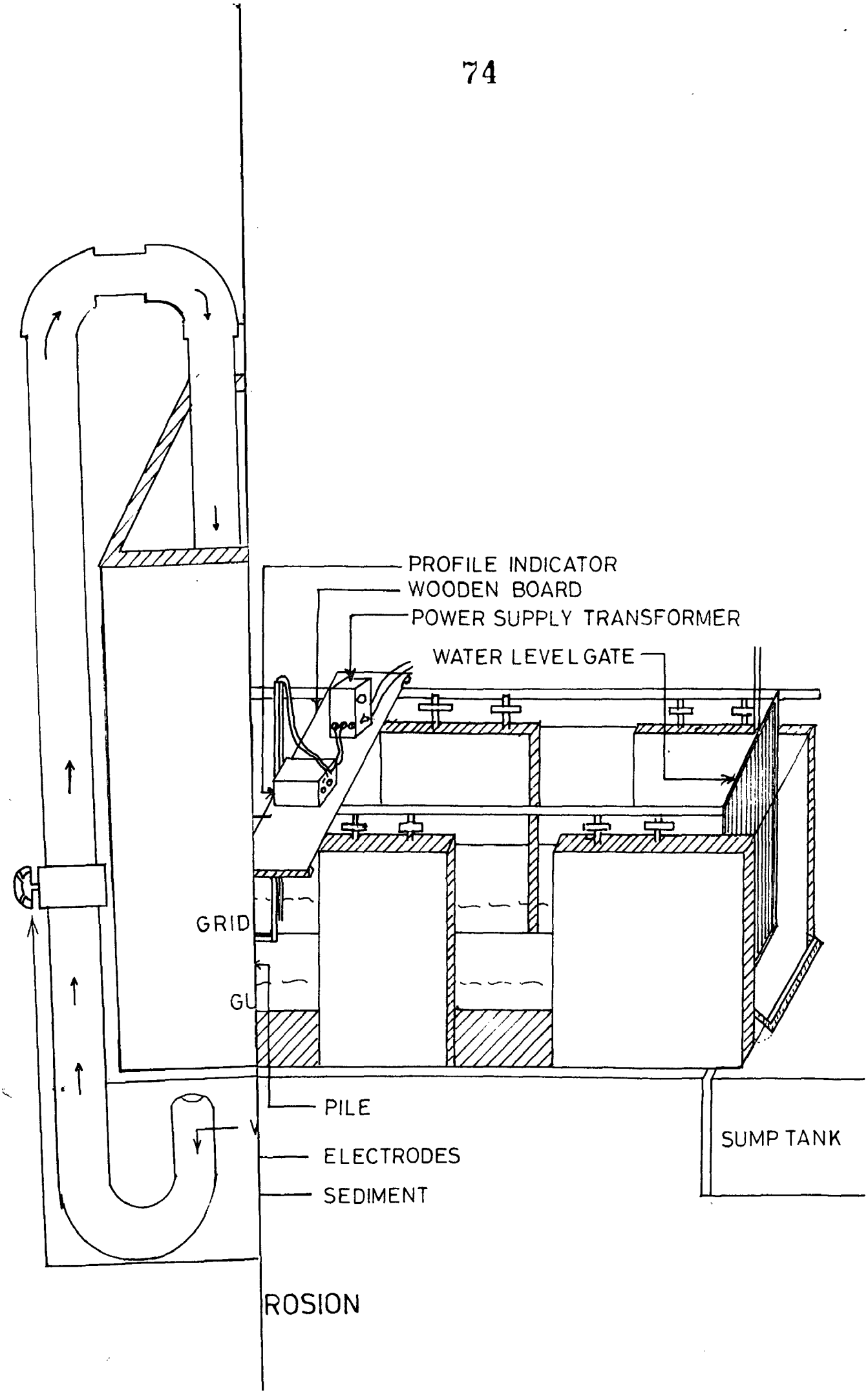
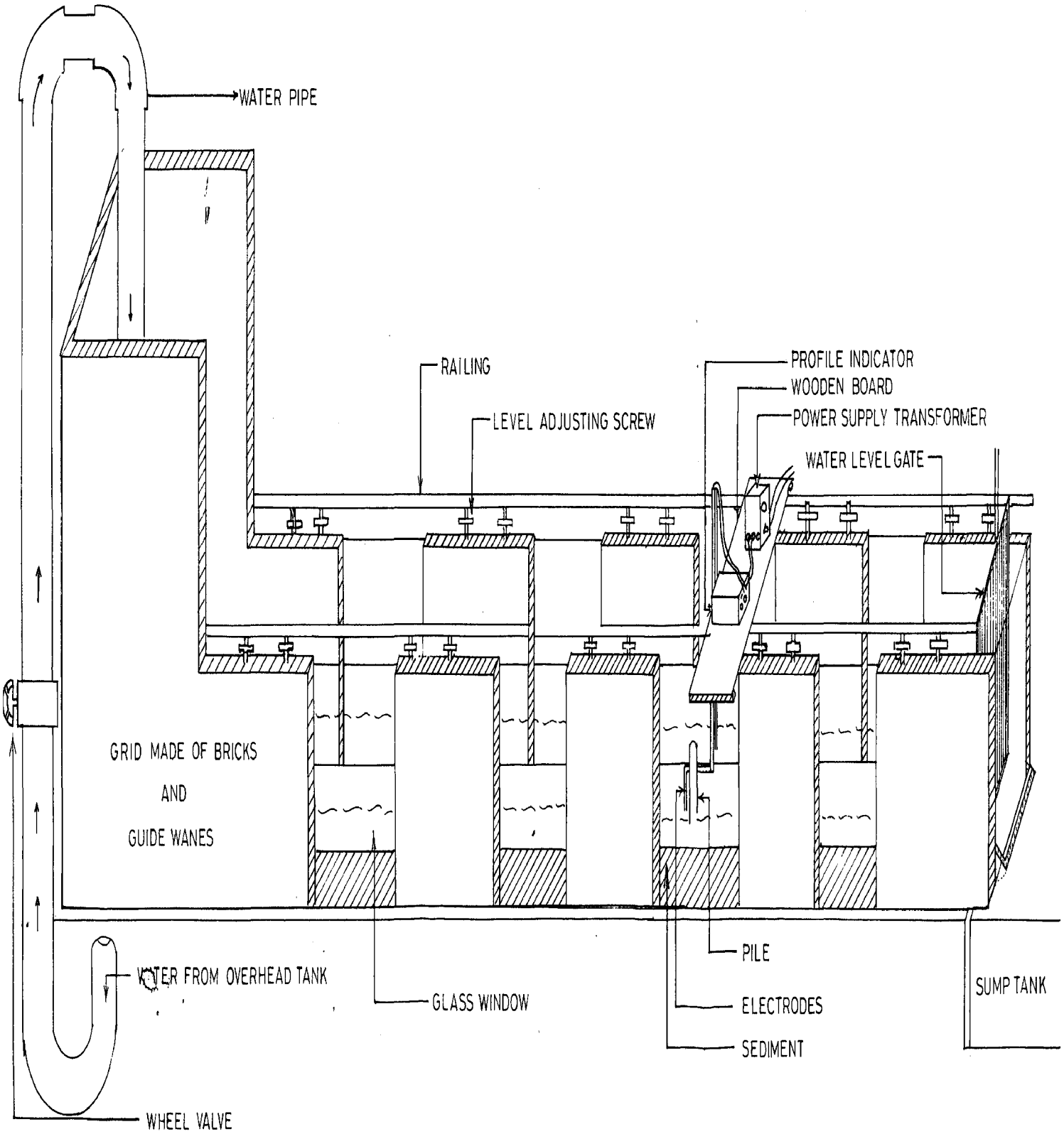

PROFILE INDICATOR
WOODEN BOARD
POWER SUPPLY TRANSFORMER
WATER LEVEL GATE
GRID
GU
PILE
ELECTRODES
SEDIMENT
SUMP TANK
ROSION

APPENDIX A-1



SIMULATED MODEL OF THE RIVER TO STUDY THE ERROSION

APPENDIX- B-1

SYSTEM SPECIFICATIONS

CPU	-	8 bit microprocessor, the 8085-A
MEMORY	-	Total on board capacity - 64 k Bytes
RAM	-	2 k bytes (6116), space for further expansion
ROM	-	4 k bytes of EPROM loaded with powerful monitor program (2732), space for further expansion using 2716/2732/2764/27128.
TIMER	-	16 bit programmable timer/counter using 8253.
I/O	-	24 I/O lines expandable to 48 I/O using 8255 PPI
INTERRUPTS	-	8 different level interrupts through 8259.
Key Board	-	10 keys for command, 16 keys for Hexadecimal data entry, 1 key for Vector interrupt and 1 key for reset.
LED Display	-	6 seven segment displays, 4 for address field, 2 for data field.
BUS	-	All data, address and control signals (TTL compatable) available at edge connector.
INTERFACE	-	1) Audio Cassette Recorder 2) 20 mA current loop through SID/SOD lines 3) RS-232-C through SID/SOD lines with auto band rate 4) One RS-232-C through 8251 with a programmable band rate 5) EPROM Programmer
Power supply requirements	-	+5V, 1.5A for the kit ± 12V, ± 5 percent, 250 mA for CRT and TTY ± 24V, ± 5 percent, 100 mA for EPROM Programmer Interface

APPENDIX B-2

SYSTEM CAPABILITIES

1. Examine the contents of any memory location.
2. Examine/modify the contents of any of the uP internal Register.
3. Modify the contents of any of the RAM Location.
4. Move a black of data from one location to another location
5. Insert one or more instructions in the user program
6. Delete one or more instructions from the user program.
7. Relocate a program written for some memory area to some other memory area.
8. Find out a string of data lying at a particular address
9. Fill a particular memory area with a constant.
10. Compare two blocks of memory
11. Insert one or more data bytes in the user's program/ Data area.
12. Delete one or more data bytes from the User's program/ Data area.
13. Transmit a program from memory to audio cassette recorder
14. Receive a program into memory from audio cassette recorder
15. Check the contents of an EPROM for blank
16. List the contents of an EPROM into RAM area
17. Verify the contents of an EPROM with any memory area
18. Program an EPROM
19. Execute a program at full clock speed
20. Execute a program in single steps i.e. instruction by instruction.

APPENDIX B-3

SIGNALS AT JUNCTION CONNECTOR J_2.

The 24 lines I/O of 8255-I are brought out at this connector. They are -

Pin	Signal	Pin	Signal	Pin	Signal
1	P1C4	10	P1B5	19	P1A2
2	P1C5	11	P1B2	20	P1A3
3	P1C2	12	P1B3	21	P1A0
4	P1C3	13	P1B0	22	P1A1
5	P1C0	14	P1B1	23	P1A6
6	P1C1	15	P1A6	24	P1A7
7	P1B6	16	P1A7	25	GND
8	P1B7	17	P1A4	26	GND
9	P1B4	18	P1A5		

SIGNALS AT JUNCTION CONNECTOR J_3

The 24 I/O lines of 8255-II are brought out at this connector. They are -

Pin	Signal	Pin	Signal	Pin	Signal
1	P2C4	10	P2B5	19	P2A2
2	P2C5	11	P2B2	20	P2A3
3	P2C2	12	P2B3	21	P2A0
4	P2C3	13	P2B0	22	P2A1
5	P2C0	14	P2B1	23	P2C6
6	P2C1	15	P2A6	24	P2C7
7	P2B6	16	P2A7	25	GND
8	P2B7	17	P2A4	26	GND
9	P2B4	18	P2A5		

APPENDIX- B-4

SIGNALS AT CONNECTOR J_1

The various signals provided at the connector are the interrupts levels of 8259, timer/counter channels points and other interrupt signals of 8085.

Pin					
1	CAS0	(cascade line)			
2	CAS1	(Cascade line)			
3	CAS2	(Cascade line)			
4	$\overline{SP}/\overline{EN}$	Slave program/Enable buffers			
5	IR0	13	CLK0	21	OUT-2
6	IR1	14	GATE0	22	RST-7.5
7	IR2	15	OUT0	23	RST-6.5
8	IR3	16	CLK1	24	MP
9	IR4	17	GATE 1	25	GND
10	IR5	18	OUT1	26	GND
11	IR6	19	CLK-2		
12	IR7	20	GATE 2		

SIGNALS AT CONNECTOR J_4

The various power supply signals and the signals for various interfaces are brought out at this connector. They are -

Pin	Signal	Pin	Signal	
01	CRT IN	08	EAR OUT	
02	CRT OUT	09	GND	
03	Tx^-	10	+24V/+21V	
04	Tx^+	11	-12V	
05	Rx^-	12	+12V	
06	Rx^+	13	+5V	
07	MIC IN			

APPENDIX B-5

SUBROUTINE : TIME

INPUT -

OUTPUT -

CALLS -

DESTROYS H,L,A

DESCRIPTION : EXPECTS DATE and time in Memory 2300. Clock and GATE SIGNAL is given through hardware. Loads 8253 counter-2 and after enabling interrupt RST 6.5 Counter counts down. After is counts down the seconds is incremented. After 60 seconds Mint is incremented and henceforth hours and then days are incremented.

	2200	3E BO	MVT A,BO	Load THE CONTROL WORD,OUTPUT
	2202	D3 13	OUT 13	TO CONTROL REGISTER WITH COUNTER-2
	2204	3E E9	MVI A,08	LOAD LOWER AND HIGHER BYTE COUNTER
	2206	D3 12	OUT 12	WITH REQUIREI NUMBER
	2208	3E 07	MVI A,EF	
	200A	D3 12	OUT 12	
	200C	3E OD	MVI A,OD	LOAD ACC.WITH DATA TO ENABLE RST.6.5 ONLY
	200 E	30	SIM	
	200F	E3	EI	ENABLE THE INTERRUPT
HLT	2210	76	HLT	HALT
	2211	C3 10 22	JMP HLT	JUMP BACK TO HALT
	27B7	C3 20 22		FROM INTERRUPT JNM TO PROG THE

```
PROG  2220   21 23 00   LXI H 2304   SEC.LOADED ADDRESS IS LOADED
      2223   7E         MOV A,M      SECOND IS BROUGHT AND INCREMENTED
      2224   C6 01      ADI 01
      2226   27         DAA          ADJUSTED TO DECIMAL VALUE
      2227   FE 60      CPI 60       IS IT 60 SEC?
      2229   C2 54 22   JN 2 SECO    NO, JUMP TO LOAD REG.OF 8253
      222C   AF         XRA A        YES, MAKE IT ZERO AND
      222D   77         MOV M,A      STORE ZERO
      222E   2B         DCX H        POINT TO MINS.ADDRESS
      222F   7E         MOV A,M      BRING MINS.
      2230   C6 01      ADI 01       INCREMENT MINS
      2232   27         DAA          ADJUST IT TO DECIMAL
      2233   FE 60      CPI 60       IS IT 60 MIN?
      2235   C2 60 22   JNZ MIN      NO, JUMP TO LOAD 8253 REG.
      2238   AF         XRA A        YES, MAKE MINS.ZERO
      2239   77         MOV M,A      STORE IT BACK IN MEMORY
      223A   2B         DCX H        POINT(H,L) TO HOURS ADDRESS
      223B   7E         MOV A,M      BRING HOURS TO ACC.
      223C   C6 01      ADI 01       INCREMENT HOURS
      223F   27         DAA          ADJUST TO DECIMAL
      2240   FE 24      CPI 24       IS IT ALREADY 24 HRS?
      2242   C2 6C 22   JN2 HOUR     NO, JUMP TO LOAD 8253 REG.
      2245   AF         XRA A        YES, START FRESH HOUR
      2246   77         MOV M,A      INITILIZE HOURS IN MEM.
      2247   2B         DCX H        POINT TO DAYS
      2248   34         INR M        INCREMENT NUMBER OF DAYS
```

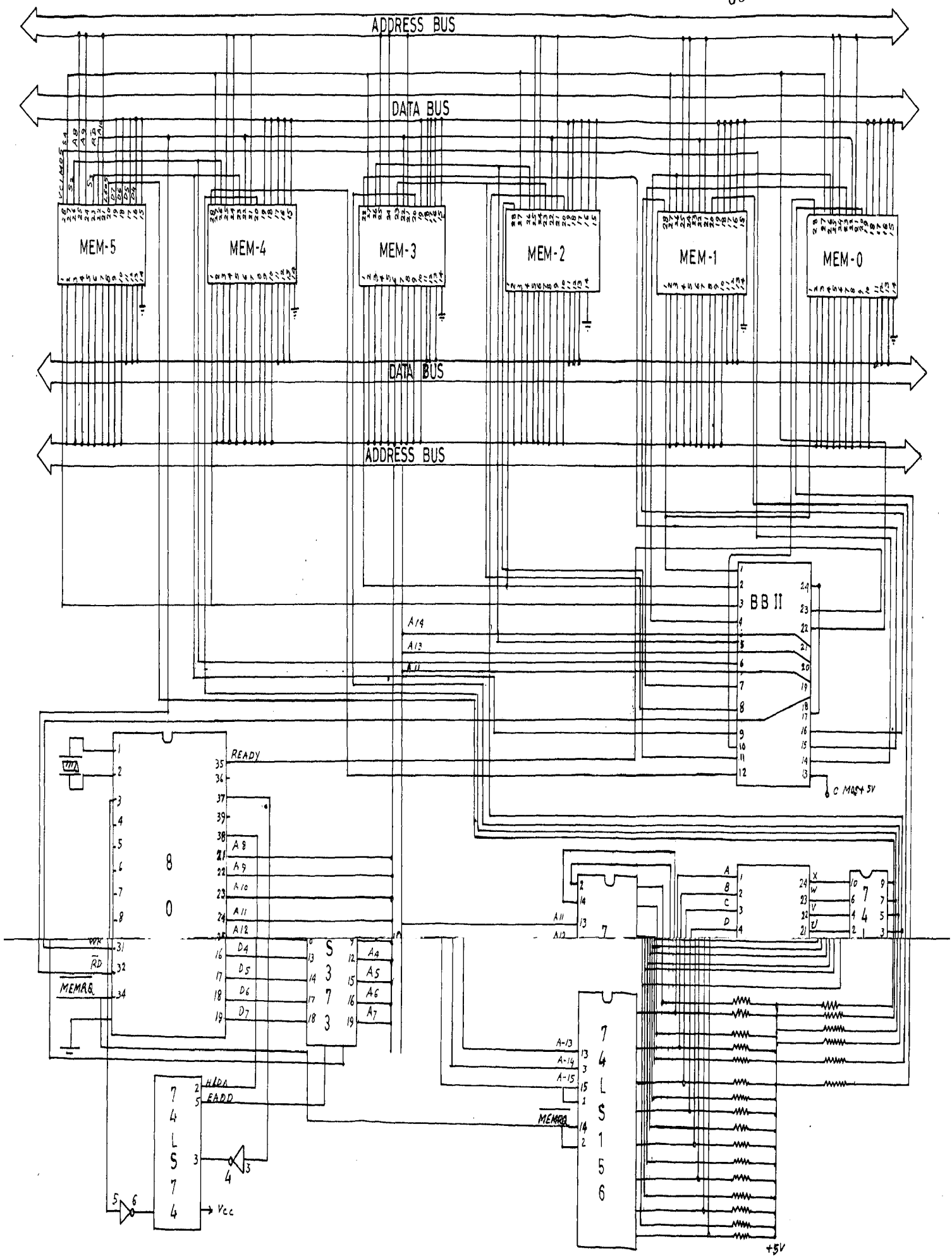
	2249	3E 08	MVI A,08	LOAD RP OF 8253 WITH
	224B	D3 12	OUT 12	NUMBER FOR SECONDS
	224D	3E EF	MVI A,EF	
	224F	D3 12	OUT 12	
	2251	C3 75 22	JMP EN I	JMP TO INTERRUPT
SECO	2254	77	MOV M,A	STORE BACK IN MEMORY
STT	2255	3E E9	MVI A,E9	LOAD 8253 R.P. TO START
	2257	DB 12	OUT 12	SECONDS COUNT DOWN
	2259	3E 07	MVI A,07	
	225B	D3 12	OUT 12	
	225D	C3 75 22	JMP ENI	JUMP TO ENABLE INTERRUPT
MIN	2260	77	MOV M,A	STORE BACK IN MEMORY
	2261	3E B6	MVI A,B6	LOAD 8253 r.p.WITH NUMBER
	2263	D3 12	OUT 12	TO START SECONDS COUNT DOWN
	2265	3E 07	MVI A,07	
	2267	D3 12	OUT 12	
	2269	C3 75 22	JMP ENI	JUMP TO ENABLE INTERRUPT
HOUR	226C	77	MOV M,A	SAVE HOURS
	226D	3E 83	MVI A,B6	
	226F	D3 12	OUT 12	LOAD 8253 R.P.WITH NUMBERS
	2271	3E 07	MVI A,07	TO START SECONDS COUNT DOWN
	2273	D3 12	OUT 12	
ENT	2275	FB	EI	ENABLE 6.5 RST
			C9	RETURN

APPENDIX-B-6

SIGNALS AT CONNECTOR SPACE J_5 - (AUY. RS-232-C)

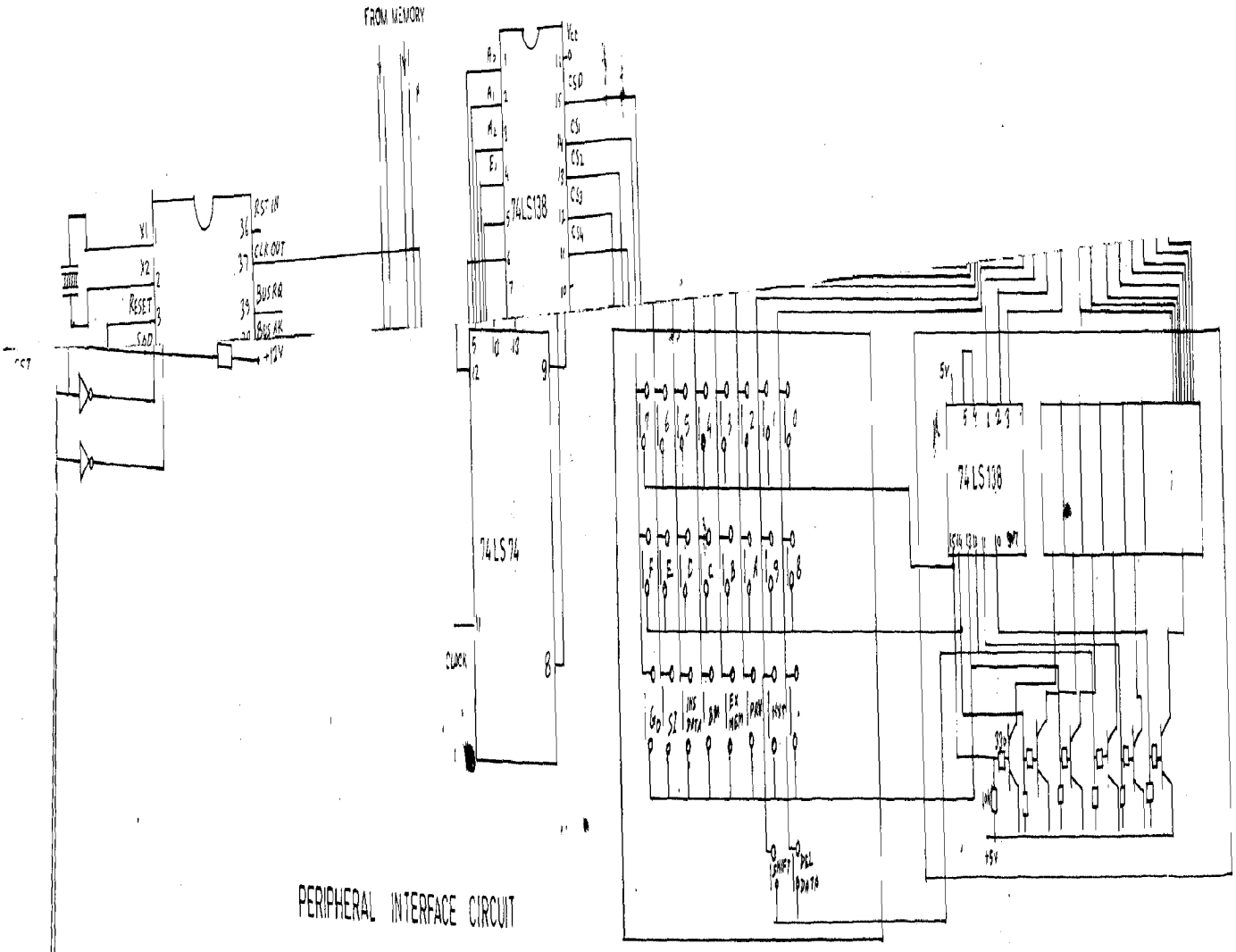
The various signals provided at the connector space J_5 are the signals of the programmable communication interface 8251. The details are -

Pin	Signal
01	GND (FRAME GROUND)
02	Tx (Transmit Data)
03	Rx (Receive data)
04	$\overline{\text{RTS}}$ (Request to send)
05	$\overline{\text{CTS}}$ (clear to send)
06	$\overline{\text{DST}}$ (Data set ready)
07	GND (Signal ground)
08-19	No connection
20	$\overline{\text{DTR}}$ (Data Terminal Ready)
21 to 25	No connection



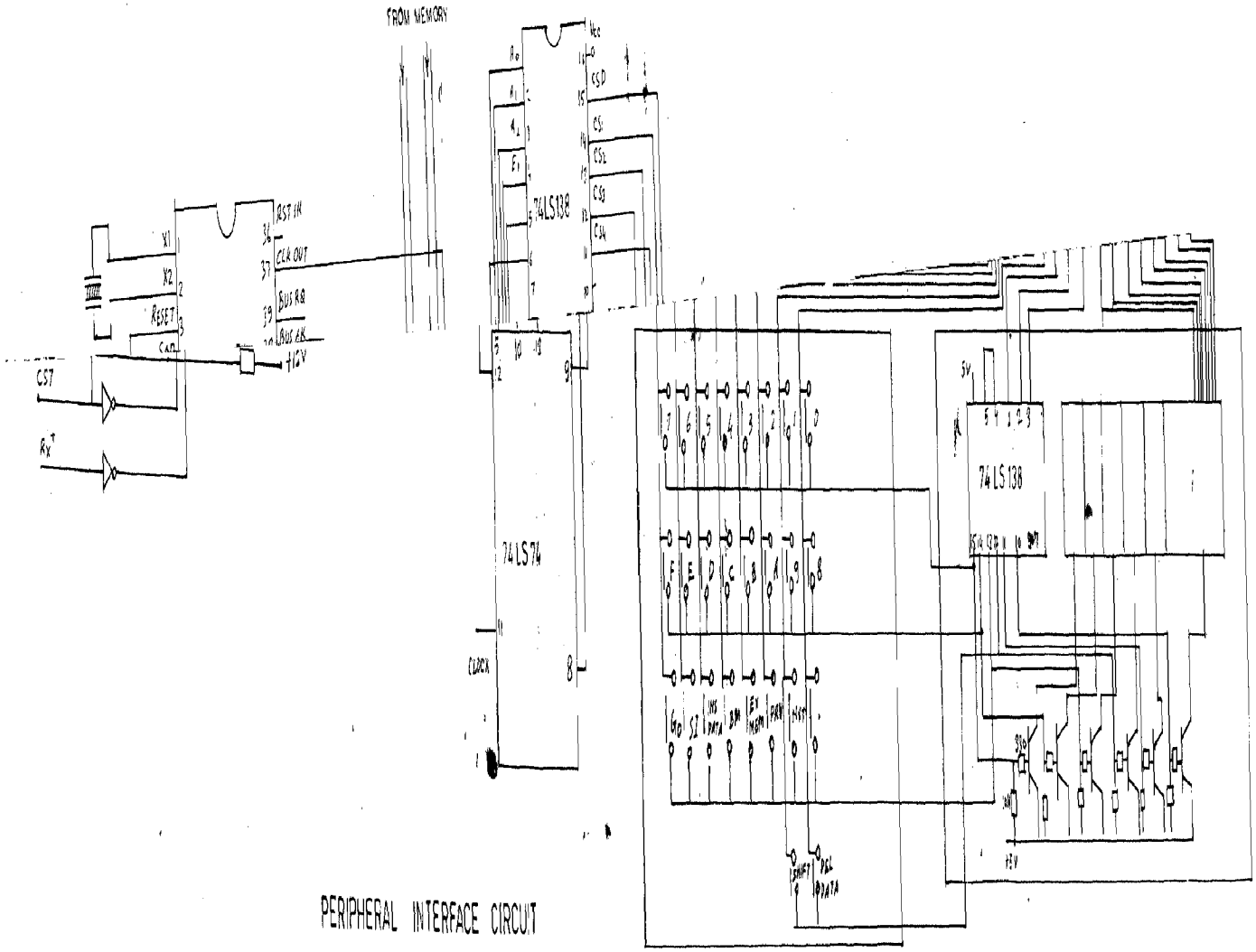
MEMORY INTERFACE CIRCUIT

APPENDIX-B-7



PERIPHERAL INTERFACE CIRCUIT

APPENDIX-B-7



PERIPHERAL INTERFACE CIRCUIT

APPENDIX C-1

CONNECTOR DETAILS

Connector Pin Chart

Signal No.	Signal	Direction	Description
1	2	3	4
1	$\overline{\text{STROBE}}$	IN	STROBE pulse of read data in. Pulse width must be more than 0.5μs at receiving terminal. The signal level is normally 'High' read-in of data is performed at the 'low' level of this signal.
2 to 9	DATA	IN	These signals represent information of the Ist to 8th bits of 11th data respectively. Each signal is at 'high' level when data is logical '1' and 'low' when logical 0.
10	$\overline{\text{ACKNLG}}$	OUT	Approx. 5μs pulse. 'Low' indicates that data has been received and that the printer is ready to accept other data.
11	BUSY	OUT	A 'High' signal indicates that the printer cannot receive data. The signal becomes 'High' in the following cases -1) during data entry, 2) during printing operation, 3) In Off-line station, 4) during printing error station
12	PE	OUT	A 'High' signal indicates that the printer is out of papers.
13	SLCT	OUT	This signal indicates that the printer is out of paper.
14	$\overline{\text{AUTO FEED}}$	IN	When this signal being at 'low' level, the paper is automatically fed one line after printing. (The signal level can be fixed to 'low' with DIP SW Pin 2-3 provided on the control circuit board).
15	NC		Not used
16	CHASSIS GND	-	Printers chasis GND. In the printers, the chassis GND and the logic GND are isolated from each other.
17 and 18	NC	-	Not used

Contd.

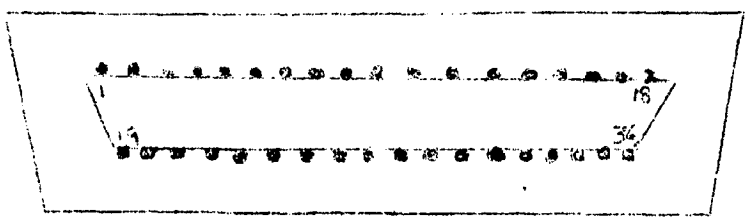
Appendix-C-1 (contd.)

1	2	3	4
19 to 30	-	-	Twisted pair return signal GND level
31	$\overline{\text{INIT}}$	IN	When the level of this signal becomes 'low', the printing controller is reset to its initial state and the print buffer is cleared. This signal is normally at 'high' level, and its pulse width must be more than 50µs at the receiving terminal.
32	$\overline{\text{ERROR}}$	OUT	The level of this signal becomes 'low' when the printer is in - 1) paper end state, 2) Off-line state, 3) Error state
33	GND	-	Same as with Pin Nos. 19 to 30
34	NC	-	Not used
35	VCC	-	Pulled up to + 5V through 3.3 kR resistor
36	SLCTIN	IN	Data entry to the printer is possible only when the level of this signal is 'low'.

Note - 1) Direction refers to the direction of signal as viewed from the printer.

2) All interface conditions are based on TTL level. Both the rise and fall times of each signal must be less than 0.2µs.

3) Data transfer must not be carried out by ignoring the ACKNLG OR BUSY signal.



36 PIN CONNECTOR

APPENDIX D-1

EQUIPMENT MULTI CHANNEL DIGITAL RECORDER

Type	-	TR2721A
Power	-	100 V, 50/60 Hz
Power consumption	-	30VA or less without printing operation
No. of channel	-	12 USVA with printing operation.
Extendable	-	24
D.C. voltage measurement	-	± 50 mV, ± 200 V, ± 2V, ± 20V, 1 to 5V
Temperature measurement sensor	-	JIST(CC), J(IC), E(CRC),K(CA),R(PR) Thermocouples
Maximum resolutions	-	0.1° C/T(CC) range 1°C/J(IC), E(CRC), K(CA),R(PR) ranges

PRINTER

Printer	-	Thermal type
Print output	-	Printing after data fetched up to the last channel
Printing speed	-	Approx. 1 line/sec.
Paper	-	Roll type heat-sensitive recording paper.
Paper length	-	App. 30 m, 6000 data (Normal mode Approx. 6 cm/12 channels) App. 12000 data (TREND Mode, Approx. 3 cm/1 to 12 channels)
Paper width	-	App. 6 cm.

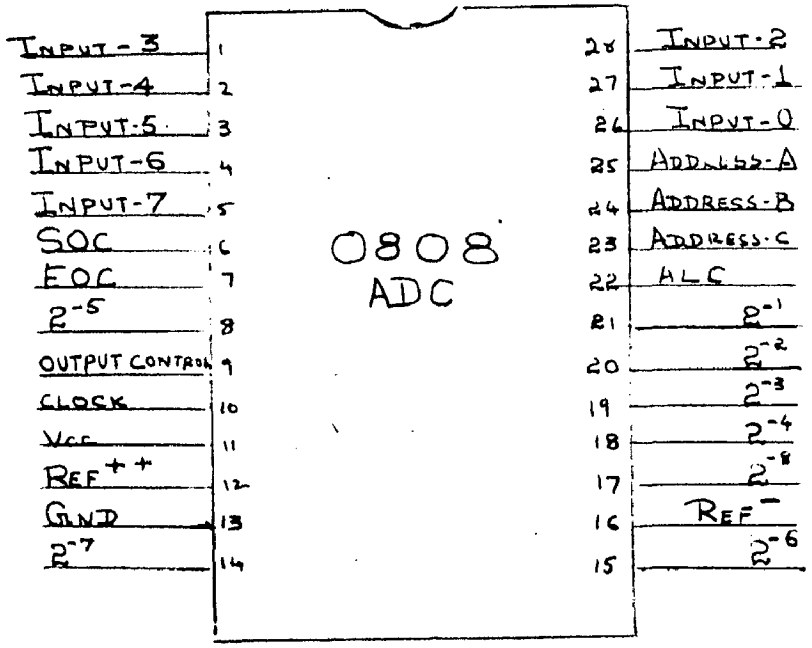
GENERAL

Input system	-	2-wire
A/D conversion system	-	Dual slope integration
Measurement Speed	-	Min (app. 0.2 to 0.5 sec), 0.5 sec. 1 sec.
SCAN period	-	CONTINUOUS, 30 sec, 1,2,5,10, 30 Mins. 1,2 hrs.
SCANNING RANGE	-	01 to 12 selectable (channels 13 to 24 with extender).

Appendix D-1(Contd.)

CLOCK	-	Time bound signal stability Approx. ± 15 sec/day (at 23°C ± 5°C)
Max. time display	-	23 hrs, 59 mins.
Display	-	7 segment LED display Channel number - 2 digits Measurement value - 4 digits Units - V, mV, °C Alarm - ALARM ('x ' indication)
External dimension	-	300 x 132 x 400 mm (wide) (high)(deep)
Weight	-	9 kg.

APPENDIX: D-2

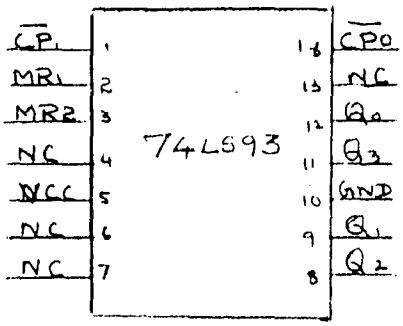


PIN CONFIGURATION

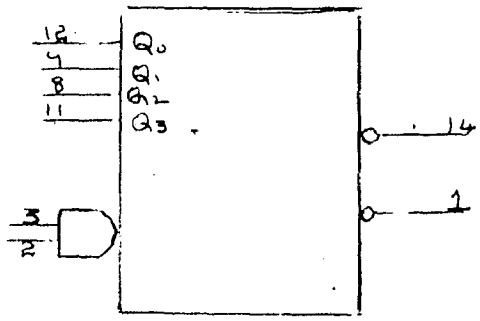
PIN NO.	SIGNAL	DIRECTION	COMMENTS
1 TO 5 26 TO 28	INPUT 0 TO 7	IN	ANALOG SIGNALS
6	START OF CONVERSION (SOC)	IN	ACTIVE HIGH PULSE TO START CONVERSION OF ANALOG TO DIGITAL
7	END OF CONVERSION (EOC)	OUT	GOES LOW WHEN CONVERSION STARTS GOES BACK HIGH WHEN CONVERSION IS COMPLETE. INDICATES THROUGH THIS
9	OUTPUT CONTROL	IN	CONTROL SIGNAL
10	CLOCK	IN	CLOCK IS GIVEN FROM 74LS93. MM.
11	Vcc	IN	SUPPLY +5V.
12	REF_+	IN	+VE REFERENCE VOLTAGE
13	GND	IN	Grounded
16	REF^-	IN	-VE REFERENCE VOLTAGE
22	ADDRESS LOAD CONTROL (ALC)	IN	CONTROL SIGNAL.
23 TO 25	ADDRESS A, B and C	IN	SELECTS ONE OF THE EIGHT INPUTS [INPUT-0-7]. DEPENDING UPON THE ADDRESS
8, 14, 15, and 17 TO 21	DIGITAL OUTPUT	OUT	EIGHT BITS OF OUTPUT IS OBTAINED

APPENDIX D-3

74LS93 4-BIT BINARY COUNTER (7)



PIN CONFIGURATION

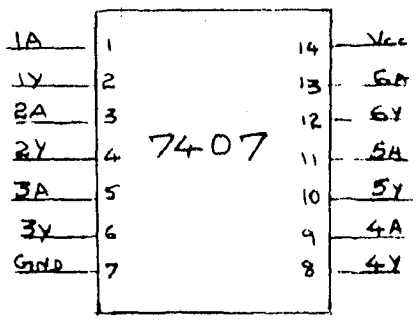


LOGIC SYMBOLYSM

PIN NO.	SIGNAL	DIRECTION
1	$\overline{CP_1}$	INPUT
2	MR1	INPUT
3	MR2	INPUT
4	NC	NO INTERNAL CONN.
5	VCC	-
6	NC	-
7	NC	-

PIN NO.	SIGNAL	DIRECTION
8	Q_2	OUTPUT
9	Q_1	OUTPUT
10	GND	-
11	Q_3	OUTPUT
12	Q_0	OUTPUT
13	NC	-
14	$\overline{CP_0}$	INPUT

7407 BUFFER (7)



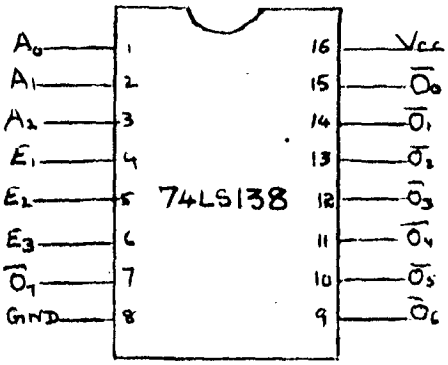
PIN CONFIGURATION

LOGIC SYMBOLYSM

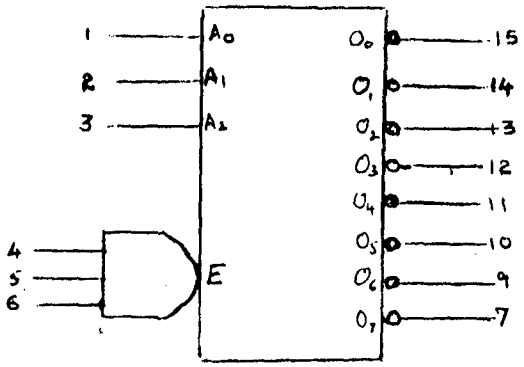
PIN NO.	SIGNAL	DIRECTION	PIN NO.	SIGNAL	DIRECTION
1	1A	IN	8	4Y	OUT
2	1Y	OUT	9	4A	IN
3	2A	IN	10	5Y	OUT
4	2y	OUT	11	5A	IN
5	3A	IN	12	6y	OUT
6	3y	OUT	13	6A	IN

APPENDIX D-4

74LS138 3-LINE TO 8-LINE DECODER (7)



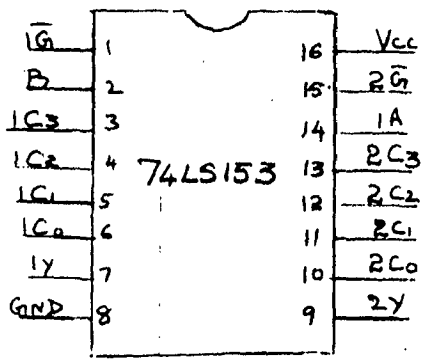
PIN CONFIGURATION



LOGIC SYMBOLISM

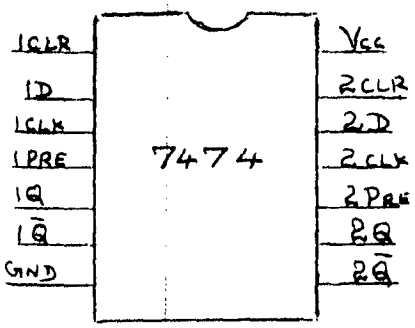
PIN NO.	SIGNAL	DIRECTION	DESCRIPTION
1 TO 3	A_0, A_1 & A_2	IN	ADDRESS
4 & 5	$\overline{E_1}$, $\overline{E_2}$	IN	ENABLE [ACTIVE LOW]
6	E_3	IN	ENABLE [ACTVE HIGH]
9 TO 15 AND 7	$\overline{O_0}$ TO $\overline{O_7}$	OUT	ACTIVE LOW OUTPUT
8	GND	IN	-
15	V_{CC}	IN	-

74LS153 (7)



PIN	ASSIGNMENT		PIN	ASSIGNMENT
1	STROBE 1G		9	OUTPUT 2Y
2	SELECT B		10 TO 13	DATA INPUT
3 TO 6	DATA INPUTS		14	SELECT A
7	OUTPUT 1Y		15	STROBE 2G
8	GND.		16	Vcc

7474 (7)



PIN NO.	ASSIGNMENT
1 & 13	$\overline{CLR}$
2 & 12	D
11 & 3	CLK
10 & 4	PRE

PIN NO.	ASSIGNMENT
5 & 9	Q
6 & 8	$\overline{Q}$
7	GND
14	Vcc.

APPENDIX D-5

TR2721A MULTI CHANNEL DIGITAL RECORDER

TR2721A multi channel digital recorder has 12 channels which can be extended to 24 channels with the channel extender. The required extender cable has to be connected for this purpose. The input terminal board has 12 channel signal line connection can be accessed by removing the rear pane terminal covers. After removing the cover the signal input terminals can be seen numbered from 01 to 12. These numbers indicate the channel numbers. The (+) leg of the thermcouple or compensation conductor connects the (+) terminal and the (-) leg connects to the (-) terminal. The external terminal and D/A terminals are also available along with the 12 signal input terminals. The external terminal is for the external reference junction when making temperature measurement. The D/A terminal outputs the analog signal when the optional D/A converter is installed. The extended terminals (13 to 24) another panel which is seen on the rear side has to be removed.

Series of switches are available at the rare side. They are -

1) Function switches 2) Range switches

There are two function switches. The first one is for selecting the measurement function. Pressing this switch measure the temperature and releasing it measured D.C. voltage. The second switch is for temperature measurement. Pressing this switch enable use of a cold-contact reference junction or other external reference junctions. Releasing this switch

enables temperature measurement with the interval computation reference junction. Range switch selects the DC voltage measurement range or the temperature measurement thermocouple. The range switches are interlocked and only one switch can be selected.

Digital recorder has a display panel adjustable switches for monitor, scan start, scan interval, scan steps, LAST channel and print mode. The display panel has 7 segment Led display, two digits for channel number and 4 digits for the measured value. Few LEDs are provided to indicate the decimal point, polarity, aloram and units. The details of the switches are explained next.

Monitor Switch -

This switch is also called as monitor channel and print time (hour, minute) set switch. This switch can be used to specify the most important channel as the monitor channel. The TR2721A digital recorder repeatedly measures the monitor channel between the end of data printing and the start of the next measurement. When the SCAN START switch is set to the stop position, the monitor channel is displayed. Monitor channel can be selected by pressing CH-SET monitor switch. Each time this switch is pressed the channel number increments and is displayed on the display panel. The required channel number can be selected pressing thin switch. The channel number can be selected from channel 01 to channel 12 without regard to the last channel. When the optional channel extended is installed, the monitor channel can be selected from channel 01 to

channel 24. When the monitor channel is not specified, the channel 01 is automatically selected. Monitor switch can also be used for set of time. To set the time, SCAN INTERVAL switch has to be set to time set position. Then the hour and minute can be set by pressing the monitor switches. Each time hour switch is pressed, the hour display is incremented by 1. The hour display counts up consecutively when this switch is pressed continuously. Minutes setting is similar to the hour setting. Setting the print mode switch at the MIN x 10^1 position, the minute increments multiple of terms as the minute monitor switch is pressed. When the scan interval switch is switched from the time set position to another position, the second display is cleared to 00 second. Therefore, to check the time after time setting, set the SCAN INTERVAL switch from the CONT to 2H positions to the TIME SET position. There is a maximum delay of 1 minute when the switch is subsequently returned to its original position. When the time is not specified, the time display indicates the time that has elapsed from the time the power switch was set to ON.

SCAN START

This switch is also called as measurement time interval switch. This switch has 3 positions DIFF., STOP and NORM. Whether switch is set in Diff. (DIFFERENCE) position, the difference between measured channel and channel 01 is computed with the internal microcomputer and displays the computed result. When in STOP position, it repeatedly measures and prints the measured results of the channel indicated on the channel no. display.

The switch in the NORM(NORMAL) position results in repeatedly measuring all the channels from first channel to last channel at the time interval selected by the Scan internal switch. It repeatedly measures the monitor channel from the end of one scan to the start of the next scan.

SCAN INTERVAL

This switch is also called as measurement time interval switch. It determines the time from the start of measurement of one channel 01 to the start of measurement of next channel 01. This switch can be set to 10 different position. They are time SET, CONT (CONTINUOUS), 30S, 1M, 2M, 5M, 10M, 30M, 1H, and 2H. Time set position is used when the time setting is necessary. Setting the switch to the CONT(CONTINUOUS) position results in immediately scans of all the channels from first channel to last channel and the monitor channel (on display), then scans from the next channel 01. To take data in different time interval is also possible. By adjusting this switch against any time indicated from 30 sec. to 2 H(Hours), it is possible to read the data with that time interval. Scanning is restarted each time the measurement time interval is changed with the SCAN-Start switch is in the diff. or Norm. position to avoid this, SCAN START switch is moved to STOP position and the required measurement interval is set and the SCAN START position is moved to the required point. All the channels will be scanned once, then measurement will be performed at the set interval.

SCAN STEP

This switch sets the channel switching time. There are 3 position indicating MIN.(MINIMUM), 0.5s and 1 sec. In the Min. position, channels are switched at the minimum measurable time interval. When the input signal is near 0V or 0°C, the channels are switched every 0.2 seconds and when the input signal is maximum (full scale), the channels are switched every 0.5 seconds. When the switch is in 0.5s position, the channel switching time is fixed to 0.5 seconds. When the switch is in 1 s position, the channel switching time is fixed to 1 second.

LAST CHANNEL

This switch has provision for setting the last channel. The desired last channel can be set from 01 to 12. When the optional channel extender is installed, the last channel can be selected from between channel 13 and channel 24. When the EXTENDER switch of the channel extender is set to the OFF position, the last channel setting is from channel 01 to channel 12.

PRINT MODE

This switch has 3 positions OFF, NORM.(NORMAL) and TREND. This switch determines the measured result printing format and printing ON/OFF. The printer can be made to print in normal mode by setting the switch in NORM. position. In these position results are printed in all digits parallel. This is shown in Fig.4-a. This type of printing is convenient when

taking and comparing data in time units. When the switch is in TREND position measured result are printed all digits serial. It is shown in Fig.4-b. This print format is especially convenient in checking the changes in the data of each channel with elapsed time. When the switch is in OFF position, the printer does not print.

00 °C

01 022.0°C
02 310.0°C
03 142.6°C
04 132.5°C
05 412.2°C
06 116.1°C
07 105.8°C
09 116.1°C
11 112.8°C
10 113.4°C
11 119.6°C
12 346.8°C

NORMAL MODE PRINTING

Fig 4-a

	01	02	03	04	05	06	07	08	09	10	°C
1	310.6	115.1	112.8	116.1	701.1*	203.7	310.8	142.6	112.2	119.6	21.12
2	310.6	115.1	112.8	116.1	701.1*	203.7	310.8	142.6	112.2	119.6	21.12

TREND MODE PRINTING

* INDICATES SENSOR OUT SIGNAL

Fig- 4-b.

PRINTER

PRINTER is built-in TR2721A multi channel recorder. The paper used for printing is thermal type. A roll of printing paper can be mounted in the paper holder. The paper should be loaded before use. If used without the paper the printer will be damaged. When red mark appears at both ends of the paper, then the paper has to be changed. Before changing the printer paper, printing operation is stepped by setting the PRINT MODE to the OFF position. The remaining paper is forced out by turning the paper feed wheel. Paper roll is inserted into the paper holder. Paper is inserted into the paper slot turning the paper feed wheel in the arrow direction shown on TR2721A. If the printing head tears or clogs the paper during printing, FREE knob is pushed in the arrow direction to release the paper. Free knob should not be touched while the printer is printing.

USING TR2721A FOR SCOUR MEASUREMENT

The leads from the profile bed indicator is brought to 01 of the TR2721A multi channel recorder and connected to the correct polarity.

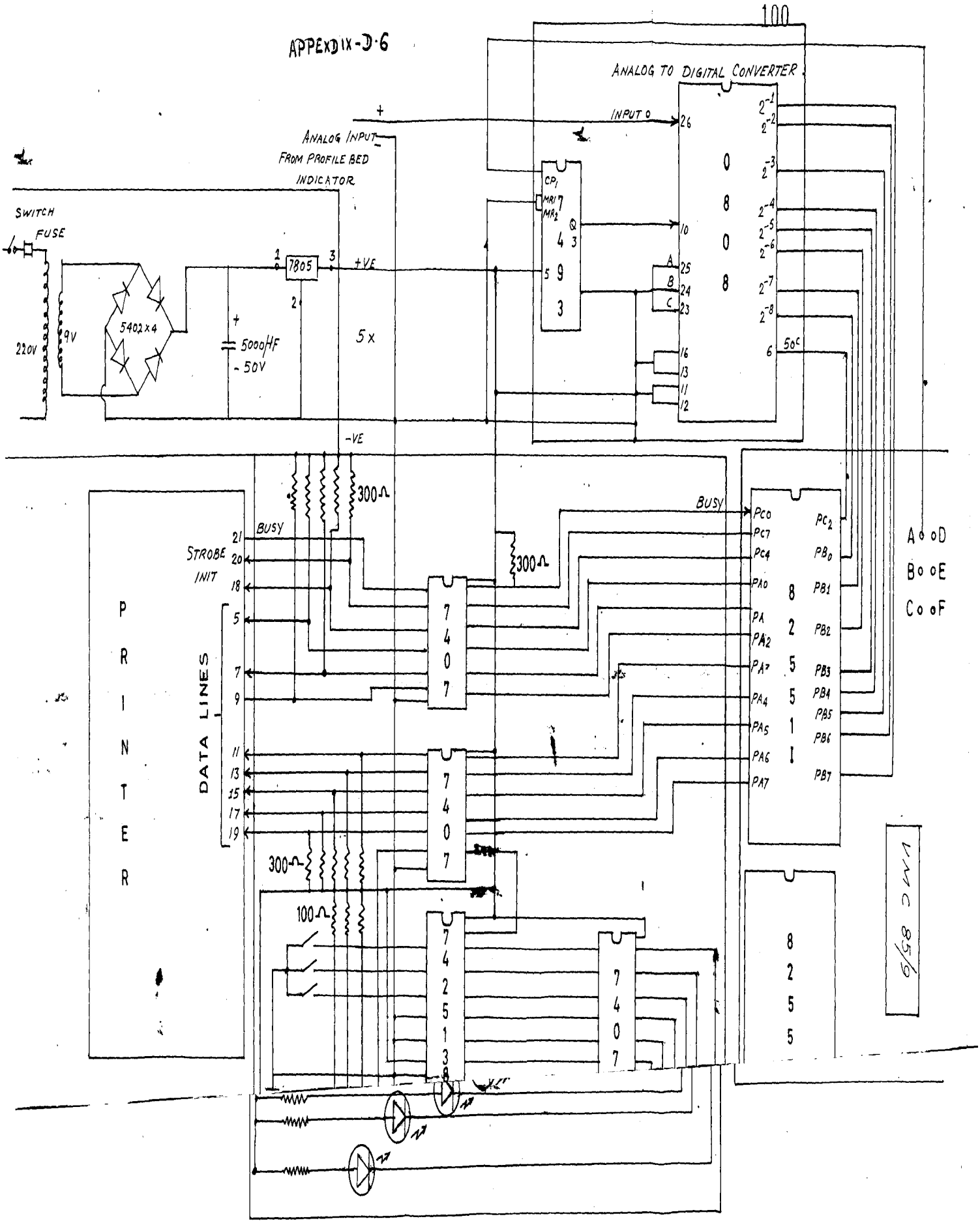
Before switching ON the power supply, switches are adjusted to the following position.

SCAN START	-	STOP position
SCAN INTERVAL	-	CONT. position
SCAN STEP	-	MIN position
LAST CHANNEL	-	01
PRINT MODE	-	OFF
CHANNEL EXTENDER	-	OFF position
EXT. START	-	OFF
FUNCTION	-	D.C. voltage
RANGE	-	1-5 Volts

WORKING OPERATION

After this adjustment power cable is connected and power switch is pressed to ON-position. After TR2721A is switched ON the time is adjusted bringing SCAN INTERVAL switch to TIME SF7. Position and again brought back to CONT. position. Now TR2721A is ready to read and record the voltage from profile bed indicator. The valve wheel is turned and the water starts flowing resultin_ in scour. Immediately SCAN START is positioned to NORM and PRINT MODE TO NORM-position. The printer starts printing the measured voltage along with the time at the rate of 1 line/second. To print the whole data it takes 2 seconds as it prints the time in the first line and the measured value in the second. The rate of printing can be varied by changing SCAN interval.

APPENDIX-D·6



INTERFACING UNIT CIRCUIT