P R L

T E C H N I C A L  N O T E

TN-95-75

# FLOPPY DISK AS DATA STORAGE MEDIUM

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MARCH 1995

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## DOCUMENT CONTROL AND DATA SHEET

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|---|---|---|---|
| 1. | Report No. | : | PRL-TN-95-75 |
| 2. | Title and sub-title<br>Floppy Disk as Data Storage Medium | | 3. Report Date : March 1995<br>4. Type of Report : Technical Report<br>5. Pages : 58<br>6. Price : Unpriced<br>7. No.of References 4 |
| 8. | Author | : | R.N. Misra |
| 9. | A. Purpose | : | Hardware and software considerations for using floppy disk as data storage medium |
| 0 | B. Useful for | : | Details of data storage on floppy disks, intercomparison of floppy disks. |
| 10. | Originating Unit | : | Planetary Atmospheres & Aeronomy Area, Physical Research Laboratory Navrangpura, Ahmedabad 380 009 |
| 11. | Sponsoring Agency | : | None |
| 12. | Abstract | : | Floppy Disk may be used to store serially organized data in Sector serial/Track serial format, with simple hardware. The same may be read on PC under BIOS commands. Recording data in Binary mode increases effective storage space of floppy disk. |
| 13. | Key words | : | Floppy Disk, Floppy Disk Controller, Data Storage. |
| 14. | Distribution statement | : | Distribution unlimited. |
| 15. | Security Classification | : | Unclassified |

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SUMMARY

Serially organized memory systems suit very well for data acquisition .The computer compatible tape (CCT), and the audio cassette tape seem to be ideal for such applications and have been in use in the past.The helical scan technology has been utilized for enhancing the storage capacity of the tape to one giga byte and the quarter inch cartridge has its own place for back up applications.The cost of drive is also a factor in deciding type of system and often CCT and audio cassette tape have been chosen in the past for such use .The universal availability of the PC has changed the direction towards PC based data acquisition systems and the floppy disk has emerged as medium of choice for many applications which were served by other media in the past.The requirement of data interchange is adequately met by the floppy disk on account of its relatively small size and easy handling.The file structure of the PC restricts the storage capacity of a floppy and it would be possible to enhance the storage capacity of a floppy by use of binary format in place of alphanumeric one .A word serial /sector serial /track serial organization of data on the floppy disk makes it look and behave like a magnetic tape.The simpler format facilitates use of minimum hardware to implement compact and rugged data acquisition system.A floppy based data aquisition system based on these priciples has been described in the text.

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KEYWORDS: Floppy Disk,Floppy Disk Drive (FDD) interface,Data Acquisition,Microprocessor.

# FLOPPY DISK AS DATA STORAGE MEDIUM

## INTRODUCTION

The use of floppy disk has become universal for computer data storage . While data stored on the magnetic tape can only be accessed sequentially ,the floppy disk provides a media which can be accessed in random fashion.This results in substantial saving of time and therefore the floppy has superceded the magnetic tape for storage of such data and programs , which need to be updated frequently and are limited to about 1 Mbyte .The increase in density of storage has been so large in the past decade that floppy disks of 3.5 inch diameter are available in 4 Mbyte storage capacity as compared to the 100 kbyte ones of late seventies.It has made data and program exchange very economical as well as convenient .The floppy can be mailed in a cover by post and tolerate moderate amount of rough handling .

Collection of data from unattended instruments , and its long term storage has usually been performed by the magnetic cassettes ,both audio as well as digital ones.The digital cassette has more or less become obsolete and its place is gradually being taken by the data cartridges which are used mostly for the backup of hard disk drives in PC's.The audio cassette has its own place in consumer market but its use in data storage has been declining over the years.The hardware requirements of a cassette based system is usually very modest and 2 Mbyte storage capacity on a C-90 type audio cassette can easily be achieved.The hardware needed ,on the other hand , for the floppy based system is quite extensive and available storage capacity is of the order of just 360 Kbytes on a standard 5.25

inch minifloppy .Reliability and convenience of operation as well as ease of data handling on a PC ,however , far outweighs the disadvantages of the floppy and use of floppy disks for data gathering is, therefore,gaining ground.

SOME BASICS

The floppy disk consists of a flexible disk cut from plastic sheet and enclosed in a protective jacket.The latter is lined with soft fabric to provide cleaning during use.The disk has a hub which engages to the motor spindle , and consequently the floppy disk spins at the speed of the motor.A small hole ,called index hole provides reference for the angular motion to the floppy disk drive (FDD) electronics with the help of a LED Photodiode pair.The disk is coated with magnetic powder exactly like typical magnetic tape ,and the data is recorded on the magnetic surface as tiny zones of magnetization.The disk spins within the protective sheath at a speed of 300 rpm and the read/ write head makes contact with the magnetic surface from the oblong window provided in the jacket for the purpose.The disk is coated on both the sides and there are two heads to read write data on both the surfaces in succession.The head assembly moves along the radius of the disk and thus forms concentric circular tracks on the disk along which data is recorded.

The head is moved with the help of stepper motor and there are only fixed number of positions on which the head can rest resulting in a definite number of tracks.The number of tracks is thus a parameter dependent upon the head positioning mechanism and it has been standardized to 40 tracks for standard minifloppy and 80 tracks for the quad density minifloppy of 5.25 inch size. The number of tracks on a 3.5 inch microfloppy is also 80.Some features of the popular floppy disks have been given in the Table I.

The 8 in. floppy is more or less obsolete and 5.25 inch floppies, both the double density type (DD) 360 K as well as quad density (HD) 1.2Mbyte types are in regular use.The 3.5 in. floppy called the microfloppy is encased in hard protective cover with a flap mechanism for the read write window to protect the magnetic surface from fingerprints and dirt.Use of 3.5 in. microfloppy is picking up.

DATA STORAGE

As described earlier, the read/write head forms concentric circular tracks on the disks on account of rotary motion and the data is recorded along these tracks.The head can be positioned over the disk on 40 different tracks or ,in other words, 40 different locations within the window provided for the purpose ( fig. 2).The locations are defined by the step size of the stepper motor driving the head assembly and constitutes a major design parameter .Interchangeability between the disks as well as drives requires that the locations of the tracks on the disk be defined within a few microns.Thus the mechanical precision limits the number of tracks possible on the disk.One is tempted to ask a question at this point that whether the360K type disks can be used in the drives specified as 1.2 Mbyte type.Here it should be noted that the HD disks are coated with magnetic material of higher coercivity and require higher recording currents as compared to the DD disks , to acheive twice the recording density. Therefore it may not be possible to use a DD disk of 360 K capacity in 1.2 M mode. The 1.2 M drives, however, are designed to be compatible to both DD as well as HD disks under software control in a PC. The 720 K byte capacity in a microfloppy is achieved by writing data at half the clock rate and the number of tracks remains 80 with a density of 135 tracks per inch.

THE FLOPPY DISK DRIVE (FDD) MECHANISM

The schematic diagram of a floppy disk drive (FDD) has been given in fig.3. It consists of the following mechanisms:

1. Disk Drive Motor
2. Head Positioning Mechanism
3. Head Load Lever

The disk drive motor runs at +12 volts (+5 volts in case of 3.5 in.drive) and can be switched on and off electrically. The head positioning mechanism is driven by a stepper motor. The stepper motor electronics is a part of the drive unit and it requires step pulses for moving the head assembly to and fro. The direction signal decides the direction of stepper motor. The head load lever is mechanical one and manually operated while inserting and locking the floppy inside the drive. The FDD contains write electronics which receives serial data as well as write clock from the Floppy Disk Controller (FDC) and generates appropriate signals to be given to the read/write head. Heads on either side of the floppy may be selected by the "hdsel" signal from the FDC. The FDC senses beginning of the track by the index signal available from the FDD. The read electronics amplifies the signal picked up by the head and shapes it for use in the

FDC.The electrical interface of the FDD has been standardised as given in the Table II.

The standard 34 wire ribbon connector terminated at 34 pin headers can cater for 4 drives which can be daisy chained and controlled from a single FDC electronics.The IBM PC ,however ,differed a little from the FDD interface as far as motor drive and drive select signals are concerned and provides two separate motor on/off as well as drive select lines in place of one motor on/off and four drive select lines .The PC AT follows the regular standard.Power connector is of molex type and requires +12 and +5 volt supplies apart from separate ground.The 3.5 inch FDD also uses separate power connector , but needs only a single supply of +5 volts and is of a smaller size.The odd numbered pins of the ribbon cable are grounded to provide adequate shielding.The FDD can be jumper selected to be located at address DSØ,DS1,DS2 or DS3.There is only one select line needed for the the drive but it is brought over separate pins by the above referred jumpers to change the device address.The IBM PC requires both the drives to be configured as drive Ø and uses special cable with twisted lines for motor and device select signals for proper operation.

THE FLOPPY DISK CONTROLLER (FDC)

Controlling a floppy disk drive would require large amount of software overhead for a microprocessor.Attempts have been made in the past by several enthusiasts to implement a floppy disk controller by software using parrallel to serial converters but were not popular .Dedicated LSI's specially designed for this purpose have become available from western digital and NEC and type 765 from NEC has become immensely popular on account of its use in the IBM PC.It is said that it is in fact a microcomputer programmed for this purpose.It can be interfaced to any 8 bit microprocessor like an I/O port and behaves as two ports located on consecutive locations.It generates all the signals needed by the FDD.The pin diagram of the 765 has been given in fig 4 .

The 765 requires 8 data lines, one chip select,one address line to select internal registers and read as well as write signals and can be interfaced like peripheral devices 8251 or 8255.It provides three more lines DRQ ,DACK and INT for DMA operation and interrupt mode data transfer respectively. The DMA based operation requires extra hardware burden on the microprocessor system and we can leave it from our discussion.The DRQ pin acts as input as well in certain modes of operation and needs to be pulled up by 5k resistor to +5 volt supply.If the data is transferred in polled mode the interrupt line can also be dispensed with.Some control lines for the FDD operation are multiplexed and require demultiplexing by the RW*/SEEK signal available on pin 39.The write enable and write data signals require special processing which has been described in the data manual of 765.Processing of the read data can be done by a variety of ways and some of those have been described in the manual of western digital.The one chosen by Padmanabhan et. al. looked attractive to the author on account of its simplicity and an implementation of FDC based on 765 in I/O mode designed by the author has been shown in fig.5 .The write clock needs to be

250 nsec. wide and has been generated in a dual JK flip flop type 7473 .The clock of 4 MHz has been derived from a 8 MHz crystal oscillator.Clock for the 765 can be selected either 4 or 8 MHz to suit medium density 360 K or high density 1.2 M floppies of 5.25 inch or 720 K and 1.44 M floppies of 3.5 inch size (fig.6).

The drive select and motor on/off signals have been generated by a separate hex flip flop type 74174 (appendix F). It eliminates need for drive select signals from the 765 and associated software complexities. The same device generates reset as well as terminal count TC signal for the 765 thus bypassing the use of DMA completely.The use of MFM mode of recording is universal and therefore the 765 has been configured in the same mode by leaving its MFM pin unconnected.The incoming signals to the FDD have been supplied by open collector gates type 7406, and in the same way the outputs of FDD are also of the open collector type.A termination network consisting of 220/330 ohm resistors on each line is therefore required at the input side. These have to be buffered in schmitt trigger inverter type 7414.

INTERRUPT vs DMA MODE OF OPERATION

The data is recorded at the rate of 250 Kbps on the 360K floppies of 5.25 inch size as well as 720 K microfloppies .The rate of 500 K is used for higher densities of 1.2 M and 1.44 Mbyte .The controller needs new data every 27 microseconds in case of former and 13 microseconds in case of latter.Polled mode of operation is possible in case of former. High density FDD would require use of faster microprocessor thus defeating the very purpose of simplicity .

The floppy disk controller (FDC) appears to the microprocessor as two consecutive locations in the I/O space.The lower location (AØ=Ø) is the status register which can only be read and is used for polling the readiness of the FDC to accept any data or command during command or data write phase or else read data or result of execution of command .The data itself is written to or read from the data register located at location AØ=1.Status register can not be written to.The bit assignments of the status register have been given in the table III.The bits Ø to 3 relate to the drive select.Since the present design uses separate latch to control the FDD,these bits are of not much consequence.The bit 4 indicates FDC busy ready status and bit 5 DMA or non DMA mode of operation.The bit 6 indicates data direction and the bit 7 is used as flag to test readyness of the FDC to accept a data byte .It is called RQM or request for master bit.This bit has to be tested to be logical ONE for the readyness of the FDC before any data transfer can take place .

In the non DMA mode , the interrupt line also carries the same information.However ,in general ,the interrupt handling takes more time and polling the bit 7 of the status register saves time as well as hardware.The bit 6 is data direction indicator. Since the direction of transfer is known before hand this bit may also be ignored. If bit 6 is logical ZERO it indicates writing the data register and a logical ONE reading the data from the data register.The microprocessor checks for bit 7 and waits it to become logical ONE before attempting any data transfer.

## FDC (765) COMMANDS

The command structure of 765 is quite elaborate. The commands can be broadly classified in two groups:-

a) FDD operation commands: the commands related to operation of FDD e.g. seek, recalibrate ,sense interrupt status etc.

b) Data commands: the commands relating to data transfer e.g. read, write, read track, scan etc.

Format command is little different than ordinary write command even though it results in writing a fill charactor in all the data locations of the disk. Format operation divides the disk space into a fixed number of sectors .One track is formatted at a time and the program has to update cylinder number, sector number etc during format operation. Information about the sector number and track number is written in the beginning of each sector. It is not possible to write on or read from an unformatted disk because the FDC searches for the particular sector on the disk by reading its contents. This is somewhat akin to drwing lines on a sheet of paper to facilitate writing on it .It is possible to write on paper without lines but counting number of lines available at any instant would be impossible .The Computers on the other hand must know exactly the locations of available memory space, hence the need for formatting the disk.

Some of the commands have been described below:

a) FDD operation commands:-

i)Specify; FDD mechanical parameters such as head load time ,step size, motor start time ,DMA or non DMA mode of operation are supplied to the FDC by this command. The bit structure of the command has been given in Table IV .It sets the interrupt line high .This command must be issued before starting any operation of the FDD.Resetting the 765 does not obliterate this data.

ii.Recalibrate ;This command causes the head assembly to move to the track ØØ.This is a two byte command,the first byte being Ø7 and the second ØØ.It sets the interrupt signal high and has no result phase.

iii.Seek :This command causes the head assembly to move to a particular track.The command consists of three bytes ,ØF,ØØ,and new cylinder number(NCN).It has no result phase and sets interrupt high.

iv.Sense Interrupt Status; This command is used to get the result of specify, recalibrate and seek commands which have no result phase .The two byte result contains status information, success or failure as first byte and the present cylinder number PCN as second byte.It resets the interrupt signal and must be issued after every seek and recalibrate command.

v.Sense Drive Status; It is a two byte command, the first byte being Ø4 , and the second contains head and drive information.The one byte result contains status information ST3.

b)Data commands:- Read data,read track,read deleted data ,write data ,write deleted data ,scan equal ,scan low or equal ,scan high or equal are identical in structure .Each one of these requires a 9 byte sequence to be issued to the data register as command sequence and provides 7 byte result after completion of the operation or execution phase.The first command bytes have been given in the Table VI.The second byte relates to head and drive number as issued by the FDC.As we intend to use a separate register for controlling the drive selection for the reasons said earlier ,only bit of importance is the H bit i.e. bit 2.The next 7 bytes relate to the present cylinder number C i.e. track number,head number H,sector number R and code for bytes per sector, where Ø2H specifies 512 bytes per sector followed by end of track EOT or number of sectors per track( Ø9),gap length GPL=2AH for read write operation,data length is to be FF for 512 byte sectors designated by N=Ø2.The details have been given in the table VII .The command ~~is~~ may be terminated during execution after issuing TC pulse to the 765.This pulse must be issued to terminate the commands .The FDC does not care about bytes per sector and the data transfer contiues till TC is issued. The result phase provides 7 byte result as given in the Table VIII. It can be seen from the table that the new C,H,R,N information is available in the result phase and can be used to update the same for next operation ,exception being the format command.However use of this information by the FDC is not essential.

The commands have to be issued in full i.e. all the relevant bytes have to be given to the FDC during the command phase,all the bytes read or written during the read or write phase and the 7 byte result must be read out from the FDC.The result is stored at some location in the memory for use in the next command if needed.Failure to follow the sequence correctly would result in cancellation of command and an error message.

The READ ID command consists of two command bytes and 7 byte result, which gives the first ID word.Result Phase is identical to other commands described before.

FORMAT :This command consists of 6 command bytes and 7 result bytes as given in Appendix C.The result bytes have to be read although these do not contain any useful information .The information about C,H,R,N read after execution of format command have no relevance to actual values.One full track on both the sides is formatted at a time.The head assembly is moved to the next track and this process repeated.Updated values of C,H,R,N have to be supplied by the microprocessor during format command execution for each sector .Thus these values are supplied to the FDC nine times for each track.

COMMAND BYTE:The first byte of any command contains two nibbles the high nibble contains information about multitrack and MFM mode.Exception being the format command which does not require multitrack bit.Read and related commands contain one SK bit which relates to the skipped data.Other commands contain only Ø as high nibble.The second nibble is unique to the command.The second byte contains information about head and drive select bits. out of which only bit relating to head is of relevance to us in the present configuration.The recalibrate command does not contain head bit.Specify and Sense interrupt status commands do not have this type of second byte.Issueing any illegal command results in 8Ø in the status byte STØ.Details of status bytes have been given in Appendix A and the symbols in the Appendix B.

SOFTWARE DETAILS

As it has been said earlier, all the commands and data are presented to and read from the data register of the FDC ,after the RQM bit is found to be logical ONE.Accordingly bit 7 test loop is a permanent feature of all operations .The basic byte read and write subroutines have been written which are called by various commands.The FDD operation commands have been stored in EPROM and are read sequentially from corresponding locations and presented to the 765.Length of commands in terms of number of bytes is the first byte of table entry to facilitate simplicity of software.Basic informations like track number or cylinder number C,head H and sector number R are stored at locations 20B7,20B8 and 20B9 in the RAM.The HDS byte is compiled from H bit as at 20B8 ,by software, and stored at 20B6.Bits related to DS0 and DS1 are kept zero for the reasons told earlier.

Sector read , sector write and format are the basic commands needed for any data aquisition system.The flow charts of these commands have been given in the Appendix K and L .The read and write commands use RAM at 3000 to 31FF as buffer .9 sectors of 512 bytes each on 40 track standard minifloppy are choseen as standard on PC.The floppy disk drive parameters have also been stored permanently in EPROM for the same .MFM recording at the rate of 250 KHz is assumed.The disassembled software has been given in the appendix D.

## CONCLUSION

A floppy disk controller interface for 360 K minifloppy which can be upgraded to 720 Kbyte microfloppy with little change in the software has been designed .It uses non DMA mode of operation and therefore can easily be interfaced to any 8 bit microprocessor system.It is aimed for use in the four channel data recorder to facilitate data interechange between users.Data is recorded in PC compatible data format although no file structure has been followed and the data is recorded in binary mode sector by sector and track by track.The 360 K minifloppy would last for 8 hours and upgradation to microfloppy with 720 K capacity would increase the recording time to 20 hours.

## ACKNOWLEDGEMENTS

The author is thankful to Messrs. R.I.Patel,H.D.Parikh and G.A.Panchal for the help provided in fabrication of the hardware.

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# APPENDIX A

## DETAILS OF COMMAND BYTE

READ DATA : Command length 9 bytes

| Bit No.-> | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Ø |
|---|---|---|---|---|---|---|---|---|
| Byte 1 | MT | MFM | SK | Ø | Ø | 1 | 1 | Ø |
| Byte 2 | Ø | Ø | Ø | Ø | Ø | HDS | DS1 | DSØ |
| Byte 3 | | C:Cylinder No.(Track No.) Ø-27H | | | | | | |
| Byte 4 | | H:Head No. Ø/1 | | | | | | |
| Byte 5 | | R:Record or Sector No. 1-9 | | | | | | |
| Byte 6 | | N:No of data bytes per sector. ( Ø2 for 512 byte per sector) | | | | | | |
| Byte 7 | | EOT:End of track 27H ( 4Ø tracks) | | | | | | |
| Byte 8 | | GPL: Gap Length 2AH for read/write | | | | | | |
| Byte 9 | | DTL:Data Length FFH | | | | | | |

where;

MT :Multitrack i.e. 1 for double sided

MFM: MFM mode ,this bit is 1 for MFM mode

SK :Skip deleted data during read, this bit 1 to skip

HDS: Head select, 1 or Ø; same as H used else where.

DS1:Drive Select bit 1 ¦ ØØ: Drive Ø; Ø1: Drive 1

DSØ:Drive Select bit Ø ¦ 1Ø: Drive 2: 11: Drive 3

MT as well as MFM bits are both 1 for popular recording format.SK bit may be kept Ø if skip facility is not needed.DSØ and DSØ bits are not used for selection of Disk Drives and can be safely kept as Ø.Thus the byte 1 for read data command becomes C4H and that for write data C5H.Byte 2 is ØØ or o4 depending upon the head used.Thus the read data command would be:

C4 ØØ C ØØ R Ø2 27 2A FF

For Head bit as Ø and:

C4 Ø4 C ØØ R Ø2 27 2A FF

For Head bit as 1(other side of the floppy)

C and R are track and sector numbers of the sector to be read or written into.

These 9 bytes are written to the data register of the 765 under handshake of the RQM bit of the main status register.Now the actual read or write command execution starts and the processor reads data from the dara register after verification of status of RQM flag for each byte transferred (In non DMA mode each byte is transferred to the data register under handshake of the RQM bit. While in DMA mode only commands are transferred in handshake mode data is transferred through DMA.)Completion of the command is to be signalled to the FDC (765) by issueing a TC pulse.The next operation involves reading of the7 bytes of the result of command execution.This reading operation is a must whether it is actually needed or not.It cycles the FDC.The result contains status bytes STØ,ST1,ST2 and ST3 which give insight to the correctness of execution of the command just issued.The updated values of the track number, sector number,head numberetc are available from the result and can be used to update the same for next operation.

# APPENDIX B

## COMMAND STATUS REGISTERS STØ,ST1,ST2 AND ST3

| | | |
|---|---|---|
| STØ: | Bit7,6 | Interrupt code (IC) |
| | | ØØ Normal operation no error |
| | | Ø1 Abnormal operation,command not completed |
| | | 1Ø Invalid command code,no execution |
| | | 11 Abnormal termination,Ready line changed state during execution |
| | Bit 5 | Seek End ( SE) |
| | Bit 4 | Equipment Check Error (EC),fault or TRØØ signal failed to appear after recalibrate command |
| | Bit 3 | Not Ready Error(NR),drive not ready |
| | Bit 2 | Head Address H at the time of interrupt |
| | Bit 1,Ø | Drive select.Number of drive selected |
| ST1: | Bit 7 | End of Track (ET),R larger than last sector. |
| | Bit 6 | Not used always Ø |
| | Bit 5 | Data Error (DE), CRC error in ID or Data |
| | Bit 4 | Overrun Error (OE),Processor is slow |
| | Bit 3 | Not used this bit is always Ø |
| | Bit 2 | No Data (ND) , sector not found |
| | Bit 1 | Write Protect Error (NW),write protected disk was subjected for write or format operation |

| | | |
|---|---|---|
| | Bit Ø | Missing Address Mark (MA),Address mark in either data or ID could not be read. |
| ST2: | Bit 7 | Not used, this bit always Ø |
| | Bit 6 | Control Mark (CM),deleted data address mark during read or data address mark during deleted data read . |
| | Bit 5 | Data Error (DD),CRC error in Sector Data |
| | Bit 4 | Cylinder Address Error (WC),Cylinder address in ID different than in FDC. |
| | Bit 3 | Scan Hit (SH), Scan condition satisfied |
| | Bit 2 | Scan Not Satisfied (SN) |
| | Bit 1 | Bad Track (BC),Cylinder address FF in ID and different than FDC. FF means hard error. |
| | Bit Ø | Missing Data Address Mark (MD) ,data address mark not detected. |
| ST3: | Bit 7 | Fault (FT) ,fault signal from drive. |
| | Bit 6 | Write Protected (WP), write protected disk in the drive. |
| | Bit 5 | Ready from Drive (RDY) |
| | Bit 4 | Track Ø (TØ) ,track ØØ reached. |
| | Bit 3 | Two Sided (TS) ,double sided drive. |
| | Bit 2 | Head Address (H) ,status of side select |
| | Bit 1,Ø | Drive Select. |

## APPENDIX C

### FORMAT COMMAND

Format command is six bytes long.The structure has been given below.

| Bits:-> | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Ø |
|---|---|---|---|---|---|---|---|---|
| Byte 1 | Ø | MFM | Ø | Ø | 1 | 1 | Ø | 1 |
| Byte 2 | Ø | Ø | Ø | Ø | Ø | HDS | DS1 | DSØ |
| Byte 3 | | N: Ø2 for 512 byte sector size | | | | | | |
| Byte 4 | | SC: Sectors per cylinder Ø9 | | | | | | |
| Byte 5 | | GPL: Gap length for format 5ØH | | | | | | |
| Byte 6 | | DTL: Filler byte F6H | | | | | | |

The values of C, H, R and N have to be supplied by hte processor during execution of format a track command.Entire cylinder is formatted and result consisting of 7 bytes has to be read after formatting one track values of C,H,R,N returned in the result are absurd and to be discarded.The command may be repeated for other tracks after issuing a seek command.

## APPENDIX D

### HEXDUMP OF DIRECT CALLS;REST PART OF MONITOR

```
Ø1ØØ 31 AØ 2Ø CD 2A ØF CF FF 31 AØ 2Ø CD 7B Ø1 CF FF
Ø11Ø 31 AØ 2Ø CD 83 Ø1 CF FF 31 AØ 2Ø CD ØØ ØF CF FF
Ø12Ø 31 AØ 2Ø CD 48 Ø1 CF FF 31 AØ 2Ø CD 6Ø Ø1 CF FF
Ø13Ø 31 AØ 2Ø CD D9 ØD CF FF 31 AØ 2Ø CD C4 ØD CF FF
Ø14Ø 31 AØ 2Ø CD A1 ØE CF FF CD 24 ØF CD 63 Ø1 C9 FF
Ø15Ø 2A 44 2Ø 22 B8 2Ø 3A 43 2Ø 21 B7 2Ø BE 77 C9 FF
Ø16Ø CD ØF ØF D5 11 FF FF CD F1 Ø5 D1 CD 84 ØF C9 FF
Ø17Ø 3A B5 2Ø E6 ØC D3 F2 32 B5 2Ø C9 3A B5 2Ø F6 Ø3
Ø18Ø C3 75 Ø1 3A B5 2Ø E6 ØD C3 75 Ø1 FF FF FF FF FF
```

### DISASSEMBLED SOFTWARE

### DIRECT CALLS FOR FLOPPY OPERATION

"RESET"

```
Ø1ØØ    31AØ2Ø    LXI SP,2ØAØ
Ø1Ø3    CD2AØF    CALL ØF2A    ; CALL' RESET'
Ø1Ø6    CF        RST 1
```

"MOTOR ON"

```
Ø1Ø8    31AØ2Ø    LXI SP,2ØAØ
Ø1ØB    CD7BØ1    CALL Ø17B    ; CALL 'MOTOR ON  '
Ø1ØE    CF        RST 1
```

" MOTOR OFF"

```
Ø11Ø    31AØ2Ø    LXI SP,2ØAØ
Ø113    CD83Ø1    CALL Ø183    ; CALL 'MOTOR OFF'
Ø116    CF        RST 1
```

"SPECIFY"

```
Ø118    31AØ2Ø    LXI SP,2ØAØ
Ø11B    CDØØØF    CALL ØFØØ    ; CALL 'SPECIFY'
Ø11E    CF        RST 1
```

"RECALIBRATE ,TR ØØ"

```
Ø12Ø    31AØ2Ø    LXI SP,2ØAØ
Ø123    CD48Ø1    CALL Ø148    ; CALL 'RECALIBRATE'
Ø126    CF        RST 1
```

" SEEK, GO TO TRACK NUMBER AS IN 2ØB7H"

```
Ø128    31AØ2Ø    LXI SP,2ØAØ
Ø12B    CD6ØØ1    CALL Ø16Ø    ; CALL 'SEEK'
Ø12E    CF        RST 1
```

```
                " READ SECTOR, SECTOR NO AS AT 2ØB9"

Ø13Ø    31AØ2Ø    LXI SP,2ØAØ
Ø133    CDD9ØD    CALL ØDD9    ; CALL 'READ SECTOR'
Ø136    CF        RST 1

                "WRITE SECTOR, SECTOR NO AT 2ØB9H"

Ø138    31AØ2Ø    LXI SP,2ØAØ
Ø13B    CDC4ØD    CALL ØDC4    ; CALL ' WRITE SECTOR'
Ø13E    CF        RST 1

                " FORMAT A TRACK "

Ø14Ø    31AØ2Ø    LXI SP,2ØAØ
Ø143    CDA1ØE    CALL ØEA1    ; CALL 'FORMAT'
Ø146    CF        RST 1

                "CALL FOR RECALIBRATE"

Ø148    CD24ØF    CALL ØF24    ; CALL 'RECALIBRATE'
Ø14B    CD63Ø1    CALL Ø163    ; CALL 'SENSE INTERRUPT STATUS'
Ø14E    C9        RET

                " UPDATE TRACK AND SECTOR NUMBER'

Ø15Ø    2A442Ø    LHLD 2Ø44    ; GET H AND R FROM THE  RESULT  OF
Ø153    22B82Ø    SHLD 2ØB8    ; PREV OPERATION AND ,LOAD
Ø156    3A432Ø    LDA 2Ø43     ; GET TRACK NUMBER  IN ACC
Ø159    21B72Ø    LXI H,2ØB7   ;
Ø15C    BE        CMP M        ; COMPARE TO CURRENT TR NO
Ø15D    77        MOV M,A      ; UPDATE TR NO
Ø15E    C9        RET          ; USE CARRY , TO MOVE HEAD

                " SEEK CALL WITH SENSE INTERRUPT STATUS (SIS)"

Ø16Ø    CDØFØF    CALL ØFØF    ; CALL 'SEEK'
Ø163    D5        PUSH D       ; SAVE DE
Ø164    11FFFF    LXI D,FFFF   ; LONG DELAY , Ø.5 SEC
Ø167    CDF1Ø5    CALL Ø5F1    ; CALL 'DELAY'
Ø16A    D1        POP D        ;
Ø16B    CD84ØF    CALL ØF84    ; CALL 'SIS'
Ø16E    C9        RET

                " MOTOR 1 ON, DRIVE 1 SELECTED"

Ø17Ø    3AB52Ø    LDA 2ØB5     ; GET FDD STATUS
Ø173    F63Ø      ORI 3Ø       ; SET BITS 4&5 TO ONE
Ø175    D3F2      OUT F2       ; TO MOTOR 1 ON AND DR 1 SELECT
Ø177    32B52Ø    STA 2ØB5     ; STORE NEW STATUS
Ø17A    C9        RET
```

" MOTOR Ø ON ,DRIVE Ø SELECTED "

```
Ø17B   3AB52Ø   LDA 2ØB5    ; GET STATUS
Ø17E   F6Ø3     ORI Ø3      ; BITS Ø,1 SET
Ø18Ø   C375Ø1   JMP Ø175    ; OUTPUT AND END
```

" MOTOR OFF , DRIVES Ø & 1 DESELECTED"

```
Ø183   3AB52Ø   LDA 2ØB5    ; GET STATUS
Ø186   E6ØC     ANI ØC      ; BIT Ø,1, 4 & 5 RESET
Ø188   C375Ø1   JMP Ø175    ; OUTPUT AND END
```

"GIVE TC PULSE"

```
Ø7EA   3AB52Ø   LDA 2ØB5    ; GET STATUS
Ø7ED   F6Ø8     ORI Ø8      ; BIT 3 MADE 1
Ø7EF   D3F2     OUT F2      ; TO GIVE TC
Ø7F1   E6Ø7     ANI 37      ; THEN Ø
Ø7F3   D3F2     OUT F2      ;
Ø7F5   C9       RET
```

" READ 7 BYTE RESULT"

```
ØCE5   Ø1Ø7ØØ   LXI B,ØØØ7  ; RESULT COUNT IN BC
ØCE8   214Ø2Ø   LXI H,2Ø4Ø  ; MEMORY TO HOLD RESULT
ØCEB   CD72ØF   CALL ØF72   ; CALL 'READ RESULT'
ØCEE   C9       RET
```

"WRITE SECTOR, C TR NO,H HEAD NO,R SECTOR NO,AS IN 2ØB7/B8/B9"

```
ØDC4   3EC5     MVI A,C5    ; CODE
ØDC6   21ØØ3Ø   LXI H,3ØØØ  ; MEMORY POINTER
ØDC9   Ø1ØØØ2   LXI B,Ø2ØØ  ; SECTOR DATA COUNT, 512
ØDCC   CD9ØØE   CALL ØE9Ø   ; CALL 'ISSUE COMMAND'
ØDCF   CD6ØØF   CALL ØF6Ø   ; CALL 'SEND DATA TO 765 REG'
ØDD2   CDEAØ7   CALL Ø7EA   ; CALL 'TC'
ØDD5   CDE5ØC   CALL ØCE5   ; CALL 'READ RESULT'
ØDD8   C9       RET         ;
```

" READ SECTOR, C,H,R AS FOR WRITE"

```
ØDD9   3EC6     MVI A,C6    ; CODE
ØDDB   21ØØ3Ø   LXI H,3ØØØ  ; DESTINATION MEMORY
ØDDE   Ø1ØØØ2   LXI B,Ø2ØØ  ; SECTOR DATA COUNT
ØDE1   CD9ØØE   CALL ØE9Ø   ; CALL ' ISSUE COMMAND'
ØDE4   CD72ØF   CALL ØF72   ; CALL 'READ DATA FROM 765 REG'
ØDE7   CDEAØ7   CALL Ø7EA   ; CALL 'TC'
ØDEA   CDE5ØC   CALL ØCE5   ; CALL 'READ RESULT'
ØDED   C9       RET
```

'CODE STRUCTURE FOR RECALIBRATE AND SIS'

```
ØE5B Ø2 Ø7 ØØ Ø1 Ø8

     REC         SIS       RECALIBRATE AND SIS ARE 2 AND 1 BYTE LONG
```

"SEND COMMAND"

```
ØE9Ø   E5       PUSH H      ;
ØE91   C5       PUSH B      ; SAVE MEM POINTER & CNTR
ØE92   214Ø2Ø   LXI H,2Ø4Ø  ; ADDRESS TO LOAD CODE BYTES
ØE95   E5       PUSH H      ; SAVE ADDRESS
ØE96   36Ø9     MVI M,Ø9    ; LENGTH OF CODE IS FIRST BYTE
ØE98   23       INX H       ;
ØE99   77       MOV M,A     ; CODE TO NEXT
ØE9A   E1       POP H       ;
ØE9B   CD19ØF   CALL ØF19   ; OUTPUT BYTES TO FDC(765)
ØE9E   C1       POP B       ; RESTORE
ØE9F   E1       POP H       ;
ØEAØ   C9       RET         ;
```

"FORMAT A TRACK"

```
ØEA1   214Ø2Ø   LXI H,2Ø4Ø  ; CODE AREA POINTER
ØEA4   E5       PUSH H      ; SAVE
ØEA5   36Ø6     MVI M,Ø6    ; CODE FOR FORMAT
ØEA7   23       INX H       ;
ØEA8   364D     MVI M,4D    ; CODE FOR FORMAT COMMAND
ØEAA   CDB8ØE   CALL ØEB8   ; CALL' FORMAT DATA'
ØEAD   E1       POP H       ;
ØEAE   CDØ3ØF   CALL ØFØ3   ; CALL 'ISSUE COMMAND'
ØEB1   CDDAØE   CALL ØEDA   ; CALL 'C,H,R,N ON DEMAND'
ØEB4   CDE5ØC   CALL ØCE5   ; CALL 'READ RESULT'
ØEB7   C9       RET         ;
```

" FORMAT DATA"

```
ØEB8   CDA9ØF   CALL ØFA9   ; CALL 'HDS FROM H'
ØEBB   32422Ø   STA 2Ø42    ; STORE HDS AT 2Ø42
ØEBE   2ABAØF   LHLD ØFBA   ; GET N, SECTOR SIZE AND  SC
ØEC1   224A2Ø   SHLD 2Ø4A   ; NO OF SECTORS , LOAD AT 2Ø4A/4B
ØEC4   22432Ø   SHLD 2Ø43   ; AND 2Ø43/44H AS WELL
ØEC7   2ABEØF   LHLD ØFBE   ; GPL AND DATA
ØECA   22452Ø   SHLD 2Ø45   ; STORED AT 2Ø45/46H
ØECD   2AB72Ø   LHLD 2ØB7   ; TRACK NO AND HEAD NO
ØEDØ   22472Ø   SHLD 2Ø47   ; STORED AT 2Ø47/48H
ØED3   3AB92Ø   LDA 2ØB9    ; SECTOR NUMBER STORED AT
ØED6   32492Ø   STA 2Ø49    ; 2Ø49H
ØED9   C9       RET         ;
```

" C,H,R,N ON DEMAND"

```
ØEDA    E5        PUSH H       ;
ØEDB    ØEØ4      MVI C,Ø4     ; C HAS DATA COUNT
ØEDD    CD6ØØF    CALL ØF6Ø    ; SEND 4 BYTES TO FDC
ØEEØ    E1        POP H        ;
ØEE1    3A492Ø    LDA 2Ø49     ; GET PREV SECTOR NO
ØEE4    FEØ9      CPI Ø9       ; LAST SECTOR
ØEE6    C8        RZ           ; IF YES THEN END
ØEE7    3C        INR A        ; ELSE GO TO NEXT SECTOR AND
ØEE8    32492Ø    STA 2Ø49     ; FORMAT MORE
ØEEB    C3DAØE    JMP ØEDA     ;
```

"SPECIFY"

```
ØFØØ    21ØBØF    LXI H,ØFØB   ; POINT TO COMMAND
ØFØ3    4E        MOV C,M      ; COUNT IN C REG
ØFØ4    23        INX H        ; NOW CODE IS POINTED
ØFØ5    Ø6ØØ      MVI B,ØØ     ; AT , B HAS OO
ØFØ7    CD6ØØF    CALL ØF6Ø    ; SEND IT ALL TO FDC
ØFØA    C9        RET          ;

ØFØB    Ø3 Ø3 CF Ø3            , COMMAND CODE FOR SPECIFY 3 BYTE LONG
```

"SEEK "

```
ØFØF    214Ø2Ø    LXI H,2Ø4Ø   ; COMMAND AREA
ØF12    E5        PUSH H       ;
ØF13    36Ø3      MVI M,Ø3     ; 3 BYTE LONG
ØF15    23        INX H        ;
ØF16    36ØF      MVI M,ØF     ; COMMAND CODE OFH
ØF18    E1        POP H        ;
ØF19    E5        PUSH H       ;
ØF1A    CDA9ØF    CALL ØFA9    ; CALL ' HDS FROM H'
ØF1D    CD9ØØF    CALL ØF9Ø    ; CALL 'SET UP COMMAND PARAMETERS
ØF2Ø    E1        POP H        ;
ØF21    C3Ø3ØF    JMP ØFØ3     ; JUMP ISSUE  COMMAND VIA "SPECIFY"
```

"RECALIBRATE"

```
ØF24    215BØE    LXI H,ØE5B   ; CODE AT OE5BH
ØF27    C3Ø3ØF    JMP ØFØ3     ; JUMP TO ISSUE LIKE 'SPECIFY'
```

" RESET"

```
ØF2A    3EØØ      MVI A,ØØ     ; OUTPUT ØØ TO REGISTER TO RESET
ØF2C    D3F2      OUT F2       ; THE FDC
ØF2E    3EØ4      MVI A,Ø4     ; THEN MAKE BIT 2  'ONE' TO
ØF3Ø    D3F2      OUT F2       ; GET READY
ØF32    32B52Ø    STA 2ØB5     ; STATUS STORED AT 2ØB5H
ØF35    21ØØØØ    LXI H,ØØØØ   ; INIT HL
ØF38    22B62Ø    SHLD 2ØB6    ; AND SET  HDS AND C=Ø
ØF3B    24        INR H        ; OO IN 2ØB8H, I.E. HDS, AND Ø1
ØF3C    22B82Ø    SHLD 2ØB8    ; AT 2ØB9H, OR SECTOR NUMBER
ØF3F    C9        RET          ;
```

"SEND BYTE TO FDC  DATA REG, HL MEM POINTER, BC BYTE COUNTER"

```
ØF6Ø    DBFØ     IN FØ       ; READ STATUS FDC ,MAIN REG
ØF62    E68Ø     ANI 8Ø      ; TEST BIT 7
ØF64    CA6ØØF   JZ ØF6Ø     ; WAIT FOR IT TO BE 1
ØF67    7E       MOV A,M     ; GET ONE BYTE FROM MEMORY
ØF68    D3F1     OUT F1      ; OUTPUT TO DATA REGISTER OF FDC
ØF6A    23       INX H       ; POINT TO NEXT DATA
ØF6B    ØB       DCX B       ; COUNT
ØF6C    78       MOV A,B     ;
ØF6D    B1       ORA C       ;
ØF6E    C26ØØF   JNZ ØF6Ø    ; SEND ALL THE BYTES
ØF71    C9       RET         ;
```

" READ  DATA REGISTER OF FDC"

```
ØF72    DBFØ     IN FØ       ; READ STATUS REGISTER OF FDC
ØF74    E68Ø     ANI 8Ø      ; WAIT FOR BIT 7
ØF76    CA72ØF   JZ ØF72     ; TO BE 1
ØF79    DBF1     IN F1       ; READ A BYTE FROM DATA REG OF FDC
ØF7B    77       MOV M,A     ; STORE IN RAM
ØF7C    23       INX H       ;
ØF7D    ØB       DCX B       ; COUNT BYTES
ØF7E    78       MOV A,B     ;
ØF7F    B1       ORA C       ;
ØF8Ø    C272ØF   JNZ ØF72    ; READ SPECIFIED NO OF BYTES
ØF83    C9       RET         ;
```

" SENSE INTERRUPT STATUS , SIS"

```
ØF84    215EØE   LXI H,ØE5E  ; CODE AT ØE5BH
ØF87    CDØ3ØF   CALL ØFØ3   ; ISSUE COMMAND LIKE SPECIFY
ØF8A    ØEØ2     MVI C,Ø2    ; GO TO READ ONLY 2 BYTE RESULT
ØF8C    CDE8ØC   CALL ØCE8   ; CALL 'READ RESULT'
ØF8F    C9       RET         ;
```

" SET UP PARAMETERS"

```
ØF9Ø    2AB62Ø   LHLD 2ØB6   ; GET HDS, C
ØF93    22422Ø   SHLD 2Ø42   ; LOAD AT 2Ø42/43H
ØF96    2AB82Ø   LHLD 2ØB8   ; GET H AND R
ØF99    22442Ø   SHLD 2Ø44   ; LOAD AT 2Ø44/45H
ØF9C    2ABAØF   LHLD ØFBA   ; GET N AND SC
ØF9F    22462Ø   SHLD 2Ø46   ; LOAD AT 2Ø46/47H
ØFA2    2ABCØF   LHLD ØFBC   ; GET GPL AND DATA LENGTH
ØFA5    22482Ø   SHLD 2Ø48   ; STORE AT 2Ø48/2Ø49H
ØFA8    C9       RET         ;
```

"GENERATE HDS FROM H"

```
ØFA9    21B62Ø    LXI H,2ØB6   ; POINT TO HDS
ØFAC    7E        MOV A,M      ; GET IN ACC
ØFAD    E6FB      ANI FB       ; KILL H BIT , BIT 2
ØFAF    77        MOV M,A      ; RESTORE
ØFBØ    23        INX H        ;
ØFB1    23        INX H        ; NOW HL POINTS TO H
ØFB2    7E        MOV A,M      ; H IN ACC
ØFB3    17        RAL          ;
ØFB4    17        RAL          ; H SHIFTED 2 TIMES TO BECOME HDS
ØFB5    2B        DCX H        ; GO BACK
ØFB6    2B        DCX H        ; TO HDS LOCATION
ØFB7    B6        ORA M        ; NEW HDS STORED
ØFB8    77        MOV M,A      ; AT 2ØB6
ØFB9    C9        RET          ;
```

FDD PARAMETRS

```
ØFBA Ø2 Ø9 2A FF 5Ø F6  : N (BYTES PER SECTOR), SC (LAST SECTOR)
                          GPL (GAP LENGTH R/W), DTL(DATA LENGTH)
                          GPL ( FORMAT)       , DATA FOR FORMAT
```

## APPENDIX E

### LIST OF IMPORTANT SUBROUTINES

| S.No. | Memory Location | Function |
|---|---|---|
| 1 | Ø1ØØ | Reset ;Direct Call |
| 2 | Ø1Ø8 | Motor Ø ON ; ,, |
| 3 | Ø11Ø | Motors OFF ; ,, |
| 4 | Ø118 | Specify ; ,, |
| 5 | Ø12Ø | Recalibrate ; ,, (Track ØØ) |
| 6 | Ø128 | Seek. HDS &C at 2ØB6/B7; Direct H and R at 2ØB8/B9: Call |
| 7 | Ø13Ø | Read a Sector as specified above and store at 3ØØØ H ; Direct Call |
| 8 | Ø138 | Write a sector as specified above Source at 3ØØØ H; Direct Call |
| 9 | Ø14Ø | Format a Track as specified;Direct Call |
| 1Ø | Ø148 | Recalibrate; called by command |
| 11 | Ø15Ø | Update track and sector number |
| 12 | Ø16Ø | Seek call with SIS |
| 13. | Ø17Ø | Motor 1 ON,Drive 1 Selected |
| 14 | Ø17B | Motor Ø ON,Drive Ø Selected |
| 15 | Ø183 | Drives 1&Ø deselected,Motors OFF |
| 16 | Ø7EA | Issue Terminal count |
| 17 | ØCE5 | Read 7 byte result store at 2Ø4Ø up |
| 18 | ØDC4 | Write Sector,Data source 3ØØØH |
| 19 | ØDD9 | Read Sector ,Destination 3ØØØH |
| 2Ø | ØE5B | Ø2 Ø7 ØØ Ø1 Ø8 codes for |

## APPENDIX F

## MEMORY/PORT USAGE AND BIT ASSIGNMENT OF CONTROL LATCH 74174

2040-204A:- Dynamic storage of command code during issue of command

2040-2047:- Storage of result after termination of command

203F-2041:- Temporary Storage of Sum of squares

20B2 :- Count of S4 exceeding the threshold

20B3 :- Status Buffer

20B4 :- Hi byte of Memory pointer

20B5 :- Floppy Drive and Motor Status.

20B6-20B7:- HDS and C ,Head select and Cylinder/Track No.

20B8-20B9:- H and R ,Head and Sector No.

20BA-20BB:- Sum of 256 data points

20BC-20BD:- Temporary storage for result pointer

### PORT USAGE

F0:- 765 FDC Main Status Register

F1:- 765 FDC data Register

F2:- Control latch port

### BIT ASSIGNMENTS OF CONTROL LATCH PORT

Bit 0:- Drive Select 0

Bit 1:- Motor 0 ON

Bit 2:- Reset to 765

Bit 3:- TC ,Terminal count to 765

Bit 4:- Drive Select 1

Bit 5:- Motor 1 ON

Bits 6,7 not used.

# APPENDIX G

## LIST OF COMPONENTS

Resistors :- 22ØE ,5pcs.33ØE,4 pcs.1K 2pcs.1k5 2pcs.

Capacitors:-1ØØØpF 1pc.Ø.1 uF 2pcs.1ØuF 1ØV 1pc.

Integrated Circuits:-

| | | | |
|---|---|---|---|
| IC1 | 74Ø6 | IC16 | 742Ø |
| IC2 | 7414 | IC17 | 8282 |
| IC3 | 74Ø4 | IC18 | 8282 |
| IC4 | 74ØØ | IC19 | 8282 |
| IC5 | 74153 | IC2Ø | 74LS245 |
| IC6 | 74175 | IC21 | 74LS155 |
| IC7 | 74161 | IC22 | 74LS32 |
| IC8 | 7474 | IC23 | 74LS138 |
| IC9 | 7473 | IC24 | 74LS245 |
| IC1Ø | 74Ø6 | IC25 | 74Ø4 |
| IC11 | 74174 | | |
| IC12 | 74174 | | |
| IC13 | 765 (FDC) | | |
| IC14 | 7493 | | |
| IC15 | 74Ø4 | | |

# APPENDIX H

## PIN OUTS OF THE EPROM PROGRAMMER PORT

34 pin double row Ø.1" connector (same as FDD interface)

| Pin No. | Signal | Pin No. | Signal |
|---|---|---|---|
| 1 | +5 V | 2 | +5 V |
| 3 | AØ (addr) | 4 | A8 |
| 5 | A1 | 6 | A9 |
| 7 | A2 | 8 | A1Ø |
| 9 | A3 | 1Ø | A11 |
| 11 | A4 | 12 | A12 |
| 13 | A5 | 14 | A13 |
| 15 | A6 | 16 | A14 |
| 17 | A7 | 18 | A15 |
| 19 | DØ (data) | 2Ø | D1 |
| 21 | D2 | 22 | D3 |
| 23 | D4 | 24 | D5 |
| 25 | D6 | 26 | D7 |
| 27 | CØ(control) | 28 | C1 |
| 29 | C2 | 3Ø | C3 |
| 31 | C4 | 32 | NC |
| 33 | GND | 34 | GND |

Notes: a)C5 disables data port out put drivers.data port is bidirectional.

b)CØ-C5 at F7H

c)DØ-D7 at F4H

d)AØ-A7 at F5H

e)A8-A15 at F6H

# APPENDIX I

## SYMBOLS AND THEIR DEFINITIONS

| | |
|---|---|
| C | Cylinder number, current selected track number, both sides taken together. |
| DSØ,DS1 | Drive select signal(decode for 4 drives). |
| DTL | Data Length, When ØØ it stands for actual bytes read/ written into the sector. |
| EOT | End Of Track ,Final sector number of the cylinder. |
| GPL | Gap Length,Length of gap 3 between sectors excluding VCO sync field. |
| H | Head Address, H stands for Head number Ø or 1. |
| HDS | Head Select, Selected Head number ( H=HDS in command words |
| HLT | Head Load Time, of FDD, 2 to 254 msec in 2 msec steps. |
| HUT | Head Unload Time ,after read or write,16 to 24Ø msec in 16 msec increments. |
| MFM | FM or MFM mode, if MFM=Ø FM mode selected, else MFM mode selected. |
| MT | Multi Track,if MT=1 then both sides are read. |
| N | Number, number of data bytes written in a sector. |
| NCN | New Cylinder Number,to be reached by SEEK. |
| ND | Non DMA Mode. |
| PCN | Present Cylinder number, position of head at present as read by Sense Interrupt Status command. |
| R | Record, Sector number to be read or written to. |
| R/W | Read / Write , Read (R) or Write(W) operation. |
| SC | Sector,Number of sectors per track. |

SK	Skip, Stands for Skip Deleted Data Address Mark.

SRT	Stepping Rate Time for FDD, 1 to 16 msec in 1 msec increments ( F=1 msec , E=2 msec etc.).

STP	Scan select increment.

# APPENDIX J

## PRLBUS SIGNALS

Connector type 86Ø7 Ø44 21 14 O/E/N make ,44 pin Dual readout,Ø.156 inch spacing

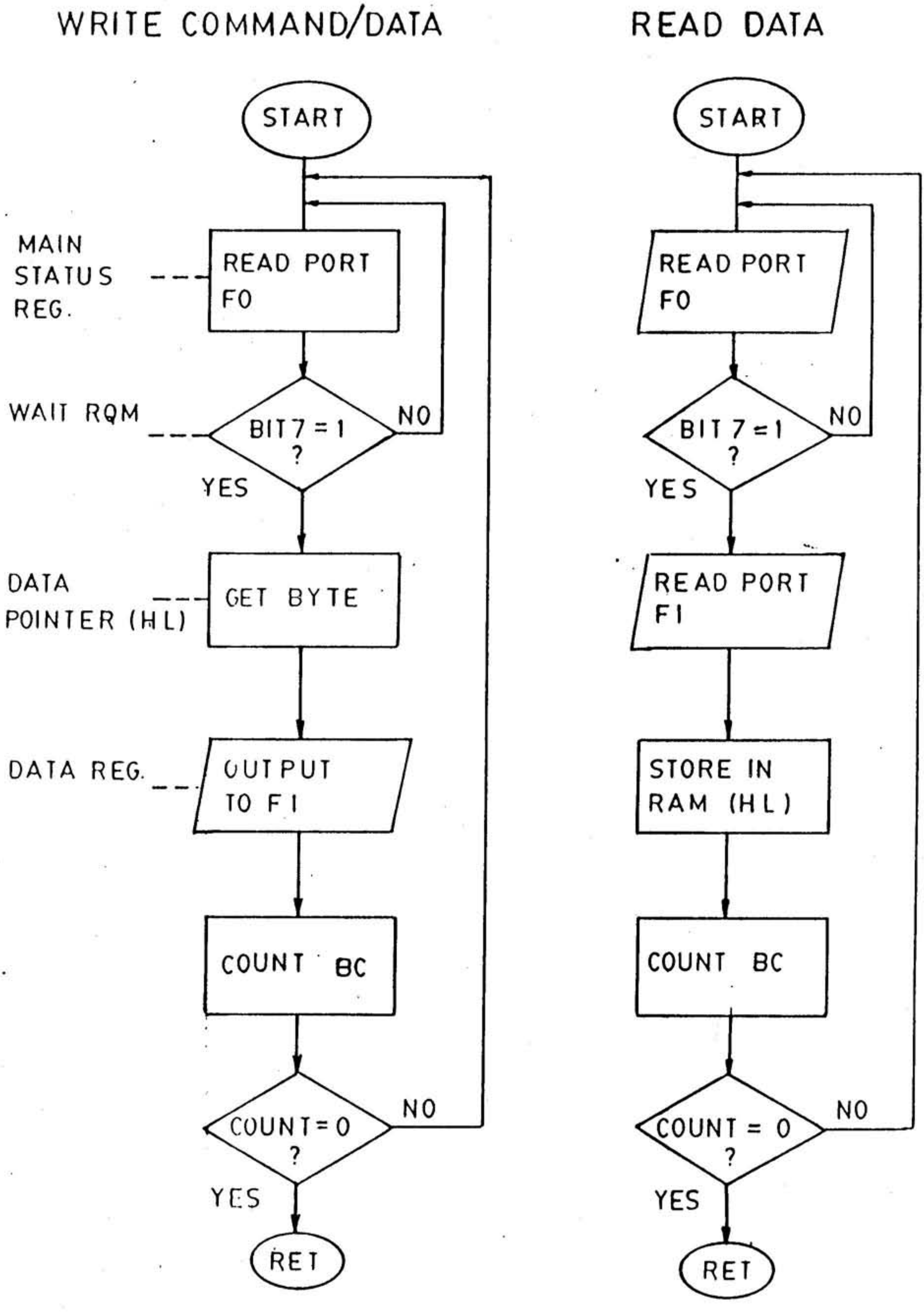
| Pin No.(Component Side) | | Pin No. (Solder Side) | |
|---|---|---|---|
| 1 | GROUND (Bottom most) | 1 | GROUND |
| 2 | DØ | 2 | AØ |
| 3 | D1 | 3 | A1 |
| 4 | D2 | 4 | A2 |
| 5 | D3 | 5 | A3 |
| 6 | D4 | 6 | A4 |
| 7 | D5 | 7 | A5 |
| 8 | D6 | 8 | A6 |
| 9 | D7 | 9 | A7 |
| 1Ø | MR* | 1Ø | A8 |
| 11 | MW* | 11 | A9 |
| 12 | IOR* | 12 | A1Ø |
| 13 | IOW* | 13 | A11 |
| 14 | NC | 14 | A12 |
| 15 | NC | 15 | A13 |
| 16 | NC | 16 | A14 |
| 17 | NC | 17 | A15 |
| 18 | INTA* | 18 | CLOCK OUT |
| 19 | NC | 19 | HLDA |
| 2Ø | INTR | 2Ø | HOLD |
| 21 | RESET OUT | 21 | RESET (Button) |
| 22 | +5V (TOPMOST) | 22 | +5V |

*Indicates Inverted Signals

# APPENDIX K

HDS FROM H
START
SET HDS BIT = 0
GET H BIT
ROTATE LEFT 2 TIMES
STORE AT HDS LOC
RET
SETUP
START
HDS & C AT 2042 & 2043
H & R AT 2044 & 2045
N & SC AT 2046 & 2047
GPL & DTL AT 2048 & 2049
RET
HL 2040 H
SEND COMMAND
START
SET UP POINTER
SET UP HDS
SET UP PARAMETERS
STORE COUNT INC
CALL SEND BYTE
RET
FORMAT A TRACK
START
POINT TO FORMAT
COUNT 5. COMMAND 4D
CALL FORMAT DATA
SEND COMMAND
SEND C,H,R,N
INCREMENT SECTOR NO.
R > 9 ?
NO
END
FORMAT DATA
START
HDS FROM H
STORE AT 2042
N & SC 204 A 204 B 2044
GPL DTL 2045 - 2046
C & H 2047 - 2048
SECTOR NO R AT 2049
RET
SEEK
START
ISSUE COMMAND
DELAY
SENSE INTERRUPT STATUS
RET

APPENDIX L


WRITE COMMAND/DATA
START
MAIN STATUS REG.
READ PORT F0
WAIT RQM
BIT 7 = 1 ?
NO
YES
DATA POINTER (HL)
GET BYTE
DATA REG.
OUTPUT TO F1
COUNT BC
COUNT = 0 ?
NO
YES
RET
READ DATA
START
READ PORT F0
BIT 7 = 1 ?
NO
YES
READ PORT F1
STORE IN RAM (HL)
COUNT BC
COUNT = 0 ?
NO
YES
RET

## TABLE I

### INTERCOMPARISON OF FLOPPY DISKS

| S. No. | Attribute | Type 1 | Type 2 | Type 3 | Type 4 | Type 5 |
|---|---|---|---|---|---|---|
| 1. | Diameter (inch) | 8 | 5.25 | 5.25 | 3.5 | 3.5 |
| 2. | Memory Size | 1.0M | 360K | 1.2M | 720K | 1.44M |
| 3. | No. of Tracks | 77 | 40 | 80 | 80 | 80 |
| 4. | Tracks Per In. | 48 | 48 | 96 | 135 | 135 |
| 5. | No. of Sectors | 26 | 9 | 15 | 9 | 18 |
| 6. | Bytes / Sector | 256 | 512 | 512 | 512 | 512 |
| 7. | Speed (rpm) | 360 | 300 | 360 | 300 | 300 |
| 8. | Data Rate (bps) | 500K | 250K | 500K | 250K | 500K |
| 9. | Interface Cable | 50 pin | ---------- 34 pin -------- | | | |
| 10. | Designation | Std. | Minifloppy | | Microfloppy | |

Notes: a) 8 inch floppy disks are obsolete.

b) 2 inch floppy disks are in use on some lap tops and still cameras.

c) Life expectancy of a floppy disk is about 6 months.

d) Double sided and MFM recording is standard.

TABLE II

SIGNAL DEFINITIONS OF ELECTRICAL INTERFACE

| Pin No. | Signal Designation | Data Direction |
|---|---|---|
| 1-33 (odd) | Ground | -- |
| 2,4,6 | Unused | -- |
| 8 | Index | FDD To FDC |
| 1Ø | Motor Enable A | FDC To FDD |
| 12 | Drive Select B | FDC To FDD |
| 14 | Drive Select A | FDC To FDD |
| 16 | Motor Enable B | FDC To FDD |
| 18 | Direction (Step) | FDC To FDD |
| 2Ø | Step Pulse | FDC To FDD |
| 22 | Write Data | FDC To FDD |
| 24 | Write Enable | FDC To FDD |
| 26 | Track ØØ | FDD To FDC |
| 28 | Write Protect | FDD To FDC |
| 3Ø | Read Data | FDD To FDC |
| 32 | Select Head 1 | FDC To FDD |
| 34 | Unused | -- |

TABLE III

BIT ASSIGNMENTS OF THE MAIN STATUS REGISTER OF 765

| Bit No. | Symbol | Description |
|---|---|---|
| Ø | DØB | Disk drive Ø busy ,it is in seek mode |
| 1 | D1B | Disk drive 1 busy ,it is in seek mode |
| 2 | D2B | Disk drive 2 busy ,it is in seek mode |
| 3 | D3B | Disk drive 3 busy ,it is in seek mode |
| 4 | CB | FDC busy,Read or Write in progress |
| 5 | NDM | Non DMA Mode |
| 6 | DIO | Data Direction ,If high then data read from data register to processor ;if low then data written to data register by the processor |
| 7 | RQM | Request for Master,Data Register is ready to send data to processor or receive data from processor. |

TABLE IV

SPECIFY COMMAND

| Memory Location | contents | Significance |
|---|---|---|
| ØFØB | Ø3 | Command length, 3 bytes |
| ØFØC | Ø3 | Command code ,Specify |
| ØFØD | CF | C: Step Rate SRT =C |
| | | F: Head Unload Time =ØF |
| ØFØE | Ø3 | BitØ=1 ,Non DMA mode |
| | | Bit1=1,Head Load Time=Ø1(7bit) |

For 1.2 M floppy drive ØFØD to contain DF,Number of sectors ØF ,GPL 1B for read/write and 54 for formatting.For 3.5" floppy number of sectors 9 for 72ØK and 12H for 1.44M capacity.GPL identical for 1.2 M 5.25" as well as 3.5" floppies in 1.44M mode .When used in 72Ø K mode 3.5" floppy would have 9 sectors and GPL would be identical to that used for 5.25" floppies of 36ØK capacity.

TABLE V

RECALIBRATE COMMAND

| Memory location | Contents | Significance |
|---|---|---|
| ØE5B | Ø2 | Command Length 2 bytes |
| ØE5C | Ø7 | command code |
| ØE5D | ØØ | Data related to DSØ/DS1 |

The R/W head retracts to the track ØØ, No results to be read

## TABLE VI

## SENSE INTERRUPT STATUS

| Memory Location | Contents | Significance |
|---|---|---|
| ØE5E | Ø1 | Command Length |
| ØE5F | Ø8 | Command Code |

Two byte result to be read after execution of this command

The first is status byte STØ, The second gives present cylinder number PCN.

THIS COMMAND HAS TO BE ISSUED AFTER SEEK AS WELL AS RECALIBRATE COMMANDS TO READ THE CYLINDER NUMBER AND TERMINATE THE SEEK AND RECALIBRATE COMMANDS

## TABLE VII

## FLOPPY DISK CONTROLLER PARAMETERS

| Memory Location | Contents | Significance |
|---|---|---|
| ØFBA | Ø2 | N ,Sector size 512 bytes |
| ØFBB | Ø9 | SC,Sectors per Cylinder,Ø9 |
| ØFBC | 2A | GPL,Gap length for read/write |
| ØFBD | FF | DTL,Data length for read/write |
| ØFBE | 5Ø | GPL,Gap length for formatting |
| ØFBF | F6 | Data,for fomatting |

## TABLE VIII

## RESULT PHASE

The following seven bytes are to be read after execution of the commands as detailed below. This is a requirement to complete the command operation.

| | | |
|---|---|---|
| R | STØ | Status Information after Command Execution |
| R | ST1 | |
| R | ST2 | |
| R | ST3 | |
| R | C | 1. Sector ID information after execution of ,Sector Read/ Write, Track Read/Write, Scan and Read/Write deleted data commands<br>2. Sector ID information during execution of Read ID command<br>3. Sector ID information irrelevant during execution of Format command |
| R | H | |
| R | R | |
| R | N | |


FIG.1 FLOPPY DISK

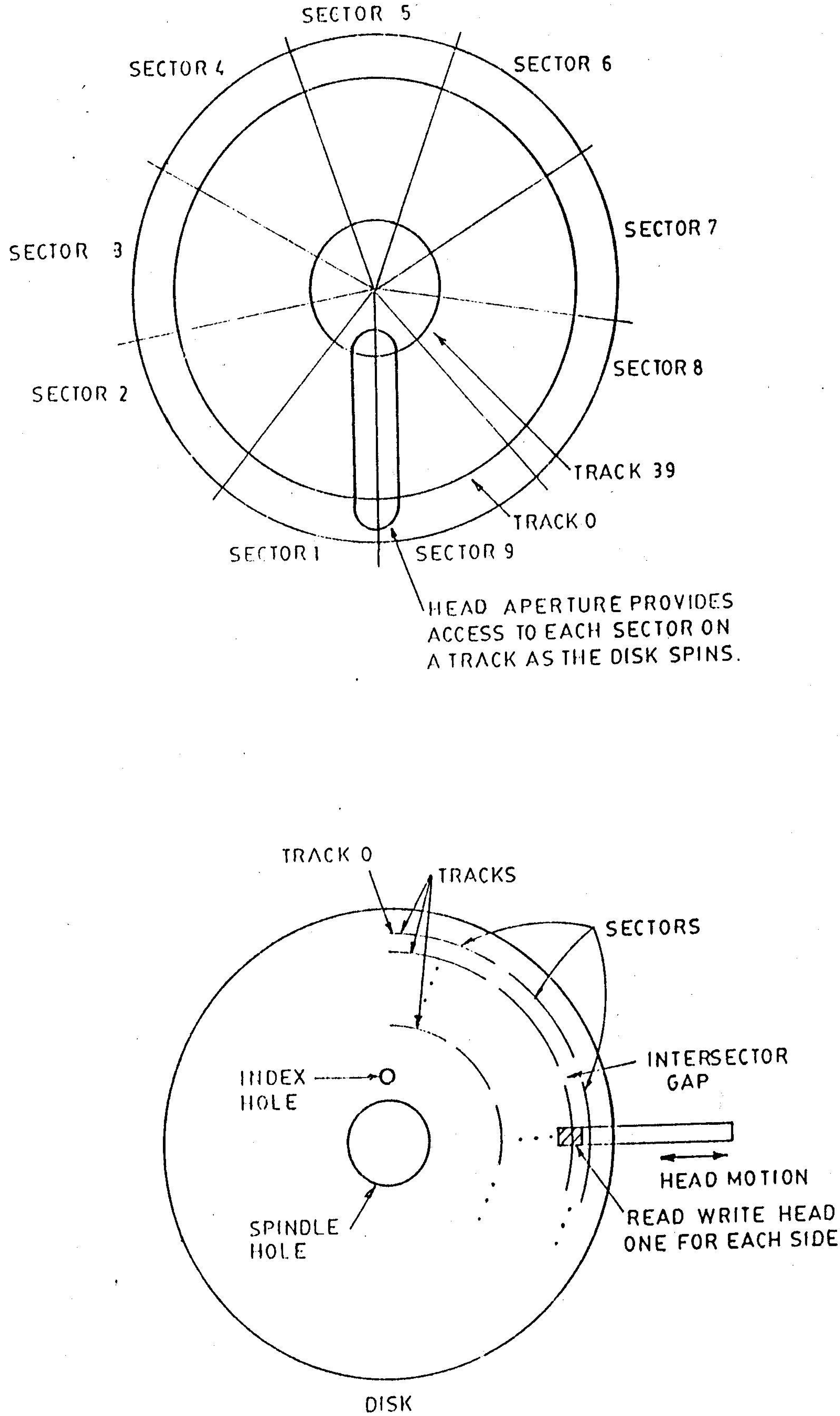



FIG.2 ORGANIZATION OF SECTORS AND TRACKS ON A FLOPPY DISK.

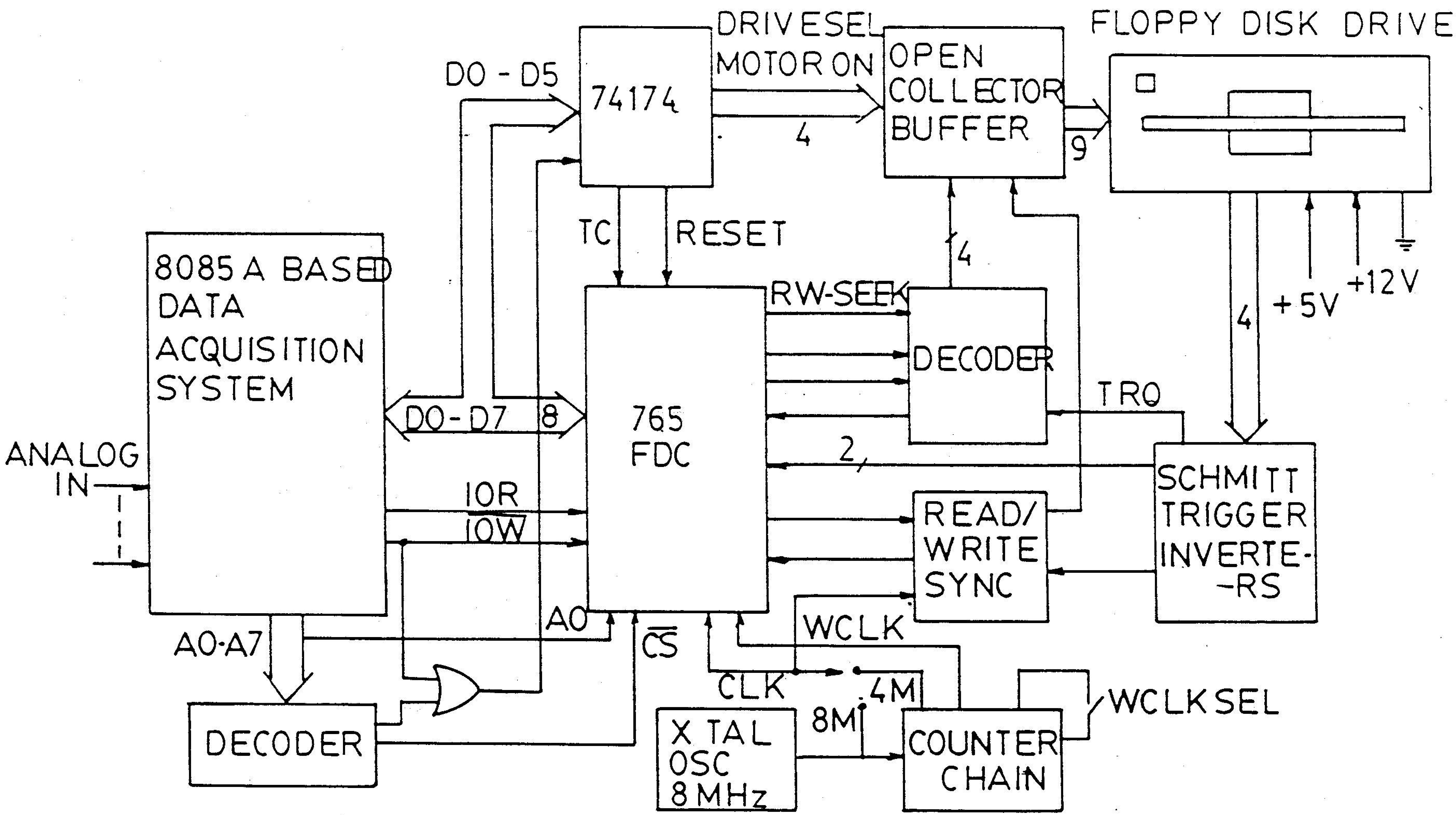



FIG.3- BLOCK DIAGRAM OF DATA STORAGE SYSTEM

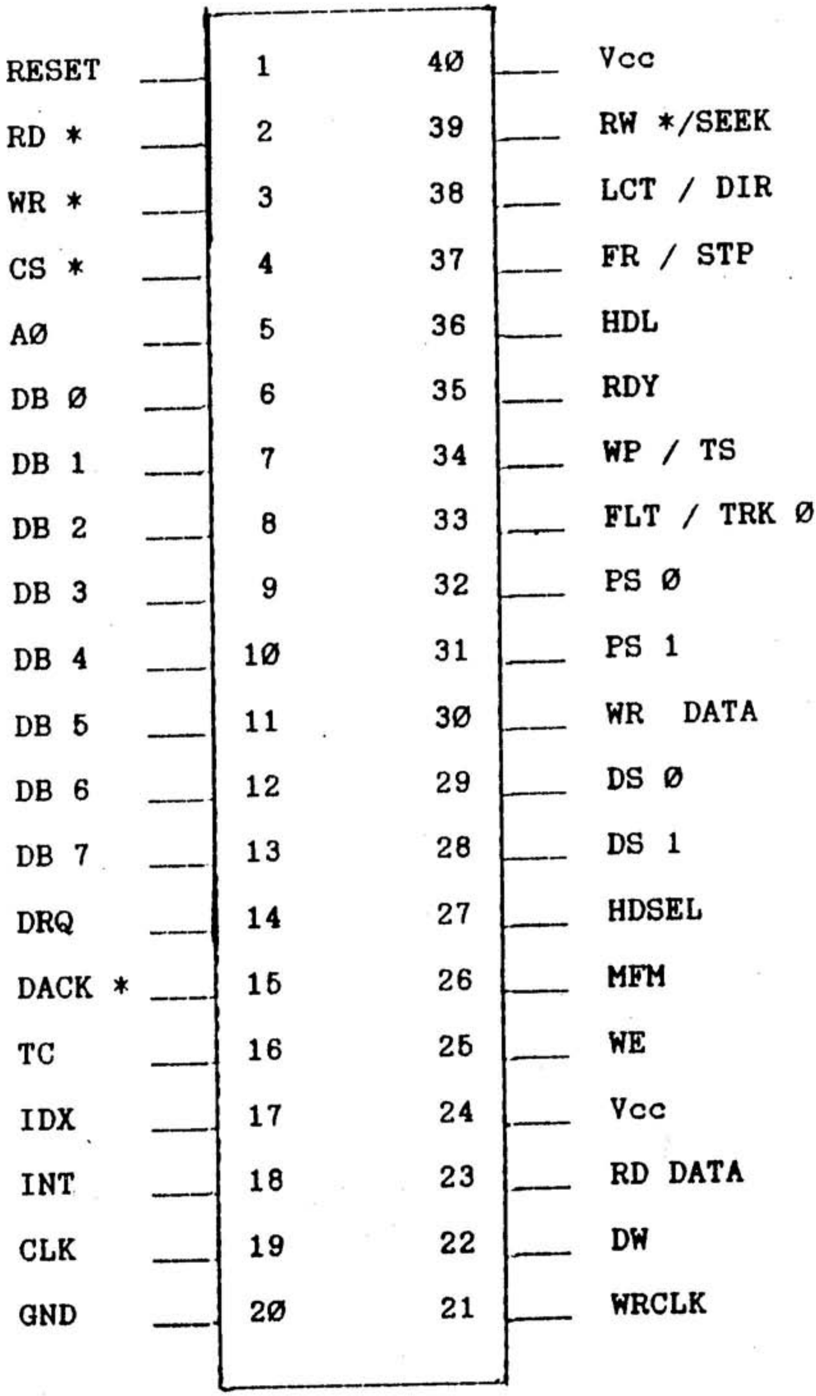



FIG. 4 - PINOUTS OF 765 ( 8272)

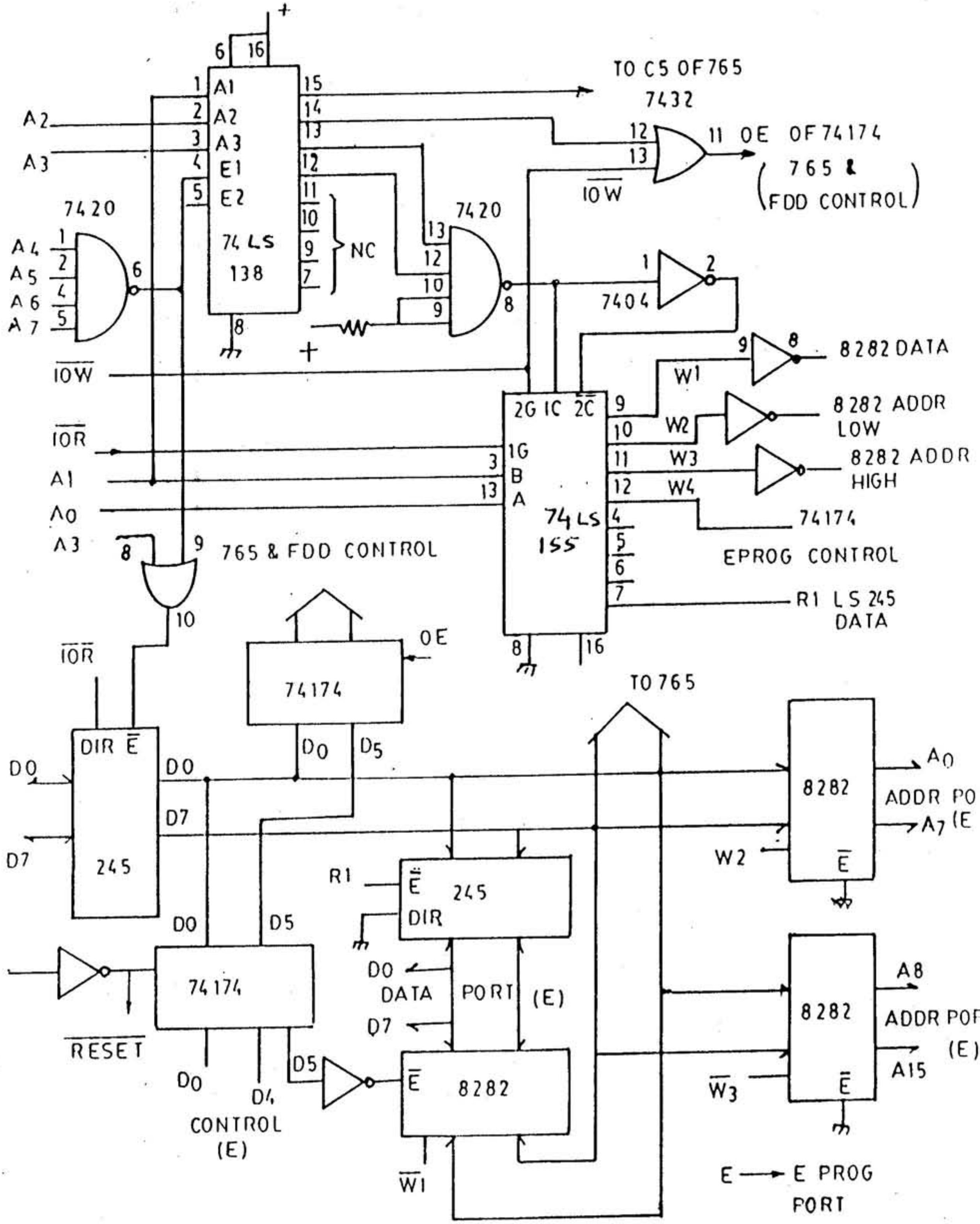



FIG. 5 CHIP SELECT LOGIC DATA BUFFERS & LATCHES


FIG. 6 - CIRCUIT DIAGRAM OF THE FLOPPY DISK CONTROLLER ELECTRONICS

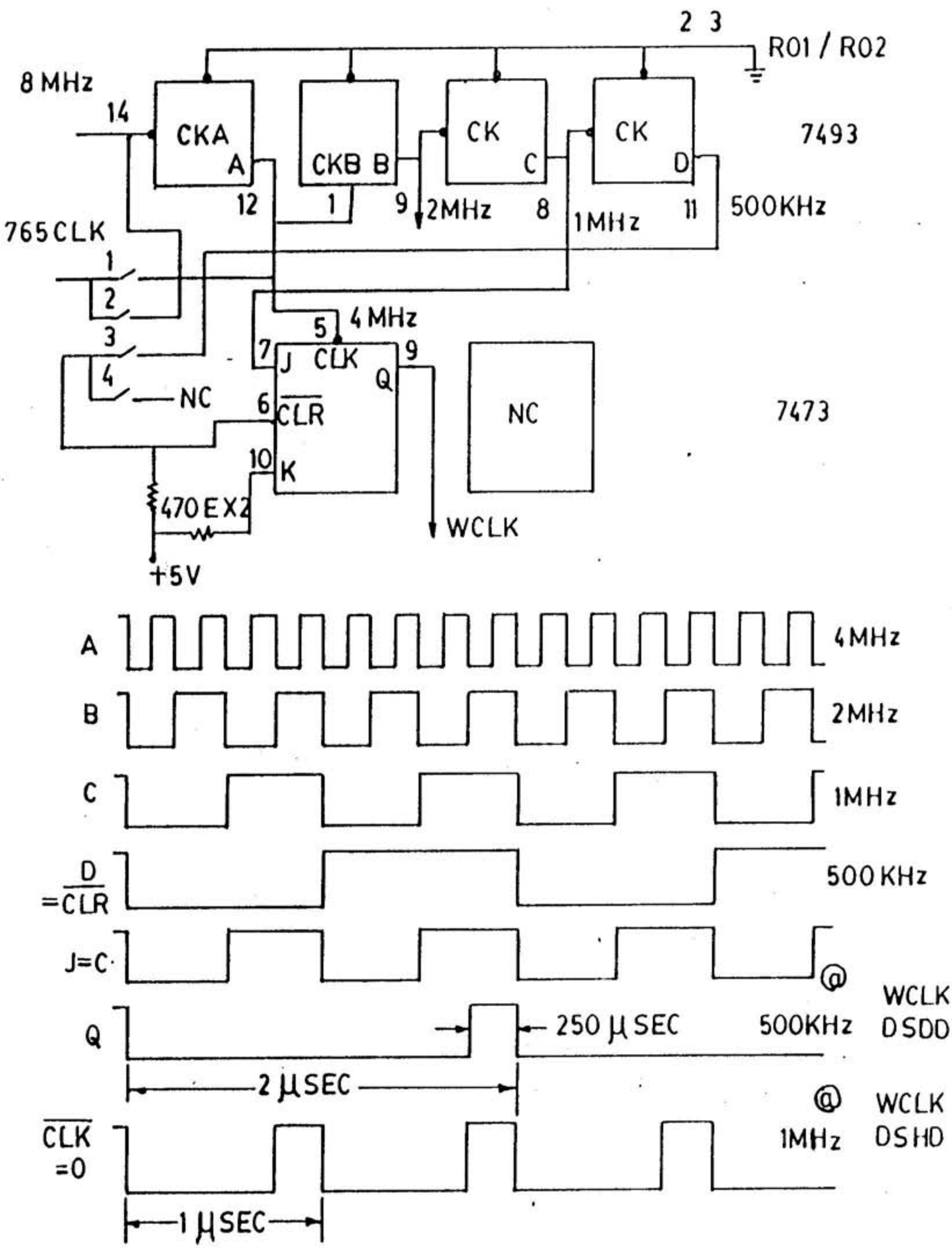



FIG. 7 - CLOCK SIGNALS FOR FDC AND DATA SYNCHRONIZATION

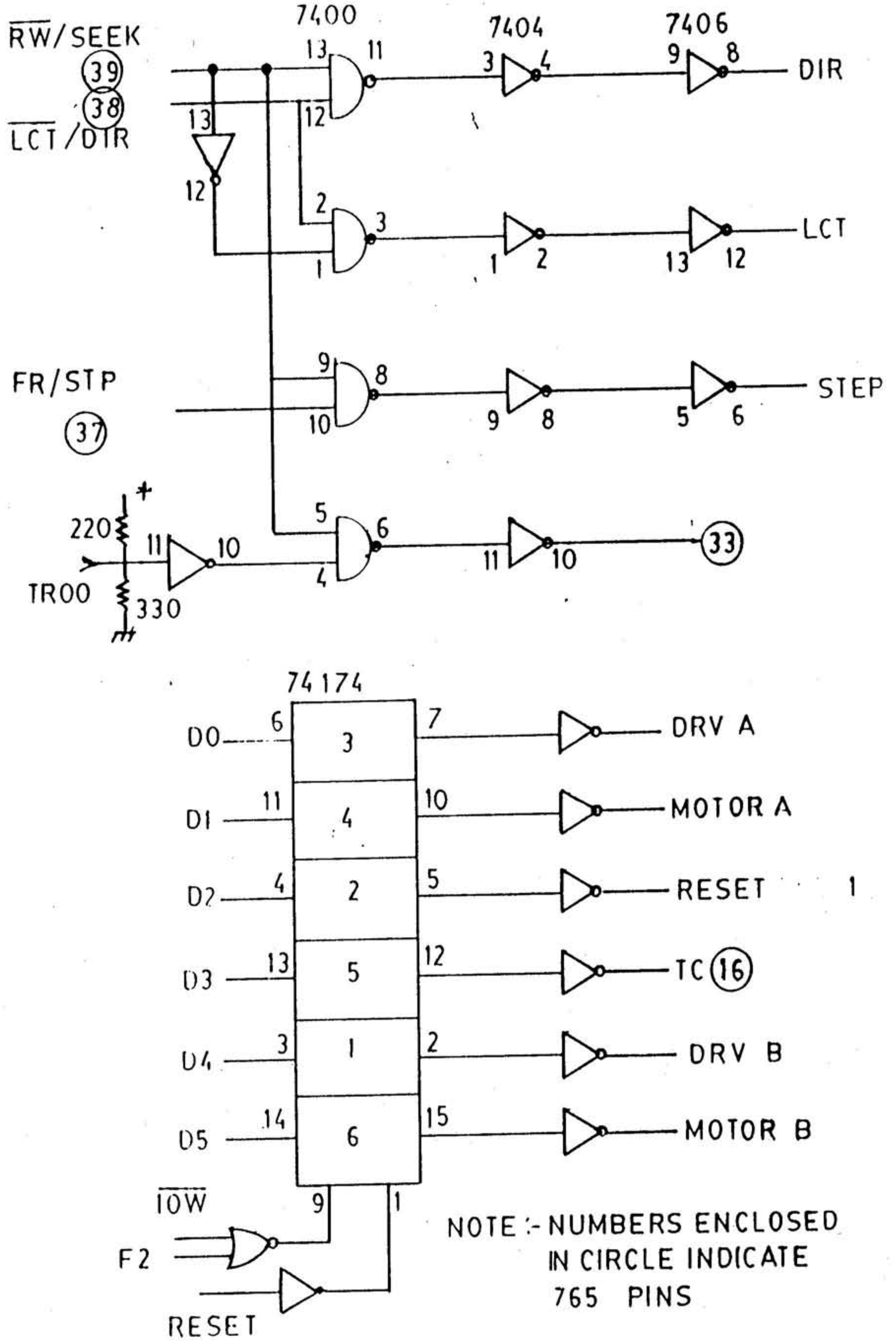
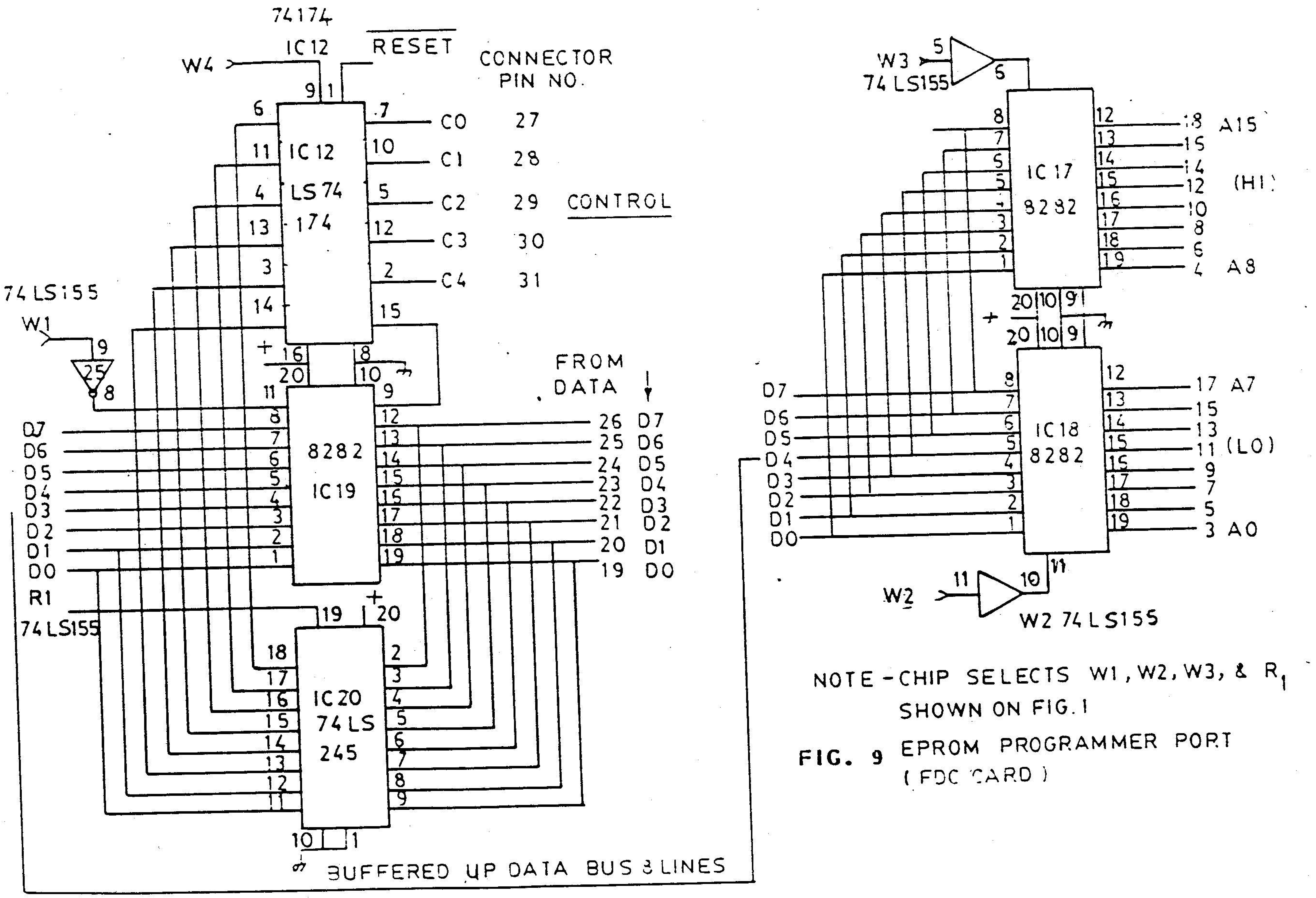



FIG. 8 - FDC CONTROL SIGNAL LATCH




NOTE - CHIP SELECTS W1, W2, W3, & $R_1$
SHOWN ON FIG. 1

**FIG. 9** EPROM PROGRAMMER PORT
(FDC CARD)

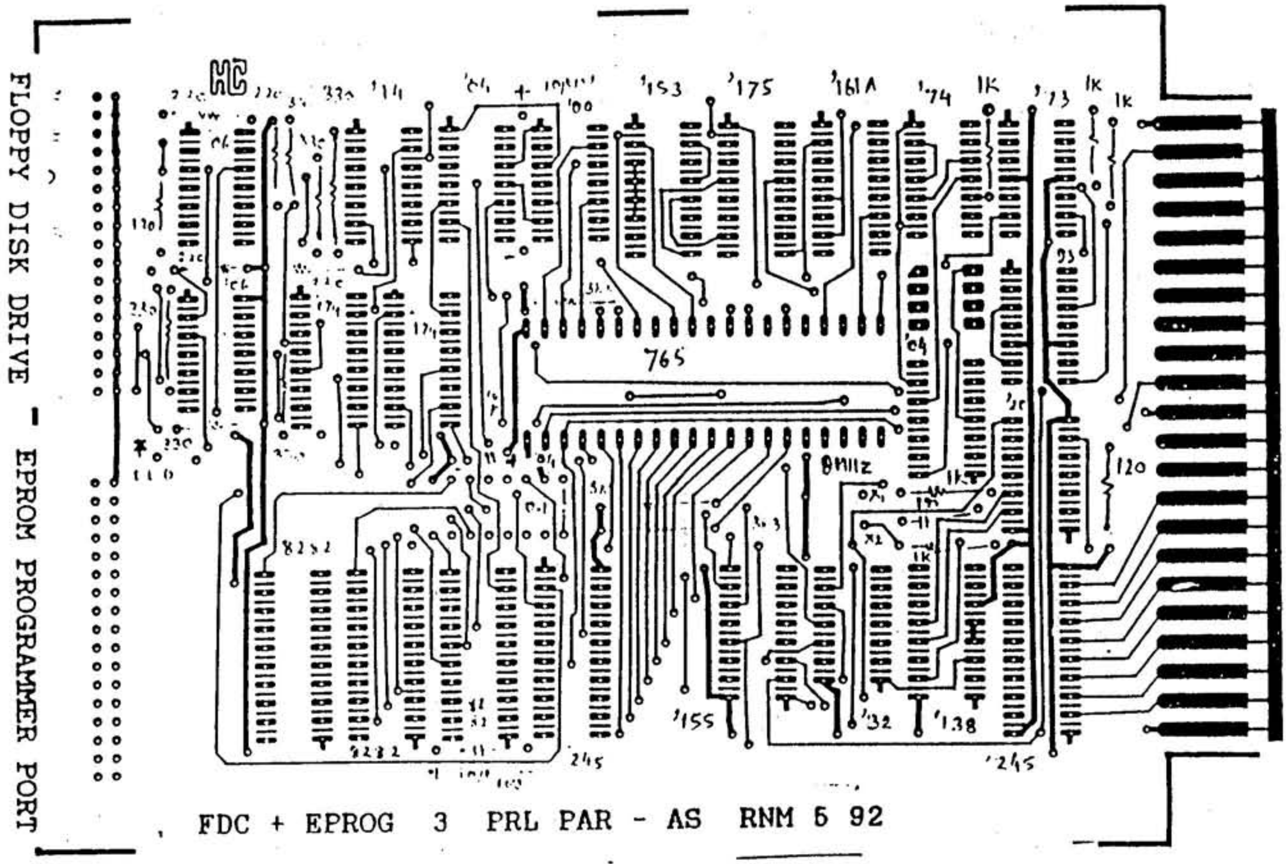



FIG. 10 - PRINTED CIRCUIT BOARD ARTWORK ,COMPONENT SIDE

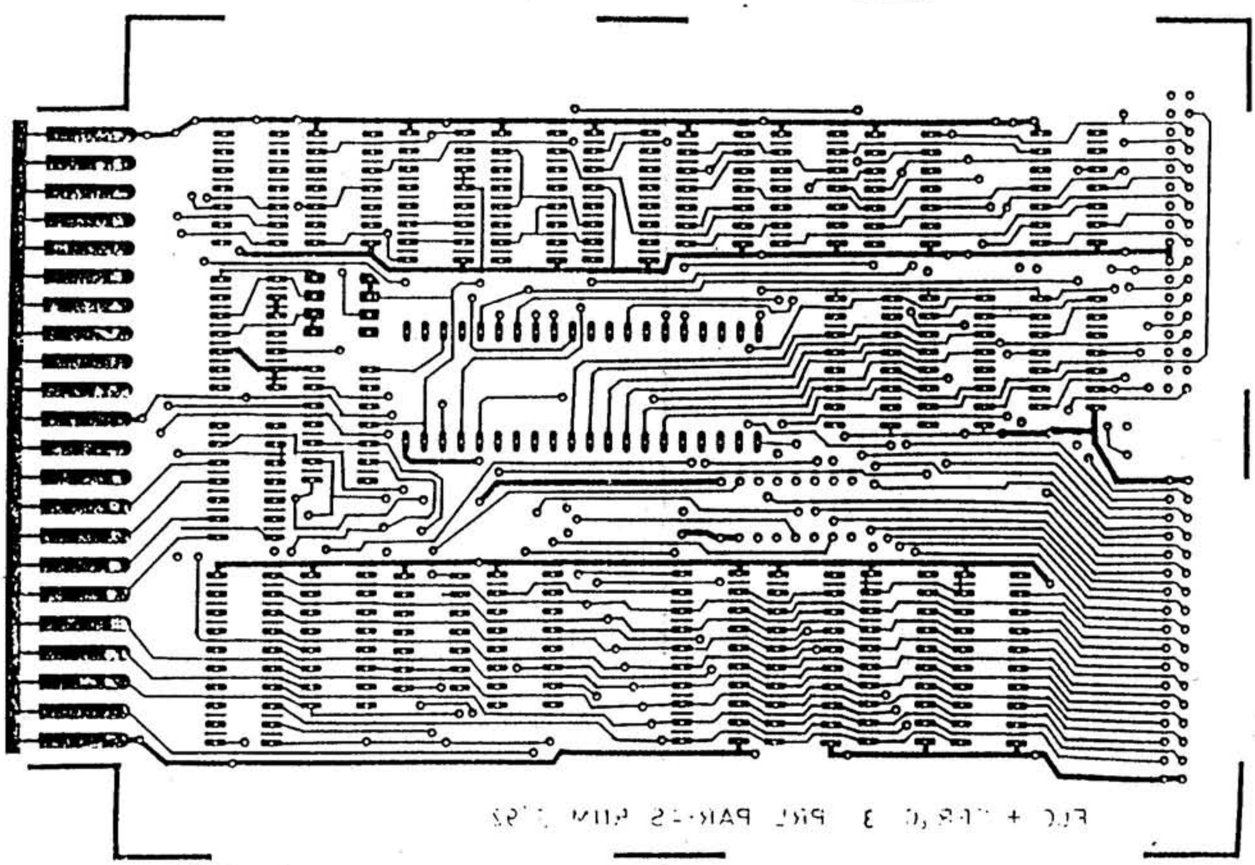


FIG. 11 - PRINTED CIRCUIT BOARD ARTWORK , SOLDER SIDE