Microtan TANDOS-R Manual

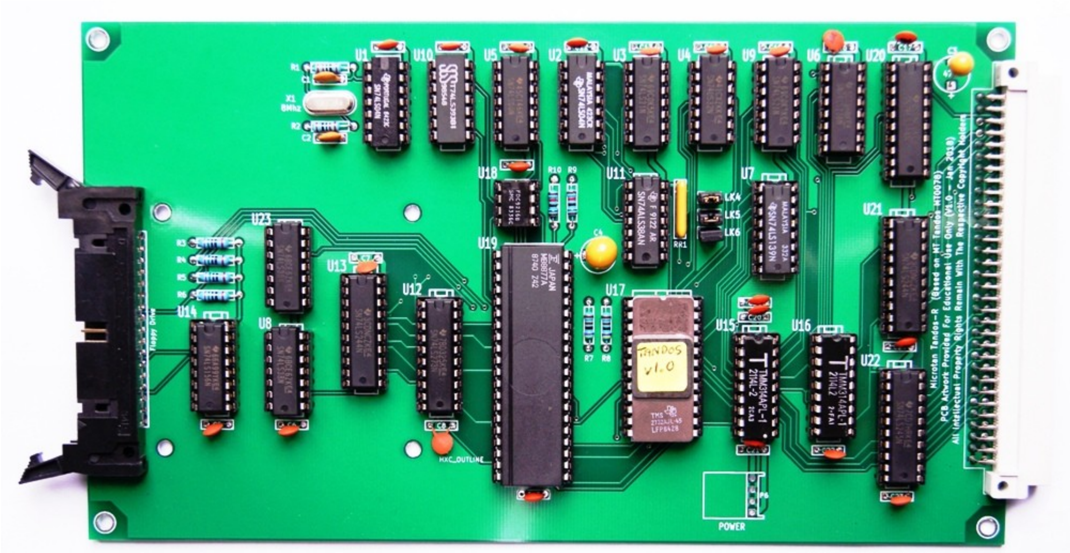


Table of Contents

Overview......3
Requirements......4
Power Supply requirements......4
Memory Requirements......4
Construction......5
PCB Layout......5
Component List......5
Assembly......6
Installation......7
Testing......8
The MASTER System Disk......9
Master Disk System Definition......9
Create Working System Disk......9
TANDOS System Description......11
Overview......11
TANDOS ROM......11
TANDOS Operating system......11
DBASIC......12
Disk Input/Output Routines......12
TANDOS RAM......13
FDC Commands......13
$03 Restore (Seek Track 0)......13
$1B Seek Track n......14
$C4 ‘Read Address’......14
$84 ‘Read Sector’......15
$A4 ‘Write Sector’......15
Error Handling......16
File Error Handling (Routine $B7C7)......16
FDMAIN Error Handling......16
TANDOS Register $BF94......16
Command Register......16
Status Register......17

Overview

The Microtan TANDOS system is designed to operate with 5.25” Floppy Disk Drives. Like the original, the TANDOS-R will interface with most of the 5 1/4" floppy disk drives that were around in the 1980s (eg those for BBC Micros). Rotation speed assumed is 300 rpm and the drives need to have stepping rates faster than 30ms. Specifically TANDOS can drive up four 40 track (48 TPI) or 80 track (96 TPI) FDD, single or double sided and even the early 35 track drives, or any combination of these. It treats doubled sided as 2 separate drives. Drives are numbered from 0 to 7. The original TANDOS laid down 9 sectors, each containing 256 bytes, per track using the ‘single density’ IBM 3740 Frequency Modulated (FM) format. This was subsequently increased to 10 sectors per track. TANDOS-R formats disks with 10 (256 byte) sectors per track using IBM 3740 FM format.

The interface between the TANDOS board and the drive adopts the Shugart[1] specification both physically and electrically. The design uses Floppy Disk Controllers FDC1793[2] (or MB8877A), and FDC9216[3] (FDC9216B).

As stated above, the system can comprise up to four disk drives. These drives may be single or double sided and have any number tracks from 35 to 80 inclusive. So far as the hardware is concerned, a two-sided disk is the same as two single sided disks. To make the system consistent, a numbering scheme for disks has been adopted which gives a unique number to each disk surface. Thus, the first side of the first disk is 0, the second side of the first disk is 1 etc. up to the second side of the fourth disk which is 7. If you have only sided-sided disks then you will not use any of the odd numbers. Similarly a two single-sided drive system will contain units 0 and 2 only.

1 www.microtan.ukpc.net/Datasheets/Shugart_SA850.pdf
2 www.microtan.ukpc.net/Datasheets/FDC1793.PDF
3 www.microtan.ukpc.net/Datasheets/FDC9216.PDF

Requirements

TANDOS requires a slot in a system rack based Microtan system with as a minimum, Microtan CPU and TANEX. It may be fitted into any spare slot but not the 'DOS' slot if using the Tangerine Motherboard. The CPU needs to be fitted with either a TANBUG v3 or TUGBUG v1.1 monitor EPROM.

Besides at least one 5.25" Floppy Disk Drive with its power supply, a floppy disk cable and Master System Disk are required. The document 'Creating a MASTER Disk' describes a procedure for making a MASTER Disk from a blank floppy disk.

Power Supply requirements

Tandos requires a +5v supply and a +12v supply to power the Floppy Disk Controller (FDC) IC.

Memory Requirements

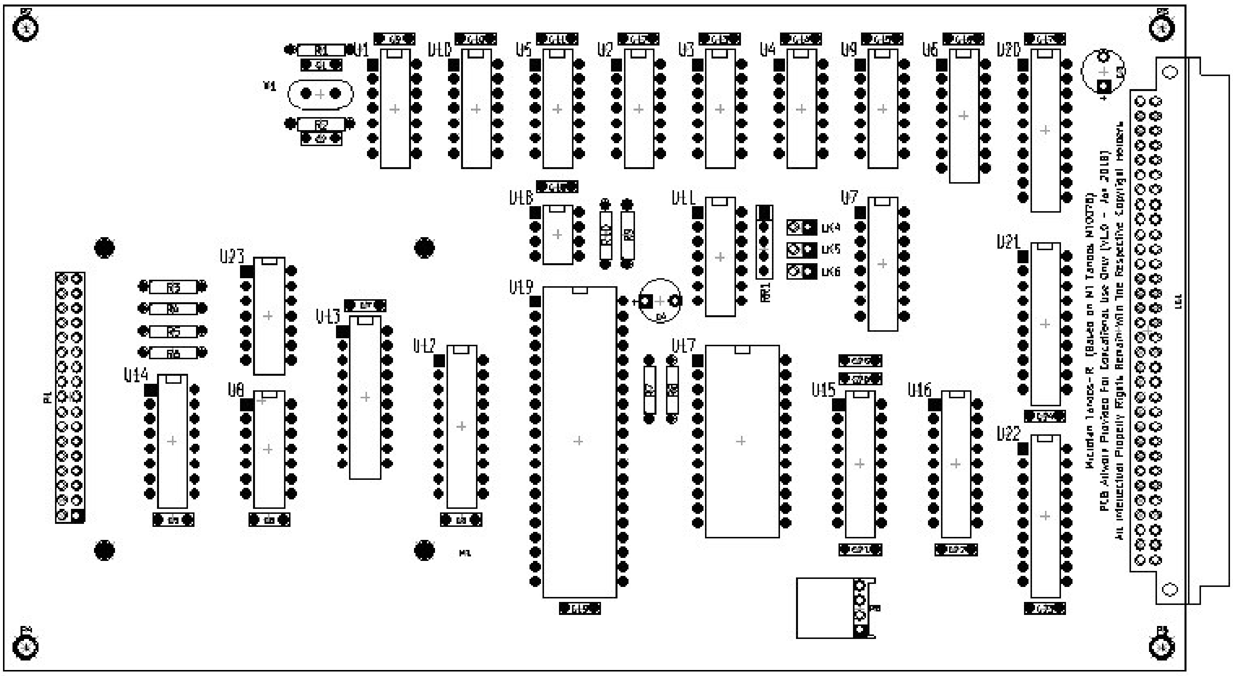
TANDOS assumes that at least 8K of User RAM is available (ie Microtan CPU and TANEX). It will operate correctly with any additional amount of memory up to the maximum 64K. It does however steal 5K of memory at locations $A800 to $BBFF for its own use.

The disk operating system uses a mixture of ROM and RAM at these locations. The necessary memory is contained on the TANDOS board so that it is not necessary to purchase additional memory to support this requirement.

The TANDOS uses five IO addresses. $BF90 - $BF93 are the four Floppy Disk Controller registers and $BF94 is the TANDOS board I/O. Reading $BF94 accesses the TANDOS Status data buffer (IC H3). Writing to $BF94 accesses the TANDOS Control data buffer (IC F3). These buffers interface both directly with the Floppy Disk Drives and the Floppy Disk Controllers.

Construction

PCB Layout



Component List

C1-2	100pf Ceramic	(2 off)
C3	47uF 10v Tantalum	
C4	47uF 25v Tantalum	
C5-25	0.1uF Ceramic	(21 off)
JP1-3	2 pin Jumper Header+Shunt	(3 off)
EC1	DIN41612 2x32 way (a+b)	
P1	2x17 way IDC socket	
P6	Berg Power Connector Plug[4]	(HxC option)
R1-2	1k	(2 off)
R3-6	150	(4 off)
R7-8	4k7	(2 off)
R9-10	10k	(2 off)
RR1	4k7 4 way Resistor Network	
U1-2	74LS04	(2 off)
U3	74LS21	
U4	74LS32	
U5	74LS00	
U6	74LS138	
U7	74LS139	
U8	74LS38	
U9	74LS21	
U10	74LS393	
U11	74LS38	
U12	74LS273	

4 Horizontal: AMP 171826-4. Vertical: AMP 171825-4

U13	74LS244	
U14	74LS156	
U15-16	2114	(2 off)
U17	2732	
U18	FDC9216B	
U19	MB8877A	
U20-21	74LS244	(2 off)
U22	74LS245	
U23	74LS38	
X1	8Mhz Crystal	

<u>IC Sockets</u>

8 way	1 off
14 way	10 off
16 way	3 off
18 way	2 off
20 way	5 off
24 way	1 off
40 way	1 off

Assembly

Use the PCB Layout and Components List above to identify the location of the components on the PCB. With the exception of the resistors, ceramic capacitors, crystal and jumpers, all other components need to be orientated correctly. The longer leads on the Tantalim capacitors are the positive leads. Square pads on the PCB denote the location of the components' Pin 1 or positive lead as appropriate.

After all components have been soldered, check underside carefully for bridged tracks and IC pins / component leads not soldered. Check topside for any bent IC pins. Ensure all ICs have been orientated corectly and are pushed fully home in their sockets by observing the gap between the IC and its socket.

A Floppy Disk cable is required. This is made up of a 34 way IDC connector at one end of a length of 34 way ribbon cable and 1, 2, 3 or 4 (as required) 34 way 5.25” floppy disk (pcb edge) connectors at the other. The connectors often have a triangle indicating pin 1. These should be orientated so that they align with Pin 1 signal line of the ribbon cable which is usually coloured red. The two parts of the connectors should be clamped around the cable using a vice so that even pressure is applied across the length of the connector.

Installation

Insert TANDOS board into a spare slot in the system rack. Ensure 3 jumper headers are fitted to the jumper links LK4,5 & 6.

Connect the board to the Floppy Disk Drive using 34 way ribbon cable fitted with 34 way IDC connectors. Ensure correct orientation of the connector. On TANDOS, Pin 1 is at the lower end; on the disk drive, Pin 1 is usually towards the centre.

If more than one disk drive is connected, they must be configured as different drive numbers. At least one must be configured as Drive 0. The disk drives are usually configured by placing a jumper header over the selected drive number jumper pins near to the floppy disk cable pcb edge connector.

Connect power to the floppy disk drive and the Microtan system.

Testing

On power up and following a RESET, the Microtan screen should display the default drive prompt “0>”. If the old ‘block’ prompt is displayed, then the monitor is not recognising that the TANDOS board is present. During the boot up sequence, TANBUG v3 and TUGBUG v1.1 inspect memory locations which reside on the TANDOS board. (For example TUGBUG writes and then reads back to the FDC memory location $BF91 (Track Register)). If it is present, then they initialise memory locations $BFC0 - $BFCF.

Enter the command DRV1 to change the default drive to Drive 1. The prompt should now display “1>”. This command should work with drive numbers from 0 to 7. Note that this command is resident in the monitor EPROM on the CPU board. It is independent of the actual system present. Default drives can be selected even if they do not physically exist. Return the default drive to “0:”.

To test if the Extended DBASIC ROM is present, enter the command “IA800” to commence the listing of the ROM which will show a number of JMP statements. Enter the command “IB000” to commence the listing of the TANDOS ROM which will show a different list of JMP statements.

Check the TANDOS RAM ($B800-$BBFF) can be read/written to using the monitor M command or run a test program (eg MTEST) to check pages B8 to BB.

To test that the TANDOS Floppy Disk Controller chip (FDC) can communicate with the drive, use the monitor M command to inspect the contents of the FDC STATUS register $BF90. If the head is over Track 0, then bit 3 will be set. If there is no floppy in the drive, then bit 2 (Index seen) will be set. When a floppy disk is inserted, it is highly likely bit2 will be reset. To move the head to a different track, load the Data Register ($BF93) with the track number (eg #$28 for Track 40) and then write to the Command Register ($BF90) value #$13 (SEEK command with a 30ms stepping rate). Note command value #$10 will instruct the head to move at 6ms stepping rate. To check which track the drive thinks the head is over, inspect the TRACK register ($BF91).

If all above testing runs well, insert the Master system disk into the floppy Disk Drive designated Drive 0. Note: a 40 track formatted Master disk will only be fully operable on a 40 Track disk drive. If only 80 track disk drives are available, then an 80 track formatted Master system disk will be required. Refer to ‘Creating a MASTER Disk’ document to make a MASTER disk from scratch.

Operate the disk closing mechanism to engage the disk drive heads with the floppy disk surface.

Type the command DIR<RETURN>. A list of 12 filenames should be displayed on the screen showing the contents and other information about the Master system disk.

The MASTER System Disk

The Master System disk contains 10 Tandos 65 disk/file management programs, a Disk-based BASIC program and a disk utility. A complete description of these 12 as well as 2 other Disk Operating System (DOS) non-disk-based commands are provided at Appendix A.

The Master system disk should be write-protected to prevent accidental over-writing or corrupted. This is done by placing a label over the indentation on the right-hand edge of the floppy disk. This label should never be removed from the Master System Disk.

Master Disk System Definition

The first 16 bytes of data contained on Track 0, Sector 1 of any TANDOS floppy disk is the System Definition. The Master disk assumes a default system definition as follows:

Drive 0:	40 Tracks
Drives 1: to 7:	not fitted

Page 0 upper memory limit:	8 Kbytes ($1FFF) ie Tanex memory only
Pages 1-7 upper memory limit:	0 Kbytes

The memory pages 1-7 refer to those created when additional TANRAM boards are plugged into specific slots in the Tangerine system motherboard.

Any working disk created from this Master disk will have the same system defintion. This definition can be amended by using the TANDOS “SYS” command. However, it is recommended the Master disk System Definition is left unmodified and the Master disk copy (see next section) is amended to reflect the actual system in use.

Create Working System Disk

Following the installation of the Tandos system and confirmation the system is operating correctly, the first task should be to create a working System disk from the Master disk. This is achieved as follows:

Insert Master disk in Drive 0:

Type DIR. Screen display will confirm this is the Master disk

Type CREATE 0:

TANDOS will respond with “Load disk 0 & press RETURN

Remove Master disk. Insert new disk. Press RETURN

TANDOS will then prompt you for the disk Name:

Enter SYSTEM01 (or whatever name you require – max 8 characters) following by RETURN

TANDOS will then format and initialise the new disk. The screen will display which track (in Hex) is being formated. On completion, TANDOS will display “disk now ready for use”.

Remove the new disk. Insert the Master disk.

Type BACKUP

TANDOS will respond with “INSERT SOURCE DISK & PRESS RETURN”

Source disk is already inserted, so just hit RETURN

When TANDOS has read the first part of the Master disk, it will respond with “INSERT DESTINATION DISK & PRESS RETURN”

The first part will be written to the new disk. This procedure is repeated for up to two times (depending on memory available) to copy across the remainder of the Master disk contents. When Backup is complete, TANDOS will respond with “BACKUP complete”.

Type DIR to check all the files are present on the new disk.

Enter SYS to update the System Definition on this disk to reflect the Microtan system configuration in use.

Stick a label on the new disk showing its name (SYSTEM01) and the number of tracks initialised (40T).

It is recommended that this new disk is write protected and used only for creating further system disks. The Master system should be kept safe away from the new ‘Master’ system disk and working disks.

TANDOS System Description

Overview

The TANDOS operating system program is held on the TANDOS EPROM at address $B000 - $B800. The Microtan BASIC extension (DBASIC) and general disk record structured file operating routines are also held on this ROM at address $A800 - $AFFF. It should be noted that as the EPROM does not 'see' the A12 address line, the TANDOS program has to be located in the lower half of the EPROM space and the BASIC extension in the top half.

The TANDOS operating system program requires the use of 1 K of RAM at address $B800 - $BBFF. This is physically located on the TANDOS board.

The TANDOS, BASIC extension ROM and RAM memory may optionally be located elsewhere in the Microtan system. These memory areas on the TANDOS board may be disabled by removal of the relevant jumper link on the board.

TANDOS controls and passes data to/from the attached floppy disk drives via the Floppy Disk Controller (FDC) chip. It uses addresses $BF90 - $BF93 to access the four FDC registers Command/Status, Track, Sector and Data registers respectively.

$BF94 is the address of the TANDOS board command /status register.

TANDOS ROM

As mentioned above, the TANDOS ROM holds the TANDOS 65 operating system in the top half[5] , and the DBASIC extension and Disk Record-structured file operating routines in the lower half[6].

TANDOS Operating system.

The main disk operating system routines accessible to the user are as follows:

DLOAD	($B000)	Entry point for DLOAD command
AUTOLOAD	($B003)	Entry point for AUTOLOAD command
WRITES	($B006)	Write sector primitive
READS	($B009)	Read sector primitive
RESET	($B00C)	Perform Disk RESTORE on Drive number in UNIT
FDMAIN	($B00F)	Main disk primitive
FDSUB	($B012)	Low-level disk primitive
SETINT	($B015)	Primitive to start disk motor etc

5 www.microtan.ukpc.net/Products/ListTANDOSv1_0.pdf
6 www.microtan.ukpc.net/Products/ListDBASICv1_0.pdf

Lower-level disk operating system routines (entry points located between $B7AF and $B7FF) are listed in the TANDOS Manual Chapter 7. Details of how to pass information to your own programs using the auto-load facility are also provided in this chapter.

DBASIC

At the TANBUG/TUGBUG monitor prompt, DBASIC is initiated with the command DBASIC <CR>. DBASIC will request ‘memory size’ as usual but if <CR> is pressed, DBASIC will use the information held in the System Definition area of the system disk in use instead of stepping through memory to find where the upper limit is. Note that DBASIC will use the top 1K of this memory as disk I/O buffers and is therefore not available to users.

The Warm (WAR) restart of DBASIC works as described in the TANBUG Manual however full recovery may not be possible if beforehand there has been significant disk activity (eg DIR or DOS commands).

DBASIC adds 4 new commands as follows:

DLOAD “n:PROG”	Load new program from disk (extension .BAS assumed)
DSAVE “n:PROG”	Save program to disk (adds extension .BAS)
DELFNP “n:PROG”	Delete program on disk (extension .BAS assumed)
DELFND “n:DATA”	Delete data file on disk (extension .BDT assumed)

DBASIC adds 6 new statements as follows:

DOPENR “n:DATAIN”	Specify data file on disk to be read from.
DOPENW “n:DATAOUT”	Specify data file on disk to be written to.
DCLOSER	Close current open data file on disk to be read from.
DCLOSEW	Close current open data file on disk to be written to.
DINPUT	Input data from disk
DPRINT	Output data to disk

A description of the use of these extra commands/statements with examples is provided in the TANDOS Manual, Chapter 4.

Disk Input/Output Routines

Seven routines are provided to support record structured disk I/O. These are as follows:

INIIO ($A803)	Called once before using any of the other routines
OPENR ($A806)	Opens a file to permit reading.
OPENW ($A809)	Opens a file to permit writing
RECIN ($A812)	Reads a single record from the current open file.

RECOUT ($A815) Writes a single record to the current open file.

CLOSER ($A80C) Closes the previously opened file for reading.

CLOSEW (A80F) Closes the previously opened file for writing.

Further details are provided in the TANDOS Manual Chapter 7

TANDOS RAM

TANDOS 65 makes extensive use of the TANDOS RAM located at $B800-$BBFF. Details are provided in the TANDOS Manual Chapter 6.

FDC Commands

The heart of the TANDOS operating system is the 'FDMAIN' routine (located at $B1DC). This routine passes commands held in the 6502 X Register to the Foppy Disk Controller (FDC) and after executing the commmand, places the FDC status in TANDOS RAM location $B809. The TANDOS Operating system uses the following five FDC commands:

$03 Restore (Seek Track 0)

Upon receipt of this command, the FDC's TR00 input is sampled. If TR00 is active (low) indicating the head is positioned over track 0, the Track Register is loaded with zeroes and an interrupt is generated. If TR00 is not active, stepping pulses at a rate specified by the r1 r0 field are issued until the TR00 input is activated. At this time, the Track Register is loaded with zeroes and an interrupt is generated.

The Restore command contains a stepping rate field r1 r0 which determines the stepping motor rate.

r0	r1	Stepping Rate
0	0	6 ms
0	1	12 ms
1	1	20 ms
1	1	30 ms

Following the receipt of this command, the FDC Status Register (READ $BF90) will show the following information:

Bit 0 **Busy** When set the write sector command is in progress

Bit 1 **Index** Set if the drive has detected the Index Mark

Bit 2 **Track 00** Setif the head is positioned over Track 0.

Bit 3 **CRC Error** Set if an error is found in the ID Field

Bit 4 **Seek Error** Set if the desired track was not verified.

Bit 5 **Head Loaded** Set if the head is loaded and engaged.

Bit 6 **Write Protect** Set if the disk is write protected

Bit 7 **Not Ready** Set if the drive is not ready.

$1B Seek Track n

This command instructs the drive specified in the TANDOS Control register to position the head over the specified track. The 2 LSBs denote the stepping rate as used above in the Restore command.

This command assumes that the FDC Track Register contains the track number of the current position of the head and the FDC Data Register contains the desired track number. The FDC will issue stepping pulses in the appropriate direction and update the Track Register until the contents of the Track Register are equal to the contents of the Data Register. An interrupt is generated at the completion of the command. Note: when using multiple drives, the FDC track register is updated for the drive selected, before the seek command is issued.

Following the receipt of this command, the FDC Status Register (READ $BF90) will show the following information:

Bit 0 **Busy** When set the write sector command is in progress

Bit 1 **Index** Set if the drive has detected the Index Mark

Bit 2 **Track 00** Setif the head is positioned over Track 0.

Bit 3 **CRC Error** Set if an error is found in the ID Field

Bit 4 **Seek Error** Set if the desired track was not verified.

Bit 5 **Head Loaded** Set if the head is loaded and engaged.

Bit 6 **Write Protect** Set if the disk is write protected

Bit 7 **Not Ready** Set if the drive is not ready.

$C4 'Read Address'

Upon receipt of the Read Address command, the head is loaded and the Busy Status bit is set. The next encountered ID field is then read in from the disk, and the six data bytes of the ID field are assembled and transferred to the Data Register, and a DRQ is generated for each byte. If DRQ has not been serviced, the command is terminated and the Lost Data status bit (FDC Status Register bit 2) is set. The six bytes of the ID field are : Track address, Side number, Sector address, Sector Length, CRC1, CRC2. Although the CRC bytes are made available to the TANDOS system, the FDC checks for validity and the CRC error status bit is set if there is a CRC error. The track address of the ID field is written into the sector register so that a comparison can be made by the user. At the end of the operation, an interrupt is generated and the Busy status bit is reset.

Following the receipt of this command, the FDC Status Register (READ $BF90) will show the following information:

Bit 0 **Busy** When set the read sector command is in progress

Bit 1 **DRQ** This is a copy of the DRQ output. Set indicates Data Register is full (byte is ready to be read). The bit is reset when the Data Register is read.

Bit 2 **Lost Data** See above

Bit 3 **CRC Error** See above

Bit 4 **Record not found** Set if the desired Track, Sector or Side were not found

Bit 5 Always zero

Bit 6 Always zero

Bit 7 **Not Ready** Set if the drive is not ready. Read Sector command is not executed if set.

$84 'Read Sector'

Upon receipt of the command, the head is loaded, the busy status bit set and when an ID field is encountered that has the correct track number, correct sector number, correct side number, and correct CRC, the data field is presented to the TANDOS system. An DRQ is generated each time a byte is transferred to the Data Register. If DRQ has not been serviced, the command is terminated and the Lost Data status bit (FDC Status Register bit 2) is set. At the end of the Read operation, the Type-of-Data Address Mark encountered in the data field is recorded in the Status Register (bit 5).

Following the receipt of this command, the FDC Status Register (READ $BF90) will show the following information:

Bit 0 **Busy** When set the read sector command is in progress

Bit 1 **DRQ** This is a copy of the DRQ output. Set indicates Data Register is full (byte is ready to be read). The bit is reset when the Data Register is read.

Bit 2 **Lost Data** See above

Bit 3 **CRC Error** Set if an error is found in one or more ID or Data Fields

Bit 4 **Record not found** Set if the desired Track, Sector or Side were not found

Bit 5 **Record Type** See above

Bit 6 Always zero

Bit 7 **Not Ready** Set if the drive is not ready. Read Sector command is not executed if set.

$A4 'Write Sector'

Upon receipt of the command, the head is loaded, the busy status bit set and when an ID field is encountered that has the correct track number, correct sector number, correct side number, and correct CRC, a DRQ is generated. The FDC counts off 11 bytes (in single density) from the Gap 2 field and the Write Gate output is made active. If DRQ has not been serviced, the command is terminated and the Lost Data status bit (FDC Status Register bit 2) is set. If the DRQ is serviced (ie. the Data Register has been loaded by the computer), 6 bytes of zeroes (in single density) are written to the disk in the Sync field, then the Data/Deleted Mark as determined by the a0 field of the command. The FDC then writes the data field and generates DRQ's to the computer for each byte of data. The status of the DRQ signal is copied to the FDC Status Register bit 1. If the DRQ is not serviced in time for continuous writing, the Lost Data Status bit is set and a byte of zeroes is written on the disk (the command is not terminated). After the last data byte has been written on the disk, the two-byte CRC is computed internally and written on the disk.

Following the receipt of this command, the FDC Status Register (READ $BF90) will show the following information:

Bit 0 **Busy** When set the write sector command is in progress

Bit 1 **DRQ** This is a copy of the DRQ output. Set indicates Data Register is empty (ready to receive next byte for writing to the disk). The bit is reset when the Data Register is updated.

Bit 2 **Lost Data** See above

Bit 3 **CRC Error** Set if an error is found in one or more ID or Data Fields

Bit 4 **Record not found** Set if the desired Track, Sector or Side were not found

Bit 5 **Write Fault** Set if a write fault is encountered

Bit 6 **Write Protect** Set if the disk is write protected

Bit 7 **Not Ready** Set if the drive is not ready. Write Sector command is not executed if set.

Error Handling

File Error Handling (Routine $B7C7)

The error Vector is located at $B94F/$B950. The routine at $B457 loads location $B4AD into this vector. This routine is called up when either DLOAD or ALOAD programs are executed.

Any errors detected by these programs result in the program being directed to the user entry point $B7C7 which diverts the program to the location contained in the Error Vector. This may follow the case where the file requested is not found (in which case “No file” is printed) or the destination memory does not exist (in which case “No Memory Pn” is printed; n is the Memory Page number).

The $B4AD routine first prints to screen “ ?”, then initiates the ZRSTR (Restore) routine which restores registers $40, $41 and the Stack back to their original values, and finally returns control back to the monitor.

FDMAIN Error Handling

The FDMAIN routine has its own error handling routine located at $B23C. On detection of an error it first initiates an FDC RESTORE command, then prints on the screen the FDC Status Register value in hexadecimal followed by “Hard Error” (or “RO Disc” in the specific case where the Write Protect bit is set), tidies up and then returns from the FDMAIN routine.

The error can be determined by inspection of the relevant FDC Status Register values in the FDC Commands section above.

TANDOS Register $BF94

The TANDOS Register supplies commands to and reads the status from the FDCs. It also manages the flow of FDC interrupt and data requests to the TANBUS.

Command Register.

The Command Register is U12, an octal D-type flip-flop. TANDOS RAM location $B80A is used to store the next/last command. It is initialised from a lookup table commencing at $B1CB which is indexed on the current TANDOS drive (DRV) selected (ie 0-7).

<u>Drive/Side Selection</u>

Floppy Disk Drive (FDD) selection is performed by the TANDOS Register bit 2 (SEL0) and bit 3 (SEL1). These outputs are fed to the U14 De-multiplexer which sets one of the four FDD selection signals (DSEL0-3). Bit 4 provides the FDC with the side selection FDC_SIDE.

<u>Interrupt Management</u>

The flow of FDC Interrupt Requests to the TANBUS IRQ signal is managed by bit 0. Flow is enabled when bit 0 is set. The FDC Interrupt Request (INTQ) is set when a command is complete and reset when the next command is written or the Status Register is read.

The flow of FDC Data Requests to the TANBUS SO signal is managed by bit 7. Flow is enabled when bit 7 is set. During the READ cycle, the FDC Data Request (DRQ) is set when the Data Register is filled with data from the disk and is ready to be read. During the WRITE cycle, the DRQ is set when the Data Register is empty and is ready to accept data for transferring to the disk.

<u>FDC Control</u>

Bit 5 controls the FDC1793 (MB8877) and FDC9216 DDEN inputs. In the current TANDOS version, this bit is always set to 1 specifying the Single Density operation mode.

Bit 1 controls the FDC9216 DATA SELO input which together with the DDEN determines the FDC9216 clock divider. In the current TANDOS version, this bit is always set to 0 . This combination selects an FDC9216 internal clock divider of 4 with an 8MHz external reference clock.

<u>HLT Control</u>

Bit 6 informs the FDC the state of the head loading. When set, the head is assumed to be loaded and settled in an engaged state (ie a pre-determined time aftet HLD is set).

Status Register

The status register U13 is an octal buffer/line driver. It reads the status of the following:

<u>Drive/Side Selection</u>

The status of Floppy Disk Drive (FDD) selection is read on bit 2 (SEL0) and bit 3 (SEL1). FDC side selection FDC_SIDE is read on bit 4.

<u>FDC Status</u>

Bit 0 is FDC_INTQ, an FDC output which is set when an FDC command has been completed.

Bit 5 is FDC_DDEN, an FDC input specifying single or double density operation mode. In TANDOS always 0 – single density.

Bit 6 is FDC_HLD, an FDC output instructing the disk drive to load the head.

Bit 7 is FDC_DRQ, an FDC output informing status of the Data Register. During the READ cycle, the FDC Data Request (DRQ) is set when the Data Register is filled with data from the disk and is ready to be read. During the WRITE cycle, the DRQ is set when the Data Register is empty and is ready to accept data for transferring to the disk.