AT3550 3.5” Wolverine

3.5” IDE Solid State Flash Drive

User Guide

80-03-00035
Revision 1.1
February 11, 2005

Memtech SSD Corporation
7628 Las Positas Road
Livermore, CA 94550
(925) 294-8483
(800) 445-5511
www.memtech.com

Table of Contents

1. HIGHLIGHTS 3

2. INTRODUCTION 3

3. INSTALLATION 4

3.1 PROCEDURE 4
3.2 JUMPERS 7
3.3 IDE INTERFACE 9

4. OPERATION 11

4.1 ACTIVE REMAP™ AND WRITE LIMITATIONS 11
4.2 ECC 11
4.3 POWER 12
4.4 TROUBLE SHOOTING GUIDE 13

5. MAINTENANCE 13

6. SPECIFICATIONS 14

6.1 INTERFACE 14
6.2 PERFORMANCE 14
6.3 ENVIRONMENTAL 14
6.4 POWER REQUIREMENTS 14
6.5 MECHANICAL 15
6.6 RELIABILITY 15

7. APPENDIX 16

7.1 CONTACT INFORMATION 16
7.2 ATA SPECIFICATION INFORMATION 16
7.3 LIMITED LIFETIME WARRANTY 16

1. HIGHLIGHTS

- 12 Gbyte capacity under 16mm (0.63")
- 60 Gbyte maximum capacity
- Full -55°C to +125°C military temperature range
- 3.5" drive low profile form-factor
- UDMA-66 compliant IDE interface
- 16 byte CRC/ECC and Active Remap™ for exceptional data reliability
- Kicker™ Hold Up Circuit
- Active Remap™ Data Reliability Feature
- 5 volt, low power operation
- Completely solid state - no moving parts
- 2000G operating shock
- 20G operating vibration
- 0.1 millisecond random access time
- 26 Mbyte/sec cached Read performance
- 20 Mbyte/sec cached Write performance
- 8 year product warranty
- 8 million erase/write cycle endurance

2. INTRODUCTION

The AT3550 "Wolverine" is a series of IDE solid state drives available in a low-profile 3.5-inch format. The drive is completely solid state, making it exceptionally rugged and able to operate in extreme environmental conditions.

Sector Erasable NAND E^2PROM (Flash) is used to provide over 60 Gbytes of nonvolatile, solid state storage in an extremely small, rugged form factor. The drive is 100% IDE compatible and requires no special drivers to operate. It is essentially a drop in replacement for standard rotating media.

The IDE interface is implemented using a commercially available IDE controller. It supports UDMA-66 transfers, LBA mode addressing, and incorporates a 1 Mbyte buffer, and a 16-byte hardware error detection and correction logic. The CRC/ECC circuitry, in conjunction with Memtech's proprietary Active Remap™ technology, makes for a virtually bulletproof medium for data retention.

The drive is available in a number of standard capacities ranging from 1 to 60 Gbytes. Drives under 12 Gbytes are 16mm tall, while 60 Gbyte capacity drives are under 35.5mm.

Each drive is fully tested under environmental extremes at the factory using Memtech's proprietary EnduroTest™ to guarantee data integrity in even the harshest conditions. Full functionality of the product is guaranteed out of the box.

3. INSTALLATION

3.1 PROCEDURE

3.1.1 ESD PRECAUTIONS

The AT3550 is sensitive to static electricity. Before handling the AT3550, please observe the following precautions to avoid ESD damage to the unit:

- Keep the drive in its shielded bag until ready to install.
- Ground yourself by touching a grounded chassis frame of the computer, or use a grounded wrist strap before and during the installation process.
- Do not touch the exposed drive electronics or connectors. Always handle the drive by the edges or mounting rails.

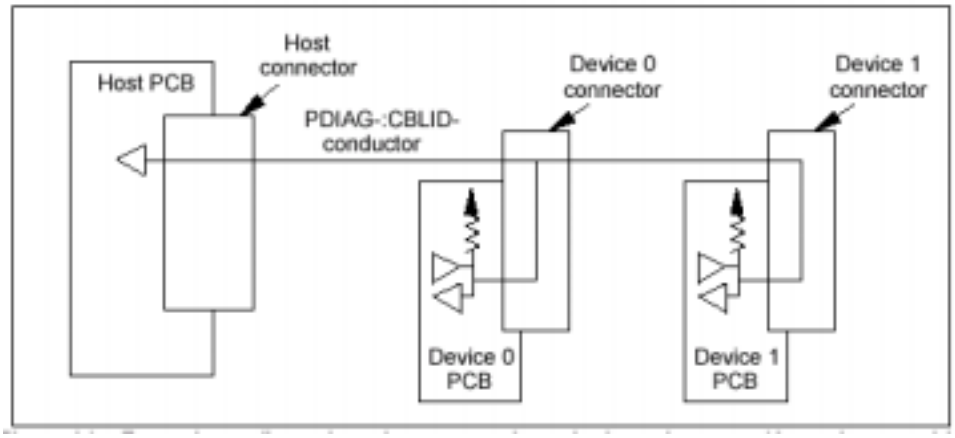
3.1.2 CONFIGURATION

Before applying power to the drive, configure the drive using the jumper diagrams given in Section 3.2. The default configuration is for a single drive system or as the master in a two-drive system. Change the configuration as required. Never attempt to change the jumpers while the drive is plugged in and the computer is on.

3.1.3 CABLE

With the computer off, attach the 40-pin, 0.1inch cable to the unitized IDE connector on the drive. Note pin 1 orientation and alignment. Care should be taken when installing the cable, as misalignment can permanently damage the drive interface. Attach the separate power cable using the 4-pin AT Power connector.

The AT3550 is UDMA66 compliant with the appropriate cable. If the host system does not detect the correct cable type, the interface will restrict transfers to UDMA33 speeds or slower. The type of cable is detected using the signal CBLID. On UDMA66 compliant cables, this signal is grounded.



3.1.4 CONNECTOR

The drive may be interfaced directly to a standard 3.5", 0.1in IDE socket connector or a standard 40pin IDE ribbon and AT power cable. See drawing below for pin 1 location. Care should be taken when installing the AT3550 into the system, as misalignment can permanently damage the drive interface connector or electronics.

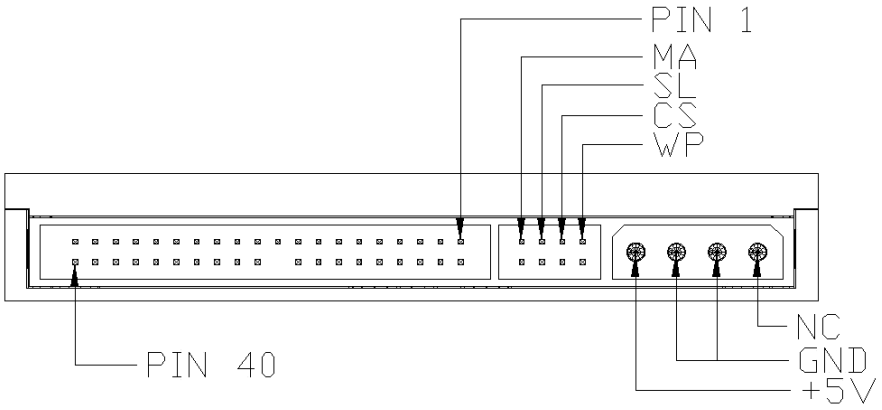


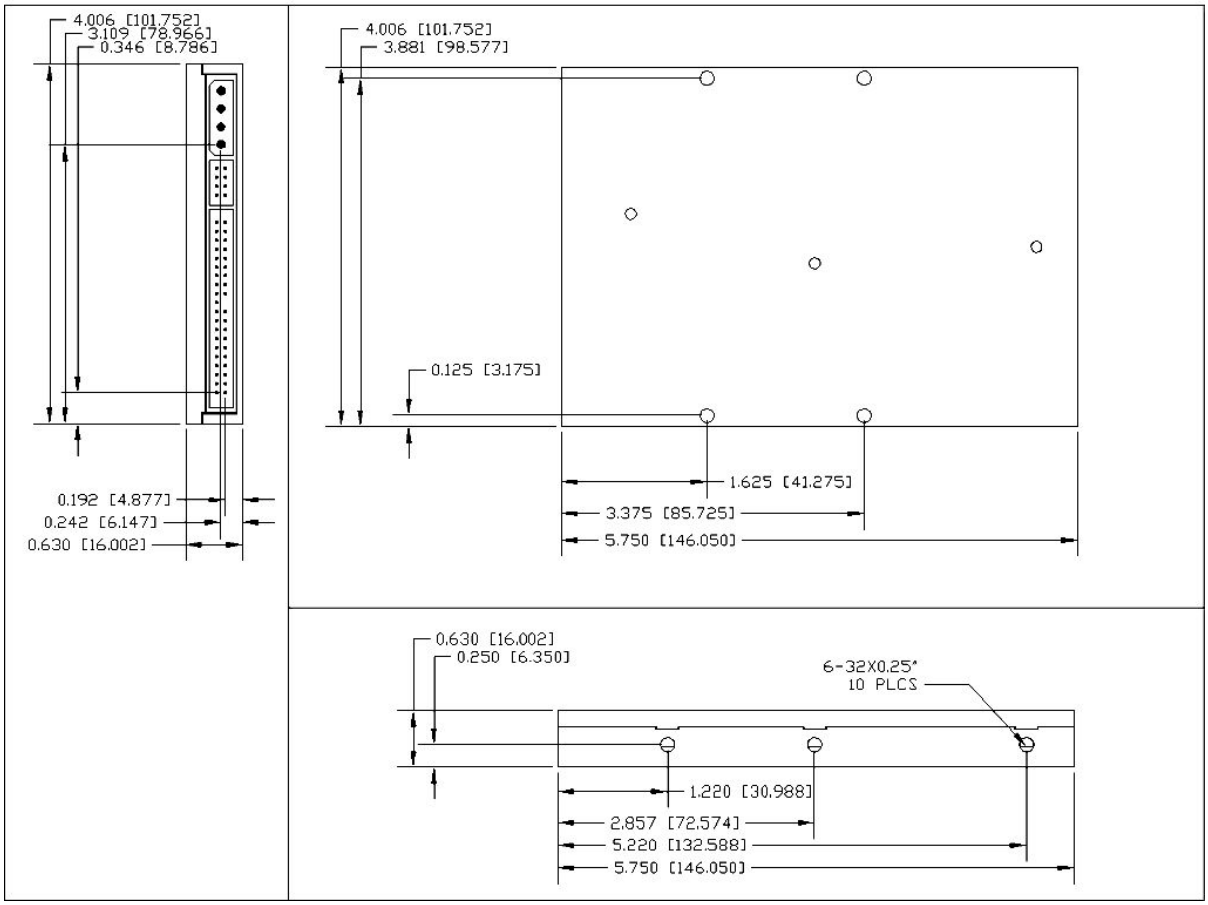
Figure 1 - Drive Connector

3.1.5 MOUNTING

The AT3550 may be mounted in any orientation. A total of four bottom and six side mounting holes are available for installation. The mounting holes require 6-32 screws with a maximum depth of 0.25 inch.

The diagram given below is valid for all capacities of the AT3550 drive. The overall outside dimensions are 4 inches (101.7 mm) wide, 5.75 inch (146.05mm) long, and 0.630 inch (16mm) tall. Please refer to the following drawing for dimensions and mounting hole locations.

The diagram given below is for a 12 Gbyte drive. Drives with higher capacities will be 0.760 inches (19.3mm) or taller. All other dimensions remain identical.



3.1.6 COMPUTER SETUP

To be recognized by the computer, the drive translation information must typically be entered into the System Setup or CMOS Setup utility. For non-PC compatible computers, this may not apply. The AT3550 supports automatic configuration if offered by the BIOS. Automatic CHS translation and LBA mode is also supported.

3.1.7 PARTITION

The drive must be partitioned using the system's FDISK utility. For operating systems other than DOS, please refer to your OS operating guides. Note that changing the partition information will erase all data currently on the drive. Refer to your OS manual for information regarding partitioning a hard disk.

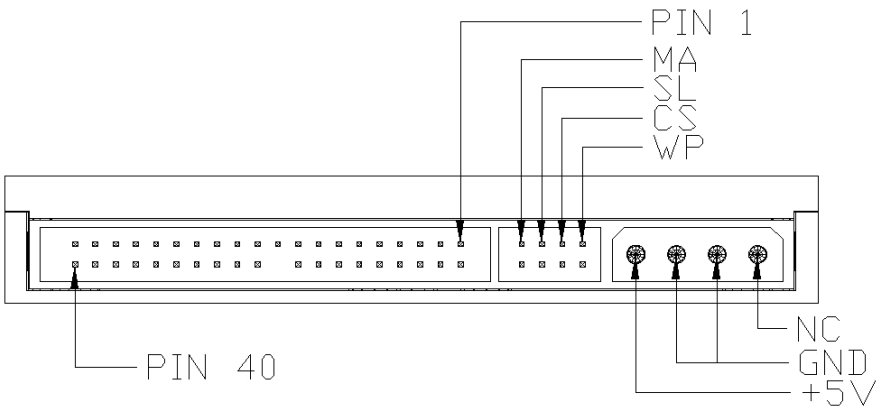
3.1.8 FORMAT

The AT3550 is low-level formatted at the factory, which establishes the 512-byte sector size. A high-level format is required after the partition has been established on the drive. Refer to your OS manual for information regarding hard disk drive format procedures.

3.2 JUMPERS

The following diagram illustrates the locations of the jumpers on the AT3550 controller card. The jumpers are found on both the J1 interface header and the J2 jumper header. Refer to the illustration below. The option jumpers control the master/slave configuration of the drive, the use of cable selection, drive write protection, and other factory related functions. All headers are on 2mm centers.

3.2.1 MAIN HEADER (J1) JUMPERS



3.2.2 MASTER/SLAVE

If no jumper is installed or the MA jumper is in place, the drive is selected as the C: or Master drive. If the drive is to be a Slave device (drive D), install the jumper ion the SL location. This jumper is part of the unitized ATA interface header and is on 0.1 inch centers. This location is factory shipped with no jumper or with the jumper in the MA position, configuring the drive as the master drive.

3.2.3 CABLE SELECT

Jumper CS can be used to let the IDE Cable Select signal select the drive configuration as either the master or slave device. Shorting the CS pins enables the Cable Select feature. Leaving the pins unconnected disables the Cable Select feature. The drive is factory shipped with these pins open.

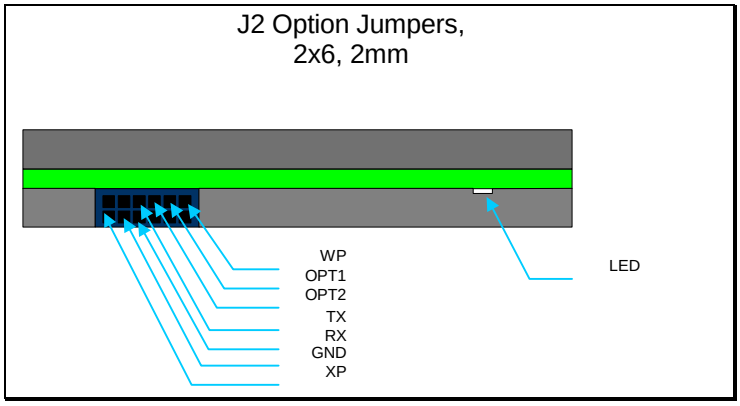
3.2.4 WRITE PROTECT

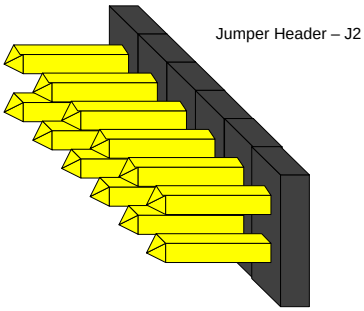
The WP jumper is used to write protect the drive. Installing this jumper on either the J1 or J2 header forces the drive to a write-protect condition, blocking any and

all writes from occurring. This jumper must be prior to the drive powering up to be recognized.

3.2.5 OPTION HEADER J2

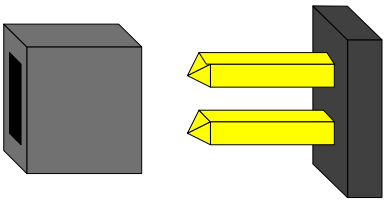
The Option Header is located on the LED-side of the drive, as illustrated below:





3.2.6 WRITE PROTECT

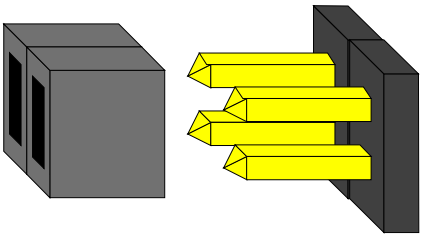
The WP jumper on header J2 is used to write-protect the drive. The default position of this jumper is OFF. Installing the WP jumper inhibits all further writes to the drive, while read accesses occur as normal.



WP: Write Protect configured for normal operation -- jumper off

3.2.7 OPTION JUMPERS

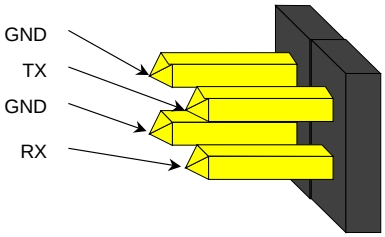
The OPT1 and OPT2 jumpers are used for factory test functions or special functions only, and should always be left open.



OPT1,2: Option Jumpers configured for normal operation -- jumpers off

3.2.8 TX/RX CONNECTIONS

The TX and RX connections are for manufacturing use only.

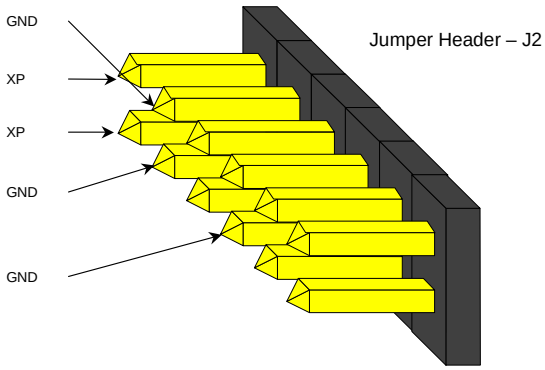


TX/RX: RS232 Communications

3.2.9 EXTERNAL POWER

The XP pins on the Option Header are used to connect external standby power to the drive. These pins are connected to the Kicker™ Holdup Circuit. Applied power should be 5 volts +/- 10%. Do not exceed 6 volts on this line, as internal damage to the drive may result.

The two outside pins on the header are used to connect power to the holdup circuit. A third pin is needed to connect the grounds of the drive to the power source.



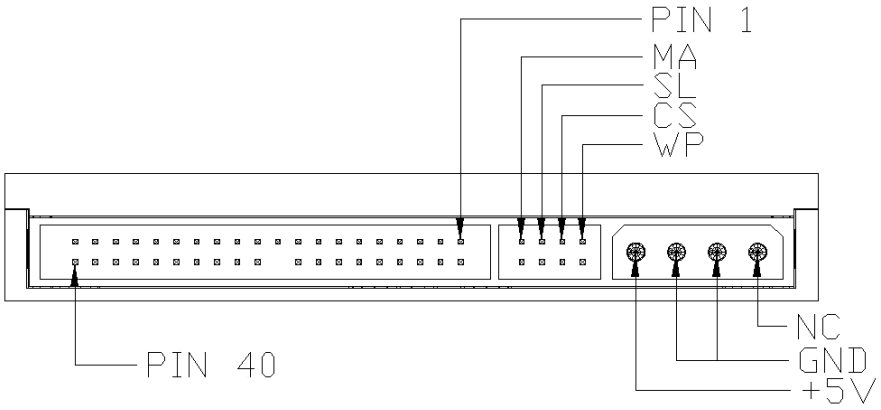
Jumper Header – J2

3.3 IDE INTERFACE

The AT3550 uses a unitized ATA connector that combines the 40-pin 0.1” IDE header, the 4-pin AT Power connector, and an 8-pin option jumper header mounted on the drives controller PCB. Maximum cable length is 18 inches. Recommended cable length is 12 inches or less, especially if an advanced PIO or UDMA transfer modes are being used. To achieve full drive performance, a UDMA cable is required.

3.3.1 IDE CONNECTOR PHYSICAL ORIENTATION

The diagram below depicts connector orientation and location.



3.3.2 IDE CONNECTOR PINOUT

The following table depicts the 40-pin, 0.1 inch signal cable interface pin out.

PIN	SIGNAL	PIN	SIGNAL
1	RESET-	2	GND
3	DATA7	4	DATA8
5	DATA6	6	DATA9
7	DATA5	8	DATA10
9	DATA4	10	DATA11
11	DATA3	12	DATA12
13	DATA2	14	DATA13
15	DATA1	16	DATA14
17	DATA0	18	DATA15
19	GND	20	KEY (NO PIN)
21	DRQ	22	GND
23	IOW-	24	GND
25	IOR-	26	GND
27	IOCHRDY	28	CSEL
29	DACK-	30	GND
31	IRQ	32	IOCS16-
33	ADDR1	34	PDIAG-
35	ADDR0	36	ADDR2
37	CS0-	38	CS1-
39	DASP-	40	GND

4. OPERATION

4.1 ACTIVE REMAP™ AND WRITE LIMITATIONS

Unlike mechanical drives, wherein the wear-out mechanism results from starting and stopping the platters and the rotation of the spindle motors, the wear-out mechanism for any solid state flash drive resides in writing to the non-volatile memory, which in Memtech's case is NAND E^2PROM. Writing the to the memory devices requires that electrons be first removed from, and then trapped on the floating gate in each cell using Fowler-Nordheim tunneling techniques. This process is inherently harsh on the oxide layer isolating the floating gate from the silicon substrate in the device, and establishes the write cycle endurance of each cell in a device as specified by the device manufacturer.

To overcome this limitation, Memtech Solid State Flash Drives have been designed with Active Remap™, which, on a detected cell failure, moves the entire failing block to a reserved location and maps the failing block out of active memory. This process is automatic and invisible to the user. It extends the device's useful life almost 100 fold, and makes the Memtech series of Solid State Drives suitable for both read mostly and read/write applications.

In an ongoing effort to determine the durability of the flash components and in turn extend the life of our products, Memtech has also conducted several endurance tests using our flash drives. The results were very encouraging. During testing, done under both benign and harsh operating conditions, Memtech observed and documented an erase/write cycle endurance of 8 to 30 million cycles. This is compared to the flash manufacturer's test and report of only 100,000 to 250,000 erase/write cycles for the flash devices.

Reading the NAND E^2PROM has no adverse effects on the storage cells or oxide layers, and is therefore unlimited.

4.2 ECC

The NRZ data interface used by the IDE controller implements a CRC/ECC mechanism to detect and correct any errors in the data stored in the flash. This polynomial is capable of correcting three 8-bit data bursts in a single sector, and detecting up to six 8-bit error bursts per sector.

An extensive retry algorithm is implemented on the AT3550, so that single event disturbances such as ESD can be readily overcome. Probability of miscorrection is approximately 10^{-20} per bit corrected for a 512-byte field.

4.3 POWER

4.3.1 POWER DOWN

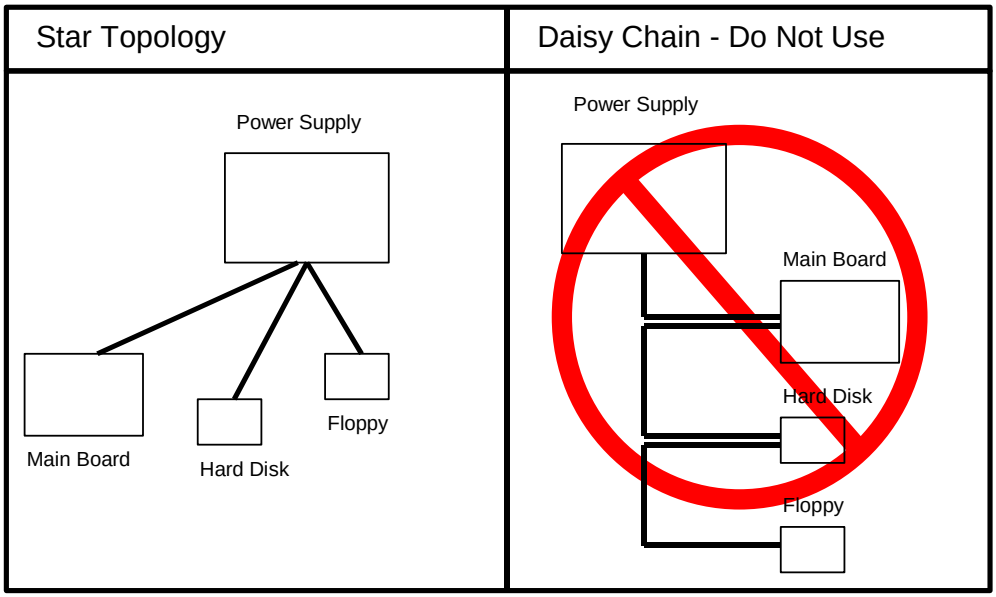
Whenever possible, do not power down the computer during a write command sequence to any mass storage device. This includes during the normal operation of the drive, and with the use of disk cache programs such as Microsft® SmartDrive. If a write routine must interrupted, use the push button reset or a soft reset. Powering down the AT3550 while it is being written may cause an incomplete write sequence, and leave as many as 32 sectors with an Address Mark Found Error or Uncorrectable Errors. DOS will report these with a message "Error Reading Drive C:".

4.3.2 POWER SUPPLY

The AT3550 voltage requirement is specified at +5 volts, +/- 5% on the drive itself. Operation outside of these limits is not guaranteed. Note that the drive will "operate" down to 4 volts, but reliability issues such as Uncorrectable Errors or invalid data reads may occur. An on board voltage monitor will inhibit writes when the supply voltage falls below 4.70 volts, thus preserving data integrity on the drive.

4.3.3 POWER ROUTING

To avoid "glitches" or noise on the Vcc and ground lines, power in the system should be routed so that all peripherals are sourced directly from the power supply as opposed to routing a single continuous supply line to each device in the system as in daisy chaining. Routing power in the star configuration, as is done on most desktop PCs, will minimize the effect of one device's current draw on another device. This is key to maintaining data integrity on the AT3550. See diagrams below.



4.4 TROUBLE SHOOTING GUIDE

4.4.1 SELF-TEST DIAGNOSTIC CODES

The AT3550 has been designed to issue blink codes via the LED in the event of a low-level or catastrophic failure. A blink code of five would be defined as five fast blinks, a pause with no blinks, and a repeat of the process. The drive will not respond to commands or a soft reset when in this state. Only powering down the drive will clear the drive state and restart internal diagnostics.

Blink codes and their associated failure mechanisms are defined below. In the event a blink code is encountered, contact the factory for further assistance.

Number of Blinks	Error
2	ROM Firmware Checksum error
3	ASIC initialization error
4	SRAM Test failed
5	IDE buffer failure
6	IDE controller error
7	NRZ data path error

4.4.2 UNCORRECTABLE ERRORS

If a drive has been subjected to a power down during a write command, or as been run under marginal or dirty power conditions, uncorrectable errors may be introduced into the media. This may result in data read errors, a corrupted FAT table entry or directory, or an invalid boot partition or partition table. Microsoft® Scandisk or Norton Disk Doctor™ will successfully correct FAT table problems and partition table errors, but should not be allowed to mark a sector in the data area as bad. On a rewrite to a data sector with uncorrectable errors, all synchronization and ECC codes will be rewritten and the error will be eliminated.

5. MAINTENANCE

No maintenance is required during the normal use of this drive.

If data is to be archived for long periods of time (> 10 years), it is recommended that the data on the drive be refreshed every 5 to 10 years. The manufacturer of the NAND E^2PROM devices will only guarantee data integrity for a period of 10 years. Programs such as Norton Speedisk©, which reallocates all sectors on the drive, or Microsoft® Scandisk, which writes and reads every sector on the disk during its surface test, achieve this end very well.

6. SPECIFICATIONS

6.1 INTERFACE

IDE Compatibility	ATA6 - T13/1410DR2A
IDE Drive Number	Drive 0 or 1
Raw Physical Capacity	12288 Mbytes under 16mm 61440 Mbytes maximum
Physical Sector Size	512 bytes

6.2 PERFORMANCE

Average Access	0.1 ms
Track/Track Access	0.1 ms
Onboard Cache	16 Mbytes
Cached Read Transfer	26 Mbytes/sec
Cached Write Transfer	20 Mbytes/sec
Read Transfer Rate	9.5 Mbytes/sec sustained
Write Transfer Rate	5.0 Mbytes/sec sustained
Burst Transfers	66 Mbytes/sec

6.3 ENVIRONMENTAL

Commercial Temperature Range	
Operating	0^{o} to 70^{o} C
Storage	-65^{o}C to 125^{o} C
Extended Temperature Range (E)	
Operating	-20^{o}C to 75^{o}C
Storage	-65^{o}C to 125^{o} C
Industrial Temperature Range (I)	
Operating	-40^{o} to 85^{o} C
Storage	-65^{o} to 125^{o} C
Military Temperature Range (M)	
Operating	-55^{o} to 125^{o} C
Storage	-65^{o} to 125^{o} C
Shock - operating	1000G, 0.5ms half sine, MIL-810F, method 516.5
Vibration - operating	15G Random, MIL-810F, method 514.5
Airflow	None required
Humidity	5% to 95% NC (target)

6.4 POWER REQUIREMENTS

Voltage	5V +/- 5%
Current	4 Gbyte drive
Idle	160 mA
Read	350 mA
Write	320 mA

6.5 MECHANICAL

Length	5.750 inches (145.05 mm)
Width	4.006 inches (101.75 mm)
Height -	
Up to 12288 Mbytes	0.630 inches (16.00 mm)
Add. 8192 Mbytes	0.130 inches (3.30 mm)
Cable Interface	40-pin, 0.1”
Max. Cable Length	18 inches (460 mm)
Rec. Cable Length	12 inches (305 mm)
Weight (4 Gbytes)	7.9oz (246g)

6.6 RELIABILITY

6.6.1 ERROR CORRECTION

A programmable 96-bit Reed-Solomon Error Correction and Detection capable of correcting three random byte errors per sector.

6.6.2 MEMORY CELL ENDURANCE

8 million write/erase cycles (excluding ECC and Active Remap™).

6.6.3 DRIVE ENDURANCE

800 million write/erase cycles minimum with ECC and Active Remap™ enabled.

Read endurance is unlimited.

7. APPENDIX

7.1 CONTACT INFORMATION

For Technical Support or Warranty Repair information, please contact Memtech at:

Memtech Technology
7628 Las Positas Road
Livermore, CA U.S.A. 94551
phone: (925) 294-8483
toll free: (800) 445-5511

7.2 ATA SPECIFICATION INFORMATION

Information regarding the ATA6 specification may be obtained from the following locations:

AT-Attachment Document Distribution
Global Engineering
15 Inverness Way East
Englewood, Co. 80112-5704
Phone: (303) 792-2181 or (800) 854-7179
Fax: (303) 792-2192

ATA Anonymous FTP Site
http://fission.dt.wdc.com

7.3 LIMITED LIFETIME WARRANTY

Memtech warrants your AT3550 against defects in material and workmanship for the life of the drive. The warranty is void in the case of misuse, accident, alteration, improper installation, misapplication or the result of unauthorized service or repair.

The implied warranties of merchantability and fitness for a particular purpose, and all other warranties, expressed or implied, except as set forth in this warranty, shall not apply to the products delivered.

In no event shall Memtech be liable for any lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, this product.

BEFORE RETURNING PRODUCT, A RETURN MATERIAL AUTHORIZATION (RMA) MUST BE OBTAINED FROM MEMTECH.

Product shall be returned to Memtech with shipping prepaid. If the product fails to conform and warranty repair is necessary, Memtech will reimburse customer for the transportation charges incurred.