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Medalist 8641, Medalist 6531

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Medalist 4321, Medalist 3221

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Medalist 2110

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Ultra ATA Interface Drives

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Product Manual

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Introduction

This manual describes the functional, mechanical and interface specifications for the Medalist® 8641 (ST38641A), Medalist 6531 (ST36531A), Medalist 4321 (ST34321A), Medalist 3221 (ST33221A) and Medalist 2110 (ST32110A). These drives are referred to throughout this manual by their model numbers. These drives provide the following key features:

- Low power consumption
- Quiet operation
- Support for S.M.A.R.T. drive monitoring and reporting
- High instantaneous (burst) data-transfer rates (up to 33.3 Mbytes per second) using Ultra DMA mode 2
- Full-track multiple-sector transfer capability without local processor intervention
- 128-Kbyte cache
- State-of-the-art caching and on-the-fly error-correction algorithms
- Support for Read Multiple and Write Multiple commands
- Support for autodetection of master/slave drives that use cable select (CSEL)
- MR recording heads and PRML technology, which provides the drives with increased areal density

Specification summary table

The specifications listed in this table are for quick reference. For details on specification measurement or definition, see the appropriate section of this manual.

| Drive Specification | ST38641A | ST36531A | ST34321A | ST33221A | ST32110A |
|---|---|------------|-----------|-----------|-----------|
| Guaranteed Mbytes ($\times 10^6$ bytes) | 8,606 | 6,505 | 4,303 | 3,227 | 2,111 |
| Guaranteed sectors | 16,809,660 | 12,706,470 | 8,404,830 | 6,303,024 | 4,124,736 |
| Bytes per sector | 512 | | | | |
| Default sectors per track | 63 | | | | |
| Default read/write heads | 16 | 15 | 15 | 16 | 16 |
| Default cylinders | 16,383 | 13,446 | 8,894 | 6,253 | 4,092 |
| Physical read/write heads | 8 | 6 | 4 | 4 | 2 |
| Discs | 4 | 3 | 2 | 2 | 1 |
| Recording density (bits/inch max) | 153,870 | | | | |
| Track density (tracks/inch) | 9,190 | | | | |
| Areal density (Mbits/inch ² max) | 1,581 | | | | |
| Spindle speed (RPM) | 5,400 | | | | |
| Internal data-transfer rate (Mbits/sec max) | 140 | | | | |
| I/O data-transfer rate (Mbytes/sec max) | 33.3 | | | | |
| ATA data-transfer modes supported | PIO modes 0, 1, 2, 3, 4; Multiword DMA modes 0, 1, 2; Ultra DMA modes 0, 1, 2 | | | | |
| Cache buffer (Kbytes) | 128 | | | | |
| Height (mm max) | 26.10 | | | | |
| Width (mm max) | 101.85 | | | | |
| Length (mm max) | 147.0 | | | | |

| Drive Specification | ST38641A | ST36531A | ST34321A | ST33221A | ST32110A |
|--|---|-----------------|-----------------|-----------------|-----------------|
| Weight (grams typical) | 544 | | | | |
| Track-to-track seek time (msec typical) | 1.3 (read), 1.7 (write) | | | | |
| Average seek time (msec typical) | 11.0 (read), 11.5 (write) | | | | |
| Full-stroke seek time (msec typical) | 19.8 (read), 20.2 (write) | | | | |
| Average latency (msec) | 5.6 | | | | |
| Power-on to ready (sec typical) | 10 | | | | |
| Standby to ready (sec typical) | 10 | | | | |
| Startup current: 12V (peak) 5V (RMS) | 1.8 amps 0.6 amps | | | | |
| Seek power and current (mean) | 9.1 watts | | | | |
| Read/Write power and current (typical) | 5.5 watts | | | | |
| Idle mode power and current (typical) | 4.9 watts | | | | |
| Standby mode power and current (typical) | 0.9 watts | | | | |
| Sleep mode power and current (typical) | 0.9 watts | | | | |
| Voltage tolerance (including noise) | 5V \pm 5% 12V \pm 8% | | | | |
| Ambient temperature | 5° to 55°C (op.), -40° to 70°C (nonop.) | | | | |
| Temperature gradient (per hour max) | 20°C | | | | |
| Relative humidity (op. and nonop.) | 8% to 90% (op.) 5% to 95% (nonop.) | | | | |

continued

continued from previous page

| Drive Specification | ST38641A | ST36531A | ST34321A | ST33221A | ST32110A |
|---|--|-----------------|-----------------|-----------------|-----------------|
| Relative humidity gradient | 10% per hour max | | | | |
| Wet bulb temperature (max) | 29.4°C (op.), 29.4°C (nonop.) | | | | |
| Altitude (meters below mean sea level, max) | -122 to 3,048 (op.) -122 to 12,192 (nonop.) | | | | |
| Shock, operating (Gs max at 11 msec) | 15 | | | | |
| Shock, nonoperating (Gs max at 11 msec) (Gs max at 2 msec) | 75 200 | | | | |
| Vibration, operating | 0.50 G (0 to peak, 22–350 Hz) | | | | |
| Vibration, nonoperating | 5.0 Gs (0 to peak, 22–350 Hz) | | | | |
| Drive acoustics (bels—sound power) Idle mode (dBA—sound pressure) | 3.5 (typical), 3.9 (max) 30 (typical) | | | | |
| Drive acoustics (bels—sound power) Read/Write mode (dBA—sound pressure) | 4.0 (typical), 4.3 (max) 32 (typical) | | | | |
| Nonrecoverable read errors | 1 per 10 ¹⁴ bits read | | | | |
| Mean time between failures (power-on hours) | 400,000 | | | | |
| Contact start-stop cycles (25°C, 40% relative humidity) | 40,000 | | | | |
| Service life (years) | 5 | | | | |

1.0 Drive specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the ST38641A, ST36531A, ST34321A, ST33221A and the ST32110A.

1.1 Formatted capacity

| Drive Model | Guaranteed Mbytes (1 Mbyte = 10 ⁶ bytes) | Guaranteed sectors | Bytes per sector |
|-------------|--|--------------------|------------------|
| ST38641A | 8,606 | 16,809,660 | 512 |
| ST36531A | 6,505 | 12,706,470 | 512 |
| ST34321A | 4,303 | 8,404,830 | 512 |
| ST33221A | 3,227 | 6,303,024 | 512 |
| ST32110A | 2,111 | 4,124,736 | 512 |

Note. DOS systems cannot access more than 528 Mbytes on a drive unless 1) the host system supports and is configured for LBA addressing or for extended CHS addressing, 2) the host system contains a specialized drive controller, or 3) the host system runs BIOS translation software. Contact your Seagate® representative for details.

1.1.1 Default logical geometry

| CHS Mode | Cylinders | Read/Write heads | Sectors per track |
|----------|-----------|------------------|-------------------|
| ST38641A | 16,383 | 16 | 63 |
| ST36531A | 13,446 | 15 | 63 |
| ST34321A | 8,894 | 15 | 63 |
| ST33221A | 6,253 | 16 | 63 |
| ST32110A | 4,092 | 16 | 63 |

LBA Mode

When addressing either drive in LBA mode, all blocks (sectors) are consecutively numbered from 0 to $n - 1$, where n is the number of guaranteed sectors as defined above.

1.1.2 Supported CHS translation geometries

These drives support any translation geometry that satisfies *all* of the following conditions:

- Sectors per track ≤ 63
- Cylinders $\leq 16,383$ (for drives over 8.4 Gbytes)
- Heads ≤ 16

The ST38641A logical cylinders are:

Logical cylinders=16,809,660 / (logical sectors per track \times logical heads)

The ST36531A logical cylinders are:

Logical cylinders=12,706,470 / (logical sectors per track \times logical heads)

The ST34321A logical cylinders are:

Logical cylinders=8,404,830 / (logical sectors per track \times logical heads)

The ST33221A logical cylinders are:

Logical cylinders=6,303,024 / (logical sectors per track \times logical heads)

The ST32110A logical cylinders are:

Logical cylinders=4,124,736 / (logical sectors per track \times logical heads)

1.2 Physical organization

| Drive Model | Read/Write heads (MR) | Number of discs |
|-------------|-----------------------|-----------------|
| ST38641A | 8 | 4 |
| ST36531A | 6 | 3 |
| ST34321A | 4 | 2 |
| ST33221A | 4 | 2 |
| ST32110A | 2 | 1 |

1.3 Recording and interface technology

| | |
|--|------------------|
| Interface | ATA |
| Recording method | 16/17 (0,14) ZBR |
| Recording density (bits/inch) | 153,870 |
| Track density (tracks/inch) | 9,190 |
| Areal density (Mbits/inch ²) | 1,581 |

| | |
|---|--|
| Spindle speed RPM (± 0.2%) | 5,400 |
| Internal data-transfer rate (Mbits per second max) | 140 |
| I/O data-transfer rate (Mbytes per second max) | 16.6 (PIO mode 4 with IORDY) 16.6 (multiword DMA mode 2) 33.3 (Ultra DMA mode 2) |
| Interleave | 1:1 |
| Cache buffer (Kbytes) | 128 |

1.4 Physical characteristics

| Drive Specification | ST38641A ST36531A | ST34321A ST33221A | ST32110A |
|------------------------------------|----------------------|----------------------|----------|
| Maximum height (mm) (inches) | 26.10 1.028 | | |
| Maximum width (mm) (inches) | 101.85 4.010 | | |
| Maximum length (mm) (inches) | 147.00 5.787 | | |
| Typical weight (grams) (pounds) | 544 1.2 | | |

1.5 Seek time

All seek times are measured using a 486 AT computer (or faster) with an 8.3 MHz I/O bus. The measurements are taken with nominal power at 25°C ambient temperature. All times are measured using drive diagnostics. The specifications in the table on page 8 are defined as follows:

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5,000 measurements of seeks between random tracks, less overhead.
- Full-stroke seek time is one-half the time needed to seek from the first data cylinder to the maximum data cylinder and back to the first data cylinder. The full-stroke typical value is determined by averaging 100 full-stroke seeks in both directions.

| Seek type | Read (msec, typ.) | Write (msec, typ.) |
|------------------|------------------------------|-------------------------------|
| Track-to-track | 1.3 | 1.7 |
| Average | 11.0 | 11.5 |
| Full-stroke | 19.8 | 20.2 |

Average latency: 5.6 msec

Note. These drives are designed to consistently meet the seek times represented in this manual. Physical seeks, regardless of mode (such as track-to-track and average) are expected to meet or exceed the noted values. Due to the manner in which these drives are formatted, however, benchmark tests that include command overhead or measure logical seeks may produce results that vary from these specifications.

1.6 Start/stop times

| | |
|-----------------------------|--------------|
| Power-on to Ready (sec) | 10 (typical) |
| Standby to Ready (sec) | 10 (typical) |
| Ready to spindle stop (sec) | 12 (typical) |

1.7 Power Specifications

The drive receives DC power (+5V or +12V) through a four-pin standard drive power connector.

1.7.1 Power consumption

Power requirements for the drives are listed in the table on page 9. Typical power measurements are based on an average of drives tested under nominal conditions, using 5.0V input voltage at 25°C ambient temperature.

Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.

During seek mode, the read/write actuator arm moves toward a specific position on the disc surface and does not execute a read or write operation. Servo electronics are active. Seek mode power represents the worst case power consumption, using only random seeks with read or write latency time. This mode is not typical and is provided for worst-case information.

Read/Write power and current are measured with the heads on track, based on a 16-sector write followed by a 32-msec delay, then a 16-sector read followed by a 32-msec delay.

Operating power and current are measured using 40 percent random seeks, 40 percent read/write mode (1 write for each 10 reads), and 20 percent drive inactive.

Idle mode power is measured with the drive up to speed, with servo electronics active, and with the heads in a random track location.

During Standby mode, the drive accepts commands, but the drive is not spinning, and the servo and read/write electronics are in power-down mode.

| Mode | Typical Watts RMS | Typical Amps RMS | |
|---------------------------------------|-------------------|------------------|------------|
| | | 5V | 12V |
| Spinup | | 0.6 | 1.8 (Peak) |
| Seeking (Random, no read/write) | 9.1 | 0.5 | 0.55 |
| Read/Write | 5.5 | 0.5 | 0.25 |
| Operating | 5.5 | 0.5 | 0.25 |
| Idle | 4.9 | 0.38 | 0.25 |
| Standby | 0.9 | 0.18 | — |
| Sleep | 0.9 | 0.18 | — |

1.7.1.1 Typical current profile

Figure 1 shows a typical current profile

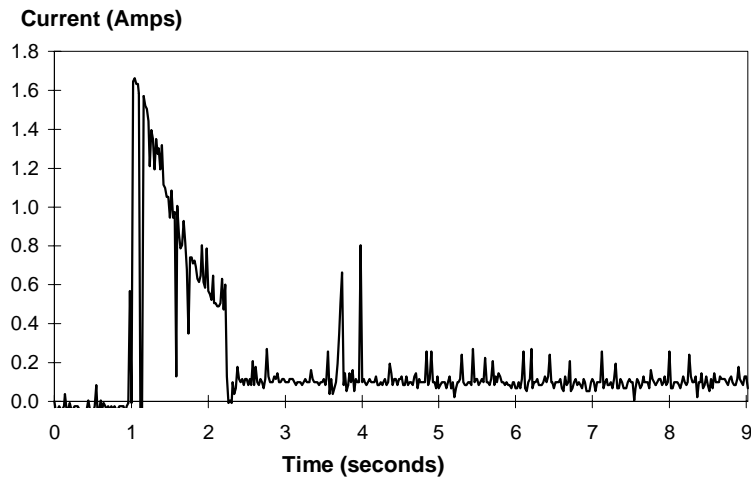


Figure 1. Typical startup and operation current profile

1.7.2 Conducted noise

Input noise ripple is measured at the host system power supply across an equivalent 80-ohm resistive load on the +12 volt line or an equivalent 15-ohm resistive load on the +5 volt line.

- Using 12-volt power, the drive is expected to operate with a maximum of 120 mV peak-to-peak square-wave injected noise at up to 10 MHz.
- Using 5-volt power, the drive is expected to operate with a maximum of 100 mV peak-to-peak square-wave injected noise at up to 10 MHz.

Note. Equivalent resistance is calculated by dividing the nominal voltage by the typical RMS read/write current.

1.7.3 Voltage tolerance

Voltage tolerance (including noise): 5V \pm 5% and 12V \pm 8%

1.7.4 Power-management modes

These drives provide programmable power management to provide greater energy efficiency. In most systems, you can control power management through the system setup program. These Seagate drives feature several power-management modes, which are summarized in the following table and described in more detail below:

| Mode | Heads | Spindle | Buffer |
|-------------|--------------|----------------|---------------|
| Active | Tracking | Rotating | Enabled |
| Idle | Tracking | Rotating | Enabled |
| Standby | Parked | Stopped | Enabled |
| Sleep | Parked | Stopped | Disabled |

Active mode. The drive is in Active mode during the read/write and seek operations.

Idle mode. The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disc access is necessary.

Standby mode. The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disc access is necessary.

Sleep mode. The drive enters Sleep mode after receiving a Sleep command from the host. The heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Active mode with all current translation parameters intact.

Standby timers. Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disc access is necessary.

1.8 Environmental tolerances

1.8.1 Ambient temperature

| | |
|--------------|------------------------------|
| Operating | 5° to 55°C (41° to 131°F) |
| Nonoperating | −40° to 70°C (−40° to 158°F) |

Note. Above 1,000 feet (305 meters), the maximum temperature is derated linearly to 112°F (44°C) at 10,000 feet (3,048 meters). Operating ambient temperature is defined as the temperature of the environment immediately surrounding the drive.

1.8.2 Temperature gradient

| | |
|--------------|---|
| Operating | 20°C/hr (68°F/hr) max, without condensation |
| Nonoperating | 20°C/hr (68°F/hr) max, without condensation |

1.8.3 Humidity

1.8.3.1 Relative Humidity

| | |
|--------------|--|
| Operating | 8% to 90% noncondensing (10% per hour max) |
| Nonoperating | 5% to 95% noncondensing (10% per hour max) |

1.8.3.2 Wet bulb temperature

| | |
|--------------|-------------------|
| Operating | 29.4°C (84°F) max |
| Nonoperating | 29.4°C (84°F) max |

1.8.4 Altitude

| | |
|--------------|--|
| Operating | −122 m to 3,048 m (−400 ft to +10,000 ft) |
| Nonoperating | −122 m to 12,192 m (−400 ft to +40,000 ft) |

1.8.5 Shock

All shock specifications assume that the drive is mounted securely with the input shock applied at the drive mounting screws. Shock may be applied in the X, Y or Z axis.

1.8.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 15.0 Gs (based on half-sine shock pulses of 11 msec). Shocks are not to be repeated more than two times per second.

1.8.5.2 Nonoperating shock

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 75 Gs (based on nonrepetitive half-sine shock pulses of 11 msec duration) or 200 Gs (based on nonrepetitive half-sine shock pulses of 2 msec duration). Shock pulses are defined by MIL-STD-202F.

1.8.6 Vibration

All vibration specifications assume that the drive is mounted securely with the input vibration applied at the drive mounting screws. Vibration may be applied in the X, Y or Z axis.

1.8.6.1 Operating vibration

The following table lists the maximum vibration levels that the drive may experience while meeting the performance standards specified in this document.

| | |
|-----------|---------------------------------------|
| 5–22 Hz | 0.02-inch displacement (peak to peak) |
| 22–350 Hz | 0.50 Gs acceleration (zero to peak) |

1.8.6.2 Nonoperating vibration

The following table lists the maximum nonoperating vibration that the drive may experience without incurring physical damage or degradation in performance when put into operation.

| | |
|-----------|---------------------------------------|
| 5–22 Hz | 0.08-inch displacement (peak to peak) |
| 22–350 Hz | 5.0 Gs acceleration (zero to peak) |

1.9 Drive acoustics

Drive acoustics are measured as overall A-weighted acoustic sound power levels (no pure tones). All measurements are generally consistent with ISO document 7779. Sound power measurements are taken under essentially free-field conditions over a reflecting plane. For all tests, the drive is oriented with the cover facing upward.

For the Seek mode, the drive is placed in seek only. The number of seeks per second is defined by the following equation:

$$\text{Number of seeks per second} = 0.4 / (\text{average latency} + \text{average access time})$$

| Mode | Typical sound power (bels) | Maximum sound power (bels) |
|------------|----------------------------|----------------------------|
| Idle | 3.5 | 3.9 |
| Read/Write | 4.0 | 4.3 |

1.10 Electromagnetic susceptibility

These drives operate without errors when subjected to the following:

| | |
|--------------------------|---------------------------------------|
| Radiated noise | ≤ 3 volt/meter, 30 Hz to 500 MHz |
| Electrostatic discharge* | ≤ 10 KVolts |
| Magnetic field strength | ≤ 5 Gauss |

* Electrostatic discharge susceptibility is measured with the drive mounted in a representative computer system (mounted to a ground plane with earth grounding). Discharges are applied to the bezel or other external surfaces on the ground plane.

1.11 Reliability

| | |
|----------------------------|---|
| Nonrecoverable read errors | 1 per 10^{14} bits read, max |
| Mean time between failures | 400,000 power-on hours (nominal power, 25°C ambient temperature) |
| Contact start-stop cycles | 40,000 cycles (at nominal voltage and temperature, with 60 cycles per hour and a 50% duty cycle) |

1.12 Agency certification

1.12.1 Safety certification

The drives are recognized in accordance with UL 1950 and CSA C22.2 (950) and meet all applicable sections of IEC950 and EN 60950 as tested by TUV North America.

1.12.2 Electromagnetic Compatibility

Hard drives that display the CE marking comply with European Union requirements specified in Electromagnetic Compatibility Directives. Testing is performed to standards EN50082-1 and EN55022-B.

Seagate uses an independent laboratory to confirm compliance with the EC directives specified in the previous paragraph. Drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with the directives when used in the test systems, we cannot guarantee that all systems will comply with the directives. The drive is designed for operation inside a properly designed enclosure, with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for their products.

Australian C-Tick

If this model has the C-Tick marking, it complies with the Australia/New Zealand Standard AS/NZS3548 1995 and meets the Electromagnetic Compatibility (EMC) Framework requirements of Australia's Spectrum Management Agency (SMA).

1.12.3 FCC verification

These drives are intended to be contained solely within a personal computer or similar enclosure (not attached as an external device). As such, each drive is considered to be a subassembly even when it is individually marketed to the customer. As a subassembly, no Federal Communications Commission verification or certification of the device is required.

Seagate Technology, Inc. has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disc drive, motherboard, power supply, etc.) does comply with the limits for a Class B computing device, pursuant to Subpart J, Part 15 of the FCC rules. Operation with noncertified assemblies is likely to result in interference to radio and television reception.

Radio and Television Interference. This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception.

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, you are encouraged to try one or more of the following corrective measures:

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

2.0 Drive mounting and configuration

2.1 Handling and static-discharge precautions

After unpacking, and before installation, the drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. Observe standard static-discharge precautions. A grounded wrist-strap is preferred.

Handle the drive only by the sides of the head/disc assembly. Avoid contact with the printed circuit board, all electronic components and the interface connector. Do not apply pressure to the top cover of the drive. Always rest the drive on a padded antistatic surface until you mount it in the host system.

2.2 Jumper settings

2.2.1 Master/slave configuration

You must establish a master/slave relationship between two drives that are attached to a single AT bus. You can configure a drive to be a master or slave by setting the master/slave jumpers, shown in Figure 2 on page 18.

These drives support master/slave configuration using the cable select option. This requires a special daisy-chain cable that grounds pin 28 (CSEL) on one of its two drive connectors. If you attach the drive to the grounded CSEL connector, it becomes a master. If you attach the drive to the ungrounded CSEL connector, it becomes a slave. To use this option, the host system and both drives must support cable select, and both drives must be configured for cable select. To configure this drive for cable select, install a jumper as shown in Figure 2.

For the master drive to recognize the slave drive using the DASP– signal, the slave drive must assert the DASP– signal at power up, and the master drive must monitor DASP– at power up.

2.2.2 Alternate capacity jumper

Some older computers may “hang” if their BIOS detects a hard drive that has more than 4,092 cylinders at startup. To allow these computers to recognize the ST38641A, the ST36531A, the ST34321 or the ST33221A, these drives include a capacity-limiting jumper, which sets the drive’s default translation geometry to 4,092 cylinders. This limits the drive’s capacity to 2.1 Gbytes, unless third-party software is used.

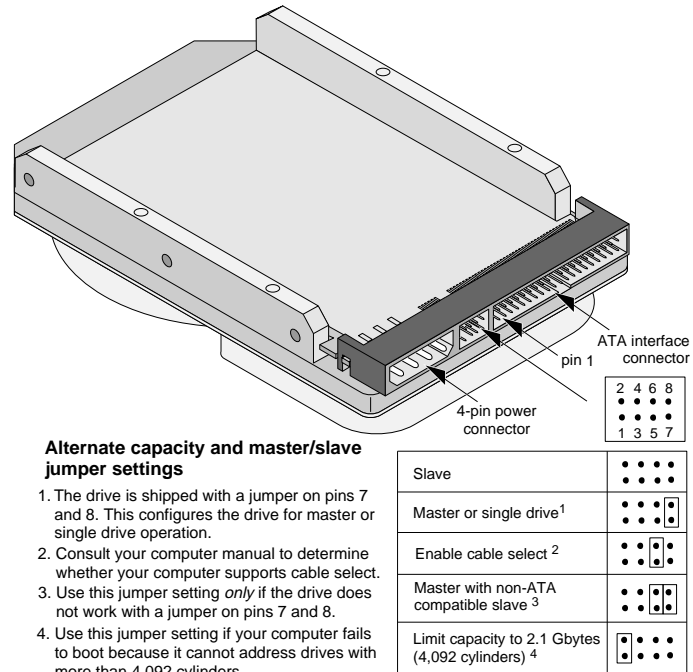


Figure 2. Alternate capacity jumper and master/slave jumpers

2.3 Drive mounting

You can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See Figure 3 for drive mounting dimensions.

Important mounting precautions:

- Allow a minimum clearance of 0.030 inches (0.76 mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.22 inch (5.58 mm) into the bottom mounting holes and no more than 0.20 inch (5.0 mm) into the side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 3 inch-lb, 0.34 N.m, 3.45 kgf.cm).
- Do not use a drive interface cable that is more than 18 inches (457 mm) long.

Note. Dimensions are shown in mm (inches)

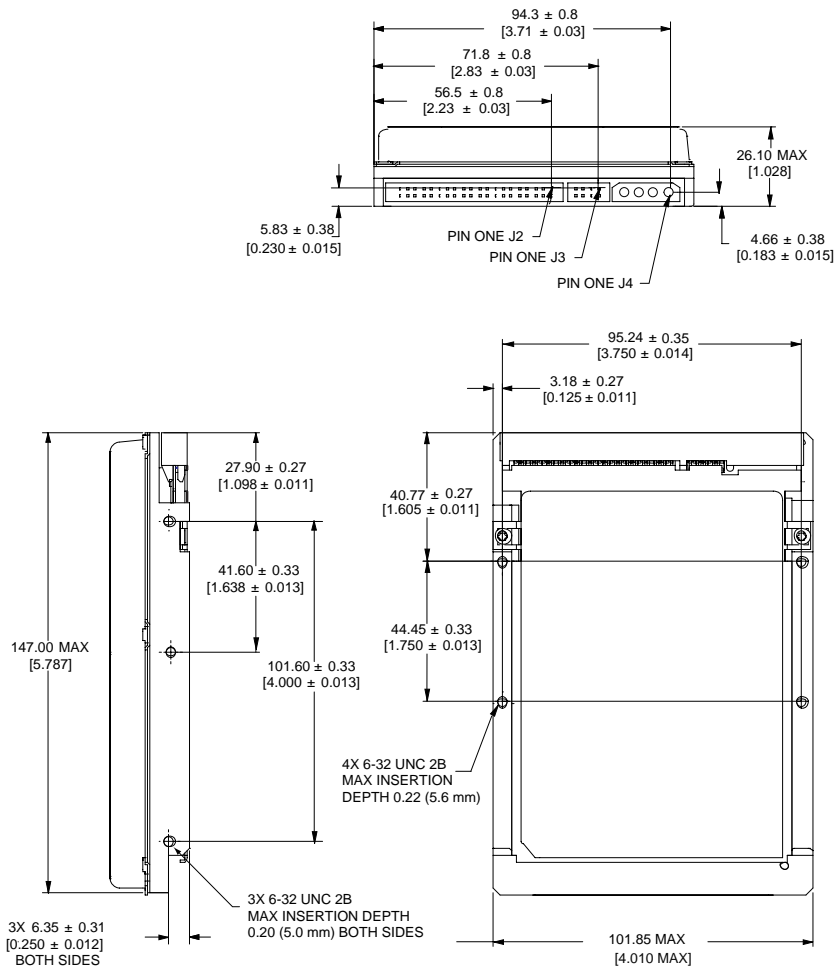


Figure 3. Mounting dimensions—top, side and end view

3.0 ATA interface

These drives use the industry-standard ATA task file interface that supports 16-bit data transfers. It supports ATA programmed input/output (PIO) modes 0, 1, 2, 3 and 4; multiword DMA modes 0, 1 and 2; and Ultra DMA modes 0, 1 and 2. The drive also supports the use of the IORDY signal to provide reliable high-speed data transfers.

You can use a daisy-chain cable to connect two drives to a single AT host bus. For detailed information regarding the ATA interface, refer to the draft of *AT Attachment with Packet Interface Extension (ATA/ATAPI-4)*, *NCITS T13 1153D*, subsequently referred to as the *Draft ATA-4 Standard*.

3.1 ATA interface signals and connector pins

Figure 4 on page 22 summarizes the signals on the ATA interface connector that the drive supports. For a detailed description of these signals, refer to the *Draft ATA-4 Standard*.

| Drive pin # | Signal name | Host pin # and signal description |
|-------------|-------------|--|
| 1 | Reset- | 1 Hardware Reset |
| 2 | Ground | 2 Ground |
| 3 | DD7 | 3 Host Data Bus Bit 7 |
| 4 | DD8 | 4 Host Data Bus Bit 8 |
| 5 | DD6 | 5 Host Data Bus Bit 6 |
| 6 | DD9 | 6 Host Data Bus Bit 9 |
| 7 | DD5 | 7 Host Data Bus Bit 5 |
| 8 | DD10 | 8 Host Data Bus Bit 10 |
| 9 | DD4 | 9 Host Data Bus Bit 4 |
| 10 | DD11 | 10 Host Data Bus Bit 11 |
| 11 | DD3 | 11 Host Data Bus Bit 3 |
| 12 | DD12 | 12 Host Data Bus Bit 12 |
| 13 | DD2 | 13 Host Data Bus Bit 2 |
| 14 | DD13 | 14 Host Data Bus Bit 13 |
| 15 | DD1 | 15 Host Data Bus Bit 1 |
| 16 | DD14 | 16 Host Data Bus Bit 14 |
| 17 | DD0 | 17 Host Data Bus Bit 0 |
| 18 | DD15 | 18 Device Data (15:0) |
| 19 | Ground | 19 Ground |
| 20 | (removed) | 20 (No Pin) |
| 21 | DMARQ | 21 DMA Request |
| 22 | Ground | 22 Ground |
| 23 | DIOW- | 23 Device I/O Write: Stop Ultra DMA Burst |
| 24 | STOP | 24 Ground |
| 25 | DIOR- | 25 Device I/O Read: Host Ultra DMA Ready: Host Ultra DMA Data Strobe |
| 26 | HDMARDY- | 26 Ground |
| 27 | HSTROBE | 27 I/O Channel Ready |
| 28 | Ground | 28 Cable Select |
| 29 | DMACK- | 29 DMA Acknowledge |
| 30 | Ground | 30 Ground |
| 31 | INTRQ | 31 Device Interrupt |
| 32 | IOCS16- | 32 Reserved |
| 33 | DA1 | 33 Host Address Bus Bit 1 |
| 34 | PDIAG- | 34 Passed Diagnostics |
| 35 | DA0 | 35 Device Address (2:0) |
| 36 | DA2 | 36 Device Address (2:0) |
| 37 | CS0- | 37 Chip Select (1:0) |
| 38 | CS1- | 38 Chip Select (1:0) |
| 39 | DASP- | 39 Drive Active / Slave Present |
| 40 | Ground | 40 Ground |

Pins 28, 34 and 39 are used for master-slave communication (details shown below).

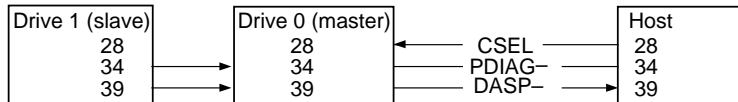


Figure 4. I/O pins and supported ATA signals

3.2 ATA Interface commands

3.2.1 Supported ATA commands

The following table lists ATA-standard commands that the drive supports. For a detailed description of the ATA commands, refer to the *Draft ATA-4 Standard*. See Section 3.2.4 on page 30 for details and subcommands used in the S.M.A.R.T. implementation.

| Command name | Command code | Supported by ST38641A, ST36531A, ST34321A, ST33221A, ST32110A |
|------------------------------|-----------------|--|
| ATA-standard commands | | |
| Download Microcode | 92H | Yes |
| Execute Device Diagnostic | 90H | Yes |
| Flush Cache | E7H | Yes |
| Format Track | 50H | Yes |
| Identify Device | EC _H | Yes |
| Initialize Device Parameters | 91H | Yes |
| Read Buffer | E4H | Yes |
| Read DMA | C8H, C9H | Yes |
| Read Multiple | C4H | Yes |
| Read Sectors | 20H, 21H | Yes |
| Read Verify Sectors | 40H, 41H | Yes |
| Recalibrate | 10H | Yes |
| Seek | 70H | Yes |
| Set Features | EFH | Yes |
| Set Multiple Mode | C6H | Yes |
| S.M.A.R.T. | B0H | Yes |

continued

continued from previous page

| Command name | Command code | Supported by ST38641A, ST36531A, ST34321A, ST33221A, ST32110A |
|---|------------------------------------|--|
| Write Buffer | E8 _H | Yes |
| Write DMA | CA _H , CB _H | Yes |
| Write Multiple | C5 _H | Yes |
| Write Sectors | 30 _H , 31 _H | Yes |
| ATA-standard power-management commands | | |
| Check Power Mode | 98 _H or E5 _H | Yes |
| Idle | 97 _H or E3 _H | Yes |
| Idle Immediate | 95 _H or E1 _H | Yes |
| Sleep | 99 _H or E6 _H | Yes |
| Standby | 96 _H or E2 _H | Yes |
| Standby Immediate | 94 _H or E0 _H | Yes |

The following commands contain drive-specific features that may not be described in the *Draft ATA-4 Standard*.

3.2.2 Identify Drive command

The Identify Drive command (command code ECH) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in the table below. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive. See Section 1 of this manual for default parameter settings.

Note. If the alternate capacity jumper is installed on these drives, the drive capacity is reduced in word 1 to 4,092 cylinders.

| Word | Description | Contents |
|------|---|---|
| 0 | Configuration information: <ul style="list-style-type: none"> • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved | 0C5AH |
| 1 | Number of logical cylinders: 16,383 (ST38641A) 13,446 (ST36531A) 8,894 (ST34321A) 6,253 (ST33221A) 4,092 (ST32110A) | 3FFFH (ST38641A) 3486H (ST36531A) 22BEH (ST34321A) 186DH (ST33221A) 0FFCH (ST32110A) |
| 2 | ATA-reserved | 0000H |
| 3 | Number of logical heads: 15 (ST36531A, ST34321A) 16 (ST38641A, ST33221A, ST32110A) | 000FH (ST36531A) (ST34321A) 0010H (ST38641A) (ST33221A) (ST32110A) |
| 4 | Retired | 0000H |

continued

| Word | Description | Contents |
|-------|---|--|
| 5 | Retired | 0000H |
| 6 | Number of logical sectors per logical track: 63 | 003FH |
| 7–9 | Retired | 0000H |
| 10–19 | Serial number: (20 ASCII characters, 0000H = none) | ASCII |
| 20 | Retired | 0000H |
| 21 | Retired | 0100H |
| 22 | Obsolete | 0000H |
| 23–26 | Firmware revision (8 ASCII character string, padded with blanks to end of string) | x.xx |
| 27–46 | Drive model number: (40 ASCII characters, padded with blanks to end of string) | ST38641A ST36531A ST34321A ST33221A ST32110A |
| 47 | (Bits 7–0) Maximum sectors per interrupt on Read Multiple and Write Multiple (64) | 8020H |
| 48 | Reserved | 0000H |
| 49 | Standard Standby timer, IORDY supported and may be disabled | 2F00H |
| 50 | ATA-reserved | 0000H |
| 51 | PIO data-transfer cycle timing mode | 0200H |
| 52 | Retired | 0200H |
| 53 | Words 54–58, 64–70 and 88 are valid | 0007H |
| 54 | Number of current logical cylinders | xxxxH |
| 55 | Number of current logical heads | xxxxH |
| 56 | Number of current logical sectors per logical track | xxxxH |
| 57–58 | Current capacity in sectors | xxxxH |

| Word | Description | Contents |
|-------|---|---|
| 59 | Number of sectors transferred during a Read Multiple or Write Multiple command | xxxxH |
| 60–61 | Total number of user-addressable LBA sectors available: 16,809,660 (ST38641A) 12,706,470 (ST36531A) 8,404,830 (ST34321A) 6,303,024 (ST33221A) 4,124,736 (ST32110A) | 7EBC _H 0100 _H (ST38641A) E2A6 _H 00C1 _H (ST36531A) 3F5E _H 0080 _H (ST34321A) 2D30 _H 0060 _H (ST33221A) F040 _H 003E _H (ST32110A) |
| 62 | Retired | 0000 _H |
| 63 | Multiword DMA active and modes supported (see note following this table) | xx07 _H |
| 64 | Advanced PIO modes supported (modes 3 and 4 supported) | 0003 _H |
| 65 | Minimum multiword DMA transfer cycle time per word (120 nsec) | 0078 _H |
| 66 | Recommended multiword DMA transfer cycle time per word (120 nsec) | 0078 _H |
| 67 | Minimum PIO cycle time without IORDY flow control (240 nsec) | 00F0 _H |
| 68 | Minimum PIO cycle time with IORDY flow control (120 nsec) | 0078 _H |
| 69–74 | ATA-reserved | 0000 _H |
| 75 | Queue depth | 0000 _H |
| 76–79 | ATA-reserved | 0000 _H |
| 80 | Major version number | 001E _H |
| 81 | Minor version number | 0000 _H |
| 82 | Command sets supported | 3069 _H |
| 83 | Command sets supported | 4001 _H |

continued

| Word | Description | Contents |
|---------|------------------------------------|-------------------|
| 84 | Command sets support extension | 4000 _H |
| 85 | Command sets enabled | 30xx _H |
| 86 | Command sets enabled | 0001 _H |
| 87 | Command sets enable extension | 4000 _H |
| 88 | Ultra DMA support and current mode | 0x07 _H |
| 89 | Security erase time | 0000 _H |
| 90 | Enhanced security erase time | 0000 _H |
| 91–127 | ATA-reserved | 0000 _H |
| 128 | Security status | 0000 _H |
| 129–159 | Seagate-reserved | xxxx _H |
| 160–255 | ATA-reserved | 0000 _H |

Note. The following Multiword DMA and Ultra DMA mode settings are used in words 63 and 88, respectively, of the Identify Drive data:

Description (if bit is set to 1)

Bit Word 63

- 0 Multiword DMA mode 0 is supported.
- 1 Multiword DMA mode 1 is supported.
- 2 Multiword DMA mode 2 is supported.
- 8 Multiword DMA mode 0 is currently active.
- 9 Multiword DMA mode 1 is currently active.
- 10 Multiword DMA mode 2 is currently active.

Bit Word 88

- 0 Ultra DMA mode 0 is supported.
- 1 Ultra DMA mode 1 is supported.
- 2 Ultra DMA mode 2 is supported.
- 8 Ultra DMA mode 0 is currently active.
- 9 Ultra DMA mode 1 is currently active.
- 10 Ultra DMA mode 2 is currently active.

3.2.3 Set Features command

This command controls the implementation of various features that the drive supports. When the drive receives this command, it sets BSY, checks the contents of the Features register, clears BSY and generates an interrupt. If the value in the register does not represent a feature that the drive supports, the command is aborted. Power-on default has the read look-ahead and write caching features enabled. The acceptable values for the Features register are defined as follows:

- 02H Enable write cache (*default*)
- 03H Set transfer mode (based on value in Sector Count register)
Sector Count register values:
 - 00H Set PIO mode to default (PIO mode 2)
 - 01H Set PIO mode to default and disable IORDY (PIO mode 2)
 - 08H PIO mode 0
 - 09H PIO mode 1
 - 0AH PIO mode 2 (*default*)
 - 0BH PIO mode 3
 - 0CH PIO mode 4
 - 20H Multiword DMA mode 0
 - 21H Multiword DMA mode 1
 - 22H Multiword DMA mode 2
 - 40H Ultra DMA mode 0
 - 41H Ultra DMA mode 1
 - 42H Ultra DMA mode 2
- 55H Disable read look-ahead (read cache) feature
- 82H Disable write cache
- AAH Enable read look-ahead (read cache) feature (*default*)
- F1H Report full capacity available

At power-on, or after a hardware reset, the default values of the features are as indicated above. A software reset also changes the features to the default values.

3.2.4 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disc drives. When S.M.A.R.T. is enabled, the drive monitors predetermined drive attributes that are susceptible to degradation over time. If self-monitoring determines that a failure is likely, S.M.A.R.T. makes a status report available to the host. Not all failures are predictable. S.M.A.R.T. predictability is limited to the attributes the drive can monitor. For more information on S.M.A.R.T. commands and implementation, see the *Draft ATA-4 Standard*.

These drives are shipped with S.M.A.R.T. features disabled. You must have a recent BIOS or software package that supports S.M.A.R.T. to enable the feature. The table below shows the S.M.A.R.T. command codes that these drives use.

| Code in Features Register | S.M.A.R.T. Command | Supported by ST38641A ST36531A ST34321A ST33221A ST32110A |
|---------------------------|--|--|
| D0H | S.M.A.R.T. Read Data | Yes |
| D1H | Vendor-specific | Yes |
| D2H | S.M.A.R.T. Enable/Disable Attribute Autosave | Yes |
| D3H | S.M.A.R.T. Save Attribute Values | Yes |
| D4H | S.M.A.R.T. Execute Off-line Immediate | Yes |
| D7H | Vendor-specific | Yes |
| D8H | S.M.A.R.T. Enable Operations | Yes |
| D9H | S.M.A.R.T. Disable Operations | Yes |
| DAH | S.M.A.R.T. Return Status | Yes |

Note. If an appropriate code is not written to the Features Register, the command is aborted and 0x04 (abort) is written to the Error register.



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