Chapter 4
SPECIFICATIONS

This chapter gives a detailed description of the physical, electrical, and environmental characteristics of the Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT hard disk drives.

4.1 SPECIFICATION SUMMARY

The Quantum Fireball TM 1080/2110AT hard disk drives utilize a 1080 MB per disk format. The Quantum Fireball TM 1280/1700/2550/3200/3840AT hard disk drives utilize a 1280 MB per disk format.

Table 4-1 gives a summary of the Quantum Fireball TM series of hard disk drives.

Table 4-1 *Specifications*

DESCRIPTION	QUANTUM FIREBALL TM HARD DISK DRIVES						
	1080AT	**1280AT**	**1700AT**	**2110AT**	**2550AT**	**3200AT**	**3840AT**
Formatted Capacity	1089.9MB	1281.9MB	1707.7MB	2111.8MB	2564.5MB	3216.3MB	3860.4MB
Nominal rotational speed (rpm)	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Number of Disks	1	1	2	2	2	3	3
Number of R/W heads	2	2	3	4	4	5	6
Data Organization:							
Zones per surface	15	15	15	15	15	15	15
Tracks per surface	6,810	6,810	6,810	6,810	6,810	6,810	6,810
Total tracks	13,620	13,620	20,430	27,240	27,240	34,050	40,860
Sectors per track:							
Inside zone	104	122	122	104	122	122	122
Outside zone	210	232	232	210	232	232	232
Total User Sectors	2,128,896	2,503,872	3,335,972	4,124,736	5,008,752	6,281,856	7,539,840
Bytes per sector	512	512	512	512	512	512	512
Number of tracks per cylinder	2	2	3	4	4	5	6

DESCRIPTION	QUANTUM FIREBALL TM HARD DISK DRIVES						
	1080AT	**1280AT**	**1700AT**	**2110AT**	**2550AT**	**3200AT**	**3840AT**
Recording:							
Recording technology	Multiple Zone	Multiple Zone	Multiple Zone	Multiple Zone	Multiple Zone	Multiple Zone	Multiple Zone
Maximum linear density	122,000 fci	139,000 fci	139,000 fci	122,000 fci	139,000 fci	139,000 fci	139,000 fci
Encoding method	16/17 PRML	16/17 PRML	16/17 PRML	16/17 PRML	16/17 PRML	16/17 PRML	16/17 PRML
Interleave	1:1	1:1	1:1	1:1	1:1	1:1	1:1
Track density	6,775 tpi	6,775 tpi	6,775 tpi	6,775 tpi	6,775 tpi	6,775 tpi	6,775 tpi
Maximum effective areal density	765.5 Mbits/in^2	887.5 Mbits/in^2	887.5 Mbits/in^2	765.5 Mbits/in^2	887.5 Mbits/in^2	887.5 Mbits/in^2	887.5 Mbits/in^2
Performance:							
Seek times:							
Read-on-arrival							
Typical	12.0 ms	12.0 ms	10.5 ms	10.5 ms	10.5 ms	10.5 ms	10.5 ms
Maximum	15.0 ms	15.0 ms	12.0 ms	12.0 ms	12.0 ms	12.0 ms	12.0 ms
Track-to-track							
Typical	3.0 ms	3.0 ms	3.0 ms	3.0 ms	3.0 ms	3.0 ms	3.0 ms
Maximum	4.0 ms	4.0 ms	4.0 ms	4.0 ms	4.0 ms	4.0 ms	4.0 ms
Average write							
Typical	14.0 ms	14.0 ms	12.0 ms	12.0 ms	12.0 ms	12.0 ms	12.0 ms
Maximum	17.0 ms	17.0 ms	14.0 ms	14.0 ms	14.0 ms	14.0 ms	14.0 ms
Full stroke							
Typical	21.0 ms	21.0 ms	18.0 ms	18.0 ms	18.0 ms	18.0 ms	18.0 ms
Maximum	27.0 ms	27.0 ms	23.0 ms	23.0 ms	23.0 ms	23.0 ms	23.0 ms
Data transfer Rates:							
Disk to Read Buffer[1]							
MB/sec. Minimum	5.6	5.6	5.6	5.6	5.6	5.6	5.6
MB/sec. Maximum	10.7	10.7	10.7	10.7	10.7	10.7	10.7
Read Buffer to IDE Bus (PIO Mode without IORDY)	6.67 MB/sec. maximum	6.67 MB/sec. maximum	6.67 MB/sec. maximum	6.67 MB/sec. maximum	6.67 MB/sec. maximum	6.67 MB/sec. maximum	6.67 MB/sec. maximum
Read Buffer to IDE Bus (PIO Mode with IORDY)	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum
Read Buffer to IDE Bus (DMA Mode)	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum	16.67 MB/sec. maximum
Buffer Size	128 KB	128 KB	128 KB	128 KB	128 KB	128 KB	128 KB
Reliability:							
Seek error rate[2]	1 in 10^6	1 in 10^6	1 in 10^6	1 in 10^6	1 in 10^6	1 in 10^6	1 in 10^6
Unrecoverable error rate[2]	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}

DESCRIPTION	QUANTUM FIREBALL TM HARD DISK DRIVES						
	1080AT	**1280AT**	**1700AT**	**2110AT**	**2550AT**	**3200AT**	**3840AT**
Error correction method (with cross check)	224-bit Reed-Solomon	224-bit Reed-Solomon	224-bit Reed-Solomon	224-bit Reed-Solomon	224-bit Reed-Solomon	224-bit Reed-Solomon	224-bit Reed-Solomon
Projected MTBF	400,000 hrs	400,000 hrs	400,000 hrs	400,000 hrs	400,000 hrs	400,000 hrs	400,000 hrs
Contact Start/Stop Cycles[3]	40,000 min.	40,000 min.	40,000 min.	40,000 min.	40,000 min.	40,000 min.	40,000 min.
Auto head-park method	AirLock®	AirLock®	AirLock®	AirLock®	AirLock®	AirLock®	AirLock®

1. Disk to read buffer transfer rate is zone-dependent.
2. Refer to Section 4.11, “DISK ERRORS” for details on error rate definitions.
3. CSS specifications assumes a duty cycle of one power off operation for every four idle spin down.

4.2 FORMATTED CAPACITY

At the factory, the Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT hard disk drive receives a low-level format that creates the actual tracks and sectors on the drive. Table 4-2 shows the capacity resulting from this process. Formatting done at the user level, for operation with DOS, UNIX, or other operating systems, will result in less capacity than the physical capacity shown in Table 4-2.

Table 4-2 *Formatted Capacity*

	QUANTUM FIREBALL TM HARD DISK DRIVES						
	1080AT	**1280AT**	**1700AT**	**2110AT***	**2550AT**	**3200AT**	**3840AT**
Formatted Capacity (MB)	1089.9	1281.9	1707.7	2111.8	2564.5	3216.3	3860.4
Number of 512-byte sectors available	2,128,896	2,503,872	3,335,972	4,124,736	5,008,752	6,281,856	7,539,840

Note: * The AT capacity is artificially limited to a 2.1 GB partition boundary.

4.3 DATA TRANSFER RATES

Data is transferred from the disk to the read buffer at a rate of up to 10.4 MB/s (83 Mbits/s) in bursts. Data is transferred from the read buffer to the IDE bus at a rate of up to 6.67 MB/sec using programmed I/O without IORDY, up to 16.67 MB/s using programmed I/O with IORDY, or at a rate of up to 16.67 MB/s using multiword DMA. For more detailed information on interface timing, refer to Chapter 6.

4.4 TIMING SPECIFICATIONS

Table 4-3 illustrates the timing specifications of the Quantum Fireball TM series of hard disk drives.

Table 4-3 *Timing Specifications*

PARAMETER	TYPICAL NOMINAL[1]	WORST CASE[2]
Sequential Cylinder Switch Time[3]	3.0 ms	4.0 ms
Sequential Head Switch Time[4]	3.0 ms	4.0 ms
Random Average (Read or Seek)	12.0 ms for one-disk drives 10.5 ms for two-disk drives 10.5 ms for three-disk drives	15.0 ms for one-disk drives 12.0 ms for two-disk drives 12.0 ms for three-disk drives
Random Average (Write)	14.0 ms for one-disk drives 12.0 ms for two -isk drives 12.0 ms for three-disk drives	17.0 ms for one-disk drives 14.0 ms for two-disk drives 14.0 ms for three-disk drives
Full-Stroke Seek	21.0 ms for one-disk drives 18.0 ms for two-disk drives 18.0 ms for three-disk drives	27.0 ms for one-disk drives 23.0 ms for two-disk drives 23.0 ms for three-disk drives
Average Rotational Latency	6.67 ms	—
Power On[5] to Drive Ready[6]	10.7 seconds	15.0 seconds
Standby[7] to Interface Ready	4.5 seconds	5.5 seconds
Drive Ready to Power Down	10.0 seconds	12.5 seconds[8]

1. Nominal conditions are as follows:
   - Nominal temperature 77˚F (25˚C)
   - Nominal supply voltages (12.0V, 5.0V)
   - No applied shock or vibration
2. Worst case conditions are as follows:
   - Worst case temperature extremes 32 to 131˚F (0˚C to 55˚C)
   - Worst case supply voltages (12.0V ±10%, 5.0 V ±5%)
3. Sequential Cylinder Switch Time is the time from the conclusion of the last sector of a cylinder to the first logical sector on the next cylinder.
4. Sequential Head Switch Time is the time from the last sector of a track to the beginning of the first logical sector of the next track of the same cylinder.
5. Power On is the time from when the supply voltages reach operating range to when the drive is ready to accept any command.
6. Drive Ready is the condition in which the disks are rotating at the rated speed and the drive is able to accept and execute commands requiring disk access without further delay at power or start up. Error recovery routines may extend the time to as long as 30 seconds for drive ready.

7. Standby is the condition at which the microprocessor is powered, but not the HDA. When the host sends the drive a shutdown command, the drive parks the heads away from the data zone, and spins down to a complete stop.
8. After 20 seconds it is safe to move the disk drive.

4.5 POWER

The Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT hard disk drives operate from two supply voltages:

- +12V ±10%
- +5V ±5%

The allowable ripple and noise is 250 mV peak-to-peak for the +12 Volt supply and 100 mV peak-to-peak for the +5 Volt supply.

4.5.1 Power Sequencing

You may apply the power in any order or manner, or open either the power or power return line with no loss of data or damage to the disk drive. However, data may be lost in the sector being written at the time of power loss. The drive can withstand transient voltages of +10% to –100% from nominal while powering up or down.

4.5.2 Power Reset Limits

When powering up, the drive remains reset until both V_{HT} reset limits in Table 4-4 are exceeded. When powering down, the drive becomes reset when either supply voltage drops below the V_{LT} threshold.

Table 4-4 *Power Reset Limits*

DC VOLTAGE	THRESHOLD	HYSTERESIS
+5 V	V_{LT} = 4.65V maximum, 4.40V minimum V_{HT} = 4.65V maximum, 4.40V minimum	50.0 mV (typical)
+12 V	V_{LT} = 9.42V maximum, 8.70V minimum V_{HT} = 9.40V maximum, 8.70V minimum	100.0 mV (typical)

4.5.3 Power Requirements

Table 4-5 lists the voltages and typical average corresponding currents for the various modes of operation of the Quantum Fireball TM series of hard disk drives.

Table 4-5 *Typical Power and Current Consumption*

MODE OF OPERATION	TYPICAL AVERAGE CURRENT[1] (mA RMS UNLESS OTHERWISE NOTED)						TYPICAL AVERAGE POWER[2] (WATTS)		
	+12V			+5V					
MODEL NUMBER	One-Disk Drive	Two-Disk Drive	Three-Disk Drive	One-Disk Drive	Two-Disk Drive	Three-Disk Drive	One-Disk Drive	Two-Disk Drive	Three-Disk Drive
Startup[1] (peak)	1350	1330	1350	460	540	540	19.0	19.0	19.0
Idle[3]	150	170	190	450	450	470	4.0	4.5	5.0
Read/Write/ Seek[4]	350	350	380	570	570	570	7.0	7.0	7.5
Maximum Seeking[5]	700	630	660	510	490	490	11.0	10.5	10.5
Standby[6]	8	6	13	240	260	270	1.5	1.5	1.5
Sleep	7	6	6	140	160	180	1.0	1.0	1.0
Read/Write/ Ontrack[7]	150	160	190	620	620	620	5.0	5.0	5.5

1. Current is rms except for startup. Startup current is the peak current of the peaks greater than 10 ms in duration.
2. Power requirements reflect nominal for +12V and +5V power.
3. Idle mode is in effect when the drive is not reading, writing, seeking, or executing any commands. A portion of the R/W circuitry is powered down, the motor is up to speed and the Drive Ready condition exists.The actuator resides on the last track accessed.
4. Read/Write/Seek mode is defined as when data is being read from or written to the disk. It is computed based on 40% seeking, 30% on-track read, and 30% on-track write.
5. Maximum seeking is defined as continuous random seek operations with minimum controller delay.
6. Standby mode is defined as when the motor is stopped, the actuator is parked, and all electronics except the interface control are in low power state. Standby occurs after a programmable time-out after the last host access. Drive ready and seek complete status exist. The drive leaves standby upon receipt of a command that requires disk access or upon receiving a spinup command.
7. Sleep is defined as when the spindle and actuator motors are off and the heads are latched in the landing zone. Receipt of a reset causes the drive to transition from the sleep to the standby mode.

8. Read/Write On Track is defined as 50% read operations and 50% write operations on a single physical track.

4.6 ACOUSTICS

Table 4-6 and Table 4-7 specify the acoustical characteristics of the Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT hard disk drives.

Table 4-6 *Acoustical Characteristics—Sound Pressure*

OPERATING MODE	MEASURED NOISE (SOUND PRESSURE)		DISTANCE
	One Disk Drives	Two and Three Disk Drives	
Idle On Track	30 dBA (typical) 35 dBA (maximum)	32 dBA (typical) 35 dBA (maximum)	39.3 in (1 m)

Table 4-7 *Acoustical Characteristics—Sound Power*

OPERATING MODE	MEASURED NOISE (SOUND POWER PER ISO 7779)	
	One Disk Drives	Two and Three Disk Drives
Idle On Track	3.5 Bels (typical) 3.9 Bels (maximum)	3.6 Bels (typical) 3.9 Bels (maximum)

4.7 MECHANICAL DIMENSIONS

Height: 1.0 in.	(25.4 mm)	
Width: 4.0 in.	(101.6 mm)	
Depth: 5.75 in.	(146.1 mm)	
Weight:	One-Disk	12.2 Oz.
	Two-Disks	17.6 Oz.
	Three-Disks	18.1 Oz.

Note: All dimensions are exclusive of any optional faceplate.

4.8 ENVIRONMENTAL CONDITIONS

Table 4-8 summarizes the environmental specifications of the Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT hard disk drives.

Table 4-8 *Environmental Specifications*

PARAMETER	OPERATING	NON-OPERATING
Temperature (Non-condensing)	0˚ to 55˚C (32˚ to 131˚F)	-40˚ to 65˚C (-40˚ to 149˚F)
Temperature Gradient (Non-condensing)	24˚C/hr maximum (75.2˚F/hr)	48˚C/hr maximum (118.4˚F/hr)
Humidity[1] Maximum Wet Bulb Temperature	10% to 90% rh 29˚C (84.2˚F)	5% to 95% rh 35˚C (95˚F)
Humidity Gradient	30% / hour	30% / hour
Altitude[2]	–200 m to 3,000 m (–650 to 10,000 ft.)	–200 m to 12, 000 m (–650 to 40,000 ft.)
Altitude Gradient	1.5 kPa/min	8 kPa/min

1. No condensation.
2. Altitude is relative to sea level.

4.9 SHOCK AND VIBRATION

The Quantum Fireball TM series of hard disk drives can withstand levels of shock and vibration applied to any of its three mutually perpendicular axes, or principal base axis, as specified in Table 4-9. A functioning drive can be subjected to specified operating levels of shock and vibration. When a drive has been subjected to specified nonoperating levels of shock and vibration, with power to the drive off, there will be no change in performance at power on.

When packed in its 1-pack shipping container, the Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT drives can withstand a drop from 30 inches onto a concrete surface on any of its surfaces, six edges, or three corners. The 12-pack shipping container can withstand a drop from 30 inches onto a concrete surface on any of its surfaces, six edges, or three corners.

Table 4-9 *Shock and Vibration Specifications*

	OPERATING	NONOPERATING
Shock 1/2 sine wave, 11 ms duration (10 hits maximum)	6 G (no soft errors)	
	10 G (no unrecovered errors)	70 G (no damage)
1/2 sine wave, 3 ms duration (10 hits maximum)	18 G (no unrecovered errors)	110 G
Vibration Sine wave (peak to peak) 1.0 octave per minute sweep	For one disk drives: 1.0 Gpp 5–400 Hz For two and three disk drives: 1.0 Gpp 5–400 Hz 0.3 Gpp 401–500 Hz (no unrecovered errors)	2.0 Gpp 5–500 Hz (no damage)

4.10 RELIABILITY

Mean Time Between Failures (MTBF): The projected field MTBF is 400,000 hours. The Quantum MTBF numbers represent Bell-Core TR-TSY-000332 MTBF predictions and represent the minimum MTBF that Quantum or a customer would expect from the drive.

Component Life: 5 years

Preventive Maintenance (PM): Not required

Start/Stop: 40,000 cycles (minimum)

Note: CSS specification assumes a duty cycle of one power off operation for every four idle mode spin downs.

4.11 DISK ERRORS

Table 4-10 provides the error rates for the Quantum Fireball TM 1.0/1.2/1.7/2.1/2.5/3.2/3.8AT hard disk drives.

Table 4-10 *Error Rates*

ERROR TYPE	MAXIMUM NUMBER OF ERRORS
Recovered read errors[1]	1 event per 10^9 bits read
Multi-read Recovered Errors[2] (Full correction enabled)	1 event per 10^{12} bits read
Unrecovered data errors[3]	1 event per 10^{14} bits read
Seek errors[4]	1 error per 10^6 seeks

1. Recovered read errors are errors which require retries for data correction. Errors corrected by ECC on the fly are not considered recovered read errors. Read on arrival is disabled to meet this specification. Minimum ECC span is 16 bits.
2. Full correction recovered read errors are those errors that require up to triple-burst error correction. This level of correction is normally applied only after the programmed retry counts are exhausted.
3. Unrecovered read errors are errors that are not correctable using ECC or retries. The drive terminates retry reads either when a repeating error pattern occurs, or after the programmed limit for unsuccessful retries and the application of triple-burst error correction.
4. Seek errors occur when the actuator fails to reach (or remain) over the requested cylinder and the drive requires the execution of a full recalibration routine to locate the requested cylinder.

Note: Error rates are for worst case temperature and voltage.

A thermal asperity recovery is invoked even at the minimum ECC condition, provided that the thermal asperity detection algorithm is triggered. Thermal asperity errors are not shown in the table above.