

WHITE PAPER

AIT CONTINUES ITS ROADMAP TO AN UNPRECEDENTED 5TH GENERATION

A comparative overview of tape technology requirements for the SMB Market: Helical Scan leads in storage density and other key features

Presented By

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Continued need for higher-capacity, robust tape-based back-up and archiving solutions

- Most important attributes are reliability, capacity and media archival life
- Other factors are size, scalability, ease of use and cost of ownership

AIT Helical Scan recording satisfies these needs best by providing:

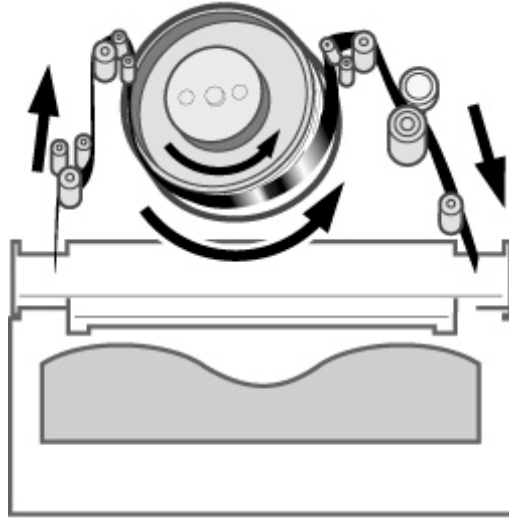
- Extremely reliable mechanisms (up to 400,000 hrs. MTBF at 100% duty cycle)
- Very high capacity (up to 400GB native or 1.04TB compressed¹ per cartridge)
- AME-III media for extreme durability and long archival life (>30 years)
- Compact, 3.5" mechanism with high capacity provides outstanding scalability (from 1U autoloaders to Enterprise tape libraries)
- Compact, dual-reel cartridge provides ease of handling and reliable media loading and unloading
- Ease of use (small drives and autoloaders, compact media)
- Lower power consumption (up to 40% less than Linear technology)
- I/O transfer rates matched to customer needs (allows mechanism to stream)
- Media investment protection through extensive AIT product family²
- Integrated WORM support for high data integrity (and functionality that can assist with regulatory compliance efforts)

Linear Recording technology does not provide an optimum solution for small to medium-sized businesses "SMBs", because:

- Large configurations (drives, media & automation) - affects space, ease of use, scalability, power and cost
- I/O transfer rates often mismatched to customer needs – may affect reliability and real throughput due to frequent start-stop "shoe shine" effect on media and tape path
- High power consumption affects cost of ownership (multiple drives and autoloaders/libraries)

1. GB means one billion bytes. TB means one trillion bytes. Compressed capacity and transfer rate using 2.6:1 ADLC. Actual capacity and transfer rate may vary.

2. AIT-5 is read/write backward compatible with AIT-4, AIT-3EX and AIT-3



Attribute	Linear (LTO)	Helical Scan (AIT)	AIT Benefits
Recording Density	Low	High	Extremely high capacity in a small Form factor
Tape Speed	High	Low	Less media, head and mechanism wear
Tape Tension	High	Low	Less media and head wear
Tape Cartridge Size	Large	Small	Ease of handling. Better automation capacity and data density
Tape Cartridge Type	Single Reel	Dual Reel	Better reliability of tape loading and unloading
Media Formulation	Metal Particle	Metal Evaporated	Less media and head wear
Passes to Fill Tape	> 50	1	Less media, head and mechanism wear
Drive Form Factor	Large	Small	Higher capacity solutions - drives and automation Better matches SMB Server I/O and allows drive to stream - enhancing reliability & overall throughput
Data Transfer Rate	High	Moderate	
Power Consumption	High	Low	Lower operating cost, better reliability

Figure 1. Summary of the benefits of Helical Scan vs. Linear

INTRODUCTION

Today's data protection and archiving requirements, together with image document and other digital content storage, continue to drive the need for higher capacity and robust tape-based solutions. In a recent industry survey, customers indicated that, for archival applications, the most important attributes were high reliability, high capacity and long term data retention³. Since tape-based data storage has been moving more towards archival use, successful tape solutions will need to pay particular attention to these customer requirements.

This paper examines some of the key attributes in today's major tape recording technologies and focuses on key differentiators that best meet the needs of the SMBs, as well as "Branch Offices" of large Enterprises. This customer segment relies on space-efficient, high-capacity, cost-effective tape technologies to meet their specific data protection and archiving needs. The applications typically involve more modest data I/O transfer rates (usually less than 70MB/sec compressed² due to capabilities of ubiquitous servers) and these customers are looking for a solution that best matches their total needs.

A REVIEW OF BASIC TAPE RECORDING TECHNOLOGIES

Sony Corporation originally developed their recording technology around Helical Scan because they saw the potential to take it further in density than linear technology could achieve. Historically, tape technologies have been differentiated by the method in which they store information; namely Helical Scan or Linear serpentine recording. Sony Corporation realized Helical Scan technologies could easily be adapted for a variety of recording applications because of its high capacity and space-efficient attributes. Helical Scan recording technology is characterized by an extremely efficient data packing density, low tape tension, low tape speeds and low power consumption, with a rotating drum/head assembly packaged into a compact mechanism. Linear serpentine recording technologies, on the other hand, are characterized by lower recording densities, very high tape speeds, high power consumption and a stationary head assembly that requires a much larger mechanism design.

In addition, Helical Scan recording only requires a single pass of the tape cartridge to record the full contents of the media, while Linear technologies require many back-and-forth transversals of the tape ("serpentine recording") to completely record the contents of the media. Linear technologies also require very large tape cartridges containing large quantities of media in order to achieve competitive capacities. In comparison, Sony's latest AIT member, AIT-5, stores the same amount of uncompressed capacity (400GB) as the much larger LTO-3, using about one-fourth the amount of tape media.⁴

The AIT Helical Scan technology, introduced in 1996, has always featured small form-factor, low power consumption, very high-capacity solutions with scalability from SMBs to the Enterprise. With the introduction of the 5th AIT generation, AIT-5, Sony extends the AIT capability to a new level of data storage capacity and sets the competitive benchmark for space-efficient, high density removable storage. In fact, AIT-5 is the first tape drive technology to achieve 400GB of native capacity and up to 1.04TB compressed¹, in a small form-factor, 3.5" mechanism.

1. GB means one billion bytes. TB means one trillion bytes. Compressed capacity and transfer rate using 2.6:1 ADLC. Actual capacity and transfer rate may vary.
3. Per published survey - Infostor May 8, 2006
4. Per manufacturer's published specifications as of 9/30/2006

RECORDING DENSITY – WHY HELICAL SCAN WINS

Recording density refers to the number of data bits that can be stored in a particular area of tape media and is the primary driver of higher storage capacity, whether in hard disk drives or tape drives. In Helical Scan tape recording, it is possible to record more than 4 times the number of data tracks per inch compared to Linear serpentine methods, and can result in up to 4 times the total recorded data density. In this example, that means in order to remain competitive in capacity, Linear technologies would need to use more than 4 times the amount of tape in a single cartridge – requiring much larger sized media and drives, consuming much more space and power. Sony's AIT technology has exploited this advantage since its introduction providing high capacity tape storage solutions with state-of-the-art features, in a small form-factor, low power consumption product line.

Technology	Helical Scan			Linear		
	Model Name	AIT-3	AIT-4	AIT-5	SDLT 600	LT02
Areal Density (Mbits/sq in)		1172	2344		200	300
Native Capacity (GB) ¹	100	200	400	300	200	400
Media Size - Width	8mm	8mm	8mm	12.7mm	12.7mm	12.7mm
Length	230m	246m	246m	600m	600m	600m
Tape Speed (Inches/Second)	< 1	< 1	< 1	> 100	> 100	> 100
Media Passes to Fill Tape	1	1	1	> 50	> 50	> 50
Drive Form-Factor	3.5"	3.5"	3.5"	5.25"FH	5.25" FH	5.25" FH/HH
Data Transfer Rate (Native) ¹	43 GB/Hr	86 GB/Hr	86 GB/Hr	129 GB/Hr	108 GB/Hr	216 GB/Hr
Power Consumption (Max)	< 20 Watts	< 20 Watts	20 Watts	> 35 Watts	> 35 Watts	38 Watts

Figure 2. Comparison of Helical Scan and Linear Tape Recording Attributes⁴

Helical Scan recording technology provides greater reliability and media durability in part due to its low tape tension, low tape speed, single-pass media recording and ultra-smooth AME media formulation. In Linear technology, the much higher mechanism speeds (>100 inches per second) and multiple tape passes (>50) to completely record a tape cartridge can result in much greater mechanism and media stresses and can affect long-term reliability of drives and media. The much smaller form-factor of helical mechanisms and media has also provided greater application scalability without sacrificing space. For example Sony's AIT-5 drive in a LIB-81 autoloader can provide an unprecedented 3.2TB (native) or 8.3TB (compressed)¹ capacity in an ultra-slim, 1U rack-mount configuration. Linear technology simply cannot achieve this.

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COMPARISON OF HELICAL SCAN FORMATS

In addition to AIT, other Helical Scan formats have been introduced to provide specific capacity and cost-performance points, while leveraging the benefits of high-density recording in a small mechanism design. However, none of them offers the same level of capacity, performance or features as Sony's AIT family. Some, such as the DDS format, were developed by Sony and Hewlett Packard to specifically focus on low-end, low duty-cycle applications. The DDS format has a large installed customer base but, according to an August 31, 2006 Gartner report, annual shipments and installed base have been declining over 10% annually over the past several years and this trend is expected to continue into the foreseeable future.

For SMB applications, particularly those requiring strong automation support, the 8mm AIT format provides a robust solution and is enjoying the benefits of extensibility to a 5th generation member, providing unparalleled capacity, backwards compatibility² and other important features.

Format Name	AIT	VXA	DDS/DAT
Mechanism Type	8mm - 3.5"	8mm - 3.5"	4mm - 3.5"
# Generations	5	3	5
Highest Native Capacity (GB)¹	400 GB	160 GB	36 GB
Highest Native Performance¹	86GB/hr	41GB/hr	13GB/hr
Target Market	SMB/S-Ent	SMB	Small Bus
Autoloader Support	Yes	Yes	Yes
Max Capacity (Native - GB)¹	3200 GB	1280 GB	288 GB
Library Support (Multi-drive)	Yes	Yes	No
Max Capacity (Native - TB)¹	> 200TB	4.8 TB	N/A

Figure 3. Comparison of Helical Scan Formats⁴

THE NEED FOR SCALABLE CAPACITY

Low cost tape solutions, whether Helical Scan or Linear, have not always kept up with the demands for data storage growth and customers are demanding greater scalability of solutions to meet their needs. Although several tape technologies provide automation support for SMB applications, the available offerings generally do not provide the breadth of capacities combined with other features to meet evolving customer needs. AIT, on the other hand, offers 5 generations of products that provide from 20GB to 400GB¹ of native capacity per cartridge and are easily integrated into automation because of their size (drives and media) and low power consumption.

Traditionally, multi-cartridge tape automation has been a key capacity "multiplier" and operational "simplifier" that met the needs for unattended, high capacity data storage. As a result, SMBs have been a major target for automation suppliers, promoting solutions from single-drive, 8 cartridges to those providing over 10 drives and several hundred tape cartridges. Historically, it has been automation applications, from SMBs to the Enterprise, that have driven the demand for AIT and account for its substantial installed base. The introduction of AIT-5 will significantly increase the

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capacity of AIT-based automation by a factor of 2 or more, and thereby offer leadership solutions for single-drive departmental or SMB customers to large multi-drive, Enterprise-class automation solutions. With its rich read and write backward compatibility feature, the AIT-5 technology can easily migrate AIT-3 and AIT-4 applications, while protecting customer investment in tape media and robotics hardware.²

The AIT technology provides a unique capability as a single format that can scale from entry-level server to large Enterprise applications for archiving and data protection. Other tape technologies are more limited in their application capability and do not span the range of capacity and performance as AIT does.

Technology	Helical Scan	Linear
Product Model	AIT-5	LTO-3
Solution:		
1U Autoloader	Yes	No
# Drives/Media	1 X 8	N/A
Native Capacity ¹	3.2 TB	N/A
2U Autoloader	Yes	Yes
# Drives/Media	2 X 16	1 X 16
Native Capacity ¹	6.4 TB	6.4 TB
Small Enterprise Library*	Yes	Yes
# Drives/Media	12 X 600	8 X 265
Native Capacity ¹	240 TB	106 TB

Figure 4. Scalable Automation Support by Tape Technology⁴

* Single Cabinet, < 70 in. High

INVESTMENT PROTECTION – MEDIA COMPATIBILITY

All tape technology suppliers, whether Helical Scan or Linear, strive to attain some level of backward compatibility with each generation of product introduction in order to minimize the economic and operational pain of transition from one generation to another. The AIT technology is no exception in this regard and the AIT-5 technology was specifically designed to provide the widest range of compatibility with prior generations of AIT. In fact, AIT-5 offers one of the best backward compatibility features of any new generation of tape technology, providing both **read and write** compatibility with 3 prior generations of AIT, namely AIT-3, AIT-3EX and AIT-4.² This capability, together with its leadership 400 GB¹ capacity, will offer strong incentive for AIT-5 migration applications. AIT is also unique in providing a compatible format spanning several generations of price, capacity and performance that can be deployed for archiving applications ranging from SMBs to the Enterprise.

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**NON-ALTERABLE DATA PROTECTION –
WORM (WRITE-ONCE, READ MANY)**

With today’s ever increasing demands for non-alterable data protection, tape products have provided a solution that will fit the budget of most customers. Unlike Enterprise customers that can afford the expense of sophisticated disk-based WORM applications, SMBs need more cost-effective alternatives that can help them meet their regulatory needs. In addition to functionality that can assist with regulatory compliance efforts, WORM recorded tapes can also be used to assure a high level of data integrity, since this capability provides one of the best “tamper-proof” data recording methods that currently exists and has become a “best practices” archiving standard. Helical Scan (AIT) was one of the first SMB tape technologies to implement WORM as an optional media type in 2000 and now has several generations of installations and customer-proven applications. The integration of WORM capability within a standard drive also provides a lower cost of ownership and media investment protection.

Technology	Helical Scan		Linear	
	AIT	VXA/DDS	SDLT	LTO
WORM Support	Yes	No	Yes	Yes
Integrated in all Models	Yes	No	No	No
# Current Generations	5	N/A	2	1
Future Roadmap⁵	Yes	N/A	Yes	Yes

Figure 5. WORM Capability by Tape Technology⁴

**PERFORMANCE CHARACTERISTICS –
MEETING REAL APPLICATIONS NEEDS**

All tape technologies utilize multiple recording heads and higher head-to-tape speeds to achieve higher levels of data transfer from one generation to the next. In larger Linear mechanisms designed for the Enterprise market their high levels of performance can only be achieved if the host system can sustain these high I/O throughput rates to tape. In most SMB real-world applications, however, high I/O throughput rates to tape (especially in a compressible data environment) are not achievable and the data transfer rate specifications of these Linear mechanisms can be misleading. Inherent latencies in the overhead of disk subsystems, system interfaces, file systems and back-up/archiving application software all limit the effective actual I/O throughput that a system can achieve.

These inherent system latencies, and resultant performance bottlenecks, cause high performance tape drives to “throttle” down to a lower data rate, or cause frequent start-stop cycles as the tape drive waits for data to be transferred. Unfortunately, this frequent start-stop cycling, or “shoe-shining” can reduce overall performance and add greater stress to the mechanism and media, which may affect long-term reliability. LTO-3 data write performance is specified to range from 576GB/hr to 864GB/hr compressed.⁴ Since this is well beyond the range of ubiquitous SMB server capabilities, the LTO drive will attempt to degrade its performance by more than 60% in order to achieve a reasonable data rate match and avoid excessive re-positioning or “shoe shining”. AIT’s data transfer rate performance, on the other hand, is more closely matched to real SMB system capabilities.

4. Per manufacturer’s published specifications as of 9/30/2006

5. Features, specifications and product plans are subject to change by Sony without notice.

Based on the customer survey³ of archival application requirements mentioned earlier, data transfer performance was not noted as a strong priority, whereas capacity was. With all of these factors in mind, Sony intends to double the storage capacity and optimize the data transfer rate specification for its next generation of AIT.⁵

DURABILITY AND RELIABILITY

The characteristics of AIT Helical Scan, with its gentle tape motion, low tension, together with the exceptional durability of Advanced Metal Evaporated (AME) media, enable AIT to achieve the reliability, durability and archiving needs for tape drives demanded by customers. The large installed base of AIT drives and media, particularly in Enterprise automation use, demonstrates that AIT has proven itself in meeting some of the most demanding requirements.

The AIT-5 design not only continues this legacy, but also incorporates additional data integrity features, such as a powerful, servo-based head tracking system to ensure that data can be recorded and read back under a wide range of conditions. The smooth, yet extremely durable AME-3 media also contributes to greater expected longevity for the AIT-5 media and key drive components.

SUMMARY

Inherent high data density, optimized data transfer performance, as well as outstanding reliability and durability characteristics, ideally position Helical Scan tape technology to satisfy the demands of data protection and archiving in SMB as well as Branch Office applications. Helical Scan recording provides high capacity in a small compact package and is ideally suited to support these needs both today and in the future⁵. Sony's AIT technology stands out as a leadership product line, providing 5 generations of price, capacity and performance points to meet market needs, from stand-alone drives for small business use, to automated loaders and libraries providing unattended operation for medium-sized businesses to small Enterprises. Linear recording technologies lag significantly in data density and compensate for this through much larger quantities of media, as well as much larger mechanism designs consuming much more space and power. SMB and Branch Office customers require a technology family that addresses their data protection and archiving needs for capacity, reliability and data retention through space efficient, low power and easy to use solutions.

For more information visit:

www.sony.com/storagebysony

www.sony.com/storagemedia

3. Per published survey - Infostor May 8, 2006

5. Features, specifications and product plans are subject to change without notice.