

LTO Tapes - Enterprise Tapes - Technical hotline - Technical interventions - Datacenter & hosting

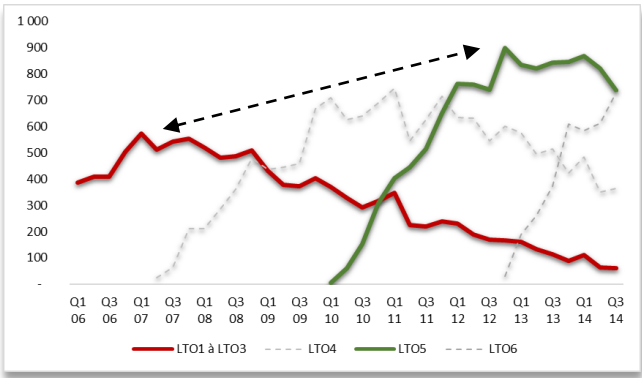
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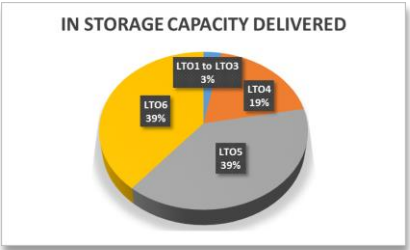
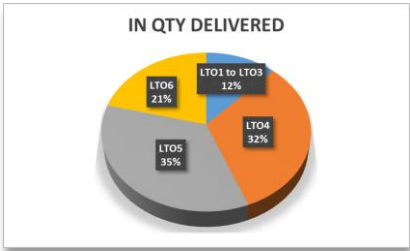
LTO5 tape cartridges quality : Fujifilm, once again, makes the difference, with a superior technology in both performance and reliability.

What is the importance of LTO5 in total LTO tape cartridges sales ?

The LTO5 cartridge is currently the LTO Tape generation that is the most sold in the European market since it represents 35% of total LTO sales in Q3 2014. Another interesting figure is the analysis of the migration of old tape generation installed basis such as LTO1, LTO2 or LTO3 to LTO5. Indeed, drive manufacturers are accustomed to offer to end users to migrate from two previous generations (for instance, from LTO3 to LTO5 or from LTO4 to LTO6). Although we should not generalize about such migration habit, we can, nevertheless, notice most end users in Europe tend to migrate accordingly with main drive manufacturers recommendations. A quick analysis of the life cycles of LTO tapes by amount of TB delivered, shows in the chart below that the rise of LTO5 goes together with a real increase of digital data stored on LTO tapes.



Above the amount of TB delivered by generation LTO (figures in thousands of TB)



Above the importance of the main generations of LTO in total sales in Europe in Q3 2014.

Specifications: why choose Fujifilm?

Fujifilm is the world's leading manufacturer of LTO tapes with over 60% manufacturing shares for all LTO generations . In addition, Fujifilm offers the only tape coating methodology that is being qualified for future LTO tape developments: the Nanocubic Barium Ferrite technology, combining the use of Barium ferrite magnetic particles with the Nanocubic coating technology. Indeed, the areal density of MP technology, commonly used for the production of LTO tapes from LTO1 to LTO5 does not offer a storage capacity potential large enough to ensure the manufacturing of any generation greater than LTO6 under current conditions. Unless a financial investment or an exceptional invention, there is a very good chance that Barium Ferrite becomes the sole method of tape coating for the next LTO7 generation that is scheduled for late 2015 (6TB native capacity). Finally, IBM and Fujifilm have already managed to develop a tape coating technology, based on Barium Ferrite, and that is able to offer 154TB native capacity on a magnetic tape. Barium Ferrite is also the technology that is used to manufacture new generations of high-end magnetic tapes such as T10000 or 3592. Such tapes offer the highest level of performance and security in the tape area.

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The next generation of LTO tape is announced for the end of the 2015. The new LTO7 tape will offer 6TB native capacity with a 280MB/s transfer rate.

At high-end level, most recommended tapes for large companies are IBM and Oracle's Enterprise tapes.

- ❖ Oracle's T10000D is already offering 8,5TB capacity with 252MB/s transfer rate. The next generation, T10000E is planned for 2016. The capacity of this new drive might be between 15TB and 17TB. To be confirmed.
- ❖ IBM has just launched its new generation of 3592 Tape and Drive. The 3592 JD will offer 10TB native capacity with a 360 MB/s transfer rate.

## The technical advantages of Fujifilm LTO5 tapes: Fujifilm's Nanocubic technology and its benefits to the user

Fujifilm's LTO5 tape cartridge is the result of significant improvements in terms of tape coating technology, physical capacity of the cartridge and data access through the LTFS (Linear Tape File System).

### 1. The Nanocubic technology.

Fujifilm's LTO 5 is manufactured with the MP technology (Metal Particle), means with iron based metallic particles.

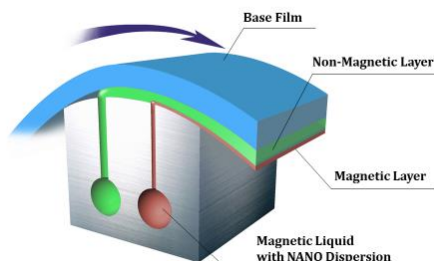
However, when it comes to coating on the tape, Fujifilm uses its own technology, the Nanocubic (that is already used for manufacturing LTO4 tapes). It is the development and mastery of its own coating technologies, in order to meet the increasing user demand in terms of capacity, transfer rate and security that enabled Fujifilm to become the worldwide leading manufacturer for LTO tapes. This combination of R&D and production capacity also made Fujifilm a key partner of the LTO Consortium, formed by three major hardware manufacturers: IBM, Quantum and HP.

The Nanocubic technology is a continuation and improvement of the Fujifilm ATOMM (Advanced Super Thin Layer and High Output Metal Media Technology). ATOMM technology was used for the production of previous generations (LTO1 to LTO3) with using Micron range particle size.

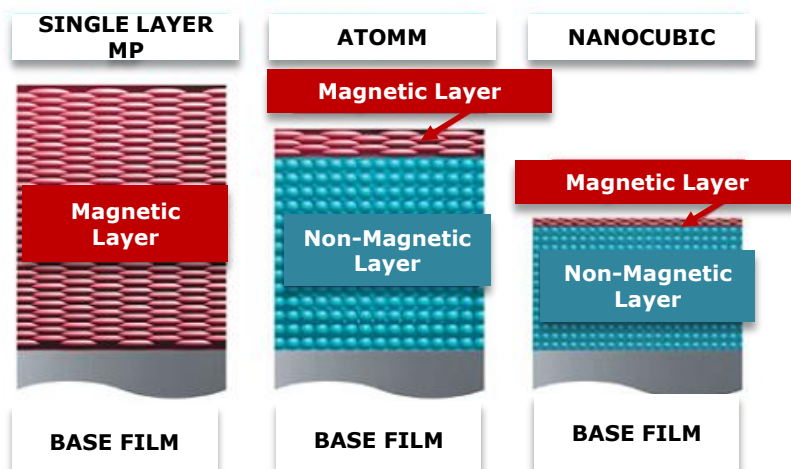
Nanocubic consists of three major points, hence the name Nanocubic (NaNO3), Nano-coating, Nano-particles and Nano-dispersion which we will discuss point by point below:

**a) Nano-coating** is the technique developed by Fujifilm to coat on the base film of the tape an ultra-thin magnetic layer whose thickness is calculated in nanometer, more specifically 50 to 100 nm. As you can see below, Fujifilm uses a method to coat on the base film, 2 layers of the structure of the LTO tape at the same time: the nonmagnetic lower layer and the upper magnetic layer (the one holding the digital data). This method differs from the AME technology (or Metal Evaporated) used by other manufacturers. Metal evaporated involves vaporizing pure Metal material containing magnetic particles that evaporate and therefore stick to the base film. If this technology could produce average-good quality tapes, it is quite unstable, leads to high production costs and is hard to master especially for mass production since optimizing such a technology would need to find ways to immobilize the tape and, therefore, prevent the tape from scrolling when applying particles, so that their (the particles) positioning and management are properly mastered.

#### NANO-COATING

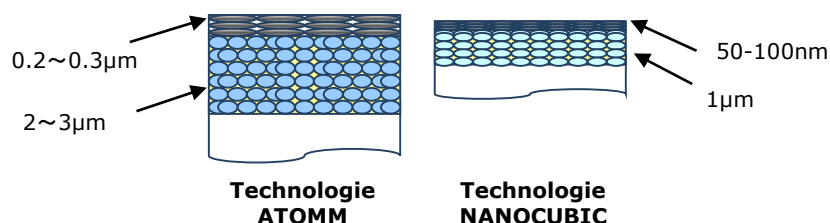


### Fujifilm's R&D – how to improve tape coating technology.

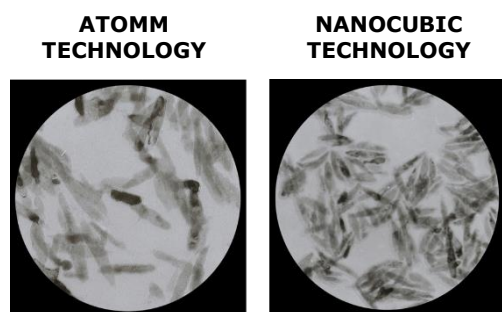


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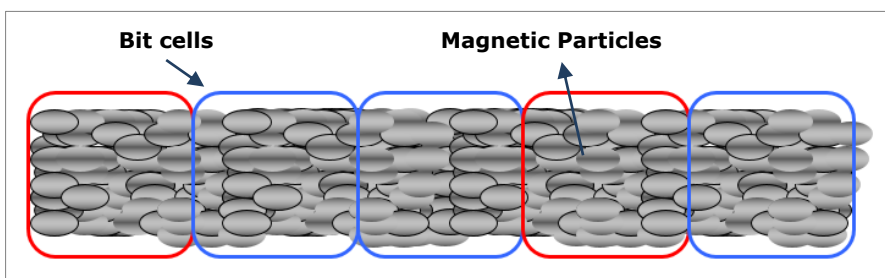
More about Nano-coating: it provides an ultra-thin magnetic layer which reduces the effects of demagnetization of the tape. Indeed, the polarization of MP particles is horizontal, so it may generate opposing magnetic forces that could create negative effects in the writing process. These negative effects can be exacerbated if the number of layers of particles is too large. In order to reduce the risk of opposing magnetic forces, Fujifilm minimizes the thickness of the magnetic layer, in particular with using a nonmagnetic lower layer that reduces the effects of demagnetization and strengthens the signal emitted by the tape to the drive head. Higher magnetic output facilitates the ability of the head to recognize the magnetic signals. Demagnetization effects can produce up to a self erase process. It is, therefore, vital to minimize them. See below the comparison of the tape thickness, Nanocubic vs Atomm technology :



**b) Nano-particles.** Fujifilm uses for the production of LTO5, ferromagnetic oblong shaped particles whose size does not exceed ten nanometers, or 78% of the size of an LTO4 particle . See below a microscopic picture of MP particles. The density on the same surface is obviously higher with NANOCUBIC technology:



It is very important to reduce the size of the magnetic particles. The reason that seems to be the most obvious is the increase in recording density and thus the storage capacity of the tape. Indeed, a magnetic tape consists of tiny magnetic particles uniformly dispersed on the surface of the tape. Cells or bits of data composed of these particles may then be used for the writing process. Each cell is positively or negatively polarized and the combination of these cells becomes an information or data (just as a digital data is the combination of 1 and 0).



Therefore, using smaller particles means that we can lay more particles on the surface of the tape, which leads to storing more data on an LTO tape cartridge.

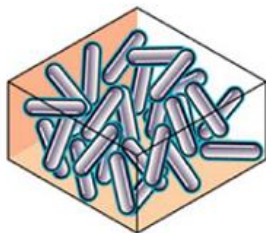


Fujifilm's LTO5 Tape cartridge

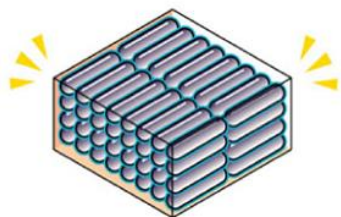


Do not forget to consult us for barcode labeling on LTO tape cartridges. Our labeling tape system allows us to deliver all European countries with delivery terms that do not exceed 5 days in the worst case scenario.

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Natural positioning of MP particles

Aligned positioning of MP particles  
with Nano-dispersion

**c) Nano-Dispersion.** The third parameter is fully complementary to the previous two. Indeed, if it is important to have small particle size, it is fundamental that particles are properly "tied up" on the tape. We call this Nano-dispersion. However, the smaller the particles are, the more they tend to stay together. We have all experienced at the beach, it is harder to get rid of fine sand grains which stick to the skin than to get rid of a thicker sand that disperses more easily. Nano-dispersion takes place in two time:

- ❖ To achieve the coating particles on the tape, Fujifilm uses in the coated substance, an organic binder made of polymer that disperses homogeneously particles on the tape.
- ❖ Once the particles are lying on the tape, they are subjected to a magnetic field in order to improve their orientation.

See on the left of this page, a scheme that summarizes the purpose of Nano-dispersion of magnetic particles.

## 2. Concrete benefits to Fujifilm LTO5 users.

The uniform alignment of the particles on the one hand and their orientation on the other hand are not insignificant factors when it comes to judging the performance of a tape cartridge. Both are essential parameters to improve the performance of the tape when combined with the benefits of Nano-coating and the use of Nano particles. We can measure significant improvements in various fields such as capacity, transfer rate, recording stability, reducing the risk of data loss and obtaining a high rate of SNR (SNR being a major indication of performance of a magnetic tape). Please see as follows some examples of concrete improvements brought by Fujifilm's LTO5 tape using Nanocubic technology and its benefits to the user :

**a) The smaller size of the particles contributes to securing data in time :** each data cell is composed of a larger number of particles. If one of them were to demagnetize naturally over time, it would not necessarily have any impact on the data cell, knowing the data cell is less depending on each of the many particles that constitute it. Data is therefore safe for a longer duration. This reduces the risk of data loss.

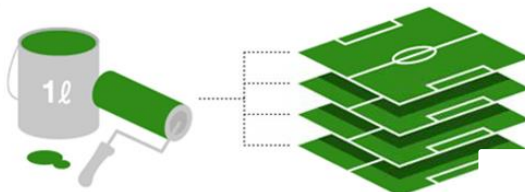
### b) Dispersion and orientation of the particles generate benefits such as :

- ❖ Capacity: It seems evident that a homogeneous dispersion of the particles can achieve a higher recording density, since it increases the number of particle that a tape surface can contain. Although all LTO5 tapes are, of course, of same capacity (1.5TB native), particle orientation makes it easier to achieve the required capacity on the limited tape length as specified by the consortium (846m).
- ❖ Signal clarity: the homogeneous dispersion of particles and their orientation contribute to
  1. obtaining a thinner magnetic layer and thus reduce the effects of demagnetization as we have seen previously
  2. producing a stronger signal or in other words, a higher magnetic output.

Just as an example, Nano-dispersion coating provides a layer so thin that a liter of coating liquid (with this Nano-dispersion technique) could fully cover four football fields

- ❖ Recording stability: the uniform dispersion of the particles allows the head of the drive to always interact with the same constant amount of particles during both the write and the read process. This definitely improves the stability of the signal and thus the data recording stability and performance.

Nanocubic tape layers are so thin that one liter of coating liquid can fully cover 4 football fields





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**c) A high rate of SNR:** The orientation and alignment of the magnetic particles which are positioned one next to the other reduce the interaction between opposite magnetic forces. The tape will, then, produce a stronger signal, thanks to the reduction of demagnetization effects as seen above, but also a clearer signal since the 'noise', that is inherent to the magnetic field is being reduced.

This parameter is measured by the rate of SNR or signal to noise ratio. This is an essential criterion since it measures somehow the clarity of the signal emitted by the tape. The more the signal is clear, the easier it is for the head to read/write on the tape. Higher SNR provides with many benefits to the users such as :

- ❖ Capacity, the drive will be able to write and read more data without needing to reduce its speed.
- ❖ "Shoe-shining" risk reduction. "Shoe-shining" is an extremely dangerous phenomenon for the drive and tapes and can cause serious damages to both of them. It occurs when the drive does not pick out the signal generated by the tape. The drive head will then go back and make a new attempt to read or write. In case of repetition, these movements can alter the tape and especially cause mechanical damages to the drive. It can, in the worst case, lead to full drive failure, means to a read or write process interruption. A high SNR rate allows the signal to be recognized more easily and quickly by the drive head and therefore prevent from Shoe-shining.
- ❖ Transfer rate. The signal is more easily detected, the drive head reads or writes faster. The low risk of being confronted with the effects of 'shoe-shining' ensures that transfer rate will not be reduced by the interruption of the writing process.

**d) A smoother tape surface.** The combination of the three main components of Nanocubic technology (improved coating technique + smaller particle size + uniform dispersion) helps manufacturing smoother tape surface. The benefits are many :

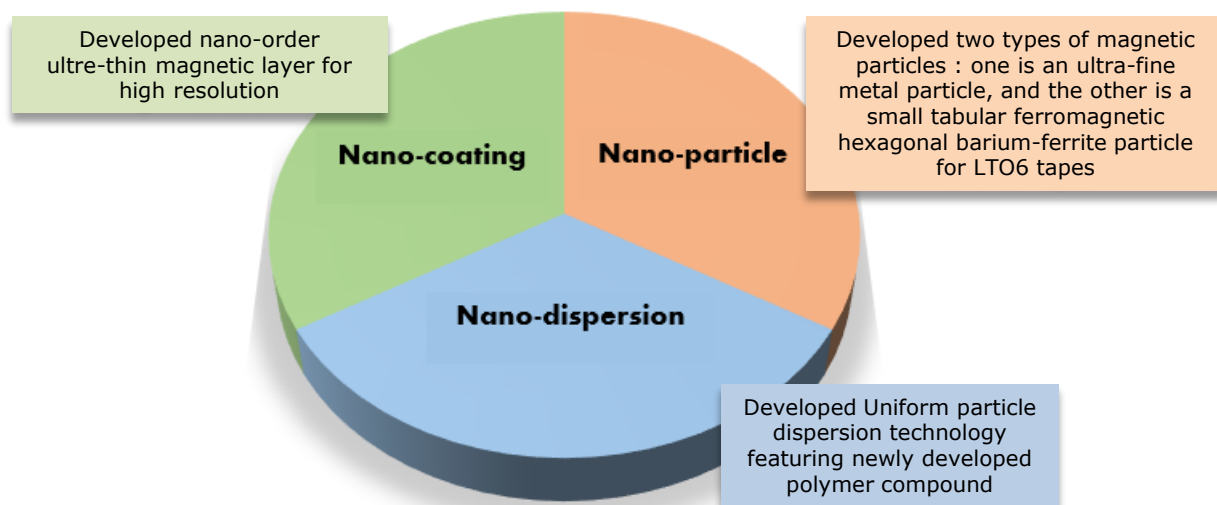
- ❖ Transfer rate: it allows the band slip more easily and quickly on the read head. This optimization of the speed of data transfer saves time during the backup process.
- ❖ Capacity: the tape slipping faster on the drive head, implies that the user can read or write more data for a given time.
- ❖ Recording stability: A less smooth tape would come with asperities that may cause fluctuations in the recorded signal level, and even more so that the friction of the tape on the drive head could create a slight flutter phenomenon of that tape. The air produced by this movement between the tape and the drive head creates a variation of distance between the head and the tape which would change the magnetic field and could disrupt recording.

### **Certifications and compliances:**

*Fujifilm LTO tapes are certified and qualified for all LTO tape drives (don't hesitate to ask us to provide you with certificate compatibility). There is therefore no drive on which you cannot use Fujifilm LTO tapes.*

*In addition, Fujifilm Recording Media Division, the entity of Fujifilm corporation that develops and distributes data storage products is ISO 9001 certified, demonstrating its ability to consistently provide products that meet customer requirements as well as legal requirements and regulations. It also demonstrates its commitment to continuously improve its processes in order to increase customer satisfaction. Our 14001 certification indicates our commitment and efforts in environmental management with a continuous improvement approach to minimize our environmental impacts, comply with legal requirements. Our products are compliant with various European health directives such as RoHS, REACH or SVHC. Fujifilm, of course, also complies with European community standard such as 'CE Standards' or 'CE Mark'.*

### **Nanocubic technology in a nutshell**



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### 3. Physical points of reliability on Fujifilm LTO 5 cartridges : a vital quality control.

Increasing the length of the tape (846m for LTO 5) and the increasing speed of the tape system would, among other phenomena, create tension on the tape reel and cause damages to the tape, up to even risking data loss. There are a number of points of reliability on an LTO tape which must necessarily be controlled by the manufacturer. As such, Fujifilm has a number of licenses and rights to the development of technologies related to the cartridge, in order to provide users with optimum safety in the use of an LTO5 tape :

**Reliability :** Pre-Recorded Servo-Track with Good Linearity on the tape surface of LTO. Servo-tracks are pre-recorded during the manufacturing process at the factory. These servo-tracks enable the tape head to accurately write and read the data in the correct place.

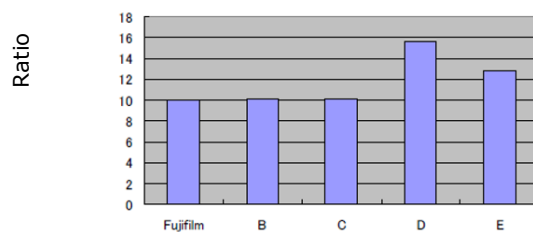
Fujifilm's tape servo-track is precisely aligned due to advanced servo-track recording technology, which has been improved over time.

Therefore Fujifilm tapes have straight servo-tracks which improve the ability the head to follow these servo-tracks on the tape and to record and read the data accurately.

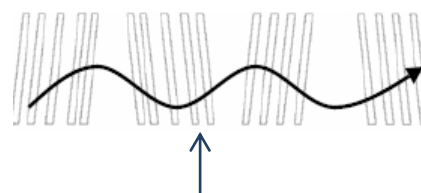
The ever-increasing demand for speed, transfer rate is such that it can hurt the cartridge or tape at different levels. For example, the tape reel : if the reel is not reinforced for newer generations of LTO tapes, and if the resistance of its mechanical parts is not enough, not only its core but also its upper and lower brackets (disks larger sizes, the kernel) can deform and expose the tape to further risk of damage, at least on its edges.

This notion of tape edge is vital, knowing that an LTO tape is composed of segments or wraps equally and longitudinally displayed on the tape surface. For instance, an LTO5 tape is divided in 4 data bands. Each of these 4 data bands contain 20 wraps and each wrap contains 16 tracks. The drive head writes on these tracks. The two outer data bands are those that are running the most risk during the write and/or read process. The transfer rate is high, so any inappropriate contact can damage the tape and and, therefore, cut off a quarter or even half of its storage potential. In our discussions with CIOs, we see that a small part of them even prefer to never use the two outer data bands in order to avoid any risk of data loss due to accidental contact between the edges of the tape and the roller guide during the tape pass into drive.

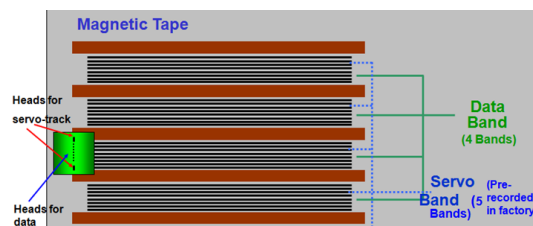
There, we can see that not taking all points of security into consideration can lead to a higher cost of usage of LTO tapes : users who are not secured about using the outer bands end up paying twice more money than necessary.



Note : Measured by Fujifilm evaluation method



Pre-recorded servo-track linearity (measure of deviation from ideal straight line) The smaller the value, the straighter it is.

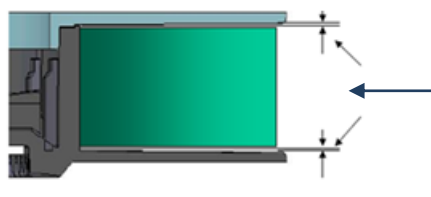


Above, an LTO tape Servo-Track structure

**Strengthened Reel , High Precision Mechanical Parts.** Newly applied fiberglass to the upper flange contributes to preventing reel core and flange deformation and maintains stable dimensional precision even when pressure from the wound tape is imposed on the reel core. In the event that the mechanical parts strength is insufficient, not only the reel core, but also the top and bottom reel flanges would be deformed, thus exposing the running tape to the risk of tape edge damage.



**Tapered Reel Flange :** The inner surface of the top and bottom reel flanges include an appropriate taper (complying with the standard), to prevent unnecessary contact of the tape edge with the flange, which protects the tape edge. An appropriate taper protects the tape edge from rubbing against the inner surface of the reel during tape running.



The inner surface of the reel flange is not strictly flat but features an appropriate taper.

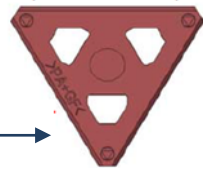
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Points reliability – 2<sup>nd</sup> part :

### Reinforcement of Release Pad

By optimizing the design of the release pad and adopting highly durable plastic, Fujifilm has achieved high durability during rotation and prolonged stable reel rotation. The release pad and the central projection of the reel lock are in contact with each other to stabilize the posture of the rotating reel. Poor durability of the release pad would adversely affect the running stability of the tape, resulting in poor rotating precision caused by abrasion at the point of contact during reel rotation.

Release Pad :  
the overhead  
view



### Unique Flange for Air Flow Control

Fujifilm's unique flange with grooves controls air flow during tape running to maintain a smooth tape pack, reducing edge damage caused by an uneven tape pack.



Good Example

Smooth

Bad Examples

Uneven

Damaged edge



### Sturdy Welded

**Cartridge** : A securely welded cartridge prevents the leader-pin from becoming loose. It also makes the cartridge tamper proof.



Welded Area

### Precision of Tape Reel

**Rotation** contributes to tape running stability. Having a reel with poor circularity could disrupt the rotation cycle and result in tape running instability. This would lead to tape edge damage.

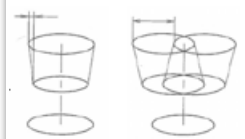
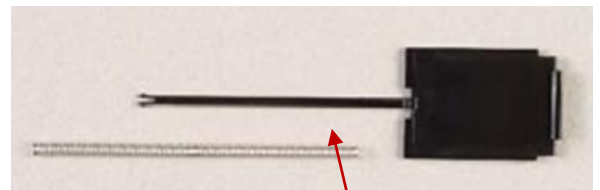


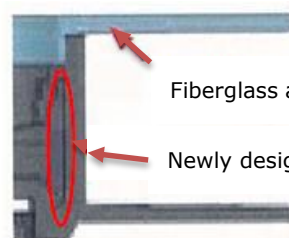
Image of poor circularity

**Simple Door Spring** : Fujifilm's simple and reliable door spring allows for a large amount of load/unload cycles of more than 25,000 times (about 20 years of five load/unload cycles per day). This is possible without any degradation of spring force. This is Fujifilm's patented technology.



Simple Door Spring

**Archivability** : By applying fiberglass to the upper flange and optimizing the shape of the reel hub, Fujifilm has achieved a tougher reel hub structure minimizing the potential for deformation caused by tape pressure. Increased hub deformation has potential risk resulting in unexpected tape deformation during storage conditions of high temperatures, such as tape edge damage or other physical anomalies. Fujifilm has successfully minimized this potential risk.



Fiberglass added to upper flange

Newly designed reel hub

#### 4. LTFS : Linear Tape File System

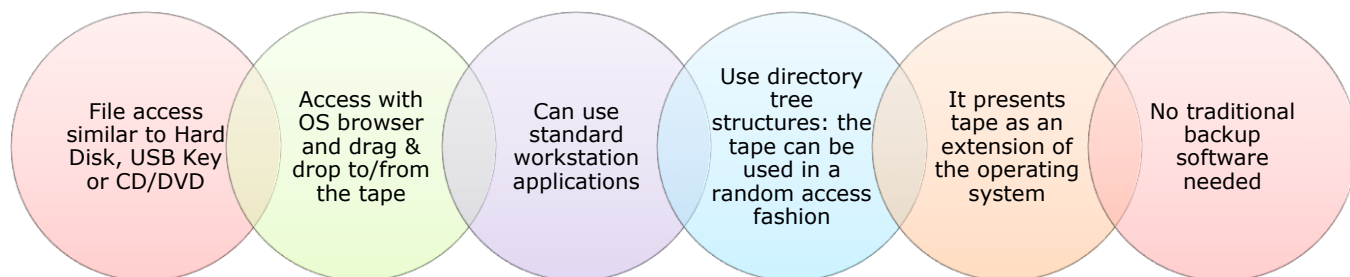
LTO format' scalability allows the development of new specifications, such as LTFS, which provides ways of preserving both gross and finalized digital content by combining high capacity, fast data access, low cost and turns tape technology into a storage tool that is as easy to use as hard disks or USB keys.

Thus, LTFS is a partition of the LTO tape in half. Part of the tape is dedicated to the inclusion of an index of the information stored as metadata. The index can be copied and modified. The old copies of it being retained, the tape cartridge can be restored to a previous state. The other part contains the data as such.

Of course, the index uses a very small space on the tape, so it does not prevent from obtaining the full native or compressed capacity of the tape.

The LTFS system is self-describing : the access and management of the files stored on the tape is as easy and friendly as with a hard disk, a USB key or a CD/DVD thanks to data indexing.

Unrelated to the backup software used to record the tape, it will retrieve the data entered independently of the hardware or software platforms used initially, making it a tool that is ideal for sharing content including during post-production.



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for you ....



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