Watermark® Tape

Watermark Magnetics is the world's most effective technology for safeguarding the security of magnetic data cards. A unique and permanent pattern is built into the Watermark tape during manufacture, using a proprietary process. This gives each card a secure machine readable identity - the Watermark Number - which is protected against copying, alteration or erasure.

Watermark Number

The pattern of magnetic particles formed during tape manufacture is controlled. This pattern represents a binary number, encoded using Aitken F2F principles. The bits of this raw binary data are organised into groups. Each group of 5 bits corresponds to a single hexadecimal character. The Watermark Number contains 9 - 12 of these characters, depending on format.

Tape Formats

Watermark tape is manufactured to meet specific customer requirements. There are several formats; the most appropriate format for any application should be selected in consultation with TSSI. The options available are:

Number Formats

- *Unique Numbers:*
  Each Watermark Number is different, giving every card a unique identity. This is recommended for access control, identity cards and similar applications.
- *Non-Unique Numbers:*
  A limited number of copies of each Watermark number within a specified range are made. For stored value cards, where uniqueness is not required, the cost advantages of this format are attractive.
- *Identical Numbers:*
  All tape in an individual batch has the same number. This lowest cost option still offers security, and is used in ticketing or other applications where there is less need to identify individual cards.

Orientation

- *90 Degree*
  The boundaries between areas of different particle orientation are set at 90□ to the edge of the tape. This orientation is used for applications where the primary data read from the card is the Watermark Number. Examples of applications where 90° tape is recommended are access control, ID and some stored value systems.

Watermark Tape

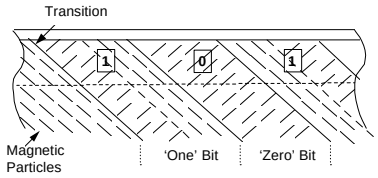
- *45 Degree*
  The boundaries between areas of different particle orientation are set at 45° to the tape edge. 45 degree tape is recommended where additional data is to be encoded on the card to ISO standards on tracks 1-3. One such application is for financial transaction cards.

Registration

- *Registered Tape*
  Tape is manufactured with the sequential Watermark numbers separated by binary zero bits (zeros). The spacing of the Watermark Numbers is matched to the card manufacturer's lay up sheet. Registration holes are punched into the tape to enable the correct placement of tape onto the sheet. This ensures that each card has a single, accurately positioned Watermark Number.
- *Non-registered Tape*
  The adjacent sequential Watermark numbers on the tape are encoded without separating zeros. This avoids the need to register the tape to the card, making the tape laying process identical to that for standard magnetic tape. Each Watermark Number occupies approximately 60% of the length of a standard card. This ensures that a Watermark Number can always be read and decoded for that card using an appropriate reader.

Bits

Binary data for all formats of tape are encoded into the tape using Aitken F2F principles. F2F encoding relies on the detection of transitions and their location relative to a unit (or 'bit') of standard length. In Watermark tape, the transitions are the boundaries between adjacent blocks of different orientation. If transitions are present only at the boundaries of the 'bit', it is a binary Zero; if an additional transition occurs at the centre of the 'bit' it is a binary One. Two Watermark bit densities (1.3 or 1.53 bits per millimetre) are available depending on the specific requirements of the application.



Bit transitions (45 degree tape)

Characters

Each Watermark character consists of four binary bits plus an odd parity check bit providing hexadecimal encoding.

Decimal Weighting	*1*	*2*	*4*	*8*	*Parity*
Binary Value	0	1	1	0	1

Example - Character Decimal 6

Registered Card Data

Leading Zeros

A minimum of 8 Leading Zeros (LZ) are encoded to allow the reader's (or decoder's) clock to synchronise for F2F decoding.

Synchronising Bit

The Synchronising Bit (SB) 1 is used to trigger the F2F decoder. If a card is read in the reverse direction, the End of Message (EOM) bit is used in a similar manner.

Start Sentinel

The Start Sentinel (SS) 0011111101 is used to locate the Watermark Number as part of the decode process.

Watermark Number

Contains between 9 and 12 characters.

Longitudinal Redundancy Check

When present the Longitudinal Redundancy Check (LRC) is the last character to be read, it is calculated by adding up the 'Ones' in the same position within each character and making the total equate to an even number. The LRC character has its own odd parity bit.

	B1	*B2*	*B3*	*B4*	*Parity*
CH1	1	0	0	0	0
CH2	0	1	0	0	0
CH3	1	1	0	0	1
CH4	0	0	1	0	0
CH5	1	0	1	0	1
CH6	0	1	1	0	1
CH7	1	1	1	0	0
CH8	0	0	0	1	0
CH9	1	0	0	1	1
LRC	1	0	0	0	0

LRC Parity Check

End of Message

The End of Message (EOM) bit 1 can be used to detect missing data if checked for position following the sentinel. Alternatively it acts as the SB when data is read in the reverse direction.

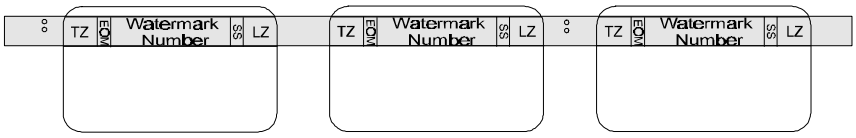
Trailing Zeros

A number of Trailing Zeros (TZ) are used to fill the card and set the decoder's clock when the card is read in the reverse direction.

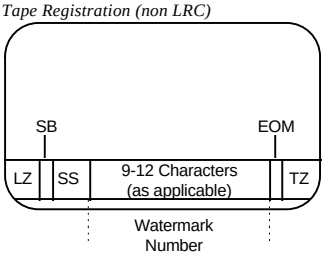
Non-Registered Card Data

When lay non-registered tape the position of the data on the card cannot be controlled. Some cards will have a complete Watermark Number preceded and followed by end and beginning segments of the two adjacent numbers (example 1). Other cards will contain incomplete end and beginning segments of two adjacent numbers (example 2). In either case a Watermark Number can be read and decoded by an appropriate reader.

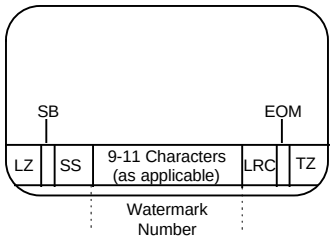
Non-Registered card data will always consist of a sequence of Watermark characters, LRC, Start Sentinel, Watermark characters etc.



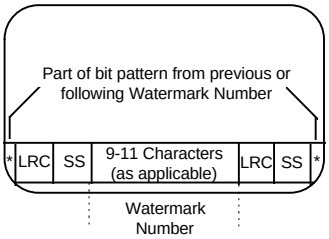
Tape Registration (non LRC)



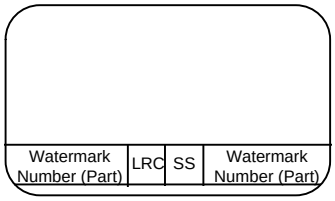
Registered (non LRC)



Registered (with LRC)



Non Registered (with LRC), example 1



Non Registered (with LRC), example 2

Tape Manufacturing

Watermark tape is manufactured using a number of processes.

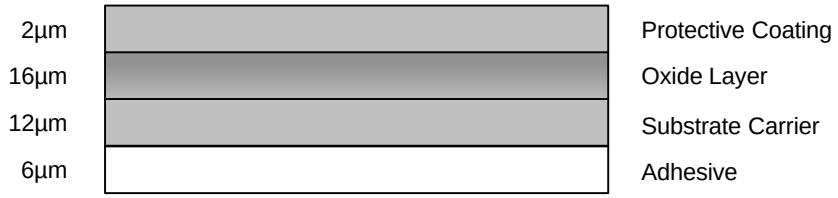
Adhesive
The adhesive is manufactured to a carefully specified formula which activates at normal laminating temperatures to attach the tape to the PVC or treated polyester card.

Substrate Carrier
This is a specially formulated polyester film which serves as a carrier, having strength, resilience, and non-stretch characteristics. In addition, it has the ability to withstand the solvent based oxide layer and the high temperatures required for the lamination process during card manufacture.

Oxide Layer
The oxide slurry is a complex formulation of components which include resins, solvents, and oxide. It is coated at controlled thickness onto a wide web of polyester base film. Both the slurry characteristics and application conditions are critical to the manufacturing process.

The magnetic particles are orientated to give the required structured pattern, and they remain in position for the rest of the process until the solvents are driven off and the resins cured. The encoded data is now fixed and cannot be erased or altered without physically destroying the magnetic medium.

Protective Coating
To improve the wear characteristics of the oxide a thin protective over layer is applied. This coating has been developed to ensure compatibility with the oxide layer and to provide excellent wear characteristics when subject to the abrasion caused by magnetic read heads.



Tape Construction - Typical Thickness

Quality control
THORN Secure Science International is accredited to internationally recognised quality standards including :
BS:EN:ISO 9002:1994

Raw materials are checked on delivery and suppliers are audited on a regular basis. Continuous on-line monitoring of the manufacturing process is performed, and the finished product is comprehensively tested before dispatch.

Each reel of tape has documentation recording the parameters measured from that reel. These include the Watermark level, mark to space ratio and asymmetry.

Security
Every precaution is taken to control availability of Watermark. All waste material is disposed in a secure manner, and all material dispatched has an audit trail. Access to production areas is strictly controlled and all personnel have been security cleared.

To maintain the Watermark tape audit trail procedures on a world-wide basis, all card manufacturers are required to enter into a licence agreement.

This agreement calls for the licensee to:

- verify the Watermark tape details immediately upon receipt.
- store the Watermark tape in a secure location with controlled access rights.
- keep records of all Watermark tape purchased and used during the term of the agreement.
- destroy all Watermark tape that has been damaged, wasted or scrapped by the licensee and maintain records accordingly.

Specifications

Physical Dimensions

Overall thickness:
30 to 42µm

Width Options:
11,43 ± 0,05mm (0,45 ± 0,002 ins)
14,99 ± 0,05mm (0,59 ± 0,002 ins)

Variable Length
Dependent on:

- card manufacturer's lay-up sheet configuration.
- the actual quantity of Watermark numbers, nominally 5000 (minimum 4500) for registered tape unless agreed otherwise.

Magnetic Properties

Coercivity
320 Oersted ± 20%

Angle of Watermark
45°
90°

Bit Densities
1.30 bits/mm ± 0.5% (standard)
1.53 bits/mm ± 0.5%

Number of Usable Characters
9 - 12 (non LRC)
9 - 11 (with LRC)

The tape is tested using proprietary equipment to determine its Watermark magnetic properties against an internally generated specification. The soft encoding properties of 45 degree orientation tape are tested to ensure conformity with ISO 7811 standards.

The following parameters are recorded on the documentation supplied with the tape:

Watermark Level

Active read:	100 ± 20
Passive read:	27 ± 5 (ES tape only) (arbitrary units)

Mark/Space Ratio

Active read:	0 ± 5%

Asymmetry

Active read:	between 35% and 70%

Batch Tolerance
The following fluctuations will be accepted in any one reel of tape:

- A maximum of 25 Words with Watermark levels above 120 and 25 Words with levels below 80 (1%).
- A maximum of 10 Words where the Watermark number cannot be properly decoded (0.2%).

A Word in this context represents a card length of tape.

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