Magnetic Stripe Cards

(All you ever wanted to know and some you didn't)

written and compiled by

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There is frequently confusion, doubt and even misinformation surrounding the humble magnetic stripe card. The following is a comprehensive guide to technical aspects of magnetic stripe cards, it is my attempt to divulge all the facts (as far as I know them and can uncover them, so please use this information with care).

Background

Magnetic stripe cards are without the most widely used cards in the world, both in access control and banking and have been around since the 1960's. While other card technologies are forging ahead and gaining wide acceptance the magnetic stripe card, due to the shear number of bank cards, credit cards, loyalty cards and the like is still by far the most widely used card world-wide.

There are two types of magnetic material used to form the magnetic stripe of a magnetic stripe card:

Standard Credit Cards use 300 Oersted magnetic tape that is generally brown in colour.
High Coercivity Cards use 4000 Oersted magnetic tape that is generally black in colour.

An Oersted (symbol Oe) is the CGS electro-magnetic unit of field strength. $1Oe = 10^3/4\pi\ Am^{-1}$

Standard magnetic tape is available from many sources and is similar to audio or videotape. High Coercivity is generally agreed to be of a value of 4000 Oersted. The 3M company is the major supplier of 4000 Oersted tape. Other manufacturers produce tape of 3500, 3000 and even 2750 Oersted that are all considered High Coercivity (Hi-Co). For access control applications 4000 Oersted tape is generally the best.

The coercivity is the values of coercive force for a substance that has been initially magnetized to saturation or more simply put its a measure of the magnetic force required to change the state (orientation) of the magnetic material. Hi-Co cards require up to 13 times the force of standard cards and as a result, they are all but immune to stray magnetic fields and are unlikely to be accidentally erased or corrupted.

A magnetic stripe card that conforms to the ISO standard can be either a standard 300 Oersted stripe or a high coercivity 4000 Oersted stripe. Bankcards currently use 300 Oersted tape to form the magnetic stripe.

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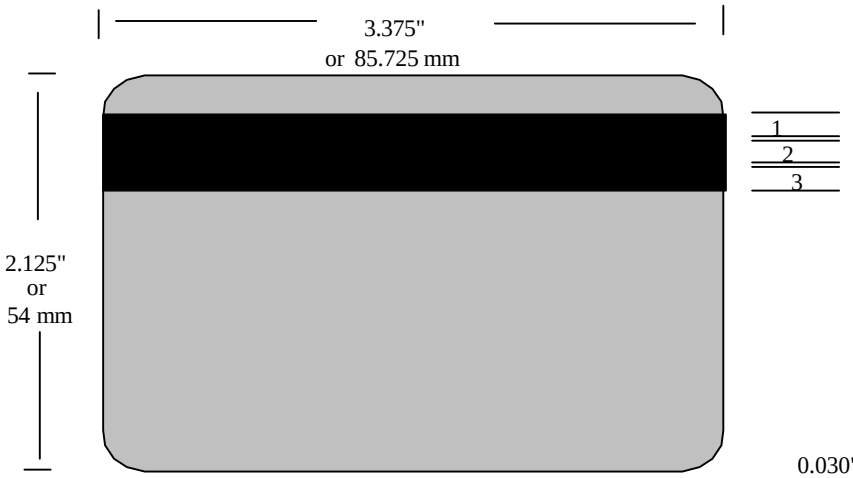

ISO 7816 Encoding Specification

	Recording Density (bits per inch)	Character Configuration (including parity bit)	Information Content (characters)
Spec'ed by IATA	210 bpi	7 bits per character	79 alphanumeric
Spec'ed by the ABA	75 bpi	5 bits per character	40 numeric only
Spec'ed by Thrift Inds.	210 bpi	5 bits per character	107 numeric only

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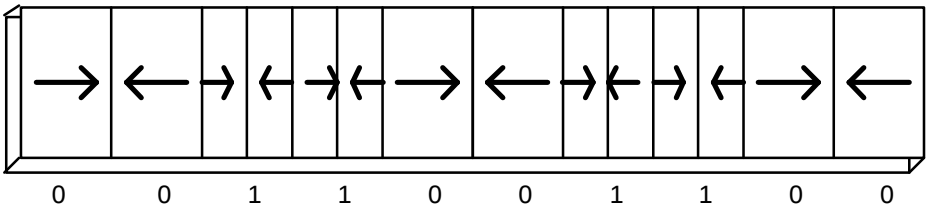
How is the data physically encoded on to the magnetic stripe?

The magnetic tape used on a standard magnetic stripe card is similar to the tape used in audio and video cassette tapes. A magnetic oxide is dispersed on to a thin plastic PVC card and bonded to its surface.



On track 2, each data bit is 75ths of an inch in length. A data 0 bit has the magnetic field aliened in one direction (the direction is not important) for a length of 75ths of an inch. A data 1 bit has a reversal of the magnetic field in the middle of the bit. There is also a reversal in the magnetic field at the edge of each bit. (See figure above).

The stripe or tape is divided in to three tracks according to ISO 7816 as follows:

Track 1

Track 1 was specified by IATA, is a read only track and is seldom used. Some banks use this track and encode the card details and the cardholders name.

Track 1 is encoded at 210 bits per inch and 7 bits per character (including parity), giving 79 **alphanumeric** characters. This track is read only.

The six data bits allow characters 0 - 9, A - Z and a few others characters such as @ = * % ( ) - / . The seventh bit is odd parity.

Data	Character	Data	Character	Data	Character	Data	Character
654321		**654321**		**654321**		**654321**	
000000	Space	010000	0	100000	*(a)*	110000	P
000001	*(a)*	010001	1	100001	A	110001	Q
000010	*(a)*	010010	2	100010	B	110010	R
000011	*(c)*	010011	3	100011	C	110011	S
000100	$	010100	4	100100	D	110100	T
000101	%*(d1)*	010101	5	100101	E	110101	U
000110	*(a)*	010110	6	100110	F	110110	V
000111	*(a)*	010111	7	100111	G	110111	W
001000	(	011000	8	101000	H	111000	X
001001	)	011001	9	101001	I	111001	Y
001010	*(a)*	011010	*(a)*	101010	J	111010	Z
001011	*(a)*	011011	*(a)*	101011	K	111011	*(b)*
001100	*(a)*	011100	*(a)*	101100	L	111100	*(b)*

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001101	-	011101	*(a)*	101101	M	111101	*(b)*
001110	.	011110	*(a)*	101110	N	111110	*(d3)*
001111	/	011111	?*(d2)*	101111	O	111111	*(a)*

(a) These characters are available for hardware control purposes only.
(b) These characters are reserved for additional national characters.
(c) Reserved for additional graphic symbols.
(d1) Start Sentinel
(d2) End Sentinel
(d3) Separator

Track 2

Track 2 was originally specified by the American Banking Association (ABA) and is without doubt the most widely used track. Most access control systems that handle magnetic stripe cards use this track. Same access control companies have products that can read encoded ISO format cards and can then enrol these cards into their system. i.e. they can use bank cards or credit cards.

Track 2 is encoded at 75 bits per inch and 5 bits per character including parity, giving 40 numeric characters. Track 2 is a read only track.

Each character consists of 4 data bits plus a parity bit. The order of the digits is normally:

Start Sentinel	1 Character
Card Data	up to 37 numeric characters
Stop Sentinel	1 Character
LRC	1 Character

Longitudinal Redundancy Check (LRC) is an even parity check on all characters, so that all characters including the LRC bit have an even parity.

Data Characters include parity and are:

Parity	Data	Character
1	0000	0
0	0001	1
0	0010	2
1	0011	3
0	0100	4
1	0101	5
1	0110	6
0	0111	7
0	1000	8
1	1001	9
1	1010	Reserved
0	1011	Start Sentinel
0	1100	Reserved
0	1101	Separator
0	1110	Reserved

1 1111 Stop Sentinel

The reserved characters are not used in credit cards, but might be used in Access Control cards. For example an ISO card number of 8902042311 is encoded on Track 2 in binary would be as follows:

01011	01000	11001	10000	00010	10000	00100	00010	10011	00001	00001	11111	1
Start	8	9	0	2	0	4	2	3	1	1	Stop	LRC

Track 3

Track 3 was originally specified by Thrift Industries and Mints, the intended use was for cashless vending. The track is a read/write track and as far as I am aware it is used by cashless vending companies and by some Banks' ATM's to write information about the last transaction, such as the amount of money withdrawn from the account on that day.

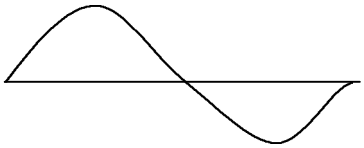
Track 3 is encoded at 210 bits per inch and 5 bits per character including parity, giving 107 numeric characters. These are the same as track 2 except that this track is used for read and write.

SCALES

To give some idea of the physical properties of the standard low coercivity tape we present the following information. It is intended to be indictive only and therefore the actual sizes may be different in reality. The particles are aliened length wise along the length of the track.

Fe_2O_3 Particle

One Wavelength of Yellow Light



Width of a Human Hair

Approximately 40 times the width of an A4 page

Surface area of a single Fe_2O_3 particle is approximately $47m^2/gm$. So roughly, 150 gms of Fe_2O_3 powder has the same surface area as a football pitch.

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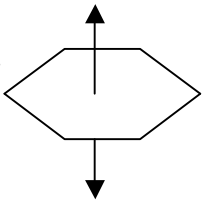
PARTICLE SHAPE

Particles for magnetic stripe tape can have many different shapes. The shape of the particles helps determine its magnetic properties.

Spherical: similar magnetic properties in all directions, therefore it can be described as isotropic

Plate: e.g. FeBa – hex plate that has its "easy axis"normal to its surface. This material is usually used in HiCo magnetic tape



Acicular: Needle shaped particles that have their "easy axis" along their length, there they can be described as anisotropic. This type of material is used in standard low coercivity tape.

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