

Date: Tue, 9 Feb 1999 12:26:00 -0800 (PST)
From: Chris Fisher <fisher@hobbes.cs.washington.edu>
To: Carl Ebeling <ebeling@olympus.cs.washington.edu>
Subject: Re: Xilinx chips

> Thanks much. On another note, I'm putting together the next Lab, which is
> to use the card reader. All I have is the data sheet, which is very thin.
> For example, it doesn't give the bit order, bits per character,
> differences between the two tracks, etc. Do you have any of this info?
> I'm going to get the students to use the logic analyzer to figure this all
> out, but we should know what the answer is so we can help them. There's
> two ways to get this, I think. 1) Use the logic analyzer ourselves and
> figure it out 2) Find the info on the web. e.g.
> <http://www.gae.ucm.es/~padilla/extrawork/stripe.html>
>
> Or a combination. Can you help on this?

The page <http://www.gae.ucm.es/~padilla/extrawork/card-o-rama.txt> seems to describe all of this. Here is the important part of the document:

**** ANSI/ISO BCD Data format ****

This is a 5-bit Binary Coded Decimal format. It uses a 16-character set, which uses 4 of the 5 available bits. The 5th bit is an ODD parity bit, which means there must be an odd number of 1's in the 5-bit character. the parity bit will "force" the total to be odd. Also, the Least Significant Bits are read FIRST on the strip. See Figure 6.

The sum of the 1's in each case is odd, thanks to the parity bit. If the read system adds up the 5 bits and gets an EVEN number, it flags the read as ERROR, and you got to scan the card again (I *know* a lot of you out there *already* understand parity, but I got to cover all the bases...not everyone sleeps with their modem and can recite the entire AT command set at will, you know). See Figure 6 for details of ANSI/ISO BCD.

Figure 6: ANSI/ISO BCD Data Format

- * Remember that b1 (bit #1) is the LSB (least significant bit)!
- * The LSB is read FIRST!
- * Hexadecimal conversions of the Data Bits are given in parenthesis (xH).

--Data Bits--				Parity	Character	Function
b1	b2	b3	b4	b5		
0	0	0	0	1	0 (0H)	Data
1	0	0	0	0	1 (1H)	"
0	1	0	0	0	2 (2H)	"
1	1	0	0	1	3 (3H)	"
0	0	1	0	0	4 (4H)	"
1	0	1	0	1	5 (5H)	"
0	1	1	0	1	6 (6H)	"
1	1	1	0	0	7 (7H)	"
0	0	0	1	0	8 (8H)	"
1	0	0	1	1	9 (9H)	"

0	1	0	1	1	:	(AH)	Control
1	1	0	1	0	;	(BH)	Start Sentinel
0	0	1	1	1	<	(CH)	Control
1	0	1	1	0	=	(DH)	Field Separator
0	1	1	1	0	>	(EH)	Control
1	1	1	1	1	?	(FH)	End Sentinel

***** 16 Character 5-bit Set *****

10 Numeric Data Characters
3 Framing/Field Characters
3 Control Characters

The magstripe begins with a string of Zero bit-cells to permit the self-clocking feature of biphasic to "sync" and begin decoding. A "Start Sentinel" character then tells the reformatting process where to start grouping the decoded bitstream into groups of 5 bits each. At the end of the data, an "End Sentinel" is encountered, which is followed by an "Longitudinal Redundancy Check (LRC) character. The LRC is a parity check for the sums of all b1, b2, b3, and b4 data bits of all preceding characters. The LRC character will catch the remote error that could occur if an individual character had two compensating errors in its bit pattern (which would fool the 5th-bit parity check).

The START SENTINEL, END SENTINEL, and LRC are collectively called "Framing Characters", and are discarded at the end of the reformatting process.

** ANSI/ISO ALPHA Data Format **

Alphanumeric data can also be encoded on magstripes. The second ANSI/ISO data format is ALPHA (alphanumeric) and involves a 7-bit character set with 64 characters. As before, an odd parity bit is added to the required 6 data bits for each of the 64 characters. See Figure 7.

Figure 7:

ANSI/ISO ALPHA Data Format

- * Remember that b1 (bit #1) is the LSB (least significant bit)!
- * The LSB is read FIRST!
- * Hexadecimal conversions of the Data Bits are given in parenthesis (xH).

-----Data Bits-----						Parity	Character	Function
b1	b2	b3	b4	b5	b6	b7		
0	0	0	0	0	0	1	space (0H)	Special
1	0	0	0	0	0	0	! (1H)	"
0	1	0	0	0	0	0	" (2H)	"
1	1	0	0	0	0	1	# (3H)	"
0	0	1	0	0	0	0	\$ (4H)	"
1	0	1	0	0	0	1	% (5H)	Start Sentinel
0	1	1	0	0	0	1	& (6H)	Special
1	1	1	0	0	0	0	' (7H)	"
0	0	0	1	0	0	0	((8H)	"
1	0	0	1	0	0	1) (9H)	"
0	1	0	1	0	0	1	* (AH)	"
1	1	0	1	0	0	0	+ (BH)	"

0	0	1	1	0	0	1	,	(CH)	"
1	0	1	1	0	0	0	-	(DH)	"
0	1	1	1	0	0	0	.	(EH)	"
1	1	1	1	0	0	1	/	(FH)	"
0	0	0	0	1	0	0	0	(10H)	Data (numeric)
1	0	0	0	1	0	1	1	(11H)	"
0	1	0	0	1	0	1	2	(12H)	"
1	1	0	0	1	0	0	3	(13H)	"
0	0	1	0	1	0	1	4	(14H)	"
1	0	1	0	1	0	0	5	(15H)	"
0	1	1	0	1	0	0	6	(16H)	"
1	1	1	0	1	0	1	7	(17H)	"
0	0	0	1	1	0	1	8	(18H)	"
1	0	0	1	1	0	0	9	(19H)	"
0	1	0	1	1	0	0	:	(1AH)	Special
1	1	0	1	1	0	1	;	(1BH)	"
0	0	1	1	1	0	0	<	(1CH)	"
1	0	1	1	1	0	1	=	(1DH)	"
0	1	1	1	1	0	1	>	(1EH)	"
1	1	1	1	1	0	0	?	(1FH)	End Sentinel
0	0	0	0	0	1	0	@	(20H)	Special
1	0	0	0	0	1	1	A	(21H)	Data (alpha)
0	1	0	0	0	1	1	B	(22H)	"
1	1	0	0	0	1	0	C	(23H)	"
0	0	1	0	0	1	1	D	(24H)	"
1	0	1	0	0	1	0	E	(25H)	"
0	1	1	0	0	1	0	F	(26H)	"
1	1	1	0	0	1	1	G	(27H)	"
0	0	0	1	0	1	1	H	(28H)	"
1	0	0	1	0	1	0	I	(29H)	"
0	1	0	1	0	1	0	J	(2AH)	"
1	1	0	1	0	1	1	K	(2BH)	"
0	0	1	1	0	1	0	L	(2CH)	"
1	0	1	1	0	1	1	M	(2DH)	"
0	1	1	1	0	1	1	N	(2EH)	"
1	1	1	1	0	1	0	O	(2FH)	"
0	0	0	0	1	1	1	P	(30H)	"
1	0	0	0	1	1	0	Q	(31H)	"
0	1	0	0	1	1	0	R	(32H)	"
1	1	0	0	1	1	1	S	(33H)	"
0	0	1	0	1	1	0	T	(34H)	"
1	0	1	0	1	1	1	U	(35H)	"
0	1	1	0	1	1	1	V	(36H)	"
1	1	1	0	1	1	0	W	(37H)	"
0	0	0	1	1	1	0	X	(38H)	"
1	0	0	1	1	1	1	Y	(39H)	"
0	1	0	1	1	1	1	Z	(3AH)	"
1	1	0	1	1	1	0	[(3BH)	Special
0	0	1	1	1	1	1	\	(3DH)	Special
1	0	1	1	1	1	0]	(3EH)	Special
0	1	1	1	1	1	0	^	(3FH)	Field Separator
1	1	1	1	1	1	1	_	(40H)	Special

***** 64 Character 7-bit Set *****

* 43 Alphanumeric Data Characters

* 3 Framing/Field Characters

* 18 Control/Special Characters

The two ANSI/ISO formats, ALPHA and BCD, allow a great variety of data to be stored on magstripes. Most cards with magstripes use these formats, but occasionally some do not.

Figure 9:

ANSI/ISO Track 1,2,3 Standards

Track	Name	Density	Format	Characters	Function
1	IATA	210 bpi	ALPHA	79	Read Name & Account
2	ABA	75 bpi	BCD	40	Read Account
3	THRIFT	210 bpi	BCD	107	Read Account & Encode Transaction

*** Track 1 Layout: ***

| SS | FC | PAN | Name | FS | Additional Data | ES | LRC |

SS=Start Sentinel "%"

FC=Format Code

PAN=Primary Acct. # (19 digits max)

FS=Field Separator "^"

Name=26 alphanumeric characters max.

Additional Data=Expiration Date, offset, encrypted PIN, etc.

ES=End Sentinel "?"

LRC=Longitudinal Redundancy Check

*** Track 2 Layout: ***

| SS | PAN | FS | Additional Data | ES | LRC |

SS=Start Sentinel ";"

PAN=Primary Acct. # (19 digits max)

FS=Field Separator "="

Additional Data=Expiration Date, offset, encrypted PIN, etc.

ES=End Sentinel "?"

LRC=Longitudinal Redundancy Check