Two-Dimensional (2D) Bar Codes in AFP

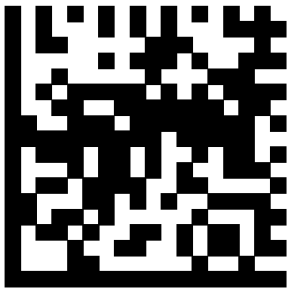
Topics

- ***Picture of 2D bar code symbols***

- ***IBM architecture status***

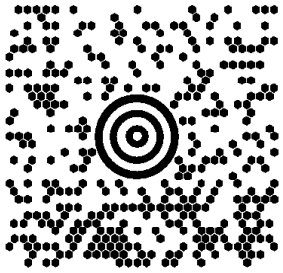
- ***Characteristics of each symbology***
  - < Data Matrix
  - < MaxiCode
  - < PDF417

- ***Data stream specifics***
  - < MO:DCA
  - < AFP line data
  - < IPDS
  - < BCOCA

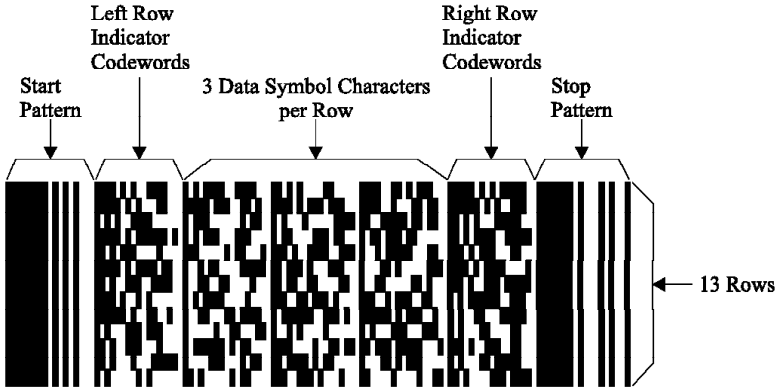


Data Matrix 2D Symbol

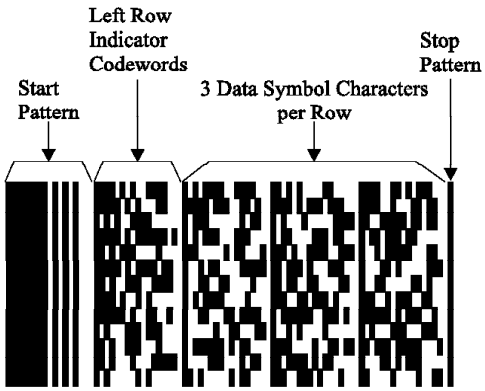
(encoding A1B2C3D4E5F6G7H8I9J0K1L2)



MaxiCode 2D Symbol



PDF417



Truncated PDF417

IBM Architecture Status

Three 2D bar code symbologies have been added to the Bar Code Object Content Architecture (BCOCA)

- BCOCA Reference manual is available now

  Hardcopy is orderable (S544-3766-04)

  PDF softcopy is available on the PSD website
  http://www.printers.ibm.com/R5PSC.NSF/Web/archm

- Symbologies specifications can be ordered from
  http://www.aimusa.org/aimstore/
  prices range from $48 to $100

  AIM International Technical Specification -- Data Matrix
  AIM International Technical Specification -- MaxiCode
  AIM Uniform Symbology Specification -- PDF417

Data Matrix Characteristics (a checkerboard-like symbol)

Data Matrix 2D Symbol
(encoding A1B2C3D4E5F6G7H8I9J0K1L2)

- Rectangular symbol (see page 6)
- Finder pattern: L-shaped alignment bars and alternating light dark modules; repeated within the symbol for larger symbols
- Extensive data compaction and error correction codes
- Reed-Solomon Error Checking and Correcting (ECC) algorithm
- ***Normal BCOCA parameters:***
  - < Each 2D module is a square, specified by the module-width parameter
  - < Element-height, height-multiplier, and wide-to-narrow ratio parameters are not used (ignored)
  - < One modifier (X'00') -- present a Data Matrix bar code symbol using ECC algorithm 200.
  - < No human-readable interpretation (HRI)
  - < Can encode up to 3116 characters per symbol depending on whether the data is character or numeric (can encode binary data)
  - < Default character encodation is ASCII ECI 000003 (an international Latin 1 code page equivalent to IBM code page 819)

Data Matrix Characteristics (continued)

Data Matrix 2D Symbol
(encoding A1B2C3D4E5F6G7H8I9J0K1L2)

- ***Special 2D function BCOCA parameters:***

  < EBCDIC-to-ASCII translation (code page 500 to code page 819)

  < Ability to ignore escape sequences (which start with a back-slash)
  in theory, escape sequences allow for code page switching using Extended Channel Interpretation (ECI) protocol numbers

  < Desired row size, can use X'0000' to let printer choose
  < Desired number of rows, can use X'0000' to let printer choose

  * Amount of data determines actual size
  * Aspect ratio is maintained

  < Structured append information (x of y plus file identification)

  < Symbol conforms to specific industry standards

  < Symbol is reader programming information

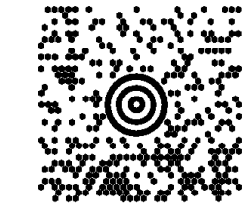
  < Macro characters to indicate a specific header or trailer

Data Matrix Characteristics (continued)

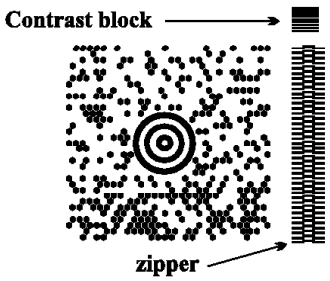
Data Matrix 2D Symbol
(encoding A1B2C3D4E5F6G7H8I9J0K1L2)

Square Symbols				Rectangular Symbols			
Symbol Size		Data Region		Symbol Size		Data Region	
Num-ber of rows	Row size	Size	Num-ber	Num-ber of rows	Row size	Size	Num-ber
10	10	8x8	1	8	18	6x16	1
12	12	10x10	1	8	32	6x14	2
14	14	12x12	1	12	26	10x24	1
16	16	14x14	1	12	36	10x16	2
18	18	16x16	1	16	36	14x16	2
20	20	18x18	1	16	48	14x22	2
22	22	20x20	1				
24	24	22x22	1				
26	26	24x24	1				
32	32	14x14	4				
36	36	16x16	4				
40	40	18x18	4				
44	44	20x20	4				
48	48	22x22	4				
52	52	24x24	4				
64	64	14x14	16				
72	72	16x16	16				
80	80	18x18	16				
88	88	20x20	16				
96	96	22x22	16				
104	104	24x24	16				
120	120	18x18	36				
132	132	20x20	36				
144	144	22x22	36				

MaxiCode Characteristics
(a targeted honeycomb symbol)
(originated by United Parcel Service)

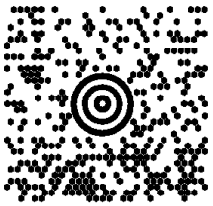


MaxiCode 2D Symbol

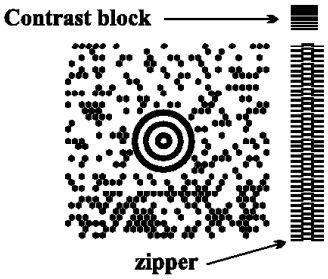


- Square honeycomb-like symbol
- Fixed size (nominally 28.14 mm by 26.91 mm)
- Finder pattern: the target
- Test pattern: contrast block and zipper
- Extensive data compaction and error correction codes
- Reed-Solomon Error Checking and Correcting (ECC) algorithm
- ***Normal BCOCA parameters:***
  - < Each 2D module is a fixed-size hexagon
  - < Module width, element-height, height-multiplier, and wide-to-narrow ratio parameters are not used (ignored)
  - < One modifier (X'00') -- present a MaxiCode bar code symbol
  - < No human-readable interpretation (HRI)
  - < Can encode up to 98 alphanumeric characters or up to 138 numeric characters per symbol
  - < Default character encodation is ASCII ECI 000003 (an international Latin 1 code page equivalent to IBM code page 819)

MaxiCode Characteristics (continued)



MaxiCode 2D Symbol



- ***Special 2D function BCOCA parameters:***

  < EBCDIC-to-ASCII translation (code page 500 to code page 819)

  < Ability to ignore escape sequences (which start with a back-slash)

  in theory, escape sequences allow for code page switching using Extended Channel Interpretation (ECI) protocol numbers

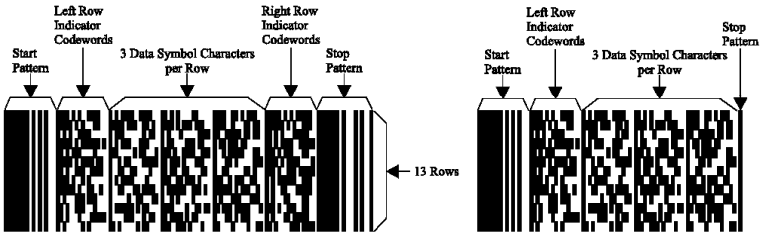
  < Symbol mode:

  Mode 2 Structured Carrier Message - numeric postal code
  Mode 3 Structured Carrier Message - alphanumeric postal code
  Mode 4 Standard Symbol
  Mode 5 Full EEC Symbol
  Mode 6 Reader Programming

  < Structured append information (x of y)

  < Zipper and contrast block (yes or no)

PDF417 Characteristics
(a stacked bar code symbol)
(originated by Symbol Technologies, Inc.)



PDF417 Truncated PDF417

- Rectangular symbol consisting of rows and columns of one-dimensional bar codes
- Finder pattern: start and stop patterns
- Extensive data compaction

  a combination of compaction schemes is selected by the printer based on input data

- Reed-Solomon Error Checking and Correcting (ECC) algorithm
- ***Normal BCOCA parameters:***
  - < Each 2D module is a rectangle whose size is specified by the module width, element-height, and height-multiplier parameters
  - < The wide-to-narrow ratio parameter is not used (ignored)
  - < Two modifiers:

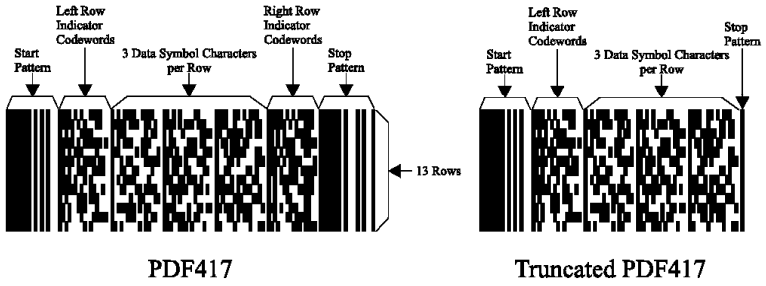
    Modifier X'00' Present a full PDF417 bar code symbol

    Modifier X'01' Present a truncated PDF417 bar code symbol

    for use in a relatively clean environment in which damage to the symbol is unlikely. This version omits the right row indicator and simplifies the stop pattern into a single module width bar.

  - < No human-readable interpretation (HRI)
  - < Can encode up to 1850 text characters, 2710 numeric digits, or 1108 bytes of binary per symbol depending upon security level
  - < Default character encodation is Global Label Identifier (GLI) protocol 0 (an ASCII code page that is similar to IBM code page 437)

PDF417 Characteristics (continued)



- ***Special 2D function BCOCA parameters:***

  < EBCDIC-to-ASCII translation (a subset of code page 500 to GLI 0, see next two pages)

  < Ability to ignore escape sequences (which start with a back-slash)

  in theory, escape sequences allow for code page switching using Global Label Identifier (GLI) protocol numbers

  < Number of data symbol characters per row

  < Desired number of rows, can use X'FF' to let printer produce the minimum number of rows

  actual number of rows is determined by the amount of data and by the security level selected

  < Security level 1-8 (maximum limit of erasures + 2*misdecodes)

Number of Data Codewords	**Recommended Security Level**
1-40	2
41-160	3
161-320	4
321-863	5

  < Macro PDF417 Control Block

PDF417 Characteristics (continued)

Table 5 in the Uniform Symbology Specification -- PDF417 shows the full set of GLI 0 code points; from this set, the 75 code points that have no EBCDIC equivalent are as follows:

158, 159, 169, 176-224, 226-229, 231-240, 242-245, 247, 249, 251-252, and 254.

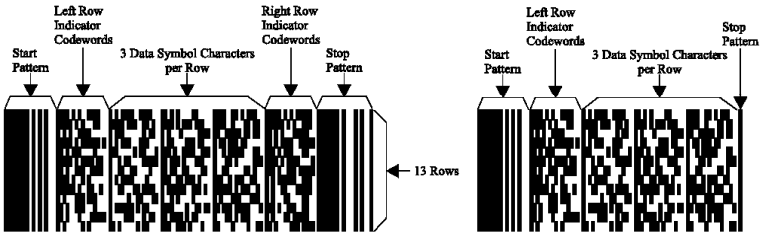
The 75 EBCDIC code points that are not covered by the translation and are thus mapped into X'7F' are as follows:

X'04', X'06', X'08'-X'0A', X'14'-X'15', X'17', X'1A'-X'1B', X'20'-X'24', X'28'-X'2C', X'30'-X'31', X'33'-X'36', X'38'-X'3B', X'3E', X'46', X'62', X'64'-X'66', X'6A', X'70', X'72'-X'78', X'80', X'8C'-X'8E', X'9D', X'9F', X'AC'-X'AF', X'B4'-X'B6', X'B9', X'BC'-X'BF', X'CA', X'CF', X'DA', X'EB', X'ED'-X'EF', X'FA'-X'FB', X'FD'-X'FF'.

Hex Digits 1st → 2nd ↓	0-	1-	2-	3-	4-	5-	6-	7-	8-	9-	A-	B-	C-	D-	E-	F-
-0	NUL SE010000	DLE SE170000			(SP) SP010000	& SM030000	_ SP100000			° SM190000	µ SM170000	¢ SC040000	{ SM110000	} SM140000	\ SM070000	0 ND100000
-1	SOH SE020000	DC1 SE180000			(RSP) SP300000	é LE110000	/ SP120000	É LE120000	a LA010000	j LJ010000	~ SD190000	£ SC020000	A LA020000	J LJ020000	÷ SA060000	1 ND010000
-2	STX SE030000	DC2 SE190000		SYN SE230000	â LA150000	ê LE150000			b LB010000	k LK010000	s LS010000	¥ SC050000	B LB020000	K LK020000	S LS020000	2 ND020000
-3	ETX SE040000	DC3 SE200000			ä LA170000	ë LE170000	Ä LA180000		c LC010000	l LL010000	t LT010000	· SD630000	C LC020000	L LL020000	T LT020000	3 ND030000
-4					à LA130000	è LE130000			d LD010000	m LM010000	u LU010000		D LD020000	M LM020000	U LU020000	4 ND040000
-5	HT SE100000		LF SE110000		á LA110000	í LI110000			e LE010000	n LN010000	v LV010000		E LE020000	N LN020000	V LV020000	5 ND050000
-6		BS SE090000	ETB SE240000			î LI150000			f LF010000	o LO010000	w LW010000		F LF020000	O LO020000	W LW020000	6 ND060000
-7	DEL SE330000		ESC SE280000	EOT SE050000	å LA270000	ï LI170000	Å LA280000		g LG010000	p LP010000	x LX010000	¼ NF040000	G LG020000	P LP020000	X LX020000	7 ND070000
-8		CAN SE250000			ç LC410000	ì LI130000	Ç LC420000		h LH010000	q LQ010000	y LY010000	½ NF010000	H LH020000	Q LQ020000	Y LY020000	8 ND080000
-9		EM SE260000			ñ LN190000	ß LS610000	Ñ Ln200000	` SD130000	i LI010000	r LR010000	z LZ010000		I LI020000	R LR020000	Z LZ020000	9 ND090000
-A					[SM060000	] SM080000		: SP130000	« SP170000	ª SM210000	¡ SP030000	¬ SM660000			² ND021000	
-B	VT SE120000				. SP110000	$ SC030000	, SP080000	# SM010000	» SP180000	º SM200000	¿ SP160000	| SM130000	ô LO150000	û LU150000		
-C	FF SE130000	FS SE350000		DC4 SE210000	< SA030000	* SM040000	% SM020000	@ SM050000		æ LA510000			ö LO170000	ü LU170000	Ö LO180000	Ü LU180000
-D	CR SE140000	GS SE360000	ENQ SE060000	NAK SE220000	(SP060000	) SP070000	_ SP090000	' SP050000					ò LO130000	ù LU130000		
-E	SO SE150000	RS SE370000	ACK SE070000		+ SA010000	; SP140000	> SA050000	= SA040000		Æ LA520000			ó LO110000	ú LU110000		
-F	SI SE160000	US SE380000	BEL SE080000	SUB SE270000	! SP020000	^ SD150000	? SP150000	" SP040000	± SA020000					ÿ LY170000		

Figure 1. : Subset of EBCDIC code page 500 that can be translated to GLI 0

PDF417 Characteristics (continued)



PDF417 Truncated PDF417

GLI 0 code points that have no EBCDIC equivalent

158	Pt	188	╝	203	╦	218	┌	235	δ
159	*f*	189	╜	204	╠	219	▉	236	∞
169	⌐	190	╛	205	═	220	▄	237	∅
176	⁞	191	┐	206	╬	221	▌	238	∈
177	▒	192	└	207	╧	222	▐	239	∩
178	▓	193	┴	208	╨	223	▀	240	≡
179	│	194	┬	209	╤	224	α	242	≥
180	┤	195	├	210	╥	226	Γ	243	≤
181	╡	196	─	211	╙	227	π	244	⌠
182	╢	197	┼	212	╘	228	Σ	245	⌡
183	╖	198	╞	213	╒	229	σ	247	≈
184	╕	199	╟	214	╓	231	τ	249	•
185	╣	200	╚	215	╫	232	ϕ	251	√
186	║	201	╔	216	╪	233	θ	252	ⁿ
187	╗	202	╩	217	┘	234	Ω	254	■

Data Stream Specifics

MO:DCA Architecture changes -- none

Begin Bar Code Object (BBC, D3A8EB)

(D3..C7) Object Environment Group

< (BDA, D3EEEB) Bar Code Data (S) >

End Bar Code Object (EBC, D3A9EB)

AFP line data -- triplets in a PAGEDEF

- Bar codes are specified in one of the following places:
  Line Descriptor (LND)
  Record Descriptor (RCD)
  using a Bar Code Symbol Descriptor (X'69') triplet
- Special 2D function BCOCA parameters are specified in a new "Additional Bar Code Parameters (X'7B') triplet"

Data Stream Specifics (continued)

Additional Bar Code Parameters (X'7B') triplet

This is an optional triplet that specifies additional parameters for non-linear bar code symbologies (e.g. 2D bar codes). This triplet may occur one or more times when a Bar Code Symbol Descriptor (X'69') triplet is specified. If this triplet is specified more than once, the data from each triplet will be concatenated in the order it is received. If a X'69' triplet is not specified, the X'7B' triplet is ignored. If a X'7B' triplet is specified and the X'69' triplet selects a linear bar code symbol, the results will be unpredictable.

Off-set	Type	Name	Range	Meaning	M/O
0	UBIN	Tlength	4-254	Length of the triplet, including Tlength	M
1	CODE	Tid	X'7B'	Identifies the Additional Bar Code Parameters Triplet	M
2				Reserved; must be zero	M
3-n	CODE	AddParm		Additional parameters for non-linear bar code symbols.	M

Triplet X'7B' Semantics

Tlength: contains the length of the triplet.

Tid: identifies the Additional Bar Code Parameters triplet.

AddParm: specifies additional parameters for non-linear bar code symbols. These parameters are specific to the particular symbology and may include parameters like symbol size (rows/columns) and processing mode.

Note: The data carried by a Bar Code Symbol Descriptor (X'69') triplet, with the exception of the SymbFlgs parameter, is used to build the Bar Code Data Descriptor (BDD) structured field for the resulting bar code object. The data carried by the Additional Bar Code Parameters triplet, along with the SymbFlgs parameter, the LND or RCD position, and the LND or RCD data, is used to build a Bar Code Data (BDA) structured field for the resulting bar code object. For a description of the contents of the Bar Code Data structured field, see the *Bar Code Object Content Architecture Reference*, S544-3766.

Data Stream Specifics (continued)

IPDS changes

1. New values returned in Obtain Printer Characteristics reply:

   X'1C' -- Data Matrix supported
   X'1D' -- MaxiCode supported
   X'1E' -- PDF417 supported

2. New exception conditions:

   X'040F..00' Either the matrix row size value or the number of rows value specified in the BSA data structure is unsupported.
   X'040F..01' An invalid structured append sequence indicator was specified in the BSA data structure.
   X'040F..02' A structured append sequence indicator specified in the BSA data structure is larger than the total number of structured append symbols.
   X'040F..03' Mismatched structured append information was specified in the BSA data structure.
   X'040F..04' An invalid number of structured append symbols was specified in the BSA data structure.
   X'040F..05' For a MaxiCode symbol, the symbol mode value specified in the BSA data structure is invalid.
   X'040F..06' For a PDF417 symbol, the number of data symbol characters per row value specified in the BSA data structure is invalid.
   X'040F..07' For a PDF417 symbol, the desired number of rows value specified in the BSA data structure is invalid.
   X'040F..08' For a PDF417 symbol, too much data was specified in the BSA data structure.
   X'040F..09' For a PDF417 symbol, the security level value specified in the BSA data structure is invalid.
   X'040F..0A' An incompatible combination of Data Matrix parameters was specified in the BSA data structure.
   X'040F..0B' An invalid structured append file identification value was specified in the BSA data structure.
   X'040F..0C' A Macro PDF417 Control Block length value specified in the BSA data structure is invalid.
   X'040F..0D' Data within a Macro PDF417 Control Block specified in the BSA data structure is invalid.

Data Stream Specifics (continued)

BCOCA Architecture changes

- Bar Code Symbol Descriptor (BSD) changes -- none

  Type X'1C' -- Data Matrix
  X'1D' -- MaxiCode supported
  X'1E' -- PDF417 supported

  LID Not used, no HRI

  Module width Data Matrix and PDF417

  Element height PDF417

  Height multiplier PDF417

  WE:NE ratio Not used

- Bar Code Symbol Data (BSA) changes

Offset	Type	Name	Range	Meaning	BCD1 Range
0	BITS	Flags			
1-2	UBIN	Xoffset	X'0001'-X'7FFF'	Xbc-coordinate of the symbol origin in the bar code presentation space	X'0001'-X'7FFF'
3-4	UBIN	Yoffset	X'0001'-X'7FFF'	Ybc-coordinate of the symbol origin in the bar code presentation space	X'0001'-X'7FFF'
The following special-function information is only used with the following bar code types: Data Matrix, MaxiCode, PDF417					
5-n	Special functions	See field description	Special-function information that is specific to the bar code type	Not supported in BCD1	
The following symbol data is specified for all bar code types					
n+1 to end	UNDF	Data	Any value defined for the bar code type selected by the BSD	Data to be encoded	Any value defined for the bar code type selected by the BSD

Data Matrix
Special-Function Parameters

Offset | Type	Name	Range	Meaning	BCD1 Range
5 BITS			Control flags	
bit 0	EBCDIC	B'0' B'1'	EBCDIC-to-ASCII translation: Do not translate Convert data from EBCDIC to ASCII	Not supported in BCD1
bit 1	Escape sequence handling	B'0' B'1'	Escape-sequence handling: Process escape sequences Ignore all escape sequences	Not supported in BCD1
bits 2-7		B'000000'	Reserved	
6-7 UBIN	Desired row size	X'0000' X'0001' - X'FFFF'	No size specified Matrix row size as allowed by symbology; see field description	Not supported in BCD1
8-9 UBIN	Desired number of rows	X'0000' X'0001' - X'FFFF'	No size specified Number of rows as allowed by symbology; see field description	Not supported in BCD1
10 UBIN	Sequence indicator	X'00' - X'10'	Structured append sequence indicator	Not supported in BCD1
11 UBIN	Total symbols	X'00' or X'02' - X'10'	Total number of structured-append symbols	Not supported in BCD1
12 UBIN	File ID 1st byte	X'01' - X'FE'	High-order byte of a 2-byte unique file identification for a set of structured-append symbols	Not supported in BCD1
13 UBIN	File ID 2nd byte	X'01' - X'FE'	Low-order byte of a 2-byte unique file identification for a set of structured-append symbols	Not supported in BCD1
14 BITS			Special-function flags	
bit 0	UCC/EAN FNC1	B'0' B'1'	Alternate data type identifier: User-defined symbol Symbol conforms to UCC/EAN standards	Not supported in BCD1
bit 1	Industry FNC1	B'0' B'1'	Alternate data type identifier: User-defined symbol Symbol conforms to industry standards	Not supported in BCD1
bit 2	Reader programming	B'0' B'1'	Reader programming symbol: Symbol encodes a data symbol Symbol encodes a message used to program the reader system	Not supported in BCD1
bits 3-4	Hdr/Trl Macro	B'00' B'01' B'10' B'11'	Header and trailer instructions to the bar code reader: No header or trailer Use the 05 Macro header/trailer Use the 06 Macro header/trailer No header or trailer	Not supported in BCD1
bits 5-7		B'000'	Reserved	

MaxiCode
Special-Function Parameters

Offset | Type	Name	Range	Meaning	BCD1 Range
5 BITS			Control flags	
bit 0	EBCDIC	B'0' B'1'	EBCDIC-to-ASCII translation: Do not translate Convert data from EBCDIC to ASCII	Not supported in BCD1
bit 1	Escape sequence handling	B'0' B'1'	Escape-sequence handling: Process escape sequences Ignore all escape sequences	Not supported in BCD1
bits 2-7		B'000000'	Reserved	
6 CODE	Symbol mode	X'02' X'03' X'04' X'05' X'06'	Mode 2 Mode 3 Mode 4 Mode 5 Mode 6	Not supported in BCD1
7 UBIN	Sequence indicator	X'00' - X'08'	Structured append sequence indicator	Not supported in BCD1
8 UBIN	Total symbols	X'00' or X'02' - X'08'	Total number of structured-append symbols	Not supported in BCD1
9 BITS			Special-function flags	
bit 0	Zipper	B'0' B'1'	No zipper pattern Vertical zipper pattern on right	Not supported in BCD1
bits 1-7		B'0000000'	Reserved	

PDF417
Special-Function Parameters

Offset | Type	Name	Range	Meaning	BCD1 Range
5 BITS			Control flags	
bit 0	EBCDIC	B'0' B'1'	EBCDIC-to-ASCII translation: Do not translate Convert data from EBCDIC to ASCII	Not supported in BCD1
bit 1	Escape sequence handling	B'0' B'1'	Escape-sequence handling: Process escape sequences Ignore all escape sequences	Not supported in BCD1
bits 2-7		B'000000'	Reserved	
6 UBIN	Data symbols	X'01 - X'1E'	Number of data symbol characters per row	Not supported in BCD1
7 UBIN	Rows	X'03 - X'5A' X'FF'	Desired number of rows Minimum necessary rows	Not supported in BCD1
8 UBIN	Security	X'00' - X'08'	Security level	Not supported in BCD1
9-10 UBIN	Macro length	X'0000' - X'7FED'	Length of Macro PDF417 Control Block that follows	Not supported in BCD1
11-n UBIN	Macro data	Any value	Data for a Macro PDF417 Control Block	Not supported in BCD1