

Chapter 15: Configure Raster Data

Introduction

The Configure Raster Data (CRD) command performs many of the same functions as the Configure Image Data (CID) command described in Chapter 14. The two commands are not mutually exclusive, but no device has yet chosen to support both.

The CRD command currently has four different forms, determined by the format number in the first byte of binary data following the command. The formats are numbered from 2 to 5 (Format 1 is obsolete). Each of these forms configures the raster data differently.

Format Number	Type of Data
1	Complex Direct Planar (obsolete)
2	Complex Direct Planar
3	RGB Direct by Pixel
4	Indexed by Pixel
5	Mixed Monochrome and Indexed by Pixel

Format 2 configures for direct planar raster transfers. The data is sent by planes, with each plane supplying one bit for each pixel in row. Pixel color is specified directly (i.e., independent of a palette). Format 2 also specifies the horizontal resolution, vertical resolution, and the number of intensity levels for each component.

Format 3 configures for direct RGB pixel-by-pixel raster transfers. Each pixel is specified directly (i.e., independent of a palette). The horizontal and vertical resolution of the source pixels is also specified.

Format 4 configures for indexed pixel-by-pixel raster transfers. The bits for each pixel form an index number to a palette entry, which is the color of the pixel. All the bits for each pixel are sent before any bits are sent for the next pixel. The horizontal and vertical resolution of the source pixels is also specified.

Format 5 configures for an indexed pixel-encoded component and a direct monochrome component. The indexed data forms an index into the current palette for each pixel to be printed.

Configure Raster Data (CRD) *Esc * g # w/W*

The Configure Raster Data (CRD) command configures the device for complex raster data transfers.

Value(#) = Number of data bytes
 Default = NA
 Range = 6 to $2^{32} - 1$

DEVICE NOTE: DeskJet 520, 560C and 850C support a maximum range of 32767.

DEVICE NOTE: DeskJet 850C locks out Simple Color (*Esc*r#U*) and Raster Resolution (*Esc*t#R*) after a valid CRD until the receipt of an *EscE* or equivalent device reset, or a CRD command with a value field of 0 (*Esc*g0W*). A CRD command with a 0 value field unlocks Simple Raster (*Esc*r#U*) and Raster Resolution (*Esc*t#R*), resets the horizontal and vertical resolutions to 75 ppi, and resets the raster mode to one-bit direct (monochrome).

The data field must contain byte-aligned binary data, not ASCII. Unsupported or out-of-range values or other invalid configurations cause the entire command to be ignored and the data bytes to be discarded. Extra bytes are discarded. Value-field signs are ignored.

CRD provides raster configurations having one or more of the following characteristics:

- Horizontal resolution differs from vertical resolution.
- Color components may be specified at different resolutions.
- Each component may be specified at a multiple intensity level.
- Indexed raster data is separate from palette configuration.
- Direct raster data does not affect the palette configuration.
- Mixed indexed raster data and monochrome data for sleek top to bottom printing.

Reset (*EscE*), Simple Color (*Esc*r#U*), and CID (*Esc*v#W*) override a CRD configuration.

Raster resolution is determined by the most recent CRD even if it is of another format, or by the Raster Resolution (*Esc*t#R*) command. A Raster Resolution command issued after CRD:

- Sets horizontal and vertical resolutions for each component to the specified resolution.
- Matches the strip height for each component to the new resolution.
- Establishes a pixel unit size for source raster height and width.
- Zeros the seed rows.
- Sets the number of levels for each component to 2.
- Has no effect on the number of expected components (raster indexing mode is unchanged).

The lowest CRD horizontal resolution determines the horizontal pixel size for the Source Raster Width (*Esc*r#S*), to which all the planes of all the rows for all components are zero-filled or clipped. Similarly, the lowest CRD vertical resolution determines the vertical pixel size for Source Raster Height (*Esc*r#T*), which defines raster area vertical height.

Missing data is zero-filled if Raster Resolution is changed or a Y Offset (*Esc*b#Y*) command is received after only part of the data defining a strip is sent.

NOTE: Seed Row Source (*Esc*b#S*) should not be used for CRD raster data; the result is undefined.

As usual, the Transfer Raster commands (*Esc*b#W*, *Esc*b#V*) download raster data, and the Compression Method (*Esc*b#M*) command defines the compression rules.

As shown below, CRD has different forms based on the format byte. Each form of CRD shares only the first byte, the format number, with the other forms of CRD. Note that Format 1 is obsolete. Format 2 is identical to Format 1 except in the four-component KCMY case. Format 2 sends the data in component order: cyan, magenta, yellow, black; Format 1 sends black first. Format 2 should be used in all future implementations.

DEVICE NOTE: Format 1 was used only on DeskJet 520 and DeskJet 560C and is being obsoleted in favor of Format 2, which should be used on all future implementations.

Format Number	Type of Data
1	Complex Direct Planar (obsolete)
2	Complex Direct Planar
3	RGB Direct by Pixel
4	Indexed by Pixel
5	Mixed Monochrome and Indexed by Pixel

Format 2 Complex Direct Planar

Format 2 configures for raster transfers where:

- Horizontal resolution differs from vertical resolution.
- Color components are specified at different resolutions.
- Multiple intensity levels are specified for one or more components.

The data for each color component is organized into strips containing one or more rows. The lowest vertical-resolution component determines the vertical displacement of the other components; higher vertical-resolution components require more rows than lower-resolution components to cover the same vertical displacement. The horizontal resolution determines the number of bytes required to define a row (e.g., 600 dpi rows contain 8 times as many bytes as 75 dpi rows). Higher horizontal and vertical resolutions must be multiples of lower horizontal and vertical resolutions, respectively. The CRD command is ignored for unsupported resolutions.

Byte	15 (MSB)	8	7 (LSB)	0	Byte
0	Format=2 (UBYTE)		Number of components (UBYTE)		1
2	Horizontal Resolution for Component 1 (UINT16)				3
4	Vertical Resolution for Component 1 (UINT16)				5
6	Number of Levels for Component 1 (UINT16)				7
...
6(n-1)+2	Horizontal Resolution for Component n (UINT16)				6(n-1)+3
6(n-1)+4	Vertical Resolution for Component n (UINT16)				6(n-1)+5
6(n-1)+6	Number of Levels for Component n (UINT16)				6(n-1)+7

Byte 0 Format

Value = 2

Format 2 configures for direct monochrome, CMY, or KCMY data in planar format.

DEVICE NOTE: Only DeskJet 540, DeskJet 660C and DeskJet 850C implement format 2.

Byte 1 Number of Components

Value = 1 Monochrome (K)
= 3 Three components (CMY)
= 4 Four components (KCMY)

Specifies the number of expected components. When the value is 3, the first component is cyan, the second magenta, and the third yellow. When the value is 4, the first component is cyan, the second magenta, the third yellow, and the fourth black. The raster transfer commands (*Esc*b#V*, *Esc*b#W*) must use the same component ordering to send data.

DEVICE NOTE: DeskJet 540 supports 1 or 3 components; DeskJet 850C only supports 1 or 4.

Bytes 2&3, 8&9, etc Horizontal Resolution

Value = 1 to 65535

Specifies the horizontal resolution of each component in pixels per inch of the source pixel. The “horizontal” axis is determined by the current Raster Presentation (*Esc*r#/F*), Orientation (*Esc&l#O*), and Print Direction (*Esc&a#P*). Bytes 2 & 3 specify the horizontal resolution for component one, bytes 8 & 9 specify the horizontal resolution for component two, etc. Higher horizontal resolutions must be multiples of lower horizontal resolutions.

DEVICE NOTE: DeskJet 540 supports only 300 ppi cyan, magenta, and yellow horizontal resolutions. Black horizontal resolution may be 300 or 600 ppi.

DEVICE NOTE: On DeskJet 660C, cyan, magenta, and yellow horizontal resolutions must be equal and must be either 300 or 600 ppi. When the cyan, magenta, or yellow horizontal resolution is 600 ppi, the vertical resolution must be 300 ppi. Black horizontal resolution may be 300 or 600 ppi.

DEVICE NOTE: On DeskJet 850C, horizontal and vertical resolutions must be equal. Cyan, magenta, and yellow resolutions must be equal and must be either 150 or 300 ppi. Black resolution may be different from the CMY resolutions and may be 150, 300, or 600.

Bytes 4&5, 10&11, etc Vertical Resolution

Value = 1 to 65535

Specifies the vertical resolution of each component of the source pixel in pixels per inch. The “vertical” axis is determined by the current Raster Presentation (*Esc*r#/F*), Orientation (*Esc&l#O*), and Print Direction (*Esc&a#P*). Bytes 4 & 5 specify the vertical resolution for component one, bytes 10 & 11 specify the vertical resolution for component two, etc. Higher vertical resolutions must be multiples of lower vertical resolutions.

DEVICE NOTE: DeskJet 540 supports only a vertical resolution of 300 ppi.

DEVICE NOTE: DeskJet 660C supports only 300 ppi cyan, magenta, and yellow vertical resolutions. Black vertical resolution may be 300 or 600 ppi. When the black vertical resolution is 300 ppi, the black horizontal resolution must also be 300 ppi.

DEVICE NOTE: On DeskJet 850C, horizontal and vertical resolutions must be equal. Cyan, magenta, and yellow resolutions must be equal and must be either 150 or 300 ppi. Black resolution may be different from the CMY resolutions and may be 150, 300, or 600.

Bytes 6&7, 12&13, etc Number of Intensity Levels

Value = 2 to 255

Specifies the number of intensity or grayscale levels for each component. A level of 2 allows only two intensities, since a pixel is either ON or OFF. A level of 4 allows four intensities, etc. The lowest intensity is 0; the highest intensity is Number of Levels - 1.

Bytes 6 and 7 specify the number of levels for component one, bytes 12 and 13 specify the number of levels for component two, etc.

The number of planes expected for each row is the ceiling function of log base 2 of the number of levels. For example, three levels require two planes. The lowest order plane is transmitted first, and the highest order plane last for a given row.

DEVICE NOTE: DeskJet 540 and DeskJet 660C support only a level of 2.

DEVICE NOTE: DeskJet 850C supports levels of 2, 3, and 4 for 300 ppi components, and a level of 2 for 150 or 600 ppi components. CMY components must have equal levels. A black component may have either two or four levels. If Black is 600 ppi, the CMY components in a four-component case must be either 2 or 4 levels.

Acceptable Combinations of Parameters for Format 2

A = Number of Components
 B = Horizontal Resolution of Component 1
 C = Vertical Resolution of Component 1
 D = Number of Intensity Levels of Component 1
 E = Horizontal Resolution of Component 2
 F = Vertical Resolution of Component 2
 G = Number of Intensity Levels of Component 2
 H = Horizontal Resolution of Component 3
 I = Vertical Resolution of Component 3
 J = Number of Intensity Levels of Component 3
 K = Horizontal Resolution of Component 4
 L = Vertical Resolution of Component 4
 M = Number of Intensity Levels of Component 4

DEVICE NOTE: Acceptable combinations of parameters for DeskJet 540:

A	B	C	D	E	F	G	H	I	J
1	600	300	2						
1	300	300	2						
3	300	300	2	300	300	2	300	300	2

DEVICE NOTE: Acceptable combinations of parameters for DeskJet 660C:

A	B	C	D	E	F	G	H	I	J	K	L	M
1	600	600	2									
1	600	300	2									
1	300	300	2									
3	600	300	2	600	300	2	600	300	2			
3	300	300	2	300	300	2	300	300	2			
4	600	600	2	600	300	2	600	300	2	600	300	2
4	600	600	2	300	300	2	300	300	2	300	300	2
4	600	300	2	600	300	2	600	300	2	600	300	2
4	600	300	2	300	300	2	300	300	2	300	300	2
4	300	300	2	300	300	2	300	300	2	300	300	2

DEVICE NOTE: Acceptable combinations of parameters for DeskJet 850C:

A	B	C	D	E	F	G	H	I	J	K	L	M
1	600	600	2									
1	300	300	4									
1	300	300	2									
1	150	150	2									
4	600	600	2	300	300	4	300	300	4	300	300	4
4	600	600	2	300	300	2	300	300	2	300	300	2
4	300	300	4	300	300	4	300	300	4	300	300	4
4	300	300	4	300	300	3	300	300	3	300	300	3
4	300	300	2	300	300	2	300	300	2	300	300	2
4	150	150	2	150	150	2	150	150	2	150	150	2

Example 1 of Format 2

Assume the following CRD command is sent:

```

Format                               =      2
Number of components                  =      4
Horizontal resolution component 1     =    300
Vertical resolution component 1       =    300
Levels for component 1                =      2
Horizontal resolution component 2     =    300
Vertical resolution component 2       =    300
Levels for component 2                =      2
Horizontal resolution component 3     =    300
Vertical resolution component 3       =    300
Levels for component 3                =      2
Horizontal resolution component 4     =    300
Vertical resolution component 4       =    300
Levels for component 4                =      2
    
```

The vertical displacement of all four strips is 1/300 of an inch, since this is the displacement of the component with the lowest vertical resolution (300 ppi).

Component 1 consists of one row containing one plane of black. Only one row is needed at 300 ppi vertical resolution to cover 1/300 of an inch of vertical displacement. And only one plane is needed to encode two intensity levels ($\log_2 2=1$).

Component 2 consists of one row containing one plane of cyan; component 3 consists of one row with one plane of magenta; and component 4 consists of one row with one plane of yellow.

Transfer Raster by Plane (*Esc*b#V*) is used to send all the planes of all the rows except the last plane of the last row within a strip, which uses Transfer Raster by Row/Block (*Esc*b#W*). As shown below, unlike Format 1, components are sent in order from 1 to 4.

Component 1	row 1	<i>Esc*b#V</i>	300 ppi Black data
Component 2	row 1	<i>Esc*b#V</i>	300 ppi Cyan data
Component 3	row 1	<i>Esc*b#V</i>	300 ppi Magenta data
Component 4	row 1	<i>Esc*b#W</i>	300 ppi Yellow data

Example 2 of Format 2

This example illustrates Format 2 in which one component is sent at a different resolution. This shows how the vertical displacement of each component of a strip is determined by the minimum vertical resolution of all components.

Assume the following CRD command is sent:

```

Format                =      2
Number of components  =      4
Horizontal resolution component 1 = 600
Vertical resolution component 1 = 600
Levels for component 1 =      2
Horizontal resolution component 2 = 300
Vertical resolution component 2 = 300
Levels for component 2 =      2
Horizontal resolution component 3 = 300
Vertical resolution component 3 = 300
Levels for component 3 =      2
Horizontal resolution component 4 = 300
Vertical resolution component 4 = 300
Levels for component 4 =      2
  
```

In this example, the vertical displacement of all four strips is 1/300 of an inch, which is the displacement of the component with the lowest vertical resolution (300 ppi).

Component 1 consists of two rows which each contain one plane of black. Two 600 ppi rows of data are required to fill a 1/300 of an inch strip. Only one plane is needed to encode two intensity levels ($\log_2 2=1$).

Component 2 consists of one row containing one plane of cyan. Only one row is needed at 300 ppi vertical resolution to cover 1/300 of an inch of vertical displacement. Only one plane is needed to encode two intensity levels ($\log_2 2=1$).

Component 3 consists of one row containing one plane of magenta; and component 4 consists of one row containing one plane of yellow.

Transfer Raster by Plane (*Esc*b#V*) is used to send all the planes of all the rows except the last plane of the last row within a strip, which uses Transfer Raster by Row/Block (*Esc*b#W*). The least significant plane of a row is sent first. Components are sent in order, from 1 to 4. Note that, as shown below, the 600 ppi planes contain twice the data of the 300 ppi planes.

Component 1	row 1	<i>Esc*b#V</i>	600 ppi Black data
	row 2	<i>Esc*b#V</i>	600 ppi Black data
Component 2	row 1	<i>Esc*b#V</i>	300 ppi Cyan data
Component 3	row 1	<i>Esc*b#V</i>	300 ppi Magenta data
Component 4	row 1	<i>Esc*b#W</i>	300 ppi Yellow data

Example 3 of Format 2

In this example one component has a different resolution, and the lower resolution components have more than two intensity levels. Assume the following CRD command is sent:

```

Format                               =      2
Number of components                  =      4
Horizontal resolution component 1     =     600
Vertical resolution component 1       =     600
Levels for component 1                =      2
Horizontal resolution component 2     =     300
Vertical resolution component 2       =     300
Levels for component 2                =      4
Horizontal resolution component 3     =     300
Vertical resolution component 3       =     300
Levels for component 3                =      4
Horizontal resolution component 4     =     300
Vertical resolution component 4       =     300
Levels for component 4                =      4

```

The vertical displacement of all four strips is 1/300 of an inch, since that is the displacement of the component with the lowest vertical resolution (300 ppi).

Component 1 consists of two rows, each containing one black plane. Two rows of 600 ppi data are required to fill a 1/300" vertical strip. One plane is needed for two intensity levels ($\log_2 2=1$).

Component 2 consists of one row containing two cyan planes. Only one row of 300 ppi data is required to fill a 1/300" vertical strip. Two planes are needed for four intensity levels ($\log_2 4=2$).

Components 3 and 4 have the same encoding as component 2. Component 3 consists of one row containing two magenta planes; component 4 consists of one row containing two yellow planes.

All the planes of all the rows use Transfer Raster by Plane (*Esc*b#V*), except the last plane of the last row within a strip, which uses Transfer Raster by Row/Block (*Esc*b#W*).

Component 1	row 1	<i>Esc*b#V</i>	600 ppi Black data
	row 2	<i>Esc*b#V</i>	600 ppi Black data
Component 2	row 1	<i>Esc*b#V</i>	300 ppi Cyan data
	plane 2	<i>Esc*b#V</i>	300 ppi Cyan data
Component 3	row 1	<i>Esc*b#V</i>	300 ppi Magenta data
	plane 2	<i>Esc*b#V</i>	300 ppi Magenta data
Component 4	row 1	<i>Esc*b#V</i>	300 ppi Yellow data
	plane 2	<i>Esc*b#W</i>	300 ppi Yellow data

Example 4 of Format 2

This example illustrates the flexibility of Format 2: all components have different resolutions and a different number of intensity levels. There is no printer that implements this complex combination of parameters, but this example shows how the sequence could meet a wide variety of future needs. Assume the following CRD command is sent:

Format	=	2
Number of components	=	4
Horizontal resolution component 1	=	300
Vertical resolution component 1	=	600
Levels for component 1	=	2
Horizontal resolution component 2	=	150
Vertical resolution component 2	=	75
Levels for component 2	=	16
Horizontal resolution component 3	=	75
Vertical resolution component 3	=	150
Levels for component 3	=	8
Horizontal resolution component 4	=	100
Vertical resolution component 4	=	300
Levels for component 4	=	4

In this example, the vertical displacement of all four strips is $1/75$ of an inch, since that is the displacement of the component with the lowest vertical resolution (75 ppi).

Component 1 consists of eight single-plane rows of black. Eight rows of 600 ppi vertical-resolution data are required to fill a $1/75$ " strip. Only one plane is needed to encode two intensity levels ($\log_2 2=1$).

Component 2 consists of one row containing four planes of cyan. Only one row is needed at 75 ppi vertical resolution to fill $1/75$ " vertical displacement. Four planes are needed to encode 16 intensity levels ($\log_2 16=4$).

Component 3 consists of two rows, each containing three planes of magenta. Two rows are needed at 150 ppi vertical resolution to fill a $1/75$ " strip. Three planes are needed to encode eight intensity levels ($\log_2 8=3$).

Component 4 consists of four rows, each containing two planes of yellow. Four rows are needed at 300 ppi vertical resolution to fill a $1/75$ " strip. Two planes are needed to encode four intensity levels ($\log_2 4=2$).

All the planes of all the rows use Transfer Raster by Plane (*Esc*b#V*) except the last plane of the last row within a strip, which uses Transfer Raster by Row/Block (*Esc*b#W*). As shown below, components are sent in order from 1 to 4. The least significant plane is sent first and the most significant plane last of the same row. Note that the 600 ppi planes contain eight times the data of the 75 ppi planes.

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Component 1	row 1	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 2	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 3	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 4	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 5	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 6	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 7	<i>Esc*b#V</i>	300 x 600 ppi Black data	
	row 8	<i>Esc*b#V</i>	300 x 600 ppi Black data	
Component 2	row 1	<i>Esc*b#V</i>	150 x 75 ppi Cyan data	
	plane 2	<i>Esc*b#V</i>	150 x 75 ppi Cyan data	
	plane 3	<i>Esc*b#V</i>	150 x 75 ppi Cyan data	
	plane 4	<i>Esc*b#V</i>	150 x 75 ppi Cyan data	
Component 3	row 1	<i>Esc*b#V</i>	75 x 150 ppi Magenta data	
	plane 2	<i>Esc*b#V</i>	75 x 150 ppi Magenta data	
	plane 3	<i>Esc*b#V</i>	75 x 150 ppi Magenta data	
	row 2	<i>Esc*b#V</i>	75 x 150 ppi Magenta data	
	plane 2	<i>Esc*b#V</i>	75 x 150 ppi Magenta data	
	plane 3	<i>Esc*b#V</i>	75 x 150 ppi Magenta data	
Component 4	row 1	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	plane 2	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	row 2	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	plane 2	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	row 3	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	plane 2	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	row 4	<i>Esc*b#V</i>	100 x 300 ppi Yellow data	
	plane 2	<i>Esc*b#W</i>	100 x 300 ppi Yellow data	

Format 3 RGB Direct by Pixel

Configures for direct RGB pixel-by-pixel raster transfers. Raster transfer is independent of the palette.

Byte	15 (MSB)	8	7 (LSB)	0	Byte
0	Format=3 (UBYTE)		Number of Bits for Red (UBYTE)		1
2	Number of Bits for Green (UBYTE)		Number of Bits for Blue (UBYTE)		3
4	Horizontal Resolution (UINT16)				5
6	Vertical Resolution (UINT16)				7

Byte 0 Format

Value = 3

Format 3 configures for direct-by-pixel device-dependent RGB data.

DEVICE NOTE: Only DeskJet 850C implements format 3.

Byte 1 Number of Bits for Red

Value = 1 to 255

Specifies the number of bits necessary to completely specify the red component of a pixel when in direct device-dependent RGB raster mode. This in turn also specifies $2^{\text{Number of Bits for Red}} - 1$ to be the maximum intensity level for a red component. The minimum intensity level is 0.

DEVICE NOTE: DeskJet 850C will support only a value of 8.

Byte 2 Number of Bits for Green

Value = 1 to 255

Specifies the number of bits necessary to completely specify the green component of a pixel when in direct device-dependent RGB raster mode. This in turn also specifies $2^{\text{Number of Bits for Green}} - 1$ to be the maximum intensity level for a green component. The minimum intensity level is 0.

DEVICE NOTE: DeskJet 850C will support only a value of 8.

Byte 3 Number of Bits for Blue

Value = 1 to 255

Specifies the number of bits necessary to completely specify the blue component of a pixel when in direct device-dependent RGB raster mode. This in turn also specifies $2^{\text{Number of Bits for Blue}} - 1$ to be the maximum intensity level for a blue component. The minimum intensity level is 0.

DEVICE NOTE: DeskJet 850C will support only a value of 8.

Bytes 4&5 Horizontal Resolution

Value = 1 to 65535

Specifies horizontal resolution in pixels per inch of the source pixel. "Horizontal" is determined by the current Raster Presentation (*Esc*r#/F*), Orientation (*Esc&l#O*), and Print Direction (*Esc&a#P*).

DEVICE NOTE: DeskJet 850C only supports only a value of 300.

Bytes 6&7 Vertical Resolution

Value = 1 to 65535

Specifies the vertical resolution in pixels per inch of the source pixel. The “vertical” axis is determined by the current Raster Presentation (*Esc*r#F*), Orientation (*Esc&l#O*), and Print Direction (*Esc&a#P*).

DEVICE NOTE: DeskJet 850C only supports a value of 300.

Example 1 of Format 3

Assume the following CRD command is sent:

Format	=	3
Number of Bits for Red	=	8
Number of Bits for Green	=	8
Number of Bits for Blue	=	8
Horizontal Resolution	=	300
Vertical Resolution	=	300

It takes eight bits (one byte) to form an R, G, or B component, i.e., a total of 24 bits (three bytes) to directly specify each pixel. Since this is pixel encoding rather than planar, each pixel in a row is fully specified before any bits are sent for the next pixel.

The data is sent in the following way for a 20-pixel wide by 10-pixel high block (total of 200 pixels):

pixel 1, pixel 2, pixel 3, pixel 4, ...pixel 200

If pixel 1 components are red = 255, green = 0, blue = 3 and each component is eight bits, the data for the first pixel is formatted as 111111110000000000000011. If pixel 2 components are red = 16, green = 128, blue = 6, the data stream for pixels 1 and 2 would appear as:

11111111	00000000	00000011	00001000	10000000	00000110
(255)	(0)	(3)	(16)	(128)	(6)

Format 4 Indexed by Pixel

Configures for indexed pixel-by-pixel raster transfers. The bits for each pixel form an index number to a palette entry, which is the color of the pixel. All the bits for each pixel are sent before any bits are sent for the next pixel. Palette configuration, performed by Configure Image Data (*Esc*v#W*) or Palette Configuration (*Esc*d#W*), is independent of raster transfer.

Byte	15 (MSB)	8	7 (LSB)	0	Byte
0	Format=4 (UBYTE)		Number of Index Bits (UBYTE)		1
2	Horizontal Resolution (UINT16)				3
4	Vertical Resolution (UINT16)				5

Byte 0 Format

Value = 4

Format 4 configures for indexed data, where the data is indexed by pixel.

DEVICE NOTE: Only DeskJet 850C implements format 4.

Byte 1 Number of Index bits

Value = 1 to 255

Specifies the number of bits required to form an index into the palette. The *Number of Index Bits* field may limit the number of possible selectable palette entries to be less than the palette size. Palette size is set by either Configure Image Data (*Esc*v#W*) or Palette Configuration (*Esc*d#W*). If a specified index exceeds the palette size, the modulo of the palette size is used to achieve an index within the palette.

DEVICE NOTE: DeskJet 850C only supports a value of 8.

Bytes 2&3 Horizontal Resolution

Value = 1 to 65535

Specifies the source pixel's horizontal resolution in pixels per inch. The "horizontal" axis is determined by the current Raster Presentation (*Esc*r#F*), Orientation (*Esc&l#O*), and Print Direction (*Esc&a#P*).

DEVICE NOTE: DeskJet 850C only supports a value of 300.

Bytes 4&5 Vertical Resolution

Value = 1 to 65535

Specifies the vertical resolution of the source pixel in pixels per inch. The "vertical" axis is determined by the current Raster Presentation (*Esc*r#F*), Orientation (*Esc&l#O*), and Print Direction (*Esc&a#P*).

DEVICE NOTE: DeskJet 850C only supports a value of 300.

Example 1 of Format 4

Assume the following CRD command is sent:

Format	=	4
Number of Index bits	=	8
Horizontal Resolution	=	300
Vertical Resolution	=	300

In this example, eight bits are required to form a palette index. If the palette was configured for 256 entries, each byte in the row describes a pixel by forming an palette entry index. Each pixel will have a resolution of 300 x 300 ppi.

The palette index for each pixel in a row is fully specified before any bits are sent for the next pixel's palette index. The *Number of Index Bits* field determines index data boundaries. The data would be sent in the following way for a block width of 20 pixels and height of 10 pixels (total of 200 pixels):

index for pixel 1, index for pixel 2, index for pixel 3, index 4 ...index for pixel 200

A *Number of Index Bits* value of 8 implies that the data stream is parsed in 8 bit segments. The following data would specify that the first three palette entries have values 16, 0 and 7.

```
00010000 00000000 00000111
  (16)    (0)    (7)
```

Example 2 of Format 4

Assume the following CRD command is sent:

Format	=	4
Number of Index bits	=	4
Horizontal Resolution	=	150
Vertical Resolution	=	150

In this example, it takes 4 bits or one nibble to form an index into the palette. If the palette was configured for 256 entries, each byte of the row describes a pixel by forming an index to a palette entry. Each pixel will have a resolution of 150 x 150 pixels per inch.

The data is sent in the following way for a block width of 20 pixels and height of 10 pixels (total of 200 pixels):

index for pixel 1, index for pixel 2, index for pixel 3, index 4, ...index for pixel 200

A *Number of Index Bits* value of 4 implies that the data stream is parsed in 4-bit segments. The following data specifies the first 6 pixels, with pixel values of 1, 0, 0, 0, 0, and 7.

```
0001 0000 0000 0000 0000 0111
  (1) (0) (0) (0) (0) (7)
```

If the palette had only 12 entries, a value of 1111 (15) would specify (index value modulo palette size - 15MOD12), or palette entry 3. This recalculation occurs whenever the palette size is smaller than the maximum number that can be specified with the number of index bits.

Format 5 Mixed Monochrome and Indexed by Pixel

Configures for an indexed pixel-encoded component and a direct monochrome component. The indexed data forms an index into the current palette for each pixel to be printed. The bits for each pixel define that pixel by forming a palette index number to a palette entry. Each pixel in a row is fully specified before bits are sent for the next pixel. Either Configure Image Data (*Esc*v#W*) or Palette Configuration (*Esc*d#W*) may configure the palette. Format 5 may be used for sleek top-to-bottom printing.

Byte	15 (MSB)	8	7 (LSB)	0	Byte
0	Format=5 (UBYTE)		Number of Index bits (UBYTE)		1
2	Indexed Horizontal Resolution (UINT16)				3
4	Indexed Vertical Resolution (UINT16)				5
6	Monochrome Horizontal Resolution (UINT16)				7
8	Monochrome Vertical Resolution (UINT16)				9
10	Data Organization (UBYTE)				

Byte 0 Format

Value = 5

Format 5 configures for combined by pixel-encoded indexed device-dependent RGB and by pixel direct monochrome data.

DEVICE NOTE: Only DeskJet 850C implements format 5.

Byte 1 Number of Index bits

Value = 1 to 255

Specifies the number of bits required to form an index into the palette. The number of bits may limit the number of selectable palette entries to less than the palette size. If an index is sent that exceeds the size of the palette, the modulo of the palette size is used to achieve an index within the palette. Palette size is set by either Configure Image Data (*Esc*v#W*) or Palette Configuration (*Esc*d#W*).

DEVICE NOTE: DeskJet 850C only supports a value of 8.

Bytes 2&3 Indexed Horizontal Resolution

Value = 1 to 65535

Specifies the horizontal resolution in pixels per inch of the source pixel for the indexed component. The “horizontal” axis is determined by the current Raster Presentation (*Esc*r#/F*), Orientation (*Esc&l#o/O*), and Print Direction (*Esc&a#p/P*).

DEVICE NOTE: DeskJet 850C only supports a value of 300.

Bytes 4&5 Indexed Vertical Resolution

Value = 1 to 65535

Specifies the vertical resolution in pixels per inch of the source pixel for the indexed component. The “vertical” axis is determined by the current Raster Presentation (*Esc*r#/F*), Orientation (*Esc&l#o/O*), and Print Direction (*Esc&a#p/P*).

DEVICE NOTE: DeskJet 850C only supports a value of 300.

Bytes 6&7 Monochrome Horizontal Resolution

Value = 1 to 65535

Specifies the horizontal resolution in pixels per inch of the monochrome source pixel. The “horizontal” axis is determined by the current Raster Presentation (*Esc*r##/F*), Orientation (*Esc&l#o/O*), and Print Direction (*Esc&a#p/P*).

DEVICE NOTE: DeskJet 850C only supports a value of 600.

Bytes 8&9 Monochrome Vertical Resolution

Value = 1 to 65535

Specifies the vertical resolution in pixels per inch of the monochrome source pixel. The “vertical” axis is determined by the current Raster Presentation (*Esc*r##/F*), Orientation (*Esc&l#o/O*), and Print Direction (*Esc&a#p/P*).

DEVICE NOTE: DeskJet 850C only supports a value of 600.

Byte 10 Data Organization

- Value = 1 Indexed first, then monochrome data, which is placed on top of indexed data
- = 2 Monochrome first, then indexed data, which is placed on top of monochrome data
- = 3 Monochrome first, then indexed. Monochrome is placed on top of indexed data.
- = 4 Indexed data first, then monochrome. Indexed is placed on top of monochrome.

Specifies how the raster scan lines are organized in the image data. A value of one means that the indexed color portion of the vertical strip is sent and processed first, followed by the monochrome portion. A value of two means the reverse. This setting is important because the temporal ordering of data causes the data sent last to be placed on top of the first data.

DEVICE NOTE: DeskJet 850C only supports a value of 1. DeskJet 860C will support 3.

Example 1 of Format 5

Assume the following CRD command is sent:

Format	=	5
Number of Index bits	=	8
Index Horizontal Resolution	=	300
Index Vertical Resolution	=	300
Monochrome Horizontal Resolution	=	600
Monochrome Vertical Resolution	=	600
Data Organization	=	1

The vertical displacement of both strips is 1/300", since that is the displacement of the component with the lowest vertical resolution (300 ppi).

A monochrome pixel has a 600 x 600 ppi resolution. The monochrome component consists of two rows, since two rows are needed at 600 ppi vertical resolution to fill 1/300" vertical displacement.

Each pixel of the indexed component has a resolution of 300 x 300 ppi. The indexed component consists of one row, since only one row is needed at 300 ppi vertical resolution to fill 1/300" of vertical displacement.

The *Number of Index Bits* field determines index data boundaries. In this example, eight bits form an index into the palette. Each byte in a row describes a pixel by forming an index to one of 256 palette entries. The index for each pixel in a row is fully specified before any bits are sent for the next pixel's index.

The data is sent in the following way for a 4-pixels wide by 2-pixels high block of 300 ppi indexed pixels (total of 8 pixels), and an 8-pixels wide by 4-pixels high block of 600 ppi monochrome pixels (total of 32 pixels):

index for pixel 1, index for pixel 2, index for pixel 3, index for pixel 4
monochrome data for pixels 1 to 8
monochrome data for pixels 9 to 16
index for pixel 5, index for pixel 6, index for pixel 7, index for pixel 8
monochrome data for pixels 17 to 24
monochrome data for pixels 25 to 32

