

B Using Color Modes (Color LaserJet, 5, 5M, DeskJet)

This appendix describes how color commands were supported on the following printers:

- HP Color LaserJet, Color LaserJet 5 / 5M
- HP DeskJet 1200C and 1600C

Since then, the PCL 5 color command set has been simplified as described in Chapter 1. Appendices A through D and Chapters 5 through 7 describe the color commands as they were supported for these printers.

Introduction

The PCL printer language has four color modes:

- Black-and-White
- Simple Color
- PCL Imaging
- HP-GL/2 Imaging

PCL allows you to use any mode or combination of modes to accomplish your printing objectives most efficiently.

All four of the color modes create a palette. The palette for each mode is discussed in the section describing that mode, and also in Appendix C (“Using Palettes”).

Black-and-White Mode (Default)

Black-and-White Mode is the default color mode. PCL devices power up in this mode and revert back to it whenever the printer receives an E_cE reset. Black-and-White mode is also selectable using the Simple Color command (E_c*r1U). This mode creates an unmodifiable, default 2-pen palette, with white at index 0 and black at index 1 (compatible with existing monochrome PCL 5 printers).

Simple Color Mode

Simple Color Mode, entered by the Simple Color command ($E_c*r\#U$), creates a fixed-size, fixed-color, unmodifiable palette. Depending on the value field, $E_c*r\#U$ can create a 2-pen Black-and-White palette, an 8-pen RGB palette, or an 8-pen CMY palette. When using the Simple Color mode, the pixel encoding mode is always indexed planar.

PCL Imaging Mode

PCL Imaging Mode, enabled by the Configure Image Data command ($E_c*v\#W$), allows a maximum of 24 bits per pixel for color specification. Therefore, more colors (produced by halftoning) may be specified than are obtainable in Simple Color Mode. In the PCL Imaging Mode, pixel encoding mode, bits per pixel, bits per primary, white/black references, and the color palette are all programmable.

HP-GL/2 Imaging Mode

In HP-GL/2, the Initialize (IN) command starts color imaging and performs the following:

- Sets the pixel encoding mode to index by plane.
- Sets bits per index to 3.
- Creates an 8-pen palette that is reprogrammable in either PCL or HP-GL/2 contexts (see Appendix C, “Using Palettes,” for more information).

Although default HP-GL/2 palettes are different than default PCL palettes, an HP-GL/2 palette is modifiable in either PCL or HP-GL/2 (using the Assign Color Index [$E_C*v\#I$] or Pen Color [PC] commands, respectively). Likewise, a PCL palette created by the Configure Image Data command ($E_C*v\#W$) is modifiable in both PCL and HP-GL/2 using the same commands.

The active palette is always transferred between HP-GL/2 and PCL contexts. Since only one palette at a time can be active, a new palette created in either context overwrites the current palette.

Simple Color Mode

The Simple Color command ($E_C^*r\#U$) specifies color selection from a fixed palette. RGB or CMY raster data must be sent by plane ($E_C^*b\#V$) as well as by row ($E_C^*b\#W$). The last plane in each row is sent using the $E_C^*b\#W$ command; all other planes are sent using the $E_C^*b\#V$ command. In Simple Color mode, the pixel encoding mode is always indexed planar.

Simple Color Command

The Simple Color command creates a fixed-size palette, whose color specification cannot be modified.

$E_C^*r\#U$

- #** = -3 - 3 planes, device CMY palette
- 1 - Single plane K (Black) palette
- 3 - 3 planes, device RGB palette

Default = 1

Range = -3, 1, 3

The absolute value of the value field specifies the number of planes per row of raster data to be sent. The number of entries in the new palette is 2^n , with index values 0 to $2^n - 1$. For example, a 3-plane palette has 8 entries, with index numbers 0 to 7.

This command destroys the active palette and creates a new palette, which becomes the active palette. When the Simple Color mode is active, PCL and HP-GL/2 commands that modify the palette are locked out (NP, PC, $E_C^*v\#A$, $E_C^*v\#B$, $E_C^*v\#C$, $E_C^*v\#I$). When a Simple Color palette is popped from the stack ($E_C^*p\#P$), it cannot be modified, and the pixel encoding mode reverts to indexed planar.

- A value field of **1** creates a 2-entry Black-and-White default palette.
- A value field of **3** creates an 8-entry Device RGB palette (compatible with a PCL Imaging Mode palette, but not an HP-GL/2 default (IN) palette).
- A value field of **-3** creates an 8-entry palette in Device CMY color space.

The Simple Color palettes are shown below:

Single Plane (value = 1)

Index	Color
0	White
1	Black

3-Plane RGB (value = 3)

Index	Color
0	Black
1	Red
2	Green
3	Yellow
4	Blue
5	Magenta
6	Cyan
7	White

3-Plane CMY (value = -3)

Index	Color
0	White
1	Cyan
2	Magenta
3	Blue
4	Yellow
5	Green
6	Red
7	Black

PCL Imaging Mode

The PCL Imaging mode, entered using the Configure Image Data (CID) command ($E_C^*v\#W$), creates a variable-sized programmable palette. It provides halftoning in the printer, with multiple color spaces, pixel encoding modes, and reprogrammable palettes.

Configure Image Data (CID) Command

The CID command provides configuration information for creating palettes and transmitting raster data. The CID command performs the following:

- Designates the color space for the default palette
- Designates the size of the palette to be created
- Provides data for transforming color-space-specific values into device-specific values
- Provides data for transforming device-dependent data (monitor RGB) to device-independent (Colorimetric RGB)
- Designates the format of raster data and how primary components are combined to yield the raster representation

$E_C^*v\#W$ [*binary data*]

= Number of data bytes

Default = NA

Range = Short form: 6 bytes
Long form: >6 bytes

Invalid configurations of the CID command are ignored and the data discarded. Any signs in the value field are ignored.

The data fields in this command must contain byte-aligned binary data, not ASCII data.

This command has two forms: the six-byte short form described below, and the long form consisting of these six bytes, plus additional information specific to the color space.

Common 6-Byte Header

The short and long forms of the CID command use a common 6-byte header, regardless of which color space is specified. The header data fields, whose meaning may vary according to the color spaces, are present in all color space specifications. The short form and long form of the CID command are explained separately in the following pages.

Byte	15 (MSB)	8	7	0 (LSB)	Byte
0	Color space (UBYTE)		Pixel encoding mode (UBYTE)		1
2	Bits/index (UBYTE)		Bits/primary #1 (UBYTE)		3
4	Bits/primary #2 (UBYTE)		Bits/primary #3 (UBYTE)		5

Byte 0 (Color Space)

This byte specifies the color space. The range of values is 0 through 4. All other values are ignored.

Byte Value	Color Space
0	Device RGB (default)
1	Device CMY
2	Colorimetric RGB Spaces
3	CIE L*a*b*
4	Luminance-Chrominance Spaces

Note

Colorimetric RGB color spaces are based on the 1931 standard 2-degree observer and specified by CIE xy chromaticity coordinates. They use the standard D6500 viewing illuminant and a 45-degree illumination model with a 0-degree collector geometry for reflective data.

CIE L*a*b* is the CIE 1976 Uniform Color Space based on the 1931 standard 2-degree observer, and using a 45-degree illumination model with a 0-degree collector geometry for reflective data. The viewing illuminant is the standard D6500 illuminant.

Luminance-Chrominance spaces are a 3x3 linear transformation from Colorimetric RGB. Like CIE L*a*b*, achromatic data is contained in one channel and chromatic data shares the other two channels.

Note

HP Color LaserJet 5 and 5M printers parse and discard the CID command when Colorimetric RGB spaces are specified. Rather than creating a Colorimetric RGB palette, a device RGB palette is created, but it is populated with the default color of the Colorimetric RGB palette. In addition, the ScreenMatch color table is selected to give the impression of Colorimetric RGB behavior while working in a device-dependent space

Byte 1 (Pixel Encoding Mode)

Byte number 1 designates the format in which raster data is to be transmitted and interpreted. The range of this value field is 0 to 3. All other values for this field are ignored.

Byte Value	Pixel Encoding Mode	Restrictions
0	Indexed by Plane (default)	Bits/index must be 1, 2, 3, 4, 5, 6, 7, or 8
1	Indexed by Pixel	Bits/index must be 1, 2, 4, or 8
2	Direct by Plane	1 bit per primary (RGB or CMY only)
3	Direct by Pixel	8 bits per primary (All Color Spaces)

You need one plane or one bit/pixel for each power of two colors in the palette. For example, a 256-color palette requires 8 planes or 8 bits/pixel ($2^8 = 256$).

Note

Direct pixel encoding modes (2, 3) cannot be compressed using raster compression modes 1 or 2. Planar pixel encoding modes (0, 2) cannot be compressed using raster compression mode 5.

MODE 0: INDEXED BY PLANE

In mode 0 (default), successive planes of data are sent for each raster row. A plane contains one bit for each pixel in a row. A pixel is not fully defined until it has received all the planes for that row. The planes in a row form index numbers that define a pixel by selecting a palette entry. Assuming 3 bits per index, the underlined column of bits below is the palette index for pixel 3 of row 1 (i1 is lsb; i3 is msb). Note that the Transfer Raster Data by Plane command ($E_C*b\#V$) is used for all planes except the last plane of each row, which uses the Transfer Raster Data by Row command ($E_C*b\#W$).

$E_C*b\#V$	row 1	plane 1	i1	i1	<u>i1</u>	i1	i1
$E_C*b\#V$		plane 2	i2	i2	<u>i2</u>	i2	i2
$E_C*b\#W$		plane 3	i3	i3	<u>i3</u>	i3	i3
$E_C*b\#V$	row 2	plane 1	i1	i1	i1	i1	i1

Example:

E_C^*v6W 00 00 03 08 08 08	# Binary data for CID represented in hex. Sets color space to RGB, pixel encoding mode to 0, palette size to 8 (3 planes), last 3 bytes ignored.
E_C^*r1A	# Start raster.
$E_C^*b1V10110000 \dots$	# Transfer plane 1 (the first bit for each pixel in the first row). Combining each bit with its corresponding bit in the other planes forms the palette index number for that pixel.
$E_C^*b1V01110000 \dots$	# Transfer plane 2 (the second bit for each pixel in the row).
$E_C^*b1W10101000 \dots$	# Transfer plane 3 (the third bit for each pixel in the row) and move to the next row. Note that the $E_C^*b\#W$ command is used to send the last plane of each row.

MODE 1: INDEXED BY PIXEL

In mode 1, each pixel in a row is fully specified before any bits are sent for the next pixel. The bits for each pixel form a palette index number. Assuming 4 bits per index, the underlined block below is the palette index for pixel 2 of row 1 (i1 is lsb).

$E_C^*b\#W$	row 1	i4 i3 i2 i1	<u>i4 i3 i2 i1</u>	...
$E_C^*b\#W$	row 2	i4 i3 i2 i1	i4 i3 i2 i1	...
$E_C^*b\#W$	row 3	i4 i3 i2 i1	i4 i3 i2 i1	...

Example:

<code>E_C*v6W 00 01 04 04 04 04</code>	# Binary data for CID represented in hexadecimal. Sets color space to RGB, pixel encoding mode to 1, palette size to 16 (4 bits to address palette index). Last 3 bytes ignored.
<code>E_C*r1A</code>	# Start raster.
<code>E_C*b1W45</code>	# Most significant nibble selects palette index 4 for the first pixel. Second pixel is set to index 5. Move to the next row.
<code>E_C*b1W6A</code>	# First pixel is index 6, second pixel is index 10. Move to the next row.
<code>E_C*b1W03</code>	# First pixel is index 0, second pixel is index 3. Move to the next row.

MODE 2: DIRECT BY PLANE

In mode 2, the color raster data for each row is downloaded by sequential planes, but the pixel color is directly specified, rather than forming an index into the palette. The underlined block below defines the actual primaries for pixel 3 of row 1.

<code>E_C*b#V</code>	row 1	red plane	r	r	<u>r</u>	r	r
<code>E_C*b#V</code>		green plane	g	g	<u>g</u>	g	g
<code>E_C*b#W</code>		blue plane	b	b	<u>b</u>	b	b
<code>E_C*b#V</code>	row 2	red plane	r	r	r	r	r

Example:

<code>^C*v6W 00 02 01 01 01 01</code>	# Binary data for CID represented in hex. Sets color space to RGB, pixel encoding mode to 2. Palette size is ignored because this is a direct selection, not indexed. Last 3 bytes are always 1 for this mode.
<code>^C*r1A</code>	# Start raster.
<code>^C*b1V10110000 . . .</code>	# Transfer plane for primary color 1. Each bit turns on or off the red primary for the pixel defined by the corresponding bits in each plane.
<code>^C*b1V01110000 . . .</code>	# Transfer plane for primary color 2. Each bit turns on or off the green primary of the pixel.
<code>^C*b1W10101000 . . .</code>	# Transfer plane for primary color 3 and move to the next row. Each bit turns on or off the blue primary of the pixel.

MODE 3: DIRECT BY PIXEL

In mode 3, the color raster data is downloaded pixel by pixel (as in mode 1), but each pixel directly specifies each color component (as in mode 2). Assuming Device RGB space with 8 bits per primary, the underlined block below defines the actual color primaries for pixel 1 of row 2.

<code>^C*b#W</code>	row 1	<code>r7-r0</code>	<code>g7-g0</code>	<code>b7-b0 . . .</code>
<code>^C*b#W</code>	row 2	<u><code>r7-r0</code></u>	<u><code>g7-g0</code></u>	<u><code>b7-b0</code></u> . . .
<code>^C*b#W</code>	row 3	<code>r7-r0</code>	<code>g7-g0</code>	<code>b7-b0 . . .</code>

Example:

<code>E_C*v6W 00 03 00 08 08 08</code>	# Binary data for CID represented in hex. Sets color space to RGB, pixel encoding mode to 3. Palette size is ignored. Send 8 bits to address each primary value for a pixel.
<code>E_C*r1A</code>	# Start raster.
<code>E_C*b3W 45 06 30</code>	# Each byte sets a primary value for the first pixel and moves to the next row (45 specifies the red, 06 the green, and 30 the blue component value of that pixel).

Byte 2 (Number of Bits per Index)

In all pixel encoding modes, this byte sets the size of the palette to 2^n , where n is the number of bits per index.

- In pixel encoding modes 0 and 1 (indexed), where raster data is interpreted as indices into a palette, this value specifies the number of bits required to access all palette entries.
- In pixel encoding modes 2 and 3 (direct), this value determines palette size, but has no effect on the specification of raster data.

Byte 3 (Number of Bits for Primary #1)

This byte is ignored in pixel encoding modes 0 and 1, but affects the black and white references in device-dependent color spaces. In Device RGB, the black reference for primary #1 is set to 0 and the white reference is set to $2^n - 1$, where n is the number of bits for primary #1. These references are reversed in Device CMY color space.

- *In pixel encoding mode 2*, this byte is ignored except in Device RGB and Device CMY color space, where it designates the number of data bits needed to specify primary #1, as well as the number of data planes to be sent for primary #1.
- *In pixel encoding mode 3*, this byte designates the number of data bits needed to specify primary #1.

A value of 0 defaults the black and white reference values for primary #1 according to the color space.

Byte 4 (Number of Bits for Primary #2)

This byte is ignored in pixel encoding modes 0 and 1, but affects the black and white references in device-dependent color spaces. In Device RGB, the black reference for primary #2 is set to 0, and the white reference is set to $2^n - 1$, where n is the number of bits for primary #2. These references are reversed in Device CMY color space.

- *In pixel encoding mode 2*, this byte is ignored except in Device RGB and Device CMY color spaces, where it designates the number of data bits needed to specify primary #2, as well as the number of data planes to be sent for primary #2.
- *In pixel encoding mode 3*, this byte designates the number of data bits needed to specify primary #2.

A value of 0 defaults the black and white reference values for primary #2 according to the color space.

Byte 5 (Number of Bits for Primary #3)

This byte is ignored in pixel encoding modes 0 and 1, but affects the black and white references in device-dependent color spaces. In Device RGB, the black reference for primary #3 is set to 0, and the white reference is set to $2^n - 1$, where n is the number of bits for primary #3. These references are reversed in Device CMY space.

- *In pixel encoding mode 2*, this byte is ignored except in Device RGB and Device CMY color space, where it designates the number of data bits needed to specify primary #3, as well as the number of data planes to be sent for primary #3.
- *In pixel encoding mode 3*, this byte designates the number of data bits needed to specify primary #3.

A value of 0 defaults the black and white reference values for primary #3 according to the color space.

Short Form of CID Command (Configure Image Data)

The Short Form of the CID command involves sending just the common 6-byte header. By changing the value of byte 0 (color space), the short form can specify the following five color spaces:

- Device RGB $E_C^*v6W[0x00, \dots]$
- Device CMY $E_C^*v6W[0x01, \dots]$
- CIE $L^*a^*b^*$ $E_C^*v6W[0x03, \dots]$

The following data ranges are allowed in CIE $L^*a^*b^*$. Hue is preserved when out-of-range data is clipped.

$L^* = 0.0$ to 100.0

$a^* = -100.0$ to 100.0

$b^* = -100.0$ to 100.0

Note

CIE $L^*a^*b^*$ color space support is at HP Color LaserJet level for HP Color LaserJet 5 and 5M printers.

- Colorimetric RGB (SMPTE RGB) $E_C^*v6W[0x02, \dots]$

Non-linear SMPTE RGB with a 2.2 gamma and 1.0 gain is the default Colorimetric RGB color space. The short form allows the following ranges:

$R = 0.0$ to 1.0

$G = 0.0$ to 1.0

$B = 0.0$ to 1.0

Note

HP Color LaserJet 5 and 5M printers bypass the Colorimetric RGB process. In place of it, a device-dependent RGB process is substituted with a Screen Match color table.

- Luminance-Chrominance (YUV) $E_c*v6W[0x04, \dots]$

YUV, which is a linear transformation from SMPTE RGB, is the default Luminance-Chrominance color space. The short form allows the following ranges:

$Y = 0.0$ to 1.0

$U = -0.89$ to 0.89

$V = -0.70$ to 0.70

Note

Luminance-Chrominance color space support is at HP Color LaserJet level for HP Color LaserJet 5 and 5M printers.

Data Range Scaling

White and black references define the encoding range for device-dependent color spaces. However, device-independent color spaces require input data pre-scaled to the range 0 to 255. For example, to use the short form for the default YUV color space, the input data must have the following ranges:

$Y = 0.0$ to 1.0

$U = -0.89$ to 0.89

$V = -0.70$ to 0.70

The user must linearly scale ($y = mx + b$) the input data to the range 0 – 255:

$Y = 0$ (0.0) to 255 (1.0)

$U = 0$ (–0.89) to 255 (0.89)

$V = 0$ (–0.70) to 255 (0.70)

Long Form of CID Command (Configure Image Data)

In addition to the short form, there is also a long form of the CID command for each color space. In device-independent color spaces, the long form can specify primaries other than the defaults provided by the short form. For example, a Sony Trinitron RGB primary base can be selected for Colorimetric RGB instead of the default non-linear SMPTE RGB primaries.

Device RGB (Long Form)

The long form for the Device RGB color space (value field 18) provides explicit entry of black and white references (range is -32767 to 32767). Black and white references are used in the direct pixel encoding modes (2,3) to set relative limits for raster data; they are also used when specifying the primary components of new palette entries ($E_C \cdot v\#A$, $E_C \cdot v\#B$, $E_C \cdot v\#C$). Black and white references have no effect on CID default palette colors. The reference values are specified as 16-bit signed integers (sint16).

Note

The short form for the Device RGB color space defaults each primary's black reference to 0 and the white reference to $2^n - 1$, where n is the number of bits for that primary.

Byte	15 (msb) 8	7 (lsb) 0	Byte
0	Color space	Pixel encoding mode	1
2	Bits per index	Bits per primary #1	3
4	Bits per primary #2	Bits per primary #3	5
6	White reference for primary #1 (sint 16)		7
8	White reference for primary #2 (sint 16)		9
10	White reference for primary #3 (sint 16)		11
12	Black reference for primary #1 (sint16)		13
14	Black reference for primary #2 (sint16)		15
16	Black reference for primary #3 (sint16)		17

Device CMY (Long Form)

The long form for the Device CMY color space (value field is 18) provides explicit entry of black and white references (range is -32767 to 32767). Black and white references are used in the direct pixel encoding modes (2,3) to set relative limits for raster data; they are also used when specifying the primary components of new palette entries ($E_C \cdot v\#A$, $E_C \cdot v\#B$, $E_C \cdot v\#C$). Black and white references have no effect on the default CID palette colors. The reference values are specified as 16-bit signed integers (sint16).

Note

The short form for the Device CMY color space defaults each primary's white reference to 0 and black reference to $2^n - 1$, where n is the number of bits for that primary.

Byte	15 (msb) 8	7 (lsb) 0	Byte
0	Color space	Pixel encoding mode	1
2	Bits per index	Bits per primary #1	3
4	Bits per primary #2	Bits per primary #3	5
6	White reference for primary #1 (sint16)		7
8	White reference for primary #2 (sint16)		9
10	White reference for primary #3 (sint16)		11
12	Black reference for primary #1 (sint16)		13
14	Black reference for primary #2 (sint16)		15
16	Black reference for primary #3 (sint16)		17

CIE L*a*b* (Long Form)

The long form for the CIE L*a*b* color space allows a larger data range than the short form defaults:

$L^* = 0.0$ to 120.0 (greater than the short form by 20.0)

$a^* = -159.0$ to 128.0 (less than the short form by -32.0 and greater than the short form by 28.0)

$b^* = -120.0$ to 80.0 (less than the short form by 20.0)

Note

Although the data ranges may extend beyond the default data ranges specified in the short form of the CID command, the printer will clip the data to the short form data ranges.

Maximum and minimum values are specified for each primary color. Floating point data must be linearly scaled ($y = mx + b$) to the range 0 – 255.

Since a^* and b^* have no theoretical limits, $L^*a^*b^*$ data may be sent outside CID constraints. Then data is clipped to preserve hue and compressed to the device's printable gamut.

Note

CIE $L^*a^*b^*$ color space support is at HP Color LaserJet level for HP Color LaserJet 5 and 5M printers.

The white point is based on the standard D6500 illuminant.

Byte	15 (msb)	8	7	(lsb) 0	Byte
0	Color space		Pixel encoding mode		1
2	Bits per index		Bits per primary #1		3
4	Bits per primary #2		Bits per primary #3		5
6	Minimum L* value (most significant word)*				7
8	Minimum L* value (least significant word)*				9
10	Maximum L* value (msw)				11
12	Maximum L* value (lsw)				13
14	Minimum a* value (msw)				15
16	Minimum a* value (lsw)				17
18	Maximum a* value (msw)				19
20	Maximum a* value (lsw)				21
22	Minimum b* value (msw)				23
24	Minimum b* value (lsw)				25
26	Maximum b* value (msw)				27
28	Maximum b* value (lsw)				29

FLOATING POINT FORMAT

The following format is used for device-independent color floating point specifications:

31	30	23	22	0
Sign	Exponent		Fractional Portion	

The above single-precision, 32-bit floating point specification is fully compliant with the IEEE Floating Point Formats.

Colorimetric RGB (Long Form)

The long form for Colorimetric RGB allows specifications other than the default non-linear SMPTE RGB with a 2.2 gamma and 1.0 gain. Each RGB primary and the white point is specified in the CID data field by chromaticity coordinates (CIE xy). The tristimulus luminance Y value of the white point is assumed to be 100% and is therefore not specified. For color spaces that are linear transformations from CIE XYZ tristimulus coordinates, gamma and gain are set to 1.0; otherwise they are set appropriately. Colorimetric RGB spaces can be used for any monitor having primaries specified as CIE xy chromaticity coordinates with white point, such as the Sony Trinitron or Hitachi Color Monitor.

Byte	15 (msb)	8	7	(lsb) 0	Byte
0	Color space		Pixel encoding mode		1
2	Bits per Index		Bits per primary #1		3
4	Bits per primary #2		Bits per primary #3		5
6	x Chromaticity for red primary (msw)				7
8	x Chromaticity for red primary (lsw)				9
10	y Chromaticity for red primary (msw)				11
12	y Chromaticity for red primary (lsw)				13
14	x Chromaticity for green primary (msw)				15
16	x Chromaticity for green primary (lsw)				17
18	y Chromaticity for green primary (msw)				19
20	y Chromaticity for green primary (lsw)				21

Byte	15 (msb) 8	7 (lsb) 0	Byte
22	x Chromaticity for blue primary (msw)		23
24	x Chromaticity for blue primary (lsw)		25
26	y Chromaticity for blue primary (msw)		27
28	y Chromaticity for blue primary (lsw)		29
30	x Chromaticity for white point (msw)		31
32	x Chromaticity for white point (lsw)		33
34	y Chromaticity for white point (msw)		35
36	y Chromaticity for white point (lsw)		37
38	Gamma for red primary (msw)		39
40	Gamma for red primary (lsw)		41
42	Gain for red primary (msw)		43
44	Gain for red primary (lsw)		45
46	Gamma for green primary (msw)		47
48	Gamma for green primary (lsw)		49
50	Gain for green primary (msw)		51
52	Gain for green primary (lsw)		53
54	Gamma for blue primary (msw)		55
56	Gamma for blue primary (lsw)		57
58	Gain for blue primary (msw)		59
60	Gain for blue primary (lsw)		61
62	Minimum red value (msw)		63
64	Minimum red value (lsw)		65
66	Maximum red value (msw)		67
68	Maximum red value (lsw)		69
70	Minimum green value (msw)		71
72	Minimum green value (lsw)		73
74	Maximum green value (msw)		75

Byte	15 (msb) 8	7 (lsb) 0	Byte
76	Maximum green value (lsw)		77
78	Minimum blue value (msw)		79
80	Minimum blue value (lsw)		81
82	Maximum blue value (msw)		83
84	Maximum blue value (lsw)		85

Note

HP Color LaserJet 5 and 5M printers bypass the Colorimetric RGB process. In place of it, a device-dependent RGB process is substituted with a Screen Match color table.

Luminance-Chrominance (Long Form)

The long form for Luminance-Chrominance allows color spaces other than the default YUV, such as Kodak Photo YCC, the proposed JPEG and TIFF 6.0 YCrCb standard, YES, and YIQ. These Luminance-Chrominance color spaces are derived from the Colorimetric RGB space using a 3x3 transformation matrix. The tristimulus luminance y value of the white point is assumed to be 100% and is therefore not specified.

Byte	15 (msb) 8	7 (lsb) 0	Byte
0	Color space	Pixel encoding mode	1
2	Bits per index	Bits per primary #1	3
4	Bits per primary #2	Bits per primary #3	5
6	Encoding for primary #1 R (msw)		7
8	Encoding for primary #1 R (lsw)		9
10	Encoding for primary #1 G (msw)		11
12	Encoding for primary #1 G (lsw)		13
14	Encoding for primary #1 B (msw)		15
16	Encoding for primary #1 B (lsw)		17
18	Encoding for primary #2 R (msw)		19
20	Encoding for primary #2 R (lsw)		21

Byte	15 (msb) 8	7 (lsb) 0	Byte
22	Encoding for primary #2 G (msw)		23
24	Encoding for primary #2 G (lsw)		25
26	Encoding for primary #2 B (msw)		27
28	Encoding for primary #2 B (lsw)		29
30	Encoding for primary #3 R (msw)		31
32	Encoding for primary #3 R (lsw)		33
34	Encoding for primary #3G (msw)		35
36	Encoding for primary #3 G (lsw)		37
38	Encoding for primary #3 B (msw)		39
40	Encoding for primary #3 B (lsw)		41
42	Minimum primary #1 value (msw)		43
44	Minimum primary #1 value (lsw)		45
46	Maximum primary #1 value (msw)		47
48	Maximum primary #1 value (lsw)		49
50	Minimum primary #2 value (msw)		51
52	Minimum primary #2 value (lsw)		53
54	Maximum primary #2 value (msw)		55
56	Maximum primary #2 value (lsw)		57
58	Minimum primary #3 value (msw)		59
60	Minimum primary #3 value (lsw)		61
62	Maximum primary #3 value (msw)		63
64	Maximum primary #3 value (lsw)		65
66	x Chromaticity for red primary (msw)		67
68	x Chromaticity for red primary (lsw)		69
70	y Chromaticity for red primary (msw)		71
72	y Chromaticity for red primary (lsw)		73
74	x Chromaticity for green primary (msw)		75

Byte	15 (msb) 8	7 (lsb) 0	Byte
76	x Chromaticity for green primary (lsw)		77
78	y Chromaticity for green primary (msw)		79
80	y Chromaticity for green primary (lsw)		81
82	x Chromaticity for blue primary (msw)		83
84	x Chromaticity for blue primary (lsw)		85
86	y Chromaticity for blue primary (msw)		87
88	y Chromaticity for blue primary (lsw)		89
90	x Chromaticity for white point (msw)		91
92	x Chromaticity for white point (lsw)		93
94	y Chromaticity for white point (msw)		95
96	y Chromaticity for white point (lsw)		97
98	Gamma for red primary (msw)		99
100	Gamma for red primary (lsw)		101
102	Gain for red primary (msw)		103
104	Gain for red primary (lsw)		105
106	Gamma for green primary (msw)		107
108	Gamma for green primary (lsw)		109
110	Gain for green primary (msw)		111
112	Gain for green primary (lsw)		113
114	Gamma for blue primary (msw)		115
116	Gamma for blue primary (lsw)		117
118	Gain for blue primary (msw)		119
120	Gain for blue primary (lsw)		121

Note

CIE L*a*b* color space support is at HP Color LaserJet level for HP Color LaserJet 5 and 5M printers.

Examples Using the CID Command

The following examples illustrate using the CID command's short and long forms for each color space. For clarity, data is shown as ASCII, rather than binary and the CID command ($\text{E}_c^*v\#W$) is shown as "CID". The following format is used:

CID (data , data , . . .)

Device RGB or Device CMY

SHORT FORM

CID(0,1,8,8,8,8)	Device RGB, 8 bits/pixel indexed
CID(1,1,8,8,8,8)	Device CMY, 8 bits/pixel indexed

Example:

The short form CID command, as a C function, can look like this:

```
short_cid(Color_mode, Pixel_mode, BitsperIndex,  
          BitsperColor_1, BitsperColor_2, BitsperColor_3)  
{  
    int Color_mode, Pixel_mode, BitsperIndex,  
        BitsperColor_1, BitsperColor_2, BitsperColor_3;  
  
    printf("\033*v6W%c%c%c%c%c%c", Color_mode,  
          Pixel_mode, BitsperIndex, BitsperColor_1,  
          BitsperColor_2, BitsperColor_3);  
}
```

LONG FORM

CID(0,1,8,8,8,8,	Device RGB, 8 bits/pixel indexed
0,0,0	White reference
100,100,100)	Black reference

CIE L*a*b*

SHORT FORM

CID(3,3,0,8,8,8) L*a*b*, direct 8 bits/primary

LONG FORM

CID(3,3,0,8,8,8,	L*a*b*, direct 8 bits/primary
0.0, 100.0,	L* data encoding
-100.0, 100.0,	a* data encoding
-100.0, 100.0)	b* data encoding

Non-Linear SMPTE RGB, 2.2 Gamma, 1.0 Gain

SHORT FORM

CID(2,3,0,8,8,8) RGB, direct 8 bits/primary

LONG FORM

CID(2,3,0,8,8,8,	RGB, direct 8 bits/primary
0.64, 0.34,	
0.31, 0.60,	Chromaticity coordinates
0.16, 0.07,	for RGB & White Point
0.3127, 0.3290,	
2.2, 1.0,	*
2.2, 1.0,	* Gamma and gain for RGB
2.2, 1.0,	*
0.0, 1.0,	
0.0, 1.0,	Data range encoding
0.0, 1.0)	

Non-Linear Sony Trinitron

SHORT FORM

Not Applicable

LONG FORM

CID(2,3,0,8,8,8	RGB, direct 8 bits/primary
0.62, 0.34,	
0.30, 0.58,	Chromaticity coordinates
0.15, 0.09,	for RGB
0.2800, 0.2933,	White Point
2.3, 1.19,	*
2.3, 1.19,	* Gamma and gain for RGB
2.3, 1.19,	*
0.0, 255.0,	
0.0, 255.0,	Data range encoding
0.0, 255.0)	

YUV Chrominance-Luminance Color Space

SHORT FORM

CID(4,3,0,8,8,8)	YUV, direct 8 bits/primary
------------------	----------------------------

YUV Chrominance-Luminance with Sony Trinitron

LONG FORM

CID(2,3,0,8,8,8	YUV, direct 8 bits/primary
0.30,0.59,0.11,	
-0.30,0.59,0.89,	3x3 YUV matrix
0.70,-0.59,-0.11,	
0.0,255.0	*
-227.0,227.0,	* Data encoding
-179.0,179.0	*
0.62,0.34,	
0.30,0.58,	Chromaticity
0.15,0.09,	coordinates
0.2800, 0.2933,	chromaticity white point
2.3,1.19,	*
2.3,1.19,	* Gamma and
2.3,1.19)	* gain for RGB

HP-GL/2 Imaging Mode

The HP-GL/2 Imaging Mode provides a way of using vector commands in printing documents. Although the default PCL and HP-GL/2 palettes are not the same, when transferring from PCL to HP-GL/2, active palette information does stay the same. You can switch between PCL and HP-GL/2 and use the same palette, and you can also modify palettes using either PCL or HP-GL/2.

Compared to monochrome printers, the Color LaserJet and DeskJet 1200C color printers have some commands that are modified for use with color printers. Chapter 7 describes the new or modified HP-GL/2 commands.

If you are not familiar with using HP-GL/2, see the *PCL 5 Printer Language Technical Reference Manual*. It provides a detailed explanation of using HP-GL/2.