3 Using Palettes

Introduction

A palette is a collection of color specifications selected using index numbers. The figure below illustrates a palette. Each palette entry associates an index number with three primary color components. For HP-GL/2 purposes only, a pen width is also associated with each palette entry.

Color Palette

HP-GL/2 Pen Width

	Primary 1	Primary 2	Primary 3		Pen Width
0					
1					
2					
3					
4					
5					
6					
7					
8					
9					
n		⋮			⋮
(max. 255)					

Bits per Primary
- Primary 1 = 8
- Primary 2 = 8
- Primary 3 = 8

In non-raster mode, the current palette contains all the available colors. In raster mode, indexed color selection uses the palette, but direct selection does not.

Default palettes are created by all the PCL color modes (Black and White, Simple Color, PCL Imaging, and HP-GL/2 Imaging). The active palette may be modified when in the PCL Imaging or HP-GL/2 imaging modes, but not when in the Simple Color or Black and White modes. When switching between PCL 5 and HP-GL/2 contexts, the active palette is automatically transferred.

Multiple palettes can exist in the system via the Palette ID and Palette Stack mechanism. However, only one palette at a time can be active. A palette created in the PCL context remains active and unchanged when switching to the HP-GL/2 context, and a palette created in the HP-GL/2 context remains active and unchanged when switching to the PCL context. Performing a reset or entering PJL overwrites the active palette with the default black and white palette.

Whenever a new palette is created, the currently or previously active palette is destroyed. A new palette is created by power-on and also by the following commands:

- PCL Reset (E_CE)
- Simple Color (E_C*r#U)
- Configure Image Data (E_C*v#W)
- HP-GL/2 Initialize (IN)

The active palette can be saved by pushing it onto the palette stack with the Push/Pop Palette command (E_C*p#P). Popping a palette from the stack destroys the active palette—the popped palette becomes the active palette.

Saving the Palette

The current palette is destroyed when a new palette is created. The Push/Pop Palette command (^{E}C*p#P) can save (push) the current palette and then restore (pop) it.

Push/Pop Palette Command

This command pushes or pops the palette from the palette stack.

^{E}C***p#P**

 # = 0 - Push (save) palette
         1 - Pop (restore) palette

Default = 0
Range = 0, 1 (invalid values are ignored)

A value of 0 (^{E}C*p0P) pushes a copy of the active palette onto the palette stack. When a palette is pushed, the active palette is not affected.

A value of 1 (^{E}C*p1P) pops the most recently pushed palette and destroys the active palette; the popped palette becomes the active palette. As with any stack, the last item pushed is the first item popped.

Pushing a palette saves the following parameters:

- Color definitions for each palette entry
- Pen widths (for HP-GL/2 use)
- Color space specification
- Number of bits per index
- Pixel encoding mode
- Number of bits per primary
- Color treatment
- Render algorithm

Pushing a palette does not save the following parameters.

- Foreground color
- Color components: 1st, 2nd, and 3rd
- Finish mode
- Monochrome print mode

The palette stack depth is limited by printer memory. Attempts to push a palette with insufficient memory cause an out-of-memory error. Attempts to pop from an empty stack are ignored.
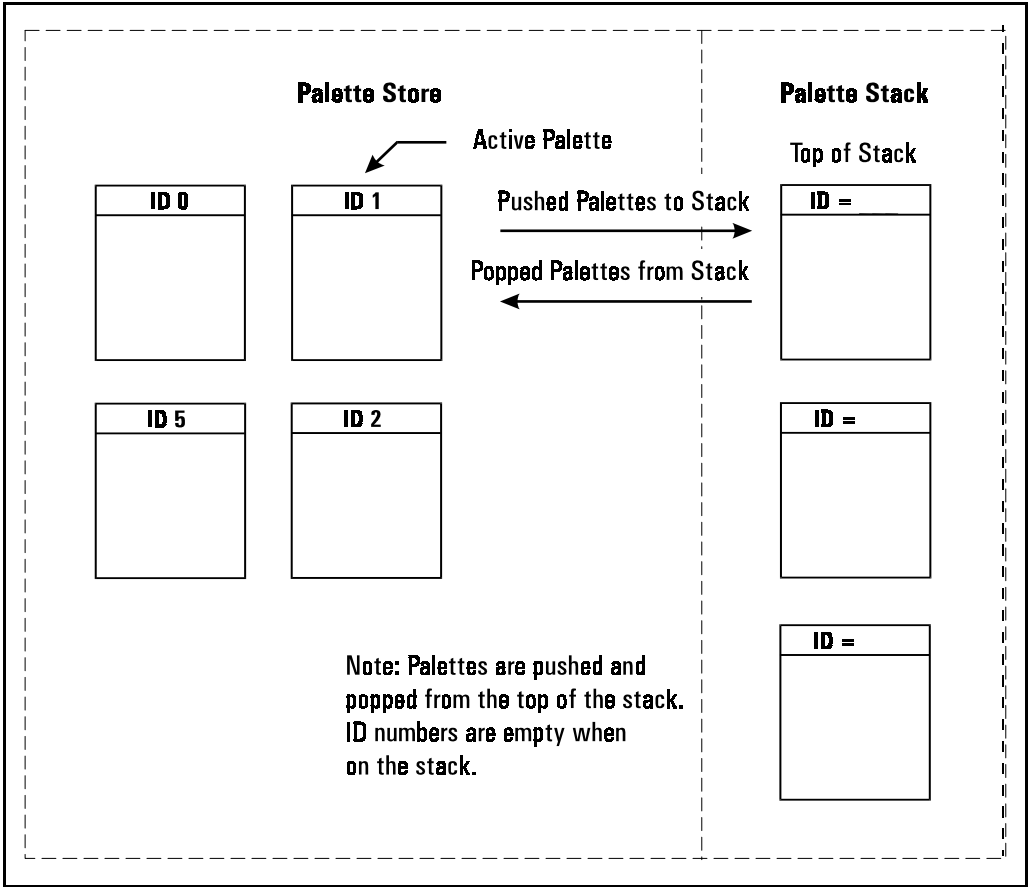
Macros can push and pop palettes. A palette that was popped in an *executed* macro remains in effect at the end of the macro (this is not true for "called" or "overlaid" macros).

The PCL reset command ($^{E}_{C}$E) or an exit to PJL causes the printer to empty the palette stack and overwrite the active palette with a non-programmable black and white palette. The HP-GL/2 commands IN and DF have no effect on the palette stack, but they do destroy the active palette and replace it with the default HP-GL/2 palette.

Palette Management by ID

All palettes have a unique ID (identification number). The default black and white palette created on power-up or E_CE has an ID of 0.

Palette management by ID lets applications have multiple palettes. As shown below, multiple palettes can exist in two areas: the palette stack and the palette store. The stack holds palettes that are pushed via a Push/Pop Palette command; the store holds palettes having palette IDs.

```
           Palette Store                    Palette Stack

                      Active Palette          Top of Stack

  ┌─ ID 0 ──┐   ┌─ ID 1 ──┐   Pushed Palettes to Stack   ┌─ ID = ──┐
  │         │   │         │   ──────────────────────>    │         │
  │         │   │         │   Popped Palettes from Stack  │         │
  │         │   │         │   <──────────────────────    │         │
  └─────────┘   └─────────┘                               └─────────┘

  ┌─ ID 5 ──┐   ┌─ ID 2 ──┐                               ┌─ ID = ──┐
  │         │   │         │                               │         │
  │         │   │         │                               │         │
  └─────────┘   └─────────┘                               └─────────┘

         Note: Palettes are pushed and                   ┌─ ID = ──┐
         popped from the top of the stack.               │         │
         ID numbers are empty when                       │         │
         on the stack.                                   └─────────┘
```

Palettes on the stack may not be selected by ID, since only a copy of a palette is pushed onto the stack; the original palette and ID remain in the palette store. A palette popped from the stack goes into the palette store, becomes the new active palette, and assumes the ID of the previously active palette, which is overwritten. Only one palette at a time may be active.

Management by ID allows applications to tag data, have multiple raster configurations, and have palettes for different color spaces—all without reconfiguring the active palette. For example, one palette can be created for PCL text, one for HP-GL/2 primitives, one for simple raster, and one for 24-bit raster. The application can then switch between palettes according to what is being sent to the printer.

Selecting a new active palette changes the PCL graphics state. Besides the color entries, a palette also has the graphics state which contains the color space, color treatment, and render algorithm. This ensures that the same color specification in a given palette will always produce the same printed color.

As described below, the Select Palette (^{E}c&p#S), Palette Control (^{E}c&p#C), and Palette Control ID (^{E}c&p#I) commands implement the three basic operations of management by ID.

- Selection of the active palette
- Deletion of palettes
- Copying of palettes

Select Palette Command

The Select Palette command selects a new active palette by specifying an ID number. The previously active palette is unchanged.

^{E}c**&p#S**

    # = Palette ID number

Default = 0
Range = 0 to 32767 (command is ignored for out- of-range values)

This command activates the designated palette in the palette store. The command is ignored if the specified ID matches the active palette's ID, or if no palette with that ID exists. The designated ID is saved as the palette select ID for the duration of the print job, or until another Select Palette command is received.

This command can be used to de-select the active palette and select as the new active palette a palette created by the Palette Control command (^{E}c&p#C). For example, to copy the active palette to an ID of 44 and select the new palette to use or modify, send ^{E}c&p44i6c44S.

When a palette creation command is received such as Configure Image Data (E_C*v#W), Simple Color (E_C*r#U), or an HP-GL/2 IN, the created palette overwrites the active palette and is assigned the current palette select ID.

A palette popped from the stack overwrites the active palette, and is assigned the current palette select ID.

E_CE resets the palette select ID value to 0 and deletes all palettes in the palette stack and palette store, including the active palette, which is replaced by a default PCL fixed black and white palette with a palette ID of 0.

Macros affect the palette select ID value as follows:

- Calling or Overlaying a macro—saves the ID value and a copy of the active palette. Upon macro exit, the restored palette again becomes the active palette with the restored ID. An existing palette with this ID is deleted.
- Executing a macro—does not save the ID value or the active palette; changes remain in effect.

Palette Control ID

The Palette Control ID command specifies the ID number to be used by the Palette Control Command.

E_C**&p#I**

= Palette ID number

Default = 0
Range = 0 to 32767 (command is ignored for out-of-range values)

The ID number specified by this command is saved as the palette control ID and is used by the Palette Control command (E_C&p#C).

E_CE or power-up resets the palette control ID to 0, which is then the default black and white palette ID.

Macros affect the palette control ID value as follows:

- Calling a macro—saves the value and restores the value at exit.
- Executing a macro—does not save the value; changes remain in effect at exit.
- Overlaying a macro—copies the value before resetting to 0, and restores at exit.

Palette Control

The Palette Control command provides a mechanism for making and deleting palettes.

E_C**&p#C**

 # =   0   -   Delete all palettes except those in the stack (active palette deleted)

          1   -   Delete all palettes in the stack (active palette is not affected)

          2   -   Delete palette (specified by Palette Control ID)

          6   -   Copy active palette to ID specified by Palette Control ID

Default   = 0
Range   = 0, 1, 2, 6 (command is ignored for unsupported values)

- A value of **0** deletes all palettes except those on the palette stack. The active palette is replaced by the default black and white palette (ID 0). The palette control ID is not used.

- A value of **1** clears the palette stack. The active palette is unaffected, and the palette control ID is not used.

- A value of **2** deletes the palette with the specified palette control ID if it exists; otherwise the command is ignored. For example, to delete palette 53, send E_C&p53i2C. If the active palette's ID is specified the active palette is replaced by the default black and white palette. This option does not change the palette control ID value.

Note   When the active palette is replaced by the default black and white palette, the graphics state associated with the previous palette is also replaced.

- A value of 6 creates a copy of the active palette. The copy receives the ID specified by the last Palette Control ID command. For example, to copy the active palette to a palette with an ID of 14, send E_C&p14i6C. The copied palette overwrites any palette that already has an ID equal to the palette control ID. The copied palette does not become the active palette. The command is ignored if a palette is to be copied to its own ID.

The Palette Control command provides a way of managing system memory by deleting palettes in either the stack or store that are no longer in use.

Palette Control that is exercised during macros can have significant impact on palettes that exist within the system. Deleting all palettes, or those on the stack, or the current palette, or all those except on the stack can have adverse effects when the macro is exited. The adverse effect could be the deletion of the desired palette, and replacement with a black and white non-programmable palette.

Simple Color Palettes

The Simple Color command ($^{E}_{C}$*r#U) provides a quick way to select colors from a fixed, non-programmable palette.

The Simple Color command overwrites the current palette with one of the fixed palettes below. When the Simple Color command is in effect, the PCL and HP-GL/2 commands that modify a palette entry (NP, PC, $^{E}_{C}$*v#A, $^{E}_{C}$*v#B, $^{E}_{C}$*v#C, $^{E}_{C}$*v*I, $^{E}_{C}$*t*I) are locked out. A popped simple color palette cannot be modified and the pixel encoding mode reverts to "index by plane". Only the IN or the CID ($^{E}_{C}$*v#W) commands can create a modifiable palette.

As shown below, a value field of 1 ($^{E}_{C}$*r1U) creates a black and white palette. A value of 3 creates an 8-pen palette in Device RGB color space. A value of −3 creates an 8-pen palette in Device CMY color space. All of these Simple Color palettes are fixed and non-programmable.

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

CID Color Palettes

The Configure Image Data command, explained in detail in Chapter 2, creates a palette based upon the parameters in its data field. CID-created palettes are programmable: any entry can be reassigned a different color using PCL commands (E_C*v#A, E_C*v#B, E_C*v#C, E_C*v*I) or HP-GL/2 commands (PC, NP). Default palettes vary by color space.

Device RGB and sRGB Palettes

Bits/Index = 1

Index	Color
0	White
1	Black

Bits/Index = 2

Index	Color
0	Black
1	Red
2	Green
3	White

Bits/Index = 3 through 8

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

Device CMY Palettes

Bits/Index = 1

Index	Color
0	White
1	Black

Bits/Index = 2

Index	Color
0	White
1	Cyan
2	Magenta
3	Black

Bits/Index = 3 through 8

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

HP-GL/2 Palettes

Regardless of the color space, a default PCL palette is always different than a default HP-GL/2 palette. The following table shows the default palettes established in HP-GL/2. Like a default CID palette, a default HP-GL/2 palette can be modified in either PCL or HP-GL/2 contexts using the following commands:

PCL

- Color Components 1, 2, and 3 (E_C*v#A, E_C*v#B, E_C*v#C)
- Assign Color Index (E_C*v#I)

HP-GL/2

- Number of Pens (NP)
- Pen Color Assignment (PC)

Note   The IN command always establishes the 8-pen palette.

Two Pens

Pen Number	Color
0	White
1	Black

Four Pens

Pen Number	Color
0	White
1	Black
2	Red
3	Green

Eight Pens

Pen Number	Color
0	White
1	Black
2	Red
3	Green
4	Yellow
5	Blue
6	Magenta
7	Cyan
n > 7	Black

Foreground Color

All PCL marking entities utilize "foreground" color, which is selected from the current palette using the Foreground Color command (E_C*v#S). Foreground color interacts with raster color depending on the print model commands in effect.

Foreground Color Command

The Foreground Color command sets the foreground color to the specified index of the current palette.

E_C***v#S**

> \# = Index number into current palette

Default = 0
Range = 0 to $2^{(current\ palette\ size)} - 1$

Specified values that are out-of-range of the current palette are mapped into a new index as follows:

Index = *Specified foreground index* modulo *palette size*

For example, specifying a foreground color index of 10 when the current palette size is 8 maps to 10 modulo 8, which is equal to 2. If the current palette was created under HP-GL/2, the index is mapped according to the HP-GL/2 mapping function.

Foreground color affects the following PCL page marking primitives:

- Text characters (they change to the foreground color, including underlining)
- Solid or monochrome patterned rectangular area fills (rules)
- Monochrome patterns (except HP-GL/2)
- Raster images

The following are not affected:

- User-defined color patterns (format 1 download patterns)
- HP-GL/2 marking primitives (HP-GL/2 uses "selected pen", but ignores foreground color)

Note   Foreground color interacts with color raster images. In the printer, all color raster is resolved into three binary raster planes of CMY. Foreground color is applied to these planes, modifying the color image. For no interaction, set foreground color to black when sending color raster images.

After a foreground color is selected, changing any of the following will not change foreground color until a new Foreground Color command (^{E}C*v#S) is issued:

- Active Palette
- Configure Image Data (CID) command
- Render Algorithm

Programming Color Palettes

Except for the default black and white palette or the Simple Color palettes (^E_C*r#U), palette entries can be modified. The three primary components of a color are specified and the resulting color is assigned to the palette entry indicated by ^E_C*v#I.

In the explanation below, the term "component" refers to the color space primary colors. For example, if the current color space is sRGB, component 1 indicates R, component 2 indicates G, and component 3 indicates B.

Color Component One

This command specifies the first component of the palette entry designated by the Assign Color Index command (^E_C*v#I).

^E_C*v#A

= First Component

Default = 0
Range = −32767.0000 to 32767.0000 (up to 4 decimal places; command is ignored for invalid configurations)

The Assign Color Index command actually applies this value and then resets it to 0.

Color Component Two

This command specifies the second component of the palette entry designated by the Assign Color Index command.

^E_C*v#B

= Second Component

Default = 0
Range = −32767.0000 to 32767.0000 (up to 4 decimal places; command is ignored for invalid configurations)

The Assign Color Index command actually applies this value and then resets it to 0.

Color Component Three

This command specifies the third component of the palette entry designated by the Assign Color Index command.

^E_C*v#C

    # = Third Component

Default = 0
Range = –32767.0000 to 32767.0000 (up to 4 decimal places; command is ignored for invalid configurations)

The Assign Color Index command actually applies this value and then resets it to 0.

Assign Color Index

This command assigns the three current color components to the specified palette index number.

^E_C*v#I

    # = Index Number

Default = 0
Range = 0 to $2^n - 1$, where n is the number of bits per index (no assignment for out-of-range values)

This command resets the color components to 0 after assignment. If the specified index number is greater than the palette size, no index assignment is made, but the three color components are set to 0.