Drawing Engine Command Set

Section 6: DRAWING ENGINE COMMAND SET

Special Programming Note:

Registers CP0-4 and XY0-4 are shadowed registers. Writing into XY0 would also write into CP0 and vice versa. Similarly, writing into XY1 would shadow into CP1, writing into XY2 would shadow into CP2, etc...

Special care must be taken when switching between 2D and 3D commands, i.e. writing into CP1 would trigger a 2D command! Also, XY or CP registers may have been written over between 2D and 3D commands.

Additional Shadowed Registers:

1) *XY3 = CP3 = CP25*
2) *XY4 = CP5*
3) *CP11 = CP27*
4) *CP19 = CP29*
5) *CMD(0x0048) = CMD(0x0168)*
6) **Register address F8 is shadowed to the register whose address is 1F8.*
7) **Register address FC is shadowed to the register whose address is 1FC.*

6.1 Noop

Command Name: No operation
Command Mnemonic: NOOP

Command Description:
The **NOOP** command performs a null operation. The CHIP returns to its idle states.

Command Capabilities:

- None

0x0	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY0			
XY1 ℗			Command Trigger
XY2			
XY3			
XY4			

℗= Command Trigger

ACTIVE PARAMETERS

BUF_CTRL	-
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	-
DE_ZPTCH	-
DE_SPTCH	-
DE_DPTCH	-
CMD_OPC	0x0
CMD_ROP	-
CMD_STYLE	-
CMD_PATRN	-
CMD_CLP	-
FORE	-
BACK	-
MASK	-
DE_KEY	-
LPAT	-

PCTRL	-
CLPTL	-
CLPBR	-
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	-
YON	-
FOG_COLOR	-
ALPHA	-
ACNTRL	-
3D_CNTRL	-
TEX_CNTRL	-

6.2 BitBlt

Command Name: Bit Block Transfer
Command Mnemonic: BITBLT

Command Description:

The BITBLT command manipulates rectangular areas in the local buffers. The source or destination can be in the Display or Virtual buffer. The BITBLT command requires the host to calculate the scanning direction and provide the correct corner of both the source and destination rectangles. The scanning direction will always be from left to right, top to bottom regardless of the DIR field for any bitblt with zoom or any packed mode bitblt.
Command capabilities:

- Transparent BLT.
- Raster operations as defined by the ROP field of the command register.
- Fast area fills with selectable pixel values.
- 32x32 and 8x8 area patterning.
- Color expansion.
- Screen door transparency in stipple mode or using Masking.
- Bit plane masking.
- Variable pitch for virtual and Mask buffers.
- OpenGL Alpha Blending

0x1	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY0	Source	X-Y	Corner of source
XY1 ℙ	Destination	X-Y	Corner of destination
XY2	Width/Height	X-Y	Width/Height of Rect
XY3	DIR	I	Direction right justified
XY4	YZOOM	NA-Y	Zoom Factor

DIRECTION	CODE	CORNER REQUIRED
L → R, T →B	0x0	Upper Left
L → R, B →T	0x1	Bottom Left
R → L, T →B	0x2	Upper Right
R → L, B →T	0x3	Bottom Right

ℙ= Command Trigger

ACTIVE PARAMETERS

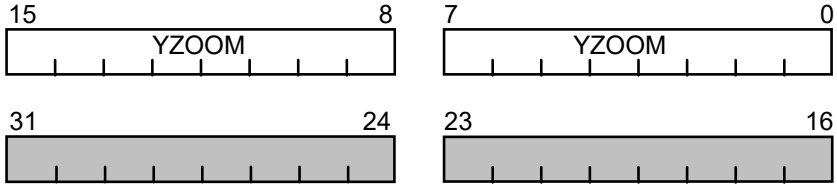
BUF_CTRL	
XYW_AD	-
XYW_SZ	-
DE_SORG	
DE_DORG	
DE_ZPTCH	-
DE_SPTCH	
DE_DPTCH	
CMD_OPC	0x1
CMD_ROP	
CMD_STYLE	
CMD_PATRN	
CMD_CLP	
FORE	
BACK	
MASK	
DE_KEY	
LPAT	-

PCTRL	-
CLPTL	
CLPBR	
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	-
YON	-
FOG_COLOR	-
ALPHA	
ACNTRL	
3D_CNTRL	-
TEX_CNTRL	-

6.2.1 XY4 Register Zoom Data Format

This register contains the Y zoom factors for the BITBLT command.

Note: Please read special programming note on page 6-2 prior to programming this command.



Bits	Name	Value	Function
XY4[15:0]	YZOOM		Y direction Zoom factor
		0x0 - 0x1	No Zoom
		0x2	2X Zoom
		0x3	3X Zoom
		0x4	4X Zoom
		0x5	5X Zoom
		0x6	6X Zoom
		0x7	7X Zoom
		0x8	8X Zoom
		0x9 - 0xF	9X to 65535X Zoom

6.3 LINE

Command Name: Line
Command Mnemonic: LINE

Command Description:
The LINE command draws straight lines in to memory using a modified Bresenham's Algorithm to ensure that a line drawn from point A to point B will exactly match a line drawn from point B to point A. This command accepts directly in X-Y format the start and end point for a line.
Command capabilities:

- 16 raster operations as defined by the ROP field of the command register.
- Gouraud shading.
- 32 bit scaled patterning.
- Color expansion.
- Screen door transparency.
- Bit plane masking.
- Open GL Alpha Blending

0x2	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY0	Source	X-Y	Start point of line
XY1	Destination	X-Y	End point of line
XY2	NA		
XY3	NA		
XY4	NA		

ACTIVE PARAMETERS

BUF_CTRL	
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	
DE_SPTCH	-
DE_ZPTCH	-
DE_DPTCH	
CMD_OPC	0x2
CMD_ROP	
CMD_STYLE	
CMD_PATRN	
CMD_CLP	
FORE	
BACK	
MASK	
DE_KEY	
LPAT	

PCTRL	
CLPTL	
CLPBR	
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	-
YON	-
FOG_COLOR	-
ALPHA	
ACNTRL	
3D_CNTRL	-
TEX_CNTRL	-

6.4 PLINE

Command Name: Poly Line
Command Mnemonic: PLINE

Command Description:

The PLINE command draws straight lines beginning at the destination of the last command. It uses modified Bresenham's Algorithm to ensure that a line drawn from point A to point B will exactly match a line drawn from point B to point A. This command accepts end point for a line in XY format.

Command capabilities:

- 16 raster operations as defined by the ROP field of the command register.
- Gouraud shading.
- 32 bit scaled patterning.
- Color expansion.
- Screen door transparency.
- Bit plane masking.
- Open GL Blending

0x5	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY0	NA		
XY1	Destination	X-Y	End point of line
XY2	NA		
XY3	NA		
XY4	NA		

ACTIVE PARAMETERS

BUF_CTRL	▤
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	▤
DE_ZPTCH	-
DE_SPTCH	-
DE_DPTCH	▤
CMD_OPC	0x5
CMD_ROP	▤
CMD_STYLE	▤
CMD_PATRN	▤
CMD_CLP	▤
FORE	▤
BACK	▤
MASK	▤
DE_KEY	▤
LPAT	▤

PCTRL	▤
CLPTL	▤
CLPBR	▤
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	-
YON	-
FOG_COLOR	-
ALPHA	▤
ACNTRL	▤
3D_CNTRL	-
TEX_CNTRL	-

6.5 Line with Initial Error

Command Name: Draw line with initial error
Command Mnemonic: ELINE

Command Description:
The ELINE is a variant of the LINE command which allows the setting of the initial and incremental values of the Bresenham error term. All the characteristics of the LINE command also apply to the ELINE command. The ELINE may be used when sub-pixel accuracy is required. By pre-loading the error terms, a line segment can be drawn and the pixels will match exactly as if the entire line had been drawn. In addition, the ELINE command allows triangle boundaries to be drawn to match precisely the pixels drawn by the triangle command.

Command capabilities:

- 16 raster operations as defined by the ROP field of the command register.
- 32 bit scaled patterning.
- Color expansion.
- Screen door transparency.
- Bit plane masking.
- OpenGL Alpha Blending

0x3	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY0	Source	X-Y	Start point of line
XY1 ☞	Destination	X-Y	End point of line
XY2	ERR	X-Y	Initial Error
XY3	ERRI	X-Y	Error Increment
XY4	NA		

ERR={(-major_delta),16'h0};

ERRI={2(major_delta),2(minor_delta)};

☞ **=Command Trigger**

ACTIVE PARAMETERS

BUF_CTRL	
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	
DE_ZPTCH	-
DE_SPTCH	-
DE_DPTCH	
CMD_OPC	0x5
CMD_ROP	
CMD_STYLE	
CMD_PATRN	
CMD_CLP	
FORE	
BACK	
MASK	
DE_KEY	
LPAT	

PCTRL	
CLPTL	
CLPBR	
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	-
YON	-
FOG_COLOR	-
ALPHA	
ACNTRL	
3D_CNTRL	-
TEX_CNTRL	-

6.6 3D Lines with Setup

Command Name: Draw line with full setup.
Command Mnemonic: LINE_3D

Command Description: LINE_3D draws 3D Gouraud shaded, fogged, lit lines and points.

Command capabilities:

- 16 raster operations as defined by the ROP field of the command register.
- Specular High Lighting.
- Fog.
- Gouraud Shading.
- Alpha blending and compare.
- 16 or 32 bit Z buffering.
- bit scaled patterning.
- Color expansion.
- Screen door transparency in stipple mode.
- Bit plane masking.

0x8	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
CP9	V1_X	Float	Vertex 0 X
CP10	V1_Y	Float	Vertex 0 Y
CP11	V1_Z	Float	Vertex 0 Z
CP12	Reserved	0x0	Reserved
CP13	V1_C	I	Vertex 0 Color {A, R, G, B}
CP14	V1_S	I	Vertex 0 Specular {F, Rs, Gs, Bs}
CP15	Reserved	0x0	Reserved
CP16	Reserved	0x0	Reserved
CP17	V2_X	Float	Vertex 1 X
CP18	V2_Y	Float	Vertex 1 Y
CP19	V2_Z	Float	Vertex 1 Z
CP20	Reserved	0x0	Reserved

REGISTER	PARAMETER	FORMAT	DESCRIPTION
CP21	V2_C	I	Vertex 1 Color {A, R, G, B}
CP22	V2_S	I	Vertex 1 Specular {F, Rs, Gs, Bs}
CP23	Reserved	0x0	Reserved
CP24	Reserved	0x0	Reserved
CP25*	SPZ_LO	I-F	Z at SPXY
CP26*	SPZ_HI	I	Z at SPXY
CP27*	DZDX_LO	I-F	Change in Z with respect to X
CP28*	DZDX_HI	I	Change in Z with respect to X
CP29*	DZDY_LO	I-F	Change in Z with respect to Y
CP30*	DZDY_HI	I	Change in Z with respect to Y
TRIGGER♦	3D Trigger	NA	Triggers 3D commands

♦=Command Trigger
***To be supplied by user when in 32bpp Z mode. Refer to appendix A for more details.**

ACTIVE PARAMETERS

BUF_CTRL	
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	
DE_ZPTCH	
DE_SPTCH	
DE_DPTCH	
CMD_OPC	0x8
CMD_ROP	
CMD_STYLE	
CMD_PATRN	
CMD_CLP	
FORE	
BACK	
MASK	
DE_KEY	
LPAT	

PCTRL	
CLPTL	
CLPBR	
DE_ZORG	
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	
YON	
FOG_COLOR	
ALPHA	
ACNTRL	
3D_CNTRL	
TEX_CNTRL	-

6.7 3D Triangle with Full Setup and Vertex Sorting

Command Name: 3D Triangle
Command Mnemonic: TRIAN_3D

Command Description:
The TRIAN command draws a Textured, Gouraud shaded, Specular lighted or flat shaded triangle. This command requires only vertex level parameters.

Command Capabilities:

- 16 raster operations as defined by the ROP field of the command register.
- Perspective corrected texture mapping.
- Bilinear filtering.
- Palettized texture maps.
- Linear MIP mapping.
- Specular Lighting.
- Fog.
- Gouraud Shading.
- Alpha blending and compare.
- 16, 24, fixed point Z buffering.
- 32 bit floating point Z buffering.
- 32x32 and 8x8 area patterning.
- Color expansion.
- Screen door transparency in stipple mode.
- Bit plane masking.
- 3D Color Keying
- Optional Float color values.
- Optional Backface culling w/ CW/CCW selection

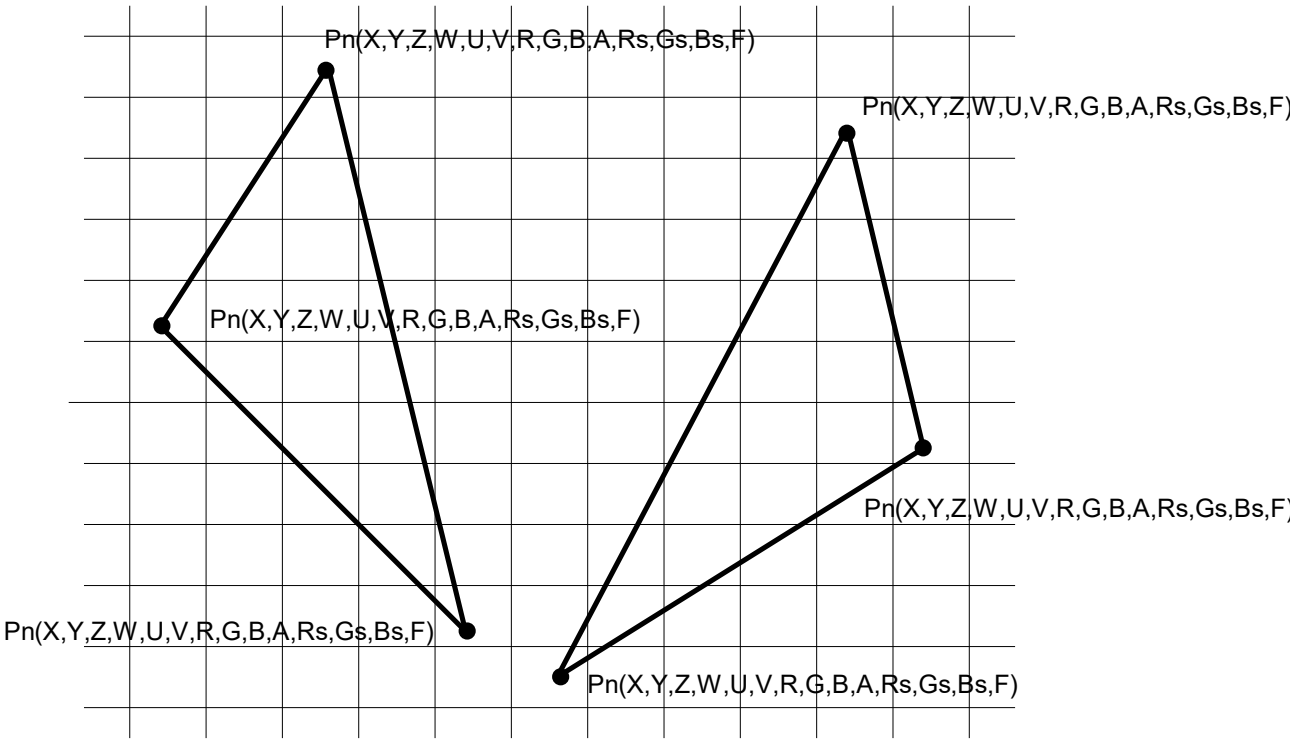
0x9	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
CP0	PPTR	X-Y	Pattern Pointer
CP1	V0_X	Float	Vertex 0 X
CP2	V0_Y	Float	Vertex 0 Y
CP3	V0_Z	Float	Vertex 0 Z
CP4	V0_W	Float	Vertex 0 W
CP5	V0_C	I	Vertex 0 Color {A, R, G, B}
CP6	V0_S	I	Vertex 0 Specular {F, Rs, Gs, Bs}
CP7	V0_U	Float	Vertex 0 U
CP8	V0_V	Float	Vertex 0 V
CP9	V1_X	Float	Vertex 1 X
CP10	V1_Y	Float	Vertex 1 Y
CP11	V1_Z	Float	Vertex 1 Z
CP12	V1_W	Float	Vertex 1 W
CP13	V1_C	I	Vertex 1 Color {A, R, G, B}
CP14	V1_S	I	Vertex 1 Specular {F, Rs, Gs, Bs}
CP15	V1_U	Float	Vertex 1 U
CP16	V1_V	Float	Vertex 1 V
CP17	V2_X	Float	Vertex 2 X
CP18	V2_Y	Float	Vertex 2 Y
CP19	V2_Z	Float	Vertex 2 Z
CP20	V2_W	Float	Vertex 2 W
CP21	V2_C	I	Vertex 2 Color {A, R, G, B}
CP22	V2_S	I	Vertex 2 Specular {F, Rs, Gs, Bs}
CP23	V2_U	Float	Vertex 2 U
CP24	V2_V	Float	Vertex 2 V
TRIGGER♦	3D Trigger	NA	Triggers 3D commands

♦=Command Trigger

Important Programming Note: The W parameter for each vertex must be set before setting the corresponding u and v parameters.


Pn(X,Y,Z,W,U,V,R,G,B,A,Rs,Gs,Bs,F)
Pn(X,Y,Z,W,U,V,R,G,B,A,Rs,Gs,Bs,F)
Pn(X,Y,Z,W,U,V,R,G,B,A,Rs,Gs,Bs,F)
Pn(X,Y,Z,W,U,V,R,G,B,A,Rs,Gs,Bs,F)
Pn(X,Y,Z,W,U,V,R,G,B,A,Rs,Gs,Bs,F)
Pn(X,Y,Z,W,U,V,R,G,B,A,Rs,Gs,Bs,F)

ACTIVE PARAMETERS

BUF_CTRL	
XYW_AD	-
XYW_SZ	-
DE_SORG	
DE_DORG	
DE_ZPTCH	
DE_SPTCH	
DE_DPTCH	
CMD_OPC	0x4
CMD_ROP	
CMD_STYLE	
CMD_PATRN	
CMD_CLP	
FORE	
BACK	
MASK	
DE_KEY	
LPAT	-

PCTRL	-
CLPTL	
CLPBR	
DE_ZORG	
LOD0_ORG	
LOD2_ORG	
LOD4_ORG	
LOD6_ORG	
LOD0_SIZE	
TPAL_ORG	-
HITH	
YON	
FOG_COLOR	
ALPHA	
ACNTRL	
3D_CNTRL	
TEX_CNTRL	

Note: DE_SORG: Origin for pattern pointer.
DE_SPTCH: Pitch for pattern pointer space and texture map space.

6.8 Texture Invalidate

Command Name: Texture Invalidate
Command Mnemonic: INV_TEX

Command Description:
The texture invalidate command is set before switching to a new texture. It instructs the silverhammer chip that the next triangle coming through has a different texture than previously used.

0xA	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY1 ℙ	Trigger		Trigger command

ℙ=Command Trigger

ACTIVE PARAMETERS

BUF_CTRL	-
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	-
DE_ZPTCH	-
DE_SPTCH	-
DE_DPTCH	-
CMD_OPC	0xA
CMD_ROP	-
CMD_STYLE	-
CMD_PATRN	-
CMD_CLP	-
FORE	-
BACK	-
MASK	-
DE_KEY	-
LPAT	-

PCTRL	-
CLPTL	-
CLPBR	-
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	-
HITH	-
YON	-
FOG_COLOR	-
ALPHA	-
ACNTRL	-
3D_CNTRL	-
TEX_CNTRL	-

6.9 Load Texture Palette

Command Name: Load Texture Palette
Command Mnemonic: LD_TPAL

Command Description:
The load texture palette command loads a palette from the system or frame buffer memory into the Imagine internal texture cache palette. This command must be used to load a palette before using a 1, 2, or 4 bit palettized texture for the first time, or whenever a new texture is required.

- 8 bit palettized, 32 bit exact
- 8 bit palettized, 16 bit filtered
- 16 bit or 32 bit color palettes at 1,2,4 bit per texel
- automatic conversion of 32 bit to either 4444 or 0565 for 8 bit palette filtering

0xB	OPCODE

Note: Please read special programming note on page 6-2 prior to programming this command.

REGISTER	PARAMETER	FORMAT	DESCRIPTION
XY0	NA		
XY1 ℙ	NA		Trigger
XY2	NA		
XY3	NA		
XY4	NA		

ℙ=Command Trigger

ACTIVE PARAMETERS

BUF_CTRL	-
XYW_AD	-
XYW_SZ	-
DE_SORG	-
DE_DORG	-
DE_ZPTCH	-
DE_SPTCH	-
DE_DPTCH	-
CMD_OPC	0xB
CMD_ROP	-
CMD_STYLE	-
CMD_PATRN	-
CMD_CLP	-
FORE	-
BACK	-
MASK	-
DE_KEY	-
LPAT	-

PCTRL	-
CLPTL	-
CLPBR	-
DE_ZORG	-
LOD0_ORG	-
LOD1_ORG	-
LOD2_ORG	-
LOD3_ORG	-
LOD4_ORG	-
TPAL_ORG	
HITH	-
YON	-
FOG_COLOR	-
ALPHA	-
ACNTRL	-
3D_CNTRL	-
TEX_CNTRL	-