



DATA SHEET

by

SYNTEK®

=====STK6005=====

Flat Panel Scaler

Version 1.0

DESIGN CENTER

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STK60005 Data Sheet

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1. GENERAL DESCRIPTION

The STK6005 chip, converting PC / Mac video images for a TFT-LCD display monitor, performs an image scaler on the RGB / YUV image data stream and outputs the scaled pixels to the LCD panel. The chip embeds line buffers for a scaling operation, so there is no external memory required. Both the OSD (On-Screen Display) circuit and the interface are embedded in this chip to support the internal and external OSD. STK6005 also provides an auto-adjustment function to automatically support the frequency & phase tuning, H / V positioning and white balance tuning. A brightness and contrast control circuit and a Gamma table correction function are also provided.

2. FEATURES

2.1 General Features:

- . Single-chip video scaling solution, no external memory required
- . Programmable independently horizontal and vertical scaling up and down
- . Advanced filters provided to get a high quality scaling image
- . Auto-adjustment to frequency, phase, H/V position, and white balance
- . Hardware display mode and field detection
- . Brightness and contrast control
- . 10-bit Gamma table
- . Dithering for 24-bit or 18-bit panel output
- . Serial 2 wires of the I²C interface
- . 0.25um CMOS technology with 3V I/O interface (5V tolerant input)
- . 128 pins of the PQFP package

2.2 Input:

- . Single pixel input port (24 bits) with input rates up to 140MHz (SXGA @75Hz)
- . DE input for digital interface
- . Support to an 8-bit YUV 4:2:2 (CCIR-656) stream format and a 16-bit YUV 4:2:2 input
- . Built-in YCbCr to RGB color space conversion circuit
- . Support to a composite sync. separation and a coast / clamp control to ADC

2.3 Output:

- . Dual pixel output ports (48 bits) with output rates up to 80MHz
- . Maximum output resolution up to SXGA @ 85Hz
- . Skew tuning between panel clock and output data

2.4 OSD features:

- . On-chip internal OSD

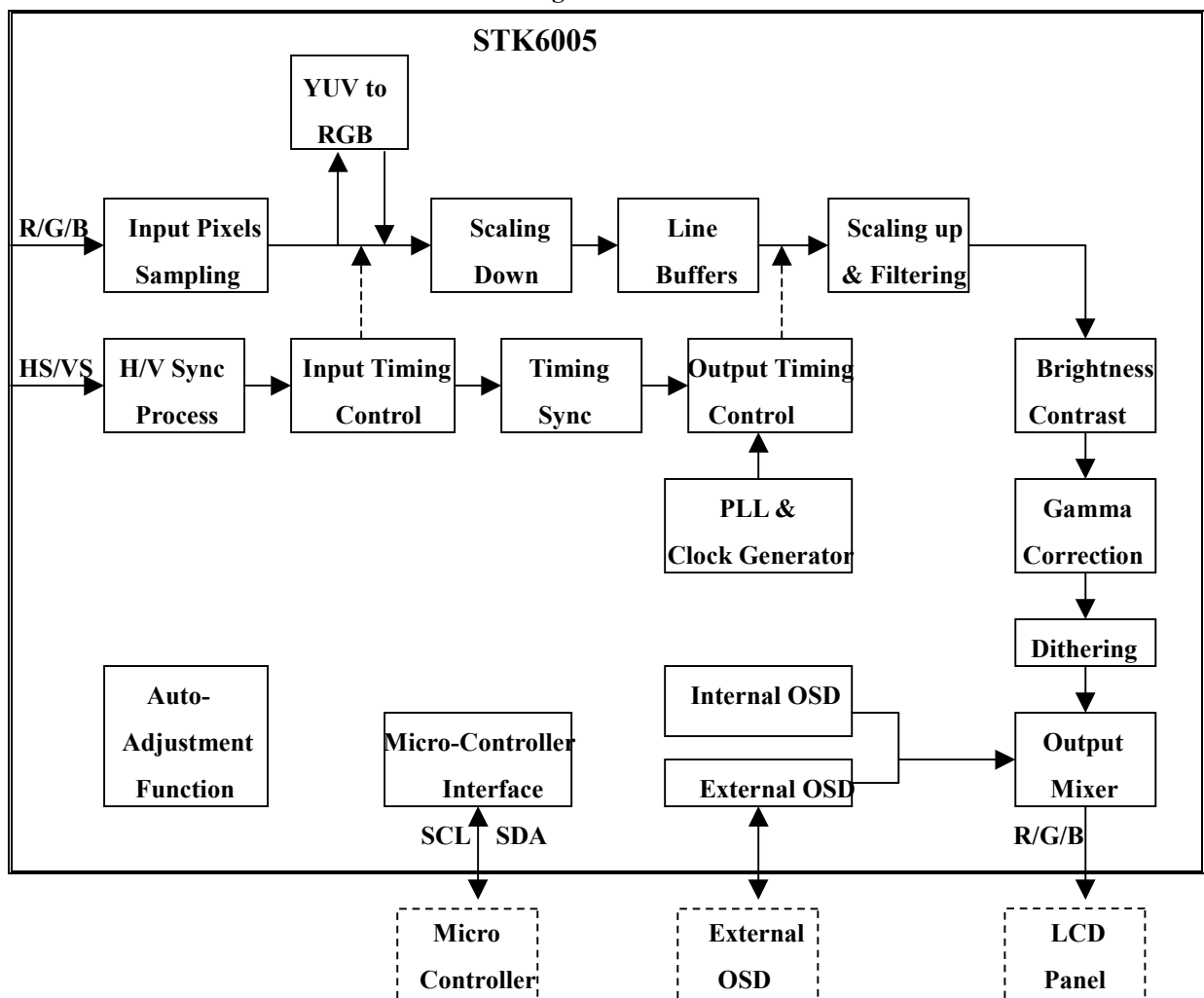
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- . Support to a rotational OSD
- . 128 fonts downloadable and 32 multi-color fonts maximum
- . 256 OSD display characters
- . Support to character transparent, blinking effects
- . Color blending effect of OSD and video
- . OSD ably zoomed to 2x independently for horizontal and vertical
- . Shadow and border effect on OSD frame
- . Support to an external OSD interface

3. BLOCK DIAGRAM

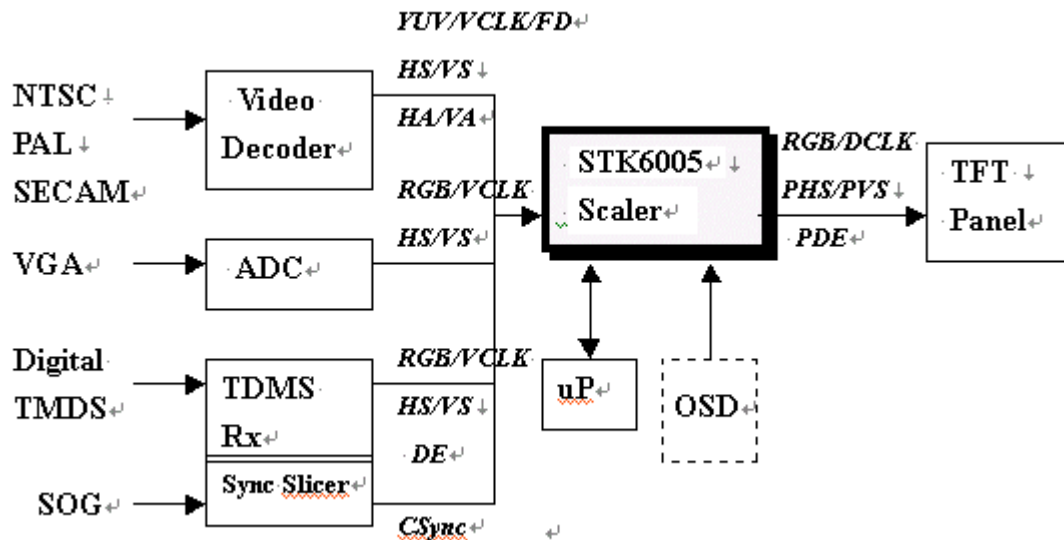
Below shown is an STK6005 internal block diagram:





3.1 Application Diagram

Shown below is an external application interface diagram:



4. PINS CONFIGURATION

PE_B[7]	38	PO_B[7]	1	VDD3	128
PE_B[6]	37	PO_B[6]	2	VSS3	127
PE_B[5]	36	PO_B[5]	3	PO_B[3]	126
PE_B[4]	35	PO_B[4]	4	PO_B[2]	125
PE_B[3]	34	PO_B[3]	5	PO_B[1]	124
PE_B[2]	33	PO_B[2]	6	PO_B[0]	123
PE_B[1]	32	PO_G[0]	7	MaskVS	122
PE_B[0]	31	PO_G[1]	8	RGHS	121
PE_G[0]	30	PO_G[2]	9	Clamp	120
PE_G[1]	29	PO_G[3]	10	ExtDE	119
PE_G[2]	28	PO_G[4]	11	VGAHS	118
PE_G[3]	27	PO_G[5]	12	VSI	117
PE_G[4]	26	PO_G[6]	13	CSync	116
PE_G[5]	25	PO_G[7]	14	HSI	115
PE_G[6]	24	VDD2	15	VCLK	114
PE_G[7]	23	VSS2	16	VDD2	113
PE_R[0]	22	VSS3	17	VSS2	112
PE_R[1]	21	PO_R[0]	18	RIN[7] / Y[7]	111
PE_R[2]	20	PO_R[1]	19	RIN[6] / Y[6]	110
PE_R[3]	19	PO_R[2]	20	RIN[5] / Y[5]	109
PE_R[4]	18	PO_R[3]	21	RIN[4] / Y[4]	108
PE_R[5]	17	PO_R[4]	22	RIN[3] / Y[3]	107
PE_R[6]	16	PO_R[5]	23	RIN[2] / Y[2]	106
PE_R[7]	15	PO_R[6]	24	RIN[1] / Y[1]	105
PE_R[8]	14	PO_R[7]	25	RIN[0] / Y[0]	104
PE_R[9]	13	PVS	26	GIN[7] / UV[7]	103
PE_R[10]	12	PVS	27	GIN[6] / UV[6]	102
PE_R[11]	11	PDE	28	GIN[5] / UV[5]	101
PE_R[12]	10	VSS3	29	GIN[4] / UV[4]	100
PE_R[13]	9	VDD3	30	GIN[3] / UV[3]	99
PE_R[14]	8	VSS2	31	GIN[2] / UV[2]	98
PE_R[15]	7	VSS3	32	GIN[1] / UV[1]	97
PE_R[16]	6	VSS2	33	GIN[0] / UV[0]	96
PE_R[17]	5	VSS3	34	BIN[7] / H[7]	95
PE_R[18]	4	VSS2	35	BIN[6] / V[6]	94
PE_R[19]	3	VSS3	36	BIN[5] / H[5]	93
PE_R[20]	2	VSS2	37	BIN[4] / V[4]	92
PE_R[21]	1	VSS3	38	BIN[3] / H[3]	91
PE_R[22]	0	VSS2	39	BIN[2] / V[2]	90
PE_R[23]	0	VSS3	40	BIN[1] / H[1]	89
PE_R[24]	0	VSS2	41	BIN[0] / V[0]	88
PE_R[25]	0	VSS3	42	BIN[0] / C[0]	87
PE_R[26]	0	VSS2	43	BIN[0] / C[0]	86
PE_R[27]	0	VSS3	44	BIN[0] / C[0]	85
PE_R[28]	0	VSS2	45	BIN[0] / C[0]	84
PE_R[29]	0	VSS3	46	BIN[0] / C[0]	83
PE_R[30]	0	VSS2	47	BIN[0] / C[0]	82
PE_R[31]	0	VSS3	48	BIN[0] / C[0]	81
PE_R[32]	0	VSS2	49	BIN[0] / C[0]	80
PE_R[33]	0	VSS3	50	BIN[0] / C[0]	79
PE_R[34]	0	VSS2	51	BIN[0] / C[0]	78
PE_R[35]	0	VSS3	52	BIN[0] / C[0]	77
PE_R[36]	0	VSS2	53	BIN[0] / C[0]	76
PE_R[37]	0	VSS3	54	BIN[0] / C[0]	75
PE_R[38]	0	VSS2	55	BIN[0] / C[0]	74
PE_R[39]	0	VSS3	56	BIN[0] / C[0]	73
PE_R[40]	0	VSS2	57	BIN[0] / C[0]	72
PE_R[41]	0	VSS3	58	BIN[0] / C[0]	71
PE_R[42]	0	VSS2	59	BIN[0] / C[0]	70
PE_R[43]	0	VSS3	60	BIN[0] / C[0]	69
PE_R[44]	0	VSS2	61	BIN[0] / C[0]	68
PE_R[45]	0	VSS3	62	BIN[0] / C[0]	67
PE_R[46]	0	VSS2	63	BIN[0] / C[0]	66
PE_R[47]	0	VSS3	64	BIN[0] / C[0]	65
PE_R[48]	0	VSS2	65	BIN[0] / C[0]	64
PE_R[49]	0	VSS3	66	BIN[0] / C[0]	63
PE_R[50]	0	VSS2	67	BIN[0] / C[0]	62
PE_R[51]	0	VSS3	68	BIN[0] / C[0]	61
PE_R[52]	0	VSS2	69	BIN[0] / C[0]	60
PE_R[53]	0	VSS3	70	BIN[0] / C[0]	59
PE_R[54]	0	VSS2	71	BIN[0] / C[0]	58
PE_R[55]	0	VSS3	72	BIN[0] / C[0]	57
PE_R[56]	0	VSS2	73	BIN[0] / C[0]	56
PE_R[57]	0	VSS3	74	BIN[0] / C[0]	55
PE_R[58]	0	VSS2	75	BIN[0] / C[0]	54
PE_R[59]	0	VSS3	76	BIN[0] / C[0]	53
PE_R[60]	0	VSS2	77	BIN[0] / C[0]	52
PE_R[61]	0	VSS3	78	BIN[0] / C[0]	51
PE_R[62]	0	VSS2	79	BIN[0] / C[0]	50
PE_R[63]	0	VSS3	80	BIN[0] / C[0]	49
PE_R[64]	0	VSS2	81	BIN[0] / C[0]	48
PE_R[65]	0	VSS3	82	BIN[0] / C[0]	47
PE_R[66]	0	VSS2	83	BIN[0] / C[0]	46
PE_R[67]	0	VSS3	84	BIN[0] / C[0]	45
PE_R[68]	0	VSS2	85	BIN[0] / C[0]	44
PE_R[69]	0	VSS3	86	BIN[0] / C[0]	43
PE_R[70]	0	VSS2	87	BIN[0] / C[0]	42
PE_R[71]	0	VSS3	88	BIN[0] / C[0]	41
PE_R[72]	0	VSS2	89	BIN[0] / C[0]	40
PE_R[73]	0	VSS3	90	BIN[0] / C[0]	39
PE_R[74]	0	VSS2	91	BIN[0] / C[0]	38
PE_R[75]	0	VSS3	92	BIN[0] / C[0]	37
PE_R[76]	0	VSS2	93	BIN[0] / C[0]	36
PE_R[77]	0	VSS3	94	BIN[0] / C[0]	35
PE_R[78]	0	VSS2	95	BIN[0] / C[0]	34
PE_R[79]	0	VSS3	96	BIN[0] / C[0]	33
PE_R[80]	0	VSS2	97	BIN[0] / C[0]	32
PE_R[81]	0	VSS3	98	BIN[0] / C[0]	31
PE_R[82]	0	VSS2	99	BIN[0] / C[0]	30
PE_R[83]	0	VSS3	100	BIN[0] / C[0]	29
PE_R[84]	0	VSS2	101	BIN[0] / C[0]	28
PE_R[85]	0	VSS3	102	BIN[0] / C[0]	27
PE_R[86]	0	VSS2	103	BIN[0] / C[0]	26
PE_R[87]	0	VSS3	104	BIN[0] / C[0]	25
PE_R[88]	0	VSS2	105	BIN[0] / C[0]	24
PE_R[89]	0	VSS3	106	BIN[0] / C[0]	23
PE_R[90]	0	VSS2	107	BIN[0] / C[0]	22
PE_R[91]	0	VSS3	108	BIN[0] / C[0]	21
PE_R[92]	0	VSS2	109	BIN[0] / C[0]	20
PE_R[93]	0	VSS3	110	BIN[0] / C[0]	19
PE_R[94]	0	VSS2	111	BIN[0] / C[0]	18
PE_R[95]	0	VSS3	112	BIN[0] / C[0]	17
PE_R[96]	0	VSS2	113	BIN[0] / C[0]	16
PE_R[97]	0	VSS3	114	BIN[0] / C[0]	15
PE_R[98]	0	VSS2	115	BIN[0] / C[0]	14
PE_R[99]	0	VSS3	116	BIN[0] / C[0]	13
PE_R[100]	0	VSS2	117	BIN[0] / C[0]	12
PE_R[101]	0	VSS3	118	BIN[0] / C[0]	11
PE_R[102]	0	VSS2	119	BIN[0] / C[0]	10
PE_R[103]	0	VSS3	120	BIN[0] / C[0]	9
PE_R[104]	0	VSS2	121	BIN[0] / C[0]	8
PE_R[105]	0	VSS3	122	BIN[0] / C[0]	7
PE_R[106]	0	VSS2	123	BIN[0] / C[0]	6
PE_R[107]	0	VSS3	124	BIN[0] / C[0]	5
PE_R[108]	0	VSS2	125	BIN[0] / C[0]	4
PE_R[109]	0	VSS3	126	BIN[0] / C[0]	3
PE_R[110]	0	VSS2	127	BIN[0] / C[0]	2
PE_R[111]	0	VSS3	128	BIN[0] / C[0]	1

128-Pin QFP



4.1 ADC Interface

Name	I/O	Description	Pin No.	Note
RIN[7:0]	I	Red input (RGB) Y[7:0] input (YUV16) YUV[7:0] input (YUV8)	111-104	
GIN[7:0]	I	Green input (RGB) / UV[7:0] input (YUV16)	103-96	
BIN[7:0]	I	Blue input (RGB) / YUV control input (YUV16) Bit 7 : Href Bit 6 : Vref Bit 5 : Hsync Bit 4 : Vsync Bit 3 : Field Bit 2 : LLC2 Bit 1 : Cref	95-88	
VCLK	I	Video input clock / YUV LLC clock	114	
HSI	I	RGB horizontal sync input (after ADC)	115	
CSync	I	Composite sync input (from SOG)	116	
VSI	I	RGB vertical sync input	117	
VGAHS	I	Original VGA H-Sync input (before ADC)	118	
ExtDE	I	External DE input	119	
Clamp	O	Clamp signal to ADC	120	
RGHS	O	To regenerate an H-Sync output	121	
MaskVS	O	Coast signal to ADC	122	

4.2 Panel Interface

Name	I/O	Description	Pin No.	Note
PE_R[7:0]	O	Even port (port A) red output	60-57, 54-51	
PE_G[7:0]	O	Even port (port A) green output	50-45, 40-39	
PE_B[7:0]	O	Even port (port A) blue output	38-31	
PO_R[7:0]	O	Odd port (port B) red output	24-17	
PO_G[7:0]	O	Odd port (port B) green output	16-15, 10-5	
PO_B[7:0]	O	Odd port (port B) blue output	4-1, 126-123	
DCLK	O	Panel data clock output	29	
PHS	O	Panel H-Sync output	25	
PVS	O	Panel V-Sync output	26	
PDE	O	Panel data enable output	27	
ExtPCLK	I	External panel clock input	69	

4.3 OSD Interface

Name	I/O	Description	Pin No.	Note
OVVS	O	Overlay V-Sync output	74	
OVHS	O	Overlay H-Sync output	75	
OVCLK	O	Overlay clock output	76	
OVR	I	Overlay red input	77	
OVG	I	Overlay green input	78	
OVB	I	Overlay blue input	79	
OVI	I	Overlay intensity input	80	
OVFB	I	Overlay color enable	81	

4.4 Micro-Controller Interface

Name	I/O	Description	Pin No.	Note
SDA	I/O	I ² C bus data	82	



SCL	I	I ² C bus clock	83	
INTN	O	Interrupt request output (active low)	84	
RSTN	I	Device reset input (active low)	85	
RefCLKI	I	Crystal oscillator input	70	
RefCLKO	O	Crystal oscillator output	71	
GPIO3-0	I/O	General purpose I/O and PWM	64-61	

4.5 Power Pins

Name	P/G	Description	Pin No.	Note
VDD2	P	Digital power supply for core cells	12,42,87,113	2.5V
VSS2	G	Digital ground for core cells	11,41,86,112	0V
VDD3	P	Digital power supply for I/O cells	14,30,44,56,73, 128	3.3V
VSS3	G	Digital ground for I/O cells	13,28,43,55,72, 127	0V
VDD2P	P	Digital power supply for PLL	68	2.5V
VSS2P	G	Digital ground for PLL	67	0V
AVDD	P	Analog power supply for PLL	66	2.5V
AVSS	G	Analog ground for PLL	65	0V

4.6 Pin List

Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
1	PO_B[4]	33	PE_B[2]	65	AVSS	97	GIN[1] / UV[1]
2	PO_B[5]	34	PE_B[3]	66	AVDD	98	GIN[2] / UV[2]
3	PO_B[6]	35	PE_B[4]	67	VSS2P	99	GIN[3] / UV[3]
4	PO_B[7]	36	PE_B[5]	68	VDD2P	100	GIN[4] / UV[4]
5	PO_G[0]	37	PE_B[6]	69	ExtPCLK	101	GIN[5] / UV[5]
6	PO_G[1]	38	PE_B[7]	70	RefCLKI	102	GIN[6] / UV[6]
7	PO_G[2]	39	PE_G[0]	71	RefCLKO	103	GIN[7] / UV[7]
8	PO_G[3]	40	PE_G[1]	72	VSS3	104	RIN[0] / Y[0]
9	PO_G[4]	41	VSS2	73	VDD3	105	RIN[1] / Y[1]
10	PO_G[5]	42	VDD2	74	OVVS	106	RIN[2] / Y[2]
11	VSS2	43	VSS3	75	OVHS	107	RIN[3] / Y[3]
12	VDD2	44	VDD3	76	OVCLK	108	RIN[4] / Y[4]
13	VSS3	45	PE_G[2]	77	OVR	109	RIN[5] / Y[5]
14	VDD3	46	PE_G[3]	78	OVG	110	RIN[6] / Y[6]
15	PO_G[6]	47	PE_G[4]	79	OVB	111	RIN[7] / Y[7]
16	PO_G[7]	48	PE_G[5]	80	OVI	112	VSS2
17	PO_R[0]	49	PE_G[6]	81	OVFB	113	VDD2
18	PO_R[1]	50	PE_G[7]	82	SDA	114	VCLK
19	PO_R[2]	51	PE_R[0]	83	SCL	115	HSI
20	PO_R[3]	52	PE_R[1]	84	INTN	116	CSync
21	PO_R[4]	53	PE_R[2]	85	RSTN	117	VSI
22	PO_R[5]	54	PE_R[3]	86	VSS2	118	VGAHS
23	PO_R[6]	55	VSS3	87	VDD2	119	ExtDE
24	PO_R[7]	56	VDD3	88	BIN[0]	120	Clamp
25	PHS	57	PE_R[4]	89	BIN[1] / Cref	121	RGHS
26	PVS	58	PE_R[5]	90	BIN[2] / LLC2	122	MaskVS
27	PDE	59	PE_R[6]	91	BIN[3] / Field	123	PO_B[0]
28	VSS3	60	PE_R[7]	92	BIN[4] / Vsync	124	PO_B[1]
29	DCLK	61	GPIO0	93	BIN[5] / Hsync	125	PO_B[2]
30	VDD3	62	GPIO1	94	BIN[6] / Vref	126	PO_B[3]
31	PE_B[0]	63	GPIO2	95	BIN[7] / Href	127	VSS3
32	PE_B[1]	64	GPIO3	96	GIN[0] / UV[0]	128	VDD3



5. FUNCTION

5.1 Input Timing and Format

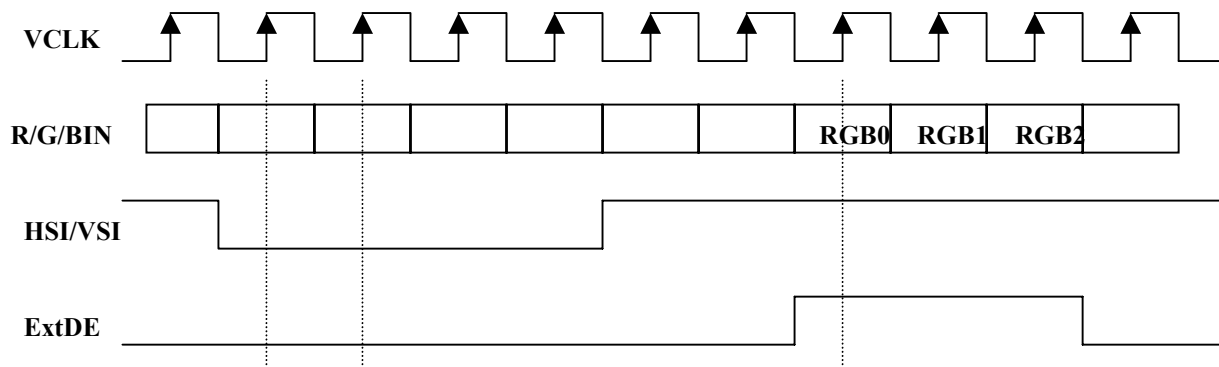
This chip supports a 24-bit RGB input (up to SXGA 75Hz) of a single port, a 16-bit YUV 4:2:2 input, and an 8-bit YUV 4:2:2 (CCIR-656) video input. The timing diagrams are provided below.

For RGB input format, the RGB data (RIN/GIN/BIN ports) and H-Sync (HSI), V-Sync (VSI) are sampled at the rising or falling edge of VCLK.

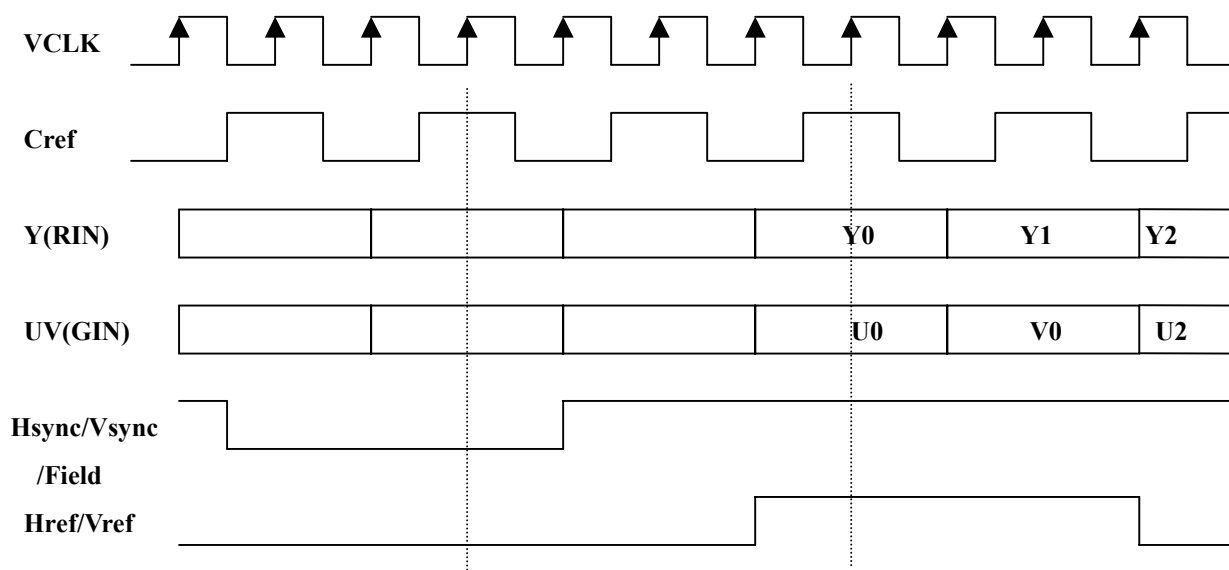
For TMDS input format, a control signal ExtDE can be provided to define the valid data.

For video input format, the input YUV ports are shared with RIN/GIN/BIN ports. The 16-bit YUV 4:2:2 format uses RIN[7:0] for Y[7:0], GIN[7:0] for UV[7:0], and BIN[7:1] for YUV control bus. Hsync / Vsync are used as H-Sync and V-Sync input signals. Cref is used as a clock edge qualifier. Href and Vref are used to define the valid data. Field input is used as the odd / even fields indicator.

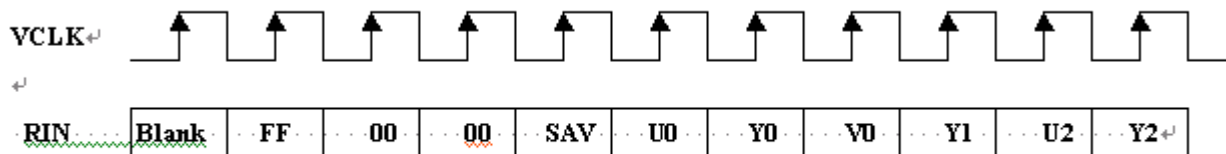
The 8-bit YUV 4:2:2 (CCIR-656) format uses RIN[7:0] for data input YUV[7:0], and the timing control is also embedded in the data stream. Therefore, there are no control signal connections needed for this format.



RGB input format timing diagram



YUV16 input format timing diagram



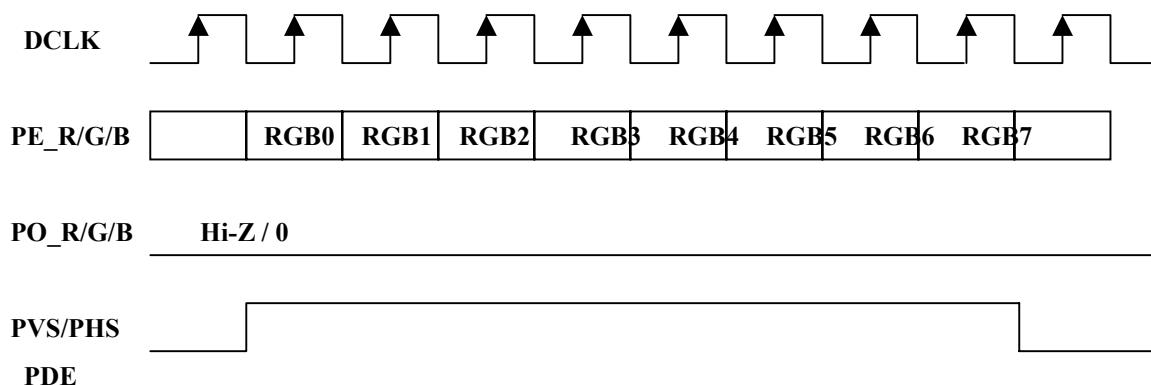
YUV8 input format timing diagram

5.2 Output Timing and Format

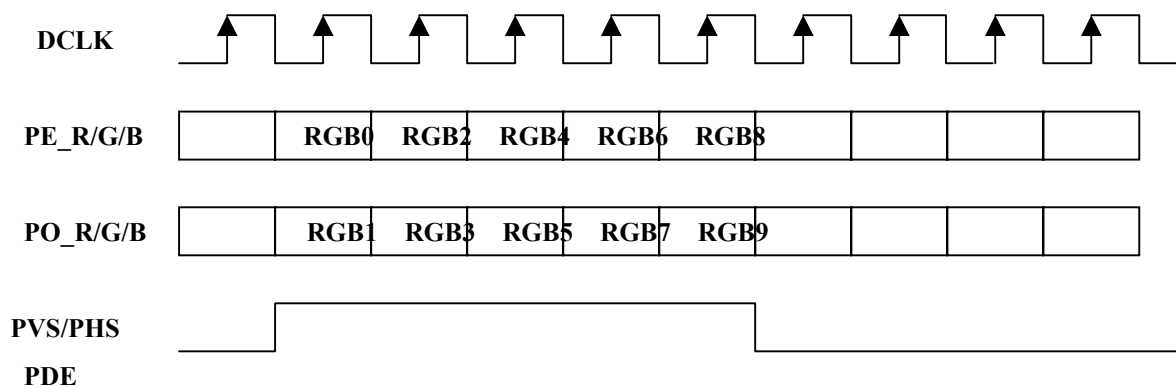
The output interface consists of two pixel ports, each containing Red / Green / Blue in colors with 6 or 8 bits of resolution. There are three output control signals for panel – PVS, PHS and PDE. The output pixels and control signals above are all synchronous to the active edge of panel output clock DCLK. The polarity of output clock / control signals and the timing of the active edge of output clock are programmable by setting the internal registers.

There are two output formats – single / dual pixels output modes. In single pixel output mode, pixel data are output from PE_R/G/B ports only, and the PO_R/G/B ports are disabled. In dual pixel output mode, pixel data are output to both PE_R/G/B and PO_R/G/B ports in parallel. The first pixel of a line will be output to PE_R/G/B ports and the second pixel will be output to PO_R/G/B ports.

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Single port output mode timing diagram



Dual port output mode timing diagram

5.3 YUV to RGB Space Converter

For video input ($EnYUV = 1$), the input YUV (YCbCr) data are converted internally into RGB format by the following equations.

$$R = Y + 1.371 (Cr - 128)$$

$$G = Y - 0.698 (Cr - 128) - 0.336 (Cb - 128)$$

$$B = Y + 1.732 (Cb - 128)$$

5.4 De-Interlace

For interlace input, the input image is separated into even and odd fields. Due to no frame buffer available, STK6005 employs the spatial interpolation method to calculate the missing lines from their neighboring lines. Internal register 0x1C should be set to enable a de-interlace function.

5.5 Input Synchronous Signals Processing

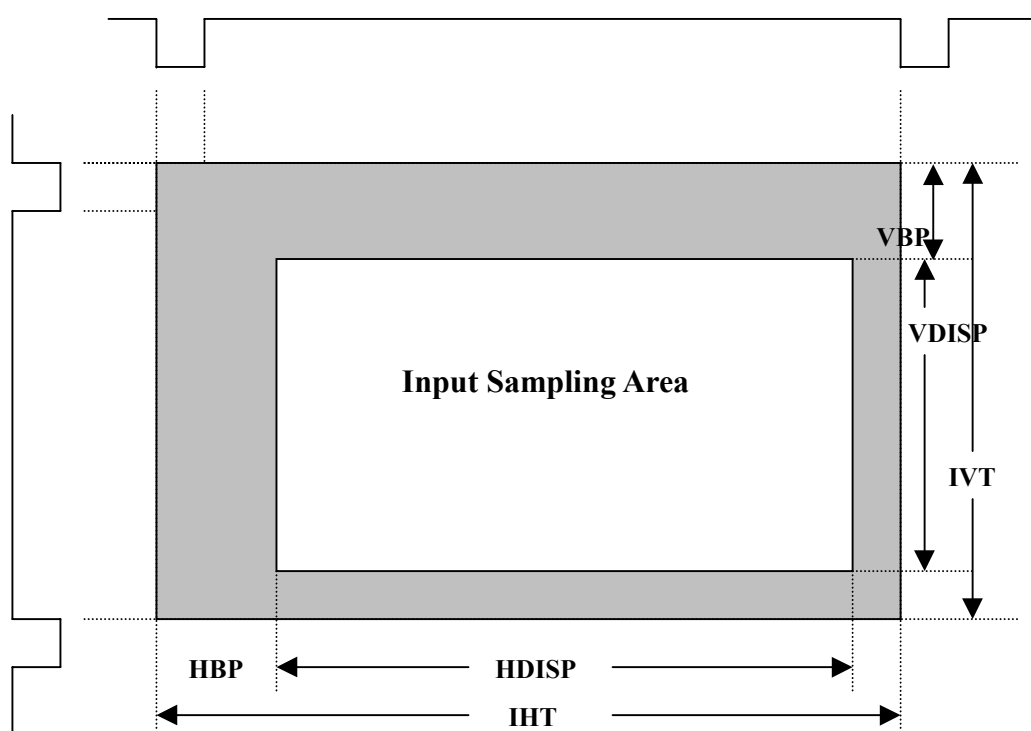
STK6005 provides a composite sync separation hardware to separate V-Sync from C-Sync and re-generate the H-Sync for the external ADC chip. STK6005 supports three combinations of input H / V synchronous signals (before ADC) which are composite sync signal from CSync or from VGAHS port, and separated sync signals from the VGAHS and VSync ports. An H-Sync output will be re-generated from



the VGAHS or CSync signals for the external ADC H-Sync input. And suitable coast and clamp signals are also generated for external ADC.

5.6 Definition of Input / Output Window

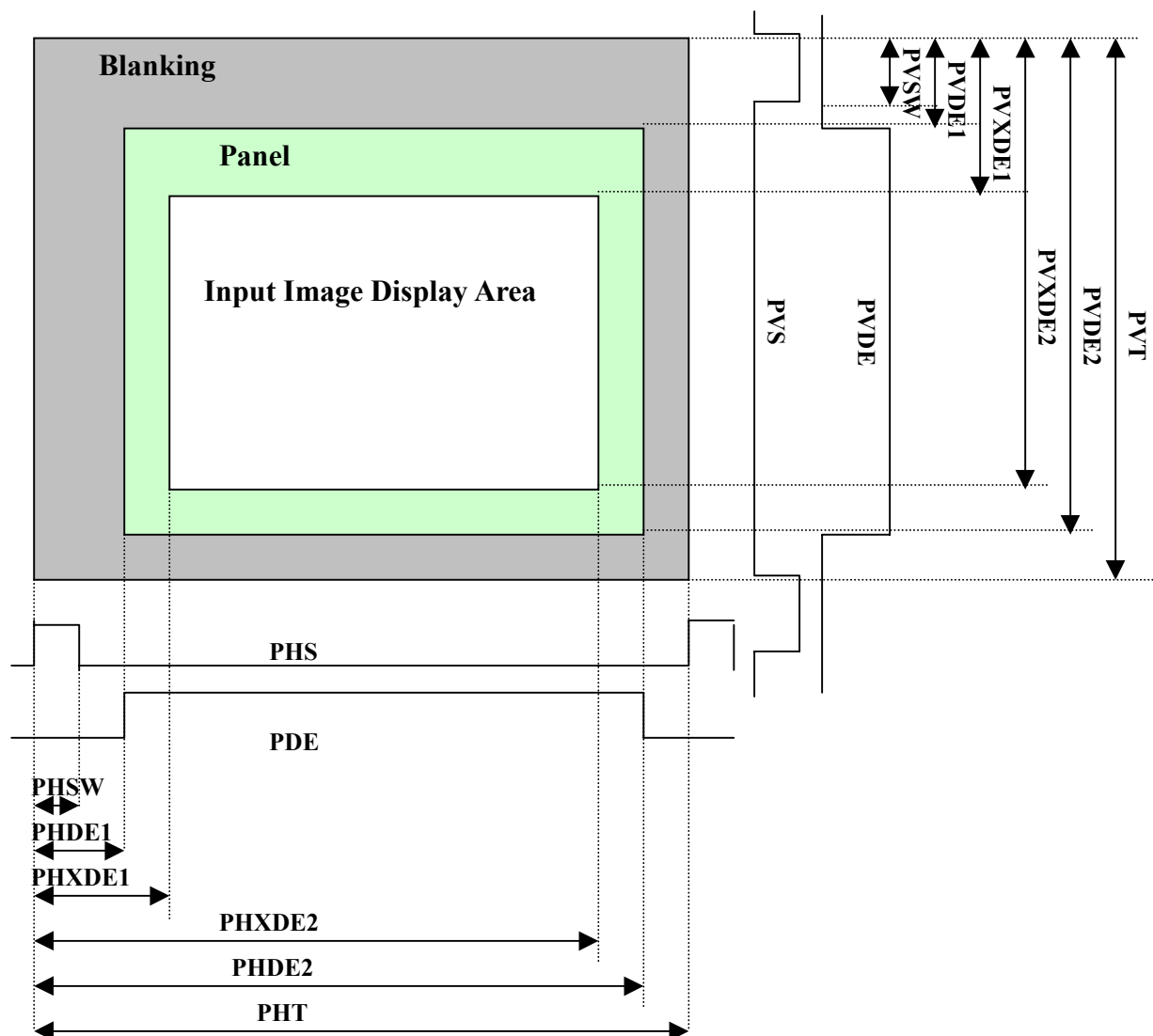
The input capture window is defined by the internal registers: HBP, HDISP, VBP, and VDISP (if SelDE is set to 0). The timing of inputs are referred to the leading edge of input H-Sync and V-Sync. The horizontal timing is counted in the number of VCLKs and the vertical timing exists in input display lines.



Input window diagram



The panel output window are defined by the following registers: PHSW, PHDE1, PHDE2, PHXDE1, PHXDE2, PHT, PVSW, PVDE1, PVDE2, PVXDE1, PVXDE2, PVT. The output timing are referenced to the leading edge of PHS and PVS. The horizontal timing is counted by number of output pixels and the vertical timing is in output display lines.



Output window definition diagram

5.7 Scaling Control

The input image can be independently scaling up and down in both horizontal and vertical directions. The scaling ratio for each direction is in the range of 0.5x ~ 16x. The registers HSR and VSR control the output scaling ratio for horizontal and vertical directions respectively. The formula to calculate the values of HSR and VSR are shown below:



$HSR = \text{horizontal input display resolution} / \text{output display resolution} * 32768$

$VSR = \text{vertical input display resolution} / \text{output display resolution} * 32768$

This chip provides 6 advanced filters to get a high quality-scaling image for requirements on different sharpness. Set EnFilt flag to 1 to enable scaling function using the filter defined by FiltType register.

5.8 Operating Mode

STK6005 uses internal line buffers to perform the scaling function. Since there is no external frame buffer serving as a frame rate converter, the output vertical frequency is always equal to the input vertical frequency during normal operation. The period of PCLK should be programmed as close as the formula listed below to avoid over-run / under-run conditions of internal line-buffers.

$\text{Period of PCLK} = \text{Period of VCLK} * \text{RateH} * \text{RateV}$

where

$\text{RateH} = \text{total pixels of an input line} / \text{total pixels of an output line}$

$\text{RateV} = \text{total input lines} / \text{total output lines}$

$= \text{total input display lines} / \text{total output display lines}$

STK6005 provides three operating modes to synchronize the input and output display timing:

1. Free-run mode:

$\text{EnSyncH} \{0x3D[7]\} = 0$

$\text{EnSyncV} \{0x3D[6]\} = 0$

In this mode, there is no timing relationship between the input and output timing. Registers PHT and PVT control the output horizontal period and vertical period respectively. For this mode, even if no input signal comes, the output timing can also be generated automatically. This mode is used when there is no valid input or used for testing purpose.

2. Synchronization to Input V-Sync:

$\text{EnSyncH} \{0x3D[7]\} = 0$

$\text{EnSyncV} \{0x3D[6]\} = 1$

In this mode, the input vertical timing has impacted on the output vertical timing. The input V-Sync leading edge will generate a locking event to lock the output display timing. Therefore, the output vertical period will keep the same as the input vertical period. The latency between the input V-Sync leading edge and the locking event can be programmed through registers DlyLine and DlyPxl. The output horizontal period is set by PHT. The PVT value should be set to maximum (0x7FF) value for this mode. For the advantage of this mode, all output horizontal periods are equal. For the disadvantage of this mode, when some errors occur in the real output video clock (PCLK) and in the ideal output video clock ($\text{VCLK} * \text{RateH} * \text{RateV}$), the buffer overrun or underrun may happen internally due to the accumulation of errors.



3. Synchronization to Input V-Sync and H-Sync:

$\text{EnSyncH} \{0x3D[7]\} = 1$

$\text{EnSyncV} \{0x3D[6]\} = x$

In this mode, the input timing also has impacted on the output horizontal and vertical timings. The input V-Sync leading edge will also generate a lock event to lock the output display timing. Therefore, the output vertical period will keep the same as the input vertical period. But the output horizontal period is gained by $(\text{EmPHT} / 16)$ cycles of input VCLK to keep output horizontal timing tracking to input horizontal timing. The register EmPHT should be set to the value of input horizontal period (in pixels) * RateV * 16, where the RateV = total input lines / total output lines. The register value of PHT will be ignored. The register value of PVT should be set to maximum (0x7FF) value for this mode. For the advantage of this mode, even when some errors result in the real output video clock (PCLK) and in the ideal output video clock ($\text{VCLK} * \text{RateH} * \text{RateV}$), the buffer overrun or underrun will not happen internally due to the accumulation of errors. For the disadvantage of this mode, each output horizontal period may be somewhat different.

5.9 Contrast and Brightness Control

STK6005 can adjust the contrast and brightness of output pixels after scaling operation. Registers GainR, GainG, and GainB adjust the contrast of red, green, and blue respectively for output pixels. Registers DC_R, DC_G, DC_B adjust the brightness for output pixels. Gain registers are those with an 8-bit unsigned value and DC registers are those in a 2's complement format. The adjustment formula is listed below:

$$\text{Red (out)} = \text{Red(in)} * \text{GainR} / 128 + \text{DC_R}$$

$$\text{Green (out)} = \text{Green(in)} * \text{GainG} / 128 + \text{DC_G}$$

$$\text{Blue (out)} = \text{Blue(in)} * \text{GainB} / 128 + \text{DC_B}$$

5.10 Gamma Correlation

STK6005 provides an 8-to-10 bits of the color look-up table for each color channel intended for Gamma correction. A 10-bit output results in an improved color depth control. The 10-bit output is then dithered down to 8 or 6 bits per color for display output. The Gamma look-up table (LUT) is user-programmable to provide an arbitrary transfer function.

Before the Gamma LUT is programmed, the Gamma correction function should be disabled first and then decides which Gamma LUTs of colors is to be programmed. The Gamma LUT will be written at the same time if the GmaWE flag for respective color is set to 1. The programming steps are shown as below:

1. Disable Gamma correction function (set EnGamma flag to 0).
2. Set respective GmaWE flag of each color to 1 to enable programming.
3. Write start programming address into uWrGmaA register.



4. Write lower 8 bits, and then write higher 2 bits data into uWrGmaD register to program a 10-bit Gamma value.
5. Go to step 4 for continuing to write the next address.
Go to step 3 for changing another address.
Go to step 2 for changing another Gamma LUT.
Go to next step to stop Gamma LUT programming.
6. Enable Gamma correlation function (set EnGamma flag to 1).

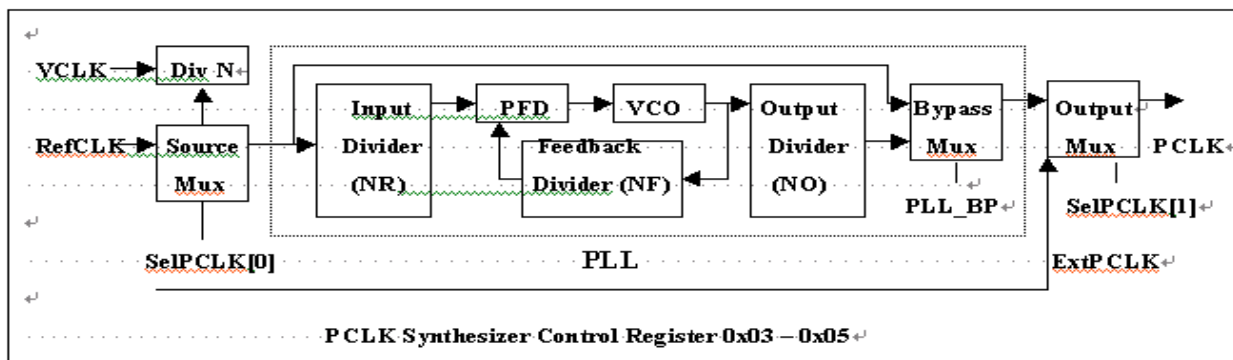
5.11 Output Dithering

The Gamma LUT outputs a 10-bit value for each color channel. This value can be dithered down to either 8 bits for 24 bits per pixel panels, or 6-bit for 18 bits per pixel panels. Dithering works by spreading the quantization error over neighboring pixels both spatially and temporarily. The dithering benefits and improves the effective color depth because the humans' eyes will tend to average neighboring pixels and a smooth image free of contours will be perceived.

5.12 Clock System

STK6005 takes input clock (VCLK) from external ADC or video decoder chips. The input pixels are latched on the rising edge of VCLK by default. The input phase of VCLK can be inverted by setting SetICLK flag to 1.

The internal panel clock PCLK can be obtained either from an external source (from ExtPCLK pin) or generated from an internal PLL. The PLL takes the external crystal oscillator input (14.3MHz) or VCLK as clock source to synthesize the clock for panel. The clock frequency synthesized by PLL can be programmed to support different display modes. The panel clock is output to DCLK with equal or 1/2 of frequency of PCLK for single or dual pixel output modes respectively. The output delay and phase of DCLK can be programmed by internal registers SetDCLK and DlyDCLK. The PLL block diagram and control registers are depicted as follows:



**Notes:**

1. The frequency derived from PLL frequency synthesizer is formulated as follows:

$$F_{out} (PCLK) = F_{in} * NF / (NR * NO).$$

Where

$$NF = PLL_M[8:0] + 2$$

$$NR = PLL_N[4:0] + 2$$

$$NO = 1 / 2 / 2 / 4 \text{ when } PLL_OD[1:0] = 00 / 01 / 10 / 11$$

2. Meanwhile, the following constraints must be followed:

$$F_{ref} = F_{in} / (NR * 2)$$

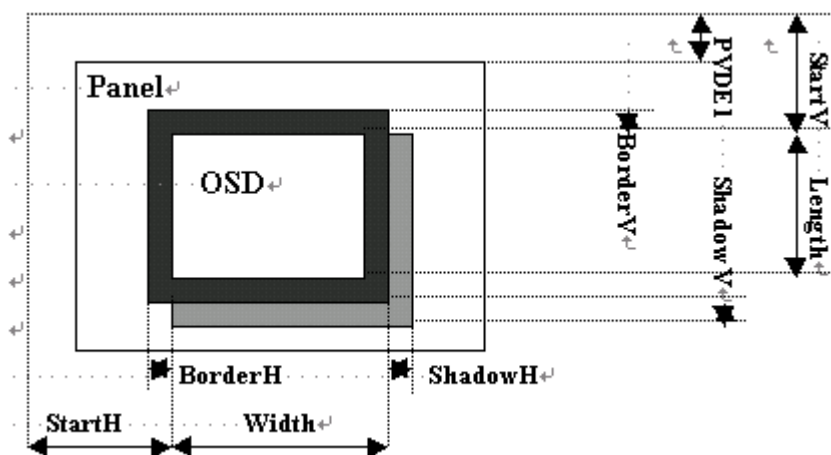
The comparison frequency (Fref) should be in the range of 800KHz to 8MHz.

$$F_{vco} = F_{in} * NF / NR$$

The output frequency of VCO should be in the range of 100MHz to 200MHz.

5.13 OSD Control**Display Area of OSD**

The following diagram shows the display area definition of STK6005 OSD.



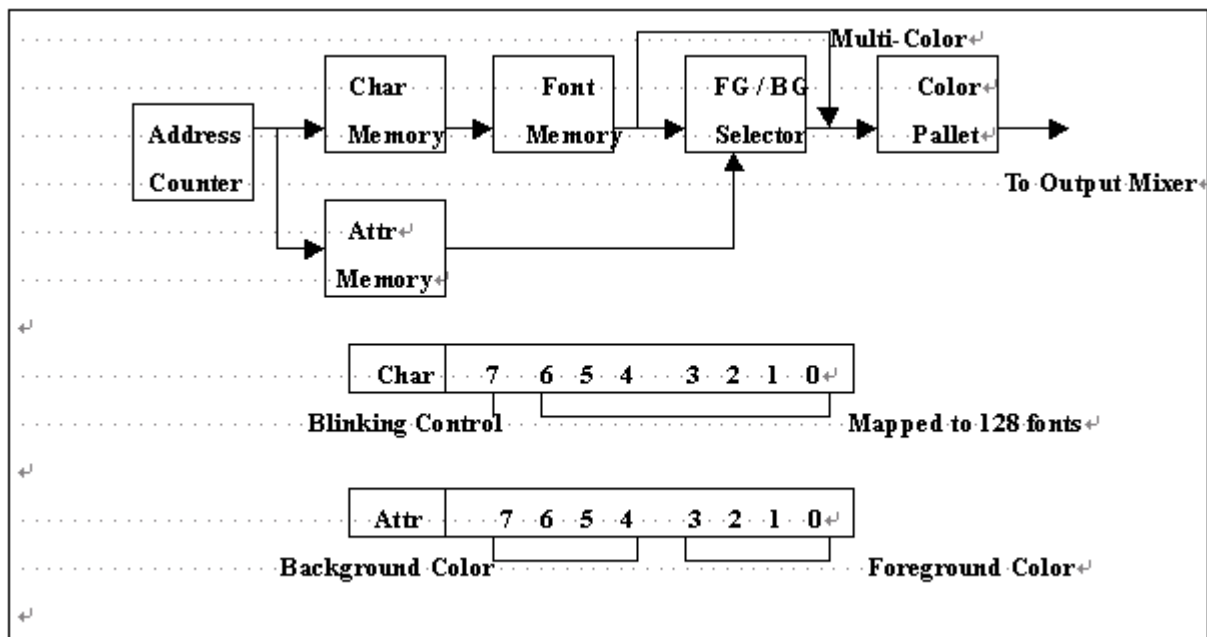
Register Width and Length of the unit is in characters; others are in lines or pixels. The values of registers StartV and StartH are calculated from the synchronous point of panel output.

Architecture of the OSD (On-Screen Display)

STK6005 provides up to 256 sets of characters and attributes to display the OSD contents. Provided is that 128 internal soft fonts (12 * 18 dots) can be selected to display for each character. The 8-bit attribute of each character consists of the foreground color and background color indices mapped to 16 colors of the pallet. The background transparent effect will be enabled when the background color index is set to 0xF.



A blinking effect will appear in the character if a bit 7 Char index is set to 1. The foreground and background color is mapped to one of 16 sets of the color pallet. Each set of color pallet is in 24 bits of true color. The following diagram shows the architecture of STK6005 OSD.



To Set a Character and an Attribute

For a char displayed on location (X, Y) of OSD window, the converting formula of the Char / Attribute memory address is shown as follows:

$$\text{Memory Address} = Y * \text{Width} + X$$

X indicates the horizontal position of the Char in OSD window (in unit of Char)

Y indicates the vertical position of the Char in OSD window (in unit of Char)

Width explains the horizontal duration of OSD window (in unit of Char)

Two sequences can be applied to write the Char / Attribute contents:

You can write Char / Attribute separately by setting CharOnly = 1. The memory address will automatically increase 1 after you write a Char or an Attribute, and then you can write a next Char or an Attribute content. Or you can write Char / Attribute pairs by setting CharOnly = 0. The memory address will not automatically increase 1 until an Attribute is written in. The steps to set Char and Attribute are shown as follows:

1. Calculate and set a memory address (write uWrAdr).
2. Write a Char index (write uWrChr). If CharOnly = 1, go to step 4.
3. Write an Attribute index (write uWrAttr).
4. Go to step 2 for continuing to set a next position of Char.

Go to step 1 to recalculate a new address or stop the procedure.

**To Set a Color Pallet**

STK6005 provides 16 sets of color pallets. Each set of color pallet is provided with 24 bits and can be set to any color. The attributes of OSD char are indexes for foreground and background colors and mapped to 24-bit colors by this color pallet. The steps to set the color pallet are shown as follows:

1. Set a color pallet No. (write uWrAdr)
2. Set a red color in the current color pallet. (write uWrColor)
3. Set a green color in the current color pallet. (write uWrColor)
4. Set a blue color in the current color pallet. (write uWrColor)
5. Go to step 2 for continuing to set a next color pallet.

Go to step 1 to set another color pallet No. or stop the procedure.

Architecture of OSD Fonts

STK6005 provides 128 sets of 12*18 fonts downloadable.

Each font can be programmed by writing 36 * 6-bit bit-map data.

The bit-map data sequences are shown in the following example:

Font writing sequence

1. Set a font No. (write uWrAdr).
2. Write 36 bytes of bit-map data.
(each data consists of 6 pixels) into the font memory sequentially (write uWrFont).
3. Go to step 2 for continuing to write a next font.
Go to step 1 for setting another font No.
Or stop the procedure.

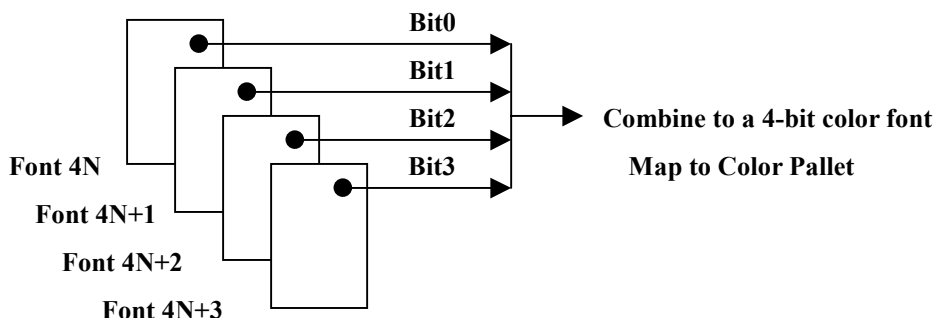
Byte0						Byte1					
5					0	5					0
ROW-00											0x00
ROW-01											0x02
ROW-02											0x04
ROW-03											0x06
ROW-04											0x08
ROW-05											0x0A
ROW-06											0x0C
ROW-07											0x0E
ROW-08											0x10
ROW-09											0x12
ROW-10											0x14
ROW-11											0x16
ROW-12											0x18
ROW-13											0x1A
ROW-14											0x1C
ROW-15											0x1E
ROW-16											0x20
ROW-17											0x22

Font "G" example



To set a Multi-Color Font

Set a register MultiChar to capture the color fonts. Each color font will occupy 4 monochrome fonts spaces. The multi-color font will occupy the space from the font index 0. For example, when MultiChar is set to 2, there are 2 multi-color fonts available. The monochrome fonts will start from font No. 8. The font No. 0 to 3 are mapped to the same color font and the font NO. 4 to 7, the other color font. The color for each pixel of a color font is also mapped to a 24-bit color through the color pallet as below.



To set an OSD Double Size

To set registers DPH / DPV = 1 will stretch the OSD by a factor of two in the horizontal / vertical direction respectively. Pixel and line replication is used to stretch the image. This option will also affect the border and shadow size around the OSD window.

Blending Effect

STK6005 provides an effect of the blending OSD with image pixel and this effect is suitable for OSD fade-in / fade-out effect. 16 levels of blending are supported. Blend level (defined by a register BlendR) for binary codes “1111” through “0000” are in the proportion of 6.25%, 12.5%, 18.75%, .. , 93.75% and 100%. The blend percentage levels depicted here are in the percentage of OSD pixel data. For example, 0001 yields an output data stream whose blended pixel data contains 93.75% OSD and 6.25% underlying image data. This OSD would be only slightly translucent.

External OSD interface

STK6005 also provides an external OSD interface to use an external OSD chip. OVCLK, OVHS, OVVS ports will output the timing of panel clock, H-Sync, and V-Sync to the external OSD chip. The output delay between OVCLK and OVHS / OVVS is tunable through register DlyOVCLK and DlyOVHS. OSD pixels data are input from OVI, OVB, OVG, and OVR and will be combined into a 4-bit color index then mapped to the color pallet. OVFB indicates the pixels to be displayed on the panel.

Rotational OSD

STK6005 also provides an internal logic to support the rotational OSD. When a font table for

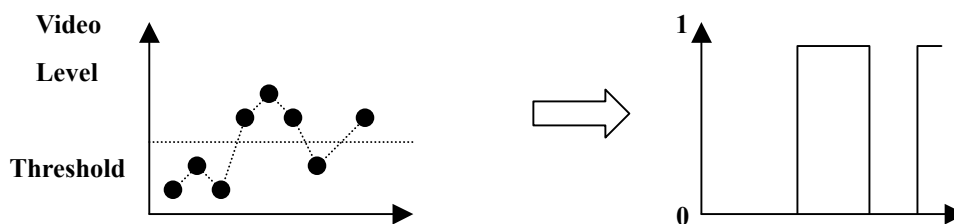


rotational OSD is defined, the bit map of fonts should rotate by 90 degrees and be programmed for each font of 36 bytes by 18 dots (3 bytes) * 12 lines. The char. and attribute contents of the OSD window should also be programmed from bottom at a corner to the left first. (from bottom to top and then from left to right) It should be noted that the registers for defining the OSD window are swapped between the horizontal and vertical.

5.14 Auto-Adjustment

To set a Color Threshold

Set the threshold of input signals before using the auto-detecting function to avoid the noise of input signals affecting the measurement results. Registers GateR, GateG, and GateB mean the threshold values for red, green, and blue of input signals. The auto-detecting circuit will allow the input signals with all colors levels higher than their thresholds level, or otherwise the input signals will not be included in the measurement.



To set a Measurement Window

Set the measurement window before using the auto-detecting function to avoid the noise of input signals among some certain positions or to measure the region of interests. Set register SelWDE to switch the active region defined by AWinH/V registers or internal DE.

To select an Input Source

Set a register SelHV to select H-Sync and V-Sync input sources for timing measurement. Set registers SelVCnt and SelHCnt to select horizontal and vertical clocks for timing measurement.

Source Timing Measurement

STK6005 provides the following source timing data for auto-adjustment

1. HCT: A 16-bit value indicates the 16-cycle period of selected input H-Sync signal.

The selected input clock RefCLK or VCLK is used to measure the period.

This value will be updated in each frame.

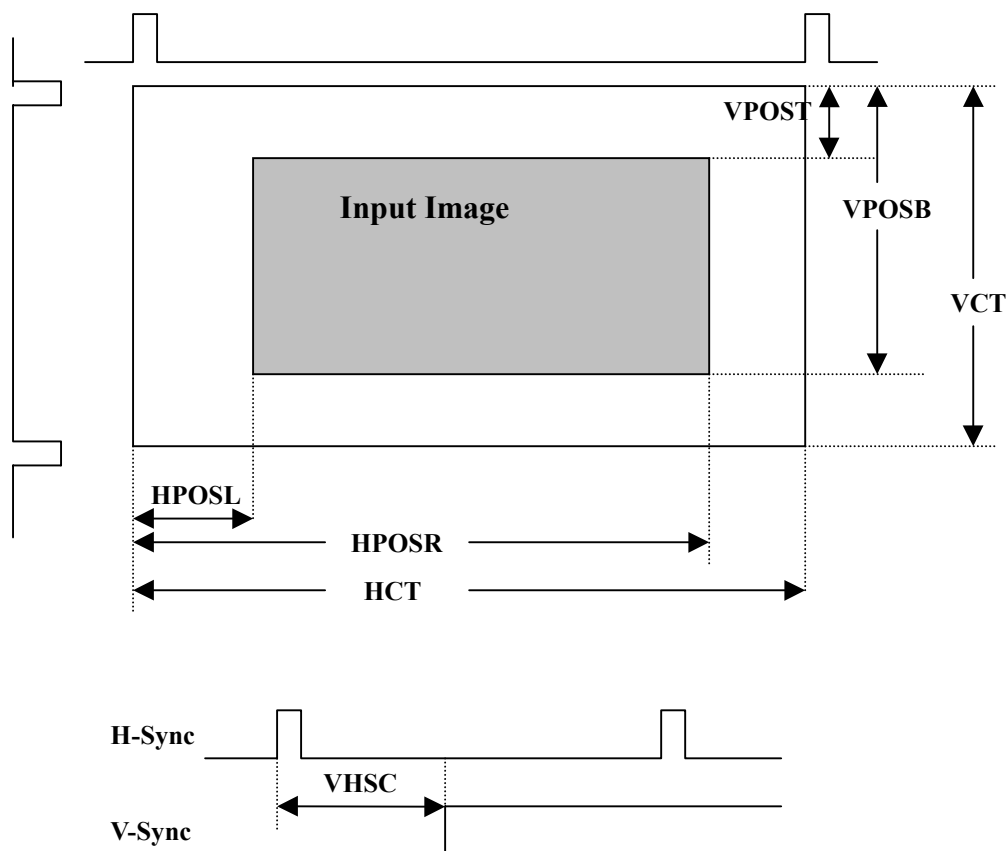
2. VCT: A 12-bit value indicates the period of selected input V-Sync signal.

The period can be measured by the input horizontal line or by $144 * \text{RefCLKs}$.

This value will be updated in each frame.



3. **VSHC:** A 12-bit value indicates the horizontal position (counted from H-Sync leading edge) of the selected input V-Sync leading edge. This value can be used as a field indicator for interlace input signal to determine whether the incoming field is even or odd. This value will be updated in each frame.
4. **HPSL:** The 12-bit value indicates the left position of input image. VCLK is the reference clock. This value will be updated in each frame.
5. **HPSR:** The 12-bit value indicates the right position of input image. VCLK is the reference clock. This value will be updated in each frame.
6. **VPOST:** The 11-bit value indicates the top position of input image. This value is counted by input horizontal lines and updated in each frame.
7. **VPOSB:** The 11-bit value indicates the bottom position of input image. This value is counted by input horizontal lines and updated in each frame.
8. **HSLost:** This flag is set to 1 when the input H-Sync period overflows.
9. **VSLost:** This flag is set to 1 when the input V-Sync period overflows.
10. **HSPol:** This flag determines whether the polarity of selected input H-Sync is positive (0) or negative (1).
11. **VSPol:** This flag determines whether the polarity of selected input V-Sync is positive (0) or negative (1).



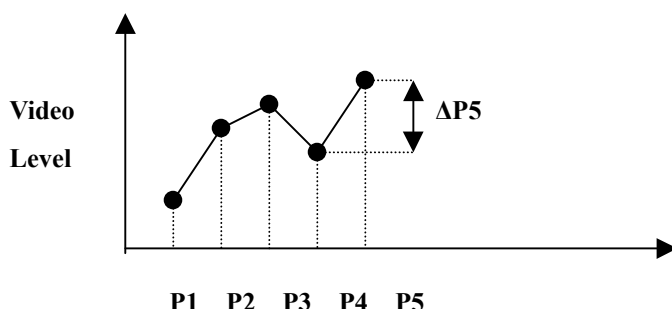
Source Level Measurement

The auto-detecting circuit can detect the minimum and maximum values (MinR, MinG, MinB, MaxR, MaxG, and MaxB) of the input video data for the contrast adjustment of external ADC. The measurement window also defines the measurement region of input image.

Source Clock Phase Measurement

STK6005 provides two methods to adjust the sampling phase for external ADC. The first method detects the toggles of input image (above or below the threshold). The auto-detecting circuit can find the position with maximum toggle rate and then reveals its position (TGX, TGY) and its toggle rate (TogRate). With this information, you can set the capture position (SetX, SetY) to capture the toggle data of 16 adjoining pixels. The 16 toggle data (LVD) will be captured in each frame and a block of this chip automatically compares said data (LVD) with the results of previous frame. The comparison results will be put in register EQC to show how many toggle data are equal to those of previous frame.

The other method is to sum up the pixel values and difference (absolute value) between adjacent pixels of input video. The measurement window defines the image region for calculation. The colors for calculation can be selected by MaskRGB flags (1 = enable calculating). Some LSBs of summing data can be truncated to avoid the noise of input video by setting the register MaskBit. The total sum of pixels' difference can be used as a merit to adjust the external ADC to correct the phase and frequency.



Buffer Status Detection

STK6005 detects the operation of internal buffer and provides the information to correctly synchronize the input and output image. The registers of buffer status are shown below:

1. **OverRun:** This flag is set to 1 when the input rate of input image is larger than the output rate. Some input video data are overwritten before output.
2. **UnderRun:** This flag is set to 1 when the output rate of output image is larger than the input rate. Some input video data are not available for output.
3. **BufUsage:** This 16-bit value indicates the maximum buffer usage. A bit 15 is also an indicator for underrun. Bits 14 to 11 indicate the maximum line usage of internal buffer. Bits 10 to 0 indicate the pixel usage of internal buffer.
4. **PosVXDE:** This 11-bit value indicates the vertical position (lines) of input image stored in the internal buffer when STK6005 starts to output the first video data of a frame. This value should be in range of 3 – 5 for a correct input-output synchronization.
5. **PosHXDE:** This 11-bit value indicates the horizontal position (pixels) of input image stored in internal buffer when STK6005 starts to output the first video data of a frame.

5.15 I²C Interface

STK6005 supports the industrial 2-wire serial bus interface to communicate with external micro-controller. The interface consists of an input pin SCL for serial clock and a bi-directional pin SDA for input / output data. The slave address of this chip is 1111010x (F4H for write and F5H for read operations). The I2C block will auto-increase the register address after each data write-in or read-out. For the operation timing and protocol, please refer to the 2-wire serial bus specification.

5.16 Interrupt

STK6005 provides 8 interrupt flags to tell the micro-controller when the defined internal events happen. The INTN pin will output low when any interrupt flag is being set. The interrupt flag register indicates what events trigger the interrupt. To write data to the interrupt enable register (0x7F) will automatically



clear the interrupt flags and reset INTN output to high.

5.17 GPIO Ports

STK6005 provides four general purpose inputs / outputs. These provide additional signals to control the various devices in the system. Each GPIO port can be independently programmed to input or output a direction (SelGPO) or a pulse width modulation output (SelPWM).

6. REGISTER DEFINITION

6.1 ADC Control

Address	Bit	Name	Initial	R/W	Description
0x10	[7:0]	HBP[7:0]	0x28	R/W	Horizontal back-porch length of input video, unit in number of input clocks
0x11	[3:0]	HBP[11:8]	0x1	R/W	
0x12	[7:0]	HDISP[7:0]	0x00	R/W	Horizontal display active length of input video, unit in number of input clocks
0x13	[3:0]	HDISP[11:8]	0x4	R/W	
0x14	[7:0]	VBP[7:0]	0x23	R/W	Vertical back-porch length of input video, unit in number of input scan lines
0x15	[2:0]	VBP[10:8]	0x0	R/W	
0x16	[7:0]	VDISP[7:0]	0x00	R/W	Vertical display active length of input video, unit in number of input scan lines
0x17	[2:0]	VDISP[10:8]	0x3	R/W	
0x18	[7:5]	ClampSTA	0x2	R/W	Clamp start from RGHS trailing edge (# of RefCLKs)
	[4:0]	ClampPW	0x08	R/W	Clamp output pulse width (# of RefCLKs)
0x19	[7:4]	MaskBW	0x4	R/W	Backward expansion width of VS mask (# of lines)
	[3:0]	MaskFW	0x4	R/W	Forward expansion width of VS mask (# of lines)
0x1A	[5]	EnClamp	0	R/W	0/1 : Clamp output low / enable
	[4]	SetClamp	0		0/1 : to set Clamp output polarity to positive / negative
	[3]	MaskSync	1		0/1 : MaskVS sync to RGHS leading / trailing edge
	[2]	MaskExp	1		1 : enable MaskVS expansion
	[1]	EnMaskVS	0		0/1 : MaskVS output low / enable
	[0]	SetMask	0		0/1 : to set MaskVS output polarity to positive / negative
0x1B	[6]	SetICLK	0	R/W	0/1 : to set input clock polarity to positive / negative
	[5]	SetIVS	0		0/1 : to set input Vsync polarity to positive / negative
	[4]	SetIHS	0		0/1 : to set input Hsync polarity to positive / negative
	[3]	HVMode	0		1 : VGAHS is composite sync and separates VS from it.
	[2]	SelCSync	0		1 : to select Csync as Hsync / Vsync input
	[1]	EnRGHS	1		0/1 : RGHS output low / enable
	[0]	SetRGHS	0		0/1 : to set RGHS output polarity to positive / negative
0x1C	[5]	EnInter	0	R/W	1 : to enable a de-interlace function
	[4]	L1Odd	1		1 : to indicate that Odd field is a first frame
	[3]	HalfOdd	0		1 : VS active at half of HS period is an Odd field.
	[2]	AdjEvenF	0		1 : to delay an active area of even field by 1 line
	[1]	AdjOddF	0		1 : to delay an active area of odd field by 1 line
	[0]	SelIntF	0		0/1 : YUV field is indicated by Field / HV sync timing.



0x1D	[7]	SelDE	0	R/W	0/1 : to select register setting / ExtDE as display active
	[6]	EnYUV	0		1 : to select a YUV input
	[5]	SetVref	0		0/1 : to set Vref polarity to positive / negative
	[4]	SetHref	0		0/1 : to set Href polarity to positive / negative
	[3]	SetCref	0		0/1 : to set Cref polarity to positive / negative
	[2]	SetField	0		0/1 : to set Field (Odd) polarity to positive / negative
	[1]	YUV16	0		0/1 : video format is a 8-bit (CCIR 656) / 16-bit format.
	[0]	SelLLC2	0		1 : to select LLC2 as input clock
0x1E	[7:0]	VSDelay	0x04	R/W	Delay of internal Vsync (* 8 input clocks)

6.2 Panel Window Control

Address	Bit	Name	Initial	R/W	Description
0x20	[7:0]	PHDE1[7:0]	0x28	R/W	Panel horizontal DE start position (# of PCLKs)
0x21	[3:0]	PHDE1[11:8]	0x1	R/W	
0x22	[7:0]	PHDE2[7:0]	0x28	R/W	Panel horizontal DE end position (# of PCLKs)
0x23	[3:0]	PHDE2[11:8]	0x5	R/W	
0x24	[7:0]	PHXDE1[7:0]	0x28	R/W	Panel horizontal image start position (# of PCLKs)
0x25	[3:0]	PHXDE1[11:8]	0x1	R/W	
0x26	[7:0]	PHXDE2[7:0]	0x28	R/W	Panel horizontal image end position (# of PCLKs)
0x27	[3:0]	PHXDE2[11:8]	0x5	R/W	
0x28	[7:0]	PHT[7:0]	0x40	R/W	Panel horizontal total (# of PCLKs) set PHT = 0xFFF if EnSyncH = 1
0x29	[3:0]	PHT[11:8]	0x5	R/W	
0x2A	[7:0]	PHSW[7:0]	0x88	R/W	Panel horizontal sync width (# of PCLKs)
0x2B	[7:0]	PVSW[7:0]	0x06	R/W	Panel vertical sync width (# of lines)
0x2C	[7:0]	PVDE1[7:0]	0x23	R/W	Panel vertical DE start position (# of lines)
0x2D	[2:0]	PVDE1[10:8]	0x0	R/W	
0x2E	[7:0]	PVDE2[7:0]	0x23	R/W	Panel vertical DE end position (# of lines)
0x2F	[2:0]	PVDE2[10:8]	0x3	R/W	
0x30	[7:0]	PVXDE1[7:0]	0x23	R/W	Panel vertical image start position (# of lines)
0x31	[2:0]	PVXDE1[10:8]	0x0	R/W	
0x32	[7:0]	PVXDE2[7:0]	0x23	R/W	Panel vertical image end position (# of lines)
0x33	[2:0]	PVXDE2[10:8]	0x3	R/W	
0x34	[7:0]	PVT[7:0]	0x26	R/W	Panel vertical total (# of lines) set PVT = 0x7FF if EnSyncH/V = 1
0x35	[2:0]	PVT[10:8]	0x3	R/W	

6.3 Scaling Control

Address	Bit	Name	Initial	R/W	Description
0x36	[7:0]	HSR[7:0]	0x00	R/W	Horizontal expansion ratio = (INres / OUTres) * 32768
0x37	[7:0]	HSR[15:8]	0x80	R/W	
0x38	[7:0]	VSR[7:0]	0x00	R/W	Vertical expansion ratio = (INres / OUTres) * 32768
0x39	[7:0]	VSR[15:8]	0x80	R/W	
0x3A	[7:0]	EmPHT[7:0]	0x00	R/W	Emulate PHT by input clocks = (Panel H period / input clock period) * 16
0x3B	[7:0]	EmPHT[15:8]	0x54	R/W	



0x3C	[3]	EnFilt	0	R/W	1 : enable scaling
	[2:0]	FiltType[2:0]	0x4		Filter type 000 ~ 101
0x3D	[7]	EnSyncH	0	R/W	00 : free-run mode
	[6]	EnSyncV	1		01 : panel timing sync to input VS 1x : panel timing sync to input HS
	[5:0]	DlyLine[5:0]	0x03		panel to input timing sync point line delay (≥ 1)
0x3E	[7:0]	DlyPxI[7:0]	0x40	R/W	panel to input timing sync point pixel delay * 8 (≥ 1)

6.4 Panel Output Control

Address	Bit	Name	Initial	R/W	Description
0x40	[7:0]	GainR[7:0]	0x80	R/W	Panel output red / green / blue contrast adjustment Range : 0x00 ~ 0x80 ~ 0xFF = dark ~ normal ~ bright
0x41	[7:0]	GainG[7:0]	0x80	R/W	
0x42	[7:0]	GainB[7:0]	0x80	R/W	
0x43	[7:0]	DC_R[7:0]	0x00	R/W	Panel output red / green / blue brightness adjustment Range : 0x80 ~ 0x00 ~ 0x7F = dark ~ normal ~ bright
0x44	[7:0]	DC_G[7:0]	0x00	R/W	
0x45	[7:0]	DC_B[7:0]	0x00	R/W	
0x46	[7:0]	uWrGmaA		W	To set address of gamma table to write
0x47	[7:0]	uWrGmaD		W	To set data to write into gamma table
0x48	[7:0]	BGColorR[7:0]	0x00	R/W	Panel background color red
0x49	[7:0]	BGColorG[7:0]	0x00	R/W	Panel background color green
0x4A	[7:0]	BGColorB[7:0]	0x00	R/W	Panel background color blue
0x4B	[6]	GmaWEB	1	R/W	Modification enable of color blue gamma table
	[5]	GmaWEG	1		Modification enable of color green gamma table
	[4]	GmaWER	1		Modification enable of color red gamma table
	[3]	EnGamma	0		1 = to enable gamma correlation
	[2]	EnFRC	1		1 = to enable dynamic dithering
	[1:0]	DithType	0x0		Dithering mode : 00 / 01 / 10 / 11 => OFF / 8 bits / 7 bits / 6 bits
0x4C	[7]	Mute	0	R/W	1 : force output panel background color
	[6]	MuteI	0		1 : force bit [1:0] output low
	[5]	SPO	0		0/1 : dual / single ports panel output
	[4]	EnTriPO	1		0/1 : output low / tri-state when panel output is disabled
	[3]	EnDCLK	0		1 : enable DCLK output
	[2]	EnPCtrl	0		1 : enable PHS / PVS / PDE output
	[1]	EnPDOB	0		1 : enable port B (odd port) output
	[0]	EnPDOA	0		1 : enable port A (even port) output
0x4D	[6]	SetPDE	0	R/W	0/1 : to set PDE output polarity to positive / negative
	[5]	SetPVS	0		0/1 : to set PVS output polarity to positive / negative
	[4]	SetPHS	0		0/1 : to set PHS output polarity to positive / negative
	[3]	SetDCLK	0		0/1 : to set DCLK output polarity to positive / negative
	[2:0]	DlyDCLK	0x0		To adjust DCLK output delay to 0 ~ 8.4ns, 1.2ns per step



6.5 OSD Control

Address	Bit	Name	Initial	R/W	Description
0x50	[7:0]	StartH[7:0]	0x00	R/W	horizontal start position of OSD window
0x51	[3:0]	StartH[11:8]	0x3	R/W	
0x52	[7:0]	StartV[7:0]	0x00	R/W	vertical start position of OSD window
0x53	[2:0]	StartV[10:8]	0x1	R/W	
0x54	[5:0]	Width[5:0]	0	R/W	OSD window width, unit in char
0x55	[5:0]	Length[5:0]	0	R/W	OSD window length, unit in row
0x56	[7:4]	BorderV[3:0]	0	W	To set border length of OSD window
	[3:0]	BorderH[3:0]	0	W	To set border width of OSD window
0x57	[7:4]	ShadowV[3:0]	0	R/W	To set shadow length of OSD window
	[3:0]	ShadowH[3:0]	0	R/W	To set shadow width of OSD window
0x58	[7]	EnFanV	0		To enable window vertical fan in/out effect
	[6]	EnFanH	0		To enable window horizontal fan in/out effect
	[5]	FanRate	0		0/1 : fan in/out time = 32 / 64 frames
	[4]	EnBlend	0		To enable blending effect
	[3:0]	BlendR	0		To set blending ratio 0x0 ~ 0xF -> 0% ~ 93.75% video
0x59	[6]	BlinkRate	0		0/1 : blink cycle time 32 / 64 frames
	[5:4]	BlinkDuty	0		00/01/1x : on time 25 / 50 / 75 %
	[3:0]	BdrColur	0x0	R/W	OSD border color index
0x5A	[4:0]	MultiChar[4:0]	0x0	R/W	To set number of multi-color characters
0x5B	[7:0]	uWrAdr[7:0]		W	To set address of Char / Font / Pallet memory
0x5C	[7:0]	uWrChr[7:0]		W	To write data into Char memory
0x5D	[7:0]	uWrAttr[7:0]		W	To write data into Attribute memory
0x5E	[5:0]	uWrFont[5:0]		W	To write data into Font memory
0x5F	[7:0]	uWrColor[7:0]		W	To write data into Pallet memory

0x4E	[7]	RstOSD	0	R/W	To write 1 to reset OSD, auto-clear after write
	[6]	EnEOSD	0		To enable external OSD
	[5]	EnIOSD	0		To enable internal OSD
	[4]	EOSD_FR	0		1 = to put external OSD in front of internal OSD
	[3]	DplV	0		1 = vertical 2x
	[2]	DplH	0		1 = horizontal 2x
	[1]	OSD_Rot	0		1 = to rotate 90° of internal OSD
	[0]	ChrOnly	0		0/1 = memory address increase after writing Char & Attr / Char or Attr
0x4F	[7]	SetOVCLKI		R/W	0/1 : to set clock polarity of latch external OSD input as positive / negative in polarity
	[6]	SelOVCLK			0/1 : to indicate that OVCLK is PCLK or PCLK/2
	[5:3]	DlyOVCLK			To set OVCLK output delay as 0 ~ 8.4ns, 1.2ns per step
	[2:0]	DlyOVHS			To set OVHS / OVVS output delay as 0 ~ 8.4ns



6.6 MISC Control

Address	Bit	Name	Initial	R/W	Description
0x00	[7:0]	ChipVer	0xA0	R	Chip Version
0x01	[4]	IntRST	0	R/W	To write 1 to reset Scalar, to auto-clear to 0 (clocks / registers not reset)
	[3]	PWRDN	0		1 = power-down mode (I ² C bus still functions.)
	[2]	EnAdj	0		1 = to enable an auto-adjustment block
	[1]	EnVIU	0		1 = to enable an input block
	[0]	EnVOU	0		1 = to enable an output block
0x02	[5:4]	SelPCLK	0x2	R/W	00 : RefCLK, 01: VCLK, 1x : ExtPCLK
	[3]	PLL_PD	0		1 = PLL power down
	[2]	PLL_BP	0		1 = PLL input bypass mode
	[1]	PLL_OE	0		0 = PLL output enabled
	[0]	PLL_RST	0		To write 1 to reset PLL, to auto-clear to 0
0x03	[7:0]	PLL_M[7:0]	0x47	R/W	9-bit PLL feedback divider
0x04	[7]	PLL_M[8]	0	R/W	divided by (PLL_M + 2)
	[6:5]	PLL_OD[1:0]	0x1		PLL output divider 00/01/10/11 : output divided by 1/2/2/4
	[4:0]	PLL_N[4:0]	0x06		5 bits PLL input divider divided by (PLL_N + 2)
0x05	[3:0]	PreDiv[3:0]	0x4	R/W	Pre-divider for VCLK source
0x06	[7:4]	SelPWM[3:0]	0x0	R/W	1 = indicates that GPIO port output is PWM output.
	[3:0]	SelGPO[3:0]	0x0		0/1 = indicates that GPIO port is input / output.
0x07	[3:0]	GPOD[3:0]	0x0	R/W	To write to GPO data / to read from GPI data
0x08	[7:0]	PWM0[7:0]	0x00	R/W	To set a GPIO0 PWM value
0x09	[7:0]	PWM1[7:0]	0x00	R/W	To set a GPIO1 PWM value
0x0A	[7:0]	PWM2[7:0]	0x00	R/W	To set a GPIO2 PWM value
0x0B	[7:0]	PWM3[7:0]	0x00	R/W	To set a GPIO3 PWM value
0x0C	[7:0]	TestCode[7:0]		W	To write (0x4B,0x43,0x16,0xA8) to enter in a debug mode

6.7 Auto-Adjustment

Address	Bit	Name	Initial	R/W	Description
0x70	[7:0]	GateR[7:0]	0x00	R/W	To set a red threshold value
0x71	[7:0]	GateG[7:0]	0x00	R/W	To set a green threshold value
0x72	[7:0]	GateB[7:0]	0x00	R/W	To set a blue threshold value
0x73	[7:0]	AWinHS[7:0]	0x28	R/W	To set a horizontal start position of the auto-adjustment active window
0x74	[7:0]	AWinHE[7:0]	0x28	R/W	To set a horizontal end position of the auto-adjustment active window
0x75	[7:4]	AWinHE[11:8]	0x5	R/W	
	[3:0]	AWinHS[11:8]	0x1	R/W	
0x76	[7:0]	AWinVS[7:0]	0x23	R/W	To set a vertical start position of the auto-adjustment active window
0x77	[7:0]	AWinVE[7:0]	0x23	R/W	To set a vertical end position of the auto-adjustment active window
0x78	[6:4]	AWinVE[10:8]	0x3	R/W	



	[2:0]	AWinVS[10:8]	0x1	R/W	
0x79	[7:0]	SetX[7:0]	0x00	R/W	To set a horizontal position (low byte) for reading out a pixel value
0x7A	[7:0]	SetY[7:0]	0x00	R/W	To set a vertical position (low byte) for reading out pixel value
0x7B	[6:4]	SetY[10:8]	0x1	R/W	To set a vertical position (high byte) for reading out a pixel value
	[3:0]	SetX[11:8]	0x03	R/W	To set a horizontal position (high byte) for reading out a pixel value
0x7C	[7:4]	VCntTol[3:0]	0x2	R/W	H-Sync period tolerance
	[3:0]	HCntTol[3:0]	0x2	R/W	V-Sync period tolerance
0x7D	[4:2]	MaskRGB[2:0]	0x7	R/W	To Select R/G/B to calculate
	[1:0]	MaskBit[1:0]	0x0	R/W	To mask off non-effective bits
0x7E	[4]	SelWDE	1	R/W	0/1 : to select internal DE / AWin for active window
	[3]	SelVCnt	1	R/W	0/1= vertical period counted by line/144*RefCLK
	[2]	SelHCnt	1	R/W	0/1= horizontal period counted by VCLK/RefCLK
	[1:0]	SelHV	0x0	R/W	To select HS/VS source for auto-adjustment 00 : HSI/VS1 or Hsync/Vsync 01 : VGAHS/VS1 10 : Csync 11 : DE
0x7F	[7]	EnIntBuf	0	R/W	1 = to enable line buffer interrupt
	[6]	EnIntPVS	0	R/W	1 = to enable PVS leading edge interrupt
	[5]	EnIntVSPol	0	R/W	1 = to enable input V-Sync polarity change interrupt
	[4]	EnIntHSPol	0	R/W	1 = to enable input H-Sync polarity change interrupt
	[3]	EnIntVCT	0	R/W	1 = to enable Vertical period change interrupt
	[2]	EnIntHCT	0	R/W	1 = to enable Horizontal period change interrupt
	[1]	EnIntVS2	0	R/W	1 = to interrupt when an input V-Sync trailing edge triggers
	[0]	EnIntVS1	0	R/W	1 = to interrupt when an input V-Sync leading edge triggers
					Note: writing to this register will clear all interrupt flags.

6.7.1 Auto-Adjustment (1)

Address	Bit	Name	Initial	R/W	Description
0x80	[7:0]	HCT[7:0]		R	horizontal period count (period of 16 lines)
0x81	[7:0]	HCT[15:8]		R	
0x82	[7:0]	VCT[7:0]		R	vertical period count (in lines)
0x83	[3:0]	VCT[11:8]		R	
0x84	[7:0]	VSHC[7:0]		R	horizontal position of input V-Sync leading edge
0x85	[3:0]	VSHC[11:8]		R	
0x86	[7:0]	HPOS[7:0]		R	the most left position of valid pixels
0x87	[3:0]	HPOS[11:8]		R	
0x88	[7:0]	HPOS[7:0]		R	the most right position of valid pixels
0x89	[3:0]	HPOS[11:8]		R	
0x8A	[7:0]	HPOS[7:0]		R	pixel counts of the most left position



0x8B	[3:0]	HPOSLC[11:8]		R	
0x8C	[7:0]	HPOSRC[7:0]		R	pixel counts of the most right position
0x8D	[3:0]	HPOSRC[11:8]		R	
0x8E	[7:0]	VPOST[7:0]		R	the most top position of valid pixels
0x8F	[2:0]	VPOST[10:8]		R	
0x90	[7:0]	VPOSB[7:0]		R	the most bottom position of valid pixels
0x91	[2:0]	VPOSB[10:8]		R	
0x92	[7:0]	TGX[7:0]		R	horizontal position of maximum toggle region
0x93	[3:0]	TGX[11:8]		R	
0x94	[7:0]	TGY[7:0]		R	vertical position of maximum toggle region
0x95	[2:0]	TGY[10:8]		R	
0x96	[3:0]	TogRate[3:0]		R	maximum toggle rate
0x97	[7:0]	LVD[7:0]		R	Data-valid flags of selected 16 pixels
0x98	[7:0]	LVD[15:8]		R	
0x99	[4:0]	EQC[4:0]		R	no-change counts of data-valid flags between 2 frames
0x9A	[7:0]	MinR[7:0]		R	minimum value of red
0x9B	[7:0]	MinG[7:0]		R	minimum value of green
0x9C	[7:0]	MinB[7:0]		R	minimum value of blue
0x9D	[7:0]	MaxR[7:0]		R	maximum value of red
0x9E	[7:0]	MaxG[7:0]		R	maximum value of green
0x9F	[7:0]	MaxB[7:0]		R	maximum value of blue

6.7.2 Auto-Adjustment (2)

Address	Bit	Name	Initial	R/W	Description
0xA0	[7]	OverRun		R	1 = line buffer overrun
	[6]	UnderRun		R	1 = line buffer underrun
	[5]	VSPol		R	0/1 = positive / negative VS detected
	[4]	HSPol		R	0/1 = positive / negative HS detected
	[3]	VSLost		R	1 = VS missing
	[2]	HSLost		R	1 = HS missing
	[1]	Field		R	1 = VS leading edge occurring at the middle of HS period
	[0]	IVS		R	input VS level
0xA1					Note : interrupt flags (cleared by write register 0x7F)
	[7]	IntBuf	0	R	1 = interrupted in the case of line buffer overrun / underrun
	[6]	IntPVS	0	R	1 = interrupted on PVS leading edge
	[5]	IntVSPol	0	R	1 = interrupted in the case of input VS polarity change
	[4]	IntHSPol	0	R	1 = interrupted in the case of input HS polarity change
	[3]	IntVCT	0	R	1 = interrupted in the case of input V period change
	[2]	IntHCT	0	R	1 = interrupted in the case of input H period change
	[1]	IntVS2	0	R	1 = interrupted on input VS trailing edge
	[0]	IntVS1	0	R	1 = interrupted on input VS leading edge
0xA2	[7:0]	SumPxI[7:0]		R	sum of pixel values
0xA3	[7:0]	SumPxI[15:8]		R	



0xA4	[7:0]	SumPxl[23:16]		R	
0xA5	[5:0]	SumPxl[29:24]		R	
0xA6	[7:0]	SumDif[7:0]		R	sum of difference between adjacent pixels
0xA7	[7:0]	SumDif[15:8]		R	
0xA8	[7:0]	SumDif[23:16]		R	
0xA9	[5:0]	SumDif[29:24]		R	
0xAA	[7:0]	VPxlCnt[7:0]		R	total number of pixels exceeding threshold
0xAB	[7:0]	VPxlCnt[15:8]		R	
0xAC	[7:0]	VPxlCnt[23:16]		R	
0xAD	[7:0]	ReadR[7:0]		R	red value of the selected pixel
0xAE	[7:0]	ReadG[7:0]		R	green value of the selected pixel
0xAF	[7:0]	ReadB[7:0]		R	blue value of the selected pixel

0x60	[7:0]	BufUsage[7:0]		R	maximum line buffer usage
0x61	[7:0]	BufUsage[15:8]		R	[15]=underrun, [14:11] = line usage, [10:0] = pixel usage
0x62	[7:0]	PosVSyncV[7:0]		R	panel vertical position when an input V-Sync leading edge triggers
0x63	[2:0]	PosVSyncV[10:8]		R	
0x64	[7:0]	PosHSyncV[7:0]		R	panel horizontal position when an input V-Sync leading edge triggers
0x65	[3:0]	PosHSyncV[11:8]		R	
0x66	[7:0]	PosVXDE[7:0]		R	line buffer input vertical position when a panel output first-pixel is present
0x67	[2:0]	PosVXDE[10:8]		R	
0x68	[7:0]	PosHXDE[7:0]		R	line buffer input horizontal position when a panel output first- pixel is present
0x69	[2:0]	PosHXDE[10:8]		R	

7. ELECTRICAL CHARACTERISTICS

7.1 Operating Conditions Recommended

Item	Ratings
Core operating voltage	2.5V \pm 10%
I/O operating voltage	3.3V \pm 10%
Operating Ambient temperature	0°C to 70°C
Storage temperature	-55°C to 150°C
Total power dissipation	TBD W (XGA @ 85Hz) TBD W (SXGA @ 85Hz)

7.2 DC Characteristics

Symbol	Description	MIN.	TYP.	MAX.
VDD3	I/O digital supply voltage	3.0 V	3.3 V	3.6 V
VDD2	Core digital supply voltage	2.25 V	2.5 V	2.75 V
VDD2P	PLL digital supply voltage	2.4 V	2.5 V	2.6 V
AVDD	PLL analog supply voltage	2.4 V	2.5 V	2.6 V
IVDD3	I/O digital supply current			TBD mA
IVDD2	Core digital supply current			TBD mA



VIL(schmit)	input low level of Schmit trigger input	-0.5 V		0.3 * VDD3
VIH(schmit)	input high level of Schmit trigger input	0.7 * VDD3		5.5 V
VIL	input low level of general input	-0.5 V		0.8 V
VIH	input high level of general input	2.0 V		5.5 V
VOL	output low voltage			0.4 V
VOH	output high voltage	2.4 V		
ILI	input leakage current	-10 uA		10 uA
ILO	output leakage current	-20 uA		20 uA

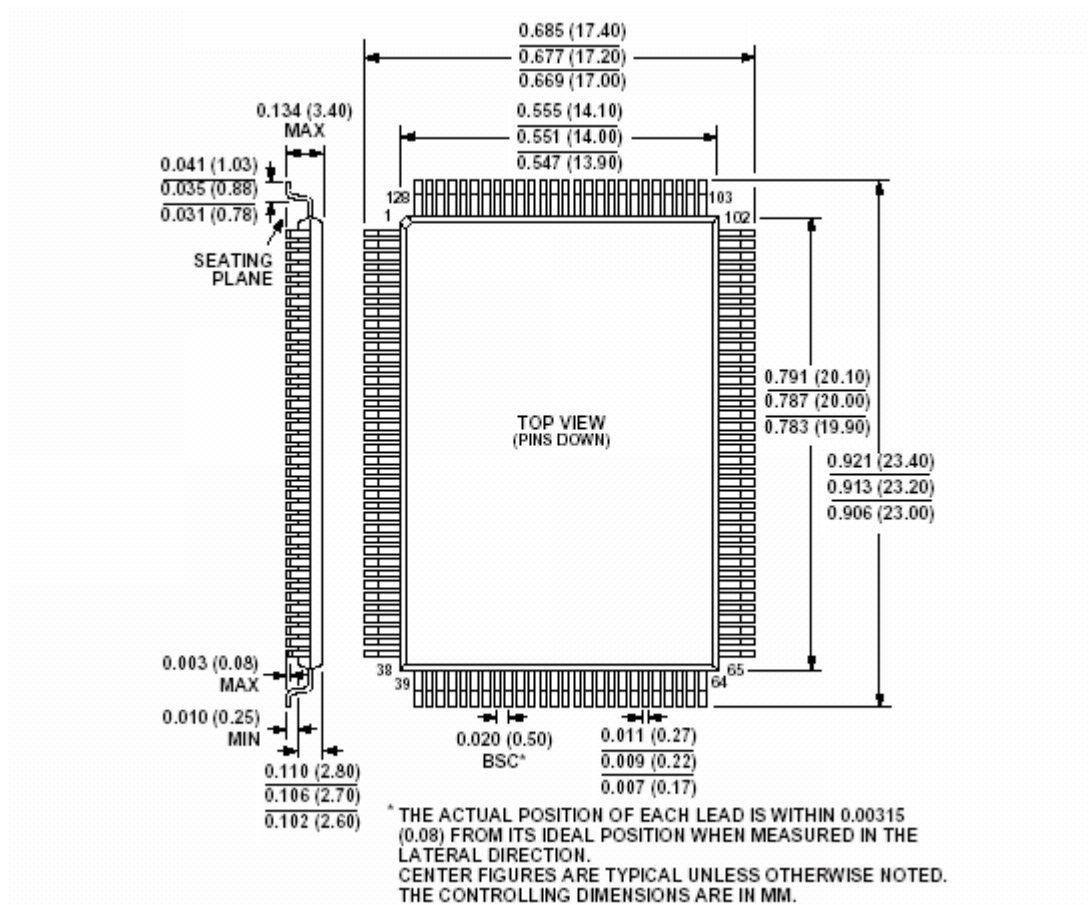
Note: VSI, VGAHS, CSync, SCL, and RSTN are Schmit trigger inputs.

7.3 AC Characteristics

Symbol	Description	MIN.	TYP.	MAX.
T_{IDS}	input pixel data setup time	3 ns		
T_{IDH}	input pixel data hold time	1 ns		
T_{ICS}	input control signals setup time	3 ns		
T_{ICH}	input control signals hold time	1ns		
T_{OD}	output pixel data to clock delay	0.5 ns		
T_{OC}	output control signals to clock delay	0.5 ns		
T_{OVIS}	OSD input setup time	5 ns		
T_{OVIH}	OSD input hold time	0 ns		
T_{OVOC}	OSD output control to clock delay	0.5 ns		



8. PACKAGE DIMENSION



Dimensions shown in inches and (mm).

128-Lead Plastic Quad Flatpack (PQFP)
(S-128)



9. INFORMATION

9.1 Order Information:

Part No : STK6005F 128 pins PQFP Package

9.2 Contact Information:

If you need more details information or samples requested, PLS contact the next window then we will response you as best as we can.

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