



DATA SHEET

TRUEVIEW 5735

Multimedia processor for Video Converter, HD PTV and LCD TV

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Table of Contents

INTRODUCTION	1
FEATURES	2
PINOUT DIAGRAM	3
PIN DIAGRAM FOR 176ETQFP	3
PIN DESCRIPTION	4
FUNCTIONAL DESCRIPTION	10
ADC	10
INPUT FORMATTER.....	10
DE-INTERLACER.....	10
FILM MODE.....	10
3D TIME – SPACE CONVERTER.....	10
VIDEO PROCESSING	10
ANALOG AND DIGITAL OUTPUT.....	11
MEMORY CONTROLLER	11
PLL AND OSCILLATOR.....	11
HOST BUS INTERFACE	11
OSD.....	12
CLOCK RECOVERY CIRCUITS	12
APPLICATION NOTES	13
ADC PIN CONNECTION.....	13
CRYSTAL PIN.....	14
VIDEO PORT USAGE	16
BOARD MEMORY CONNECTION:	24
ELECTRICAL CHARACTERISTICS	29
ABSOLUTE MAXIMUM RATINGS.....	29
DC CHARACTERISTICS	30
AC CHARACTERISTICS	32
MEMORY INTERFACE AC CHARACTERISTICS.....	34
DAC CHARACTERISTICS.....	38
ADC CHARACTERISTICS.....	39
CONTACT INFORMATION	41

Table of Figures

Figure 1: Block Diagram	1
Figure 2: OSD Icons	12
Figure 3: Example ADC Signal Connection	13
Figure 4: Crystal Connection Diagram	14
Figure 5: External Clock Drive Configuration	14
Figure 6: Internal Driver Configuration	15
Figure 7: Digital 24-bit YUV/RGB Input with Analog Output Mode	17
Figure 8: Digital 16-bit YUV 4:2:2 Input with Analog Output Mode	18
Figure 9: Digital 8-bit 601/656 4:2:2 YUV Input with Analog Output Mode	19
Figure 10: Analog YUV/RGB Input with Analog Output Mode	20
Figure 11: Digital 8-bit 601/656 4:2:2 YUV Input with 16bit Digital Output	21
Figure 12: Analog RGB/YUV Input with 16bit Digital Output Mode.....	22
Figure 13: Analog RGB/YUV Input with 24bit Digital Output Mode.....	23
Figure 14: THREE 1MX16X2BANK MEMORY (1).....	24
Figure 15: THREE 1MX16X2BANK MEMORY (2).....	25
Figure 16: ONE 1MX16X4BANK MEMORY.....	26
Figure 17: ONE 512KX32X4BANK MEMORY	27
Figure 18: TWO 1MX16X4BANK MEMORY	28
Figure 19: Video Input Port AC Timing.....	32
Figure 20: Video Output Port AC timing	33
Figure 21: Memory Interface AC Input timing.....	34
Figure 22: Memory Interface AC output timing.....	35
Figure 23: Definition of timing for F/S-mode devices on the I ² C-bus	36
Figure 24: Package Dimensions for 176ETQFP	40

Table of Tables

Table 1: Digital Video Input Pins	4
Table 2: Digital Video Output Pins	4
Table 3: Analog Video input Pins	5
Table 4: Analog Video Output Interface Pins	6
Table 5: Clock Generation Pins	6
Table 6: System Interface Pins.....	6
Table 7: SDRAM Interface Pins.....	7
Table 8: Digital Power and Ground Pins	8
Table 9: Numerical Pin List.....	9
Table 10: I ² C Slave Addresses.....	12
Table 11: Over sampling ratio	12
Table 12: Absolute Maximum Ratings.....	29
Table 13: DC Characteristics.....	30
Table 14: Video Input Port AC Timing.....	32
Table 15: Video Output Port AC timing	33
Table 16: Memory Interface AC Input timing.....	34
Table 17: Memory Interface AC output timing.....	35
Table 18: Characteristics of the SDA and SCL bus lines for F/S-mode I ² C-bus devices.....	37
Table 19: DAC Characteristics	38
Table 20: ADC Characteristics	39

INTRODUCTION

The TrueView5735 is a low pin count, low-cost advanced and highly integrated Digital and Analog Video Display Processor providing the key features needed to design HD-READY, Progressive scan or LCD Televisions

TrueView5735 accepts interlaced or progressive video input and graphic input such as NTSC/PAL, 1080p,1080i/720p, and SXGA, etc. in both analog and digital channels. It provides a high quality display output. It is capable of advanced de-interlacing, video enhancement, advanced 3D noise reduction, Y/C cross talk suppression and frame rate conversion. It also provides superior video output quality.

It integrates a complete triple 8-bit pipeline ADC with a clock-recovery and sync separation circuit to generate the sampling clock from HSYNC. In applications where the analog outputs are used the 24-bit digital pins can be inputs if the pins are not used for digital output.

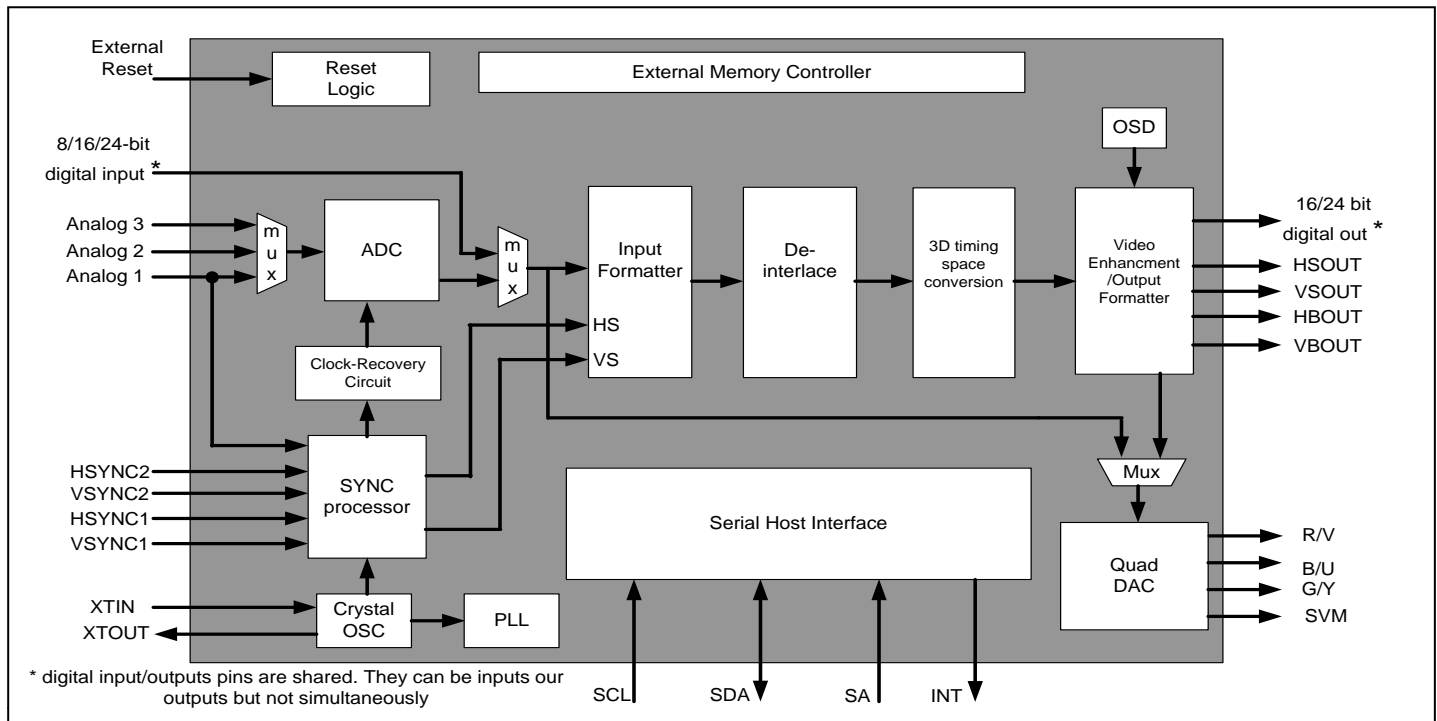
With the high quality video DACs, the video stream is displayed through its de-interlaced RGB/YPbPr outputs.

The I²C host interface enables OEMs to select from many different CPU's in order to meet their system and technical requirements.

OEMs can easily design a very low cost solution, while minimizing their software development time by leveraging on TrueView5735's level of integration and software support.

TrueView5735 provides 3D motion adaptive de-interlacing with diagonal edge detection. It performs high quality line doubling and high-accuracy non-linear motion estimation. It performs pixel based motion detection using two-field buffers. The Video De-interlacing Processor automatically detects noise level and can respond to different noise thresholds. It can also automatically detect input modes such as still images, 3:2 / 2:2 films and provide adaptive processing.

Figure 1: Block Diagram

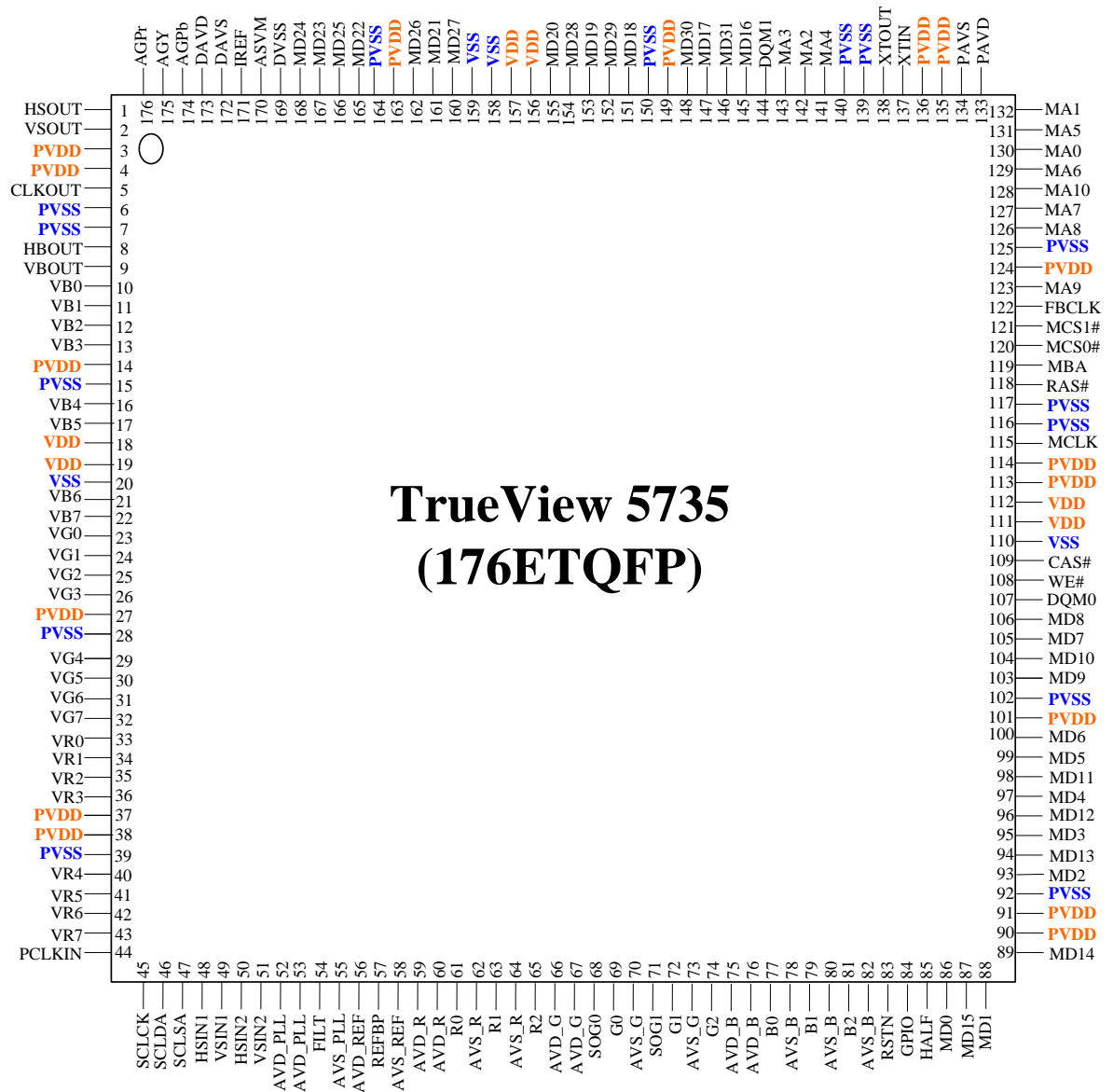


FEATURES

- **Analog Input Formatter**
 - Max three channel analog inputs
 - RGB/YCbCr/YPbPr input
 - Analog input range: 0.5V – 1.0V (p-p)
 - Programmable gain/offset controls
 - DC or AC coupling inputs
 - Internal sync separator to support SOG/SOY
 - UXGA (1600x1200@60Hz) at 162MHz
 - HDTV up to 1080p
 - Macrovision input detection
 - **Triple 8-bit ADC**
 - Maximum analog sampling rate up to 162MSPS
 - **Clock-recovery Circuit**
 - Programmable phase adjustment cells
 - HSYNC frequency range is from 15KHz to 110KHz
 - **Digital Input Formatter**
 - 24bit RGB/YUV input
 - 8/16bit YUV input
 - 8bit 656/601 input
 - NTSC/PAL input
 - 480p, 576p input
 - VGA/SVGA/XVGA input
 - 720p, 1080i, 1080p HD input
 - Support DVI interface
 - **Output formatter**
 - 480p, 576p, 720p, 1080i, 1080p
 - Up to SXGA graphic output formats
 - 100/120 interlace double scan
 - 75Hz interlace single scan
 - 50-75Hz scan rate conversion
 - 15~80KHz horizontal frequency
 - 16bit YPbPr digital output with syncs
 - 24bit YPbPr/RGB digital output with syncs
 - **De-interlace**
 - HD 1080i support
 - SD NTSC/PAL
 - Direct Edge Correction De-interlace
 - Motion Detection
 - Edge Detection
 - Mode Detection
 - Noise Detection
 - 3:2/2:2 pull-down detection
 - **Memory Controller**
 - 2-8Mbyte memory support
 - 16/32bit data access
 - **Video enhancement**
 - Black Level Expansion (BLE)
 - White Level Expansion (WLE)
 - Color Transition Improvement (DCTI)
 - Dynamic Range expansion
 - Brightness, Saturation, Contrast, HUE
 - Dynamic 2D Peaking
 - 2D coring
 - 3D noise reduction
 - Scan Velocity Modulation (SVM)
 - 2D Nonlinear scaling
 - Primary Color Enhancement
 - Skin Tone Enhancement
 - Blue Stretch
 - **OSD**
 - Simple OSD generator to support component video inputs
 - **Host Interface and I/O**
 - Two-wire I²C interface
 - GPIO
 - **Quadruple 10bit DAC**
 - **Package and Technology**
 - 176-pin ETQFP 20*20mm
 - 0.18 micron, 3.3V / 1.8V technology
- Note: All packages are lead-free and RoHS compliant.

PINOUT DIAGRAM

PIN DIAGRAM FOR 176ETQFP



PIN DESCRIPTION

Table 1: Digital Video Input Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
PCLKIN	44	IPD	Digital input video clock
HSIN1	48	I	Digital input video H-sync Shared with Analog input video H-sync1
VSIN1	49	I	Digital input video V-sync Shared with Analog input video V-sync1
VG [7:0]	32~29, 26~23	IOPD	Video Green Input data. <ul style="list-style-type: none"> • G data for 24bit RGB mode. • Y data for 4:4:4 mode • YUV data for 8bit 4:2:2 YUV mode. • Y/G data for 24bit input Shared with digital video output data
VB [7:0]	22~21, 17~16, 13~10	IOPD	Video Blue Input data. <ul style="list-style-type: none"> • B data for 24bit RGB mode. • U data for 4:4:4 YUV mode. • UV data for 16bit 4:2:2 YUV mode. • U/B data for 24bit input. • Y data for 16bit input. Shared with digital video output data
VR [7:0]	43~40, 36~33	IOPD	Video Red Input data. <ul style="list-style-type: none"> • R data for 24bit RGB mode. • V data for 4:4:4 mode. • Y data for 16bit 4:2:2 mode. • V/R data for 24bit input • U/V data for 16bit input Shared with digital video output data
CLKOUT	5	IO	Display enable input from DVI/HDMI decoder Shared with video clock output & GPIO bit 7
HSOUT	1	IO	Input H-sync for digital input mode Shared with H-sync output
VSOUT	2	IO	Input V-sync for digital input mode Shared with V-sync output
HALF	85	IOPD	Half tone input Shared with GPIO bit 1

Table 2: Digital Video Output Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
CLKOUT	5	IO	Digital video display output clock Shared with display enable input & GPIO bit 7
HSOUT	1	IO	Digital video display output H-sync Shared with H-sync input for digital input mode
VSOUT	2	IO	Digital video display output V-sync Shared with V-sync output for digital input mode
VBOUT	9	IO	Display enable output in LCD application

			Shared with GPIO bit 6 and V-blank output
VG [7:0]	32~29, 26~23	IOPD	<ul style="list-style-type: none"> Y/G data for 24bit digital output. Shared with digital video input data
VB [7:0]	22~21, 17~16, 13~10	IOPD	<ul style="list-style-type: none"> UV data for 16bit digital output. R/V data for 24bit digital output. Shared with digital video input data
VR [7:0]	43~40, 36~33	IOPD	<ul style="list-style-type: none"> Y data for 16bit digital output. B/U data for 24bit digital output. Shared with digital video input data

Table 3: Analog Video input Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
HSIN1	48	I	Analog video input H-sync1 Shared with digital video input H-sync
VSIN1	49	I	Analog video input V-sync1 Shared with digital video input V-sync
HSIN2	50	I	Analog video input H-sync2
VSIN2	51	I	Analog video input V-sync2
SOG0	68	AI	Green input 0 for Sync-On-Green sync tip clamping
SOG1	71	AI	Green input 1 for Sync-On-Green sync tip clamping
R0	61	AI	Analog input for Red input channel 0
G0	69	AI	Analog input for Green input channel 0
B0	77	AI	Analog input for Blue input channel 0
R1	63	AI	Analog input for Red input channel 1
G1	72	AI	Analog input for Green input channel 1
B1	79	AI	Analog input for Blue input channel 1
R2	65	AI	Analog input for Red input channel 2
G2	74	AI	Analog input for Green input channel 2
B2	81	AI	Analog input for Blue input channel 2
REFBP	57	AI	Internal reference bypass
AVD_R	59, 60	AP	Analog power (3.3V)
AVS_R	62, 64	AG	Analog ground
AVD_G	66, 67	AP	Analog power (3.3V)
AVS_G	70, 73	AG	Analog ground
AVD_B	75, 76	AP	Analog power (3.3V)
AVS_B	78, 80, 82	AG	Analog ground
AVD_REF	56	AP	Analog power (3.3V)
AVS_REF	58	AG	Analog ground
AVD_PLL	52, 53	AP	Analog power (3.3V) for PLLAD
FILT	54	AI	Connection for External Filters components for PLLAD
AVS_PLL	55	AG	Analog ground for PLLAD

Table 4: Analog Video Output Interface Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
HSOUT	1	IO	Analog video display output H-sync Shared with H-sync input for digital input mode
VSOUT	2	IO	Analog video display output V-sync Shared with V-sync output for digital input mode
HBOUT	8	IO	Analog video display output H-Blank Shared with GPIO bit 5
VBOUT	9	IO	Analog video display output V-Blank Shared with GPIO bit 6 and DE output for digital video output
AGPb	174	AO	Analog Blue/Pb output
AGY	175	AO	Analog Green/Y output
AGPr	176	AO	Analog Red/Pr output
ASVM	170	AO	Analog SVM output
IREF	171	AI	Full-scale adjust resistor
DVSS	169	AG	Big current GND
DAVS	172	AG	Analog ground for DAC
DAVD	173	AP	Analog power for DAC

Table 5: Clock Generation Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
XTOUT	138	O	External crystal output.
XTIN	137	I	External crystal input.
PAVD	133	AP	Analog power (3.3V) for PLL648
PAVS	134	AG	Analog ground for PLL648

Table 6: System Interface Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
SCLSA	47	IOPU	Serial bus slave address selection, Shared with GPIO bit 2
SCLCK	45	I	Serial bus clock
SCLDA	46	IO	Serial bus data
RSTN	83	I	External asynchronous reset, low active
GPIO	84	IOPD	GPIO bit 0 Shared with Interrupt Output, low active

Table 7: SDRAM Interface Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
MD31	146	IOPD	Memory Data Bus [31:0]
MD30	148	IOPD	
MD29	152	IOPD	
MD28	154	IOPD	
MD27	160	IOPD	
MD26	162	IOPD	
MD25	166	IOPD	
MD24	168	IOPD	
MD23	167	IOPD	
MD22	165	IOPD	
MD21	161	IOPD	
MD20	155	IOPD	
MD19	153	IOPD	
MD18	151	IOPD	
MD17	147	IOPD	
MD16	145	IOPD	
MD15	87	IOPD	
MD14	89	IOPD	
MD13	94	IOPD	
MD12	96	IOPD	
MD11	98	IOPD	
MD10	104	IOPD	
MD9	103	IOPD	
MD8	106	IOPD	
MD7	105	IOPD	
MD6	100	IOPD	
MD5	99	IOPD	
MD4	97	IOPD	
MD3	95	IOPD	
MD2	93	IOPD	
MD1	88	IOPD	
MD0	86	IOPD	
DQM0#	107	O	Memory data qualify signal 0
DQM1#	144	O	Memory data qualify signal 1
MCLK	115	O	SDRAM clock
WE#	108	O	Write enable control for SDRAM
RAS#	118	O	Row address strobe
CAS#	109	O	Column address strobe
FBCLK	122	IOPD	Feed back clock for SDRAM Chip Selection 2 for 6MByte external memory
MBA	119	IOPD	SDRAM bank select Shared with GPIO bit 3

Pin Name	176ETQFP Pin #	Type	Pin Description
MCS1#	121	IOPD	Memory chip Selection 1, And shared with GPIO bit 4.
MCS0#	120	IOPD	Memory chip Selection 0
MA10	128	IOPD	Memory address bus [10:0]
MA9	123	IOPD	
MA8	126	IOPD	
MA7	127	IOPD	
MA6	129	IOPD	
MA5	131	IOPD	
MA4	141	IOPD	
MA3	143	IOPD	
MA2	142	IOPD	
MA1	132	IOPD	
MA0	130	IOPD	

Table 8: Digital Power and Ground Pins

Pin Name	176ETQFP Pin #	Type	Pin Description
VSS	20, 110, 158, 159	DG	Core Power GND
VDD	18, 19, 111, 112, 156, 157	DP	1.8V Core Power
PVDD	3, 4, 14, 27, 37, 38, 90, 91, 101, 113, 114, 124, 135, 136, 149, 163	DP	3.3V I/O Power
PVSS	6, 7, 15, 28, 39, 92, 102, 116, 117, 125, 139, 140, 150, 164	DG	I/O GND

Pin types include the following:

- I Digital Input
- IPD Digital Input with pull-down
- O Digital Output
- OPD Digital Output with pull-down
- IO Digital Bi-directional (input/output)
- IOPU Digital Bi-directional (input/output) with pull-up
- IOPD Digital Bi-directional (input/output) with pull-down
- AI Analog Input
- AO Analog Output
- DP Digital Power
- DG Digital Ground
- AP Analog Power
- AG Analog Ground

Table 9: Numerical Pin List

Pin Name	176ETQFP Pin #	Pin Name	176ETQFP Pin #	Pin Name	176ETQFP Pin #	Pin Name	176ETQFP Pin #
HSOUT	1	SCLCK	45	MD14	89	PAVD	133
VSOUT	2	SCLDA	46	PVDD	90	PAVS	134
PVDD	3	SCLSA	47		91	PVDD	135
PVDD	4	HSIN1	48	PVSS	92		136
CLKOUT	5	VSIN1	49	MD2	93	XTIN	137
PVSS	6	HSIN2	50	MD13	94	XTOUT	138
PVSS	7	VSIN2	51	MD3	95	PVSS	139
HBOUT	8	AVD_PLL	52	MD12	96	PVSS	140
VBOUT	9	AVD_PLL	53	MD4	97	MA4	141
VB0	10	FILT	54	MD11	98	MA2	142
VB1	11	AVS_PLL	55	MD5	99	MA3	143
VB2	12	AVD_REF	56	MD6	100	DQM1	144
VB3	13	REFBP	57	PVDD	101	MD16	145
PVDD	14	AVS_REF	58	PVSS	102	MD31	146
PVSS	15	AVD_R	59	MD9	103	MD17	147
VB4	16	AVD_R	60	MD10	104	MD30	148
VB5	17	R0	61	MD7	105	PVDD	149
VDD	18	AVS_R	62	MD8	106	PVSS	150
VDD	19	R1	63	DQM0	107	MD18	151
VSS	20	AVS_R	64	WE#	108	MD29	152
VB6	21	R2	65	CAS#	109	MD19	153
VB7	22	AVD_G	66	VSS	110	MD28	154
VG0	23	AVD_G	67	VDD	111	MD20	155
VG1	24	SOG0	68	VDD	112	VDD	156
VG2	25	G0	69	PVDD	113	VDD	157
VG3	26	AVS_G	70	PVDD	114	VSS	158
PVDD	27	SOG1	71	MCLK	115	VSS	159
PVSS	28	G1	72	PVSS	116	MD27	160
VG4	29	AVS_G	73	PVSS	117	MD21	161
VG5	30	G2	74	RAS#	118	MD26	162
VG6	31	AVD_B	75	MBA	119	PVDD	163
VG7	32	AVD_B	76	MCS0#	120	PVSS	164
VR0	33	B0	77	MCS1#	121	MD22	165
VR1	34	AVS_B	78	FBCLK	122	MD25	166
VR2	35	B1	79	MA9	123	MD23	167
VR3	36	AVS_B	80	PVDD	124	MD24	168
PVDD	37	B2	81	PVSS	125	DVSS	169
PVDD	38	AVS_B	82	MA8	126	ASVM	170
PVSS	39	RSTN	83	MA7	127	IREF	171
VR4	40	GPIO	84	MA10	128	DAVS	172
VR5	41	HALF	85	MA6	129	DAVD	173
VR6	42	MD0	86	MA0	130	AGPb	174
VR7	43	MD15	87	MA5	131	AGY	175
PCLKIN	44	MD1	88	MA1	132	AGPr	176

FUNCTIONAL DESCRIPTION

The TrueView 5735 TV Display Processor consists of a number of functional blocks which are described below.

ADC

The ADC can accommodate input signals with inputs ranging from 0.5V to 1.0V full scale. The full-scale range is set in three 8-bit registers (Red Gain, Green Gain, and Blue Gain).

The ADC offset control shifts the input source a DC level, there are three 7-bit registers (Red Offset, Green Offset, Blue Offset) available to independently control each channel. The offset controls provide a ± 63 LSB adjustment range. If the input range is 1.0V, the adjustable range is $\pm 0.25V$. Every step is 4mV ($0.25 / 63 = 0.004V$). If the input range is 0.5V, the adjustable range is $\pm 0.125V$. Every step is 2mV ($0.125 / 63 = 0.002V$).

The ADC has three input data channels, two SOG input channels and two separate H/V-sync input channels. It also generates an over-sampling clock from H-sync with a frequency range from lower than 10MHz up to 162Mhz.

INPUT FORMATTER

The Input Formatter accepts video data in several formats.

- 24-bit YCbCr or RGB
- 4:4:4 or 4:2:2
- 8 bit ITU-R BT.656
- 8 or 16 or 24 bit ITU-R BT.601
- NTSC or PAL
- 24 bit VGA (800*525@60Hz), SVGA, XGA and SXGA
- 1080i, 720p, 1080p, HD

The True View 5735 can automatically detect all supported monitor and TV modes including NTSC, PAL, VGA, SVGA, XGA, SXGA and HD modes and their supported refresh rate.

DE-INTERLACER

The TrueView5735 Motion Adaptive De-interlacer automatically determines the type of

incoming video content such as film, static interlaced or moving interlaced video. Different algorithms are applied for each content type. The de-interlacer produces a progressive scan video output. Noise which otherwise would be seen as motion can be removed during motion processing. It also uses an edge detection algorithm that enables the smoothing of jagged edges that could occur in the de-interlacing process. Several different detection angles can be programmed.

FILM MODE

The De-interlace Processor can detect video that has originated from film and detects 3:2 or 2:2 pull down. If film originated video is detected the two fields from the original frame are combined into one progressive frame.

Thirty frames per second interlaced video can be output as 60 or 72Hz progressive frames.

Twenty-five frames per second interlaced video can be output as 50 or 75Hz progressive frames, or 100Hz-interlaced fields.

The de-interlacer continuously monitors the incoming video to detect any changes to the pull-down sequence. If a change is detected the deinterlacer quickly adapts its de-interlacing algorithm to compensate.

3D TIME – SPACE CONVERTER

The 3D Time – Space converter is used to alter the size of the picture depending on the output resolution. It contains an Up-Down scaler and Rate converter.

VIDEO PROCESSING

The Video Enhancer is a high-quality programmable processor that brings out details and color in the video.

Output Formatter

The Output formatter formats the output to give the required levels for RGB or YPbPr. It contains a 2X interpolator to increase sharpness that results from a smaller aperture.

Transient Improvement

Digital Chroma Transient improvement (DCTI) improves video by replacing slower edges of the video with edges that have steeper rise and fall times. DCTI turns sloped or sinusoidal waveforms into rectangular or square waveforms with the same duty cycles and peak-to-peak amplitude. It improves the color transitions of vertical objects and reduces color smearing introduced by a video decoder.

Black & white Level Expansion

The black and white-level expander enhances the contrast of the picture. The luminance signal is modified with an adjustable, non-linear function. Dark areas of the picture are made blacker, while bright areas of the picture are made whiter.

2D Peaking

Especially if the input signals are decoded composite signals and a notch filter has been used for luminance/color separation, it is necessary to improve the luminance/color frequency characteristics. The TrueView5735 2D peaking process uses edge enhancement to improve the Y and C sharpness in the vertical and horizontal directions. For Y, there is 2D peaking and for UV, there is only vertical peaking.

Skin tone correction

Skin tone correction is used to alter skin color to make it look more natural.

Non-linear saturation

Non-linear saturation is used to enhance the saturation of some colors without affecting other colors. Both the Y and UV parameters of the range of colors to be enhanced are programmable.

Brightness and Contrast

Brightness and contrast can be programmed by adjusting the offset and gain of the video signal. Contrast is adjusted by multiplying the luminance by a constant. Brightness is adjusted by adding or subtracting a constant, from the luminance value.

Saturation

Saturation can be changed by changing the UV gain of the color signal

Hue

The Hue of the color can be changed by rotating the

UV vectors in either direction.

Background Noise Reduction

Background noise reduction is a process that uses a digital filtering algorithm on the digital image data to reduce the amount of random noise such as RF noise or comb filter artifacts in composite video sources etc. It is 3D motion adaptive and pixel based

Scan Velocity Modulation

The Scan Velocity Modulation (SVM) output is used to modulate the horizontal CRT scan timing. It has the effect of sharpening the transitions from dark to light and light to dark which results in a clearer sharper picture.

ANALOG AND DIGITAL OUTPUT

The Analog Display Port generates the analog RGB or YPbPr with triple Digital-to-Analog Converters (DACs). The DAC's have 10-bit quality. The analog RGB or YPbPr output is generated in synchronization with H and V timing signals. The 16-bit YCbCr digital output is ITU-R BT.601 compatible with a 1 X clock. The output comes from the 3D time-space converter block and is in 4:2:2 format.

MEMORY CONTROLLER

The internal Memory Controller supports the addressing and control of up to 8MB of external SDRAM. The external SDRAM memory buffer is used to store video fields and motion data. The Memory Controller also supports frame rate up-conversion with different input and output refresh rates.

PLL AND OSCILLATOR

The TrueView 5735 integrates a PLL to generate the MCLK to the Memory interface and the VCLK to the display. Only an external crystal is required to be connected between the XTIN and XTOUT pins. On power-up, the PLL is initialized to provide a 108 MHz MCLK and a 27 MHz VCLK when a 27MHz reference is used. Alternatively, the MCLK and VCLK can be driven directly by external clocks.

HOST BUS INTERFACE

Access to the TrueView 5735 registers is provided by an I²C 2-wire serial bus interface. The Interface

supports standard and fast modes, up to 400kbits/S. Only slave mode is supported in the TrueView 5735 TV Display Processor.

The slave address is hardware selectable.

Table 10: I²C Slave Addresses

TrueView 5735 I ² C slave addresses	
Read	Write
2F	2E
AF	AE

OSD

The TrueView 5735 OSD engine is a simple eight icon, hardware graphic engine. It consists of eight 13x13 hard-wired OSD ROM locations containing the most common TV OSD symbols. Brightness, contrast, hue, sound, up/down adjustment, left/right adjustment, horizontal size adjustment, and vertical size adjustment.

Figure 2: OSD Icons



One of eight foreground and background colors can be selected and they can be zoomed in the horizontal or vertical direction up to eight times horizontally and four times vertically.

CLOCK RECOVERY CIRCUITS

The clock recovery circuit generates the ADC sampling clock and its over-sampling clock up to 162Mhz. The hsync signal can also be recovered from the PLL even when the input clock reference is a composite sync signal. This is achieved by sending a COAST high signal to the PLL to disable the PLL from tracking the input reference and to maintain the PLL output clock frequency if the input reference is not a regular period hsync signal. FS, KS and ICP registers are used to optimize the PLL performance for each specific video format. The CKOS register is used to control the over-sampling ratio. The following table gives the possible over-sampling cases. The over sampling ratio is determined by the

relationship of the KS and CKOS register values.

Table 11: Over sampling ratio

KS	CKOS	OSR
00	00	1
01	00	2
	01	1
10	00	4
	01	2
	10	1

APPLICATION NOTES

ADC PIN CONNECTION

The analog RGB signals are connected to the TrueView5735 as shown below:

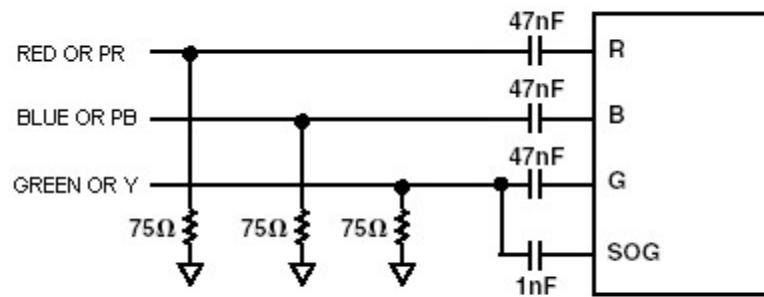


Figure 3: Example ADC Signal Connection

CRYSTAL PIN

1. EXTERNAL

XTIN and XTOUT are the input and output, respectively, of an inverting amplifier, which can be configured for use as an on-chip oscillator, as shown below. A 27 MHz crystal is preferred. In addition to an external crystal, the oscillator requires two external capacitors and an external feedback resistor.

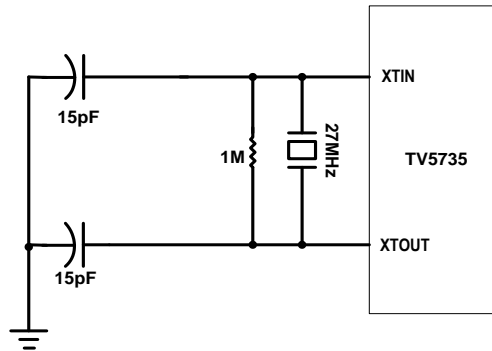


Figure 4: Crystal Connection Diagram

To drive the device from an external clock source, XTIN should be driven, while XTOUT floats, as shown below.

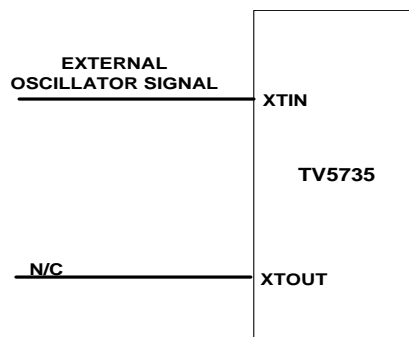


Figure 5: External Clock Drive Configuration

2. INTERNAL

C[2:0] are register bits, for changing the clock driver drive capability. The default value is 0 as shown below. SMT_EN_O is the register bit to select between a TTL or Schmitt trigger input buffer.

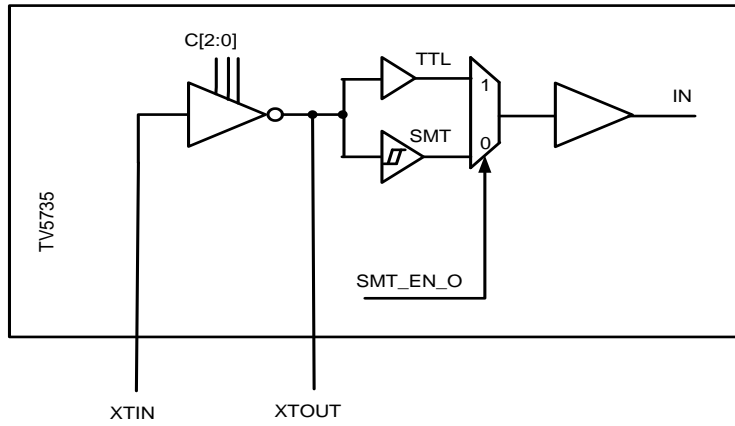


Figure 6: Internal Driver Configuration

VIDEO PORT USAGE

The TrueView 5735 has both analog and digital video input ports.

For analog input port:

- Three ADC input channels 0, 1, 2
- Two separate sync h/v or composite sync for ADC channels 0, 1, 2
- Two SOG inputs for ADC input channels 0, 1

For analog output port:

- One set of RGBS, H/V-sync, H/V-blank outputs
- It can output sync-on-Y YPbPr or sync-on-green RGB signal

For digital input port:

- One digital 24-bit input port
- 8-bit 601/656 YUV, 16-bit YUV, 24-bit YUV/RGB input
- De-in (display enable input) signal

For digital output port:

- Shared with 24-bit digital input port
- 16-bit YUV, 24-bit YUV/RGB.
- De-out (display enable output) signal
- H/V-sync and pixel clock
- H/V Blank <-----Note: H/V blank could be used for letter-box mode and pillar-box mode

The following pages show the port usage and corresponding register programming:

System Solution 1: Digital 24-bit YUV/RGB Input with Analog Output Mode

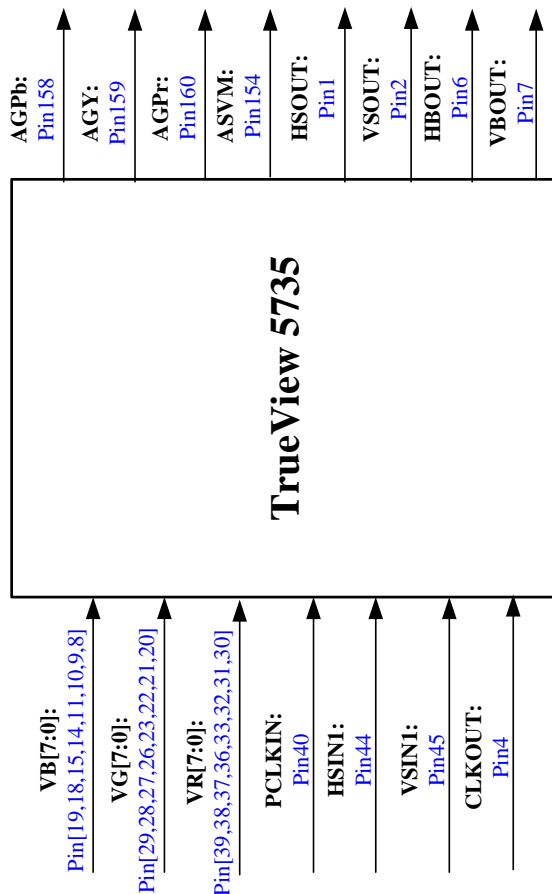


Figure 7: Digital 24-bit YUV/RGB Input with Analog Output Mode

5735 Key Register Setting		
Register Name	Address	Value
pad_bout_en	Reg_S0_48[0]	1'b0
pad_bin_enz	Reg_S0_48[1]	1'b
pad_rout_en	Reg_S0_48[2]	0'b
pad_rin_enz	Reg_S0_48[3]	0'b
pad_gout_en	Reg_S0_48[4]	0'b
pad_gin_enz	Reg_S0_48[5]	0'b
pad_ckout_enz	Reg_S0_49[1]	1'b
pad_sync_out_enz	Reg_S0_49[2]	0'b
pad_blk_out_enz	Reg_S0_49[3]	0'b
vds_do_16b_en	Reg_S3_50[7]	0
out_blank_sel_0	Reg_S0_50[0]	0
if_sel_adc_sync	Reg_S1_28[2]	1'b
if_sel_656	Reg_S1_00[3]	0
if_sel16bit	Reg_S1_00[4]	X
if_sel24bit	Reg_S1_01[7]	1'b

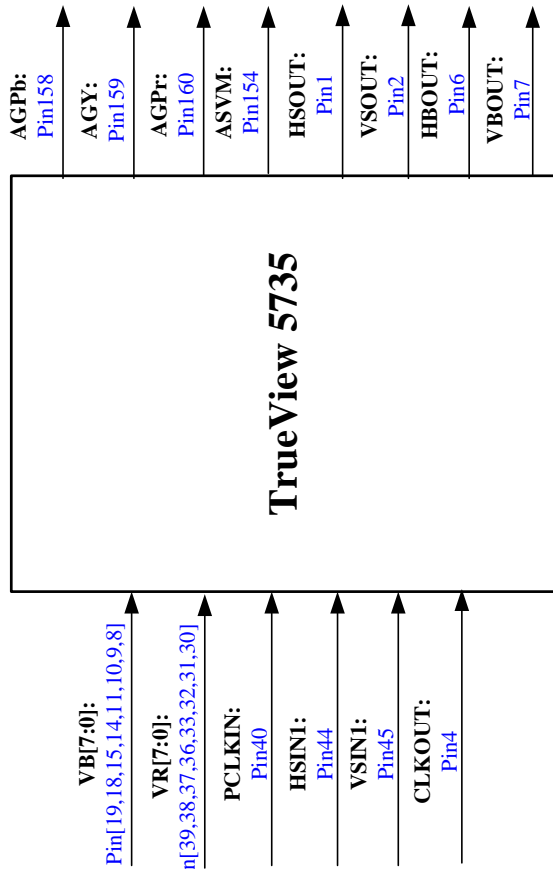
Note: "X" means either "0" or "1" is OK.

Input Pin	Description	Output Pin	Description
VB[7:0]	Digital Blue/U data input	AGPb	Analog Blue/Pb output
VG[7:0]	Digital Green/Y data input	AGY	Analog Green/Y output
VR[7:0]	Digital Red/V data input	AGPr	Analog Red/Pr output
PCLKIN	Pixel clock input	ASVM	Analog SVM output
HSIN1	Video H-sync input	HSOULT	Video H-sync output
VSIN1	Video V-sync input	VSOUT	Video V-sync output
CLKOUT	DE input from DVI/HDMI	HBOUT	Video H-blank output
		VBOUT	Video V-blank output

System Solution 2: Digital 16-bit YUV 4:2:2 Input with Analog Output Mode

5735 Key Register Setting		
Register Name	Address	Value
pad_bout_en	Reg_S0_48[0]	1'b0
pad_bin_enz	Reg_S0_48[1]	1'b
pad_rout_en	Reg_S0_48[2]	1'b
pad_rin_enz	Reg_S0_48[3]	1'b
pad_gout_en	Reg_S0_48[4]	X
pad_gin_enz	Reg_S0_48[5]	X
pad_ckout_enz	Reg_S0_49[1]	1'b
pad_sync_out_enz	Reg_S0_49[2]	1'b
pad_blk_out_enz	Reg_S0_49[3]	1'b
vds_do_16b_en	Reg_S3_50[7]	1'b
out_blank_sel_0	Reg_S0_50[0]	0
if_sel_adc_sync	Reg_S1_28[2]	1'b
if_sel_656	Reg_S1_00[3]	1'b
if_sel16bit	Reg_S1_00[4]	1'b1
if_sel24bit	Reg_S1_01[7]	1'b
		0

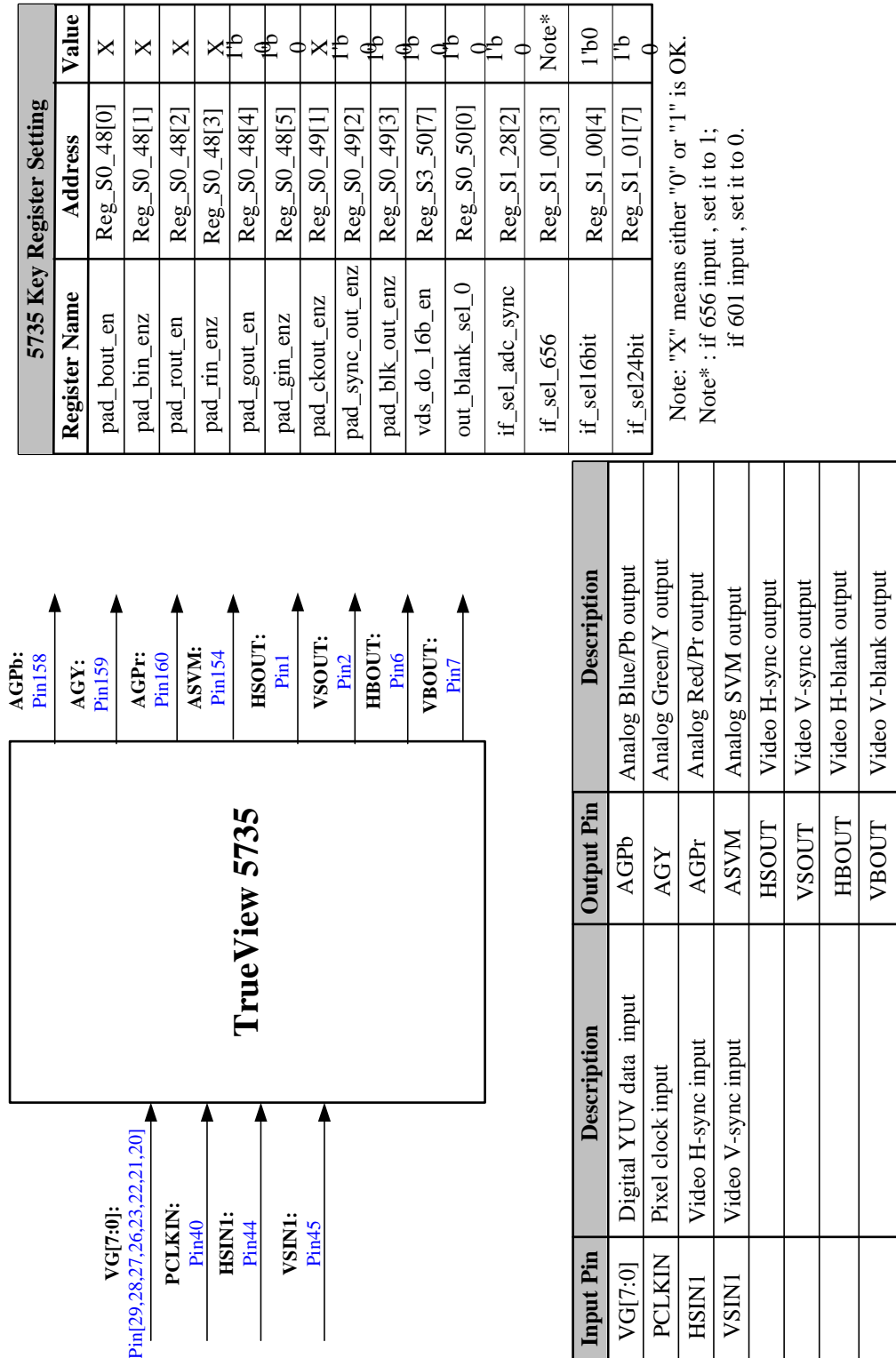
Note: "X" means either "0" or "1" is OK.



Input Pin	Description	Output Pin	Description
VB[7:0]	Digital UV data input	AGPb	Analog Blue/Pb output
VR[7:0]	Digital Y data input	AGY	Analog Green/Y output
PCLKIN	Pixel clock input	AGPr	Analog Red/Pr output
HSIN1	Video H-sync input	ASVM	Analog SVM output
VSIN1	Video V-sync input	HSOUT	Video H-sync output
CLKOUT	DE input from DVI/HDMI	VSOUT	Video V-sync output
		HBOUT	Video H-blank output
		VBOUT	Video V-blank output

Figure 9: Digital 8-bit 601/656 4:2:2 YUV Input with Analog Output Mode

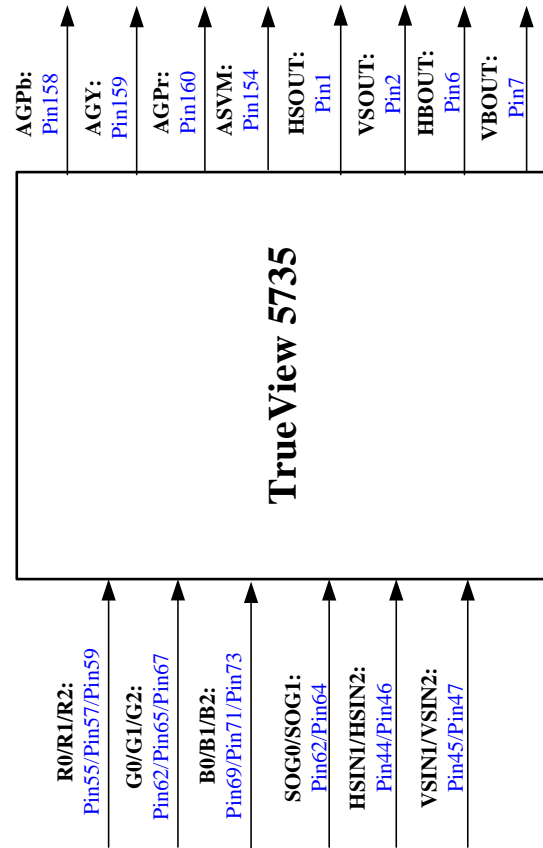
System Solution 3: Digital 8-bit 601/656 4:2:2 YUV Input with Analog Output Mode



5735 Key Register Setting		
Register Name	Address	Value
pad_bout_en	Reg_S0_48[0]	X
pad_bin_enz	Reg_S0_48[1]	X
pad_rout_en	Reg_S0_48[2]	X
pad_rin_enz	Reg_S0_48[3]	X
pad_gout_en	Reg_S0_48[4]	1'b
pad_gin_enz	Reg_S0_48[5]	0
pad_ckout_enz	Reg_S0_49[1]	X
pad_sync_out_enz	Reg_S0_49[2]	1'b
pad_blk_out_enz	Reg_S0_49[3]	0
vds_do_16b_en	Reg_S3_50[7]	0
out_blank_sel_0	Reg_S0_50[0]	0
if_sel_adc_sync	Reg_S1_28[2]	1'b
if_sel_656	Reg_S1_00[3]	Note*
if_sel16bit	Reg_S1_00[4]	1'b0
if_sel24bit	Reg_S1_01[7]	1'b

Note: "X" means either "0" or "1" is OK.
 Note*: if 656 input, set it to 1;
 if 601 input, set it to 0.

System Solution 4: Analog YUV/RGB Input with Analog Output Mode



5735 Key Register Setting		
Register Name	Address	Value
pad_bout_en	Reg_S0_48[0]	X
pad_bin_enz	Reg_S0_48[1]	X
pad_rout_en	Reg_S0_48[2]	X
pad_rin_enz	Reg_S0_48[3]	X
pad_gout_en	Reg_S0_48[4]	X
pad_gin_enz	Reg_S0_48[5]	X
pad_ckout_enz	Reg_S0_49[1]	X
pad_sync_out_enz	Reg_S0_49[2]	1'b
pad_blk_out_enz	Reg_S0_49[3]	1'b
vds_do_16b_en	Reg_S3_50[7]	0
out_blank_sel_0	Reg_S0_50[0]	0
if_sel_adc_sync	Reg_S1_28[2]	1'b
if_sel_656	Reg_S1_00[3]	1'b
if_sel16bit	Reg_S1_00[4]	X
if_sel24bit	Reg_S1_01[7]	1'b

Note: "X" means either "0" or "1" is OK.

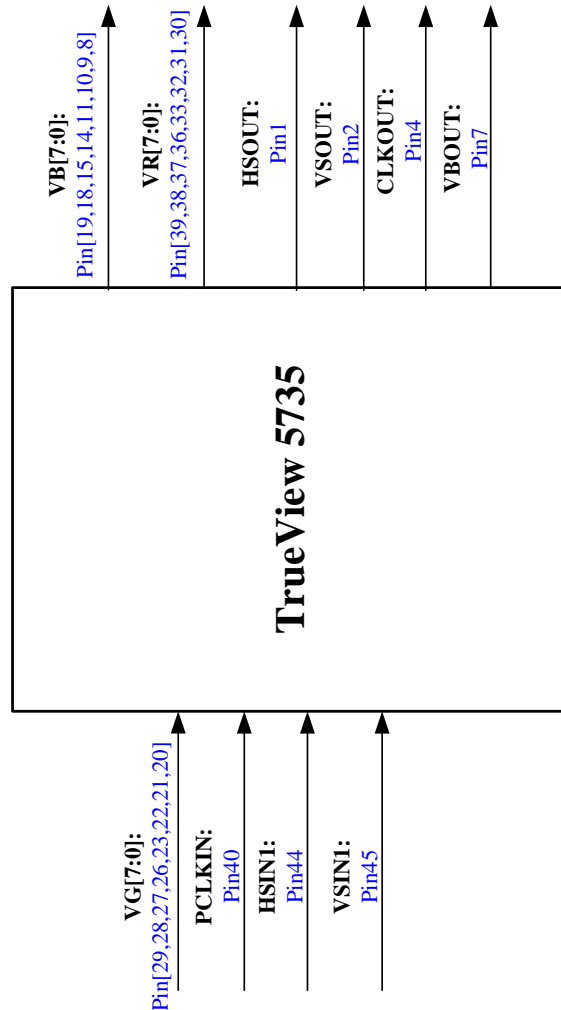
Input Pin	Description	Output Pin	Description
R0/R1/R2	Analog R/V input of CHN0/1/2	AGPb	Analog Blue/Pb output
G0/G1/G2	Analog G/Y input of CHN0/1/2	AGY	Analog Green/Y output
B0/B1/B2	Analog B/U input of CHN0/1/2	AGPr	Analog Red/Pr output
SOG0/SOG1	Analog SOG/Y input of CHN0/1	ASVM	Analog SVM output
HSIN1/HSIN2	Video H-sync input 1/2*	HSOUT	Video H-sync output
VSIN1/V SIN2	Video V-sync input 1/2**	VSOUT	Video V-sync output
		HBOUT	Video H-blank output
		VBOUT	Video V-blank output

Note*: HSIN1/V SIN1 and HSIN2/V SIN2 could be programmed for analog channel 0/1/2

System Solution 5: Digital 8-bit 601/656 4:2:2 YUV Input with 16bit Digital Output Mode

Figure 11: Digital 8-bit 601/656 4:2:2 YUV Input with 16bit Digital Output

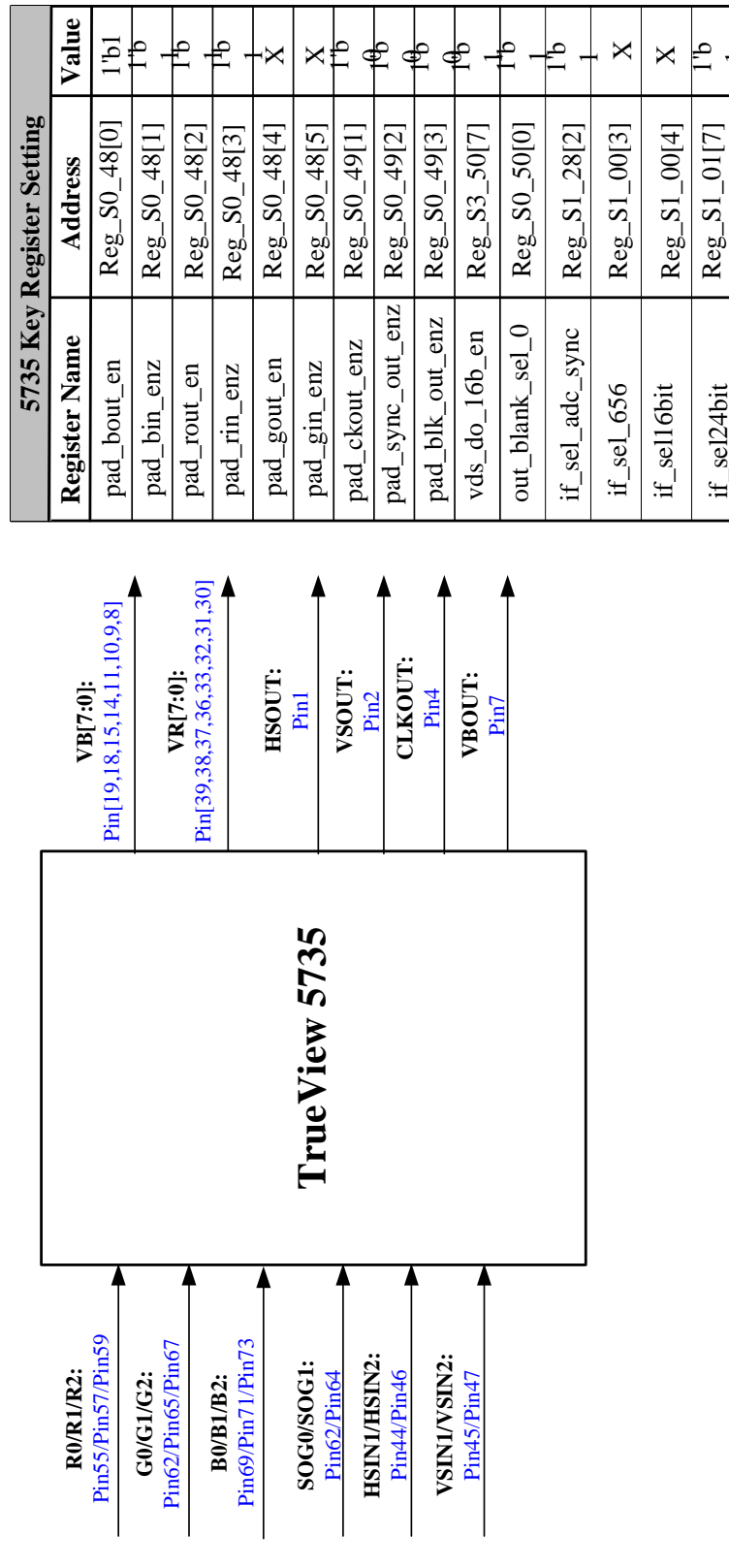
5735 Key Register Setting		
Register Name	Address	Value
pad_bout_en	Reg_S0_48[0]	1'b1
pad_bin_enz	Reg_S0_48[1]	1'b
pad_rout_en	Reg_S0_48[2]	1'b
pad_rin_enz	Reg_S0_48[3]	1'b
pad_gout_en	Reg_S0_48[4]	1'b
pad_gin_enz	Reg_S0_48[5]	0'b
pad_ckout_enz	Reg_S0_49[1]	0'b
pad_sync_out_enz	Reg_S0_49[2]	0'b
pad_blk_out_enz	Reg_S0_49[3]	0'b
vds_do_16b_en	Reg_S3_50[7]	0'b
out_blank_sel_0	Reg_S0_50[0]	1'b
if_sel_adc_sync	Reg_S1_28[2]	1'b
if_sel_656	Reg_S1_00[3]	0
if_sel16bit	Reg_S1_00[4]	1'b0
if_sel24bit	Reg_S1_01[7]	1'b
		0



Note: "X" means either "0" or "1" is OK.

Input Pin	Description	Output Pin	Description
VG[7:0]	Digital YUV data input	VB[7:0]	Digital UV data output
PCLKIN	Pixel clock input	VR[7:0]	Digital Y data output
HSINI	Video H-sync input	HSOUT	Video H-sync output
VSINI	Video V-sync input	VSOUT	Video V-sync output
		CLKOUT	Video display clock output
		VBOUT	Display enable output for LCD

System Solution 6: Analog RGB/YUV Input with 16bit Digital Output Mode



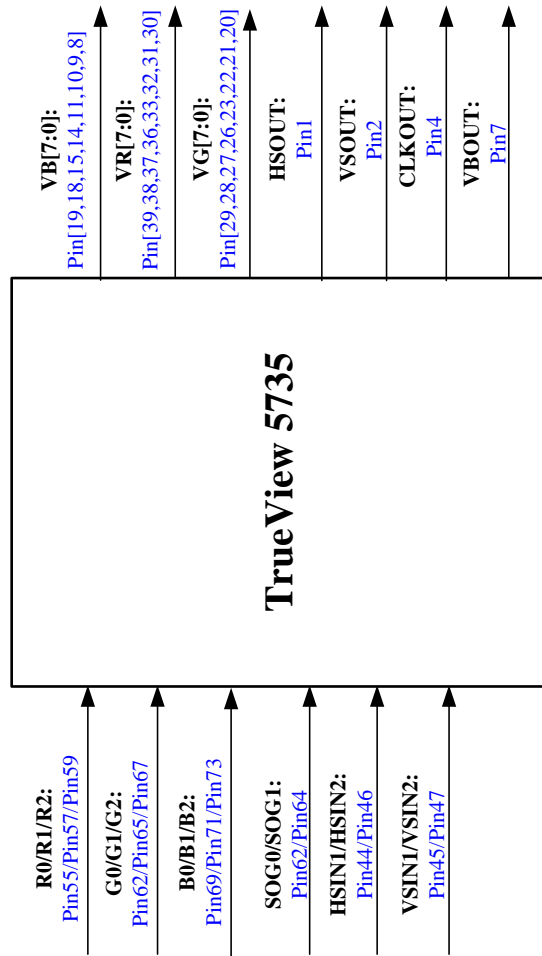
Note: "X" means either "0" or "1" is OK.

Input Pin	Description	Output Pin	Description
R0/R1/R2	Analog R/V input of CHN0/1/2	VB[7:0]	Digital UV data output
G0/G1/G2	Analog G/Y input of CHN0/1/2	VR[7:0]	Digital Y data output
B0/B1/B2	Analog B/U input of CHN0/1/2	HSOUT	Video H-sync output
SOG0/SOG1	Analog SOG/Y input of CHN1/2	VSOUT	Video V-sync output
HSIN1/HSIN2	Video H-sync input 1/2*	CLKOUT	Video display clock output
VSIN1/V SIN2	Video V-sync input 1/2*	VBOUT	Display enable output for LCD

Note*: HSIN1/V SIN1 and HSIN2/V SIN2 could be programmed for analog channel 0/1/2

Figure 13: Analog RGB/YUV Input with 24bit Digital Output Mode

System Solution 7: Analog RGB/YUV Input with 24bit Digital Output Mode



5735 Key Register Setting		
Register Name	Address	Value
pad_bout_en	Reg_S0_48[0]	1'b1
pad_bin_enz	Reg_S0_48[1]	1'b
pad_rout_en	Reg_S0_48[2]	1'b
pad_rin_enz	Reg_S0_48[3]	1'b
pad_gout_en	Reg_S0_48[4]	1'b
pad_gin_enz	Reg_S0_48[5]	1'b
pad_ckout_enz	Reg_S0_49[1]	1'b
pad_sync_out_enz	Reg_S0_49[2]	1'b
pad_blk_out_enz	Reg_S0_49[3]	1'b
vds_do_16b_en	Reg_S3_50[7]	1'b
out_blank_sel_0	Reg_S0_50[0]	1
if_sel_adc_sync	Reg_S1_28[2]	1'b
if_sel_656	Reg_S1_00[3]	1'b
if_sel16bit	Reg_S1_00[4]	X
if_sel24bit	Reg_S1_01[7]	1'b

Note: "X" means either "0" or "1" is OK.

Input Pin	Description	Output Pin	Description
R0/R1/R2	Analog R/V input of CHN0/1/2	VB[7:0]	Digital R/V data output
G0/G1/G2	Analog G/Y input of CHN0/1/2	VG[7:0]	Digital G/Y data output
B0/B1/B2	Analog B/U input of CHN0/1/2	VR[7:0]	Digital B/U data output
SOG0/SOG1	Analog SOG/Y input of CHN1/2	HSOUT	Video H-sync output
HSIN1/HSIN2	Video H-sync input 1/2*	VSOUT	Video V-sync output
VSIN1/VSIN2	Video V-sync input 1/2*	CLKOUT	Video display clock output
		VBOUT	Display enable output for LCD

Note*: HSIN1/VSIN1 and HSIN2/VSIN2 could be programmed for analog channel 0/1/2

BOARD MEMORY CONNECTION:

Figure 14: THREE 1MX16X2BANK MEMORY (1)

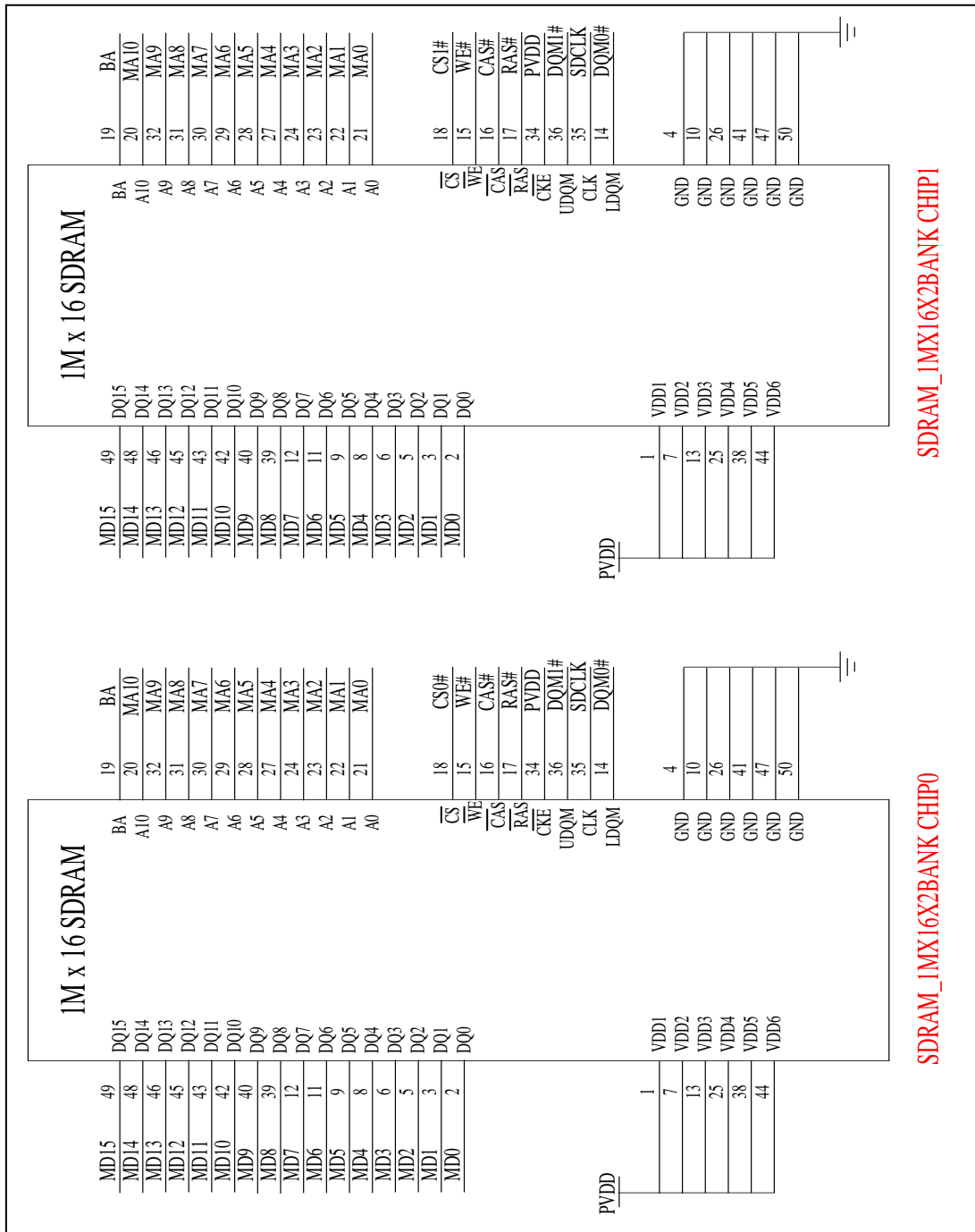


Figure 15: THREE 1MX16X2BANK MEMORY (2)

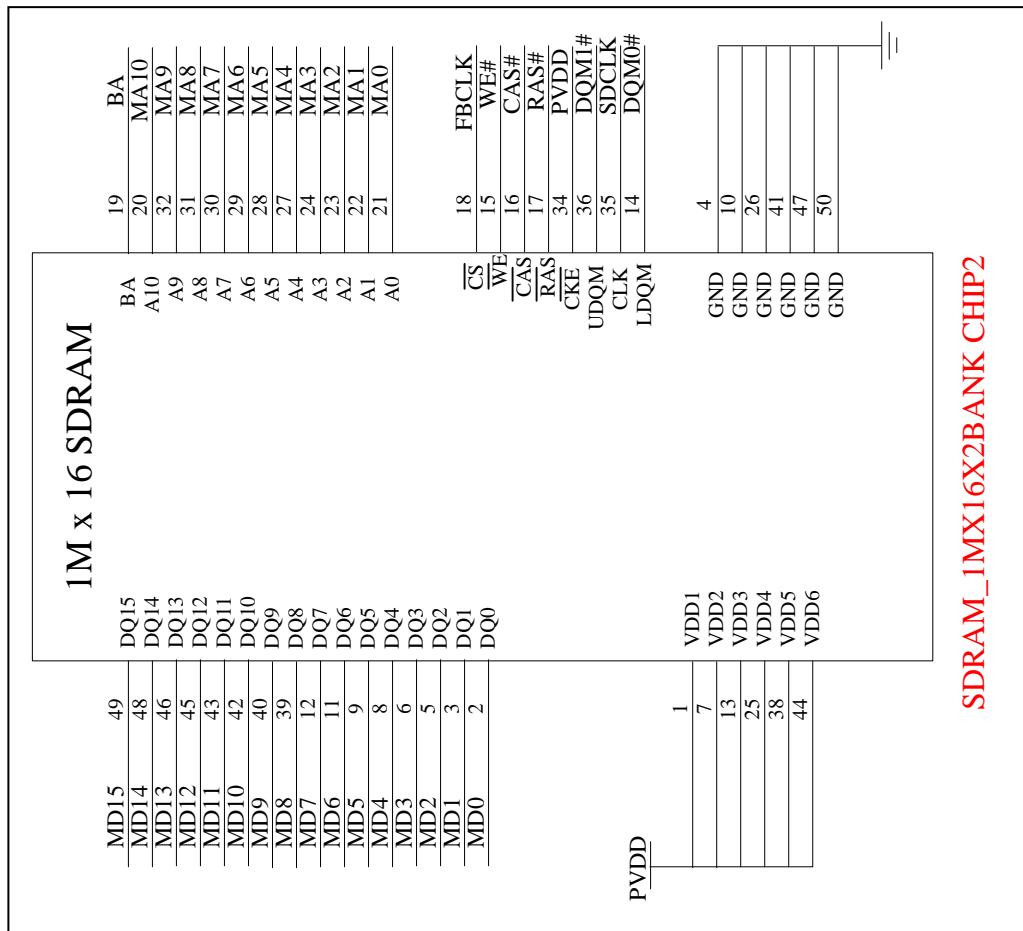


Figure 16: ONE 1MX16X4BANK MEMORY

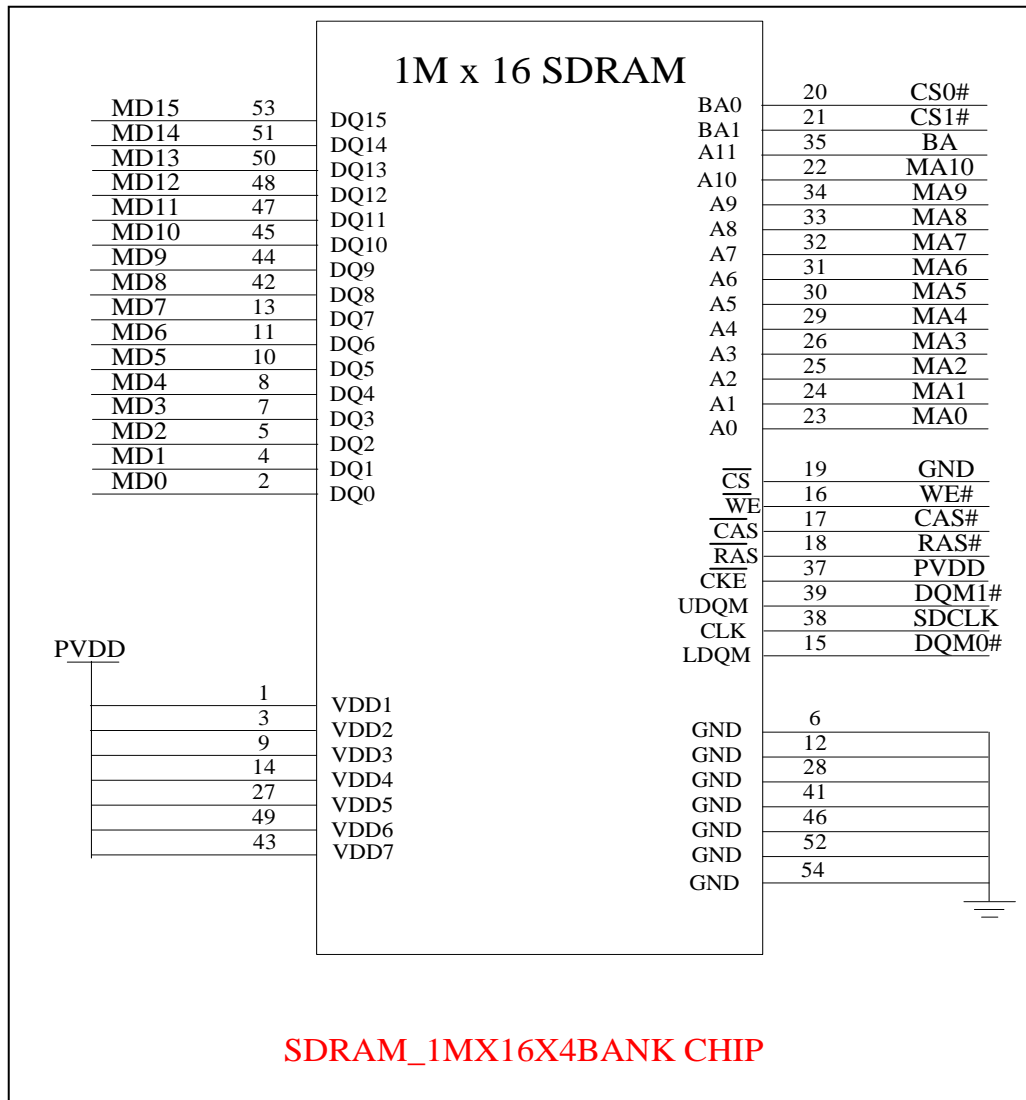
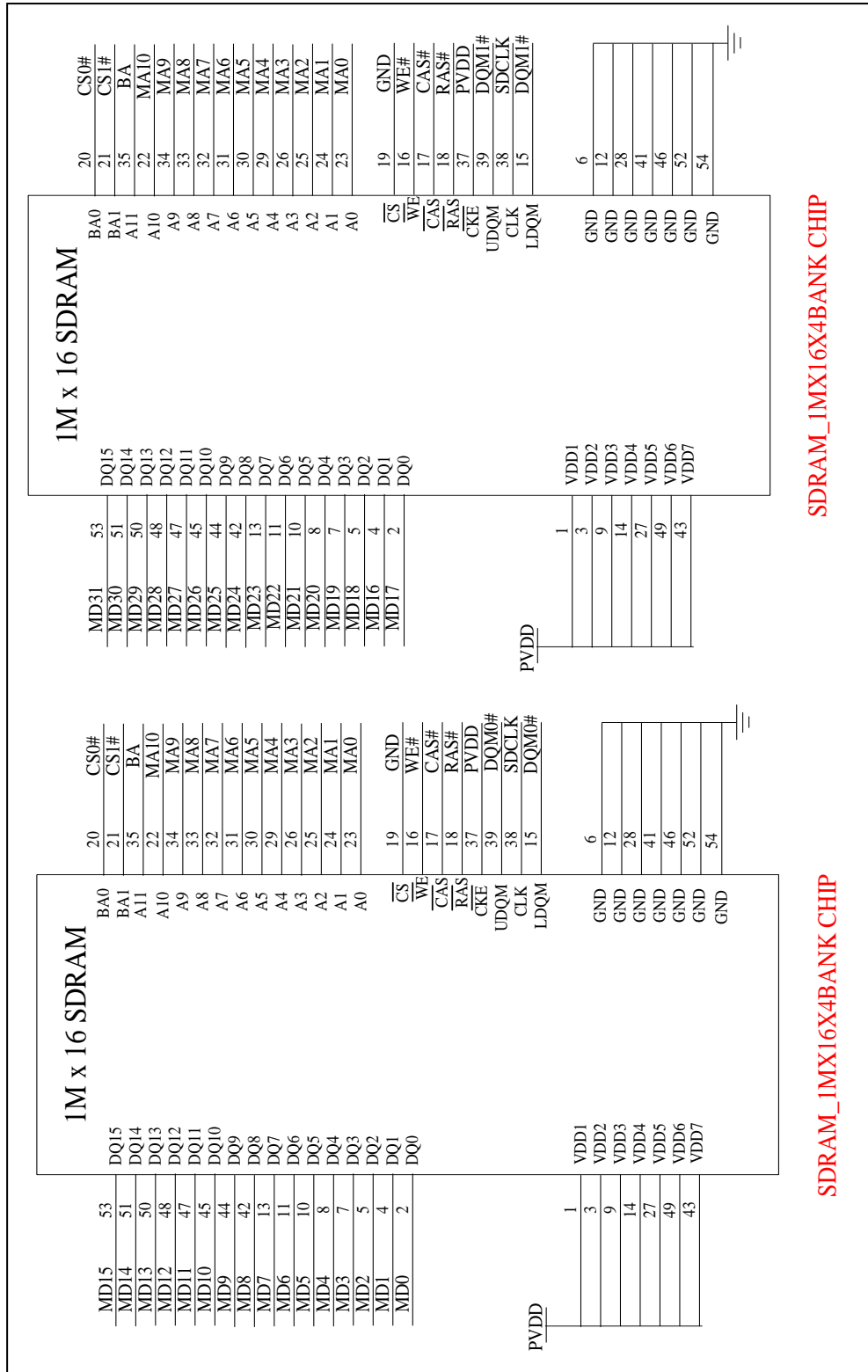


Figure 18: TWO 1MX16X4BANK MEMORY



SDRAM_1MX16X4BANK CHIP

SDRAM_1MX16X4BANK CHIP

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

Table 12: Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Conditions
3.3V Power Supply Voltage (Reference to Ground)	VDD ¹	- 0.3	4.0	V	
1.8V Power Supply Voltage (Reference to Ground)	VCC	- 0.3	2.2	V	
Voltage on any input	V _I	- 0.3	VDD+0.3	V	
Storage Temperature	T _S	- 40	125	°C	
Operating temperature	T _O	0	70	°C	

Warning: Stressing the device beyond the “Absolute maximum Ratings” may cause permanent damage.

Notes

¹: TV5735's 3.3V power supply : PVDD, DAVD, PAVD, AVD_PLL, AVD_REF, AVD_R, AVD_G, AVD_B.

DC CHARACTERISTICS

Table 13: DC Characteristics

Parameter	Symbol	Min	Typ	Max	Units	Comments
1.8V Power Supply Voltage (1.8V±5%)	VCC	1.71		1.89	V	1.8V Operation
3.3V Power Supply Voltage (3.3V±5%)	PVDD, DAVD, PAVD, AVD_PLL, AVD_REF, AVD_R, AVD_G, AVD_B	3.135		3.465	V	3.3V Operation
1.8V Supply Current ^{1.a} (VCC)	IVCC		320		mA	
3.3V Supply Current ^{1.a} (PVDD, PAVD, AVD_PLL)	IVDD33		100		mA	
3.3V Supply Current ^{1.b} (AVD_REF, AVD_R, AVD_G, AVD_B)	IAVD		240		mA	
3.3V Supply Current ^{1.c} (DAVD)	IDAVD		85		mA	
Input Low Voltage	VIL	0		0.8	V	
Input High Voltage	VIH	2.0		Vcc + 0.3	V	
Schmitt Input Low Voltage ²	VILS	0		1.0	V	
Schmitt Input High Voltage ²	VIHS	2.4		Vcc + 0.3	V	
Output Low Voltage	VOL			0.4	V	IOL = 8mA
Output High Voltage	VOH	2.4			V	IOH = -8mA
Input Capacitance	CIN		7		pF	
Output Capacitance	COUT		7		pF	

Notes

1. Current measured condition:

- a. @ HD 1080i, 74.25MHz input, SOG, 162MHz 32bit memory, 108MHz Display clock, VCC is 1.8V.
- b. @ UXGA 60Hz, power supply is 3.3V.
- c. For VESA Video Levels, the R_{ref} in the board is 160ohms. The output load is double terminated with 75ohms and 10pf per channel. Full-scale for all four channels is 0.7V, power supply is 3.3V. Measurement temperature is 25°C. This is a preliminary measurement and is subject to change by Tvvia, Inc.

2. Schmitt trigger PADS (Total: 41 Pads):

HSOUT, VSOUT
CLKOUT
HBOUT, VBOUT
VB[0:7]
VG[0:7]
VR[0:7]
PCLKIN
SCLSA
HSIN1, VSIN1, HSIN2, VSIN2
RSTN
GPIO
HALF
MBA
MCS1#
FBCLK

AC Characteristics

Figure 19: Video Input Port AC Timing

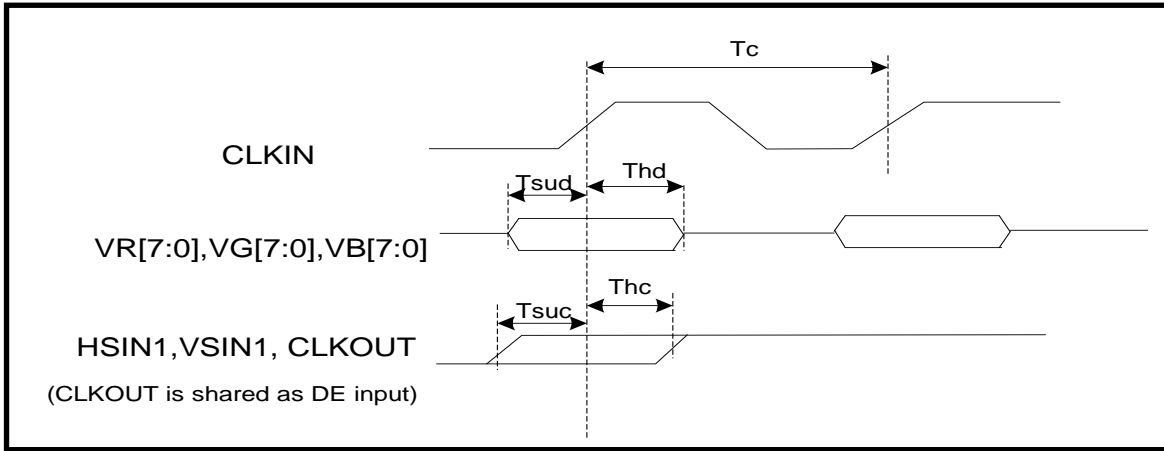


Table 14: Video Input Port AC Timing

Parameter	Symbol	Min	Typ	Max	Units	Conditions
VR[7:0], VG[7:0], VB[7:0] Setup Time to CLKIN	Tsud	2			ns	
VR[7:0], VG[7:0], VB[7:0] Hold Time to CLKIN	Thd	5			ns	
HSIN1, VSIN1, CLKOUT Setup Time to CLKIN	Tsuc	2			ns	
HSIN1, VSIN1, CLKOUT Hold Time to CLKIN	Thc	6			ns	
CLKIN Frequency	1/Tmc			80	MHz	

Figure 20: Video Output Port AC timing

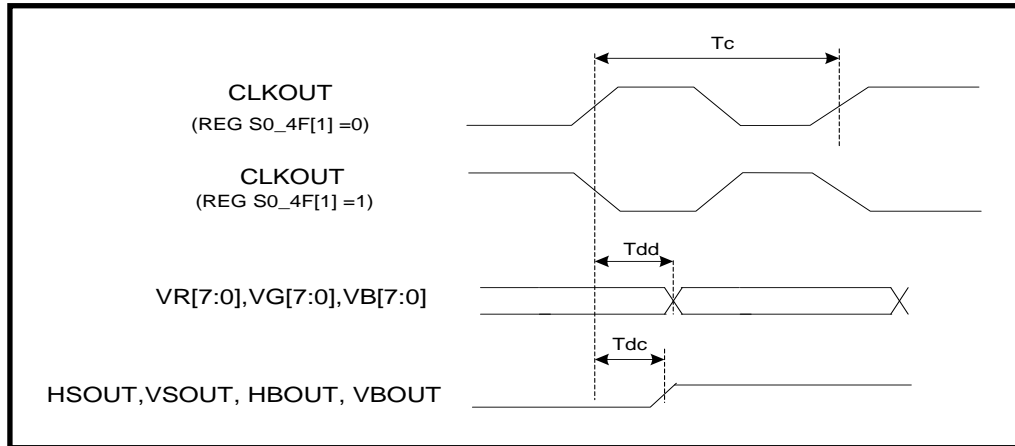


Table 15: Video Output Port AC timing

Parameter	Symbol	Min	Typ	Max	Units	Conditions
VR[7:0], VG[7:0], VB[7:0] Delay Timing from CLKOUT	Tdd	-1		1.5	ns	20pF load
HSOUT, VSOUT, HBOUT, VBOUT Delay Timing from CLKOUT	Tdc	-1		2.5	ns	20pF load
CLKOUT Frequency	1/Tmc			108	MHz	20pF load

MEMORY INTERFACE AC CHARACTERISTICS

Figure 21: Memory Interface AC Input timing

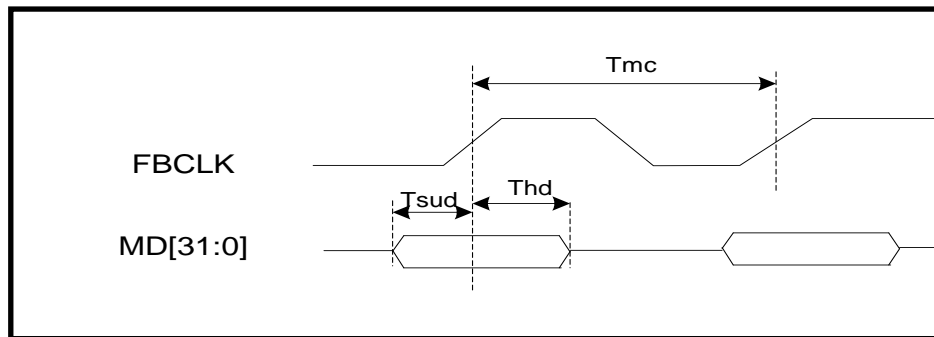


Table 16: Memory Interface AC Input timing

Parameter	Symbol	Min	Typ	Max	Units	Conditions
MD[31:0] Setup Time to FBCLK	T_{sud}	2.0			ns	
MD[31:0] Hold Time to FBCLK	T_{hd}	1.5			ns	
FBCLK Frequency	$1/T_{mc}$			162	MHz	

Figure 22: Memory Interface AC output timing

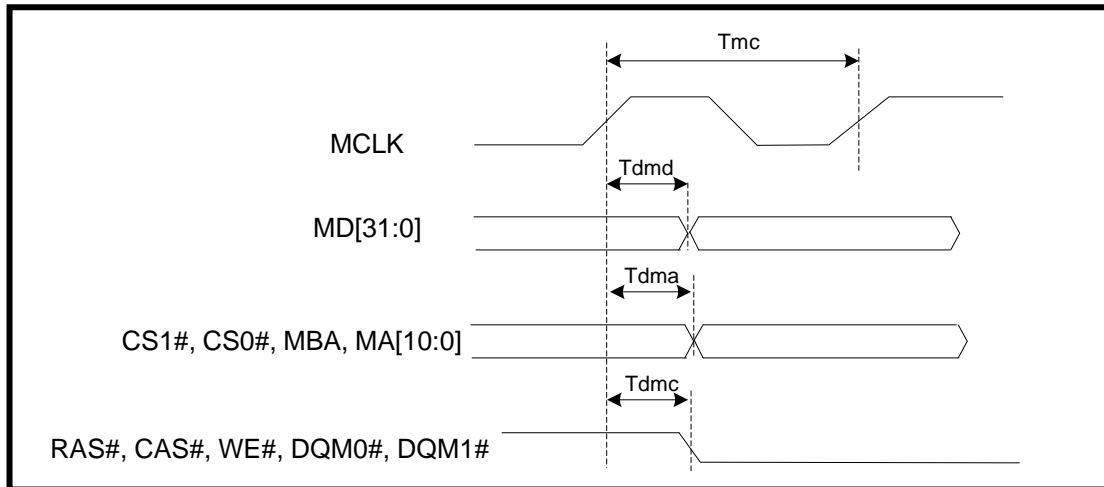
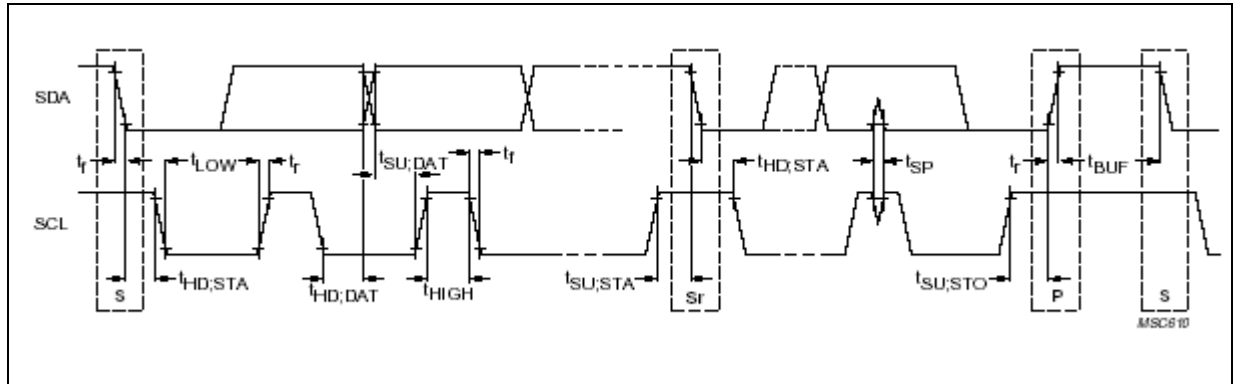


Table 17: Memory Interface AC output timing

Parameter	Symbol	Min	Typ	Max	Units	Conditions
MD[31:0] Delay Time from MCLK	Tdmd	3.7		5.4	ns	20pF load
CS1#, CS0#, MBA, MA[10:0] Delay Time from MCLK	Tdma	3.7		5.4	ns	20pF load
RAS#, CAS#, WE#, DQM0#, DQM1# Delay Time from MCLK	Tdmc	3.7		5.4	ns	20pF load
MCLK Frequency	1/Tmc			162	MHz	20pF load

Figure 23: Definition of timing for F/S-mode devices on the I²C-bus



* **Figure 7 Referenced document:**

Philips Semiconductors, "The I²C-BUS Specification, version 1.1---January 2000"

Page 33: Fig. 31: Definition of timing for F/S-mode devices on the I²C-bus.

Table 18: Characteristics of the SDA and SCL bus lines for F/S-mode I²C-bus devices

PARAMETER	SYMBOL	STANDARD-MODE		FAST-MODE		UNIT
		MIN.	MAX.	MIN.	MAX.	
SCL clock frequency	f _{SCL}	0	100	0	400	kHz
Hold time (repeated) START condition. After this period, the first clock pulse is generated	t _{HD;STA}	4.0	–	0.6	–	μs
LOW period of the SCL clock	t _{LOW}	4.7	–	1.3	–	μs
HIGH period of the SCL clock	t _{HIGH}	4.0	–	0.6	–	μs
Set-up time for a repeated START condition	t _{SU;STA}	4.7	–	0.6	–	μs
Data hold time: for CBUS compatible masters	t _{HD;DAT}					
for I ² C-bus devices		5.0 0 ⁽²⁾	– 3.45 ⁽³⁾	– 0 ⁽²⁾	– 0.9 ⁽³⁾	μs μs
Data set-up time	t _{SU;DAT}	250	–	100 ⁽⁴⁾	–	ns
Rise time of both SDA and SCL signals	t _r	–	1000	20 + 0.1C _b ⁽⁵⁾	300	ns
Fall time of both SDA and SCL signals	t _f	–	300	20 + 0.1C _b ⁽⁵⁾	300	ns
Set-up time for STOP condition	t _{SU;STO}	4.0	–	0.6	–	μs
Bus free time between a STOP and START condition	t _{BUF}	4.7	–	1.3	–	μs
Capacitive load for each bus line	C _b	–	400	–	400	pF
Noise margin at the LOW level for each connected device (including hysteresis)	V _{nL}	0.1V _{DD}	–	0.1V _{DD}	–	V
Noise margin at the HIGH level for each connected device (including hysteresis)	V _{nH}	0.2V _{DD}	–	0.2V _{DD}	–	V

Notes:

1. A device must internally provide a hold time of at least 300 ns for the SDA signal (referred to the V_{IHmin} of the SCL signal) to bridge the undefined region of the falling edge of SCL.
2. The maximum t_{HD;DAT} has only to be met if the device does not stretch the LOW period (t_{LOW}) of the SCL signal.
3. A Fast-mode I²C-bus device can be used in a Standard-mode I²C-bus system, but the requirement t_{SU;DAT} ≥ 250 ns must then be met. This will automatically be the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line t_{r max}+ t_{SU;DAT} = 1000 + 250 = 1250 ns (according to the Standard-mode I²C-bus specification) before the SCL line is released.
4. C_b = total capacitance of one bus line in pF.

*** Table 17 Referenced document:**

Philips Semiconductors, "The I²C-BUS Specification, version 1.1---January 2000"

Page 32: Table 5: Characteristics of the SDA and SCL bus lines for F/S-mode I²C-bus devices¹

DAC CHARACTERISTICS

Table 19: DAC Characteristics

Parameter	Min	Typical	Max	Unit	Notes
Resolutions			10	Bits	
Number of channels	4				
Clock Rate		162		MHz	
INL	-1.0		+1.0	LSB	
DNL	-1.0		+1.0	LSB	
Full Scale Voltage	665	700	770	mV	1, 2
LSB Current		18.2		uA	1
Monotonicity	Guaranteed				
RGB Video Output Rise Time (10-90% of full-scale)		2.6	4.7	ns	3
RGB Video Output Fall Time (10-90% of full-scale)		2.5	4.0	ns	3

NOTES:

1. For VESA Video Levels, the R_{ref} in the board is 160ohms. The output load is double terminated with 75ohms and 10pf per channel. Full-scale for all four channels is 0.7V.
2. For good linearity, the full-scale voltage should be less than 1V when the output load is 75ohms and 10pf per channel.
3. As measured with 37.5ohm and 10pf load.

ADC CHARACTERISTICS

Table 20: ADC Characteristics

Parameter	Min	Typical	Max	Unit	Notes
Resolutions			8	Bits	
Number of channels	3				
Sampling Frequency (Fs)	10		162	MHz	
Full Scale Adjust Range at RGB Inputs	0.5		1	V	1
Reference Voltage		1.24		V	2
INL		+/- 1.2		LSB	
DNL		+/- 0.8		LSB	
No Missing Codes	Guaranteed				

NOTES:

1. Operation with 8-bit gain controller and 7-bit offset controller.
2. Internal reference voltage output.

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