CX23880/CX23881/CX23882/CX23883
PCI Audio/Video Broadcast Decoder

Data Sheet

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Ordering Information

Model Number	Package	Operating Temperature
CX23880/CX23881/CX23882/CX23883	176-pin LQFP	0 to +70 ^{o}C

Revision History

Revision	Level	Date	Description
A	Preliminary	August 2002	Created

Related Documents

CX23490 HD Theater MPEG2 Decoder Data Sheet
CX22702 COFDM Demodulator Data Sheet
CX24110 QPSK Demodulator Data Sheet
CX24108 Satellite Tuner Data Sheet
CX25870/871 Flicker Filter Encoder Data Sheet

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CX23880/CX23881/CX23882/CX23883

PCI Audio/Video Broadcast Decoder

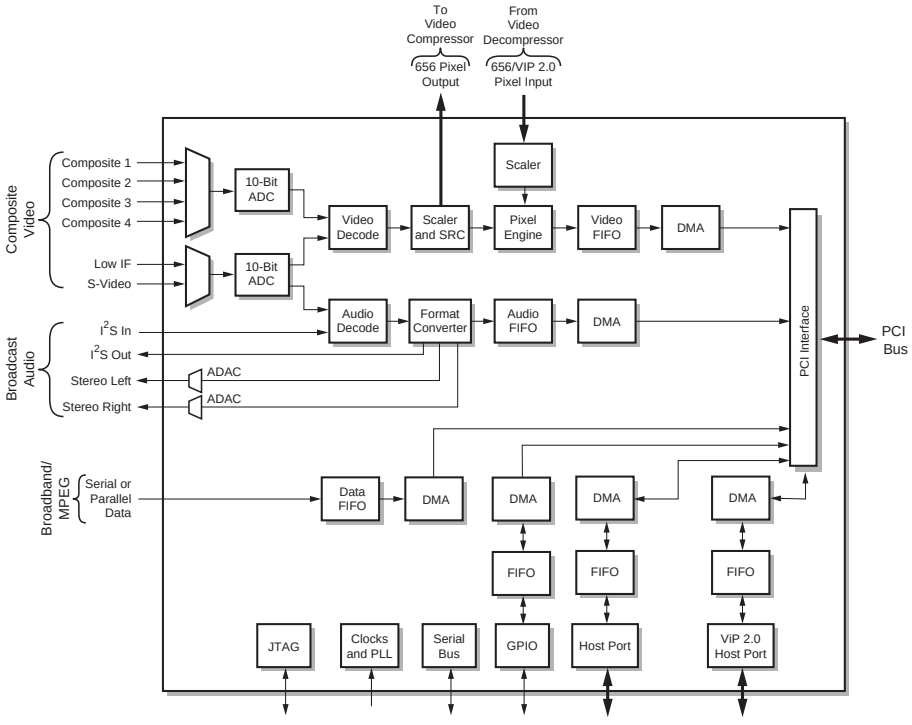
The CX23880/CX23881/CX23882/CX23883 decoders are a pin-compatible family of highly flexible single chip solutions that enable television, radio, DTV, and broadband data capture over the PCI bus.

The CX23880 family supports all analog broadcast video and audio formats used worldwide today. This enables audio/video capture, video display, and audio playback on the host PC, or storage and playback at a later time via software or hardware audio/video codecs.

The CX23880 family is fully compatible with Conexant's family of digital channel demodulators for capture of High and Standard Definition digital television streams and broadband data over terrestrial, satellite, or cable links.

The CX23880 family supports a variety of third-party peripheral connectivity options via its GPIO pins and CPU host port interface to enable board vendor-specific functionality and market place differentiation.

CX23880 Functional Block Diagram



CX23880 Distinguishing Features

Video Subsystem

- 10-bit video ADCs
- Global video standards that support [NTSC (M,J, 4.43), PAL (B, D, G, H, I, M, N, N-combination), SECAM (K, L)]
- Capture resolution up to 768x576 (Square Pixel PAL/SECAM)
- NTSC and PAL adaptive comb filter for 2-D Y/C luminance and chrominance separation
- AGC video circuit
- Multiple YCrCb and RGB pixel formats and YUV planar formats support on output
- Selectable pixel density: 8, 16, 24, and 32 bits per pixel
- Complex clipping of video source and VGA video overlay
- Allowance for different program control and color space/scaling for even and odd fields
- Support of Windows “Scatter/Gather” DMA
- High-quality multitap horizontal and vertical image scaler for decoded video or 4:2:2 sources
- ITU-R *BT.656* 8-bit or 10-bit 4:2:2 output port for MPEG II Encoder connection
- ITU-R *BT.656/VIP 2.0* pixel input port for MPEG II ML or HL Decoder connection
- Flexible VBI data capture for closed captioning, teletext, other analog broadcast data types
- Hue, Brightness, Contrast, Saturation control for video decoder

—Continued on the next page—

Distinguishing Features (continued)

Audio Subsystem

- Low IF sampling direct from tuner
- CX23880: GIobal broadcast audio support (BTSC-dbx, NICAM728, A2, System L, EIA-J, FM)
- CX23881: European broadcast audio support (NICAM, A2, FM)
- Decoded 48 kHz audio stream to PCI bus for real time encoding to MP3
- Integrated 90 dB SNR stereo audio DACs to drive sound card or headphones
- I^2S Input port for external source connectivity to on-board stereo DACs
- I^2S Output port to drive coaxial/optical digital audio interface
- Flexible audio sample rate converter

Multipurpose I/O Subsystem

- Bidirectional 33 MBps VIP 2.0 Host port. Compatible with the CX23490 All-Format MPEG 2 Decoder (CX23880 only)
- Bidirectional 10 MBps Intel/Motorola-compatible General Purpose Host port
- Unidirectional 10 MBps parallel/serial MPEG Transport/Data Stream port. Compatible with all Conexant digital television channel demodulator ICs.
- MPEG Packet Synchronization
- User-defined General Purpose Input/ Output pins

PCI Subsystem

- 5 independent functions each with Target/Master and Local register space (Video, Audio, MPEG Port, VIP 2.0 Host Port, GP Host Port)
- All RISC/Control programs executed on-chip
- On-chip SRAM for PCI data buffering Up/Down
- Vital product data
- DMA byte alignment
- PCI revision 2.2-compliant

Miscellaneous

- ACPI and power-down support
- Only one crystal for all video and audio decoding required
- 400 kHz serial bus master
- JTAG boundary scan interface
- Compact 176-pin TQFP
- Low power

Applications

- PC television
- PC theater
- Digital television
- Digital VCR
- Analog and digital video editing
- MP3 radio
- PCI cable modem
- PCI satellite modem
- Data broadcast receiver
- Media hub for home server

Contents

Figures

Tables

1 Product Overview

1.1 Functional Overview

The CX23880/CX23881/CX23882/CX23883 devices are a pin and software compatible family of mixed-signal monolithic integrated circuits, enabling a new platform for analog and digital broadcast video and audio in the PC. They are implemented as a multifunction PCI bus master and fabricated in an advanced CMOS process operating from +3.3 V I/P and 1.8 V (digital core) power supplies. PCI inputs are +5 V/3.3 V tolerant.

The CX23880 family is designed to be a higher quality, more flexible, and configurable successor to the previous generation Fusion 878A. The key differences between the Fusion 878A and the CX2388x family are summarized in Table 1-1.

The pin and software compatible nature of the CX2338x family enables a board vendor to build a wide variety of analog and digital TV capture products from a common code base.

The CX23880 and CX23882 are designed to enable high-functionality broadcast-centric PC cards that require high speed I/O capability. This capability is necessary to support simultaneous compressed and uncompressed digital video/audio data flows in conjunction with hardware MPEG II/MPEG IV encoders and decoders. The CX23382 has the same feature set as the CX23880, with the exception of BTSC stereo with dbx audio companding and VIP Host Port.

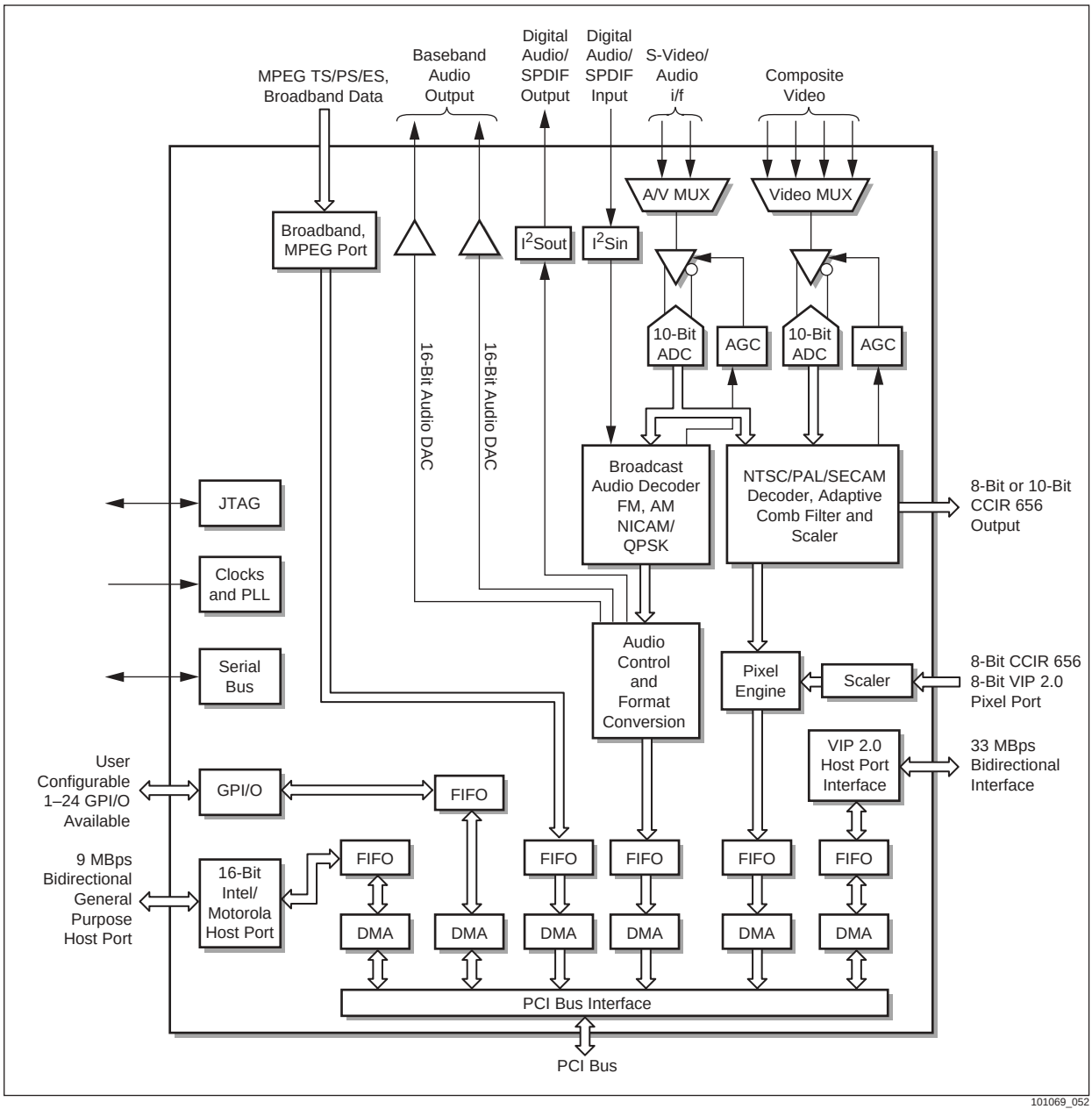
The CX23881 and CX23883 are designed to enable entry-level analog TV and stereo broadcast PC cards. Additionally, TV channel demodulators can be connected to enable software-based decoding of MPEG transport streams. The CX23881 has the same feature set as the CX23882, with the exception of BTSC stereo with dbx audio companding.

Table 1-1. Feature Comparison of CX2388x and Fusion 878A

Conexant PCI Decoder Standard Features	Fusion 878A	CX23881	CX23883	CX23882	CX23880
4-input CVBS ADC	X	X	X	X	X
Chroma ADC (S-Video)	X	X	X	X	X
NTSC/PAL/SECAM Video	X	X	X	X	X
Multiple YCrCb and RGB Formats	X	X	X	X	X
Notch and Comb Y/C Separation	X	X	X	X	X
Serial MPEG Input Port	X	X	X	X	X
I_2S Input Port	X	X	X	X	X
24-bit General Purpose I/O	X	X	X	X	X
Number of DMA Channels	2	7	11	7	11
WHQL Certification	X	X	X	X	X
CX2388x Family Standard Features	**Fusion 878A**	**CX23881**	**CX23883**	**CX23882**	**CX23880**
10-bit Video ADCs		X	X	X	X
Multi-Line 2D-Adaptive Comb Filter		X	X	X	X
High Speed Parallel MPEG Port		X	X	X	X
I^2S Output Port		X	X	X	X
Stereo Line Out DACs		X	X	X	X
EIAJ/NICAM/A2/FM Stereo Decode		X	X	X	X
CX2388x Family Speciality Functions	**Fusion 878A**	**CX23881**	**CX23883**	**CX23882**	**CX23880**
BTSC with dbx Stereo Decode			X		X
ITU-R 656 Output Port				X	X
ITU-R 656 Input Port				X	X
Intel/Motorola Host Port (I/O)				X	X
VIP 2.0 Host Master Port (I/O)					X

Figure 1-1 illustrates a block diagram of the CX23880.

Figure 1-1. CX23880 Detailed Block Diagram



1.2 Detailed Features

1.2.1 Analog Video Capture

1.2.1.1 Overview

The CX2388x integrates a 10-bit NTSC/PAL/SECAM composite and an S-Video decoder, image resizer/scaler, Direct Memory Access (DMA) controller, and Peripheral Component Interface (PCI) Bus master on a single device. The CX2388x can place video data directly into host memory for video capture applications and into a target video display frame buffer for video overlay applications. As a PCI initiator, the CX2388x can take control of the PCI bus as soon as it is available, thereby avoiding the need for onboard frame buffers. The CX2388x contains a pixel data First In, First Out (FIFO) to decouple the high-speed PCI bus from the continuous video data stream. The video data input can be scaled, color-translated, and burst-transferred to a target location on a field basis. This allows for simultaneous preview of one field, and capture of the other field. Alternatively, the CX2388x can capture or preview both fields simultaneously. The fields can be interlaced into memory or sent to separate field buffers.

1.2.1.2 Input Interface

Analog video signals are input to the CX2388x via a four-input multiplexer. The multiplexer can select between four composite source inputs, or between three composite and a single S-Video input source. When an S-Video source is input to the CX2388x, the luma component is fed through the input analog multiplexer, and the chroma component feeds directly into the C-input pin. An Automatic Gain Control (AGC) circuit enables the CX2388x to compensate for nonstandard amplitudes in the analog signal input.

1.2.1.3 Image Scaler

The CX2388x can reduce the video image size in both horizontal and vertical directions independently, using arbitrarily selected scaling ratios. The X and Y dimensions can be scaled down to one-sixteenth of the full resolution. Horizontal scaling is implemented with a six-tap interpolation filter, while up to five-tap interpolation is used for vertical scaling with a line store. The video image can be arbitrarily cropped by reducing the number of active scan lines and active horizontal pixels per line. The CX2388x supports a temporal decimation feature that reduces video bandwidth. This is accomplished by allowing frames or fields to be dropped from a video sequence at fixed but arbitrarily selected intervals.

1.2.1.4 Reduced Instruction Set Computer Engine

The CX2388x enables separate destinations for the odd and even video fields, each controlled by a pixel Reduced Instruction Set Comptuter (RISC) instruction list. This instruction list is created by the CX2388x device driver and can be run in the onboard memory or host memory. The instructions control the transfer of pixels to target memory locations on a byte resolution basis. Complex clipping can be accomplished by the instruction list, blocking the generation of PCI bus cycles for pixels that are not to be seen on the display.

The DMA channels can be programmed on a field basis to deliver the video data in packed or planar format. In packed mode, YCrCb data is stored in a single continuous block of memory. In planar mode, the YCrCb data is separated into three streams which are burst to different target memory blocks. Having the video data in planar format is useful for applications where the data compression is accomplished via software and the CPU.

1.2.1.5 UltraLock™

The CX2388x employs a proprietary technique known as UltraLock to lock to the incoming analog video signal. It always generates the required number of pixels per line from an analog source in which line length can vary by as much as a few microseconds. UltraLock's digital locking circuitry enables the CX2388x to lock onto video signals quickly and accurately, regardless of their source. Because the technique is completely digital, UltraLock can recognize unstable signals caused by VCR head switches or any other deviation and adapt the locking mechanism to accommodate the source. UltraLock uses nonlinear techniques that are difficult, if not impossible, to implement in genlock systems. And, unlike linear techniques, it adapts the locking mechanism automatically.

1.2.1.6 Vertical Blanking Interval (VBI) Data Capture

The CX2388x provides a flexible solution for capturing and decoding disparate VBI data types such as closed caption data, teletext, Vertical Internal Time and Control (VITC) codes, HTML data, or multicast data. The CX2388x can operate in a VBI Line Output mode, in which the VBI data is only captured during selected lines. This mode of operation enables concurrent capture of VBI lines containing ancillary data and normal video image data. In addition, the CX2388x supports a VBI Frame Output mode in which every line in the video frame is treated as if it were a VBI line. This mode of operation is designed for use with still-frame capture and processing applications where sophisticated image decoding can be performed in the software domain.

1.2.1.7 Macrovision Detector

With the advent of powerful Central Processing Units (CPUs) that enable software-based video compression, low-cost hardware MPEG encoders, cheap and rewritable storage media, and pervasive broadband communications, original content protection is paramount. To this end, the CX2388x fully implements Macrovision 7.01. When an end user attempts to connect a Digital Video Disk (DVD) player, a digital satellite/ cable decoder's composite, or S-Video outputs to the input of a CX2388x-based PCI card, the Macrovision pulses, signals are detected, and a bit is set. It is up to the board vendor to read the bit and determine what action will be taken.

1.2.2 Analog Audio Capture

The CX2388x captures and decodes all major terrestrial broadcast audio standards. The CX2388x digitizes and oversamples the low Intermediate Frequency (IF) signal from a Television (TV) tuner, and extracts and decodes the broadcast audio signal. The decoded audio is sample rate converted to a 48 kHz Pulse Code Modulation (PCM) stereo signal to simplify processing and interfacing. This 48 kHz stream can be routed to the built-in +85 dB Signal-to-Noise Ratio (SNR) stereo audio Digital-to-Analog Converters (DACs) for connection to the PC's sound card or headphones, to an external digital-audio interface, or to the PCI bus and host for direct capture by a software audio codec.

If capture of line-level stereo audio signals is required, an inexpensive audio Analog-to-Digital Converter (ADC) can be directly connected to the CX2388x's I^2S input port and controlled via the serial bus master.

1.2.3 ITU-R 656 4:2:2 Data Output

The CX23880/CX23882 provides a 27-MHz, 8- or 10-bit ITU-R 656 decoded video output interface to allow connection of a third-party MPEG II encoder or other type of video codec. This is useful when the host CPU is not powerful enough to perform such tasks in software, or when high-quality encoding must be achieved. Please contact Conexant Application Engineering for a list of supported third-party video compressors.

1.2.4 ITU-R 656/VIP 2.0 Pixel Data Input

The CX23880/CX23882 provides a 27-MHz, 8-bit ITU-R 656 decoded video input interface to allow a third-party MPEG II decoder or codec to send 4:2:2 data over the PCI bus to a target video display frame buffer for video overlay. Alternatively, 480-line progressive scan video from the CX23490 All-Format MPEG II decoder can be input to this port using Video Interface Port (VIP) 2.0-compliant pixel timing at up to 54 MHz.

1.2.5 MPEG Data Port

Channel demodulators used for digital television or broadband data applications over terrestrial, satellite, or cable networks can be directly connected to the CX2388x's MPEG data port to deliver transport streams to the host for subsequent storage to disk or software decode. Either parallel, common-interface Digital Video Broadcasting (DVB) or serial data paths from the channel demodulator can be supported at data transfer rates of up to 80 Mbps. If the Serial Interface mode is used, the remaining unused pins on this port can be allocated as General Purpose Input/Output (GPIO).

1.2.6 VIP 2.0 Host-Master Interface Port (CX23880)

The VIP 2.0 Host-Master interface allows the CX23880 to communicate with all devices that are compliant with the VIP slave specification. This implementation of a VIP 2.0 master is backward-compatible with all VIP 1.1-compliant slave interfaces. The CX23880 is designed to connect to the CX23490 All-Format MPEG II decoder via this interface.

The functionality of the VIP Host Master Interface is threefold. The first concept is to stream data from a VIP slave into host memory via the PCI bus. The second concept is to stream out data to a VIP slave that is sent over the PCI bus by the host. The third concept is for the host to be able to access register space on connected VIP slave devices.

1.2.7 General Purpose Host Interface Port (CX23880/CX23882)

The General Purpose Host interface allows the connection of moderate-to-relatively slow speed third party peripherals such as infrared remote control processors, codec host ports, smart card controllers, etc., to the CX23880/CX23882. This port allows simultaneous connection to two peripherals gluelessly, or as many as four peripherals with the use of external glue logic to provide the additional chip selects. This interface can have one upstream and one downstream DMA channel active to or from the external peripherals at any given time. Data bursting is not supported.

1.2.8 GPIO Port

The CX2388x provides up to 24 GPIO pins. These GPIO pins are shared with the following pins/ports groups so that the user can determine exactly which pins can be dedicated to specific functions versus general purpose I/O functions.

1. MPEG Parallel Data Port
2. ITU–R 656 4:2:2 Data Output
3. ITU–R 656 4:2:2 Data Input
4. Extended VIP Host Port
5. Extended General Purpose Host Port

1.2.9 Serial Bus Interface

The CX2388x's serial bus interface supports both 99.2 kHz timing transactions and 396.8 kHz, repeated start, multibyte sequential transactions. As a serial bus master, CX23880/CX23881 can program other devices on the video card, such as a TV tuner, as long as the device address is known. The CX2388x supports multibyte sequential reads (more than one transaction) and multibyte write transactions (greater than three transactions), which enable communication to devices that support auto-incremental internal addressing.

1.2.10 PCI Bus Interface

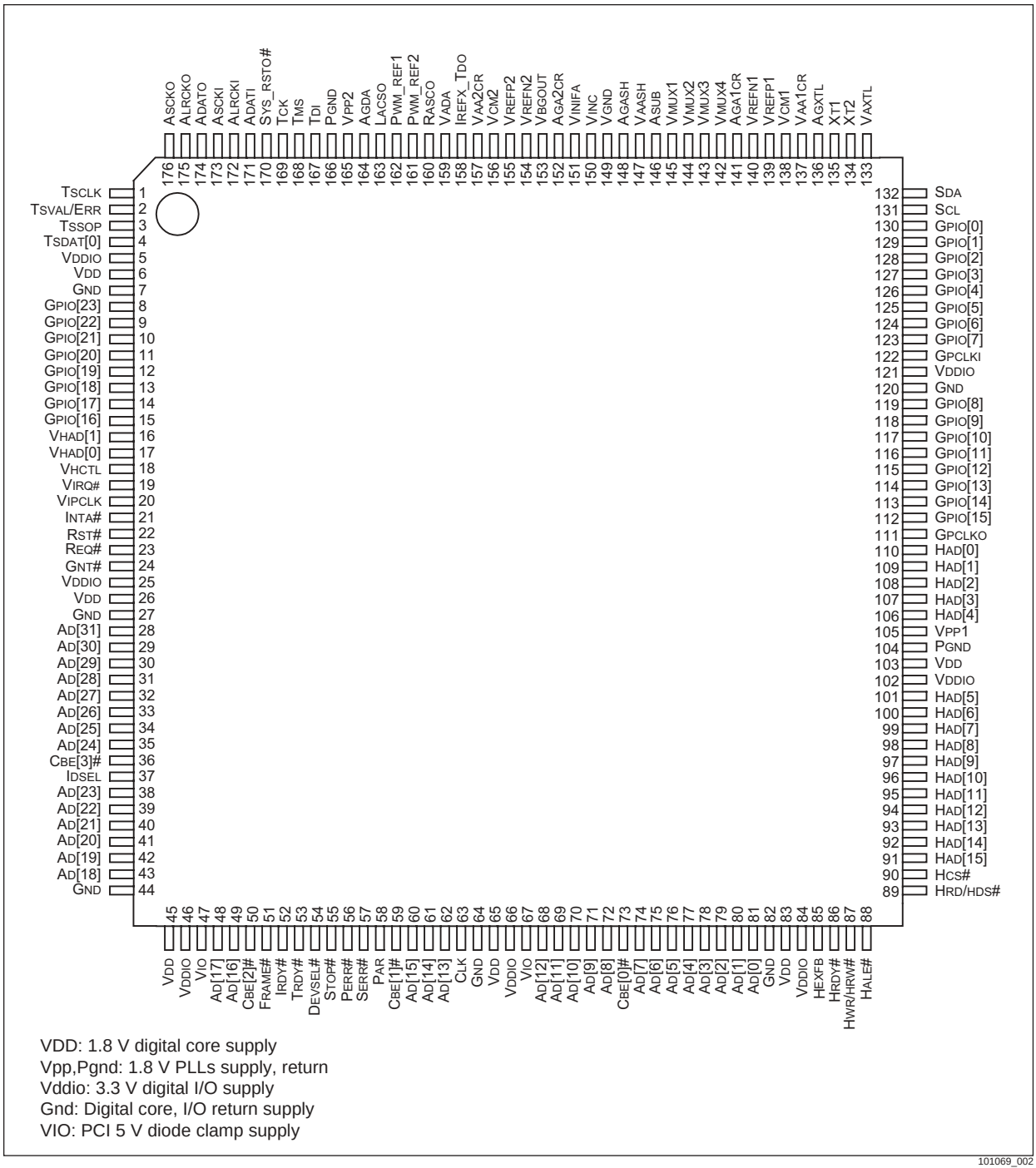
The CX2388x is designed to efficiently utilize the available 132 MBps PCI bus. The 32-bit dwords are output on the PCI bus with the appropriate image data under the control of the DMA channels. The video stream consumes bus bandwidth with average data rates varying from 44 MBps for full-size 768 × 576 PAL RGB32, to 4.6 MBps for NTSC CIF 320 × 240 RGB16, to 0.14 MBps for NTSC ICON 80 × 60 8-bit mode.

The pixel instruction stream for the DMA channels consumes a minimum of 0.1 MBps. The CX2388x provides the means for mitigating the bandwidth bottlenecks caused by slow targets and long bus access latencies that can occur in some system configurations. To overcome these system bottlenecks, the CX2388x gracefully degrades and recovers from FIFO overruns to the nearest pixel in real-time.

1.3 Pin Descriptions

Figure 1-2 displays the CX23880 Pinout diagram. Table 1-2 provides a description of pin functions grouped by common function.

Figure 1-2. CX23880 Pinout Diagram



VDD: 1.8 V digital core supply
Vpp,Pgnd: 1.8 V PLLs supply, return
Vddio: 3.3 V digital I/O supply
Gnd: Digital core, I/O return supply
VIO: PCI 5 V diode clamp supply

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Table 1-2. Pin Descriptions Grouped by Pin Function *(1 of 5)*

Pin Number	Pin Name	Dir	Type	Signal	Description
PCI Interface (50 Pins)					
63	CLK	I	—	Clock	All PCI signals except RST# and INTA# are sampled on the rising edge of this 33.3333 MHz clock.
22	RST#	I	—	Reset	Bus reset causes all PCI outputs to asynchronously three-state.
23	REQ#	O	t/s	Request	Agent requests bus
24	GNT#	I	—	Grant	Agent granted bus
37	IDSEL	I	—	Initialization Device Select	Selects device during configuration read and write transactions.
[28–35, 38–43, 48, 49, 60–62, 68–72, 74–81]	AD[31:0]	I/O	t/s	Address/Data	Address phase when FRAME# is 1st asserted, and data transfer when IRDY# and TRDY# are both asserted.
[36, 50, 59, 73]	CBE[3:0]#	I/O	t/s	Bus Command/ Byte Enables	Bus transaction-type command during address phase, and byte enables during entire data phase.
58	PAR	I/O	t/s	Parity	Even parity across {AD, C/BE#}, lags address/data phase
51	FRAME#	I/O	s/t/s	Cycle Frame	Asserted to begin bus transaction. Deasserted when transaction in final data phase.
52	IRDY#	I/O	s/t/s	Initiator Ready	Indicates the Initiator is ready to accept read data or has placed valid write data on the AD.
53	TRDY#	I/O	s/t/s	Target Ready	Indicates the Target is ready to accept write data or has presented valid data on AD during a read.
54	DEVSEL#	I/O	s/t/s	Device Select	Indicates the driving device has decoded the address as the target of the current access.
55	STOP#	I/O	s/t/s	Stop	Target requesting master to stop current transaction
56	PERR#	I/O	s/t/s	Parity Error	Report data parity error
57	SERR#	O	t/s	System Error	Report address parity or system error
21	INTA#	O	t/s	Interrupt A	Request an interrupt
JTAG Signals (4 Pins)					
169	TCK	I	—	Test Clock	Used to synchronize all JTAG test structures. Tie low when not using JTAG.

Table 1-2. Pin Descriptions Grouped by Pin Function *(2 of 5)*

Pin Number	Pin Name	Dir	Type	Signal	Description
168	TMS	I	r	Test Mode Select	Transitions drive JTAG state machine sequence. Tie high or leave floating when not using JTAG. A fixed sequence on this pin initializes the JTAG tap controller.
167	TDI	I	r	Test Data In	Load input instructions and/or test vector data for boundary scan and internal scan. Tie high or leave floating when not using JTAG.
158	IREFX—TDO	O		Test Data Out	Output for verifying JTAG serial operations. The output is 3-stated when not using JTAG port.
VIP 2.0 Host Master Signals (5 or 11 Pins)					
16, 17 8–15	VHAD[1:0](1) GPIO[23:16]	I/O	—	VIP Host Address/ Data	VIP Address and Data bus, defaults to VIP1.1 interface with 2 addr/data pins. Can be configured as VIP 2.0 with 8 addr/ data pins (GPIO).
18	VHCTL	I/O	—	VIP Host Control	VIP System Host control
19	VIRQ#	I/O	od	VIP Interrupt Request	VIP Interrupt Request (open drain)
20	VIPCLK	O	—	VIP Clock	VIP master output clock. This clock is buffered. PCI CLK = 33.3333 MHz
Transport Stream Signals (4 or 11 Pins)					
4	TSDAT[0](2)	I	—	Transport Stream Data	Transport Stream Input data bus. TSDAT[0] is used in serial mode.
3	TSSOP	I	—	Transport Stream Start of Packet	Transport Stream Start-of-Packet indicator. Indicates first byte in serial or parallel transport packet.
2	TSVAL/ERR	I	—	Transport Stream Error/Valid	Transport Stream Error or Valid indicator
1	TSCLK	I	—	Transport Stream Clock	Transport Stream input clock. All other transport stream inputs are sampled on the rising (falling) edge of TSCLK
Host Master Signals (22 Pins)					
[91–101, 106–110]	HAD[15:0]	I/O	—	General Purpose Host Address/Data	Bidirectional address/data access bus
90	HCS#	O	—	General Purpose Host Chip Select	External chip select
89	HRD#/ HDS#	O	—	General Purpose Host Read/Data Strobe	Either the active-low read signal or the programmable polarity data strobe signal

Table 1-2. Pin Descriptions Grouped by Pin Function *(3 of 5)*

Pin Number	Pin Name	Dir	Type	Signal	Description
88	HALE#	O	—	General Purpose Host Address Latch Enable	Address Latch Enable signal, used only in multiplexed 16-bit address/data mode
87	HWR/ HRW#	O	—	General Purpose Host Write/Read, not Write	Either the active-low write signal or the read/write bar
86	HRDY#	I	r	General Purpose Host Ready	External data transfer acknowledge signal
85	HEXFB	I	r	General Purpose Host External Status	Handshaking signal for use in DMA mode to indicate the status of the external source or destination FIFO.
GPIO/Serial Bus/Reset (29 Pins)					
[8–15, 112–119, 123–130]	GPIO[23:0]	I/O	I/O	General Purpose Input/Output	See GPIO Cross-Reference Table
122	GPCLKI	I	I	General Purpose Input Clock	Digital Video Input Reference clock
111	GPCLKO	O	O	General Purpose Output Clock	Digital Video Output Reference clock
132	SDA	I/O	od	Serial Data	Bit data or acknowledge
131	SCL	I/O	od	Serial Clock	Bit clock
170	SYS_RSTO#	O	t/s	System Reset Out	Logical PCI reset, soft reset, or power-on reset output. This is used to reset CX23880's peripheral under software control or with hard reset.
Digital Audio (6 Pins)					
171	ADATI	I	r	Audio Data In	Bit Serial Input data
172	ALRCKI	I	r	Audio Left/Right Clock In	Left/Right Framing Input clock
173	ASCKI	I	r	Audio Serial Clock Input	Bit Serial Input clock
174	ADATO	O	r	Audio Data Out	Bit Serial Output data
175	ALRCKO	O	r	Audio Left/Right Clock Out	Left/Right Framing Output clock
176	ASCKO	O	r	Audio Serial Clock Output	Bit Serial Output clock
Crystal Interface Signals (4 Pins)					
134	XT2	O	—	XT2	Crystal oscillator input pin
135	XT1	I	—	XT1	Crystal oscillator or clock oscillator input pin can be connected to XT1.

Table 1-2. Pin Descriptions Grouped by Pin Function *(4 of 5)*

Pin Number	Pin Name	Dir	Type	Signal	Description
133	VAXTL	—	—	PSUP_XTAL	XTAL and Sample and Hold digital power/ground. Nominal VA = 3.3 V
136	AGXTL	—	—	NSPU_XTAL	
ADC Interface (23 Pins)					
[145:142]	VMUX[1:4]	I	A	Video Mux {1:4}	Analog composite video inputs to the on-chip 4:1 analog multiplexer. Unused inputs should be tied to AGA1.
150 151	VINC VINIFA	I	A	Chroma baseband vid: Audio low IF	Analog chroma input to the C-A/D, multiplexed with Audio IF input from the tuner. Unused input should be tied to AGA2.
138 156	VCM1 VCM2	O	A	VCM_ADC{1:2}	Common mode voltage reference
140 154	VREFN1 VREFN2	O	A	VREFN{1:2}	Input Negative reference (1.0 V)—one for each Y and C/Aud ADCs, cap to AGA.
139 155	VREFP1 VREFP2	O	A	VREFP{1:2}	Input Positive reference (1.8 V)—one for each Y and C/Aud ADCs, cap to AGA.
153	VBGOUT	O	A	VBGOUT	Voltage reference 1.21 V nominal, cap to AGA
137, 157	VAA{1:2}CR	—	A	VAA{1:2}CR	A/D core power/ground. Nominal VA = 3.3 V
141, 152	AGA{1:2}CR	—	A	AGA{1:2}CR	
146	ASUB	—	—	ASUB	A/D core substrate (ground)
147	VAASH	—	—	PSUPA_SHA_ADC	A/D Sample and Hold Analog power/ ground. Nominal VA = 3.3 V
148	AGASH	—	—	NSUPA_SHA_ADC	
149	VGND	I	A/D	Virtual Ground	Single-end-to-differential converter input for common-mode noise rejection. Connect to analog ground via 3.3 µF series capacitor.
105, 165	VPP1/VPP2	—	—	VPP1, VPP2	PLL power supply. VD = 1.8 V
104, 166	PGND	—	—	PGND	PLL return supply
158	IREFX_TDO	I/O	A/D	IREF_EXT/TDO	Shared analog current ref pin JTAG TDO pin
Audio Output DAC Signals (6 Pins)					
159	VADA	—	—	VADA	DAC analog core power and ground. VA = 3.3 V
164	AGDA	—	—	AGDA	
163	LASCO	O	A	LASCO	DAC Pulse Width Modulator (PWM), left stereo audio output channel
160	RASCO	O	A	RASCO	DAC PWM, right stereo audio output channel
161	PWM_REF2	O	A	PWM_REF2	Audio DAC reference, right
162	PWM_REF1	O	A	PWM_REF1	Audio DAC reference, left

Table 1-2. Pin Descriptions Grouped by Pin Function *(5 of 5)*

Pin Number	Pin Name	Dir	Type	Signal	Description
I/O and Core Power and Ground (23 Pins)					
6, 26, 45, 65, 83, 103	VDD	—	—	VDD	Digital core power supply. Nominal VDD = 1.8 V
7, 27, 44, 64, 82, 120	GND	—	—	GND	Ground for digital core (GND)
5, 25, 46, 66, 84, 102, 121	VDDIO	—	—	VDDI and VDDO	Digital inputs/outputs power supply. VD = 3.3 V
47, 67	VIO	—	—	VIO	+5 V reference for 5 V-tolerant PCI input buffers

Note(s):
(1) VHAD[1:0] is the default for the 5-pin VIP Host Port setting.
(2) TSDAT[0] is the default for the 4-pin serial MPEG Data Port setting. The 11-pin setting shares GPIO pins.
3. Type: r active resistive pull-up
od open-drain
t/s three-state
s/t/s sustained three-state
[x:y] Bus
{u:v} Array of signal ports—expand to number without braces.
4. All signal I/O are LVTTL compatible (3.3 V operation with 3.9 V tolerance), except for the PCI signals which are all 5.5 V tolerant.
5. All inputs are Schmitt unless otherwise noted. The PCI inputs do not have hysteresis.
6. All outputs have drive capability I_{OL} = 4 mA unless otherwise noted.

2 Functional Description

2.1 Audio Decoder

This section of the data sheet describes the functionality of the analog broadcast audio decoder in logical sequence from the audio input at the analog front end, to the output of digital audio samples to the PCI bus or to the on-board stereo DACs.

2.1.1 Overview

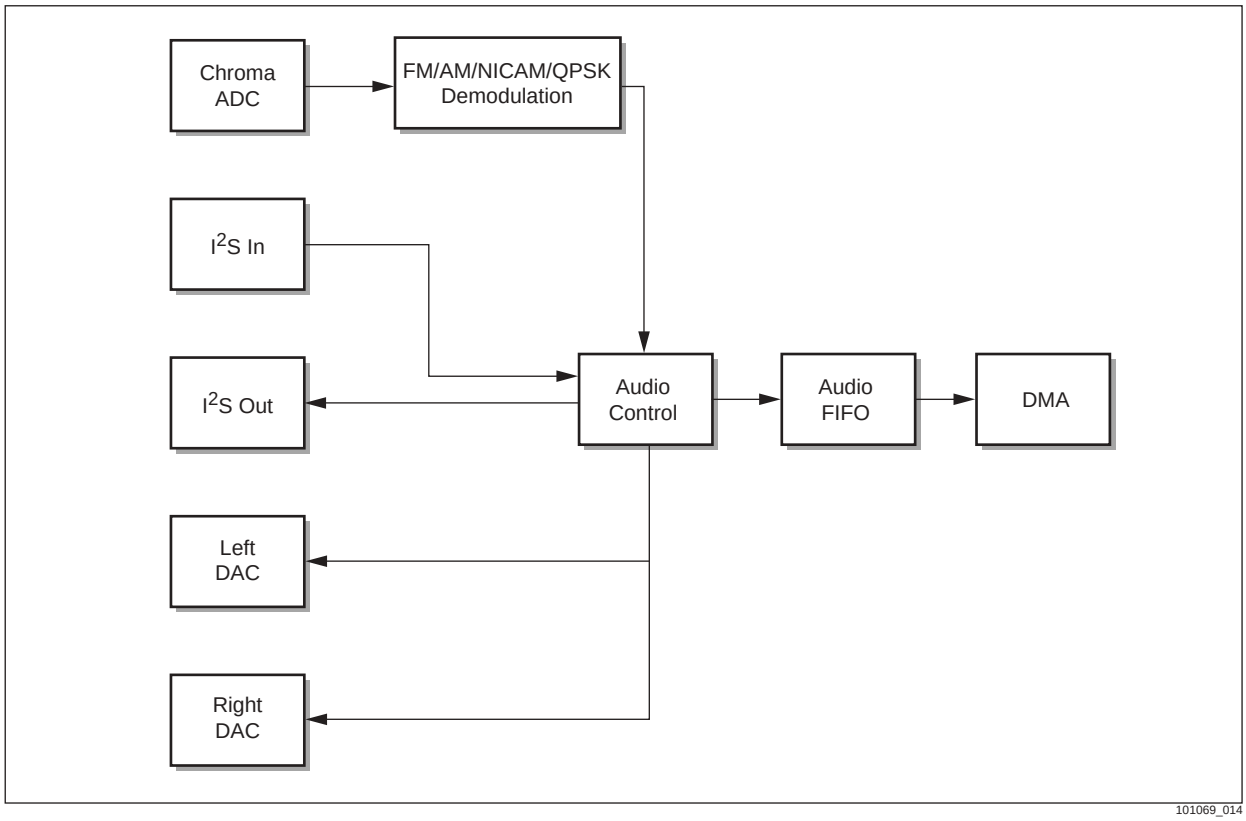
The CX2388x's audio subsystem provides hardware-based demodulation for all major terrestrial broadcast audio standards used world-wide.

Decoded broadcast audio can be output directly to the on-board stereo DACs for connection to the PC's sound card, to I^2S for high-fidelity digital coaxial and optical interfaces, or to the host via the PCI bus for software-based playback or encoding.

The major functional blocks of the audio subsystem are illustrated in Figure 2-1 and are broken down into the following sections:

- Analog Front End (AFE) and Chroma-ADC (C-ADC)
- Multistandard audio demodulator
- Broadcast audio standard selection
- Audio PLL initialization
- Input Source Select
- Dematrix Control
- Audio control and Sample Rate Converter
- I^2S input and output
- Audio DACs

Figure 2-1. Simplified Block Diagram of CX2388x Audio Subsystem



2.1.2 Analog Front End (AFE) and Chroma-ADC (C-ADC)

The CX2388x has a dedicated input pin, VINIFA (pin 151), that is used as the input to the C-ADC for sampling low-IF audio signals from a television/FM tuner. This pin is multiplexed with input pin VINC (pin 150) for access to the C-ADC.

Recognizing that broadcast video sources are composite video only, the 10-bit C-ADC is shared between the low-IF broadcast audio signal and the chroma portion of a baseband S-Video signal (Y, C). As broadcast video and S-Video are mutually exclusive, the CX2388x takes advantage of this fact to utilize the C-ADC to capture broadcast audio signals.

See Table 2-1 for the CX2388x ADC assignments.

Table 2-1. ADC Assignments

Application	ADC 1/-1	ADC 2/C
Capture composite video from a video camcorder	Composite signal digitization	—
Capture S-Video from a video camcorder	Y-signal digitization	C-signal digitization
Capture composite video and broadcast audio from a TV tuner	Composite signal digitization	Low IF signal digitization

To enable the C-ADC for broadcast audio sources, the CX2388x must be programmed appropriately for composite/broadcast audio sources versus S-Video sources. Bit [0] of the AFE_CFG_IO register (location 24'h35C04C) is used to configure the C-ADC for either a broadcast audio signal or a chroma video signal.

24'h35C04C—AFE_CFG_IO Register

Bits	Type	Default	Name	Description
[0]	RW	1'b0	V_A_Mode	0 = selects audio mode 1 = selects video mode

See Chapter 3 for details of the external circuit required to connect the audio output of a television/FM tuner to the CX2388x.

2.1.2.1 Selecting Optional Gain Stage

The low-IF audio signal from a television/FM tuner is nominally 120 mV_{RMS} amplitude. For best performance, the C-ADC, when configured to capture broadcast audio, expects a 1.0 V_{RMS} input signal.

For nominal low-IF audio signals, an optional +12 dB gain stage should be enabled to provide optimal signal amplitude to the C-ADC for maximum ADC performance.

24'h320628—AFE_12DB_EN Register

Bits	Type	Default	Name	Description
[0]	RW	1'b0	AFE_12DB_EN	Enable +12 dB gain at AFE
[15:1]	RO	15'h0000	—	Reserved

2.1.3 Multistandard Audio Demodulator

The CX23880 supports the broadcast audio standards listed in Table 2-2.

Table 2-2. Supported Broadcast Audio Standards

Broadcast System	Sound Carrier Frequency (MHz)	Modulation	Country
NTSC (M)	4.5	BTSC-Stereo + SAP	USA, Canada, Mexico, Taiwan
NTSC (M)	4.5	FM-FM (EIAJ)	Japan
NTSC (M)	4.5/4.724212	FM-Stereo (A2)	Korea
PAL (B)	5.5/5.7421875	FM-Stereo (A2)	Germany
PAL (D)	6.5/5.85	FM-Mono/NICAM	China
PAL (G)	5.5/5.85	FM-Mono/NICAM	Scandinavia, Spain
PAL (I)	6.0/6.552	FM-Mono/NICAM	UK, Hong Kong
SECAM (K)	6.5/6.2578125	FM-Stereo	East Europe
SECAM (L)	6.552/5.85	AM-Mono/NICAM	France
FM-Radio	10.7	FM Stereo Radio	Various

The specifications of the supported broadcast audio standards are listed Tables 2-3 through 2-8.

Table 2-3. BTSC (FM/AM/FM)

Parameter	Description	Stereo	SAP	Unit
S/N	Signal-to-Noise	60	55	dB
THD	Total Harmonic Distortion + Noise	0.1	0.1	%
BW_{audio}	Audio Bandwidth	50–15k	50–10k	Hz
XTALK	Crosstalk	70	70	dB
Separation	Stereo Separation	30	N/A	dB
IF	Audio 2^{nd} IF, Block FM	4.50000		MHz
F_{sub}	Subcarrier Frequency	L+R: None L-R: 31468	78670	Hz
Modulation	Modulation Type	L+R: FM, 25 kHz deviation L-R: AM, dual sideband, suppressed carrier	FM: 10 kHz deviation	—
Emphasis	Emphasis Applied	L+R: 75us L-R: dbx	dbx	—
Pilot	Subcarrier Pilot	Tone @ 15734 kHz		—

Table 2-4. A2 (FM/FM)

Parameter	Description	Mono	Stereo	Unit
S/N	Signal-to-Noise	55	55	dB
THD	Total Harmonic Distortion + Noise	0.1	0.1	%
BW_{audio}	Audio Bandwidth	40–15k	40–15k	Hz
XTALK	Crosstalk	—	70	dB
Separation	Stereo Separation	—	40	dB
IF	Audio 2nd IF (B/G)	5.5	5.7421875	MHz
	Audio 2nd IF (D/K)	6.5	6.2578125 6.7421875	MHz
	Audio 2nd IF (M)	4.5	4.724212	MHz
Modulation	Modulation Type (B/G/D/K)	FM: ±50 kHz	FM: ±50 kHz	—
	Modulation Type (M)	FM: ±25 kHz	FM: ±25 kHz	—
Emphasis	Emphasis Applied (B/G/D/K)	50	50	—
	Emphasis Applied (M)	75	75	—
Content	Content of Signal (B/G/D/K)	(L+R)/2	R	—
	Content of Signal (M)		(L-R)/2	
Pilot	Subcarrier Pilot (B/G/D/K)	None	50% AM carrier at 54.6875 kHz with tone at 117.5 Hz (Stereo) 274.1 Hz (dual)	—
	Subcarrier Pilot (M)		50% AM carrier at 55.0699 kHz with tone at 149.9 Hz (Stereo) 276.0 Hz (dual)	—

Table 2-5. System L (AM Mono)

Parameter	Description	Mono	Unit
S/N	Signal-to-Noise	40	dB
THD	Total Harmonic Distortion + Noise	0.1	%
BW_{audio}	Audio Bandwidth	40–15k	Hz
XTALK	Crosstalk	—	dB
IF	Audio 2nd IF, Block FM	6.5	MHz
Modulation	AM	54	%
Emphasis	Emphasis Applied	—	—

Table 2-6. EIA-J (FM/FM)

Parameter	Description	L+R	L-R	Unit
S/N	Signal-to-Noise	60	60	dB
THD	Total Harmonic Distortion + Noise	0.1	0.1	%
BW_{audio}	Audio Bandwidth	50–15k	50–15k	Hz
XTALK	Crosstalk	70	70	dB
Separation	Stereo Separation	30		dB
IF	Audio 2nd IF, Block FM	4.500000		MHz
F_{sub}	Subcarrier Frequency	None	31468	Hz
Modulation	Modulation Type	FM: 25 kHz deviation	FM: 20 kHz deviation	—
Emphasis	Emphasis Applied	75	75	µs
Delay	Transmitter-sided Delay	20	0	µs
Pilot	Subcarrier Pilot	60% AM at 55069 kHz, unmodulated if Mono, 982.5 Hz if Stereo, 922.5 Hz if bilingual		—

Table 2-7. FM Radio (FM/AM)

Parameter	Description	L+R	L-R	Unit
S/N	Signal-to-Noise	65		dB
THD	Total Harmonic Distortion + Noise	0.1		%
BW_{audio}	Audio Bandwidth	20–19k		Hz
Separation	Stereo Separation	40		dB
IF	Audio 2nd IF, Block FM	10.70000		MHz
F_{sub}	Subcarrier Frequency	None	38000	Hz
Modulation	Modulation Type	FM: 75 kHz deviations	AM: double sideband, suppressed carrier	—
Emphasis	Emphasis Applied (US)	75	75	µs
	Emphasis Applied (Europe)	50	50	µs
Pilot	Subcarrier Pilot	19 kHz FM		—
RDS	RDS Output Data Stream	38 kHz, 16-bit I/Q		—

Table 2-8. NICAM (DQPSK)

Parameter	Description	Stereo	Unit
S/N	Signal-to-Noise	72	dB
THD	Total Harmonic Distortion + Noise	0.1	%
BW_{audio}	Audio Bandwidth	20–15k	Hz
BER	Bit-Error Rate	$1x10^{-7}$	—
XTALK	Crosstalk Attenuation	80	dB
Separation	Stereo Separation	80	dB
IF	Audio 2^{nd} IF (I)	6.552	MHz
	Audio 2nd IF (B/G/L/D/K)	5.85	MHz
Modulation	Modulation Type	DQPSK	—
Emphasis	Emphasis Applied	CCITT J.17	—
Rolloff	Spectrum Shaping Rolloff filter (I)	100	%
	Spectrum Shaping Rolloff filter (B/G/L/D/K)	40	
Format	Digital Coding Format	Two 32 kHz 14-to-10-bit companded interleaved protected digital data channels.	—

2.1.4 Selecting the Broadcast Audio Standard

Bits [5:0] of the AUD_INIT register (location 24'h320100) are used to select the desired broadcast audio mode.

24'h320100—AUD_INIT Register

Bits	Type	Default	Name	Description
[5:0]	RW	6'h00	AUD_INIT	Autoconfigure initialization register
				01—Configure BTSC
				02—Configure EIAJ
				04—Configure A2
				08—Configure BTSC-SAP
				10—Configure NICAM
				20—Configure FM Radio
[15:6]	RO	10'h000	—	Reserved

Once the standard has been selected and the appropriate bit written, then a write to the AUD_INIT_LD register enables the standard selected.

24'h320104—AUD_INIT_LD Register

Bits	Type	Default	Name	Description
[0]	WO	1'b0	AUD_INIT_LD	Enable loading of AUD_INIT initialization
[15:1]	RO	15'h0000	—	Reserved

After bit 0 of the AUD_INIT_LD register has been written, bit 0 of the AUD_SOFT_RESET register must be asserted to maintain the state of the audio subsystem, while the rest of the CX2388x is programmed for device configuration and setup. After all programming steps have been accomplished, this bit can be manually deasserted.

24'h320108—AUD_SOFT_RESET Register

Bits	Type	Default	Name	Description
[0]	RW	1'b0	SOFT_RESET	Enable software reset of everything other than the programmable registers. Used to keep the audio subsection in a known state until all programming is complete. Can also be used to disable audio altogether.
[15:1]	RO	15'h0000	—	Reserved

2.1.5 Audio PLL Initialization

The audio PLL is automatically configured for 28.636363 MHz crystal frequency with the AUD_INIT_LD register. If using a crystal of frequency other than 28.636363 MHz, please contact Conexant Applications Engineering. If using the I^2S output mode, the PLL must be programmed to exactly 221.184 MHz in fractional mode.

2.1.6 Input Source Select

Once the broadcast audio type has been selected, then it is necessary to specify how it should operate. The 12 LSBs [11:0] of the AUD_CTL register (location 24'h32058C) are used to determine the desired operation of the audio decoder.

24'h32058C—AUD_CTL Register

Bits	Type	Default	Name	Description
[5:0]	RW	6'h00	IN_SRC_SEL	Input source select
[6]	RW	1'b0	Reserved	Reserved
[8:7]	RW	2'h0	DMTRX_CTL	Dematrix control
[9]	RW	RESERVED	Reserved	Reserved
[10]	RW	1'b0	Reserved	Reserved
[11]	RW	1'b0	DMTRX_BYPASS	Dematrix bypass enable bit
[12]	RW	1'b0	DAC_ENABLE	DAC enable bit
[13]	RW	1'b0	I^2SOUT_ENABLE	I^2S output enable bit
[14]	RW	1'b0	I^2S_STR2DAC	I^2S input straight to DAC enable bit
[15]	RW	1'b0	I^2SIN_ENABLE	I^2S input enable bit

The CX2388x's audio subsystem performs the detection and decoding functions listed in Sections 2.1.6.1–2.1.6.4.

2.1.6.1 BTSC-Stereo

For BTSC-stereo, the CX23880 uses the presence of the pilot signal to determine the existence of a stereo and/or a Second Audio Program (SAP) signal. The BTSC pilot is detected by a circuit that compares the measured pilot period against the expected frequency. When a stereo signal is detected, it is assumed that a stereo carrier and a SAP carrier are present. BTSC signals are received as (L + R) / 2 and (L – R) / 2, therefore, left and right are recovered by taking the sum and difference of the two received signals. The dbx is permanently enabled on the CX23880/CX23883 and permanently disabled on the CX23881/CX23882.

2.1.6.2 FM Radio

The operation for FM radio is identical to that of BTSC-stereo, with the exception that there is no SAP carrier, and dbx is not used.

2.1.6.3 A2 and Electronic Industries Association of Japan (EIAJ)

For A2 and EIAJ Audio, pilot detection first detects the presence of a second carrier and then discriminates between dual-sideband AM tones to determine if it is stereo or mono. The following two modes are possible when in A2 and EIAJ decoding mode:

1. In A2/EIAJ auto-stereo mode, if a signal is available, the audio decoder automatically decodes the stereo signal.
2. In A2/EIAJ auto-mono2mode, the audio decoder attempts to decode a second mono channel. If that is unavailable, it falls back and attempts to decode stereo. As a last resort, if only a mono signal is available, it decodes that.

NOTE: Auto-mono2 is not recommended, as undesirable switching between two languages may occur under some signal conditions.

2.1.6.4 NICAM Stereo

The operation of Near Instantaneously Companded Audio Multiplex (NICAM) stereo decoding is similar to that of the A2/EIAJ mode in that is possible for the user to invoke an auto-stereo mode or an auto-mono mode as follows:

- In NICAM auto-stereo mode, if a signal is available, the audio decoder automatically decodes the stereo signal.
- In NICAM auto-mono mode, the audio decoder attempts to decode a second mono channel. If that is unavailable, it falls back and attempts to decode stereo. As a last resort, if only a mono signal is available, it decodes that.

2.1.6.5 Force/Auto Modes

For each supported standard there are two basic modes of operation, force and auto. The force modes ignore broadcast signals that try to set the mode and make the source select and dematrix operate in a certain manner. The auto modes attempt to determine the type of signal being broadcast and use that information to set the source select and dematrix accordingly. As a rule, the auto mode is the preferred method of operation for speed, and force modes are preferred for second language; however, certain circumstances may warrant use of the force mode.

24'h32058C—AUD_CTL, Bits [5:0]

Bits	Type	Default	Name	Description
[5:0]	RW	6'h00	IN_SRC_SEL	Input source select

Table 2-9 lists the six LSBs [5:0] of the AUD_CTL register control for the operation of the audio decoder.

Table 2-9. Audio Mono and Stereo Modes

Value	Description
000000	BTSC force mono
000001	BTSC force stereo
000010	BTSC force SAP
000101	BTSC auto-stereo
000100	BTSC auto-SAP (Not recommended)
001000	A2 force mono 1
001001	A2 force mono 2
001010	A2 force stereo
001011	A2 auto-mono 2 (Not recommended)
001100	A2 auto-stereo
010000	EIAJ force mono 1
010001	EIAJ force mono 2
010010	EIAJ force stereo
010011	EIAJ auto-mono 2 (Not recommended)
010100	EIAJ auto-stereo
011000	FM radio force mono
011001	FM radio force stereo
011010	FM radio auto-stereo
100000	NICAM force mono 1
100001	NICAM force mono 2
100010	NICAM force stereo
100011	NICAM auto-mono 2
100100	NICAM auto-stereo

The Audio Status register provides the host with information concerning the current state of the audio subsystem.

24'h320590—AUD_STATUS Register

Bits	Type	Default	Name	Description
[1:0]	RO	2'b00	STEREO_MODE	Current stereo mode in use: 00 = Mono 01 = Dual mono 10 = Stereo 11 = SAP
[3:2]	RO	2'b00	DEMOD_PILOT	Current pilot correlation from demodulator: 00 = No pilot detected 01 = Pilot C1 detected 10 = Pilot C2 detected
[4]	RO	1'b0	TIMER_TIMEOUT	Time-out of timer used for both initialization and mode change debounce.
[5]	RO	1'b0	—	—
[15:6]	RO	10'h000	MAIN_AFC	First rotator Automatic Frequency Control (AFC) input for detecting if the desired carrier has been acquired (for use in determining the system being broadcast)

The status of DEMOD_PILOT should be monitored when a second language is used. If **pilot C2 detected** is consistently set, a second language transmission is probably available. (For SAP only, pilot C1 is set).

2.1.7 Dematrix Control

The dematrix circuit is the portion of the audio decoder that combines the received broadcast audio signals into left and right channels (see Table 2-10). Most audio standards require slightly different operations to transform the stereo pair of received signals into discrete left and right channels. As a result, the dematrix section functions differently for each standard. BTSC, EIAJ, and FM radio signals are received as (L + R) / 2 and (L – R) / 2; therefore, left and right are recovered by taking the sum and difference of the two received signals. A2 is received as (L + R) and (R), so left is recovered as the difference, and right is the second channel. NICAM is transmitted directly as left and right, so the dematrix circuit just passes the signals straight through. If a mono signal is desired from a stereo input, the dematrix circuit passes both left and right as (L + R) / 2.

Table 2-10. Dematrix Control

Value	Description	
00	Dematrix Sum/Diff	(CH1 + CH2, CH1–CH2)
01	Dematrix Sum/R	(CH1 x 2 – CH2, CH2)
10	Dematrix LR	(CH1, CH2)
11	Dematrix Mono	(CH1 + CH2)/2

The audio decoder automatically attempts to determine the appropriate setting for the dematrix circuit based on the incoming broadcast audio standard. This automatic setting can be overridden by setting the DMTRX_CTL bits in the AUD_CTL register as follows:

24'h32058C—AUD_CTL Register, Bits [8:7]

Bits	Type	Default	Name	Description
[8:7]	RW	2'h0	DMTRX_CTL	Dematrix control

The dematrix control reg can be used to create a certain effect, such as content-left/ narration-right from a multichannel transmission. These types of effects are most commonly used in Japan. It is recommended that the Automatic Switching mode from the source select be utilized because it has been optimized for each standard and requires no software intervention when switching between standards.

2.1.8 Audio Control and Sample Rate Converter

2.1.8.1 Audio Demodulator Sample Rate Converter

All broadcast audio formats supported by the CX2388x are upconverted from their native sampled format to 48 kHz. This simplifies internal filtering and interfacing to external hardware peripherals via I^2S, the internal audio DACs, or to software codecs.

2.1.8.2 Volume

The volume control provides gain to both the left and right audio channel in 1 dB increments. The volume range is –63 to 0 dB and is controlled by the VOL_CTL register.

In addition, flexible control over muting is possible by the ability to control the muting of the selected source from the audio demodulator, the I^2S output and the audio DAC. During initialization, from reset to the end of the AUD_START_TIMER count, all three of these mutes are enabled automatically to avoid pops or clicks on any of the outputs. Additionally, when the audio demodulator is decoding NICAM audio, the demodulator can assert the source mute until it has achieved lock to the incoming bit stream, or after it has lost lock due to a weak signal.

24'h320594—VOL_CTL Register

Bits	Type	Default	Name	Description
[5:0]	RW	8'h00	VOLUME	Volume control in dB steps, 0 to –63 dB
[6]	RW	1'b0	SRC_MUTE_EN	Source mute enable
[7]	RW	1'b0	I^2S_MUTE_EN	I^2S mute enable
[8]	RW	1'b0	DAC_MUTE_EN	DAC mute enable
[15:9]	RW	7'h00	—	Reserved

2.1.8.3 Balance

Digital balance control is used to alter the relative gain between the left and right channel outputs. Balance is controlled by providing an attenuation to one channel while maintaining 0 dB gain to the other channel. Attenuation of either channel is in the range of –63 to 0 dB in 1 dB steps. Balance attenuation is performed prior to the volume control.

24'h320598—BAL_CTL Register

Bits	Type	Default	Name	Description
[5:0]	RW	8'h00	BAL_LEVEL	Attenuation to be provided to the selected channel in dB. Range is 0 to –63 dB.
[6]	RW	1'b0	BAL_RIGHT	Select right channel for balance control if 1, select left channel if 0.
[15:7]	RO	7'h00	—	Reserved.

2.1.9 I^2S Input and Output

2.1.9.1 I^2S Input

The CX2388x supports I^2S input and output interfaces to a wide variety of external audio components. The 3 pins that make up the I^2S input interface are ADATAI (Audio Data In, pin 171), ALRCKI (Audio Left/Right Clock In, pin 172), ASCKI (Audio Serial Clock In, pin 173).

The I^2S input to the CX2388x can be used by an external audio/video processor to take advantage of the CX2388x on-board audio DACs.

The CX2388x supports multiple I^2S formats for maximum flexibility when connecting to external devices. The bit width of the input samples can range from 16–32 bits, and the input sample rate can be either 48, 96, 144, or 192 kHz. Sony or Philips-style formats are supported. If the input samples are larger than 16 bits, the LSBs beyond 16 bits are truncated. Because the data rate to the audio subsystem is 48 kHz, if incoming input samples are received at rates in excess of 48 kHz, the extra samples are dropped. For instance, if the input format is 24 bits at 96 kHz, then the eight lowest LSBs are truncated, and every other sample are dropped.

The CX2388x can be configured as either an I2S master or a slave. As a master it generates the clock and word select. As a slave it receives the clock and word select from the external I^2S source.

An autobaud feature determines the baud rate of the incoming I^2S serial data stream. The detected baud can be read in the I^2S Input Status register, bits 5:0.

24'h320120—I²SINPUT Register

Bits	Type	Default	Name	Description
[0]	RW	1'b0	NSlaveMaster	0 = CX2388x is slave 1 = CX2388x is master
[1]	RW	1'b0	NPhilipsSony	0 = Conform to Philips specification 1 = Conform to Sony specification
[2]	RW	1'b0	DisableAutoBaud	0 = Autobaud 1 = Disable autobaud
[15:3]	RO	13'h0000	—	Reserved

24'h320124—I²SINPUTSTATUS Register

Bits	Type	Default	Name	Description
[5:0]	RO	6'h000	Status	0 = 0 kHz 1 = 48 kHz 2 = 96 kHz 3 = 144 kHz 4 = 192 kHz 5 = 240 kHz (not supported) 6 = 288 kHz (not supported) > 6 => 288 kHz (not supported)
[15:6]	RO	9'h000	—	Reserved

2.1.9.2 I²S Output

The CX2388x supports I²S output to allow the user to bypass the built-in audio DACs and drive a Sony/Philips/Digital Interconnect Format (S/PDIF) driver for connection to a sound card, external surround processor, or digital recorder using an all-digital interface. In addition, this feature is useful when interfacing the CX2388x to a hardware MPEG II video/audio encoder for compression and synchronization between video and audio streams generated by the CX2388x.

In I²S output mode, the CX2388x is always the master device. It generates the clock and word select.

Output muting is possible by asserting the Mute bit in the I²SOUTPUT register.

24'h320128—I²SOUTPUT Register

Bits	Type	Default	Name	Description
[0]	RW	1'b0	NPhilipsSony	0 = Conform to Philips specification 1 = Conform to Sony specification
[1]	RW	1'b0	Mute	Holds SCK, WS, and SD outputs
[15:2]	RW	14'h0000	—	Reserved

2.1.10 I²S Control

The CX2388x can be used in a wide variety of audio applications. To support as many I²S interface combinations as possible, the I²SCTL register provides several methods of multiplexing pins and signal information according to application. In addition to supporting timing master and slave modes on the I²S input interface, an over-sample clock output is provided for interfacing to external audio ADCs or DACs. The over-sample clock runs at 256 x the sample rate, which for 48 kHz audio is 12.288 MHz.

24'h3205EC- I²SCTL

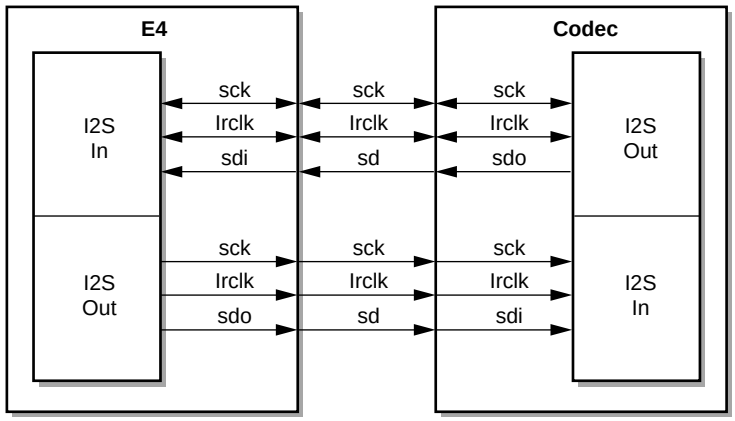
Bits	Type	Default	Name	Description
[0]	RW*	1’b0	OSCLK2SCKOUT	Send oversample clock out to the I²S Out sck (serial clock) pin
[1]	RW*	1’b0	OSCLK2SCKIN	Send oversample clock out to the I²S In sck (serial clock) pin. Forces output enables for I²S In pins to be high (output mode)
[2]	RW*	1’b0	I²SOUT2IN	Use I²S Out serial clock and word clock to drive I²S In block internally.
[3]	RW*	1’b0	I²SDIN2DOUT	Connects the I²S In serial data input directly to the I²S Out serial data output.
[15:4]	RW*	12’h0000		Reserved

The I²SCTL register supports five modes for audio interfacing to external audio ADCs, DACs and compression ICs.

2.1.10.1 Normal Mode

Normal mode operation supports transfer of decoded broadcast audio samples to an MPEG Encoder/CODEC or to nyquist-rate audio ADCs and DACs. No oversample clock is provided and each I^2S interface has its own dedicated three signals, SCK, LRCK, SDAT. This is illustrated in Figure 2-2. Normal mode is the default configuration. It can also be programmed by writing 0x0 to the I^2SCTL register.

Figure 2-2. Normal Mode Operation



GENERAL NOTE:

1. I2S In enabled.
2. I2S Out enabled.
3. No oversample clock provided.

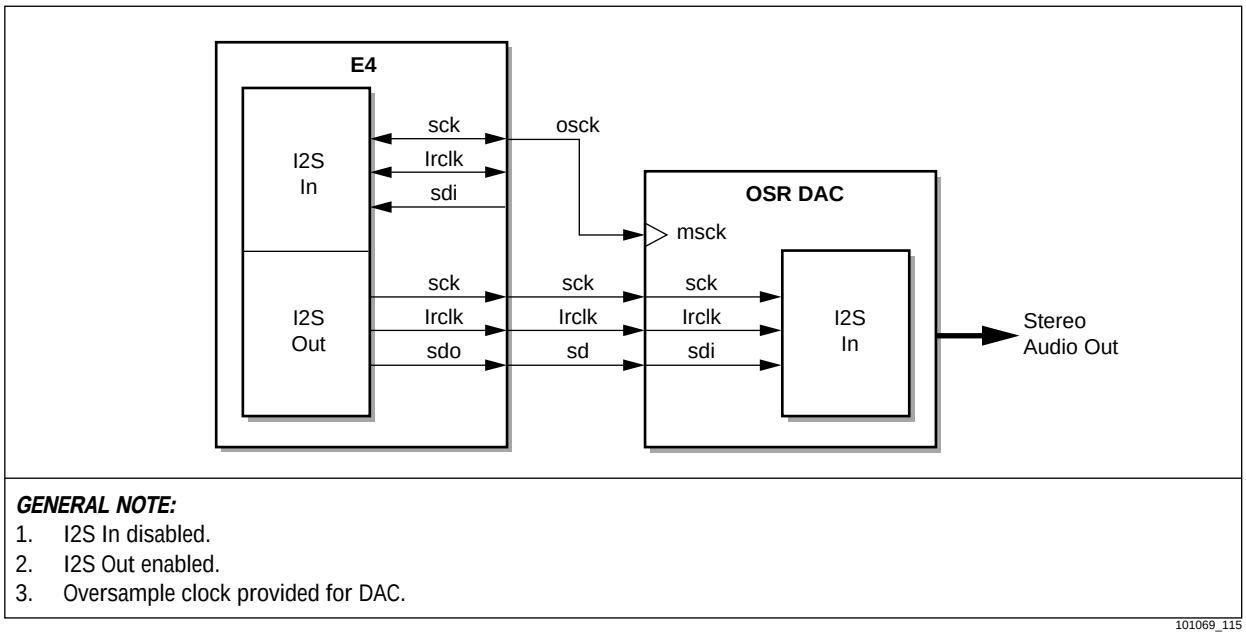
101069_114

2.1.10.2 OSR DAC Mode

OSR DAC Mode is available to drive an external high quality stereo audio DAC which requires an oversampled clock. The I^2S input is not available in this mode. The I^2S input serial clock pin is used to output the oversampled clock. The I^2S output pins are still available.

OSR DAC mode is programmed by writing 0x2 to the I^2SCTL register. Additionally, the I^2SIN_ENABLE bit in the AUDCTL register must be disabled and the I^2SOUT_ENABLE bit should be enabled. OSRDAC mode is illustrated in Figure 2-3.

Figure 2-3. OSR DAC Mode Operation



GENERAL NOTE:

1. I2S In disabled.
2. I2S Out enabled.
3. Oversample clock provided for DAC.

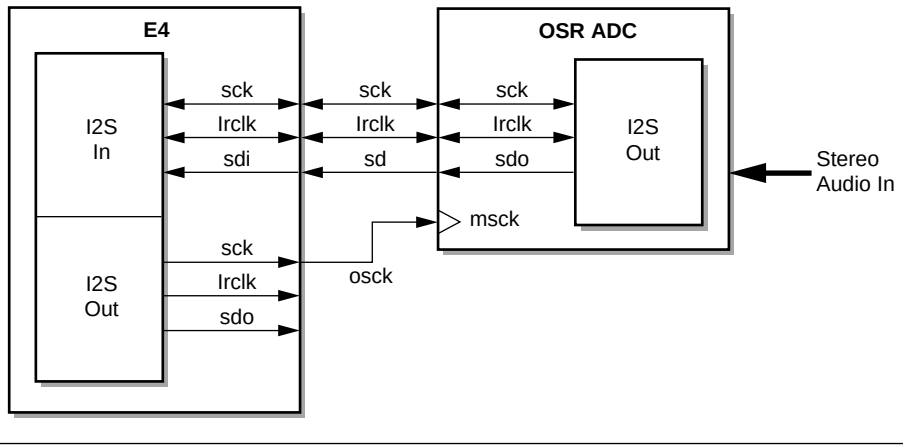
101069_115

2.1.10.3 OSR ADC Mode

OSR ADC mode is available as an input for baseband stereo audio via an external audio ADC which requires an oversample clock. The I^2S output is not available in this mode. The I^2S output serial clock pin is used to output the oversampled clock. The I^2S input pins are still available for use.

OSR ADC mode is programmed by writing 0x1 to the I^2SCTL register. Additionally, the I^2SIN_ENABLE bit in the AUDCTL register should be enabled and the I^2SOUT_ENABLE bit should be disabled. OSR ADC mode is illustrated in Figure 2-4.

Figure 2-4. OSR ADC Mode Operation



GENERAL NOTE:

1. I2S In enabled.
2. I2S Out disabled.
3. Oversample clock provided for ADC.

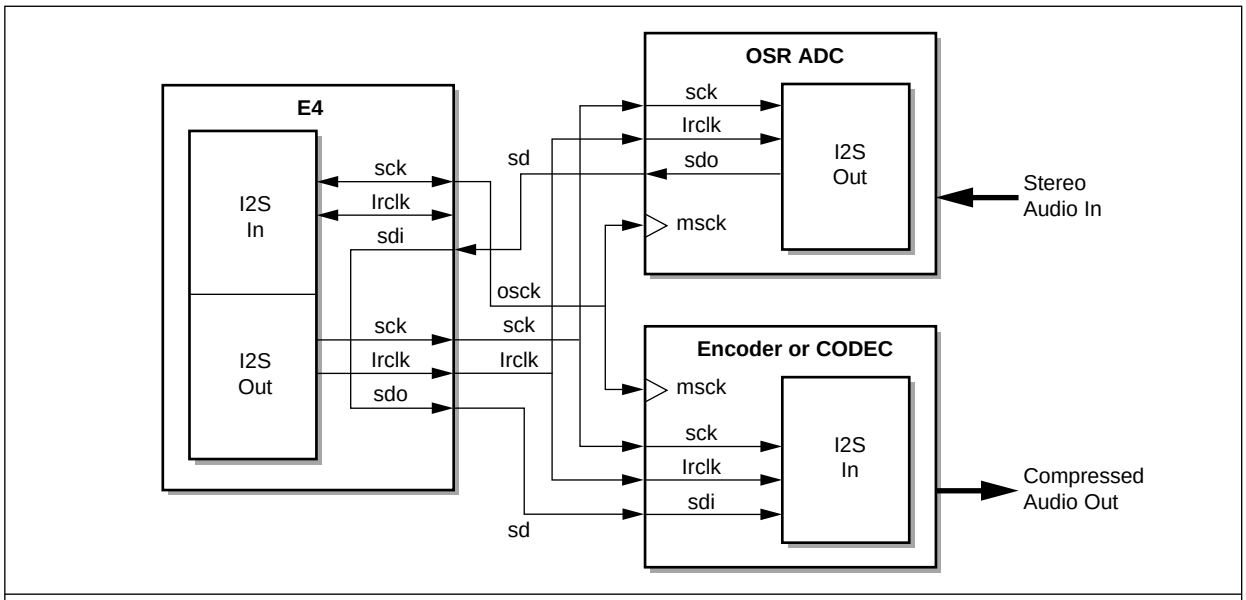
101069_116

2.1.10.4 Pass-Thru Mode

Pass-Thru mode is provided as a method of making the CX2388x act as a multiplexer between its own digital output from the broadcast audio decoder and the digital output from an I^2S input when either the I^2S input or output (or both) require an oversample clock. In this mode, the oversample clock is sent to the I^2S input serial clock pin. Both the external I^2S devices are connected to the I^2S output serial clock and word clock. The I^2S input serial data pin is internally connected directly to the I^2S output serial data output pin. Both of the external I^2S devices must support slave-mode operation. This is illustrated in Figure 2-5.

Pass-thru mode is programmed by writing 0x8 to the I^2SCTL register. Additionally, the I^2SIN_ENABLE bit in the AUDCTL register should be disabled and the I^2SOUT_ENABLE bit should be enabled.

Figure 2-5. Pass-Thru Mode Operation



GENERAL NOTE:

1. I2S In disabled.
2. I2S Out enabled.
3. External ADC and CODEC (or DAC) slaved to I2S Out.
4. I2S In serial data passed directly to I2S Out serial data.
5. Oversample clock provided for ADC and/or DAC.

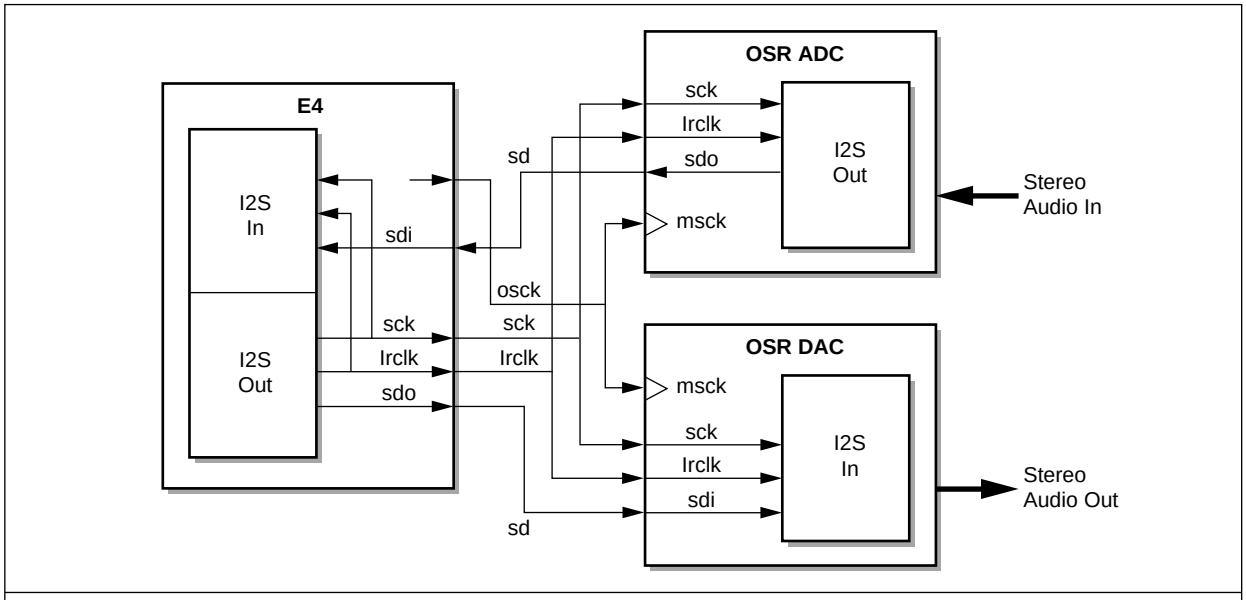
101069_117

2.1.10.5 Full Functionality Mode

Full functionality mode is available as a method for providing an oversampled clock to external I^2S devices, while still maintaining separate I^2S streams in and out. In this mode, the I^2S input is internally slaved to the I^2S output serial clock and word clock, the external devices are both connected to the I^2S output serial clock and word clock, the oversample clock is provided on the I^2S output serial clock pin, and only the serial data in to the I^2S Input block and serial data out from the I^2S Output block are kept separate. In this mode, it is possible to send broadcast data from the I^2S output to a MPEG encoder or codec, while simultaneously streaming baseband stereo audio in the I^2S input over the PCI, enabling DVCR record-one, play-another functionality with an S-Video or composite source with stereo inputs. Like the Pass-thru mode, both I^2S devices must support slave mode operation. This mode is illustrated in Figure 2-6.

Full functionality mode is enabled by programming 0x6 to the I^2SCTL register, which enables the oversample clock output on the I^2S input serial clock pin, and slaves the I^2S input off the I^2S output serial clock and word clock internally. Additionally, the I^2SIN_ENABLE bit, and the I^2SOUT_ENABLE bit in the AUDCTL register should be enabled. Finally, the NSLAVEMASTER bit in the I^2SINPUT register should be disabled to put the I^2S Input into slave mode.

Figure 2-6. Full Functionality Mode



GENERAL NOTE:

1. I2S In enabled.
2. I2S Out enabled.
3. External ADC and DAC slaved from I2S Out.
4. I2S In serial clock and word clock slaved from I2S Out.
5. Oversample clock provided for ADC and/or DAC.

101069_118

2.1.11 Audio DACs

The CX2388x provides an analog stereo audio output that can drive a PC audio card or a stereo preamplifier input. Two integrated audio DACs provide approximately 85 dB SNR when used with an external active filter circuit, or approximately 75 dB SNR when used with a simple RC external construction filter. See Chapter 3 for external component example circuits.

NOTE: Even when using the simple external RC filter, the audio system performance exceeds the dynamic range inherent with broadcast audio sources.

The input to the audio DACs is based on two bits present in the AUD_CTL register: DAC_ENABLE and I^2S_STR2DAC. If DAC_ENABLE is disabled, then no signals or enables are passed to the DAC. If DAC_ENABLE is enabled, then either the I^2S input (if I^2S_STR2DAC is enabled) or the upstream DMA channel (if I^2S_STR2DAC is disabled) is passed to the DAC.

24'h32058C—AUD_CTL Register, Bits [12], [14]

Bits	Type	Default	Name	Description
[12]	RW	1'b0	DAC_ENABLE	DAC enable bit
[14]	RW	1'b0	I^2S_STR2DAC	I^2S input straight to DAC enable bit

The DAC output sample rate is a fixed divide off the PLL clock. The sample rate is calculated as the PLL frequency divided by 18 (the DAC pulse width modulated output rate) and divided by 128 (the DAC oversampling ratio). Whichever sample rate converter is used to drive the input to the DAC (through a FIFO) must be programmed to this sample rate, not the 48 kHz sample rate that is normally used. For instance, if the demodulator is used as the source to the DAC, then the demodulator sample rate converter DDS frequency must be programmed to provide output samples at the calculated sample rate of the DAC instead of 48 kHz.

2.1.12 Broadcast Audio Programming Examples

Tables 2-11 through 2-15 list broadcast audio programming examples. Please contact Conexant Applications Engineering to obtain updated programming examples.

Table 2-11. NICAM Broadcast Audio Decode and Output to Built-in Stereo DACs

Register Name	Location	Value	Description
AFE_CFG_IO	24'h35C04C	32'h00000000	Enable audio DAC and video ADC bandgaps. Select audio mode.
AFE_12DB_EN	24'h320628	16'h0001	Enable +12 dB gain for audio signal from tuner
AUD_INIT	24'h320100	16'h0010	Configure NICAM broadcast audio
AUD_INIT_LD	24'h320104	16'h0001	Enable selected broadcast audio standard
AUD_SOFT_RESET	24'h320108	16'h0001	Enable audio soft reset. Keeps audio subsystem in a known state until programming steps are complete.
AUD_RATE_ADJ1	24'h3205D8	16'h0010	Recommended values for NICAM setup
AUD_RATE_ADJ2	24'h3205DC	16'h0040	Recommended values for NICAM setup
AUD_RATE_ADJ3	24'h3205E0	16'h0100	Recommended values for NICAM setup
AUD_RATE_ADJ4	24'h3205E4	16'h0400	Recommended values for NICAM setup
AUD_RATE_ADJ5	24'h3205E8	16'h1000	Recommended values for NICAM setup
Location 32'h02320D01	32'h02320D01	8'h06	QAM setup
Location 32'h02320D02	32'h02320D02	8'h82	QAM setup
Location 32'h02320D03	32'h02320D03	8'h16	QAM setup
Location 32'h02320D04	32'h02320D04	8'h05	QAM setup
Location 32'h02320D2A	32'h02320D2A	8'h34	QAM setup
Location 32'h02320D2B	32'h02320D2B	8'h4C	QAM setup
AUD_SOFT_RESET	24'h320108	16'h0000	Deassert audio soft reset
AUD_VOL_CTL	24'h32058C	16'h0000	Set volume control to 0 dB attenuation

Table 2-12. FM Radio Decode and Output to Built-In Stereo DACs

Register Name	Location	Value	Description
AFE_CFG_IO	24'h35C04C	32'h00000000	Enable audio DAC and video ADC bandgaps. Select audio mode.
AFE_12DB_EN	24'h320628	16'h0001	Enable +12 dB gain for audio signal from tuner
AUD_INIT	24'h320100	16'h0020	Configure FM broadcast audio
AUD_INIT_LD	24'h320104	16'h0001	Enable selected broadcast audio standard
AUD_SOFT_RESET	24'h320108	16'h0001	Enable audio soft reset. Keeps audio subsystem in a known state until programming steps are complete.
AUD_SOFT_RESET	24'h320108	16'h0000	Deassert audio soft reset
AUD_VOL_CTL	24'h32058C	6'h00	Set volume control to 0 dB attenuation

Table 2-13. BTSC Broadcast Audio Decode and Output to Built-in Stereo DACs

Register Name	Location	Value	Description
AFE_CFG_IO	24'h35C04C	32'h00000000	Enable audio DAC and video ADC bandgaps. Select audio mode.
AFE_12DB_EN	24'h320628	16'h0001	Enable +12 dB gain for audio signal from tuner
AUD_INIT	24'h320100	16'h0001	Configure BTSC broadcast audio
AUD_INIT_LD	24'h320104	16'h0001	Enable selected broadcast audio standard
AUD_SOFT_RESET	24'h320108	16'h0001	Enable audio soft reset. Keeps audio subsystem in a known state until programming steps are complete.
AUD_DBX_IN_GAIN	24'h320500	16'hA5D0	Recommended values for BTSC setup
AUD_DBX_WBE_GAIN	24'h320504	16'h4163	Recommended values for BTSC setup
AUD_DBX_SE_GAIN	24'h320508	16'h5C0A	Recommended values for BTSC setup
DEEMPH 0_G0	24'h320448	16'h0C02	Recommended values for BTSC setup
PHASE_FIX_CTL	24'h3205F0	16'h0030	Recommended values for BTSC setup
AUD_SOFT_RESET	24'h320108	16'h0000	Deassert audio soft reset
AUD_VOL_CTL	24'h32058C	6'h00	Set volume control to 0 dB attenuation

Table 2-14. EIAJ Broadcast Audio Decode and Output to Built-in Stereo DACs

Register Name	Location	Value	Description
AFE_CFG_IO	24'h35C04C	32'h00000000	Enable audio DAC and video ADC bandgaps. Select audio mode.
AFE_12DB_EN	24'h320628	16'h0001	Enable +12 dB gain for audio signal from tuner
AUD_INIT	24'h320100	16'h0002	Configure EIAJ broadcast audio
AUD_INIT_LD	24'h320104	16'h0001	Enable selected broadcast audio standard
AUD_SOFT_RESET	24'h320108	16'h0001	Enable audio soft reset. Keeps audio subsystem in a known state until programming steps are complete.
AUD_RATE_ADJ1	24'h3205D8	16'h0100	Recommended values for EIAJ setup
AUD_RATE_ADJ2	24'h3205DC	16'h0200	Recommended values for EIAJ setup
AUD_RATE_ADJ3	24'h3205E0	16'h0300	Recommended values for EIAJ setup
AUD_RATE_ADJ4	24'h3205E4	16'h0400	Recommended values for EIAJ setup
AUD_RATE_ADJ5	24'h3205E8	16'h0500	Recommended values for EIAJ setup
AUD_THR_FR	24'h3203C0	16'h0000	Recommended values for EIAJ setup
AUD_PILOT_BQD_1_K0	24'h320380	32'h00008000	Recommended values for EIAJ setup
AUD_PILOT_BQD_1_K1	24'h320384	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_1_K2	24'h320388	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_1_K3	24'h32038C	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_1_K4	24'h320390	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_2_K0	24'h320394	32'h00C00000	Recommended values for EIAJ setup
AUD_PILOT_BQD_2_K1	24'h320398	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_2_K2	24'h32039C	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_2_K3	24'h3203A0	32'h00000000	Recommended values for EIAJ setup
AUD_PILOT_BQD_2_K4	24'h3203A4	32'h00000000	Recommended values for EIAJ setup
AUD_C2_UP_THR	24'h3203D8	16'h1000	Recommended values for EIAJ setup
AUD_C2_LO_THR	24'h3203DC	16'h0400	Recommended values for EIAJ setup
AUD_C1_UP_THR	24'h3203D0	16'h1800	Recommended values for EIAJ setup
AUD_C1_LO_THR	24'h3203D4	16'h1000	Recommended values for EIAJ setup
AUD_MODE_CHG_TIMER	24'h3205B4	16'h0080	Recommended values for EIAJ setup
AUD_START_TIMER	24'h3205B0	16'h0200	Recommended values for EIAJ setup
AUD_AFE_16DB_EN	24'h320628	16'h0001	Recommended values for EIAJ setup
AUD_DEEMPH0_G0	24'h320448	16'h23F8	Recommended values for EIAJ setup
AUD_PHASE_FIX_CTL	24'h3205F0	16'h0009	Recommended values for EIAJ setup
AUD_CORDIC_SHIFT_0	24'h320308	16'h0006	Recommended values for EIAJ setup
AUD_CORDIC_SHIFT_1	24'h320314	16'h0006	Recommended values for EIAJ setup
AUD_SOFT_RESET	24'h320108	16'h0000	Deassert audio soft reset
AUD_VOL_CTL	24'h32058C	16'h0000	Set volume control to 0 dB attenuation

Table 2-15. A2 Broadcast Audio Decode and Output to Built-in Stereo DACs

Register Name	Location	Value	Description
AFE_CFG_IO	24'h35C04C	32'h00000000	Enable audio DAC and video ADC bandgaps. Select audio mode.
AFE_12DB_EN	24'h320628	16'h0001	Enable +12 dB gain for audio signal from tuner
AUD_INIT	24'h320100	16'h0004	Configure A2 broadcast audio
AUD_INIT_LD	24'h320104	16'h0001	Enable selected broadcast audio standard
AUD_SOFT_RESET	24'h320108	16'h0001	Enable audio soft reset. Keeps audio subsystem in a known state until programming steps are complete
AUD_DMD_RA_DDS	24'h3205BC	32'h002A73BD	Recommended values for A2 setup
AUD_RATE_ADJ1	24'h3205D8	16'h0100	Recommended values for A2 setup
AUD_RATE_ADJ2	24'h3205DC	16'h0200	Recommended values for A2 setup
AUD_RATE_ADJ3	24'h3205E0	16'h0300	Recommended values for A2 setup
AUD_RATE_ADJ4	24'h3205E4	16'h0400	Recommended values for A2 setup
AUD_RATE_ADJ5	24'h3205E8	16'h0500	Recommended values for A2 setup
AUD_THR_FR	24'h3203C0	16'h0000	Recommended values for A2 setup
AUD_PILOT_BQD_1_K0	24'h320380	32'h0001C000	Recommended values for A2 setup
AUD_PILOT_BQD_1_K1	24'h320384	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_1_K2	24'h320388	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_1_K3	24'h32038C	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_1_K4	24'h320390	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_2_K0	24'h320394	32'h00C00000	Recommended values for A2 setup
AUD_PILOT_BQD_2_K1	24'h320398	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_2_K2	24'h32039C	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_2_K3	24'h3203A0	32'h00000000	Recommended values for A2 setup
AUD_PILOT_BQD_2_K4	24'h3203A4	32'h00000000	Recommended values for A2 setup
AUD_C2_UP_THR	24'h3203D8	16'h1C00	Recommended values for A2 setup
AUD_C2_LO_THR	24'h3203DC	16'h1000	Recommended values for A2 setup
AUD_C1_UP_THR	24'h3203D0	16'h4C00	Recommended values for A2 setup
AUD_C1_LO_THR	24'h3203D4	16'h4000	Recommended values for A2 setup
AUD_MODE_CHG_TIMER	24'h3205B4	16'h0030	Recommended values for A2 setup
AUD_START_TIMER	24'h3205B0	16'h0200	Recommended values for A2 setup
AUD_AFE_16DB_EN	24'h320628	16'h0001	Recommended values for A2 setup
AUD_CORDIC_SHIFT_0	24'h320308	16'h0006	Recommended values for A2 setup
AUD_SOFT_RESET	24'h320108	16'h0000	Deassert audio soft reset
AUD_VOL_CTL	24'h32058C	16'h0000	Set volume control to 0 dB attenuation

2.2 General Purpose Host Port

2.2.1 Introduction

The CX23880/CX23882 features a general purpose bidirectional host processor interface. This enables board vendors to add additional components to a basic CX2388x design to create value-added products based around a broadcast capture solution that capitalizes on the explosion of interest in digital video and broadband data.

Table 2-16 gives some examples of peripherals that can be added to the CX23880/CX23882's host port to create higher functionality and differentiated products.

Table 2-16. CX23880/CX23882 Applications Enabled by Host Port Peripherals

Application	ICs that connect to the CX23880/CX23882 General Purpose Host Port
Digital VCR	Conexant MPEG Encoder IC
Cable Modem PC/TV	Conexant Cable Modem IC
PC/TV with IR remote control	IR Controller
Video Editor	DV Codec

2.2.2 Host Port Overview

The General Purpose Host Port (GPHP) supports peripherals that conform to either Motorola- or Intel-style bus interface signaling protocols, with appropriate big endian vs. little endian byte ordering. The GPHP supports either discrete or multiplexed address/data buses as follows:

- 8-bit data path and 8-bit address on a nonmultiplexed bus
- 16-bit data path and 16-bit address on a multiplexed bus

The GPHP allows simultaneous connection to two peripheral ICs with no external interface logic, or four peripheral ICs with external glue logic. The function of the glue logic is to decode the chip select information encoded onto the two chip select pins when in encoded chip select mode. The GPHP can then be used to gain access to the memory map of these external devices for register reads and writes.

The GPHP interface is configurable via the host interface registers. These registers allow for the selection of the bus size, handshaking mode, signal polarity, and control signal timing adjustment.

The GPHP pin interface is defined in Table 2-17.

Table 2-17. GPHP Pin Definition

Pin Number	Pin Name	Dir	Full Name	Description: GPHP Signals
91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 106, 107, 108, 109, 110	HAD[15:0]	I/O	General Purpose Host Address/Data	Bidirectional address/data access bus. The width is selectable between an 8-bit address and 8-bit data bus or a multiplexed 16-bit address/data bus.
90	HCS#	O	General Purpose Host Chip Select	External Chip select
89	HRD/HDS#	O	General Purpose Host Read/ Data Strobe	Either the active low read signal (Intel mode) or the programmable polarity data strobe signal (Motorola mode).
87	HWR/HRW#	O	General Purpose Host Write/ Read NOT Write	Either the active low write signal (Intel mode) or the read/not write (Motorola mode).
88	HALE#	O	General Purpose Host Address Latch Enable	Address Latch Enable signal. Used only in multiplexed 16-bit address/data mode.
86	HRDY#	I	General Purpose Host Ready	External data transfer acknowledge signal
85	HEXFB	I	General Purpose Host External Status	Handshaking signal for use in DMA mode to indicate the status of the external source or destination FIFO.

Host Wait-State Control

24'h380054—HST_WSC Register

Bits	Type	Default	Name	Description
[31:28]	RW	4'h1	HST_W3W	Wait state control for external write cycles to chip select: HCS[3]#. Length of write cycle = (register value * bclk period)
[27:24]	RW	4'h1	HST_W2W	HCS[2] write cycle.
[23:20]	RW	4'h1	HST_W1W	HCS[1] write cycle.
[19:16]	RW	4'h1	HST_W0W	HCS[0] write cycle.
[15:12]	RW	4'h1	HST_W3R	Wait state control for external read cycles to chip select: HCS[3]#. Length of write cycle = (register value * bclk period)
[11:8]	RW	4'h1	HST_W2R	HCS[2] read cycle.
[7:4]	RW	4'h1	HST_W1R	HCS[1] read cycle.
[3:0]	RW	4'h1	HST_W0R	HCS[0] read cycle.

Host Transfer Control

24'h380058—HST_XFER_CNTL Register

Bits	Type	Default	Name	Description
[15]	RW	1'b0	Hcs3_cs_hold	HCS[3] chip select hold time (15ns) relative to read or write enable (1 = On, 0 = Off)
[14]	RW	1'b0	Hcs2_cs_hold	HCS[2] chip select hold time
[13]	RW	1'b0	Hcs1_cs_hold	HCS[1] chip select hold time
[12]	RW	1'b0	Hcs0_cs_hold	HCS[0] chip select hold time
[11]	RW	1'b0	Hcs3_ds_polarity	External Data Strobe polarity for HCS[3](1 = positive, 0 = negative) Motorola mode only.
[10]	RW	1'b0	Hcs2_ds_polarity	External Data Strobe polarity for HCS[2]
[9]	RW	1'b0	Hcs1_ds_polarity	External Data Strobe polarity for HCS[1]
[8]	RW	1'b0	Hcs0_ds_polarity	External Data Strobe polarity for HCS[0]
[7]	RW	1'b0	Hcs3_xfer_mode	External Transfer mode for HCS[3](we# & re# or r/w# & ds#) (intel(0) or Motorola(1)
[6]	RW	1'b0	Hcs2_xfer_mode	External Transfer mode for HCS[2]
[5]	RW	1'b0	Hcs1_xfer_mode	External Transfer mode for HCS[1]
[4]	RW	1'b0	Hcs0_xfer_mode	External Transfer mode for HCS[0]
[3]	RW	1'b0	Hcs2_sh_extend	External data setup and hold time extend for HCS[3] (0 = 1x bclk period 1 = 2x bclk period)
[2]	RW	1'b0	Hcs2_sh_extend	External setup and hold extend for HCS[2]
[1]	RW	1'b0	Hcs1_sh_extend	External setup and hold extend for HCS[1]
[0]	RW	1'b0	Hcs0_sh_extend	External setup and hold extend for HCS[0]

Host Interface Width

24'h38005C—EXT_INTF_WIDTH Register

Bits	Type	Default	Name	Description
[3]	RW	1'b0	Ext_intf_width[3]	HCS3 : (0) : 16-bit (multiplexed), (1): 8-bit
[2]	RW	1'b0	Ext_intf_width[2]	HCS2 : (0) : 16-bit (multiplexed), (1): 8-bit
[1]	RW	1'b0	Ext_intf_width[1]	HCS1 : (0) : 16-bit (multiplexed), (1): 8-bit
[0]	RW	1'b0	Ext_intf_width[0]	HCS0 : (0) : 16-bit (multiplexed), (1): 8-bit

Host Peripheral Handshake

24'h380060—HRDY_HANDSHAKE Register

Bits	Type	Default	Name	Description
[3]	RW	1'b0	Mstr_handshake[3]	HCS3 HRDY handshake enable bit
[2]	RW	1'b0	Mstr_handshake[2]	HCS2 HRDY handshake enable bit
[1]	RW	1'b0	Mstr_handshake[1]	HCS1 HRDY handshake enable bit
[0]	RW	1'b0	Mstr_handshake[0]	HCS0 HRDY handshake enable bit

Host Multiplexed 16-bit Transfer Parameters

24'h380064—MUX16_PARAM Register

Bits	Type	Default	Name	Description
[31:28]	RW	4'b0001	HCS3_ale_timing	HCS3 HRDY handshake enable bit
[27:24]	RW	4'b0001	HCS2_ale_timing	HCS2 HRDY handshake enable bit
[23:20]	RW	4'b0001	HCS1_ale_timing	HCS1 HRDY handshake enable bit
[19:16]	RW	4'b0001	HCS0_ale_timing	HCS0 HRDY handshake enable bit
[15:12]	RW	4'b0010	HCS3_addr_cyc	HCS3 Address cycle width (register value * bclk period) setup time not included
[11:8]	RW	4'b0010	HCS2_addr_cyc	HCS2 Address cycle width
[7:4]	RW	4'b0010	HCS1_addr_cyc	HCS1 Address cycle width
[3:0]	RW	4'b0010	HCS0_addr_cyc	HCS0 Address cycle width

Host Chip Select Mode

24'h380068—HCS_MODE_SEL Register

Bits	Type	Default	Name	Description
[0]	RW	1'b0	HCS_mode_sel	This bit selects between the two possible chip select modes: 0 : 2-bit dedicated chip selects. For times when two or fewer devices are connected to the host port. 1 : 2-bit encoded chip selects. For times when more than two devices are connected to the host port.

Host Software Reset

24'h38C06C—HOST_SOFT_RST Register

Bits	Type	Default	Name	Description
[0]	WO	1'b0	HOST_SOFT_RST	Host Software Reset. Writing a one to this register triggers a reset of the host logic.

Host Interrupt Mask

24'h200090—HST_INT_MSK Register

Bits	Type	Default	Name	Description
[19:0]	RW	20'b0	HST_INT_MASK	A value of 1 enables the corresponding interrupt bit location in the HST_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

Host Interrupt Status

24'h200094—HST_INT_STAT Register

Bits	Type	Default	Name	Description
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/ target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/unused opcode in the instruction sequence.
[13]	RR	1'b0	UP_SYNC	Set when number of lines or bytes do not match the upstream host RISC program expectations.
[12]	RR	1'b0	DN_SYNC	Set when number of lines or bytes do not match the downstream host RISC program expectations.
[9]	RR	1'b0	UPF_UF	Set when upstream host FIFO underflow condition is being handled.
[8]	RR	1'b0	DNF_OF	Set when downstream host FIFO overflow condition is being handled.
[5]	RR	1'b0	UP_RISCI2	Set when the IRQ2 bit in a upstream host RISC instruction is set.
[4]	RR	1'b0	DN_RISCI2	Set when the IRQ2 bit in a downstream host RISC instruction is set.
[1]	RR	1'b0	UP_RISCI1	Set when the IRQ1 bit in a upstream host RISC instruction is set.
[0]	RR	1'b0	DN_RISCI1	Set when the IRQ1 bit in a downstream host RISC instruction is set.

Host Interrupt Masked Status

24'h200098—HST_INT_MSTAT Register

Bits	Type	Default	Name	Description
[19:0]	RO	20'b0	HST_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

Host Interrupt Set Status

24'h20009C—HST_INT_SSTAT Register

Bits	Type	Default	Name	Description
[16:0]	WO	17'b0	HST_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

The GPHP can support one upstream DMA (transfer from host to peripheral via CX23880/CX23882) and one downstream (transfer from peripheral to host via the CX23880/CX23882) DMA channel active at any time. These DMA channels are configured by the EPHP DMA registers and are detailed in Table 2-17.

IPB DMAC Current Buffer Pointer

24'h3000A8—DMA31_PTR1 Register

24'h3000AC—DMA32_PTR1 Register

Bits	Type	Default	Name	Description
[23:2]	RO	22'hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Current Table Pointer

24'h3000E8—DMA31_PTR2 Register

24'h3000EC—DMA32_PTR2 Register

Bits	Type	Default	Name	Description
[23:2]	RW*	22'hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Buffer Limit

24'h300128—DMA31_CNT1 Register

24'h30012C—DMA32_CNT1 Register

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

IPB DMAC Table Size

24'h300168—DMA31_CNT2 Register

24'h30016C—DMA32_CNT2 Register

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.

General Purpose Counter (Immediate access)

24'h38C020—HSTD_GP_CNT Register

24'h38C024—HSTU_GP_CNT Register

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC program.

General Purpose Counter Control (Immediate access)

24'h38C030—HSTD_GP_CNT_CNTRL Register

24'h38C034—HSTU_GP_CNT_CNTRL Register

Bits	Type	Default	Name	Description
[1:0]	WO	2'b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

Host Interface Streaming Enable (Immediate access)

24'h38C040—HST_STREAM_EN Register

Bits	Type	Default	Name	Description
[5]	RW	1'b0	HSTU_RISC_EN	RISC Controller enable for the host interface upstream DMA channel.
[4]	RW	1'b0	HSTD_RISC_EN	RISC Controller enable for the host interface downstream DMA channel
[1]	RW	1'b0	HSTU_FIFO_EN	Enable for pulling data out of the host upstream DMA FIFO or cluster descriptor table.
[0]	RW	1'b0	HSTD_FIFO_EN	Enable for fetching downstream data from the external source.

Host Upstream DMA Control Register #1

24'h380048—HSTU_DMA_CTRL1 Register

Bits	Type	Default	Name	Description
[25]	RW	1'b0	UP_FIFO_HK_EN	Host upstream FIFO handshake enable. This enables the CX23880/CX23882 to monitor the External_fifo_busy bit and act accordingly.
[24]	RW	1'b0	HSTU_AINC_EN	Host upstream address auto-increment enable. Used to DMA data to sequential addresses within the slave device. Not to be used when the destination is a FIFO.
[23:0]	RW	24'hxxxxxx	HSTU_DST_ADDR	HST upstream IPB DMA Destination address. If auto-increment is enabled then the value loaded into this register should be the starting address.

Host Downstream DMA Control Register #1

24'h38004C—HSTD_DMA_CTRL1 Register

Bits	Type	Default	Name	Description
[25]	RW	1'b0	DN_FIFO_HK_EN	Host downstream FIFO handshake enable. This enables CX23880/CX23882 to monitor the External_fifo_busy bit and act accordingly.
[24]	RW	1'b0	HSTD_AINC_EN	Host downstream address auto-increment enable. Used to DMA data to sequential addresses within the slave device. Not to be used when the destination is a FIFO.
[23:0]	RW	24'hxxxxxx	HSTD_SRC_ADDR	HOST downstream IPB DMA source address. If auto increment is enabled then the value loaded into this register should be the starting address.

Host Downstream DMA Control Register #2

24'h380050—HSTD_DMA_CTRL2 Register

Bits	Type	Default	Name	Description
[11:0]	RW	12'b0	HST_LNGTH	HST downstream transfer count in bytes.

2.2.3 General Purpose Host Port Memory Space

The memory space associated with the GPHP is divided into two categories, internal registers and the external peripheral address space. Table 2-18 provides descriptions of each address range in the GPHP memory space.

Table 2-18. GPHP Memory Space

ADDRESS RANGE	SIZE	DESCRIPTION
380000–38FFFF	64 KB	HOST local registers, specific to the CX23880
390000–39FFFF	64 KB	Peripheral 1 address space
3A0000–3AFFFF	64 KB	Peripheral 2 address space
3B0000–3BFFFF	64 KB	Peripheral 3 address space
3C0000–3CFFFF	64 KB	Peripheral 4 address space

2.2.4 General Purpose Host Port Interface Register Access

There are 64 KB of address space available within the GPHP address space for each of the four possible peripherals and all of the registers pertaining to the GPHP configuration. For the peripherals that are connected to the CX23880/CX223882 via the 8-bit data interface, only the lower 256 bytes of this space are accessible. This register mapping allows the peripherals to have their registers directly mapped into the CX23880/CX23882 memory map.

2.2.5 General Purpose Host Interface External DMA Transfers

Streaming of data upstream and downstream is achieved via the DMA mechanism resident in the GPHP. There are two dedicated DMA channels that are available One channel is dedicated to upstream DMA while the other is dedicated to downstream DMA.

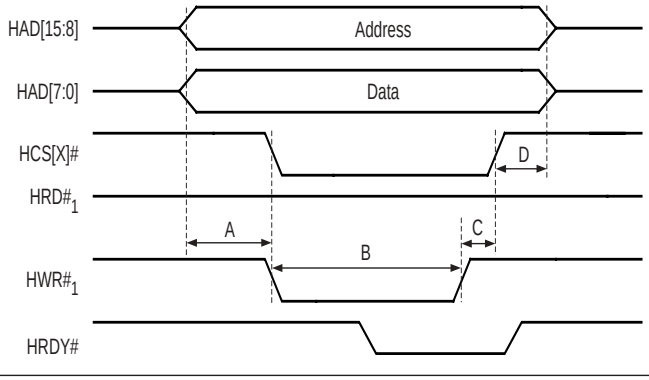
Once the DMAC is set up for the transfer, the GPHP must be configured. This configuration consists of the programming of the GPHP DMA Setup registers. For upstream transfers, the GPHP must be programmed with the external destination address, auto increment enable/disable, and end-of-transfer interrupt enable. For downstream transfers, the GPHP must be programmed with the external source address, byte count, auto increment enable/disable, and end-of-transfer interrupt enable. These reads and writes are then forwarded by the GPHP to the appropriate external source or destination address.

Upon completion of a packet of data, the GPHP generates the appropriate DMA interrupt.

The GPHP uses its external FIFO status pin to interface with an external streaming FIFO. When enabled, this pin is used to indicate when the external destination can safely accept more data in the upstream case, and when the external source has data to transfer in the downstream case. Because there are two DMA channels and only one FIFO status pin, one of the two DMA channels must use the register polling approach to obtain the FIFO status in the case where both channels are being used simultaneously.

2.2.6 General Purpose Host Interface Signaling—Nonmultiplexed Mode

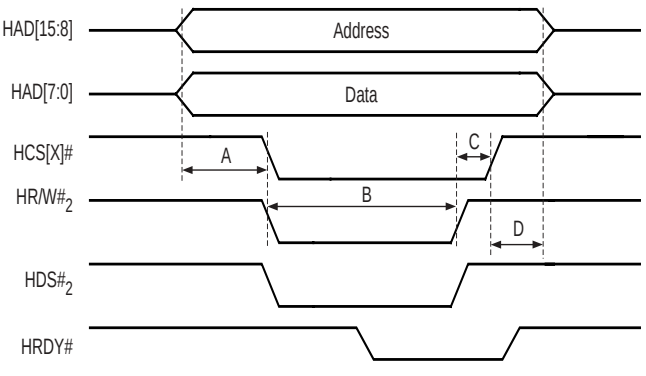
Figure 2-7. Host Interface Write Operation—Intel Style (Accessing an External Device)



NOTE(S):
- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# has programmable polarity. HRDY# is shown here in its default setting, active low.

101069_059

Figure 2-8. Host Interface Write Operation—Motorola Style (Accessing an External Device)

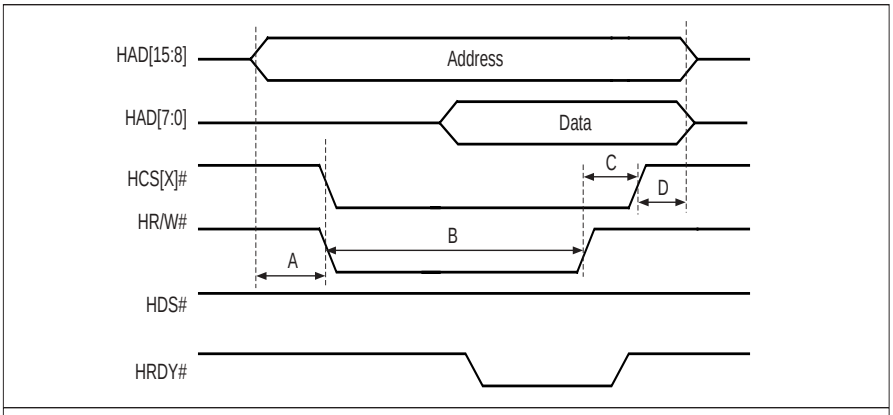


NOTE(S):
- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# and HDS# each have programmable polarity. Both are shown here in their default settings, active low.

101069_060

Description		Min	Max
A	Addr/Data setup time relative to write pulse and chip select and HDS pulse	1x PCLK Period	2x PCLK Period
B	Write pulse width, HDS pulse width	1x PCLK Period	15x PCLK Period
C	Chip select hold time relative to write pulse and HDS pulse	0	1x PCLK Period
D	Addr/Data hold time relative to chip select	1x PCLK Period	2x PCLK Period

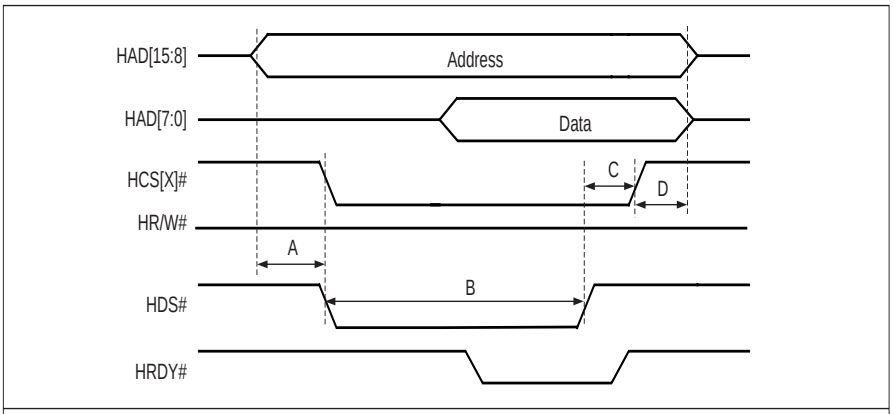
Figure 2-9. Host Interface Read Operation—Intel Style (Accessing an External Device)



NOTE(S):
- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# has programmable polarity. HRDY# is shown here in its default setting, active low.

101069_061

Figure 2-10. Host Interface Read Operation—Motorola Style (Accessing an External Device)



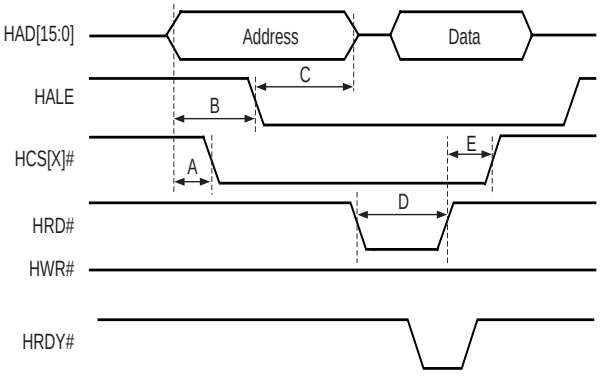
NOTE(S):
- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# and HDS# each have programmable polarity. Both are shown here in their default settings, active low.

101069_062

Description		Min	Max
A	Addr/Data setup time relative to write pulse and chip select and HDS pulse	1x PCLK Period	2x PCLK Period
B	Write pulse width, HDS pulse width	1x PCLK Period	15x PCLK Period
C	Chip select hold time relative to write pulse and HDS pulse	0	1x PCLK Period
D	Addr hold time relative to chip select	1x PCLK Period	2x PCLK Period

2.2.7 General Purpose Host Interface Signaling—Multiplexed Mode

Figure 2-11. Host Interface Read Operation—Intel Style Multiplexed Address/Data Bus (Accessing an External Device)

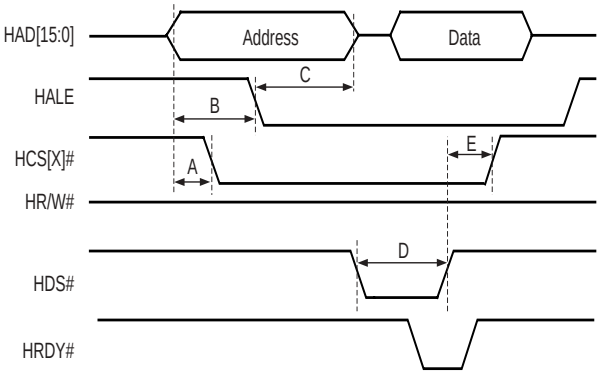


NOTE(S):

- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# has programmable polarity. HRDY# is shown here in its default setting, active low.

101069_063

Figure 2-12. Host Interface Read Operation—Motorola Style Multiplexed Address/Data Bus (Accessing an External Device)



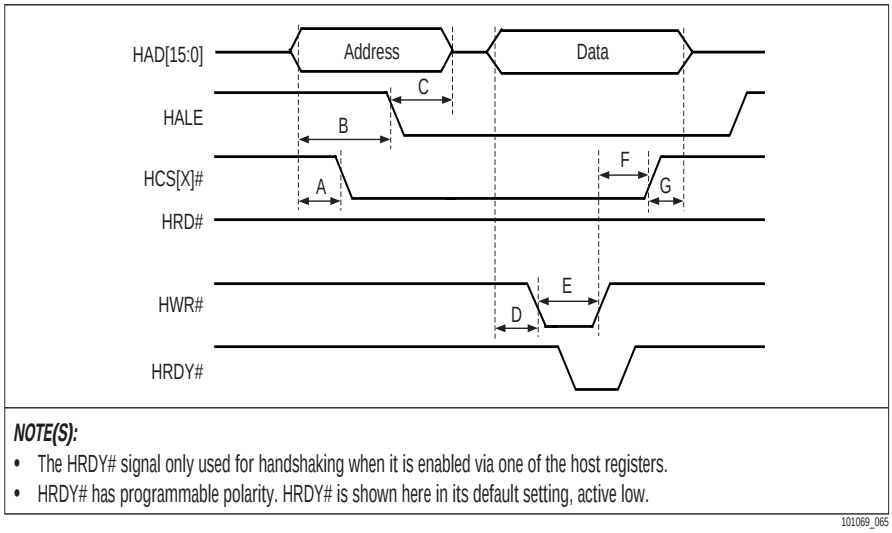
NOTE(S):

- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# and HDS# each have programmable polarity. Both are shown here in their default settings, active low.

101069_064

Description		Min	Max
A	Addr/Data setup time to chip select	1x PCLK Period	2x PCLK Period
B	Addr setup time relative to HALE	2x PCLK Period	3x PCLK Period
C	Chip select hold time relative to address latch enable	1x PCLK Period	1x PCLK Period
D	Read pulse width, HDS pulse width	1x PCLK Period	15x PCLK Period
E	Chip select hold time relative to read pulse and HDS pulse	0	1x PCLK Period

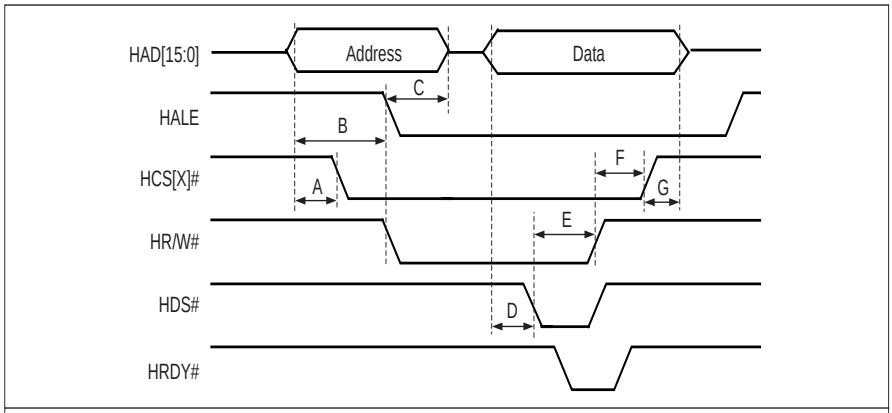
Figure 2-13. Host Interface Write Operation—Intel Style Multiplexed Address/Data Bus (Accessing an External Device)



NOTE(S):
- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# has programmable polarity. HRDY# is shown here in its default setting, active low.

101069_065

Figure 2-14. Host Interface Write Operation—Motorola Style Multiplexed Address/Data Bus (Accessing an External Device)



NOTE(S):
- The HRDY# signal only used for handshaking when it is enabled via one of the host registers.
- HRDY# and HDS# each have programmable polarity. Both are shown here in their default settings, active low.

101069_066

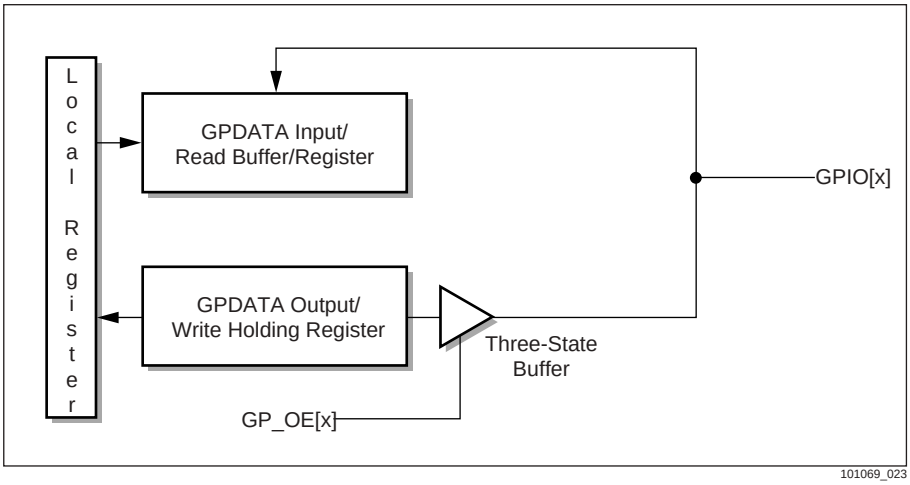
Description		Min	Max
A	Addr setup time relative to chip select	1x PCLK Period	2x PCLK Period
B	Addr setup time relative to address latch enable (hale) and HR/W#	2x PCLK Period	3x PCLK Period
C	Addr hold time relative to address latch enable (hale)	1x PCLK Period	1x PCLK Period
D	Data setup relative to (Intel) write pulse or (Moto) HDS pulse	1x PCLK Period	1x PCLK Period
E	(Intel) Write pulse width (Moto) HDS pulse width	1x PCLK Period	15x PCLK Period
F	Chip select hold time relative to write pulse and HDS pulse	0	1x PCLK Period
G	Data hold time relative to the chip select	1x PCLK Period	2x PCLK Period

2.3 General Purpose Input/Output

2.3.1 GPIO Pin Architecture

Each General Purpose Input/Output (GPIO) pin is set up as a basic I/O buffer, with each bit of the General Purpose Output Enable (GPOE) register used to enable an individual pin's output driver (see Figure 2-15).

Figure 2-15. GPIO Pin Architecture



2.3.2 GPIO Modes in CX2388x

Twenty-four pins are provided for GPIO. They are mapped onto the pin numbers listed in Table 2-19.

Table 2-19. GPIO Pin Numbers

Pin Numbers	GPIO Number
8–15	[23–16]
112–119	[15–8]
123–130	[7–0]

The GPIO port is highly flexible and can be assigned to the following functions with the CX23880. For CX23881/CX23883, not all of these functions are available. See Table 1-1.

- General purpose I/O functions
- MPEG input parallel port (DVB common interface-compatible)
- VIP parallel host port expansion
- Digital video output from the video decoder as either 8-bit or 10-bit, 4:2:2 samples with 601-like external synchronization signals
- Digital video output from the video decoder as 8-bit, *ITU-R656*, 27 MHz, 4:2:2 samples
- Digital video input to the CX238880/CX23882 image scaler (and subsequent DMA to VGA overlay surface) from an external MPEG decoder outputting *ITU-R656*, 27 MHz, 4:2:2 interlaced samples or 54 MHz noninterlaced video samples
- General purpose host port external chip select function

The PINMUX_IO register is used to configure the entire GPIO port as desired. On power up or PCI reset, all GPIO pins are undedicated. The 8 bits of the PINMUX_IO register [7:0] can be used to select any of 9 different basic functional usage configurations. Combinations of modes are possible, provided I/O pins do not overlap. The priority with respect to pin allocation to a desired function is from bit 7 down to bit 0. Therefore, if multiple GPIO modes are selected, the modes with the higher index is dominant and overwrites the functional meaning of pins selected by the lower index modes. In other words, MPEG_PAR_EN takes priority over VIP_MODE.

24'35C044—PINMUX_IO

Bits	Mode	Default	Program	Mode Name	Description
[7]	1	0	1	MPEG_PAR_EN	MPEG parallel port
[6:5]	2/3	00	xx	VIP_MODE	VIP host port width
[4]	4	0	1	VID_SYNC_EN	601 Video external output syncs
[3]	5	0	1	VID8_OUT_EN	656 Video 8-bit output port
[2]	6	0	1	VID10_OUT_EN	656 Video 10-bit output port
[1]	7	0	1	VID_IN_EN	656 Video input port
[0]	8	0	1	HCS1_EN	Host port chip select

Table 2-20 illustrates which modes can be used with other modes and which are mutually exclusive. Table 2-21 illustrates the GPIO mode versus pin usage.

NOTE: MPEG_PAR_EN, VIP4_MODE, VIP8_MODE, and HCS1_EN are extensions of the existing serial MPEG port, 2-bit VIP Host Master port, and General Purpose Host Port, which are available at all times, irrespective of GPIO configuration.

Table 2-20. GPIO Mode Allocation

Mode Name	GPIO Pins																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
MPEG_PAR_EN																		X	X	X	X	X	X	X
VIP4_MODE																	X	X						
VIP8_MODE																	X	X	X	X	X	X		
VID_SYNC_EN	X	X	X	X	X	X	X																	
VID8_OUT_EN									X	X	X	X	X	X	X	X								
VID10_OUT_EN									X	X	X	X	X	X	X	X							X	X
VID_IN_EN	X	X	X	X	X	X	X	X																
HCS1_EN																								X
Note(s): X = Used in that mode; blank is unused and the pin is available for normal GPIO.																								

Table 2-21. GPIO Mode versus Pin Usage

Default Power-Up Reset State		PINMUX_IO		PINMUX_IO		PINMUX_IO		PINMUX_IO	
Pin	Dir	MPEG_PAR_EN=1		VIP_MODE=01		VIP_MODE=10		HCS1_EN=1	
		Signal	Dir	Signal	Dir	Signal	Dir	Signal	Dir
GPIO[23]	I/O	Tsdat[1]	I					HCS[1]#	O
GPIO[22]	I/O	Tsdat[2]	I						
GPIO[21]	I/O	Tsdat[3]	I			VHAD[7]	I/O		
GPIO[20]	I/O	Tsdat[4]	I			VHAD[6]	I/O		
GPIO[19]	I/O	Tsdat[5]	I			VHAD[5]	I/O		
GPIO[18]	I/O	Tsdat[6]	I			VHAD[4]	I/O		
GPIO[17]	I/O	Tsdat[7]	I	VHAD[3]	I/O	VHAD[3]	I/O		
GPIO[16]	I/O			VHAD[2]	I/O	VHAD[2]	I/O		
GPIO[23]	I/O					VDO[1]	O		
GPIO[22]	I/O					VDO[0]	O		
GPIO[21]	I/O								
GPIO[20]	I/O								
GPIO[19]	I/O								
GPIO[18]	I/O								
GPIO[17]	I/O								
GPIO[16]	I/O								
GPIO[15]	I/O			VDO[9]	O	VDO[9]	O		
GPIO[14]	I/O			VDO[8]	O	VDO[8]	O		
GPIO[13]	I/O			VDO[7]	O	VDO[7]	O		
GPIO[12]	I/O			VDO[6]	O	VDO[6]	O		
GPIO[11]	I/O			VDO[5]	O	VDO[5]	O		
GPIO[10]	I/O			VDO[4]	O	VDO[4]	O		
GPIO[9]	I/O			VDO[3]	O	VDO[3]	O		
GPIO[8]	I/O			VDO[2]	O	VDO[2]	O		
GPIO[7]	I/O							VDI[7]	I
GPIO[6]	I/O	V_NVRESET	O					VDI[6]	I
GPIO[5]	I/O	V_NHRESET	O					VDI[5]	I
GPIO[4]	I/O	V_HACTIVE	O					VDI[4]	I
GPIO[3]	I/O	V_VACTIVE	O					VDI[3]	I
GPIO[2]	I/O	V_CBFLAG	O					VDI[2]	I
GPIO[1]	I/O	V_FIELD	O					VDI[1]	I
GPIO[0]	I/O	V_VALID	O					VDI[0]	I

2.3.3 GPIO Normal Mode

The GPIO Port Normal mode can be used to input or output general board-level signals to or from the CX2388x. The PINMUX_IO bits are in the default state of 32'h0000 during Normal mode. When in Normal mode, these pins are not designed to support a high speed interface for video or broadband data. For such applications, the other modes must be used.

24'h350010—GP0_IO Register

24'h350014—GP1_IO Register

24'h350018—GP2_IO Register

24'h35001C—GP3_IO Register

Bits	Type	Default	Name	Description
[31:26]	RO	6'h00		Reserved
[25]	RW	1'b0	GP3_MODE	A value of 0 enables the GPIO register interface in default mode where each set of 8 pins are controlled by a GP{x}_IO register. A value of 1 enables all 24 GPIO and/or GPOE bits to be read/written simultaneously.
[24]	RO	1'b0		Reserved
[23:16]	Wd		GP{x}_BWE	If this field is equal to 8'h00, then the whole GPIO byte register operates in normal RW mode. If any bit is set, then the corresponding GP_OE and GP_IO bit locations are enabled for writing. If the bit write enable is not set, the corresponding GPIO bits will be unaffected.
[15:8]	RW	8'h00	GP{x}_OE	A value of 1 enables corresponding GP_IO bit to be output on the GPIO pin.
[7:0]	RW*	8'h00	GP{x}_IO	Writing provides data for GPIO output pin drivers. Reading accesses data directly from input pin buffers.

Note that the GP3_* control bits are only available in register GP3_IO. If GP3_MODE is set to 24-bit access mode, then the GPIO register interface loses bit resolution field control capability and looks like:

24'h350010—GPIO

Bits	Type	Default	Name	Description
[23:0]	RW*	24'h000000	GP_IO	Writing provides data for GPIO output pin drivers. Reading accesses data directly from input pin buffers.

24'h350014—GPOE

Bits	Type	Default	Name	Description
[23:0]	RW*	24'h000000	GP_OE	A value of 1 enables corresponding GP_IO bit to be output on the GPIO pin.

In addition to capturing or generating simple input/output signals, some GPIO pins have the capability of servicing externally generated interrupts. GPIO [23:22] (pins 8 and 9) have input interrupt capability. The GPIO_ISM register allows control of input signal polarity and level or edge sensitivity.

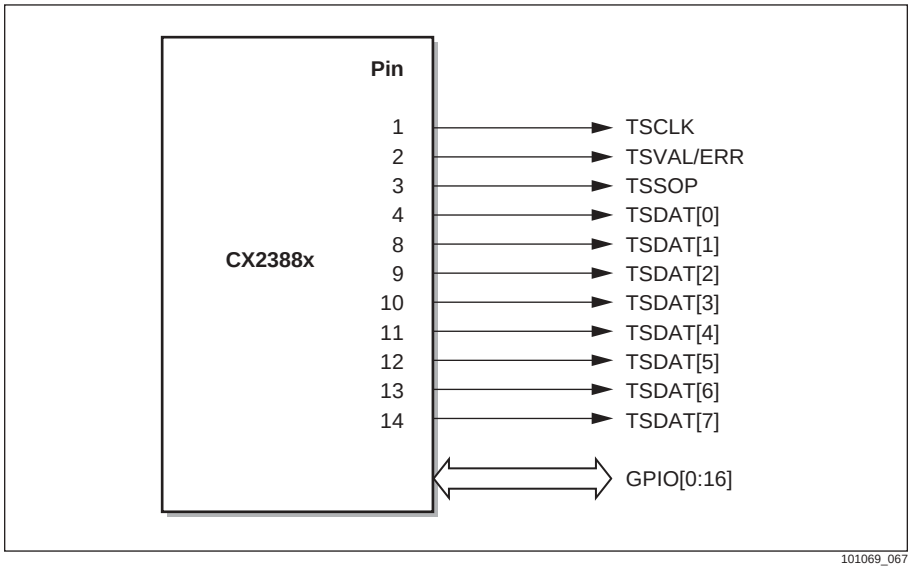
24'h350028—GPIO_ISM

Bits	Type	Default	Name	Description
[3:2]	WO	2'b00	GP_ISM_SNS	Sensitivity mode for interrupt inputs GPIO[23:22]. 0 = level-sensitive 1 = edge-sensitive
[1:0]	WO	2'b00	GP_ISM_POL	Polarity control for interrupt inputs GPIO[23:22]. 1 = active-hi or posedge 0 = active-lo or negedge Note this control inverted from SPIPE for active low interrupts default.

2.3.4 MPEG Parallel Port

From Table 2-21, it can be seen that setting the PINMUX_IO register to 8'h80 enables the MPEG_PAR_EN mode, whereby the existing serial MPEG port is augmented by GPIO [17:23] to enable a full parallel MPEG input port for connection of DVB channel demodulators (which typically use an 8-bit data interface conforming to ETSI document EN 50221). Alternatively, MPEG encoders outputting compressed data over an 8-bit path should use this mode. GPIO [0:16] become available for other functions such as 4:2:2 video input, output or GPIO. This is illustrated in Figure 2-16.

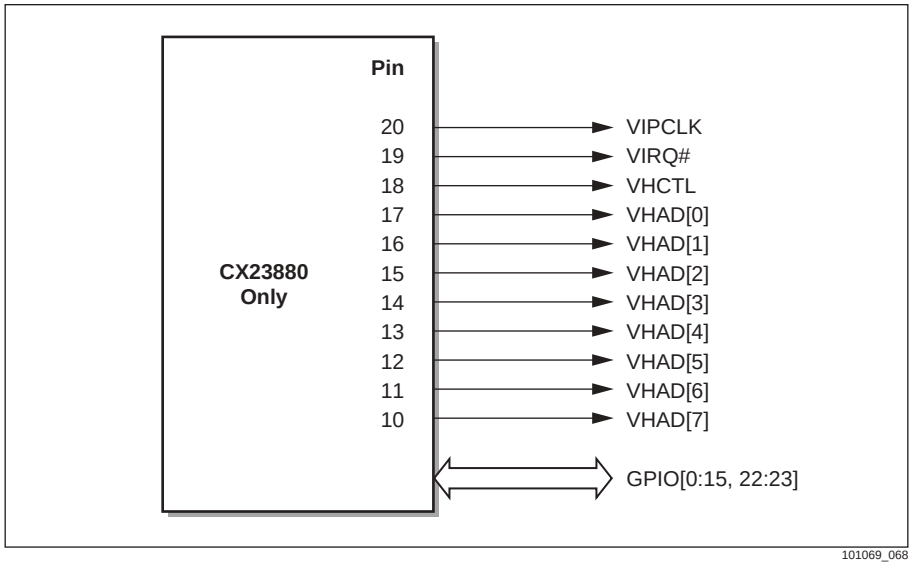
Figure 2-16. MPEG Parallel Port



2.3.5 8-bit Parallel VIP Host Master

From Table 2-21, setting PINMUX_IO register to 8'h40 enables the 8-bit VIP Host Port mode, whereby the existing 2-bit VIP Host Port mode is augmented by GPIO [16:21] to enable a full 8-bit parallel VIP Host Master interface for connection of high performance digital video or graphics peripherals. GPIO [0:15,22:23] become available for other functions such as 4:2:2 video input, output or GPIO. As seen from Table 2-21, this mode is mutually exclusive from MPEG_PAR_EN. This mode is not available on the CX23881/CX23882/CX23883. See Figure 2-17.

Figure 2-17. 8-bit Parallel VIP Host Master



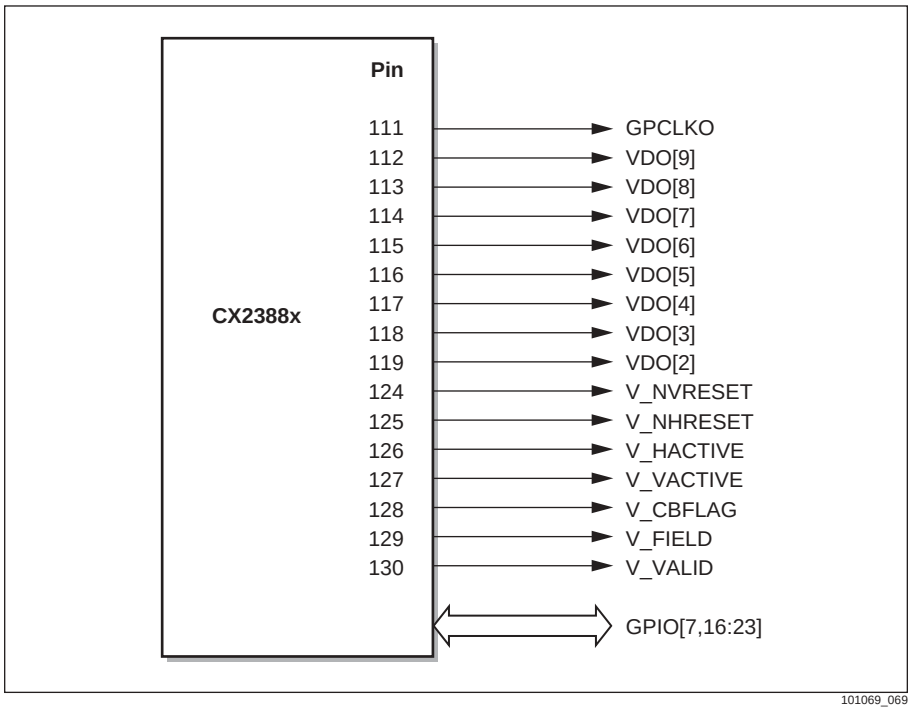
2.3.6 4-bit Parallel VIP Host Master

From Table 2-21, setting PINMUX_IO register to 8'h20 enables the 4-bit VIP Host Port mode, whereby the existing 2-bit VIP Host Port mode is augmented by GPIO [16:17] to enable a 4-bit parallel VIP Host Master interface for connection of medium performance digital video or graphics peripherals. GPIO [0:15, 18:23] become available for other functions such as 4:2:2 video input, output or GPIO. As seen from Table 2-21, this mode is mutually exclusive from MPEG_PAR_EN. This mode is not available on the CX23881/CX23882/CX23883.

2.3.7 Video Synchronous Pixel (SPI) Mode

This mode enables 8- or 10-bit 4:2:2 data to be output from the CX23880/CX23882 to an external compressor or hardware deinterlacing integrated circuit, etc., which may not implement embedded video synchronization codes as used in ITU-R. BT656 or VIP 1.1 standards. If discrete video synchronization signals are required, then this mode which is invoked by setting PINMUX_IO register to 8'h08 should be used. From Table 2-21 GPIO [0:6] provide external synchronization signals, GPIO [8:15] are used for 8-bit 4:2:2 output samples and GPIO [7, 16:23] are available for other functions. See Figure 2-18.

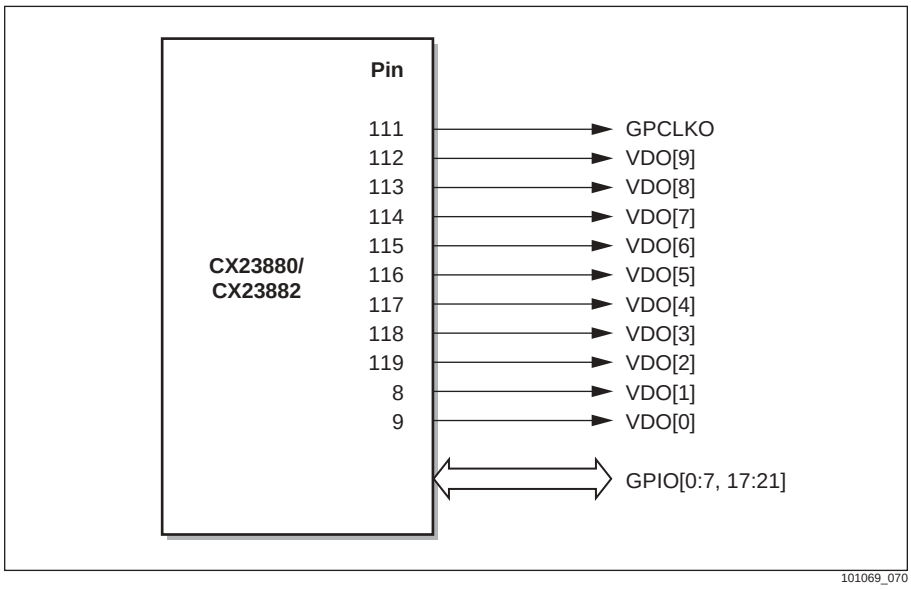
Figure 2-18. Video Synchronous Pixel (SPI) Mode



2.3.8 10-bit ITU-R. BT656 Output Mode

This mode enables 10-bit 4:2:2 data to be output from the CX23880/CX23882 to an external compressor or hardware deinterlacing integrated circuit etc. which implements embedded video synchronization codes as used in ITU-R. BT656 or VIP 1.1 standards. This mode is invoked by setting PINMUX_IO register to 8'h04. From Table 2-21 GPIO [8:15, 22:23] are used for 10-bit 4:2:2 output samples and GPIO [0:7, 16:21] are available for other functions. See Figure 2-19.

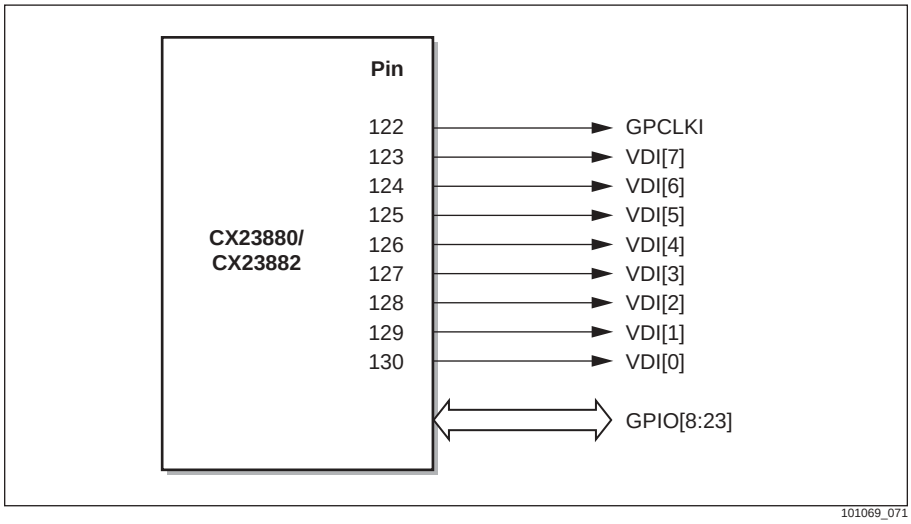
Figure 2-19. 10-bit ITU-R. BT656 Output Mode



2.3.9 8-bit ITU-R. BT656/VIP 2.0 Pixel Input Mode

This mode enables 8-bit 4:2:2 data to be input to the CX23880/CX23882 from an external video de-compressor for scaling and DMA transfer to a VGA overlay surface for display. The incoming video data must adhere to 27 MHz ITU-R. BT656/VIP 1.1 or 8-bit VIP 2.0 pixel data at a maximum data rate of 54 MHz. This mode is configured by setting PINMUX_IO register to 8'h02. From Table 2-21 GPIO [0:7] are used for 8-bit 4:2:2 input samples and GPIO [8:23] are available for other functions. See Figure 2-20.

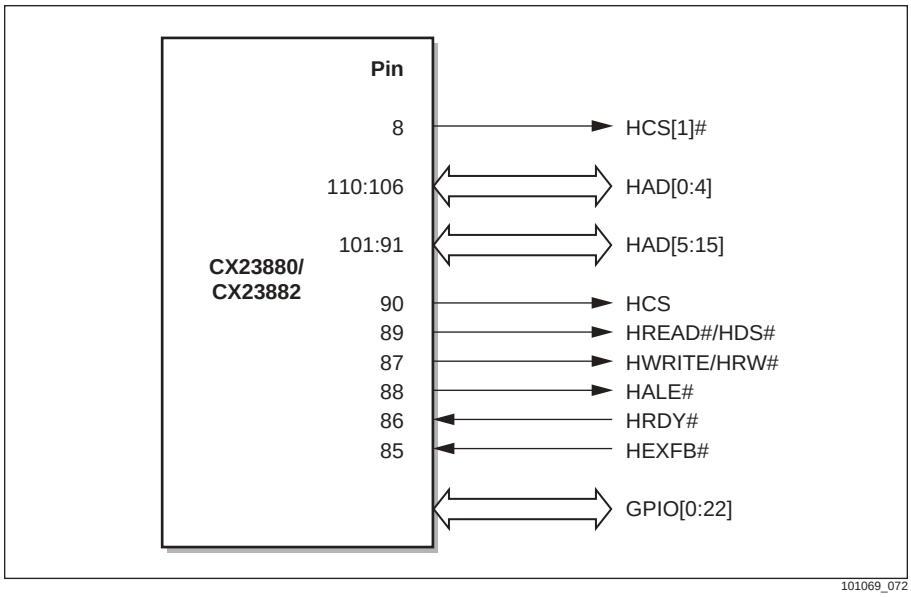
Figure 2-20. 8-bit ITU-R. BT656/VIP 2.0 Pixel Input Mode



2.3.10 Host Port Chip Select Enable Mode

This mode enables four external peripheral devices to be connected to the CX23880/CX23882 General Purpose Host Port with simple glue decode logic. In conjunction with Pin 90 (HCS), GPIO[23] becomes a second chip select pin, thus enabling selection of up to four external peripherals. This mode is configured by setting PINMUX_IO register to 8'h01. From Table 2-21 GPIO [23] is used as the HCS[1] pin and GPIO[0:22) are available for other functions. See Figure 2-21.

Figure 2-21. Host Port Chip Select Enable Mode



2.4 Peripheral Component Interface (PCI)

The PCI subsystem contains the interfaces, data buffers, and control registers to allow the high integrity, high bandwidth transfer of data between the CX2388x and the host. The subsystem is very flexible to allow being tailored to fit the many possible applications. Many features have been incorporated to enable the handling of PCI bus latencies with minimal data loss. Data is buffered internally using a programmable SRAM based architecture, and transferred using a unique RISC and DMA controller architecture. The PCI subsystem also allows the host to access all internal memory, internal registers and external peripheral registers. The interface is implemented as a 32-bit wide, 33 MHz data path that conforms to the PCI Local Bus Specification Revision 2.2.

2.4.1 PCI Functions

The five peripherals of the CX23880 are assigned to the PCI functions detailed in Table 2-22.

Table 2-22. PCI Functions

Function	Peripheral
0	Video
1	Audio
2	Transport Stream
3	VIP Host Port
4	General Purpose Host Port

The CX23880 is configurable to have from one to five PCI functions depending on a particular application. For example, if an application only uses video, audio, and transport stream, the VIP Host Port and General Purpose Host Port functions can be disabled. This is useful to eliminate the need for software drivers for functions that are not needed. Any combination of functions can be enabled or disabled, with the exception that function 0 cannot be disabled as required by the PCI specification.

Functions one through five are enabled using bits [1:4] of $I^2C^{®}$ compatible address 15'h5000, respectively, in the I^2C compatible EEPROM which are automatically loaded into the CX23880 at reset. While the functions are automatically being configured after reset, any PCI accesses to the CX23880 will be retried, to ensure that the PCI configuration space will be established before the PCI system BIOS begins to access it. If no I^2C compatible EEPROM is connected to the CX23880 via I^2C compatible, all functions will be disabled except for function 0. The EEPROM can be programmed before being placed on the printed circuit board (PCB), or it can be written using the CX23880 I^2C compatible control registers or the Vital Product Data (VPD) mechanism.

2.4.2 PCI Configuration Space

Each enabled function has its own PCI configuration space. There are separate Device ID, Command, Status, Master Latency Timer, Maximum Latency, Minimum Grant, Interrupt Line, Base Address, and Power Management registers for each function, to allow independent control. A few registers, which contain information common to all functions, are shared though they appear in the configuration spaces of all functions (e.g., Vendor ID, Subsystem Vendor, Subsystem ID, and Vital Product Data). The CX2388x will not respond to an attempted configuration space access to a disabled function, and therefore the access will terminate with a Master Abort, as required by the PCI specification

2.4.3 PCI Subsystem IDs

The Subsystem ID and Subsystem Vendor ID registers are automatically loaded at reset with the data located in the I^2C compatible EEPROM at I^2C compatible address 15'h5004 through 15'h5007. While the registers are being loaded after reset, any PCI accesses to the CX2388x will be retried, to ensure that the Subsystem ID and Subsystem Vendor ID will be established before the PCI system BIOS begins to access them. If no I^2C compatible EEPROM is connected to the CX2388x via I^2C compatible, the Subsystem ID and Subsystem Vendor ID registers will be loaded with 0. The EEPROM can be programmed before being placed on the printed circuit board (PCB), or it can be written using the CX2388x I^2C compatible control registers or the Vital Product Data (VPD) mechanism. The Subsystem ID and Subsystem Vendor ID registers can also be written directly by software. To enable this, the SVIDS_EN bit in the Device Control #1 register must be first written to a 1.

2.4.4 Accessing VPD on the CX23880

To access the I²C EEPROM on the CX23880, the software application must add 15'h5008 to the address.

A typical example is when the application program needs to access memory address 15'h0020 in the I²C EEPROM. The application program must add 15'h5008 to the 15'h0020 address. The sum 15'h5028 is then written in the VPD_ADRS register.

The application program must add 15'h5008 to the address because there is no re-mapping of the I²C EEPROM in the CX23880. VPD starts at the physical address of 16'h5008. The 15-bit physical address maps directly to the EEPROM physical storage space. Addresses 11'h000-11'h007 are reserved in the EEPROM for function enables and Subsystem Vendor ID. Therefore, the first available VPD address is 15'h5008.

The I^2C compatible EEPROM can be read any time by using the I^2C compatible hardware, software, or direct mode.

2.4.5 PCI Specification Regarding VPD Implementation

Section 6.4 (Vital Product Data) in *PCI Specification revision 2.2* states that implementation of VPD is optional. In addition, operating systems such as Microsoft Windows and system BIOS do not access VPD data during the PCI configuration cycle of the system.

Even though VPD implementation is optional, adapter manufacturers are encouraged to provide VPD support by the PCI Special Interest Group due to its "inherent benefits for the adapter, system manufacturers, and for Plug and Play." For this reason if Conexant has a next generation of the CX23880 it will incorporate the re-map that enables application developers programs to work properly when accessing VPD data on the CX23880.

2.4.6 Using VPD Data with Multiple Functions on One Card

Function 0 for Video will be the only function that uses VPD. This is permitted as indicated by fourth paragraph preceding Figure I-2 in Appendix-I of *PCI specification revision 2.2*.

2.4.7 PCI Power Management

The CX2388x implements the power management mechanism according to the *PCI Bus Power Management Interface Specification Revision 1.1*. Power states D0 (on), $D3_{cold}$ (off), and $D3_{hot}$ are supported. When the power state of all enabled functions is $D3_{hot}$, the CX2388x will go into a low power consumption mode.

2.4.8 Memory Space

The CX2388x registers and 32 KByte SRAM are mapped into the 16 MByte address space defined by each PCI function Base Address register. This means that the registers and SRAM can be accessed in the memory space of any function. The memory map in Table 2-23 indicates the 24-bit offset from the base address of the functions.

Table 2-23. CX23880 Memory Space

Beginning Address	Resource
24'h000000	unused
24'h180000	SRAM (32 Kbytes)
24'h188000	unused
24'h200000	DMAC
24'h310000	Video
24'h320000	Audio
24'h330000	Transport Stream
24'h340000	VIP
24'h350000	Miscellaneous
24'h360000	I^2C compatible
24'h370000	unused
24'h380000	General Purpose Host
24'h3D0000	unused

2.4.9 PCI Data Streaming

The CX2388x uses the resources in the PCI Subsystem to stream data between its peripherals and the host processor, across the PCI bus. A total of 12 streams of data are supported, and can be active simultaneously, though the typical application scenario will use a subset of the streams. The streams are independent from each other and are controlled on an individual basis. There are two types of data stream channels, namely downstream and upstream. A downstream channel transfers data from a peripheral to the host memory using the PCI bus. An upstream channel transfers data from the host memory to a peripheral using the PCI bus. High performance internal data paths and programmable depth FIFOs are used to optimize the throughput of data across the PCI bus. The programmable depth FIFOs, which are implemented using the internal SRAM, de-couple the constant rate flow of peripheral data from the bursts and latencies of the PCI bus. The channels have been assigned an arbitrary number that is used for identification. Table 2-24 shows the channel information.

D

Table 2-24. MA Channel Assignment

Channel Number	Purpose	Type	$BW_{max\ (MHz)}$
21	Video packed or planar Y (luminance)	down	48
22	Video planar U (chrominance)	down	6
23	Video planar V (chrominance)	down	6
24	Video VBI (vertical blanking interval data)	down	36
25	Audio (from audio decoder)	down	0.2
26	Audio (to digital-analog converters)	up	0.2
28	Transport Stream (MPEG)	down	9
29	VIP Host (from Video Interface Port peripheral)	down	6.5
30	VIP Host (to Video Interface Port peripheral)	up	6.5
31	GP Host (from General Purpose Host peripheral)	down	6.5
32	GP Host (to General Purpose Host peripheral)	up	6.5

2.4.10 SRAM

The CX2388x contains an internal 32 Kbyte SRAM that is used to store data and control information for the active streams. The usage of the SRAM is programmable to accommodate a wide range of application scenarios. For example, an application can implement larger FIFOs on high bandwidth streams and smaller FIFOs on low bandwidth streams to handle the transfer latencies that may be encountered on the PCI bus. A multiple stream application may have some streams that are more tolerant to occasional data loss than others. The more critical streams can use deeper FIFOs, while the more tolerant streams can use smaller FIFOs. In addition to the FIFOs, the SRAM is used for control information, namely, RISC instruction queues, Channel Management Data Structures (CMDS), and optionally RISC programs. For each application, the FIFO depth for each stream is programmable, with the obvious restriction that the SRAM space used for the FIFOs plus the control information for all the active streams, cannot exceed 32 Kbytes.

2.4.11 FIFO Size Calculation

FIFOs are used to decouple the constant data rate stream and the burst transfer nature of the PCI bus. Though the PCI bus has sufficient average bandwidth to accommodate the demands of the peripherals, latencies can exist that are significant and can cause loss of peripheral data if no buffering were provided. The amount of FIFO buffering required depends on the average bandwidth of the peripheral data and the duration of PCI latencies to be tolerated. Latencies encountered on PC systems are usually in the 10-20 microsecond range, with occasionally longer latencies of 100-200 microseconds. By sizing the FIFO buffers properly, most applications will be able to protect its streams from the PCI latencies that are commonly encountered. The amount of buffering is the multiplication product of the average bandwidth of the data stream and the PCI latency duration.

The following is an example calculation of the FIFO buffer required for a video PAL, 768 pixel x 576 lines, RGB16 stream to tolerate a 200 microsecond PCI latency. The data stream bandwidth would be 24 Mbytes per second (25 frames per second * 625 total lines per frame * 768 pixels per line * 2 bytes per pixel = 24 Mbytes per second). The amount of FIFO buffering required would be 4800 bytes (24 Mbytes per second * 200 microseconds = 4800 bytes). Since the FIFO buffer must be a multiple number of lines and be two or greater, the FIFO buffer would actually be 6144 bytes (4800 bytes / 2 bytes per pixel / 768 pixels per line = 3.125 lines, rounded up to 4 lines * 768 pixels per line * 2 bytes per pixel = 6144 bytes). The actual latency protection would be 256 microseconds (6144 bytes / 24 Mbytes per second = 256 microseconds). Rounding down to 3 lines would require only 4608 bytes (3 lines * 768 pixels per line * 2 bytes per pixel = 4608 bytes), which would provide latency protection of 192 microseconds (4608 / 24 Mbytes per second = 192 microseconds).

The following is an example calculation of the FIFO buffer required for an ATSC MPEG transport stream (2.5 Mbytes per second) to tolerate a 200 microsecond PCI latency. The artificial line length is arbitrary, and the value chosen will affect the size of the FIFO as it must be a multiple number of lines. This example will be done using an artificial line length of 4 MPEG packets, which is 752 bytes (4 packets * 188 bytes per packet). The amount of FIFO buffering required would be 500 bytes (2.5 Mbytes per second * 200 microseconds = 500 bytes). Since the FIFO buffer must be a multiple number of lines and must two or greater, the FIFO buffer would actually be 1504 bytes (752 bytes per line * 2 lines = 1504 bytes). The actual latency protection would be 601.6 microseconds (1504 bytes / 2.5 Mbytes per second = 601.6 microseconds).

2.4.12 Programmable FIFO

A programmable FIFO is implemented in the SRAM using a number of equal sized buffers, known as Cluster Buffers, and a table of pointers to the buffers, known as a Cluster Descriptor Table. The number of buffers and the size of the buffers are programmable, and are chosen based on the depth of the FIFO needed. For example, if a 1 Kbyte FIFO is needed for a stream, it could be implemented using 4, 256 byte buffers. A different stream could have a 1 Kbyte FIFO implemented using 8, 128 byte buffers.

Though the number and size of the buffers are programmable, there are a few restrictions. The number of buffers must be two or greater. This allows the peripheral to be streaming data to or from a buffer, while the PCI DMA controller bursts data to or from a different buffer. Each buffer must large enough to accommodate one and only one line of peripheral data, and be an integer number of qwords (8 bytes). For video streams, the line size is dependent on the video format. For example, a 768 pixel x 576 line, RGB32 format would have 3 Kbyte lines. The other downstream peripherals are not inherently line based and therefore use an artificial line length chosen by the application. For example, an MPEG Transport Stream may chose a line length equal to four packets, which would be 752 bytes (4x 188 bytes).

To specify the buffer size, use the DMAx_CNT1 register, where x is the number of the stream from Table 2-24. The register is written with the number of qwords minus one. For example, to specify 3 Kbytes as the size of the buffers for the packed video stream, write 11'h17F to the DMA21_CNT1 register. To specify the buffer locations, use the Cluster Descriptor Table as described in the following paragraphs.

The set of buffers that make up a FIFO are supported by a Cluster Descriptor Table (CDT), which is also located in the SRAM. The table contains a four dword descriptor for each buffer, therefore the size of the CDT is directly related to the number of buffers that make up the FIFO. For example, a FIFO that was made up of three buffers would have a three entry table which would be a total of 48 bytes. The first dword of each entry is the address of the beginning of the buffer. The address is a 24-bit SRAM address (24'h18xxxx) and must be dword aligned. The other three dwords of each descriptor are reserved for use by the internal hardware.

To specify the CDT size, use the DMAx_CNT2 register, where x is the number of the stream from Table 2-24. The register is written with the number of qwords. For example, to specify 48 bytes as the size of the CDT for the packed video stream, write 11'h006 to the DMA21_CNT2 register. This value must also be written to the Cluster Descriptor Table Size field in the Channel Management Data Structure (CMDS).

To specify the SRAM location of the CDT, use the DMAx_PTR2 register, where x is the number of the stream from Table 2-24. The register is written with the 24-bit SRAM address (24'h18xxxx) and must be dword aligned. For example, to specify 15'h1000 as the CDT location for the packed video stream, write 24'h181000 to the DMA21_PTR2 register. This value must also be written to the Cluster Descriptor Table Base field in the Channel Management Data Structure (CMDS).

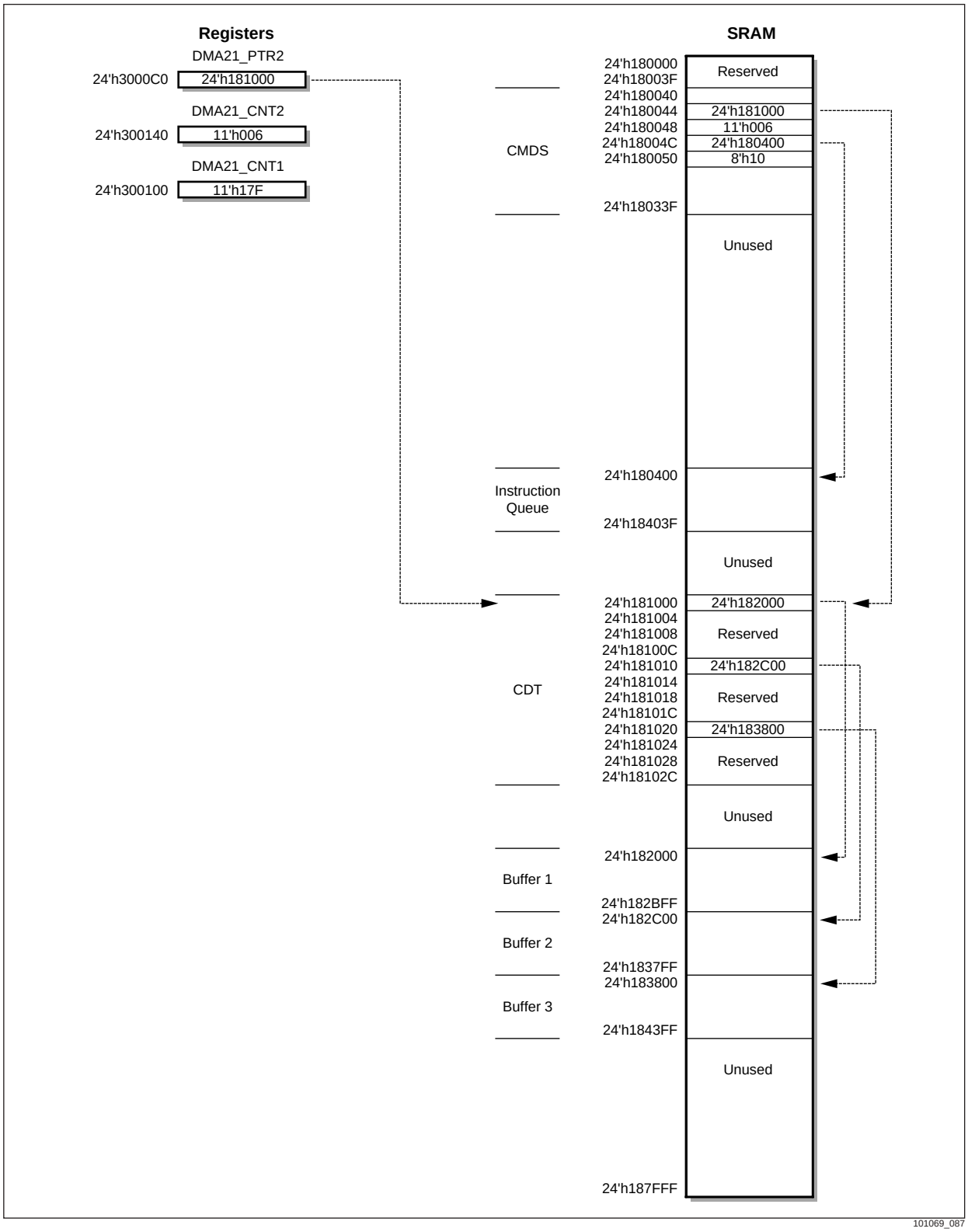
To specify the SRAM locations of the buffers, use the first dword of each descriptor in the CDT. The register is written with the 24-bit SRAM address (24'h18xxxx) and must be dword aligned. For example, to specify the SRAM locations for the start of three, 3 Kbyte buffers to be 15'h2000, 15'h2C00, and 15'h3800, using a CDT that is located at 15'h1000, write 24'h182000 to 24'h181000, 24'h182C00 to 24'h181010, and 24'h183800 to 24'h181020.

The CDT and buffers can be located anywhere in the SRAM with the exception of the address range 15'h0000 to 15'h033F, which is reserved for the Channel Management Data Structures.

2.4.13 RISC Instruction Queue

The CX2388x DMA architecture includes a RISC controller, which is programmed using a simple set of RISC instructions. A series of RISC instructions form a program that specifies the PCI target addresses and the amount of data to be read or written by the CX2388x DMA controller. The RISC programs are generated by the software driver on the host and are stored either in host memory or in CX2388x SRAM. Each active stream implements a RISC instruction queue in the SRAM to maximize the flow of instructions from the program memory to the RISC controller. When the RISC controller has no other higher priority task to attend to, such as transferring stream data, it will attempt to keep the instruction queue full. This increases the system performance as the RISC controller will virtually always have the next instruction available in SRAM when it needs it, and will not have to wait until it can fetch it from the host memory. The instruction queues are programmable in size and location in the SRAM. The minimum size is 8 dwords, the maximum size is 255 dwords, and the typical size is 16 dwords. Use the Instruction Queue Base and Instruction Queue Size fields in the Channel Management Data Structure (CMDS) to specify the location and size. The address must be dword aligned, and the size is in dwords. For example, to specify the packed video instruction queue to be 16 dwords in size and begin at address 15'h0400 in the SRAM, write 24'h180400 to address 24'h18004C, and write 8'h10 to address 24'h180050. See Figure 2-22 for an example.

Figure 2-22. SRAM Resource Example



2.4.14 Channel Management Data Structure

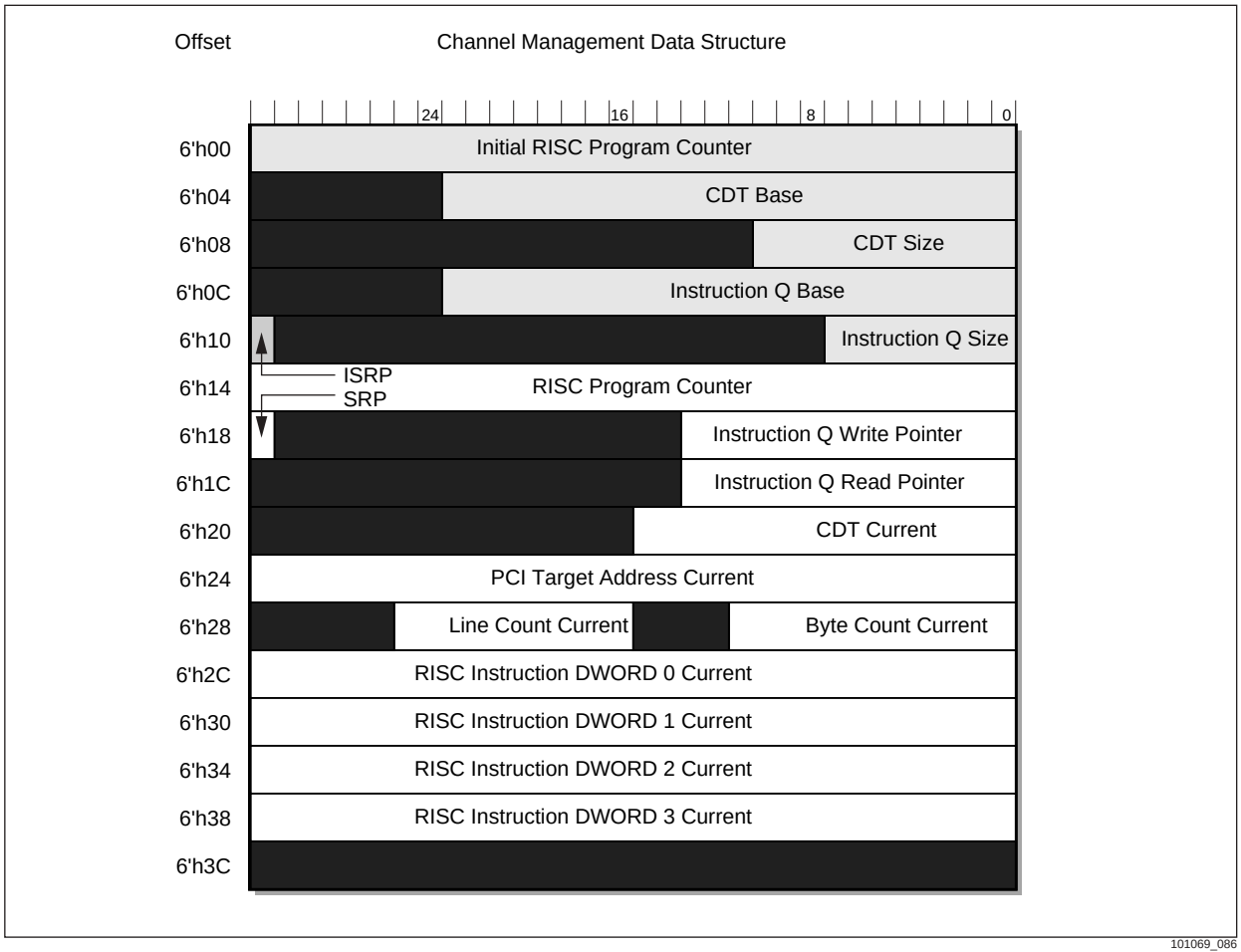
The CX2388x uses the SRAM to store information to manage each stream channel. This information is called the Channel Management Data Structure (CMDS) and is fixed in the SRAM from address 15'h0040 to 15'h033F. The CMDS for each channel is located in the SRAM as shown in Table 2-25.

Table 2-25. Channel Management Data Structure

Number	Purpose	CMDS Base
21	Video packed or planar Y (luminance)	15'h0040
22	Video planar U (chrominance)	15'h0080
23	Video planar V (chrominance)	15'h00C0
24	Video VBI (vertical blanking interval data)	15'h0100
25	Audio (from audio decoder)	15'h0140
26	Audio (to digital to analog converters)	15'h0180
28	Transport Stream (MPEG)	15'h0200
29	VIP Host (from Video Interface Port peripheral)	15'h0240
30	VIP Host (to Video Interface Port peripheral)	15'h0280
31	GP Host (from General Purpose Host peripheral)	15'h02C0
32	GP Host (to General Purpose Host peripheral)	15'h0300

The CMDS is composed of 16 dwords. The first five dwords (shown in gray in Figure 2-23) are information that is supplied by the host software to control and set up the RISC controller. The next ten dwords (shown in white in Figure 2-23) are used by the RISC controller to manage the stream channel. These fields are not to be written by the host software, though they can be read to monitor the channel information. The last dword (shown in black) is reserved and not used at this time, as are the rest of the fields shown in black in Figure 2-23. This figure also shows the layout of the CMDS. The fields of the CMDS are described in the next paragraph.

Figure 2-23. Channel Management Data Structure



Initial RISC Program Counter[31:0]

Location of the first RISC instruction. In SRAM Resident Program mode (SRP =1), this location will be an SRAM address, and only bits [23:0] are relevant. In PCI Memory Resident Program mode (SRP = 0), it will be a PCI target address of the host memory. The SRP bit is located at bit [31] in the dword at offset 6'h10.

CDT Base[23:0]

Location of beginning of the Cluster Descriptor Table in the SRAM. This address must match the address written to the DMAx_PTR2 register, where x is the number of the stream from Table 2-24. See the description of the CDT in the Programmable FIFOs section.

CDT Size[10:0]

The size in qwords of the CDT. This value must match the size written to the DMAx_CNT2 register, where x is the number of the stream from Table 2-24. See the description of the CDT in the Programmable FIFOs section.

Instruction Q Base[23:0]

Location of the beginning of the RISC instruction queue.

Instruction Q Size[7:0]

The size in dwords of the RISC instruction queue.

ISRP[31] (Initial SRAM Resident Program)

Used to specify whether the address in the Initial RISC Program Counter field is an SRAM address (ISRP =1), or a PCI target address (ISRP = 0).

RISC Program Counter[31:0]

The RISC controller uses this as temporary storage for the address of the current RISC instruction it is processing.

SRP[31] (SRAM Resident Program)

Used by the RISC controller to determine whether the program counter contains an SRAM address (SRP =1), or a PCI target address (SRP = 0).

Instruction Q Write Pointer[13:0]

Used by the RISC controller to maintain the location of the next dword to be written. This is a dword address, not a byte address.

Instruction Q Read Pointer[13:0]

Used by the RISC controller to maintain the location of the next dword to be read. This is a dword address, not a byte address.

CDT Current[15:0]

The RISC controller uses this as temporary storage for the current entry in the CDT that is being processed.

PCI Target Address Current[31:0]

The RISC controller uses this as temporary storage for the current PCI target address.

Byte Count Current[11:0]

The RISC controller uses this as temporary storage for the number of bytes of the current line that have been processed.

Line Count Current[25:16]

The RISC controller uses this as temporary storage for the current line it is processing.

RISC Instruction DWORD 0-3 Current[31:0]

The RISC controller uses this as temporary storage for the current instruction being processed.

2.4.15 RISC Controller

The CX2388x DMA architecture includes a RISC controller, which coordinates the transfer of data over the 12 stream channels. Though each channel has independent control and data buffering, they are all handled by the single RISC controller. The RISC controller is put into a reset state whenever the CX2388x is reset. To allow the RISC controller to operate the RUN_RISC bit[5] in the Device Control #2 register must be set to one. The RISC controller can be returned to the reset state at any time by clearing the RUN_RISC bit to zero.

2.4.16 RISC Instructions

The RISC controller processes a program made up of a series of RISC instructions. The purpose of the RISC program is to specify the PCI target addresses and the amount of data to be read or written by the CX2388x DMA controller. The RISC programs are generated by the software driver on the host and are stored either in host memory or in CX2388x SRAM. The address of the beginning of the program must be written to the Initial RISC Program Counter field in the CMDS. When the channel is turned on, the RISC controller will load the initial program counter into the program counter and begin processing the instructions. Programs that are stored in the host

memory are called PCI Memory Resident Programs, while programs that are stored in the CX2388x SRAM are called SRAM Resident Programs. To indicate whether the address in the Initial RISC Program Counter is a PCI memory address or a CX2388x SRAM address, the Initial SRAM Resident Program (ISRP) bit must be written. The ISRP bit is bit [31] at offset 6'h10 in the CMDS. A PCI Memory Resident Program is specified by writing the ISRP bit to 0, an SRAM Resident Program is specified by writing the ISRP bit to 1. See Figure 2-23, Channel Management Data Structure.

The RISC instruction set is composed of 10 instructions that can be categorized as downstream, upstream, and common to both directions. The downstream instructions are SYNC, WRITE, and WRITEC. The upstream instructions are READ and READC. The instructions that can be used in both downstream and upstream programs are JUMP, SKIP, WRITERM, WRITECM, and WRITECR. See Figures 2-24 through 2-33 for RISC instruction specifics.

Figure 2-24. SYNC downstream RISC Instruction

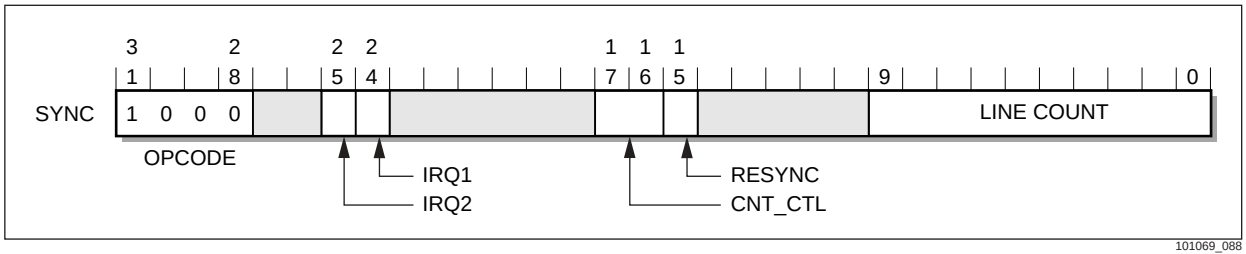


Figure 2-25. WRITE downstream RISC Instruction

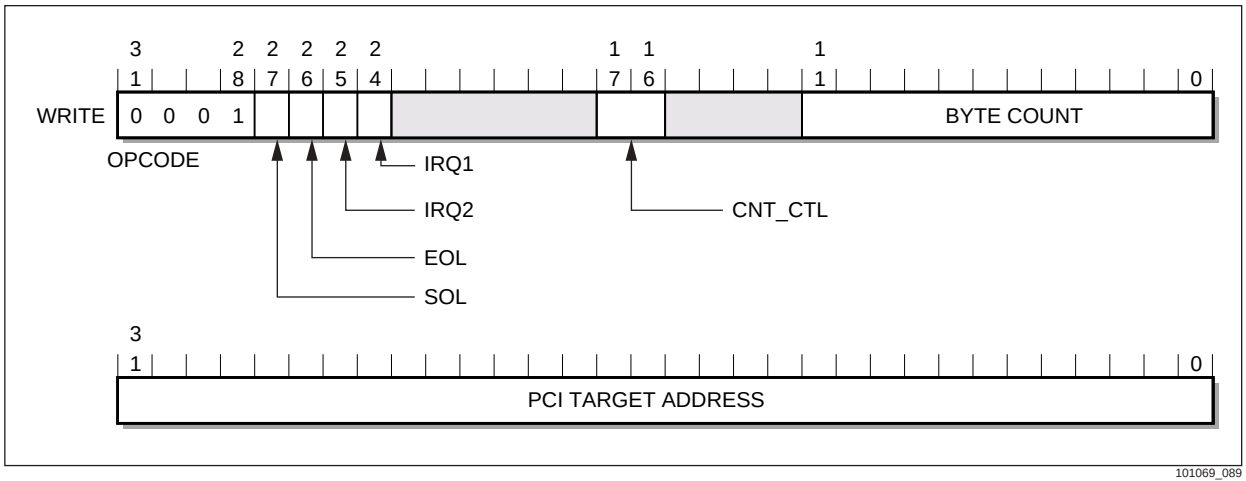


Figure 2-26. WRITEC downstream RISC instruction

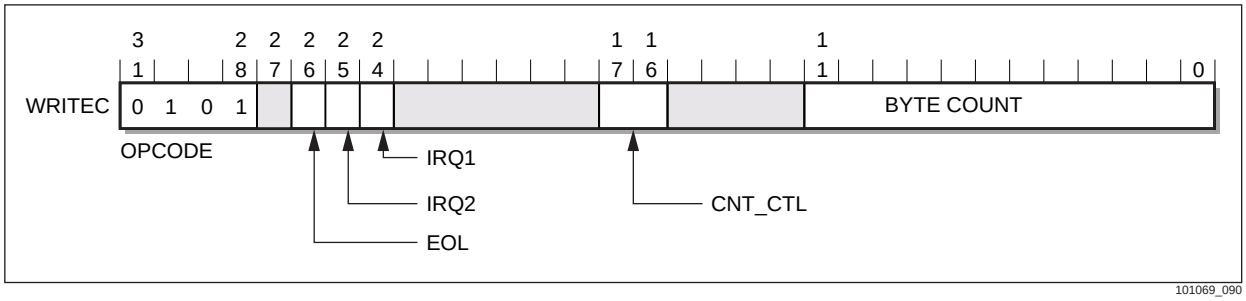


Figure 2-27. READ upstream RISC Instruction

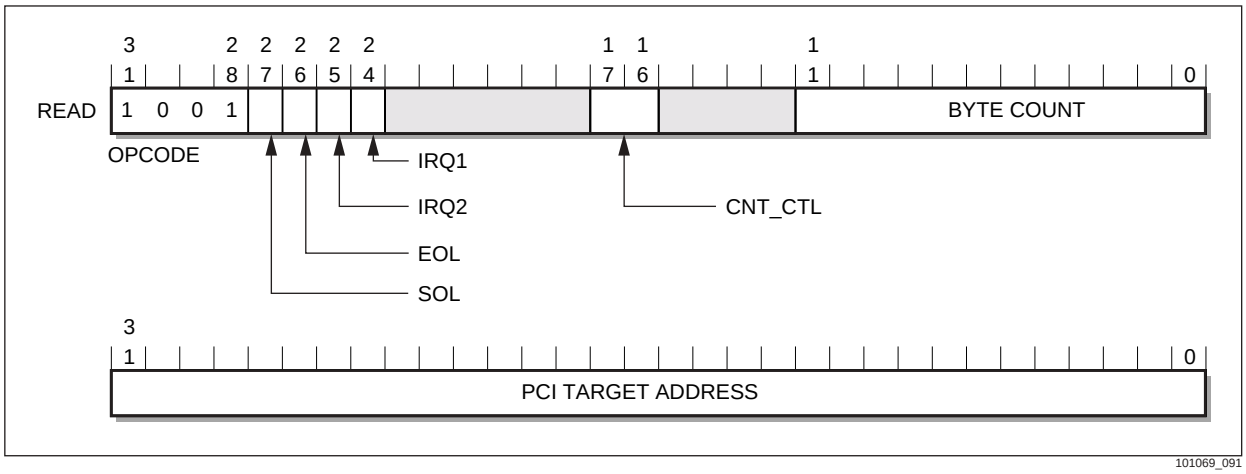


Figure 2-28. READC upstream RISC Instruction

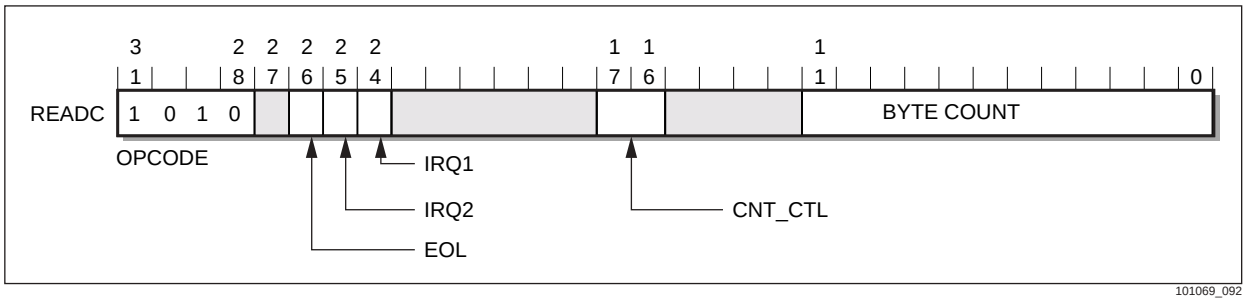


Figure 2-29. SKIP RISC Instruction

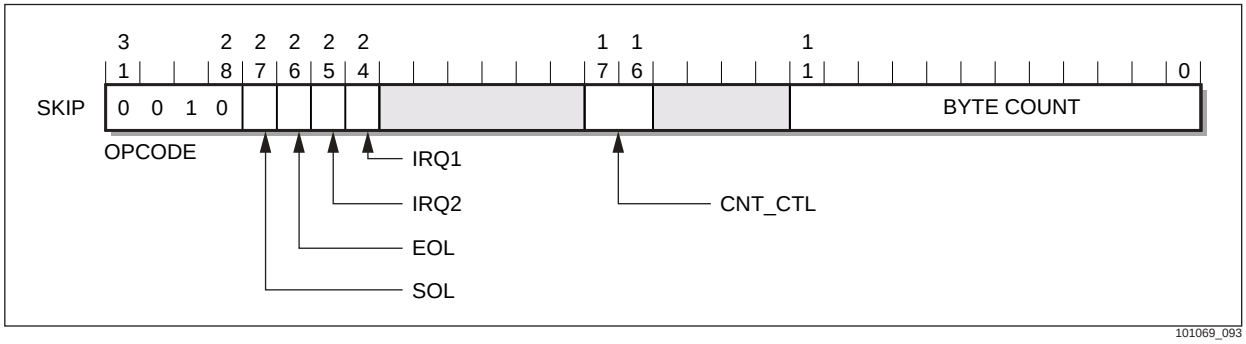


Figure 2-30. Jump RISC Instruction

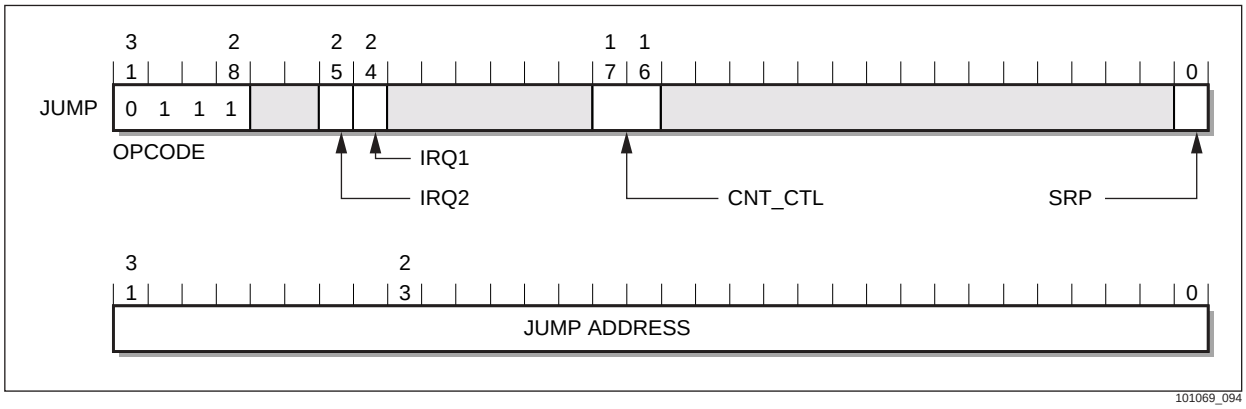


Figure 2-31. WRITERM RISC Instruction

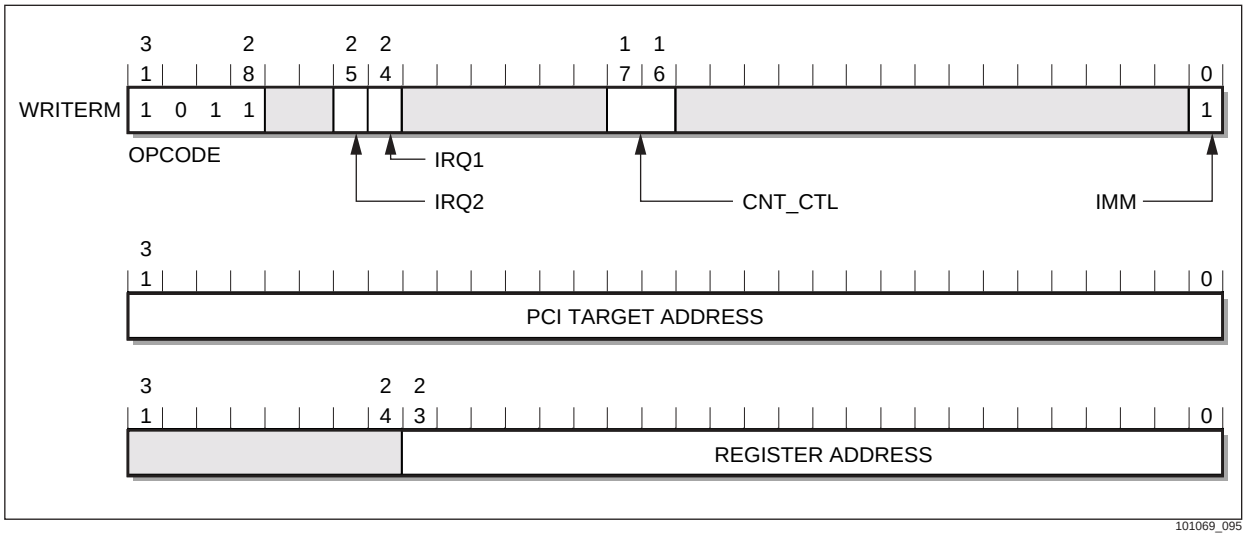


Figure 2-32. WRITECM RISC Instruction

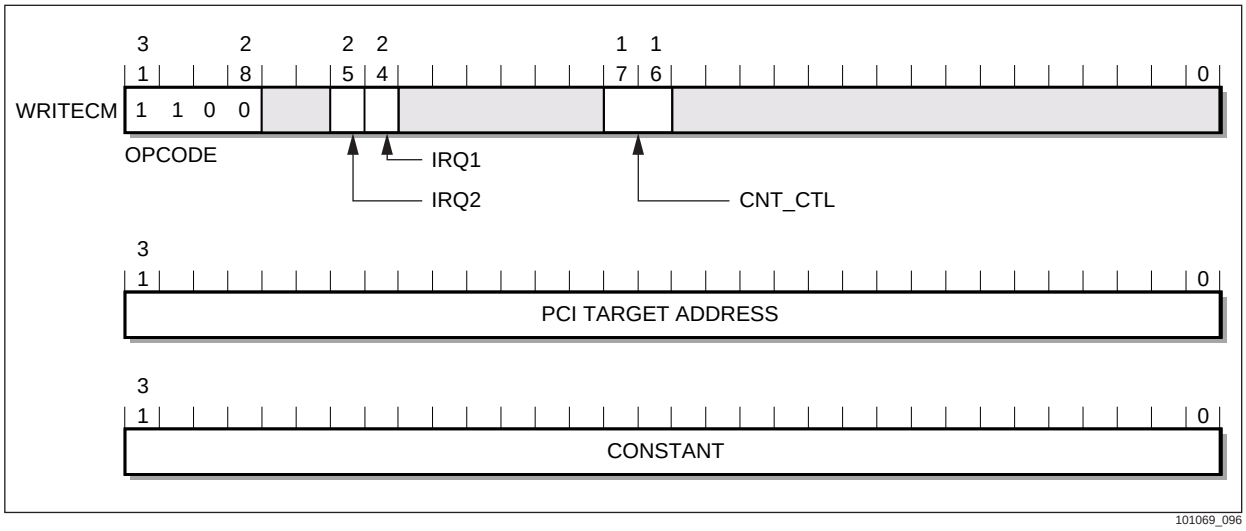
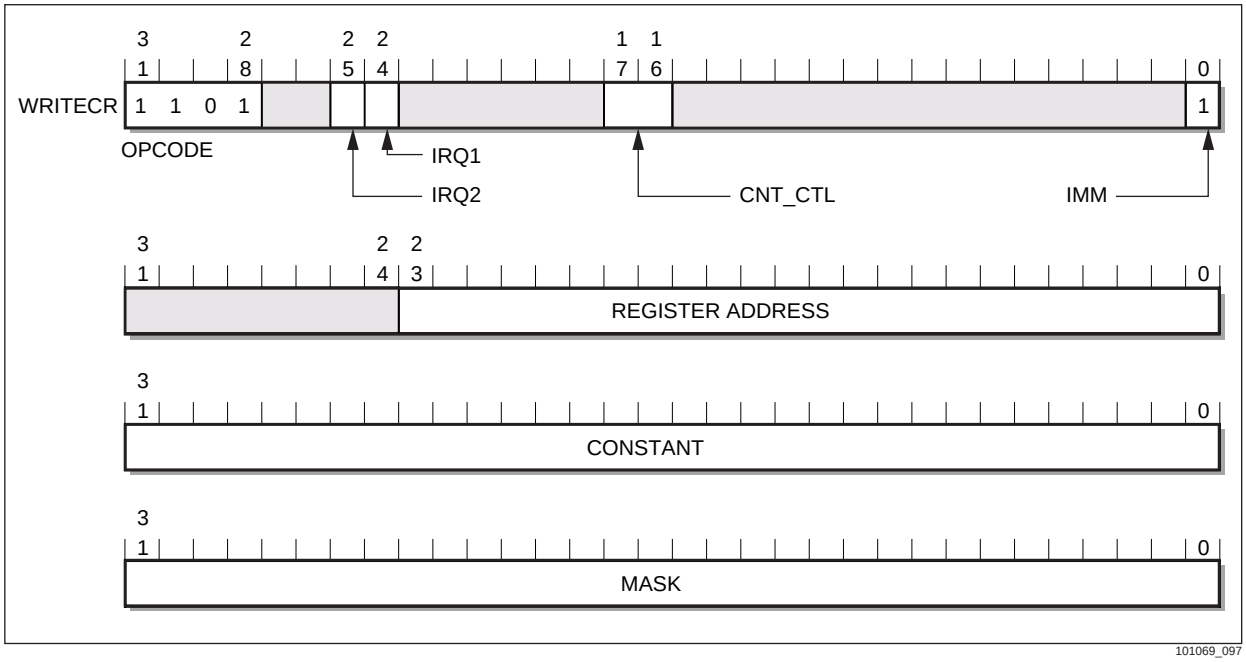


Figure 2-33. WRITECR RISC Instruction



All instructions contain two interrupt bits, IRQ1 and IRQ2, that can be used to set the RISCI1 and RISCI2 bits respectively, in the interrupt status register of the corresponding function. This allows a PCI interrupt to be generated when the instruction is executed by the RISC controller. All instructions have control bits for the general purpose counter associated with each channel. This allows the software driver to count RISC program events. The two bit CNT_CTL field is coded for the following action: 2'b00 = no change, 2'b01 = increment, 2'b10 = reserved, 2'b11 = reset to zero.

SYNC is a one dword instruction as shown above. It is used only in downstream channels to specify which line to synchronize to. This is especially important for the video streams, which are by nature line based. The lines of the odd video field are numbered starting at 10'h000, while the even video field are numbered starting at 10'h200. The other downstream channels are not naturally line based, and therefore use artificial lines. Each downstream channel has a line length register to program the number of bytes in each line. Typically, the streams that have artificial lines use a SYNC to line 10'h000 instruction.

The RISC controller will discard the data of all lines until it encounters the line specified in the SYNC instruction. The SYNC instruction is then complete, and the next instruction will be processed. If the RESYNC bit is 0, the x_SYNC bit in the interrupt status register of the corresponding function will be set, where x is the associated channel. If the RESYNC bit is 1, the interrupt bit will not be set.

WRITE is a two dword instruction as shown above. It is used only in downstream channels to specify the number of bytes of the current line to transfer, and the PCI target address to which the data must be written. The WRITE instruction is used to write an entire line or a portion of a line. It can not be used to write multiple lines. The SOL (start of line) and EOL (end of line) bits are used to specify the portion of the current line to be processed by the instruction. The SOL bit must be set when the instruction applies to the beginning of the line (i.e., no portion of the line has been transferred or discarded by the previous instruction). The EOL bit must be set when the instruction applies to the end of the line (i.e., all data of the line will have been transferred). See Table 2-26 for the possible combinations. If these bits do not match the expectations of the RISC controller, the x_SYNC bit in the interrupt status register of the corresponding function will be set, where x is the associated channel.

Table 2-26. SOL/EOL Combinations

SOL	EOL	Usage
1	0	A beginning portion of the line.
0	0	A middle portion of the line.
0	1	An ending portion of the line.
1	1	The entire line.

WRITEC is a one dword instruction as shown above. It is used only in downstream channels to continue the processing of a line that has been started by a previous WRITE or SKIP. The data is written to the PCI target address that immediately follows the last address accessed by the previous WRITE or SKIP. The WRITEC instruction can also follow other WRITEC or SKIP instructions. There is no SOL bit, as WRITEC cannot be used to transfer the beginning of a line. The EOL bit must be set when the instruction applies to the end of the line (i.e., all data of the line will have been transferred). See Table 2-26 for the possible combinations. If this bit does not match the expectations of the RISC controller, the x_SYNC bit in the interrupt status register of the corresponding function will be set, where x is the associated channel.

READ is a two dword instruction as shown above. It is used only in upstream channels to specify the number of bytes of the current line to transfer, and the PCI target address to which the data must be read. The READ instruction is used to read an

entire line or a portion of a line. It can not be used to read multiple lines. The SOL (start of line) and EOL (end of line) bits are used to specify the portion of the current line to be processed by the instruction. The SOL bit must be set when the instruction applies to the beginning of the line (i.e., no portion of the line has been transferred or discarded by the previous instruction). The EOL bit must be set when the instruction applies to the end of the line (i.e., all data of the line will have been transferred). See Table 2-26 for the possible combinations. If these bits do not match the expectations of the RISC controller, the x_SYNC bit in the interrupt status register of the corresponding function will be set, where x is the associated channel.

READC is a one dword instruction as shown above. It is used only in upstream channels to continue the processing of a line that has been started by a previous READ or SKIP. The data is read from the PCI target address that immediately follows the last address accessed by the previous READ or SKIP. The READC instruction can also follow other READC or SKIP instructions. There is no SOL bit, as READC can not be used to transfer the beginning of a line. The EOL bit must be set when the instruction applies to the end of the line (i.e., all data of the line will have been transferred). See Table 2-26 for the possible combinations. If this bit does not match the expectations of the RISC controller, the x_SYNC bit in the interrupt status register of the corresponding function will be set, where x is the associated channel.

SKIP is a one dword instruction as shown above. It is used both in downstream and upstream channels to specify the number of bytes of the current line to discard. The data is discarded beginning at the PCI target address that immediately follows the last address accessed by the previous instruction. The PCI target address will be advanced by the number of bytes in the instruction. The SKIP instruction is used to discard an entire line or a portion of a line. It can not be used to discard multiple lines. The SOL (start of line) and EOL (end of line) bits are used to specify the portion of the current line to be processed by the instruction. The SOL bit must be set when the instruction applies to the beginning of the line (i.e., no portion of the line has been transferred or discarded by the previous instruction). The EOL bit must be set when the instruction applies to the end of the line (i.e., all data of the line will have been transferred). See Table 2-26 for the possible combinations. If these bits do not match the expectations of the RISC controller, the x_SYNC bit in the interrupt status register of the corresponding function will be set, where x is the associated channel.

JUMP is a two dword instruction as shown above. It is used both in downstream and upstream channels to load the current program counter with the specified address. The jump address can be either an SRAM address (SRP = 1) in which case only address bits [23:0] are relevant, or a PCI target address (SRP = 0) in which case all 32 address bits are used.

WRITERM is a three dword instruction as shown above. It is used both in downstream and upstream channels to write the value of a CX2388x register specified by the address field to the PCI target address. This instruction is typically used as a debug tool, but may be found to useful in some special situations. The only registers that can be used with WRITERM are the ones referred to as immediate, which are shown in Table 2-27. The IMM bit must always be set to 1.

Table 2-27. WRITERM Registers

Address Range	Resource
24'h18xxxx	SRAM
24'h20xxxx	Miscellaneous registers
24'h30xxxx	Miscellaneous registers
24'h31Cxxx	Video registers
24'h32Cxxx	Audio registers
24'h33Cxxx	Transport Stream registers
24'h34Cxxx	Video Interface Port Host registers
24'h35xxxx	Miscellaneous registers
24'h38Cxxx	General Purpose Host registers

WRITECM is a three dword instruction as shown in Figure 2-32. It is used both in downstream and upstream channels to write a 32-bit constant value to the PCI target address. This instruction is typically used as a debug tool, but may be found to useful in some special situations.

WRITECR is a four dword instruction as shown above. It is used both in downstream and upstream channels to write a 32-bit constant value to a CX2388x register specified by the address field according to the specified mask. A one in any bit position of the mask field will cause the corresponding bit in the constant field to be written to the specified register. A zero in any bit position of the mask field will cause the corresponding bit in the register to be left unchanged. This instruction is typically used as a debug tool, but may be found to useful in some special situations. It is often used to turn on the FIFO enable bit of an upstream channel after the FIFO has been filled by previous READ instructions. The only registers that can be used with WRITECR are the ones referred to as immediate, which are shown in Table 2-27. The IMM bit must always be set to 1.

2.4.17 Data Stream Control

Each of the 12 stream channels has a RISC_EN bit to control whether the RISC controller is actively processing the stream of data. The RISC_EN bit is located in the Streaming Enable register of the VIP and general purpose host functions, and in the DMA Control register of the video, audio, and transport stream functions. This bit is used to turn on the streaming of a channel after it has been configured (i.e., FIFO, RISC instruction queue, CMDS, RISC program, peripheral specific setup). This bit is used to turn off the streaming of a channel at any time by clearing it to zero.

Each of the 12 stream channels has a FIFO_EN bit to control whether the peripheral is actively storing data to the FIFO (in the case of a downstream channel) or taking data from the FIFO (in the case of an upstream channel). The FIFO_EN bit is located in the Streaming Enable register of the VIP and general purpose host functions, and in the DMA Control register of the video, audio, and transport stream functions.

In the downstream channels, the FIFO_EN bit is typically turned on at the same time as the RISC_EN bit, as they are in the same register. In the upstream channels, the RISC_EN bit is typically turned on by the software driver writing the register, and the FIFO_EN bit is turned on by the upstream RISC program with a WRITECR instruction. This allows the RISC controller to fill the FIFO with data before the peripheral begins taking data from it.

2.4.18 Data Stream User's Guide

The following is a description of the steps that must be taken to stream data using the CX2388x. These steps are described in the following sections, and *must* be executed in the sequence listed below.

1. Determine total FIFO buffer size based on stream bandwidth and PCI latency
2. Initialize the Cluster Descriptor Table (CDT) in SRAM
3. Initialize the Cluster Buffer size.
4. Initialize the Cluster Descriptor Table (CDT) location and size
5. Build the RISC program in PCI memory or SRAM
6. Initialize the Channel Management Data Structure (CMDS) in SRAM
7. Configure the peripheral
8. Enable the RISC controller
9. Enable the peripheral

Step 1: FIFO Buffer Size

Based on the bandwidth of the data stream and the PCI latency to tolerate, determine the amount of FIFO data buffering needed. Then based on the line size of the data stream, determine the number of cluster buffers are needed to provide the total data buffer requirement. This determines the number of entries needed in the Cluster Descriptor Table (CDT).

Step 2: Cluster Descriptor Table (CDT)

Choose the locations for the cluster buffers in the SRAM and program the pointer to each using the first dword of each descriptor of the CDT. The remaining three dwords of each descriptor do not need to be initialized by the software, as the RISC controller will initialize them upon being enabled. This table does not need to be reinitialized by the software when the data stream is disabled. The only time it needs to be changed is when the cluster buffers need to move, or additional entries are desired in the table.

Step 3: Cluster Buffer Size

Based on the line size of the data stream (from video format or artificial) specify the cluster buffer size in qwords using the DMAx_CNT1 register, where x is the number of the stream from Table 2-24. This register does not need to be reinitialized by the software when the data stream is disabled. The only time it needs to change is when the cluster buffers size needs to change.

Step 4: Cluster Descriptor Table (CDT) Location and Size

Specify the SRAM location of the CDT using the DMAx_PTR2 register, where x is the number of the stream from Table 2-24. Based on the number of entries in the CDT, specify its size in qwords using the DMAx_CNT2 register, where x is the number of the stream from Table 2-24. These registers need to be reinitialized by the software before the data stream is enabled.

NOTE: Writing DMA{x}_CNT2 registers (location 24'h300140_14C) causes the hardware to begin using the CDT information. It is imperative to perform this step only after initialization of the Cluster Description Table, Cluster Buffer Size, and CDT location.

Step 5: RISC Program

Place the RISC program into PCI memory or SRAM depending on where it is to reside. The RISC program can reside in noncontiguous blocks of memory, with the JUMP instruction used to load the program counter with the address of the beginning of the next block.

Step 6: Channel Management Data Structure (CMDS)

Write the address of the beginning of the RISC program in the Initial RISC Program Counter field. Depending on whether the program resides in PCI memory or SRAM, write the ISRP bit.

Write the Cluster Descriptor Table (CDT) Base and Size with the same values written to the DMAx_PTR2 and DMAx_CNT2 registers, respectively.

Decide the size and location in the SRAM of the RISC instruction queue. Write the Instruction Q Base and Size with the respective values. The size value is expressed in dwords. A size of 16 dwords is typical.

These fields do not need to be reinitialized by the software when the data stream is disabled.

Step 7: Configure Peripheral

Program any downstream line length register.

Program any other configuration registers specific to the operation of the peripheral.

Clear the interrupt status register and set the interrupt mask register of the function (video, audio, MPEG transport stream, VIP, general purpose host).

Set the mask of the PCI interrupt register.

Step 8: Enable RISC Controller

The RISC controller is held in a reset state by default after the CX2388x has been reset. Enable it to run by setting the RUN_RISC bit[5] in the Device Control #2 register to one. The RISC controller will not begin to execute instructions and process data stream until the RISC enable bit for the data stream is set to one.

Step 9: Enable Peripheral Data Stream

Enable the RISC controller to begin executing instructions and processing the data stream by setting the RISC_EN bit to one. The RISC_EN bit is located in the Streaming Enable register of the VIP and general purpose host functions, and in the DMA Control register of the video, audio, and transport stream functions.

Enable the downstream peripheral to begin storing data to the FIFO. This is done by setting the FIFO_EN bit to one. This is typically done at the same time as the RISC_EN bit is done, as they are in the same register.

Upstream peripherals will, typically, be enabled using a WRITECR RISC instruction to set the FIFO_EN bit to a one. This allows the RISC controller to fill the FIFO with data, providing PCI latency protection, before the peripheral begins taking data from it.

2.4.19 PCI Master

The PCI master uses the cache line commands, Memory Write and Invalidate, Memory Read Line, and Memory Read Multiple, when appropriate, if enabled by the Memory Write and Invalidate Enable bit in the PCI Configuration Space Command register.

The PCI master arbitrates between writing the downstream data and reading the upstream or RISC instruction data. The transfer in either direction will continue until completion, and then will switch to transfer in the other direction. An exception to this is if the target terminates with RETRY consecutively and reaches the retry limit value programmed into the DMA_RTRY_LMT field in the Device Control #1 register. When this occurs, the master will switch to transfer in the other direction.

A small percentage of PCI core logic chip sets may start a bus transaction during the same cycle that GNT# is deasserted. This is not PCI 2.2 compliant. To ensure compatibility when using PCs with these PCI core logic chip sets, the EN_VSFX bit in the Device Control #1 register is provided. When in this mode, the GNT# is not passed to the CX2388x master unless its REQ# is asserted. This prevents a bus transaction from starting the same cycle as GNT# is deasserted. This also has the side effect of not being able to take advantage of bus parking, this lowering arbitration performance. The CX2388x software driver must query for these noncompliant chip sets, and set the EN_VSFX bit only if required.

2.5 MPEG Data Port

The CX2388x has a dedicated high-speed port to receive MPEG transport, elementary or program streams from digital television channel demodulators or video compressors/codecs. Using DMA, these streams are sent to the host for software-based decompression or storage.

2.5.1 Digital Television Channel Demodulators

The CX2388x can operate with any digital television channel demodulator that outputs either a serial or parallel MPEG II transport stream. See Table 2-28 for the devices that are recommended for optimal performance with the CX2388x.

Table 2-28. Recommended Channel Demodulators

Delivery Method	Modulation Scheme	Maximum Forward Error Corrected Data Rate	Conexant Device	3rd Party Device
Terrestrial (ATSC)	8VSB	20 Mbps	N/A	Nextwave NXT2002/2004
Terrestrial (DVB)	2K/8K COFDM	40 Mbps	CX22702	N/A
Cable (DOCSIS, DVB)	64/256 QAM	40 Mbps	CN9414/943	N/A
Satellite (DVB)	QPSK or 8-PSK	80 Mbps	CX24110	N/A

2.5.2 Video Compressors/Codecs

Alternatively, this port can be used to transfer compressed MPEG II or MPEG IV streams from video compressors/codecs that support compressed data output over a non-CPU-based bus, where data is continuously output and is synchronized either to an output clock or a data valid signal. The MPEG data port can absorb data rates up to 80Mbps without throttling.

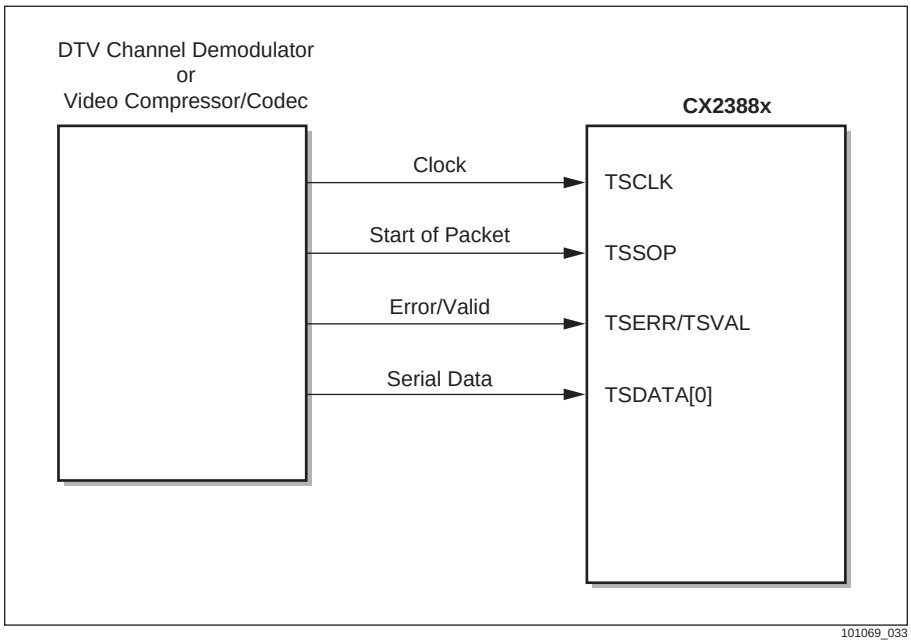
2.5.3 Serial vs. Parallel Interface

The MPEG data port can be configured for either a serial or parallel mode connection according to the functionality of the chosen channel demodulator or the video compressor/codec. Figure 2-34 illustrates the MPEG port serial interface, and Figure 2-35 illustrates the MPEG port parallel interface.

If the channel demodulator or video compressor/codec supports both a serial and a parallel mode capability, then the serial mode connection allows pins to be freed up and assigned as GPIO if desired (see Figures 2-36 through 2-39). For MPEG port setup and hold timing, see Figure 2-40.

NOTE: For very high-speed data applications (>40 Mbps), the parallel interface mode eases board layout concerns.

Figure 2-34. MPEG Port Serial Interface



To set up the CX2388x's MPEG data port in serial mode, set the IPB_SMODE in register 24'h33C050 (TS General Control) to a logical 1.

Figure 2-35. MPEG Port Parallel Interface

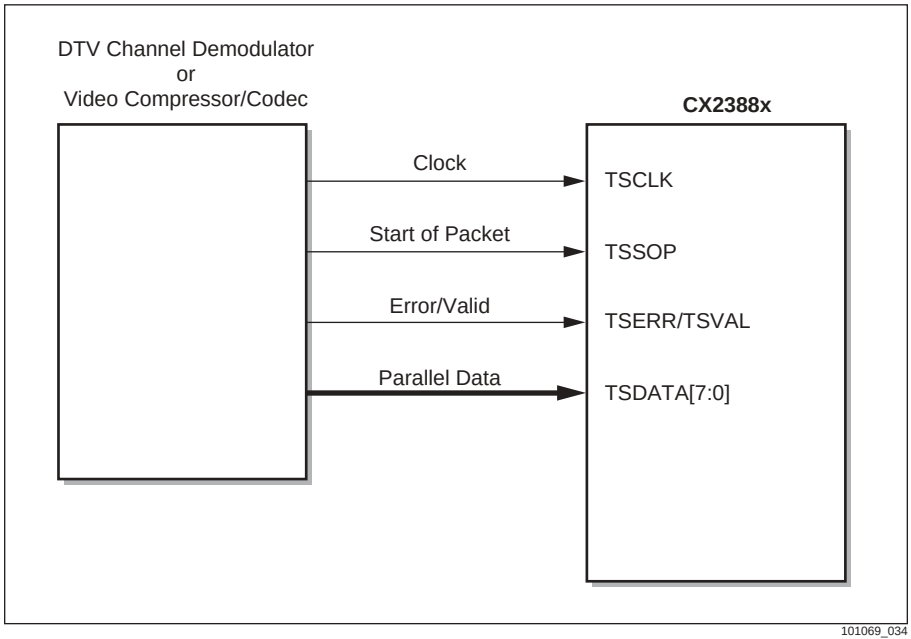


Figure 2-36. MPEG Port Parallel Mode Operation: Nonpunctured Clock, Default 188 Bytes/Pkt

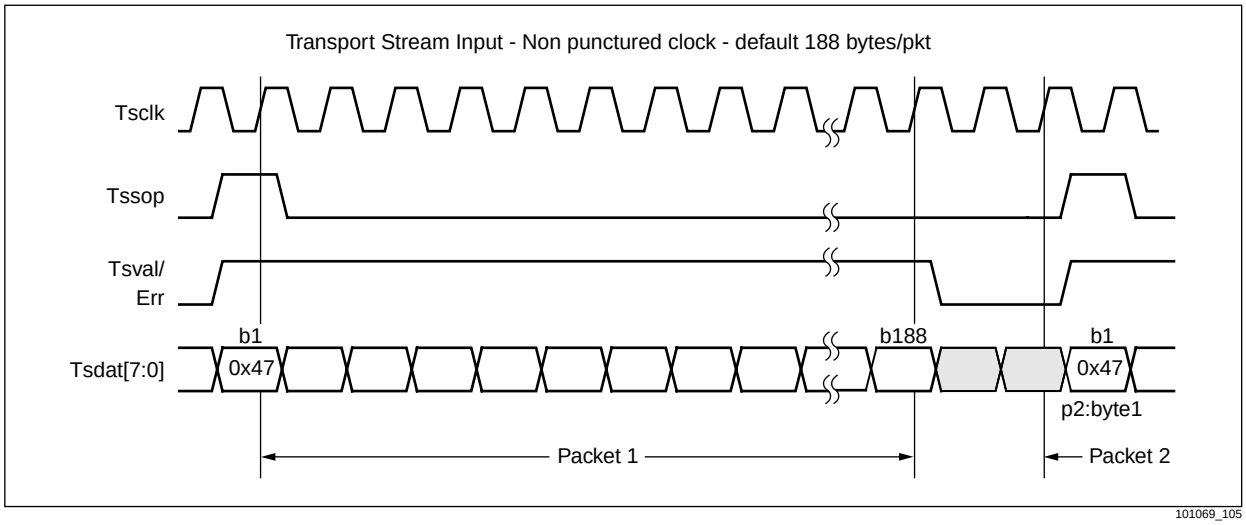


Figure 2-37. MPEG Port Parallel Mode Operation: Punctured Clock, Default 188 Bytes/Pkt

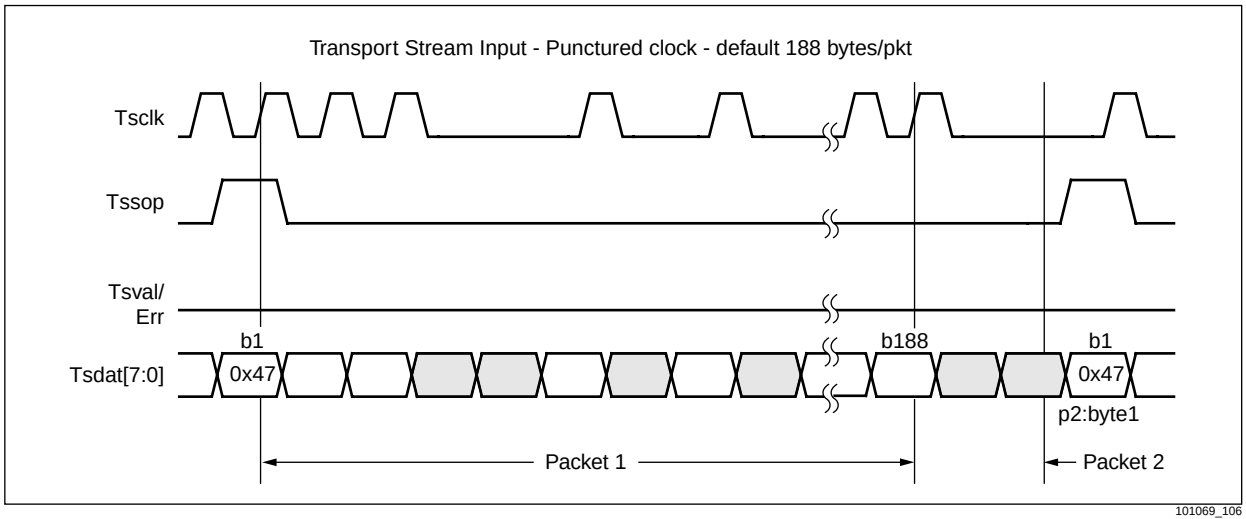


Figure 2-38. MPEG Port Serial Mode Operation: Nonpunctured Clock

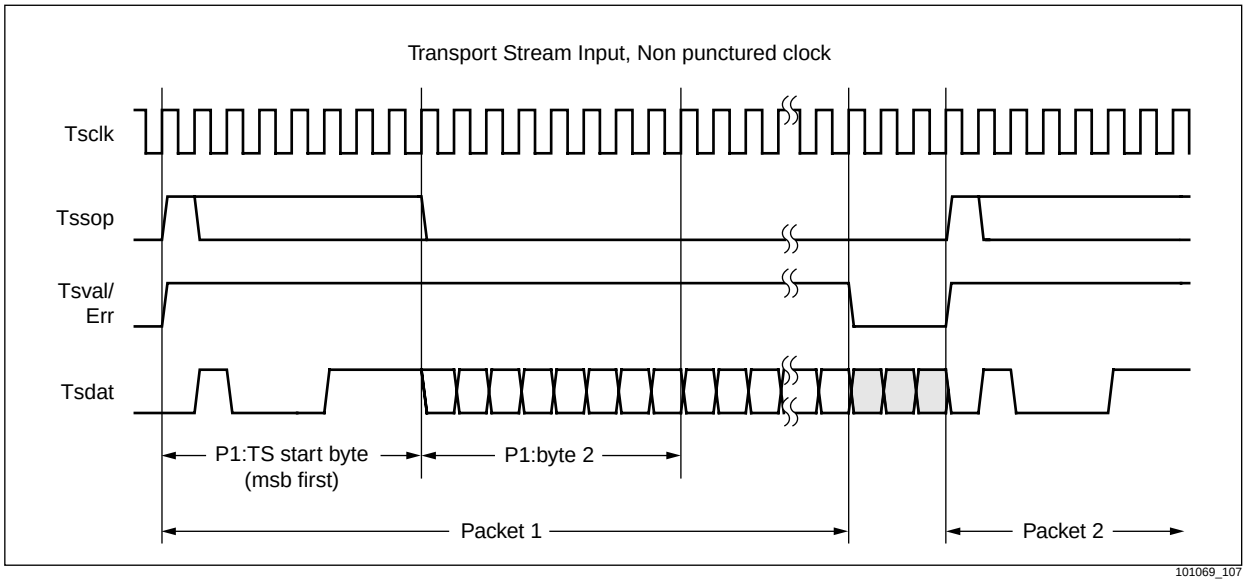


Figure 2-39. MPEG Port Parallel Mode Operation: Internally Gated Punctured Clock

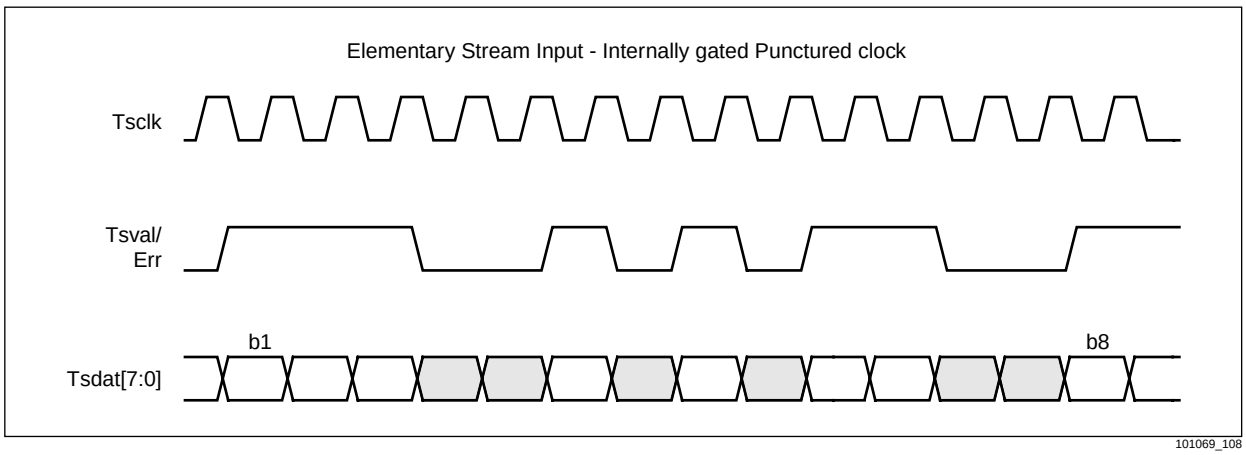
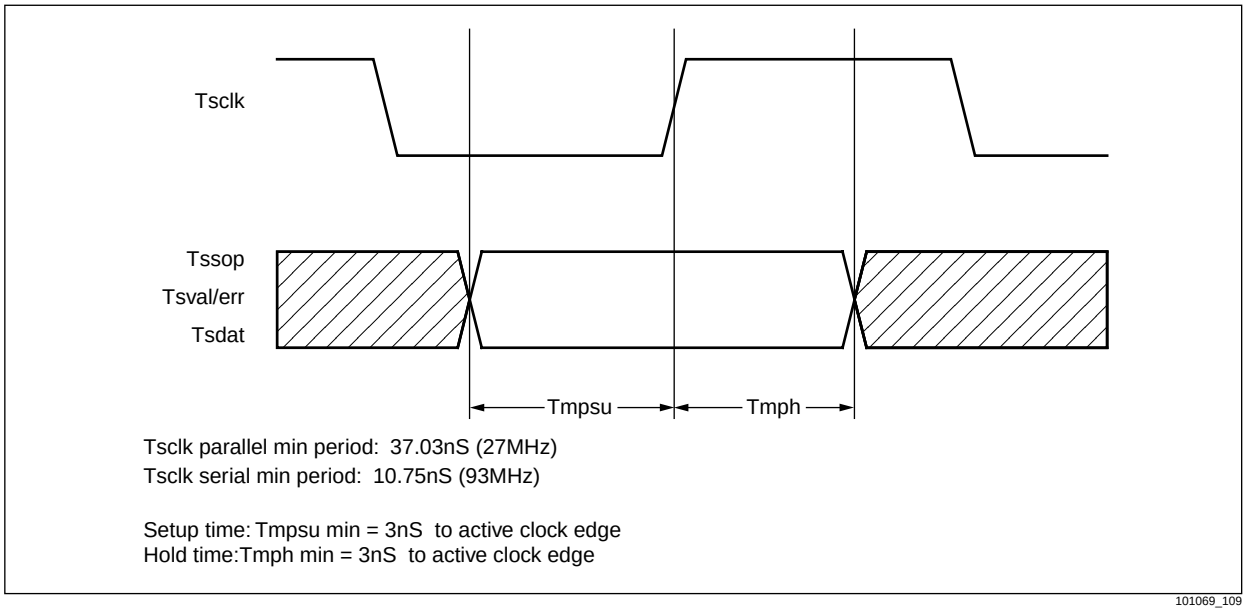


Figure 2-40. MPEG Port Setup and Hold Timing



To set up the CX2388x's MPEG data port in parallel mode, set the IPB_SMODE in register 24'h33C050 (TS General Control) to logical 0. Refer also to Section 2.3 for details on configuring the GPIO port to parallel data input.

TS General Control (Immediate Access)

Register 24'h33C050—TS_GEN_CONTROL

Bits	Type	Default	Name	Description
[7]	WO	1'b0	IPB_STAT_CLR	Active-High reset for stat registers.
[6]	WO	1'b0	IPB_SW_RST	Active-High Software reset.
[5]	RW	1'b0	IPB_ERR_ACK	Determines whether the interface is in an error ack mode. This is only valid while IPB_PUNC_CLK is active.
[4]	RW	1'b0	IPB_BIT_RVRS	This reverses each byte-wide input one byte at a time.
[3]	RW	1'b1	IPB_SMODE	Input Mode Select. 0 – Parallel Mode 1 – Serial Mode
[2]	RW	1'b0	IPB_PUNC_CLK	Determines whether the TS interface is operating in punctured clock mode.
[1]	RW	1'b0	IPB_MCLK_POL	Polarity of MPEG generated MCLK. Default means TS inputs are negedge driven. When asserted high TS inputs are negedge sampled and assumed posedge driven.
[0]	RO	1'b0	MPEG_IN_SYNC	Active-high "in sync" indicator for MPEG.

2.6 Video Decoder

This section describes the functionality of the analog video decoder in sequence from the video input at the analog front end to the output of digital video pixels from the pixel engine to the internal peripheral bus. For details of the analog front-end interfacing circuit to baseband video signals, see Chapter 3.

2.6.1 Video Input Multiplexer

The CX2388x has a 4:1 multiplexer that can be used to switch between four composite video sources, or three composite video sources and one S-Video source. This multiplexer is controlled by the YADC_SEL bits 14 and 15 of the Input Format register.

Input Format Register

Register 24'h310104

Bits	Type	Default	Name	Description
[15:14]	RW	2'b00	YADC_SEL	Video input source selection. 00 = MUX0 01 = MUX1 10 = MUX2 11 = MUX3

Please refer to Chapter 3 for details of the external circuit and how the connection of composite and S-Video signals should be made to the multiplexer.

2.6.2 10-bit Video Analog-to-Digital Converters (ADCs)

The CX2388x has two 10-bit, on-chip ADCs to digitize incoming video baseband signals.

The first ADC is used for digitizing composite video from baseband sources such as TV tuners or video camcorders. The first ADC can also be used to digitize the luminance portion (Y) of an S-Video signal from sources such as video camcorders, satellite decoder boxes, or DVD players.

The second ADC is used for digitizing the low intermediate frequency (IF) signal from TV tuners that have FM radio and broadcast audio capability. The second ADC can also be used to digitize the chrominance portion (C) of an S-Video signal from sources such as video camcorders, satellite decoder boxes, or DVD players.

See Table 2-29 for the ADC assignments.

Table 2-29. Analog-to-Digital Converter Assignment

Application	ADC 1	ADC 2
Capture composite video from a video camcorder	Composite signal digitization	—
Capture S-Video from a video camcorder	Y-signal digitization	C-signal digitization
Capture composite video and broadcast audio from a TV tuner	Composite signal digitization	Low IF signal digitization

The video decoder must be programmed appropriately for composite/broadcast audio sources vs. S-Video sources. Table 2-30 lists the register values that need to be programmed for each input format:

Table 2-30. Composite Versus S-Video ADC Initialization

Register	Bit	Composite Video Only	Composite Video and Broadcast Audio	S-Video
Input Format (16'h0104)	[4]	0	0	1
	[16]	0	0	1

2.6.3 Video Signal Locking

The line length (the interval between the midpoints of the falling edges of succeeding horizontal sync pulses) of analog video sources is not constant. For a stable source such as a studio quality source, test signal generator, or DVD player, this variation is very small (±2 ns). However, for an unstable source such as a VCR, the line length variation is as much as a few microseconds.

Digital display systems require a fixed number of pixels per line despite these variations. The CX2388x employs a technique known as UltraLock to lock to the horizontal sync and subcarrier of the desired analog video signal and generating the required number of pixels per line.

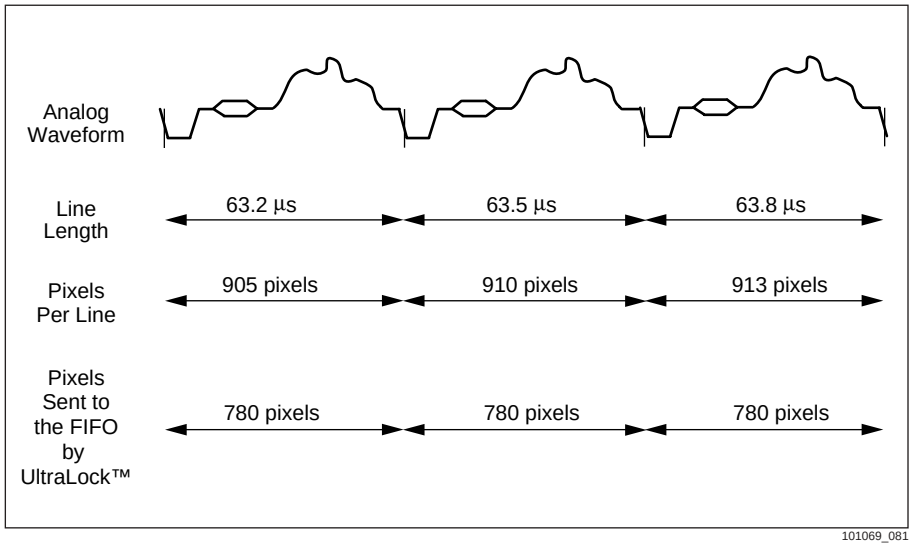
2.6.3.1 UltraLock Overview

UltraLock is based on video signal oversampling using a fixed-frequency, stable clock. Because the video line length varies, the number of samples generated using a fixed-frequency sample clock also varies from line to line. If the number of generated samples per line is always greater than the number of samples per line required by the particular video format, the number of acquired samples can be reduced to fit the required number of pixels per line.

UltraLock accommodates line length variations from nominal in the incoming video by always acquiring more samples than are required by the particular video format and outputting the correct number of pixels per line. UltraLock then interpolates the required number of pixels in a way that maintains the stability of the original image despite variation in the line length of the incoming analog waveform.

Figure 2-41 illustrates an example using 4x Fsc sampling of 3 successive lines of video being decoded for square-pixel NTSC output. The first line is shorter than the nominal NTSC line time interval of 63.5 µs. On this line, a line time of 63.2 µs sampled at 4 × Fsc (14.31831 MHz) generates only 905 pixels. The second line matches the nominal line time of 63.5 ms and provides the expected 910 pixels. Finally, the third line is too long at 63.8 µs within which 913 pixels are generated. In all three cases, UltraLock outputs only 780 pixels.

Figure 2-41. UltraLock Behavior for NTSC Square Pixel Output using 4x Fsc sampling rate



UltraLock can be used to extract any programmable number of pixels from the original video stream as long as the sum of the nominal pixel line length (910 for NTSC and 1,135 for PAL/SECAM) and the worst case line length validation from nominal in the active region is greater than or equal to the required number of output pixels per line:

$$P_{Nom} + P_{Var} \geq P_{Desired}$$

where: P_{Nom} = Nominal number of pixels per line at 4 × Fsc sample rate (910 for NTSC, 1,135 for PAL/SECAM) *

P_{Var} = Variation of pixel count from nominal at 4 × Fsc (can be a positive or negative number)

$P_{Desired}$ = Desired number of output pixels per line

NOTE: Total number of pixels includes active video region plus blanking and front porch.

2.6.4 Video Sample Rate Converter

2.6.4.1 Flexible Video Timing Formats

In the CX2388x, the Ultralock circuit has been enhanced by a Video Sample Rate Converter. This capability is required for applications such as video editing/authoring and time shifting that require decoded video to be sent out of the CX2388x for compression and simultaneous direct connection to a digital video encoder such as the Bt865A or Bt860/861.

In combination with Ultralock implemented in the Video Decoder, the Sample Rate Converter allows a choice of video sampling rates and video decoding rates. This flexibility means that video can be captured at the highest possible sampling rate, using Ultralock, to acquire the maximum number of samples at the 10-bit Analog to Digital Converter(s).

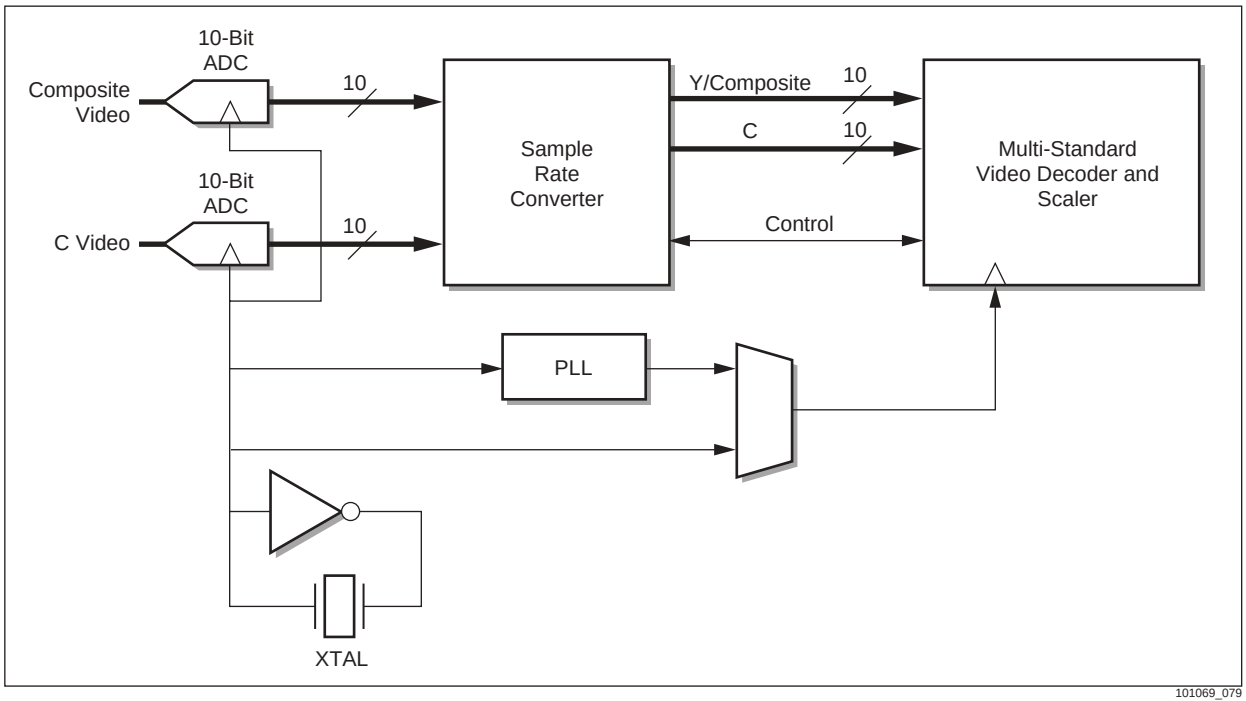
If decoded video is required on the CX23880's output pixel port for connection of hardware MPEG compressors, TV encoders or hardware video deinterlacers, the Sample Rate Converter can be enabled to provide digital video with the following attributes:

- A valid video data sample present with each output clock
- Produces the same number of output clocks per line
- Generates consistent sample point locations from line-to-line.

These attributes are mandatory for interfacing to the aforementioned devices.

Figure 2-42 provides a top level overview of the Sample Rate Converter and Video Decoder

Figure 2-42. Ultra Lock and Sample Rate Converter



From Figure 2-42 it can be seen that there is a clock domain for the analog to digital converters and another domain for the Multistandard Video Decoder and Scaler. Typically an 8x Fsc (video subcarrier frequency) crystal is used to provide a sampling clock for the video Analog to Digital Converters in order to obtain more samples per line than is required (see Ultralock Overview) for square pixel or 4:3 aspect ratio decoding.

If no external video processing is required, the Sample Rate Converter can be bypassed and the video decoder clocked at the same frequency as the Analog to Digital Converters. The decoded video samples are DMAd to the PCI bus and the graphics overlay surface in the same fashion as the previous generation Fusion 878A decoder.

If external video processing is required, then the Sample Rate Conversion register should be programmed for the desired frequency of video decode. This is typically 27MHz for ITU-R. BT656 decoding, although other formats such as square pixel NTSC (24.5454/12.2727 MHz) or PAL (29.5/14.75 MHz) may be supported. See Table 2-31.

.

Table 2-31. Video Decoding Formats

Video Standard	Parameter	601/656	Square Pixel
NTSC	Horizontal Pixels	720	640
	Vertical Lines	480	480
	Clock Rate	27 MHz	24.5454 MHz
PAL/SECAM	Horizontal Pixels	720	768
	Vertical Lines	576	576
	Clock Rate	27 MHz	29.5 MHz

In order to use the Sample Rate Converter the ratio between the ADC sampling frequency (typically 8x Fsc) and the desired Video decoder core frequency (typically 24.54, 27.0 or 29.5MHz) must be derived, multiplied by 2^{17} and then converted to binary or hexadecimal.

Sample Rate Conversion Register

Register 24’h310170

Bits	Type	Default	Name	Description
[18]	RW	19’h21F07	SRC_REG_VAL	19-bit SRC programmable value. This is a ratio of the ADC clock rate to video clock rate. (ADC sampling frequency / Video decoder core frequency) * 2^{17}

Some examples of ADC sampling frequency versus desired video decoder frequency and the SRC value to be programmed are illustrated in Table 2-32.

Table 2-32. Sample Rate Conversion

XTAL Frequency (MHz)	Desired Video Decoding Frequency (MHz)	Application	SRC_REG_VAL (HEX)
28.636363	24.545454	Square Pixel NTSC	16'h23DF3
28.636363	27.000000	"601/656" NTSC/PAL/SECAM	16'h21F07
28.636363	28.636363	8x Fsc NTSC	16'h20000
28.636363	29.500000	Square Pixel PAL/SECAM	16'h1F102
28.636363	35.440000	8x Fsc PAL/SECAM	16'h19D5F

2.6.5 Composite Video Input Formats

The CX2388x supports all broadcast video formats in use worldwide. Table 2-33 lists the video formats and some of the countries in which each format is used.

Table 2-33. Video Input Formats Supported by the CX2388x

Format	Lines	Fields	Fsc (MHz)	Country
NTSC-M	525	60	3.58	U.S., many others
NTSC-Japan(1)	525	60	3.58	Japan
PAL-B, G, H	625	50	4.43	Western/Central Europe, others
PAL-D	625	50	4.43	China
PAL-I	625	50	4.43	U.K., Ireland, South Africa
PAL-M	525	60	3.58	Brazil
PAL-NC	625	50	3.58	Argentina
PAL-N	625	50	3.58	Paraguay, Uruguay
SECAM	625	50	4.25/4.406	France, Eastern Europe

Note(s):
(1) NTSC—Japan has 0 IRE setup.

The video decoder must be programmed appropriately for each of the composite video input formats. Table 2-34 lists the register values that need to be programmed for each input format.

Table 2-34. Register Values for Square Pixel Video Input Formats

Register	Bit	NTSC-M	NTSC-J	NTSC-4.43	PAL-B, D, G, H, I	PAL-M	PAL-N	PAL-NC	PAL-60	SECAM
Input Format (24'h310104)	FMT[3:0]	0001	0010	0011	0100	0101	0110	0111	1000	1001

2.6.6 Y/C Separation and Chroma Demodulation

2.6.6.1 The Y/C Separation Problem

Many video decoders employ a luminance notch filter, a chrominance band-pass filter, and a chrominance comb filter. The luminance signal is derived by filtering out the color information (chrominance) from a composite video signal with a notch filter. This works because the NTSC color information is in a frequency band centered at about 3.58 MHz that extends approximately. ±1.3 MHz (i.e., from 2.3 to 4.9 MHz). The Y filter rejects frequencies in that range. Although this effectively filters most of the chrominance signal out of the luminance signal, it also removes the higher frequency luminance signal components. This loss of bandwidth reduces the horizontal resolution of the luminance signal, and fine detail in the picture is lost. The chrominance signal is derived by band-pass filtering the composite video signal to extract the frequency band centered at 3.58 MHz that contains the color information. A chrominance comb filter removes any residual luminance (Y) signal that overlaps the chrominance (C) signal in this frequency range.

Other video decoders employ a line comb filter. These line comb filters operate by delaying the previous composite video horizontal scan line and comparing it to the current horizontal scan line. Adding the two lines together cancels the C signal and provides the Y signal. Subtracting the current line from the delayed line provides the C signal. This process creates two filters which have a frequency response that look like teeth in a comb. This type of filter is usually known as a 1-H comb filter, since it uses a 1-horizontal scan line delay to process the signals. More complex filters can be built using 2-horizontal scan line delays and are called 2-H comb filters. While these filters show improvement with a multiburst test pattern compared to a notch filter, and demonstrate a horizontal flat frequency response, the multiburst pattern does not show that 50% of the vertical resolution is lost due to the averaging of two lines. These filters still suffer the “hanging dot” problem noticeable on test patterns such as the SMPTE color bar test pattern.

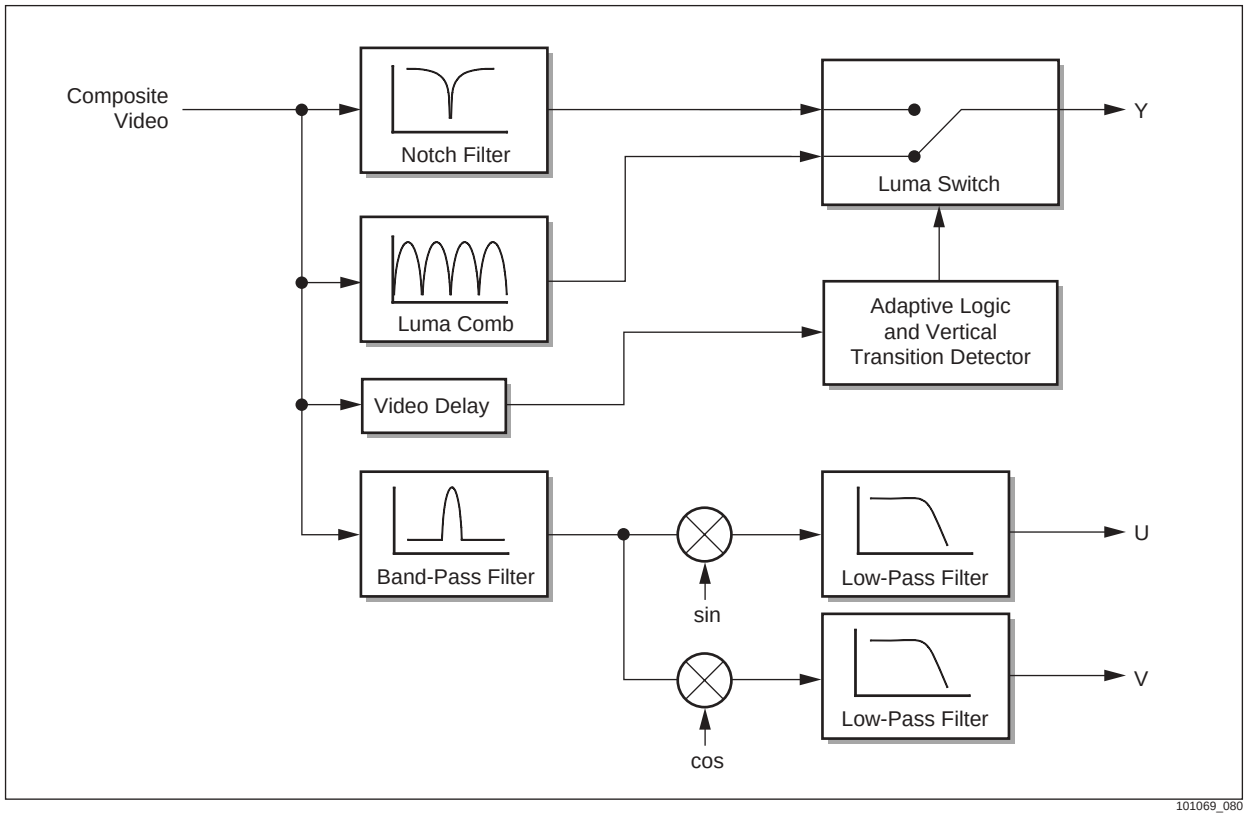
2.6.6.2 Conexant Adaptive Comb Filter

In order to overcome this hanging dot problem and the loss of vertical resolution, a sophisticated 3-line, adaptive comb filter has been implemented in the CX2388x to separate the Y/C components in composite NTSC/PAL video signals. As stated previously, simple 1-H comb filters can not eliminate “hanging dots” on a vertical color transition. Comb filtering two successive scan lines with different color values at the same horizontal positions along the lines cause the problem. The line comb filter cannot separate the Y/C signals correctly in this situation. The color signal crosses over into the luminance signal, creating a cross-luminance artifact. In a 3-line adaptive Y/C separation filter, adaptive logic continuously evaluates the video image and then selects the most efficient processing algorithm available in the filter. This is sometimes called a 2-D filter, because both the horizontal scan lines and vertical transitions are processed. This eliminates the hanging dot problem by detecting vertical transitions in the image.

The adaptation logic examines three successive horizontal scan lines simultaneously. If a vertical transition occurs between the first and third lines, notch filtered luminance and bandpass filtered chrominance are used directly, without comb filtering. Hence, two lines with different colors will not be input to the comb filter at a

transition boundary. Therefore, the Y/C signals will be fully separated and the hanging dots eliminated. The CX2388x accomplishes this adaptive processing on a pixel-by-pixel basis, compared to other decoders which can only comb filter on a line by line basis. Figure 2-43 illustrates a high-level diagram of the NTSC/PAL adaptive comb filter.

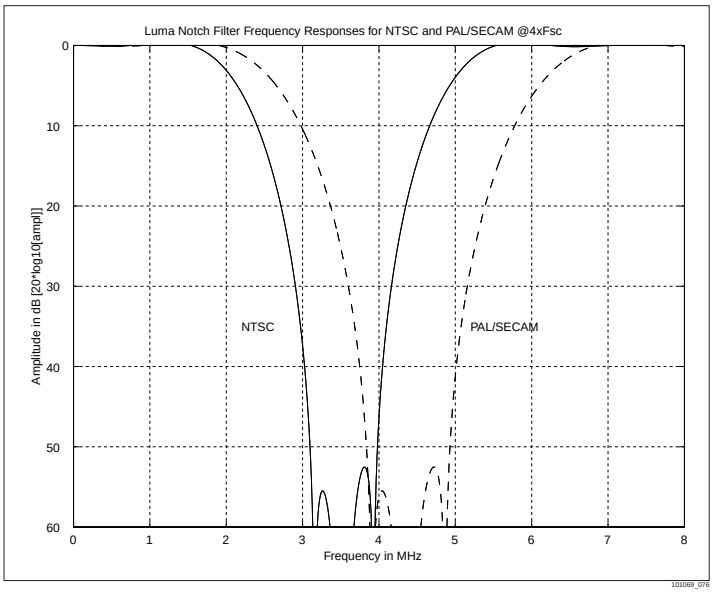
Figure 2-43. Y/C Separation and Chroma Demodulation Circuit for Composite NTSC/PAL Video



2.6.7 Y/C Separation and Chroma Demodulation

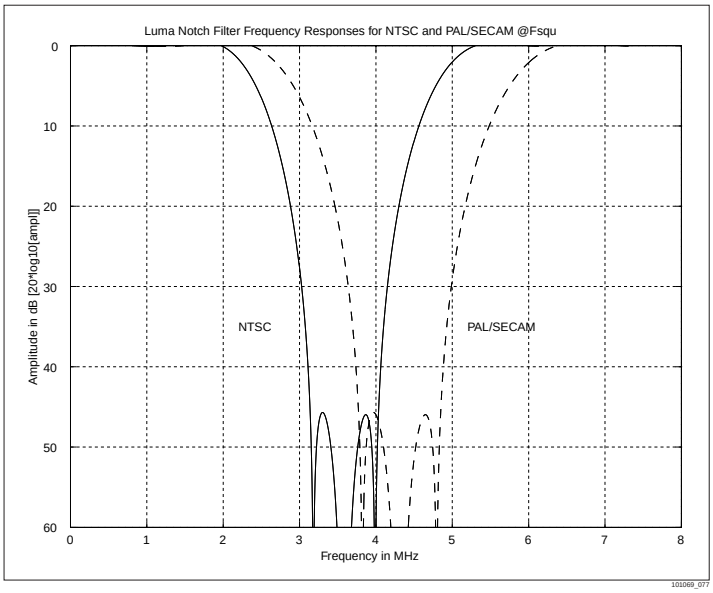
The luma notch filter responses for NTSC, PAL, SECAM video using 4x Fsc Decoding (Y comb filter disabled) is illustrated in Figure 2-44.

Figure 2-44. Luma Notch Filter Frequency Responses for NTSC and PAL/SECAM @ 4x Fsc Decoding Frequencies



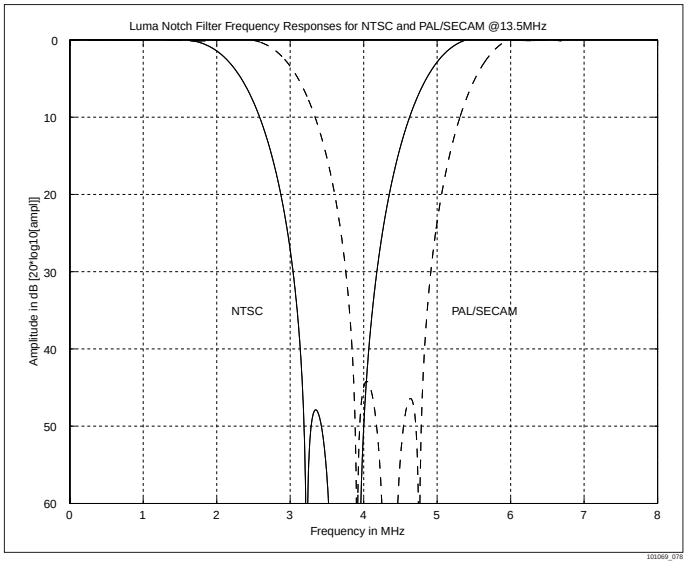
The luma notch filter response for NTSC, PAL, SECAM video using Square Pixel Decoding (Y comb filter disabled) is illustrated in Figure 2-45.

Figure 2-45. Luma Notch Filter Frequency Responses for NTSC and PAL/SECAM @ Square Pixel Decoding Frequencies



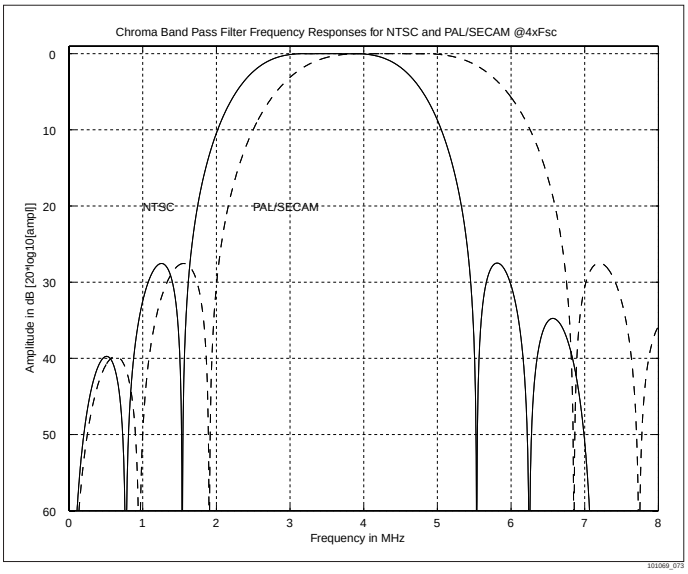
The luma notch filter response for NTSC, PAL, SECAM video using 13.5MHz Decoding (Y comb filter disabled) is illustrated in Figure 2-46.

Figure 2-46. Luma Notch Filter Frequency Responses for NTSC and PAL/SECAM @ 13.5 MHz Decoding Frequency



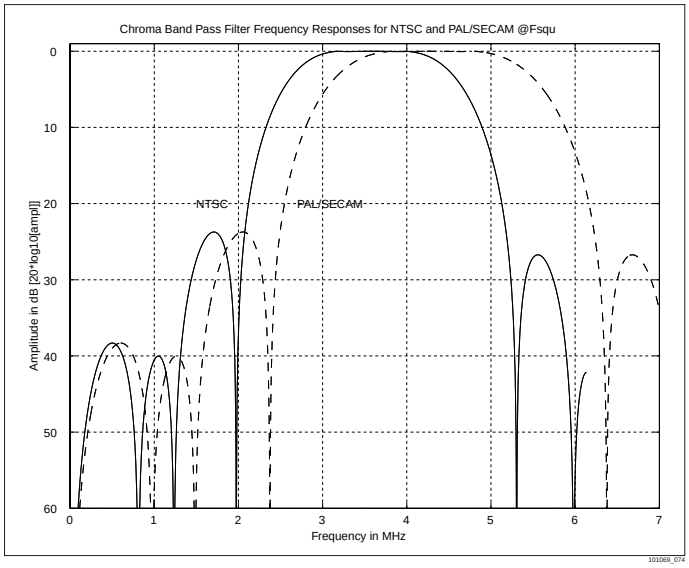
The chroma bandpass filter response for NTSC, PAL, SECAM video using 4x Fsc Decoding is illustrated in Figure 2-47.

Figure 2-47. Chroma Band Pass Filter Frequency Responses for NTSC and PAL/SECAM @ 4x Fsc Decoding Frequencies



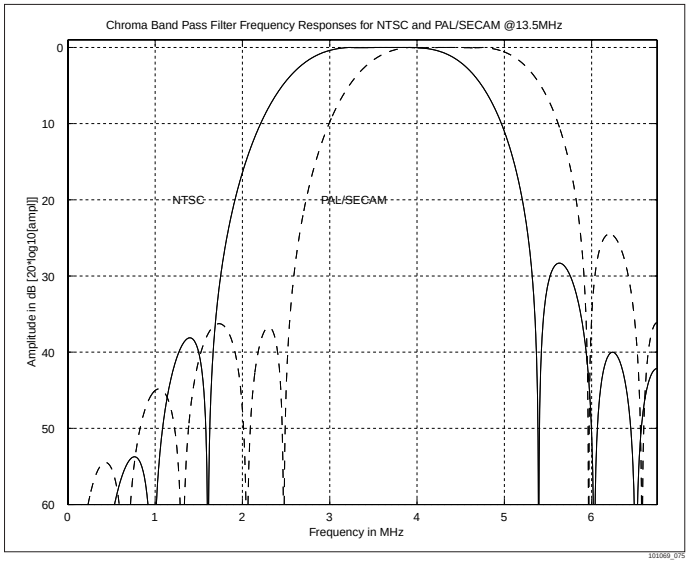
The chroma bandpass filter response for NTSC, PAL, SECAM video using Square Pixel Decoding is illustrated in Figure 2-48.

Figure 2-48. Chroma Band Pass Filter Frequency Responses for NTSC and PAL/SECAM @ Square Pixel Decoding Frequencies



The chroma bandpass filter response for NTSC, PAL, SECAM using 13.5MHz Decoding is illustrated in Figure 2-49.

Figure 2-49. Chroma Band Pass Filter Frequency Responses for NTSC and PAL/SECAM @ 13.5 MHz Decoding Frequency



When the adaptive comb filter determines that luma comb decoding is required, the luminance data that is "combed out" out of the chroma data by the bandpass/chroma-comb filter is "added back" to the notched luma response, thereby restoring the full horizontal luminance content and ensuring a flat frequency response in the luma channel.

When using the video decoder with composite video sources, it is important not to disable the luma notch filter (bit 13 of even and odd field register(s) Horizontal/ Vertical Filters Control). This bit defaults to 0 = enable notch filter. This bit should only be programmed to a 1 when using S-Video sources. In addition, it is important to ensure that the comb filter bits (bits 5 and 6 of register Horizontal/Vertical Filters Control) remains at the default of 00 when capture sizes of 640x480 through 768x576 are required. For capture sizes below 640x480, the comb filter bits should be set to chroma-comb only (01) as the reduced luminance information is typically below the sub-carrier frequency thus rendering luma comb decoding irrelevant. In this case, bit 27 of the Output Format and 2D Comb Control register (24'h310164) must be disabled by writing a logical 0.

Horizontal/Vertical Filters Control Register

Register 24'h31015C—Even Field

Register 24'h310160—Odd Field

Bits	Type	Default	Name	Description
[13]	RW	1'b0	LNOTCH	0 = Enable notch filter 1 = Disable (recommended for monochrome input – enables full luma bandwidth)
[6:5]	RW	2'b00	COMB	Selects comb filter. 00 = Full Comb 01 = Chroma comb only 10 = reserved 11 = none

The Output Format and 2H Comb Control register (24'h310164) has additional bit fields related to comb filtering with the defaults configured for optimal quality for the majority of applications. These defaults should not require user intervention unless adaptive comb filtering is required to be switched off, such as when decoding at small capture sizes. However, for PAL video sources, if full luma and chroma Y/C separation is required at resolutions greater than 640x480, bit 26 (PAL_INV_PHASE) must be asserted and a logical 1 written.

Output Format and 2H Comb Control Register

Register 24'h310164

Bits	Type	Default	Name	Description
[31:29]	RO	3'h0		RESERVED
[28]	RW	1'b1	PREVREMOD	Enable previous line remodulation; must be used in conjunction with COMBALT = 1
[27]	RW	1'b1	COMBALT	3 Line/2 Line adaptive comb filter 0 = Disable 1 = Enable
[26]	RW	1'b0	PAL_INV_PHASE	Used in PAL 2D comb filter mode.

2.6.8 Video Scaling, Cropping, and Temporal Decimation

The CX2388x provides three mechanisms to reduce the amount of video pixel data in its output stream: down-scaling, cropping, and temporal decimation. All three can be controlled independently.

2.6.8.1 Down-Scaling

Horizontal and Vertical Scaling

The CX2388x provides independent and arbitrary horizontal and vertical down-scaling. The maximum scaling ratio is 16:1 in both X and Y dimensions. The maximum vertical scaling ratio is reduced from 16:1 when using frames to 8:1 when using fields. The different methods used for scaling luminance and chrominance are described in the following sections.

Field Aligned Vertical Scaling

If Common Interchange Format (CIF) resolution video is viewed at 60/50 Hz rates, then the video fields must be field-aligned for proper overlay (sequenced on top of each other successively). This could be done in interlaced Vertical Scaling mode (INT set) which group delays (filters) only one field by one line. The two fields are vertically aligned for overlay, but the two fields have different frequency responses. One has not been filtered, while the other has been line-averaged. An option exists to filter both fields in a similar manner yet maintain proper field alignment. This mode is selected by setting the FDALIGN bit of the Horizontal/Vertical Filters Control to a 1 and setting the VINT bit to a 0 for noninterlaced vertical scaling.

Luminance Scaling— Horizontal Scaling

The first stage in horizontal luminance scaling is an optional pre-filter which provides the capability to reduce anti-aliasing artifacts. It is generally desirable to limit the bandwidth of the luminance spectrum prior to performing horizontal scaling because the scaling of high-frequency components may create image artifacts in the resized image. The optional low pass filters illustrated in Figures 2-50 and 2-51 reduce the horizontal high-frequency spectrum in the luminance signal. Combined luma notch 2x oversampling and optional low-pass filter responses are illustrated in Figures 2-52 and 2-53.

The CX2388x implements horizontal scaling through poly-phase interpolation. The CX2388x uses 64 different phases to accurately interpolate the value of a pixel. This provides an effective pixel jitter of less than 4 ns.

In simple pixel- and line-dropping algorithms, noninteger scaling ratios introduce a step function in the video signal that effectively introduces high-frequency spectral components. Poly-phase interpolation accurately interpolates to the correct pixel and line position providing more accurate information. This results in aesthetically pleasing video as well as higher compression ratios in bandwidth-limited applications.

Figure 2-50. Optional Horizontal Luma Low-Pass Filter Responses for NTSC

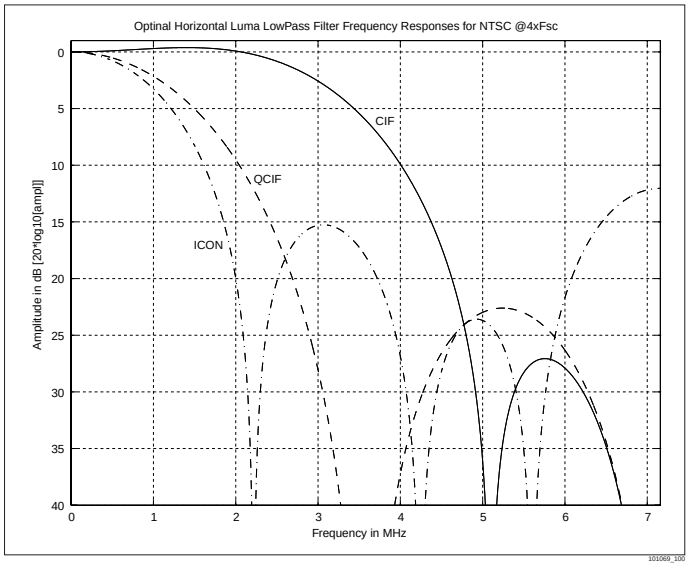


Figure 2-51. Optional Horizontal Luma Low-Pass Filter Responses for PAL/SECAM

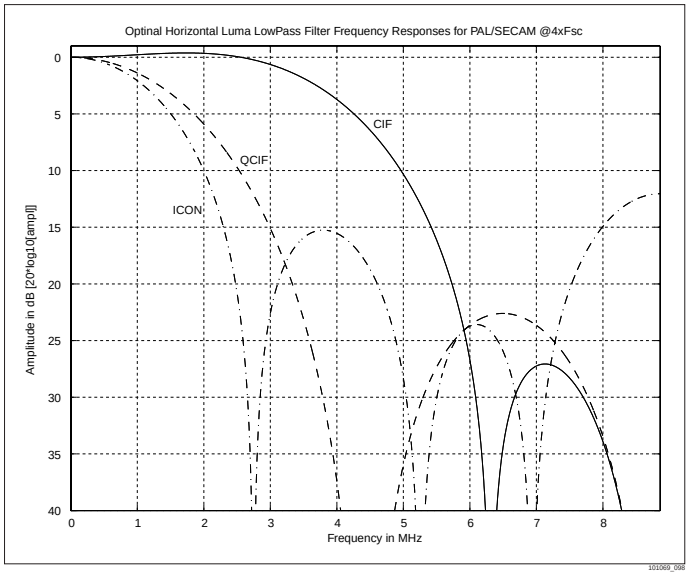


Figure 2-52. Combined Luma Notch 2x Oversampling and Optional Low-Pass Filter Response for NTSC

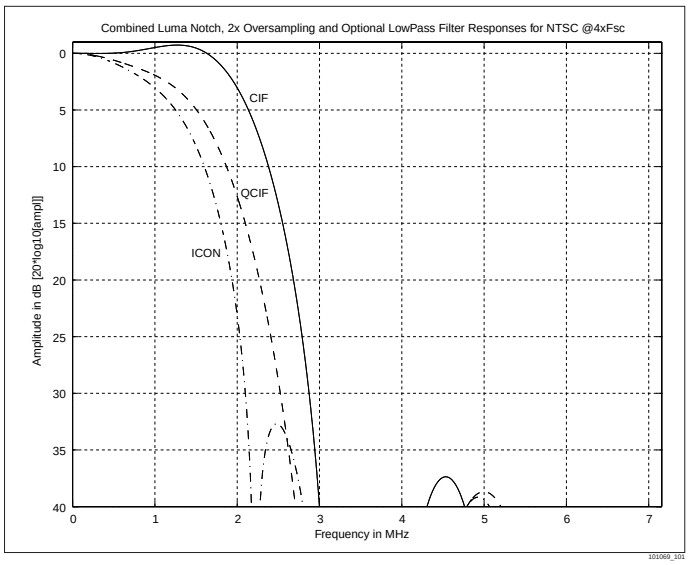
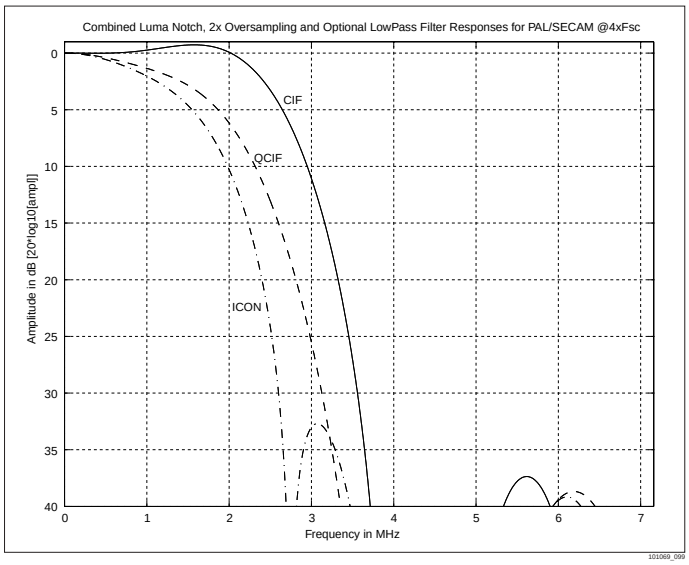


Figure 2-53. Combined Luma Notch 2x Oversampling and Optional Low-Pass Filter Response for PAL/SECAM

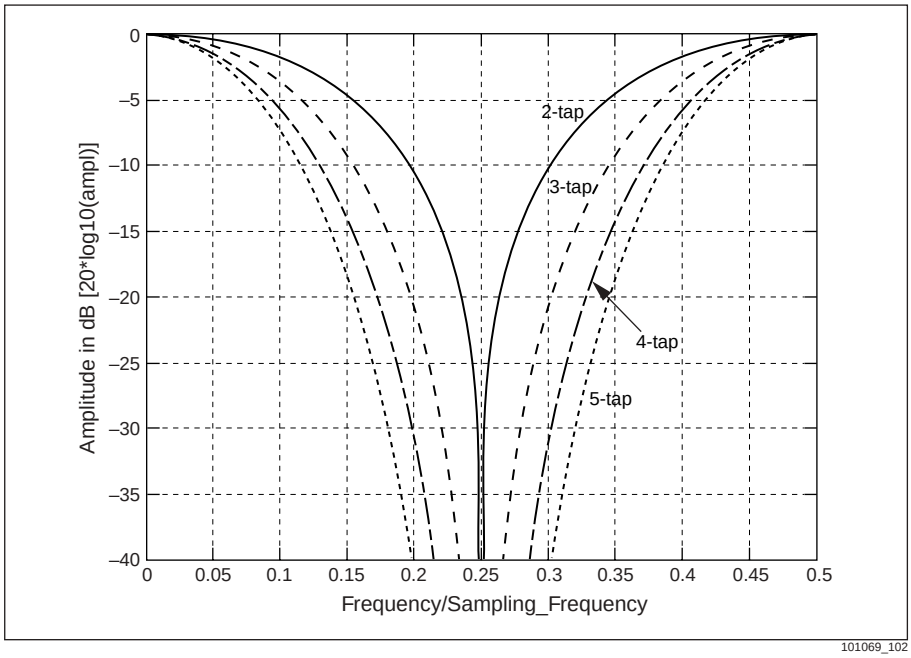


2.6.8.2 Vertical Scaling

For vertical scaling, the CX2388x uses a line store to implement four different filtering options. The filter characteristics are illustrated in Figure 2-54. The CX2388x provides up to 5-tap filtering to ensure removal of aliasing artifacts.

Bits [2:0] (VFILT) of the Horizontal/Vertical Filters Control register set the number of taps in the vertical filter. The user can select 2, 3, 4 or 5 taps. The number of taps must be chosen in conjunction with the horizontal scale factor to ensure the required data does not overflow the internal FIFO.

Figure 2-54. Frequency Responses for the Four Optional Vertical Luma Low-Pass Filters



As the scaling ratio increased, the number of taps available for vertical scaling increases. In addition to low pass filtering, vertical interpolation is also employed to minimize artifacts when scaling to noninteger scaling ratios. In the VFILT section of the Horizontal/Vertical Filters Control register it is also possible to select the multitap filters without interpolation for scaling to integer scaling ratios.

2.6.8.3 Chrominance Scaling

A 4-tap, 64-phase interpolation filter is used for horizontal scaling of chrominance. Vertical scaling of chrominance is implemented by a 2 to 5-tap filter, depending on the size of the image to be scaled. Both Cr and Cb data have their own filter.

2.6.8.4 Video Peaking Filters

The CX2388x enables four different user-selectable peaking filters by programming bits [8:7] (PSEL) of the Horizontal/Vertical Filters Control register. Peaking ranges of +2.0 dB, +3.5 dB, 5.0 dB and +6.0 dB at the NTSC or PAL chroma subcarrier frequencies are offered. These filter responses are illustrated in Figures 2-55 and 2-56.

Figure 2-55. NTSC Peaking Filters

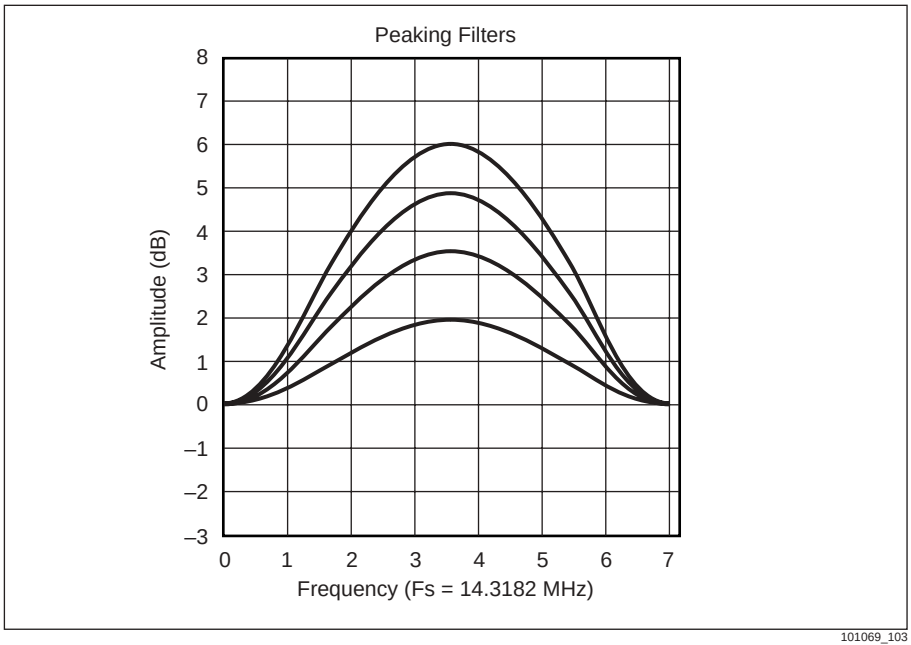
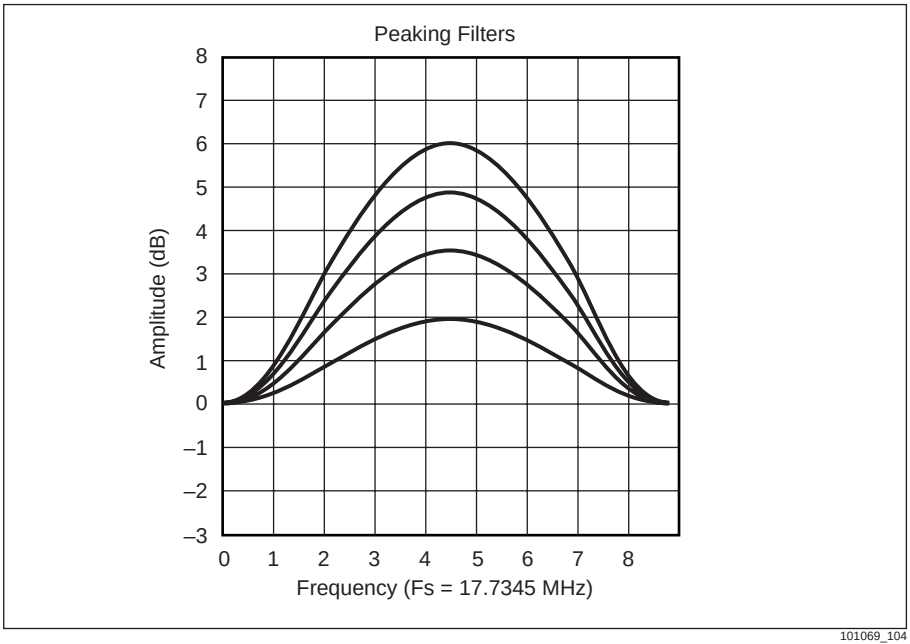


Figure 2-56. PAL/SECAM Peaking Filters



2.6.8.5 The Horizontal Scaling Ratio (HSCALE) Register

The 16-bit HSCALE register is programmed with the horizontal scaling ratio. When outputting unscaled video (in NTSC), the CX2388x produces 910 pixels per line. This corresponds to the pixel rate at 4x Fsc. This register is the control for scaling the video to the desired size. For example, square pixel NTSC requires 780 total samples per line, while CCIR601/656 requires 858 total samples per line. The method below uses pixel ratios to determine the scaling ratio. The following formula should be used to determine the scaling ratio to be entered into the 16-bit register:

NTSC HSCALE = $[(910 / P_{Desired}) - 1] \times 4{,}096$

PAL/SECAM HSCALE = $[(1{,}135 / P_{Desired}) - 1] \times 4{,}096$

where $P_{Desired}$ = Desired number of pixels per line of video, including active, sync, and blanking

For example, to scale PAL/SECAM input to square-pixel Quarter Common Intermediate Format (QCIF), the total number of horizontal pixels desired is 236:

HSCALE = $[(1{,}135 / 236) - 1] \times 4{,}096$

= 12,331

= 0 x 3CF2

An alternative method for determining the HSCALE value uses the ratio of the scaled active region to the unscaled active region as follows:

NTSC HSCALE = $[(754 / HACTIVE) - 1] \times 4{,}096$

PAL/SECAM HSCALE = $[(922 / HACTIVE) - 1] \times 4{,}096$

where HACTIVE = Desired number of pixels per line of video, not including sync or blanking.

In this equation, the HACTIVE value cannot be cropped; it represents the total active region of the video line. This equation produces roughly the same results as using the full-line length ratio shown in the first example. However, due to truncation, the HSCALE values determined using the active pixel ratio method will be slightly different from those obtained using the total line length pixel ratio method.

2.6.8.6 The Vertical Scaling Ratio Register (VSCALE)

The 13-bit VSCALE register is programmed with the vertical scaling ratio. It defines the number of vertical lines output by the CX2388x. The following formula should be used to determine the value to be entered into this 13-bit register.

$$VSCALE = (10000_{16} - \{[(vertical\_scaling\_ratio_{10}) - 1_{10}] \times 512_{10}\}) \text{ AND } 1FFF_{16}$$

NOTE: The desired vertical scaling ratio and other inner terms of this equation are decimal and must be converted to hexadecimal to complete the calculation. Worked examples are shown below:

- To vertically scale captured NTSC/PAL/SECAM to CIF vertical resolution:

$$VSCALE = (10000_{16} - \{[(2_{10}) - 1_{10}] \times 512_{10}\}) \text{ AND } 1FFF_{16} = 1E00_{16}$$

- To vertically scale captured NTSC/PAL/SECAM to QCIF vertical resolution:

$$VSCALE = (10000_{16} - \{[(4_{10}) - 1_{10}] \times 512_{10}\}) \text{ AND } 1FFF_{16} = 1A00_{16}$$

- To vertically scale captured NTSC/PAL/SECAM to ICON vertical resolution:

$$VSCALE = (10000_{16} - \{[(8_{10}) - 1_{10}] \times 512_{10}\}) \text{ AND } 1FFF_{16} = 1200_{16}$$

NOTE: When scaling below CIF resolution, it may be useful to use a single field as opposed to using both fields. Using a single field ensures there are no interfield motion artifacts on the scaled output. When performing single field scaling, the vertical scaling ratio is twice as large as when scaling with both fields. For example, CIF scaling from one field does not require any vertical scaling, but when scaling from both fields, the scaling ratio is 50%. Also, the noninterlaced bit should be reset when scaling from a single field (INT = 0 in the VSCALE_HI register).

Table 2-35 lists scaling ratios for various video formats and the register values required.

Table 2-35. Scaling Ratios for Popular Formats Using Frequency Values

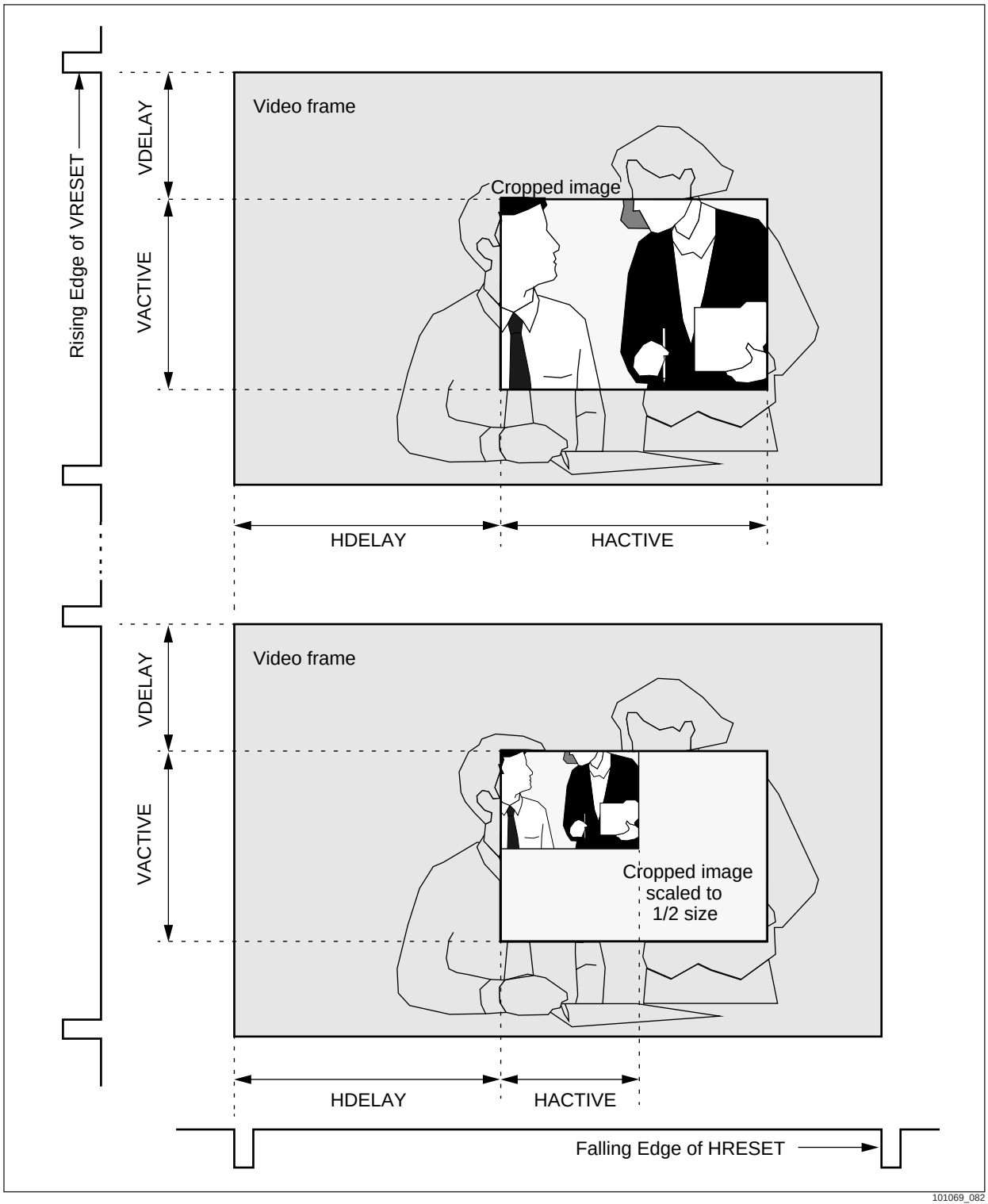
Scaling Ratio	Format	Total Resolution(1)	Output Resolution (Active Pixels)	HSCALE Register Values (HEX)	VSCALE Register Values (HEX)	
					Use Both Fields	Single Field
Full Resolution 1:1	NTSC SQ Pixel NTSC CCIR601 PAL CCIR601 PAL SQ Pixel	780 × 525 858 × 525 864 × 625 944 × 625	640 × 480 720 × 480 720 × 576 768 × 576	02AA 00F8 0504 033C	0000 0000 0000 0000	N/A N/A N/A N/A
CIF 2:1	NTSC SQ Pixel NTSC CCIR601 PAL CCIR601 PAL SQ Pixel	390 × 262 429 × 262 432 × 312 472 × 312	320 × 240 360 × 240 360 × 288 384 × 288	1555 11F0 1A09 1679	1E00 1E00 1E00 1E00	0000 0000 0000 0000
QCIF 4:1	NTSC SQ Pixel NTSC CCIR601 PAL CCIR601 PAL SQ Pixel	195 × 131 214 × 131 216 × 156 236 × 156	160 × 120 180 × 120 180 × 144 192 × 144	3AAA 3409 4412 3CF2	1A00 1A00 1A00 1A00	1E00 1E00 1E00 1E00
ICON 8:1	NTSC SQ Pixel NTSC CCIR601 PAL CCIR601 PAL SQ Pixel	97 × 65 107 × 65 108 × 78 118 × 78	80 × 60 90 × 60 90 × 72 96 × 72	861A 7813 9825 89E5	1200 1200 1200 1200	1A00 1A00 1A00 1A00

Note(s):
(1) Including sync and the blanking interval.

2.6.9 Image Cropping

Cropping enables the user to output any subsection of the video image. The start of the active area in the vertical direction is referenced to VRESET (the beginning of a new field). In the horizontal direction, it is referenced to HRESET (the beginning of a new line). The dimensions of the active video region are defined by HDELAY, HACTIVE, VDELAY, and VACTIVE. All four registers have 10-bit ranges. The vertical and horizontal delay values determine the position of the cropped image within a frame while the horizontal and vertical active values set the pixel dimensions of the cropped image as illustrated in Figure 2-57.

Figure 2-57. Effect of the Delay and Active Registers



2.6.10 Cropping Registers

2.6.10.1 Horizontal Delay Register (HDELAY)

For video decoding, HDELAY is programmed with the number of pixels between horizontal sync and the first pixel of each line to be displayed or captured. HDELAY should be an even number to get Cb as the first pixel, an odd number to get Cr.

The register value is programmed with respect to the scaled frequency clock.

2.6.10.2 Horizontal Active Register (HACTIVE)

For video decoding, HACTIVE is programmed with the actual number of displayed or captured pixels per line.

The register value is programmed with respect to the scaled frequency clock. The video line can be considered a combination of the following three components:

1. Back Porch and Sync: defined by HDELAY
2. Active Video: defined by HACTIVE
3. Front Porch: total scaled pixels—HDELAY through HACTIVE

For uncropped images, the square pixel values for these components at 4 × Fsc are displayed in Table 2-36.

Table 2-36. 4x Fsc Pixel Values

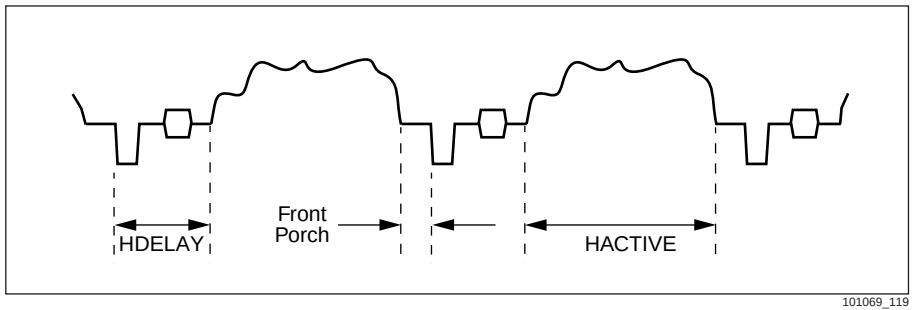
Video Standard	CLK × 1 Front Porch	CLK × 1 HDELAY	CLK × 1 HACTIVE	CLK × 1 Total
NTSC	21	135	754	910
PAL/SECAM	27	186	922	1,135

Therefore, for uncropped images the values are:

$$\text{HDELAY (NTSC)} = (135 / 754 \times \text{HACTIVE}) \,\&\, 0 \times 3\text{FE}$$
$$\text{HDELAY(PAL)} = (186 / 922 \times \text{HACTIVE}) \,\&\, 0 \times 3\text{FE}$$

For cropped images, HDELAY can be increased and HACTIVE decreased so that HDELAY + HACTIVE ≤ 889 × HSCALE for NTSC and ≤ 1,108 × HSCALE for PAL. If HDELAY + HACTIVE is too large, then front or back porch pixels, are observed. Regions of the video signal are illustrated in Figure 2-58.

Figure 2-58. Regions of the Video Signal



2.6.10.3 The Vertical Delay Register (VDELAY)

For video decoding, VDELAY is programmed with the number of half lines between the end of the serration pulses and the first line to be displayed or captured.

The register value is programmed with respect to the unscaled input signal. VDELAY must be programmed to an even number to avoid apparent field reversal.

2.6.10.4 The Vertical Active Register (VACTIVE)

It is important to note the difference between the implementation of the horizontal (HSCALE, HDELAY, and HACTIVE) and vertical registers (VSCALE, VDELAY, and VACTIVE). Horizontally, HDELAY and HACTIVE are programmed with respect to the scaled pixels defined by HSCALE. Vertically, VDELAY and VACTIVE are programmed with respect to the number of lines before scaling (before VSCALE is applied).

2.6.11 Temporal Decimation

Temporal decimation provides a solution for video synchronization during periods when the full frame rate cannot be supported due to bandwidth and system restrictions.

For example, when capturing live video for storage, system limitations such as hard disk transfer rates or system bus bandwidth may limit the frame capture rate. If these restrictions limit the frame rate to 15 frames per second, the CX23880's time scaling operation enables the system to capture every other frame instead of allowing hard disk timing restrictions to dictate which frame to capture. This maintains an even distribution of captured frames and alleviates the jerky effect caused by systems that burst-in data when the bandwidth becomes available.

The CX23880 provides temporal decimation on either a field or frame basis. Bits [5:0] (TEMPDEC) of the Temporal Decimation register are loaded with a value from 1–60 (NTSC) or 1–50 (PAL/SECAM). This value is the number of fields or frames skipped by the chip during a sequence of 60 for NTSC or 50 for PAL/SECAM. Skipped fields and frames are considered inactive, which is indicated by the Active pin remaining low.

Examples:

TDEC	= 0×02—	Decimation is performed by frames. Two frames are skipped per 60 frames of video, assuming NTSC decoding. Frames 1–29 are output normally, then Active remains low for 1 frame. Frames 31–59 are then output, followed by another frame of inactive video.
TDEC	= 0×9E—	Decimation is performed by fields. Thirty fields are output per 60 fields of video, assuming NTSC decoding. This value outputs every other field (every odd field) of video starting with field 1 in frame 1.
TDEC	= 0×01—	Decimation is performed by frames. One frame per 50 frames of video is skipped, assuming PAL/SECAM decoding.
TDEC	= 0×00—	Decimation is not performed. Full-frame rate video is output by the CX2388x.

When changing the programming in the Temporal Decimation register, 0×00 should be loaded first and then the decimation value. This ensures that the decimation counter is reset to 0. If 0 is not loaded first, the decimation may start on any field or frame in the sequence of 60 (or 50 for PAL/SECAM). On power-up, this preload is not necessary because the counter is internally reset.

When decimating fields, the TDALGN bit in the TDEC register can be programmed to choose whether the decimation starts with an odd or even field. If the TDALGN bit is set to logical 0, the first field dropped during the decimation process will be an odd field. Conversely, setting the TDALGN bit to logical 1 causes the even field to be dropped first in the decimation process.

2.6.12 Video Adjustments

The CX2388x provides programmable hue, contrast, saturation, and brightness.

2.6.12.1 The Hue Adjust Register

The Hue Adjust register (HUE) is used to offset the hue of the decoded signal. In NTSC, the hue of the video signal is defined as the phase of the subcarrier with reference to the burst. The value programmed in this register is added to or subtracted from the phase of the subcarrier, which effectively changes the hue of the video. The hue can be shifted by ±90 degrees.

2.6.12.2 The Contrast Adjust Register

The Contrast Adjust register (CONTRAST) (also called the luma gain) provides the ability to change the contrast from approximately 0–200 percent of the original value. The decoded luma value is multiplied by the 8-bit coefficient loaded into this register.

2.6.12.3 The Saturation Adjust Registers

The Saturation Adjust registers (VSAT, USAT) are additional color adjustment registers. It is a multiplicative gain of the U and V signals. The values programmed in these registers are the coefficients for the multiplication. The saturation range is from approximately 0–200 percent of the original value, over an 8-bit range.

2.6.12.4 The Brightness Register

The Brightness register (BRIGHT) is simply an offset for the decoded luma value. The programmed value is added to or subtracted from the original luma value, which changes the brightness of the video output. The luma output is in the range of 0–255. Brightness adjustment can be made over a range of –128 to +127 (2's complement).

2.6.12.5 Automatic Chrominance Gain Control (ACGC)

The ACGC compensates for reduced chrominance and color-burst amplitudes. Here, the color-burst amplitude is calculated and compared to nominal. The color-difference signals are then increased or decreased in amplitude according to the color-burst amplitude difference from nominal. The range of chrominance gain is 0.5–2 times the original amplitude. This compensation coefficient is then multiplied by the saturation

adjust value for a total chrominance gain range of 0–2 times the original signal. ACGC may be disabled.

2.6.13 Low Color Detection and Removal

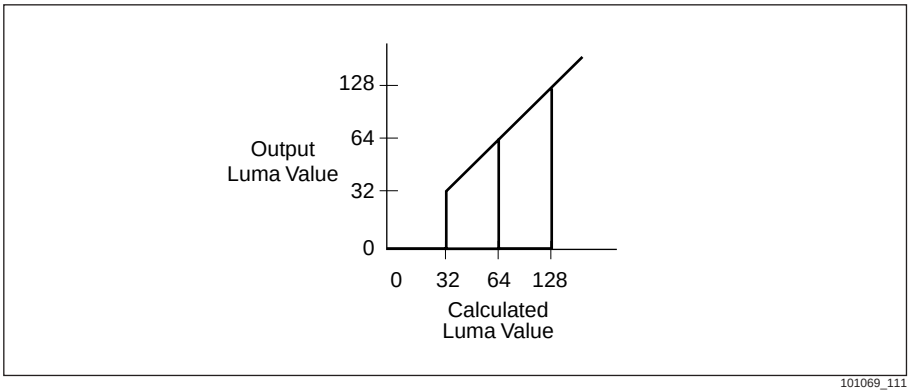
If a color-burst of 25 (NTSC) or 35 (PAL/SECAM) percent or less of the nominal amplitude is detected for 127 consecutive scan lines, the color-difference signals U and V are set to 0. When the low color detection is active, the reduced chrominance signal is still separated from the composite signal to generate the luminance portion of the signal. The resulting Cr and Cb values are 128. Output of the chrominance signal is re-enabled when a color-burst of 43 (NTSC) or 60 (PAL/SECAM) percent or greater of nominal amplitude is detected for 127 consecutive scan lines. Low color detection and removal may be disabled.

2.6.14 Coring

The CX2388x video decoder can perform a coring function in which it forces all values below a programmed level to be 0. This is useful because the human eye is more sensitive to variations in black images. By taking near-black images and turning them into black, the image appears clearer to the eye.

Four coring values can be selected: 0, 32, 64, or 128 above black. If the total luminance level is below the selected limit, the luminance signal is truncated to the black value. If the luma range is limited (i.e., black is 16), then the coring circuitry automatically takes this into account and references the appropriate value for black. Coring is illustrated in Figure 2-59.

Figure 2-59. Coring Map



2.6.15 VBI Data Output Interface

A video frame is composed of 525 lines for NSTC and 625 for PAL/SECAM. Figure 2-60 illustrates an NTSC video frame in which there are a number of distinct regions. The video image or picture data is contained in the odd and even fields within lines 21–263 and 283–525, respectively. Each field of video also contains a region for vertical synchronization (lines 1–9 and 264–272) and a region which can contain nonvideo ancillary data (lines 10–20 and 273–283). These regions between the vertical synchronization region and the video picture region are referred to as the VBI portion of the video signal. Figure 2-61 illustrates a PAL video frame.

Figure 2-60. Regions of the NTSC Video Frame

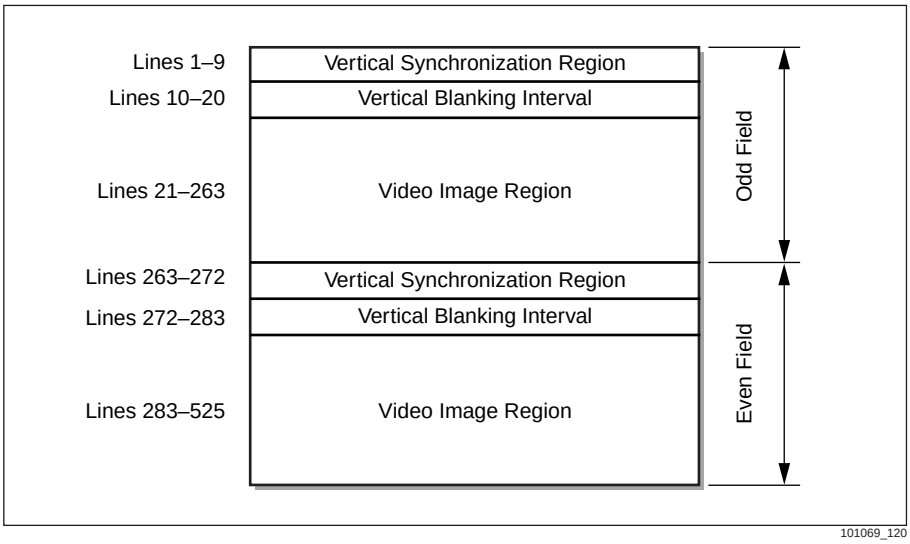
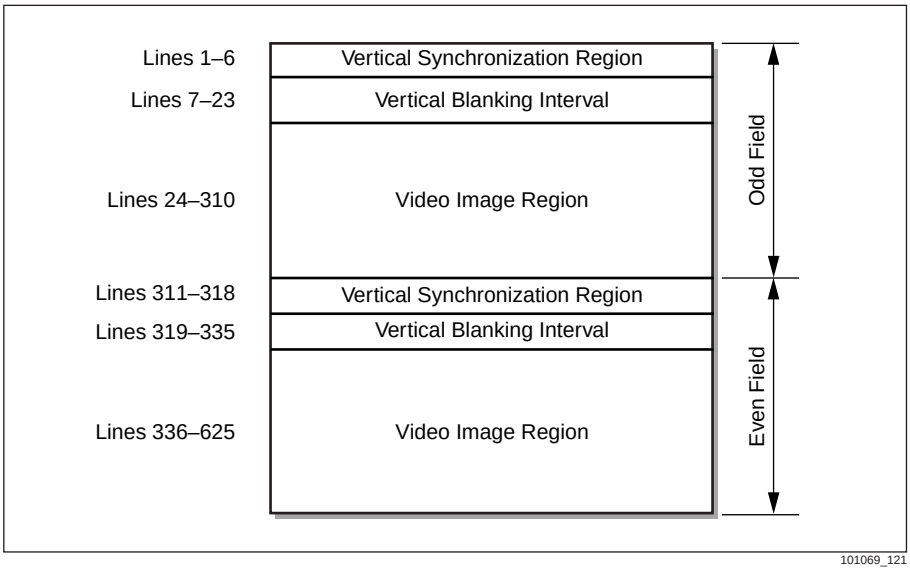


Figure 2-61. Regions of the PAL Video Frame (Fields 1, 2, 5, and 6)



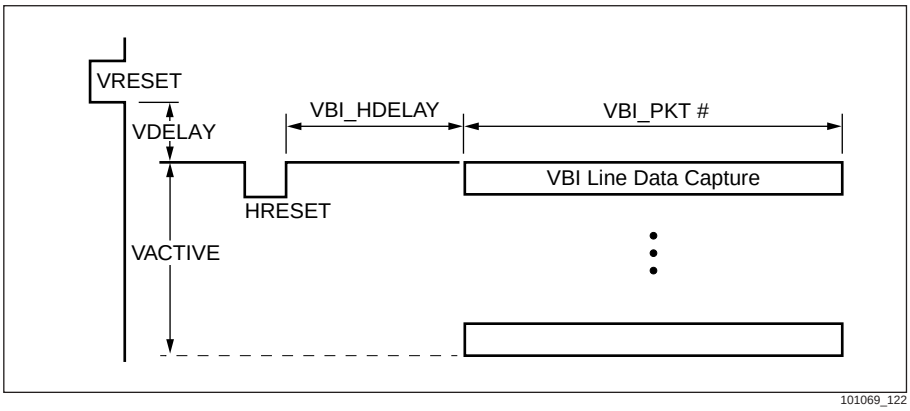
The CX2388x is able to capture VBI data and store it in the host memory for subsequent processing by the VBI decoder software. Two modes of VBI capture exist, VBI line output mode and VBI frame output mode. Both types of data may be captured during the same field.

2.6.16 VBI Line Output Mode

In the VBI Line Output mode, VBI capture occurs during the vertical blanking interval. The start of VBI data capture is set by the VBI_HDELAY bit in the VBI Packet Size/Delay register, and is in reference to the trailing edge of the HRESET signal. The number of dwords of VBI data is selected by the user. Each dword contains 4 VBI bytes, and each VBI pixel consists of 2 VBI samples. For example, for a given 800 pixel line in the VBI region, there exist 1,600 VBI samples, which are equivalent to 400 dwords of VBI data. The VBI_PKT_HI and VBI_PKT_LO register bits are concatenated to create the 9-bit value for the number of dwords to be captured.

VBI line data capture occurs when the CAPTURE_VBI_EVEN register bit is enabled for the even field and the CAPTURE_VBI_ODD register bit is enabled for the odd field. The VBI data is sampled at a rate of 8 × Fsc and is stored in the FIFO as a sequence of 8-bit samples. Line mode VBI data starts horizontally beginning at the VBI_HDELAY pixels from the trailing edge of HRESET and ending after the VBI_PKT number of dwords. Line mode VBI data starts vertically beginning at the first line following VRESET and ending at VACTIVE. VBI register settings can be changed only on a per-frame basis. The VBI timing is illustrated in Figure 2-62.

Figure 2-62. VBI Timing



Once the VBI data has been captured and stored in the CX2388x FIFO, it is treated as any other type of data. It is output over the PCI bus via RISC instructions. If the number of VBI lines desired by the user is smaller than the entire vertical blanking region, the extra data is discarded by the use of the SKIP RISC instruction. Alternatively, if the user desires a larger VBI region in the VBI line output mode, the vertical blanking region can be extended by setting the VDELAY register to the appropriate value. The VBI line output mode can, in effect, extend the VBI region to the entire field.

In the VBI frame output mode, VBI data capture occurs in the active video region and includes all the horizontal blank/sync information in the data stream. This feature can be used to provide a high-quality still-capture of video. The data is vertically bound beginning at the first line during VACTIVE and ending after a fixed number of packets. The data stream is packetized into a series of 256-dword blocks.

A fixed number of dword blocks (434 for NTSC and 650 for PAL) are captured during each field. This is equivalent to 111,104 dwords for NTSC (434 × 256 dwords) and 166,400 dwords for PAL (650 × 256 dwords) per field. The VBI frame capture region can be extended to include the 10 lines prior to the default VACTIVE region by setting the EXT_FRAME register bit. VDELAY must also be set to its minimum value of 2.

The extended dword block size is 450 dword blocks for NTSC and 674 dword blocks for PAL.

The VBI frame data capture occurs during the even field when the CAPTURE_EVEN register bit is set and the COLOR_EVEN bit is set to raw mode, and during the odd field when the CAPTURE_ODD register bit is set and the COLOR_ODD bit is set to raw mode. The captured data stream is continuous and not aligned with HSYNC.

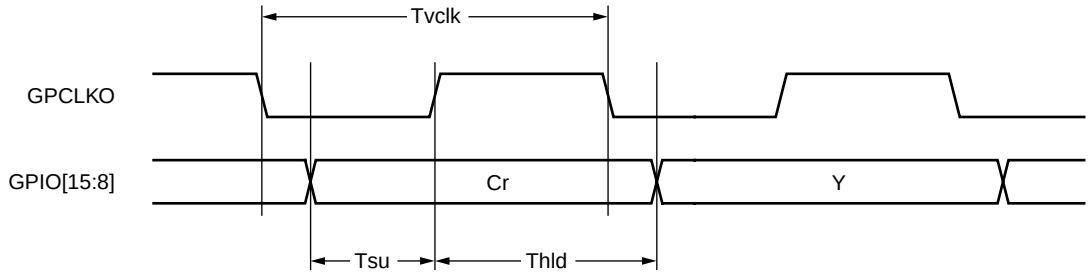
2.6.16.1 Macrovision Detection

The CX2388x has been certified by Macrovision Corporation for full hardware-based detection compliance of the Macrovision Detect Specification Revision 1. Please contact Conexant Applications Engineering if your organization is Macrovision licensed to obtain the Macrovision Detection Register description.

2.6.17 ITU-R656 Output Interface

This port outputs 4:2:2, 720 × 480 interlaced YCrCb pixels with embedded timing codes synchronous with a 27-MHz output clock (see Figure 2-63). Please refer to Section 2.3 for details on configuring the GPIO pins to enable this mode.

Figure 2-63. Video ITU-R 656 Output Timing



GPCLKO period: Tvclk = 37.04 nS (27 MHz typ)
Output Setup min: Tsu = 12.5 nS
Output Hold min: Thld = 18.5 nS

NOTE(S):
Setup and Hold are referenced to rising edge of GPCLKO.

101069_110

2.6.18 ITU-R656/VIP 2.0 8-bit Pixel Input Interface

This port accepts 720 × 480 interlaced 4:2:2 YCrCb pixels synchronous with a 27-MHz input clock. Bit 17 of the Input Format register toggles between the analog video input and the digital pixel ITU-R656/VIP data input.

Input Format Register

Register 24'h310104

Bits	Type	Default	Name	Description
[17]	RW	1'b0	PESRC_SEL	0 = pixel engine input selects analog input data and clock 1 = pixel engine input selects digital input data and clock (VIP input source)

Figures 2-64 and 2-65 illustrate ITU-R.BT656 timing from an external MPEG II decoder to the CX23880/CX23882's Pixel Input Interface.

Alternatively, this port can accept 4:2:2 720 × 480 progressive YCrCb pixels synchronous with a 54-MHz input clock.

Please refer to Section 2.3 for details on configuring the GPIO pins to enable this mode.

Figure 2-64. MPEG 2 Decoder to CX23880/CX23882 ITU-R656 Connection, Example 1

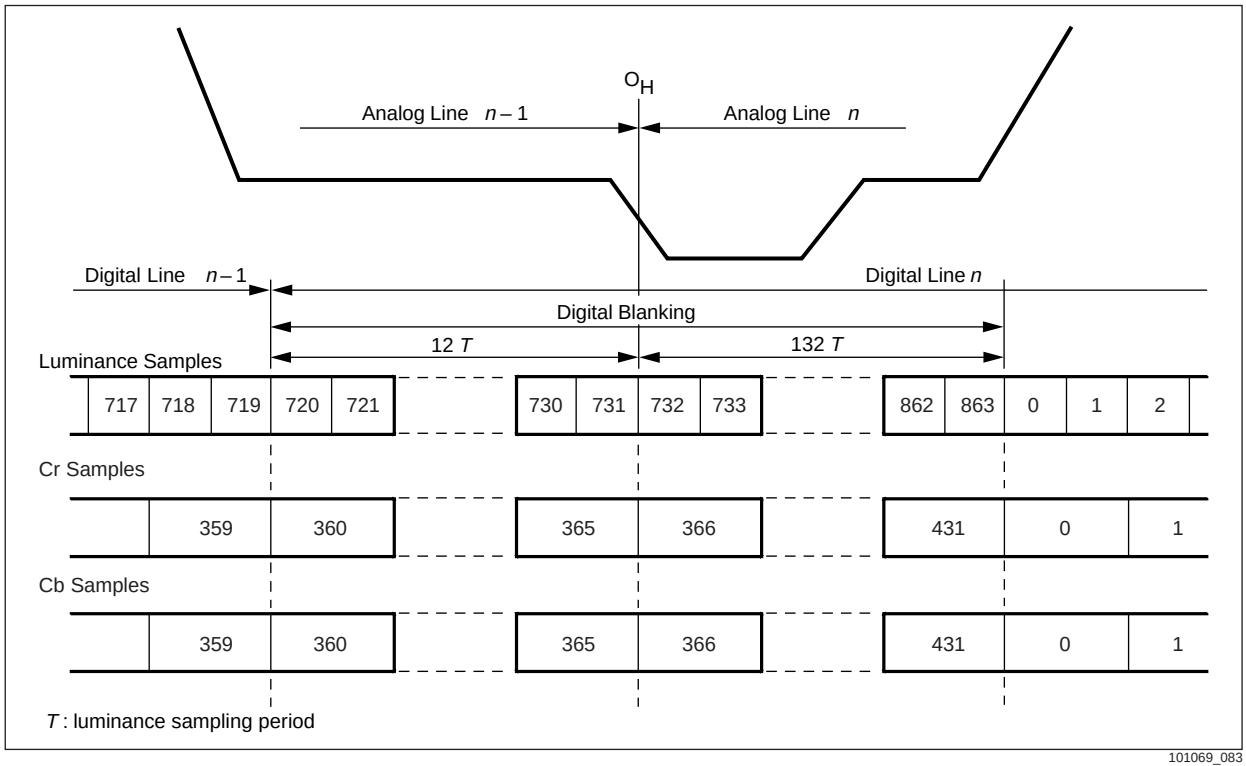
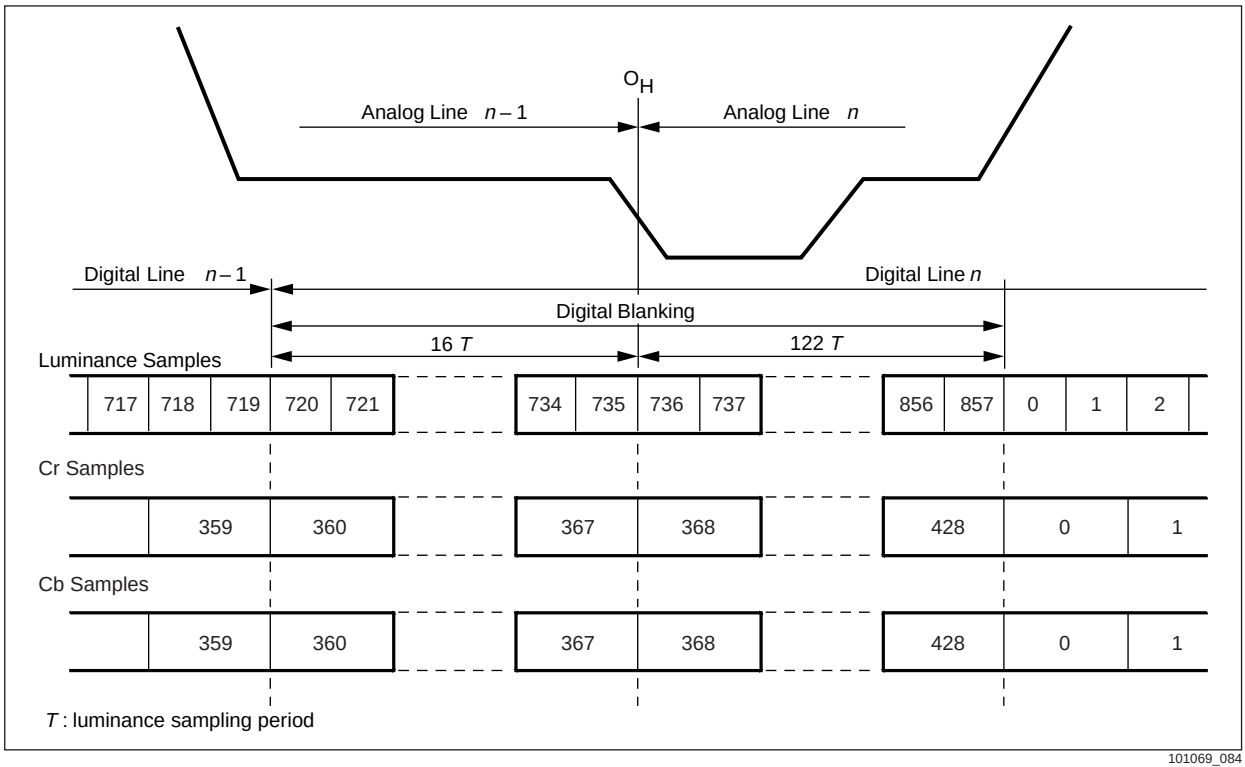


Figure 2-65. MPEG 2 Decoder to CX23880/CX23882 ITU-R656 Connection, Example 2



2.7 VIP 2.0 Host Master

2.7.1 Introduction

The VESA VIP 2.0 Host Master interface is a high bandwidth, minimal pin count interface for connecting multiple video components.

Please refer to the Video Electronics Standards Association (VESA) *Video Interface Port*, version 2, specification for full implementation details.

The VIP 2.0 Host Master interface enables the CX23880 to communicate with devices which are compliant with either the VIP 1.1 or 2.0 slave specification.

The CX23490 is a high-level MPEG II decoder that is a VIP 2.0 slave device. It is designed to connect to the CX23880 in a glue-free manner via the VIP 2.0 Host Master interface.

NOTE: The CX23881, CX23882, and CX223883 do not support this interface.

2.7.2 VIP 2.0 Host Master Overview

The VIP 2.0 Host Master Interface (VHMI) is a slave on the CX23880 Internal Peripheral Bus (IPB). The IPB is designed so that there is only one master, the DMAC, but several slaves—the VHMI being one of them. Data is fetched from the VHMI by the DMAC after a request for service is indicated by the VHMI's assigned DMA request channel.

The VHMI can be configured for either a 2-, 4-, or an 8-bit data path. If only a 2-bit data interface is required, then the 6 remaining unused data path pins can be assigned as GPIO. Table 2-37 describes the CX23880's 11 VHMI pins.

Table 2-37. VIP Host Master Interface Pin Description

Pin No	Pin Name	Dir	Type	Signal	VIP 2.0 Host Master Signals Description (5 or 11 Pins)
20	VIPCLK	O	—	VIP Clock	VIP master output clock
8–17	VHAD[7/1:0]	I/O	—	VIP Host Address/Data	This multipurpose bus is used to transfer commands, addresses, and data between the CX23880 and VIP slave devices. This bus will only be fully utilized when communicating with a VIP slave that supports the 4x host port. The VIP 2.0 specification declares that all VIP devices must be backward compatible with VIP 1.1 specification. This means that the CX23880 must support those VIP devices that have 2-, 4-, or 8-pin HAD bus implementations.
18	VHCTL	I/O	—	VIP Host Control	The VHCTL pin is a shared control pin that is used to begin, end, or throttle data transfers. Because this is a shared pin, the VIP spec clearly outlines the protocol for driving this signal to avoid conflict.
19	VIRQ#	I/O	od	VIP Interrupt Request	The VIRQ pin is an open-collector interrupt pin that can be used by a VIP slave device to interrupt the CX23880.

The VIP Configuration and VIP Terminate registers below are required to configure and control the VHMI port.

VIP Configuration

24'h340048—VIP_CFG Register

Bits	Type	Default	Name	Description
[11:8]	RW	4'b1111	VIP Timeout_length	VIP timeout length
[7:6]	RW	2'b00	Peripheral #1 config	2'b00 = 1x configuration (2-bit) 2'b01 = 2x configuration (4-bit) 2'b10 = reserved 2'b11 = 4x configuration (8-bit)
[5:4]	RW	2'b00	Peripheral #2 config	See channel #1 above.
[3:2]	RW	2'b00	Peripheral #3 config	See channel #1 above.
[1:0]	RW	2'b00	Peripheral #4 config	See channel #1 above.

VIP Terminate

24'h340060—VIP_XFER_TERMINATE Register

Bits	Type	Default	Name	Description
[14:5]	RW	10'h3FF	P1_retry_limit	This caps off how many retries will be attempted to a vip slave on a target read or write.
[4]	WO	1'b1	VIP_soft_rst	Software controllable reset for the entire vip design. (VIP Clock Domain Only) Writing a 0 will cause a reset pulse to the VIP block.
[3]	WO	1'b1	ISI_soft_rst	Software controllable reset for the ISI design core. Writing a 0 will cause a reset pulse to the ISI block.
[2]	WO	1'b0	Terminate_ch1	Writing a one to this register will cause the vip transfer state machine for the register r/w channel to be reset.
[1]	WO	1'b0	Terminate_ch2	Writing a one to this register will cause the vip transfer state machine for the downstream DMA channel to be reset.
[0]	WO	1'b0	Terminate_ch3	Writing a one to this register will cause the vip transfer state machine for the upstream DMA channel to be reset.

The following VIP Interrupt registers are listed below: VIP Interrupt Control, VIP Interrupt Mask, VIP Interrupt Status, VIP Interrupt Masked Status, and VIP Interrupt Set Status

VIP Interrupt Control

24'h34C05C—VIP_INTR_CTRL Register

Bits	Type	Default	Name	Description
[1]	RW	1'b0	VIP_intr_type	Level or Edge sensitive interrupt. 0 = level sensitive 1 = edge sensitive
[0]	RW	1'b0	VIP_intr_polarity	Interrupt polarity. 0 = active low 1 = active high

VIP Interrupt Mask

24'h200080—VIP_INT_MASK Register

Bits	Type	Default	Name	Description
[21:0]	RW	22'b0	VIP_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the VIP_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

VIP Interrupt Status

24'h200084—VIP_INT_STATUS Register

Bits	Type	Default	Name	Description
[21]	RR	1'b0	VIP_TM_OUT	Set when a time out occurs during a VIP transfer.
[20]	RR	1'b0	VIP_EXT	Set when the VIP external interrupt signal is asserted.
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/ target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/unused opcode in the instruction sequence.
[13]	RR	1'b0	UP_SYNC	Set when number of lines or bytes do not match the upstream VIP RISC program expectations.

Bits	Type	Default	Name	Description
[12]	RR	1'b0	DN_SYNC	Set when number of lines or bytes do not match the downstream VIP RISC program expectations.
[9]	RR	1'b0	UPF_UF	Set when upstream VIP FIFO underflow condition is being handled.
[8]	RR	1'b0	DNF_OF	Set when downstream VIP FIFO overflow condition is being handled.
[5]	RR	1'b0	UP_RISCI2	Set when the IRQ2 bit in a upstream VIP RISC instruction is set.
[4]	RR	1'b0	DN_RISCI2	Set when the IRQ2 bit in a downstream VIP RISC instruction is set.
[1]	RR	1'b0	UP_RISCI1	Set when the IRQ1 bit in a upstream VIP RISC instruction is set.
[0]	RR	1'b0	DN_RISCI1	Set when the IRQ1 bit in a downstream VIP RISC instruction is set.

VIP Interrupt Masked Status

24'h200088—VIP_INT_MSTAT Register

Bits	Type	Default	Name	Description
[21:0]	RO	22'b0	VIP_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

VIP Interrupt Set Status

24'h20008C—VIP_INT_SSTAT Register

Bits	Type	Default	Name	Description
[16:0]	WO	17'b0	VIP_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

2.7.3 VIP 2.0 Host Master System Functionality

The VIP Host Master interface is designed to perform the following three main tasks:

1. Stream data from a VIP slave into host memory via the PCI bus (Downstream DMA)
2. Stream data to a VIP slave that is sent over the PCI bus by the host (Upstream DMA)
3. Host access to register space on connected VIP slave devices

All data streaming across the VIP bus should be done via the two DMA channels that have been set up to handle this function. Once the DMAC is set up to point to the correct source or destination in memory, the VIP interface block must be set up to kick-off the transfer. The following sections describe the protocol for both downstream and upstream data transfers. The VIP DMA registers are listed on the following page.

APB DMAC Current Buffer Pointer

24'h3000A0—DMA29_PTR1 Register

24'h3000A4—DMA30_PTR1 Register

Bits	Type	Default	Name	Description
[23:2]	RO	22'hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

APB DMAC Current Table Pointer

24'h3000E0—DMA29_PTR2 Register

24'h3000E4—DMA30_PTR2 Register

Bits	Type	Default	Name	Description
[23:2]	RW*	22'hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

APB DMAC Buffer Limit

24'h300120—DMA29_CNT1 Register

24'h300124—DMA30_CNT1 Register

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

APB DMAC Table Size

24'h300160—DMA29_CNT2 Register

24'h300164—DMA30_CNT2 Register

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.

General Purpose Counter (Immediate Access)

24'h34C020—VIPD_GP_CNT Register

24'h34C024—VIPU_GP_CNT Register

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC.

General Purpose Counter Control (Immediate Access)

24'h34C030—VIPD_GP_CNT_CNTRL Register

24'h34C034—VIPU_GP_CNT_CNTRL Register

Bits	Type	Default	Name	Description
[1:0]	WO	2'b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

VIP Streaming Enable (Immediate Access)

24'h34C040—VIP_STREAM_EN Register

Bits	Type	Default	Name	Description
[5]	RW	1'b0	VIPU_RISC_EN	RISC Controller enable for the VIP interface upstream DMA channel.
[4]	RW	1'b0	VIPD_RISC_EN	RISC Controller enable for the VIP interface downstream DMA channel
[1]	RW	1'b0	VIPU_FIFO_EN	Enable for pulling data out of the VIP upstream DMA FIFO or cluster descriptor table.
[0]	RW	1'b0	VIPD_FIFO_EN	Enable for fetching downstream data from the external source.

VIP Upstream DMA Control Register #1

24'h34004C—VIPU_DMA_CTRL1 Register

Bits	Type	Default	Name	Description
[23:0]	RW	24'hxxxxxx	VIPU_DST_ADDR	VIP upstream APB DMA Destination address.

VIP Downstream DMA Control Register #2

24'h340050—VIPD_DMA Register

Bits	Type	Default	Name	Description
[23:0]	RW	24'hxxxxxx	VIPD_SRC_ADDR	VIP downstream APB DMA source address.

VIP Downstream DMA Control Register #3

24'h340054—VIPD_DMA Register

Bits	Type	Default	Name	Description
[11:0]	RW	12'hxxx	VIP_LNGTH	VIP downstream transfer count in bytes.

VIP Downstream DMA Control Register #4

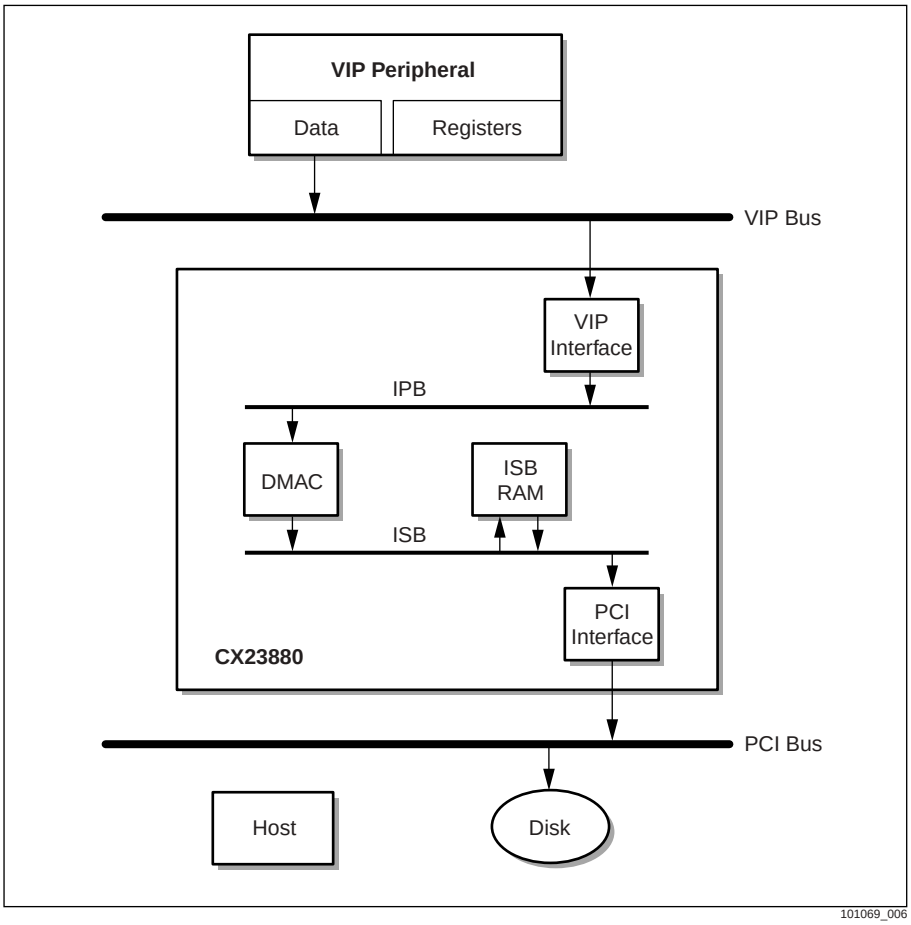
24'h340058—VIP_BURST_LENGTH Register

Bits	Type	Default	Name	Description
[15:8]	RW	8'FF	VIPU_BURST_LNGTH	VIP Maximum Upstream burst length in terms of vip data cycles. This value entered here should depend upon vip mode (1x, 2x, 4x) 1x = 1byte/data cycle, 2x = 2 bytes/data cycle…
[7:0]	RW	8'hFF	VIPD_BURST_LNGTH	Maximum burst length for Downstream transfers.

2.7.3.1 Downstream DMA Channel

This is a case where the CX23490 high-level MPEG II decoder is sending Program-Specific Information (PSI) data to the host. The CX23880 internal VIP interface module fetches the PSI data from the CX23490 and places it into a small transfer buffer within the VIP interface module (see Figure 2-66). The VHMI then initiates a transfer request to the DMAC. The DMAC then moves the data into a temporary buffer within the Internal System Bus (ISB) RAM. The data is then sent over the PCI bus to the host for processing.

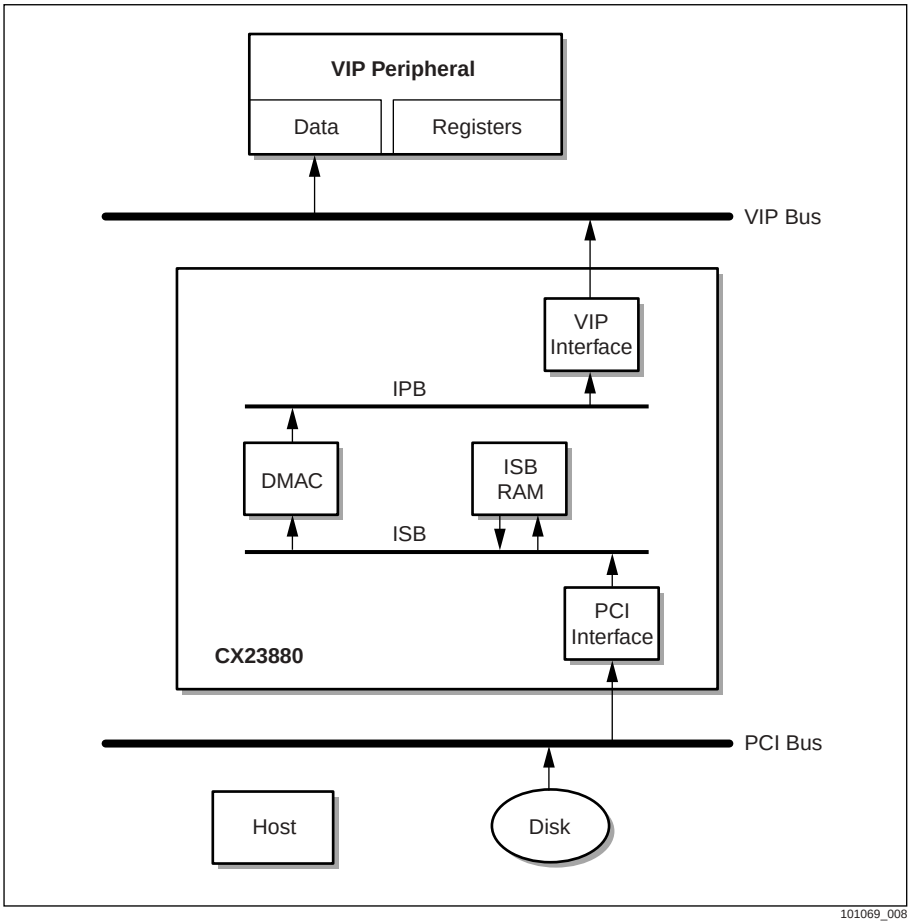
Figure 2-66. Data Transfer from VIP 2.0 Slave to Host via CX23880



2.7.3.2 Upstream DMA Channel

This is a scenario where the host is sending compressed high-definition video data from the disk to the CX23490 high-level MPEG decoder via the CX23880. The host sends the compressed data to the CX23880 via the PCI bus, where the PCI Interface module decodes the PCI data and places it into the ISB RAM. The DMAC and VIP modules are then programmed with the appropriate data to setup the transfer of the compressed data from the ISB RAM to the VIP module (see Figure 2-67). The VIP Interface module then reformats the data and sends it out on the VIP bus to the all-format decoder.

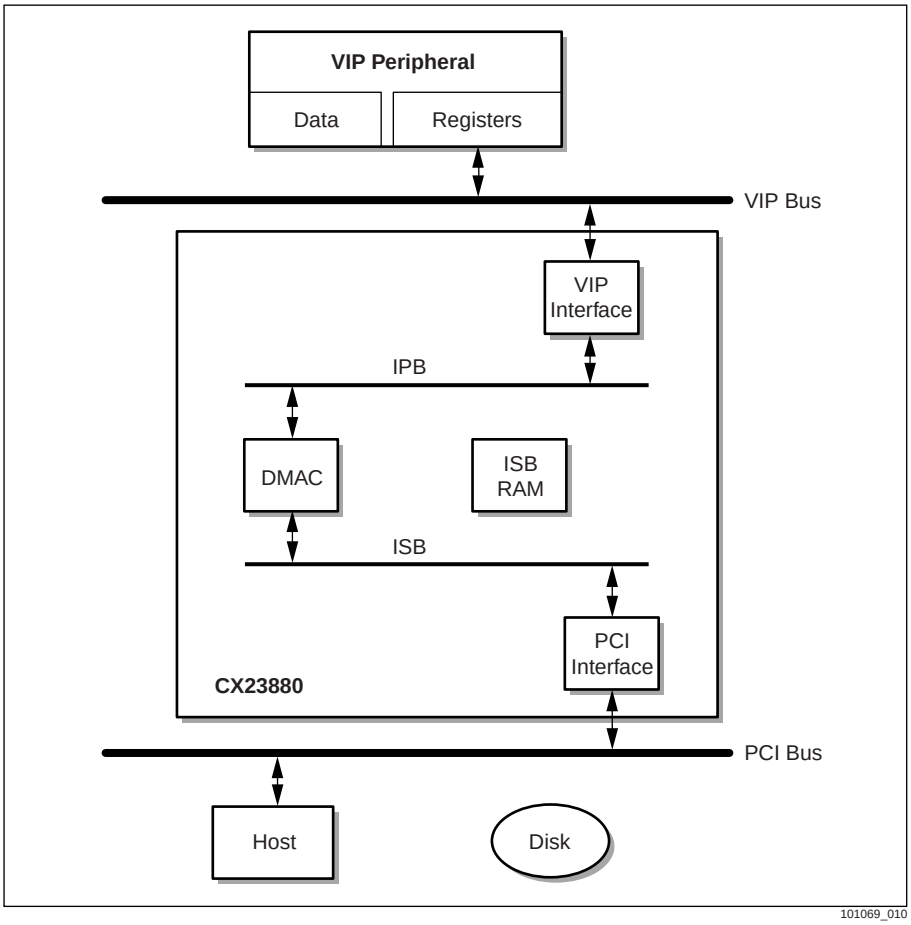
Figure 2-67. Data Transfer from Host to VIP SIave via CX23880



2.7.3.3 VIP External Register Access

This scenario is one in which the host wants to read or write registers in a device that is attached to the VIP Host Port, such as the CX23490 All-Format decoder (see Figure 2-68).

Figure 2-68. VIP External Register Access



2.7.3.4 VIP Local Register Access

All internal VIP Host-Master Interface registers are mapped into the IPB address space so they are accessible from any ISB or IPB masters. This allows the Host to access this register space via the PCI module.

2.7.4 VIP Memory Space

The VIP register space in the CX23880 has been divided up into the following three main groups:

1. Local VIP registers
2. External status registers
3. Main external peripheral address space

Memory VIP space is defined in Table 2-38.

Table 2-38. Memory VIP Space

Address Range	Size	Description
340000–3407FF	4,031 Bytes	VIP delayed across local registers
340800–340FBF	—	Reserved
341000–341FFF	4 KBytes	Peripheral 1 address space
342000–342FFF	4 KBytes	Peripheral 2 address space
343000–343FFF	4 KBytes	Peripheral 3 address space
344000–344FFF	4 KBytes	Peripheral 4 address space
345000–34FFFF	—	Reserved
345FFF–345000	256 bytes	Peripheral 1 predefined FIFO and status ports
346000–346FFF	256 bytes	Peripheral 2 predefined FIFO and status ports
347000–347FFF	256 bytes	Peripheral 3 predefined FIFO and status ports
348000–348FFF		Peripheral 4 predefined FIFO and status ports
345000–34BFFF		Reserved
34C000–34CFFF		VIP Immediate access local registers

2.7.5 VIP Address Space

Through the VIP port, we have access to up to 4 KBytes of address space for each VIP peripheral and the internal VIP registers. Because the VHMI supports up to 4 slaves in any given configuration, that means there are 16 KBytes of CX23880 memory space directly mapped to these external devices. This direct-mapped address space is supplied for external register access and is not intended for streaming data to the peripheral. All data streaming should be via the DMA channels.

3 Electrical Interfaces

3.1 Input Interfaces

3.1.1 Analog Signal Selection

The CX2388x contains an on-chip 4:1 multiplexer (VMUX[4:1]) that can be used to switch between four composite video sources or three composite video sources and one S-Video source. For the first configuration, connect the inputs of the MUX to the four composite sources. For the second configuration, connect three inputs to the composite sources and the other input to the luma component of the S-Video connector. When an S-Video source is input to the CX2388x, the luma component feeds through the input analog multiplexer and the chroma component feeds directly into the VINC input pin. An AGC circuit enables the CX2388x to compensate for nonstandard amplitudes in the analog signal input.

When capture and demodulation of broadcast audio is required, the low IF audio output from a suitable television tuner may be connected to the VINIFA pin.

3.1.2 Multiplexer Considerations

The composite/Y video and chroma/low IF multiplexer are not break-before-make designs. Therefore, during multiplexer switching time, it is possible for the input video signals to be momentarily connected together through the equivalent of 200 Ω In addition, the multiplexers cannot be switched on a real-time, pixel-by-pixel basis.

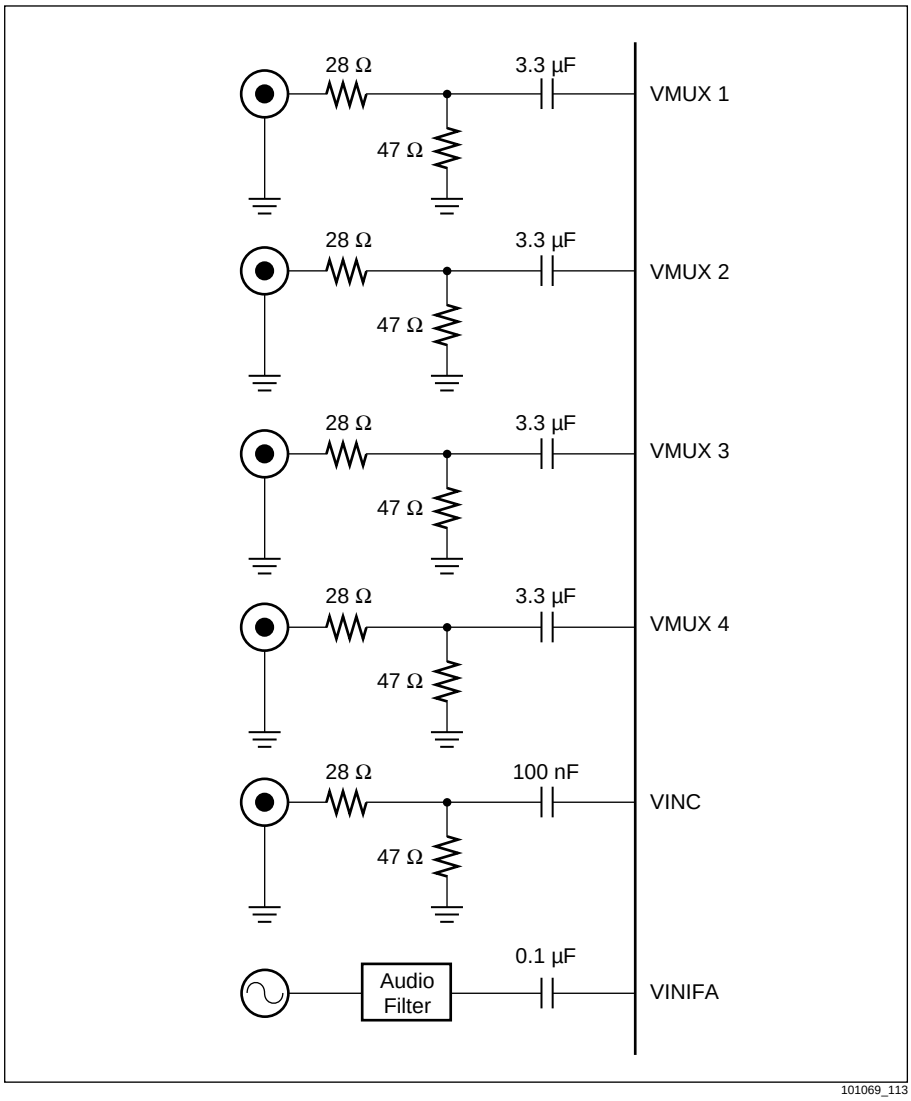
3.1.2.1 ADCs

The CX2388x uses two on-chip, 10-bit ADCs to digitize the baseband video signals and broadcast audio low IF signals.

The input video and audio signals are always AC-coupled to the decoder. A resistor-divider network provides correct input termination, as illustrated in Figure 3-1.

Please contact Conexant Applications Engineering to obtain Audio Filter topologies for desired TV tuner.

Figure 3-1. Resistor-Divider Network



3.1.3 Power-Up Operation

Upon power-up, the status of the CX2388x's registers is indeterminate. The RST signal must be asserted to set the register bits to their default values. Upon reset, the CX2388x defaults to NTSC-M format.

3.1.4 Crystal Inputs and Clock Generation

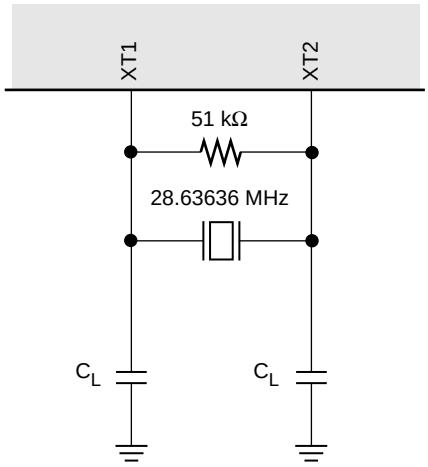
The CX2388x includes an internal Phase Lock Loop (PLL) that may be used to decode NTSC, PAL, SECAM, and all broadcast audio standards using a single crystal. The clock signal interface consists of a pair of I/O pins (XTI and XTO) connected to a 28.63636 MHz (8 × NTSC Fsc) crystal. When using the PLL, a 28.63636 MHz, 50 ppm, fundamental (or third overtone) crystal must be connected across XT1 and XT2. Alternately, a single-ended oscillator can be connected to XT1.

Crystals are specified as follows:

- 28.63636 MHz
- Fundamental cut or Third Overtone
- Parallel resonant
- 30 pF load capacitance
- 50 ppm at 25° C
- Series resistance 40 Ω or less

Figure 3-2 illustrates the fundamental crystal oscillator clock circuit. Figure 3-3 illustrates the 3rd Overtone crystal oscillator clock circuit.

Figure 3-2. Fundamental Crystal Oscillator

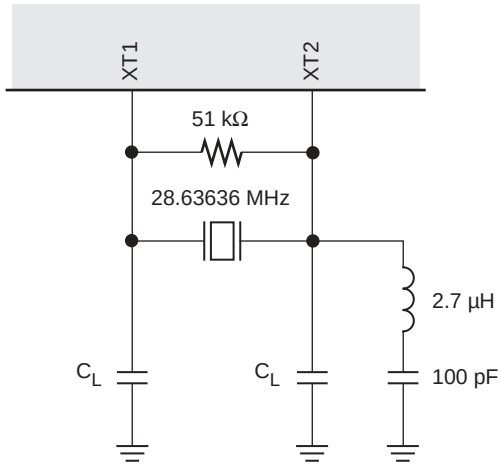


Fundamental Crystal Oscillator

NOTE(S):
Value for C_L varies by crystal manufacturer. Use capacitor recommended by vendor.

101069_112a

Figure 3-3. 3rd Overtone Crystal Oscillator



3rd Overtone Crystal Oscillator

NOTE(S):
Value for C_L varies by crystal manufacturer. Use capacitor recommended by vendor.

101069_112

Recommended crystals for use with the CX2388x are listed in Table 3-1.

Table 3-1. Recommended Crystals

Crystal Manufacturer	Part Number
Standard Crystal (El Monte, CA) Phone: (626) 443-2121 Fax: (626) 443-9049 E-mail: stdxtl@worldnet.att.net Web: www.standardcrystalcorp.com	2AAK28M636363GLE30A, Fundamental
MMD Components (Irvine, CA) Phone: (949) 753-5888 Fax: (949) 753-5889 E-mail: info@mmdcomp.com Web: www.mmd.com	A30BA1-28.63636, Fundamental
General Electronics (San Marcos, CA) Phone: (760) 591-4170 Fax: (760) 591-4164 E-mail: gedlm@4dcomm.com Web: www.gedlm.com	PKHC49/U-28.63636-.030-005-15R(F), Fundamental
Reichenbach International, Inc. Phone: (805) 495-7003 Fax: (805) 379-4310 E-mail: reichenbach@aol.com Web: www.reichenbachintl.com	HC49U – 28.63636 – 50 PPM – 30
Bomar (Middlesex, NJ) Phone: (732) 356-7787 Fax: (732) 356-7362 E-mail: sales@bomarcrystal.com Web: www.bomarcrystal.com	BC1FFA330-28.63636 MHz, 3rd Overtone BC1FFA130-28.63636 MHz, Fundamental
Fox Electronics (Fort Meyers, FL) Phone: (941) 693-0099 Fax: (941) 693-1554 E-mail: sales@foxonline.com Web: www.foxonline.com	HC49U–FOX 286, 3rd Overtone

The clock source tolerance should be 50 ppm or less. Devices that output CMOS voltage levels are required. The load capacitance in the crystal configurations may vary depending on the magnitude of board parasitic capacitance. The CX2388x is dynamic and, to ensure proper operation, the clocks must always be running with a minimum frequency of 28.63636 MHz.

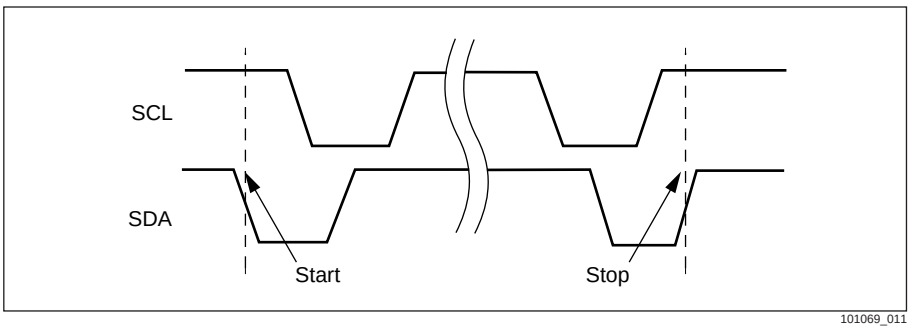
3.2 Serial Bus Interface

The serial bus is a two wire serial interface that is compatible with the I^{2}C compatible bus. Serial clock and data signals, SCL and SDA, are used to transfer data between the bus master and the slave device. The CX2388x implements the serial bus to support multiple EEPROM devices, and other I^{2}C compatible devices. Serial bus transfers can be initiated in several ways using the I^{2}C compatible Direct, I^{2}C compatible Data/Control, or VPD registers. The I^{2}C compatible_INT bit will be set in the PCI Interrupt Status register when an I^{2}C compatible operation has completed. This bit can be masked and polled, or be unmasked and used to send an interrupt to the host. The I^{2}C compatible interface can be programmed to run at 100 kHz or 400 kHz.

The I^{2}C compatible Direct register is a 15-bit address range that can be used to read and write four consecutive bytes. The upper 7 bits are the I^{2}C compatible chip address and the lower 8 bits are the I^{2}C compatible sub address. The VPD mechanism also can be used to read and write four consecutive bytes, using its 15-bit address range for the I^{2}C compatible chip and sub addresses. The I^{2}C compatible Data/Control register can be used to perform single and multiple byte transfers using hardware logic. It can also be used to directly provide software control of the two I^{2}C compatible signals SCL and SDA.

The relationship between SCL and SDA is decoded to provide both start and stop conditions on the bus. To initiate a transfer on the I^{2}C compatible bus, the master must transmit a start pulse to the slave device. This is accomplished by taking the SDA signal low while the SCL signal is held high. The master should only generate a start pulse at the beginning of the cycle, or after the transfer of a data byte to or from the slave. To terminate a transfer, the master must take the SDA signal high while the SCL signal is held high. The master may issue a stop pulse at any time during an I^{2}C compatible cycle. Care must be taken to ensure that data is stable during the high phase of the clock, as the I^{2}C compatible bus will interpret any transition on the SDA signal during the high phase of the SCL signal as a start or stop pulse. This is illustrated in Figure 3-4.

Figure 3-4. The Relationship Between SCL and SDA



An I^{2}C compatible write transaction consists of sending a START, two or three bytes of data (checking for a receiver acknowledge after each byte), and a STOP. The write data is supplied by the I^{2}C compatible Data/Control register bytes I^{2}C compatible_DB0, I^{2}C compatible_DB1, and I^{2}C compatible_DB2. The least significant bit of I^{2}C compatible_DB0 is the read/write bit and will be low for a write. Two or three bytes of data can be selected for transfer by using the I^{2}C compatible_W3BRA bit.

An I^2C compatible read transaction consists of sending a START, one byte of data (checking for a receiver acknowledge), reading one data byte from the slave, sending the master NACK, and sending the STOP. The data read will be available in the I^2C compatible_DB2 byte. The least significant bit of I^2C compatible_DB0 is the read/write bit and will be high for a read.

A transaction sequence involving a repeated START usually occurs after setting up a slave read address using a two byte write transaction, then following with a one byte read (with one byte slave address write) transaction. The STOP can be disabled for the first transaction by setting I^2C compatible_NOSTOP high only for the first register write. I^2C compatible_NOSTOP should be reset during the second register write. This is because every set of I^2C compatible transactions should begin with a START and end with a STOP (rule applicable to overall transaction set or sequence).

Multiple byte (>3) write transactions enable communication to devices that support auto-incrementing internal addressing. To avoid reset of the internal address sequencer in some devices, a STOP is not transmitted until the very end of the sequence. The first register write should enable a two byte write transaction with START. I^2C compatible_NOSTOP should be set to disable STOP temporarily. The SCL signal will be held in the low state while the I^2C compatible_DONE interrupt is processed. The second and successive register writes will enable one byte writes to be transmitted without START and without STOP (I^2C compatible_NOS1B and I^2C compatible_NOSTOP both high). The last register write should enable the final STOP to be sent to end the sequential write transaction set. The one byte write data is sent from I^2C compatible_DB0. The read/write mode was saved from the first register write when the START was transmitted.

For multiple byte (>1) sequential reads, the first register write enables the START and slave address to be transmitted. The first read byte is received into I^2C compatible_DB2. The STOP is disabled via I^2C compatible_NOSTOP. Since the reading will continue, the master should ACK at the end of the first read (set I^2C compatible_W3BRA high). The SCL signal will be held in the low state while the I^2C compatible_DONE interrupt is processed. The second and successive register writes will enable one byte reads to be received without sending START or STOP (I^2C compatible_NOS1B and I^2C compatible_NOSTOP both high). The last register write should reset E2C_W3BRA low to master NACK. This will indicate final read from slave, and enable the final STOP to be sent to end the sequential read transaction set. The one byte read data is also read from I^2C compatible_DB2. The read/write mode was saved from the first register write when the START was transmitted, so I^2C compatible_DB0 is a don't-care during one byte reads.

3.3 Serial Bus Serial EEPROM Interface

An external EEPROM is required to support Subsystem ID, function enables, and Vital Product Data (VPD). The EEPROM must reside on the I^2C compatible bus {SDA,SCL}. This interface supports ICs equivalent to the Catalyst CAT24C02 or Microchip 24C02A 2K-bit 5V CMOS Serial EEPROM. The EEPROM can be read anytime by using the I^2C compatible HW, SW, or direct modes. Thus a normal 2-byte write transaction without STOP followed by a 2-byte read transaction will allow random access to a data byte.

The CX2388x can support multiple EEPROMs, typically 24C02 (256 byte), 24C04 (512 byte), and 24C08 (1024 byte). The 7-bit slave device address is 7'b1010_xxx where the xxx bits are determined according to the way the A2, A1, A0 pins on the EEPROMs are tied. The 8-bit addressable physical memory space is specified using the 8-bit base address of the I^2C compatible transaction. Any combination of EEPROM devices can be accessed, up to a maximum of 2 Kbytes.

NOTE: The address re-mapping scheme used by the Fusion 878/878A is not implemented in the CX2388x.

The first two dwords of the address space are reserved for function enable bits (15'h5000), and Subsystem ID (15'h5004). The remaining locations of EEPROM are available for Vital Product Data (VPD), and other vendor information.

3.3.1 EEPROM Upload at PCI Reset

The function enables and the 32-bit PCI Subsystem IDs are read from the EEPROM automatically by the hardware immediately following PCI reset deassertion. The function enables are contained in bits[4:1] of the byte at address 15'h5000. Bits 4 through 1 are used for functions 4 through 1, respectively. Function 0 must always be enabled, and therefore has no enable bit. The bytes from 15'h5001-15'h5003 will be read, but currently have no meaningful information.

The Subsystem ID is contained in 4 bytes of the EEPROM starting at address 15'h5004. To get the Subsystem IDs, a read transaction to access the 4 bytes beginning at address 15'h5004 will occur. The Subsystem IDs are stored in the EEPROM in the same order as they appear in the PCI configuration space. The full read sequence is detailed in Table 3-2.

Table 3-2. EEPROM Read Sequence

Master		Slave		Master	Comment
Control	**Data**	**Data**	**Control**	**Control**	
START	8'hA0		ACK		Write control byte with slave chip address
	8'h00		ACK		Data bytes base address
START	8'hA1		ACK		Read control byte with slave chip address
		8'h??		ACK	
		8'h??		ACK	
		8'h??		ACK	
		8'h??		NACK, STOP	
START	8'hA0		ACK		Write control byte with slave chip address
	8'h04		ACK		Data bytes base address
START	8'hA1		ACK		Read control byte with slave chip address
		8'h??		ACK	Subs Vendor ID [7:0] @ 11'h004
		8'h??		ACK	Subs Vendor ID [15:8] @ 11'h005
		8'h??		ACK	Subsystem ID [7:0] @ 11'h006
		8'h??		NACK, STOP	Subsystem ID [15:8] @ 11'h007

If at any time the slave device issues a NACK (because the device is not present), the sequence is aborted, the enables will be all 0, and the Subsystem Vendor IDs read 32'h0000_0000. In this case, function 0 will be the only function enabled. Normally it will take approximately 1.3 mS to read these dwords into the PCI configuration register. Any attempted PCI transactions to the CX2388x during this process will result in a RETRY.

3.3.2 Register load from BIOS

The Subsystem ID register is read-only. However, by enabling SVIDS_EN in the user-defined PCI configuration control register, the Subsystem ID can be written. Then SVIDS_EN should be disabled. This value needs to be programmed before the operating system boots and has access during configuration. This must occur via support from the BIOS versus the IC driver.

3.3.3 Programming and Write-Protect

The EEPROM can be programmed before soldering onto the PCB, or it may be programmed through the CX2388x using the I^2C compatible HW or SW modes. The write transaction sequence would be: START, 8'hA0, 8-bit byte address, 8-bit write data, followed by STOP. This 3-byte transaction then initiates a programming cycle internal to the EEPROM. The write completion status can be monitored by initiating another write transaction and checking the ACK status. Anytime a transaction has been aborted with a slave NACK, that implies the EEPROM device is still busy with the internally timed programming cycle. The upper half of a 24C02 device can be write-protected by adding a pull-up resistor to the EEPROM WP pin. Simply pull the pin to GND during programming.

3.3.4 Page-Mode limitations

Even though multiple EEPROMs can be supported, there is a restriction that a page-mode access can not occur across separate devices. Also, some EEPROMs larger than 256 bytes may not support page-mode accesses across 256 byte internal boundaries. For example: The 24C04 contains two pages and does not support the page-mode writes across the page boundary. Using a 24C04 will work if writing to it, is limited to word resolution around the page boundary. Byte resolution may not be used for reading or writing when crossing the IC chip-size boundaries. These limitations are introduced by using the page-mode word-write and dword sequential read operations available to speed up access.

3.4 Vital Product Data

VPD is usable by the board manufacturer, system vendor, and the customer. This data is required by PCI Local Bus Specification Rev 2.2 (for devices after 6/30/98). The VPD format in the EEPROM uses the Large Resource Date type, which allows efficient storage of variable-length data fields. Most of the data is in ASCII format. Each function's VPD is accessed through any of the function's configuration space VPD interface support registers.

3.4.1 Required VPD

A Plug and Play compatible product name is the first VPD item. The Product Name large resource type ID string tag field value is 0x82. The tag is followed by a length-of-data word and actual ASCII data. The large resource type VPD-R (tag field value is 0x90) wraps other required read-only VPD field items (keyword): Part Number of Assembly (PN), Field Replaceable Unit Part Number (FN), Engineering Change Level of Assembly (EC), Manufacture ID (MN), Serial Number (SN), and Checksum and Reserved (RV).

3.4.2 VPD Access

The flag bit in the VPD Capability register is used to indicate the transfer of data between the VPD Data register and the EEPROM. To read VPD information a zero is written to the flag at the same time the 15-bit byte address is supplied to the VPD Address register. The device sets the flag after it reads four bytes from the EEPROM. The four VPD Data register bytes, a dword, correspond to VPD Address+3 … Address+0, or little-endian format. Software monitors the flag to determine the appropriate time to read the VPD Data register. To write data to the R/W portion of the EEPROM, software must write a dword to the VPD Data register, then set the flag bit to a one while supplying the VPD Address. When the device completes writing the four bytes to the EEPROM, it will reset the flag bit to zero. The VPD Data register is byte accessible. However, all transfers to/from the EEPROM are always 4-byte transactions (except when done with a memory-mapped I^2C compatible transaction).

3.4.3 VPD Address

The 15-bit logical byte address maps directly to the EEPROM physical storage space. Bits[14:11] must be 4’b1010 to match the defined I^2C compatible EEPROM chip address, bits[10:8] select one of eight 256 byte spaces, and bits[7:0] is the byte address within the 256 byte space. Addresses 11’h000-11’h007 are reserved in the EEPROM for function enables and Subsystem Vendor ID, therefore the first available VPD address is {4’b1010,3’b000,8’b00001000} (15’h5008). Since all VPD accesses are a full dword, the four bytes will use the VPD address as its base.

3.4.4 VPD Read

When software resets the VPD flag bit, the CX2388x initiates the I^2C compatible sequence shown in Table 3-3 to read four bytes from the EEPROM (assumes VPD address was set to 15’h5008):

Table 3-3. VPD Read Sequence

Master		Slave		Master	Comment
Control	**Data**	**Data**	**Control**	**Control**	
START	8’hA0		ACK		Write ctrl byte with slave chip adr
	8’h08		ACK		Data bytes base address
START	8’hA1		ACK		Read ctrl byte with slave chip adr
		8’h??		ACK	VPD[31:24] @ 11’h00B
		8’h??		ACK	VPD[23:16] @ 11’h00A
		8’h??		ACK	VPD[15:8] @ 11’h009
		8’h??		NACK, STOP	VPD[7:0] @ 11’h008

The device sets the VPD flag bit once all four bytes are read into the VPD data register. If a slave NACK is received, the sequence is aborted and the flag bit is not set.

3.4.5 VPD Write

When software sets the VPD flag bit, the CX2388x initiates the I^2C compatible sequence shown in Table 3-4 to write four bytes to the EEPROM (assumes VPD address was set to 15'h57FC):

Table 3-4. VPD Write Sequence

Master		Slave		Master	Comment
Control	**Data**	**Data**	**Control**	**Control**	
START	8'hAE		ACK		Write ctrl byte with slave chip adr
	8'hFC		ACK		Data bytes base address
	8'h??		ACK		VPD[31:24] @ 11'h7FF
	8'h??		ACK		VPD[23:16] @ 11'h7FE
	8'h??		ACK		VPD[15:8] @ 11'h7FD
	8'h??		ACK	STOP	VPD[7:0] @ 11'h7FC
START	8'hAC		?ACK?	STOP	Loop until ACK, then STOP

The device resets the VPD flag bit once all four bytes from the VPD data register are programmed into the EEPROM. If a slave NACK is received during either page write, the sequence is aborted and the flag bit is not reset. Note that a SW timeout on the flag status is the only way to detect an error. It takes approximately 4 mS to program the dword into the EEPROM.

3.5 Power Management Interface

The CX2388x supports the new capabilities feature for power management as outlined in *PCI Bus Power Management Interface Specification*, revision 1.1. Power management states D0, D3hot, and D3cold are supported. Optional power states D1 and D2 are not supported because there are no significant power savings without going to D3. Restoring a function from D1 to D2 would also require device-specific interaction that the operating system does not currently support.

3.5.1 PME#

The Power Management Even signal PME# is not used because wake-up events are not generated by the CX2388x.

3.5.2 D3 Power States

The CX2388x supports D0 (on) and D3cold (off) by default. Each function also supports D3hot independently. When placing a function in D3hot, the operating system is required to disable I/O, memory space, and bus mastering via the PCI Command register. Restoring a function from D3 requires the operating system to reinitialize the function. Full context must be restored before the function is capable of resuming normal operation.

Functions in D3hot respond to configuration space accesses as long as the power and clock are supplied. In addition to each function being disabled from memory access and bus mastering, the D3hot power state enables extra power savings by powering down as many circuits as possible. The video function disables the VFE (sleep ADCs, disable AGC), PLL, and decoder clocks (gate off XTAL signals in CLKIOGEN). The audio function disables its clock and the AFE. In addition, each function resets as many circuits as possible without disabling configuration access.

3.6 JTAG Interface

3.6.1 Need for Functional Verification

As the complexity of imaging chips increases, the need to easily access individual chips for functional verification is becoming vital. The CX2388x has incorporated special circuitry that allows it to be accessed in full compliance with standards set by the Joint Test Action Group (JTAG). Conforming to IEEE Standard *P1149.1*, "Standard Test Access Port and Boundary Scan Architecture," the CX2388x has dedicated pins that are used for testability purposes only.

3.6.2 JTAG Approach to Testability

The JTAG's approach to testability uses boundary scan cells placed at each digital pin and digital interface. In the CX2388x, a digital interface is the boundary between an analog block and a digital block. All cells are interconnected into a boundary scan register that applies or captures test data used for functional verification of the integrated circuit. The JTAG is particularly useful for board testers using functional testing methods.

The JTAG consists of four dedicated pins comprising the Test Access Port (TAP):

- Test Mode Select (TMS)
- Test Clock (TCK)
- Test Data Input (TDI)
- Test Data Out (TDO)

Verification of the integrated circuit and its connection to other modules on the printed circuit board can be achieved through these four TAP pins.

With boundary scan cells at each digital interface and pin, the CX2388x has the capability to apply and capture the respective logic levels. Because all of the digital pins are interconnected as a long shift register, the TAP logic has access and control of all the necessary pins to verify functionality. The TAP controller can shift in any number of test vectors through the TDI input and apply them to the internal circuitry. The output result is scanned out on the TDO pin and externally checked. While isolating the CX2388x from other components on the board, the user has easy access to all digital pins and digital interfaces through the TAP and can perform complete functionality tests without using expensive bed-of-nails testers.

3.6.3 Optional Device ID Register

The CX2388x has the optional device identification register defined by the JTAG specification as listed in Table 3-5. This register contains information concerning the revision, actual part number, and manufacturer's identification code specific to Conexant. This register can be accessed through the TAP controller via an optional JTAG instruction.

Table 3-5. Device Identification Register

Version				Part Number														Manufacturer ID											
X	X	X	X	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1
0				0x036E														0x0D6											
4 Bits				16 Bits														11 Bits											

3.6.4 Verification with the TAP Controller

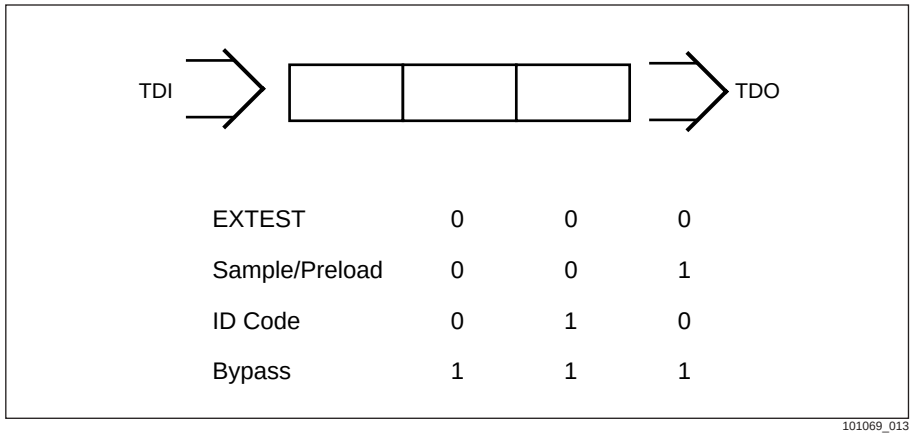
A variety of verification procedures can be performed through the TAP controller. With a set of four instructions, the CX2388x can verify board connectivity at all digital interfaces and pins. The following instructions are accessible by using a state machine standard to all JTAG controllers:

- Sample/Preload
- Extest
- ID Code
- Bypass (see Figure 3-5)

Refer to the *IEEE Standard 1149.1* specification for details concerning the Instruction register and JTAG state machine (http://standards.ieee.org/).

Conexant has created a Boundary Scan Descriptive Language (BSDL) with the AT&T BSD™ Editor. For JTAG testing, obtain a disk with an ASCII version of the complete BSDL file by contacting your local Conexant applications engineer.

Figure 3-5. Instruction Register



4 PC Board Layout Considerations

4.1 Layout Considerations

The PC board layout should be optimized for lowest noise on the CX2388x power and ground lines. Route digital traces away from analog traces. All shields must be connected to the ground plane with a low impedance connection. Use shielded connectors.

4.1.1 Capacitors

Place bypass capacitors (using 0.1 µF ceramic capacitors) close to the CX2388x where possible. Also, whenever possible, place traces from all power pins to a bypass capacitor on the component side in addition to any feed-through. Finally, place traces from all ground pins to a bypass capacitor on the component side, in addition to any feed-through, when possible.

Ensure that there is an ample ground plane under the CX2388x. Make wide paths of copper under and around the CX2388x, if possible. Avoid creating a cut in the plane with feed-throughs, instead, disperse them. Also, ensure that there is an ample power plane under the CX2388x.

Fill as follows:

- 2-layer PCB, use ground fill on bottom side.
- 4-layer PCB, no ground fill on top and bottom sides.

4.1.2 Components

Place the following components as close as possible to the CX2388x.

- Voltage regulators
- Analog audio filters

5 Applications Examples

5.1 Broadcast TV/Audio/FM Radio Capture Card

Please contact Conexant Applications Engineering for schematics and details of this CX23880 design.

5.2 Digital Video Recorder Capture Card

Please contact Conexant Applications Engineering for schematics and details of this CX23880 design.

5.3 ATSC HDTV Hardware Decode Card

Please contact Conexant Applications Engineering for schematics and details of this CX23880 design.

5.4 DVB DTV Software Decode Card

Please contact Conexant Applications Engineering for schematics and details of this CX23881 design.

5.5 IEEE 1394 DV Editing and Broadcast TV/Audio/FM Radio Capture Card

Please contact Conexant Applications for schematics and details of this CX23880/ CX23881 design.

6 Registers

CX2388x register types are listed in Figure 6-1.

Table 6-1. Register Types

Register Type	Description
RO	Read-only
WO	Write-only
RW	Read/Write
RW*	Read/Write, but data may not be same as written at a later time (volatile).
RR	Same as RW, but writing a 1 resets corresponding bit location, writing 0 has no effect.

Unused register bits will read back 0.

6.1 PCI Configuration Registers: Function 0: Video

These registers are related to the video function only. Since the CX2388x is a multifunction PCI device, AD[10:8] are used to indicate which function the PCI bus is addressing. This function will only respond when AD[10:8] are equal to 3'b000 during a configuration type 0 transaction.

Functions 1-4 share the same physical Device Control register as Function 0. The enable/control bits affect all functions. The Subsystem Vendor IDs are also a shared register having read-write access by all functions. There also is one PLL test control register which is accessible by all functions in the PCI configuration space.

Since VPD is required for each function of a multifunction PCI device, VPD for each of the functions can be accessed through the same VPD configuration space mechanism as defined in function 0. Each function's VPD data register interface through the same flag, address, and data registers. So, it is not possible to start multiple read/write transactions by communicating multiplex to multiple functions (physically impossible given only one EEPROM).

The configuration registers are also mapped into the internal CX2388x memory space for software convenience.

Vendor and Device ID

Register 8'h00—F0_VNDR_DEV_ID_CFG

Register 24'h2F0000—F0_VNDR_DEV_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RO	16'h8800	DEV_ID	CX23880 part ID. DEV_ID = 16'h8800
[15:0]	RO	16'h14F1	VNDR_ID	Conexant ID.
NOTE:The JTAG ID also reflects the Device ID as set by the bond options.				

Command and Status Register

Register 8'h04—F0_CMD_STAT_CFG

Register 24'h2F0004—F0_CMD_STAT_MM

Bits	Type	Default	Name	Description
[31]	RR	1'b0	PAR_ERR_DET	Set when a parity error is detected in the address or data, regardless of the Parity Error Response control bit.
[30]	RR	1'b0	SYS_ERR	Set when SERR# is asserted.
[29]	RR	1'b0	MSTR_ABRT	Set when master transaction is terminated with Master Abort.
[28]	RR	1'b0	TRGT_ABRT_RCV	Set when master transaction is terminated with Target Abort.
[27]	RO	1'b0	TRGT_ABRT_SIG	Set when target terminates transaction with Target Abort. This bit will always be 0 as CX23880 does not respond with a target abort.
[26:25]	RO	2'b01	DEVSEL_TIME	Responds with medium DEVSEL# timing.
[24]	RR	1'b0	MSTR_PAR_ERR	Set when the master asserts PERR# during a read transaction or observes PERR# asserted by target when writing data to target. The Parity Error Response bit in the command register must be enabled.
[23]	RO	1'b1	TRGT_B2B_CAP	CX23880 target is capable of fast back to back transactions.
[22]	RO	1'b0	Reserved	Defined as reserved in the PCI spec.
[21]	RO	1'b0	66MHZ_CAP	CX23880 is NOT designed to work at 66 MHz.
[20]	RO	1'b1	CAP_LIST	CX23880 implements a PCI capabilities list, beginning at address offset 8'h34.
[19:16]	RO	4'b0	Reserved	Defined as reserved in the PCI spec.
[15:10]	RO	6'b0	Reserved	Defined as reserved in the PCI spec.
[9]	RO	1'b0	MSTR_B2B_CAP	CX23880 master is not capable of fast back to back transactions.

Bits	Type	Default	Name	Description
[8]	RW	1'b0	SERR#_EN	SERR# driver enable. A value of 1 enables the driver. Address parity errors are reported only if this bit and Parity Error Response bit are 1.
[7]	RO	1'b0	ADR_DATA_STEP	CX23880 does not do address or data stepping.
[6]	RW	1'b0	PAR_ERR_RSP	A value of 1 enables parity error reporting.
[5]	RO	1'b0	VGA_SNP	CX23880 does not snoop VGA palette accesses.
[4]	RW	1'b0	MEM_WR_INV_EN	CX23880 does not use memory write and invalidate command, so does not need this enable.
[3]	RO	1'b0	SPCL_CYCL_EN	CX23880 does not use special cycles.
[2]	RW	1'b0	MSTR_EN	A value of 1 allows CX23880 to behave as a master.
[1]	RW	1'b0	MEM_RSP	A value of 1 allows CX23880 to respond to memory space accesses.
[0]	RO	1'b0	IO_RSP	CX23880 has no IO address space.

Revision ID and Class Code

Register 8'h08—F0_REVID_CLASS_CFG

Register 24'h2F0008—F0_REVID_CLASS_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'h040000	CLASS_CODE	This CX23880 video function is a multimedia video device.
[7:0]	RO	8'hxx	REV_ID	This register identifies the device revision. See appendix for revision codes.

Cache Line Size, Latency Timer, Header Type, BIST

Register 8'h0C—F0_LN_LAT_HDR_CFG

Register 24'h2F000C—F0_LN_LAT_HDR_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	BIST	CX23880 does not implement this BIST function.
[23:16]	RO	8'h80	HDR_TYPE	CX23880 is a multifunction PCI device.
[15:8]	RW	8'h00	LAT_TIMER	The number of PCI bus clocks for the latency timer used by the master for this function. Once the latency expires, the master will initiate transaction termination as soon as GNT# is removed.
[7:0]	RW	8'h00	CACHE_LN_SZ	System software loads this with the system cache line size. This information is used by the masters using Memory Write and Invalidate, Memory Read Line, and Memory Read Multiple.

Base Address 0

Register 8'h10—F0_BAR0_CFG

Register 24'h2F0010—F0_BAR0_MM

Bits	Type	Default	Name	Description
[31:24]	RW	8'h00	BASE_ADRS_UPR	These upper bits are written by the system software to locate this functions registers in the PCI address space.
[23:0]	RO	24'h000000	BASE_ADRS_LWR	These lower bits indicate to the system software that 16 Mbytes of non-prefetchable data are required anywhere in the 32-bit memory address space.

Subsystem Vendor and Subsystem ID

Register 8'h2C—F0_SUBSYS_ID_CFG

Register 24'h2F002C—F0_SUBSYS_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RW	16'h0000	SUBSYS_ID	This will be automatically loaded at reset with the value from addresses 12'h006 (least significant byte) and 12'h007 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.
[15:0]	RW	16'h0000	SUBSYS_VNDR_ID	This will be automatically loaded at reset with the value from addresses 12'h004 (least significant byte) and 12'h005 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.

Capabilities Pointer

Register 8'h34—F0_CAP_PTR_CFG

Register 24'h2F0034—F0_CAP_PTR_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'b0	Reserved	Defined as reserved in the PCI spec.
[7:0]	RO	8'h44	CAP_PTR	Dword-aligned byte address offset in configuration space to the first item in the list of capabilities.

Interrupt Line, Interrupt Pin, Minimum Grant, Maximum Latency

Register 8'h3C—F0_INT_GNT_LAT_CFG

Register 24'h2F003C—F0_INT_GNT_LAT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h37	MAX_LAT	Require bus access every 13.9 us, in units of 250 ns. Affects the setting for the latency timer. See Video PCI Latency Parameters for more information.
[23:16]	RO	8'h14	MIN_GNT	Desire a minimum grant burst period of 5 us, in units of 250 ns. Affects the setting for the latency timer. See Video PCI Latency Parameters for more information.
[15:8]	RO	8'h01	INT_PIN	CX23880 interrupt pin is connected to INTA#.
[7:0]	RW	8'h00	INT_LINE	The interrupt line register communicates interrupt line routing information between the POST code and the device driver. The POST code initializes this register with a value specifying to which input (IRQ) of the system interrupt controller the CX23880 interrupt pin is connected. Device drivers can use this value to determine interrupt priority and vector information.

Device Control #1

Register 8'h40—F0_DEV_CNTRL1_CFG

Register 24'h2F0040—F0_DEV_CNTRL1_MM

Bits	Type	Default	Name	Description
[31:29]	RO	11'b0	Reserved	
[28]	RW	1'b1	FNC4_EN	When 1, this function is enabled. When 0, it is disabled. This bit will be loaded from EEPROM automatically when PCI reset is deasserted. The RW accessibility is for test purposes only.
[27]	RW	1'b1	FNC3_EN	Same as bit 28 above
[26]	RW	1'b1	FNC2_EN	Same as bit 28 above
[25]	RW	1'b1	FNC1_EN	Same as bit 28 above
[24]	RO	1'b1	FNC0_EN	Same as bit 28 above, except there is no write allowed. PCI function 0 may not be disabled.
[20]	RW	1'b1	I^2C Compatible_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[19]	RW	1'b1	GPHST_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[18]	RW	1'b1	VIP_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[17]	RW	1'b1	AUD_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[16]	RW	1'b1	VID_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.

Bits	Type	Default	Name	Description
[12]	RW	1'b1	I^2C Compatible_RDY_EN	When 1, the ready and transfer-in-progress logic for I^2C compatible is enabled. When 0, the logic is disabled. In this case, the I^2C Compatible_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[11]	RW	1'b1	GPHST_RDY_EN	When 1, the ready and transfer-in-progress logic for General Purpose Host is enabled. When 0, the logic is disabled. In this case, the GPHST_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[10]	RW	1'b1	VIP_RDY_EN	When 1, the ready and transfer-in-progress logic for VIP is enabled. When 0, the logic is disabled. In this case, the VIP_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[9]	RW	1'b1	AUD_RDY_EN	When 1, the ready and transfer-in-progress logic for audio is enabled. When 0, the logic is disabled. In this case, the AUD_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[8]	RW	1'b1	VID_RDY_EN	When 1, the ready and transfer-in-progress logic for video is enabled. When 0, the logic is disabled. In this case, the VID_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[6:4]	RW	3'b011	DMA_RTRY_LMT	Selects the number of retries that are allowed before the DMA arbiter switches to the other channel.
[3]	RW	1'b0	EN_VSFX	Enable VIA/SIS PCI controller compatibility mode for all functions 0, 1, 2, 3, and 4.
[0]	RW	1'b0	SVIDS_EN	A value of 1 enables writes to the Subsystem and Subsystem Vendor ID register for all functions 0, 1, 2, 3, and 4.

VPD Capability

Register 8'h44—F0_VPD_CAP_CFG

Register 24'h2F0044—F0_VPD_CAP_MM

Bits	Type	Default	Name	Description
[31]	RW	1'b0	VPD_Flag	This flag is set to a value of 1 when the device completes reading and transfer of four bytes between the EEPROM and the VPD data register. The flag is reset to 0 when the device completes a 4-byte write transaction. SW initiates R or W transactions by setting this flag to 0 or 1 respectively when supplying the VPD byte address.
[30:16]	RW	15'b0	VPD_ADRS	Logical byte address of the VPD to be accessed.
[15:8]	RO	8'h4C	VPD_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h03	VPD_ID	VPD new capability data structure ID assigned by SIG.

VPD Data

Register 8'h48—F0_VPD_DATA_CFG

Register 24'h2F0048—F0_VPD_DATA_MM

Bits	Type	Default	Name	Description
[31:0]	RW*	32'b0	VPD_DATA	Four bytes are always transferred between the VPD data register and the EEPROM. The LSByte…MSByte is transferred from/to VPD_ADRS…VPD_ADRS+3.

Power Management Capability

Register 8'h4C—F0_PWR_MAN_CAP_CFG

Register 24'h2F004C—F0_PWR_MAN_CAP_MM

Bits	Type	Default	Name	Description
[31:27]	RO	5'b00000	PMC_PME	PME# cannot be asserted from this function.
[26]	RO	1'b0	PMC_D2	The function does not support the D2 power management state.
[25]	RO	1'b0	PMC_D1	The function does not support the D1 power management state.
[24:22]	RO	3'b000		Reserved.

Bits	Type	Default	Name	Description
[21]	RO	1'b1	PMC_DSI	A value of 1 indicates that the function requires a device specific initialization sequence following transition to the D0 uninitialized state.
[20]	RO	1'b0		Reserved.
[19]	RO	1'b0	PMC_PME_CLK	A value of 0 indicates that no PCI clock is required for the function to generate PME#.
[18:16]	RO	3'b010	PMC_VRSN	Function complies with version 1.1 of the PCI Power Management Specification.
[15:8]	RO	8'h00	PMC_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h01	PMC_ID	PCI Power Management new capability data structure ID assigned by SIG.

Power Management Support Registers

Register 8'h50—F0_PWR_MAN_SPRT_CFG

Register 24'h2F0050—F0_PWR_MAN_SPRT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	PWR_DATA	This field is used to report the state dependent data requested by DATA_SEL and scaled by DATA_SCALE. Optional and not supported.
[23:16]	RO	8'h00	PMCSR_BSE	Reserved for bridge support extensions.
[15]	RO	1'b0	PME_STATUS	Function does not support PME# from $D3_{cold}$.
[14:13]	RO	2'b00	DATA _SCALE	This field indicates the scaling factor to be used when interpreting the value of the PWR_DATA register. Optional and not supported.
[12:9]	RO	4'h0	DATA_SEL	This field selects which data is to be reported through the PWR_DATA register. Optional and not supported.
[8]	RO	1'b0	PME_EN	Function does not support PME# from $D3_{cold}$.
[7:2]	RO	6'h00		Reserved
[1:0]	RW	2'b00	PWR_STATE	This field determines the current power state of a function and supports setting the function into a new power state. 00 = D0 01 = D1 (not supported) 10 = D2 (not supported) 11 = $D3_{hot}$

Bits [15:0] are also known as the Power Management Control/Status register or PMCSR. Attempting to set PowerState to D1 or D2 will result in no change of state for that 2-bit field.

6.2 PCI Configuration Registers: Function 1: Audio

These registers are related to the audio function only. Since the CX23880 is a multifunction PCI device, AD[10:8] are used to indicate which function the PCI bus is addressing. This function will only respond when AD[10:8] are equal to 3'b001 during a configuration type 0 transaction.

Vendor and Device ID

Register 8'h00—F1_VNDR_DEV_ID_CFG

Register 24'h2F0100—F1_VNDR_DEV_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RO	16'h8801	DEV_ID	CX23880 part ID. 0: DEV_ID = 16'h8801 1: DEV_ID = 16'h8811 (no dbx audio)
[15:0]	RO	16'h14F1	VNDR_ID	Conexant ID.
NOTE:The JTAG ID also reflects the Device ID as set by the bond options.				

Command and Status Register

Register 8'h04—F1_CMD_STAT_CFG

Register 24'h2F0104—F1_CMD_STAT_MM

Bits	Type	Default	Name	Description
[31]	RR	1'b0	PAR_ERR_DET	Set when a parity error is detected in the address or data, regardless of the Parity Error Response control bit.
[30]	RR	1'b0	SYS_ERR	Set when SERR# is asserted.
[29]	RR	1'b0	MSTR_ABRT	Set when master transaction is terminated with Master Abort.
[28]	RR	1'b0	TRGT_ABRT_RCV	Set when master transaction is terminated with Target Abort.
[27]	RO	1'b0	TRGT_ABRT_SIG	Set when target terminates transaction with Target Abort. This bit will always be 0 as CX23880 does not respond with a target abort.
[26:25]	RO	2'b01	DEVSEL_TIME	Responds with medium DEVSEL# timing.
[24]	RR	1'b0	MSTR_PAR_ERR	Set when the master asserts PERR# during a read transaction or observes PERR# asserted by target when writing data to target. The Parity Error Response bit in the command register must be enabled.
[23]	RO	1'b1	TRGT_B2B_CAP	CX23880 target is capable of fast back to back transactions.
[22]	RO	1'b0	Reserved	Defined as reserved in the PCI spec.

Bits	Type	Default	Name	Description
[21]	RO	1'b0	66MHZ_CAP	CX23880 is NOT designed to work at 66 MHz.
[20]	RO	1'b1	CAP_LIST	CX23880 implements a PCI capabilities list, beginning at address offset 8'h34.
[19:16]	RO	4'b0	Reserved	Defined as reserved in the PCI spec.
[15:10]	RO	6'b0	Reserved	Defined as reserved in the PCI spec.
[9]	RO	1'b0	MSTR_B2B_CAP	CX23880 master is not capable of fast back to back transactions.
[8]	RW	1'b0	SERR#_EN	SERR# driver enable. A value of 1 enables the driver. Address parity errors are reported only if this bit and Parity Error Response bit are 1.
[7]	RO	1'b0	ADR_DATA_STEP	CX23880 does not do address or data stepping.
[6]	RW	1'b0	PAR_ERR_RSP	A value of 1 enables parity error reporting.
[5]	RO	1'b0	VGA_SNP	CX23880 does not snoop VGA palette accesses.
[4]	RW	1'b0	MEM_WR_INV_EN	CX23880 does not use memory write and invalidate command, so does not need this enable.
[3]	RO	1'b0	SPCL_CYCL_EN	CX23880 does not use special cycles.
[2]	RW	1'b0	MSTR_EN	A value of 1 allows CX23880 to behave as a master.
[1]	RW	1'b0	MEM_RSP	A value of 1 allows CX23880 to respond to memory space accesses.
[0]	RO	1'b0	IO_RSP	CX23880 has no IO address space.

Revision ID and Class Code

Register 8'h08—F1_REVID_CLASS_CFG

Register 24'h2F0108—F1_REVID_CLASS_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'h048000	CLASS_CODE	This CX23880 audio function is a multimedia other device.
[7:0]	RO	8'h	REV_ID	This register identifies the device revision. See appendix for revision codes.

Cache Line Size, Latency Timer, Header Type, BIST

Register 8'h0C—F1_LN_LAT_HDR_CFG

Register 24'h2F010C—F1_LN_LAT_HDR_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	BIST	CX23880 does not implement this BIST function.
[23:16]	RO	8'h80	HDR_TYPE	CX23880 is a multifunction PCI device.
[15:8]	RW	8'h00	LAT_TIMER	The number of PCI bus clocks for the latency timer used by the master for this function. Once the latency expires, the master will initiate transaction termination as soon as GNT# is removed.
[7:0]	RW	8'h00	CACHE_LN_SZ	System software loads this with the system cache line size. This information is used by the masters using Memory Write and Invalidate, Memory Read Line, and Memory Read Multiple.

Base Address 0

Register 8'h10—F1_BAR0_CFG

Register 24'h2F0110—F1_BAR0_MM

Bits	Type	Default	Name	Description
[31:24]	RW	8'h00	BASE_ADRS_UPR	These upper bits are written by the system software to locate this functions registers in the PCI address space.
[23:0]	RO	24'h000000	BASE_ADRS_LWR	These lower bits indicate to the system software that 16 Mbytes of non-prefetchable data are required anywhere in the 32-bit memory address space.

Subsystem Vendor and Subsystem ID

Register 8'h2C—F1_SUBSYS_ID_CFG

Register 24'h2F012C—F1_SUBSYS_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RW	16'h0000	SUBSYS_ID	This will be automatically loaded at reset with the value from addresses 12'h006 (least significant byte) and 12'h007 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.
[15:0]	RW	16'h0000	SUBSYS_VNDR_ID	This will be automatically loaded at reset with the value from addresses 12'h004 (least significant byte) and 12'h005 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.

Capabilities Pointer

Register 8'h34—F1_CAP_PTR_CFG

Register 24'h2F0134—F1_CAP_PTR_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'b0	Reserved	Defined as reserved in the PCI spec.
[7:0]	RO	8'h44	CAP_PTR	Dword-aligned byte address offset in configuration space to the first item in the list of capabilities.

Interrupt Line, Interrupt Pin, Minimum Grant, Maximum Latency

Register 8'h3C—F1_INT_GNT_LAT_CFG

Register 24'h2F013C—F1_INT_GNT_LAT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'hFF	MAX_LAT	Require bus access every 64 us, in units of 250 ns. The audio can actually tolerate up to 148.9 us latency, so the maximum value for this parameter is used. Affects the setting for the latency timer. See section Audio PCI Latency Parameters for more information.
[23:16]	RO	8'h04	MIN_GNT	Desire a minimum grant burst period of 1 us, in units of 250 ns. Affects the setting for the latency timer. See section Audio PCI Latency Parameters for more information.
[15:8]	RO	8'h01	INT_PIN	CX23880 interrupt pin is connected to INTA#.
[7:0]	RW	8'h00	INT_LINE	The interrupt line register communicates interrupt line routing information between the POST code and the device driver. The POST code initializes this register with a value specifying to which input (IRQ) of the system interrupt controller the CX23880 interrupt pin is connected. Device drivers can use this value to determine interrupt priority and vector information.

Device Control #1

Register 8'h40—F1_DEV_CNTRL1_CFG

Register 24'h2F0140—F1_DEV_CNTRL1_MM

Bits	Type	Default	Name	Description
[31:29]	RO	11'b0	Reserved	
[28]	RW	1'b1	FNC4_EN	When 1, this function is enabled. When 0, it is disabled. This bit will be loaded from EEPROM automatically when PCI reset is deasserted. The RW accessibility is for test purposes only.
[27]	RW	1'b1	FNC3_EN	Same as bit 28 above
[26]	RW	1'b1	FNC2_EN	Same as bit 28 above
[25]	RW	1'b1	FNC1_EN	Same as bit 28 above
[24]	RO	1'b1	FNC0_EN	Same as bit 28 above, except there is no write allowed. PCI function 0 may not be disabled.
[20]	RW	1'b1	I^2C Compatible_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[19]	RW	1'b1	GPHST_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[18]	RW	1'b1	VIP_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[17]	RW	1'b1	AUD_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[16]	RW	1'b1	VID_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.

Bits	Type	Default	Name	Description
[12]	RW	1'b1	I^2C Compatible_RDY_EN	When 1, the ready and transfer-in-progress logic for I^2C compatible is enabled. When 0, the logic is disabled. In this case, the I^2C Compatible_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[11]	RW	1'b1	GPHST_RDY_EN	When 1, the ready and transfer-in-progress logic for General Purpose Host is enabled. When 0, the logic is disabled. In this case, the GPHST_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[10]	RW	1'b1	VIP_RDY_EN	When 1, the ready and transfer-in-progress logic for VIP is enabled. When 0, the logic is disabled. In this case, the VIP_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[9]	RW	1'b1	AUD_RDY_EN	When 1, the ready and transfer-in-progress logic for audio is enabled. When 0, the logic is disabled. In this case, the AUD_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[8]	RW	1'b1	VID_RDY_EN	When 1, the ready and transfer-in-progress logic for video is enabled. When 0, the logic is disabled. In this case, the VID_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[6:4]	RW	3'b011	DMA_RTRY_LMT	Selects the number of retries that are allowed before the DMA arbiter switches to the other channel.
[3]	RW	1'b0	EN_VSFX	Enable VIA/SIS PCI controller compatibility mode for all functions 0, 1, 2, 3, and 4.
[0]	RW	1'b0	SVIDS_EN	A value of 1 enables writes to the Subsystem and Subsystem Vendor ID register for all functions 0, 1, 2, 3, and 4.

VPD Capability

Register 8'h44—F1_VPD_CAP_CFG

Register 24'h2F0144—F1_VPD_CAP_MM

Bits	Type	Default	Name	Description
[31]	RW	1'b0	VPD_Flag	This flag is set to a value of 1 when the device completes reading and transfer of four bytes between the EEPROM and the VPD data register. The flag is reset to 0 when the device completes a 4-byte write transaction. SW initiates R or W transactions by setting this flag to 0 or 1 respectively when supplying the VPD byte address.
[30:16]	RW		VPD_ADRS	Logical byte address of the VPD to be accessed.
[15:8]	RO	8'h4C	VPD_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h03	VPD_ID	VPD new capability data structure ID assigned by SIG.

VPD Data

Register 8'h48—F1_VPD_DATA_CFG

Register 24'h2F0148—F1_VPD_DATA_MM

Bits	Type	Default	Name	Description
[31:0]	RW*		VPD_DATA	Four bytes are always transferred between the VPD data register and the EEPROM. The LSByte…MSByte is transferred from/to VPD_ADRS…VPD_ADRS+3.

Power Management Capability

Register 8'h4C—F1_PWR_MAN_CAP_CFG

Register 24'h2F014C—F1_PWR_MAN_CAP_MM

Bits	Type	Default	Name	Description
[31:27]	RO	5'b00000	PMC_PME	PME# cannot be asserted from this function.
[26]	RO	1'b0	PMC_D2	The function does not support the D2 power management state.
[25]	RO	1'b0	PMC_D1	The function does not support the D1 power management state.
[24:22]	RO	3'b000		Reserved.
[21]	RO	1'b1	PMC_DSI	A value of 1 indicates that the function requires a device specific initialization sequence following transition to the D0 uninitialized state.
[20]	RO	1'b0		Reserved.
[19]	RO	1'b0	PMC_PME_CLK	A value of 0 indicates that no PCI clock is required for the function to generate PME#.
[18:16]	RO	3'b010	PMC_VRSN	Function complies with version 1.1 of the PCI Power Management Specification.
[15:8]	RO	8'h00	PMC_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h01	PMC_ID	PCI Power Management new capability data structure ID assigned by SIG.

Power Management Support Registers

Register 8'h50—F1_PWR_MAN_SPRT_CFG

Register 24'h2F0150—F1_PWR_MAN_SPRT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	PWR_DATA	This field is used to report the state dependent data requested by DATA_SEL and scaled by DATA_SCALE. Optional and not supported.
[23:16]	RO	8'h00	PMCSR_BSE	Reserved for bridge support extensions.
[15]	RO	1'b0	PME_STATUS	Function does not support PME# from $D3_{cold}$.
[14:13]	RO	2'b00	DATA _SCALE	This field indicates the scaling factor to be used when interpreting the value of the PWR_DATA register. Optional and not supported.
[12:9]	RO	4'h0	DATA_SEL	This field selects which data is to be reported through the PWR_DATA register. Optional and not supported.
[8]	RO	1'b0	PME_EN	Function does not support PME# from $D3_{cold}$.
[7:2]	RO	6'h00		Reserved
[1:0]	RW	2'b00	PWR_STATE	This field determines the current power state of a function and supports setting the function into a new power state. 00 = D0 01 = D1 (not supported) 10 = D2 (not supported) 11 = $D3_{hot}$

Bits [15:0] are also known as the Power Management Control/Status register or PMCSR. Attempting to set PowerState to D1 or D2 will result in no change of state for that 2-bit field.

6.3 PCI Configuration Registers: Function 2: MPEG TS

These registers are related to the MPEG Transport Stream function only. Since CX23880 is a multifunction PCI device, AD[10:8] are used to indicate which function the PCI bus is addressing. This function will only respond when AD[10:8] are equal to 3'b010 during a configuration type 0 transaction.

Vendor and Device ID

Register 8'h00—F2_VNDR_DEV_ID_CFG

Register 24'h2F0200—F2_VNDR_DEV_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RO	16'h8802	DEV_ID	CX23880 part ID. 0: DEV_ID = 16'h8802
[15:0]	RO	16'h14F1	VNDR_ID	Conexant ID.
NOTE:The JTAG ID also reflects the Device ID as set by the bond options.				

Command and Status Register

Register 8'h04—F2_CMD_STAT_CFG

Register 24'h2F0204—F2_CMD_STAT_MM

Bits	Type	Default	Name	Description
[31]	RR	1'b0	PAR_ERR_DET	Set when a parity error is detected in the address or data, regardless of the Parity Error Response control bit.
[30]	RR	1'b0	SYS_ERR	Set when SERR# is asserted.
[29]	RR	1'b0	MSTR_ABRT	Set when master transaction is terminated with Master Abort.
[28]	RR	1'b0	TRGT_ABRT_RCV	Set when master transaction is terminated with Target Abort.
[27]	RO	1'b0	TRGT_ABRT_SIG	Set when target terminates transaction with Target Abort. This bit will always be 0 as CX23880 does not respond with a target abort.
[26:25]	RO	2'b01	DEVSEL_TIME	Responds with medium DEVSEL# timing.
[24]	RR	1'b0	MSTR_PAR_ERR	Set when the master asserts PERR# during a read transaction or observes PERR# asserted by target when writing data to target. The Parity Error Response bit in the command register must be enabled.
[23]	RO	1'b1	TRGT_B2B_CAP	CX23880 target is capable of fast back to back transactions.
[22]	RO	1'b0	Reserved	Defined as reserved in the PCI spec.
[21]	RO	1'b0	66MHZ_CAP	CX23880 is NOT designed to work at 66 MHz.

Bits	Type	Default	Name	Description
[20]	RO	1'b1	CAP_LIST	CX23880 implements a PCI capabilities list, beginning at address offset 8'h34.
[19:16]	RO	4'b0	Reserved	Defined as reserved in the PCI spec.
[15:10]	RO	6'b0	Reserved	Defined as reserved in the PCI spec.
[9]	RO	1'b0	MSTR_B2B_CAP	CX23880 master is not capable of fast back to back transactions.
[8]	RW	1'b0	SERR#_EN	SERR# driver enable. A value of 1 enables the driver. Address parity errors are reported only if this bit and Parity Error Response bit are 1.
[7]	RO	1'b0	ADR_DATA_STEP	CX23880 does not do address or data stepping.
[6]	RW	1'b0	PAR_ERR_RSP	A value of 1 enables parity error reporting.
[5]	RO	1'b0	VGA_SNP	CX23880 does not snoop VGA palette accesses.
[4]	RW	1'b0	MEM_WR_INV_EN	CX23880 does not use memory write and invalidate command, so does not need this enable.
[3]	RO	1'b0	SPCL_CYCL_EN	CX23880 does not use special cycles.
[2]	RW	1'b0	MSTR_EN	A value of 1 allows CX23880 to behave as a master.
[1]	RW	1'b0	MEM_RSP	A value of 1 allows CX23880 to respond to memory space accesses.
[0]	RO	1'b0	IO_RSP	CX23880 has no IO address space.

Revision ID and Class Code

Register 8'h08—F2_REVID_CLASS_CFG

Register 24'h2F0208—F2_REVID_CLASS_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'h048000	CLASS_CODE	This CX23880 MPEG transport stream interface function is a multimedia other device.
[7:0]	RO	8'h	REV_ID	This register identifies the device revision. See appendix for revision codes.

Cache Line Size, Latency Timer, Header Type, BIST

Register 8'h0C—F2_LN_LAT_HDR_CFG

Register 24'h2F020C—F2_LN_LAT_HDR_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	BIST	CX23880 does not implement this BIST function.
[23:16]	RO	8'h80	HDR_TYPE	CX23880 is a multifunction PCI device.
[15:8]	RW	8'h00	LAT_TIMER	The number of PCI bus clocks for the latency timer used by the master for this function. Once the latency expires, the master will initiate transaction termination as soon as GNT# is removed.
[7:0]	RW	8'h00	CACHE_LN_SZ	System software loads this with the system cache line size. This information is used by the masters using Memory Write and Invalidate, Memory Read Line, and Memory Read Multiple.

Base Address 0

Register 8'h10—F2_BAR0_CFG

Register 24'h2F0210—F2_BAR0_MM

Bits	Type	Default	Name	Description
[31:24]	RW	8'h00	BASE_ADRS_UPR	These upper bits are written by the system software to locate this functions registers in the PCI address space.
[23:0]	RO	24'h000000	BASE_ADRS_LWR	These lower bits indicate to the system software that 16 Mbytes of non-prefetchable data are required anywhere in the 32-bit memory address space.

Subsystem Vendor and Subsystem ID

Register 8'h2C—F2_SUBSYS_ID_CFG

Register 24'h2F022C—F2_SUBSYS_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RW	16'h0000	SUBSYS_ID	This will be automatically loaded at reset with the value from addresses 12'h006 (least significant byte) and 12'h007 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.
[15:0]	RW	16'h0000	SUBSYS_VNDR_ID	This will be automatically loaded at reset with the value from addresses 12'h004 (least significant byte) and 12'h005 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.

Capabilities Pointer

Register 8'h34—F2_CAP_PTR_CFG

Register 24'h2F0234—F2_CAP_PTR_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'b0	Reserved	Defined as reserved in the PCI spec.
[7:0]	RO	8'h44	CAP_PTR	Dword-aligned byte address offset in configuration space to the first item in the list of capabilities.

Interrupt Line, Interrupt Pin, Minimum Grant, Maximum Latency

Register 8'h3C—F2_INT_GNT_LAT_CFG

Register 24'h2F023C—F2_INT_GNT_LAT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h58	MAX_LAT	Require bus access every 22.2 µs, in units of 250 ns. Affects the setting for the latency timer. See section MPEG Transport Stream PCI Latency Parameters for more information.
[23:16]	RO	8'h06	MIN_GNT	Desire a minimum grant burst period of 1.5 µs, in units of 250 ns. Affects the setting for the latency timer. See section MPEG Transport Stream PCI Latency Parameters for more information.
[15:8]	RO	8'h01	INT_PIN	CX23880 interrupt pin is connected to INTA#.
[7:0]	RW	8'h00	INT_LINE	The interrupt line register communicates interrupt line routing information between the POST code and the device driver. The POST code initializes this register with a value specifying to which input (IRQ) of the system interrupt controller the CX23880 interrupt pin is connected. Device drivers can use this value to determine interrupt priority and vector information.

Device Control #1

Register 8'h40—F2_DEV_CNTRL1_CFG

Register 24'h2F0240—F2_DEV_CNTRL1_MM

Bits	Type	Default	Name	Description
[31:29]	RO	11'b0	Reserved	
[28]	RW	1'b1	FNC4_EN	When 1, this function is enabled. When 0, it is disabled. This bit will be loaded from EEPROM automatically when PCI reset is deasserted. The RW accessibility is for test purposes only.
[27]	RW	1'b1	FNC3_EN	Same as bit 28 above
[26]	RW	1'b1	FNC2_EN	Same as bit 28 above
[25]	RW	1'b1	FNC1_EN	Same as bit 28 above
[24]	RO	1'b1	FNC0_EN	Same as bit 28 above, except there is no write allowed. PCI function 0 may not be disabled.
[20]	RW	1'b1	I^2C Compatible_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[19]	RW	1'b1	GPHST_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[18]	RW	1'b1	VIP_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[17]	RW	1'b1	AUD_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[16]	RW	1'b1	VID_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.

Bits	Type	Default	Name	Description
[12]	RW	1'b1	I^2C Compatible_RDY_EN	When 1, the ready and transfer-in-progress logic for I^2C compatible is enabled. When 0, the logic is disabled. In this case, the I^2C Compatible_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[11]	RW	1'b1	GPHST_RDY_EN	When 1, the ready and transfer-in-progress logic for General Purpose Host is enabled. When 0, the logic is disabled. In this case, the GPHST_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[10]	RW	1'b1	VIP_RDY_EN	When 1, the ready and transfer-in-progress logic for VIP is enabled. When 0, the logic is disabled. In this case, the VIP_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[9]	RW	1'b1	AUD_RDY_EN	When 1, the ready and transfer-in-progress logic for audio is enabled. When 0, the logic is disabled. In this case, the AUD_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[8]	RW	1'b1	VID_RDY_EN	When 1, the ready and transfer-in-progress logic for video is enabled. When 0, the logic is disabled. In this case, the VID_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[6:4]	RW	3'b011	DMA_RTRY_LMT	Selects the number of retries that are allowed before the DMA arbiter switches to the other channel.
[3]	RW	1'b0	EN_VSFX	Enable VIA/SIS PCI controller compatibility mode for all functions 0, 1, 2, 3, and 4.
[0]	RW	1'b0	SVIDS_EN	A value of 1 enables writes to the Subsystem and Subsystem Vendor ID register for all functions 0, 1, 2, 3, and 4.

VPD Capability

Register 8'h44—F2_VPD_CAP_CFG

Register 24'h2F0244—F2_VPD_CAP_MM

Bits	Type	Default	Name	Description
[31]	RW	1'b0	VPD_Flag	This flag is set to a value of 1 when the device completes reading and transfer of four bytes between the EEPROM and the VPD data register. The flag is reset to 0 when the device completes a 4-byte write transaction. SW initiates R or W transactions by setting this flag to 0 or 1 respectively when supplying the VPD byte address.
[30:16]	RW		VPD_ADRS	Logical byte address of the VPD to be accessed.
[15:8]	RO	8'h4C	VPD_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h03	VPD_ID	VPD new capability data structure ID assigned by SIG.

VPD Data

Register 8'h48—F2_VPD_DATA_CFG

Register 24'h2F0248—F2_VPD_DATA_MM

Bits	Type	Default	Name	Description
[31:0]	RW*		VPD_DATA	Four bytes are always transferred between the VPD data register and the EEPROM. The LSByte…MSByte is transferred from/to VPD_ADRS…VPD_ADRS+3.

Power Management Capability

Register 8'h4C—F2_PWR_MAN_CAP_CFG

Register 24'h2F024C—F2_PWR_MAN_CAP_MM

Bits	Type	Default	Name	Description
[31:27]	RO	5'b00000	PMC_PME	PME# cannot be asserted from this function.
[26]	RO	1'b0	PMC_D2	The function does not support the D2 power management state.
[25]	RO	1'b0	PMC_D1	The function does not support the D1 power management state.
[24:22]	RO	3'b000		Reserved.
[21]	RO	1'b1	PMC_DSI	A value of 1 indicates that the function requires a device specific initialization sequence following transition to the D0 uninitialized state.
[20]	RO	1'b0		Reserved.
[19]	RO	1'b0	PMC_PME_CLK	A value of 0 indicates that no PCI clock is required for the function to generate PME#.
[18:16]	RO	3'b010	PMC_VRSN	Function complies with version 1.1 of the PCI Power Management Specification.
[15:8]	RO	8'h00	PMC_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h01	PMC_ID	PCI Power Management new capability data structure ID assigned by SIG.

Power Management Support Registers

Register 8'h50—F2_PWR_MAN_SPRT_CFG

Register 24'h2F0250—F2_PWR_MAN_SPRT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	PWR_DATA	This field is used to report the state dependent data requested by DATA_SEL and scaled by DATA_SCALE. Optional and not supported.
[23:16]	RO	8'h00	PMCSR_BSE	Reserved for bridge support extensions.
[15]	RO	1'b0	PME_STATUS	Function does not support PME# from $D3_{cold}$.
[14:13]	RO	2'b00	DATA _SCALE	This field indicates the scaling factor to be used when interpreting the value of the PWR_DATA register. Optional and not supported.
[12:9]	RO	4'h0	DATA_SEL	This field selects which data is to be reported through the PWR_DATA register. Optional and not supported.
[8]	RO	1'b0	PME_EN	Function does not support PME# from $D3_{cold}$.
[7:2]	RO	6'h00		Reserved
[1:0]	RW	2'b00	PWR_STATE	This field determines the current power state of a function and supports setting the function into a new power state. 00 = D0 01 = D1 (not supported) 10 = D2 (not supported) 11 = $D3_{hot}$

Bits [15:0] are also known as the Power Management Control/Status register or PMCSR. Attempting to set PowerState to D1 or D2 will result in no change of state for that 2-bit field.

6.4 PCI Configuration Registers: Function 3: VIP

These registers are related to the VIP Host Master function only. Since the CX23880 is a multifunction PCI device, AD[10:8] are used to indicate which function the PCI bus is addressing. This function will only respond when AD[10:8] are equal to 3'b011 during a configuration type 0 transaction.

Vendor and Device ID

Register 8'h00—F3_VNDR_DEV_ID_CFG

Register 24'h2F0300—F3_VNDR_DEV_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RO	16'h8803	DEV_ID	CX23880 part ID. 0: DEV_ID = 16'h8803
[15:0]	RO	16'h14F1	VNDR_ID	Conexant ID.
Note(s): The JTAG ID also reflects the Device ID as set by the bond options.				

Command and Status Register

Register 8'h04—F3_CMD_STAT_CFG

Register 24'h2F0304—F3_CMD_STAT_MM

Bits	Type	Default	Name	Description
[31]	RR	1'b0	PAR_ERR_DET	Set when a parity error is detected in the address or data, regardless of the Parity Error Response control bit.
[30]	RR	1'b0	SYS_ERR	Set when SERR# is asserted.
[29]	RR	1'b0	MSTR_ABRT	Set when master transaction is terminated with Master Abort.
[28]	RR	1'b0	TRGT_ABRT_RCV	Set when master transaction is terminated with Target Abort.
[27]	RO	1'b0	TRGT_ABRT_SIG	Set when target terminates transaction with Target Abort. This bit will always be 0 as CX23880 does not respond with a target abort.
[26:25]	RO	2'b01	DEVSEL_TIME	Responds with medium DEVSEL# timing.
[24]	RR	1'b0	MSTR_PAR_ERR	Set when the master asserts PERR# during a read transaction or observes PERR# asserted by target when writing data to target. The Parity Error Response bit in the command register must be enabled.
[23]	RO	1'b1	TRGT_B2B_CAP	CX23880 target is capable of fast back to back transactions.
[22]	RO	1'b0	Reserved	Defined as reserved in the PCI spec.
[21]	RO	1'b0	66MHZ_CAP	CX23880 is NOT designed to work at 66 MHz.

Bits	Type	Default	Name	Description
[20]	RO	1'b1	CAP_LIST	CX23880 implements a PCI capabilities list, beginning at address offset 8'h34.
[19:16]	RO	4'b0	Reserved	Defined as reserved in the PCI spec.
[15:10]	RO	6'b0	Reserved	Defined as reserved in the PCI spec.
[9]	RO	1'b0	MSTR_B2B_CAP	CX23880 master is not capable of fast back to back transactions.
[8]	RW	1'b0	SERR#_EN	SERR# driver enable. A value of 1 enables the driver. Address parity errors are reported only if this bit and Parity Error Response bit are 1.
[7]	RO	1'b0	ADR_DATA_STEP	CX23880 does not do address or data stepping.
[6]	RW	1'b0	PAR_ERR_RSP	A value of 1 enables parity error reporting.
[5]	RO	1'b0	VGA_SNP	CX23880 does not snoop VGA palette accesses.
[4]	RW	1'b0	MEM_WR_INV_EN	CX23880 does not use memory write and invalidate command, so does not need this enable.
[3]	RO	1'b0	SPCL_CYCL_EN	CX23880 does not use special cycles.
[2]	RW	1'b0	MSTR_EN	A value of 1 allows CX23880 to behave as a master.
[1]	RW	1'b0	MEM_RSP	A value of 1 allows CX23880 to respond to memory space accesses.
[0]	RO	1'b0	IO_RSP	CX23880 has no IO address space.

Revision ID and Class Code

Register 8'h08—F3_REVID_CLASS_CFG

Register 24'h2F0308—F3_REVID_CLASS_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'h048000	CLASS_CODE	This CX23880 VIP master function is a multimedia other device.
[7:0]	RO	8'h	REV_ID	This register identifies the device revision. See appendix for revision codes.

Cache Line Size, Latency Timer, Header Type, BIST

Register 8'h0C—F3_LN_LAT_HDR_CFG

Register 24'h2F030C—F3_LN_LAT_HDR_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	BIST	CX23880 does not implement this BIST function.
[23:16]	RO	8'h80	HDR_TYPE	CX23880 is a multifunction PCI device.
[15:8]	RW	8'h00	LAT_TIMER	The number of PCI bus clocks for the latency timer used by the master for this function. Once the latency expires, the master will initiate transaction termination as soon as GNT# is removed.
[7:0]	RW	8'h00	CACHE_LN_SZ	System software loads this with the system cache line size. This information is used by the masters using Memory Write and Invalidate, Memory Read Line, and Memory Read Multiple.

Base Address 0

Register 8'h10—F3_BAR0_CFG

Register 24'h2F0310—F3_BAR0_MM

Bits	Type	Default	Name	Description
[31:24]	RW	8'h00	BASE_ADRS_UPR	These upper bits are written by the system software to locate this functions registers in the PCI address space.
[23:0]	RO	24'h000000	BASE_ADRS_LWR	These lower bits indicate to the system software that 16 Mbytes of non-prefetchable data are required anywhere in the 32-bit memory address space.

Subsystem Vendor and Subsystem ID

Register 8'h2C—F3_SUBSYS_ID_CFG

Register 24'h2F032C—F3_SUBSYS_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RW	16'h0000	SUBSYS_ID	This will be automatically loaded at reset with the value from addresses 12'h006 (least significant byte) and 12'h007 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.
[15:0]	RW	16'h0000	SUBSYS_VNDR_ID	This will be automatically loaded at reset with the value from addresses 12'h004 (least significant byte) and 12'h005 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.

Capabilities Pointer

Register 8'h34—F3_CAP_PTR_CFG

Register 24'h2F0334—F3_CAP_PTR_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'b0	Reserved	Defined as reserved in the PCI spec.
[7:0]	RO	8'h44	CAP_PTR	Dword-aligned byte address offset in configuration space to the first item in the list of capabilities.

Interrupt Line, Interrupt Pin, Minimum Grant, Maximum Latency

Register 8'h3C—F3_INT_GNT_LAT_CFG

Register 24'h2F033C—F3_INT_GNT_LAT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'hFF	MAX_LAT	Require bus access every 64 µs, in units of 250 ns. The VIP can actually tolerate up to 80 us latency, so the maximum value for this parameter is used. Affects the setting for the latency timer. See section VIP Master Interface PCI Latency Parameters for more information.
[23:16]	RO	8'h06	MIN_GNT	Desire a minimum grant burst period of 1.5 us, in units of 250 ns. Affects the setting for the latency timer. See section VIP Master Interface PCI Latency Parameters for more information.
[15:8]	RO	8'h01	INT_PIN	CX23880 interrupt pin is connected to INTA#.
[7:0]	RW	8'h00	INT_LINE	The interrupt line register communicates interrupt line routing information between the POST code and the device driver. The POST code initializes this register with a value specifying to which input (IRQ) of the system interrupt controller the CX23880 interrupt pin is connected. Device drivers can use this value to determine interrupt priority and vector information.

Device Control #1

Register 8'h40—F3_DEV_CNTRL1_CFG

Register 24'h2F0340—F3_DEV_CNTRL1_MM

Bits	Type	Default	Name	Description
[31:29]	RO	11'b0	Reserved	
[28]	RW	1'b1	FNC4_EN	When 1, this function is enabled. When 0, it is disabled. This bit will be loaded from EEPROM automatically when PCI reset is deasserted. The RW accessibility is for test purposes only.
[27]	RW	1'b1	FNC3_EN	Same as bit 28 above
[26]	RW	1'b1	FNC2_EN	Same as bit 28 above
[25]	RW	1'b1	FNC1_EN	Same as bit 28 above
[24]	RO	1'b1	FNC0_EN	Same as bit 28 above, except there is no write allowed. PCI function 0 may not be disabled.
[20]	RW	1'b1	I^2C Compatible_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[19]	RW	1'b1	GPHST_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[18]	RW	1'b1	VIP_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[17]	RW	1'b1	AUD_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[16]	RW	1'b1	VID_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.

Bits	Type	Default	Name	Description
[12]	RW	1'b1	I^2C Compatible_RDY_EN	When 1, the ready and transfer-in-progress logic for I^2C compatible is enabled. When 0, the logic is disabled. In this case, the I^2C Compatible_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[11]	RW	1'b1	GPHST_RDY_EN	When 1, the ready and transfer-in-progress logic for General Purpose Host is enabled. When 0, the logic is disabled. In this case, the GPHST_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[10]	RW	1'b1	VIP_RDY_EN	When 1, the ready and transfer-in-progress logic for VIP is enabled. When 0, the logic is disabled. In this case, the VIP_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[9]	RW	1'b1	AUD_RDY_EN	When 1, the ready and transfer-in-progress logic for audio is enabled. When 0, the logic is disabled. In this case, the AUD_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[8]	RW	1'b1	VID_RDY_EN	When 1, the ready and transfer-in-progress logic for video is enabled. When 0, the logic is disabled. In this case, the VID_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[6:4]	RW	3'b011	DMA_RTRY_LMT	Selects the number of retries that are allowed before the DMA arbiter switches to the other channel.
[3]	RW	1'b0	EN_VSFX	Enable VIA/SIS PCI controller compatibility mode for all functions 0, 1, 2, 3, and 4.
[0]	RW	1'b0	SVIDS_EN	A value of 1 enables writes to the Subsystem and Subsystem Vendor ID register for all functions 0, 1, 2, 3, and 4.

VPD Capability

Register 8'h44—F3_VPD_CAP_CFG

Register 24'h2F0344—F3_VPD_CAP_MM

Bits	Type	Default	Name	Description
[31]	RW	1'b0	VPD_Flag	This flag is set to a value of 1 when the device completes reading and transfer of four bytes between the EEPROM and the VPD data register. The flag is reset to 0 when the device completes a 4-byte write transaction. SW initiates R or W transactions by setting this flag to 0 or 1 respectively when supplying the VPD byte address.
[30:16]	RW		VPD_ADRS	Logical byte address of the VPD to be accessed.
[15:8]	RO	8'h4C	VPD_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h03	VPD_ID	VPD new capability data structure ID assigned by SIG.

VPD Data

Register 8'h48—F3_VPD_DATA_CFG

Register 24'h2F0348—F3_VPD_DATA_MM

Bits	Type	Default	Name	Description
[31:0]	RW*		VPD_DATA	Four bytes are always transferred between the VPD data register and the EEPROM. The LSByte…MSByte is transferred from/to VPD_ADRS…VPD_ADRS+3.

Power Management Capability

Register 8'h4C—F3_PWR_MAN_CAP_CFG

Register 24'h2F034C—F3_PWR_MAN_CAP_MM

Bits	Type	Default	Name	Description
[31:27]	RO	5'b00000	PMC_PME	PME# cannot be asserted from this function.
[26]	RO	1'b0	PMC_D2	The function does not support the D2 power management state.
[25]	RO	1'b0	PMC_D1	The function does not support the D1 power management state.
[24:22]	RO	3'b000		Reserved.

Bits	Type	Default	Name	Description
[21]	RO	1'b1	PMC_DSI	A value of 1 indicates that the function requires a device specific initialization sequence following transition to the D0 uninitialized state.
[20]	RO	1'b0		Reserved.
[19]	RO	1'b0	PMC_PME_CLK	A value of 0 indicates that no PCI clock is required for the function to generate PME#.
[18:16]	RO	3'b010	PMC_VRSN	Function complies with version 1.1 of the PCI Power Management Specification.
[15:8]	RO	8'h00	PMC_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h01	PMC_ID	PCI Power Management new capability data structure ID assigned by SIG.

Power Management Support Registers

Register 8'h50—F3_PWR_MAN_SPRT_CFG

Register 24'h2F0350—F3_PWR_MAN_SPRT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	PWR_DATA	This field is used to report the state dependent data requested by DATA_SEL and scaled by DATA_SCALE. Optional and not supported.
[23:16]	RO	8'h00	PMCSR_BSE	Reserved for bridge support extensions.
[15]	RO	1'b0	PME_STATUS	Function does not support PME# from $D3_{cold}$.
[14:13]	RO	2'b00	DATA _SCALE	This field indicates the scaling factor to be used when interpreting the value of the PWR_DATA register. Optional and not supported.
[12:9]	RO	4'h0	DATA_SEL	This field selects which data is to be reported through the PWR_DATA register. Optional and not supported.
[8]	RO	1'b0	PME_EN	Function does not support PME# from $D3_{cold}$.
[7:2]	RO	6'h00		Reserved
[1:0]	RW	2'b00	PWR_STATE	This field determines the current power state of a function and supports setting the function into a new power state. 00 = D0 01 = D1 (not supported) 10 = D2 (not supported) 11 = $D3_{hot}$

Bits [15:0] are also known as the Power Management Control/Status register or PMCSR. Attempting to set PowerState to D1 or D2 will result in no change of state for that 2-bit field.

6.5 PCI Configuration Registers: Function 4: Host

These registers are related to the GP Host Master function only. Since the CX23880 is a multifunction PCI device, AD[10:8] are used to indicate which function the PCI bus is addressing. This function will only respond when AD[10:8] are equal to 3'b100 during a configuration type 0 transaction.

Vendor and Device ID

Register 8'h00—F4_VNDR_DEV_ID_CFG

Register 24'h2F0400—F4_VNDR_DEV_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RO	16'h8804	DEV_ID	CX23880 part ID. 0: DEV_ID = 16'h8804
[15:0]	RO	16'h14F1	VNDR_ID	Conexant ID.
Note(s): The JTAG ID also reflects the Device ID as set by the bond options.				

Command and Status Register

Register 8'h04—F4_CMD_STAT_CFG

Register 24'h2F0404—F4_CMD_STAT_MM

Bits	Type	Default	Name	Description
[31]	RR	1'b0	PAR_ERR_DET	Set when a parity error is detected in the address or data, regardless of the Parity Error Response control bit.
[30]	RR	1'b0	SYS_ERR	Set when SERR# is asserted.
[29]	RR	1'b0	MSTR_ABRT	Set when master transaction is terminated with Master Abort.
[28]	RR	1'b0	TRGT_ABRT_RCV	Set when master transaction is terminated with Target Abort.
[27]	RO	1'b0	TRGT_ABRT_SIG	Set when target terminates transaction with Target Abort. This bit will always be 0 as CX23880 does not respond with a target abort.
[26:25]	RO	2'b01	DEVSEL_TIME	Responds with medium DEVSEL# timing.
[24]	RR	1'b0	MSTR_PAR_ERR	Set when the master asserts PERR# during a read transaction or observes PERR# asserted by target when writing data to target. The Parity Error Response bit in the command register must be enabled.
[23]	RO	1'b1	TRGT_B2B_CAP	CX23880 target is capable of fast back to back transactions.
[22]	RO	1'b0	Reserved	Defined as reserved in the PCI spec.
[21]	RO	1'b0	66MHZ_CAP	CX23880 is NOT designed to work at 66 MHz.

Bits	Type	Default	Name	Description
[20]	RO	1'b1	CAP_LIST	CX23880 implements a PCI capabilities list, beginning at address offset 8'h34.
[19:16]	RO	4'b0	Reserved	Defined as reserved in the PCI spec.
[15:10]	RO	6'b0	Reserved	Defined as reserved in the PCI spec.
[9]	RO	1'b0	MSTR_B2B_CAP	CX23880 master is not capable of fast back to back transactions.
[8]	RW	1'b0	SERR#_EN	SERR# driver enable. A value of 1 enables the driver. Address parity errors are reported only if this bit and Parity Error Response bit are 1.
[7]	RO	1'b0	ADR_DATA_STEP	CX23880 does not do address or data stepping.
[6]	RW	1'b0	PAR_ERR_RSP	A value of 1 enables parity error reporting.
[5]	RO	1'b0	VGA_SNP	CX23880 does not snoop VGA palette accesses.
[4]	RW	1'b0	MEM_WR_INV_EN	CX23880 does not use memory write and invalidate command, so does not need this enable.
[3]	RO	1'b0	SPCL_CYCL_EN	CX23880 does not use special cycles.
[2]	RW	1'b0	MSTR_EN	A value of 1 allows CX23880 to behave as a master.
[1]	RW	1'b0	MEM_RSP	A value of 1 allows CX23880 to respond to memory space accesses.
[0]	RO	1'b0	IO_RSP	CX23880 has no IO address space.

Revision ID and Class Code

Register 8'h08—F4_REVID_CLASS_CFG

Register 24'h2F0408—F4_REVID_CLASS_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'h048000	CLASS_CODE	This CX23880 host interface function is a multimedia other device.
[7:0]	RO	8'h	REV_ID	This register identifies the device revision. See appendix for revision codes.

Cache Line Size, Latency Timer, Header Type, BIST

Register 8'h0C—F4_LN_LAT_HDR_CFG

Register 24'h2F040C—F4_LN_LAT_HDR_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	BIST	CX23880 does not implement this BIST function.
[23:16]	RO	8'h80	HDR_TYPE	CX23880 is a multifunction PCI device.
[15:8]	RW	8'h00	LAT_TIMER	The number of PCI bus clocks for the latency timer used by the master for this function. Once the latency expires, the master will initiate transaction termination as soon as GNT# is removed.
[7:0]	RW	8'h00	CACHE_LN_SZ	System software loads this with the system cache line size. This information is used by the masters using Memory Write and Invalidate, Memory Read Line, and Memory Read Multiple.

Base Address 0

Register 8'h10—F4_BAR0_CFG

Register 24'h2F0410—F4_BAR0_MM

Bits	Type	Default	Name	Description
[31:24]	RW	8'h00	BASE_ADRS_UPR	These upper bits are written by the system software to locate this functions registers in the PCI address space.
[23:0]	RO	24'h000000	BASE_ADRS_LWR	These lower bits indicate to the system software that 16 Mbytes of non-prefetchable data are required anywhere in the 32-bit memory address space.

Subsystem Vendor and Subsystem ID

Register 8'h2C—F4_SUBSYS_ID_CFG

Register 24'h2F042C—F4_SUBSYS_ID_MM

Bits	Type	Default	Name	Description
[31:16]	RW	16'h0000	SUBSYS_ID	This will be automatically loaded at reset with the value from addresses 12'h006 (least significant byte) and 12'h007 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.
[15:0]	RW	16'h0000	SUBSYS_VNDR_ID	This will be automatically loaded at reset with the value from addresses 12'h004 (least significant byte) and 12'h005 (most significant byte) in the EEPROM. It can also be written when enabled by the SVIDS_EN bit in the user-defined PCI Device Control register.

Capabilities Pointer

Register 8'h34—F4_CAP_PTR_CFG

Register 24'h2F0434—F4_CAP_PTR_MM

Bits	Type	Default	Name	Description
[31:8]	RO	24'b0	Reserved	Defined as reserved in the PCI spec.
[7:0]	RO	8'h44	CAP_PTR	Dword-aligned byte address offset in configuration space to the first item in the list of capabilities.

Interrupt Line, Interrupt Pin, Minimum Grant, Maximum Latency

Register 8'h3C—F4_INT_GNT_LAT_CFG

Register 24'h2F043C—F4_INT_GNT_LAT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'hFF	MAX_LAT	Require bus access every 64 µs, in units of 250 ns. The host interface can actually tolerate up to 80 µs latency, so the maximum value for this parameter is used. Affects the setting for the latency timer. See section Host Interface PCI Latency Parameters for more information.
[23:16]	RO	8'h06	MIN_GNT	Desire a minimum grant burst period of 1.5 µs, in units of 250 ns. Affects the setting for the latency timer. See section Host Interface PCI Latency Parameters for more information.
[15:8]	RO	8'h01	INT_PIN	CX23880 interrupt pin is connected to INTA#.
[7:0]	RW	8'h00	INT_LINE	The interrupt line register communicates interrupt line routing information between the POST code and the device driver. The POST code initializes this register with a value specifying to which input (IRQ) of the system interrupt controller the CX23880 interrupt pin is connected. Device drivers can use this value to determine interrupt priority and vector information.

Device Control #1

Register 8'h40—F4_DEV_CNTRL1_CFG

Register 24'h2F0440—F4_DEV_CNTRL1_MM

Bits	Type	Default	Name	Description
[31:29]	RO	11'b0	Reserved	
[28]	RW	1'b1	FNC4_EN	When 1, this function is enabled. When 0, it is disabled. This bit will be loaded from EEPROM automatically when PCI reset is deasserted. The RW accessibility is for test purposes only.
[27]	RW	1'b1	FNC3_EN	Same as bit 28 above
[26]	RW	1'b1	FNC2_EN	Same as bit 28 above
[25]	RW	1'b1	FNC1_EN	Same as bit 28 above
[24]	RO	1'b1	FNC0_EN	Same as bit 28 above, except there is no write allowed. PCI function 0 may not be disabled.
[20]	RW	1'b1	I^2C Compatible_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.

Bits	Type	Default	Name	Description
[19]	RW	1'b1	GPHST_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[18]	RW	1'b1	VIP_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[17]	RW	1'b1	AUD_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[16]	RW	1'b1	VID_RDY	When 1, the ready and transfer-in-progress logic has completed any previous transfers. When 0, the previous transfer has not completed, thus any attempted accesses will result in a PCI retry. This bit is for test purposes, and will not be accessed during normal operation.
[12]	RW	1'b1	I^2C Compatible_RDY_EN	When 1, the ready and transfer-in-progress logic for I^2C compatible is enabled. When 0, the logic is disabled. In this case, the I^2C Compatible_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[11]	RW	1'b1	GPHST_RDY_EN	When 1, the ready and transfer-in-progress logic for General Purpose Host is enabled. When 0, the logic is disabled. In this case, the GPHST_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.

Bits	Type	Default	Name	Description
[10]	RW	1'b1	VIP_RDY_EN	When 1, the ready and transfer-in-progress logic for VIP is enabled. When 0, the logic is disabled. In this case, the VIP_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[9]	RW	1'b1	AUD_RDY_EN	When 1, the ready and transfer-in-progress logic for audio is enabled. When 0, the logic is disabled. In this case, the AUD_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[8]	RW	1'b1	VID_RDY_EN	When 1, the ready and transfer-in-progress logic for video is enabled. When 0, the logic is disabled. In this case, the VID_XFER_STATUS register must be polled to ensure valid data is read and also to ensure previous transfer is complete before attempting another one.
[6:4]	RW	3'b011	DMA_RTRY_LMT	Selects the number of retries that are allowed before the DMA arbiter switches to the other channel.
[3]	RW	1'b0	EN_VSFX	Enable VIA/SIS PCI controller compatibility mode for all functions 0, 1, 2, 3, and 4.
[0]	RW	1'b0	SVIDS_EN	A value of 1 enables writes to the Subsystem and Subsystem Vendor ID register for all functions 0, 1, 2, 3, and 4.

VPD Capability

Register 8'h44—F4_VPD_CAP_CFG

Register 24'h2F0444—F4_VPD_CAP_MM

Bits	Type	Default	Name	Description
[31]	RW	1'b0	VPD_Flag	This flag is set to a value of 1 when the device completes reading and transfer of four bytes between the EEPROM and the VPD data register. The flag is reset to 0 when the device completes a 4-byte write transaction. SW initiates R or W transactions by setting this flag to 0 or 1 respectively when supplying the VPD byte address.
[30:16]	RW		VPD_ADRS	Logical byte address of the VPD to be accessed.
[15:8]	RO	8'h4C	VPD_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h03	VPD_ID	VPD new capability data structure ID assigned by SIG.

VPD Data

Register 8'h48—F4_VPD_DATA_CFG

Register 24'h2F0448—F4_VPD_DATA_MM

Bits	Type	Default	Name	Description
[31:0]	RW*		VPD_DATA	Four bytes are always transferred between the VPD data register and the EEPROM. The LSByte…MSByte is transferred from/to VPD_ADRS…VPD_ADRS+3.

Power Management Capability

Register 8'h4C—F4_PWR_MAN_CAP_CFG

Register 24'h2F044C—F4_PWR_MAN_CAP_MM

Bits	Type	Default	Name	Description
[31:27]	RO	5'b00000	PMC_PME	PME# cannot be asserted from this function.
[26]	RO	1'b0	PMC_D2	The function does not support the D2 power management state.
[25]	RO	1'b0	PMC_D1	The function does not support the D1 power management state.
[24:22]	RO	3'b000		Reserved.
[21]	RO	1'b1	PMC_DSI	A value of 1 indicates that the function requires a device specific initialization sequence following transition to the D0 uninitialized state.
[20]	RO	1'b0		Reserved.
[19]	RO	1'b0	PMC_PME_CLK	A value of 0 indicates that no PCI clock is required for the function to generate PME#.
[18:16]	RO	3'b010	PMC_VRSN	Function complies with version 1.1 of the PCI Power Management Specification.
[15:8]	RO	8'h00	PMC_NXT_PTR	Dword-aligned byte address offset in configuration space to the next item in the list of capabilities. A value of 0 indicates there are no more.
[7:0]	RO	8'h01	PMC_ID	PCI Power Management new capability data structure ID assigned by SIG.

Power Management Support Registers

Register 8'h50—F4_PWR_MAN_SPRT_CFG

Register 24'h2F0450—F4_PWR_MAN_SPRT_MM

Bits	Type	Default	Name	Description
[31:24]	RO	8'h00	PWR_DATA	This field is used to report the state dependent data requested by DATA_SEL and scaled by DATA_SCALE. Optional and not supported.
[23:16]	RO	8'h00	PMCSR_BSE	Reserved for bridge support extensions.
[15]	RO	1'b0	PME_STATUS	Function does not support PME# from $D3_{cold}$.
[14:13]	RO	2'b00	DATA _SCALE	This field indicates the scaling factor to be used when interpreting the value of the PWR_DATA register. Optional and not supported.
[12:9]	RO	4'h0	DATA_SEL	This field selects which data is to be reported through the PWR_DATA register. Optional and not supported.
[8]	RO	1'b0	PME_EN	Function does not support PME# from $D3_{cold}$.
[7:2]	RO	6'h00		Reserved
[1:0]	RW	2'b00	PWR_STATE	This field determines the current power state of a function and supports setting the function into a new power state. 00 = D0 01 = D1 (not supported) 10 = D2 (not supported) 11 = $D3_{hot}$

Bits [15:0] are also known as the Power Management Control/Status register or PMCSR. Attempting to set PowerState to D1 or D2 will result in no change of state for that 2-bit field.

6.6 Memory Mapped Registers: Miscellaneous Control

The registers in this section are used by all functions.

NOTE: Each PCI configuration space function has a base address 0 register. Each one will be assigned a different value when the system Configuration Manager allocates memory-mapped resources. The local memory-mapped registers address locations are specified as 24-bit offsets to the value loaded into the memory base address register. Internal base address is 24'hXXXXXX.

PCI DMAC FIFO Threshold

Register 24'h200000—PDMA_STHRSH

Register 24'h200010—PDMA_DTHRSH

Bits	Type	Default	Name	Description
[11:8]	RW	4'h7	PDMA_{x}ISBTHRSH	FIFO threshold for Internal System Bus (ISB) controller. Burst begins when this many FIFO entries (dwords) are available. For reliable operation and to avoid possible deadlock condition this value must be 0 < x < = 7.
[3:0]	RW	4'h7	PDMA_{x}PCITHRSH	FIFO threshold for PCI controller. Burst begins when this many FIFO entries (dwords) are available. For reliable operation and to avoid possible deadlock condition this value must be 0 < x < = 7.

PCI DMAC Target Address

Register 24'h200004—PDMA_STRGT_ADRS

Register 24'h200014—PDMA_DTRGT_ADRS

Bits	Type	Default	Name	Description
[31:0]	RW	32'b0	PDMA_{x}TRGT_ADRS	PCI target address for PCI DMA transfer.

PCI DMAC Internal Address

Register 24'h200008—PDMA_SINTL_ADRS

Register 24'h200018—PDMA_DINTL_ADRS

Bits	Type	Default	Name	Description
[31:0]	RW	32'b0	PDMA_{x}INTL_ADRS	ISB SRAM address for PCI DMA transfer.

PCI DMAC Control

Register 24'h20000C—PDMA_SCNTRL

Register 24'h20001C—PDMA_DCNTRL

Bits	Type	Default	Name	Description
[19]	RW	1'b0	PDMA_INST	Specifies the DMA is for RISC instructions (1) or data (0). This bit only exists for the destination channel (PDMA_DCNTRL).
[18:16]	RW	3'b0	PDMA_FUNC	Specifies the PCI function for which the DMA transfer is for. Used by the PCI master to use appropriate latency timer value.
[15:0]	RW	16'b0	PDMA_CNT	Byte count for PCI DMA transfer. Writing this register initiates a SRC or DST PCI DMA.

PCI Subsystem Vendor and Subsystem ID Load

Register 24'h200030—LD_SUBSYS_ID_CFG

Bits	Type	Default	Name	Description
[31:16]	WO	16'h0000	LD_SUBSYS_ID	The value written to this register will be loaded into the Subsystem ID register in the PCI configuration space. It will over write any value previously loaded.
[15:0]	WO	16'h0000	LD_SUBSYS_VNDR_ID	The value written to this register will be loaded into the Subsystem Vendor ID register in the PCI configuration space. It will over write any value previously loaded.

Device Control #2

Register 24'h200034—DEV_CNTRL2

Bits	Type	Default	Name	Description
[12]	WO	Reserved	Reserved	Reserved
[7]	WO	Reserved	Reserved	Reserved
[6]	WO	Reserved	Reserved	Reserved
[5]	WO	Reserved	RUN_RISC	A value of 1 enables the RISC controller. A value of 0 holds the RISC controller in a reset state.
[4]	WO	Reserved	Reserved	Reserved
[3:2]	WO	Reserved	Reserved	Reserved

PCI Interrupt Mask

Register 24'h200040—PCI_INT_MSK

Bits	Type	Default	Name	Description
[20:0]	RW	21'b0	PCI_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the PCI_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

PCI Interrupt Status

Register 24'h200044—PCI_INT_STAT

Bits	Type	Default	Name	Description
[20]	RR	1'b0	GPIO_INT1	Set when GPIO interrupt condition occurs on pin GPIO[23].
[19]	RR	1'b0	GPIO_INT0	Set when GPIO interrupt condition occurs on pin GPIO[22].
[18]	RR	1'b0	IR_SMP_INT	Set when 32 input samples have been collected over gpio[16] pin into GP_SAMPLE register.
[17]	RR	1'b0	I^2C Compatible_RACK	Set when an I^2C compatible read or write operation has completed successfully. Latched on rising edge of I^2C Compatible_INT. Intended for status only. Typically masked off.
[16]	RR	1'b0	I^2C Compatible_INT	Set when an I^2C compatible read or write operation has completed.
[15]	RR	1'b0	IPB_DMA_BERR_INT	
[14]	RR	1'b0	DST_DMA_BERR_INT	Set when the BERR signal is asserted to the ISB master during a DST DMA.
[13]	RR	1'b0	SRC_DMA_BERR_INT	Set when the BERR signal is asserted to the ISB master during a SRC DMA.
[12]	RR	1'b0	BRDG_BERR_INT	Set when the BERR signal is asserted to the ISB master of the PCI bridge.
[11]	RR	1'b0	RISC_WR_BERR_INT	
[10]	RR	1'b0	RISC_RD_BERR_INT	
[9]	RR	1'b0	DST_DMA_INT	Set when the destination DMA channel completes the current transfer.
[8]	RR	1'b0	SRC_DMA_INT	Set when the source DMA channel completes the current transfer.

Bits	Type	Default	Name	Description
[7]	RR	1'b0	TM1_INT	Set when timer TM_CNT1 reaches its limit TM_LMT1.
[4]	RO	1'b0	HST_INT	Set when a host (function 4) interrupt condition occurs. Cleared by clearing the bits of the Host Interrupt Status register.
[3]	RO	1'b0	VIP_INT	Set when a VIP (function 3) interrupt condition occurs. Cleared by clearing the bits of the VIP Interrupt Status register.
[2]	RO	1'b0	TS_INT	Set when a transport stream (function 2) interrupt condition occurs. Cleared by clearing the bits of the Transport Stream Interrupt Status register.
[1]	RO	1'b0	AUD_INT	Set when an audio (function 1) interrupt condition occurs. Cleared by clearing the bits of the Audio Interrupt Status register.
[0]	RO	1'b0	VID_INT	Set when a video (function 0) interrupt condition occurs. Cleared by clearing the bits of the Video Interrupt Status register.

PCI Interrupt Masked Status

Register 24'h200048—PCI_INT_MSTAT

Bits	Type	Default	Name	Description
[20:0]	RO	21'b0	PCI_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

PLL (Immediate Access)

Register 24'h35C008—PLL_B

Bits	Type	Default	Name	Description
[31:28]	RO	4'b0000		RESERVED
[27]	RO	1'b1	PLL_LK	The value read at this bit location indicated the PLL's lock status. When high and stable, the PLL is in lock.
[26]	RW	1'b0	PLL_DDS	A value of 1 disables the ΔΣ and forces integer-only divides.
[25:24]	WO	2'b00	PLL_B_CR[1:0]	PLL_B clock rate Bus Clock Rate: 00 = 80 MHz ISB, 40 MHz IPB 01 = 100 MHz ISB, 50 MHz IPB 10,11 reserved.
[23:22]	RW	2'b10	PLL_PRE	Reference input prescale divider: 00 = divide by 2 01 = divide by 5 10 = divide by 4 11 = divide by 3
[21:16]	RW	6'h16	PLL_INT	6-bit integer divide. A value of 0 puts the PLL in a power-down state, otherwise a value >= 14 enables the PLL for normal operation as a clock synthesizer.
[15:0]	WO	16'h8E10	PLL_FRAC	16-bit fractional divide

GPIO

Register 24’h350010—GP0_IO

Register 24’h350014—GP1_IO

Register 24’h350018—GP2_IO

Register 24’h35001C—GP3_IO

Bits	Type	Default	Name	Description
[31: 26]	RO	6’h00		Reserved
[25]	RW	1’b0	GP3_MODE	A value of 0 enables the GPIO register interface in default mode where each set of 8 pins are controlled by a GP{x}_IO register. A value of 1 enables all 24 GPIO and/or GPOE bits to be read/written simultaneously.
[24]	RO	1’b0		Reserved
[23:16]	Wd		GP{x}_BWE	If this field is equal to 8’h00, then the whole GPIO byte register operates in normal RW mode. If any bit is set, then the corresponding GP_OE and GP_IO bit locations are enabled for writing. If the bit write enable is not set, the corresponding GPIO bits will be unaffected.
[15:8]	RW	8’h00	GP{x}_OE	A value of 1 enables corresponding GP_IO bit to be output on the GPIO pin.
[7:0]	RW*	8’h00	GP{x}_IO	Writing provides data for GPIO output pin drivers. Reading accesses data directly from input pin buffers.

NOTE: The GP3_* control bits are only available in register GP3_IO. If GP3_MODE is set to 24-bit access mode, then the GPIO register interface looks like:

Register 24’h350010—GPIO

Bits	Type	Default	Name	Description
[23:0]	RW*	24’h000000	GP_IO	Writing provides data for GPIO output pin drivers. Reading accesses data directly from input pin buffers.

Register 24’h350014—GPOE

Bits	Type	Default	Name	Description
[23:0]	RW*	24’h000000	GP_OE	A value of 1 enables corresponding GP_IO bit to be output on the GPIO pin.

GPIO Interrupts Sensitivity Mode

Register 24'h350028—GPIO_ISM

Bits	Type	Default	Name	Description
[3:2]	WO	2'b00	GP_ISM_SNS	Sensitivity mode for interrupt inputs GPIO[23:22]. 0 = level-sensitive 1 = edge-sensitive
[1:0]	WO	2'b00	GP_ISM_POL	Polarity control for interrupt inputs GPIO[23:22]. 1 = active-hi or posedge 0 = active-lo or negedge Note this control inverted from SPIPE for active low interrupts default.

Timer Counters (Immediate Access)

Register 24'h35C034—TM_CNT1_LDW

Bits	Type	Default	Name	Description
[31:0]	RO	32'b0	TM_CNT1_LDW	Lower dword of timer. The timer increments every 100 ns, from 0 to the limit value, then resets to 0 and counts again. The maximum value provides for ~325 days. The upper 16-bits of the timer are captured for reading at the TM_CNT_UDW register whenever the TM_CNT_LDW register is read.

Register 24'h35C038—TM_CNT1_UDW

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	TM_CNT1_UDW	Upper 16-bits of the 48-bit timer, captured at the time the lower 32-bits were read. The timer increments every 100 ns, from 0 to the limit value, then resets to 0 and counts again. The maximum value provides for ~325 days.

Timer Limit Values (Immediate Access)

Register 24’h35C03C—TM_LMT1_LDW

Bits	Type	Default	Name	Description
[31:0]	RW	32’b0	TM_LMT1_LDW	When the current count value of the timer reaches the limit value, an interrupt TM1_INT is set. The periodic timer interrupt event rate is = 10 MHz/(TM_LMT1 + 1). If TM_LMT1 is set to 0, TM_CNT1 remains reset.

Register 24’h35C040—TM_LMT1_UDW

Bits	Type	Default	Name	Description
[31]	RW	1’b0	TM_LMT1_DIV	When 0, the timer uses PCLK/5 for its clock. When 1, the timer uses PCLK/4 for its clock.
[15:0]	RW	16’b0	TM_LMT1_UDW	When the current count value of the timer reaches the limit value, an interrupt TM1_INT is set. The periodic timer interrupt event rate is = 10 MHz/(TM_LMT1 + 1). If TM_LMT1 is set to 0, TM_CNT1 remains reset. TM_CNT1 is reset whenever TM_LMT1_UDW is written.

PINMUX_IO (Immediate Access)

Register 24'h35C044—PINMUX_IO

Bits	Type	Default	Name	Description
[7]	RW	1'b0	MPEG_PAR_EN	1 = GPIO[17:23] map to TSDAT[7:1] inputs. 0 = leave pins as GPIO.
[6:5]	RW	2'b00	VIP_MODE	2'b10 = GPIO[21:16] map to VHAD[7:2] I/O, this in combination with VHAD[1:0] allows VIP2.0 I/O mode. 2'b01 = GPIO[17:16] map to VHAD[3:2] I/O, this in combination with VHAD[1:0] allows for 4 bit VHAD bus. 2'b00 = leave pins as GPIO.
[4]	RW	1'b0	VID_SYNC_EN	1 = Video Sync signals are output on GPIO[6:0] see section 9.2.4 for detailed mapping. 0 = leave pins as GPIO.
[3]	RW	1'b0	VID8_OUT_EN	1 = map GPIO[15:8] to vipo[9:2] VIP/ITU-656 digital video output. Data referenced to rising edge of GPCKO pin. 0 =leave pins as GPIO.
[2]	RW	1'b0	VID10_OUT_EN	1 = same mapping as in VID8_OUT_EN, with GPIO[23:22] = vipo[1:0] for 10 bit output. 0 = leave pins as GPIO.
[1]	RW	1'b0	VID_IN_EN	1 = map GPIO[7:0] to vipi[7:0] VIP digital video input. Data referenced to rising edge of GPCKI input pin. 0 = leave pins as GPIO.
[0]	RW	1'b0	HCS1_EN	1 = map Host chip select 1# to GPIO[23] (output mode).

AFECFG_IO (Immediate Access)

Register 24'h35C04C—AFE_CFG_IO

Bits	Type	Default	Name	Description
[31:5]	RO	27'h0000000		Reserved
[4]	RW	1'b0	DAC_PWRDN	1 = Power down audio DAC's bandgap and current references. 0 = Normal operation.
[3]	RW	1'b0	Y_PWRDN	1 = Power down Luma/Composite ADC. 0 = Normal operation.
[2]	RW	1'b0	C_PWRDN	1 = Power down Audio/Chroma ADC. 0 = Normal operation.
[1]	RW	1'b0	BG_PWRDN	1 = Power down bandgap used in ADCs. 0 = Normal operation.
[0]	RW	1'b0	V_A_MODE	1 = Select video mode for Audio/Chroma ADC. Vinc input selected for input to this ADC. VGA controlled from video core logic. 12 dB_block gain deasserted. Video reg selects analog mux input to Audio/Chroma ADC. 0 = Selects audio mode. VIN_IFA input selected for analog input. VGA, and 12 dB block gain controlled from Audio core logic. 6 dB_loss_enable deasserted.

SRST_IO (Immediate Access)

Register 24'h35C05C—SRST_IO

Bits	Type	Default	Name	Description
[31:1]	RO	31'h0000000		Reserved
[0]	RW	1'b1	SRST_OUT	This reg bit directly controls SYS_RSTO_ pin. Intended use is for software to generate reset to external components on the same board through CX23880 pin.

I²C Compatible Direct

Register 24'h360000-24'h367FFF—I²C Compatible_DIRECT

Bits	Type	Default	Name	Description
[31:0]	RW	32'b0	I²C Compatible_DATA	A dword written to this address range will cause the hardware I²C compatible interface to write the 4 bytes beginning at the I²C compatible chip address from address bits [14:8] and sub address from address bits [7:0]. A dword read from this address range will cause the hardware I²C compatible to read the 4 bytes beginning at the I²C compatible chip address from address bits [14:8] and sub address from address bits [7:0].

I²C Compatible Data/Control

Register 24'h368000—I²C Compatible_DATA/CONTROL

Bits	Type	Default	Name	Description
[31:24]	RW	8'b0	I²C Compatible_DB0	First byte sent in an I²C compatible transaction. Typically this will be the base or chip 7-bit address and the R/W bit.
[23:16]	RW	8'b0	I²C Compatible_DB1	Second byte sent in an I²C compatible transaction, usually a sub-address.
[15:8]	RW	8'b0	I²C Compatible_DB2	Third byte sent in an I²C compatible write transaction, usually the first data byte. After a read transaction, this byte register will contain the data read from the slave.
[7]	RW	1'b0	I²C Compatible_MODE	I²C compatible mode. 0 = software. 1 = hardware.
[6]	RW	1'b0	I²C Compatible_RATE	I²C compatible timing frequency. 0 = 99.2 kHz. 1 = 396.8 kHz.

Bits	Type	Default	Name	Description
[5]	RW	1'b0	I^2C Compatible_NOSTOP	I^2C compatible stop mode. 0 = transmit stop at end of transaction. 1 = do not transmit stop at end of transaction. Hold SCL low.
[4]	RW	1'b0	I^2C Compatible_NOS1B	I^2C compatible start mode. 0 = transmit START or repeated START transaction. The R/W status from bit 24 is saved for any future one byte transactions. 1 = enable one byte read or write without START.
[3]	RW	1'b0	I^2C Compatible_SYNC	I^2C compatible synchronization. 0 = disallows the slave to insert wait states. 1 = allows the slave to insert bit-level clock wait states.
[2]	RW	1'b0	I^2C Compatible_W3BRA	Number of bytes sent and master/slave acknowledge. This bit has no meaning when I^2C Compatible_NOS1B (bit 4) is high during a write transaction. 0 = write transaction of 2 bytes I^2C Compatible_DB(0-1). During a 1 byte read transaction (I^2C Compatible_NOS1B is high), master sends a NACK to end the reads from the slave. 1 = write transaction of 3 bytes I^2C Compatible_DB(0-2). During a 1 bytes read transaction (I^2C Compatible_NOS1B is high), master sends an ACK after reading the data byte.
[1]	RW	1'b1	I^2C Compatible_SCL	A value of 1 releases the SCL output, and a 0 forces the SCL output low. This bit must be set to a 1 during hardware mode. This override is for direct software control of the bus. Reading this bit provides access to the buffered SCL input pin.
[0]	RW	1'b1	I^2C Compatible_SDA	A value of 1 releases the SDA output, and a 0 forces the SDA output low. This bit must be set to a 1 during hardware mode. This override is for direct software control of the bus. Reading this bit provides access to the buffered SDA input pin.

I²C Compatible Control (Immediate Access)

Register 24'h36C004—I²C Compatible_CTRL

Bits	Type	Default	Name	Description
[2]	RW	1'b0	I²C Compatible_SLAVE_WSE	I²C compatible direct mode wait state enable. This enables or disables I²C compatible slave wait state insertion.
[1]	RW	1'b0	I²C Compatible_DIRECT_SPD	I²C compatible Direct Mode speed. 0 = 100 kHz 1 = 400 kHz
[0]	RW	1'b0	I²C Compatible_STOP_CTRL	Control for the I²C compatible following a PCI reset. This register bit is only reset on a power-on reset. 0 = No I²C compatible Stop issued following PCI reset. 1 = I²C compatible Stop issued following PCI reset.

I²C Compatible Transfer Status Register (Immediate Access)

Register 24'h36C044—I²C Compatible_XFER_STATUS

Bits	Type	Default	Name	Description
[0]	RO	1'b0	XFER_IN_PROG	I²C compatible transfer in progress signal. This may be used to determine when it is safe to access the I²C compatible registers. This register returns a value immediately, thus it doesn't follow the delayed read rules.

6.7 Memory Mapped Registers: Function 0: Video

NOTE: Each PCI configuration space function has a base address 0 register. Each one will be assigned a different value when the system Configuration Manager allocates memory-mapped resources. The local memory-mapped registers address locations are specified as 16-bit offsets to the value loaded into the memory base address register.

Video Decoder

The Video Decoder registers have the same field-based control as the Fusion 878A with necessary changes to accommodate increased functionality.

Device Status

Register 24’h310100

Bits	Type	Default	Name	Description
[31]	RO	20’h00000		RESERVED
[30:16]	RO	15’h0000	SCHERR	Subcarrier loop filter error
[15:8]	RO	8’h00000		RESERVED
[7]	RO	1’b0	NSPLAY	Special Play Status. Input vertical sync timing non-standard 0 = in VCR special play mode 1 = Normal mode
[6]	RO	1’b0	VPRES	Video Present 0 = No video detected 1 = Video detected
[5]	RO	1’b0	HLOCK	Horizontal Lock 0 = Not locked 1 = Locked
[4]	RO	1’b0	FIELD	Field Identifier 0 = Odd field 1 = Even field
[3]	RO	1’b0	NUML	Number of lines per frame 0 = 525 1 = 625
[2]	RO	1’b0	PLL	A value of 0 indicates the PLL is out of lock. Should be checked after initializing the PLL and cleared until no longer set (up to 100 mS).
[1]	RR	1’b0	LOF	Luma ADC Over/Underflow. If a Y-A/D overflow or underflow occurs, this bit is set. It is reset by writing a one to this bit.
[0]	RR	1’b0	COF	Chroma ADC Over/Underflow. If a C-A/D overflow or underflow occurs, this bit is set. It is reset by writing a one to this bit.
Note(s): The subcarrier loop filter error is provided for subcarrier tracking status. Also, the A/D overflow bits are register type RR.				

Input Format

Register 24’310104

Bits	Type	Default	Name	Description
[31:18]	RO	14’h0000		RESERVED
[17]	RW	1’b0	PESRC_SEL	0 = pixel engine input selects analog input data and clock 1 = pixel engine input selects digital input data and clock (VIP input source)
[16]	RW	1’b0	SVID_C_SEL	0 = select audio input for C/Audio-ADC 1 = select C in Y/C mode input for C/Audio-ADC
[15:14]	RW	2’b00	YADC_SEL	Video input source selection. 00 = MUX1 01 = MUX2 10 = MUX3 11 = MUX4
[13]	RW	1’b0	AGCEN	AGC Enable 0 = disable AGC 1 = enable AGC
[12]	RW	1’b0	NCAGC	AGC Gain 0 = coarse AGC gain adjust (+1) 1 = normal AGC gain (+4)
[11]	RW	1’b0	WCEN	White crush circuit monitors A/D for overflows and automatically adjusts input signal gain. 0 = Nonadaptive AGC 1 = Adaptive AGC
[10]	RW	1’b0	CAGCEN	0 = Chroma AGC disabled (SECAM) 1 = Chroma AGC enabled (NTSC/PAL)

Bits	Type	Default	Name	Description
[9]	RW	1'b0	CKILLEN	Enable low-color removal for all video standards including SECAM. 0 = Color killer disabled 1 = Color killer enabled
[8]	RW	1'b0	SCSPD	Chroma subcarrier lock speed. 0 = Normal 1 = Fast
[7]	RW	1'b1	VERTEN	A value of 1 enables vertical sync detection in determining VPRES status.
[6:5]	RO	2'b00		RESERVED
[4]	RW	1'b0	SVID	0 = Composite Video (does NOT auto-disable C/Audio-ADC) 1 = Y/C component Video (auto-disables notch filter, does NOT auto select C input C/Audio-ADC)
[3:0]	RW	4'b0000	FMT	Selects input video format. 0000 = Auto format detection 0001 = NTSC-M 0010 = NTSC-J 0011 = NTSC-4.43 0100 = PAL-BDGHI 0101 = PAL-M 0110 = PAL-N 0111 = PAL-Nc 1000 = PAL-60 1001 = SECAM

Temporal Decimation

Register 24'h310108

Bits	Type	Default	Name	Description
[31:12]	RO	20'h00000		RESERVED
[11:10]	RW	2'b00	HL_LP	Horizontal Loop Lowpass Filter Speed
[9]	RO	1'b0		RESERVED
[8]	RW	1'b0	CDISE	Comparator Clamp Enable 0 = enable 1 = disable
[7]	RW	1'b0	TDFIELD	Defines whether decimation is by fields or frames. 0 = Decimate frames 1 = Decimate fields
[6]	RW	1'b0	TDALGN	Aligns start of decimation with even or odd field. 0 = Start on odd field 1 = Start on even field
[5:0]	RW	6'b000000	TEMPDEC	Number of fields or frames dropped out of 50 (625/50) or 60(525/60). This value should not exceed 60 for 60 Hz systems, or 50 for 50 Hz systems.

AGC/Burst Delays

Register 24'h31010C

Bits	Type	Default	Name	Description
[31:16]	RO	16'h0000		RESERVED
[15:8]	RW	8'b6d	BGDEL	The burst gate delay for subcarrier sampling. The following equation should be used to determine the value for the register: BDELAY = (6.5us * video decoder core sample frequency) + 21 Example for an NTSC input signal: BDELAY = (6.5 µs x 13.50 MHz + 21 = 109 (0x6D)
[7:0]	RW	8'h63	AGCDEL	AGC gate delay for back-porch sampling. The following equation should be used to determine the value for this register: ADELAY = (6.8 µs * video decoder core sample frequency) + 15 Example for an NTSC input signal: ADELAY = (6.8 µs * 13.5 MHz) + 15 = 107 (0x6B)

Contrast and Brightness

Register 24’h310110

Bits	Type	Default	Name	Description
[31:16]	RO	16’h0000		RESERVED
[15:8]	RW	8’h39	CNTRST	The decoded luminance portion of the video is multiplied by this contrast value. Values from 00 to FF are allowed.
[7:0]	RW	8’h00	BRITE	Brightness offset applied to the video. Values from 00 to FF are allowed. The 2’s complement value programmed into this register is added to the decoded luminance portion of the video signal. Brightness is applied after contrast.

UV Saturation

Register 24’h310114

Bits	Type	Default	Name	Description
[31:16]	RO	16’h0000		RESERVED
[15:8]	RW	8’b5A	VSAT	SAT_V gain will apply to the decoded V vector of the chrominance. Values from 00 to FF are allowed.
[7:0]	RW	8’h7F	USAT	SAT_U gain will apply to the decoded U vector of the chrominance. Values from 00 to FF are allowed. Note(s): For ITU-R BT.656 decoding or SECAM video, USAT and VSAT must have equal values.

Hue

Register 24’h310118

Bits	Type	Default	Name	Description
[31:8]	RO	24’h000000		RESERVED
[7:0]	RW	8’h00	HUE	HUE will apply the phase offset of the decoders internal subcarrier. Values from 00 to FF are allowed.

White Crush Up/Down

Register 24'h31011C

Bits	Type	Default	Name	Description
[31:15]]	RO	17'h00000		RESERVED
[14]	RW	1'b1	WCFRAME	This bit programs the rate at which the DNCNT and UPCNT values are accumulated. 0 = Once per field 1 = Once per frame
[13:8]	RW	6'b111111	DNVAL	White crush down count value. 2's complement, a negative sign bit is assumed i.e., 3F = -1 3E = -2 … … 00 = –64
[7:6]	RW	2'b11	MAJSEL	These bits determine the majority comparison point for the white crush up function. 00 = 3/4 maximum luma 01 = 1/2 maximum luma 10 = 1/4 maximum luma 11 = Automatic
[5:0]	RW	6'b001111	UPVAL	White crush up value. The value programmed in these bits accumulates once per field or frame, in the case where the majority of the pixels in the active region of the image are below a selected value. The accumulated value determines the extent to which the AGC value needs to be raised in order to keep the SYNC level proportionate with the white level. The UPCNT value is assumed positive i.e., 3F = 63 3E = 62 …. … 00 = 0

Y/C Separation Notch Filter Selection and Total Pixel Count

Register 24’h310120

Bits	Type	Default	Name	Description
[31:13]	RO	19’h00000		RESERVED
[12:11]	RW	2’b10	NOTCHSEL	Coefficient selection of HL notch filter 00 = use 4x Fsc optimized filter 01 = use square pixel freq. optimized filter 10 = use 13.5 MHz NTSC optimized filter 11 = use 13.5 MHz PAL optimized filter
[10:0]	RW	11’h35A	HTOTAL	Programmable total number of pixel per line

Horizontal Delay

Register 24’h310124: Even Field

Register 24’h310128: Odd Field

Bits	Type	Default	Name	Description
[31:10]	RO	21’h000000		RESERVED
[9:0]	RW	10’h07E	HBLANK	This is the horizontal delay. It defines the number of scaled pixels between the falling edge of HRESET and the start of active video. Values between 1 and 1023 are allowed. For NTSC: hblank = 9.4 x F_{sample} For PAL: hblank = 10.5 x F_{sample}

Vertical Delay

Register 24’h31012C: Odd Field

Register 24’h310130: Even Field

Bits	Type	Default	Name	Description
[31:10]	RO	22’h000000		RESERVED
[9:0]	RW	10’h014	VBLANK	This is the vertical delay. It defines the number of half lines between the trailing edge of VRESET and the start of active video. Values between 1 and 1023 are allowed.

Vertical Delay in ITU-R BT.656 output mode

Register 24'h310134: Odd Field

Register 24'h310138: Even Field

Bits	Type	Default	Name	Description
[31:8]	RO	24'h000000		RESERVED
[7:0]	RW	8'h0C	V656BLANK	This is the vertical delay used in ITU-R BT.656 mode. It defines the number of half lines between the trailing edge of VRESET and the start of active video.

Horizontal Active

Register 24'h31013C: Even Field

Register 24'h310140: Odd Field

Bits	Type	Default	Name	Description
[31:10]	RO	22'h000000		RESERVED
[9:0]	RW	10'h2D0	HACTIVE	This is the horizontal active. It defines the number of horizontal active pixels per line. Values between 1 and 1023 are allowed.

Vertical Active

Register 24'h310144: Even Field

Register 24'h310148: Odd Field

Bits	Type	Default	Name	Description
[31:10]	RO	22'h000000		RESERVED
[9:0]	RW	10'h1E7	VACTIVE	This is the vertical active. It defines the number of half lines used in the vertical scaling process. Values between 1 and 1023 are allowed.

Horizontal Scaling

Register 24'h31014C: Even Field

Register 24'h310150: Odd Field

Bits	Type	Default	Name	Description
[31:16]	RO	16'h0000		RESERVED
[15:0]	RW	10'h000	HSCALE	Horizontal scaling ratio.

Vertical Scaling

Register 24'h310154: Even Field

Register 24'h310158: Odd Field

Bits	Type	Default	Name	Description
[31:13]	RO	19'h00000		RESERVED
[12:0]	RW	13'h0000	VSCALE	Vertical Scaling Ratio. The following equation should be used to determine the value for this register: VSF = (0x10000 –{[(scaling_ratio-1)*512}) and 0x1FFF

Horizontal/Vertical Filters Control

Register 24'h31015C: Even Field

Register 24'h310160: Odd Field

Bits	Type	Default	Name	Description
[31:23]	RO	9'h000		RESERVED
[22]	RW	1'b0	P3LPFSEL	Optional LPF select in chroma path 0 = bypass 1 = enable $(1 + z^{-1})/2$ filter
[21]	RW	1'b0	P2LPFSEL	Optional LPF select in chroma path 0 = bypass 1 = enable $(1 + z^{-1})/2$ filter
[20]	RW	1'b0	P1LPFSEL	Optional LPF select in chroma path 0 = bypass 1 = enable $(1 + z^{-2})/2$ filter
[19]	RW	1'b1	CFILT	If this bit is set, this chroma filter is used when luma is not remodulated. 0 = bypass 1 = enable $(1 + 2z^{-2} + z^{-4})/4$ filter
[18]	RW	1'b0	SNOTCH	Secam luma notch filter 0 = disable 1 = enable
[17]	RW	1'b0	CLPF3SEL	Third chroma demodulation LPF selection. Used with SECAM video only. 0 = bypass 1 = enable $(1 + z^{-1})/2$ filter
[16]	RW	1'b0	CLPF2SEL	Second chroma demodulation LPF selection. Used with SECAM video only. 0 = bypass 1 = enable $(1 + z^{-1})/2$ filter

Bits	Type	Default	Name	Description
[15:14]	RW	2'b00	CLPF1SEL	First chroma demodulation LPF selection. Used with SECAM video only. 00 = use 11-tap 01 = use 11-tap and 3-tap ([1 + z^{-2}]/2) 10 = use 29-tap (for SECAM) 11 = reserved
[13]	RW	1'b0	LNOTCH	0 = Enable notch filter 1 = Disable (recommended for monochrome input – enables full luma bandwidth)
[12]	RW	1'b0	LDEC	0 = Enable luma decimation filter 1 = Disable luma decimation
[11:10]	RW	2'b00	HFILT	When LDEC is a 0, used to select which horizontal low pass filter is used. 00 = AUTO 01 = CIF 10 = QCIF (Required for SECAM) 11 = ICON
[9]	RW	1'b0	PEAKEN	Enables luminance peaking filters.

Bits	Type	Default	Name	Description
[8:7]	RW	2'b00	PSEL	Selects peaking response. 00 = +2 dB at 3.58/4.43 MHz 01 = +3.5 dB at 3.58/4.43 MHz 10 = +5.0 dB at 3.58/4.43 MHz Fsc 11 = +6.0 dB at 3.58/4.43 MHz Fsc
[6:5]	RW	2'b00	COMB	Selects comb filter. 00 = Full Comb 01 = Chroma comb only 10 = reserved 11 = none
[4]	RW	1'b0	FLDALGN	Field-aligned vertical scaling 0 = Non field-aligned. Disables Interfield Interpolation 1 = Field-aligned. Enables Interfield Interpolation
[3]	RW	1'b0	VINT	VS Interlace Format 0 = Non-interlaced Vertical Scaling. Use for single field capture 1 = Interlaced Vertical Scaling. Use for capturing both fields
[2:0]	RW	3'b000	VFILT	These bits control the number of taps in the Vertical Scaling Filter. The number of taps must be chosen in conjunction with the horizontal scale factor to ensure the needed data does not overflow the internal FIFO. 000 = 2-tap interpolation only.(1) 001 = 3-tap interpolation.(2) 010 = 4-tap interpolation.(3) 011 = 5-tap interpolation.(3) 100 = 2-tap and no interpolation.(1) 101 = 3-tap and no interpolation.(2) 110 = 4-tap and no interpolation.(3) 111 = 5-tap and no interpolation.(3)

Note(s):
(1) Available at all resolutions
(2) Only available if scaling to less than 385 horizontal active pixels (CIF or smaller)
(3) Only available if scaling to less than 193 horizontal active pixels (QCIF or smaller)

Output Format and 2H Comb Control

Register 24'h310164

Bits	Type	Default	Name	Description
[31:29]	RO	3'h0		RESERVED
[28]	RW	1'b1	PREVREMOD (PAL video only)	Enable previous line remodulation; must be used in conjunction with COMBALT = 1
[27]	RW	1'b1	COMBALT	3 Line/2 Line adaptive comb filter 0 = Disable (PAL/SECAM) 1 = Enable (NTSC)
[26]	RW	1'b0	PAL_INV_PHASE	Used in PAL 2D comb filter mode. 0 = Normal – PAL B, D, G, H, I, and NTSC 1 = Invert – PAL M/NC
[25:16]	RW	10'h01F	COMB_RANGE	Adaptive comb filter enable threshold. If COMB_RANGE = 31, the comb filter will be enabled when the pixels difference is greater than –32 and less than 31.
[15]	RW	1'b0	DISIFX	Disable IFX interpolation. 0 = Enable 1 = Disable
[14]	RW	1'b0	INVCBF	Invert sense of CBFLAG. 0 = Normal 1 = Invert
[13]	RW	1'b0	DISADAPT	Disable adaptation algorithm. 0 = Enable 1 = Disable
[12]	RW	1'b0	NARROWADAPT	Narrow adaptation algorithm. 0 = Normal 1 = Narrow
[11]	RW	1'b0	FORCE2H	Forces selection of 2H comb filtered chroma data, if 2H comb enabled with NCCOMB.
[10]	RW	1'b0	FORCEREMD	Forces remodulation of excess chroma. 0 = Adaptive remodulation 1 = Forced remodulation
[9]	RW	1'b0	NCHROMAEN	Chroma 2H comb enable. 0 = Enable 1 = Disable
[8]	RW	1'b0	NREMODEN	Remodulation enable. 0 = Enable 1 = Disable

Bits	Type	Default	Name	Description
[7:6]	RW	2'b00	YCORE	Luma Coring. The signal is truncated to zero when level less than: 00 = 0 (no coring) 01 = 32 (5 LSBs) 10 = 64 (6 LSBs) 11 = 128 (7 LSBs)
[5:4]	RW	2'b00	CCORE	Chroma Coring. The signal is truncated to zero when level less than: 00 = 0 (no coring) 01 = ±7 (3 LSBs) 10 = ±15 (4 LSBs) 11 = ±31 (5 LSBs)
[3]	RW	1'b0	RANGE	Luma output range. The range must be limited when using the control codes as video timing. 0 = Normal Y:[16,253], C:[2,253] 1 = Full Range Y:[0,255], C:[2,253]
[2]	RW	1'b0	HACTEXT	HACTIVE extend.
[1]	RW	1'b0	HSFMT	Selects width of HRESET (CLKx1s) 0 = 64 1 = 32
[0]	RO	1'b0		RESERVED

PLL Register

Register 24'h310168

Bits	Type	Default	Name	Description
[31:29]	RO	3'b000		RESERVED
[28]	RW	1'b0	PLL_DDS	A value of 1 disables the ΔΣ and forces integer-only divides.
[27:26]	RW	2'b00	PLL_PRE	Reference input prescale divider: 00 = divide by 2 01 = divide by 5 10 = divide by 4 11 = divide by 3
[25:20]	RW	6'h0F	PLL_INT	6-bit integer divide. A value of 0 puts the PLL in a power-down state, otherwise a value > = 14 enables the PLL for normal operation as a clock synthesizer.
[19:0]	RW	20'h15F18	PLL_FRAC	20-bit fractional divide (default setting is for 28.63636 MHz xtal and 27 MHz PLL frequency)
Note(s): The equation to derive PLL frequency is: *Desired PLL frequency = ((XTAL freq/PLL_PRE)/8) * (PLL_INT + (PLL_FRAC/2^{20}))*				

PLL Adjust Control Register

Register 24’h31016C

Bits	Type	Default	Name	Description
[31:26]	RO	6’h00		RESERVED
[25]	RW	1’b1	PLL_ADJ_EN	Enable PLL adjust logic 0 = disable 1 = enable
[24:19]	RW	6’h20	PLL_MAX_OFFSET	Maximum internal PLL adjustment
[18:14]	RW	5’h07	PLL_DRIFT_TH	
[13:7]	RW	7’h63	PLL_TH2	PLL threshold
[6:0]	RW	7’h10	PLL_TH1	PLL threshold

Sample Rate Conversion Register

Register 24'h310170

Bits	Type	Default	Name	Description
[31:19]	RO	13’h0000		RESERVED
[18:0]	RW	19’h21F07	SRC_REG_VAL	19bit SRC programmable value. This is a ratio of the ADC clock rate to video clock rate. (ADC sampling frequency/Video decoder core frequency) * 2^{17}

Sample Rate Conversion FIFO

Register 24’h310174

Bits	Type	Default	Name	Description
[31:22]	RO	10’h000		RESERVED
[21:12]	RW	10’h3F8	SRC_UP_LMT	SRC FIFO upper limit
[11:10]	RO	2’b00		RESERVED
[9:0]	RW	10’h008	SRC_LOW_LMT	SRC FIFO lower limit

Subcarrier Step Size

Register 24’h310178

Bits	Type	Default	Name	Description
[31:23]	RO	9’h000		RESERVED
[22:0]	RW	23’h43E0F8	SCSTEP	Subcarrier step size SCSTEP = (8*Fsc/video decoder core clock frequency) * 2^{22}

Subcarrier Step Size for DR Line

Register 24'h31017C

Bits	Type	Default	Name	Description
[31:23]	RO	9'h000		RESERVED
[22:0]	RW	23'h538e38	DRSCSTEP	Subcarrier step size for DR Line DRSCSTEP = (8*4406250/video decoder core clock frequency) * 2^{22}

Capture Control

Register 24'h310180

Bits	Type	Default	Name	Description
[31:7]	RO	25'h0000000		RESERVED
[6]	RW	0	CAP_RAW_ALL	A value of 1 enables continuous raw data mode capture.
[5]	RW	0	RAW16	0 = 8xFsc 8-bit data mode (Raw Data) 1 = 4xFsc 16-bit data mode (Filtered VBI data)
[4]	RW	0	CAPTURE_VBI_ODD	A value of 1 enables VBI data to be captured into the FIFO during the odd field.
[3]	RW	0	CAPTURE_VBI_EVEN	A value of 1 enables VBI data to be captured into the FIFO during the even field.
[2]	RW	0	CAPTURE_ODD	A value of 1 enables odd capture and allows video decoder to write data to FIFOs during the odd field.
[1]	RW	0	CAPTURE_EVEN	A value of 1 enables even capture and allows video decoder to write data to FIFOs during the even field.
[0]	RW	0	FRM_DITH	0 = Dither matrix applied to consecutive lines in a field 1 = Full frame mode

Color Format/Control

Register 24'h310184

Bits	Type	Default	Name	Description
[31:15]	RO	17'h0000000		RESERVED
[14]	RW	0	COLOR_EN	A value of 1 enables a color bars pattern at the input of the VDFC block.
[13]	RW	0	RGB_DED	A value of 0 enables error diffusion for RGB16/RGB15 modes. A value of 1 disables it.
[12]	RW	0	GAMMA_DIS	A value of 0 enables gamma correction removal. The inverse gamma correction factor of 2.2 or 2.8 is applied and auto-selected by the respective mode NTSC/PAL. A value of 1 disables gamma correction removal.
[11]	RW	0	WSWAP_ODD	WordSwap Odd Field. A value of 1 enables word swapping of data entering the FIFO. W2[31:16] swapped with W0[15:0].
[10]	RW	0	WSWAP_EVEN	WordSwap Even Field. A value of 1 enables word swapping of data entering the FIFO. W2[31:16] swapped with W0[15:0].
[9]	RW	0	BSWAP_ODD	ByteSwap Odd Field. A value of 1 enables byte swapping of data entering the FIFO. B3[31:24] swapped with B2[23:16] and B1[15:8] swapped with B0[7:0].
[8]	RW	0	BSWAP_EVEN	ByteSwap Even Field. A value of 1 enables byte swapping of data entering the FIFO. B3[31:24] swapped with B2[23:16] and B1[15:8] swapped with B0[7:0].

Bits	Type	Default	Name	Description
[7:4]	RW	4'b0000	COLOR_ODD	Odd Field Color Format 0000 = RGB32 0001 = RGB24 0010 = RGB16 0011 = RGB15 0100 = YUV2 4:2:2 0101 = BtYUV 4:1:1 0110 = Y8 (Gray scale) 0111 = TGB8 (Dithered) 1000 = YcrCb 4:2:2 Planar 1001 = YcrCb 4:1:1 Planar (YUV9,YUV12) 1010 = Reserved 1011 = Reserved 1100 = Reserved 1101 = Reserved 1110 = Raw 8x Data 1111 = Reserved
[3:0]	RW	4'b0000	COLOR_EVEN	Even Field Color Format 0000 = RGB32 0001 = RGB24 0010 = RGB16 0011 = RGB15 0100 = YUV2 4:2:2 0101 = BtYUV 4:1:1 0110 = Y8 (Gray scale) 0111 = TGB8 (Dithered) 1000 = YcrCb 4:2:2 Planar 1001 = YcrCb 4:1:1 Planar 1010 = Reserved 1011 = Reserved 1100 = Reserved 1101 = Reserved 1110 = Raw 8x Data 1111 = Reserved

VBI Packet Size/Delay

Register 24'h310188

Bits	Type	Default	Name	Description
[31:29]	RO	3h0		RESERVED
[28:17]	RW	12h000	FRM_SIZE	VBI Frame Size Used in both RAW all mode and VBI frame mode specifies # of bytes packed in each packet has to be QWORD boundary.
[16:11]	RW	6'h00	VBI_V_DEL	The number of CLKx1's to delay from the trailing edge of HRESET before starting VBI line capture. Used in both VBI line mode and VBI frame mode, where in VBI frame mode it has to set to a value of 2.
[10]	RW	0	EXTERN	A value of 1 extends the frame output capture region to include the 20 half lines prior to the default VACTIVE region.
[9:0]	RW	10'h000	VBI_PKT_SIZE	VBI Packet Size. The number of raw data dwords (four 8-bit samples) to capture per line while in VBI capture mode (only used in VBI line mode).

Field Capture Counter

Register 24'h310190

Bits	Type	Default	Name	Description
[31:10]	RO	22'h000000		RESERVED
[9:0]	RW	10'h000	FCNTR	Counts field transitions when any CAPTURE bit is set. Any write to this register resets the content to 0.

VIP Configuration

Register 24'h310194

Bits	Type	Default	Name	Description
[31:5]	RO	27'h0000000		RESERVED
[4]	RW	1'b0	VIP_DROP	Enables frame rate reduction by dropping every other frame in a progressive source, or every other field in an interlace source.
[3]	RW	1'b0	VIP_VS_INT	Enable VIP vertical scaler interface mode. Used when data from both fields is used in creating scaled image. Typically only used on interface sources when the vertical scaling ration is less than 2:1. I.E. Between full resolution and CIF resolution. Should not be used when scaling progressive scan sources.
[2]	RW	1'b0	VIP_C_SCALE	Enable Chroma scaling in vertical scaler
[1]	RW	1'b0	VIP_MODE	VIP 1.1/VIP2.0 selection 0 = VIP 1.1 1 = VIP 2.0
[0]	RW	1'b0	VIP_IN_EN	Enable VIP input port. VIP input clock must be running prior to enabling the VIP input port.

VIP Contrast and Brightness

Register 24'h310198

Bits	Type	Default	Name	Description
[31:16]	RO	16'h0000		RESERVED
[15:8]	RW	8'h80	VIP_CONTRAST	The luminance portion of the VIP data is multiplied by this contrast value. Values from 00 to FF are allowed. Range is 0 to 1.992.
[7:0]	RW	8'h00	VIP_BRIGHT	Brightness offset applied to the VIP data. Values from 00 to FF are allowed. The 2's complement value programmed into this register is added to the luminance portion of the VIP data. Brightness is applied after contrast.

VIP Saturation

Register 24'h31019C

Bits	Type	Default	Name	Description
[31:8]	RO	24'h000000		RESERVED
[7:0]	RW	8'h80	VIP_SAT	VIP_SAT gain will apply to the VIP chroma data. Values from 00 to FF are allowed. Range is 0 to 1.992

VIP Horizontal Scaling

Register 24'h3101A0

Bits	Type	Default	Name	Description
[31:15]	RO	16'h0000		RESERVED
[15:0]	RW	16'h0000	VIP_HSCALE	Horizontal Scaling Ratio

VIP Vertical Scaling

Register 24'h3101A4

Bits	Type	Default	Name	Description
[31:16]	RO	16'h0000		RESERVED
[15:13]	RW	3'b000	VIP_VFILT	These bits control the number of taps in the VIP Vertical Scaling Filter. The number of taps must be chosen in conjunction with the VIP horizontal scale factor to ensure the needed data does not overflow the internal FIFO. 000 = 2-tap interpolation only(1) 001 = 3-tap interpolation(2) 010 = 4-tap interpolation(3) 011 = 5-tap interpolation(3) 100 = 2-tap and no interpolation(1) 101 = 3-tap and no interpolation(2) 110 = 4-tap and no interpolation(3) 111 = 5-tap and no interpolation(3)
[12:0]	RW	13'h000	VIP_VSCALE	Vertical Scaling Ratio

FOOTNOTE:
(1) Available at all resolution
(2) Only available if scaling to less than 385 horizontal active pixels
(3) Only available if scaling to less than 193 horizontal active pixels

VBOS Control

Register 24’h3101A8

Bits	Type	Default	Name	Description
[31:22]	RO	10’b000		RESERVED
[21]	RW	1’b0	VIP_VBIT	VIP V-Bit setting 0 = normal V-bit generation 1 = new V-bit equals (V-bit and T-bit)
[20]	RW	1’b0	VIP_OPT_AL	VIP optional active line enable
[19]	RW	1’b0	CLKGT	GPCLKO gating 0 = CLKx1 or CLKx2 is inverted and gated with VALID and ACTIVE to create GPCLKO. Used in punctured clock mode. 1 = CLKx1 or CLKx2 is inverted and gated with VALID to create GPCLKO when VLDFMT = 0. Used in 656 mode.
[18]	RW	1’b1	VIP_LINE_DLY	When this bit is set, the output of the VIP control codes will be delayed by one line to match the delay introduced by the comb filter.
[17]	RW	1’b0	MODE656	ITU-R-BT.656 mode 0 = disable 1 = enable
[16]	RW	1’b0	MODE10B	Pixel output mode 0 = 8 bit output 1 = 10 bit output
[15]	RW	1’b0	VBIEN	Enable VBI capture 0 = Disable VBI capture 1 = Enable VBI capture
[14]	RW	1’b0	VLDFMT	VALID format 0 = VALID indicates nonscaled pixels 1 = VALID is logical AND of nominal VALID and ACTIVE, where ACTIVE is controlled by ACTFMT. GPCLKO is inverted CLKx1 or CLKx2.
[13]	RW	1’b0	VBIFMT	VBI Output Format 0 = Pixel N on VD[15:8], Pixel N+1 on VD[7:0] 1 = Pixel N on VD[7:0], Pixel N+1 on VD[15:8]
[12]	RW	1’b0	VBIFRM	VBI Frame (raw) mode 0 = VBI frame mode disabled 1 = VBI frame mode enabled

Bits	Type	Default	Name	Description
[11]	RW	1'b1	ACTFMT	ACTIVE format 0 = ACTIVE is composite active 1 = ACTIVE is horizontal active
[10]	RW	1'b0	BSTRMEN	Enables Bytestream control code insertion 0 = No Bytestream control codes 1 = Bytestream control codes inserted
[9]	RW	1'b1	VIPEN	Enables VIP control code insertion 0 = NO VIP control codes 1 = VIP control codes inserted
[8]	RW	1'b0	NBYTE	0 = 8-bit output (GPCLKO = CLKx2) 1 = 16-bit output (GPCLKO = CLKx1)
[7:1]	RW	7'h00	VPOLE	
[0]	RO	1'b0		RESERVED

AGC Back Porch/VBI/Interval Counter Control

Register 24'h310200

Bits	Type	Default	Name	Description
[31:28]	RO	4'h00		RESERVED
[27]	RW	1'b0	CLAMP_VBI_EN	
[26]	RW	1'b0	AGC_VBI_EN	
[25]	RW	1'b0	BP_REF_SEL	Back Porch reference Select 0 = Selects WhiteCrush for Back Porch reference 1 = Selects BP_REF register for Back Porch reference
[24:16]	RW	9'h0E0	BP_REF	Sets desired value for Back Porch
[15:12]	RO	4'h0		RESERVED
[11:0]	RW	12'h555	INTRVL_CNT_VAL	Maximum count for interval counter in min-max detect

AGC Sync Slicer

Register 24'h310204

Bits	Type	Default	Name	Description
[31:22]	RO	10'h000		RESERVED
[21]	RW	1'b1	DLY_UPD_EN	
[20]	RW	1'b1	SAM_SYNC_EN	
[19]	RW	1'b1	STD_SLICE_EN	Enables standard sync slicer
[18:16]	RW	3'h4	MM_MULT	
[15:8]	RW	8'h60	BP_SAM_DLY	Back porch sample delay
[7:0]	RW	8'h1C	SYNC_SAM_DLY	Sync sample delay

AGC Sync Tip Adjust 1

Register 24'h310208

Bits	Type	Default	Name	Description
[31:29]	RO	3'b000		RESERVED
[28:17]	RW	12'h1C0	TRK_MODE_THR	
[16:9]	RW	8'h00	TRK_CORE_THR	Sets coring threshold level during tracking mode
[8:7]	RW	2'b00	TRK_G_VAL	Set gain level during tracking mode 00 = x1 gain 01 = x2 gain 10 = x4 gain 11 = x8 gain
[6:0]	RW	7'h0F	TRK_SAT_VAL	Set saturation level during tracking mode

AGC Sync Tip Adjust 2

Register 24'h31020C

Bits	Type	Default	Name	Description
[31:29]	RO	3'b000		RESERVED
[28:17]	RW	12'h020	ACQ_MODE_THR	
[16:9]	RW	8'h00	ACQ_CORE_THR	Sets coring threshold level during acquisition mode
[8:7]	RW	2'b01	ACQ_G_VAL	Set gain level during acquisition mode 00 = x1 gain 01 = x2 gain 10 = x4 gain 11 = x8 gain
[6:0]	RW	7'h3F	ACQ_SAT_VAL	Set saturation level during acquisition mode

AGC Sync Tip Adjust 3

Register 24’h310210

Bits	Type	Default	Name	Description
[31:29]	RO	3’b000		RESERVED
[28:16]	RW	13’h1E48	LOW_STIP_TH	
[15:8]	RW	8’hE0	ACC_MIN	Accumulator
[7:0]	RW	8’h40	ACC_MAX	Accumulator

AGC Gain Adjust 1

Register 24’h310214

Bits	Type	Default	Name	Description
[31:29]	RO	3’b000		RESERVED
[28:17]	RW	12’h0E0	TRK_AGC_MODE_TH	
[16:9]	RW	8’h0E	TRK_AGC_CORE_TH_VAL	Sets coring threshold level during tracking mode
[8:7]	RW	2’b00	TRK_GAIN_VAL	AGC error gain (in powers of 2) for tracking mode
[6:0]	RW	7’h07	TRK_AGC_SAT_VAL	AGC error saturation value for tracking mode

AGC Gain Adjust 2

Register 24’h310218

Bits	Type	Default	Name	Description
[31:29]	RO	3’b000		RESERVED
[28:17]	RW	12’h020	ACQ_AGC_MODE_TH	
[16:9]	RW	8’h00	ACQ_AGC_CORE_TH_VAL	Sets coring threshold level during acquisition mode
[8:7]	RW	2’b10	ACQ_GAIN_VAL	AGC error gain (in powers of 2) for acquisition mode
[6:0]	RW	7’h0F	ACQ_AGC_SAT_VAL	AGC error saturation value for acquisition mode

AGC Gain Adjust 3

Register 24’h31021C

Bits	Type	Default	Name	Description
[31:24]	RO	8’h00		RESERVED
[23:16]	RW	8’h28	ACC_MIN_VAL	Minimum value for AGC accumulator
[15:8]	RW	8’h38	ACC_MAX_VAL	Maximum value for AGC accumulator
[7:0]	RW	8’hC0	ACC_INC_VAL	

AGC Gain Adjust 4

Register 24’h310220

Bits	Type	Default	Name	Description
[31:24]	RO	8’h00		RESERVED
[23]	RW	1’b0	INIT_6DB_VAL	0 = ON (+ 6 dB) 1 = OFF (no gain)
[22]	RW	1’b1	SLICE_REF_EN	
[21]	RW	1’b1	VGA_EN	
[20:16]	RW	5’h0A	INIT_VGA_VAL	Initial value to be loaded to the VGA counter
[15:8]	RW	8’h2C	LOW_ACC_VAL	Minimum value to be compared with digital gain accumulator output to qualify a decrement in VGA counter
[7:0]	RW	8’h34	HIGH_ACC_VAL	Maximum value to be compared with digital gain accumulator output to qualify a increment in VGA counter

IPB DMAC Current Buffer Pointer

Register 24’h300080—DMA21_PTR1

Register 24’h300084—DMA22_PTR1

Register 24’h300088—DMA23_PTR1

Register 24’h30008C—DMA24_PTR1

Bits	Type	Default	Name	Description
[23:2]	RO	22’hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2’b00		Reserved

IPB DMAC Current Table Pointer

Register 24’h3000C0—DMA21_PTR2

Register 24’h3000C4—DMA22_PTR2

Register 24’h3000C8—DMA23_PTR2

Register 24’h3000CC—DMA24_PTR2

Bits	Type	Default	Name	Description
[23:2]	RW*	22’hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2’b00		Reserved

IPB DMAC Buffer Limit

Register 24'h300100—DMA21_CNT1

Register 24'h300104—DMA22_CNT1

Register 24'h300108—DMA23_CNT1

Register 24'h30010C—DMA24_CNT1

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

IPB DMAC Table Size

Register 24'h300140—DMA21_CNT2

Register 24'h300144—DMA22_CNT2

Register 24'h300148—DMA23_CNT2

Register 24'h30014C—DMA24_CNT2

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.
NOTE:Writing DMA{x}_CNT2 registers (location 24'h300140_14C) causes the hardware to begin using the CDT information. It is imperative to perform this step only after initialization of the Cluster Description Table, Cluster Buffer Size, and CDT location.				

General Purpose Counter (Immediate Access)

Register 24'h31C020—VIDY_GP_CNT

Register 24'h31C024—VIDU_GP_CNT

Register 24'h31C028—VIDV_GP_CNT

Register 24'h31C02C—VBI_GP_CNT

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC program.

General Purpose Counter Control (Immediate Access)

Register 24'h31C030—VIDY_GP_CNT_CNTRL

Register 24'h31C034—VIDU_GP_CNT_CNTRL

Register 24'h31C038—VIDV_GP_CNT_CNTRL

Register 24'h31C03C—VBI_GP_CNT_CNTRL

Bits	Type	Default	Name	Description
[1:0]	WO	2'b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

IPB DMA Control (Immediate Access)

Register 24'h31C040—VID_DMA_CNTRL

Bits	Type	Default	Name	Description
[7]	RW	1'b0	VBI_ RISC _EN	VBI RISC controller enable.
[6]	RW	1'b0	VIDV_ RISC _EN	Planar V RISC controller enable.
[5]	RW	1'b0	VIDU_ RISC _EN	Planar U RISC controller enable.
[4]	RW	1'b0	VIDY_RISC_EN	Planar Y and packed RISC controller enable.
[3]	RW	1'b0	VBI_ FIFO _EN	VBI FIFO enable.
[2]	RW	1'b0	VIDV_ FIFO _EN	Planar V FIFO enable.
[1]	RW	1'b0	VIDU_ FIFO _EN	Planar U FIFO enable.
[0]	RW	1'b0	VIDY_FIFO_EN	Planar Y and packed FIFO enable.

Video Transfer Status Register (Immediate access)

Register 24'h31C044—VID_XFER_STATUS

Bits	Type	Default	Name	Description
[0]	RO	1'b0	XFER_IN_PROG	Video transfer in progress signal. This may be used to determine when it is safe to access the video registers. This register returns a value immediately, thus it doesn't follow the delayed read rules.

Video Interrupt Mask

Register 24'h200050—VID_INT_MSK

Bits	Type	Default	Name	Description
[19:0]	RW	20'b0	VID_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the VID_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

Video Interrupt Status

Register 24'h200054—VID_INT_STAT

Bits	Type	Default	Name	Description
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/ unused opcode in the instruction sequence.
[15]	RR	1'b0	VBI_SYNC	Set when number of lines or bytes do not match the VBI RISC program expectations.
[14]	RR	1'b0	V_SYNC	Set when number of lines or bytes do not match the V video RISC program expectations.
[13]	RR	1'b0	U_SYNC	Set when number of lines or bytes do not match the U video RISC program expectations.
[12]	RR	1'b0	Y_SYNC	Set when number of lines or bytes do not match the Y video RISC program expectations.
[11]	RR	1'b0	VBIF_OF	Set when VBI FIFO overflow condition is being handled.
[10]	RR	1'b0	VF_OF	Set when V video FIFO overflow condition is being handled.
[9]	RR	1'b0	UF_OF	Set when U video FIFO overflow condition is being handled.
[8]	RR	1'b0	YF_OF	Set when Y video FIFO overflow condition is being handled.
[7]	RR	1'b0	VBI_RISCI2	Set when the IRQ2 bit in a VBI RISC instruction is set.
[6]	RR	1'b0	V_RISCI2	Set when the IRQ2 bit in a V video RISC instruction is set.

Bits	Type	Default	Name	Description
[5]	RR	1'b0	U_RISCI2	Set when the IRQ2 bit in a U video RISC instruction is set.
[4]	RR	1'b0	Y_RISCI2	Set when the IRQ2 bit in a Y video RISC instruction is set.
[3]	RR	1'b0	VBI_RISCI1	Set when the IRQ1 bit in a VBI RISC instruction is set.
[2]	RR	1'b0	V_RISCI1	Set when the IRQ1 bit in a V video RISC instruction is set.
[1]	RR	1'b0	U_RISCI1	Set when the IRQ1 bit in a U video RISC instruction is set.
[0]	RR	1'b0	Y_RISCI1	Set when the IRQ1 bit in a Y video RISC instruction is set.

Video Interrupt Masked Status

Register 24'h200058—VID_INT_MSTAT

Bits	Type	Default	Name	Description
[19:0]	RO	20'b0	VID_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

Video Interrupt Set Status

Register —

Bits	Type	Default	Name	Description
[16:0]	WO	17'b0	VID_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

6.8 Memory Mapped Registers: Function 1: Audio

Audio Capture

AUD_INIT

Register 24'h320100

Bits	Type	Default	Name	Description
[5:0]	RW*	6'h00	AUD_INIT	Auto-configure initialization register 01 – Configure BTSC 02 – Configure EIAJ 04 – Configure A2 08 – Configure BTSC-SAP 10 – Configure NICAM 20 – Configure FM Radio
[15:6]	RO*	10'h000		Reserved

AUD_INIT_LD

Register 24'h320104

Bits	Type	Default	Name	Description
[0]	WO*	1'b0	AUD_INIT_LD	Enable loading of AUD_INIT initialization.
[15:1]	RO*	15'h0000		Reserved

SOFT_RESET

Register 24'h320108

Bits	Type	Default	Name	Description
[0]	RW*	1'b0	SOFT_RESET	Enable software reset of everything other than the programmable registers. Used to keep the audio subsection in a known state until all programming is complete.
[15:1]	RO*	15'h0000		Reserved

AUD_CTL

Register 24'h32058C

Bits	Type	Default	Name	Description
[5:0]	RW*	6'h00	SOFT_RESET	Enable software reset of everything other than the programmable registers. Used to keep the audio subsection in a known state until all programming is complete.
[6]	RW*	1'b0	Reserved	Reserved
[8:7]	RW*	2'h0	DMTRX_CTL	Dematrix control
[9]	RW*	1'b0	Reserved	Reserved
[10]	RW*	1'b0	Reserved	Reserved
[11]	RW*	1'b0	DMTRX_BYPASS	Dematrix bypass enable bit
[12]	RW*	1'b0	DAC_ENABLE	DAC enable bit
[13]	RW*	1'b0	I^2SOUT_ENABLE	I^2S output enable bit
[14]	RW*	1'b0	I^2S_STR2DAC	I^2S input direct to DAC enable bit
[15]	RW*	1'b0	I^2SIN_ENABLE	I^2S input enable

AUD_STATUS

Register 24'h320590

Bits	Type	Default	Name	Description
[1:0]	RO*	2'b00	STEREO_MODE	Current stereo mode in use: 10 = Mono 01 = Dual mono 00 = Stereo 11 = SAP
[3:2]	RO*	2'b00	DEMOD_PILOT	Current pilot correlation from demodulator: 00 = No Pilot detected 01 = Pilot C1 detected 10 = Pilot C2 detected
[4]	RO*	1'b0	TIMER_TIMEOUT	Timeout of timer used for both initialization and mode change debounce.
[5]	RO*	1'b0	VFILE_OK	DBX register memory check successful
[15:6]	RO*	10'h000	MAIN_AFC	First rotator AFC input for detecting if the desired carrier has been acquired (for use in determining the system being broadcast)

VOL_CTL

Register 24'h320594

Bits	Type	Default	Name	Description
[5:0]	RW*	8'h00	VOLUME	Volume control in dB steps. 0 to –63 dB
[6]	RW*	1'b0	SRC_MUTE_EN	Source mute enable
[7]	RW*	1'b0	I^2S_MUTE_EN	I^2S mute enable
[8]	RW*	1'b0	DAC_MUTE_EN	DAC mute enable
[15:9]	RW*	7'h00		Reserved

BAL_CTL

Register 24'h320598

Bits	Type	Default	Name	Description
[5:0]	RW*	8'h00	BAL_LEVEL	Attenuation to be provided to the selected channel in dB. Range is 0 to –63 dB.
[6]	RW*	1'b0	BAL_LEFT	Select left channel for balance control if 1, select right channel if 0
[15:7]	RO*	7'h00		Reserved

I^2SINPUT

Register 24'h320120

Bits	Type	Default	Name	Description
[0]	RW*	1'b0	NSlaveMaster	0 = Chip is slave 1 = Chip is master
[1]	RW*	1'b0	NPhilipsSony	0 = Conform to Philips spec 1 = Conform to Sony spec
[2]	RW*	1'b0	DisableAutoBaud	0 = Autobaud 1 = Disable autobaud
[15:3]	RO	13'h0000		Reserved

I2SINPUTSTATUS

Register 24’h320000

Bits	Type	Default	Name	Description
[5:0]	RO	6’h000	Status	0 = 0 kHz 1 = 48 kHz 2 = 96 kHz 3 = 144 kHz 4 = 192 kHz 5 = 240 kHz (not supported) 6 = 288 kHz (not supported) > 6 = > 288 kHz (not supported)
[15:6]	RO	9’h000		Reserved

I2SOUTPUT

Register 24’h320128

Bits	Type	Default	Name	Description
[0]	RW*	1’b0	NPhilipsSony	0 = Conform to Philips spec 1 = Conform to Sony spec
[1]	RW*	1’b0	Mute	Holds SCK, WS, and SD outputs
[15:2]	RW*	14’h0000		Reserved

IPB DMAC Current Buffer Pointer

Register 24’h300090—DMA25_PTR1

Register 24’h300094—DMA26_PTR1

Register 24’h300098—DMA27_PTR1

Bits	Type	Default	Name	Description
[23:2]	RO	22’hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2’b00		Reserved

IPB DMAC Current Table Pointer

Register 24'h3000D0—DMA25_PTR2

Register 24'h3000D4—DMA26_PTR2

Register 24'h3000D8—DMA27_PTR2

Bits	Type	Default	Name	Description
[23:2]	RW*	22'hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Buffer Limit

Register 24'h300110—DMA25_CNT1

Register 24'h300114—DMA26_CNT1

Register 24'h300118—DMA27_CNT1

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

IPB DMAC Table Size

Register 24'h300150—DMA25_CNT2

Register 24'h300154—DMA26_CNT2

Register 24'h300158—DMA27_CNT2

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.
NOTE:Writing DMA{x}_CNT2 registers (location 24'h300140_14C) causes the hardware to begin using the CDT information. It is imperative to perform this step only after initialization of the Cluster Description Table, Cluster Buffer Size, and CDT location.				

General Purpose Counter (Immediate Access)

Register 24'h32C020—AUDD_GP_CNT

Register 24'h32C024—AUDU_GP_CNT

Register 24'h32C028—AUDR_GP_CNT

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC program.

General Purpose Counter Control (Immediate Access)

Register 24’h32C030—AUDD_GP_CNT_CNTRL

Register 24’h32C034—AUDU_GP_CNT_CNTRL

Register 24’h32C038—AUDR_GP_CNT_CNTRL

Bits	Type	Default	Name	Description
[1:0]	WO	2’b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

IPB DMA Control (Immediate Access)

Register 24’h32C040—AUD_DMA_CNTRL

Bits	Type	Default	Name	Description
[6]	RW	1’b0	AUDR_ RISC _EN	Audio RDS RISC enable.
[5]	RW	1’b0	AUDU_ RISC _EN	Audio upstream RISC enable.
[4]	RW	1’b0	AUDD_ RISC _EN	Audio downstream RISC enable.
[2]	RW	1’b0	AUDR_ FIFO _EN	Audio RDS FIFO enable.
[1]	RW	1’b0	AUDU_ FIFO _EN	Audio upstream FIFO enable.
[0]	RW	1’b0	AUDD_ FIFO _EN	Audio downstream FIFO enable.

Audio Transfer Status Register (Immediate Access)

Register 24’h32C044—AUD_XFER_STATUS

Bits	Type	Default	Name	Description
[0]	RO	1’b0	XFER_IN_PROG	Audio transfer in progress signal. This may be used to determine when it is safe to access the audio registers. This register returns a value immediately, thus it doesn’t follow the delayed read rules.

Line Length

Register 24’h32C048—AUDD_LNGTH

Register 24’h32C04C—AUDR_LNGTH

Bits	Type	Default	Name	Description
[11:0]	RW	12’b0	AUD{x}_LNGTH	Audio downstream line length in bytes.

Audio Interrupt Mask

Register 24'h200060—AUD_INT_MSK

Bits	Type	Default	Name	Description
[21:0]	RW	22'b0	AUD_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the AUD_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

Audio Interrupt Status

Register 24'h200064—AUD_INT_STAT

Bits	Type	Default	Name	Description
[21]	RR	1'b0	MCHG_IRQ	Mode change, set when operational mode changes without software intervention.
[20]	RR	1'b0	BER_IRQ	NICAM Bit Error Rate Interrupt, set when the measured rate crosses programmable threshold.
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/ unused opcode in the instruction sequence.
[14]	RR	1'b0	RDS_DN_SYNC	Set when number of lines or bytes do not match the RDS downstream audio RISC program expectations.
[13]	RR	1'b0	UP_SYNC	Set when number of lines or bytes do not match the upstream audio RISC program expectations.
[12]	RR	1'b0	DN_SYNC	Set when number of lines or bytes do not match the downstream audio RISC program expectations.
[10]	RR	1'b0	RDS_DNF_OF	Set when downstream RDS audio FIFO overflow condition is being handled.
[9]	RR	1'b0	UPF_UF	Set when upstream audio FIFO underflow condition is being handled.
[8]	RR	1'b0	DNF_OF	Set when downstream audio FIFO overflow condition is being handled.

Bits	Type	Default	Name	Description
[6]	RR	1'b0	RDS_DN_RISCI2	Set when the IRQ2 bit in a RDS downstream audio RISC instruction is set.
[5]	RR	1'b0	UP_RISCI2	Set when the IRQ2 bit in an upstream audio RISC instruction is set.
[4]	RR	1'b0	DN_RISCI2	Set when the IRQ2 bit in a downstream audio RISC instruction is set.
[2]	RR	1'b0	RDS_DN_RISCI1	Set when the IRQ1 bit in a RDS downstream audio RISC instruction is set.
[1]	RR	1'b0	UP_RISCI1	Set when the IRQ1 bit in an upstream audio RISC instruction is set.
[0]	RR	1'b0	DN_RISCI1	Set when the IRQ1 bit in a downstream audio RISC instruction is set.

Audio Interrupt Masked Status

Register 24'h200068—AUD_INT_MSTAT

Bits	Type	Default	Name	Description
[21:0]	RO	22'b0	AUD_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

Audio Interrupt Set Status

Register 24'h20006C—AUD_INT_SSTAT

Bits	Type	Default	Name	Description
[16:0]	WO	17'b0	AUD_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

6.9 Memory Mapped Registers: Function 2: MPEG TS

IPB DMAC Current Buffer Pointer

Register 24'h30009C—DMA28_PTR1

Bits	Type	Default	Name	Description
[23:2]	RO	22'hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Current Table Pointer

Register 24'h3000DC—DMA28_PTR2

Bits	Type	Default	Name	Description
[23:2]	RW*	22'hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Buffer Limit

Register 24'h30011C—DMA28_CNT1

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

IPB DMAC Table Size

Register 24'h30015C—DMA28_CNT2

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.
NOTE:Writing DMA{x}_CNT2 registers (location 24'h300140_14C) causes the hardware to begin using the CDT information. It is imperative to perform this step only after initialization of the Cluster Description Table, Cluster Buffer Size, and CDT location.				

General Purpose Counter (Immediate Access)

Register 24'h33C020—TS_GP_CNT

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC program.

General Purpose Counter Control (Immediate Access)

Register 24’h33C030—TS_GP_CNT_CNTRL

Bits	Type	Default	Name	Description
[1:0]	WO	2’b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

IPB DMA Control (Immediate Access)

Register 24’h33C040—TS_DMA_CNTRL

Bits	Type	Default	Name	Description
[4]	RW	1’b0	TS_RISC_EN	Transport stream RISC controller enable.
[0]	RW	1’b0	TS_FIFO_EN	Transport stream FIFO enable.

Transport Stream Transfer Status Register (Immediate Access)

Register 24’h33C044—TS_XFER_STATUS

Bits	Type	Default	Name	Description
[0]	RO	1’b0	XFER_IN_PROG	Transport stream transfer in progress signal. This may be used to determine when it is safe to access the transport stream registers. This register returns a value immediately, thus it doesn’t follow the delayed read rules.

Line Length (Immediate Access)

Register 24’h33C048—TS_LNGTH

Bits	Type	Default	Name	Description
[11:0]	RW	12’b0	TS_LNGTH	Transport stream line length in bytes.

HW SOP Control (Immediate Access)

Register 24'h33C04C—HW_SOP_CONTROL

Bits	Type	Default	Name	Description
[23:16]	RW	8'd47	IPB_STRT_BYTE	Byte start pattern that is searched for in the MPEG transport stream that signals start of transport stream. This is issued every MPEG packet.
[15:4]	RW	12'd188	IPB_PKT_LNGTH	Used to sync/mark detect SOP
[3:0]	RW	4'b0000	IPB_STRT_FLTR_CNT	Defines the number of IPB_strt_bytes that need to be detected before the MPEG fec interface is declared as being in sync.

TS General Control (Immediate Access)

Register 24'h33C050—TS_GEN_CONTROL

Bits	Type	Default	Name	Description
[7]	WO	1'b0	IPB_STAT_CLR	Active-High reset for stat registers.
[6]	WO	1'b0	IPB_SW_RST	Active-High Software reset.
[5]	RW	1'b0	IPB_ERR_ACK	Determines whether the interface is in an error ack mode. This is only valid while IPB_PUNC_CLK is active.
[4]	RW	1'b0	IPB_BIT_RVRS	This reverses each byte-wide input one byte at a time.
[3]	RW	1'b1	IPB_SMODE	Input Mode Select. 0 = Parallel Mode 1 = Serial Mode
[2]	RW	1'b0	IPB_PUNC_CLK	Determines whether the TS interface is operating in punctured clock mode.
[1]	RW	1'b0	IPB_MCLK_POL	Polarity of MPEG generated MCLK. Default means TS inputs are negedge driven. When asserted high TS inputs are negedge sampled and assumed posedge driven.
[0]	RO	1'b0	MPEG_IN_SYNC	Active-high synchronization indicator for MPEG.

TS Bad Packet Status (Immediate Access)

Register 24'h33C054—TS_BD_PKT_STATUS

Bits	Type	Default	Name	Description
[12]	RW	1'b0	IPB_BAD_PKT_CHK	Enables bad pkt status and MPEG_BAD_PKT interrupt
[11:0]	RO	12'h000	MPG_BAD_PKT_STAT	Bad pkt counter status. When enabled, counter output is incremented every time a packet number of bytes received is less than or greater than the expected programmed number of bytes.

TS SOP Status (Immediate Access)

Register 24'h33C058—TS_SOP_STATUS

Bits	Type	Default	Name	Description
[16]	RW	1'b0	IPB_TSSOP_POL	Polarity select 0 = Active High (default) 1 = Active Low
[15:14]	RW	2'b00	IPB_SOP_SEL	SOP Format. 00 = detects rising edge of TSSOP input 01 = detects rising edge of TSVALERR input 10 = detects rise and fall edge of TSSOP input 11 = detects start byte in data stream
[13]	RW	1'b0	IPB_SOP_BYTEWIDE	SOP width select. Byte wide is only an option in serial mode. 0 = Bit width 1 = Byte width
[12]	RW	1'b0	IPB_SOP_SYNC_CHK	Enables bad sop status and mpeg_bad_pkt interrupt
[11:0]	RO	12'h000	MPG_BAD_SOP_STAT	Bad SOP counter status. When enabled, counter output is incremented every time there is a SOP mis-compare. Counter status is updated at the falling edge of TS_BAD_PKT interrupt, generated by the internal mpeg_ts.

TS Fifo Overflow Status (Immediate Access)

Register 24'h33C05C—TS_FIFO_OVFL_STAT

Bits	Type	Default	Name	Description
[12]	RW	1'b0	IPB_FIFO_OVFL_CHK	Enables FIFO overflow status and mpeg_bad_pkt
[11:0]	RO	12'h000	MPG_FIFO_OVFL_STAT	When enabled the counter output is incremented every time the MPEG TS FIFO overflows.

TS Valid Miscellaneous (Immediate Access)

Register 24'h33C060—TS_VLD_MISC

Bits	Type	Default	Name	Description
[13]	RW	1'b0	IPB_TSVALERR_POL	Control for polarity of tsvalerr input. 0 = Active-High (Default) 1 = Active-Low
[12]	RW	1'b0	IPB_VAL_SEL	Selects whether tsvalerr is active. 0 = selects the external tsvalerr (default) 1 = internally generated valid
[11:0]	RW	12'h000	IPB_VAL_LNGTH	Programmable valid length. Used when mode requires TS to be terminated after a count versus the input valid (tsvalerr)

Transport Stream Interrupt Mask

Register 24'h200070—TS_INT_MSK

Bits	Type	Default	Name	Description
[20:0]	RW	21'b0	TS_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the TS_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

Transport Stream Interrupt Status

Register 24'h200074—TS_INT_STAT

Bits	Type	Default	Name	Description
[20]	RR	1'b0	TS_BAD_PCKT	Set when the MPEG transport stream interface detects an error (either of the three status check bits are set and the appropriate error condition is detected).
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/ unused opcode in the instruction sequence.
[12]	RR	1'b0	TS_SYNC	Set when number of lines or bytes do not match the transport stream RISC program expectations.
[8]	RR	1'b0	TSF_OF	Set when transport stream FIFO overflow condition is being handled.
[4]	RR	1'b0	TS_RISCI2	Set when the IRQ2 bit in a transport stream RISC instruction is set.
[0]	RR	1'b0	TS_RISCI1	Set when the IRQ1 bit in a transport stream RISC instruction is set.

Transport Stream Interrupt Masked Status

Register 24'h200078—TS_INT_MSTAT

Bits	Type	Default	Name	Description
[20:0]	RO	21'b0	TS_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

Transport Stream Interrupt Set Status

Register 24'h20007C—TS_INT_SSTAT

Bits	Type	Default	Name	Description
[16:0]	WO	17'b0	TS_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

6.10 Memory Mapped Registers: Function 3: VIP

IPB DMAC Current Buffer Pointer

Register 24'h3000A0—DMA29_PTR1

Register 24'h3000A4—DMA30_PTR1

Bits	Type	Default	Name	Description
[23:2]	RO	22'hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Current Table Pointer

Register 24'h3000E0—DMA29_PTR2

Register 24'h3000E4—DMA30_PTR2

Bits	Type	Default	Name	Description
[23:2]	RW*	22'hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Buffer Limit

Register 24'h300120—DMA29_CNT1

Register 24'h300124—DMA30_CNT1

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

IPB DMAC Table Size

Register 24'h300160—DMA29_CNT2

Register 24'h300164—DMA30_CNT2

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.
NOTE:Writing DMA{x}_CNT2 registers (location 24'h300140_14C) causes the hardware to begin using the CDT information. It is imperative to perform this step only after initialization of the Cluster Description Table, Cluster Buffer Size, and CDT location.				

General Purpose Counter (Immediate Access)

Register 24'h34C020—VIPD_GP_CNT

Register 24'h34C024—VIPU_GP_CNT

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC program.

General Purpose Counter Control (Immediate Access)

Register 24'h34C030—VIPD_GP_CNT_CNTRL

Register 24'h34C034—VIPU_GP_CNT_CNTRL

Bits	Type	Default	Name	Description
[1:0]	WO	2'b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

VIP Streaming Enable (Immediate Access)

Register 24'h34C040—VIP_STREAM_EN

Bits	Type	Default	Name	Description
[5]	RW	1'b0	VIPU_RISC_EN	RISC Controller enable for the VIP interface upstream DMA channel.
[4]	RW	1'b0	VIPD_RISC_EN	RISC Controller enable for the VIP interface downstream DMA channel
[1]	RW	1'b0	VIPU_FIFO_EN	Enable for pulling data out of the VIP upstream DMA fifo or cluster descriptor table.
[0]	RW	1'b0	VIPD_FIFO_EN	Enable for fetching downstream data from the external source.

VIP Transfer Status Register (Immediate Access)

Register 24'h34C044—XFER_STATUS

Bits	Type	Default	Name	Description
[4]	RO	1'b0	Timeout_ch1	This register should be read following a vip timeout interrupt to determine if the register R/W channel has timed out.
[3]	RO	1'b0	Timeout_ch2	This register should be read following a vip timeout interrupt to determine if the downstream DMA channel has timed out.
[2]	RO	1'b0	Timeout_ch3	This register should be read following a vip timeout interrupt to determine if the upstream DMA channel has timed out.
[1]	RO	1'bx	VIP_slave_detect	This register is set to a logic 1 when the VIP detects a presence of a VIP compliant slave device. This value is set by the slave a result of the slave pulling-down HAD[0] during reset.
[0]	RO	1'b0	Xfer_in_progress	VIP transfer in progress signal. This may be used to determine when it is safe to access the host. This register returns a value immediately, thus it doesn't follow the delayed read rules.

VIP Configuration

Register 24'h340048—VIP_CFG

Bits	Type	Default	Name	Description
[11:8]	RW	4'b1111	VIP Timeout_length	VIP timeout length
[7:6]	RW	2'b00	Peripheral #1 config	2'b00 = 1x configuration (2-bit) 2'b01 = 2x configuration (4-bit) 2'b10 = reserved 2'b11 = 4x configuration (8-bit)
[5:4]	RW	2'b00	Peripheral #2 config	See channel #1 above.
[3:2]	RW	2'b00	Peripheral #3 config	See channel #1 above.
[1:0]	RW	2'b00	Peripheral #4 config	See channel #1 above.

VIP Upstream DMA Control Register #1

Register 24'h34004C—VIPU_DMA_CTRL1

Bits	Type	Default	Name	Description
[23:0]	RW	24'hxxxxxx	VIPU_DST_ADDR	VIP upstream IPB DMA Destination address.

VIP Downstream DMA Control Register #2

Register 24'h340050—VIPD_DMA_CTRL2

Bits	Type	Default	Name	Description
[23:0]	RW	24'hxxxxxx	VIPD_SRC_ADDR	VIP downstream IPB DMA source address.

VIP Downstream DMA Control Register #3

Register 24'h340054—VIPD_DMA_CTRL3

Bits	Type	Default	Name	Description
[11:0]	RW	12'hxxx	VIP_LNGTH	VIP downstream transfer count in bytes.

VIP Downstream DMA Control Register #4

Register 24'h340058—VIP_BURST_LENGTH

Bits	Type	Default	Name	Description
[15:8]	RW	8'hFF	VIPU_BURST_LNGTH	VIP Maximum Upstream burst length in terms of vip data cycles. This value entered here should depend upon vip mode (1x, 2x,4x) 1x = 1byte/data cycle, 2x = 2 bytes/data cycle…
[7:0]	RW	8'hFF	VIPD_BURST_LNGTH	Maximum burst length for Downstream transfers.

VIP Interrupt Control Register

Register 24'h34C05C—VIP_INTR_CTRL

Bits	Type	Default	Name	Description
[1]	RW	1'b0	VIP_intr_type	Level or Edge sensitive interrupt. 0 = level sensitive 1 = edge sensitive
[0]	RW	1'b0	VIP_intr_polarity	Interrupt polarity. 0 = active low 1 = active high

VIP Terminate Register

Register 24’h340060—VIP_XFER_TERMINATE

Bits	Type	Default	Name	Description
[14:5]	RW	10’h3FF	P1_retry_limit	This caps off how many retries will be attempted to a vip slave on a target read or write.
[4]	WO	1’b1	VIP_system_rst	Software controllable reset for the entire vip subsystem. (VIP Clock Domain Only) Writing a 0 will cause a reset pulse to the VIP block.
[3]	WO	1’b1	VIP_core_rst	Software controllable reset for the vip core. Writing a 0 will cause a reset pulse to the ISI block.
[2]	WO	1’b0	Terminate_ch1	Writing a one to this register will cause the vip transfer state machine for the register r/w channel to be reset.
[1]	WO	1’b0	Terminate_ch2	Writing a one to this register will cause the vip transfer state machine for the downstream DMA channel to be reset.
[0]	WO	1’b0	Terminate_ch3	Writing a one to this register will cause the vip transfer state machine for the upstream DMA channel to be reset.

VIP Interrupt Mask

Register 24’h200080—VIP_INT_MSK

Bits	Type	Default	Name	Description
[21:0]	RW	22’b0	VIP_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the VIP_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

VIP Interrupt Status

Register 24'h200084—VIP_INT_STAT

Bits	Type	Default	Name	Description
[21]	RR	1'b0	VIP_TM_OUT	Set when a time out occurs during a VIP transfer.
[20]	RR	1'b0	VIP_EXT	Set when the VIP external interrupt signal is asserted.
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/ unused opcode in the instruction sequence.
[13]	RR	1'b0	UP_SYNC	Set when number of lines or bytes do not match the upstream VIP RISC program expectations.
[12]	RR	1'b0	DN_SYNC	Set when number of lines or bytes do not match the downstream VIP RISC program expectations.
[9]	RR	1'b0	UPF_UF	Set when upstream VIP FIFO underflow condition is being handled.
[8]	RR	1'b0	DNF_OF	Set when downstream VIP FIFO overflow condition is being handled.
[5]	RR	1'b0	UP_RISCI2	Set when the IRQ2 bit in a upstream VIP RISC instruction is set.
[4]	RR	1'b0	DN_RISCI2	Set when the IRQ2 bit in a downstream VIP RISC instruction is set.
[1]	RR	1'b0	UP_RISCI1	Set when the IRQ1 bit in a upstream VIP RISC instruction is set.
[0]	RR	1'b0	DN_RISCI1	Set when the IRQ1 bit in a downstream VIP RISC instruction is set.

VIP Interrupt Masked Status

Register 24'h200088—VIP_INT_MSTAT

Bits	Type	Default	Name	Description
[21:0]	RO	22'b0	VIP_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

VIP Interrupt Set Status

Register 24’h20008C—VIP_INT_SSTAT

Bits	Type	Default	Name	Description
[16:0]	WO	17’b0	VIP_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

6.11 Memory Mapped Registers: Function 4: Host

IPB DMAC Current Buffer Pointer

Register 24'h3000A8—DMA31_PTR1

Register 24'h3000AC—DMA32_PTR1

Bits	Type	Default	Name	Description
[23:2]	RO	22'hxxxxxx	DMA{x}_PTR1	Current DMA qword address pointer. Points to next qword transfer location within source or destination buffer. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Current Table Pointer

Register 24'h3000E8—DMA31_PTR2

Register 24'h3000EC—DMA32_PTR2

Bits	Type	Default	Name	Description
[23:2]	RW*	22'hxxxxxx	DMA{x}_PTR2	Current DMA CDT address pointer. Points to current CDT entry. Always dword-aligned.
[1:0]	RO	2'b00		Reserved

IPB DMAC Buffer Limit

Register 24'h300128—DMA31_CNT1

Register 24'h30012C—DMA32_CNT1

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT1	Initialize to DMA buffer size in # of qwords. Increments during DMA data transfers and reloads when next CDT pointer is fetched.

IPB DMAC Table Size

Register 24'h300168—DMA31_CNT2

Register 24'h30016C—DMA32_CNT2

Bits	Type	Default	Name	Description
[10:0]	RW*	11'hxxx	DMA{x}_CNT2	Initialize to DMA CDT size in # of qwords.
NOTE:Writing DMA{x}_CNT2 registers (location 24'h300140_14C) causes the hardware to begin using the CDT information. It is imperative to perform this step only after initialization of the Cluster Description Table, Cluster Buffer Size, and CDT location.				

General Purpose Counter (Immediate Access)

Register 24'h38C020—HSTD_GP_CNT

Register 24'h38C024—HSTU_GP_CNT

Bits	Type	Default	Name	Description
[15:0]	RO	16'b0	{x}_GP_CNT	General purpose counter used by RISC program.

General Purpose Counter Control (Immediate Access)

Register 24'h38C030—HSTD_GP_CNT_CNTRL

Register 24'h38C034—HSTU_GP_CNT_CNTRL

Bits	Type	Default	Name	Description
[1:0]	WO	2'b00	{x}_GP_CNT_CNTRL	General purpose counter control used by RISC program: 00 = no change 01 = increment 10 = reserved 11 = reset to 0

Host Interface Streaming Enable (Immediate Access)

Register 24'h38C040—HST_STREAM_EN

Bits	Type	Default	Name	Description
[5]	RW	1'b0	HSTU_RISC_EN	RISC Controller enable for the host interface upstream DMA channel.
[4]	RW	1'b0	HSTD_RISC_EN	RISC Controller enable for the host interface downstream DMA channel
[1]	RW	1'b0	HSTU_FIFO_EN	Enable for pulling data out of the host upstream DMA fifo or cluster descriptor table.
[0]	RW	1'b0	HSTD_FIFO_EN	Enable for fetching downstream data from the external source.

Host Transfer Status Register (Immediate Access)

Register 24'h38C044—XFER_STATUS

Bits	Type	Default	Name	Description
[0]	RO	1'b0	Xfer_in_progress	Host transfer in progress signal. This may be used to determine when it is safe to access the host. This register returns a value immediately, thus it doesn't follow the delayed read rules.

Host Upstream DMA Control Register #1

Register 24'h380048—HSTU_DMA_CTRL1

Bits	Type	Default	Name	Description
[25]	RW	1'b0	UP_FIFO_HK_EN	Host upstream fifo handshake enable. This enables the CX23880 to monitor the External_fifo_busy bit and act accordingly.
[24]	RW	1'b0	HSTU_AINC_EN	Host upstream address auto-increment enable. Used to DMA data to sequential addresses within the slave device. Not to be used when the destination is a fifo.
[23:0]	RW	24'hxxxxxx	HSTU_DST_ADDR	HST upstream IPB DMA Destination address. If auto increment is enabled then the value loaded into this register should be the starting address.

Host Downstream DMA Control Register #1

Register 24'h38004C—HSTD_DMA_CTRL1

Bits	Type	Default	Name	Description
[25]	RW	1'b0	DN_FIFO_HK_EN	Host downstream fifo handshake enable. This enables the CX23880 to monitor the External_fifo_busy bit and act accordingly.
[24]	RW	1'b0	HSTD_AINC_EN	Host downstream address auto-increment enable. Used to DMA data to sequential addresses within the slave device. Not to be used when the destination is a fifo.
[23:0]	RW	24'hxxxxxx	HSTD_SRC_ADDR	HOST downstream IPB DMA source address. If auto increment is enabled then the value loaded into this register should be the starting address.

Host Downstream DMA Control Register #2

Register 24'h380050—HSTD_DMA_CTRL2

Bits	Type	Default	Name	Description
[11:0]	RW	12'b0	HST_LNGTH	HST downstream transfer count in bytes.

Host Wait-State Control

Register 24'h380054—HST_WSC

Bits	Type	Default	Name	Description
[31:28]	RW	4'h1	HST_W3W	Wait state control for external write cycles to chip select: HCS[3]#. Length of write cycle = (register value * bclk period)
[27:24]	RW	4'h1	HST_W2W	HCS[2] write cycle.
[23:20]	RW	4'h1	HST_W1W	HCS[1] write cycle.
[19:16]	RW	4'h1	HST_W0W	HCS[0] write cycle.
[15:12]	RW	4'h1	HST_W3R	Wait state control for external read cycles to chip select: HCS[3]#. Length of write cycle = (register value * bclk period)
[11:8]	RW	4'h1	HST_W2R	HCS[2] read cycle.
[7:4]	RW	4'h1	HST_W1R	HCS[1] read cycle.
[3:0]	RW	4'h1	HST_W0R	HCS[0] read cycle.

Host Transfer Control

Register 24'h380058—HST_XFER_CNTL

Bits	Type	Default	Name	Description
[15]	RW	1'b0	Hcs3_cs_hold	HCS[3] chip select hold time (15ns) relative to read or write enable (1 = On, 0 = Off)
[14]	RW	1'b0	Hcs2_cs_hold	HCS[2] chip select hold time
[13]	RW	1'b0	Hcs1_cs_hold	HCS[1] chip select hold time
[12]	RW	1'b0	Hcs0_cs_hold	HCS[0] chip select hold time
[11]	RW	1'b0	Hcs3_ds_polarity	External Data Strobe polarity for HCS[3](1 = positive 0 = negative) Motorola mode only.
[10]	RW	1'b0	Hcs2_ds_polarity	External Data Strobe polarity for HCS[2]
[9]	RW	1'b0	Hcs1_ds_polarity	External Data Strobe polarity for HCS[1]
[8]	RW	1'b0	Hcs0_ds_polarity	External Data Strobe polarity for HCS[0]
[7]	RW	1'b0	Hcs3_xfer_mode	External Transfer mode for HCS[3](we# and re# or r/w# and ds#) (intel(0) or Motorola(1)
[6]	RW	1'b0	Hcs2_xfer_mode	External Transfer mode for HCS[2]

Bits	Type	Default	Name	Description
[5]	RW	1'b0	Hcs1_xfer_mode	External Transfer mode for HCS[1]
[4]	RW	1'b0	Hcs0_xfer_mode	External Transfer mode for HCS[0]
[3]	RW	1'b0	Hcs2_sh_extend	External data setup and hold time extend for HCS[3] (0 = 1x bclk period 1 = 2x bclk period)
[2]	RW	1'b0	Hcs2_sh_extend	External setup and hold extend for HCS[2]
[1]	RW	1'b0	Hcs1_sh_extend	External setup and hold extend for HCS[1]
[0]	RW	1'b0	Hcs0_sh_extend	External setup and hold extend for HCS[0]

Host Interface Width

Register 24'h38005C—EXT_INTF_WIDTH

Bits	Type	Default	Name	Description
[3]	RW	1'b0	Ext_intf_width[3]	HCS3: (0): 16-bit (multiplexed), (1): 8-bit
[2]	RW	1'b0	Ext_intf_width[2]	HCS2: (0): 16-bit (multiplexed), (1): 8-bit
[1]	RW	1'b0	Ext_intf_width[1]	HCS1: (0): 16-bit (multiplexed), (1): 8-bit
[0]	RW	1'b0	Ext_intf_width[0]	HCS0: (0): 16-bit (multiplexed), (1): 8-bit

Host Peripheral Handshake

Register 24'h380060—HRDY_HANDSHAKE

Bits	Type	Default	Name	Description
[3]	RW	1'b0	Mstr_handshake[3]	HCS3 HRDY handshake enable bit
[2]	RW	1'b0	Mstr_handshake[2]	HCS2 HRDY handshake enable bit
[1]	RW	1'b0	Mstr_handshake[1]	HCS1 HRDY handshake enable bit
[0]	RW	1'b0	Mstr_handshake[0]	HCS0 HRDY handshake enable bit

Host Multiplexed 16-bit Xfer Parameters

Register 24'h380064—MUX16_PARAM

Bits	Type	Default	Name	Description
[31:28]	RW	4'b0001	HCS3_ale_timing	HCS3 Address Latch Enable timing (register value * bclk period) after HCS goes active
[27:24]	RW	4'b0001	HCS2_ale_timing	HCS2 Address Latch Enable timing
[23:20]	RW	4'b0001	HCS1_ale_timing	HCS1 Address Latch Enable timing
[19:16]	RW	4'b0001	HCS0_ale_timing	HCS0 Address Latch Enable timing
[15:12]	RW	4'b0010	HCS3_addr_cyc	HCS3 Address cycle width (register value * bclk period) setup time not included
[11:8]	RW	4'b0010	HCS2_addr_cyc	HCS2 Address cycle width
[7:4]	RW	4'b0010	HCS1_addr_cyc	HCS1 Address cycle width
[3:0]	RW	4'b0010	HCS0_addr_cyc	HCS0 Address cycle width

Host Chip Select Mode

Register 24'h380068—HCS_MODE_SEL

Bits	Type	Default	Name	Description
[0]	RW	1'b0	HCS_mode_sel	This bit selects between the two possible chip select modes: 0: 2-bit dedicated chip selects. For times when two or fewer devices are connected to the host port. 1: 2-bit encoded chip selects. For times when more than two devices are connected to the host port.

Host Software Reset

Register 24'h38C06C—HOST_SOFT_RST

Bits	Type	Default	Name	Description
[0]	WO	1'b0	HOST_SOFT_RST	Host Software Reset. Writing a one to this register triggers a reset of the host logic.

Host Interrupt Mask

Register 24'h200090—HST_INT_MSK

Bits	Type	Default	Name	Description
[19:0]	RW	20'b0	HST_INT_MSK	A value of 1 enables the corresponding interrupt bit location in the HST_INT_STAT register. Unmasking a bit may generate an interrupt immediately due to a previously pending condition. The interrupt remains asserted until the device driver clears or masks the pending request.

Host Interrupt Status

Register 24'h200094—HST_INT_STAT

Bits	Type	Default	Name	Description
[19]	RR	1'b0	PCI_ABORT	Set when the PCI master does a master-abort, or a target responds with a target-abort.
[18]	RR	1'b0	RIP_ERR	Set when a data parity error is detected (parity error response must be set while the master is reading RISC instructions.
[17]	RR	1'b0	PAR_ERR	Set when a parity error is detected on the PCI bus for any of the transactions, R/W, address/data phases, master/target, regardless of the parity error response bit.
[16]	RR	1'b0	OPC_ERR	Set when the RISC controller detects a reserved/ unused opcode in the instruction sequence.
[13]	RR	1'b0	UP_SYNC	Set when number of lines or bytes do not match the upstream host RISC program expectations.
[12]	RR	1'b0	DN_SYNC	Set when number of lines or bytes do not match the downstream host RISC program expectations.
[9]	RR	1'b0	UPF_UF	Set when upstream host FIFO underflow condition is being handled.
[8]	RR	1'b0	DNF_OF	Set when downstream host FIFO overflow condition is being handled.
[5]	RR	1'b0	UP_RISCI2	Set when the IRQ2 bit in a upstream host RISC instruction is set.
[4]	RR	1'b0	DN_RISCI2	Set when the IRQ2 bit in a downstream host RISC instruction is set.
[1]	RR	1'b0	UP_RISCI1	Set when the IRQ1 bit in a upstream host RISC instruction is set.
[0]	RR	1'b0	DN_RISCI1	Set when the IRQ1 bit in a downstream host RISC instruction is set.

Host Interrupt Masked Status

Register 24'h200098—HST_INT_MSTAT

Bits	Type	Default	Name	Description
[19:0]	RO	20'b0	HST_INT_MSTAT	These bits are the logical AND of the corresponding bits in the status and mask registers.

Host Interrupt Set Status

Register 24'h20009C—HST_INT_SSTAT

Bits	Type	Default	Name	Description
[16:0]	WO	17'b0	HST_INT_SSTAT	Writing a 1 to these bits will set the corresponding bits in the status register.

7 Electrical and Mechanical Specifications

7.1 DC Electrical Parameters

The DC electrical parameters are specified in Tables 7-1 through 7-3.

Table 7-1. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
I/O Power Supply	VDDIO	3.135	3.3	3.465	V
Core Power Supply	VDD, VPP	1.71	1.8	1.89	V
PCI I/O High Voltage Clamp Supply	VIO	3.0	—	5.5	V
Input Voltage Low	V_{IL}	–0.5	—	0.8	V
Input Voltage High	V_{IH}	2.0	—	VDDIO +0.3	V
Output Voltage Low	V_{OL}	0.0	—	0.4	V
Output Voltage High	V_{OH}	2.4	—	VDDIO	V
MUX0, MUX1, MUX2, and MUX3 Input Range (AC coupling required)	—	0.5	0.8	2.5	V
C_{IN} Amplitude Range (AC coupling required)	—	0.5	0.8	2.5	V
Audio Input Range (AC coupling required)	—	0.1	0.8	2.5	Vp–p
Audio Output Range R_{Load} = 500Ω	—	—	2	—	Vp–p
Ambient Operating Temperature	TA	0	—	+70	°C

Table 7-2. Absolute Maximum Ratings

Parameter		Symbol	Min	Max	Units
VAA (measured to AGND)		TBD	—	5.0	V
VDD (measured to GND)		TBD	—	3.0	V
VDDIO I/O Supply		VDDIO	—	5	V
VIO PCI 5V Clamp ref		VIO	—	6	V
Voltage on any Signal Pin[1]	PCI pins	—	AGND – 0.5	VIO +0.5	V
	Non-PCI pins	—	DGND – 0.5	VDDIO + 0.5	V
Analog Input Voltage		—	TBD	VAA + 0.5	V
Ambient Operating Temperature		TA	0	+70	°C
Storage Temperature		TS	–65	+150	°C
Junction Temperature		TJ	—	+125	°C
Vapor Phase Soldering (15 seconds)		TVSOL	—	+220	°C

NOTE:Stresses above those listed may cause permanent damage to the device. This is a stress rating only, and functional operation at these or any other conditions above those listed in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE:This device employs high-impedance CMOS devices on all signal pins. It must be handled as an ESD-sensitive device. Voltage on any signal pin that exceeds the power supply voltage by more than +0.5 V or drops below ground by more than +0.5 V can induce destructive latchup.

FOOTNOTE:

(1) These ratings are relative to operating condition power supply voltages.

Table 7-3. DC Characteristics

Parameter	Symbol	Min	Typ	Max	Units
Digital Inputs					
PCI Inputs					
Input High Voltage (TTL)	V_{IH}	2.0	—	VIO + 0.5	V
Input Low Voltage (TTL)	V_{IL}	–0.5	—	0.8	V
GPIO Input					
Input High Voltage	V_{IH}	2.0	—	VDDIO + 0.5	V
Input Low Voltage	V_{IL}	DGND– 0.5	—	0.8	V
Serial Bus Input					
Input High Voltage	V_{IH}	0.7 * VDDIO	—	VDDIO + 0.5	V
Input Low Voltage	V_{IL}	DGND – 0.5	—	0.3 * VDDIO	V
Input Capacitance (f = 1 MHz, V_{IN} = 2.4 V)	C_{IN}	—	TBD	—	pF
Digital Outputs					
PCI Outputs					
Output High Voltage (I_{OH} = –2 mA)	V_{OH}	2.4	—	—	V
Output Low Voltage (I_{OL} = 6 mA)	V_{OL}	—	—	0.55	V
GPIO					
Output High Voltage (I_{OH} = –1.2 mA)	V_{OH}	2.4	—	—	V
Output Low Voltage (I_{OL} = 6 mA)	V_{OL}	—	—	0.4	V
Three-State Current	I_{OZ}	—	—	10	µA
Output Capacitance	C_O	—	TBD	—	pF
Serial Bus Output					
Output Low Voltage (IOL = 3 mA)	V_{OL}	—	—	0.4	V
Analog Pin Input Capacitance	C_A	—	TBD	—	pF

7.2 AC Electrical Parameters

AC electrical parameters are specified in Tables 7-4 through 7-7. Timing diagrams for clock, GPIO, and JTAG are provided in Figures 7-1 and 7-2. (See also Figure 3-5 and Table 3-4.)

Table 7-4. Clock Timing Parameters

Parameter	Symbol	Min	Typ	Max	Units
8 × NTSC Fsc Rate (50 ppm source required)	FS	28.63493	28.63636	28.63779	MHz
XTI Input:					
Cycle Time	1	—	34.92	—	ns
High Time	2	14	—	—	ns
Low Time	3	14	—	—	ns

Figure 7-1. Clock Timing Diagram (TBD)

Table 7-5. Power Supply Current Parameters

Parameter	Symbol	Min	Typ	Max	Units
Core Logic Current: TA = 25 °C, VDD, VDP = 1.8 V	IDD + IPP	TBD	150	TBD	mA
I/O Current: TA = 25 °C, VDDIO = 3.3 V	IDDIO	TBD	60	TBD	mA
Analog Current: TA = 25 °C, VAA = 3.3 V	IAA	TBD	200	TBD	mA

Table 7-6. JTAG Timing Parameters

Parameter	Symbol	Min	Typ	Max	Units
TMS, TDI setup time	10	—	2	—	ns
TMS, TDI hold time	11	—	2	—	ns
TCK asserted to TDO valid	12	—	15	—	ns
TCK asserted to TDO driven	13	—	14	—	ns
TCK negated to TDO three-stated	14	—	85	—	ns
TCK low time	15	25	—	—	ns
TCK high time	16	25	—	—	ns

Figure 7-2. JTAG Timing Diagram

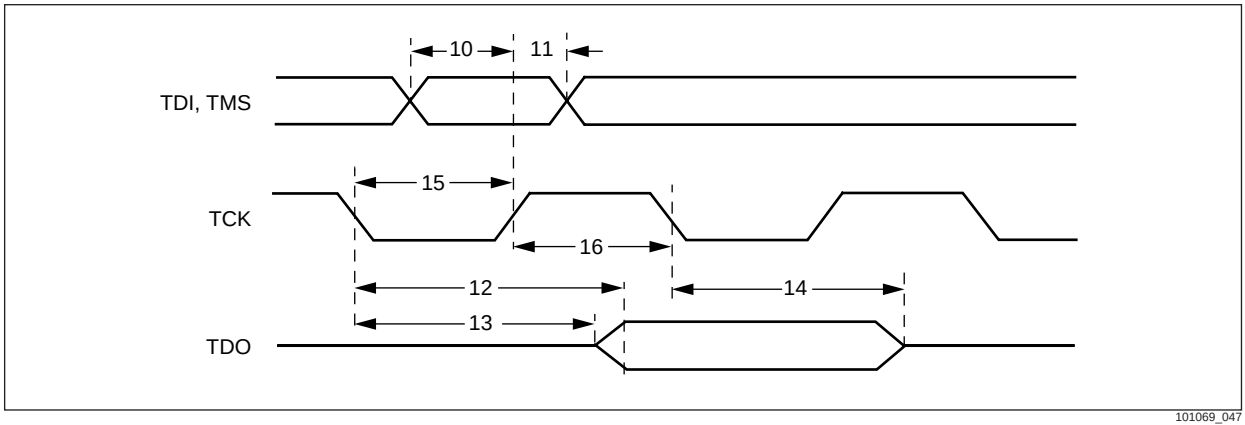


Table 7-7. Decoder Performance Parameters

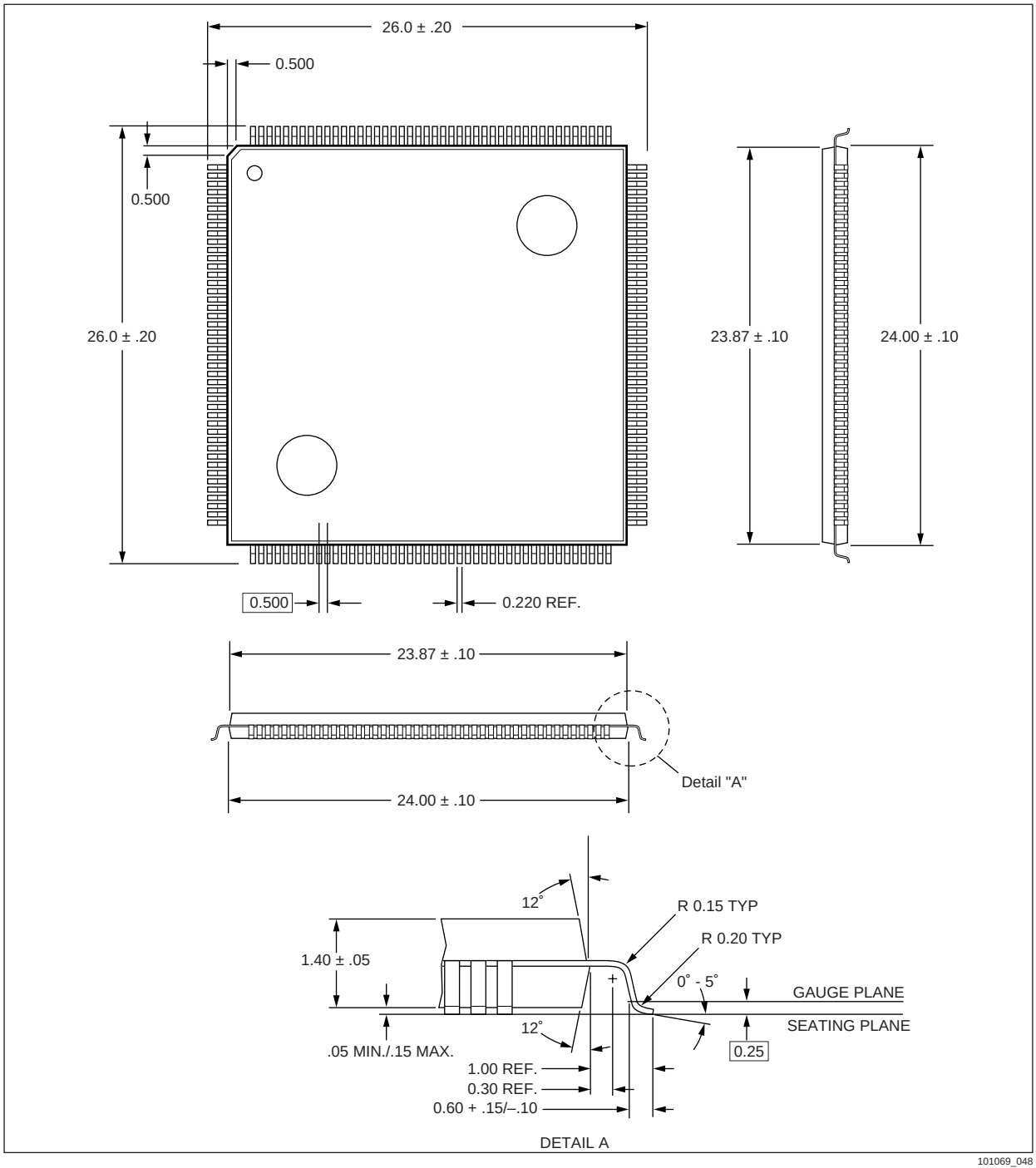
Parameter	Symbol	Min	Typ	Max	Units
Horizontal Lock Range	—	—	—	±7	% of Line Length
Fsc, Lock-in Range	—	±800	—	—	Hz
Gain Range	—	–6	—	6	dB

NOTE:Test conditions (unless otherwise specified): "Recommended Operating Conditions." TTL input values are 0–3 V, with input rise/fall times ≤ 3 ns, measured between the 10% and 90% points. Timing reference points at 50% for digital inputs and outputs. Pixel and control data loads ≤ 30 pF and ³ 10 pF. GPCLK load ≤ 50 pF. See PCI Specification, Revision 2.2, for PCI timing parameters.

7.3 Package Mechanical Drawing

Figure 7-3 provides a mechanical drawing of the 176-pin Thin Quad Flat Pack (TQFP) package.

Figure 7-3. 176-pin TQFP Package Mechanical Drawing



A

Abbreviations and Acronyms

The acronym list does not include names of pins, registers, or bits.

A/D	Analog-to-Digital
ACGC	Automatic Chrominance Gain Control
ACK	Acknowledge
ACPI	Advanced Configuration and Power Interface
ADC	Analog-to-Digital Converter
AF	Audio Frequency
AFC	Automatic Frequency Control
AFE	Audio Front End
AGC	Automatic Gain Control
ASCII	American Standards Code for Information Interchange
ATSC	Advanced Television Standards Committee
BER	Bit Error Rate
BIOS	Basic Input/Output System
BSDL	Boundary Scan Descriptive Language
BTSC	Broadcast Television System Committee
BTSC-MTS	Broadcast Television Systems Committee-Multichannel Television Sound
C-ADC	Chroma-Analog-to-Digital Converter
CCIR 601	[A Recommendation From The International Radio Communications Committee]
CDT	Cluster Descriptor Table
CIF	Common Interchange Frequency (or Form)
CMOS	Complementary Metal-Oxide Semiconductor
codec	coder/decoder
COFDM	Coded Orthogonal Frequency Division Multiplexing
CPU	Central Processing Unit
DAC	Digital-to-Analog Converter
DAP	Digital Audio Packetizer
DBS	Direct Broadcast Satellite
DDF	Digital Decimation Filter
DIF	Digital Interconnect Format
DMA	Direct Memory Access
DMAC	DMA Controller
DTV	Digital Television
DVB	Digital Video Broadcasting
DVD	Digital Video Disk
dword	double word
EEPROM	Electrically Erasable Programmable Read-Only Memory

EIAJ	Electronic Industries Association of Japan
EMI	Electromagnetic Interference
EOL	End-Of-Line
ESD	Electrostatic Discharge
FAE	Field Applications Engineer
FAFULL	FIFO Almost Full
FIFO	First In, First Out
FM	Frequency Modulation
fps	Frames Per Second
Fsc	Frequency, Subcarrier
GFX	Graphics Controller
GPHP	General Purpose Host Port
GPIO	General Purpose Input/Output
GPOE	General Purpose Output Enable
HDTV	High Definition Television
HTML	Hypertext Markup Language
HW	Hardware
I^2C Compatible	Inter-integrated Circuit
IC	Integrated Circuit
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
I^2S	Inter-IC Sound
INT	Integer
IPB	Internal Peripheral Bus
IRE	Institute of Radio Engineers
ISB	Internal System Bus
ITU	International Telecommunications Union
JTAG	Joint Test Action Group
KB	Kilo Bytes
LPF	Low Pass Filter
LSB	Least Significant Bit
LSByte	Least Significant Byte
LVTTL	Low Voltage Transistor-to-Transistor Logic
MIC	Microphone
MPEG	Motion Picture Experts Group
MPU	Microprocessing Unit
MSB	Most Significant Bit
MSByte	Most Significant Byte
MUX	Multiplexer
NACK	Negative Acknowledgement
NICAM	Near Instantaneously Companded Audio Multiplex
NTSC	National Television Standards Committee (an American video standard)
Opcode	Operational Code
OS	Operating System
PAL	Phase Alternate Line (a European video standard)
PCB	Printed Circuit Board

PCI	Peripheral Component Interface (or Interconnect)
PCM	Pulse Code Modulation
PLL	Phase Lock Loop
PME	Power Management Event
POST	Power-On Self Test
PQFP	Plastic Quad Flat Pack
PWM	Pulse Width Modulator
QAM	Quadrature Amplitude Modulation
QCIF	Quarter Common Intermediate Format
QPSK	Quarternary Phase Shift Keying
qword	quarternary word
R/W	Read/Write
RC	Resister-Capacitor
RGB	Red, Green, Blue (Display)
RGB	Red, Green, Blue
RISC	Reduced Instruction Set Computer
SAP	Service Access Port
SCL	Serial Clock
SDA	Serial Data
SECAM	*Systeme Electronique Couleur Avec Memoire* (a European video standard)
SECAM	[A European video standard]
SIG	Special Interest Group
SNR	Signal-to-Noise Ratio
SOL	Start-Of-Line
SP	Sony-Phillips
SPI	Synchronous Pixel Interface
SRAM	Static RAM
SW	Software
sync	synchronizing signal
TAP	Test Access Port
TQFP	Thin Quad Flat Pack
TTL	Transistor-Transistor Logic
TV	Television
VBI	Vertical Blanking Interval
VCR	Videocassette Recorder
VDFC	Video Data Format Conversion
VESA	Video Electronics Standards Association
VFE	Video Front End
VGA	Variable Graphics Array
VHMI	VIP 2.0 Host Master Interface
VIP	Video Interface Port
VITC	Vertical Interval Time and Control
VPD	Vital Product Data
VTC	Video Timing Controller
Y/C	Luminance/Chrominance
YUV	Luminance, Chrominance, and Saturation

www.conexant.com
General Information:
U.S. and Canada: (800) 854-8099
International: (949) 483-6996
Headquarters – Newport Beach
4311 Jamboree Rd.
Newport Beach, CA. 92660-3007

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