

## FEATURES

- Reference Design for Evaluating the CS4610 & CS423xB PCI/ISA Audio Solution
- 32-Bit, 5V, PCI Add-in Card Includes circuitry for six channel audio output.
- Interfaces with the CrystalClear™ CRD423xB ISA reference design.
- Minimal layout area required, approximately 1.3in<sup>2</sup>
- Features CS4610 PCI Audio Accelerator
  - PCI Based 300 MIPS (800MOPS), Dual Harvard DSP core with efficient scatter-gather DMA controller.
  - Multiple audio stream mixing and sample rate conversion for 2D and 3D positional audio data.
  - Accelerates DirectSound®, DirectSound3D®, DirectShow® and Aural A3D™ API's
  - Dolby® Digital (AC-3®) decoding with 5.1 Channel output virtualized on two channels or discrete 6 channel output
  - Concurrent wavetable synthesis with chorus and reverb effects processing.

## DESCRIPTION

The CRD4610-2 is a 4 layer, PCI 2.1 compliant add-in card. It is designed to be used in conjunction with a CRD423xB-8 ISA CODEC reference design in order to evaluate the CS4610/CS423xB multimedia audio solution. An on-board header and supplied cable allow a digital data link with the

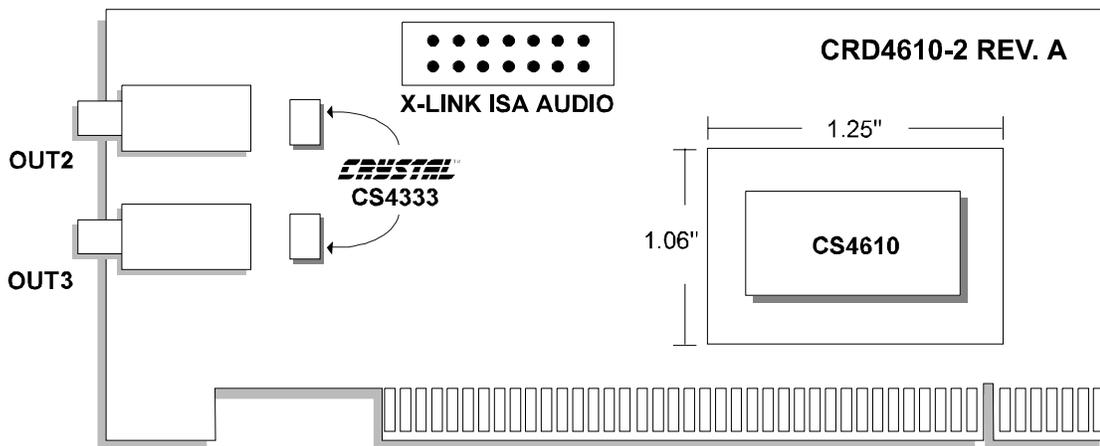
**ORDERING INFO**  
CRD4610-2

**CrystalClear™**  
**CS4610 PCI to ISA Link**  
**Motherboard Audio**  
**Reference Design**

ISA based CS423xB-8. The CS423xB provides DOS legacy support and analog input/output while the CS4610 executes hardware acceleration of digital audio mixing and sample rate conversion, 3D positional processing, wavetable synthesis and more.

The CS4610 is a PCI 2.1 compliant, audio accelerator. The CS4610's 300 MIPS, dual Harvard based DSP core and efficient scatter-gather DMA controller are optimized for digital audio processing. The standard driver set for the CS4610 includes binary DSP code for 3D audio positioning, support for hardware acceleration of Windows 95® DirectSound®, DirectSound3D®, DirectShow® and Aural A3D™ API's, support for Dolby® Digital (AC-3®) decoding and a concurrent General MIDI compliant wavetable synthesizer. A host RAM based sample set is also supplied.

The CS4610 may also be used as an AC'97 controller, refer to the CRD4610-1 data sheet for an example of CS4610 operation with the CrystalClear™ CS4297 AC-97 CODEC.



## OVERVIEW

The CRD4610-2 PCI Add-in card is designed to operate in conjunction with a CRD423xB-8 ISA add-in card. Headers on the PCI based CRD4610-2 and the ISA based CRD423xB-8 allow digital data transfer through a bi-directional serial link between the two devices via a ribbon cable. This link also allows MIDI messages to be passed from the CS423xB to the CS4610.

In the Windows 95 environment, a MIDI stream and a number of simultaneous audio streams from Windows 95 applications may be sent to the CS4610 over the PCI bus. The CS4610 performs hardware accelerated audio stream mixing and processing, including sample rate conversion, 3D positional audio processing, wavetable synthesis and Dolby Digital (AC-3) decode, then sends the output stream over the digital audio link to the CS423xB. The CS423xB performs the digital to analog conversion (DAC) for this digital audio output stream and also provides multiple analog audio inputs, analog mixing, Analog-to-Digital Conversion (ADC), standard joystick inputs and external MIDI interface.

In the native DOS environment, the CS423xB provides legacy games compatibility in hardware. DOS applications may directly address the ISA-based CS423xB register set for Sound Blaster and Sound Blaster Pro compatibility. The CS423xB codec also provides an MPU-401 interface in native DOS. In this environment the codec transfers serial MIDI data to the CS4610 over the serial link and the CS4610 performs the wavetable synthesis function, sending the synthesized audio back to the CS423xB via the digital link.

## SYSTEM DESCRIPTION

### CS4610

The CS4610, a PCI 2.1 compliant device, is a bus mastering, 300 MIPS DSP optimized for audio signal processing. An efficient on-chip DMA control-

ler and stream processor DSP core provide a number of signal processing functions including:

- Hardware acceleration for Windows 95 DirectSound, DirectSound3D, DirectShow and Aureal A3D API's
- 3-D positional processing for DirectSound3D API calls using HRTF-based 3D algorithms
- Mixing and sample rate conversion for multiple concurrent 2D and 3D digital audio streams
- Concurrent General MIDI compliant, wavetable synthesis with chorus and reverb effects processing.
- Dolby Digital (AC-3) 5.1 channel decoding which can be output on 6 channels or virtualized on two channels.

For more detailed information on the CS4610, please refer to the CS4610 product data sheet.

### CS4610 PCI Interface Resources

#### Interface Requirements

The CS4610 is a PCI revision 2.1 compliant, bus mastering device, and presents a single PCI bus load to the system. The device requires a single PCI interrupt, (INTA# pin on CS4610) which must be connected to the system interrupt controller.

#### Device Configuration

Device configuration is accomplished through standard PCI-compliant methods. The Subsystem ID and Subsystem Vendor ID can be programmed at boot-up by writing the appropriate data to the CS4610 SSVID register. In a mother board application, this may be accomplished using either a host load procedure or an optional on-board EEPROM. Add-in cards will require an on-board EEPROM.

Similarly, the CS4610 can be programmed at boot-up to operate in one of four different modes by writing configuration data to CS4610 configuration load registers, CFL1 and CFL2. By default, the CS4610 is configured to enable communication

with the CS423xB, CFL=0h and CFL2=0h. If 6 channel output is required (x-link expanded mode) the CS4610 configuration registers CFL1 and CFL2 must be loaded with 4h and 0h respectively. Additionally, the CS4610 can be configured to operate independently or as an AC-97 controller. For more details on CS4610 configuration, please refer to the CS4610 data sheet and the software installation guide.

### *Host Memory Space*

The CS4610 memory space requirements consist of one 4KB block of memory for command/status access and one 1MB block of memory for accessing the CS4610 Stream Processor (SP) memory. These two memory blocks can be located anywhere in host memory space, as allocated by the system's plug and play resource manager.

### *Configuration EEPROM*

Following a hardware reset, the CS4610 checks for the existence of an EEPROM and if detected, the EEPROM memory is read. The EEPROM contains the values for the CS4610 configuration load registers as well as Subsystem ID and Subsystem Vendor ID values required for the PCI configuration space. An I2C interface is used to download data in the EEPROM to the CS4610. A utility, pcirsrc.exe, is supplied to program the EEPROM with correct configuration, Subsystem ID and Subsystem Vendor ID data.

If the CS4610 is implemented on a mother board, an external EEPROM is not required for proper operation as a host load procedure may be used for configuration. However, silicon revisions rev. C and prior must use an EEPROM if a unique Subsystem ID is required. This is due to an errata which causes the upper byte of the subsystem vendor ID to be duplicated in the subsystem ID field during host load to the SSVID register.

It is recommended that an EEPROM be used during system development to allow debug and con-

figuration changes without having to modify BIOS code. If host load will be used in production, the EEPROM circuitry can be left unpopulated.

### *Power Requirements*

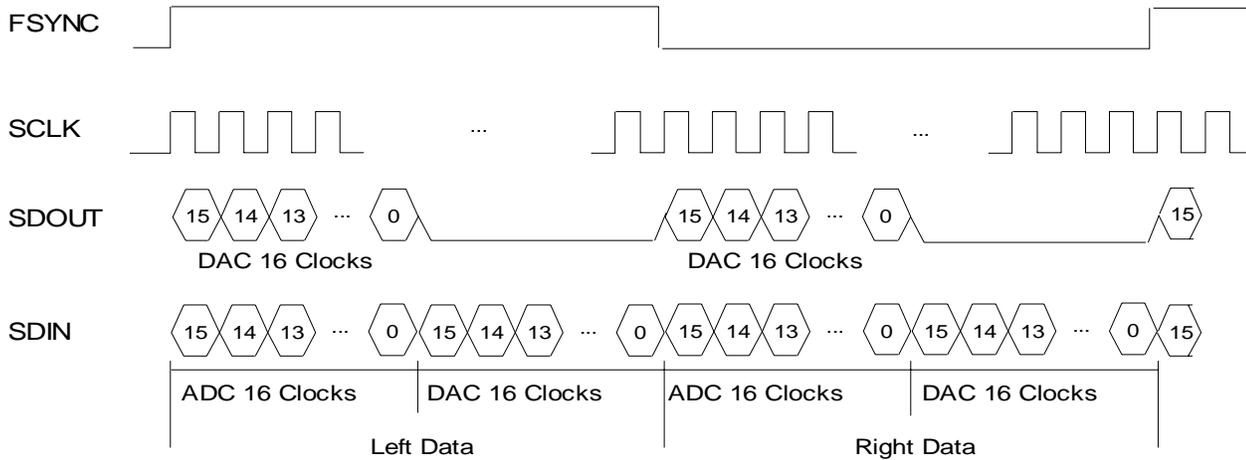
3.3V power for the CS4610 is derived from the +5V on the PCI connector and regulated to +3.3V using a Linear Technology LT11173 Voltage Regulator. The maximum current requirement for the +3.3V power supplies is 500mA with typical operating currents in the 200-300mA range during audio processing tasks.

### *Auxiliary Analog Output*

In the x-link configuration, the ISA based CS423xB provides a stereo (two channels) audio output capability for the CS4610 primary output stream (ASDOUT). However, the CS4610 has the capability to output 4 additional channels of digital audio data using two auxiliary output pins. The CRD4610-2 includes circuitry necessary to support these additional output channels.

Two CS4333 DACs are used to convert the additional 4 channels of digital audio from CS4610 pins SDO2 and SDO3. Stereo, 1/8" jacks output line level, 1.2Vrms signals to an amplifier stage or powered speakers with a minimum load of 10kΩ. The OUT2 jack, J2, outputs the converted audio data from the SDO2 output pin while the OUT3 jack, J3, outputs converted audio data from the SDO3 pin. Power, +5V, for the CS4333 DACs is sourced from the +12V pin on the PCI connector and regulated to +5V output by a Linear Technology LT1121-5. The maximum total current requirement for the two DACs is 64mA with typical currents of approximately 50mA.

Dolby Digital (AC-3) program material may provide six channels of audio information corresponding to a left, right, center, left surround, right surround, and sub-woofer speaker configuration (Dolby Digital (AC-3) is often referred to as a "5.1 channel" system because the sub-woofer is a re-



**Figure 1. CS4610/CS423xB Serial Link Format**

duced bandwidth channel). In CS4610 expanded x-link mode, the auxiliary analog output circuitry can be used to output the additional 4 channels of decoded Dolby Digital (AC-3) program material. While the x-link header, J1, provides the main left and right channels to the CS423xB-8 add-in card, the CRD4610-2 jack, J2, provides output for the left surround and right surround channels and J3 supplies center channel on the tip and sub-woofer channel on the ring. Please refer to Figure 3, "CRD4610-2 Auxiliary Analog Output"

### **CS4610 Software**

All required drivers are supplied for operation under Windows 95 OSR2. The drivers are DirectX® compatible and include binary DSP code for DirectSound3D® positioning, and wavetable synthesis. A host RAM based sample set for wavetable synthesis is also supplied.

The CRD4610-2 is supplied with a utility, pcirsrc.exe, to program the on-board EEPROM with appropriate configuration data. Please see the documentation supplied with the pcirsrc.exe program.

### **CS4610 and CS423xB Serial Link**

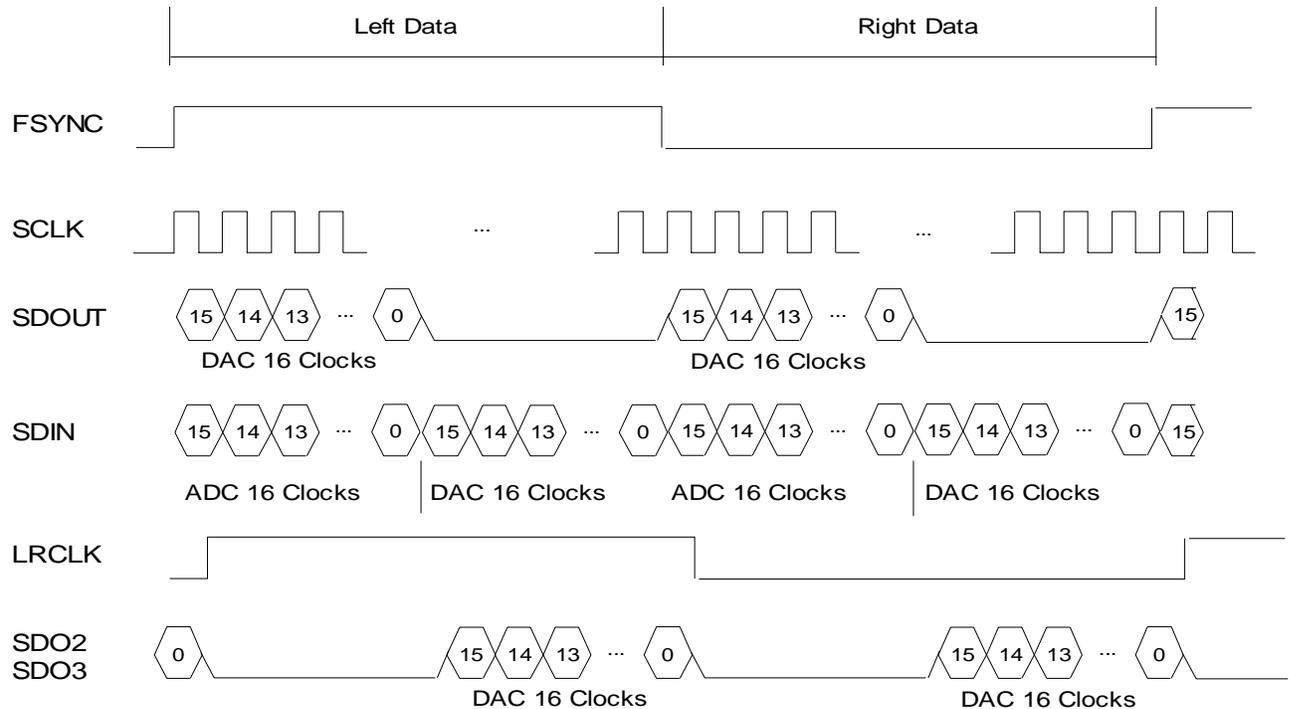
#### **X-link Mode**

A direct cable connection to the CRD423xB-8 ISA

reference design is implemented using a ribbon cable connected to a 14 pin header, J1, on the CRD4610-2. In the default serial communications mode (x-link mode), the CS423xB is the timing master and provides a 2.822 MHz bit clock, SCLK, signal and a 44.1 kHz Frame Sync, FSYNC, to the CS4610. The timing format for the serial link in x-link mode is shown in Figure 1, "CS4610/CS423xB Serial Link Format". Digital audio data, SDOUT, is output to the CS423xB, via header J1, on ASDOUT pin of the CS4610 at 44.1 kS/s. The CS4610 accepts digital data, SDIN, from the CS423xB, via header J1, on ASDIN pin of the CS4610. Please refer to Figure 4, "CS4610 Connections" in the schematics section for CS4610/CS423xB interface connections.

#### **Expanded X-link Mode**

Six channel audio output is enabled by configuring the CS4610 to operate in the expanded x-link mode. In this mode an additional 4 audio channels are output on CS4610 SDO2 and SDO3 pins along with left/right clock on the CS4610 LRCK pin. These signals, along with a 16.9344MHz master clock from the CS423xB are routed to two CS4333 DACs to provide an additional 4 channels of analog audio output. This mode can be used to provide a full 5.1 channel Dolby Digital (AC-3) decoded out-



**Figure 2. CS4610/CS423xB Serial Link in Expanded X-link Mode**

put. Refer to Figure 2, "CS4610/CS423xB Serial Link in Expanded X-link Mode" for the timing format for this configuration.

### *Independent Mode*

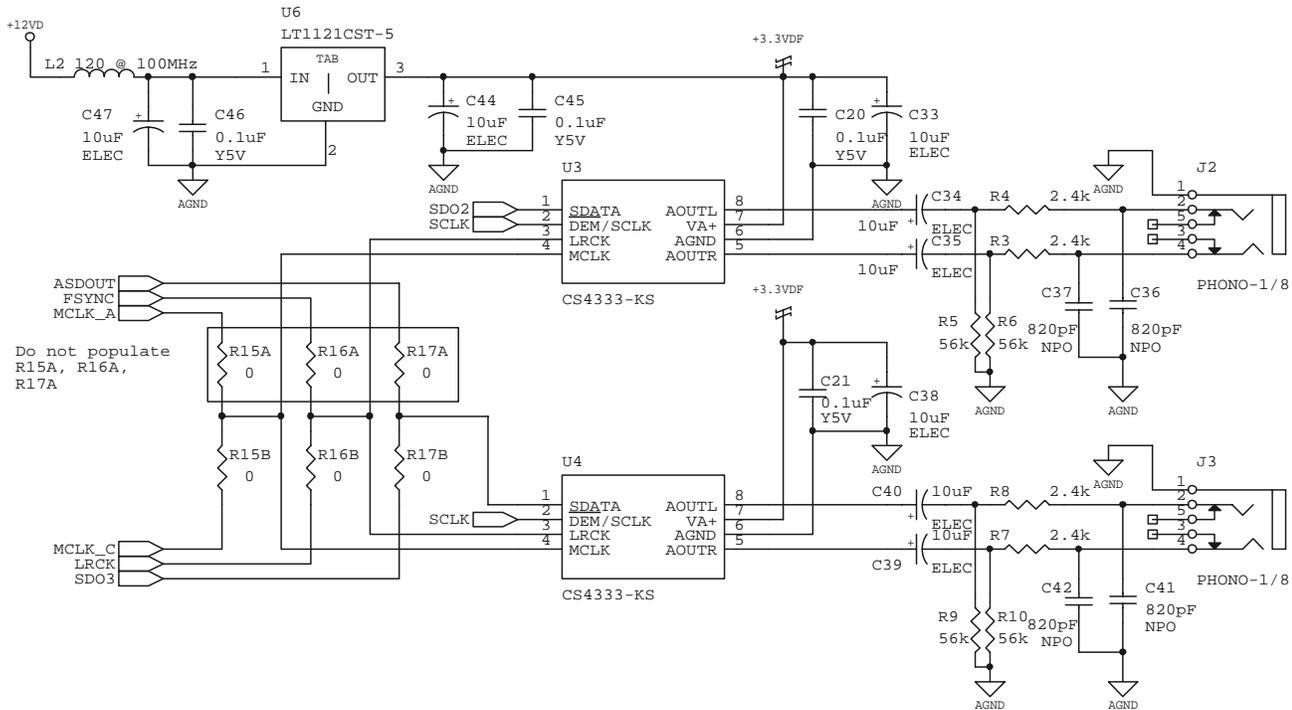
The CRD4610-2 can be configured to operate as a stand alone card. Independent mode configuration is accomplished by making a resistor stuff option modification and by programming the EEPROM with the correct data to load CS4610 CFL1 with 06h. The 06h value in the CS4610 Configuration Load Register 1, CFL1, will put the CS4610 into independent operation mode. The CS4610 will be clocked using the external crystal and CS4610 crystal oscillator. The x-link cable must be disconnected in this configuration or the card will not function properly. Three zero ohm resistors, R15B, R16B and R17B must be moved to the R15A, R16A and R17A positions. This will reroute the ASDOUT, MCLK and LRCLK lines to the

CS4333 labeled U4 and output audio data on J3. Note that this mode does not provide DOS games compatibility. Currently, the driver software supplied with the CS4610 contains no mixer support for independent mode operation.

### **Board Layout**

The CRD4610-2 add-in card follows the requirements of the PCI 2.1 specification section 4.4.3 which defines specific limits on trace lengths and signal characteristics as follows.

- Maximum trace length for all 32-bit interface signals is 1.5" with the exception of CLK, RST# and INT traces.
- The trace length for PCI CLK signal is 2.5" ±0.1" and must be routed to only one load.
- All traces are controlled impedance to 75Ω



**Figure 3. CRD4610-2 Auxiliary Analog Output**

Decoupling caps are placed as close to their appropriate pins as possible with traces connected directly to the pins.

The CS4333 DACs and all associated analog circuitry have been isolated over a separate power and ground plane to avoid conductive noise coupling from the noisy digital environment. Output traces have been made as short as possible. The analog and digital Ground planes are connected at a single point near the DACs.

Note that for a mother board implementation, the Crystal, Voltage regulator, and EEPROM circuitry are not required. When these components are removed, the CS4610 pins XTALI, XTALO, EECLK, and EEDAT should be pulled to +3.3VDF through a 100kΩ pull-up resistor. Please refer to Cirrus Logic application note AN108, “A Desktop

PC Audio Design Using the CS4610 and CS4236B” for further details on motherboard design implementation. Refer to PCI 2.1 specification section 4.6 for motherboard layout recommendations.

## Schematic & Layout Review Service

**Confirm Optimum Schematic & Layout Before Building Your Board.**

**For Our Free Review Service Call Applications Engineering.**



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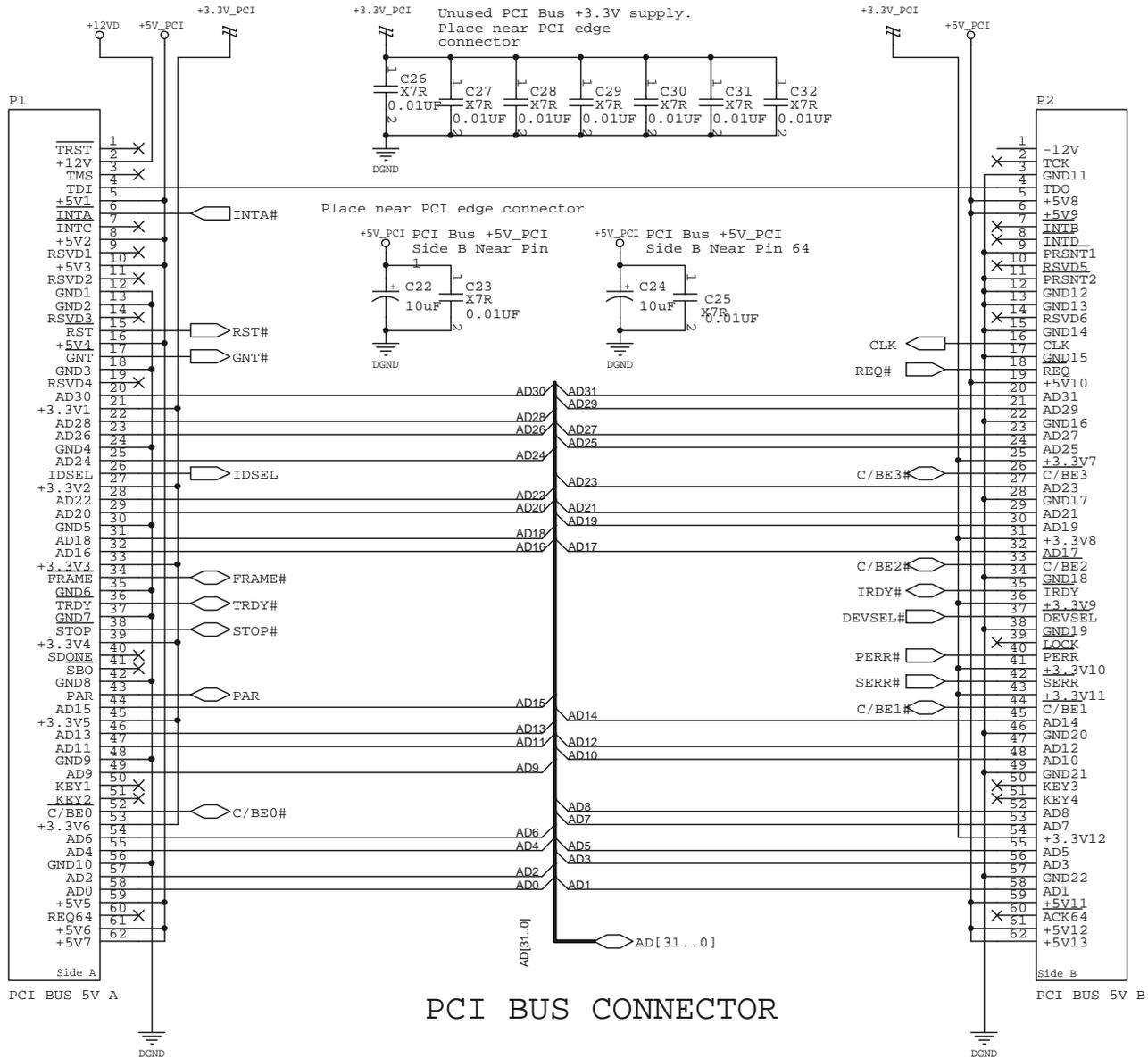
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**Figure 5. PCI Bus Connector**



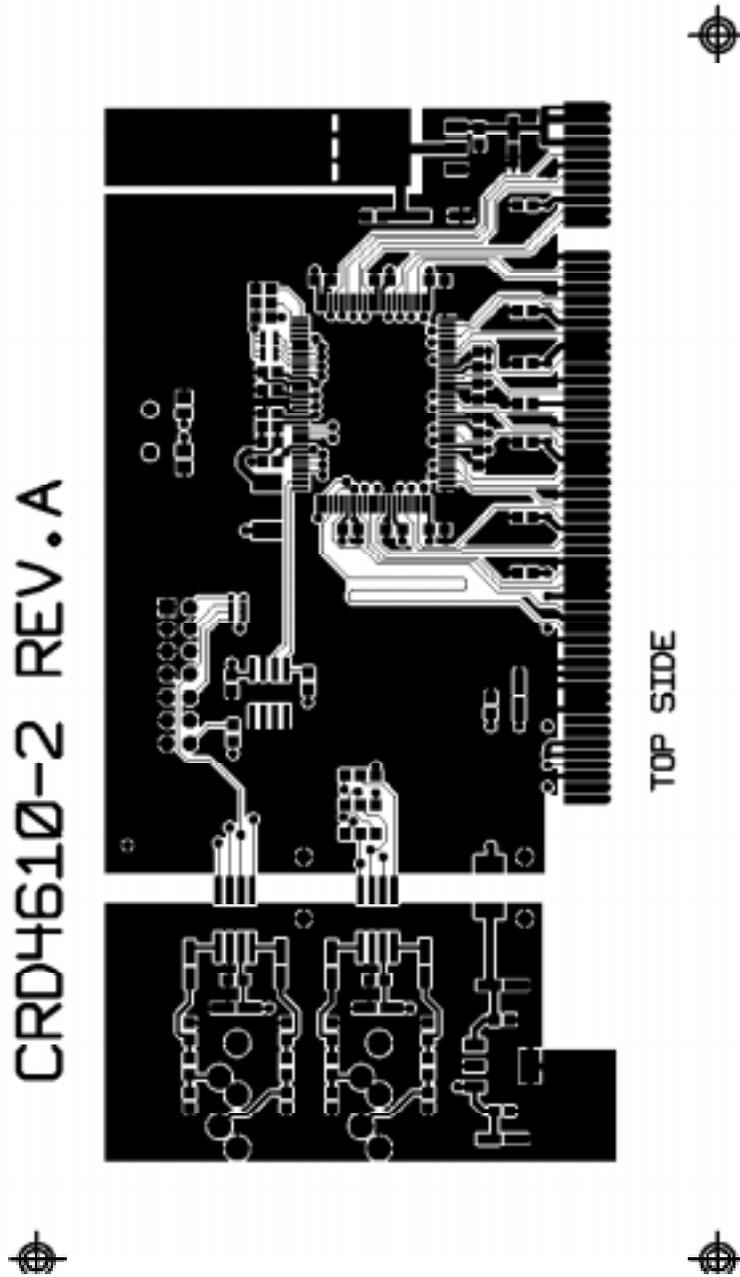


Figure 7. CRD4610-2 Top Side Layout

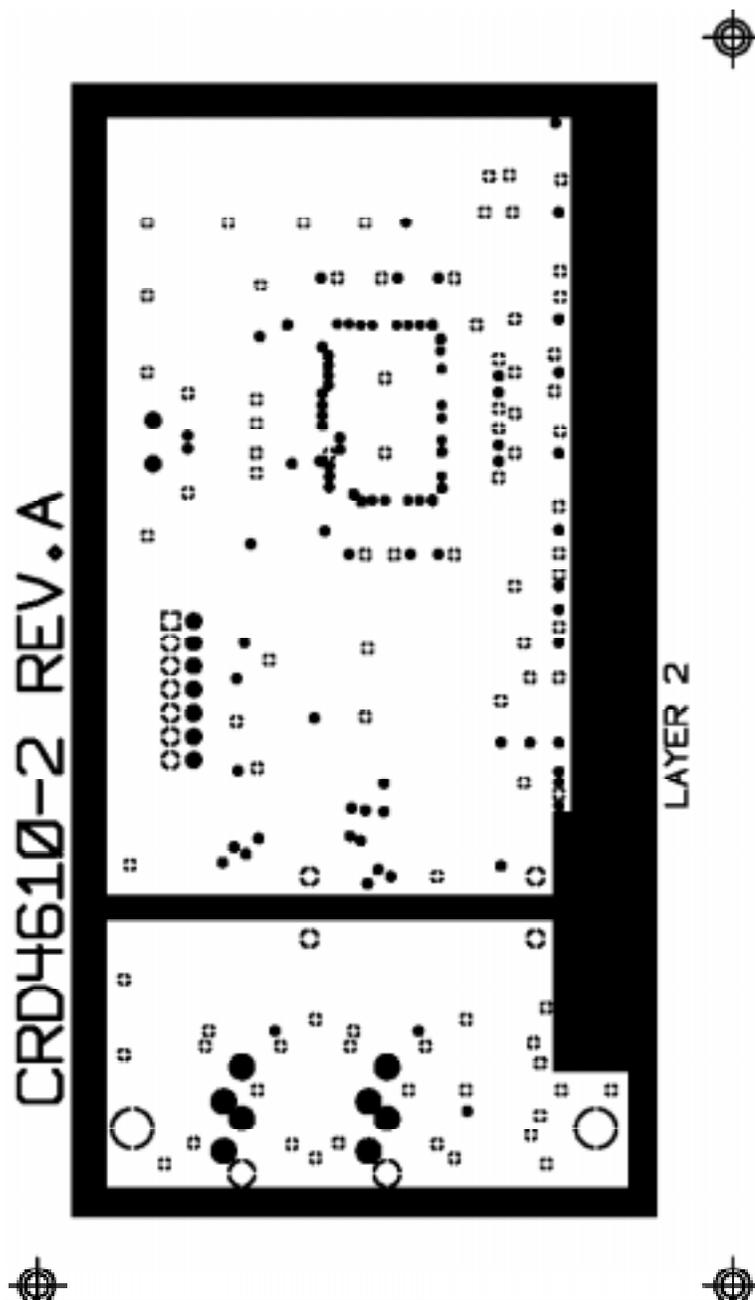


Figure 8. CRD4610-2 Internal Ground Plane Layout

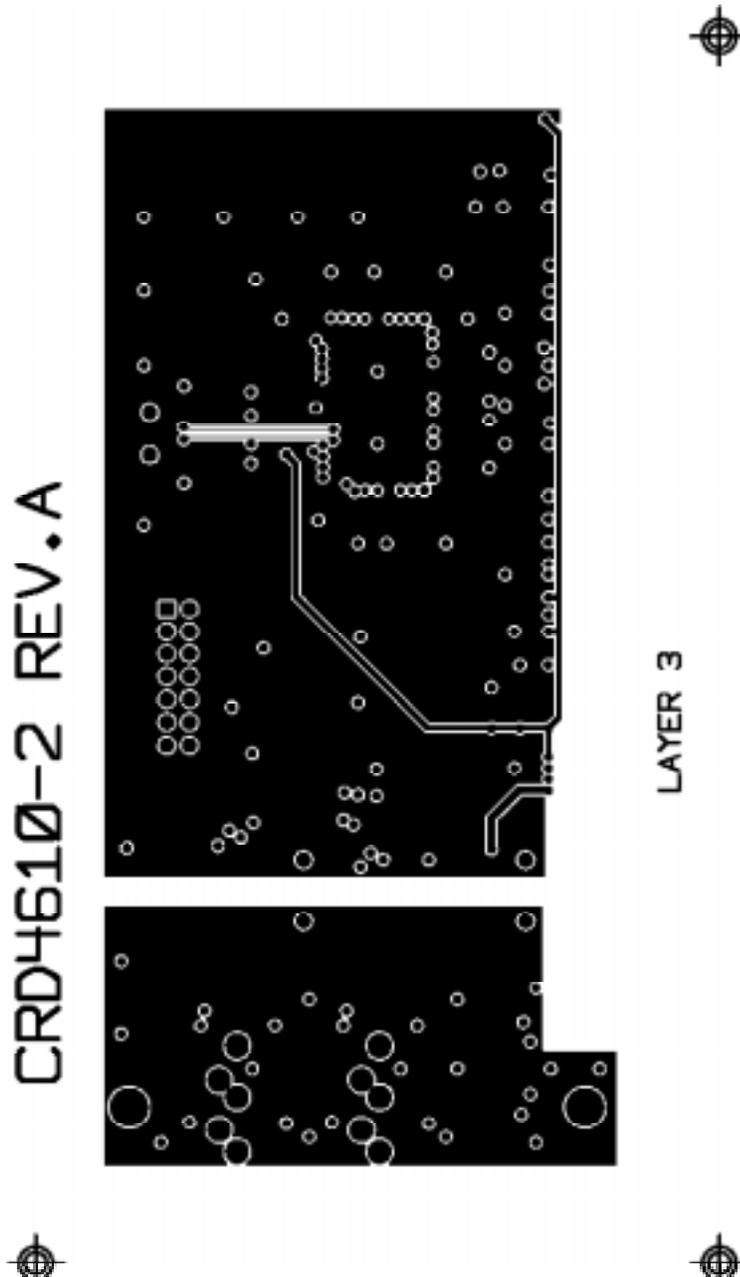


Figure 9. CRD4610-2 Internal Power Plane Layout

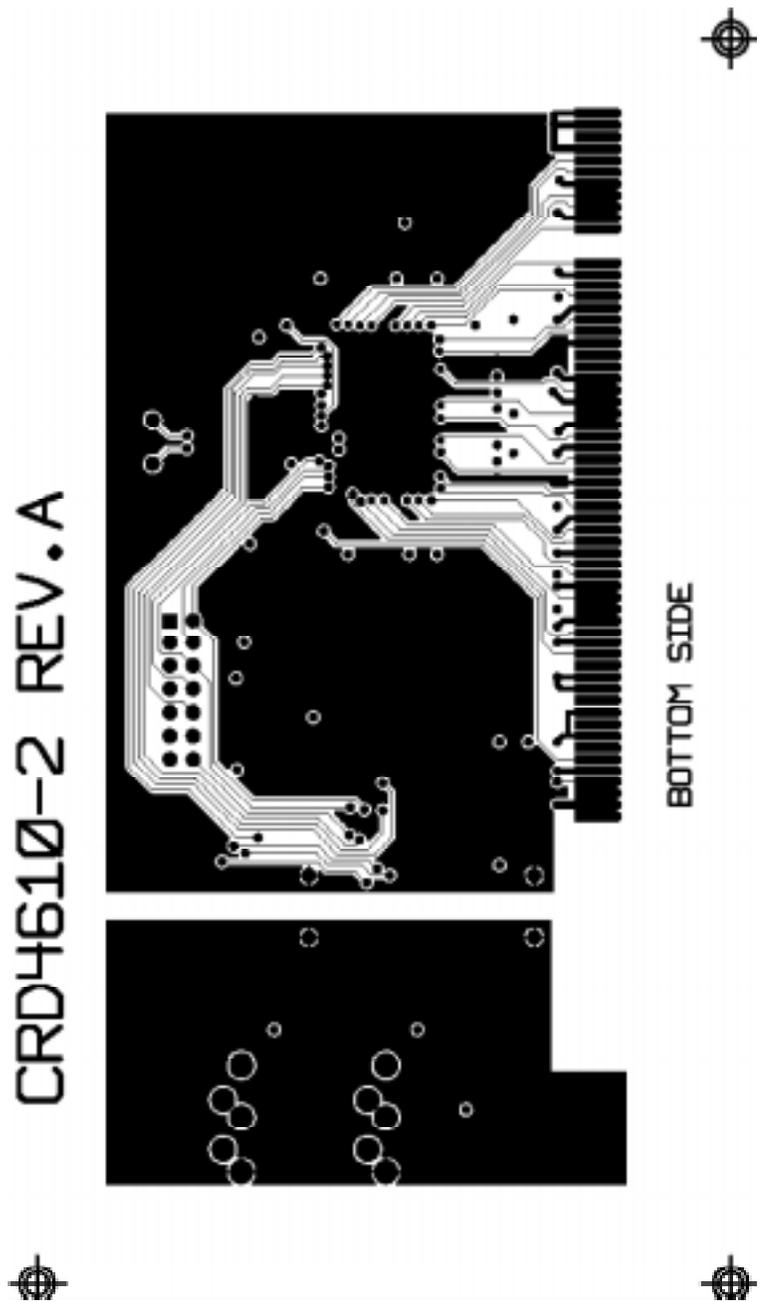


Figure 10. CRD4610-2 Bottom Side Layout

CRD4610-2 REV A. SCH: A3A 10/6/97 17:22							
QTY	REF.DESIGNATOR	VALUE	TYPE	PCB FTRPNT	MFG PART NO.	MFG.	DESCRIPTION
<b>Components required for motherboard application</b>							
15	C1,C2,C3,C4,C5,C6, C7,C8,C9,C10,C11, C12,C13,C14,C16	0.1uF	Y5V	CC0603	ECU-V1C104ZFV	PANASONIC	CAP,0.1uF,16V,+80/-20%,0603, Y5V
1	C15	1000pF	X7R	CC0603	ECU-V1H102KBV	PANASONIC	CAP,1000pF,50V,10%,0603,X7R
1	L1	120 @ 100MHz	FERRITE	CC1812	HF30ACB453215-T	TDK	IND,FBEAD,1812,120@100MHz, 25%
1	RP2	100k	MTL FILM	RESARRAY/SMT 8	EXB-V8V104V	PANASONIC	RES ARRAY,4 ISOLATED, 100K,1/16W,5%,0.6mm,SMT
3	R2,R12,R13 (Note 1)	10k	MTL FILM	RES/RC0603	ERJ-3GSYJ103V	PANASONIC	RES,10k,0603,1/16W,5%,MTL FILM
1	U1	CS4610-CM		MQFP100	CS4610-CM	CRYSTAL	PCI AUDIO ACCELERATOR
<b>Additional components required for 4 channel auxiliary analog output</b>							
4	C20,C21,C45,C46,	0.1uF	Y5V	CC0603	ECU-V1C104ZFV	PANASONIC	CAP,0.1uF,16V,+80/-20%,0603, Y5V
8	C33,C34,C35,C38, C39,C40,C44,C47	10uF	ELEC		ECE-V1CA100R	PANASONIC	CAP,10uF,ELEC,SO,CASE B,20%,16V
4	C36,C37,C41,C42	820pF	NPO	CC0603	ECU-V1H821KCV	PANASONIC	CAP,820pF,50V,10%,0603,NPO
2	J2,J3	PHONO-1/8		PHONO-1/8	SJ372-375	LZR ELECTRONICS	CONN,1/8" SWITCHED STEREO PHONE JACK,TH
1	L2	120 @ 100MHz	FERRITE BEAD	CC1812	HF30ACB453215-T	TDK	IND,FBEAD,1812,120@100MH z,25%
1	RP1	100k	MTL FILM	RESARRAY/SMT8	EXB-V8V104V	PANASONIC	RES ARRAY,4 ISOLATED, 100K,1/16W,5%,0.6mm,SMT
1	R14	100k	MTL FILM	RES/RC0603	ERJ-3GSYJ104V_ 0	PANASONIC	RES,100k,0603,1/16W,5%,MTL FILM
4	R3,R4,R7,R8	2.4k	MTL FILM	RES/RC0603	ERJ-3GSYJ242V	PANASONIC	RES,2.4k,0603,1/16W,5%,MTL FILM
4	R5,R6,R9,R10	56k	MTL FILM	RES/RC0603	ERJ-3GSYJ563V	PANASONIC	RES,56k,0603,1/16W,5%,MTL FILM
2	U3,U4	CS4333-KS		SOIC8	CS4333-KS	CRYSTAL	ADC,STEREO,SOIC8
1	U6	LT1121CST-5		SOT-223	LT1121CST-5_1	Linear Technology	+5V Low Dropout Regulator, 150mA, SOT-223



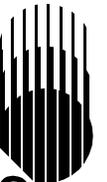
CIRRUS LOGIC

CrystalClear™ CS4610 PCI to ISA Link Motherboard

CRD4610-2

CRD4610-2 REV A.		SCH: A3A		10/6/97 17:22			
QTY	REF.DESIGNATOR	VALUE	TYPE	PCB FTFRNT	MFG PART NO.	MFG.	DESCRIPTION
<b>Additional components required for add-in card</b>							
1	C48	0.1uF	Y5V	CC0603	ECU-V1C104ZFV	PANASONIC	CAP,0.1uF,16V,+801-20%,0603, Y5V
2	C18,C17 (Note 2)	22pF	NPO	CC0805	ECU-V1H220KCV	PANASONIC	CAP,22pF,50V,5%,0603,NPO
10	C19,C23,C25,C26, C27,C28,C29,C30, C31,C32	0.01uF	X7R	CC0603	ECU-V1H103KBV	PANASONIC	CAP,0.01F,50V,10%,0603,X7R
2	C22,C24	10uF	ELEC		ECE-V1CA100R	PANASONIC	CAP,10uF,ELEC,SO,CASE B, 20%,16V
1	C43	100uF ELEC			ECE-VOJV101	PANASONIC	CAP,ELEC,100UF,SMT,CASE D, 20%,6.3V
1	J1	HDR7X2		SHROUDED	103309-2	AMP	HDR,SHROUDED,7X2.025"PIN, .1"CNTR
1	R1	4.7k	MTL FILM	RES/RC0603	ERJ-3GSYJ472V	PANASONIC	RES,4.7k,0603,1/16W,5%,MTL FILM
1	U2	X24C04	512X8BIT	SOIC8	AT24C04N-10SC	ATMEL	IC,24C04,512X8BIT,SO,SOIC8, EEPROM
1	U5	LT1117CST-3.3		SOT-223	LT1117CST-3.3	Linear Technology	+3.3V Low Dropout Regulator, 800mA, SOT-223
1	Y1 (Note 2)	12.288 MHz	PAR RES, FUND	XTL2-H	HC49S-12.288	FOX	CRYSTAL, 12.288MHz, Fund Mode Par Res
<b>Additional components not required</b>							
3	R15B, R16B, R17B (Note 3)	0	MTL FILM	RES/RC0603	ERJ-3GSYJ0R0V	PANASONIC	RES,0,0603,1/16W,5%,MTL FILM
3	R15A, R16A, R17A (Note 3)	do not populate	do not populate				

- Notes:
1. If Auxiliary analog outputs, SDO2 and SDO3 will not be used, a 10k pull-up will be required on each pin 56-59 (4 total).
  2. These components are only required if the CS4610 will be used in independent mode. These pins should be pulled to +3.3 V through a 10 k $\Omega$  if a crystal is not connected.
  3. R15A-R17A, R15B-R17B are not required in an actual application. They are for evaluation board purposes only.



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