CRD4281-5

Reference Design Data Sheet

FEATURES

- **PCI Audio Accelerator add-in card designed to meet AC '97 specification**
- **2-layer low cost single sided adapter board**
- **CS4281 PCI Audio Controller and CS4297A Audio Codec '97**
- **Complete suite of Analog I/O connections:**
  - — Line In, Line Out, Mic In, Modem audio connection, CD In, Video In, and Aux In
- **Optional hardware volume control connector**
- **Joystick/MIDI Interface**
- **Meets or exceeds Microsoft's® PC 97, PC 98 and PC 99, both required and advanced, audio performance requirements.**
- **Pin compatible with CS4614 and CS4280-CM**
- **Pin compatible with CS4297 and CS4299**

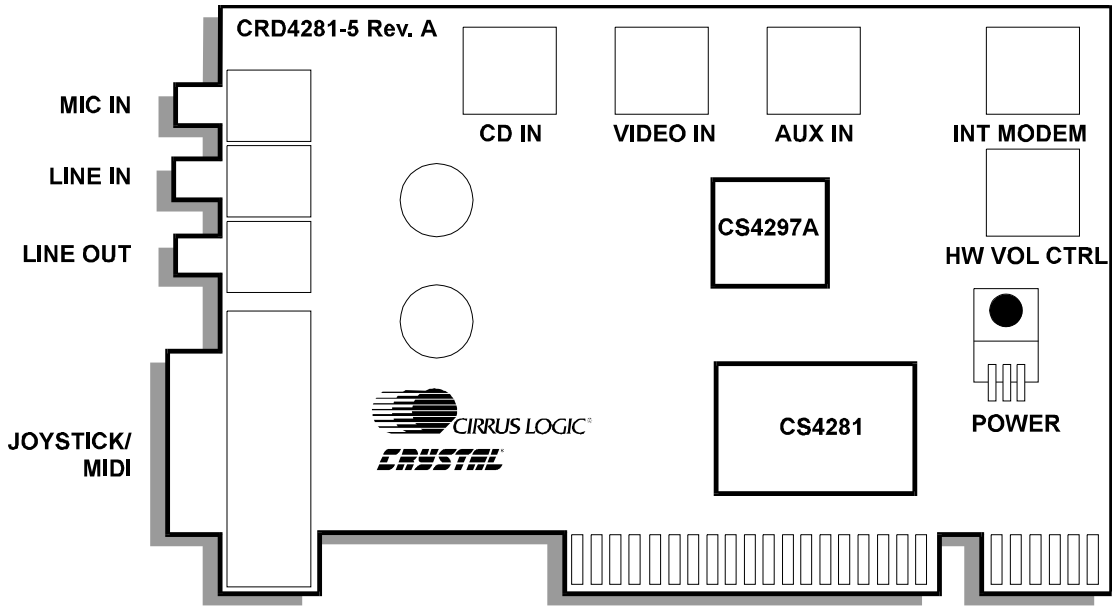
CrystalClear™ AC '97 Low Cost PCI Audio Adapter Reference Design

DESCRIPTION

The CRD4281-5 low cost PCI add-in board reference design showcases Cirrus Logic's CS4281 Audio Controller and the CS4297A Audio Codec '97. The CRD4281-5 card is 3.8 inches high by 4.7 inches long.

The CRD4281-5 reference design includes a customer-ready manufacturing kit. Included in the kit are a full set of schematic design files (OrCAD® 7.2 format), PCB job files (PADS® ASCII), PCB artwork files, and bill of materials. The design is production ready as is, or can be easily modified to incorporate specific OEM value-add.

ORDERING INFO
CRD4281-5



CIRRUS LOGIC REFERENCE DESIGN DATA SHEET

GENERAL INFORMATION

The CRD4281-5 is a reference design of a production-grade AC '97 PCI Audio card using the CrystalClear CS4281 PCI Audio Controller and the CS4297A Audio Codec '97. These two integrated circuits demonstrate Cirrus' controller and CrystalClear audio quality in a single PCI add-in card reference design. The CRD4281-5 audio measurements meet or exceed Microsoft's PC 97, PC 98, and PC 99, both required and advanced, audio performance requirements.

Today's multimedia applications demand high quality PC audio and numerous audio connections. To meet this demand, Intel® defined the AC '97 (Audio Codec '97) specification that defines a two-chip audio solution [1].

The advantage of a two chip audio solution lies in the complete separation of the analog section from the noisy digital environment of the personal computer. A 5-wire digital link is all that is required to connect the audio codec to the PCI bus-based AC '97 controller. This allows the audio section to reach the required dynamic range of ~90 dB FS A while making the layout and placement of the audio section easier to implement.

In the Windows 95® environment, a MIDI stream and a number of simultaneous audio streams from Windows 95 applications can be sent to the CS4281 over the PCI bus. The CS4281 performs hardware-controlled audio stream mixing and processing, including sample rate conversion, then sends the output stream over the AC '97 Link to the CS4297A. The CS4297A provides multiple analog audio inputs and outputs, analog mixing, Analog-to-Digital Conversion (ADC) and Digital-to-Analog Conversion (DAC).

The CRD4281-5 is designed to provide the highest possible functionality, along with industry leading audio performance at a low manufacturing cost. Care was taken with component placement and signal routing to minimize sources which can degrade audio performance.

The CRD4281-5 reference design illustrates a low cost two-layer add-in card layout. The card is sectioned into three main parts: the CS4281 PCI Audio Controller section, the CS4297A Audio Codec '97 section, and the Analog I/O section.

CS4281 PCI AUDIO CONTROLLER

The CS4281 is a PCI 2.1 compliant device which provides a complete high quality audio solution. It includes an integrated FM synthesizer and Plug-and-Play interface. In addition, the CS4281 offers hardware volume control.

The circuitry supporting the CS4281 includes the required bypass capacitors, an EEPROM, the

joystick interface and a buffer circuit for the external MIDI connection. The layout of this section complies with the PCI specification version 2.1 [2] for add-in cards. Please refer to the schematic and layout sections of this document for more information. For more information on the CS4281, refer to the *CS4281 Data Sheet* [3].

PCI Power Requirements

3.3 V power for the CS4281 is generated from the +5 V on the PCI connector and regulated to +3.3 V using a low dropout linear voltage regulator. This is required since not all mother boards are guaranteed to have +3.3 V power available on the PCI connectors.

Joystick/MIDI connection

The DB-15 connector allows a joystick or an external MIDI device to be connected to the CS4281. The external connection can also take MIDI data from an external source to the CS4281. A buffer circuit allows the MIDIOUT pin of the CS4281 to drive an external MIDI devices requiring 5 V signaling levels.

External EEPROM

The CS4281 EEPROM contains the required Subsystem Vendor ID and Subsystem ID values. The CS4281 uses 9 data bytes in the EEPROM for configuration. The PCI Special Interest Group assigns manufacturers a Subsystem Vendor ID. To meet WHQL™ standards, the Subsystem ID must be a non-zero value.

A separate utility, PCIRSRC.EXE, is supplied with this kit to download configuration and OEM specific data to the EEPROM.

Please call Cirrus Logic PC Products Audio Division at (512) 445-7222 to have a Subsystem ID assigned to a particular project.

For information regarding the programming and timing of the EEPROM, refer to the *CS4281 Data Sheet* [3].

CS4297A AUDIO CODEC '97

The CS4297A is a mixed-signal serial Codec based on the AC '97 specification. The CS4281 Controller is responsible for all communications between the CS4297A and the rest of the system. The CS4297A functions as an analog mixer, a stereo ADC, a stereo DAC, and a control and digital audio stream interface to the CS4281.

The CS4297A contains two distinct functional sections: digital and analog. The digital section includes the AC-link registers, power management support, SYNC detection circuitry, and AC-link serial port interface logic. The analog section includes the analog input multiplexer (mux), stereo output mixer, mono output mixer, stereo ADCs, stereo DACs, and analog volume controls. For more information refer to the *CS4297A Data Sheet* [4], which also discusses the capacitors required for the CS4297A and their placements.

Codec Power Requirements

A Motorola MC78L05CDT regulates the PCI +12 V supply down to provide a clean +5 V analog supply for the CS4297A. A voltage regulator is recommended for the analog supply. The MC78L05CDT regulator provides adequate current for the CS4297A and associated analog circuitry.

AUDIO INPUTS AND OUTPUTS

The CS4297A has multiple analog inputs and outputs that may or may not be used depending on the system's application. Unused inputs should be tied to Vrefout (pin 28) or capacitively coupled via 0.1 µF to the analog ground plane. The analog section contains the components for a headphone amplifier or power amplifier as a stuff option.

The Modem Audio, CD In, Video In and Aux In headers are also part of the Analog I/O section. The header and its associated components are optional based on feature requirements.

A full feature set of the CS4297A's analog I/O is represented on the reference design card through internal headers and external connectors:

- Line Out
- Mic In
- Line In
- CD In
- Modem audio connection
- Aux In
- Video In

Line Out

The output of the CS4297A is capable of driving impedances greater than 10 kΩ with a maximum output voltage of 1 Vrms. The ouput drive is adequate for self-powered speakers or external power amplifiers. Two additional population options are available for driving lower impedances. The first option populated is a low-noise, low-distortion amplifier for driving headphones, typically impedances greater than 30 Ω. The second option is a power amplifier for driving 8 Ω or 4 Ω speakers. The Line Out connection is through the external 1/8" jack.

- Maximum output level: 1 Vrms

Headphone Amp output:

- Capable of driving low impedance loads such as 32 Ω headphones
- Maximum output level: 2.0 Vrms

Power Amp output option:

- Capable of driving low impedance loads such as 4 Ω or 8 Ω speakers
- Maximum output level: 2.9 Vrms into 4 Ω or 8 Ω

Line In

The Line In 1/8" jack provides an input to the Line In pins of the CS4297A.

Maximum input level: 2 Vrms

Mic In

The Microphone In 1/8" jack provides an input to a microphone pre-amplifier circuit that applies 18 dB of gain to the signal.

- Maximum input level:
  - Microphone Boost enabled: 12.5 mVrms
  - Microphone Boost disabled: 125 mVrms
- Supports 3-pin electret (power on ring) and 2-pin dynamic microphones

CD In

The CD In audio input headers are connected in parallel, which means only one can be active at a time. The first header is a 4 pin (0.1 inch center) right-angled connector that is compatible with the Sony and ATAPI standards.

- Maximum input level: 2 Vrms
- Differential input using the CD common pin as the ground
- 0.1 inch connector wired as:
  - Pin 1 : Left Channel
  - Pin 2 : Analog Ground
  - Pin 3 : Analog Ground
  - Pin 4 : Right Channel

The second option is a 4 pin (2 mm center) Mitsumi shrouded connector.

- 2 mm connector wired as:
  - Pin 1 : Right Channel
  - Pin 2 : Analog Ground
  - Pin 3 : Left Channel
  - Pin 4 : Analog Ground

Aux In

- Internal 4-pin (0.1 inch center) right-angled connector
- Wired as:
  - Pin 1 : Left Channel
  - Pin 2 : Analog Ground

- Pin 3 : Analog Ground
- Pin 4 : Right Channel

- Maximum input level: 2 Vrms

Video In

- Internal 4-pin (0.1 inch center) right-angled connector
- Wired as:
  - Pin 1 : Left Channel
  - Pin 2 : Analog Ground
  - Pin 3 : Analog Ground
  - Pin 4 : Right Channel

Maximum input level: 2 Vrms

Modem Audio Connection

The modem audio connection can be made through the internal 4-pin (0.1 inch center) right-angled connector. This connector carries both a mono input and a mono output. The Mono Out signal from the CRD4281-5 transfers audio to the modem, and the Phone signal receives audio from the modem.

- Internal 4 pin header (0.1 inch center)
- Wired as:
  - Pin 1 : Phone Input (from modem)
  - Pin 2 : Analog Ground
  - Pin 3 : Analog Ground
  - Pin 4 : Mono output (to modem)
- Phone maximum input level: 1 Vrms
- Mono Out maximum output level: 0.7 Vrms
- Minimum load impedance: 10 kΩ

SCHEMATIC DESCRIPTION

Figures 1 through 9 show the schematics for the CRD4281-5 card. This section will describe particular pages of the schematic that need to be discussed.

Figure 1: Block Diagram

The block diagram is an interconnection overview between schematic pages.

Figure 2: Analog Inputs

The inputs for AUX, VIDEO, CD, and LINE are passed through a divider circuit that reduces the voltage by 6 dB to allow connection of line level sources up to 2 Vrms. The 220 pF capacitors are provided on Line In, Mic In, CD In, Aux In, Video In, and Internal Modem connection for EMC suppression. These may be removed if EMC testing determines they are not required.

2.2 µF AC coupling capacitors are used on the Line In, Mic In, CD In, Aux In, Video In, and Internal Modem circuit to minimize the low frequency roll-off. The internal CD audio connection utilizes a pseudo-differential interface with CD GND as the common return path for both the left and right channels. Therefore, the input impedance of this block is half of that of the other inputs.

An additional CD In connector footprint, J2, is provided to support the legacy 2mm, Mitsumi style, analog connector. Since J1 and J2 are on top of each other, only one CD In audio connector can be installed.

The modem connection is both a mono input and output. The output is fed from the CS4297A's MONO_OUT. No standards exists for the internal modem connector. R34, R35, and R36 are added in case voltage dividers are required to adjust signal levels. If an output voltage lower than 1 Vrms is desired, the resistors can be replaced with appropriate values, as long as the total load on the output is kept greater than 10 kΩ. The input is not divided and can accommodate a line level source up to 1 Vrms.

Figure 3: Microphone Pre-amp and Bias

A Motorola MC33078D low noise dual op-amp provides an +18 dB gain stage for the microphone and buffers the phantom power supply for the mic. The phantom power is derived from the +5 V analog supply and buffered by U1A to provide a max-

imum of 4.2 V with no load and a minimum of 2.0 V under a 0.8 mA load on the ring, as required by *PC Design Guidelines*, Chapter 17, Audio Components [6]. To accommodate PC 99 recommendation, the microphone circuit is implemented to have -3 dB rolloffs at 60 Hz and 15 kHz.

Figure 4: Analog Output, Headphone Amp, Power Amp

Three population options are provided for audio out. The first population option is a headphone amplifier, the Motorola MC1458, which is capable of driving stereo headphones with impedances greater than 30 Ω or powered speakers. A jumper must be installed across pins 2 & 3 of JP1 and JP2 for proper operation. The headphone amp can be bypassed by the OEM or customer by installing the jumper across pins 1 & 2 of JP1 and JP2.

The second population option is the addition of a power amplifier, the Philips TDA1517P. A jumper must be installed across pins 2 & 3 of JP1 and JP2 for proper operation. The power amp can be bypassed by the OEM or customer by installing a jumper across pins 1 & 2 of JP1 and JP2.

The third and least expensive option is to not populate either the headphone amp or power amp. This option is the least flexible since only powered speakers can be driven. A jumper must be installed across pins 1 & 2 of JP1 and JP2 for proper operation.

Figure 5: CS4281 PCI Controller

The 0.1 µF capacitors connected to the power pins of the CS4281 should be as close as possible to the chip. L3, C56, and C57 are used to filter the power supply for the internal DLL circuit. R19 and R20 are termination resistors in the serial AC link between the CS4297A and the CS4281. All unused input and bi-directional pins are tied to their respective inactive levels through a 10 kΩ resistor.

Figure 6: CS4297A AC'97 Audio Codec

R17 and R18 are termination resistors in the serial AC link between the CS4297A and the CS4281. All filtering capacitors of audio signals are NPO-type to ensure minimal added distortion. Two footprints are also provided for the crystal, XTAL. A CA-301 pin-in-hole footprint, Y1, for miniature crystals, and a standard HC-49S package, Y2.

Figure 7: MIDI and Joystick Connection

A buffer driver circuit is used on the MIDIOUT pin to provide the necessary 5 V TTL compatible output on the DB-15 connector. This circuit can be removed, and R37 populated to bypass the buffer circuit if a 3.3 V compatible output is sufficient. L4, C72, C77, C78, C79 are provided for EMC suppression and can be removed if EMC testing shows they are not required. In this case replace L4 with a 0 Ω resistor. C73 - C76 and C80 - C83 are functional to the joystick circuitry as well as provide for EMC suppression and therefore must not be removed.

Figure 8: PCI Bus Connection

The PCI 2.1 specification requires that each unused +3.3 V power pin should be connected with an average of 0.01 µF capacitor [2]. Seven 0.1 µF capacitors in parallel provide the required capacitance for the +3.3 V power pins. 0 Ω resistors R43 and R44 can be used to omit the +3.3V regulator if this voltage is known to be provided on the PCI bus.

Figure 9: Power Supplies

The CS4297A requires both a digital +3.3 V and an analog +5 V supply. The digital power is supplied from the PCI bus. A separate regulator is recommended for the analog voltage supply to provide good audio signal quality. A Motorola MC78L05 regulates the +12 V supply from the PCI bus down to a clean +5 V analog supply. For the best audio performance, the analog voltage regulator, should be located near the CS4297A. Two packaging options are supported, where U2 is an SO8 surface

mount package and U3 is a TO-92 pin-in-hole package. The -12 V power pin is decoupled through C29/C30, and supplies power to the headphone circuit.

The low drop-out voltage regulator, Micrel MIC2920A, is used to provide the required +3.3 V to the CS4281 in the absence of +3.3 V on the PCI bus. Two packaging options are supported. U8 is a SOT-223 surface mount package, and U9 is a TO-220 pin-in-hole package. 0 Ω resistors are provided as a stuffing option if +3.3V is known to be available on the PCI bus.

CS4614 / CS4280 Compatibility

This board is backwards compatible with CS4614 and CS4280. The following pull-up resistors are not integrated on those chips and need to be populated externally on the board.

- R76 and R77 for hardware volume control
- R23 for MIDI Input
- R24-R27 for Joystick buttons

Component Selection

Great attention was given to the particular components used on the CRD4281-5 board with cost, performance, and package selection as the most important factors. Listed are some of the guidelines used in the selection of components:

- No components smaller than 0805 package.
- Only single package components; no resistor packs.
- 8-pin devices are in surface mount packages.
- The TDA1517P power amp is pin in hole package
- Dual footprint for XTAL. Standard H49S, and small circular CA-301 pin in hole package.
- Dual footprint for +5 V and +3.3 V regulators. Surface mount and pin in hole packages are supported.

EMC Components

A number of capacitors and inductors are included to help the board meet EMC compliance tests, such as FCC Part 15. Modifying this selection of components without EMC testing could result in EMC compliance failure.

GROUNDING AND LAYOUT

The component layout and signal routing of the CRD4281-5 provides a good example of how to layout a PCI add-in card. PCI-bus based add-in cards have explicit requirements on trace lengths that are not imposed on motherboard designs. These trace length limits for add-in cards are as follows:

- Maximum trace length for 32-bit signals on 32-bit and 64-bit cards is 1.5 inches.
- Maximum trace lengths for signals on the 64-bit extension are 2 inches.
- Trace length for the PCI CLK signal is 2.5 inches ± 0.1 inch.
- The PCI CLK signal must drive only one load.

Please refer to the PCI 2.1 Specification [2], Section 4.3.6, for information on routing PCI bus signals on a motherboard.

Partitioned Voltage and Ground Planes

The CRD4281-5 is partitioned into a digital and analog section to keep digital and analog ground currents from crossing. Ground currents from digital signals are inherently noisy with respect to analog signals and should be isolated from the audio section. The first rule in laying out mixed signal PCBs is to keep all digital signals over the digital ground plane and all analog signals over the analog ground plane. When digital and analog signals cross planes, they introduce noise into the audio section reducing performance.

The pinout of the CS4297A allows the ground split to completely separate digital signals on one side and analog signals on the other. This split is located

very close to the CS4297A so analog and digital ground return currents originating from the CS4297A may flow through their respective ground planes. A bridge is made across the split to maintain the proper reference potential for each ground plane.

The area around the crystal oscillator and the two XTAL signals is filled with copper on the top and bottom sides and attached to digital ground. This ground plane serves to keep noise from coupling onto these pins. All data converters are highly susceptible to noise on the crystal pins.

A separate chassis ground provides a reference plane for all of the EMC components. The chassis ground plane is connected to the analog ground plane at the external jacks.

CS4297A Layout Notes

Refer to the *CS4297A Data Sheet* [4] for partitioning and bypass capacitors placement. Pay close attention to bypass capacitors on REFFLT, AFLT1, AFLT2 and the power supply capacitors. The pinout of the CS4297A is designed to keep digital and analog signals from crossing when laying out the board.

REFERENCES

1) Intel, Audio Codec '97 Component Specification, Revision 2.1, May 22, 1998. *http://developer.intel.com/pc-supp /platform/ac97/*

2) PCI Special Interest Group, PCI Local Bus Specification, Revision 2.1, June 1, 1995. *http://www.pcisig.com/*

3) Cirrus Logic, CS4281 PCI Audio Interface Data Sheet *http://www.cirrus.com/products /overviews/cs4281.html*

4) Cirrus Logic, CS4297A SoundFusion Audio Codec '97 Data Sheet *http://www.cirrus.com/products /overviews/CS4297A.html*

5) Steve Harris, Clif Sanchez, Personal Computer Audio Quality Measurements, Ver 0.5 *http://www.cirrus.com/products /papers/meas/meas.html*

6) Microsoft, PC Design Guidelines, *http://www.microsoft.com/hwdev/desguid/*

7) M. Montrose. Printed Circuit Board Design Techniques for EMC Compliance, IEEE Press, New York: 1996.

ADDENDUM

- Schematic drawings
- Layout drawings
- Bracket drawings
- Bill of materails

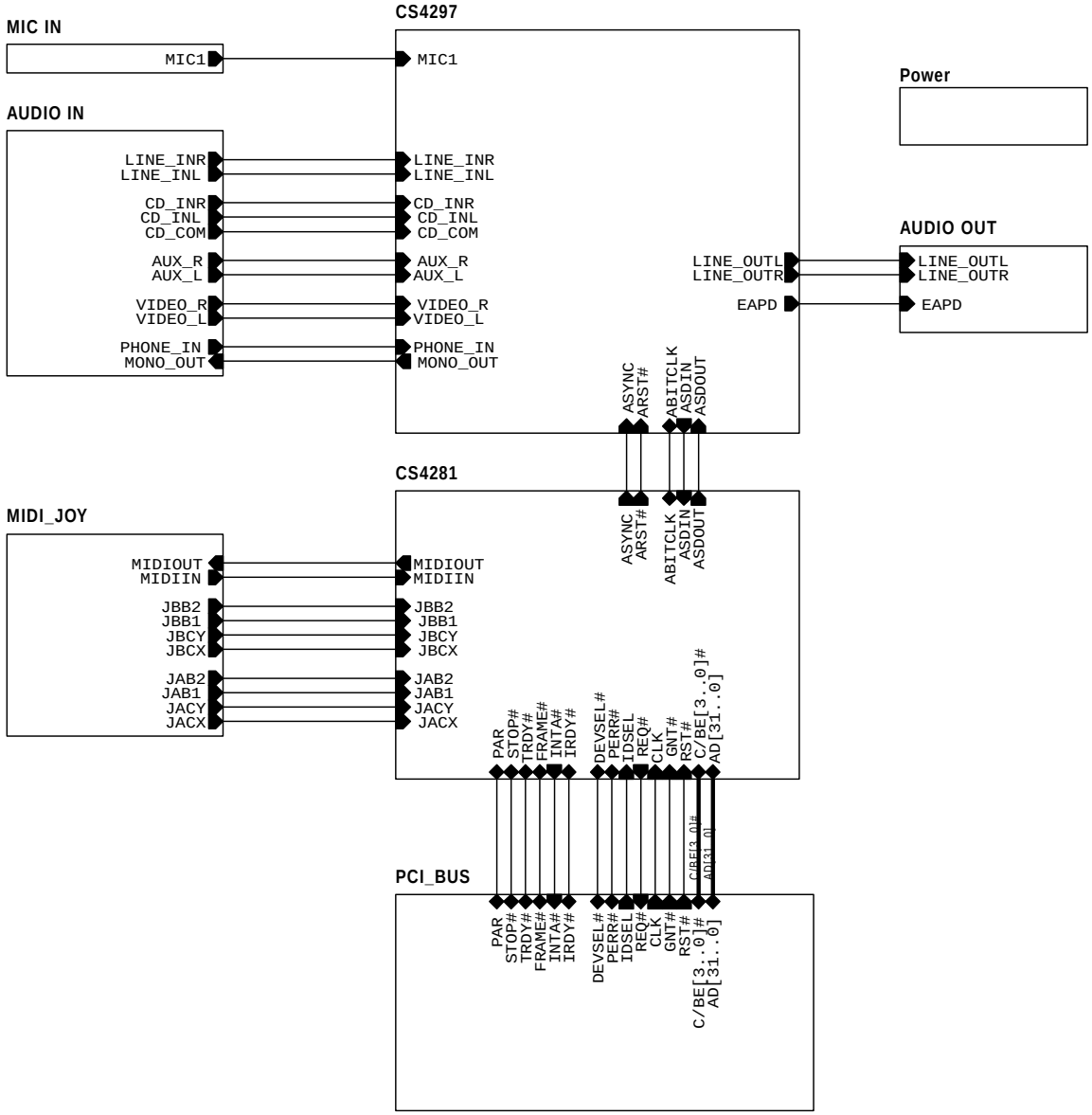


Figure 1. Block Diagram

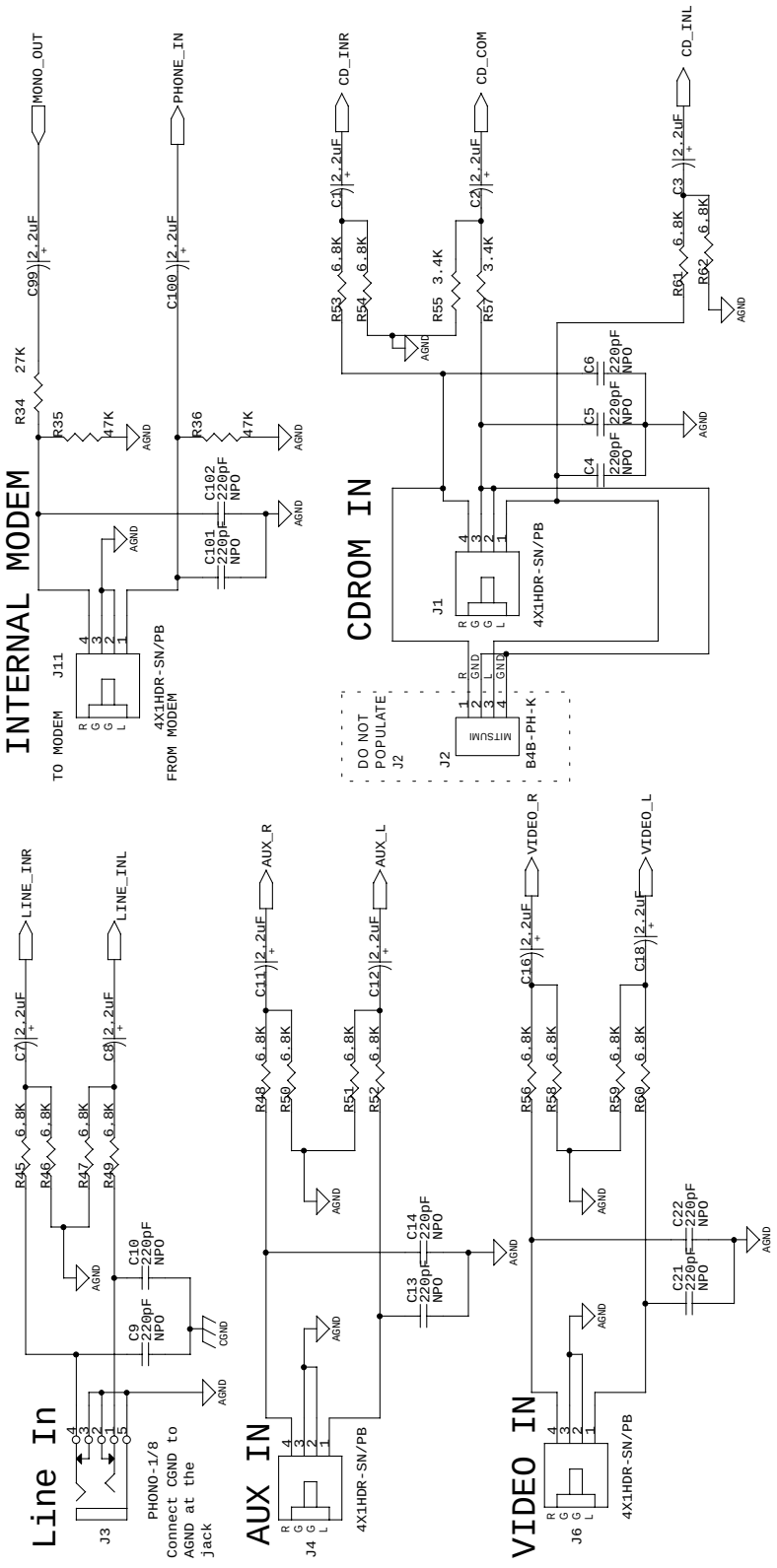


Figure 2. Audio In

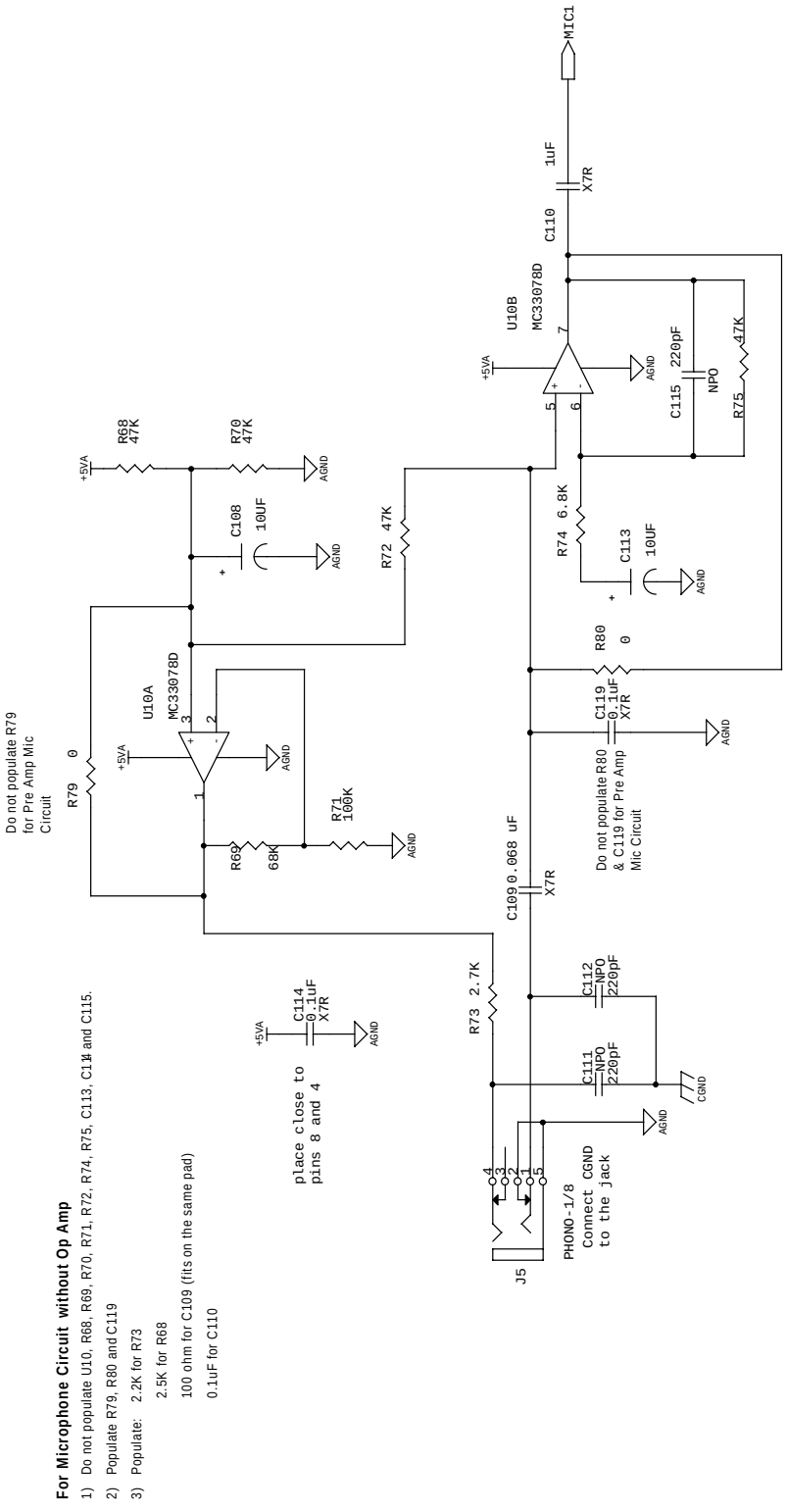


Figure 3. Mic In

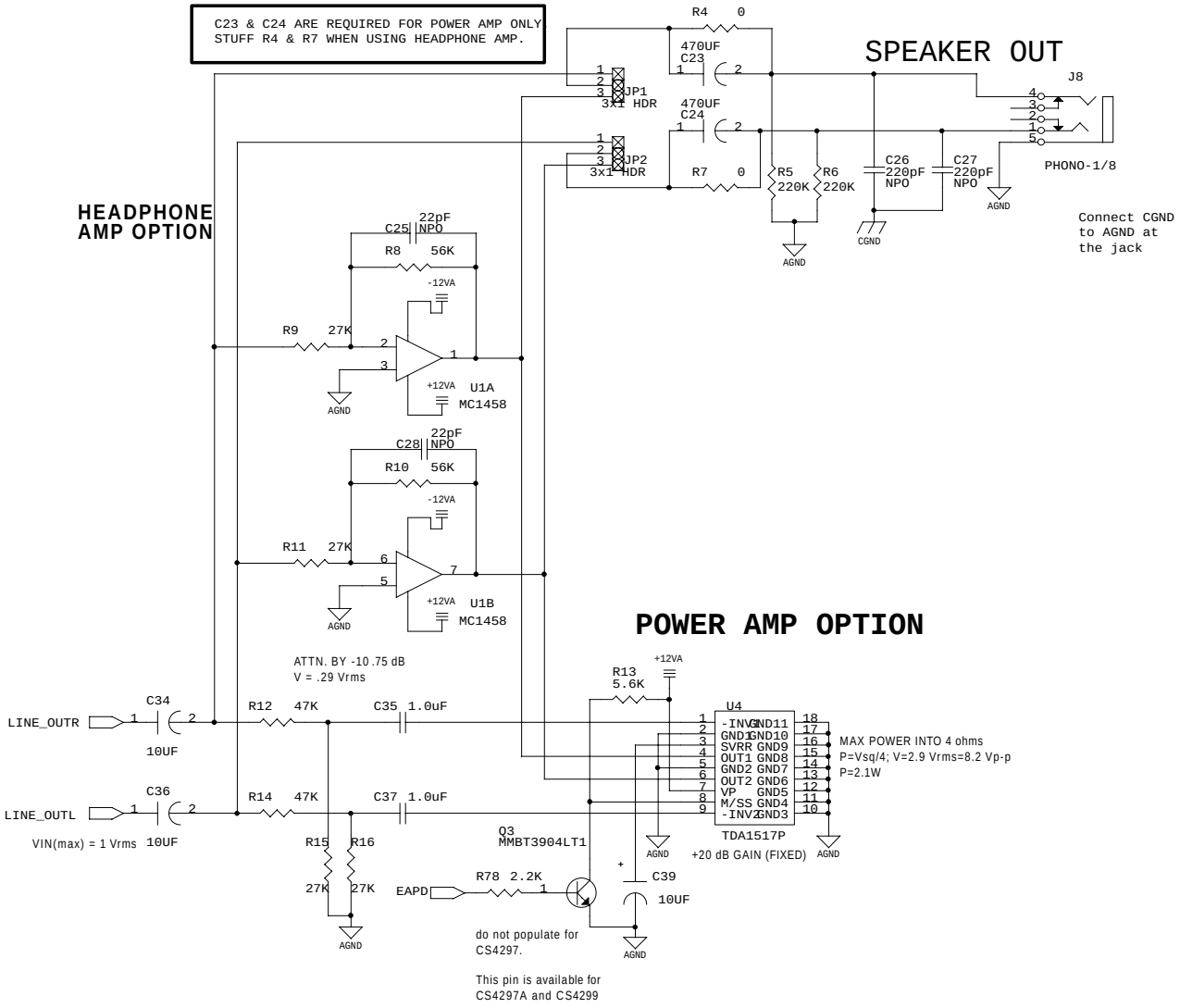


Figure 4. Audio Out

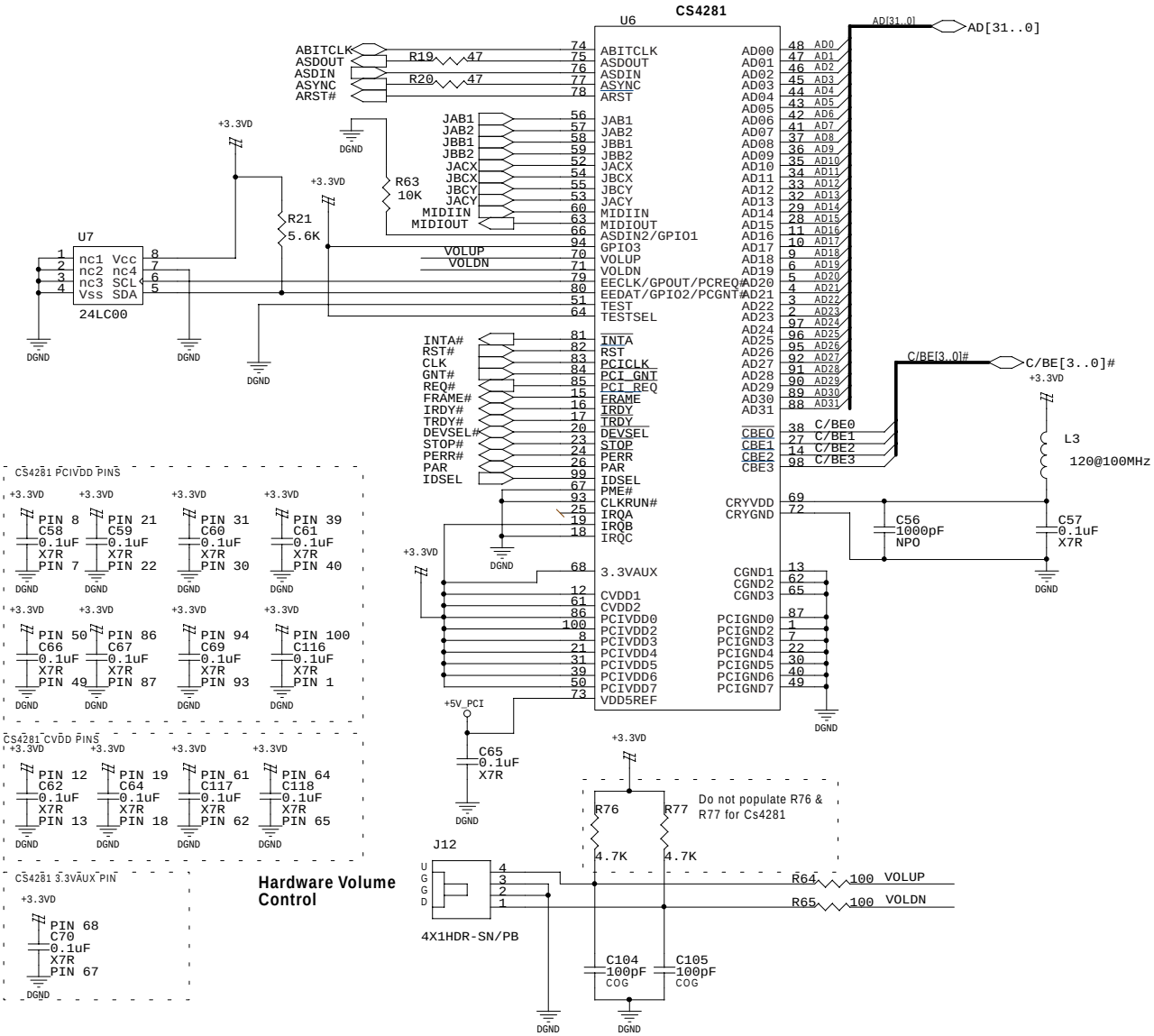


Figure 5. CS4281 PCI Audio Controller

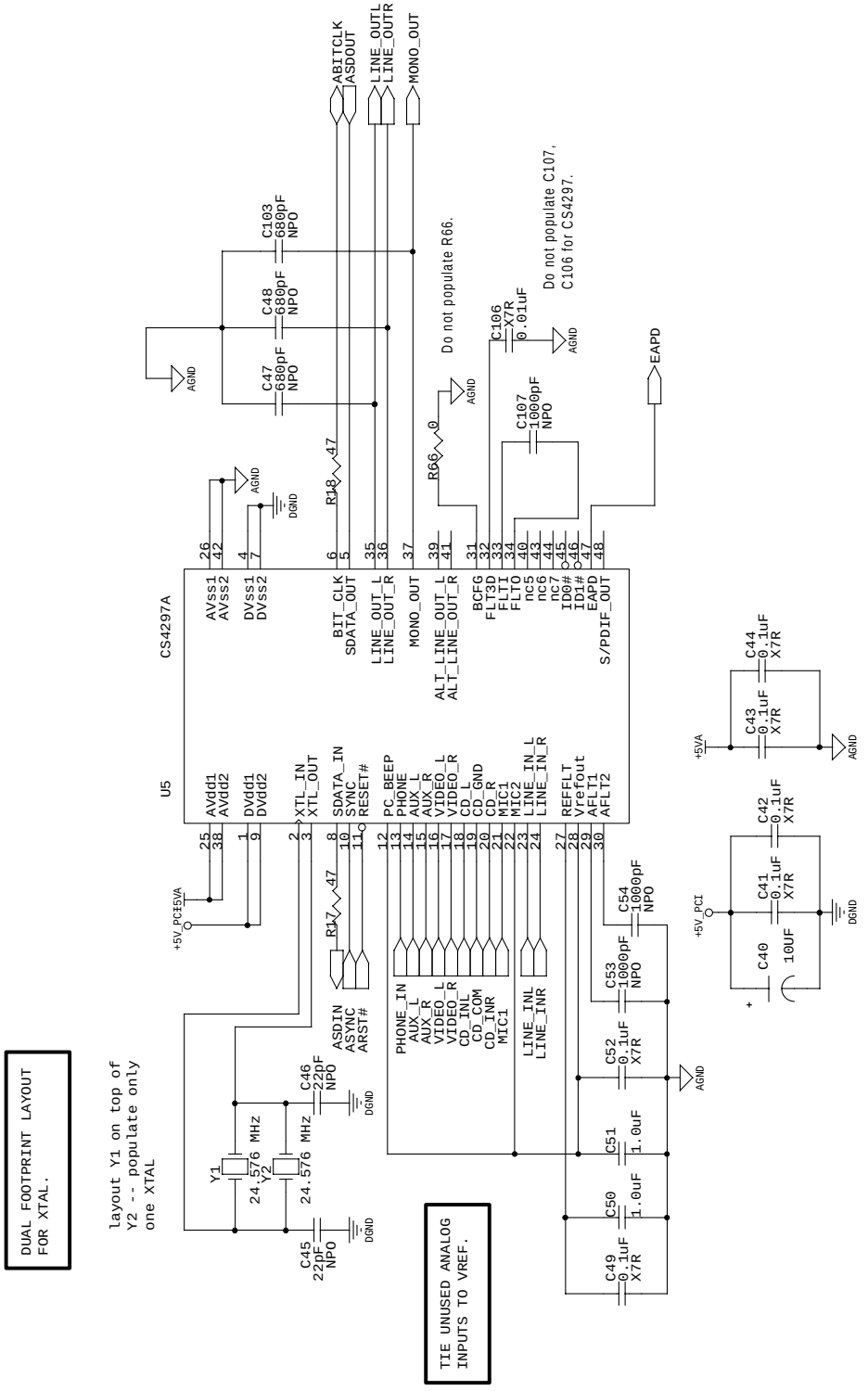


Figure 6. CS4297A AC '97 Audio Codec

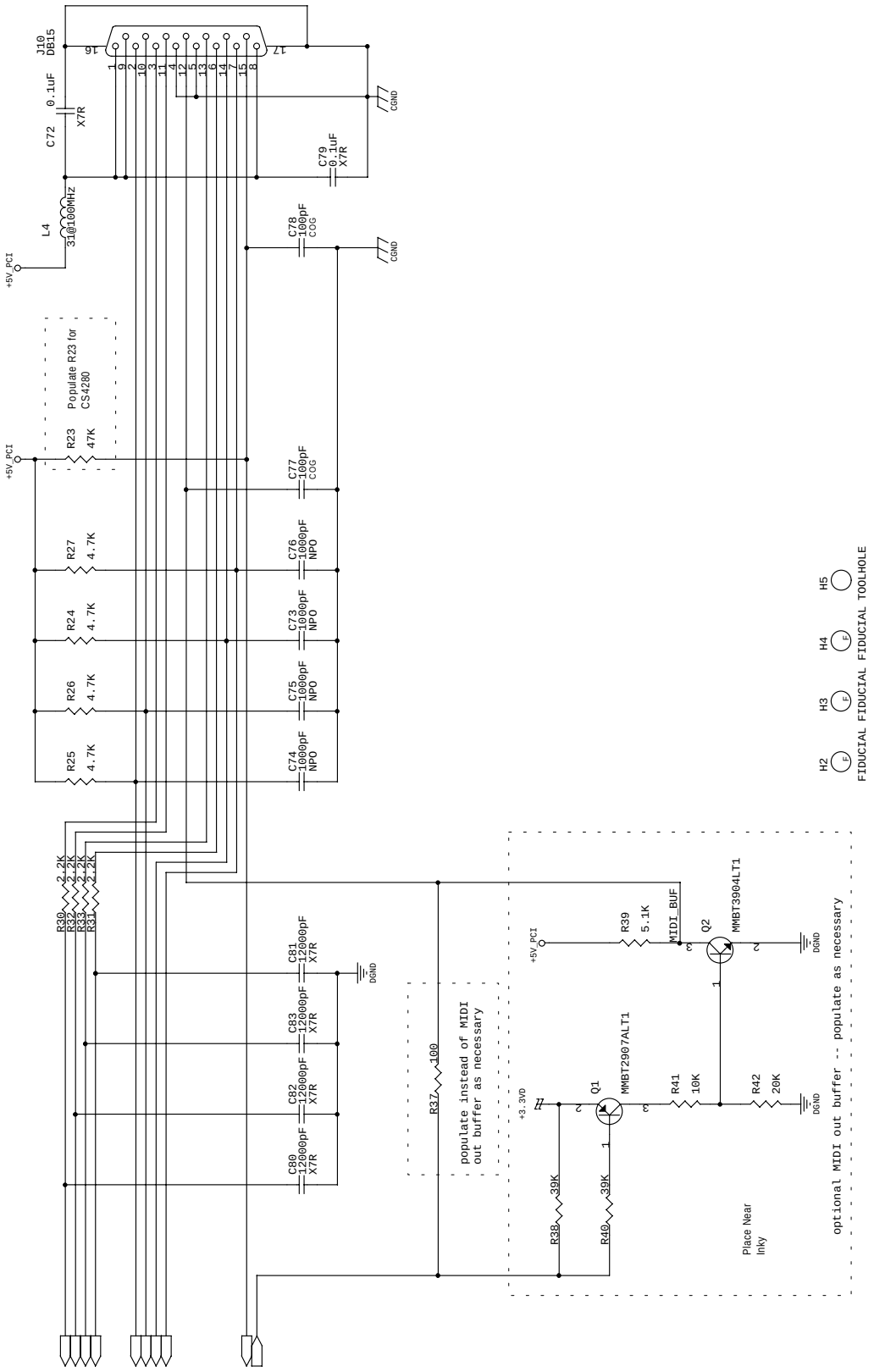


Figure 7. Joystick/MIDI Circuitry

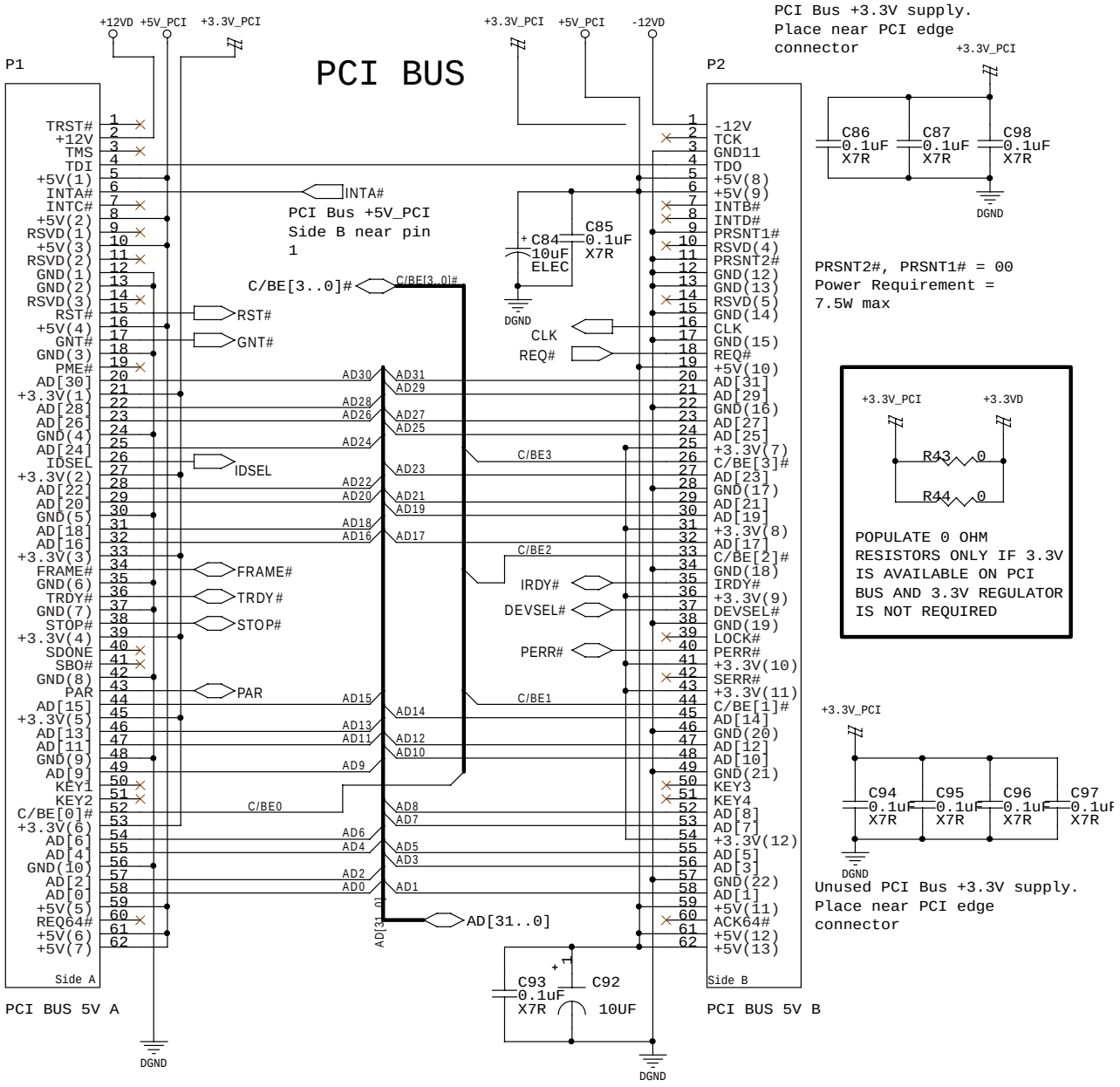


Figure 8. PCI Bus

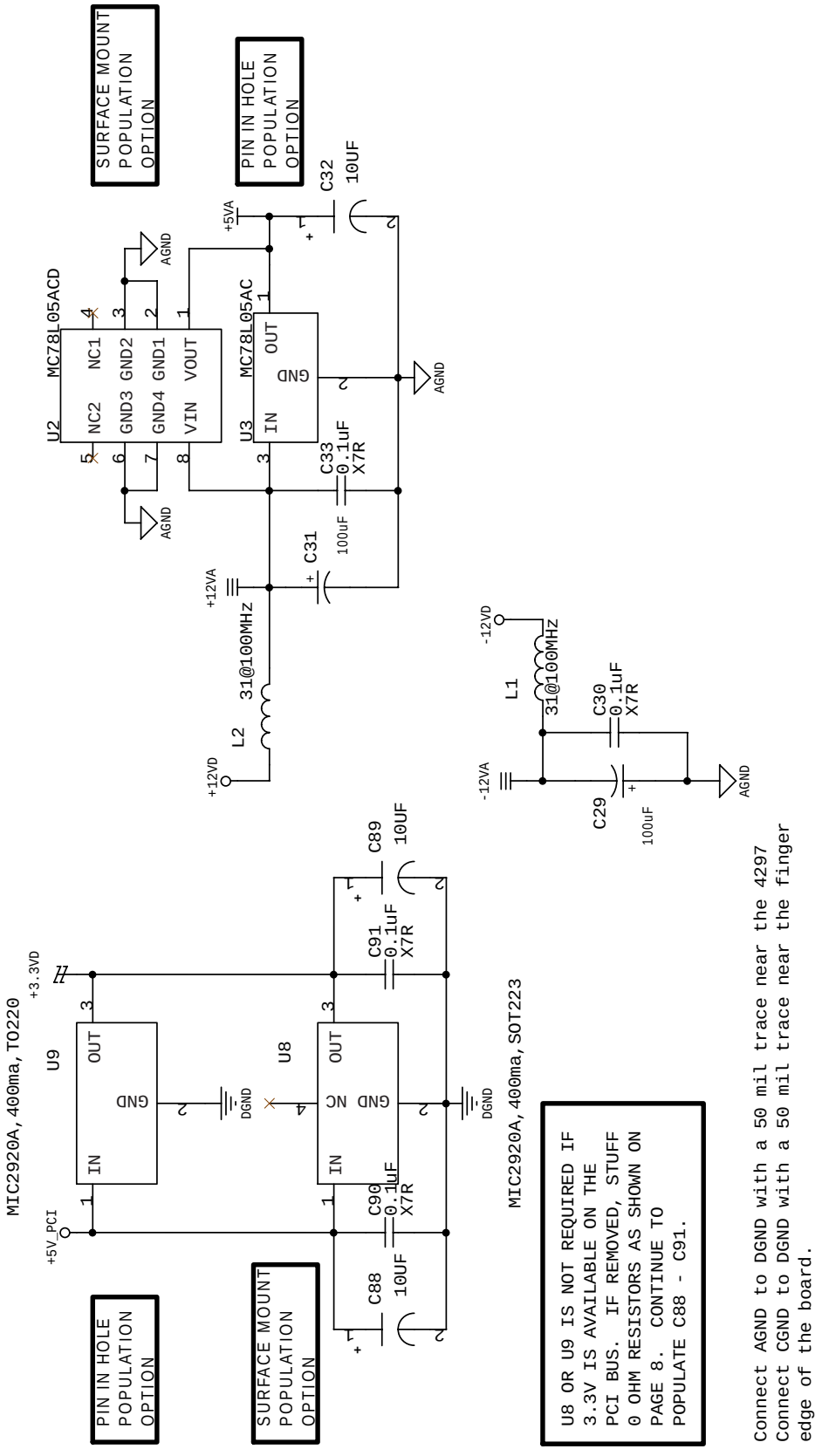


Figure 9. Power

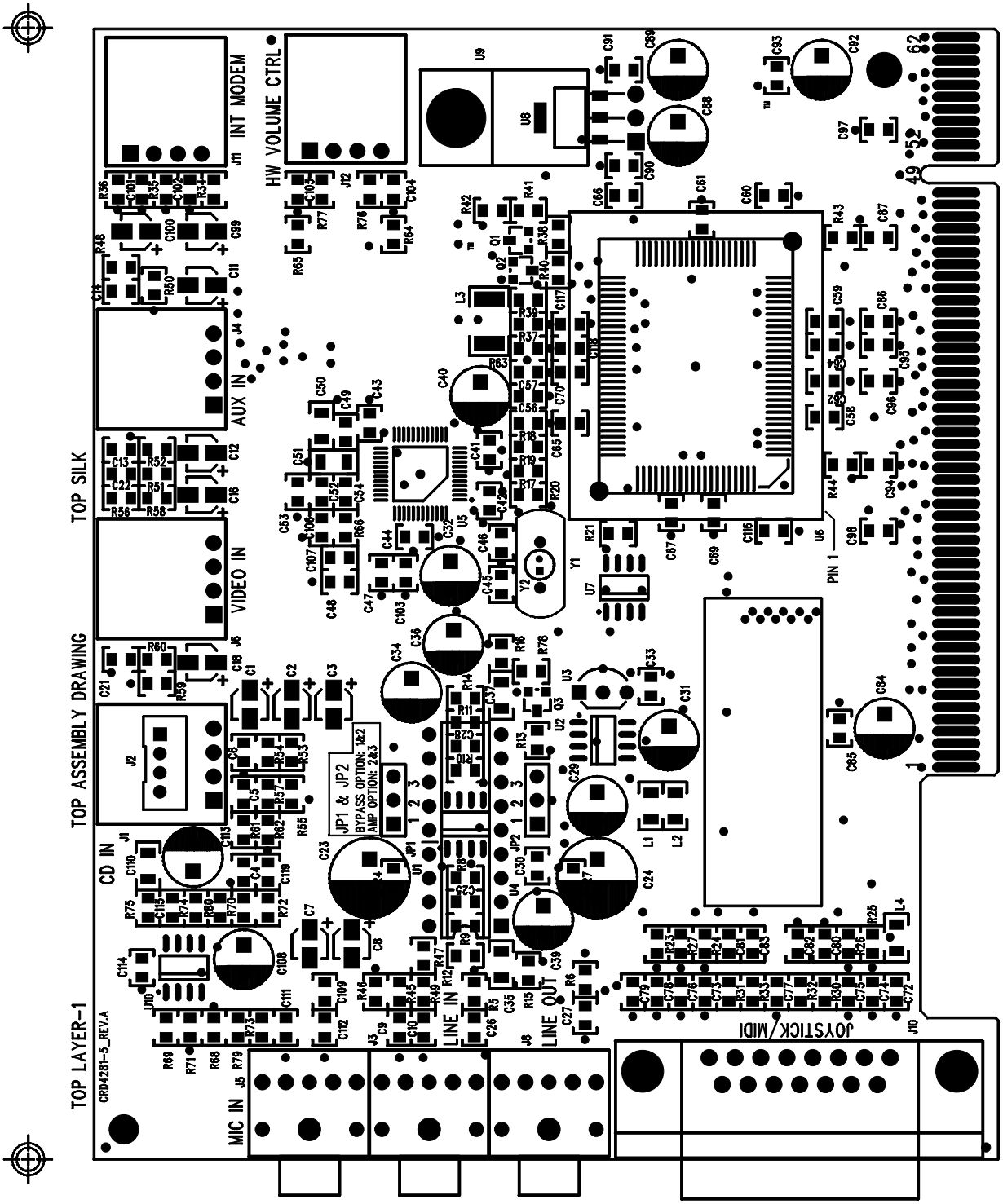


Figure 10. Assembly Drawing

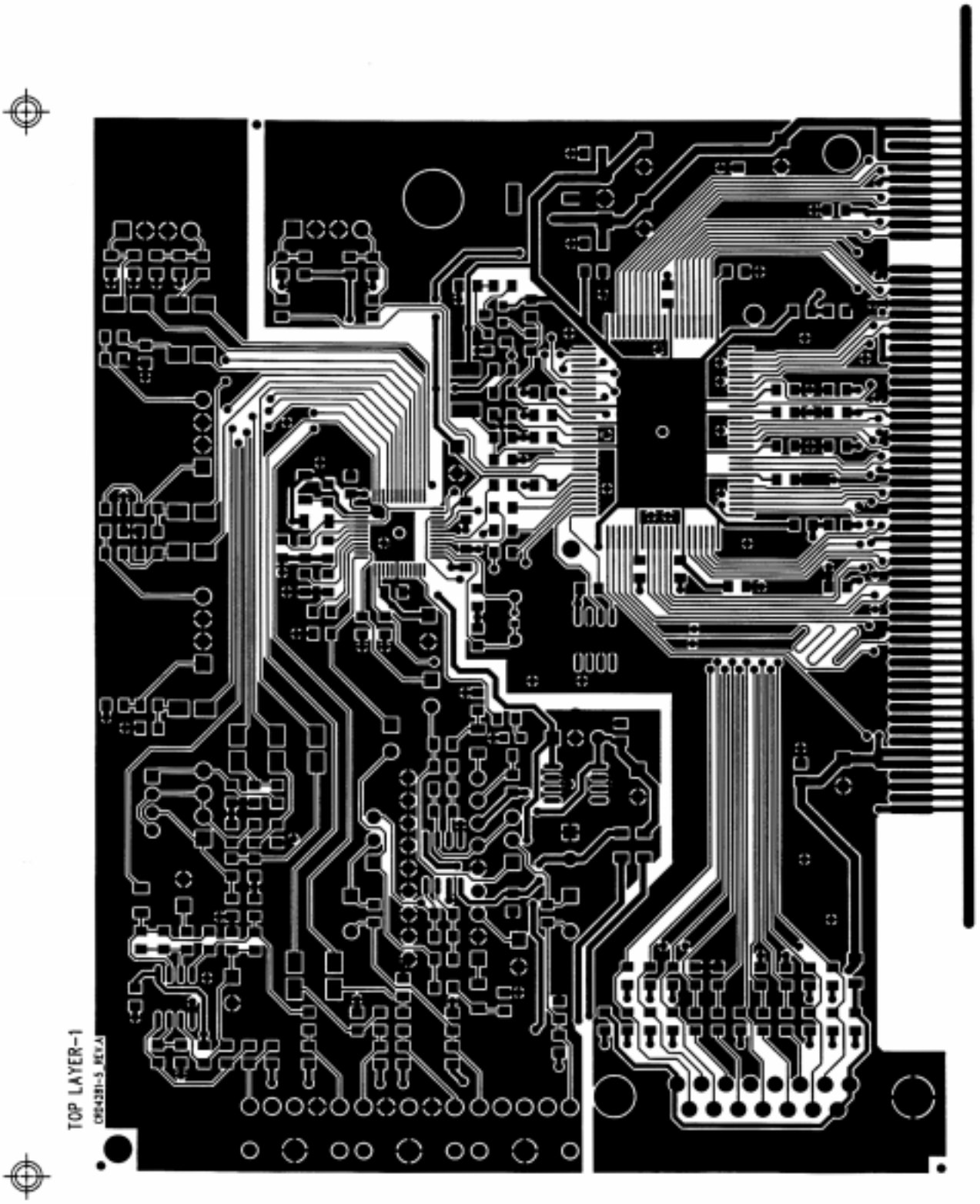


Figure 11. Top Layer

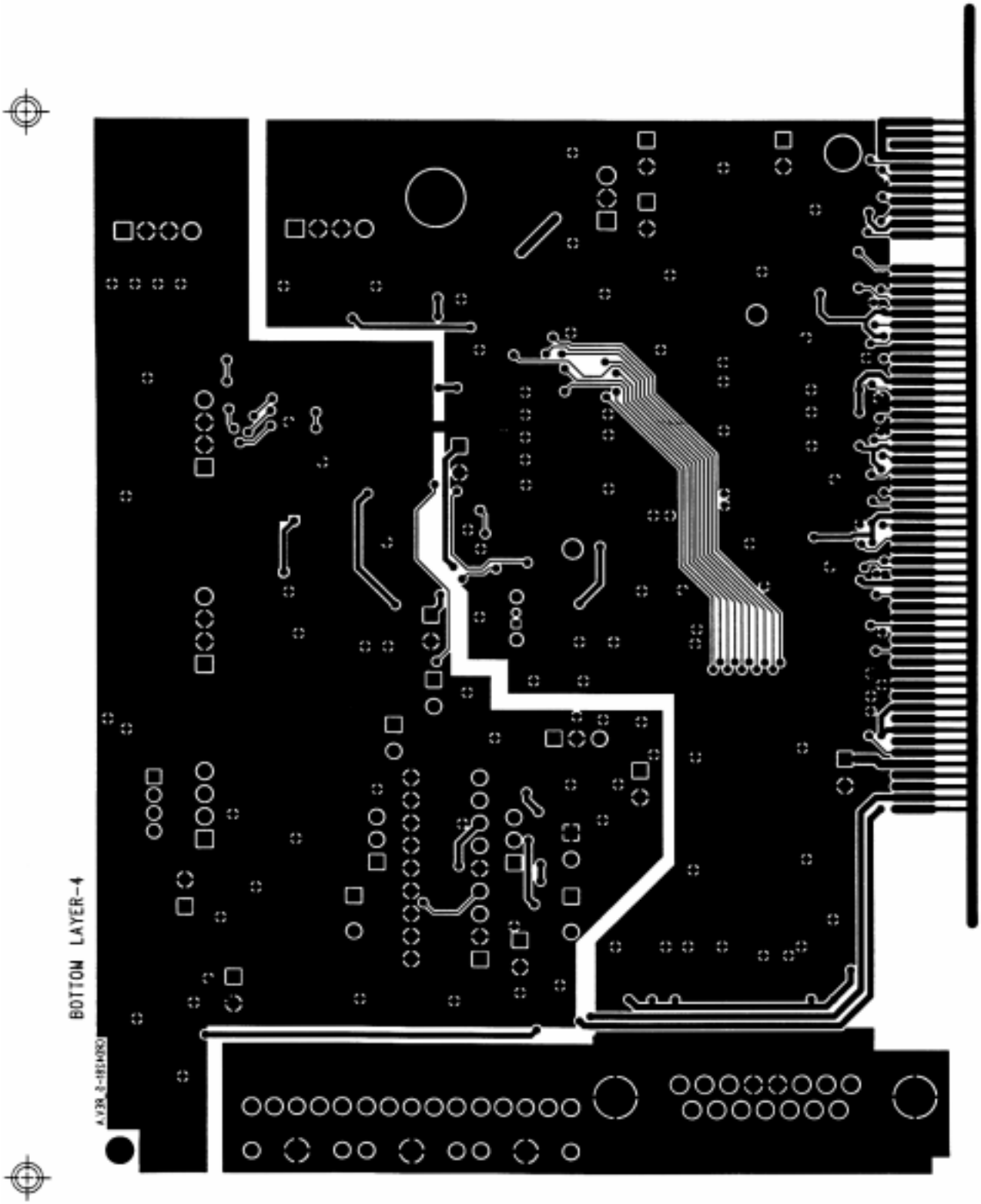


Figure 12. Bottom Layer

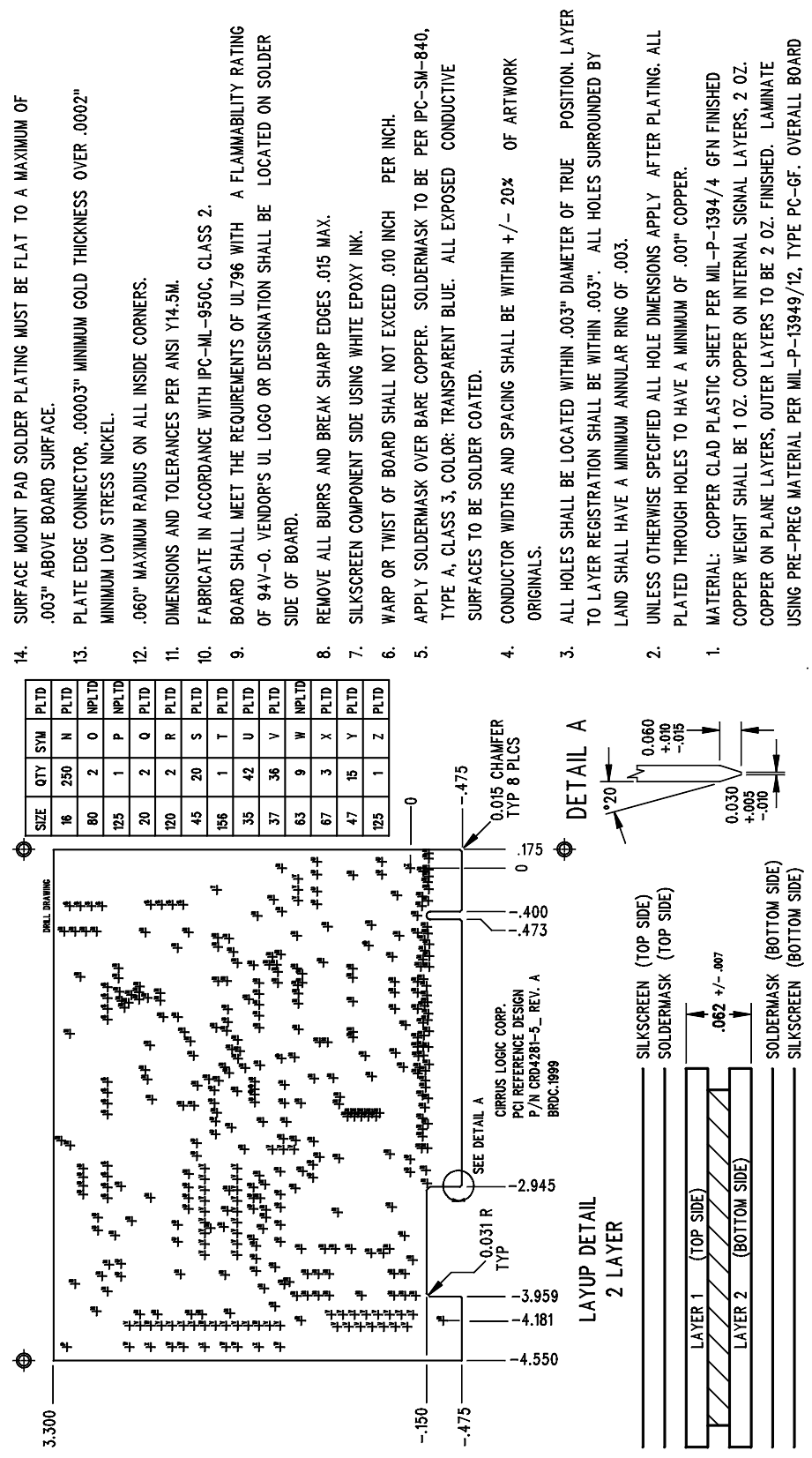


Figure 13. Drill Drawing and Manufacturing Instructions

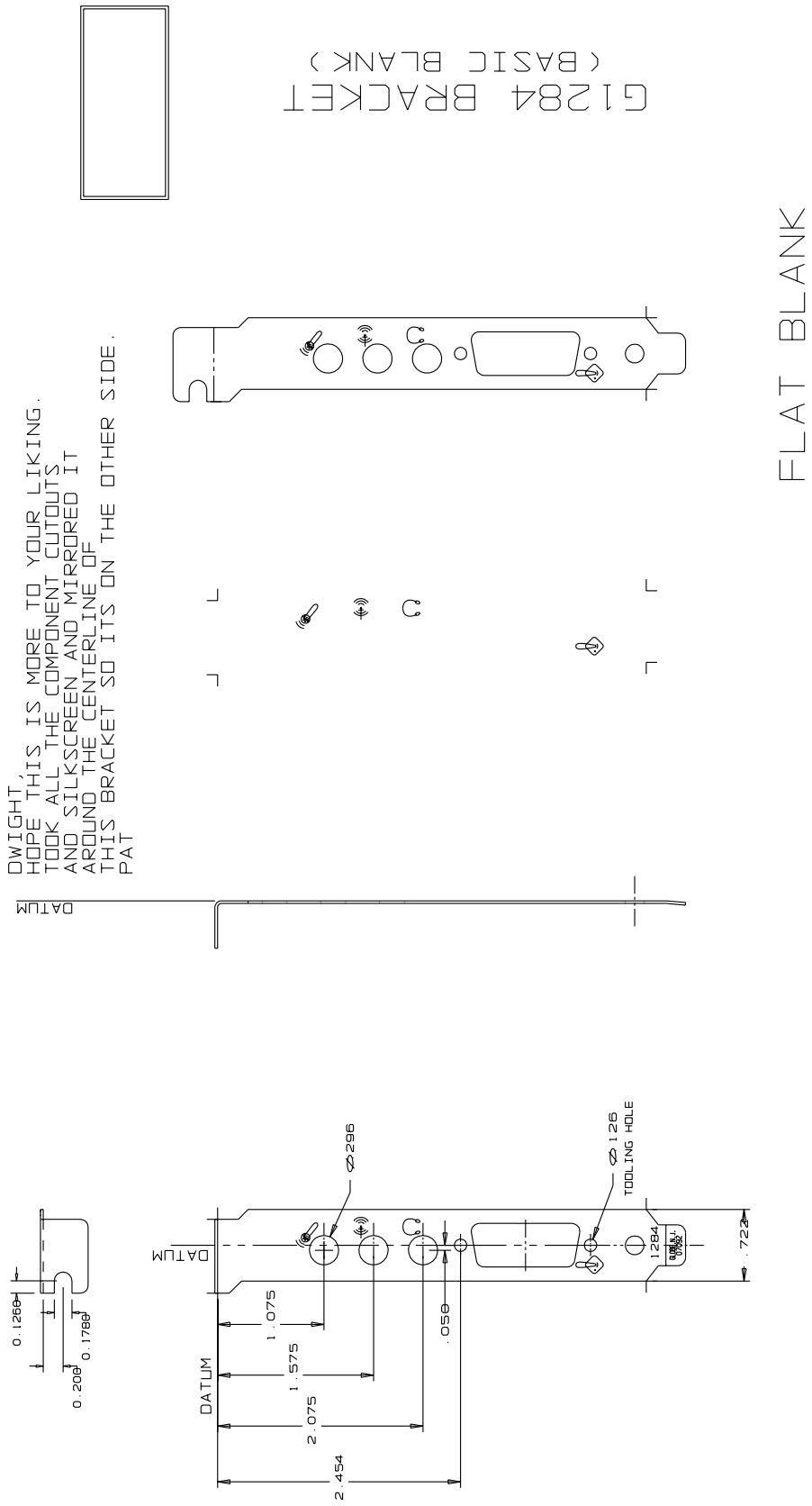


Figure 14. Bracket Drawing

BILL OF MATERIALS

CRD4281-5 Headphone Option							
Item	**Qty**	**Reference**	**Part Description**	**Type**	**Package**	**Manf.**	**Part Number**
1	11	C1,C2,C3,C7,C8,C11, C12,C16,C18,C99,C100	CAP, SMT A, ELEC, 2.2uF, 20%, 35V	ELEC	CE_2.2uF_35V	PANASONIC	ECE-V1VS2R2SR
2	16	C4,C5,C6,C9,C10,C13, C14,C21,C22,C26,C27, C101,C102C111,C112, C115	CAP, 0805, C0G, 220pF, 5%, 50V	NPO	0805_221_C0G_50V_5%	KEMET	C0805C221J5GAC
3	4	C25,C28,C45,C46	CAP, 0805, C0G, 22pF, 5%, 50V	NPO	0805_220_C0G_50V_5%	KEMET	C0805C220J5GAC
4	2	C29,C31	ALUM ELECT, 100uF,20%,16V,POL	PIH	ECEA1CGE101	PANASONIC	ECA-1CM101
5	37	C30,C33,C41,C42,C43, C44,C49,C52,C57,C58, C59,C60,C61,C62,C64, C65,C66,C67,C69,C70, C72,C79,C85,C86,C87, C90,C91,C93,C94,C95, C96,C97,C98,C114, C116,C117,C118	CAP, 0805, X7R, .1uF, 10%, 50V	X7R	0805_104_X7R_50V_10%	KEMET	C0805C104K5RAC
6	10	C32,C34,C36,C40,C88, C89,C92,C108,C113, C84	ALUM ELECT,10uF,20%,16V,POL	ALUM	CAP4X11U106L016	PANASONIC	ECA-1CM100
7	2	C50,C51	CAP,1.0UF,SO,1206,+80/-20%,25V,Y5V	Y5V	GRM42-6Y5V105Z25BL	MURATA	GRM42-6Y5V105Z25BL
8	3	C47,C48,C103	CAP, 0805, C0G, 680pF, 5%, 50V	NPO	0805_681_C0G_50V_5%	KEMET	C0805C681J5GAC
9	7	C53,C54,C56,C73,C74, C75,C76	CAP, 0805, C0G, 1000pF, 10%, 50V	NPO	0805_102_C0G_50V_10%	KEMET	C0805C102K5GAC
10	4	C77,C78,C104,C105	CAP, 0805, COG, 100pF, 5%, 50V	COG	0805_101_COG_50V_5%	KEMET	C0805C101J5GAC
11	4	C80,C81,C82,C83	CAP, 0805, X7R, 12000pF, 10%, 50V	X7R	0805_123_X7R_50V_10%	KEMET	C0805C123K5RAC
12	1	C109	CAP, 0805, X7R, 68000pF, 10%, 50V	X7R	0805_683_X7R_50V_10%	KEMET	C0805C683K5RAC
13	1	C110	CAP, 1206, X7R, 1uF, 10%, 25V	X7R	1206_1uF_X7R_25V_10%	VENKEL	C1206X7R500-105KNE
14	2	JP1,JP2	HDR, 3x1, 0.025" PIN, 0.1" CTR	HEADER	TSW-103-07-G-S	SAMTEC	TSW-103-07-G-S
15	4	J1,J4,J6,J11	HDR, 4X1, 0.025" PIN, 0.1" CTR, 150u" SN/PB	HEADER	MOLEX 70553-0038_0	MOLEX	70553-0038
16	3	J3,J5,J8	1/8" PHONO JACK	CONN	AJ-0356A-5P	A/D ELECTRONICS	AJ-3056A-5P
17	1	J10	CONN, 15D SHELL, FEMALE, RT ANGLE PC MOUNT	CONN	AMP 747845-3	AMP	747845-3
18	1	J12	HDR, 4X1, 0.025" PIN, 0.1" CTR, 150u" SN/PB	HEADER	MOLEX 70553-0038_2	MOLEX	70553-0038
19	3	L1,L2,L4	IND, FBEAD, 1206, 31@100MHz, 25%	FERRITE	HF50ACB321611-T	TDK	HF50ACB321611-T
20	1	L3	IND, FBEAD, 1812, 120@100MHz, 25%	FERRITE	HF30ACB453215-T	TDK	HF30ACB453215-T
21	1	Q1	TRAN, SO, PNP, SOT23	TRANS	MMBT2907ALT1	NATIONAL	MMBT2907ALT1

Table 1. Headphone Amp Population Option

CRD4281-5 Headphone Option							
Item	**Qty**	**Reference**	**Part Description**	**Type**	**Package**	**Manf.**	**Part Number**
22	1	Q2	TRAN, SO, NPN, SOT23	TRANS	MMBT3904LT1	NATIONAL	MMBT3904LT1
23	3	R4,R7,R66	RES, SO, 0805, 0, 5%, 1/10W, METAL FILM	RES	9C08052A0R00J	PHILIPS	9C08052A0R00J
24	2	R5,R6	RES,220K,SO,0805,5%,1/10,METAL FILM	RES	9C08052A224J	PHILIPS	9C08052A224J
25	2	R8,R10	RES, SO, 0805, 56K, 5%, 1/10W, METAL FILM	RES	9C08052A5602J	PHILIPS	9C08052A5602J
26	3	R9,R11,R34	RES, SO, 0805, 27K, 5%, 1/10W, METAL FILM	RES	9C08052A2702J	PHILIPS	9C08052A2702J
27	6	R35,R36,R68,R70,R72, R75	RES, SO, 0805, 47K, 5%, 1/10W, METAL FILM	RES	9C08052A4702J	PHILIPS	9C08052A4702J
28	4	R17,R18,R19,R20	RES, SO, 0805, 47, 5%, 1/10W, METAL FILM	RES	9C08052A47R0J	PHILIPS	9C08052A47R0J
29	1	R21	RES,5.6K,SO,0805,5%,1/10W,METAL FILM	RES	9C08052A5601J	PHILIPS	
30	6	R24,R25,R26,R27,R76, R77	RES, SO, 0805, 4.7K, 5%, 1/10W, METAL FILM	RES	9C08052A4701J	PHILIPS	9C08052A4701J
31	4	R30,R31,R32,R33	RES, SO, 0805, 2.2K, 5%, 1/10W, METAL FILM	RES	9C08052A2201J	PHILIPS	9C08052A2201J
32	2	R64,R65	RES, SO, 0805, 100, 5%, 1/10W, METAL FILM	RES	9C08052A1000J	PHILIPS	9C08052A1000J
33	2	R38,R40	RES, SO, 0805, 39K, 5%, 1/10W, METAL FILM	RES	9C08052A3902J	PHILIPS	9C08052A3902J
34	1	R39	RES, SO, 0805, 5.1K, 5%, 1/10W, METAL FILM	RES	9C08052A5101J	PHILIPS	9C08052A5101J
35	2	R41,R63	RES, SO, 0805, 10K, 5%, 1/10W, METAL FILM	RES	9C08052A1002J	PHILIPS	9C08052A1002J
36	1	R42	RES, SO, 0805, 20K, 5%, 1/10W, METAL FILM	RES	9C08052A2002J	PHILIPS	9C08052A2002J
37	17	R45,R46,R47,R48,R49, R50,R51,R52,R53,R54, R56,R58,R59,R60,R61, R62,R74	RES, SO, 0805, 6.8K, 1%, 1/10W, METAL FILM	RES	9C08052A6801F	PHILIPS	9C08052A6801F
38	2	R55,R57	RES, SO, 0805, 3.4K, 1%, 1/10W, METAL FILM	RES	9C08052A3401F	PHILIPS	9C08052A3401F
39	1	R69	RES, SO, 0805, 68K, 5%, 1/10W, METAL FILM	RES	9C08052A6802J	PHILIPS	9C08052A6802J
40	1	R71	RES, SO, 0805, 100K, 5%, 1/10W, METAL FILM	RES	9C08052A1003J	PHILIPS	9C08052A1003J
41	1	R73	RES, SO, 0805, 2.7K, 5%, 1/10W, METAL FILM	RES	9C08052A2701J	PHILIPS	9C08052A2701J
42	1	U1	DUAL HEADPHONE AMP	AMP	MC1458	Motorola	MC1458
43	1	U3	5V POS. VOLT. REG., 100ma	VREG	MC78L05ACP	Motorola	MC78L05AC
44	1	U5	IC, SO, AC '97 2.0 SERIAL CODEC w/ SRC	CODEC	CS4297A	CRYSTAL	CS4297A
45	1	U6	CS4281-100 MQFP	CON-TROLLER	CS4281 100PIN MQFP	CRYSTAL	CS4281
46	1	U7	IC, SO, SOIC8, SERIAL EEPROM, 16 x 8, 2.5V	EE PROM	24LC00	MICROCHIP	24LC00/SN
47	1	U9	MIC2090A,400MA,TO220	TO220	MIC2920A-TO220	MIRCEL	MIC2920A-3.3BT
48	1	U10	IC, SO, SOIC8, 33078, DUAL OP AMP	OP AMP	MC33078D	MOTOROLA	MC33078D
49	1	Y1	XTAL, 24.576MHz, HC49S,Fund Mode, Par Res	PAR RES, FUND	FOX HC49S_24.576	FOX	FS24.576

Table 1. Headphone Amp Population Option *(cont.)*

CRD4281-5 Headphone Option							
Item	**Qty**	**Reference**	**Part Description**	**Type**	**Package**	**Manf.**	**Part Number**
DO NOT POPULATE							
1	1	C107	CAP, 0805, C0G, 1000pF, 10%, 50V	NPO	0805_102_C0G_50V_10%	KEMET	C0805C102K5GAC
2	1	C106	CERM CAP, .01uF, 10%, 50V,X7R	X7R	0805_103_X7R_50V_10%	KEMET	C0805C103K5RAC
3	2	C35,C37	CAP,1.0UF,SO,1206,+80/-20%,25V,Y5V	Y5V	GRM42-6Y5V105Z25BL	MURATA	GRM42-6Y5V105Z25BL
4	1	C39	ALUM ELECT,10uF,20%,16V,POL	ELEC PIH	CAP4X11U106L016	PANASONIC	ECA-1CM100
5	2	C23,C24	ALUM ELECT,470uF,20%,10V,POL	ELEC PIH	ECEA1AGE471(470 uF)	PANASONIC	ECA-1AM471
6	1	C119	CAP, 0805, X7R, .1uF, 10%, 50V	X7R	0805_104_X7R_50V_10%	KEMET	C0805C104K5RAC
7	1	R13	RES, SO, 0805, 5.6K, 5%,1/10W, METAL FILM	RES	9C08052A5601J	PHILIPS	9C08052A5601J
8	1	R78	RES, SO, 0805, 2.2K, 5%,1/10W, METAL FILM	RES	9C08052A2201J	PHILIPS	9C08052A2201J
9	3	R12,R14,R23	RES, SO, 0805, 47K, 5%,1/10W, METAL FILM	RES	9C08052A4702J	PHILIPS	9C08052A4702J
10	2	R15,R16	RES, SO, 0805, 27K, 5%,1/10W, METAL FILM	RES	9C08052A2702J	PHILIPS	9C08052A2702J
11	1	R37	RES, SO, 0805, 100, 5%,1/10W, METAL FILM	RES	9C08052A1000J	PHILIPS	9C08052A1000J
12	2	R79,R80	RES, SO, 0805, 0, 5%, 1/10W, METAL FILM	RES	9C08052A0R00J	PHILIPS	9C08052A0R00J
13	1	Q3	TRAN, SO, NPN, SOT23	TRANS	MMBT3904LT1	NATIONAL	MMBT3904LT1
14	1	U4	2X6W POWER AMP	IC	TDA1517P	PHILIPS	TDA1517P
15	1	U2	5V POS. VOLT. REG., 100ma	VREG	MC78L05ACD	Motorola	MC78L05ACD
16	1	U8	MIC2920A,400ma,SOT223	VREG	SOT223	MIRCEL	MI2920A-3.3BS
18	1	J2	4 PIN SHROUDED HEADER, .08"	CONN	B4B-PH-K	JST	B4B-PB-K
19	1	Y2	XTAL, 24.576MHz, CA-301, Fund Mode, Par Res	PAR RES, FUND	EPSON CA-301_24.576	EPSON	CA-301_24.576M-C

Table 1. Headphone Amp Population Option *(cont.)*