CRD4281-15

CrystalClear™ AC '97 2 Channel Low Cost PCI Audio Reference Design

Features

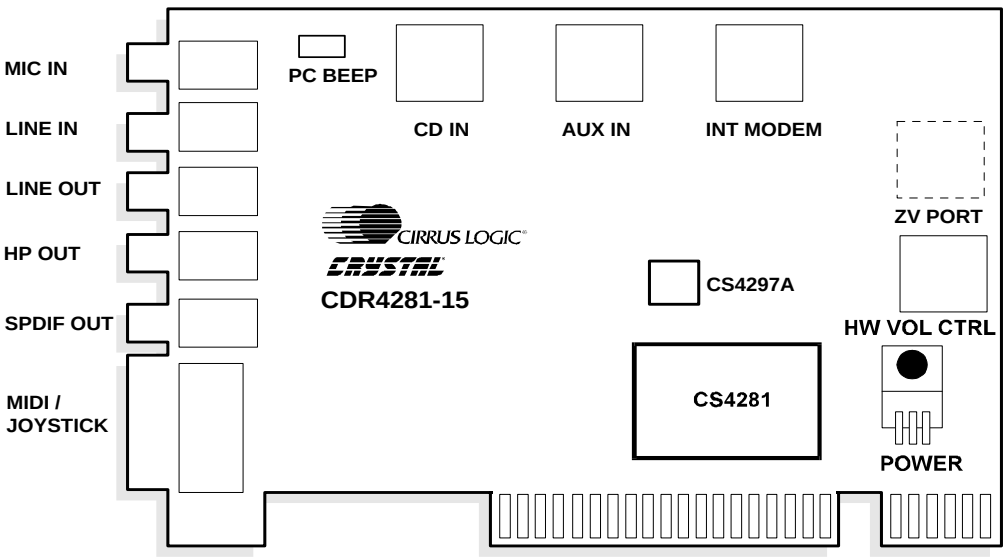
- 2 Channel Low Cost High Performance PCI Audio Accelerator add-in card
- CS4281 PCI Audio Controller and CS4297A Audio Codec '97
- Complete suite of Analog I/O connections:
  - Line, Mic, CD, and Aux Inputs
  - Line and Headphone Outputs
- S/PDIF (IEC-958) digital output
- ZV Port Input
- Joystick/MIDI Interface
- 2-layer low cost adapter board
- Exceeds Microsoft's® PC 99 audio performance specifications.
- Complies with the AC '97 version 2.1 specification

Description

The CRD4281-15 is a low cost PCI add-in board reference design that showcases Cirrus Logic's CS4281 audio controller and the CS4297A audio codec. The card features two channel 20-bit DACs, two channel 18-bit ADCs, an optional ZV port digital input, and a S/PDIF digital output.

The CRD4281-15 reference design is available by ordering the CMK4281-15 manufacturing kit. Use this kit to help you develop high quality PCI add-in cards and PC motherboard audio designs. The CMK4281-15 includes a full set of schematic design files (OrCAD® 7.2 format), PCB job files (PADS® ASCII), PCB artwork files, and bill of materials. This design is production ready. It can also be easily modified to meet your specific requirements.

ORDERING INFO
CMK4281-15 (Manufacturing Kit)



Preliminary Product Information | This document contains information for a new product.
Cirrus Logic reserves the right to modify this product without notice.

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LIST OF FIGURES

1. GENERAL INFORMATION

The CRD4281-15 is a PCI add-in card that features the CS4281 PCI audio controller and the CS4297A AC-97 audio codec. The CRD4281-15 is a low cost board with a rich feature set and industry leading audio performance. In order to maintain high audio quality, careful consideration has been given to component selection and PC layout.

The CS4297A is a mixed-signal serial audio codec based on the Intel AC '97 2.1 specification. The CS4297A features a 20-bit stereo DAC, an 18-bit stereo ADC, a digital S/PDIF output, and a very flexible analog audio mixer. The CS4297A has four line-level stereo inputs, two mono line-level inputs, two switchable microphone inputs, and a stereo pseudo-differential CD input. The input signals can be routed to the ADC for recording, or mixed together for recording and direct playback. The CS4297A has 64 registers that are used to control its various features such as volume levels, mutes and signal routing. The CS4297A maintains high audio quality throughout its signal chain and exceeds the Microsoft PC-99 audio performance specification.

The CS4281 controller streams digital audio data and MIDI over the PCI bus. It also performs hardware-controlled signal processing and sample rate conversion. The CS4281 features several peripheral interfaces including MIDI output, joystick and game controller input, hardware volume control and several General Purpose I/Os.

The CS4297A and the CS4281 communicate through a 5-wire serial digital interface known as the AC-Link. The AC-Link is used to transfer digital audio between the two devices. Its is also used to send commands from the CS4281 to the CS4297A's registers. For more information on the AC-Link, see the AC'97 version 2.1 specification.

2. SCHEMATIC DESCRIPTION

The block diagram in Figure 1 illustrates the interconnections between the schematic pages. The following are descriptions of the other pages contained in the schematics.

2.1 Analog Inputs

The inputs for AUX, CD, and LINE shown in Figure 2 are attenuated 6dB by a voltage dividers. This allows for input levels up to 2 Vrms. Each of these inputs has 220 pF EMI suppression capacitors. These may be removed if EMC testing determines they are not required.

The CS4297A analog inputs and outputs need to be AC coupled because of internal bias voltages. 10 uF AC coupling capacitors are used on the Line, CD, Aux, and Internal Modem inputs to minimize low frequency roll-off. The CS4297A CD input is pseudo-differential. The CD signal acts as one side of the differential input and CD_COM as the other. CD_COM is a common return path for both the left and right channels. For good common mode rejection performance, the voltage divider resistors for CD_COM have been set to half the value of those for CD L and R inputs.

There are provisions for two types of analog audio CD connectors. J1 is for the standard ATAPI connector and J2 is for the legacy 2 mm Mitsumi connector. You can install only one of the two connectors because the footprints of J1 and J2 are placed on top of each other.

The CRD4281-15 has circuitry to accommodate the audio from a modem. The modem connection uses the CS4297A's MONO_OUT and PHONE_IN. The MONO_OUT circuit has a voltage divider that can be adjusted to accommodate small output levels.

2.2 ZV Port Digital Input

The ZV port in Figure 3, accepts PCM audio data in I^2S serial format and routes it to the CS4334 DAC. The analog output of this DAC is connected to the VIDEO_IN audio inputs of the CS4297A.

2.3 Line Output

The LINE_OUT circuit in Figure 4 consists of a Motorola MC1458 dual op-amp. This device is capable of driving high impedance line level signals, such as powered speakers, and stereo headphones with impedances greater than 32 Ω. This circuit has a gain of 6 dB. The output of the op-amp is connected to an anti-pop circuit that is described in Figure 5. This anti-pop circuit suppresses power-on transient pops.

2.4 Headphone Output and Anti-Pop Circuitry

The headphone output circuit in Figure 5 consists of a Motorola MC1458 dual op-amp connected to the ALT_LINE_OUT of the CS4297A. The MC1458 circuit has a gain of 6 dB and is capable of driving stereo headphones with impedances greater than 32 Ω.

The headphone output is connected to an anti-pop circuit. During power up, transistors Q5-Q8 in the anti-pop circuit suppress power-on transients by temporarily muting the audio output.

2.5 CS4281 PCI Controller

The CS4281, in Figure 6, has 0.1 µF decoupling capacitors connected to each of its power pins. All of these capacitors are located physically close to the device. L3, C56, and C57 are used to filter the power supply for the internal PLL circuit.

The AC-Link requires series termination resistors to prevent reflections. The resistors are placed as close as possible to device originating the signal. The CS4281 generates SYNC and SDATA_OUT and each has a 47 ohm series termination resistor, R19 and R20.

All unused inputs and bi-directional pins on the CS4281 are tied to their respective inactive levels through a 10 kΩ resistor.

2.6 CS4297A Audio Codec

The audio codec is shown in Figure 7. All analog inputs are sent to the codec from the circuitry in Figure 2 (Audio In) and Figure 8 (Microphone In). All of these signals are AC coupled. Unused analog input should be tied to Vref (pin 28) or AC coupled to ground through a capacitor to prevent noise. Mic 2 is the only unused input on the CRD4281-15 and is tied directly to Vref.

The CS4297A generates two AC-Link signals, BITCLK and SDATA_IN. Both outputs have a 47 Ω series termination resistor to prevent reflections on the AC-Link.

2.7 Mic Pre-amp and Phantom Power

The microphone pre-amp in figure 8 uses a Motorola MC33078D low noise dual op-amp. One of the op-amps provides 18 dB gain stage for the microphone. The other op-amp buffers the phantom power supply for the mic. The phantom power is derived from the +5 V analog supply and buffered by U10A to provide a maximum of +4.2 V with no load and a minimum of +2.0 V under a 0.8 mA load, as required by PC 99. The microphone circuit also has 3 dB rolloffs at 60 Hz and 15 kHz as specified in PC-99.

2.8 MIDI and Joystick Connection

The MIDIOUT buffer driver circuit in Figure 9 is used to provide +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 EMI 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 required for the

joystick circuitry to be functional and must not be removed.

2.9 S/PDIF Output

The S/PDIF (IEC-958) digital output, in Figure 10, is compatible with digital inputs on consumer devices such as consumer stereo receivers and MiniDisk recorders. The CS4297A S/PDIF output is coupled to J16 through an isolation transformer. This design uses a low cost industry standard device, the PE65612 by Pulse Engineering.

The S/PDIF and DAC outputs are derived from the same 48 KHz PCM signal. This means that whatever digitally effects LINE_OUT, such as sample rate conversion, also effects the S/PDIF output.

2.10 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. In Figure 11, seven 0.1 µF capacitors in parallel provide the required capacitance for the +3.3 V power pins.

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. In Figure 12, a Motorola MC78M05 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. Optionally, U3, a 78L05, can be used in applications where LINE_OUT and ALT_LINE_OUT are only going to drive high impedance loads (10 KΩ or greater). The -12 V power pin is decoupled through C29 and C30, and supplies power to the headphone circuit.

The Micrel MIC2920A low dropout regulator is provides 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 through hole package. 0 Ω resistors are provided as a build option if +3.3 V is guaranteed to be available on the PCI bus.

2.11 Component Selection

Great attention was given to the particular components used on the CRD4281-15 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.
- Dual footprint for the 24.576 MHz. crystal. Standard H49S, and small circular CA-301 through hole package.
- Dual footprint for +5 V and +3.3 V regulators. Surface mount and through hole packages are supported.

2.12 EMI Components

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

3. GROUNDING AND LAYOUT

The component layout and signal routing of the CRD4281-15 provides a good model for laying out your own 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 , Section 4.3.6, for information on routing PCI bus signals on a motherboard.

3.1 Partitioned Voltage and Ground Planes

The CRD4281-15 is partitioned into separate digital and analog sections to prevent digital noise from affecting the performance of the analog circuits. The analog section is completely isolated from the digital section. The analog and digital sections each have their own separate ground plane. All analog components, power traces and signal traces lie over the analog ground plane. Digital components, power traces and signal traces are not allowed to cross-over into the analog section.

The CS4297A is placed at the transition point between the analog and digital ground planes. The pins are arranged on the CS4297A so that the analog and digital signals are separated from each other. The analog and digital ground planes must be tied together for the codec to maintain proper voltage references. For best results, the two ground planes are tied together with a single wide trace under the codec near its digital ground pins.

Data converters are generally susceptible to noise on the crystal pins. In order reduce noise from coupling onto these pins, the area around the crystal and its signal traces is filled with copper on the top and bottom of the PCB and attached to digital ground.

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

3.2 CS4297A Layout Notes

Refer to the *CS4297A Data Sheet* for partitioning and bypass capacitors placement. Pay close attention to bypass capacitors on REFFLT, AFLT1, AFLT2 and the power supply capacitors.

4. 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 1.0
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.

4.1 ADDENDUM

- Schematic drawings
- Layout drawings
- Bracket drawings
- Bill of materials

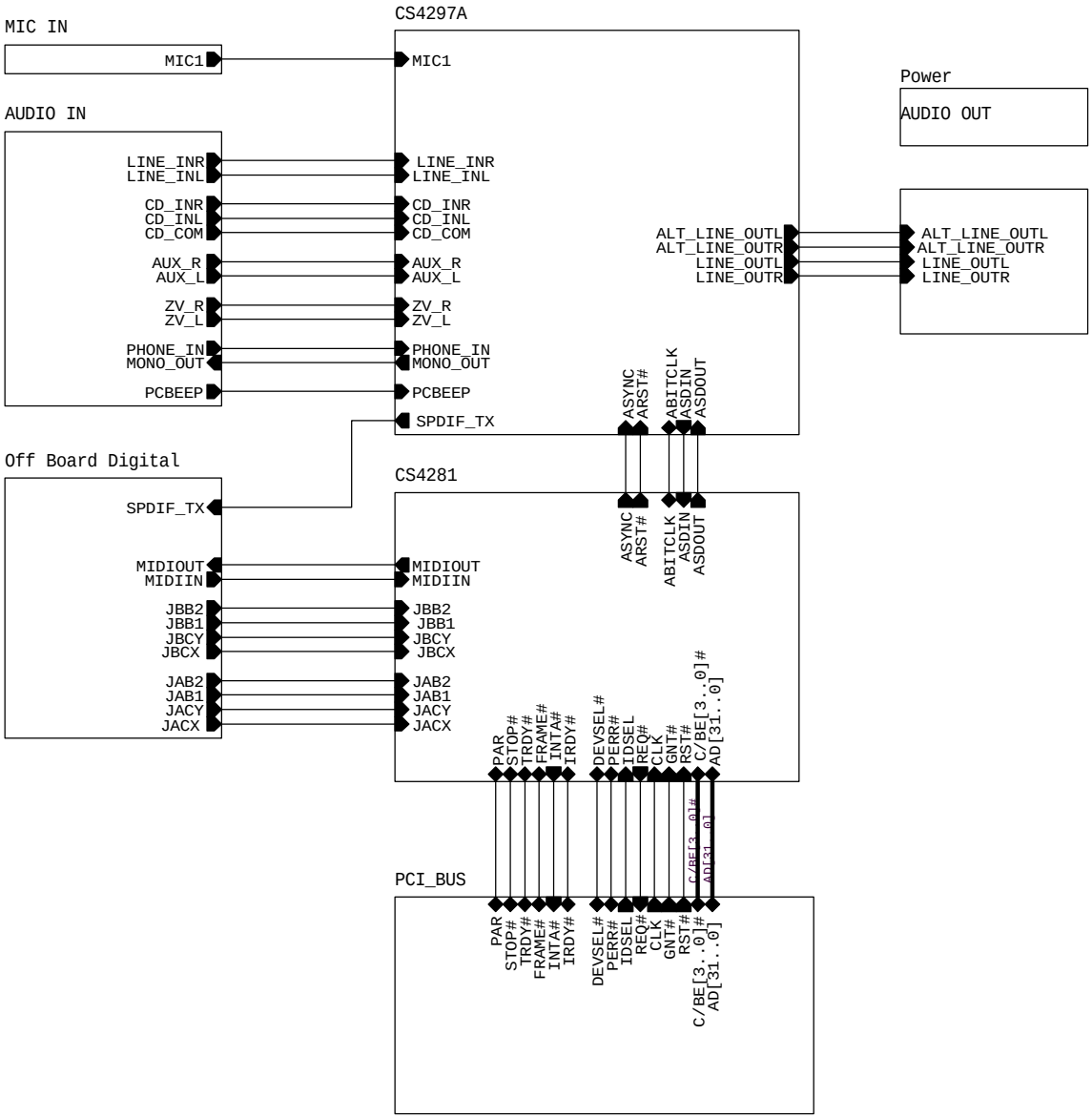


Figure 1. Block Diagram

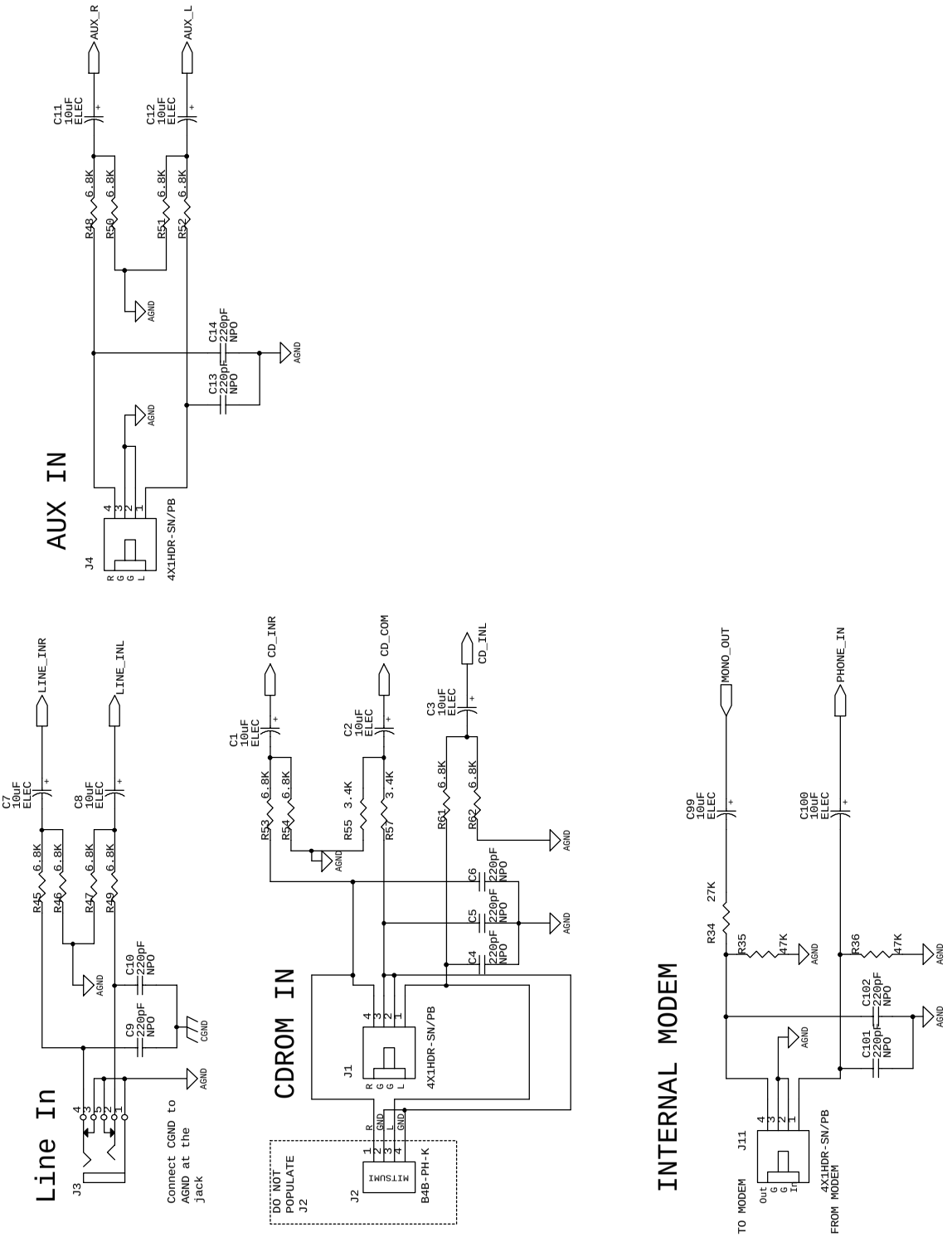
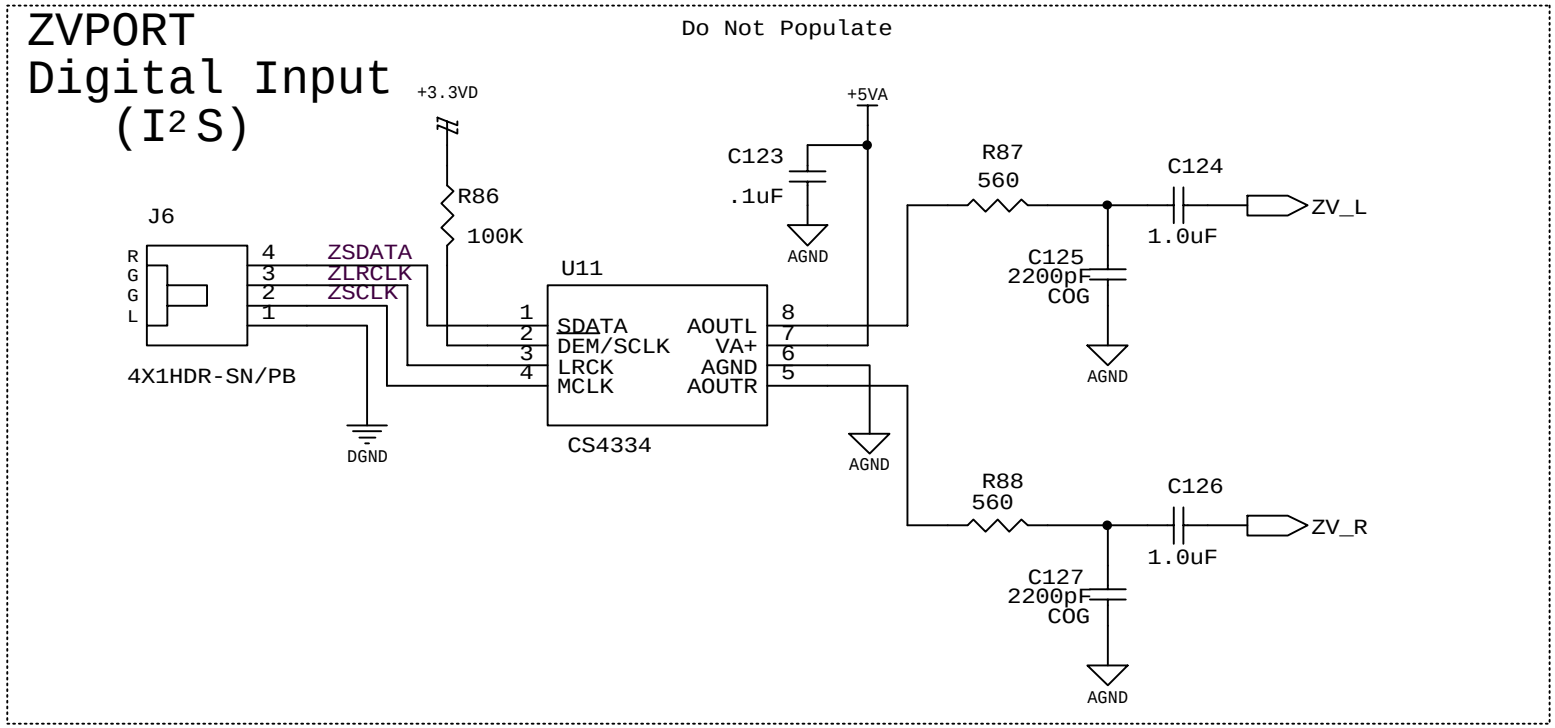


Figure 2. Audio In



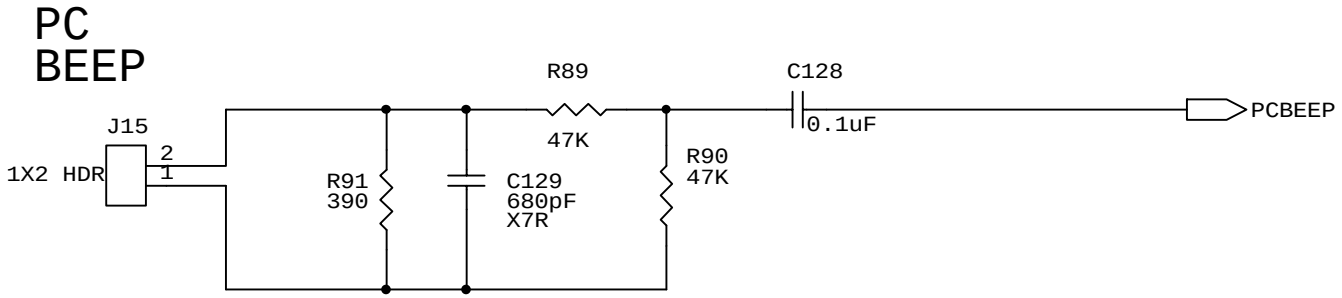


Figure 3. ZV Port Digital Input and PC Beep Input

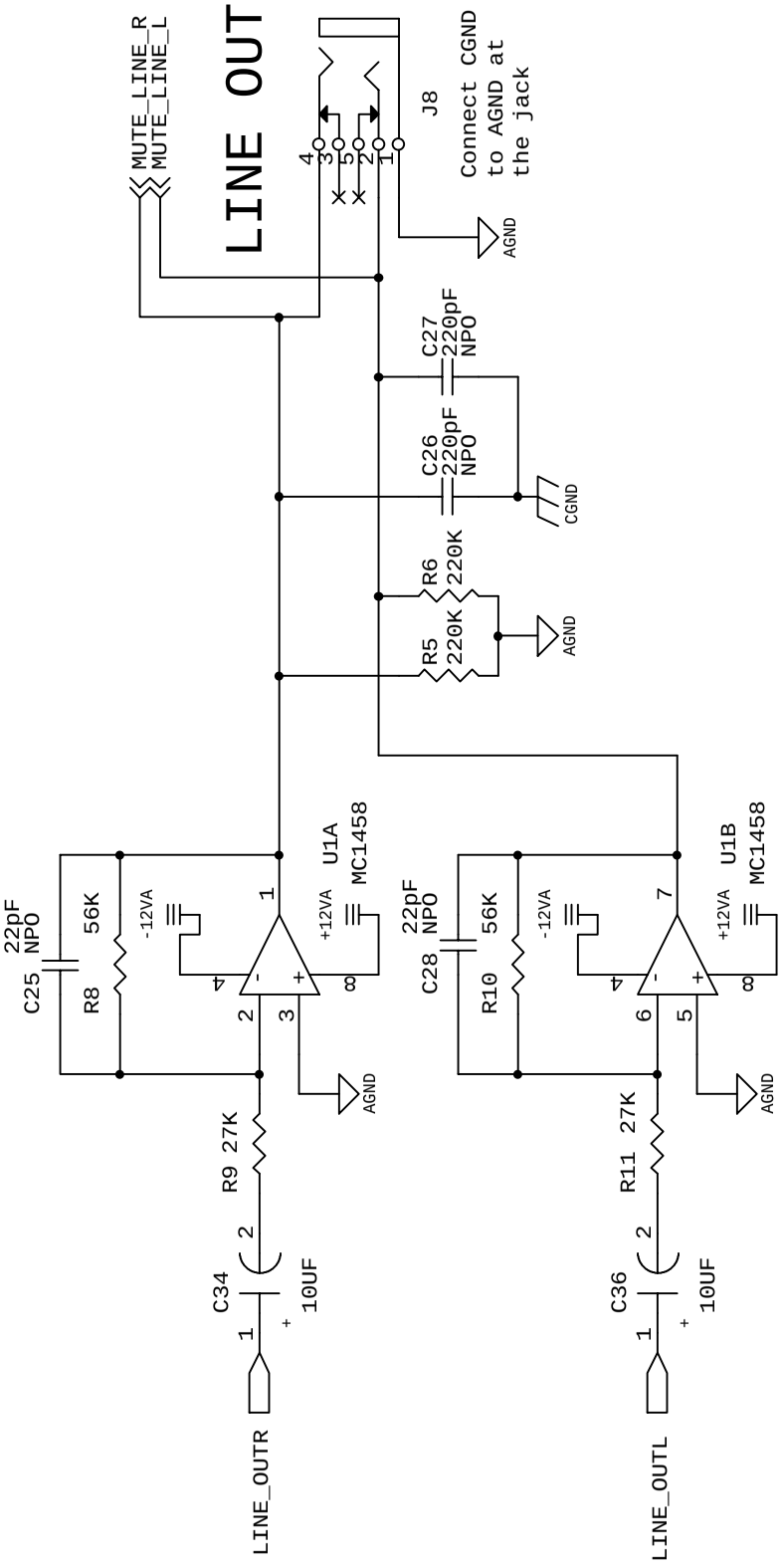


Figure 4. Line Out

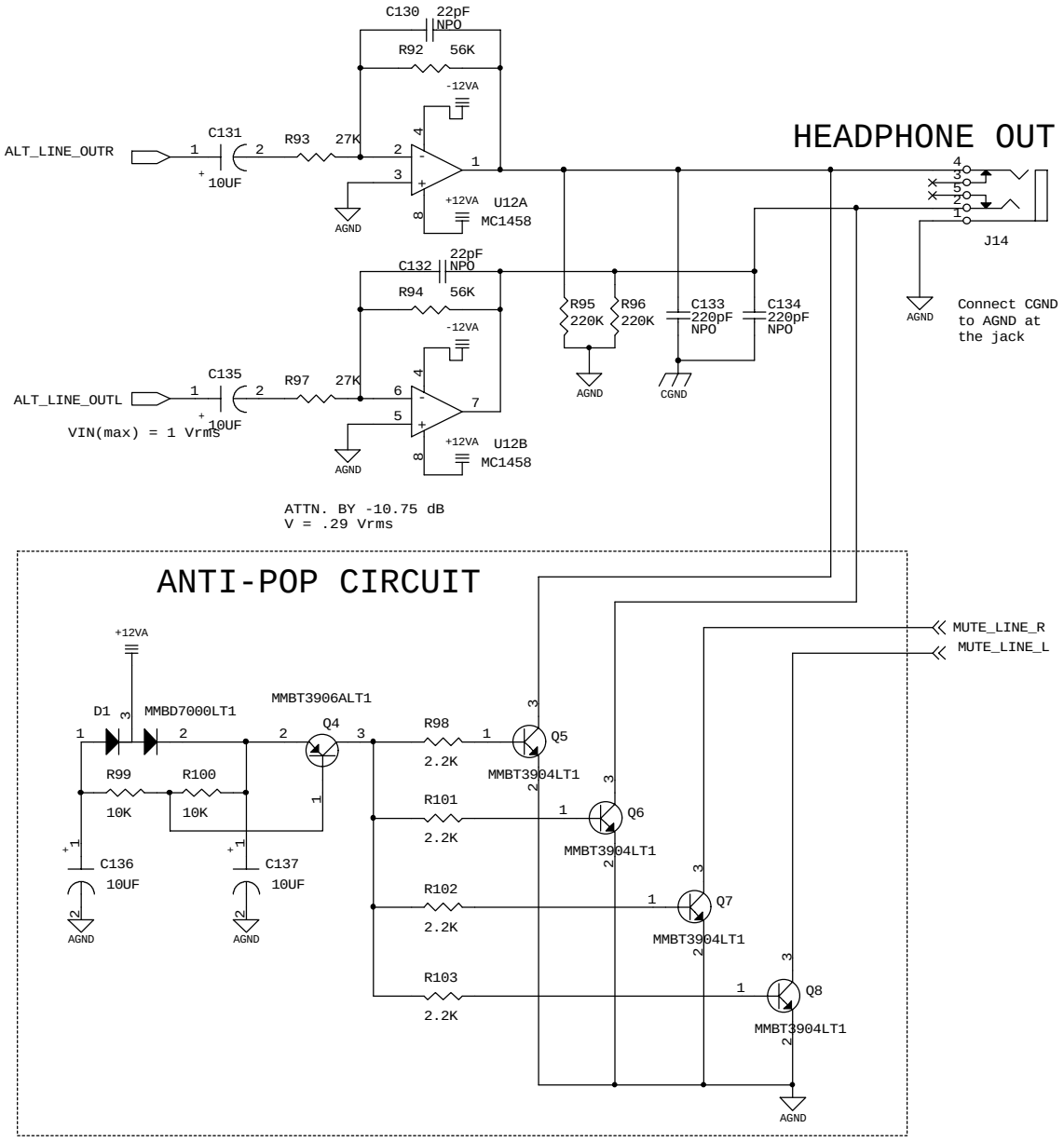


Figure 5. Headphone Output and Output Mute Circuit

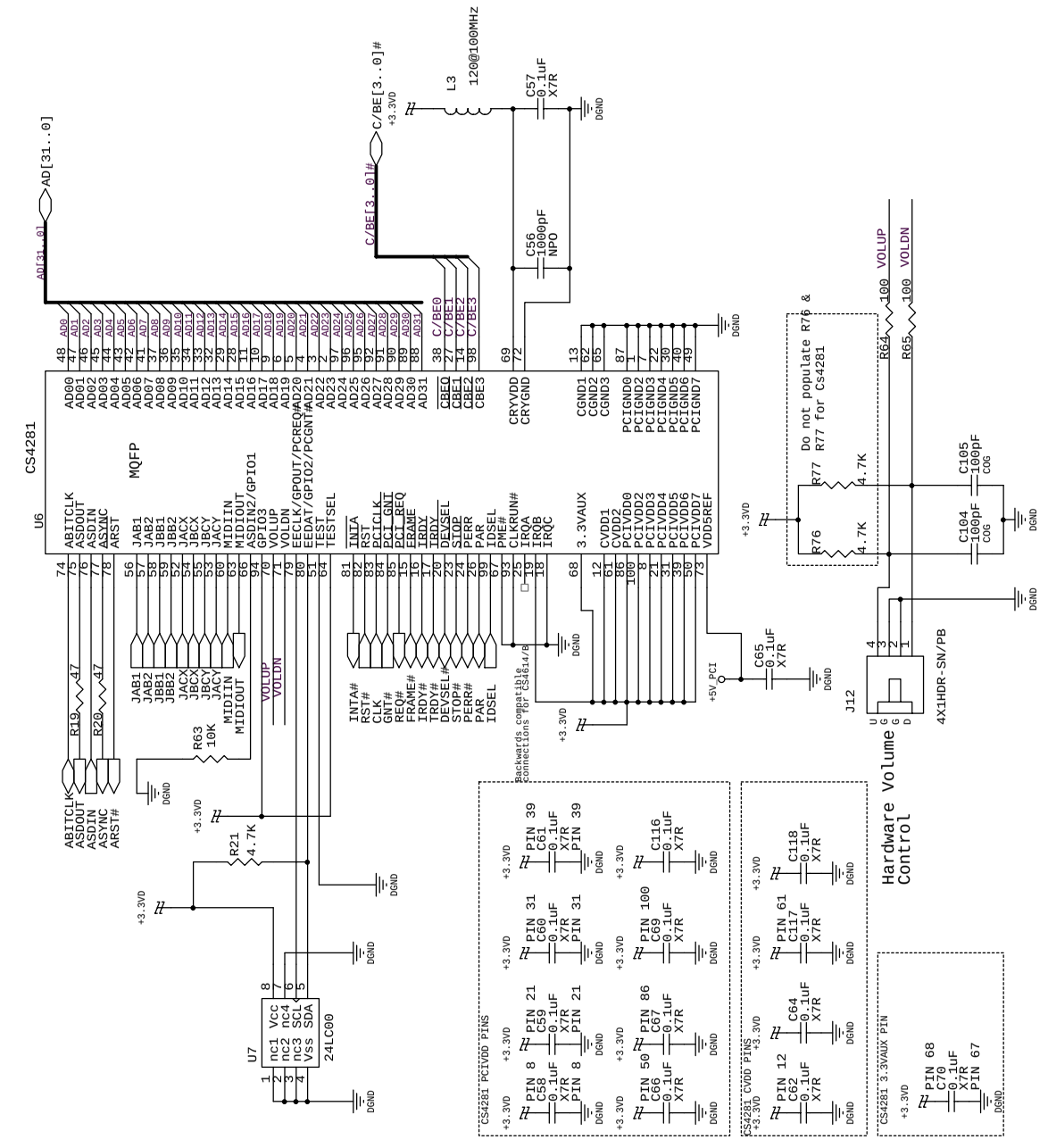


Figure 6. CS4281 PCI Audio Controller

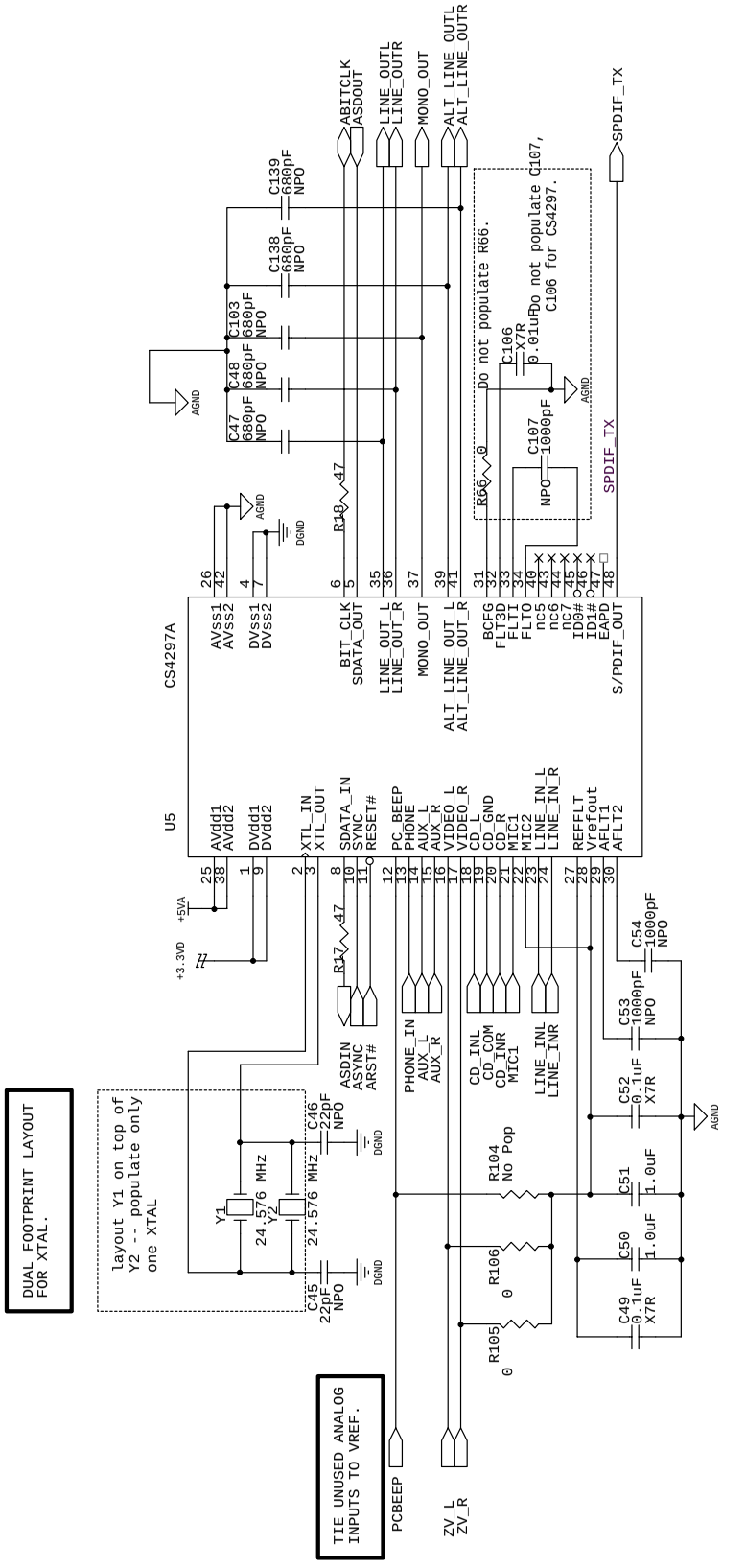


Figure 7. CS4297A Codec

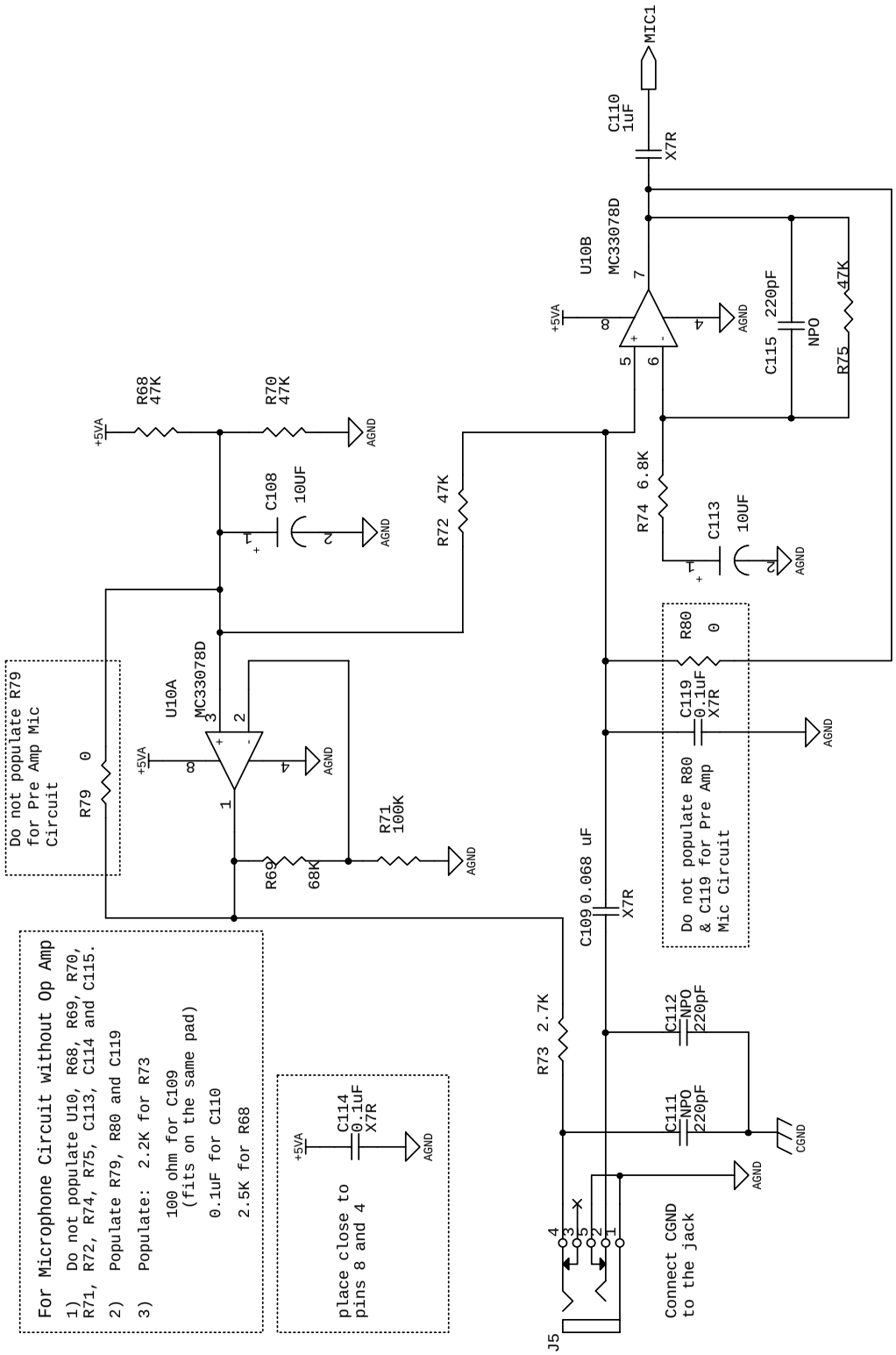


Figure 8. Microphone Input Circuit

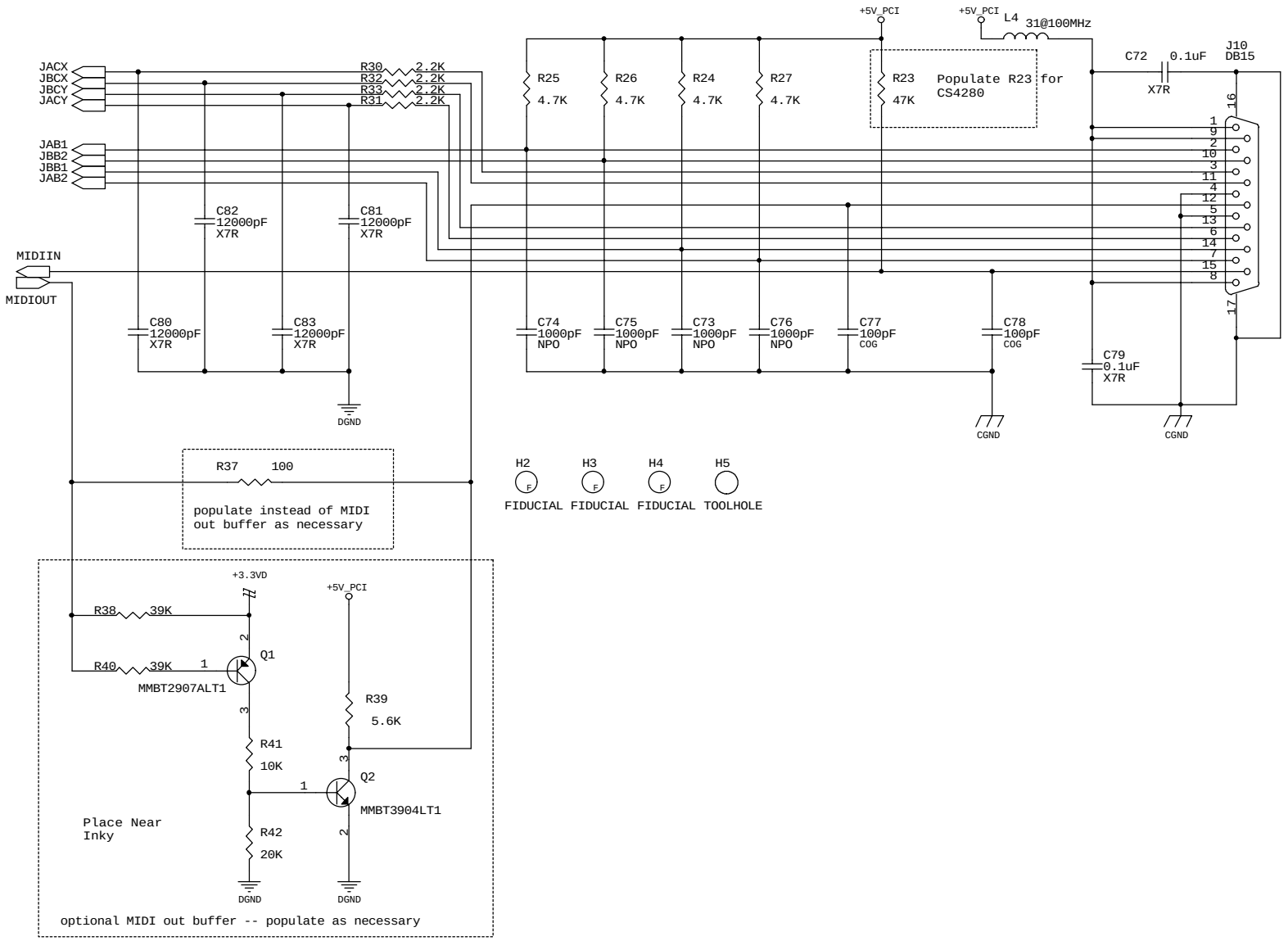


Figure 9. MIDI and Joystick Control

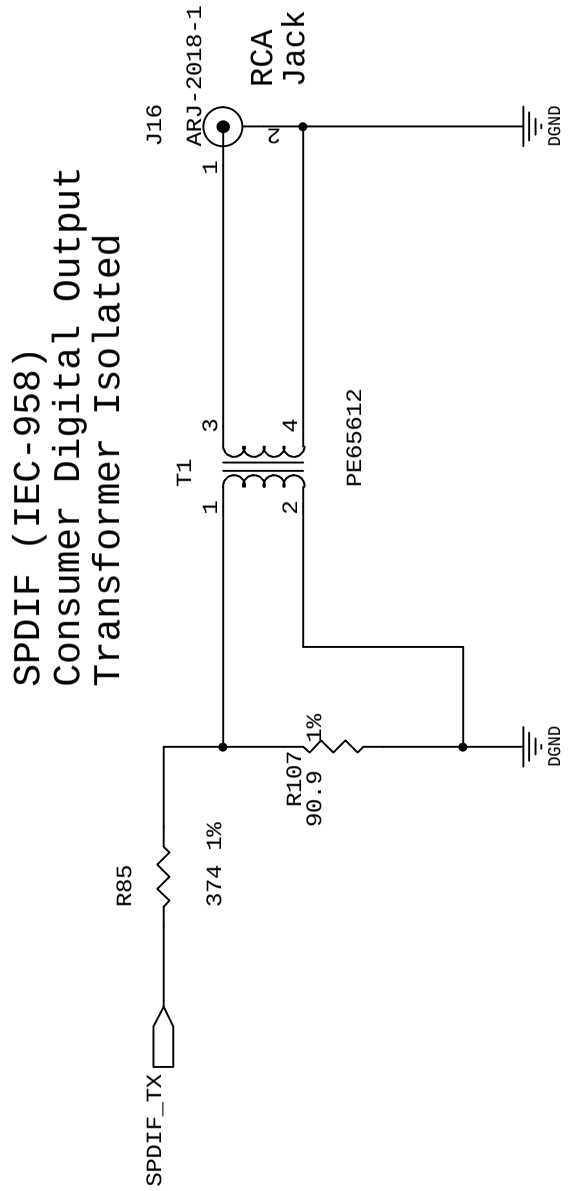


Figure 10. S/PDIF Consumer Digital Output

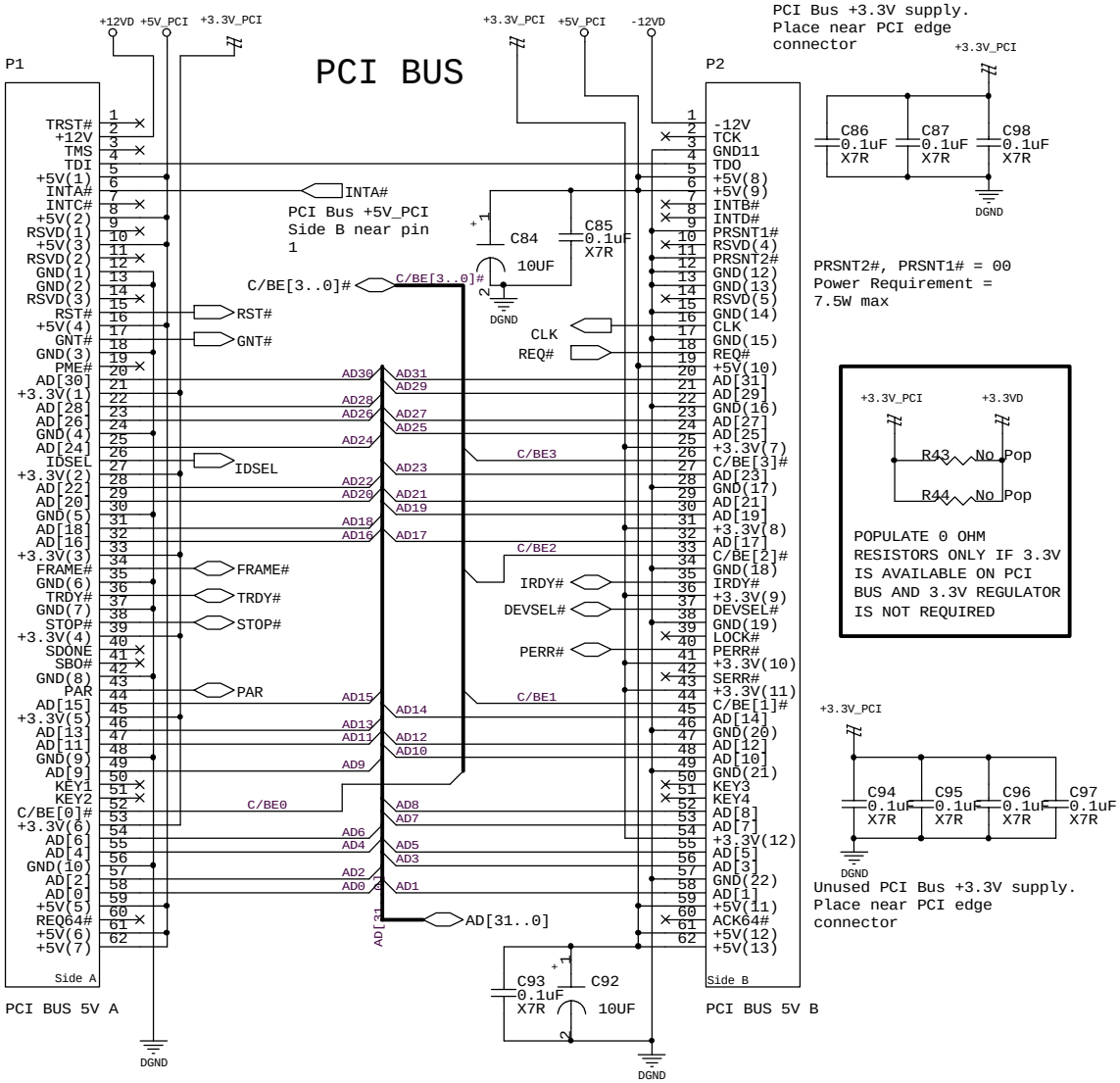


Figure 11. PCI Bus

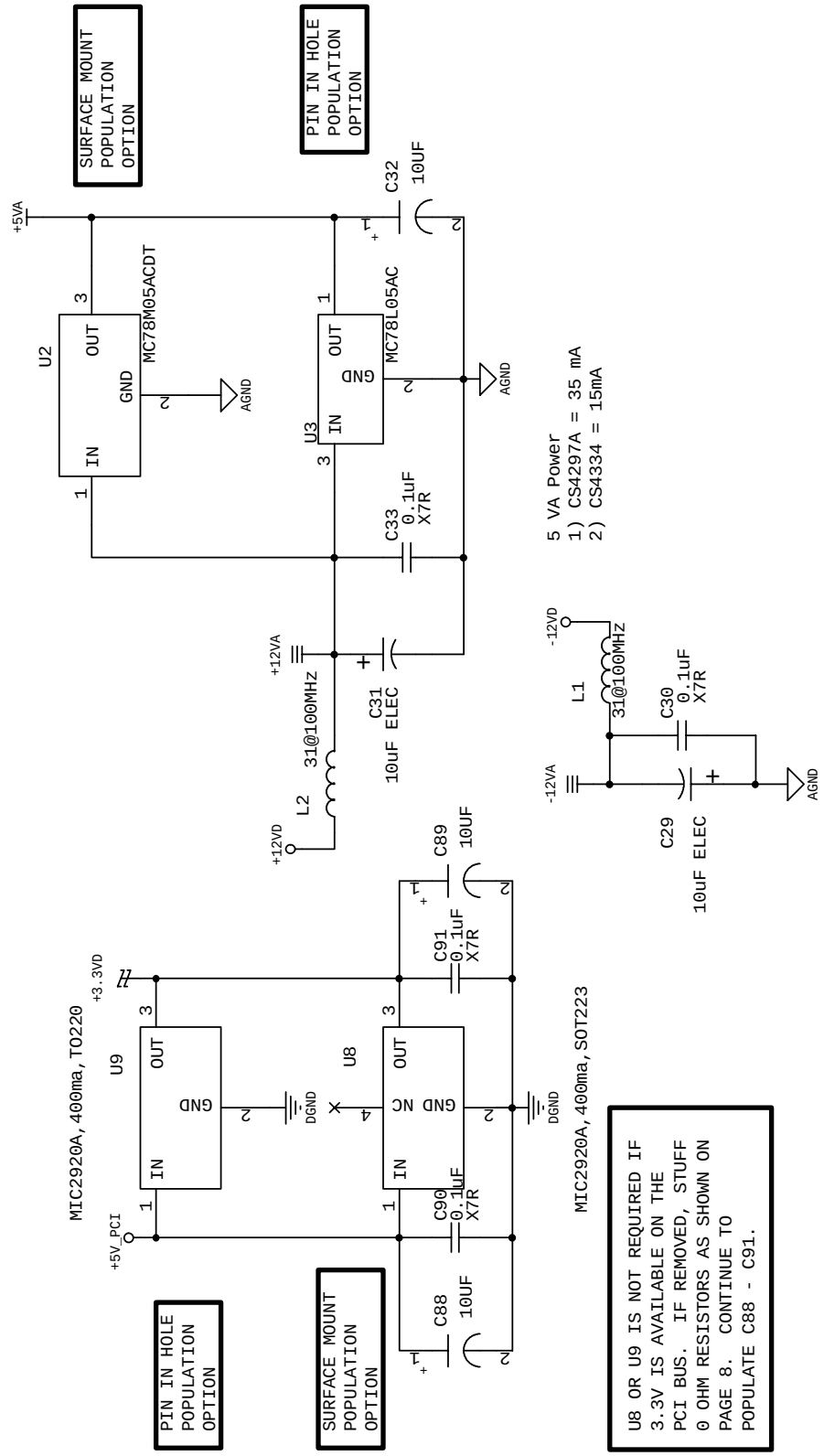


Figure 12. Power

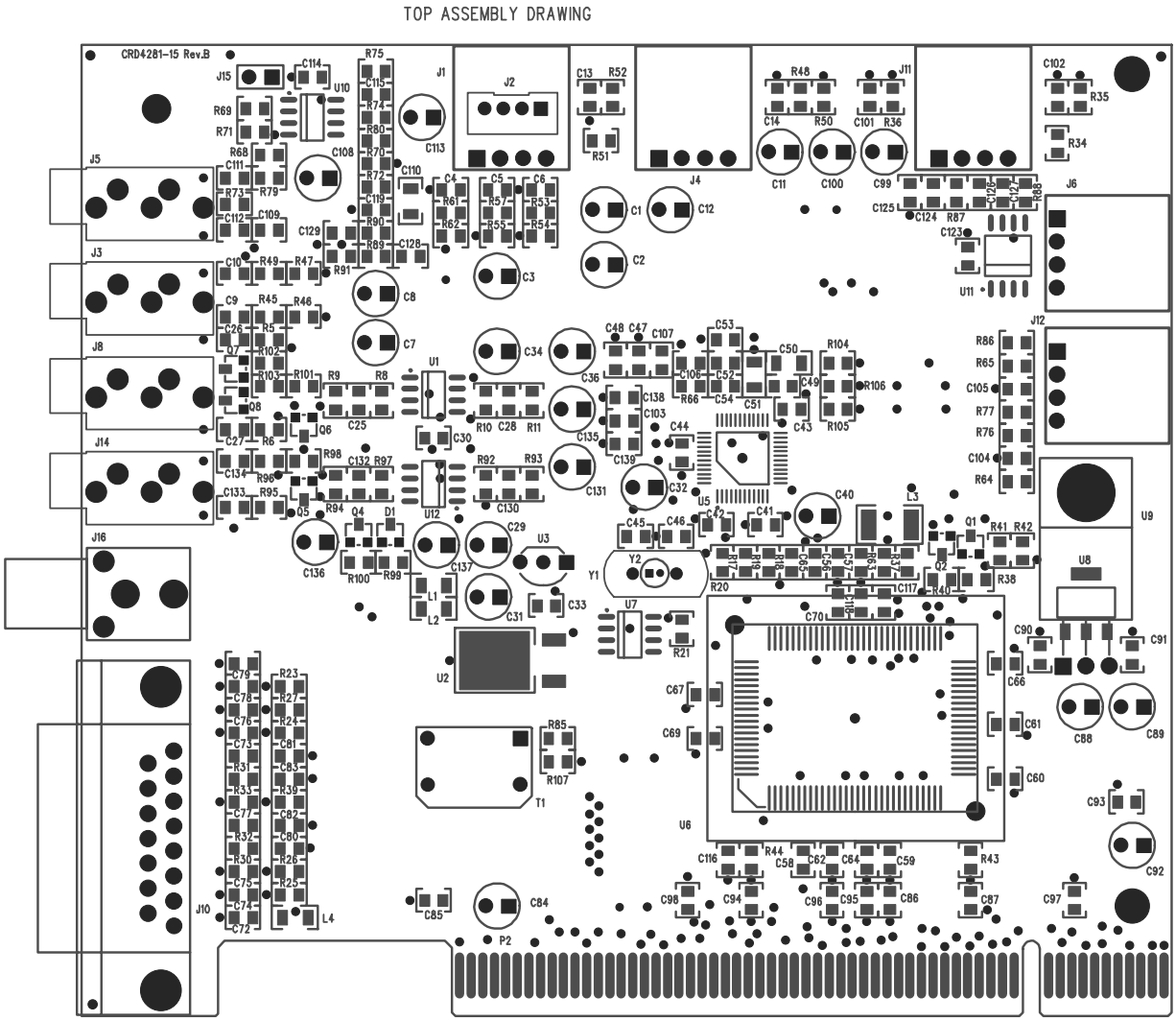


Figure 13. Top Assembly Drawing

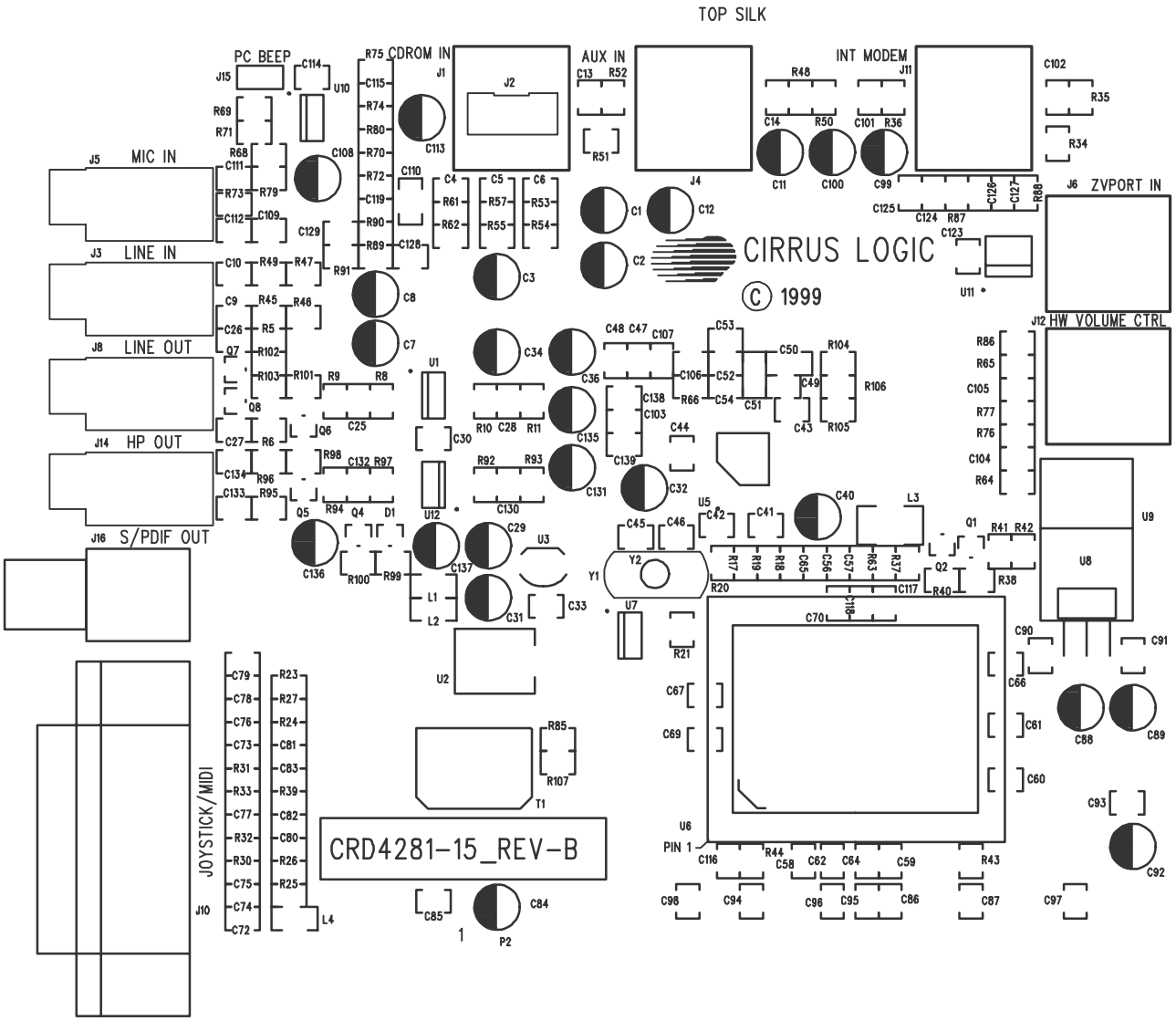


Figure 14. Top Silkscreen

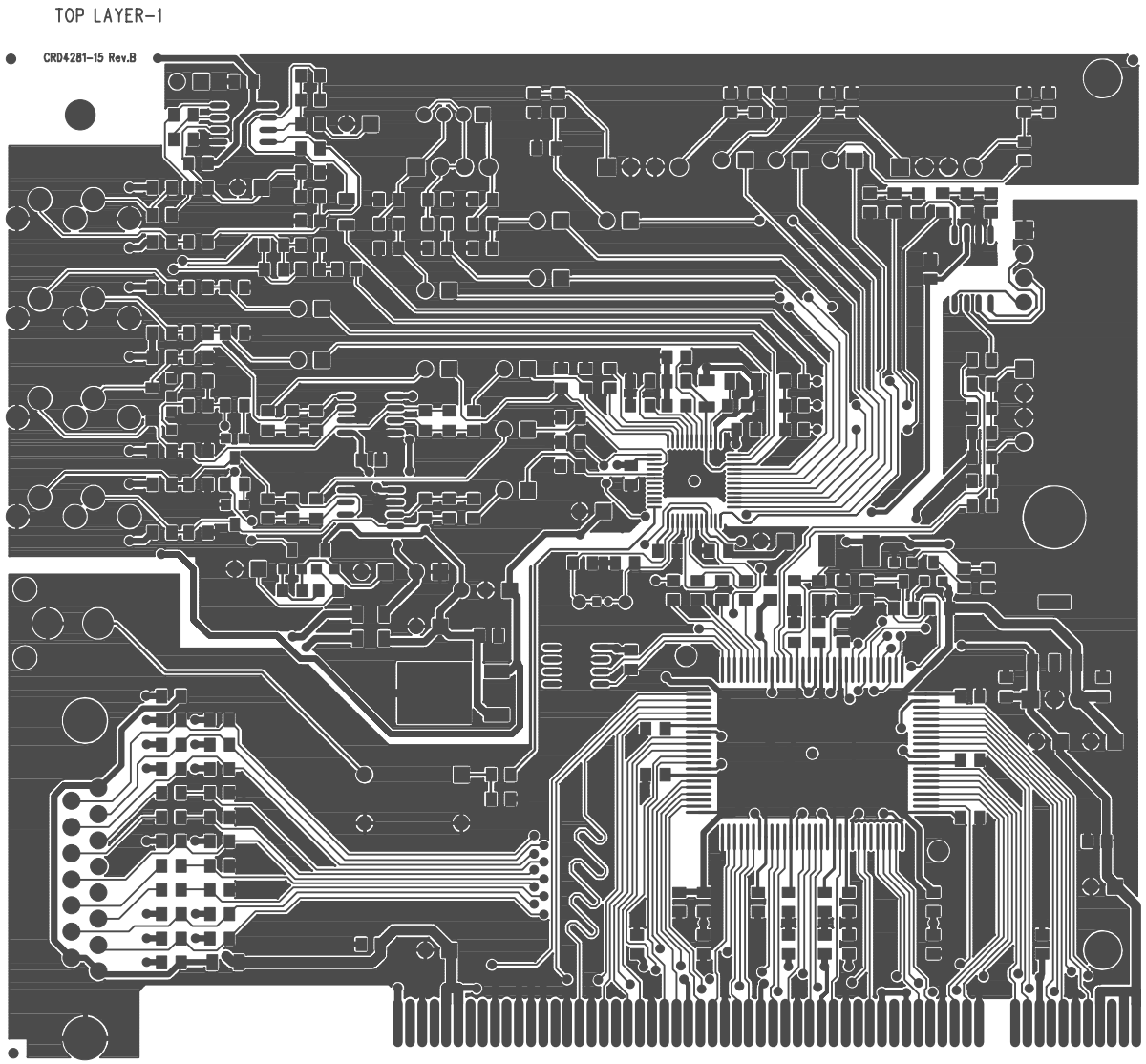


Figure 15. PCB Layout: Top Layer

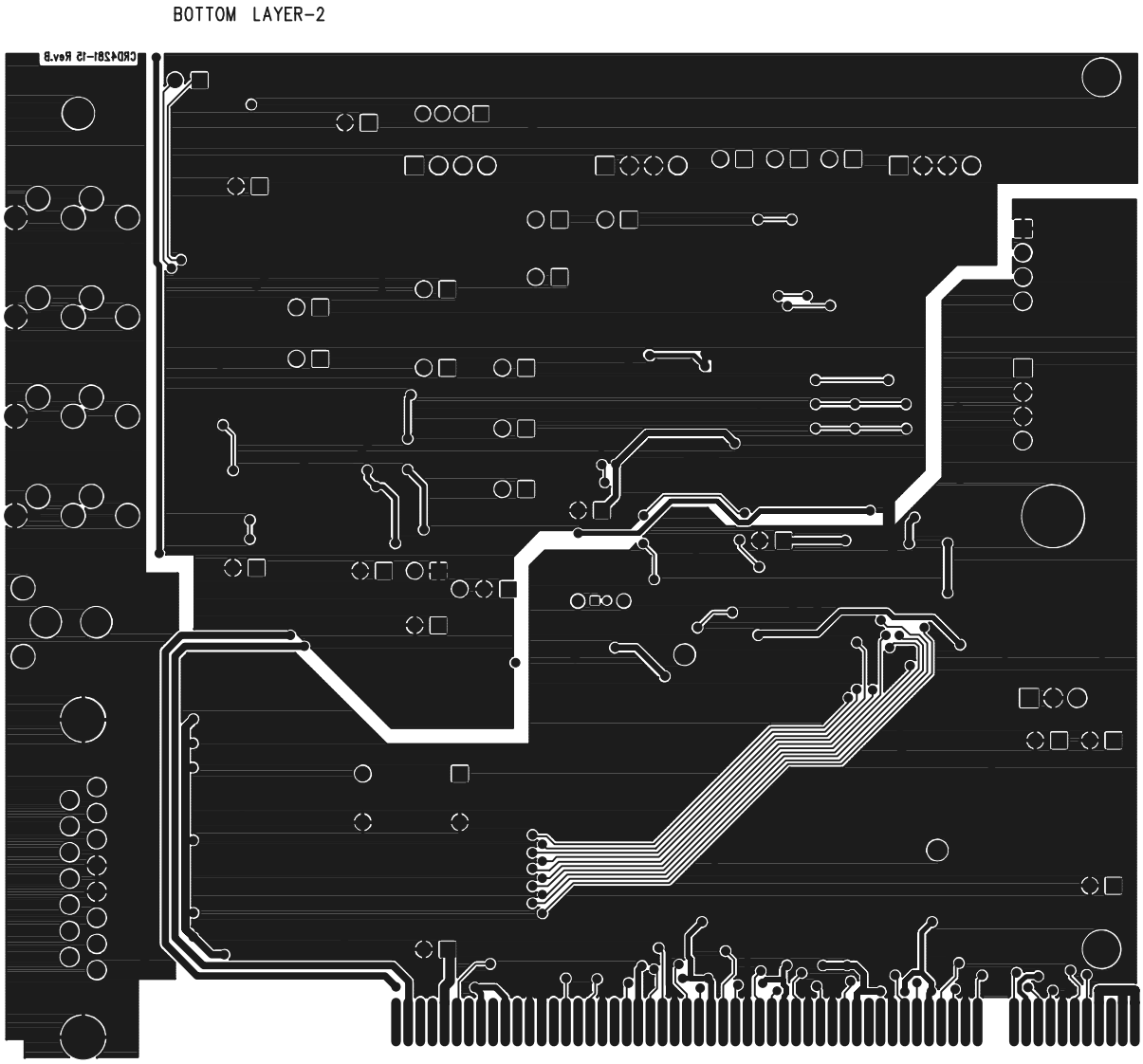
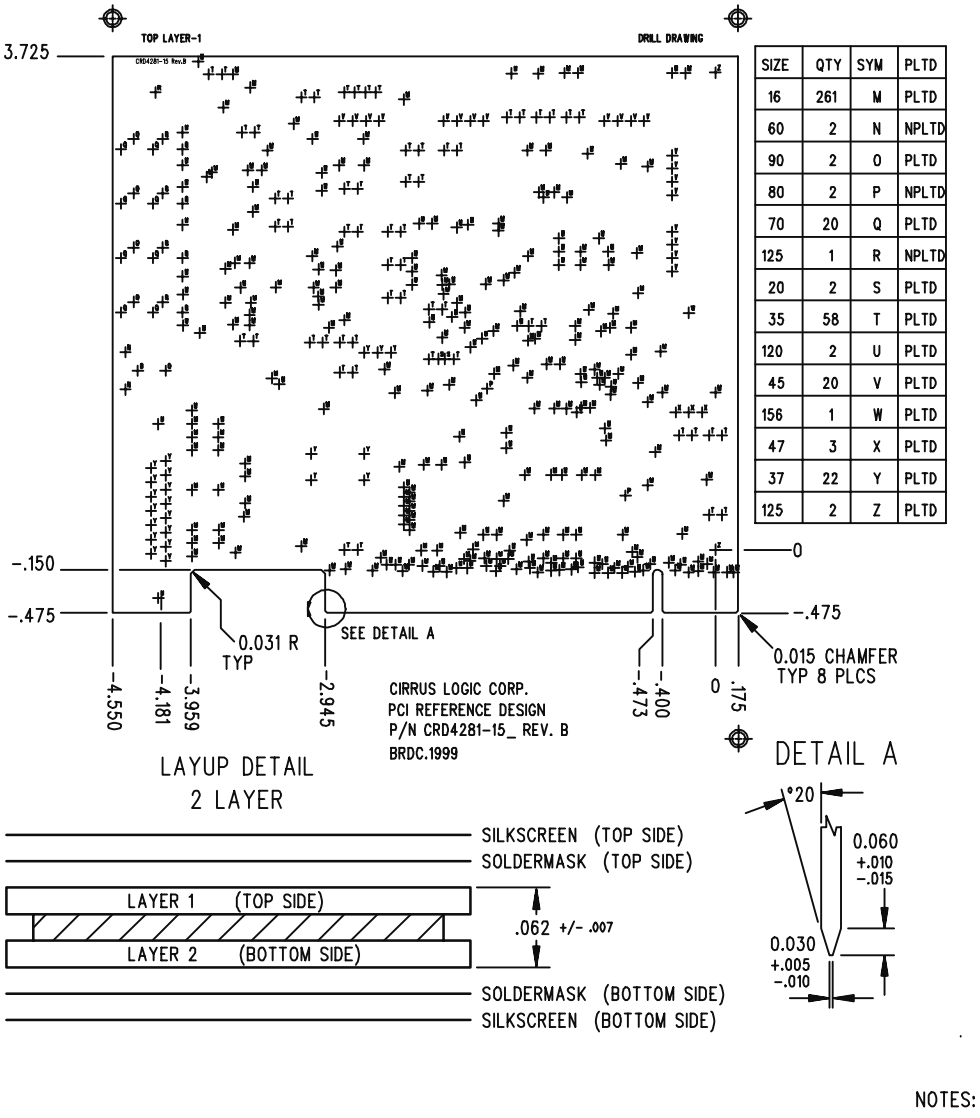


Figure 16. PCB Layout: Bottom Layer



SIZE	QTY	SYM	PLTD
16	261	M	PLTD
60	2	N	NPLTD
90	2	O	PLTD
80	2	P	NPLTD
70	20	Q	PLTD
125	1	R	NPLTD
20	2	S	PLTD
35	58	T	PLTD
120	2	U	PLTD
45	20	V	PLTD
156	1	W	PLTD
47	3	X	PLTD
37	22	Y	PLTD
125	2	Z	PLTD

Figure 17. Drill Drawing and Manufacturing Instructions

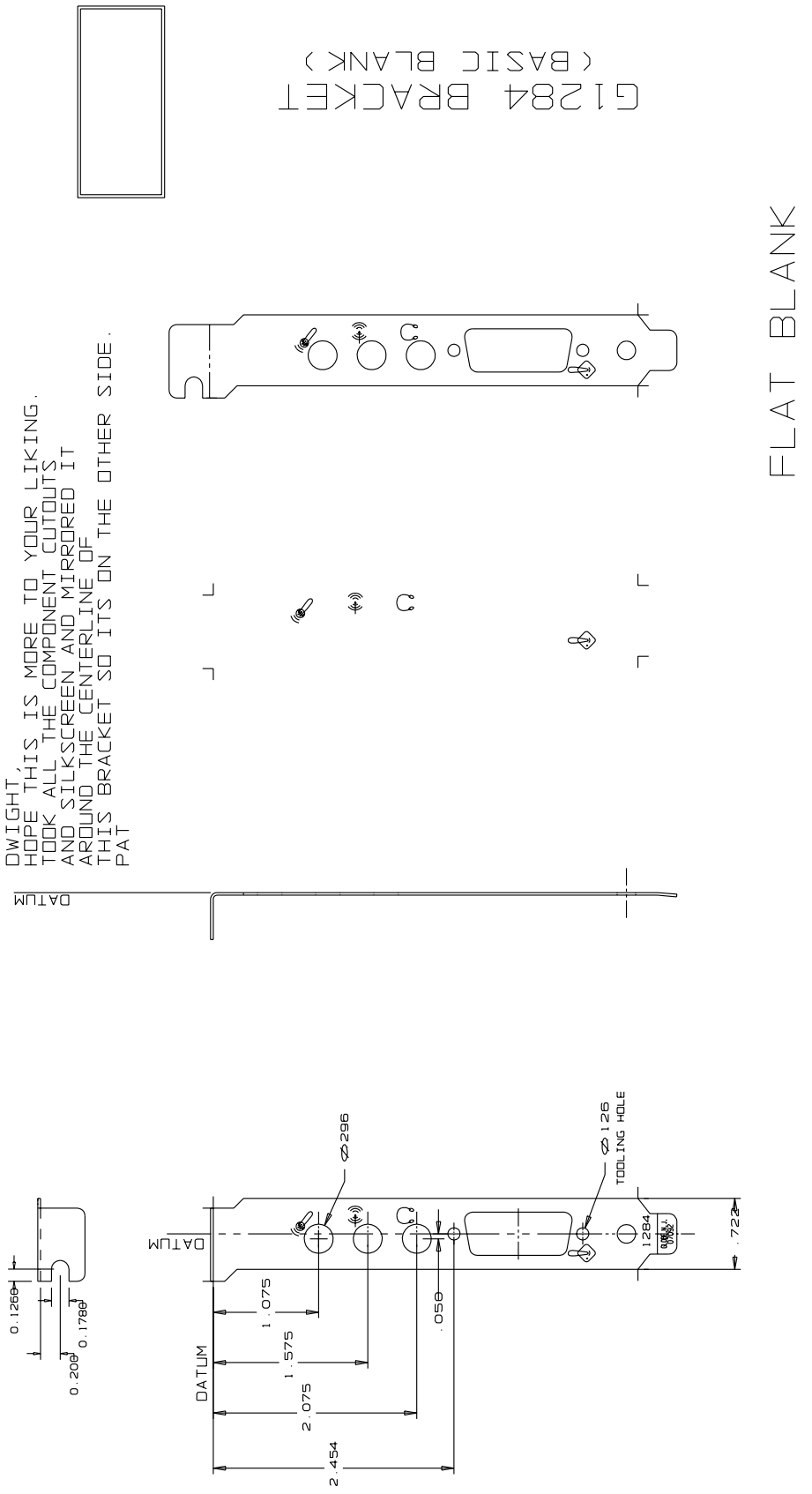


Figure 18. Bracket Drawing

5. BILL OF MATERIALS

Item	Qty	Description	Reference	Package	Manf.	Part Number
1	25	CAP,ELEC,10UF,TH,CASE A,20%,16V	C1,C2,C3,C7,C8,C11,C12, C99,C100,C29,C31 C32,C34,C36,C40,C84,C88, C89,C92,C108,C113, C131,C135,C136,C137	PTH 5MM	PANASONIC	ECE-A16Z10
2	16	CAP, 0805, C0G, 220pF, 5%, 50V	C4,C5,C6,C9,C10,C13,C14, C26,C27,C101,C102,C111,C112,C115,C133,C134	CSN_0805	KEMET	C0805C221J5GAC
3	6	CAP, 0805, C0G, 22pF, 5%, 50V	C25,C28,C45,C46,C130,C132	CSN_0805	KEMET	C0805C220J5GAC
4	39	CAP, 0805, X7R, .1uF, 10%, 50V	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,C119,C128	CSN_0805	KEMET	C0805C104K5RAC
5	2	CAP,1.0UF,SO,1206,+80/-20%,25V,Y5V	C50,C51	CSN_1206	MURATA	GRM42-6Y5V105Z25BL
6	6	CAP, 0805, C0G, 680pF, 10%, 50V	C47,C48,C103,C129,C138,C139	CSN_0805	KEMET	C0805C681K5GAC
7	8	CAP, 0805, C0G, 1000pF, 10%, 50V	C53,C54,C56,C73,C74,C75, C76,C107	CSN_0805	KEMET	C0805C102K5GAC
8	4	CAP, 0805, COG, 100pF, 5%, 50V	C77,C78,C104,C105	CSN_0805	KEMET	C0805C101J5GAC
9	4	CAP, 0805, X7R, 12000pF, 10%, 50V	C80,C81,C82,C83	CSN_0805	KEMET	C0805C123K5RAC
10	1	CAP, 0805, X7R, 68000pF, 10%, 50V	C109	CSN_0805	KEMET	C0805C683K5RAC
11	1	CERM CAP, .01uF, 10%, 50V,X7R	C106	CSN_0805	KEMET	C0805C103K5RAC
12	1	CAP, 1206, X7R, 1uF, 10%, 25V	C110	CSN_1206	VENKEL	C1206X7R500-105KNE
13	4	HDR, 4X1, 0.025" PIN, 0.1" CTR, 150u" SN/PB	J1,J4,J11,J12	CON_MLX_70553_4	MOLEX	70553-0003
14	4	1/8" PHONO JACK	J3,J5,J14,J8	AJ-356	A/D ELECTRON-ICS	AJ-3056A-5P
15	1		J15	PTH-2	Samtek	TSW-102-07-G-S
16	1	CONN, 15D SHELL, FEMALE, RT ANGLE PC MOUNT	J10	DB15-HF	AMP	747845-3
	1		J16	PTH	A/D ELECTRON-ICS	ARJ-2018-1
17	3	IND, FBEAD, 1206, 31@100MHz, 25%	L1,L2,L4	IND_FB1206	TDK	HF50ACB321611-T
18	1	IND, FBEAD, 1812, 120@100MHz, 25%	L3	IND_FB1812	TDK	HF30ACB453215-T
19	1	DIODE, DUAL, SOT23	D1	SOT23	NATIONAL	MMBD7000LT1
20	4	TRAN, SO, NPN, SOT23	Q5,Q6,Q7,Q8	SOT23	NATIONAL	MMBT3904LT1
21	1	TRAN, SO, PNP, SOT23	Q4	SOT23	NATIONAL	MMBT3906LT1
22	4	RES,220K,SO,0805,5%,1/10,METAL FILM	R5,R6,R95,R96	RES_0805	PHILIPS	9C08052A224J
23	4	RES, SO, 0805, 56K, 5%, 1/10W, METAL FILM	R8,R10,R92,R94	RES_0805	PHILIPS	9C08052A5602J
24	5	RES, SO, 0805, 27K, 5%, 1/10W, METAL FILM	R9,R11,R34,R93,R97	RES_0805	PHILIPS	9C08052A2702J
25	9	RES, SO, 0805, 47K, 5%, 1/10W, METAL FILM	R23,R35,R36,R68, R70,R72,R75,R89,R90	RES_0805	PHILIPS	9C08052A4702J
25	4	RES, SO, 0805, 47, 5%, 1/10W, METAL FILM	R17,R18,R19,R20	RES_0805	PHILIPS	9C08052A47R0J
26	5	RES, SO, 0805, 4.7K, 5%, 1/10W, METAL FILM	R21,R24,R25,R26,R27	RES_0805	PHILIPS	9C08052A4701J
27	8	RES, SO, 0805, 2.2K, 5%, 1/10W, METAL FILM	R30,R31,R32,R33 R98,R101,R102,R103	RES_0805	PHILIPS	9C08052A2201J
28	3	RES, SO, 0805, 100, 5%, 1/10W, METAL FILM	R37,R64,R65	RES_0805	PHILIPS	9C08052A1000J
29	3	RES, SO, 0805, 10K, 5%, 1/10W, METAL FILM	R63,R99,R100	RES_0805	PHILIPS	9C08052A1002J

30	13	RES, SO, 0805, 6.8K, 1%, 1/10W, METAL FILM	R45,R46,R47,R48,R49,R50, R51,R52,R53,R54, R61,R62,R74	RES_0805	PHILIPS	9C08052A6801F
31	2	RES, SO, 0805, 3.4K, 1%, 1/10W, METAL FILM	R55,R57	RES_0805	PHILIPS	9C08052A3401F
32	1	RES, SO, 0805, 68K, 5%, 1/10W, METAL FILM	R69	RES_0805	PHILIPS	9C08052A6802J
33	1	RES, SO, 0805, 100K, 5%, 1/10W, METAL FILM	R71	RES_0805	PHILIPS	9C08052A1003J
34	1	RES, SO, 0805, 2.7K, 5%, 1/10W, METAL FILM	R73	RES_0805	PHILIPS	9C08052A2701J
	1	RES, SO, 0805, 374, 1%, 1/10W, METAL FILM	R85	RES_0805	PHILIPS	9C08052A374J
	1	RES, SO, 0805, 90.9, 1%, 1/10W, METAL FILM	R107	RES_0805	PHILIPS	9C08052A90J
	1	RES, SO, 0805, 390, 5%, 1/10W, METAL FILM	R91	RES_0805	PHILIPS	9C08052A3900J
35	2	RES, SO, 0805, 0, 5%, 1/10W, METAL FILM	R105,R106	RES_0805	PHILIPS	9C08052A0R00J
36	1	Pulse Transformer, Isolation, 1:1	T1	PTH-4	Pulse Engineering	PE65612
37	2	Dual head phone amp	U1,U12	SO8	Motorola	MC1458
38	1	5V POS. VOLT. REG., 500ma	U2	DPAK	Motorola	MC78M05ACDT
39	1	IC, SO, AC '97 2.0 SERIAL CODEC w/ SRC	U5	QFP48_7X7	CRYSTAL SEMI-COND.	CS4297A-KQ
40	1	100 PIN MQFP PCI Controller	U6	MQFP100	CRYSTAL SEMI-COND.	CS4281-CM
41	1	IC, SO, SOIC8, SERIAL EEPROM, 16 x 8, 2.5V	U7	SO8	MICROCHIP	24LC00/SN
42	1	3.3V POS. VOLT.REG., 400ma,SO	U8	SOT223	MICREL	MIC2920A 3.3BS
43	1	IC, SO, SOIC8, 33078, DUAL OP AMP	U10	SO8	MOTOROLA	MC33078D
44	1	XTAL, 24.576MHz, CA-301, Fund Mode, Par Res	Y2	XTL_CA301	EPSON	CA-301_24.576M-C

• Notes •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