CRD4205-1

CrystalClear® Notebook Audio Docking Station Example

Features

- Emulates Docking Station Environment
  - Simulates audio portion of a notebook computer
  - "Docks" to the CRD4205-2
- Features the CS4205 AC '97 audio codec.
  - 18-bit Analog to Digital Converters (ADCs)
  - 20-bit Digital to Analog Converters (DACs)
  - Digital mixer
  - Integrated digital effects
- Four stereo and two mono analog inputs
- Digital ZV port input
- Five GPIO pins
- CNR interface
- S/PDIF (IEC-958) digital output
- Crystal, oscillator, or PLL operation
- Exceeds Microsoft PC-99 and PC-2001 audio performance requirements

Description

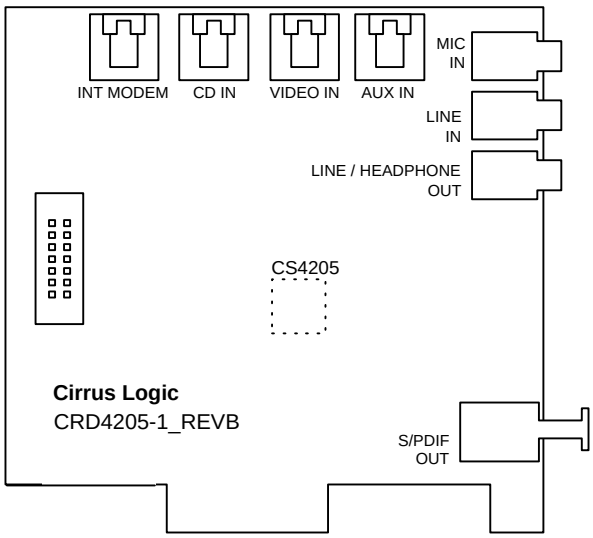
The CRD4205-1 reference design features the CS4205 AC '97 audio codec and emulates the audio sub-system in a PC notebook computer. The CRD4205-1 can be used alone or with the CRD4205-2 companion card. The CRD4205-2 companion card simulates the audio sub-system in a PC digital docking station.

This reference design features stereo analog audio inputs for Line, CD, Video, and Aux inputs. In addition, the card has mono analog inputs for Microphone, Modem Audio, and PC Beep. It also has several advanced features including a ZV port digital input and a S/PDIF digital output.

The CRD4205-1 is available by ordering the CMK4205-3 manufacturing kit. This kit includes a full set of schematics (OrCAD® 7.2 format), PCB job files (PADS® ASCII), PCB Gerber files, and bill of materials. In addition, WDM audio drivers that support Windows 98se, Millennium®, and Windows 2000 are also included.

ORDERING INFORMATION

CMK4205-3 Manufacturing Kit for the CRD4205-1



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1. GENERAL INFORMATION

The CRD4205-1 reference design can be used for the development of CNR or motherboard PC audio systems that use the CS4205. The CRD4205-1 can also be used in conjunction with the CRD4205-2 to develop audio systems for PC notebook computers with digital docking stations.

The CS4205 is an AC '97 audio codec with the same great features as our other Crystal Clear® audio codecs and some unique features especially designed for PC notebook computers. These include I^2S outputs for digital docking and a ZV port for digital audio inputs. For additional information on the CS4205 audio codec, see the *CS4205 Datasheet*.

2. SCHEMATIC DESCRIPTION

This section describes the CRD4205-1 schematics shown in figures 1 through 7. These schematics are also available in the CMK4205-3 manufacturing kit as ORCAD version 7.2 files.

2.1 Block Diagram

The block diagram shows the interconnections between schematic pages. The schematic is divided into six blocks: the CS4205 Audio Codec, Analog Inputs, Docking Interface, Analog Outputs, S/PDIF Optical Output, and CNR Connector.

2.2 CS4205 Audio Codec

Figure 2 shows the CS4205 and its associated circuitry. The CS4205 communicates digitally to the audio controller or core logic through a five wire bi-directional 12.288 MHz serial interface called the AC-Link. The AC-Link may require series termination resistors. These resistors should be located close to their respective signal source. The BIT_CLK and SDATA_IN signals are driven from the CS4205, while the SDATA_OUT, SYNC, and RESET# signals are driven from the controller. RESET# does not require serial termination.

The CS4205 has anti-alias filters for the ADCs that require external filter capacitors on AFLT1, AFLT2, and AFLT3 (pins 29, 30, and 31). Each pin has a 1000 pF NPO/COG capacitor to analog ground. NPO/COG capacitors are used to minimize audio distortion.

The internal ADCs, DACs, and AC-Link operate at a fixed 48 kHz sampling rate. The CS4205 is clocked by a 24.576 MHz ($\pm$ 50 PPM) crystal. This design provides two population options for different crystal footprints. Footprint Y1 is for CA-301 miniature crystals and footprint Y2 supports standard HC-49S package. Footprint Y3 is for an optional clock oscillator.

Many notebook computers have a ZV or "Zoomed Video" port that carries PCM audio data in I^2S serial format. The CS4205 has a built-in ZV port input connected to JP5.

The CS4205 has seven multi-purpose pins that primarily support I^2S serial inputs and outputs for digital docking or multi-channel audio. These signals are tied to a a 5x2 (0.1 inch center) breakout connector.

Pin	Function
1	LRCLK
3	SDO1
5	DSSD1
7	DSSD2
9	DSDD3
Even Pins	Digital Ground

Table 1. Serial I/O Breakout Connector

2.3 Analog Inputs

The CRD4205-1 has four stereo and three mono analog audio inputs as shown in figure 3. The inputs for VIDEO, AUX 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 100 pF capacitors are provided on Line In and Mic In for EMI suppression. The capacitors may be removed if EMC testing determines they are not required.

MIC IN and PC BEEP IN are AC coupled through 0.1 µF capacitors. All analog other analog inputs are AC coupled through 2.2 µF electrolytic capacitors 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. This arrangement will reduce any common mode noise picked up by the CD signal path.

The MODEM AUDIO connector provides monitoring of modem audio signals during modem dialing and connecting. This connector has both the modem audio input and output signals. The modem input voltage is divided by 6 dB and can accommodate a line level source up to 2 Vrms. The output is connected to the CS4205 MONO_OUT pin. The maximum output voltage is 1 Vrms.

The MIC IN circuit complies with PC-99 requirements for both microphone phantom power and optional frequency response roll-offs. Phantom power for the microphone is derived from the +5 V analog supply and filtered by R14, R15, C27, and C28. The 3 dB roll-off points located at 60 Hz and 15 kHz.

The PC BEEP input connector routes the computer beep tones to the CS4205. The CS4205 has a feature called PC Beep Bypass that allows system beeps to be heard even during system reset or BIOS boot-up.

2.4 Dock Interface

The CRD4205-1 is designed to "dock" with the CRD4205-2 to simulate a notebook computer digital docking system. The CRD4205-1 simulates the audio circuitry in the notebook computer and the CRD4205-2 simulates the audio circuitry in the docking station. The CS4205 serial ports provides the digital audio output for the digital docking station.

2.5 Analog Outputs

The LINE_OUT jack in figure 5 functions as the main stereo outputs in a two channel system. This circuit utilizes a Motorola MC34072 dual opamp which is capable of driving high impedance line level signals (10 kΩ or greater). This circuit has a gain of 3 dB.

2.6 S/PDIF Optical Output

The S/PDIF (IEC-958) digital output in figure 6 is compatible with digital inputs on consumer devices such as stereo receivers and MiniDisc recorders. The S/PDIF output of the CS4205 operates at a fix sampling frequency of 48 kHz. The CRD4205-1 S/PDIF digital optical output uses an industry standard Toshiba TOTX-173 optical transmitter.

2.7 CNR Connector

The CNR connector shown in figure 7 is the interface between the CRD4205-1 and the system motherboard. The CNR interface supports audio, modem, and LAN subsystems. Also present on the CNR connector is 12 Volt, 5 Volt, and 3.3 Volt power. The CRD4205-1 uses the AC-Link, SMBus, 12 Volt, and 3.3 Volt power. The SMBus signals are connected to a AT24C02 EEPROM that enables plug-in-play functionality. The EEPROM holds the subsystem vendor ID and subsystem ID. It also contains other information for implementing a Plug-and-Play CNR card. See the Intel® Communication and Network Riser homepage at *http://developer.intel.com/technology/cnr/* for CNR design specifications, programming utilities, and information on programming the EEPROM.

The CRD4205-1 CNR connector includes jumpers for several functions. These are summarized in table 2.

Jumper	Pins 1-2	Pins 2-3
JP1 Codec Reset	Reset from CNR Bus	Force Low
JP2 3.3 V supply	3.3 V from CNR Bus	Not Used
JP3 Primary Down	From CNR Bus	Force Low
JP8 Secondary Down	From CNR Bus	Force Low
JP4 SDIN Target	SDATA_IN0	SDATA_IN1
JP9 Primary Down	Places pull-up on Primary Down when inserted.	NA (2 pin jumper)

Table 2. CNR Connector Jumper Settings

Note:The CRD4205-1 default positions for all jumpers is between pins 1-2

JP9 inserts a 1 kΩ pull-up on Primary Down. This is used to disable on-board audio for motherboards that have a 10 kΩ pull-down resistor on Primary Down as required by the CNR 1.1 specification.

In addition, JP3 and JP8 can be used to determine the clocking mode of the CS4205. The CS4205 supports three clocking modes: oscillator (Osc), crystal (Xtal), and AC-Link bit clock (BIT_CLK). This is shown in table 3.

JP8	JP3	ID	Osc	PLL	Frequency	Mode
1-2	1-2	0	Osc	no	24.576 MHz	Primary
1-2	2-3	0	Osc	yes	14.318 MHz	Primary
2-3	1-2	0	Osc	yes	27.000 MHz	Primary
2-3	2-3	0	Osc	yes	48.000 MHz	Primary
1-2	1-2	0	Xtal	no	24.576 MHz	Primary
1-2	2-3	1	Bclk	no	12.288 MHz	Secondary
2-3	1-2	2	Bclk	no	12.288 MHz	Secondary
2-3	2-3	3	Bclk	no	12.288 MHz	Secondary

Table 3. JP8 and JP3 Positions for Each Clock Mode

The CS4205 requires both digital +3.3 V and analog +5 V supply. The digital power is supplied from the CNR connector. A Motorola MC78M05C regulates the +12 V supply from the CNR bus down to a clean +5 V analog supply. This +5 V linear regulator is used to maintain good audio quality.

2.8 Component Selection

Great attention was given to the particular components used on the CRD4205-1 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 passive components. No resistor packs. This reduces the risk of crosstalk between audio signals.
- All ICs are surface mount.
- Dual footprint for XTAL. Standard H49S and small circular CA-301 pin in hole package.

2.9 EMC Components

Optional capacitors and inductors are included to help the board meet EMI compliance tests, such as FCC Part 15. Choose these component values according to individual requirements.

3. GROUNDING AND LAYOUT

One of the most critical aspects of PC audio design is good PC board layout. The PC is a hostile environment for audio and good layout is essential for achieving high audio quality.

The CRD4205-1 is partitioned into a digital and analog sections to help isolate noisy digital circuitry from quiet analog audio circuitry. The most important rule for successful PC audio layout is to keep all digital signal traces and components over the digital ground plane, and all analog signal traces and components over an analog ground plane. These planes are separated by a minimum of 60 to 100 mils (0.060 to 0.100 inches). Do not allow digital and analog signals to cross planes, otherwise digital noise may be induced into the analog signals and severely reduce audio performance.

The CS4205 is placed at the transition point of the analog and digital ground planes. The CS4205 pins are partitioned into analog and digital areas. This is

done to make board layout easier. The digital and analog grounds are tied together by a wide trace, over 50 mils or 0.050 inches, at a single point underneath the CS4205 in order to provide a common ground reference.

Delta-sigma converters are highly susceptible to noise on the crystal pins. 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. 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. The capacitors on REFFLT, AFLT1, AFLT2, AFLT3, and the power supply are placed close to the CS4205 pins for best audio performance.

4. REFERENCES

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

2) Communication and Network Riser Specification revision 1.0, Feb 7, 2000 http://developer.intel.com/technology/cnr/.

3) Steve Harris, Clif Sanchez, Personal Computer Audio Quality Measurements, Ver 1.0 *www.cirrus.com/products/papers/meas/meas.htm*

4) Cirrus Logic, CS4205 Data Sheet

5. ADDENDUM

- Schematic drawings
- Layout drawings

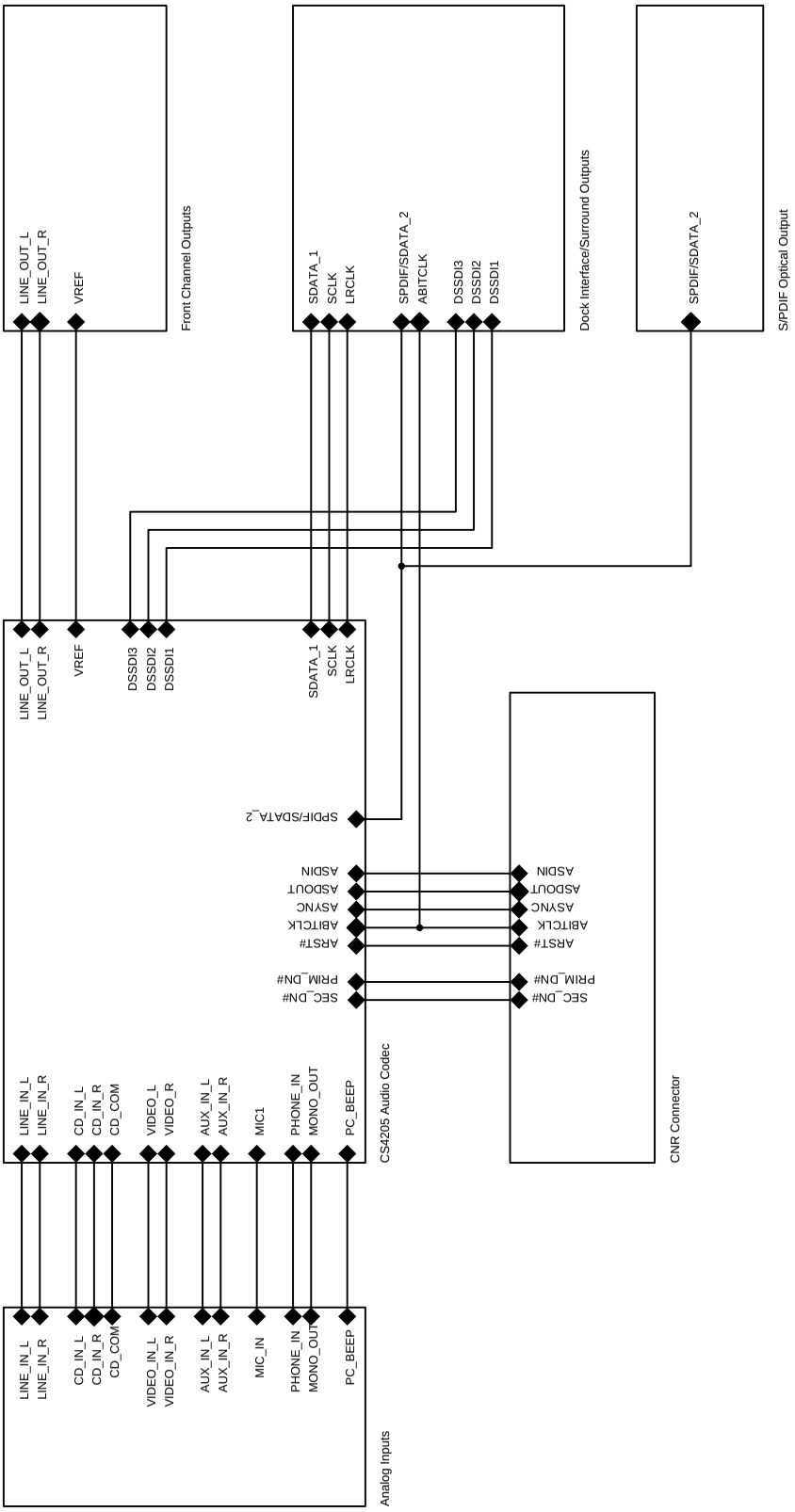


Figure 1. Block Diagram

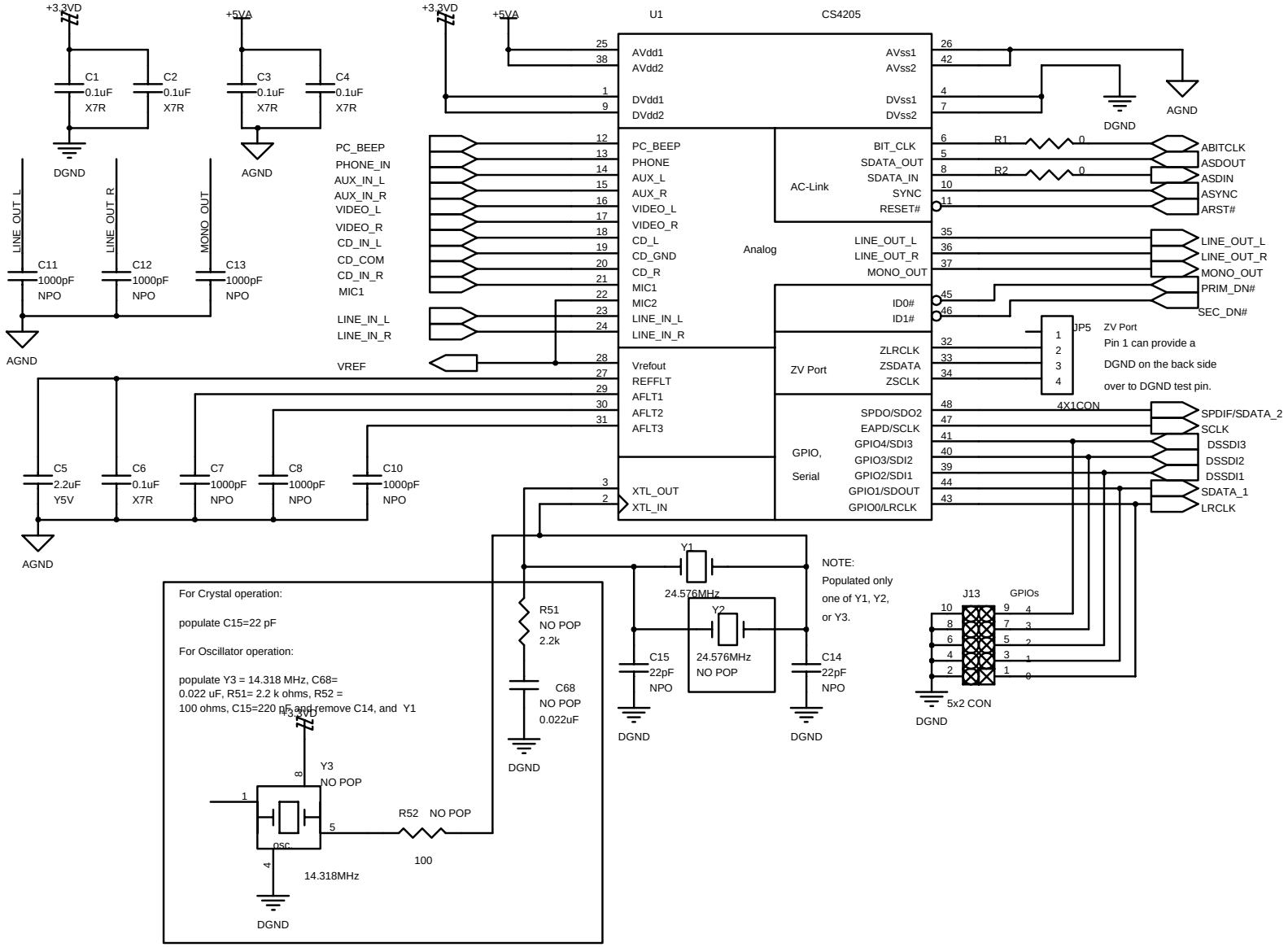
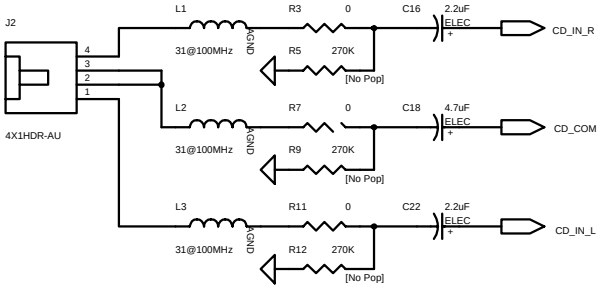
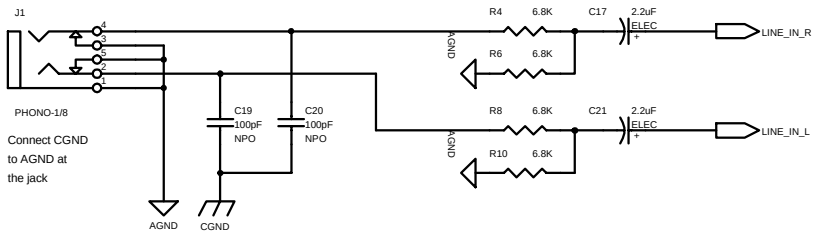


Figure 2. CS4205 Audio Codec

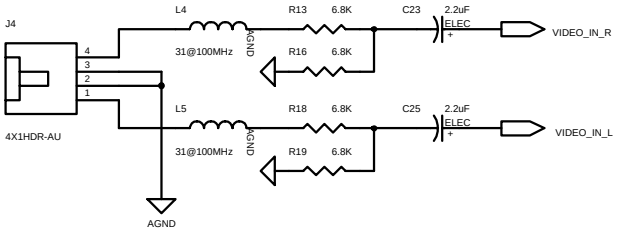
CD IN



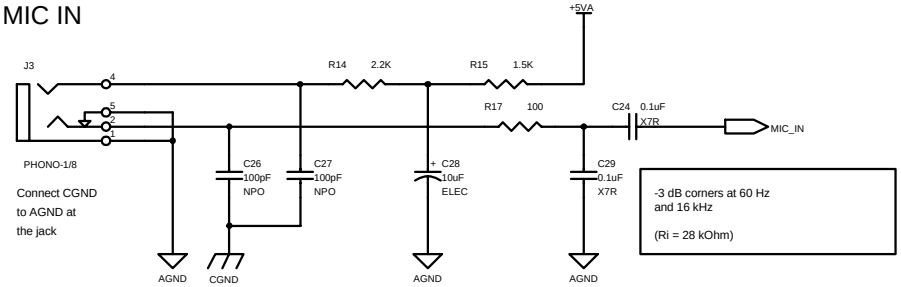
LINE IN



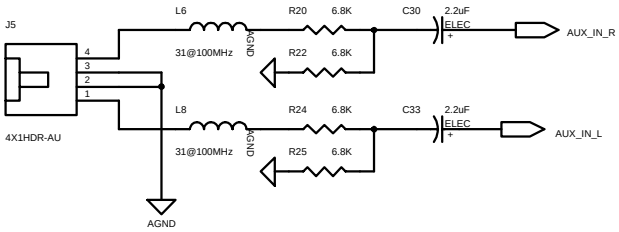
VIDEO IN



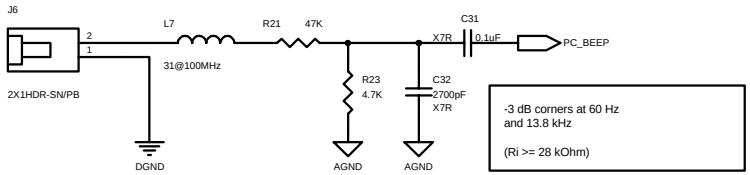
MIC IN



AUX IN



PC BEEP IN



MODEM AUDIO

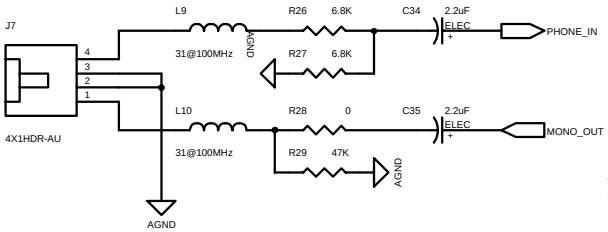


Figure 3. Analog Inputs

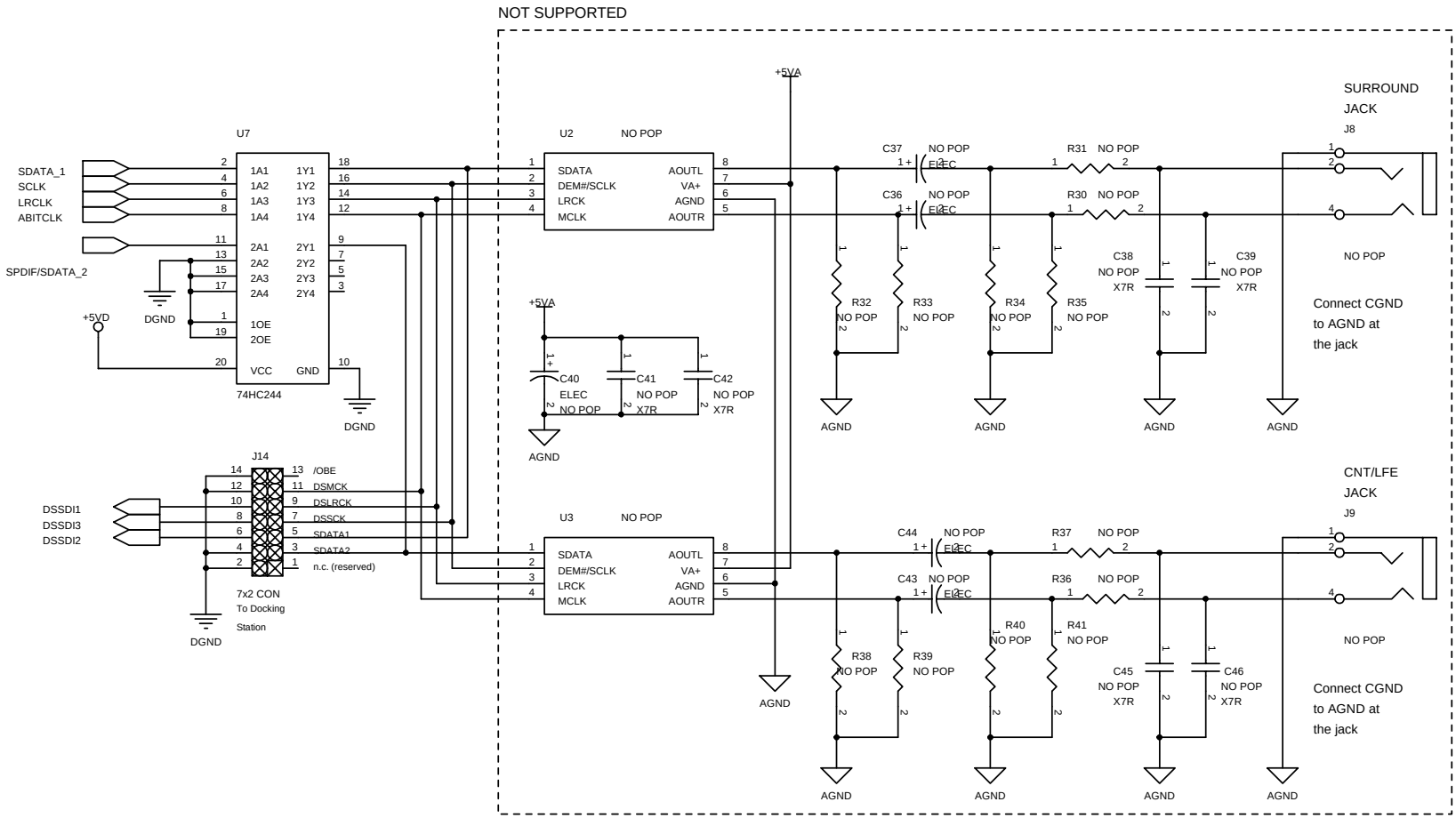


Figure 4. Docking Interface

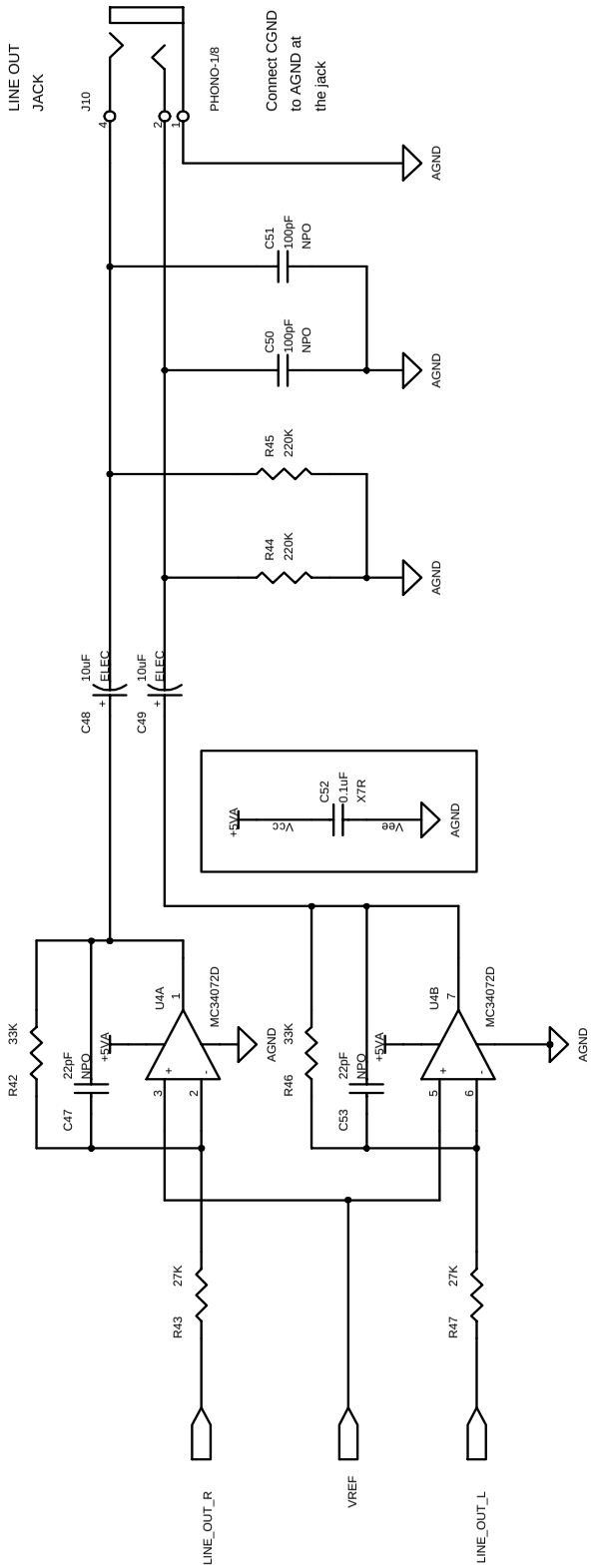


Figure 5. Analog Outputs

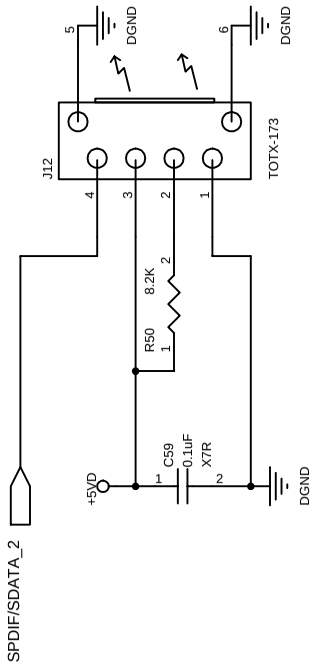
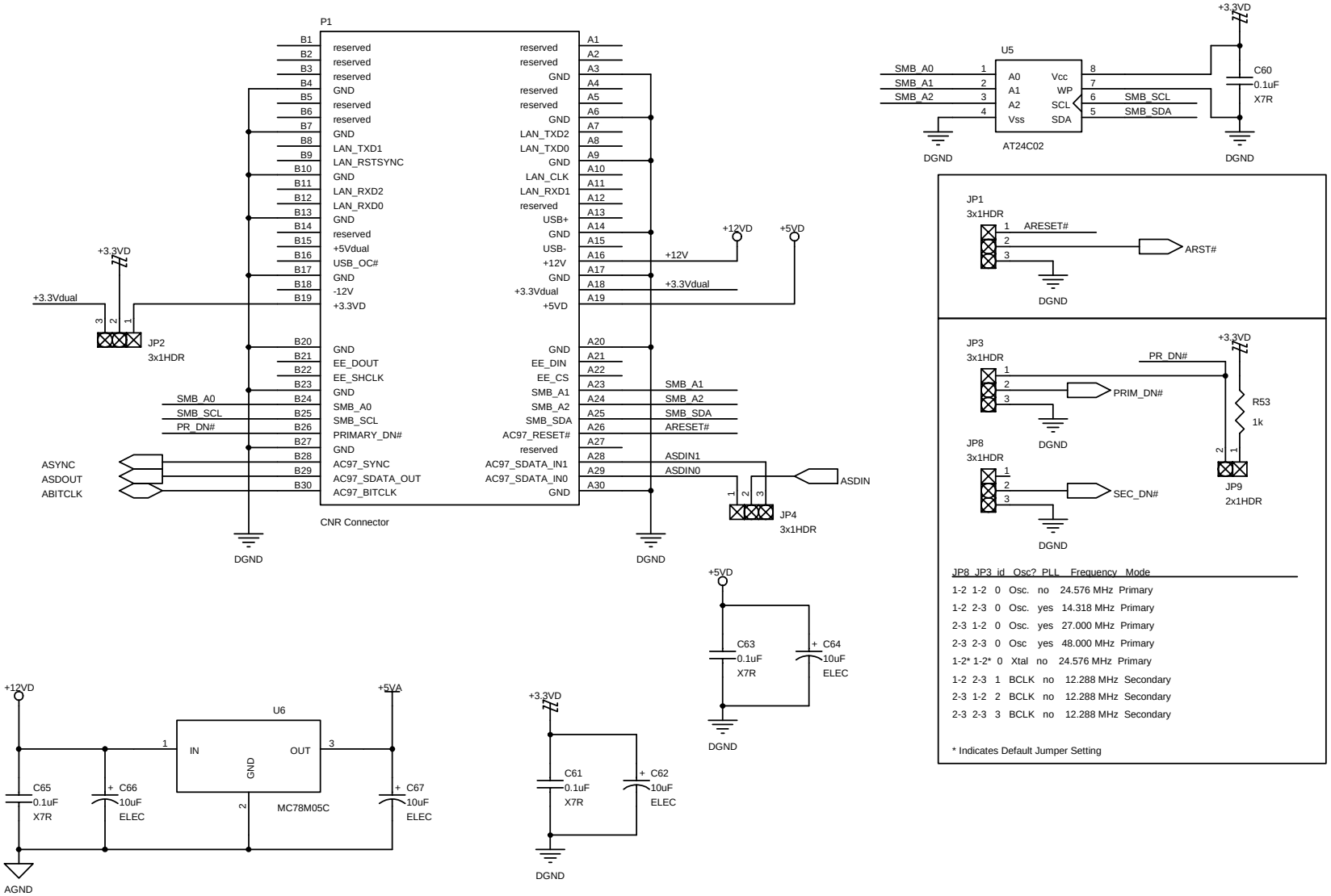


Figure 6. S/PDIF Optical Outputs



JP8	JP3	id	Osc?	PLL	Frequency	Mode
1-2	1-2	0	Osc.	no	24.576 MHz	Primary
1-2	2-3	0	Osc.	yes	14.318 MHz	Primary
2-3	1-2	0	Osc.	yes	27.000 MHz	Primary
2-3	2-3	0	Osc	yes	48.000 MHz	Primary
1-2*	1-2*	0	Xtal	no	24.576 MHz	Primary
1-2	2-3	1	BCLK	no	12.288 MHz	Secondary
2-3	1-2	2	BCLK	no	12.288 MHz	Secondary
2-3	2-3	3	BCLK	no	12.288 MHz	Secondary

* Indicates Default Jumper Setting

Connect AGND to DGND with a 50 mil trace near the regulator.

Connect CGND to DGND with a 50 mil trace near the finger edge of the board.

Figure 7. CNR Connector

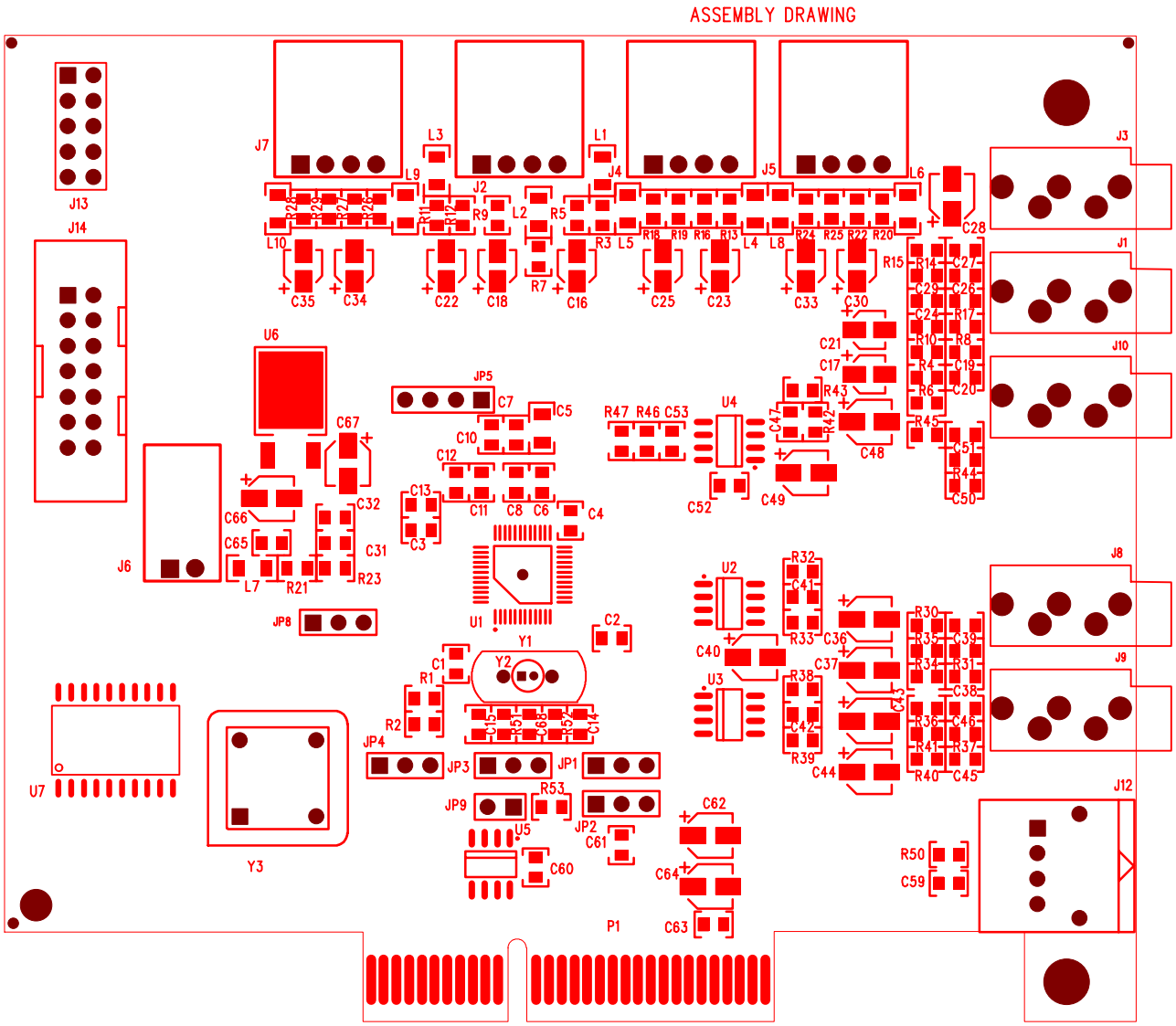


Figure 8. Assembly Drawing

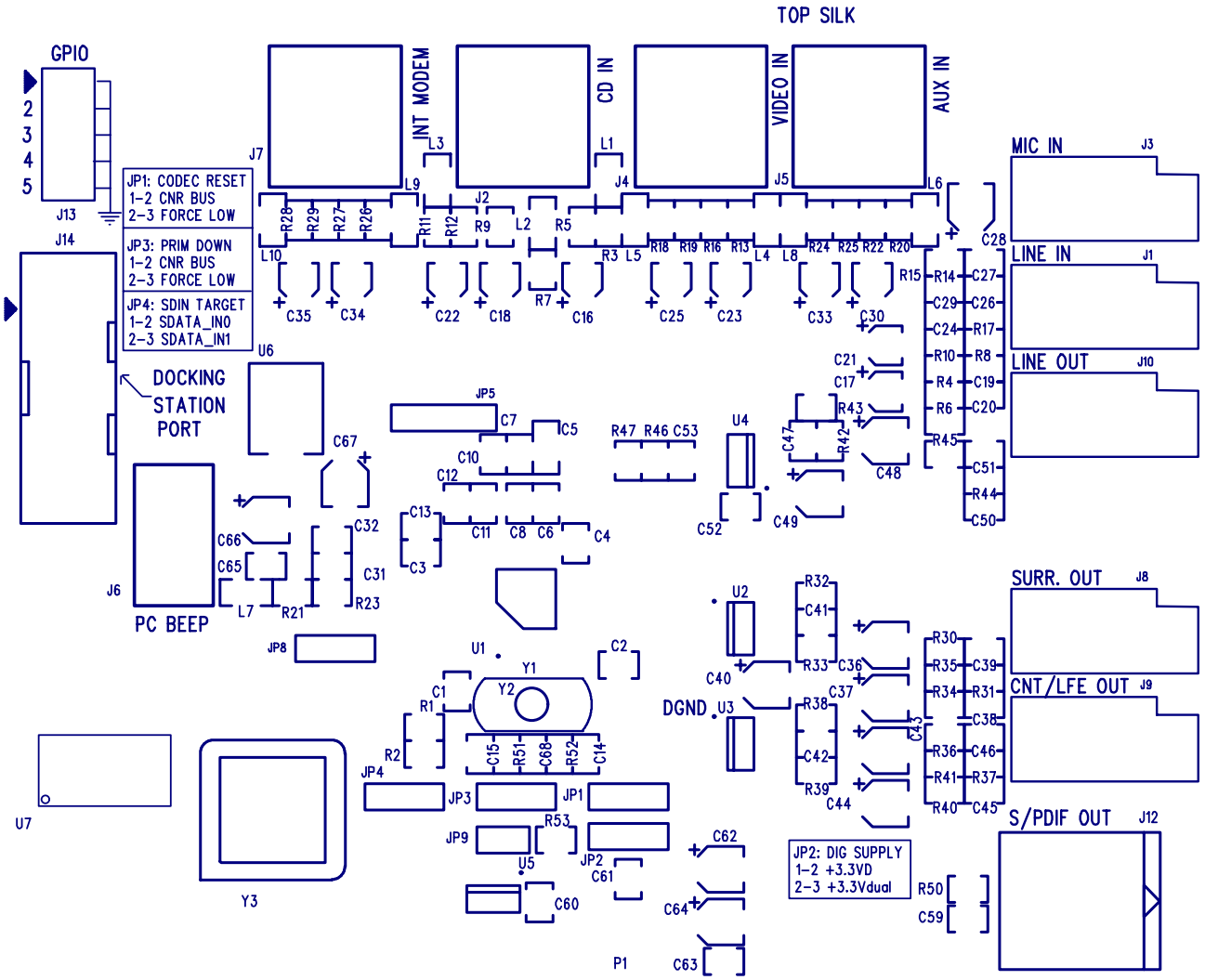


Figure 9. Top Silkscreen

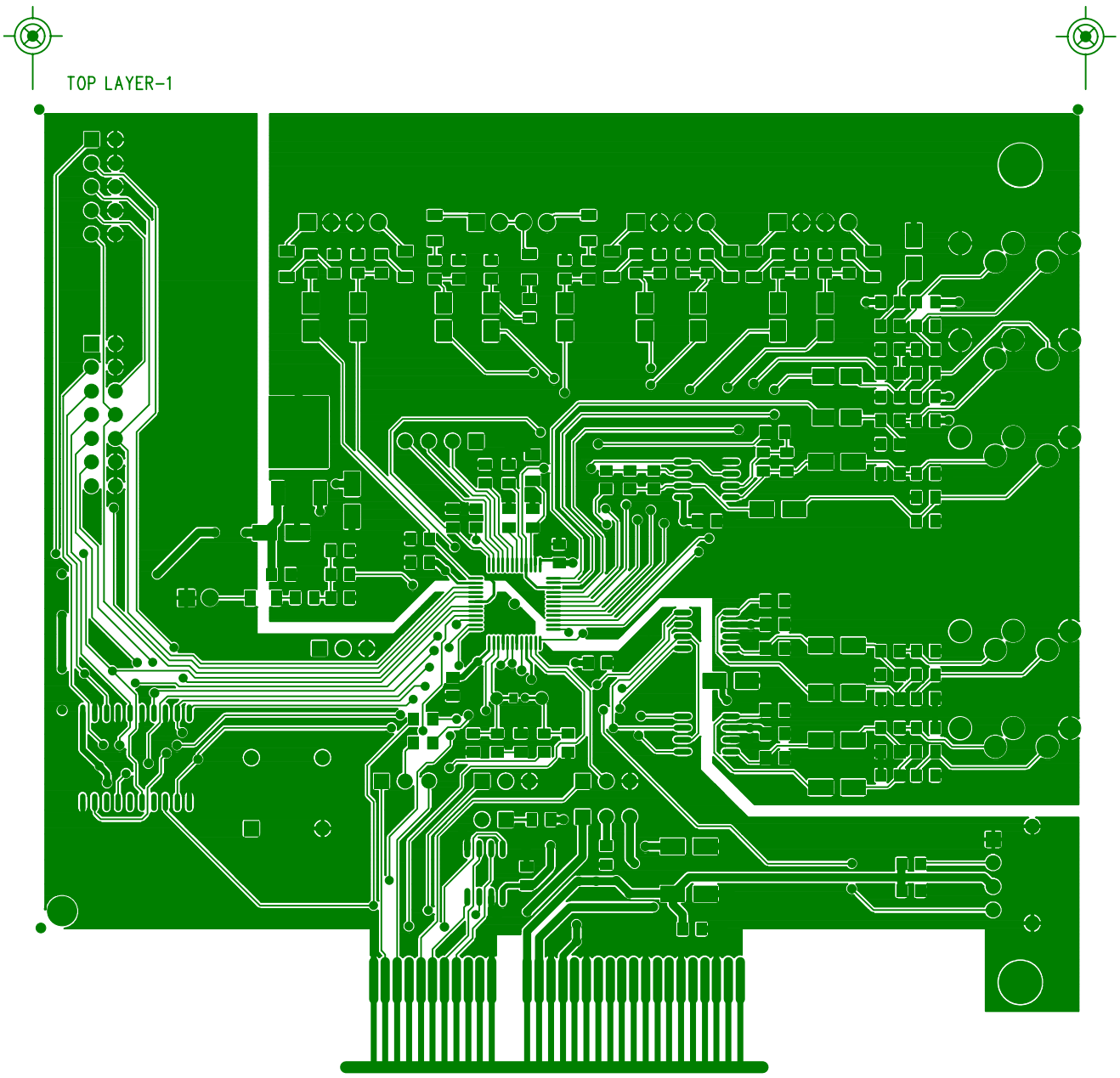


Figure 10. Top Layer

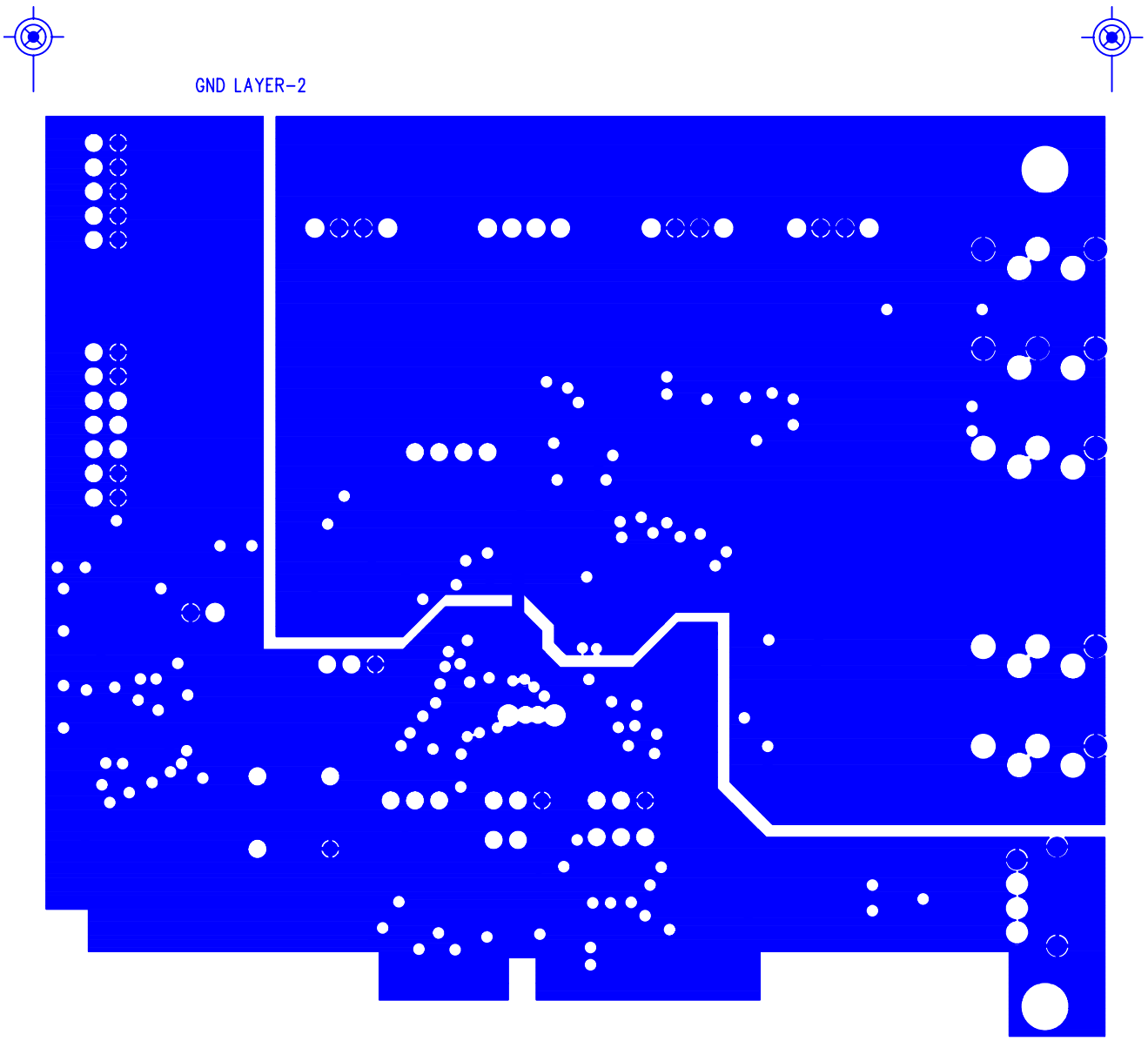


Figure 11. Ground Layer

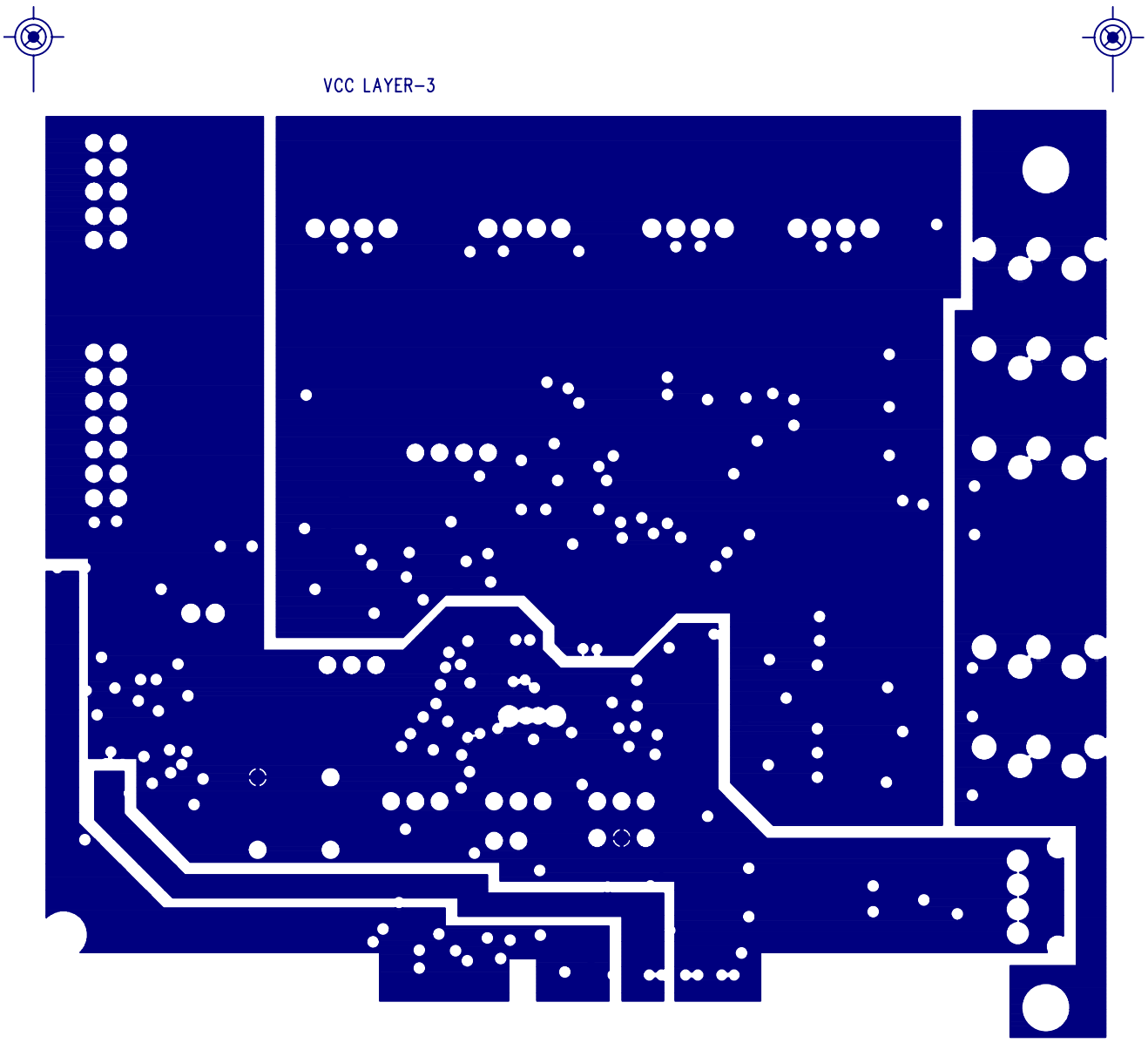


Figure 12. Vcc Layer

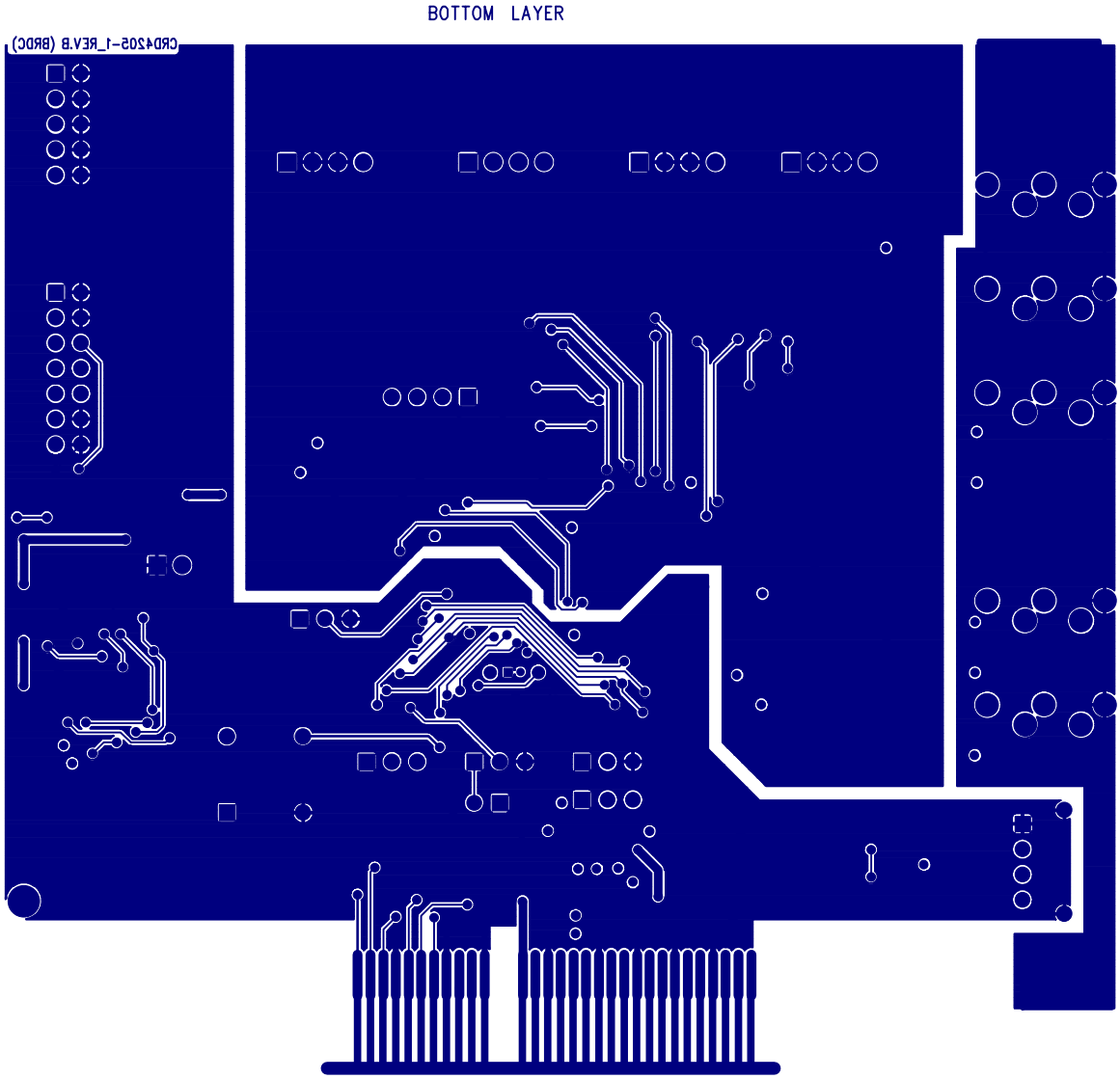


Figure 13. Bottom Layer

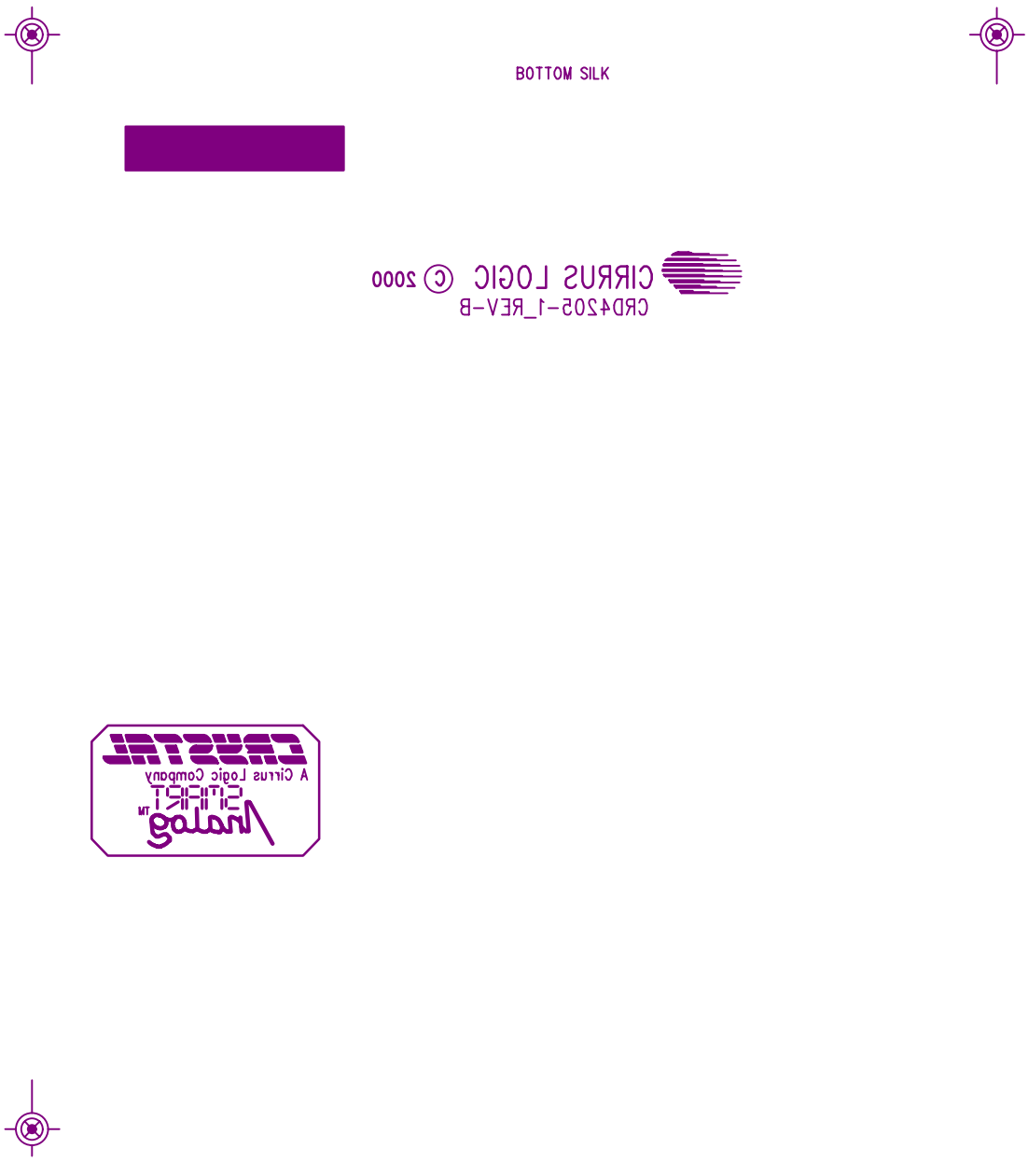


Figure 14. Bottom Silkscreen

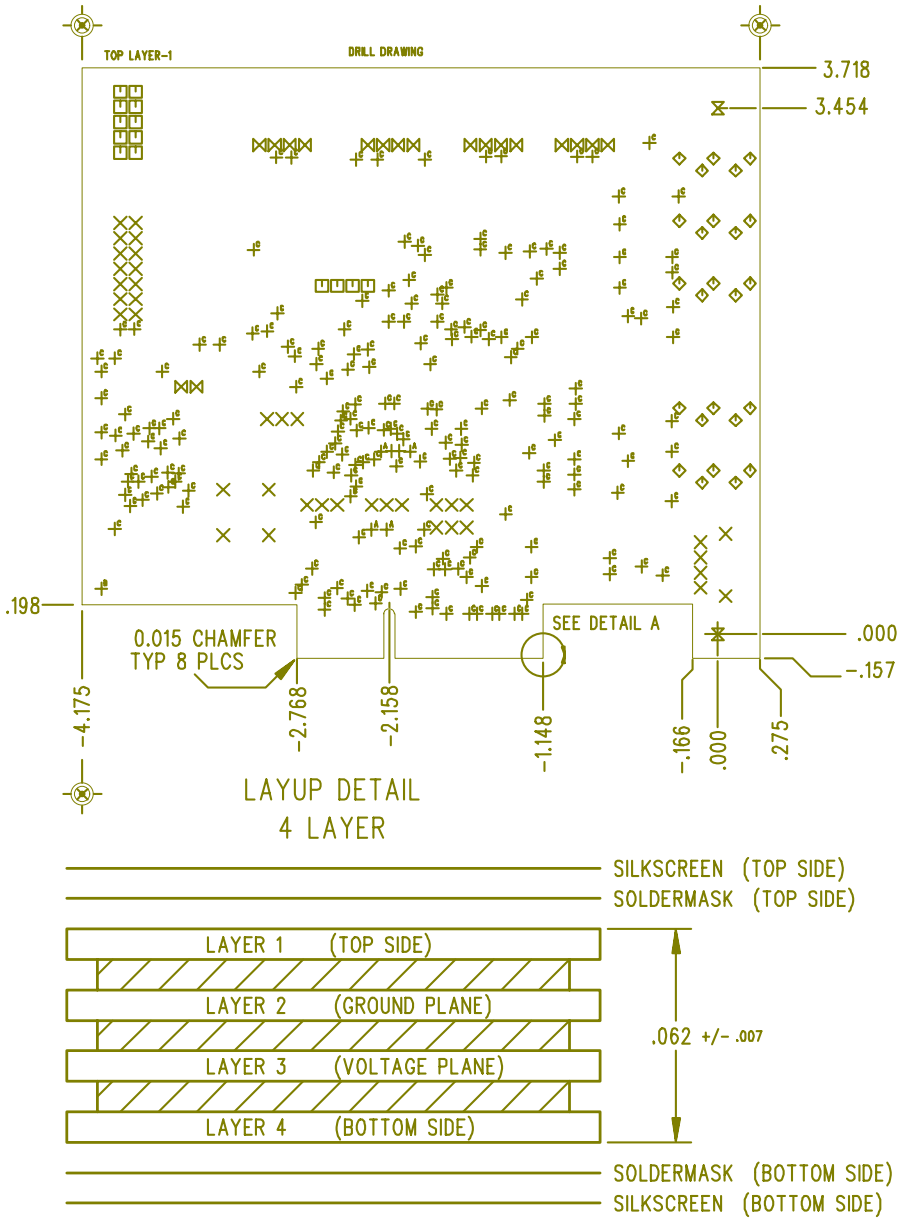


Figure 15. Drill Drawing

6. BILL OF MATERIALS

Item	Quantity	Reference	Manufacturer	Part Number	Description
1	14	C1,C2,C3,C4,C6,C24,C29, C31,C52,C59,C60,C61,C63, C65	KEMET	C0805C104K5RAC	CAP, 0805, X7R, .1uF, 10%, 50V
2	1	C5	KEMET	C1206C225M8VAC	CAP, 1206, Y5V, 2.2uF, 20%, 10V
3	6	C7,C8,C10,C11,C12,C13	KEMET	C0805C102K5GAC	CAP, 0805, C0G, 1000pF, 10%, 50V
4	4	C14,C15,C47,C53	KEMET	C0805C220K5GAC	CAP, 0805, C0G, 22pF, 10%, 50V
5	10	C16,C17,C21,C22,C23,C25, C30,C33,C34,C35	PANASONIC	ECE-V1VS2R2SR	CAP, SMT A, ELEC, 2.2uF, 20%, 35V
6	1	C18	PANASONIC	ECE-V1ES4R7SR	CAP, SMT A, ELEC, 4.7uF, 20%, 25V
7	6	C19,C20,C26,C27,C50,C51	KEMET	C0805C101J5GAC	CAP, 0805, COG, 100pF, 5%, 50V
8	7	C28,C48,C49,C62,C64,C66, C67	PANASONIC	ECE-V1CA100R	CAP, SMT B, ELEC, 10uF, 20%, 16V
9	1	C32	KEMET	C0805C272K5RAC	CAP, 0805, X7R, 2700pF, 10%, 50V
10	5	C36,C37,C40,C43,C44	NO POP	NO POP	NO POP
11	6	C38,C39,C42,C45,C46,C68	NO POP	NO POP	NO POP
12	1	C41	KEMET	NO POP	NO POP
13	5	JP1,JP2,JP3,JP4,JP8	SAMTEC	TSW-103-07-T-S	HDR, 3x1, 0.025" PIN, 0.1" CTR
14	1	JP5	SAMTEC	TSW-104-07-G-S	HDR, 4x1, 0.025" PIN, 0.1" CTR
15	1	JP9	SAMTEC	TSW-102-07-T-S	HDR, 2x1, 0.025" PIN, 0.1" CTR
16	1	J1	LZR ELECTRONICS	SJ372	CONN, 3.5MM DOUBLE SW. STEREO PHONE JACK
17	4	J2,J4,J5,J7	MOLEX	70553-0003	HDR, 4X1, 0.025" PIN, 0.1" CTR, 15u" AU
18	1	J3	LZR ELECTRONICS	SJ374	CONN, 3.5MM DOUBLE SW. STEREO PHONE JACK
19	1	J6	MOLEX	70553-0036	HDR, 2X1, 0.025" PIN, 0.1" CTR, 150u" SN/PB
20	1	J8	NO POP	NO POP	NO POP
21	1	J9	NO POP	NO POP	NO POP
22	1	J10	LZR ELECTRONICS	SJ373	CONN, 1/8" NON-SW. STEREO PHONE JACK
23	1	J12	TOSHIBA	TOTX173	CONN, OPTICAL TOSLINK TRANSMITTER
24	1	J13	MOLEX	10-89-1101	CONN, 5x2 HEADER, MALE, STRAIGHT
25	1	J14	AMP	103309-2	CONN, 7x2 RIBBON, MALE, STRAIGHT, SHROUDED
26	10	L1,L2,L3,L4,L5,L6,L7,L8,L9, L10	TDK	HF50ACB321611-T	IND, FBEAD, 1206, 31@100MHz, 25%
27	1	P1	NONE	NONE	CNR BUS CONNECTOR
28	6	R1,R2,R3,R7,R11,R28	PHILIPS	9C08052A0R00J	RES, SO, 0805, 0, 5%, 1/10W, METAL FILM
29	14	R4,R6,R8,R10,R13,R16,R18, R19,R20,R22,R24,R25,R26, R27	PHILIPS	9C08052A6801F	RES, SO, 0805, 6.8K, 1%, 1/10W, METAL FILM
30	3	R5,R9,R12	PHILIPS	9C08052A2703J	RES, SO, 0805, 270K, 5%, 1/10W, METAL FILM
31	1	R14	PHILIPS	9C08052A2201J	RES, SO, 0805, 2.2K, 5%, 1/10W, METAL FILM
32	1	R15	PHILIPS	9C08052A1501J	RES, SO, 0805, 1.5K, 5%, 1/10W, METAL FILM
33	1	R17	PHILIPS	9C08052A1000J	RES, SO, 0805, 100, 5%, 1/10W, METAL FILM
34	2	R29,R21	PHILIPS	9C08052A4702J	RES, SO, 0805, 47K, 5%, 1/10W, METAL FILM
35	1	R23	PHILIPS	9C08052A4701J	RES, SO, 0805, 4.7K, 5%, 1/10W, METAL FILM

36	14	R30,R31,R32,R33,R34,R35, R36,R37,R38,R39,R40,R41, R51,R52	NO POP	NO POP	NO POP
37	2	R42,R46	PHILIPS	9C08052A3302F	RES, SO, 0805, 33K, 1%, 1/10W, METAL FILM
38	2	R43,R47	PHILIPS	9C08052A2702F	RES, SO, 0805, 27K, 1%, 1/10W, METAL FILM
39	2	R45,R44	PHILIPS	9C08052A2203J	RES, SO, 0805, 220K, 5%, 1/10W, METAL FILM
40	1	R50	PHILIPS	9C08052A8201J	RES, SO, 0805, 8.2K, 5%, 1/10W, METAL FILM
41	1	R53	PHILIPS	9C08052A1001J	RES, SO, 0805, 1k, 5%, 1/10W, METAL FILM
42	1	U1	CIRRUS LOGIC	CS4205-KQ	IC, TQFP, AC '97 2.1 SERIAL CODEC
43	2	U2,U3	NO POP	NO POP	NO POP
44	1	U4	MOTOROLA	MC34072D	IC, SO, SOIC8, 34072, SINGLE SUPPLY DUAL OP AMP
45	1	U5	ATMEL	AT24C02N-10SC-2.7	IC, SO, SOIC8, SERIAL EEPROM, 256 x 8, 2.7V
46	1	U6	MOTOROLA	MC78M05CDT	IC, SO, +5V REGULATOR, DPAK, 4%, 500mA
47	1	U7	MC74HC244DAW	MOTOROLA	IC,74HC244, HCTTL, S020
48	1	Y1	FOX	FS24.576	XTAL, 24.576MHz, HC49S, Fund Mode, Par Res
49	1	Y2	NO POP	NO POP	NO POP
50	1	Y3	NO POP	NO POP	NO POP

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