

## CrystalClear<sup>®</sup> PC Audio Docking Station Companion Board

### Features

- Companion board to CRD4205-1
- Emulates Docking Station Environment
  - Simulates audio portion of PC docking station.
  - Digital Interface to CRD4205-1
- High quality, low cost analog to digital (ADCs) and digital to analog (DACs) converters
  - CS5334 18-bit serial ADCs
  - CS4334 24-bit serial DACs
- PCI Slot card (power only)
- Two stereo inputs
- One microphone input
- Four channel audio output

### Description

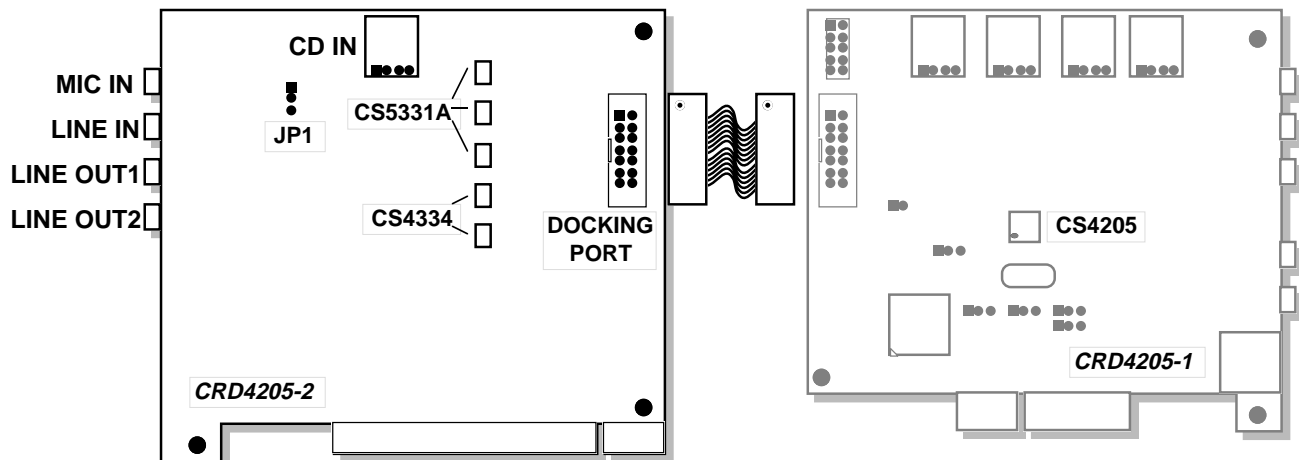
The CRD4205-2 reference design is a companion card to the CRD4205-1. The CRD4205-2 emulates the audio sub-system in a PC digital docking station, and the CRD4205-1 simulates the audio sub-system in a PC notebook computer.

This reference design features stereo analog inputs for Line, CD, and a mono input for Microphone. The card also has four channel analog audio outputs. The docking port is completely digital. The analog inputs in the CRD4205-2 are processed by high quality 18-bit serial ADCs. The analog outputs are processed by high quality serial 24-bit DACs.

The CRD4205-2 is available by ordering the CMK4205-3 manufacturing kit. This kit includes a full set of schematics (OrCAD<sup>®</sup> 7.2 format), PCB job files (PADS<sup>®</sup> ASCII), PCB Gerber files, bill of materials and WDM audio drivers that support Windows 98se, Millennium<sup>®</sup> and Windows 2000.

### ORDERING INFORMATION

CMK4205-3 Manufacturing Kit for the CRD4205-2



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## 1. GENERAL INFORMATION

The CRD4205-2 is designed to emulate a high quality PC audio docking station. This is not a stand-alone card but used in conjunction with the CRD4205-1. The CRD4205-1 contains a CS4205 audio codec and simulates the audio sub-system in a PC notebook computer.

The CRD4205-2 has all the circuitry typically found in a high quality PC digital docking audio sub-system. In addition, this reference design includes four channel analog audio outputs driven by 24-bit serial DACs. Microphone, stereo Line, and stereo CD inputs feature high quality serial 18-bit ADCs.

## 2. SCHEMATIC DESCRIPTION

This section describes the CRD4205-2 schematics shown in figures 1 through 4. These schematics are also available in the CMK4205-3 manufacturing kit as ORCAD 7.2 files.

### 2.1 Block Diagram

The block diagram in Figure 1, shows the interconnection between schematic pages. The schematic is divided into three blocks: Analog In, Analog Out, and PCI Bus.

### 2.2 Analog Inputs

The Analog Input page in Figure 2 illustrates the Mic, stereo Line and stereo CD inputs and their associated ADCs. The LINE inputs connect to a divider circuit that reduces the voltage by 6 dB to allow for line level sources up to 2 Vrms. The 100 pF capacitors are provided on Line In and Mic In for EMI suppression. These may be removed if EMC testing determines they are not required.

Since the analog inputs of the CS5331 ADCs are DC biased, all of the analog inputs must be AC coupled. The microphone input is coupled with a 0.1  $\mu$ F capacitor. The Line and CD inputs are AC coupled with 2.2  $\mu$ F capacitors to minimize the low frequency roll-off.

The analog audio input signals are converted to digital data by three CS5331A 18-bit ADCs. The ADCs share a common clock, but have independent data outputs. The clock and serial data signals are routed to the docking port header.

The MIC IN circuit complies with PC-99 requirements for microphone phantom power and recommendations for frequency response roll-off. The 3 dB roll-off frequencies are 60 Hz and 15 kHz. Phantom power for the microphones is derived from the +5 V analog supply and filtered by R11, C13, and R12.

Jumper JP1 controls how the microphone signal is routed to the ADC, U3.

| JP1 Position | Description  |
|--------------|--|
| Out          | Microphone signal routed to AINL of the CS5331A. The AINR is floating. |
| 1-2          | Not Used!  |
| 2-3          | Microphone signal routed to both AINL and AINR of the CS5331A.         |

**Table 1. Microphone Input Jumper JP1**

### 2.3 Analog Output

The CS4205 sends audio to the docking port through I<sup>2</sup>S serial digital outputs, as shown in figure 3. These signals are converted to analog audio through two CS4334 serial DACs. Both CS4334s share common clocks but have independent data inputs. All clocks originate from the CS4205 on the CRD4205-1 card.

The output of the DACs are connected to a Motorola MC34072 dual op-amp which is capable of driving high impedance (10 k $\Omega$  or higher) line level signals. This circuit has a gain of 3 dB.

It is possible to drive headphones with impedances as low as 32  $\Omega$  by replacing the MC34072 with a TDA1308 and increasing the values of C23, C24, C29, and C30 to 220  $\mu$ F. These op-amps are pin compatible.

## 2.4 PCI Bus

The PCI bus is only used to supply power to the board, so that an external supply is not required. The PCI bus connections are shown in Figure 4. The digital power is supplied from the PCI bus. A Motorola MC78M05C 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 is located over the analog ground plane near the partition between the analog and digital planes. The regulator ground pin is connected to the analog ground.

Figure 4 also shows the docking port header. This connector couples the serial data from the CRD4205-1 and is buffered by a 74HC244 octal buffer.

## 2.5 Component Selection

Great attention was given to the particular components used on the CRD4205-2 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.
- All ICs are in surface mount packages.

## 2.6 EMC Components

A number of capacitors and inductors are included to help the board meet EMI compliance tests, such as FCC Part 15. The EMC part values are only

meant as starting points. Modify these values to meet individual EMC 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 CRD4205-2 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).

When digital and analog signals cross planes, they introduce noise into the audio section reducing performance. The CS4334 DACs and CS5331A ADCs are placed over the partition of the analog and digital ground planes. The ADCs and DACs both have their analog and digital signals partitioned to opposite sides of the ICs to help simplify PCB layout. Digital and analog ground are tied together by a wide trace (over 50 mils or 0.050 inches) at a single point underneath the converters in order to provide a common ground reference.

For more information on layout specifically for the CS4334 and the CS5331A, see their respective datasheets.

**4. REFERENCES**

- 1) Intel, Audio Codec '97 Component Specification, Revision 2.1, May 22, 1998. <http://developer.intel.com/ial/scalableplatforms/audio/>
- 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 <http://www.crystal.com/pubs/meas100.pdf>
- 4) Cirrus Logic, CS4205 Data Sheet
- 5) Cirrus Logic, CS4334/5/6/7/8/9 Data Sheet <http://www.crystal.com/pubs/4334.pdf>
- 6) Cirrus Logic, CS5330A/31A Data Sheet <http://www.crystal.com/pubs/5330a.pdf>

**5. ADDENDUM**

- Schematic drawings
- Layout drawings

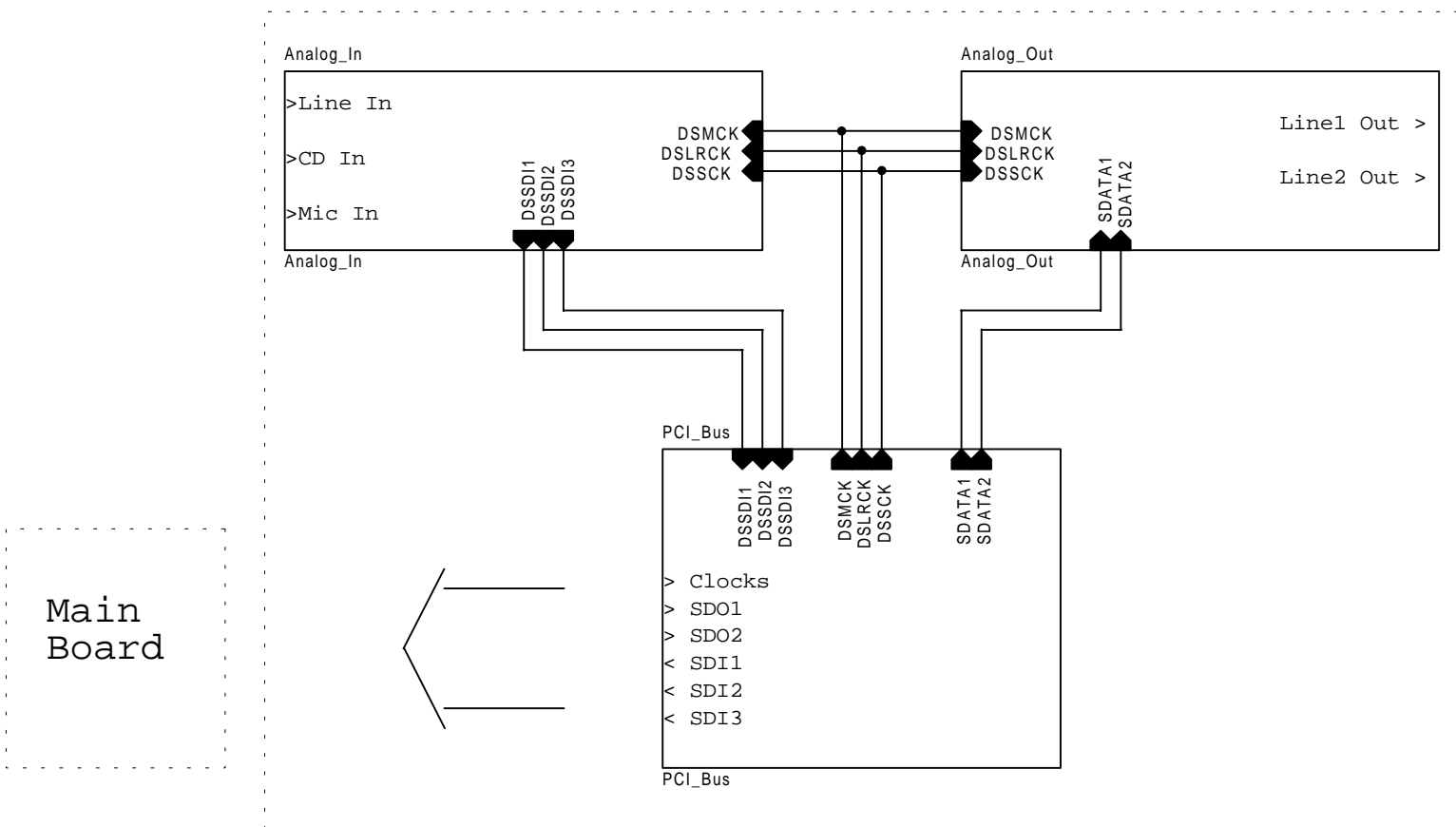


Figure 1. Block Diagram

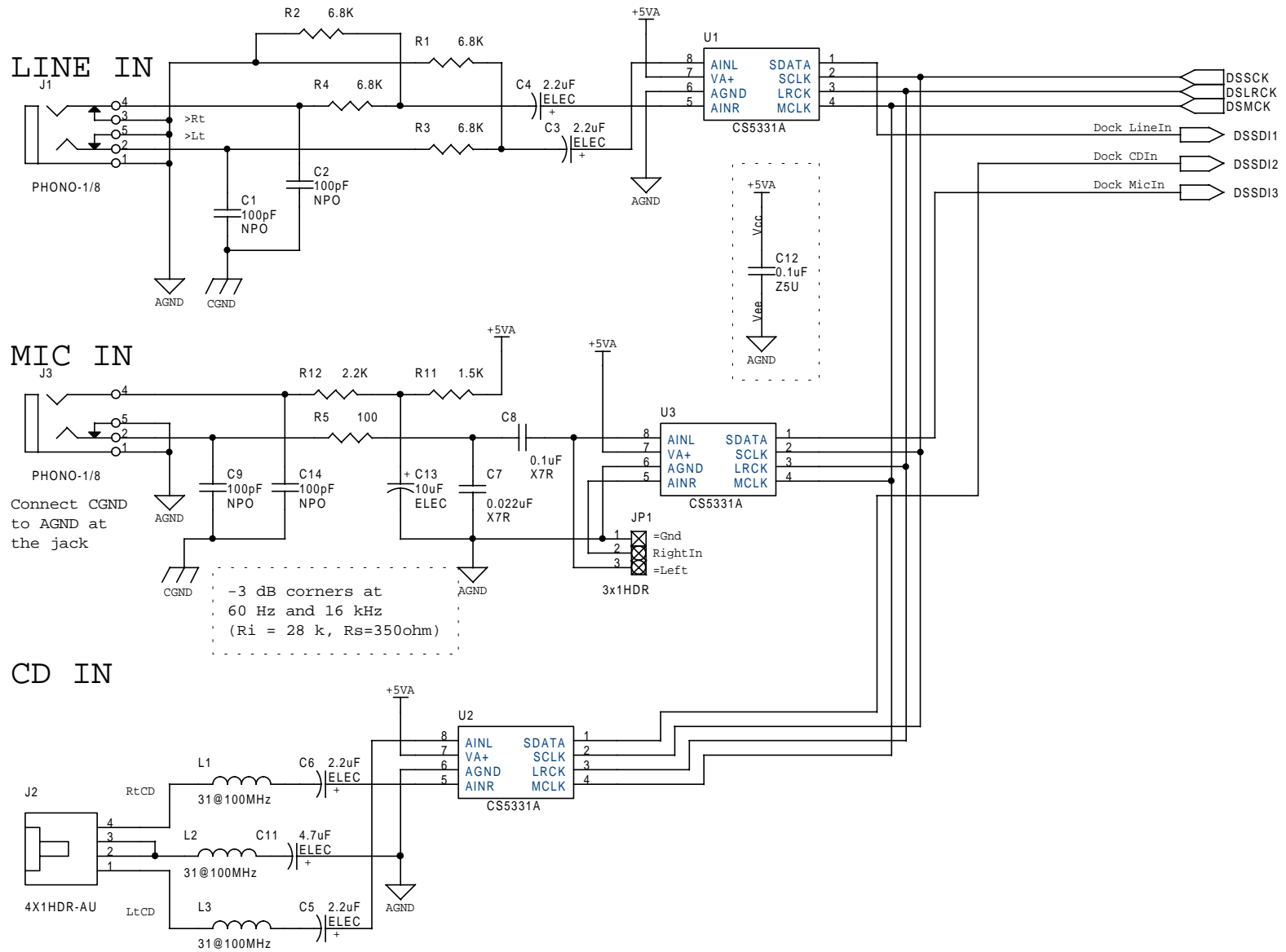


Figure 2. Analog In



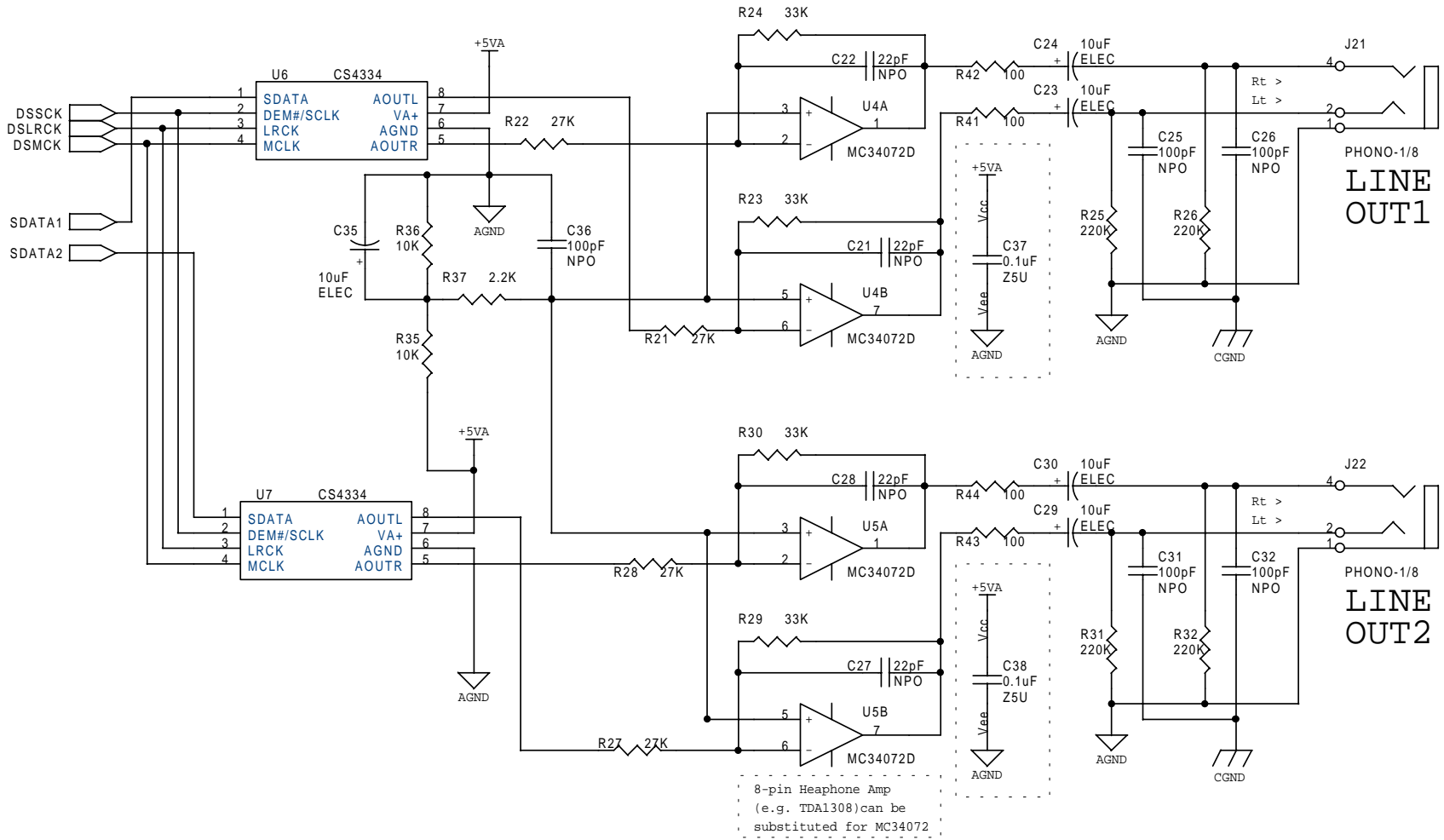


Figure 3. Analog Out





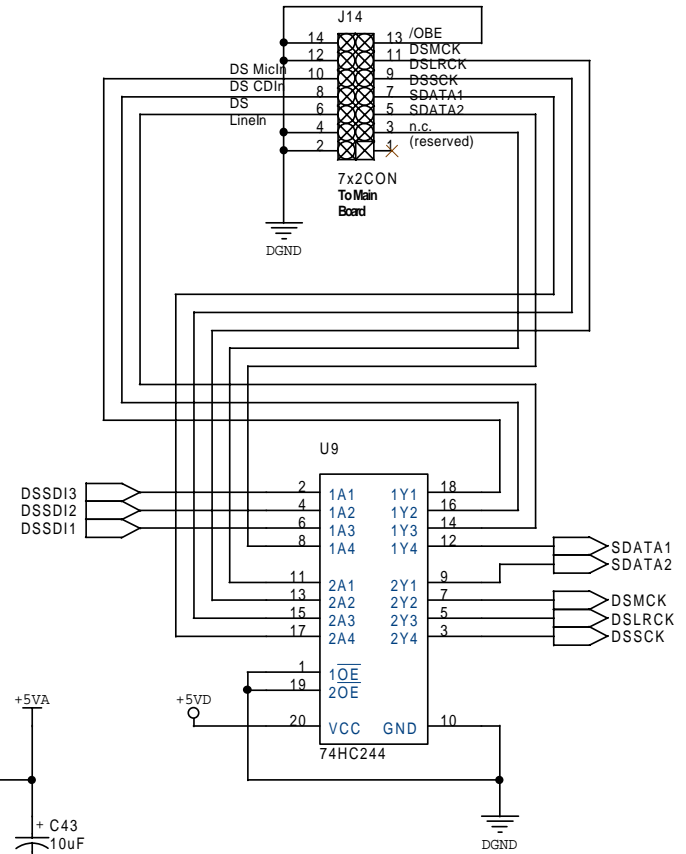
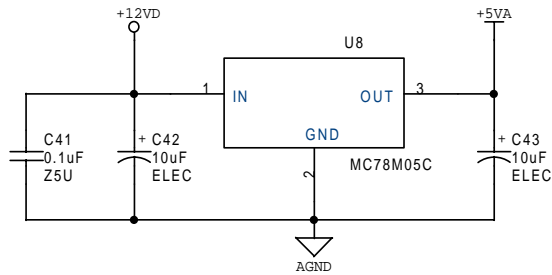
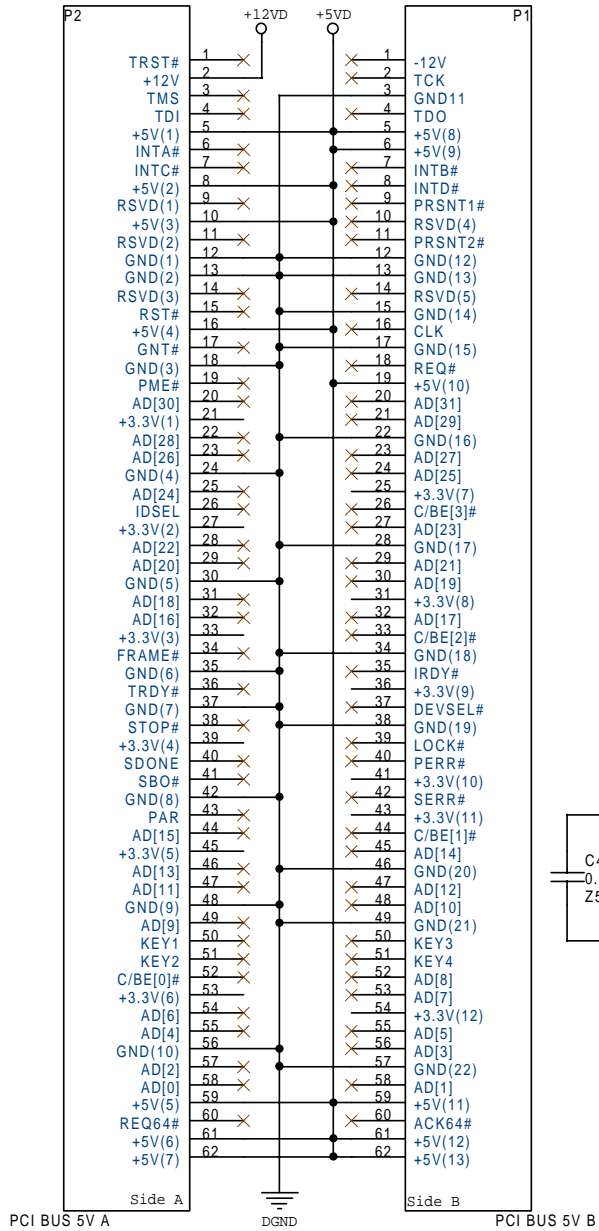


Figure 4. PCI Bus



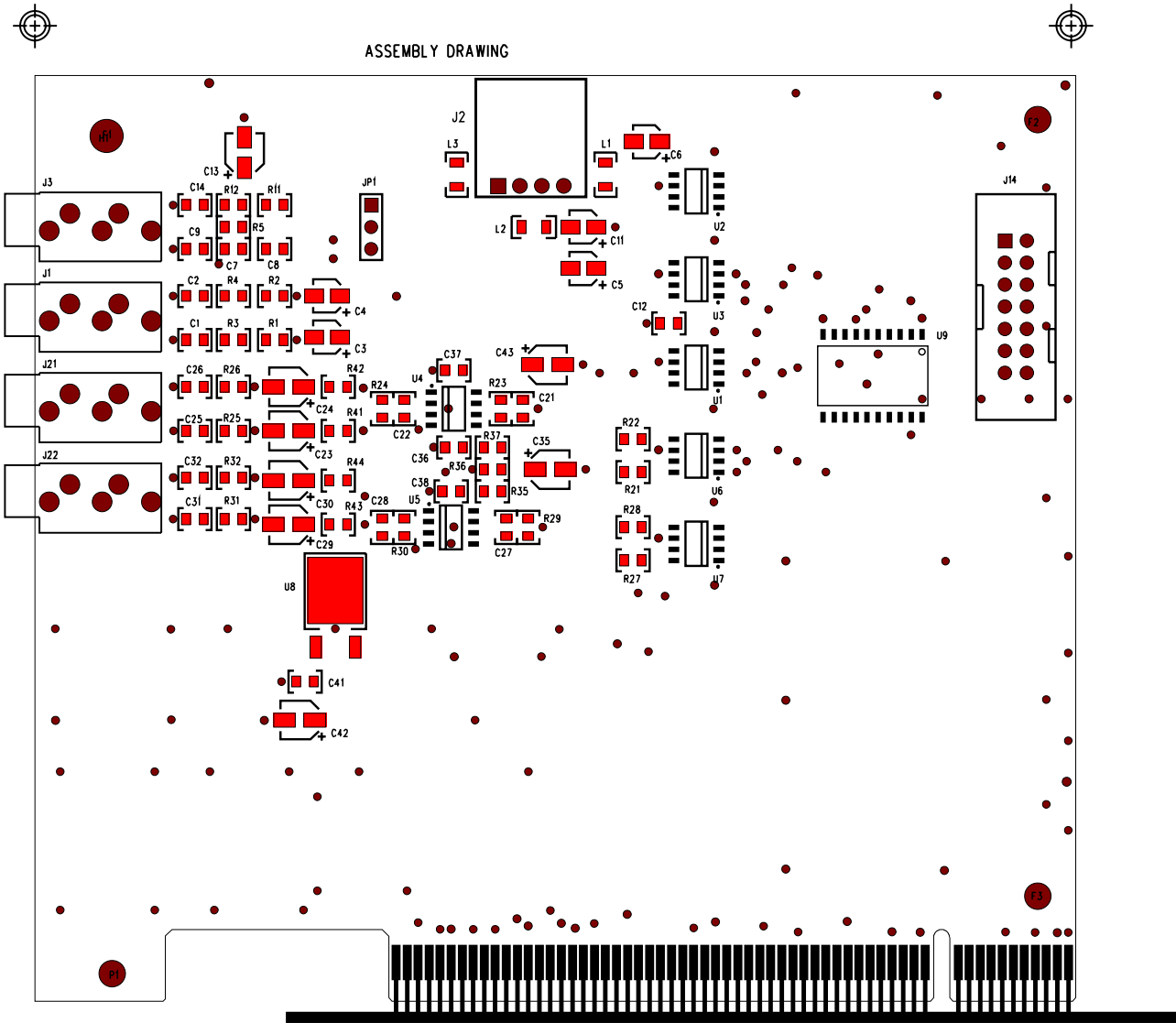


Figure 5. Assembly Drawing

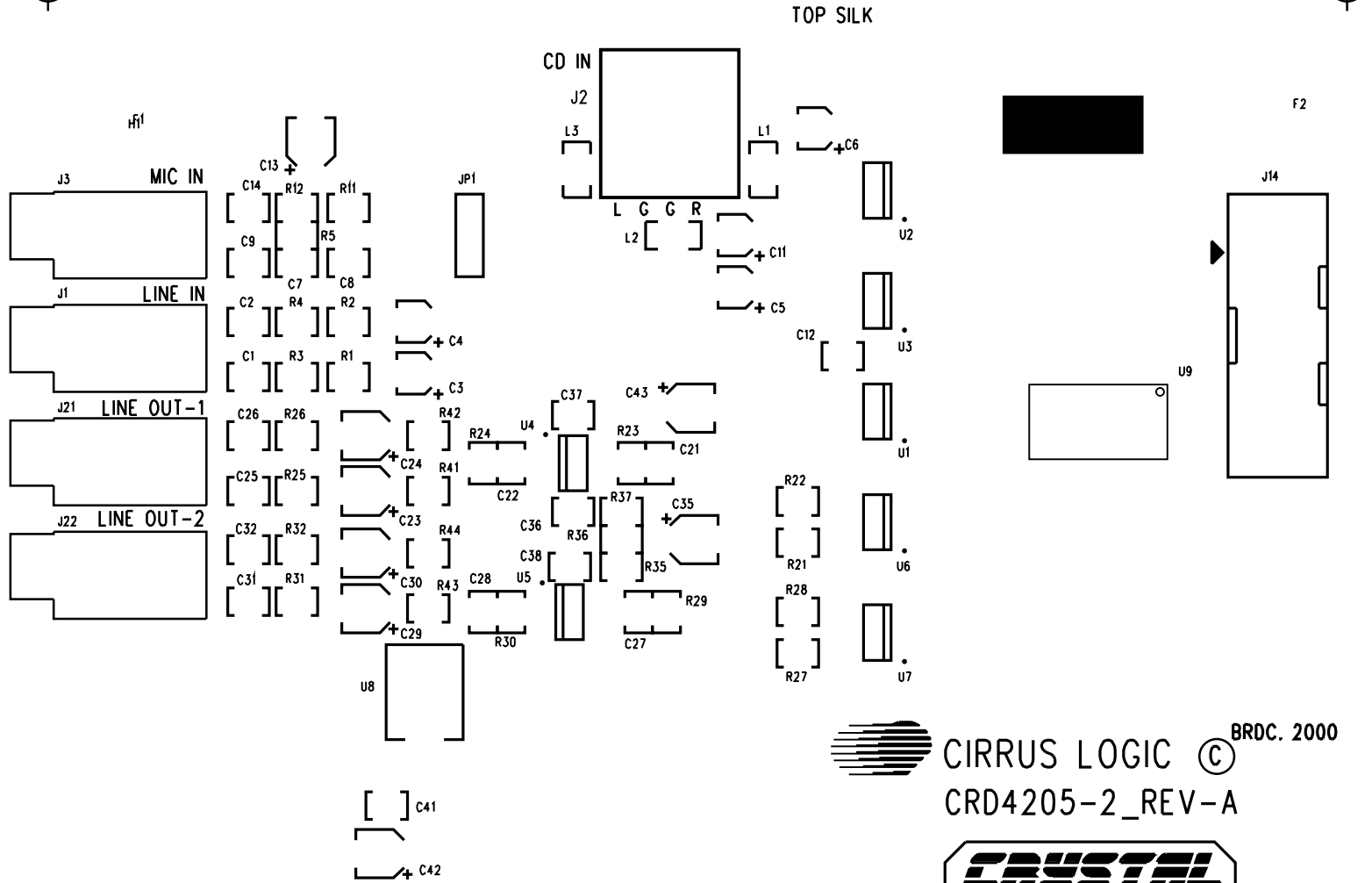
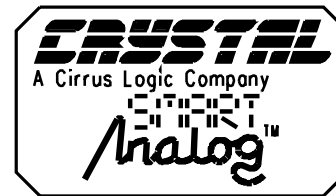


Figure 6. Silkscreen



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 CRD4205-2\_REV-A



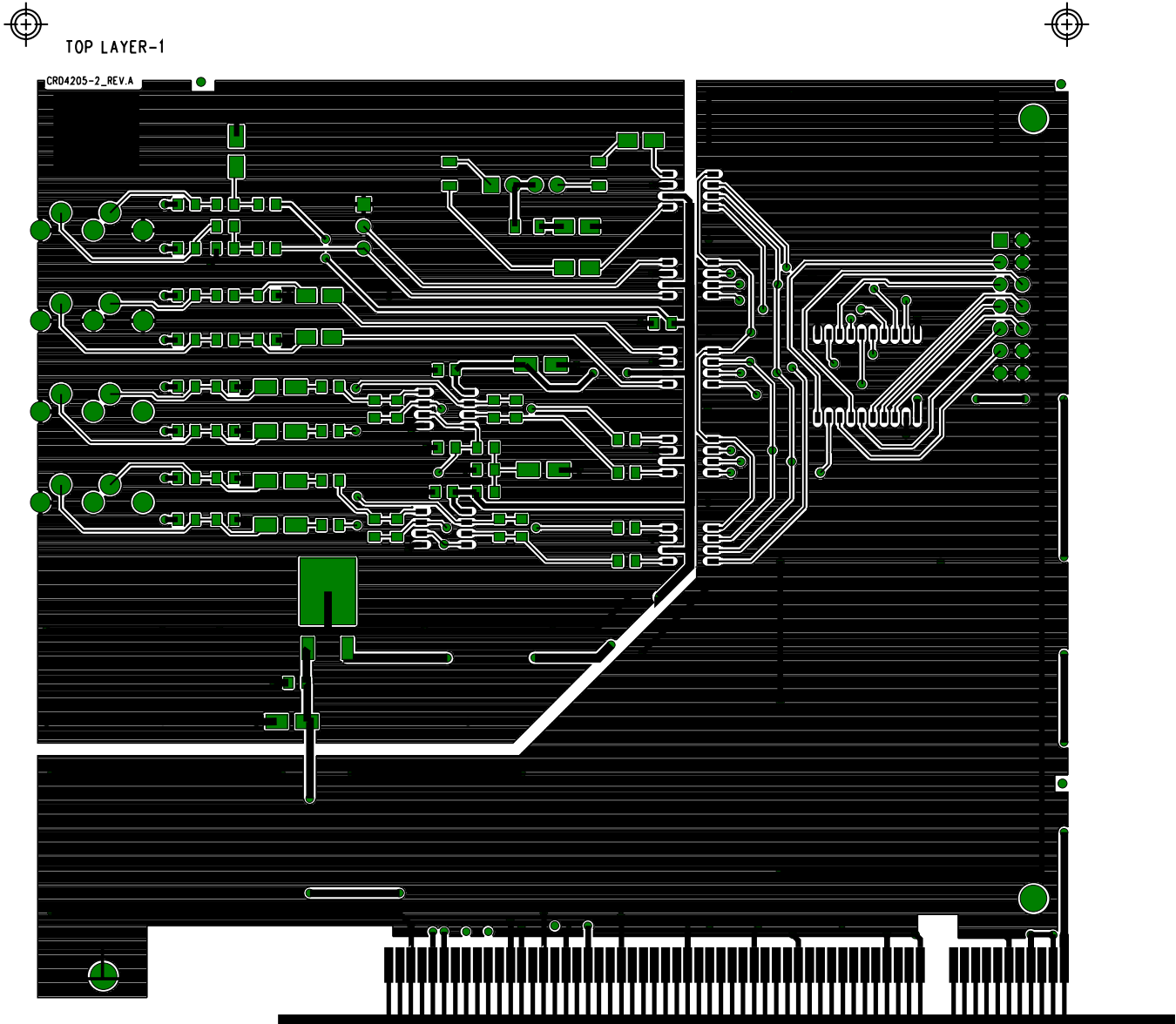


Figure 7. Top Layer

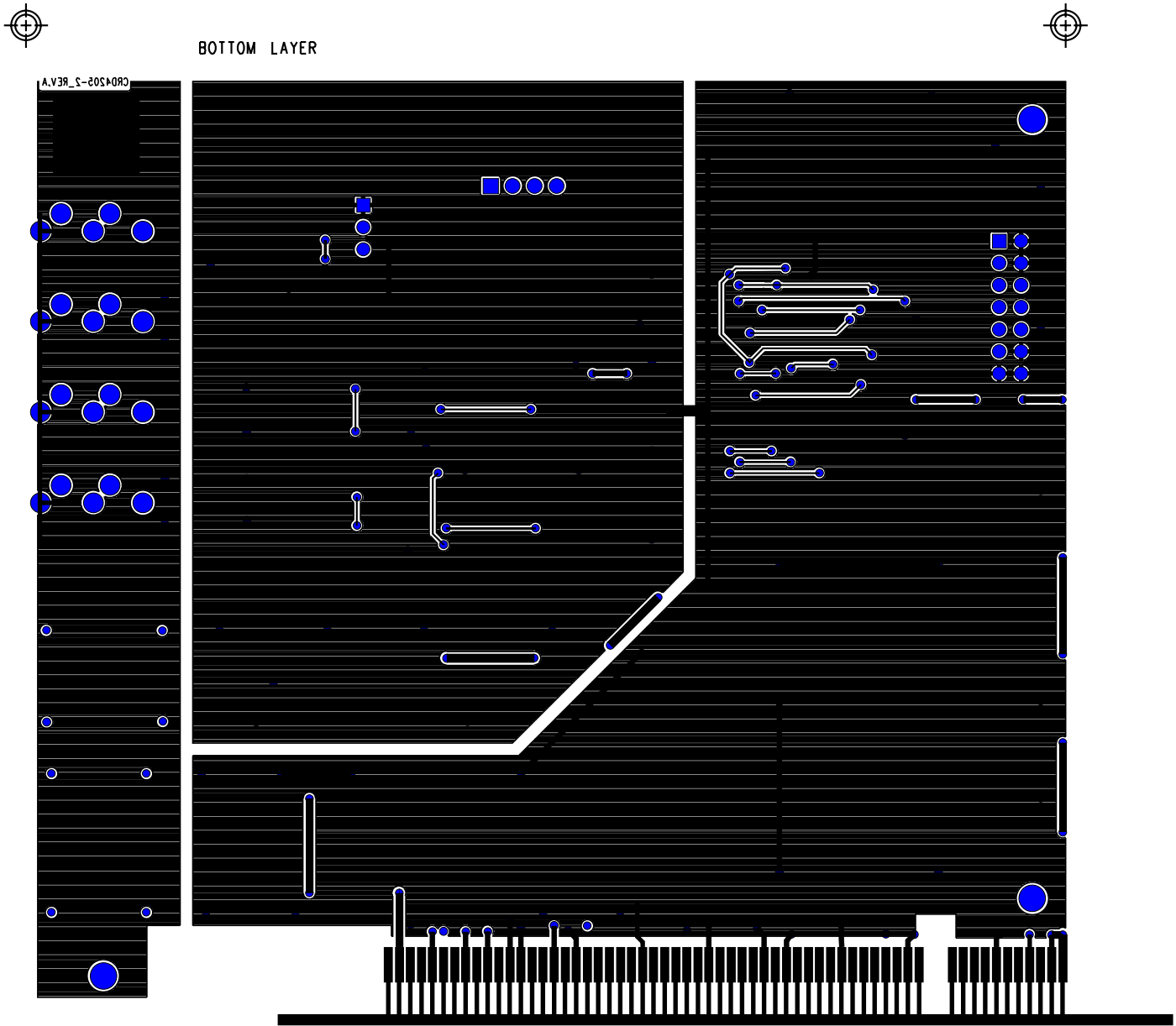
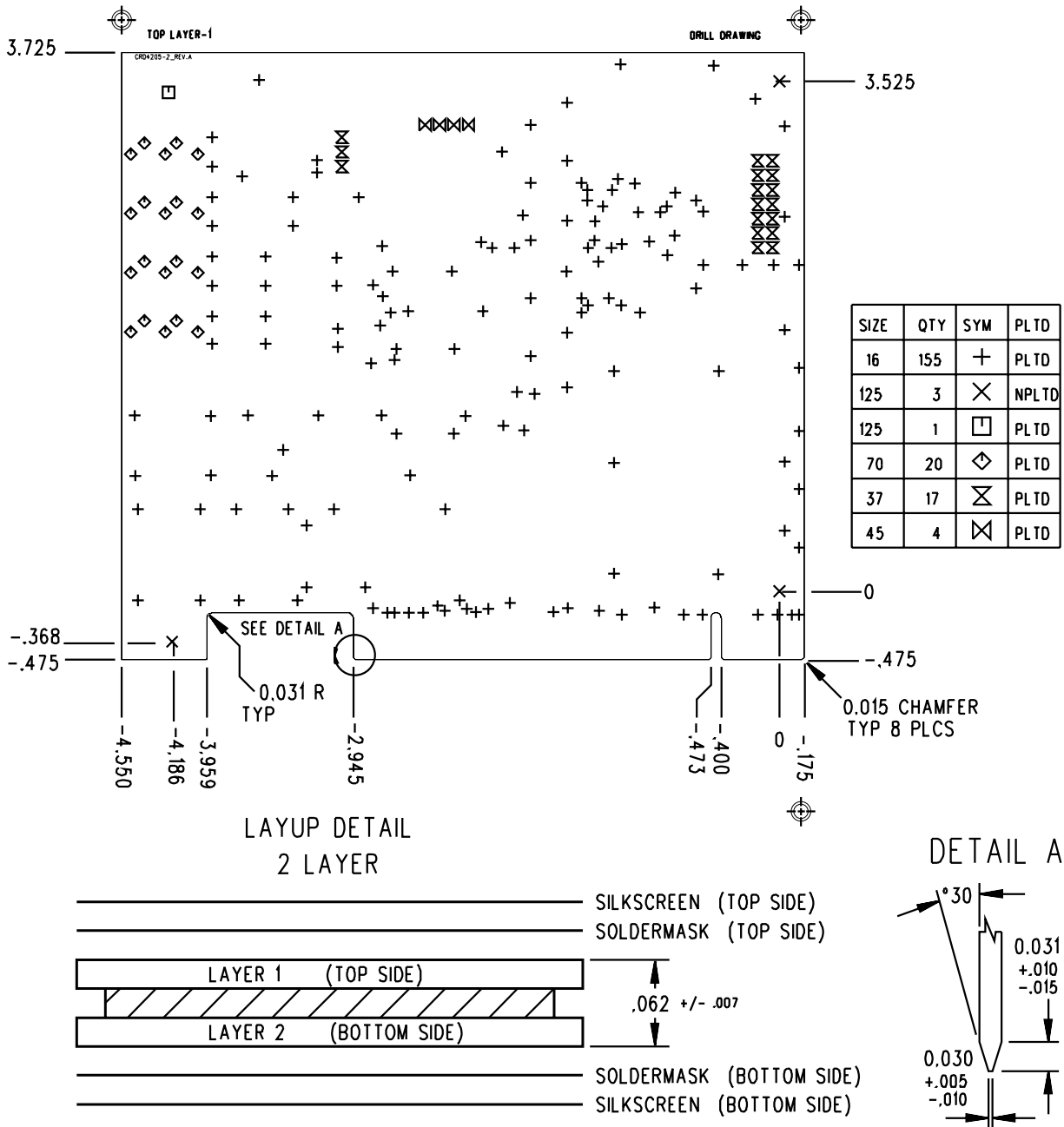


Figure 8. Bottom Layer



**Figure 9. Drill Drawing**

## 6. BILL OF MATERIALS

## PRINTED CIRCUIT BOARD ASSEMBLY

| Item | Quantity | Reference                             | Description  | Manufacturer          | Manufacturer PN  |
|------|----------|---------------------------------------|--|-----------------------|------------------|
| 1    | 9        | C1,C2,C9,C14,C25,C26,C31.<br>C32,C36. | CAP, 0805, COG, 100pF, 5%, 50V.                      | KEMET.                | C0805C101J5GAC.  |
| 2    | 4        | C3,C4,C5,C6.                          | CAP, SMT A, ELEC, 2.2uF, 20%, 35V.                   | PANASONIC.            | ECE-V1VS2R2SR.   |
| 3    | 1        | C7.                                   | CAP, 0805, X7R, .022uF, 10%, 50V.                    | KEMET.                | C0805C223K5RAC.  |
| 4    | 5        | C8,C12,C37,C38,C41.                   | CAP, 0805, X7R, .1uF, 10%, 50V.                      | KEMET.                | C0805C104K5RAC.  |
| 5    | 1        | C11.                                  | CAP, SMT A, ELEC, 4.7uF, 20%, 25V.                   | PANASONIC.            | ECE-V1ES4R7SR.   |
| 6    | 8        | C13,C23,C24,C29,C30,C35.<br>C42,C43.  | CAP, SMT B, ELEC, 10uF, 20%, 16V.                    | PANASONIC.            | ECE-V1CA100R.    |
| 7    | 4        | C21,C22,C27,C28.                      | CAP, 0805, COG, 22pF, 10%, 50V.                      | KEMET.                | C0805C220K5GAC.  |
| 8    | 1        | JP1.                                  | HDR, 3x1, 0.025" PIN, 0.1" CTR.                      | SAMTEC.               | TSW-103-07-T-S.  |
| 9    | 1        | J1.                                   | CONN, 1/8" DOUBLE SW. STEREO PHONE JACK.             | LZR ELECTRON-<br>ICS. | SJ372.           |
| 10   | 1        | J2.                                   | HDR, 4X1, 0.025" PIN, 0.1" CTR, 15u" AU.             | MOLEX.                | 70553-0003.      |
| 11   | 1        | J3.                                   | CONN, 1/8" SINGLE SW. STEREO PHONE JACK.             | LZR ELECTRON-<br>ICS. | SJ374.           |
| 12   | 1        | J14.                                  | CONN, 7x2 RIBBON, MALE, STRAIGHT, SHROUDED.          | AMP.                  | 103309-2.        |
| 13   | 2        | J21,J22.                              | CONN, 1/8" NON-SW. STEREO PHONE JACK.                | LZR ELECTRON-<br>ICS. | SJ373.           |
| 14   | 3        | L1,L2,L3.                             | IND, FBEAD, 1206, 31@100MHz, 25%.                    | TDK.                  | HF50ACB321611-T. |
| 15   | 1        | P1.                                   | PCI BUS 5V SIDE B.                                   | .                     | .                |
| 16   | 1        | P2.                                   | PCI BUS 5V SIDE A.                                   | .                     | .                |
| 17   | 4        | R1,R2,R3,R4.                          | RES, SO, 0805, 6.8K, 1%, 1/10W, METAL FILM.          | PHILIPS.              | 9C08052A6801F.   |
| 18   | 1        | R11.                                  | RES, SO, 0805, 1.5K, 1%, 1/10W, METAL FILM.          | PHILIPS.              | 9C08052A1501F.   |
| 19   | 2        | R37,R12.                              | RES, SO, 0805, 2.2K, 1%, 1/10W, METAL FILM.          | PHILIPS.              | 9C08052A2201F.   |
| 20   | 4        | R21,R22,R27,R28.                      | RES, SO, 0805, 27K, 1%, 1/10W, METAL FILM.           | PHILIPS.              | 9C08052A2702F.   |
| 21   | 4        | R23,R24,R29,R30.                      | RES, SO, 0805, 33K, 1%, 1/10W, METAL FILM.           | PHILIPS.              | 9C08052A3302F.   |
| 22   | 4        | R25,R26,R31,R32.                      | RES, SO, 0805, 220K, 5%, 1/10W, METAL FILM.          | PHILIPS.              | 9C08052A2203J.   |
| 23   | 2        | R36,R35.                              | RES, SO, 0805, 10K, 1%, 1/10W, METAL FILM.           | PHILIPS.              | 9C08052A1002F.   |
| 24   | 5        | R41,R42,R43,R44,R5.                   | RES, SO, 0805,100, 1%, 1/10W, METAL FILM.            | PHILIPS.              | 9C08052A1000F.   |
| 25   | 3        | U1,U2,U3.                             | IC, CS5331A, 18-BIT ADC.                             | CIRRUS LOGIC.         | CS5331A-KS.      |
| 26   | 2        | U5,U4.                                | IC, SO, SOIC8, 34072, SINGLE SUPPLY DUAL OP AMP.     | MOTOROLA.             | MC34072D.        |
| 27   | 2        | U6,U7.                                | IC, SO, SOIC8, CS4334, DAC, STEREO.                  | CIRRUS LOGIC.         | CS4334-KS.       |
| 28   | 1        | U8.                                   | IC, SO, +5V REGULATOR, MC78M05C, DPAK, 4%,<br>500mA. | MOTOROLA.             | MC78M05CDT.      |
| 29   | 1        | U9.                                   | IC, 74HC244.   | MOTOROLA.             | MC74HC244ADW.    |

**MECHANICAL ASSEMBLY**

| Item | Quantity | Name                         | Manufacturer      | PN               | Comments                                |
|------|----------|------------------------------|-------------------|------------------|---|
| 1    | 1        | Printed Circuit Board (PCB). | .                 | CRD4205-2 Rev A. | PN located in upper left corner of PCB. |
| 2    | 1        | PCI Bracket.                 | Globe.            | .                | .                                       |
| 3    | 1        | Label.                       | Internal Crystal. | NA.              | Label content "CRD4205-2".              |





• **Notes** •

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