

## FEATURES

- MPC3 compliant (with enhancements), Windows Sound System™, DOS Games and AdLib™ compatible
- Low Cost Two-Sided Board that Maintains Quality
- Crystal Single-Chip CS9236 Wavetable Music Synthesizer
- Design accepts the CS4235 , or CS4236B, CS4237B, CS4238B family of devices with simple Bill-of-Material changes
- Jumper selectable output amplifier option. Switch between a high quality headphone capable amplifier, or a speaker driver.
- MODEM audio connection for Audio Telephony Applications (Requires a separate Modem Card)
- Fully Plug-and-Play Compliant

## ORDERING INFO

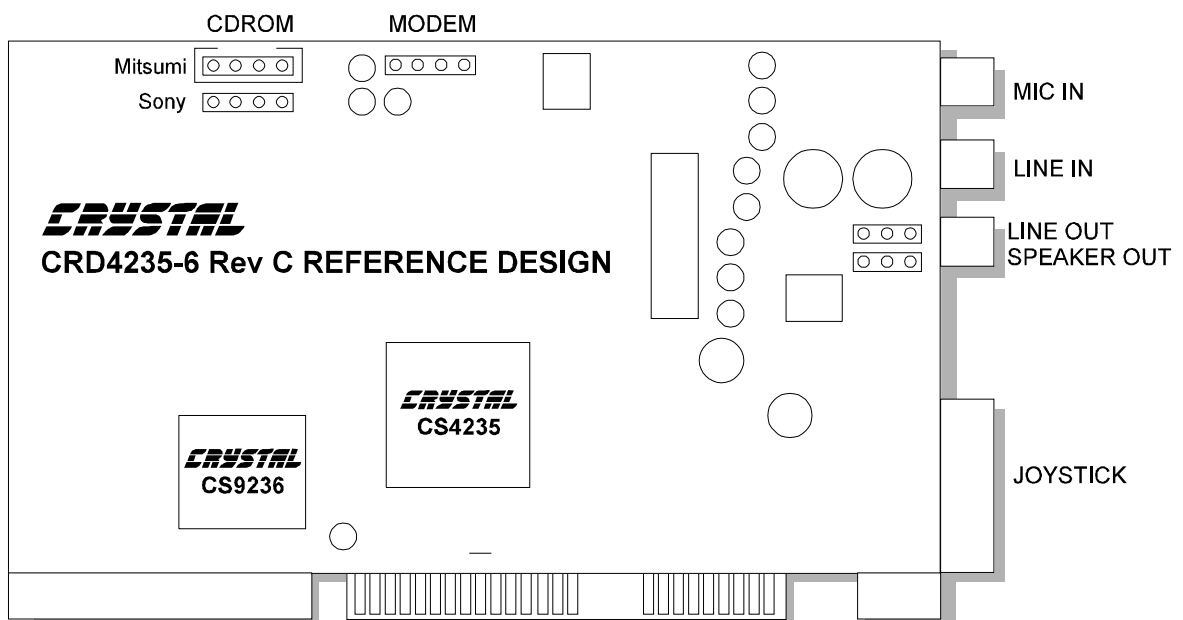
CMK4235-6

**CrystalClear™**  
**16-bit Low-Cost Audio**  
**Adapter Reference Design**

## DESCRIPTION

The CD-quality CRD4235-6 reference design is fully MPC3 compliant, Ad Lib, DOS Games and Windows Sound System compatible. The design is a half size two-sided ISA-bus PC adapter board, based on the CS4235 Multimedia Audio Codec. The CS9236 is a high quality low-cost way to add Wavetable music synthesis to the sound card and can be soldered down during the production process, or added later if a PLCC socket is installed.

The CRD4235-6 reference design is backed by a customer ready manufacturing kit. Included in the kit are full schematic and library design files, PWB job files, and PWB artwork files. The OEM has the option of quickly modifying the existing design for their specific requirements or implementing the design as is. Documentation source files are available to allow the OEM to quickly create an accurate end user manual.



## GENERAL INFORMATION

The CRD4235-6 is a reference design of a production-grade PC-AT adapter card using the Crystal-Clear CS4235 Multimedia Audio Codec. This card is designed to provide the highest possible functionality, along with superlative audio performance at a low manufacturing cost. The CRD4235-6 is FCC class B and CISPR certified. All logical subsystems are fully Plug and Play compliant and ready for all Microsoft® Operating Systems. The design provides a full set of features required for today's multimedia applications.

The CRD4235-6 reference design includes many features that make it possible to manufacture one board and actively compete in different markets. All of the following features can be eliminated from the design during the manufacturing process if a cost reduction is desired.

- The microphone input feature allows the use of both internal and external microphone sources.
- Jumper selectable output amplifier. The CRD4235-6 can be manufactured with both amplifiers, or the OEM has the option to only populate the desired amplifier at the time of manufacture, and hard-wire the jumper for a fixed configuration.
- The CD-ROM audio input has been designed to provide two popular header sizes, since both connectors cannot be used simultaneously, the OEM can elect to only populate the desired CD-ROM Audio jack.
- The MODEM audio circuitry has been designed to interface to a audio capable modem board, and can be completely removed from the CRD4235-6 if this feature is not required.
- A dual joystick and MIDI interface is available with an industry standard 15-pin D-sub connector.
- Wavetable audio is available with the on-board CS9236 single chip Wavetable IC.

Software drivers are available for the CS4235 that support all major operating systems. The Windows 95™ drivers are fully Plug and Play compatible, and like the Windows NT™ drivers, will utilize the

embedded multimedia applets provided by Microsoft. Cirrus Logic provides the essential multimedia applets and drivers required for the Windows® 3.1 and OS/2® operating systems on the drivers diskette. DOS utilities are also available which allow the computer to play a CD-ROM and control the sound volume.

All aspects of the design have been optimized to ensure top performance at the lowest cost. Care was taken with signal routing and component placement to minimize sources which can degrade performance. Cirrus' analog design know-how has resulted in a board which preserves the exceptional analog performance of the CS4235 audio Codec.

## BOARD AUDIO INTERCONNECTIONS

Three external stereo jacks (listed top to bottom) allow connection to a mono Microphone input, a stereo Line input, and a stereo Line/Headphone or speaker output. Headers for internal microphone, two common styles of CD-ROM audio, and a MODEM audio interface are also supported.

The first jack, designated MIC IN, is a single-ended microphone (as opposed to differential) input, supporting most common types of dynamic or phantom powered microphones. The microphone input circuitry provides no signal amplification, but a 20 dB gain block inside the CS4235 can be software enabled (the "Boost" button in the Windows input applet) if signal levels are too low. In many cases, the additional "Boost" will be required with the CRD4235-6 implementation in order to achieve a desirable audio level.

The second input jack, designated LINE IN, is for line inputs and is connected to the AUX1 inputs of the CS4235. Each channel has an input impedance of approximately 15 kΩ. The maximum full scale input that the LINE IN function can tolerate is  $2 V_{RMS}$ .

The third jack is LINE OUT/SPEAKER OUT. The line output from the CS4235 is either amplified by

a low-noise, low-distortion amplifier, or by a speaker amplifier. The unused amplifier need not be populated at manufacturing time in order to simplify this output function.

The CS4235 CD-ROM audio input headers are connected in parallel, which means that only one can be active at a time. The OEM will need to make this clear to end users, or delete the unused connector entirely.

The MODEM header provides an audio interface between the sound card and a modem. Mono out and Mic out signals transfer audio from the sound card to the modem, and a mono in signal transfers audio from the modem to the sound card.

## **CIRCUIT DESCRIPTIONS**

The functional block diagram is shown in Figure 1.

The CS4235 (as shown in Figure 2) is the heart of the CRD4235-6 reference design. The CS4235 is a Plug-and-Play aware device that controls all aspects of the sound card. See CS4235 Datasheet for complete information on this device.

The interconnections for ISA bus signals are detailed in Figure 3.

The DB-15 connector shown in Figure 4, provides an interface to an external joystick and MIDI I/O. The joystick interface supports two joysticks: two pair of X/Y coordinates and four buttons. The internal resistors and 1000 pF caps provide the correct debounce period for the joystick buttons. The timing for the joystick position is determined by the joystick potentiometer, the series 2.2 k $\Omega$  resistor and the 5600 pF capacitor. Deviation from the 2.2 k $\Omega$  and 5600 pF component values will result in improper joystick positioning. The MIDI TXD and MIDI RXD signals are TTL level signals and not compatible with direct MIDI cabling. An external "break-out" box attached to the 15-pin D-sub connector interfaces the TTL MIDI signals to an isolated MIDI connector.

On-board music synthesis is furnished by an FM synthesizer internal to the CS4235. For enhanced synthesis support, the CS9236 single-chip Wavetable Synthesis IC can be populated. The CS9236 provides a digital signal to the CS4235 via a serial interface, which is internally converted to an analog signal. The CS9236 interface is enabled by setting the WTEN bit in the EEPROM.

The Line and CD analog inputs shown in Figure 5 are both routed through 6 dB attenuators, and DC blocking capacitors. This circuitry provides input protection for the CS4235, and isolation from the analog input DC bias. 100 pF capacitors can be populated on the line input to provide better FCC filtering.

The output (Figure 6) of the CS4235 mixer is only capable of driving impedances greater than 10 k $\Omega$  with a maximum voltage of 1 V<sub>RMS</sub>. Some form of output amplifier is usually required to drive powered speakers or headphones. The CRD4235-6 has the several output amplifier options. A low-cost LM1458, or a high-quality NE5532 amplifier can be populated at location U7. Both amplifier options are not capable of driving non-amplified (4  $\Omega$  - 16  $\Omega$ ) speakers. The other output option is discussed in detail under Figure 8. The header which selects the output amplifier is J8 (Left) and J9 (Right).

An alternate output circuit configuration is based around U13. The LM1458N (Figure 6) provides left and right mixing to supply a mono-out signal to an external modem. This option would normally be used in addition to one or more of the above mentioned options, instead of as a replacement.

The microphone circuit (Figure 7) was designed to be low cost, with a low component count. No amplification of the incoming signal is provided. The +5 VA supply is reduced to 2.5 V with a resistive voltage divider. This reference is used to provide a low-noise source for phantom powered microphones. Phantom power is permanently applied

through a 2.2 k $\Omega$  resistor to either the right or left channels of the stereo jack. This provides for microphones that require bias on either the tip or ring of the microphone's plug. The choice of right or left phantom power is a hardware population option. Placing phantom power on the ring connection of the jack is the typical configuration. An internal microphone can be connected to a header, in place of the external microphone jack input.

The U13 LM1458N (Figure 7) circuitry has been provided to supply an amplified microphone signal to an external modem. The U13 device can be non-populated if the modem function is not required.

The TDA1517 can provide amplified audio power to a set of non-powered speakers (Figure 8). It is also capable of driving headphones, and powered speakers. This device can be used as the only output amplifier on the CRD4235-6, but the overall audio performance is not as good as that provided by the LM1458N.

An "L" series 5 V regulator (Figure 9) provides a clean low noise supply for the analog subsections of the CRD4235-6. The TO-92 package is adequate to provide the current and power dissipation required. If cost is the deciding factor, the LM78L05 can be non-populated and replaced with R44, with a loss of audio quality. The 3.3 V<sub>D</sub> supply is re-

quired for the CS9236 and can be non-populated when the CS9236 is not used. Two different methods are provided for generating the 3.3V supply voltage. A 3.3 V regulator is available by populating the LT1121CZ-3.3 (U10), or by using the lower-cost configuration of an MPS2222 (Q1), 1N5228 (D1) and a 100  $\Omega$  resistor (R45). The +12 V and -12 V power are filtered through a simple LC filter.

An external serial EEPROM (also shown in Figure 9) contains the Plug-and-Play configuration table. The CRD4235-6 includes a footprint for both a DIP and a SOIC EEPROM. Only one of these should be populated. After a power-on-reset, the data within the EEPROM is serially transferred to the CS4235. The XA0 pin serves as the serial clock while the XD0 pin functions as the bi-directional serial data-path. The EEPROM's data pin and the CS4235 XD0 pin are open collectors; a pull-up resistor is mandatory. If a Microsoft WHQL logo is not required, then the EEPROM can be removed and the CRD4235-6 will function based on internal resources.

#### **Reference design:**

- silk screen. (Figure 10)
- (component) top side. (Figure 11)
- (solder) bottom side. (Figure 12)

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Windows NT, Windows 95 and Windows Sound System are trademarks of Microsoft.  
OS/2 is a registered trademark of International Business Machines Corporation.  
Ad Lib is a trademark of Adlib Corporation.  
CrystalClear is a trademark of Cirrus Logic, Inc.

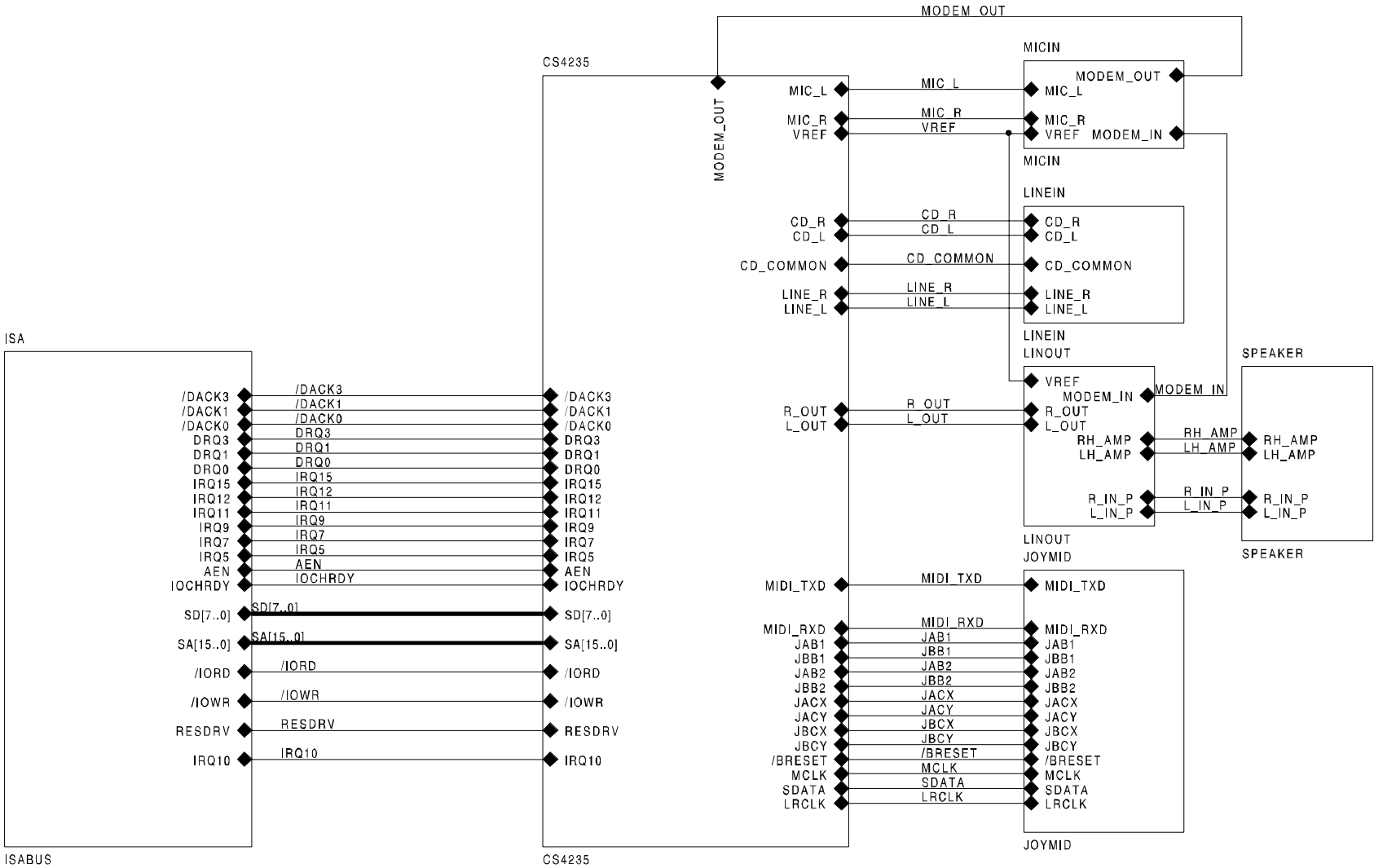
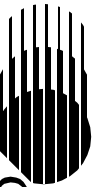


Figure 1. CS4235-1E Schematic Block Diagram



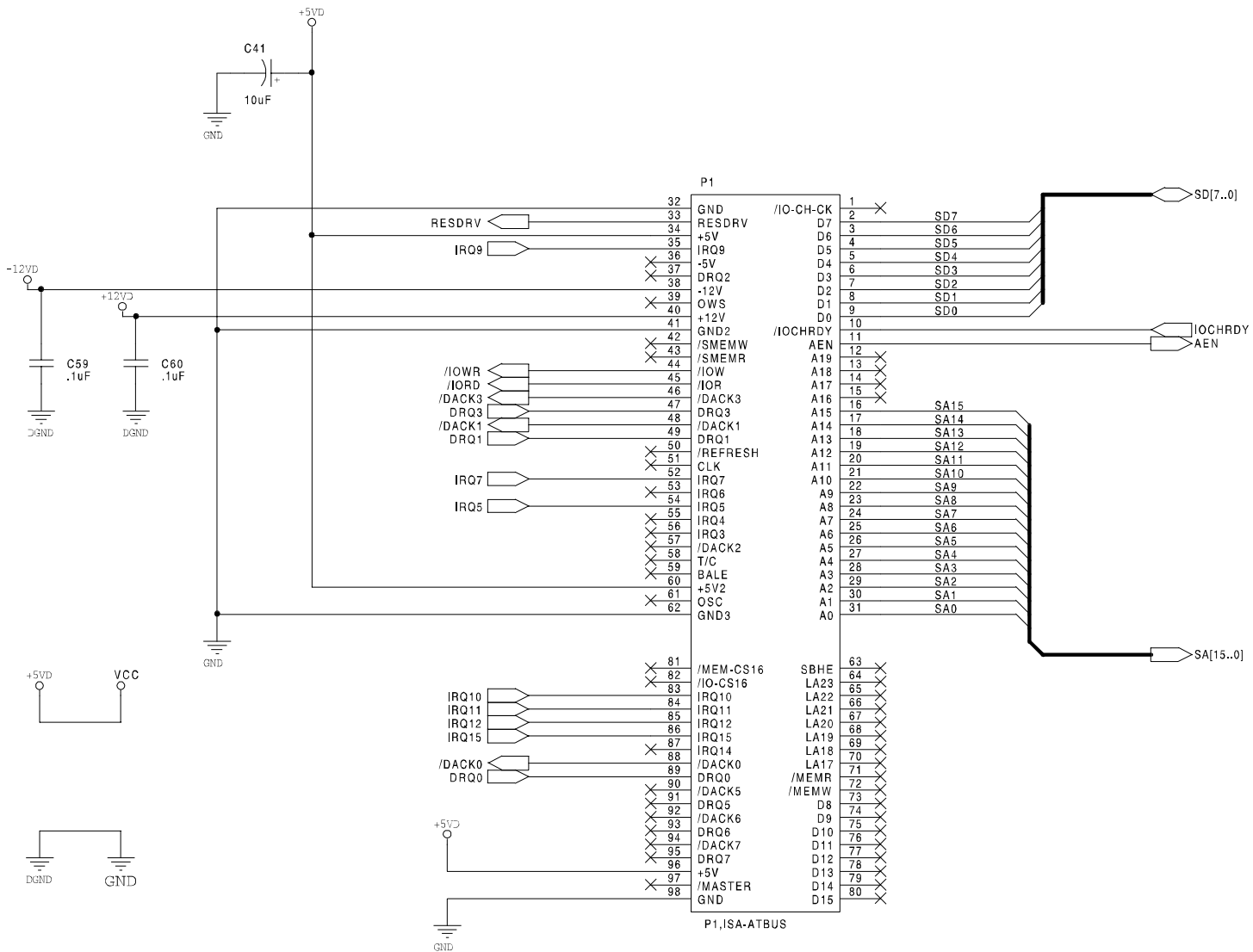
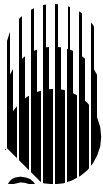
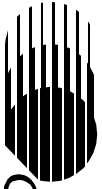


Figure 3. ISA Bus



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Bach  
Wavetable  
Synthesis

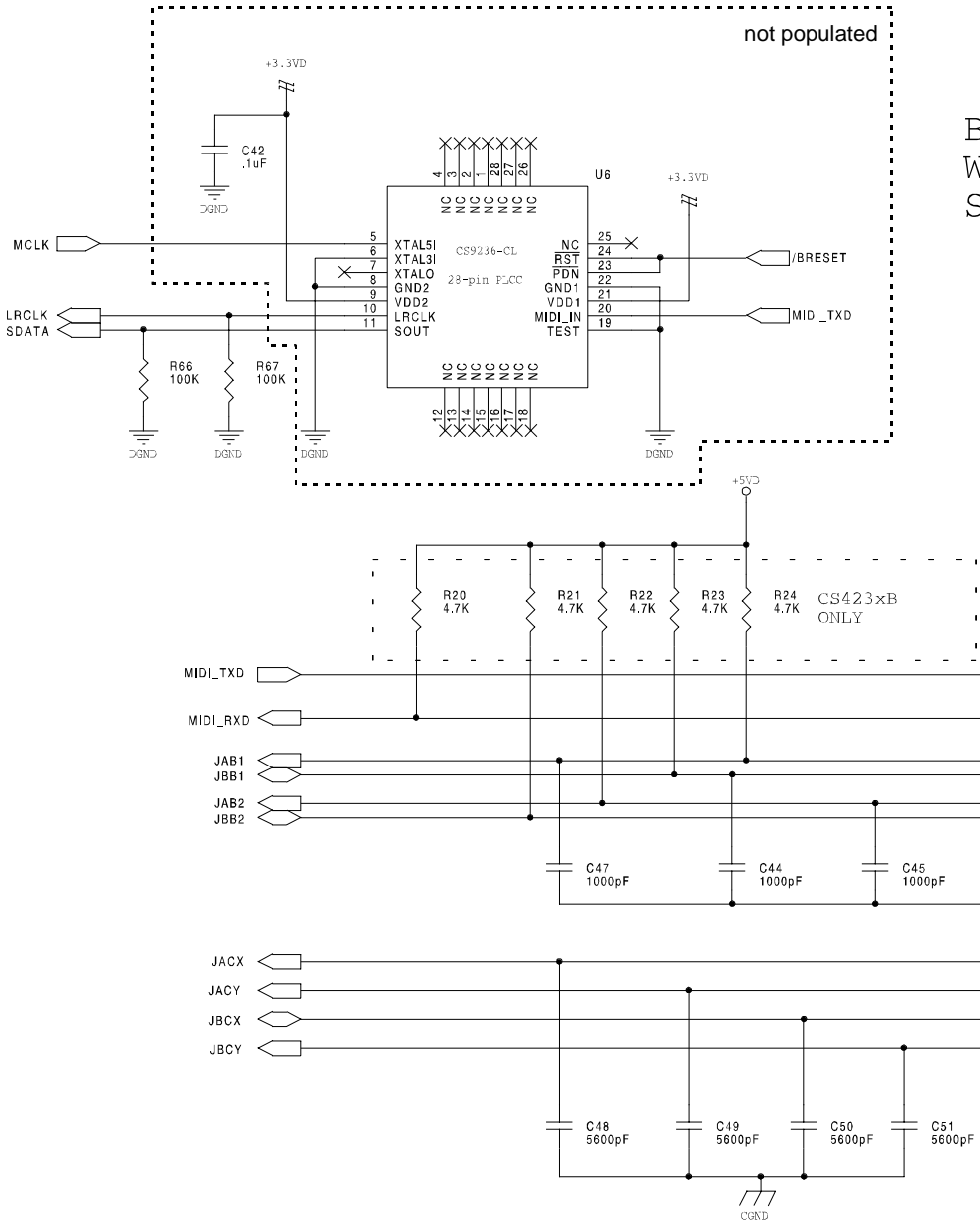


Figure 4. Game Port / Wavetable



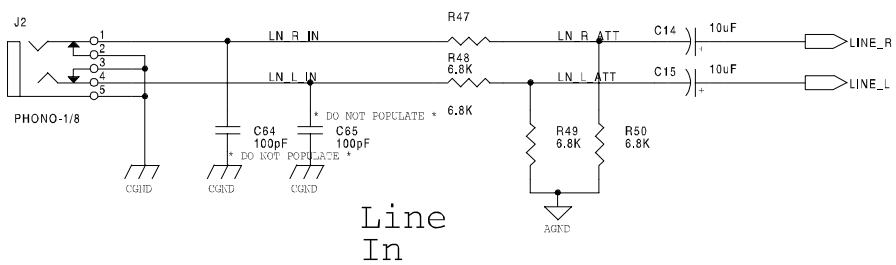
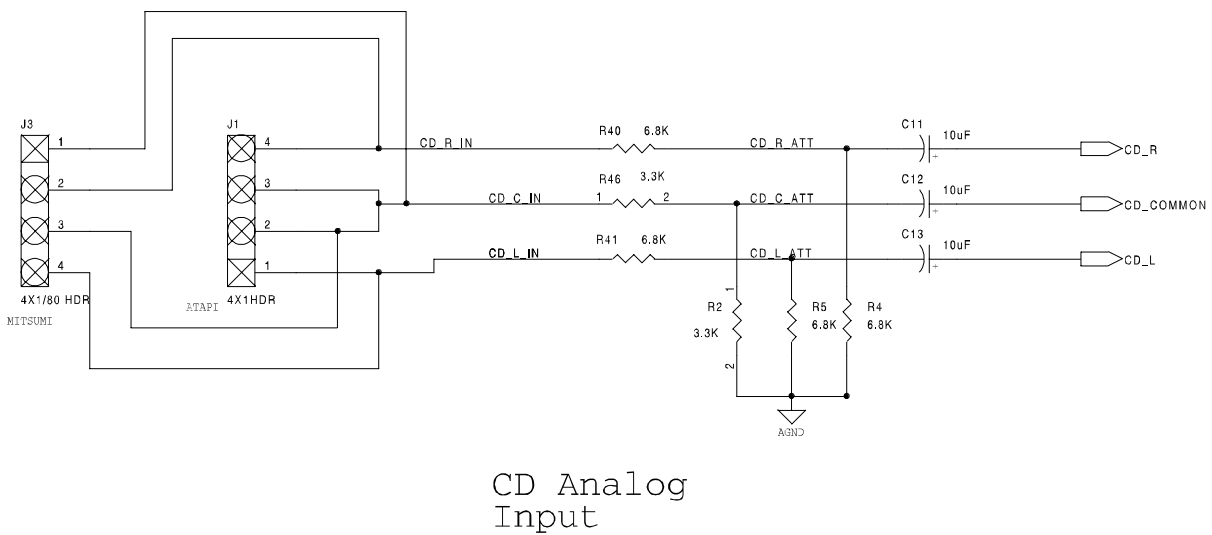
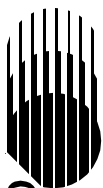


Figure 5. CD Analog and Line Inputs

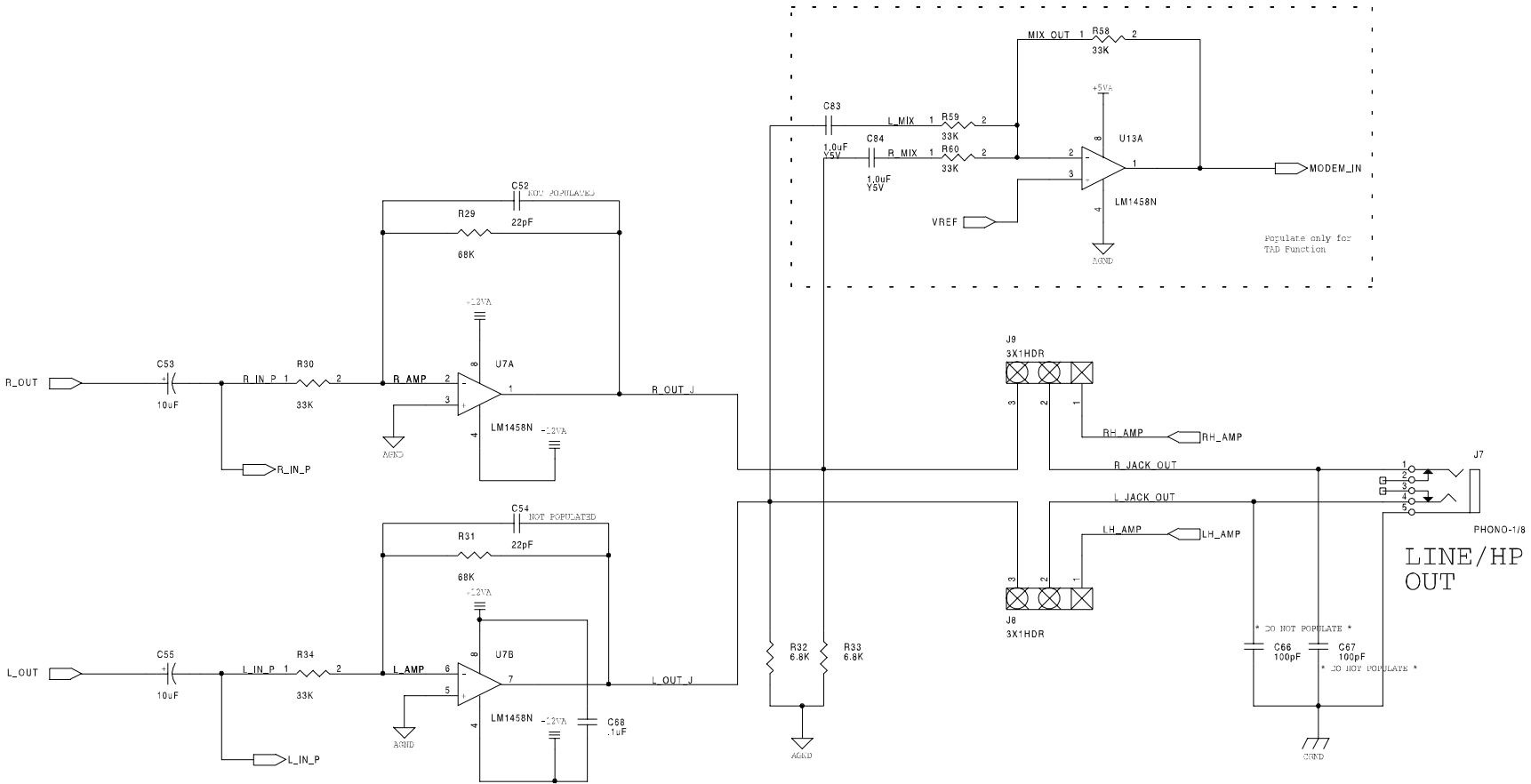
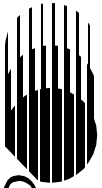
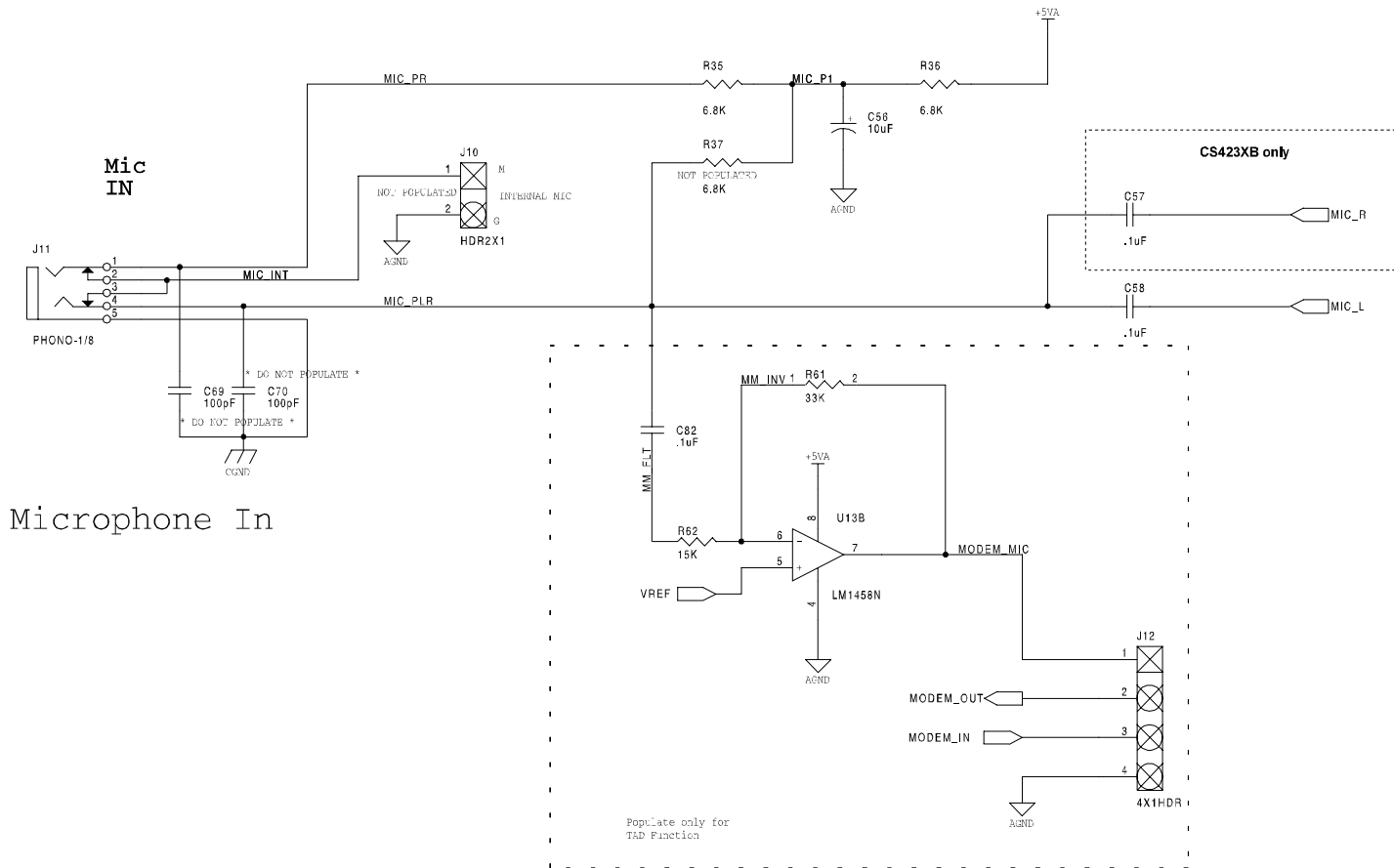
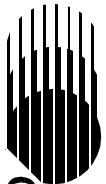
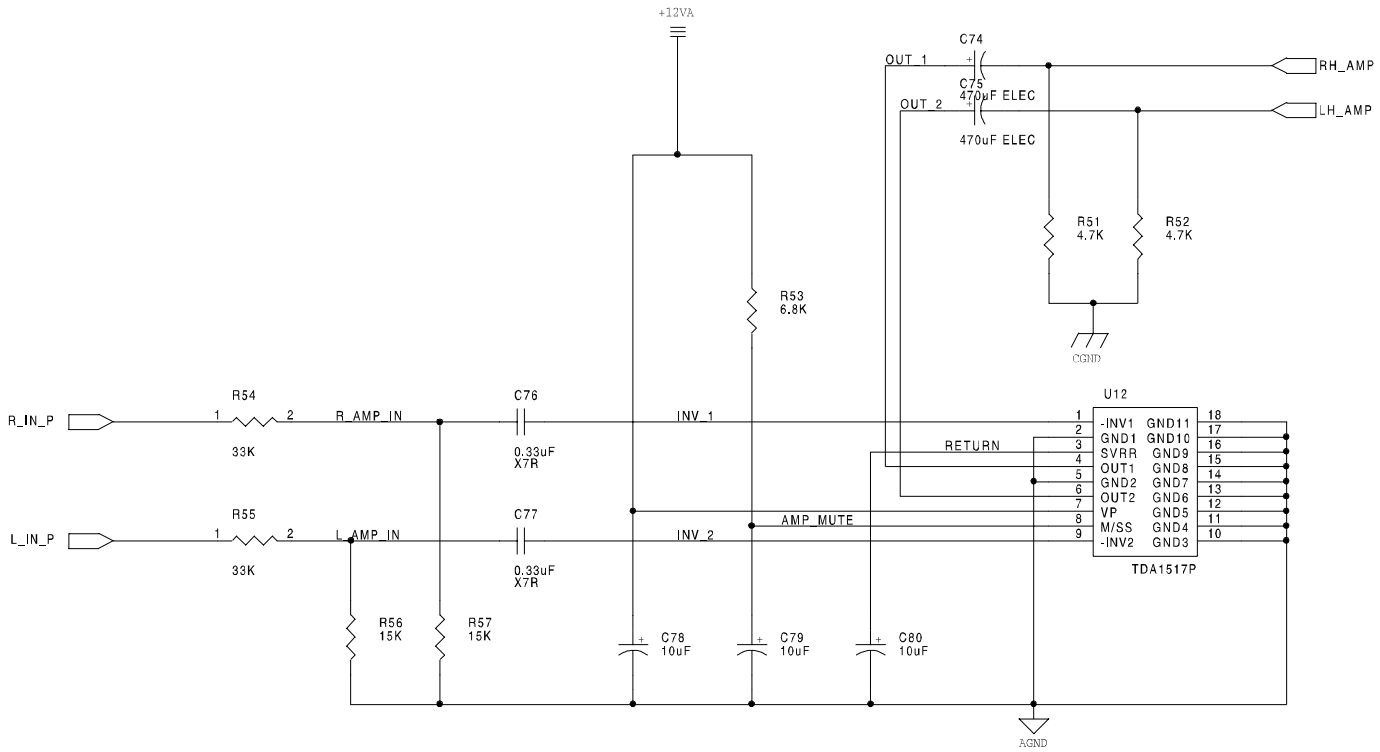
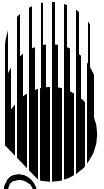


Figure 6. Line / Headphone Output



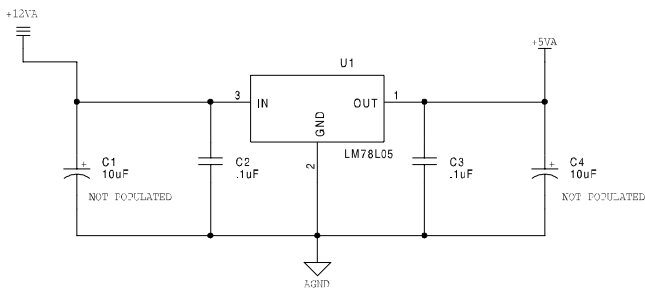
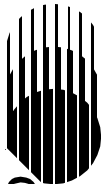
Microphone In

Figure 7. Microphone Input

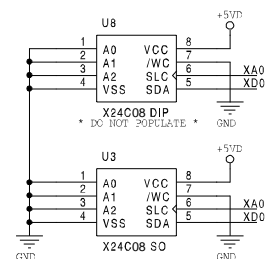
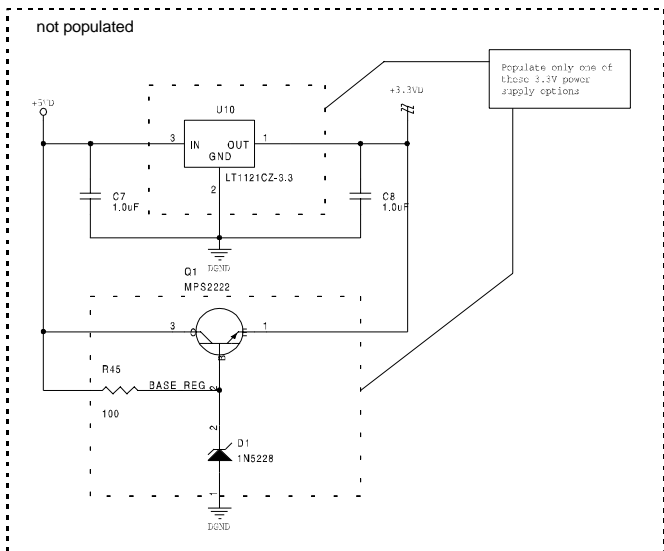
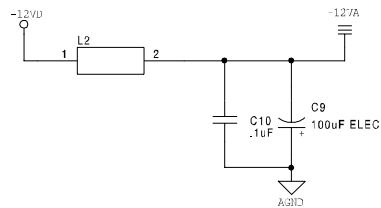
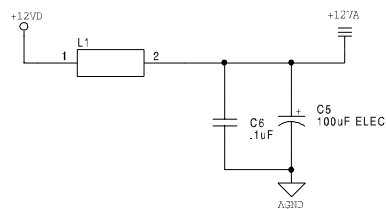


Amplified Speaker Out

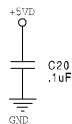
Figure 8. Speaker Amplifier



Analog Power

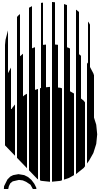


Plug and Play EEPROM



NOTE: The Analog (AGND) and the Digital (GND) Ground Planes MUST be connected together

Figure 9. Analog Power and EEPROM



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16-bit Low-Cost Audio Adapter Reference Design

CRD4235-6

**CRYSTAL**  
A Cirrus Logic Company  
CRD4235-6 REV.C

**SMART Analog™**

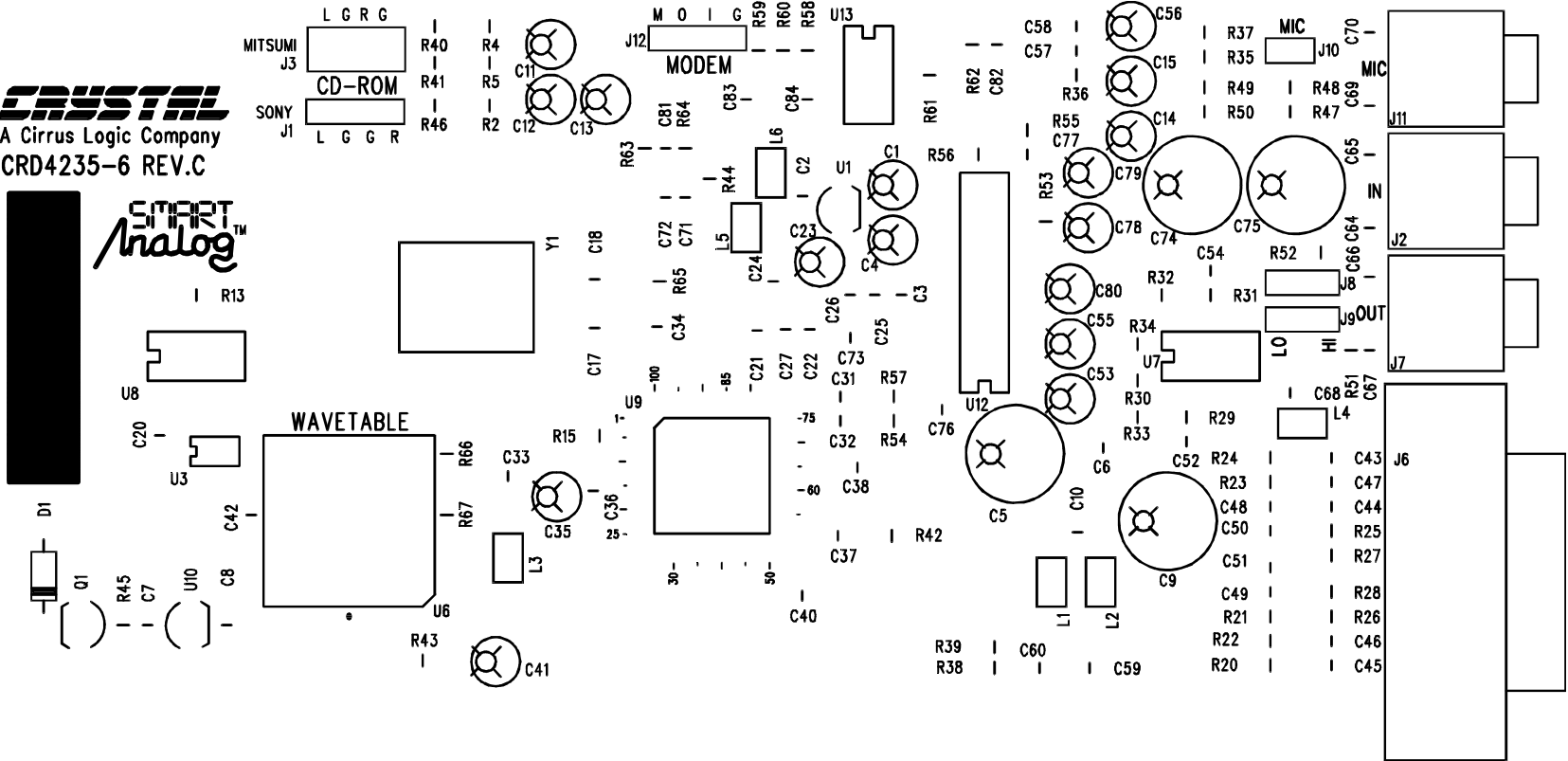


Figure 10. Silk Screen

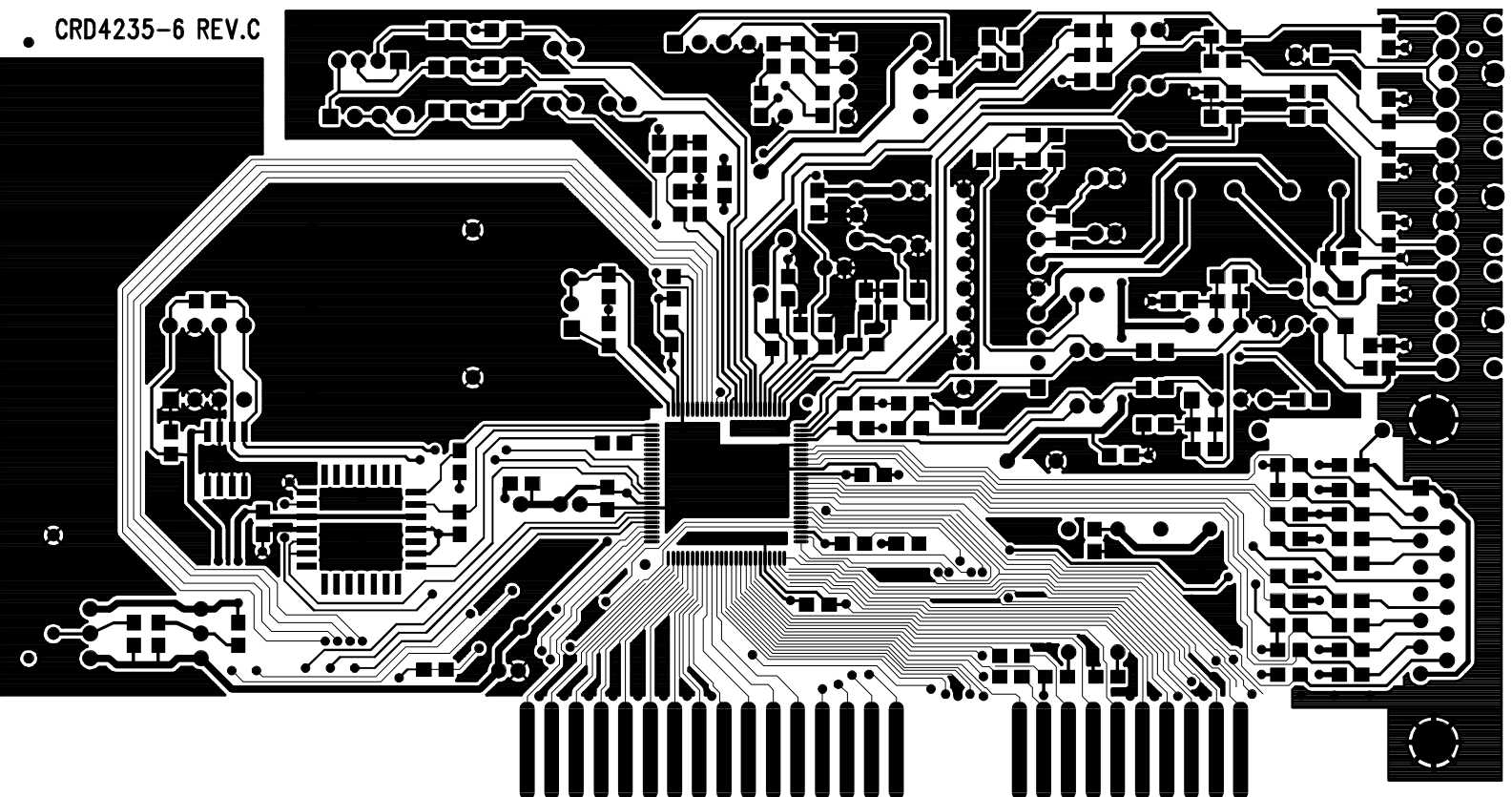


Figure 11. Top Side

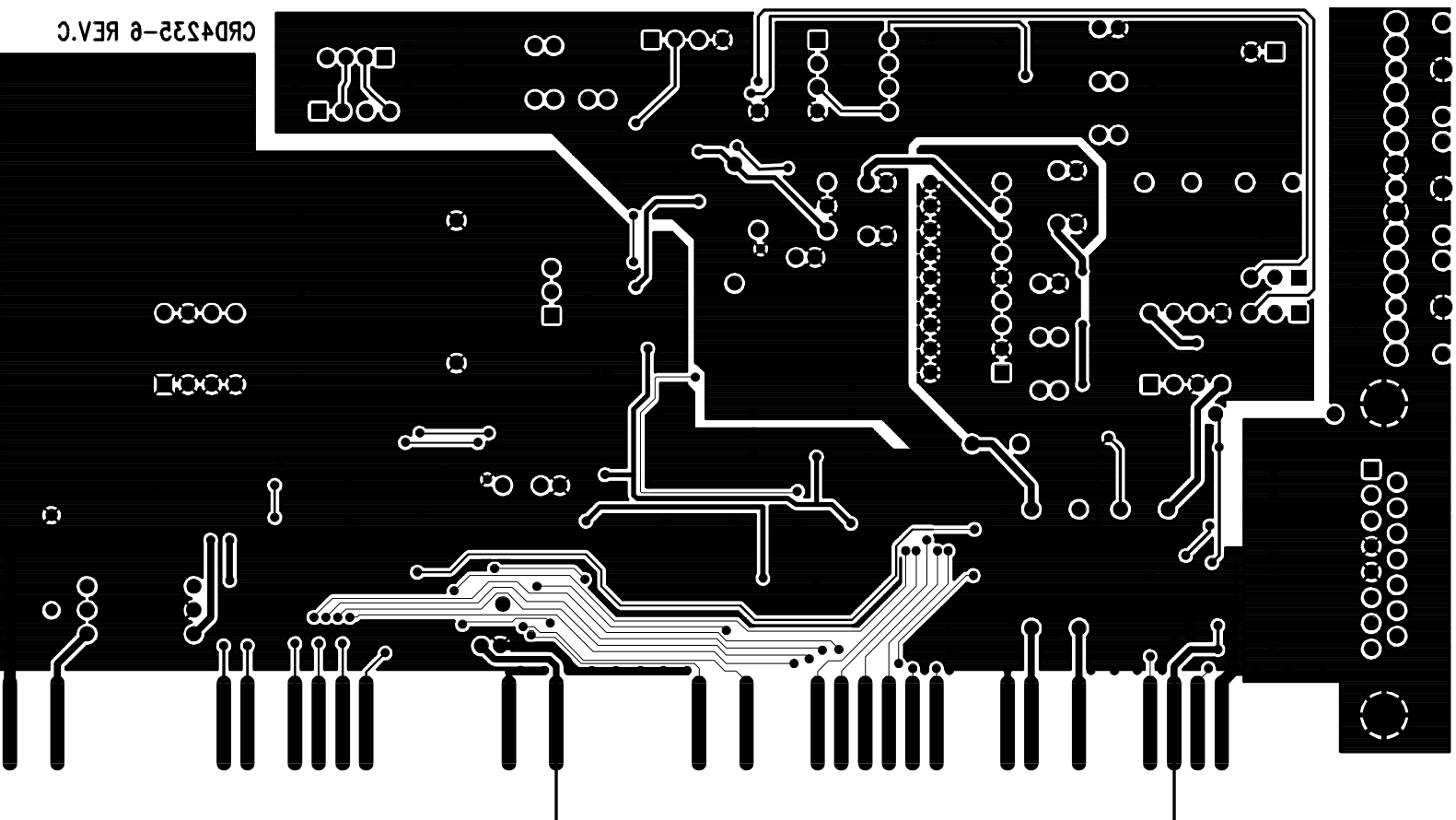
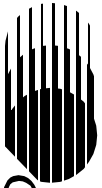


Figure 12. Bottom Side





Bill Of Materials    October 13,1997    11:52:59						
Item	Quan.	Reference	Part	PN	Manufacturer	Description
1	12	C11,C12,C13,C14,C15,C41,C53,C55,C56,C78,C79,C80	10uF	ECE-A1CN100S	PANASONIC	CAP,ELEC,10UF,TH,CASE C,20%,16V
2	18	C2,C3,C6,C10,C20,C21,C22,C27,C33,C34,C36,C38,C40,C43,C58,C59,C60,C68	.1uF	C0805C104K5RAC	KEMET	CAP,.1UF,SO,0805,10%,50V,X7R
3	2	C5,C9	100uF ELEC	ECE-A1CKA101	PANASONIC	CAP,ELEC,100uF,TH,CASE C,20%,16V
4	2	C24,C72	1.0uF	GRM40-6Y5V105Z016AD	MURATA	CAP,1.0UF,SO,0805,+80/-20%,16V,Y5V
5	2	C17,C18	22pF	C0805C220J5GAC	KEMET	CAP,22pF,SO,0805,5%,50V,COG
6	7	C31,C32,C44,C45,C46,C47,C73	1000pF	C0805C102J5GAC	KEMET	CAP,1000pF,SO,0805,5%,50V,COG
7	4	C48,C49,C50,C51	5600pF	C0805C562K5RAC	KEMET	CAP,5600pF,SO,0805,10%,50V,X7R
8	1	C71	0.01uF	O8052R103K9BB2	PHILIPS	CAP,0.01uF,SO,0805,10%,50V,X7R
9	2	C74,C75	470uF ELEC	ECE-A1CGE471	PANASONIC	CAP,ELEC,470UF,SO,CASE E,20%,16V
10	2	C76,C77	0.33uF	GRM40-6X7R334K016AL	MURATA	CAP,0.33uF,0805,+/-10%,16V,X7R
12	1	J1	4X1HDR	TSW-104-07-T-S	SAMTEC	HDR,4X1,0.025"PIN,0.1"CTR
13	3	J2,J7,J11	PHONO-1/8	AJ-0356A-5P	A/D ELECTRONICS	CONN,1/8" SWITCHED STEREO PHONE JACK
14	1	J3	4X1/80 HDR	B4B-PH-K	JSF	HDR,4X1/80,0.025"PIN,0.08"CTR
15	1	J6	DB15	747845-3	AMP	CONN,15D SHELL,FEMALE,RT ANGLE PC MOUNT
16	2	J9,J8	3X1HDR	TSW-103-07-T-S	SAMTEC	HDR,3X1,0.025"PIN,0.1"CTR
17	6	L1,L2,L3,L4,L5,L6	FERRITE	EXC-ELSA35	PANASONIC	IND,FBEAD,TH,AXIAL
19	2	R2,R46	3.3K	9C08052A3301J	PHILIPS	RES,3.3K,SO,0805,5%,1/10,METAL FILM
20	13	R4,R5,R32,R33,R35,R36,R40,R41,R47,R48,R49,R50,R53	6.8K	9C08052A6801J	PHILIPS	RES,6.8K,SO,0805,5%,1/10W
21	3	R13,R51,R52	4.7K	9C08052A4701J	PHILIPS	RES,4.7K,SO,0805,5%,1/10W
23	4	R25,R26,R27,R28	2.2K	9C08052A2201J	PHILIPS	RES,2.2K,SO,0805,5%,1/10
24	2	R29,R31	68K	9C08052A6802J	PHILIPS	RES,68K,SO,0805,5%,1/10W,METAL FILM
25	4	R30,R34,R54,R55	33K	9C08052A3302J	PHILIPS	RES,33K,SO,0805,5%,1/10,METAL FILM
26	2	R39,R38	10	9C08052A10R0J	PHILIPS	RES,10,SO,0805,5%,1/10W
27	1	R43	0	9C08052A0R00J	PHILIPS	RES,0,SO,0805
28	2	R56,R57	15K	9C08052A1502J	PHILIPS	RES,15K,SO,0805,5%,1/10W
29	2	R66,R67	100K	9C08052A1003J	PHILIPS	RES,100K,SO,0805,5%,1/10W,METAL FILM
30	1	U1	LM78L05	uA78L05CLP	TI	IC,78L05,TH,TO-226AA,+ 5V VOLTAGE REGULATOR
31	1	U3	X24C08 SO	AT24C08N-10SC	ATMEL	IC,24C08,SO,SOIC8,EEPROM



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Bill Of Materials    October 13,1997    11:52:59						
Item	Quan.	Reference	Part	PN	Manufacturer	Description
33	1	U7	LM1458N	LM1458N	NATIONAL	IC,1458,TH,DIP,DUAL OP AMP
34	1	U9	CS4235-KQ	CS4235-KQ-Prelim	CRYSTAL	IC,SO,TQFP100,MULTIMEDIA CODEC
35	1	U12	TDA1517P	TDA1517P	PHILIPS	SOT398-1,DIP-18
36	1	Y1	16.9344 MHz	HC49S-16.9344	FOX	CRYSTAL

• Notes •

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SMART  
Analog™