

# Reference Design for the CS49300 and CS42528

## Features

- Supports 4 digital S/PDIF (IEC60958/IEC61937) inputs
- 8 Discrete analog inputs using the CS42528 + 3 external CS5351 ADCs for 8 analog channels of input at 48 kHz and 96 kHz
- 2 Channel upsampling supported
- 8 Discrete analog outputs from the CS42528
- 2 Digital S/PDIF (IEC60958/IEC61937) outputs using the CS42528 Mux and XMT958 transmitter on the CS49300
- On board SRAM for AAC 5.1 discrete channel decoding
- In system programmable Flash, capable of holding 16 DSP programs

## Description

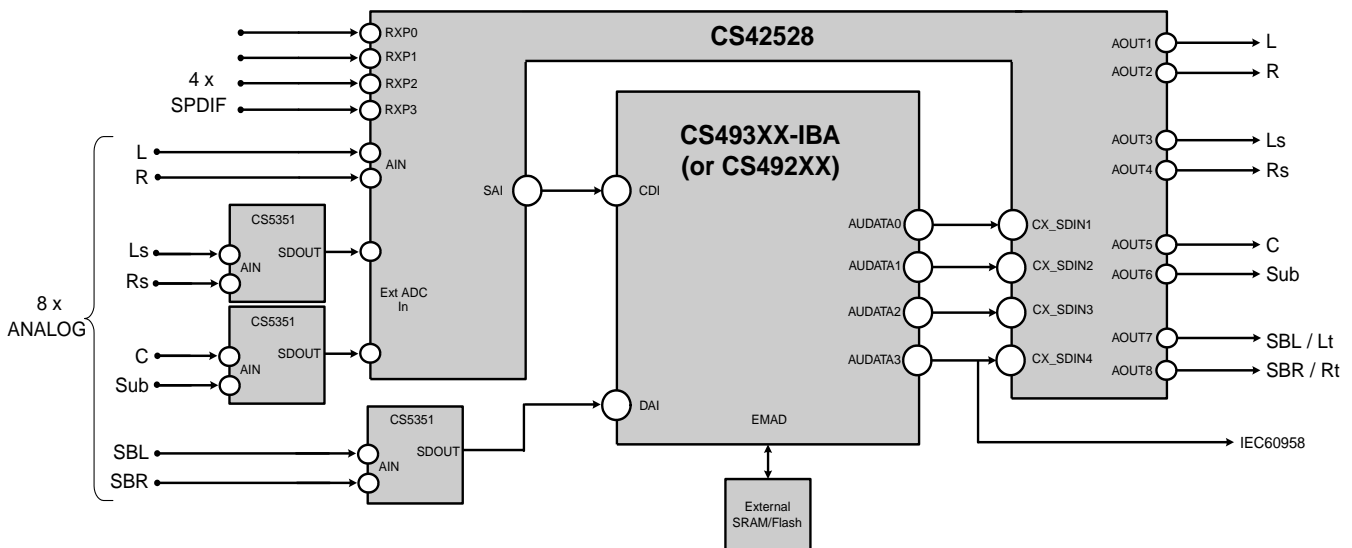
The CRD42528 is a reference design for the CS49300 DSP family and the CS42528 CODEC. It supports up to 8 channels of analog input at 48 and 96 kHz, or 2 channels of analog input at 192 kHz. One of four digital S/PDIF inputs may be selected. Additionally, up to 2 channels of digital S/PDIF output and 8 channels of analog output at up to 192 kHz are supported. The on board SRAM is included to allow for AAC 5.1 discrete channel decoding, and on-board flash memory is included to allow in-system programming of up to 16 DSP images. The DSP supports the following algorithms, including (but not limited to) AAC, Dolby Digital (AC-3), Dolby Digital EX, DTS, DTS-ES, DTS Neo:6, Cirrus Original Surround (including COS 6.1), SRS CircleSurround, SRS TruSurround, Pro Logic II, MPEG Multichannel (including EX), and HDCD.

The control interface to the CRD42528 is the UDSP System Platform. All control and data I/O is connected to headers, which allows the CRD42528 to be used easily in a end system or as a reference design. A larger block diagram is shown on the next page.

## ORDERING INFORMATION

CRD42528

Reference Design



*Preliminary Product Information*

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

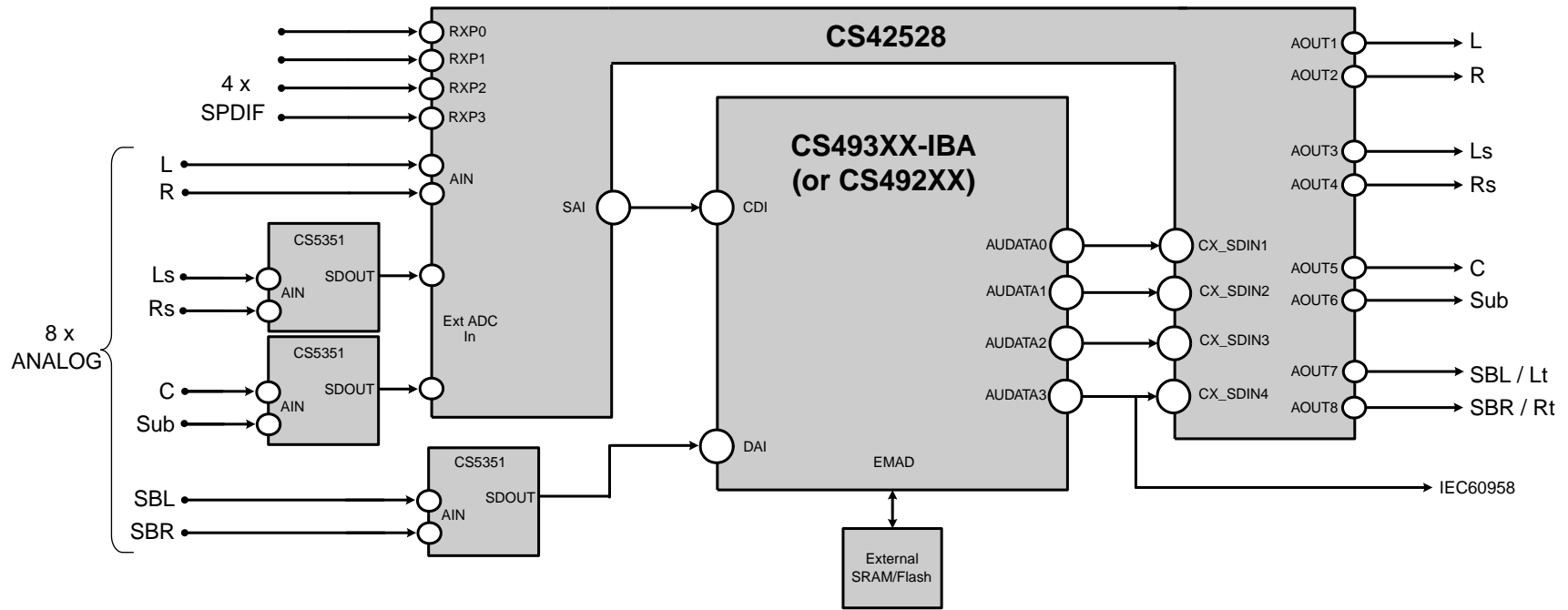


Figure 1. Block Diagram of the CRD42528

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## 1. QUICK START

A PC with an ECP parallel port, a stereo analog audio source, and powered speakers are required to use the CRD42528 in the mode specified in this Quick Start.

- 1) Install the drivers supplied with the board on the PC. Refer to [“UDSP Schematics” on page 37](#) for details on installing the drivers.
- 2) Connect the supplied parallel port cable to J46 on the UDSP MainBoard (marked P PORT) and to the computer’s ECP parallel port.
- 3) Connect the analog output from an audio source to AIO7-8 (Left and Right Inputs) The input channels are mapped as follows:
  - AIO8 - Left
  - AIO7 - Right
  - AIO6 - Left Surround
  - AIO5 - Right Surround
  - AIO4 - Center
  - AIO3 - Subwoofer / Low Frequency Effects (LFE)
  - AIO2 - Surround Back Left
  - AIO1 - Surround Back Right
- 4) Connect powered speakers to AIO15-16. The output channels are mapped as follows (more speakers can be connected to the line level outputs as required by each application):
  - AIO16 - Left
  - AIO15 - Right
  - AIO14 - Left Surround
  - AIO13 - Right Surround
  - AIO12 - Center
  - AIO11 - Subwoofer or Low Frequency Effects (LFE)
  - AIO10 - Surround Back Left or Lt
  - AIO9 - Surround Back Right or Rt
- 5) Connect the supplied power supply to the power connector on the board and to an appropriate power outlet.
- 6) Verify that LEDs D1, D7, D9, and D11 on the UDSP board are lit. LED D2 will flash to indicate that the PLD on the UDSP is functional.
- 7) Open a DOS window and navigate to the C:\CS49300\CRD42528\Configs directory.
- 8) Type in “setpld -r 99” on the DOS prompt. (This reads the PLD version register and verifies that the PC can communicate with the board). If the driver generates the error message “!!! Board does not appear to be connected !!!”, then your parallel port address may not be 0x378 or your port is not ECP capable. If your parallel port address is not 0x378, depress the reset switch S3 and type in “setpld -r 99 -p3bc” or “setpld -r 99 -p278” to communicate using a different parallel port address.
- 9) Verify that LED D1 (marked ERR) has turned OFF, indicating that the driver has successfully communicated with the board.
- 10) If the above steps give an error, refer to [“UDSP Schematics” on page 37](#) and verify that the drivers and PC have been set up as described (and that the parallel port address is correct / set to ECP mode).
- 11) If the above steps give the expected results, type in “analog\_in\_96kHz”, “analog\_in\_96kHz -p3bc”, or “analog\_in\_96kHz -p278” (depending on your parallel port address) at the DOS prompt. This batch file will configure the PLD, boot the DSP, and configure the CS42528 for 8 channel analog processing at 96 kHz.
- 12) The audio data on the Left and Right Input connectors (AIO7-8) should now be heard on the output.
- 13) The batch files use various files to configure the software, board, and the DSP code. Each batch

file has been commented. Various batch files for the commonly used applications have been supplied with the software. These batch files can be run from the DOS prompt like the “analog\_in\_96kHz.bat” file. Please note that while only license-free code is supplied with the CRD42528, a complete list of algorithms supported by the CRD42528 (including Dolby

Digital EX and DTS-ES) is available from your local *Cirrus Logic, Inc.* Field Applications Engineer.

**Caution:** Use caution while editing and making changes to these files (editing a copy will always insure an easily accessible backup). It is strongly recommended that jumpers and switches on the UDSP MainBoard be left in their default positions.

## 2. DESIGN DESCRIPTION

### 2.1 Clock and Data Connections

There are 2 main modes of operation of the CRD42528, Analog Input Mode and Digital Input Mode. In Analog Input Mode, up to 8 channels of analog input can be processed by the DSP. In Digital Input Mode, S/PDIF (IEC61937/IEC60958) data is sent to the DSP for decoding or processing. In both cases, the output from the DSP is sent back to the CS42528 to generate analog output.

#### 2.1.1 Analog Input Mode

A detailed diagram of the clock and data connections for analog input mode can be found in [Figure 4, “Data and Clock Connections for 8 Channel Analog Input and Output,” on page 10](#). When Analog Input Mode is used, the CRD42528 will process up to 8 channels of analog input. The analog source is the analog I/O connectors on the UDSP MainBoard, which are routed directly to the CRD42528. The Left (L) and Right (R) analog inputs are connected, via input filters, to the CS42528’s analog input pins. When 6 channel (referred to as 5.1 channel) input is desired, two external CS5351 Analog to Digital Converters are used. These external ADCs receive the RMCK output from the CS42528. In this mode, RMCK will pass through the 12.288 MHz oscillator connected to OMCK. The external ADC serial ports are driven from the CS42528’s CX port clocks. The Left Surround (Ls), Right Surround (Rs), Center (C), and Subwoofer (Sub) inputs to the CRD42528 are connected to the external CS5351’s analog inputs, and the digital outputs from the two external CS5351s is then connected to the CS42528’s ADCIN1/2 pins. The CS42528 will incorporate all of the data from the external ADCs and its own analog input data onto a single line and send it to the DSP via the CS42528’s SAI port. In this way, the DSP gets the L, R, Ls, Rs, C, and Sub channels into its CDI port.

For 7 or 8 channel (6.1 or 7.1 channel) operation, another external CS5351 is used to convert the Surround Back Left (SBL) and Surround Back Right (SBR) analog inputs. Please note that many appli-

cations use a single mono surround channel, referred to as Surround Back (SB). The digital output from the CS5351 is sent directly to the DSP’s DAI port.

Once the DSP has processed the incoming digital inputs, data is returned to the CS42528 to be converted back to analog. The data, coming from the DSP’s DAO port, is clocked by the CS42528’s CX port clocks.

#### 2.1.2 Digital Input Mode

A detailed diagram of the clock and data connections for analog input mode can be found in [Figure 5, “Clock and Data Connections for S/PDIF \(IEC61937 / IEC60958\) Input,” on page 11](#). To process incoming S/PDIF (IEC61937/IEC60958) data streams, digital input is wired directly from the UDSP’s optical receivers to the CS42528. The CS42528 will then lock to the incoming stream and convert it to an I<sup>2</sup>S data stream, which is then sent to the DSP from the CS42528’s SAI port. This data is input on the DSP’s CDI port. The DSP will process this stream (i.e., decode the compressed stream or process the PCM data), and then send up to 8 channels of I<sup>2</sup>S data to the CS42528 on its DAO port. This PCM data is input on the CS42528’s CX port. The CS42528 then converts the audio data back to analog.

## 2.2 Control

Control of the CRD42528 is done via the UDSP headers (J2 and J3) in either SPI or I<sup>2</sup>C mode. Different resistors must be populated or not populated according to the desired communication mode. These options can be found in [Table 1](#).

For I<sup>2</sup>C mode, please note that the DSP defaults to address checking disabled. This can only be changed after a firmware image has been loaded onto the DSP (either via host boot or autoboot). Please see the CS49300 datasheet for more details on I<sup>2</sup>C address checking.

Mode	Populate	Do Not Populate
SPI	R98, R99, R10, R12, R16, R143	R13, R14, R18, R100, R144, R168, R166
I <sup>2</sup> C	R13, R14, R18, R100, R144, R168, R166	R98, R99, R10, R12, R16, R143

**Table 1. Communication Mode Options**

## 2.3 Assembly Options for Ease of Manufacture

There are variety of options available on a build of the CRD42528 that allow for different input and output options, as well as performance differentiation. This allows the same board to be used in both low-end and high-end applications. Please note that systems with lower performance may require external analog Bass Management circuitry to comply with Dolby specifications.

### 2.3.1 Analog Input Options

The CRD42528 supports 2, 6, or 8 channels of analog input. A list of components that needs to be populated for each configuration is shown in [Table 2](#).

Number of Analog Input Channels	Populate	Do Not Populate
2 (L, R)	R148, R149, R150	U18, U33, U2, Ls, Rs, C, Sub, SBL and SBR Input Filters
6 (L, R, Ls, Rs, C, Sub)	R150, U18, U33, Ls, Rs, C, Sub, SBL and SBR Input Filters	R148, R149, U2, SBL and SBR Input Filters
8 (L, R, Ls, Rs, C, Sub, SBL/Lz, SBR/Rz)	U18, U33, U2, Ls, Rs, C, Sub, SBL and SBR Input Filters	R148, R149, R150

**Table 2. Analog Input Assembly Options**

### 2.3.2 Analog Output Options

The CRD42528 supports 2, 6, or 8 channels of analog output. A list of components that needs to be populated for each configuration is shown in [Table 3](#).

Number of Analog Output Channels	Populate	Do Not Populate
2 (L/Lt, R/Rt)	U27 = CS42516 or CS42526, L/R Output Filters	Ls/Rs, C/Sub, SBL/SBR Output Filters
6 (L, R, Ls, Rs, C, Sub)	U27 = CS42516 or CS42526, L/R, Ls/Rs, C/Sub Output Filters	SBL/SBR Output Filters
8 (L, R, Ls, Rs, C, Sub, SBL/Lz, SBR/Rz)	U27 = CS42518 or CS42528, L/R, Ls/Rs, C/Sub, SBL/SBR Output Filters	

**Table 3. Analog Output Assembly Options**



### 2.3.3 Memory Options

There are many available applications that can run on the CS49300 family DSP. DSP applications require a 32k-byte page in an external ROM, Flash, or other non-volatile storage. Some applications, called Internal Boot Assisted (IBA) codes, consist of a few hundred bytes of download firmware. When using IBA codes ONLY, the external Flash or ROM may be omitted from the design IF AND ONLY IF the IBA codes are stored in the host microcontroller's available non-volatile memory. In these applications, U24 and C132 may be omitted.

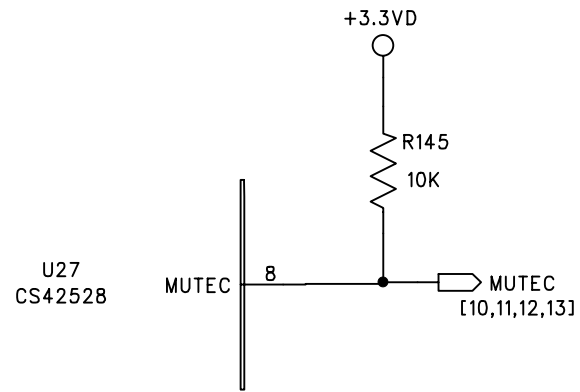
For a full AAC 5.1 discrete channels of output, external SRAM must be used. For all other applications, the SRAM U16 and support component C133 may be omitted. Other options exist for AAC multichannel, including a stereo downmixed AAC output following by Dolby ProLogic II processor, which generates 5.1 channels of output.

For a full list of codes (including IBA codes) and their requirements, please contact your local Cirrus Field Applications Engineer.

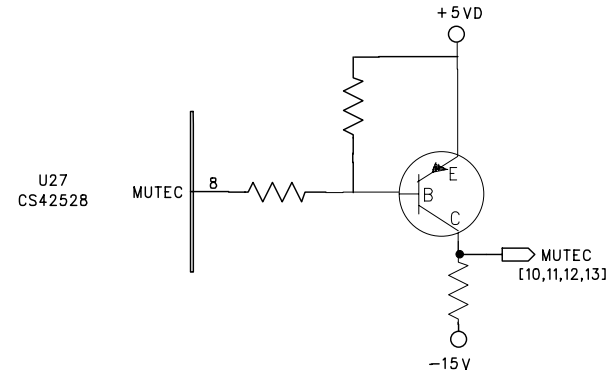
### 2.4 Revision A Errata

The revision A CRD42528 requires the following modification to the mute circuitry. The mute signal

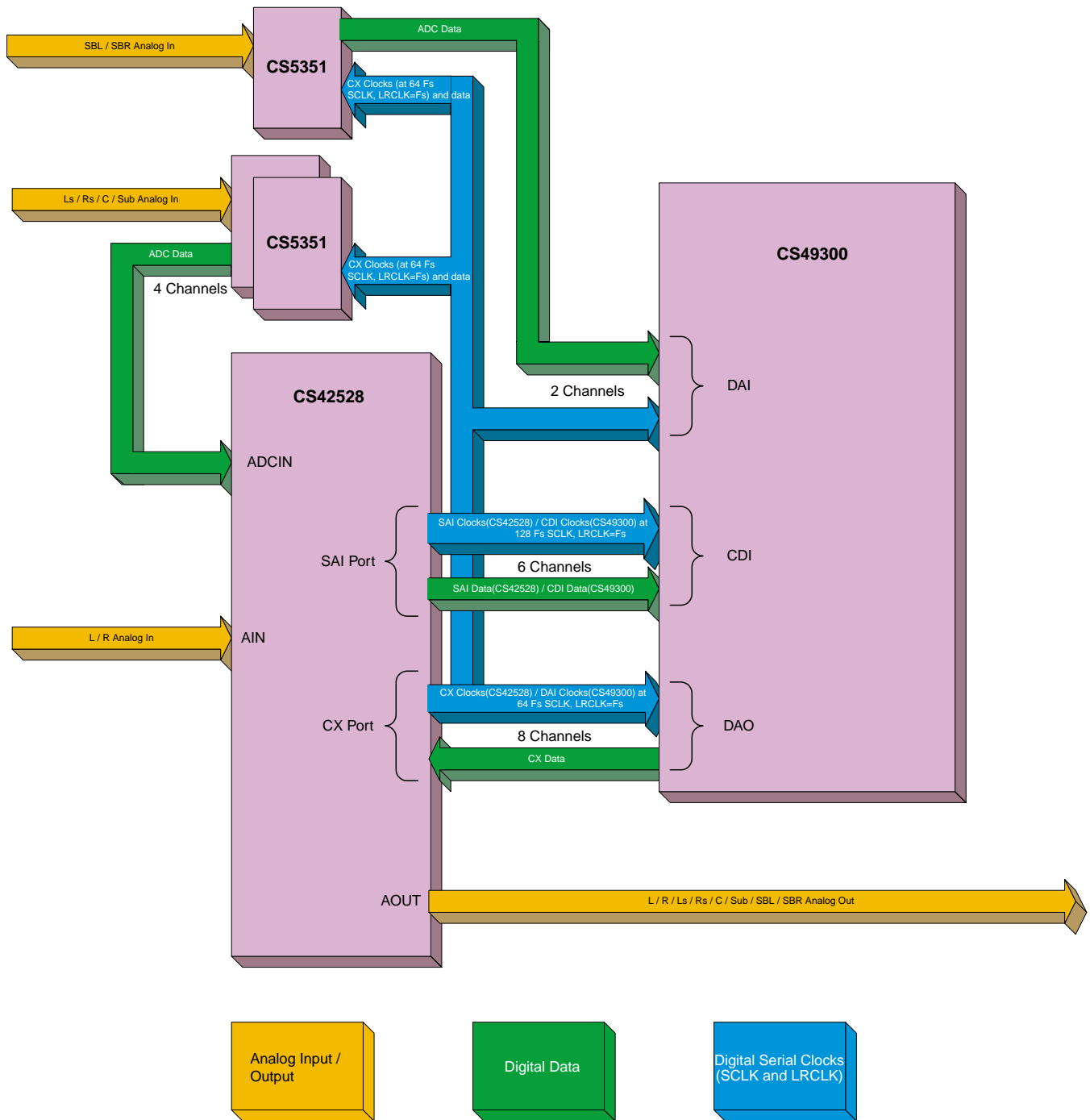
as shown in Figure 2 should be modified as shown in Figure 3.



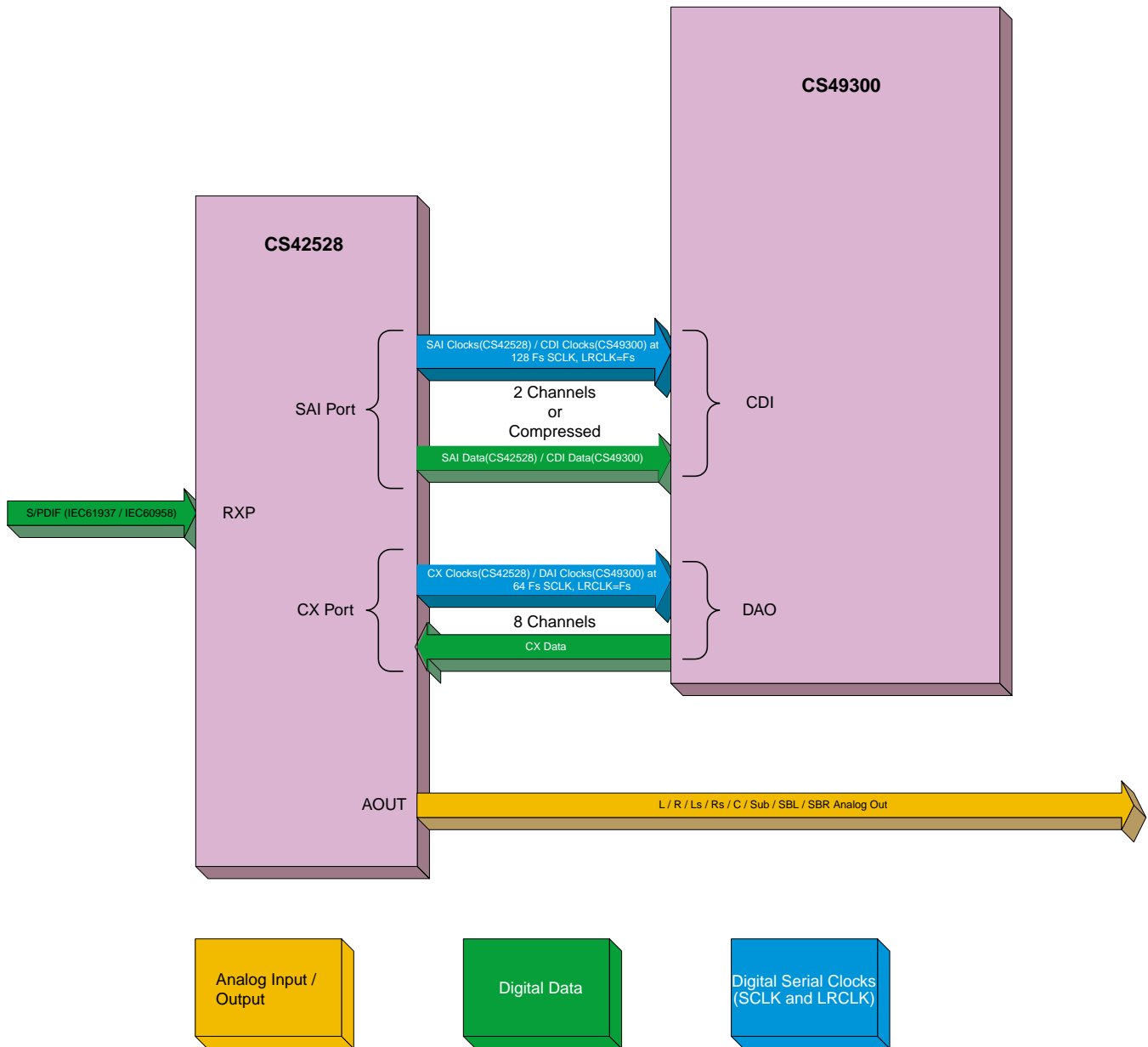
**Figure 2. Mute Control Rev A**



**Figure 3. Mute Control - Corrected**



**Figure 4. Data and Clock Connections for 8 Channel Analog Input and Output**



**Figure 5. Clock and Data Connections for S/PDIF (IEC61937 / IEC60958) Input**

## APPENDIX A: INSTALLATION OF BOARD CONTROL SOFTWARE

The UDSP PC driver utility set comes in two versions. The Direct Hardware version will communicate directly with the PC's parallel port to control the UDSP board. The DLPortIO version uses the DLPortIO driver to access the parallel port on hardware protected operating systems.

In general, direct hardware capable operating systems (such as Microsoft® Windows 95®, Windows 98®, and Windows ME®) allow any program to directly control any of the PC's peripherals. With the UDSP board, this allows for faster interface speeds (up to 4 times faster).

For protected operating systems (such as Microsoft® Windows NT®, Windows 2000®, and Windows XP®), the UDSP driver set requires the use of the DLPortIO driver. This utility allows the UDSP drivers to access the parallel port safely.

The UDSP driver set requires bidirectional communication with the UDSP board, and hence a bidirectional capable parallel port is needed. An ECP-type port is required. Please note that an SPP-type port will not work with the UDSP board. The type and location (I/O address) of the parallel port installed can be found in the Windows Control Panel (please see Windows Help for more information on these settings). The UDSP drivers assume by default that the parallel port address is 0x378. Other ports may be used with the -pXXX option, where XXX is 3bc or 278.

### **Installation on Microsoft® Windows 95®, 98®, ME® and other direct hardware capable Windows® versions**

1. Run "Setup.exe" from the CRD42528 CD that was shipped with the kit.

*The UDSP drivers have now been successfully installed. The CRD42528 kit is now ready for use. Several demonstration batch files (\*.bat) are available in the CRD42528\Configs directory. Please see the "Quick Start" on page 5 for information on the use of these batch files.*

### **Installation on Microsoft® Windows NT®, Windows 2000®, and Windows XP® and other protected Windows® versions**

1. Run "Setup.exe" from the CRD42528 CD that was shipped with the kit.

2. Run "Port95nt.exe" from c:\udsp directory to install the DLPortIO driver to access the parallel port.

The UDSP drivers have now been successfully installed. The CRD42528 kit is now ready for use. Several demonstration batch files (\*.bat) are available in the CRD42528\Configs directory. Please see "Quick Start" on page 5 for information on the use of these batch files.

## APPENDIX B: CRD42528.INI

# Horizontal Fields:

# [part] [I2Caddr] [SPIaddr] [SPI CSn]  
# [reset(bit to drop in PLD addr 0x01)]  
# [INTREQ\_NUM] [Print Format]  
#[Parallel word length] [Parallel CSn]  
#[Read\_Type]

#

# Vertical Fields:

#board - first non-comment, non-blank line

#parts - other lines

# note: reset can only take on values 01,02

#

# Default is CS4930 interface

#

# INTREQ\_NUM is the bit position within the INT register in the PLD

#

# Read\_Type can be DSP or normal

#

# Word Length is in bytes

#

CRD42528

DSP 02 00 00 01 02 03 01 00 DSP

42528 9e 9e 02 02 ff 01 00 00 normal

default 02 00 00 01 02 03 01 00 DSP

## APPENDIX C: BOARD CONTROL SOFTWARE

There is a suite of programs used to control the UDSP from a PC DOS command line.

These software tools are designed to so that they can be scripted using the MS-DOS batch language. They will work with any of the 3 standard parallel port addresses (0x378, 0x3bc, 0x278). The default address for all of the programs is 0x378 (typically LPT1). The port address can be changed by using the '-p' option. Each time a program is executed, the address that was used can be shown on the screen using the '-v' option. If a program seems to fail, verification of the parallel port address should always be the first step in troubleshooting.

All of these programs are designed to access the daughter card connected to the UDSP board using SPI or I<sup>2</sup>C<sup>®</sup> serial communication. The communication mode can be chosen from the command line with the '-m' option. The mode chosen must correspond to the communication mode used by the devices on the daughter card. If the device on the board is set up for one communication mode, and the drivers are used with another, results will be unpredictable. All devices on the daughter card are configured for SPI serial

communication mode by default, and that is also the default mode for the software.

The usage of each program will vary, depending on the type of UDSP daughter card that is installed. The URST, URD, and UCMD programs get a valid list of devices for the installed daughter card from the file specified by the "uINI\_path" DOS environment variable. This file will list all of the devices available to the UDSP parallel port drivers, along with each device's I<sup>2</sup>C address, SPI address, chip select number, and reset number (for reset capable devices). It also specifies how messages from the device should be read. For DSP-style reads, the driver will read until the  $\overline{\text{INTREQ}}$  line goes high. For non-DSP devices, the read operation will read out 1 byte. Please note that most non-DSP devices require an aborted write operation to properly set the MAP pointer before reading.

The device list file, called CRD42528.INI, must follow a very specific format. An example of this can be found "["CRD42528.INI" on page 13](#)". This file should not be changed.

A list of available drivers and their usage is found below:

### UCMD.exe - Send commands or configuration files to a target device.

```
Usage: ucmd <[ABCDEF..] or [-fX]> [-dZZZZ..] [-mY] [-pWWW] [-v]
```

```
-d = device  
ZZZZ.. = device designator, eg dspab, dspc, 8415a, etc.  
  
-m = communication mode  
Y = mode designator (i=I2C, s=SPI*, m=MOT, n=INT)  
  
ABCDEF.. = hex data (1-100 bytes)  
-f = send configuration file  
X = .cfg file containing configuration parameters  
  
-p = parallel port address  
WWW = address in hex (278, 378* or 3bc)  
  
-v = enable verbose mode  
  
* = default value
```

```
Example: ucmd 000001 -d4341 -p3bc
```

Notes: A configuration file is a list of commands, contained in an ASCII text file. This file can be any length, and should list the commands in hex, with an even number of characters per line. Comments can be made in the file by putting a # at the beginning of the line. The entire line will be interpreted as a comment. Please see the accompanying \*.cfg files for examples of a configuration file.

**URD.exe - Program used to read back responses from a target device. If a DSP-type device is selected and the INTREQ pin is not low when URD.exe is executed, the program will wait until INTREQ drops. Press the 'Enter' key to exit the read wait loop.**

Usage: urd [-dZZZZ..] [-mY] [-pXXX] [-v] [-h]

-d = device  
ZZZZ = device designator, eg dspab, dspc, 8415a, etc.  
  
-m = communication mode  
Y = mode designator (i=I2C, s=SPI\*, m=MOT, n=INT)  
  
-p = parallel port address  
XXX = address in hex (278, 378\* or 3bc)  
  
-v = enable verbose mode  
  
-h = this message  
  
\* = default value

EXAMPLE: urd -d4940c -p378

Notes: If the associated INTREQ pin is not low when URD is executed, the program will wait until INTREQ drops for DSP devices ONLY. Press the 'Enter' key to exit the program in this case.

**URST.exe - Program used to perform hard reset or soft reset on the target device.**

Usage: urst [-dZZZZ..] [-mY] [-s] [-pXXX] [-v] [-h]

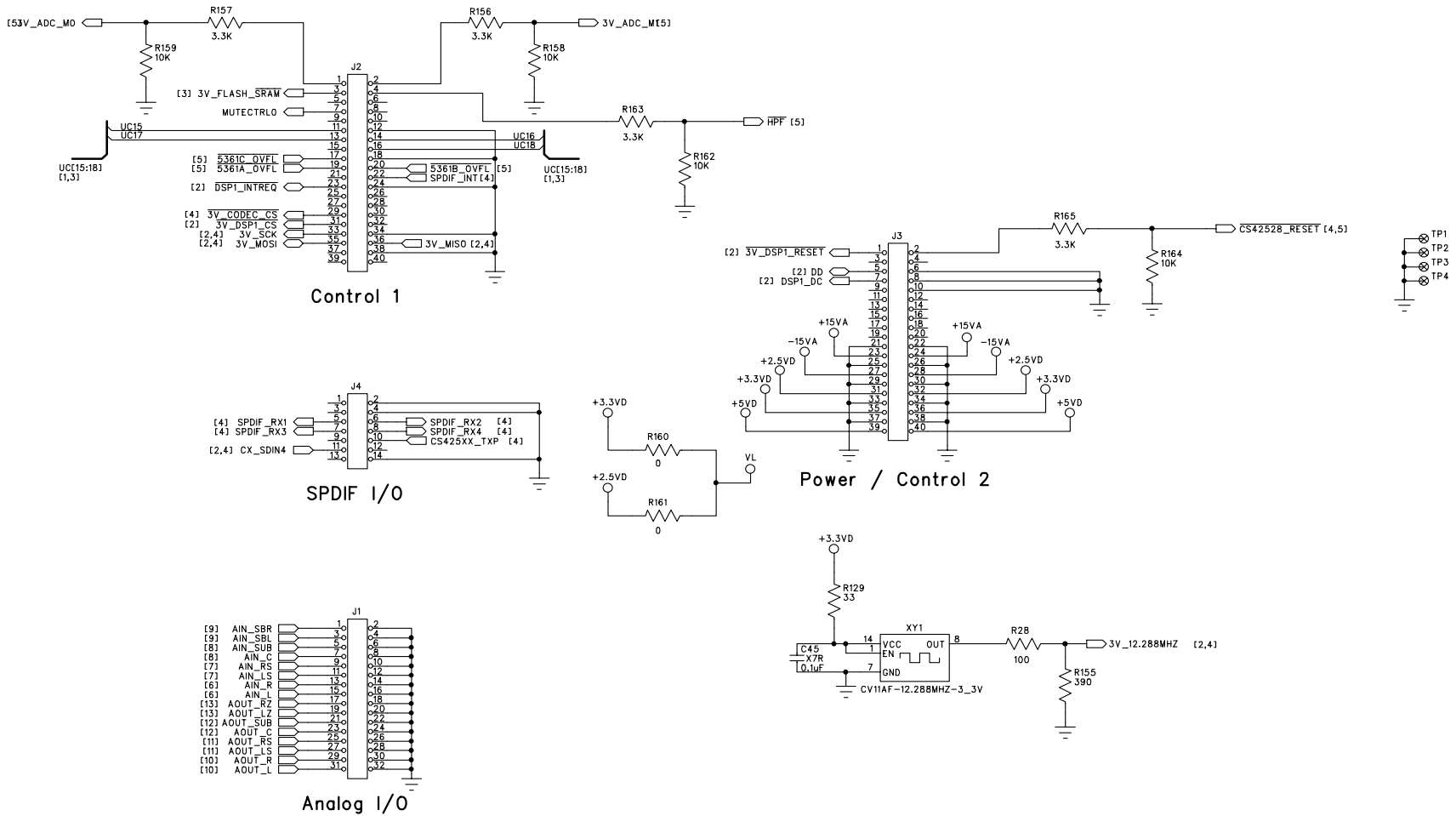
-d = device  
ZZZZ = device designator, eg dspab, dspc, 8415a  
  
-m = communication mode  
Y = mode designator (i = I2C, s = SPI\*, n = INTEL, m = MOTOROLA)  
  
-s = Soft Reset  
  
-p = parallel port address  
XXX = address in hex (278, 378\* or 3bc)  
  
-v = enable verbose mode  
  
-h = this message  
  
\* = default value

**SetPLD.exe - Program used to read and write PLD registers.**

Usage: setpld -r/-w RR [DD]

Where -r is to read from register RR, -w is to write data DD into register RR. RR and DD are in hex.

APPENDIX D: SCHEMATICS



Connectors line up with UDSP interface, and should be mounted on the bottom of the board.

Figure 6. Control and Data I/O



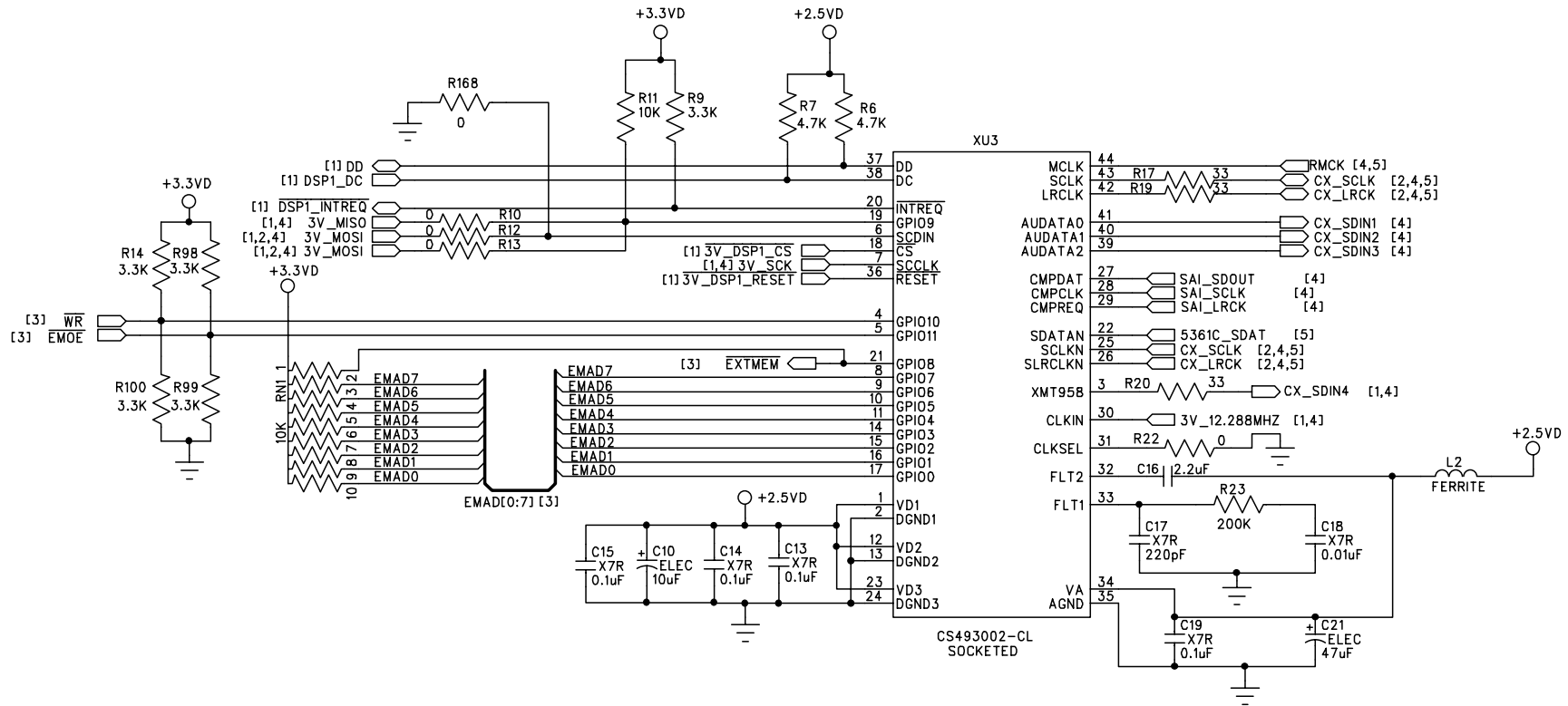
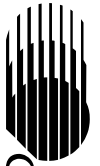
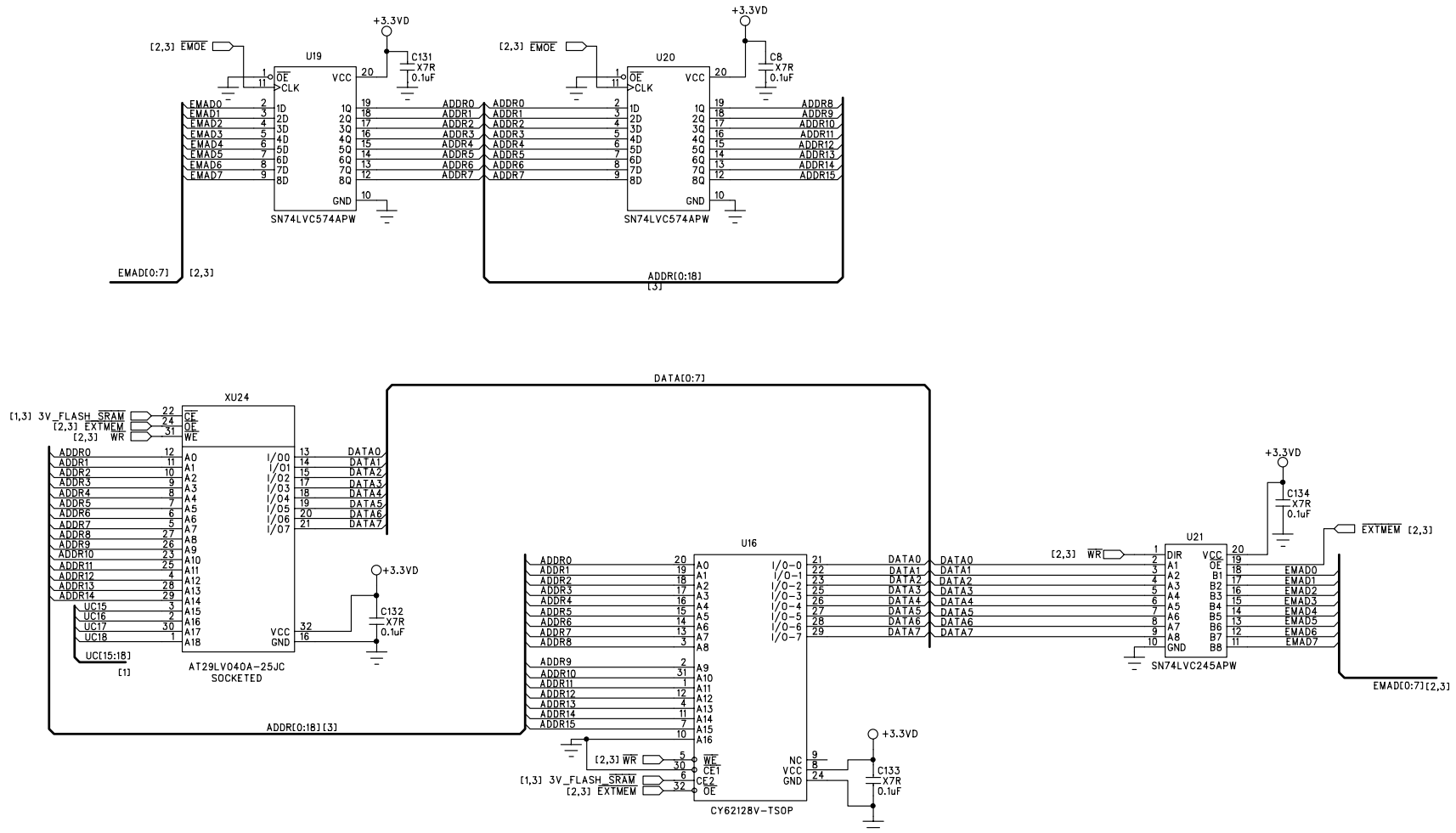


Figure 7. DSP



SRAM\_FLASH is used to select FLASH or SRAM.

Notes: External Flash/ROM/PROM is only required for Autoboot operation, and SRAM is only required for AAC 5.1 channel decoding.

Figure 8. External Memory

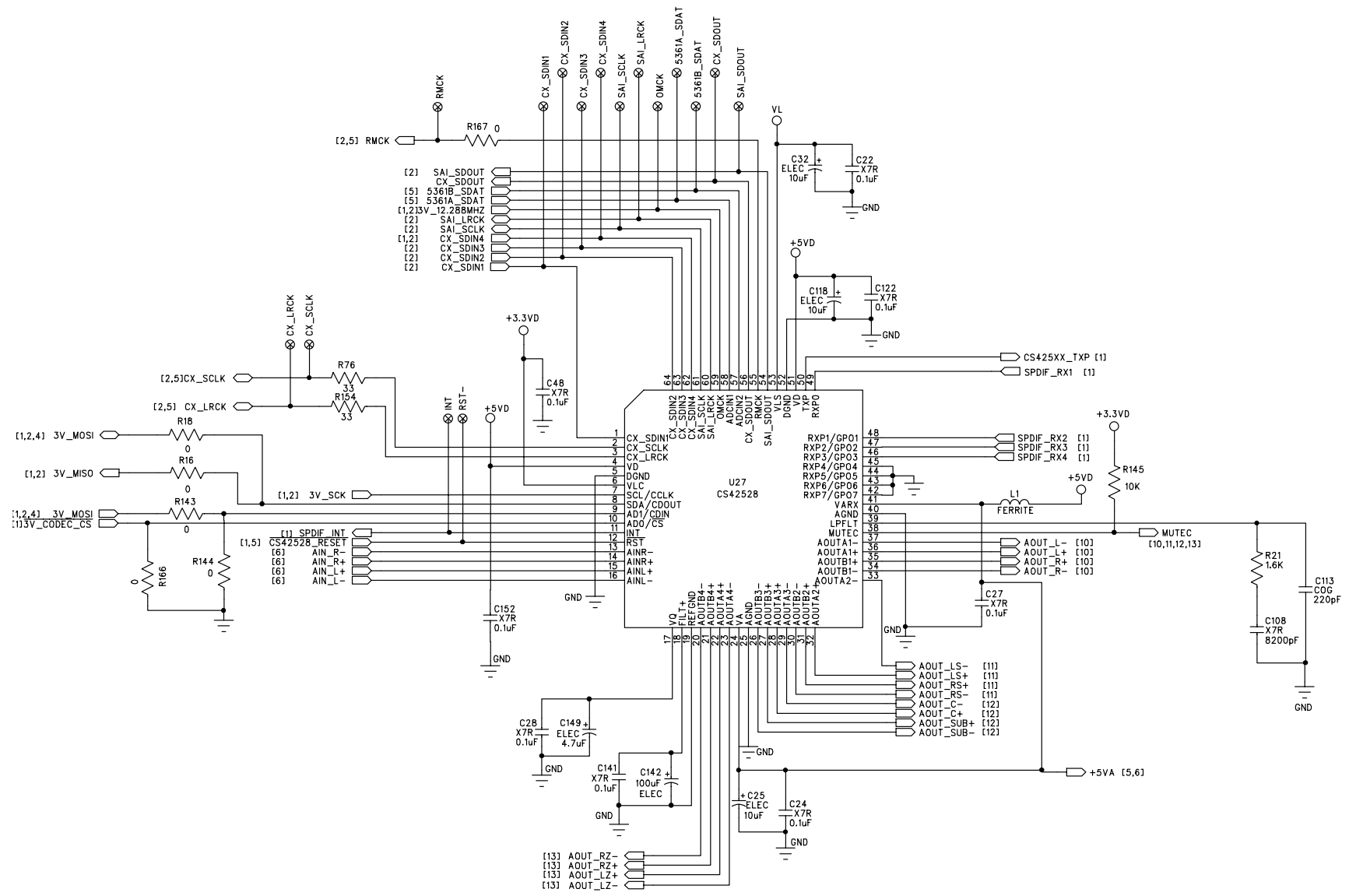


Figure 9. CoDec

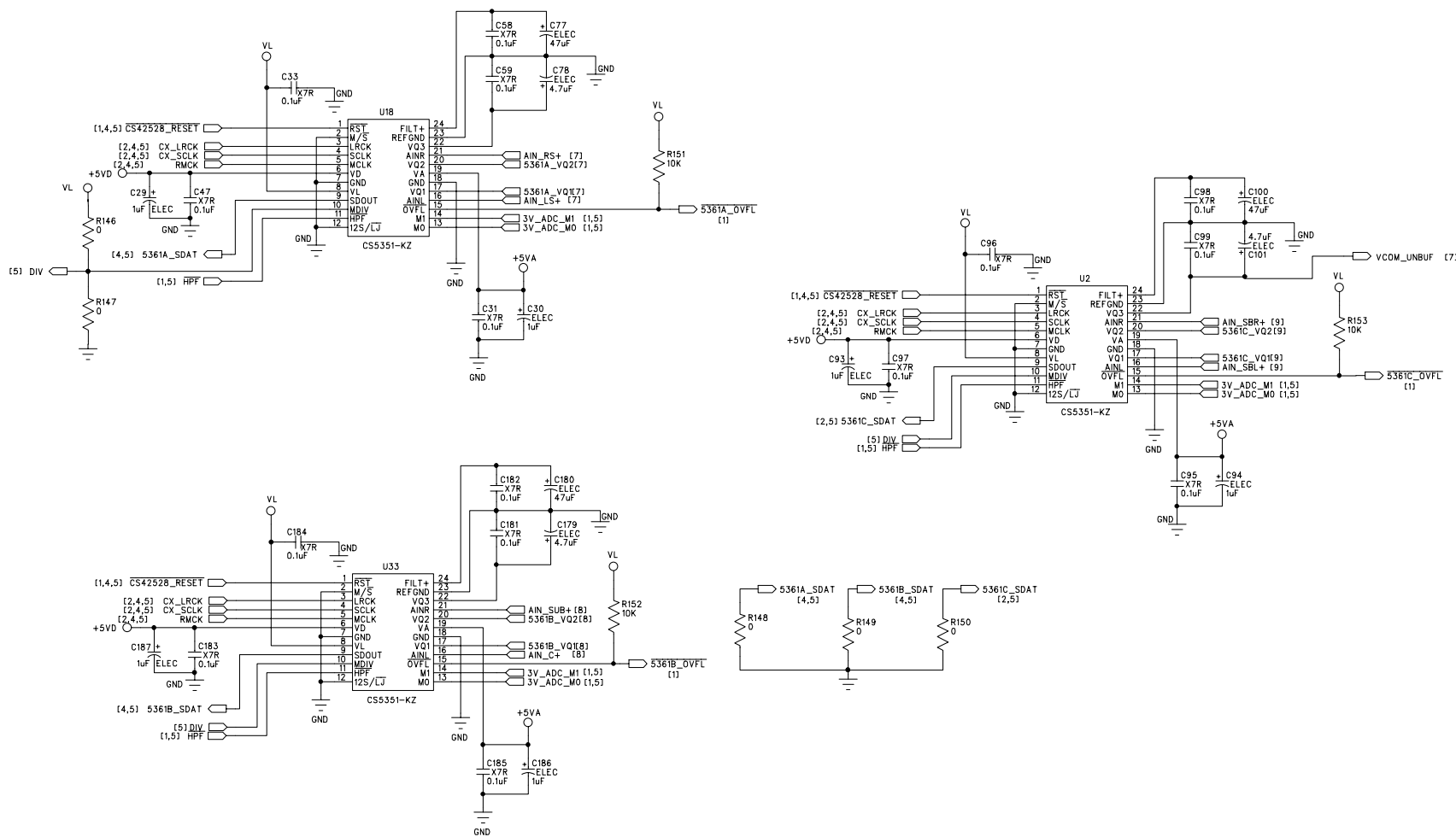


Figure 10. External A/D Converters

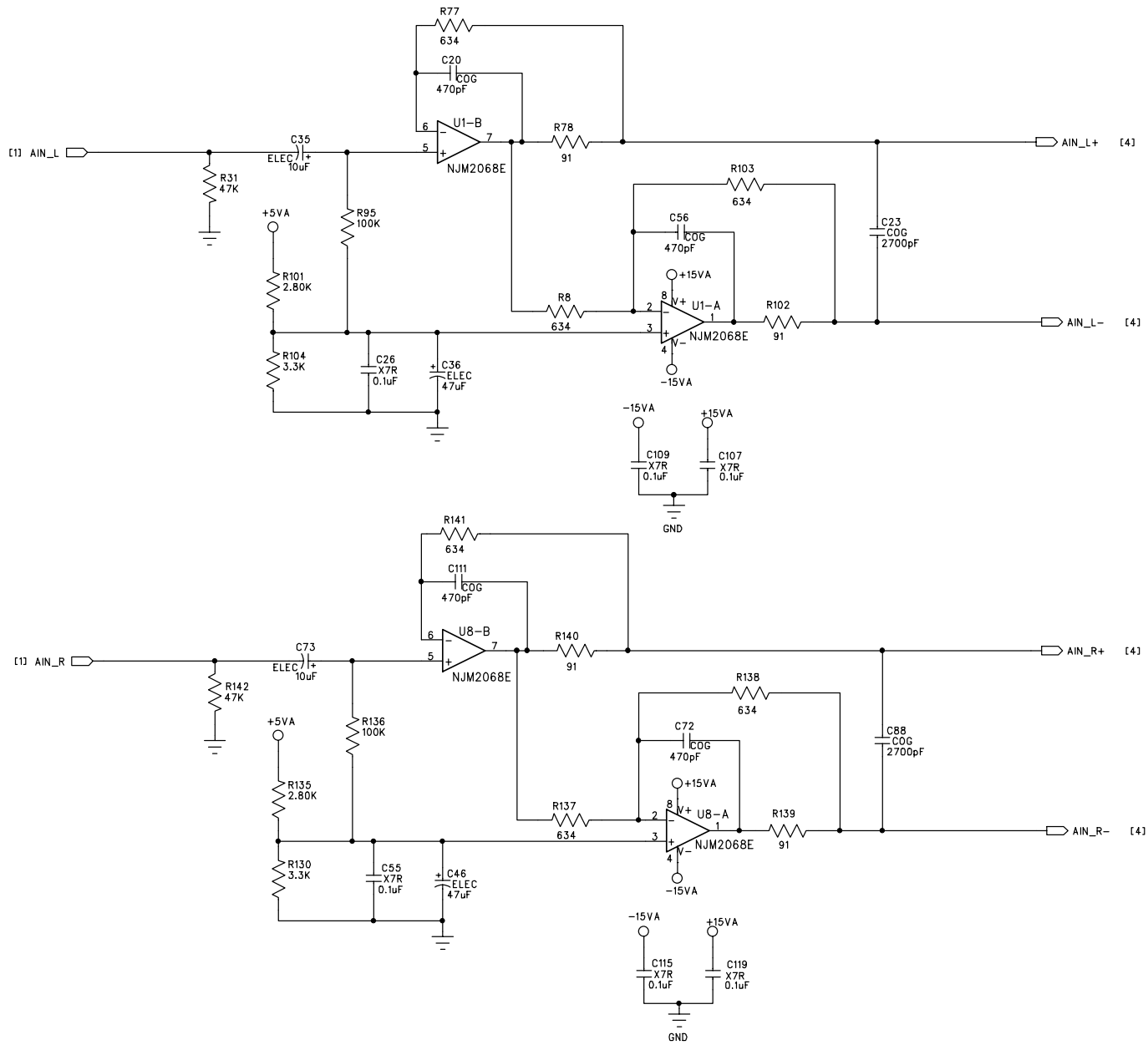
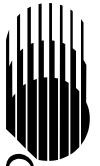


Figure 11. L/R Input Filters

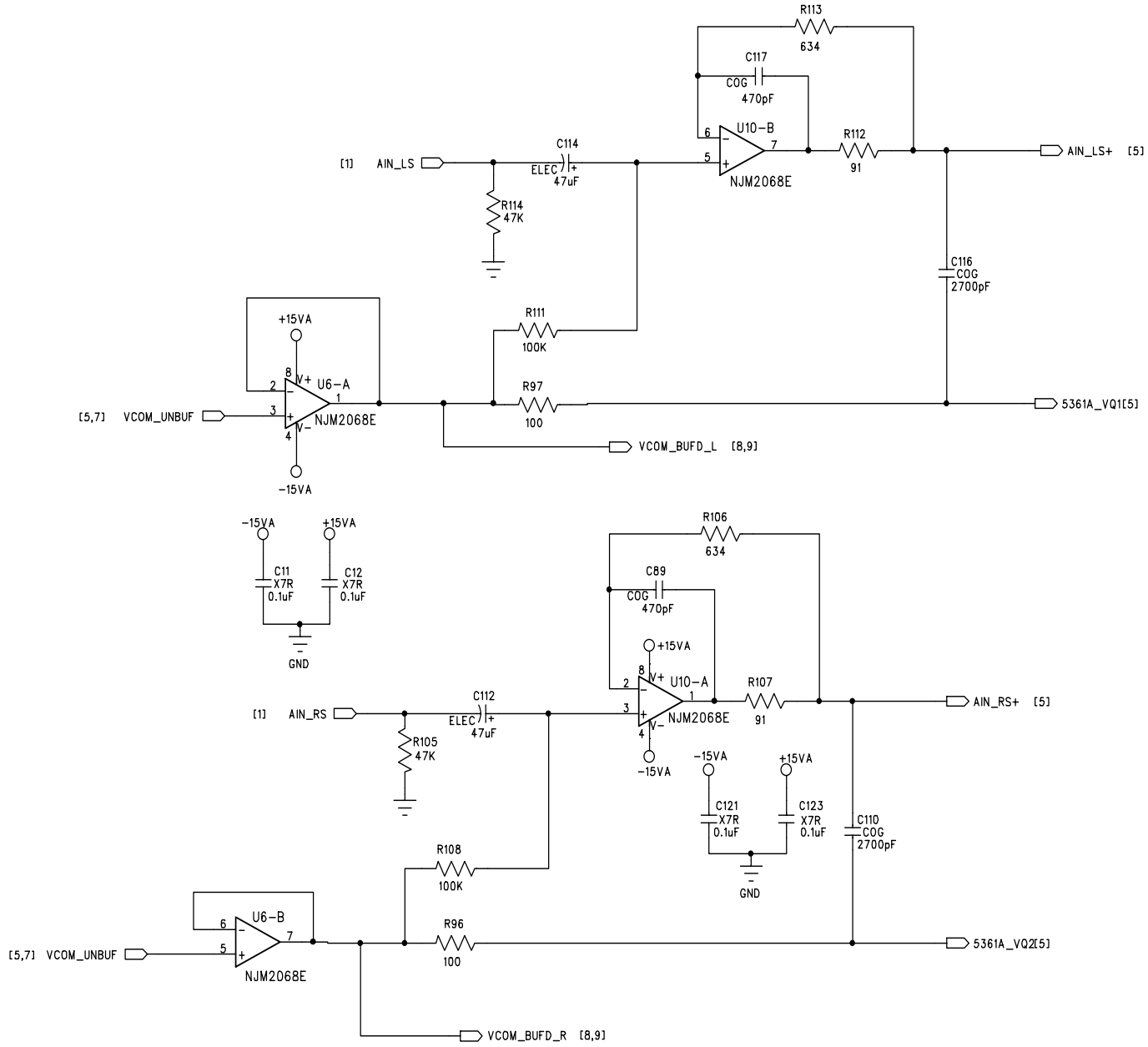


Figure 12. Ls/Rs Input Filters

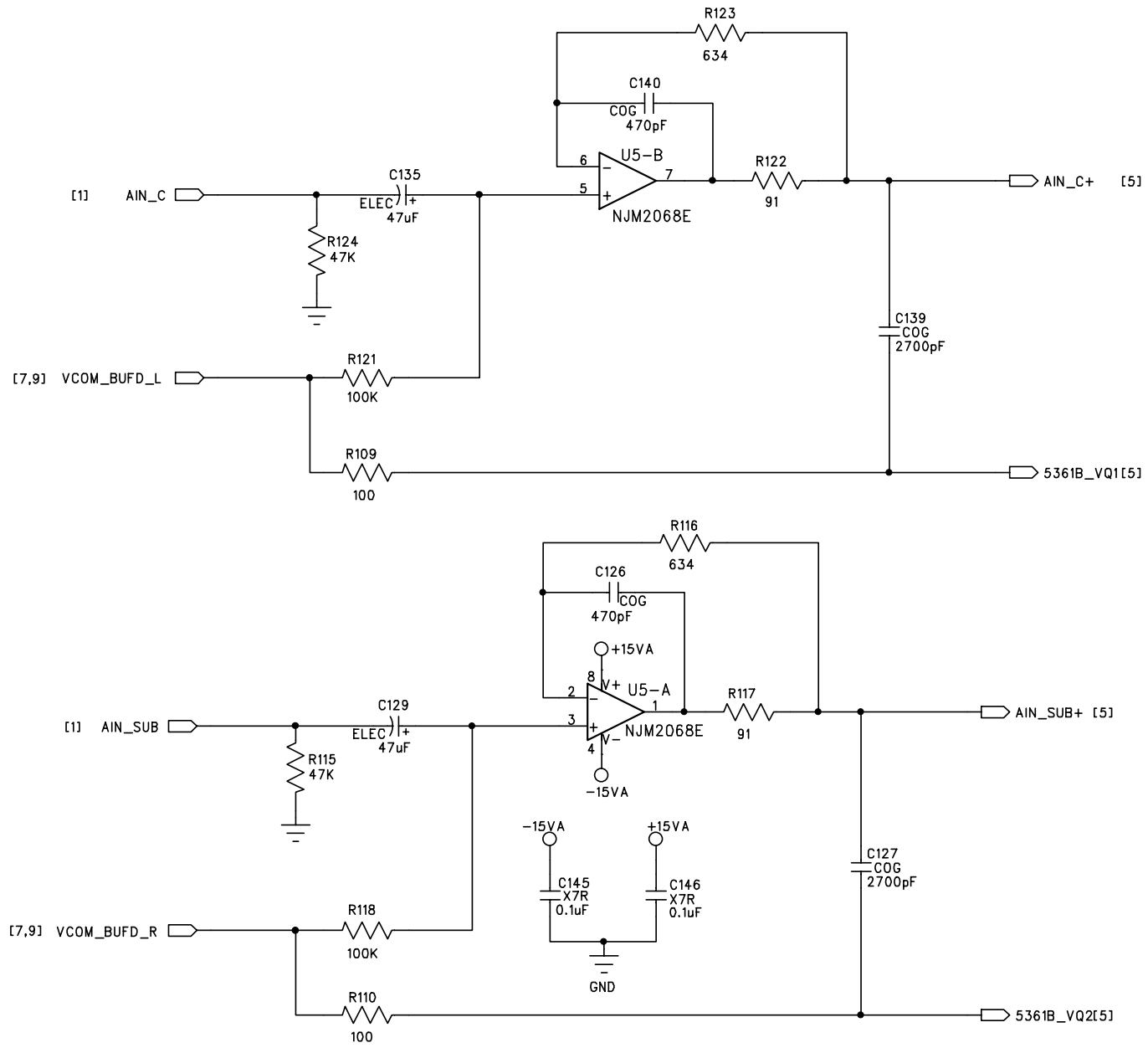
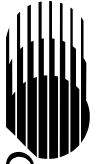


Figure 13. C/Sub Input Filters

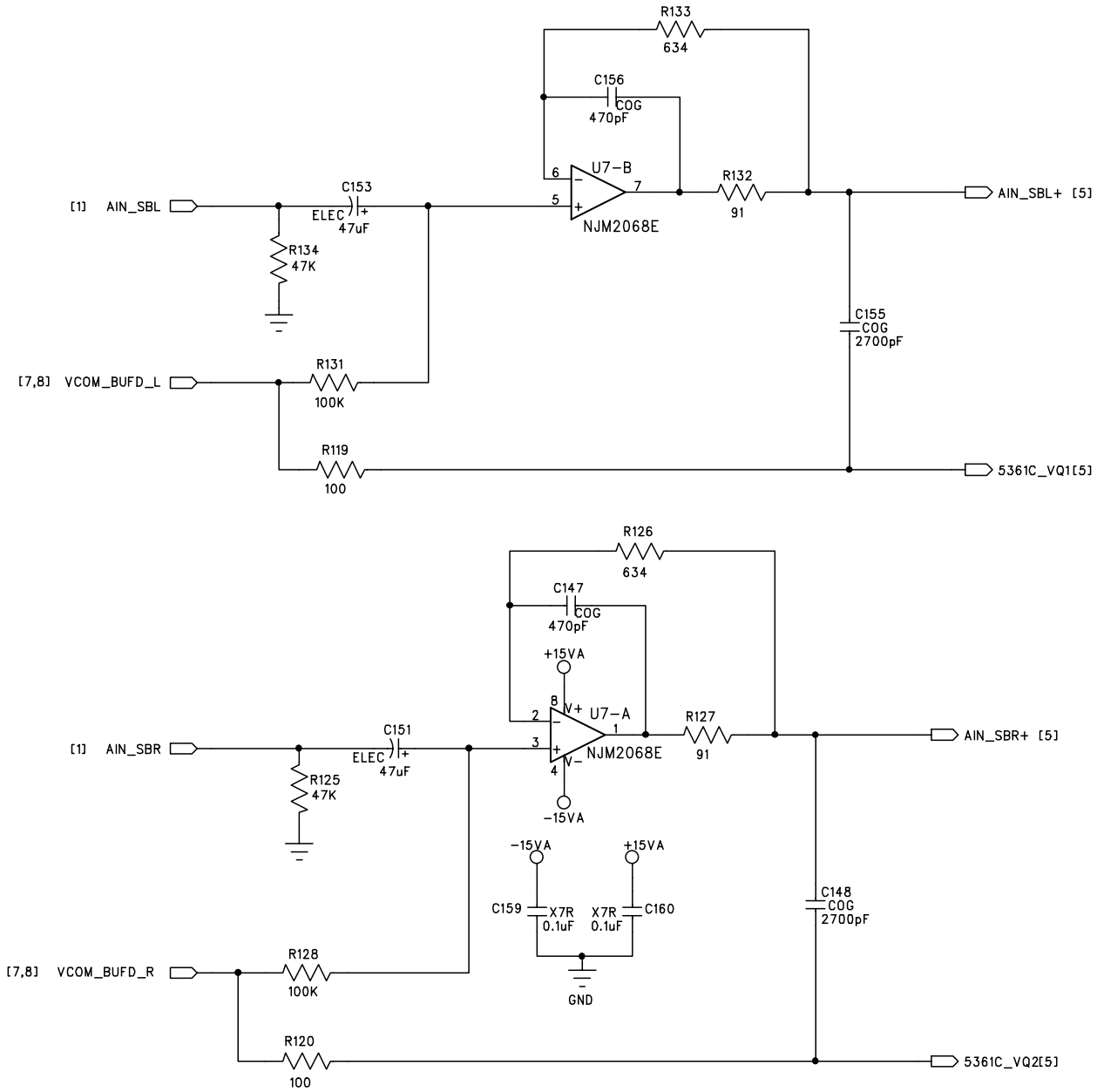


Figure 14. SBL/SBR Input Filters



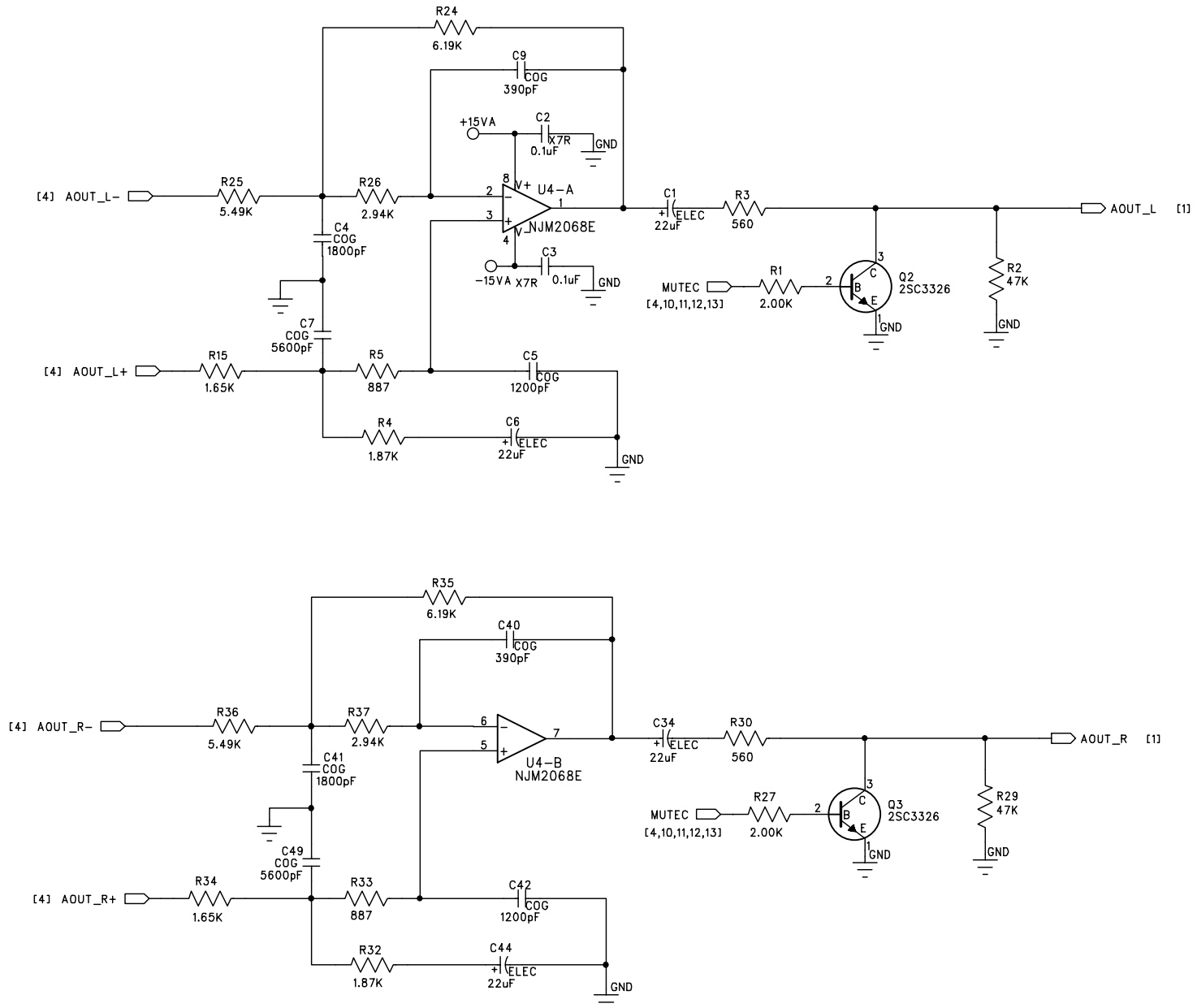
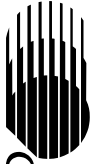


Figure 15. L/R Output Filters

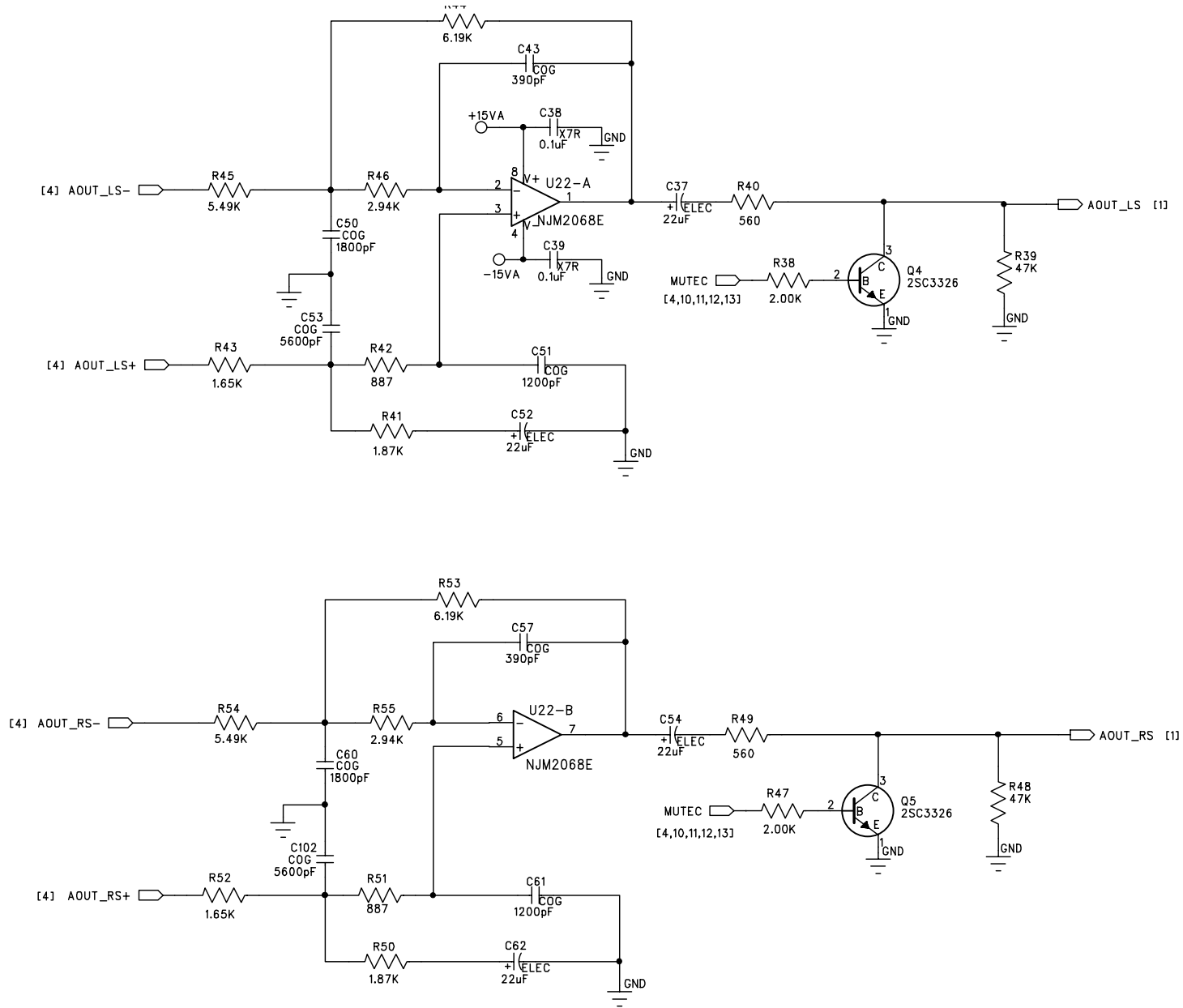


Figure 16. Ls/Rs Output Filters

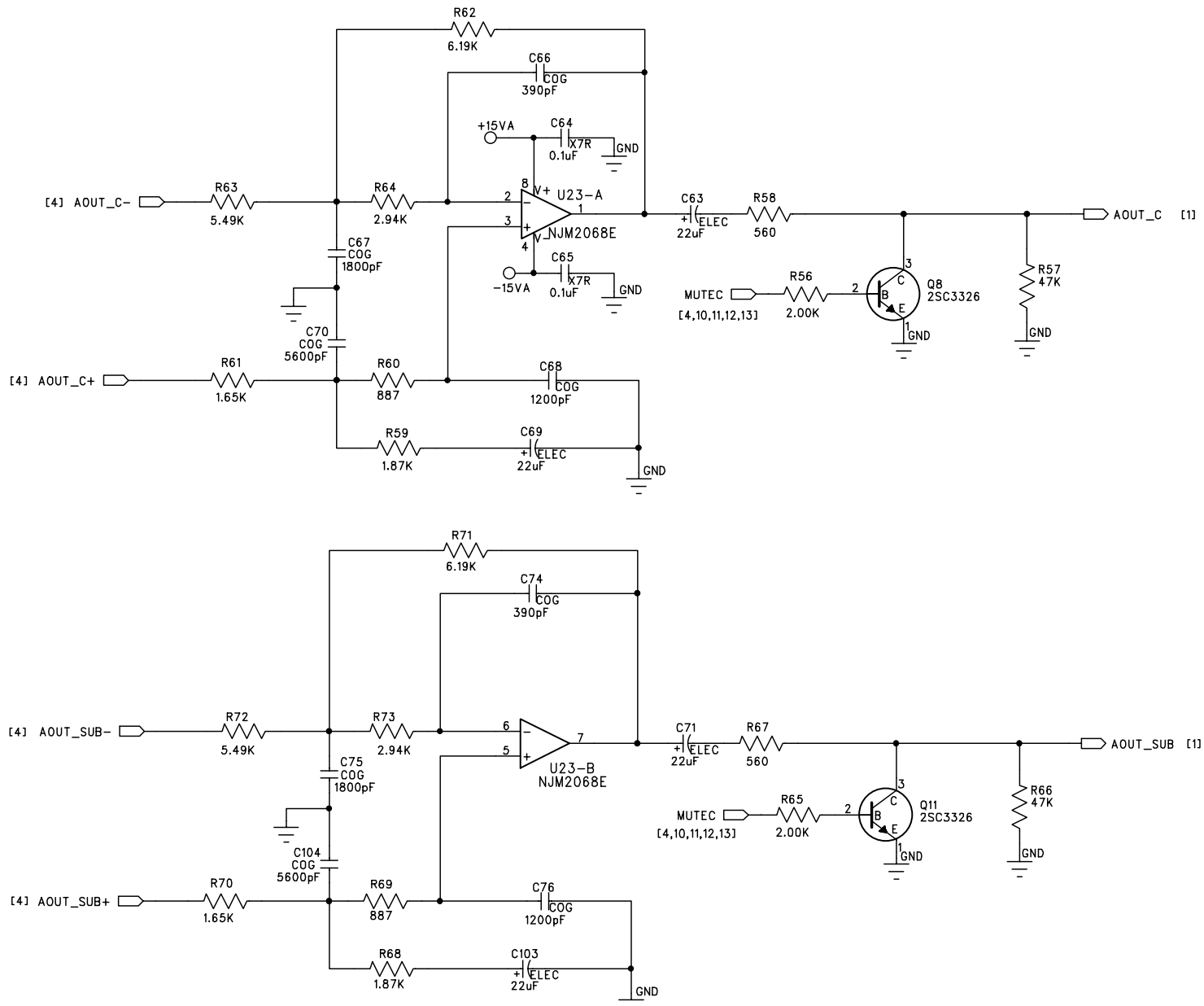
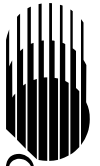


Figure 17. C/Sub Output Filters

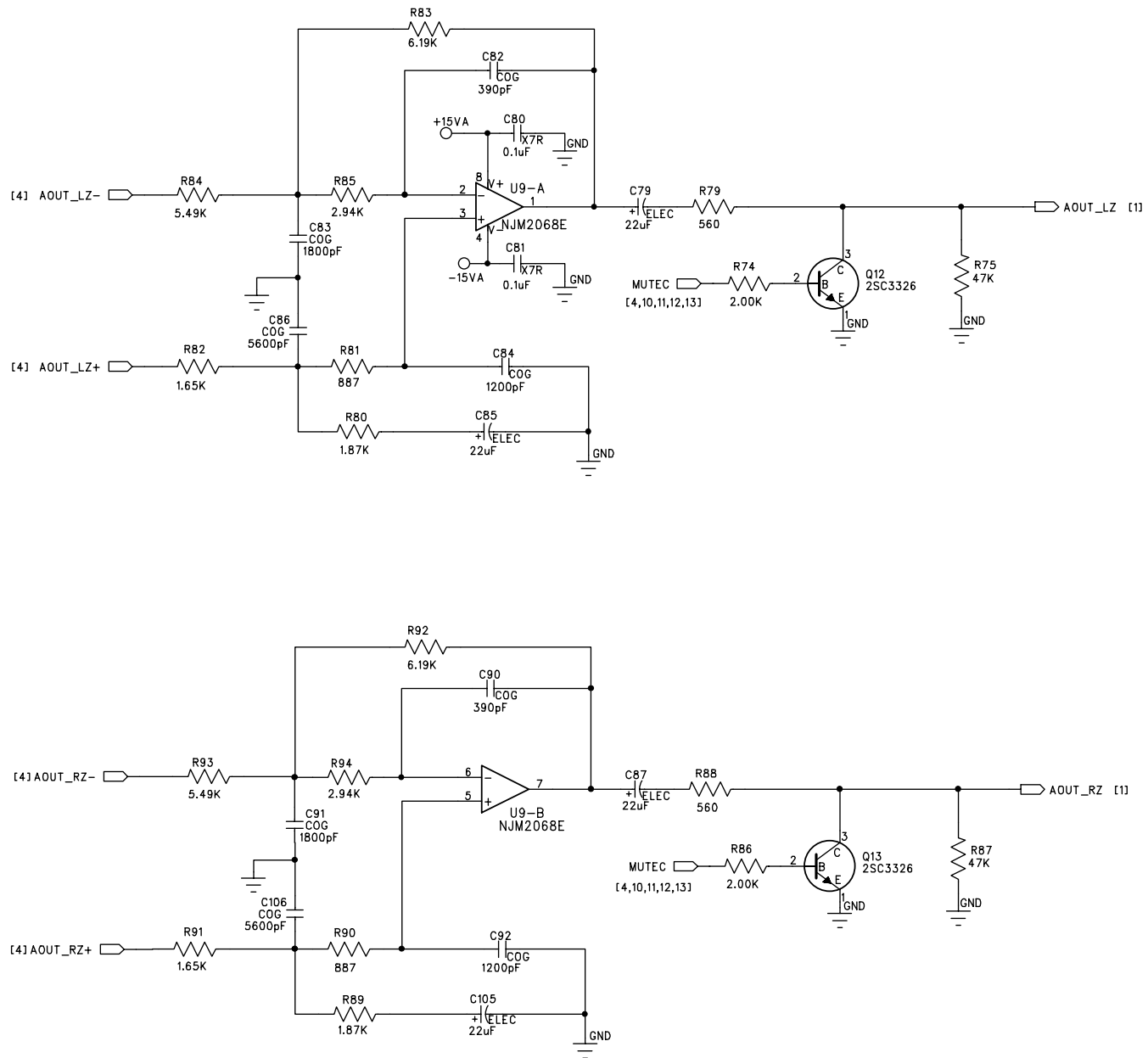
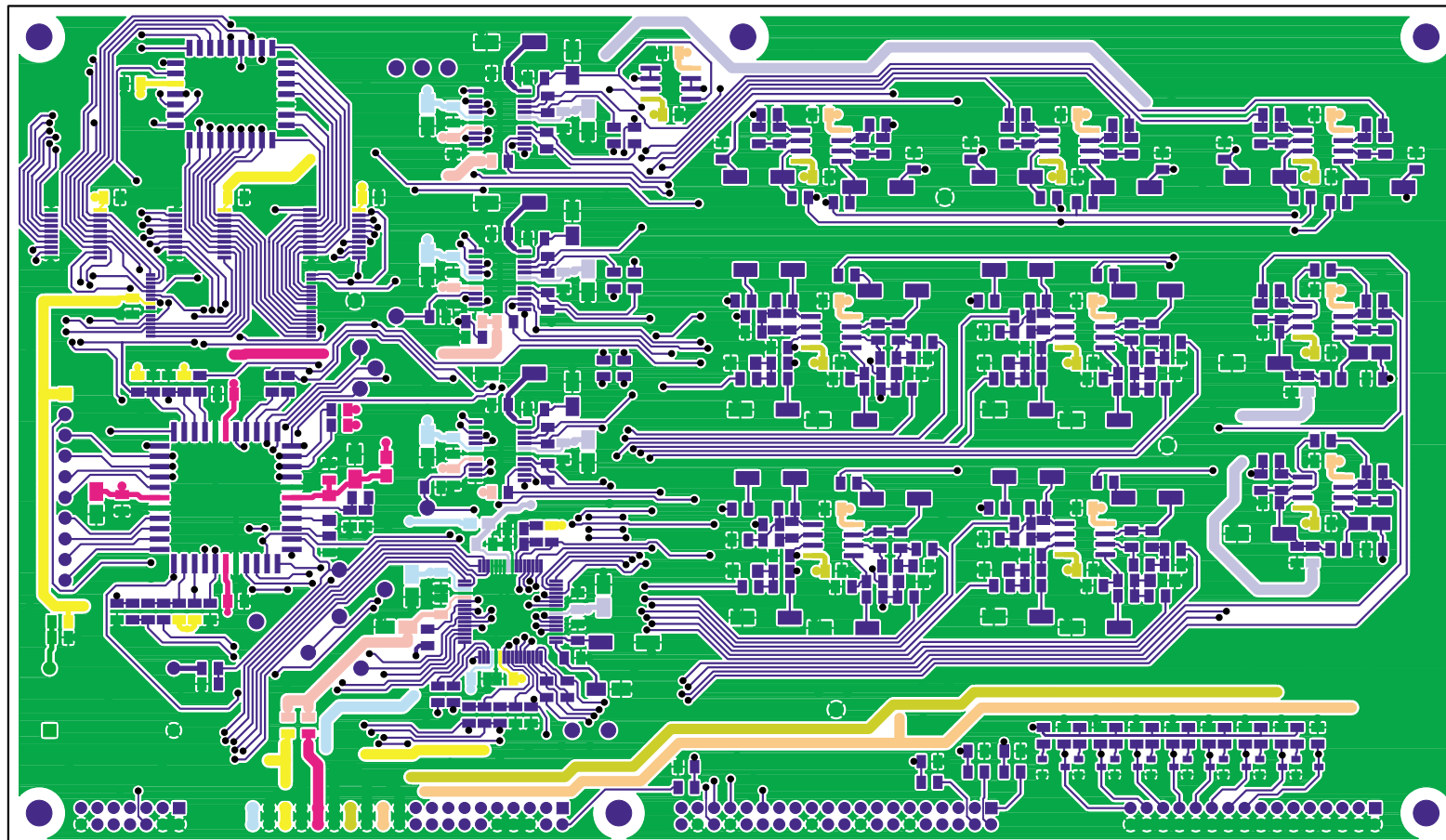


Figure 18. SBL/SBR Output Filters

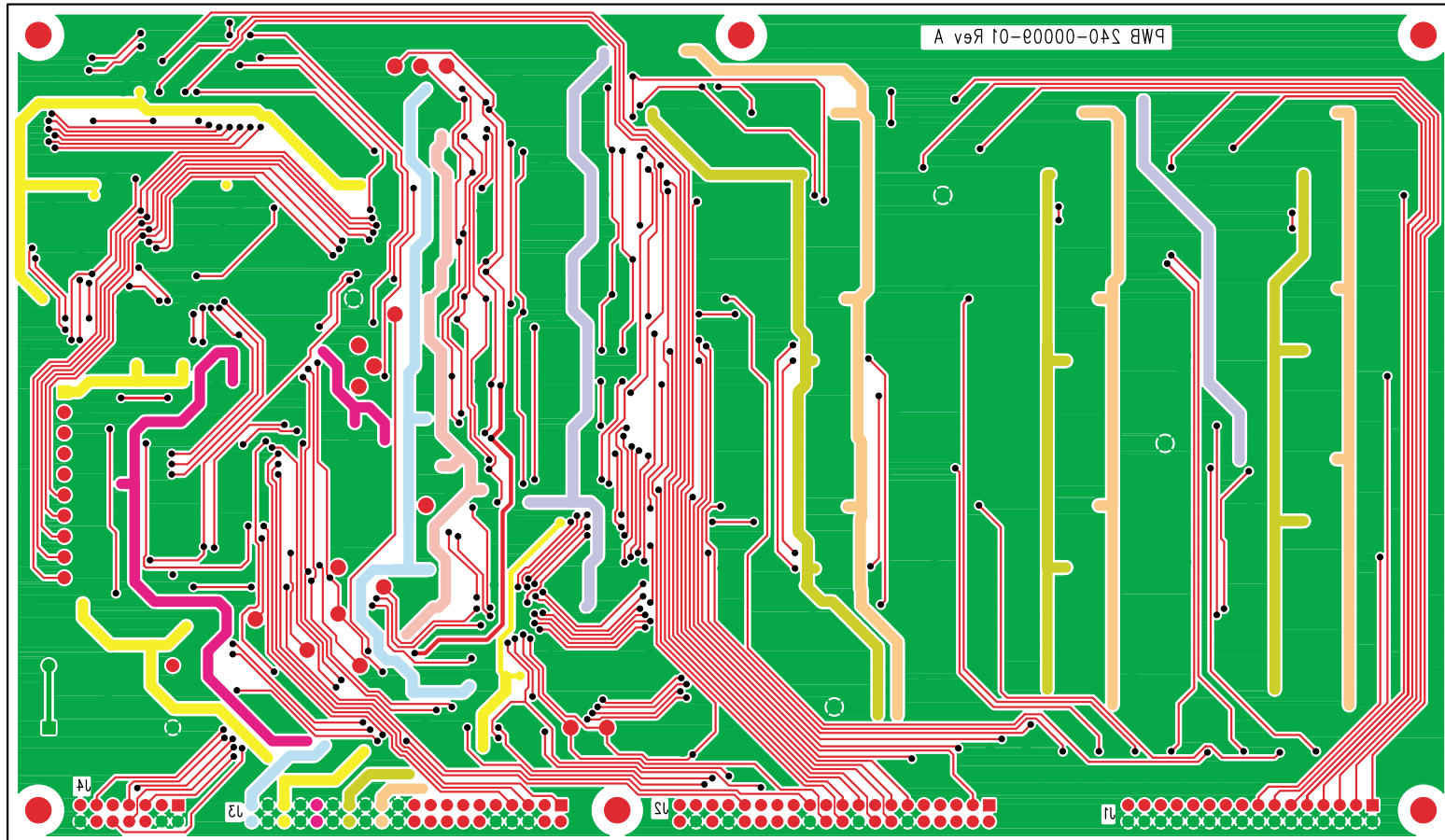
APPENDIX E: LAYOUT PLOTS (GROUND PLANE VIAS ARE FLOODED)



CIRRUS LOGIC CRD42528

TOP SIDE

Figure 19. Top Layer



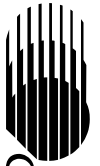
CIRRUS LOGIC CRD42528

BOTTOM SIDE

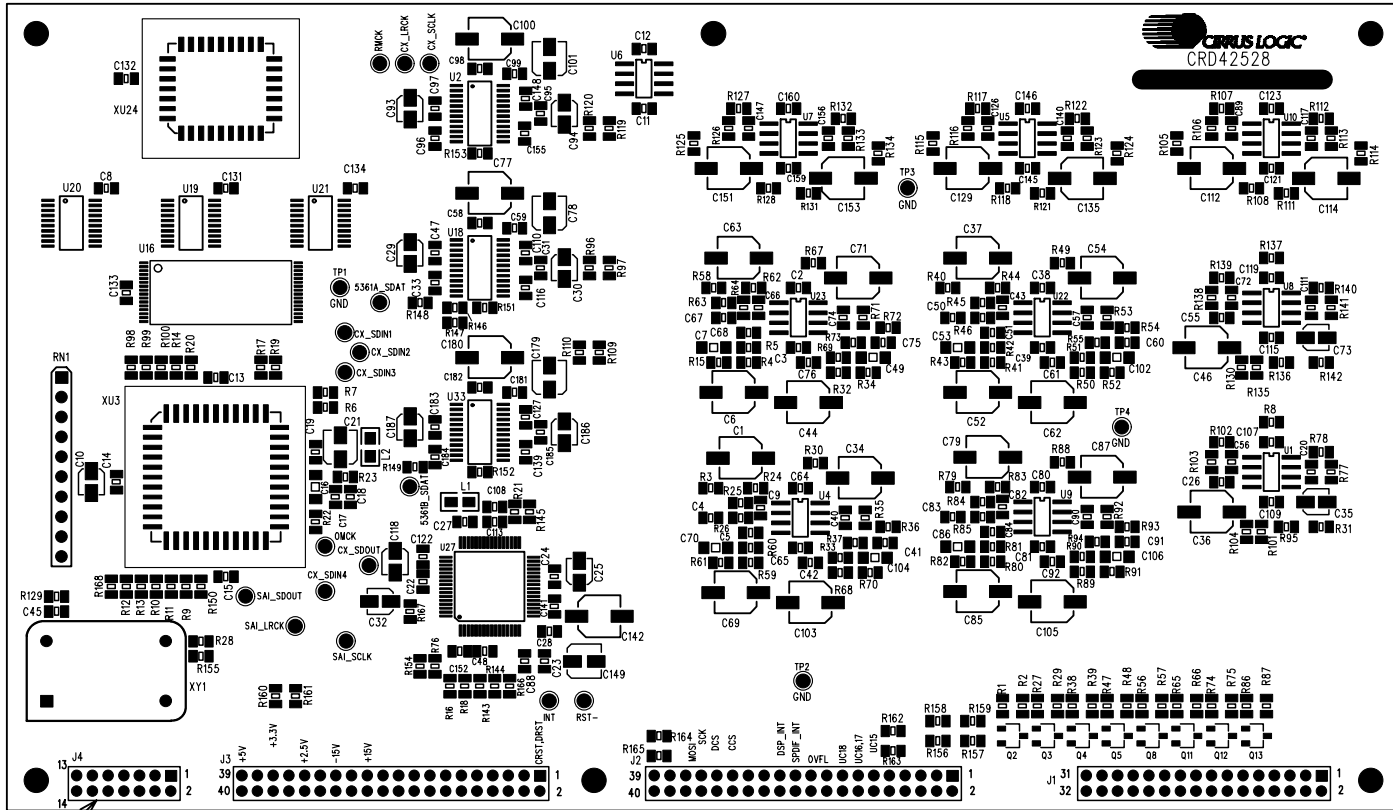
Figure 20. Bottom Layer



CIRRUS LOGIC®



CIRRUS LOGIC®



CIRRUS LOGIC CRD42528

TOP SIDE

SILKSCREEN TOP

ASSEMBLY DRAWING TOP

PRIMARY SIDE

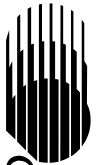
SEE NOTE 1

NOTES:  
1. INSTALL J1, J2, J3 AND J4 ON SECONDARY SIDE.

Figure 21. Assembly Drawing

## APPENDIX F: BILL OF MATERIALS - CRD42528

Item	Qty	Reference	Part Number	Manufacturer	Description	Notes
1	20	5361A_SDAT 5361B_SDAT CX_LRCK CX_SCLK CX_SDIN1 CX_SDIN2 CX_SDIN3 CX_SDIN4 CX_SDOUT INT OMCK RMCK RST- SAI_LRCK SAI_SCLK SAI_SDOUT TP1 TP2 TP3 TP4	5002	KEYSTONE	TESTPOINT, SINGLE POST	
2	16	C1 C6 C34 C37 C44 C52 C54 C62 C63 C69 C71 C79 C85 C87 C103 C105	ECE-V1CA220SR	PANASONIC	CAP, 22uF, ELEC, VS SERIES, SMT CASE-C, 16V, 20%	
3	55	C2 C3 C8 C11 C12 C13 C14 C15 C19 C22 C24 C26 C27 C28 C31 C33 C38 C39 C45 C47 C48 C55 C58 C59 C64 C65 C80 C81 C95 C96 C97 C98 C99 C107 C109 C115 C119 C121 C122 C123 C131 C132 C133 C134 C141 C145 C146 C152 C159 C160 C181 C182 C183 C184 C185	C0805C104K5RAC	KEMET	CAP, 0.1UF, X7R, 0805, 50V, 10%	
4	8	C4 C41 C50 C60 C67 C75 C83 C91	C0805C182K5GAC	KEMET	CAP, 1800PF, COG, 0805, 50V, 10%	
5	8	C5 C42 C51 C61 C68 C76 C84 C92	C0805C122J5GAC	KEMET	CAP, 1200pF, COG, 0805, 50V, 5%	
6	8	C7 C49 C53 C70 C86 C102 C104 C106	C1206C562J5GAC	KEMET	CAP, 5600PF, COG, 1206, 50V, 5%	
7	8	C9 C40 C43 C57 C66 C74 C82 C90	C0805C391J5GAC	KEMET	CAP, 390PF, COG, 0805, 50V, 5%	
8	6	C10 C25 C32 C35 C73 C118	ECE-V1CS100SR	PANASONIC	CAP, 10uF, ELEC, VS SERIES, SMT CASE-A, 16V, 20%	

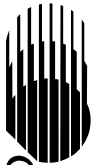


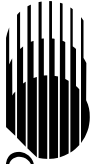




Item	Qty	Reference	Part Number	Manufacturer	Description	Notes
9	1	C16	C1206C225K8RAC	KEMET	CAP, 2.2uF, X7R, 1206, 10V, 10%.	
10	1	C17	C0805C221J5RAC	KEMET	CAP, 220PF, X7R, 0805, 50V, 5%	
11	1	C18	C0805C103K5RAC	KEMET	CAP, 0.01UF, X7R, 0805, 50V, 10%	
12	10	C20 C56 C72 C89 C111 C117 C126 C140 C147 C156	C0805C471J5GAC	KEMET	CAP, 470PF, COG, 0805, 50V, 5%	
13	1	C21	ECE-VOJA470WR	PANASONIC	CAP, 47uF, ELEC, VA SERIES, SMT CASE-B, 6.3V, 20%	
14	8	C23 C88 C110 C116 C127 C139 C148 C155	ECJ-2VC1H272J	PANASONIC	CAP, 2700PF, COG, 0805, 50V, 5%	
15	6	C29 C30 C93 C94 C186 C187	ECE-V1HS010SR	PANASONIC	CAP, 1uF, ELEC, VS SERIES, SMT CASE-A, 50V, 20%	
16	11	C36 C46 C77 C100 C112 C114 C129 C135 C151 C153 C180	ECE-V1AA470WR	PANASONIC	CAP, 47uF, ELEC, VA SERIES, SMT CASE-C, 10V, 20%	
17	4	C78 C101 C149 C179	ECE-V1EA4R7SR	PANASONIC	CAP, 4.7uF, ELEC, VS SERIES, SMT CASE-B, 25V, 20%	
18	1	C108	C0805C822J5RAC	KEMET	CAP, 8200PF, X7R, 0805, 50V, 5%	
19	1	C113	C0805C221J5GAC	KEMET	CAP, 220PF, COG, 0805, 50V, 5%	
20	1	C142	ECE-V1AA101WR	PANASONIC	CAP, 100uF, ELEC, VS SERIES, SMT CASE-C, 10V, 20%	
21	1	J1	87089-3216	MOLEX	STAKE HEADER, 16X2, 2MM PITCH	Install on secondary side

Item	Qty	Reference	Part Number	Manufacturer	Description	Notes
22	2	J2 J3	87089-4016	MOLEX	STAKE HEADER, 20X2, 2MM PITCH	Install on second- ary side
23	1	J4	87089-1417	MOLEX	STAKE HEADER, 7X2, 2MM PITCH	Install on second- ary side
24	2	L1 L2	BLM21P300	MURATA	FBEAD,0805,30- 100MHz,3AMPS	
25	8	Q2 Q3 Q4 Q5 Q8 Q11 Q12 Q13	2SC3326	TOSHIBA	TRANSISTOR, NPN, EPI- TAXIAL TYPE, SC59	
26	8	R1 R27 R38 R47 R56 R65 R74 R86	CRCW08052001F	DALE	RES, 2.00K, 0805, 1/10W, 1%. 100ppm	
27	16	R2 R29 R31 R39 R48 R57 R66 R75 R87 R105 R114 R115 R124 R125 R134 R142	CRCW0805473J	DALE	RES, 47K, 0805, 1/10W, 5%, 200ppm	
28	8	R3 R30 R40 R49 R58 R67 R79 R88	CRCW08055600F	DALE	RES, 560, 0805, 1/10W, 1%, 100ppm	
29	8	R4 R32 R41 R50 R59 R68 R80 R89	CRCW08051871F	DALE	RES, 1.87K, 0805, 1/10W, 1%. 100ppm	
30	8	R5 R33 R42 R51 R60 R69 R81 R90	CRCW08058870F	DALE	RES, 887 OHMS, 0805, 1/10W, 1%. 100ppm	
31	2	R6 R7	CRCW0805472J	DALE	RES, 4.7K, 0805 1/8W, 5%, 200ppm	
32	12	R8 R77 R103 R106 R113 R116 R123 R126 R133 R137 R138 R141	CRCW08056340F	DALE	RES, 634 OHMS, 0805, 1/10W, 1%. 100ppm	
33	11	R9 R14 R98 R99 R100 R104 R130 R156 R157 R163 R165	CRCW0805332J	DALE	RES, 3.3K, 0805, 1/10W, 5%, 200ppm	R14,R100 are not populated
34	18	R10 R12 R13 R16 R18 R22 R143 R144 R146 R147 R148 R149 R150 R160 R161 R166 R167 R168	CRCW0805000FT	DALE	RES, 0-OHM, 0805	R13,R18,R144,R 146,R148,R149, R150,R160,R166 ,R168 are not populated





Item	Qty	Reference	Part Number	Manufacturer	Description	Notes
35	9	R11 R145 R151 R152 R153 R158 R159 R162 R164	CRCW0805103J	VISHAY	RES, 10K, 0805, 1/10W, 5%. 200ppm	
36	8	R15 R34 R43 R52 R61 R70 R82 R91	CRCW08051651F	DALE	RES, 1.65K, 0805, 1/10W, 1%. 100ppm	
37	6	R17 R19 R20 R76 R129 R154	ERJ-6GEYJ330V	PANASONIC	RES, 33 OHMS, 1/10W,0805, 5%	
38	1	R21	CRCW0805162J	DALE	RES, 1.6K, 0805, 1/10W, 5%, 200ppm	
39	1	R23	CRCW08052003F	DALE	RES, 200K, 0805, 1/10W, 1%. 100ppm	
40	8	R24 R35 R44 R53 R62 R71 R83 R92	CRCW08056191F	DALE	RES, 6.19K, 0805, 1/10W, 1%. 100ppm	
41	8	R25 R36 R45 R54 R63 R72 R84 R93	CRCW08055491F	DALE	RES, 5.49K, 0805, 1/10W, 1%. 100ppm	
42	8	R26 R37 R46 R55 R64 R73 R85 R94	CRCW08052941F	DALE	RES, 2.94K, 0805, 1/10W, 1%. 100ppm	
43	7	R28 R96 R97 R109 R110 R119 R120	CRCW08051000F	DALE	RES, 100-OHM, 0805, 1/10W, 1%. 100ppm. 100ppm	
44	10	R78 R102 R107 R112 R117 R122 R127 R132 R139 R140	CRCW0805910J	DALE	RES, 91 OHMS, 0805, 1/8W, 5%	
45	8	R95 R108 R111 R118 R121 R128 R131 R136	CRCW08051003F	DALE	RES, 100K, 0805, 1/10W, 1%. 100ppm	
46	2	R101 R135	CRCW08052801F	DALE	RES, 2.80K, 0805, 1/10W, 1%. 100ppm	
47	1	R155	CRCW0805391J	DALE	RES, 390, 0805, 1/10W, 5%, 200ppm	
48	1	RN1	4610X-101-103	BOURNS	RESISTOR NETWORK, 9 BUSSED, SIP10, 10K	

Item	Qty	Reference	Part Number	Manufacturer	Description	Notes
49	10	U1 U4 U5 U6 U7 U8 U9 U10 U22 U23	NJM-2068E	NJR	IC, DUAL LOW NOISE OP-AMP, SO8-150	
50	3	U2 U18 U33	CS5351-KZ	CRYSTAL SEMI	IC,CS5351-KZ,192 kHz AUDIO A/D CONVERTER,TSSOP24-173	
51	1	U16	CY62128VLL-70ZI	CYPRESS	128 X 8 STATIC RAM, 32 LEAD TSOP, 70NS	
52	2	U19 U20	SN74LVC574APW	TEXAS INSTRUMENTS INC	IC, OCTAL EDGE-TRIGGERED D-TYPE FLIP-FLOPS WITH 3-STATE OUTPUTS, TSSOP20-173	
53	1	U21	SN74LVC245APW	TEXAS INSTRUMENTS INC	IC, OCTAL BUS TRANSCEIVER WITH 3-STATE OUTPUTS, TSSOP20-173	
54	1	U27	CS4252	CIRRUS LOGIC	IC, ELVIS, QFP64, 10X10mm, 0.5mm PITCH	
55	1	U3	CS493302-CL	CIRRUS LOGIC	IC, MULTI-STANDARD AUDIO DECODER, PLCC44	
56	1	U24	AT29LV040A-25JC	ATMEL	IC, FLASH MEMORY, 512KX8, 256 BYTE SECTOR, PLCC32	
57	1	Y1	CV11AF-12.288MHZ	CAL CRYSTAL	OSCILLATOR, 12.288MHZ, 3.3V, FULL-SIZE CASE	
58	4	XY1	8134-HC-5P2	AUGAT	Socket, Pin, Pop-in, SM	
59	1	XU3	540-99-044-17-40000	MILL-MAX	Socket, PLCC-44	
60	1	XU24	540-99-032-17-40000	MILL-MAX	Socket, PLCC-32	



# APPENDIX G: UDSP SCHEMATICS

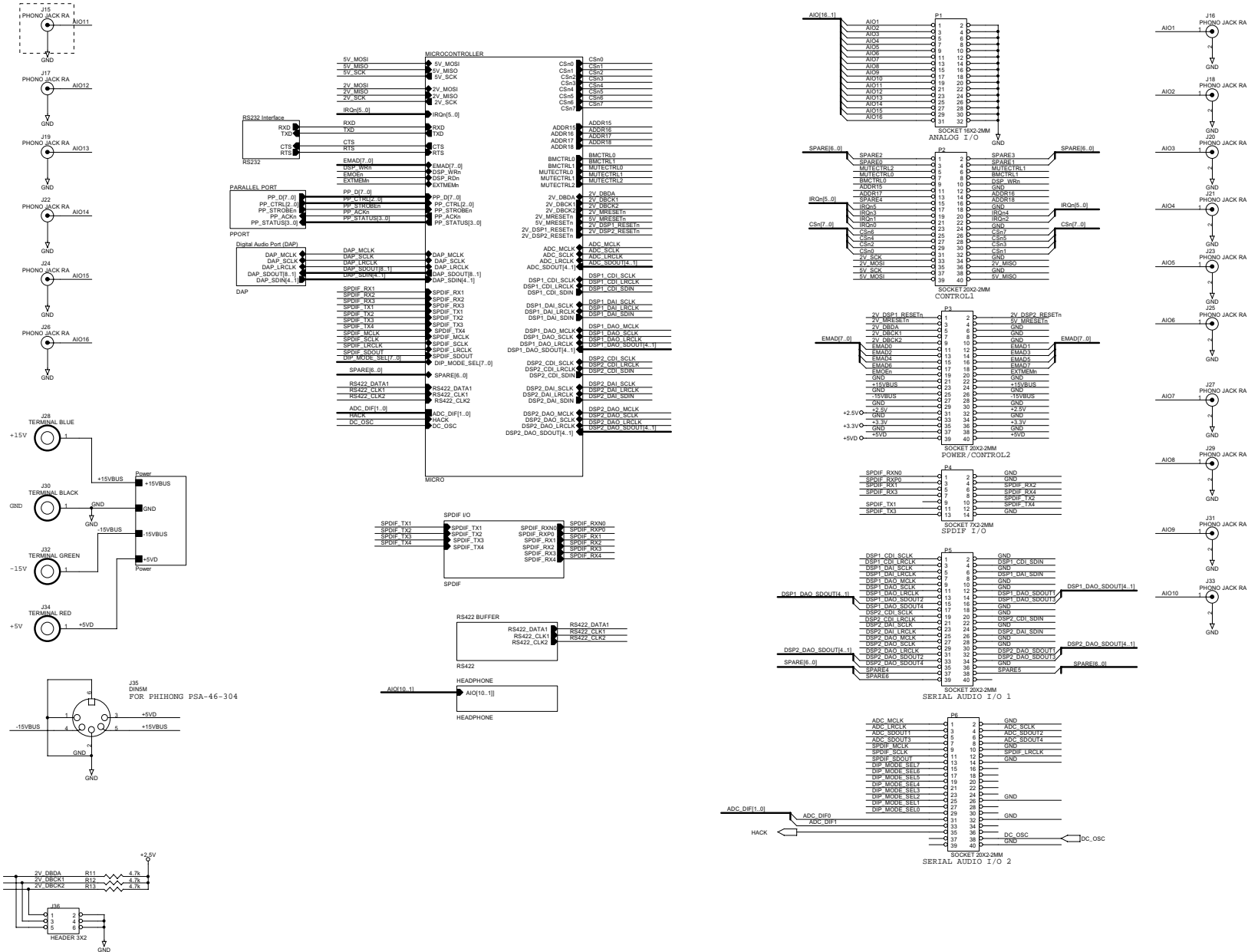


Figure 22. UDSP - Top

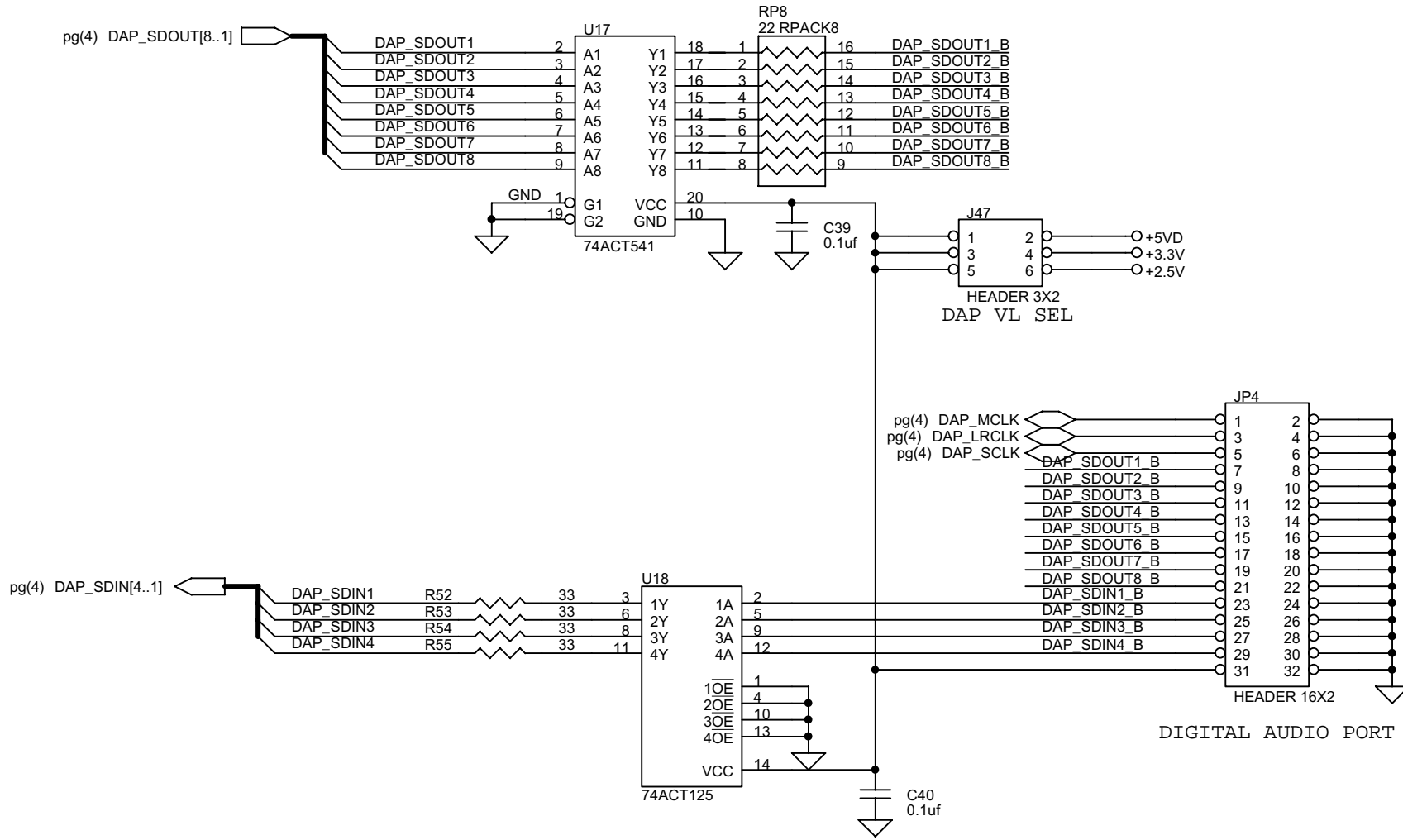
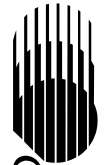


Figure 23. UDSP - Digital Audio Port

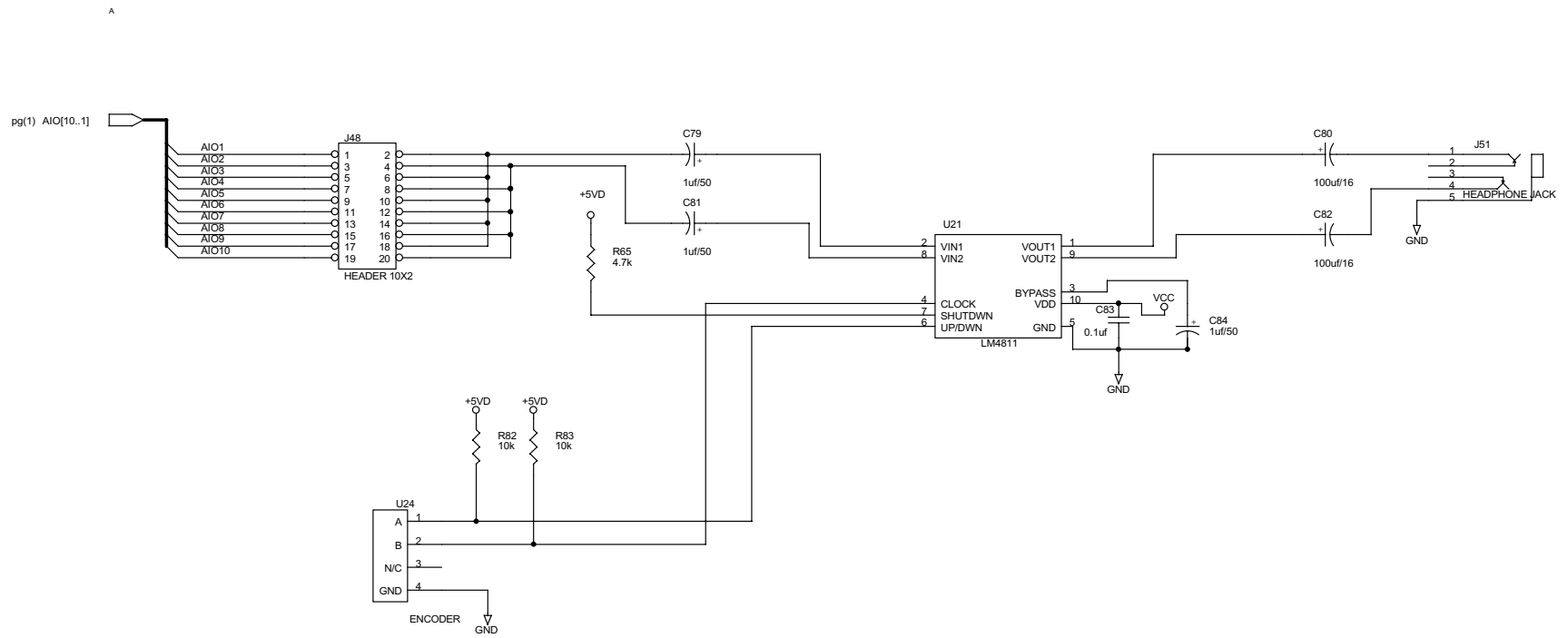
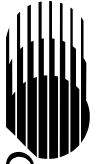


Figure 24. UDSP - Headphone Amplifier

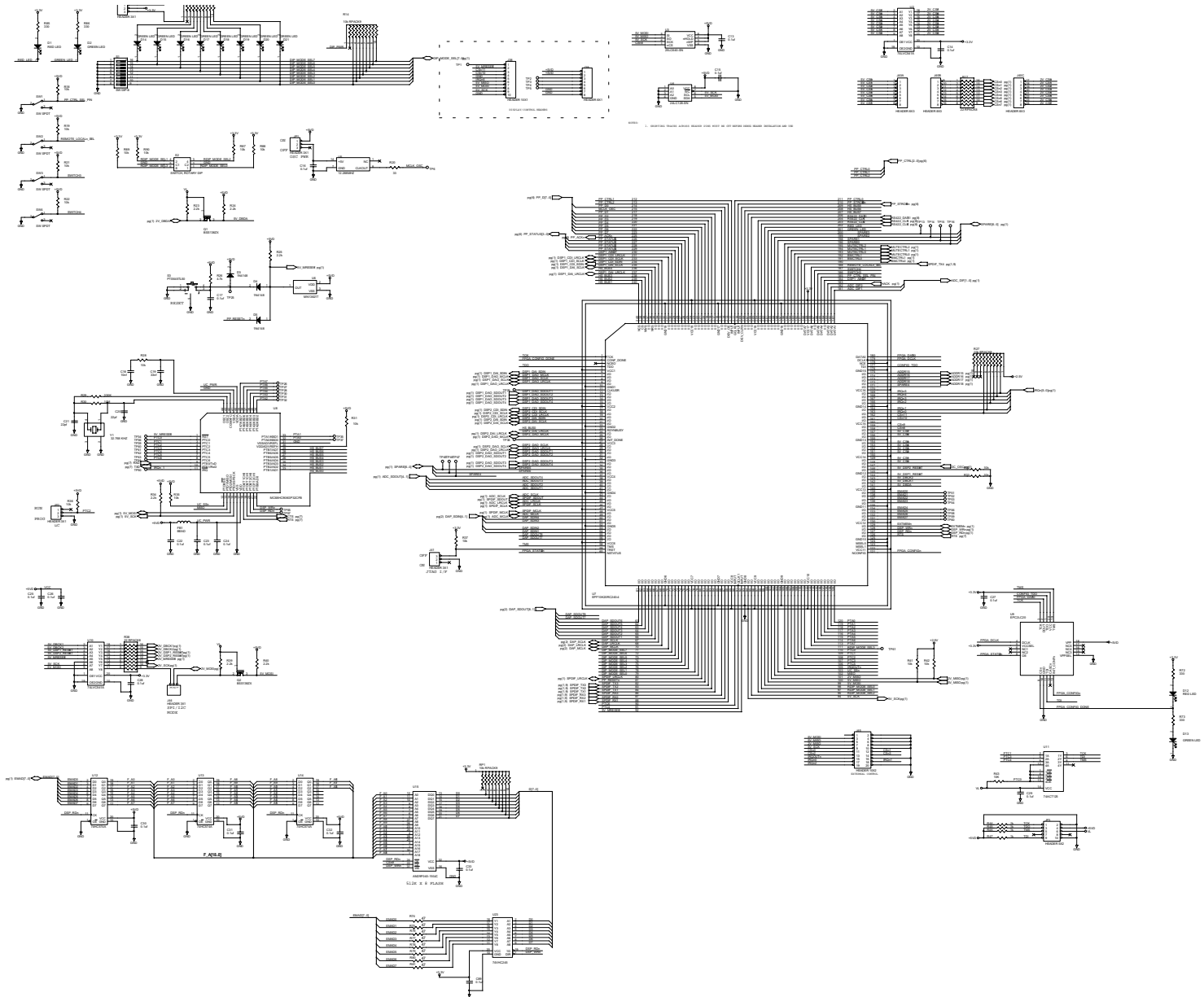


Figure 25. UDSP - Microcontroller



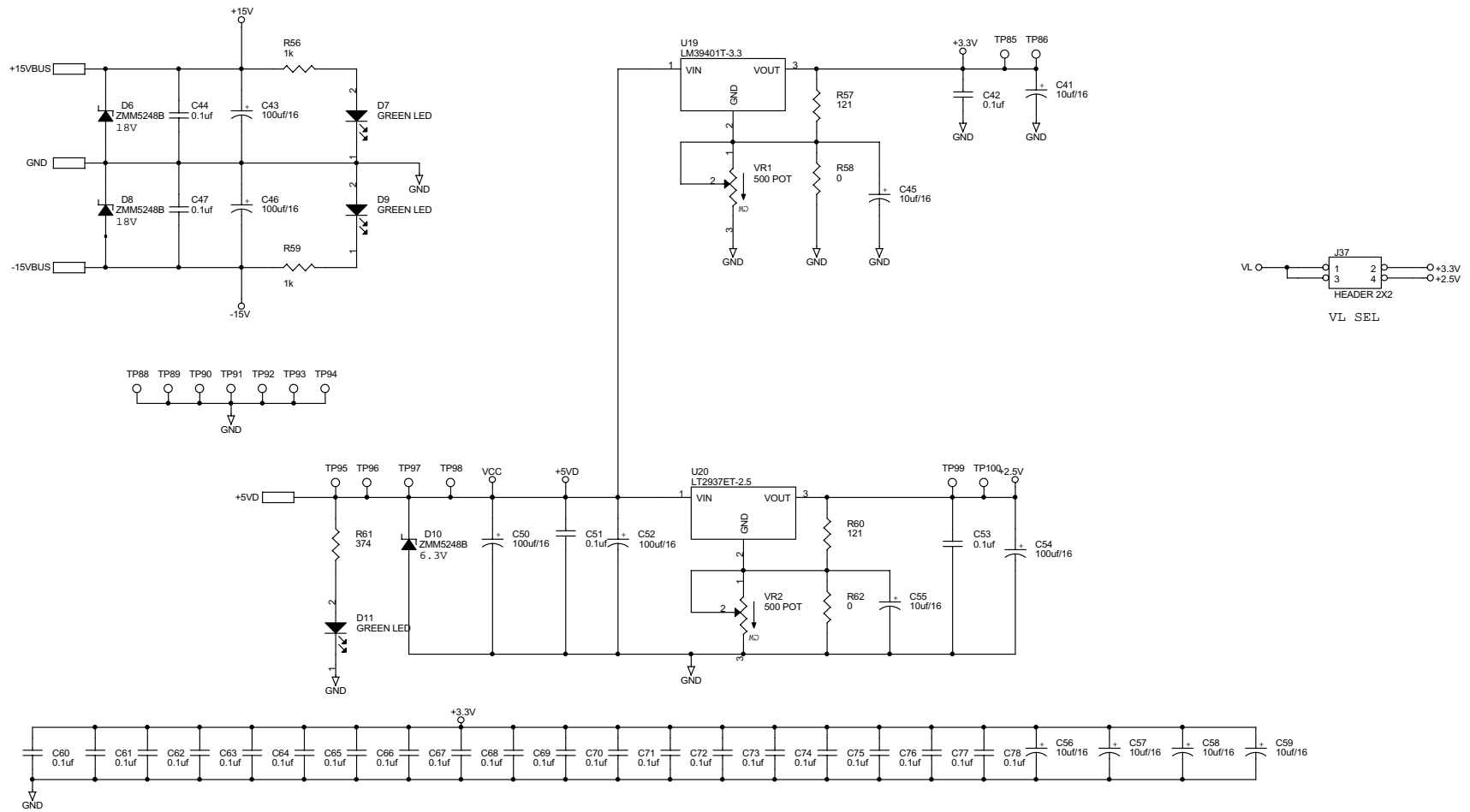
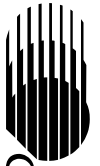


Figure 26. UDSP - Power

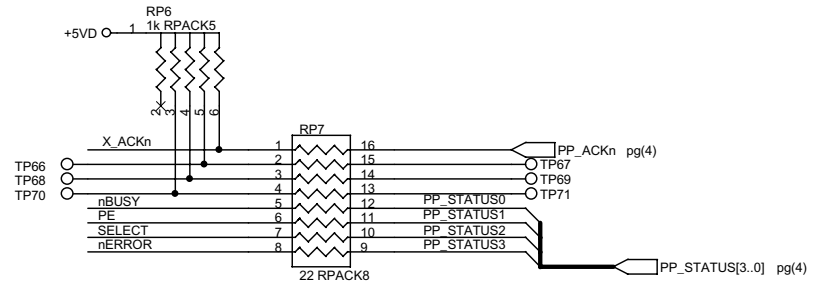
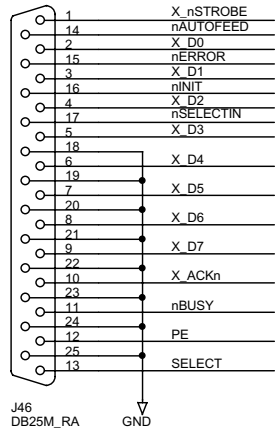
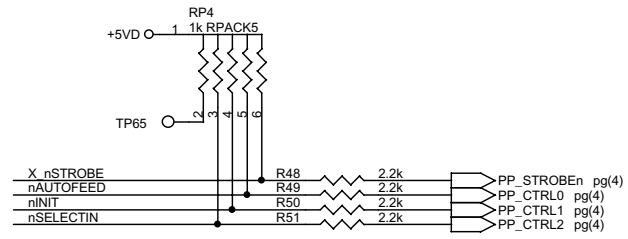
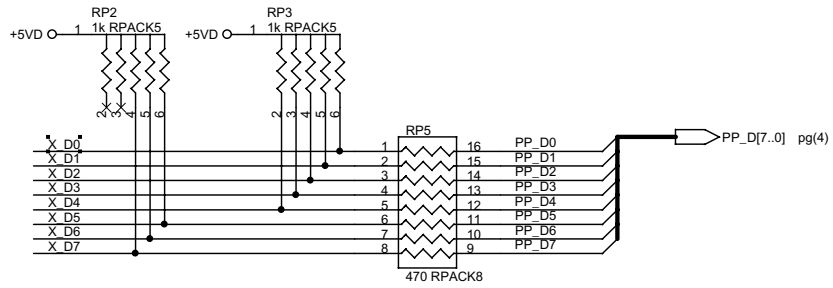


Figure 27. UDSP - Parallel Port Interface

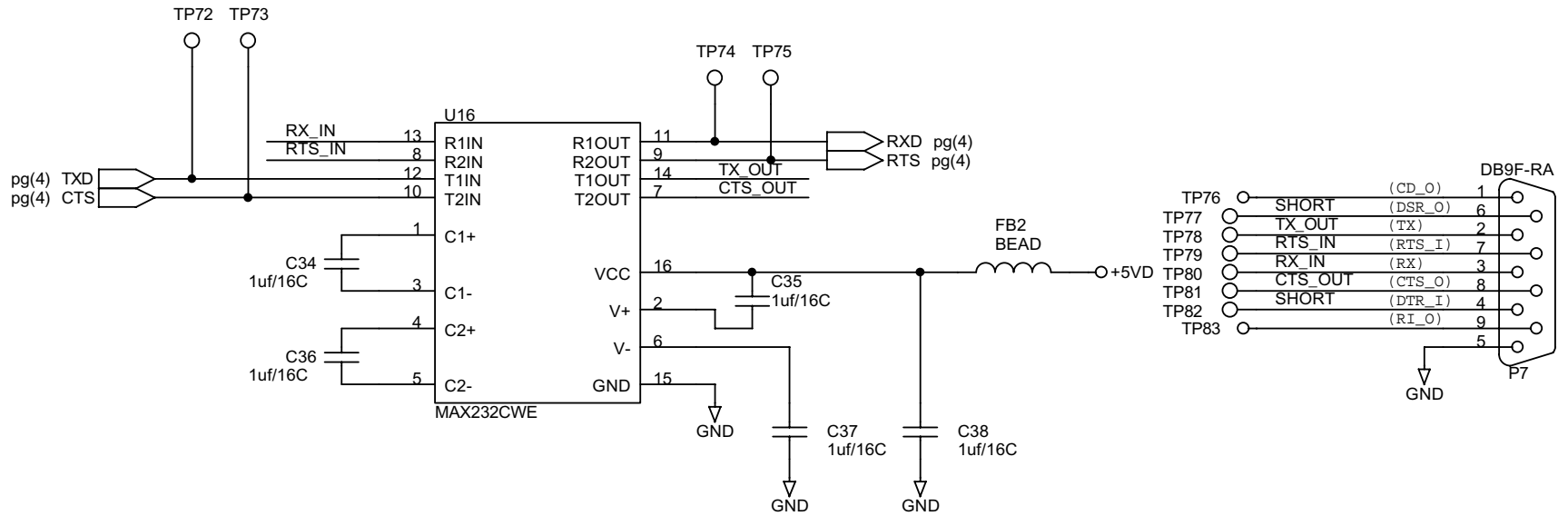
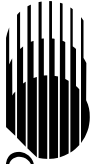


Figure 28. UDSP - RS232 Interface

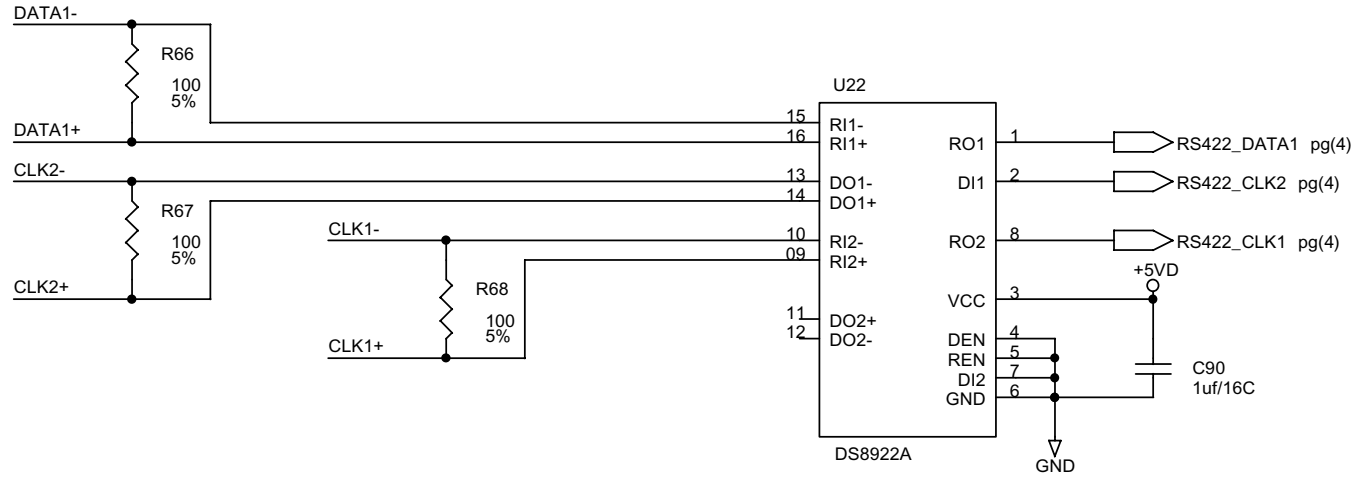
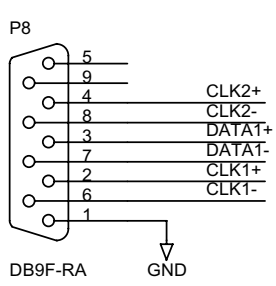


Figure 29. UDSP - RS422 Interface

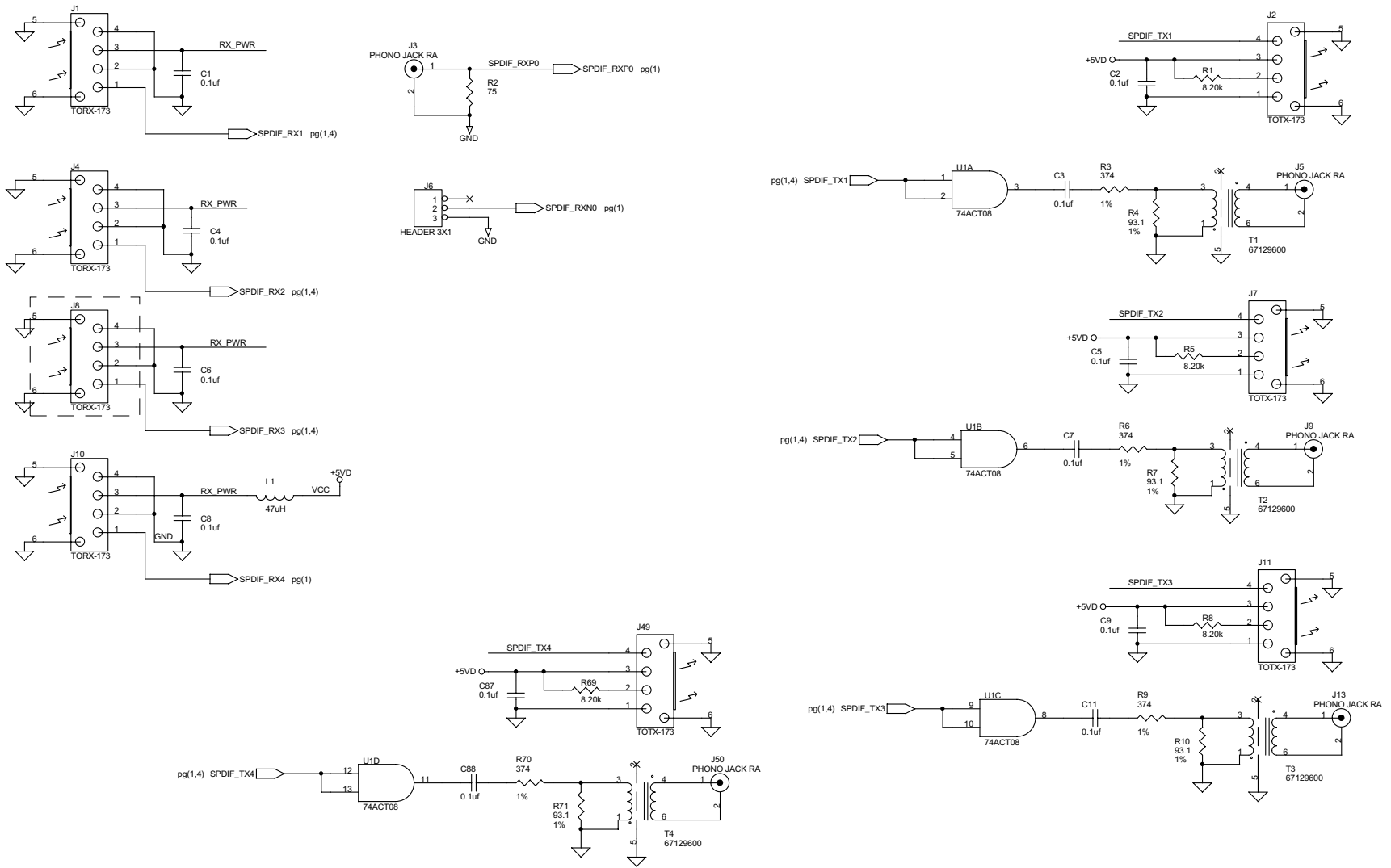
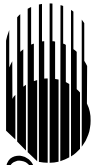


Figure 30. UDSP - S/PDIF I/O

## APPENDIX H: BILL OF MATERIALS - UDSP

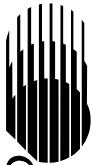
Item	Qty	Reference	MFG_PN	MFG	DESCRIPTION
1	57	C1 C2 C3 C4 C5 C6 C7 C8 C9 C11 C13 C14 C15 C16 C17 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32 C33 C39 C40 C42 C44 C47 C51 C53 C60 C61 C62 C63 C64 C65 C66 C67 C68 C69 C70 C71 C72 C73 C74 C75 C76 C77 C78 C83 C87 C88 C89	C1206C104K5RAC	KEMET	CAP CERAMIC 0.1UF 50V 10% X7R 1206
2	1	C18	C1206C103K1RAC	KEMET	CAP CERAMIC 10NF 100V 10% X7R 1206
3	1	C19	C1206C333K1RAC	KEMET	CAP CERAMIC 33NF 100V 10% X7R 1206
4	2	C21 C20	C1206C220J1GAC	KEMET	CAP CERAMIC 22PF 100V 5% COG 1206
5	6	C34 C35 C36 C37 C38 C90	C1206C105M4RAC	KEMET	CAP CERAMIC 1UF 16V 20% 1206
6	5	C41 C56 C57 C58 C59	ECE-V1CA100SR	PANASONIC	CAP ELECT AL 10UF 16V 20% SM_B
7	7	C43 C46 C50 C52 C54 C80 C82	ECE-V1CA101WP	PANASONIC	CAP ELECT AL 100UF 16V 20% SM_D
8	2	C55 C45	ECE-V1CA100SR	PANASONIC	CAP ELECT AL 10UF 16V 20% SM_B
9	3	C79 C81 C84	ECE-V1HS010SR	PANASONIC	CAP 1uF ELEC VS SERIES SMT CASE-A 50V 20%
10	2	D1 D12	LN1251C-(TR)	PANASONIC	LED RED DIFF 10MA SM
11	13	D2 D7 D9 D11 D13 D14 D15 D16 D17 D18 D19 D20 D21	LN1351C-(TR)	PANASONIC	LED GREEN DIFF 10MA SM
12	3	D3 D4 D5	LL4148DI	VISHAY	DIODE HS SWITCHING MELF SOD-80
13	3	D6 D8 D10	ZMM5248B	VISHAY	DIODE ZENER 18V 500MW SOD-80
14	2	FB1 FB2	EXC-ML45A910U	PANASONIC	FERRITE BEAD 1806
15	6	JP1 JP2 JP5 J6 J41 J44	TSW-103-07-G-S	SAMTEC	HEADER MALE 0.1 IN HDR3X1
16	1	JP3	TSW-105-07-G-D	SAMTEC	HEADER MALE 0.1 IN HDR5X2
17	1	JP4	TSW-116-07-T-D	SAMTEC	STAKE HEADER 16X2 .1" CENTER TIN
18	4	J1 J4 J8 J10	TORX-173	TOSHIBA	OPTICAL TOSLINK RECIEVER
19	4	J2 J7 J11 J49	TOTX-173	TOSHIBA	OPTICAL TRANSMITTER
20	21	J3 J5 J9 J13 J15 J16 J17 J18 J19 J20 J21 J22 J23 J24 J25 J26 J27 J29 J31 J33 J50	ARJ2018	A/D ELECT	PHONO JACK RA GOLD
21	1	J28	111-0110-001	E.F.JOHNSON	BINDING POST BLUE BPOST
22	1	J30	111-0103-001	E.F.JOHNSON	BINDING POST BLACK BPOST





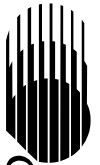
Item	Qty	Reference	MFG_PN	MFG	DESCRIPTION
23	1	J32	111-0104-001	E.F.JOHNSON	BINDING POST GREEN BPOST
24	1	J34	111-0102-001	E.F.JOHNSON	BINDING POST RED BPOST
25	4	JX28 JX30 JX32 JX34	"1-1.5 X.25'TIN X.25'" TIN	TYPE E"	SQUIRES
26	1	J35	SDS-50J	CUI STACK	CONNECTOR CIRCULAR DIN5M
27	2	J36 J47	TSW-103-07-G-D	SAMTEC	HEADER MALE 0.1 IN HDR3X2
28	1	J37	TSW-102-07-G-D	SAMTEC	HEADER MALE 0.1 IN HDR2X2
29	1	J38	TSW-110-07-G-S	SAMTEC	HEADER MALE 0.1 IN HDR10X1
30	1	J39	TSW-108-07-G-S	SAMTEC	HEADER MALE 0.1 IN HDR8X1
31	1	J40	TSW-108-07-G-T	SAMTEC	HEADER MALE 0.1 IN HDR8X3
32	2	J45 J48	TSW-110-07-G-D	SAMTEC	HEADER MALE 0.1 IN HDR10X2
33	1	J46	747238-4	AMP	CONNECTOR DB25 MALE RA
34	1	J51	CON-AD3056-50	A/D ELECTRON- ICS	CONNECTOR STEREO HEADPHONE JACK
35	1	L1	ELJ-FA470KF	PANASONIC	INDUCTOR 47UH 1210
36	1	P1	ESQT-116-03-G-D-375	SAMTEC	HEADER FEMALE 2MM SOK16X2-2MM
37	4	P2 P3 P5 P6	ESQT-120-03-G-D-375	SAMTEC	HEADER FEMALE 2MM SOK20X2-2MM
38	1	P4	ESQT-107-03-G-D-375	SAMTEC	HEADER FEMALE 2MM SOK7X2-2MM
39	2	P8 P7	745781-4	AMP	CONNECTOR D-SHELL9 RA .318 MOUNT FEMALE
40	2	Q2 Q1	BSS138ZX	ZETEX	MOSFET N CH 1.5VT SOT23
41	3	RP1 R14 R27	4610X-101-103	BOURNS	RES R-PACK9 10K 1/8W 2% SIP10
42	2	RP2 RP3	4606X-101-102	BOURNS	RES R-PACK5 1K 1/8W 2% SIP6
43	2	RP4 RP6	4606X-101-102	BOURNS	RES R-PACK5 1K 1/8W 2% SIP6
44	1	RP5	4816P-T01-220	BOURNS	RES R-PACK8 221/8W 2% SO16N
45	4	RP7 RP8 R17 R38	4816P-T01-220	BOURNS	RES R-PACK8 22 1/8W 2% SO16N
46	4	R1 R5 R8 R69	ERJ-8GEYJ822	PANASONIC	RES THICK FILM 8.20K 1/8W 5% 1206
47	1	R2	ERJ-8ENF75R0	PANASONIC	RES THICK FILM 75 1/8W 5% 1206
48	5	R3 R6 R9 R61 R70	ERJ-8ENF3740	PANASONIC	RES THICK FILM 374 1/8W 1% 1206
49	4	R4 R7 R10 R71	ERJ-8ENF93R1	PANASONIC	RES THICK FILM 93.1 1/8W 1% 1206
50	5	R11 R12 R13 R26 R65	ERJ-8GEYJ472	PANASONIC	RES THICK FILM 4.7K 1/8W 5% 1206

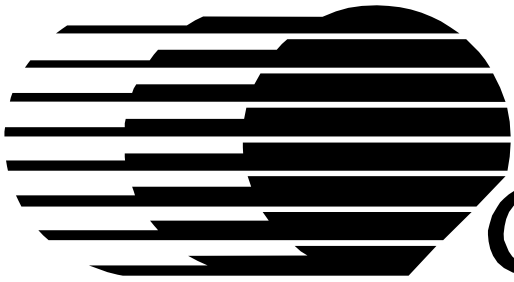
Item	Qty	Reference	MFG_PN	MFG	DESCRIPTION
51	20	R18 R19 R21 R22 R28 R31 R32 R33 R35 R36 R37 R41 R42 R43 R82 R83 R87 R88 R89 R90	ERJ-8ENF1002	PANASONIC	RES THICK FILM 10K 1/8W 1% 1206
52	5	R20 R52 R53 R54 R55	ERJ-8GEYJ330	PANASONIC	RES THICK FILM 33 1/8W 5% 1206
53	10	R23 R24 R25 R34 R39 R40 R48 R49 R50 R51	ERJ-8GEYJ222	PANASONIC	RES THICK FILM 2.2K 1/8W 5% 1206
54	1	R29	ERJ-8GEYJ334	PANASONIC	RES THICK FILM 330K 1/8W 5% 1206
55	1	R30	ERJ-8GEYJ106	PANASONIC	RES THICK FILM 10MEG 1/8W 5% 1206
56	6	R44 R45 R46 R47 R56 R59	ERJ-8GEYJ102	PANASONIC	RES THICK FILM 1K 1/8W 5% 1206
57	2	R60 R57	ERJ-8ENF1210	PANASONIC	RES THICK FILM 121 1/8W 1% 1206
58	2	R62 R58	ERJ-8GEY0R00V	PANASONIC	RES THICK FILM 0 1/8W 5% 1206
59	3	R66 R67 R68	CRCW12061000F	DALE	RES 100 OHMS 1206 1/8W 1% 100ppm
60	4	R72 R73 R85 R86	ERJ-8GEYJ331	PANASONIC	RES THICK FILM330 1/8W 5% 1206
61	8	R74 R75 R76 R77 R78 R79 R80 R81	ERJ-8GEYJ470V	PANASONIC	RES 49.9-OHM 1% 0805 1/10W
62	1	R84	4610X-101-331	BOURNS	RES R-PACK9 330 1/8W 2% SIP10
63	4	SW1 SW2 SW3 SW4	TS01CBE	C&K	SWITCH SLIDE SPDT
64	1	S1	76SB08	GRAYHILL	SWITCH DIP 8 POS ROCKER DIP16
65	1	S2	94HBB16	GRAYHILL	SWITCH DIP ROTARY HEX SM
66	1	S3	PTS645TL50	C&K	SWITCH 6MM TACT W/ ESD PIN 130GF DPST
67	78	TP1 TP2 TP3 TP4 TP5 TP6 TP13 TP14 TP15 TP16 TP25 TP26 TP27 TP28 TP29 TP30 TP31 TP32 TP34 TP35 TP36 TP37 TP38 TP39 TP40 TP41 TP42 TP43 TP44 TP45 TP46 TP47 TP50 TP51 TP52 TP53 TP54 TP55 TP56 TP57 TP58 TP59 TP60 TP61 TP65 TP66 TP67 TP68 TP69 TP70 TP71 TP72 T	NONE	NONE	TEST POINT PAD62H40
68	4	T1 T2 T3 T4	67129600	SCHOTT	TRANSFORMER TH
69	1	U1	74ACT08SC	FAIRCHILD	IC QUAD AND GATE SO14N
70	2	U2 U10	SN74LVC541ADW	TI	IC OCTAL BUFFER SO20-300
71	1	U3	25LC640I-SN	MICROCHIP	IC EEPROM SERIAL SPI 8KX8 SO8N
72	1	U4	24LC128I-SN	MICROCHIP	IC EEPROM I2C SERIAL 16KX8 SO8N





Item	Qty	Reference	MFG_PN	MFG	DESCRIPTION
73	1	U5	CX21AF-12.2880MHZ	CAL CRYSTAL	IC OSCILLATOR 12.2880MHZ 50PPM OSC14
74	4	UX5	8134-HC-5P2	AUGAT	SOCKET PIN P0P-INSM
75	1	U6	MN13821T	PANASONIC	IC VOLTAGE DETECTOR OD 4.4-4.7V SC59A
76	1	U7	EPF10K30AQC240-1	ALTERA	IC FPGA -4 PQFP240
77	1	U8	MC68HC908GP32CFB	MOTOROLA	IC MICROCONTROLLER 32K PQFP44
78	1	U9	EPC2LC20	ALTERA	IC CONFIG EEPROM PLCC20
79	1	UX9	540-99-020-17-40000	MILL-MAX	SOCKET PLCC-20 SMT
80	2	U11 U18	MM74ACT125AD	FAIRCHILD	IC QUAD BUFFER W/ 3-STATE SO14-150
81	3	U12 U13 U14	SN74HCT574DW	TI	IC D-FLOP TRI-STATE OCTAL SO20-300
82	1	U15	AM29F040B-150JC	AMD	IC FLASH 512KX8 150NS 32PLCC
83	1	U16	MAX232CWE	MAXIM	IC RS232 TRANSCEIVER SO16W
84	1	U17	MM74ACT541AD	FAIRCHILD	IC BUFFER OCTAL SO20-300
85	1	U19	LM39401T-3.3	NATIONAL SEMI	IC VREG POSITIVE 3.3V TO220AB
86	1	U20	LT2937ET-2.5	LINEAR TECH	IC VREG POSITIVE 2.5V TO220AB
87	1	U21	LM4811MM	NATIONAL SEMI	IC HEADPHONE AMPLIFIER MSOP-8
88	1	U22	DS8922M	NATIONAL SEMI	IC RS422 DIFFERENTIAL LINE DRIVER SO16-240
89	1	U23	TC74VHC245FT	TOSHIBA	BI-DIR OCTAL BUFFER TRI-STATE TSSOP20
90	1	U24	EVQ-VEMF0224B	PANASONIC	ENCODER ROTARY
91	2	VR2 VR1	3296Y-501	BOURNS	RES POTENTIOMETER 500 25 TURN TOP ADJ TH
92	1	Y1	CM200S32.768KDZFT	CITIZEN	CRYSTAL 32.768 KHZ PARALLEL 12.5PF LOAD
93	8		313-6477-032	E.F. JOHNSON	STAND-OFF .875" HT 1/4 FLAT 4-40 THREAD
94	8		H343-ND	DIGI-KEY	SCREW 4-40 5/16 MACHINE
95	1		UDSP-1B.0		PRINTED CIRCUIT BOARD





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