APOGEE TECHNOLOGY, INC.

EB-5160

DDX 6.1 Channel Evaluation Amplifier

FEATURES

MULTI-CHANNEL DIGITAL AUDIO SOLUTION

- FOR DVD AND CD PLAYERS
- PC AUDIO SYSTEMS
- HOME THEATRE WITH SURROUND
- 6x35W, 1x70W

TYPICAL PERFORMANCE

- THD+N < 0.08% (1W, 1kHz)
- SNR: 89dB (A-weighted)
- 88% EFFICIENT AT 30W

INPUT/OUTPUT

- S/PDIF COAX/OPTICAL (STEREO)
- I^2S INPUT/OUTPUT (6.1 CHANNELS)
- Intel AC`97 LINK INPUT INTERFACE
- SAMPLE RATES FROM 32 TO 96kHz
- STEREO ADC ANALOG INPUT

DIGITAL PREAMP FEATURES

- VOLUME, BALANCE
- BASS, TREBLE
- PARAMETRIC EQ
- ANTICLIPPING, AUTO MUTE
- BASS MANAGEMENT

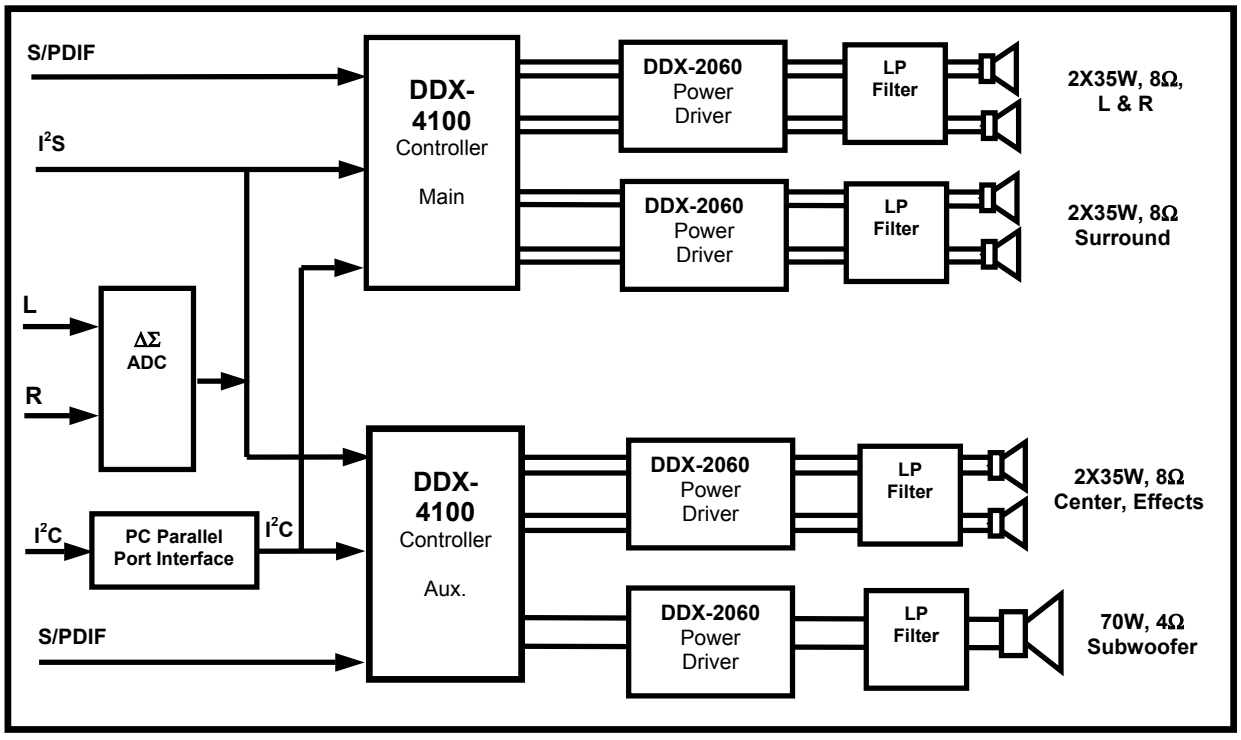
GENERAL DESCRIPTION

The EB-5160 is an evaluation amplifier that showcases Apogee's patented all-digital, high efficiency Direct Digital Amplification (DDX®) technology. The board features two DDX-4100 Controllers and four DDX-2060 Power Devices which provide full digital audio preamplifier functions and power amplification for seven channels. The board includes coaxial and optical S/PDIF interfaces, analog input, digital volume, balance, bass, treble and EQ controls and local power regulation. Automatic fault protection guards the system from excess voltage, current and temperature.

ORDERING INFO

EB-5160 – DDX 6.1 channel evaluation amplifier

EB-5160 BLOCK DIAGRAM



Document # 09010001-03 February 2002

Recommended Operating Conditions [1]

EB-5160

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
VL	Logic Power supply voltage - J4 Terminal block	6.5	7.0	15	V
VB+	H-Bridge Power supply voltage - J2 Terminal block	9	28	30	V
VIH	Logic inputs, High - J5,J6,J9 Headers	2.7		3.6	V
VIL	Logic inputs, Low - J5,J6,J9 Headers			0.65	V
Fs	PCM Input Sample Rate - SRC enabled	32		96	KHz
VinA	Analog Inputs - J20,J22			1.3	Vpk
T_A	Ambient Temperature	0		70	°C

1. Performance not guaranteed beyond recommended operating conditions.

Electrical Characteristics [2]

Refer to circuit Sheets 1-10. VB+=28V, f=1kHz, TA=25C, RL=8Ω, and measurement bandwidth 20kHz.

SYMBOL	PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
Po	Output power - L, C, R, LS, RS, E	THD+N <1%		33		Wrms
	Output power - SUB	THD+N <1%, RL=4 Ω		65		Wrms
$VB+_{TH}$	Over voltage Protection Threshold		30	35		V
$VB+_{TL}$	Under voltage Protection Threshold			7	9	V
I_L	VL supply current - J4 Power	VL= +7.0V	250	440	550	mA
I_{B+}	VB+ supply current in Powerdown	SW2 POS3, 4,5,6 closed.		3	5	mA
	VB+ quiescent current	Damped State (Muted) SW2 POS3, 4,5,6 open.		105		mA
	VB+ supply current - J2 Power	7-Chan. switching at 384KHz. Dither signal applied at J6		281		mA
		All channels driven to full scale output			12	A
I_{SCO}	Short circuit output current limit	L, C, R, LS, RS, E Outputs	3.0	5.0	6.5	A
		SUB Output	6.0	10	13	A
THD+N	Total Harmonic Distortion + Noise	Po=1.0 Wrms Po= 33 Wrms		.08 .31	.20 .55	%
SNR	Signal-to-Noise Ratio, all channels	A-weighted		89		dB
η	Efficiency (Single DDX-2060 driven), VB+ Supply only	Po=2 x 33W		88		%
CX	Output Channel Cross Talk, (all VB+ supplies linked)	Left output at -6 db FS: To Right channel To other channels		 -74 -80		 dB dB

2. Characteristics are for the DDX-2060 power device driven by DDX-4100 processor.

EB-5160 OVERVIEW

The EB-5160 is an all-digital audio amplifier evaluation board that demonstrates the application of Apogee's DDX-4100/2060 chip set to multi-channel audio.

HARDWARE DESCRIPTION

The EB-5160 amplifier consists of up to 7 channels of audio amplification rated at 6x35W + 1x70W. There are two DDX-4100 processing ICs and four DDX-2060 power devices on this board. The system may be configured for 2.1, 4.1, 5.1, and 6.1 channels. The default board setup is 5.1 channels. The EB-5160 is shipped with jumpers placed to configure the board for two Analog inputs, sent to all channels. Figure 12 shows the physical location of connectors and configuration switches and jumpers.

A Graphical User's Interface (GUI) is included with the board. The GUI communicates I^2C serial information through the PC's parallel port in accordance with the protocol detailed in section 11 of the DDX-4100 datasheet. Additional control and status bits are sent and monitored via the parallel port as well. Once configured(SW2: POS2 closed, see Fig. 12), the parallel port connector can be removed without causing settings to change. The hardware circuit is described on Sheet 8 of the schematic and consists of a DB25 connector and with a one to one pin mapping from the PC's parallel port and several inverting buffers to send and receive information.

DDX-4100 OVERVIEW

The DDX-4100 Controller is a 3.3V digital integrated circuit that converts serial PCM digital audio signals into PWM drive signals. These PWM signals are then amplified by the DDX-2060 for audio output. The device supports volume, bass, treble, 4 biquad EQ stages, muting and anti-clipping functions under I^2C control. A block diagram of the device is shown in Figure 1.

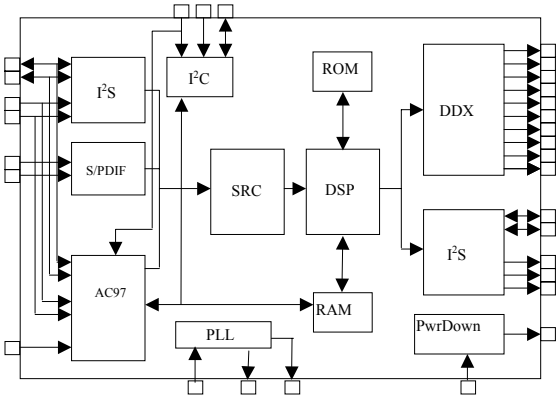


Figure 1 - DDX-4100 Block Diagram

DDX-2060 OVERVIEW

The DDX-2060 Power Device is a dual channel H-Bridge that can deliver over 35 watts per channel of audio output power. The DDX-2060 includes a logic interface, integrated bridge drivers, high efficiency MOSFET outputs and protection circuitry. Two logic level signals per channel are used to control high-speed MOSFET switches to connect the speaker load to the input supply or to ground in a bridge configuration, according to Apogee's patented damped ternary PWM. The DDX-2060 includes over-current, thermal, and over-voltage protection and under-voltage lockout with automatic recovery. A thermal warning status is also provided.

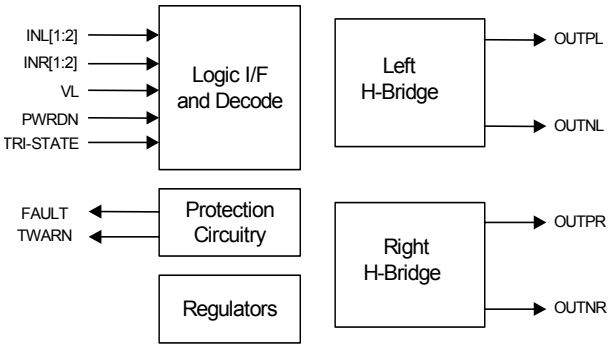


Figure 2 - DDX-2060 Block Diagram

SCHEMATIC DESCRIPTION

S/PDIF INPUT INTERFACE (Sheets 2 and 3)

Each of the two DDX-4100 controllers has a direct S/PDIF connection available. The EB-5160x accommodates either coaxial or optical S/PDIF digital audio interfaces. Either input may be selected by moving jumper J8 or J11. Connect pins 1-2 for optical or pins 2-3 for coaxial S/PDIF. The DDX-4100 will support sample rates from 32kHz to 96kHz, with an internal sample rate converter (SRC).

ANALOG INPUTS (Sheet 9)

Stereo analog inputs can be brought through RCA connectors J20(Left) and J22(Right). These signals are converted to digital by analog to digital converter U15, and may be jumper connected to any I^2S data signal.

DIGITAL SIGNAL PROCESSING (Sheets 2 and 3)

The DDX-4100 converts pulse code modulated, PCM, digital audio input signals into pulse-width-modulated, PWM, digital output signals. As supplied, the EB-5160 is configured to use the internal sample rate converter, SRC, in the DDX-4100. When the SRC is enabled all PCM input sample rates are converted to a fixed PWM output rate determined by the clock frequency applied to the XTI input. The EB-5160 is configured with a 24.576MHz crystal, which corresponds with a PWM output rate of 384KHz, or an effective sample rate of 48KHz. SRC bypass is provided for applications that supply a synchronous master clock derived from the PCM data source. As with all digital audio systems synchronous clocking should be used for the highest quality output. Refer to the DDX-4100 datasheet for more information on the SRC. Signals from I^2S or the S/PDIF receiver are applied as inputs to the DDX processor. Output PWM signals from the DDX processor are applied to the inputs of the DDX power stage.

The DDX-4100 has independent volume control registers that have an adjustment range from 0dB to -111dB in 1.5 dB increments. Tone control registers boost or cut the treble and bass by 12dB, in 2dB steps. EQ filters are IIR biquads configurable by programmable coefficients. The DDX-4100 Filter Editor program is provided to simplify generation of the filter coefficients.

MCU

An expansion provision is available for an MCU control interface. A PIC16 microcontroller with a multi-input ADC is installed at position U1(Sheet 10) to implement a master volume control as well as three volume controls; one for left, center and right, one for surround channels, and one for the subwoofer. These levels are adjusted using four on-board potentiometers. The DC voltages set by the potentiometers are read by the microcontroller interfaced to the I^2C input of the DDX-4100. For MCU control, make sure J19, pins 3 and 5 are shorted, and pins 4 and 6 are shorted, and J24 pins 2 and 3 are shorted. Refer to Sheet 8 of the Schematic.
Expansion Header J1 controls I^2S or S/PDIF input selection. Shorting J1, pins 1 and 2 selects S/PDIF input. Removing the short selects I^2S. Additional pins on J1 are provided for custom interface development.

POWER OUTPUT (Sheets 4 to 7)

The DDX-2060 provides power amplification by translating logic level PWM signals into power level signals. These power level signals are applied to a passive two-pole lowpass filter to reconstruct the audio signal providing power to the load. The output filter functions to prevent unwanted switching frequency signals from reaching the load. A filter design for 8ohm loads is shown on Sheets 4 to 6 of the schematic for reference.

The DDX-2060 is designed for stereo operation as either two independent full-bridges or for mono operation as one full-bridge with twice the current capability, enabling higher output power. The EB-5160 demonstrates both configurations. Sheet 7 shows the mono 70W at 4ohm configuration, for the subwoofer output.

Peak voltage on the DDX-2060 output and power pins must not exceed 40V. Snubbers are employed to protect the output MOSFETs from inductive transients, which can reach levels higher than the supply voltage. Output snubbers for the stereo implementation are R29 & C73 and R37 & C86 on Sheet 4 and the snubber for the mono implementation is R14/74 & C153 on Sheet 7.

A thermal warning indicator is activated by the DDX-2060 if the junction temperature exceeds 130°C. The thermal warning output is used to force the overtemperature LEDs (D5-D8 on Sheets 4 to 7) to change color from green to red. If Autoprotect is enabled, the overheating chip's channels will mute. The DDX-2060 shuts down when it reaches 150°C.

SUPPLY VOLTAGE, REGULATORS (Sheet 1)

The EB-5160 features local power regulation for logic supplies. Separate inputs are available for logic supply as well as each of the four output power sections. This offers flexibility to run different speaker sets on different supply levels. All four power output supplies come strapped together with jumpers JP1-JP6 from the factory. These must be removed if more than one output power stage supply is to be used.

Input protection is provided for the amplifier by diodes D1-D4. These diodes will protect from overvoltage and reverse power connection.

Supervisor U2 is used for power-on-reset and power-off sequencing.

HEADERS (Sheets 2 and 3)

Headers J5 and J9 are PWM and I^2S outputs. They facilitate monitoring and debug. J6 has the I^2S/AC'97 inputs for multi-channel operation. AC'97 and I^2S are the only input interfaces that support 4.1, 5.1 and 6.1 channel operation.

SWITCHES

Momentary pushbutton SW1 provides a global RESET signal. DIP switch SW2 has six switches. SW2: POS2 open selects AC'97, closed selects I^2S input mode. Switches 3 thru 6 enable the four power outputs (Surround R/L, Front R/L, SUBW, and EFFECTS/CENTER) when in Open position. Default settings are positions 1 and 2 Closed and 3 through 6 Open. Refer to Demo Board Setup for operation.

POWER-UP, POWER-DOWN

Applying Logic Power, VL, then Output Power, VB+, is the preferred power on sequence. Removing VB+ then VL is the preferred power off sequence.

ADDITIONAL INFORMATION

BILL of MATERIALS

A bill of materials for the evaluation board is provided in Table 1 for reference. Note equivalent components from alternate manufacturers may be substituted. No warranty of system performance or fitness for use is implied by Apogee through use of the reference bill of materials.

PERFORMANCE MEASUREMENTS

Class D amplifiers produce measurable switching noise outside the audio bandwidth. Apogee's DDX amplifier uses a patented PWM modulation scheme that significantly reduces the size of these products compared to typical Class D designs. However, in order to obtain accurate performance measurements in the audio band (i.e., 20Hz to 20kHz), additional filtering is required.

The Typical Performance data in was taken using a AES17 brick wall filter with a break frequency of 20kHz. This type of filter is often provided as part of audio measurement systems.

Typical performance measurements for the evaluation board are shown in Figures 4 through 7.

ALTERNATE CONFIGURATIONS

6.1 Channel Configuration & Operation

To reconfigure the board for 7 discrete channels (6.1) operation, remove R23, near U7, pin 1. (See Sheet 3). Digital audio comes in through I^2S.

4.1, 2.1 Channel Configuration & Operation

For bass redirection via 'Main' processor to SUBW channel, R79 and R81 must be removed. Zero-ohm jumpers must be installed in R78 and R80. These are found between J6 and LED D8 (see Sheet 7). Digital audio can be delivered on I^2S for 4.1 channels, or S/PDIF for 2.1 channels. For 4.1 channels on S/PDIF, two stereo S/PDIF inputs must be used. Main and Aux controllers each provide two channels, and the Main controller can redirect the bass signal to a Subwoofer. This can be set up with the GUI.

DEMO BOARD SETUP

This procedure contains three methods for configuring the production release EB-5160 RevC Demo Board. Please refer to the EB-5160 Datasheet or schematic and assembly drawing when using this procedure.

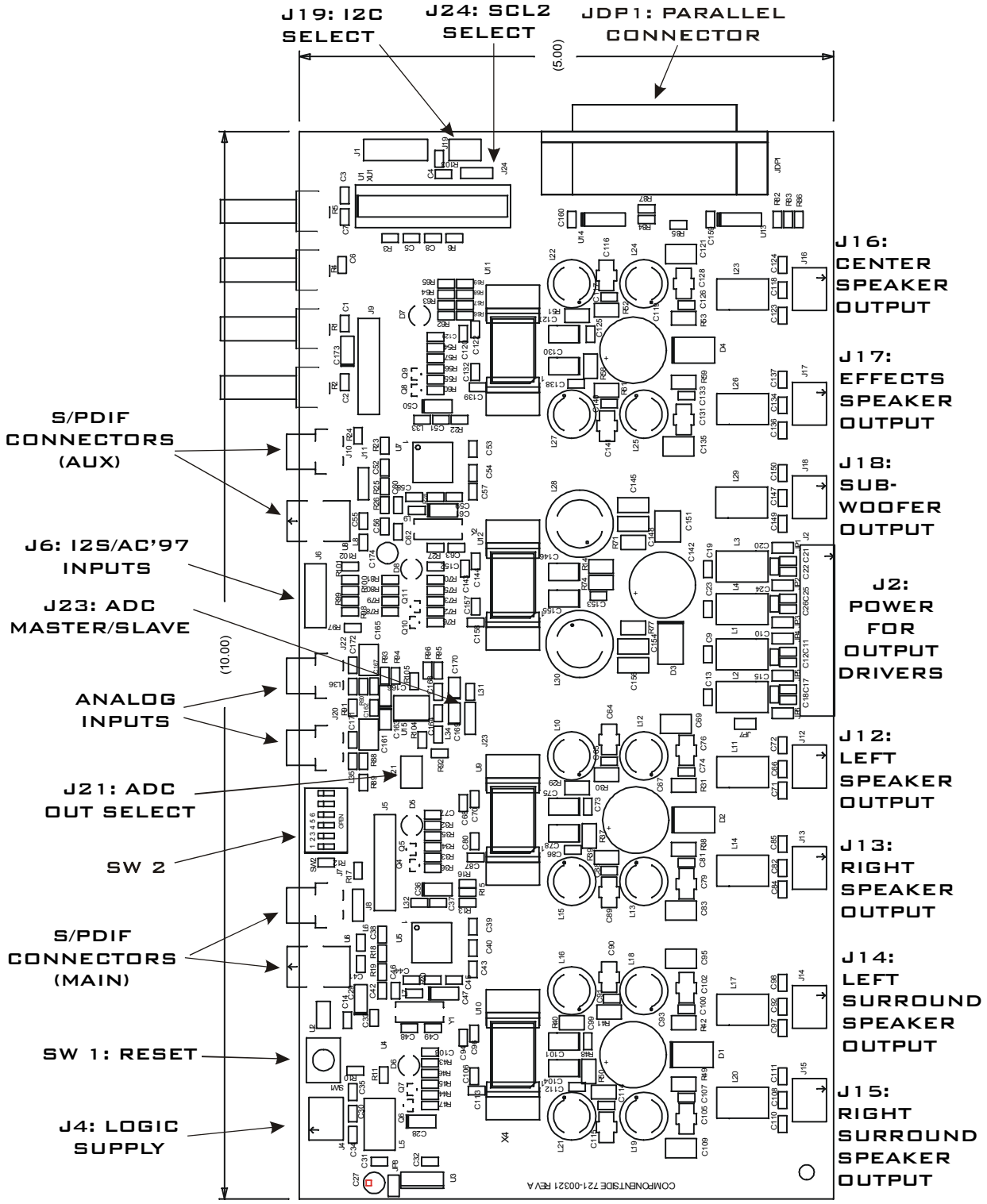
Described below are three methods for configuring the demonstration board.

1. The first method is 5.1 discrete channels of operation using the I^2S serial input interface. The demonstration board must be connected to the I^2S outputs of an AC3 decoder IC, e.g. the STA310. This method is most appropriate for testing in a laboratory setting.

2. The second method is stereo operation using the analog interface. The serial digital output of the ADC can be tied to any stereo pair or operate all of the channels. This method is the simplest setup for demonstration purposes.

3. The third method is 2.1 channels of operation using the S/PDIF digital inputs. The S/PDIF input labeled ***"Main"*** either coaxial or optical input applies for the primary L,R channels. The S/PDIF input labeled ***"Aux"*** is for the subwoofer channel. This method is most appropriate for demonstrating true digital operation from a convenient digital source.

FIGURE 12 - DDX EVALUATION AMPLIFIER ASSEMBLY DRAWING



Configure EB-5160 for 5.1 Channel operation using I^2S serial digital input:

1. Jumper Selection
   - J19 pins 1-3 and 2-4 shorted and J24 pins 1-2 shorted. (PC operation)
   - J21 pins open. Must remove all shorting jumpers.
   - J23 pins 2-3 shorted (ADC slave mode)
2. Dip Switch Selection
   - Switch SW1 & SW2 in *Closed* position
   - Switches 3 – 6 control which output stage is on (*Open* = on)
     - SW3 controls U10 (SL, SR)
     - SW4 controls U9 (L, R)
     - SW5 controls U12 (Sub) {4 Ohm}
     - SW6 controls U11 (C, E) {Effects channel for an 8 Ohm Sub.}
3. Connecting to a computer
   - Using the supplied parallel cable, connect JDP1 to the parallel port on your computer.
4. Power connections
   - Connect a 7 Volt DC power supply to J4 (logic power)
     - Negative connection is next to the bump on the terminal block. Positive connection has square pad on solder side of PCB.
   - Connect a 28 Volt DC power supply to J2 (output power) {9V to 30V DC power supply is OK. Board requires 28V for rated output power.}
     - Facing J2, the negative power connection is next to the bump on the terminal block with a positive connection next and then repeating in pairs of two (- +, - +, - +, - +). Power can be applied to any of the terminal pairs. The square pad on the solder side of the PCB is the positive connection on the first power pair.
5. I^2S Digital Input connections
   - Connect I^2S signals from an AC3 decoder IC or test equipment at J6. The board defaults to the I^2S serial protocol. See the DDX4100 datasheet for details.
     - Refer to schematic page 3 for connections. {L,R data to pin 1, LS,RS data to pin 3, C,Sub to pin 5,7, LRCK to pin 9, BCK to pin 11. GND to pins 2,4,6,8,10,12.} Do not exceed +3.3V levels on any of these signals. Also, signals should remain static {logic low level} until the board is configured to operate.
6. Speaker connections
   - Connect 8 Ohm speakers and a 4 Ohm subwoofer {recommended}.
     - L,R,LS,RS,C outputs at J12, J13, J14, J15, J16 terminal blocks.
     - Connect an 8 Ohm subwoofer to the Effects output at J17 or a 4 Ohm subwoofer to the Sub output at J18. Both may be connected as well.
     - Negative speaker connections are next to the bumps on the terminal blocks. Positive speaker connections are at the square pads on the solder side of the PCB.
7. Configuring GUI
   - Run the EB5160 Control Panel (EB-5160.exe)
   - Apply power to logic J4 (+7V) and to output J2 (+28V)
   - Go to "Registers" page.
   - On "Registers" page under 'HW Reset/PWDN' **press** the ***Reset*** button.
   - On "Registers" page under 'I/O Test' **press** the ***Test*** button. The control panel should report "***Main Passed, Aux Passed***" indicating proper I2C communication with both IC's.
   - On "Settings" page, uncheck ***DDX Reset*** under the 'Commands' section.
   - On "Settings" page press ***Turn ON*** under the 'Commands' section.
   - On "Settings" page uncheck ***Mute All*** under the 'Controls' section.
   - Volume sliders L,R,LS,RS channels control outputs from the *Main IC* {U5}. Volume sliders CNT,EFX,LFE control outputs from the *Aux IC* {U7} or the *Main IC*{U5}.
   - Tone sliders control L,R channel outputs and the Selected {U7-L or U7-R} output.

Apogee EB-5160 Demo Board is now ready to operate!

Configure EB-5160 for Two Channel operation using Analog :

1. Jumper Selection
   - J19 pins 1-3 and 2-4 shorted and J24 pins 1-2 shorted. (PC operation)
   - J21 pins as follows:
     - Pins 1-2 shorted applies stereo data to L,R channels.
     - Pins 3-4 shorted applies stereo data to LS,RS channels.
     - Pins 5-6 shorted applies stereo data to C,E,Sub channels.
     - Pins 1-2, 3-4, 5-6 shorted applies stereo data to all channels.
   - J23 pins 1-2 shorted (ADC master mode)
2. Dip Switch Selection
   - Switch SW1 & SW2 in *Closed* position
   - Switches 3 – 6 control which output stage is on (*Open* = on)
     - SW3 controls U10 (SL, SR)
     - SW4 controls U9 (L, R)
     - SW5 controls U12 (Sub) {4 Ohm}
     - SW6 controls U11 (C, E) {Effects channel for an 8 Ohm Sub.}
3. Connecting to a computer
   - Using the supplied parallel cable, connect JDP1 to the parallel port on your computer.
4. Power connections
   - Connect a 7 Volt DC power supply to J4 (logic power)
     - Negative connection is next to the bump on the terminal block. Positive connection has square pad on solder side of PCB.
     - Connect a 28 Volt DC power supply to J2 (output power) {9V to 30V on the terminal block with a positive connection next and then repeating in pairs of two (- +, - +, - +, - +). Power can be applied to any of the terminal pairs. The square pad on the solder side of the PCB is the positive connection on the first power pair.
5. Analog Input connections
   - Connect an analog source to RCA connectors J20 {Left} and J22 {Right}. Note, analog signals above 1.3V peak will saturate the ADC inputs. Disconnect signals from the J6 header {I2S/AC97 inputs} to prevent signal contention.
6. Speaker connections
   - Connect 8 Ohm speakers and a 4 Ohm subwoofer {recommended}.
     - L,R,LS,RS,C outputs at J12,J13,J14,J15,J16 terminal blocks.
     - Connect an 8 Ohm subwoofer to the Effects output at J17 or a 4 Ohm subwoofer to the Sub output at J18. Both are OK.
     - Negative speaker connections are next to the bumps on the terminal blocks. Positive speaker connections are at the square pads on the solder side of the PCB.
7. Configuring GUI
   - Run the EB5160 Control Panel (EB-5160.exe)
   - Apply power to logic J4 (+7V) and to output J2 (+28V)
   - Go to "Registers" page.
   - On "Registers" page under 'HW Reset/PWDN' **press** the ***Reset*** button.
   - On "Registers" page under 'I/O Test' **press** the ***Test*** button. The control panel should report "***Main Passed, Aux Passed***" indicating proper I2C communication with both IC's.
   - On "Settings" page, uncheck ***DDX Reset*** under the 'Commands' section.
   - On "Settings" page press ***Turn ON*** under the 'Commands' section.
   - On "Settings" page uncheck ***Mute All*** under the 'Controls' section.
   - Volume sliders L,R,LS,RS channels control outputs from the *Main IC* {U5}. Volume sliders CNT,EFX,LFE control outputs from the *Aux IC* {U7} or the *Main IC*{U5}.
   - Tone sliders control L,R channel outputs and the Selected {U7-L or U7-R} output.

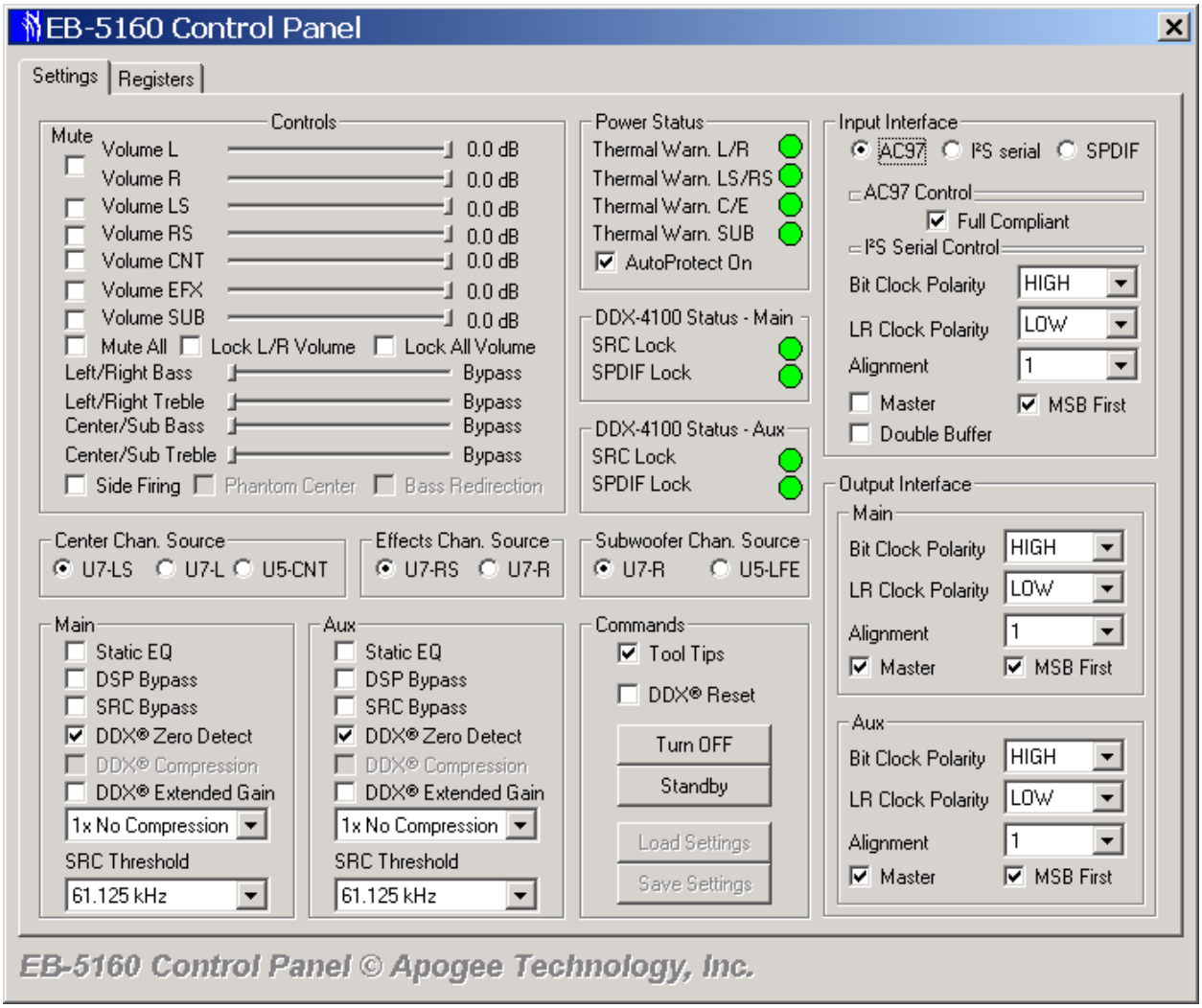
Apogee EB-5160 Demo Board is now ready to operate!

Configure EB-5160 for 2.1 Channels operation using S/PDIF inputs

1. Jumper Selection
   - J8 selects either optical (U6) or coaxial (J7) inputs for the main processor (U5).
     - Pins 1-2 shorted for coaxial
     - Pins 2-3 shorted for optical
   - J11 selects either optical (U8) or coaxial (J10) inputs for the auxiliary processor (U7).
     - Pins 1-2 shorted for coaxial
     - Pins 2-3 shorted for optical
   - J19 pins 1-3 and 2-4 shorted and J24 pins 1-2 shorted. (PC operation)
2. Dip Switch Selection
   - Switch SW1 & SW2 in *Closed* position
   - Switches 3 – 6 control which output stage is on (*Open* = on)
     - SW3 controls U10 (SL, SR)
     - SW4 controls U9 (L, R)
     - SW5 controls U12 (Sub) {4 Ohm}
     - SW6 controls U11 (C, E) {Effects channel for an 8 Ohm Sub.}
3. Connecting to a computer
   - Using the supplied parallel cable, connect JDP1 to the parallel port on your computer.
4. Power connections
   - Connect a 7 Volt DC power supply to J4 (logic power)
     - Negative connection is next to the bump on the terminal block. Positive connection has square pad on solder side of PCB.
   - Connect a 28 Volt DC power supply to J2 (output power) {9V to 30V DC power supply is OK. Board requires 28V for rated output power.}
     - Facing J2, the negative power connection is next to the bump on the terminal block with a positive connection next and then repeating in pairs of two (- +, - +, - +, - +). Power can be applied to any of the terminal pairs. The square pad on the solder side of the PCB is the positive connection on the first power pair.
5. S/PDIF Input connections
   - Connect an **S/PDIF PCM** (not AC3) digital source {L,R}either coaxial or optical at J7 or U6 for the ***Main IC*** {U5} and/or another {C,Sub} at J10 or U8 for the ***Aux IC*** {U7}. Select the appropriate jumper connections from above.
6. Speaker connections
   - Connect 8 Ohm speakers and a 4 Ohm subwoofer.
     - L,R outputs at J12,J13 terminal blocks.
     - Connect a 4 Ohm subwoofer to the Sub output at J18
     - Negative speaker connections are next to the bumps on the terminal blocks. Positive speaker connections are at the square pads on the solder side of the PCB.
7. Configuring GUI
   - Run the EB5160 Control Panel (EB-5160.exe)
   - Apply power to logic J4 (+7V) and to output J2 (+28V)
   - Go to "Registers" page.
   - On "Registers" page under 'HW Reset/PWDN' **press** the ***Reset*** button.
   - On "Registers" page under 'I/O Test' **press** the ***Test*** button. The control panel should report "***Main Passed, Aux Passed***" indicating proper I2C communication with both IC's.
   - Go to "Settings" page.
   - On "Settings" page, under 'Input Interface' section, **select** the **S/PDIF** option.
   - On "Settings" page, uncheck ***DDX Reset*** under the 'Commands' section.
   - On "Settings" page press ***Turn ON*** under the 'Commands' section.
   - On "Settings" page uncheck ***Mute All*** under the 'Controls' section.
   - Volume sliders L,R control outputs from the *Main IC* {U5}. Volume slider LFE controls output from the *Aux IC* {U7} or the *Main IC*{U5}. S/PDIF input applies only to the L,R channels on the ***Main IC*** and R {Sub} channel on the ***Aux IC***.
   - Tone sliders control L,R channel outputs and the Selected {U7-L or U7-R} output.

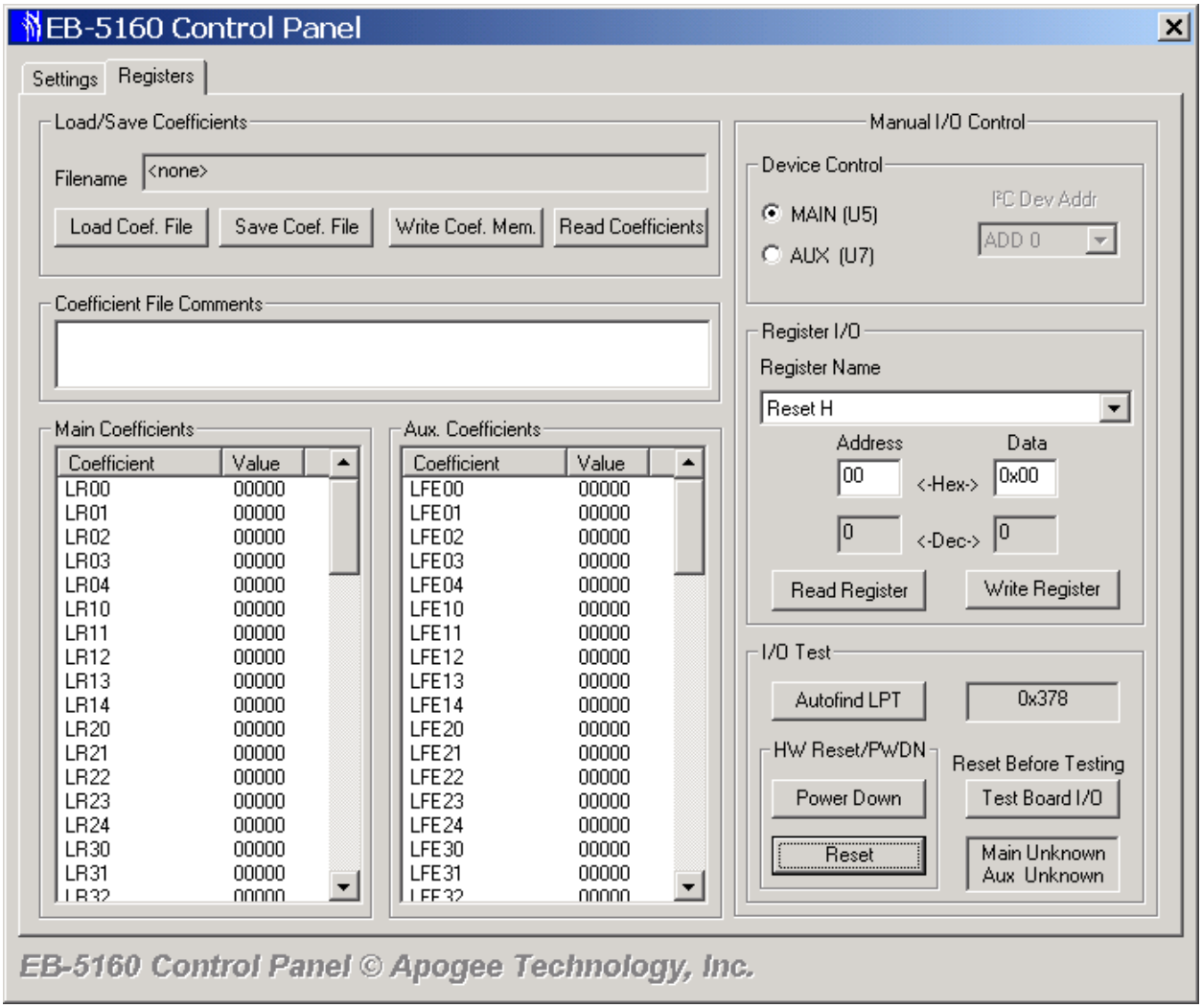
Apogee EB-5160 Demo Board is now ready to operate!

GUI: Settings Page



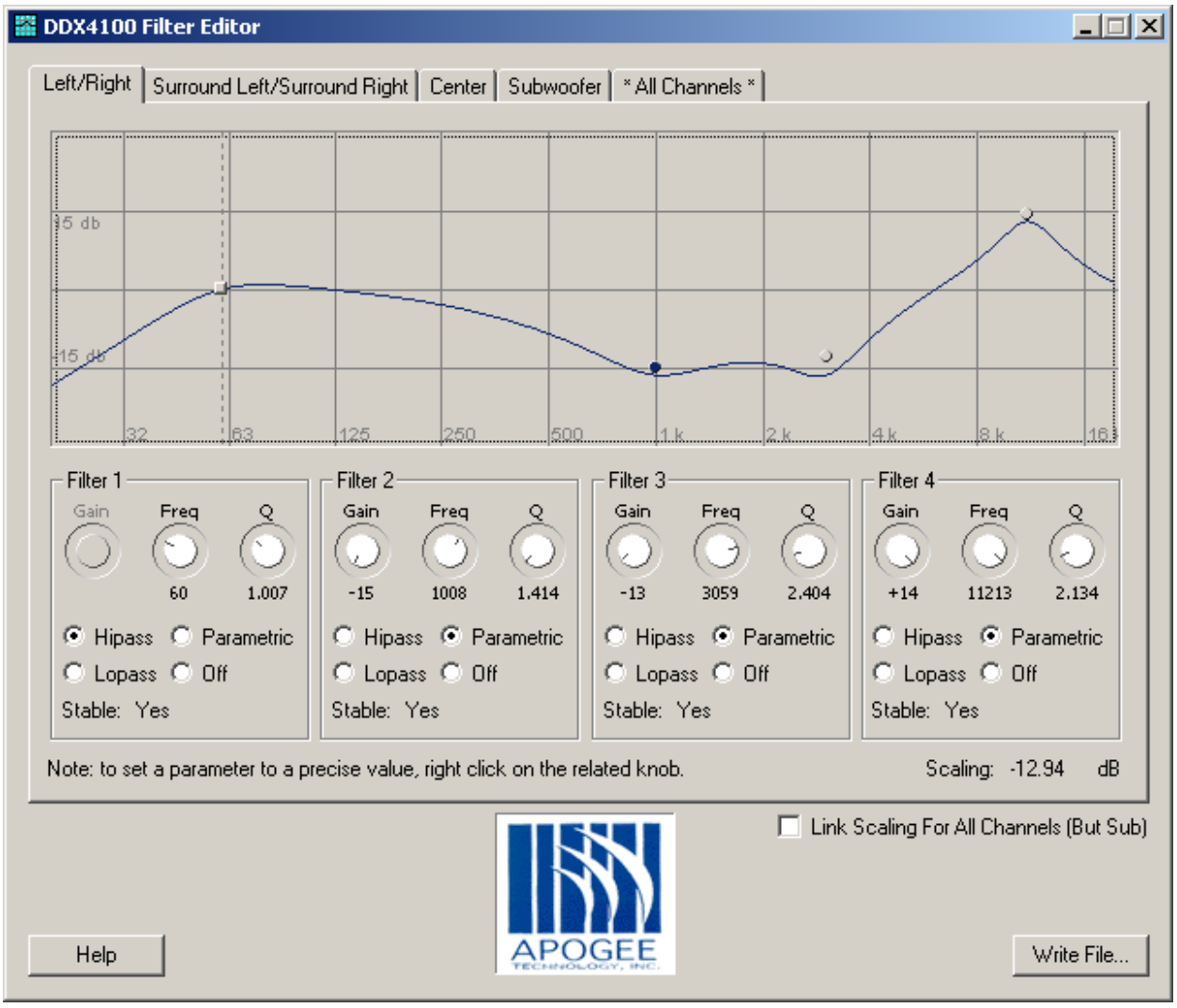
"Tool Tips" automatically display the function of each control. For instance, if you position the cursor over "SRC Bypass" in the Main area (lower left), the tip will display: **SRC Block Bypassed, Input Directly Connected to DSP.**

GUI: Registers Page



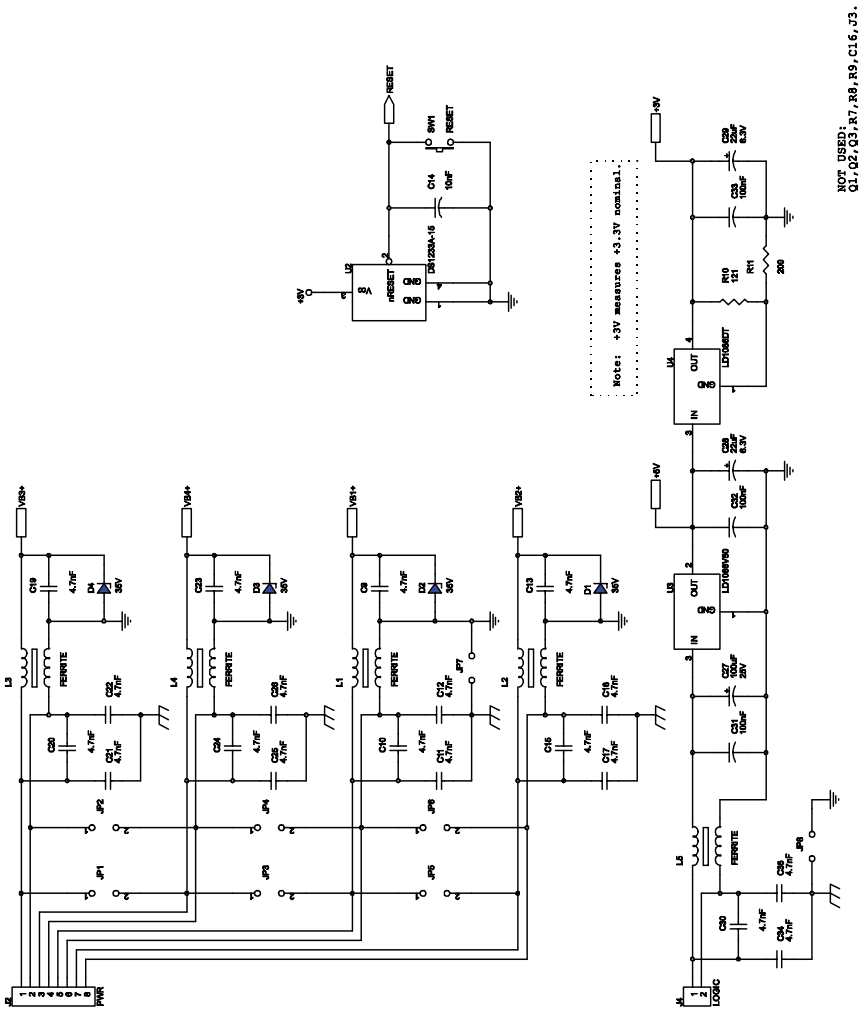
DDX-4100 registers can be written or read from the **Registers** window. **Load/Save Coefficients** handles the EQ Coefficients File (see next page). Main and Aux Coefficients display the EQ Filter coefficients. **Manual I/O Control** lets users read and write to individual, named registers.

FILTER EDITOR

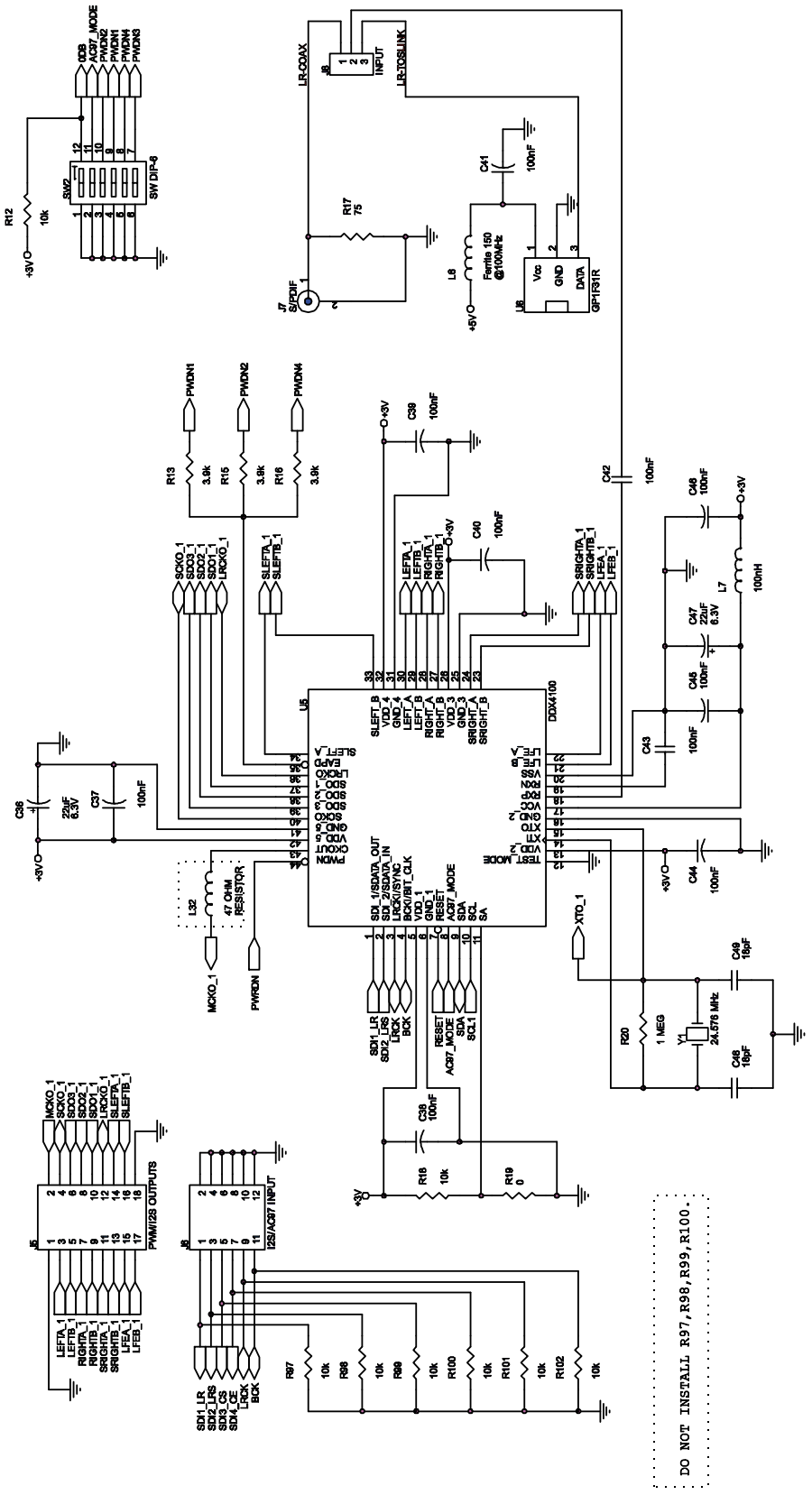


Create filters by right-clicking mouse to add points, then drag points with mouse, or by selecting type of filter, clicking on knob and moving mouse up or down. When filter is complete, click "Write File…". This file is used by the GUI to write EQ filter coefficients into DDX-4100 chips on the EB-5160.

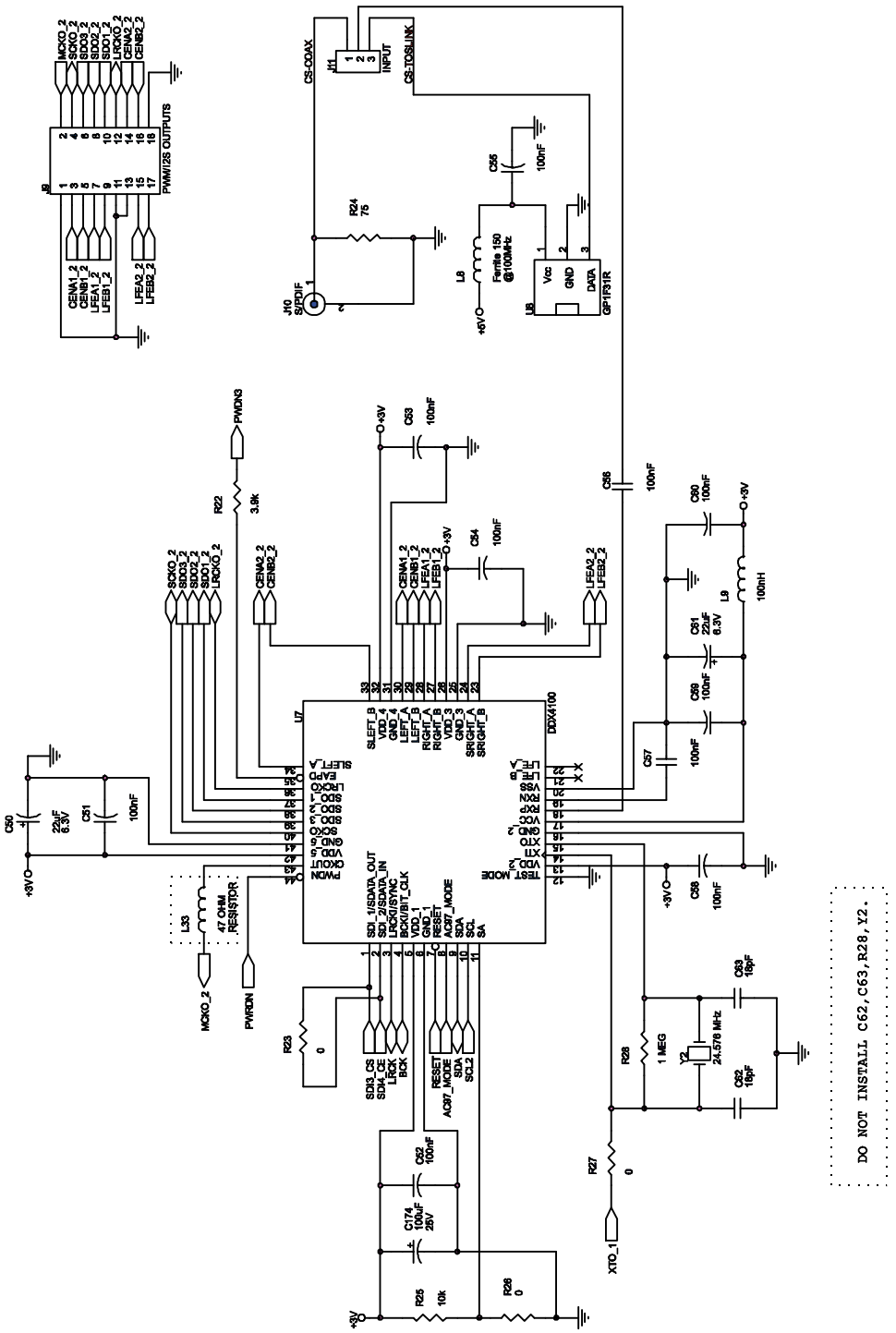
SHEET 1: REGULATORS AND FILTERS



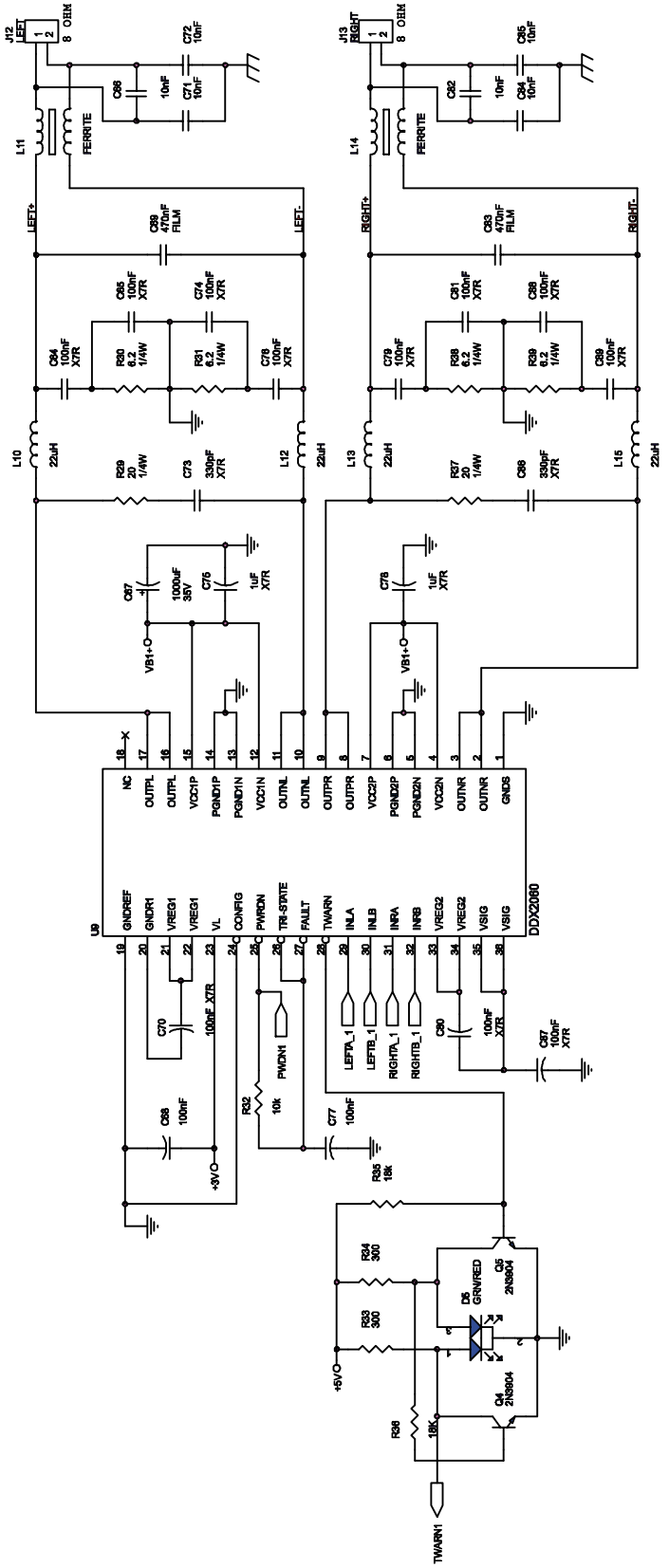
SHEET 2: DDX-4100 MAIN PROCESSOR



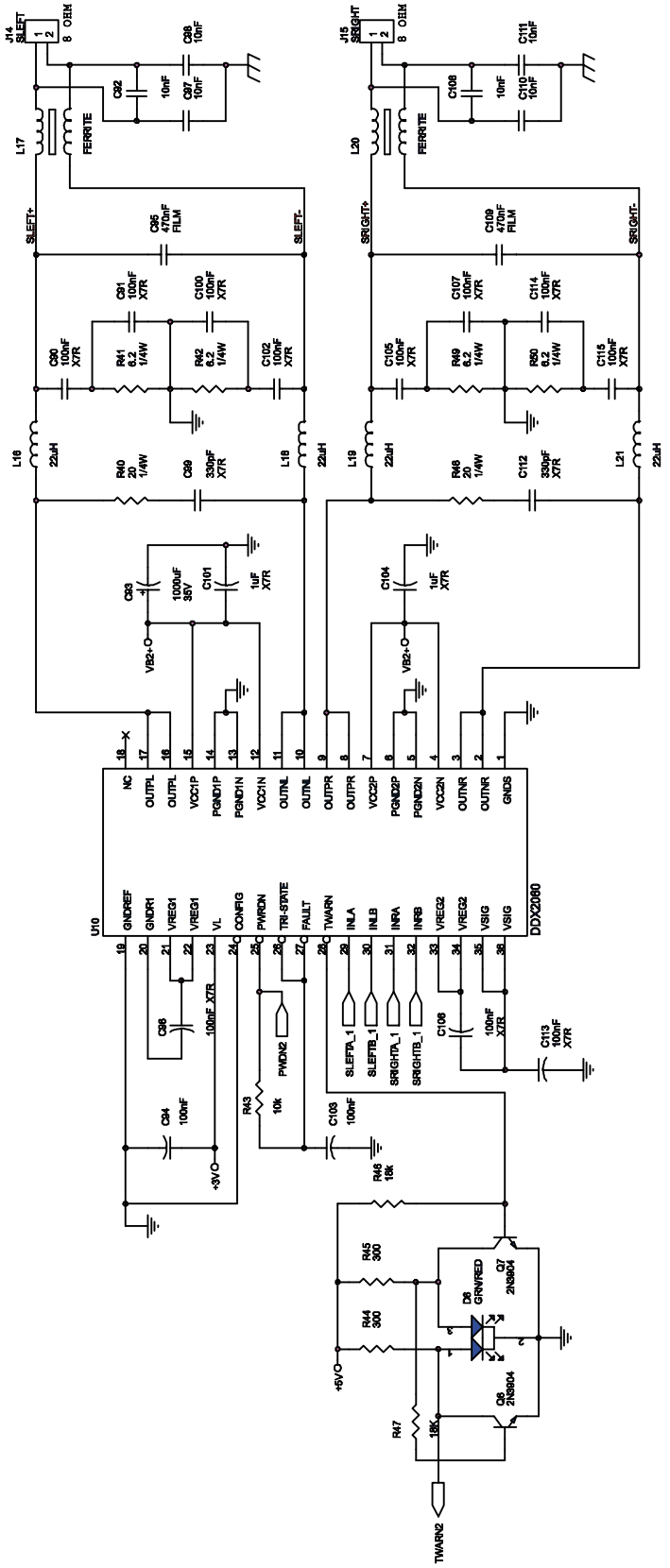
SHEET 3: DDX-4100 AUX PROCESSOR



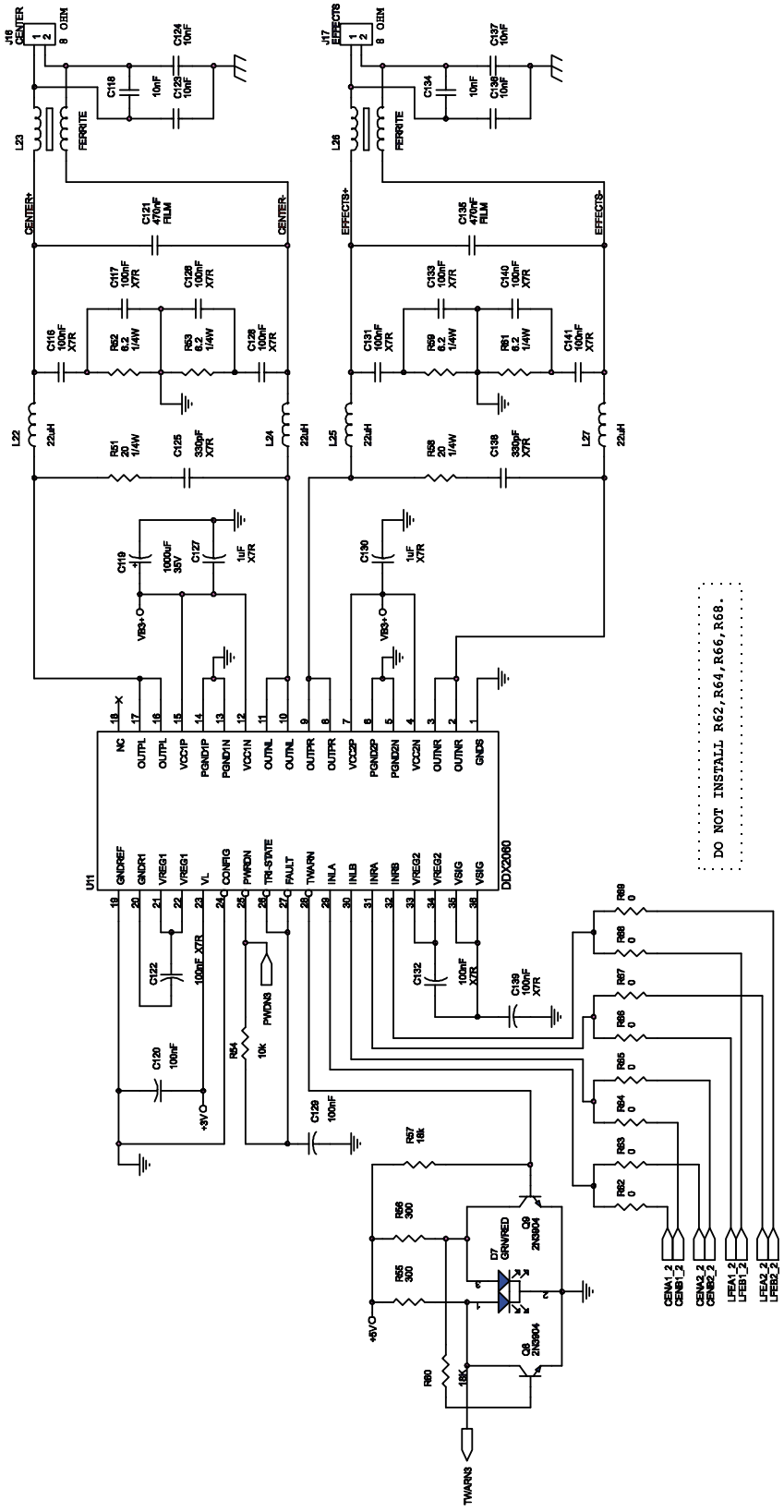
SHEET 4: L & R OUTPUTS



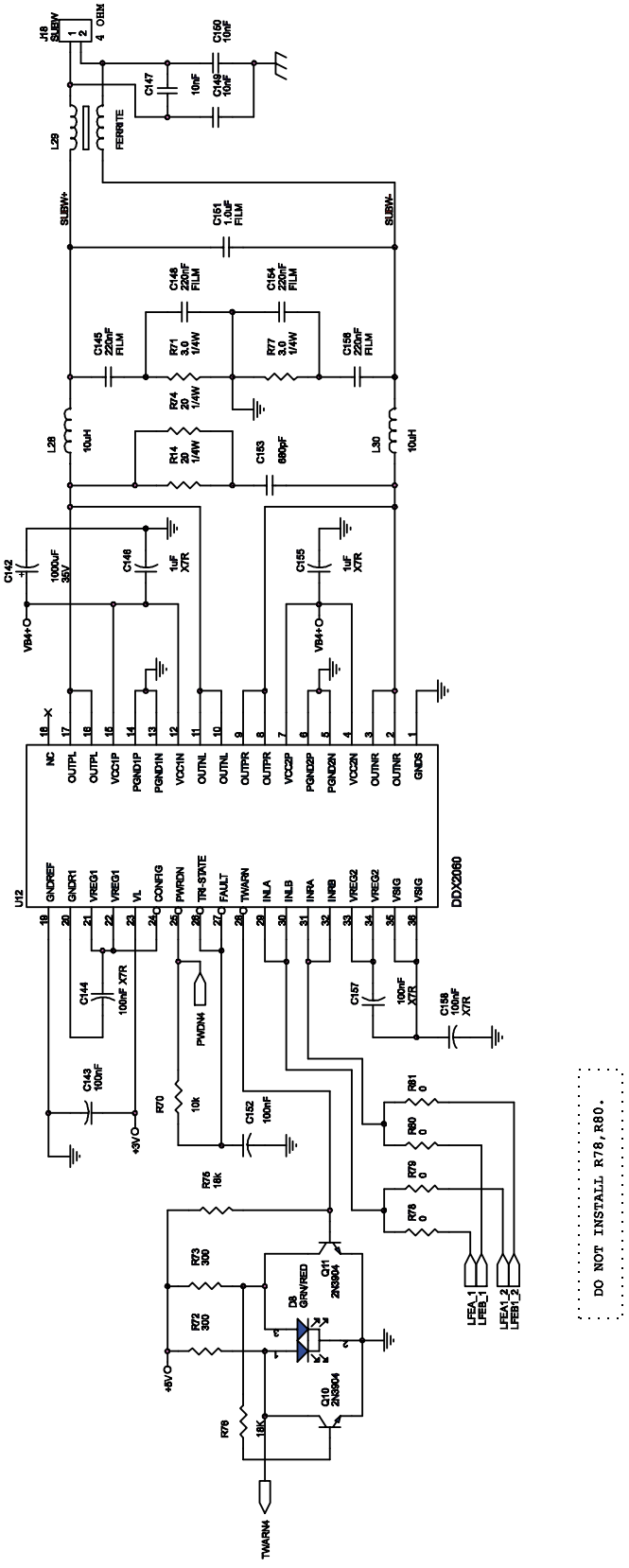
SHEET 5: LS & RS OUTPUTS



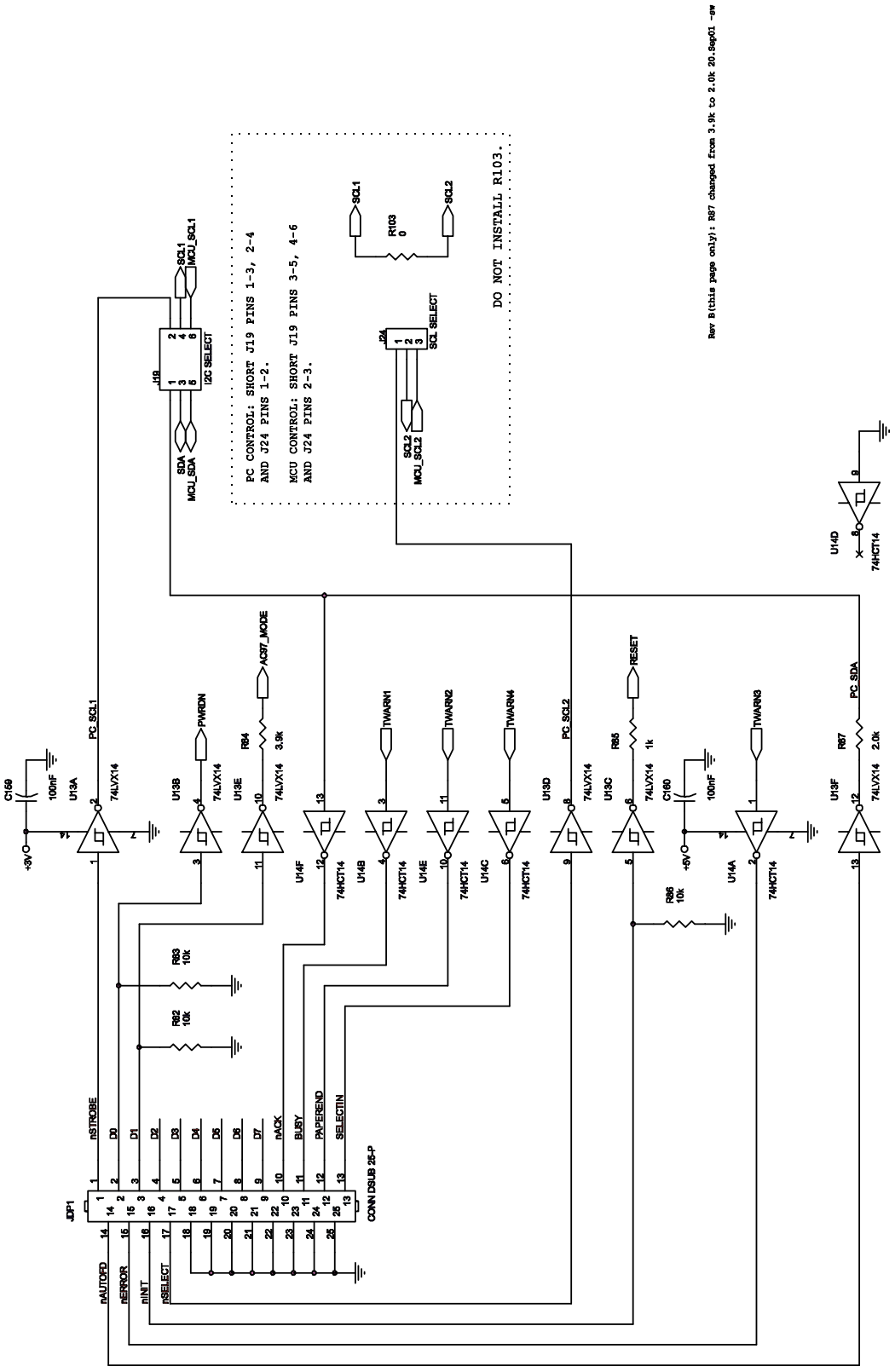
SHEET 6: C & E OUTPUTS



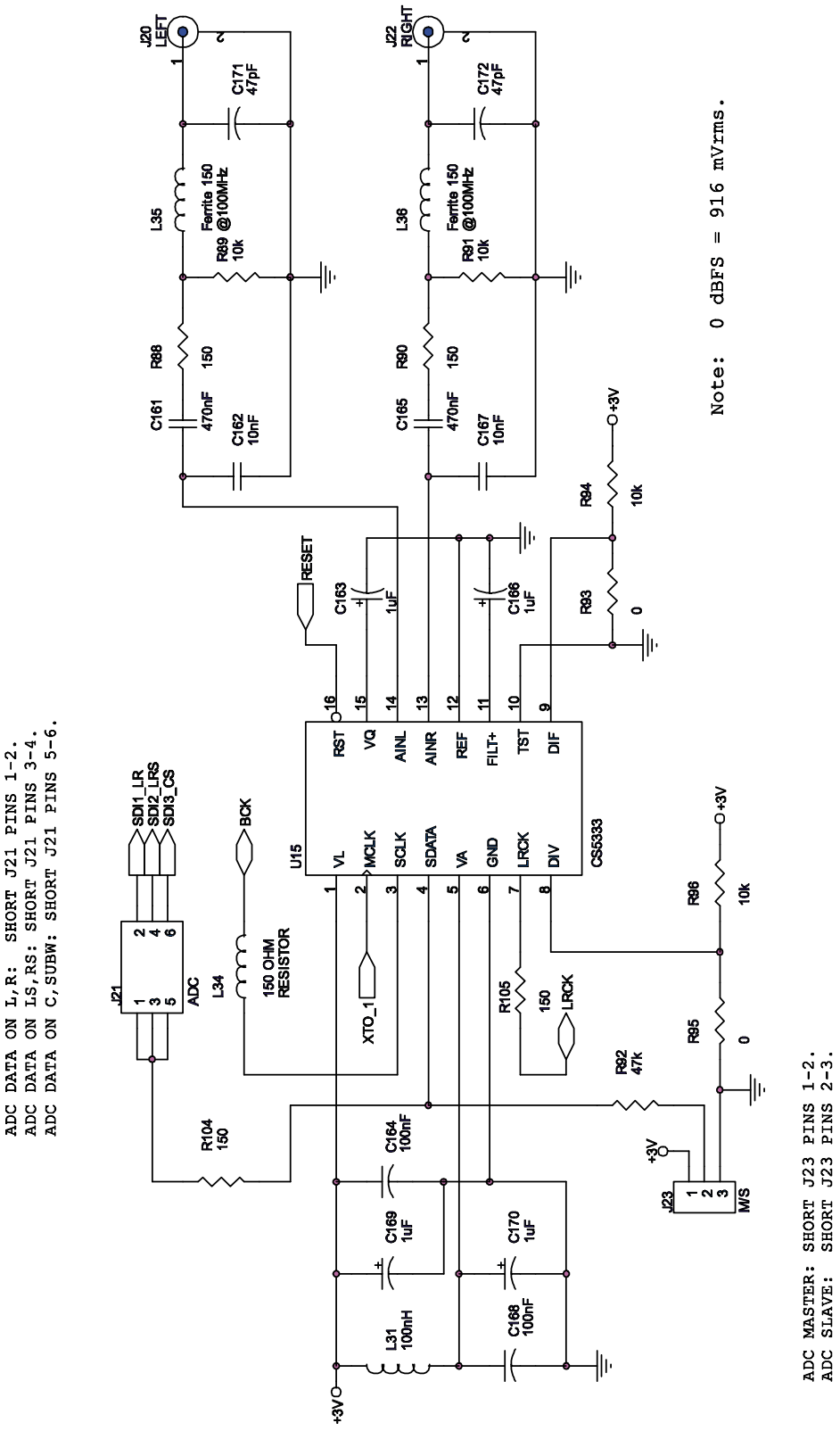
SHEET 7: SUBWOOFER OUTPUT



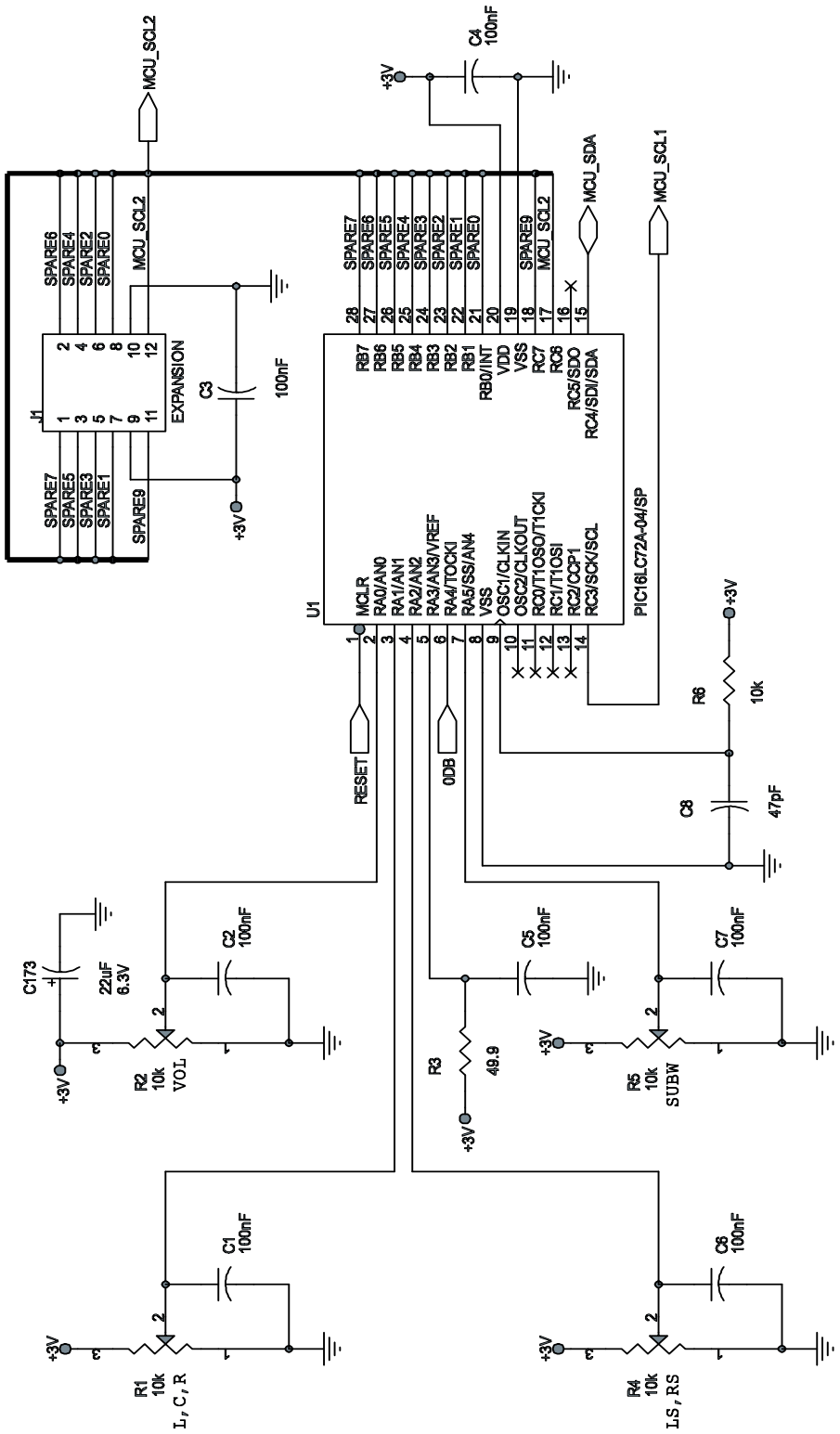
SHEET 8: PC INTERFACE



SHEET 9: ANALOG INTERFACE



SHEET 10: MCU


MCU_SCL2
C4
100nF
+3V
MCU_SDA
MCU_SCL1
SPARE6
SPARE4
SPARE2
SPARE0
MCU_SCL2
SPARE7
SPARE6
SPARE5
SPARE4
SPARE3
SPARE2
SPARE1
SPARE0
SPARE9
MCU_SCL2
J1
EXPANSION
C3
100nF
SPARE7
SPARE5
SPARE3
SPARE1
SPARE9
+3V
U1
PIC16LC72A-04/SP
MCLR
RA0/AN0
RA1/AN1
RA2/AN2
RA3/AN3/VREF
RA4/T0CKI
RA5/SS/AN4
VSS
OSC1/CLKIN
OSC2/CLKOUT
RC0/T1OSO/T1CKI
RC1/T1OSI
RC2/CCP1
RC3/SCK/SCL
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0/INT
VDD
VSS
RC7
RC6
RC5/SDO
RC4/SDI/SDA
RESET
ODB
R6
10k
C8
47pF
C173
22uF
6.3V
C2
100nF
R2
10k
VOL
C5
100nF
R3
49.9
C7
100nF
R5
10k
SUBW
C1
100nF
R1
10k
L,C,R
C6
100nF
R4
10k
LS,RS

Typical Performance Characteristics at Vcc = 28V, 8Ω load.

Fig 4: Frequency Response: Left Channel SRC bypassed(top), SRC active(bottom)

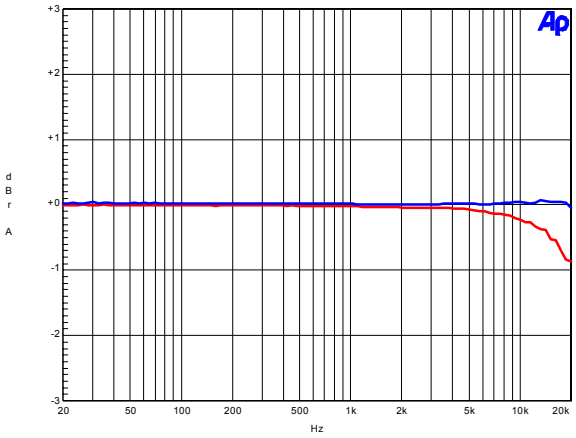


Fig 5: Frequency response: Subwoofer

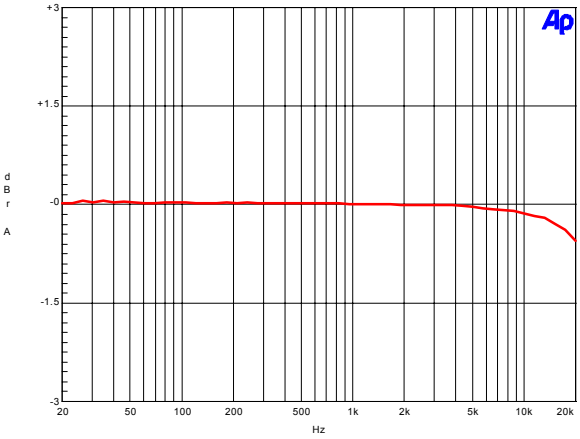


Fig 6: Left Chnl. THD+N vs. Output Power

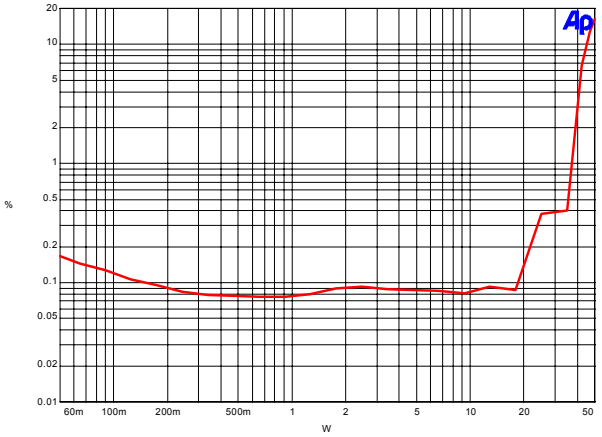


Fig 7: SUBW THD+N vs. Output Power

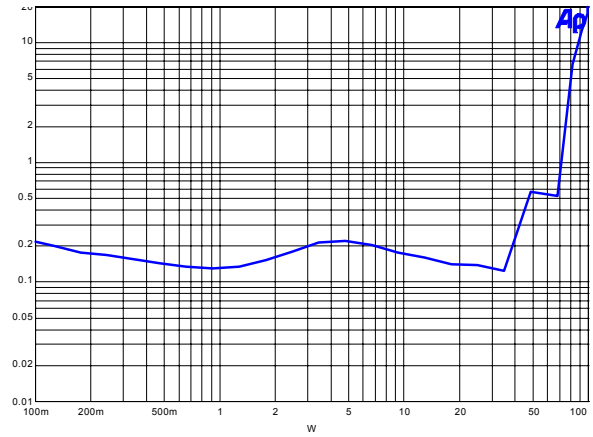


Fig 8: Left Chnl.THD+N vs Frequency 10W (top), 1W(btm)

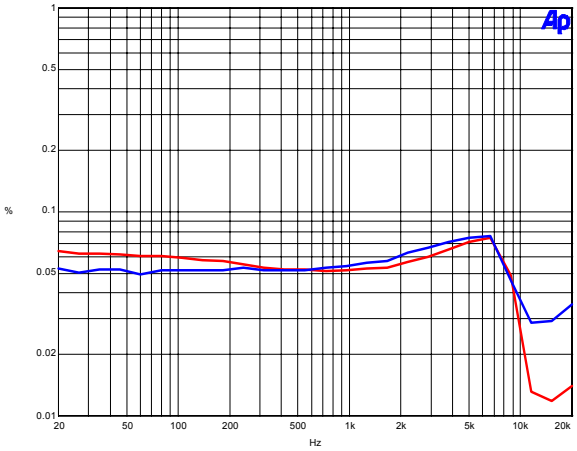
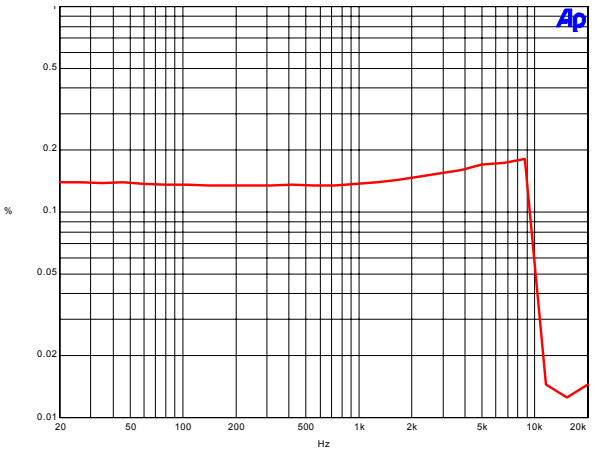


Fig. 9: SUBW THD+N vs Frequency 20W



Typical Performance Characteristics at Vcc = 28V, 8Ω load.

Fig 10: FFT: 1W, 44.1kHz Fs

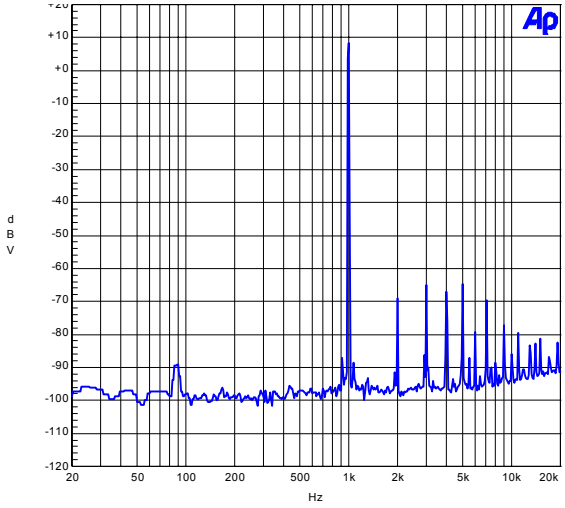
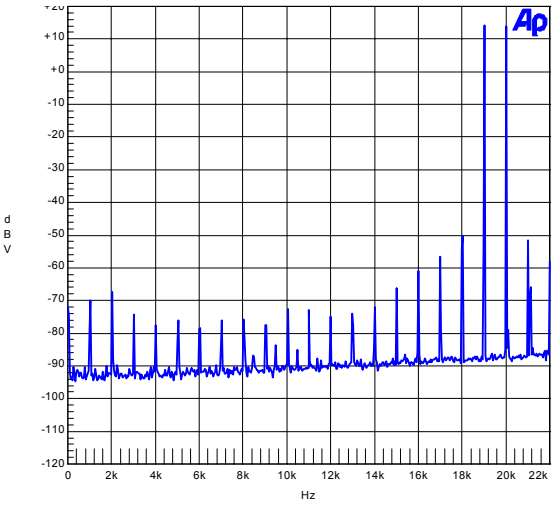


Fig.11: IMD: -3dB, 19 & 20kHz, 44.1kHz Fs



Note: The FFT plots are scaled in dBV (relative to 1Vrms) not dB relative to full scale output. Relative to full scale output, subtract 24dB from the FFT plot's Y-axis.

BILL OF MATERIALS

APOGEE TECHNOLOGY
129 MORGAN DRIVE
NORWOOD, MA 02062
Voice 781-551-9450
Fax 781-440-9528

EB-5160 DDX Evaluation Board / Reference Design 5.1 Channels PCB P/N 721-00321
PL110702-301 REV B

Bill Of Materials for Assembly **August 15, 2001** **Proprietary Information**

Item	Quantity	Reference	Part	Description	Package	Mfr. Part No.
1	40	C1,C2,C3,C4,C5,C6,C7,C31,	100nF	Capacitor, Ceramic, Y5V, 100nF, 25V, +80/ -20%	Chip 0805	ECJ-2VF1E104Z
		C32,C33,C37,C38,C39,C40,				
		C41,C42,C43,C44,C45,C46,				
		C51,C52,C53,C54,C55,C56,				
		C57,C58,C59,C60,C68,C77,				
		C94,C103,C120,C129,C143,				
		C152,C159,C160				
2	26	C65,C70,C74,C80,C81,C87,		Capacitor, Ceramic, X7R, 100nF, 50V, 10%	Chip 0805	ECJ-2YB1H104K
		C88,C91,C96,C100,C106,C107,				
		C113,C114,C117,C122,C126,				
		C132,C133,C139,C140,C144,				
		C157,C158,C164,C168				
3	12	C64,C76,C79,C89,C90,C102,		Capacitor, Polyester Film, 100nF, 100V, 5%	Radial W3.5/L7.2mm	2222 370 22104
		C105,C115,C116,C128,C131,C141				
		ALTERNATE		Capacitor, Ceramic, X7R, 100nF, 50V, 10%	Chip 1206	ECJ-3VB1H104K
4	3	C8,C171,C172	47pF	Capacitor, Ceramic, NPO, 47pF, 50V, 5%	Chip 0805	ECJ-2VC1H470J
		ALTERNATE				ECU-V1H470JCG
5	19	C9,C10,C11,C12,C13,C15,	4.7nF	Capacitor, Ceramic, X7R, 4.7nF, 50V, 10%	Chip 0805	ECJ-2VB1H472K
		C17,C18,C19,C20,C21,C22,				
		C23,C24,C25,C26,C30,C34,				
		C35				
6	24	C14,C66,C71,C72,C82,C84,	10nF	Capacitor, Ceramic, X7R, 10nF, 50V, 10%	Chip 0805	ECJ-2VB1H103K
		C85,C92,C97,C98,C108,				
		C110,C111,C118,C123,C124,				
		C134,C136,C137,C147,C149,				
		C150,C162,C167				
7						
8	2	C27,C174	100uF	Capacitor, Aluminum Electrolytic, FC-Series, 100uF, 25V, 20%	Radial D6.3/H11.2/LS2.0/.5mm	EEU-FC1E101S
9	7	C28,C29,C36,C47,C50,C61,C173	22uF	Capacitor, Tantalum Electrolytic, 22uF, 6.3V, 20%	EIA Size B	ECS-T0JX226R
10	4	C48,C49,C62,C63	18pF	Capacitor, Ceramic, NPO, 18pF, 50V, 5%	Chip 0805	ECJ-2VC1H180J
11	4	C67,C93,C119,C142	1000uF	Capacitor, Aluminum Electrolytic, FC-Series, 1000uF, 35V, 20%	Radial D16/H20/LS7.5/.8mm	EEU-FC1V102S
12	8	C69,C83,C95,C109,C121,	470nF	Capacitor, Polyester Film, 470nF, 63V, 5%	Radial W4.5/L7.2mm	2222 370 12474
		C135,C161,C165				
13	6	C73,C86,C99,C112,C125,C138	330pF	Capacitor, Ceramic, X7R, 330pF, 100V, 10%	Chip 0805	ECJ-2VB2A331K
14	8	C75,C78,C101,C104,C127,	1uF	Capacitor, Ceramic, X7R, 1uF, 50V, 10%	Chip 1812	C1812C105K5RAC
		C130,C146,C155				
		ALTERNATE		Capacitor, Tantalum Electrolytic, 1uF, 35V, 20%	EIA Size B	ECS-T1VX105R
15	4	C163,C169,C166,C170		Capacitor, Tantalum Electrolytic, 1uF, 16V, 20%	EIA Size A	ECS-T1CY105R
16	4	C145,C148,C154,C156	220nF	Capacitor, Polyester Film, 220nF, 63V, 5%	Radial W3.5/L7.2mm	2222 370 12224
17	1	C151	1.0uF	Capacitor, Polyester Film, 1uF, 63V, 5%	Radial W6/L7.2mm	2222 370 12105
18	1	C153	680pF	Capacitor, Ceramic, X7R, 680pF, 100V, 10%	Chip 0805	ECJ-2VB2A681K
19	4	D1,D2,D3,D4	35V	Diode, TVS, 1.5KW, Uni-Directional, 30V Standoff, 35.8VBR, 7%	SMCJ	SMCJ30A
20	4	D5,D6,D7,D8	GRN/RED	LED, T1 3/4, Green/Red, White Diffused	T1 3/4/ 0.1" spacing	LN11WP23
21	1	JDP1	CONN DSUB 25-P	D-Sub Connector, 25-pin, Male, Pcb-mount, Right Angle		747238-4
22	8	JP1,JP2,JP3,JP4,JP5,JP6,JP7,JP8	JUMPER	Buss Wire Jumper, 22 AWG	0.100 Centers	
23	2	J1,J6	EXPANSION, I2S/AC97	Header, 12-pin, 2X6, 0.10 spacing.	0.100 Centers	TSW-106-07-S-D-LL
24	1	J2	PWR	Connector, Terminal Block Plug, 5.08mm, 14-30 AWG, Eight-position	8 x 5.08mm	1729186
25	8	J4,J12,J13,J14,J15,J16,J17,J18	CON2	Connector, Terminal Block Plug, 5.08mm, 14-30 AWG, Two-position	2 x 5.08mm	1729128
26	2	J9,J5	PWM/I2S OUTPUTS	Header, 18-pin, 2X9, 0.10 spacing.	0.100 Centers	TSW-109-07-S-D-LL
27	4	J7,J10,J20,J22	S/PDIF,LEFT,RIGHT	RCA Phono connector, Right Angle PCB, Tin Plate		901
28	4	J8,J11,J23,J24	INPUT,M/S	Header, 3-pin, 1X3, 0.10 spacing.	0.100 Centers	TSW-103-07-S-S-LL
29	2	J19,J21	I2C SELECT,ADC	Header, 6-pin, 2X3, 0.10 spacing.	0.100 Centers	TSW-103-07-S-D-LL
30	8	Used on J8,J11,J19,J21,J23, J24.	JUMPERS	Shorting Jumper		SPC02SYAN
31	12	L1,L2,L3,L4,L5,L11,L14,	FERRITE	Choke, Common- Mode Ferrite, SMD, 10A, 63 Ohms at 100MHz	SMD	CM3322X630R-00
		L17,L20,L23,L26,L29				
		ALTERNATE		Choke, Common- Mode Ferrite, 10A, 170 Ohms at 100MHz	Radial	CM2545X111B-00
32	4	L6,L8,L35,L36	Ferrite 150	Ferrite Chip, EMI Supression, SMD, 150 Ohm @100MHz, 0.2A	Chip 0805	HZ0805E601R-00
33	3	L7,L9,L31	100nH	Inductor, SMD, 100nH, 10%, 300mA	Chip 0805	LL2012-FR10K

BILL OF MATERIALS (continued)

33	3	L7,L9,L31	100nH	Inductor, SMD, 100nH, 10%, 300mA	Chip 0805	LL2012-FR10K
34	12	L10,L12,L13,L15,L16,L18,	22uH	Inductor, 22uH, 5%, 2.0A, .062 DCR	Radial D8.5/H11/LS5mm	
				Inductor, 22uH, 10%, 2.0A, .062 DCR		
		L19,L21,L22,L24,L25,L27				
		ALTERNATE		Inductor, 22uH, 5%, 6.1A, .046 DCR	Radial D.450/H.710/LS.290	RL-5480-4-22
35	2	L28,L30	10uH	Inductor, 10uH, 10%, 8.8A, .031 DCR	Radial D.450/H.710/LS.290/.032	RL-5480-4-10
		ALTERNATE		Inductor, 10uH, 10%, 10A, .01 DCR	Radial D.61/H.83/LS.50/.054	PCV-2-103-10
36						
37						
38	8	Q4,Q5,Q6,Q7,Q8,Q9,Q10,Q11	2N3904	Transistor, NPN, 330mW, 40V CEO	SOT-23	FMMT3904
39	2	R2,R5	10k	Potentiometer, 10k, 9mm Audio, Linear taper, Right angle	0.100 Centers	EVU-E2AF25B14
40	2	R1,R4		Potentiometer, 10k, 9mm Audio, Linear taper, Right angle, Center Detent	0.100 Centers	EVU-E3AF25B14
41	21	R6,R12,R18,R25,R32,R43,		Resistor, Chip, Thk Film, 10K, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ103V
		R54,R70,R82,R83,R86,R89,				
		R91,R94,R96,R97,R98,R99,				
		R100,R101,R102				
42	3	R3,L32,L33	49.9	Resistor, Chip, Thk Film, 49.9, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF49R9V
43						
44						
45	1	R10	121	Resistor, Chip, Thk Film, 121, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF1210V
46	1	R11	200	Resistor, Chip, Thk Film, 200, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF2000V
47	6	R13,R15,R16,R22,R84,R87	3.9k	Resistor, Chip, Thk Film, 3.9K, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ392V
48	2	R24,R17	75	Resistor, Chip, Thk Film, 75, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ750V
49	19	R19,R23,R26,R27,R62,R63,	0	Zero Ohm Jumper, SMD 0805	Chip 0805	ERJ-6GEYJ000V
		R64,R65,R66,R67,R68,R69,				
		R78,R79,R80,R81,R93,R95,R103				
50	2	R20,R28	1 MEG	Resistor, Chip, Thk Film, 1MEG, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ105V
51	8	R14,R29,R37,R40,R48,R51	20	Resistor, Chip, Thk Film, 20, 5%, 1/4W, 200ppm	Chip 1210	ERJ-14YJ200U
		R58,R74				
52	12	R30,R31,R38,R39,R41,R42,	6.2	Resistor, Chip, Thk Film, 6.2, 5%, 1/4W, 200ppm	Chip 1210	ERJ-14YJ6R2U
		R49,R50,R52,R53,R59,R61				
53	8	R33,R34,R44,R45,R55,R56,	300	Resistor, Chip, Thk Film, 300, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ301V
		R72,R73				
54	8	R35,R36,R46,R47,R57,R60,	18K	Resistor, Chip, Thk Film, 18k, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ183V
		R75,R76				
55	2	R77,R71	3	Resistor, Chip, Thk Film, 3.0, 5%, 1/4W, 200ppm	Chip 1210	ERJ-14YJ3R0U
56	1	R85	1k	Resistor, Chip, Thk Film, 1k, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ102V
57	5	R88,R90,R104,R105,L34	150	Resistor, Chip, Thk Film, 150, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ151V
58	1	R92	47k	Resistor, Chip, Thk Film, 47k, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ473V
59	1	SW1	RESET	Switch, Momentary Tact, SMD, 230gf	SMD	B3S-1002
60	1	SW2	SW DIP-6	DIP Switch, 6-position, Raised-rocker, sealed	DIP	76SB06S
61	1	U1	PIC16LC72A-04/SP	Microcontroller, 8-Bit, 28-Pin, w/ 5-Channel ADC	DIP-28/L1.4/W.30/LS.10	PIC16LC72A-04/SP
62	1	U2	DS1233A-15	Supervisor, 3.3V Econoreset	SOT-223	DS1233A-15/SM
63	1	U3	LD1086V50	Linear LDO Regulator, 5V, 1.5A	TO-220	LD1086V50
64	1	U4	LD1086DT	Linear LDO Regulator, Adjustable, 1.5A	TO-252	LD1086DT
65	2	U7,U5	DDX4100	DDX Digital Processor, 4.1 Channels	TQFP-44	DDX-4100
66	2	U8,U6	GP1F31R	Toslink Light Receiving Unit	Radial	GP1F31R
67	4	U9,U10,U11,U12	DDX2060	DDX Power IC, 35W x 2-Channels	POWERSO-36	DDX-2060
68	1	U13	74LVX14	Hex Inverter, Schmitt-Trigger, Low-Voltage, 5V Tolerant	SOIC-14	TC74LVX14FN
69	1	U14	74ACT14	Hex Inverter, Schmitt-Trigger, TTL Compatible	SOIC-14	TC74ACT14FN
70	1	U15	CS5333	Stereo ADC, 24-Bit, 96 kHz	TSSOP-16	CS5333-KZ
71	2	Y2,Y1	24.576MHz MHz	Crystal, 24.576MHz	SMD	HCM49-24.576MABJT
72	1	Used with U1		DIP Socket, 28-Pin, 0.300"	DIP-28/L1.4/W.30/LS.10	110-93-324-41-001
73	4	Used with U9,U10,U11,U12		Heatsink, SMD, D3PAK	SMD	573400D00010
74	1			Printed Circuit Board, 5" x 10", 2-Layer		721-00321 REVA
75	4			Bumpon, Round, Black, 0.44" W x 0.20" H		
76	1			Heatsink, TO-220, Slide-on, 0.5" x 0.5" x 0.75"		576802B00000
77	2	Used with JDP1		Machine Screw, Panhead, 4-40 x 5/16		
78	2	Used with JDP1		Lock Washer, #4		
79	2	Used with JDP1		Hex Nut, #4		
80	1	R87	2.0k	Resistor, Chip, Thick Film, 2.0K, 5%, 1/10W, 200ppm	Chip 0805	ERJ-6GEYJ202V

Notes:

1.) Reference Designations not used: C16, J3, Q1, Q2, Q3, R7, R8, R9, R21.
2.) Install shorting jumpers find #30 on J8 pins 1-2, J11 pins 1-2, J19 pins 1-3 and 2-4, J21 pins 1-2 and 3-4 and 5-6, J23 pins 1-2, and J24 pins1-2.