

Evaluation Platform for the DDX-8000

FEATURES

MULTI-CHANNEL DIGITAL AUDIO SOLUTION

- FOR DVD and A/V RECEIVERS
- MINI/MICRO COMBO, AUTOMOTIVE
- POWERED SPEAKERS, SET TOP BOX, TV
- 2x35W, <1% THD OUTPUT
- 2x45W, <10% THD OUTPUT

TYPICAL PERFORMANCE

- THD+N < 0.05% (1W, 1kHz)
- SNR: 100dB (A-weighted)
- 90% EFFICIENT AT 2x35W

INPUT/OUTPUT

- S/PDIF COAX/OPTICAL (STEREO)
- I²S INPUT/OUTPUT (8 CHANNELS)
- SAMPLE RATES FROM 32 TO 192kHz @ 24-BITS
- RB-86xxx INTERFACE

DIGITAL PREAMP FEATURES

- VOLUME, BALANCE
- BASS, TREBLE
- PARAMETRIC EQ
- AUTO MUTE
- BASS MANAGEMENT
- DUAL LIMITERS
- 5.1 OUTPUT CHANNELS
- STEREO HEADPHONE OUTPUTS

1. GENERAL DESCRIPTION

The EB-8000A is an evaluation amplifier that showcases Apogee's patented all-digital, high efficiency Direct Digital Amplification (DDX[®]) technology. The board features the DDX-8000 Controller and one DDX-2060 Power Device which provide full digital audio preamplifier functions and power amplification for two selectable channels. The board includes coaxial and optical S/PDIF interfaces, digital volume, balance, bass, treble and EQ controls and local power regulation. Automatic fault protection guards the circuit from excess voltage, current and temperature. A comprehensive graphical user interface is provided for ease of controlling all features of the DDX-8000, including on-the-fly control of EQ. The EB-8000A can also be used to send audio and control data to 5.1 channel reference boards RB-86125, RB-86300 and RB-86600.

ORDERING INFO

EB-8000A – Evaluation Board for DDX-8000

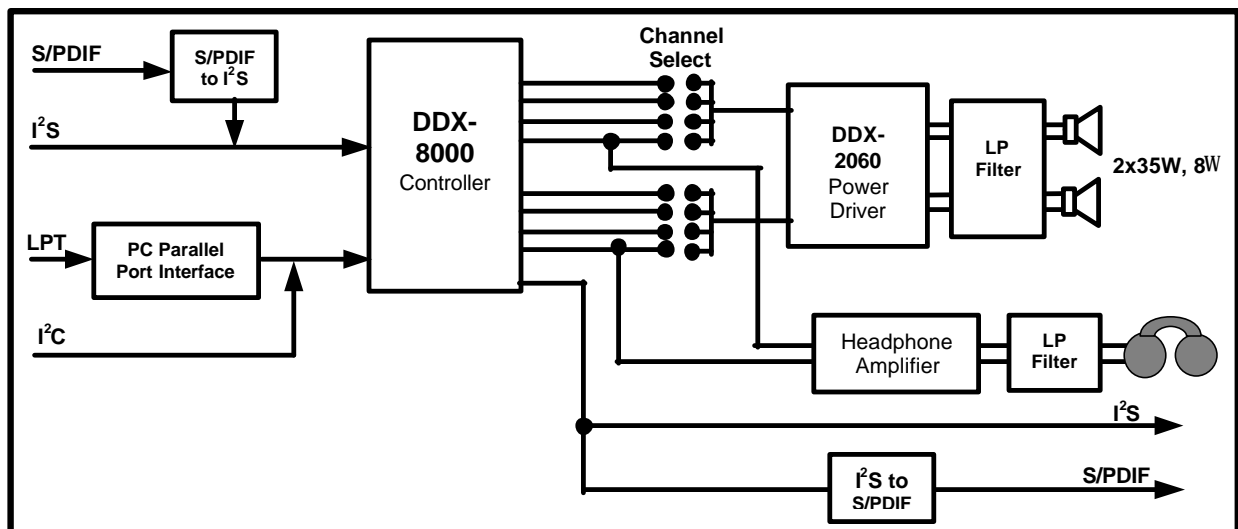


Figure 1. EB-8000A Block Diagram

This is preliminary information on a new product. Details are subject to change without notice.

2. RECOMMENDED OPERATING CONDITIONS [NOTE 1]

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
V _L	Logic Power supply voltage - J2 Terminal block	6.5	7.0	15	V
V _{B+}	H-Bridge Power supply voltage - J1 Terminal block	9	28	30	V
V _{IH}	Logic inputs, High - J6 Headers	2.0		5.0	V
V _{IL}	Logic inputs, Low - J6 Headers			0.8	V
F _s	PCM Input Sample Rate - I ² S Input on J6	32		192	KHz
	PCM Input Sample Rate - S/PDIF Input	32		96	
T _A	Ambient Operating Temperature	0		50	°C

Note 1. Performance not guaranteed beyond recommended operating conditions.

3. ELECTRICAL CHARACTERISTICS [2]

Refer to circuit Sheets 1 - 7. V_{B+}=28V, f=1kHz, T_A=25C, R_L=8Ω, and measurement bandwidth 20kHz.

SYMBOL	PARAMETER	CONDITION	MIN	TYP	MAX	UNIT	
P _o	Output Power	THD+N <1%		35		Wrms	
	Output Power	THD+N <10%		45		Wrms	
V _{B+TH}	Over voltage Protection Threshold		30	35		V	
V _{B+TL}	Under voltage Protection Threshold			7	9	V	
I _L	V _L supply current - J4 Power	V _L = +7.0V		170		mA	
I _{B+}	V _{B+} supply current in Powerdown	SW2 POS1 closed.		11		mA	
	V _{B+} quiescent current	Damped State (Muted) SW2 POS1,2,3,closed.		44		mA	
	V _{B+} supply current - J2 Power	2-Channel switching at 384KHz. Dither signal applied			60		mA
		2 channels driven to 0dBFS (34W) outputs			2.8		A
I _{SC}	Short circuit output current limit	Each output	3.5	5.0	6.5	A	
THD+N	Total Harmonic Distortion + Noise	P _o =1.0 Wrms P _o = 34 Wrms		.05 .15		%	
SNR	Signal-to-Noise Ratio, all channels	A-weighted, I ² S input on J6, MCLK on J14		100		dB	
		A-weighted, S/PDIF input		98		dB	
η	Efficiency (Single DDX-2060 driven), V _{B+} Supply only	P _o =2 x 35W P _o =2 x 50W		90 90		%	
CX	Output Channel Cross Talk, (all V _{B+} supplies linked)	Left output at 9W to Right channel		-60		dB	

2. Characteristics are for the DDX-2060 power device driven by the DDX-8000 processor.

4. EB-8000A OVERVIEW

The EB-8000A is an all-digital audio amplifier evaluation board that demonstrates the application of Apogee's DDX-8000/2060 chip set.

4.1. HARDWARE DESCRIPTION

The EB-8000A amplifier consists of two channels of audio amplification rated at 2x35W. There is one DDX-8000 processing IC and one DDX-2060 power device on this board. The EB-8000A is shipped with jumpers placed to configure the board for a S/PDIF input, sent to 2 output channels. Figure 4 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 I²C serial information through the PC's parallel port in accordance with the protocol detailed in Section 2 of the DDX-8000 datasheet (Apogee Doc # 903-000021). Additional control and status bits are sent and monitored via the parallel port as well. The hardware circuit is described on Sheet 5 of the schematic and consists of a DB25 connector with a one to one pin mapping from the PC's parallel port and several inverting buffers to send and receive information.

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NOTE: When data is provided using I²S in lieu of S/PDIF, it is necessary to disable “Auto-EAPD on SPDIF Unlock” from the GUI Device Preferences menu. See Page 12 for more detail.

4.2. DDX-8000 OVERVIEW

The DDX-8000 Controller is a 2.5V core/3.3V interface digital integrated circuit that converts serial PCM digital audio signals into PWM drive signals. PWM output formats include DDX® Ternary, bridged or single-ended Binary. These PWM signals are then amplified by the DDX-2060 or DDX-2100 for audio output. The device supports volume, bass, treble, EQ, muting and limiter functions under I²C control. A block diagram of the device is shown in Figure 2.

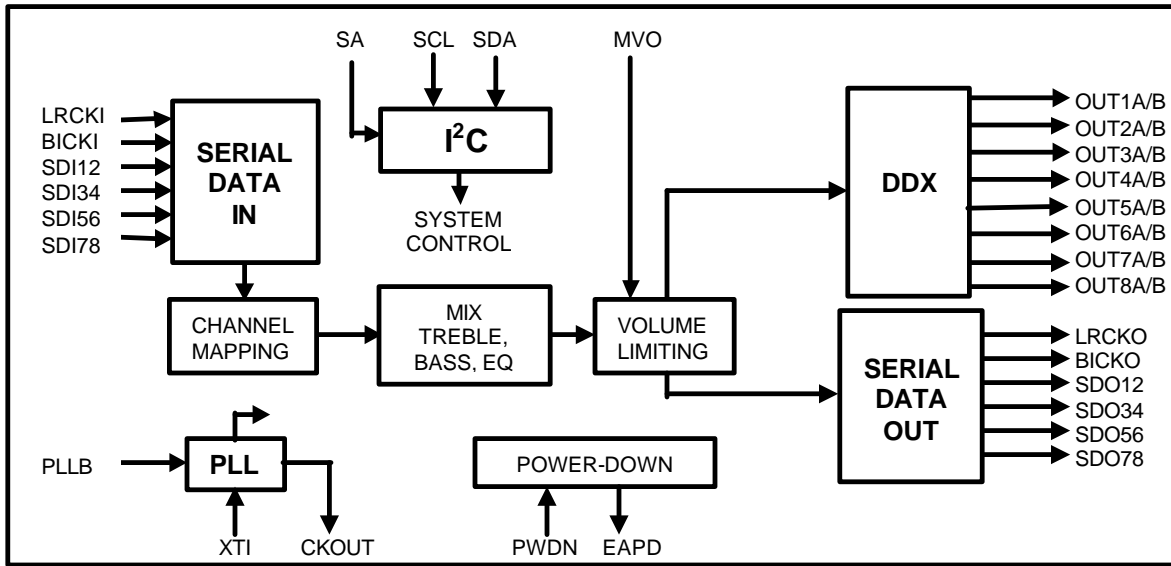


Figure 2: DDX-8000 Block Diagram

4.3. DDX-2060 OVERVIEW

The DDX-2060 Power Device is a dual channel HBridge 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.

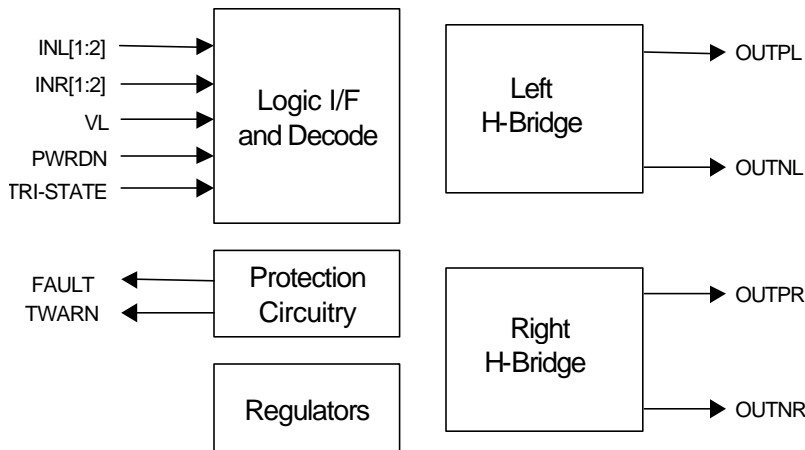


Figure 3: DDX-2060 Block Diagram

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5. SCHEMATIC DESCRIPTION

5.1. S/PDIF INPUT/OUTPUT INTERFACE (SHEET 6)

The DDX-8000 controller's data interface is serial I²S for inputs and outputs. The EB-8000A input accommodates coaxial or optical S/PDIF digital audio interfaces using a digital audio receiver IC. Either input may be selected by jumper J18. Connect pins 1-2 for coaxial or pins 2-3 for optical S/PDIF. S/PDIF interfaces will support sample rates from 32kHz to 96kHz. LED D3 indicates S/PDIF Lock. A S/PDIF coaxial output is provided at J20 from a digital audio transmitter IC configured to serial data outputs 1 and 2 (DDX-8000 pin 57). This enables the EB-8000A to be used as a digital preamplifier with the DDX-8000 processor.

5.2. DIGITAL SIGNAL PROCESSING (SHEET 3)

The DDX-8000 converts pulse code modulated, PCM, digital audio input signals into DDX® pulse-width-modulated (PWM) digital output signals. Two of 8 input channels can be mapped to the outputs. Signals from I²S 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-8000 has eight independent volume control registers that have an adjustment range from +24dB to -103dB in 0.5 dB increments. In addition, the Master Volume is adjustable from 0dB to -127dB in 0.5dB steps. 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-8000 GUI program is provided to simplify generation and download of the filter coefficients, enabling on-the-fly equalization changes.

5.3. POWER OUTPUT (SHEET 4)

The DDX-2060 provides power amplification by translating logic level PWM signals into power level signals. These power level signals are applied to passive two-pole lowpass filters, and provide very low distortion audio power to the load. The output filter functions to prevent unwanted high frequency switching frequency signals from reaching the load. A filter design for 8ohm loads is shown on Sheet 4 of the schematic for reference.

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 are R15 & C32, R18 & C38, R23 & C48 and R27 & C52 on Sheet 4. The other critical components for power device reliability are the 1uF bypass capacitors from VCC to PGND pins on the DDX-2060. These capacitors must be X7R Ceramic or Tantalum SMD construction, and must be located very close to the device pins. Refer to Apogee reference board designs and application notes for proper placement of these critical capacitors.

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 (D2 on Sheet 4) to change color from green to red. The DDX-2060 shuts down when it reaches 150°C.

5.4. SUPPLY VOLTAGE, REGULATORS (SHEET 1)

The EB-8000A features local 5V, 3.3V and 2.5V power regulation for logic circuitry. Separate power supply inputs are available for the logic supply as well as the output power section.

Input protection is provided for the amplifier by diode D1. This diode will protect from overvoltage and reverse power connection.

Supervisor U1 is used for power-on-reset and power-off sequencing.

5.5. HEADERS AND JUMPERS (SHEETS 2, 3, 4, 5, 6, 7)

SHEET 2: Header J6 has a dual-purpose. First, It can be used as an I2S data and control interface to any one of three DDX-8000 Multi-channel reference boards designated RB-86125 (5x15W +50W), RB-86300 (6x50W), RB-86600 (6x100W). Refer to the set-up instructions which follow for using the EB-8000A to control the reference boards. It can also be configured to apply I²S inputs to the DDX-8000. Header J3 provides I²S outputs from the DDX-8000. Headers J7, J8, and J10-13 select which signal source will be received by the DDX-8000, I²S or S/PDIF. They are also used to apply I2S signals from the S/PDIF receiver IC to Header J6 (when the EB-

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8000A is used to interface to a reference board). J5 and J9 select which of the DDX-8000's outputs go to the DDX-2060 power device. Header J4 outputs regulated 3.3V and 2.5V.

SHEET 3: Header J14: shorting pins 3 and 4 selects Master Clock (MCK) as clock input (CKIN) to the DDX-8000. MCK can be sourced by the S/PDIF receiver or brought in from an external source. Pin 1 has the DDX-8000 clock output (CKOUT) for external connection. Jumpers JP1-3 connect the headphone PWM outputs to the headphone amplifier circuit on Sheet 7.

SHEET 4: Jumpers JP4-7 select Half or Full Bridge Output Mode.

SHEET 5: Header J17 selects PC control.

SHEET 6: Header J18 selects Coaxial or Optical S/PDIF input.

SHEET 7: Jumper JP13 connects onboard 3.3V to the Headphone Amplifier circuit. The Headphone Amplifier circuit can also be connected to an external supply, and will work from 2.2V to 4.2V. JP9 and 11 are installed for ternary (rather than binary) operation. JP8, 10 and 12 select Filtered or Filterless Headphone output.

5.6. SWITCHES

Momentary pushbutton SW1 provides a global RESET signal. DIP switch SW2 has four switches. Position 1 controls PWDN which turns off the DDX-2060 outputs. Position 2 controls Master Volume Override (MVO), which sets all channels to 0dB gain, independent of f_c or register settings. Position 3 controls PLL bypass (PLLb), which selects MCLK as the internal master clock for the DDX-8000. Position 4 is unused.

5.7. 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.

6. ADDITIONAL INFORMATION

6.1. 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.

6.2. 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 was taken using an AES17 brick wall measurement 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 Figure 5 through Figure 9.

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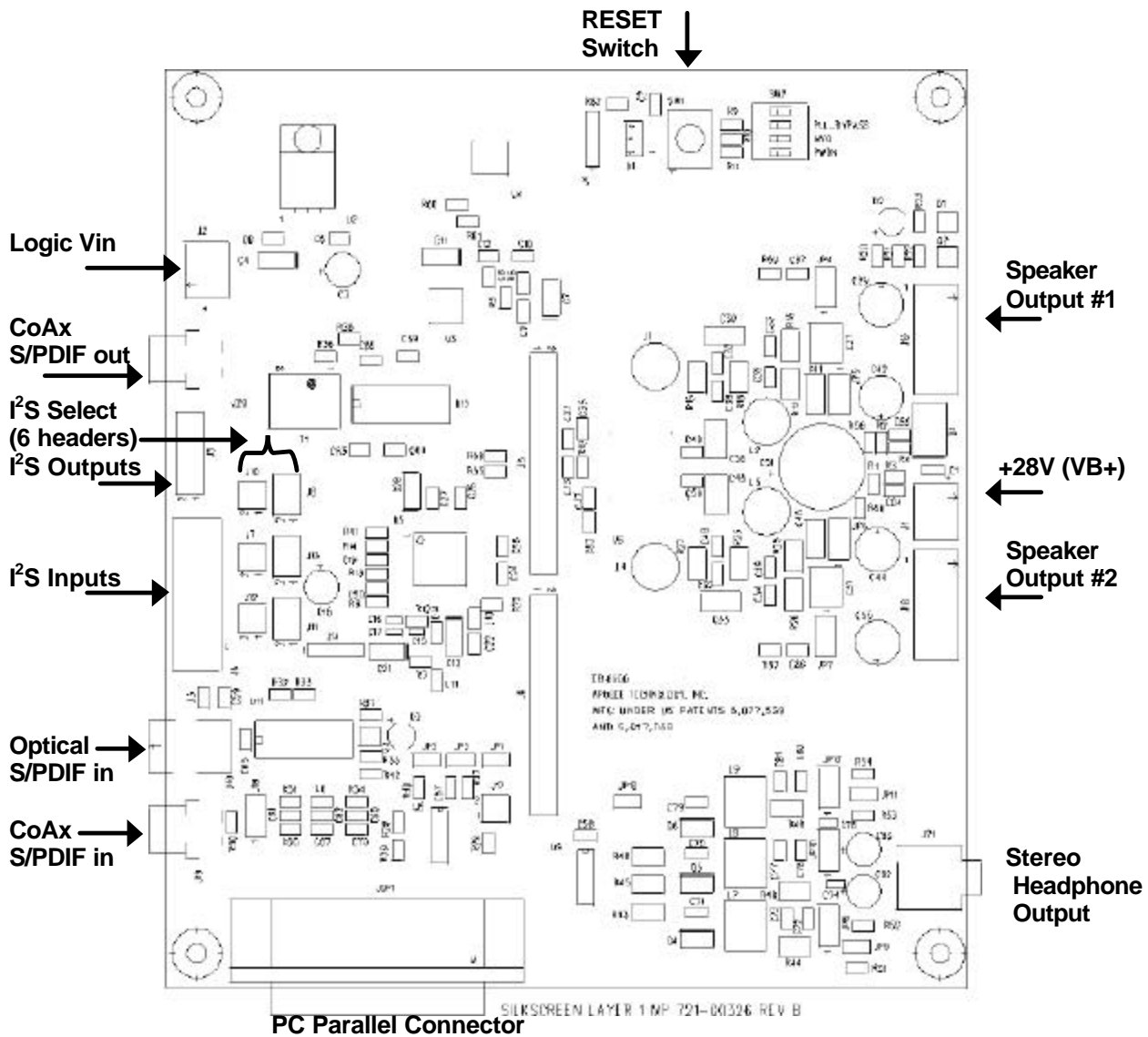


Figure 4. : Assembly Drawing

This is preliminary information on a new product. Details are subject to change without notice.

6.3. CONFIGURE EB-8000A FOR 2-CHANNEL SPDIF INPUT: (2 channel Power Output, Computer I²C Control[©])

6.3.1. Jumper Settings:

- **J18** Selects S/PDIF cable type.
 - CoAxial Cable: Short **J18** pins **1-2**
 - Optical (TOSlink) Cable: short **J18** pins **2-3**
- **J7, J10 and J12** – Short **2-4** to connect SPDIF Receiver I²S output to DDX-8000 I²S input.
- **J8, J11 and J13** – Short **3-4** to connect I²S data to all inputs on DDX-8000.
- **J14** – Short **3-4** to connect SPDIF Receiver MCK output to DDX-8000 XTI input.
- **J17** – Short **1-3 and 2-4** to connect I²C data from PC parallel port to DDX-8000 I²C input.
- **J5, J9** – Short **1-2 and 7-8** to connect channel 1 and 2 DDX-8000 PWM output to DDX-2060 PWM input.
- **JP4, JP5, JP6, JP7** – Short **1-2** for normal DDX-2060 operation.

6.3.2. Dip Switch Settings (SW2):

- **1 – PWDN, Set to Open for normal operation.**
- **2 – MVO, Set to Closed for normal operation.**
- **3 – PLL_Bypass, Set to Closed for normal operation.**

6.3.3. Speaker Connections:

- **Connect 8 Ohm(recommended) speakers to J15 and J16 pins 1 and 4, pin 1 is positive phase. For headphone operation, see Section 6.3.7 below**

6.3.4. Connection to Computer:

- **Use the supplied parallel port cable to connect JDP1 to computer parallel port.**

6.3.5. Power Connections:

- Connect +7V and GND to J2, the square pad on the underside of the pc board is pin 1 and should receive 7V. In other words, facing the wire openings of the green Phoenix connector, Ground goes in the left-hand opening, and +7V goes in the right.
- Connect +10V to +28V and GND to J1, the square pad on the underside of the pc board is pin 1 and should receive 10V to 28V. In other words, facing the wire openings of the green Phoenix connector, Ground goes in the left-hand opening, and +10 to 28V goes in the right.

6.3.6. Configuring GUI Software:

- Run the DDX-8000ControlPanel.exe software.
- Go to “Registers” page on GUI.
- Click “Power Up” button
- Click “Test Board I/O”, If “passed” it is OK, If “failed” then perform manual board reset by pressing SW1 button and try again, if still “failed” then make sure connections are OK.
- Go to “Control” page on GUI.
- Click “Ext Amp Power Up” to enable DDX-2060.
- Increase “ALL” master volume control.

6.3.7. Headphone Connections and Operation:

- Short Jumpers JP1, JP2, JP3, JP9, JP11, JP13.
- For Filtered output, short JP8, JP10 and JP12, pins 2&3.
- For Unfiltered output, short JP8, JP10 and JP12, pins 1&2.
- Plug Stereo Headphones into J21.
- In the GUI, on the “Control” page, click the “Headphone Enable” button.

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6.4. CONFIGURE EB-8000A FOR INTERFACE TO RB-86XXX, PC I²C CONTROL:

6.4.1. Jumper Settings:

- J18 Selects S/PDIF cable type.
 - CoAxial Cable: Short J18 pins 1-2
 - Optical (TOSlink) Cable: short J18 pins 2-3
- J7, J10 and J12 – Short 1-3 and 2-4 to connect SPDIF Receiver I2S output to I2S signals on J6 for the RB-86xxx.
- J8, J11 – Short 1-3 to connect I2S data to all data signals on J6 for the RB-86xxx.
- J14 – Short 3-4 to connect SPDIF Receiver MCK output to J6 for the RB-86xxx.
- J17 – Remove Jumpers 1-3 and 2-4.

6.4.2. Dip Switch Settings (SW2):

- 1 – PWDN, Set to Open for normal operation.

6.4.3. Connect EB-8000A to RB-86xxx

- Insert 16 pin ribbon cable into J6 on EB-8000A and J1 on RB-86xxx

6.4.4. Speaker Connections:

- Connect the recommended speakers to J2; speaker connector on RB-86xxx.

6.4.5. Connection to Computer:

- Use the supplied parallel port cable to connect JDP1 to computer parallel port.

6.4.6. Power Connections:

- Connect +7V and GND to J2 on the EB-8000A. The square pad on the underside of the pc board is pin 1 and should receive 7V. In other words, facing the wire openings of the green Phoenix connector, Ground goes in the left-hand opening, and +7V goes in the right.
- Connect 3.3V and 10 to 28V and GND to JP1 on the RB-86125, 3.3V and 10 to 36V to JP1 on the RB-86300 or 3.3V and 10 to 34V on the RB-86600.

6.4.7. Configuring GUI Software:

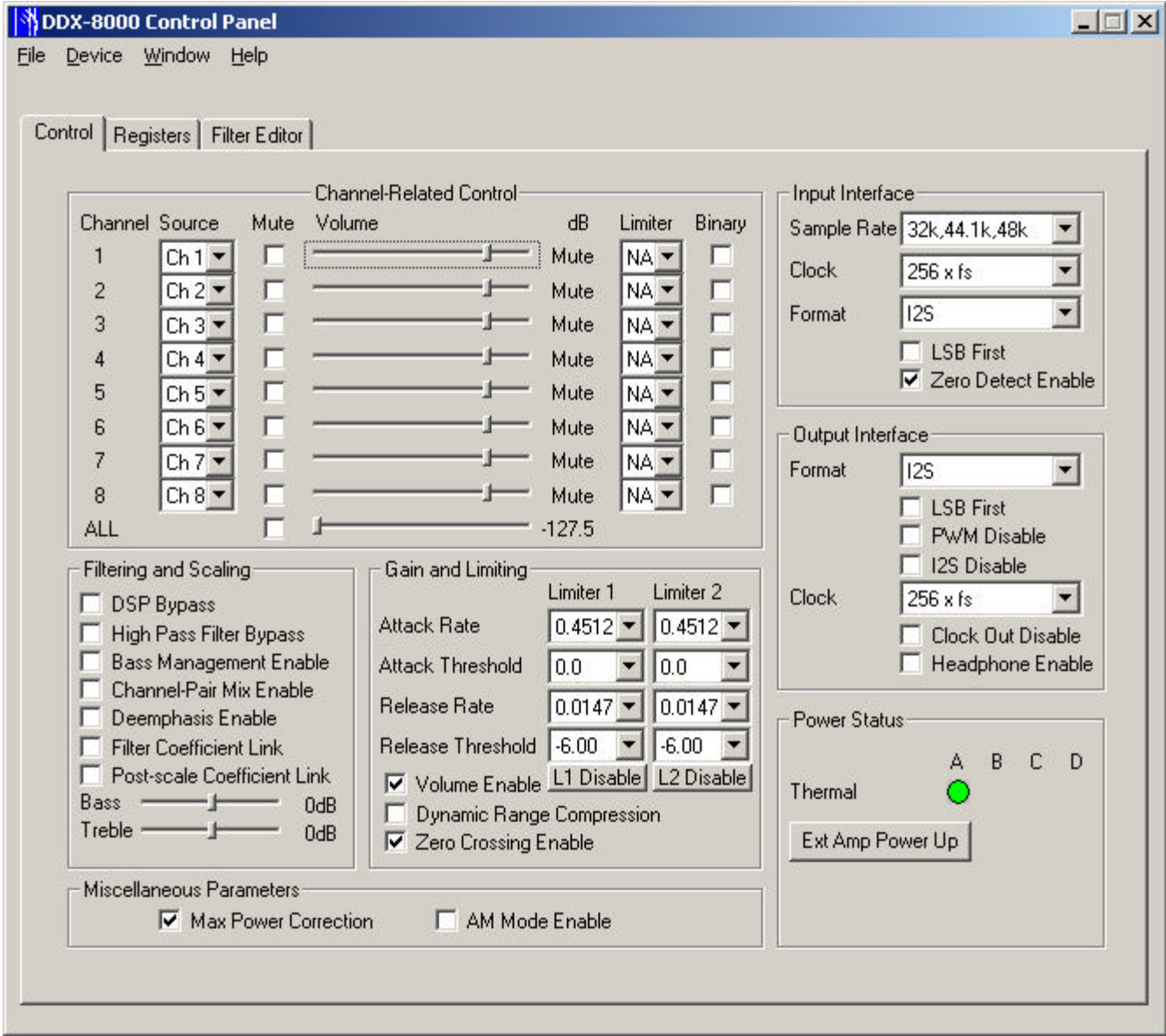
- Run the DDX-8000ControlPanel.exe software.
- Go to “Registers” page on GUI.
- Click “Power Up” button
- Click “Test Board I/O”, If “passed” it is OK, If “failed” then perform manual board reset by pressing SW1 button and try again, if still “failed” then make sure connections are OK.
- Go to “Control” page on GUI.
- For RB-86125 only, click “Binary” boxes next to Channels 1,3,5 and 7.
- Click “Ext Amp Power Up” to enable power devices (DDX-2060 or DDX-2100).
- Increase “ALL” master volume control.

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7. GRAPHIC USER INTERFACE (GUI) FOR THE EB-8000A

7.1. GUI: CONTROL PAGE

The Control Page contains Volume, Muting and Limiter settings, Sample Rate range select, Output Format, Filtering, Scaling, Gain and Limiting, Thermal Status, Max Power Correction and AM Mode.



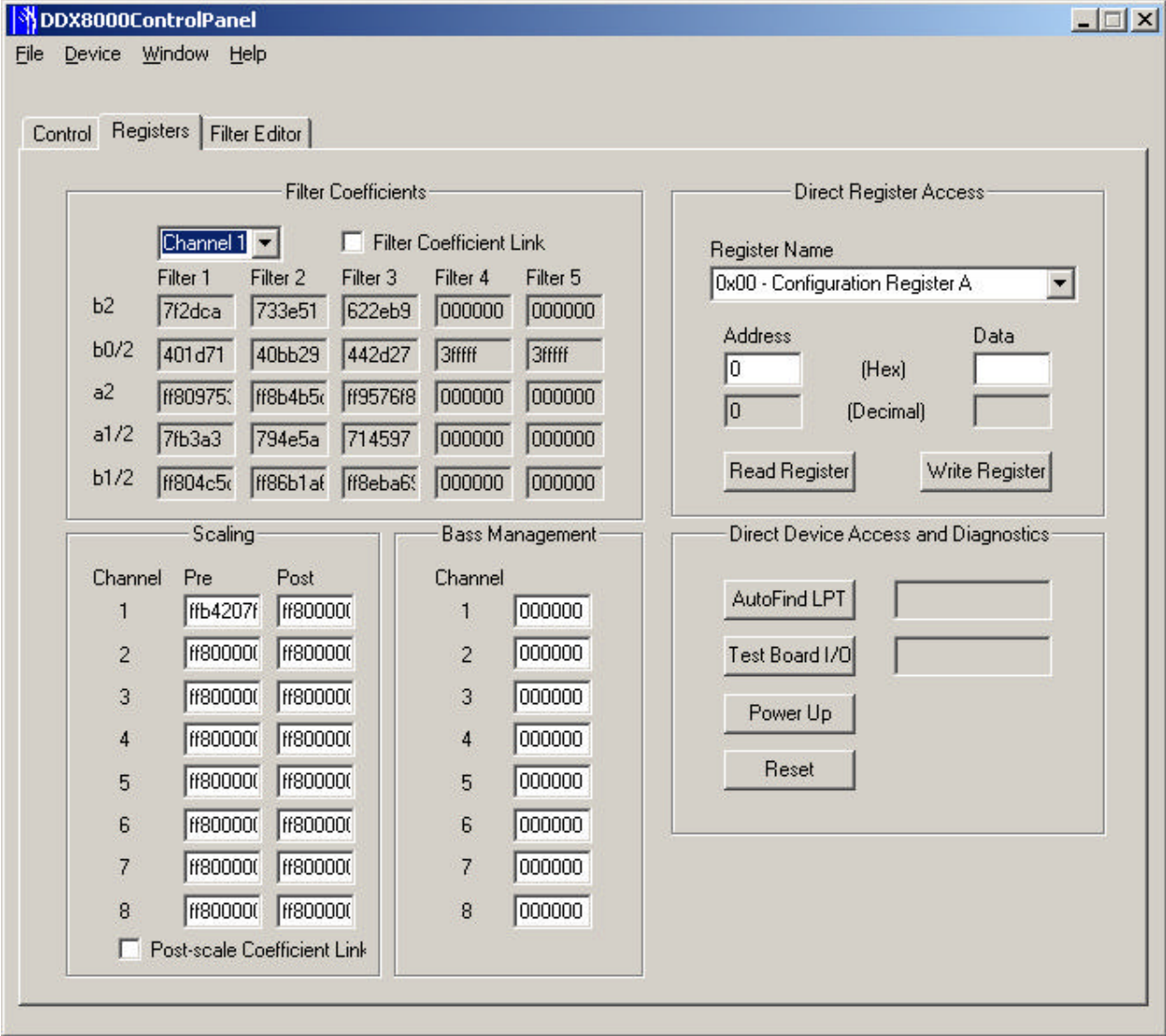
GUI Shot 1. Control Page

This is preliminary information on a new product. Details are subject to change without notice.

7.2. GUI: REGISTERS PAGE

Direct Register Access allows writing or reading registers directly. Scaling and Bass Management coefficients, explained in Section 5 of the DDX-8000 datasheet, can be entered here. Finally, PC Port address and board I/O can be tested, the board can be powered up or down, or reset in the Direct Device Access and Diagnostics area.

Filter Coefficients can be created by the Filter Editor (Refer to GUI Shot 3, Filter Editor).

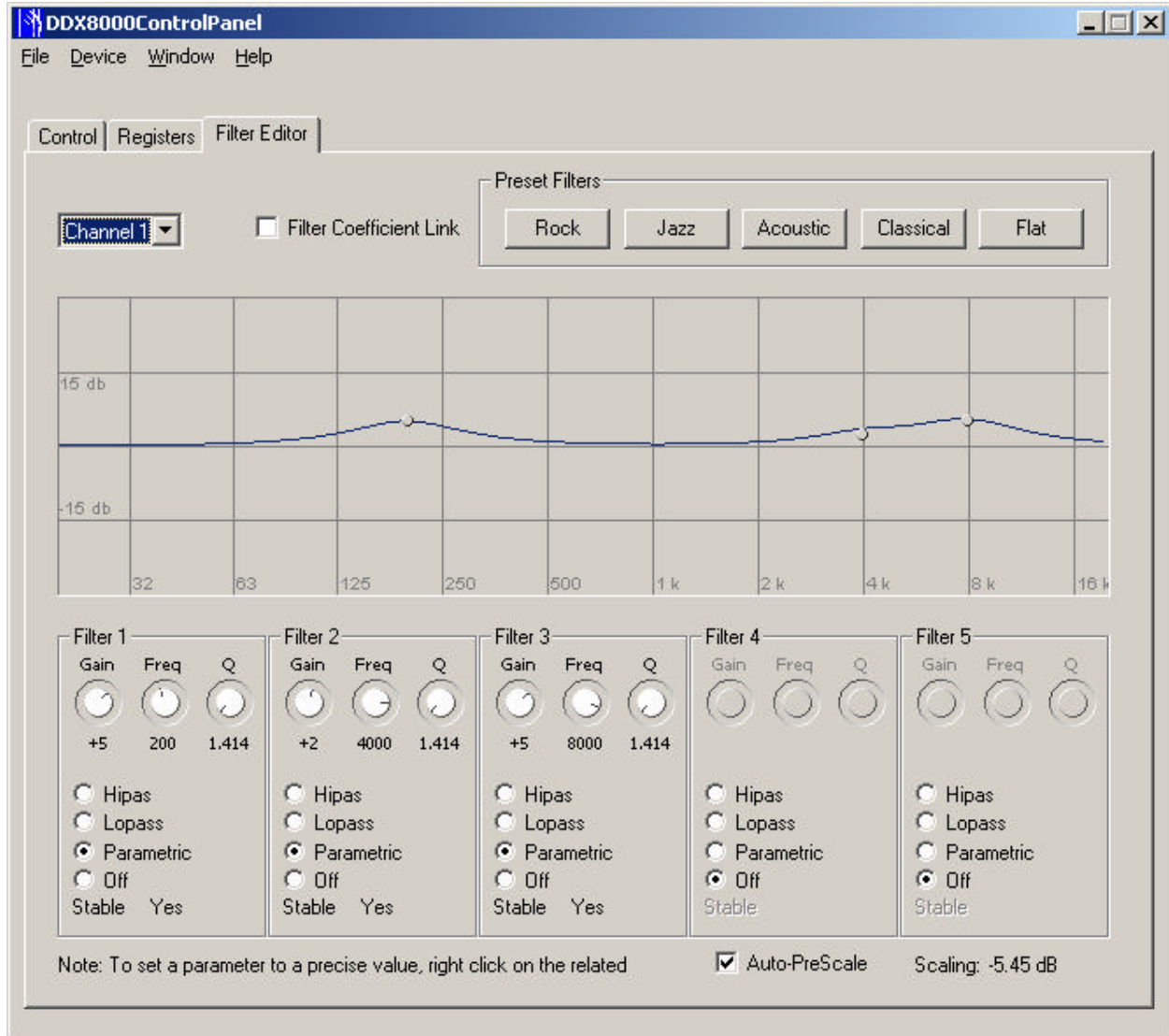


GUI Shot 2. Registers Page Page

This is preliminary information on a new product. Details are subject to change without notice.

7.3. GUI: FILTER EDITOR

Up to 5 filters can be programmed for each of the 8 channels. Entry can be by dragging the round filter point with the mouse, or by clicking on the knobs and dragging up or down. Checking the Filter Coefficient Link box allows all eight (8) channels to share the same filter data.

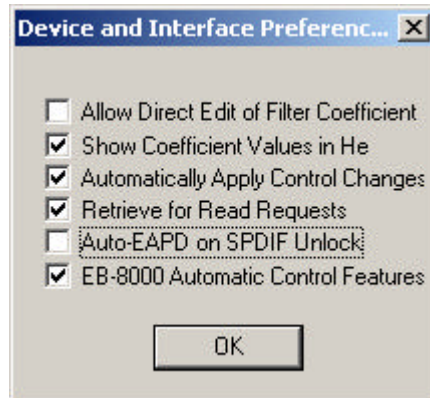


GUI Shot 3. Filter Editor

This is preliminary information on a new product. Details are subject to change without notice.

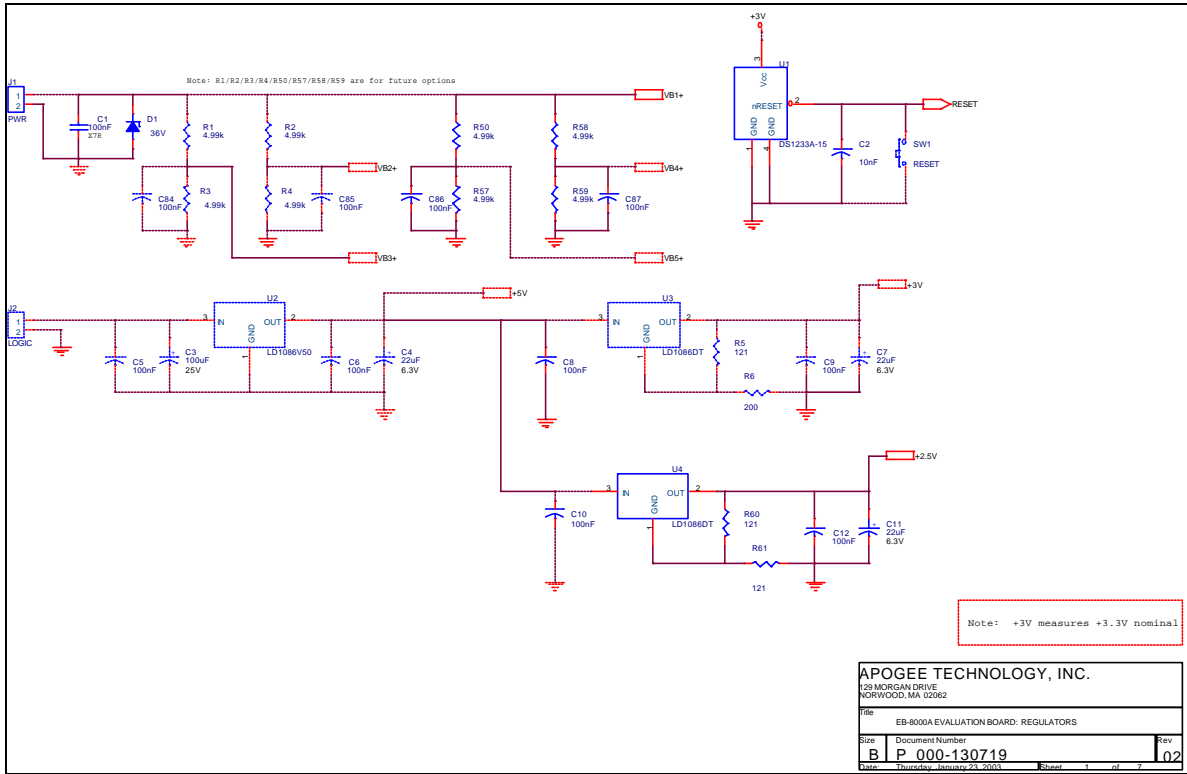
7.4. GUI: DEVICE SETTING FOR I²S INPUT

If audio data input is I2S and NOT S/PDIF, uncheck the “Auto-EAPD on SPDIF Unlock” box in the Device Preferences window. In the GUI, click “Device” in the upper left hand corner of the GUI window. Then select “Preferences” for the Device Preferences window.

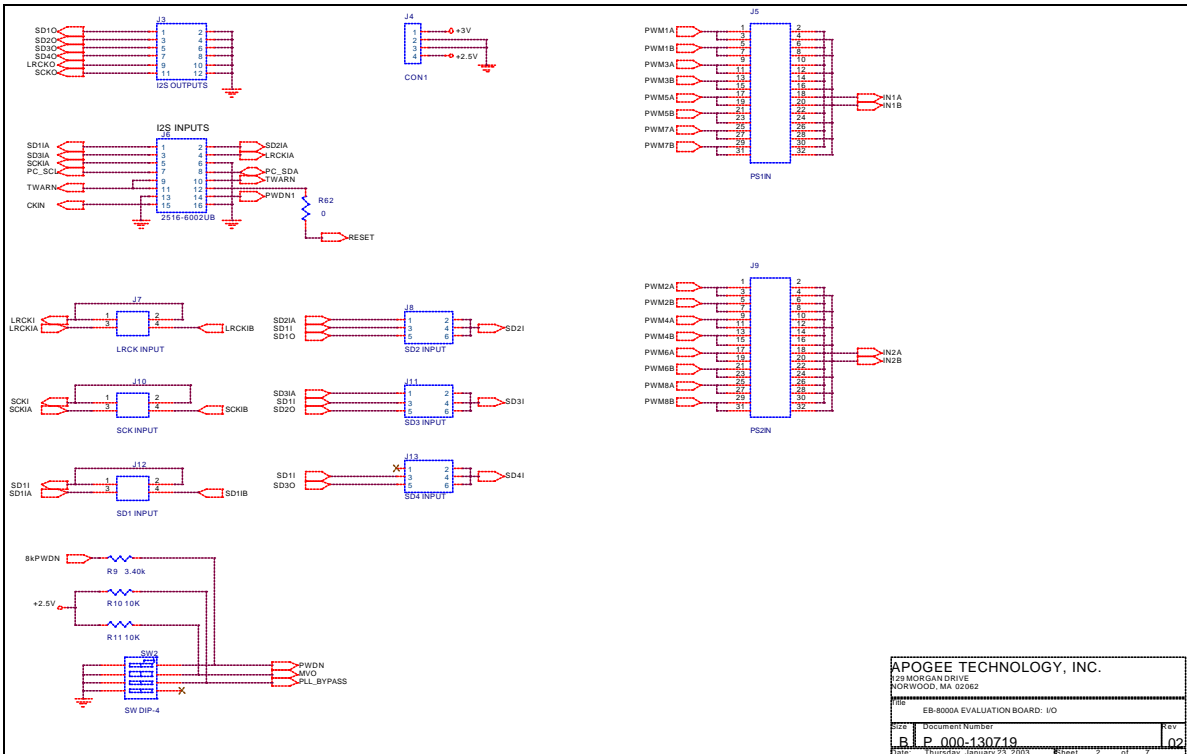


GUI Shot 4. Device Setting for I2S Input

8. EB-8000A SCHEMATIC:

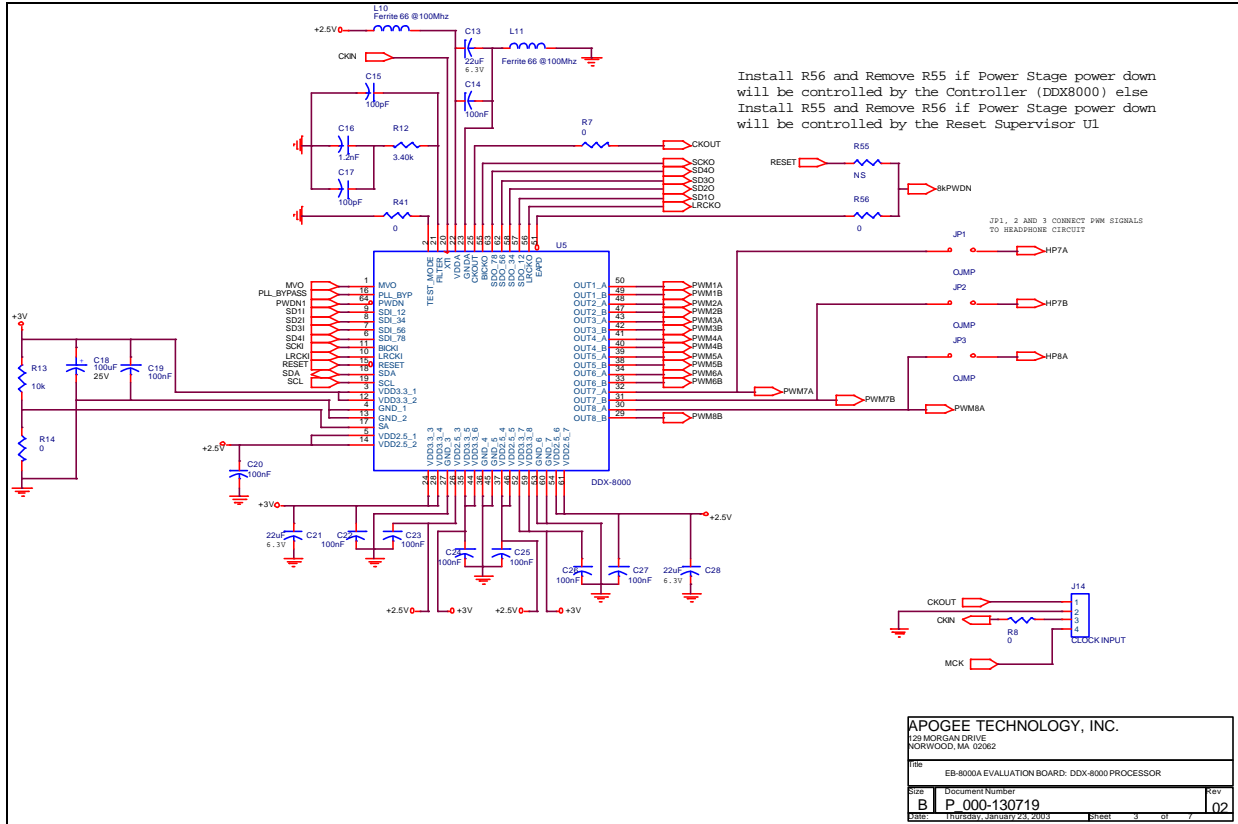


Sheet 1. Regulators, Filters

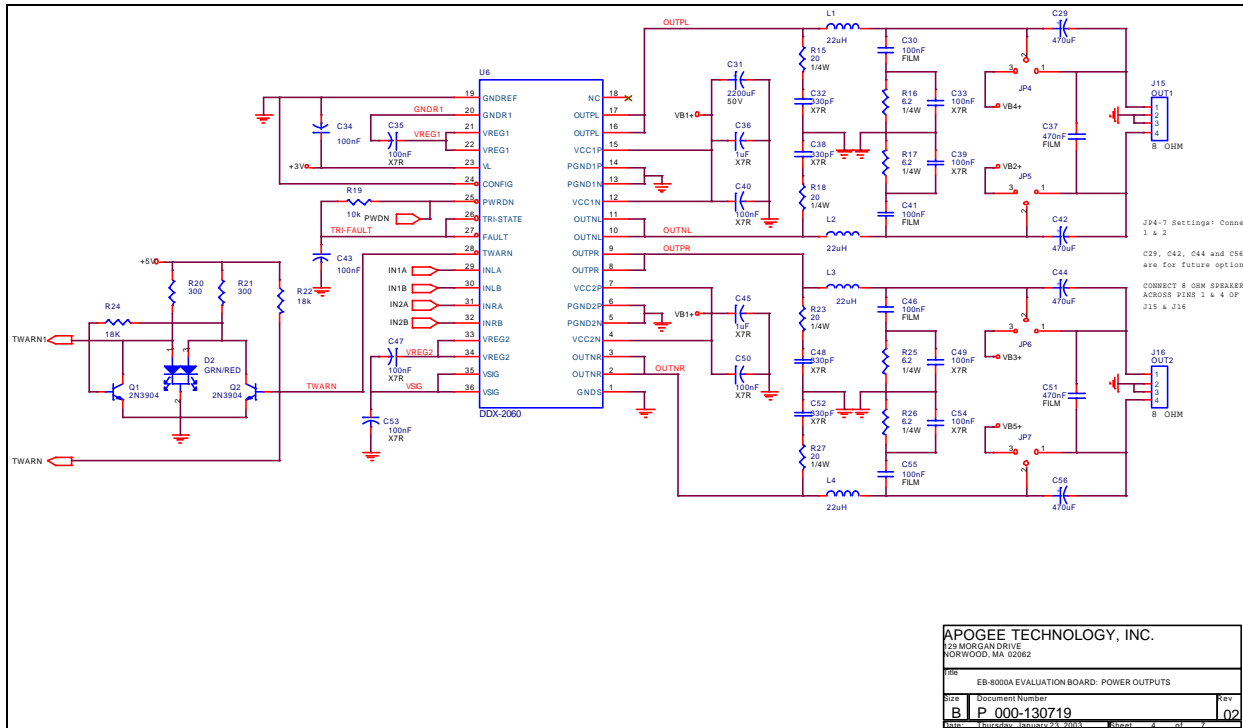


Sheet 2. I/O, Headers

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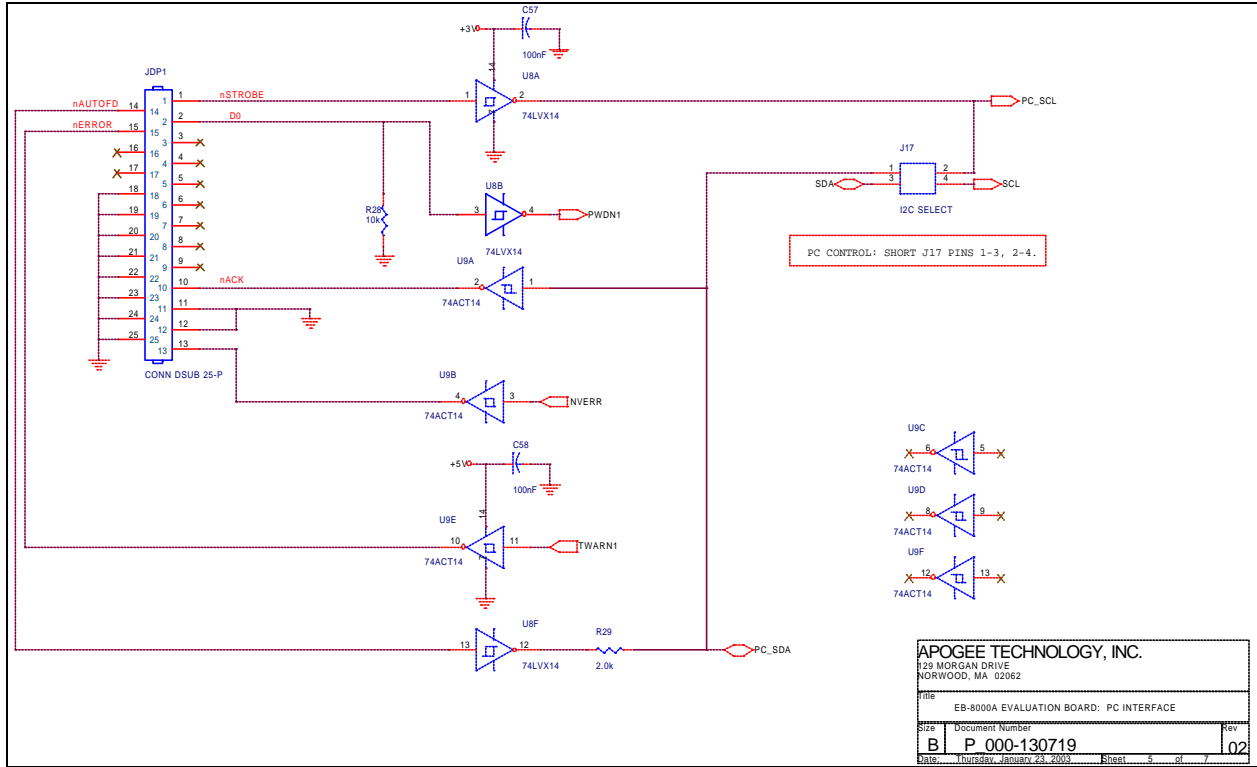


Sheet 3. DDX-8000 Digital Audio Processor

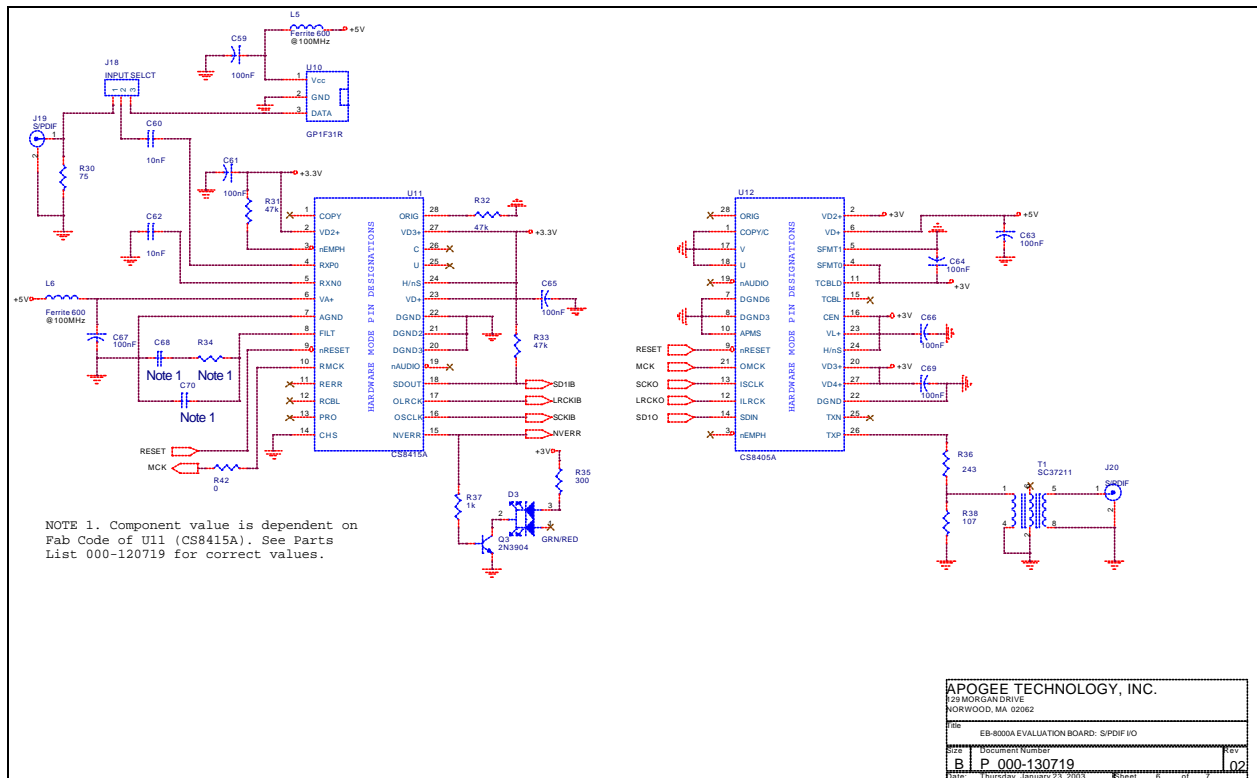


Sheet 4. Outputs

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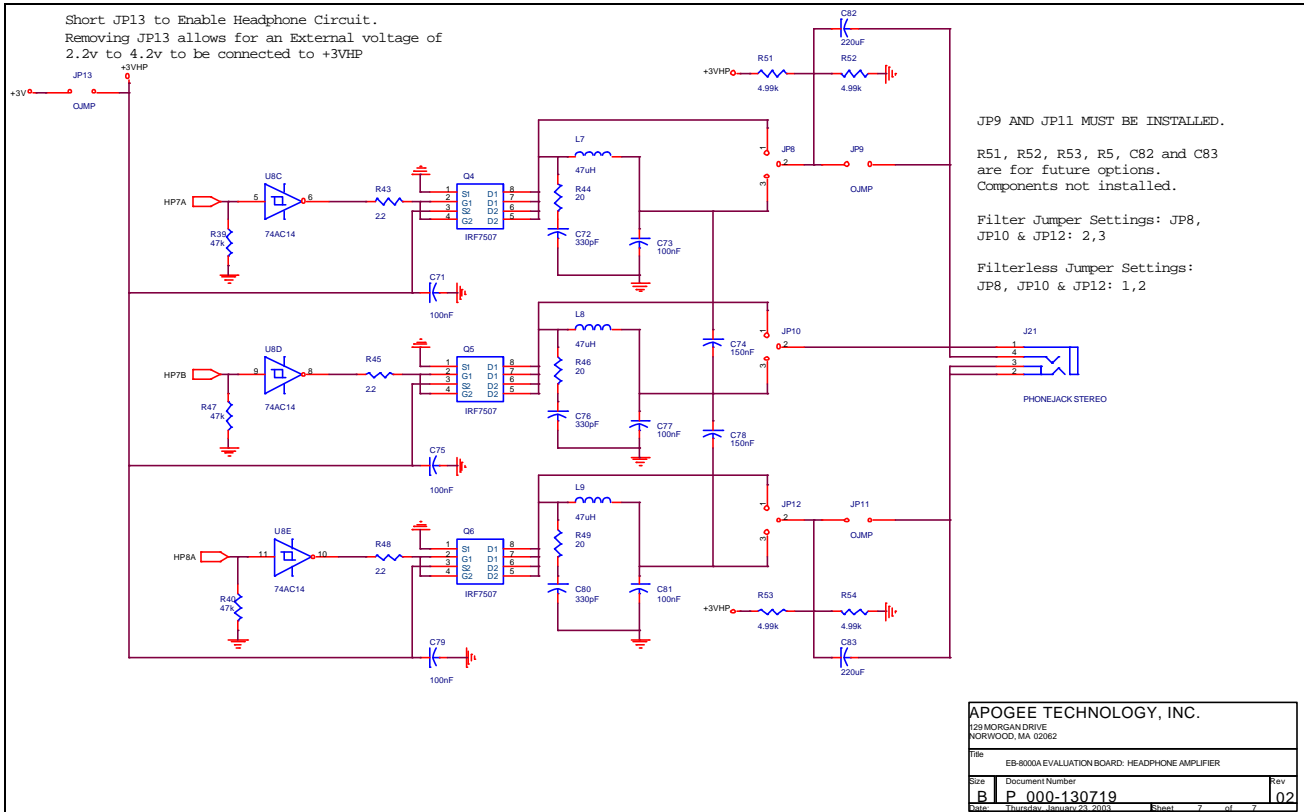


Sheet 5. PC Interface



Sheet 6. S/PDIF I/O Interface

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Sheet 7. Headphone Amp

9. TYPICAL PERFORMANCE CHARACTERISTICS, VCC=28V, 80HM LOADS.

THD vs. Frequency

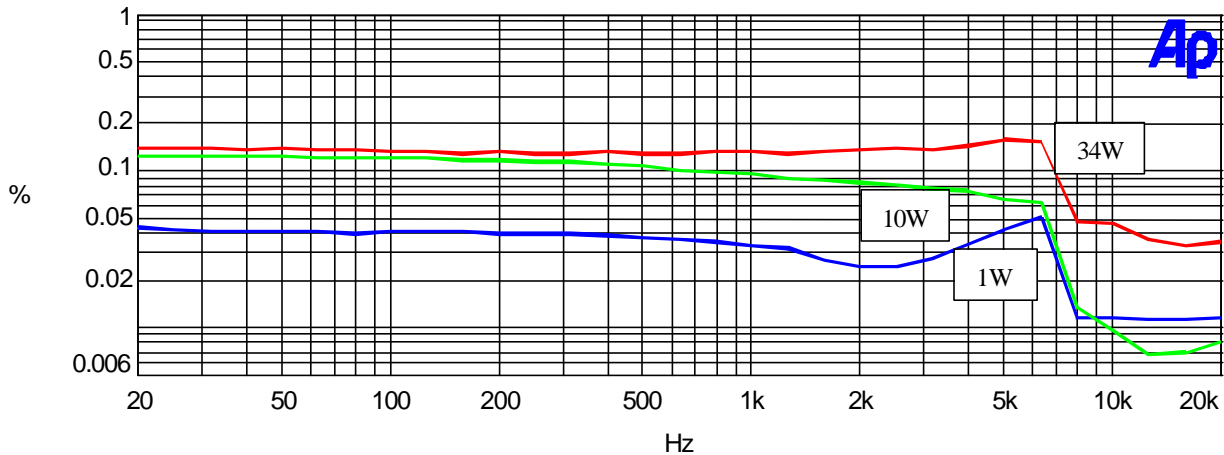


Figure 5. THD vs. Frequency

This is preliminary information on a new product. Details are subject to change without notice.

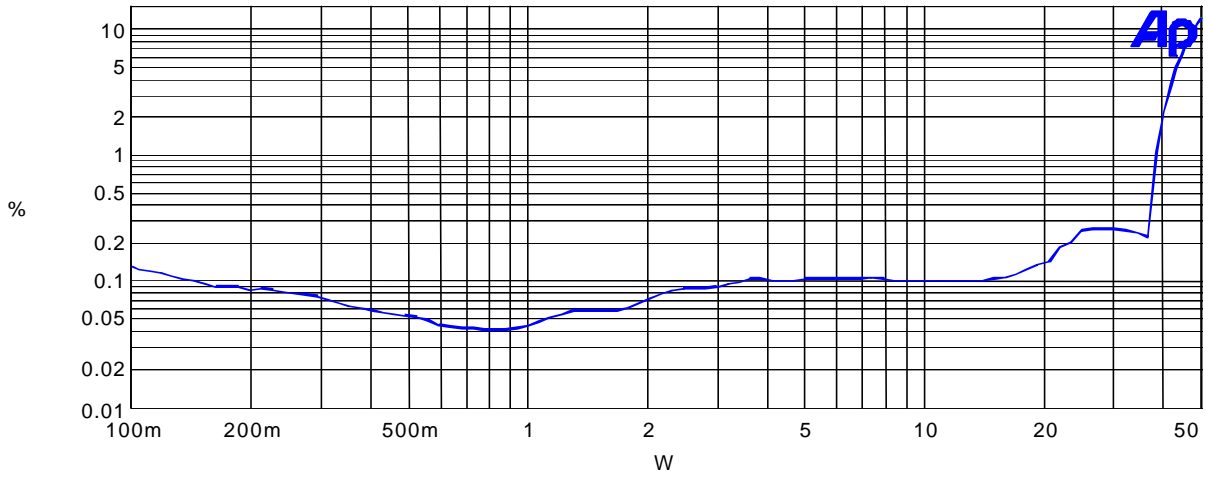


Figure 6. THD vs. Power

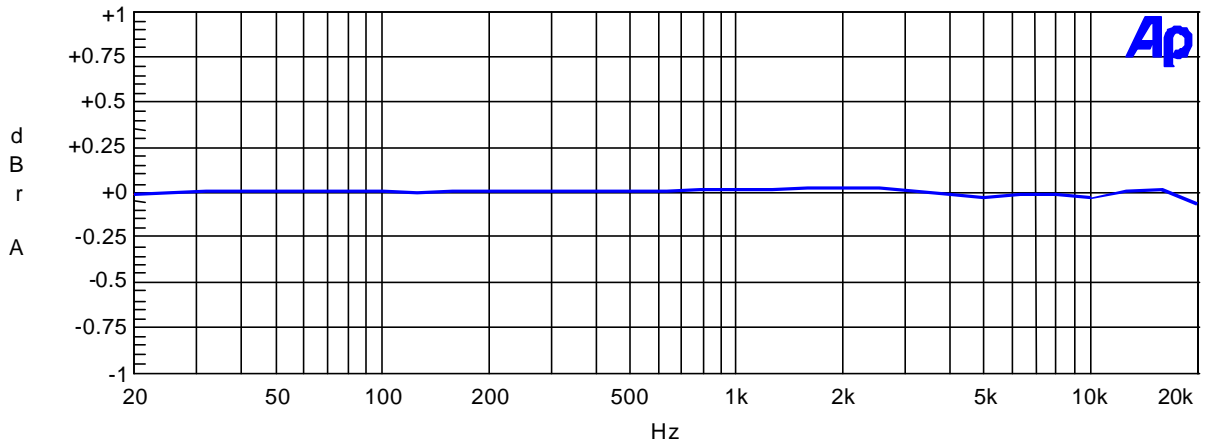


Figure 7. Frequency Response

This is preliminary information on a new product. Details are subject to change without notice.

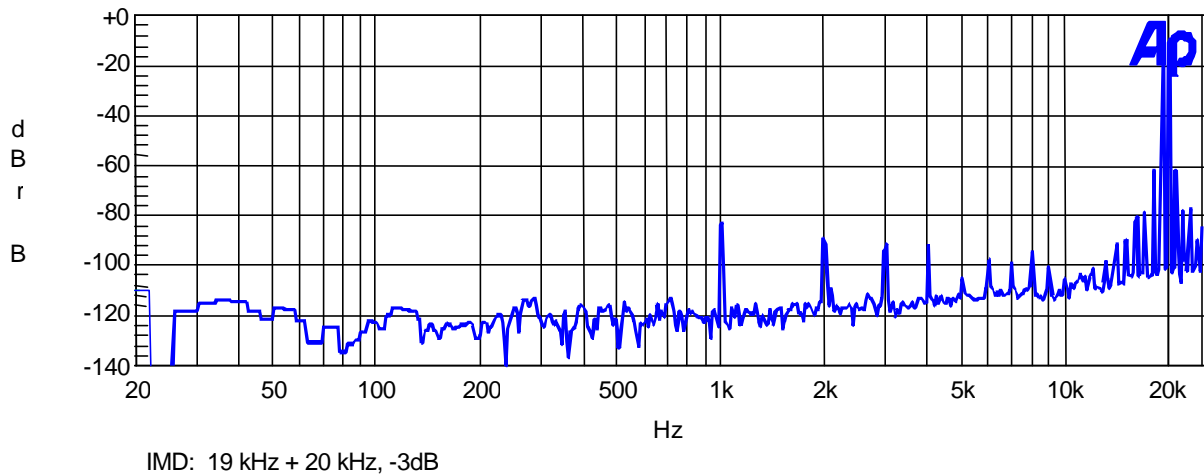


Figure 8. IMD

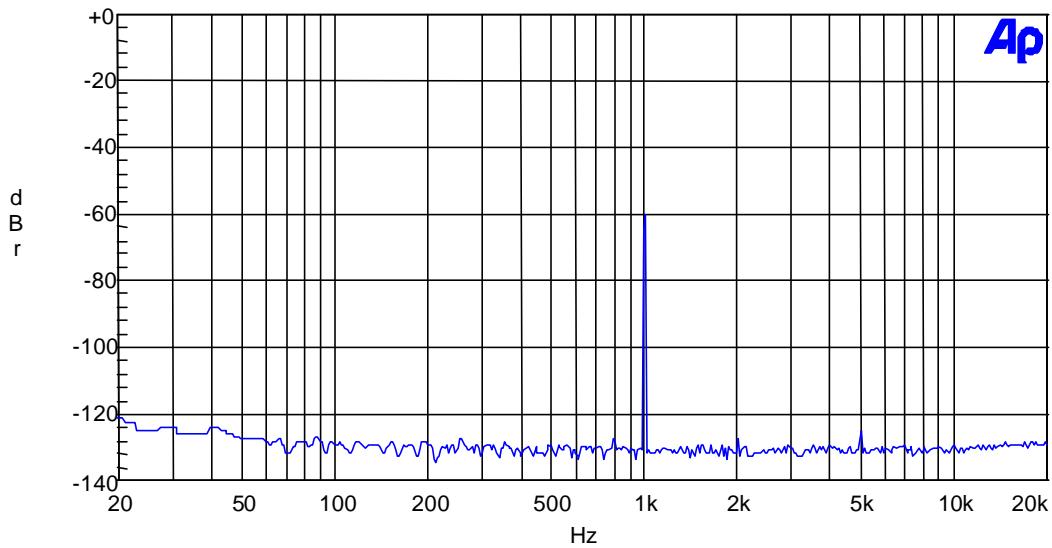


Figure 9. FFT: -60dB, 1kHz Output

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TABLE 1: BILL OF MATERIALS

Reference	Description	Package	Mfr. Part No.	Manufacturer
	Assembly, EB-8000A Ref Board		000-140708	APOGEE
	Schematic, EB-8000A Ref Board		000-130708	APOGEE
	PC Board, EB-8000A Ref Board		721-000326	APOGEE
C5, C6, C8, C9, C10, C12, C14, C19, C20, C22, C23, C24, C25, C26, C27, C34, C43, C57, C58, C59, C61, C63, C64, C65, C66, C67, C69, C71, C73, C75, C77, C79, C81, C84, C85, C86, C87	Capacitor, Ceramic, Y5V, 100nF, 25V, +80/-20%	Chip 0805	ECJ-2V1E104Z	Panasonic
C1, C33, C35, C39, C40, C47, C49, C50, C53, C54	Capacitor, Ceramic, X7R, 100nF, 50V, 10%	Chip 0805	ECJ-2YB1H104K	Panasonic
C74, C78	Capacitor, Ceramic, X5R, 150nF, 10V, 10%	Chip 0603	ECJ-1VB1A154K	Panasonic
C30, C41, C46, C55	Capacitor, Polyester Film, 100nF, 100V, 5%	Radial W3.5/L7.2mm	2222 370 22104	BC Components
ALTERNATE	Capacitor, Ceramic, X7R, 100nF, 50V, 10%	Chip 0805	ECJ-2YB1H104K	Panasonic
C2	Capacitor, Ceramic, X7R, 10nF, 50V, 10%	Chip 0805	ECJ-2VB1H103K	Panasonic
C60, C62	Capacitor, Ceramic, Y5V, 10nF, 50V, +80/-20%	Chip 0805	ECJ-2VF1H103Z	Panasonic
C68 DEFAULT, Fab Code "R"	Capacitor, Ceramic, X7R, 100nF, 25V, 10%	Chip 0805	ECJ-2VB1E104K	Panasonic
C68 ALT., Fab Code "Z"	Capacitor, Ceramic, X7R, 82nF, 25V, 10%	Chip 0805	ECJ-2VB1E823K	Panasonic
C70 DEFAULT, Fab Code "R"	Capacitor, Ceramic, X7R, 4.7nF, 50V, 10%	Chip 0805	ECJ-2VB1H472K	Panasonic
C70 ALT., Fab Code "Z"	Capacitor, Ceramic, X7R, 2.2nF, 50V, 10%	Chip 0805	ECJ-2VB1H222K	Panasonic
C3, C18	Capacitor, Aluminum Electrolytic, FC-Series, 100uF, 25V, 20%	Radial D6.3/H11.2/LS2.5/.5mm	EEU-FC1E101S	Panasonic
C4, C7, C11, C13, C21, C28	Capacitor, Tantalum Electrolytic, 22uF, 6.3V, 20%	EIA Size B	ECS-T0JX226R	Panasonic
C31	Capacitor, Aluminum Electrolytic, M-Series, 2200uF, 50V, 20%	Radial D16/H31.5/LS7.5/.8mm	ECA-1HM222	Panasonic
C29, C42, C44, C56	Capacitor, Aluminum Electrolytic, FC-Series, 470uF, 25V, 20%	Radial D8/H20/LS3.5/6mm	EEU-FC1E471L	Panasonic
C37, C51	Capacitor, Polyester Film, 470nF, 63V, 5%	Radial W4.5/L7.2mm	2222 370 12474	BC Components
C32, C38, C48, C52, C72, C76, C80	Capacitor, Ceramic, X7R, 330pF, 100V, 10%	Chip 0805	ECJ-2VB2A331K	Panasonic
C16	Capacitor, Ceramic, X7R, 1.2nF, 25V, 10%	Chip 0402	ECJ-0EB1E122K	Panasonic
C15, C17	Capacitor, Ceramic, X7R, 100pF, 25V, 10%	Chip 0402	ECJ-0EB1E101K	Panasonic
C36, C45	Capacitor, Ceramic, X7R, 1uF, 50V, 10%	Chip 1812	C1812C105K5RAC	Kemet
C82, C83	Capacitor, Aluminum Electrolytic, FC-Series, 220uF, 6.3V, 20%	Radial D6.3/H11.2/LS2.0/.5mm	EEUFC0J221	Panasonic
D1	Diode, TVS, 1.5KW, Uni-Directional, 36V Standoff, 40VBR, 7% SMCJ	SMCJ	SMCJ36A	Diodes Inc.
D2, D3	LED, T1 3/4, Green/Red, White Diffused	T1 3/4/ 0.1" spacing	LN11WP23	Panasonic
JDP1	D-Sub Connector, 25-pin, Male, Pcb-mount, Right Angle		747238-4	AMP
J3	Header, 12-pin, 2X6, 0.10 spacing.	0.100 Centers	TSW-106-07-S-D-LL	Samtec
J6	Header, 16-pin, 2x8		MHB16K-ND	3M
J15, J16	Connector, Terminal Block Plug, 5.08mm, 14-30 AWG, Four position	4 x 5.08mm	1729144	Phoenix Contact
J1, J2	Connector, Terminal Block Plug, 5.08mm, 14-30 AWG, Two position	2 x 5.08mm	1729128	Phoenix Contact
J5, J9	Header, 32-pin, 2X16, 0.10 spacing.	0.100 Centers	TSW-116-07-S-D-LL	Samtec
J19, J20	RCA Phono connector, Right Angle PCB, Tin Plate		901	Keystone
J18, JP4, JP5, JP6, JP7, JP8, JP10, JP12	Header, 3-pin, 1X3, 0.10 spacing.	0.100 Centers	TSW-103-07-S-S-LL	Samtec
J8, J11, J13	Header, 6-pin, 2X3, 0.10 spacing.	0.100 Centers	TSW-103-07-S-D-LL	Samtec
J7, J10, J12, J17	Header, 4-pin, 2X2, 0.10 spacing.	0.100 Centers	TSW-102-07-S-D-LL	Samtec
J4, J14	Header, 4-pin, 1X4, 0.10 spacing.	0.100 Centers	TSW-104-07-S-S-LL	Samtec
JP1, JP2, JP3, JP9, JP11, JP13	Header, 2-pin, 1X2, 0.10 spacing.	0.100 Centers	TSW-102-07-S-S-LL	Samtec
L1, L2, L3, L4	Inductor, 22uH, 5%, 2.0A, .062 DCR	Radial D8.5/H11/LS5mm		Central Technologies
ALTERNATE	Inductor, 22uH, 10%, 2.0A, .062 DCR			Central Technologies
L5, L6, L10, L11	Ferrite Chip, EMI Suppression, SMD, 600 Ohm @100MHz, 0.5A	Chip 0805	HZ0805E601R-00	Steward
L7, L8, L9	Fixed Inductor Type D73F Series, 47uH		636FY-470M-P3	TOKO
Q1, Q2, Q3	Transistor, NPN, 330mW, 40V CEO, 2N3904 type	SOT-23	FMMT3904	Zetex
Q4, Q5, Q6	MOSFET, Hex Power, IRF7507	Micro8	IRF7507	International Rectifier
R10, R11, R13, R19, R28	Resistor, Chip, Thk Film, 10K, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ103V	Panasonic
R29	Resistor, Chip, Thick Film, 2.0K, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ202V	Panasonic
ALTERNATE	Resistor, Chip, Thick Film, 2.0K, 1%, 1/8W, 200ppm	Chip 0805	ERJ-6ENF2001V	Panasonic
R9, R12	Resistor, Chip, Thick Film, 3.40K, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF3401V	Panasonic
R1, R2, R3, R4, R50, R57, R58, R59	Resistor, Chip, Thk Film, 4.99K, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF4991V	Panasonic
R51, R52, R53, R54	Resistor, Chip, Thk Film, 4.99K, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF4991V	Panasonic
R34, DEFAULT, Fab Code "R"	Resistor, Chip, Thk Film, 1.21K, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF1211V	Panasonic
R34 ALT., Fab Code "Z"	Resistor, Chip, Thk Film, 4.99K, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF4991V	Panasonic
R5, R60, R61	Resistor, Chip, Thk Film, 121, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF1210V	Panasonic
R6	Resistor, Chip, Thk Film, 200, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF2000V	Panasonic
R30	Resistor, Chip, Thk Film, 75, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ750V	Panasonic
R7, R8, R14, R41, R42	Zero Ohm Jumper, SMD 0805	Chip 0805	ERJ-6GEY0R00V	Panasonic
R55, R56	Zero Ohm Jumper, SMD 0805	Chip 0805	ERJ-6GEY0R00V	Panasonic
R62	Zero Ohm Jumper, SMD 0805	Chip 0805	ERJ-6GEY0R00V	Panasonic
R38	Resistor, Chip, Thk Film, 107, 1%, 1/10W, 100ppm	Chip 0805	ERJ-6ENF1070U	Panasonic
R36	Resistor, Chip, Thk Film, 243, 1%, 1/10W, 200ppm	Chip 0805	ERJ-6ENF2430U	Panasonic
R15, R18, R23, R27, R44, R46, R49	Resistor, Chip, Thk Film, 20, 5%, 1/4W, 200ppm	Chip 1210	ERJ-14YJ200U	Panasonic
R16, R17, R25, R26	Resistor, Chip, Thk Film, 6.2, 5%, 1/4W, 200ppm	Chip 1210	ERJ-14YJ6R2U	Panasonic
R43, R45, R48	Resistor, Chip, Thk Film, 2.2, 5%, 1/4W, 200ppm	Chip 1210	ERJ-14YJ2R2U	Panasonic
R20, R21, R35	Resistor, Chip, Thk Film, 300, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ301V	Panasonic
R22, R24	Resistor, Chip, Thk Film, 18k, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ183V	Panasonic

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Reference	Description	Package	Mfr. Part No.	Manufacturer
R37	Resistor, Chip, Thk Film, 1k, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ102V	Panasonic
R31, R32, R33, R39, R40, R47	Resistor, Chip, Thk Film, 47k, 5%, 1/8W, 200ppm	Chip 0805	ERJ-6GEYJ473V	Panasonic
SW1	Switch, Momentary Tact, SMD, 230gf	SMD	B3S-1002	Omron
SW2	DIP Switch, 4-position, Raised-rocker, sealed	DIP	76SB04S	Grayhill
U1	Supervisor, 3.3V Econoreset, DS1233A-15	SOT-223	DS1233A-15/SM	Dallas
U2	Linear LDO Regulator, 5V, 1.5A, LD1086V50	TO-220	LD1086V50	ST Microelectronics
U3, U4	Linear LDO Regulator, Adjustable, 1.5A, LD1086DT	TO-252	LD1086DT	ST Microelectronics
U11 (Note 1)	Digital Audio Interface Receiver IC, CS8415A	SOIC-28	CS8415A-CS	Crystal/Cirrus logic
U12	Digital Audio Interface Transmitter IC, CS8405A	SOIC-28	CS8405A-CS	Crystal/Cirrus logic
T1	Digital Audio, SMT Transformer		37211	Scott Corporation
U5	DDX-8000 Digital Processor, 8 Channels	TQFP-44	DDX-8000	APOGEE
U6	DDX-2060 Power IC, 35W x 2-Channels	POWERSO-36	DDX-2060	APOGEE
U8	Hex Inverter, Schmitt-Trigger, Low-Voltage, 74AC14	SOIC-14	74AC14SC	Fairchild
U9	Hex Inverter, Schmitt-Trigger, TTL Compatible, 74ACT14	SOIC-14	74ACT14FN	Toshiba
U10	Foslink Light Receiving Unit	Radial	GP1F31R	Sharp
J21	3.5mm Rt Angle PCB Mount Jack, Stereo		SJ-3504	CUI Stack
J5(2), J7, J8, J9(2), J10, J11, J12, J13, J14, J17(2), JP1-JP12, JP13 & J18	Shorting Jumper		SPC02SYAN	Sullins Electronic Corp
	Bumpon, hemisphere, black, 0.44"W x 0.20"H		SJ-5003 Black	3M

NOTES:

1. Use 1 EA DEFAULT parts when ITEM 63 (CS8415A) has Fab Code "R" and "ALT Parts with Fab Code "Z"
2. Note: R51, R52, R53, R54, C82 & C83 are for future options
3. Install R56 and Remove R55 if Power Stage power down will be controlled by the Controller (DDX-8000) else Install R55 and Remove R56 if Power Stage power down will be controlled by the Reset Supervisor U1.

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