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Evaluating the SSM2804 Audio Subsystem

FEATURES

Accepts either differential or single-ended inputs
Full featured evaluation board for the SSM2804
PCB footprint for optional EMI filter
Includes USB hardware interface for plug-and-play operation
Microsoft Windows-based evaluation software with simple graphical user interface

EQUIPMENT NEEDED

Audio source with ⅛" male stereo plug or 0.100" header
Power supply (5.0 V, 2.0 A recommended)
EVAL-SSM2804Z board
PC running Windows XP or later; USB 2.0 port required
Stereo speakers, headphones, or other load

DOCUMENTS NEEDED

SSM2804 data sheet

SOFTWARE NEEDED

SSM2804 evaluation software

GENERAL DESCRIPTION

The SSM2804 evaluation board is a complete solution for driving two loudspeakers as well as a set of stereo headphones. It includes the SSM2804 amplifier IC and the additional components needed to connect the I^{2}C bus to a personal computer using a universal serial bus (USB) connection.

The SSM2804 features an I^{2}C interface with many useful settings. Using the I^{2}C control interface, the gain of the SSM2804 input stage can be adjusted over a 30 dB range in steps of 1 dB. Other features available when using the I^{2}C interface include full volume control of the Class-D amplifier output stage and the Class G headphone amplifier output stage, independent functional block shutdown, input channel routing and mixing through the subsystem, EMI emission control modes, speaker protection including automatic level control (ALC), and headphone output power limiting.

This user guide describes how to use the EVAL-SSM2804Z to test the features of the SSM2804 stereo amplifier. It describes the hardware and software of the SSM2804 evaluation board, including detailed schematics and PCB layout artwork.

The SSM2804 data sheet, available at www.analog.com/SSM2804, provides detailed information about the specifications, internal block diagrams, and application guidance for the amplifier IC.

The SSM2804 evaluation software can be downloaded from www.analog.com/SSM2804. Click **Evaluation Boards & Kits** and choose the appropriate Windows® version (32-bit or 64-bit).

TYPICAL CONFIGURATION

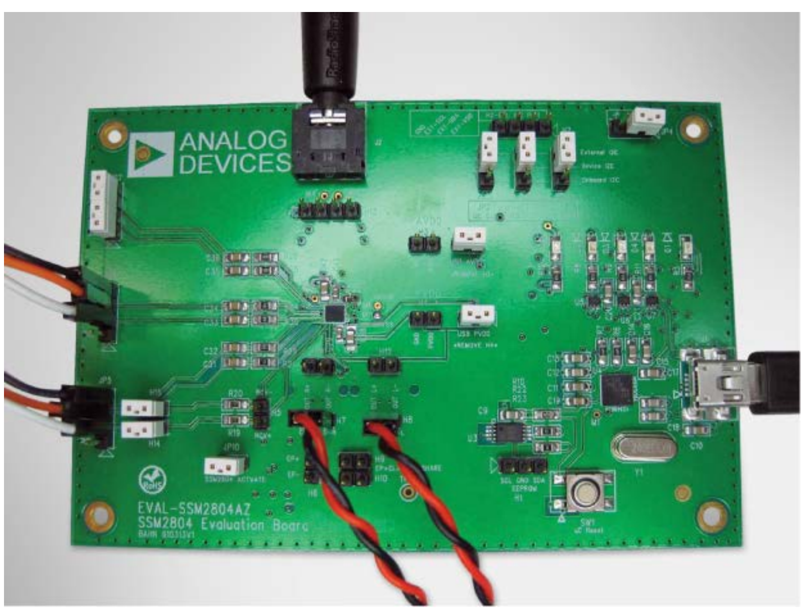

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Figure 1. Typical Configuration with USB Interface, USB Power, Two Inputs, and Headphone and Class-D Outputs

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REVISION HISTORY

1/12—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

The SSM2804 evaluation board provides all of the support circuitry required to operate the SSM2804 amplifier, including a computer interface for the I^{2}C bus. Figure 1 shows the typical bench characterization setup used to evaluate the audio performance of the SSM2804. See the Evaluation Board Software Quick Start Procedures section to get started.

POWER SUPPLIES

The SSM2804 requires two external dc power supplies: PVDD and AVDD. PVDD voltages between 2.7 V and 5.5 V and AVDD supply voltages between 2.5 and 3.6 V are accepted. Note that PVDD supply currents may exceed 1 A, depending on supply voltage and load impedance.

H3 and H4, 2-pin 0.100" male headers, are provided to connect external supplies to the PVDD and AVDD supply rails. Alternatively, a 5 V USB power supply can be used to power the chip, although the USB 2.0 specification only allows a total current draw of up to 500 mA. JP8 is used to connect USB power to the PVDD rail, and JP9 is used to connect USB power to the AVDD rail. These jumpers are shown in Figure 2.

Be sure to remove JP8 when using an external power supply, because this shorts the USB voltage to the external supply. Conversely, be sure to remove the external supply from H4 when using USB power. Be cautious of supplying any significant amount of power when using the USB port.

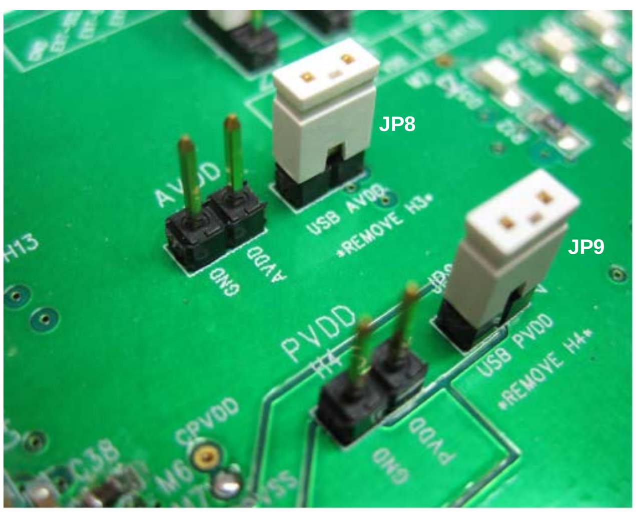

Figure 2. Connecting USB Power Supply to AVDD and PVDD

INPUT SIGNALS

On the left side of the PCB are three 4-pin headers: JP5, JP6, and JP7. These are used to connect the input audio signals to the amplifier. If the input audio signal is differential, use the two center pins (for example, INA1 and INA2) for the inverting and noninverting signals. For clarity, in this configuration, the two signals are called INA+ and INA– to emphasize their differential nature. Connect either the top or the bottom pin to the source/signal ground.

For single-ended audio inputs, each channel can be used as a stereo input. In this configuration, the signals on the INA1 and INA2 pins are called INAL and INAR, respectively. These signals are referred to a source ground, which should be connected to the top or bottom GND pin of the header.

OUTPUT SIGNALS

Each channel of the amplifier output is available at two 2-pin 0.100" headers: H8 and H12 for the left channel, and H7 and H11 for the right channel. The speakers are connected in bridge-tied load (BTL) configuration, and the output pins are labeled with their polarity; for example, OUT L+ indicates the left channel noninverting terminal.

In the standard filterless configuration, the two headers on each channel are connected with 0 Ω links on the pads marked B1 to B4. In this case, the two headers on each channel are tied together and can be used interchangeably as attachment points for the load and an audio analyzer. The EMI filtering is not populated on the SSM2804 evaluation board to allow proper measurement of key parameters such as SNR and THD.

A ferrite bead-based EMI filter can be implemented using the B1 to B4 and C43 to C50 footprints on the secondary side. If this filtering is used, only H7 and H8 connect at the proper location with respect to the filter components—the load must be connected to these headers. Measurements of the unfiltered waveform can be taken at H11 and H12.

Finally, a ground-referred Class-G headphone output is available on J2 and H13. J2 is an ordinary 0.125" headphone jack, and H13 is a 4-pin 0.100" header connected to the same signals. The left and right channels are connected to the center pins; the outer pins connect to the headphone common.

SHUTDOWN AND MODE JUMPERS

A 2-pin jumper, JP10, is used to enable and disable the SSM2804 amplifier. Inserting a jumper across JP10 pulls the $\overline{SD}$ pin to the SPKVDD supply rail, activating the amplifier. Removing the jumper from JP8 shuts down both channels of the SSM2804 so that minimal current (about 20 nA) is drawn from the power supply.

RECEIVER SWITCH

The SSM2804 includes an integrated receiver bypass switch that can be configured to pass an audio signal directly from the input to the output.

The switch inputs, RCV+ and RCV−, are connected to the 2-pin header, H5. In addition, the receiver inputs can be connected to the INA1 and INA2 input headers by shorting across H14 and H15 with two jumpers. To protect the switch in the case of a short circuit or other fault condition,12 Ω series resistors (R19 and R20) are included in the signal path

The switch outputs, EP+ and EP−, are connected to the 2-pin header, H6. Alternatively, the outputs can be tied directly to the right channel Class-D outputs (H7 and H11) by shorting across H9 and H10 with two jumpers.

LEDS

The LEDs provide feedback to the user about the status of the Cypress USB microcontroller. The function of each LED is shown in Table 1.

Table 1. LED Functions

Reference Designator	Color	Function
D1	Red	5 V power is supplied over the USB bus
D2	Yellow	I^{2}C mode is active
D3	Blue	GPIO LED, for firmware debug purposes
D4	Yellow	SPI mode is active
D5	Blue	USB power switch enabled (USB_PWR_ON)

EEPROM

The USBi has an EEPROM on the I^{2}C bus at Address 0x51, which it uses to indicate its vendor ID and product ID to the PC, as well as to boot its internal program. The EEPROM is an important system element that identifies the board to the host PC and stores the firmware for the Cypress USB interface. The EEPROM is programmed during manufacturing via the H1 connector.

Avoid having any other EEPROMs in your system design at this address. This EEPROM is not write-protected; therefore, an attempt to write to Address 0x51 overwrites the USBi's on-board EEPROM, and the USBi will cease to function. The USBi cannot be reprogrammed without returning it to Analog Devices, Inc.

USB POWER SWITCH

The SSM2804 evaluation board is capable of taking 5 V power from the USB port after the Cypress USB microcontroller has finished its boot-up process. The USB_PWR_ON signal, which can be set in the SSM2804 software, appears on one pin of the Cypress microcontroller. This signal controls Q1 and Q2, which create a connection between USB power and the supply rail. D5, a blue LED, lights up when this supply is activated. Note that the current available from the USB bus is limited; therefore, the amplifier power stage may not drive low impedance loads properly.

I^{2}C SOURCE JUMPERS

If an external I^{2}C source is to be used, place the JP1, JP2, and JP3 jumpers such that they connect the device I^{2}C lines to the external I^{2}C lines. Otherwise, they should connect the device I^{2}C lines to the on-board I^{2}C lines, as shown in the red rectangular area of Figure 3. If an external I^{2}C is used, an external I^{2}C source can be attached to H2, following the silkscreen labels displayed on the board.

The voltage of the external I^{2}C interface should match the value set on JP4; the two voltages are taken from two separate on-board regulators. The on-board I^{2}C interface works properly in either configuration.

For the Cypress USB microcontroller to boot properly from the EEPROM, it may be necessary to power down (or disconnect) any other devices from the I^{2}C bus, including the SSM2804. In this case, remove the external 5 V supply while the USB connection is first established, or remove the JP2 and JP3 jumpers and replace them only after the connection is activated.

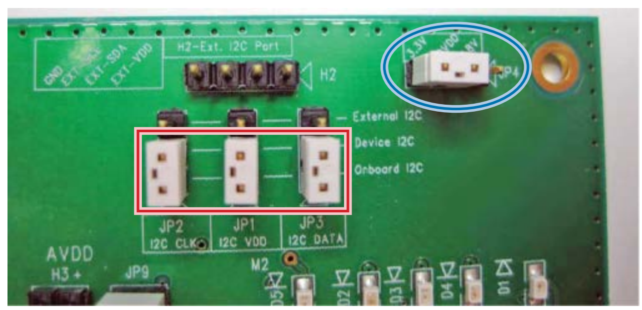

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Figure 3. Jumpers as Configured for On-Board I^{2}C Operation

EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

SSM2804 CONTROL SOFTWARE SETUP

Do not connect the evaluation board until software is installed. The SSM2804 software interface requires Microsoft® .NET Framework (Version 2.0 or later). The installer automatically downloads it if .NET Version 2.0 is not already installed.

To install the control software, use the following steps:

1. Go to www.analog.com/SSM2804.
2. Click **Evaluation Boards & Kits**.
3. Choose the appropriate Windows version (32-bit or 64-bit) to download.
4. Extract the SSM2804 zipped installation file to a convenient location and double-click **setup.exe** to begin the installation process. Follow the installation instructions when prompted.
5. The software and USB drivers are installed in **C:\Program Files\Analog Devices Inc\SSM2804**.

SSM2804 USB Driver Installation

Before connecting the SSM2804 evaluation board to a PC or notebook, the following procedure may need to be completed. (This procedure only needs to be executed once on each computer that uses the SSM2804 software. This procedure can be skipped if the user has previously installed any SigmaStudio or USBi related drivers from Analog Devices.)

1. Exit the SSM2804 user interface software.
2. Remove jumpers from JP1, JP2, and JP3, located at the top of the evaluation board, to completely isolate the Cypress USB driver from the SSM2804.
3. Connect JP4 in the 3.3 V location as shown in the blue circled area of Figure 3. The purpose of this is to power the Cypress USB controller to establish communication between the software and the board.
4. Make sure the software is closed. Connect the SSM2804 evaluation board to the PC via the USB cable.
5. The PC recognizes the new hardware. When the hardware is recognized, a prompt asks to let Windows find the proper drivers for the hardware. Do not let Windows install the drivers.
6. You must direct the driver installation to the following path by clicking the **Browse** tab: **C:\Program Files\Analog Devices Inc\SSM2804**
7. After the path has been properly selected, you can continue with the driver installation process. Windows properly establishes the link between the Cypress USB controller and the PC.
8. After the previous steps are followed, you can run the SSM2804 control software. The software is located at the following path: **C:\Program Files\Analog Devices Inc\SSM2804\SSM2804.exe**.
9. For quick access to this software, the installer creates a shortcut from the **SSM2804.exe** file to the desktop.
10. If all steps were properly followed, at the top of the SSM2804 software window, a status message of **USBi Connected** appears. If the installation was not successful, a message of **USBi – Cannot Find Device** appears.
11. After a successful installation, the SSM2804 software recognizes a connection from the PC to the SSM2804 evaluation board. There is no need to adjust the jumper positions of JP1, JP2, and JP3, but they should be connected as shown in Figure 3.

Uninstall SSM2804 Control Software

To uninstall the software, follow these steps:

1. Locate the directory where the SSM2804 zipped installer file was extracted.
2. Double-click **setup.exe**. Simply select **Uninstall** to remove the software from the host PC.

INITIAL SSM2804 HARDWARE SETUP

To allow the SSM2804 software to control the SSM2804 evaluation board, you must make a few simple jumper connections:

1. Connect the bottom and middle terminals of each jumper (JP1, JP2, and JP3). The purpose of this is to connect the on-board Cypress USB-I^2C interface to the SSM2804. The signals connected are I^2C VDD, I^2C CLK, and I^2C DATA.
2. Connect JP4 in one of two positions, 1.8 V or 3.3 V, to choose an I^2C supply rail. These two voltages come from separate on-board LDOs. The SSM2804 control interface works well under either of these I^2C supply voltage conditions.

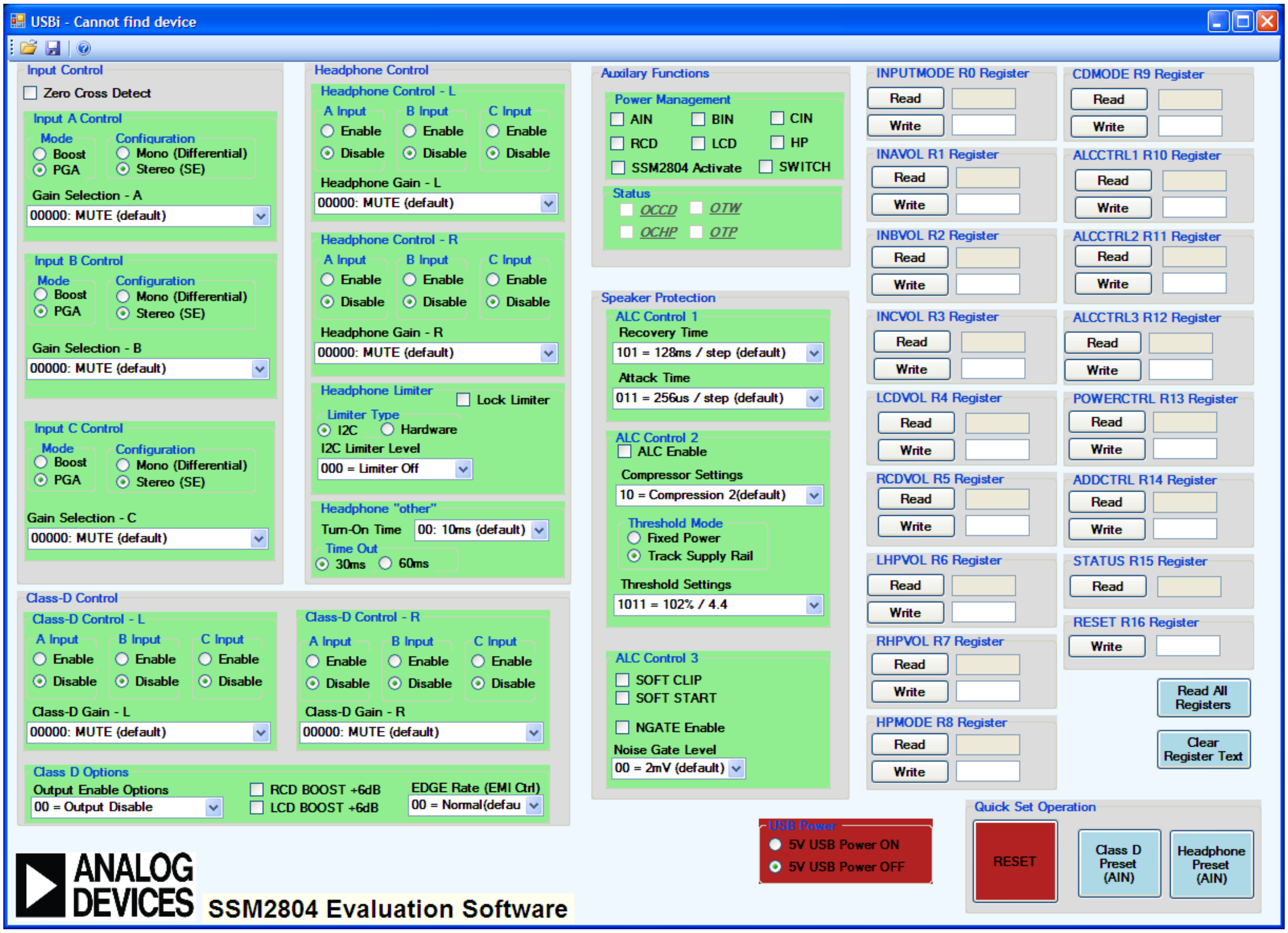

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Figure 4. SSM2804 Evaluation Software

SSM2804 GUI FUNCTIONAL BLOCKS

The SSM2804 control software is logically split into several different functional blocks. Each functional block is split into individual subsections. For details of the individual register functions, refer to the SSM2804 data sheet.

Note that when the power supply of the SSM2804 is interrupted, you must reset the SSM2804 software to synchronize with the device. Simply click the red **RESET** button at the bottom-right corner of the software window (see Figure 4).

INPUT CONTROL

This section controls the gain and configuration of the three input channels.

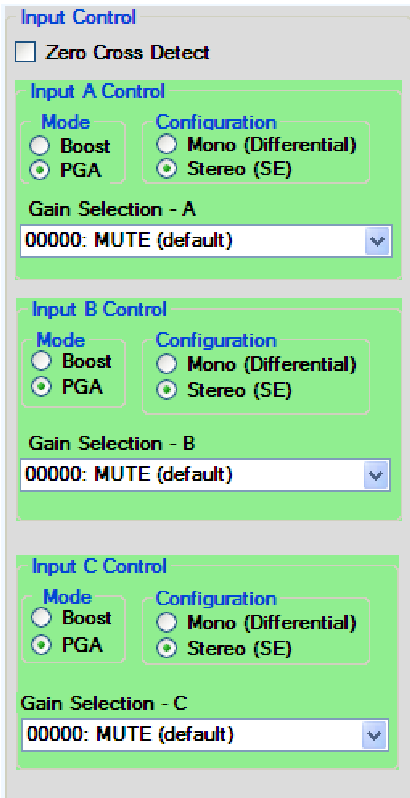

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Figure 5. Input Control Section of SSM2804 GUI

Input Channel Mode Control (Register 0x00)

This allows independent selection of the various operating modes for each of the three input channels. The configuration can be set to either **Mono (Differential)** or **Stereo (SE)**, and either the fixed-impedance **Boost** mode or the adjustable impedance **PGA** mode can be chosen.

This register also controls the zero-cross detector, which forces gain changes to occur at a zero-crossing event to reduce the audible pop caused by a discontinuity in the audio signal.

Channel A, Channel B, and Channel C Input Volume (Register 0x01, Register 0x02, Register 0x03)

These registers are used to adjust the gain for each input stage. If PGA mode is selected using the appropriate bit in Register R0 (0x00), this control offers gain adjustments with 1 dB resolution between −12 dB and +18 dB. If boost mode is selected, the gain is restricted to three preset values.

CLASS-D CONTROL

This section contains the channel mixing, gain, and EMI control settings for the Class-D speaker driver.

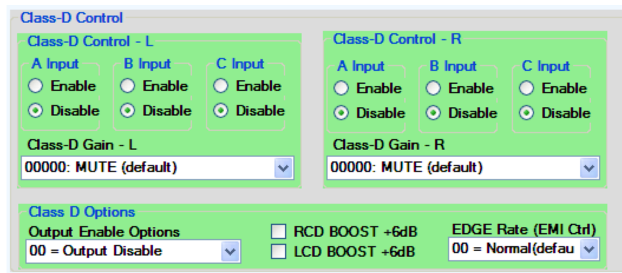

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Figure 6. Class-D Control Section of SSM2804 GUI

Class-D Gain—Left/Right (Register 0x04, Register 0x05)

These registers provide independent 32-level volume controls for each channel. The gain reduction ranges from 0 dB to −75 dB, plus a mute setting.

Class-D Enable and Mixer (Register 0x08)

Input A, Input B, and Input C can be individually mixed into the two channels of the Class-D output by setting the appropriate bits in Register 0x08.

Class D Boost (Register 0x0C) and EMI Control (Register 0x0E)

An additional 6 dB boost is available on each Class-D output channel, if needed. The left and right channel boost can be enabled by selecting the **RCD BOOST** and **LCD BOOST** options.

In addition, four levels of edge rate control for the Class-D output are available, allowing for improved electromagnetic interference (EMI) reduction. **Slow**, **Slow –**, and **Slow ––** represent progressively slower transitions in the output stage, which correspond to decreased EMI emissions.

SPEAKER PROTECTION CONTROL

This section controls the automatic level control (ALC) of the SSM2804.

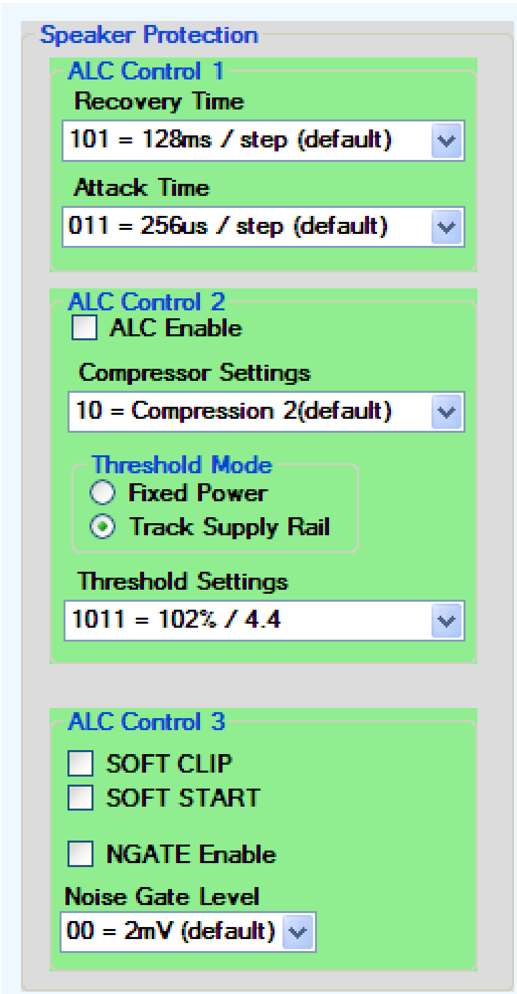

Figure 7. Output Control Section of SSM2804 GUI

ALC Control 1 (Register 0x0A)

This section allows you to adjust the attack and recovery time for the ALC. For details, see the SSM2804 data sheet.

ALC Control 2 (Register 0x0B)

This section allows you to enable ALC operation, to set the compressor operation mode (light to heavy compression and limiting), to set the limiter level, and to set the limiter mode.

There are two limiter modes: fixed power and supply tracking. Fixed power mode sets the output limiter level to a fixed value, independent of the power supply rail. Supply tracking mode sets the limiter as a percentage of SPKVDD.

Note that, if you intend to change the gain setting register, R0 or R1, you must toggle the **ALC Enable** check box to allow the new gain settings to take effect.

ALC Control 3 (Register 0x0C)

This section controls the soft clip and soft start modes, the noise gate enable, and the noise gate level.

HEADPHONE CONTROL

This section controls the auto level control (ALC) of the SSM2804.

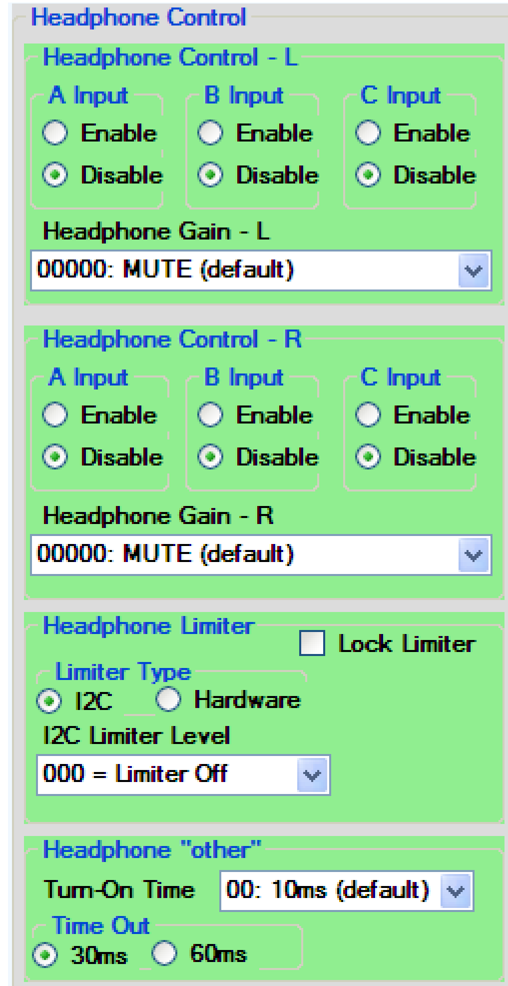

Figure 8. Headphone Control Section of SSM2804 GUI

Headphone Gain—Left/Right (Register 0x06, Register 0x07)

These registers provide independent 32-level volume controls for each channel. The gain reduction ranges from 0 dB to −75 dB, plus a mute setting.

Headphone Mixer (Register 0x08)

Input A, Input B, and Input C can be individually mixed into the headphone output by setting the appropriate bits in Register 0x08.

Headphone Turn-on Time and Timeout (Register 0x08)

The headphone turn-on time controls the duration of the soft turn-on when the headphone output is enabled. This is related to the amplitude of the pop-click discontinuity when the headphone output is enabled.

AUXILIARY FUNCTIONS

This section allows user access to the power management control registers, current/thermal fault recovery, mixing operation, and edge rate control.

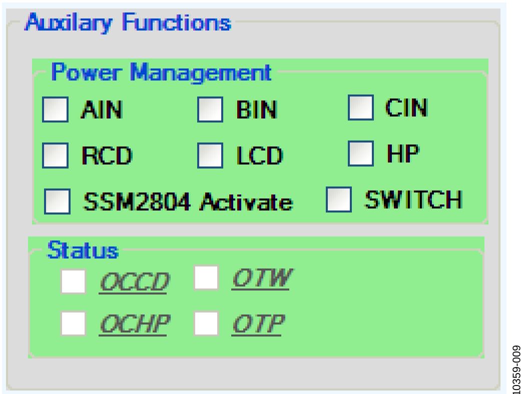

Figure 9. Auxiliary Function Section of SSM2804 GUI

Power Management (Register 0x0D)

To enable the SSM2804, select the **SSM2804 Activate** option. Individual blocks can be enabled as needed.

Status (Register 0x0F)

This section is associated with Control Register R6 (0x06). Each box is a read-only indicator that is activated when a particular fault condition is encountered. It does not update unless the R6 **Read** button is clicked, as detailed in the Direct I^{2}C Register Access section. This feature is only active if the fault recovery options (overcurrent autorecovery and overtemperature autorecovery) are enabled.

QUICK SET BUTTONS

The GUI includes a collection of buttons to switch to several predefined configurations quickly. See Figure 10 and the following three sections for details.

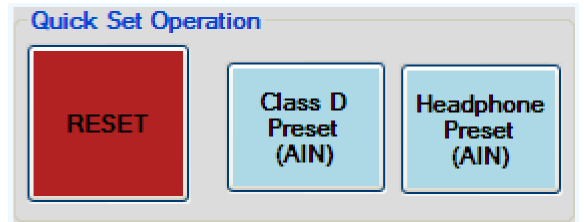

Figure 10. Preset Button Section of SSM2804 GUI

RESET

RESET first initializes the SSM2804 by writing all 0s to Control Register R8 (0x08). It then clears all previously stored read/write windows and ensures that all registers are set to the proper default value. The **RESET** button should be clicked every time power is disrupted from the SSM2804 to synchronize the SSM2804 to the control software.

Class-D Preset (AIN)

By clicking the **Class D Preset** button, the following occurs:

- Input A is enabled as a stereo, single-ended PGA input. The gain is set to 0 dB.
- Stereo Class-D output is enabled, and the mixer is configured to pass Input A to both channels. The Class-D gain is set to 12 dB.
- In the **Power Management** section, the SSM2804 is activated. Input A and both channels of the Class-D output are enabled.

Headphone Preset (AIN)

By clicking the **Headphone Preset** button, the following occurs:

- Input A is enabled as a stereo, single-ended PGA input. The gain is set to 0 dB.
- Stereo headphone output is enabled, and the mixer is configured to pass Input A to both channels. The headphone gain is set to −3 dB.
- In the **Power Management** section, the SSM2804 is activated. Input A and the headphone amplifier are enabled.

DIRECT I²C REGISTER ACCESS

Within each subsection is direct access to the associated I²C control register. Data can be directly written to the control register by typing the register data byte in hexadecimal format in the desired register write box (see Figure 11). Click the **Write** button when you are ready to send this data to the SSM2804. The associated subsection options from the main GUI section are also updated. You can also check the register contents by clicking the **Read** button. The register contents are displayed in the box next to each button.

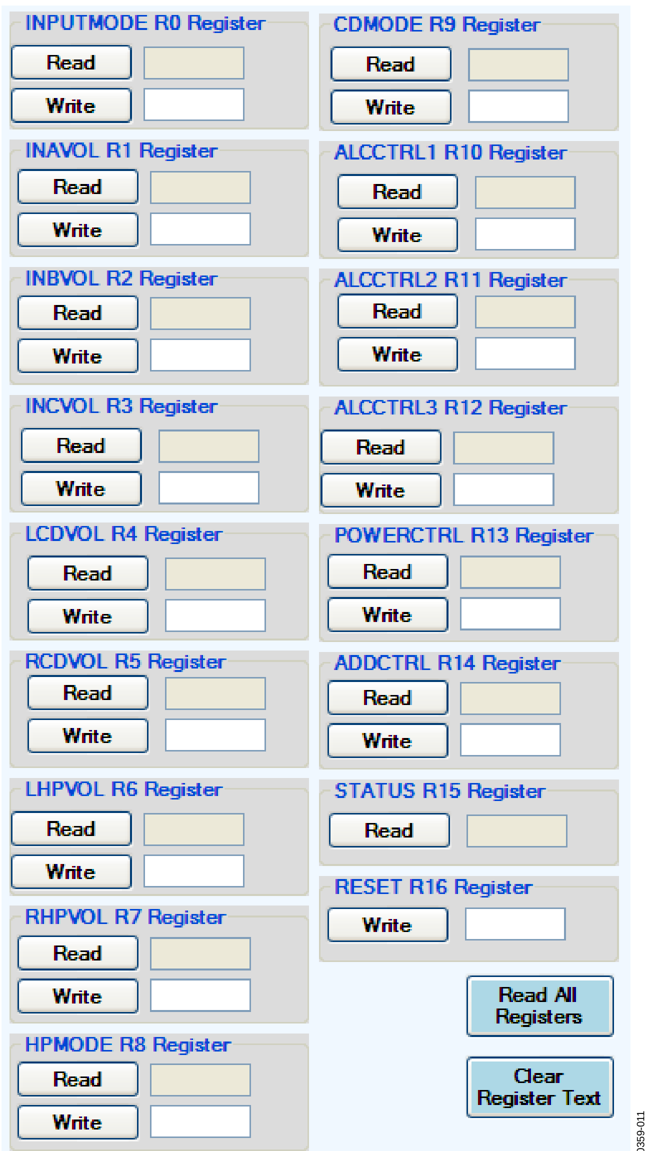

Figure 11. I2C Register Direct Control of SSM2804 GUI

USB POWER

The 5 V power switch, described in the USB Power Switch section, is activated by clicking **5V USB Power ON** as shown in Figure 12.

Figure 12. USB Power Control

USB—I²C INTERFACE

GENERAL DESCRIPTION

The EVAL-ADUSB2EBZ, also known as the USBi, is a standalone communications interface adapter and programmer used in the evaluation of SigmaDSP® systems. It translates USB control commands from SigmaStudio to the I²C and SPI communications protocols.

To simplify bench evaluation, an interface based on the USBi adapter is included on the SSM2804 evaluation board. This eliminates the need for a separate interface board and 10-pin ribbon cable; only a USB mini-B cable is required. This interface is shown in Figure 13.

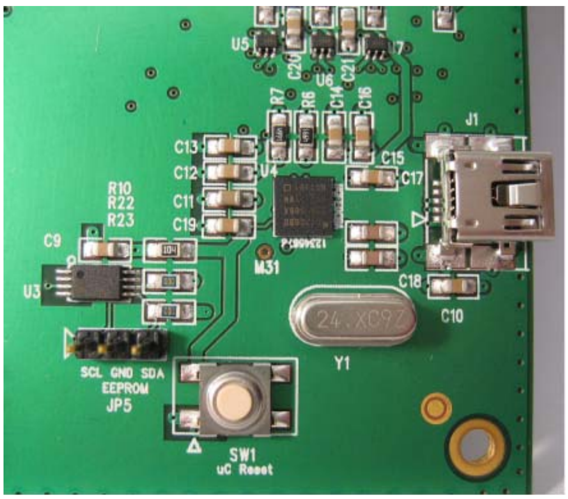

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Figure 13. USB to I²C Microcontroller and USB Interface

The on-board regulators enable both 1.8 V and 3.3 V IOVDD operation, allowing for increased testing flexibility.

The USBi interface can also control SigmaDSP systems in real time via SigmaStudio, and it is capable of programming an EEPROM in self-boot systems. It is an ideal solution for in-circuit programming and tuning of prototype systems.

The USBi only supports USB Version 2.0 interfaces; it does not work with PCs that only support USB Version 1.0 and USB Version 1.1.

USB CONNECTOR

The connection between the host PC and the Cypress USB interface device is via a standard USB cable that carries D+ and D− signals for data communications, a 5 V power supply, and ground. The D+ and D− lines are a 1-wire communication interface carried by half-duplex differential signals on a twisted pair. The clock is embedded in the data using the nonreturn-to-zero inverted (NRZI) line code. These signal lines connect directly to pins on the Cypress USB interface.

A surface-mounted USB miniature Type B jack was selected for its low profile and increasing popularity in consumer electronics.

POWER REGULATOR

The Cypress USB interface I/O ports are capable of operating in both 1.8 V and 3.3 V modes, depending on the target device in the system. Two regulators, U1 for 5 V to 3.3 V regulation and U2 for 5 V to 1.8 V regulation, run simultaneously when the board is powered. A jumper (JP4) is provided to easily switch the IOVDD supply between the two regulators. D1 provides visual feedback that the board is being supplied with 5 V power from the PC USB port.

The position of Jumper JP4 should not be changed when the board is connected to the USB bus.

CYPRESS USB INTERFACE

The Cypress USB interface is the core of the system, including all of the necessary functionality to convert USB commands into corresponding I²C or SPI read/write transfers, and acts as a FIFO to route data between the host PC and the target device.

CRYSTAL OSCILLATOR

The Cypress USB interface is its own clock master, and the board includes a crystal oscillator circuit with a 24 MHz crystal resonator to provide stability to the oscillator circuit. The crystal resonator is driven by the XTALOUT and XTALIN pins of the Cypress USB interface.

PASSIVE COMPONENT SELECTION

Although the evaluation board is preloaded with the passive components required for a basic configuration, the same circuit can be evaluated with different component values or filter designs. Selecting the proper components is the key to achieving the performance required at the budgeted cost.

INPUT COUPLING CAPACITOR SELECTION (C31 TO C36)

The input coupling capacitors, C31 to C36, should be large enough to couple the low frequency signal components in the incoming signal but small enough to filter out unnecessary low frequency signals. For music signals, the cutoff frequency chosen is often between 20 Hz and 30 Hz to preserve the low frequency components of the signal; for applications with small speakers, a higher cutoff frequency is often chosen to reduce the power wasted on audio that cannot be reproduced by the speaker.

The value of each input capacitor is calculated by

$$C = 1/(2\pi R_{IN} f_C)$$

where:
R_{IN} is the sum of the amplifier's input resistance and any external series resistor.
f_C is the cutoff frequency.

The SSM2804 has two input modes: PGA mode and boost mode. In boost mode, three gain settings are available, and the input impedance is fixed at 20 kΩ.

In PGA mode, the system gain is adjustable in 31 steps from −12 dB to +18 dB; however, the input impedance is not constant. Because R_{IN} varies with amplifier gain value over the entire gain range of the SSM2804, this calculation must be performed carefully to ensure that the low frequency performance is acceptable at all gain levels.

As an example calculation, suppose that the low frequency cutoff is to be no higher than 200 Hz and that the amplifier gain varies between −12 dB and +18 dB. In the worst case, the input resistance is as low as 4.5 kΩ. Because the cutoff frequency is highest when the input resistance is small, the calculation should be performed using this minimum resistance value—in this case, giving a minimum capacitance of approximately 180 nF. Use a larger standard value (perhaps 220 nF) to account for the ordinary variation due to, for example, tolerance and temperature coefficient.

OUTPUT FERRITE BEADS (B1 TO B4)

The output beads, B1 to B4, are suggested components for filtering out the EMI caused at the switching output nodes. The penalty for using ferrite beads for EMI filtering is slightly worse noise and distortion performance at the system level due to the nonlinearity of the beads. Ensure that these beads have enough current conducting capability while providing sufficient EMI attenuation. The current rating needed for an 8 Ω load is approximately 420 mA, and impedance at 100 MHz must be ≥120 Ω. In addition, the lower the dc resistance (DCR) of these beads, the better for minimizing their power consumption. Table 2 describes suggested beads.

OUTPUT SHUNTING CAPACITORS (C43, C45, C47, AND C49)

There are four output shunting capacitors, C43, C45, C47, and C49, that work with the B1 to B4 ferrite beads, if they are used. Use small size (0603 or 0402), multilayer ceramic capacitors that are made of X7R or C0G (NP0) materials. Note that the capacitors can be used in pairs: a capacitor with small capacitance (up to 100 pF) plus a capacitor with a larger capacitance (less than 1 nF). This configuration provides thorough EMI reduction for the entire frequency spectrum. Alternatively, a single capacitor of approximately 470 pF can be used if reducing the bill of materials is a priority.

Table 2. Suggested Output Beads

Part No.	Manufacturer	Z (Ω)	I_{MAX} (mA)	DCR (Ω)	Size (mm)
BLM18PG121SN1D	Murata	120	2000	0.05	1.6 × 0.8 × 0.8
MPZ1608S101A	TDK	100	3000	0.03	1.6 × 0.8 × 0.8
MPZ1608S221A	TDK	220	2000	0.05	1.6 × 0.8 × 0.8
BLM18EG221SN1D	Murata	220	2000	0.05	1.6 × 0.8 × 0.8

EVALUATION BOARD SCHEMATICS AND ARTWORK

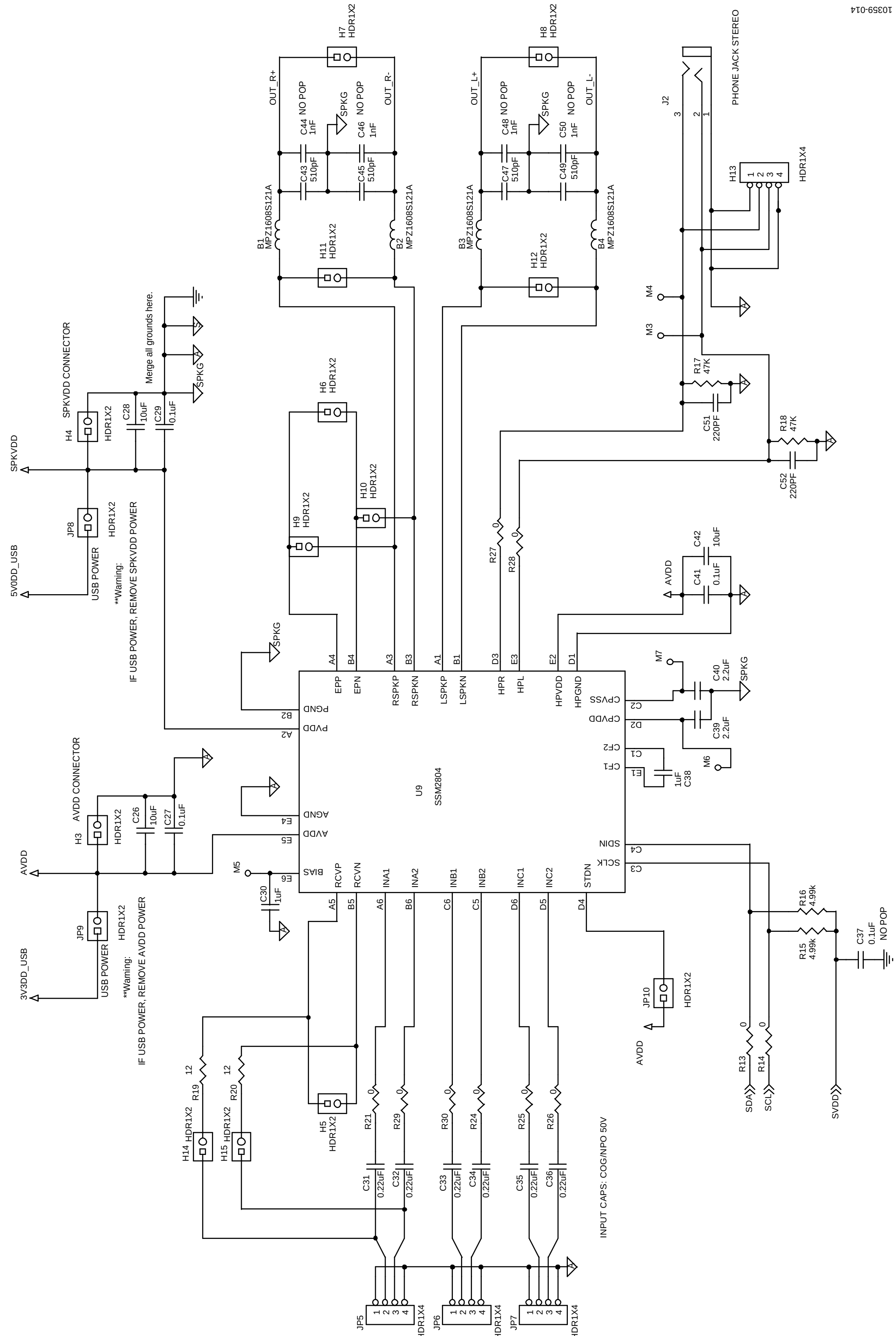

Figure 14. SSM2804 evaluation board schematic

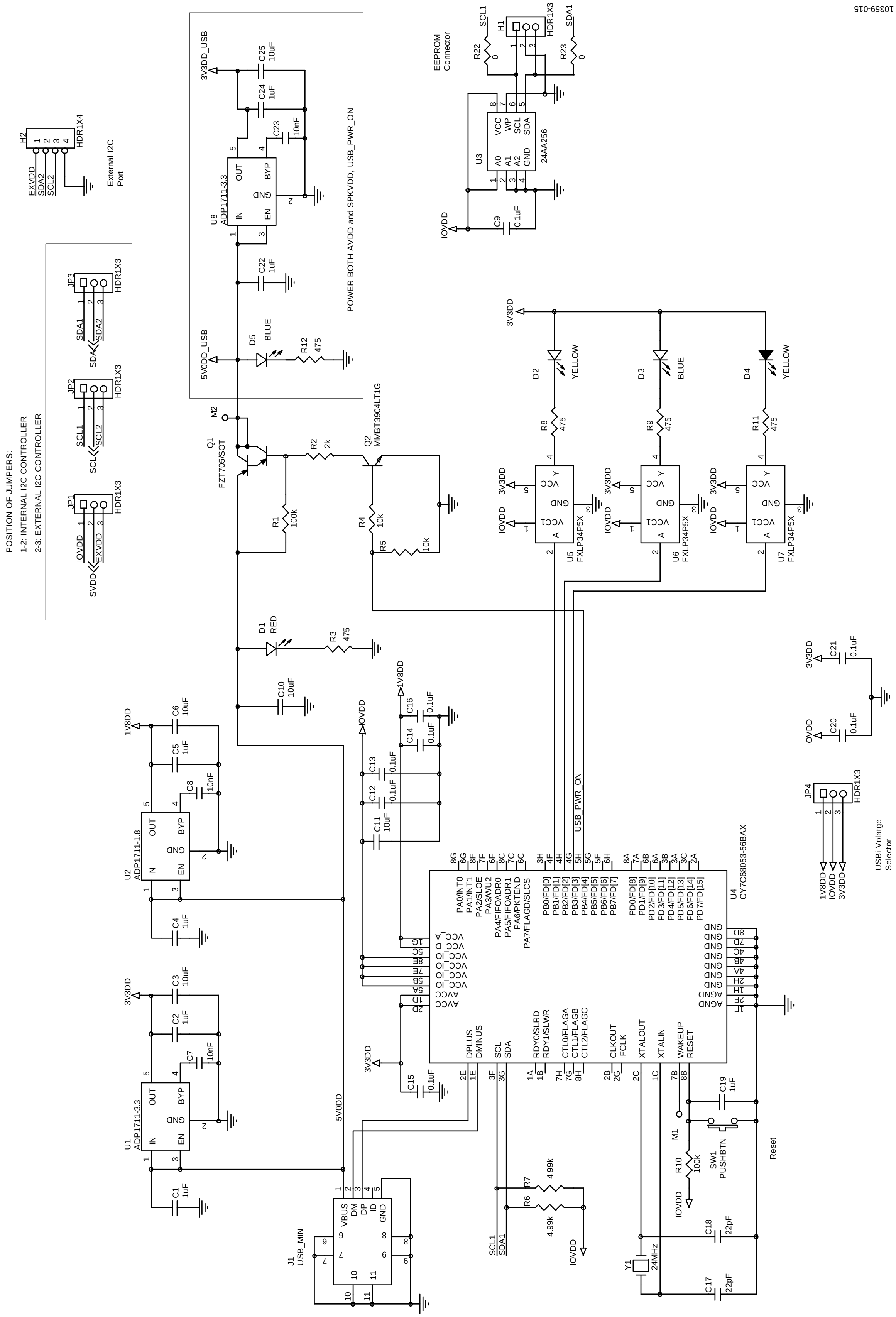

Figure 15. SSM2804 evaluation board schematic (continued)

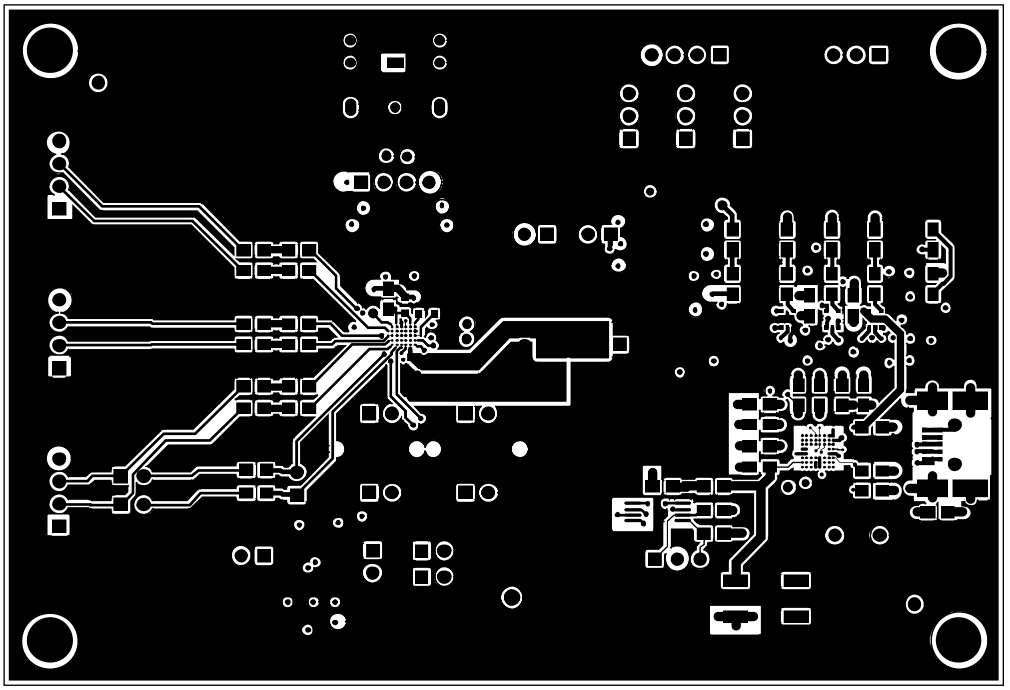

Figure 16. Evaluation Board Layout, Primary Side (Layer 1)

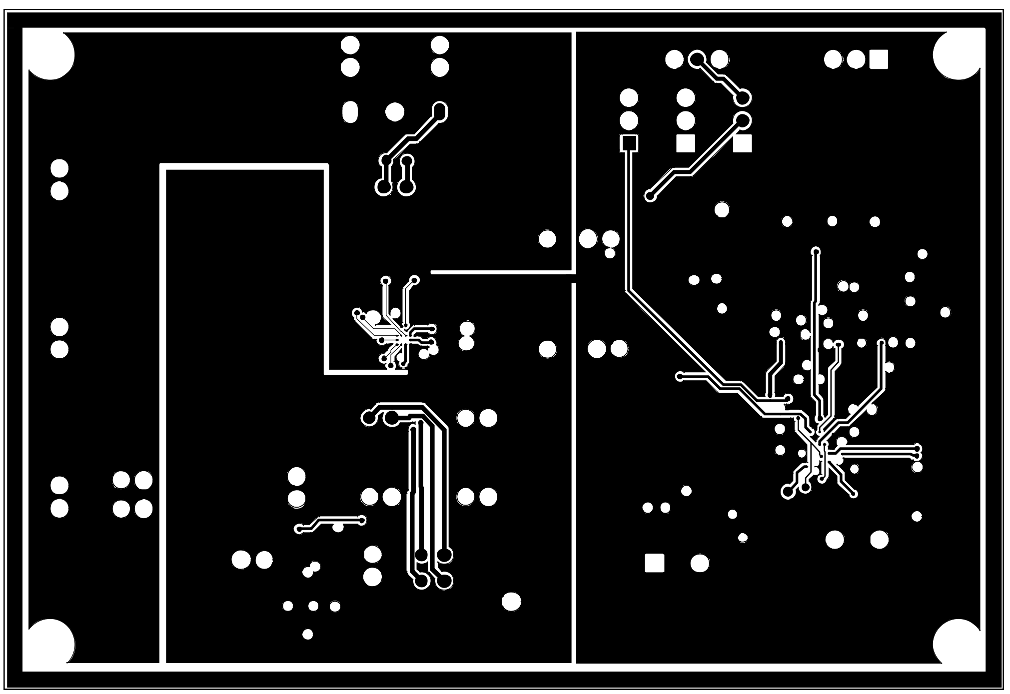

Figure 17. Evaluation Board Layout, Ground Plane (Layer 2)

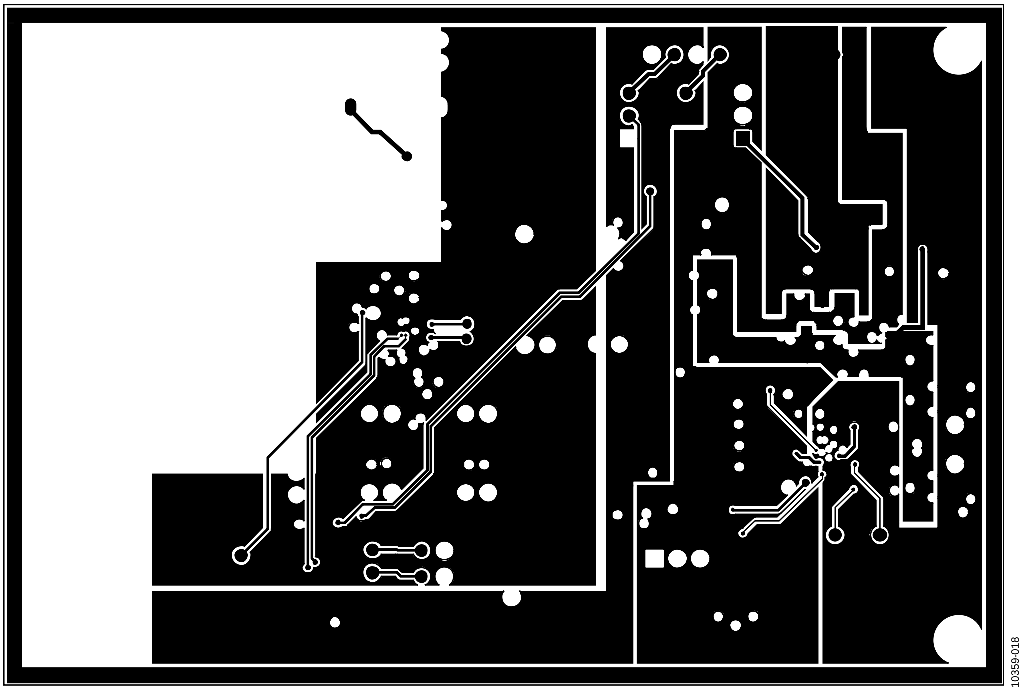

Figure 18. Evaluation Board Layout, Power Plane (Layer 3)

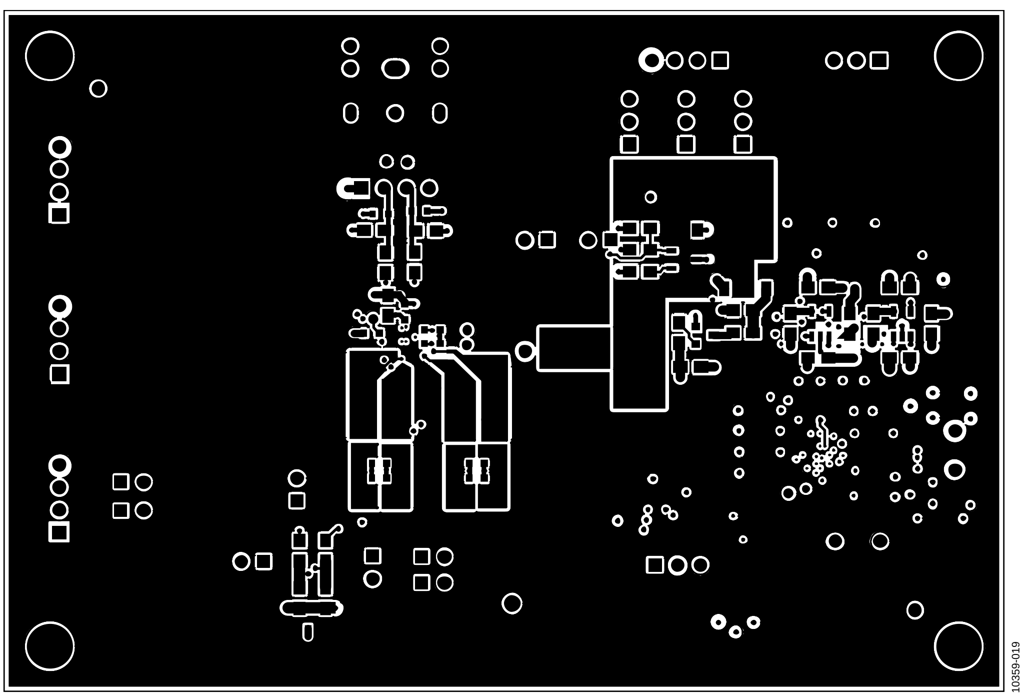

Figure 19. Evaluation Board Layout, Secondary Side (Layer 4)

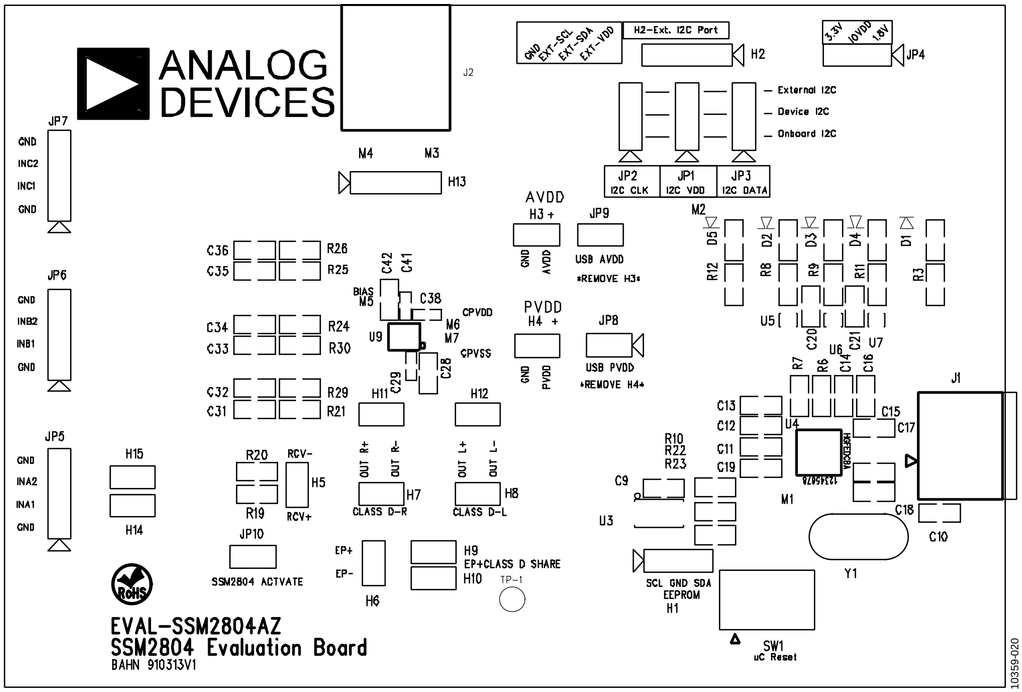

Figure 20. Evaluation Board Layout, Top Silkscreen

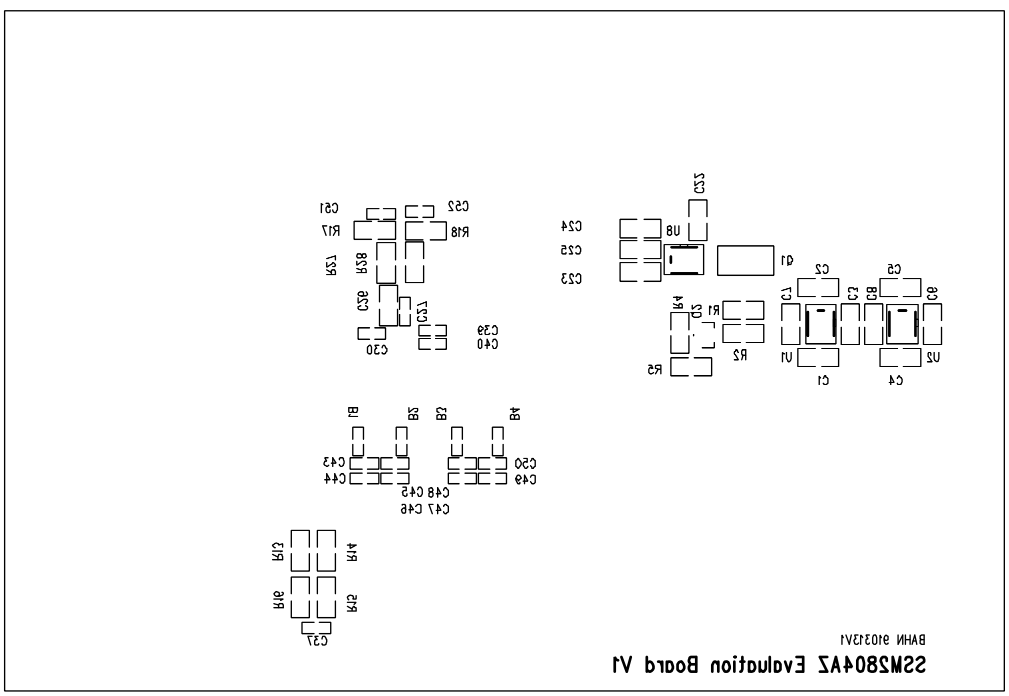

Figure 21. Evaluation Board Layout, Bottom Silkscreen

ORDERING INFORMATION

BILL OF MATERIALS

Table 3.

Item	Qty	Reference Designator	Description	Manufacturer	Mfg Part Number
1	4	B1, B2, B3, B4	Resistor, 0.0 Ω, 1/10 W, 0603	Panasonic—ECG	ERJ-3GEY0R00V
2	7	C1, C2, C4, C5, C19, C22, C24	Capacitor ceramic, 1 μF, 10 V, 10%, X7R, 0805	Kemet	C0805C105K8RACTU
3	8	C3, C6, C10, C11, C25, C26, C28, C42	Capacitor ceramic, 10 μF, 10 V, 10%, X5R, 0805	Murata Electronics North America	GRM21BR61A106KE19L
4	3	C7, C8, C23	Capacitor ceramic, 10000 pF, 50 V, 10%, X7R, 0603	AVX Corporation	06035C103KAT2A
5	8	C9, C12, C13, C14, C15, C16, C20, C21	Capacitor ceramic, 0.10 μF, 25 V, X5R, 0603	Taiyo Yuden	TMK107BJ104KA-T
6	2	C17, C18	Capacitor ceramic, 22 pF, 50 V, 0603	Panasonic—ECG	ECJ-1VC1H220J
7	4	C27, C29, C37,[1] C41	Capacitor ceramic, 0.10 μF, 25 V, X5R, 0603	Taiyo Yuden	TMK107BJ104KA-T
8	2	C30, C38	Capacitor ceramic, 1 μF, 10 V, 1%, X7R, 0805	Venkel, Ltd.	C0805X7R100-105KNE
9	6	C31, C32, C33, C34, C35, C36	Capacitor ceramic, 0.22 μF, 50 V, X7R, 10%, 0805	TDK Corporation	C2012X7R1H224K
10	2	C39, C40	Capacitor ceramic, 2.2 μF, 16 V, X5R, 0603	Murata Electronics North America	GRM188R61C225KE15D
11	4	C43, C45, C47, C49[2]	Capacitor ceramic, 510 pF, 50 V, 5%, C0G, 0603	Murata Electronics North America	GRM1885C1H511JA01D
12	4	C44, C46, C48, C50[3]	Capacitor ceramic, 1000 pF, 25 V, 5%, C0G, 0603	Venkel, Ltd.	C0603COG500-102JNE
13	2	C51, C52	Capacitor ceramic, 22 pF, 50 V, 0603, SMD	Panasonic—ECG	ECJ-1VC1H220J
14	1	D1	LED mini SMD red, 7.5 MCD, GAASP/GAP	Vishay	TLMS2100-GS08
15	2	D2, D4	LED mini SMD yellow, 7.5 MCD, GAASP/GAP	Vishay	TLMY2100-GS08
16	2	D3, D5	LED blue, 471 nm, clear SMD	OSRAM Opto Semiconductors, Inc.	LB M673-L1M2-35-Z
17	5	JP1, H1, JP2, JP3, JP4	Connector header BRKWAY, 0.100, 3-position, STR	TE Connectivity	4-103747-0-03
18	5	H2, JP5, JP6, JP7, H13	Connector header BRKWAY, 0.100, 4-position, STR	TE Connectivity	4-103747-0-04
19	15	H3, H4, H5, H6, H7, JP8, H8, JP9, H9, JP10, H10, H11, H12, H14, H15	Connector header BRKWAY, 0.100, 2-position, STR	TE Connectivity	4-103747-0-02
20	1	J1	Connector mini USB RCPT, RA Type B SMD	TE Connectivity	1734035-2
21	1	J2	Connector jack stereo R/A 3-pin, 3.5 mm	CUI, Inc	SJ1-3523N
22	1	Q1	Trans PNP, −120 V, −2000 mA, SOT-223	Diodes/Zetex	FZT705TA
23	1	Q2	Transistor GP NPN, amp SOT-23	Fairchild Semiconductor	MMBT3904FSCT-ND
24	2	R1, R10	Resistor, 100 kΩ, 1/8 W, 1%, 0805, SMD	Panasonic—ECG	ERJ-6ENF1003V
25	1	R2	Resistor, 2.00 kΩ, 1/8 W, 1%, 0805, SMD	Yageo	RC0805FR-072KL
26	5	R3, R8, R9, R11, R12	Resistor, 475 Ω, 1/8 W, 1%, 0805, SMD	Panasonic—ECG	ERJ-6ENF4750V
27	2	R4, R5	Resistor, 10.0 kΩ, 1/8 W, 1% 0805 SMD	Yageo	RC0805FR-0710KL
28	4	R6, R7, R15, R16	Resistor, 4.99 kΩ, 1/8 W, 1%, 0805, SMD	Yageo	RC0805FR-074K99L
29	12	R13, R14, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30	Resistor, 0.0 kΩ, 1/8 W, 0805, SMD	Panasonic—ECG	ERJ-6GEY0R00V
30	2	R17, R18	Resistor, 47 kΩ, 1/10 W, 1%, 0805, SMD	Venkel, Ltd.	CR0805-10W-4702FT
31	2	R19, R20	Resistor, 12.0 Ω, 1/8 W, 1%, 0805, SMD	Rohm Semiconductor	MCR10EZHF12R0
32	1	SW1	Switch tactile SPST-NO 0.05 A, 24 V	Omron Electronics, Inc, EMC Div	B3SN-3012
33	2	U1, U8	IC REG LDO, 150 mA, 3.3 V, 5-lead TSOT	Analog Devices	ADP1711AUJZ-3.3-R7
34	1	U2	IC REG LDO, 150 mA 1.8 V, 5-lead TSOT	Analog Devices	ADP1711AUJZ-1.8-R7

Item	Qty	Reference Designator	Description	Manufacturer	Mfg Part Number
35	1	U3	IC EEPROM 256 kB, 400 kHz, 8TSSOP	Microchip Technology	24AA256-I/ST
36	1	U4	IC MCU MOBL-USB 56-VFBGA	Cypress Semiconductor Corp	CY7C68053-56BAXI
37	3	U5, U6, U7	Translator, 1-bit, unidirect, SC70-5	Fairchild Semiconductor	FXLP34P5X
38	1	U9	Audio subsystem 30-ball WLCSP	Analog Devices	SSM2804CBZ-RL
39	1	Y1	Crystal, 24.00014 MHz, 18 pF, HC49/U	Citizen Finetech Miyota	HC49US-24.00014MABJ

[1] C37 is not populated.
[2] C43, C45, C47, and C49 are not populated.
[3] C44, C46, C48, and C50 are not populated.

NOTES

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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