

General Description

The MAX98091 evaluation kit (EV kit) is a fully assembled and tested circuit board that evaluates the MAX98091 audio codec. The MAX98091 is an integrated audio codec including an earpiece amplifier, stereo Class D amplifier, stereo DirectDrive® headphone amplifier, and digital signal processing.

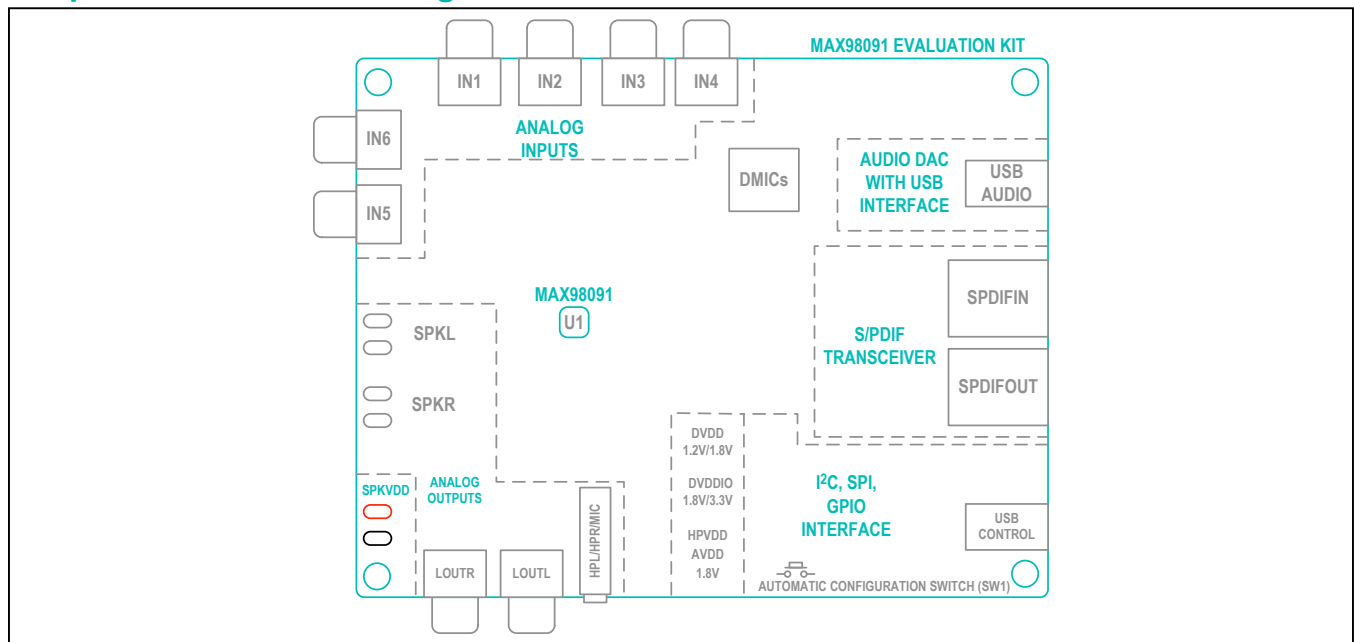
To enable easy connection to a wide range of audio sources, the EV kit includes audio devices to convert both USB and S/PDIF data to I²S data. The EV kit also integrates a MAXQ2000 microcontroller to enable I²C and SPI communication with the on-board I²C- and SPI-capable devices. A simple and intuitive graphical user interface (GUI) provides communication with the EV kit through Windows® OS running Windows XP®, Windows 7-, or Windows 8-compatible software.

Features

- 2.8V to 5.5V Single-Supply Operation
- On-Board USB-to-I²C Interface
- On-Board USB-to-I²S Converter
- On-Board S/PDIF Transceiver
- On-Board Clock Source
- On-Board Digital Microphone
- Windows XP-, Windows 7-, and Windows 8-Compatible Software
- Fully Assembled and Tested

Ordering Information appears at end of data sheet.

Simplified EV Kit Block Diagram



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Quick Start

Required Equipment

- MAX98091 EV kit
- Two A to mini-B USB cables (included)
- 2.8V to 5.5V, 2A DC power supply
- Set of headphones with a 3.5mm plug
- User-supplied Windows XP, Windows 7, or Windows 8 PC with two available USB ports

Note: In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the EV kit software. Text in **bold and underlined** refers to items from the Windows operating system.

Procedure

Follow the steps below to configure the EV kit for PC audio playback to verify the EV kit’s functionality:

- 1) Visit www.maximintegrated.com/evkitsoftware to download the latest version of the MAX98091 software, MAX98091EVSwSetupVx.x.ZIP. Save the software to a temporary folder and uncompress the ZIP file.
- 2) Install the software and USB driver on your computer by running the executable (.exe) program inside the temporary folder. The program files are copied and icons are created in the Windows **Start | Programs | Maxim Integrated | MAX98091 | Evaluation Software** menu. During software installation, some versions of Windows may show a message indicating that this software is from an unknown publisher. This is not an error condition and it is safe to proceed with the installation.
- 3) Verify that all jumpers are in their default positions, as shown in [Figure 1](#) (same as listed in [Table 2](#)).
- 4) Connect the power supply between the SPKVDD and GND PCB pads.
- 5) Set the power supply to 4.2V with a 2A current limit and turn it on.

- 6) Connect a USB cable between the PC and the J1 USB port (USB CONTROL) on the EV kit. A Windows message appears when connecting to the EV kit for the first time. Each version of Windows may have a slightly different message. If Windows reports that the device is ready to use, then the USB driver has been installed successfully.
- 7) If needed, the USB driver can be manually installed by navigating to the **C:\Program Files(x86)\Maxim Integrated\MAX98091\Evaluation Software** folder (default installation directory) and following the instructions in the **USB_Driver_Help.PDF** document. The help file is located in the **USBDriver** folder.
- 8) Connect the headphones to the headphone jack (HP).
- 9) Start the MAX98091 Evaluation Software by opening its icon in the **Start | Programs | Maxim Integrated | MAX98091 | Evaluation Software** menu. The software main window appears, as shown in [Figure 3](#).
- 10) Wait while the software connects to the EV kit. Once the connection is established, the status bar at the bottom indicates that the USB and MAX98091 are connected.
- 11) Once the USB and device connections have been established, select the **Block Diagram** tab.
- 12) Click on the **USB** block.
- 13) Click **Yes** to automatically configure the EV kit for USB audio playback.
- 14) Connect a USB cable between the PC and the J2 USB port (USB AUDIO). Windows automatically detects the EV kit as a sound card and installs the USB audio class drivers.
Open Windows’ **Sound** dialog and select the **Playback** tab. A **USB Audio DAC** item, similar to [Figure 2](#), is added to the list of available playback devices. All audio played through this device is sent to the EV kit.
- 15) Verify that the **USB Audio DAC** item is set as the default device.
- 16) Verify that audio can be heard through the connected headphones.
- 17) Quick start complete. Refer to the MAX98091 IC data sheet for additional information.

Table 1. MAX98091 Software Install Folder

ITEM	DESCRIPTION
MAX98091.exe	MAX98091 evaluation software
USBDriver/FTDI/CDM21000.exe	USB driver installer
USBDriver/USB_Driver_Help_300.pdf	USB driver installation help file
Uninstall.exe	Uninstalls the MAX98091 evaluation software

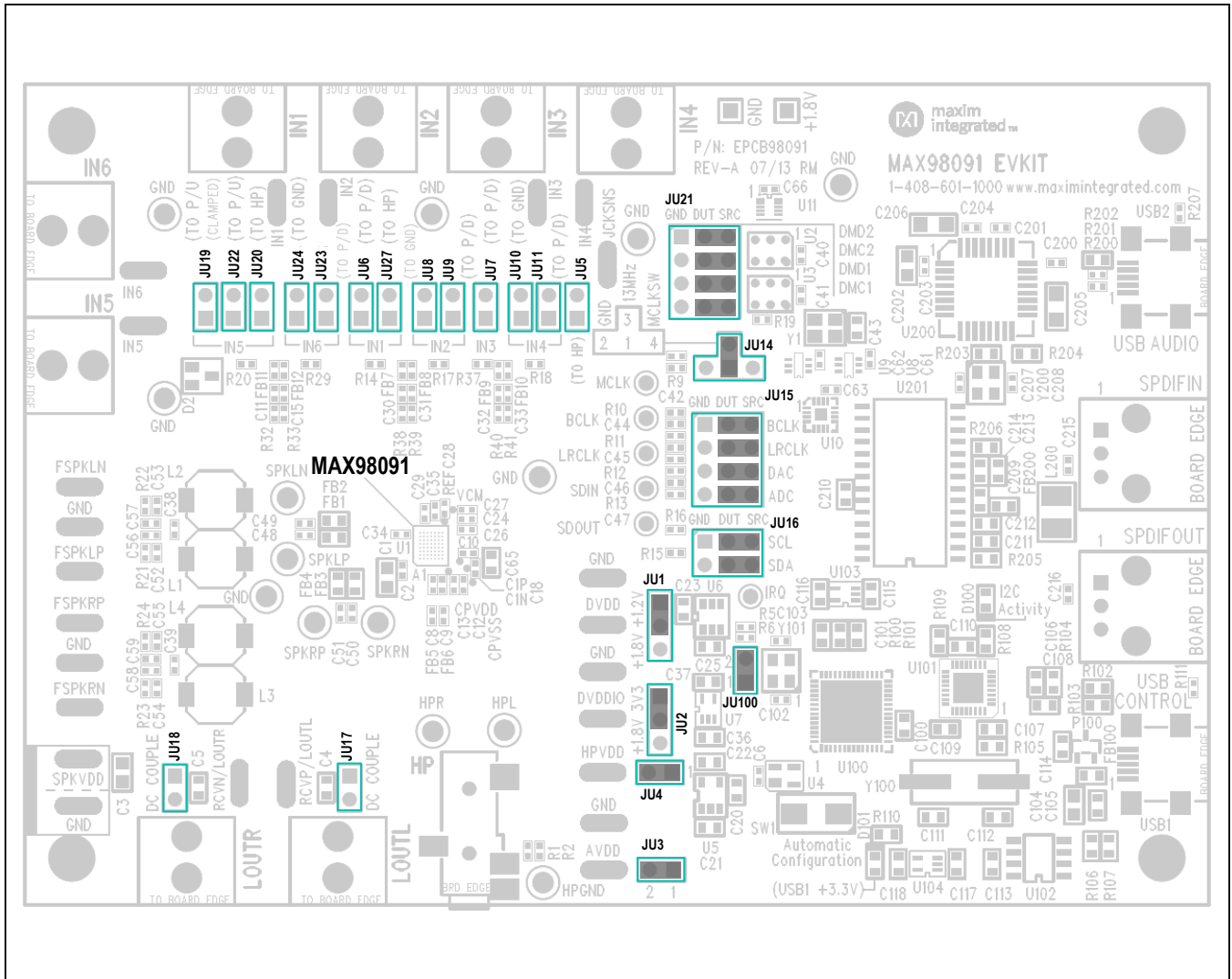


Figure 1. Default Shunt Configuration

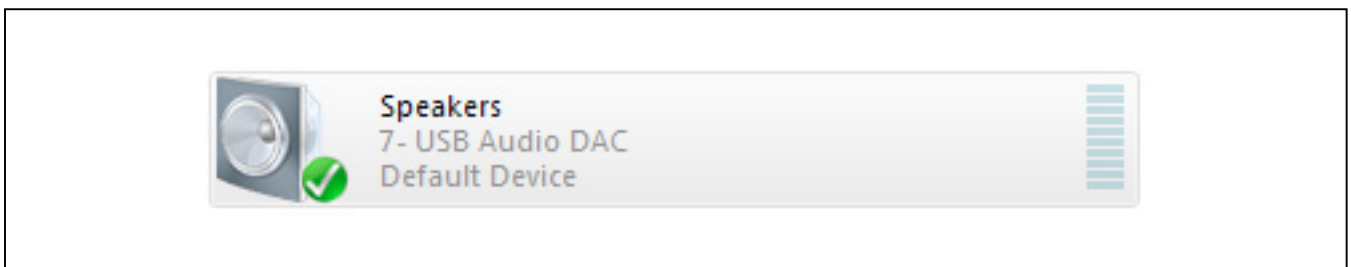


Figure 2. Playback Device

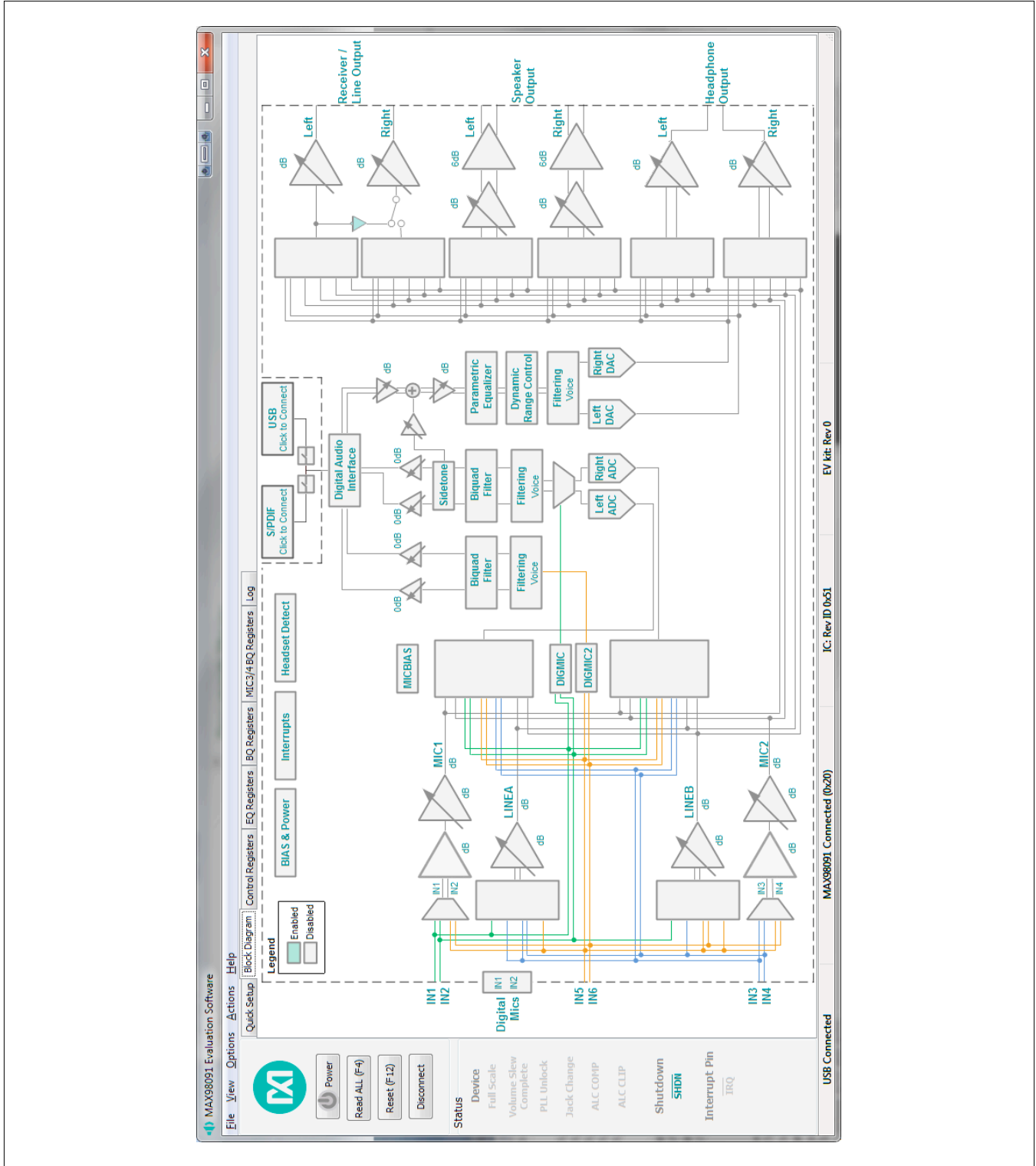


Figure 3. MAX98091 Software Main Window

Detailed Description of Software

The MAX98091 EV kit is intended to be evaluated with the MAX98091 software, as it provides an intuitive graphical user interface (GUI) for programming the MAX98091 device and also includes a handful of features that are intended to aid evaluation.

The MAX98091 software main window is divided into three sections: software buttons, status panel, and tabbed pages (Figure 3). The buttons provide basic functionality and the status panel provides monitoring capabilities. The tabbed pages provide the controls for programming the MAX98091.

The **Quick Setup** tab provides access to the device’s quick setup registers (0x04–0x0B). The **Block Diagram** tab provides access to all the device registers and utilizes diagram blocks to access dialog windows. The dialogs contain the GUI controls used to program the device. The **Control Registers** tab provides access to registers 0x00–0x45 as well as to the revision ID register, 0xFF. The **EQ Registers** tab provides access to the device’s parametric equalizer (EQ), registers 0x46–0xAE. The **BQ Registers** tab provides access to the device’s biquad (BQ) filter, registers 0xAF–0xBD. The **MIC3/4 BQ Registers** tab provides access to the biquad (BQ) filter, registers 0xC3–0xD1, in the DIGMIC2 path.

Go to www.maximintegrated.com/evkitsoftware to download the MAX98091 software. When evaluating with the EV kit and software, it is recommended that this document be used in conjunction with the MAX98091 IC data sheet.

Software Buttons

There are four buttons available on the main window of the MAX98091 software: **Power**, **Read All (F4)**, **Reset (F12)**, and **Connect**. These buttons are always accessible, regardless of the active tab.

Power

The **Power** button programs the MAX98091’s $\overline{\text{SHDN}}$ bit to enable/disable the device. When the device is disabled/enabled, the button image is gray/blue, respectively. When the device is in shutdown ($\overline{\text{SHDN}}$ bit = 0) the software is still able to communicate with the device, as its I2C interface remains active.

Read All (F4)

The **Read All (F4)** button performs the following sequence of reads and updates the associated register tab. This function is also available from the **Actions** menu.

- Read the MAX98091 $\overline{\text{IRQ}}$ pin. This only updates the **Status** panel.
- Read the status register (0x01). This also updates the **Status** panel.
- Read control registers (0x03–0x45).
- Read parametric equalizer registers (only if the **EQ Registers** tab is visible or if EQ bands are enabled).
- Read biquad registers (only if the **BQ Registers** tab is visible or if the biquad filter is enabled).
- Read Revision ID register (0xFF).
- Read S/PDIF Transceiver (U201) registers.

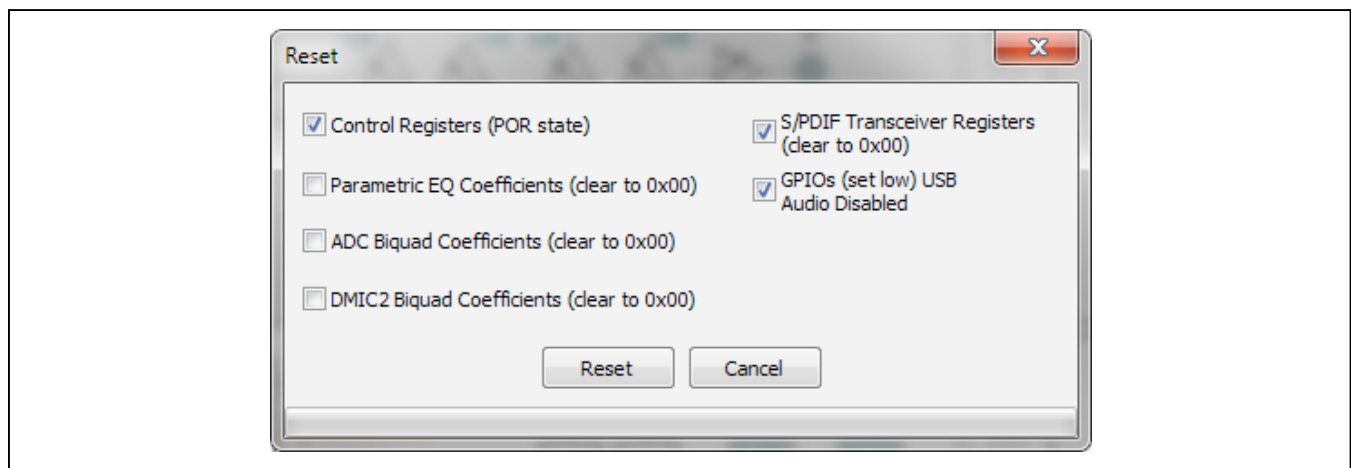


Figure 4. Reset Dialog

Reset (F12)

The **Reset (F12)** button resets the checked items as indicated on the **Rest** dialog window (Figure 4). This function is also available from the **Actions** menu.

Connect/Disconnect

The **Connect/Disconnect** button is used to connect or disconnect the software from the EV kit, which connects to a PC through its USB CONTROL (J1) port or a TCP connection. The button either displays **Connect** or **Disconnect**, depending on the current state of the EV kit connection.

When the button displays **Connect**, it indicates that the software is not connected to the EV kit. Pressing the button initiates the connection sequence. When using a TCP connection, ensure that it has been set up in the software before pressing **Connect**. The TCP connection is configured from the **TCP Configuration Setup** dialog, which is accessed by selecting **Options | Connect Options | TCP** from the **Menu** bar.

When the button displays **Disconnect**, it indicates that the software is connected to the EV kit. Pressing the button initiates the disconnect sequence.

Status Panel

The MAX98091 **Status** panel, located on the left side of the software main window, displays the state of the six status bits (register 0x01), the shutdown bit (register 0x45), and the state of the MAX98091 hardware IRQ pin. The color of a **Status** label indicates whether it is asserted or not. When asserted the label is teal colored and when not asserted, the label is light gray.

Note: A status bit's interrupt must be enabled in order for the status bit to get updated in the Status register. The interrupts are enabled from the **Interrupts** block.

Quick Setup Tab

The **Quick Setup** tab provides controls for configuring the quick setup registers (0x04–0x0B). These quick setup registers are write-only and function like pushbuttons. Refer to the *Quick Setup Configuration* section in the MAX98091 IC data sheet for additional details.

As the first four steps are completed, the section at the bottom of **Step 5** is updated. Checkmarks indicate that the step is complete and the **Reg:** and **Bit-** labels indicate which quick setup register and bit are programmed.

For simplicity, this tab is divided into five steps as shown in Figure 5. The first three steps configure the **System**

Clock, Sample Rate, Mode, and Format. The fourth step configures the audio **Input** and **Output** (I/O) signal path. As I/O selections are made, a corresponding image is shown in the **Configuration** group box, providing a visual representation of the selected path. When a valid I/O path is selected, **Step 4** is complete. To clear the input and output selections, press the **Clear** button.

Once all four checkmarks are visible, press the **Configure** button to program the device. If an invalid I/O path is selected, the software reports “**Not a valid I/O configuration**” and the I/O selections are cleared.

Block Diagram Tab

The MAX98091 software uses a block diagram to facilitate the programming of the MAX98091 as well as provide a visual representation of the device's functions and current configuration. The controls for a given function(s) are grouped on the same dialog window, which is opened by clicking on the associated block image. The blocks that are within the dotted border are related to the MAX98091 device and the blocks outside the dotted border are for the associated support circuitry.

There are two types of blocks in the block diagram and they are distinguished by the mouse cursor image. The mouse cursor changes to a hand when over an active block and changes to an up-arrow when over a toggle block. An active block opens a dialog window, containing controls for configuring the device. A toggle block does not open a dialog window, but toggles a specific setting when clicked.

The color of the blocks changes, depending on the enabled state of the function(s) it controls. A disabled block is grey and an enabled block is teal. Figure 6 shows the block diagram with the MAX98091 configured for USB audio input and headphone output. **Note:** A disabled/enabled block does not necessarily indicate that its associated audio path is disabled/enabled.

S/PDIF and USB

The S/PDIF and USB blocks are outside the dotted border and thus not related to the MAX98091 device. These blocks represent the stereo digital audio transceiver (U201) and the USB stereo audio DAC (U200) that are designed onto the EV kit. These blocks are used to enable the associated circuits, but also include controls that automatically configure the MAX98091 to work with the enabled audio device.

Step-1 System Clock

- 256 *fs
- 11.2896MHz
- 12MHz
- 12.288MHz
- 13MHz
- 19.20MHz
- 26MHz

Step-2 Sample Rate

- 8kHz
- 16kHz
- 32kHz
- 44.1kHz
- 48kHz
- 96kHz

Step-3 Mode

- Master
- Slave

Format

- Right Justified
- Left Justified
- 12S

Step-4 Input

- IN1: Direct, Single Ended
- IN2: Direct, Single Ended
- IN3: Direct, Single Ended, Differential
- IN4: MIC1 (1,2), MIC2 (3,4)
- DIGITAL AUDIO: DAI
- IN5: Direct, Single Ended, Differential
- IN6: Direct, Single Ended, Differential

Step-4 Output

- MODE: LINE, BTL, LINE/R/CVR
- Right: Speaker, Headphone
- Left: Speaker, Headphone
- DIGITAL AUDIO: DAI

Step-5 Configuration

Configuration Diagram: DIGITAL AUDIO → L → R → Headphones

Reg: 0x04	Bit-4	<input checked="" type="checkbox"/>	Step-1
Reg: 0x05	Bit-4	<input checked="" type="checkbox"/>	Step-2
Reg: 0x06	Bit-2	<input checked="" type="checkbox"/>	Step-3
Reg: 0x07	Bit-7	<input checked="" type="checkbox"/>	Step-4

Buttons: Clear, Configure

Figure 5. Quick Start Tab

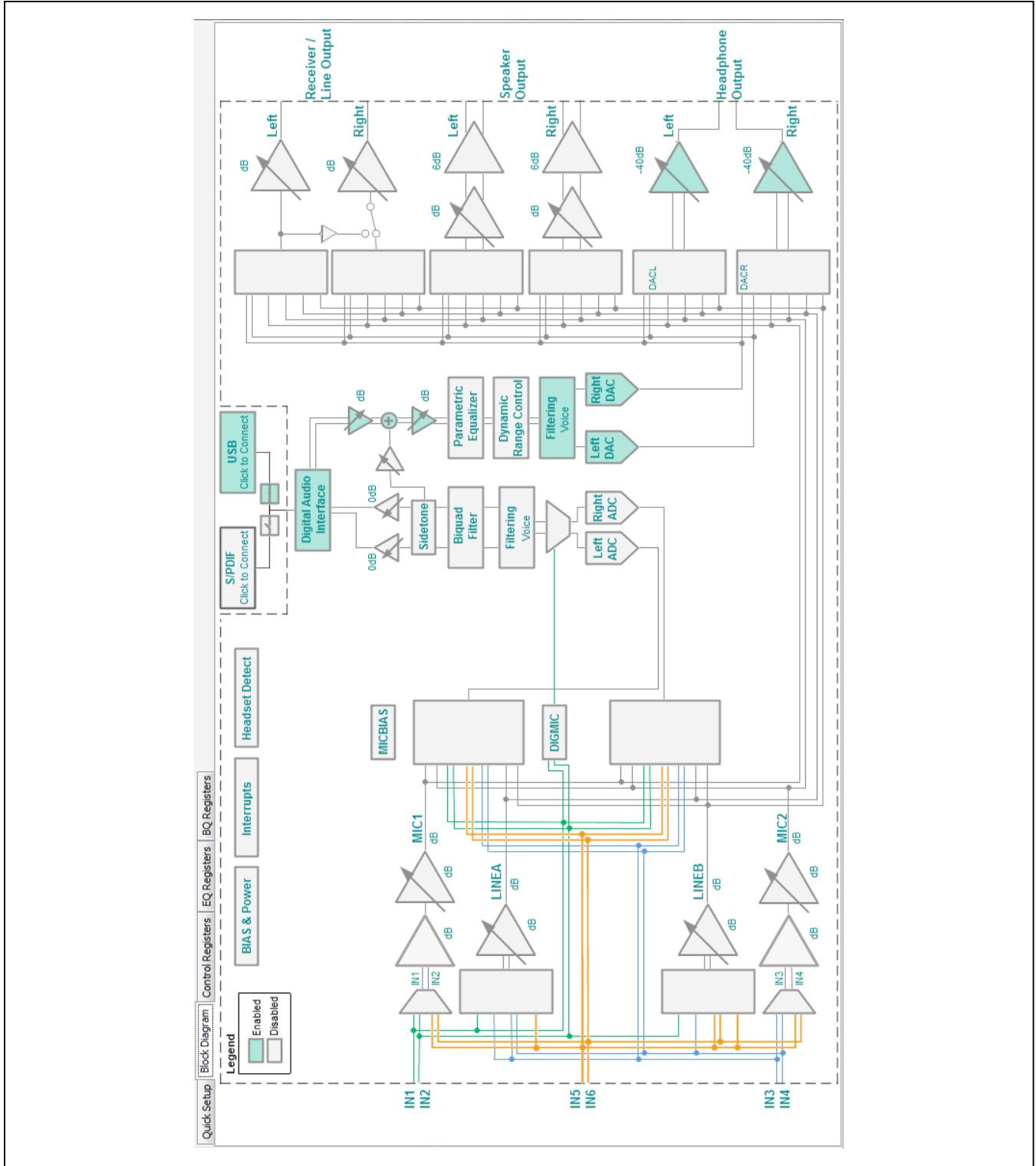


Figure 6. MAX98091 Software Block Diagram

The S/PDIF and USB audio devices are connected to the MAX98091 I²S bus through analog switches (U8–U10), which are controlled through the MAX98091 software. These switches are automatically configured once the S/PDIF or USB block is enabled, but they can be toggled by clicking on the switch blocks.

Dialog Windows

Dialog windows are associated with specific blocks in the block diagram and they contain the controls for configuring the registers that are associated with that particular block of the MAX98091 device. The highlighted blocks in [Figure 7](#) are the blocks that share a dialog window. In addition, the blocks that are outlined can have their dialog windows synchronized to each other. This dialog sync feature is a software feature and is enabled by selecting the **Sync Right and Left** checkbox in the dialog window. When enabled, the software programs the same user configurations to both the left and right output channels.

A dialog window is opened by clicking on a diagram block. [Figure 8](#) shows the typical GUI controls that are found on dialog windows and [Figure 9](#) shows the biquad filter dialog. When a control's state is changed, it results in the programming of the associated device register(s).

The biquad dialog uses the same types of controls as other dialogs, but it also provides a plot of the filter's amplitude and phase. This provides a visual representation of the programmed coefficients as well as some insight into the filter's behavior. The only two blocks that use this type of biquad filter dialog are the **Biquad Filter** and **Parametric Equalizer** blocks.

The filter dialog shown in [Figure 9](#) is for the 7-band parametric equalizer as can be seen by the seven available filters. Each filter can be individually programmed and when selected appears as yellow lines on the plots. A sum of all the enabled filters can be displayed by selecting the **Show Cascade** checkbox. The cascaded response appears as a blue line on the plots. The **Biquad Filter** dialog window is similar to that shown in [Figure 9](#), except that it is only a single biquad filter.

Registers Tabs

The MAX98091 software has four device register tabs: **Control Registers**, **EQ Registers**, **BQ Registers**, and **MIC3/4 BQ Registers**. These register tabs display the device's registers in a typical register map format. Each of the register tabs provides two methods for configuring the device. As an example, [Figure 10](#) shows the register tab elements of register 0x25.

The first configuration method involves clicking on the register's bit labels. A greyed-out bit label indicates that the bit is currently set low. A **bold** bit label indicates that the bit is currently set high. Clicking on a bit toggles its state and result in a write to that register. This action also updates the value displayed in the register's **Edit** box, located to the right of the bit labels. **Note:** Read-only bits cannot be clicked/toggled and are only meant to display the register's current state. These read-only bits are updated by performing a read all operation.

The second configuration method involves entering a hexadecimal value in the register's associated **Edit** box and then pressing the Enter key. The software automatically configures the device register once the Enter key is pressed. This method also updates the state of the bit labels to reflect the value shown in the **Edit** box.

Control Registers

The **Control Registers** tab provides access to most of the device's control registers and all of its status registers. The range of registers accessible from this tab is from register address 0x00–0x45 and the revision ID register (0xFF).

The **Write All (F8)** button writes to all the writeable registers on the **Control Registers** tab. It also writes to all the S/PDIF transceiver registers and updates the configurable GPIOs.

Register changes made through this tab are reflected on the **Block Diagram** tab. As such, the **Control Registers** tab and the **Block Diagram** tab are always in sync. However, register changes made through the **Control Registers** tab are not automatically reflected on open dialog windows. To have an open dialog window updated, close then reopen the dialog window.

Equalizer (EQ) Registers

The main use of the **EQ Registers** tab is to provide access to the raw data contained in the EQ registers (0x46–0xAE). The preferred method for configuring the device's equalizer is through the **7-Band Parametric Equalizer** dialog window ([Figure 9](#)).

The registers on this tab are grouped into seven bands (Band 1 through Band 7) and each band consists of fifteen registers. These fifteen registers are then divided into five coefficients (B0_, B1_, B2_, A1_, and A2_). The coefficients are configured by clicking the register bit labels or by entering a 24-bit hex-formatted value in its **Edit** box.

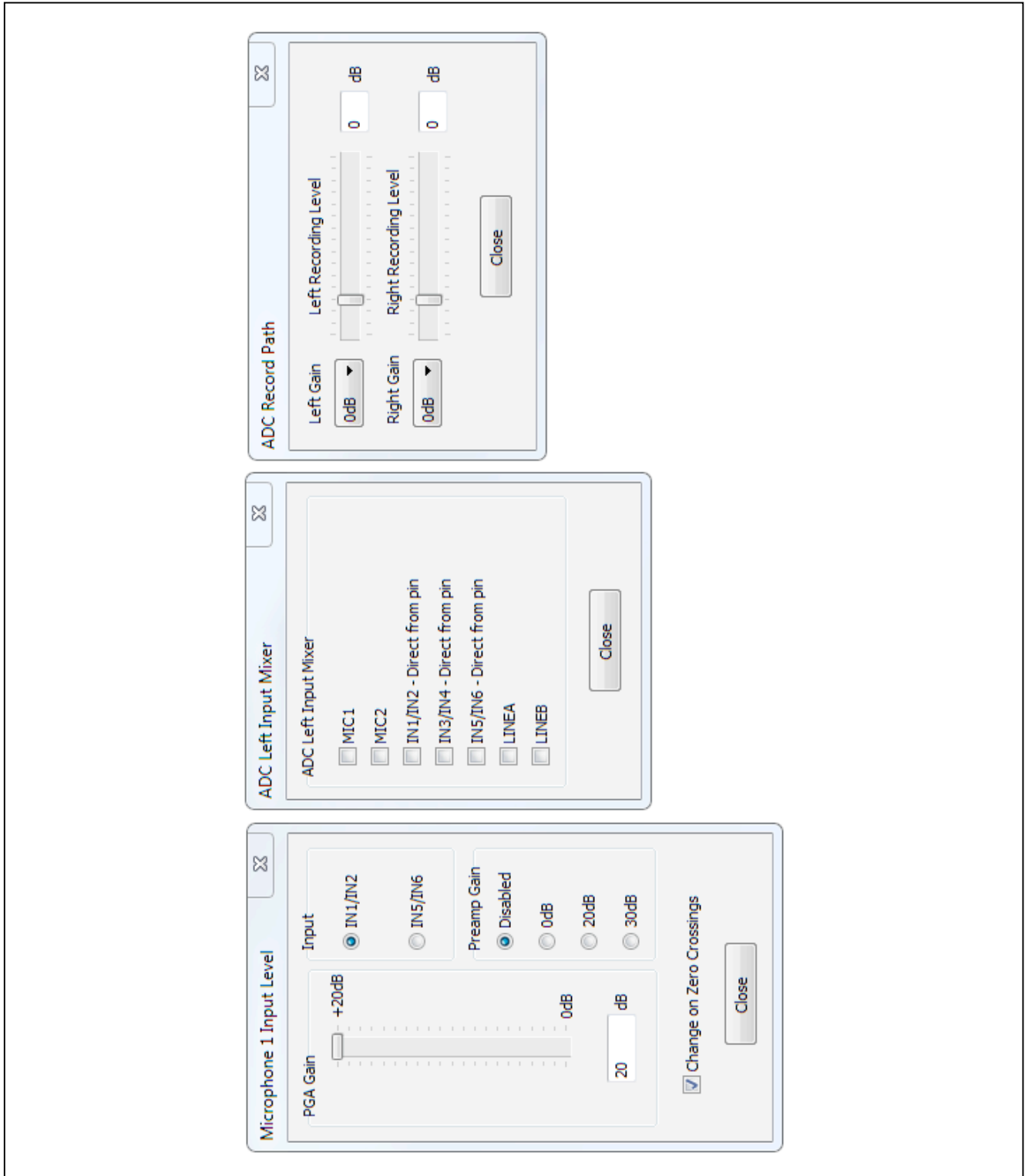


Figure 7. Dialog Windows

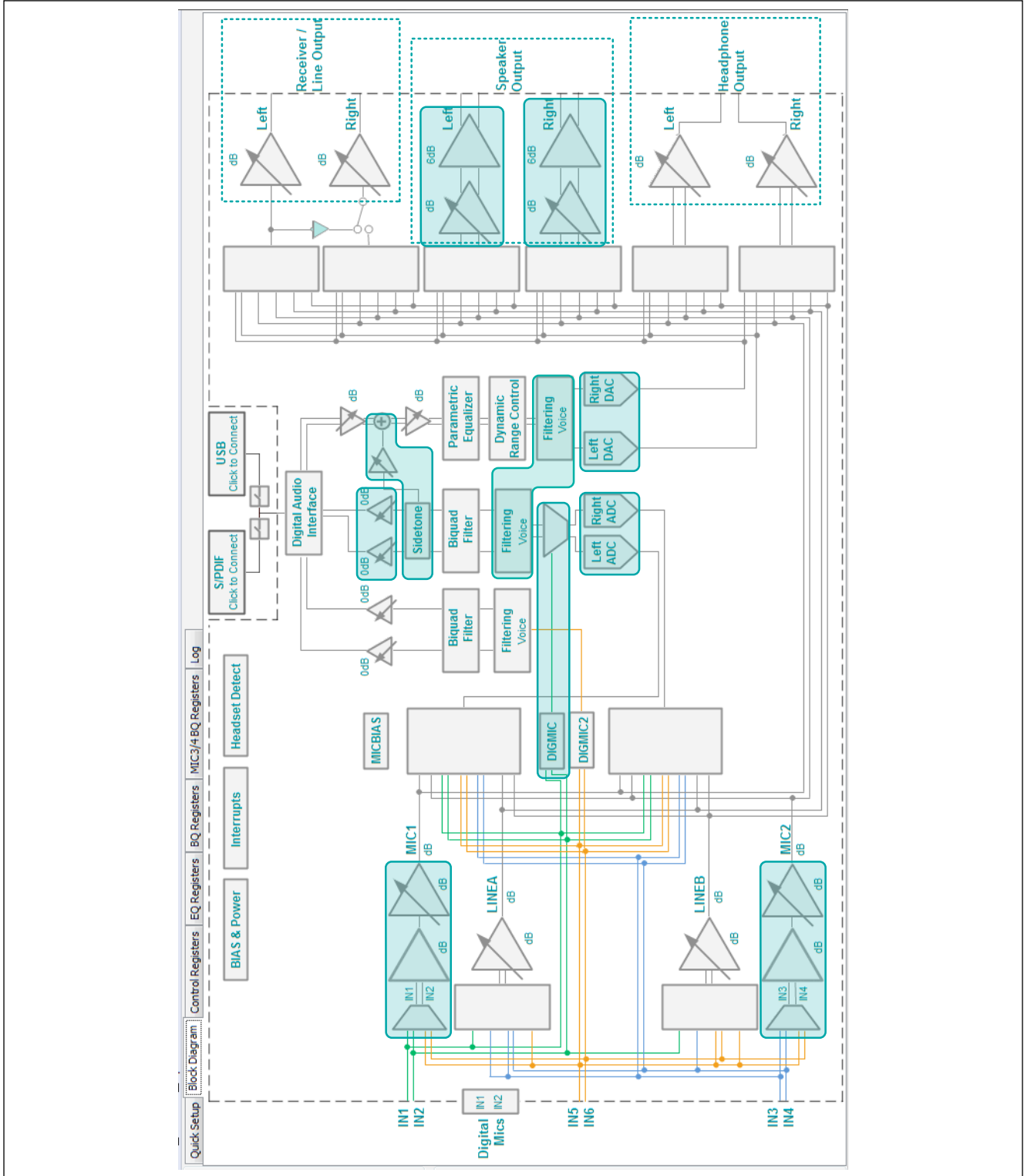


Figure 8. Diagram Blocks with Shared and/or Synchronized Dialog Windows

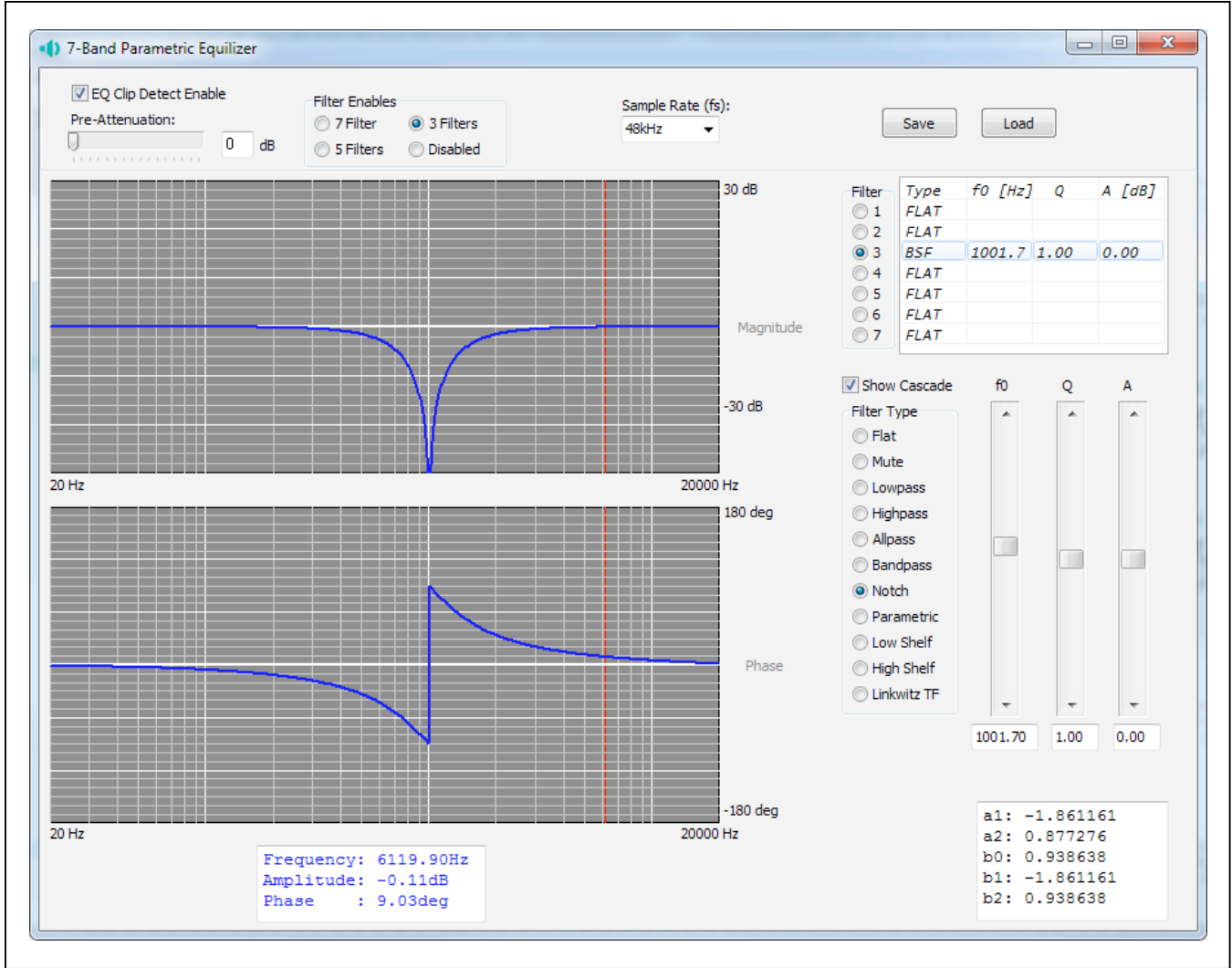


Figure 9. Biquad Filter Dialog Window

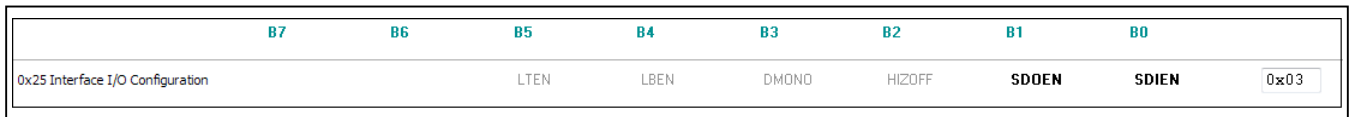


Figure 10. Register Tab Elements

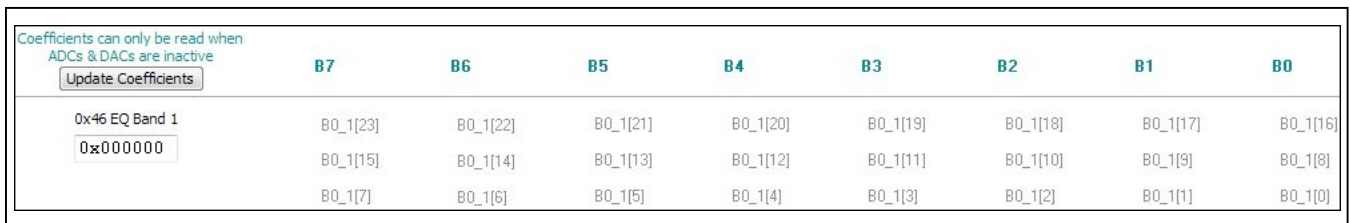


Figure 11. Coefficient (B0) of EQ Band 1

The **Update Coefficients** button updates the EQ register map to reflect any changes that were made through the **7-Band Parametric Equalizer** dialog window.

Note: Coefficient changes made through this **EQ Registers** tab are not reflected on the **Block Diagram** tab or the **7-Band Parametric Equalizer** dialog window.

Biquad (BQ) Registers

The main use of the **BQ Registers** and **MIC3/4 BQ Registers** tab is to provide access to the raw data contained in the 15 BQ registers (0xAF–0xBD) and 15 MIC3/4 BQ registers (0xC3–0xD1), respectively. The preferred method for configuring the device's biquad filter is through the **Biquad Filter** dialog window.

The BQ registers are divided into five coefficients (B0, B1, B2, A1, A2) that are configured by clicking the register bit labels or entering a 24-bit hex-formatted value in the coefficient's **Edit** box.

The **Update Coefficients** button updates the tab to reflect any changes that were made through the **Biquad Filter** dialog window.

Note: Coefficient changes made through the **BQ Registers** tabs are not reflected on the **Block Diagram** tab or the **Biquad Filter** dialog window.

Menu Bar

All the **Menu** bar items are described in [Table 1](#). Additional information on a few of the menu items is provided in the following sections.

File

The software's save and load features are accessed from the **File** menu item. The save feature saves the data currently displayed on the **Control Registers** tab and **S/PDIF Transceiver** tab. The current state of the configurable GPIO pins is also saved to the configuration file. The data from the **EQ Registers** and **BQ Registers** tabs is saved if the filters are enabled.

A configuration file's main purpose is to capture the current state of the MAX98091's registers, as displayed on the register tabs. This feature makes it easy to program a device to a saved/known state and allows for the sharing of configuration files between users. The file and save features can still be used when an EV kit is not connected. This allows configuration files to be created and opened without the hardware and further contributes

to the sharing of configuration files. To facilitate file usage, use descriptive file names when saving configuration files.

Since the configuration file is automatically generated by the software, it is not meant to be manually formatted and doing so can cause file loading issues. To open a configuration file for viewing, use a plain text editor.

Select **File | Save Settings Ctrl+S** to create a configuration file. Data is saved as tab-delimited values and the file is saved with a .98091 extension.

To load a saved configuration file select **File | Load Settings Ctrl+O**. Only writeable registers are programmed with data from the loaded configuration file.

Connect Options

The **Connect Options** item is accessed from the **Options** menu. This menu item provides two options for connecting the EV kit to the MAX98091 software. The simplest method (**MAXQ USB**) uses a standard male-to-male USB cable (A to mini-B) connection. A local PC, running the MAX98091 software, connects to the USB CONTROL port (J1) on the EV kit. This method utilizes the on-board MAXQ2000 microcontroller circuitry to communicate with the MAX98091 I²C-capable device.

The **TCP** option is used to set up an internet connection between the EV kit and the software. To use this feature, additional hardware and software (not provided) are required. The additional tools would function as the communication medium between the ethernet connection and the MAX98091's I²C bus. When using this option, the USB CONTROL port (J1) on the EV kit still needs to be powered to supply the on-board LDOs.

Detailed Hardware Description

The MAX98091 EV kit evaluates the WLP package version of the MAX98091 audio codec and provides access to all analog and digital inputs/outputs on the device. The EV kit also includes USB-powered linear-dropout (LDO) regulators that allow the EV kit to be evaluated with a single external supply (+2.8V to +5.5V).

Integrated into the EV kit design are a stereo digital audio transceiver (U201) and a stereo audio DAC with USB interface (U200). The digital audio transceiver provides audio input and output through the on-board TOSLINK (SPDIFOUT and SPDIFIN) connectors and the USB audio DAC allows for audio input from the USB AUDIO port (J2).

Table 1. Menu Bar Items

MENU ITEM	DESCRIPTION
FILE	
Load Settings Ctrl+O	Loads a configuration file (as saved by the Save Settings option).
Save Settings Ctrl+S	Saves a configuration file containing the current device settings.
Exit	Closes the MAX98091 software.
VIEW	
Show S/PDIF Transceiver Registers	Toggles the visibility of the S/PDIF Transceiver register tab, allowing for more control of the on-board S/PDIF transceiver (U201).
OPTIONS	
Autoconnect	When selected, the software checks the connection status of the MAXQ2000 interface and the MAX98091 device approximately every second. If not connected, the software attempts to establish a connection.
Autoread Status	When selected, the device's status registers read approximately every second. The Status panel and Control Registers tab are refreshed after each read.
Autoshutdown for Register Writes	When selected, the software ensures that the MAX98091 is in shutdown before writing to certain registers. Refer to Table 90 of the MAX98091 data sheet for the registers that should only be programmed while the device is in shutdown.
I²C CLOCK SPEED	
100kHz	Configures the clock speed of the I ² C interface.
400kHz	
Configure MCLK Routing	Opens the MCLK Routing dialog window that is used to select a clock source for the MAX98091 master clock (MCLK) input. In order for this clock to drive the MAX98091, a shunt must be placed on pins 1–4 of header JU14.
Connect Options	Sets the interface method between the EV kit and MAX98091 software.
Cmod USB	The MAX98091 EV kit interfaces to a local PC through its USB Control (J1) port.
TCP	The MAX98091 EV kit interfaces to a remote PC through a TCP connection. Additional hardware setup required.
ACTIONS	
Read All Registers F4	Reads all MAX98091 registers and updates the GUI. Also reads all of the S/PDIF transceiver (U201) registers.
Write All Registers F8	Writes the data from the Edit boxes, on the Control Registers tab, to the MAX98091 device and updates the GUI. Also writes to the S/PDIF transceiver (U201) registers and updates all configurable GPIO pins.
Reset All Registers F12	Resets the device according to the check box selections on the Reset dialog window.
HELP	
About	Pop-up window that provides information about the software.

In addition, the EV kit includes a MAXQ2000 microcontroller that facilitates evaluation by providing I²C, SPI, and GPIO interfaces, allowing the MAX98091 software to communicate with the devices on the EV kit.

Power Supplies

The EV kit requires a single 2.8V to 5.5V external supply (SPKVDD) to operate. All other MAX98091 supply inputs are powered from the J1 USB port. Jumpers JU1–JU4 (see [Table 2](#)) allow all MAX98091 supply inputs to be disconnected from USB power and connected to external supplies. In addition, jumpers JU1 and JU2 are used to configure the on-board voltage connected to DVDD and DVDDIO, respectively. See [Table 2](#) for jumper JU1–JU4 configuration options.

To perform supply current and power-consumption measurements use external supplies to power the MAX98091 supply inputs: HPVDD, AVDD, DVDD, and DVDDIO.

Jumper Selection

The EV kit includes 25 jumpers to adjust various hardware configuration options. [Table 2](#) describes all the jumpers available on the EV kit.

Master Clock (MCLK) Selection

Jumper JU12 selects which master clock (MCLK) source drives the MAX98091 device. The available clock configurations are listed in [Table 3](#). When streaming audio through the on-board USB AUDIO port or S/PDIF connectors, the EV kit software automatically configures the U8 and U9 switches to route the appropriate clock signal to the MAX98091 MCLK input.

If an external audio source is used, choose either the on-board 13MHz oscillator or an external clock. To connect an external clock, remove the shunt from JU14 and connect the clock to pin 1.

I²S Audio I/O

The EV kit provides three methods for evaluating the MAX98091's digital audio interface (DAI). The first method is through the I²S header (JU15). This method provides the most direct connection to the MAX98091's DAI.

The two other methods involve streaming audio onto or off the EV kit. The USB AUDIO port (J2) is used to stream audio onto the EV kit. The SPDIFIN and SPDIFOUT optical connectors are used to stream audio onto or off the EV kit, respectively.

The USB and S/PDIF digital audio signals are switched onto the PCM bus through switches U10 and U11. The switches are automatically configured by the evaluation kit software, depending on which path has been enabled (**USB** or **S/PDIF**).

Note: All PCM digital audio is routed through the I²S header before routing to the MAX98091's DAI. This is true for the USB AUDIO input as well as for the S/PDIF I/O. See [Figure 12](#).

Digital Audio Interface Header (JU15)

Header JU15 provides access to the MAX98091 digital audio interface (DAI). See [Table 4](#) for individual pin descriptions. Follow the steps below to configure JU15:

Direct connection of PCM digital audio:

- 1) Remove the shunts from JU15 (place shunts on Position 1 for safekeeping).
- 2) Connect the PCM signals/grounds to the corresponding position 2 (center) and position 3 (right) pins of JU15.

USB Audio Input or SPDIF I/O:

- 1) Install the four shunts between position 2 and position 3 of JU15.
- 2) For audio input, connect an audio output device to the USB AUDIO or SPDIFIN connector.
- 3) For audio output, connect an audio input device to the SPDIFOUT connector.

Table 2. Jumper Configuration

HEADER	SHUNT POSITION	DESCRIPTION
JU1	1-2*	DVDD connected to +1.2V
	2-3	DVDD connected to +1.8V
	Open	DVDD externally supplied
JU2	1-2	DVDDIO connected to +3.3V
	2-3*	DVDDIO connected to +1.8V
	Open	DVDDIO externally supplied
JU3	Installed*	AVDD connected to +1.8V
	Open	AVDD externally supplied
JU4	Installed*	HPVDD connected to +1.8V
	Open	HPVDD externally supplied
JU5	Installed	Connects JACKSNS to headphone jack, HP, for jack detection; ensure that a shunt is installed on JU27/JU6 or JU28/JU22 for proper jack detection.
	Open*	Disconnects JACKSNS from the headphone jack, HP
JU6	Installed	Connects MICBIAS to the IN1 input through a 2.2kΩ resistor (for microphone input)
	Open*	Disconnects MICBIAS from the IN1 input
JU7	Installed	Connects MICBIAS to the IN3 input through a 2.2kΩ resistor (for microphone input)
	Open*	Disconnects MICBIAS from the IN3 input
JU8	Installed	Connects IN2 directly to ground for single-ended operation
	Open*	Allows for differential operation
JU9	Installed	Connects IN2 to ground through a 2.2kΩ resistor (used when IN1 is mic biased)
	Open*	Disconnects IN2 from ground
JU10	Installed	Connects IN4 directly to ground for single-ended operation
	Open*	Allows for differential operation
JU11	Installed	Connects IN4 to ground through a 2.2kΩ resistor (used when IN3 is mic biased)
	Open*	Disconnects IN4 from ground
JU14	—	See Table 3
JU15	—	See Table 4
JU16	2-3, 5-6*	Connects the on-board I ² C master to MAX98091
	Open	Allows external I ² C control of MAX98091
JU17	Installed	Removes AC-coupling capacitor, C4, from LOU _{TL} line output
	Open*	Adds AC-coupling capacitor, C4, to LOU _{TL} line output
JU18	Installed	Removes AC-coupling capacitor, C5, from LOU _{TR} line output
	Open*	Adds AC-coupling capacitor, C5, to LOU _{TR} line output
JU19	Installed	Connects MICBIAS to IN5 through a Schottky diode and 2.2kΩ resistor
	Open*	Disconnects MICBIAS from IN5
JU20	Installed	Connects IN5 to the headphone jack, HP (for microphone input)
	Open*	Disconnects IN5 from the headphone jack, HP

Table 2. Jumper Configuration (continued)

HEADER	SHUNT POSITION	DESCRIPTION
JU21	—	See Table 8.
JU22	Installed	Connects MICBIAS to IN5 through a 2.2kΩ resistor
	Open*	Disconnects MICBIAS from IN5
JU23	Installed	Connects IN6 to ground through a 2.2kΩ resistor (when IN5 is microphone biased)
	Open*	Disconnects IN6 from ground
JU24	Installed	Connects IN6 directly to ground for single-ended operation
	Open*	Allows for differential operation
JU27	Installed	Connects IN1 to the headphone jack, HP (for microphone input)
	Open*	Disconnects IN1 from the headphone jack, HP
JU100	Installed*	Connects the MAX98091 interrupt output (\overline{IRQ}) to the on-board microcontroller
	Open	Disconnects the MAX98091 interrupt output (\overline{IRQ}) from the on-board microcontroller

*Default position.

Table 3. Master Clock Source Configuration (JU14)

SHUNT POSITION	CLOCK SOURCE
1-2	Disabled
1-3	13MHz oscillator
1-4*	Software-selected clock source

*Default position.

Table 4. DAI Header (JU15)

JU16		
POSITION 1 (LEFT)	POSITION 2 (CENTER)	POSITION 3 (RIGHT)
GND	CODEC_BCLK	I2S_BCLK
GND	CODEC_LRCLK	I2S_LRCLK
GND	CODEC_SDIN	I2S_DAC
GND	CODEC_SDOUT	I2S_ADC

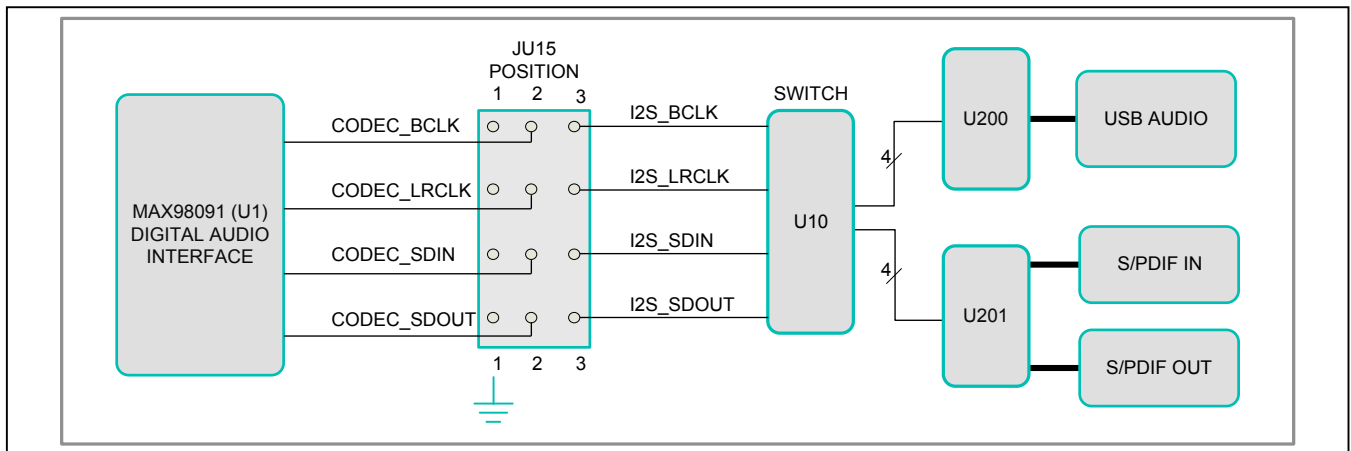


Figure 12. I²S Routing

S/PDIF Transceiver

The S/PDIF transceiver (U201) serves as a format converter between I²S and S/PDIF. Use this device to send and receive digital audio over the optical connectors (SPDIFIN, SPDIFOUT).

When receiving S/PDIF data, the transceiver outputs a recovered master clock that is exactly 256 x f_S, where f_S is the sample rate. This clock signal can be used to clock the MAX98091.

When transmitting S/PDIF data, the transceiver requires a master clock input and if data is also being received, it uses the data to generate its own master clock.

If S/PDIF data is not being received, the transceiver generates a master clock based on the LRCLK signal being output by the MAX98091. For proper transmit-only operation, the S/PDIF transceiver must be configured in master mode.

The S/PDIF transceiver is controlled through the SPI interface of the on-board MAXQ2000 microcontroller. See the [Control Interface](#) section.

USB Audio

The audio DAC with USB interface (U200) accepts an audio stream from a PC, connected to the USB AUDIO port (J2), and converts it to I²S data. The USB audio DAC generates a master clock signal that can be used to clock the MAX98091. The clock signal is 256 x f_S.

The USB audio DAC supports standard class drivers that are included with most operating systems. As a result, no

drivers are required for this device, and it appears as a sound card in the PC. This allows for audio playback from the PC through the MAX98091 audio codec.

Analog Inputs

The MAX98091 analog input pairs (IN1/IN2, IN3/IN4, and IN5/IN6) can be configured for microphone input, single-ended input, or differential input. These input connections are made through the provided RCA connectors or PCB pads (IN1–IN6). In addition, the IN1/IN2 and IN5/IN6 device inputs can be connected to the 3.5mm audio jack (HP) for single-ended microphone input from a headset. [Table 5](#) lists the configuration headers associated with each input pair. See the specific input sections for configuration details.

Single-Ended and Differential Inputs

The three analog input pairs are configured for single-ended or differential line input by configuring the associated input headers (as listed in [Table 6](#)). For single-ended inputs, the input header configuration is independent of the input type. For differential inputs, the header configuration is different for microphone inputs powered by the MAX98091 MICBIAS output.

Analog Microphone

When using the analog input pairs for microphone input, the MAX98091 microphone bias (MICBIAS) output can be used to power the connected microphone. The MICBIAS output is connected to the IN1, IN3, or IN5 input through the input’s associated MICBIAS header.

Table 5. Analog Input Headers

INPUT PAIR	SINGLE-ENDED/ DIFFERENTIAL HEADER	DIFFERENTIAL MICROPHONE HEADER	MICBIAS HEADER
IN1/IN2*	JU8	JU9	JU6
IN3/IN4	JU10	JU11	JU7
IN5/IN6*	JU24	JU23	JU22 or JU19

*The microphone input from the HP headset is routed to IN1 and IN5 of these input pairs.

Table 6. Analog Input Header Configuration

INPUT	SINGLE-ENDED	DIFFERENTIAL	DIFFERENTIAL MICROPHONE (W/ MICBIAS)
IN1/IN2	JU8 = On	JU8 = Off JU9 = Off	JU8 = Off JU9 = On
IN3/IN4	JU10 = On	JU10 = Off JU11 = Off	JU10 = Off JU11 = On
IN5/IN6	JU24 = On	JU24 = Off JU23 = Off	JU24 = Off JU23 = On

When evaluating with two analog microphones, and jack detection is required, the IN5 input needs to be connected to MICBIAS through jumper JU19. See [Table 7](#).

Digital Microphone

The EV kit includes an on-board digital microphones (U2 and U3) for evaluation of the MAX98091’s digital microphone interface. The digital microphone interface is enabled and configured through the software.

Install shunts on columns 2 and 3 (DUT and SRC) of jumper JU21 ([Table 8](#)) to connect the digital microphone(s) to the circuit. Use the **Digital Mics** block in the evaluation software to select which inputs (IN1/I2 or IN5/IN6) are connected to the digital microphones and use the **DIGMIC** and **DIGMIC2** blocks to enable the MAX98091 digital microphone inputs. Refer to the MAX98091 IC data sheet for additional details.

Jack Detection

The MAX98091’s flexible, software-configurable jack-detection interface is used to detect the presence or absence of a headphone/headset connected to the HP jack. To provide jack detection on the HP jack, install a shunt on header JU5.

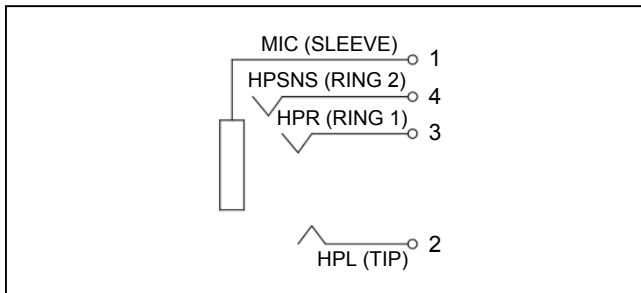


Figure 13. Headphone Jack

Analog Outputs

The EV kit provides connections for each of the three analog outputs. [Table 9](#) lists the outputs and their available connections.

Headphone

The MAX98091 stereo headphone output (HPR/HPL) is routed to the on-board 3.5mm audio jack (HP), as shown in [Figure 13](#). The HP jack also allows for a headset connection, with the microphone input (MIC) connected to either IN1 or IN5. See the [Analog Inputs](#) section for input configuration options.

Stereo Class D Speaker Amplifier

The MAX98091 integrates a filterless Class D stereo amplifier. In systems with short speaker traces, the stereo speaker outputs (SPKLP/SPKLN and SPKRP/SPKRN test points) can be connected directly to the speaker loads. Although this amplifier is designed to operate completely filterless, the EV kit does provide stuffing options for two types of output filters.

When long speaker cables are used, a ferrite bead plus capacitor filter can be installed to prevent excessive EMI radiation. Although it is best to choose filter components based on EMI test results, the combination of a 680pF capacitor (C48–C51) with the Murata BLM18SG331TN1 ferrite bead (FB1–FB4) generally works well. With this configuration, connect the speaker loads to the SPKLP/SPKLN and SPKRP/SPKRN test points.

To allow analysis of the audio output with an oscilloscope, or an analyzer not designed to accept Class D switching waveforms, populate L1–L4 with the included 22µH inductors and make connections, to external equipment or speakers, at FSPKLP/FSPKLN and FSPKRP/FSPKRN. The LC filter is designed to work best with an 8Ω load. Do not connect a load to the unfiltered SPKLP/SPKLN and SPKRP/SPKRN outputs when L1–L4 are installed.

Table 7. MICBIAS Connection

MICROPHONE CONNECTION	MICBIAS CONNECTED	MICBIAS DISCONNECTED
IN1	JU6 = On	JU6 = Off
IN3	JU7 = On	JU7 = Off
IN5	JU22 = On JU19 = Off	JU22 = Off JU19 = Off
IN5*	JU22 = Off JU19 = On	JU22 = Off JU19 = Off

*Configuration for two analog microphones, requiring jack detection.

Table 8. Digital Microphone Configuration (JU21)

SHUNT POSITION	CONNECTIONS
8-9, 11-12	Digital microphones (U2, U3) connected to the MAX98091 digital microphone 1 interface (IN1/DMD1 and IN2/DMC1).
2-3, 5-6	Digital microphones (U2, U3) connected to the MAX98091 digital microphone 2 interface (IN5/DMD2 and IN6/DMC2).

Table 9. Analog Outputs

OUTPUT	CONNECTIONS
Headphone	3.5mm audio jack (HP)
Speaker	Unfiltered and filtered connection options (SPK_P/SPK_N and FSPK_P/FSPK_N)
Receiver/Line-Out	RCA connectors (LOUTL and LOUTr)

Table 10. I2C Header (JU16)

JU16		
POSITION 1 (LEFT)	POSITION 2 (CENTER)	POSITION 3 (RIGHT)
GND	CODEC_SCL	SCL
GND	CODEC_SDA	SDA

Receiver/Line Output

The MAX98091 receiver/line output can be configured either as a differential receiver/earpiece output or as a stereo single-ended line output. The receiver/line outputs are routed, through AC-coupling capacitors, to the LOUTr and LOUTr RCA connectors. The AC-coupling capacitors can be shorted (effectively removed from the signal path) by installing a shunt on JU17 and JU18.

Control Interface

The MAXQ2000 (U100) microcontroller circuitry is the bridge between the on-board interface-enabled devices and the EV kit software, running on a PC connected to the USB CONTROL port (J1). The EV kit utilizes the MAXQ2000’s I2C, SPI, and GPIO interfaces. See the [Detailed Description of Software](#) section for additional software details.

I2C Interface

The MAXQ2000’s I2C interface is routed to the MAX98091 device through jumper JU16, by installing shunts across pins 2-3 of each row (Table 10). When using an external I2C master, remove both shunts from JU16 and connect the external SDA and SCL signals to the position 2 pins of JU16. Ground connections can be made to the position 1 pins of JU16. Install pullup resistors at R15 and R16 if the external master does not include pullup resistors.

SPI Interface

The MAXQ2000 SPI interface is used to control the on-board S/PDIF transceiver (U201). In the MAX98091 software go to **View | Show S/PDIF Transceiver Registers** to activate the **S/PDIF Transceiver** tab.

GPIO Interface and Pushbutton Programmer

Six of the MAXQ2000 general-purpose inputs/outputs (GPIOs) are used for either controlling or monitoring a specific on-board device/signal. Four of the GPIOs are used as general-purpose outputs and are automatically set/cleared based on configuration settings made through the MAX98091 software.

The other two GPIOs are used as general-purpose inputs to monitor a specific signal. The first general-purpose input (CODEC_IRQ) is connected to the MAX98091 interrupt (IRQ) output. This IRQ is monitored by the microcontroller and its state is reported in the **Status** group box on the left side of the software main window. This general-purpose input can be disconnected from the MAX98091’s IRQ output by removing the shunt from jumper JU100.

The second general-purpose input is connected to a tactile switch (SW1) to realize a pushbutton programmer. When SW1 is pressed, the MAXQ2000 microcontroller responds by transmitting a sequence of configuration settings that have been preprogrammed into its firmware. This allows the EV kit to be quickly programmed with a specific configuration, without the need for a PC running the software. By default, the pushbutton programming feature is not enabled.

Component List, Schematics, and PCB Layout Diagrams

See the following links for component, schematic, and PCB information:

- [MAX98091WLP EV kit component list](#)
- [MAX98091WLP EV kit schematic](#)
- [MAX98091WLP EV kit PCB](#)

Ordering Information

PART	TYPE
MAX98091EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	4/16	Initial release	—

PRELIMINARY

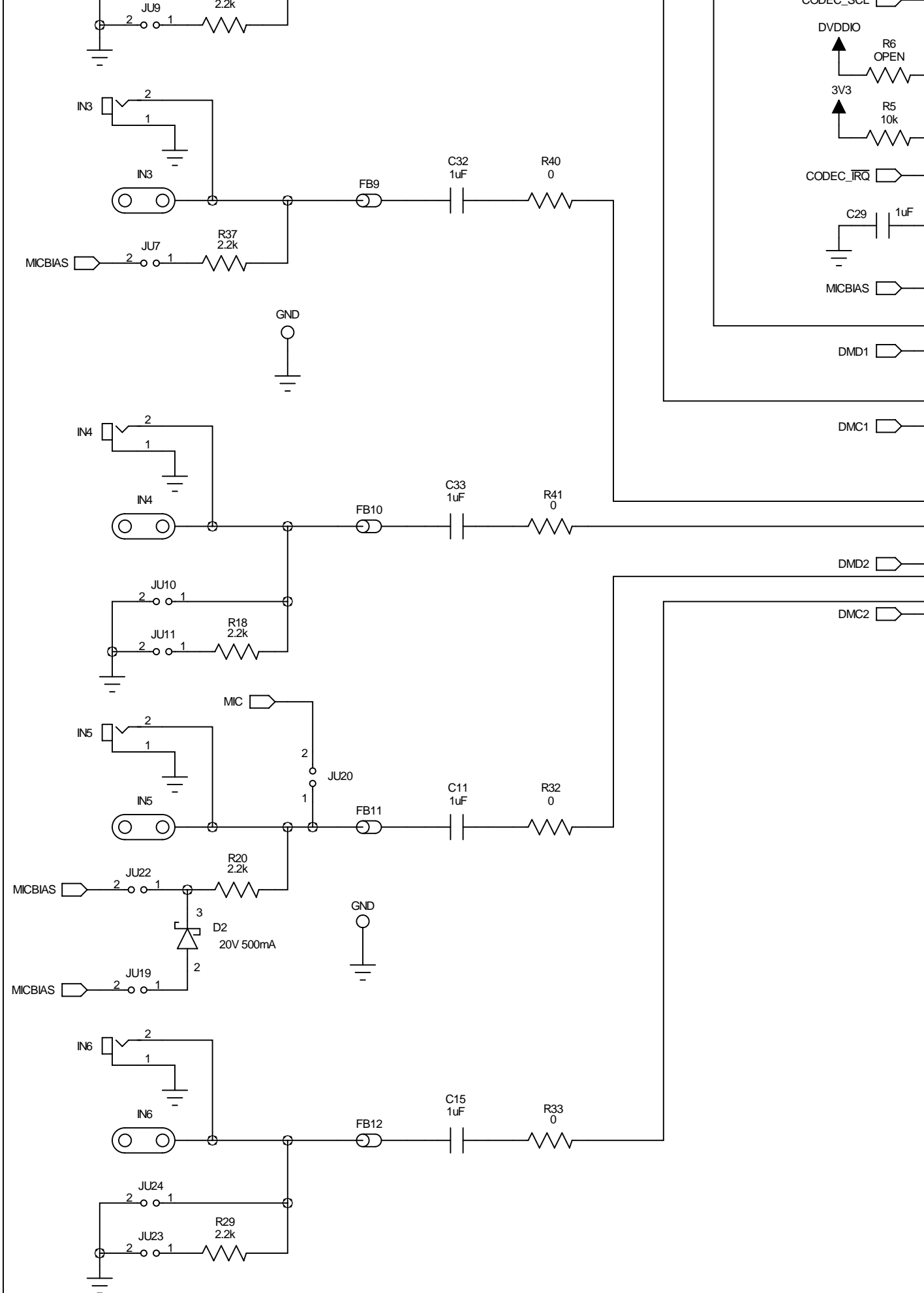
For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

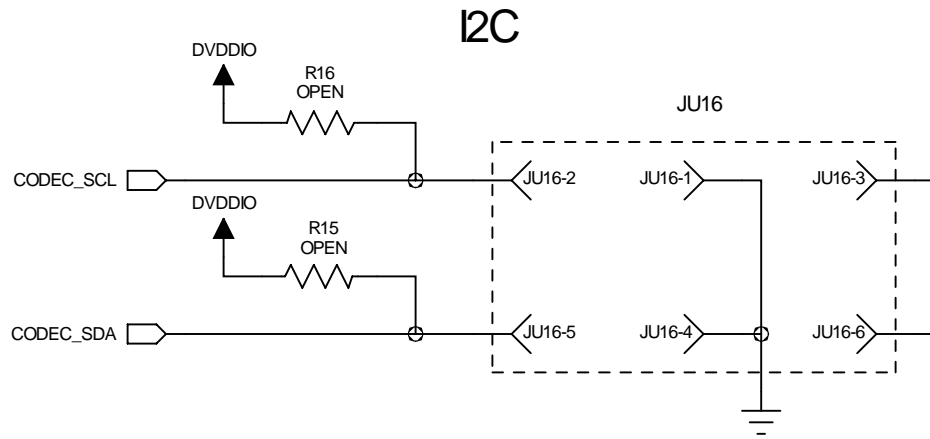
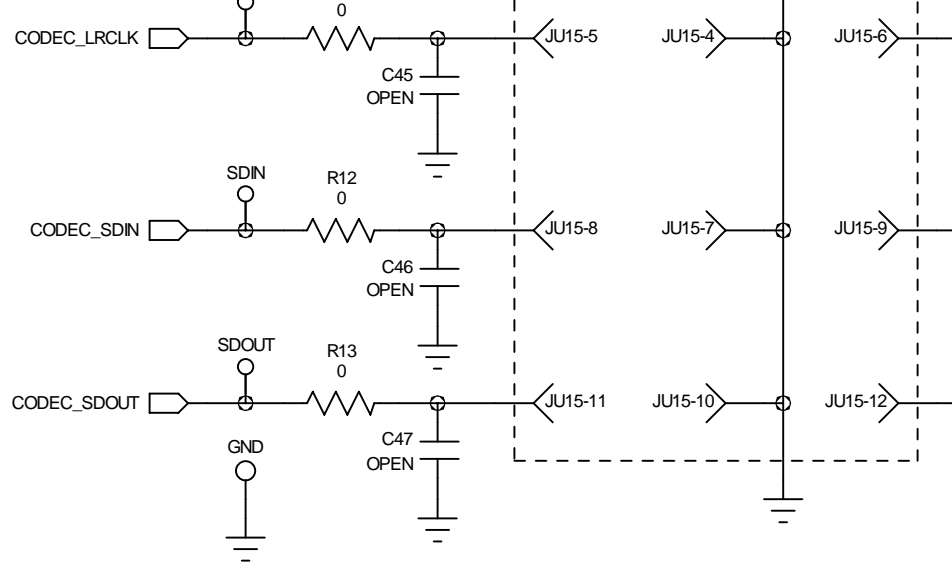
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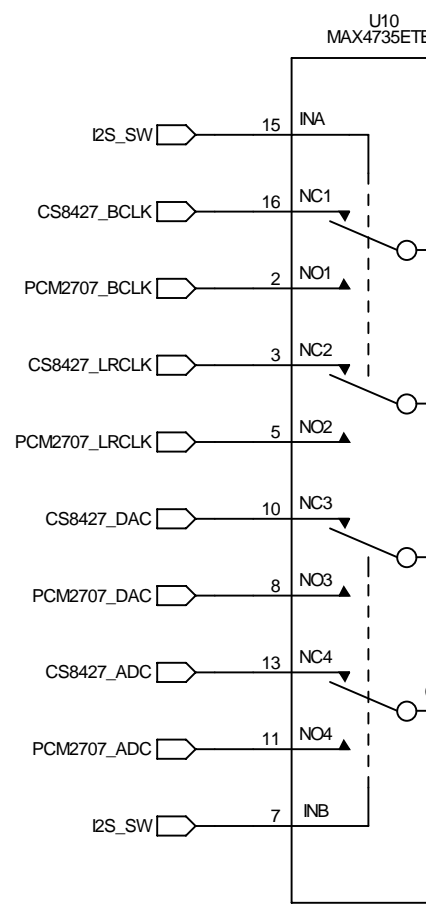
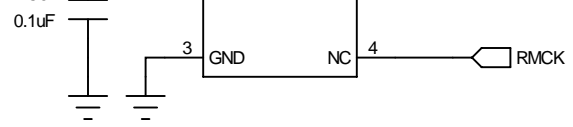
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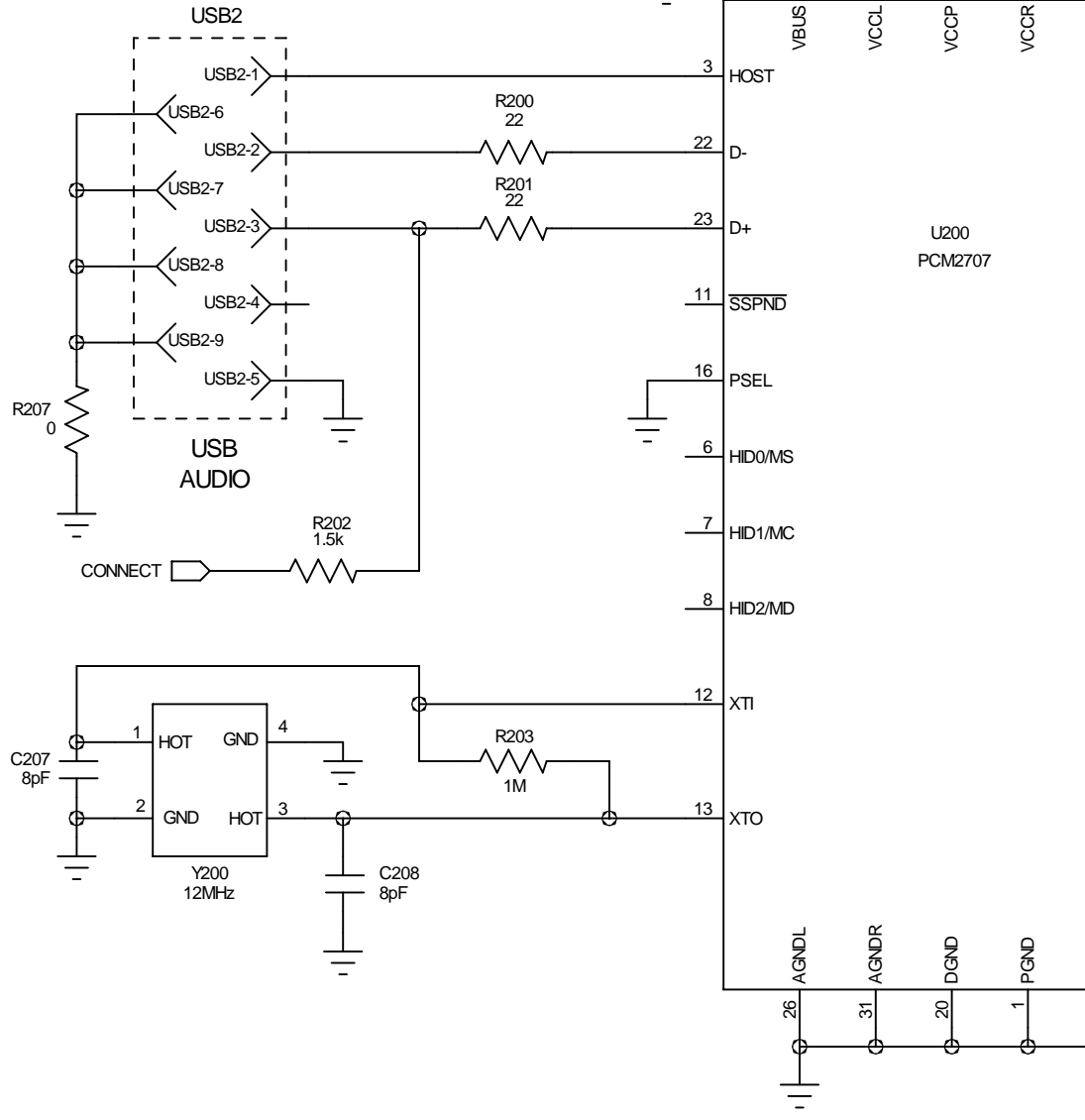
Parent Number	Item	Component Description	Qty	Primary Part	Alternate Part(s)	Assembly DNI = Do Not Install	Procurement DNP = Do Not Purchase
MAX98091EVKIT#	1	10uF ±20%, 6.3V X5R CER CAP (0805)	4				
	2	1uF ±10%, 6.3V X5R CER CAP (0402)	19				
	3	1uF ±20%, 6.3V X5R CER CAP (0603)	10				
	4	0.1uF ±10%, 10V X7R CER CAP (0402)	11				
	5	10pF ±5%, 50V C0G CER CAP (0402)	2				
	6	0.01uF ±10%, 50V X7R CER CAP (0603)	4				
	7	2.2uF ±10%, 6.3V X5R CER CAP (0603)	2				
	8	2.2uF ±20%, 6.3V X5R CER CAP (0402)	1				
	9	0.22uF ±10%, 6.3V XR5 CER CAP (0402)	10				
	10	OPEN, capacitor (0402)	0				
	11	10uF ±20%, 6.3V X5R CER CAP (0603)	1				
	12	0.1uF ±10%, 50V X5R CER CAP (0603)	11				
	13	8pF ±0.5pF, 50V C0H CER CAP (0402)	4				
	14	33000pF ±10%, 25V X7R CER CAP (0603)	1				
	15	18pF ±5%, 50V C0G CER CAP (0603)	2				
	16	47uF ±20%, 6.3V X5R CER CAP (1206)	2				
	17	0.47uF ±10%, 6.3V X5R CER CAP (0603)	1				
	18	47000pF ±10%, 25V X7R CER CAP (0603)	1				
	19	Schottky Diode (SOT23)	1				
	20	LED, YELLOW (0603)	1				
	21	LED, RED (0603)	1				
	22	00hms ±5% Resistor (0603)	4				
	23	00hms ±5% Resistor (0402)	2				
	24	FERRITE BEAD (0402)	6				
	25	FERRITE BEAD (0603)	2				
	26	Receptacle, USB Mini B Receptacle	2				
	27	Jack, Stereo Headphone 3.5MM, 4 positions	1				
	28	JACK, PC MOUNT NON-SWITCHED , RED	8				
	29	3-pin header, 0.1" centers	2				
	30	2-pin header, 0.1" centers	18				
	31	4-pin header, 0.1" centers	1				
	32	12-pin header (3x4), 0.1" centers	1				
	33	6-pin header (2x3), 0.1" centers	1				
	34	12-pin header (4x3), 0.1" centers	1				
	35	OPEN, inductor, 22uH, 1A (6.2mm x 6.3mm)	4			DNI	
	36	FERRITE BEAD, 47uH 220mA (1812)	1				
	37	MOSFET, -20V, -2.4A, P-Channel (SuperSOT-3)	1	1/2			
	37	MOSFET, -20V, -2.4A, P-Channel (SuperSOT-3)	1		2/2		
	38	00hms ±5% Resistor (0402)	15				
	39	10KOhms ±5% Resistor (0402)	1				
	40	OPEN, resistor (0402)	0			DNI	DNP
	41	2.2KOhms ±5% Resistor (0402)	6				
	42	22Ohms ±5% Resistor (0402)	6				
	43	1.5KOhms ±5% Resistor (0603)	5				
	44	27Ohms ±5% Resistor (0603)	2				
	45	470Ohms ±5% Resistor (0603)	1				
	46	2.2KOhms ±5% Resistor (0603)	1				
	47	10KOhms ±5% Resistor (0603)	1				
	48	220Ohms ±5% Resistor (0603)	2				
	49	1KOhms ±5% Resistor (0603)	1				
	50	1MOhms ±5% Resistor (0603)	1				
	51	47KOhms ±5% Resistor (0603)	1				
	52	402Ohms ±1% Resistor (0603)	1				
	53	CONNECTOR, Digital Audio Optical Transmitter	1				
	54	CONNECTOR, Digital Audio Optical Receiver	1				
	55	SPST, tactile switch	1				
	56	STEREO AUDIO CODEC (56 WLP)	1				
	57	DIGITAL MICROPHONE (6 LGA)	2	1/2			
	57	DIGITAL MICROPHONE (6 LGA)	2		2/2		
	58	Single CMOS Switch Debouncer (4 SOT143)	1				
	59	1.8V LOW NOISE LINEAR REGULATOR (5 SOT23)	1				
	60	300mA LDO regulator (SOT23-6)	1				
	61	3.3V LOW NOISE LINEAR REGULATOR (5 SC70)	2				
	62	Low Voltage SPDT CMOS analog switch (6 SC70-6)	2				
	63	Low Voltage Quad-SPDT analog switch (16 TQFN)	1				
	64	Analog Switch (10-pin uDFN)	1				
	65	MICROCONTROLLER (56 TQFN)	1				

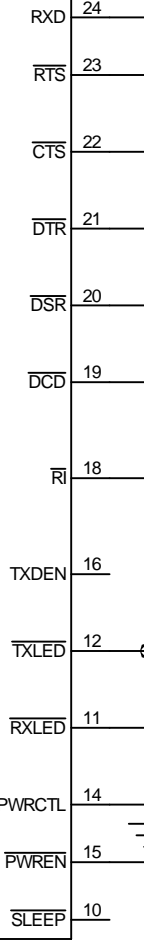
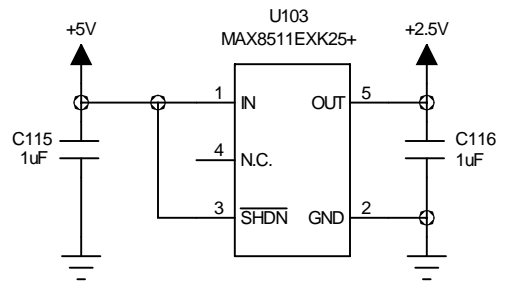
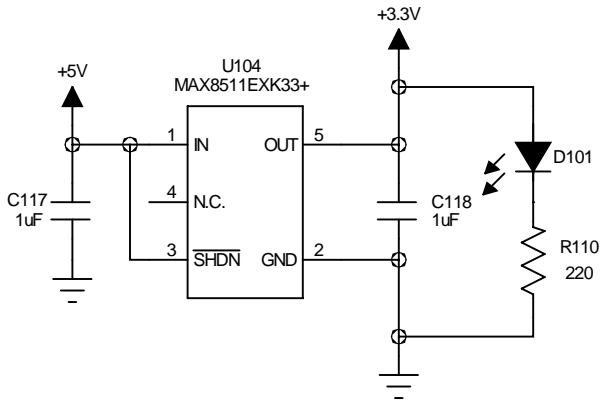
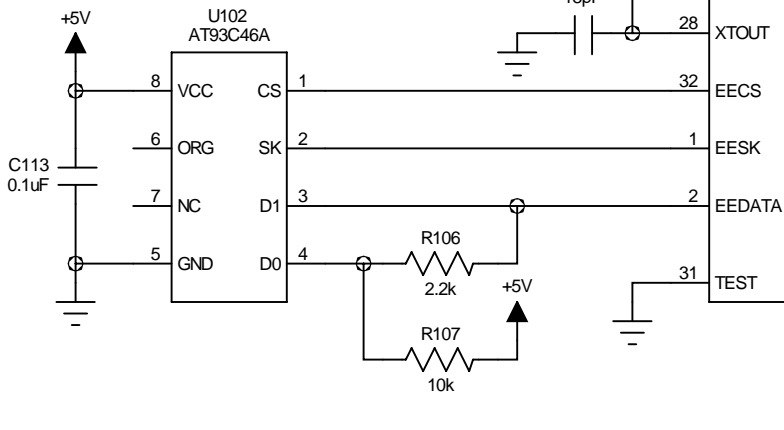
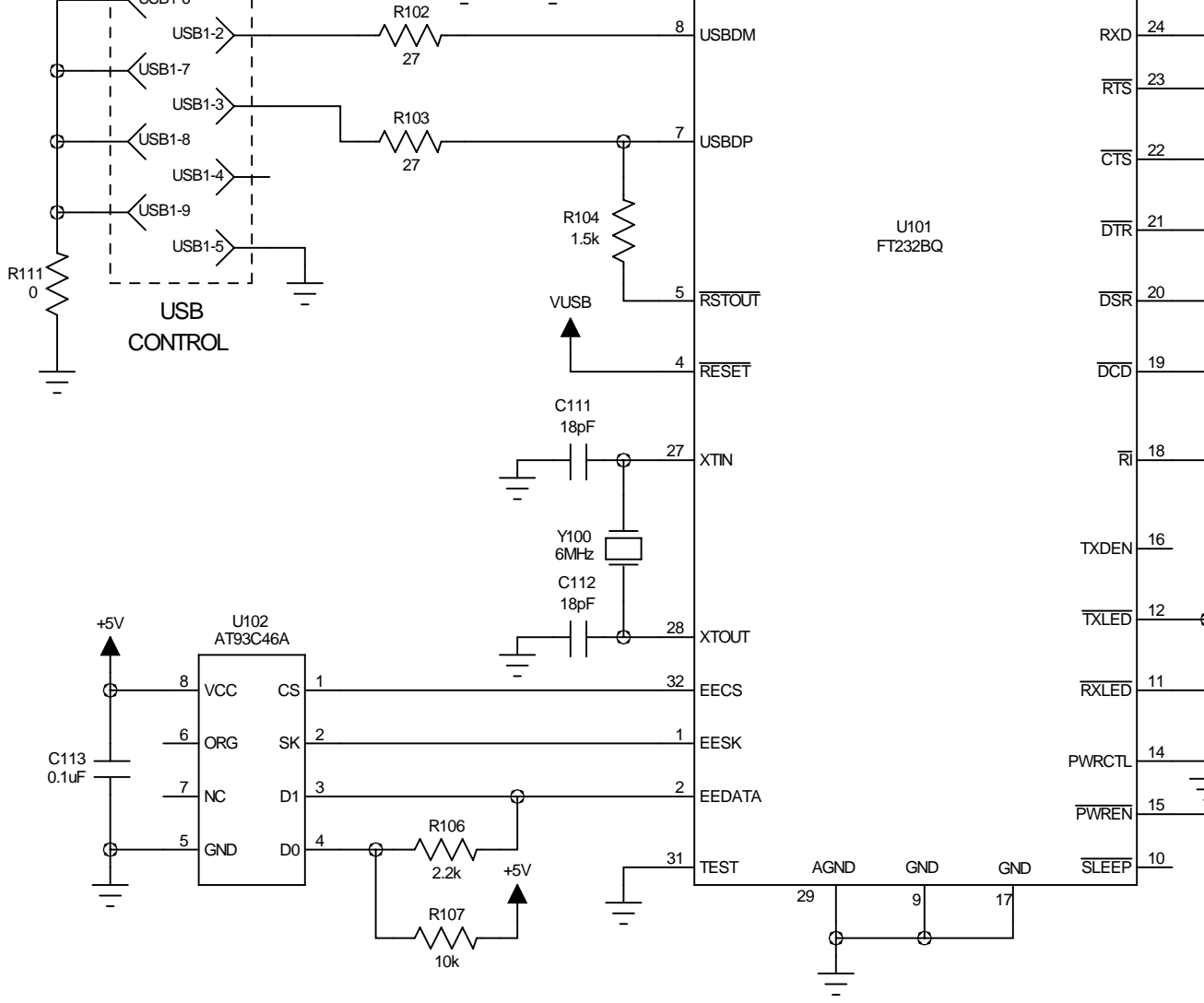
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68	2.5V LOW NOISE LINEAR REGULATOR (5 SC70)	1				
69	USB AUDIO CODEC (32 QFP)	1				
70	DIGITAL AUDIO TRANSCEIVER (28 SO)	1				
71	13Mhz Clock Oscillator (2.5mm x 2.0mm)	1				
72	6MHz crystal	1				
73	CRYSTAL, 16MHz (3.2mm x 2.5mm)	1				
74	CRYSTAL, 12MHz (3.2mm x 2.5mm)	1				
75	Test Point "Miniature" 40mil drill size (Red)	6				
76	Test points	6			DNI	DNP
77	Test Point "Multipurpose" 63mil drill size (Red)	4				
78	Test Point "Multipurpose" 63mil drill size (Black)	10				
79	1-pin header	2				
80	Shunt, Shorting Jumper, 2 position, 0.1 center	31				
81	WIRE, BUSS, 20G plated solid copper 0.25 inch U-shape wire loop	24				
82	PCB	1				

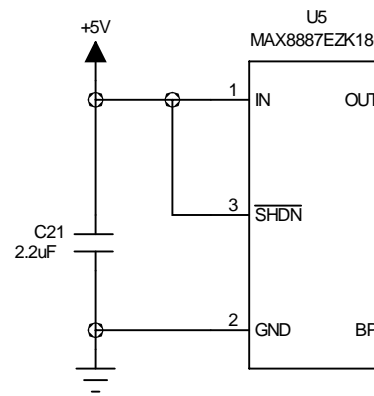
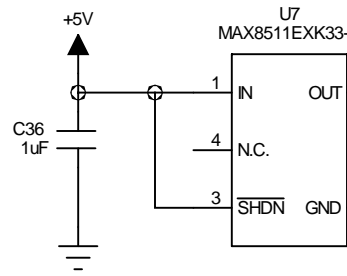





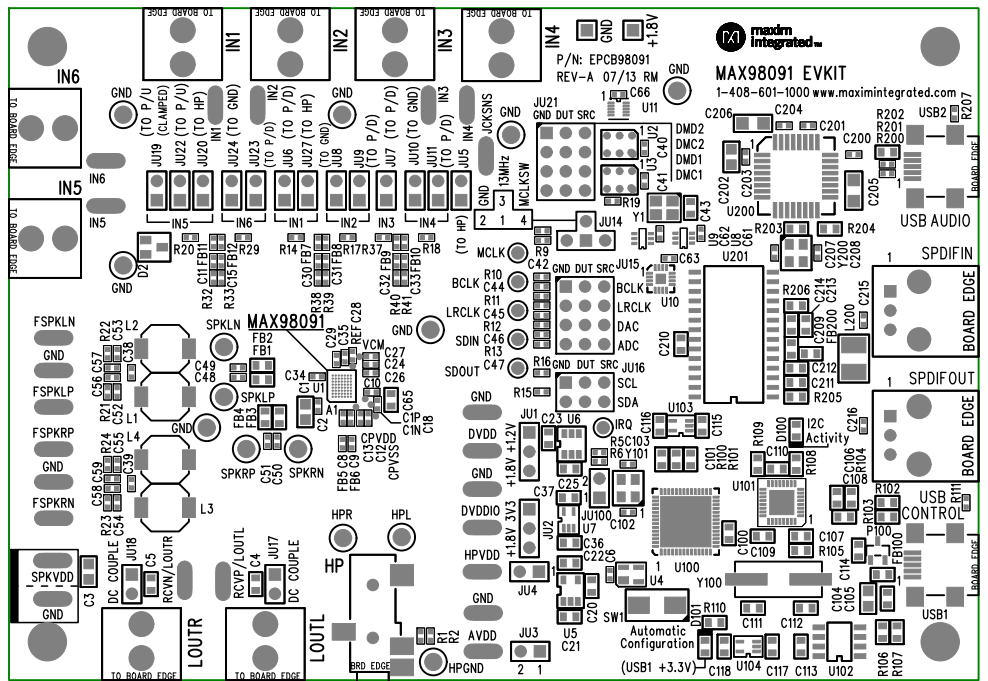




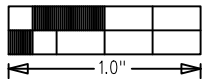





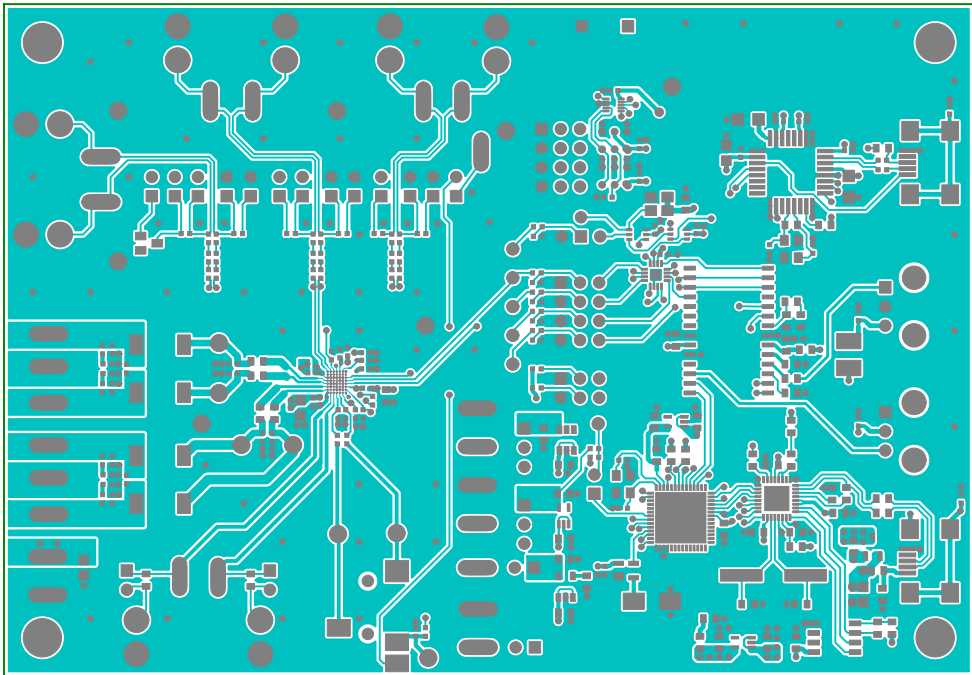
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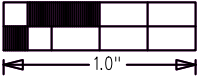
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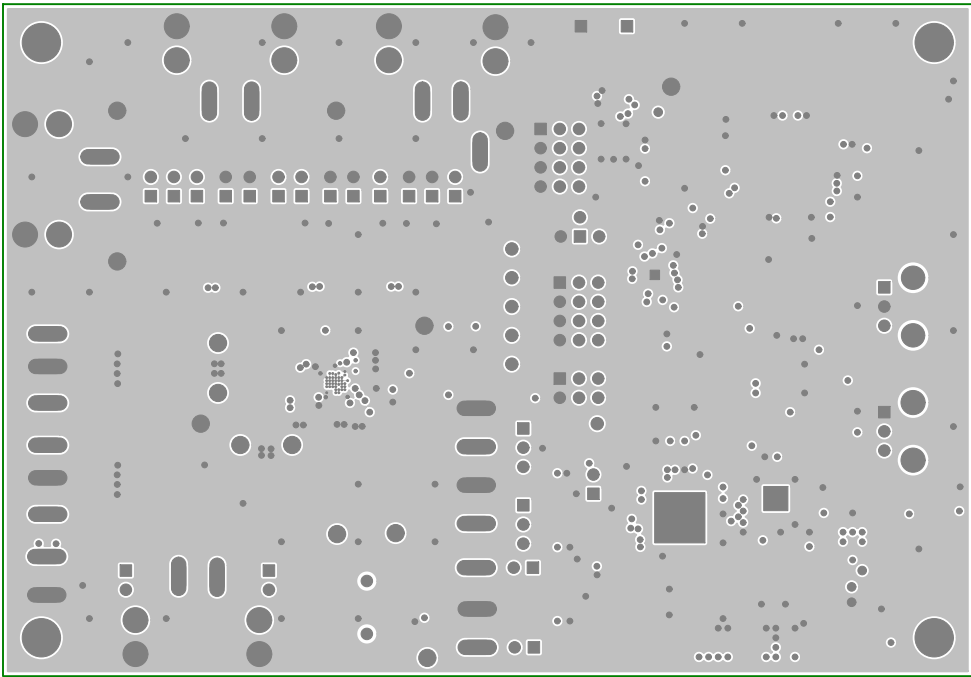
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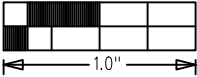
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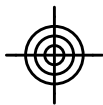
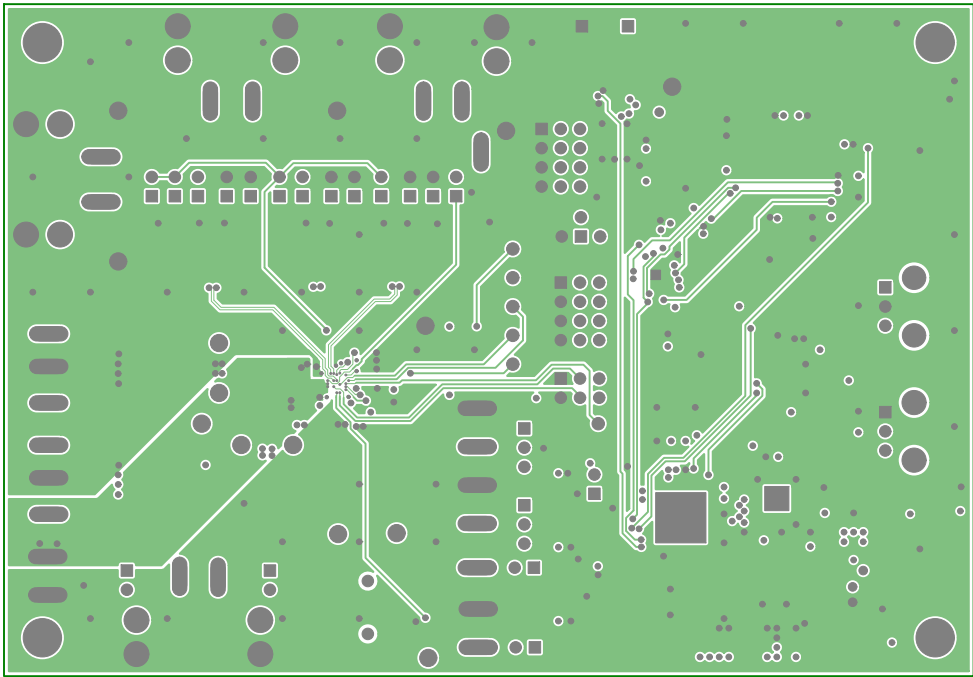
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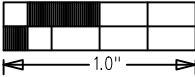
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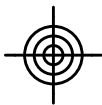
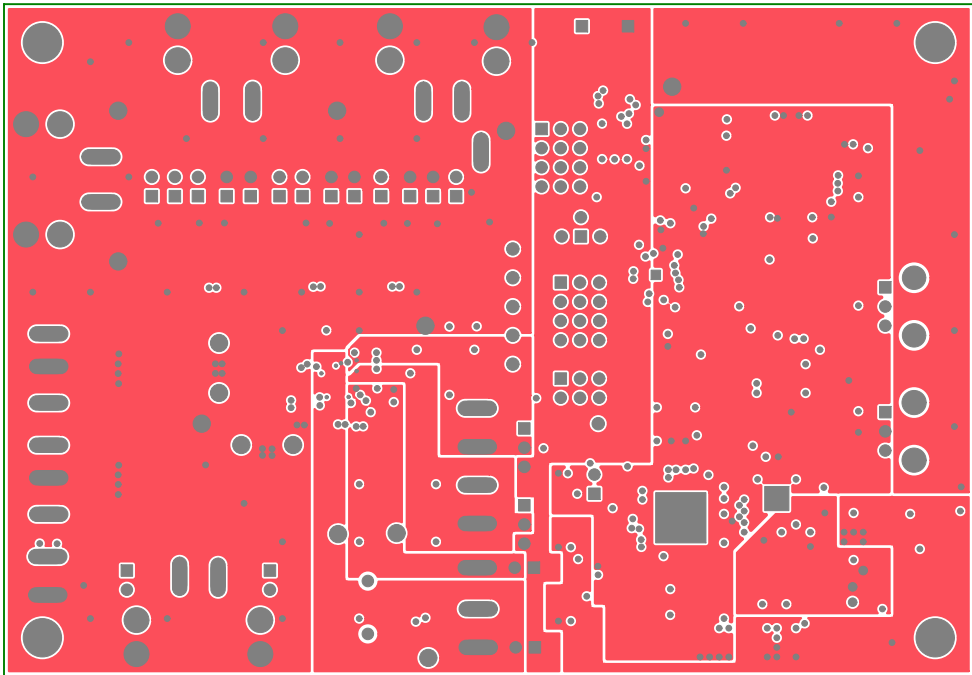
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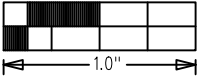
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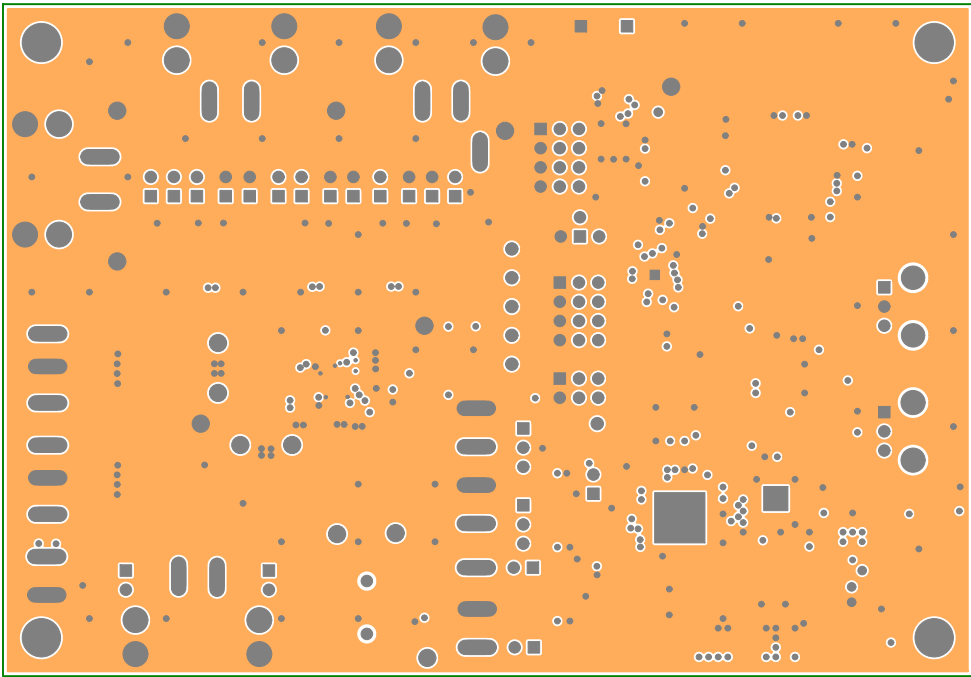
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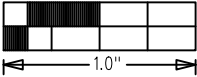
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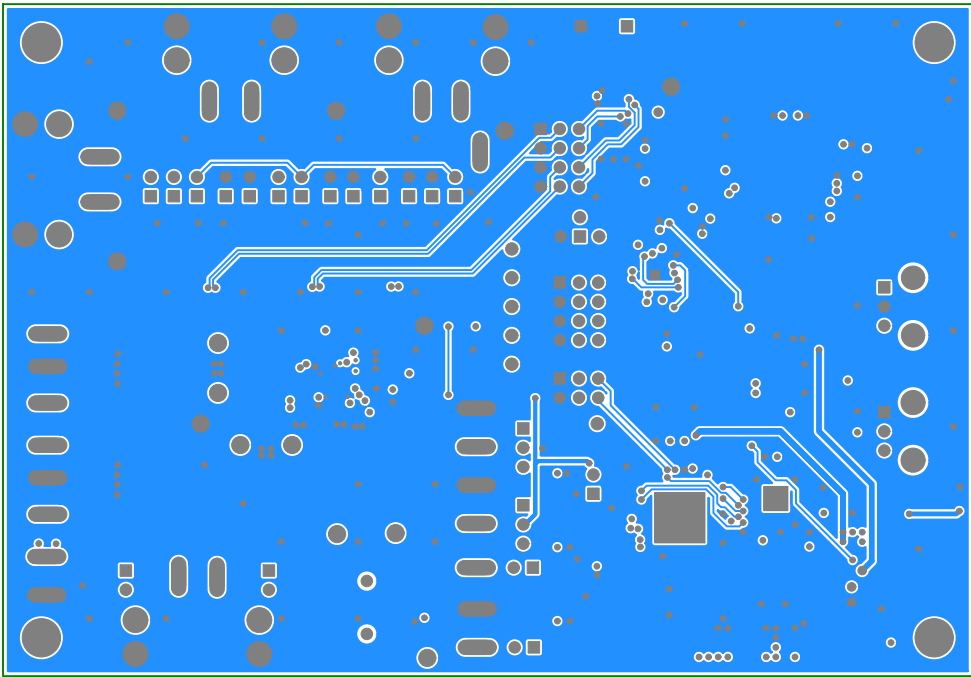
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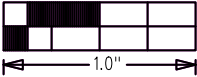
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