



MAX8821 Evaluation Kit

Evaluates: MAX8821

General Description

The MAX8821 evaluation kit (EV kit) is a fully assembled and tested circuit for evaluating the MAX8821 white LED charge pump with a mono Class D audio amplifier and dual LDOs. The MAX8821 EV kit operates from a 2.7V to 5.5V input supply range and is controlled by an I²C interface. The MAX8821 features a high-efficiency, adaptive-mode inverting charge pump that drives up to six LEDs with constant current for uniform brightness.

The EV kit also includes Windows® 2000/XP/Vista® -compatible software that provides a simple graphical user interface (GUI) for exercising the features of the MAX8821. The EV kit software features an I²C interface to control the LED current, ramp-up/ramp-down time, and blink on/off-time. An internal temperature derating function reduces the current above +40°C to protect the LEDs.

The MAX8821 also features a mono Class D audio amplifier with adjustable gain, through the I²C interface, from -3dB to +24dB in ten 3dB steps. The I²C control interface selects the audio amplifier fixed-frequency mode or spread-spectrum mode, in addition to selecting individual LDO output voltages.

Features

- ◆ **Windows 2000/XP/Vista (32-Bit)-Compatible Software**
- ◆ **CMAXQBUSB+ Interface Board with USB PC Connection (Cable Included)**
- ◆ **Proven PCB Layout**
- ◆ **Fully Assembled and Tested**
- ◆ **White LED Inverting Charge Pump**
 - Independent Adaptive Current Regulators for Each LED
 - Six Low-Dropout Current Regulators
 - Flexible I²C Dimming Control for Each LED
 - Ramp Up/Down Current Control for Each LED
 - Low 70µA (typ) Quiescent Current
 - T_A Derating Function Protects LEDs
- ◆ **Mono 2W Class D Loudspeaker Amplifier**
 - 85% Efficiency (R_L = 8Ω, P_{OUT} = 600mW)
 - Low 0.05% THD+N at 1kHz
 - High 65dB PSRR at 1kHz
 - Fully Differential Inputs
 - 3dB to +24dB Gain Settings in 3dB Steps
 - Integrated Click-and-Pop Suppression
 - Low Quiescent Current
- ◆ **Dual Low-Noise LDO**
 - 45µV_{RMS} Output Noise, 73dB PSRR
 - Flexible I²C-Controlled Output Voltages
 - 200mA and 300mA Output Current Drive

Ordering Information

PART	TYPE
MAX8821EVKIT+	EV Kit

+Denotes lead-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2, C3, C6, C8, C9, C11	7	1µF ±10%, 6.3V X5R ceramic capacitors (0402) TDK C1005X5R0J105K Murata GRM155R60J105K Taiyo Yuden LMK105BJ105K
C4, C12	2	0.1µF ±10%, 10V X5R ceramic capacitors (0402) TDK C1005X5R1C104K Murata GRM155R61A104K Taiyo Yuden LMK105BJ104K
C5, C7, C10	3	2.2µF ±20%, 6.3V X5R ceramic capacitors (0402) Taiyo Yuden JMK105BJ225M

DESIGNATION	QTY	DESCRIPTION
C13, C15	2	33,000pF ±10%, 10V X7R ceramic capacitors (0402) Murata GRM155R71A333K Taiyo Yuden EMK105B7333K KEMET C0402C333K8RACTU
C14, C16	2	68,000pF ±10%, 10V X5R ceramic capacitors (0402) TDK C1005X5R1C683K Murata GRM155R61A683K
C17	1	0.15µF ±10%, 6.3V X7R ceramic capacitor (0402) TDK C1005X5R0J154K AVX 04026D154KAT2A

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
D1–D6	6	White LEDs Nichia NSCW215T
D7	1	Lumex RGB LED SML-LX3632SISUGSBC
J1	1	2 x 10 right-angle receptacle Methode M65S-R220-11-01W
JU1, JU2, JU3	3	2-pin headers 1 x 36-pin header, 0.1in centers (comes in 1 x 36-pin strips, cut to fit) Sullins PEC36SAAN Digi-Key S1012E-36-ND
JU4, JU5	2	3-pin headers 1 x 36-pin header, 0.1in centers (comes in 1 x 36-pin strips, cut to fit) Sullins PEC36SAAN Digi-Key S1012E-36-ND

DESIGNATION	QTY	DESCRIPTION
JU6, JU7	2	5-pin headers 1 x 36-pin header, 0.1in centers (comes in 1 x 36-pin strips, cut to fit) Sullins PEC36SAAN Digi-Key S1012E-36-ND
L1, L2	2	15 μ H inductors TOKO A916CY-150M (D63CB series)
R1, R2	2	2.21k Ω \pm 1% resistors (0402) lead-free
R3, R4	2	22.1k Ω \pm 1% resistors (0402) lead-free
U1	1	White LED charge pump (28 thin QFN-EP*) Maxim MAX8821ETI+
—	1	CMAXUSB+ interface module including USB high-speed A-to-B cables, 6ft
—	1	MAX8821EVKIT+ PCB

*EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corp.	843-448-9411	www.avxcorp.com
KEMET Corp.	864-963-6300	www.kemet.com
Lumex, Inc.	520-877-8456	www.lumex.com
Methode Electronics	708-867-6777	www.methode.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Nichia Corp.	248-349-9800	www.nichia.com
Taiyo Yuden	408-573-4150	www.t-yuden.com
TDK Corp.	847-803-6100	www.component.tdk.com
TOKO America, Inc	408-432-8281	www.tokoam.com
Vishay	402-563-6866	www.vishay.com

Note: Indicate that you are using the MAX8821 when contacting these component suppliers.

MAX8821 EV Kit Software Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX8821.EXE	Application program
FTD2XX.INF	USB device driver file
UNINST.INI	Uninstalls the EV kit software
USB_Driver_Help.PDF	USB driver installation help file

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Quick Start

Recommended Equipment

- MAX8821 EV kit
- 2.5V to 5.5V power supply capable of delivering 2A
- Two digital multimeters (DMM1, DMM2)
- Audio source (i.e., CD player, MP3 player, etc.)
- 4Ω/8Ω speaker
- A user-supplied Windows 2000/XP/Vista PC with a spare USB port
- CMAXQUSB+ command module (USB cable included)

Note: In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the MAX8821 EV kit software. Text in **bold and underlined** refers to items from the Windows 2000/XP/Vista operating system.

Procedure

The MAX8821 EV kit is a fully assembled and tested surface-mount board. Follow the *Power Up* section to verify board operation and *Power Down* section to safely power down the EV kit.

Power Up

Reference Figure 1 and the power-up procedure below to properly verify the MAX8821 EV kit.

- 1) Visit www.maxim-ic.com/evkitsoftware to download the latest version of the EV kit software, 8821Rxx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.
- 2) Install the EV kit software on your computer by running the INSTALL.EXE program inside the temporary folder. The program files are copied and icons are created in the Windows **Start | Programs** menu.
- 3) Connect the USB cable from the PC to the EV kit board. A **Building Driver Database** window pops up in addition to a **New Hardware Found** message when installing the USB driver for the first time. If you do not see a window that is similar to the one described above after 30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.
- 4) Follow the directions of the **Add New Hardware Wizard** to install the USB device driver. Choose the **Search for the best driver for your device** option. Specify the location of the device driver to be **C:\Program Files\MAX8821** (default installation directory) using the **Browse** button. During device driver installation, Windows may show a warning message indicating the device driver that Maxim uses does not contain a digital signature. This is not an error condition and it is safe to proceed with installation. Refer to the document USB_Driver_Help.PDF for additional information.
- 5) Preset the power supply to 3.6V. Turn off the power supply. **Do not turn on the power supply until all connections are complete.**
- 6) On the CMAXQUSB command module, ensure that the shunt on jumper JU1 is in the 3.3V position.
- 7) Verify that JU1 (MAX8821 EV kit) is installed.
- 8) Verify that JU4 and JU5 (MAX8821 EV kit) have shunts installed across pins 1 and 2.
- 9) Verify that the center pin of JU6 is connected to PCB label B.
- 10) Verify that the center pin of JU7 is connected to PCB label R.
- 11) Carefully connect the boards by aligning the 20-pin connector of the MAX8821 EV kit with the 20-pin header of the CMAXQUSB interface board. Gently press them together.
- 12) Connect the positive lead of the power supply to VBATT+ and the negative lead to VBATT-.
- 13) **Observe correct speaker polarity.** Connect the speaker across the SPK+ and SPK- test points.

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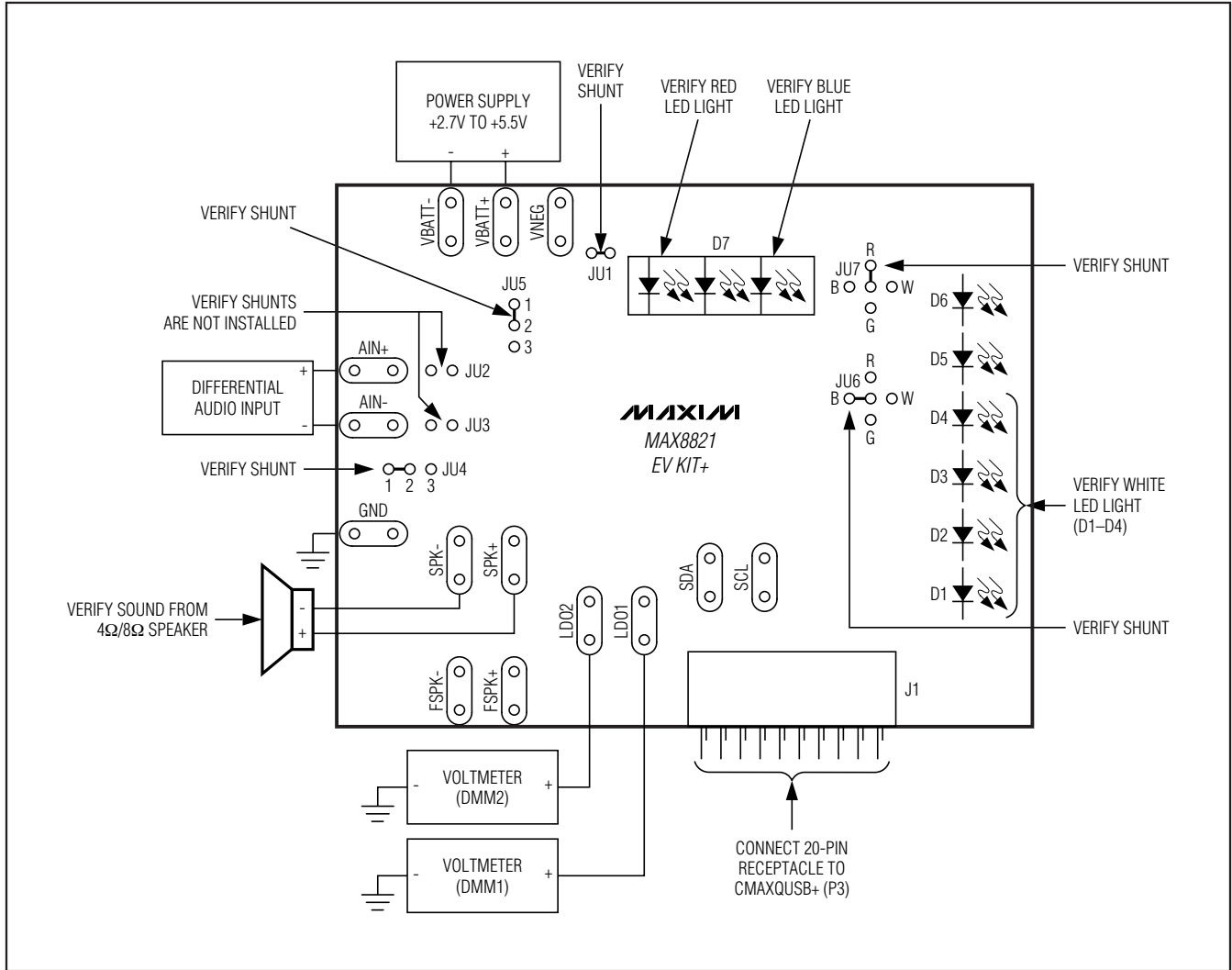


Figure 1. Test Procedure Setup for MAX8821 EV Kit

- 14) **Observe correct audio source polarity.** Connect the audio source to AIN+ and AIN-. Refer to the MAX8821 data sheet for more information about differential audio signals, single-ended audio signals, input capacitors (C1, C2 in Figure 5), and the common-mode bias voltage range.
- 15) Connect the positive lead of DMM1 to LDO1 and the negative lead to GND.
- 16) Connect the positive lead of DMM2 to LDO2 and the negative lead to GND.
- 17) Turn on the power supply.
- 18) Turn on the audio source.
- 19) Start the MAX8821 EV kit software by opening its icon at **Start | Programs | MAX8821 EVALUATION KIT**.

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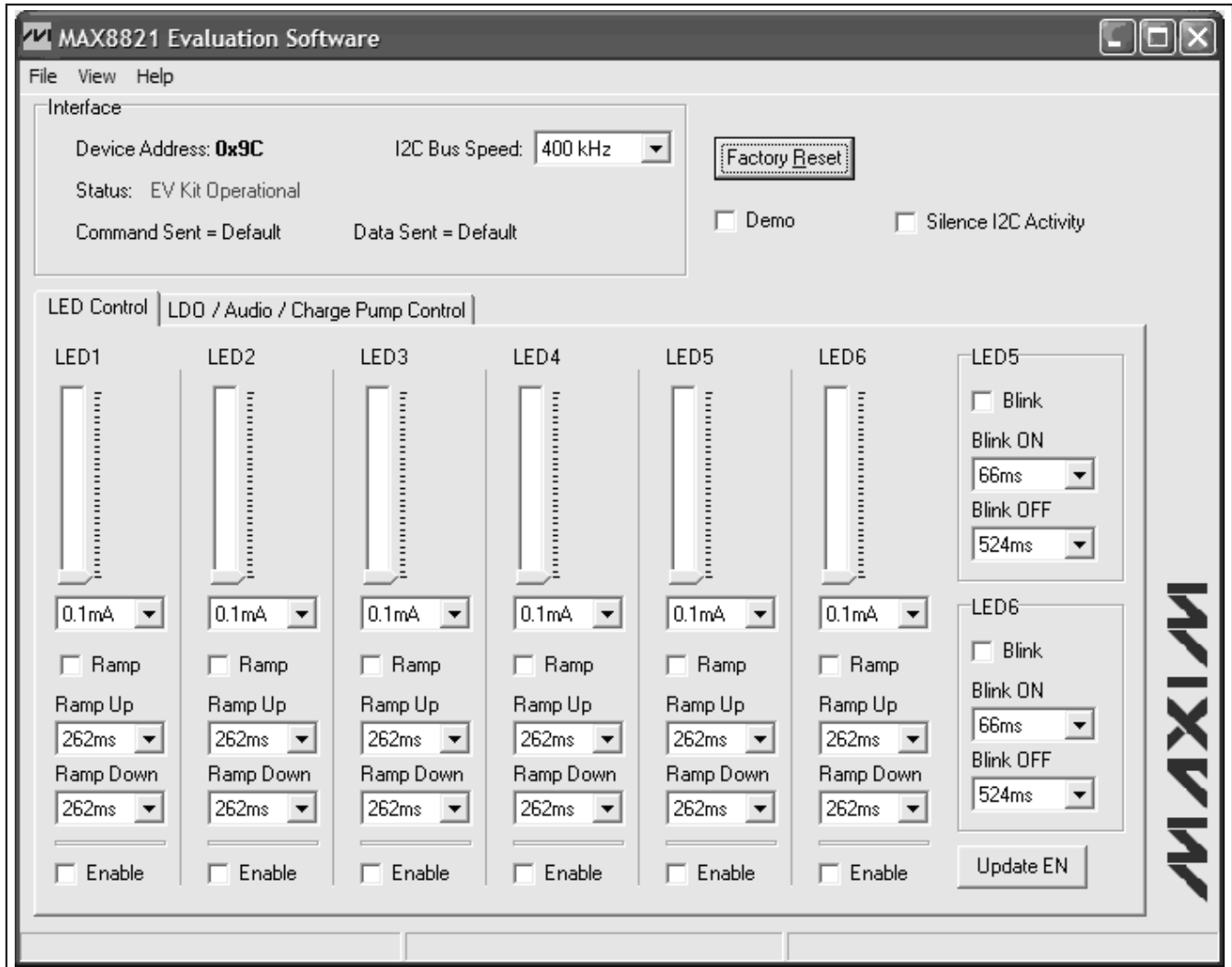


Figure 2. Status: EV Kit Operational

- 20) Normal device operation is verified when **EV Kit Operational** is displayed by the **Status** indicator as shown in Figure 2. If the status indicator displays an error, see the *Troubleshooting* section.
- 21) Select the LDO1 output voltage to be 3.2V.
- 22) Select the corresponding **Enable** box to enable LDO1.
- 23) Verify the voltage read by DMM1 is 3.2V.
- 24) Select the corresponding **Active Pull Down** and disable LDO1.
- 25) Verify the voltage read by DMM1 is 0V.
- 26) Select the LDO2 output voltage to be 3.3V.
- 27) Select the corresponding **Enable** box to enable LDO2.
- 28) Verify the voltage read by DMM2 is 3.3V.
- 29) Select the corresponding **Active Pull Down** and disable LDO2.
- 30) Verify the voltage read by DMM2 is 0V.
- 31) Set LED1–LED6 to the 25.6mA setting.
- 32) Enable the ramp function for LED1–LED4 by selecting the corresponding **Ramp** boxes.
- 33) Select LED1 to a ramp-up and ramp-down time of 262ms.

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- 34) Select LED2 to a ramp-up and ramp-down time of 524ms.
- 35) Select LED3 to a ramp-up and ramp-down time of 1048ms.
- 36) Select LED4 to a ramp-up and ramp-down time of 2097ms.
- 37) Enable LED1–LED4 by selecting the corresponding **Enable** boxes.
- 38) Verify that D1–D4 emit white light and display a sequenced ramp-up time with LED1 as the fastest ramp-up time and LED4 as the slowest.
- 39) Enable the blink function for LED5 and LED6 by selecting the corresponding **Blink** boxes.
- 40) Select LED5 to a blink ON time of 512ms and blink OFF time of 512ms.
- 41) Select LED6 to a blink ON time of 66ms and blink OFF time of 4194ms.
- 42) Enable LED5 and LED6 by selecting the corresponding **Enable** boxes.
- 43) Verify that D7 emits both red and blue light.
- 44) Verify that D7 emits the blue light for a longer time than the red light.
- 45) Select the audio amplifier to have a +3dB gain.
- 46) Enable the audio amplifier by selecting the corresponding **Enable** box.
- 47) Verify that sound is coming from the speaker.
- 48) Set the audio gain to +12dB and verify that the volume has increased.

Power Down

When evaluation of the MAX8821 EV kit is completed, use the following steps to power down the MAX8821 EV kit:

- 1) Turn off the power supply and audio source.
- 2) Disconnect the power supply, audio source, speaker, DMMs, and test leads from the MAX8821 EV kit.
- 3) Disconnect the MAX8821 EV kit from the CMAXQUSB+ command module.

Table 1. Jumper Settings

JUMPER	FUNCTION
JU1	Shorts VBATT+ (2.7V to 5.5V) to the anodes of all LEDs (D1–D7). Short JU1 to connect all LEDs to the power supply for normal operation. Open JU1 to disconnect all LEDs from the power supply.
JU2	Short JU2 to directly apply a common-mode audio signal (0.5V to $V_{IN3} - 1.2V$) to the IC's noninverting input. Open JU2 to remove the DC bias from the audio input with the AC-coupling capacitor (C2).
JU3	Short JU3 to directly apply a common-mode audio signal (0.5V to $V_{IN3} - 1.2V$) to the IC's inverting input. Open JU3 to remove the DC bias from the audio input with the AC-coupling capacitor (C1).
JU4	Connect pins 1 and 2 of JU4 to apply a differential signal to AIN-. Connect pins 2 and 3 to connect AIN- to ground to apply a single-ended audio signal to AIN+. (Note: JU2 must be open when a single-ended audio signal is applied to AIN+.)
JU5	Connect pins 2 and 3 to connect V_{DD} (1.5V to 5.5V), the I ² C power supply, to VBATT+ (2.7V to 5.5V). Connect pins 1 and 2 to connect V_{DD} (1.5V to 5.5V) to the I ² C interface supply voltage with J1.
JU6	Connect the center pin of JU6 to the pin labeled W to connect a white LED (D5) to the internal current regulator. Connect the center pin of JU6 to the pin labeled R to connect the red LED in the RGB diode (D7) to the internal current regulator. Connect the center pin of JU6 to the pin labeled B to connect the blue LED in the RGB diode (D7) to the internal current regulator. Connect the center pin of JU6 to the pin labeled G to connect the green LED in the RGB diode (D7) to the internal current regulator.
JU7	Connect the center pin of JU7 to the pin labeled W to connect a white LED (D6) to the internal current regulator. Connect the center pin of JU7 to the pin labeled R to connect the red LED in the RGB diode (D7) to the internal current regulator. Connect the center pin of JU7 to the pin labeled B to connect the blue LED in the RGB diode (D7) to the internal current regulator. Connect the center pin of JU7 to the pin labeled G to connect the green LED in the RGB diode (D7) to the internal current regulator.

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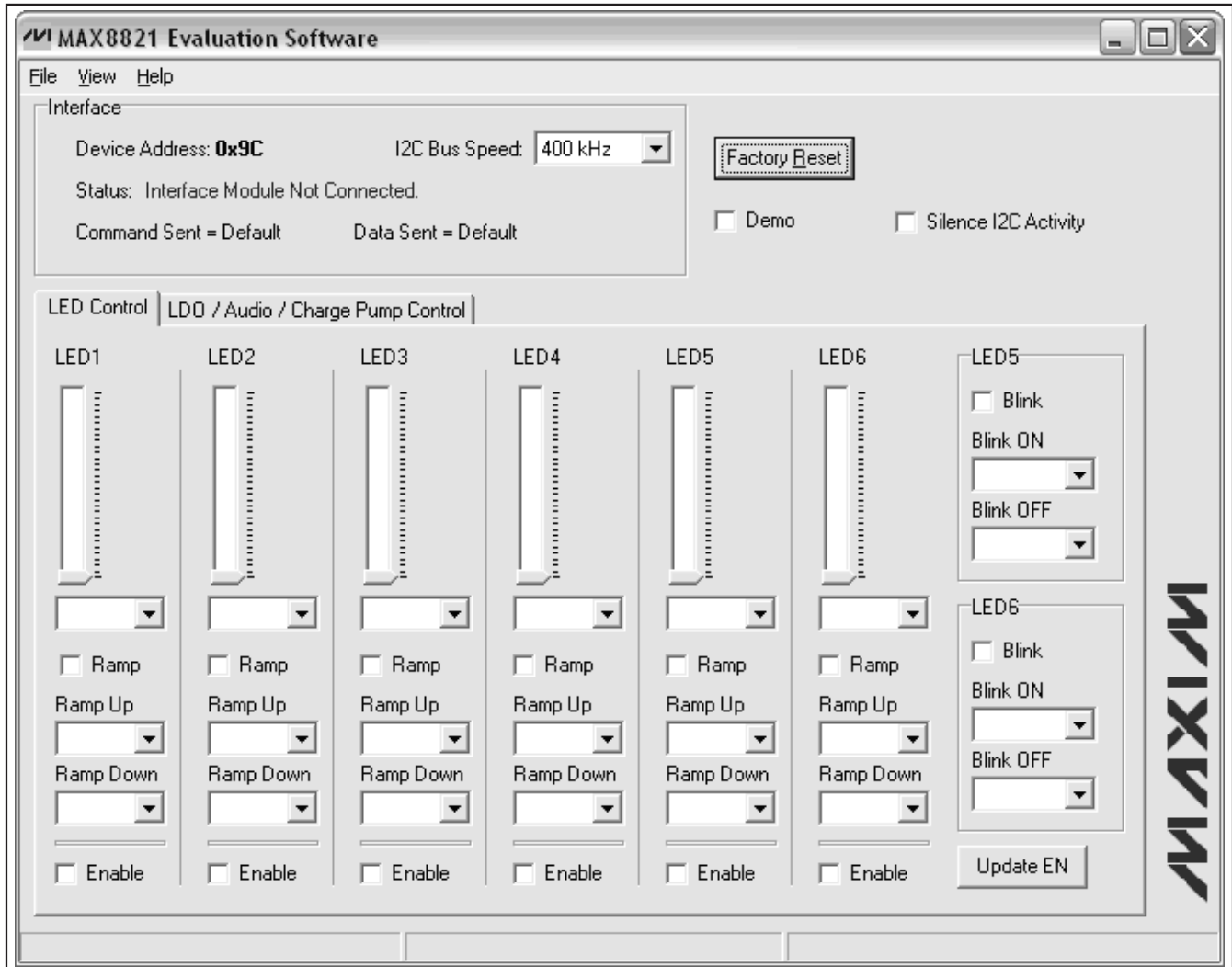


Figure 3. Status: Interface Module Not Connected

Troubleshooting

If the status indicator shows **Interface Module Not Connected** as shown in Figure 3 verify that the USB cable is plugged into the original port. If the USB cable is plugged into a different port, the interface module drivers need to be reinstalled. Refer to the HELP.PDF found at **Start | Programs | MAX8821 EVALUATION KIT** for further details.

If the status indicator shows **EV Kit Not Found** as shown in Figure 4 check the following:

- 1) Verify that the power supply is properly connected and is within the 2.7V to 5.5V range.
- 2) Verify that the MAX8821 EV kit is connected to the CMAXQUSB+ by J1.
- 3) Verify that JU1 on the CMAXQUSB+ command module selects a 3.3V logic level.
- 4) Verify that shunts are installed for J3 and J2 on the CMAXQUSB+ command module.
- 5) On the MAX8821 EV kit, verify that pins 1 and 2 of JU5 are connected.

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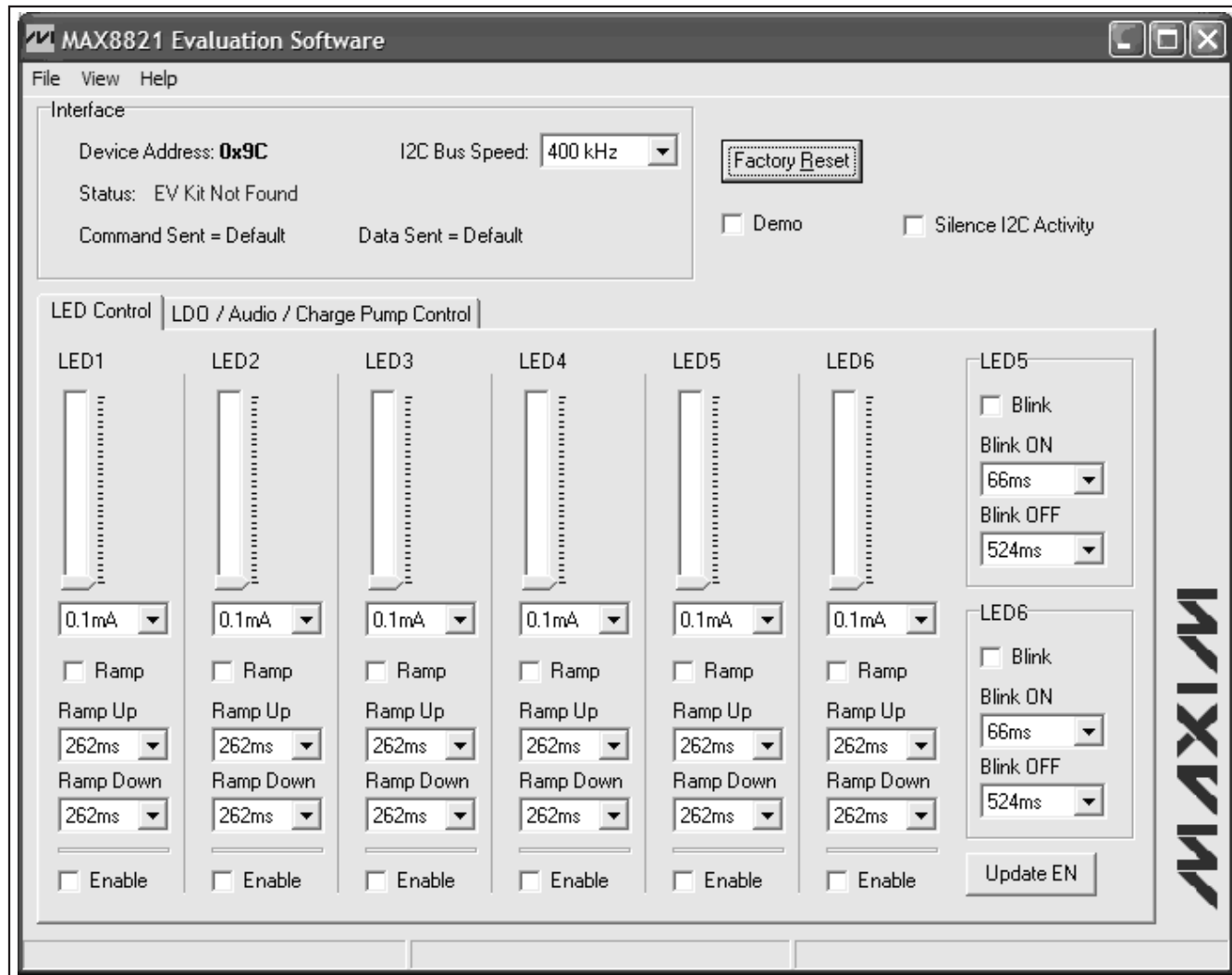


Figure 4. Status: EV Kit Not Found

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Detailed Description

The MAX8821 EV kit features LED display backlighting, an audio loudspeaker amplifier, and dual LDOs for camera functions. The MAX8821 includes soft-start, thermal shutdown, open-circuit and short-circuit protections for the white LEDs, audio amplifier, and two LDOs.

LED Charge Pump

The MAX8821 features an inverting charge pump and six current regulators capable of 25.6mA each to drive six LEDs. The current regulators are matched to within $\pm 1\%$ (typ), providing uniform white LED brightness for LCD backlight applications. To maximize efficiency, the current regulators operate with as little as 0.15V voltage drop. Individual white LED current regulators conduct current to GND or NEG to extend usable battery life. In the case of mismatched forward voltage of white LEDs, only the white LEDs requiring higher voltage are switched to direct current to NEG instead of GND, further raising efficiency and reducing battery current drain. The on-chip ambient temperature derating function safely allows bright 25.6mA full-scale output current while automatically reducing current gradually above $+40^{\circ}\text{C}$ in accordance with popular LED ratings.

Ramp-Up and Ramp-Down Function

The LED drivers in the MAX8821 provide ramp-up, and ramp-down of LED current for smooth transitions between different brightness settings. A controlled ramp is used when the LED current level is changed, when the LEDs are enabled, and when the LEDs are disabled.

The LED currents ramp up and down smoothly on a pseudo-log scaling of the LED current sources. Each LED source has an individual ramp control making it possible to ramp different LEDs at different rates.

Blink Timer

The current regulators for LED5 and LED6 feature a blink function. The OFF and ON time for LED5 and LED6 can be set using the MAX8821 EV kit software.

Combining Blink Timer and Ramp Function

To combine the ramp function together with the blink timer for LED5 and/or LED6, special timing considerations need to be fulfilled. It is recommended to keep the ramp-up timer shorter than the ON blink timer and the ramp-down timer shorter than the OFF timer.

Failing to comply with these timing constraints results in the LED_ not reaching the programmed current during the ON time, and the $I_{\text{LED}_}$ current not returning to 0mA during the off time. Refer to the equations found in the *Combining Blink Timer and Ramp Function* section of the MAX8821 IC data sheet.

LED Short and Open-Circuit Protection

If any LED fails as an open circuit, the corresponding LED_ is internally connected to ground and the charge pump is enabled. To disable the corresponding current regulator, short any unused LED_ to VBATT+. The MAX8821 contains special circuitry to detect this condition and disables the corresponding current regulator to avoid wasting battery power.

Temperature Derating

The MAX8821 contains a derating function that automatically limits the LED current at high temperatures in accordance with the recommended derating curve of popular white LEDs. The derating function enables the safe usage of higher LED current at room temperature, thus reducing the number of LEDs required to backlight the display. The derating circuit reduces the LED current above $+40^{\circ}\text{C}$ at approximately $1.67\%/^{\circ}\text{C}$. The temperature derating function is enabled/disabled using the MAX8821 EV kit software and by default is disabled.

Audio Amplifier

The audio amplifier in the MAX8821 is a 2W Class D loudspeaker amplifier. The amplifier features a programmable gain control through the MAX8821 EV kit software and can be set from -3dB to +24dB.

The amplifier operates from a single 2.7V to 5.5V supply and features an internally generated common-mode bias voltage of $V_{\text{IN}3}/2$ referenced to ground.

A unique filterless modulation scheme and spread-spectrum mode create a compact, flexible, low-noise, efficient audio power amplifier while occupying minimal board space. The differential input architecture reduces common-mode noise pickup with or without the use of input-coupling capacitors. The MAX8821 audio amplifier can also be configured as a single-ended input amplifier. The input capacitor C2 is required for single-ended input applications.

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Audio Input Filter

The fully differential amplifier inputs can be biased at voltages other than midsupply. The common-mode feedback circuit adjusts for input bias, ensuring the outputs are still biased at midsupply. Input capacitors (C2, C1 in Figure 5) are not required as long as the common-mode input voltage is within the specified range listed in the *Electrical Characteristics* table found in the MAX8821 IC data sheet. If the input capacitors are used in conjunction with on-chip R_{INT} , they form a high-pass filter that removes the DC bias from an incoming signal. The AC-coupling capacitor allows the amplifier to bias the signal to an optimum DC level.

LDO1 and LDO2

The linear regulators are designed for low-dropout and low quiescent current to maximize battery life. Both LDOs are controlled through the I²C interface, minimizing the number of control lines to the MAX8821. I²C controls the output voltages, and the enable/disable state for both LDO1 and LDO2. At startup, the LDOs are off but are preset to 1.2V for LDO1 and 1.5V for LDO2.

Thermal Shutdown

The MAX8821 includes a thermal-limit circuit that shuts down the IC at a junction temperature of approximately +160°C. The IC turns on after it cools by approximately 20°C.

Shutdown Mode

The MAX8821 can be put into two different shutdown modes. The first shutdown mode is achieved by driving V_{DD} low. In this mode, the I²C interface becomes disabled. The second shutdown is a lower power mode. To enter the low-power mode, disable LED_, audio amplifier, or LDOs through the MAX8821 EV kit software. In low-power mode, the I²C interface is still active.

I²C Address

The MAX8821 acts as a slave transmitter/receiver. The slave address of the MAX8821 is preset to 1001110X, where X is the R/W bit. The address 0x9C is designated for write operations and 0x9D for read operations. The I²C register is reset back to the default value when either V_{IN} drops below the UVLO threshold, or V_{DD} is driven low.

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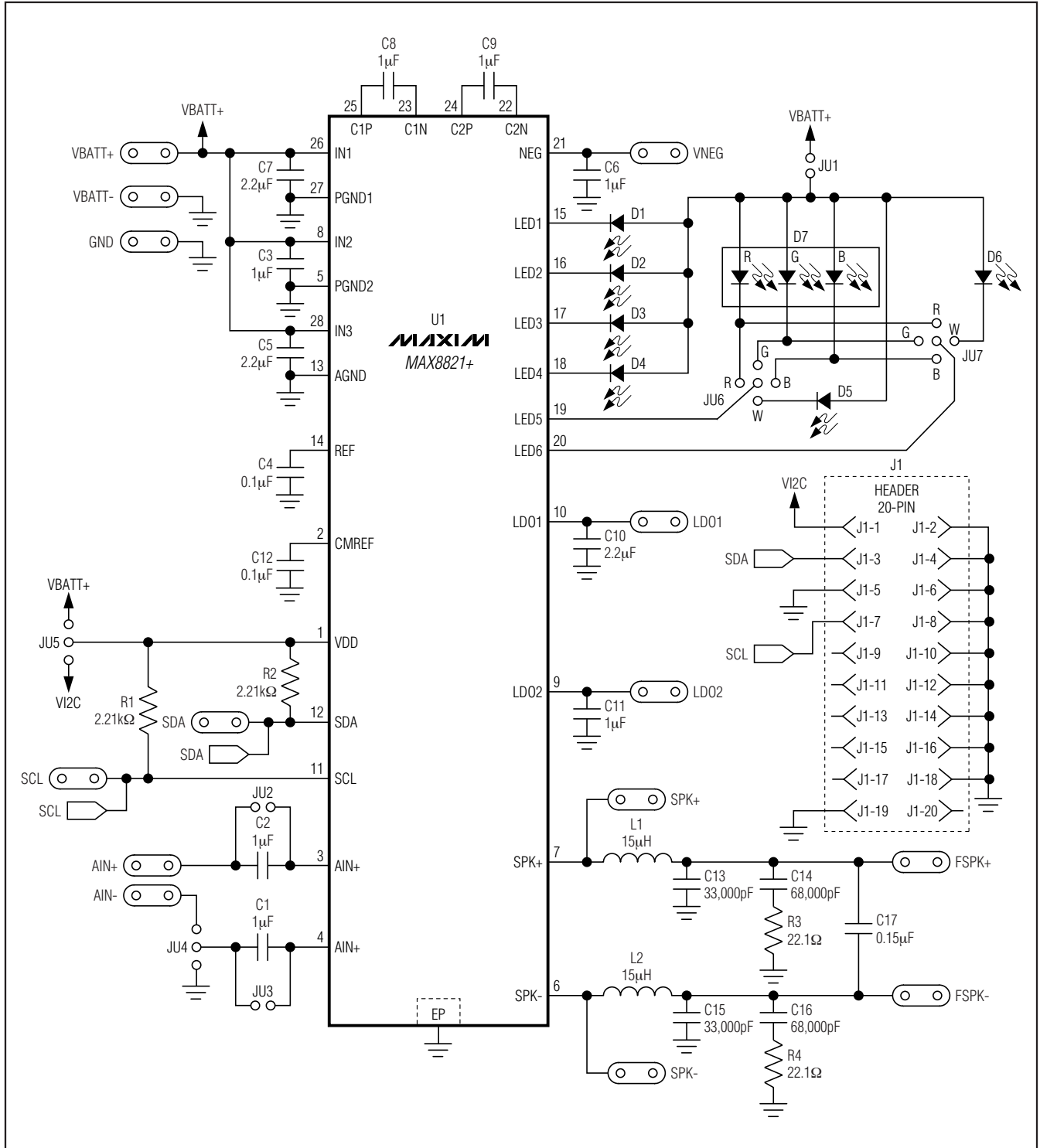


Figure 5. MAX8821 EV Kit Schematic

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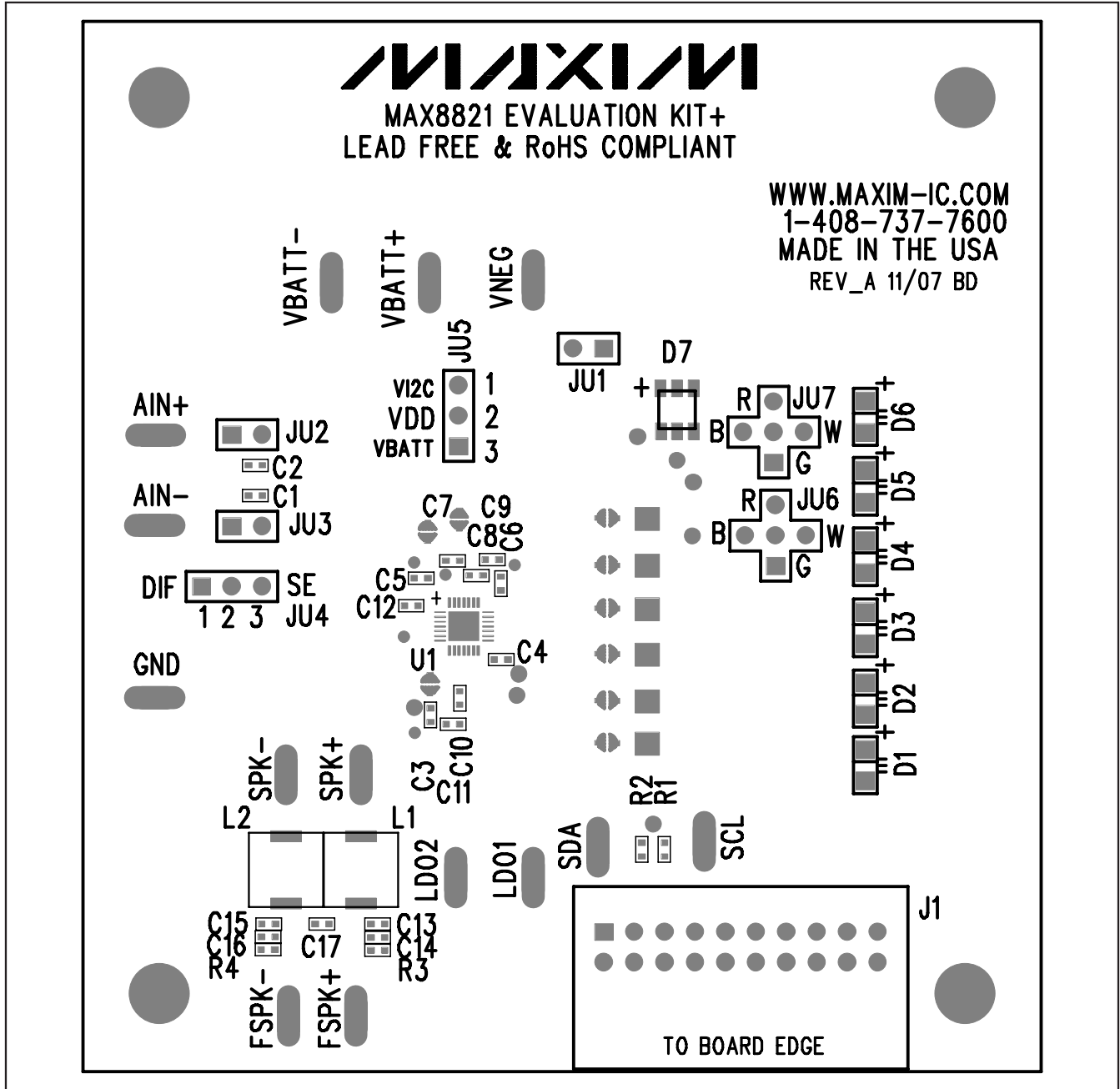


Figure 6. MAX8821 EV Kit Component Placement Guide—Component Side

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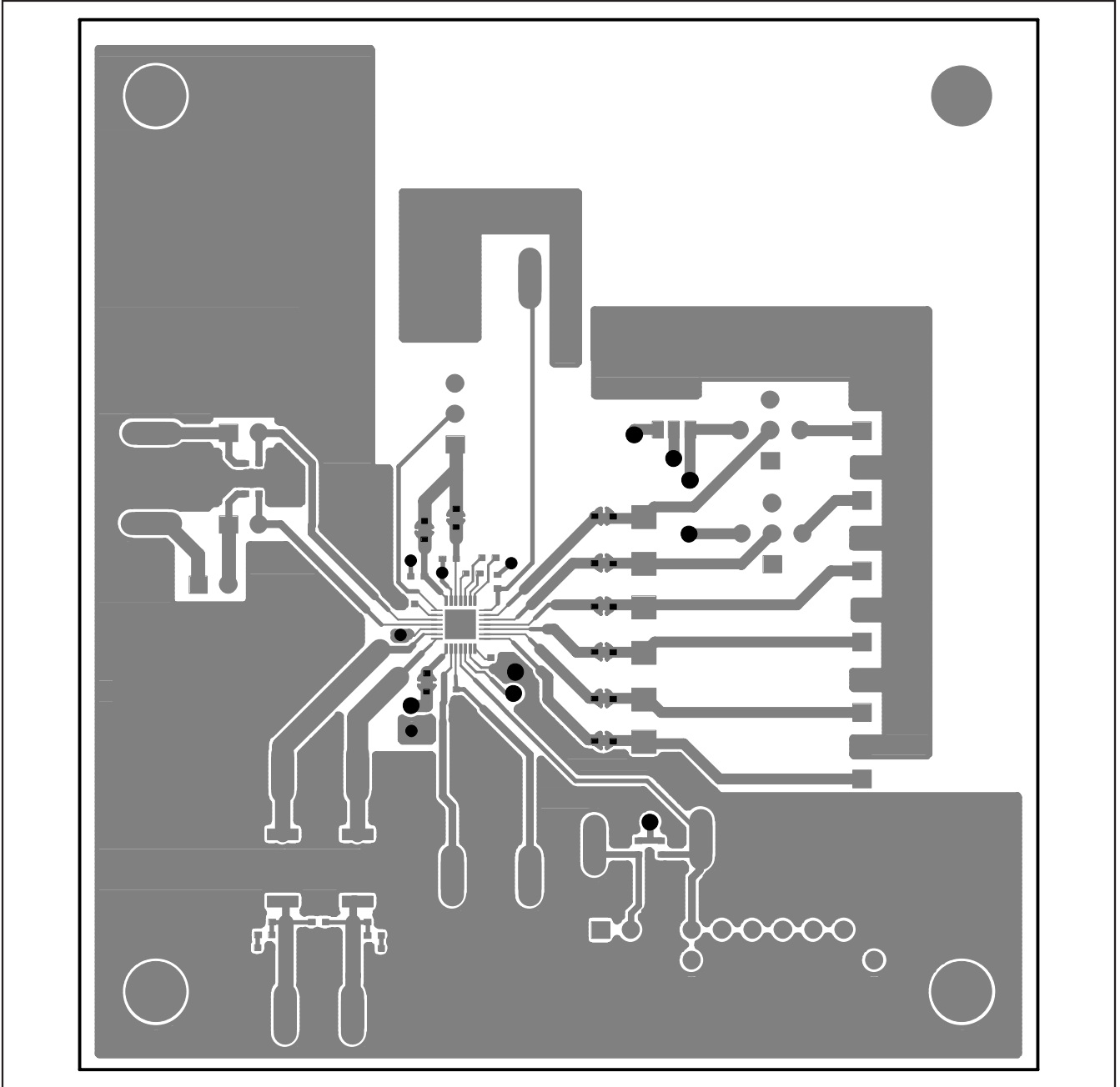


Figure 7. MAX8821 EV Kit PCB Layout—Component Side

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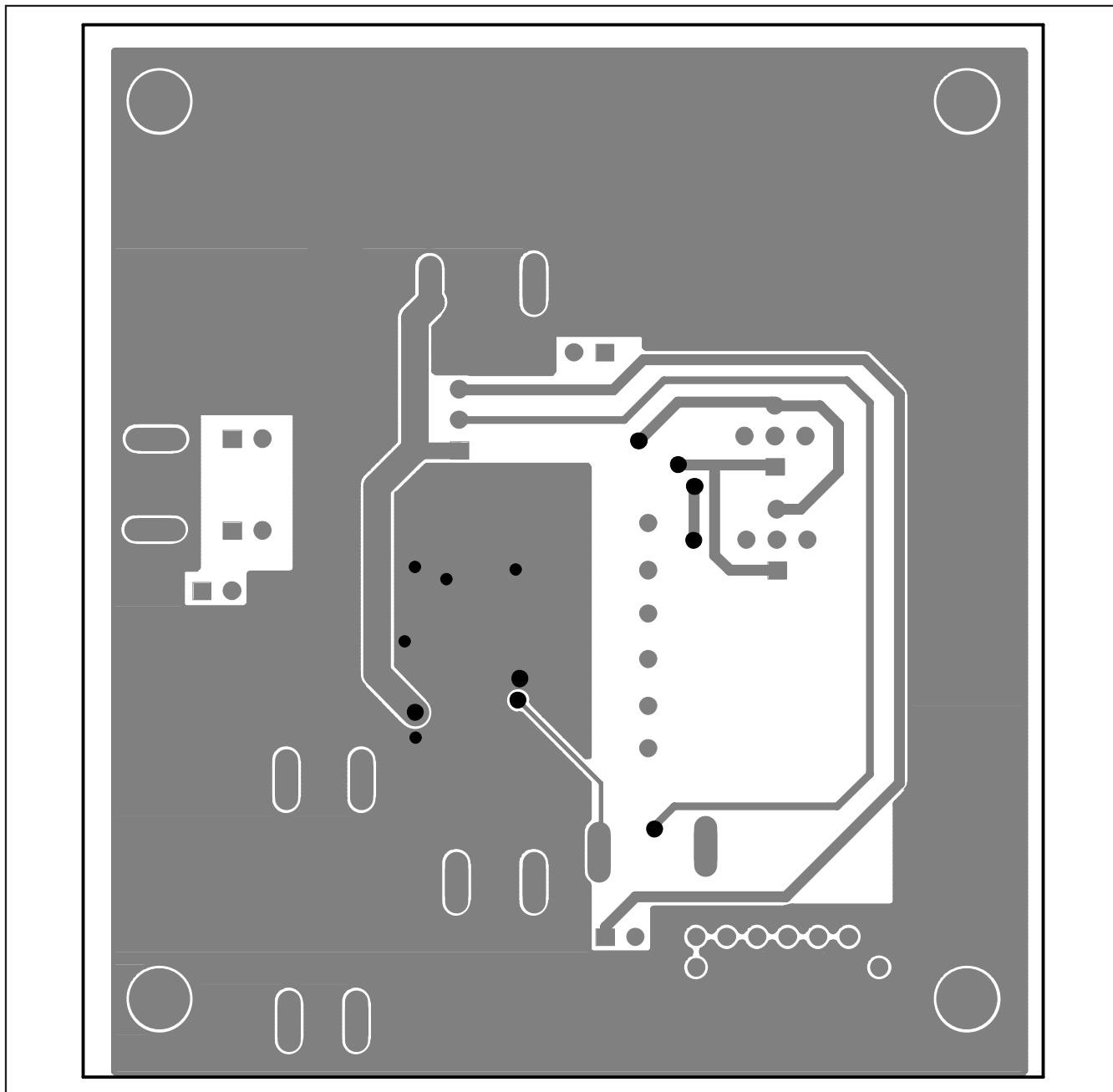


Figure 8. MAX8821 EV Kit PCB Layout—Solder Side

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