19-3916; Rev 1; 4/08

MAX9709 Evaluation Kit

Evaluates: MAX9709

General Description

The MAX9709 evaluation kit (EV kit) is a fully assembled and tested circuit board that configures the MAX9709 Class D amplifier to drive 25W into each of two 8Ω speakers in stereo mode, or 50W into a single 4Ω speaker in mono mode. The EV kit's speaker outputs can be filterless to minimize the circuit area or can be filtered to ease evaluation.

The EV kit operates from a 10V DC to 22V DC power supply. The MAX9709 EV kit accepts single-ended or differential input signals, and provides fully differential outputs. The EV kit provides an option to select between +22dB, +25dB, +29.5dB, or +36dB gains. The MAX9709 EV kit offers an option to select between fixed-frequency modulation (FFM) mode or spread-spectrum modulation (SSM) mode.

The MAX9709 EV kit provides a thermal flag that can be programmed for eight different thermal thresholds. The MAX9709 EV kit can be synchronized with an external clock. Additionally, the EV kit provides a synchronous output that allows units to be cascaded and frequency locked in a multiamplifier system.

Features

- **10V to 22V Single DC Power-Supply Operation**
- **Fully Differential or Single-Ended Inputs**
- **Fully Differential Outputs**
- **Drives Up to 2 x 25W into 8Ω Speakers in Stereo Mode**
- **Drives Up to 1 x 50W into 4Ω Speaker in Mono Mode**
- **Selectable Between Spread-Spectrum and Fixed-Frequency Modulation**
- **Selectable Gains (+22dB, +25dB, +29.5dB, or +36dB)**
- **Programmable Thermal Flag**
- **Shutdown and Mute Control**
- **Input and Output Clock Sync Signals**
- **Thermally Efficient 56-Pin TQFN-EP Package**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX9709EVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
MINIMAL COMPONENTS FOR CUSTOMER DESIGN		
C1, C2, C3	3	2.2µF ±10%, 25V X5R ceramic capacitors (0805) TDK C2012X5R1E225K
C8, C9	2	47µF ±20%, 35V tantalum capacitors (E-case) AVX TPSE476M035R0200
C12–C15, C24	5	1µF ±10%, 25V X7R ceramic capacitors (0805) TDK C2012X7R1E105K
C21	1	0.01µF ±10%, 25V X7R ceramic capacitor (0402) TDK C1005X7R1E103K
C22	1	0.47µF ±10%, 10V X7R ceramic capacitor (0603) TDK C1608X7R1A474K
C23	1	0.1µF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H104K
R2, R3	2	10kΩ ±5% resistors (0603)
U1	1	Class D amplifier (56 TQFN-EP*) Maxim MAX9709ETN+

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION		
C4	1	10µF ±20%, 10V X5R ceramic capacitor (0805) TDK C2012X5R1A106M
C5	1	1µF ±10%, 25V X7R ceramic capacitor (0805) TDK C2012X7R1E105K
C6, C7, C35, C36	0	Not installed, stacked metallized film capacitors Panasonic ECQV1H103JL recommended
C10, C11, C16–C19	6	100pF ±10%, 50V C0G ceramic capacitors (0603) TDK C1608C0G1H101K
C25–C28	4	0.1µF ±10%, 25V X7R ceramic capacitors (0805) Murata GRM21BR71E104K
C29, C30	2	0.47µF ±10%, 25V X7R ceramic capacitors (0805) TDK C2012X7R1E474K

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION (continued)		
C31–C34	4	0.33µF ±10%, 50V X7R ceramic capacitors (0805) Murata GRM219R71H334K
C37, C38	2	0.68µF ±10%, 25V X7R ceramic capacitors (0805) Murata GRM219BR71E684K
D1	1	6V, 350mW zener diode (SOT23) Central Semiconductor CMPZ5233B LEAD FREE
JU1, JU2, JU3, JU7–JU13	10	3-pin headers
JU4, JU5, JU6	3	2-pin headers
JU15, JU16, JU17	0	Not installed, 2-pin headers
JU18	0	Not installed, 5-pin header Waldom 26-48-1051 recommended

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION (continued)		
L1	1	30Ω at 100MHz, 10mΩ DCR, 5A ferrite bead (0805) TDK MPZ2012S300A
L2–L5	4	100Ω at 100MHz, 50mΩ DCR, 3A ferrite beads (0603) TDK MPZ1608S101A
L6–L9	0	Not installed, inductors Sumida CDRH127/LD series recommended, see the *Output Filtering* section
R1, R9	2	10kΩ ±5% resistors (0603)
R5–R8	4	18Ω ±5% resistors (0805)
R10, R11	2	9.1Ω ±5% resistors (0805)
—	13	Shunts
—	1	PCB: MAX9709 Evaluation Kit+

**EP = Exposed pad.*

Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corp.	843-946-0238	www.avxcorp.com
Central Semiconductor	631-435-1110	www.centralsemi.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Sumida Corp.	847-545-6700	www.sumida.com
TDK Corp.	847-803-6100	www.component.tdk.com

Note: *Indicate that you are using the MAX9709 when contacting these component suppliers.*

Quick Start

Recommended Equipment

Before beginning, the following equipment is needed:

- MAX9709 EV kit
- 10V to 22V, 5A DC power supply
- Audio source (i.e., CD player, cassette player)
- Two 8Ω speakers

Procedures

The MAX9709 EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Caution: Do not turn on the power supply until all connections are completed.**

1) Install a shunt across pins 1-2 of jumper JU1 (DV_{DD} = 5V).
2) Install a shunt across pins 1-2 of jumper JU2 ($\overline{SHDN}$ high, EV kit enabled).
3) Install a shunt across pins 1-2 of jumper JU3 ($\overline{MUTE}$ high, signal enabled).
4) Install a shunt across jumper JU4 (SYNCIN low, internal clock enabled).
5) Install a shunt across jumpers JU5 and JU6 (single-ended input mode).
6) Install a shunt across pins 2-3 of jumpers JU7 and JU8, and pins 1-2 of JU9 (thermal flag set to +120°C).
7) Install a shunt across pins 1-2 of jumpers JU10 and JU11 (switching frequency set to spread-spectrum modulation mode).

8) Install a shunt across pins 1-2 of jumpers JU12 and JU13 (gain = +25dB).
9) Jumpers JU15, JU16, and JU17 are intentionally left uninstalled and OPEN (stereo mode).
10) Connect the first 8Ω speaker across the L+ and L- pads (pins 1-2 of JU18).
11) Connect the second 8Ω speaker across the R+ and R- pads (pins 4-5 of JU18).
12) Connect the positive terminal of the power supply to the VDD pad and the power-supply ground terminal to the GND pad.
13) Connect the positive terminal of the audio source to the IN_L+ and IN_R+ pads.
14) Connect the ground terminal of the audio source to the SGND pad.
15) Turn on the power supply.
16) Turn on the audio source.

Detailed Description of Hardware

The MAX9709 EV kit is designed to evaluate the MAX9709 Class D amplifier in a 56-pin TQFN-EP package. The MAX9709 is a Class D amplifier that can be configured to drive up to 25W into each of the two 8Ω speakers. Stereo mode is the default mode on the EV kit. The EV kit can be reconfigured to drive up to 50W into 4Ω speakers in mono mode. The EV kit operates from a DC power supply that can provide 10V to 22V and 5A of current.

The MAX9709 EV kit accepts single-ended or differential input signals, and provides fully differential outputs. The EV kit provides an option to select between +22dB, +25dB, +29.5dB, or +36dB gains. The MAX9709 EV kit offers an option to select between three frequencies when in fixed-frequency modulation (FFM) mode or single-center frequency in a spread-spectrum modulation (SSM) mode. Refer to the *Operating Modes* section in the MAX9709 IC data sheet for additional information.

The MAX9709 EV kit provides a thermal flag ($\overline{TEMP}$) pad that outputs a logic-low signal when the IC's junction temperature exceeds the thermal threshold. The MAX9709 thermal flag can be programmed for eight different thermal thresholds. Refer to the *Thermal Sensor* section in the MAX9709 IC data sheet for additional information.

The MAX9709 EV kit features a synchronization input (SYNCIN) pad that allows the MAX9709 to synchronize with an external clock. The EV kit also provides a synchronization output (SYNCOUT) pad to synchronize other devices to the MAX9709. The SYNCOUT frequency is four times the switching frequency of the MAX9709. Refer to the *Synchronous Switching Mode* section in the MAX9709 IC data sheet for additional information.

Output Filtering

The IC speaker outputs (OUTL± and OUTR±) can be connected directly to a pair of speaker loads without any filtering. Use the L± and R± pins of jumper JU18 to connect the speakers directly to the MAX9709 IC outputs. This configuration is for a typical audio application.

Audio analyzers typically cannot accept pulse-width modulated (PWM) signals at their inputs. Therefore, the MAX9709 EV kit features a pair of lowpass filters optimized for 8Ω loads to ease evaluation. The recommended lowpass filter capacitors C25–C34, C37, and C38, as well as resistors R5–R8, R10, and R11 are preinstalled on the MAX9709 EV kit. Additionally, PCB pads are provided for the recommended inductors L6–L9, which are shipped in a bag of extra components along with the EV kit. The outputs can be accessed through the FOUTL± and FOUTR± PCB pads, but this requires installation of inductors L6–L9. See Table 1 below for the recommended inductors, L6–L9.

Table 1. Suggested Inductors (L6–L9)

DESIGNATION	DESCRIPTION
L6–L9	33µH ±20%, 3.9A inductors Sumida CDRH127/LD-330

Jumper Selection

DVDD (JU1)

The MAX9709 EV kit operates from a DC power supply between 10V to 22V. This power-supply range is too high for most of the digital input pins on the IC. The MAX9709 EV kit includes a circuit to regulate the input power supply to +5V to power all the logic circuits on the EV kit. Jumper JU1 sets the DVDD voltage. See Table 2 for shunt positions. Note that the MAX9709 features an internal, 6V regulator output (REG). The MAX9709 REG output pin simplifies system design and reduces system cost by providing a logic-voltage high for the MAX9709 logic pins. However, REG is not available as a logic-voltage high in shutdown mode, and therefore, cannot be applied as an input-voltage high to the MAX9709 $\overline{SHDN}$ pin.

Shutdown Mode ($\overline{SHDN}$)

The MAX9709 features a shutdown mode to reduce the quiescent current to 0.1µA (typ). Jumper JU2 controls the shutdown pin ($\overline{SHDN}$) of the MAX9709 IC. See Table 3 for shunt positions.

Mute Function ($\overline{MUTE}$)

The MAX9709 features a mute function to mute the output of the EV kit. Jumper JU3 controls the mute pin ($\overline{MUTE}$) of the MAX9709 IC. See Table 4 for shunt positions.

Synchronization Switching Input (SYNCIN)

The MAX9709 EV kit provides a SYNCIN pad that allows the MAX9709 switching frequency to synchronize to an external clock. The external clock frequency can range from 600kHz to 1.2MHz and can have any duty cycle, but the minimum pulse width must be greater than 100ns. Jumper JU4 selects the synchronization options for the MAX9709 IC. See Table 5 for shunt positions.

Single-Ended/Differential Audio Inputs

The MAX9709 EV kit features an option to select between single-ended mode or differential mode for the audio input source. Jumpers JU5 and JU6 select the input mode for the audio input source. In single-ended mode, do not operate with inputs IN_L+ and IN_R+ unconnected. The imbalance in the input impedance with these inputs unconnected can result in click-and-pop at power-up. Table 6 lists the selectable jumper options.

Table 2. JU1 Jumper Selection (DVDD)

SHUNT POSITION	MAX9709 DVDD REGULATED TO	EV KIT FUNCTION
1-2 (Default)	+5V	EV kit digital inputs power on
2-3	0V	EV kit digital inputs power off

Table 3. JU2 Jumper Selection ($\overline{SHDN}$)

SHUNT POSITION	MAX9709 $\overline{SHDN}$ PIN CONNECTED TO	EV KIT FUNCTION
1-2 (Default)	DVDD	EV kit enabled
2-3	GND	Shutdown mode

Table 4. JU3 Jumper Selection ($\overline{MUTE}$)

SHUNT POSITION	MAX9709 $\overline{MUTE}$ PIN CONNECTED TO	EV KIT OUTPUT
1-2 (Default)	DVDD	Normal operation
2-3	GND	Mute

Table 5. JU4 Jumper Selection (SYNCIN)

SHUNT POSITION	MAX9709 SYNCIN PIN CONNECTED TO	MAX9709 SWITCHING FREQUENCY
Installed (Default)	GND	Internal clock enabled
Not Installed: External Clock Source Connected to SYNCIN Pad	External clock source from 600kHz to 1.2MHz	Synchronize with external clock source

Table 6. JU5 and JU6 Jumper Selection (Input Mode)

AUDIO INPUT MODE	JUMPER	SHUNT POSITION	AUDIO INPUT CHANNELS
Single Ended*	JU5	Installed	IN_L+
	JU6		IN_R+
Differential	JU5	Not installed	IN_L-, IN_L+
	JU6		IN_R-, IN_R+

**When using the EV kit in single-ended mode, use audio input IN_L+ for the left channel and use audio input IN_R+ for the right channel.*

Thermal Thresholds (TH0, TH1, TH2)

The MAX9709 EV kit provides eight jumper options to set the MAX9709 thermal threshold flag. Jumpers JU7, JU8, and JU9 set the thermal threshold flag for the MAX9709 IC junction temperature. Table 7 lists the selectable jumper options.

Table 7. JU7, JU8, JU9 Jumper Selection (Thermal Threshold Flag)

MAX9709 FLAG THRESHOLD TEMPERATURE (°C)	SHUNT POSITION		
	JU9 (TH2)	JU8 (TH1)	JU7 (TH0)
80	2-3 (LOW)	2-3 (LOW)	2-3 (LOW)
90	2-3 (LOW)	2-3 (LOW)	1-2 (HIGH)
100	2-3 (LOW)	1-2 (HIGH)	2-3 (LOW)
110	2-3 (LOW)	1-2 (HIGH)	1-2 (HIGH)
120	1-2 (HIGH)	2-3 (LOW)	2-3 (LOW)
129	1-2 (HIGH)	2-3 (LOW)	1-2 (HIGH)
139	1-2 (HIGH)	1-2 (HIGH)	2-3 (LOW)
—	1-2 (HIGH)	1-2 (HIGH)	1-2 (HIGH)

Frequency Modulation

The MAX9709 can operate in fixed-frequency modulation mode or in spread-spectrum modulation mode. There are three different frequencies in the fixed-frequency modulation mode of operation.

Jumpers JU10 and JU11 on the MAX9709 EV kit provide an option to select the different frequency modulation modes for the MAX9709. Table 8 lists the selectable jumper options for JU10 and JU11.

Gain Selection

The MAX9709 features four gain settings. Jumpers JU12 and JU13 provide four options to select the desired gain for the MAX9709 IC. The gain of the MAX9709 is selectable between +22dB, +25dB, +29.5dB, and +36dB. See Table 9 for shunt positions.

Table 9. JU12, JU13 Jumper Selection (GAIN)

GAIN (dB)	SHUNT POSITION	
	JU13	JU12
+22	2-3 (LOW)	1-2 (HIGH)
+25	1-2 (HIGH)	1-2 (HIGH)
+29.5	1-2 (HIGH)	2-3 (LOW)
+36	2-3 (LOW)	2-3 (LOW)

Table 8. JU10, JU11 Jumper Selection (Switching Frequency)

SHUNT POSITION		MAX9709 SWITCHING FREQUENCY (kHz)	SYNCOUT SWITCHING FREQUENCY (kHz)	MODULATION
JU10	JU11			
2-3 (LOW)	2-3 (LOW)	200	800	Fixed-frequency modulation
2-3 (LOW)	1-2 (HIGH)	250	1000	Fixed-frequency modulation
1-2 (HIGH)	2-3 (LOW)	160	640	Fixed-frequency modulation
1-2 (HIGH)	1-2 (HIGH)	200 ±4	800 ±16	Spread-spectrum modulation

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Stereo/Mono Operation (JU15, JU16, JU17)

The MAX9709 EV kit provides an option to reconfigure the output from the default stereo mode to the mono mode. The mono mode is optimized to drive 50W into a 4Ω load.

Follow the steps below to reconfigure the MAX9709 EV kit to operate in mono mode.

Important notes:

- Do not turn on power until ALL modifications have been made.
- Step 6 automatically optimizes the output filter for a 4Ω speaker load.

To reconfigure the EV kit to mono mode, **complete ALL of the following steps:**

1) Short jumper JU15 (MONO high, mono mode enabled).
2) Short jumper JU16 (FOUTL+ shorted to FOUTR+).
3) Short jumper JU17 (FOUTL- shorted to FOUTR-).
4) Short test points L+ and R+.
5) Short test points L- and R-.
6) Install the supplied inductors L6–L9.
7) Connect a 4Ω speaker load across the FOUTL- and FOUTR+ PCB pads.
8) Apply the audio inputs to the IN_R+ and IN_R- PCB pads.

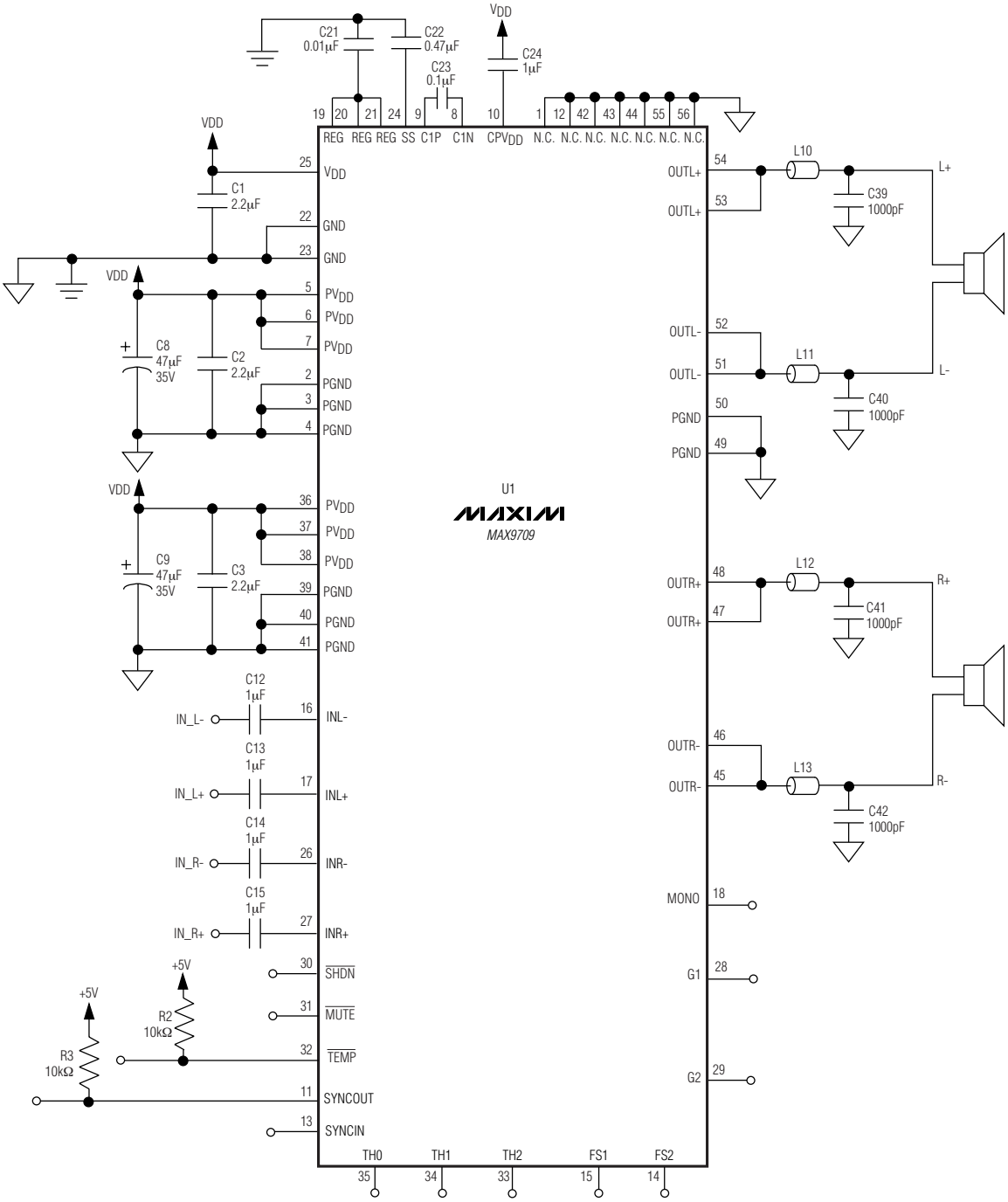
Jumpers JU15, JU16, and JU17 configure the output mode for the MAX9709 EV kit. Table 10 lists the selectable jumper options.

Table 10. JU15, JU16, JU17 Jumper Selection (Stereo/Mono)

MAX9709 OUTPUT MODE	SHUNT POSITION			HEADER JU18 CONFIGURATION	
	JU15 (MONO)	JU16 (FOUTL+ AND FOUTR+ PADS)	JU17 (FOUTL- AND FOUTR- PADS)	L+ AND R+	L- AND R-
Stereo (Default)	Not Installed (OPEN)	Not Installed (OPEN)	Not Installed (OPEN)	(OPEN)	(OPEN)
Mono*	Installed (SHORTED)	Installed (SHORTED)	Installed (SHORTED)	(SHORTED, L+ to R+)	(SHORTED, L- to R-)

**Important notes:*

DO NOT turn on power until after ALL modifications have been made.



NOTES: (1) SOME OF THE IC PINS ARE SHOWN UNCONNECTED IN THIS SCHEMATIC. TO CONFIGURE THESE PINS CORRECTLY, REFER TO THE MAX9709 IC DATA SHEET.
(2) FERRITE BEADS L10–L13, AND CAPACITORS C39–C42 ARE OPTIONAL AND ARE REQUIRED FOR EMC ONLY. THE EV KIT DOES NOT INCLUDE PC PADS FOR THESE COMPONENTS.

Figure 1. MAX9709 Customer Design Schematic with Minimal Components

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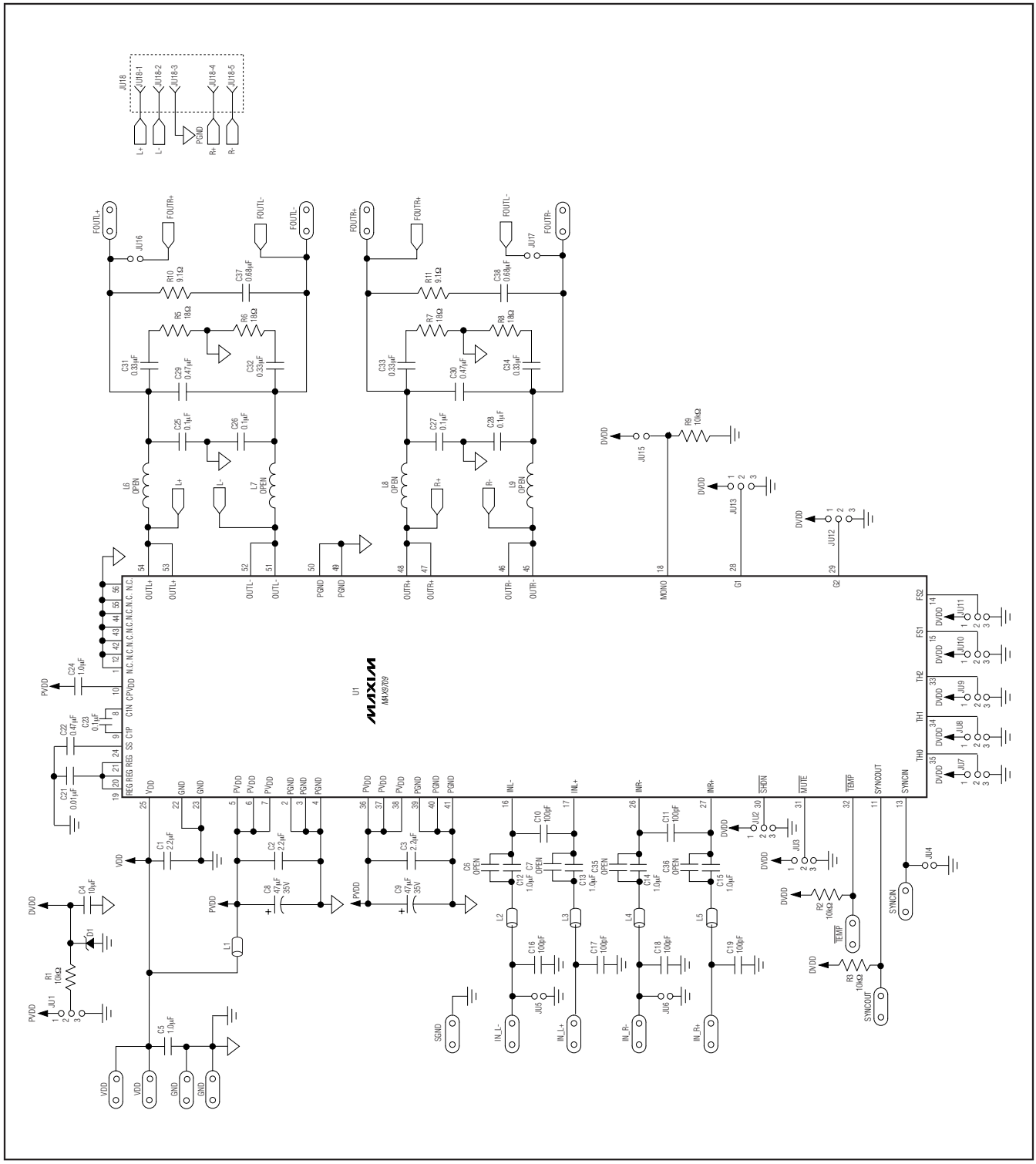

Figure 2. MAX9709 EV Kit Schematic

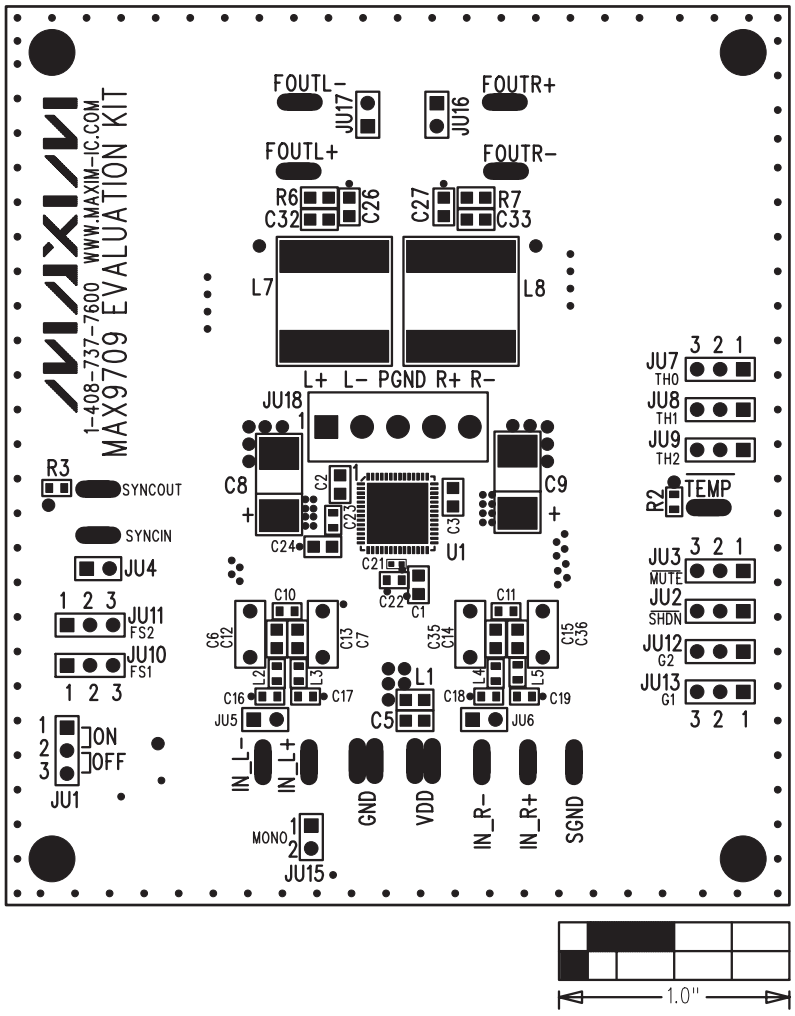

Figure 3. MAX9709 EV Kit Component Placement Guide—Component Side

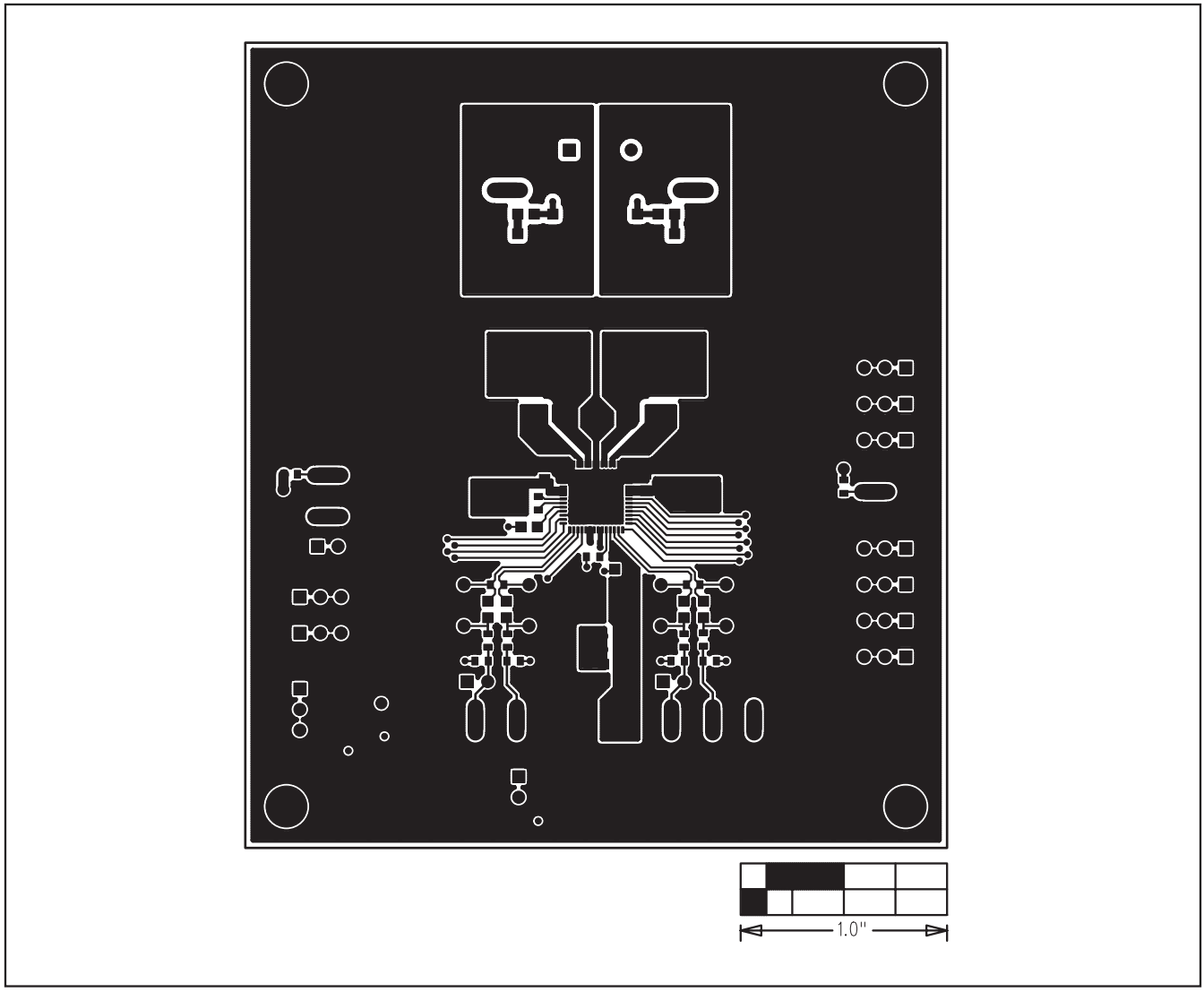

Figure 4. MAX9709 EV Kit PCB Layout—Component Side

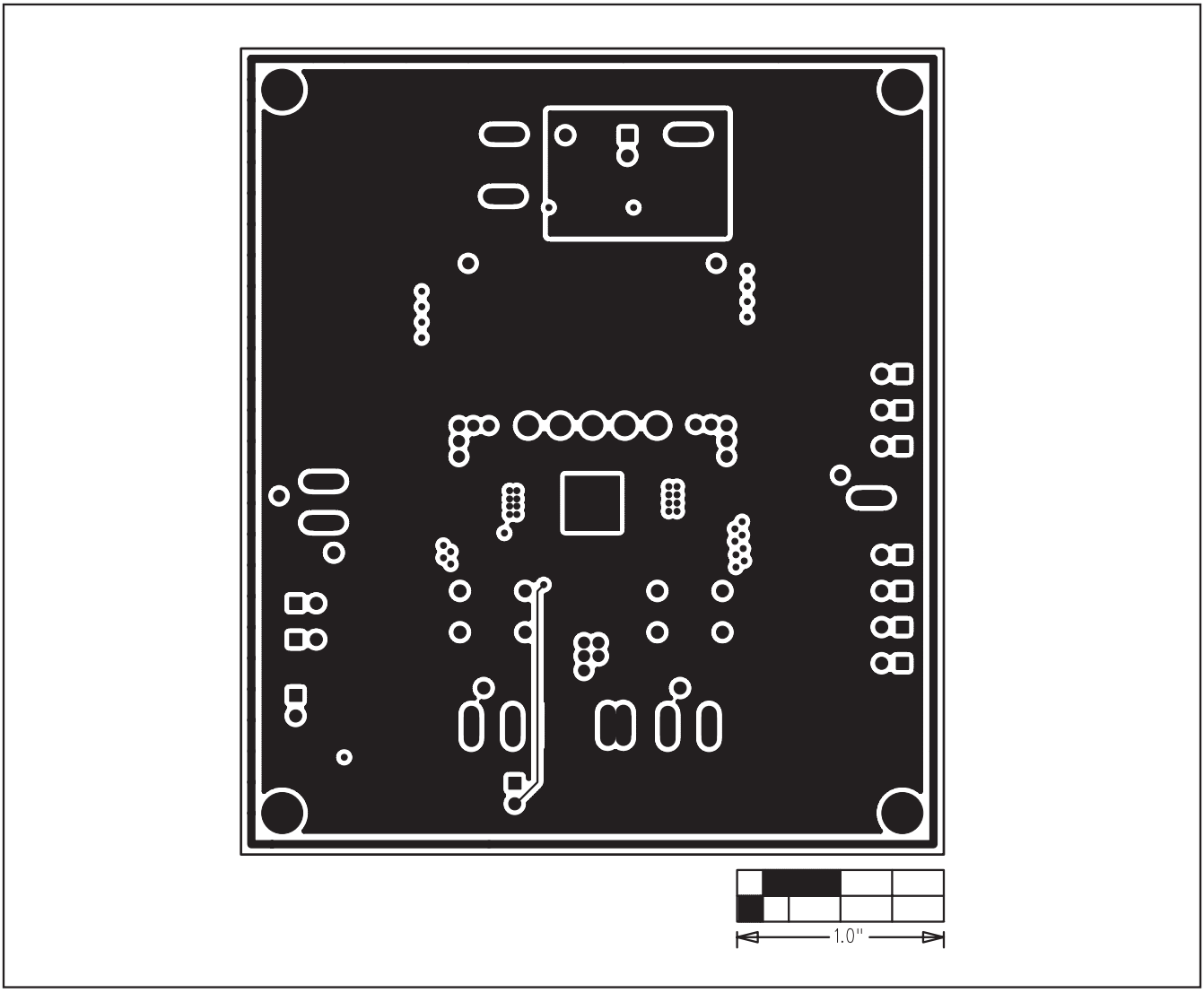

Figure 5. MAX9709 EV Kit PCB Layout—GND Layer 2

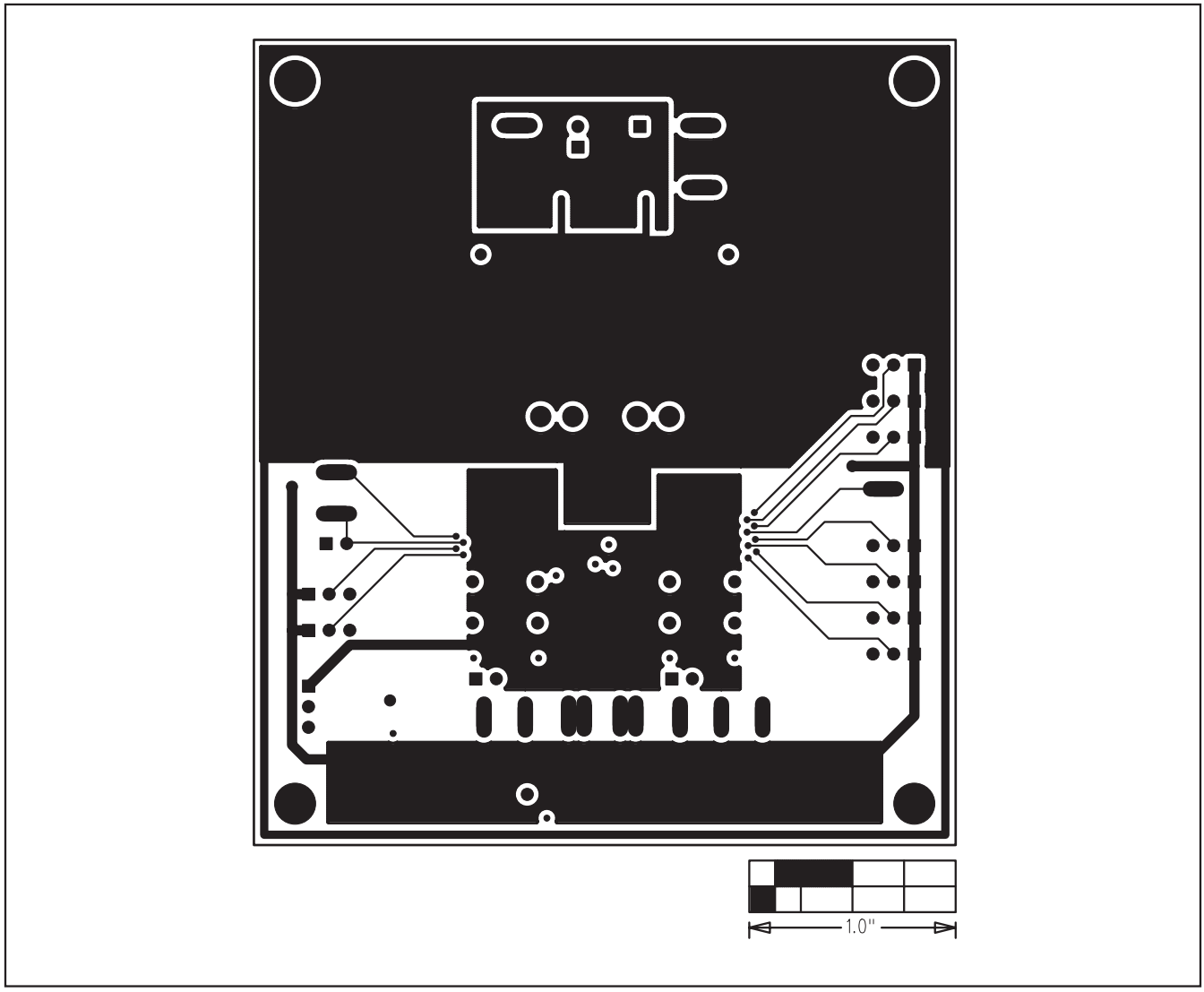

Figure 6. MAX9709 EV Kit PCB Layout—VDD Layer 3

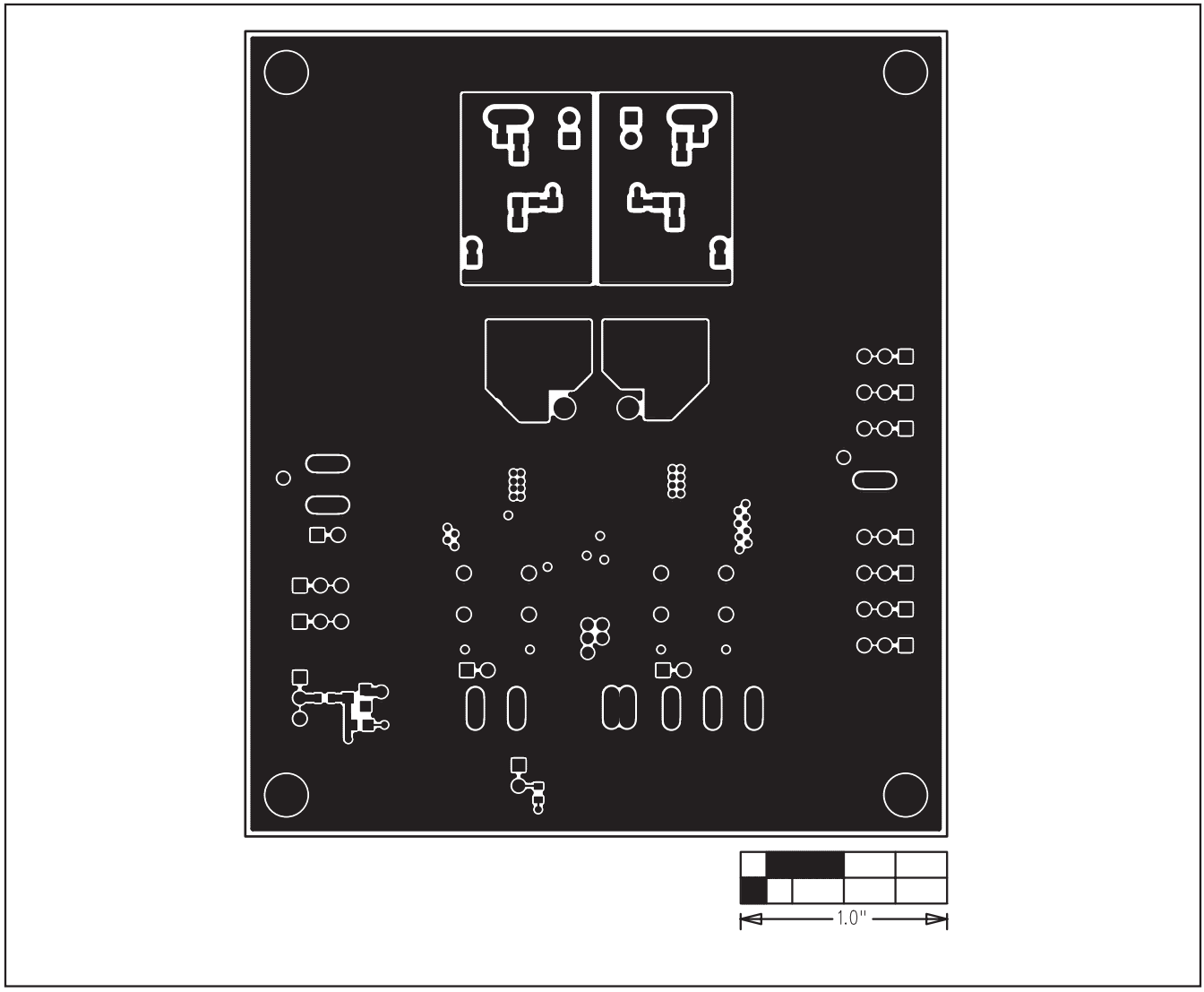

Figure 7. MAX9709 EV Kit PCB Layout—Solder Side

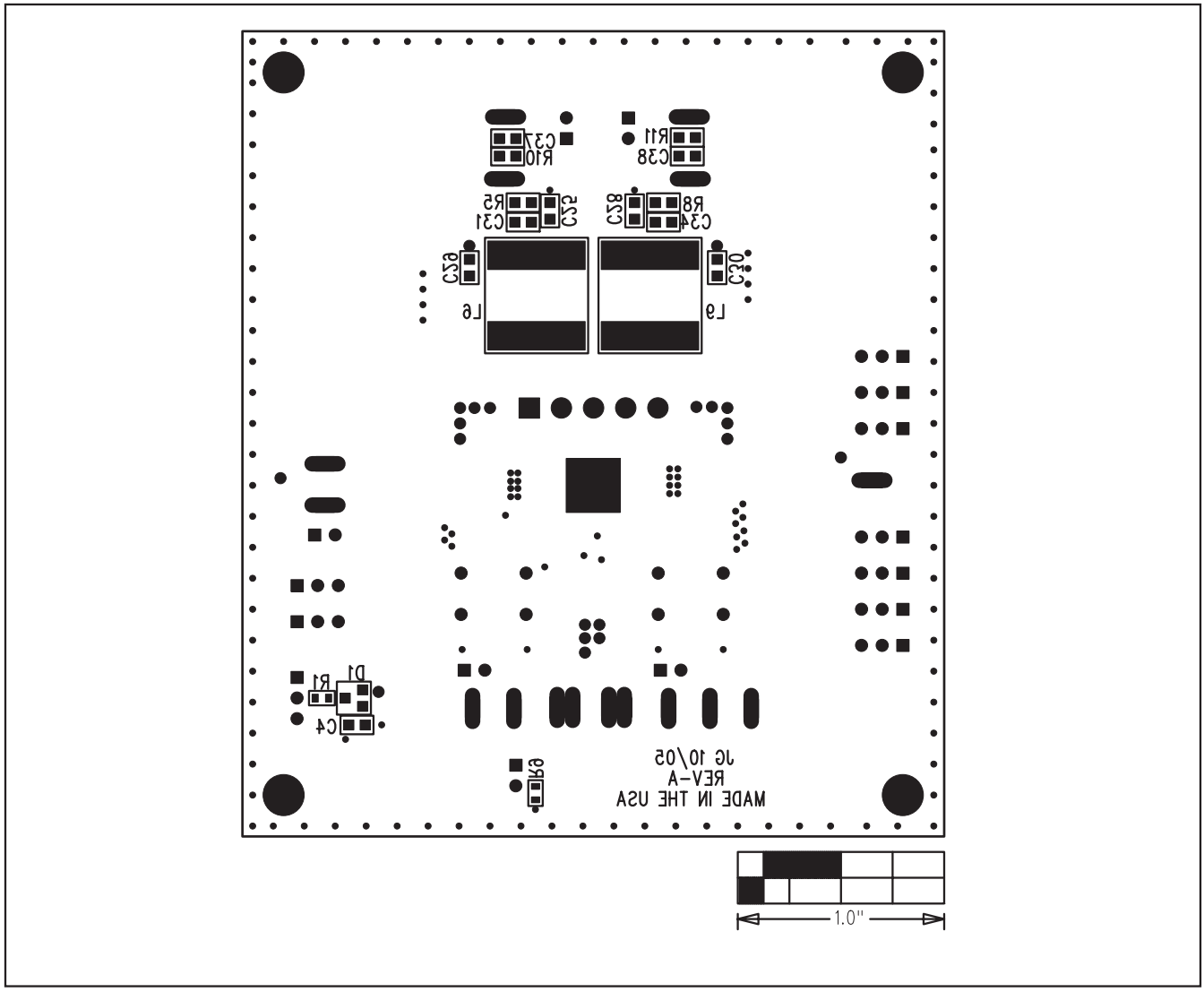

Figure 8. MAX9709 EV Kit Component Placement Guide—Solder Side

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/06	Initial release	—
1	4/08	Updated to RoHS compliance.	1, 2, 3