



MAX9708 Evaluation Kit

Evaluates: MAX9708

General Description

The MAX9708 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that configures the MAX9708 Class D amplifier to drive 2 x 21W into a pair of 8Ω speakers in stereo mode, or 1 x 42W into a single 4Ω speaker in mono mode for audio applications. 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 10VDC to 18VDC power supply. The MAX9708 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 MAX9708 EV kit offers an option to select between fixed-frequency modulation (FFM) mode or spread-spectrum modulation (SSM) mode.

The MAX9708 EV kit provides a thermal flag that can be programmed for eight different thermal thresholds. The MAX9708 EV kit can be synchronized with an external clock, and the EV kit provides a synchronous output that allows units to be cascaded and frequency locked in a multi-amplifier system.

Features

- ◆ 10V to 18V Single DC Power-Supply Operation
- ◆ Fully Differential or Single-Ended Inputs
- ◆ Fully Differential Outputs
- ◆ Drives 2 x 21W into 8Ω Speakers in Stereo Mode
- ◆ Drives 1 x 42W 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	TEMP RANGE	IC PACKAGE
MAX9708EVKIT	0°C to +70°C*	56 TQFN-EP**
MAX9708EVKIT+	0°C to +70°C*	56 TQFN-EP**

+ Denotes a lead-free and RoHS-compliant EV kit.

* This limited temperature range applies to the EV kit PCB only. The MAX9708 IC temperature range is -40°C to +85°C.

** EP = Exposed paddle.

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2, C3, C23	4	0.1μF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H104K
C6–C9	4	47μF ±20%, 35V tantalum capacitors (E case) AVX TPSE476M035R0250
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
R2, R3	2	10kΩ ±5% resistors (0603)
U1	1	MAX9708ETN+ (56-pin TQFN-EP 8mm x 8mm)

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION		
C4	1	10μF ±20%, 10V X5R ceramic capacitor (1206) TDK C3216X5R1A106M
C5	1	1000pF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H102K
C10, C11, C16–C19	6	100pF ±10%, 50V C0G ceramic capacitors (0603) TDK C1608C0G1H101K
C25–C28	4	0.022μF ±10%, 250V X7R ceramic capacitors (0805) TDK C2012X7R2E223K
C29, C30	2	0.1μF ±10%, 25V X7R ceramic capacitors (0805) Murata GRM21BR71E104K
C31–C34	4	0.01μF ±10%, 100V X7R ceramic capacitors (0805) Murata GRM21BR72A103K

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION		
D1	1	6V, 350mW zener diode (SOT-23) Central Semiconductor CMPZ5233B, lead free
L1	1	Ferrite bead, 30Ω at 100MHz, 10mΩ DCR, 5A (0805) TDK MPZ2012S300A
L2-L5	4	Ferrite beads, 100Ω at 100MHz, 50mΩ DCR, 3A (0603) TDK MPZ1608S101A
L6-L9	4	22μH ±20%, 4.7A inductors Sumida CDRH127/LDNP-220MC

DESIGNATION	QTY	DESCRIPTION
OPTIONAL COMPONENTS FOR CUSTOMER EVALUATION		
R1, R9	2	10kΩ ±5% resistors (0603)
R5-R8	4	100Ω ±5% resistors (0805)
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
—	13	Shunts
—	1	PCB: MAX9708 Evaluation Kit+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corp.	843-946-0238	www.avxcorp.com
Central Semiconductor	631-435-1110	www.centralsemi.com
Murata Mfg. Co., Ltd.	770-436-1300	www.murata.com
Sumida USA	847-545-6700	www.sumida.com
TDK Corp.	847-803-6100	www.component.tdk.com

Note: Indicate that you are using the MAX9708 when contacting these component suppliers.

Quick Start

Recommended Equipment

- 10V to 18V, 5A DC power supply
- Audio source (i.e., CD player, cassette player)
- Two 8Ω speakers

The MAX9708 EV kit is fully assembled and tested. Follow the steps listed below to verify board operation.

Do not turn on the power supply until all connections are completed:

- 1) Install a shunt across pins 1 and 2 of jumper JU1 (DVDD = 5V).
- 2) Install a shunt across pins 1 and 2 of jumper JU2 (SHDN high, EV kit enabled).
- 3) Install a shunt across pins 1 and 2 of jumper JU3 (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 1 and 2 of jumpers JU7, JU8, and JU9 (thermal flag disabled).
- 7) Install a shunt across pins 1 and 2 of jumpers JU10 and JU11 (switching frequency set to spread-spectrum modulation mode).
- 8) Install a shunt across pins 1 and 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 FOUTL+ and FOUTL- pads.
- 11) Connect the second 8Ω speaker across the FOUTR+ and FOUTR- pads.
- 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 negative terminal of the audio source to the IN_L- and IN_R- pads.
- 15) Turn on the power supply.
- 16) Turn on the audio source.

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Detailed Description

The MAX9708 EV kit is designed to evaluate the MAX9708 in the 56-pin TQFN-EP package. The MAX9708 is a Class D amplifier that can be configured to drive 2 x 21W into a pair of 8Ω speakers (default). The EV kit can be reconfigured to drive 1 x 42W into a mono 4Ω speaker. The EV kit is configured for stereo mode from the factory. The EV kit operates from a DC power supply that can provide 10V to 18V and 5A of current.

The MAX9708 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 MAX9708 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 Mode* section in the MAX9708 IC data sheet for additional information.

The MAX9708 EV kit provides a thermal flag ($\overline{\text{TEMP}}$) pad that outputs a logic-low signal when the IC's junction temperature exceeds the thermal threshold. The MAX9708 thermal flag can be programmed for eight different thermal thresholds. Refer to the *Thermal Sensor* section in the MAX9708 IC data sheet for additional information.

The MAX9708 EV kit features a synchronization input (SYNCIN) pad that allows the MAX9708 to synchronize with an external clock. The EV kit also provides a synchronization output (SYNCOUT) pad to synchronize other devices to the MAX9708. The SYNCOUT frequency is four times the switching frequency of the MAX9708. Refer to the *Synchronous Switching Mode* section in the MAX9708 IC data sheet for additional information.

Filterless Output

The MAX9708 filterless outputs (L+/- and R+/-) can be connected directly to a pair of speaker loads without any filtering. Use the L+/- and R+/- test points to connect speakers directly to the MAX9708 outputs.

Output Filtering

Audio analyzers typically cannot accept pulse-width-modulated (PWM) signals at their inputs. Therefore, the MAX9708 EV kit features a pair of lowpass filters at each of the outputs to ease evaluation. Use the filtering output pads (FOUTL+/- and FOUTR+/-) to connect the filtered PWM outputs to the audio analyzer. The default lowpass filters at the outputs of the EV kit are optimized for a pair of 8Ω speakers in stereo mode. To optimize the output filter for a single 4Ω speaker in mono mode, see the *Stereo/Mono Operation (JU15, JU16, JU17)* section.

Jumper Selection

DVDD (JU1)

The MAX9708 EV kit operates from a DC power supply between 10V to 18V. This power-supply range is too high for most of the digital input pins on the IC. The MAX9708 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 1 for shunt positions. Note that the MAX9708 features an internal, 6V regulator output (VREG). The MAX9708 REG output pin simplifies system design and reduces system cost by providing a logic voltage high for the MAX9708 logic pins. However, VREG is not available as a logic voltage high in shutdown mode and therefore cannot be applied as an input voltage high to the MAX9708 SHDN pin.

Shutdown Mode ($\overline{\text{SHDN}}$)

The MAX9708 features a shutdown mode to reduce the quiescent current to 0.1μA (typ). Jumper JU2 controls the shutdown pin (SHDN) of the MAX9708 IC. See Table 2 for shunt positions.

Table 1. JU1 Jumper Selection (DVDD)

SHUNT POSITION	MAX9708 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 2. JU2 Jumper Selection ($\overline{\text{SHDN}}$)

SHUNT POSITION	MAX9708 $\overline{\text{SHDN}}$ PIN CONNECTED TO	EV KIT FUNCTION
1-2 (Default)	DVDD	EV kit enabled
2-3	GND	Shutdown mode

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Mute Function (MUTE)

The MAX9708 features a mute function to mute the output of the EV kit. Jumper JU3 controls the mute pin ($\overline{\text{MUTE}}$) of the MAX9708 IC. See Table 3 for shunt positions.

Synchronization Switching Input (SYNCIN)

The MAX9708 EV kit provides a SYNCIN pad that allows the MAX9708 switching frequency to synchronize with 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 MAX9708 IC. See Table 4 for shunt positions.

Single-Ended/Differential Audio Inputs

The MAX9708 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. Table 5 lists the selectable jumper options.

Thermal Thresholds (TH0, TH1, TH2)

The MAX9708 EV kit provides eight jumper options to set the MAX9708 thermal threshold flag. Jumpers JU7, JU8, and JU9 set the thermal threshold flag for the MAX9708 IC junction temperature. Table 6 lists the selectable jumper options.

Frequency Modulation

The MAX9708 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 MAX9708 EV kit provide an option to select the different frequency modulation modes for the MAX9708. Table 7 lists the selectable jumper options for JU10 and JU11.

Table 3. JU3 Jumper Selection ($\overline{\text{MUTE}}$)

SHUNT POSITION	MAX9708 $\overline{\text{MUTE}}$ PIN CONNECTED TO	EV KIT OUTPUT
1-2 (Default)	DVDD	Normal operation
2-3	GND	Mute

Table 4. JU4 Jumper Selection (SYNCIN)

SHUNT POSITION	MAX9708 SYNCIN PIN CONNECTED TO	MAX9708 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 5. 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.

Table 6. JU7, JU8, JU9 Jumper Selection (Thermal Threshold Flag)

MAX9708 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)
N/A	1-2 (HIGH)	1-2 (HIGH)	1-2 (HIGH)

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Table 7. JU10, JU11 Jumper Selection (Switching Frequency)

SHUNT POSITION		MAX9708 SWITCHING FREQUENCY (kHz)	SYNCOUT SWITCHING FREQUENCY (Hz)	MODULATION
JU10	JU11			
2-3 (LOW)	2-3 (LOW)	200	800k	Fixed-frequency modulation
2-3 (LOW)	1-2 (HIGH)	250	1M	Fixed-frequency modulation
1-2 (HIGH)	2-3 (LOW)	160	640k	Fixed-frequency modulation
1-2 (HIGH)	1-2 (HIGH)	200 ±4	800k ±16k	Spread-spectrum modulation

Gain Selection

The MAX9708 features four gain settings. Jumpers JU12 and JU13 provide four options to select the desired gain for the MAX9708 IC. The gain of the MAX9708 is selectable between +22dB, +25dB, +29.5dB, and +36dB. See Table 8 for shunt positions.

Table 8. 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)

Stereo/Mono Operation (JU15, JU16, JU17)

The MAX9708 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 42W into a 4Ω load.

Important notes:

- Do not turn on power until ALL modifications have been made.
- Steps 2 to 5 below automatically optimize 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) Connect a 4Ω speaker load across the FOUTL- and FOUTR+ PCB pads.
- 7) Apply the audio inputs to the IN_R+ and IN_R- PCB pads.

Jumpers JU15, JU16, and JU17 configure the output mode for the MAX9708 EV kit. Table 9 lists the selectable jumper options.

Table 9. JU15, JU16, JU17 Jumper Selection (Stereo/Mono)

MAX9708 OUTPUT MODE	SHUNT POSITION			TEST POINTS	
	JU15 (MONO)	JU16 (FOUTL+ AND FOUTR+ PADS)	JU17 (FOUTL- AND FOUTR- PADS)	L+ AND R+	L- AND R-
Stereo (Default)	Not Installed (OPENED)	Not Installed (OPENED)	Not Installed (OPENED)	(OPENED)	(OPENED)
Mono*	Installed (SHORTED)	Installed (SHORTED)	Installed (SHORTED)	(SHORTED)	(SHORTED)

*Important Notes:

- DO NOT turn on power until after ALL modifications have been made.
- In mono mode, ALL the jumpers and test points listed in Table 9 must be SHORTED.
- In stereo mode, ALL the jumpers and test points listed in Table 9 must be OPENED.

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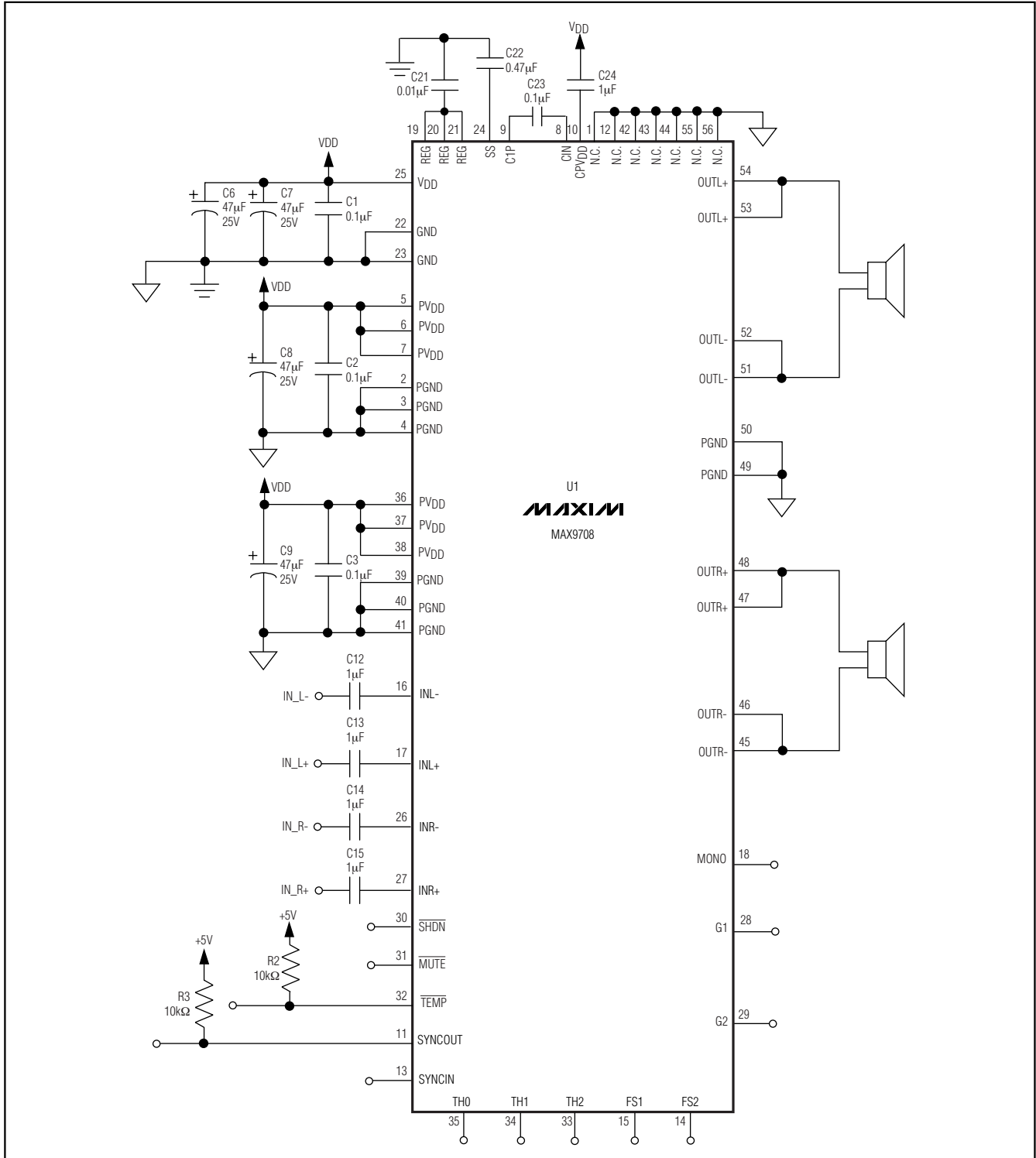


Figure 1. MAX9708 Customer Design Schematic

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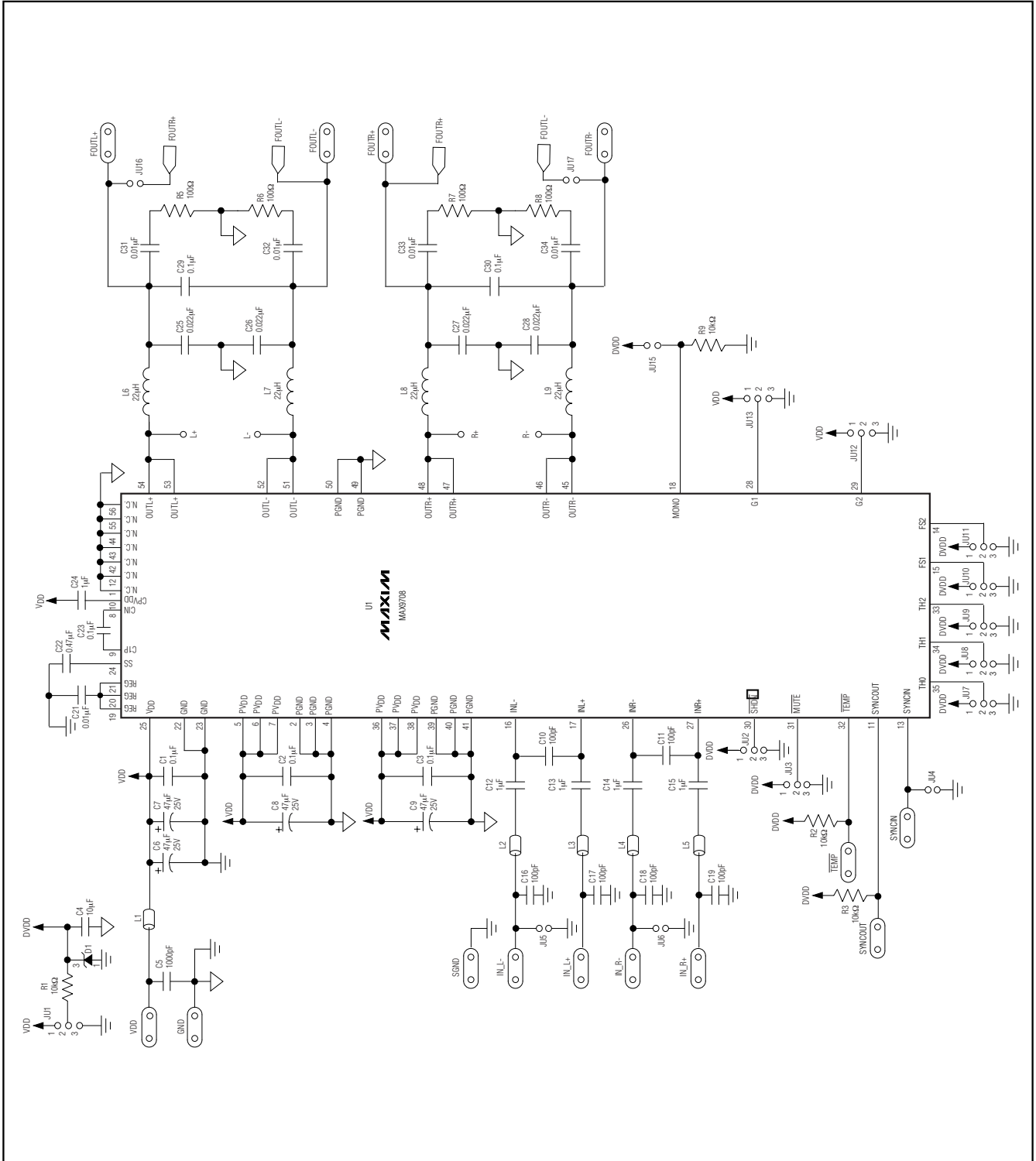


Figure 2. MAX9708 EV Kit Schematic

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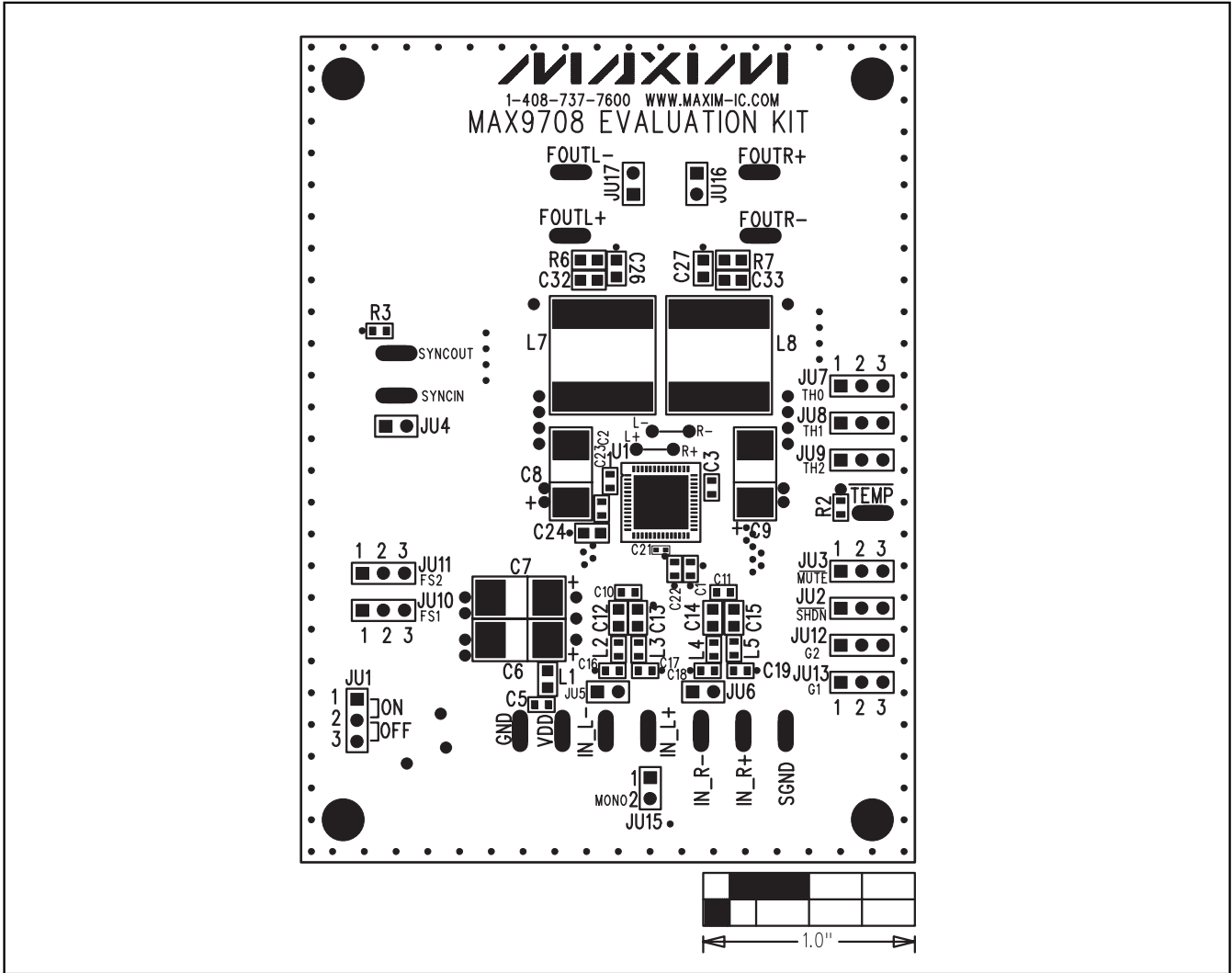


Figure 3. MAX9708 EV Kit Component Placement Guide—Component Side

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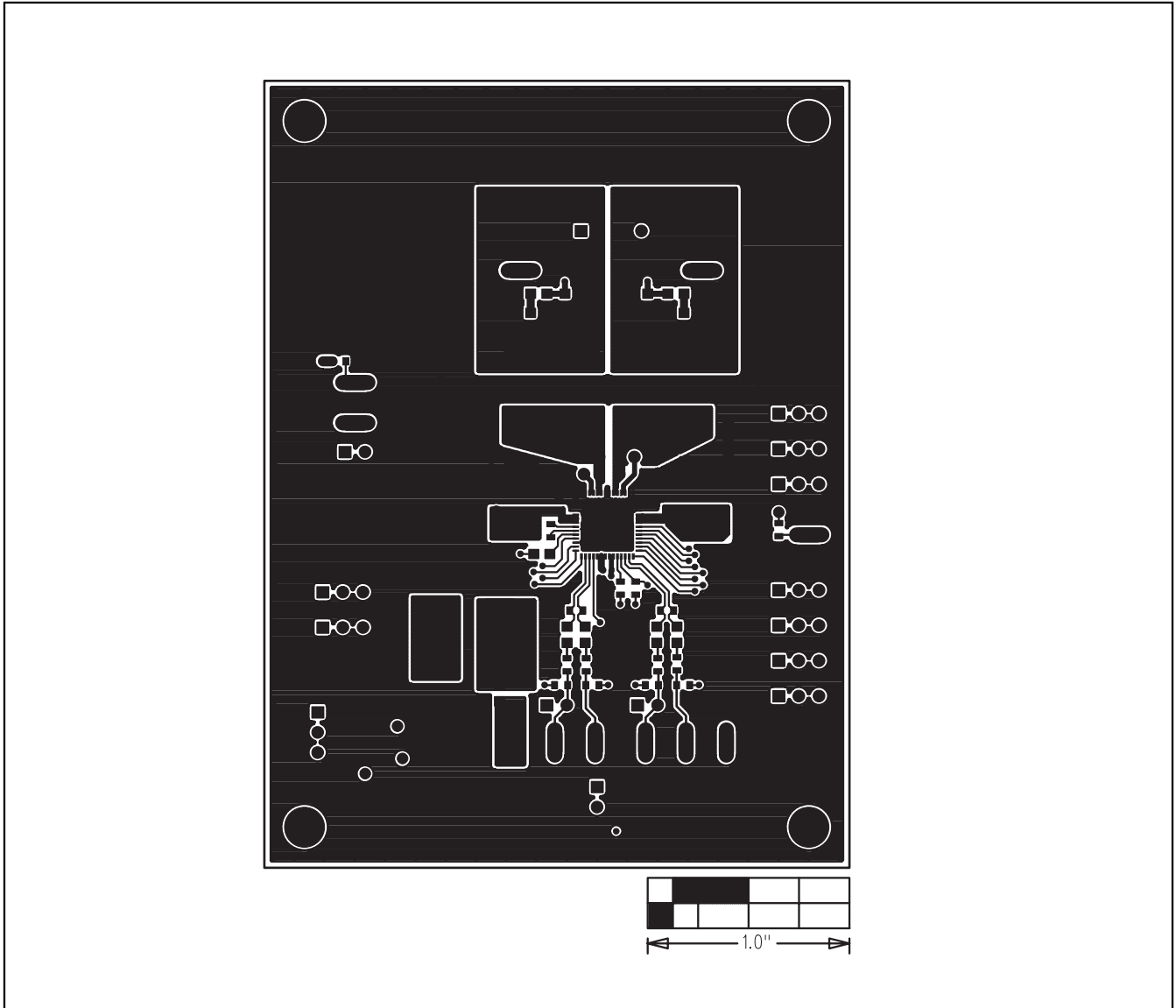


Figure 4. MAX9708 EV Kit PCB Layout—Component Side

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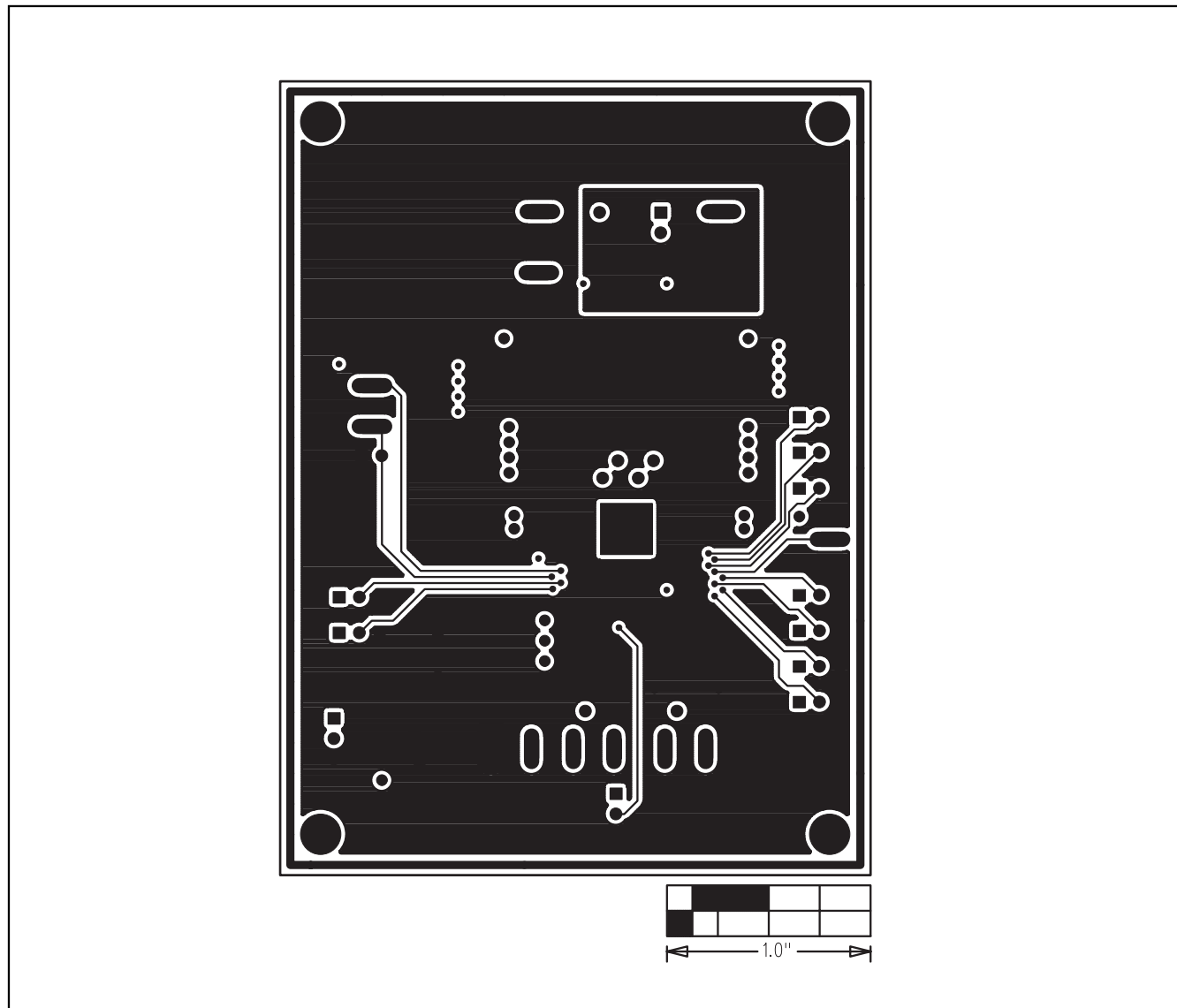


Figure 5. MAX9708 EV Kit PCB Layout—GND Layer 2

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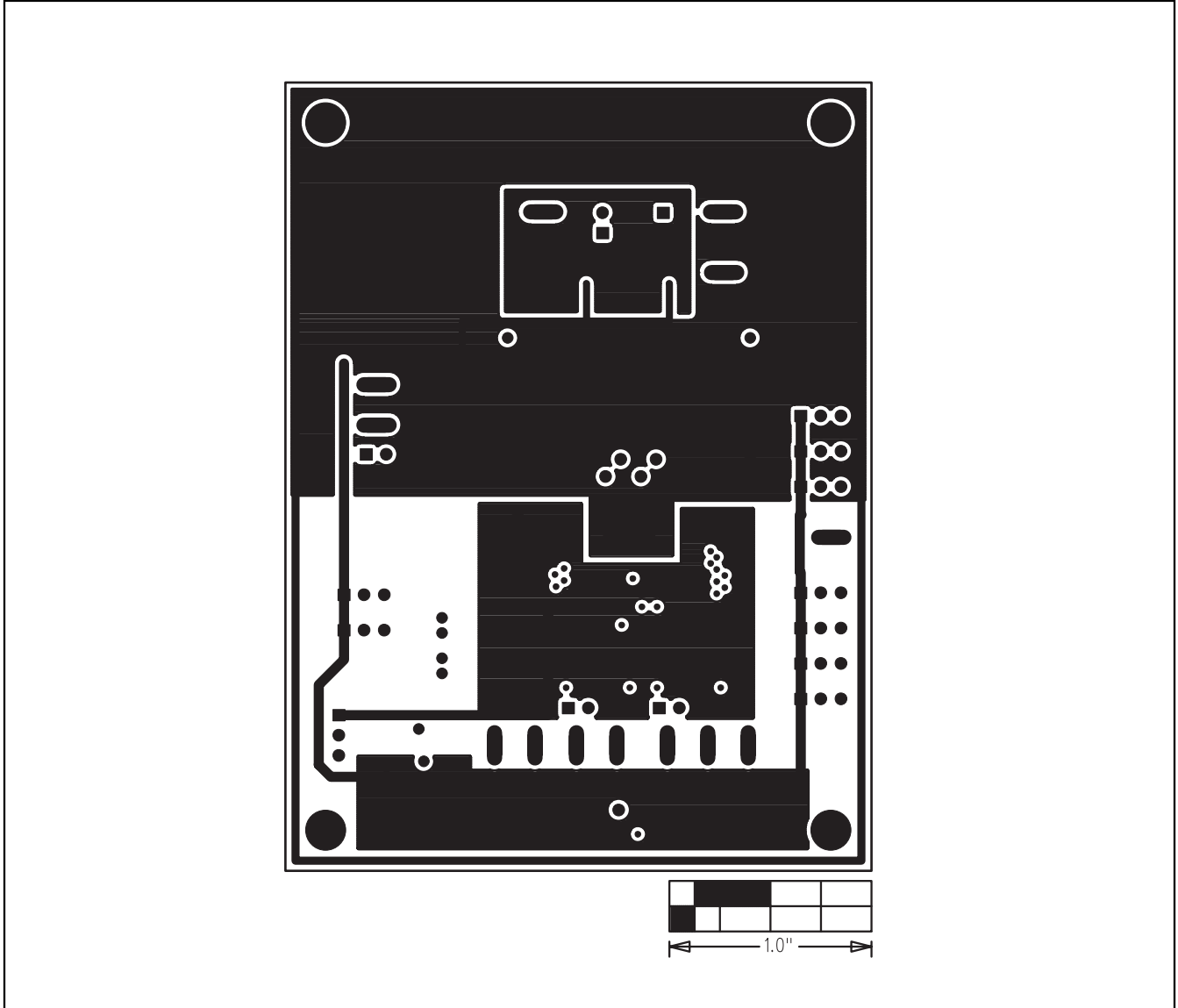


Figure 6. MAX9708 EV Kit PCB Layout—VDD Layer 3

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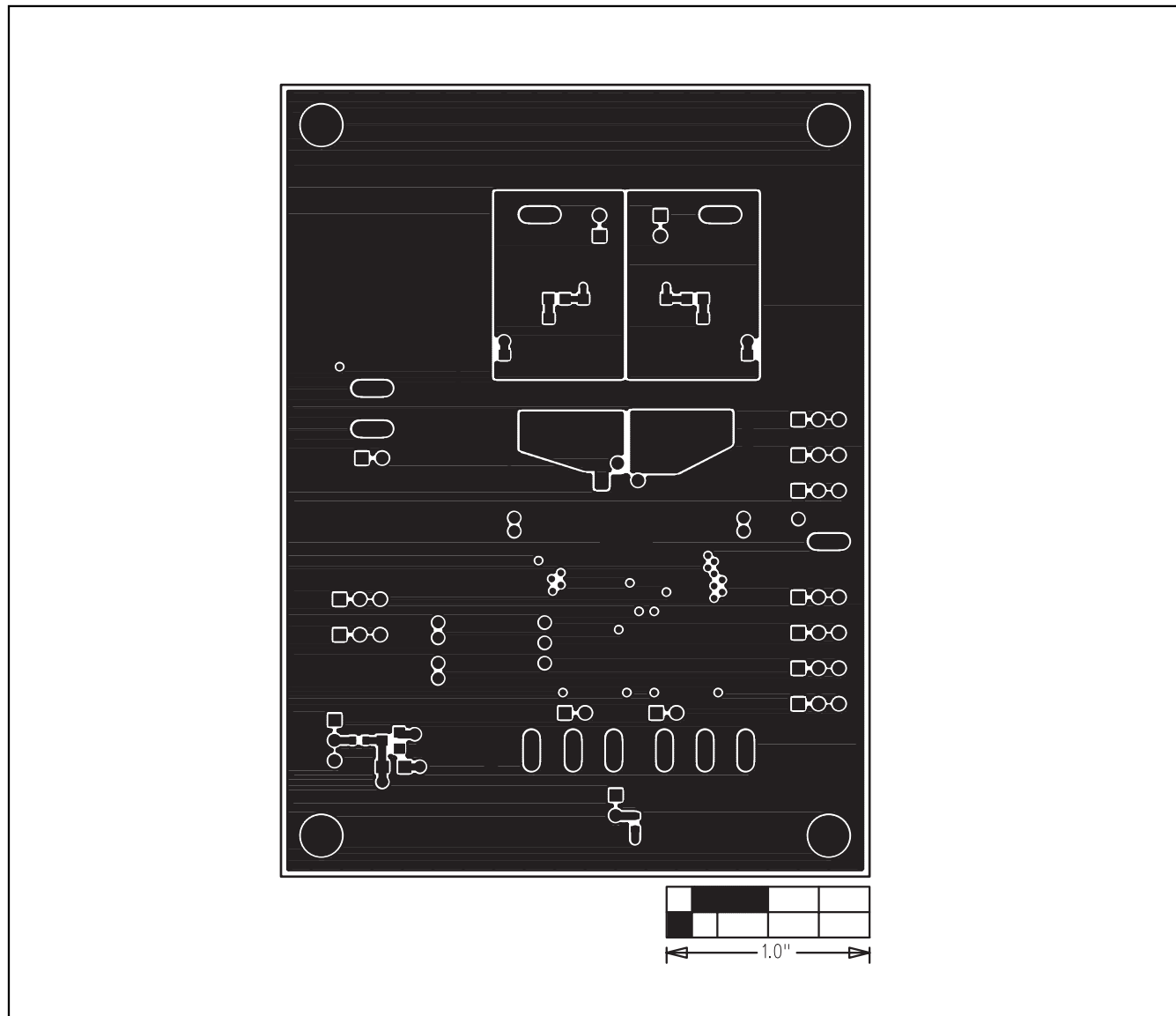


Figure 7. MAX9708 EV Kit PCB Layout—Solder Side

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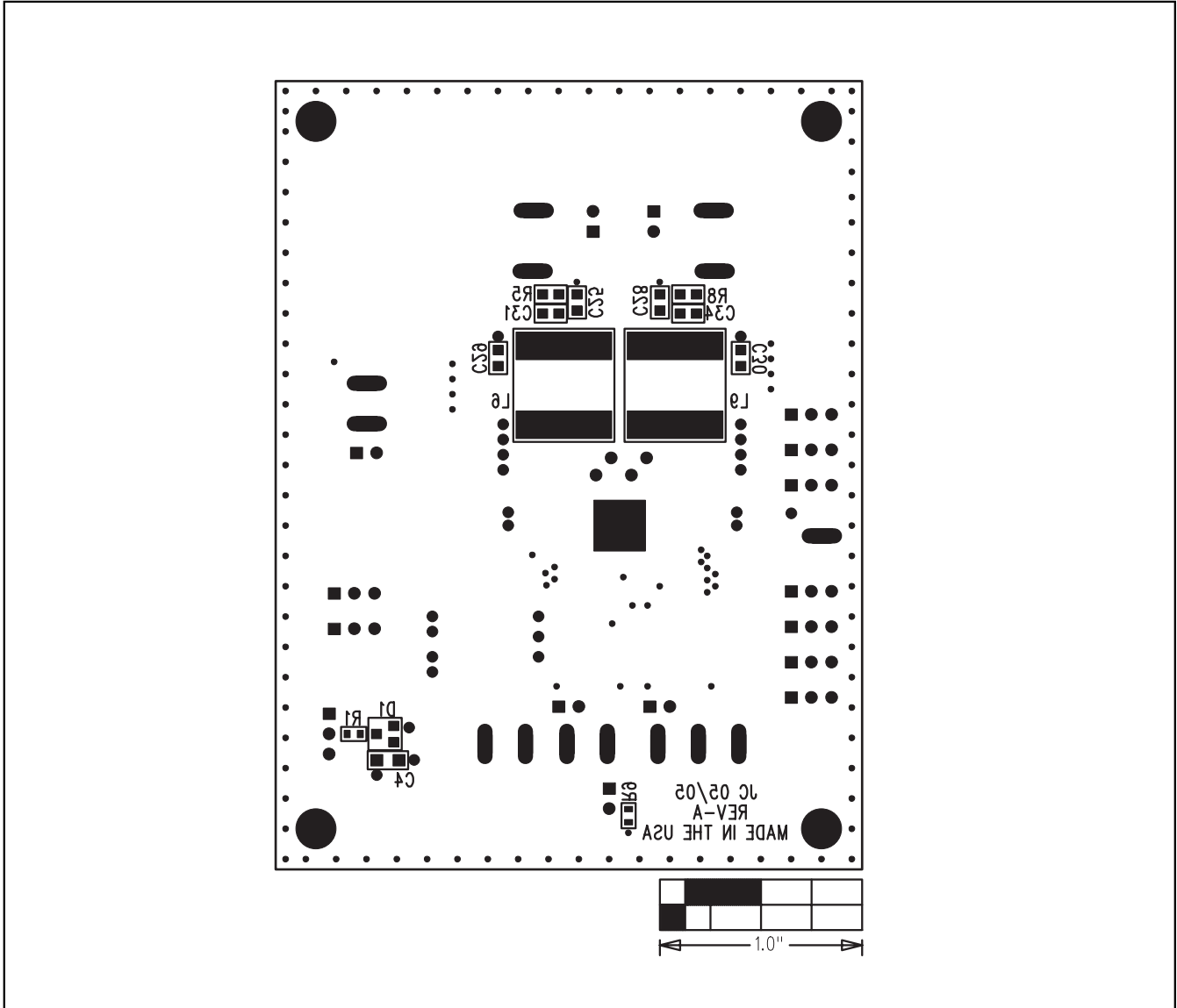


Figure 8. MAX9708 EV Kit Component Placement Guide—Solder Side

Revision History

Pages changed at Rev 1: 1, 2, 5, 9–13

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