



# MAX98400B Evaluation Kit

## General Description

The MAX98400B evaluation kit (EV kit) configures the MAX98400B Class D amplifier to drive 2x12W into a pair of 8Ω speakers in stereo mode for audio applications. The EV kit operates from an 8V to 28V DC power supply. The EV kit has a programmable gain and the jumper settings default to a +20.1dB gain. The EV kit accepts a pair of single-ended or differential input signals and provides two sets of differential outputs for speakers.

The EV kit has two independent amplifier circuits, demonstrating direct speaker driving (for low component count) and filtered output driving (for ease of evaluation). The EV kit comes with two MAX98400BETG+ devices installed.

The EV kit provides an option to control the limiter, thermal foldback, input configuration, gain, and shut-down mode of the device. The EV kit includes convenient audio input and output connectors.

## Features

- ◆ 8V to 28V Single DC Power-Supply Operation
- ◆ Fully Differential Inputs and Outputs
- ◆ Drives 2x12W into 8Ω Speakers in Stereo Mode
- ◆ Limiter Control
- ◆ Thermal Foldback
- ◆ Shutdown Control
- ◆ Evaluates the MAX98400B in a 24-Pin TQFN Package with an Exposed Pad
- ◆ U1 Configured for Filterless Output
- ◆ U2 Configured for Filtered Output
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TYPE
MAX98400BEVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

## Component List

DESIGNATION	QTY	DESCRIPTION
<b>FILTERLESS EVALUATION (U1)</b>		
C101	1	220μF ±20%, 35V electrolytic capacitor (radial leaded, 5mm spacing), 10mm diameter x 12.5mm high Panasonic EEU-FM1V221
C102A, C102B	2	1μF ±10%, 50V X7R ceramic capacitors (0805) TDK C2012X7R1H105K
C103, C104	2	1μF ±10%, 10V X7R ceramic capacitors (0603) Murata GRM188R71A105K
C105–C108	4	1μF ±10%, 25V X7R ceramic capacitors (0805) Murata GRM21BR71E105K
C111–C114	0	Not installed, ceramic capacitors (0603)
FB1	1	22Ω at 100MHz ferrite bead (0805) Murata BLM21PG220SN1D

DESIGNATION	QTY	DESCRIPTION
GAIN1_1, GAIN2_1, LIM_1	3	3-pin headers
INL1	1	White phono jack
INR1	1	Red phono jack
JU104, JU105, SHDN_1, TEMP_1	4	2-pin headers
L1+, L1-, R1+, R1-	0	Not installed, multipurpose test points
R101, R103, R104, R105	0	Not installed, resistors (0603)
R106	0	Not installed, potentiometer (3/8in)
R107	1	100kΩ ±5% resistor (0603)
R111–R114	4	0Ω ±5% resistors (0805)
SPKL1+, SPKL1-, SPKR1+, SPKR1-	4	Binding posts
U1	1	Stereo Class D audio amplifier (24 TQFN-EP*) Maxim MAX98400BETG+

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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
—	10	600Ω at 100MHz, 150mΩ DCR, 2A ferrite beads (0805) Würth Elektronik 742792040
—	10	330pF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H331K
<b>FILTERED EVALUATION (U2)</b>		
C201	1	220μF ±20%, 35V electrolytic capacitor (radial leaded, 5mm spacing), 10mm diameter x 12.5mm high Panasonic EEU-FM1V221
C202A, C202B	2	1μF ±10%, 50V X7R ceramic capacitors (0805) TDK C2012X7R1H105K
C203, C204	2	1μF ±10%, 10V X7R ceramic capacitors (0603) Murata GRM188R71A105K
C205–C208	4	1μF ±10%, 25V X7R ceramic capacitors (0805) Murata GRM21BR71E105K
C220–C223, C226–C229	8	0.15μF ±10%, 50V X7R ceramic capacitors (0805) Murata GRM21BR71H154K
C224, C225	2	0.68μF ±10%, 50V X7R ceramic capacitors (0805) Murata GRM21BR71H684K
FB2	1	22Ω ferrite bead (0805) Murata BLM21PG220SN1D
FOUTL2+, FOURL2-, FOUTR2+, FOUTR2-	4	Binding posts
GAIN1_2, GAIN2_2, LIM_2	3	3-pin headers

DESIGNATION	QTY	DESCRIPTION
INL2	1	White phono jack
INR2	1	Red phono jack
JU204, JU205	2	2-pin headers
L20–L23	4	33μH ±20%, 3.1A inductors Sumida CDRH127NP-330NC
R201, R203, R204, R205	0	Not installed, resistors (0603)
R206	0	Not installed, potentiometer (3/8in)
R207	1	100kΩ ±5% resistor (0603)
R226–R229	4	15Ω ±5% resistors (1206)
U2	1	Stereo Class D audio amplifier (24 TQFN-EP*) Maxim MAX98400BETG+
<b>COMMON TO BOTH SIDES</b>		
C1	1	0.1μF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H104K
C2	1	1μF ±10%, 10V X7R ceramic capacitor (0603) Murata GRM188R71A105K
D1	1	4.3V, 20mA zener diode (SOT23) Central Semi CMPZ5229B
JU1	1	3-pin header
PGND, PVDD	2	Binding posts
R1	1	10kΩ ±5% resistor (0603)
—	13	Shunts
—	1	PCB: MAX98400B EVALUATION KIT+

\*EP = Exposed pad.

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor Corp.	631-435-1110	www.centalsemi.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
Würth Electronik GmbH & Co. KG	201-785-8800	www.we-online.com

**Note:** Indicate that you are using the MAX98400B when contacting these component suppliers.

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## Quick Start

### Required Equipment

- MAX98400B EV kit
- 8V to 28V, 3A DC power supply
- Audio source with volume control (e.g., CD player)
- Two speakers

### Procedure—Filterless Evaluation (U1)

The 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) Verify that all jumpers are in their default positions, as shown in Table 1.
- 2) If not using the filtered evaluation side, remove the shunt from SHDN\_2 (disable).
- 3) Connect the first speaker across the SPKL1- and SPKL1+ PCB binding posts.
- 4) Connect the second speaker across the SPKR1- and SPKR1+ PCB binding posts.
- 5) Connect the positive terminal of the power supply to the PVDD binding post and the power-supply ground terminal to the PGND binding post.
- 6) Connect the left output terminal of the audio source to the INL1 RCA phono jack.
- 7) Connect the right output terminal of the audio source to the INR1 RCA phono jack.
- 8) Turn on the audio source at minimum volume.
- 9) Turn on the power supply.
- 10) Gradually increase the audio source volume until audio is heard through the loud speakers.

### Procedure—Filtered Evaluation (U2)

The 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) Verify that all jumpers are in their default positions, as shown in Table 2.
- 2) If not using the filterless evaluation side, remove the shunt from SHDN\_1 (disable).
- 3) Connect the first speaker across the FOUTL2- and FOUTL2+ PCB binding posts.
- 4) Connect the second speaker across the FOUTR2- and FOUTR2+ PCB binding posts.
- 5) Connect the positive terminal of the power supply to the PVDD binding post and the power-supply ground terminal to the PGND binding post.
- 6) Connect the left output terminal of the audio source to the INL2 RCA phono jack.
- 7) Connect the right output terminal of the audio source to the INR2 RCA phono jack.
- 8) Turn on the audio source at minimum volume.
- 9) Turn on the power supply.
- 10) Gradually increase the audio source volume until audio is heard through the loud speakers.

## Detailed Description of Hardware

The MAX98400B EV kit provides a proven layout for evaluating the MAX98400B. The EV kit is designed to evaluate the device in a 24-pin TQFN package with an exposed pad. The device is a Class D amplifier that can be configured to drive 2x12W into a pair of 8Ω speakers. The EV kit operates from a DC power supply that provides 8V to 28V and 3A of current. The EV kit PCB is designed with two layers and has 2oz copper for optimized power dissipation. Each side of the EV kit accepts a pair of differential or single-ended input signals and provides two sets of amplified differential audio outputs.

### Optional External Preampifier Power Supply (VS)

The EV kit provides input pads (VS1 for U1 and VS2 for U2) to accept an optional 5V external power supply for powering the device's preamplifiers. The external power supply for the preamplifiers must be in the 4.5V to 5.5V range. Refer to the MAX98400A/MAX98400B IC data sheet for more information.

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## Filterless Output (U1)

The EV kit's filterless outputs (SPKL1+/SPKL1- and SPKR1+/SPKR1-) can be connected directly to a pair of speaker loads without any filtering.

## Output Filtering Requirements (U1)

The device can pass CE EN55022B regulations with only ferrite-bead filters, especially when speaker-wire lengths are less than or equal to 1m. To install the ferrite-bead filters, first remove the 0Ω resistors (R111–R114). Next, replace resistors R111–R114 with ferrite beads listed in Table 3 (provided with the EV kit), and install filter capacitors on the C111–C114 pads. The speaker wire should be connected to the L1+/L1- and R1+/R1- test points. Although component selection for the output filter is dependent on speaker-wire length, the components in Table 3 are provided with the EV kit as a starting point. Final component selection should be determined during EMC testing. Contact the factory, if required. Note that an inductive load is required at this terminal. If using an 8Ω power resistor, add a 68μH series inductor. If using a 4Ω power resistor, add a 33μH series inductor.

## Filtered Output (U2)

Audio analyzers typically cannot accept pulse-width modulated (PWM) signals at their inputs. Therefore, the EV kit features a pair of lowpass filters at each of the outputs to ease evaluation. Use the filtering output posts (FOUTL2+/FOUTL2- and FOUTR2+/FOUTR2-) to connect the filtered PWM outputs to the audio analyzer. The default lowpass filters at the EV kit outputs are optimized for a pair of 8Ω power resistors or 8Ω speakers.

## Thermal Foldback

As shipped from the factory, the thermal-foldback feature is enabled (TEMP\_1 and TEMP\_2 jumpers open). To disable thermal foldback, install a shunt across the TEMP\_1 or TEMP\_2 jumper. Refer to the MAX98400A/MAX98400B IC data sheet for information on selecting this resistor value.

## Limiter

As shipped from the factory, the limiter-threshold control is disabled. To enable the limiter in PVDD tracking mode, move the LIM\_1 or LIM\_2 shunt to the 2-3 position. To enable the limiter in programmable mode, leave the LIM\_1 or LIM\_2 jumper open and select appropriate values for R103, R104, and R105 or R203, R204, and R205. Refer to the MAX98400A/MAX98400B IC data sheet for information on selecting these component values.

**Table 1. Jumper Descriptions (U1)**

JUMPER	SHUNT POSITION	DESCRIPTION
$\overline{\text{SHDN}}_1$	1-2*	Normal operation; U1 $\overline{\text{SHDN}} = \text{DVDD}$ (external logic-high)
	Open	Shutdown; U1 $\overline{\text{SHDN}} = \text{GND}$
TEMP_1	Open*	Thermal foldback enabled; U1 TEMPLOCK = unconnected
	1-2	Thermal foldback disabled; U1 TEMPLOCK = GND
LIM_1	1-2*	Limiter disabled; U1 LIM_TH = VS1
	2-3	Limiter enabled in PVDD tracking mode; U1 LIM_TH = GND
	Open	Limiter programmable mode; U1 LIM_TH is determined by R103, R104, and R105

\*Default position.

JUMPER	SHUNT POSITION	DESCRIPTION
JU104	1-2*	Single-ended input mode; U1 INL- = GND
	Open	Differential input mode; U1 INL- is not connected to GND
JU105	1-2*	Single-ended input mode; U1 INR- = GND
	Open	Differential input mode; U1 INR- is not connected to GND
GAIN1_1	1-2	U1 G1 = VS1
	2-3*	U1 G1 = GND
	Open	U1 G1 is not driven
GAIN2_1	1-2	U1 G2 = VS1
	2-3	U1 G2 = GND
	Open*	U1 G2 is not driven

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**Table 2. Jumper Descriptions (U2)**

JUMPER	SHUNT POSITION	DESCRIPTION
$\overline{\text{SHDN}}_2$	1-2*	Normal operation; U2 $\overline{\text{SHDN}}$ = DVDD (external logic high)
	Open	Shutdown; U2 $\overline{\text{SHDN}}$ = GND
TEMP_2	Open*	Thermal foldback enabled; U2 TEMPLOCK = unconnected
	1-2	Thermal foldback disabled; U2 TEMPLOCK = GND
LIM_2	1-2*	Limiter disabled; U2 LIM_TH = VS2
	2-3	Limiter enabled in PVDD tracking mode; U2 LIM_TH = GND
	Open	Limiter programmable mode; U2 LIM_TH is determined by R203, R204, and R205
JU204	1-2*	Single-ended input mode; U2 INL- = GND
	Open	Differential input mode; U2 INL- is not connected to GND
JU205	1-2*	Single-ended input mode; U2 INR- = GND
	Open	Differential input mode; U2 INR- is not connected to GND
GAIN1_2	1-2	U2 G1 = VS2
	2-3*	U2 G1 = GND
	Open	U2 G1 is not driven
GAIN2_2	1-2	U2 G2 = VS2
	2-3	U2 G2 = GND
	Open*	U2 G2 is not driven

\*Default position.

**Table 3. Recommended EMI Filter Components for 8Ω Loads**

DESIGNATION	DESCRIPTION
R111–R114	600Ω at 100MHz, 150mΩ DCR, 2A ferrite beads (0805) Würth Elektronik 742792040
C111–C114	330pF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H331K or TDK C1608X7R1H331K

**Note:** 3A current-rating ferrite beads are recommended for 4Ω load drive.

**Table 4. Gain Jumper Descriptions\***

SHUNT POSITION		GAIN (dB)
GAIN1_1, GAIN1_2	GAIN2_1, GAIN2_2	
2-3	2-3	9.0
Open		13.0
1-2		16.7
2-3	Open	20.1
Open		23.3
1-2		26.4
2-3	1-2	29.8
Open		32.9
1-2		Reserved

\*GAIN1\_1 and GAIN2\_1 set the gain for U1.  
GAIN1\_2 and GAIN2\_2 set the gain for U2.

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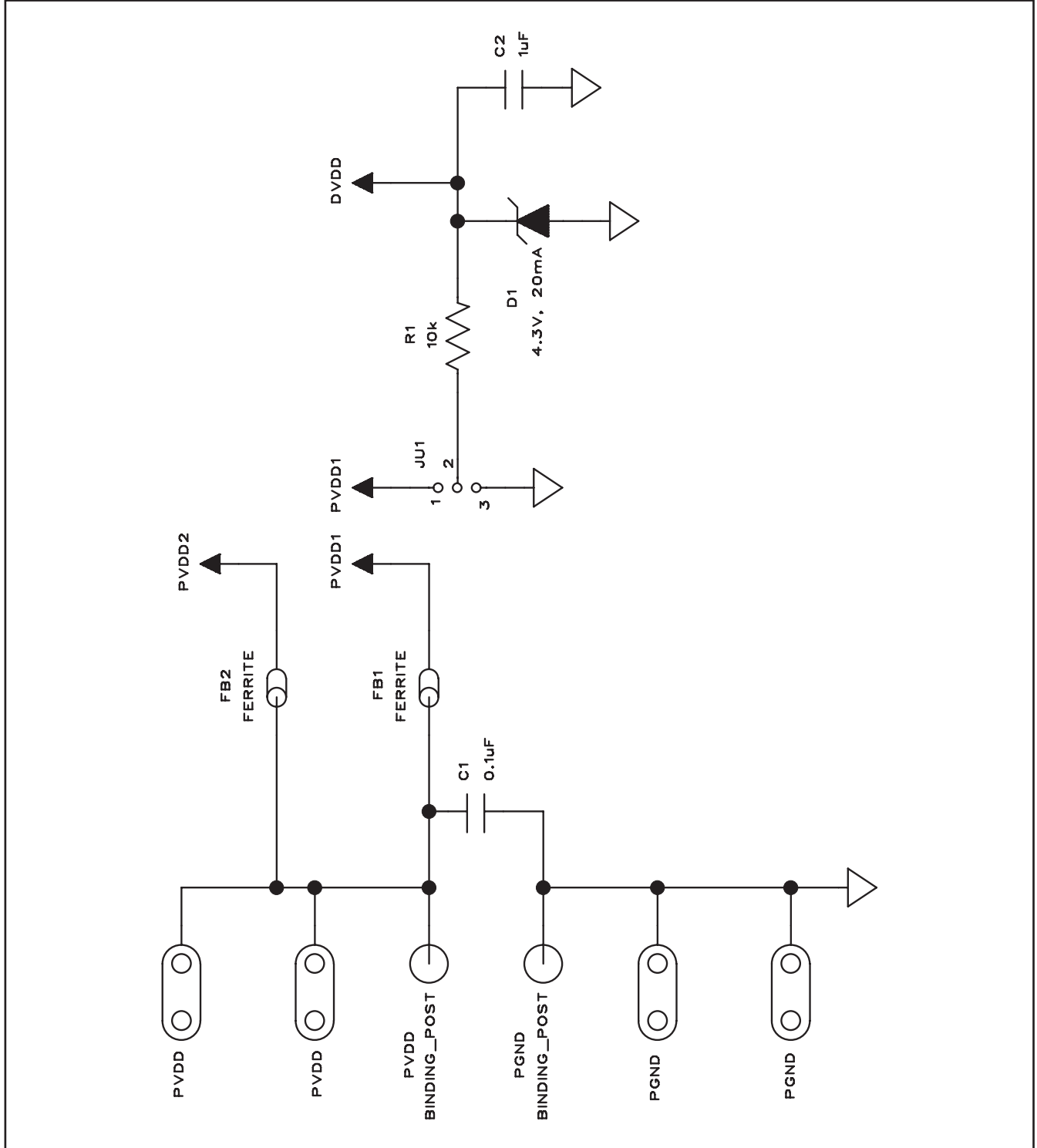


Figure 1a. MAX98400B EV Kit Schematic (Sheet 1 of 3)

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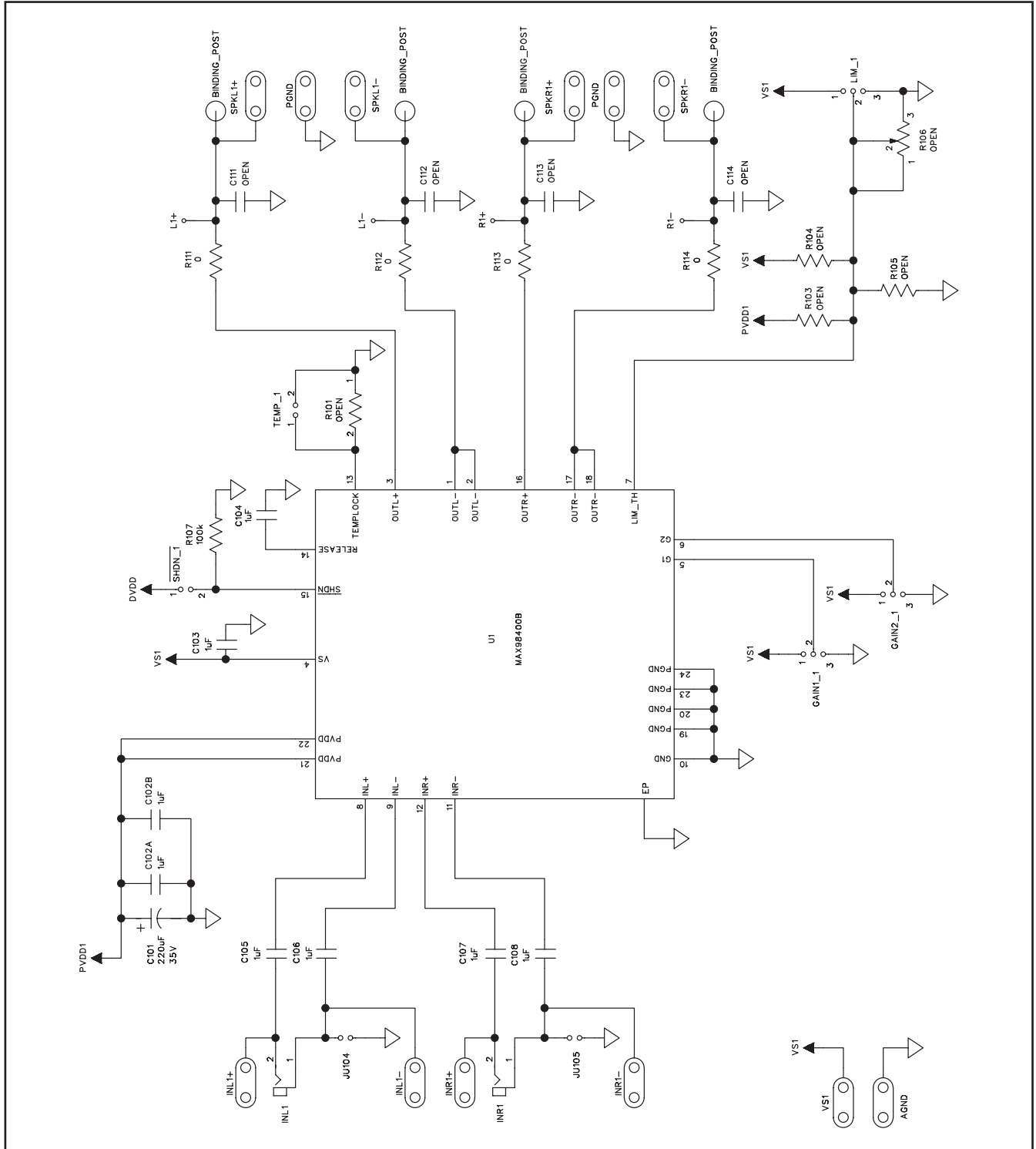


Figure 1b. MAX98400B EV Kit Schematic (Sheet 2 of 3)

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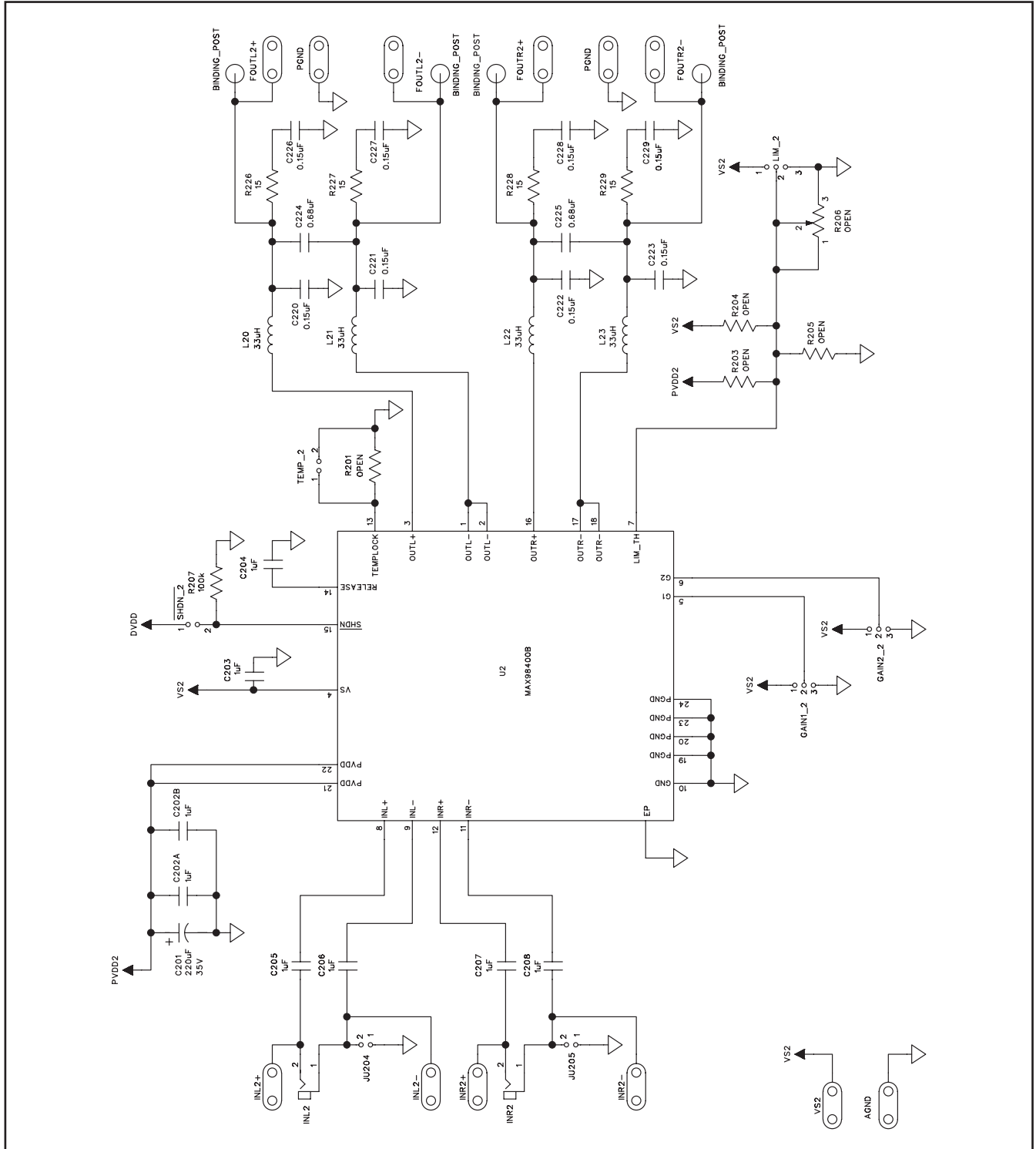


Figure 1c. MAX98400B EV Kit Schematic (Sheet 3 of 3)



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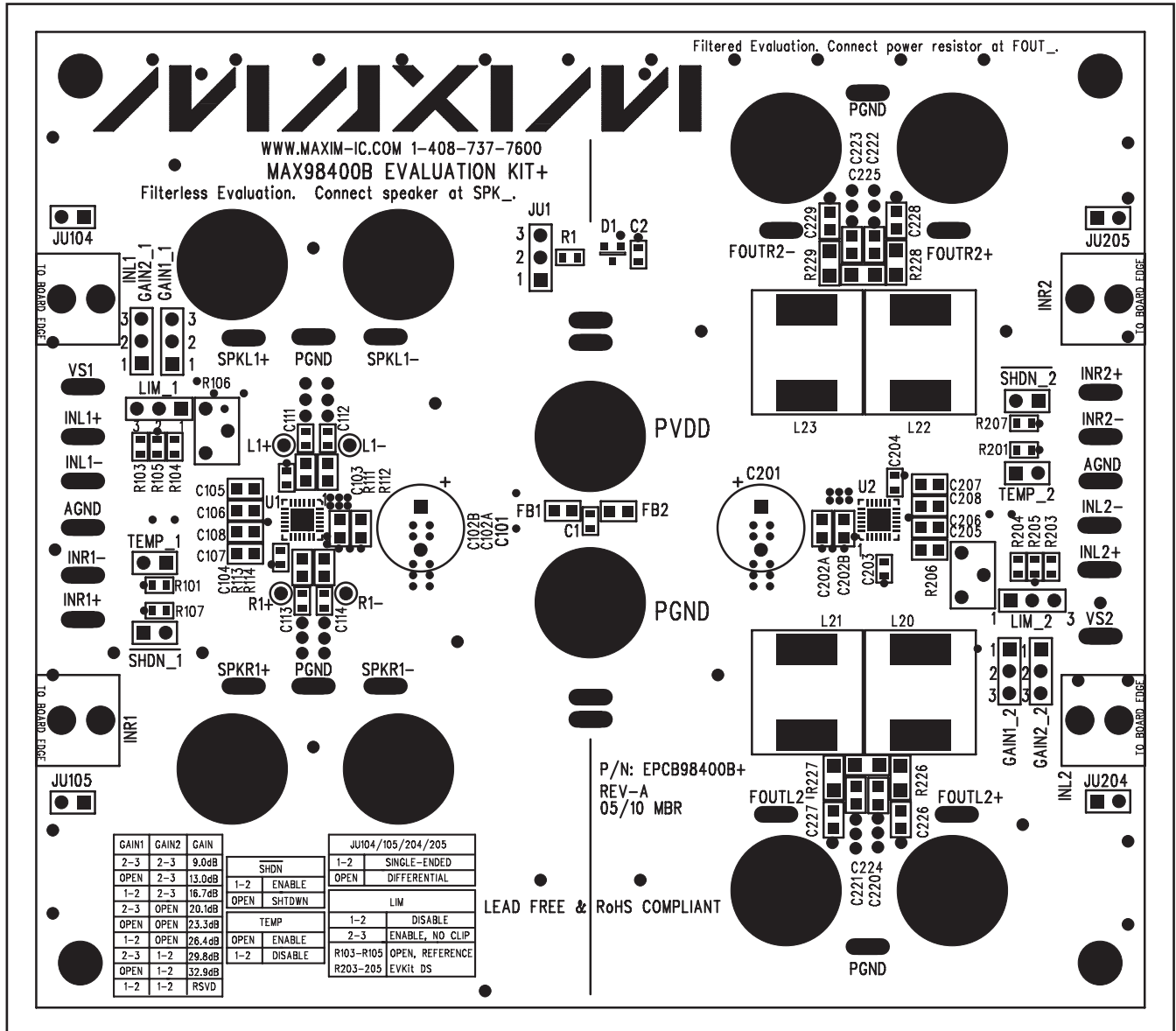


Figure 2. MAX98400B EV Kit Component Placement Guide—Component Side

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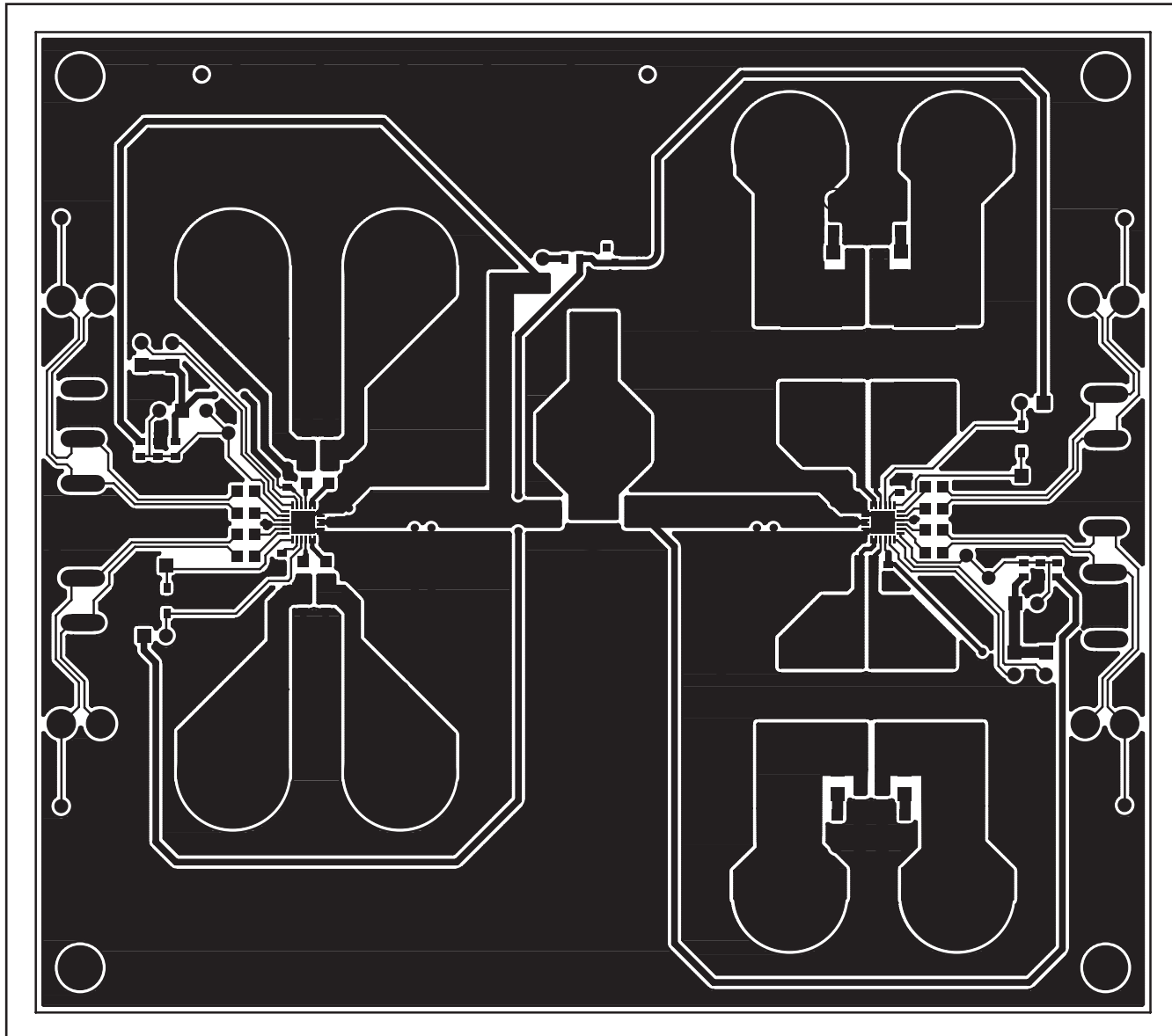


Figure 3. MAX98400B EV Kit PCB Layout—Component Side

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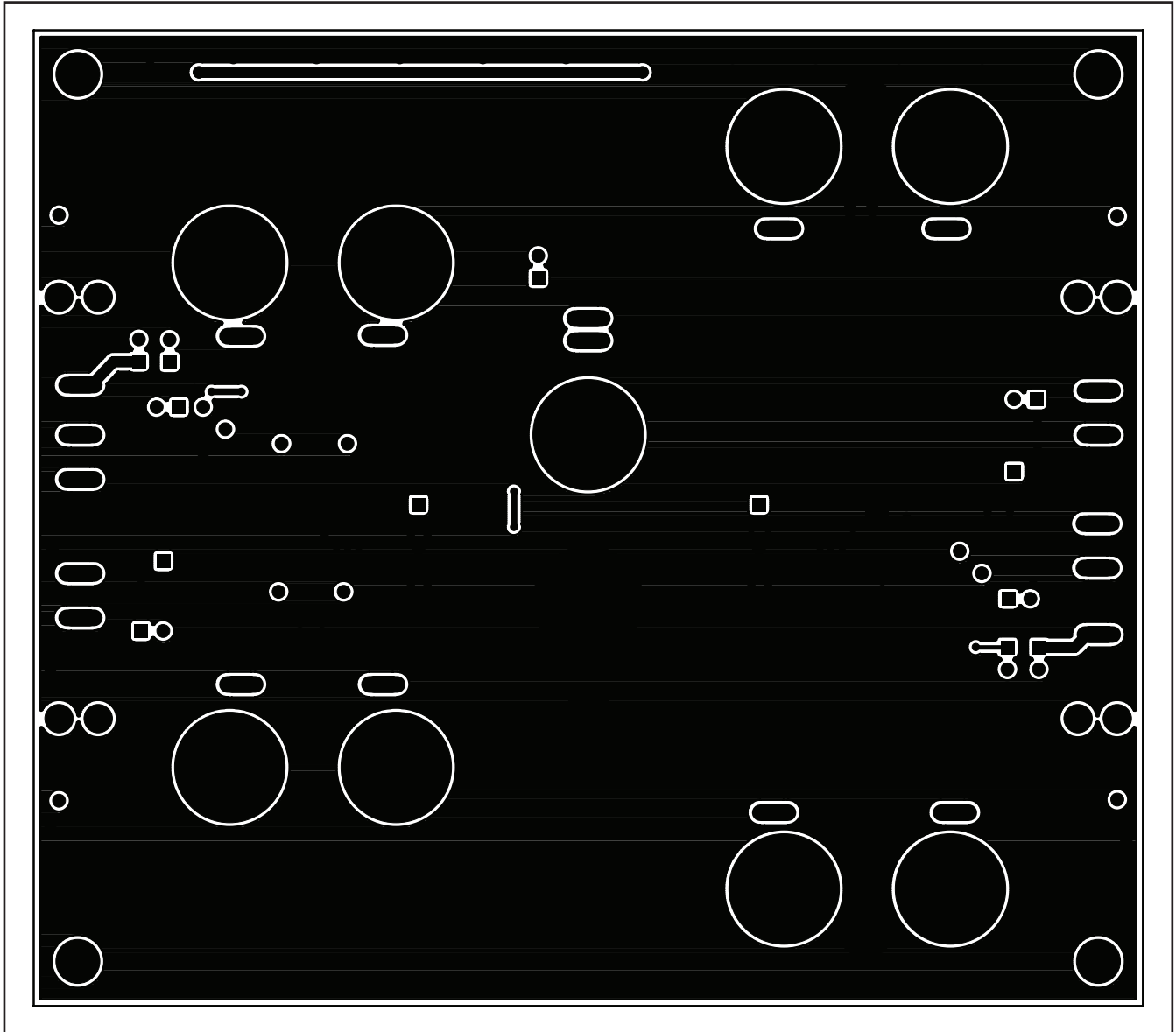


Figure 4. MAX98400B EV Kit PCB Layout—Solder Side

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## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/10	Initial release	—

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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