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MAX5099 Evaluation Kit

Evaluates: MAX5099/MAX5098A

General Description

The MAX5099 evaluation kit (EV kit) is an assembled and tested PCB that contains all the components necessary to evaluate the MAX5099 IC. The MAX5099 is a dual-output, synchronous step-down DC-DC converter. The EV kit is powered from a DC supply providing 5.2V to 19V and up to 5A. The EV kit can also be reconfigured for an input range between 4.5V to 5.5V. The EV kit is designed to withstand a load-dump condition up to 80V.

The MAX5099 EV kit can deliver 5V at 2A from the first step-down DC-DC converter output and 3.3V at up to 1A from the second step-down DC-DC converter output. The MAX5099 switching frequency is set to 1.9MHz, and the two outputs switch 180° out-of-phase with respect to each other. A SYNC input facilitates external frequency synchronization of the EV kit. The 5V converter switching frequency is configurable to half that of the 3.3V converter. The EV kit includes a shutdown feature, converter power-up sequencing, and individual converter enables.

Features

♦ **Load-Dump Protection Circuit Withstands Input Transients Up to 80V**
♦ **5.2V to 19V Input Supply Voltage Range**
♦ **Configurable to Work from 4.5V to 5.5V Input Supply Voltage Range**
♦ **5V at 2A Output (Converter 1)**
♦ **3.3V at 1A Output (Converter 2)**
♦ **180° Out-of-Phase Operation Reduces Input Capacitance**
♦ **Configurable Switching Frequency (200kHz to 2.2MHz)**
♦ **Individual Enable Inputs and SYNC Input**
♦ **Power-On Sequencing**
♦ **Low-Cost Solution**
♦ **Evaluates the MAX5099/MAX5098A in a 32-Pin (5mm x 5mm) TQFN Package**
♦ **Lead-Free and RoHS Compliant**
♦ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX5099EVKIT+	EV Kit

+Denotes lead-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	22µF ±20%, 100V aluminum electrolytic capacitor (Size F or 8mm x 10.2mm) Panasonic EEEFK2A220P
C2	1	4.7µF ±20%, 35V aluminum electrolytic capacitor (Size B or 4mm x 5.8mm) Panasonic EEEFK1V4R7R
C3	1	150µF ±20%, 25V aluminum electrolytic capacitor (Size F or 8mm x 10.2mm) Panasonic EEEFK1E151P
C4, C5	2	10µF ±10%, 25V X5R ceramic capacitors (1206) Murata GRM31CR61E106K
C6, C14	2	0.1µF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H104K
C7, C15, C25	3	22µF ±20%, 6.3V X5R ceramic capacitors (0805) Murata GRM21BR60J226M

DESIGNATION	QTY	DESCRIPTION
C8, C16	2	270pF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H271K
C9	1	2200pF ±10%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H222K
C10, C18, C22, C23, C24	0	Not installed, capacitors (0603)
C11	1	0.22µF ±10%, 10V X7R ceramic capacitor (0603) Murata GRM188R71A224K
C12	1	2.2µF ±10%, 10V X5R ceramic capacitor (0603) Murata GRM188R61A225K
C13	1	4.7µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J475K
C17	1	2700pF ±10%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H272K

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Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C19	1	1µF ±10%, 25V X5R ceramic capacitor (0603) Murata GRM188R61E105K
C20	1	33pF ±5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H330J
C21	1	56pF ±5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H560J
C26	0	Not installed, capacitor (0805)
C27, C28	0	Not installed, capacitors (Size F or 8mm x 10.2mm)
D1, D4	2	200mA, 40V Schottky diodes (SOD523) Central Semi CMOSH-4E LEAD FREE (Top Mark: 4E)
D2, D5	2	1A, 40V Schottky diodes (SOD123F) Central Semi CMMSH1-40 LEAD FREE (Top Mark: CS40F)
D3	0	Not installed, Schottky diode (SMB) Diodes Inc. B340LB-13-F (Recommended)
D6	0	Not installed, Schottky diode (SMA) Diodes Inc. B240/A-13-F (Recommended)
D7	1	200mA, 100V high-conductance, ultra-fast diode (SOT23) Fairchild Semi MMBD4148 (Top Mark: 5H)
J1, JU1, JU4, JU5, JU6	5	2-pin headers
JU2, JU3	2	3-pin headers

DESIGNATION	QTY	DESCRIPTION
L1, L2	2	4.7µH, 3.4A DC inductors Sumida CDRH8D28NP-4R7NC
N1	1	100V, 44A n-channel MOSFET (TO-252/DPAK) Fairchild Semi FDD3672
N2, N3	2	30V, 5.1A n-channel MOSFETs (SuperSOT-6) Fairchild Semi Si3456DV (Top Mark: 456)
R1	1	3.9kΩ ±5% resistor (1210)
R2	1	1MΩ ±5% resistor (0603)
R3	1	100Ω ±5% resistor (0603)
R4, R13	2	0Ω ±5% resistors (0603)
R5	0	Not installed, resistor (0603)
R6	1	52.3kΩ ±1% resistor (0603)
R7, R20, R22, R23	4	10kΩ ±1% resistors (0603)
R8, R17	2	976Ω ±1% resistors (0603)
R9	1	12.7kΩ ±1% resistor (0603)
R10, R11, R19	3	100kΩ ±5% resistors (0603)
R12	1	6.49kΩ ±1% resistor (0603)
R14	0	Not installed, resistor (0402)
R15	1	37.4kΩ ±1% resistor (0603)
R16	1	12.1kΩ ±1% resistor (0603)
R18	1	7.15kΩ ±1% resistor (0603)
R21	1	1Ω ±5% resistor (0603)
U1	1	Dual-output, step-down converter (32 TQFN-EP*) Maxim MAX5099ATJ+
—	6	Shunts
—	1	PCB: MAX5099 Evaluation Kit+

*EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor Corp.	631-435-1110	www.centralsemi.com
Diodes Inc.	805-446-4800	www.diodes.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerican.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Sumida Corp.	847-545-6700	www.sumida.com

Note: Indicate that you are using the MAX5099 or MAX5098A when contacting these component suppliers.

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Quick Start

Required Equipment

Before beginning, the following equipment is needed:

- MAX5099 EV kit
- Adjustable 5.2V to 19V, 5A DC power supply
- Two electronic (e.g., HP6060B) or passive loads
- Two voltmeters

Procedure

The MAX5099 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 a shunt is installed on jumper JU1 (EV kit on).

2) Verify that no shunt is installed on jumper JU2 (converter 1 enabled).

3) Verify that a shunt is installed on pins 2-3 of jumper JU3 (converter 2 enabled after converter 1).

4) Verify that no shunt is installed on jumper JU4 (converter 1's switching frequency is the same as converter 2's).

5) Verify that a shunt is installed on jumper JU5 (no synchronization).

6) Verify that no shunt is installed on jumper JU6 (input-voltage range from 5.2V to 19V).

7) Connect a voltmeter to the VOUT1 and PGND PCB pads.

8) Connect a voltmeter to the VOUT2 and PGND PCB pads

9) Connect a 2A electronic load to the VOUT1 and PGND PCB pads. Disable the 2A electronic load.

10) Connect a 1A electronic load to the VOUT2 and PGND PCB pads. Disable the 1A electronic load.

11) Connect a 5.2V to 19V DC power supply to the VIN and PGND PCB pads, and set the voltage to 12V.

12) Turn on the power supply.

13) Verify that VOUT1 is 5V.

14) Verify that VOUT2 is 3.3V.

15) Enable both electronic loads and verify that VOUT1 is 5V and VOUT2 is 3.3V.

Detailed Description of Hardware

The MAX5099 EV kit contains two step-down DC-DC converters. The MAX5099's converter switching frequency can be set within the 200kHz to 2.2MHz range. The EV kit is designed to operate from a DC power supply that provides 5.2V to 19V and at least 5A of current. The EV kit can be reconfigured for a 4.5V to 5.5V input-voltage range by installing a shunt on jumper JU6, shorting VL to the V+ pad, and connecting the input supply to the V+ and PGND pads. This input range limits the converter 1 (VOUT1) output to < 90% of the input voltage.

Converter 1 (VOUT1) generates 5V and provides up to 2A of current. Capacitors C8, C9, and C20 and resistors R8 and R9 provide a compensation network for VOUT1 on the MAX5099 EV kit. Resistors R6 and R7 set the VOUT1 output to 5V. Converter 2 (VOUT2) generates 3.3V and provides up to 1A of current. Capacitors C16, C17, and C21 and resistors R17 and R18 provide a compensation network for VOUT2 on the MAX5099 EV kit. Resistors R15 and R16 set the VOUT2 output to 3.3V.

The switching frequency of the converter is set to 1.9MHz by resistor R12. To set the converter switching frequency between 200kHz and 2.2MHz, select a different resistor value for R12. Refer to the _Setting the Switching Frequency_ section in the MAX5099 IC data sheet for instructions on calculating a different value for R12. Each converter is switching 180° out-of-phase with respect to the other converter.

Enable Inputs (EN1, EN2)

The MAX5099 EV kit provides separate enable inputs (EN1 and EN2) to individually control or sequence the output voltages. EN1 and EN2 are pulled to VL (5.2V) by resistors R10 and R19, respectively. The external enable input signal can be connected to pin 2 of jumper JU2 (JU2-2, EN1), and converter 2's enable input signal can be connected to pin 2 of jumper JU3 (JU3-2, EN2). The MAX5099 enable pins are input logic pins that are active high and TTL compatible (see Table 2).

Power-Good Outputs (PGOOD1, PGOOD2)

The MAX5099 EV kit provides separate power-good output signals (PGOOD1 and PGOOD2) to validate the individual converter outputs. PGOOD1 is pulled up to VOUT1 by resistor R22, while PGOOD2 is pulled up to VOUT2 by resistor R23. The power-good output signals pull low when their respective converter outputs drop below 92.5% of their nominal regulated voltages. The PGOOD1 output signal is available on the PGOOD1 PCB pad and on pin 3 of jumper JU3. The PGOOD2 output signal is available on the PGOOD2 PCB pad and on pin 3 of jumper JU2 (see Table 2).

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Frequency Select (FSEL_1)

The MAX5099 EV kit provides an option to reduce the converter 1 frequency to half of converter 2. As configured, the MAX5099 FSEL_1 pin is pulled up to VL (5.2V) by a 100kΩ resistor (R11). When FSEL_1 is high, converter 1's switching frequency is the same as converter 2's switching frequency. To reduce converter 1's switching frequency to half of converter 2's, install a shunt on jumper JU4 (see Table 3).

Synchronization Input (SYNC)

The MAX5099 EV kit provides a synchronization input (SYNC) that enables the MAX5099 to synchronize with external systems. The synchronization frequency must be two times the individual converter switching frequency. To synchronize the MAX5099 EV kit with an external logic clock, connect a TTL clock signal to pin 1 of jumper JU5 (JU5-1, SYNC) and the clock signal ground to pin 2 of jumper JU5 (JU5-2, SGND). See Table 4 and refer to the *Synchronization (SYNC)* section in the MAX5099 IC data sheet for additional information.

Jumper Selection

ON/OFF (JU1)

The MAX5099 EV kit provides an option to set the MAX5099 IC to a shutdown mode, thus reducing the supply current (5.2V to 19V input-voltage range). To set the MAX5099 to the shutdown mode, remove the shunt from jumper JU1. Table 1 lists the options to set the MAX5099 EV kit to the shutdown mode.

Table 1. JU1 Jumper Functions (ON/OFF)

SHUNT POSITION	ON/OFF PINS CONNECTED TO	EV KIT FUNCTION
Installed*	VIN (through resistor R1)	Enabled
Not installed	SGND (through resistor R2)	Shutdown

*Default position.

Converter Enables and Sequencing, EN1, EN2 (JU2, JU3)

The MAX5099 EV kit circuit features two jumpers (JU2 and JU3) to enable or disable the individual converter and to set the power-on sequence of the two converters. Table 2 lists the various JU2 and JU3 options for configuring the enable/disable and sequencing of the outputs.

Table 2. JU2 and JU3 Jumper Functions (EN1, EN2)

SHUNT POSITION		EN1, EN2 PINS CONNECTED TO	EV KIT FUNCTION
JU2	**JU3**		
Not installed*	Not installed	• EN1 to VL (through R10) • EN2 to VL (through R19)	• Both converters enabled • No sequencing
	1-2	• EN1 to VL (through R10) • EN2 to SGND	• Converter 1 enabled • Converter 2 disabled
	2-3*	• EN1 to VL (through R10) • EN2 to PGOOD1	• Converter 1 enabled first • Converter 2 enabled last
1-2	Not installed	• EN1 to SGND • EN2 to VL (through R19)	• Convert 1 disabled • Convert 2 enabled
	1-2	• EN1 to SGND • EN2 to SGND	• Both converters disabled
	2-3	• EN1 to SGND • EN2 to PGOOD1	• Both converters disabled
2-3	Not installed	• EN1 to PGOOD2 • EN2 to VL (through R19)	• Convert 2 enabled first • Convert 1 enabled last
	1-2	• EN1 to PGOOD2 • EN2 to SGND	• Both converters disabled
	2-3	• EN1 to PGOOD2 • EN2 to PGOOD1	• Not allowed

*Default position.

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Converter 1 Frequency Selection, FSEL_1 (JU4)

The MAX5099 EV kit provides an option to reduce the converter 1 switching frequency to half that of converter 2. Jumper JU4 selects the switching frequency for converter 1 on the MAX5099 EV kit. Table 3 lists the selectable JU4 jumper options.

Table 3. JU4 Jumper Functions (FSEL_1)

SHUNT POSITION	FSEL_1 PIN CONNECTED TO	CONVERTER 1's SWITCHING FREQUENCY
Not installed*	VL (through resistor R11)	Same as converter 2
Installed	SGND	Half of converter 2

*Default position.

Synchronization Input, SYNC (JU5)

The MAX5099 EV kit provides a synchronization input (SYNC) that enables the MAX5099 to synchronize with external logic systems. The synchronization frequency is two times the individual converter switching frequency. To synchronize the MAX5099 EV kit with an external clock, connect a TTL clock signal to pin 1 of jumper JU5 (JU5-1, SYNC) and the clock signal ground to pin 2 of jumper JU5 (JU5-2, SGND). Table 4 lists the selectable table JU5 jumper options.

Table 4. JU5 Jumper Functions (SYNC)

SHUNT POSITION	SYNC PIN CONNECTED TO	EV KIT SYNCHRONIZATION
Installed*	SGND	Internal oscillator
Not installed	SGND (through resistor R20)	Internal oscillator
Not installed (external clock signal connected to pin 1 of JU5)	User provided TTL clock signal	External clock

*Default position.

Input Voltage Range (JU6)

The MAX5099 EV kit can be reconfigured for an input-voltage range of 4.5V to 5.5V by installing a shunt on jumper JU6, shorting VL to the V+ PCB pad, and connecting the input supply to the V+ and PGND PCB pads. Jumper JU6 selects the input-voltage range for the MAX5099. Table 5 lists the selectable JU6 jumper options.

Table 5. JU6 Jumper Functions (VL, V+)

SHUNT POSITION	VL, V+ PINS	INPUT-VOLTAGE RANGE
Not installed*	Not connected	5.2V to 19V
Installed	Connected	4.5V to 5.5V

*Default position.

Evaluating the MAX5098A

The MAX5099 EV kit can also evaluate the MAX5098A after IC replacement. To evaluate the MAX5098A, modify the EV kit as follows:

1) Replace U1 with the MAX5098A IC.

2) Remove resistor R4 or MOSFET N2.

3) Install a 0Ω (0603) resistor at the R5 pad (not needed if MOSFET N2 has been removed).

4) Install a 0Ω (0402) resistor at the R14 pad, or short the R14 pads.

5) Install diode D3 (Diodes Inc. B340LB-13-F) at the D3 pad.

6) Install diode D6 (Diodes Inc. B240/A-13-F) at the D6 pad.

7) Refer to the MAX5098A IC data sheet for additional information.

When evaluating the MAX5098A, the EV kit provides a clock output (CKO) on pin 1 of header J1. This clock output can be used to synchronize two EV kits in a master-slave configuration. To synchronize two EV kits, connect the CKO (J1-1) pin of the master EV kit to the SYNC (JU5-1) pin of the slave EV kit, and connect the SGND (J1-2) pin of the master EV kit to the SGND (JU5-2) pin of the slave EV kit.
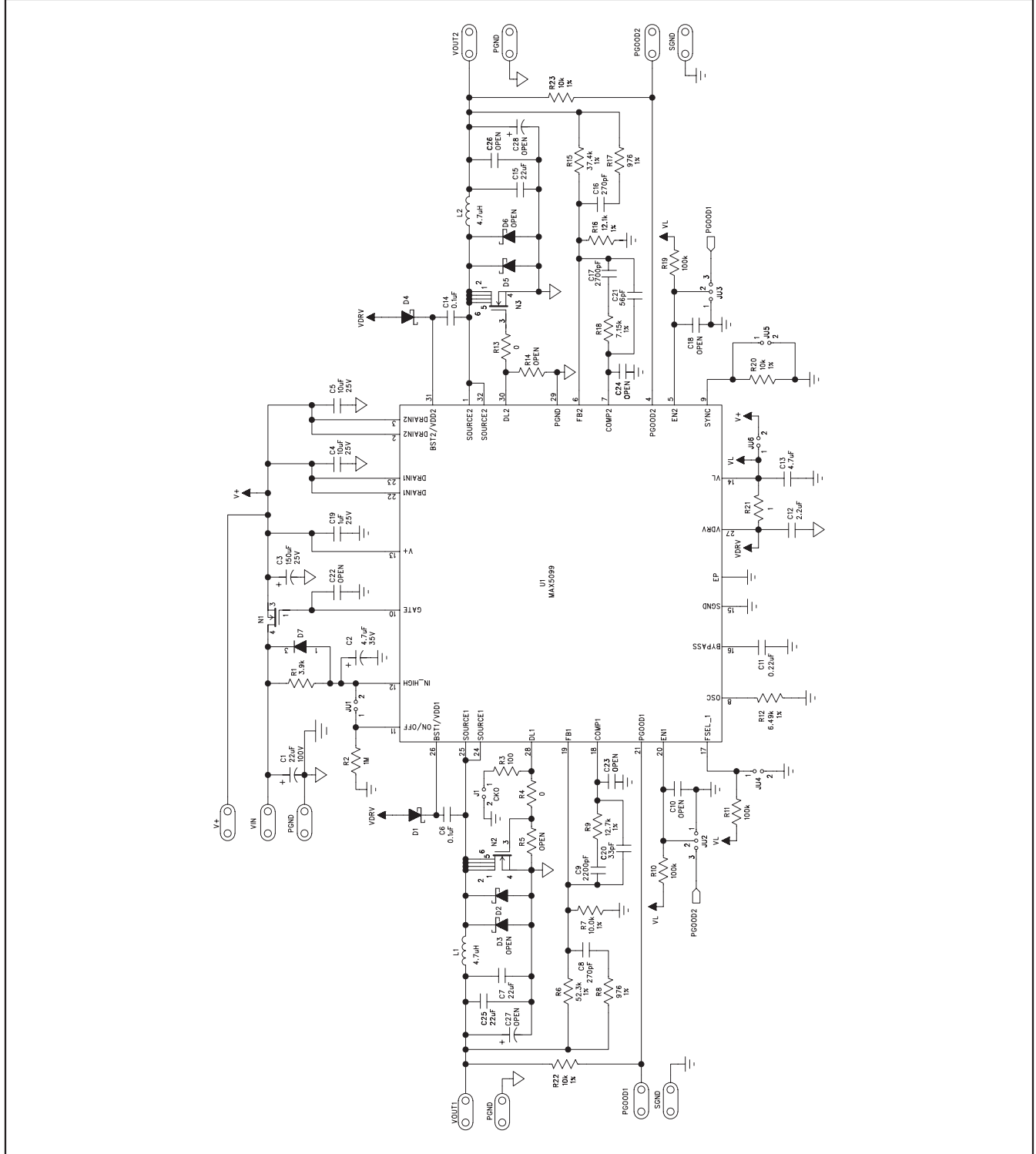
Evaluates: MAX5099/MAX5098A
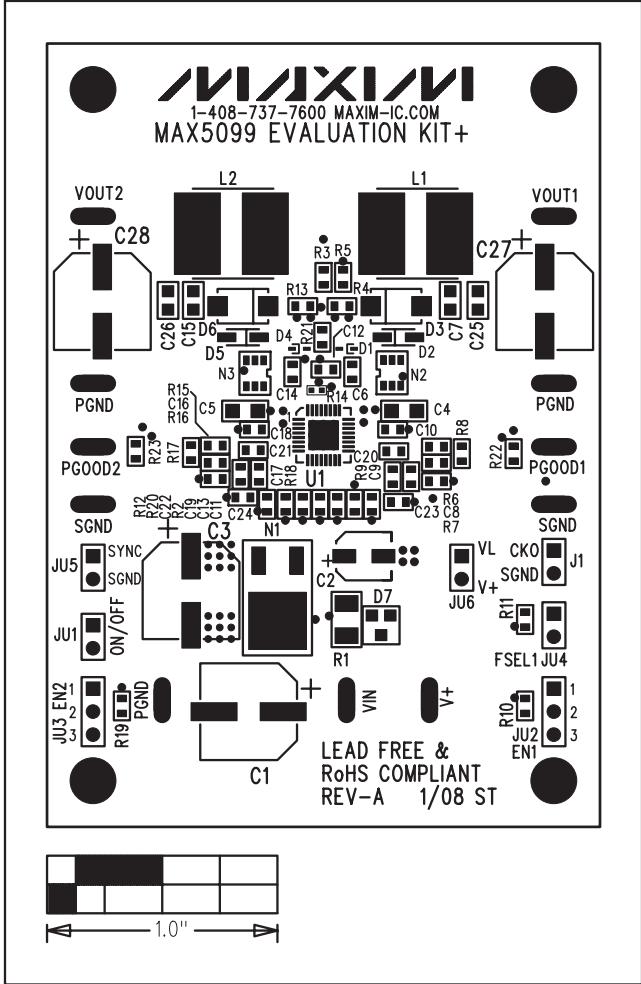

Figure 1. MAX5099 EV Kit Schematic

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Figure 2. MAX5099 EV Kit Component Placement Guide—Component Side
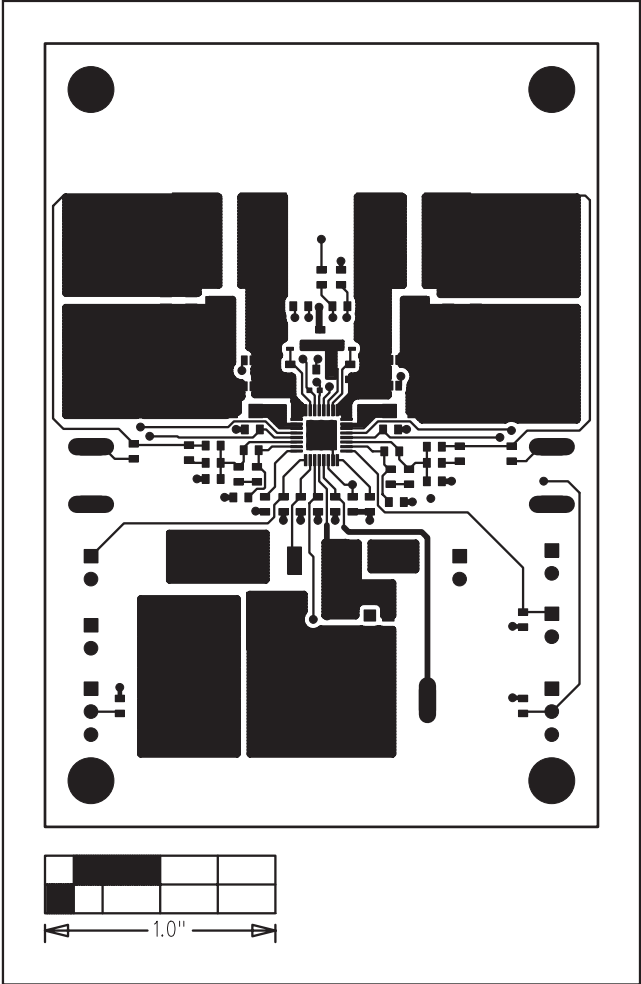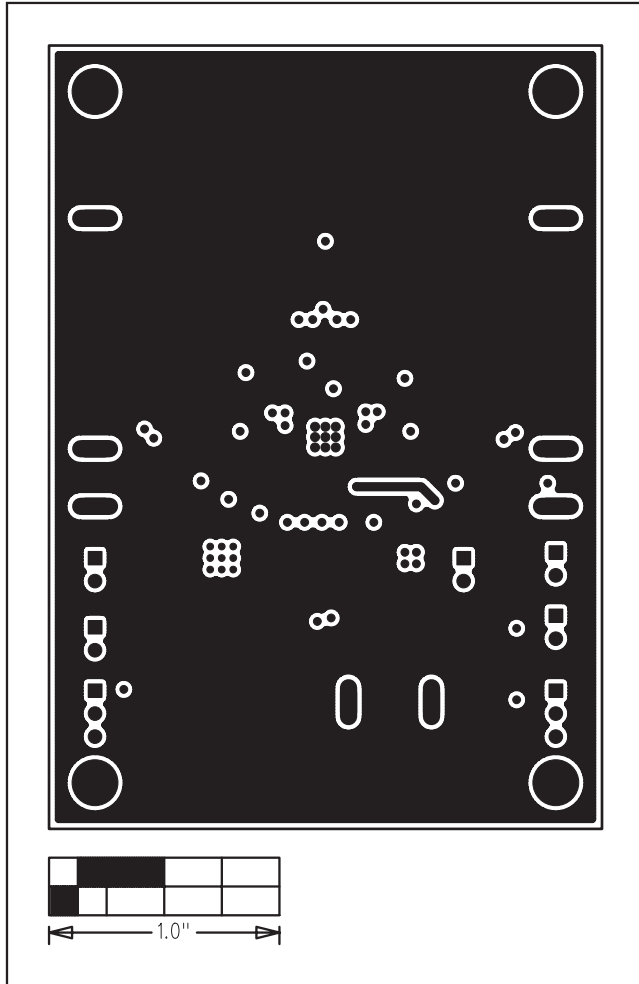

Figure 3. MAX5099 EV Kit PCB Layout—Component Side

Figure 4. MAX5099 EV Kit PCB Layout—Layer 2 (PGND)
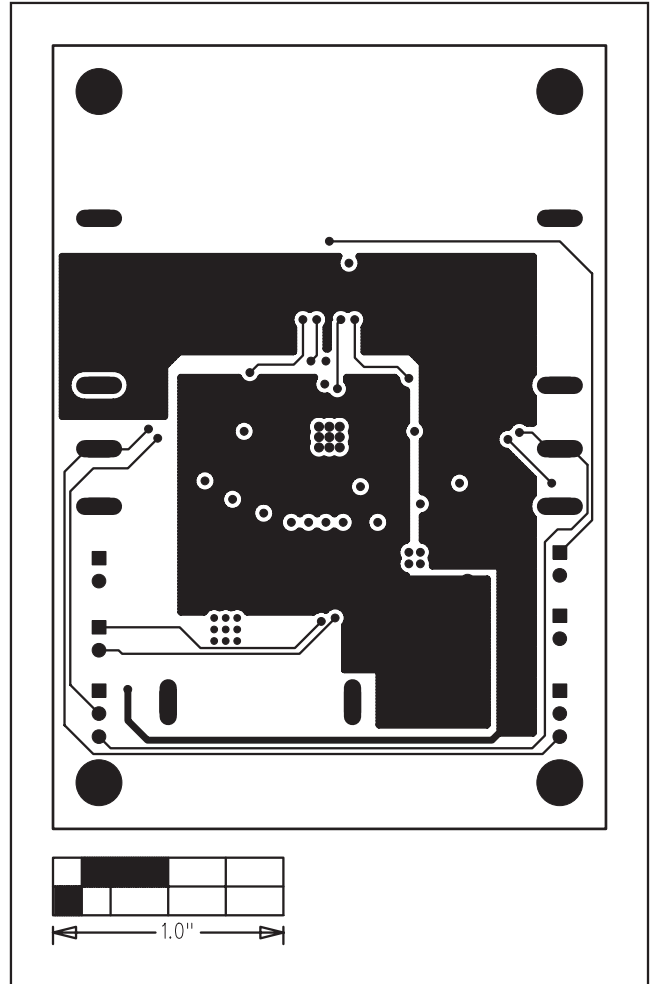
Figure 5. MAX5099 EV Kit PCB Layout—Layer 3 (Signal)
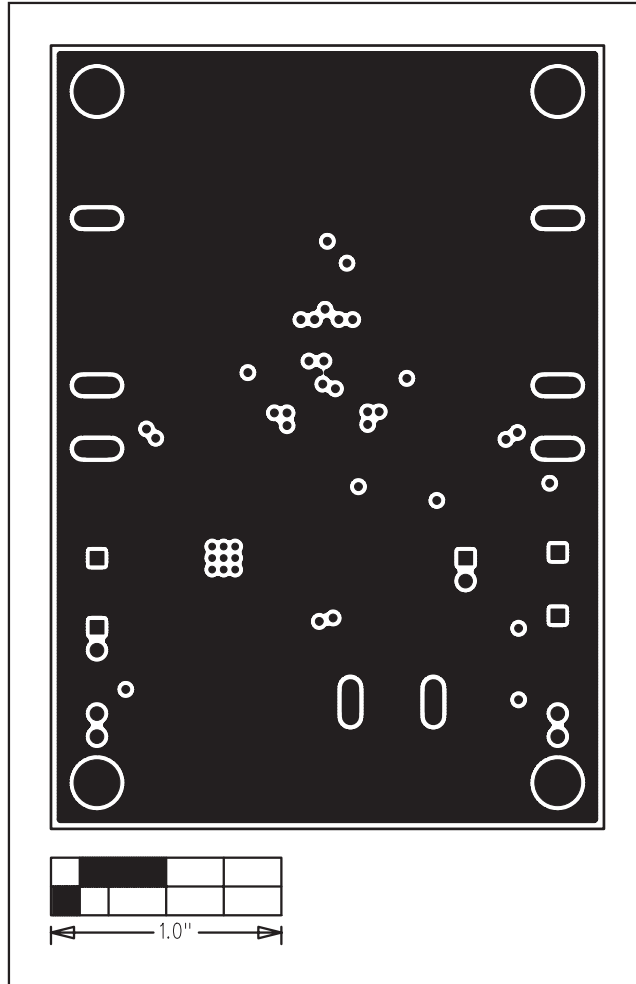
Figure 6. MAX5099 EV Kit PCB Layout—Solder Side

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