General Description

The MAX16930 evaluation kit (EV kit) is a fully assembled and tested application circuit for the MAX16930 high-voltage, dual synchronous step-down controller with preboost. The EV kit is set up to provide 5V and 3.3V from an input voltage ranging from 3.5V to 36V (without preboost). The preboost circuit maintains the 10V supply rail for input voltages below 10V. Each buck rail can deliver up to 5A load current. Various jumpers are provided to help evaluate features of the MAX16930 IC.

Benefits and Features

- Dual, Synchronous Step-Down Controllers Operate at 180° Out-of-Phase to Reduce Switching Noise
- Preboost Controller to Maintain Operation with Low Supply Voltage
- 3.5V to 36V Wide Input Supply Range
- Buck Output Voltage: 5V and 3.3V Fixed or Adjustable Between 1V and 10V
- Current-Mode Controllers with Forced-PWM and Skip Modes
- Resistor-Programmable Frequency Between 1MHz and 2.2MHz
- Frequency Synchronization Input
- Independent Enable Inputs
- Voltage Monitoring PGOOD_ Outputs
- Fully Assembled and Tested

EV Kit Contents

- MAX16930 EV Kit Board

Ordering Information ***appears at end of data sheet.***

Quick Start

Recommended Equipment

- MAX16930 EV kit
- 3.5V to 36V, 15A power supply (the power supply should be capable of providing 15A at 3V input)
- Two voltmeters
- Two electronic loads capable of sinking 5A each

Procedure

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

1) Verify that all jumpers are in their default configurations according to Table 1.
2) Connect the positive and negative terminals of the power supply to the VBATF and PGND test pads, respectively.
3) Connect the positive terminal of the first electronic load to the VOUT1 test pad. Connect the ground terminal of the electronic load to the corresponding PGND test pad.
4) Connect the positive terminal of the second electronic load to the VOUT2 test pad. Connect the ground terminal of the electronic load to the corresponding PGND test pad.
5) Set the power-supply voltage to 14V.
6) Turn on the power supply.
7) Enable the electronic loads.
8) Verify that VOUT1 is approximately 5V.
9) Verify that VOUT2 is approximately 3.3V.
10) Verify the switching frequency of VOUT1 and VOUT2 is approximately 2.0MHz.

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Table 1. Default Jumper Settings

JUMPER	DEFAULT SHUNT POSITION	FUNCTION
JU1, JU2	Installed	PGOOD_ pulls up to VBIAS when OUT_ is in regulation.
JU3	Installed	Preboost on-indicator enabled.
JU5	1-4	Switches to EXTVCC. Internal regulator disabled.
JU6	1-2	Forced-PWM mode.
JU7, JU8, JU9	1-2	Buck outputs, preboost enabled.
JU10	2-3	$f_{BOOST} = f_{SW}$

Detailed Description of Hardware

The MAX16930 EV kit, which evaluates the MAX16930 high-voltage, dual synchronous step-down controller with preboost, can supply up to two rails. The EV kit includes two current-mode buck outputs that are fixed to 5V and 3.3V, or programmable from 1V to 10V with external resistor-dividers. The current capability is 5A per rail. Both outputs are current limited and can be controlled independently through their respective enable inputs EN_. The EV kit includes an external preboost, which enables full output functionality during undervoltage events. The EV kit also includes a 5V, 100mA internal linear regulator (BIAS), which powers the internal circuitry of the MAX16930.

Switching Frequency/ External Synchronization

The EV kit switching frequency can be adjusted from 1MHz to 2.2MHz by changing the FOSC resistor R75. The EV kit can also be synchronized to an external clock by connecting the external clock signal to the FSYNC test point. Refer to the *Switching Frequency/External Synchronization* section in the MAX16930 IC data sheet for more details.

Buck Output Monitoring (PGOOD_)

The EV kit provides two power-good output test points (PGOOD1 and PGOOD2) to monitor the status of the two buck outputs (OUT1 and OUT2). Each PGOOD_ goes high (high impedance) when the corresponding regulator output voltage is in regulation. Each PGOOD_ goes low when the corresponding regulator output voltage drops below 15% (typ) or rises above 10% (typ) of its nominal regulated voltage.

To obtain a logic signal, pull up PGOOD_ to VBIAS by installing shunts on JU1 and JU2.

Table 2. EXTVCC (JU5)

SHUNT POSITION	EXTVCC PIN	BIAS
1-2	Connected to VOUT2	Switches to EXTVCC. Internal regulator disabled.
1-3	Connected to PGND	Internal regulator enabled to generate BIAS supply.
1-4*	Connected to VOUT1	Switches to EXTVCC. Internal regulator disabled.

**Default configuration.*

Table 3. Mode of Operation (JU6)

SHUNT POSITION	FSYNC PIN	MODE
1-2*	Connected to BIAS	Forced-PWM mode
2-3	Connected to GND	Skip mode

**Default configuration.*

EXTVCC Switchover Comparator

The internal linear regulator can be bypassed by connecting an external supply (3V to 5.2V) or the output of one of the buck converters to EXTVCC. BIAS internally switches to EXTVCC and the internal linear regulator turns off. If V_{EXTVCC} drops below $V_{TH,EXTVCC}$ = 3V(min), the internal regulator enables and switches back to BIAS.

Mode of Operation

The EV kit features jumper JU6 to configure the mode switch-control input. Drive FSYNC high (pins 1-2 of JU6) to enable forced-PWM mode. Drive FSYNC low (pins 2-3 of JU6) to enable skip mode under light loads.

Enable Control

The EV kit features jumpers JU7, JU8, and JU9 to independently control the digital enable inputs of the buck 1 controller, the buck 2 controller, and the boost controller, respectively. Connect the active-high input EN_ to VIN (pins 1-2) to enable the corresponding controller. Connect the EN_ pin to ground (pins 2-3) to disable the corresponding controller. See Table 4.

Preboost Frequency Select

The boost frequency is selected as a multiple of the buck frequency by setting the input voltage of FSELBST. Connect FSELBST to GND (pins 2-3) to set the preboost frequency to be the same switching frequency as buck 1. Connect FSELBST to BIAS (pins 1-2) to set the preboost frequency to have a switching frequency that is 1/5th that of buck 1.

Setting the Output Voltage in Buck Converters

To externally adjust the output voltage OUT1 between 1V and 10V, remove R61. Connect a resistive divider from the output OUT1 to FB1 to AGND. Place appropriate resistors in positions R58 and R59 according to the following equation:

$$R58 = R59\left[\left(\frac{V_{OUT1}}{V_{FB1}}\right) - 1\right]$$

where V_{FB1} = 1V (typ).

To externally adjust the output voltage OUT2 between 1V and 10V, remove R73. Connect a resistive divider from the output OUT2 to FB2 to GND. Place appropriate resistors in positions R70 and R71 according to the following equation:

$$R70 = R71\left[\left(\frac{V_{OUT2}}{V_{FB2}}\right) - 1\right]$$

where V_{FB2} = 1V (typ).

Preboost

The EV kit includes an asynchronous current-mode preboost with adjustable output. The boost converter output is called VIN since it powers the input supply pin of the device. This preboost can be used independently, but is ideally suited for applications that need to stay fully functional during input voltage dropouts typical for automotive cold-crank or start-stop.

To externally adjust the boost output voltage (VIN), place appropriate resistors in positions R78 and R79 according to the following equation:

$$R78 = R79\left[\left(\frac{V_{VIN}}{V_{FB3}}\right) - 1\right]$$

where V_{FB3} = 1.25V (typ).

Evaluating the MAX16931 on the MAX16930 EV Kit

The MAX16930 EV kit can be modified to operate the MAX16931. The MAX16931 operates at a switching frequency of 400kHz, which requires a change in the following components:

1) Replace U1 with the MAX16931 IC.
2) Replace R75 (R_{FOSC}) with 80.6kΩ to achieve 400kHz switching frequency.
3) Replace the preboost inductor (L6) with a 2.2µH 15A inductor.
4) Replace the buck inductors (L4, L5) with a 6.8µH 7A inductor.

Contact Technical Support at **www.maximintegrated.com/support** for any further questions.

Table 4. Enable Control (JU7, JU8, JU9)

SHUNT POSITION	EN_ PIN	CONTROLLER_
1-2*	Connected to VIN	Enabled
2-3	Connected to PGND	Disabled

**Default configuration.*

Table 5. FSELBST (JU10)

SHUNT POSITION	FSELBST PIN	BOOST FREQUENCY
1-2	Connected to BIAS	$f_{BOOST} = 0.2f_{SW}$
2-3*	Connected to PGND	$f_{BOOST} = f_{SW}$

**Default configuration.*

Component List

DESIGNATION	QTY	DESCRIPTION
C2, C3, C4, C7, C33, C41	5	0.1µF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H104K
C5, C48-C51, C53-C55, C74	9	4.7µF ±10%, 50V X7R ceramic capacitor (1210) Murata GCM32ER71H475KA55L
C34, C35, C42, C43	4	47µF ±10%, 10V X7R ceramic capacitor (1210) Murata GRM32ER71A476K
C36, C44	2	4700pF ±10%, 50V X7R ceramic capacitor (0402) Murata GRM155R71H472K
C37	1	22pF ±5%, 50V C0G ceramic capacitor (0402) Taiyo Yuden UMK105CG220JV-F
C39	1	6.8µF ±10%, 16V X7R ceramic capacitor (1206) TDK C3216X7R1C685K
C40	1	2.2µF ±10%, 10V X7R ceramic capacitor (0603) Murata GRM188R71A225K
C45	1	10pF ±5%, 50V C0G ceramic capacitor (0402) Murata GRM1555C1H100J
C46	1	150µF, 35V aluminum electrolytic capacitor (8.00mmx10.2mm) Panasonic EEHZA1V151P
C47	1	270µF, 35V aluminum electrolytic capacitor (10.0mmx10.2mm) Panasonic EEHZA1V271P
C57	1	0.022µF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H223K
C6, C7-C10, C56, C60, C61	0	Capacitors, not installed
D1, D2	2	3A, 40V Schottky diodes Vishay SS3P4HM3\84A
D7, D12	2	200mA, 30V diodes (SOT23) Fairchild BAT54
D16	1	10A, 45V Schottky diode (SMPC) Vishay SS10PH45HM3/86A
JU1, JU2, JU3	3	2-pin headers (CUT TO FIT) SULLINS PEC36SAAN
JU5	1	4-pin header (CUT TO FIT) SULLINS PEC36SAAN
JU6-JU10	5	3-pin headers (CUT TO FIT) SULLINS PEC36SAAN
L1*	1	Inductor, not installed
L4, L5	2	2.2µH 7A power inductors Vishay IHLP2525CZER2R2M11
L6	1	0.47µH 26A power inductor Vishay IHLP2525CZERR47M01
PGOOD1, PGOOD2, BSTON, FSYNC	4	40-mil drill size test points (RED) Keystone Electronics 5002
Q8, Q9, Q10, Q11	4	40V, 7.6A n-channel MOSFETs (8 SO) Fairchild FDMC8015L
Q12	1	40V, 10.4A n-channel MOSFET (PowerPAK SO-8) Vishay SiR426DP-T1-GE3
R52-R54, R61, R64-R66, R73, R82	9	0Ω ±5% resistors (0603)
R1, R2, R3	3	1kΩ ±5% resistors (0603)
R55, R67	2	15mΩ, 0.5W sense resistors (1206) IRC LRF1206LF-01-R015-F
R62	1	22.1kΩ ±1% resistors (0603)
R63	1	1Ω ±5% resistor (0603)
R74	1	14kΩ ±1% resistor (0603)
R79, R81	2	20kΩ ±1% resistors (0603)
R75	1	15.4kΩ 1% resistor (0603)

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R76	1	100kΩ ±1% resistor (0603)
R77	1	0.012Ω ±1%, 2W current-sense resistor (2512) IRC LRF2512LF-01-R012-F
R78	1	140kΩ ±1% resistor (0603)
R80	1	133kΩ ±1% resistor (0603)
R95, R96, R97	3	51.1kΩ ±5% resistors (0603)

DESIGNATION	QTY	DESCRIPTION
R58, R59, R70, R71	0	Resistors, not installed
U1	1	Automotive boost dual buck with preboost (40 TQFN-EP**) Maxim Integrated MAX16930ATLR/V+
—	1	PCB: MAX16930 EVKIT

**L1 can be populated with a 6A ferrite bead (1806) Murata BLM41PG600SN1L if EMI testing is needed. To be included with the EMI circuit is C8 = C9 = 0.1µF ±10%, 50V X7R (0603) and C1 = C10 = 1000pF ±10%, 50V X7R (0603).*

***EP = Exposed pad.*

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
IRC, Inc.	361-992-7900	www.irctt.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com
TDK Corp.	847-803-6100	www.component.tdk.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
Vishay	402-563-6866	www.vishay.com

Note: *Indicate that you are using the MAX16930 when contacting these component suppliers.*

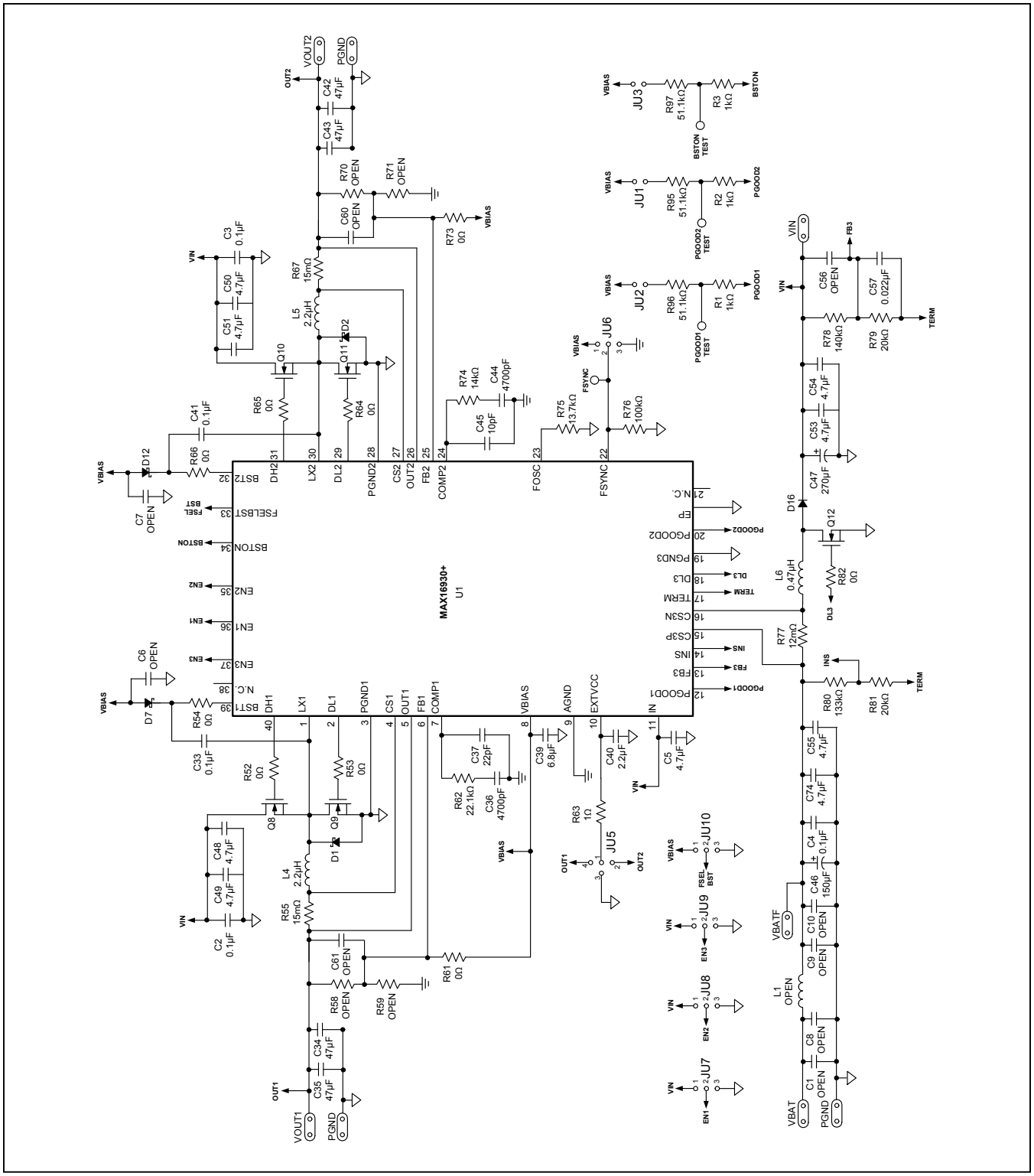

Figure 1. MAX16930 EV Kit Schematic

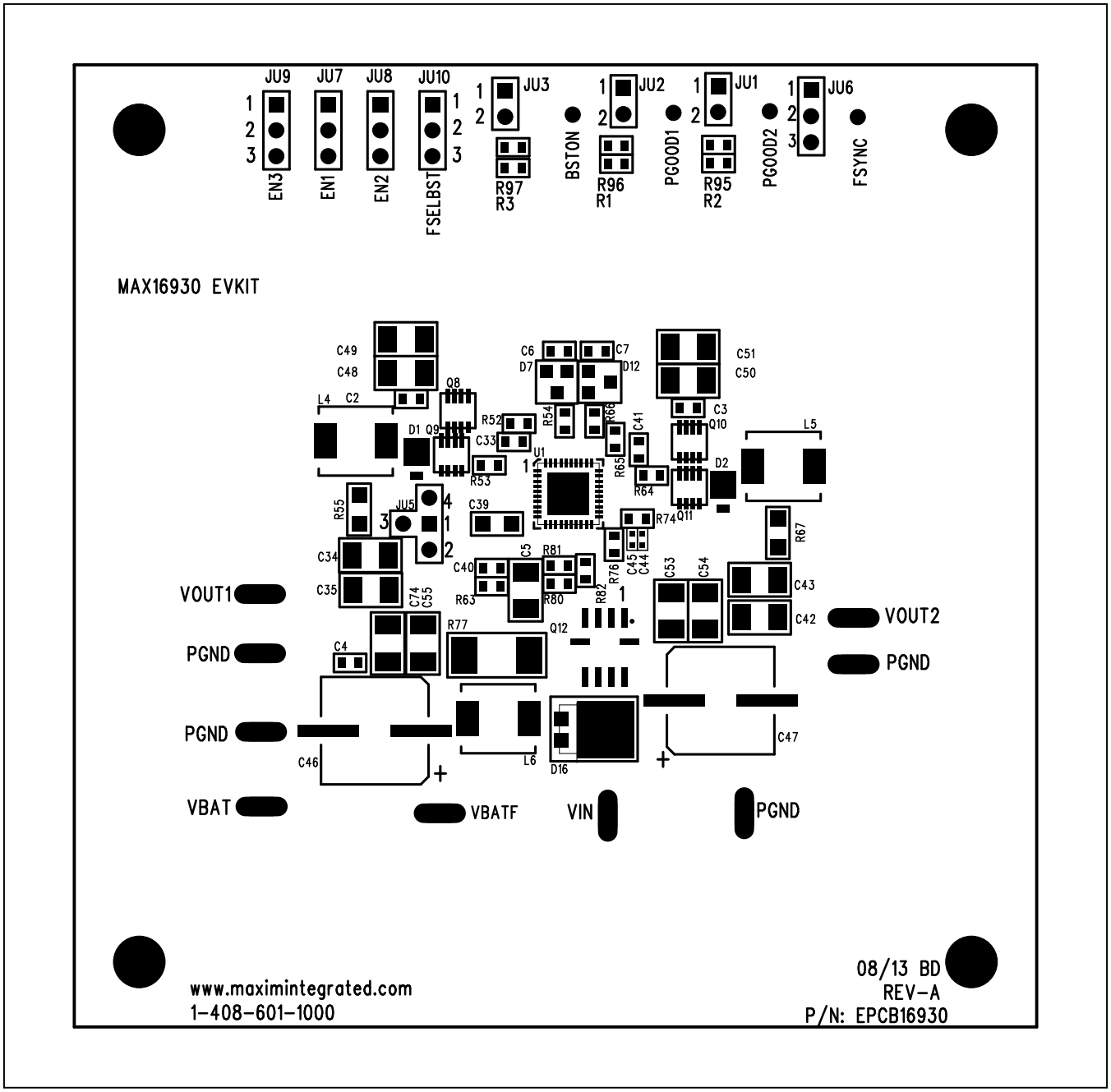

Figure 2. MAX16930 EV Kit Component Placement Guide—Component Side

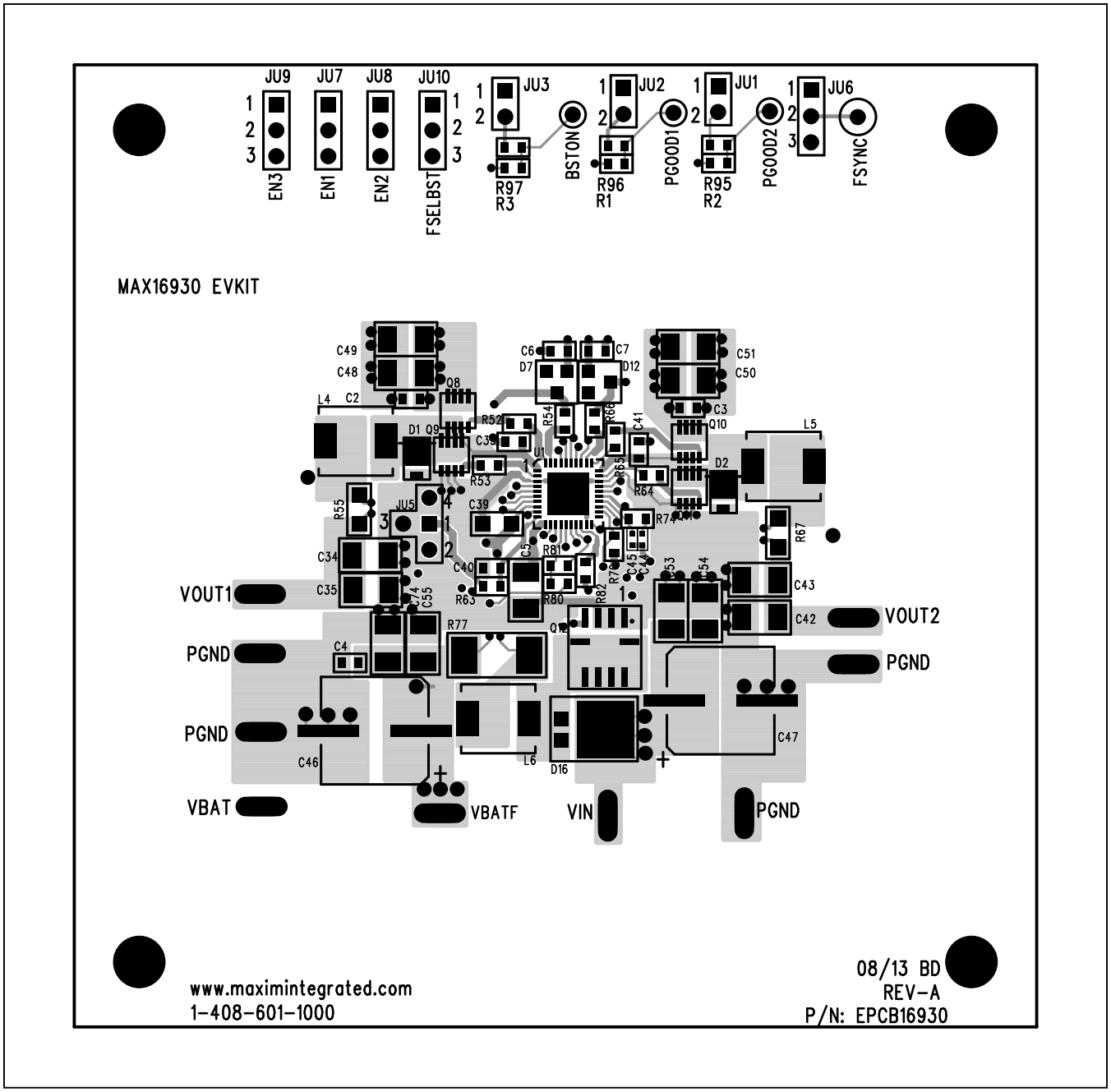

Figure 3. MAX16930 EV Kit PCB Layout—Component Side

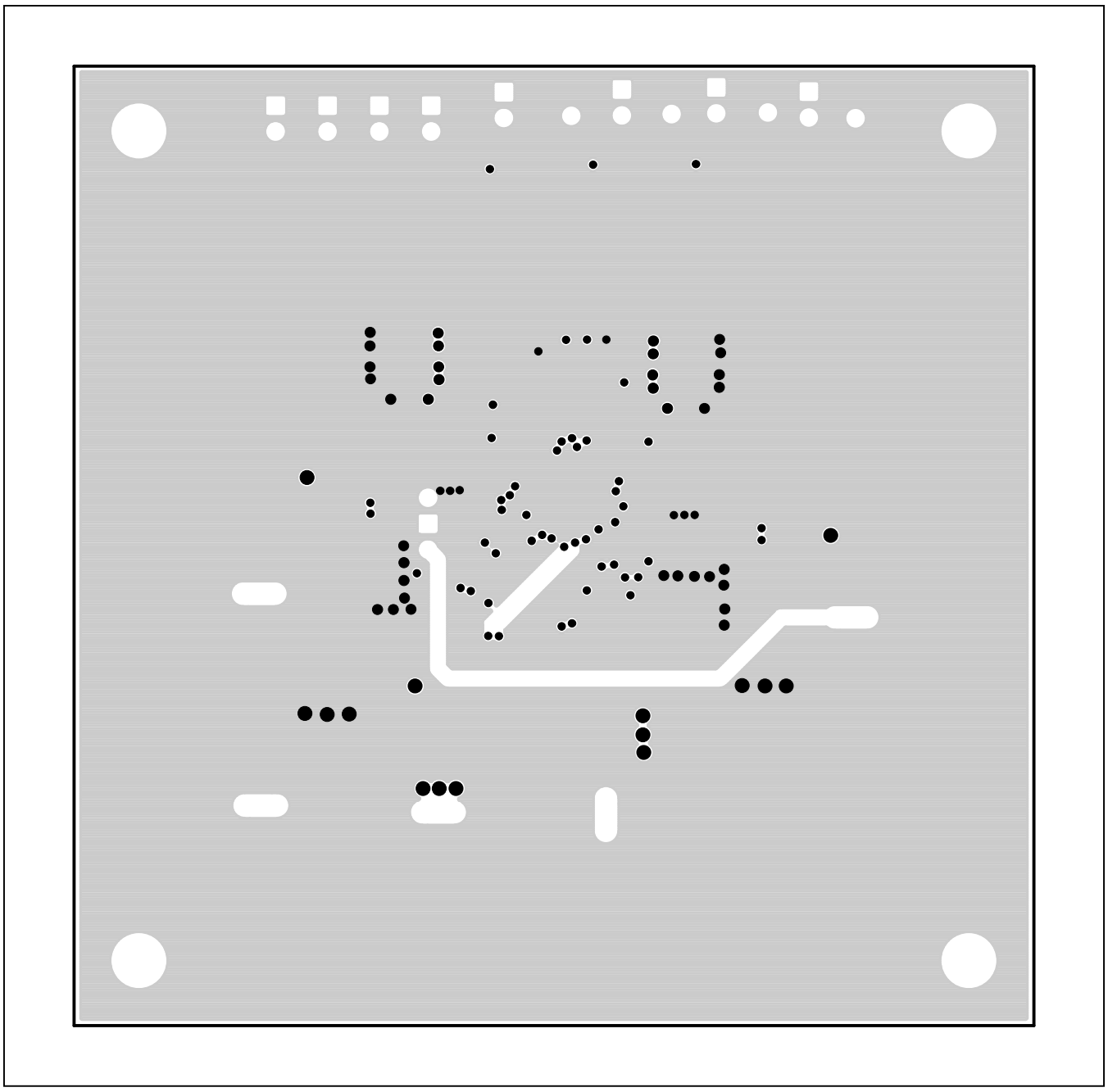

Figure 4. MAX16930 EV Kit PCB Layout—Layer 2 (PGND)

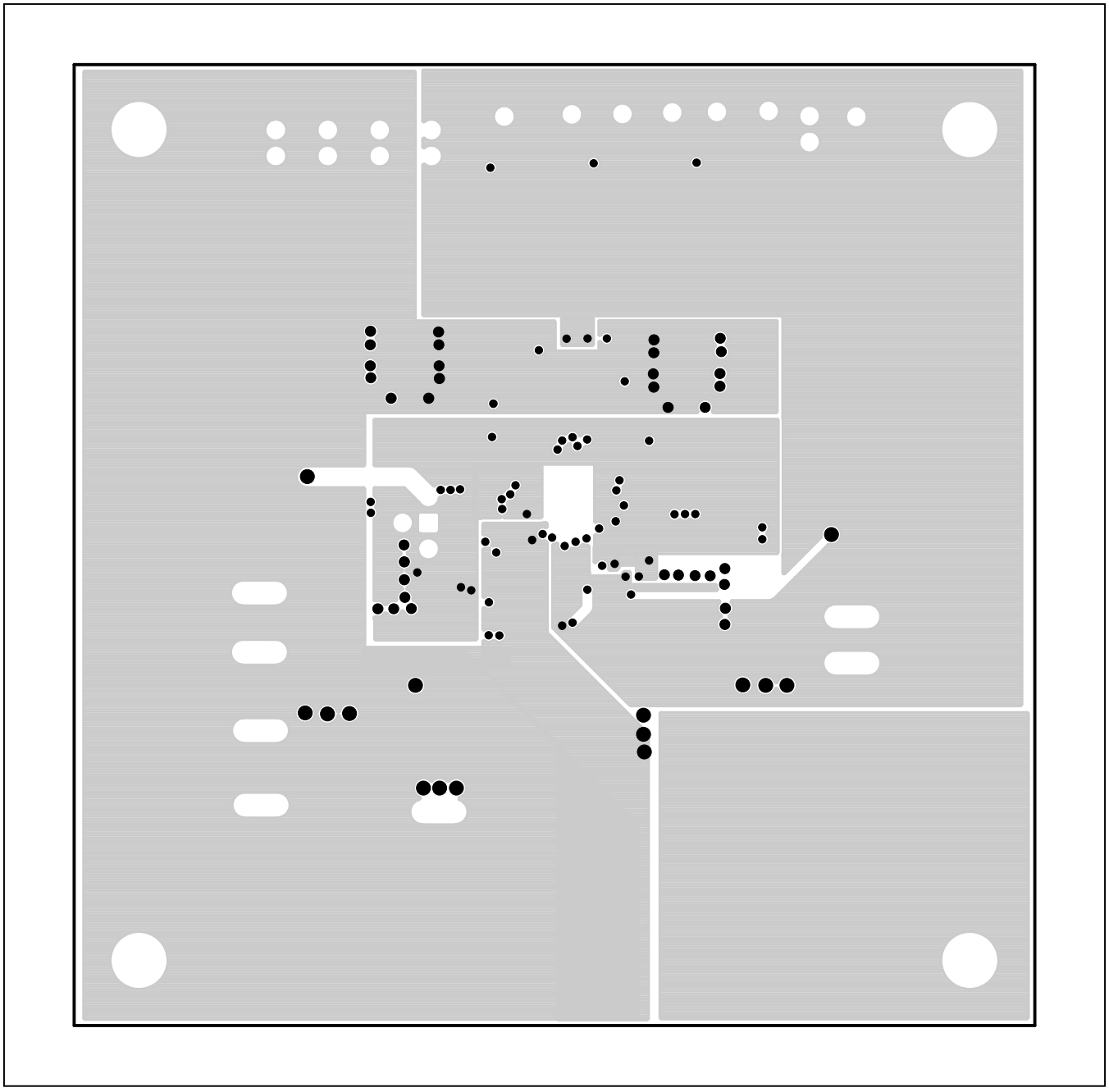

Figure 5. MAX16930 EV Kit PCB Layout—Layer 3 (VIN and AGND)

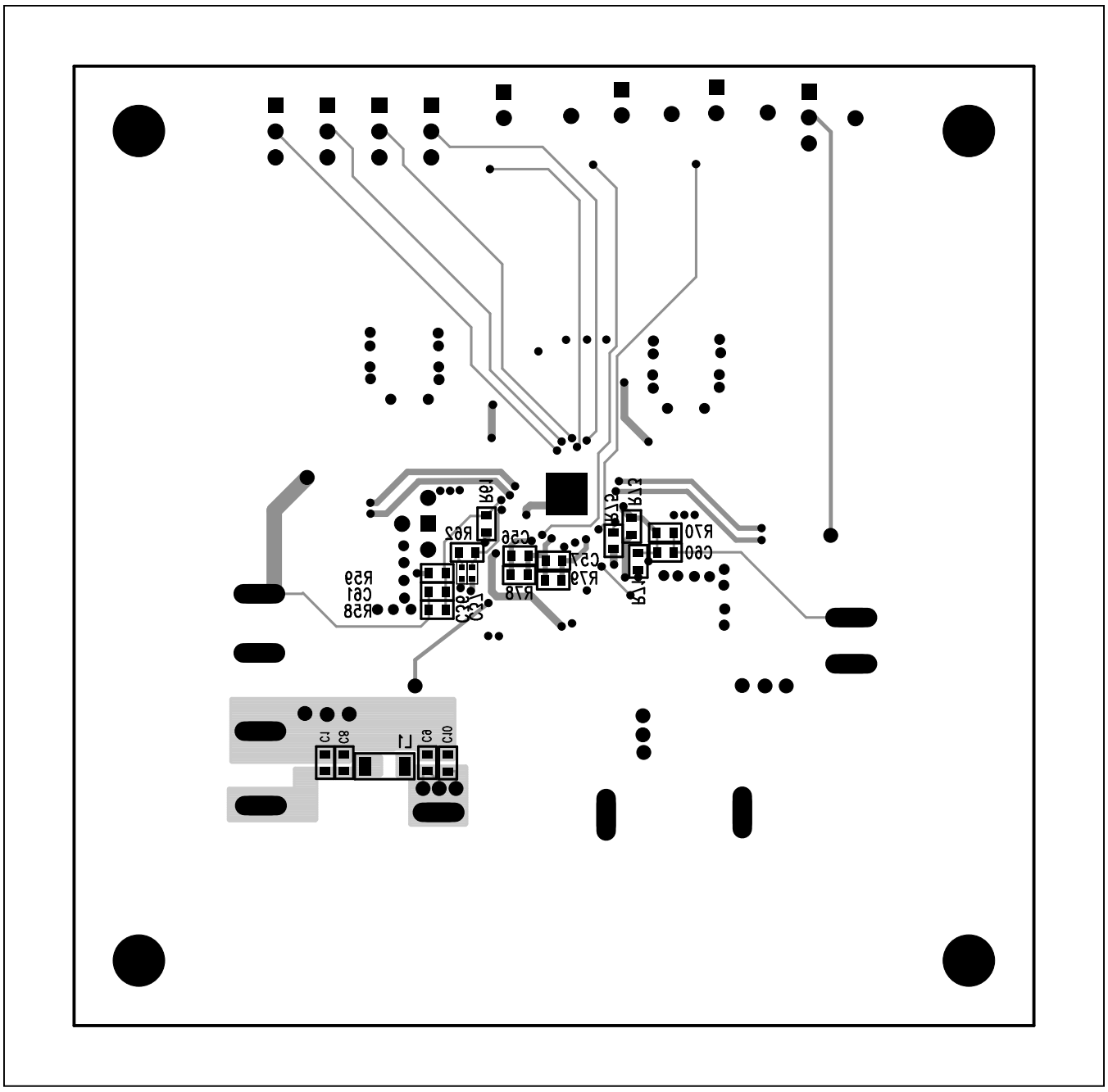

Figure 6. MAX16930 EV Kit PCB Layout—Solder Side

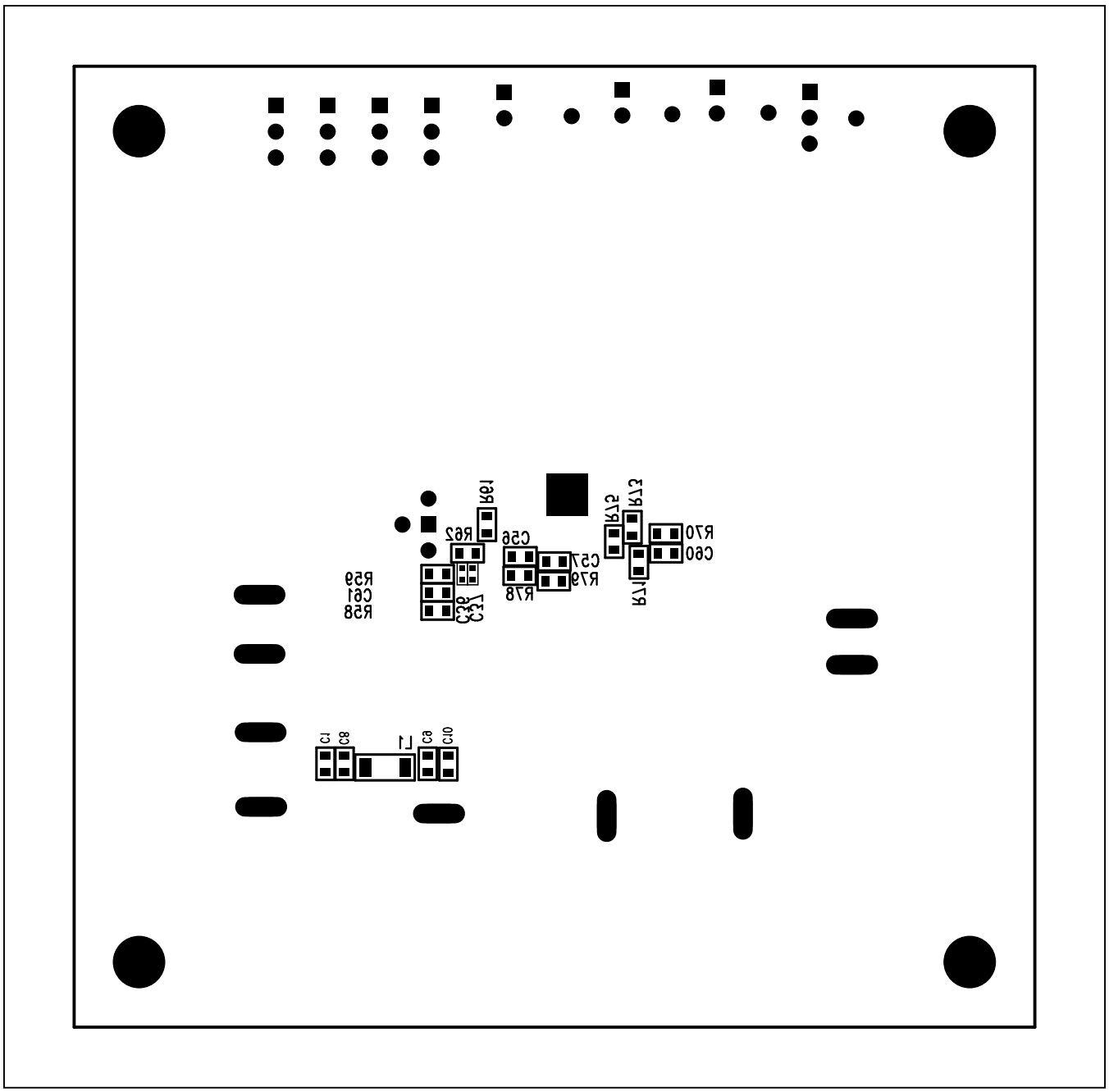

Figure 7. MAX16930 EV Kit Component Placement Guide—Solder Side

Ordering Information

PART	TYPE
MAX16930EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/13	Initial release	—
1	11/15	Updated Figure 1 schematic	6
2	9/16	Changed resistor R72 to R71 in *Component List*	5

