19-5975; Rev 1; 10/11

MAX17710 Evaluation Kit
Evaluates: MAX17710

General Description

The MAX17710 evaluation kit (EV kit) is a fully assembled and tested PCB that contains all the components necessary to evaluate the performance of the MAX17710 energy-harvesting charger and protector. The EV kit features the THINERGY® micro-energy cell (MEC) from Infinite Power Solutions, Inc. (IPS), a solid-state, rechargeable, thin-power solution. Solar cells are installed on the EV kit as the power source for an energy-harvesting application. The solar cells demonstrate low-power charging of the MEC with ambient light. The IC can regulate and charge from various energy-harvesting sources that can be added externally.

The EV kit is a self-powered board. The EV kit output charges the THINERGY MEC with current as low as 1µA. The EV kit provides test points to monitor the inputs and outputs, and jumpers to test the various settings. An LED is included on the CHG output to indicate if the boost is operating. The IC is available in a 12-pin UTDFN package with an exposed pad.

Features

- **Self-Powered by On-Board Solar Cells**
- **THINERGY Micro-Energy Cell (MEC) Included**
- **Variable Switching Frequency Adjusts for Input Power Levels**
- **Various Test Points Included for Evaluation**
- **Proven PCB Layout**
- **Fully Assembled and Tested**

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

Component List

DESIGNATION	QTY	DESCRIPTION
AC+, AE, BATT+, CHG, FB, LCE, PCKP, REG, SEL2, SOLAR+	10	Red multipurpose test points
AC-, GND (x4)	5	Black multipurpose test points
BATT	1	THINERGY1mAh micro-energy cell (MEC) IPS MEC101-10PES
C1, C24	0	Not installed, ceramic capacitors (0603)
C2	1	10µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J106M
C3	1	1µF ±10%, 16V X7R ceramic capacitor (0603) Murata GRM188R71C105K
C4, C7	2	0.1µF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H104K

DESIGNATION	QTY	DESCRIPTION
C5	1	47µF ±20%, 6.3V X7R ceramic capacitor (1210) Murata GRM32ER70J476M
C6	1	1000pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H102K
D1	1	10V, 570mA Schottky diode (SOD323) Diodes Inc. ZLLS410TA
D2	1	Surface-mount Schottky diode array (SOT363) Diodes Inc. BAS70DW-04-7-F
D5	1	Green LED (0603)
D6	0	Not installed, zener diode (SOD123)
J1	1	6-pin right-angle male header
JU1	1	4-pin (1 x 4) header
JU2, JU4	2	3-pin headers
JU3, JU5, JU6, JU7	4	2-pin headers

THINERGY is a registered trademark of Infinite Power Solutions, Inc.

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
L1	1	1.5µH, 1.5A inductor Murata LQM2HPN1R5MG0
LX	0	Not installed, 1-pin header
N1	1	N-channel digital FET Fairchild FDV301N
R1	1	51kΩ ±5% resistor (0603)
R2	0	Not installed, resistor (0603)
R3	1	10kΩ ±5% resistor (0603)
R4, R5, R7	3	1MΩ ±5% resistors (0603)
R6	1	10Ω ±5% resistor (0603)
R9	1	150Ω ±5% resistor (0603)

DESIGNATION	QTY	DESCRIPTION
R22	1	620Ω ±5% resistor (0603)
S1–S4	4	Momentary pushbutton switches
SOLAR1, SOLAR2, SOLAR3	3	Amorphous solar cells (single) China Solar RS-2510
U1	1	Energy-harvesting charger and protector (12 UTDFN-EP) Maxim MAX17710G+U
—	8	Shunts
—	1	PCB: MAX17710 EVALUATION KIT

Component Suppliers

SUPPLIER	PHONE	WEBSITE
China Solar Ltd.	86-755-8351-5659	www.solar-china.com
Diodes Incorporated	805-446-4800	www.diodes.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Infinite Power Solutions	303-749-4800	www.infinitepowersolutions.com
Murata Electronics North America, Inc	770-436-1300	www.murata-northamerica.com

Note: *Indicate that you are using the MAX17710 when contacting these component suppliers.*

Quick Start

Required Equipment

- MAX17710 EV kit
- Oscilloscope
- Precision voltmeter

Procedure

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

1) Verify that two shunts are installed on jumper JU1 (pins 1-2 and 3-4). Solar cells SOLAR1, SOLAR2, and SOLAR3 are connected in parallel as the power source.
2) Install a shunt in the 2-3 position on jumper JU2 to connect the IC to the on-board MEC through a 10Ω resistor. **Important:** The MEC (BATT) must always be connected before the solar cell or damage could result. Always connect JU2 first and disconnect JU2 last.
3) Install a shunt on jumper JU3 to connect the on-board solar cells as the power source. The solar cell voltage can be monitored on the SOLAR+ test point. If verification with an external energy-harvesting source is required, remove the shunt from JU3 and apply the external power source to the SOLAR+ test point. The power-source ground can connect to any GND test point.
4) Connect the oscilloscope probe to the CHG test point. The CHG test point is the output of the boost regulator. Set the time division to 200ms and the voltage division to 1V.
5) Under ambient light, the battery charges with a small current. The oscilloscope displays voltage pulses from the boost regulator. The boost output pulses because of the solar cells' limited current.
6) Increase the ambient light source on the solar cells and observe the increase in frequency of pulses at the CHG test point.
7) To turn on the internal regulator and enable the battery pack output, press the S1 button.
8) Install shunts on jumpers JU5 and JU6. LED D5 pulses with the voltage pulses at the CHG test point. D5 is a visual indication of the boost output.
9) To measure the MEC charging current, observe the voltage across resistor R6. A precision voltmeter is needed. The charging current can be as low as 1µA and the voltmeter needs the precision to be able to pulse-average over several seconds of data. An average voltage of 10µV indicates a 1µA average charging current.

Table 1. Solar Power Options (JU1)

JUMPER	SHUNT POSITION	DESCRIPTION	INPUT POWER
JU1	1-2	SOLAR1 and SOLAR2 are connected in parallel as the power source.	Medium
	3-4	SOLAR2 and SOLAR3 are connected in parallel as the power source.	Medium
	1-2* and 3-4*	SOLAR1, SOLAR2, and SOLAR3 are connected in parallel as the power source.	High
	2-3 and Open	SOLAR2 is connected as the power source.	Low

**Default position.*

Table 2. Jumper Table (JU2–JU7)

JUMPER	SHUNT POSITION	DESCRIPTION
JU2	1-2	Connects the IC charger output to the MEC (BATT) directly. To prevent possible IC damage, JU2 must always be the first jumper installed and the last jumper removed.
	2-3	Connects the IC charger output to the MEC (BATT) through a 10Ω resistor (R6). Use this setting to measure the charger current. To prevent possible IC damage, JU2 must always be the first jumper installed and the last jumper removed.
	Not installed*	The IC is not connected to the battery.
JU3	Installed	The on-board solar cells power the EV kit.
	Not installed*	For low-voltage DC external energy-harvesting sources, remove this shunt and apply the power source to the SOLAR+ test point.
JU4	Not installed*	See the *Regulator Output Voltage (SEL1)* section.
JU5	Installed	Connects LED D5 to the battery pack output (PCKP test point).
	Not installed*	Disconnects LED D5 from the PCKP test point. The PCKP output can be used to power an external load.
JU6	Installed	Enables the LED indicator.
	Not installed*	Disables the LED indicator.
JU7	Installed	Connects the resistor-divider to FB.
	Not installed*	Does not connect the resistor-divider to FB.

**Default position.*

Detailed Description of Hardware

The MAX17710 EV kit is a fully assembled and tested PCB that contains all the components necessary to evaluate the MAX17710 energy-harvesting charger and protector. The IC is available in a 12-pin UTDFN package with an exposed pad. The EV kit circuit uses an efficient boost controller to regulate and charge the on-board THINERGY MEC (BATT). The EV kit has three on-board solar cells that are connected in parallel. On-board jumpers and test points allow external power sources to power the IC. The IC has low reverse leakage to prevent discharge of the on-board energy cell. Ambient light can charge the on-board MEC with current as low as 1µA

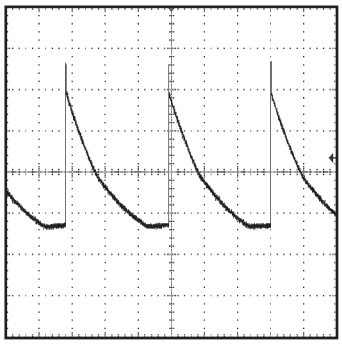


Figure 1. CHG Test Point Voltage Using On-Board Solar Cells as the Power Source

Charger

The CHG test point monitors the CHG pin. The CHG test point is connected to the output of the boost regulator and the CHG pin is the input to the battery charger. The IC charges the MEC based off the voltage on the CHG test point. The power sources to the CHG test point can come from solenoid, piezo, mechanical, or RF sources, and must exceed the MEC voltage. When CHG exceeds the MEC voltage by 50mV, the IC uses the CHG supply to charge the on-board MEC. The IC is designed to use input supplies from energy-harvesting sources, which are highly variable, poorly regulated, and usually power-limited. Apply the variable input supply source to the AC+ and AC- test points. The power source is rectified and supplied to the CHG test point through the full-wave bridge diode (D2).

Internal Boost

For power sources that are lower than the battery voltage, such as solar or the above-mentioned sources, the IC features a boost converter to step up the voltage to charge the on-board MEC. The output of the boost is the CHG test point. The IC uses the voltage on the CHG test point to charge the MEC. An additional power source can be present on CHG through the AC+ and AC- test points while the boost is active.

Figure 1 shows the CHG test-point voltage observed on an oscilloscope with ambient light using the on-board solar cells as the power source. The number of pulses increase as the EV kit is brought closer to the light source and decrease when taken away from the light source.

Power Sources

The on-board power source is a parallel connection of three solar cells. The voltage can be monitored on the SOLAR+ and GND test points. The start-up voltage for the IC boost is approximately 750mV at the FB pin. To supply an external power source, remove the shunt from jumper JU3 and apply the power source to the SOLAR+ and GND test points.

On-Board Micro-Energy Cell (BATT)

The EV kit features the THINERGY micro-energy cell (MEC) from IPS as the on-board energy storage cell. The MEC101 included on the EV kit is roughly the size of a postage stamp and is soldered directly to the board. The BATT footprint can also accommodate the MEC201. **Caution:** The MEC case is conductive. To protect the MEC, do not touch the MEC with conductive material.

MEC Pack Power

The IC has a regulator output and battery pack output (PCKP) to provide power to external loads. The IC PCKP test point provides the MEC voltage to external loads while the REG test point provides a regulated voltage (Table 3). External unregulated loads from the MEC should always be connected through the PCKP test point. External loads connected directly from the MEC can cause irreversible damage to the MEC if the voltage goes too low.

LED Indicator On Pack Power

The D5 LED is connected through a digital FET at the PCKP test point. The LED blinks as pulses are generated at the CHG test point. The LED is a visual display that the boost regulator is operating.

Logic Inputs

The EV kit provides various pushbutton switches and test points to evaluate the device. There are two regulators internal to the IC, which are available through AE and LCE. AE controls the default regulator and LCE controls the low-current regulator.

Regulator Output Enable (AE)

The IC features a default regulator that can be enabled by the AE signal. Press the S1 switch to connect PCKP and enable the default regulator. Press the S2 switch to disconnect PCKP and disable the default regulator output. The output voltage is selected by jumper JU4 (see Table 3). If the MEC voltage drops below 2.15V, the AE and PCKP outputs are disabled until a charger is applied.

Low-Current Mode Enable (LCE)

The IC features a low-current regulator that reduces the quiescent current by a factor of 5. The low-current regulator can be enabled by the LCE and AE signals. To enter the low-current mode, first turn on the default regulator by pressing S1, then press S3 to enable the low-current regulator, and finally turn off the default regulator by pressing S2. Afterwards, press S4 to disable the low-current regulator. If low-current mode is enabled, pressing S1 enables the default regulator, but pressing S2 switches back to the low-current regulator if originally enabled. If the MEC voltage drops below 3V, the AE and PCKP outputs are disabled until a charger is applied.

Regulator Output Voltage (SEL1)

Table 3 shows the regulator output options. SEL1 is connected to jumper JU4. The regulator output is locked when the regulator is active. To change the regulator output voltage, first change the setting on jumper JU4 to obtain the desired output voltage (Table 3), then press S2 and S4 to disable both the default and low-current regulators. Lastly, press S1 to enable the default regulator and optionally S3 to enable the low-current regulator. The regulator output voltage can be monitored on the REG test point and outputs the new voltage.

Table 3. Regulator Output Voltage (SEL1)

SEL1	JU4 SHUNT POSITION	REG (V)
BATT	1-2	1.8
GND	2-3	2.3
Unconnected	Not installed*	3.3

**Default position.*

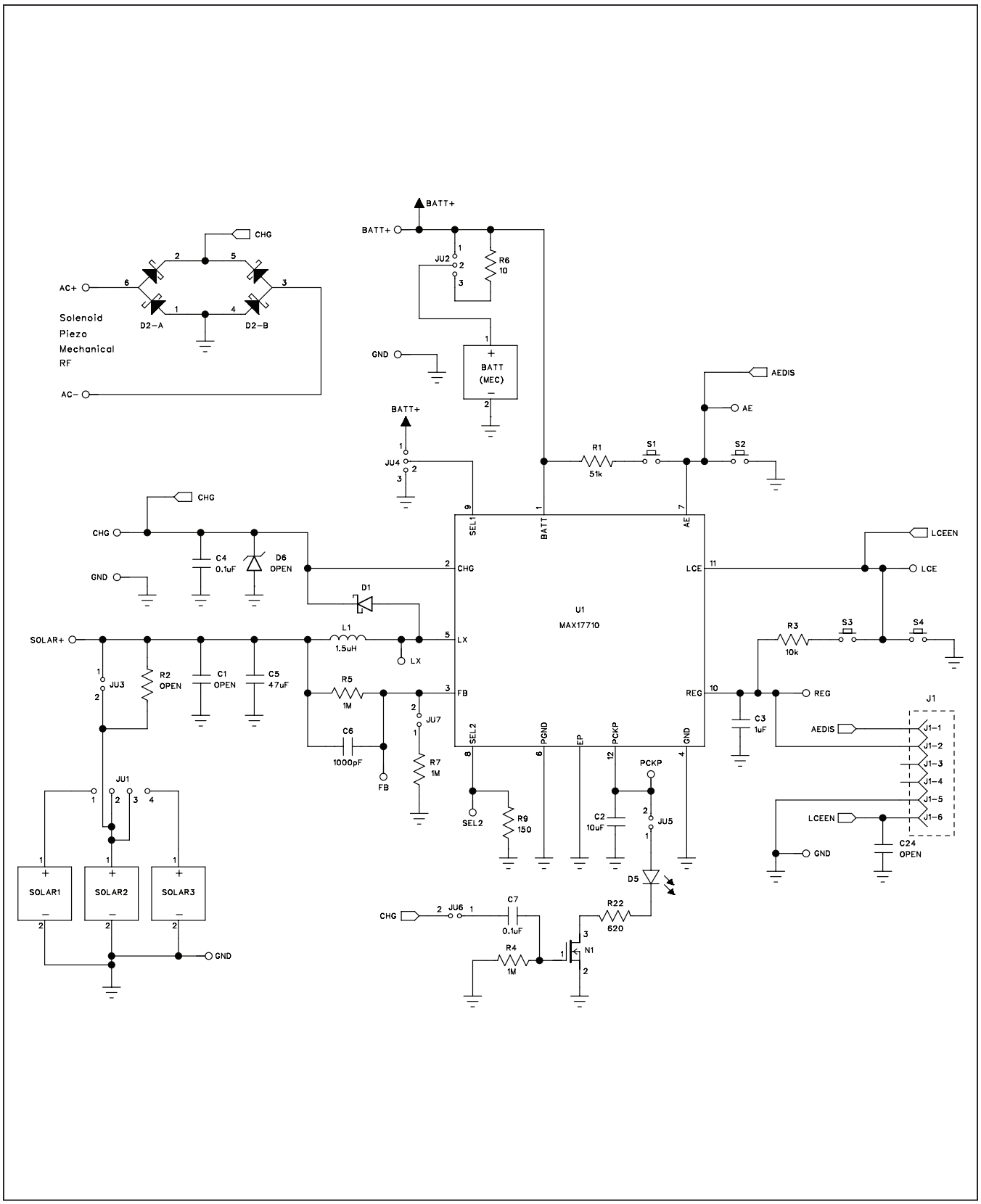


Figure 2. MAX17710 EV Kit Schematic

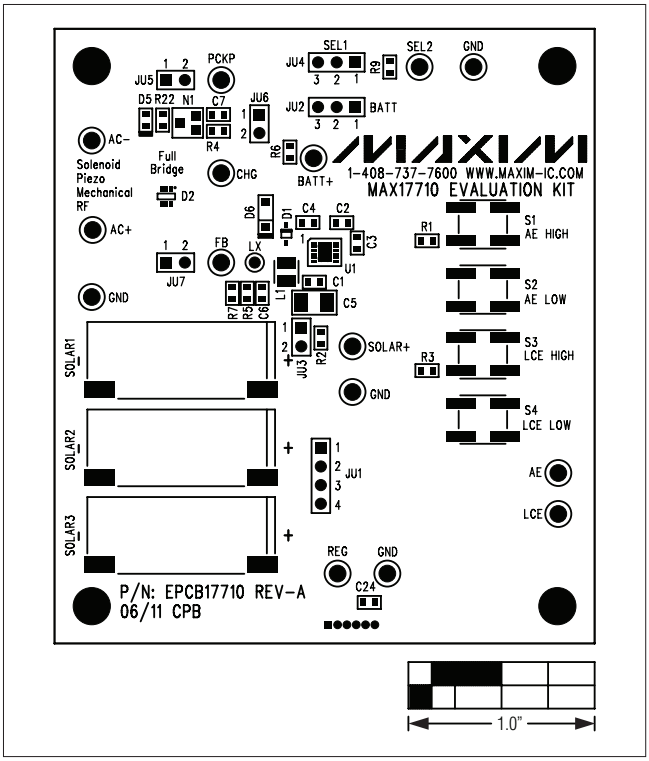


Figure 3. MAX17710 EV Kit Component Placement Guide—Component Side

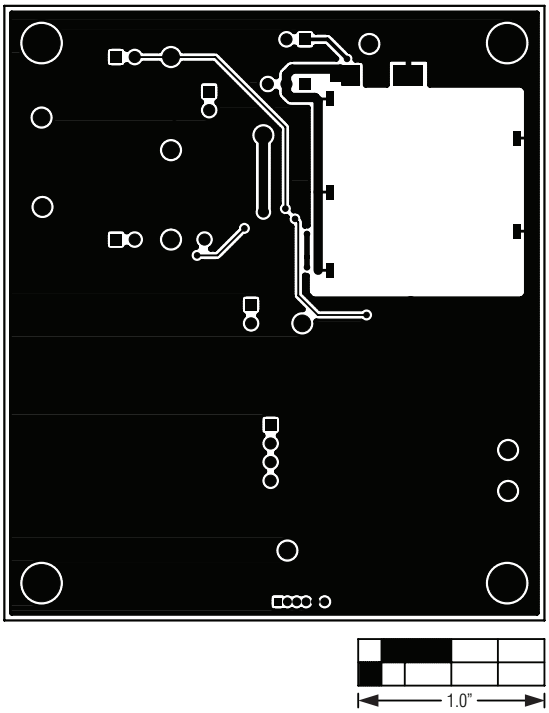


Figure 5. MAX17710 EV Kit PCB Layout—Solder Side

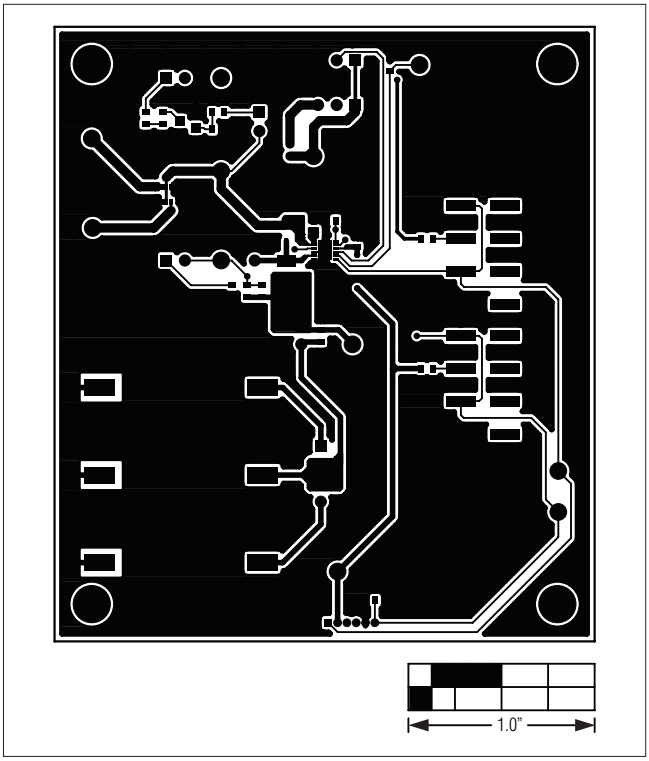


Figure 4. MAX17710 EV Kit PCB Layout—Component Side

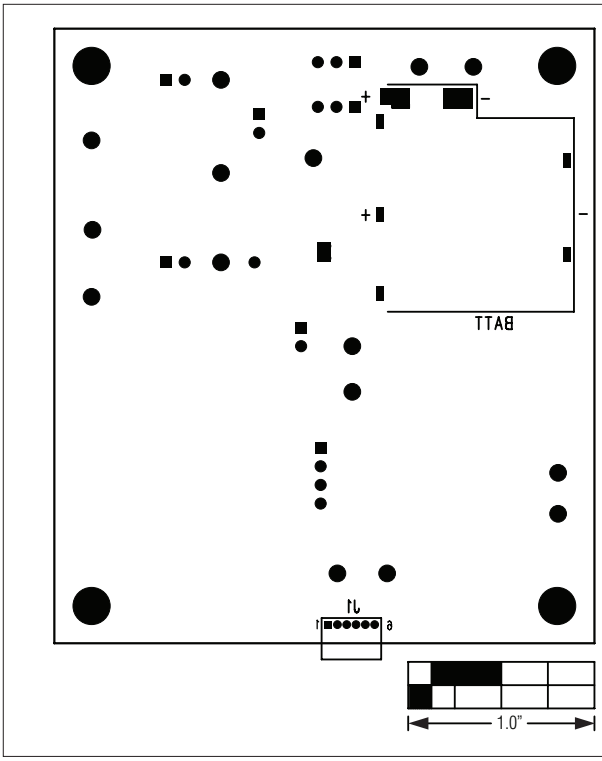


Figure 6. MAX17710 EV Kit Component Placement Guide—Solder Side

Ordering Information

PART	TYPE
MAX17710EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/11	Initial release	—
1	10/11	Swapped *Quick Start* steps 2 and 3 and added warnings about connecting jumper JU2 first and removing JU2 last	2, 3

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.

© 2011 Maxim Integrated Products Maxim is a registered trademark of Maxim Integrated Products, Inc.