



# MAX1938 Evaluation Kit

## General Description

The MAX1938 evaluation kit (EV kit) is a fully tested and assembled power supply that demonstrates the full functionality of the MAX1937/MAX1938/MAX1939 family of synchronous, two-phase, step-down controllers. The circuit operates from an input supply range of 8V to 14V and provides VID-controlled CPU core voltage with up to 60A of output current. The EV kit comes with the MAX1938 installed, which provides a 5-bit VID code interface to meet Intel Voltage-Regulator Module (VRM) 9.0/9.1 specifications. The MAX1937 and MAX1939 can also be evaluated using the same board by replacing the MAX1938. The MAX1937 supports the AMD Hammer CPU VID codes, and the MAX1939 supports the AMD Athlon® Mobile CPU VID codes.

## Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX1938EVKIT	-40°C to +85°C	28 QSOP
MAX1938EVKIT+	-40°C to +85°C	28 QSOP

**Note:** To evaluate the MAX1937 or MAX1939, request free samples along with the MAX1938 EV kit.

+Denotes lead-free and RoHS-compliant.

## Features

- ◆ ±0.75% Output Voltage Accuracy
- ◆ Up to 90% Efficiency—No Heatsinks
- ◆ Up To 60A Output Current
- ◆ Quick-PWM™ Architecture Reduces Output Capacitors
- ◆ 8V to 14V Input Range (8V to 22V with Component Change)
- ◆ 500kHz Output Ripple Frequency
- ◆ MAX1937: AMD Hammer Compatible
- ◆ MAX1938: Intel VRM 9.0/9.1 Compatible
- ◆ MAX1939: AMD Athlon Mobile Compatible
- ◆ Controlled (On-the-Fly) VID Voltage Transition
- ◆ Power-Good (PWRGD) Output
- ◆ User-Programmable Voltage Positioning
- ◆ Fully Assembled and Tested

## Component List

DESIGNATION	QTY	DESCRIPTION
C1, C4	2	2.2µF, 10V X5R capacitors (0805) Taiyo Yuden LMK212BJ225KG or equivalent
C2	1	2.2µF, 16V X7R capacitor (1206) Taiyo Yuden EMK316BJ225ML or equivalent
C3, C7	2	0.22µF, 10V X7R capacitors (0603) Taiyo Yuden LMK107BJ224KA or equivalent
C5	1	0.47µF, 10V X5R capacitor (0603) Taiyo Yuden LMK107BJ474KA or equivalent
C6	1	47pF, 50V C0G capacitor (0603) Murata GRM1885C1H470J or equivalent
C8, C9, C17, C32	4	1000pF, 50V X7R capacitors (0603) Murata GRM188R71H102K or equivalent
C10–C14	5	1µF, 10V X7R capacitors (0805) Taiyo Yuden LMK212BJ105MG or equivalent

Quick-PWM is a trademark of Maxim Integrated Products, Inc.

AMD Athlon is a registered trademark of Advanced Micro Devices, Inc.

DESIGNATION	QTY	DESCRIPTION
C15	1	0.01µF, 50V X7R capacitor (0603) Taiyo Yuden UMK107B103KZ or equivalent
C16	0	Not installed (0603)
C18–C23	6	330µF, 25V Al electrolytic capacitors SANYO 25MV330WX
C24–C31	8	560µF, 4V OSCON (E) capacitors SANYO 4SP560M
C33, C34, C45, C46	4	10µF, 16V X5R capacitors (1210) Taiyo Yuden TMK325BJ106MM or equivalent
C35–C44, C54–C57	0	Open
C47–C53	0	Open
C58, C59	2	2200pF, 50V X7R (0805) AVX 08055A222AT2A
CON1–CON6	6	Banana jacks, noninsulated
D1	1	Diode (SOD123) Central Semiconductor CMHD4448 LEAD FREE
D2	1	Dual Schottky diodes (SOT23) Central Semiconductor CMPSH-3A LEAD FREE

Evaluates: MAX1937/MAX1938/MAX1939

# MAX1938 Evaluation Kit

## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
D3, D4	0	Not installed (D-Pak)
JU4–JU9	6	2-pin headers
L1, L2	2	0.60μH inductors Panasonic ETQP1HOR6BFA BI HM7340R50 (alternate)
N1, N2, N3, N6, N7, N8	6	n-channel MOSFETs (D-Pak) IRF IRLR7811WPBF
N4, N5, N9, N10	4	n-channel MOSFETs (D <sup>2</sup> PAK) Fairchild ISL9N303AS3ST_NL
N11–N22	0	Not installed, 8-pin SO
R1	1	10Ω ±5% resistor (0603)
R2	1	51.1kΩ ±1% resistor (0603)
R3	1	200kΩ ±1% resistor (0603)
R4	1	68.1kΩ ±1% resistor (0603)
R5, R8	2	1.8Ω ±5% resistors (0603)
R6	1	100kΩ ±5% resistor (0603)
R7	1	120kΩ ±5% resistor (0603)
R9, R10	2	200Ω ±5% resistors (0603)
R13	1	4.7Ω ±5% (0603)
R16, R19	2	1.5Ω ±5% (1206)
R17, R18	2	100Ω ±5% resistors (0603)
R20	0	Not installed (0603) PCB short
U1	1	MAX1938EEI+ QSOP
U2	1	6V linear regulator (DPAK) Fairchild KA78M06RTF
None	6	Shunts
Part of Kit	1	MAX1938EVKIT PC board

## Quick Start

### Required Equipment

The following equipment is required before beginning:

- 8V to 14V, at least 150W power supply or battery
- Adjustable load capable of sinking 60A at 0.8V
- Two digital multimeters (DMMs)
- Oscilloscope

**Note:** Active electronic loads have a minimum input voltage required when sinking current. Make sure that the load is capable of sinking the necessary current at the lowest voltage. Take into account the voltage drop in the wires connecting the EV kit to the load. To minimize the voltage drop in the wires, two connectors are provided on the EV kit for the output allowing two wires to be connected in parallel. It is also acceptable to use two loads, each sinking half the current.

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
BI Technologies	714-447-2345	www.bitechnologies.com
Central Semiconductor	631-435-1110	www.centalsemi.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
International Rectifier	310-322-3331	www.irf.com
Kamaya, Inc.	260-489-1533	www.kamaya.com
Murata Mfg. Co., Ltd.	770-436-1300	www.murata.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Sanyo Corp.	619-661-6835	www.sanyo.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
Vishay	203-268-6261	www.vishay.com

**Note:** Indicate that you are using the MAX1938 when contacting these component suppliers.

### Procedure

Follow these steps to verify operation of the MAX1938 EV kit. When making connections to the high-current input and output, make sure that the wire gauge is heavy enough to handle the necessary current and minimize voltage drop in these wires. **Caution: Do not turn on the power supply until all connections are completed.**

- 1) Preset the power supply between 8V and 14V. Turn off the power supply.
- 2) Select the desired output voltage using the VID\_ jumpers (see Table 1 for a list of jumper settings and corresponding output voltages).
- 3) Verify that the pins of jumper EN are not shorted.
- 4) Connect the positive (+) power-supply output to the banana connector labeled IN on the MAX1938 EV kit.
- 5) Connect the negative (-) power-supply output to the banana connector labeled GND located near the center of the MAX1938 EV kit.
- 6) If available, connect the positive (+) power-supply sense lead to the pad labeled IN, and connect the negative (-) power-supply sense lead to the pad labeled GND (next to IN).
- 7) If the power supply does not have sense connections, use a DMM to monitor the input voltage on the board. Connect the positive terminal of DMM 1 to the pad labeled IN, and connect the common (COM) or ground terminal of the DMM to the pad labeled GND (next to the IN pad).

# MAX1938 Evaluation Kit

Evaluates: MAX1937/MAX1938/MAX1939

- 8) If using an active load, connect the positive side of the load to the banana connectors labeled OUT (located at the top of the EV kit board). Two OUT connections are provided on the board so that two parallel wires can be used to connect the load. Alternatively, two loads can be connected in parallel, one to each OUT connector. Connect the negative side of the load to the banana connectors labeled GND (located near the top of the board by the OUT connectors). Two GND connections are provided for paralleling wires to the load or connecting multiple loads.
- 9) Use a DMM to monitor the output voltage. Connect the positive (+) terminal of DMM 2 to the pad labeled OUT (located in the upper-left corner of the EV kit board as shown in Figure 3). Connect the common (COM) or ground terminal of the DMM to the GND pad (located next to the OUT pad in the upper left corner).
- 10) If desired, connect an oscilloscope probe to the connector located between the OUT and GND banana connectors. The oscilloscope can then be used to observe the output ripple.
- 11) Turn on the power supply.
- 12) Using DMM 2, verify that the output voltage matches the voltage selected with the VID\_ inputs.
- 13) Set the active load to the desired current (up to 60A), or connect a passive load to the output.
- 14) Verify that the correct output voltage appears on DMM 2.
- 15) To verify operation of the enable/shutdown feature, connect the pins of jumper EN using the shunt provided. The MAX1938 shuts down and the output voltage drops to zero.
- 16) Remove the shunt across jumper EN. The MAX1938 powers up and the output voltage returns to its nominal value.
- 17) To use the on-the-fly VID code feature, change the VID\_ jumper settings (see Table 1). The output voltage changes to the newly selected value at a controlled rate without overshoot or undershoot.

## Detailed Description

### Setting the Output Voltage (VID\_)

The MAX1938 EV kit uses a 5-bit VID interface for selecting the output voltage. Table 1 shows the output voltages corresponding to each VID code. Either each VID\_ input can be driven as a digital input, or the code can be set using the jumpers provided on the board. If the jumpers

are used, short the pins of the VID\_ jumper with the provided shunts to set the VID\_ bits to logic 0. Remove the shunt from the jumper to set the corresponding bit to logic 1. If the VID\_ inputs are driven as digital inputs, remove all the shunts from the VID\_ jumpers.

The VID code can be changed either when the converter is off or when it is functioning (on-the-fly). When the VID code is changed on-the-fly, the output voltage ramps up or down at a controlled rate until the new voltage is reached (refer to the MAX1937/MAX1938/MAX1939 data sheet for more details).

### Enable Input (EN)

The enable input can be used to enable or shut down the controller. This can be done either by using the EN jumper provided on the EV kit, or by driving the EN input as a digital input. When using the jumper, short the pins of the EN jumper to shut down or remove the short to enable the output (see Table 2). When using EN as a digital input, remove the shunt from the EN jumper. Drive EN high to enable the output or drive EN low for shutdown.

### Power-Good Output (PWRGD)

Power-good (PWRGD) is an open-drain output with a 100k $\Omega$  external pullup resistor to VDD. This output is low if the output voltage deviates more than 12.5% from the value set by the VID code, and high when the output is in regulation. PWRGD is low when the part is in shutdown or during startup.

## Customizing the MAX1938 EVKIT

### Evaluating the MAX1937 or MAX1939

The MAX1938 EV kit comes with the MAX1938 installed, providing a VID code interface to meet Intel VRM 9.0/VRM 9.1 specifications. The MAX1937 and MAX1939 can also be evaluated using the same board by replacing the MAX1938. The MAX1937 supports the AMD Hammer CPU VID codes, whereas the MAX1939 supports the AMD Athlon Mobile CPU VID codes.

To evaluate the MAX1937 or MAX1939, carefully remove the MAX1938 from the EV kit and replace it with the new part. Free samples of the MAX1937 and MAX1939 can be obtained from Maxim. The EV kit can be preconfigured with the MAX1937 or MAX1939 upon request.

# MAX1938 Evaluation Kit

Evaluates: MAX1937/MAX1938/MAX1939

**Table 1. VID Programmed Output Voltage (VID0–VID4)**

VID4	VID3	VID2	VID1	VID0	Vout (V)		
					MAX1937	MAX1938	MAX1939
0	0	0	0	0	1.550	1.850	2.000
0	0	0	0	1	1.525	1.825	1.950
0	0	0	1	0	1.500	1.800	1.900
0	0	0	1	1	1.475	1.775	1.850
0	0	1	0	0	1.450	1.750	1.800
0	0	1	0	1	1.425	1.725	1.750
0	0	1	1	0	1.400	1.700	1.700
0	0	1	1	1	1.375	1.675	1.650
0	1	0	0	0	1.350	1.650	1.600
0	1	0	0	1	1.325	1.625	1.550
0	1	0	1	0	1.300	1.600	1.500
0	1	0	1	1	1.275	1.575	1.450
0	1	1	0	0	1.250	1.550	1.400
0	1	1	0	1	1.225	1.525	1.350
0	1	1	1	0	1.200	1.500	1.300
0	1	1	1	1	1.175	1.475	Shutdown
1	0	0	0	0	1.150	1.450	1.275
1	0	0	0	1	1.125	1.425	1.250
1	0	0	1	0	1.100	1.400	1.225
1	0	0	1	1	1.075	1.375	1.200
1	0	1	0	0	1.050	1.350	1.175
1	0	1	0	1	1.025	1.325	1.150
1	0	1	1	0	1.000	1.300	1.125
1	0	1	1	1	0.975	1.275	1.100
1	1	0	0	0	0.950	1.250	1.075
1	1	0	0	1	0.925	1.225	1.050
1	1	0	1	0	0.900	1.200	1.025
1	1	0	1	1	0.875	1.175	1.000
1	1	1	0	0	0.850	1.150	0.975
1	1	1	0	1	0.825	1.125	0.950
1	1	1	1	0	0.800	1.100	0.925
1	1	1	1	1	Shutdown	Shutdown	Shutdown

**Note:** In the above table, a zero indicates VID<sub>n</sub> is driven low or the jumper pin is connected. A 1 indicates VID<sub>n</sub> is driven high or the jumper is not connected.

**Table 2. EN Jumper Functions**

EN JUMPER	FUNCTION
OPEN	Enable the output
SHORT	Shut down the output

# MAX1938 Evaluation Kit

Evaluates: MAX1937/MAX1938/MAX1939

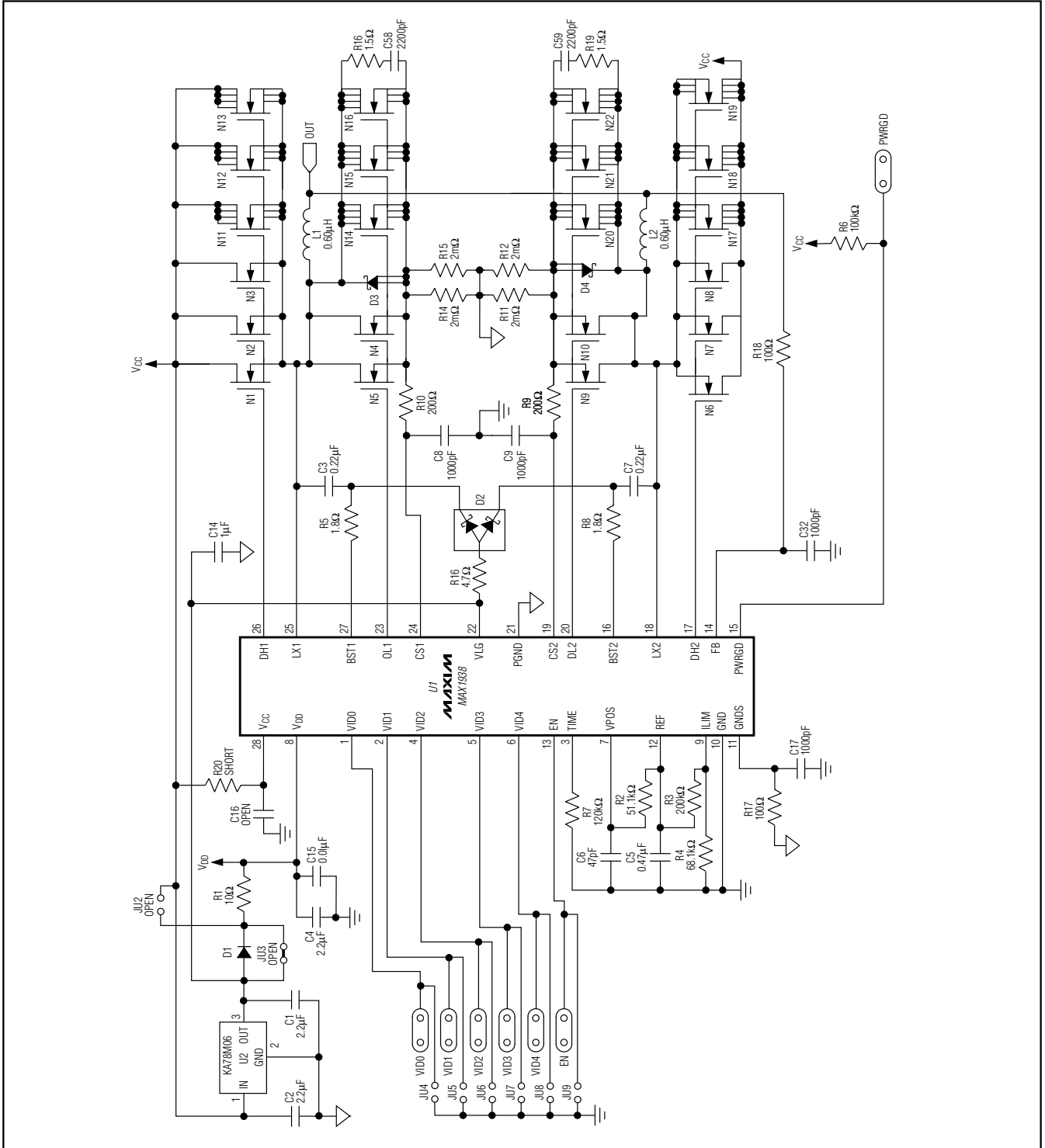


Figure 1a. MAX1938 EV Kit Schematic (Sheet 1 of 2)

# MAX1938 Evaluation Kit

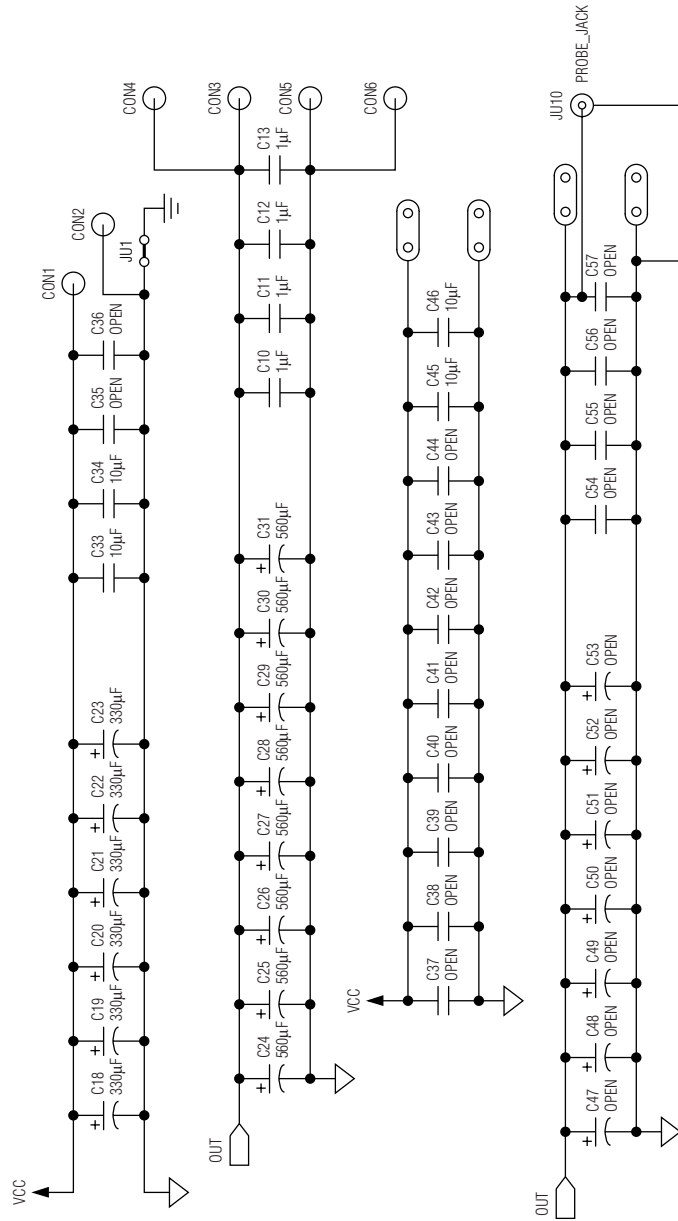


Figure 1b. MAX1938 EV Kit Schematic (Sheet 2 of 2)

# MAX1938 Evaluation Kit

Evaluates: MAX1937/MAX1938/MAX1939

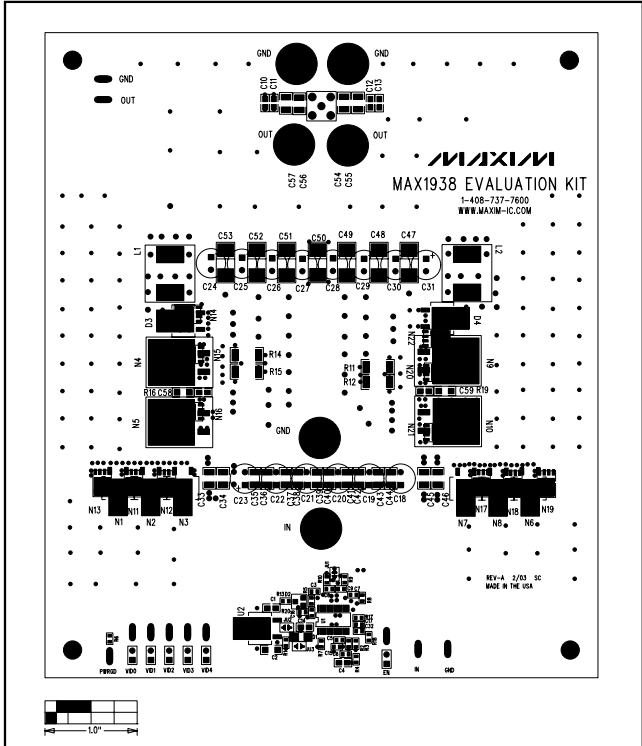


Figure 2. MAX1938 EV Kit Component Placement Guide—Component Side

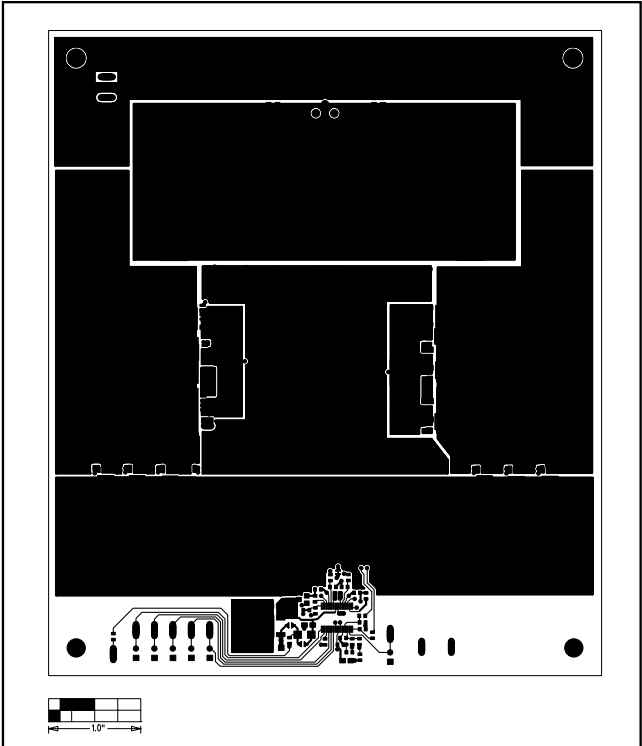


Figure 3. MAX1938 EV Kit PCB Layout—Component Side

# MAX1938 Evaluation Kit

Evaluates: MAX1937/MAX1938/MAX1939

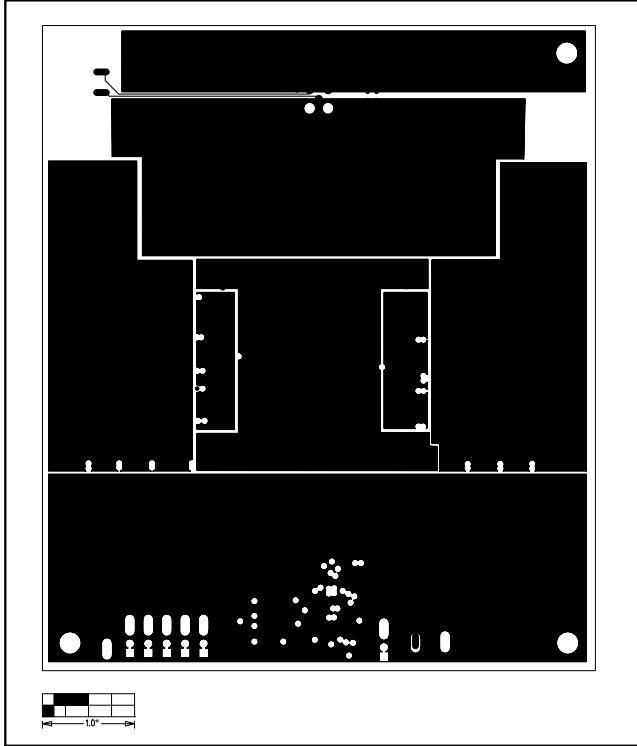


Figure 4. MAX1938 EV Kit PCB Layout—Inner Layer 2

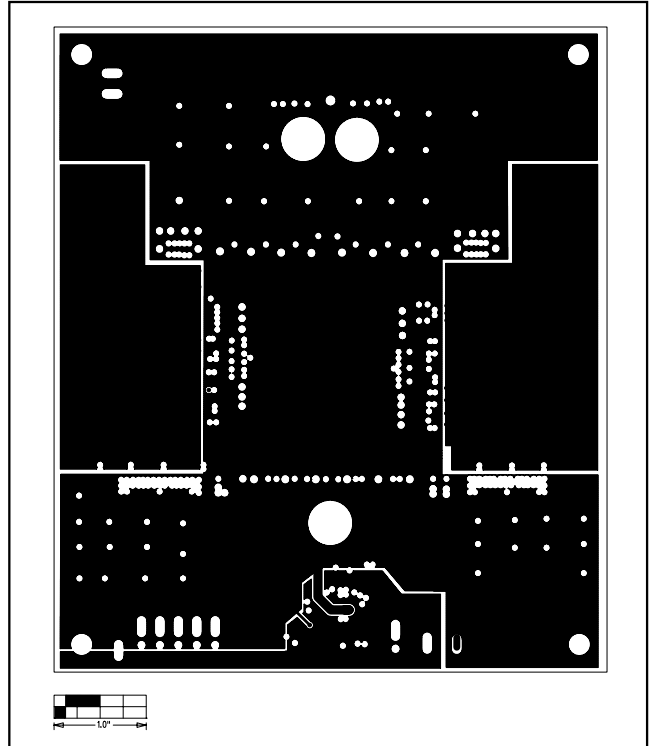


Figure 5. MAX1938 EV Kit PCB Layout—Inner Layer 3



# MAX1938 Evaluation Kit

Evaluates: MAX1937/MAX1938/MAX1939

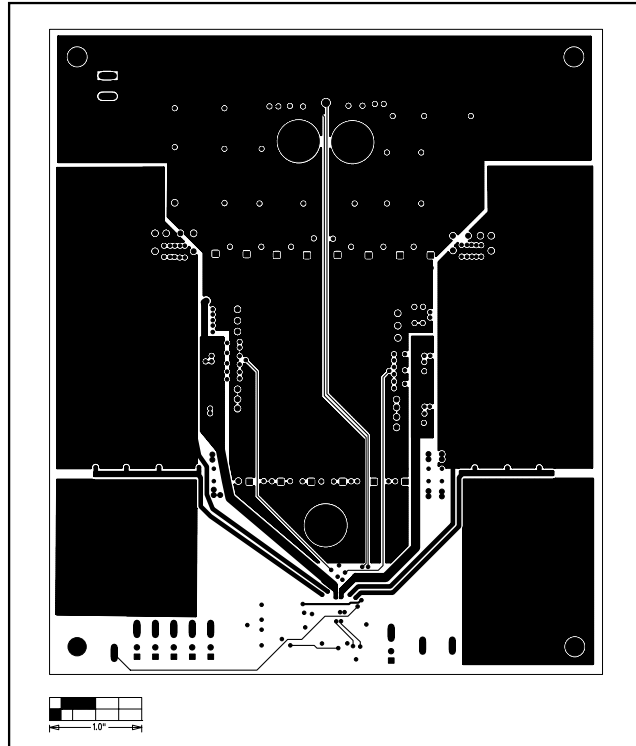


Figure 6. MAX1938 EV Kit PCB Layout—Solder Side

## Revision History

Pages changed at Rev 1: 1, 2, 5, 9

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.

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 \_\_\_\_\_ 9

© 2007 Maxim Integrated Products

MAXIM is a registered trademark of Maxim Integrated Products, Inc.