Evaluates: MAX16170

MAX16170 Evaluation Kit

General Description

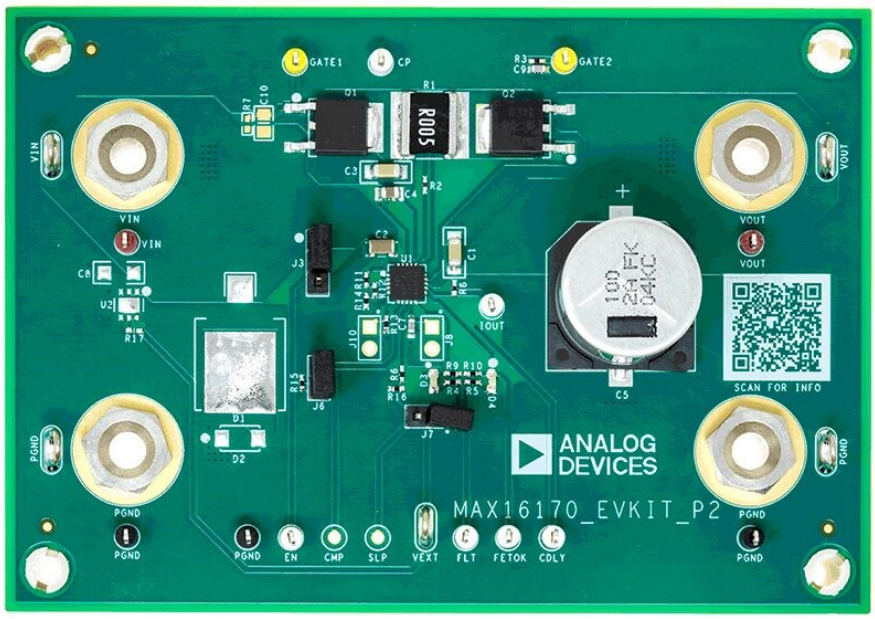
The MAX16170 evaluation kit (EV kit) evaluates the MAX16170, an automotive protection IC with up to 30kHz active rectification in a 20-pin thin quad-flat no-leads (TQFN) package. It has several test points for device evaluation. The EV kit is fully assembled and tested over the automotive temperature range of -40°C and +125°C, and is available with the MAX16170_TP/VY+.

Features and Benefits

- -42V to +76V Input Protection
- +3V to +65V Operating Voltage Range
- Proven 2-Layer 2oz Copper Printed circuit board (PCB) Layout
- PCB Pads for Optional Transient Voltage Suppressor (TVS) Diodes
- Automotive Temperature Range: -40°C and +125°C
- Fully Assembled and Tested

Ordering Information *appears at end of data sheet.*

MAX16170 EV Kit Photo



319-100992; Rev 0; 4/23

Quick Start

Required Equipment

- MAX16170 EV kit
- 65V, 5A DC Power Supply
- 5V, 100mA DC Power Supply
- Electronic Load
- Two Digital Voltmeters (DVM1, DVM2)
- 4-Channel Oscilloscope

Procedure

The EV kit is fully assembled and tested. Follow these steps to verify board operation.

CAUTION: Do not turn on power supply until all connections are completed.

1. Verify all jumpers (JP1) are in their default positions, as shown in *Table 1*.
2. Connect the positive terminal of the 65V DC power supply to the VIN banana jack connection and the negative terminal to the PGND banana jack connection.
3. Connect the positive terminal of the 5V DC power supply to VEXT test point and the negative terminal to GPND test point.
4. Connect the positive terminal of the electronic load to the VOUT banana jack connection and the negative terminal to the PGND banana jack connection.
5. Connect DVM1 to VOUT and PGND test points.
6. Connect DVM2 to IOUT and PGND test points.
7. Enable the power supply.
8. Verify that V_{OUT} = V_{IN} = 12V and $\overline{FLT}$ = $\overline{FETOK}$ = 5V by using an oscilloscope probe. (LED D3 and D4 are OFF).
9. Increase the V_{IN} voltage to more than 45V.
10. Verify that V_{OUT} goes down and $\overline{FLT}$ = 0V by using an oscilloscope probe. (LED D3 is ON).
11. Decrease the V_{IN} voltage to lower than 40V.
12. Verify that V_{OUT} goes high and $\overline{FLT}$ = 5V by using an oscilloscope probe. (LED D3 is OFF).
13. Decrease the V_{IN} voltage lower than 7.5V.
14. Verify that V_{OUT} goes down and $\overline{FLT}$ = 0V by using an oscilloscope probe. (LED D3 is ON).
15. Increase the V_{IN} voltage to more than 10V.
16. Verify that V_{OUT} goes high and $\overline{FLT}$ = 5V by using oscilloscope probe. (LED D3 is OFF).
17. Increase the V_{IN} voltage to 12V.
18. Enable the DC loader and set the load current to 1A.
19. Verify that DVM2 is connected to IOUT and PGND test points reads about 1.65V.
20. Increase the load current to more than 4A.
21. Verify that V_{OUT} goes down and $\overline{FLT}$ = 0V by using an oscilloscope probe. (LED D3 is ON)
22. Disconnect the DC loader.
23. Short jumper J7 to enter sleep
24. Verify that $\overline{FLT}$ = 0V by using oscilloscope probe. (LED D3 is ON)
25. Increase the V_{IN} voltage to 30V.
26. Verify V_{OUT} is 24V~28V around.
27. Short jumper J6.
28. Verify V_{OUT} is ~29.3V.
29. Disable the power supply and default set all jumpers.

Table 1. Jumper Connection Guide

JUMPER	DEFAULT	FEATURE
J3	1-2	1-2: Enabled $V_{EN} = V_{IN}$, 2-3: Disabled V_{EN} = GND
J10	OPEN	OPEN: Normal, SHORT: Disable OC feature
J8	OPEN	OPEN: Normal, SHORT: Disable OC response delay
J6	OPEN	OPEN: SLP CMP low, SHORT: SLP CMP high
J7	OPEN	OPEN: Normal, SHORT: Enable sleep mode

Detailed Description

The MAX16170 EV kit evaluates the MAX16170, an ideal diode controller and protection device that protects systems against fault conditions such as reverse current, reverse voltage, undervoltage, overvoltage, and negative transients, and helps designers to evaluate the operation and performance of the MAX16170. The external N-channel MOSFETs (Q1 and Q2) emulate an ideal diode and switcher under the MAX16170's control. A resistor's divider (R11, R12, and R14) is used to set the undervoltage threshold and overvoltage threshold of V_{IN}. A resistor (R13) and a capacitor (C7) are used to set the overcurrent threshold and response delay time separately. A sensor resister (R1) detects the load current and current output from the I_{OUT} pin to indicate the load current lineally. Two LEDs indicate $\overline{FLT}$ and $\overline{FETOK}$ output visually.

Power Supply

The EV kit can be powered by two power providers, one for the normal operation between VIN and PGND and another for the external pull high power source between VEXT and PGND when the $\overline{FLT}$, $\overline{FETOK}$, and SLP test points are used. The V_{EXT} should not be greater than 5V.

Shutdown Input (SHDN)

The EV kit provides a jumper (J3) to enable or disable the MAX16170. See *Table 1* for J3 jumper settings. Pulling $\overline{SHDN}$ to ground allows the MAX16170 to enter the shutdown mode and cut the loader off. EN test point provides a way to be controlled externally.

Fault Condition Output

The EV kit provides an $\overline{FLT}$ test point to indicate the work condition. Once any fault event is triggered, the $\overline{FLT}$ is pulled down. The fault events contain UVLO, undervoltage, overvoltage, overcurrent, reverse, sleep mode, thermal shutdown, and active shutdown.

FET Condition Output

The MAX16170 EV kit provides a $\overline{FETOK}$ test point to indicate the FET condition. After MAX16170 is powered, its start-up initialization achieves the FET detection program. Once any fault status of both MOSFETs is detected, $\overline{FETOK}$ is pulled down. MOSFET's fault status includes the short circuit and open circuit failure modes.

Clamp Selection

The EV kit provides a jumper (J6) and an optional CMP test point to set OUT's voltage options to clamp in the sleep mode. See *Table 1* for the J6 jumper settings.

Sleep Mode

The EV kit provides a jumper (J7) and an SLP test point to set the MAX16170 to enter the sleep mode. See *Table 1* for the J7 jumper settings. The sleep mode is activated using an active high logic input through jumper J7 or test point SLP.

CSA Feature

The MAX16170 EV kit provides a fixed setting for the CSA feature of the MAX16170. The current sensor resistor (R1) is 5mΩ, output resistor (R8) to ground is 33kΩ, and input resistor (R2) is 100Ω. The test point (I_{OUT}) is an output to provide the voltage level for current.

The following equation calculates the output voltage on I_{OUT} to the actual load current.

$$V_{IOUT} = \frac{I_{OUT} \times R1 \times R8}{R2} = \frac{I_{OUT} \times 5m\Omega \times 33k\Omega}{100\Omega} = 1.65 \times I_{OUT}$$

V_{IOUT} is the IOUT's voltage in unit of Volt (V), and I_{OUT} is the load current in unit of Ampere (A).

Soft Start

While the MAX16170 enables the soft-start mode, GATE2 is driven by a constant pull-high current to charge the soft-start capacitor. So, the soft-start time is determined by the soft-start capacitor (C9) connected between the GATE2 and ground.

Once the soft-start begins, assume the load current is constant in an application, the OUT capacitor C_{OUT} is charged to the output voltage V_{OUT} by an approximate constant current I_{CHG}, and its total current must not exceed the overcurrent threshold.

Following is the sample recommended to get the start0up time t_{SS} and GATE capacitor C_{GATE}.

$$t_{SS} = \frac{C_{OUT} \times V_{OUT}}{I_{CHG}} = \frac{C_{GATE} \times \left(V_{OUT} + V_{GS(TH)}\right)}{I_{GATE}}$$

$$C_{GATE} = C_{OUT} \times \frac{I_{GATE}}{I_{CHG}} \times \frac{V_{OUT}}{\left(V_{OUT} + V_{GS(TH)}\right)}$$

$V_{GS(TH)}$ is the gate threshold voltage of MOSFET, and I_{GATE} is fixed at an approximate average of 20µA.

Optional Components

The EV kit features optional components to evaluate the MAX16170 in a system.

Two clamp diodes (D1 and D2) limit the application's DC input voltage range. If two clamp diodes (D1 and D2) are installed, the EV kit can also clamp the positive and negative transients for some automotive standard tests.

A linear regulator (U4, C8, and R17) can provide an additional pullup source for $\overline{FETOK}$ and $\overline{FLT}$ outputs.

Note: These optional components are not necessary for the proper operation of the MAX16170 but are provided to optimize system operation, facilitate testing, and evaluate the IC.

Ordering Information

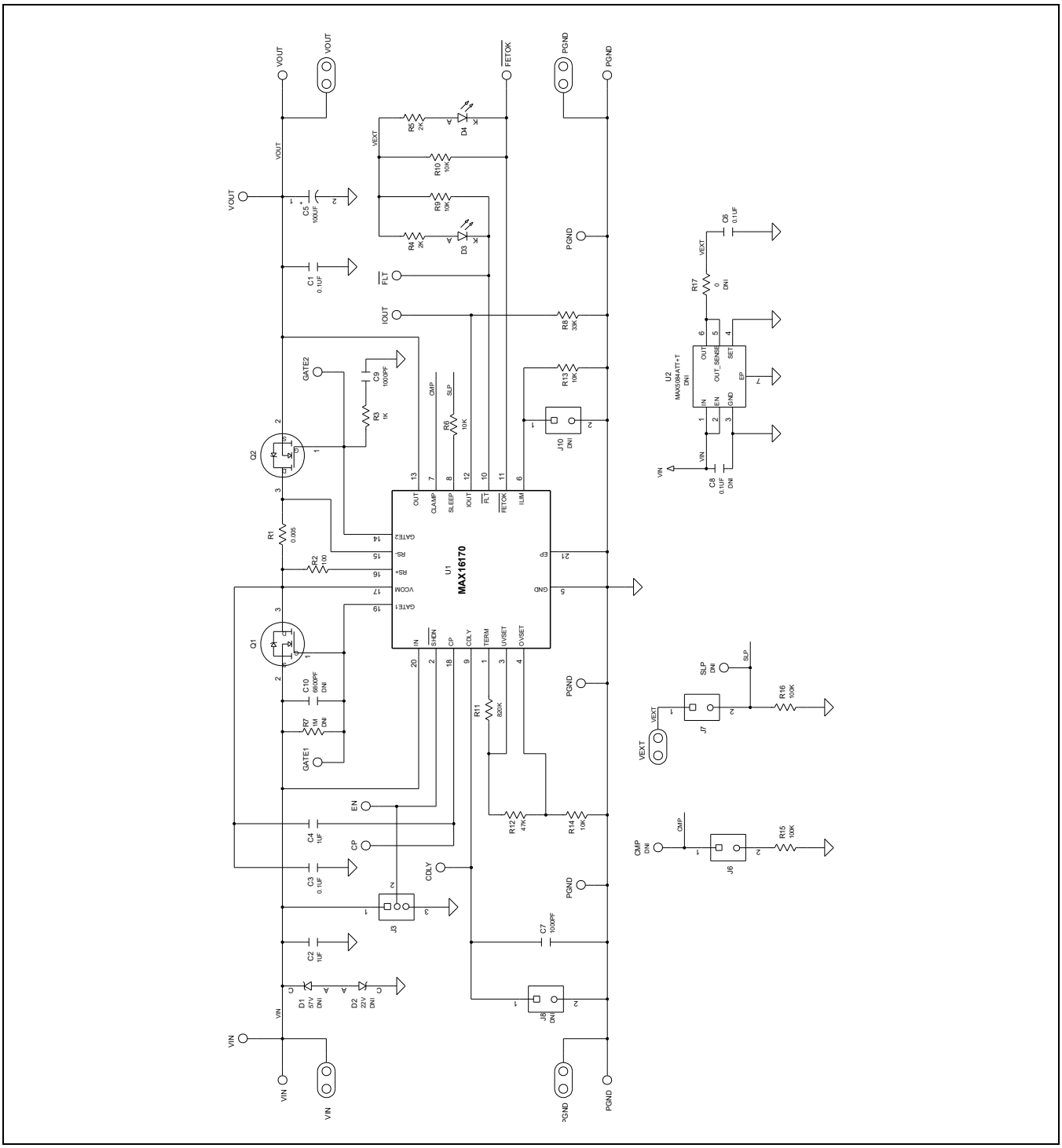
PART	TYPE
MAX16170EVKIT#	EV Kit

#Denotes RoHS-compliant.

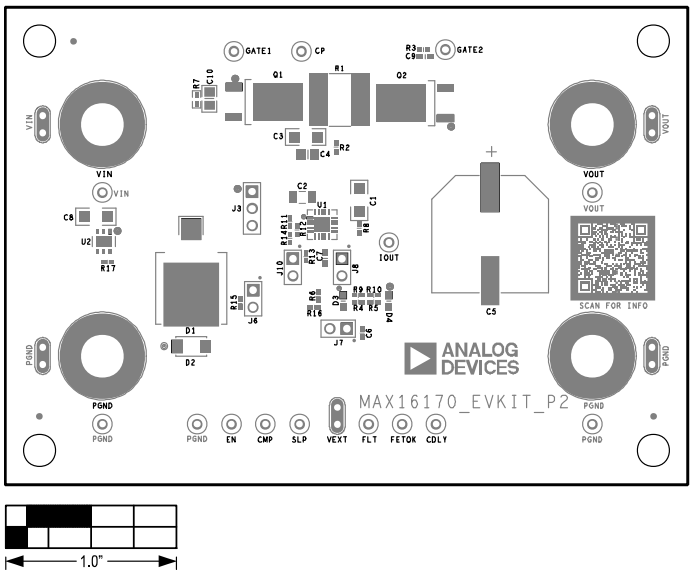
MAX16170 EV Kit Bill of Materials

PART	QTY	DESCRIPTION
C1, C3	2	0.1UF; 10%; 250V; X7R; CERAMIC MURATA: GRM31CR72E104KW03
C2	1	1UF; 10%; 100V; X7R; CERAMIC TDK: C3216X7R2A105K160AA MURATA: GCH31CR72A105KE01 TAIYO YUDEN: HMK316B7105KLH
C4	1	1UF; 10%; 25V; X5R; CERAMIC TDK: C2012X5R1E105K125AA
C5	1	100UF; 20%; 100V; ALUMINUM-ELECTROLYTIC PANASONIC: EEV-FK2A101
C6	1	0.1UF; 10%; 6.3V; X5R; CERAMIC MURATA: GRM155R60J104KA01 KEMET: C0402C104K9PAC
C7, C9	2	1000PF; 10%; 100V; C0G; CERAMIC KEMET: C0603C102K1GAC TDK: C1608C0G2A102K080AA
CDLY, CP, EN, $\overline{\text{FETOK}}$, $\overline{\text{FLT}}$, IOUT	6	TEST POINT KEYSTONE: 5002
D3, D4	2	LED OSRAM: LS Q976-NR-1
GATE1, GATE2	2	TEST POINT KEYSTONE: 5004
J3	1	CONNECTOR SULLINS: PCC03SAAN
J6, J7	2	CONNECTOR SULLINS: PEC02SAAN
MH1-MH4	4	MACHINE FABRICATED KEYSTONE: 9032
PGND, PGND7, VIN, VOUT	4	CONNECTOR EMERSON NETWORK POWER: 108-0740-001
PGND1, PGND2, VEXT, VIN2, VOUT2	5	WEICO WIRE: 9020 BUSS
PGND4-PGND6	3	TEST POINT KEYSTONE: 5001
Q1, Q2	2	POWER MOSFET ON SEMICONDUCTOR: NVD6824NLT4G-VF01
R1	1	0.005; 1%; 2728; +/-25PPM STACKPOLE ELECTRONICS: CSSH2728FT5L00
R2	1	100; 5%; 0402
R3	1	1K; 1%; 0402
R4, R5	2	2K; 0.10%; 0402
R6, R9, R10, R13, R14	5	10K; 5%; 0402
R8	1	33K; 1%; 0402
R11	1	820K; 1%; 0402
R12	1	47K; 5%; 0402
R15, R16	2	100K; 5%; 0402
U1	1	MAX16170
VIN3, VOUT3	2	TEST POINT KEYSTONE: 5000
PCB	1	PCB:MAX16170 EVALUATION KIT

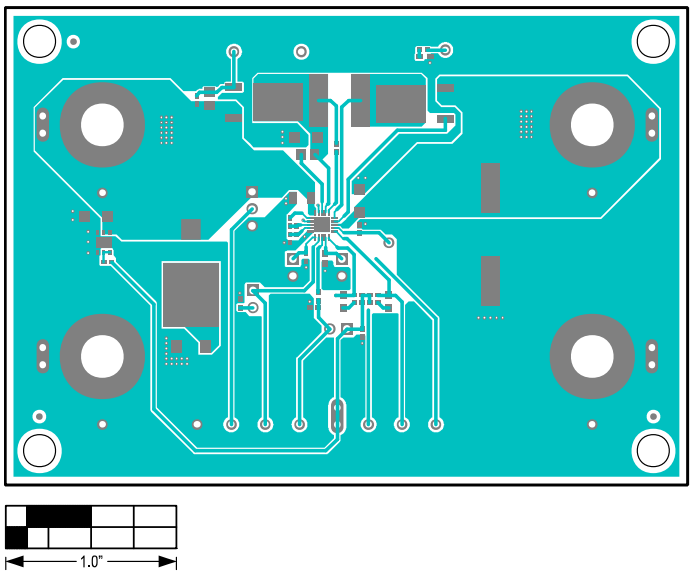
MAX16170 EV Kit Schematic Diagram



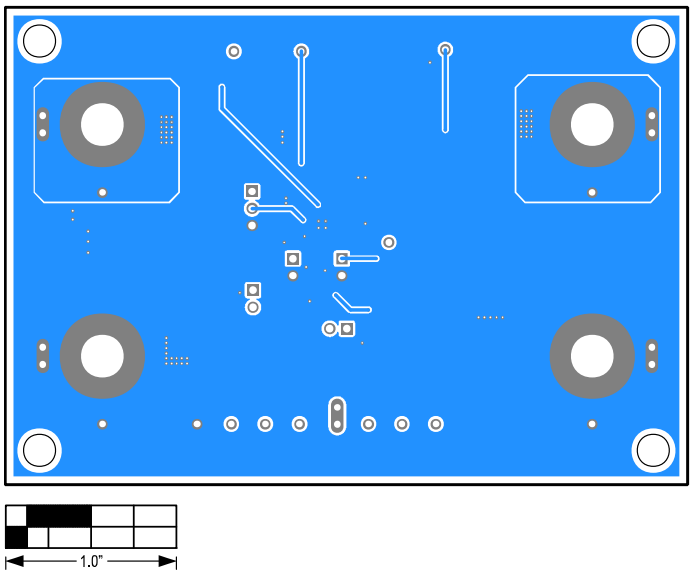
MAX16170 EV Kit PCB Layout Diagrams



MAX16170 EV Kit Component Placement Guide—Top Silkscreen



MAX16170 EV Kit PCB Layout—Top View



MAX16170 EV Kit PCB Layout—Bottom View

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	04/23	Initial release	—