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Evaluates: MAX17702 in 13.8V Lead-Acid Battery Charger Application

MAX17702EVKITA# Evaluation Kit

General Description

The MAX17702EVKITA# (EV kit) provides a proven design to evaluate the MAX17702 high-efficiency, high-voltage, Himalaya synchronous step-down DC-DC lead-acid (Pb-acid) charger controller. The EV kit charges the Pb-acid battery in constant current (CC), absorption constant-voltage (CV) states, and enters an floating CV state after detecting the taper current threshold or absorption CV timer timeout in the absorption CV state. The EV kit is designed to charge the Pb-acid battery with 10A CC mode charging current (I_{CHGMAX}) and 13.8V absorption CV voltage (V_{OUT}) from a 16.8V to 60V input supply. The EV kit is optimized for 24V nominal input-voltage application. The switching frequency of the EV kit is set at 350kHz (f_{SW}) for optimum efficiency and component size. The EV kit features an absorption CV timer (TMR) to set the maximum charging time in the absorption CV state. The EV kit features battery temperature sensing and charges only when the temperature is in the allowable charging temperature range. The EV kit also features the charging voltage temperature compensation based on battery temperature. The EV kit also provides a good layout example, which is optimized for conducted, radiated EMI and thermal performance. For more details about the IC benefits and features, refer to the MAX17702 IC data sheet.

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

Features

- Operates from a 16.8V to 60V Input Supply
- 10A CC Mode Charging Current
- 13.8V Absorption CV Voltage and 13.5V Floating CV Voltage
- 350kHz Switching Frequency
- Resistor-Programmable UVLO Threshold (EN/UVLO)
- Input Short Protection
- 11V Programmed Deeply Discharged Battery Detection
- Capacitor Programmed 17 hours Absorption CV Timer
- Full-Battery Detection with Taper Current Threshold or Absorption CV Timer
- Cycle-by-Cycle Overcurrent Limit
- External Clock Synchronization (RT/SYNC)
- Charger Status Flags (FLG1 and FLG2)
- Charging Current Monitoring (ISMON)
- Battery Temperature Sensing and Charge when Within Operating Temperature Range of -20°C to +60°C
- Charging Voltage Temperature Compensation (-18mV/°C)
- IC Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested
- Complies with CISPR 32 (EN55032) Class B Conducted and Radiated Emissions

319-100745; Rev 2; 4/22

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Quick Start

Recommended Equipment

- MAX17702EVKITA#
- 60V, 10A DC input power supply (PS1)
- 12V, 84Ah Pb-acid battery with 22mΩ battery charging resistance
  (or)
  24V, 25A DC power supply (PS2) and 12A DC electronic load (LOAD)
- Four digital voltmeters (DVM)

Equipment Setup and Test Procedure

The 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. Carefully make the connections to avoid the battery short circuit at the output. Do not operate the EV kit without battery or preloaded supply.

The battery charger can be tested in two different ways, either with a battery or preloaded supply (power supply with electronic load).

Testing with Battery:

1) Set the power supply at a voltage between 16.8V and 60V. Disable the power supply (PS1).
2) Make sure that the battery has an open-circuit voltage of 12V.
3) Connect PS1 and Pb-acid battery to the EV kit as shown in Figure 1.
4) Verify that the shunts are installed across pins 1–2 on all jumpers: charger enable/disable jumper (J1), CC mode charging current jumper (J2), TEMP feature jumper (J3) and charger timer jumper (J4). See Table 1, Table 2, Table 3, and Table 4 for details.
5) Connect the digital voltage meter (DVM1) between the ISMON PCB pad and the nearest SGND PCB pad for monitoring the charging current. Connect DVM2 between the VOUT PCB pad and the nearest PGND PCB pad for measuring the charging voltage.
6) Connect the DVM3 between the FLG1 PCB pad and the nearest SGND PCB pad for monitoring the charger status.
7) Connect the DVM4 between the FLG2 PCB pad and the nearest SGND PCB pad for monitoring the charger status. See Table 5 for details.
8) Turn on the DC power supply (PS1).
9) The charger starts in CC state. Verify that the DVM1 displays 1.5V, proportional to the 10A charging current (I_{CHGMAX}).
10) In the CC state, verify that DVM3 and DVM4 display 0V and 5.1V, respectively.
11) When the charging voltage reaches above 13.4V, the charger enters the absorption CV state, and the charging current starts to fall from 10A. Verify that when DVM2 displays above 13.4V, the voltage reading on DVM1 falls from 1.5V, proportional to the charging current. In the absorption CV state, the charger timer counter starts.
12) When the charging current falls below 1A or the default 17-hour absorption CV timer timeout has elapsed, the charger enters the floating state. Verify that DVM1 shows less than 0.15V, proportional to the charging current of less than 1A. Verify that both DVM3 and DVM4 display 0V.
13) In floating CV state, the charging voltage is regulated at 13.5V to maintain the Pb-acid battery at full charge.
14) After testing is completed, switch off the power supply and remove the connections from the EV kit.
15) Carefully remove the battery connection from the EV kit.

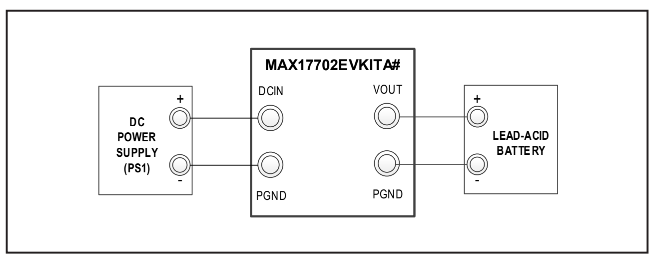


Figure 1. Battery Connection with the EV kit

Testing with Preloaded Supply:

1) Set the first power supply (PS1) at a voltage between 16.8V and 60V. Disable the power supply (PS1).
2) Set the second power supply (PS2) at a voltage of 12V and with current limit of 13A. Disable the power supply (PS2).
3) Set the electronic load (LOAD) at 12A in constant current (CC) mode and disable the load.
4) Connect PS1, PS2, and LOAD to the EV kit as shown in Figure 2.
5) Make sure that the LOAD is connected across the PS2 terminals and the connection resistance from the EV kit to the preloaded supply is not greater than 100mΩ.
6) Verify that the shunts are installed across pins 1–2 on all jumpers: charger enable/disable jumper (J1), CC mode charging current jumper (J2), TEMP feature jumper (J3), and charger timer jumper (J4). See Table 1, Table 2, Table 3, and Table 4 for details.
7) Connect a digital voltage meter (DVM1) between the ISMON PCB pad and the nearest SGND PCB pad for monitoring the charging current.
8) Connect the DVM2 between the VOUT PCB pad and the nearest PGND PCB pad for measuring the charging voltage.
9) Connect the DVM3 between the FLG1 PCB pad and the nearest SGND PCB pad for monitoring the charger status.
10) Connect the DVM4 between the FLG2 PCB pad and the nearest SGND PCB pad for monitoring the charger status. See Table 5 for details.
11) Turn on LOAD and PS2. Verify that 12A load current is supplied by PS2 and adjust the PS2 voltage to maintain the EV kit terminal voltage at 12V.
12) Turn on the DC power supply (PS1).
13) The charger starts in CC state. Verify that DVM1 displays 1.5V, proportional to 10A charging current (I_{CHGMAX}).
14) In CC state, verify that DVM3 and DVM4 display 0V and 5.1V, respectively.
15) Increase the voltage on PS2 in steps of 0.1V to maintain the DVM2 reading at 13.4V where the charger enters the absorption CV state, and the charging current starts to fall from 10A. Verify that when DVM2 displays above 13.4V, the voltage reading in DVM1 falls from 1.5V, proportional to the charging current.
16) Increase the voltage on PS2 such that the charging current falls below the taper current threshold, i.e.,1A. Verify that DVM1 shows less than 0.15V, proportional to the charging current. The charger enters the floating state upon detecting the taper current threshold. Verify that both DVM3 and DVM4 display 0V.
17) In the floating CV state, charging voltage is regulated at 13.5V.
18) Reduce the voltage on PS2 in steps of 0.1V to maintain the DVM2 reading at 13.5V where the charging voltage is regulated in floating CV state.
19) After testing is completed, switch off PS1 and remove the connection.
20) Switch off PS2 and LOAD. Carefully remove the preloaded supply connections from the EV kit.

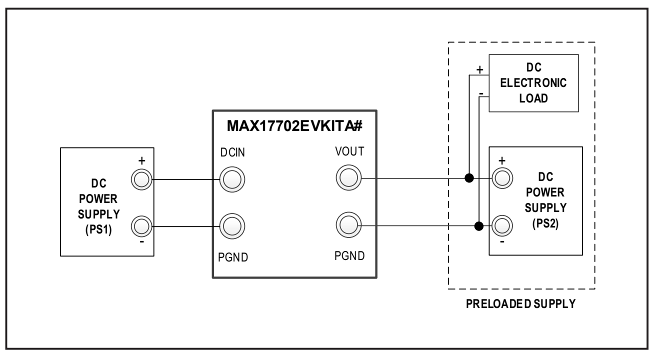


Figure 2. Preloaded Supply Connection with the EV kit

Detailed Description

The MAX17702EVKITA# (EV kit) provides a charging solution for an 84Ah Pb-acid battery with a CC mode charging current of 10A (I_{CHGMAX}), absorption CV voltage of 13.8V, and floating CV voltage of 13.5V from a 16.8V to 60V input supply. The EV kit features a 350kHz switching frequency for optimum efficiency and component size. The RT/SYNC PCB pad allows an external clock to synchronize the device. The EV kit includes jumper J1 to enable/disable the controller. The FLG1 and FLG2 PCB pads allow monitoring of the charger status. The ISMON PCB pad enables the charging current monitor.

Enable/Undervoltage-Lockout (EN/UVLO) Programming

The EV kit offers an adjustable input undervoltage lockout (UVLO) feature. Figure 3 shows the input undervoltage lockout setting on the EV kit. The input voltage above which the charger is enabled, can be set with a resistor-divider connected to EN/UVLO from DCIN to PGND. See Table 1 for charger enable/disable jumper (J1) settings. To enable the charger and set the UVLO, install a shunt across pins 1–2 on jumper J1.

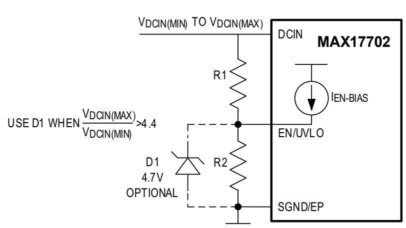


Figure 3. Setting the Input Undervoltage Lockout

To disable the charger, install a shunt across pins 2–3 on jumper J1. The $V_{DCIN(MIN)}$ is selected as 16V for this EV kit.

Choose R1 as follows:

$$R1 \leq (10000 \times V_{DCIN(MIN)})$$

where $V_{DCIN(MIN)}$ is the voltage at which the device is required to turn on.

Calculate the value of R2 using the following equation:

$$R2 = \frac{V_{EN\_TH\_R} \times R1}{V_{DCIN(MIN)} - V_{EN\_TH\_R} + (I_{EN-BIAS} \times R1)}$$

where:

$I_{EN-BIAS}$ = Internal bias pullup current on the EN/ULVO pin (3μA)

$V_{EN\_TH\_R}$ = EN/UVLO pin rising threshold voltage (1.25V)

For more details about setting the undervoltage lockout level, refer to the MAX17702 data sheet.

CC Mode Charging Current Setting (ILIM)

The EV kit provides the CC mode charging current programming feature. The ILIM PCB pad on the EV kit supports external control of the CC mode charging current (I_{CHGMAX}). See Table 2 for the CC mode charging current jumper J2 settings. To fix the I_{CHGMAX} at 10A, install a shunt across pins 1–2 on jumper J2. To control I_{CHGMAX}, install a shunt across pins 2–3 on jumper J2 and apply a voltage (V_{ILIM}) between the ILIM_EXT test point and the nearest SGND PCB pad. The allowable voltage range on ILIM_EXT is 0.9V–1.5V. To fix the I_{CHGMAX} at 6A, remove the shunt on jumper J2. For more details about the CC mode charging current setting, refer to the MAX17702 IC data sheet.

Table 1. Charger Enable/Disable Jumper (J1) Settings

JUMPER	SHUNT POSITION	EN/UVLO PIN	CHARGER OPERATION
J1	1–2*	Connected to the input UVLO divider midpoint	Enabled, UVLO level is set by the resistor devider from DCIN to SGND/EP
	2–3	Connected to SGND/EP	Disabled

**Default position.*

Table 2. CC Mode Charging Current Jumper (J2) Settings

JUMPER	SHUNT POSITION	ILIM PIN	I_{CHGMAX} SETTING
J2	1–2*	Connected to V_{REF}	10A
	2–3	Connected to the ILIM_EXT PCB pad	6.67 x V_{ILIM}
	Not installed	Connected to the ILIM resistor divider (R8 and R9) midpoint	6A

**Default position.*

Deeply Discharged Battery Detection and Preconditioning

The EV kit features deeply discharged battery detection and preconditioning of the Pb-acid battery. The deeply discharged battery voltage level is set at 11V on the EV kit as per a typical 12V/84Ah Pb-acid battery specification. If the battery voltage detected is less than 11V across the EV kit output, then the charger enters the precharge state. In the precharge state, the charging current is set to 1/10th of I_{CHGMAX} (1A) and the charger timer counter starts. If the EV kit output is not reached above 11V within the precharge-timer timeout (2.1 hours), the charger enters the latched-fault state. Otherwise, the charger enters the CC state.

For the deeply discharged battery voltage level setting other than 11V, R3 and R4 resistors need to be changed on the EV kit. Use the following equations to calculate the required R3 and R4 values for the deeply discharged battery voltage level setting (V_{OUTDD}).

Select R_3 in the range of 50kΩ to 100kΩ.

$$R4 = \frac{R3}{\left(\frac{V_{OUTDD}}{1.25} - 1\right)}$$

For more details about the battery precharge state detection mechanism, refer to the MAX17702 IC data sheet.

Battery Operating Temperature Range Setting (TEMP)

The EV kit features a battery operating temperature range setting (TEMP) and charges only when the battery temperature is within the programmed operating temperature range using a negative temperature coefficient (NTC) thermistor. Figure 4 shows the TEMP setting on the EV kit. The battery operating temperature range setting on the EV kit is -20°C to +60°C. See Table 3 for the TEMP feature jumper J3 settings. To disable the TEMP feature, install a shunt across pins 1–2 on jumper J3. To enable TEMP feature, install a shunt across 2–3 on jumper J3, 47kΩ NTC thermistor (with B-constant (25°C–85°C) = 4108, packed out with the EV kit) should be connected at the RT1 PCB footprint, on the EV kit. The NTC thermistor head should be attached on the battery to sense the battery temperature.

For changing the battery operating temperature range, use the following equations to calculate the required R6, R16, and R7 values for the desired battery operating temperature range.

$$R7 = 127k\Omega;\ \text{For}\ (T_{HOT} - T_{COLD}) > 45°C$$

$$= \frac{2.86 \times R_{NTCCOLD} \times R_{NTCHOT}}{(R_{NTCCOLD} - 3.86 \times R_{NTCHOT})};$$

$$\text{For}\ (T_{HOT} - T_{COLD}) \leq 45°C$$

$$R16 = 0.35 \times R_{EFF\_COLD} - 1.35 \times R_{EFF\_HOT};$$

$$\text{For}\ (T_{HOT} - T_{COLD}) > 45°C$$

$$R16 = 0;\ \text{For}\ (T_{HOT} - T_{COLD}) \leq 45°C$$

$$R6 = \frac{2}{3}(R16 + R_{EFF\_COLD})$$

$$R_{EFF\_COLD} = \frac{R_{NTCCOLD} \times R7}{(R_{NTCCOLD} + R7)}$$

$$R_{EFF\_HOT} = \frac{R_{NTCHOT} \times R7}{(R_{NTCHOT} + R7)}$$

where:

T_{HOT} = Maximum battery charging temperature limit in °C

T_{COLD} = Minimum battery charging temperature limit in °C

R_{NTCHOT} = Resistance value of the 47kΩ NTC thermistor (RT1) at T_{HOT}

$R_{NTCCOLD}$ = Resistance value of the 47kΩ NTC thermistor (RT1) at T_{COLD}

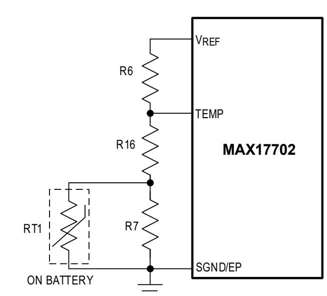


Figure 4. Setting the Battery Operating Temperature Range

Table 3. TEMP Feature Jumper (J3) Settings

JUMPER	SHUNT POSITION	TEMP CONNECTION SETTING	TEMP FEATURE
J3	1–2*	Connected to the 47kΩ resistor (R5)	Disabled
	2–3	Connected to the 47kΩ NTC thermistor (RT1)	Enabled, set the operating battery temperature range of -20°C to +60°C

**Default position.*

Charger Timers (TMR)

The EV kit features a charger timer to set the timeout in precharge and absorption CV states. The charger timer setting is adjusted by the value of the capacitor between TMR and SGND/EP. The default programmed absorption CV timer timeout on the EV kit is 17 hours. The programmed precharge timer timeout on the EV kit is 2.1 hours (1/8th of the absorption CV timer timeout). For more details on charger timers, refer to the MAX17702 IC data sheet.

To enable the timer feature, install a shunt across 1–2 on the charger timer jumper (J4) to connect the TMR capacitor to TMR pin. To disable the timer feature, install a shunt across pins 2–3 on jumper J4 to connect the V_{REF} pin to TMR pin. See Table 4 for jumper J4 settings.

To change the charger timer setting on the EV kit, the TMR capacitor needs to be calculated as per the required charging time in the absorption CV state from the battery charging characteristics and replace C16 with the desired TMR capacitor. Use the following equation to calculate the C_{TMR} for the required charger timer period in absorption CV state (T_{FCHG}):

$$C_{TMR} \geq 1.15 \times \left(\frac{T_{FCHG}}{2 \times t_{FCHG}}\right) \times \left(\frac{I_{TMR}}{V_{TNR\_H} - V_{TMR\_L}}\right)$$

where,

T_{FCHG} = Desired absorption CV timer setting in seconds

C_{TMR} = TMR capacitor in Farad

t_{FCHG} = Number of TMR cycles in absorption CV state (2097151)

V_{TMR_H} = TMR oscillator upper threshold (1.5V)

V_{TMR_L} = TMR oscillator lower threshold (0.96V)

I_{TMR} = TMR pin source/sink current (10μA).

For more details about charger timers and charger operation, refer to the MAX17702 IC datasheet.

External Clock Synchronization (RT/SYNC)

The EV kit provides an RT/SYNC PCB pad to synchronize the MAX17702 to an optional external clock. The external synchronization clock frequency must be between 0.9 x f_{SW} and 1.1 x f_{SW}, where f_{SW} is the frequency of operation set by R10. The switching frequency (f_{SW}) programmed on the EV kit is 350kHz. In the presence of a valid external clock for synchronization for 112 cycles of internal switching clock, the MAX17702 starts to sync with an external clock. For more details about external clock synchronization, refer to the MAX17702 IC data sheet.

Charger Status Output (FLG2, FLG1)

The EV kit provides FLG1 and FLG2 PCB pads to indicate the charger status. Table 5 shows the charger status flag summary.

Table 4. Charger Timer Jumper (J4) Settings

JUMPER	SHUNT POSITION	TMR CONNECTION SETTING	CHARGER TIMER FEATURE
J4	1–2*	Connected to TMR capacitor (0.27μF)	Enabled, set at 17 hours
	2–3	Connected to V_{REF}	Disabled

**Default position.*

Table 5. Charger Status Output Indications

CHARGER STATUS FLAGS (FLG2 AND FLG1)	FLG2 VOLTAGE (V)	FLG1 VOLTAGE (V)	CHARGER STATUS
11	5.1	5.1	Charger off
10	5.1	0	Charging in progress
00	0	0	Floating charging
01	0	5.1	Latched-fault or charge suspend due to high- (> +60°C) or low-(< -20°C) battery-temperature detection*

**A latched-fault state includes latched hardware faults and faulty battery states. Charge suspended due to high or low battery temperature is not a latched fault.*

For more details about hardware faults, refer to the MAX17702 IC data sheet.

Charging Voltage Temperature Compensation

The EV kit provides temperature compensation of battery charging voltage by including a linear positive temperature coefficient (PTC) resistor in an output-voltage feedback circuit. Temperature compensation is disabled on the default EV kit. A battery charging voltage temperature compensation of -18mV/°C can be enabled by removing the R21 resistor and connecting the PTC resistor (packed out with the EV kit) across the RT2 terminals. The PTC thermistor head should be attached to the battery. Operate the charger only when either the R21 or RT2 resistor is connected, but not when both are connected. For more details on temperature compensation, refer to the MAX17702 IC data sheet.

System Considerations

The MAX17702 EV kit is designed to charge Pb-acid batteries. When load current is drawn during the battery charging process, the charging current available for battery charging reduces. This influences the charging time in precharge and absorption CV states. The timer setting must be adjusted accordingly for the intended charging process. If the load current drawn is more than the taper current threshold (1A), the charger continues to operate in the absorption CV state until the timer is elapsed. The charger enters an floating CV state, after the timer elapses in the absorption CV state. If the timer is disabled and the load current is more than 1A, the charger continues to operate in the absorption CV state.

For safe operation, follow the procedure below while making connections:

1) Connect the battery terminals to the output of the charger circuit. Note that the output capacitors of the charger can draw current from the battery during a hot plug-in/connection process.
2) Connect the input power source to the battery charger circuit only after securely connecting the battery at the output.
3) Do not operate the charger without a battery or a preloaded supply.

For more details about charger operation, refer to the MAX17702 IC data sheet.

EV Kit Redesign Recommendation for Custom Battery Charging Parameters

The MAX17702EVKITA# is designed for 12V/84Ah Pb-acid battery with a charging resistance of 22mΩ. For other battery specification, the following battery charging parameters need to be considered to redesign the EV kit application circuit.

Battery Charging Resistance

The charger controller needs to be designed according to worst-case maximum battery charging resistance (R_{BAT}). If R_{BAT} is greater than 100mΩ, the compensation capacitor (C17) on the EV kit needs to be redesigned using the following equation:

$$C17 = \frac{0.8 \times L1}{R12 \times R_E}$$

where:

$R_E = R_{DCR} + R_S + R_{DS\_ON(HS)} \times D_{MIN} + R_{DS\_ON(LS)} \times (1 - D_{MIN}) + R_{BAT}$

R_{DCR} = DC resistance of inductor (L1)

R_S = Current sense resistor value (R27)

$R_{DS\_ON(HS)}$, $R_{DS\_ON(LS)}$ = Maximum on-state resistances of high-side MOSFET (Q4) and low-side MOSFET (Q3), respectively

V_{OUT} = Desired regulation voltage across the battery in absorption CV state

V_{DCIN_MAX} = Maximum operating input voltage

$$D_{MIN} = \frac{V_{OUT}}{V_{DCIN\_MAX}}$$

Battery Charging Current (I_{CHGMAX})

If the battery charging current in CC state needs to be increased greater than 10A or less than 6A on the EV kit, the following components on the EV kit might need to be redesigned:

1) Buck converter inductor (L1)
2) Current sense resistor (R27)
3) ILIM resistor divider circuit (R8 and R9)
4) Input capacitance on VIN (refer to the schematic)
5) Output capacitance on VOUT (Refer to the schematic)
6) Current regulation loop compensation (R12, C17, and C18)
7) Step-down converter nMOSFET selection (Q2, Q3, Q4, and Q5)
8) Input short-circuit protection external nMOSFET selection (Q1)

For the detailed design guidelines, refer to the MAX17702 IC datasheet.

Battery Charging Voltage (V_{OUT})

If the battery charging voltage in the absorption CV state and floating CV state needs to be changed on the EV kit, the following components on the EV kit might need to be redesigned:

1) Battery feedback resistor divider circuit (R22, R30 and R31)
2) External power-supply input for EXT-LDO (EXTVCC) connection circuit (R15 and C23)
3) Buck converter inductor (L1)
4) Input capacitance on VIN (Refer to the schematic)
5) Output capacitance on VOUT (Refer to the schematic)
6) Step-down converter nMOSFET selection (Q2, Q3, Q4, and Q5)
7) Input short-circuit protection external nMOSFET selection (Q1)

For the detailed design guidelines, refer to the MAX17702 IC datasheet.

Hot Plug-In and Long Input Cables

The MAX17702EVKITA# PCB layout provides an electrolytic capacitor (C15 = 68μF/100V). This capacitor limits the peak voltage at the input of the MAX17702 when the DC input source is “hot-plugged” to the EV kit input terminals (DCIN) with long cables. The equivalent series resistance (ESR) of the electrolytic capacitor dampens the oscillations caused by interaction of the inductance of the long input cables, and the ceramic capacitors at the charger input (VIN). An electrolytic capacitor at DCIN prevents the DCIN voltage from being less than -0.3V during input short events by providing damping with ESR. Additionally, if required, add a Schottky diode (D3; refer to the *MAX17702EVKITA# Schematic*) with an 80V rating at DCIN in parallel with the electrolytic capacitor (C15).

Long Output Cables

The MAX17702EVKITA# PCB layout provides an electrolytic capacitor foot print (C56) to place an electrolytic capacitor, if required. In applications with a long cable between the MAX17702EVKITA# output and the battery, to dampen the oscillations caused by the interaction of the cable inductance with the low ESR output capacitors of the MAX17702EVKITA#, an electrolytic capacitor with appropriate ESR (equivalent series resistance) may be used.

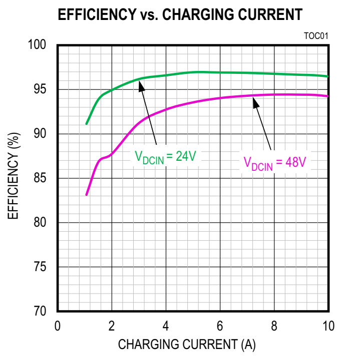
Choose an electrolytic capacitor equal to 1.5 times the value of selected low ESR output capacitance (C_{OUT_SEL}). Select an electrolytic capacitor with the an equivalent series resistance (ESR_{ELCO}) as calculated below:

$$ESR_{ELCO} = \sqrt{\frac{L_{CABLE}}{C_{OUT\_SEL}}}$$

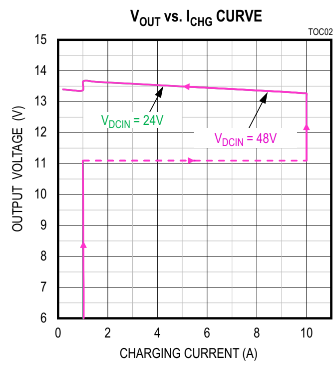
where L_{CABLE} is the output cable inductance.

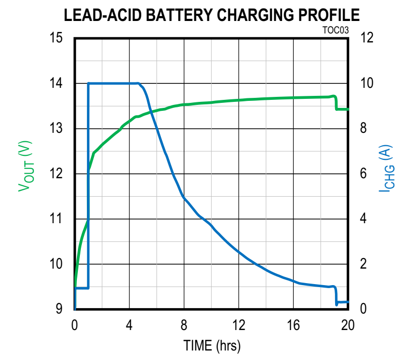
MAX17702EVKITA# Performance Report

(V_{DCIN} = 24V, V_{OUT} = 13.8V, I_{CHGMAX} = 10A, f_{SW} = 350kHz, T_A = +25ºC, unless otherwise noted.)

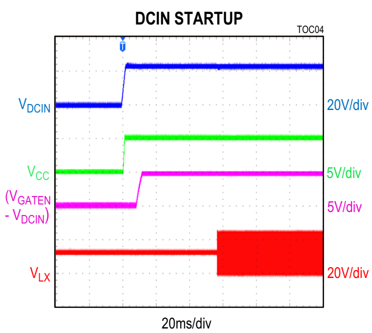


CONDITIONS: ABSORPTION CV STATE

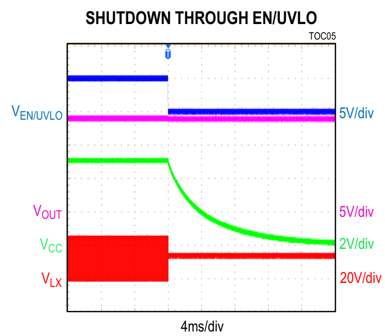




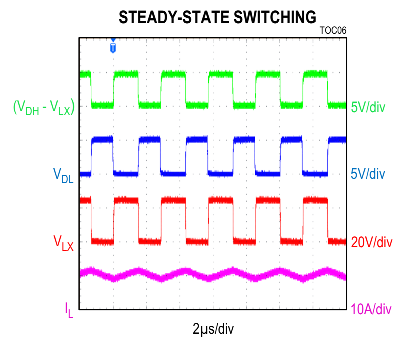
CONDITIONS: START WITH PRECHARGE STATE, LEAD-ACID BATTERY: 12V, 84Ah



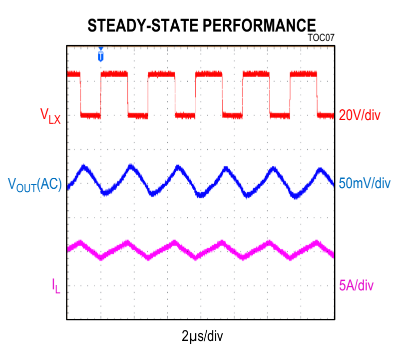
CONDITIONS: CC STATE



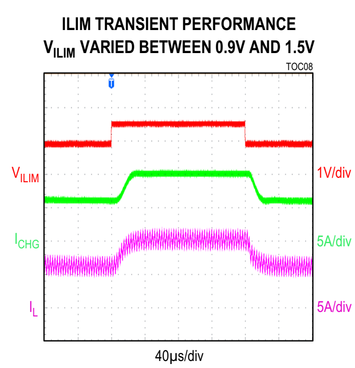
CONDITIONS: ABSORPTION CV STATE, I_{CHG} = 2A



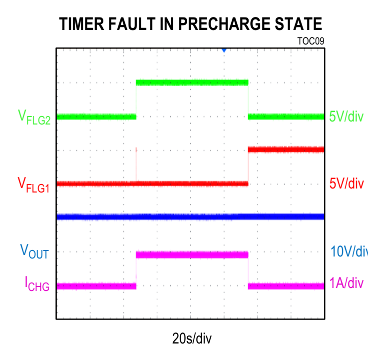
CONDITIONS: CC STATE



CONDITIONS: ABSORPTION CV STATE, I_{CHG} = 5A



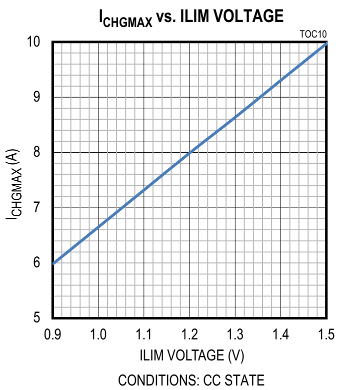
CONDITIONS: CC STATE

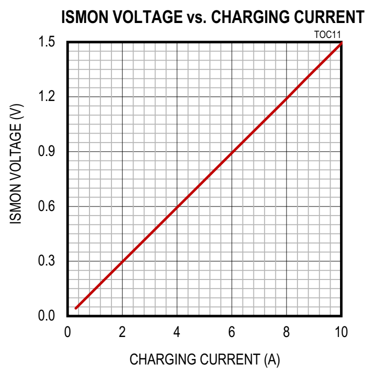


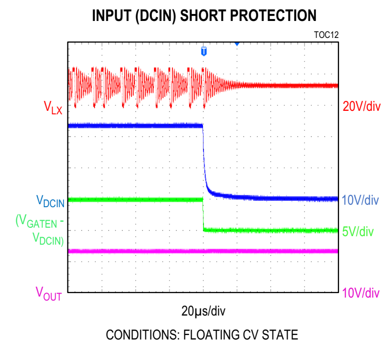
CONDITIONS: C16 = 2.2nF (TMR CAPACITOR)

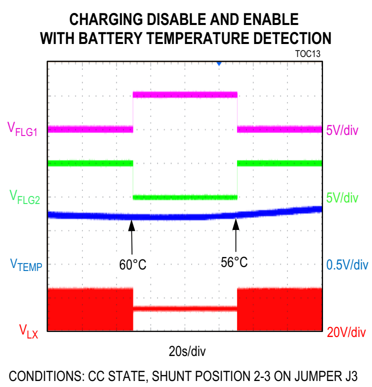
MAX17702EVKITA# Performance Report (continued)

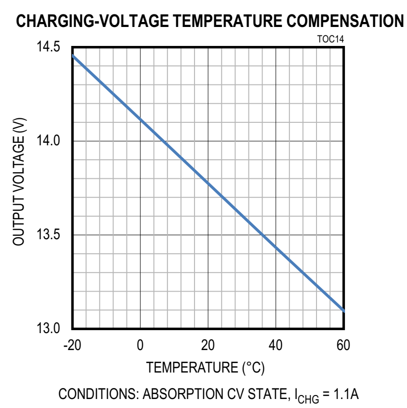
(V_{DCIN} = 24V, V_{OUT} = 4.2V, I_{CHGMAX} = 10A, f_{SW} = 350kHz, T_A = +25ºC, unless otherwise noted.)

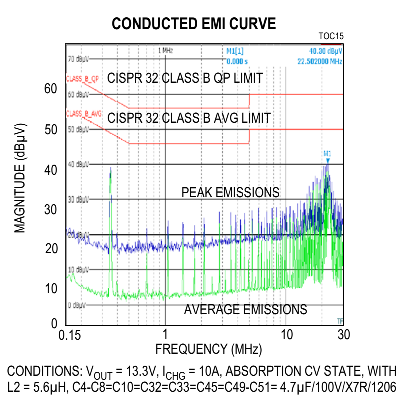


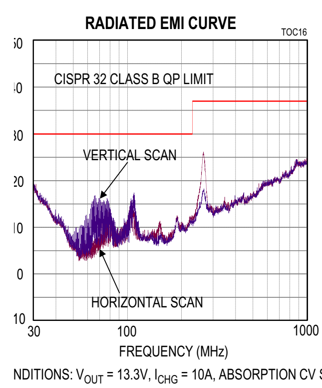












Component Suppliers

SUPPLIER	WEBSITE
Coilcraft, Inc.	www.coilcraft.com
Murata Americas	www.murataamericas.com
Panasonic Corp.	www.panasonic.com
TDK	www.tdk.com
Vishay	www.vishay.com
Taiyo Yuden	www.yuden.co.jp
Diodes Inc.	www.diodes.com
Yageo Corp.	www.yageo.com

Note: Indicate that you are using the MAX17702 when contacting these component suppliers.

Ordering Information

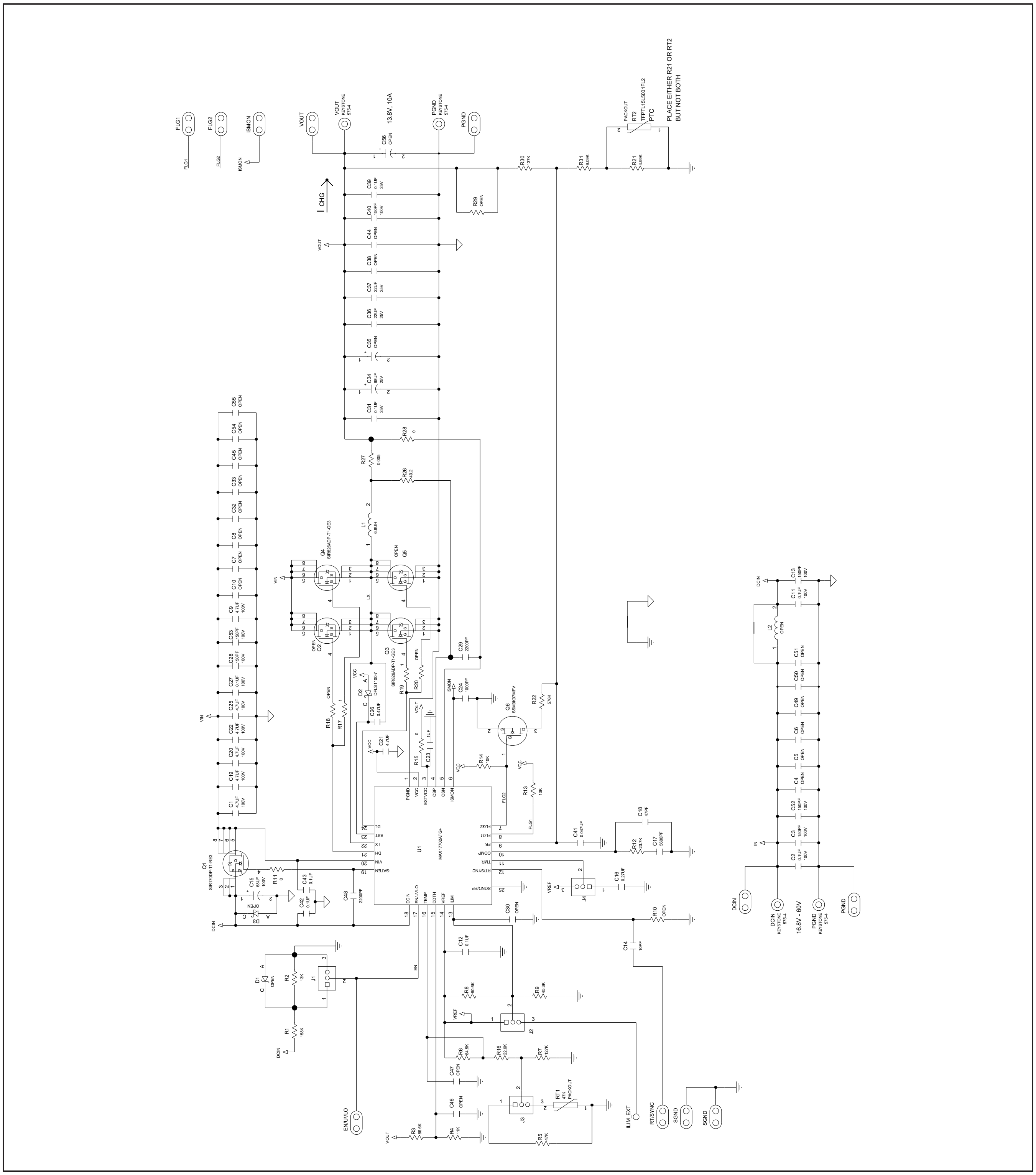
PART	TYPE
MAX17702EVKITA#	EV Kit

MAX17702EVKITA# Bill of Materials

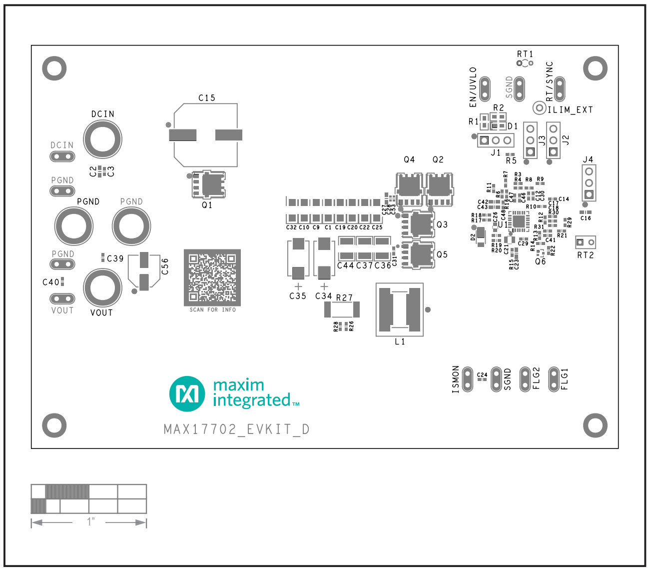
S. No	DESIGNATOR	DESCRIPTION	QUANTITY	MANUFACTURER PART NUMBER
1	C1, C9, C19, C20, C22, C25	4.7μF, 10%, 100V, X7R, Ceramic capacitor (1206)	6	MURATA GRM31CZ72A475KE11
2	C2, C11, C27, C42, C43	0.1μF, 10%, 100V, X7R, Ceramic capacitor (0603)	5	TAIYO YUDEN HMK107B7104KA
3	C3, C13, C28, C40, C52, C53	150pF, 5%, 100V, COG, Ceramic capacitor (0402)	6	TDK C1005C0G2A151J050BA
4	C12	0.1μF, 10%, 16V, X7R, Ceramic capacitor (0402)	1	TAIYO YUDEN EMK105B7104KV
5	C14	10pF, 5%, 50V, COG, Ceramic capacitor (0402)	1	KEMET C0402C100J5GAC
6	C15	ALUMINUM-ELECTROLYTIC; 68UF; 100V; TOL=20%; MODEL=EEV SERIES	1	PANASONIC EEV-FK2A680Q
7	C16	0.27μF, 10%, 16V, X7R, Ceramic capacitor (0603)	1	KEMET C0603C274K4RAC
8	C17	5600pF, 10%, 50V, X7R, Ceramic capacitor (0402)	1	KEMET C0402C562K5RAC
9	C18	47pF, 5%, 50V, COG, Ceramic capacitor (0402)	1	YAGEO CC0402JRNPO9BN470
10	C21	4.7μF, 10%, 16V, X7R, Ceramic capacitor (0805)	1	MURATA GRM21BR71C475KA73
11	C23	1μF, 10%, 25V, X7R, Ceramic capacitor (0603)	1	TAIYO YUDEN TMK107B7105KA
12	C24	1000pF, 10%, 16V, X7R, Ceramic Capacitor (0402)	1	KEMET C0402C102K4RAC
13	C26	0.47μF, 10%, 16V, X7R, Ceramic capacitor (0603)	1	MURATA GRM188R71C474K
14	C29, C48	2200pF, 10%, 50V, X7R, Ceramic capacitor (0402)	2	MURATA GRM155R71H222KA01
15	C31, C39	0.1μF, 10%, 25V, X7R, Ceramic capacitor (0402)	2	MURATA GRM155R71E104KE14
16	C34	68μF, 20%, 25V, Tantalum capacitor (2917)	1	AVX TCJE686M025R0050
17	C36, C37	22μF, 10%, 25V, X7R, Ceramic capacitor (1210)	2	MURATA GRM32ER71E226KE15
18	C41	47nF, 10%, 50V, X7R, Ceramic capacitor (0402)	1	TDK C1005X7R1H473K
19	D2	SCHOTTKY DIODE PIV=100V; IF=1A	1	DIODES INCORPORATED DFLS1100-7
20	L1	INDUCTOR, 6.8μH, 18.5A (11mm x 11mm), 8.9mΩ	1	COILCRAFT XAL1010-682ME
21	Q1	N-CHANNEL POWER MOSFET (PowerPAK® SO-8) PD-(6.25W); I-(95A); V-(100V)	1	VISHAY SIR170DP-T1-RE3
22	Q3, Q4	N-CHANNEL POWER MOSFET (PowerPAK®SO-8) PD-(6.25W); I-(60A); V-(80V)	2	VISHAY SIR826ADP-T1-GE3
23	Q6	N-CHANNEL SMALL-SIGNAL MOSFET (SOT-723) PD-(0.15W); I-(0.25A); V-(20V)	1	TOSHIBA SSM3K37MFV
24	R1	RESISTOR, 158KΩ, 1% (0603), 0.1W	1	VISHAY DALE CRCW0603158KFK
25	R2	RESISTOR, 13KΩ, 1% (0603), 0.1W	1	VISHAY DALE CRCW060313K0FK
26	R3	RESISTOR, 86.6KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040286K6FK
27	R4	RESISTOR, 11KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040211K0FK
28	R5	RESISTOR, 47KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040247K0FK
29	R6	RESISTOR, 84.5KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040284K5FK
30	R7	RESISTOR, 127KΩ, 1% (0402), 0.1W	1	PANASONIC ERJ-2RKF1273
31	R8	RESISTOR, 80.6KΩ, 1% (0402), 0.1W	1	PANASONIC ERJ-2RKF8062
32	R9	RESISTOR, 45.3KΩ, 1% (0402), 0.0625W	1	PANASONIC ERJ-2RKF4532
33	R11, R15, R28	RESISTOR, 0Ω, 5% (0402), 0.0625W	3	YAGEO PHYCOMP RC0402JR-070RL
34	R12	RESISTOR, 23.7KΩ, 1% (0402), 0.1W	1	PANASONIC ERJ-2RKF2372
35	R13, R14	RESISTOR, 10KΩ, 1% (0402), 0.0625W	2	YAGEO PHYCOMP RC0402FR-0710KL
36	R16	RESISTOR, 22.6KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040222K6FK
37	R17, R19	RESISTOR, 1Ω, 1% (0402), 0.0625W	2	VISHAY DALE CRCW04021R00FK
38	R21	RESISTOR, 4.99KΩ, 1% (0805), 0.125W	1	VISHAY DALE CRCW08054K99FK
39	R22	RESISTOR, 576KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW0402576KFK
40	R26	RESISTOR, 40.2Ω, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040240R2FK
41	R27	RESISTOR, 0.005Ω, 1% (2512), 1W	1	VISHAY DALE WSL25125L000F
42	R30	RESISTOR, 137KΩ, 1% (0402), 0.0625W	1	PANASONIC ERJ-2RKF1373
43	R31	RESISTOR, 9.09KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW04029K09FK
44	U1	SYNCHRONOUS STEP-DOWN LEAD-ACID BATTERY CHARGER CONTROLLER (TQFN24-EP 4mm x 4mm)	1	MAX17702ATG+
45	DCIN, PGND, PGND2, VOUT	BANANA JACK (5.2mm DIA X 5.5mm LENGTH)	4	KEY STONE 575-4
46	ILIM_EXT	TEST POINT, PIN DIA=0.1IN; TOTAL LENGTH=0.3IN;	1	KEY STONE 5000
47	J1-J4	3-pin header (0.1" centers)	4	SULLINS PEC03SAAN
48	-	SHUNTS	4	SULLINS STC02SYAN
49	RT1	THERMISTOR, NTC, 47KOHM, 1%, 4108K (B25°C-85°C) THROUGH HOLE-RADIAL LEAD	1 (Separate Packout with EV kit)	MURATA NXFT15WB473FA2B150
50	RT2	THERMISTOR PTC 5KOHM, 1%, THROUGH HOLE-RADIAL LEAD	1 (Separate Packout with EV kit)	VISHAY TFPTL15L5001FL2
51	C4-C8, C10, C32, C33, C45, C49-C51	OPTIONAL: 4.7μF, 10%, 100V, X7R, Ceramic capacitor (1206)	12	MURATA GRM31CZ72A475KE11
52	L2	OPTIONAL: INDUCTOR, 5.6μH, 12.6A (6.7mm x 6.5mm), 11.7mΩ	1	COILCRAFT XGL6060-562ME
53	C30, C46, C47	OPEN: CAPACITOR (0402)	0	
54	C35	OPEN: TANTALUM CAPACITOR (2917)	0	
55	C38, C44	OPEN: CAPACITOR (1210)	0	
56	C54, C55	OPEN: CAPACITOR (1206)	0	
57	C56	OPEN: ALUMINUM-ELECTROLYTIC CAPACITOR (7mmx8.5mm)	0	
58	D1	OPEN: SOD-523F	0	
59	D3	OPEN: SCHOTTKY DIODE (SMB)	0	
60	Q2, Q5	OPEN: PowerPAK®SO-8	0	
61	R10, R18, R20, R29	OPEN: RESISTOR (0402)	0	

DEFAULT JUMPER TABLE	
JUMPER	SHUNT POSITION
J1, J2, J3, J4	1-2

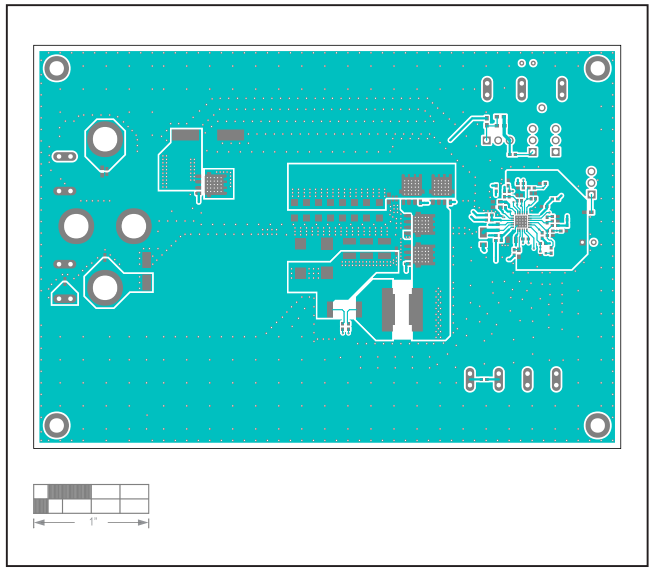
MAX17702EVKITA# Schematic



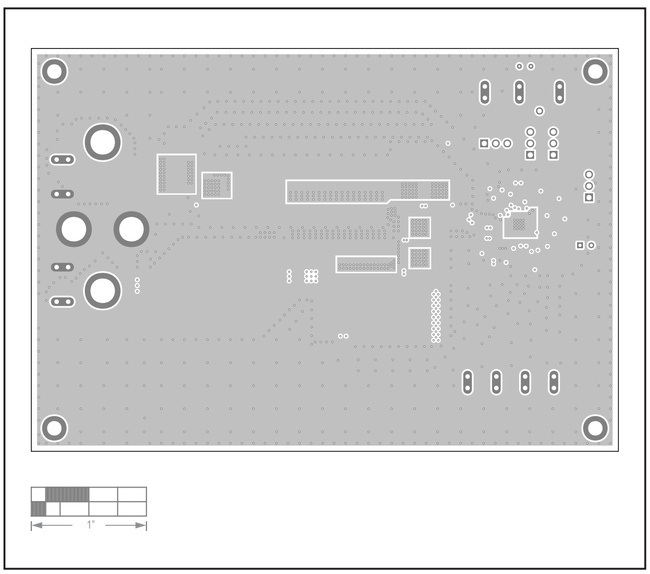
MAX17702EVKITA# PCB Layout



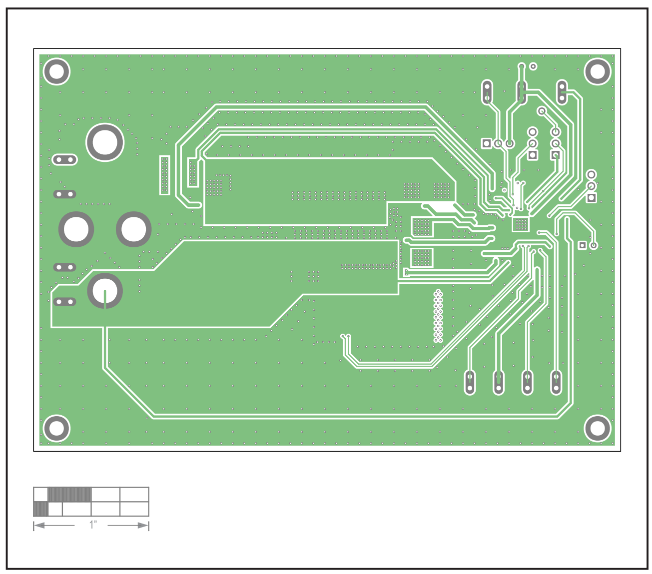
MAX17702EVKITA#—Top Silkscreen



MAX17702EVKITA#—Top Layer

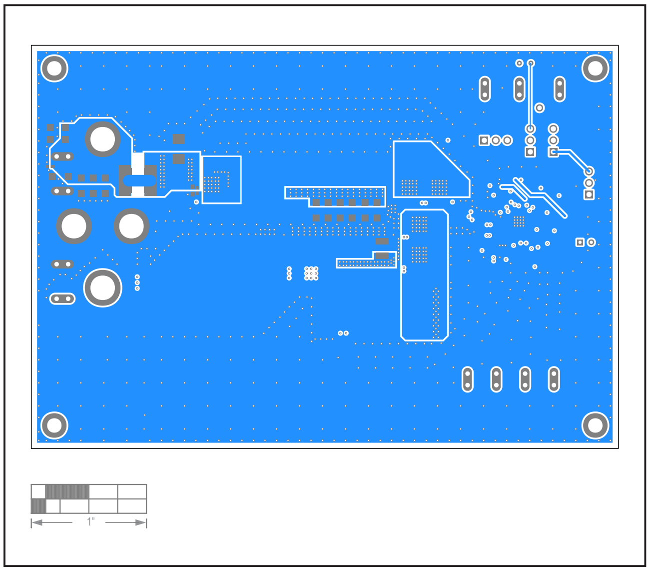


MAX17702EVKITA#—Layer 2

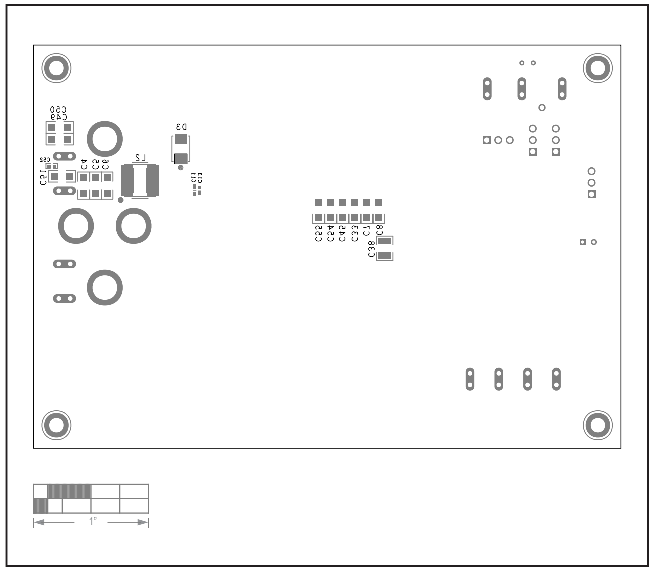


MAX17702EVKITA#—Layer 3

MAX17702EVKITA# PCB Layout (continued)



MAX17702EVKITA#—Bottom Layer



MAX17702EVKITA#—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	4/21	Initial Release	—
1	1/22	Updated *Features*, *Equipment Setup and Test Procedure*, and *Detailed Description* sections, *Typical Operating Characteristics* 1, 2, 12, 13, 15, and 16, *Bill of Materials, Schematic*, and *PCB Layouts*	1–6, 8–15
2	2/22	Updated Table 1 and Table 2	4

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