*Click here to ask about the production status of specific part numbers.*

# MAX17760BEVKIT# Evaluation Kit

# Evaluates: MAX17760 in 12V Output-Voltage Application

## General Description

The MAX17760BEVKIT# evaluation kit (EV kit) provides a proven design to evaluate the MAX17760 high-efficiency, high-voltage, synchronous step-down DC-DC converter in a TDFN package. The EV kit generates 12V at load currents up to 300mA from a 16V to 76V input supply. The EV kit features a 400kHz switching frequency for optimum efficiency and component size. The EV kit features adjustable input undervoltage lockout, adjustable soft-start, adjustable switching frequency, open-drain $\overline{\text{RESET}}$ signal, and external clock synchronization. The EV kit also provides a good layout example, which is optimized for thermal performance. For more details about the IC Benefits and Features, refer to the MAX17760 IC data sheet.

## Features

- Operates from a 16V to 76V Input Supply
- 12V Output Voltage
- Up to 300mA Output Current
- 400kHz Switching Frequency
- Enable/UVLO Input, Resistor-Programmable UVLO Threshold
- Adjustable Soft-Start Time
- MODE Pin to Select between PWM or PFM Modes
- Bootstrap Bias Input for Improved Efficiency
- Open-Drain $\overline{\text{RESET}}$ Output
- External Clock Synchronization
- Overcurrent and Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested

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

## Quick Start

### Recommended Equipment

- MAX17760BEVKIT#
- 76V, 0.5A DC input power supply
- Load capable of sinking 300mA
- 2 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.**

1) Set the power supply at a voltage of 14V. Then, disable the power supply.
2) Connect the positive terminal of the power supply to the VIN PCB pad and the negative terminal to the nearest PGND PCB pad. Connect the positive terminal of the 300mA load to the VOUT PCB pad and the negative terminal to the nearest PGND PCB pad.
3) Connect one DVM across the VOUT PCB pad and the nearest PGND PCB pad, and the other DVM across the $\overline{\text{RESET}}$ PCB pad and SGND PCB pad.
4) Verify that shunts are installed across pins 1–2 on jumper JU1 and JU2 (see Table 1 and Table 2 for details), and JU3 is open.
5) Turn on the DC power supply.
6) Enable the load.
7) Verify that both the DVMs display approximately 0V.
8) Increase the input voltage to 16V, which is just above the EN/UVLO rising threshold.
9) Verify that the DVM across the VOUT PCB pad and the nearest PGND PCB pad displays 12V.
10) Verify that the DVM across the $\overline{\text{RESET}}$ PCB pad and the SGND PCB pad displays 5V.
11) The power-supply voltage can be set at any voltage between 16V and 76V and both the DVMs still read the same voltages.
12) Reduce the input voltage to 11.5V, which is below the EN/UVLO falling threshold.
13) Verify that both the DVMs display approximately 0V.
14) Disable the input power supply.



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## Detailed Description

The MAX17760BEVKIT# provides a proven design to evaluate the MAX17760 high-efficiency, high-voltage, synchronous step-down DC-DC converter. The EV kit generates 12V at load currents up to 300mA from a 16V to 76V input supply. The EV kit features a 400kHz switching frequency for optimum efficiency and component size. The EV kit includes an EN/UVLO PCB pad and JU1 to enable the output at a desired input voltage or enable the converter through an external enable signal on the EN/UVLO PCB pad. The RT/SYNC PCB pad and JU3 allow an external clock to synchronize the device. An additional $\overline{\text{RESET}}$ PCB pad is available for monitoring when the converter output is in regulation.

### Enable/Undervoltage-Lockout (EN/UVLO) Programming

The MAX17760 offers an Enable and an adjustable input undervoltage lockout feature. In this EV kit, for always-on operation, leave the EN/UVLO jumper (JU1) open. To disable the MAX17760, install a shunt across pins 2–3 on JU1. See Table 1 for JU1 settings. The EN/UVLO PCB pad on the EV kit supports external Enable/Disable control of the device. Leave JU1 open when external Enable/Disable control is desired. A potential divider formed by R1 and R2 sets the input voltage ($V_{INU}$) above which the converter is enabled when a shunt is connected across pins 1–2 on JU1.

Choose R1 as follows:

$$R1 \le (110000 \times V_{INU})$$

## Table 1. Converter EN/UVLO Jumper (JU1) Settings

| JUMPER | SHUNT POSITION | EN/UVLO PIN | MAX17760 OUTPUT |
|---|---|---|---|
| JU1 | 1-2* | Connected to the center node of resistor-divider R1 and R2 | Enabled, UVLO level set through the R1 and R2 resistors |
| | Not installed | Floating | Always ON |
| | 2-3 | Connected to SGND | Disabled |

**Default Position*

where, $V_{INU}$ is the voltage at which the device is required to turn on, and R1 is in Ω. Calculate the value of R2 as follows:

$$R2 = \frac{1.215 \times R1}{(V_{INU} - 1.215 + (2.5\mu A \times R1))}$$

### Soft-Start Input (SS)

The EV kit offers an adjustable soft-start function to limit inrush current during startup. The soft-start time is adjusted by the value of the external soft-start capacitor (C6) connected between SS and SGND. The selected output capacitance ($C_{SEL}$) and the output voltage ($V_{OUT}$) determine the minimum required soft-start capacitor as follows:

$$C_{SS} \ge 30 \times 10^{(-6)} \times C_{SEL} \times V_{OUT}$$

The soft-start time ($t_{SS}$) is related to the capacitor connected at SS ($C_{SS}$) by the following equation:

$$t_{SS} = \frac{C_{SS}}{6.25 \times 10^{-6}}$$

For example, to program a 0.9ms soft-start time, a 5.6nF capacitor should be connected from the SS pin to SGND.

### Mode of Operation Selection (MODE)

The EV kit provides a jumper (JU2) that allows the MAX17760 to operate either in PWM or PFM modes. Table 2 shows the mode selection (JU2) settings that can be used to configure the desired mode of operation. Refer to the MAX17760 IC data sheet for more details on the modes of operation.

The mode of operation cannot be changed on-the-fly after power-up.

## Table 2. Modes Selection Jumper (JU2) Settings

| SHUNT POSITION | MODE PIN | MODE OF OPERATION |
|---|---|---|
| 1-2* | Connected to SGND | PWM |
| Not Installed | Unconnected | PFM |

**Default Setting*

### External Clock Synchronization (RT/SYNC)

The EV kit provides an RT/SYNC PCB pad, to synchronize the MAX17760 to an optional external clock. Short jumper (JU3) when external clock signals are applied. See Table 3 for JU3 settings. In the presence of a valid external clock for synchronization, the MAX17760 operates in PWM mode only. For more details about external clock synchronization, refer to the MAX17760 IC data sheet.

## Table 3. External Clock Synchronization Jumper (JU3) Settings

| SHUNT POSITION | RT/SYNC PIN |
|---|---|
| 1-2 | Connected to RT/SYNC PCB pad through a 22pF capacitor. |
| Not Installed* | Not connected to RT/SYNC PCB pad |

**Default Position*

### Active-Low, Open-Drain Reset Output ($\overline{RESET}$)

The EV kit provides a $\overline{RESET}$ PCB pad to monitor the status of the converter. $\overline{RESET}$ goes high when $V_{OUT}$ rises above 95% (typ) of its nominal regulated output voltage. $\overline{RESET}$ goes low when $V_{OUT}$ falls below 92% (typ) of its nominal regulated voltage.

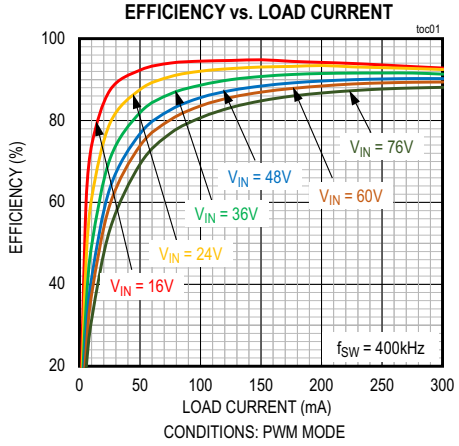
### Hot Plug-In and Long Input Cables

The MAX17760BEVKIT# EV kit PCB layout provides an optional electrolytic capacitor (C1 = 22µF/100V). This capacitor limits the peak voltage at the input of the MAX17760 when the DC input source is “Hot-Plugged” to the EV kit input terminals with long input cables. The equivalent series resistance (ESR) of the electrolytic capacitor dampens the oscillations caused by the interaction of the inductance of the long input cables and the ceramic capacitors at the buck converter input.

## MAX17760BEVKIT# Performance Report

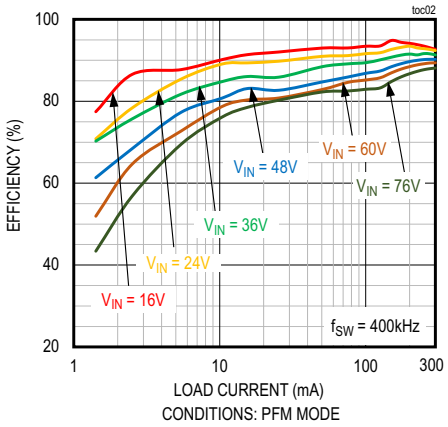
($V_{OUT}$ = 12V, $f_{SW}$ = 400kHz, $T_A$ = +25°C, unless otherwise noted.)

EFFICIENCY vs. LOAD CURRENT



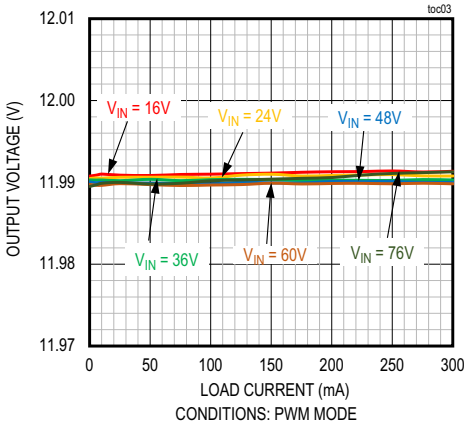

CONDITIONS: PWM MODE

EFFICIENCY vs. LOAD CURRENT



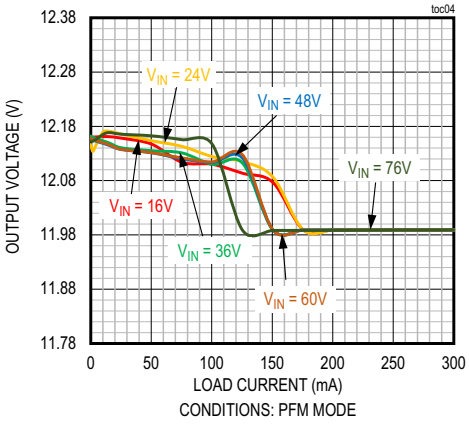

CONDITIONS: PFM MODE

LINE AND LOAD REGULATION



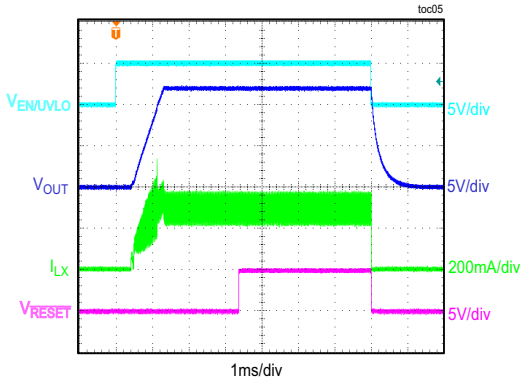

CONDITIONS: PWM MODE

LINE AND LOAD REGULATION



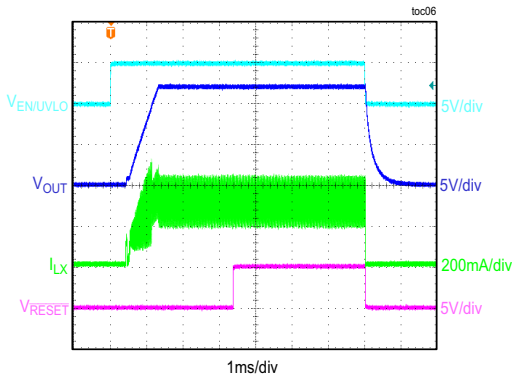

CONDITIONS: PFM MODE

SOFT-START/SHUTDOWN THROUGH EN/UVLO




CONDITIONS: $V_{IN}$ = 24V, 40Ω RESISTIVE LOAD

SOFT-START/SHUTDOWN THROUGH EN/UVLO

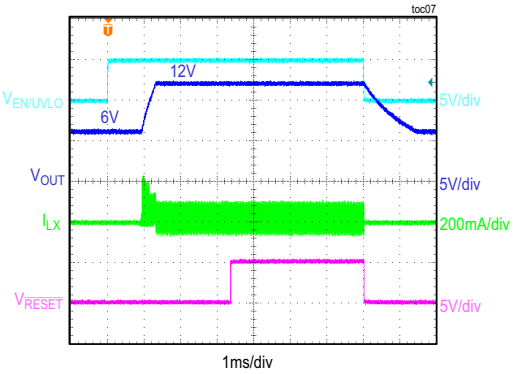



CONDITIONS: $V_{IN}$ = 48V, 40Ω RESISTIVE LOAD

## MAX17760BEVKIT# Performance Report (continued)

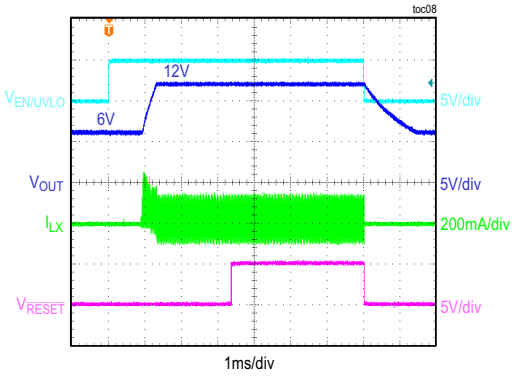
($V_{OUT}$ = 12V, $f_{SW}$ = 400kHz, $T_A$ = +25°C, unless otherwise noted.)

**SOFT START WITH PREBIAS OF VOLTAGE OF 6V**



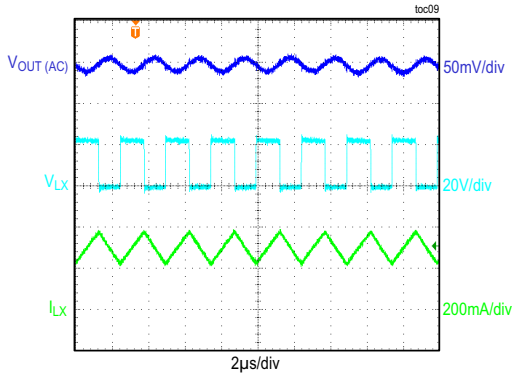

CONDITIONS: PWM MODE, $V_{IN}$ = 24V, 600Ω RESISTIVE LOAD

**SOFT START WITH PREBIAS OF VOLTAGE OF 6V**



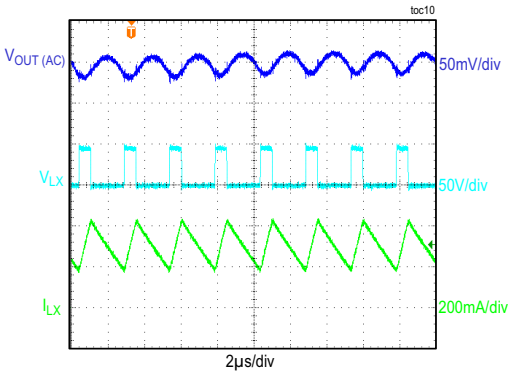

CONDITIONS: PWM MODE, $V_{IN}$ = 48V, 600Ω RESISTIVE LOAD

**STEADY-STATE PERFORMANCE**



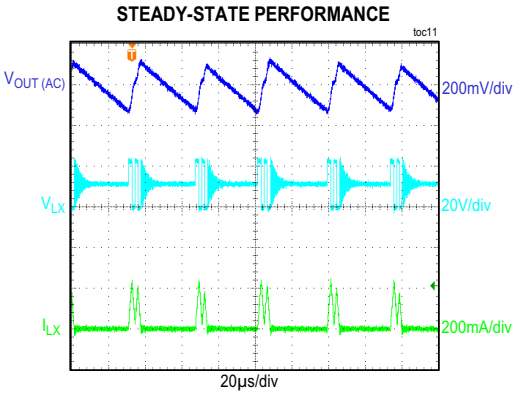

CONDITIONS: $V_{IN}$ = 24V, 40Ω RESISTIVE LOAD

**STEADY-STATE PERFORMANCE**



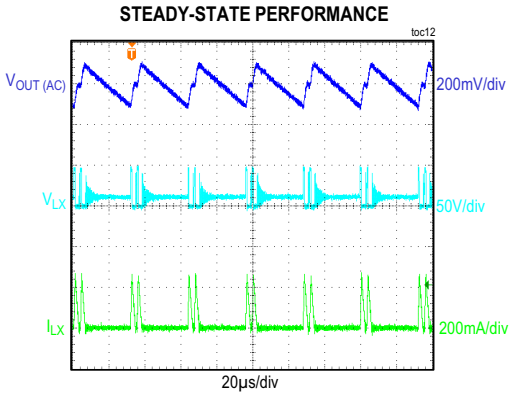

CONDITIONS: $V_{IN}$ = 48V, 40Ω RESISTIVE LOAD

**STEADY-STATE PERFORMANCE**




CONDITIONS: PFM MODE,$V_{IN}$ = 24V, 600Ω RESISTIVE LOAD

**STEADY-STATE PERFORMANCE**

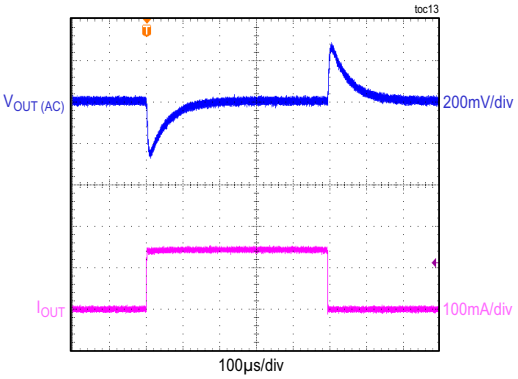



CONDITIONS: PFM MODE, $V_{IN}$ = 48V, 600Ω RESISTIVE LOAD

## MAX17760BEVKIT# Performance Report (continued)

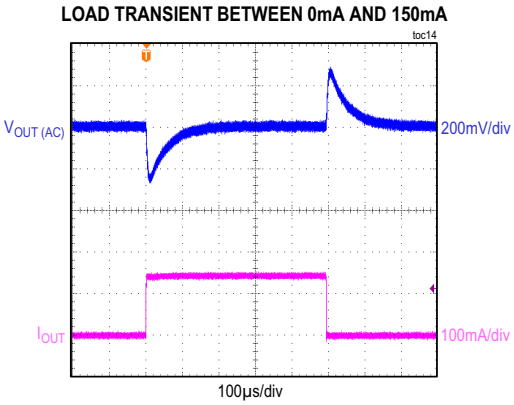
($V_{OUT}$ = 12V, $f_{SW}$ = 400kHz, $T_A$ = +25°C, unless otherwise noted.)

**LOAD TRANSIENT BETWEEN 0mA AND 150mA**



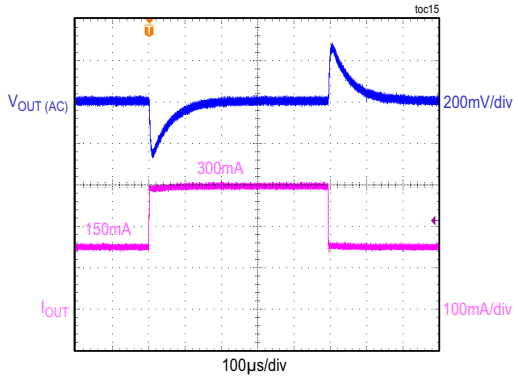

CONDITIONS: PWM MODE, $V_{IN}$ = 24V

**LOAD TRANSIENT BETWEEN 0mA AND 150mA**



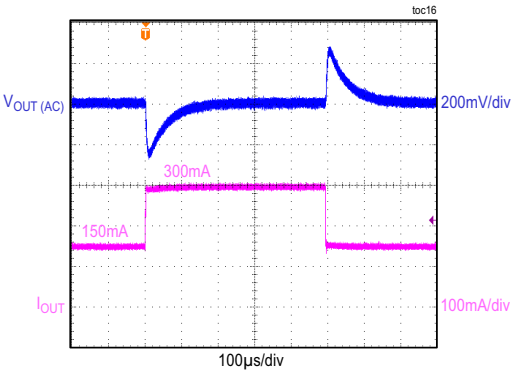

CONDITIONS: PWM MODE, $V_{IN}$ = 48V

**LOAD TRANSIENT BETWEEN 150mA AND 300mA**



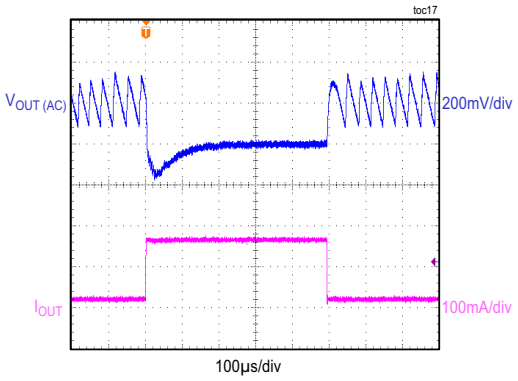

CONDITIONS: PWM MODE, $V_{IN}$ = 24V

**LOAD TRANSIENT BETWEEN 150mA AND 300mA**



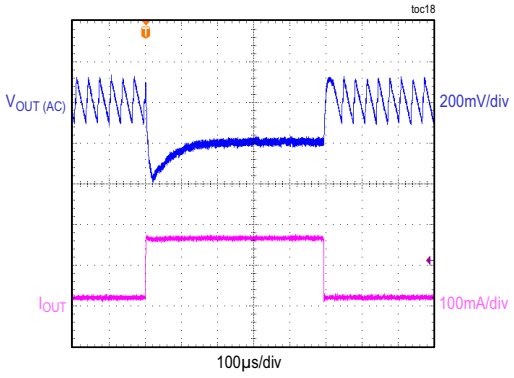

CONDITIONS: PWM MODE, $V_{IN}$ = 48V

**LOAD TRANSIENT BETWEEN 20mA AND 170mA**




CONDITIONS: PFM MODE, $V_{IN}$ = 24V

**LOAD TRANSIENT BETWEEN 20mA AND 170mA**

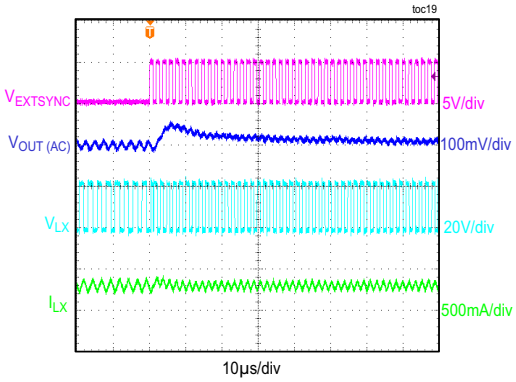



CONDITIONS: PFM MODE, $V_{IN}$ = 48V

## MAX17760BEVKIT# Performance Report (continued)

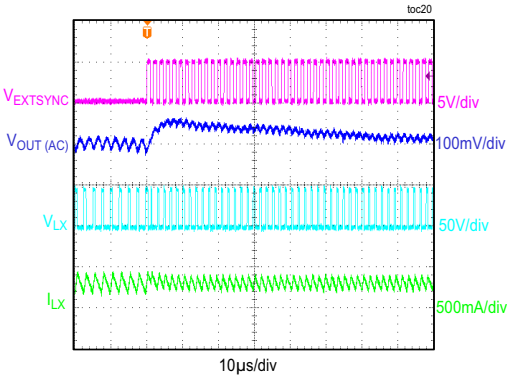
($V_{OUT}$ = 12V, $f_{SW}$ = 400kHz, $T_A$ = +25°C, unless otherwise noted.)

**CLOCK SYNCHRONIZATION WITH 560kHz**



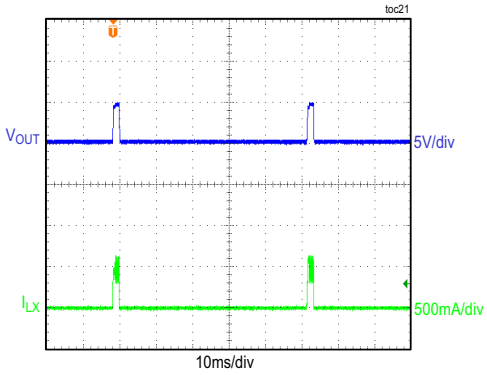

CONDITIONS: $V_{IN}$ = 24V, 40Ω RESISTIVE LOAD

**CLOCK SYNCHRONIZATION WITH 560kHz**



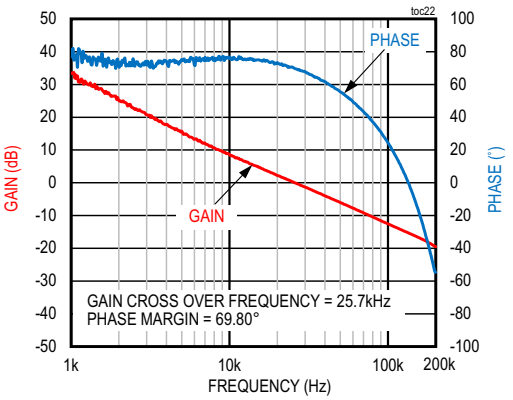

CONDITIONS: $V_{IN}$ = 48V, 40Ω RESISTIVE LOAD

**OVERLOAD PROTECTION**



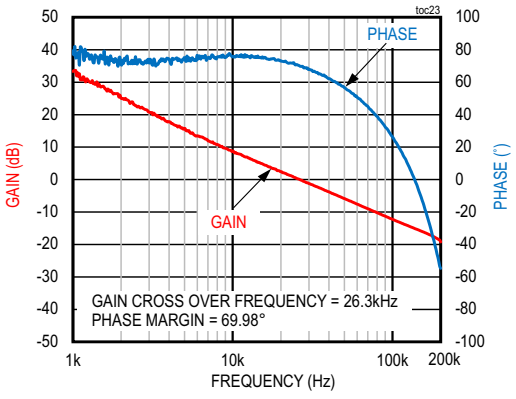

CONDITIONS: PWM MODE, $V_{IN}$ = 24V, 5Ω RESISTIVE LOAD

**BODE PLOT**




CONDITIONS: $V_{IN}$ = 24V, 40Ω RESISTIVE LOAD

**BODE PLOT**




CONDITIONS: $V_{IN}$ = 48V, 40Ω RESISTIVE LOAD

## Component Suppliers

| SUPPLIER | WEBSITE |
|---|---|
| Murata Americas | www.murata.com |
| Panasonic Corp. | www.panasonic.com |
| TDK Corp. | www.tdk.com |
| SULLINS | www.sullinscorp.com |
| Wurth Electronics | www.we-online.com |
| Kemet | www.kemet.com |

***Note:*** *Indicate that you are using the MAX17760 when contacting these component suppliers.*

## Ordering Information

| PART | TYPE |
|---|---|
| MAX17760BEVKIT# | EV Kit |

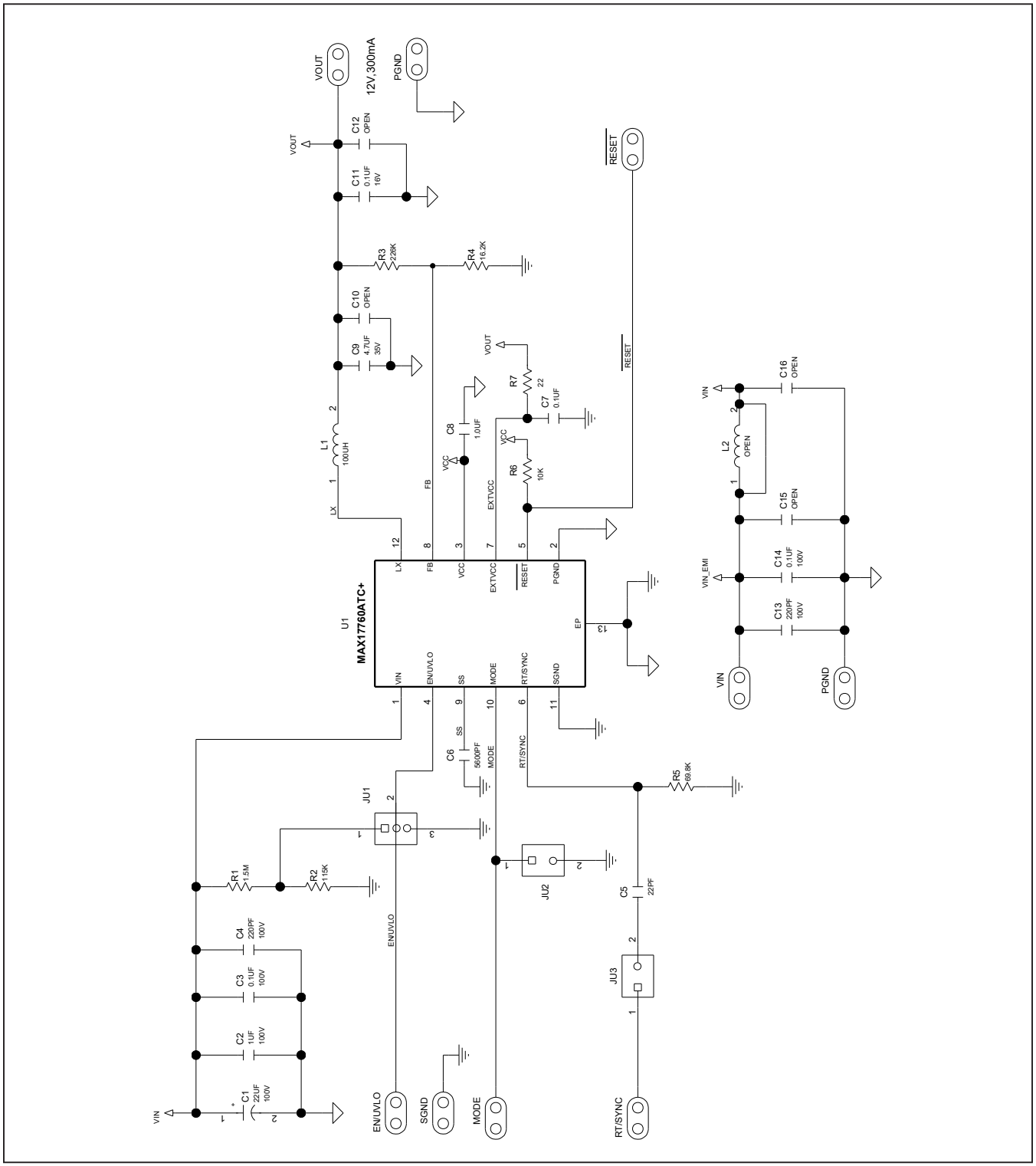
*#Denotes RoHS compliant.*

## MAX17760BEVKIT# EV Kit Bill of Materials

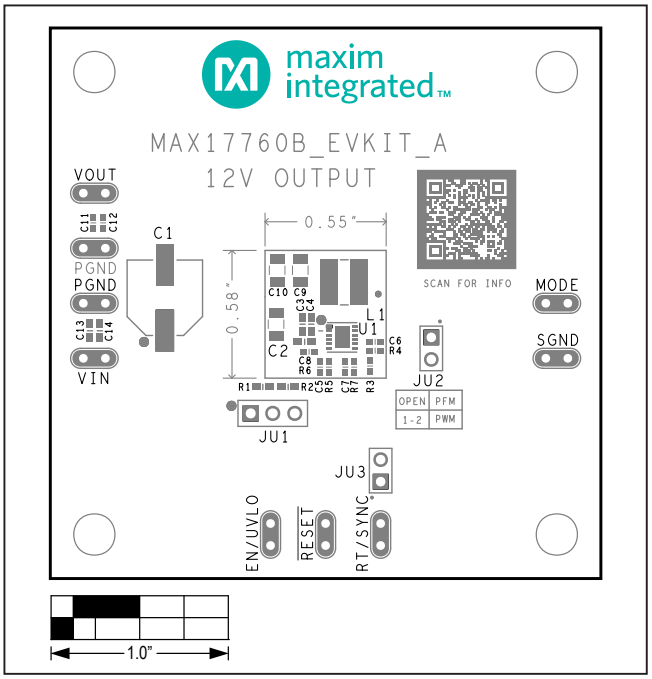
| S.No | DESIGNATOR | DESCRIPTION | QTY | MANUFACTURER PART NUMBER |
|---|---|---|---|---|
| 1 | C1 | 22uF±20%, 100V, Electrolytic capacitor | 1 | PANASONIC EEE-TG2A220UP |
| 2 | C2 | 1µF± 10%; 100V; X7R; Ceramic Capacitor (1206) | 1 | TDK C3216X7R2A105K160AA |
| 3 | C3, C14 | 0.1µF±10%; 100V; X7R; Ceramic Capacitor (0603) | 2 | MURATA GRM188R72A104KA35 |
| 4 | C4, C13 | 220pF±10%; 100V; X7R; Ceramic Capacitor (0603) | 2 | KEMET C0603C221K1GAC |
| 5 | C5 | 22pF±5%; 50V; C0G; Ceramic Capacitor (0402) | 1 | MURATA GRM1555C1H220JA01 |
| 6 | C6 | 5600pF± 10%; 25V; X7R; Ceramic Capacitor (0402) | 1 | MURATA GRM155R71E562KA01 |
| 7 | C7 | 0.1µF±10%; 50V; X7R; Ceramic Capacitor (0402) | 1 | MURATA GCM155R71H104KE02 |
| 8 | C8 | 1µF±10%; 6.3V; X7R; Ceramic Capacitor (0603) | 1 | MURATA GRM188R70J105KA01 |
| 9 | C9 | 4.7µF±10%; 35V; X7R; Ceramic Capacitor (1206) | 1 | TDK C3216X7R1V475K160AB |
| 10 | C11 | 0.1µF±10%; 16V; X7R; Ceramic Capacitor (0402) | 1 | MURATA GRM155R71C104KA88 |
| 11 | JU1 | 3-pin header | 1 | SULLINS PEC03SAAN |
| 12 | JU2, JU3 | 2-pin header | 2 | SULLINS PEC02SAAN |
| 13 | L1 | INDUCTOR, 100µH, 0.52A (4.8mm x 4.8mm) | 1 | WURTH 74408943101 |
| 14 | R1 | 1.5MΩ, ±1%, 1/10W, Resistor (0603) | 1 | |
| 15 | R2 | 115kΩ, ±1%, 1/10W, Resistor (0603) | 1 | |
| 16 | R3 | 226kΩ, ±1%, 1/10W, Resistor (0402) | 1 | |
| 17 | R4 | 16.2kΩ, ±1%, 1/16W, Resistor (0402) | 1 | |
| 18 | R5 | 69.8kΩ, ±1%, 1/10W, Resistor (0402) | 1 | |
| 19 | R6 | 10kΩ, ±5%, 1/10W, Resistor (0402) | 1 | |
| 20 | R7 | 22Ω, ±5%, 1/10W, Resistor (0402) | 1 | |
| 21 | | Shunts | 3 | SULLINS STC02SYAN |
| 22 | U1 | Buck Converter, MAX17760 (TDFN12-EP 3X3) | 1 | MAXIM MAX17760ATC+ |
| 23 | C10, C15, C16 | OPEN: Capacitor (1206) | 0 | |
| 24 | C12 | OPEN: Capacitor (0402) | 0 | |
| 25 | L2 | OPEN: INDUCTOR (2mm x 2mm) | 0 | |

| DEFAULT JUMPER TABLE | |
|---|---|
| JUMPER | SHUNT POSITION |
| JU1 | 1-2 |
| JU2 | 1-2 |
| JU3 | Open |

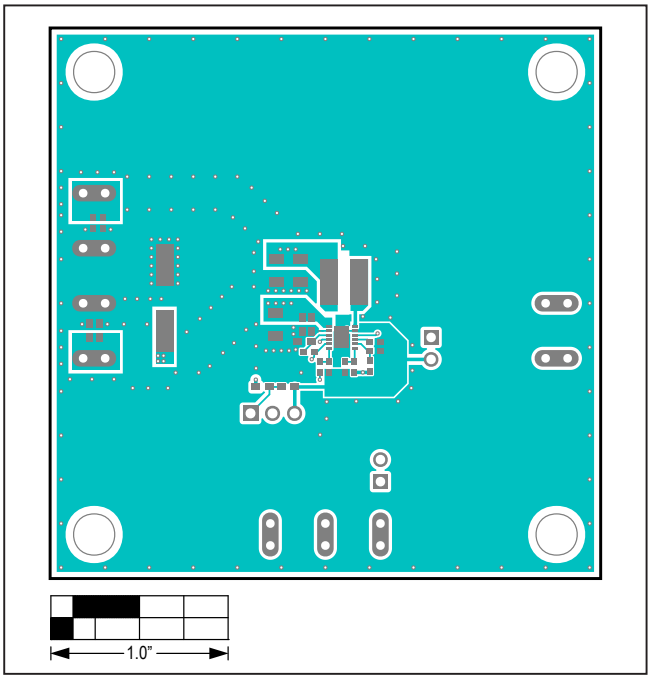
## MAX17760BEVKIT# EV Kit Schematic Diagram



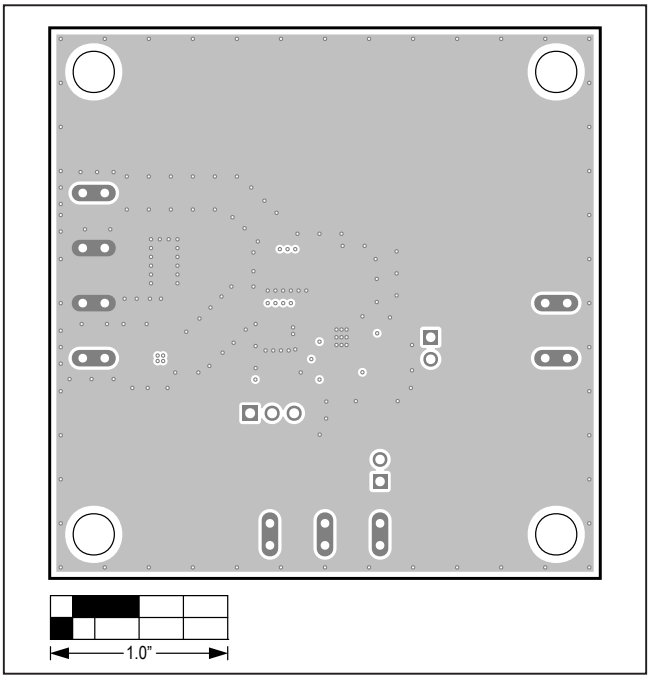
## MAX17760BEVKIT# EV Kit PCB Layout Diagrams




*MAX17760BEVKIT# EV Kit Component Placement Guide—Top Silkscreen*

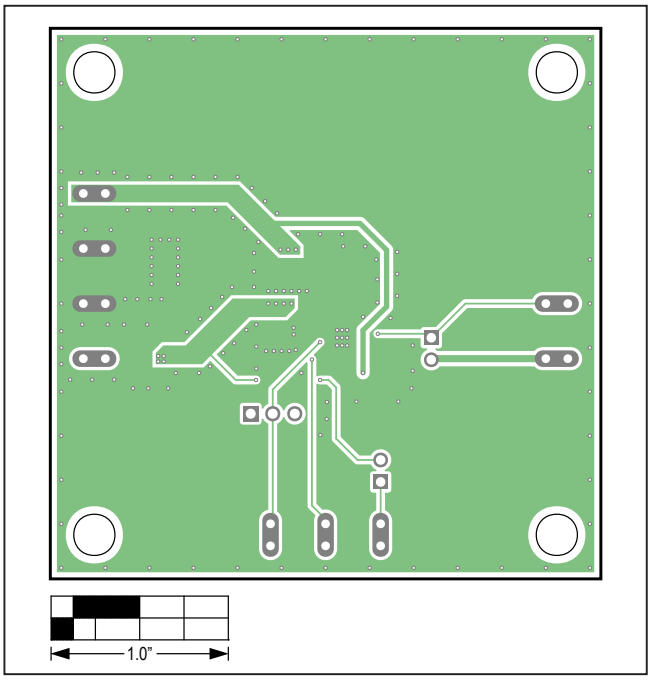



*MAX17760BEVKIT# EV Kit PCB Layout—Top Layer*

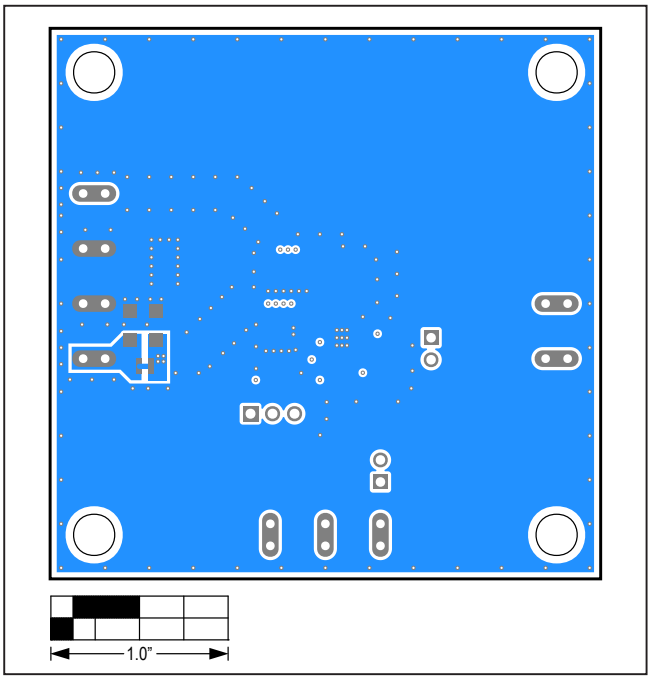



*MAX17760BEVKIT# EV Kit PCB Layout—Layer 2*

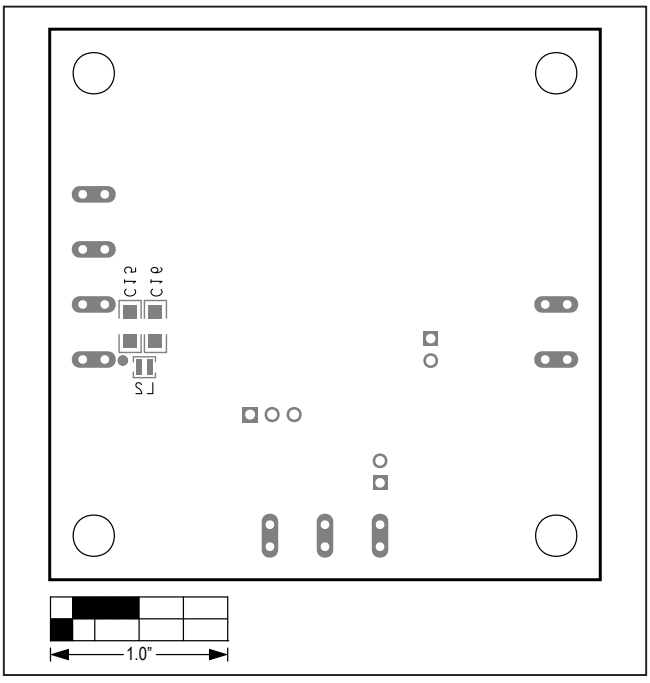
## MAX17760BEVKIT# EV Kit PCB Layout Diagrams (continued)




*MAX17760BEVKIT# EV Kit PCB Layout—Layer 3*




*MAX17760BEVKIT# EV Kit PCB Layout—Bottom Layer*




*MAX17760BEVKIT# EV Kit PCB Layout—Bottom Silkscreen*

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 8/21 | Release for Market Intro | — |