MAXM17503 5V Output Evaluation Kit

Evaluates: MAXM17503 in 5V Output-Voltage Application

General Description

The MAXM17503 evaluation kit (EV kit) is a demonstration circuit of the MAXM17503 high-voltage, high-efficiency, current-mode scheme, synchronous step-down DC-DC switching power module. The EV kit is designed for a 5V output and delivers up to a 2.5A load current from a wide input voltage range of 11V to 60V. The EV kit switches at an optimal 500kHz switching frequency to allow the use of small component sizes, helping to minimize solution size while maintaining high performance. The EV kit provides a precision-enable input, an open-drain $\overline{\text{RESET}}$ output signal, and external frequency synchronization to provide a simple and reliable startup sequence and eliminate beat frequency between regulators. The EV kit also includes optional component footprints to program different output voltages, an adjustable input undervoltage lockout, and a soft-start time to control inrush current during startup. The MAXM17503 IC data sheet provides a complete description of the part that should be read in conjunction with this data sheet prior to modifying the demo circuit.

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

Features

- Highly Integrated Solution with Integrated Shield Inductor
- Wide 11V to 60V Input Range
- Preset 5V Output with a Fixed Resistor-Divider on the Feedback Pin (FB)
- Programmable Output-Voltage Feature (0.9V to 12V)
- Up to 2.5A Output Current
- High 93% Efficiency (V_{IN} = 12V, V_{OUT} = 5V at 1.0A)
- 500kHz Switching Frequency
- Enable/UVLO Input, Resistor-Programmable UVLO Threshold
- Adjustable Soft-Start Time
- Selectable PWM, PFM, or DCM Mode
- Open-Drain $\overline{\text{RESET}}$ Output
- External Frequency Synchronization
- Overcurrent and Overtemperature Protection
- Low-Profile, Surface-Mount Components
- Lead(Pb)-Free and RoHS Compliant
- Fully Assembled and Tested
- Proven PCB Layout

19-7624; Rev 0; 5/15

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Quick Start

Recommended Equipment

- MAXM17503 EV kit
- 11V to 60V DC power supply (V_{IN})
- Dummy load capable of sinking 2.5A
- Digital voltmeter (DVM)
- 100MHz dual-trace oscilloscope

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 between 11V and 60V. Disable the power supply.
2) Connect the positive and negative terminals of the power supply to IN and PGND PCB pads, respectively.
3) Connect the positive and negative terminals of the 2.5A load to OUT and PGND2 PCB pads, respectively, and set the load to 0A.
4) Connect the DVM across the OUT PCB pad and the PGND2 PCB pad.
5) Verify that no shunts are installed across pins 1-2 on jumper JU1 to enable UVLO (see Table 1 for details).
6) Verify that a shunt is installed across JU3 to disable external synchronization (see Table 3 for details).
7) Verify that a shunt is installed across JU2 to enable PWM mode (see Table 2 for details).
8) Enable the input power supply.
9) Verify the DVM displays 5V.
10) Increase the load up to 2.5A to verify the DVM continues displaying 5V.

Detailed Description of Hardware

The MAXM17503 EV kit is a proven circuit to demonstrate the high-voltage, high-efficiency, and compact solution-size of the synchronous step-down DC-DC power module. The output voltage is preset for 5V to operate from 11V to 60V and provides up to 2.5A load current. The optimal frequency is set at 500kHz to maximize efficiency and minimize component size. The EV kit includes JU1 to enable/disable UVLO of the device, JU2 to configure in PWM, PFM, or DCM mode to improve light-load efficiency, and JU3 to enable/disable external clock synchronization (SYNC). The $\overline{RESET}$ PCB pad is also available for monitoring output-voltage regulation to enable/disable the application circuit of the load. The electrolytic capacitor (C8) is required only when the V_{IN} power supply is situated far from device circuit. When R4 is open, the device switches at a 500kHz switching frequency. On the bottom layer, additional footprints of optional components are included to ease board modification for different input/output configurations.

Soft-Start Input (SS)

The device utilizes an adjustable soft-start function to limit inrush current during startup. The soft-start time is programmed by the value of the external capacitor from SS to GND (C1). The selected output capacitance (C_{SEL}) and the output voltage (V_{OUT}) determine the minimum value of C1, as shown by the following equation:

$$C1 \geq 28 \times 10^{-3} \times C_{SEL} \times V_{OUT}$$

where C1 is in nF and C_{SEL} is in µF

The soft-start time (t_{SS}) is calculated by the equation below:

$$t_{SS} = C1 / 5.55$$

where t_{SS} is in ms and C1 is in nF.

Programmable Undervoltage Lockout (UVLO)

The EV kit offers an adjustable input undervoltage-lockout level by resistor-dividers connecting between the IN, EN/UVLO, and GND pins. For normal operation, a shunt should not be installed across pins 1-2 on JU1 to enable the output through an internal pullup 3.3MΩ resistor from the EN/UVLO to IN pins. To disable the output, install the shunt across pins 1-2 on JU1 to pull the EN/UVLO pin to GND. See Table 1 for JU1 setting details. The EV kit also provides an optional R3 PCB footprint to program a UVLO threshold voltage at which an input-voltage-level device turns on. The R3 resistor can be calculated by the following equation:

$$R3 = \frac{4009.5}{(V_{INU} - 1.215)}$$

where V_{INU} is the input voltage at which the device is required to turn on, and R3 unit is in kΩ.

Table 1. UVLO Enable/Disable Configuration (JU1)

SHUNT POSITION	EN PIN	MAXM17503_ OUTPUT
Installed	Connected to GND	Disable
Not installed*	Connected to VIN	Enable

**Default position.*

Mode Selection (MODE)

The device's MODE pin can be used to select among the PWM, PFM, or DCM modes of operation to improve constant frequency or high-efficiency at light load. The logic state of the MODE pin is latched when the V_{CC} and EN/UVLO voltage exceeds the respective UVLO rising thresholds and all internal voltages are ready to allow LX switching. The changes on the MODE pin are ignored during normal operation. Refer to the MAXM17503 IC data sheet for more information on the PWM, PFM, and DCM modes of operation. Table 2 shows EV kit jumper settings that can be used to configure the desired mode of operation.

External Clock Synchronization (SYNC)

The internal oscillator of the device can be synchronized to an external clock signal to eliminate beat frequency between regulators through the SYNC pin. The external synchronization clock frequency must be between $1.1f_{SW}$ and $1.4f_{SW}$, where f_{SW} is the frequency of operation set by R5. The minimum external clock high-pulse width and amplitude should be greater than 50ns and 2.1V, respectively. The minimum external clock low-pulse width should be greater than 160ns, and the maximum external clock low-pulse amplitude should be less than 0.8V. Table 3 describes the connection of the SYNC pin.

Setting V_{OUT} with a Resistive Voltage-Divider at FB

The EV kit is preset for 5V and offers an adjustable output voltage range as low as 0.9V up to 12V at 2.5A maximum load. The adjustable output voltage can be programmed by the set of resistor-dividers R1 and R2. Refer to Table 1 (Selection Component Values) of the MAXM17503 IC data sheet to select optimal component values for each specific input voltage range from 4.5V up to 60V and an output voltage from 0.9V up to 12V. To obtain an output voltage other than the default-setting outputs in Table 1, only seven component (R1, R2, C1–C4, and C8) values need to be modified by the equation described in the *Setting the Output Voltage* section of the MAXM17503 IC data sheet.

Table 2. MODE Description (JU2)

SHUNT POSITION	MODE PIN	MAXM17503_ MODE
Not installed	Unconnected	PFM mode of operation
1-2	Connected to VCC	DCM mode of operation
2-3*	Connected to GND	PWM mode of operation

**Default position.*

Table 3. SYNC Description (JU3)

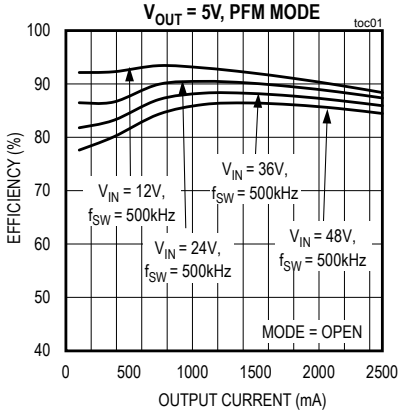
SHUNT POSITION	SYNC PIN	MAXM17503_ SYNC
1-2	Connected to SGND	SYNC feature unused
Not installed*	Connected to test loop on PCB	Frequency can be synchronized with an external clock

**Default position.*

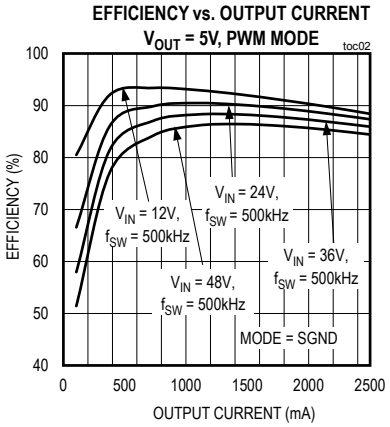
Typical Operating Characteristics

V_{IN} = 11V - 60V, V_{OUT} = 5V, I_{OUT} = 0 – 2.5A, T_A = +25°C, unless otherwise noted.

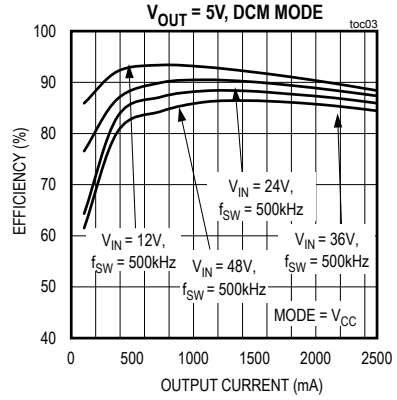
EFFICIENCY vs. OUTPUT CURRENT
V_{OUT} = 5V, PFM MODE



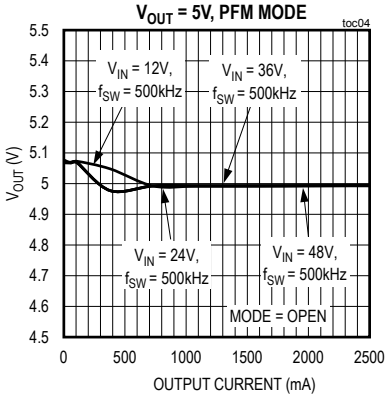
EFFICIENCY vs. OUTPUT CURRENT
V_{OUT} = 5V, PWM MODE



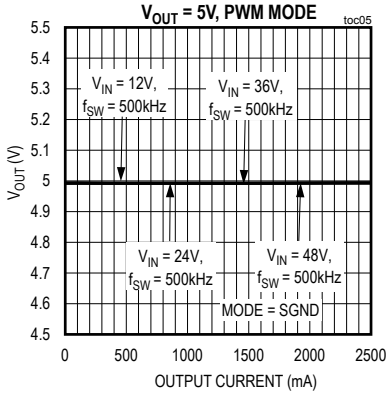
EFFICIENCY vs. OUTPUT CURRENT
V_{OUT} = 5V, DCM MODE



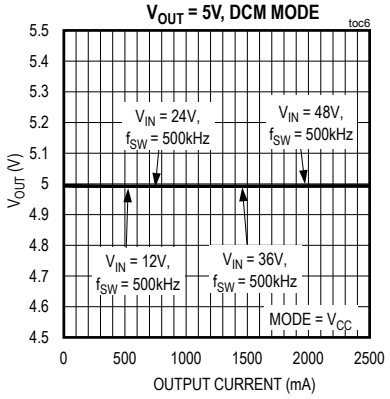
LOAD AND LINE REGULATION
V_{OUT} = 5V, PFM MODE



LOAD AND REGULATION
V_{OUT} = 5V, PWM MODE



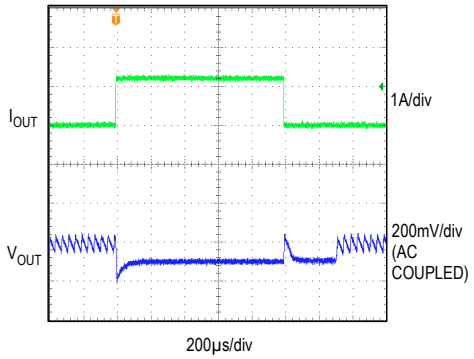
LOAD AND LINE REGULATION
V_{OUT} = 5V, DCM MODE



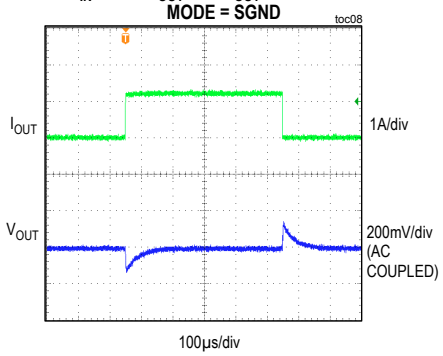
Typical Operating Characteristics (continued)

V_{IN} = 11V - 60V, V_{OUT} = 5V, I_{OUT} = 0 – 2.5A, T_A = +25°C, unless otherwise noted.

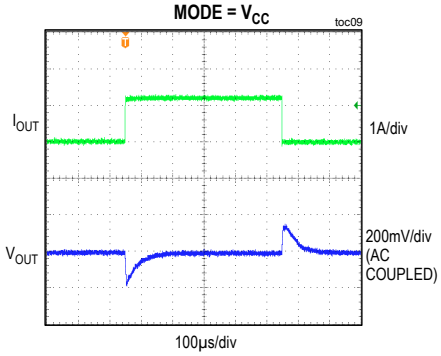
LOAD CURRENT TRANSIENT RESPONSE
V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 0.05A - 1.25A,
MODE = OPEN



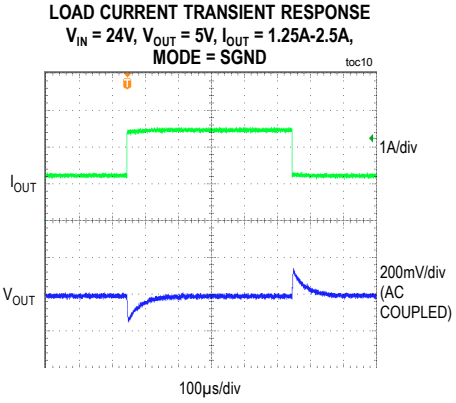
LOAD CURRENT TRANSIENT RESPONSE
V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 0.05A–1.25A,
MODE = SGND



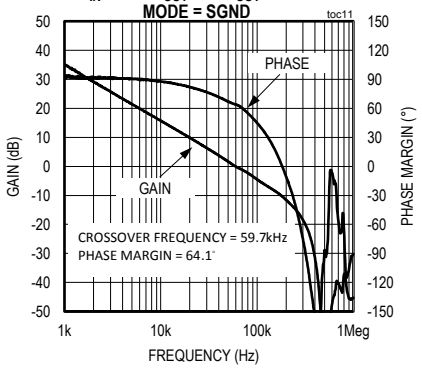
LOAD CURRENT TRANSIENT RESPONSE
V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 0.05A–1.25A,
MODE = V_{CC}



LOAD CURRENT TRANSIENT RESPONSE
V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 1.25A-2.5A,
MODE = SGND



CLOSED-LOOP BODE PLOT
V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 2.5A,
MODE = SGND



Component Suppliers

SUPPLIER	WEBSITE
Murata Americas	www.murata.com
NEC TOKIN America, Inc.	www.nec-tokinamerica.com
Panasonic Corp.	www.panasonic.com
SANYO Electric Co., Ltd.	www.sanyodevice.com
TDK Corp.	www.component.tdk.com
TOKO America, Inc.	www.tokoam.com

Note: *Indicate that you are using the MAXM17503 when contacting these component suppliers.*

Component List and Schematic

Refer to the following files attached to this data sheet for component information and schematic:

- MAXM17503_EV_BOM.xls
- MAXM17503EV_Schematic.pdf

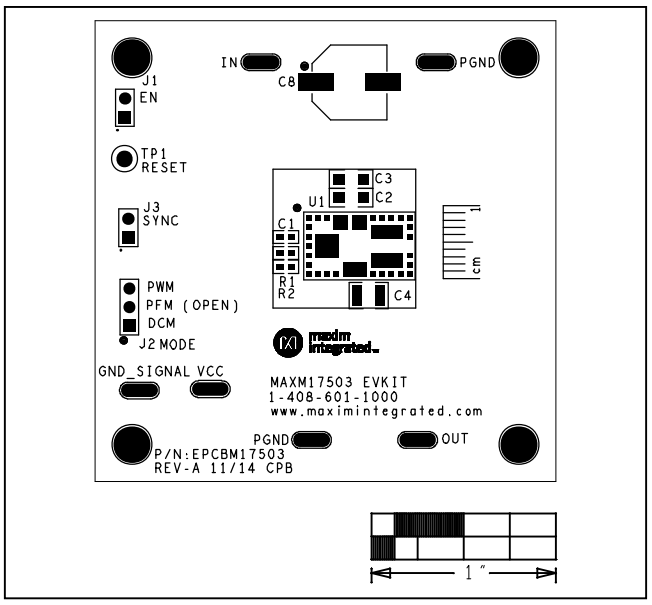


Figure 1 MAXM17503 EV Kit Component Placement Guide—Component Side

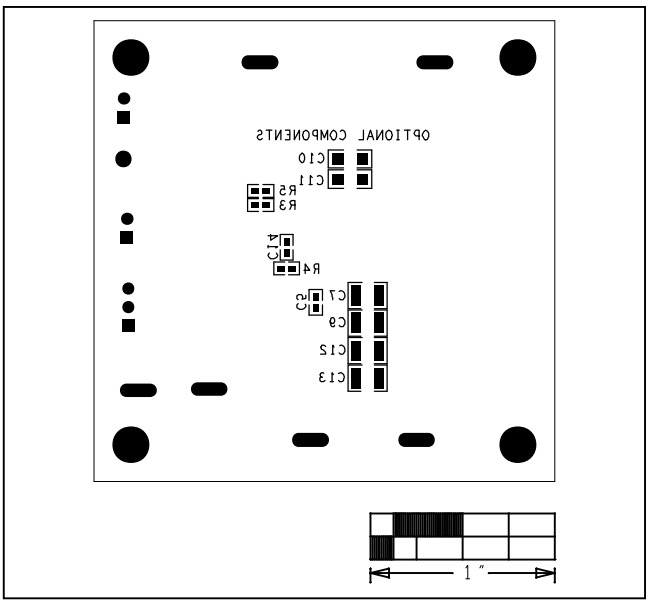


Figure 2 MAXM17503 EV Kit Component Placement Guide—Solder Side

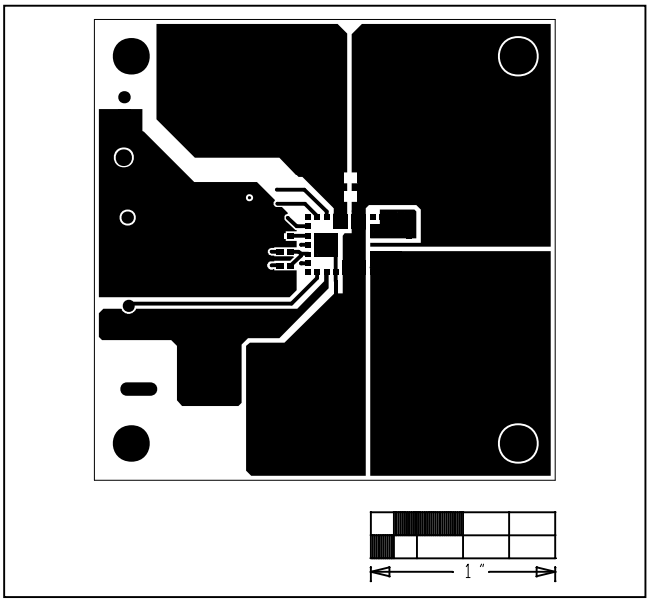


Figure 3. MAXM17503 EV Kit PCB Layout—Component Side

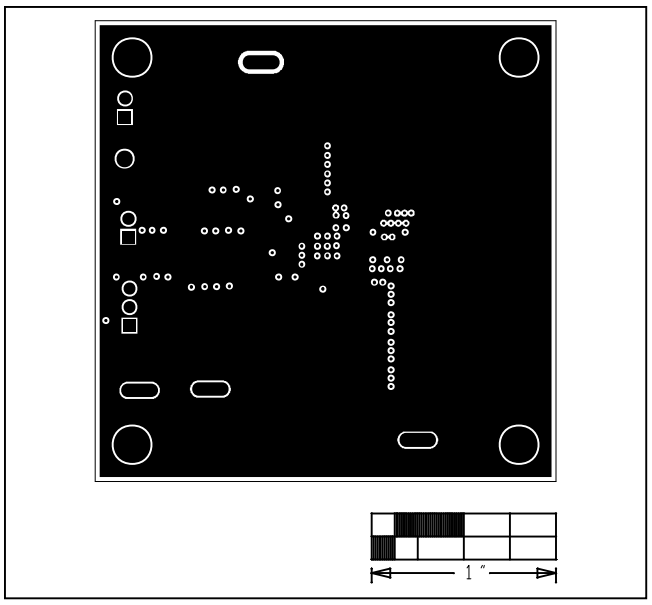


Figure 4. MAXM17503 EV Kit PCB Layout—PGND Layer 2

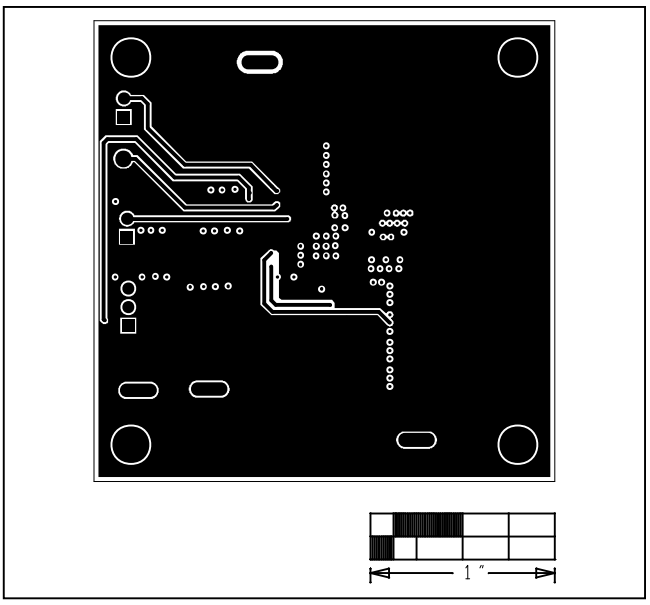


Figure 5. MAXM17503 EV Kit PCB Layout—PGND Layer 3

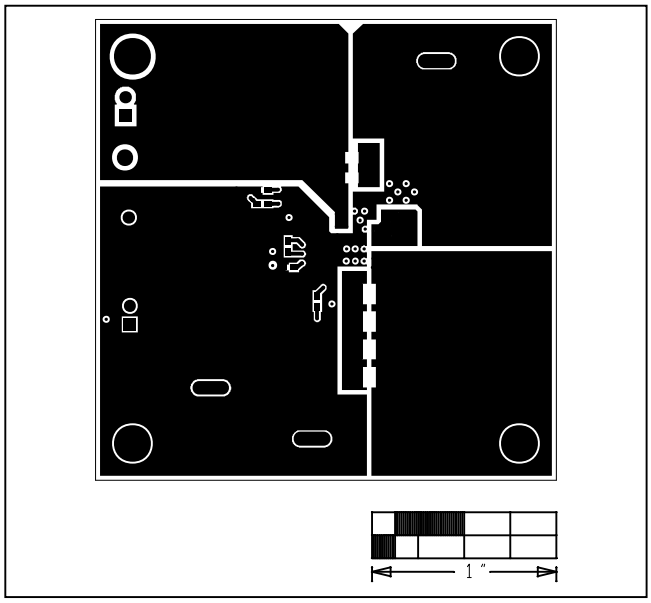


Figure 6. MAXM17503 EV Kit PCB Layout—Solder Side

Ordering Information

PART	TYPE
MAXM17503EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/15	Initial release	—

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

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