19-4053; Rev 0; 2/08

MAX15003 Evaluation Kit

General Description

The MAX15003 evaluation kit (EV kit) is a fully assembled and tested surface-mount printed-circuit board (PCB) that demonstrates the capabilities of the MAX15003 IC. The MAX15003 IC is a high-performance triple-output synchronous buck controller, capable of delivering up to 10A per output with tracking and sequencing capability. The EV kit requires a DC input-voltage range of 6V to 14V (12V typ) for normal operation.

The EV kit outputs are configured for 3.3V, 2.5V, and 1.2V, and provide 3A, 4A, and 10A, respectively. The MAX15003 IC switching frequency is programmed to 600kHz or can be synchronized to an external clock signal with a frequency of up to 2.2MHz. The phase-and-tracking/sequencing operation modes are configurable. The PGOOD1, PGOOD2, PGOOD3, and $\overline{\text{RESET}}$ logic signal output pads are provided for circuit monitoring.

Features

- **Triple-Output Power Supply**
  - **VOUT1 (3.3V, 3A)**
  - **VOUT2 (2.5V, 4A)**
  - **VOUT3 (1.2V, 10A)**
- **600kHz PWM Switching**
- **Programmable Switching Frequency Up to 2.2MHz**
- **External Frequency Synchronization**
- **Selectable Tracking or Sequencing Operation Mode**
- **Selectable Phase Operation Mode**
- **Individual PGOOD and $\overline{\text{RESET}}$ Signal Outputs**
- **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX15003EVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	150µF ±20%, 16V aluminum electrolytic capacitor (D8) Panasonic EEEFK1C151XP
C2, C8, C14	3	22µF ±20%, 16V X5R ceramic capacitors (1210) TDK C3225X5R1C226M or Murata GRM31CR61C226M
C3, C9, C15, C20, C24, C25, C26	7	0.1µF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H104K or Murata GRM188R71H104K
C4, C10, C16, C23	4	100µF ±20%, 6.3V X5R ceramic capacitors (1210) TDK C3225X5R0J107M or Murata GRM32ER60J107M
C5, C17	2	1500pF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H152K
C6, C12, C18	3	47pF ±5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H470J
C7	1	680pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H681K
C11	1	2200pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H222K
C13	1	820pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H821K
C19	1	270pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H271K
C21	1	2.2µF ±10%, 6.3V X5R ceramic capacitor (0603) TDK C1608X5R0J225K or Murata GRM188R60J225K
C22	1	0.022µF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1H223K or Murata GRM188R71H223K
D1, D3, D5	3	100mA, 30V Schottky diodes (SOD523) Central Semiconductor CMOSH-3 + LEAD FREE (Top Mark: 53)

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
D2, D4, D6	3	1A, 20V Schottky diodes (SOD123F) Central Semiconductor CMMSH1-20 + LEAD FREE (Top Mark: CS20F)
IN, PGND (4), VOUT1, VOUT2, VOUT3	8	Noninsulated banana-jack connectors
JU1, JU2	2	3-pin headers
L1	1	2.2µH, 6A, 19mΩ inductor Sumida CDMC6D28NP-2R2M or Vishay IHLP-2525CZ-ER-2R2-M-11
L2	1	3.3µH, 5A, 30mΩ inductor Sumida CDMC6D28NP-3R3M or Vishay IHLP-2525CZ-ER-3R3-M-11
L3	1	0.47µH, 13.6A, 4mΩ inductor Sumida CDMC6D28NP-R47M or Vishay IHLP-2525CZ-ER-R47-M-01
N1	1	7.6A/11A, 30V dual n-channel MOSFET (8-pin SO) International Rectifier IRF7904UPbF
N2	1	11A, 30V, 13.8mΩ n-channel MOSFET (8-pin SO) International Rectifier IRF7807ZPbF or International Rectifier IRF7821UpbF
N3	1	30A, 20V, 3mΩ n-channel MOSFET (PowerPAK 8-pin SO) Vishay Si7336ADP-T1-E3
N4	1	8.6A/6.3A, 30V dual n-channel MOSFET (8-pin SO) Fairchild FDS6982AS or International Rectifier IRF7905PbF
R1	1	15Ω ±5% resistor (0603)
R2, R3, R7, R8, R19, R20, R26, R27, R31, R32	0	Not installed, resistors (0603) R2, R8, R20, R26, and R32 are open; R3, R7, R19, R27, R31 are short

DESIGNATION	QTY	DESCRIPTION
R4	1	25.5kΩ ±1% resistor (0603)
R5	1	8.06kΩ ±1% resistor (0603)
R6, R18, R30	3	11kΩ ±1% resistors (0603)
R9, R21	0	Not installed, resistors—short (1206)
R10	1	787Ω ±1% resistor (0603)
R11	1	3.09kΩ ±1% resistor (0603)
R12, R24, R36, R38, R39	5	10kΩ ±5% resistors (0603)
R13	1	22Ω ±5% resistor (0603)
R14	1	332kΩ ±1% resistor (0603)
R15, R41	2	100kΩ ±1% resistors (0603)
R16	1	26.7kΩ ±1% resistor (0603)
R17	1	5.90kΩ ±1% resistor (0603)
R22	1	649Ω ±1% resistor (0603)
R23	1	2.87kΩ ±1% resistor (0603)
R25	1	6.8Ω ±5% resistor (0603)
R28, R29	2	54.9kΩ ±1% resistors (0603)
R33	0	Not installed, resistor—short (1210)
R34	1	1.96kΩ ±1% resistor (0603)
R35	1	2.26kΩ ±1% resistor (0603)
R37, R45, R46	3	2.2Ω ±5% resistors (0603)
R40	1	165kΩ ±1% resistor (0603)
R42, R43, R44	3	21.5kΩ ±1% resistors (0603)
TP1, TP2, TP3	3	Test points, red
TP4, TP5, TP6	3	Test points, black
U1	1	Triple output buck controller (48-pin TQFN-EP*, 7mm x 7mm) Maxim MAX15003ATM+
—	2	Shunts (JU1, JU2)
—	1	PCB: MAX15003 Evaluation Kit+

*EP = Exposed pad.

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor	631-435-1110	www.centralsemi.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
International Rectifier	310-322-3331	www.irf.com
Murata Mfg. Co., Ltd.	770-436-1300	www.murata.com
Panasonic Corp.	800-344-2112	www.panasonic.com
Sumida Corp.	847-545-6700	www.sumida.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	203-268-6261	www.vishay.com

Note: *Indicate that you are using the MAX15003 when contacting these component suppliers.*

Quick Start

Required Equipment

Before beginning, the following equipment is needed:

- One 14V, 10A adjustable power supply
- Three voltmeters
- One 4-channel oscilloscope

Procedure

The MAX15003 EV kit is a fully assembled and tested surface-mount board. Follow the steps below to verify board operation. **Caution: Do not turn on the power supply until all connections are completed.**

1) Verify that a shunt is across pins 1-2 of jumper JU1 (ratiometric tracking mode).
2) Verify that a shunt is across pins 2-3 of jumper JU2 (out-of-phase mode).
3) Connect a voltmeter across the VOUT1 and PGND two-hole PCB pads.
4) Connect a voltmeter across the VOUT2 and PGND two-hole PCB pads.
5) Connect a voltmeter across the VOUT3 and PGND two-hole PCB pads.
6) Connect the 4-channel oscilloscope probes to the PGOOD1, PGOOD2, PGOOD3, and $\overline{\text{RESET}}$ two-hole PCB pads. Connect each probe ground lead to the SGND two-hole PCB pad.
7) Set the adjustable power supply to 12V and disable the output.
8) Connect the positive terminal of the power supply to the IN banana jack connector. Connect the negative terminal of this power supply to the PGND banana jack connector.
9) Turn on the power supply.
10) Verify that the VOUT1, VOUT2, and VOUT3 outputs measure 3.3V, 2.5V, and 1.2V, respectively.
11) Verify that the PGOOD1, PGOOD2, PGOOD3, and $\overline{\text{RESET}}$ signals measure approximately 3.3V, 2.5V, 1.2V, and 5V, respectively.
12) The EV kit is ready for load testing. Use the respective VOUT_ banana jacks for high-current load testing.

Detailed Description of Hardware

The MAX15003 EV kit is a fully assembled and tested surface-mount PCB that demonstrates the MAX15003 IC, which integrates three high-performance PWM switching step-down DC-DC controllers. Additionally, the MAX15003 IC can be enabled in tracking or sequence modes and can operate in phase or 120° out-of-phase. The EV kit circuit operates over the input-voltage range of 6V to 14V. The outputs are configured for 3.3V, 2.5V, and 1.2V, providing up to 3A, 4A, and 10A, respectively. The MAX15003 switching frequency of 600kHz is programmed with resistor R40. The frequency can be programmed from 200kHz to 2.2MHz by replacing this resistor, or can be synchronized to an external clock signal through the SYNC input pad. The MAX15003 EV kit PCB is designed with 4-layer and 2oz copper for optimum performance.

The phase and tracking/sequencing operation modes are selectable through jumpers JU1 and JU2. Coincident tracking, ratiometric tracking, or sequencing options enable tailoring of the power-up/power-down sequence depending on the application requirements. PGOOD1, PGOOD2, PGOOD3, and $\overline{\text{RESET}}$ logic signal output pads are provided for circuit monitoring.

Table 1. Current-Limit Resistor Configuration

VOUT_ OUTPUT	ILIM_ RESISTORS	OPEN RESISTOR	0Ω RESISTOR	INDUCTOR CURRENT-SENSING ELEMENTS
VOUT1	R44, R23	R20	R19	N4-A + R21
		R19	R20	R21
VOUT2	R42, R11	R8	R7	N1-B + R9
		R7	R8	R9
VOUT3	R43, R35	R32	R31	N3 + R33
		R31	R32	R33

Input Source

The MAX15003 EV kit is configured for normal operation with an input power source of 6V to 14V. However, the upper input-voltage limit can be raised to 23V by replacing capacitors C1, C2, C8, and C14 with higher voltage-rated capacitors. The EV kit circuit requires a minimum 5.5V input to generate the 5V regulation voltage (REG) used to power the MOSFET gate drivers and provide the pullup voltage for the SEL and PHASE inputs.

Triple Outputs

The MAX15003 EV kit's three outputs are configured to different voltages. VOUT1 is configured to 3.3V, with resistors R16 and R17, and can supply up to 3A. VOUT2 is configured to 2.5V, with resistors R4 and R5, and can supply up to 4A. VOUT3 is configured to 1.2V, with resistors R28 and R29, and can supply up to 10A. The output voltage for each output can be reconfigured between 0.6V and 0.9V x IN by replacing the respective feedback resistors. Refer to the *Type III: Compensation when* $f_{CO} < f_{ZERO, ESR}$ section in the MAX15003 IC data sheet for instructions on selecting new resistor values for the respective outputs. Also refer to the *Inductor Selection, Input Capacitor Selection*, and the *Compensation Design Guidelines* sections in the IC data sheet to verify whether other components need replacement for proper operation after reconfiguring the output voltage.

Current Limit

The current limit for each MAX15003 EV kit output is set with resistors. VOUT1 current limit is set to a nominal 4.5A, at room temperature, with resistors R44 and R23. VOUT2 current limit is set to a nominal 6A, at room temperature, with resistors R42 and R11. VOUT3 current limit is set to a nominal 15A, at room temperature, with resistors R43 and R35. To reconfigure the current limits, refer to the *Setting the Current Limit* section in the MAX15003 IC data sheet to calculate new resistor values for R44/R23, R42/R11, and R43/R35.

The MAX15003 IC limits the inductor current by sensing the voltage drop across the respective MOSFET's low-side on-resistance ($R_{DS(ON)}$) at each output. The equivalent low-side sense resistance for each output can be changed by cutting open the PCB shorting trace across R9, R21, and R33 and installing sense resistors. Alternatively, the low-side MOSFET's $R_{DS(ON)}$ can be eliminated from the equivalent low-side sense resistance, at each buck converter, by cutting open the PCB shorting trace across R19, R7, or R31, and installing a shorting resistor at R20, R31, or R32, respectively. See Table 1 for current-limit resistor configuration.

Switching Frequency

The MAX15003 PWM switching frequency is set to 600kHz with resistor R40 (165kΩ). Replace resistor R40 with a new resistor value to progam the switching frequency between 200kHz and 2.2MHz. Use the following equation to choose the appropriate resistor value to reconfigure the switching frequency (f_{SW}):

$$f_{SW}\ (Hz) = 10^{11}/(R40 + 1750)\ (\Omega)$$

The switching frequency can also be synchronized to an external digital clock signal connected to the EV kit SYNC PCB pad. For proper synchronization, the external signal frequency must be at least 20% higher than 3x the frequency programmed through resistor R40. The digital clock signal should have peak amplitude of 3V to 5V, offset voltage of 1/2 the amplitude, frequency in the 600kHz to 6.9MHz range, and a duty cycle of 50%. The MAX15003 IC switching frequency will be 1/3 the SYNC frequency. Refer to the *Inductor Selection, Input Capacitor Selection*, and the *Compensation Design Guidelines* sections in the MAX15003 IC data sheet to verify whether other components need replacement for proper operation after reconfiguring the switching frequency.

Table 2. Track/Sequence Operation (Jumper JU1)

SHUNT POSITION	SEL PIN CONNECTION	EV KIT VOUT_ OPERATION	EV KIT CIRCUIT MODIFICATIONS
1-2*	Connected to REG	Ratiometric tracking mode*	Open resistors (R2, R26) Short/0Ω resistors (R3, R27)
		Coincident tracking mode	Calculate values for resistors R2, R3, R26, and R27
2-3	Connected to SGND	Sequence mode	

**Default position.*

Output Sequencing/Tracking

The MAX15003 IC can be programmed to power up and power down the three outputs in sequence, ratiometric tracking, or coincident tracking mode by configuring the SEL pin. The MAX15003 EV kit features jumper JU1 to configure the SEL pin. See Table 2 for jumper JU1 configuration. The EV kit circuit is configured for ratiometric tracking operation by default (resistors R3 and R27 shorted with PC trace), and can be easily modified for sequencing or coincident tracking. In ratiometric tracking mode, the soft-start controllers for VOUT1, VOUT2, and VOUT3 are synchonized, and hence their respective output voltages will track ratiometrically.

In concident tracking mode, the VOUT2 and VOUT3 output voltages ramp up, tracking the VOUT1 voltage depending on the resistor-divider ratio used for R2/R3 and R26/R27, respectively.

In sequencing mode, VOUT2 and VOUT3 outputs do not turn on until the voltage at the IC EN/TRACK_ input pin for each output reaches 1.22V. The ratio of resistor pairs R2/R3 and R26/R27 set the voltage threshold that VOUT1 must reach before VOUT2 and VOUT3 are turned on.

For sequencing or concident tracking operation, the EV kit PCB requires modification. Cut open the shorting PCB trace at resistors R3 and R27 and install resistors R2, R3, R26, and R27. Refer to the *Coincident/Ratiometric Tracking (SEL, EN/TRACK_)* and the *Output-Voltage Sequencing (SEL, EN/TRACK_, PGOOD)* sections in the MAX15003 IC data sheet to calculate the proper values for resistors R2, R3, R26, and R27.

Phase Operation

The three DC-DC converters can switch in phase or at 120° out-of-phase. Operating the converters in the out-of-phase mode increases the input capacitor ripple frequency, reduces the RMS input ripple current, and thus the size of the input bypass capacitor requirement. EV kit jumper JU2 is used to configure the phase mode operation. See Table 3 for jumper JU2 configuration.

Table 3. Phase Mode (Jumper JU2)

SHUNT POSITION	PHASE PIN CONNECTION	EV KIT OPERATION
1-2	Connected to REG	In-phase mode
2-3*	Connected to SGND	120° out-of-phase mode

**Default position.*

Status Output Signals

The MAX15003 EV kit provides PGOOD1, PGOOD2, and PGOOD3 logic output signals to indicate the regulation state of VOUT1, VOUT2, and VOUT3. A logic-low at the PGOOD_ pads indicates that output voltage has dropped below 92.5% of its regulation voltage. Each PGOOD_ signal is pulled high to the respective VOUT_ voltage when in regulation. The EV kit also provides a $\overline{\text{RESET}}$ logic output signal that indicates when all three PGOOD outputs are logic-high. The $\overline{\text{RESET}}$ output is pulled high (5V) after all three PGOOD signals are pulled high and a timeout period of 22ms has elapsed. Use the following equation to calculate the new capacitor value for C22 to modify the timeout period:

$$C22 = \frac{2\mu A \times T_{TIMEOUT}}{2V}$$

MAX15003 Evaluation Kit

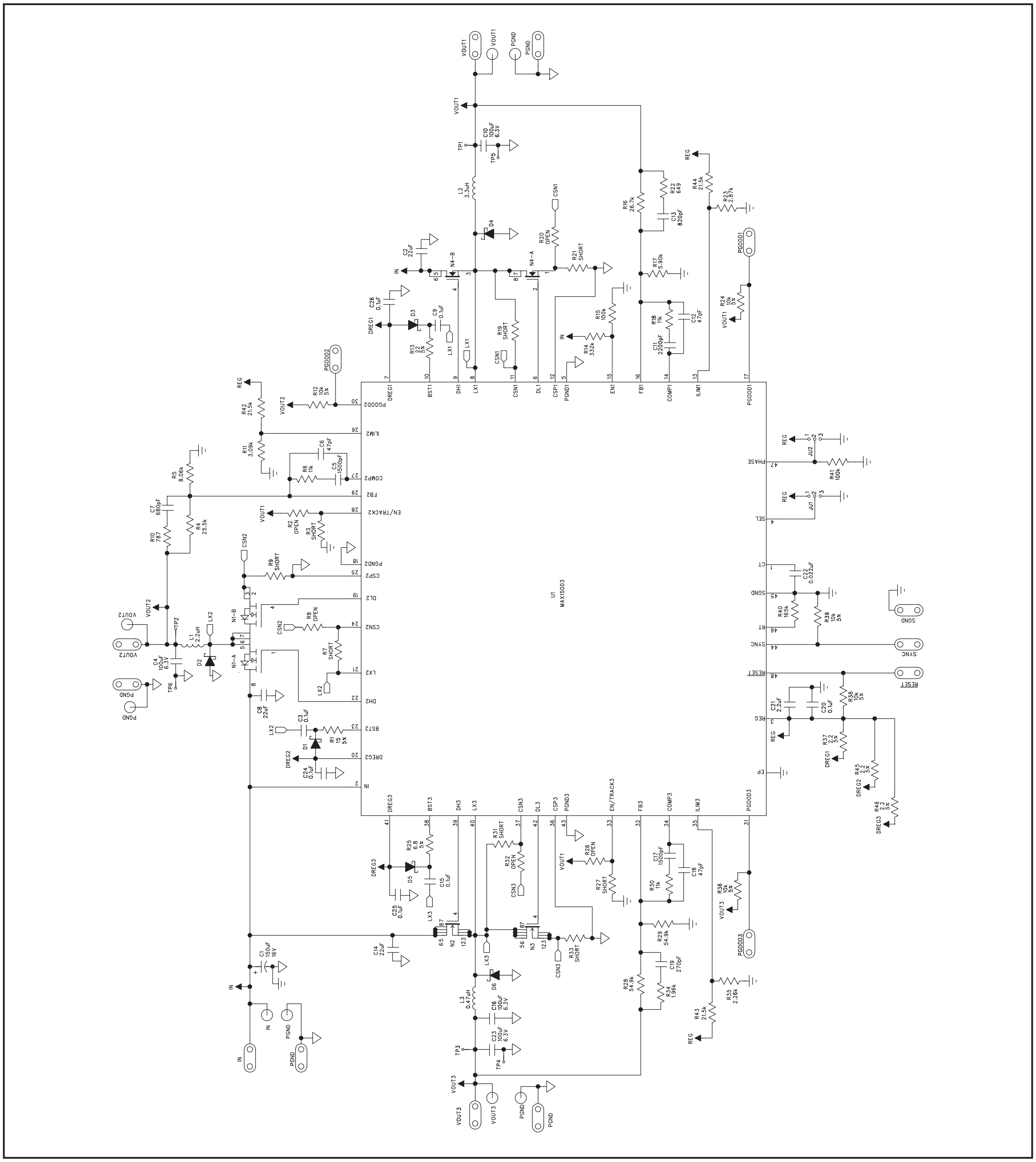

Figure 1. MAX15003 EV Kit Schematic

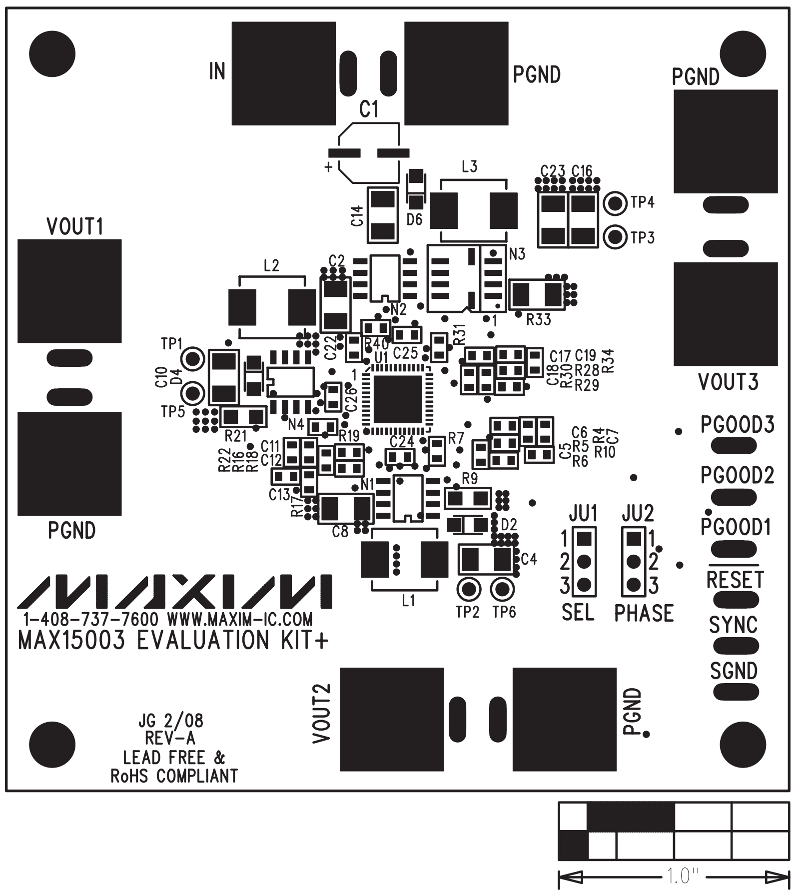

Figure 2. MAX15003 EV Kit Component Placement Guide—Component Side

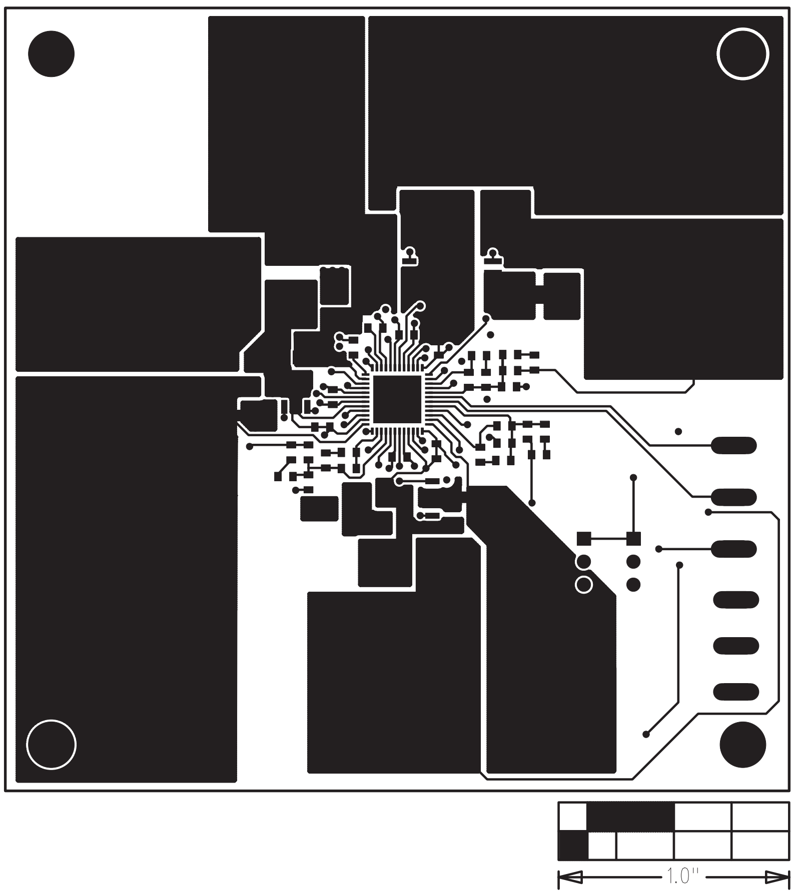

Figure 3. MAX15003 EV Kit PCB Layout—Component Side

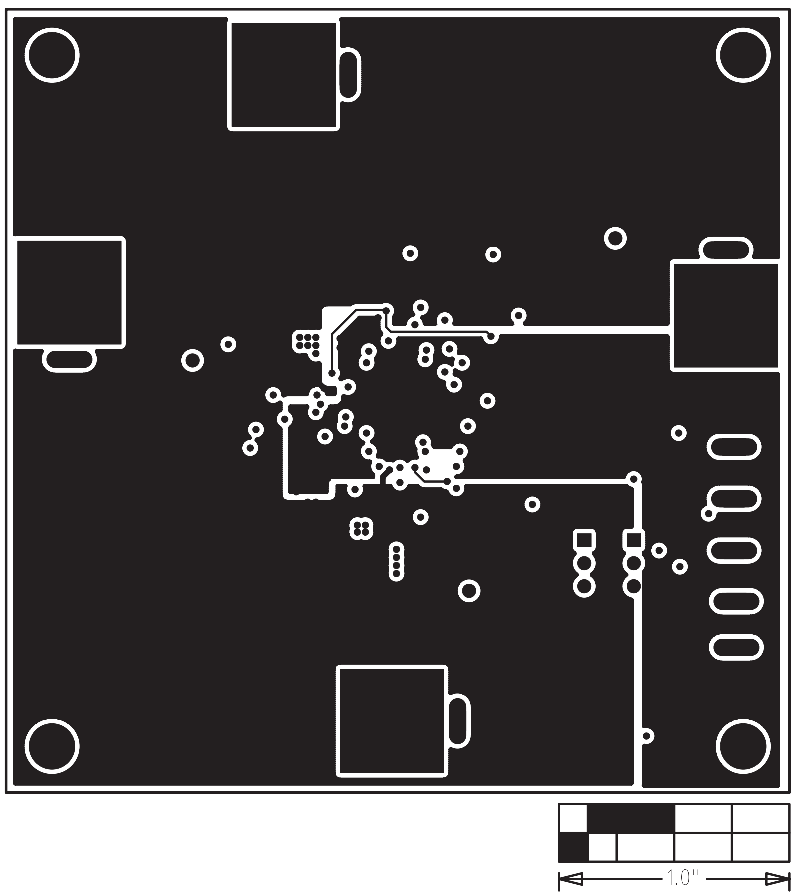

Figure 4. MAX15003 EV Kit PCB Layout—Layer 2 (Ground Layer)

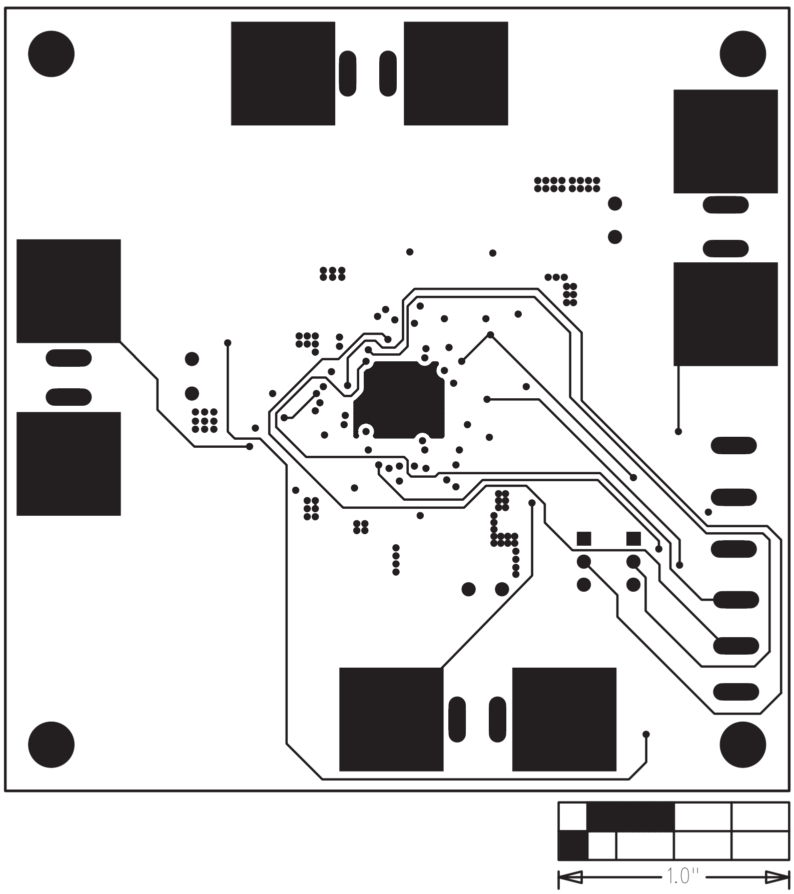

Figure 5. MAX15003 EV Kit PCB Layout—Layer 3 (Power Layer)

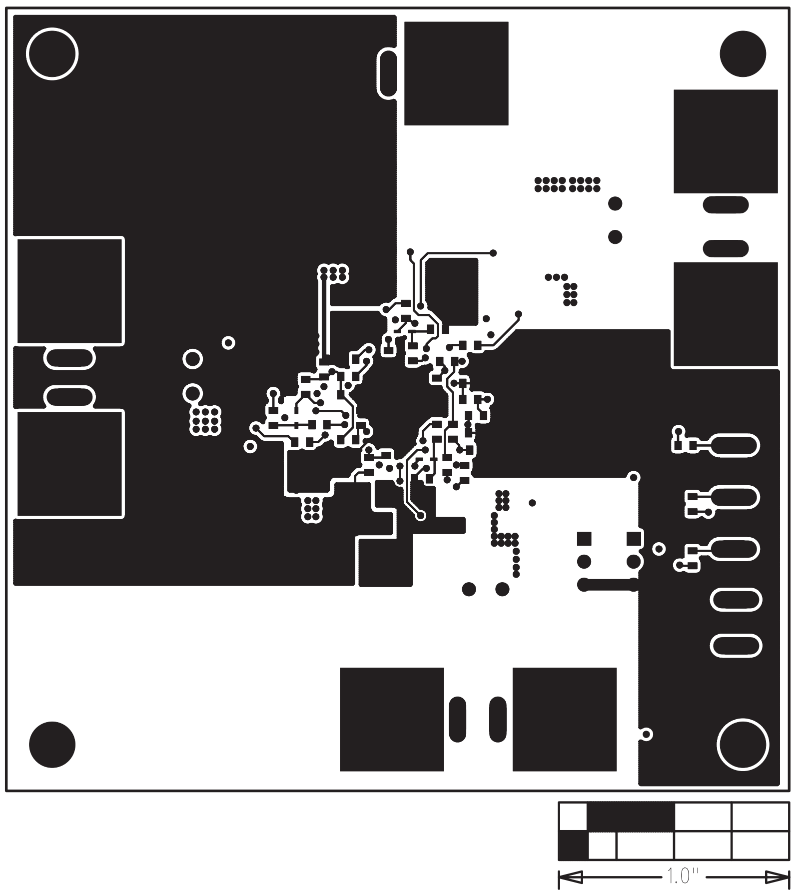

Figure 6. MAX15003 EV Kit PCB Layout—Solder Side

MAX15003 Evaluation Kit

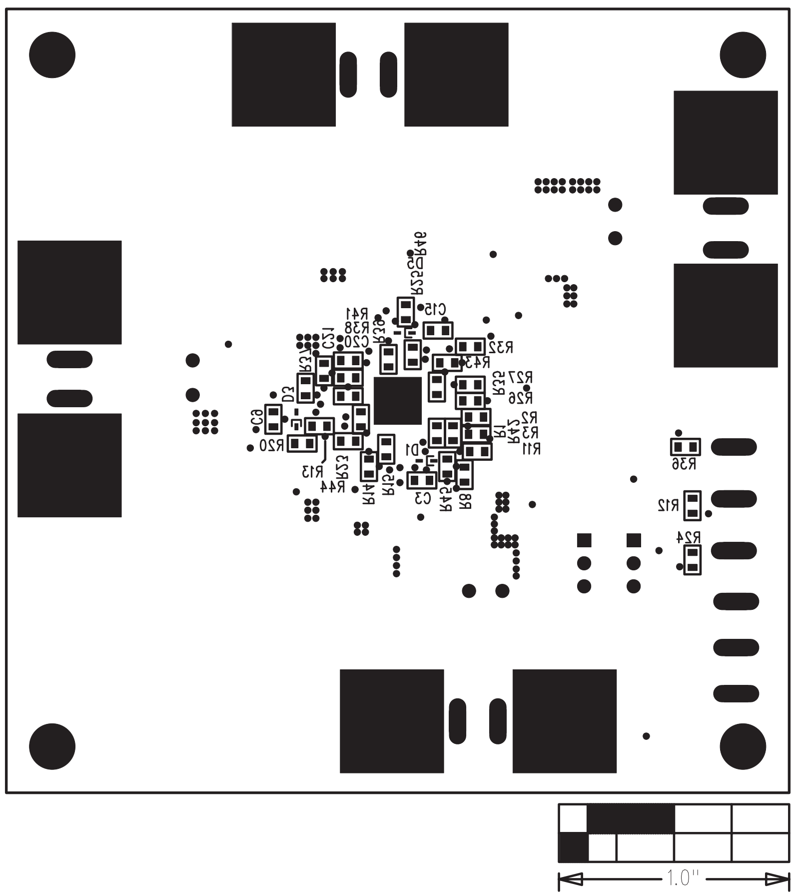

Figure 7. MAX15003 EV Kit Component Placement Guide—Solder Side

Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)
Факс: 8 (812) 320-02-42
Электронная почта: org@eplast1.ru
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.