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## MAX77541 Evaluation Kit

## Evaluates: MAX77541 in Wafer-Level Package

### General Description

The MAX77541 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that demonstrates the MAX77541 dual-phase configurable step-down regulator. The board is equipped with test points and jumpers for testing all pins on the device. Three potentiometers allow the user to adjust the SEL1/SEL2/CFG configuration pins at will. There are also probe sockets on critical nodes (VOUTx, LXx) for precise measurements. The board also comes with some spare inductors (L3-L6) for testing out efficiency/performance tradeoffs. The PCB is designed with Maxim Integrated's recommended layout of the IC and external components. The IC sets default output voltages by way of R13 and R14, but can be changed with the potentiometers or through I<sup>2</sup>C communication. Maxim Integrated's graphical user interface (GUI) can be used by connecting J11 to a Windows®-based PC through a MAXUSB\_INTERFACE# device.

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

### Features

- Probe sockets for high-accuracy measurements
- Test points for all features (POK, FPWM, EN, and IRQB)
- Default output voltage adjustable through SEL
- I<sup>2</sup>C slave ADDR, ILIM, f<sub>SW</sub> preset by CFG
- Connector for custom I<sup>2</sup>C host

### Checklist

- The MAX77541 EV kit
- USB to I<sup>2</sup>C interface (MAXUSB\_INTERFACE#)
- USB Type-A to Micro-USB cable
- Windows-based graphical user interface (GUI) software is available for use with the EV kit and can be downloaded from Maxim Integrated's website at <https://www.maximintegrated.com/products/MAX77541EVKIT> under the Design Resources tab. Windows 7 or newer is required to use the EV kit GUI software.

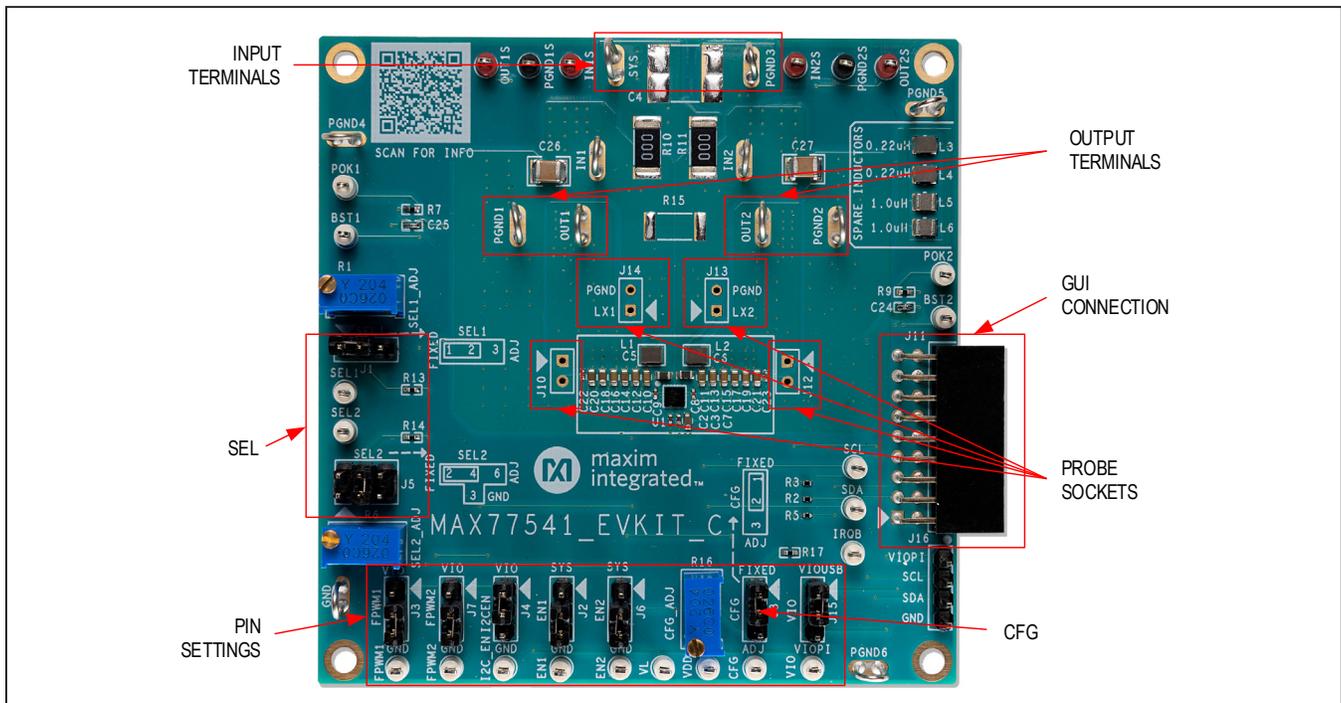


Figure 1. MAX77541 Evaluation Board

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### EV kit Specification and Default Configuration

The MAX77541 EV kit comes with the following default settings:

- $V_{OUT1} = 0.65V$  (dual phase)
- $V_{OUT2} = 1.1V$  (ignored since buck is in dual phase)
- $f_{SW} = 1.6MHz$
- Skip mode
- Soft-Start and DVS ramp up rate =  $5.0mV/\mu s$
- Soft-Stop and DVS ramp down rate =  $-0.15mV/\mu s$
- $100\Omega$  active discharge enabled ( $7\Omega$  is disabled)
- Current Limit = 4.6A when set to dual phase
- MAX77541AAWV+T installed

**Table 1. EV Kit Default Specifications**

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage		2.2		5.5	V
Output Voltage	Configurable by SEL or with I <sup>2</sup> C	0.3		5.2	V
Output Current	Per Phase	0		3	A
Switching Frequency			1.6		MHz
Current Limit			4.6		A

**Table 2. Default Shunt Positions and Jumper Descriptions**

JUMPER	NODE OR FUNCTION	SHUNT POSITION	FUNCTION
J1	SEL1	1-2*	Connects SEL1 to fixed 649Ω resistor ( $0.65V_{OUT}$ default)
		2-3	Connects SEL1 to the potentiometer for adjustable default $V_{OUT}$
J2	EN1	1-2	Connects EN1 to SYS (enables Buck 1)
		2-3*	Connects EN1 to GND (disables Buck 1)
J3	FPWM1	1-2	Connects FPWM1 to VIO (Buck 1 FPWM mode enabled)
		2-3*	Connects FPWM1 to GND (Buck 1FPWM mode disabled)
J4	I2C_EN	1-2*	Connects I2C_EN to VIO (enables I <sup>2</sup> C)
		2-3	Connects I2C_EN to GND (disables I <sup>2</sup> C)
J5	SEL2	2-4	Connects SEL2 to fixed 2.87kΩ resistor ( $1.1V_{OUT}$ default)
		3-4*	Connects SEL2 to GND (enables dual-phase operation)
		4-6	Connects SEL2 to the potentiometer for adjustable default $V_{OUT}$
J6	EN2	1-2	Connects EN2 to SYS (enables Buck 2)
		2-3*	Connects EN2 to GND (disables Buck 2)
J7	FPWM2	1-2	Connects FPWM2 to VIO (Buck 2 FPWM mode enabled)
		2-3*	Connects FPWM2 to GND (Buck 2 FPWM mode disabled)
J8	CFG	1-2*	Connects CFG to 64.9kΩ (sets I <sup>2</sup> C address, Mx_ILIM, and Mx_FREQ)
		2-3	Connects CFG to potentiometer (sets I <sup>2</sup> C address, Mx_ILIM, and Mx_FREQ)
J11	USB Connector (GUI)	N/A	GUI (MAXUSB_INTERFACE#) connector
J15	VIO	1-2*	Powers VIO from the GUI connector
		2-3	Powers VIO from the external header J16
J16	External I <sup>2</sup> C	N/A	External header for I <sup>2</sup> C host
R12	Phase Configuration	N/A	Remove to separate OUT2 from OUT1

\*Default position.

**Quick Start**

**Required Equipment**

- Adjustable DC power supply or applicable battery
- Multimeter
- MAXUSB\_INTERFACE# for I<sup>2</sup>C serial interface (optional)
- USB Type-A to Micro-USB Cable (optional)

- Windows-based PC with MAX77541 EV kit GUI (optional)

**Setup Overview**

Figure 2 depicts a simplified block diagram of a typical EV kit setup, attach more meters and scope probes as needed. Figure 3 depicts a typical application circuit of the MAX77541.

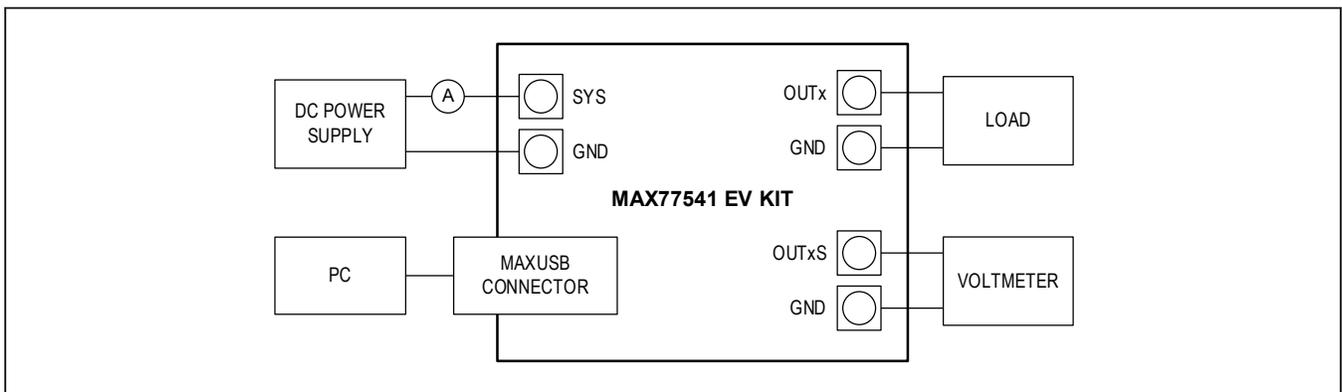


Figure 2. Simplified Setup Block Diagram

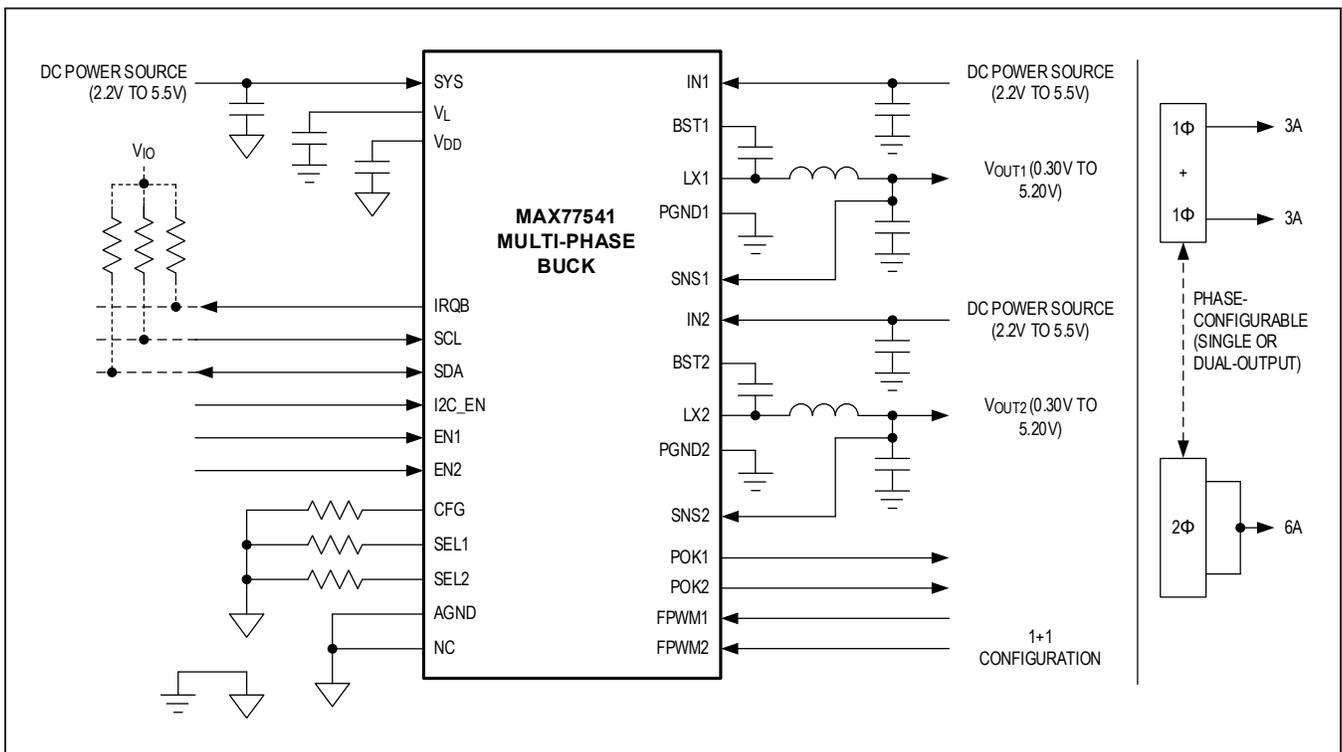


Figure 3. Application Circuit

## Procedure

Follow this procedure for first time evaluation:

- 1) Ensure that the jumpers are configured as shown in [Table 2](#).
- 2) Apply a valid voltage (like 3.8V) from a power supply to the SYS and PGND3 terminals of the EV kit. Do not turn it on yet.
- 3) **Important:** make sure the phase configuration is correct. See the [Phase Configuration](#) section.
- 4) Connect the MAXUSB\_INTERFACE# circuit to J11 on the EV kit, then connect a USB cable between the PC and the MAXUSB\_INTERFACE circuit.
- 5) Turn on the power supply and connect to the EV kit through the GUI.
- 6) Turn on Buck 1 either with the GUI or moving the shunt on the EN1 jumper to SYS.
- 7) Measure OUT1 with a voltmeter. It should read 0.65V.
- 8) Use the GUI to exercise the various features of the MAX77541.

**Note:** When powering down or power cycling the device, remove VIO (or set I2C\_EN to ground with J4) before removing power from SYS.

The next steps of the procedure use the EV kit GUI and MAXUSB\_INTERFACE# to evaluate MAX77541's I<sup>2</sup>C serial interface. If evaluation of the I<sup>2</sup>C serial interface is not required, the following steps can be skipped. The EV kit includes onboard 2.2k $\Omega$  pullup resistors (R4 and R7) to VIO.

**Note:** In the following sections, software-related items are identified as follows: Text in **bold** refers to items directly from the evaluation software. Text in **bold and underlined** refers to items from the Windows operating system.

- 9) Install GUI software. Visit the product webpage at <https://www.maximintegrated.com/products/MAX-77541EVKIT> and navigate to the Design Resources to download the latest version of the EV kit software. Save the EV kit software installation file to a temporary folder and decompress the ZIP file. Run the .EXE file and follow the on-screen instructions to complete installation.
- 10) Turn off the 1.8V VIO power supply and input power supply connected in steps 4 and 5.
- 11) Disconnect the 1.8V VIO power supply connected in step 4 from the EV kit. MAXUSB\_INTERFACE# has an on-board LDO to supply 1.8V to VIO.
- 12) Ensure SW1 and SW2 switches on the MAXUSB\_INTERFACE# are set to the ON position. This enables I<sup>2</sup>C mode on MAXUSB\_INTERFACE#.
- 13) Connect the MAXUSB\_INTERFACE# to the MAX77541 EV kit. Connect the MAXUSB\_INTERFACE# to the PC's USB port with a USB Type-A to Micro-USB cable.
- 14) Turn on the input power supply.
- 15) Open the GUI and click the **Device** button in the menu bar. Select **Connect** in the **Device** drop-down list. Wait for the device to respond, then click the **Connect** button in the **Synchronize** window.
- 16) Drag the slider bar in the **Output Voltage Configuration** section to change the output voltage and click the **Write** button.
- 17) Confirm with a DVM that the software instruction to change output voltage was successful. If so, the I<sup>2</sup>C serial interface is confirmed to be working.

This concludes the Quick Start procedure. Users are now encouraged to further explore the device and its register settings with the GUI software. For more information on the GUI, see the [Detailed Description of Software](#) section.

## EV Kit Hardware

### MAXUSB\_INTERFACE#

The MAXUSB\_INTERFACE# along with the companion EV kit GUI software allows users to easily change MAX77541's register settings with a Windows PC. Before connecting the MAXUSB\_INTERFACE# to the EV kit's MAXUSB\_INTERFACE# connector (J5), make sure the MAXUSB\_INTERFACE# is configured with the following settings:

- SW1, SW2 to the ON position (this enables I<sup>2</sup>C mode on the MAXUSB\_INTERFACE#)
- V<sub>L</sub> Jumper (J5) to 1.8V (this sets MAXUSB\_INTERFACE#'s V<sub>IO</sub> voltage)

MAXUSB\_INTERFACE# also includes an on-board LDO that can supply necessary voltage to V<sub>IO</sub>.

### External I<sup>2</sup>C Bus

To use a different I<sup>2</sup>C host, disconnect the MAXUSB\_INTERFACE# or the USB cable and attach I<sup>2</sup>C wires to J16 on the EV kit.

**Phase Configuration**

To set the MAX77541 to dual-phase operation, set J5 to the 3:4 position. Use the nearby silk screen as a reference.

Phase configuration is set by SEL2. If SEL2 is shorted to GND (effectively 0Ω), the part will be in 2 phase; if SEL2 is higher than 200Ω, the part will be in 1+1 phase. Resistor R12 (on the bottom side of the board) connects the two outputs together. Ensure that R12 is installed/uninstalled based on desired phase configuration (see [Table 3](#)).

**Change Default Setup with RSEL1/RSEL2**

Note that the MAX77541 EV kit is default configured for dual phase operation, with VOUT1 set to 0.65V and VOUT2 set to 1.1V (by way of R13 and R14). To evaluate other default configurations (for different voltages/ranges upon first power-up), change the resistance at SEL1/2 with either of the potentiometers or R13/R14. Refer to the device datasheet for more information.

**High Temperature Testing**

The MAX77541 is rated for operation under ambient/junction temperatures up to 125°C. Note that not all components on the EV kit are rated for temperatures that high. Some ceramic capacitors experience extra leakage when put under temperatures higher than they are rated for, and supply current readings for the IC might be larger than expected. Double check the components on the EV kit if testing at 125°C ambient temperatures.

**Table 3. Phase Configuration Truth Table**

SEL2	R12	PHASE CONFIGURATION
0Ω	0Ω	Dual Phase (2φ)
0Ω	Open	Mismatch
>200Ω	0Ω	Mismatch
>200Ω	Open	Single Phase (1φ + 1φ)

**Table 4. Test Point Selection for Measurement**

LOAD TRANSIENT, OUTPUT RIPPLE	LOAD REGULATION, LINE REGULATION, VOUT ACCURACY	EFFICIENCY		SWITCHING NODE	
		OUTPUT VOLTAGE	INPUT VOLTAGE	LX1	LX2
J10 (VOUT1 SOCKET), J12 (VOUT2 SOCKET)	INxS, OUTxS, PGNDxS	OUTxS, PGNDxS	INxS, OUTxS	J14	J13

List of caps not rated for 125°C:

C10-C23 (Buck 1 and 2 output capacitors)

Consider replacing these components if IC operation at 125°C ambient temperature is an important use case.

**Test Points and Critical Node Measurement (VOUT & LX)**

The EV kit comes with sockets presoldered onto the board for measuring the critical nodes VOUT1 (J10), LX1 (J14), VOUT2 (J12), and LX2 (J13). Use these probe sockets to eliminate as much noise as possible when measuring the critical nodes. To ensure best results, use a very short ground wire from the ground sleeve of the scope probe to the GND side of the probe socket and use the bare tip of the probe directly to the signal side of the probe socket. Following these guidelines gives the most accurate results when measuring parameters like output voltage ripple, switching waveforms, and load transient response.

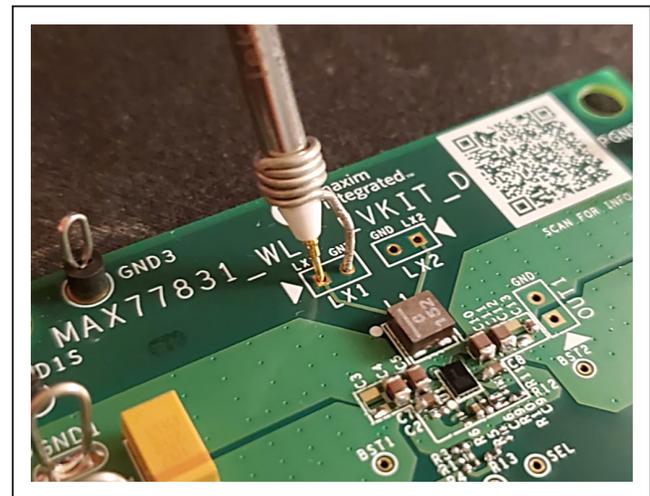


Figure 4. Example of Probing Sensitive Node

### Detailed Description of Software

The Graphical User Interface (GUI) software allows for quick, easy, and thorough evaluation of the MAX77541. The GUI drives I<sup>2</sup>C communication with the EV kit (the GUI along with the MAXUSB\_INTERFACE# drives I<sup>2</sup>C communication with the EV kit). Every control in the GUI corresponds directly to a register within the MAX77541. Refer to the *Register Map* section of MAX77541 IC data sheet for a complete description of the registers. See [Figure 5](#) for a screenshot of the GUI upon launch.

### Installation

Visit the product webpage at <https://www.maximintegrated.com/products/MAX77541EVKIT> and navigate to Design Resources to download the latest version of the EV kit software. Save the EV kit software installation file to a temporary folder and decompress the ZIP file. Run the .EXE installer and follow the on-screen instructions to complete the installation.

### Windows Driver

After plugging in the MAXUSB\_INTERFACE# to the PC with a Micro-USB cable for the first time, wait about 30 seconds for Windows to automatically install the necessary drivers.

### Connecting GUI

After opening the GUI, click the **Device** drop down list in the upper left corner of the GUI window and select **Connect**.

The **Device Synchronization** menu opens ([Figure 7](#)) once the MAX77541 IC responds (voltages on SYS pin and V<sub>IO</sub> pin must be valid on the MAX77541 IC for it to respond). The I<sup>2</sup>C address shown is the MAX77541 IC's 7-bit slave address. The address shown changes depending on the EV kit's ADDR configuration. Click the **Connect** button. The text at the bottom right of the GUI window changes from *MAXUSB\_INTERFACE# is Disconnected* to *MAXUSB\_INTERFACE# is Connected*.

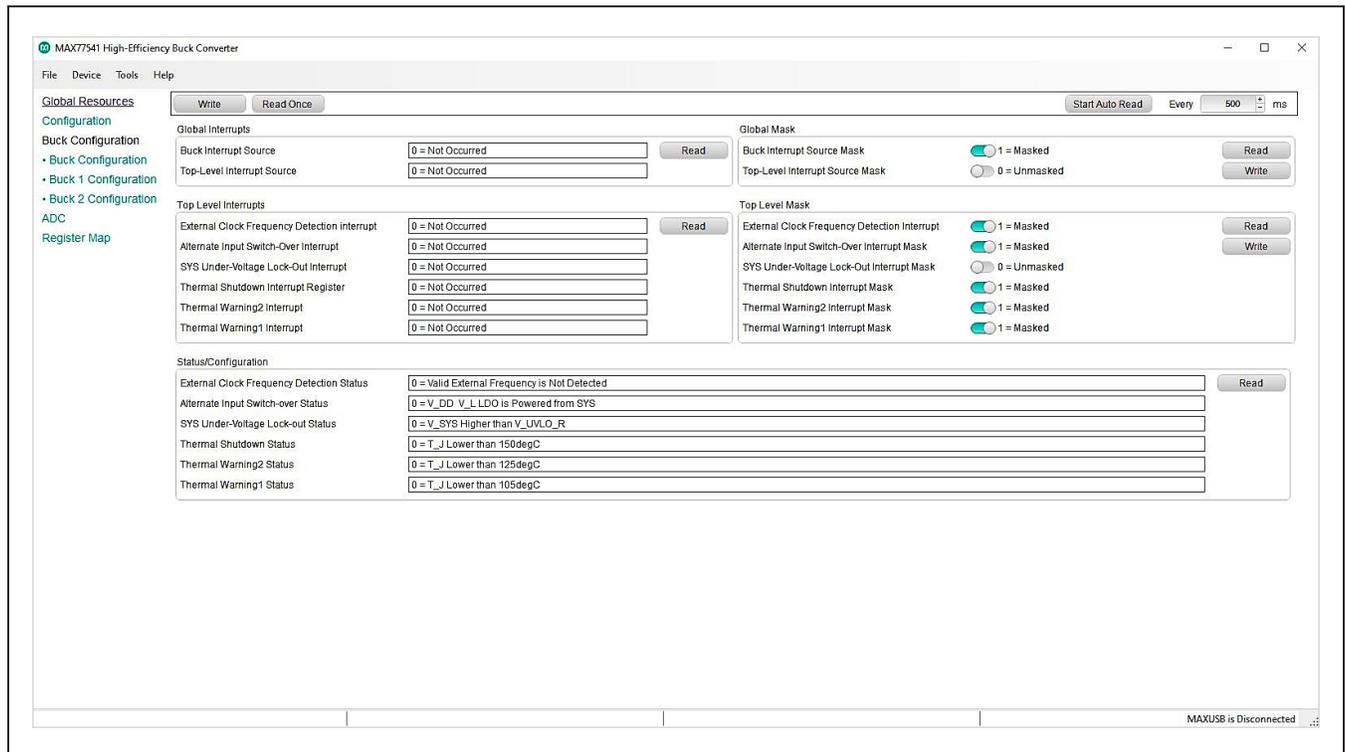


Figure 5. MAX77541 Evaluation Kit GUI Top-Level Interface (before Connecting)

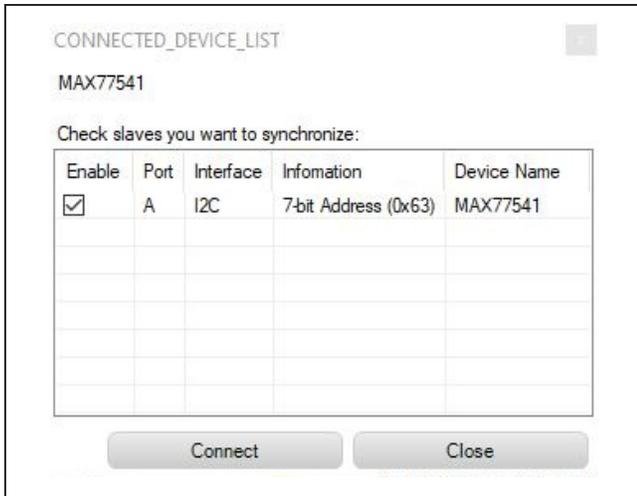


Figure 6. Port Synchronization Menu

### Configuring the Regulator

The GUI has a configuration tab for each buck (Buck 1 Configuration and Buck 2 Configuration). Use these to adjust the various parameters of each buck. Note that Buck 2 Configuration is disabled during dual phase operation. Figure 7 shows a snapshot of the Buck 1 Configuration tab. To use the GUI, select the desired option in one of the interactable fields (button, slider, or drop-down list) and click the **Write** button next to it. Use the **Read** button to refresh the current state of the registers.

### PCB Layout Guidelines

Careful circuit board layout is critical to achieve low switching power losses and clean, stable operation. Refer to <https://www.maximintegrated.com/products/MAX77541EVKIT> for the *PCB Layout Guideline* section of the MAX77541 data sheet.

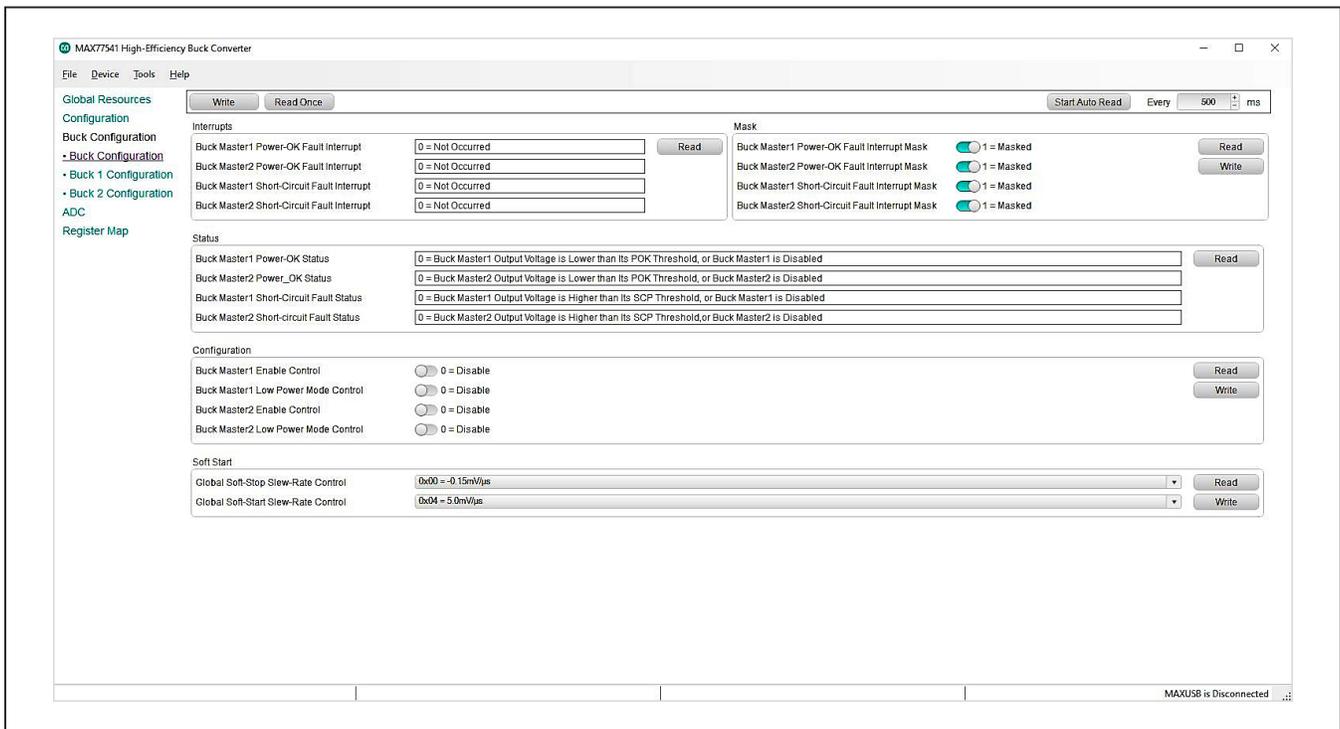


Figure 7. Primary Control Portion of Main GUI Window

### Ordering Information

PART	U1 IC
MAX77541EVKIT#	MAX77541AAWV+T

#Denotes RoHS compliant

## MAX77541 EV Kit Bill of Materials

REF_DES	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
C2	2	C1005X7S1A225K050BC	TDK	2.2UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 2.2UF; 10V; TOL = 10%; TG=-55 DEGC TO +125 DEGC; TC = X7S;
C3	1	C1005X7S1A105K; GRM155C71A105KE11	TDK/MURATA	1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 1UF; 10V; TOL = 10%; TG=-55 DEGC TO +125 DEGC; TC = X7S;
C5, C6	2	GRM188R61E106MA73	MURATA	10UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 10UF; 25V; TOL=20%; TG=-55 DEGC TO +85 DEGC; TC=X5R
C7	1	GRM188R71A225KE15	MURATA	2.2UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 2.2UF; 25V; TOL=10%; MODEL=; TG=-55 DEGC TO +125 DEGC; TC=X7R
C8, C9	2	C1005X7R1C104K050BC	TDK	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 16V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R
C10-C21	12	C1608X5R1A226M080A; GRM188R61A226ME15	TDK; MURATA	22UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 22UF; 10V; TOL=20%; TG=-55 DEGC TO +85 DEGC; TC=X5R
C22, C23	2	GRM155R71E104KE14; C1005X7R1E104K050BB	MURATA; TDK	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 25V; TOL=10%; MODEL=GRM SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R
L1, L2	2	GLULMR4701A	ALPS	0.47UH	INDUCTOR; SMT (1008); METAL; 0.47UH; 20%; 5.6A
U1	1	MAX77541AAWV+	MAXIM	MAX77541AAWV+	EVKIT PART-IC; MAX77541AAWV+; PACKAGE OUTLINE:21-100479; PACKAGE CODE: W302R2Z+1; WLP30
Components below this line are outside of the immediate MAX77541 evaluation circuit and solution silkscreen.					
BST1, BST2, CFG, EN1, EN2, FPWM1, FPWM2, I2C_EN, IRQB, POK1, POK2, SCL, SDA, SEL1, SEL2, VDD, VIO, VL	18	5002	KEystone	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; WHITE; PHOSPHOR BRONZE WIRE SILVER;

## MAX77541 EV Kit Bill of Materials (continued)

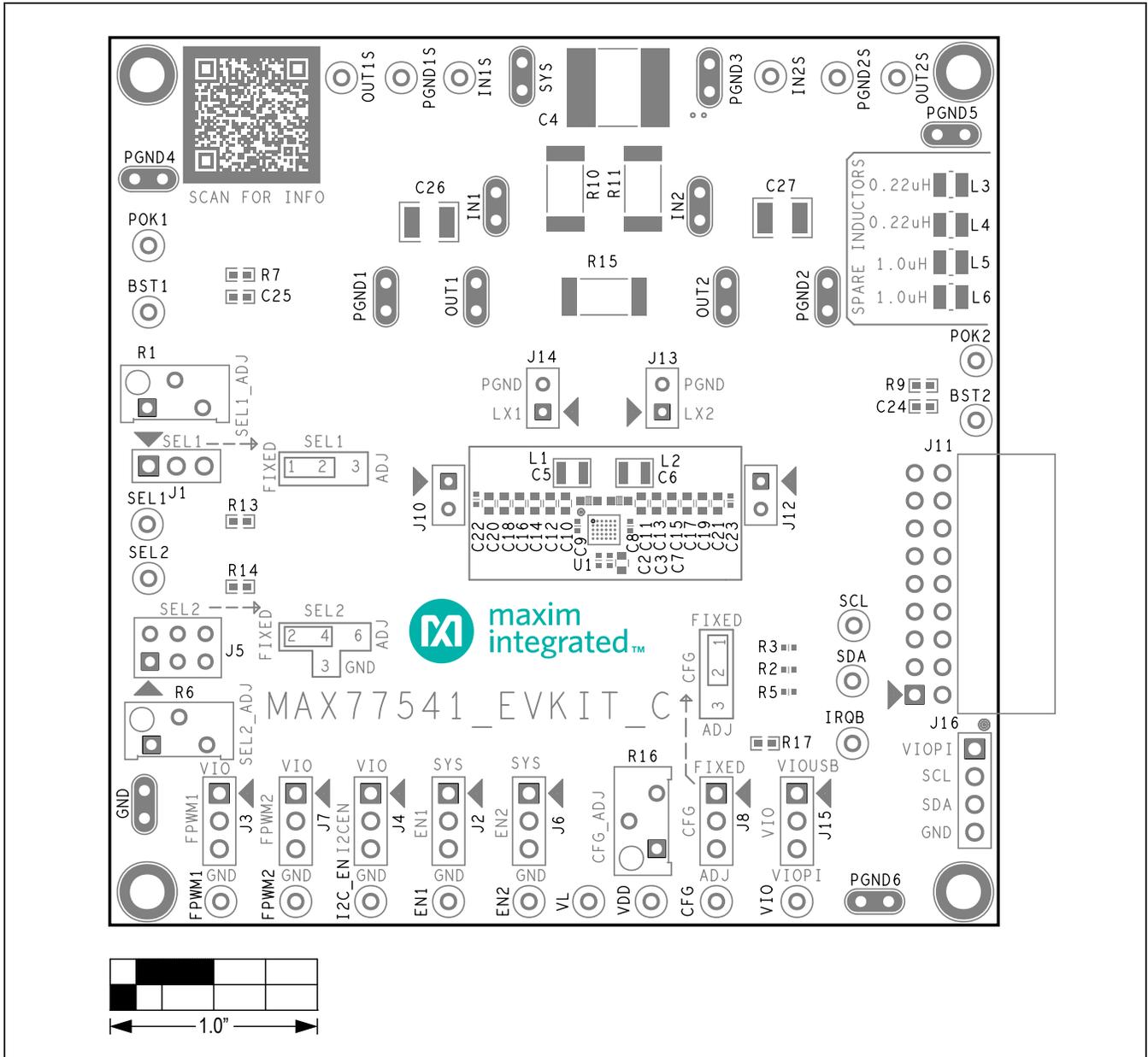
REF_DES	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
C24, C25	2	C0402C101K5GAC; C1005C0G1H101K050BA	KEMET;TDK	100PF	CAPACITOR; SMT; 0402; CERAMIC; 100pF; 50V; 10%; COG; -55degC to + 125degC; 0 +/-30PPM/degC
C26, C27	2	GRM32ED71A476KE15	MURATA	47UF	CAP; SMT (1210); 47UF; 10%; 10V; X7T; CERAMIC CHIP
GND, IN1, IN2, OUT1, OUT2, PGND1-PGND6, SYS	12	9020 BUSS	WEICO WIRE	MAXIMPAD	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG
IN1S, IN2S, OUT1S, OUT2S	4	5000	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
J1-J4, J6-J8, J15	8	TSW-103-07-T-S	SAMTEC	TSW-103-07-T-S	CONNECTOR; THROUGH HOLE; TSW SERIES; SINGLE ROW; STRAIGHT; 3PINS
J5	2	TSW-102-26-T-T	SAMTEC	TSW-102-26-T-T	CONNECTOR; THROUGH HOLE; TSW SERIES; TRIPLE ROW; STRAIGHT; 6PINS
J11	1	PPPC092LJBN-RC	SULLINS ELECTRONICS CORP	PPPC092LJBN-RC	CONNECTOR; FEMALE; THROUGH HOLE; PPP SERIES; RIGHT ANGLE; 18PINS
J16	1	PEC04SAAN	SULLINS ELECTRONICS CORP.	PEC04SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 4PINS
J18	1	PBC02SAAN	SULLINS ELECTRONICS CORP.	PBC02SAAN	EVKIT PART-CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 2PINS; -65 DEGC TO +125 DEGC;
L3, L4	2	GLULMR2201A	ALPS	0.22UH	INDUCTOR; SMT (1008); METAL; 0.22UH; 20%; 7.00A
L5, L6	2	DFE252012F-1R0M	MURATA	1.0UH	INDUCTOR; SMT (1008); SHIELDED; 1.0UH; 20%; 3.3A
PGND1S, PGND2S	2	5001	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;

## MAX77541 EV Kit Bill of Materials (continued)

REF_DES	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
R1, R6, R16	2	3296Y-1-204LF	BOURNS	200K	RESISTOR; THROUGH HOLE-RADIAL LEAD; 3296 SERIES; 200K OHM; 10%; 100PPM; 0.5W
R2, R3	2	CRCW04022K20FK; RC0402FR-072K2L	VISHAY DALE; YAGEO PHICOMP	2.2K	RESISTOR, 0402, 2.2K OHM, 1%, 100PPM, 0.0625W, THICK FILM
R4, R8	2	ERJ-2GE0R00	PANASONIC	0	RESISTOR; 0402; 0 OHM; 0%; JUMPER; 0.10W; THICK FILM
R5, R7, R9	3	CRCW040210K0FK; RC0402FR-0710KL	VISHAY DALE; YAGEO PHICOMP	10K	RESISTOR; 0402; 10K; 1%; 100PPM; 0.0625W; THICK FILM
R10-R12	3	CRCW25120000ZS	VISHAY DALE	0	RESISTOR; 2512; 0 OHM; 1%; JUMPER; 1.0W; METAL FILM
R13	1	ERJ-2RKF6490	PANASONIC	649	RESISTOR; 0402; 649 OHM; 1%; 100PPM; 0.1000W;
R14	1	CR0402-16W-2871F; CRCW04022K87	VENKEL LTD.; VISHAY DALE	2.87k	RES; SMT (0402); 2.87K; 1%; +/-100PPM/DEGC; 0.0630W
R17	1	CRCW040264K9FK; RC0402FR-0764K9L	VISHAY; YAGEO	64.9K	RES; SMT (0402); 64.9K; 1%; +/-100PPM/DEGK; 0.0630W
PCB	1	MAX77541	MAXIM	PCB	PCB:MAX77541
C4	0	KTJ250B107M76BFT00	UNITED CHEMI-CON	100UF	CAP; SMT (3126); 100UF; 20%; 25V; X7R; CERAMIC CHIP
R15	0	N/A	N/A	OPEN	RES; SMT (2512); OPEN

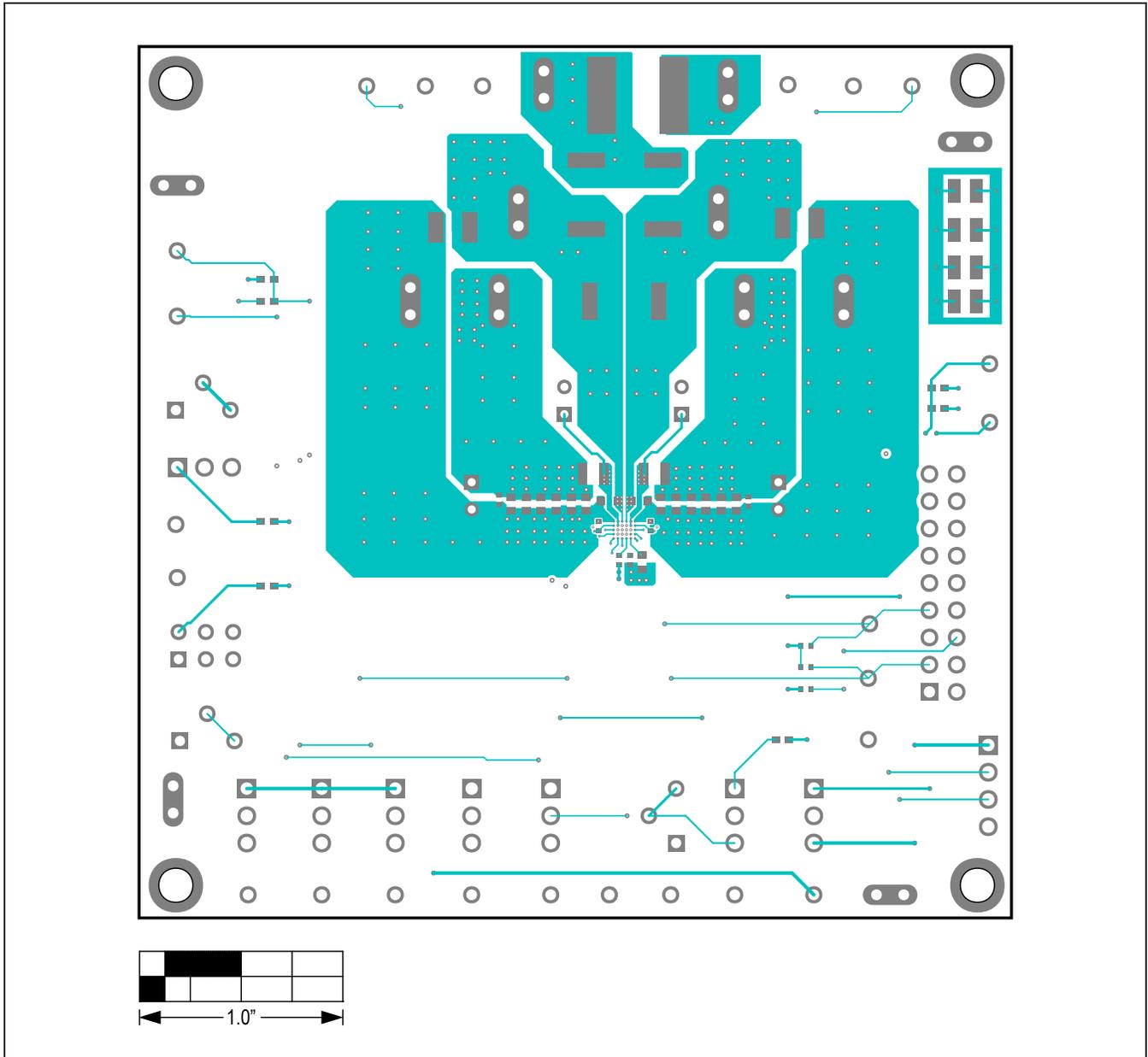


MAX77541 EV Kit PCB Layout Diagrams



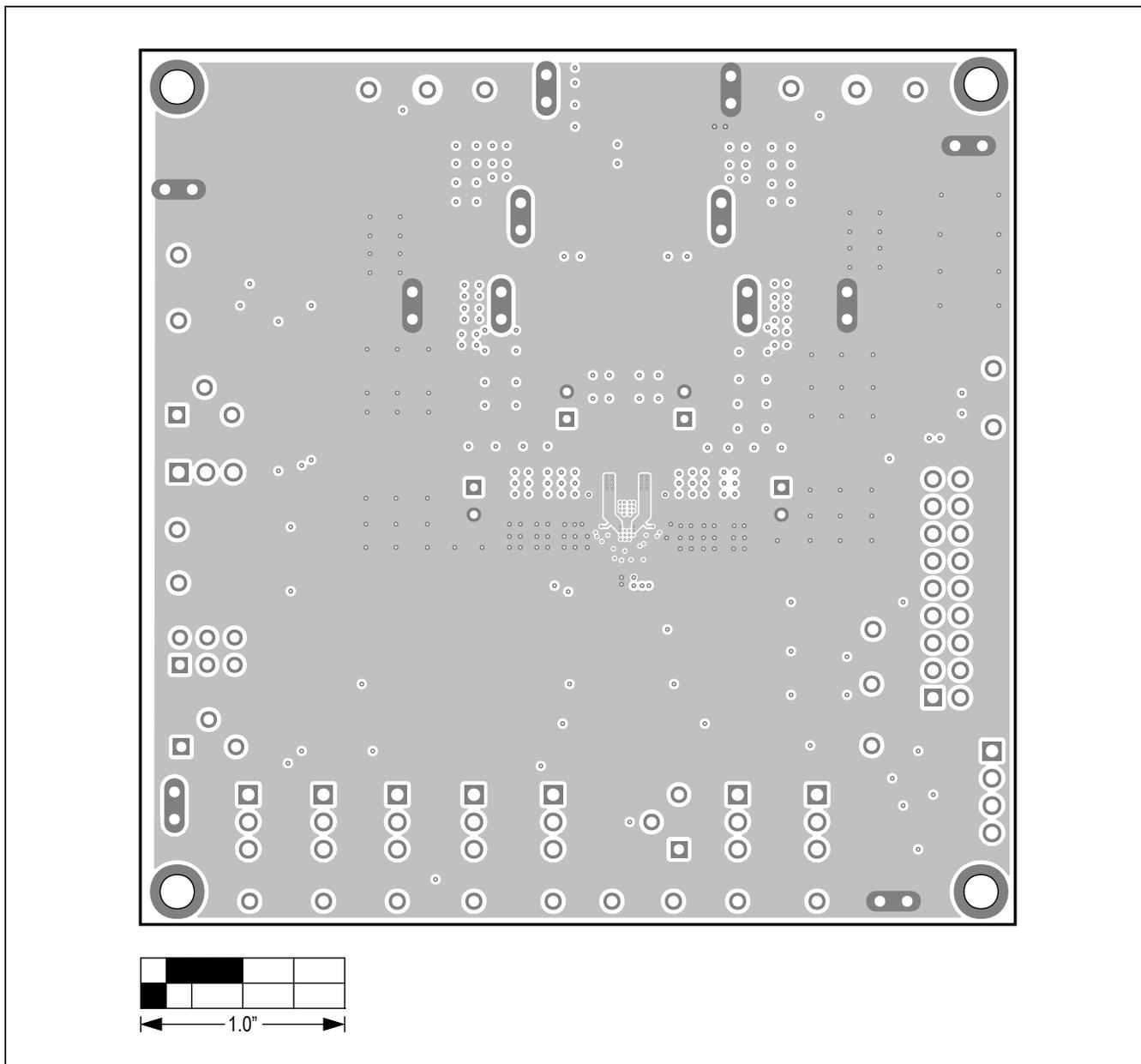
MAX77541 EV Kit Component Placement Guide—Top Silkscreen

MAX77541 EV Kit PCB Layout Diagrams (continued)



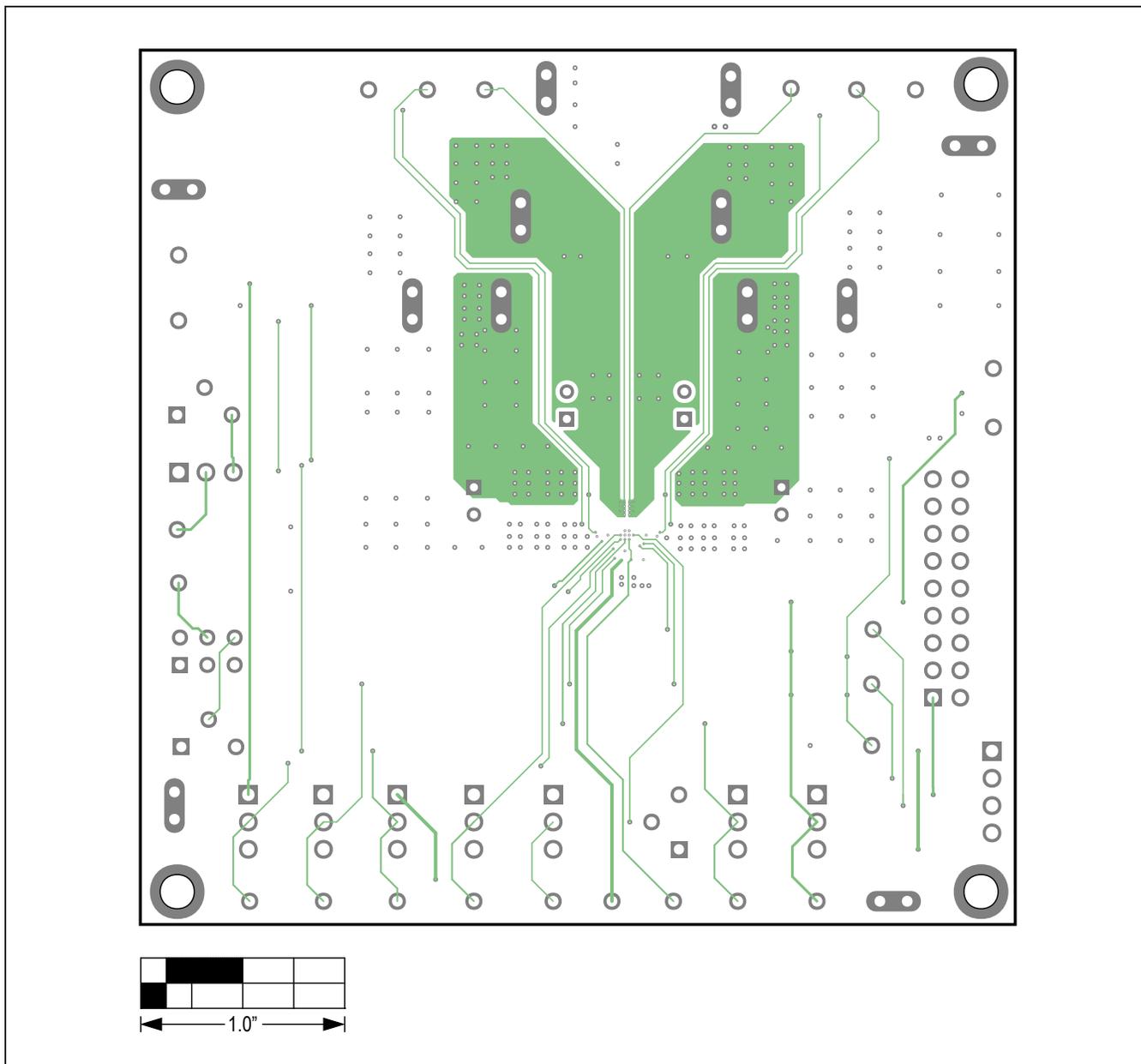
MAX77541 EV Kit PCB Layout—Top Layer

MAX77541 EV Kit PCB Layout Diagrams (continued)



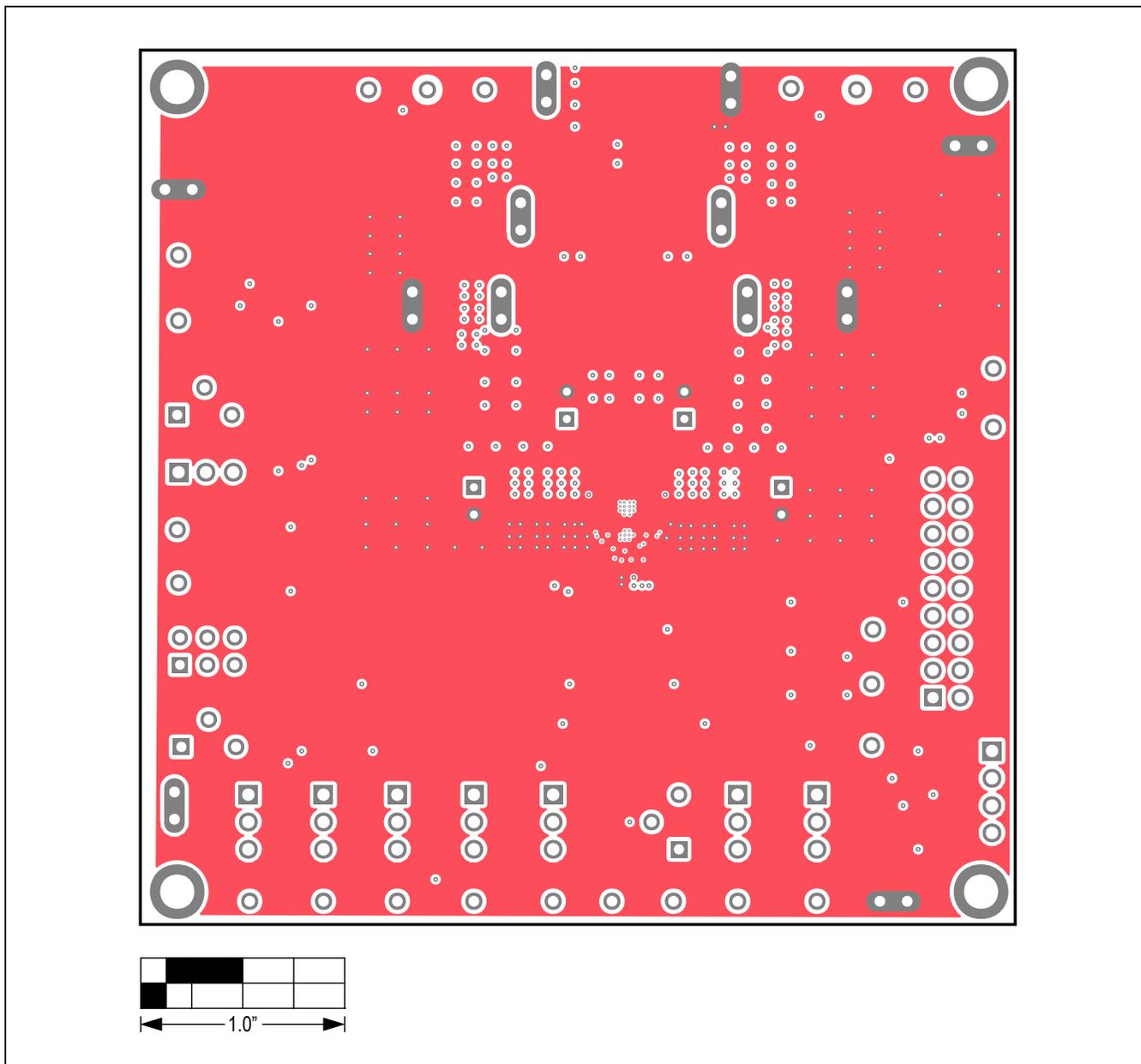
MAX77541 EV Kit PCB Layout—Internal Layer 2

MAX77541 EV Kit PCB Layout Diagrams (continued)



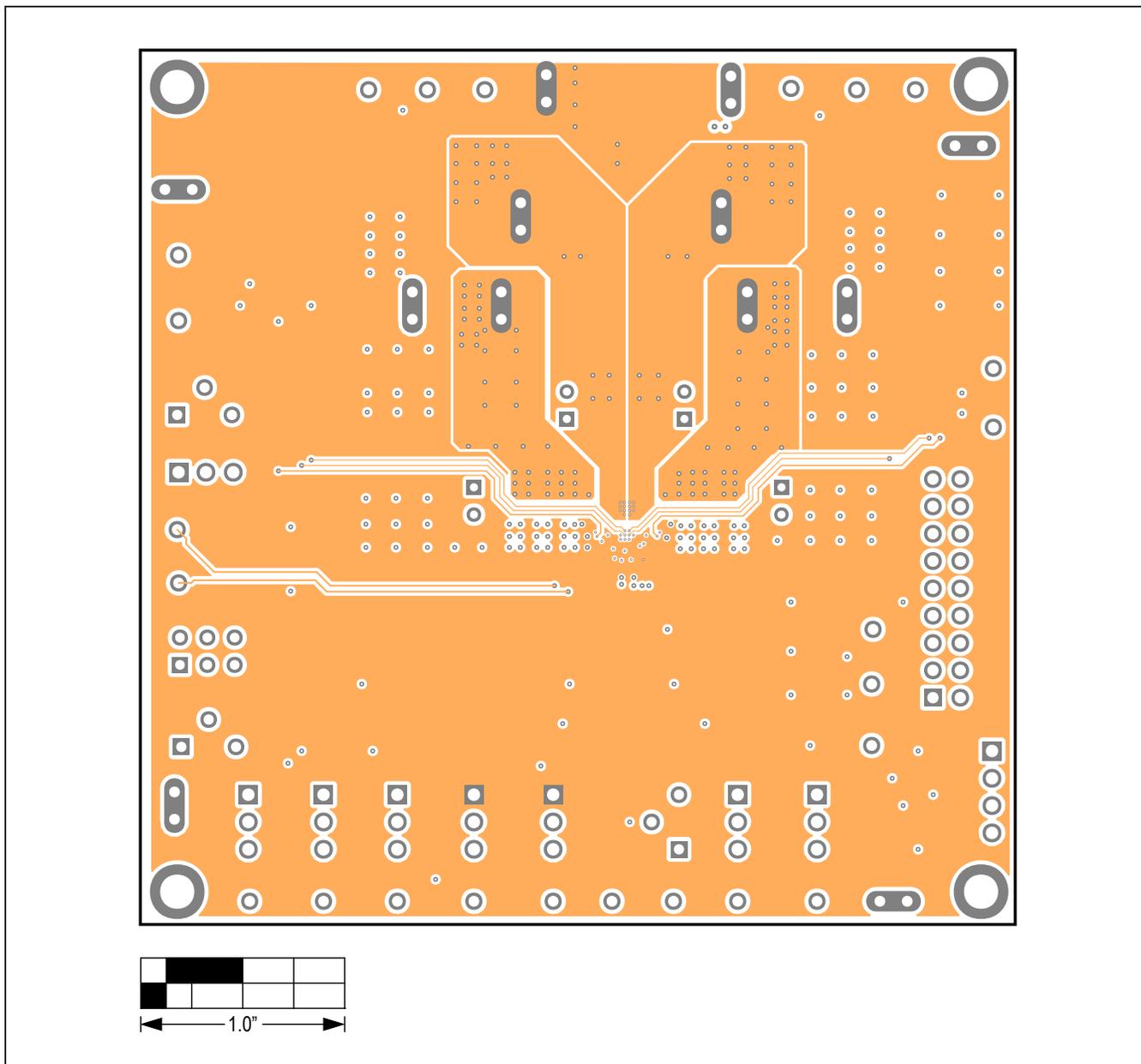
MAX77541 EV Kit PCB Layout—Internal Layer 3

MAX77541 EV Kit PCB Layout Diagrams (continued)



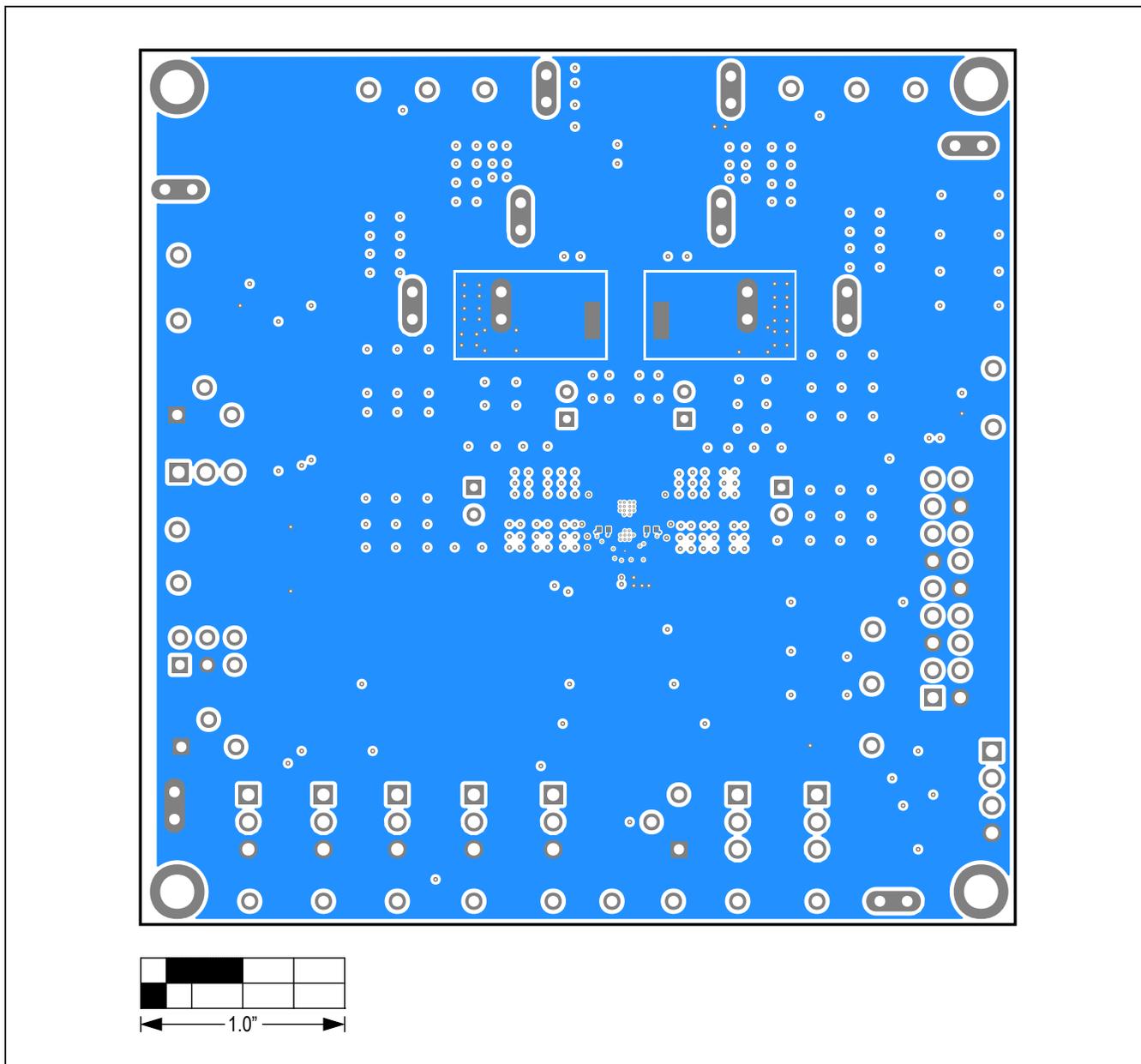
MAX77541 EV Kit PCB Layout—Internal Layer 4

MAX77541 EV Kit PCB Layout Diagrams (continued)



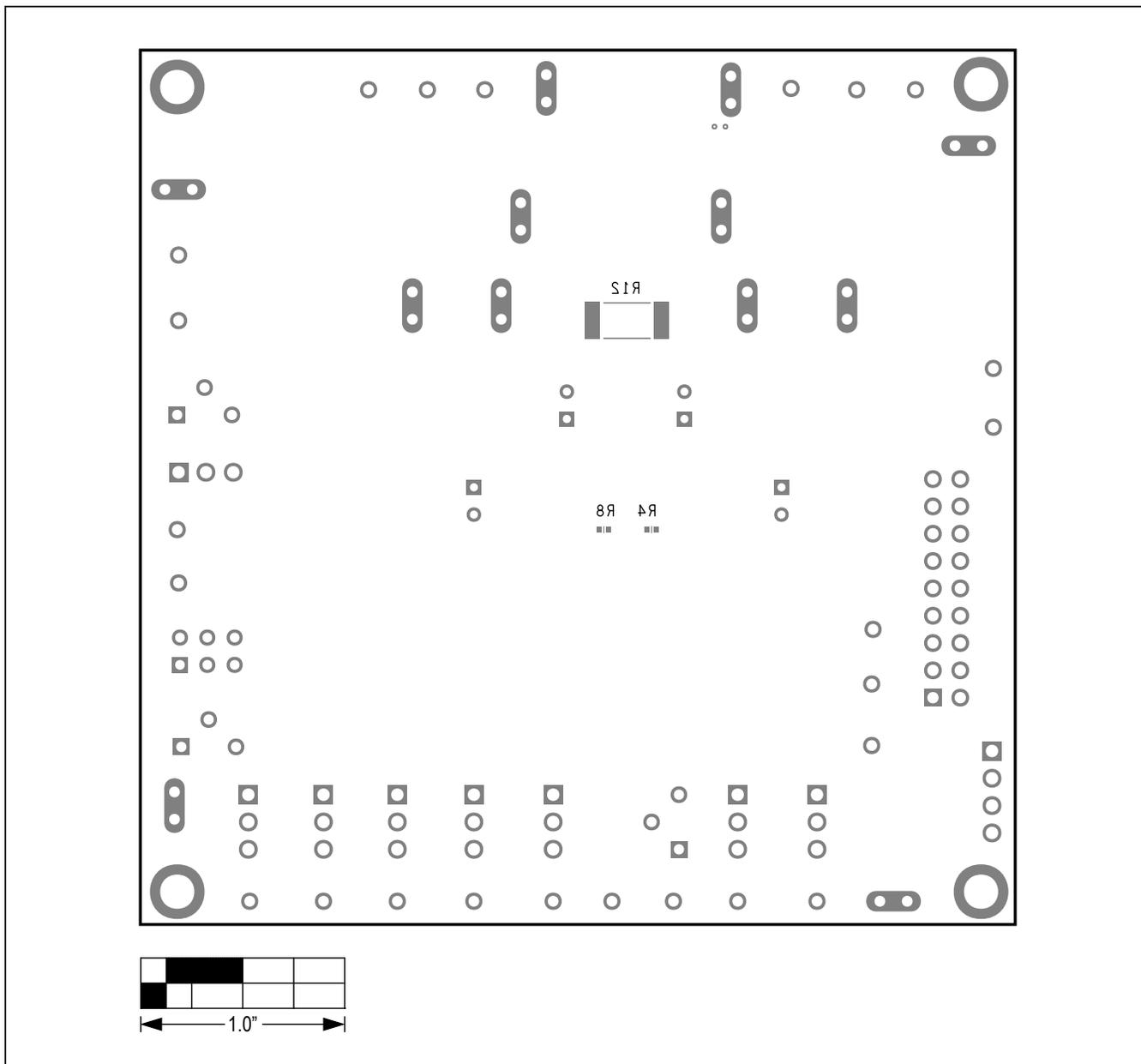
MAX77541 EV Kit PCB Layout—Internal Layer 5

MAX77541 EV Kit PCB Layout Diagrams (continued)



MAX77541 EV Kit PCB Layout—Bottom Layer

MAX77541 EV Kit PCB Layout Diagrams (continued)



MAX77541 EV Kit Component Placement Guide—Bottom Silkscreen

### Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/21	Release for Market Intro	—

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