Evaluation Board User Guide

MAX77727 Evaluation Kit

Evaluates: MAX77727

General Description

The MAX77727 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that demonstrates the MAX77727 synchronous buck converter with ultrasonic mode.

The EV kit is a step-down voltage regulator circuit based on the MAX77727. It supports an input voltage range from 3.6V to 22V and delivers up to 3A of continuous load current. The output voltage is adjustable through I^2C, ranging from 1.8V to 4.9V with 100mV resolution and from 5V to 15V with 250mV resolution. Figure 1 shows the actual MAX77727 EV kit.

Check List

Required Equipment

- MAX77727 EV kit
- Adjustable DC power supply supporting up to 22V and 3A
- Digital multimeters
- Electronic load rated for 20V/10A, operated in constant-current mode
- MAXUSB_INTERFACE# (USB-to-I^2C serial interface)
- USB Type-A to Micro-USB cable
- Windows-based graphical user interface (ACE) software

Features

- Proven PCB Design and Layout Benefit
- Fully Assembled and Tested
- Sense Points Provided for High-Accuracy Measurements
- MAXUSB_INTERFACE# Enables Easy Communication with a Windows PC
- ACE Software Supports the I^2C Serial Interface for Optional Software Control
- I^2C Interface Controls Enable (EN) Function, Ultrasonic Mode (USM), and Output Voltage

EV Kit Specifications

Table 1 specifies the electrical characteristics of the MAX77727 device. Table 2 defines the default jumper configurations on the MAX77727 EV kit.

Key Specifications

- IC Part Number: MAX77727
- Switching Current Limit: 4.6A
- Input Voltage Range: 3.6V to 22V
- Output Voltage: 1.8V to 15V (adjustable)

Ordering Information appears at end of data sheet.

MAX77727 EV Kit Photo

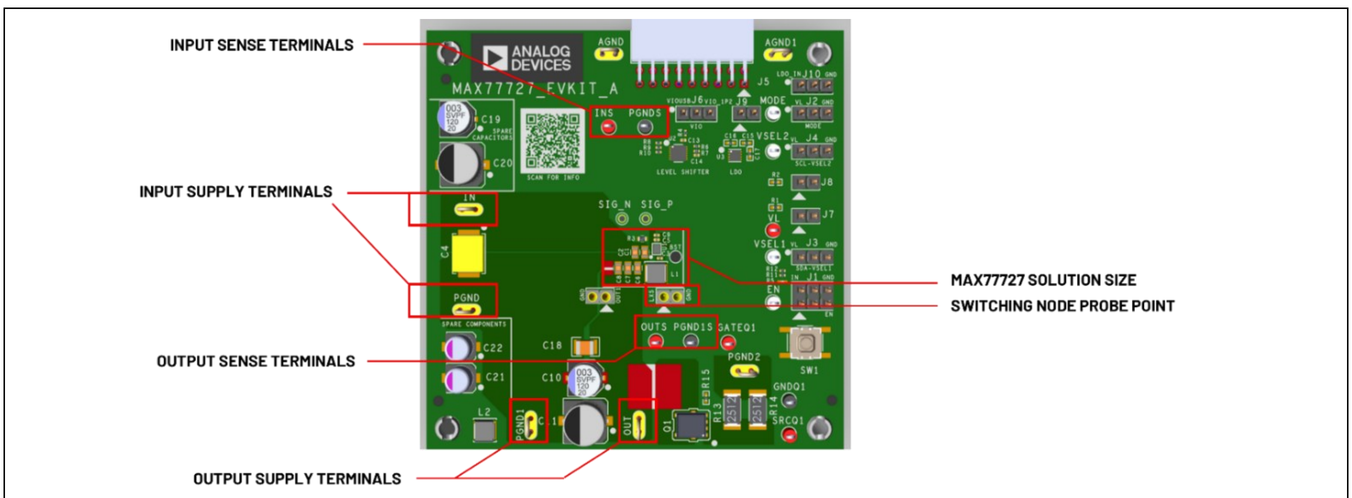


Figure 1. MAX77727 Evaluation Board

Table 1. EV Kit Specifications

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
Operating Input Voltage Range		3.6		22	V
Input Undervoltage Lockout (UVLO)	V_{IN} rising	3.40	3.50	3.60	V
	V_{IN} falling	3.20	3.30	3.40	V
OUTPUT CHARACTERISTICS					
Output Voltage Range	Programable through I^2C	1.8		15	V
SYSTEM CHARACTERISTICS					
Input High Level	EN, MODE	1.0			V
Input Low Level	MODE			0.4	V
	EN			0.3	V

$T_A \approx T_J$, V_{IN} = 9.0V, V_{OUT} = 3.3V, typical values are at $T_A \approx T_J$ = +25°C, unless otherwise noted.

Table 2. Jumper Connection Guide

JUMPER	NODE	POSITION	FUNCTION
J1	EN	1-2*	Use divider resistor from V_{IN} to enable MAX77727.
		3-4	Connects EN to V_{IN} through a 100kΩ pullup resistor. Further, optional controlling EN level by SW1.
		5-6	Connects EN to GND to disable the MAX77727.
		Not installed	Disable the MAX77727 due to it has internal 300kΩ pulldown resistor.
J2	MODE	2-3*	Connects MODE to GND, for MAX77727 need to set MODE Pin to 0, using MODE register to switch LPM, USM and FPWM.
J3	VSEL1	Not installed*	This jumper is set up for MAX77726 (non-I^2C version) use. Refer MAX77726/MAX77727 data sheet. Do not install during MAX77727 evaluation.
J4	VSEL2	Not installed*	This jumper is set up for MAX77726 (non-I^2C version) use. Refer MAX77726/MAX77727 data sheet. Do not install during MAX77727 evaluation.
J6	VIO	1-2	Connects VIO to MAXUSB. Allow VIO to be powered from MAXUSB.
		2-3*	Connects VIO to LDO. Allow VIO to be powered from LDO.
		Not installed	VIO is not powered by either the MAXUSB or the LDO.
J7	SDA	1-2*	Connects VIO to SDA_VSEL1 through 2.2kΩ on board pullup resistor.
		Not installed	Disconnect onboard pull-up resistor.
J8	SCL	1-2*	Connects VIO to SCL_VSEL2 through 2.2kΩ on board pullup resistor.
		Not installed	Disconnect onboard pullup resistor.
J9	VIO_MAXUSB	1-2*	Connects VIO_MAXUSB to LDO_IN.
		Not installed	Disconnects VIO_MAXUSB to LDO_IN.
J10	LDO	1-2	Set LDO output to 1.2V.
		2-3*	Set LDO output to 1.8V.

**Default position*

Quick Start Guide

Typical Application Circuit

The typical application diagram for the MAX77727 is given in *Figure 2*. See the *MAX77727 EV Kit Schematic* and *MAX77727 EV Kit PCB Layout* sections for more information.

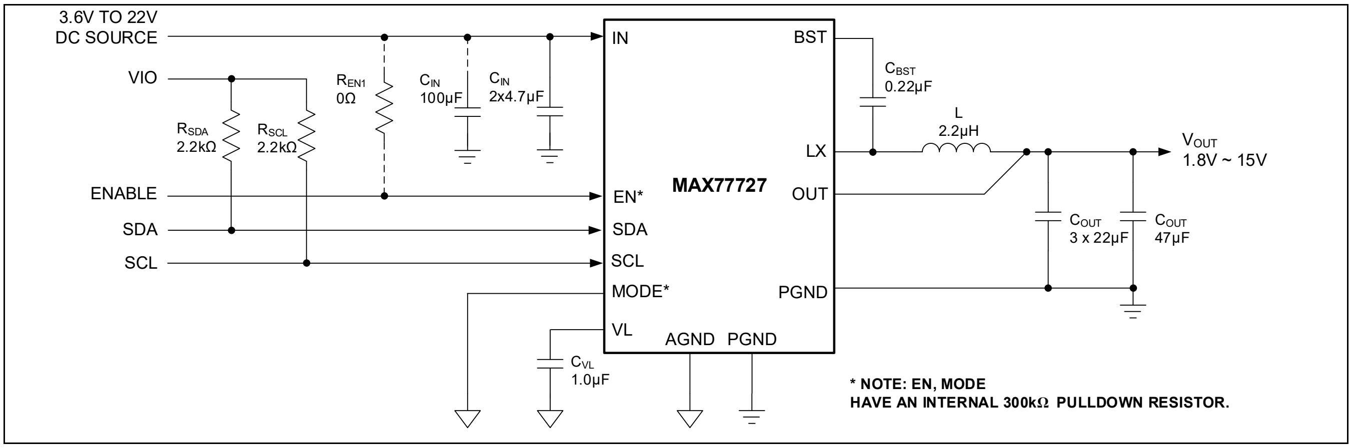


Figure 2. Typical Application Circuit

Procedure

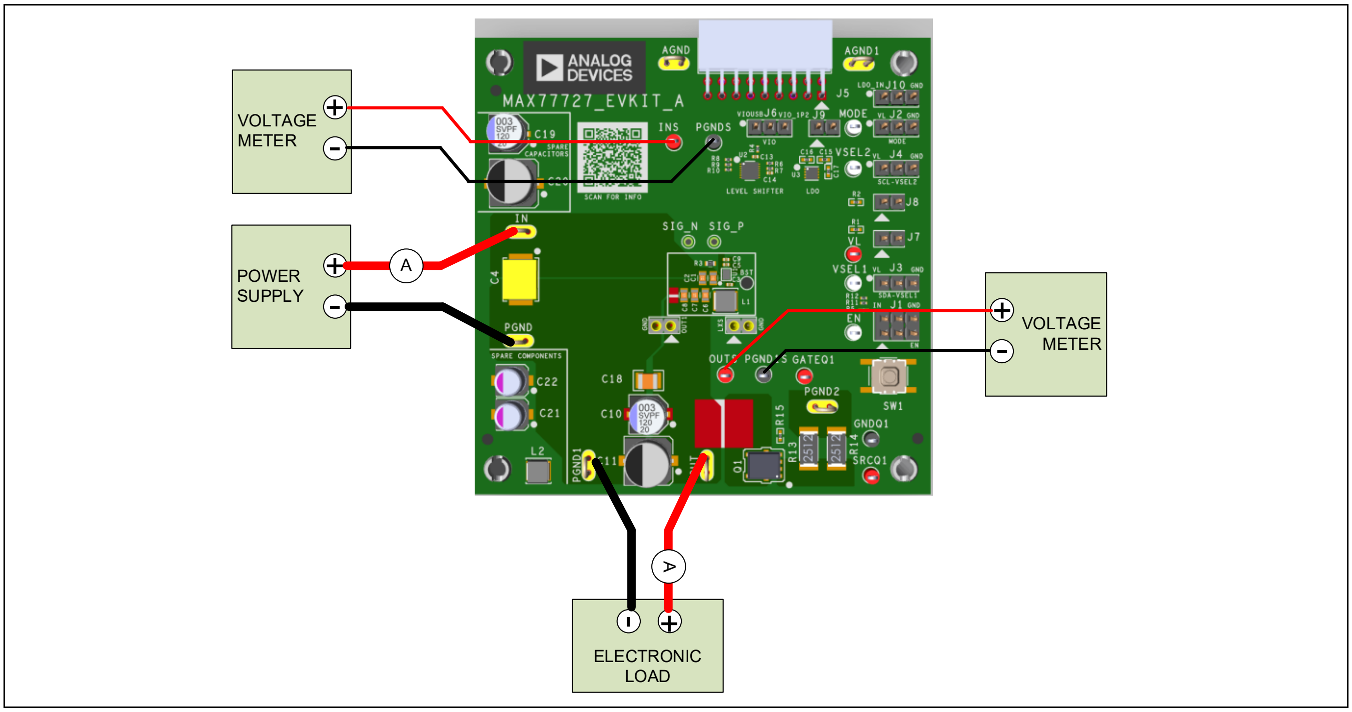


Figure 3. Typical Test Circuit

Read the MAX77726/MAX77727 IC data sheet before operating this EV kit. A typical MAX77727 test bench setup is shown in *Figure 3*. Follow these steps to arrange the required equipment and start the EV kit operation:

1. Configure the jumpers as shown in *Table.2*.
2. Connect a digital voltmeter (DVM) between the INS and PGNDS test points to measure the input voltage.
3. Connect a DVM between the OUTS and PGND1S test points to measure the output voltage.
4. Apply power from a supply set to 0V (100mA current limit) through an ammeter (1mA range) across the IN and PGND terminals of the EV kit. Turn the supply on and increase the voltage to 9V.

5. Verify the input and output voltages using the DVMs. The default output voltage is 1.8V after register EN ON.
6. Ensure the ammeter is either shorted or its range is increased before drawing load from the EV kit output. Failure to do so causes a voltage drop across the input ammeter, which may trigger undervoltage lockout on the MAX77727.

Detailed Description of Hardware

Mode Selection

The device supports three operating modes: low-power mode (LPM), ultrasonic mode (USM) and forced PWM mode (FPWM). These modes can be selected through the Mode register. The user can switch between LPM, USM, FPWM by adjusting I^{2}C control.

- **LPM:** Minimizes power consumption, making it ideal for applications that prioritize energy efficiency.
- **USM:** Maintains a switching frequency above 30kHz, effectively avoiding audible noise in the sound frequency range. This mode is suitable for applications where noise reduction is essential, as it keeps operating frequencies outside the range detectable by human hearing.
- **FPWM:** The converter maintains a constant switching frequency across the entire output-load range, enabling fast transient response and ripple performance. The inductor current is allowed to go negative (reverse current) during the off-time to maintain continuous conduction mode (CCM).

Transient and Critical Node Measurement (OUT and LX)

To improve measurement quality and minimize noise coupling, the MAX77727 EV kit provides a dedicated test point for the buck converter's LX node. *Figure 4* illustrates an example using a probe jig to create the shortest path to ground. A proper connection between LXS and GND for the LX node measurement reduces the influence of L-C ringing.

The same consideration applies to output transient measurements. Using the OUT1-GND test point ensures more accurate monitoring of output voltage drop and transient performance.

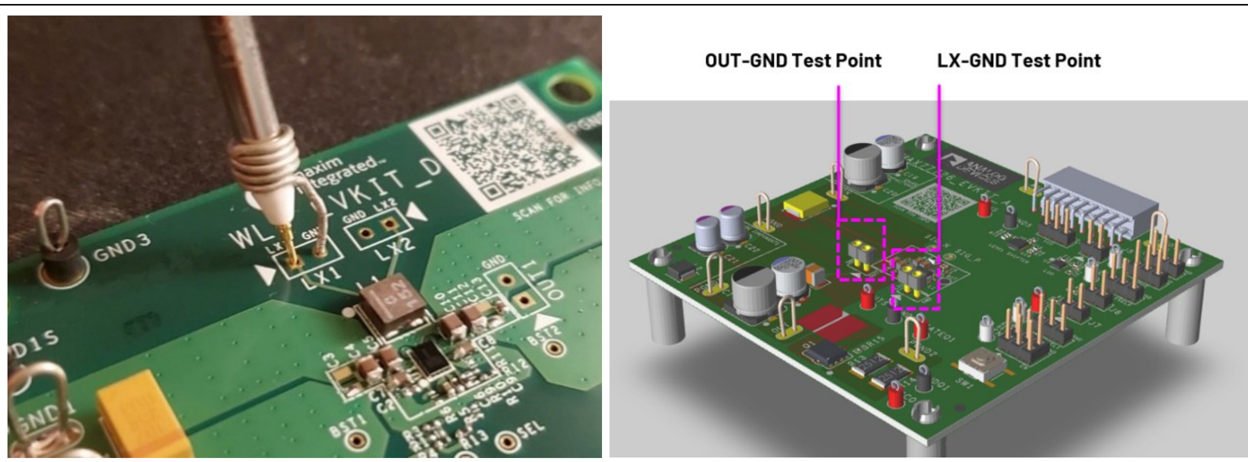


Figure 4. Transient and Critical Node Measure Suggestion

Efficiency Measurement

Figure 3 illustrates the typical efficiency measurement setup. Consider the ambient temperature during efficiency testing and monitor its effect on efficiency. When necessary, provide additional cooling (such as airflow) to stabilize the temperature. As illustrated in *Figure 3*, use the test points provided on the board and connect them in Kelvin when measuring input and output voltages. This prevents voltage drops caused by PCB trace resistance, ammeter resistance, or terminal contact impedance, ensuring measurement accuracy.

Warning:

- Sense pins are for voltage measurement only.
- Do not connect the input supply to the input sense pins, and do not connect an electronic load to the output sense pins. These pins are not designed to carry current.
- Doing so damages the EV kit.
- Always use the input supply terminals to connect the input supply and the output terminals to connect the electronic load, as shown in *Figure 3*.

High-Temperature Testing

The MAX77727 is rated for operation at junction temperatures up to +125°C. However, not all components on the MAX77727 EV kit are rated for such high temperatures. Certain ceramic and tantalum capacitors may exhibit increased leakage at temperatures beyond their specified limits, resulting in higher-than-expected supply current readings for the IC.

When testing at +125°C ambient or junction temperature, verify the ratings of all components on the EV kit. Consider replacing components that are not specified for high-temperature operation if maintaining IC performance at +125°C is a critical requirement.

EV Kit Software

The graphical user interface (ACE GUI) software provides a quick, easy, and comprehensive evaluation of the MAX77727 EV kit. The ACE GUI, together with the MAXUSB_INTERFACE#, drives I^2C communication with the EV kit. Each control in the ACE GUI corresponds directly to a register within the MAX77727. For a complete description of the registers, refer to the *Register Map* section of the *MAX77726/MAX77727 IC* data sheet. Figure 5 shows a screenshot of the ACE GUI when it first opens.

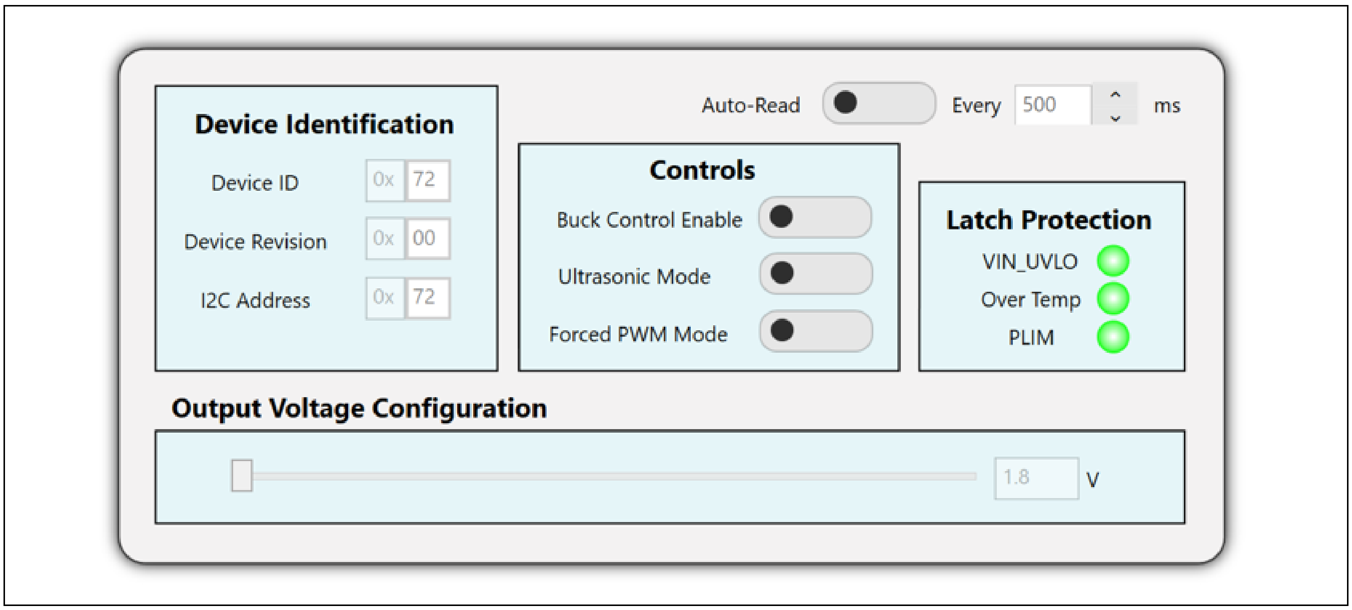


Figure 5. ACE GUI Software Configuration Tab

Windows Driver

After plugging MAXUSB_INTERFACE# into the PC for the first time using a Micro-USB cable, wait about 30 seconds for Windows to install the necessary drivers automatically.

Connecting the ACE GUI to MAXUSB_INTERFACE#

After opening the ACE GUI, the **Attached Hardware** panel displays the MDXX board (Figure 6). Click the board name and select **MAX77727** from the drop-down menu, then click **Navigate to Chip** (Figure 7). When the connection is successful, the lower-left corner shows **Status = Good**, and access the **Configuration Tab** (Figure 5).

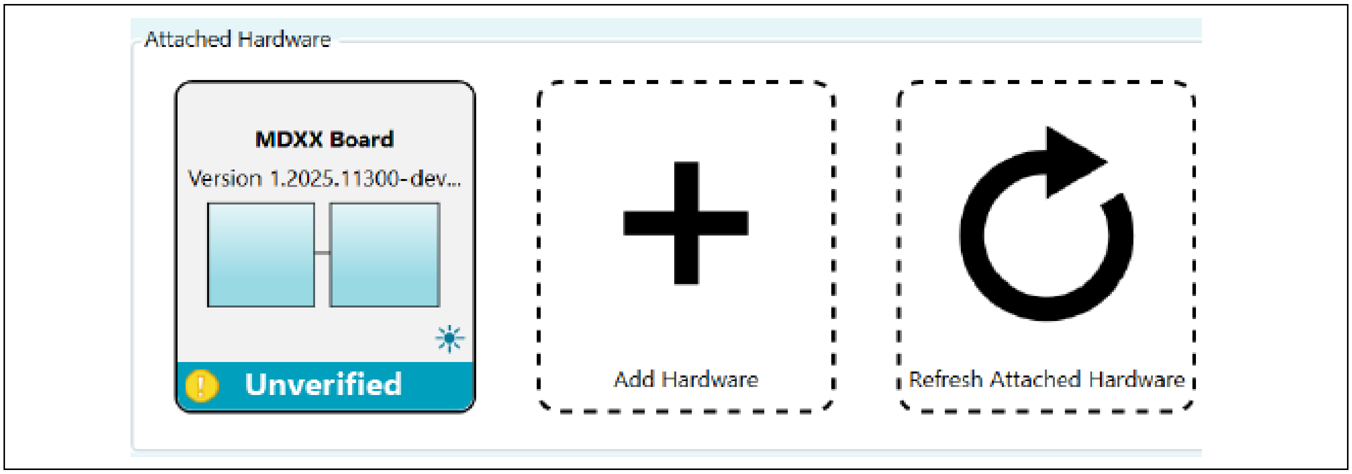


Figure 6. ACE GUI Showing Attached Hardware

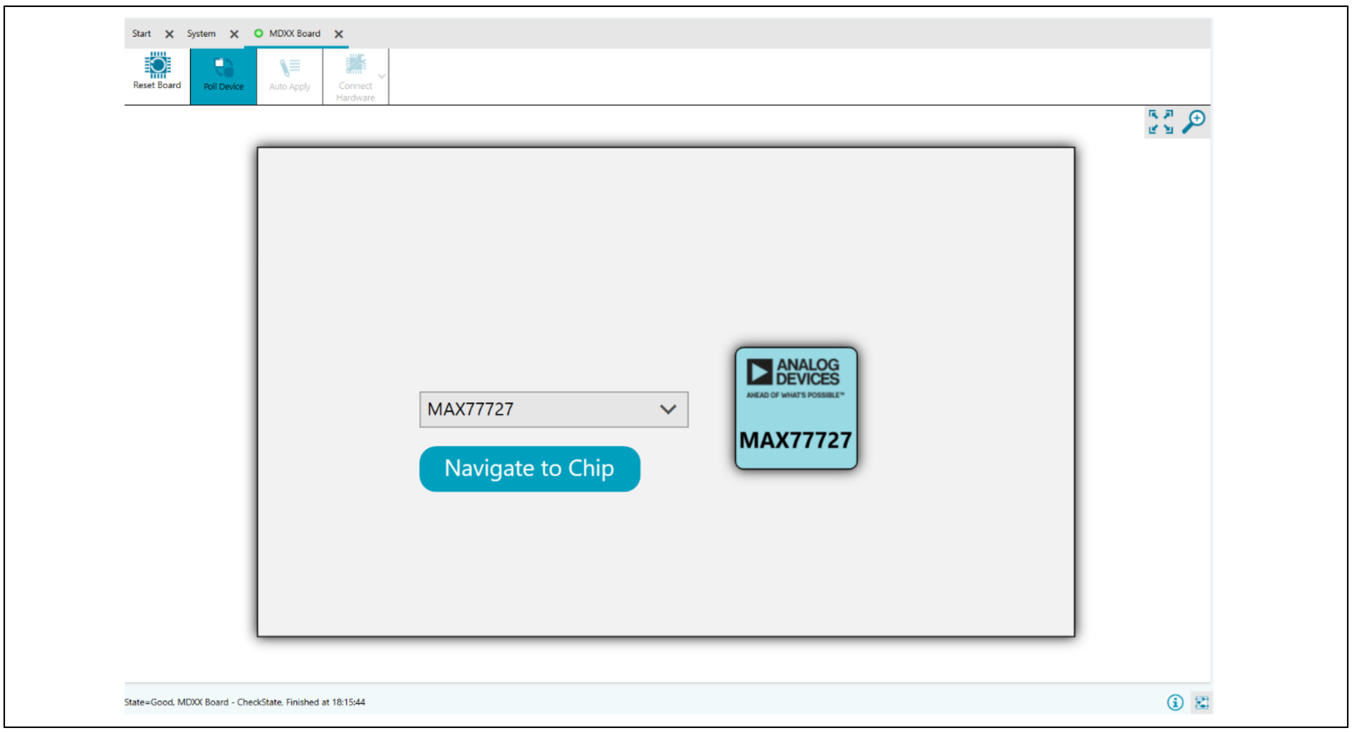


Figure 7. ACE GUI Drop-Down Menu

Configuration Tab

The Configuration tab (*Figure 5*) displays the IC information and status on the EV kit, along with all available register settings. It is divided into the following sections:

- Device Identification
- Enable and USM Control
- Output Voltage Selection

Click **Read All** at the top of the ACE GUI window to retrieve all setting values currently stored in the MAX77727 registers. After modifying the settings in the ACE GUI software, click **Apply Changes** at the top of the window to apply all changes to the MAX77727 registers.

Layout Guideline

An optimized PCB layout improves product performance by reducing switching losses, minimizing copper losses, ensuring smoother power flow, and maintaining cleaner control signals. The MAX77727 pinout clearly separates power and signal stages, enabling a clean, efficient layout.

Figure 8 shows Analog Devices' recommended PCB layout for the MAX77727. Only the HDI PCB layout is shown; for non-HDI PCB designs, contact Analog Devices for further assistance.

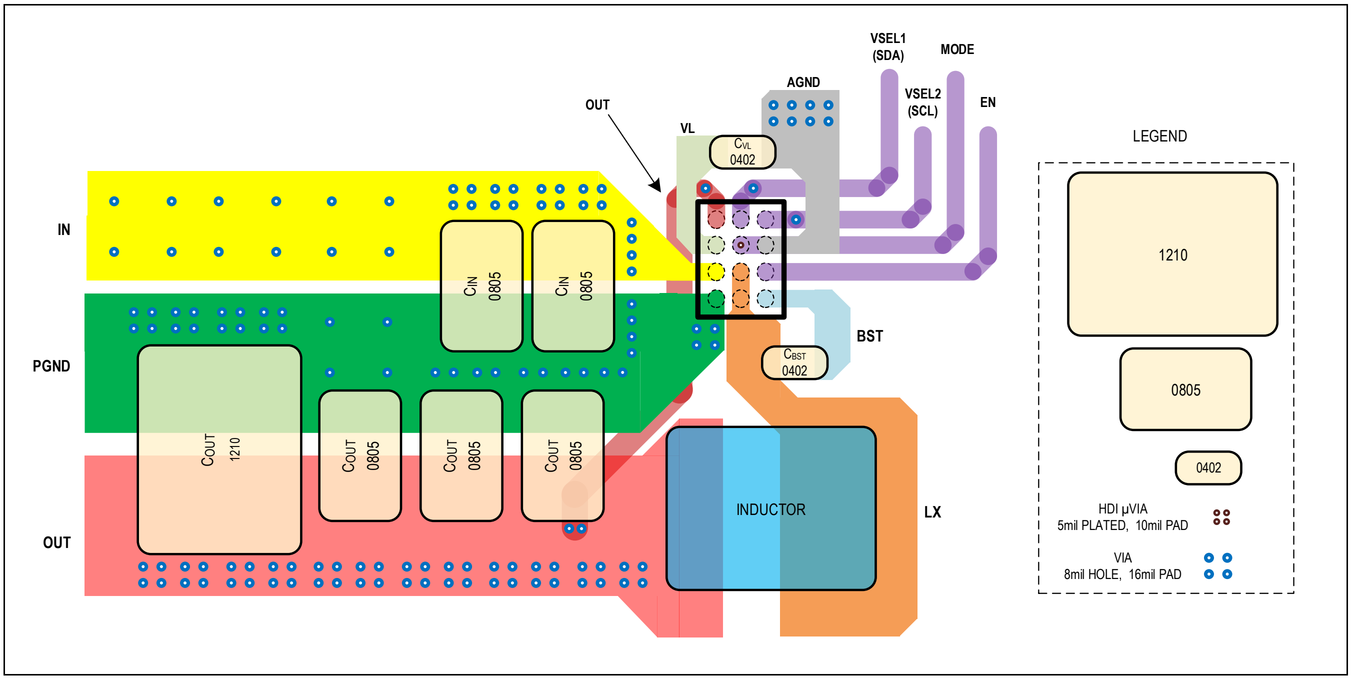


Figure 8. EV Kit PCB Layout Suggestion

Here are the key recommendations for PCB layout:

- Input and Output Capacitors: Place input and output capacitors close to the IC pinout. This minimises ringing caused by loop inductance and improves transient response. Position C_{OUT} near the IC to reduce AC ripple losses; if placed too far, ACR losses increase due to the longer path.
- BST Capacitor: Place the BST capacitor as close as possible to the IC to maintain the power quality of the high-side driver, as it provides the VGS voltage for the internal high-side switch.
- LX Node Arrangement: Route the LX node on the top layer and position PGND underneath as shielding. This creates a coaxial effect that reduces radiation interference, important because LX has high dv/dt.
- OUT Sensor: Position the OUTS feedback pin close to the MLCC and connect it back to the IC using a Kelvin connection. This path also serves as the active discharge path, with a maximum current of approximately 200mA, so ensure adequate current-carrying capability.
- VIA Planning: Use smaller diameter vias and increase through count at higher frequencies to mitigate skin effect. For reliability, only laser-drilled vias are allowed in the vertical direction under the WLP package pinout.
- PGND and AGND Arrangement: Connect PGND bumps to a low-impedance ground plane with vias placed next to the bumps. Avoid creating PGND islands, as they interrupt hot loops. Connect AGND to the same low-impedance ground plane as PGND.
- Ceramic Capacitor DC Voltage Derating: Do not overlook DC voltage derating for ceramic capacitors. Select capacitor values and case sizes carefully. Refer to the *Output Capacitor Selection* section in the *MAX77726/MAX77727 IC* data sheet and *Tutorial 5527* for more information.

Ordering Information

PART	TYPE
MAX77727EVKIT#	EV Kit

#Denotes RoHS-compliant.

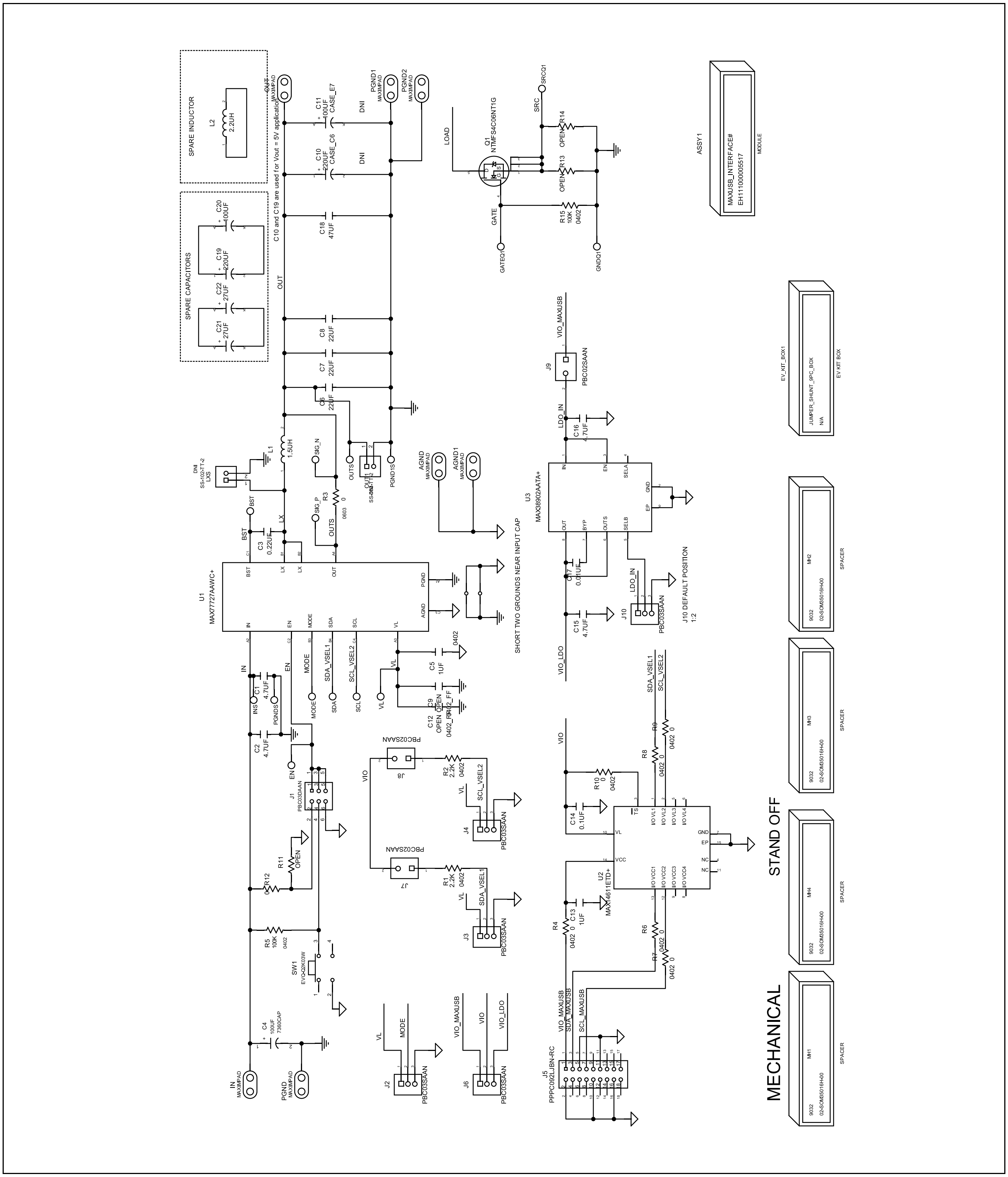
MAX77727 EV Kit Bill of Materials

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
1	AGND, AGND1, IN, OUT, PGND, PGND1, PGND2	—	7	9020 BUSS	WEICO WIRE	ANALOGPAD	EVK KIT PARTS; ANALOG PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG
2	ASSY1	—	1	MAXUSB_INTERFACE#	ANALOG DEVICES	MAXUSB_INTERFACE#	EVKIT PART-MODULE; KIT; MAXUSB INTERFACE; DUAL-PORT USB-TO-SERIAL INTERFACE BOARD
3	C1, C2	—	2	CGA4J1X7R1V475K125AE;CGA4J1X7R1V475K125AC	TDK;TDK	4.7µF	CAP; SMT (0805); 4.7µF; 10%; 35V; X7R; CERAMIC
4	C3	—	1	C1005X7R1E224K050BB	TDK	0.22µF	CAP; SMT (0402); 0.22µF; 10%; 25V; X7R; CERAMIC
5	C4	—	1	T52M1107M035C0055	VISHAY	100µF	CAP; SMT (7360); 100µF; 20%; 35V; TANTALUM
6	C5, C13	—	2	GRM155C80J105KE15	MURATA	1µF	CAP; SMT (0402); 1µF; 10%; 6.3V; X6S; CERAMIC
7	C6-C8	—	3	C2012X5R1E227M125AC;CL21A227MAQNNN;GRM21BR61E227ME44	TDK;SAMSUNG ELECTRO-MECHANICS;MURATA	22µF	CAP; SMT (0805); 22µF; 20%; 25V; X5R; CERAMIC
8	C14	—	1	CGA2B1X7R1C104K050BC;GCM155R71C104KA55	TDK;MURATA	0.1µF	CAP; SMT (0402); 0.1µF; 10%; 16V; X7R; CERAMIC
9	C15, C16	—	2	ZRB15XR61A475ME01;CL05A475MP5NRN;GRM155R61A475MEAA;C1005X5R1A475M050BC	MURATA;SAMSUNG;MURATA;TDK	4.7µF	CAP; SMT (0402); 4.7µF; 20%; 10V; X5R; CERAMIC
10	C17	—	1	GRM155R61A103KA01	MURATA	0.01µF	CAP; SMT (0402); 0.01µF; 10%; 10V; X5R; CERAMIC
11	C18	—	1	TMK325ABJ476MM	TAIYO YUDEN	47µF	CAP; SMT (1210); 47µF; 20%; 25V; X5R; CERAMIC
12	C19	—	1	10SVPE220M	PANASONIC	220µF	CAP; SMT (CASE_C6); 220µF; 20%; 10V; N/A; CONDUCTIVE POLYMER;
13	C20	—	1	25SVPF100M	PANASONIC	100µF	CAP; SMT (CASE_E7); 100µF; 20%; 25V; ALUMINUM-ORGANIC
14	EN, MODE, VSEL1, VSEL2	—	4	5002	KEYSTONE	N/A	TEST POINT; PIN DIA = 0.1IN; TOTAL LENGTH = 0.3IN; BOARD HOLE=0.04IN; WHITE; PHOSPHOR BRONZE WIRE SILVER;
15	GATEQ1, INS, OUTS, SRCQ1, VL	—	5	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;
16	GNDQ1, PGND1S, PGNDS	—	3	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;
17	J1	—	1	PBC03DAAN	SULLINS ELECTRONICS CORP.	PBC03DAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 6PINS; -65 DEGC TO +125 ºC

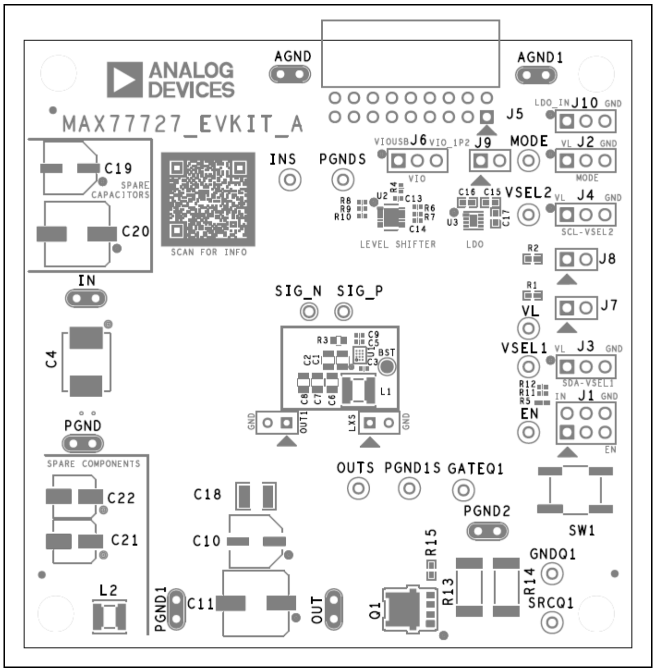
ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
18	J2-J4, J6, J10	—	5	PBC03SAAN	SULLINS	PBC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS; -65ºC TO +125ºC
19	J5	—	1	PPPC092LJBN-RC	SULLINS ELECTRONICS CORP	PPPC092LJBN-RC	CONNECTOR; FEMALE; THROUGH HOLE; PPP SERIES; RIGHT ANGLE; 18PINS
20	J7-J9	—	3	PBC02SAAN	SULLINS ELECTRONICS CORP.	PBC02SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 2PINS
21	L2	—	1	HBLE041H-1R5MS; DFE322520F-1R5M	CYNTEC	1.5µH	EVKIT PART - INDUCTOR; SMT; POWER CHOKE COIL; 1.5µH; TOL = ±20%; 5.5A;
22	L1	—	1	HBLE041H-2R2MS; DFE322520F-2R2M	CYNTEC	2.2µH	EVKIT PART - INDUCTOR; SMT; 2.2µH; POWER CHOKE COIL; TOL = ±20%; 4.7A;
23	MH1-MH4	—	4	9032	KEYSTONE	9032	MACHINE FABRICATED; ROUND-THRU HOLE SPACER; NO THREAD; M3.5; 5/8IN; NYLON
24	Q1	—	1	NTMFS4C06NT1G	ON SEMICONDUCTOR	NTMFS4C06NT1G	TRAN; POWER MOSFET; NCH; SO-8 FL; PD-(2.55W); IC-(69A); VCEO-(30V)
25	R1, R2	—	2	CRCW04022K20FK	VISHAY	2.2k	RES; SMT (0402); 2.2K; 1%; ±100PPM/ºC; 0.0630W
27	R3	—	1	RC1608J000CS;CR0603-J/-000ELF;RC0603JR-070RL	SAMSUNG ELECTRONICS;BOURNS;YAGEO PH	0	RES; SMT (0603); 0; 5%; JUMPER; 0.1000W
27	R4, R6-R10	—	6	CRCW04020000Z0EDHP ; RCS04020000Z0	VISHAY DRALORIC;VISHAY DALE	0	RES; SMT (0402); 0; JUMPER; JUMPER; 0.2000W
28	R5, R15	—	2	ERJ-2RKF1003	PANASONIC	100k	RES; SMT (0402); 100k; 1%; ±100PPM/ºC; 0.1000W
29	R12	—	1	ANY	ANY	0	RESISTOR; 0402; 0Ω; 0%; JUMPER; 0.10W; THICK FILM; FORMFACTOR
30	SW1	—	1	EVQ-Q2K03W	PANASONIC	EVQ-Q2K03W	SWITCH; SPST; SMT; 15V; 0.02A; LIGHT TOUCH SWITCH; RCOIL = Ω; RINSULATION = Ω; PANASONIC
31	U1	—	1	MAX77727	ANALOG DEVICES	MAX77727	EVKIT PART-IC; PACKAGE OUTLINE 21-100776; PACKAGE CODE: W121S1Z+1
32	U2	—	1	MAX14611ETD+	ANALOG DEVICES	MAX14611ETD+	IC; TRANS; QUAD BIDIRECTIONAL LOW-VOLTAGE LOGIC LEVEL TRANSLATOR; TDFN14-EP
33	U3	—	1	MAX38902AATA+	ANALOG DEVICES	MAX38902AATA+	IC; REG; LOW NOISE 500 MILLIAMPERE LDO LINEAR REGULATOR; TDFN8-EP
34	PCB	—	1	MAX77727	ANALOG DEVICES	PCB	PCB: MAX77727
35	EV_KIT_BOX1	—	9	NPC02SXON-RC	SULLINS ELECTRONICS CORP.		CONNECTOR; FEMALE; MINI SHUNT; 0.100IN CC; OPEN TOP; JUMPER; STRAIGHT; 2PINS
36	C10	DNP	0	10SVPE220M	PANASONIC	220µF	CAP; SMT (CASE_C6); 220µF; 20%; 10V; N/A; CONDUCTIVE POLYMER;

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
37	C11	DNP	0	25SVPF100M	PANASONIC	100µF	CAP; SMT (CASE_E7); 100µF; 20%; 25V; ALUMINUM-ORGANIC
38	C21, C22	DNP	0	25SVPF27MX	PANASONIC	27µF	CAP; SMT (CASE_B6); 27µF; 20%; 25V; ALUMINUM-ELECTROLYTIC;
39	LXS, OUT1	DNP	0	SS-102-TT-2	SAMTEC	SS-102-TT-2	IC-SOCKET; SIP; STRAIGHT; PRECISION MACHINED SOCKET STRIP; OPEN FRAME; 2PINS; 100MIL
40	C9, C12	DNP	0	N/A	N/A	OPEN	CAPACITOR; SMT (0402); OPEN; FORMFACTOR
41	R11	DNP	0	N/A	N/A	OPEN	RESISTOR; 0402; OPEN; FORMFACTOR
42	R13, R14	DNP	0	N/A	N/A	OPEN	RES; SMT (2512); OPEN

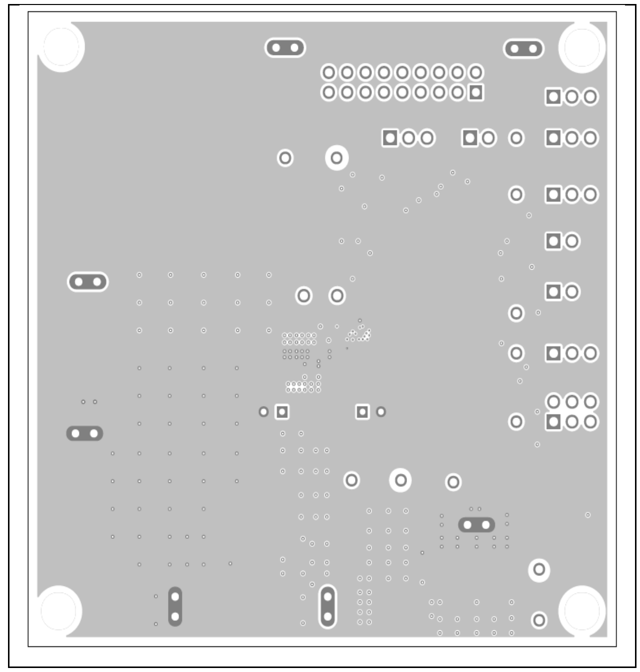
MAX77727 EV Kit Schematic



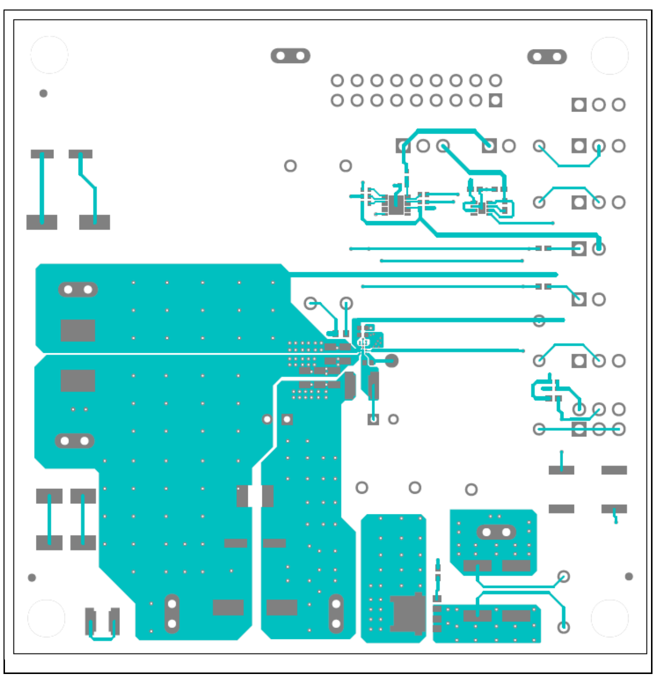
MAX77727 EV Kit PCB Layout



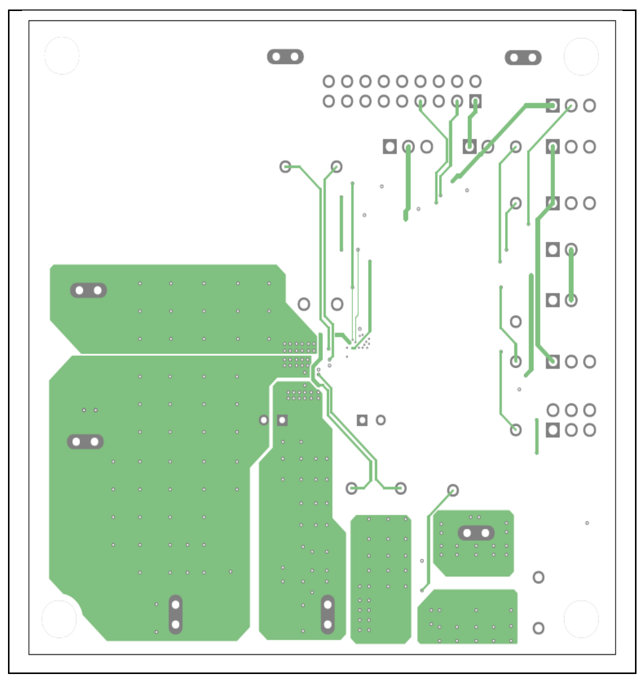
MAX77727 EV Kit Component Placement Guide—Top



MAX77727 EV Kit PCB Layout—Layer 2

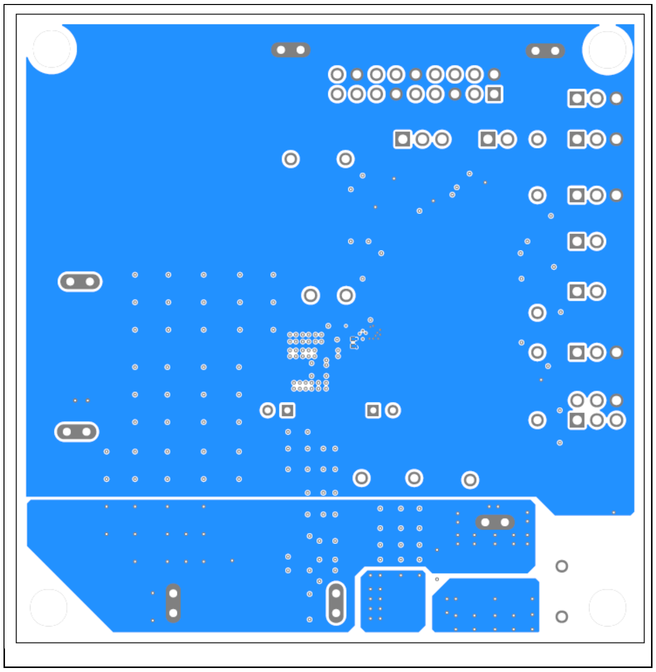


MAX77727 EV Kit PCB Layout—Top

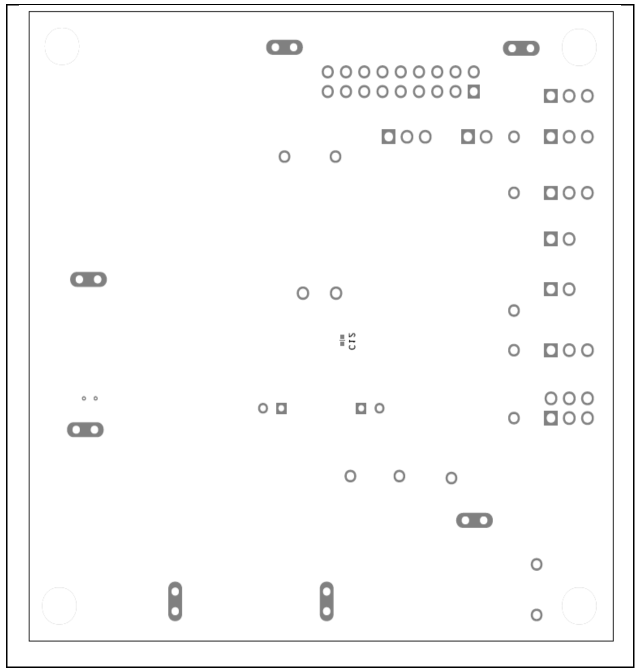


MAX77727 EV Kit PCB Layout—Layer 3

MAX77727 EV Kit PCB Layout (continued)



MAX77727 EV Kit PCB Layout—Bottom



MAX77727 EV Kit Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/25	Initial release	—

Notes