MAX77726 Evaluation Kit

Evaluate: MAX77726

General Description

The MAX77726 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that demonstrates the MAX77726, synchronous buck converter with ultrasonic mode.

The EV kit is a step-down voltage regulator circuit using the MAX77726 that is capable of a 3.6V to 22V input, 3A of continuous load, and an adjustable output voltage between 3.3V, 5.0V, 9.0V, and 15V using logic level on the VSEL1 and VSEL2 pins.

Check List

Required Equipment

- MAX77726 EV kit
- Adjustable DC power supply with 22V and 3A capability
- Digital multimeters
- Electronic load capable of 20V/10A used in constant current mode

Features

- Proven PCB Reference Design and Layout
- Easy to Use
  - Simple Hardware Control: Jumpers and Test Points for IN, EN, SEL, VL, and OUT
  - Fully Assembled and Tested

EV Kit Default Specification

Table 1 specifies the electrical characteristics of the MAX77726 device. *Table 2* specifies the default jumper configurations on the EV kit.

- IC Part Number: MAX77726
- Switching Current Limit = 4.6A
- Input Voltage = 3.6V to 22V
- Output Voltage = 5V

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

EV Kit Photo

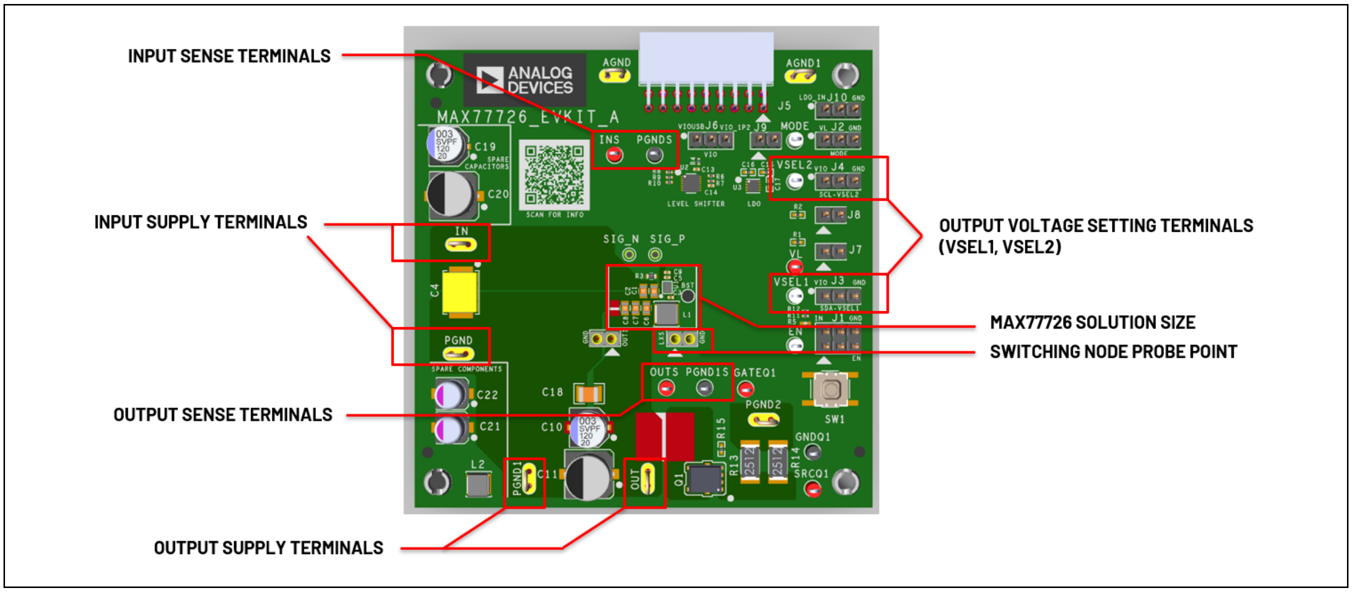


Figure 1. MAX77726 Evaluation Board

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	Selectable through VSELx. Default = 5V	3.3		15	V
SYSTEM CHARACTERISTICS					
Input High Level	EN, MODE, VSEL1, VSEL2	1.0			V
Input Low Level	MODE, VSEL1, VSEL2			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 a divider resistor from V_{IN} to enable MAX77726.
		3-4	Connects EN to V_{IN} through a 100kΩ pullup resistor. Further, optional controlling of the EN level by SW1.
		5-6	Connects EN to GND to disable the MAX77726.
		Not installed	Disable the MAX77726 because it has an internal 300kΩ pulldown resistor.
J2	MODE	1-2	Connects MODE to V_L and sets the MODE to High to enable Ultrasonic mode.
		2-3*	Connects MODE to GND, and sets the MODE to Low to disable Ultrasonic mode.
		Not installed	The logic level is Low, and Ultrasonic mode is Disabled because 'MODE' has an internal 300kΩ pull-down resistor.
J3	VSEL1	1-2	Connects VSEL1 to V_L and sets VSEL1 to High.
		2-3*	Connects VSEL1 to GND, sets VSEL1 to Low.
		Not installed	The logic level is Low because 'VSEL1' has an internal 300kΩ pulldown resistor.
J4	VSEL2	1-2	Connects VSEL2 to V_L and sets VSEL2 to High.
		2-3*	Connects VSEL2 to GND, sets VSEL2 to Low.
		Not installed	The logic level is Low because VSEL2 has an internal 300kΩ pulldown resistor.
J6	VIO	Not installed	This jumper is set up for use with MAX77727 (I^2C version). Refer to the MAX77726/MAX77727 data sheet for more information. Do not install during MAX77727 evaluation.
J7	SDA		
J8	SCL		
J9	VIO_MAXUSB		
J10	LDO		

**Default position*

Quick Start Guide

Typical Application Circuit

The typical application diagram is seen in *Figure 2*. See the *MAX77726 EV Kit Schematic* and *MAX77726 EV Kit PCB Layout* sections for more information.

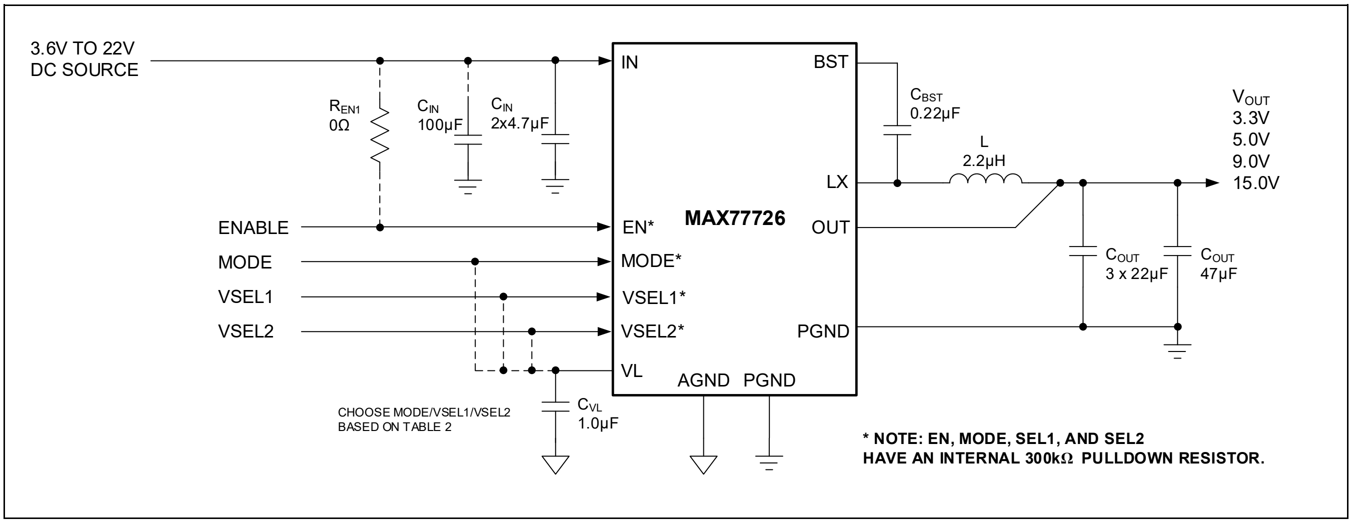


Figure 2. Typical Application Circuit

Procedure

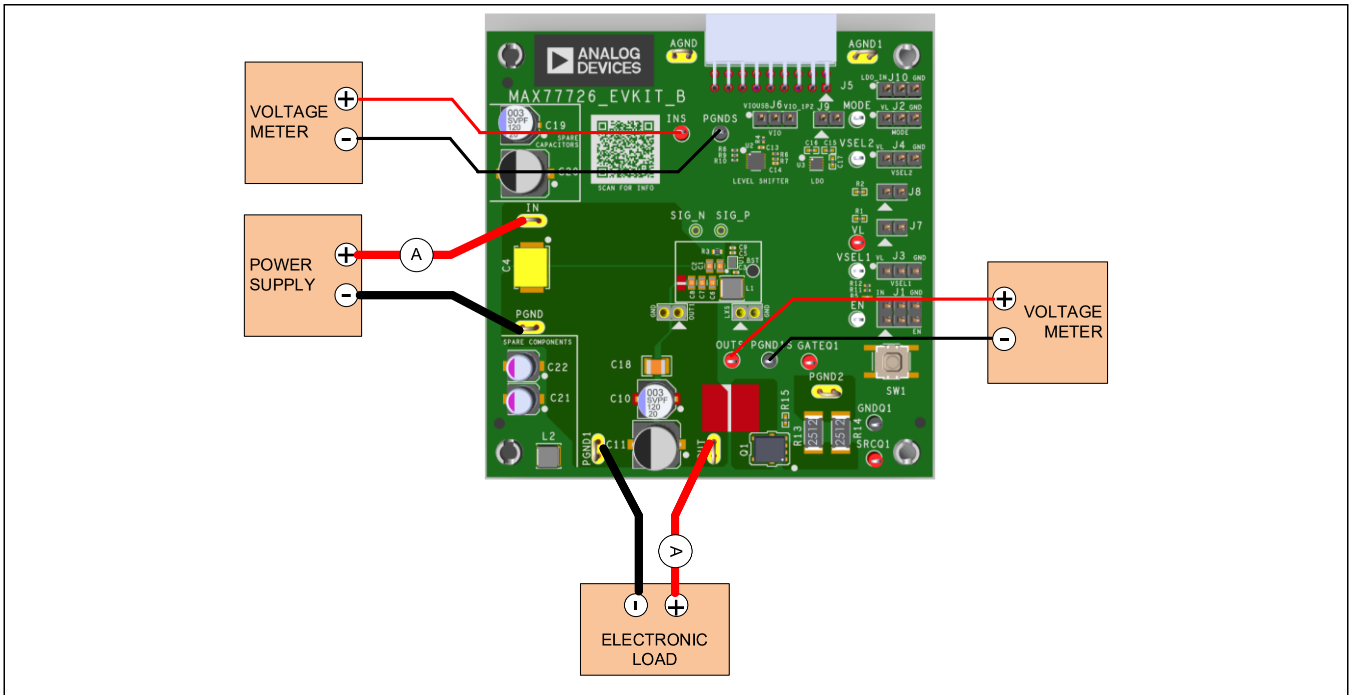


Figure 3. Typical Test Circuit

Refer to the *MAX77726/MAX77727* data sheet before using this EV kit. A typical MAX77726 test bench setup is shown in *Figure 3*. Follow the steps to properly arrange the required equipment and start the EV kit's operation.

1. Set up the jumper according to *Table 2*.
2. Connect a DVM between the IN and PGND test points to measure the input voltage.

3. Connect a DVM between the OUT and PGND1 test points to measure the output voltage.
4. Apply a power 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. Confirm the input and output voltages through the input and output DVMs. The default output voltage is 5V.
6. Ensure that the ammeter is either shorted out or the ammeter range is increased before drawing a load through the output of the MAX77726 EV kit. If this is not done, the voltage drop across the input ammeter triggers the MAX77726 to enter undervoltage lockout.

Detailed Description of Hardware

Output Voltage Setting

The MAX77726 EV kit demonstrates the operation of the current-control hysteretic buck converter, which supports input voltages from 3.6V to 22V, and an adjustable output voltage from 3.3V to 15V. The output voltage is set at startup by reading the VSEL pin. The logic levels and corresponding output voltages are listed in *Table 3*. On the EV kit, jumper J3 and J4 can be moved and set the logic level of VSEL1 and VSEL2, respectively. The user also has the flexibility to use their equipment to provide voltages on Pin2 of J3 and J4 to set VSEL directly. The VSEL pin has a 300kΩ pulldown resistor; therefore, the default output voltage is 5V. (Both VSEL1 and VSEL2 are low-level, shown in *Figure 4*)

The device supports an output voltage of 3.3V to 15V. However, the recommended output voltage ranges vary for the output capacitor (C_{OUT}). Refer to the *Electrical Characteristics* table in the MAX77726/MAX77727 data sheet. It is also essential to consider the voltage derating of the ceramic capacitors when using them as output capacitors. The EV kit comes populated with an output capacitance of 3 x 22µF ceramic capacitors marked C6, C7, and C8 on the silkscreen. The exact component used is listed in the *MAX77726 EV Kit Bill of Materials*.

This evaluation kit should be used with the following documents:

- MAX77726/MAX77727 data sheet
- MAX77726 EV kit data sheet (this document)

These documents, or links to them, are included on the MAX77726 EV kit. For the latest versions of the documents listed above, use the following link: *www.Analog.com/MAX77726*.

Table 3. VOUT SET

VSEL1	VSEL2	OUTPUT VOLTAGE (V)
L	L	5.0
L	H	3.3
H	L	9.0
H	H	15.0

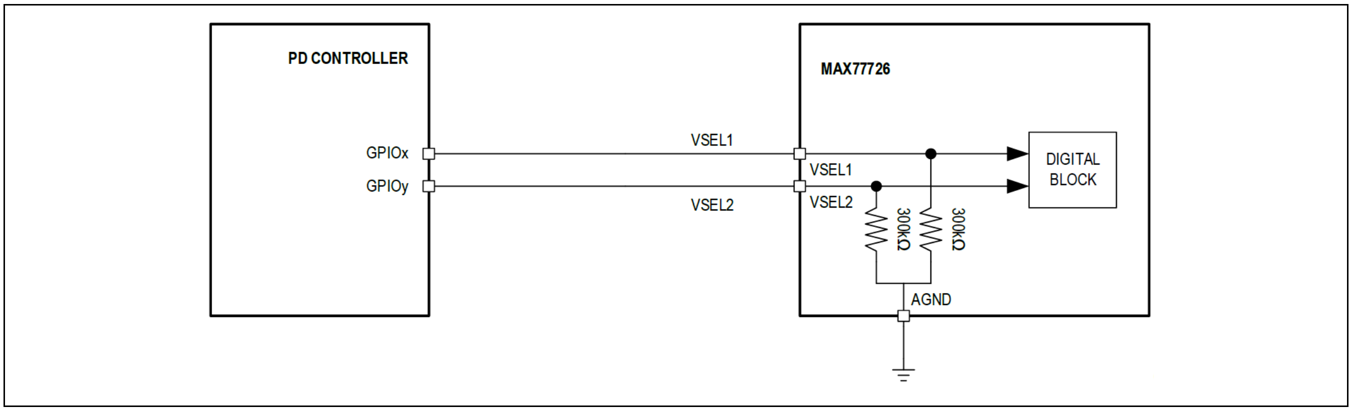


Figure 4. VSEL Pulldown Resistor

Low Power Mode and Ultrasonic Mode

The device supports two operating modes, Low Power Mode (LPM) and Ultrasonic Mode (USM), which can be selected through the mode pin. As shown in *Table 4*, setting the mode pin to 0, or leaving it unconnected, enables Low Power Mode, while setting it to 1 enables Ultrasonic Mode. The user can easily switch between Low Power Mode and Ultrasonic Mode by adjusting the logic level of the MODE pin through the J2 Jumper.

- Low Power Mode: The device minimizes power consumption, which is ideal for applications that prioritize energy efficiency.
- Ultrasonic Mode: The device maintains a frequency above 30kHz, effectively avoiding audible noise in the sound frequency range. This mode is suitable for scenarios where noise reduction is essential, as it keeps operating frequencies outside the range detectable by human hearing.

Table 4. MODE SET

MODE	LIGHT LOAD OPERATION
H	Ultrasonic mode enabled
L	Low power mode enabled. Ultrasonic mode disabled.
Unconnected	Same as Logic -- 'L'

Transient and Critical Node Measurement (OUT and LX)

To improve measurement quality and avoid noise coupling, the EV kit provides an exclusive test point on the LX node of the buck converter. *Figure 5* shows an example of adopting a probe jig to make the shortest path to ground. A proper connection to LXS-GND for LX Node measurement can reduce the influence of L-C swing.

Same consideration for output transient measurement. Using OUT1-GND for more accurate monitoring output voltage drop and transient performance.

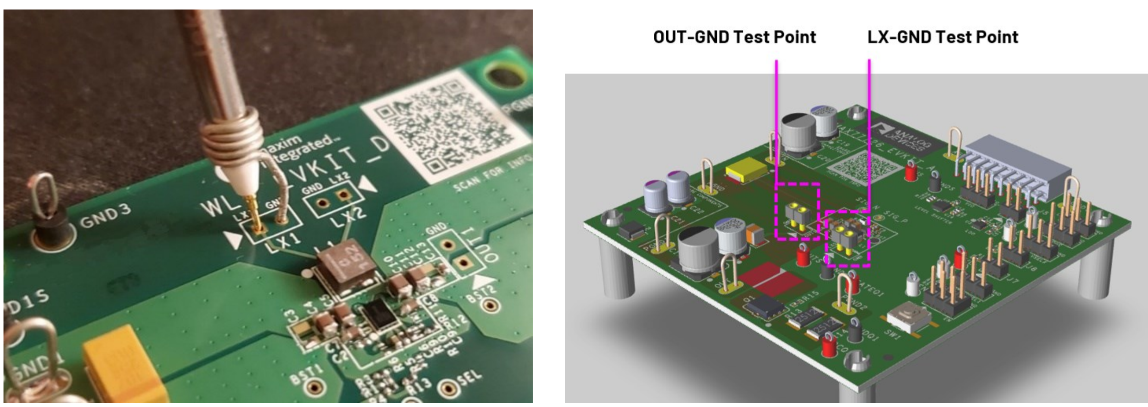


Figure 5. Transient and Critical Node Measure Suggestion

Efficiency Measurement

Figure 3 shows the typical efficiency measurement method. It is essential to consider the ambient temperature during efficiency measurements and to monitor its effect on efficiency. If necessary, additional cooling (such as air flow) may be provided to stabilize the temperature. As illustrated in *Figure 3*, be sure to use the test points provided on the board and adopt Kelvin connections 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: These sense pins are only for measuring voltages. Do not connect input supply to input sense pins and do not connect an electronic load to output sense pins, as these sense pins are not designed to have current running through them. Doing so damages the EV kit. Use input supply terminals for connecting to input supply and use output terminals for connecting to electronic load as shown in *Figure 3*.

High-Temperature Testing

The MAX77726 is rated for operation under junction temperatures up to +125°C. Note that not all components on the EV kit are rated for temperatures this high. Some ceramic and tantalum capacitors experience extra leakage when put under temperatures higher than they are rated for and supply current readings for the IC might be higher than expected. Doublecheck the components on the EV kit if testing at +125°C ambient or junction temperatures. Consider replacing these components if IC operation at +125°C ambient or junction temperature is an important use case.

Layout Guideline

An excellent PCB layout optimizes product performance, resulting in lower switching losses, reduced copper losses, smoother power flow, and cleaner control signals. The pinout design clearly separates the power and signal stages, enabling a cleaner layout. Based on this, *Figure 6* shows the recommended PCB layout. Only the HDI PCB layout is shown here; for non-HDI PCB, contact Analog Devices for further assistance.

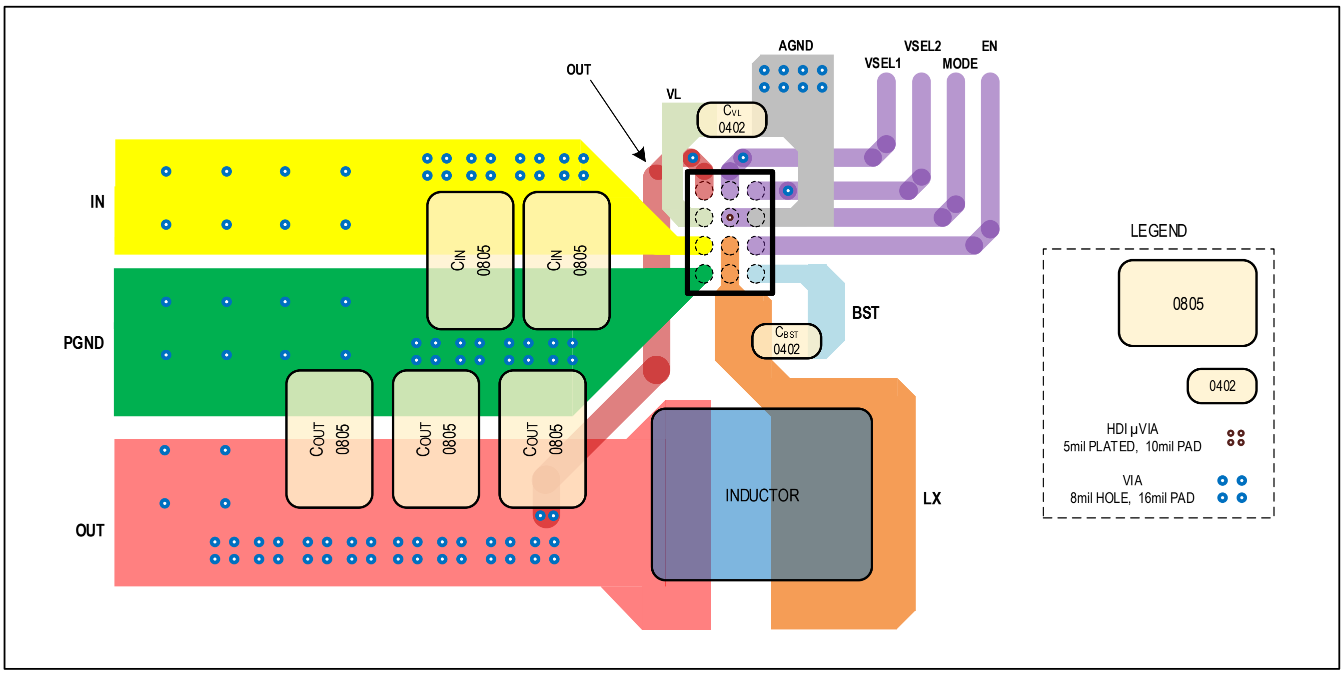


Figure 6. PCB Layout Suggestion

The following are summaries of the key points for PCB layout:

- Input and Output Capacitors Should Be Placed Close to the IC Pinout: Since the IC operates at high frequencies, this layout minimizes ringing caused by loop inductance and improves transient response. It is recommended to place C_{OUT} close to the IC as well, as the AC ripple current still passes through C_{OUT}. If Cout is too far, ACR losses increase due to the longer path.
- Place the BST Capacitor as Close to the IC as Possible: The BST capacitor provides the VGS voltage for the internal high-side (HS) switch. It should be placed as close as possible to the pinout to maintain the HS driver's power quality.
- LX Node Arrangement: The LX Node in a Buck circuit has high dv/dt, so it is recommended to use the Top Layer for the LX path and place PGND underneath it as shielding, which can create a coaxial cable effect to prevent radiation interference.
- OUT Sensor: OUTS is the output voltage feedback pin, which should be placed as close as possible to the MLCC and connected back to the IC using a Kelvin connection. Additionally, it serves as the active discharge path, with a maximum current of approximately 200mA (guaranteed by design). Attention must be paid to the current-carrying capability of this path.
- VIA Planning: The number and diameter of vias depend on the operating frequency. Due to the skin effect, smaller diameters and an increased number of vias are preferred at higher frequencies. This also depends on PCB thickness,

layer count, and other factors. Additionally, for reliability, only laser-drilled vias, not mechanical drilling, are allowed under the WLP package's IC pinout in the vertical direction.

- PGND and AGND Arrangement: Connect the inner PGND bumps to the low-impedance ground plane on the PCB with vias placed next to the bumps. Do not create PGND islands, as PGND islands risk interrupting hot loops. Connect the AGND and AGND island to the same low-impedance ground plane on the PCB (the same net as PGND).
- Do Not Overlook Ceramic Capacitor DC Voltage Derating: Choose 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
MAX77726EVKIT#	EV Kit

#Denotes RoHS-compliant.

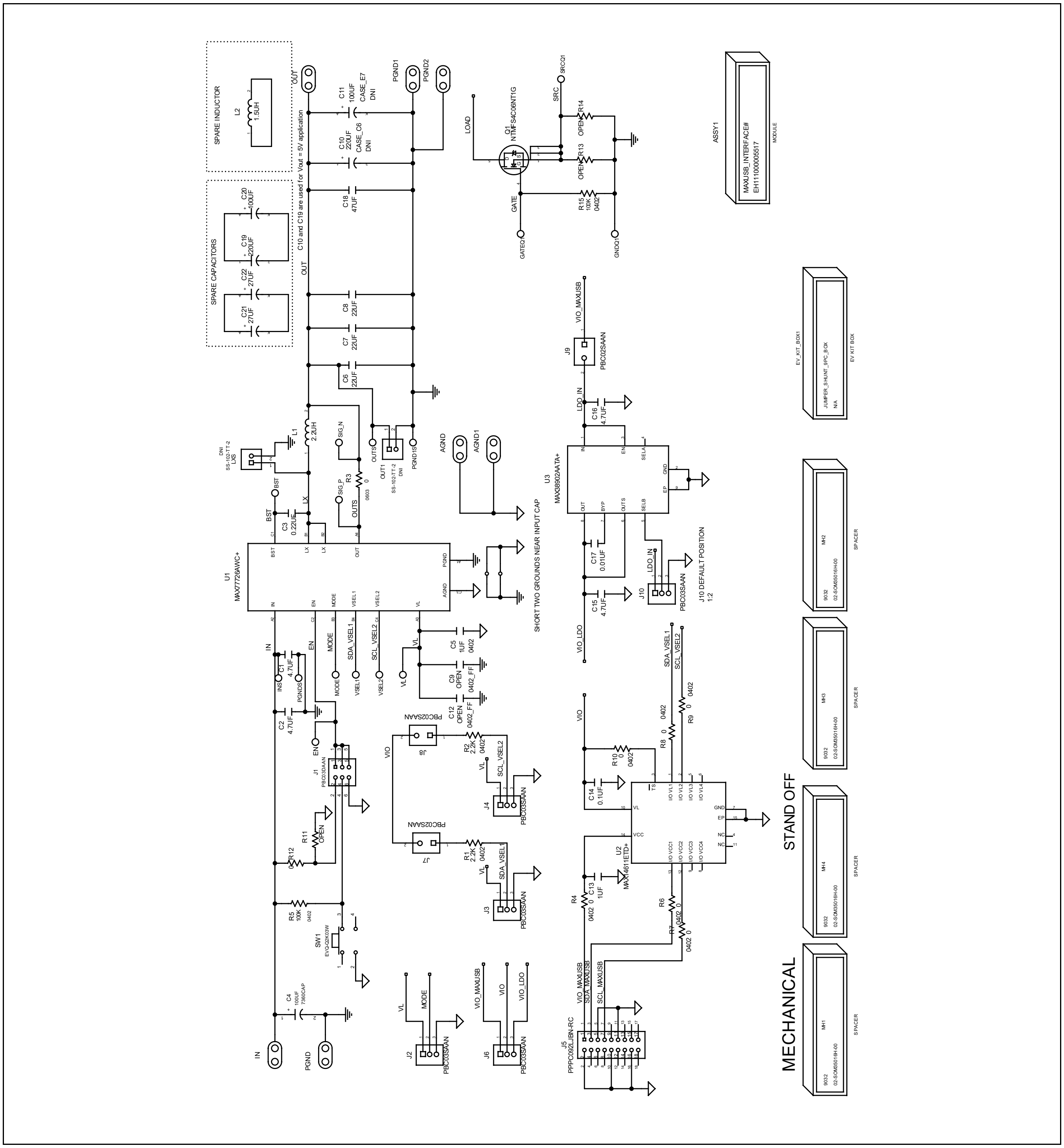
MAX77726 EV Kit Bill of Materials

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
1	AGND, AGND1, IN, OUT, PGND, PGND1, PGND2	—	7	9020 BUSS	WEICO WIRE	MAXIMPAD	EVK KIT PARTS; MAXIM 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	C2012X5R1E226M125AC;CL21A226MAQNNN;GRM21BR61E226ME44	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;

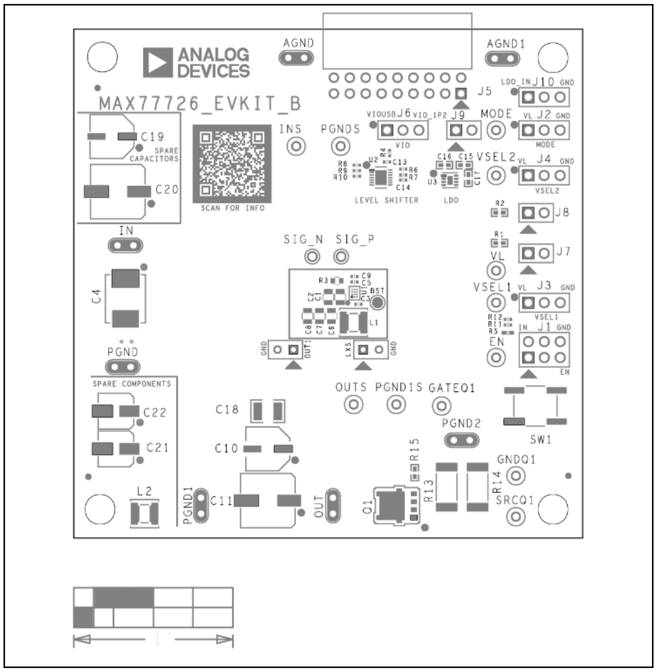
ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
15	GATEQ1, INS, OUTS, SRCQ1, VL	—	5	5000	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
16	GNDQ1, PGND1S, PGNDS	—	3	5001	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; 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°C TO +125°C
18	J2-J4, J6, J10	—	5	PBC03SAAN	SULLINS	PBC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS; -65°C TO +125°C
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/DEGC; 0.0630W
26	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

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
28	R5, R15	—	2	ERJ-2RKF1003	PANASONIC	100K	RES; SMT (0402); 100K; 1%; ±100PPM/DEGC; 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	MAX77726	ANALOG DEVICES	MAX77726	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	MAX77726	ANALOG DEVICES	PCB	PCB: MAX77726
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;
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

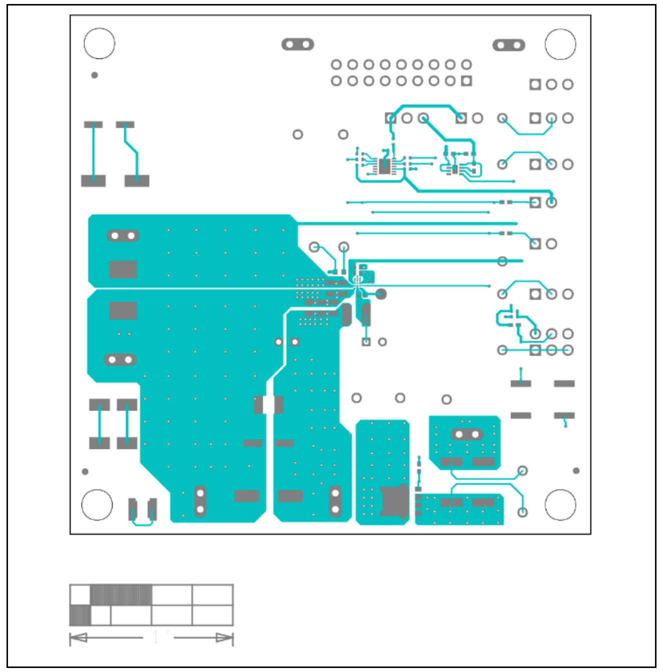
MAX77726 EV Kit Schematic



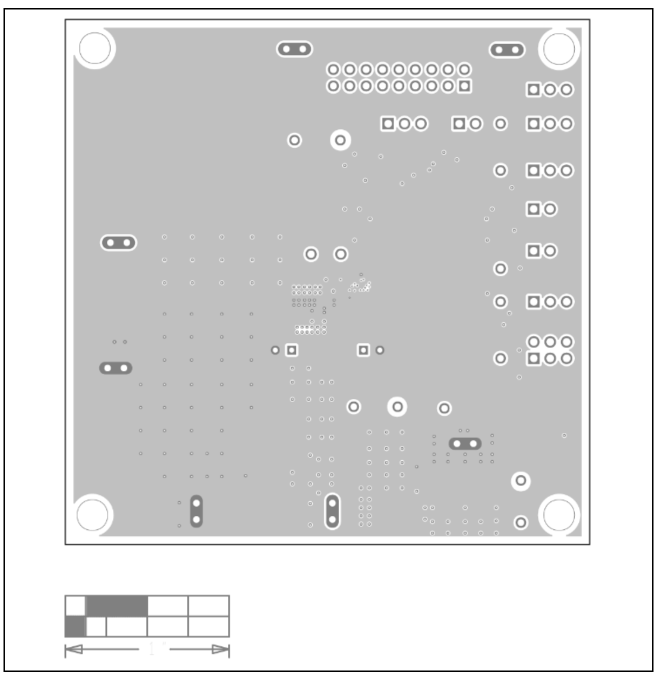
MAX77726 EV Kit PCB Layout



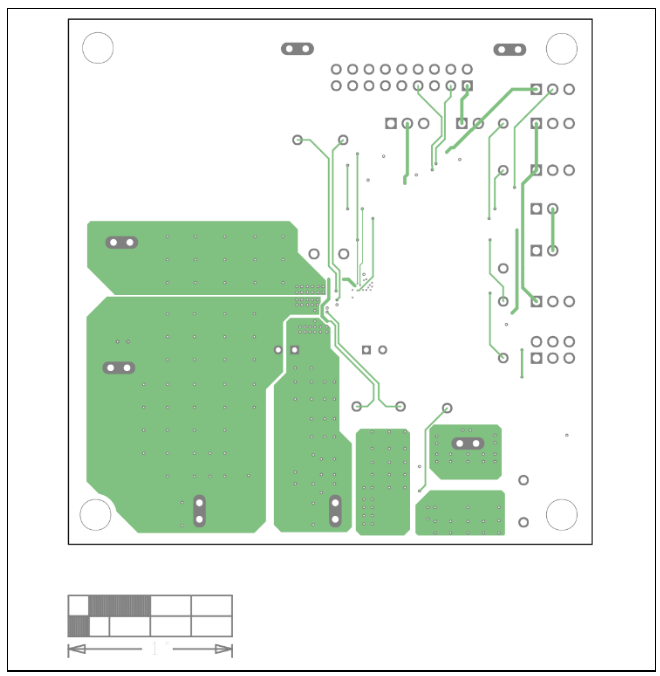
MAX77726 EV Kit Component Placement Guide—Top Silkscreen



MAX77726 EV Kit PCB Layout—Layer 2

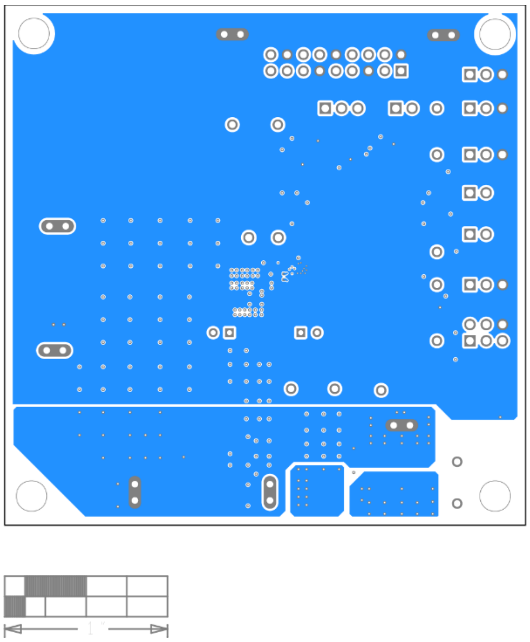


MAX77726 EV Kit PCB Layout—Top

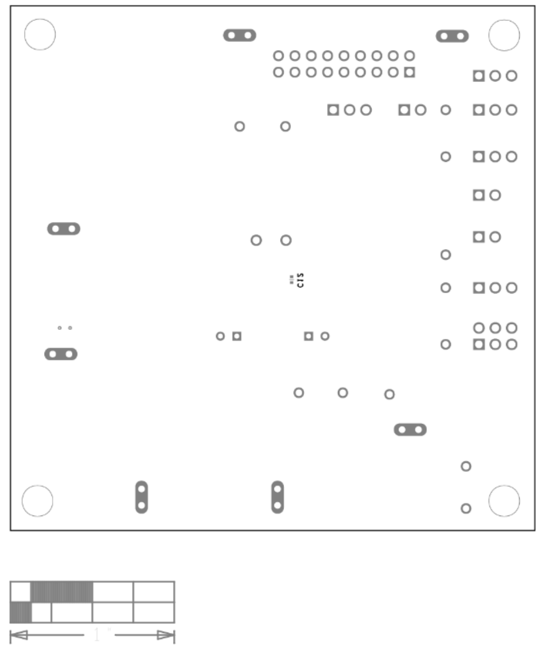


MAX77726 EV Kit PCB Layout—Layer 3

MAX77726 EV Kit PCB Layout (continued)



MAX77726 EV Kit PCB Layout—Bottom



MAX77726 EV Kit Component Placement Guide—Bottom Silkscreen

Revision History

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

Notes