MAX77505 Evaluation Kit

Evaluates: MAX77505

General Description

The MAX77505 evaluation kit (EV kit) is a fully assembled and tested printed circuit board (PCB) that demonstrates the MAX77505 hysteretic step-down (buck) converter. The EV kit is a step-down voltage regulator circuit using the MAX77505 that is capable of a 2.5V to 16V input, 3A of continuous load, and an adjustable output voltage between 0.8V to 5.5V using an R_{SEL} resistor between the SEL pin and GND.

Features

- Proven PCB Reference Design and Layout
- Easy to Use
  - Simple Hardware Control: Jumpers and Test Points for IN, EN, SEL, VL, POK, VIO, and OUT
  - Fully Assembled and Tested
- On-board Potentiometer for Setting the Desired Output Voltage on Startup.

Check List

- MAX77505 EV Kit
- Adjustable DC Power Supply with 16V and 3A Capability
- Digital Mult-Meters
- Electronic Load

EV Kit Default Specification

Table 1 specifies the electrical characteristics of the MAX77505 device. ***Table 2*** specifies the default jumper configurations on the EV kit.

- IC Part Number—MAX77505AEFB+
- Switching Current Limit = 4.6A
- Input Voltage = 2.5V to 16V
- Output Voltage = 3.3V

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

EV Kit Photo

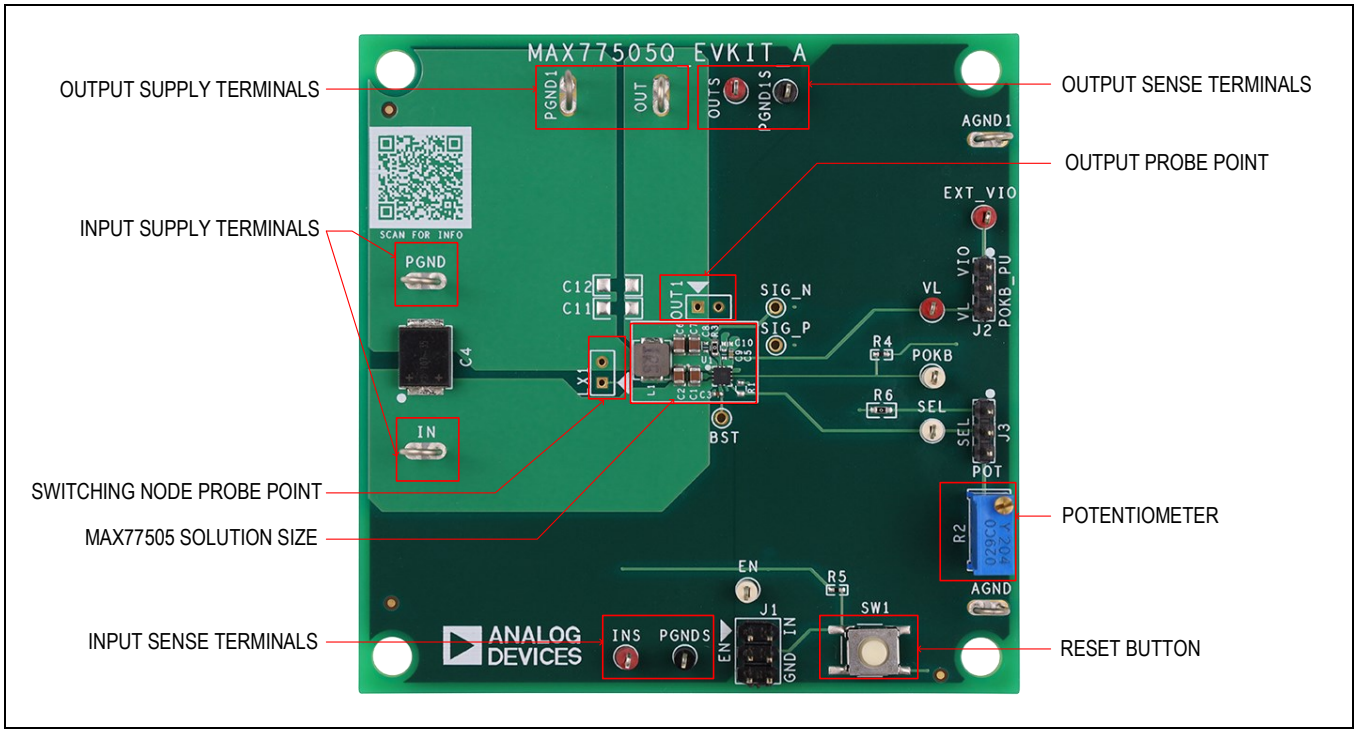

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Table 1. EV Kit Specifications

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Input Voltage Range		2.5		16	V
Output Voltage Range	Selectable through R_{SEL}. Default = 3.3V	0.8		5.5	V
Input Undervoltage Lockout (UVLO)	V_{IN} Rising	2.4	2.45	2.5	V
	V_{IN} Falling	2.325	2.375	2.425	
Shutdown Current	EN = Low, V_{IN} < 13V, T_J = +25°C		70	300	nA
Quiescent Current	EN = High, No Load, T_J = +25°C		800		µA

V_{IN} = 7.6V, V_{OUT} = 3.3V, T_A = T_J = -40°C to +125°C, typical values are at T_A = T_J = +25°C, unless otherwise noted.

Table 2. Jumper Connection Guide

JUMPER	NODE	SHUNT POSITION	FUNCTION
J1	EN	1-2*	Connects EN to IN to enable the MAX77505.
		3-4	Connects EN to SW1 through a 10kΩ pullup resistor.
		5-6	Connects EN to GND to disable the MAX77505.
J2	POK	1-2	Connects POKB to VIO** through a 10kΩ pullup resistor.
		2-3*	Connects POKB to VL through a 10kΩ pullup resistor.
J3	SEL	1-2*	Connects SEL to a 0Ω resistor (Sets V_{OUT} to 3.3V).
		2-3	Connects SEL to the on-board potentiometer.

**Default position*
***VIO is external voltage with a maximum value of 2.0V. It can be connected to the EXT_VIO terminal.*

Quick Start Guide

Required Equipment

- MAX77505 EV Kit
- Adjustable DC Power Supply which supports 16V and 3A
- Digital Multimeter
- Electronic Load

Setup Overview

The typical application diagram for the MAX77505 is given in *Figure 1*. *Figure 2* describes the connections for a typical test setup that is used to evaluate MAX77505. See the *MAX77505 EV Kit Schematic* and *MAX77505 EV Kit PCB Layout* sections for more information.

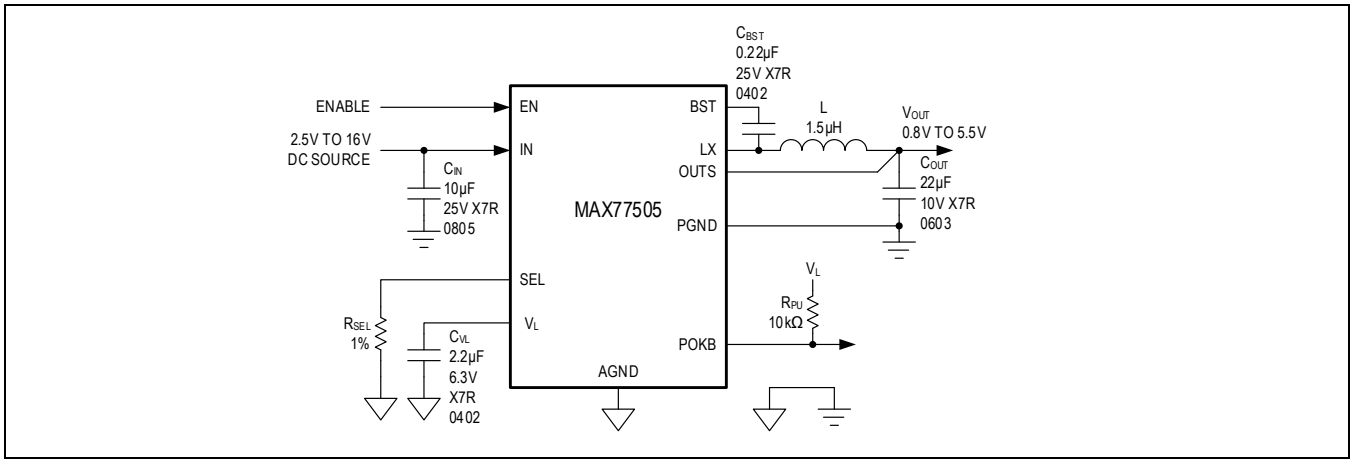


Figure 1. MAX77505 Typical Application Circuit

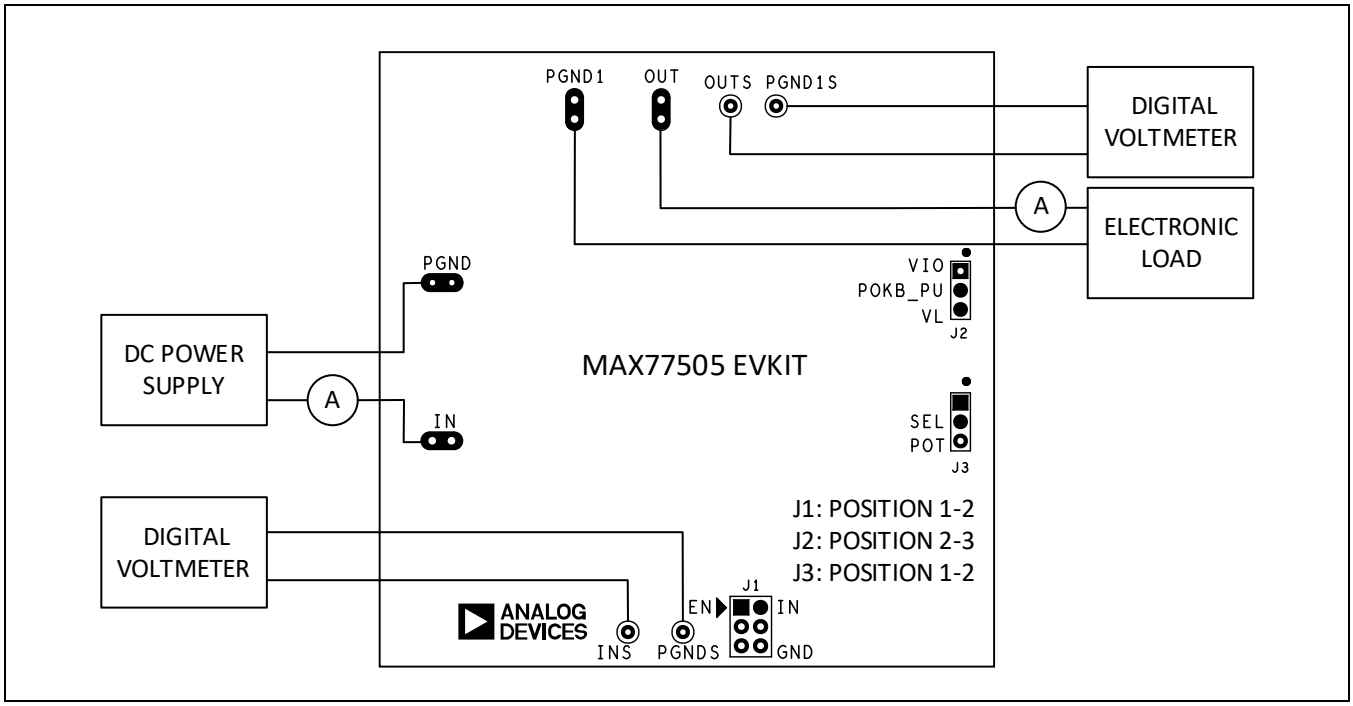


Figure 2. MAX77505 EV Kit Board Connections

Procedure

The EV kit is fully assembled and tested. Follow the steps to make the required hardware connections, and start the operation of the EV kit.

1. Install the EV kit jumpers according to *Table 2*.
2. Connect a DVM between INS and PGNDS test points to measure input voltage.
3. Connect a DVM between the OUTS and PGND1S 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 7.6V.
5. Confirm the input and output voltages through the input and output DVMs. The default output voltage is 3.3V. The input ammeter should give a reading near 1µA.
6. Ensure that the ammeter is either shorted out or the ammeter range is increased before drawing load through the output of the MAX77505 EV kit. If this is not done, the voltage drop across the input ammeter causes the MAX77505 to go into undervoltage lockout.

Detailed Description of Hardware

The MAX77505 EV kit demonstrates the operation of the low-quiescent current (800nA typ) hysteretic buck converter which can support input voltages from 2.5V to 16V with an adjustable output voltage between 0.8V to 5.5V. The output voltage is set when the part starts up by reading the SEL pin which has R_{SEL} connected to ground. The default configuration as shown in *Table 2* is set for an output voltage of 3.3V. The jumper J3 must be moved to position 2-3 to use the potentiometer as R_{SEL}. The user also has the flexibility of using their resistance by disconnecting J3 and connecting the desired resistance between position 1-2.

The part supports output voltage of 0.8V to 5.5V, however, the minimum recommended output capacitance for each voltage should be chosen from *Table 3* for best operation. It is also important to consider the voltage derating of the ceramic capacitors when using them as output capacitors since *Table 3* lists the minimum effective output capacitance the part needs for best operation. The EV kit comes populated with an output capacitance of 2 x 10µF 25V X7S 0805 ceramic capacitors marked C6 and C7 on the silkscreen. The exact component used is listed in the *MAX77505 EV Kit Bill of Materials*.

Table 3. Recommended Output Capacitance

OUTPUT VOLTAGE (V)	MINIMUM EFFECTIVE OUTPUT CAPACITANCE (µF)
0.8 to 1.5	20
1.5 to 5.5	10

This evaluation kit should be used with the following documents:

- MAX77505 Data Sheet
- MAX77505 EV Kit Data Sheet (this document)

Setting the Output Voltage

The EV kit has an on-board potentiometer to allow the user to evaluate the entire output voltage range of the MAX77505.

Use the following steps to evaluate a different output voltage.

1. Disable the MAX77505 by either removing the input power supply or by connecting J1 to jumpers 5-6.
2. Remove Jumper J3 and connect a DVM set to measure resistance between pin 3 of J3 and AGND.
3. Set the potentiometer resistance for the desired output voltage using *Table 4*.
4. Remove the DVM and connect J3 to position 2-3.
5. Re-enable the MAX77505 by reversing step 1.

Table 4. Output Voltage Selection

R_{SEL}(Ω)	V_{OUT} (V)	R_{SEL}(Ω)	V_{OUT} (V)
≤95.3	3.3	3.74k	3.0
200	0.8	8.06k	3.2
309	0.9	12.4k	3.4
422	1.0	16.9	3.6
536	1.1	21.5k	3.7
649	1.2	26.1	3.8
768	1.3	30.9	4.0
909	1.5	36.5	4.2
1.05k	1.8	42.2k	4.3
1.21k	1.9	48.7k	4.5
1.40k	2.2	56.2k	5.0
1.62k	2.3	64.9k	5.2
1.87k	2.5	75.0k	5.3
2.15k	2.7	86.6k	5.5
2.49k	2.8	100k	3.1
3.87k	2.9	≥115k	4.8

Measuring the Efficiency

The MAX77505 hysteretic buck converter shows excellent efficiency performance for a wide load range. The EV kit is equipped with sense pins for accurately measuring input voltage (INS, PGNDS) and output voltage (OUTS, PGND1S). It is important to use the pins for the most accurate results for efficiency, load regulation, and line regulation tests.

Warning: It is important not to connect the electronic load or DC power supply to the sense pins. These pins are not designed to carry large amounts of current and are only designed to measure voltages. Drawing any large current through

these pins can damage the EV kit and exhibit less than optimal performance due to higher resistance. Use input supply terminals for connecting to input supply and output terminals for connecting to electronic load as shown in *Figure 2*.

The following steps explain how to measure the efficiency of MAX77505 using the EV kit.

Connect a DC power supply set to 0V with an ammeter in series to the IN and PGND terminals of the EV kit.
Connect an electronic load with an ammeter in series to the OUT and PGND terminals of the EV kit. It is important to note that the wires to the electronic load should be thick and short to ensure minimal voltage drop across the resistance of the wires at a full load of 3A. It is also important to note that the electronic load should be able to support the burden voltage, especially at a minimum output voltage of 0.8V, if that is the test case. It is recommended to use the highest range setting on the output ammeter to prevent blowing the fuse in the digital ammeter as well as to prevent output voltage dropping too much as seen by the electronic load. Make sure that the electronic load is off.
Connect a digital multimeter to INS and PGNDS to measure input voltage, and OUTS and PGND1S to measure the output voltage.
Ensure that J2 is disconnected and J1 is connected between position 1-2.
Select the default position for J3 if the required output voltage is 3.3V. Follow the steps listed in the *Setting the Output Voltage* section if the required output voltage is different from the default output voltage of 3.3V.
Make sure the output capacitance on the evaluation board follows *Table 3*.
Set the desired input voltage (2.5V to 16V) at the DC power supply and turn it on.
Ensure that the output voltage is correct from the output voltage multimeter. If not, repeat the steps outlined in the *Setting the Output Voltage* section.
Set the desired load current (max 3A) at the electronic load and turn it on.
Measure the efficiency only after allowing the output voltage to settle. It is recommended to use the highest integration time setting (100 NPLC) at the multimeters to get the most accurate measurement.
Once the measurement is complete, turn off the electronic load followed by the DC power supply.

Critical Node Measurement (OUT1 and LX1)

The EV kit provides socket test points for the measurement of critical nodes such as LX1 and OUT1. These probe points can be seen in *Figure 2*. It is important to use a probe with a pig-tail connector attached and connected directly to the test points as shown in *Figure 3*. The pig-tail connector serves to minimize the ground loop inductance for the measurement thereby minimizing the noise coupling. This method gives the most accurate results for output voltage ripple, switching waveforms, and load transients.

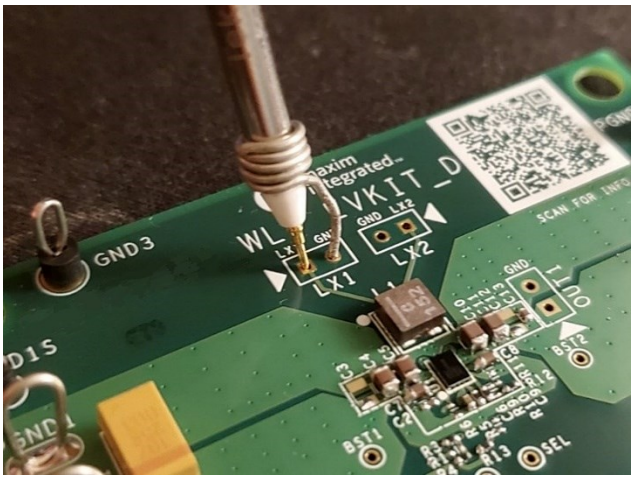


Figure 3. MAX77505 Critical Node Measurement

Bode Plot Measurement

The EV kit comes equipped with test points SIG_P and SIG_N across a 0Ω resistor R3 placed between converter output voltage OUT and MAX77505 feedback pin OUTS. These test points can be used to apply a disturbance and measure the changes in the output voltage for a bode plot measurement. It is important to note that R3 should be replaced with a 1Ω resistance before such measurement is attempted. *Figure 4* details the bode plot measurement setup using a Bode100. A similar setup can be used for any other device that is used for bode plot measurement.

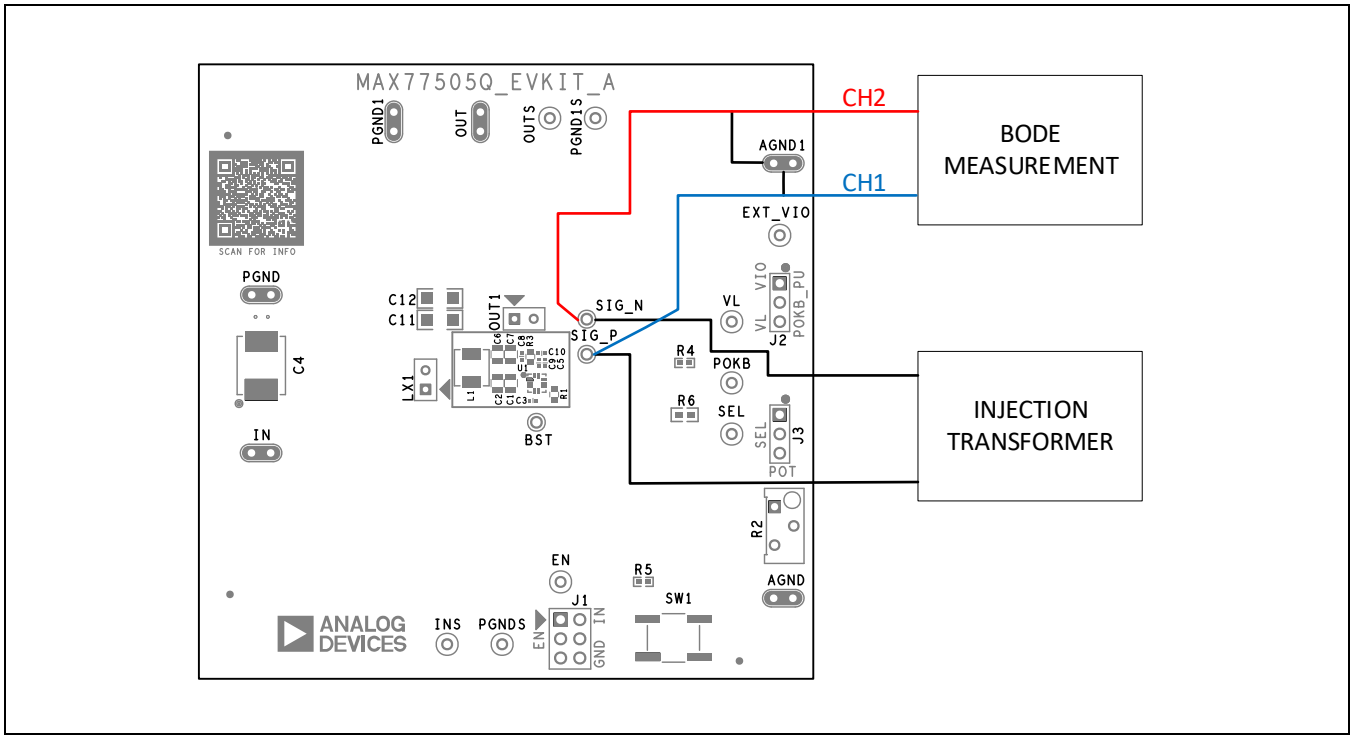


Figure 4. MAX77505 Bode Plot Measurement

High-Temperature Testing

The MAX77505 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. Double-check 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. C4 (input bulk capacitance) is not rated for +125°C.

Ordering Information

PART	U1 IC	DEFAULT OUTPUT VOLTAGE	TYPE
MAX77505QEVKIT#	MAX77505AEFB+	3.3V	EV Kit

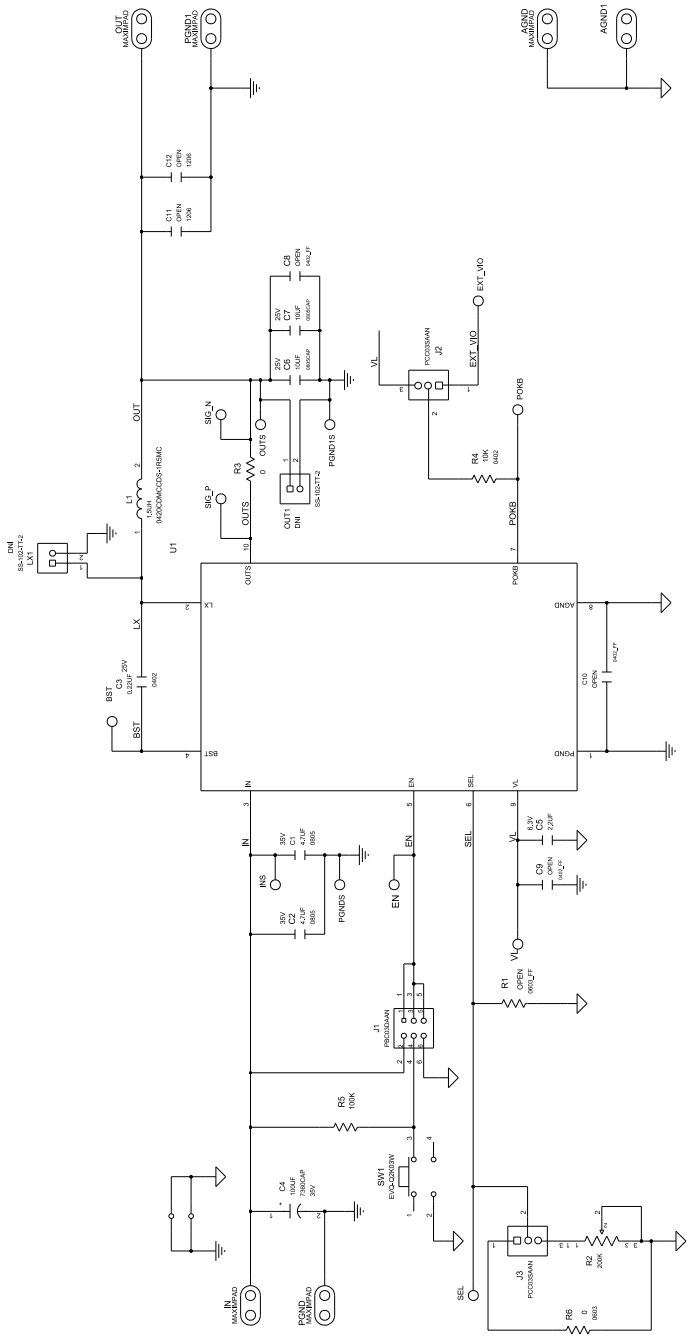
+Denotes a lead(Pb)-free/RoHS-compliant package.

MAX77505 EV Kit Bill of Materials

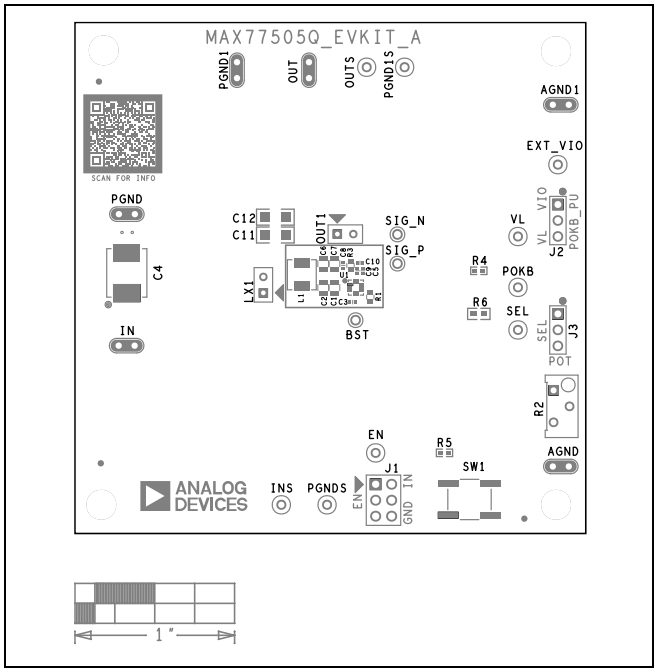
PART	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
C1, C2	2	CGA4J1X7R1V475K125AE; CGA4J1X7R1V475K125AC	TDK;TDK	4.7UF	CAP; SMT (0805); 4.7UF; 10%; 35V; X7R; CERAMIC
C3	1	C1005X7R1E224K050BB	TDK	0.22UF	CAP; SMT (0402); 0.22UF; 10%; 25V; X7R; CERAMIC
C5	1	C1005X7S0J225K050BC; RM155C70J225KE11	TDK;MURATA	2.2UF	CAP; SMT (0402); 2.2UF; 10%; 6.3V; X7S; CERAMIC
C6, C7	2	GRM21BC71E106KE11	MURATA	10UF	CAP; SMT (0805); 10UF; 10%; 25V; X7S; CERAMIC
L1	1	0420CDMCCDS-1R5MC	SUMIDA	1.5UH	INDUCTOR; SMT; COMPOSITE; 1.5UH; 20%; 4.9A
U1	1	MAX77505AEFB+	ANALOG DEVICES	MAX77505AEFB+	EVKIT PART - IC; MAX77505AEFB+; 16V LOW IQ 3A/1.5A BUCK CONVERTER; PACKAGE CODE: F102A2F+3; PACKAGE OUTLINE DRAWING: 21-100644; LAND PATTERN: 90-100218; FC2QFN10
R3	1	RC1608J000CS;CR0603-J/-000ELF;RC0603JR-070RL	SAMSUNG ELECTRONICS;BOURNS;YAGEO PH	0	RES; SMT (0603); 0; 5%; JUMPER; 0.1000W
C8-C10	DNP	N/A	N/A	OPEN	CAPACITOR; SMT (0402); OPEN; FORMFACTOR
R1	DNP	N/A	N/A	OPEN	RESISTOR; 0603; OPEN; FORMFACTOR
Components below this line are outside of the immediate MAX77505 evaluation circuit and solution silkscreen					
AGND, AGND1, IN, OUT, PGND, PGND1	6	9020 BUSS	WEICO WIRE	MAXIM PAD	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG
EN, POKB, SEL	3	5002	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; WHITE; PHOSPHOR BRONZE WIRE SILVER;
EXT_VIO, INS, OUTS, VL	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	1	PBC03DAAN	SULLINS ELECTRONICS CORP.	PBC03DAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 6PINS; -65 DEGC TO +125 DEGC
J2, J3	2	PCC03SAAN	SULLINS	PCC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 3PINS; -65 DEGC TO +125 DEGC
MH1-MH4	4	9032	KEYSTONE	9032	MACHINE FABRICATED; ROUND-THRU HOLE SPACER; NO THREAD; M3.5; 5/8IN; NYLON
PGND1S, PGNDS	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;
R2	1	3296Y-1-204LF	BOURNS	200K	RESISTOR; THROUGH HOLE-RADIAL LEAD; 3296 SERIES; 200K OHM; 10%; 100PPM; 0.5W

PART	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
R6	1	RC1608J000CS;CR0603-J/-000ELF;RC0603JR-070RL	SAMSUNG ELECTRONICS;BOURNS;YAGEO PH	0	RES; SMT (0603); 0; 5%; JUMPER; 0.1000W
R4	1	RC0402FR-0710KL;CR0402-FX-1002GLF	YAGEO;BOURNS	10K	RES; SMT (0402); 10K; 1%; +/-100PPM/DEGC; 0.0630W
R5	1	ERJ-2RKF1003	PANASONIC	100K	RES; SMT (0402); 100K; 1%; +/-100PPM/DEGC; 0.1000W
SW1	1	EVQ-Q2K03W	PANASONIC	EVQ-Q2K03W	SWITCH; SPST; SMT; 15V; 0.02A; LIGHT TOUCH SWITCH; RCOIL= OHM; RINSULATION= OHM; PANASONIC
PCB	1	MAX77505Q	ANALOG DEVICES	PCB	PCB:MAX77505Q
EV_KIT_BOX1	4	NPC02SXON-RC	SULLINS ELECTRONICS CORP.		CONNECTOR; FEMALE; MINI SHUNT; 0.100IN CC; OPEN TOP; JUMPER; STRAIGHT; 2PINS
LX1, OUT1	DNP	SS-102-TT-2	SAMTEC	SS-102-TT-2	IC-SOCKET; SIP; STRAIGHT; PRECISION MACHINED SOCKET STRIP; OPEN FRAME; 2PINS; 100MIL
C11, C12	DNP	N/A	N/A	OPEN	CAPACITOR; SMT (1206); OPEN; IPC MAXIMUM LAND PATTERN
C4	1	T52M1107M035C0055	VISHAY	100UF	CAP; SMT (7360); 100UF; 20%; 35V; TANTALUM

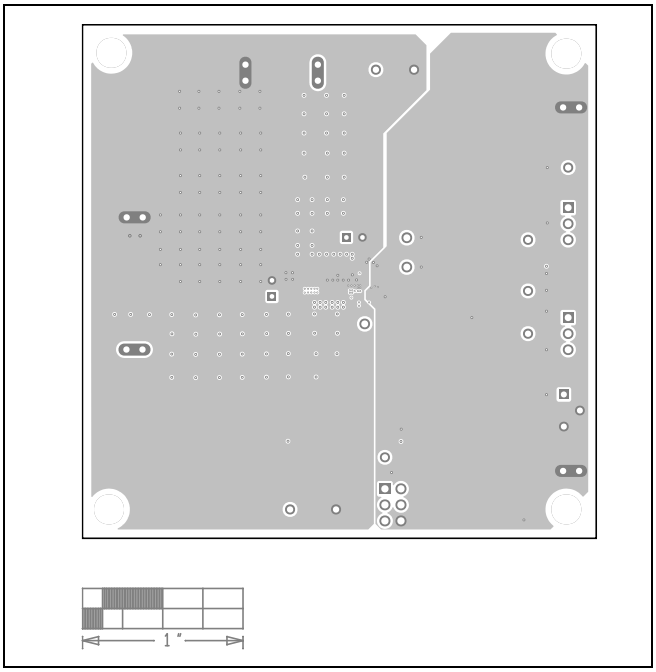
MAX77505 EV Kit Schematic



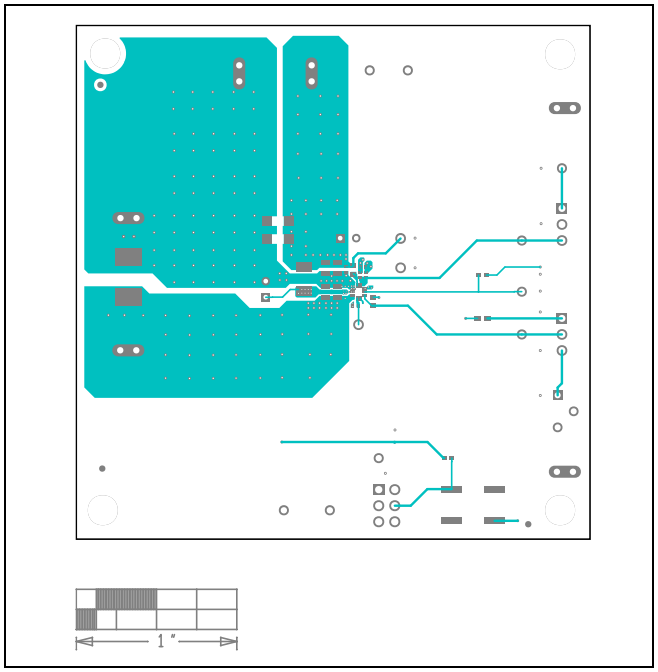
MAX77505 EV Kit PCB Layout



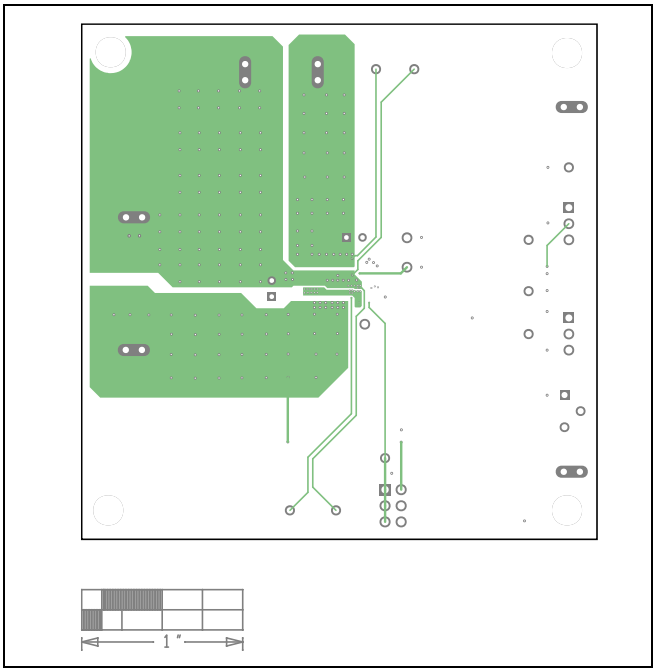
MAX77505 EV Kit Component Placement Guide—Top Silkscreen



MAX77505 EV Kit PCB Layout—Layer 2

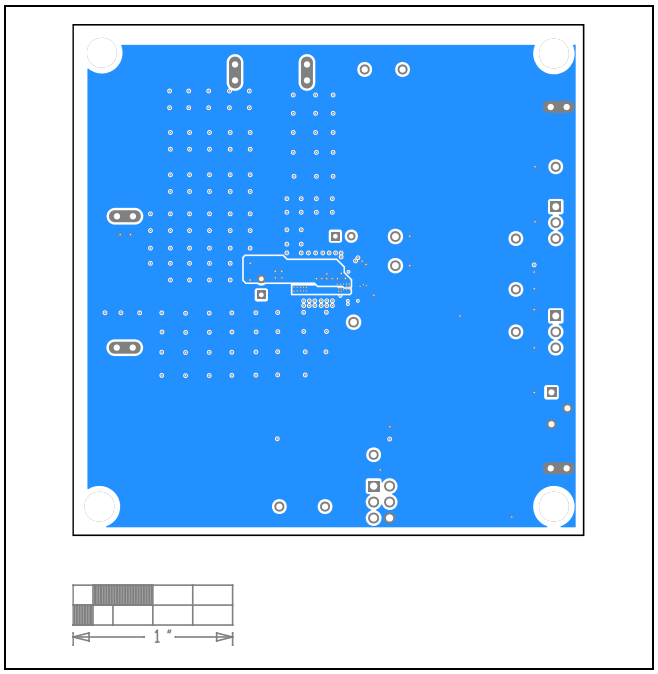


MAX77505 EV Kit PCB Layout—Top



MAX77505 EV Kit PCB Layout—Layer 3

MAX77505 EV Kit PCB Layout (continued)



MAX77505 EV Kit PCB Layout—Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/23	Initial release	—

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