LT8334
Low I_Q Boost/SEPIC/Inverting Converter with 5A, 40V Switch

DESCRIPTION

Evaluation circuit EVAL-LT8334-AZ features the LT®8334 in a SEPIC configuration. It operates with a switching frequency of 2MHz and is designed to convert a 3V to 26V source to 12V output. The converter can output up to 2.2A depending on the input voltage (see Figure 3 for the maximum output current vs V_{IN} curve).

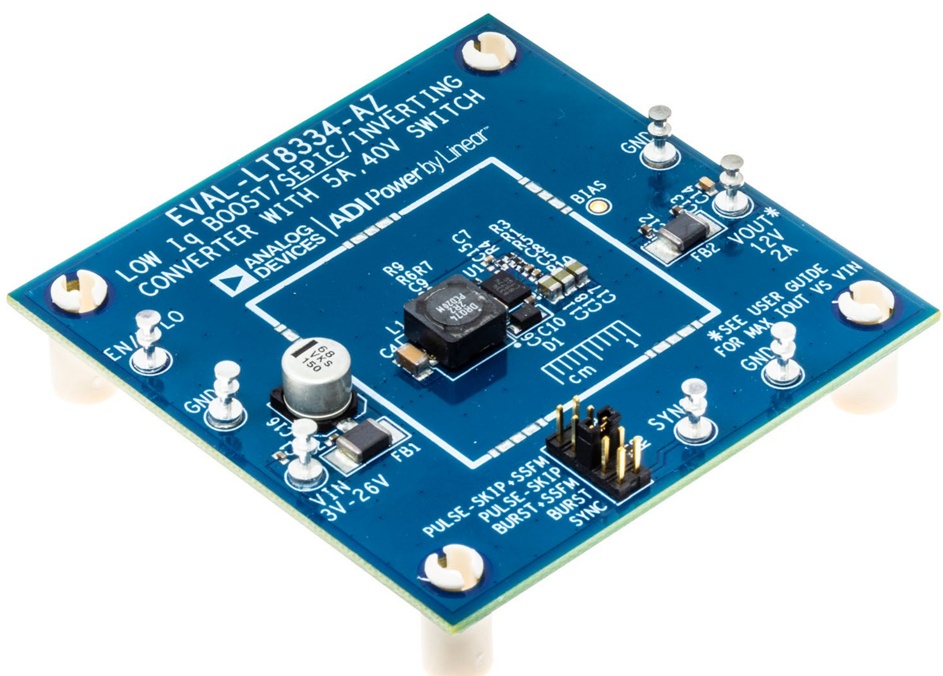
This evaluation circuit features Spread Spectrum Frequency Modulation (SSFM), EMI filters, and space for an option EMI shield to provide optimum EMI performance. This PCB layout is optimized for good EMI performance and small solution size. The evaluation board contains a selectable jumper, JP1, to aid in the selection of the desired SYNC pin mode of operation. At light load, either PULSE SKIP or low-ripple BURST mode can be selected to improve the efficiency.

The LT8334 boost/SEPIC/inverting converter IC operates over an input range of 2.8V to 40V, suitable for automotive, telecom, and industrial applications. The converter provides adjustable and synchronizable operation from 300kHz to 2MHz with SSFM option. The LT8334 packs other popular features such as soft-start, bias pin, input undervoltage lockout. The IC can exhibit a low quiescent current down to 9µA in BURST mode and 1µA in shutdown, which makes it ideal for battery-operated systems. The LT8334 is assembled in a thermally enhanced 12-lead 4mm × 3mm DFN package.

The data sheet gives a complete description of the device, operation, and applications information. The data sheet must be read in conjunction with this demo manual for EVAL-LT8334-AZ.

Design files for this circuit board are available.

BOARD PHOTO



PERFORMANCE SUMMARY Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage (V_{IN})	V_{OUT} = 12V	3		26	V
Output Voltage (V_{OUT})	R6 = 1MΩ, R7 = 154kΩ		12		V
Maximum Output Current (I_{OUT})	V_{OUT} = 12V, V_{IN} = 9V		1.75		A
	V_{OUT} = 12V, V_{IN} = 12V		2		A
	V_{OUT} = 12V, V_{IN} = 16V to 26V		2.2		A
Switching Frequency (f_{SW})	R2 = 20.0kΩ, SSFM OFF		2		MHz
	R2 = 20.0kΩ, SSFM ON	2		2.4	MHz
Input EN Voltage (Rising)	R3 = 1MΩ, R1 = 1.15MΩ		3.2		V
Input UVLO Voltage (Falling)	R3 = 1MΩ, R1 = 1.15MΩ		3.0		V
Typical Efficiency (with EMI Filters)	V_{IN} = 9V, V_{OUT} = 12V, I_{OUT} = 1.75A		86		%
	V_{IN} = 12V, V_{OUT} = 12V, I_{OUT} = 2A		87		%
	V_{IN} = 16V, V_{OUT} = 12V, I_{OUT} = 2.2A		87		%
Zero Load Quiescent Current (V_{OUT} = 12V)* R6 = 1MΩ, R7 = 154kΩ R3 = 1MΩ, R1 = 1.15MΩ	V_{IN} = 12V, JP1 = BURST		35		µA
	V_{IN} = 12V, JP1 = PULSE SKIP		1.2		mA
	V_{IN} = 24V, JP1 = BURST		33		µA
	V_{IN} = 24V, JP1 = PULSE SKIP		1.2		mA

*Please see PULSE SKIP, BURST, SSFM, SYNC section on how to achieve lower quiescent current.

QUICK START PROCEDURE

Evaluation circuit EVAL-LT8334-AZ is easy to set up to evaluate the performance of the LT8334. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below.

NOTE: Make sure that the input voltage is always with the specification.

1. Connect EN/UVLO turret to GND.
2. With power off, connect the input power supply to V_{IN} and GND terminals of the board. Include voltage and current meters as shown in Figure 1 if desired.
3. Connect the load to the V_{OUT} and GND terminals.
4. Turn on the power at the input. Increase V_{IN} slowly to 12V.
5. Disconnect EN/UVLO turret from GND and the output turns on.
6. Check for the proper output voltage. The output should be regulated at 12V.

   If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
7. Once the proper output voltage is established, adjust the input voltage and load current within the operating range and observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

   NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the input and output capacitors.

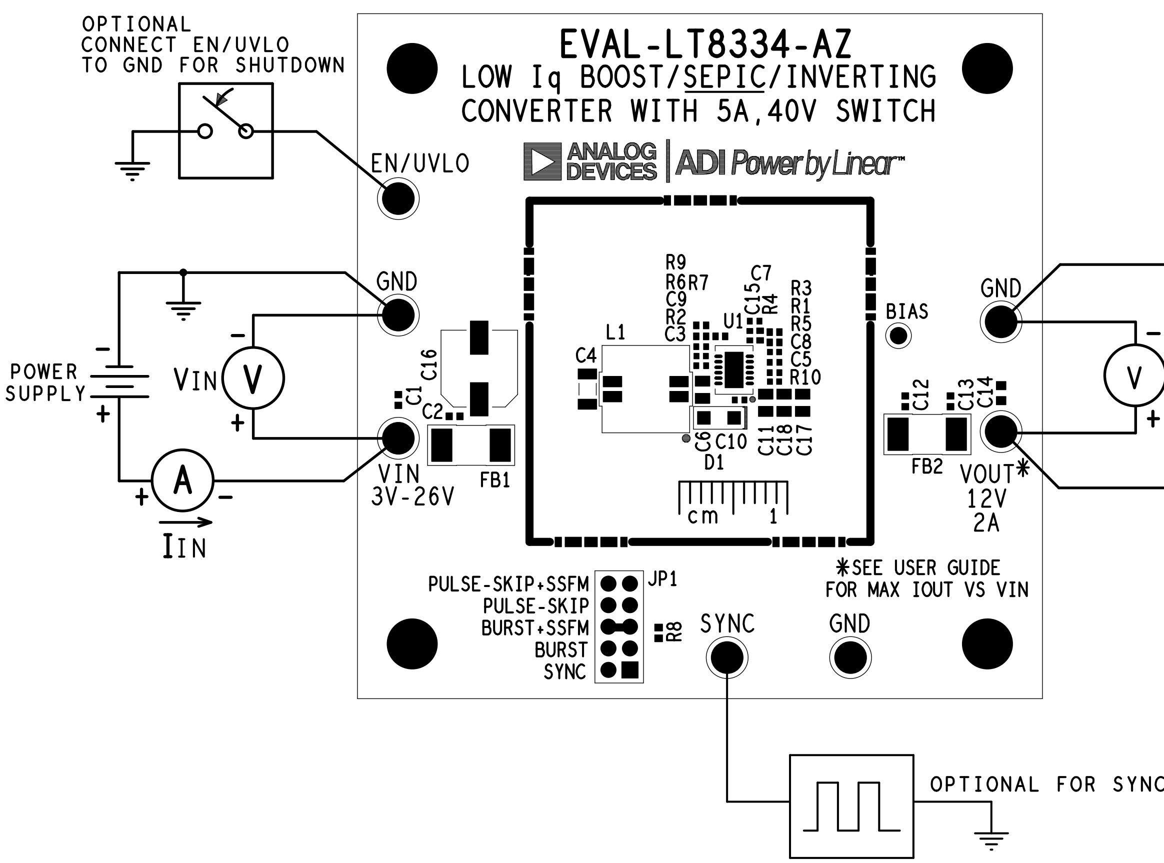


Figure 1. Proper Equipment Setup for EVAL-LT8334-AZ

QUICK START PROCEDURE

OUTPUT VOLTAGE AND POWER

The LT8334 is a low I_Q non-synchronous DC/DC converter that can be configured in boost, SEPIC, or inverting converters. Although EVAL-LT8334-AZ is designed to regulate 12V output from a 3V-to-26V source, the feedback resistors R6 and R7 can be easily adjusted for higher or lower output voltage. In addition to adjusting feedback resistors, the input and output capacitors should be sized appropriately. The catch diode, D1, must also be able to handle the output voltage.

The 5A peak switch current limit allow a maximum 2.2A output current at $16V_{IN}$ or higher. Figure 3 shows the maximum output current for versus V_{IN} for DC operation.

PULSE SKIP, BURST, SSFM, SYNC

The LT8334 achieves low power consumption at light loads. The different SYNC/MODE pin states can be evaluated by changing the position of jumper JP1. It is easy to change from BURST to PULSE SKIP and to explore SSFM ON, SSFM OFF, and external SYNC with this jumper.

PULSE SKIP allows low quiescent current at light load consumption without changing switching frequency until a very light load. BURST allows the lowest light load power consumption and has a unique low ripple feature on the LT8334. These two features can be explored further in the data sheet of the LT8334. For even lower no-load input current, the EN/UVLO pin should be shorted to V_{IN} and the R1 resistor should be removed. The feedback resistors, R6 and R7, can be replaced with higher resistance values for best no-load input current results.

Spread Spectrum Frequency Modulation (SSFM) can be enabled to reduce the emissions of the converter. SSFM spreads the frequency between the R_T-programmed frequency and +20% higher.

If an external SYNC signal is provided, the SYNC option of JP1 can be used to synchronize with an external clock. The clock frequency should be slightly higher than the R_T-programmed frequency for best performance.

EN/UVLO

R3 and R1 set the undervoltage lockout falling and rising thresholds. The LT8334 data sheet gives a formula for calculating these values. EVAL-LT8334-AZ has a falling UVLO threshold of 3V and a rising threshold of 3.2V. This threshold can easily be adjusted by changing resistors R3 and R1 according to the data sheet equations.

BIAS

In this evaluation circuit, the bias pin is unused and tied to GND through R5. However, the bias pin can be connected to an auxiliary input supply for powering $INTV_{CC}$ to improve efficiency when $4.4V \le BIAS \le V_{IN}$. To use the BIAS pin, R5 needs to be replaced by an 0402 sized ceramic capacitor with a value of at least 1µF, and BIAS terminal should be connected to the auxiliary source, which could be V_{OUT}.

OUTPUT SHORT-CIRCUIT PROTECTION

The LT8334 configured in a SEPIC configuration protects the circuitry when the output is shorted. The EVAL-LT8334-AZ prevents damage to circuitry during quick transient output short circuits. However, the existing diode on the evaluation circuit is selected for optimal efficiency and quiescent current, but not for protecting continuous short-circuits. If continuous output short circuit protection is required, a diode with the current rating above the “Switch Overcurrent Threshold” stated in the data sheet is recommended.

TEST RESULTS

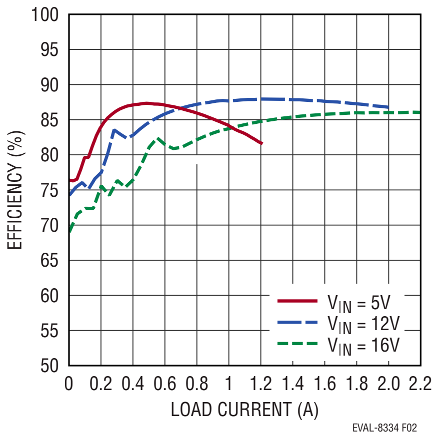


Figure 2. EVAL-LT8334-AZ Efficiency at V_{OUT} = 12V and Different V_{IN}, EVAL-LT8334-AZ is Assembled with EMI Filters, JP1 = BURST

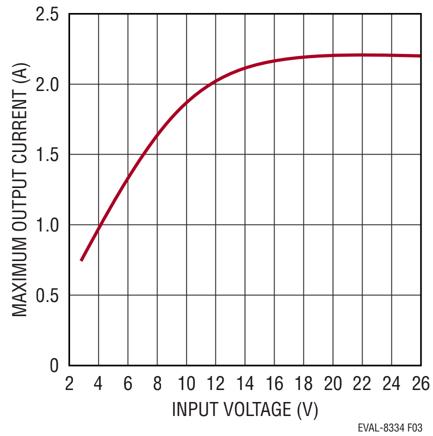


Figure 3. EVAL-LT8334-AZ Steady State Maximum Output Current vs Input Voltage

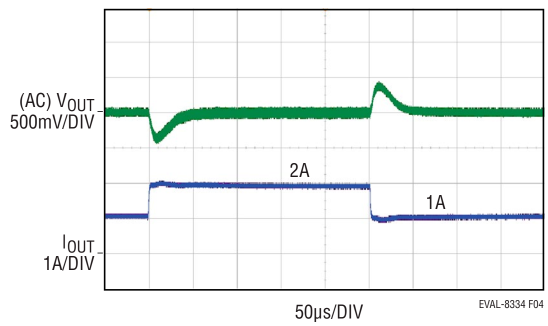


Figure 4. EVAL-LT8334-AZ V_{OUT} Transient Response with V_{IN} = 12V, V_{OUT} = 12V, I_{OUT} = 1A to 2A (JP1 = PULSE SKIP)

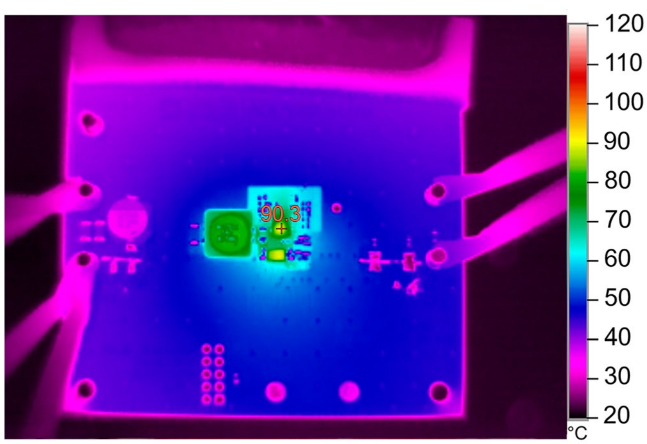


Figure 5. EVAL-LT8334-AZ Thermals at V_{IN} = 12V, V_{OUT} = 12V, I_{OUT} = 2A

TEST RESULTS

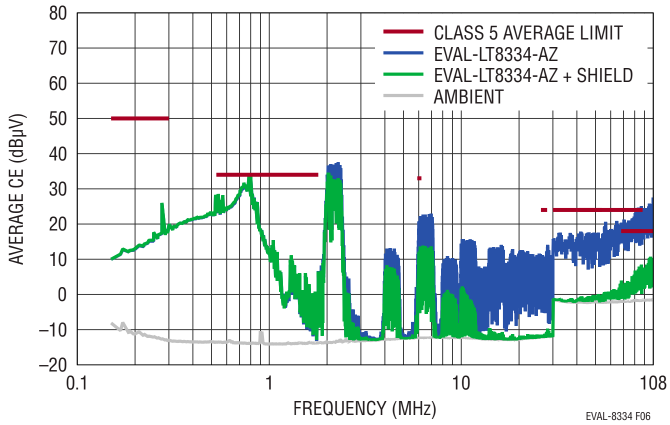


Figure 6. EVAL-LT8334-AZ CISPR25 Voltage Conducted EMI Average Performance with $12V_{IN}$ to $12V_{OUT}$ at 2A, JP1 = BURST+SSFM

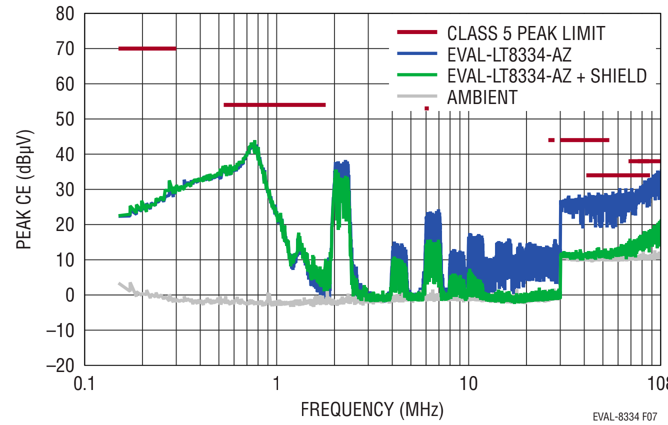


Figure 7. EVAL-LT8334-AZ CISPR25 Voltage Conducted EMI Peak Performance with $12V_{IN}$ to $12V_{OUT}$ at 2A, JP1 = BURST+SSFM

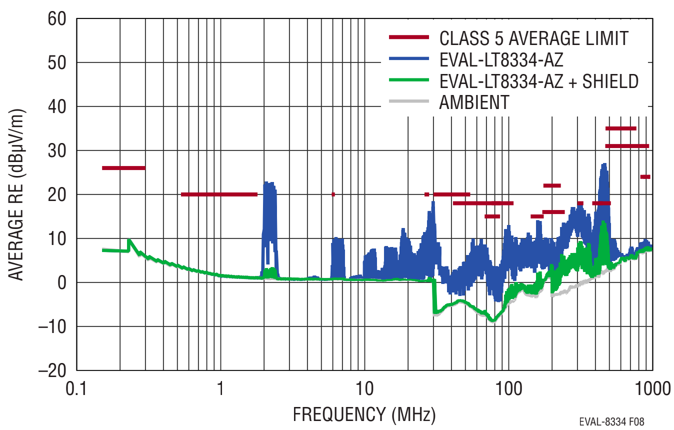


Figure 8. EVAL-LT8334-AZ CISPR25 Radiated EMI Average Performance with $12V_{IN}$ to $12V_{OUT}$ at 2A, JP1 = BURST+SSFM

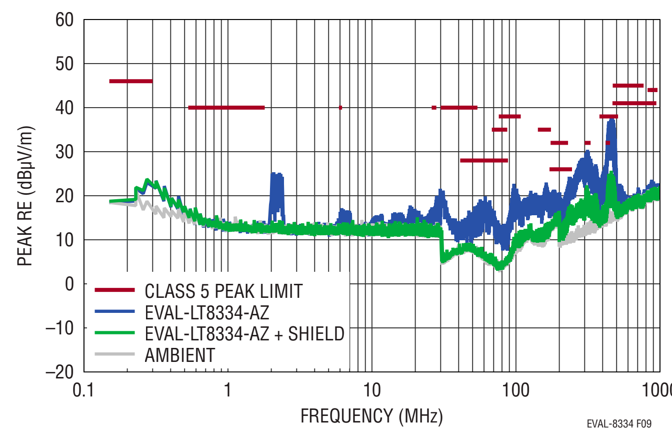


Figure 9. EVAL-LT8334-AZ CISPR25 Radiated EMI Peak Performance with $12V_{IN}$ to $12V_{OUT}$ at 2A, JP1 = BURST+SSFM

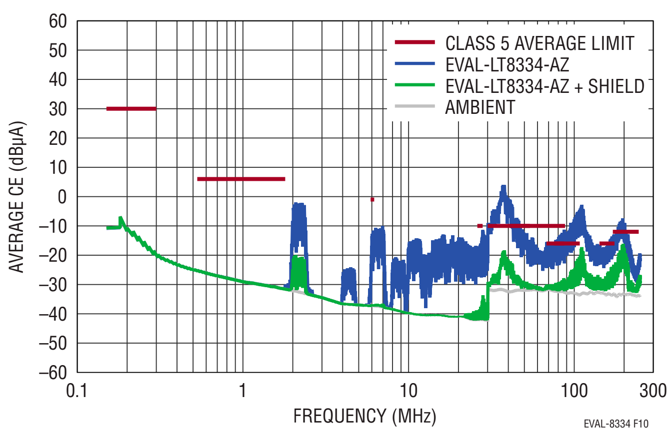


Figure 10. EVAL-LT8334-AZ CISPR25 Current Conducted EMI Average Performance with $12V_{IN}$ to $12V_{OUT}$ at 2A, JP1 = BURST+SSFM

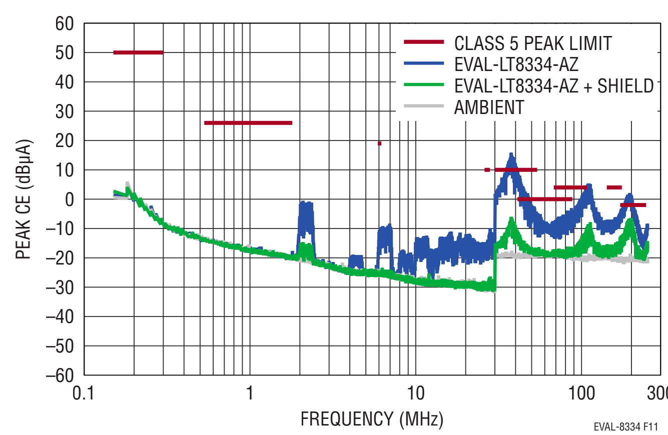


Figure 11. EVAL-LT8334-AZ CISPR25 Current Conducted EMI Peak Performance with $12V_{IN}$ to 12VOUT at 2A, JP1 = BURST+SSFM

EMISSIONS SHIELD (OPTION)

For the ultimate lowest emissions, an EMI shield can be attached to EVAL-LT8334-AZ. The PCB was fabricated with placeholders for five shield clips which can hold a 32mm × 32mm metal shield. Part numbers for an example shield are provided in the Parts List section in the Hardware list. The top silkscreen picture (Figure 12) shows the placeholders for the eight surface mount shield clips. Then the emissions of the board can be tested with and without the removable clip-shield.

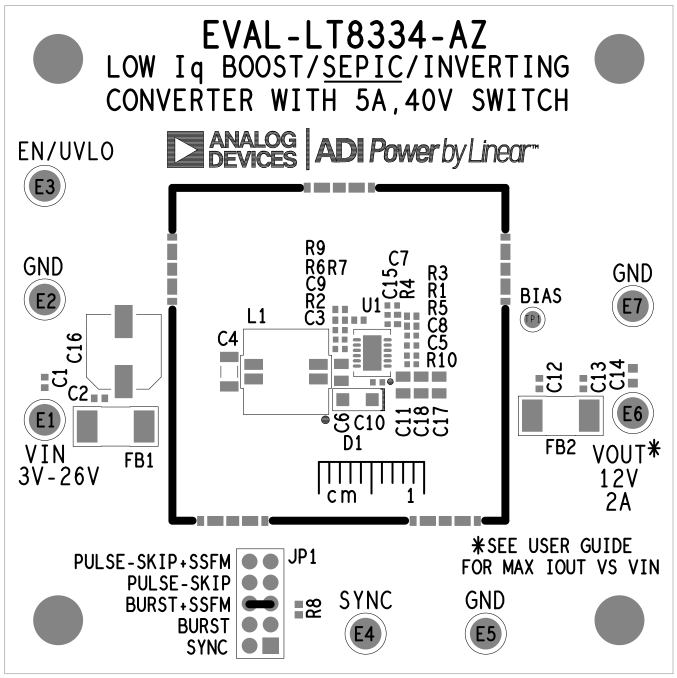
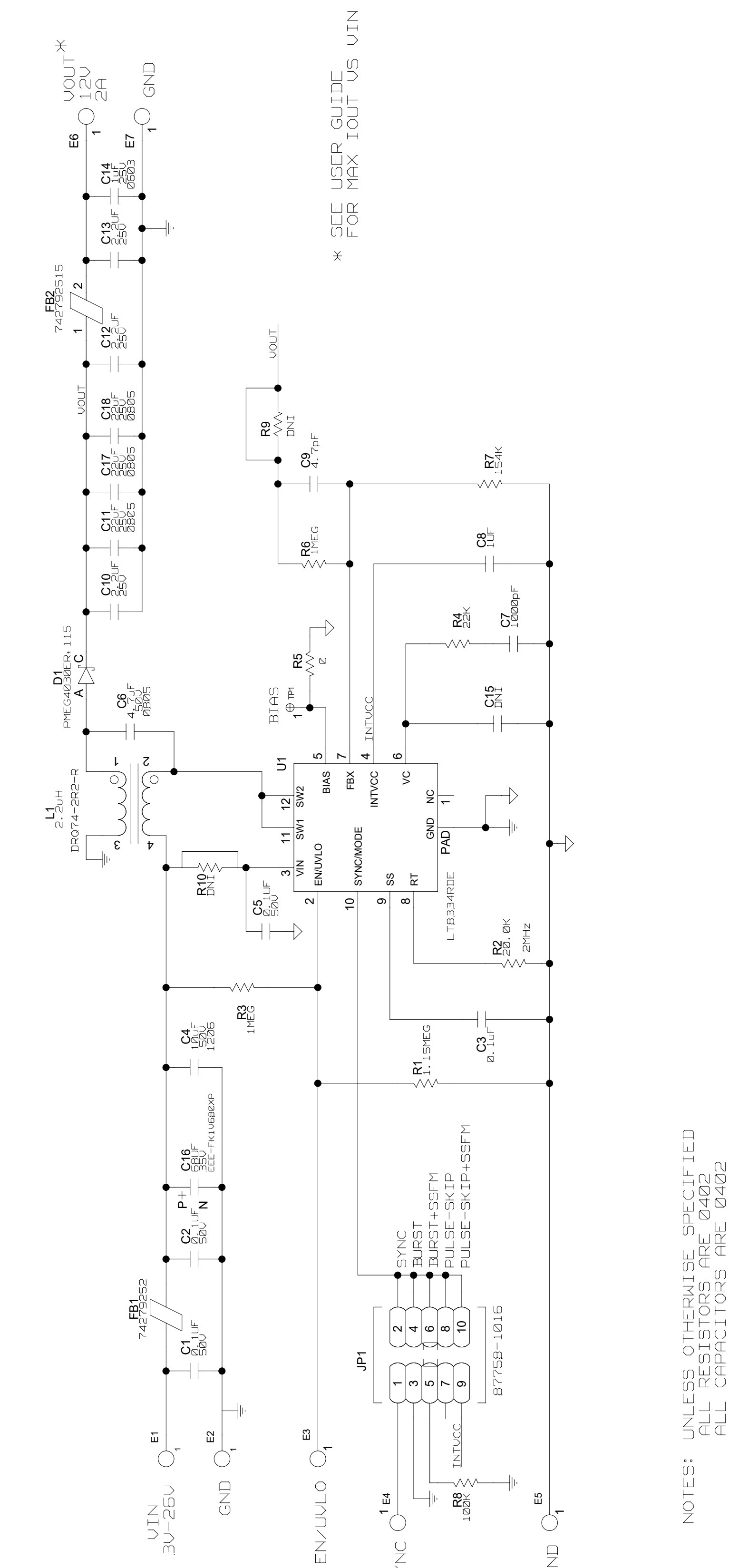


Figure 12. EMI Shield Clips Can Be Soldered to the Five Placeholders on the PCB, a Square 32mm × 32mm Outline Shows Where the EMI Shield Fits onto the PCB

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Electrical Components				
1	1	C5	CAP. CER 0.1µF 50V 10% X7R 0402 AEC-Q200	MURATA, GCM155R71H104KE02D
2	3	C11, C17, C18	CAP. CER 22µF 25V 20% X5R 0805 AEC-Q200	MURATA, GRT21BR61E226ME13L
3	1	C3	CAP. CER 0.1µF 25V 10% X7R 0402 AEC-Q200	TAIYO YUDEN, TMK105B7104KVHF
4	1	C4	CAP. CER 10µF 50V 20% X5R 1206 AEC-Q200	MURATA, GRT31CR61H106ME01L
5	1	C6	CAP. CER 4.7µF 50V 10% X5R 0805 AEC-Q200 LOW ESR	TDK, CGA4J3X5R1H475K125AB
6	1	C7	CAP. CER 1000pF 10V 10% X7R 0402	KEMET, C0402S102K8RACAUTO
7	1	C8	CAP. CER 1µF 25V 10% X5R 0402 AEC-Q200	MURATA, GRT155R61E105KE01D
8	1	C9	CAP. CER 4.7pF 0.25pF 50V C0G 0402 AEC-Q200	MURATA, GCM1555C1H4R7CA16D
9	1	D1	DIODE LOW VF MEGA SCHOTTKY BARR RECT	NXP SEMICONDUCTORS, PMEG4030ER, 115
10	1	L1	IND. POWER SHIELDED DRUM CORE 1.986µH/7.944µH 20% 100kHz 4.66A/2.33A 0.013Ω/0.0521Ω DCR	EATON, DRQ74-2R2-R
11	1	R1	RES. SMD 1.15M 1% 1/16W 0402 AEC-Q200	VISHAY, CRCW04021M15FKED
12	1	R2	RES. SMD 20k 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF2002X
13	2	R3, R6	RES. SMD 1M 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF1004X
14	1	R4	RES. SMD 22k 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF2202X
15	1	R7	RES. SMD 154k 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF1543X
16	1	U1	IC-ADI LOW I_Q BOOST/SEPIC/INVERTING CONVERTER WITH 5A 40V SWITCH	ANALOG DEVICES, LT8334RDE#PBF
Optional Low EMI Components				
1	2	C1, C2	CAP. CER 0.1µF 50V 10% X7R 0402 AEC-Q200	MURATA, GCM155R71H104KE02D
2	3	C10, C12, C13	CAP. CER 2.2µF 25V 10% X5R 0402 AEC-Q200	MURATA, GRT155R61E225KE13D
3	1	C14	CAP. CER 1µF 25V 10% X7R 0603 AEC-Q200	MURATA, GRT188R71E105KE13D
4	1	C16	CAP. ALUM ELECT 68µF 35V 20% 6.3mm × 7.7mm AEC-Q200 280mA 2000H	PANASONIC, EEE-FK1V680XP
5	1	FB1	IND. FERRITE BEAD MULTI-LAYER 880Ω 25% 100MHz 4A 0.035Ω 1812 AEC-Q200	WURTH ELEKTRONIK, 74279252
6	1	FB2	IND. CHIP FERRITE BEAD, 0.05Ω DCR, 3A	WURTH ELEKTRONIK, 742792515
Optional Electrical Components				
1	0	C15	CAP., OPTION, 0402	
2	1	R5	RES SMD 0Ω JUMPER 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2GE0R00X
3	1	R8	RES SMD 100k 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF1003X
4	0	R9, R10	RES., OPTION, 0402	
Hardware: For Evaluation Circuit Only				
1	7	E1, E2, E3, E4, E5, E6, E7	CONN-PCB SOLDER TERMINAL TURRETS	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	CONN-PCB 10-POS MALE HDR UNSHROUDED DOUBLE ROW ST, 2mm PITCH, 4mm POST HEIGHT, 2.6mm SOLDER TAIL	MOLEX, 87758-1016
3	0	CL1–CL5	FIVE EMI SHIELD CLIPS	WURTH, 36900000
4	0	SH1	EMI SHIELD 32mm × 32mm	WURTH, 36906326S

SCHEMATIC DIAGRAM



ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.