
42V, 1A/2.5A Step-Down Silent Switcher 3 with Ultra-Low Noise Reference

General Description

The EVAL-LT83401-AZ and EVAL-LT83402-AZ (abbreviated as EVAL-LT83401/2-AZ) demonstration boards are 42V, 1A, and 2.5A synchronous [Silent Switcher](#)[®] 3 step-down regulators with ultra-low noise, high efficiency, and power density, featuring the LT83401 and LT83402 (abbreviated as LT83401/2), respectively. The input voltage range of the EVAL-LT83401/2-AZ is 4.8V to 42V. The default demo board setting is 3.3V output with a maximum 1A/2.5A DC output current. The LT83401/2 is a compact, ultra-low noise, ultra-low emission, high efficiency, and high-speed synchronous monolithic step-down switching regulator. The uniquely designed combination of the ultra-low noise reference and third-generation Silent Switcher architecture enables the LT83401/2 to achieve both high efficiency and excellent wideband noise performance. A minimum on-time of 22ns allows high V_{IN} to low V_{OUT} conversion at high frequency.

The LT83401/2's switching frequency can be programmed either through an external resistor (R_T) or an external clock over a 300kHz to 6MHz range. The default frequency of EVAL-LT83401/2-AZ demo boards is 2MHz. The SYNC/MODE pin on the demo boards is connected to ground by default for pulse-skip mode operation. To synchronize to an external clock, move JP1 to SYNC and apply the external clock to the SYNC terminal. Select the forced continuous mode (FCM) by moving the JP1 shunt, respectively. [Figure 1](#) and [Figure 2](#) show the efficiency of the EVAL-LT83401/2-AZ at the 12V and 24V inputs in FCM operation (input from V_{IN} terminal). [Figure 3](#) shows the temperature rise of the LT83401 on the EVAL-LT83401-AZ demo board under 12V and 24V input voltage conditions across the full load range. [Figure 4](#) shows the temperature rise of the LT83402 on the EVAL-LT83402-AZ demo board under 12V and 24V input voltage conditions across the full load range. The case

temperature rise was measured with the following reference points: The peak IC case temperature and a point on the board, marked with a red 'X' as shown in the thermal images [Figure 12](#) and [Figure 13](#).

Both demo boards have an electromagnetic interference (EMI) filter installed by default, with VIN_EMI as its input terminal. The EMI performance of the EVAL-LT83401/2-AZ is shown in [Figure 5](#) and [Figure 6](#). The red lines in these figures represent the CISPR25 Class 5 limits, indicating that both the EVAL-LT83401-AZ and EVAL-LT83402-AZ meet the CISPR25 standard.

The LT83401/2 also feature ultra-low noise across a wide frequency range. [Figure 7](#) shows the noise spectral density of the LT83402 on a default EVAL-LT83402-AZ under various loads. At full load, the noise hump near 100kHz does not exceed $10\text{nV}/\sqrt{\text{Hz}}$.

[Figure 8](#) and [Figure 9](#) show the output ripple of EVAL-LT83401/2-AZ boards. The transient response of the EVAL-LT83401/2-AZ demo boards is shown in [Figure 10](#) and [Figure 11](#). Refer to the LT83401/LT83402 data sheet for figures showing faster transient response with corresponding modifications.

The [LT83401/LT83402](#) data sheet provides a comprehensive description, including operational and application information, and serves as a valuable reference in conjunction with this user guide for the EVAL-LT83401/2-AZ demo boards. The LT83401/2 are assembled in 3mm x 2mm x 0.75mm LFCSP packages with exposed ground pads for low thermal resistance. The layout recommendations for low EMI operation and maximum thermal performance are available in the *PCB Layout Recommendations* section of the LT83401/LT83402 data sheet.

Design files for this circuit board are available in the Design Center at www.analog.com

Performance Summary ($T_A = 25^\circ\text{C}$)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range V_{IN}		4.8		42	V
Output Voltage		3.29	3.32	3.35	V
Default Switching Frequency			2		MHz
Maximum Output Current	EVAL-LT83401-AZ Derating is necessary for certain V_{IN} , V_{OUT} , and thermal conditions	1			A
	EVAL-LT83402-AZ Derating is necessary for certain V_{IN} , V_{OUT} , and thermal conditions	2.5			
Efficiency	EVAL-LT83401-AZ $V_{IN} = 12\text{V}$, $f_{SW} = 2\text{MHz}$, $V_{OUT} = 3.3\text{V}$ at $I_{OUT} = 1\text{A}$		89.1		%
	EVAL-LT83402-AZ $V_{IN} = 12\text{V}$, $f_{SW} = 2\text{MHz}$, $V_{OUT} = 1\text{V}$ at $I_{OUT} = 2\text{A}$		84.4		

Typical Performance Characteristics

(Standard demo board at $f_{sw} = 2\text{MHz}$, $\text{MODE} = \text{FCM}$, $T_A = +25^\circ\text{C}$, unless otherwise noted.)

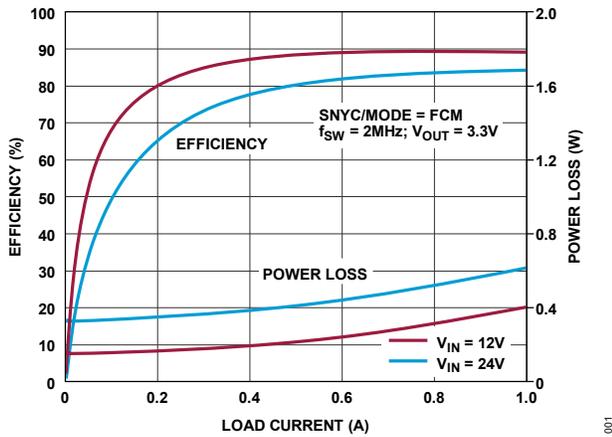


Figure 1. EVAL-LT83401-AZ Efficiency vs. Load Current (Input from V_{IN} Terminal)

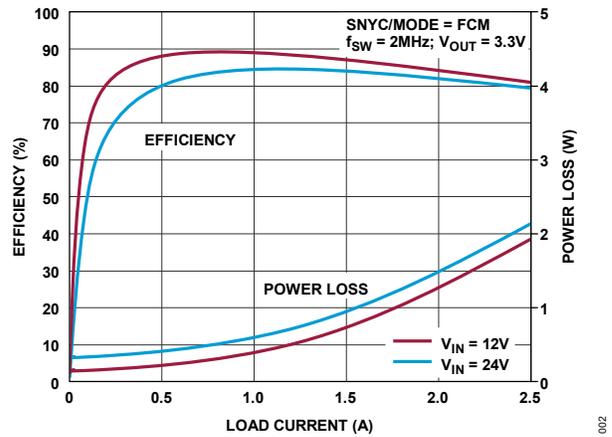


Figure 2. EVAL-LT83402-AZ Efficiency vs. Load Current (Input from V_{IN} Terminal)

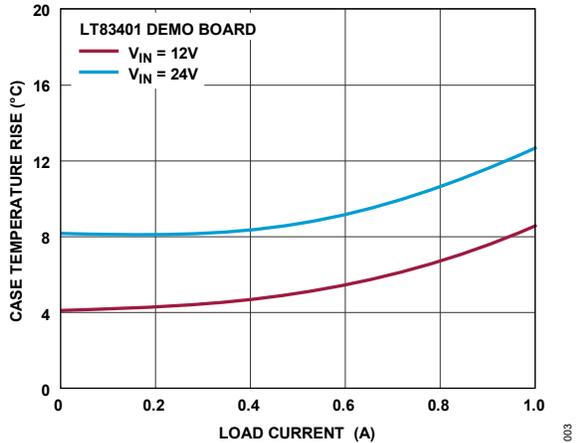


Figure 3. EVAL-LT83401-AZ Temperature Rising vs. I_{OUT}

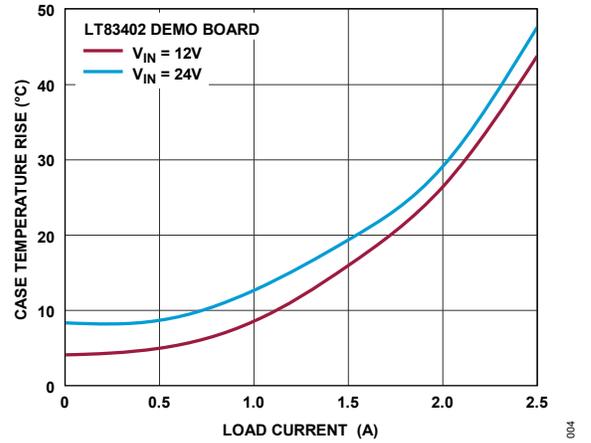
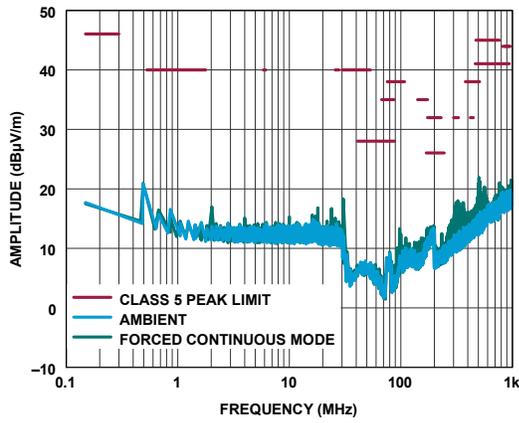


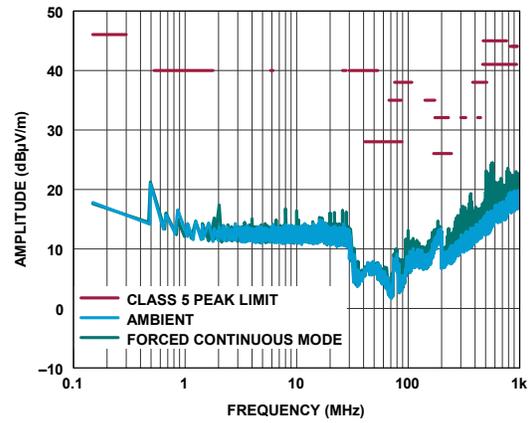
Figure 4. EVAL-LT83402-AZ Temperature Rising vs. I_{OUT}



EVAL-LT83401-AZ DEMO BOARD
(WITH EMI FILTER INSTALLED)
12V INPUT TO 3.3V OUTPUT AT 1A, $f_{SW} = 2\text{MHz}$

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Figure 5. EVAL-LT83401-AZ Radiated EMI Performance



EVAL-LT83401-AZ DEMO BOARD
(WITH EMI FILTER INSTALLED)
12V INPUT TO 3.3V OUTPUT AT 2.5A, $f_{SW} = 2\text{MHz}$

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Figure 6. EVAL-LT83402-AZ Radiated EMI Performance

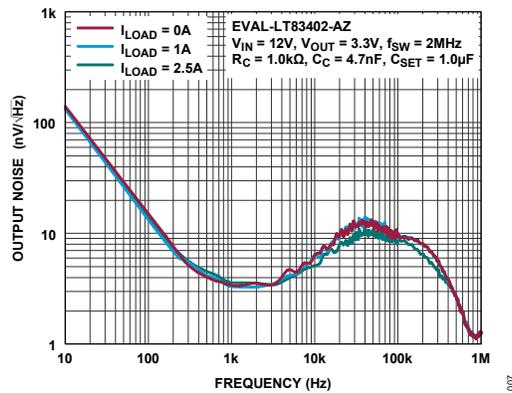


Figure 7. EVAL-LT83402-AZ Noise Spectral Density

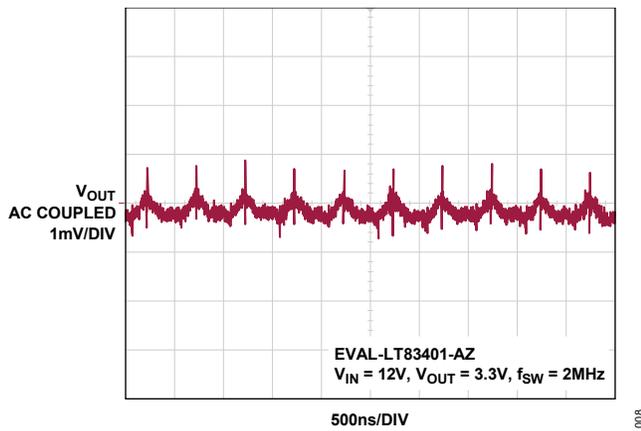


Figure 8. EVAL-LT83401-AZ Output Voltage Ripple Measured Through J6 ($I_{OUT} = 1A$), with a 200MHz BWL. A 50Ω Resistor at R13 is Used for Clean Ripple Measurements.

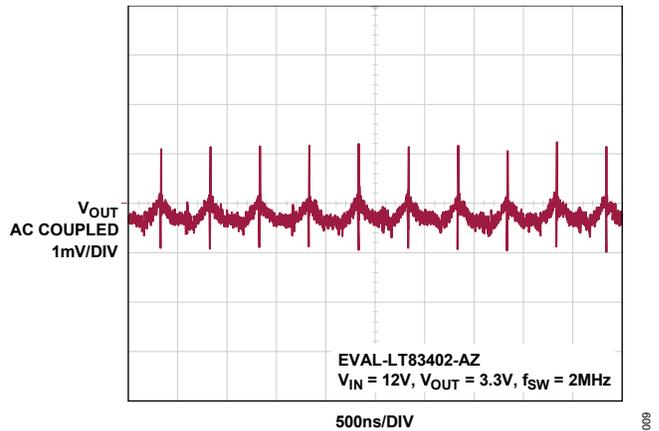


Figure 9. EVAL-LT83402-AZ Output Voltage Ripple Measured Through J6 ($I_{OUT} = 2.5A$), with a 200MHz BWL. A 50Ω Resistor at R13 is Used for Clean Ripple Measurements.

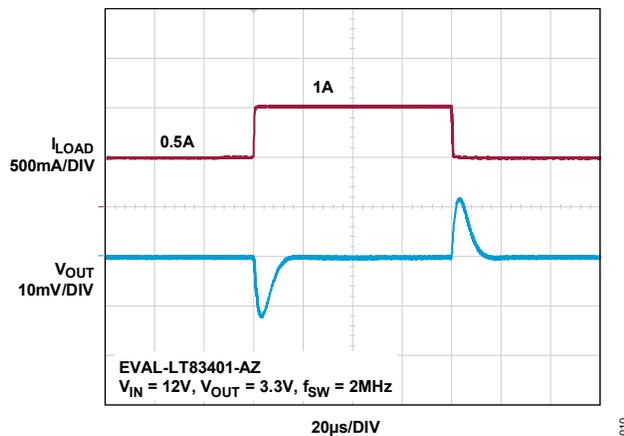


Figure 10. EVAL-LT83401-AZ Transient Response with Load Steps from 0.5A to 1A to 0.5A. V_{OUT} is Measured at J6.

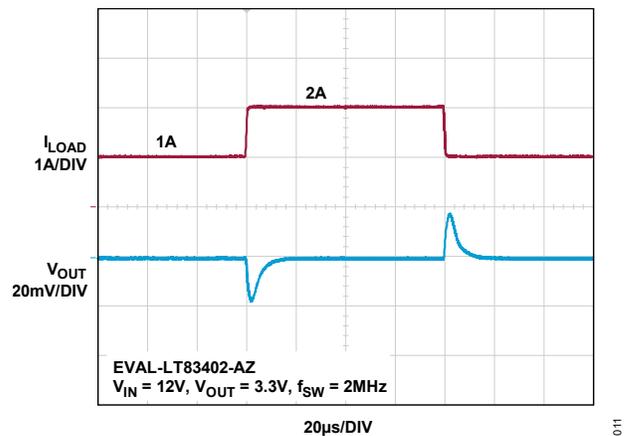


Figure 11. EVAL-LT83402-AZ Transient Response with Load Steps from 1A to 2A to 1A. V_{OUT} is Measured at J6.

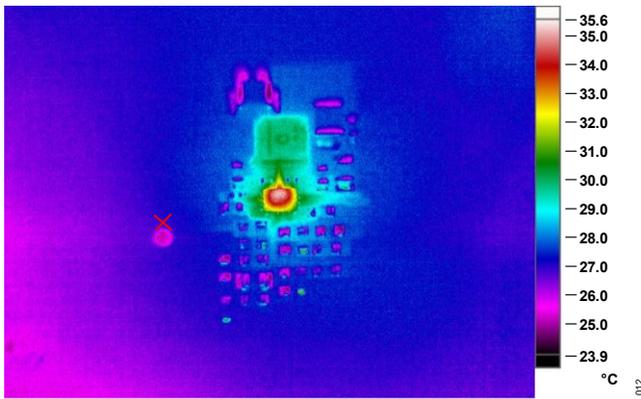


Figure 12. EVAL-LT83401-AZ Thermal Performance,
 $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 1A$

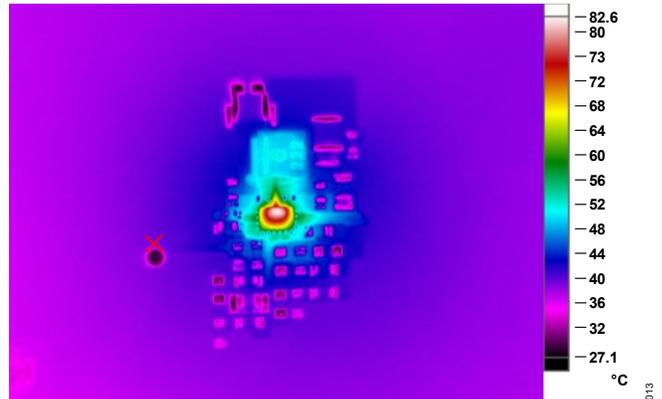


Figure 13. EVAL-LT83402-AZ Thermal Performance,
 $V_{IN} = 12V$, $V_{OUT} = 3.3V$, $I_{OUT} = 2.5A$

Quick Start Procedure

The EVAL-LT83401/2-AZ demo boards are easy to set up to evaluate the performance of LT83401 and LT83402. See [Figure 14](#) for a proper test setup and follow this test procedure. The EVAL-LT83401-AZ uses the same test setup as EVAL-LT83402-AZ shown in [Figure 14](#).

Note: When measuring the input or output voltage ripple, be careful to avoid a long ground lead on the oscilloscope probe. For the input and output voltage ripple, measure them through the U.FL connectors—“VIN SENSE” (J5), and “VO SENSE” (J6), respectively. [Figure 8](#) and [Figure 9](#) show the output voltage ripple measured at the “VO SENSE” U.FL connector.

1. Place JP1 in the FCM position.
2. With power off, connect the input power supply to VIN (E6) and GND (E7).
3. With power off, connect the load's "+" input to the board's VOUT (E12), and connect the load's "-" input to the board's GND (E13).
4. Connect the digital multimeter (DMM) between the input test points: “VIN SENSE” (E3) and “GND SENSE” (E4) to monitor the input voltage. Connect another DMM between “VO SENSE” (E10) and “GND SENSE” (E11) to monitor the output voltage.
5. Set the power supply voltage to 12V and enable it.
6. Check for the proper output voltage ($V_{OUT} = 3.3V$).
7. Once the input and output voltages are properly established, adjust the load current within the operating range of 0A to 1A maximum (EVAL-LT83401-AZ) or 2.5A maximum (EVAL-LT83402-AZ). Observe the output voltage regulation, output voltage ripples, switching node waveform, load transient response, and other parameters.
8. (Optional) Add an external clock to the SYNC terminal when using the SYNC function (JP1 on the SYNC position). Choose the R_T resistor (R4) to set the LT83401/2 switching frequency at least 20% below the lowest SYNC frequency.

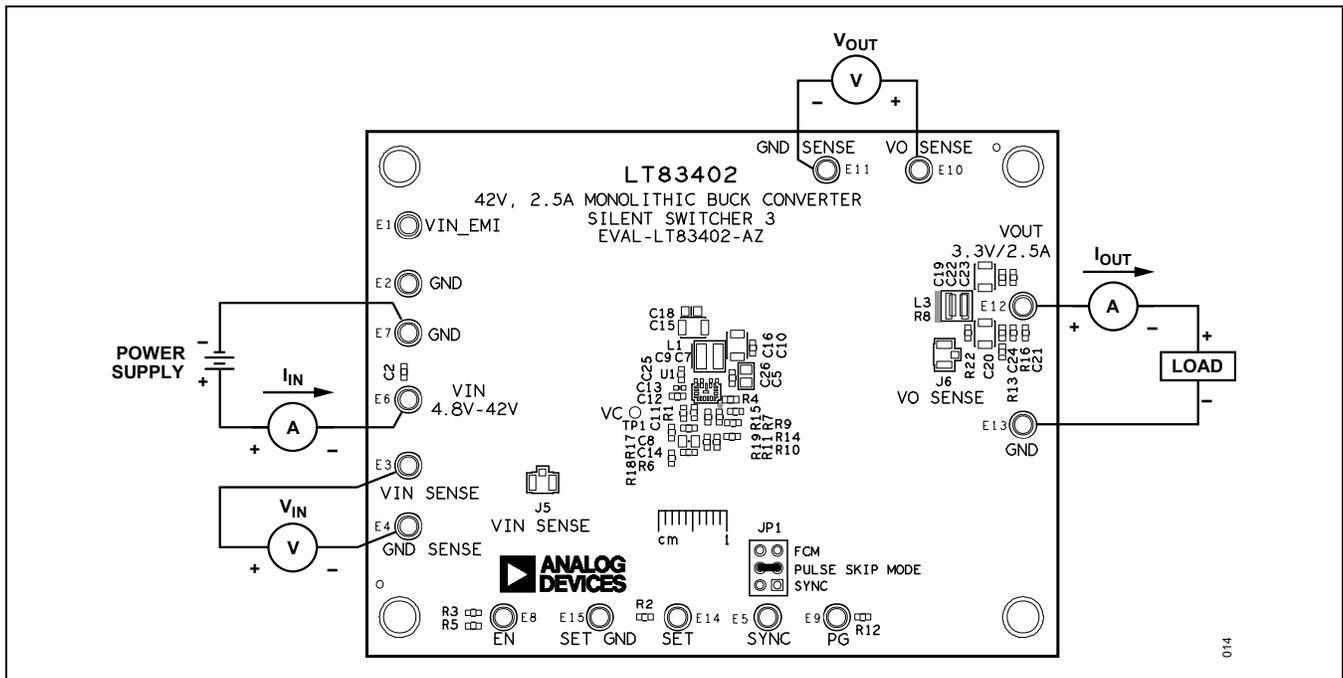


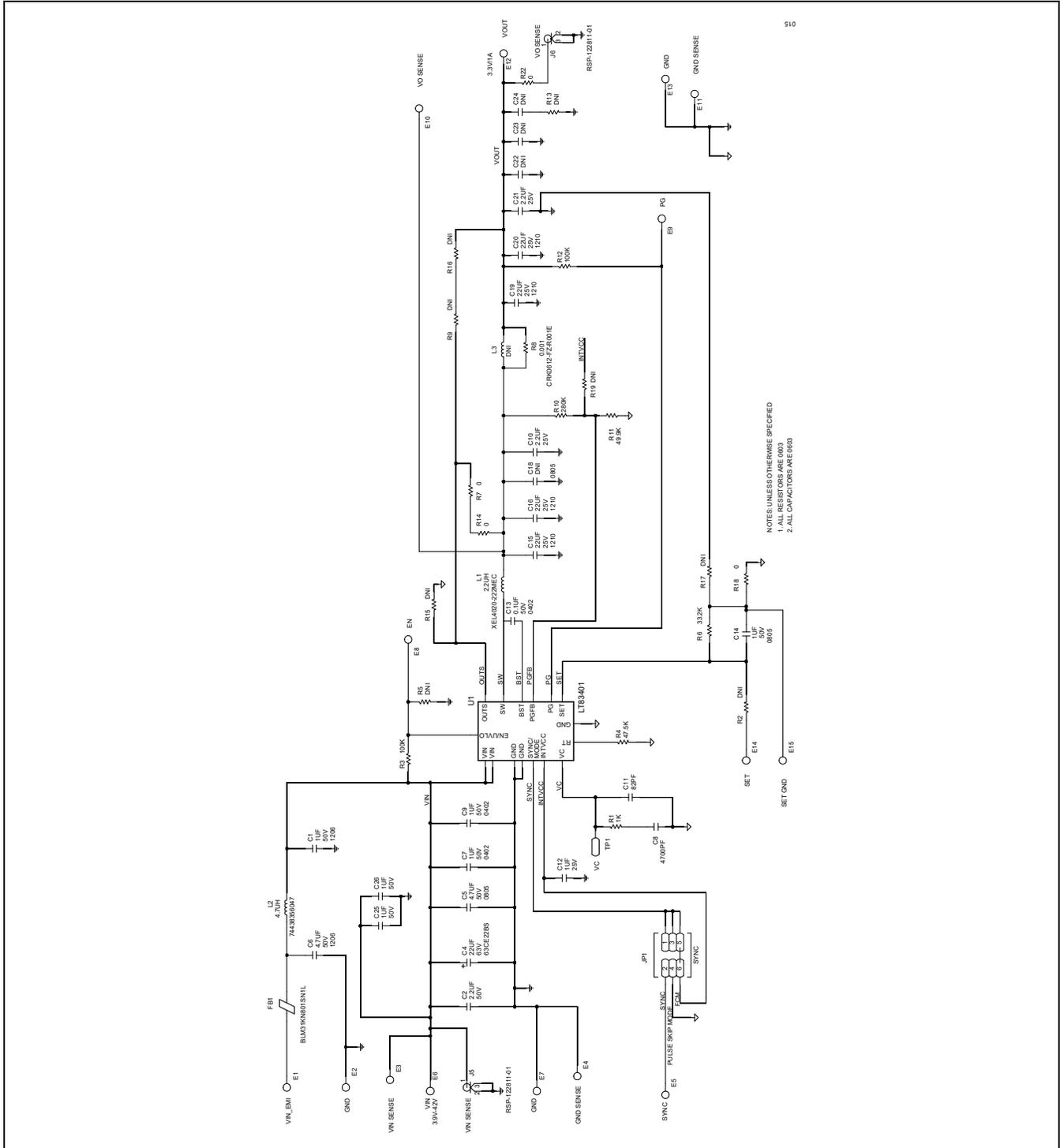
Figure 14. Board Test Setup

Bill of Materials

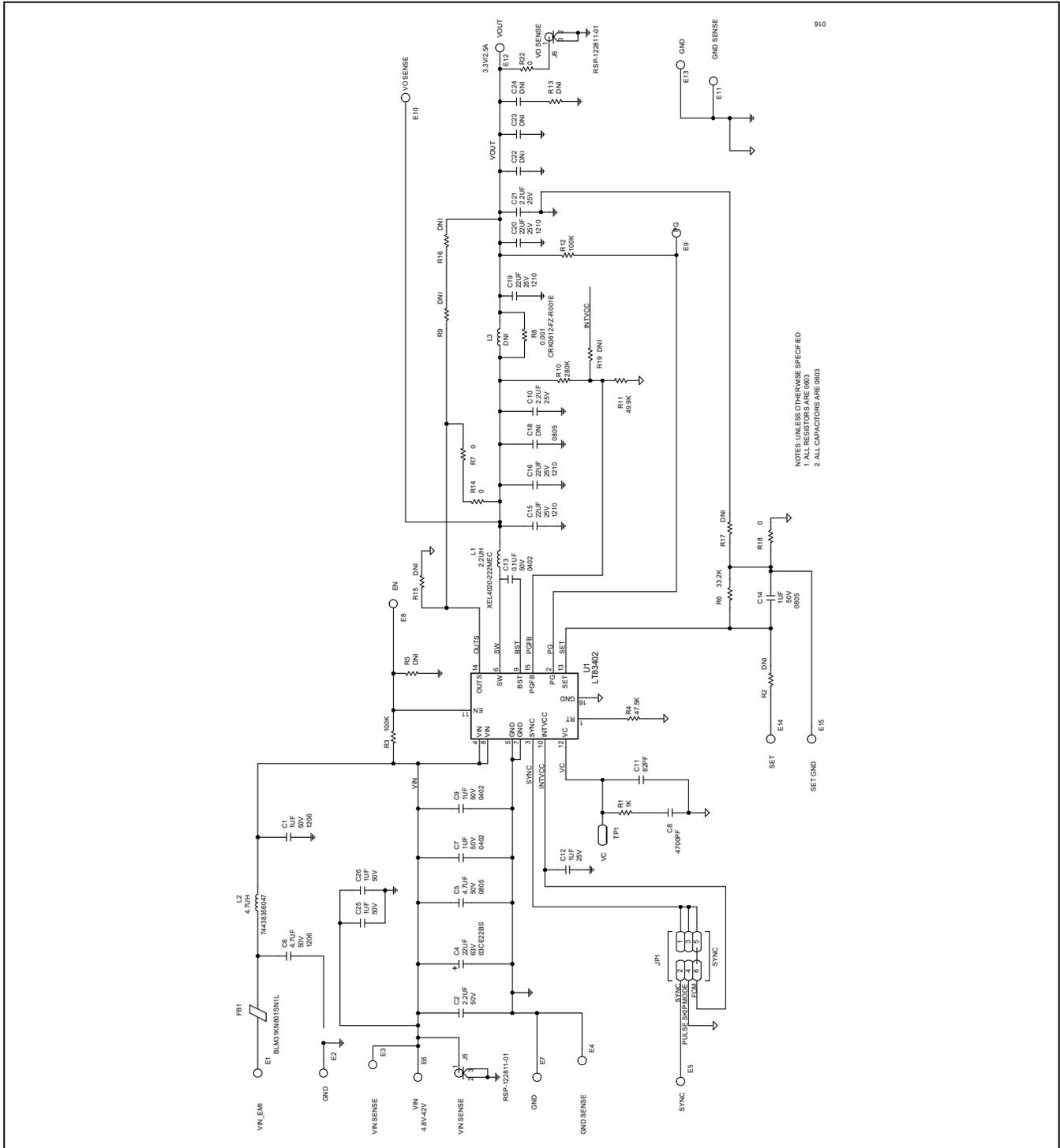
ITEM	QTY	DESIGNATOR	DESCRIPTION	MANUFACTURER PART NUMBER
REQUIRED CIRCUIT COMPONENTS				
1	1	C1	CAP., 1 μ F, X8L, 25V, 10%,1206, AEC-Q200	MURATA, GCM31CL81H105KA55L
2	2	C10, C21	CAP., 2.2 μ F, X5R, 25V, 10%, 0603	MURATA, GRM188R61E225KA12D
3	1	C11	CAP., 82pF, C0G, 50V, 5%, 0603	AVX CORPORATION, 06035A820JAT2A
4	1	C12	CAP., 1 μ F, X7R, 25V, 10%, 0603,AEC-Q200	MURATA, GCM188R71E105KA64D
5	1	C13	CAP., 0.1 μ F, X7R, 50V, 10%, 0402	TDK, C1005X7R1H104K050BB
6	1	C14	CAP., 1 μ F, X7R, 50V, 10%, 0805	MURATA, GCM21BR71H105KA03L
7	4	C15, C16, C19, C20	CAP., 22 μ F, X7R, 25V, 10%, 1210	SAMSUNG, CL32B226KAJNNNE
8	1	C2	CAP., 2.2 μ F, X5R, 50V, 10%, 0603	MURATA, GRM188R61H225KE11J
9	2	C25, C26	CAP., 1 μ F, X7R, 50V, 10%, 0603,	TAIYO YUDEN, UMK107AB7105KA-T
10	1	C4	CAP., ALUM, 22 μ F, 63V, 20%, 6.3 x 7.7MM, AEC-Q200, 1.2 Ω ,120MA, 2000H	PANASONIC, EEEFN1J220XP
11	1	C5	CAP., 4.7 μ F, X7R, 50V,10%, 0805	MURATA, GRM21BZ71H475KE15L
12	1	C6	CAP., 4.7 μ F, X7R, 50V, 10%,1206	MURATA, GRM31CR71H475KA12L
13	2	C7, C9	CAP., 1 μ F, X5R, 50V, 10%, 0402	MURATA, GRM155R61H105KE05D
14	1	C8	CAP., 4700pF, X7R, 50V, 10%, 0603	YAGEO, CC0603KRX7R9BB472
15	1	FB1	IND., FERRITE BEAD, 800 Ω , 25% 100MHZ, 2.5A, 0.05 Ω DCR, 1206	MURATA, BLM31KN801SN1L
16	1	L1	IND., 2.2 μ H, PWR, SHIELDED, 20%, 5.5A, 38.7m Ω , 4.3mm x 4.3mm	COILCRAFT, XEL4020-222MEC
17	1	L2	IND., 4.7H, PWR, SHIELDED WIREWOUND, 20%,100KHZ, 2.9A, 0.076M Ω , 4.1 x 4.1MM, AEC-Q200	WÜRTH ELEKTRONIK, 74438356047
18	1	R1	RES., 1k Ω , 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ-3EKF1001V
19	1	R10	RES., 280K Ω , 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ-3EKF2803V
20	1	R11	RES., 49.9K Ω , 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ-3EKF4992V
21	2	R3, R12	RES., 100K Ω , 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ-3EKF1003V
22	4	R7, R14, R18, R22	RES., 0 Ω ,1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
23	1	R4	RES., 47.5K Ω , 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060347K5FKEA
24	1	R6	RES., 33.2K Ω , 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ-3EKF3322V

ITEM	QTY	DESIGNATOR	DESCRIPTION	MANUFACTURER PART NUMBER
25	1	R8	RES., 0.001Ω, 1%, 1W, 1206	BOURNS, CRK0612-FZ-R001E
26	1	U1	EVAL-LT83401-AZ: IC-ADI, 42V, 1A SYNC STEP-DOWN SILENT SWITCHER, LFCSP-15	ANALOG DEVICES, LT83401RUDB#PBF
			EVAL-LT83402-AZ: IC-ADI, 42V, 2.5A SYNC STEP-DOWN SILENT SWITCHER, LFCSP-15	ANALOG DEVICES, LT83402RUDB#PBF
OPTIONAL CIRCUIT COMPONENTS				
1	0	C18	CAP., OPTION, 0805	
2	0	C22-C24	CAP., OPTION, 0603	
3	0	L3	IND., OPTION, XGL4030-222MEC	
4	0	R2, R5, R9, R13, R15 to R17, R19	RES., OPTION, 0603	
HARDWARE – FOR EVALUATION CIRCUIT ONLY				
1	15	E1-E15	CONN., SOLDER TERMINAL TEST POINT TURRET 0.094" MTG. HOLE PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	J5, J6	CONN., COAX RCPT MALE 0HZ TO 6GHZ, 50Ω	SAMTEC, RSP-122811-01
3	1	JP1	CONN., 6POS MALE HDR UNSHROUDED DOUBLE ROW ST, 2.54MM PITCH, 5.84MM POST HEIGHT, 2.54MM SOLDER TAIL	SAMTEC, TSW-103-07-F-D
5	4	MH1-MH4	STANDOFF, BRD SPT SNAP FIT 12.7MM LENGTH	KEYSTONE, 8833
6	1	Socket	SOCKET, 2POS, 0.100 PITCH, CONN SHUNT	SAMTEC, SNT-100-BK-G

EVAL-LT83401-AZ EV Kit Schematic Diagram



EVAL-LT83402-AZ EV Kit Schematic Diagram



Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGE NUMBER
0	10/25	Initial release	—
1	02/26	Updated Figure 2	3

Notes

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