Evaluation Board User Guide

EVAL-LT8292-AZ

60V Dual-Phase Synchronous Buck-Boost Controller

General Description

Evaluation circuit EVAL-LT8292-AZ features the *LT®8292*: a parallelable 4-switch synchronous buck-boost controller. The LT8292 regulates the output voltage and output or input current from an input voltage below, equal to, or above the output voltage. With a wide 5.5V to 60V input range and a seamless transition between operating regions, the LT8292 is ideal for automotive, industrial, and telecom systems. The buck-boost peak current mode architecture allows adjustable phase-lockable 100kHz to 650kHz fixed frequency operation or internal spread spectrum operation for low Electromagnetic interference (EMI). Additionally, LT8292 features ISHARE and IGND pins, allowing for multi-IC leaderless current-sharing capabilities for higher-power applications.

The EVAL-LT8292-AZ operates from 9V to 36V input voltage range and generates an output of 12V. A maximum output current of 50A allows up to 600W power delivery while achieving efficiencies that exceed 97%. The board utilizes two LT8292s in parallel, both set to 100kHz, to achieve high power and efficiency.

The output voltage and EN/UVLO are both programmed by resistor dividers. The LT8292 supports an output voltage range from 1V to 60V with a 2% tolerance. EN/UVLO is set so the circuit will turn off when the input voltage falls below 8.1V and will turn on when the input voltage rises above 8.5V.

LT8292 utilizes split pull-up/pull-down gate drivers and four selectable dead time settings. EVAL-LT8292-AZ allows for simple alterations to optimize these features.

The PGOOD status flag indicates when the output voltage is within ±8% of the final regulation voltage.

The EVAL-LT8292-AZ features MOSFETs that complement the 5V gate drive of the LT8392 to achieve high efficiency. 40V MOSFETs are used on the input and output side of the four-switch topology. Ceramic capacitors are used at both the circuit input and output because of their small size and high ripple current capability. In addition to ceramic capacitors, there are bulk aluminum polymer capacitors on the input and output to make input and output stable during the transient period.

The ICTRL input is pulled up to the V_{REF} pin through a 100kΩ resistor to set the output current limit to its maximum, and an external voltage on the ICTRL pin can be used to lower the current limit. A capacitor at the SS pin programs soft-start.

High power operation, parallel capability, 5.5V input voltage operation, 4-switch buck-boost topology, proprietary peak current mode architecture, fault protection, and output current limiting make the LT8292 attractive for high power voltage regulator circuits.

The LT8292AFE is available in a thermally enhanced 38-lead TSSOP package. The LT8292 datasheet gives a complete description of this part, its operation, and applications information. The LT8292 data sheet must be read in conjunction with this user guide to properly use the evaluation circuit EVAL-LT8292-AZ. The evaluation circuit is designed to be easily reconfigured to suit other applications, including the example schematics in the datasheet. Consult the factory for assistance.

One Analog Way, Wilmington, MA 01887-2356, U.S.A. | Tel: 781.329.4700 |

Performance Summary (T_A = 25°C)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}			9		36	V
Output Voltage	V_{OUT}				12		V
Output Current	I_{OUT}	No Heatsink, No Airflow			50		A
Gate Driver Supply Voltage	$INTV_{CC}$				5.0		V
V_{IN} Undervoltage Lockout (UVLO) Falling	$V_{EN/UVLO(-)}$	R9, R40 = 499kΩ; R10, R42 = 80.6kΩ			8.1		V
V_{IN} Enable Turn-On (EN) Rising	$V_{EN/UVLO(+)}$	R9, R40 = 499kΩ; R10, R42 = 80.6kΩ			8.5		V
Switching Dead Time	t_{DELAY}	$R_{DT1,DT2}$ = 0Ω to $INTV_{CC}$			40		ns
Switching Frequency	f_{SW}	R_T = 523kΩ			100		kHz
Efficiency	η	I_{OUT} = 50A	V_{IN} = 9V		96.7		%
			V_{IN} = 12V		97.1		%
			V_{IN} = 36V		96.2		%

Quick Start Procedure

The EVAL-LT8292-AZ is easy to set up to evaluate the performance of the LT8292AFE. See Figure 1 for proper equipment setup and use the following procedure:

1. Set JP1 at ENABLE to sync channel 1 and channel 2 180° phasing.
2. Connect the EN/UVLO_1 and EN/UVLO_2 turrets to the ground with clip-on leads.
3. With the power supply off, connect the positive terminal of the power supply to V_{IN} and the negative terminal to GND.
4. Connect the load (<10A) between the OUT and GND terminals.
5. Set the power supply to 12V and turn it on.
   Note: Ensure that the voltage applied to V_{IN} does not exceed 40V, which is the voltage rating for input side MOSFETs.
6. Remove the clip-on leads from EN/UVLO_1 and EN/UVLO_2. Verify that the output voltage is 12V.
   Note: If the output voltage is low, temporarily disconnect the load to ensure that it is not set too high.
7. Once the proper output voltage is established, adjust the input voltage and load within the operating ranges 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 minimize the length of the oscilloscope probe ground lead. Measure the input or output voltage ripple by connecting the probe tip directly across the V_{IN} or V_{OUT} and GND terminals, preferably across the input or output capacitors.

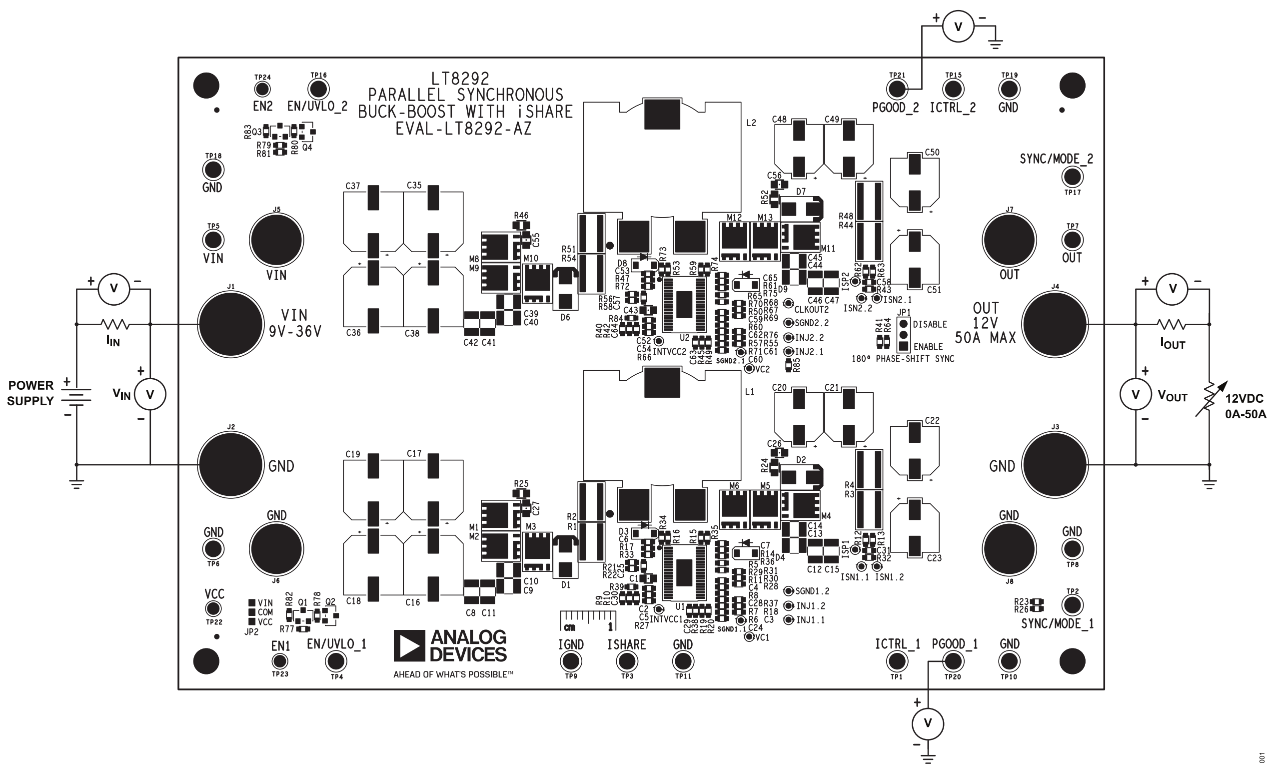

Figure 1. EVAL-LT8292-AZ Board Connections

Adjust Output Voltage

To change the output voltage from the programmed 12V, change R7, R8, R57, and R60. Refer to the *Programming Output Voltage and Thresholds* section in the datasheet to calculate the V_{FB} resistor divider values for the desired output voltage. All the corresponding components must also be adjusted to handle the desired output voltage.

Thermal Performance

The EVAL-LT8292-AZ features excellent thermal performance across its entire input voltage range due to the high efficiency of the synchronous buck-boost circuit operation. The component temperatures of EVAL-LT8292-AZ with a typical 12V output and 50A load are shown in *Figure 6*–*Figure 8*. The six-layer Printed circuit board (PCB) layout features solid copper planes that help spread the heat across the entire board.

Parallel Multiple ICs

The LT8292 is designed to easily be paralleled for even higher output power. This can be achieved by tying all ISHARE pins together and kelvin connecting all IGND pins to a common GND.

The CLKOUT pin of LT8292 IC provides a 180° out-of-phase clock signal fixed at 50% duty cycle. For an interleaved dual-phase operation, the CLKOUT pin of the first phase can be connected to the SYNC/MODE pin of the second IC. In this configuration, it is recommended the first phase be set to fixed-frequency forced continuous mode (FCM) by floating the SYNC/MODE pin.

JP1 on EVAL-LT8292-AZ can be set to either ENABLE or DISABLE. Setting to ENABLE will sync both channels to 180° phasing utilizing the CLKOUT pin. Setting to DISABLE allows the two channels to run independently or be synced with an external clock signal.

Start-Up and Shutdown with a Microcontroller

The circuit enable, and undervoltage lockout is set with a resistor divider to the EN/UVLO pin. The EVAL-LT8292-AZ also has optional circuitry that can be populated to enable and disable the channels via a microcontroller. The circuitry ensures proper start-up and shutdown when using a microcontroller. To utilize, populate Q1-Q4, R77, R79, R81, R82 and R83. Also, add a 0Ω jumper from COM to the desired supply voltage of V_{IN} or V_{CC}. The microcontroller signal can be applied to EN1.

Select Mode of Operation

LT8292 uses a SYNC/MODE pin to select different modes of operation.

1) External Clock: For external frequency synchronization and FCM.
2) $INTV_{CC}$: For spread spectrum around internal oscillator frequency and FCM.
3) Float: For internal oscillator frequency and FCM at light load.
4) 100kΩ to GND: For internal oscillator frequency and pulse-skipping mode at light load.
5) GND: For internal oscillator frequency and low ripple Burst® mode at light load.

EVAL-LT8292-AZ allows for easy modification of each channel to select the desired mode of operation.

Select Dead Times

LT8292 has four selectable dead time settings for the boost side switching and the buck side switching. A single resistor is used for each pin, R_{DT1}, and R_{DT2}, to set the dead times.

1) 0Ω to $INTV_{CC}$: 40ns
2) 130kΩ to GND: 20ns
3) 82kΩ to GND: 10ns
4) 51kΩ to GND: 2ns

Performance

(V_{IN} = 12V, T_A = 25°C, unless otherwise noted.)

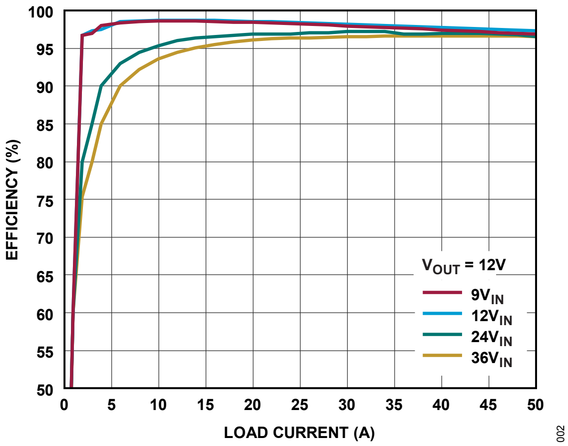

Figure 2. Efficiency vs. Load Current (No Heatsink)

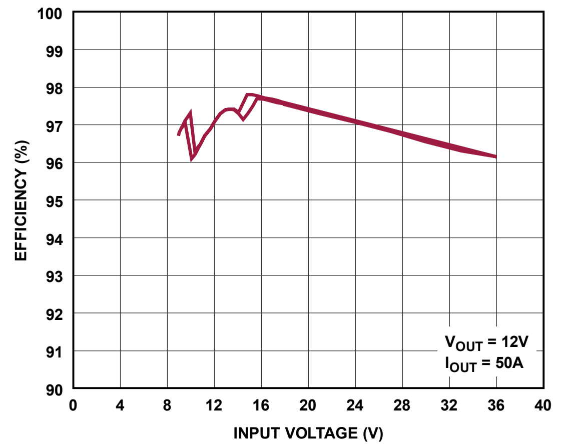

Figure 3. Efficiency vs. Input Voltage at I_{OUT} = 50A (No Heatsink)

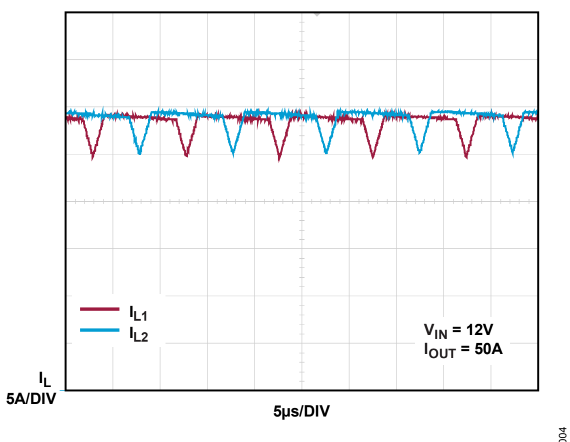

Figure 4. Inductor Current with 180° phasing at V_{IN} =12V, I_{OUT} = 50A

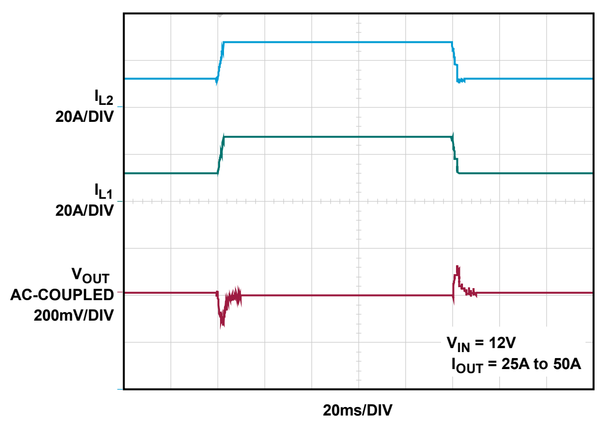

Figure 5. Load Transient Response at V_{IN} = 12V, 25A to 50A

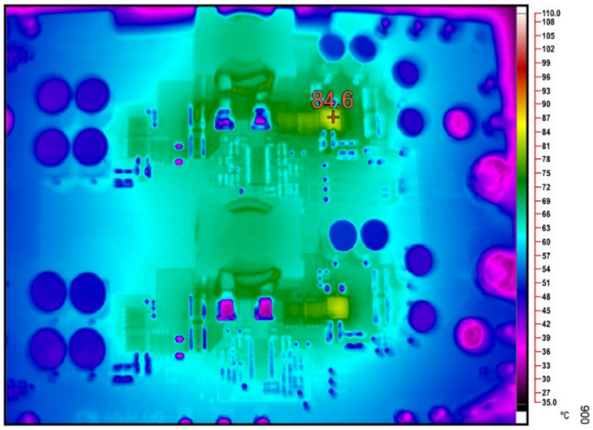

Figure 6. Thermal Image at V_{IN} = 9V, V_{OUT} = 12V, I_{OUT} = 50A

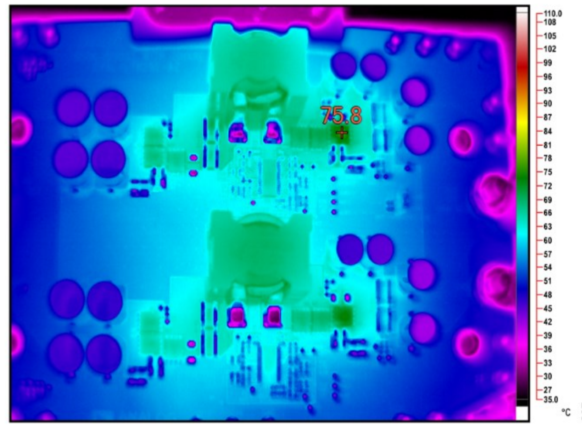

Figure 7. Thermal Image at V_{IN} = 12V, V_{OUT} = 12V, I_{OUT} = 50A

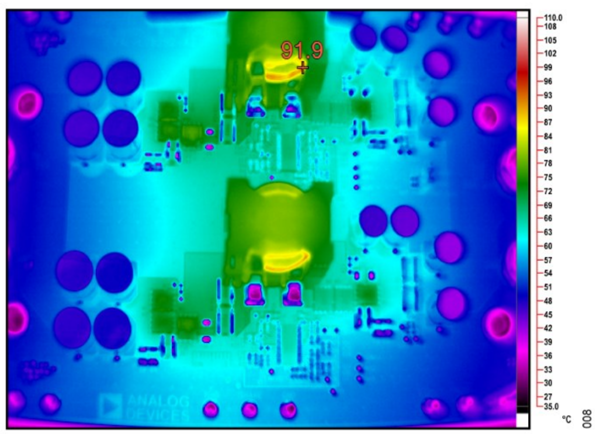

Figure 8. Thermal Image at V_{IN} = 36V, V_{OUT} = 12V, I_{OUT} = 50A

Bill of Materials

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
REQUIRED CIRCUIT COMPONENTS				
1	2	C1, C43	CAP CER 1µF 50V 10% X7R 0805 AEC-Q200	MURATA, GCM21BR71H105KA03L
2	8	C8, C9, C10, C11, C39, C40, C41, C42	CAP CER 10µF 50V 10% X7R 1210	MURATA, GRM32ER71H106KA12L
3	8	C12, C13, C14, C15, C44, C45, C46, C47	CAP CER 47µF 16V 20% X5R 1210	AVX CORPORATION, 1210YD476MAT2A
4	8	C16, C17, C18, C19, C35, C36, C37, C38	CAP ALUM POLY 180UF 50V 20% 10X12.7MM AEC-Q200 0.038Ω 3.5A 4000H	NICHICON CORPORATION, PCR1H181MCL1GS
5	2	C2, C52	CAP CER 4.7µF 10V 10% X5R 0603 AEC-Q200	TAIYO YUDEN, LMK107BJ475KAHT
6	8	C20, C21, C22, C23, C48, C49, C50, C51	CAP ALUM POLY 560UF 16V 20% 8X10MM 0.014Ω 4.95A 5000H	PANASONIC, 16SVPF560M
7	2	C3, C61	CAP CER 0.068UF 25V 10% X7R 0603	KYOCERA, KGM15BR71E683KT
8	2	C30, C64	CAP CER 2200pF 50V 10% X7R 0603	SAMSUNG, CL10B222KB8NNNC
9	2	C31, C58	CAP CER 10µF 25V 20% X5R 0603	MURATA, GRM188R61E106MA73D
10	6	C4, C6, C7, C53, C59, C65	CAP CER 0.1µF 25V 10% X7R 0603	KEMET, C0603C104K3RACTU
11	2	C5, C54	CAP CER 1µF 25V 10% X7R 0603 AEC-Q200	MURATA, GCM188R71E105KA64D
12	2	L1, L2	IND POWER CHOKE SHIELDED WIREWOUND 3.3UH 20% 100KHZ 47.5A 0.00088Ω, AEC-Q200	WÜRTH ELEKTRONIK, 7443640330B
13	12	M1, M2, M3, M4, M5, M6, M8, M9, M10, M11, M12, M13	TRAN N-CH POWER MOSFET 100A	INFINEON TECHNOLOGIES, BSC014N04LSI
14	6	R1, R2, R4, R48, R51, R54	RES SMD 0.002Ω 2% 3W 2512 AEC-Q200 LONG SIDE TERM	SUSUMU CO, LTD, KRL6432E-M-R002-G-T1
15	2	R10, R42	RES SMD 80.6KΩ 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW060380K6FKEA
16	4	R11, R19, R45, R50	RES SMD 100KΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1003V
17	4	R12, R13, R62, R63	RES SMD 49.9Ω 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF49R9V
18	8	R14, R16, R34, R36, R53, R61, R73, R75	RES SMD 3.9Ω 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW06033R90FKEA
19	4	R15, R17, R47, R59	RES SMD 3Ω 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW06033R00FKEA
20	2	R3, R44	RES SMD 0.003Ω 1% 3W 2512 AEC-Q200	SUSUMU CO, LTD, KRL6432E-M-R003-F-T1
21	4	R33, R35, R72, R74	RES SMD 1.2Ω 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW06031R20FKEA
22	2	R39, R84	RES SMD 4.99KΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF4991V
23	2	R9, R40	RES SMD 499KΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF4993V
24	2	R5, R65	RES SMD 523KΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ3EKF5233V
25	2	R7, R57	RES SMD 110KΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1103V
26	2	R6, R71	RES SMD 15KΩ 1% 1/10W 0603	YAGEO, RC0603FR-0715KL
27	2	R8, R60	RES SMD 10KΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1002V
28	2	U1, U2	PRELIM, IC-ADI 60V LOW I_Q FULL-FEATURED SYNCHRONOUS BUCK-BOOST CONTROLLER	ANALOG DEVICES, LT8292AFE#PBF

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
OPTIONAL CIRCUIT COMPONENTS				
1	0	C24, C28, C29, C60, C62, C63	DO NOT INSTALL (TBD_C0603) PLEASE USE SYM_3 AND/OR SYM_4	
2	0	C25, C57	DO NOT INSTALL (TBD_C0603) PLEASE USE SYM_3 AND/OR SYM_4	
3	0	C26, C27, C55, C56	DO NOT INSTALL (TBD_C0805) PLEASE USE SYM_3 AND/OR SYM_4	
4	0	D1, D2, D6, D7	DIODE SCHOTTKY POWER RECTIFIER SMD	ON SEMICONDUCTOR, MBRS2040LT3G
5	0	D3, D4, D8, D9	DIODE SCHOTTKY POWER RECTIFIER SMD	ON SEMICONDUCTOR, MBR130T3G
6	0	Q1, Q2, Q3, Q4	TRANS N-CHA ENHANCE MODE MOSFET	DIODES INCORPORATED, 2N7002-7-F
7	0	R20, R23, R26, R28, R29, R32, R37, R38, R41, R43, R49, R64, R66, R69, R70, R76, R77, R78, R79, R80, R81, R82, R83, R85	DO NOT INSTALL (TBD_R0603), PLEASE USE SYM_3 AND/OR SYM_4	
8	0	R24, R25, R46, R52	DO NOT INSTALL (TBD_R0805), PLEASE USE SYM_3 AND/OR SYM_4	
9	11	R18, R21, R22, R27, R30, R31, R55, R56, R58, R67, R68	RES SMD 0Ω JUMPER 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3GEY0R00V
HARDWARE – FOR EVALUATION CIRCUIT ONLY				
1	1		SHUNT, 2POS, 2MM PITCH, BLACK	SAMTEC INC., 2SN-BK-G
2	4		STANDOFF, BRD SPT SNAP FIT 15.9MM LENGTH	KEYSTONE, 8834
3	4		CONNECTOR RING LUG TERMINAL, 10 CRIMP, NON-INSULATED	KEYSTONE, 8205
4	4		WASHER, #10 FLAT STEEL	KEYSTONE, 4703
5	8		NUT, HEX STEEL, 10-32 THREAD, 9.27MM OUT DIA	KEYSTONE, 4705
6	4	J1, J2, J3, J4	CONN-PCB THREADED BROACHING STUD 10-32 FASTENER 0.625, USE ALT_SYMBOL FOR C450D200 PAD	CAPTIVE FASTENER, CKFH1032-10
7	4	J5, J6, J7, J8	CONN-PCB, BANANA JACK, FEMALE, NON-INSULATED, THT, SWAGE, 0.218 INCHES LENGTH	KEYSTONE ELECTRONICS, 575-4
8	1	JP1	CONN-PCB 3POS MALE HDR UNSHROUDED SINGLE ROW, 2MM PITCH, 3MM SOLDER TAIL	SAMTEC INC., TMM-103-02-L-S
9	18	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP15, TP16, TP17, TP18, TP19, TP20, TP21	CONN-PCB SOLDER TERMINAL TEST POINT TURRET 0.094" MTG. HOLE PCB 0.062 INCH THK	MILL-MAX, 2501-2-00-80-00-00-07-0
10	3	TP22, TP23, TP24	CONN-PCB SOLDER TERMINAL TURRETS FOR CLIP LEADS	MILL-MAX, 2308-2-00-80-00-00-07-0

Schematic

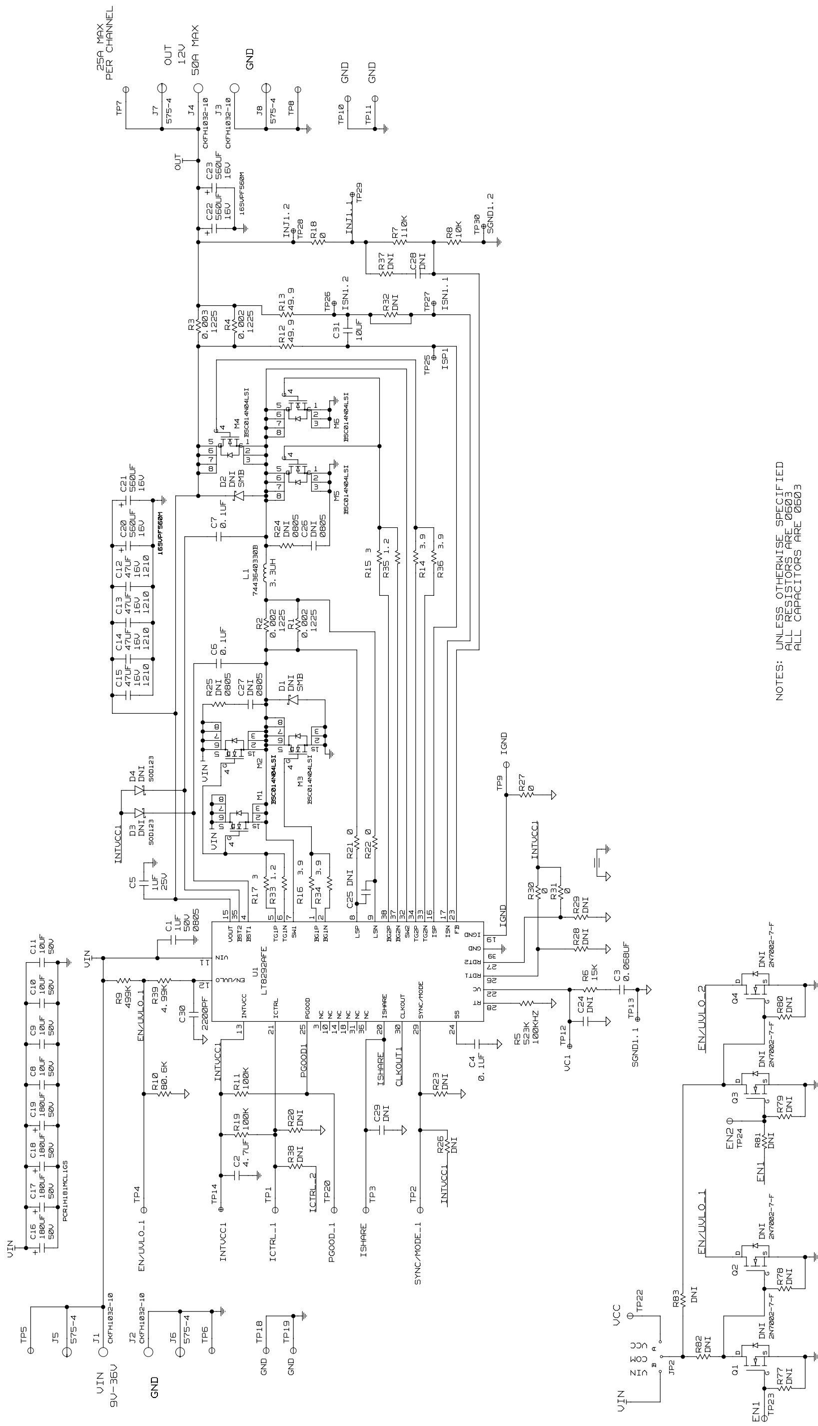

Figure 9. EVAL-LT8292-AZ Schematic (1 of 2)

Schematic (continued)

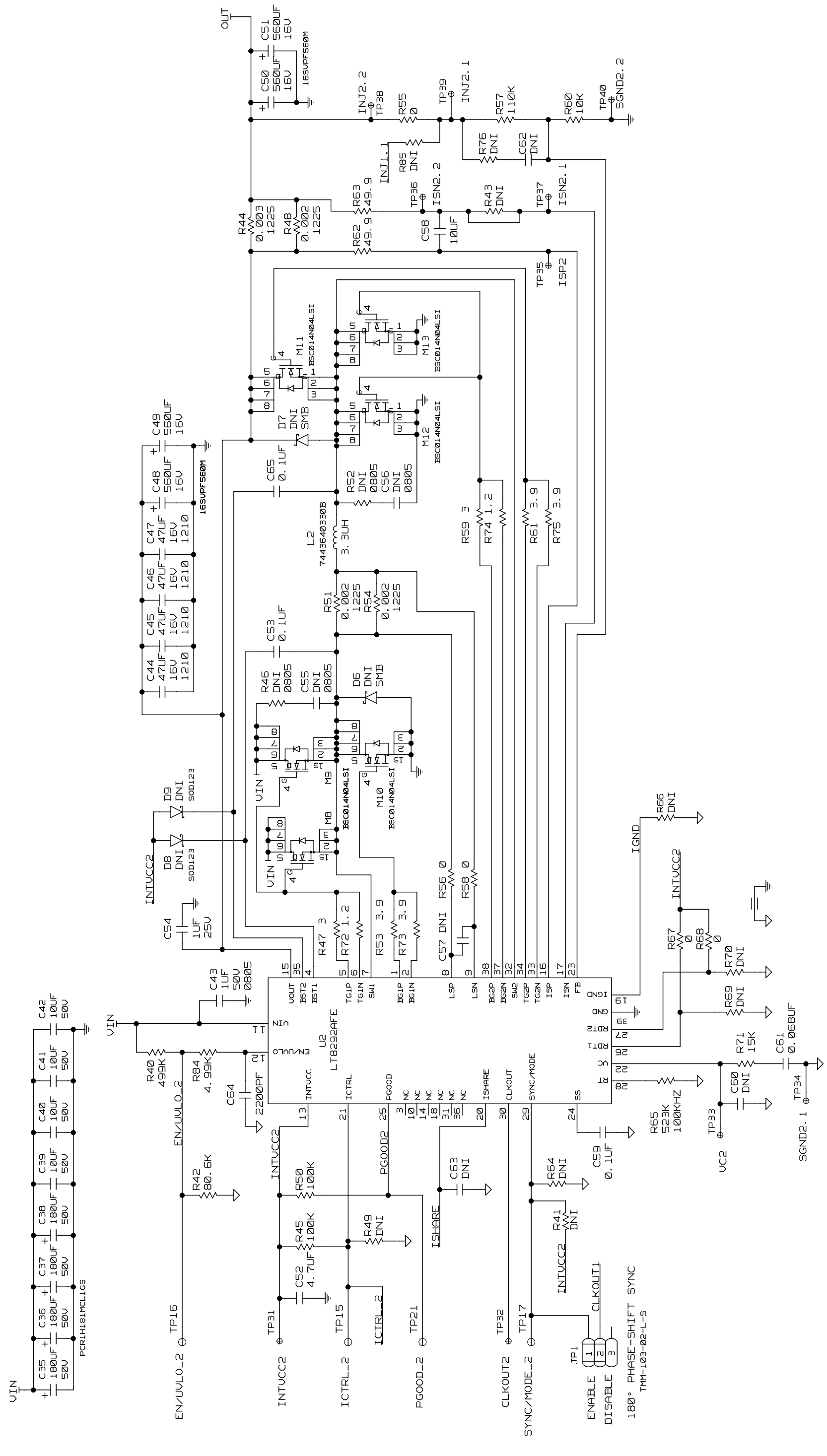

Figure 10. EVAL-LT8292-AZ Schematic (2 of 2)

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/24	Initial Release	—

Notes