Evaluation Board User Guide

EVAL-LT8292-GZ

Parallel Synchronous Buck-Boost with iSHARE Featuring GaN FETs

General Description

The evaluation circuit EVAL-LT8292-GZ 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, the LT8292 features ISHARE and IGND pins, allowing for multi-IC leaderless current-sharing capabilities for higher-power applications.

The EVAL-LT8292-GZ operates from a 36V to 60V input voltage range and generates an output of 48V. A maximum output current of 30A+ allows up to 1400W+ power delivery while achieving efficiencies that exceed 98%. The board utilizes two LT8292s in parallel, both set to 400kHz, 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 ~32.7V and will turn on when the input voltage rises above ~34.1V.

The LT8292 utilizes split pull-up/pull-down gate drivers and four selectable dead time settings. The EVAL-LT8292-GZ 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-GZ features GaN FETs that complement the 5V gate drive of the LT8292 to achieve high efficiency. 100V GaN FETs are used on the input and output sides 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} ($INTV_{CC}$) 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 data sheet 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-GZ. The evaluation circuit is designed to be easily reconfigured to suit other applications, including the example schematics in the data sheet. 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}			36		60	V
Output Voltage	V_{OUT}				48		V
Output Current	I_{OUT}	No Heatsink, No Airflow			30		A
Gate Driver Supply Voltage	$INTV_{CC}$				5.0		V
V_{IN} Undervoltage Lockout (UVLO) Falling	$V_{EN/UVLO(-)}$	R10, R51 = 499kΩ; R5, R46 = 18.7kΩ			32.7		V
V_{IN} Enable Turn-On (EN) Rising	$V_{EN/UVLO(+)}$	R10, R51 = 499kΩ; R5, R46 = 18.7kΩ			34.3		V
Switching Dead Time	t_{DELAY}	R_{DT1}, R_{DT2} = 82kΩ to GND			10		ns
Switching Frequency	f_{SW}	R_T = 127kΩ			400		kHz
Efficiency	η	I_{OUT} = 30A	V_{IN} = 36V		98.3		%
			V_{IN} = 48V		98.2		%
			V_{IN} = 60V		98.1		%

Quick Start Procedure

The EVAL-LT8292-GZ 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 to 180° phase-shift sync.
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 (<1A) between the V_{OUT} and GND terminals.
5. Set the input power supply to between 36V and 60V and turn it on.
   Note: Ensure that the voltage applied to V_{IN} does not exceed 60V.
6. Remove the clip-on leads from EN/UVLO_1 and EN/UVLO_2. Verify that the output voltage is 48V on the DMM connected to V_{OUT}.
   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, slowly 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.
8. The evaluation board is designed to deliver 48V output at a load current of up to 30A without a heatsink or airflow across the V_{IN} range of 36V to 60V.

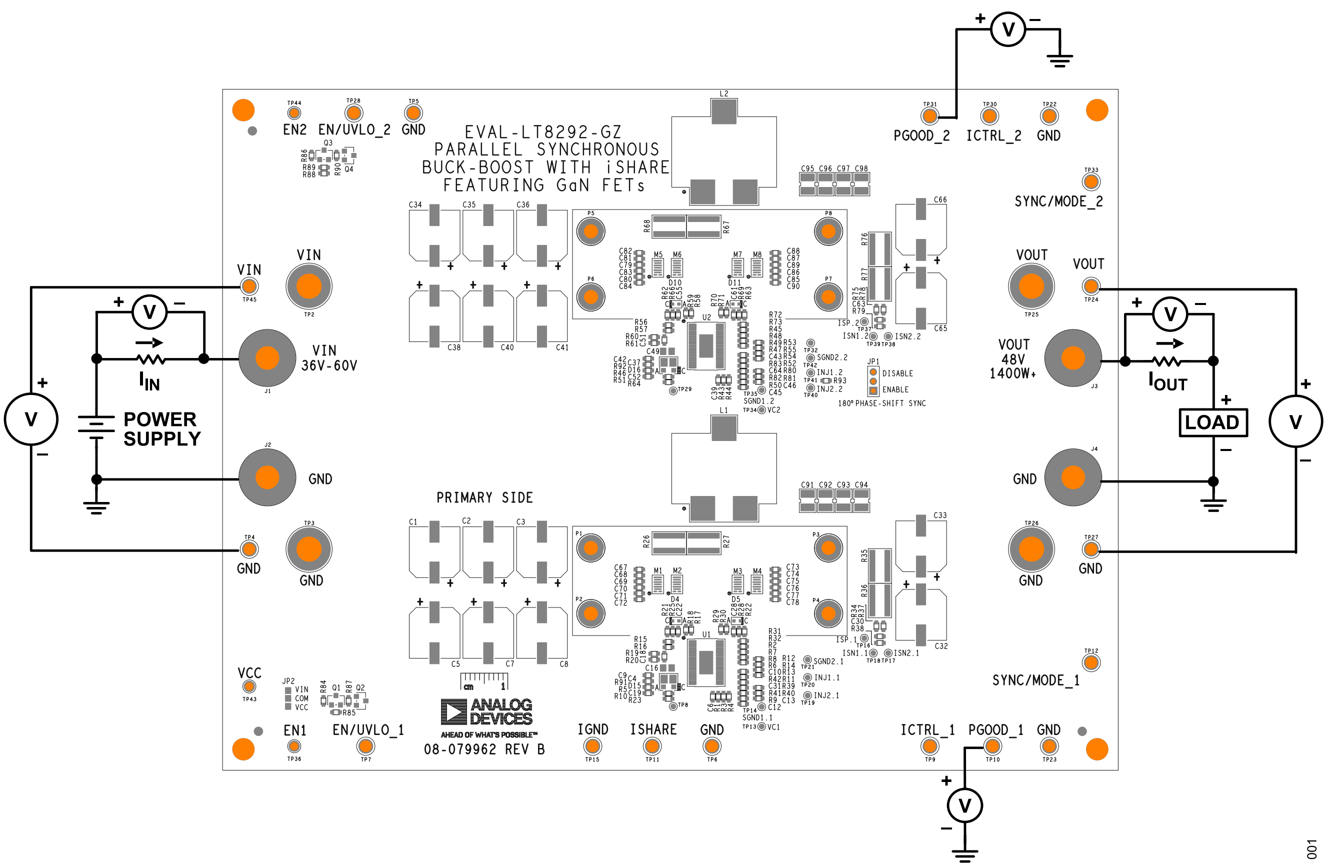

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Figure 1. EVAL-LT8292-AZ Board Connections

Adjusting the Output Voltage

To change the output voltage from the programmed 48V, change R41, R42, R82, and R83. Refer to the Programming Output Voltage and Thresholds section in the data sheet 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-GZ 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-GZ with a typical 48V output and 30A load are shown in *Figure 7*–*Figure 9*. The six-layer printed circuit board (PCB) layout features solid copper planes that help spread the heat across the entire board. Optional heat sinks (listed on the schematic) can be used to reduce thermal load and extend operation with airflow. Use caution when tightening screws.

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 the LT8292 IC provides a 180° out-of-phase clock signal fixed at a 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-GZ can be set to either ENABLE or DISABLE. Setting to ENABLE will sync both channels to 180° phasing using the CLKOUT pin. Setting to DISABLE allows the two channels to run independently or be synced with an external clock signal.

Startup and Shutdown with a Microcontroller

The circuit enable and undervoltage lockout are set with a resistor divider to the EN/UVLO pin. The EVAL-LT8292-GZ also has optional circuitry that can be populated to enable and disable the channels via a microcontroller. The circuitry ensures proper startup and shutdown when using a microcontroller. To utilize, populate Q1-Q4, R84, R85, R86, R88, and R89. 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.
6. EVAL-LT8292-GZ allows for easy modification of each channel to select the desired mode of operation.

Select Dead Times

The 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

*Important Note

Short circuiting at high voltages close to the voltage limit of the IC may result in permanent damage to the LT8292 IC. If there is any requirement for fault tests, external protection circuitry may be required. Contact the Applications Team for further information.

Performance

(V_{IN} = 48V, T_A = 25°C, unless otherwise noted.)

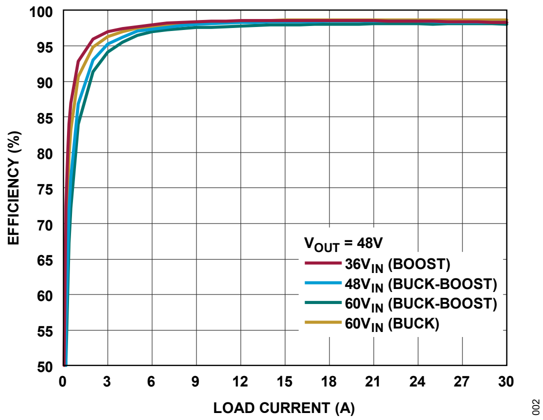

Figure 2. Efficiency vs. Load Current (No Heatsink or airflow)

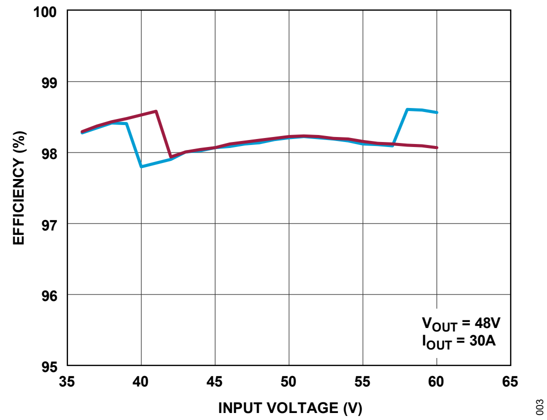

Figure 3. Efficiency vs. Input Voltage at I_{OUT} = 30A (No Heatsink or airflow)

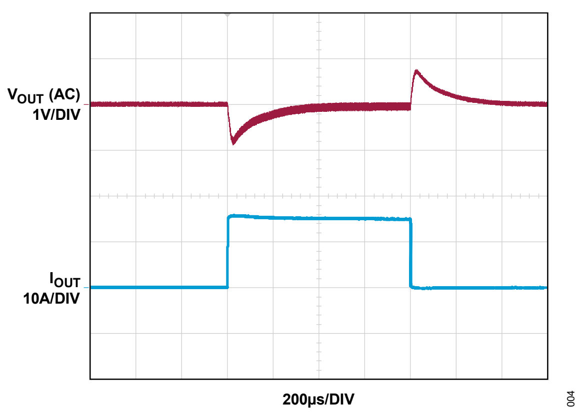

Figure 4. Load Transient Response at V_{IN} = 36V, 15A to 30A

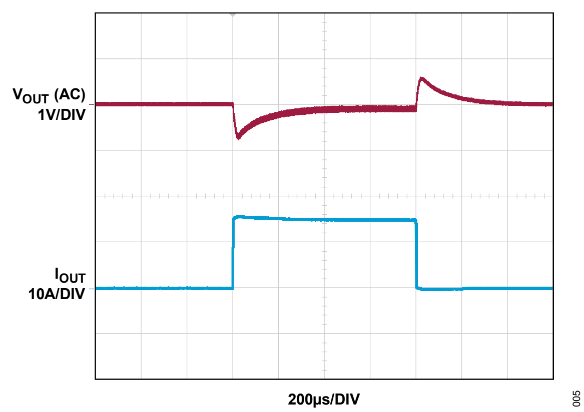

Figure 5. Load Transient Response at V_{IN} = 48V, 15A to 30A

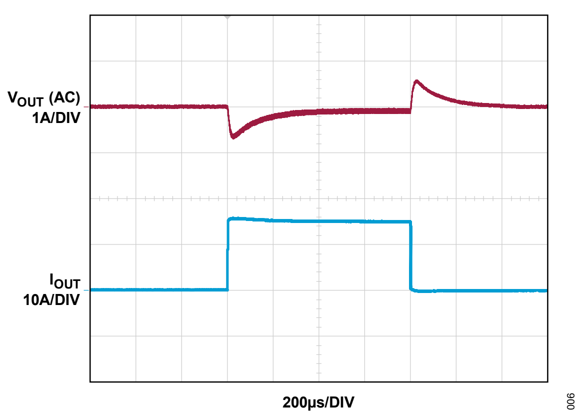

Figure 6. Load Transient Response at V_{IN} = 60V, 15A to 30A

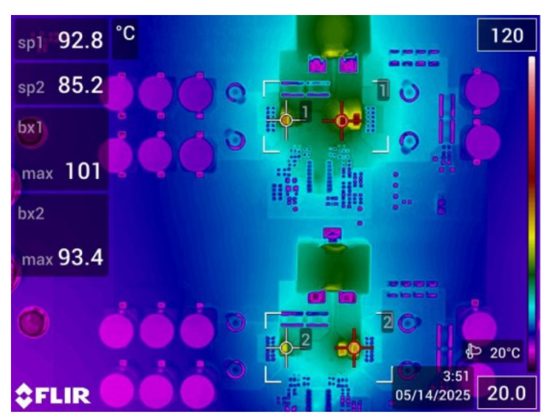

Figure 7. Thermal Image at V_{IN} = 36V, V_{OUT} = 48V, I_{OUT} = 30A

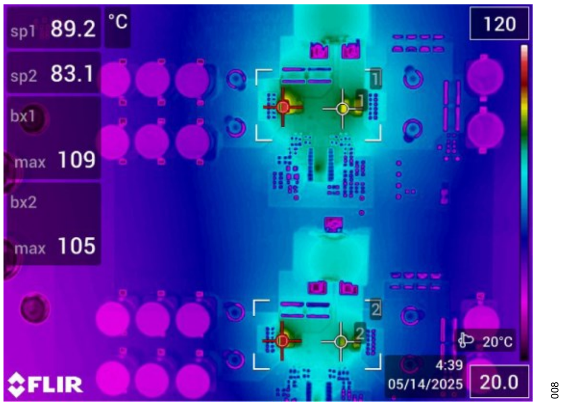

Figure 8. Thermal Image at V_{IN} = 48V, V_{OUT} = 48V, I_{OUT} = 30A

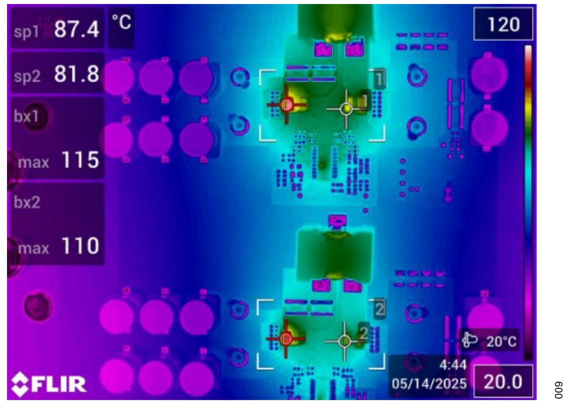

Figure 9. Thermal Image at V_{IN} = 60V, V_{OUT} = 48V, I_{OUT} = 30A

Bill of Materials

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
REQUIRED CIRCUIT COMPONENTS				
1	16	C1, C2, C3, C5, C7, C8, C32, C33, C34, C35, C36, C38, C40, C41, C65, C66	Aluminum polymer capacitors, 68µF, 80V, 20%, 10 x 12.7mm, AEC-Q200, 0.056Ω, 2100mA, 4000h	Nichicon Corporation, PCR1K680MCL1GS
2	6	C10, C22, C28, C43, C55, C61	Ceramic capacitors, 0.1µF, 25V, 10%, X7R 0603	Kemet, C0603C104K3RACTU
3	8	C11, C14, C15, C17, C44, C47, C48, C50	Ceramic capacitors, 4.7µF, 100V, 10%, X7S 1210, AEC-Q200	Murata, GCM32DC72A475KE02L
4	2	C13, C46	Ceramic capacitors, 6800pF, 50V, 5%, X7R 0603, AEC-Q200	Kyocera, KAM15AR71H682JT
5	2	C16, C49	Ceramic capacitors, 1µF, 100V, 10%, X7S 0805	TDK, C2012X7S2A105K125AB
6	2	C18, C51	Ceramic capacitors, 1000pF, 50V, 5%, C0G 0603	Murata, GRM1885C1H102JA01D
7	14	C19, C52, C73, C74, C75, C76, C77, C78, C85, C86, C87, C88, C89, C90	Ceramic capacitors, 1µF, 100V, 10%, X7T 0603	Murata, GRM188D72A105KE01D
8	16	C21, C23, C24, C25, C54, C56, C57, C58, C91, C92, C93, C94, C95, C96, C97, C98	Ceramic capacitors, 10µF, 100V, 10%, X7R 1210	TDK, C3225X7R2A106K250AC
9	2	C30, C63	Ceramic capacitors, 10µF, 25V, 20%, X5R 0603	Murata, GRM188R61E106MA73D
10	2	C4, C37	Ceramic capacitors, 10µF, 16V, 10%, X5R 0805	Murata, GRM21BR61C106KE15L
11	2	C9, C42	Ceramic capacitors, 2200pF, 50V, 10%, X7R 0603	Samsung, CL10B222KB8NNNC
12	12	C67, C68, C69, C70, C71, C72, C79, C80, C81, C82, C83, C84	Ceramic capacitors, 0.22µF, 100V, 10%, X7S 0603, AEC-Q200	Taiyo Yuden, MCASH168SC7224KTCA1J
13	4	D1, D2, D7, D8	Diode schottky single barrier	NXP Semiconductors, BAT46WJ,115
14	4	D4, D5, D10, D11	Diode zener, 5.1V, 0.5W, 2%, 60Ω, SOD523	Onsemi, MM5Z5V1ST1G
15	4	D3, D6, D9, D12	Diode schottky, 100V, 3A, powerDI5, automotive	Diodes Incorporated, PDS3100-13
16	2	D13, D14	Diode schottky, barrier rectifier, 2A	Diodes Incorporated, DFLS260-7
17	2	D15, D16	Diode zener, 5.42V, 2.49%	Vishay, PLZ5V6A-G3/H
18	4	J1, J2, J3, J4	Connectors PCB, threaded broaching stud, 625mil length	Penn Engineering, KFH-032-10ET
19	8	J5, J6, J7, J8, J9, J10, J11, J12	Connectors PCB, MMCX jack, straight, 50Ω, 0GHz to 6GHz	Molex, 0734152063
20	1	JP1	Connector PCB 3 positions, male header unshrouded single row, 2mm pitch, 3mm solder tail	Samtec Inc., TMM-103-02-L-S

Bill of Materials (continued)

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
21	2	L1, L2	Inductor power choke shielded, wirewound, 3.1µH, 15%, 100kHz, 26A, 0.00023Ω, AEC-Q200	Wurth Elektronik, 7443630310
22	8	M1, M2, M3, M4, M5, M6, M7, M8	Tran N-channel, egan enhancement mode power, 100V, 60A	Efficient power conversion corporation, EPC2088
23	8	P1, P2, P3, P4, P5, P6, P7, P8	PCB connectors, 1 position, steel spacer with M2 x 0.4, threaded	Wurth elektronik, 9774010243R
24	2	R10, R51	Resistors, surface-mount device (SMD), 499kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF4993V
25	4	R11, R12, R52, R53	Resistors, SMD, 82kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF8202V
26	8	R15, R18, R29, R32, R56, R59, R70, R73	Resistors, SMD, 2Ω, 5%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3GEYJ2R0V
27	8	R16, R17, R30, R31, R57, R58, R71, R72	Resistors, SMD, 1Ω, 5%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3GEYJ1R0V
28	4	R19, R20, R60, R61	Resistors, SMD, 80.6Ω, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF80R6V
29	7	R21, R22, R23, R40, R62, R63, R81	Resistors, SMD, 0Ω, jumper, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3GEY0R00V
30	4	R25, R28, R66, R69	Resistors, SMD, 20Ω, 1%, 1/10W, 0603, AEC-Q200	Vishay, CRCW060320R0FKEA
31	4	R26, R27, R67, R68	Resistors, SMD, 0.003Ω, 1%, 3W, 2512, AEC-Q200	Susumu Co., Ltd. KRL6432E-M-R003-F-T1
32	4	R3, R6, R43, R47	Resistors, SMD, 100kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF1003V
33	4	R34, R37, R75, R78	Resistors, SMD, 49.9Ω, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF49R9V
34	4	R35, R36, R76, R77	Resistors, SMD, 0.004Ω, 1%, 3W, 2512, AEC-Q200, long-side term metal sense	Susumu Co., Ltd. KRL6432E-M-R004-F-T1
35	2	R41, R82	Resistors, SMD, 475kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF4753V
36	2	R42, R83	Resistors, SMD, 10kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF1002V
37	4	R5, R9, R46, R50	Resistors, SMD, 18.7kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF1872V
38	2	R8, R49	Resistors, SMD, 127kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF1273V
39	2	R91, R92	Resistors, SMD, 4.99kΩ, 1%, 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF4991V
40	18	TP4, TP5, TP6, TP7, TP9, TP10, TP11, TP12, TP15, TP22, TP23, TP24, TP27, TP28, TP30, TP31, TP33, TP45	Connector PCB solder terminal test point turret, 0.094" mounting hole, PCB 0.062" thick	Mill-Max, 2501-2-00-80-00-00-07-0

Bill of Materials (continued)

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
41	4	TP2, TP3, TP25, TP26	Connector PCB, banana jack, female, non-insulated, through hole technology, swage, 0.218” length	Keystone Electronics, 575-4
42	3	TP36, TP43, TP44	Connector PCB, solder terminal turrets for clip leads	Mill-Max, 2308-2-00-44-00-00-07-0
43	2	U1, U2	IC-ADI, 60V, low I_Q full-featured synchronous buck-boost controller	Analog Devices, Inc., LT8292AFE#PBF
OPTIONAL CIRCUIT COMPONENTS				
1	6	C6, C12, C31, C39, C45, C64	Do not install (DNI) (DNI_C0603), use SYM_3 and/or SYM_4	DNI0603
2	4	C20, C27, C53, C60	Do not install (DNI_C0805), use SYM_3 and/or SYM_4	DNI0805
3	4	Q1, Q2, Q3, Q4	Trans N-channel enhance mode MOSFET	Diodes Incorporated, D, BSS123-7-F
4	20	R1, R2, R4, R7, R38, R39, R44, R45, R48, R64, R79, R80, R84, R85, R86, R87, R88, R89, R90, R93	Do not install (DNI_R0603), use SYM_3 and/or SYM_4	DNI0603
5	4	R13, R14, R54, R55	Resistors, SMD, 0Ω, jumper 1/10W, 0603, AEC-Q200	Panasonic, ERJ-3GEY0R00V
6	4	R24, R33, R65, R74	Do not install (DNI_R0805), use SYM_3 and/or SYM_4	DNI0805
HARDWARE–FOR EVALUATION CIRCUIT ONLY				
1	1	-	Shunt, 2 positions, 2mm pitch, black	Samtec Inc., 2SN-BK-G
2	4	-	Standoff board support snap fit, 15.9mm length	Keystone, 8834
3	4	-	Connector ring lug terminal, 10 crimp, non-insulated	Keystone, 8205
4	4	-	Washer, external tooth lock, #10, 0.19 x 0.41 x 0.03	McMaster-carr, 98438A230
5	8	-	Nut, brass, narrow hex, 10-32 thread, 5/16 in width	McMaster-carr, 95130A160
6	8	-	Hex nut, brass, 10-32 thread	McMaster-carr, 92671A195

Schematics

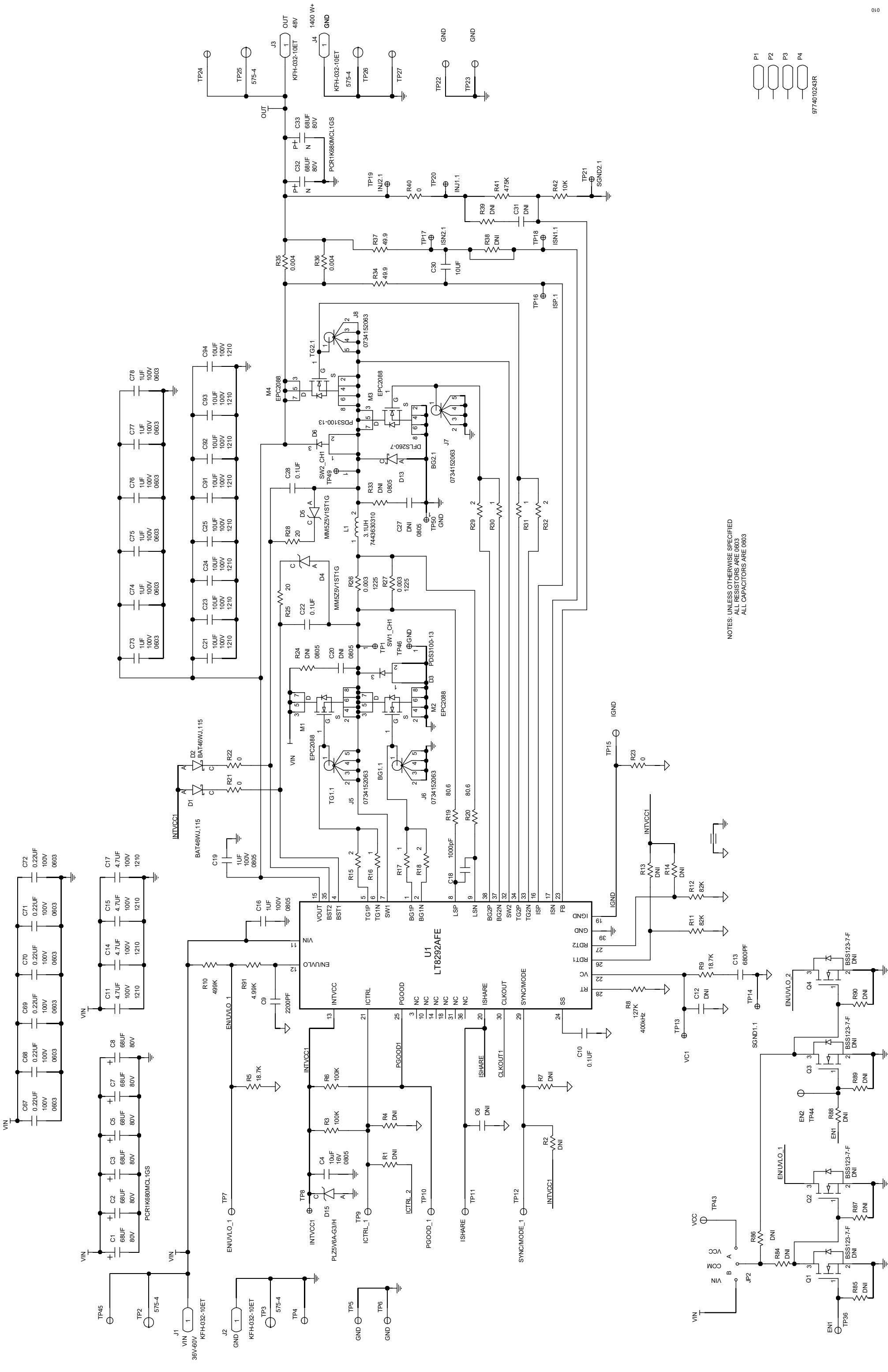

Figure 10. EVAL-LT8292-GZ Schematic (1 of 2)

Schematics (continued)

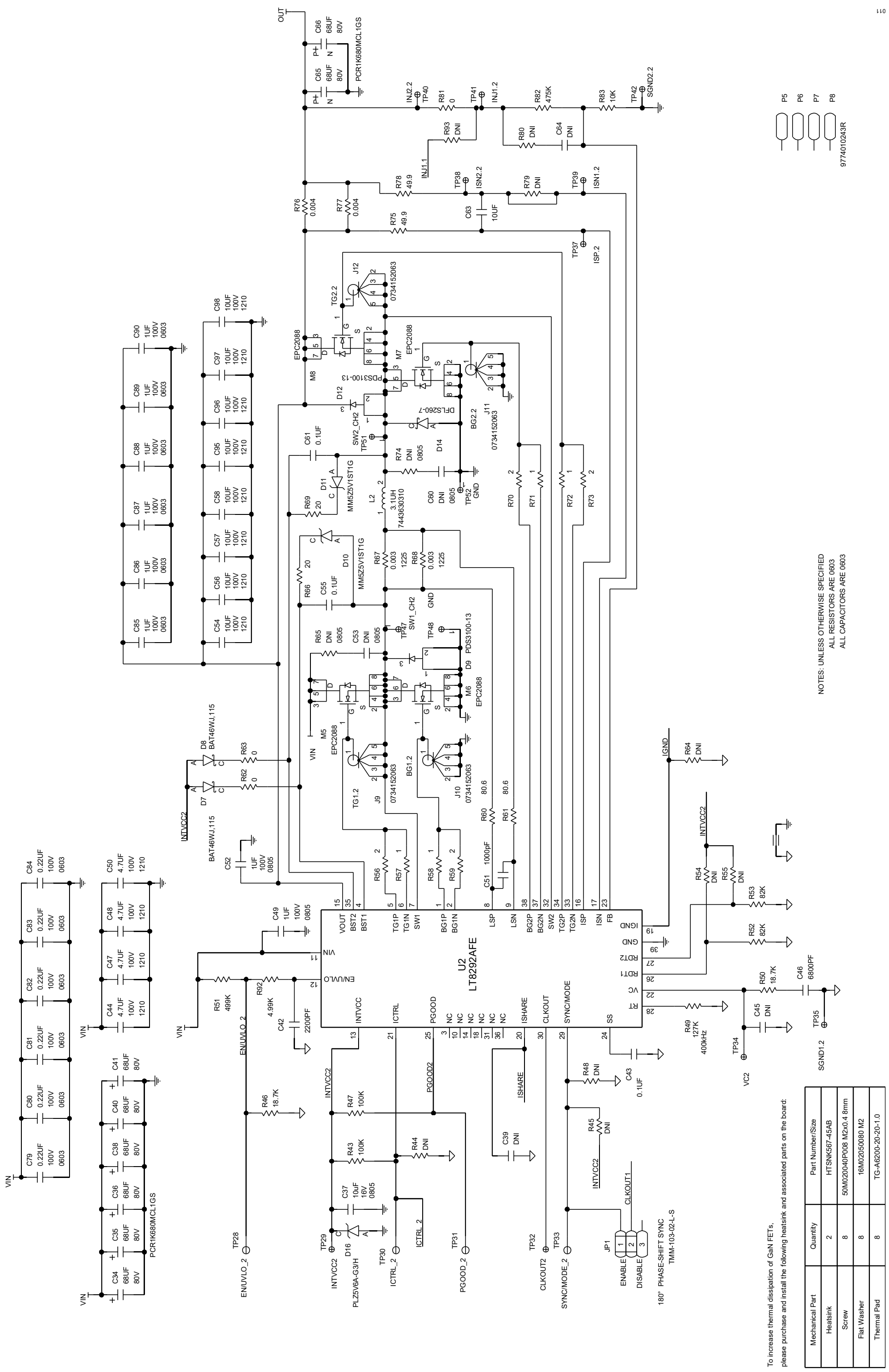

Figure 11. EVAL-LT8292-GZ Schematic (2 of 2)

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/25	Initial Release	—

Notes