

## LTM4638

### 20V<sub>IN</sub> PolyPhase Step-Down $\mu$ Module Regulator, 4 $\times$ LTM4638, 60A

### General Description

The EVAL-LTM4638-AZ evaluation board is a power supply generating 1V, 60A (max) from a 3.1V to 20V input. It is a quad PolyPhase<sup>®</sup> solution featuring the [LTM<sup>®</sup>4638](#), a high-performance and high-efficiency step-down regulator. The LTM4638 is a complete DC-to-DC point-of-load (POL) regulator in a thermally enhanced 6.25mm  $\times$  6.25mm  $\times$  5.02mm BGA package.

The EVAL-LTM4638-AZ is optimized using a default frequency of 600kHz, and the current mode control architecture allows easy current sharing. The LTM4638 operates in continuous-conduction mode (CCM) by default but can be placed in pulse-skipping mode (PSM) to optimize efficiency at light loads.

An external clock IC, [LTC6902](#), is included in the EVAL-LTM4638-AZ and is used to provide clock synchronization signals to interleave the four channels 90° out-of-phase for reduced root mean square (RMS) input current ripple and output voltage ripple. The [LT3088](#) is also included in this solution to power the clock IC.

The LTM4638 data sheet gives a complete description of the device, including operation and application information. The data sheet must be read in conjunction with this evaluation board user guide prior to working on or modifying the EVAL-LTM4638-AZ.

### Features and Benefits

- Current Mode Control
  - Good Current Sharing
- External Frequency Synchronization
- Differential Remote Sensing

### EVAL-LTM4638-AZ Evaluation Board

FILE	DESCRIPTION
<a href="#">EVAL-LTM4638-AZ</a>	Evaluation board design files.

[Ordering Information](#) appears at end of this user guide.

### Evaluation Board Photo

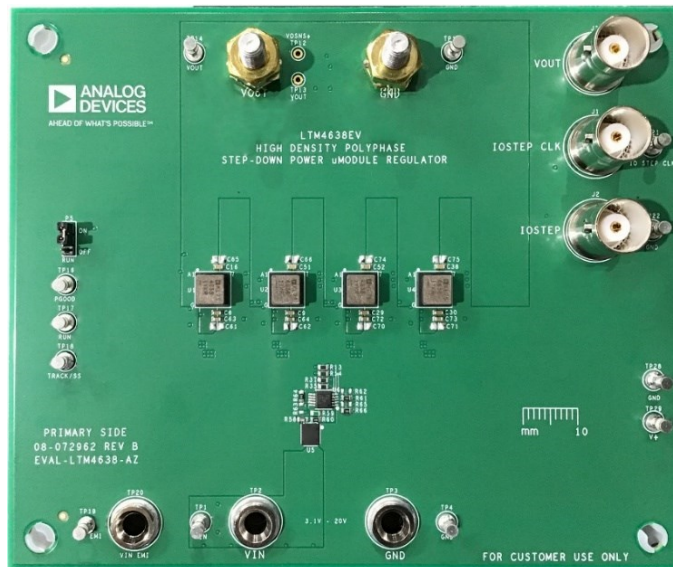


Figure 1. EVAL-LTM4638-AZ Evaluation Board (Part Marking Is either Ink Mark or Laser Mark)

## Performance Summary

Specifications are at  $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input voltage range		3.1		20	V
Output voltage, $V_{OUT}$	$R_{22} (R_{FB}) = 90.9\text{k}\Omega$	0.98	1	1.02	V
Maximum continuous output current	Derating is necessary for certain operating conditions (Refer to the LTM4638 data sheet for more details).		60		A
Default operating frequency	$R_{FREQ} = \text{open}$		600		kHz
Efficiency	$V_{IN} = 12\text{V}, V_{OUT} = 1\text{V}, I_{OUT} = 60\text{A}$		86.2		%

## Quick Start

### Required Equipment

- A power supply
- An electronic load
- Two digital multimeters (DMMs)

### Procedure

The EVAL-LTM4638-AZ evaluation board is an easy way to evaluate the performance of four parallel LTM4638 ICs. See [Figure 2](#) for test setup connections and use the following procedure.

1. With power off, place the P5 jumper in the ON position.
2. With the power off, connect the input voltage supply between TP2 and TP3. Connect an electronic load between P4 and P3. Connect one DMM between TP1 and TP4 and the second DMM between TP14 and TP15, as shown in [Figure 2](#). Preset the load current to 0A.
3. Turn on the input power and adjust the voltage supply between 3.1V and 20V. Ensure the input voltage does not exceed 20V. Check that the output voltage measures  $1\text{V} \pm 2\%$ .
4. Once the proper output voltage is established, adjust the load current in the 0A to 60A range and observe the load regulation, efficiency, and other parameters. Measure the output voltage ripple across the output capacitor with a Bayonet Neill–Concelman (BNC) cable and the oscilloscope from J3.
5. For optional load transient testing, an onboard transient circuit is provided to measure transient response. Place a positive pulse signal (0V to 3V) between the IO\_STEP\_CLK (TP21) pin and the GND pin (TP22). The pulse amplitude sets the load step current amplitude. Keep the pulse width short (<1ms) and the pulse duty cycle low (<1%) to limit the thermal stress on the load transient circuit. Monitor the load step with a BNC connected to J2 (5mV/A).

NOTE: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See [Figure 3](#) for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead, and the probe tip needs to touch the (+) lead.

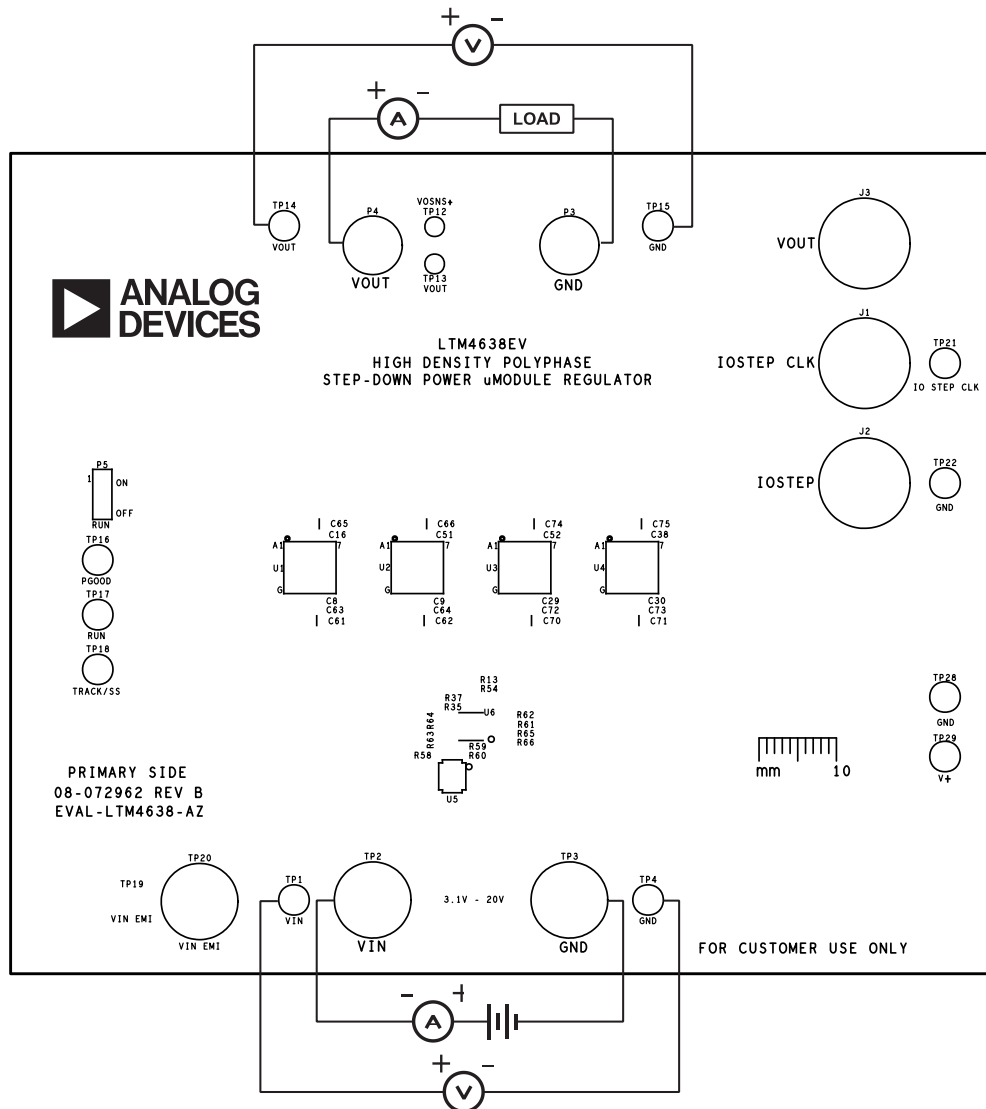


Figure 2. Test Setup of EVAL-LTM4638-AZ

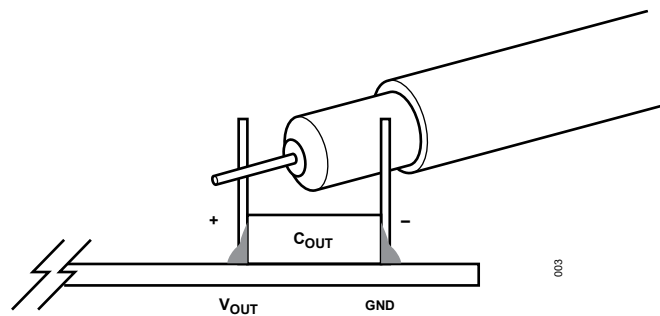


Figure 3. Measuring Output Voltage Ripple

Typical Performance Characteristics

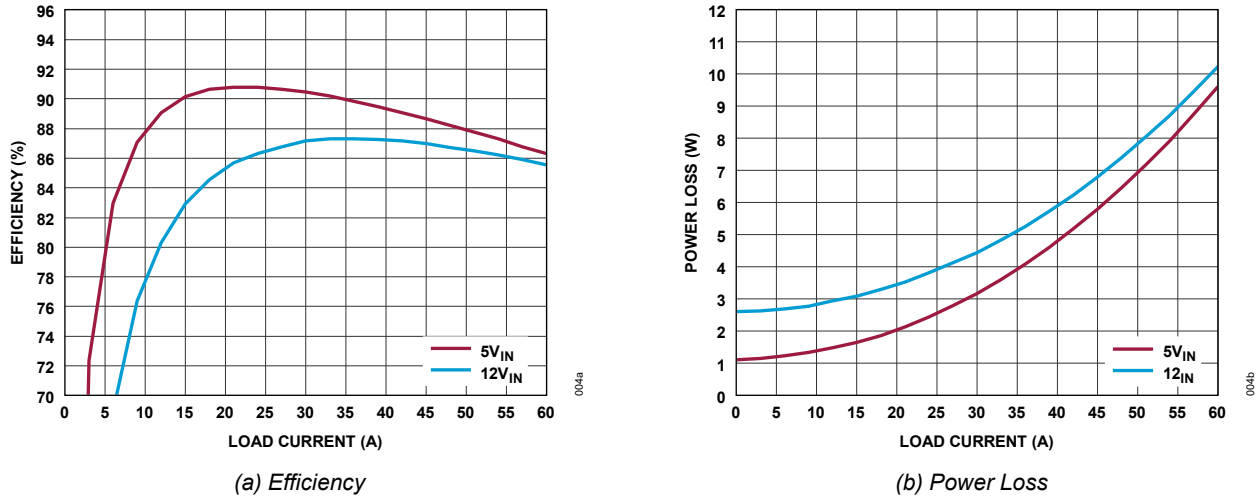


Figure 4. Measured Supply at V<sub>OUT</sub> = 1V, f<sub>sw</sub> = 600kHz

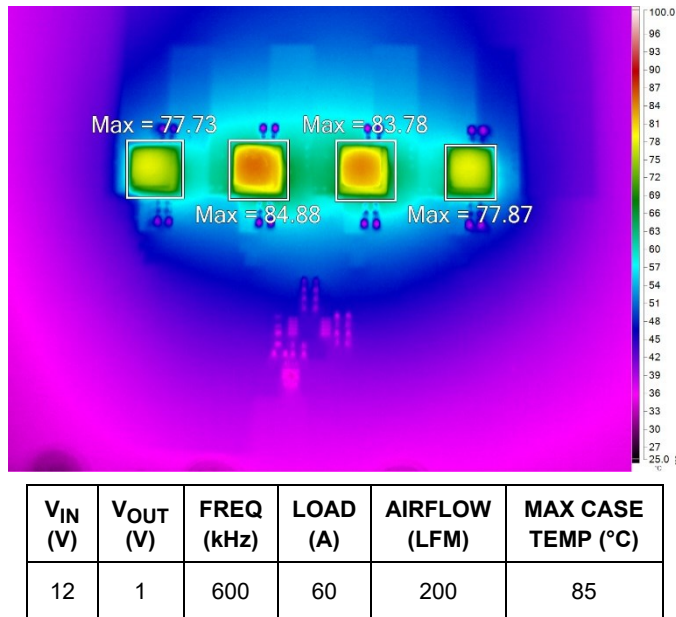
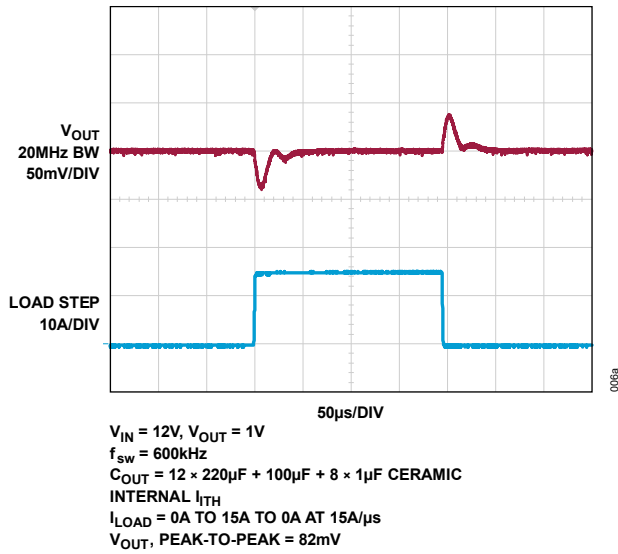
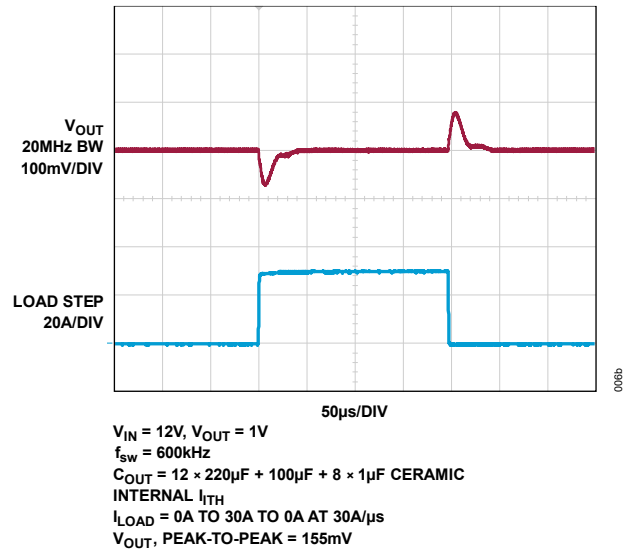


Figure 5. Measured Thermal Captures with 200LFM Forced Airflow

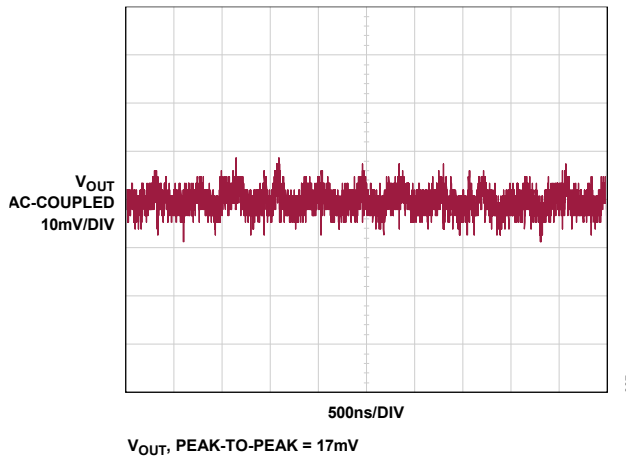


(a) 15A Step

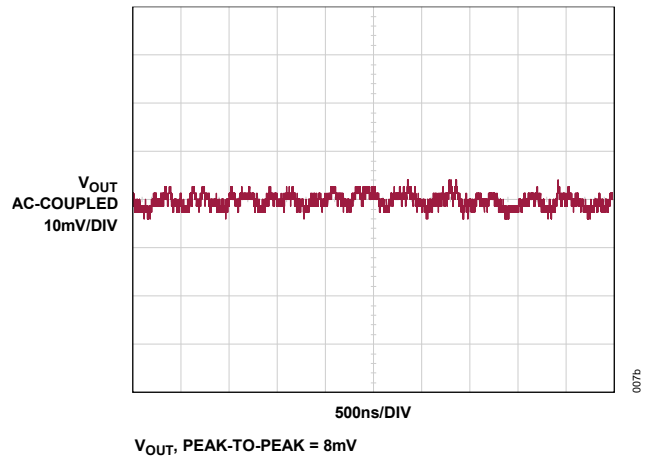


(a) 30A Step

Figure 6. Load Transient Response Waveforms, 12V<sub>IN</sub>, 1V<sub>OUT</sub>, 600kHz



(a) 1V<sub>OUT</sub>, 600kHz, Full Bandwidth at 500MHz



(b) 1V<sub>OUT</sub>, 600kHz, 20MHz Bandwidth

Figure 7. Tested V<sub>OUT</sub> AC-Ripple at 12V<sub>IN</sub>, I<sub>OUT</sub> = 60A, V<sub>OUT</sub> Ripple is Tested Across C76

## EVAL-LTM4638-AZ Evaluation Board Bill of Materials

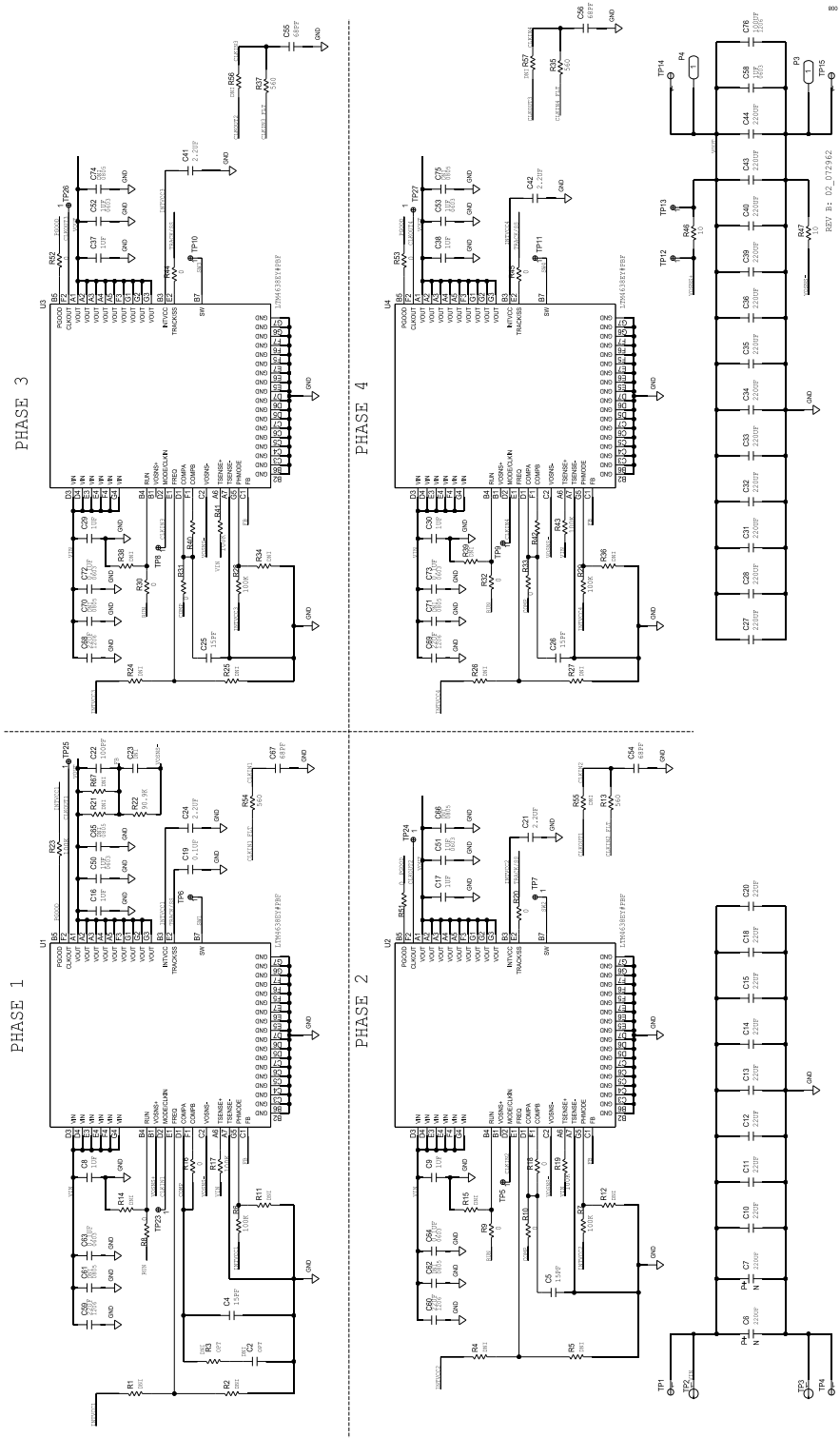
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Evaluation Board Components</b>				
1	8	C10-C15, C18, C20	CAP. CER 22 $\mu$ F 25V 10% X5R 1206	SAMSUNG, CL31A226KAHNNNE
2	14	C8, C9, C16, C17, C29, C30, C37, C38, C49, C50-C53, C58	CAP. CER 1 $\mu$ F 25V 10% X7R 0603 AEC-Q200	MURATA, GCM188R71E105KA64D
3	1	C19	CAP. CER 0.1 $\mu$ F 50V 10% X7R 0603 AEC-Q200 LOW ESR	TDK, CGA3E2X7R1H104K080AA
4	4	C21, C24, C41, C42	CAP. CER 2.2 $\mu$ F 16V 10% X7S 0603 AEC-Q200 LOW ESR	TDK, CGA3E1X7S1C225K080AC
5	1	C22	CAP. CER 100pF 50V 5% C0G 0603 AEC-Q200 LOW ESR	TDK, CGA3E2C0G1H101J080AA
6	4	C4, C5, C25, C26	CAP. CER 15pF 16V 5% X7R 0603	WÜRTH ELEKTRONIK, 885012000000
7	12	C27, C28, C31-C36, C39, C40, C43, C44	CAP. CER 220 $\mu$ F 6.3V 20% X5R 1206	MURATA, GRM31CR60J227ME11
8	4	C54-C56, C67	CAP. CER 68pF 50V 5% C0G 0603 EXTREME LOW ESR	KEMET, C0603H680J5GACTU
9	4	C59, C60, C68, C69	CAP. CER 22 $\mu$ F 16V 10% X5R 1206	AVX CORPORATION, 1206YD226KAT2A
10	2	C6, C7	CAP. ALUM ELECT 0.22 $\mu$ F 50V 20% 10mm $\times$ 10.2mm AEC-Q200 670mA 5000H	PANASONIC, EEEFK1H221GP
11	4	C63, C64, C72, C73	CAP. CER 0.1 $\mu$ F 50V 5% X7R 0603	KEMET, C0603C104J5REC7411
12	1	C76	CAP. CER 100 $\mu$ F 10V 20% X5R 1206 LOW ESR	TDK, C3216X5R1A107M160AC
13	1	Q1	TRAN N-CH MOSFET 40V 14A	VISHAY, SUD50N04-8M8P-4GE3
14	19	R8-R10, R16, R18, R20, R30-R33, R40, R42, R44, R45, R51-R53, R60, R61, R64, R66	RES. SMD 0 $\Omega$ JUMPER 1/10W 0603 AEC-Q200 PRECISION POWER	VISHAY, CRCW06030000Z0EA

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
15	4	R13, R35, R37, R54	RES. SMD 560Ω 1% 1/16W 0603	MULTICOMP (SPC), MC0063W06031560R
16	5	R17, R19, R23, R41, R43	RES. SMD 100kΩ 1% 1/4W 0603 AEC-Q200 ANTI-SURGE	PANASONIC, ERJ-PA3F1003V
17	1	R22	RES. SMD 90.9kΩ 0.1% 1/10W 0603 AEC-Q200 HIGH RELIABILITY	PANASONIC, ERA-3AEB9092V
18	4	R6, R7, R28, R29	RES. SMD 100kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1003V
19	2	R46, R47	RES. SMD 10Ω 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF10R0V
20	1	R48	RES. SMD 150kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1503V
21	1	R49	RES. SMD 10kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1002V
22	1	R50	RES. SMD 0.005Ω 1% 1W 2512 AEC-Q200	TT ELECTRONICS, ULRB12512R005FLFSLT
23	1	R58	RES. SMD 66.5kΩ 1% 1/10W 0603	YAGEO, RC0603FR-0766K5L
24	1	R59	RES. SMD 83.5kΩ 0.1% 1/10W 0603	VISHAY, TNPW060383K5BEEA
25	4	U1-U4	IC-ADI 20V <sub>IN</sub> , 15A STEP-DOWN DC-TO-DC μModule REGULATOR	ANALOG DEVICES, LTM4638EY#PBF
26	1	U5	IC-LIN 800mA SINGLE RESISTOR RUGGED LINEAR REGULATOR	ANALOG DEVICES, LT3088EDD#PBF
27	1	U6	IC-ADI MULTIPHASE OSCILLATOR WITH SPREAD SPECTRUM FREQUENCY MODULATION	ANALOG DEVICES, LTC6902CMS#PBF
<b>Additional Evaluation Board Circuit Components</b>				
1	0	C2, C23, C57, C77, C78	CAP., OPTION, 0603	
2	0	C45	CAP., OPTION, 2312	
3	0	C46-C48	CAP., OPTION, 1206	
4	0	C61, C62, C65, C66, C70, C71, C74, C75	CAP., OPTION, 0805	
5	0	L1,L2	IND., OPTION, 1206	
6	0	R1, R2, R3, R4, R5, R11, R12, R14, R15, R21, R24-R27, R34, R36, R38, R55-R57, R62, R63, R65, R67	RES., OPTION 0603	

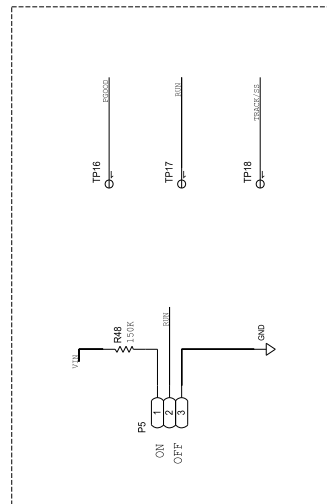
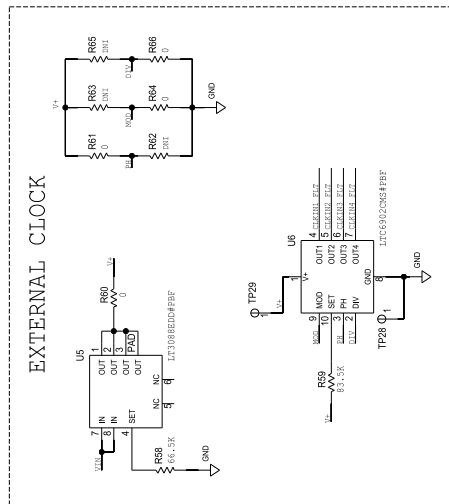
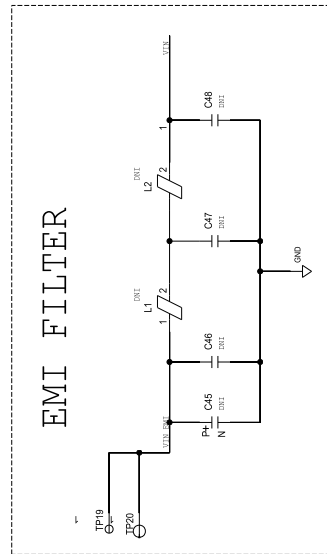
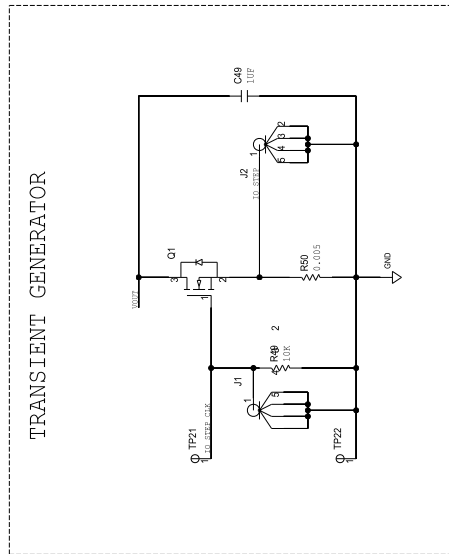
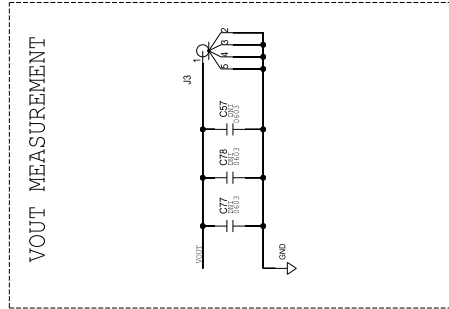
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Hardware: For Evaluation Board Only</b>				
1	3	J1-J3	CONN-PCB BNC JACK ST 50Ω	AMPHENOL CONNEX, 112404
2	2	P3, P4	WASHER, #10 FLAT STEEL	KEYSTONE, 4703
3	4	P3, P4	NUT, HEX STEEL, 10-32 THREAD, 9.27mm OUT DIA	KEYSTONE, 4705
4	2	P3, P4	CONN-PCB THREADED BROACHING STUD, 625mil LENGTH	PENN ENGINEERING, KFH-032-10ET
5	1	P5	CONN-PCB 3-POS MALE HDR UNSHROUDED SINGLE ROW, 2mm PITCH, 3mm SOLDER TAIL	SAMTEC INC., TMM-103-02-L-S
6	1	P5	SHUNT, 2mm JUMPER WITH TEST POINT	WÜRTH ELEKTRONIK, 60800213421
7	12	TP1, TP4, TP14-TP19, TP21, TP22, TP28, TP29	CONN-PCB SOLDER TERMINAL TEST POINT TURRET 0.094" MTG. HOLE PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
8	3	TP2, TP3, TP20	CONN-PCB BANANA JACK	KEYSTONE ELECTRONICS, 575-4
9	4	MP1-MP4	STANDOFF, SELF-RETAINING SPACER, 12.7mm LENGTH	WÜRTH ELEKTRONIK, 702935000



EVAL-LTM4638-AZ Schematic



EVAL-LTM4638-AZ Schematic (continued)



600  
REV B: 02\_072962

## Ordering Information

PART	TYPE
EVAL-LTM4638-AZ	The EVAL-LTM4638-AZ board features the LTM4638 $\mu$ Module regulator.

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/24	Initial release.	—

## Notes

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