

LTM4683

Low V_{OUT} Quad 31.25A (EVAL-LTM4683-A1Z) or Single 125A (EVAL-LTM4683-A2Z)
 μ Module Regulator with Digital Power System Management

General Description

The EVAL-LTM4683-A2Z evaluation board features the [LTM4683](#): the wide input and output voltage range, high efficiency and power density, quad output PolyPhase[®] DC-to-DC step-down μ Module[®] (micromodule) regulator with digital power system management (PSM). The EVAL-LTM4683-A2Z evaluation board is configured as a 4-phase single output. A similar evaluation board with a 4-phase four outputs is also available ([EVAL-LTM4683-A1Z](#)).

The EVAL-LTM4683-A2Z evaluation board's default input voltage range is 4.5V to 14V. However, if V_{IN} is lower than 6V and within $4.5V \leq V_{IN} \leq 5.75V$, a minor modification to certain existing on-board components is required. See step 7 ([Operation at Low \$V_{IN}\$: \$4.5V \leq V_{IN} \leq 5.75V\$](#)) in the [Procedure](#) section.

The factory default output voltage $V_{OUT} = 0.4V$ at 125A maximum load current. Forced airflow and heatsink might also be used to further optimize the output power when all output rails are on and fully loaded. The evaluation board output voltages can be adjusted from 0.3V up to 0.7V. Refer to the [LTM4683](#) data sheet for thermal derating curves and recommended switching frequency when adjusting the output voltage. The factory default switching frequency is preset at 350kHz (typical). The EVAL-LTM4683-A2Z evaluation board comes with a PMBus interface and digital PSM functions. An on-board 12-pin connector is available for the users to connect the dongle DC1613A to the evaluation board, which provides an easy way to communicate and program the part using the LTpowerPlay[®] software development tool.

The LTpowerPlay software and the I²C/PMBus/SMBus dongle DC1613A allow the users to monitor real-time telemetry of input and output voltages, input, and output current, switching frequency, internal IC die temperatures,

external power component temperatures, and fault logs. Programmable parameters include device address, output voltages, control loop compensation, switching frequency, phase interleaving, discontinuous-conduction mode (DCM) or continuous-conduction mode (CCM) of operation, digital soft start, sequencing, and time-based shutdown, fault responses to input and output overvoltage, output overcurrent, IC die and power component over temperatures.

The LTM4683 is available in a thermally enhanced, low-profile 330-pin, (15mm × 22mm × 5.71mm) BGA package. It is recommended to read the LTM4683 data sheet and this user guide prior to using or making any hardware changes to the EVAL-LTM4683-A2Z evaluation board.

Features and Benefits

- Quad digitally adjustable analog loops with a digital interface for control and monitoring.
- Optimized for low output voltage ranges.
- 15mm × 22mm × 5.71mm BGA package.

EVAL-LTM4683-A2Z Evaluation Board

FILE	DESCRIPTION
EVAL-LTM4683-A2Z	Design files.
LTpowerPlay	Easy-to-use Windows [®] based graphical user interface (GUI) development tool.
DC1613A	The USB to PMBus controller dongle.

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

Evaluation Board Photo

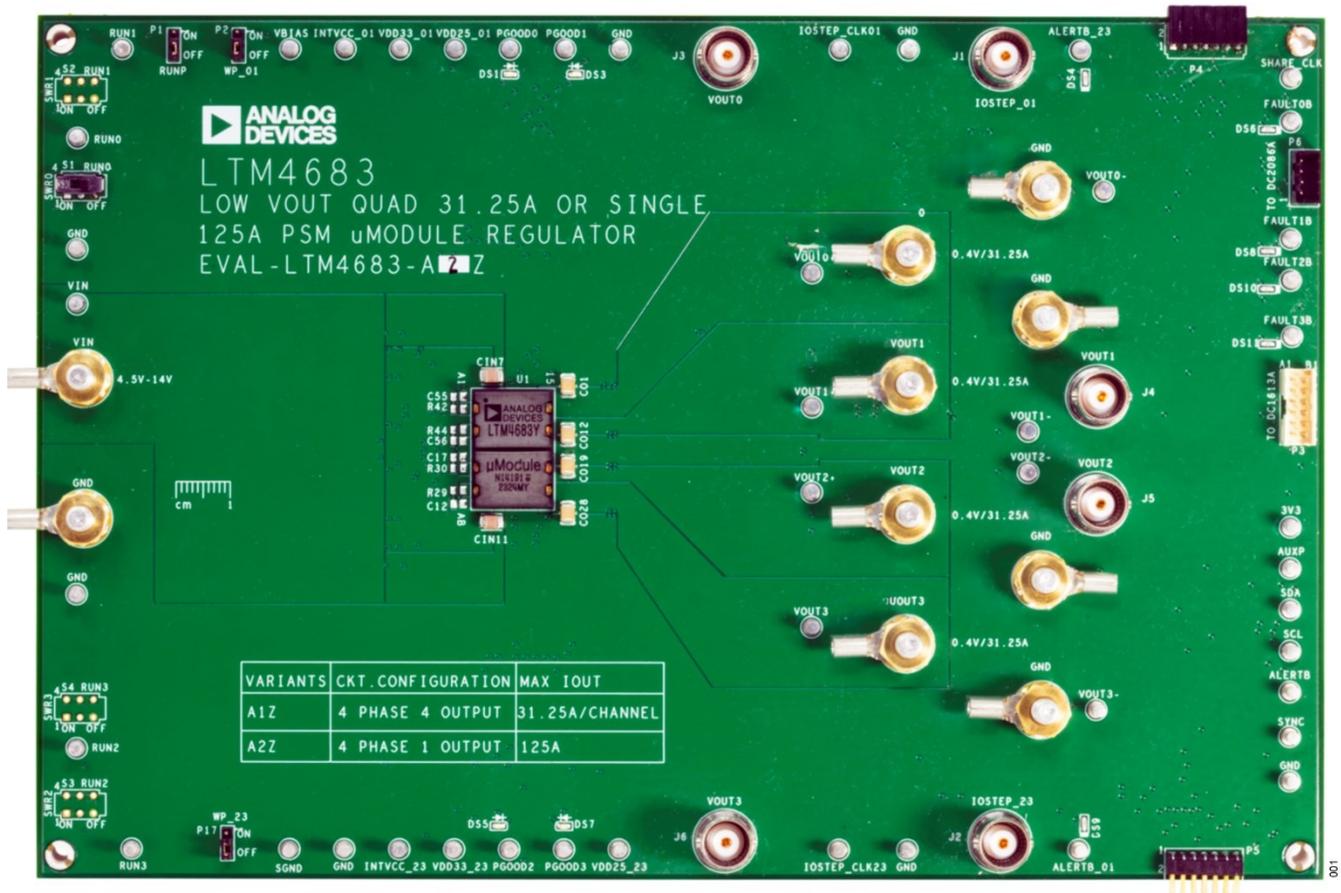


Figure 1. EVAL-LTM4683-A2Z Evaluation Board (Part Marking Is either Ink Mark or Laser Mark)

Performance Summary

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage V _{IN} range		4.5	12	14	V
Evaluation board default output voltage, V _{OUT}	f _{SW} = 350kHz, V _{IN} = 12V, I _{OUT} = 125A.		0.4		V
Switching frequency, f _{SW}	Factory default switching frequency.		350		kHz
Maximum continuous output current, I _{OUT}			120	125	A
Efficiency	f _{SW} = 350kHz, V _{IN} = 12V, V _{OUT} = 0.4V, I _{OUT} = 125A, V _{BIAS} = 5.5V (RUNP: ON), no forced airflow, no heatsink.		77.85		%
Thermal performance	f _{SW} = 350kHz, V _{IN} = 12V, V _{OUT} = 0.4V, I _{OUT} = 125A, V _{BIAS} = 5.5V (RUNP: ON), no forced airflow, no heatsink.		87.3		°C

Quick Start

Required Equipment

- One power supply that can deliver 20V at 20A.
- Electronic loads that can deliver 125A at 0.3V each load.
- Two digital multimeters (DMMs).

Procedure

The EVAL-LTM4683-A2Z evaluation board is easy to set up to evaluate the performance of the LTM4683. See [Figure 2](#) for proper measurement equipment setup and use the following test procedures.

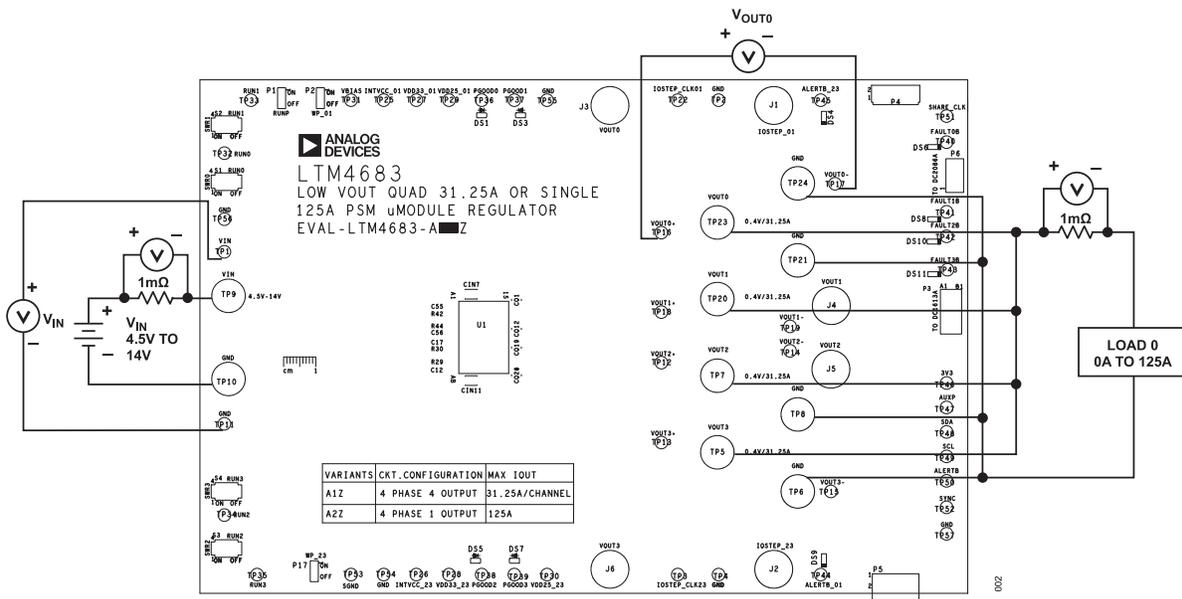


Figure 2. Proper Measurement Equipment Setup

1. With power off, connect the input power supply between VIN (TP9) and GND (TP10). Set the input voltage supply to 0V.
2. Connect the first load between VOUT0 (TP23) and GND (TP24), if more than one load is being used, connect the second load between VOUT1 (TP20) and GND (TP21), connect the third load between VOUT2 (TP7) and GND (TP8), and connect the fourth load between VOUT3 (TP5) and GND (TP6). Preset all the loads to 0A.
3. Connect the DMM between the input test points: VIN (TP1) and GND (TP11) to monitor the input voltage. Connect DMM between VOUT0+ (TP16) and VOUT0- (TP17) to monitor the DC output voltages. These output voltage test points are Kelvin sensed directly across COUT2 (Channel 0) to provide an accurate measurement of the output voltage. Do not apply load current to any of the above test points to avoid damage to the regulator. Do not connect the scope probe ground leads to VOUT0-, VOUT1-, VOUT2-, and VOUT3-.
4. Prior to powering up the EVAL-LTM4683-A2Z, check the default position of the jumpers and switches in the following positions.

SWITCH/JUMPER	SWR0, SWR1 SWR2, SWR3	P1	P2 P17
DESCRIPTION	RUN0, RUN1 RUN2, RUN3	RUNP	WP_01 WP_23
POSITION	OFF	ON	OFF

- Turn on the power supply at the input. Slowly increasing the input voltage from 0V to 12V (typical). Measure and make sure the input supply voltage is 12V and flip SWR0 (RUN0) to the ON position. The output voltage should be $0.4V \pm 0.5\%$ (typical).
- Once the input and output voltages are properly established, adjust the input voltage between 6V to 14V max and the total load current within the operating range of 0A to 125A max. Observe the output voltage regulation, output voltage ripples, switching node waveform, load transient response, and other parameters. See [Figure 3](#) for proper output voltage ripples measurement.

To measure the input/output voltage ripples properly, 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 input or output capacitor. The probe's ground ring needs to touch the (-) lead, and the probe tip needs to touch the (+) lead.

(Option) Operation with V_{BIAS}

- The V_{BIAS} pin is the 5.5V output of an internal buck regulator that can be enabled or disabled with RUNP. The V_{BIAS} regulator input is the V_{IN_VBIAS} pin and is powered from V_{IN} . The advantage of using V_{BIAS} is bypassing the internal $INTVCC_LDO$ powered from V_{IN} , turning on the internal switch connected to the 5.5V V_{BIAS} to $INTVCC_01$ and $INTVCC_23$ of the part, therefore, reducing the power loss, improving the overall efficiency, and lowering the temperature rise of the part when operating at high V_{IN} and high switching frequency. The V_{BIAS} must exceed 4.8V, and the V_{IN} must be greater than 7V to activate the internal switch connecting V_{BIAS} to $INTVCC_01$ and $INTVCC_23$ of the part. In typical applications, it is recommended to enable V_{BIAS} .

Operation at Low V_{IN} : $4.5V \leq V_{IN} \leq 5.75V$

- Remove R31 to disconnect V_{IN_VBIAS} from V_{IN} . Remove C25. Set RUNP (P1) to the OFF position. Tie SV_{IN_01} to $INTVCC_01$ by stuffing R142 with a 0Ω resistor. Tie SV_{IN_23} to $INTVCC_23$ by stuffing R143 with a 0Ω resistor. Make sure V_{IN} is within $4.5V \leq V_{IN} \leq 5.75V$. Additional input electrolytic capacitors may be installed between V_{IN} (TP9) and GND (TP10) to prevent V_{IN} from drooping or overshoot to a voltage level that can exceed the specified minimum V_{IN} (4.5V) and maximum V_{IN} (5.75V) during large output load transient.

(Option) On-Board Load Step Circuit

- The EVAL-LTM4683-A2Z evaluation board provides an on-board load transient circuit to measure ΔV_{OUT} peak-to-peak deviation during rising or falling dynamic load transient. The simple load step circuit consisting of two paralleled 40V N-channel power MOSFETs in series with two paralleled $10m\Omega$, 2W, 1% current sense resistors. The MOSFETs are configured as voltage control current source (V_{CCS}) devices; therefore, the output current step and its magnitude are created and controlled by adjusting the amplitude of the applied input voltage step at the gate of the MOSFETs. Use a function generator to provide a voltage pulse between $IOSTEP_CLK01$ (TP22) and GND (TP2). The input voltage pulse should be set at a pulse width of less than $300\mu s$ and a maximum duty cycle of less than 2% to avoid excessive thermal stress on the MOSFET devices. The output current step is measured directly across the current sense resistors and monitored by connecting the BNC cable from $IOSTEP_01$ (J1) to the input of the oscilloscope (scope probe ratio 1:1, DC-coupling). The equivalent voltage to the current scale is $5mV/1A$. The load step current slew rate dI/dt can be varied by adjusting the rise time and fall time of the input voltage pulse. The load step circuit is connected to V_{OUT0} by default. See the [Schematics](#) section for more details. Output ripple voltage and output voltage during load transients are measured at CO37; a $1\times$ scope probe and probe jack should be used. The DC output voltage should be measured between V_{OUT0+} (TP16) and V_{OUT0-} (TP17).

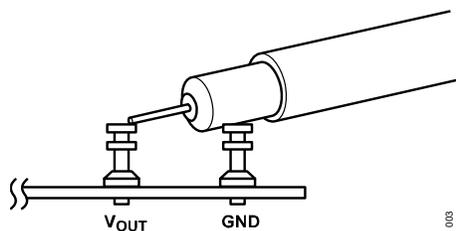


Figure 3. Scope Probe Placement for Measuring Output Ripple Voltage

Connecting a PC to the EVAL-LTM4683-A2Z

Use a PC to reconfigure the digital PMS features of the LTM4683, such as nominal V_{OUT} , margin set points, OV/UV limits, output current and temperature fault limits, sequencing parameters, the fault logs, fault responses, GPIOs, and other functionality. The DC1613A dongle can be hot plugged when V_{IN} is present. See [Figure 4](#) for the proper setup of the evaluation board.

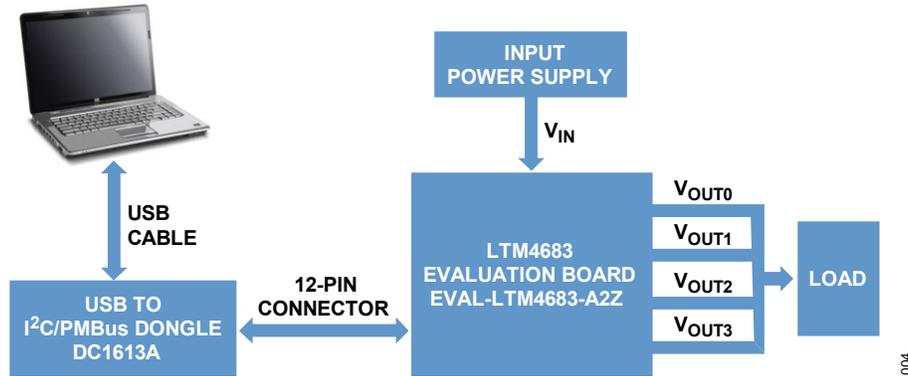


Figure 4. EVAL-LTM4683-A2Z Evaluation Board Setup with a PC

LTpowerPlay Quick Start Guide

The LTpowerPlay is a powerful Windows® based development environment that supports Analog Devices and Digital power system management (PSM) ICs. The software supports a variety of different tasks. Use the LTpowerPlay to evaluate Analog Devices, digital PSM μModule ICs by connecting to an evaluation board system.

The LTpowerPlay can also be used in an offline mode (with no hardware present) to build a multichip configuration file that can be saved and reloaded anytime.

The LTpowerPlay provides unprecedented diagnostic tools and debug features. It becomes a valuable diagnostic tool during board bring-up to program or tweak the power management scheme in a system, or to diagnose power issues when bringing up rails.

The LTpowerPlay utilizes the DC1613A, USB-to-PMBus controller, to communicate with one of the many potential targets, including all the parts in the PSM product category evaluation system. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. Download and install the LTpowerPlay software at [LTpowerPlay](#).

To access technical support documents for Analog Devices digital PSM products, visit Help or view online help on the LTpowerPlay menu.

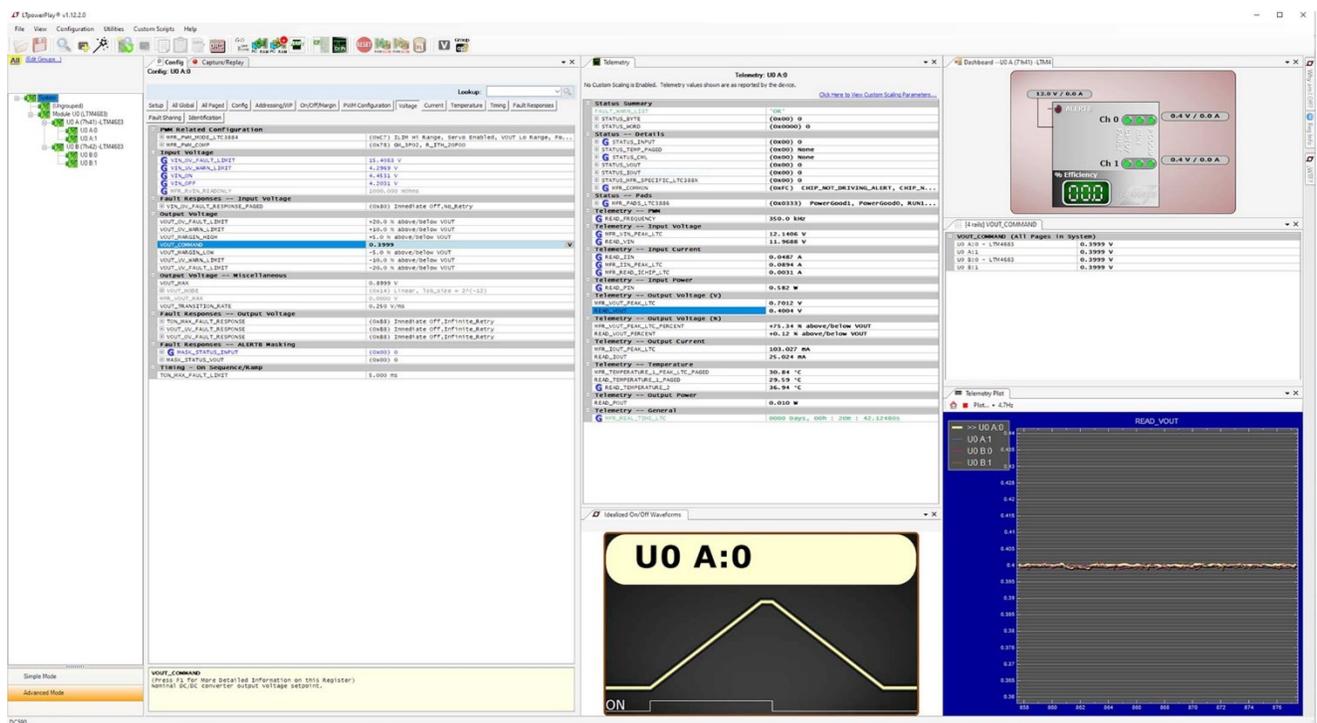
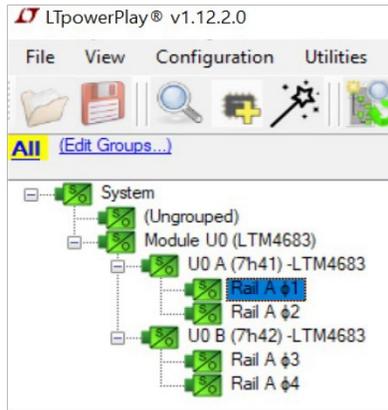


Figure 5. LTpowerPlay Main Interface

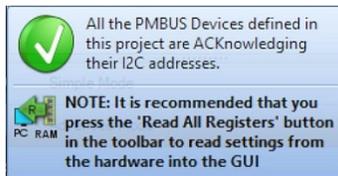
LTpowerPlay Procedure

Use the following procedure to monitor and change the settings for the LTM4683.

10. Launch the LTpowerPlay GUI. The GUI should automatically identify the EVAL-LTM4683-A2Z (see system tree below).



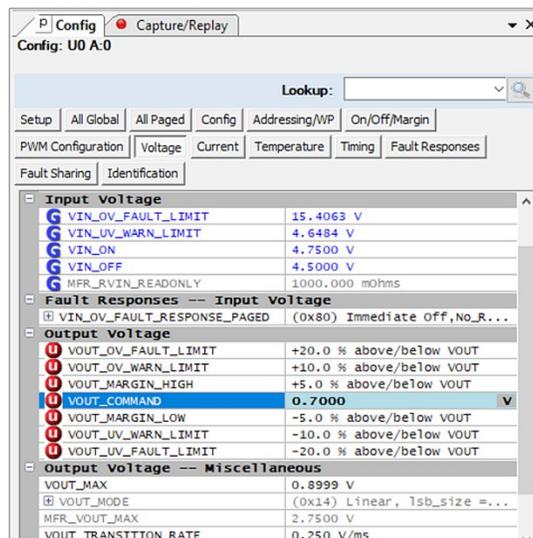
11. A green message box shows for a few seconds in the lower left-hand corner, confirming that LTM4683 is communicating.



12. In the Toolbar, **click the R** (RAM to PC) icon to read the RAM from the LTM4683. The configuration is read from the LTM4683 and loaded into the GUI.



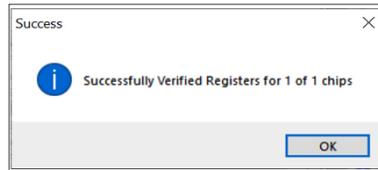
13. Example of programming the output voltage to a different value. In the Config Tab, **click on the Voltage** tab in the main menu bar, and **type in 0.7V in the VOUT_COMMAND box as shown below.**



14. Then **click the W** (PC to RAM) icon to write these register values to the LTM4683.



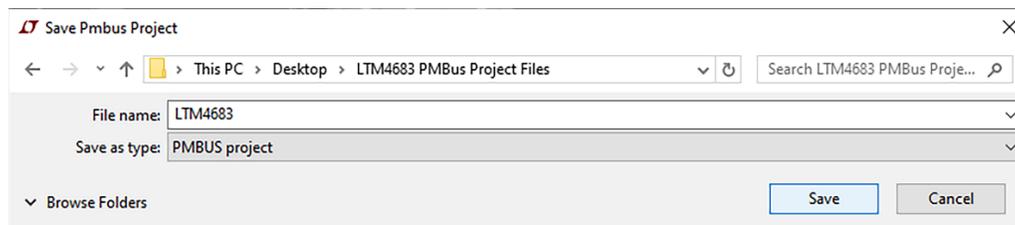
15. The output voltage will change to 0.7V. If the write command is successfully executed, the following message should be seen.



16. All user configuration or changes can be saved in to the NVM. In the Toolbar, **Click RAM to NVM** icon.



17. Save the evaluation board configuration to a (*.proj) file. **Click the Save icon** and save the file with a preferred file name.



Typical Performance Characteristics

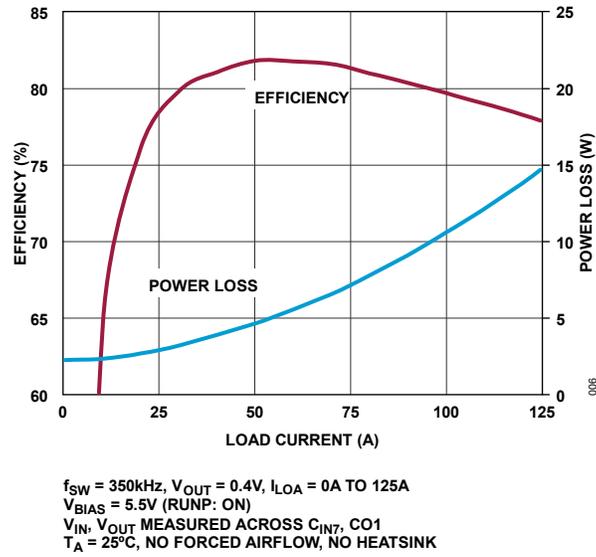


Figure 6. Efficiency vs. Load Current

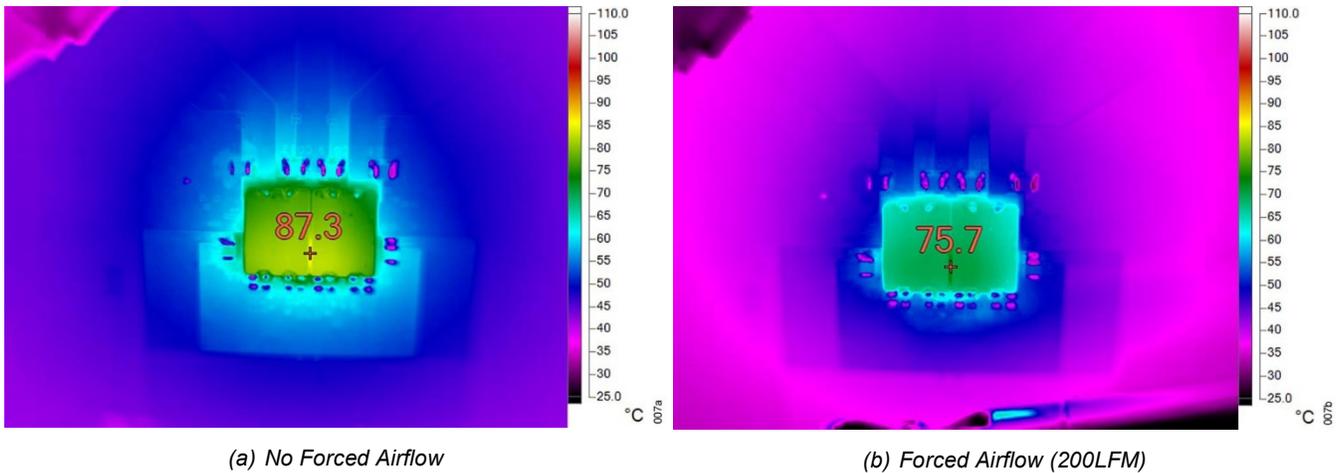


Figure 7. Thermal Performance, $V_{OUT} = 0.4\text{V}$, $I_{LOAD} = 125\text{A}$, $V_{BIAS} = 5.5\text{V (RUNP: ON)}$, $f_{SW} = 350\text{kHz}$, $T_A = 25^\circ\text{C}$, No Heatsink

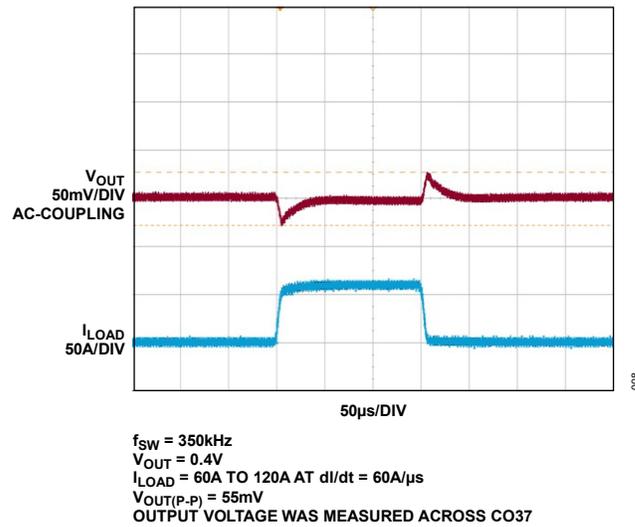


Figure 8. Load Transient Response

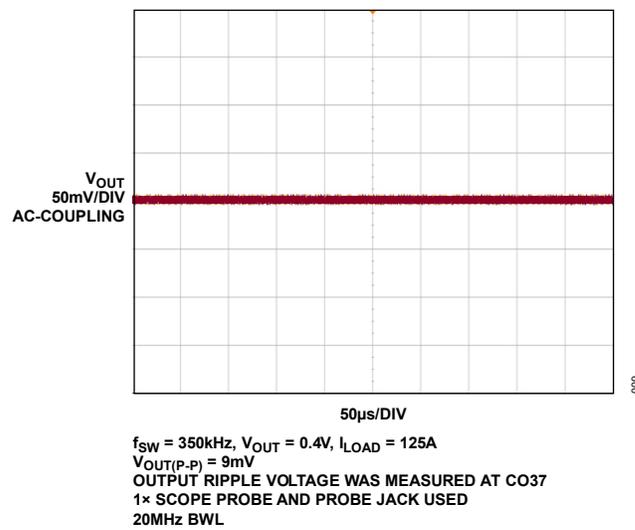


Figure 9. Output Ripple Voltage

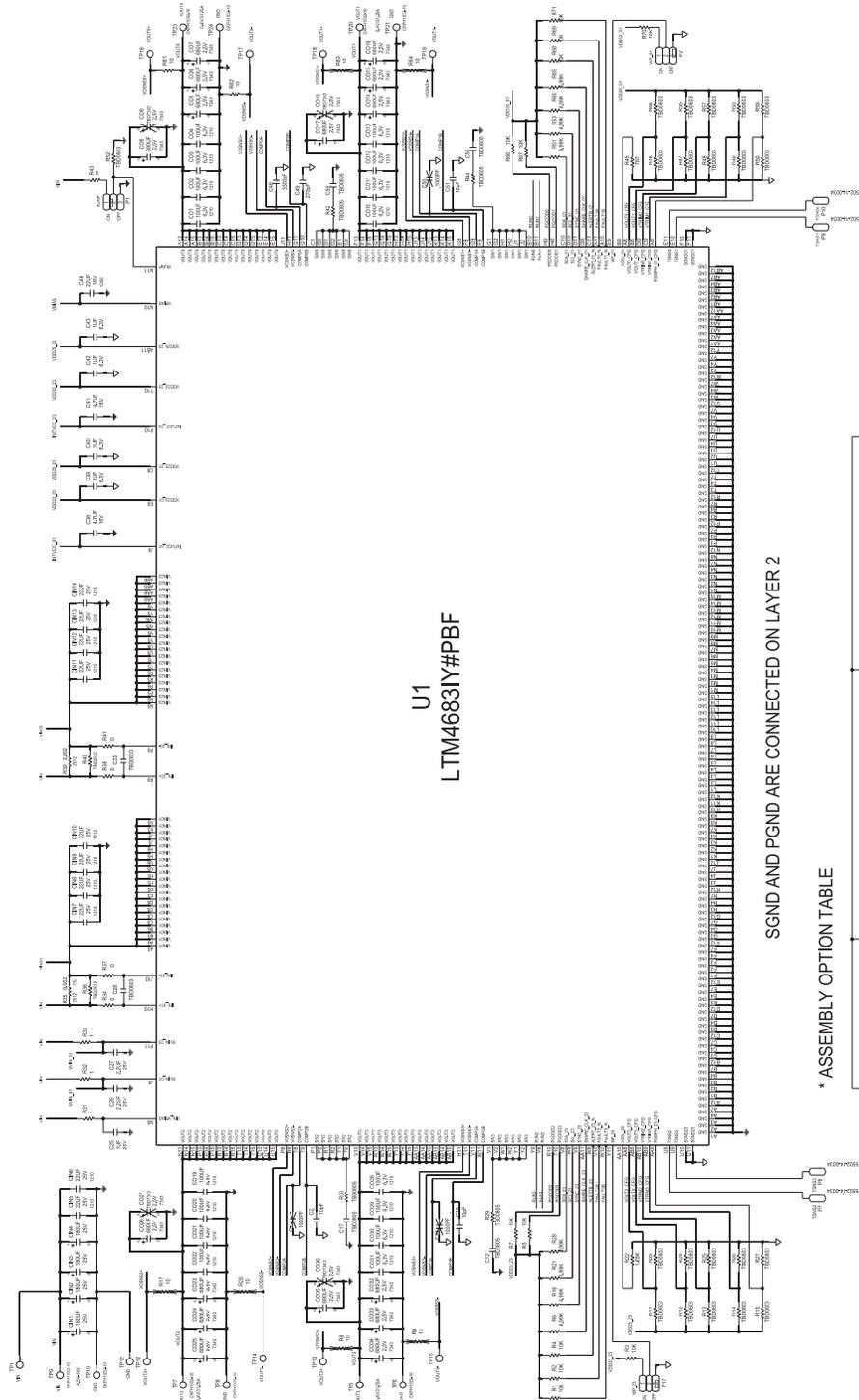
EVAL-LTM4683-A2Z Evaluation Boards Bill of Materials

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components			
4	C12, C17, C55, C56	DO NOT INSTALL	TBD0805
1	C14	CAP. CER 0.1 μ F 16V 10% X7R 0603	WÜRTH ELEKTRONIK, 885012206046
3	C2, C19, C51	CAP. CER 10pF 50V 5% C0G 0603	KEMET, C0603H100J5GAC7867
1	C25	CAP. CER 1 μ F 25V 10% X7R 0603	WURTH ELEKTRONIK, 885012206076
2	C26, C27	CAP. CER 2.2 μ F 25V 10% X5R 0603	MURATA, GRM188R61E225KA12D
2	C28, C33	DO NOT INSTALL	TBD0603
2	C38, C41	CAP. CER 4.7 μ F 16V 10% X6S 0603	MURATA, GRM188C81C475KE11D
4	C39, C40, C42, C43	CAP. CER 1 μ F 6.3V 20% X5R 0603	AVX CORPORATION, 06036D105MAT2A
1	C44	CAP. CER 22 μ F 16V 10% X5R 1206	AVX CORPORATION, 1206YD226KAT2A
1	C48	CAP. CER 3300pF 50V 10% X7R 0603	YAGEO, CC0603KRX7R9BB332
1	C49	CAP. CER 270pF 50V 5% C0G 0603	YAGEO, CC0603JRNPO9BN271
2	C65, C66	CAP. CER 100 μ F 6.3V 10% X5R 1206	MURATA, GRM31CR60J107KEA8L
21	C67–C70, CO1–CO4, CO10–CO13, CO19–CO22, CO28–CO31, CO37	CAP. CER 100 μ F 6.3V 20% X7S 1210	MURATA, GRM32EC70J107ME15L
12	C71–C82	CAP. CER 0.1 μ F 16V 20% X7R 0603	VISHAY, VJ0603Y104MXJAP
4	C84–C87	CAP. CER 0.1 μ F 16V 10% X7R 0805	YAGEO, CC0805KRX7R7BB104
1	C88	CAP. CER 0.01 μ F 25V 5% C0G 0603 EXTREME LOW ESR	KEMET, C0603C103J3GACTU
4	CIN1–CIN4	CAP. ALUM POLY 180 μ F 25V 20% 8mm \times 11.9mm 0.016 Ω 4650mA 5000h	PANASONIC, 25SVPF180M
10	CIN5–CIN14	CAP. CER 22 μ F 25V 10% X7R 1210	SAMSUNG, CL32B226KAJNNNE
16	CO5–CO8, CO14–CO17, CO23–CO26, CO32–CO35	CAP. TANT POLY 680 μ F 2.5V 20% 2917	PANASONIC, ETCF680M5H
2	D1, D2	DIODE SCHOTTKY BARRIER RECTIFIER	NEXPERIA, PMEG2005AEL, 315
4	DS1, DS3, DS5, DS7	LED GREEN WATER CLEAR, 515nm	WURTH ELEKTRONIK, 150060GS75000
6	DS4, DS6, DS8–DS11	LED SMD 0603 RED	VISHAY, TLMS1100-GS08
6	J1–J6	CONN-PCB BNC JACK ST 50 Ω	AMPHENOL CONNEX, 112404
3	P1, P2, P17	CONN-PCB 3-POS MALE HDR UNSHROUDED SINGLE ROW, 2mm PITCH, 3.60mm POST HEIGHT, 2.80mm SOLDER TAIL	SULLINS, NRPN031PAEN-RC
4	P7–P10	DO NOT INSTALL	R&D INTERCONNECT SOLUTIONS, TBD 5502-14-0034
1	P3	CONN-PCB 12-POS SHROUDER HDR, 2mm PITCH, 4mm POST HEIGHT, 2.5mm SOLDER TAIL	AMPHENOL, 98414-G06-12ULF

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	P4	CONN-PCB 14-POS FEMALE HRD RA 2mm PITCH, 3mm SOLDER TAIL	SULLINS, NPPN072FJFN-RC
1	P5	CONN-PCB HDR 14-POS 2.0mm GOLD 14.0mm × 4.3mm THRESHOLD	MOLEX, 877601416
1	P6	CONN-PCB 4-POS SHROUDED HDR MALE 2mm PITCH	HIROSE ELECTRIC CO., DF3A-4P-2DSA
4	Q1–Q4	TRAN N-CHAN. MOSFET 40V 14A	VISHAY, SUD50N04-8M8P-4GE3
4	Q5, Q8, Q11, Q13	TRAN MOSFET N-CHAN. ENHANCEMENT MODE	DIODES INCORPORATED, 2N7002A-7
6	Q9, Q12, Q14–Q17	TRAN P-CHAN. D-S MOSFET, 5A	VISHAY, SI2333DDS-T1-GE3
15	R1–R5, R7, R66–R73, R127	RES. SMD 10kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1002V
25	R54, R79-R85, R96–R102, R108–R114, R125, R140, R145	RES. SMD 0Ω JUMPER 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3GEY0R00V
15	R86-R90, R103–R107, R116–R120	RES. SMD 0Ω JUMPER 2512 AEC-Q200 SULFUR RESISTANT	VISHAY, WSL251200000ZEA9
48	R11–R15, R23–R27, R46–R50, R52, R55–R59, R121, R122, R126, R128, R132, R134, R142, R143, R149, R150, R154, R155, R163–R166, R168–R170, R172–R179	DO NOT INSTALL	TBD0603
4	R78, R91, R115, R123	DO NOT INSTALL	TBD2512
10	R124, R130, R136, R139, R144, R180, R181–R184	RES. SMD 301Ω 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF3010V
3	R61, R62, R129	RES. SMD 10Ω 0.1% 1/16W 0603	TE CONNECTIVITY, RN73C1J10RBTDF
18	R34, R37, R38, R41, R43, R148, R151–R153, R156–R162, R167, R171	RES. SMD 0Ω JUMPER 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3GEY0R00V
10	R6, R16, R18, R19, R21, R28, R51, R53, R60, R65	RES. SMD 4.99kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF4991V
1	R22	RES. SMD 1.65kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1651V
4	R29, R30, R42, R44	DO NOT INSTALL	TBD0805
3	R31-R33	RES. SMD 1Ω 5% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3GEYJ1R0V
2	R35, R39	RES. SMD 0.002Ω 1% 1W 2512 AEC-Q200	VISHAY, WSL25122L000FEA
2	R36, R40	RES. SMD TBD R2512H35	VISHAY, TBD2512H35
1	R45	RES. SMD 787Ω 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF7870V
4	R74-R77	RES. SMD 0.01Ω 1% 2W 2512 AEC-Q200	VISHAY, WSL2512R0100FEA18
1	R92	RES. SMD 0Ω JUMPER 2512 AEC-Q200 SULFUR RESISTANT	VISHAY, WSL251200000ZEA9
1	S1	SWITCH SLIDE DPDT 300mA 6V	C&K, JS202011CQN

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
47	TP1–TP4, TP11–TP19, TP22, TP25–TP57	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	TP5–TP10, TP20, TP21, TP23, TP24	CONN-PCB THREADED BROACHING STUD 10-32 FASTENER 0.625"	CAPTIVE FASTENER, CKFH1032-10
1	U1	IC-ADI μ Module REGULATOR WITH DIGITAL POWER SYSTEM MANAGEMENT (PSM)	ANALOG DEVICES, LTM4683IY#PBF
1	U3	IC EEPROM 2KBIT I ² C SERIAL EEPROM 400kHz	MICROCHIP TECHNOLOGY, 24LC025-I/ST
Hardware: For Evaluation Board Only			
10		WASHER, #10 FLAT STEEL	KEYSTONE, 4703
10		CONNECTOR RING LUG TERMINAL, 10 CRIMP, NON-INSULATED	KEYSTONE, 8205
20		NUT, HEX STEEL, 10-32 THREAD, 9.27mm OUT DIA	KEYSTONE, 4705
3		SHUNT, 2mm JUMPER WITH TEST POINT	WÜRTH ELEKTRONIK, 60800213421
4		STANDOFF, BRD SPT SNAP FIT 12.7mm LENGTH	KEYSTONE, 8833
Optional Evaluation Board Circuit Components			
2	Q7, Q10	TRAN P-CHAN. MOSFET 20V 5.9A SOT-23	VISHAY, SI2365EDS-T1-GE3
2	R93-R95	RES. SMD 0 Ω JUMPER 2512 AEC-Q200 SULFUR RESISTANT	VISHAY, WSL251200000ZEA9

EVAL-LTM4683-A2Z Schematics



U1
LTM4683Y#PBF

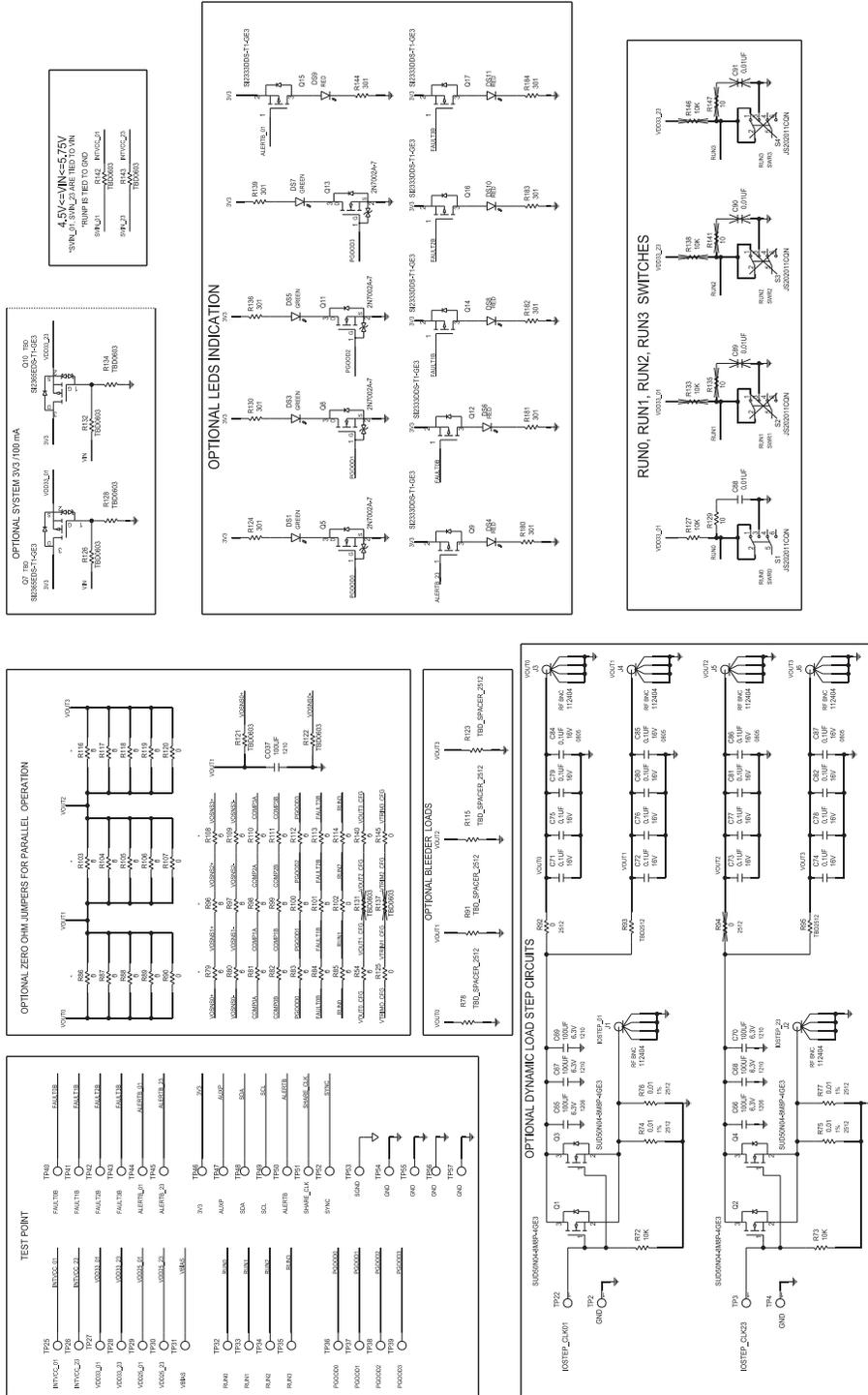
SGND AND PGND ARE CONNECTED ON LAYER 2

* ASSEMBLY OPTION TABLE

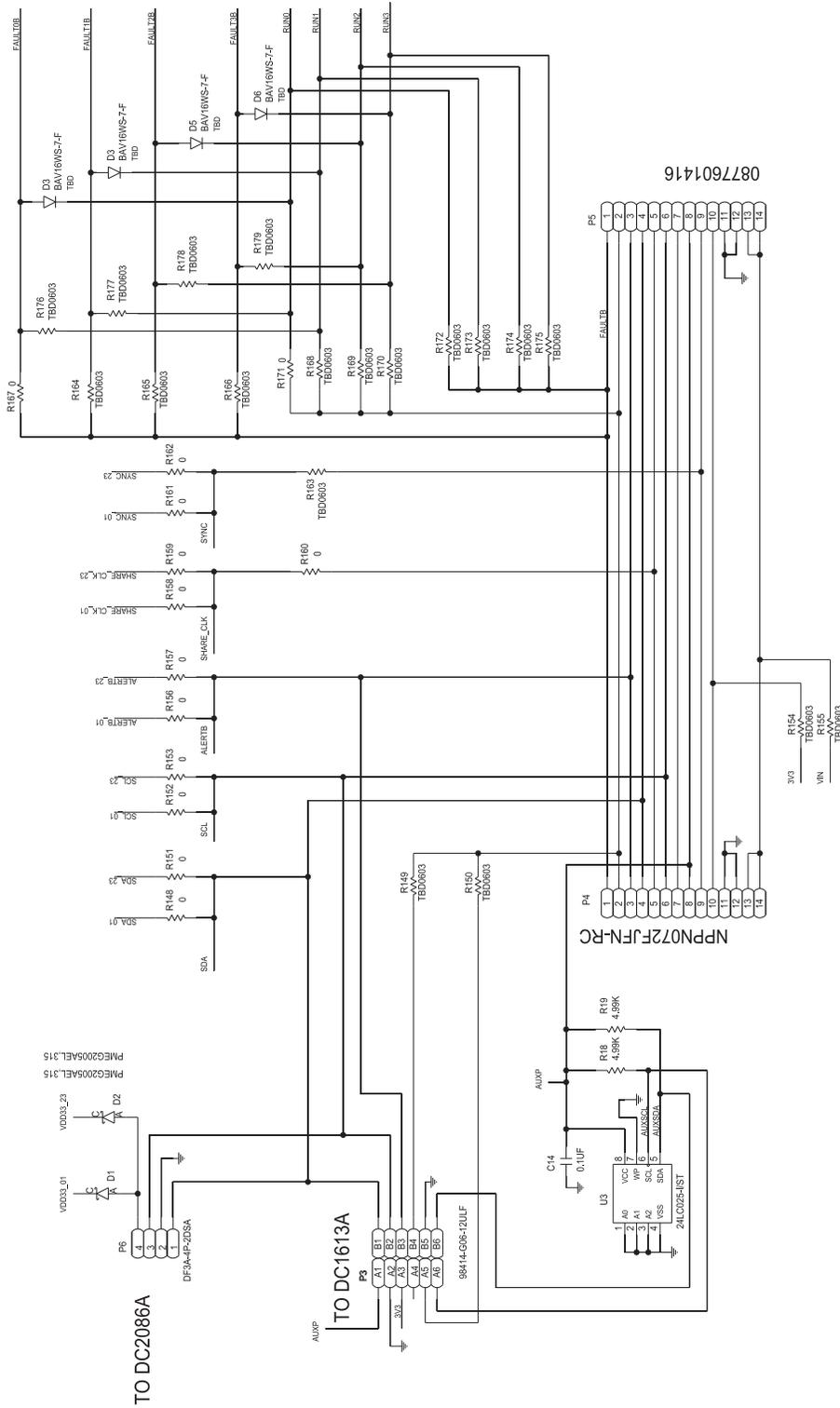
VARIANTS	CIRCUIT CONFIGURATION	MAX IO/UT
A1Z	4 PHASE 4 OUTPUT	31.25A PER CHANNEL
A2Z	4 PHASE 1 OUTPUT	125A

REV C

EVAL-LTM4683-A2Z Schematics (continued)



EVAL-LTM4683-A2Z Schematics (continued)



*ALL PARTS ON THIS PAGE ARE FOR EVALUATION BOARD ONLY, NOT NEEDED IN CUSTOMER DESIGN.

Ordering Information

PART	TYPE
EVAL-LTM4683-A2Z	The EVAL-LTM4683-A2Z evaluation board features the LTM4683, quad output regulator with digital power system management (PSM) configured as a 4-phase single output.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	04/24	Initial release.	—

Notes

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