EVAL-LTM4682-A2Z

LTM4682

Low V_{OUT} Quad 31.25A or Single 125A µModule Regulator with Digital Power System Management

General Description

The EVAL-LTM4682-A2Z evaluation board features the LTM4682: the wide input and output voltage range, high efficiency and power density, quad output PolyPhase® DC-to-DC step-down µModule® (micromodule) power regulator with digital power system management (PSM). The EVAL-LTM4682-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-LTM4682-A1Z).

The EVAL-LTM4682-A2Z evaluation board's default input voltage range is 4.5V to 16V. However, if V_{IN} is lower than 6V and within 4.5V ≤ V_{IN} ≤ 5.75V, a minor modification to certain existing on-board components is required. See step 8 (Operation at Low V_{IN}: 4.5V ≤ V_{IN} ≤ 5.75V) in the Procedure section.

The factory default output voltage V_{OUT} = 0.7V 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 0.7V up to 1.35V. Refer to the LTM4682 data sheet for thermal derating curves and recommended switching frequency when adjusting the output voltage.

The factory default switching frequency is preset at 575kHz (typical). The EVAL-LTM4682-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 I^2C/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 LTM4682 is available in a thermally enhanced, low-profile 330-pin (15mm × 22mm × 5.71mm) BGA package. It is recommended to read the LTM4682 data sheet and this user guide prior to using or making any hardware changes to the EVAL-LTM4682-A2Z evaluation board.

Ordering Information appears at end of this datasheet.

Evaluation Board Photo

Figure 1. EVAL-LTM4682-A2Z Evaluation Board (Part Marking is either Ink Mark or Laser Mark)

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

Performance Summary

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNIT
Input Voltage V_{IN} Range			4.5	12	16	V
Evaluation board default output voltage, V_{OUT}	f_{SW} = 575kHz, V_{IN} = 12V, I_{OUT} = 125A.		0.697	0.7	0.704	V
Switching frequency, f_{SW}	Factory default switching frequency.			575		kHz
Maximum continuous output current per channel, I_{OUT}				120	125	A
Efficiency	f_{SW} = 575kHz, V_{IN} = 12V, V_{OUT} = 0.7V, I_{OUT} = 0A to 125A, V_{BIAS} = 5.5V (RUNP: ON), no forced airflow, no heatsink.	I_{OUT} = 60A		88.5		%
		I_{OUT} = 125A		84.75		%
Thermal performance	f_{SW} = 575kHz, V_{IN} = 12V, V_{OUT} = 0.7V, I_{OUT} = 125A, V_{BIAS} = 5.5V (RUNP: ON), no forced airflow, no heatsink.			97.1		°C

Features and Benefits

- Quad digitally adjustable analog loops with a digital interface for control and monitoring.
- Optimized for low output voltage ranges and fast load transient response.
- 15mm × 22mm × 5.71mm Ball grid array (BGA) package.

EVAL-LTM4682-A2Z Evaluation Board

FILE	DESCRIPTION
EVAL-LTM4682-A2Z	Design files.
LTpowerPlay	Easy-to-use Windows® based graphical user interface (GUI) development tool.
DC1613A	The USB to PMBus controller dongle.

Quick Start

Required Equipment

- One power supply that can deliver 20V at 20A.
- Electronic loads that can deliver 125A at 0.7V each load.
- Two digital multimeters (DMMs).

Procedure

The EVAL-LTM4682-A2Z evaluation board is easy to set up to evaluate the performance of the LTM4682. See *Figure 2* for proper measurement equipment setup and use the following test procedures.

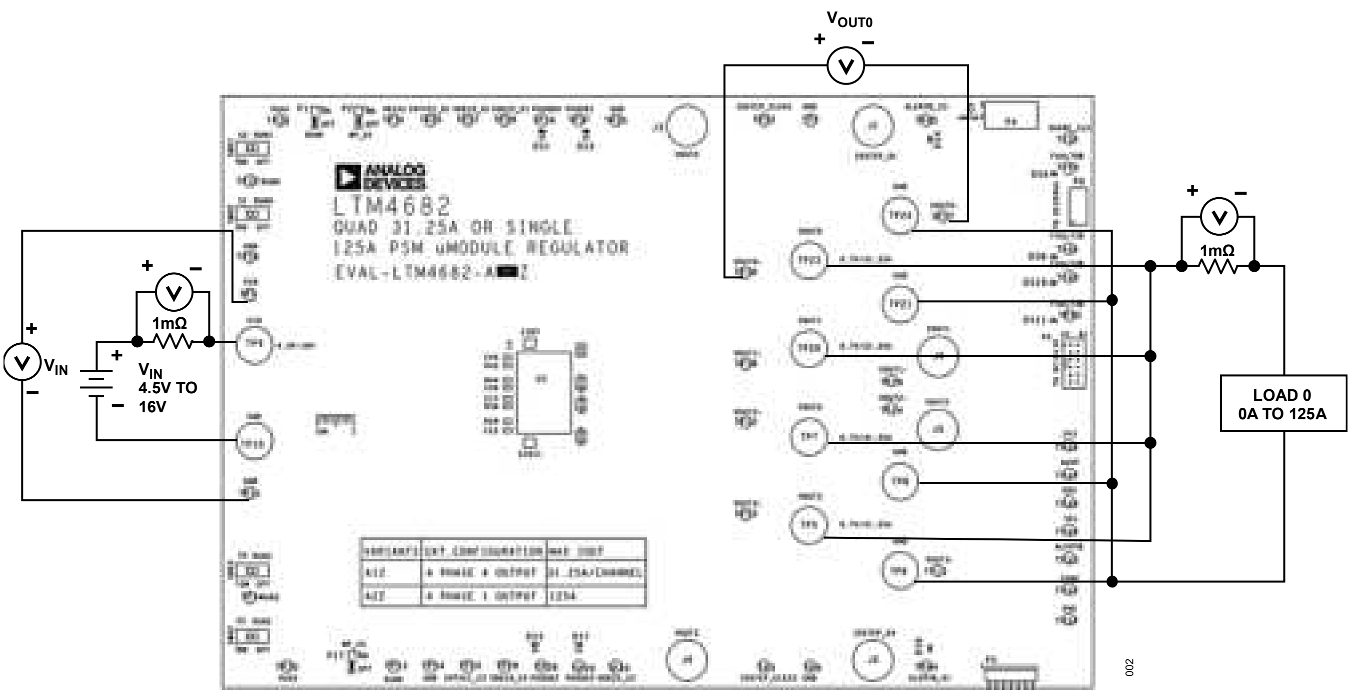


Figure 2. Proper Measurement Equipment Setup

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-LTM4682-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

5. Turn on the power supply at the input. Slowly increasing the input voltage from 0V to 12V (typical). Measure and ensure the input supply voltage is 12V and flip SWR0 (RUN0) to the ON position. The output voltage should be 0.7V ±0.5% (typical).

6. 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 ripple 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.

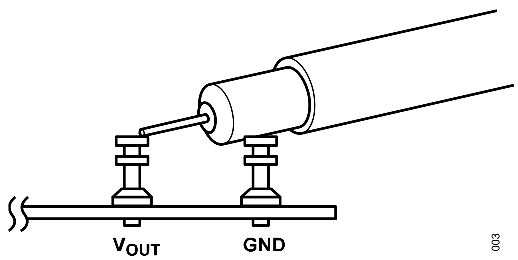


Figure 3. Scope Probe Placement for Measuring Output Ripple Voltage

(Option) Operation with V_{BIAS}

7. 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 by V_{IN}. The advantage of using V_{BIAS} is bypassing the internal $INTV_{CC\_LDO}$ powered from V_{IN}, turning on the internal switch connected to the 5.5V V_{BIAS} to $INTV_{CC\_01}$ and $INTV_{CC\_23}$ 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 $INTV_{CC\_01}$ and $INTV_{CC\_23}$ of the part. In typical applications, it is recommended that V_{BIAS} is enabled.

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

8. Remove R31 to disconnect V_{IN_VBIAS} from V_{IN}. Remove C25. Set RUNP (P1) to the OFF position. Tie SV_{IN_01} to $INTV_{CC\_01}$ by stuffing R142 with a 0Ω resistor. Tie SV_{IN_23} to $INTV_{CC\_23}$ 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 VIN (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**

9. The EVAL-LTM4682-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 consists of two paralleled 40V N-channel power MOSFETs in series with two paralleled 10mΩ, 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. A function generator provides a voltage pulse between IOSTEP_CLK01 (TP22) and GND (TP2). The input voltage pulse should be set at a pulse width of less than 300µs 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 oscilloscope's input (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 VOUT0 by default. See the *Schematics* section for more details. Output ripple voltage and output voltage during load transients are measured at CO37; a 1× scope probe and probe jack should be used. The DC output voltage should be measured between VOUT0+ (TP16) and VOUT0− (TP17).

Connecting a PC to the EVAL-LTM4682-A2Z

Use a PC to reconfigure the digital power system management (PSM) features of the LTM4682, such as nominal V_{OUT}, margin set points, overvoltage/undervoltage 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.

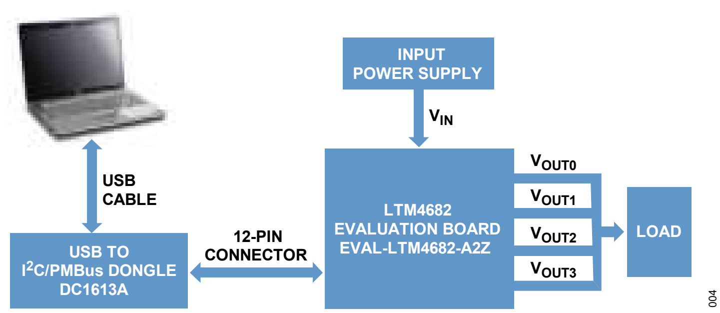


Figure 4. EVAL-LTM4682-A2Z Evaluation Board Setup with a PC

LTpowerPlay Quick Start Guide

The LTpowerPlay is a powerful Windows® based development environment that supports Analog Devices digital power system management (PSM) ICs. The software supports a variety of different tasks. Use the LTpowerPlay to evaluate Analog Devices digital PSM μModule devices 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 the LTpowerPlay Help menu. Online help is also available through the LTpowerPlay interface.

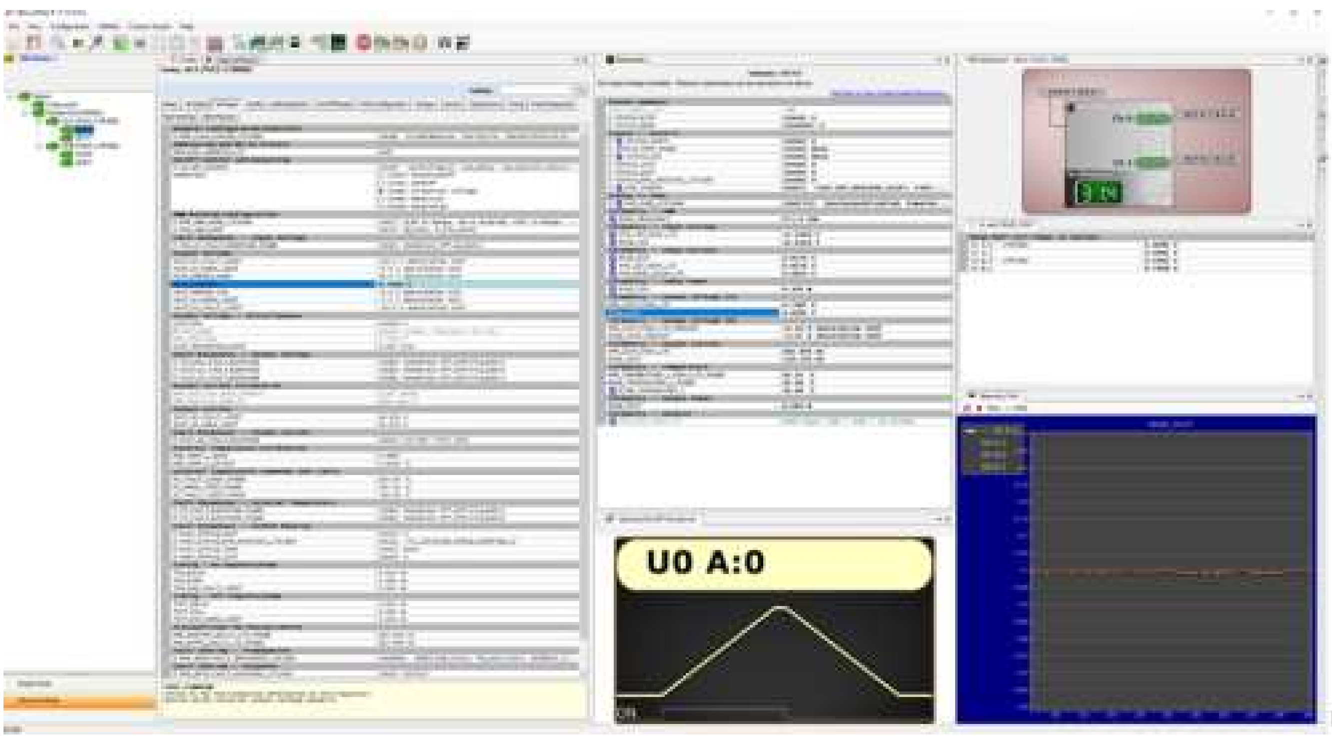
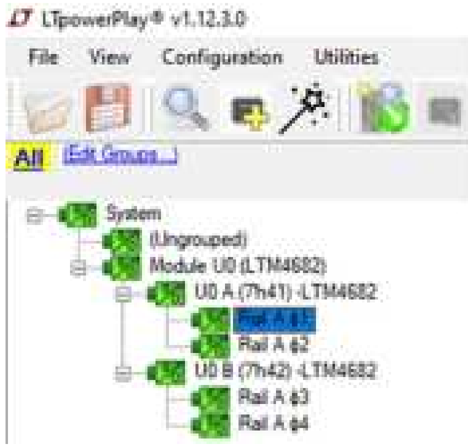


Figure 5. LTpowerPlay Main Interface

LTpowerPlay Procedure

Use the following procedure to monitor and change the settings for the LTM4682.

1. Launch the LTpowerPlay GUI. The GUI should automatically identify the EVAL-LTM4682-A2Z (see the following system tree).



2. A green message box shows for a few seconds in the lower left-hand corner, confirming that LTM4682 is communicating.

3. In the Toolbar, **click the R** (RAM to PC) icon to read the RAM from the LTM4682. The configuration is read from the LTM4682 and loaded into the GUI.

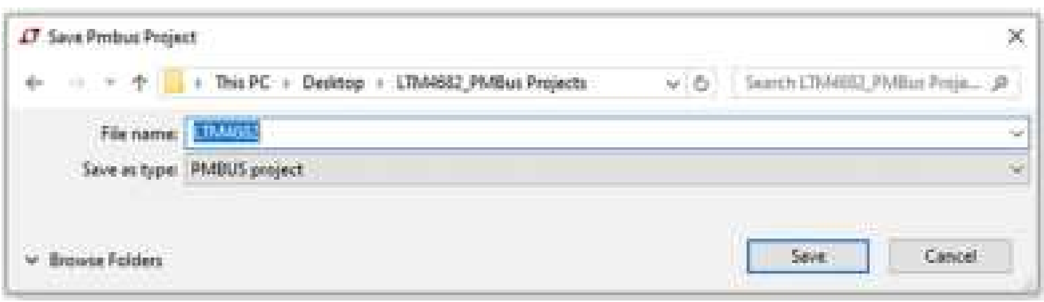
4. Example of programming the output voltage to a different value. In the Config Tab, **click on the Voltage** tab in the main menu bar, **and type in 1V in the VOUT_COMMAND box** as shown in the following figure.

5. Then, **click the W** (PC to RAM) icon to write these register values to the LTM4682.

6. The output voltage will change to 1V. If the write command is successfully executed, the following message should be seen.

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

8. 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

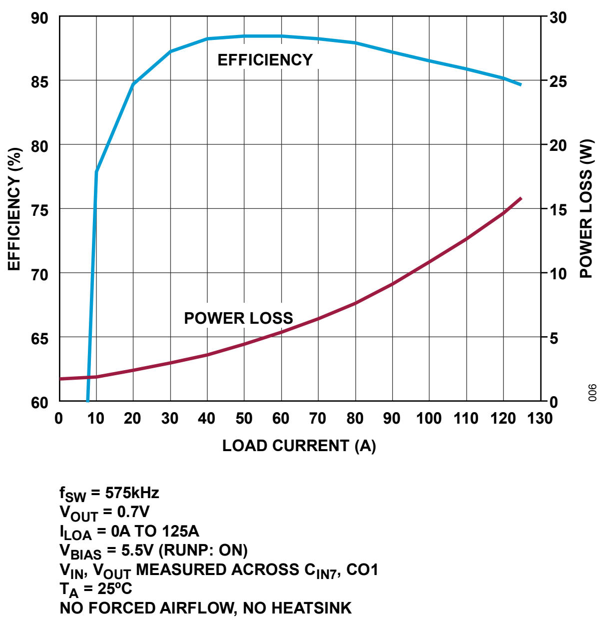
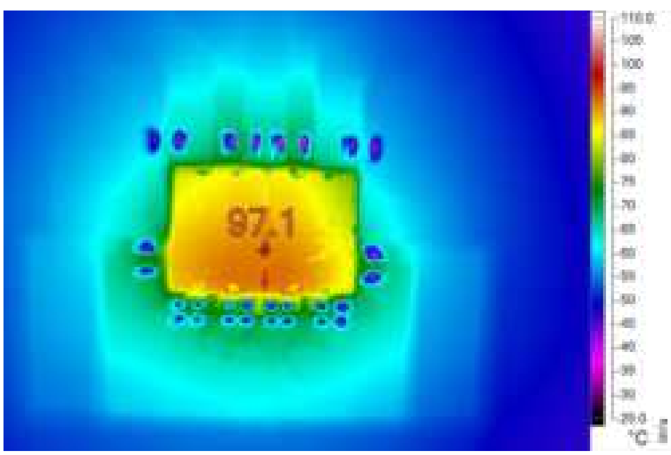
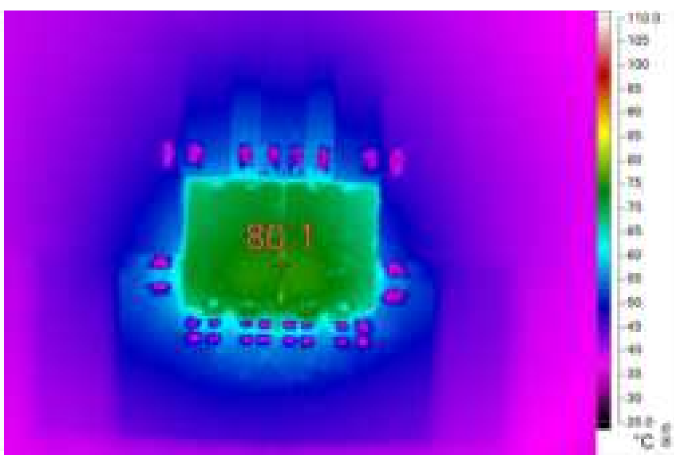


Figure 6. Efficiency vs. Load Current

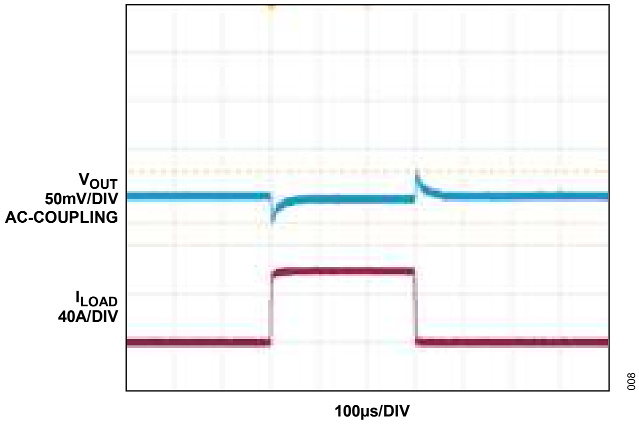


(a) No Forced Airflow



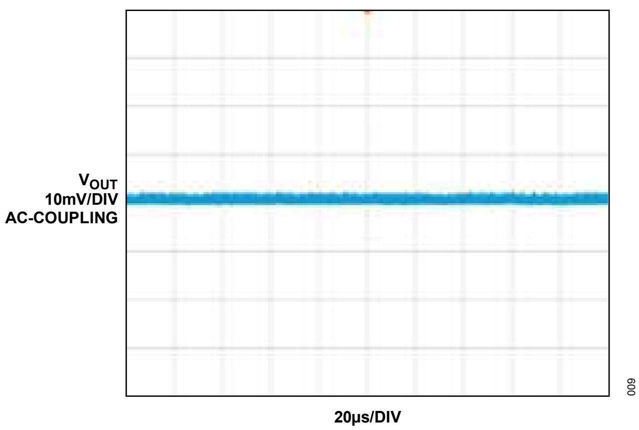
(b) Forced Airflow (200LFM)

Figure 7. Thermal Performance, V_{OUT} = 0.7V, I_{LOAD} = 125A, V_{BIAS} = 5.5V (RUNP: ON), f_{SW} = 575kHz, T_A = 25°C, No Heatsink



f_{SW} = 575kHz
V_{OUT} = 0.7V
I_{LOAD} = 60A TO 120A AT di/dt = 60A/µs
$V_{OUT(P-P)}$ = 53mV
OUTPUT VOLTAGE WAS MEASURED ACROSS C037

Figure 8. Load Transient Response



f_{SW} = 575kHz
V_{OUT} = 0.7V
I_{LOAD} = 125A
$V_{OUT(P-P)}$ = 2.5mV
OUTPUT RIPPLE VOLTAGE WAS MEASURED AT CO37
1× SCOPE PROBE AND PROBE JACK USED
20MHz BWL

Figure 9. Output Ripple Voltage

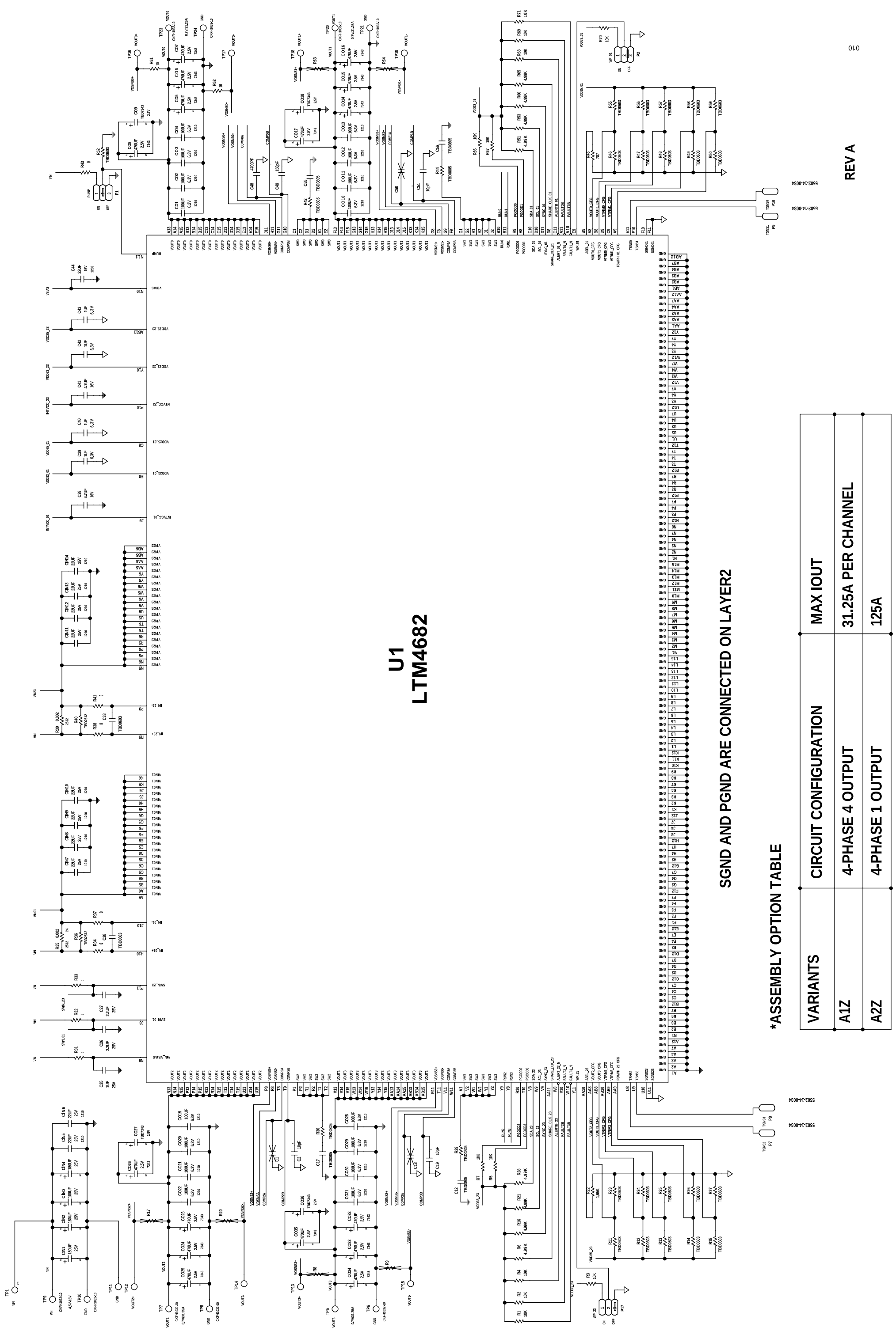
EVAL-LTM4682-A2Z Evaluation Boards Bill of Materials

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components			
4	C12, C17, C55, C56	DO NOT INSTALL	TBD, 0805
1	C14	CAP. CER 0.1µF 16V 10% X7R 0603	KEMET, C0603C104K4RAC
3	C2, C19, C51	CAP. CER 10pF 100V 5% C0G 0603 AEC-Q200	MURATA, GCM1885C2A100JA16D
1	C25	CAP. CER 1µF 25V 10% X7R 0603	WÜRTH ELEKTRONIK, 885012206076
2	C26, C27	CAP. CER 2.2µF 25V 10% X5R 0603	MURATA, GRM188R61E225KA12D
2	C28, C33	DO NOT INSTALL	TBD, 0603
2	C38, C41	CAP. CER 4.7µF 16V 10% X6S 0603	MURATA, GRM188C81C475KE11D
4	C39, C40, C42, C43	CAP. CER 1µF 6.3V 20% X5R 0603	AVX CORPORATION, 06036D105MAT2A
1	C44	CAP. CER 22µF 16V 10% X5R 1206	AVX CORPORATION, 1206YD226KAT2A
1	C48	CAP. CER 4700pF 50V 10% X7R 0603	YAGEO, CC0603KRX7R9BB472
1	C49	CAP. CER 150pF 16V 10% X7R 0603	WÜRTH ELEKTRONIK, 885012206029
2	C65, C66	CAP. CER 100µF 6.3V 10% X5R 1206	MURATA, GRM31CR60J107KE39L
21	C67–C70, CO1–CO4, CO10–CO13, CO19–CO22, CO28–CO31, CO37	CAP. CER 100µF 6.3V 20% X7S 1210	MURATA, GRM32EC70J107ME15L
12	C71–C82	CAP. CER 0.1µF 16V 20% X7R 0603	VISHAY, VJ0603Y104MXJAP
4	C84–C87	CAP. FILM 0.1µF 16V 20% 0805	PANASONIC, ECP-U1C104MA5
1	C88	CAP. CER 0.01µF 25V 5% C0G 0603	KEMET, C0603C103J3GACTU
4	CIN1–CIN4	CAP. ALUM POLY 180µF 25V 20% 8mm × 11.9mm 0.016Ω 4650mA 5000h	PANASONIC, 25SVPF180M
10	CIN5–CIN14	CAP. CER 22µF 25V 10% X7R 1210	SAMSUNG, CL32B226KAJNNNE
16	CO5-CO8, CO14–CO17, CO23–CO26, CO32–CO35	CAP. ALUM POLY 470µF 2.5V 20% 2917	PANASONIC, EEFGX0E471R
2	D1, D2	DIODE SCHOTTKY BARRIER RECTIFIER	NEXPERIA, PMEG2005AEL, 315
4	D3-D6	DO NOT INSTALL, DIODE SWITCHING	DIODES INCORPORATED, TBD SOD323
4	DS1, DS3, DS5, DS7	LED GREEN WATER CLEAR 0603	WÜRTH ELEKTRONIK, 150060GS75000
6	DS4, DS6, DS8–DS11	LED SMD 0603 COLOR RED AEC-Q101	VISHAY, TLMS1100-GS15
6	J1-J6	CONN-PCB BNC JACK ST 50Ω	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, CONN-PCB INVISI PIN 0.64mm × 0.64mm STANDARD PIN	R&D INTERCONNECT SOLUTIONS, TBD
1	P3	CONN-PCB 12-POS SHROUDER HDR, 2mm PITCH, 4mm POST HEIGHT, 2.5mm SOLDER TAIL	AMPHENOL, 98414-G06-12ULF

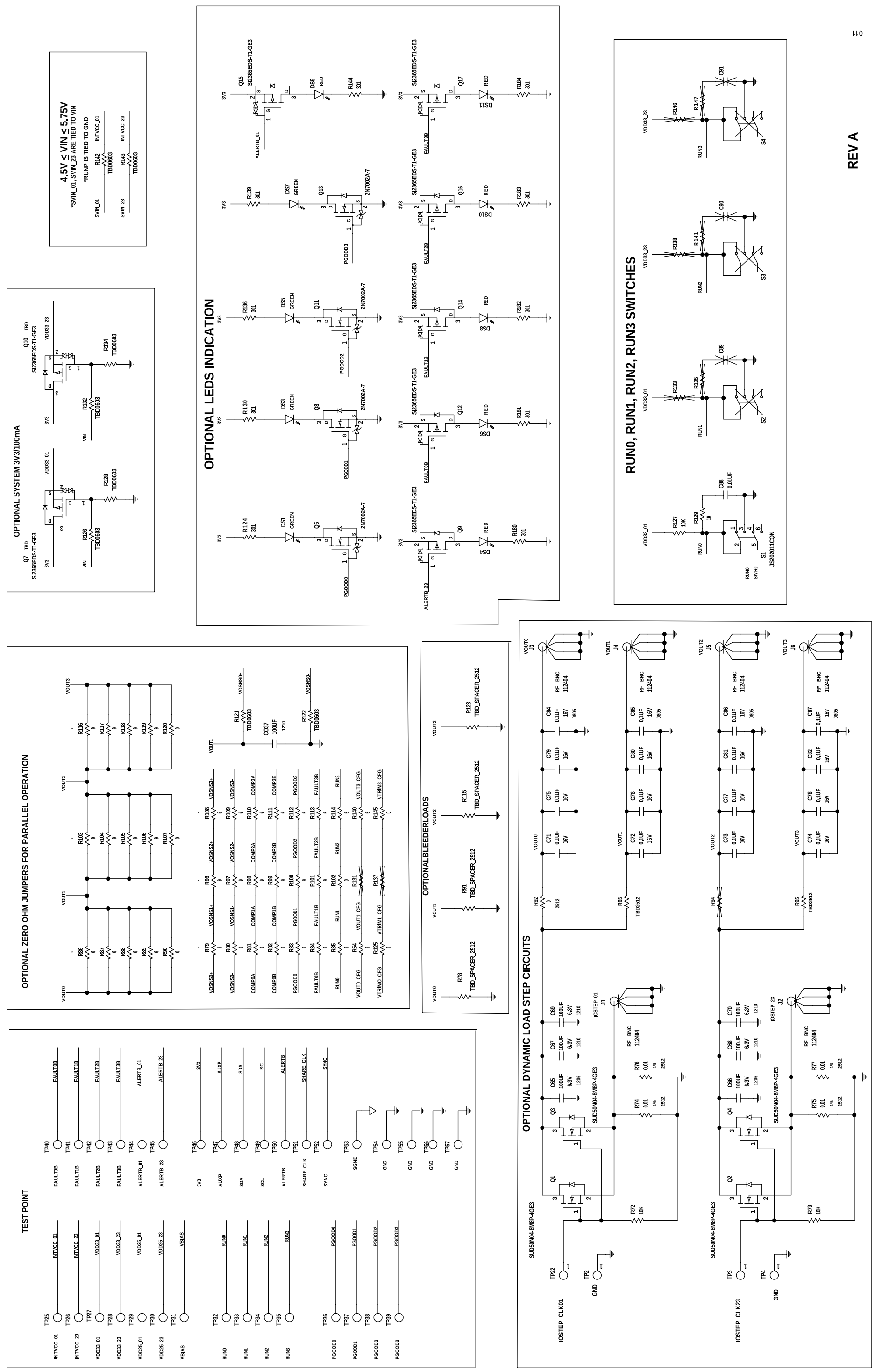
QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	P4	CONN-PCB 14-POS FEMALE HRD RA 2mm PITCH, 3mm SOLDER TAIL	SULLINS, NPPN072FJFN-RC
1	P5	CONN-PCB HDR 14-POS 2.0mm GOLD 14.0mm × 4.3mm TH	MOLEX, 877601416
1	P6	CONN-PCB 4-POS SHROUDED HDR MALE 2mm PITCH	HIROSE ELECTRIC CO., DF3A-4P-2DSA
4	Q1–Q4	TRAN N-CH MOSFET 40V 14A	VISHAY, SUD50N04-8M8P-4GE3
4	Q5, Q8, Q11, Q13	TRAN MOSFET N-CHANNEL ENHANCEMENT MODE	DIODES INCORPORATED, 2N7002A-7
6	Q9, Q12, Q14–Q17	TRAN P-CHANNEL MOSFET 20V 5.9A SOT-23	VISHAY, SI2365EDS-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	VISHAY, WSL251200000ZEA9
48	R11–R15, R23–R27, R46–R50, R52, R55–R59, R121, R122, R126, R128, R132, R134,	DO NOT INSTALL	TBD, TBD0603
	R142, R143, R149, R150, R154, R155, R163–R166, R168–R170, R172–R179		
4	R78, R91, R115, R123	DO NOT INSTALL	TBD, 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 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW060310R0FKEA
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 4.99kΩ1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF4991V
1	R22	RES. SMD 1.65kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1651V

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
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
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	VISHAY, WSL251200000ZEA9
1	S1	SWITCH SLIDE DPDT 300mA 6V	C&K, JS202011CQN
47	TP1–TP4, TP11–TP19, TP22, TP25–TP34,	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
	TP35–TP57		
10	TP5-TP10, TP20, TP21, TP23, TP24	CONN-PCB THREADED BROACHING STUD 10-32 FASTENER 0.625", USE ALT_SYMBOL FOR C450D200 PAD	CAPTIVE FASTENER, CKFH1032-10
1	U1	IC-ADI LOW V_{OUT} QUAD 31.25A OR SINGLE 125A µMODULE REGULATOR WITH DIGITAL POWER SYSTEM MANAGEMENT	ANALOG DEVICES, LTM4682
1	U3	IC EEPROM 2KBIT I2C SERIAL EEPROM 400kHZ	MICROCHIP TECHNOLOGY, 24LC025-I/ST
Hardware: For Evaluation Board Only			
4		STANDOFF, SELF-RETAINING SPACER, 12.7mm LENGTH	702935000
10		CONNECTOR RING LUG TERMINAL, 10 CRIMP, NON-INSULATED	8205
10		WASHER, #10 FLAT STEEL	4703
20		NUT, HEX STEEL, 10-32 THREAD, 9.27mm OUT DIA	4705
3		SHUNT, 2mm JUMPER WITH TEST POINT	60800213421
Optional Evaluation Board Circuit Components			
4	CO9, CO18, CO27, CO36	CAP. ALUM POLY 7343-20	TBD, TBD7343-20
2	Q7, Q10	TRAN P-CHANNEL MOSFET 20V 5.9A SOT-23	VISHAY, SI2365EDS-T1-GE3
2	R93, R95	RES. SMD 0Ω JUMPER 2512 AEC-Q200	VISHAY, WSL251200000ZEA9
2	R36, R40	RES. SMD 0.002Ω 1% 1W 2512 AEC-Q200	VISHAY, WSL25122L000FEA
9	R8, R9, R17, R20, R63, R64, R135, R141, R147	RES. SMD 10Ω 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW060310R0FKEA

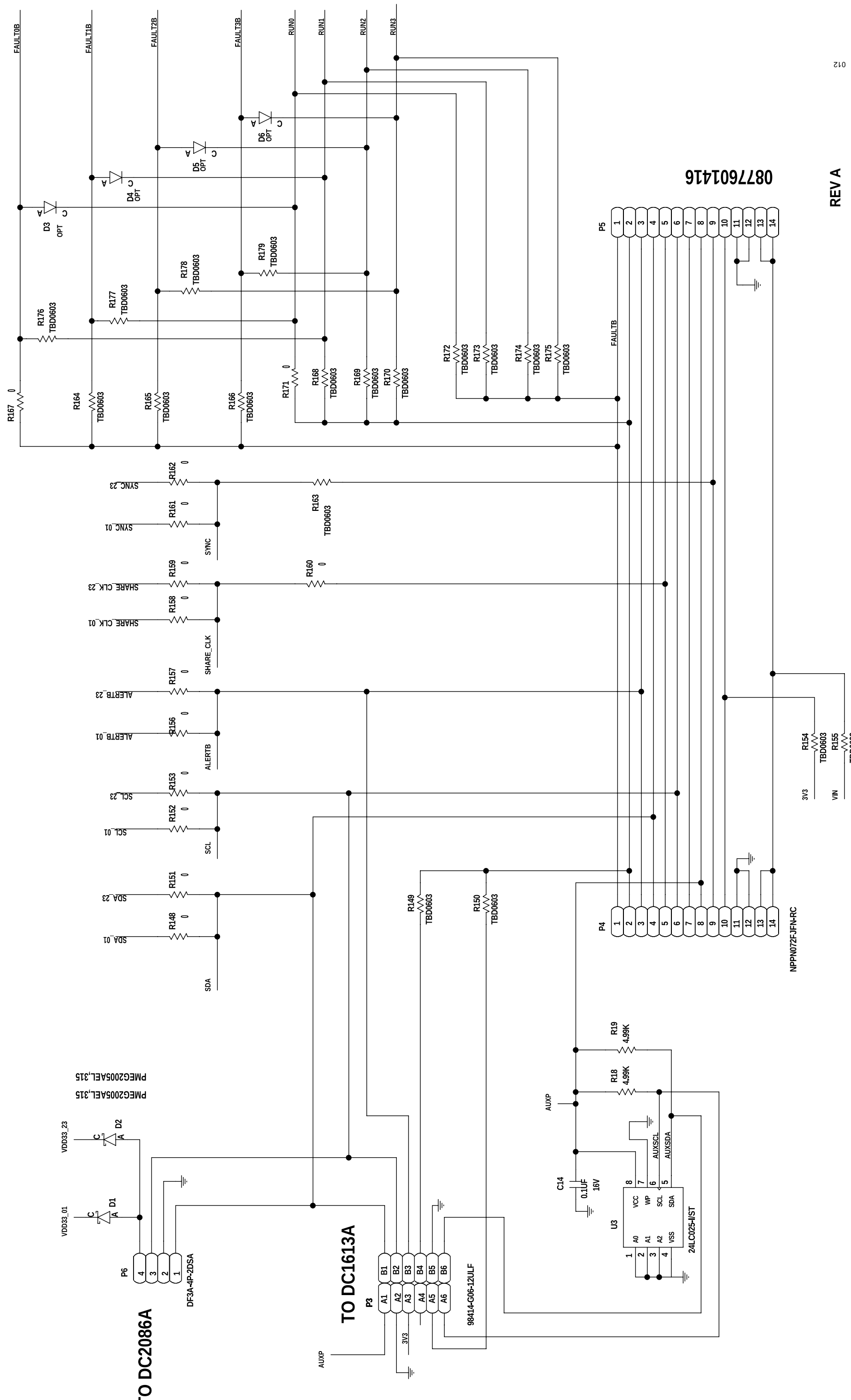
EVAL-LTM4682-A2Z Schematics



EVAL-LTM4682-A2Z Schematics (continued)



EVAL-LTM4682-A2Z Schematics (continued)



Ordering Information

PART	TYPE
EVAL-LTM4682-A2Z	The EVAL-LTM4682-A2Z evaluation board features the LTM4682, 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	03/25	Initial release.	—

Notes