EVAL-LTM4739-AZ

LTM4739
$15V_{IN}$, Single 10A Step-Down µModule Regulator with PMBus

General Description

The EVAL-LTM4739-AZ evaluation board features the LTM®4739: a complete, high efficiency, high power-density, single 10A DC-to-DC step-down power µModule® (micromodule) regulator with PMBus interface. The LTM4739 is available in a 49-lead 6.25mm × 6.25mm × 5.07mm Ball grid array (BGA) package. Read the *LTM4739* data sheet before using or making any hardware changes to the EVAL-LTM4739-AZ evaluation board.

The EVAL-LTM4739-AZ input voltage range is 3V to 15V, and the output voltage range is 0.4V to 5.5V. The maximum load current is 10A. The output voltage is adjusted through the feedback resistor divider or the PMBus VOUT_COMMAND (the factory default output voltage is 1V). The switching frequency range is 500kHz to 2MHz (factory default frequency is 500kHz), configured through the pin-strap resistor at the PGM1 or with PMBus commands. The resistor value at the PGM1 pin is also used to adjust the control loop compensation parameters. The resistor value at the PGM0 pin is used to configure the positive overcurrent (POC) protection triggering level and the factory default PMBus address (0x39h). The factory default POC protection sets the peak inductor current limit to 15A. At a high ambient temperature, the current output may need to be derated (Refer to the LTM4739 data sheet for more details).

The onboard 12-pin connector, the I2C/PMBus/SMBus DC1613A dongle controller, along with the LTpowerPlay® development tool, provides an easy way to communicate and program the EVAL-LTM4739-AZ evaluation board.

Features and Benefits

- Complete single-phase point-of-load (POL) solution.
- 90% full load efficiency from $12V_{IN}$ to $1V_{OUT}$ at 10A.
- PMBus telemetry of output current, reference voltage, input voltage, and junction temperature.

EVAL-LTM4739-AZ Evaluation Board

FILE	DESCRIPTION
EVAL-LTM4739-AZ	Evaluation board 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

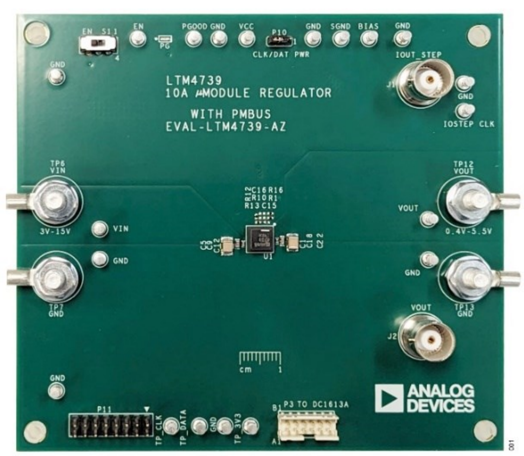

Figure 1. EVAL-LTM4739-AZ Evaluation Board (Part Marking is either ink Mark or Laser Mark)

DOCUMENT FEEDBACK
TECHNICAL SUPPORT
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Performance Summary

Specifications are at T_A = 25°C.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input voltage range		3		15	V
Output voltage, V_{OUT}		0.4	1	5.5	V
Maximum output current, I_{OUT}	Refer to the *LTM4739 data sheet thermal derating* curves section.		10		A
Typical efficiency	V_{IN} = 12V, V_{OUT} = 1.0V, I_{OUT} = 10A		90 (see *Figure 6*)		%
Default switching frequency			500		kHz

Quick Start

Required Equipment

- Power supply.
- Load such as an electronic load.
- Analog multimeter and/or digital multimeter (AMM/DMM).
- DC1613A USB-to-I^2C dongle.

Quick Start Procedure

The EVAL-LTM4739-AZ evaluation board is easy to set up to evaluate the performance of the LTM4739. See *Figure 2* for the proper measurement equipment setup and use the following procedure.

1. With the power off, connect the input power supply between VIN (TP6) and GND (TP7). Set the input voltage supply to 0V.
2. Connect the load between VOUT (TP12) and GND (TP13). Preset the load to 0A.
3. Connect the AMM/DMM between the input test points: VIN (TP5) and GND (TP8) to monitor the input voltage. Connect AMM/DMM between VOUT (TP19) and GND (TP20) to monitor the DC output voltage. These output voltage test points are Kelvin sensed directly across the C1 output capacitor to provide an accurate measurement of the output voltage. Do not apply load current to any of the test points to avoid damaging the regulator. Do not connect the scope probe ground leads to the GND test points TP8 and TP20 to prevent an unexpected impact on the accuracy of the measurement.
4. Before powering up the EVAL-LTM4739-AZ, check the default position of the jumpers and switches. See the following default switch and jumper positions.

Switch/Jumper Name	S1	P10
Description	EN	(Optional) Power for the optional dongle is interfaced with the P11 connector
Position	OFF	Short 2–3

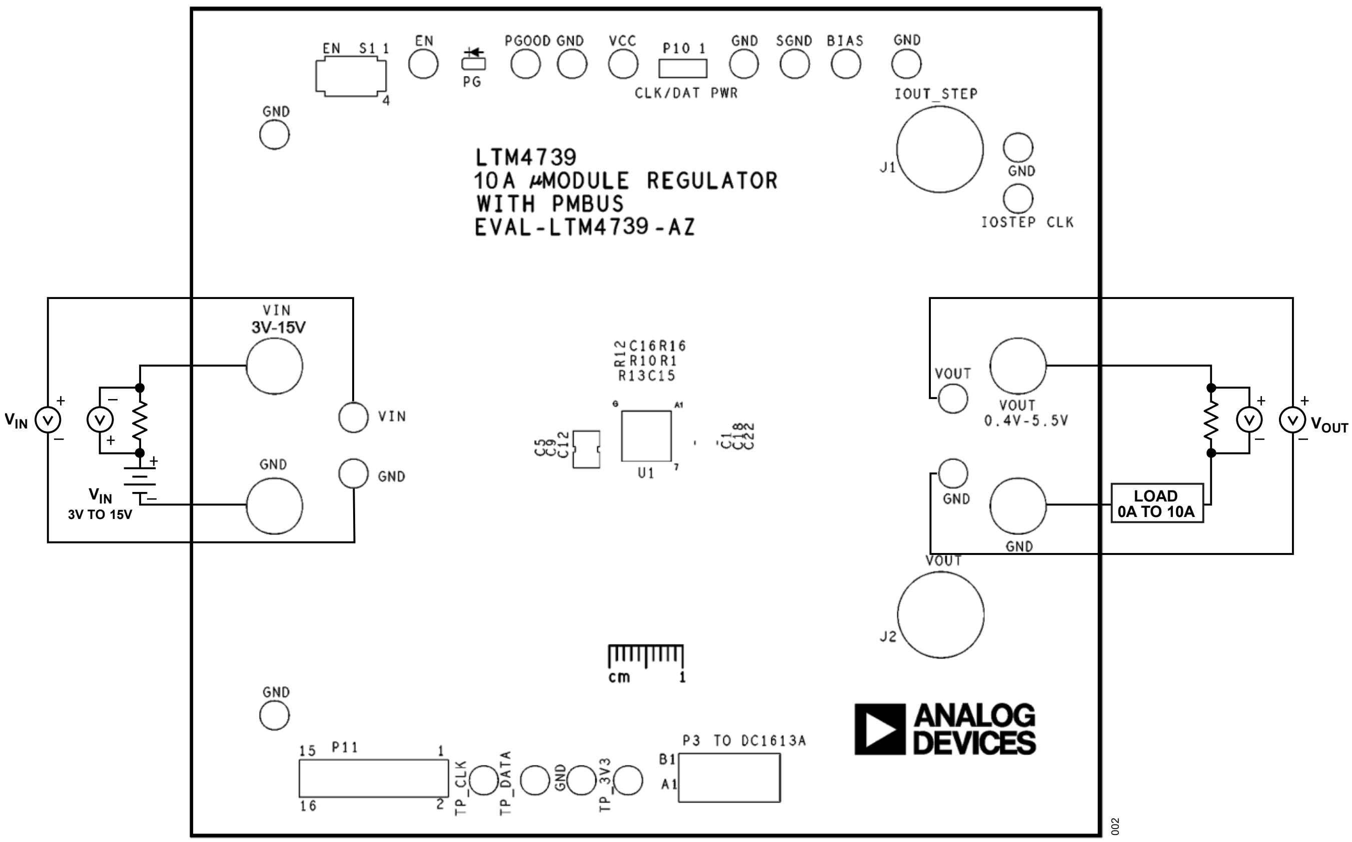


Figure 2. Proper Measurement Equipment Setup

5. Turn on the power supply at the input. Slowly increase the input voltage from 0V to 12V (typical). Measure and ensure that the input supply voltage is 12V, and then flip the EN pin to the ON position. The output voltage should be 1V typical.
6. Once the input and the output voltages are properly established, adjust the input voltage (15V max) and the load current within the operating range of 0A to 10A max. Observe the output voltage regulation, output voltage ripple, load transient response, and other parameters.

Output Voltage Ripple and Input Voltage Ripple Measurement

The output voltage ripple can be monitored using onboard Bayonet Neill–Concelman (BNC) terminals (J2). Connect short BNC cables from J2 to the inputs of a channel of an oscilloscope (scope probe ratio 1:1, AC-coupling) to observe output voltage ripple. The output voltage ripple can also be measured by the closed-loop passive probe.

When measuring the output or the 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.

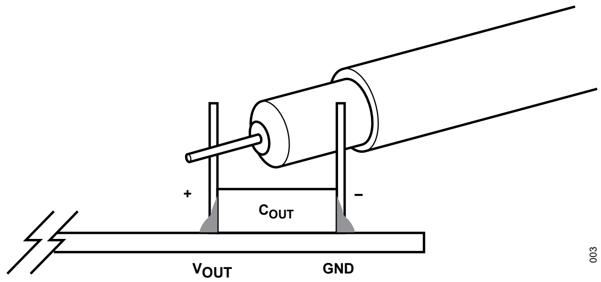


Figure 3. Measuring Output Voltage Ripple

Load Transient Response Measurement

The load transient response measurement can be conducted by either the onboard load transient circuit, or with the Analog Devices *EVAL-LTP™A-KIT* evaluation board laboratory tool kit. If the EVAL-LTM4739-AZ onboard load transient circuit is used, the ΔVOUT peak-to-peak deviation can be conveniently measured at the J2 connector while load current can be measured at the J1 connector, during the rising or falling of the dynamic load transient.

The simple load step circuit consists of a 40V N-channel power MOSFET and a 5mΩ, 1W, 1% current sense resistor. The MOSFET is configured as a voltage control current source (VCCS) device; 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 MOSFET.

Use a function generator to provide a voltage pulse between IOSTEP CLK (TP21) and GND (TP3). The input voltage pulse should be set to keep the pulse width short (<1ms) and pulse duty cycle low (<5%) to limit the thermal stress on the MOSFET device.

The output current step is measured directly across the current sense resistor and monitored by connecting a BNC cable from IOUT_STEP (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.

Bode Plot Measurement

To observe the loop gain frequency response of the LTM4739, the EVAL-LTM4739-AZ provides an easy way to measure the Bode plot and get the closed-loop bandwidth, phase margin, and gain margin information. This would help to evaluate the small-signal loop stability and response speed with selected compensation configurations.

The injected signal can be added at the R16 resistor by connecting the positive injection terminal to V_{OUT} and the negative injection terminal to the interconnection point between R16 and R12. The amplitude of the injection signal can affect the results of the gain and phase measurements. At low frequencies, the open-loop gain is high. By increasing the injected signal level at the low frequencies and improving the signal-to-noise ratio, the noise in the reading can be reduced. As the frequency is increased, the device under test (DUT) needs to drive the decreasing output capacitance impedance, which could lead to inaccurate gain and phase measurements. At the middle range of frequencies, the signal level could be set to a relatively low value. At higher frequencies (~500kHz+), the gain can be much less than 1, and it might be useful to increase the signal level again.

There are different types of laboratory equipment that can be utilized for the Bode plot measurement, including the Analog Devices *EVAL-LTPA-KIT* evaluation board laboratory tool kit or the AP300 Frequency Response Analyzer. The EVAL-LTPA-KIT evaluation board is a convenient laboratory tool kit to use in a compact setup to conduct the Bode plot and the load transient measurements, which saves time and debugging efforts.

(Option) Operation with V_{BIAS}

The BIAS pin is the optional internal low dropout (LDO) input pin, allowing connection from an external 2.5V to 5.5V bias input supply. The advantage of using V_{BIAS} is bypassing the internal LDO powered from V_{IN}, therefore, reducing the power loss, improving the overall efficiency, and lowering the temperature rise of the part, especially when operating at high V_{IN} and high switching frequency. In typical applications, it is recommended to enable V_{BIAS}.

Connecting a PC to the EVAL-LTM4739-AZ

Use a PC to reconfigure the power management features of the LTM4739, such as the V_{OUT} command, switching frequency, output current fault limit, loop compensation parameters, and other functionalities. See *Figure 4* for the proper evaluation board setup with a PC. The LTpowerPlay GUI design tool also offers voltage, current, and temperature real-time telemetry reporting, and fault status indication. The DC1613A dongle can be hot-plugged when V_{IN} is present.

The LTM4739 programmable parameters include reference voltage, switching frequency, loop compensation, forced continuous mode (FCM) operation, and discontinuous-conduction mode (DCM) operation at light load, soft start time, and POC protection level.

The EVAL-LTM4739-AZ evaluation board powers up to default settings based on configuration resistors at PGM0 and PGM1 pins without the need for any serial bus communication. This allows easy evaluation of the LTM4739. To access the PMBus features of the LTM4739, download the graphical user interface (GUI) software *LTpowerPlay* onto your PC and use the Analog Devices I^2C/SMBus/PMBus DC1613A dongle controller to connect to the EVAL-LTM4739-AZ evaluation board. Refer to the *LTM4739 User Reference Manual* for the supported PMBus and manufacturer-specific command set definitions.

For more details and instructions on using the LTpowerPlay design tool, refer to the *LTpowerPlay* GUI website.

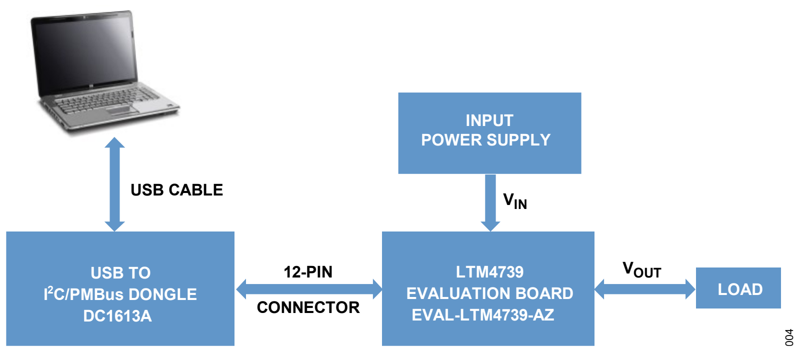


Figure 4. EVAL-LTM4739-AZ Evaluation Board Setup with a PC

LTpowerPlay Quick Start Guide

The LTpowerPlay is a powerful Windows-based development environment that supports the LTM4739. The software supports telemetry monitoring, configurable parameter updates, and fault status reporting. You can use LTpowerPlay to evaluate this family of products by connecting them to an evaluation board system.

The LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with the LTM4739 evaluation board system, or a customer board. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. The LTpowerPlay software can be downloaded *here*.

Figure 5 shows the LTpowerPlay main interface when the EVAL-LTM4739-AZ evaluation board is connected to the PC through the DC1613A dongle.

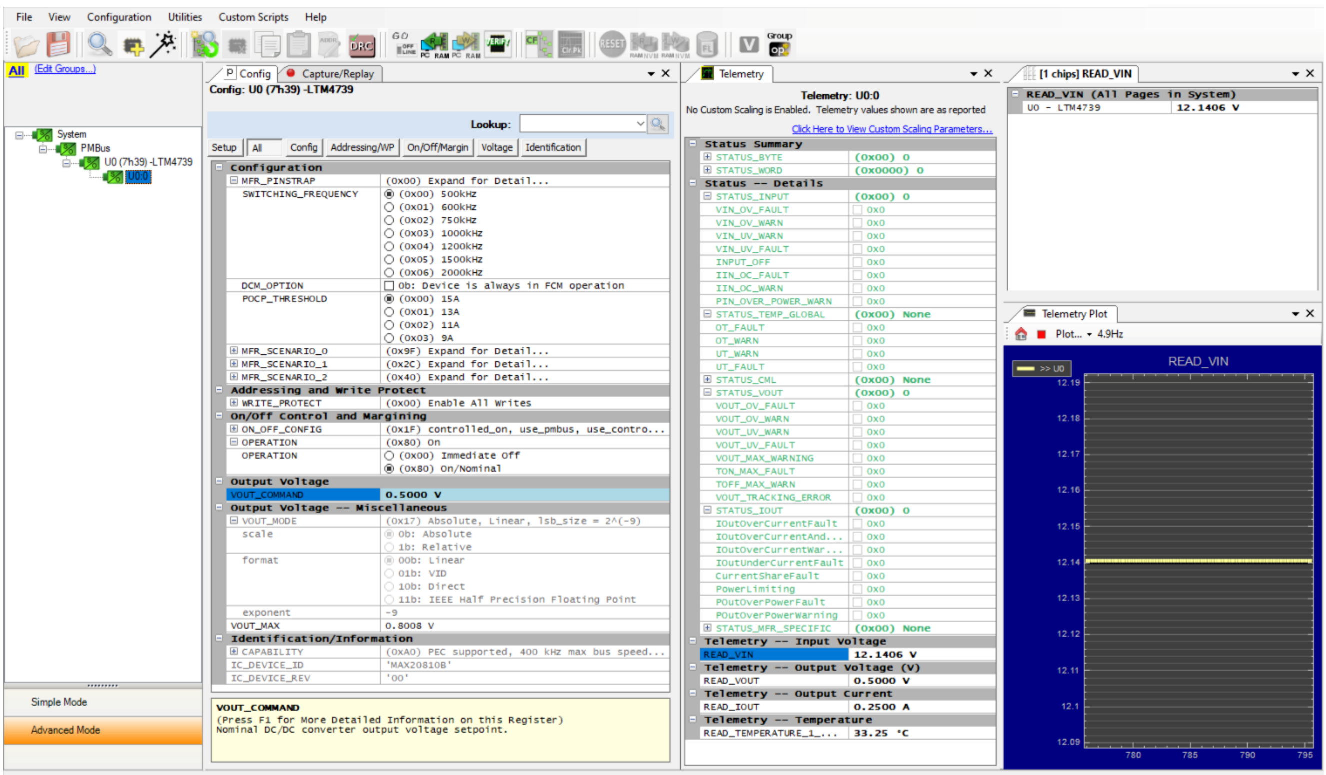
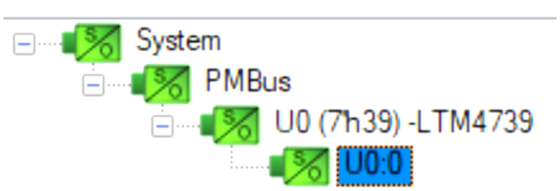


Figure 5. LTpowerPlay Main Interface

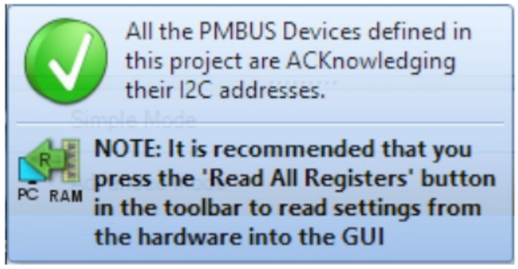
LTpowerPlay Procedure

The following procedure describes how to use the LTpowerPlay to monitor and change the settings of the LTM4739.

1. Download and install the LTpowerPlay GUI. Launch the LTpowerPlay GUI. If the GUI does not automatically identify the EVAL-LTM4739-AZ, **Click Detect Chips.** The system tree on the left-hand side should look like it follows.

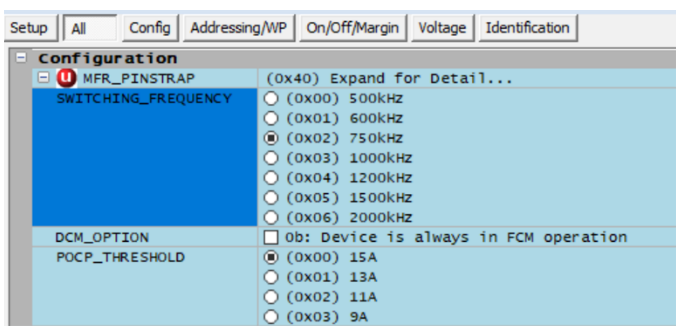


2. A message box shows for a few seconds in the lower left-hand corner, confirming that the LTM4739 is communicating.



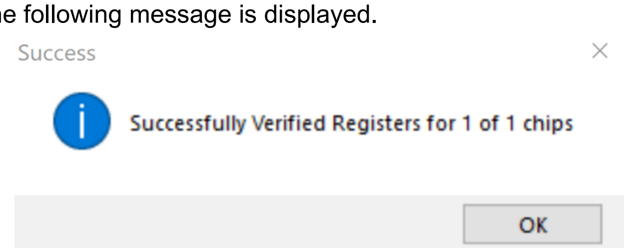
3. In the Toolbar, **Click the R** (RAM to PC) icon to read the RAM from the LTM4739. This reads the configuration from the RAM of the LTM4739 and loads it into the GUI.

4. If you want to change the switching frequency to a different value, like 750kHz, in the Configuration tab under the MFR_PINSTRAP option, **Select the SWITCHING_FREQUENCY**, and in the drop-down menu, **Select 750kHz** as shown in the following figure.



5. Then, **Click the W** (PC to RAM) icon to write these register values to the LTM4739. After finishing this step, the switching frequency will change to 750kHz. It could be verified by probing the output voltage ripple waveform at J2.

6. If the **Write** is successful, the following message is displayed.



7. Similar changes can be made to the VOUT_COMMAND register, POC protection triggering level, FCM/DCM operation at light load, soft start time, and loop compensation parameters.

Typical Performance Characteristics

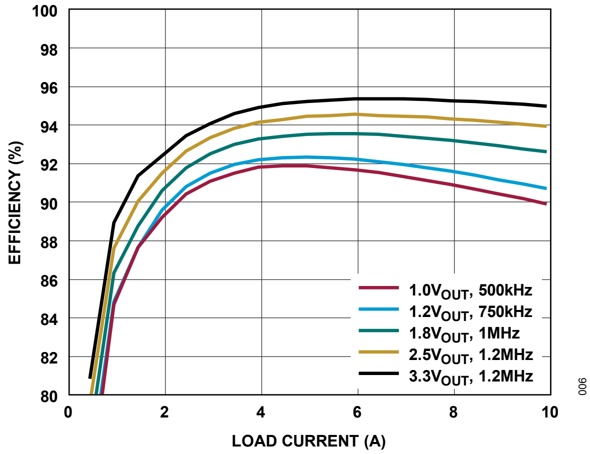


Figure 6. Efficiency vs. Load Current at V_{IN} = 12V with 3.3V_{BIAS}

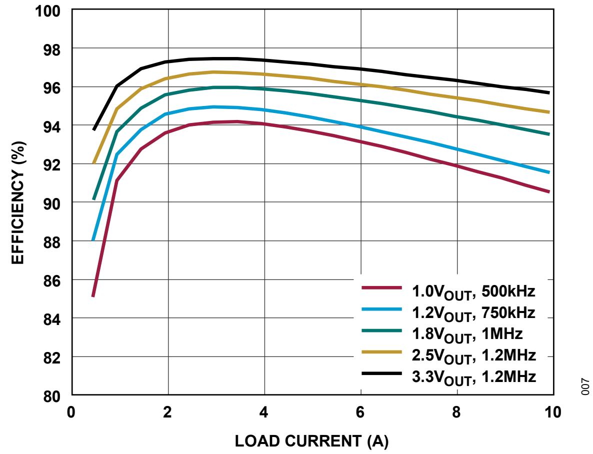


Figure 7. Efficiency vs. Load Current at V_{IN} = 5V with 3.3V_{BIAS}

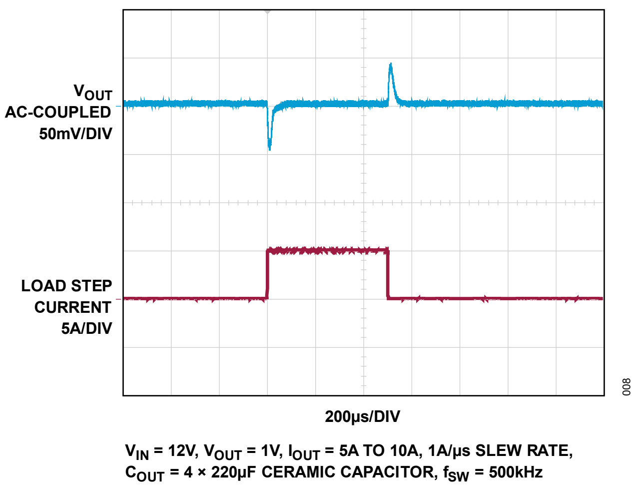


Figure 8. V_{OUT} Load Transient Response

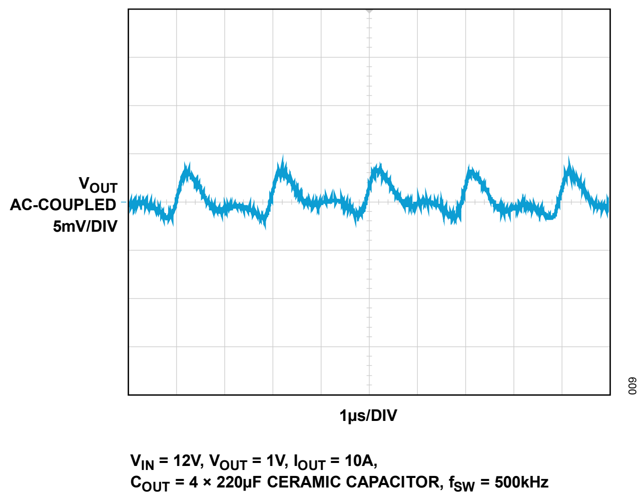


Figure 9. V_{OUT} Voltage Ripple

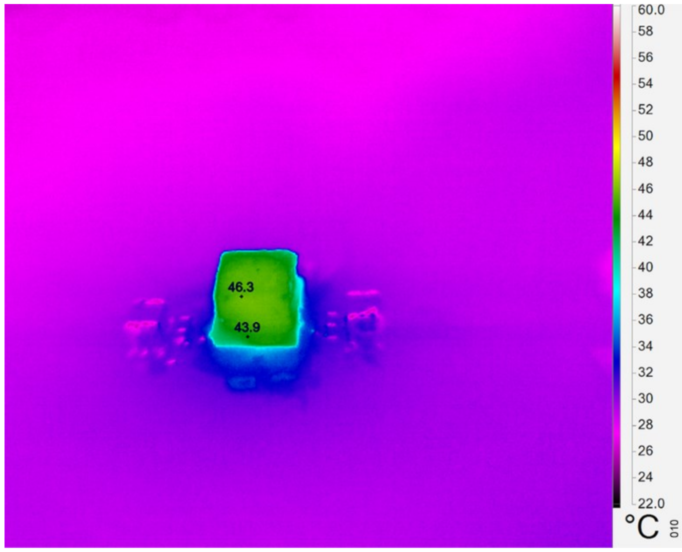


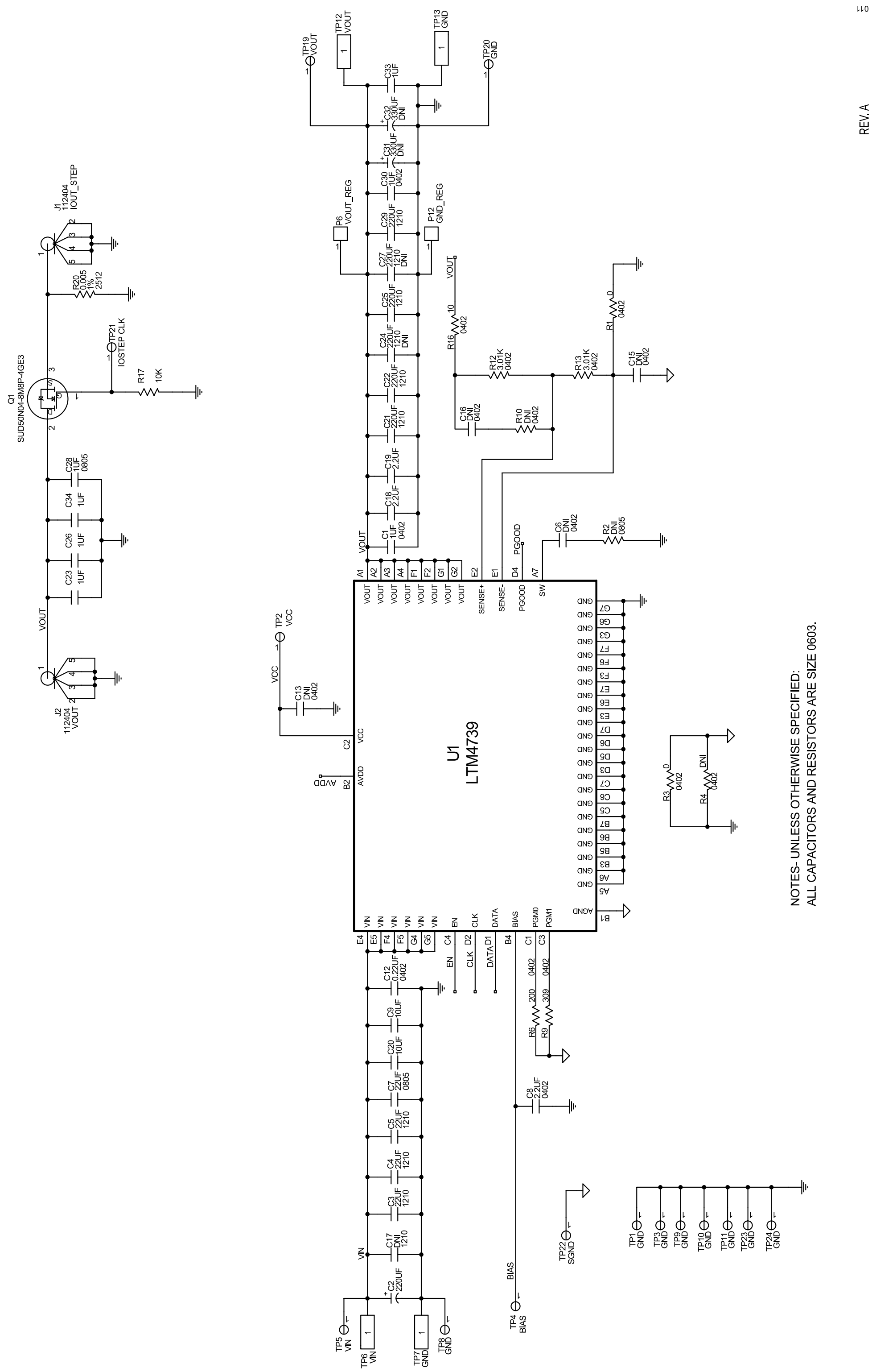
Figure 10. Thermal at V_{IN} = 12V, V_{OUT} = 1V, f_{SW} = 500kHz, I_{OUT} = 10A, T_A = 25°C, No Airflow

EVAL-LTM4739-AZ Evaluation Board Bill of Materials

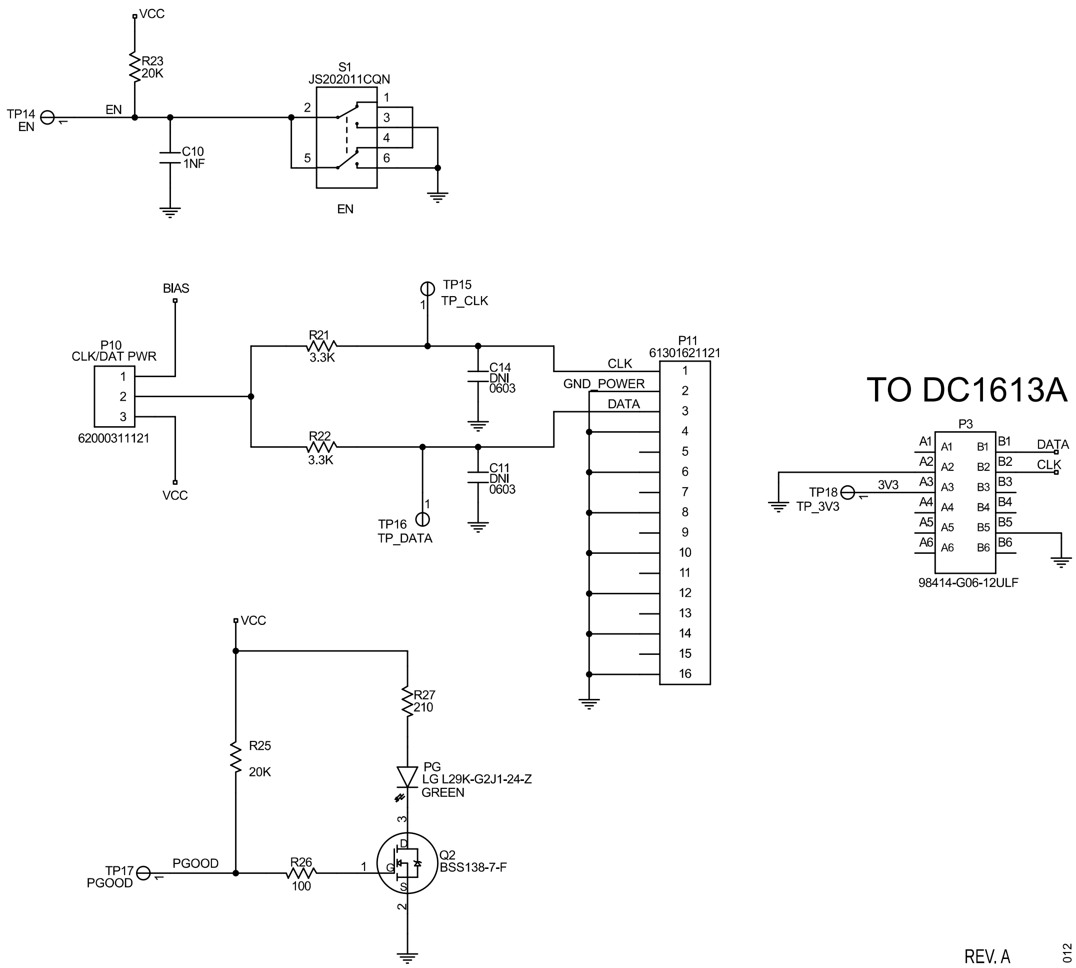
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	C1, C30	CAP. CER 1µF 10V 10% X7S 0402	TDK, C1005X7S1A105K050BC
2	1	C10	CAP. CER 1µF 100V 10% X7R 0603	AVX CORPORATION, 06031C102KAT2A
3	1	C12	CAP. CER 0.22µF 25V 10% X5R 0402	YAGEO, CC0402KRX5R8BB224
4	2	C18, C19	CAP. CER 2.2µF 10V 10% X7R 0603	MURATA, GRM188R71A225KE15D
5	1	C2	CAP. ALUM ELECT 220µF 25V 20% 2312 AEC-Q200	PANASONIC, EEETG1E221UP
6	2	C9, C20	CAP. CER 10µF 25V 20% X5R 0603	MURATA, GRM188R61E106MA73D
7	4	C21, C22, C25, C29	CAP. CER 220µF 6.3V 20% X5R 1210	MURATA, GRM32ER60J227ME05L
8	4	C23, C26, C33, C34	CAP., SMD, 0603, 1µF, 10%, 25V, X7R, CERAMIC	TDK, C1608X7R1E105K080AB
9	1	C28	CAP. CER 1µF 25V 10% X7R 0805 AEC-Q200	MURATA, GCM21BR71E105KA56L
10	3	C3-C5	CAP., SMT (1210), 22µF, 10%, 25V, X7R, CERAMIC	MURATA, GRM32ER71E226KE15
11	1	C7	CAP. CER 22µF 25V 20% X5R 0805	MURATA, GRM21BR61E226ME44L
12	1	C8	CAP. CER 2.2µF 6.3V 20% X5R 0402	MURATA, GRM155R60J225ME15D
13	2	J1, J2	CONN-PCB BNC JACK ST 50Ω	AMPHENOL CONNEX, 112404
14	1	P10	CONNECTOR, MALE, THROUGH HOLE, WR-PHD THT STRAIGHT SINGLE PIN HEADER, STRAIGHT, 3 PINS	WÜRTH ELECTRONICS, 62000311121
15	1	P11	CONN-PCB 16POS MALE HDR UNSHROUDED DOUBLE ROW ST, 2.54mm PITCH, 3mm SOLDER TAIL, 6mm POST HEIGHT	WÜRTH ELECTRONICS, 61301621121

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
16	2	P6, P12	CONN-PCB SMD CIRCUIT PROBE PAD	TE CONNECTIVITY, RCU-0C
17	1	P3	CON., MALE, STRAIGHT, TH, 12P, SHROUDED HEADER, 650V, 2A	AMPHENOL, 98414-G06-12ULF
18	1	PG	DIODE HYPER BRIGHT LOW CURRENT LED (GREEN)	OSRAM OPTO SEMICONDUCTORS, LG L29K-G2J1-24-Z
19	1	Q1	TRAN N-CH MOSFET 40V 14A	VISHAY, SUD50N04-8M8P-4GE3
20	1	Q2	TRAN MOSFET N-CH 50V 0.2A SOT23-3	DIODES INCORPORATED, BSS138-7-F
21	2	R1, R3	RES. SMD 0Ω JUMPER 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2GE0R00X
22	2	R12, R13	RES. SMD 3.01kΩ 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF3011X
23	1	R16	RES. SMD 10Ω 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF10R0X
24	1	R17	RES. SMD 10kΩ 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1002V
25	1	R20	RES. SMD 0.005Ω 1% 1W 2512 AEC-Q200	VISHAY, WSL25125L000FEA
26	2	R21, R22	RES. SMD 3.3kΩ 5% 1/10W 0603 AEC-Q200	VISHAY, CRCW06033K30JNEA
27	2	R23, R25	RES. SMD 20kΩ 5% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3GEYJ203V
28	1	R26	RES. SMD 100Ω 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1000V
29	1	R27	RES. SMD 210Ω 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW0603210RFKEA
30	1	R6	RES. SMD 200Ω 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF2000X
31	1	R9	RES. SMD 309Ω 1% 1/10W 0402 AEC-Q200	PANASONIC, ERJ-2RKF3090X
32	1	S1	SWITCH SLIDE DPDT 300MA 6V	C&K COMPONENTS, JS202011CQN
33	20	TP1-TP5, TP8-TP11, TP14-TP24	CONN-PCB SOLDER TERMINAL TEST POINT TURRET 0.094-INCH MTG. HOLE PCB 0.062-INCH THK	MILL-MAX, 2501-2-00-80-00-00-07-0
34	4	TP6, TP7, TP12, TP13	CUSTOM, CON, ASSY, TH, BROACHING STUDS, LENGTH 0.625-INCH, HEAD DIAMETER 0.250-INCH, SHANK 0.065-INCH, 10-32 THREAD, PHOSPHOR BRONZE	PENN ENGINEERING, KFH-032-10ET
35	1	U1	SINGLE 10A STEP-DOWN, 15V_{IN}, 6.25mm × 6.25mm, μModule, 49-PIN	ANALOG DEVICES, LTM4739
Additional Evaluation (Demo) Board Circuit Components				
1	0	C15, C16	CAP., OPTION, 0402	
2	0	C11, C14	CAP., OPTION, 0603	
3	0	C13	CAP., OPTION, 0402	
4	0	C17	CAP., OPTION, 1210	
5	0	C24, C27	CAP., OPTION, 1210	
6	0	C31, C32	CAP., OPTION, 7343	
7	0	C6	CAP., OPTION, 0402	
8	0	R4, R10	RES., OPTION, 0402	
9	0	R2	RES., OPTION, 0805	

EVAL-LTM4739-AZ Evaluation Board Schematic



EVAL-LTM4739-AZ Evaluation Board Schematic (continued)



Ordering Information

MODEL	DESCRIPTION
EVAL-LTM4739-AZ	15V_{IN}, single 10A µModule regulator evaluation board with PMBus feature.
DC1613A	The USB to PMBus controller dongle.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/25	Initial release	—

Notes

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