EVAL-LTM3360B-AZ

LTM3360B

5V$_{IN}$, 33A High Density Step-Down DC-to-DC µModule Regulator with I^{2}C and Integrated Capacitors

General Description

The EVAL-LTM3360B-AZ features the LTM®3360B, a 5V high-density buck power µModule® regulator. The high switching frequency of 2.5MHz permits integration of not only the input and output capacitors but also the power inductor, resulting in the highest density of output current-to-PC board footprint achievable in the industry today with minimal external components required. The LTM3360B has the highest output current-to-total solution footprint density at 1A/mm^2. The constant-frequency valley current mode control offers an extremely small on-time of 11ns. The LTM3360B can support up to 12 phases in a multiphase parallel configuration. The LTM3360B is available in a 160-pin 6.55mm × 5mm × 3.31mm ball grid array (BGA) package with excellent thermal performance. Refer to the LTM3360B data sheet before using or making any hardware changes to the EVAL-LTM3360B-AZ evaluation board.

The EVAL-LTM3360B-AZ input voltage range is from 2.9V to 5.5V, with a default output voltage set at 0.5V. The output voltage is adjustable from 0.3V to 1V using the LTpowerPlay® graphical user interface (GUI) or by using an external voltage divider. The EVAL-LTM3360B-AZ operates in forced continuous mode (FCM) at 2.5MHz switching frequency (f_{SW}).

The LTM3360B can also synchronize to an external clock using the SYNC input. An on-board transient circuit is included to demonstrate the fast transient performance. The LTM3360B data sheet gives a complete description of the device, its operation, and application information.

Features and Benefits

- Transient Circuit included for Transient Load Evaluation
- External Clock Synchronization
- GUI with LTpowerPlay Development Tool

EVAL-LTM3360B-AZ Evaluation Board Files

FILE	DESCRIPTION
EVAL-LTM3360B-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-LTM3360B-AZ Evaluation Board (Device 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, V_{OUT} = 0.5V.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input voltage range, V_{IN}		2.9		5.5	V
Output voltage, V_{OUT}		495	500	505	mV
Maximum output current, I_{OUT}			33		A
f_{SW}			2.5		MHz
Typical efficiency	V_{IN} = 3.3V, I_{OUT} = 10A		86.8		%

Quick Start

Required Equipment

- DC voltage sources
- An electronic load
- Analog multimeter and/or digital multimeter (AMM/DMM)
- A signal generator
- An oscilloscope
- DC1613A USB-to-I^{2}C dongle

Quick Start Procedure

Before following this quick start procedure, and to measure accurate input/output voltages and efficiency, ensure that the V_{IN} is measured at the VIN SNSE and GND SNSE turrets. The V_{OUT} is measured at the VOUT SNSE and GND SNSE turrets. See *Figure 2* for the proper measurement equipment test setup.

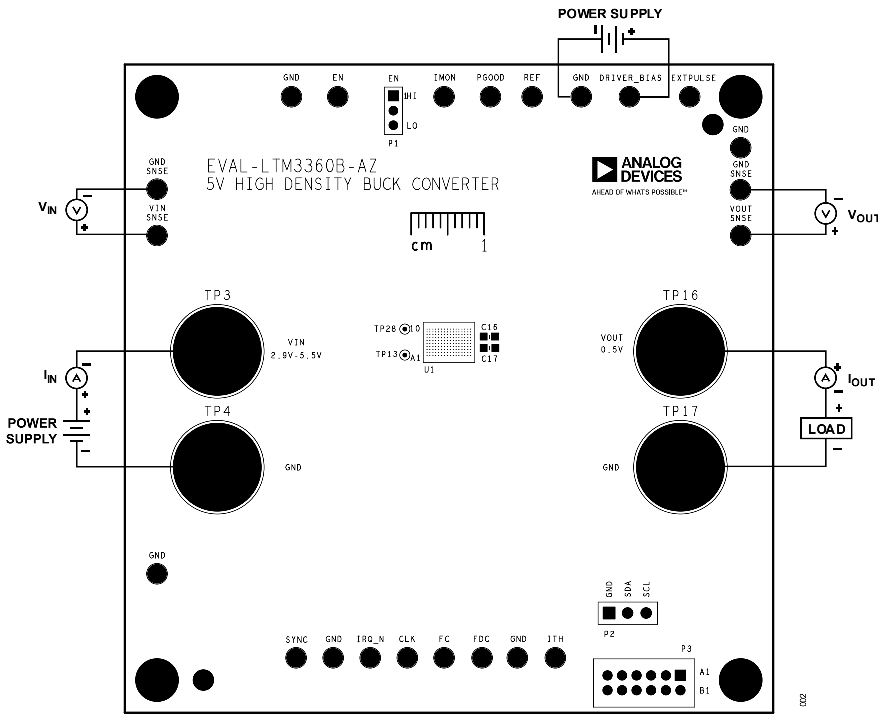


Figure 2. Test Setup for EVAL-LTM3360B-AZ

1. Set the P1 jumper to the high position.
2. With the power supply turned off, connect the input power supply to VIN and GND.
3. Set input power supply voltage between 2.9V to 5V, and current limit to 10A.
4. Set the electronic load to constant current (CC) mode with 0A current and connect to VOUT and GND.
5. Turn on the input power supply.
6. Verify that V_{IN} and V_{OUT} read the correct voltage level. Check I_{IN} and I_{OUT}. Once the proper output voltages are established, adjust the loads within the operating range, observe the output voltage regulation, ripple voltage, and other parameters.
7. Connect an oscilloscope voltage probe as shown in *Figure 3* to avoid a long ground lead on the oscilloscope probe. For high-frequency output ripple measurement, it is recommended to use the micro-miniature coaxial (MMCX) plug on J1.
8. To evaluate the transient response, connect a 5V second power supply to the DRIVER_BIAS and GND turrets. Connect a signal generator to the EXTPULSE and GND turrets. It is recommended to start the signal generator with a 10µs pulse width, a 5% duty cycle, and an amplitude of 0V to 0.5V.
9. Measure the J2 voltage over the R_{SNS} = 2mΩ to observe the current. It is recommended to use the MMCX plug on J2 to accurately measure the R_{SNS} voltage. Adjust the amplitude of the external pulse, V_{EXT}, to provide the desired transient. Adjust the rising and falling edges of the pulse to provide the desired ramp rate. *Figure 9* shows a load step from 0A to 5A in 1µs (see Equation *1* and Equation *2*).

$$I_{OUT} = \frac{V_{RSNS}}{2m\Omega} \quad (1)$$

$$V_{EXT} = I_{OUT} \times 2mV/A \quad (2)$$

10. When done, turn off the signal generator, DRIVER_BIAS power supply, load, and V_{IN} power supply. Remove all the connections to the EVAL-LTM3360B-AZ evaluation board.

Output Voltage Ripple Measurement

The output voltage ripple can be monitored using the onboard MMCX connector terminal (J1). Connect a short MMCX to a BNC cable from J1 to the input of a channel of an oscilloscope (scope probe ratio 1:1, 50Ω impedance) to observe output voltage ripple. The output voltage ripple can also be measured by the closed-loop passive probe. When measuring the output 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.

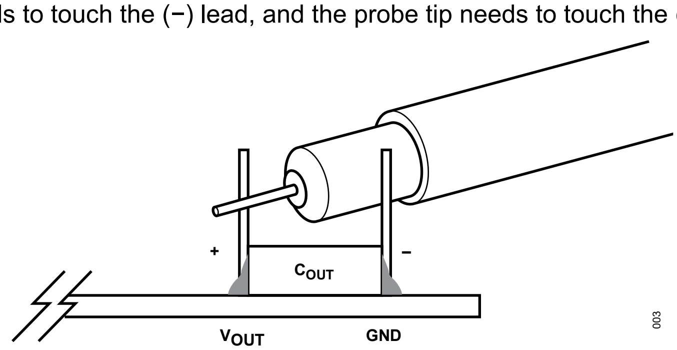


Figure 3. Technique for Measuring Output Ripple and Step Response with a Scope Probe

Load Transient Response Measurement

The load transient response measurement can be conducted by the onboard load transient circuit. The ΔV_{OUT} peak-to-peak deviation can be conveniently measured at the J1 connector while load current can be measured at the J2 connector, during the rising or falling of the dynamic load transient.

The simple load-step circuit consists of a 25V N-channel power metal-oxide-semiconductor field-effect transistor (MOSFET) and a 2mΩ, 1W, 1% current sense resistor. The MOSFET is configured as a voltage-controlled current source (V_{CCS}) 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 EXTPULSE (TP14) and GND (TP9). 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 MMCX–to–bayonet Neill–Concelman (BNC) cable from J2 to the oscilloscope's input (scope probe ratio 1:1, 50Ω impedance). The equivalent voltage to the current scale is 2mV/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.

Hiccup Mode for Short-Circuit Protection

To prevent the LTM3360B from overheating during a short circuit, the hiccup mode can be enabled by connecting the EN pin to the $\overline{IRQ}$ pin through R14 = 0Ω.

When a short circuit occurs, the $\overline{IRQ}$ pin is pulled low, disabling the regulator and shutting down the device for protection. Once V_{OUT} drops and the output current decreases, the $\overline{IRQ}$ pin resumes high, and the system successfully attempts to restart. If the short-circuit still persists, the EN pin is pulled low again, repeating the cycle.

FC and FDC Connection

Current version of the evaluation (demo) board proves it's okay to float FC_GND and FDC_GND in the main mode. These two pins are preferred to be grounded as suggested by data sheet.

LTpowerPlay Quick Start Guide

The LTpowerPlay is a powerful Windows®-based development environment that supports the LTM3360B. The software supports telemetry monitoring, configurable parameter updates, and fault status reporting. LtpowerPlay can be used to evaluate the LTM3360B by connecting it to an evaluation board system.

The LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with the EVAL-LTM3360B-AZ evaluation 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 4 shows the LTpowerPlay main window interface when the EVAL-LTM3360B-AZ evaluation board is connected to the PC through the DC1613A dongle, as shown in *Figure 5*.

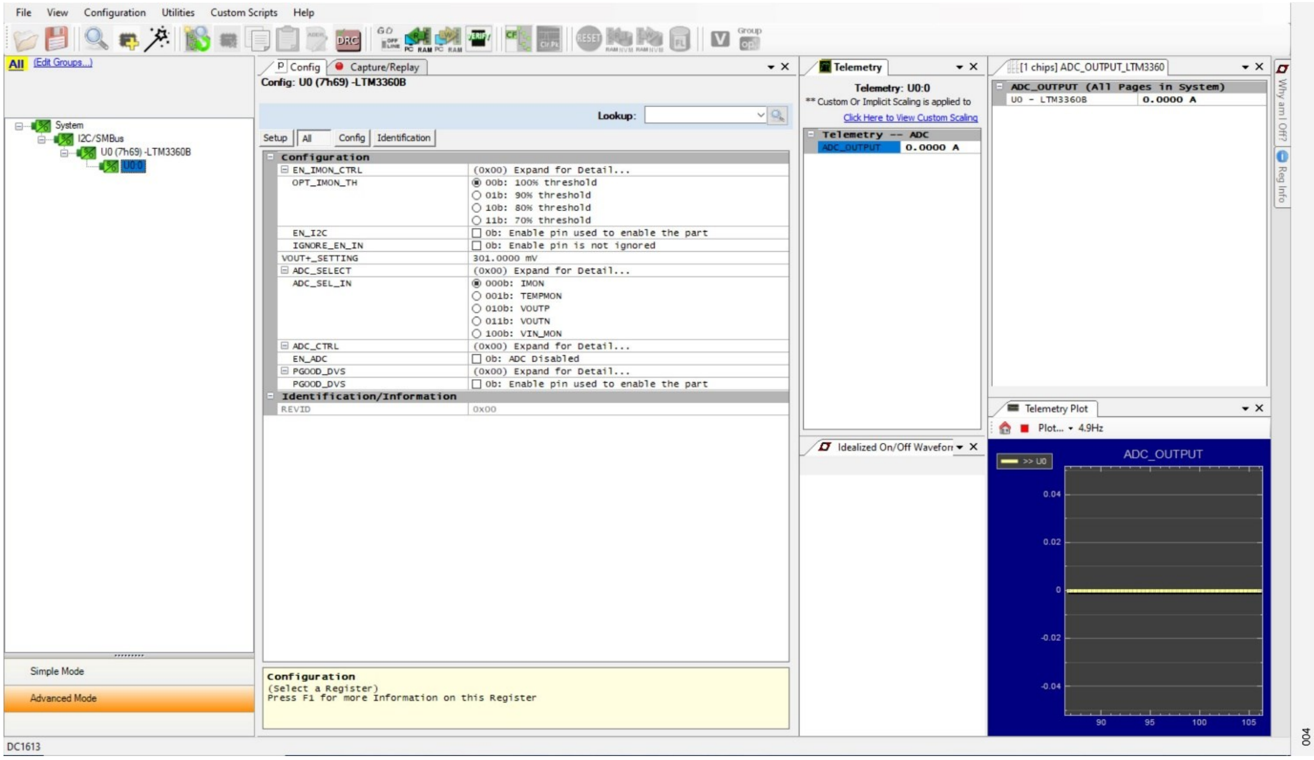


Figure 4. LTM3360B GUI Main Window

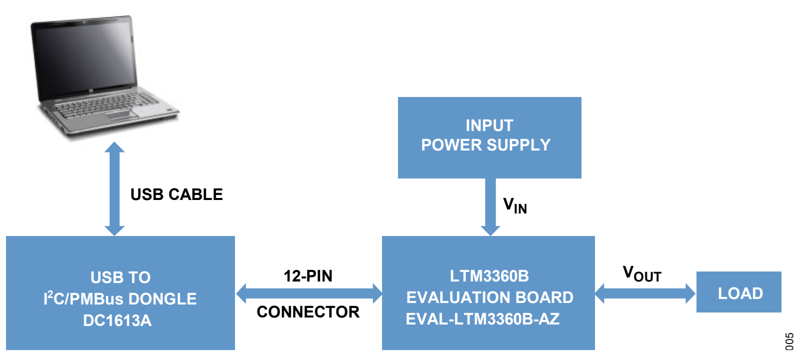


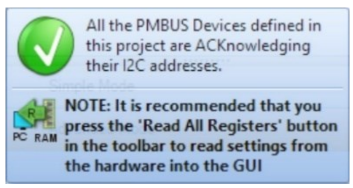
Figure 5. EVAL-LTM3360B-AZ Evaluation Board Setup with a PC

LTpowerPlay Procedure

The following procedure describes how to use LTpowerPlay to monitor and change the LTM3360 B's settings.

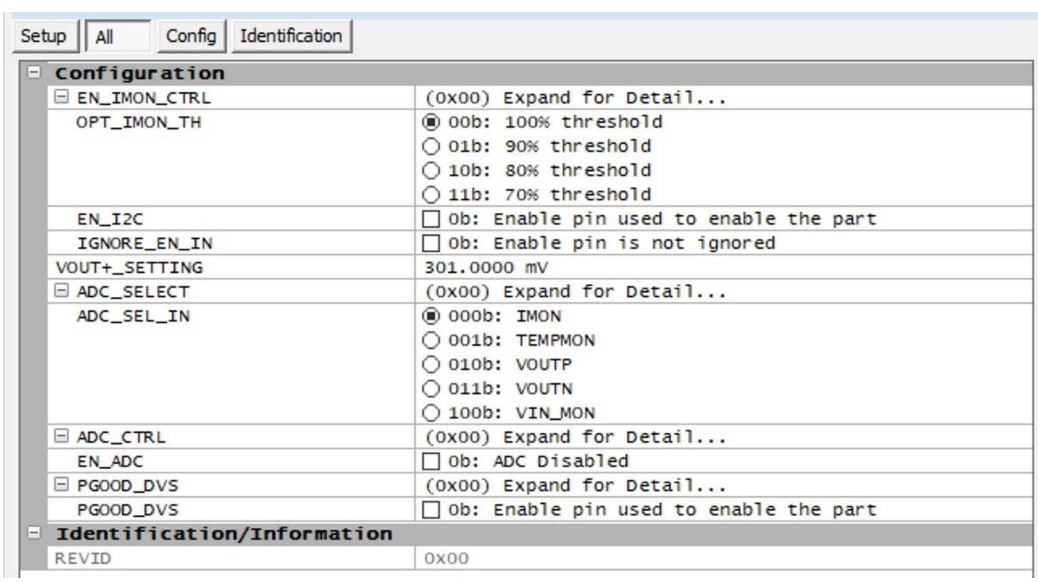
1. Download and install the LTpowerPlay GUI. Connect EVAL-LTM3360B-AZ with the DC1613A dongle as shown in *Figure 5*. Power up the evaluation board. Launch the LTpowerPlay GUI. **Click Select Chips** and find the LTM3360B device in the list. After the main window loads, **Click the Go Online/Offline** button. The system tree on the left-hand side should look like it as follows.

2. A message box shows for a few seconds in the lower left-hand corner, confirming that the LTM3360B is communicating.



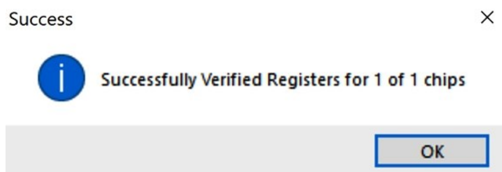
3. In the toolbar, **Click the R icon** (RAM to PC) to read the RAM from the LTM3360B device. This reads the configuration from the LTM3360B and loads it into the GUI.

4. To change the settings of the LTM3360B μModule, modify the associated registers.

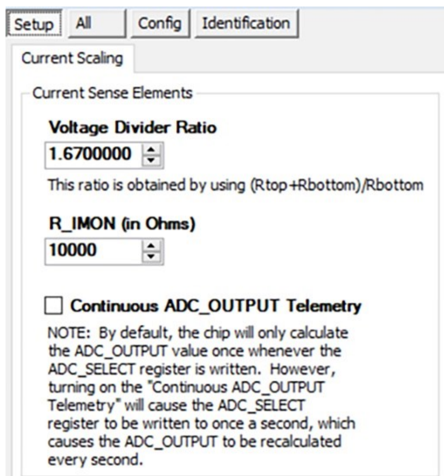


5. Then, **Click the W** icon (PC to RAM) to write these register values to the LTM3360B. After this, the changes can be verified on the board.

6. If the write is successful, the following message is displayed. The changes can also be verified on the board.



7. For a specific output voltage, the voltage divider needs to be changed on the board. To view the correct output voltage in Telemetry, change the voltage divider ratio in the GUI.



Typical Performance Characteristics

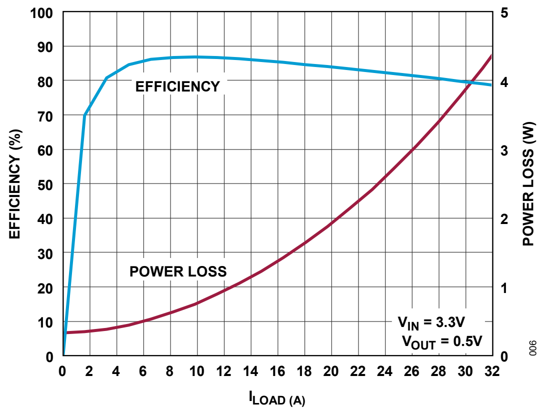


Figure 6. Efficiency vs. Load Current

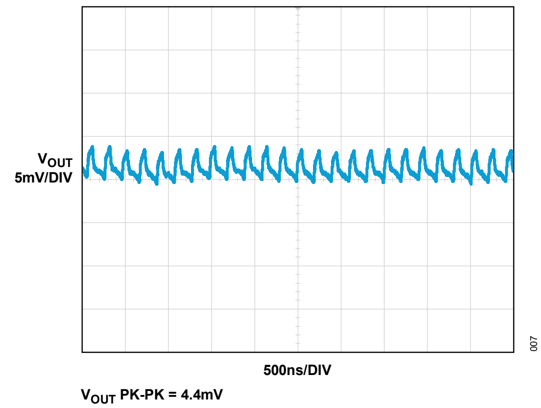


Figure 7. Output Voltage Ripple, V_{IN} = 3.3V, V_{OUT} = 0.5V, No Load

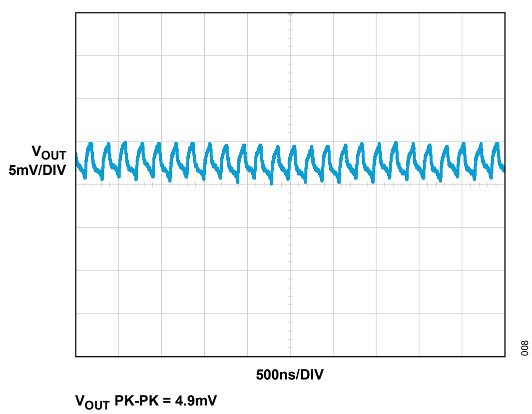


Figure 8. Output Voltage Ripple, V_{IN} = 3.3V, V_{OUT} = 0.5V, 33A Load

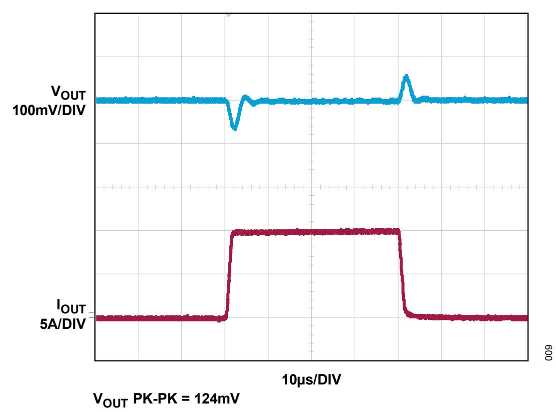


Figure 9. Load Step Response, V_{IN} = 3.3V, V_{OUT} = 0.5V

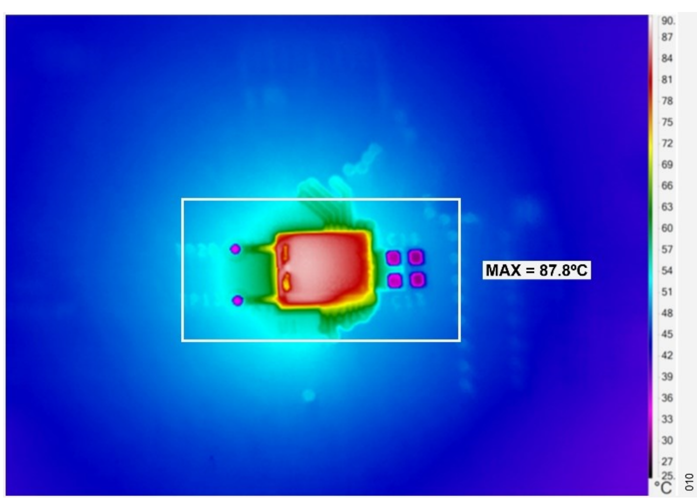


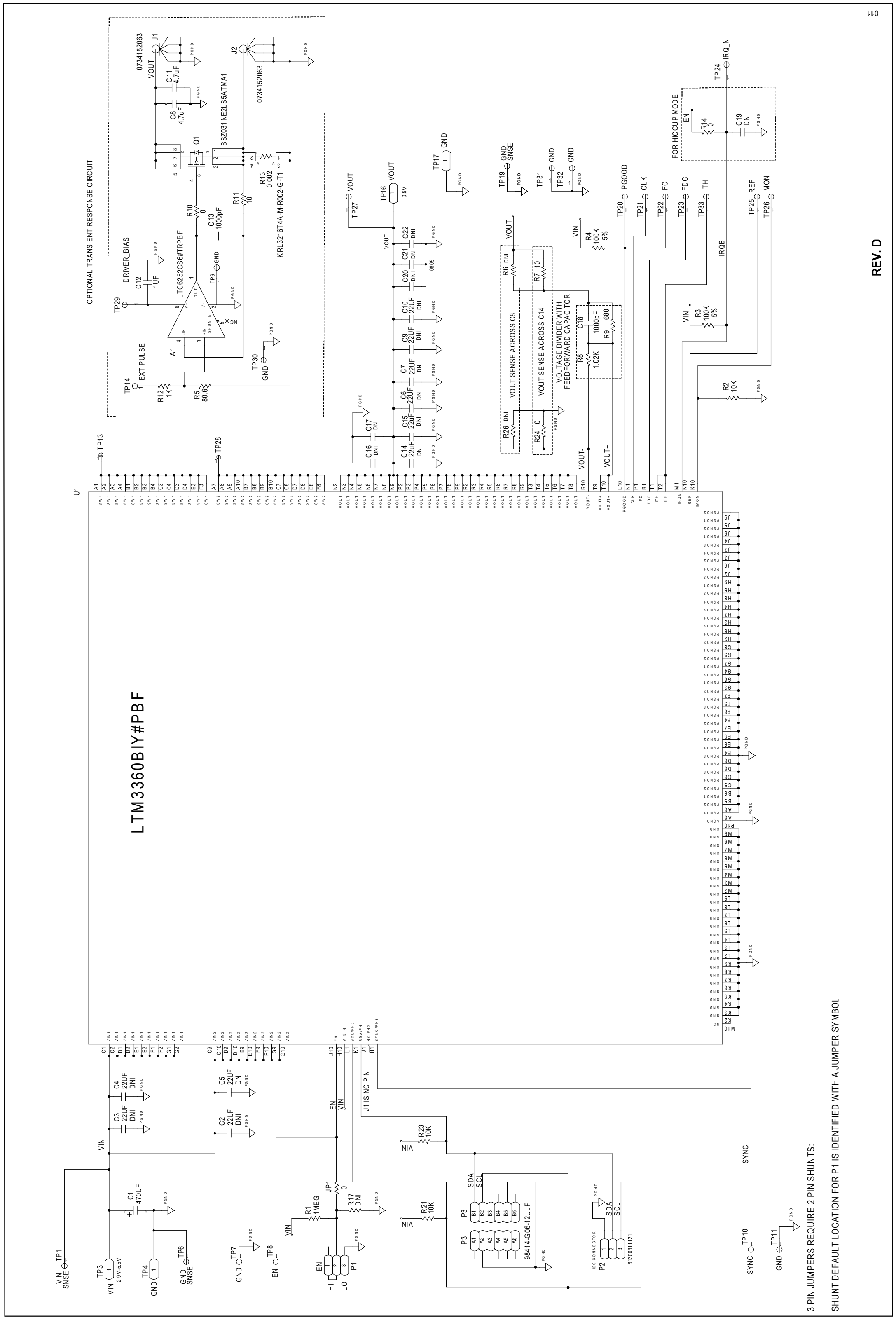
Figure 10. Thermal Performance, V_{IN} = 3.3V, V_{OUT} = 0.5V, Load = 33A, No Heatsink or Airflow

EVAL-LTM3360B-AZ Evaluation Board Bill of Materials

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components			
1	A1	IC-ADI 720MHz, 3.5mA, POWER EFFICIENT RAIL-TO-RAIL I/O OP AMP	ANALOG DEVICES, LTC6252CS6#TRPBF
1	C1	CAP. TANT POLY 470µF, 6.3V, 20% 7343-40	PANASONIC, 6TCE470MI
2	C8, C11	CAP. CER 4.7µF, 6.3V, 20% X6S 0402 AEC-Q200	MURATA, GRT155C80J475ME13D
1	C12	CAP. CER 1µF, 25V, 10% X5R 0603	MURATA, GRM185R61E105KA12D
1	C13	CAP. CER 1000pF, 50V, 5% C0G 0603	MURATA, GRM1885C1H102JA01D
1	C18	CAP. CER 1000pF, 16V, 10% X7R 0402	YAGEO, CC0402KRX7R7BB102
2	J1, J2	CONN-PCB MMCX JACK STR 50Ω 0GHz to 6GHz	MOLEX, 734152063
4	JP1, R10, R14, R24	RES. SMD 0Ω, JUMPER 1/16W 0402 AEC-Q200	VISHAY, CRCW04020000Z0ED
1	P1	CONN-PCB 3-POS MALE HDR UNSHROUDED, SINGLE ROW ST, 2mm PITCH, 2.70mm SOLDER TAIL	WÜRTH ELEKTRONIK, 62000311121
1	P2	CONN-PCB UNSHROUDED HDR, 6mm POST HEIGHT, 2.54mm PITCH	WÜRTH ELEKTRONIK, 61300311121
1	P3	CONN-PCB 12-POS SHROUDER HDR, 2mm PITCH, 4mm POST HEIGHT, 2.5mm SOLDER TAIL	AMPHENOL, 98414-G06-12ULF
1	Q1	TRAN. MOSFET N-CH 25V, 19A 8LD TSDSON EP	INFINEON TECHNOLOGIES, BSZ031NE2LS5ATMA1
1	R1	RES. SMD 1MΩ, 1% 1/16W, 0402 AEC-Q200	VISHAY, CRCW04021M00FKED
1	R11	RES. SMD 10Ω, 1% 1/10W, 0402 AEC-Q200	PANASONIC, ERJ-2RKF10R0X
1	R12	RES. SMD 1kΩ, 1% 1/16W, 0402 AEC-Q200	VISHAY, CRCW04021K00FKED
1	R13	RES. SMD 0.002Ω, 1W, 2% 1206 AEC-Q200	SUSUMU CO., LTD., KRL3216T4A-M-R002-G-T1
3	R2, R21, R23	RES. SMD 10kΩ, 1% 1/16W, 0402 AEC-Q200	VISHAY, CRCW040210K0FKED
2	R3, R4	RES. SMD 100kΩ, 5% 1/16W, 0402 AEC-Q200	VISHAY, CRCW0402100KJNED
1	R5	RES. SMD 80.6Ω, 1% 1/16W, 0402 AEC-Q200	VISHAY, CRCW040280R6FKED
1	R7	RES. SMD 10Ω, 5% 1/10W, 0603 AEC-Q200	VISHAY, CRCW060310R0JNEA

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	R8	RES. SMD 1.02kΩ, 0.1% 1/16W 0402 AEC-Q200 HIGH RELIABILITY	PANASONIC, ERA-2ARB1021X
1	R9	RES. SMD 680Ω, 0.1% 1/16W 0402 AEC-Q200 HIGH RELIABILITY	PANASONIC, ERA-2ARB681X
22	TP1, TP6 to TP11, TP14, TP19, TP20 to TP27, TP29 to TP33	CONN-PCB SOLDER TERMINAL TURRETS FOR CLIP LEADS	MILL-MAX, 2308-2-00-80-00-00-07-0
4	TP3, TP4, TP16, TP17	CONN-PCB THREADED BROACHING STUD, 625Mil LENGTH	PENN ENGINEERING, KFH-032-10ET
1	U1	ADI 5V, 33A HIGH DENSITY µModule DC-TO-DC REGULATOR WITH INTEGRATED CAPACITOR	ANALOG DEVICES, LTM3360BIY#PBF
Additional Evaluation Board Circuit Components			
1		SHUNT FEMALE 2-POS 2mm	WURTH ELEKTRONIK, 60800213421
4		STANDOFF, SELF-RETAINING SPACER, 12.7mm LENGTH	WURTH ELEKTRONIK, 702935000
4		WASHER, #10 FLAT STEEL	KEYSTONE, 4703
4		CONNECTOR RING LUG TERMINAL, 10 CRIMP, NON-INSULATED	KEYSTONE, 8205
8		NUT, HEX STEEL, 10-32 THREAD, 9.27mm OUT DIA.	KEYSTONE, 4705
Hardware: For Evaluation Board Only			
8	C2 to C7, C9, C10	CAP. CER 22µF, 10V, 20% X5R 0402	MURATA, GRM158R61A226ME15
2	C14, C15	CAP CER 22µF, 10V, 20% X5R 0603	MURATA, GRM188R61A226ME15D
2	C16, C17	DO NOT INSTALL (TBD_C0603), USE SYM_3 AND/OR SYM_4	TBD0603, TBD0603
1	C19	DO NOT INSTALL (TBD_C0402), USE SYM_3 AND/OR SYM_4	TBD0402, TBD0402
3	C20-C22	DO NOT INSTALL (TBD_C0805), USE SYM_3 AND/OR SYM_4	TBD0805, TBD0805
1	R17	RES SMD 1MΩ 1% 1/16W 0402 AEC-Q200	VISHAY, CRCW04021M00FKED
1	R26	RES SMD 0Ω JUMPER 1/8W 0402 AEC-Q200	VISHAY, RCC04020000Z0ED
1	R6	DO NOT INSTALL (TBD_R0603), USE SYM_3 AND/OR SYM_4	TBD0603, TBD0603

EVAL-LTM3360B-AZ Evaluation Board Schematic



Ordering Information

MODEL	DESCRIPTION
EVAL-LTM3360B-AZ	The EVAL-LTM3360B-AZ evaluation board features the LTM3360B, 5V, 33A high-density μModule buck regulator.
DC1613A	The USB-to-PMBus controller dongle.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/25	Initial release	—

Notes