EVAL-LTM4712-A2Z

LTM4712
36V, High Efficiency Quad PolyPhase Buck-Boost µModule Regulator
4x LTM4712, 48A

General Description

The EVAL-LTM4712-A2Z evaluation board is a power supply generating 12V, 48A (max) from a 5V to 36V input. It is a quad PolyPhase® solution featuring the *LTM4712*, a high-efficiency, buck-boost µModule® (micromodule) regulator. The EVAL-LTM4712-A2Z is capable of 48A in buck and buck-boost modes and 24A in boost mode. Derating is necessary for certain V_{IN}, V_{OUT}, frequency and thermal conditions. See the *Performance Summary* and the LTM4712 data sheet.

The EVAL-LTM4712-A2Z has an optional constant-current feature to deliver a precise, regulated current while the load may vary.

The EVAL-LTM4712-A2Z is optimized using a default frequency of 400kHz. The peak current mode control architecture allows easy current sharing. The LTM4712 operates in continuous current mode by default but can be placed in pulse-skipping mode to optimize efficiency at light loads.

The LTM4712 is offered in a 16mm × 16mm × 8.34mm ball grid array (BGA) package suitable for automated assembly by standard surface mount equipment. The µModule package features an inductor on top of the molded substrate for improved heatsinking capability.

The LTM4712 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 manual prior to working on or modifying the EVAL-LTM4712-A2Z evaluation board.

Features and Benefits

- Parallel for high-power applications
  - Good current sharing
- Current monitoring pin for all channels
- Optional constant current mode

EVAL-LTM4712-A2Z Files

FILE	DESCRIPTION
EVAL-LTM4712-A2Z	Evaluation board design files.

***Ordering Information* appears at end of data sheet.**

Quick Start

Required Equipment

- One power supply
- One electronic load
- Two multimeters

Quick Start Procedure

The EVAL-LTM4712-A2Z is an easy way to evaluate the performance of the LTM4712 in a multiphase application. See *Figure 2* for proper measurement equipment setup and use the following procedure.

1. Place jumpers in the following positions for a typical $12V_{OUT}$ operation.

JP1	RUN	ON
JP2	MODE	FCM

2. With power off, connect the input power supply to VIN (TP1) and to GND (TP2).
3. Connect the output load to VOUT (TP19) and to GND (TP20).
4. Connect DMM between test points VIN (TP3) and GND (TP4) to measure input voltage. Connect another DMM between test points VOUT (TP17) and GND (TP18) to measure DC output voltage.
5. Turn on the power at the input. Set the voltage of the DC power supply between 5V to 36V. Note: Make sure the input voltage does not exceed 36V. Check that the output voltage measures 12V ±0.5% (or 11.94V to 12.06V).
6. Once the proper output voltage is established, adjust the load within the operating range and measure the output voltage regulation, ripple voltage, efficiency, and other parameters.

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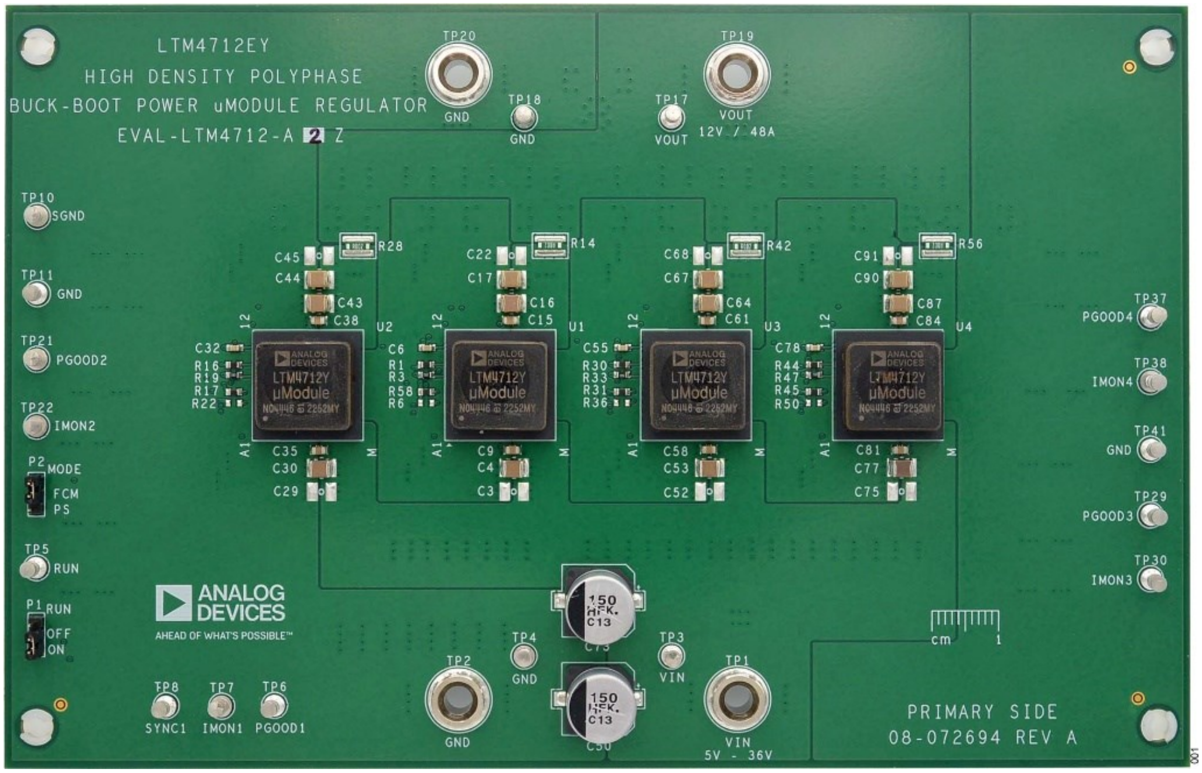


Figure 1. EVAL-LTM4712-A2Z Evaluation Board (Part Marking Is either Ink Mark or Laser Mark)

Performance Summary

Specifications are at T_A = 25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	VALUE
Input voltage range	V_{IN}		5		36	V
Output voltage	V_{OUT}	R_{FB} = 2.26kΩ (R12)		12		V
Maximum C_{OUT} Voltage		Default C_{OUT}		16		V
Switching frequency	f_{SW}	R_{FREQ} = 158kΩ (R3, R19, R33, R47)		400		kHz
Maximum output current	I_{OUT}	V_{IN} = 10V to 36V, f_{SW} = 400kHz			48	A
Maximum output current	I_{OUT}	V_{IN} = 5V to 10V, f_{SW} = 400kHz			24	A
Efficiency	η	V_{IN} = 12V, I_{OUT} = 48A, f_{SW} = 400kHz		96		%
Peak efficiency		V_{IN} = 24V, I_{OUT} = 31A, f_{SW} = 400kHz		97.1		%

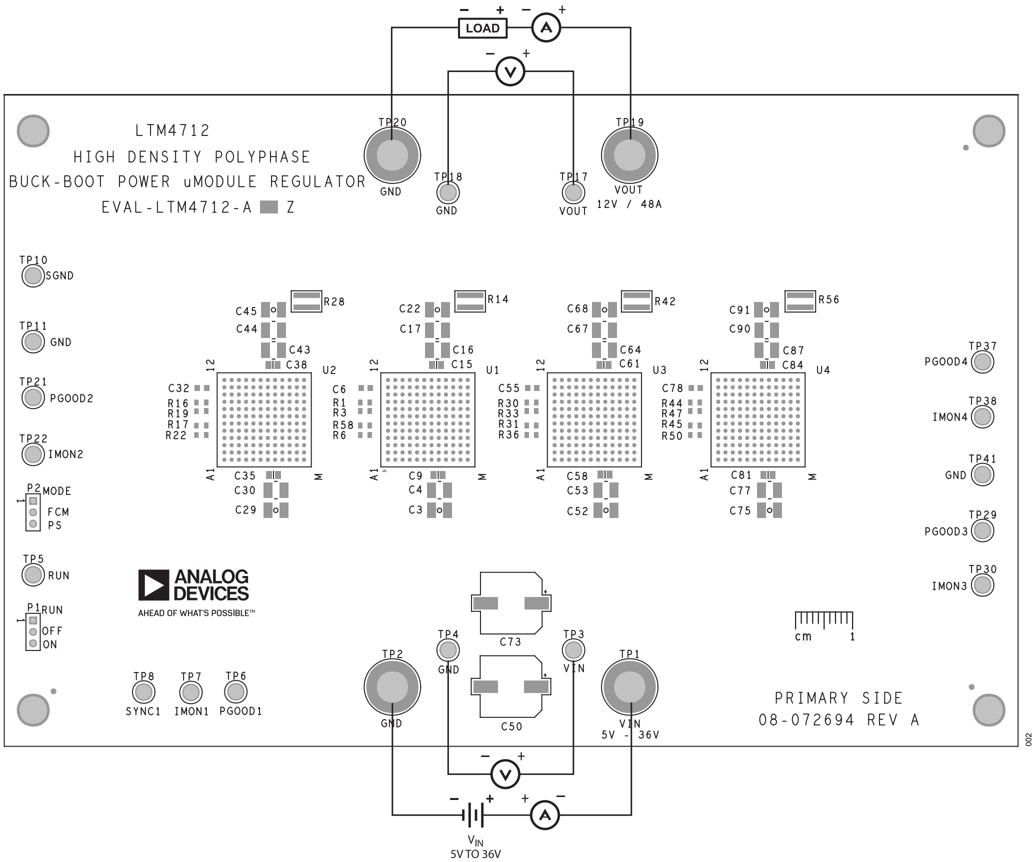


Figure 2. EVAL-LTM4712-A2Z Evaluation Board Test Setup

Quick Start Evaluation Board Features Procedure

To measure the input/output voltage ripples properly, do not use the long ground lead on the oscilloscope probe. See *Figure 3* for a proper probing technique of input/output voltage ripples. 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.

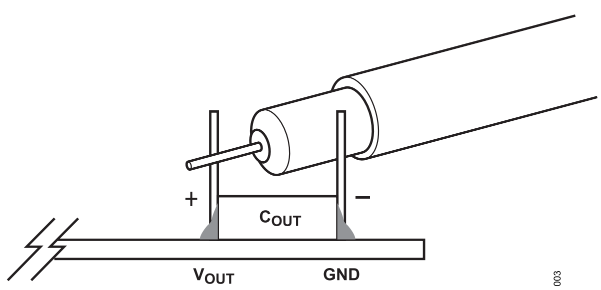


Figure 3. Scope Probe Placement for Measuring Input or Output Ripple Voltage

Current Monitoring

The EVAL-LTM4712-A2Z features output current monitoring (I_{MON}) for each channel. By measuring the voltage between ISP and ISN with a sense resistor, a voltage directly proportional to the measured current can be observed and used to accurately determine the amount of current supplied by each LTM4712 as shown in *Figure 4*. To accurately monitor the output current in each paralleled μModule, 2mΩ sense resistors are added to each channel output, connecting each channel to a shared V_{OUT}. The respective current values are given by I_{OUT} = [(V_{IMON} – 0.2V)/20]/2mΩ.

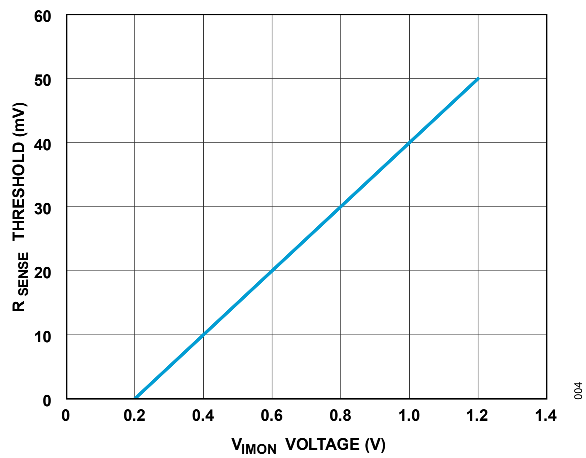


Figure 4. R_{SENSE} Voltage Threshold vs. V_{IMON}

Constant Current Mode (Optional)

The LTM4712 can produce a constant-current output after simple component selection. Each μModule maintains constant-output current according to (I_{SET}) voltage limit and R_{SENSE} value. I_{OUT} = V_{SENSE_MAX}/R_{SENSE}. The V_{SENSE} is determined by I_{SET} voltage as shown in *Figure 4*. All μModule ICs in parallel must have the same value of R_{ISET} and R_{SENSE}. Refer to the LTM4712 data sheet for more detailed information.

Note

The V_{OUT} needs to be set higher than *n* × (I_{OUT} × R_{LOAD}) to maintain constant-current regulation, where *n* is the number of modules in parallel. For example, using four LTM4712s, V_{OUT} is set to 12V (2.26kΩ on R_{FB}), and the R_{SENSE} voltage limit on each part is set to 10mV (26.3kΩ on each I_{SET}). When a resistive load of 3Ω is placed on the shared output, I_{OUT} follows 12V_{OUT}/3Ω = 4A total or 1A per channel. As the value of R_{LOAD} decreases, I_{OUT} will increase according to this equation. When the I_{OUT} total reaches 20A, each module supplies 5A, and each R_{SENSE} voltage threshold is reached (10mV = 5A × 2mΩ). If R_{LOAD} decreases further, instead of allowing I_{OUT} to increase, COMP voltage is pulled lower, and V_{OUT} changes to support a constant-current value of 5A per channel (20A total). Therefore, if R_{LOAD} decreases to 0.5Ω, V_{OUT} decreases to 10V_{OUT} to maintain 20A or 5A load per channel (10V/0.5Ω/4 channels = 5A/channel).

Typical Performance Characteristics

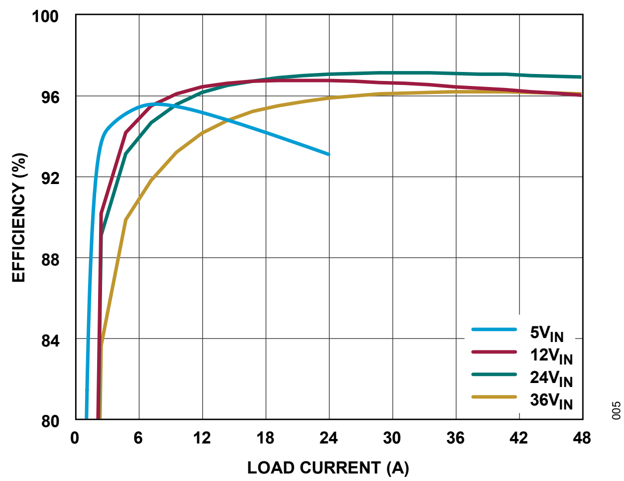


Figure 5. Efficiency vs. Load Current (12V_{OUT}, T_A = 25°C)

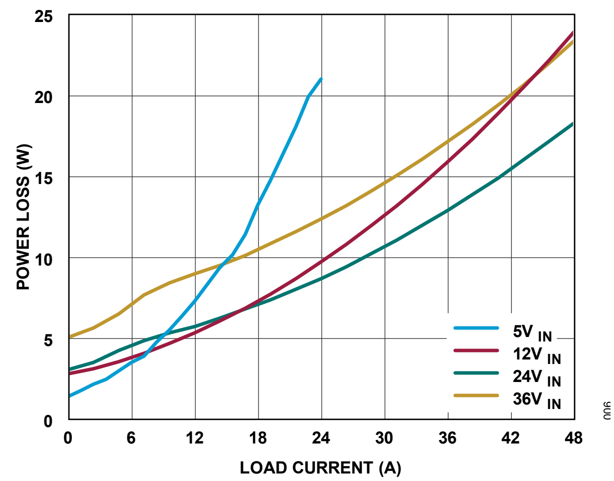


Figure 6. Power Loss vs. Load Current (12V_{OUT}, T_A = 25°C)

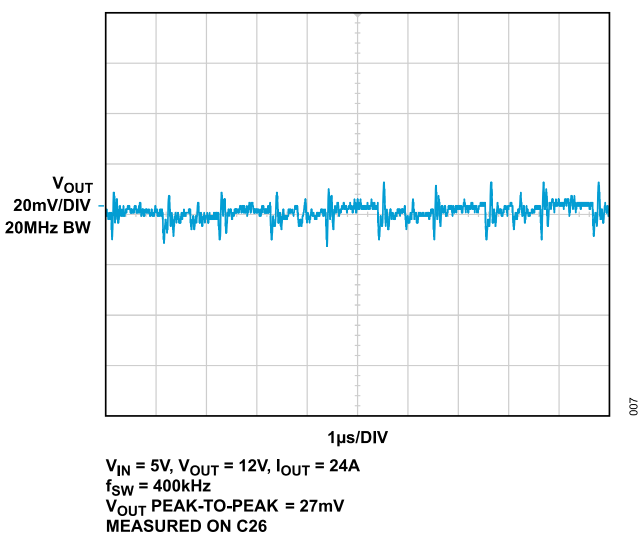


Figure 7. Output Voltage Ripple (Boost Mode)

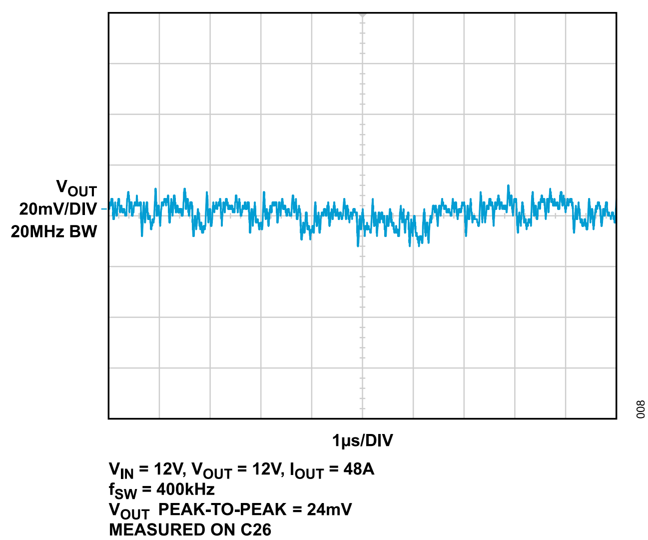


Figure 8. Output Voltage Ripple (Buck-Boost Mode)

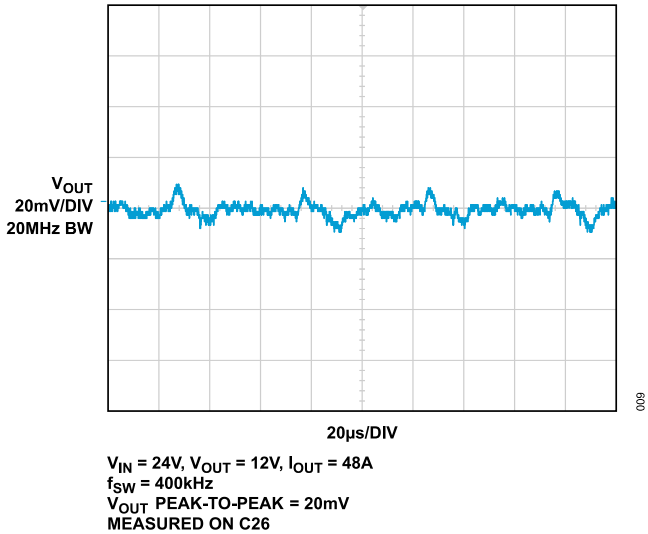


Figure 9. Output Voltage Ripple (Buck Mode)

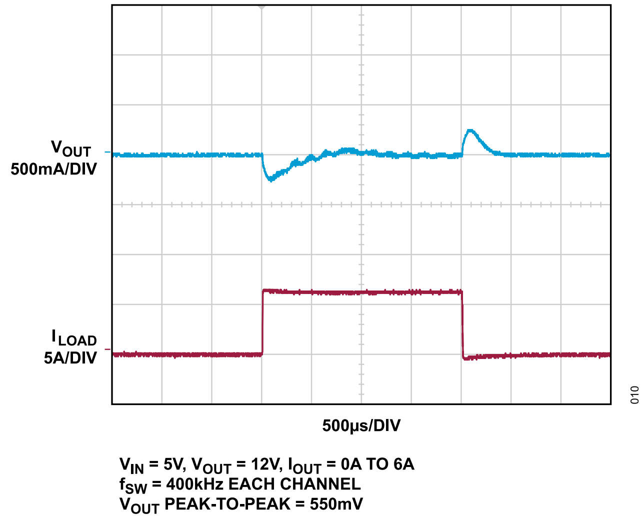


Figure 10. Load Transient Response (Boost Mode)

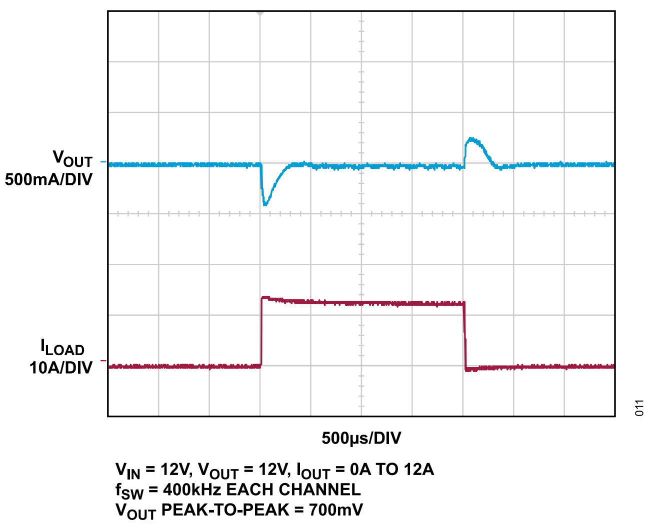


Figure 11. Load Transient Response (Buck-Boost Mode)

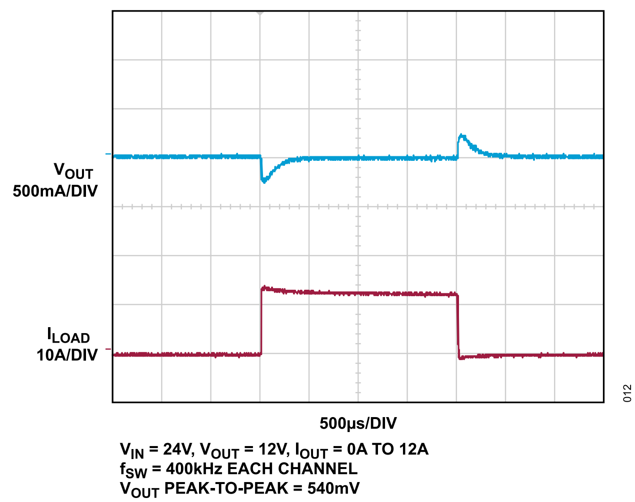
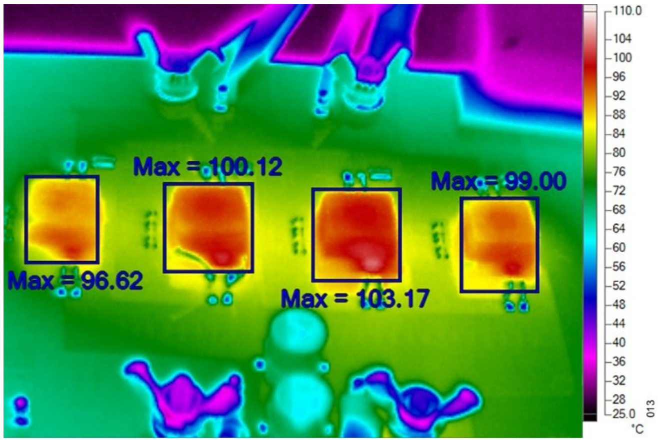
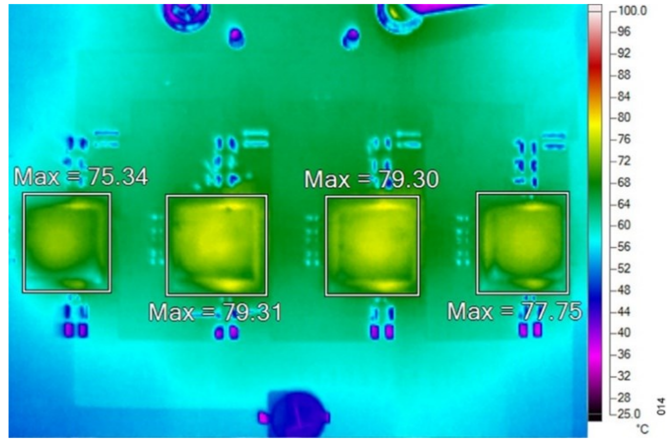


Figure 12. Load Transient Response (Buck Mode)



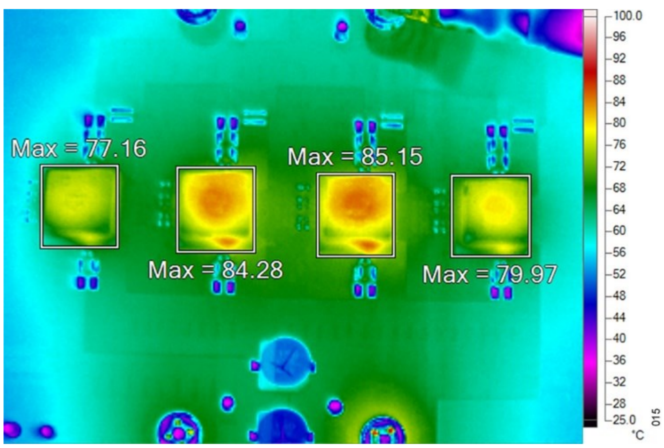
V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)	MAX CASE TEMP (°C)
12	12	48	103

Figure 13. Buck-Boost Mode Measured Thermal Capture with 0LFM Airflow, T_A = 25°C



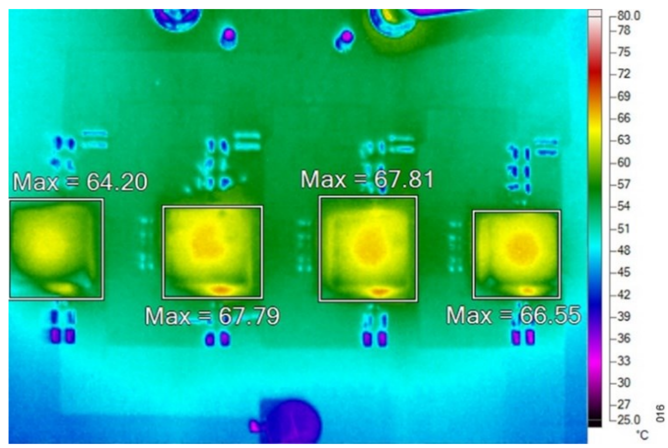
V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)	MAX CASE TEMP (°C)
12	12	48	79.3

Figure 14. Buck-Boost Mode Measured Thermal Capture with 200LFM Airflow, T_A = 25°C



V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)	MAX CASE TEMP (°C)
5	12	24	85.2

Figure 15. Boost Mode Measured Thermal Capture with 200LFM Airflow, T_A = 25°C



V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)	MAX CASE TEMP (°C)
24	12	48	67.8

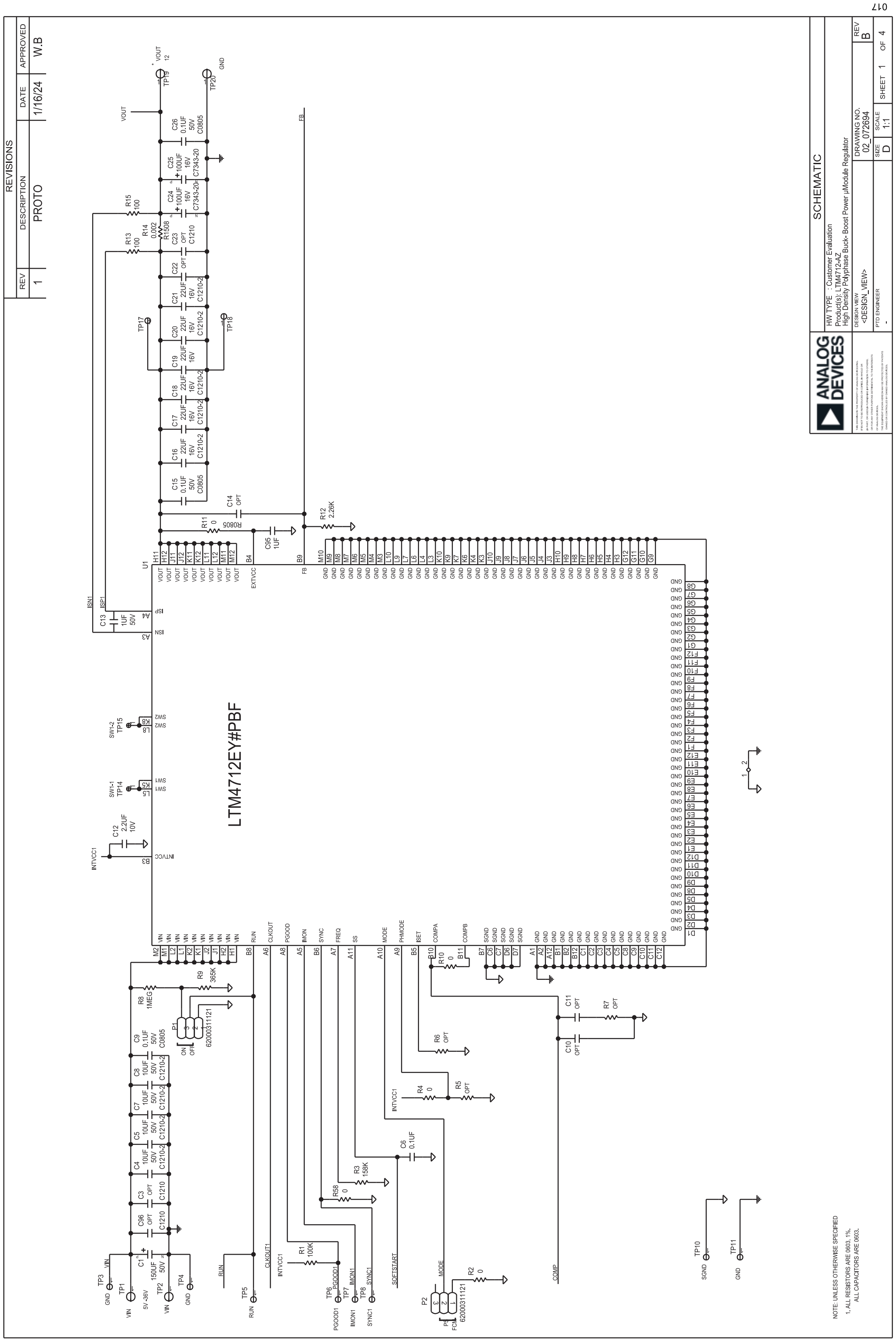
Figure 16. Buck Mode Measured Thermal Capture with 200LFM Airflow, T_A = 25°C

EVAL-LTM4712-A2Z Bill of Materials

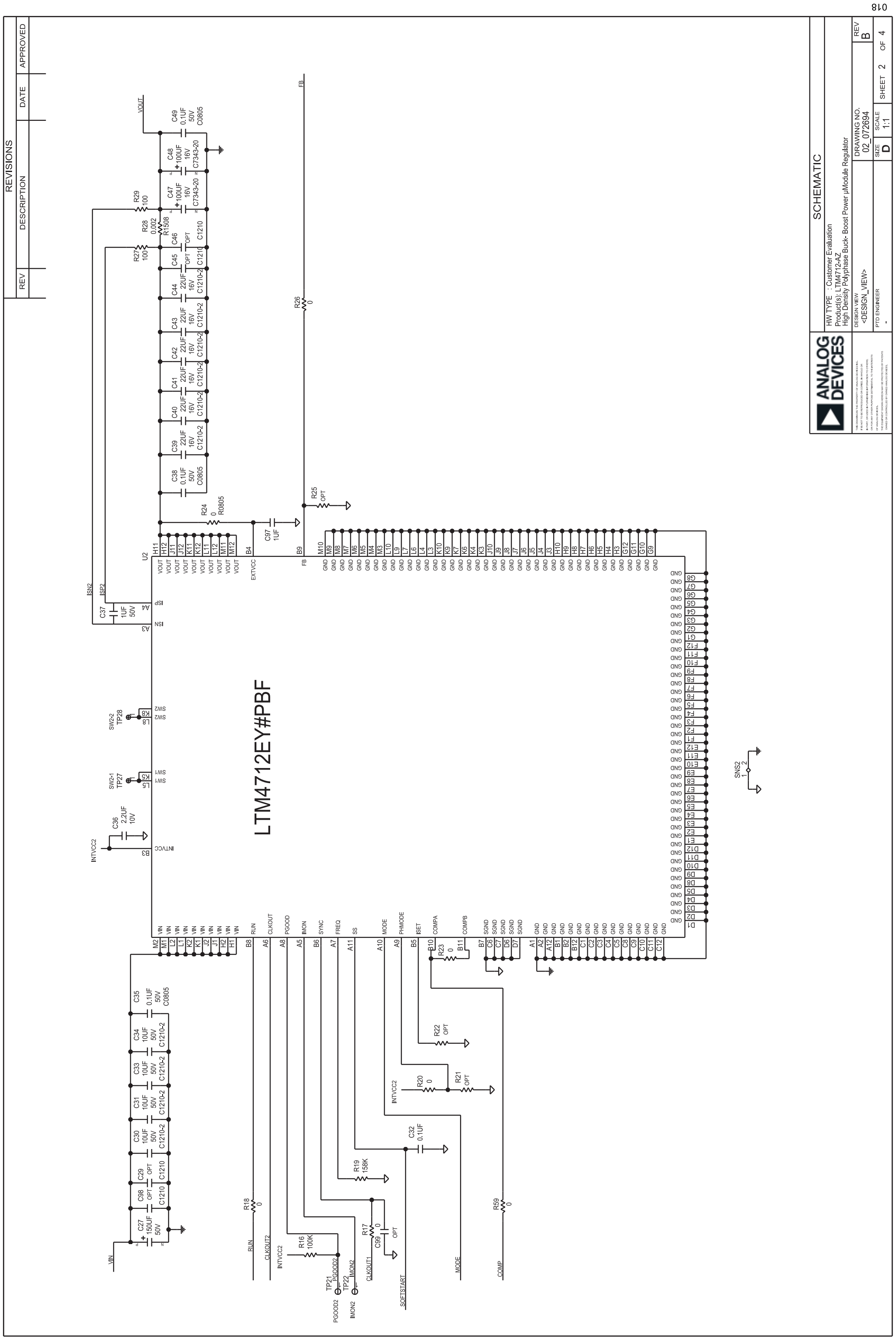
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	4	C1, C27, C50, C73	CAP. ALUM POLY 150µF 50V 20% 10mm × 10.2mm AEC-Q200 670mA 2000h	PANASONIC, EEEFK1H151P
2	4	C95, C97, C101, C104	CAP. CER 1µF 16V 10% X7R 0603	TAIYO YUDEN, EMK107B7105KA-T
3	4	C12, C36, C59, C82	CAP. CER 2.2µF 10V 10% X7R 0603	MURATA, GRM188R71A225KE15D
4	4	C13, C37, C60, C83	CAP. CER 1µF 50V 10% X7R 0603	TAIYO YUDEN, MSASU168AB7105KTNA01
5	10	C9, C15, C26, C35, C38, C49, C58, C61, C81, C84	CAP. CER 0.1µF 10% 50V X7R 0805	AVX CORPORATION, 08055C104KAT2A
6	24	C16-C21, C39-C44, C62-C67, C85-C90	CAP. CER 22µF 16V 10% X7R 1210	MURATA, GRM32ER71C226KEA8L
7	9	C24, C25, C47, C48, C70-C72, C93, C94	CAP. TANT POLY 100µF 20% 16V 7343-20, 0.05Ω ESR	PANASONIC, 16TQC100MYF
8	16	C4, C5, C7, C8, C30, C31, C33, C34, C53, C54, C56, C57, C76, C77, C79, C80	CAP. CER 10µF 50V 10% X7R 1210	MURATA, GRM32ER71H106KA12L
9	4	C6, C32, C55, C78	CAP. CER 0.1µF 16V 10% X7R 0603	AVX, 0603YC104KAT2A
10	4	R1, R16, R30, R44	RES. SMD 100kΩ 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW0603100KFKEA
11	22	R2, R4, R10, R17, R18, R20, R23, R26, R31, R32, R34, R37, R40, R45, R46, R48, R51, R54, R58-R61	RES. SMD 0Ω JUMPER 1/10W 0603 AEC-Q200 PRECISION POWER	VISHAY, CRCW06030000Z0EA
12	4	R11, R24, R38, R52	RES. SMD 0Ω JUMPER 1/8W 0805 AEC-Q200	VISHAY, CRCW08050000Z0EA
13	1	R12	RES. SMD 2.26kΩ 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW06032K26FKEA
14	8	R13, R15, R27, R29, R41, R43, R55, R57	RES. SMD 100Ω 1% 1/10W 0603 AEC-Q200	PANASONIC, ERJ-3EKF1000V
15	4	R14, R28, R42, R56	RES. SMD 0.002Ω 1% 1W 1508 LONG-SIDE TERMINAL	SUSUMU CO, LTD, RL3720WT-R002-F
16	4	R3, R19, R33, R47	RES. SMD 158kΩ 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW0603158KFKEA
17	1	R8	RES. SMD 1MΩ 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW06031M00FKEA
18	1	R9	RES. SMD 365kΩ 1% 1/10W 0603 AEC-Q200	VISHAY, CRCW0603365KFKEA
19	4	U1-U4	IC, 36V_{IN} 12A BUCK-BOOST µModule REGULATOR, BGA-144	ANALOG DEVICES, LTM4712

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	6	C10, C11, C14, C99, C102, C105	CAP., OPTION, 0603	
2	16	C3, C22, C23, C29, C45, C46, C52, C68, C69, C75, C91, C92, C96, C98, C100, C103	CAP., OPTION, 1210	
3	12	R5, R6, R7, R21, R22, R25, R35, R36, R39, R49, R50, R53	RES., OPTION, 0603	
Hardware For Demo Board Only				
1	17	TP3-TP8, TP10, TP11, TP17, TP18, TP21, TP22, TP29, TP30, TP37, TP38, TP41	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
2	4	TP1, TP2, TP19, TP20	CONN-PCB BANANA JACK	KEYSTONE ELECTRONICS, 575-4
3	2	P1, P2	CONN-PCB 3-POS MALE HDR UNSHROUDED SINGLE ROW ST, 2mm PITCH, 2.70mm SOLDER TAIL	WURTH ELEKTRONIK, 62000311121
4	4	MOUNTING HOLE	STANDOFF, SELF-RETAINING SPACER, 12.7mm LENGTH	WURTH ELEKTRONIK, 702935000
5	2	XJP1, XJP2	SHUNT FEMALE 2-POS 2mm	WURTH ELEKTRONIK, 60800213421

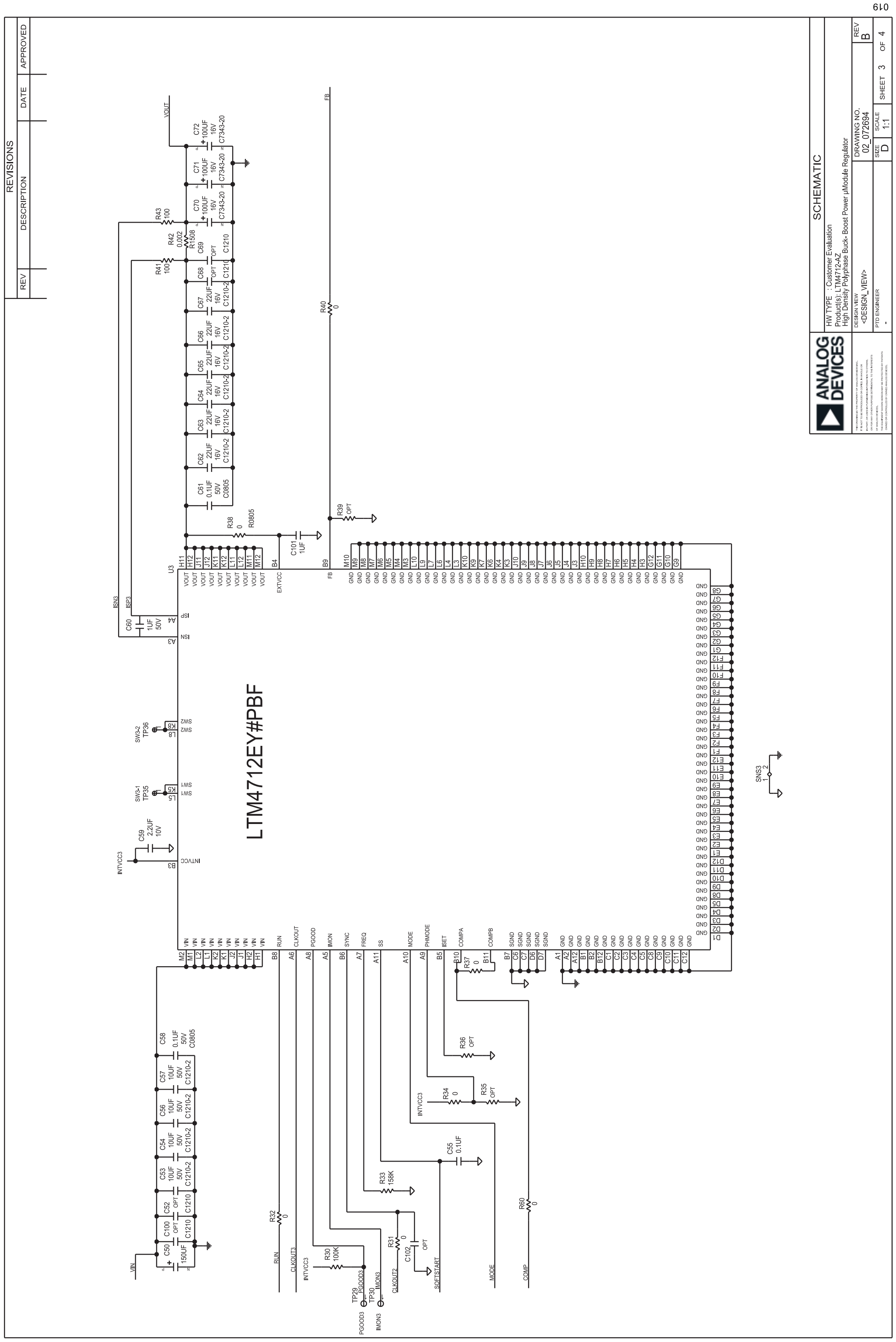
EVAL-LTM4712-A2Z Schematics



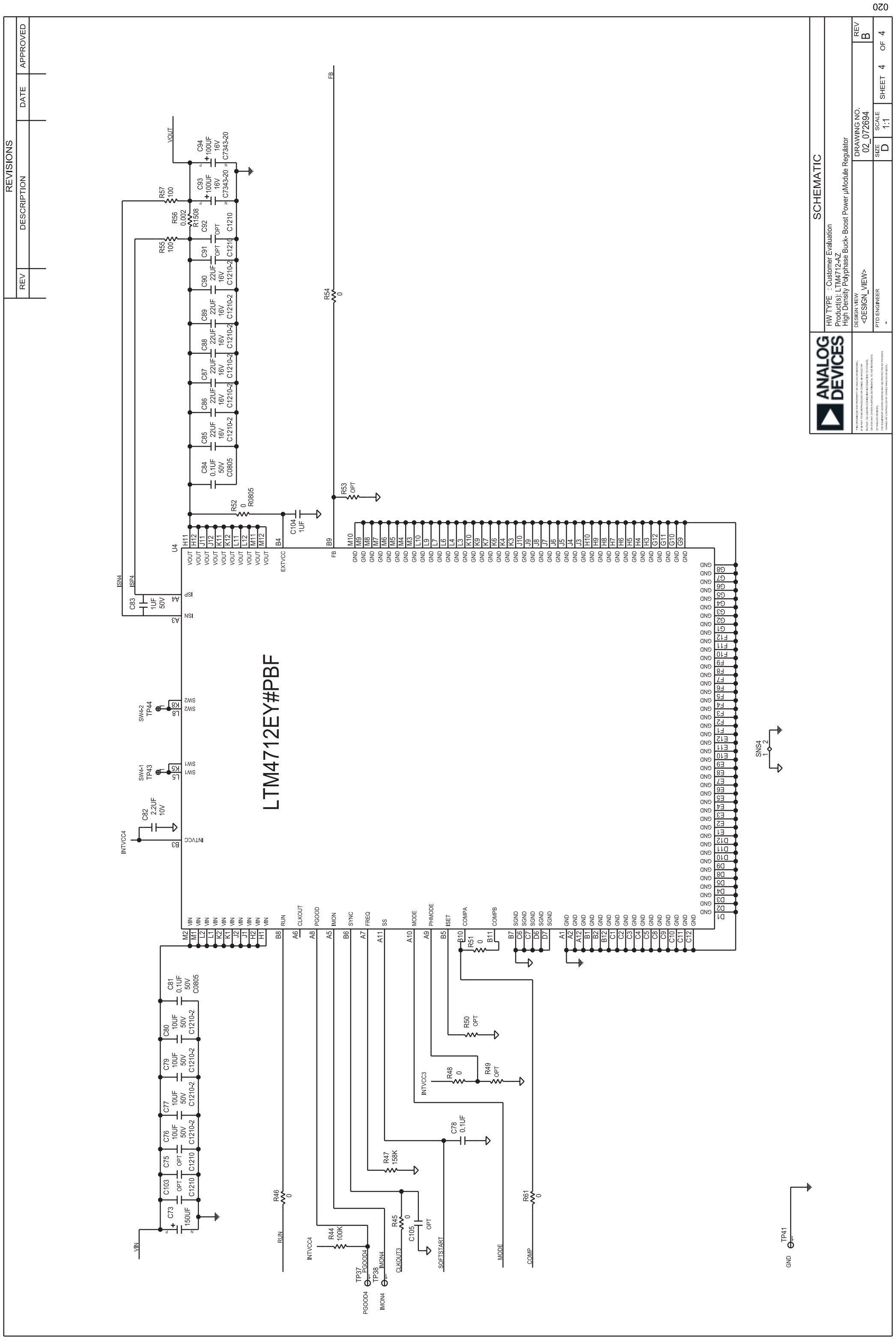
EVAL-LTM4712-A2Z Schematics (continued)



EVAL-LTM4712-A2Z Schematics (continued)



EVAL-LTM4712-A2Z Schematics (continued)



Ordering Information

PART	TYPE
EVAL-LTM4712-A2Z	Evaluation Board

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	03/24	Initial release	—

Notes

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