

# LTM4636 High Efficiency, PolyPhase 120A Step-Down Power $\mu$ Module Regulator

## DESCRIPTION

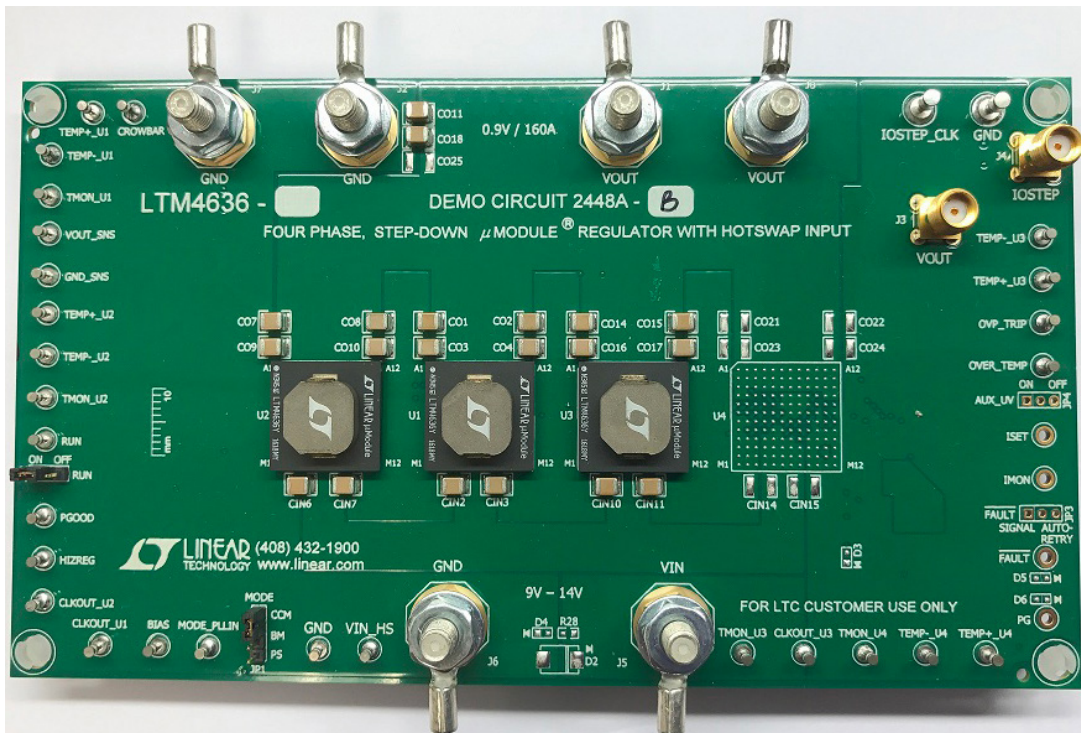
Demonstration circuit 2448A-B features a PolyPhase<sup>®</sup> design using the LTM<sup>®</sup>4636EY, a 40A high efficiency, switch mode step-down power  $\mu$ Module<sup>®</sup> regulator. The input voltage range is from 4.7V to 15V. When  $V_{IN} < 5.5V$ , short PVCC to  $V_{IN}$  with  $R1 = 0\Omega$ , and set  $R3 = 0\Omega$  and remove  $R2$ . The output voltage range is 0.6V to 3.3V. The DC2448A-B can deliver a nominal 120A output current. As explained in the data sheet, output current derating is necessary for certain  $V_{IN}$ ,  $V_{OUT}$ , and thermal conditions. The board operates in continuous conduction mode in heavy load conditions. For high efficiency at low load currents, the MODE\_PLLIN jumper selects pulse-skipping mode

for noise sensitive applications or Burst Mode<sup>®</sup> operation in less noise sensitive applications. The MODE\_PLLIN pin also allows the LTM4636 to synchronize to an external clock signal. The phases of the three LTM4636s are 0 degrees, 120 degrees and 240 degrees. DC2448A-B has the option of choosing both internal and external compensation circuit for LTM4636. The LTM4636 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2448A-B.

[Design files for this circuit board are available.](#)

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## BOARD PHOTO



# DEMO MANUAL

## DC2448A-B

### PERFORMANCE SUMMARY Specifications are at T<sub>A</sub> = 25°C

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		4.7V to 15V
Output Voltages		0.9V ±1.3%
Maximum Continuous Output Current	Derating is necessary for certain operating conditions. See data sheet for details.	120A <sub>DC</sub>
Operating Frequency		350kHz
Efficiency	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 0.9V, I <sub>OUT</sub> = 120A	85.9% Figure 2
Load Transient V <sub>OUT(P-P)</sub>	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 0.9V, I <sub>STEP</sub> = 0A TO 30A	91mV Figure 3

### QUICK START PROCEDURE

Demonstration circuit DC2448A-B is an easy way to evaluate the performance of PolyPhase operation of the LTM4636EY. Due to the high input/output current, the user should select the proper input supply/load/cable which can sustain the full load operation. Please refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

- Place jumpers in the following positions for a typical application:

MODE	RUN
CCM	ON

- With power off, connect the input power supply, load and meters as shown in Figure 1. Preset the load to 0A and V<sub>IN</sub> supply to 12V.
- Turn on the power supply at the input. The output voltage should be 0.9V ± 1.3% (0.888V to 0.912V).

- Vary the input voltage from 6V to 15V and adjust the load current from 0A to 120A. Observe the output voltage regulation, ripple voltage, efficiency and other parameters.
- (Optional) For optional load transient test, apply an adjustable pulse signal between IOSTEP\_CLK and GND test points. The pulse amplitude sets the load step current amplitude. Keep the pulse width short (<1ms) and pulse duty cycle low (<5%) to limit the thermal stress on the load transient circuit.
- (Optional) LTM4636 can be synchronized to an external clock signal. Apply a clock signal (0V to 5V, square wave) on the MODE\_PLLIN test point.
- (Optional) The outputs of LTM4636 can track another supply. The output voltage tracks the voltage on TRACK when a valid signal is applied on the test point.

**QUICK START PROCEDURE**

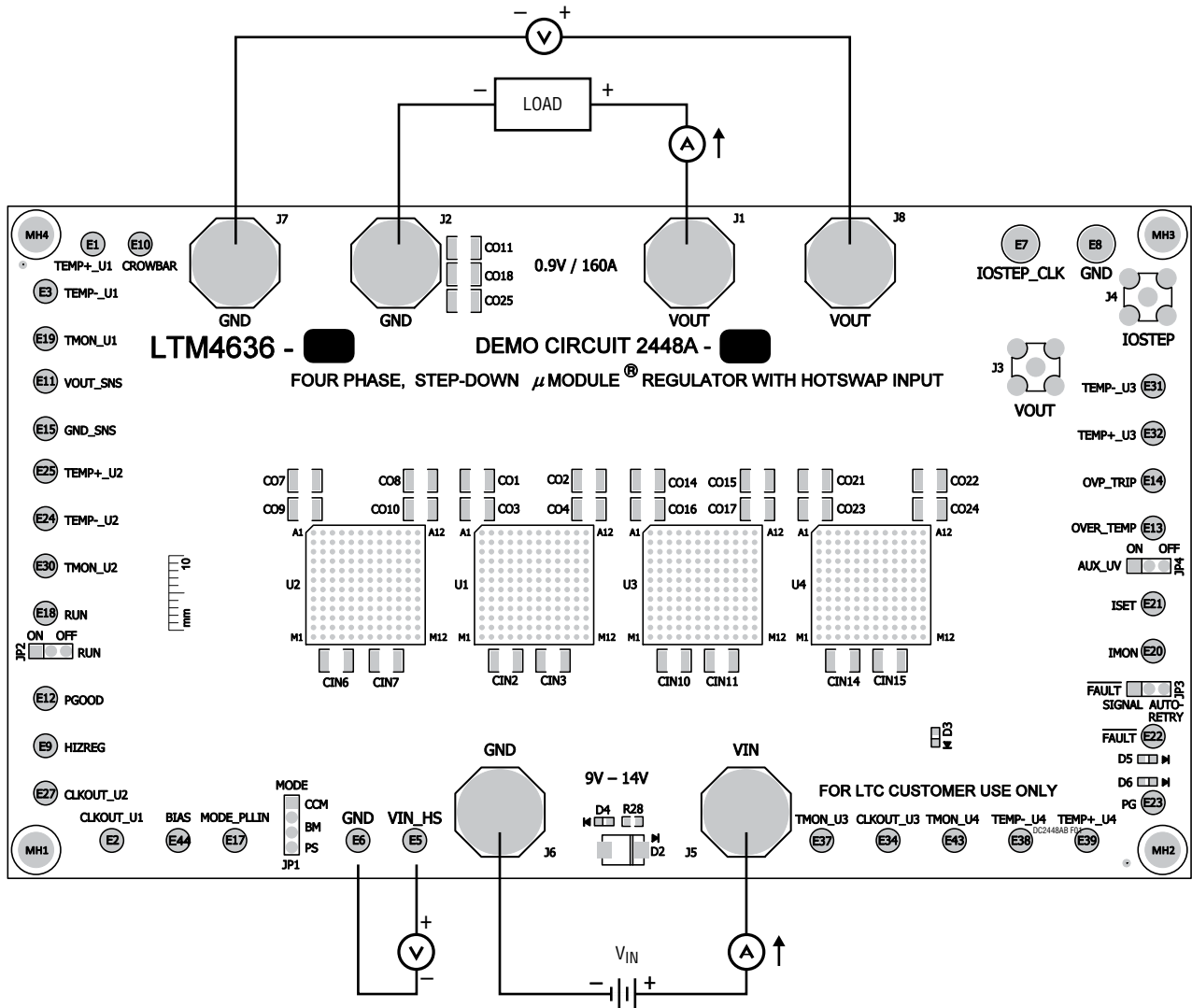


Figure 1. Measurement Setup of DC2448A-B

### QUICK START PROCEDURE

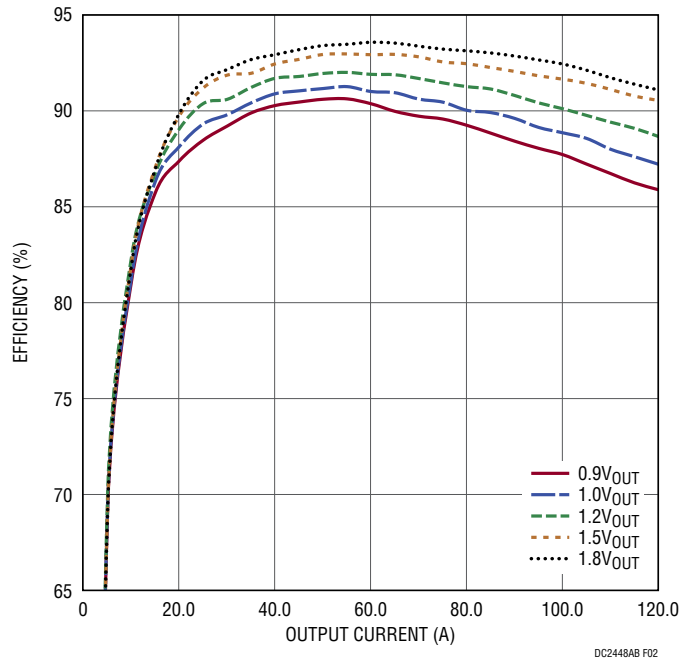


Figure 2. Measured Efficiency at  $V_{IN} = 12V$ ,  $f_{SW} = 350kHz$ , CCM

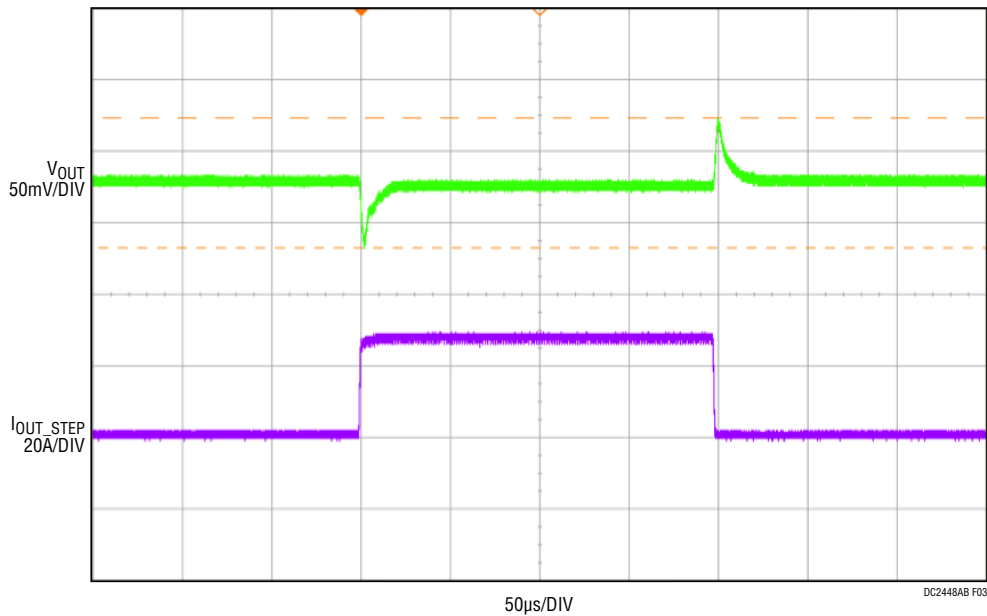


Figure 3. Measured Load Transient  
 $V_{IN} = 12V$ ,  $V_{OUT} = 0.9V$ ,  $I_{STEP} = 0A$  to  $30A$

## QUICK START PROCEDURE

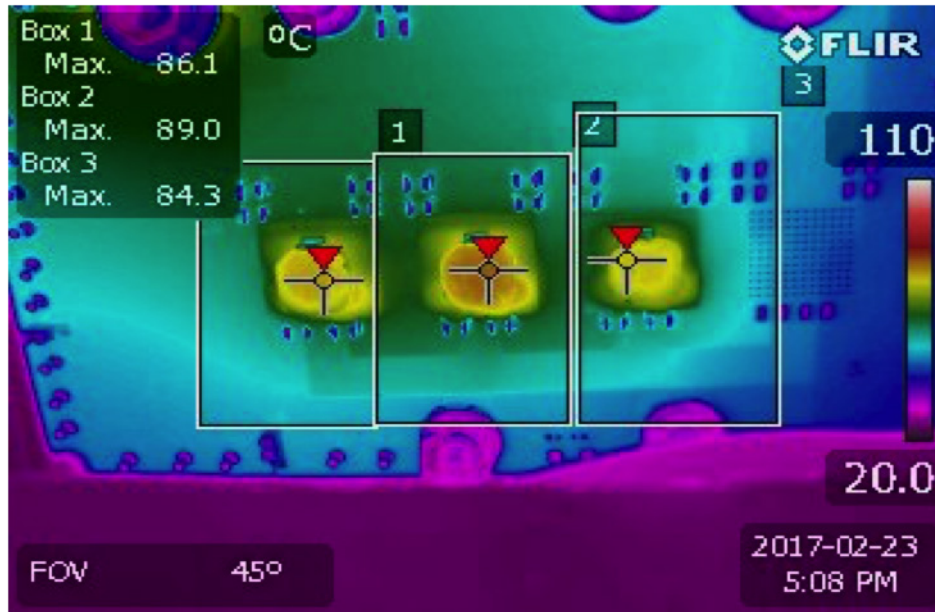


Figure 4. Thermal Capture at  $V_{IN} = 12V$ ,  $V_{OUT} = 0.9V$ , 120A ( $T_A = 25^\circ C$ , 200LFM Airflow and No Heat Sink)

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	3	C1, C14, C19	CAP, 22 $\mu$ F, X7R, 10V, 10%, 1206	MURATA, GRM31CR71A226KE15L
2	3	C2, C15, C20	CAP, 4.7 $\mu$ F, X5R, 25V, 20%, 0805	MURATA, GRM21BR61E475MA12L
3	1	C8	CAP, 100pF, X7R, 50V, 10%, 0603	AVX, 06035C101KAT2A
4	2	C9, C10	CAP, 0.47 $\mu$ F, X7R, 10V, 10%, 0603	AVX, 0603ZC474KAT2A MURATA, GRM188R71A474KA61D
5	2	C29, C30	CAP, 10 $\mu$ F, X5R, 6.3V, 10%, 0805	MURATA, GRM21BR60J106KE19L
6	16	C31, C32, C01, C02, C03, C04, C07, C08, C09, C010, C011, C014, C015, C016, C017, C018	CAP, 100 $\mu$ F, X5R, 6.3V, 20%, 1210	MURATA, GRM32ER60J107ME20L
7	1	CIN1	CAP, 150 $\mu$ F, ALUM., 35V, 20%, 10x10.5mm, SMD, HVH SERIES	SUN ELECTRONIC INDUSTRIES CORP, 35HVH150M
8	12	CIN2, CIN3, CIN4, CIN5, CIN6, CIN7, CIN8, CIN9, CIN10, CIN11, CIN12, CIN13	CAP, 22 $\mu$ F, X5R, 25V, 10%, 1210	AVX, 12103D226KAT2A MURATA, GRM32ER61E226KE15L
9	6	CO5, CO6, CO12, CO13, CO19, CO20	CAP, 470 $\mu$ F, TANT. POLY., 4V, 20%, 7343, D3L	PANASONIC, 4TPE470MCL
10	1	R14	RES., 10k, 1%, 1/10W, 0603	KOA SPEER, RK73H1JTTD1002F PANASONIC, ERJ3EKF1002V VISHAY, CRCW060310K0FKEA

# DEMO MANUAL

## DC2448A-B

### PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
11	1	R20	RES., 4.99k, 1%, 1/10W, 0603	NIC, NRC06F4991TRF VISHAY, CRCW06034K99FKEA
12	3	R22, R51, R60	RES., 34.8k, 1%, 1/10W, 0603	VISHAY, CRCW060334K8FKEA YAGEO, RC0603FR-0734K8L
13	3	U1, U2, U3	IC, HIGH EFFICIENCY 40A $\mu$ MODULE	ANALOG DEVICES, LTM4636EY#PBF

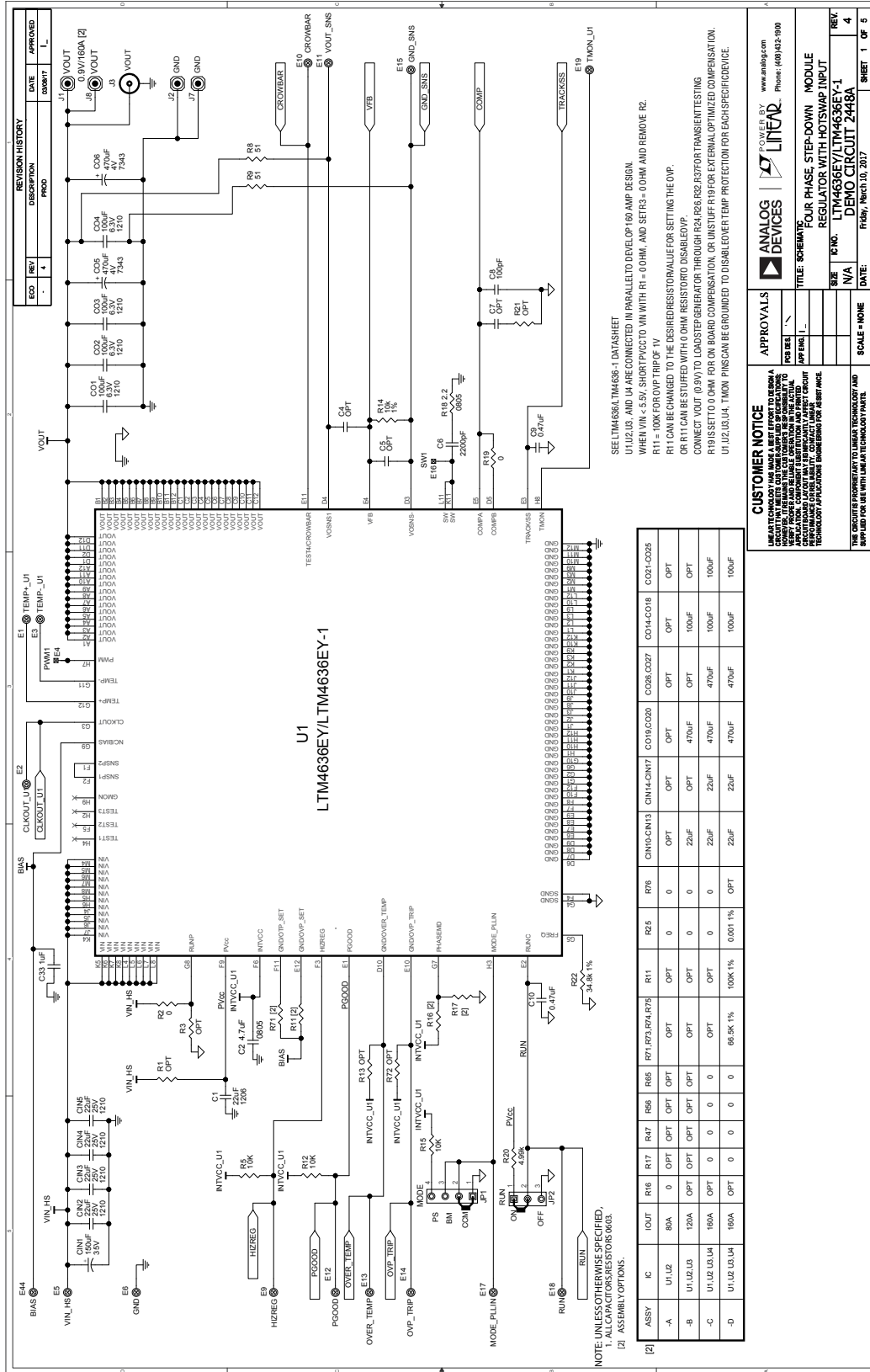
#### Additional Demo Board Circuit Components

1	3	C6, C17, C22	CAP, 2200pF, X7R, 50V, 10%, 0603	AVX, 06035C222KAT2A
2	1	C33	CAP, 1 $\mu$ F, X7R, 16V, 10%, 0603	AVX, 0603YC105KAT2A NIC, NMC0603X7R105K16TRPF TDK, C1608X7R1C105K080AC
3	1	Q3	XSTR., MOSFET, N-CH, 40V, TO-252	VISHAY, SUD50N04-8M8P-4GE3
4	6	R2, R19, R45, R50, R54, R59	RES., 0 $\Omega$ , 1/10W, 0603	NIC, NRC06ZOTRF VISHAY, CRCW06030000Z0EA
5	4	R4, R5, R12, R15	RES., 10k, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ103V VISHAY, CRCW060310K0JNEA
6	1	R7	RES., 0.01 $\Omega$ , 1%, 1W, 2010, HIGH POWER	VISHAY, WSL2010R0100FEA18
7	2	R8, R9	RES., 51 $\Omega$ , 5%, 1/10W, 0603	VISHAY, CRCW060351R0JNEA
8	3	R18, R49, R58	RES., 2.2 $\Omega$ , 5%, 1/8W, 0805, AEC-Q200	VISHAY, CRCW08052R20JNEA
9	4	R24, R26, R32, R37	RES., 0 $\Omega$ , 3/4W, 2010, AEC-Q200	VISHAY, CRCW20100000Z0EF
10	1	R25	RES., 0 $\Omega$ , 1W, 2512, SENSE	VISHAY, WSL25120000ZEA9
11	1	R76	RES., 0 $\Omega$ , 1W, 2010, SENSE, AEC-Q200	VISHAY, WSL20100000ZEA9

#### Hardware: For Demo Board Only

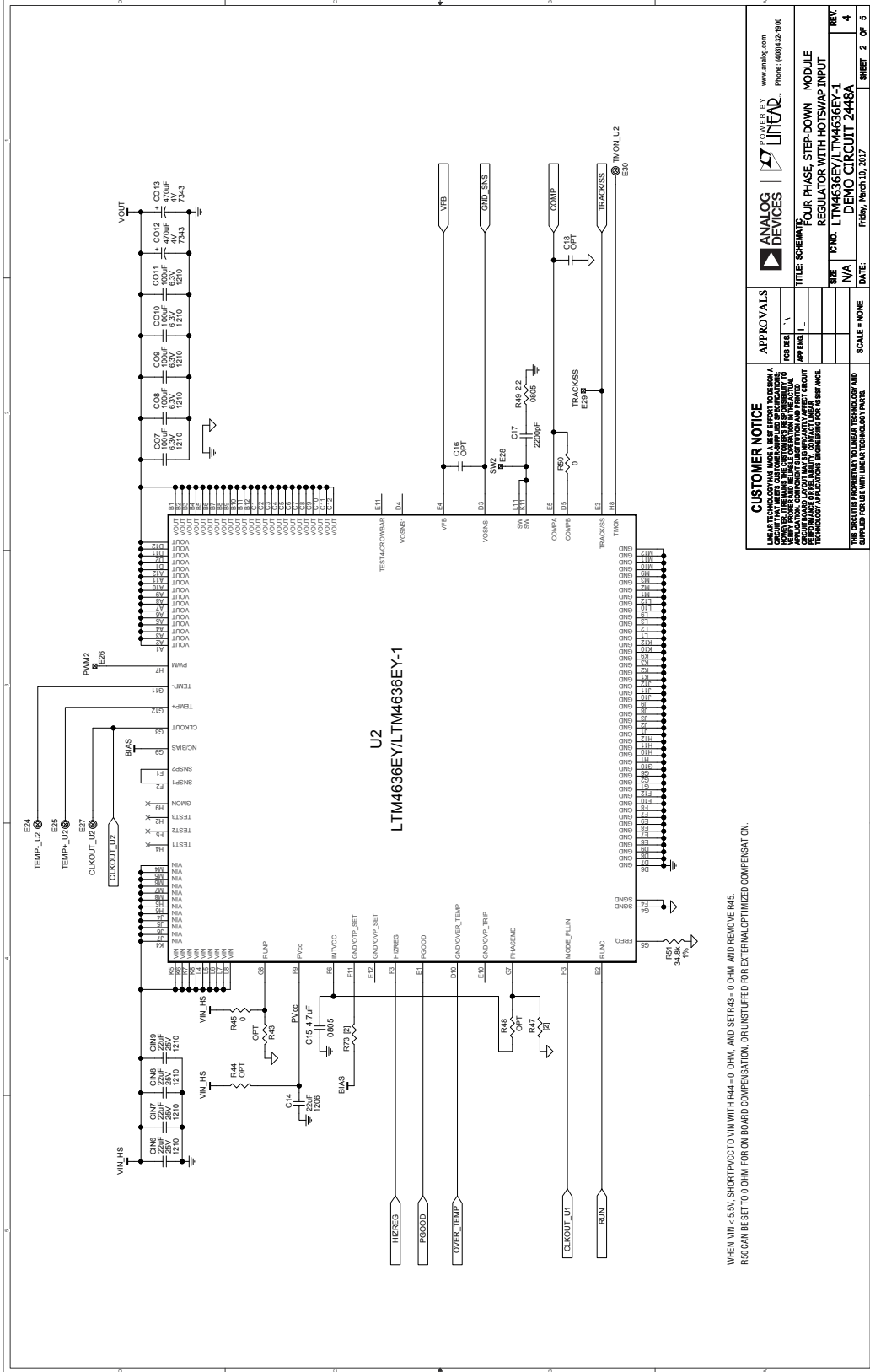
1	27	E1, E2, E3, E5, E6, E9, E10, E11, E12, E13, E14, E15, E17, E18, E19, E24, E25, E27, E30, E31, E32, E34, E37, E38, E39, E43, E44	TEST POINT, TURRET, 0.064", MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
2	2	E7, E8	TEST POINT, TURRET, 0.094", MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
3	6	J1, J2, J5, J6, J7, J8	WASHER, FLAT, STEEL, ZINC PLATE, OD: 0.436 [11.1]	KEYSTONE, 4703
4	6	J1, J2, J5, J6, J7, J8	RING, LUG, CRIMP, #10, NON-INSULATED, SOLDERLESS TERMINALS	KEYSTONE, 8205
5	6	J1, J2, J5, J6, J7, J8	STUD, FASTENER, #10-32	PENNENGINEERING, KFH-032-10ET
6	6	J1, J2, J5, J6, J7, J8	NUT, HEX, STEEL, ZINC PLATE, 10-32	KEYSTONE, 4705
7	2	J3, J4	CONN., SMA RF COAX, PCB JACK RCPT, THT, STR	MOLEX, 73391-0060
8	1	JP1	CONN., HDR., MALE, 1x4, 2mm, THT, STR	SAMTEC, TMM-104-02-L-S
9	1	JP2	CONN., HDR., MALE, 1x3, 2mm, THT, STR	SAMTEC, TMM-103-02-L-S
10	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.250"	KEYSTONE, 8831 WURTH ELEKTRONIK, 702931000
11	2	XJP1, XJP2	CONN., SHUNT, FEMALE, 2 POS, 2mm	SAMTEC, 2SN-BK-G

## SCHEMATIC DIAGRAM



# DEMO MANUAL DC2448A-B

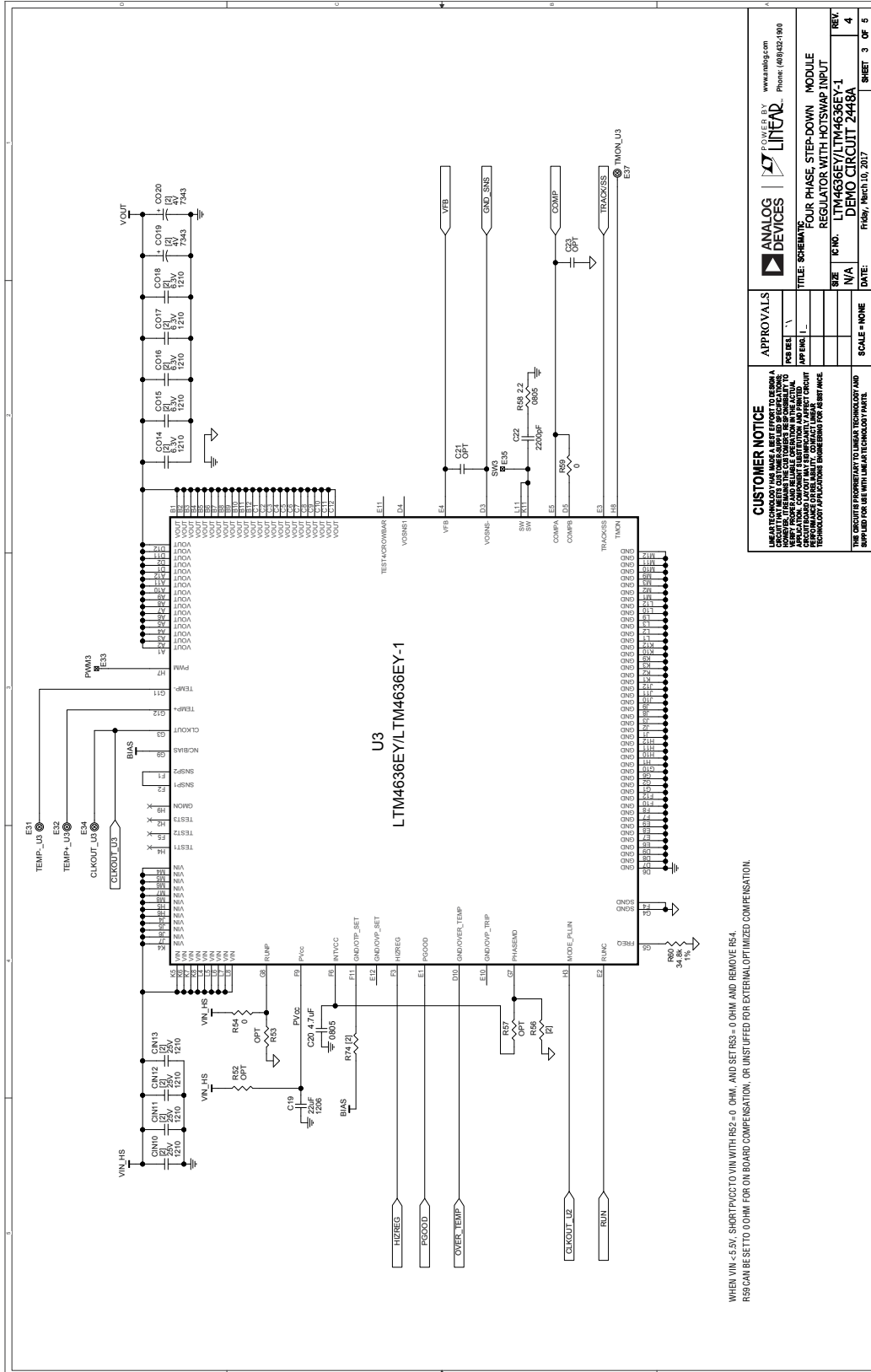
## SCHEMATIC DIAGRAM



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<b>ANALOG DEVICES</b>   POWER BY <b>LINEAR</b> <a href="http://www.analog.com">www.analog.com</a>   Phone: (408)435-1990		<b>SCALE = NONE</b>
<b>TITLE: SCHEMATIC</b> <b>FOUR PHASE, STEP-DOWN REGULATOR WITH HOTSWAP INPUT</b>		<b>REV:</b> 4
<b>SIZE:</b> N/A <b>DATE:</b> F0407, March 10, 2017		<b>SHEET 2 OF 5</b>
<b>THE CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.</b>		<b>REV.:</b> LTM4636EY/LTM4636EY-1 <b>DEMO CIRCUIT 2448A</b>



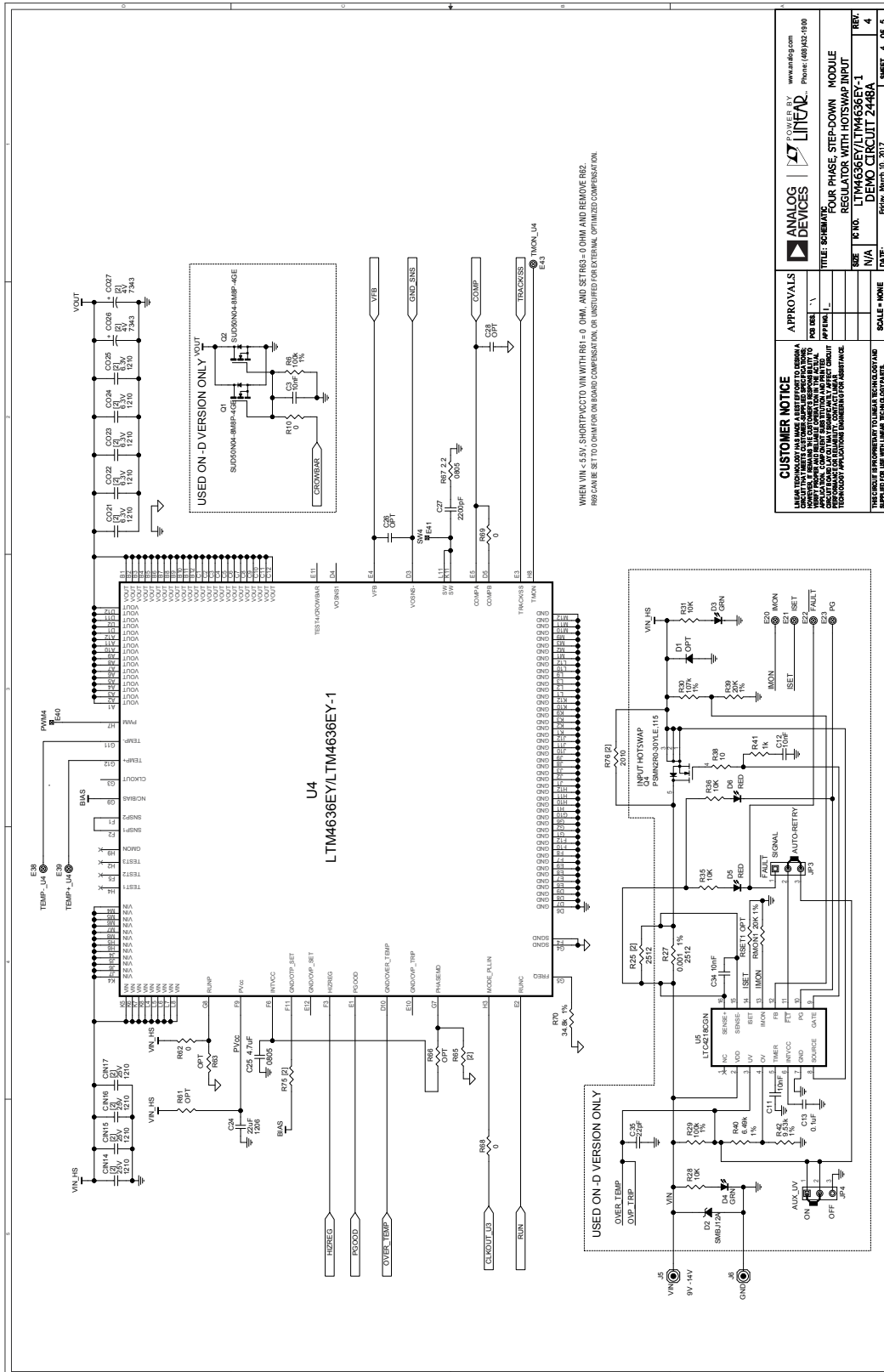
## SCHEMATIC DIAGRAM



WHEN VIN < 5.5V, SHORT PVCC TO VIN WITH RS2 = 0 OHM, AND SET RS3 = 0 OHM AND REMOVE RS4.  
RS9 CAN BE SET TO 0 OHM FOR ON BOARD COMPENSATION, OR UNLIFTED FOR EXTERNAL OPTIMIZED COMPENSATION.

# DEMO MANUAL DC2448A-B

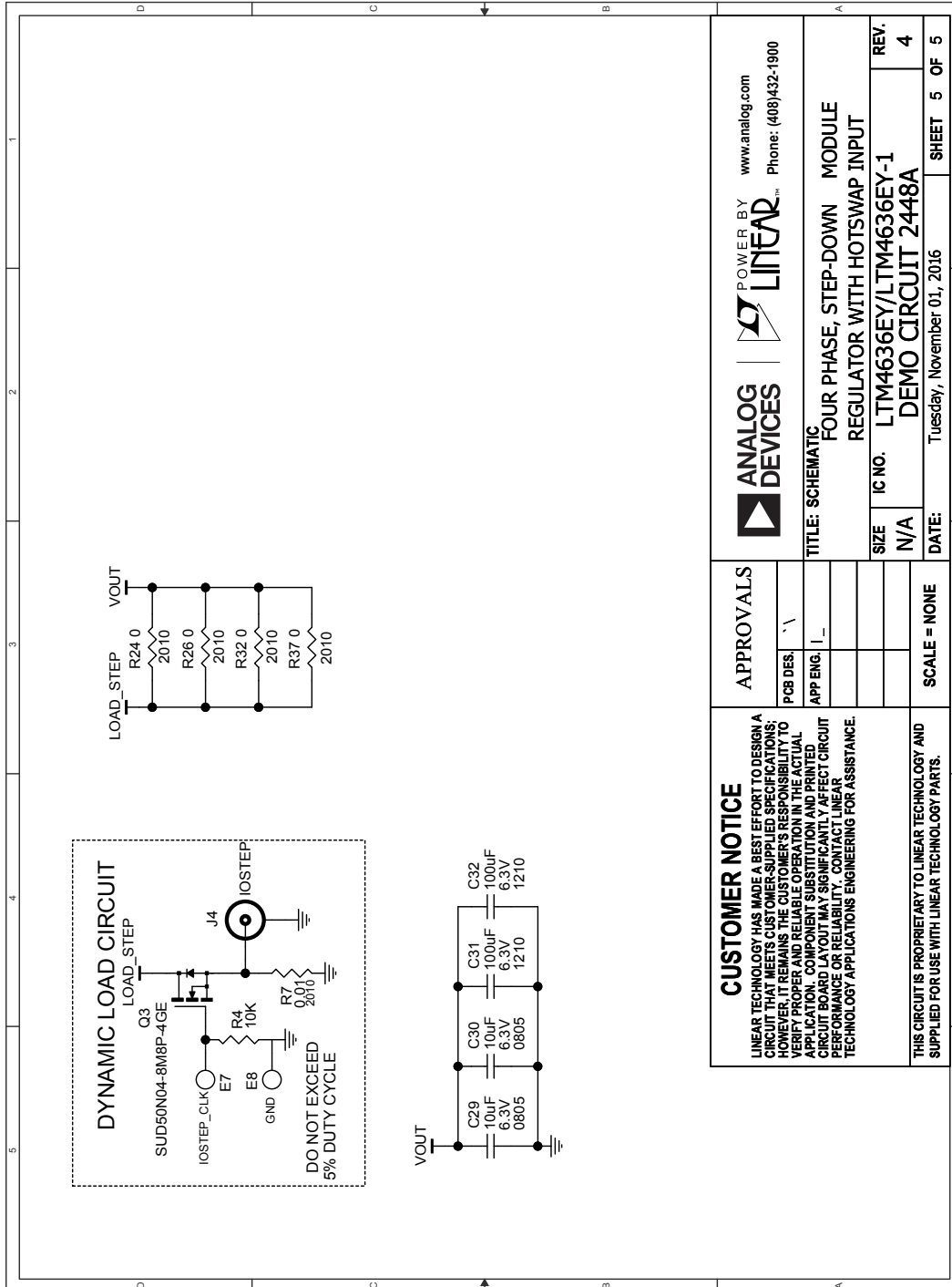
## SCHEMATIC DIAGRAM



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<b>APPROVALS</b> PER DES: _____ APPR: _____	
<b>POWER BY</b> ANALOG DEVICES   LINEAR www.analog.com Phone: (617) 329-1800	
<b>TITLE: SCHEMATIC FOUR PHASE STEP-DOWN MODULE REGULATOR WITH HOTSWAP INPUT</b>	
<b>REV:</b> 4	<b>REV:</b> 4
<b>DATE:</b> N/A	<b>DATE:</b> N/A
<b>SCALE:</b> NONE	<b>SHEET:</b> 4 OF 5

WHEN VIN < 5.5V, SHORT PWCCTO VIN WITH R61 = 0 OHM, AND SET RES = 0 OHM AND REMOVE RES2.  
RES CAN BE SET TO 0 OHM FOR ON BOARD COMPENSATION, OR UNLISTED FOR EXTERNAL, OPTIMIZED COMPENSATION.

## SCHEMATIC DIAGRAM





### ESD Caution

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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