

LTM4636-1

PolyPhase 160A Step-Down Power μ Module Regulator with Overvoltage and Overtemperature Protection

DESCRIPTION

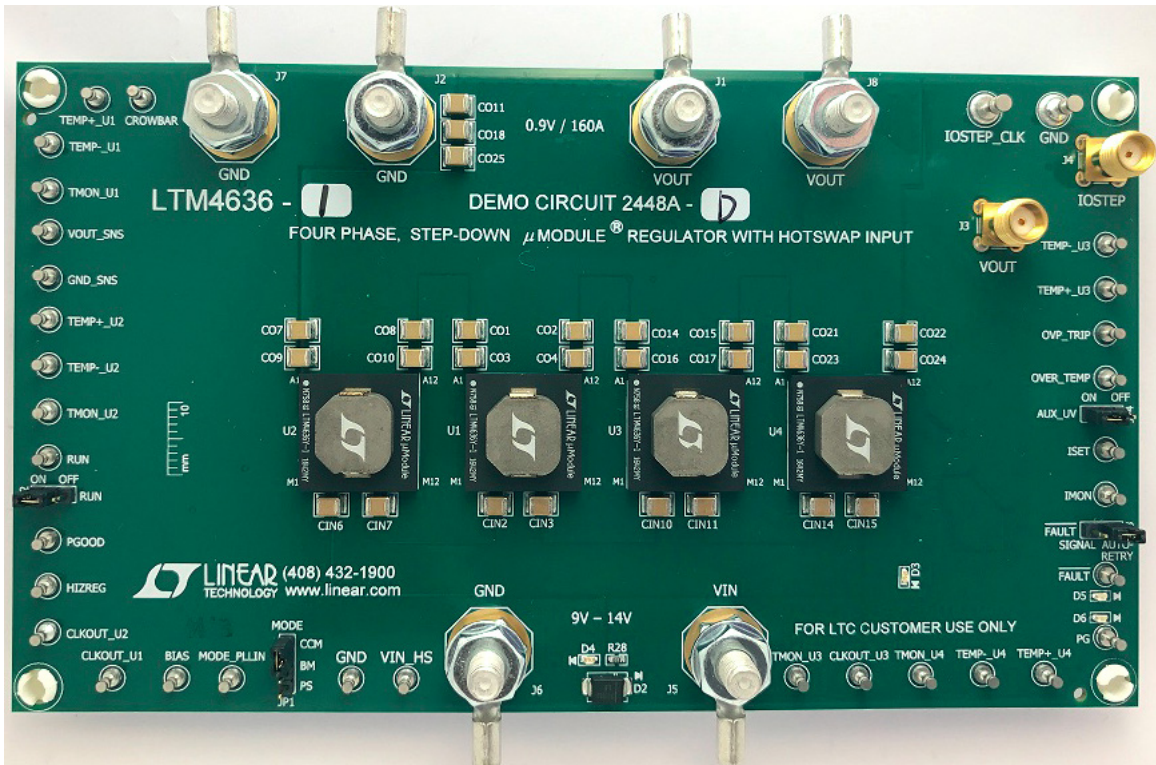
Demonstration circuit DC2448A-D features a PolyPhase® design using the [LTM®4636-1EY](#), a 40A high efficiency, switch mode step-down power μ Module® regulator with overvoltage and overtemperature protection features. The input voltage range is from 9V to 15V. The output voltage range is 0.6V to 3.3V. The DC2448A-D can deliver a nominal 160A output current. DC2448A-D has on-board hot swap circuit that can disconnect input supply and protect the LTM4636-1 and the load under overvoltage and overtemperature conditions. 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® operation in less noise sensitive applications. The MODE_PLLIN pin also allows the LTM4636-1 to synchronize to an external clock signal. DC2448A-D has the option of choosing both internal and external compensation circuits for LTM4636-1. The LTM4636-1 data sheet must be read in conjunction with this demo manual prior to working on or modifying demo circuit DC2448A-D.

Design files for this circuit board are available at <http://www.analog.com/DC2448A-D>

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BOARD PHOTO



DEMO MANUAL

DC2448A-D

PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		9V to 15V
Output Voltages		$0.9\text{V} \pm 1.3\%$
Maximum Continuous Output Current	Derating is necessary for certain operating conditions. See data sheet for details.	160A_{DC}
Operating Frequency		350kHz
Efficiency	$V_{\text{IN}} = 12\text{V}$, $V_{\text{OUT}} = 0.9\text{V}$, $I_{\text{OUT}} = 160\text{A}$	86.1% Figure 2
Load Transient $V_{\text{OUT(P-P)}}$	$V_{\text{IN}} = 12\text{V}$, $V_{\text{OUT}} = 0.9\text{V}$, $I_{\text{STEP}} = 0\text{A TO } 40\text{A}$	95mV Figure 3
V_{OUT} Overvoltage Threshold	$R11 = 100\text{k}\Omega$	1V
Overtemperature Threshold	$R71 = R73 = R74 = R75 = 66.5\text{k}\Omega$, $V_{\text{BIAS}} = 5\text{V}$	130°C

QUICK START PROCEDURE

Demonstration circuit DC2448A-D is an easy way to evaluate the performance of PolyPhase operation of the LTM4636-1EY. 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_{IN} supply to 12V.
- Turn on the power supply at the input. The output voltage should be $0.9\text{V} \pm 1.3\%$ (0.888V to 0.912V).

- Vary the input voltage from 9V to 15V and adjust the load current from 0A to 160A. Observe the output voltage regulation, ripple voltage, efficiency and other parameters.
- (Optional) For optional load transient test, apply an adjustable pulse signal between $I_{\text{STEP_CLK}}$ and GND test points. The pulse amplitude sets the load step current amplitude. Keep the pulse width short ($<1\text{ms}$) and pulse duty cycle low ($<5\%$) to limit the thermal stress on the load transient circuit.
- (Optional) LTM4636-1 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 LTM4636-1 can track another supply. The output voltage tracks the voltage on TRACK when a valid signal is applied on the test point.
- (Optional) To test the OVP and OTP circuitry of LTM4636-1, another external 5V power supply is needed at the BIAS pin.

QUICK START PROCEDURE

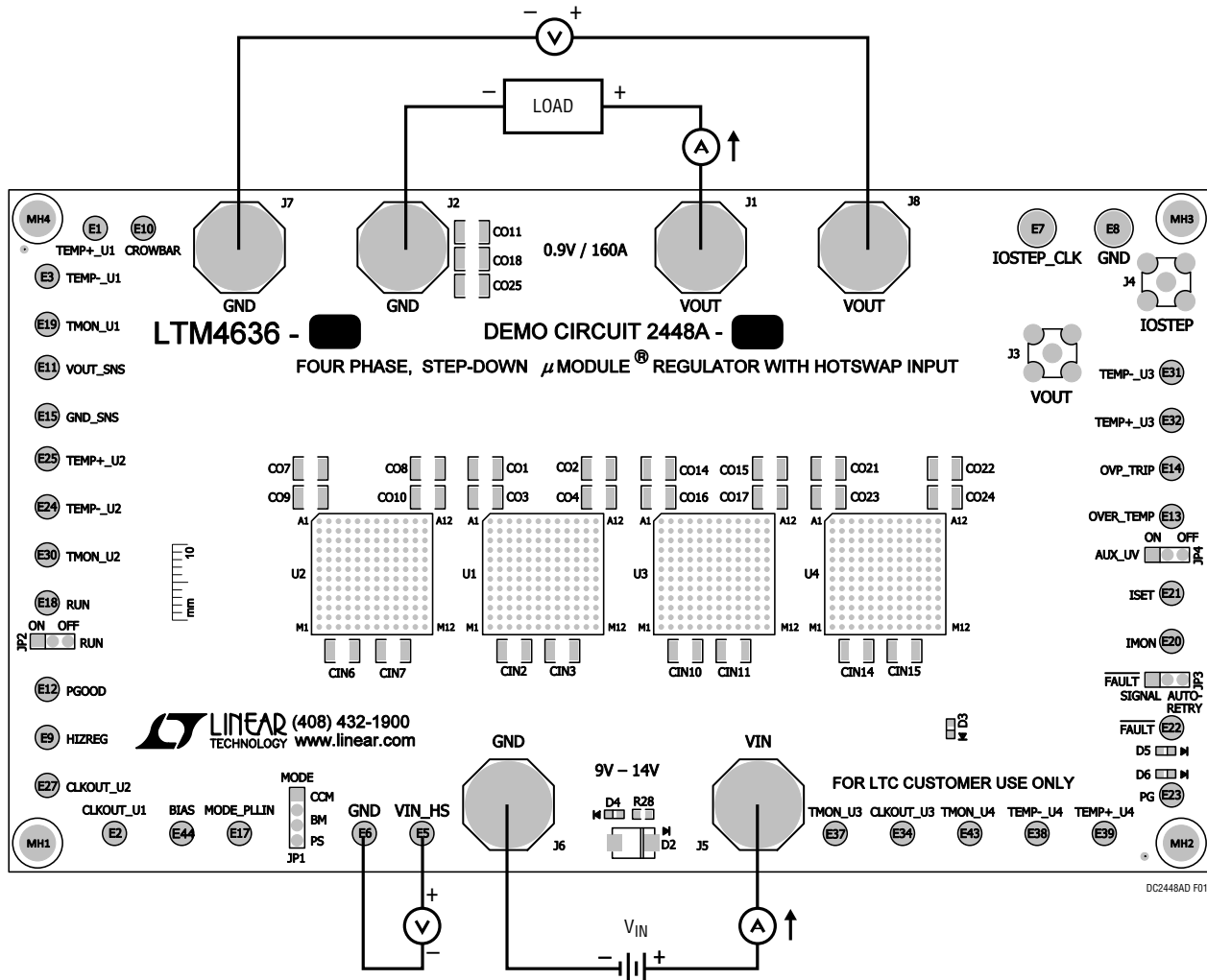


Figure 1. Measurement Setup of DC2448A-D

QUICK START PROCEDURE

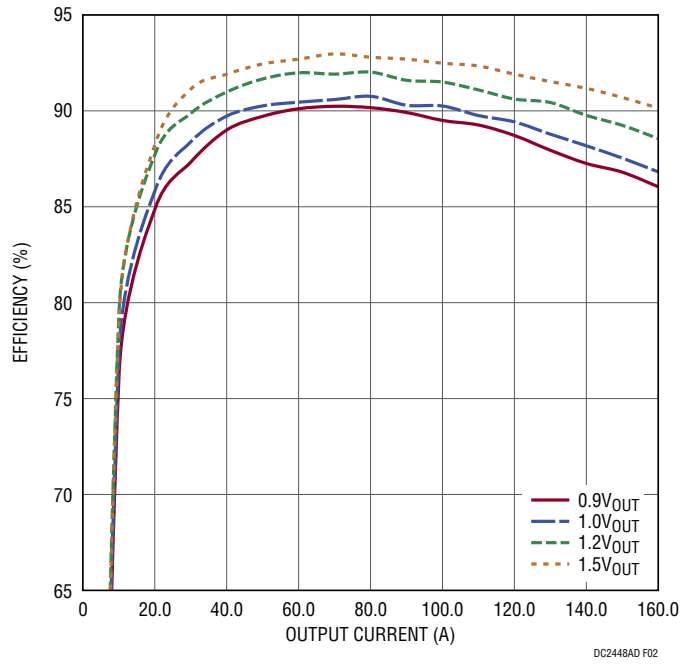


Figure 2. Measured Efficiency at $V_{IN} = 12V$, $f_{SW} = 350kHz$, CCM

QUICK START PROCEDURE

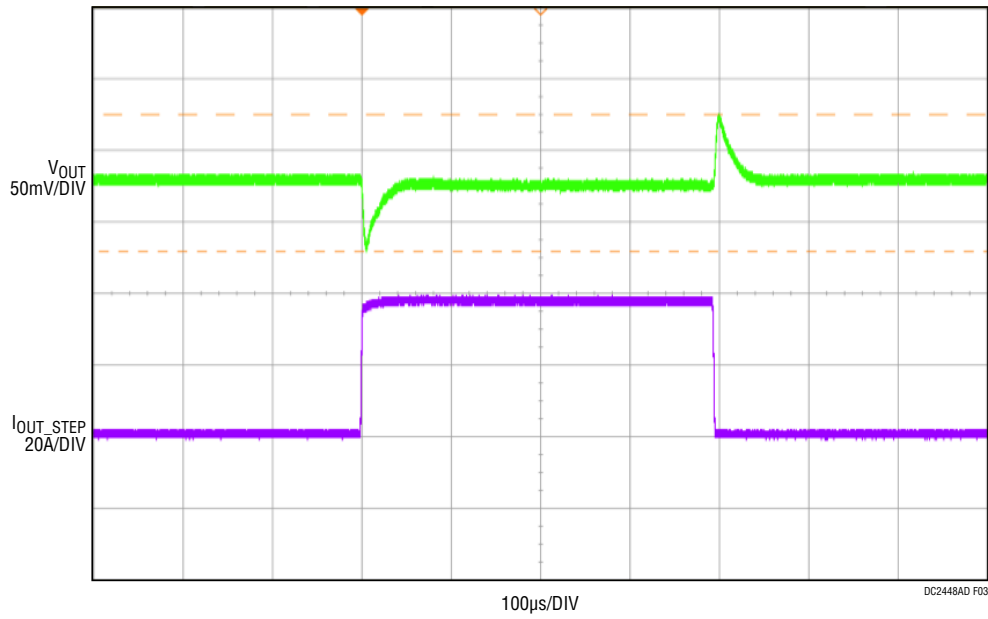


Figure 3. Measured Load Transient
 $V_{IN} = 12V$, $V_{OUT} = 0.9V$, $I_{STEP} = 0A$ to $40A$

QUICK START PROCEDURE

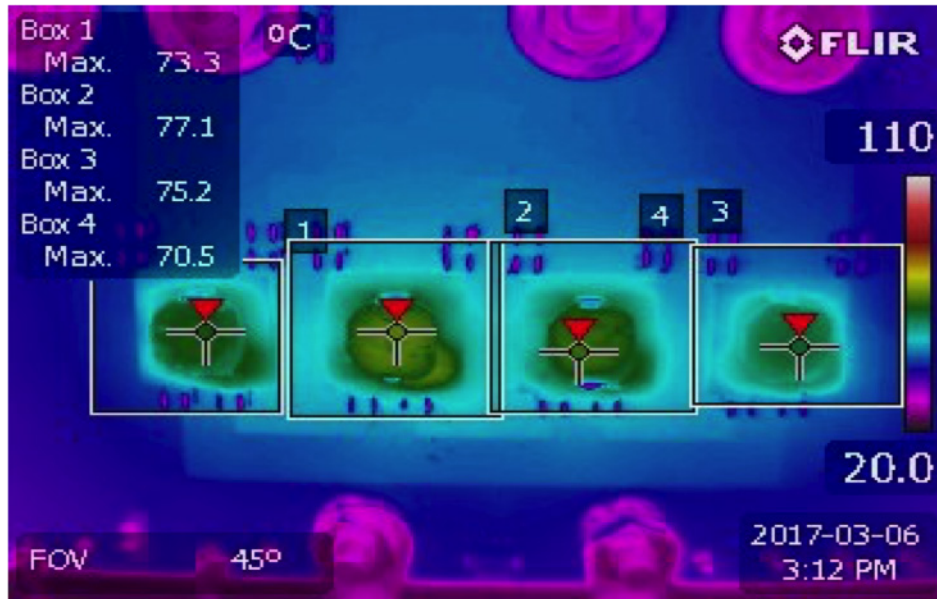


Figure 4. Thermal Capture at $V_{IN} = 12V$, $V_{OUT} = 0.9V$, 160A ($T_A = 25^\circ C$, 400LFM Airflow and No Heat Sink)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	4	C1, C14, C19, C24	CAP, 22 μ F, X7R, 10V, 10%, 1206	MURATA, GRM31CR71A226KE15L
2	4	C2, C15, C20, C25	CAP, 4.7 μ 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 μ F, X7R, 10V, 10%, 0603	AVX, 0603ZC474KAT2A MURATA, GRM188R71A474KA61D
5	2	C29, C30	CAP, 10 μ F, X5R, 6.3V, 10%, 0805	MURATA, GRM21BR60J106KE19L
6	21	C31, C32, C01, C02, C03, C04, C07, C08, C09, C010, C011, C014, C015, C016, C017, C018, C021, C022, C023, C024, C025	CAP, 100 μ F, X5R, 6.3V, 20%, 1210	MURATA, GRM32ER60J107ME20L
7	1	CIN1	CAP, 150 μ F, ALUM., 35V, 20%, 10x10.5mm, SMD, HVH SERIES	SUN ELECTRONIC INDUSTRIES CORP, 35HVH150M
8	16	CIN2, CIN3, CIN4, CIN5, CIN6, CIN7, CIN8, CIN9, CIN10, CIN11, CIN12, CIN13, CIN14, CIN15, CIN16, CIN17	CAP, 22 μ F, X5R, 25V, 10%, 1210	AVX, 12103D226KAT2A MURATA, GRM32ER61E226KE15L
9	8	C05, C06, C012, C013, C019, C020, C026, C027	CAP, 470 μ 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
11	1	R20	RES., 4.99k, 1%, 1/10W, 0603	NIC, NRC06F4991TRF VISHAY, CRCW06034K99FKEA
12	4	R22, R51, R60, R70	RES., 34.8k, 1%, 1/10W, 0603	VISHAY, CRCW060334K8FKEA YAGEO, RC0603FR-0734K8L
13	3	U1, U2, U3, U4	IC, HIGH EFFICIENCY 40A μ MODULE	ANALOG DEVICES, LTM4636EY#PBF
Additional Demo Board Circuit Components				
1	4	C3, C11, C12, C34	CAP, 0.01 μ F, X7R, 100V, 10%, 0603	AVX, 06031C103KAT2A
2	4	C6, C17, C22, C27	CAP, 2200pF, X7R, 50V, 10%, 0603	AVX, 06035C222KAT2A
3	1	C13	CAP, 0.1 μ F, X7R, 25V, 10%, 0603	AVX, 06033C104KAT2A
4	1	C33	CAP, 1 μ F, X7R, 16V, 10%, 0603	AVX, 0603YC105KAT2A NIC, NMC0603X7R105K16TRPF TDK, C1608X7R1C105K080AC
5	1	C35	CAP, 22pF, C0G, 50V, 5%, 0603	MURATA, GRM1885C1H220JA01J
6	1	D2	DIODE, TVS, 12V, 600W, SMB/DO-214AA	FAIRCHILD SEMI, SMBJ12A
7	2	D3, D4	LED, GREEN, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060GS75000
8	2	D5, D6	LED, SUPER RED, WATERCLEAR, 0603	WURTH ELEKTRONIK, 150060SS75000
9	3	Q1, Q2, Q3	XSTR., MOSFET, N-CH, 40V, TO-252	VISHAY, SUD50N04-8M8P-4GE3
10		Q4	XSTR., MOSFET, N-CH, 30V, 100A, LFPK, S08(SOT669)	NXP SEMICONDUCTORS, PSMN2R0-30YLE, 115
11	14	R2, R10, R17, R19, R45, R47, R50, R54, R56, R59, R62, R65, R68, R69	RES., 0 Ω , 1/10W, 0603	NIC, NRC06ZOTRF VISHAY, CRCW06030000Z0EA
12	8	R4, R5, R12, R15, R28, R31, R35, R36	RES., 10k, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ103V VISHAY, CRCW060310K0JNEA

DEMO MANUAL

DC2448A-D

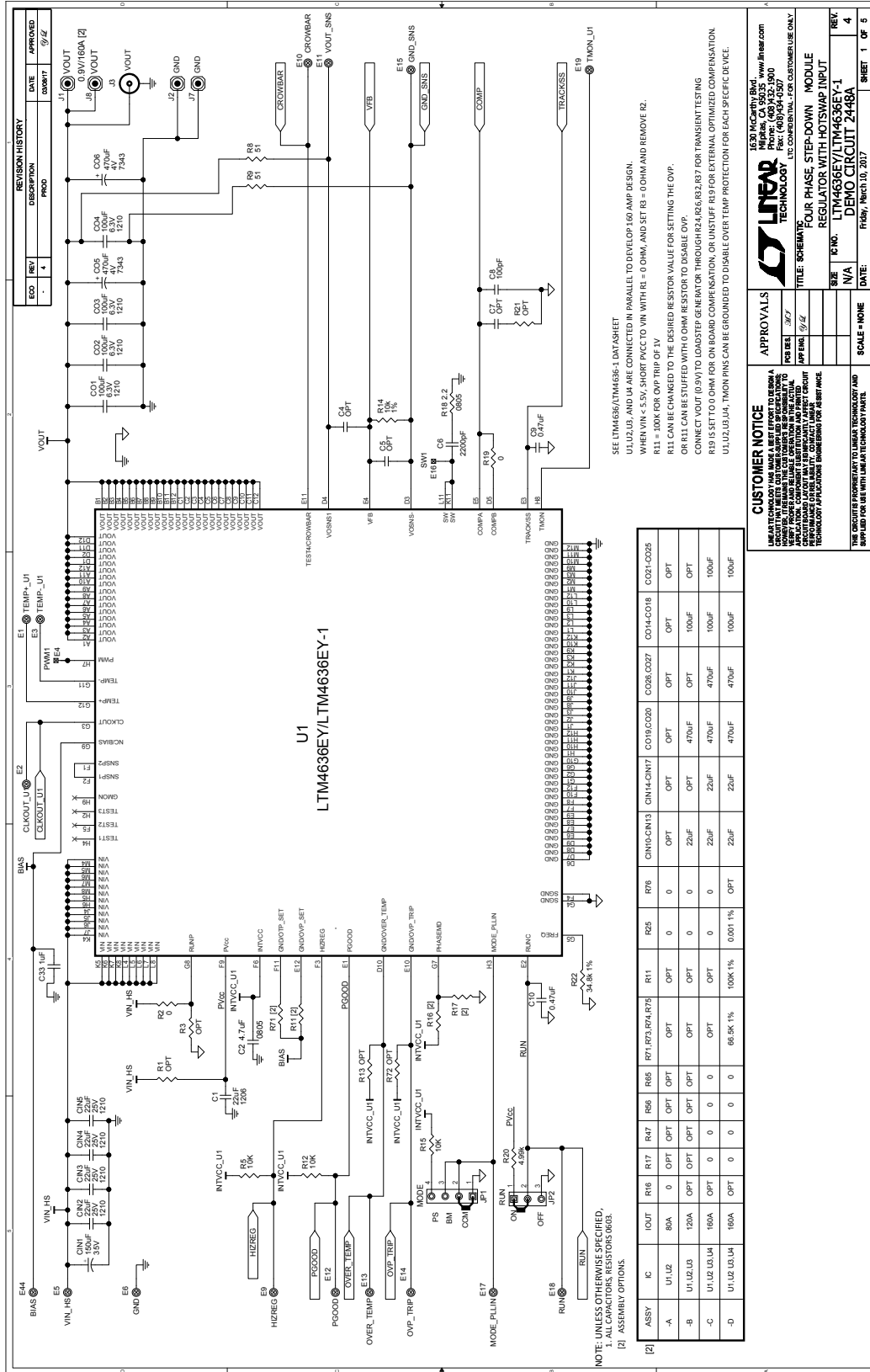
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
13	6	R6, R11, R29, R46, R55, R64	RES., 100k, 1%, 1/10W, 0603	NIC, NRC06F1003TRF PANASONIC, ERJ3EKF1003V VISHAY, CRCW0603100KFKEA
14	1	R7	RES., 0.01Ω, 1%, 1W, 2010, HIGH POWER	VISHAY, WSL2010R0100FEA18
15	2	R8, R9	RES., 51Ω, 5%, 1/10W, 0603	VISHAY, CRCW060351R0JNEA
16	4	R18, R49, R58, R67	RES., 2.2Ω, 5%, 1/8W, 0805, AEC-Q200	VISHAY, CRCW08052R20JNEA
17	4	R24, R26, R32, R37	RES., 0Ω, 3/4W, 2010, AEC-Q200	VISHAY, CRCW20100000Z0EF
18	2	R25, R27	RES., 0.001Ω, 1%, 1W, 2512, SENSE	VISHAY, WSL25121L000FEA
19	1	R30	RES., 107k, 1%, 1/10W, 0603	NIC, NRC06F1073TRF VISHAY, CRCW0603107KFKEA
20	1	R38	RES., 10Ω, 5%, 1/10W, 0603	NIC, NRC06J100TRF VISHAY, CRCW060310R0JNEA
21	2	RMON1, R39	RES., 20k, 1%, 1/10W, 0603	VISHAY, CRCW060320K0FKEA YAGEO, RC0603FR-0720KL
22	1	R40	RES., 6.49k, 1%, 1/10W, 0603	VISHAY, CRCW06036K49FKEA YAGEO, RC0603FR-076K49L
23	1	R41	RES., 1k, 5%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06031K00JNEA
24	1	R42	RES., 9.53k, 1%, 1/10W, 0603	VISHAY, CRCW06039K53FKEA
25	4	R71, R73, R74, R75	RES., 66.5k, 1%, 1/10W, 0603	NIC, NRC06F6652TRF VISHAY, CRCW060366K5FKEA YAGEO, RC0603FR-0766K5L
26	1	U5	IC, HOTSWAP CONTROLLER, SSOP-16	ANALOG DEVICES, LTC4218CGN#PBF ANALOG DEVICES, LTC4218CGN#TRPBF

Hardware: For Demo Board Only

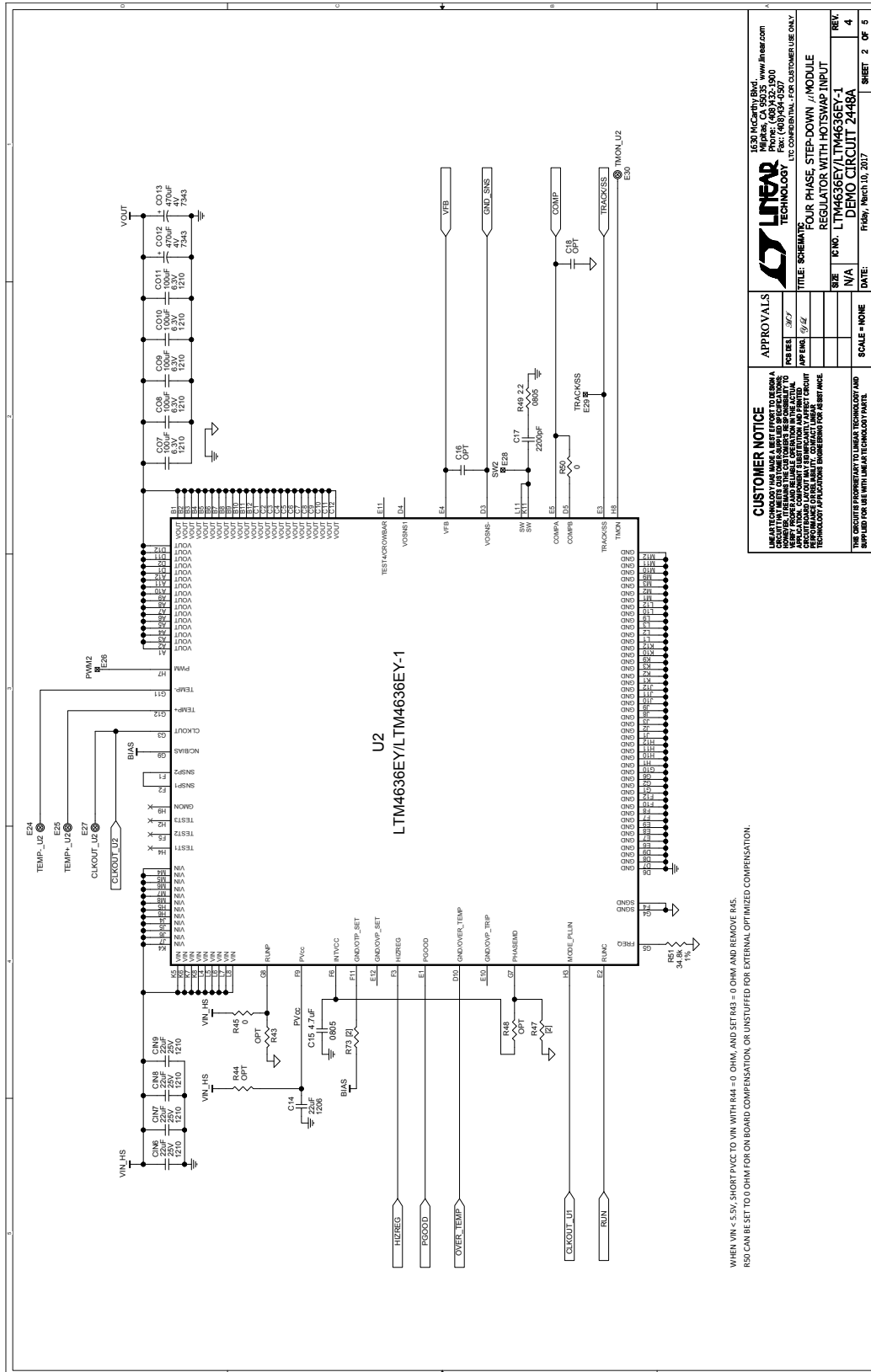
1	31	E1, E2, E3, E5, E6, E9, E10, E11, E12, E13, E14, E15, E17, E18, E19, E20, E21, E22, E23, E24, E25, E27, E30, E31, E32, E34, E37, E38, E39, E43, E44	TEST POINT, TURRET, 0.064", MTG. HOLE	MILL-MAX, 2308-2-00-80-00-00-07-0
2	2	E7, E8	TEST POINT, TURRET, 0.094", MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
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	PENNINGENGINEERING, 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	4	XJP1, XJP2, XJP3, XJP4	CONN., SHUNT, FEMALE, 2 POS, 2mm	SAMTEC, 2SN-BK-G

SCHEMATIC DIAGRAM



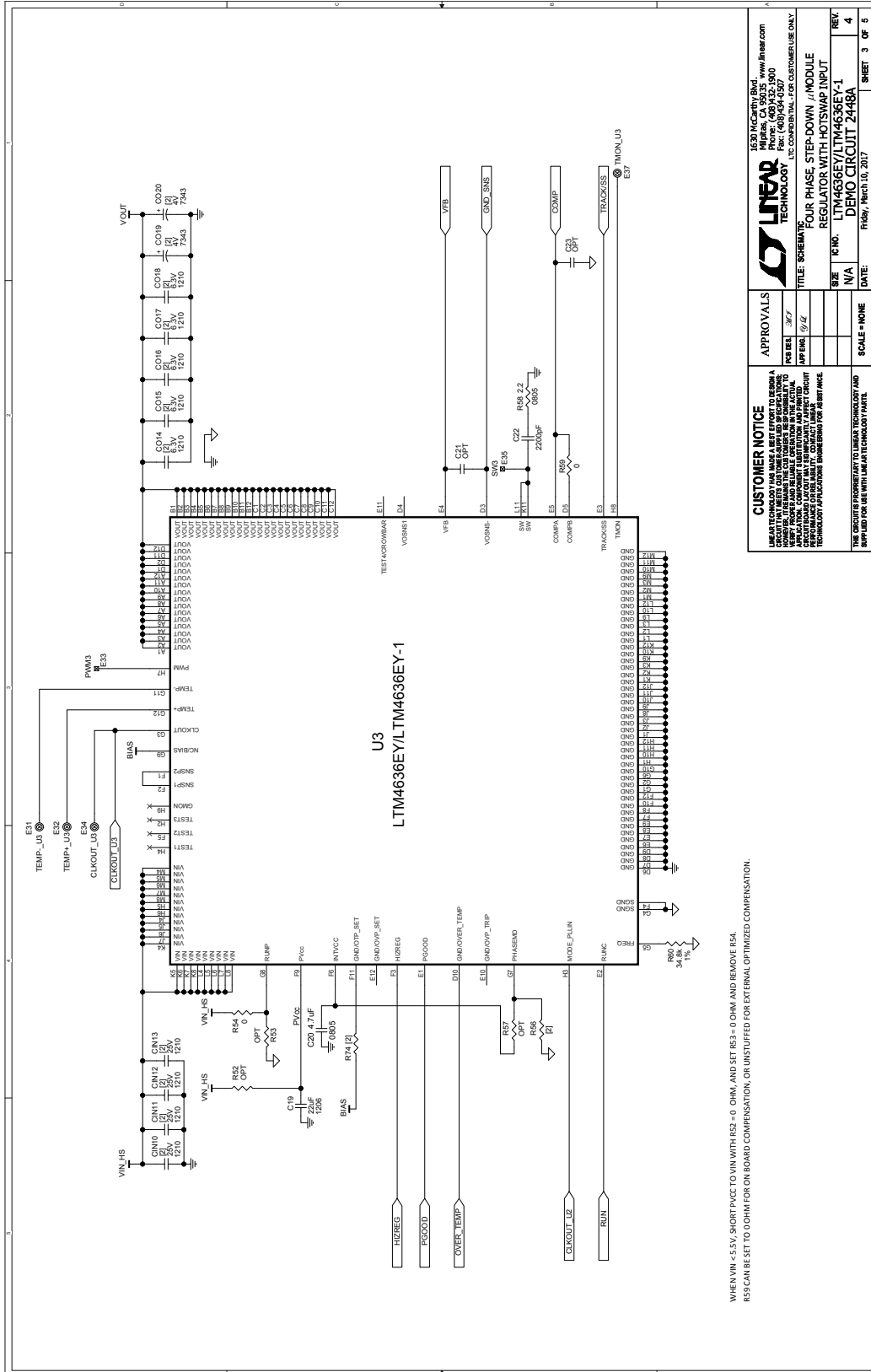
DEMO MANUAL DC2448A-D

SCHEMATIC DIAGRAM



WHEN VIN = 5.5V, SHORT PVCC TO VIN WITH R44 = 0 OHM, AND SET R43 = 0 OHM AND REMOVE R45.
 R50 CAN BE SET TO 0 OHM FOR ON BOARD COMPENSATION, OR UNSTUFFED FOR EXTERNAL OPTIMIZED COMPENSATION.

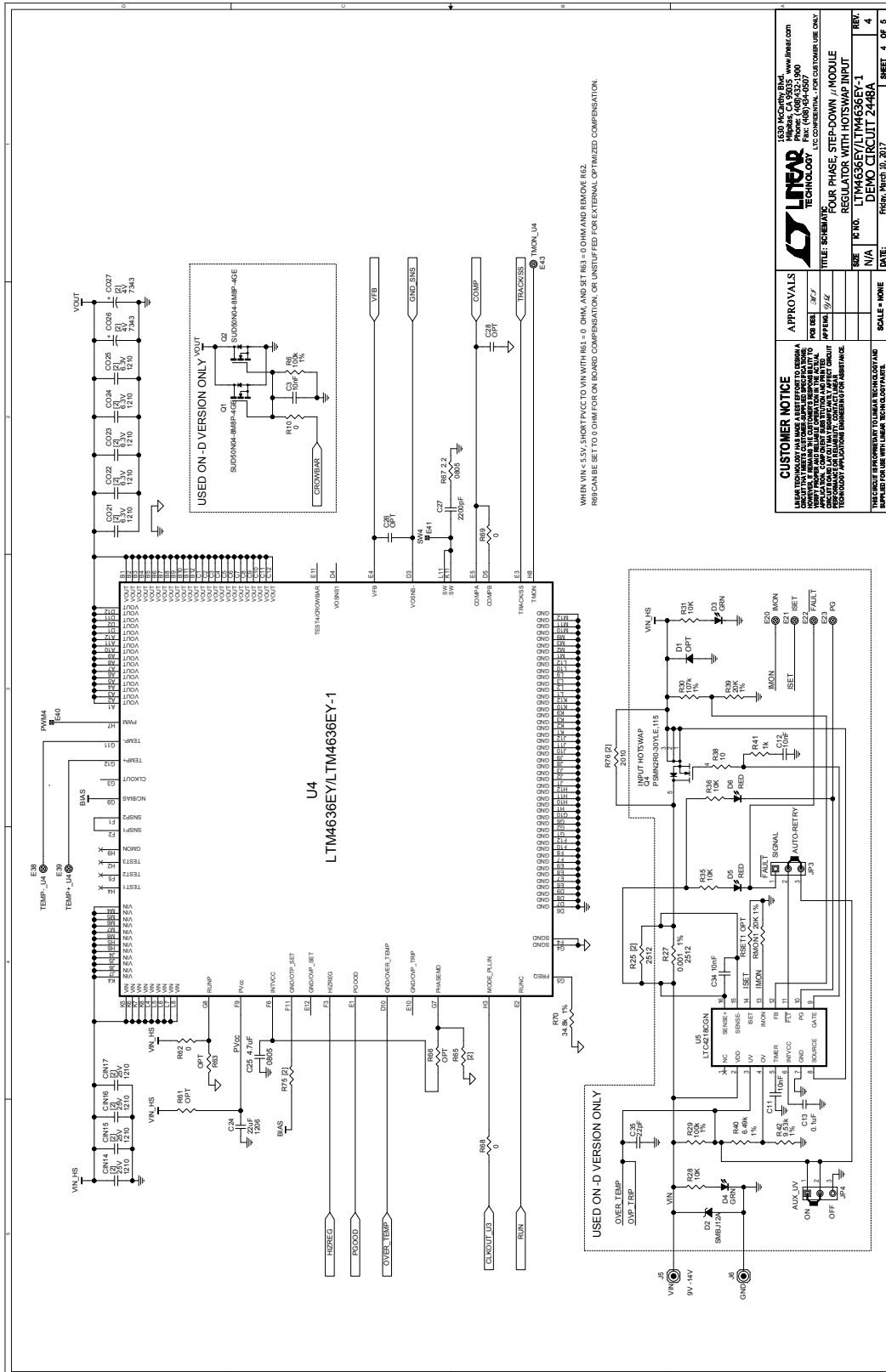
SCHEMATIC DIAGRAM



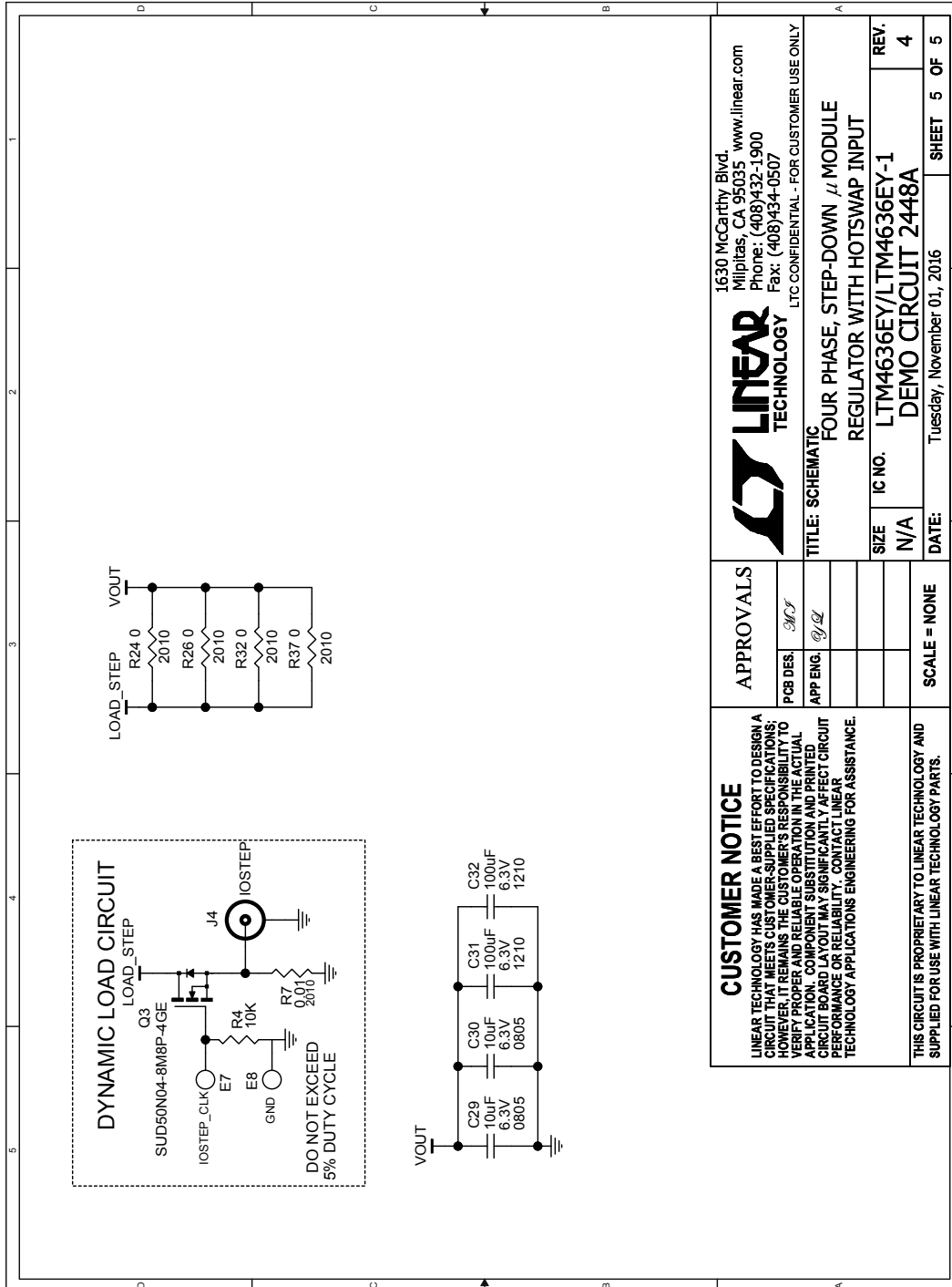
WHEN VIN < 5.5V, SHORT PVCC TO VIN WITH RS2 = 0 OHM, AND SET RS3 = 0 OHM AND REMOVE RS4.
 RS9 CAN BE SET TO 0 OHM FOR ON BOARD COMPENSATION, OR UNINSTALLED FOR EXTERNAL OPTIMIZED COMPENSATION.

DEMO MANUAL DC2448A-D

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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LINEAR TECHNOLOGY

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TITLE: SCHEMATIC
FOUR PHASE, STEP-DOWN, // MODULE
REGULATOR WITH HOTSWAP INPUT

IC NO.	LTM4636EY/LTM4636EY-1	REV.	4
SIZE	N/A	DATE:	Tuesday, November 01, 2016
SCALE = NONE		SHEET 5 OF 5	

APPROVALS

PCB DES.	SJC
APP ENG.	BJL

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THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.



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