LTM4650
High Efficiency, Single 50A or Dual 25A Step-Down Power µModule Regulator

DESCRIPTION

Demonstration circuit DC2378A-A features the LTM®4650EY, the high efficiency, high density, dual 25A, single 50A, switch mode step-down power module regulator. The input voltage is from 4.5V to 15V. The output voltage is programmable from 0.6V to 1.8V. DC2378A-A can deliver 25A maximum current from each channel. 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 jumper (JP1) selects pulse-skipping mode for noise sensitive applications or Burst Mode® operation in less noise sensitive applications. Two outputs can be connected in parallel for a single 50A output solution with optional jumper resistors. The board allows the user to program how its output ramps up and down through the TRACK/SS pin. The output can be set up to either coincidentally or ratiometrically track with another supply's output. Remote output voltage sensing is available for improved output voltage regulation at the load point. These features and the availability of the LTM4650EY in a compact 15mm × 15mm × 5.01mm BGA package make it ideal for use in many high density point-of-load regulation applications. The LTM4650 data sheet must be read in conjunction with this demo manual for working on or modifying the demo circuit DC2378A-A.

Design files for this circuit board are available at http://www.linear.com/demo/DC2378A-A

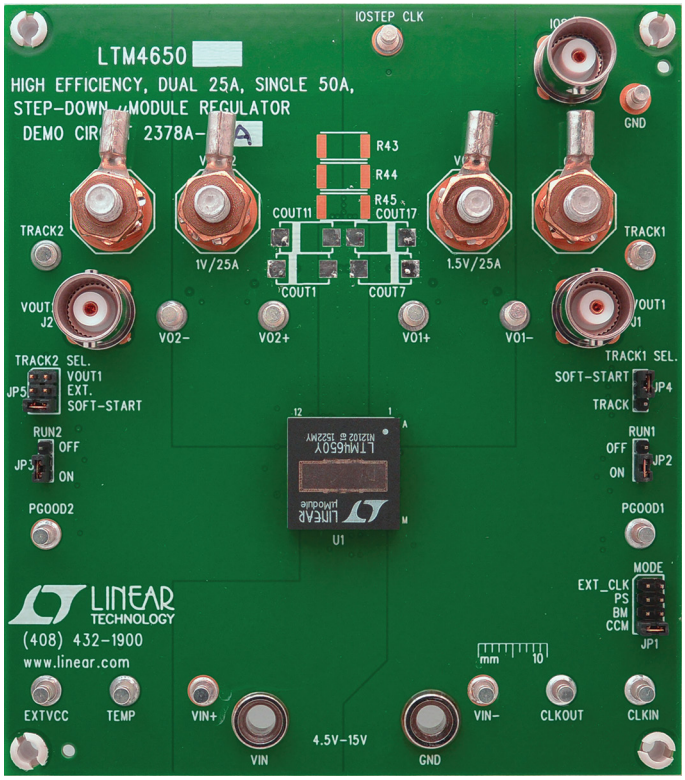


Figure 1. LTM4650/DC2378A-A Demo Board

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		4.5		15	V
Output Voltage V_{OUT1}	V_{IN} = 4.5V ~ 15V, I_{OUT1} = 0A ~ 25A, JP1: CCM		1.5 ±1.5%		V
Output Voltage V_{OUT2}	V_{IN} = 4.5V ~ 15V, I_{OUT2} = 0A ~ 25A, JP1: CCM		1 ±1.5%		V
Per-Channel Maximum Continuous Output Current	Derating Is Necessary for Certain V_{IN}, V_{OUT} and Thermal Conditions, See Data Sheet for Detail.		25 (Per-Channel)		A
Default Operating Frequency			500		kHz
Resistor Programmable Frequency Range		250		780	kHz
External Clock Sync. Frequency Range		400		780	kHz
Efficiency of Channel 1	V_{IN} = 12V, V_{OUT1} = 1.5V, I_{OUT1} = 25A, f_{SW} = 500kHz		88.8 See Figure 4		%
Efficiency of Channel 2	V_{IN} = 12V, V_{OUT2} = 1V, I_{OUT2} = 25A, f_{SW} = 500kHz		86.5 See Figure 5		%
Load Transient of Channel1	V_{IN} = 12V, V_{OUT1} = 1.5V, I_{STEP} = 12.5A ~ 18.75A		See Figure 6		
Load Transient of Channel2	V_{IN} = 12V, V_{OUT2} = 1V, I_{STEP} = 12.5A ~ 18.75A		See Figure 7		

QUICK START PROCEDURE

Demonstration circuit DC2378A-A is easy to set up to evaluate the performance of the LTM4650EY. Please refer to Figure 2 for proper measurement setup and follow the procedure below:

1. Place jumpers in the following positions for a typical application:

JP1	JP2	JP3	JP4	JP5
MODE	**RUN1**	**RUN2**	**TRACK1 SEL.**	**TRACK2 SEL.**
CCM	ON	ON	SOFT-START	SOFT-START

2. With power off, connect the input power supply, load and meters as shown in Figure 2. Preset the load to 0A and V_{IN} supply to 12V.
3. Turn on the power supply at the input. The output voltage in channel 1 should be 1.5V ±1.5% (1.4775V ~ 1.5225V) and the output voltage in channel 2 should be 1V ±1.5% (0.985V ~ 1.015V).
4. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, output voltage ripple, efficiency and other parameters. Output ripple should be measured at J1 and J2 with BNC cables. 50Ω termination should be set on the oscilloscope or BNC cables.
5. (Optional) For optional load transient test, apply an adjustable pulse signal between IOSTEP CLK and GND test point. Pulse amplitude (3V ~ 3.5V) sets the load step current amplitude. The output transient current can be monitored at the BNC connector J3 (10mV/A). The pulse signal should have very small duty cycle (< 1%) to limit the thermal stress on the transient load circuit. Switch the jumper resistors R34 or R35 (on the backside of boards) to apply load transient on channel 1 or channel 2 correspondingly.
6. (Optional) LTM4650 can be synchronized to an external clock signal. Place the JP1 jumper on EXT_CLK and apply a clock signal (0V ~ 5V, square wave) on the CLKIN test point.
7. (Optional) The outputs of LTM4650 can track another supply. The jumpers JP4 and JP5 allow choosing soft-start or output tracking. If tracking external voltage is selected, the corresponding test points, TRACK1 and TRACK2, need to be connected to a valid voltage signal.
8. (Optional) LTM4650 can be configured for a 2-phase single output at up to 50A on DC2378A-A. Install 0Ω resistors on R14, R17, R28, R39, R43, R44, R45 and remove R7, R19. Output voltage is set by R25 based on equation V_{OUT} = 0.6V(1 + 60.4k/R25).

QUICK START PROCEDURE

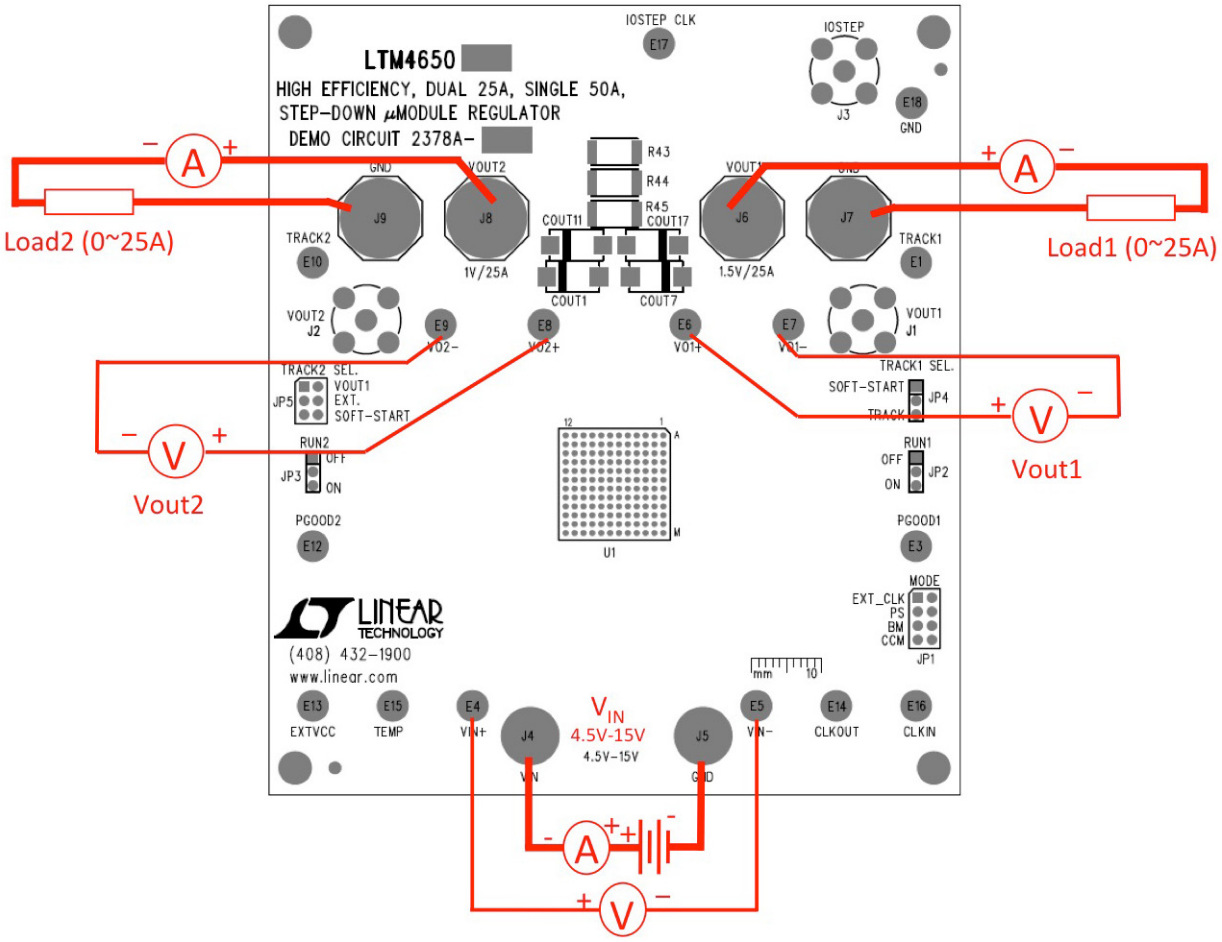


Figure 2. Test Setup of DC2378A-A

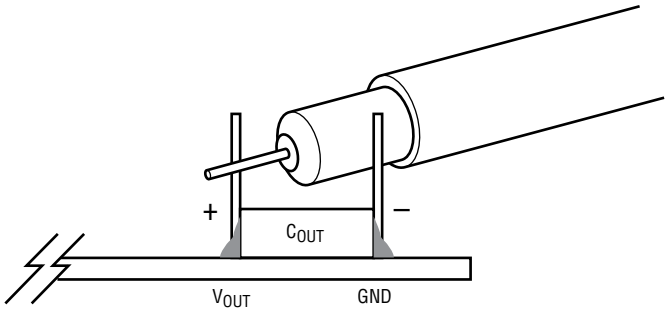


Figure 3. Measuring Output Voltage Ripple

QUICK START PROCEDURE

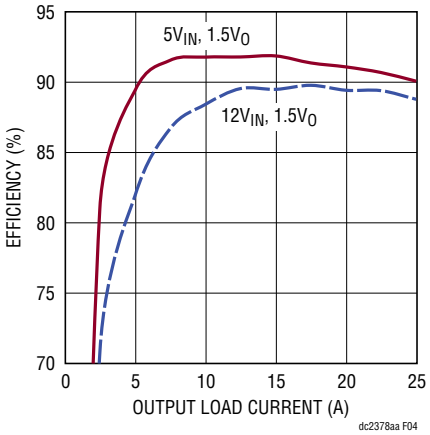


Figure 4. Measured Efficiency on Channel 1 (V_{OUT1} = 1.5V, f_{SW} = 500kHz, Channel 2 Disabled)

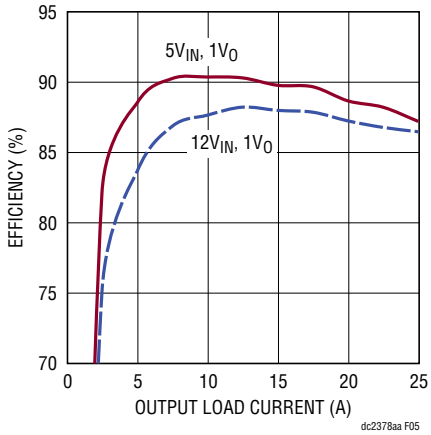


Figure 5. Measured Efficiency on Channel 2 (V_{OUT2} = 1V, f_{SW} = 500kHz, Channel 1 Disabled)

Figure 6. Measured Channel 1 12.5A to 18.75A Load Transient (V_{IN} = 12V, V_{OUT1} = 1.5V)

Figure 7. Measured Channel 2 12.5A to 18.75A Load Transient (V_{IN} = 12V, V_{OUT2} = 1V)

QUICK START PROCEDURE

Figure 8. Measured Output Voltage Ripple at 12V Input, 1.5V/25A with Standard Demo Circuit Default Setup

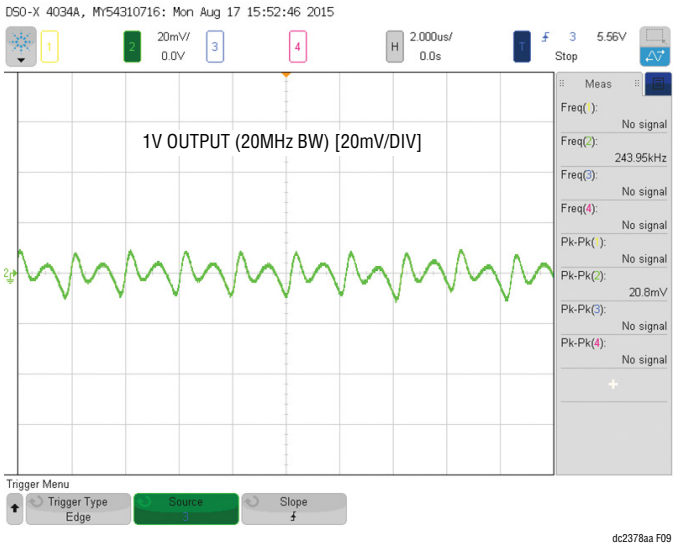


Figure 9. Measured Output Voltage Ripple at 12V Input, 1V/25A with Standard Demo Circuit Default Setup

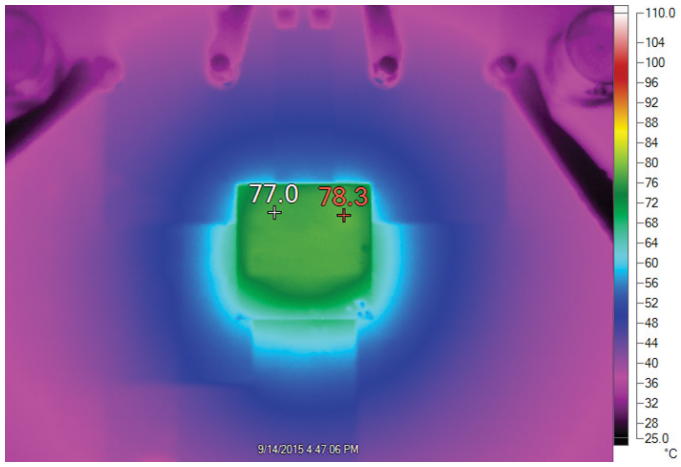


Figure 10. Thermal Capture at $12V_{IN}$, $1.5V_{OUT}$ at 25A and $1V_{OUT}$ at 25A (Ambient Temperature = 23°C, 200 LFM Airflow and No Heat Sink)

PARTS LIST

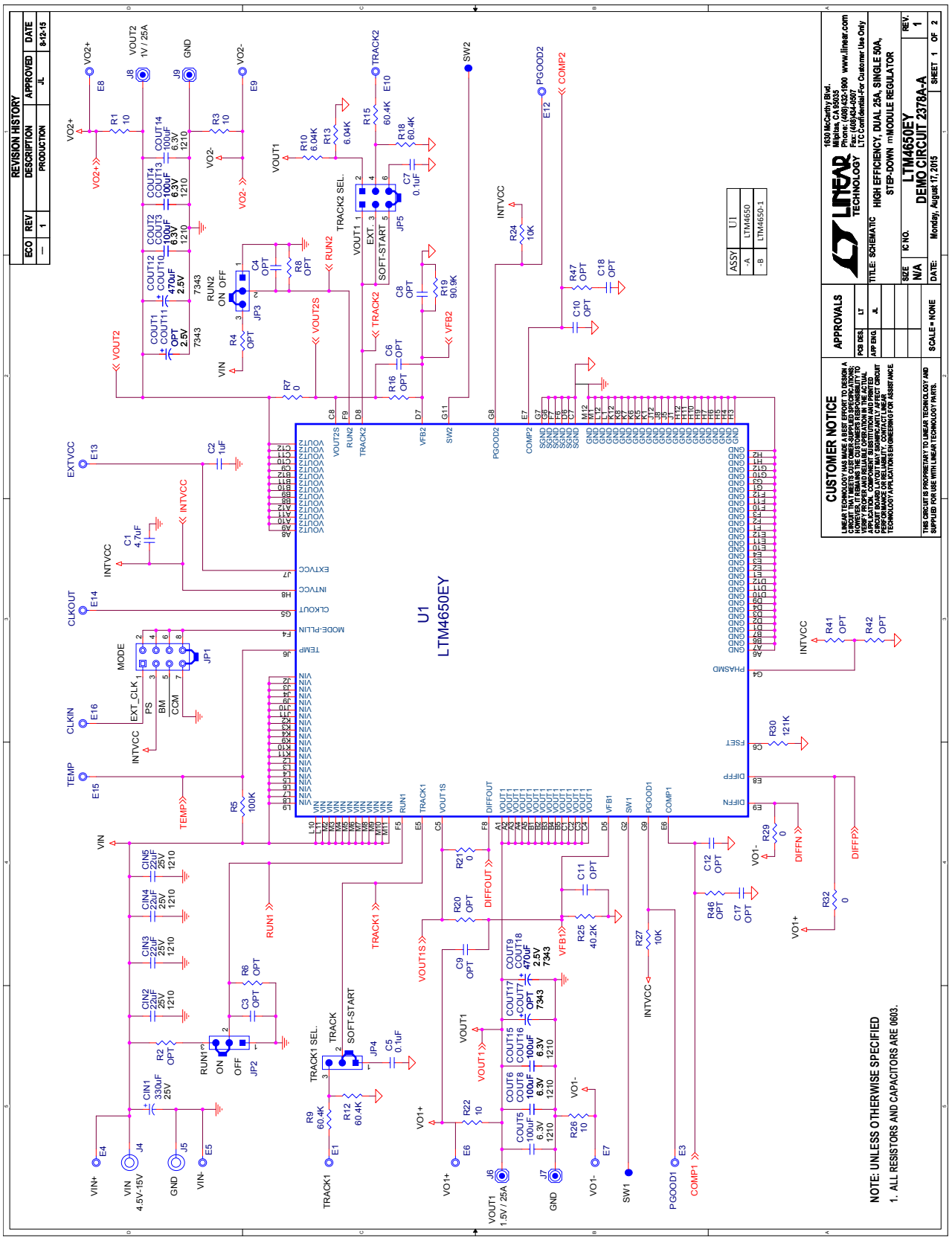
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP., ALUM. ELECT., 330µF, 25V, 20%	PANASONIC, 25SVPF330M
2	4	CIN2, CIN3, CIN4, CIN5	CAP., 22µF, X5R, 25V, 10%, 1210	MURATA, GRM32ER61E226KE15L
3	8	COUT9, COUT10, COUT12, COUT18	CAP., POSCAP, 470µF, 2.5V, 0.005Ω, 7343	PANASONIC, ETPF470M5H
4	10	COUT2, COUT3, COUT4, COUT5, COUT6, COUT8, COUT13, COUT14, COUT15, COUT16	CAP., 100µF, X5R, 6.3V, 20%, 1210	AVX, 12106D107MAT2A
5	1	C1	CAP., 4.7µF, X5R, 16V, 20%, 0805	KEMET, C0805C475M4PACTU
6	1	C2	CAP., 1µF, X7R, 25V, 10%, 0805	AVX, 08053C105KAT2A
7	2	C5, C7	CAP., 0.1µF, X5R, 25V, 10%, 0603	AVX, 06033D104KAT2A
8	4	C13, C14, C15, C16	CAP., 1µF, X7R, 10V, 10%, 0603	AVX, 0603ZC105KAT2A
9	1	Q1	XSTR., N-CH, 40V, DPAK-2, TO-252	VISHAY, SUD50N04-8M8P-4GE3
10	4	R1, R3, R22, R26	RES., 10Ω, 1/10W, 1%, 0603	NIC, NRC06F10R0TRF
11	1	R5	RES., 100k, 1/10W, 1%, 0603	VISHAY, CRCW0603100KFKEA
12	4	R9, R12, R15, R18	RES., 60.4k, 1/10W, 1%, 0603	VISHAY, CRCW060360K4FKEA
13	2	R10, R13	RES., 6.04k, 1/10W, 1%, 0603	VISHAY, CRCW06036K04FKEA
14	1	R19	RES., 90.9k, 1/10W, 1%, 0603	VISHAY, CRCW060390K9FKEA
15	3	R24, R27, R36	RES., 10k, 1/10W, 1%, 0603	YAGEO, RC0603FR-0710KL
16	1	R25	RES., 40.2k, 1/10W, 1%, 0603	VISHAY, CRCW060340K2FKEDA
17	1	R30	RES., 121k, 1/10W, 1%, 0603	VISHAY, CRCW0603121KFKEA
18	1	R37	RES., HIGH POWER, 0.01Ω, 2W, 1%, 2512	VISHAY, WSL2512R0100FEA18
19	1	U1	I.C., 16×16×5.01 BGA	LINEAR TECH., LTM4650EY#PBF
Additional Demo Board Circuit Components				
1	0	COUT1, COUT7, COUT11, COUT17	CAP., OPT, 7343	OPT
2	0	C3, C4, C6, C8, C9, C10, C11, C12, C17, C18	CAP., OPTION, 0603	OPT
3	0	R2, R4, R6, R8, R11, R14, R16, R17, R20, R23, R28, R31, R33, R39, R40, R41, R42, R46, R47, R48	RES., OPTION, 0603	OPT
4	4	R7, R21, R29, R32	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
5	1	R34	RES., 0Ω, 1/2W, 2010	VISHAY, CRCW20100000Z0EF
6	0	R35	RES., OPTION, 2010	OPT
7	0	R38, R43, R44, R45	RES., OPTION, 2512	OPT

PARTS LIST

Hardware: For Demo Board Only

1	16	E1, E3, E4, E5, E6, E7, E8, E9, E10, E12, E13, E14, E15, E16, E17, E18	TEST POINT, TURRET, 0.094" MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	CONN., HEADER, 2×4, 2mm	WURTH ELEKTRONIK, 62000821121
3	3	JP2, JP3, JP4	CONN., HEADER, 1×3, 2mm	WURTH ELEKTRONIK, 62000311121
4	1	JP5	CONN., HEADER, 2×3, 2mm	WURTH ELEKTRONIK, 62000621121
5	5	XJP1, XJP2, XJP3, XJP4, XJP5	SHUNT, 2mm	WURTH ELEKTRONIK, 60800213421
6	3	J1, J2, J3	CONN., BNC STR PCB JK, THRU- HOLE, 5PINS	CONNEX 112404
7	2	J4, J5	CONN., JACK, BANANA, NON-INSULATED, 0.218"	KEYSTONE, 575-4
8	4	J6, J7, J8, J9	STUD, TESTPIN	PEM KFH-032-10
9	8	J6, J7, J8, J9 (x2)	NUT, BRASS 10-32	ANY #10-32
10	4	J6, J7, J8, J9	RING, LUG #10	KEYSTONE, 8205, #10
11	4	J6, J7, J8, J9	WASHER, TIN PLATED BRASS	ANY #10, #10EXT BZ TN
12	4	(STAND-OFF)	STANDOFF, NYLON, SNAP-ON, 0.500"	KEYSTONE, 8833

SCHEMATIC DIAGRAM



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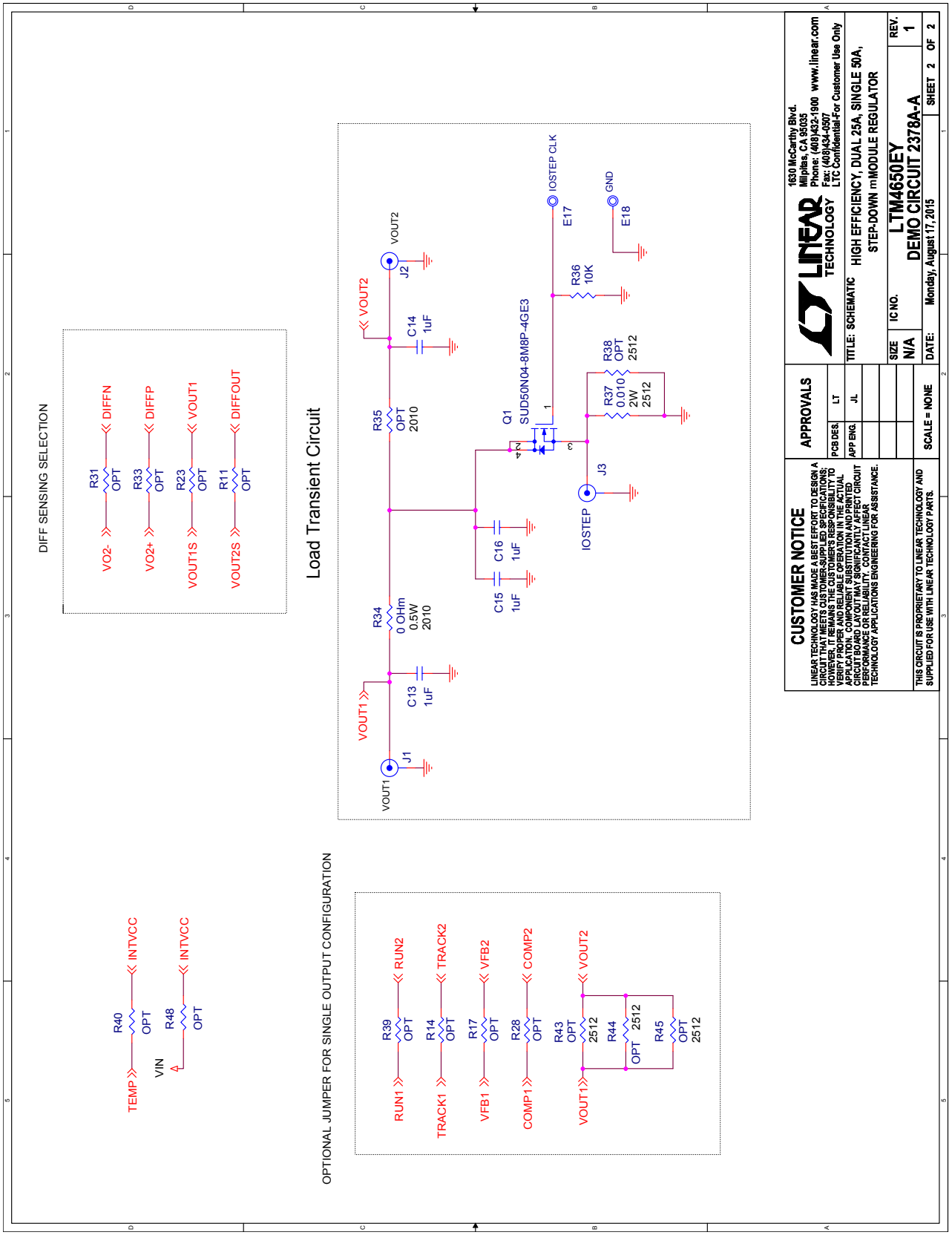
SCHEMATIC DIAGRAM



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