

### LTM4650EY-1

## High Efficiency, PolyPhase 100A Step-Down Power $\mu$ Module<sup>®</sup> Regulator

### 2x LTM4650EY-1, 100A

## DESCRIPTION

Demonstration Circuit 2455A-A features PolyPhase<sup>®</sup> design using the **LTM<sup>®</sup>4650EY-1** (B-grade), the high efficiency, high density, dual 25A, switch mode step-down power module regulator. The input voltage is from 4.5V to 15V. The output voltage is jumper selectable from 0.9V to 1.8V. DC2455A-A can deliver nominal 100A output current. As explained in the data sheet, output current de-rating is necessary for certain  $V_{IN}$ ,  $V_{OUT}$ , and thermal conditions. The LTM4650-1 on DC2455A-A always operate in continuous conduction mode. The switching frequency can be programmed through a resistor or can be synchronized to an external clock signal. The board allows the user to program how its output voltage ramps up and down through the

TRACK pin. The output voltage is tightly regulated between “ $V_0^+$ ” and “ $V_0^-$ ” through remote output voltage sensing which improves output voltage regulation at heavy loads. These features and the availability of the LTM4650EY-1 in a compact 16mm  $\times$  16mm  $\times$  5.01mm BGA package make it ideal for use in many high-density point-of-load regulation applications. The LTM4650-1 data sheet must be read in conjunction with this demo manual for working on or modifying the demo circuit DC2455A-A.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2455A-A>**

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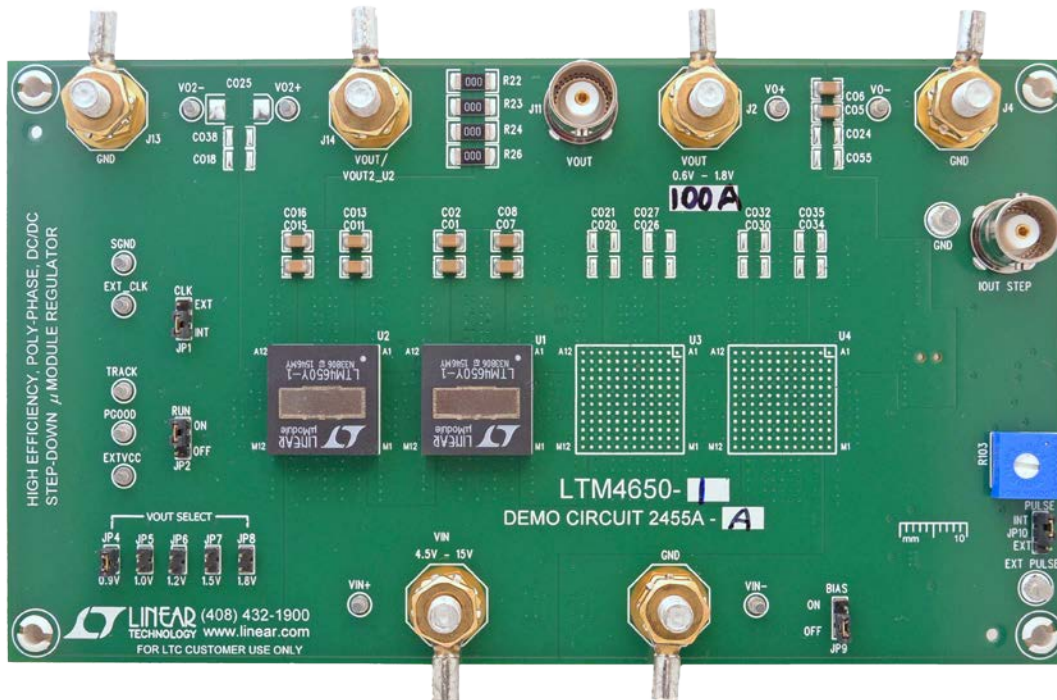


Figure 1. 2x LTM4650-1, 100A PolyPhase LTM4650-1/DC2455A-A Demo Board

# DEMO MANUAL DC2455A-A

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

PARAMETER	CONDITIONS / NOTES	VALUE
Input Voltage Range		4.5V ~ 15V
Output Voltage $V_{OUT}$	$V_{IN} = 4.5\text{V to }15\text{V}$ , $I_{OUT} = 0\text{A to }100\text{A}$ , JP5: 1.0V	$1.0\text{V} \pm 1.5\%$ (0.985V ~ 1.015V)
Maximum Continuous Output Current	De-rating is necessary for certain $V_{IN}$ , $V_{OUT}$ and thermal conditions, see data sheet for detail.	100A
Default Operating Frequency		500kHz
Resistor Programmable Frequency Range		400kHz – 780kHz
External Clock Sync. Frequency Range		400kHz – 780kHz
Efficiency	$V_{IN} = 12\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{OUT} = 100\text{A}$ , $f_{SW} = 500\text{kHz}$	86.5% See Figure 3
Load Transient	$V_{IN} = 12\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{STEP} = 50\text{A to }75\text{A}$	< 57mV, See Figure 4

## QUICK START PROCEDURE

Demonstration circuit DC2455A-A is easy to set up to evaluate the performance of PolyPhase operation of the LTM4650EY-1. Due to the high input/output current, user should select the proper input supply/load/cable which can sustain the full load operation. It's recommended to pull load current from J2 and J4. The load current pulled from J5 and J6 shouldn't exceed 25A. Please refer to Figure 2 for proper measurement setup and follow the procedure below:

1. Place jumpers in the following positions for a typical 1.0V<sub>OUT</sub> application:

JP1	JP2	JP4~JP8
<b>CLK</b>	<b>RUN</b>	<b>V<sub>OUT</sub> SELECT</b>
INT	OFF	ON JP5 / 1.0V

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. Place JP2 to ON position. The output voltage between “V<sub>0+</sub>” and “V<sub>0-</sub>” should be  $1.0\text{V} \pm 1.5\%$  (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 voltage ripple should be measured at J11 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 J12 (5mV/A). The pulse signal should be very small duty cycle (< 10%) to limit the thermal stress on the transient load circuit.
6. (Optional) LTM4650-1 can be synchronized to an external clock signal. Place the JP1 jumper on EXT and apply a clock signal (0V~5V, square wave) on the “EXT\_CLK” test point.
7. (Optional) The outputs of LTM4650-1 can track another supply. The output voltage tracks the voltage on TRACK when a valid signal is applied on the test point.
8. (Optional) DC2455A-A can be configured to a dual outputs configuration with  $V_0$  at 75A load current and  $V_{O2}$  at 25A load current. Stuff 0Ω resistor on R61 and 0.1μF on C14. Remove R22, R23, R24, R26, R27, R28, R32, R33, R35. Output voltage  $V_{O2}$  is set by R37 based on the equation  $V_{O2} = 0.6\text{V}(1 + 60.4\text{k}/\text{R37})$ .

QUICK START PROCEDURE

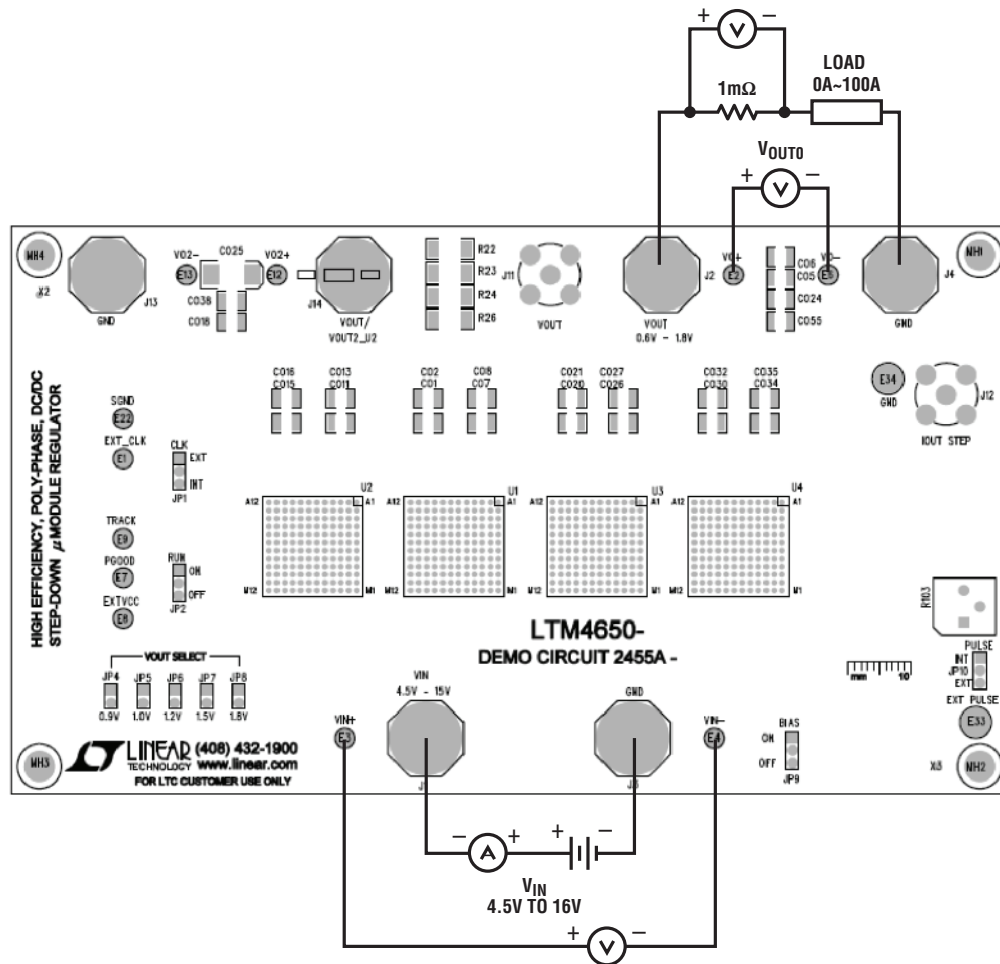


Figure 2. Test Setup of DC2455A-A

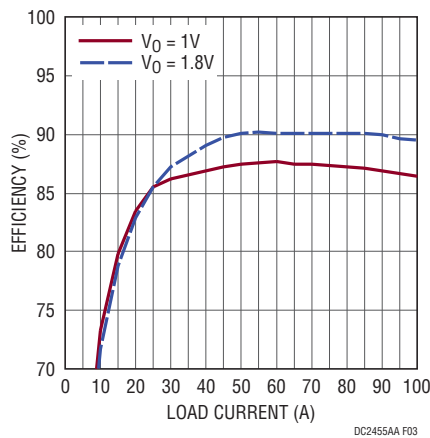
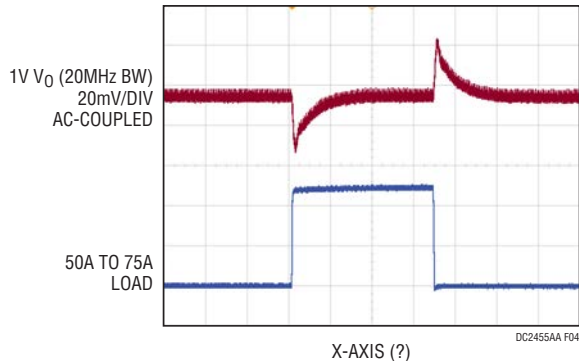
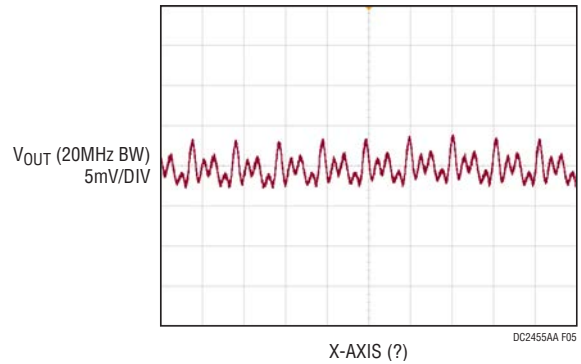


Figure 3. Measured Efficiency  $V_{IN} = 12V$ ,  $f_{SW} = 500kHz$

## QUICK START PROCEDURE



**Figure 4. Load Transient 50A to 75A**  
( $V_{IN} = 12V$ ,  $V_{OUT1} = 1V$ ,  $f_{SW} = 500kHz$ )



**Figure 5. Output Voltage Ripple** ( $V_{IN} = 12V$ ,  
 $V_{OUT1} = 1V$ ,  $I_{OUT} = 100A$ ,  $f_{SW} = 500kHz$ )



**Figure 6. Thermal Performance at  $V_{IN} = 12V$ ,  $V_{OUT} = 1V$ ,  $I_{OUT} = 100A$ ,  $T_A = 23.8^\circ C$ , 200LFM Air Flow**

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	1	CIN1	CAP, 150µF 25% 25V ALUM	SUN ELECT, 25HVH150M
2	2	CIN2,CIN11	CAP, 1206 1µF 10% 25V X5R	TAIYO YUDEN, TMK316BJ105KD-T
3	8	CIN3-CIN10	CAP, 1210 22µF 10% 25V X5R	AVX, 12103D226KAT2A
4	16	C01, C02, C05, C06, C07, C08, C011, C013, C015, C016, C024, C055, C056, C057, C058, C059	CAP, 1206 220µF 20% 4V X5R	MURATA, GRM31CR60G227ME11L
5	1	C1	CAP, 0603 330pF 10% 50V X7R	AVX, 06035C331KAT2A-CT
6	4	C4, C10, C18, C22	CAP, 0603 4.7µF 20% 10V X5R	TAIYO YUDEN, LMK107BJ475MA-T
7	7	C6, C11, C19, C23, COUT26, C42, C43	CAP, 0603 1µF 10% 10V X7R	TAIYO YUDEN, LMK107BJ105KA-T
8	1	C7	CAP, 0603 0.1µF 10% 25V X7R	AVX, 06033C104KAT2A
9	1	C31	CAP, 0603 15nF 10% 50V X7R	AVX, 06035C153KAZ2A
10	1	C39	CAP, 0603 100nF 10% 100V X7R	MURATA, GRM188R72A104KA35D
11	1	C40	CAP, 0603 150pF 5% 50V C0G	AVX, 06035A151JAT2A
12	2	C41, C48	CAP, 1210 100µF 10V X5R	MURATA, GRM32ER61A107ME20L
13	8	C41, C44, C45, C48, C52, C53, C54, C55	CAP, 1210 100µF 10% 6.3V X5R	MURATA, GRM32ER60J107ME20L
14	1	C46	CAP, 1210 10µF 16V X5R	MURATA, GRM32DR61C106KA01L
15	1	C47	CAP, 0603 220pF 10% 50V X7R	AVX, 06035C221KAT2A
16	1	C49	CAP, 0603 47nF 10% 50V X7R	AVX, 06035C473KAZ2A
17	1	L1	IND, 68 µH, CDRH105	SUMIDA CDRH105RNP-680N
18	2	Q1, Q2	MOSFET, N-CH D-S 40V TO252	VISHAY, SUD50N04-8M8P-4GE3
19	4	R1, R3, R25, R29	RES, 0603 10Ω 5% 1/10W	VISHAY, CRCW060310R0JNEA
20	9	R2, R9, R14, R21, R31, R39, R43, R47, R51	RES, 0603 121kΩ 1% 1/10W	VISHAY, CRCW0603121KFKEA
21	4	R4, R36, R41, R98	RES, 0603 10kΩ 5% 1/10W	VISHAY, CRCW060310K0JNEA
22	1	R11	RES, 0603 1.74kΩ 1% 1/10W	VISHAY, CRCW06031K74FKEA
23	1	R15	RES, 0603 90.9kΩ 1% 1/10W	VISHAY, CRCW060390K9FKEA
24	1	R16	RES, 0603 60.4kΩ 1% 1/10W	VISHAY, CRCW060360K4FKEA
25	1	R17	RES, 0603 40.2kΩ 1% 1/10W	VISHAY, CRCW060340K2FKEA
26	1	R18	RES, 0603 30.1kΩ 1% 1/10W	VISHAY, CRCW060330K1FKEA
27	1	R89	RES, 0603 2Ω 1% 1/10W	VISHAY CRCW06032R00FNEA
28	1	R92	RES, 0603 3.3Ω 1% 1/10W	VISHAY, CRCW06033R3FKEA
29	1	R93	RES, 0603 154kΩ 1% 1/10W	VISHAY, CRCW0603154KFKEA
30	1	R94	RES, 0603 1MΩ 5% 1/10W	VISHAY CRCW06031M00JNEA
31	3	R95, R96, R107	RES, 0603 20kΩ 5% 1/10W	VISHAY, CRCW060320K0JNTA
32	1	R97	RES, 0603 681kΩ 1% 1/10W	VISHAY, CRCW0603681KFKEA
33	1	R99	RES, 0603 301Ω 1% 1/10W	VISHAY, CRCW0603301RFKEA
34	1	R100	RES, 0603 82.5Ω 1% 1/10W	VISHAY, CRCW060382R5FKEA
35	2	R101, R102	RES, 2512 0.010Ω 1% 1W	VISHAY, WSL2512R01000FEA
36	1	R103	RES POT, 5k	BOURNS 3386P-1-502-LF
37	1	R104	RES, 0603 1kΩ 1% 1/10W	VISHAY, CRCW06031K00FKEA
38	1	R105	RES, 0603 105kΩ 1% 1/10W	VISHAY CRCW0603105KFKEA
39	1	R106	RES, 0603 80.6kΩ 1% 1/10W	VISHAY CRCW060380K6FKEA



# DEMO MANUAL DC2455A-A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
40	2	U1, U2	IC, VOLTAGE REGULATOR, BGA	LINEAR TECH., LTM4650EY-1B#PBF
41	1	U5	IC, TimerBlox®	LINEAR TECH., LTC6992IS6-1#PBF
42	1	U6	IC, OP-AMP, SINGLE, BIPOLAR	LINEAR TECH., LT1803IS5#PBF
43	1	U7	IC, LTC3630EMSE	LINEAR TECH., LTC3630EMSE#PBF

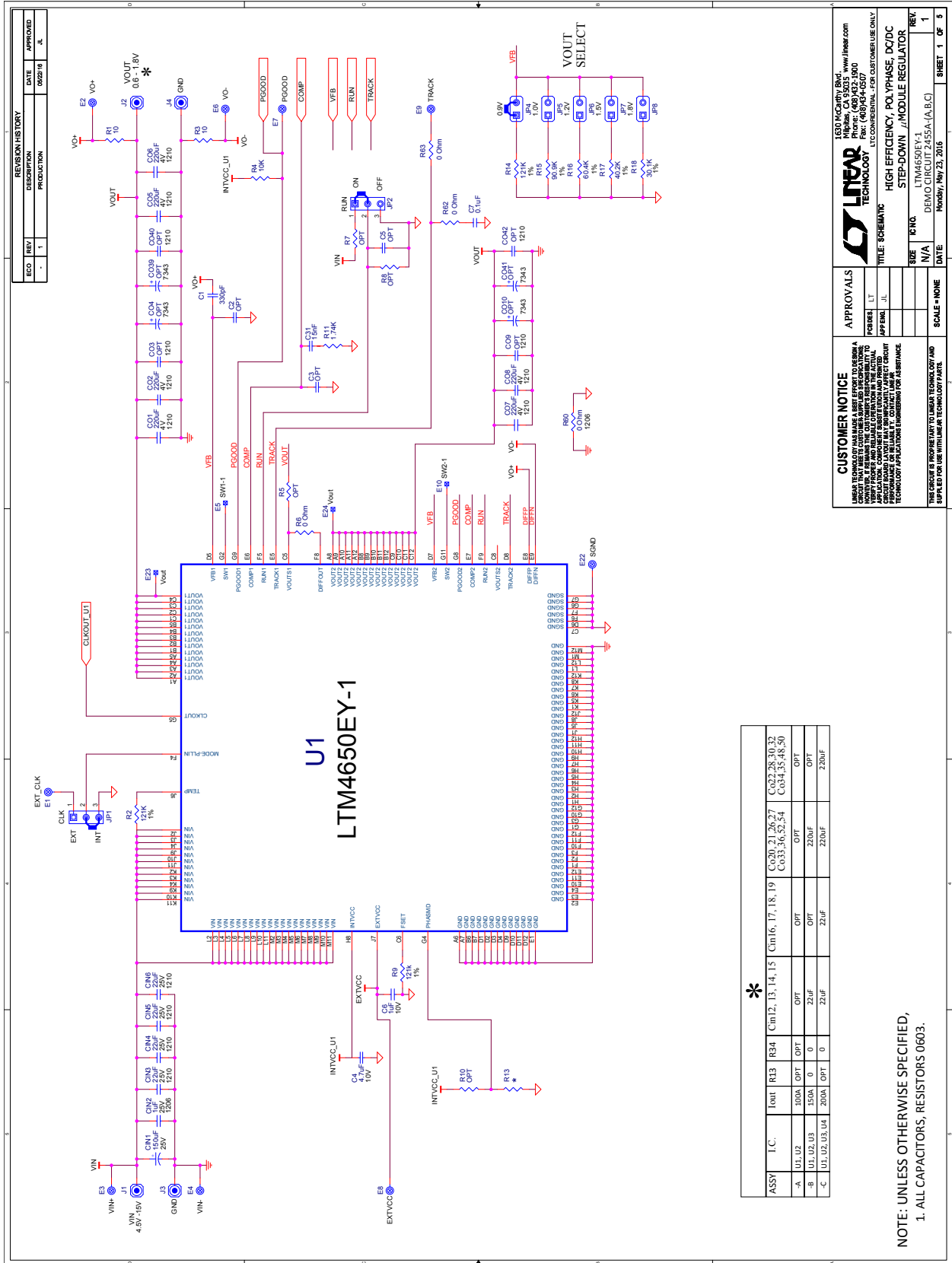
### Additional Demo Board Circuit Components

1	0	C1N12-C1N19, C020, C021, C022, C026, C027, C028, C030, C032, C033, C034, C035, C036, C048, C050, C052, C054	CAP, OPTION	OPTION
2	0	R13, R34	RES, 0603 OPTION	OPTION
3	0	C03, C09, C014, C017, C018, C038, C040, C042, C045, C046	CAP, 1210 OPTION	OPTION
4	0	C04, C010, C012, C019, C023, C025, C029, C031, C037, C039, C041, C043, C044, C047, C049, C051, C053	CAP, 7343 OPTION	OPTION
5	0	C2, C3, C5, C8, C9, C12, C17, C20, C21, C29, C30, C32	CAP, 0603 OPTION	OPTION
6	0	R5, R7, R8, R10, R30, R37, R38, R42, R44, R48, R49, R50, R52, R53, R55, R61, R64, R87	RES, 0603 OPTION	OPTION
7	13	R6, R19, R20, R27, R28, R32, R33, R35, R40, R45, R62, R63, R91	RES, 0603 0Ω JUMPER	VISHAY, CRCW06030000Z0EA
8	4	R22, R23, R24, R26	RES, 2010 0Ω JUMPER	VISHAY, CRCW20100000ZEA9
9	1	R60	RES, 1206 0Ω JUMPER	VISHAY, CRCW12060000Z0EA
10	0	U3, U4	DO NOT STUFF	

### Hardware: For Demo Board Only

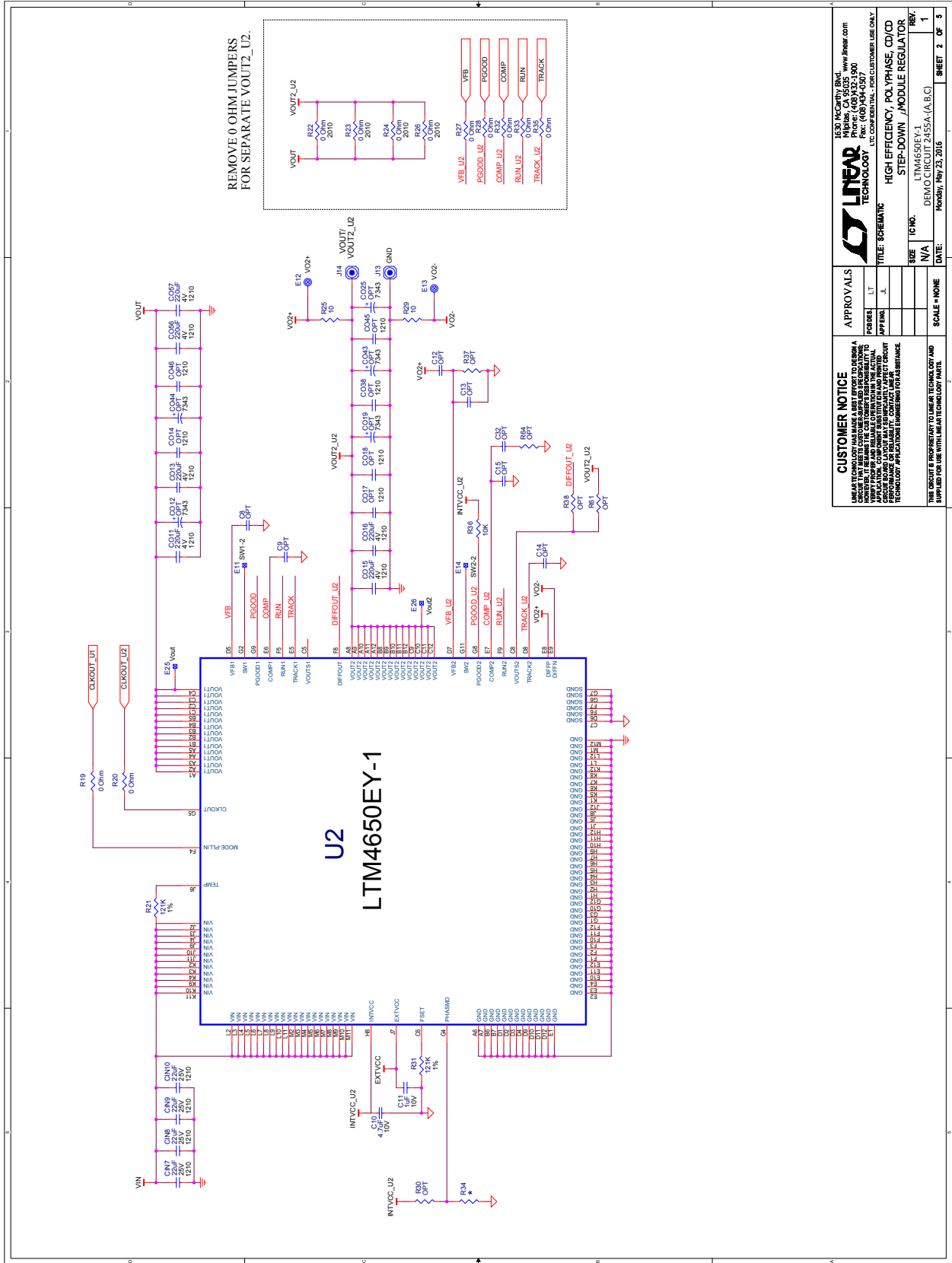
1	11	E1-E4, E6-E9, E12, E13, E22	TESTPOINT, TURRET, .063"	MILL MAX, 2308-2-00-80-00-00-07-0
2	0	E5, E10, E11, E14, E15, E16, E17, E18, E23, E24, E25, E26, E27, E28, E29, E30	TEST PAD SMD	
3	2	E33, E34	TESTPOINT, TURRET, .094"	MILL MAX, 2501-2-00-80-00-00-07-0
4	4	JP1, JP2, JP9, JP10	HEADER, 3 PIN 2mm SINGLE ROW	WURTH ELEKTRONIK, 620-003-111-21
5	5	JP4, JP5, JP6, JP7, JP8	HEADER, 2 PIN 2mm SINGLE ROW	WURTH ELEKTRONIK, 620-002-111-21
6	6	J1, J2, J3, J4, J13, J14	STUD, TEST PIN	PEM, KFH-032-10
7	12	J1, J2, J3, J4, J13, J14 (x2)	NUT, BRASS PL # 10-32	ANY, 10-32M/S BR PL
8	6	J1, J2, J3, J4, J13, J14	LUG RING, #10	KEYSTONE, 8205
9	6	J1, J2, J3, J4, J13, J14	WASHER, TIN PLATED BRASS	ANY, #10EXT BZ TN
10	2	J11, J12	CON, BNC, 5 PINS	CONNEX, 112404
11	5	XJP1, XJP2, XJP4, XJP9, XJP10	SHUNT 2mm	WURTH ELEKTRONIK, 608-002-134-21
12	4	MTGS AT 4 CORNERS	STAND-OFF, NYLON	KEYSTONE, 8833

SCHEMATIC DIAGRAM



# DEMO MANUAL DC2455A-A

## SCHEMATIC DIAGRAM



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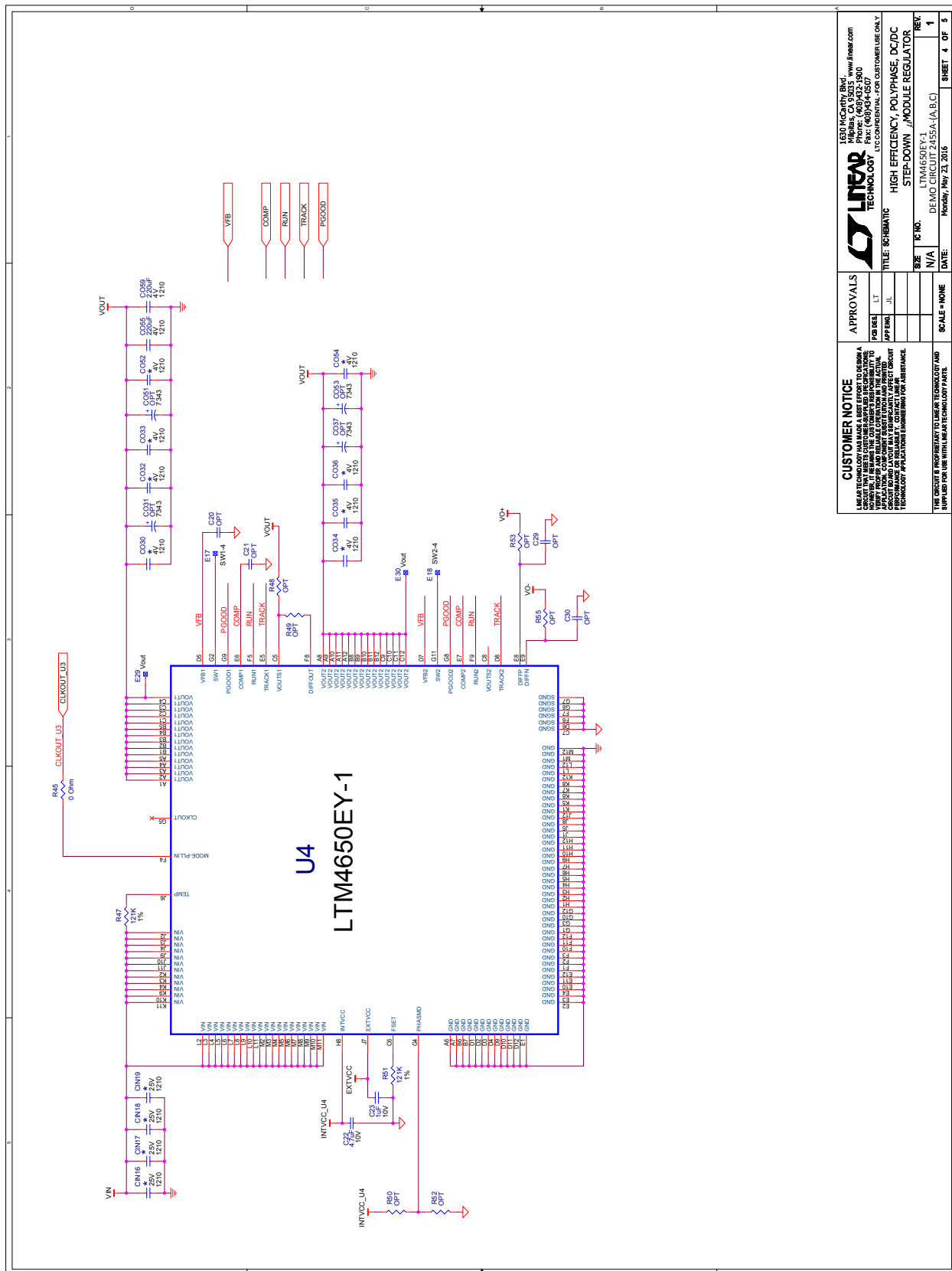
U2: LTM4650EY-1  
 DEMO CIRCUIT 2455A-A (A, B, C)  
 Moosvi, May 23, 2016





# DEMO MANUAL DC2455A-A

## SCHEMATIC DIAGRAM



dc2455aaf



# DEMO MANUAL DC2455A-A

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Mailing Address:

Linear Technology  
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Milpitas, CA 95035

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