LTM4650A-1
High Efficiency, PolyPhase 200A Step-Down Power µModule Regulator 4× LTM4650A-1, 200A

DESCRIPTION

Demonstration circuit 3064A features PolyPhase® design using the LTM®4650AEY-1, the high efficiency, high density, dual 25A, switch mode step-down power µModule® regulator. The input voltage is from 4.5V to 16V. The output voltage is jumper selectable from 1.0V to 5.1V. DC3064A can deliver nominal 200A output current. As explained in the data sheet, output current derating is necessary for certain V_{IN}, V_{OUT}, and thermal conditions. The LTM4650A-1 on DC3064A always operates 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 "VO+" and "VO–" through remote output voltage sensing which improves output voltage regulation at heavy loads. These features and the availability of the LTM4650AEY-1 in a compact 16mm × 16mm × 5.01mm BGA package make it ideal for use in many high density point-of-load regulation applications. The LTM4650A-1 data sheet must be read in conjunction with this demo manual for working on or modifying the demo circuit DC3064A.

Design files for this circuit board are available.

BOARD PHOTO

Part marking is either ink mark or laser mark

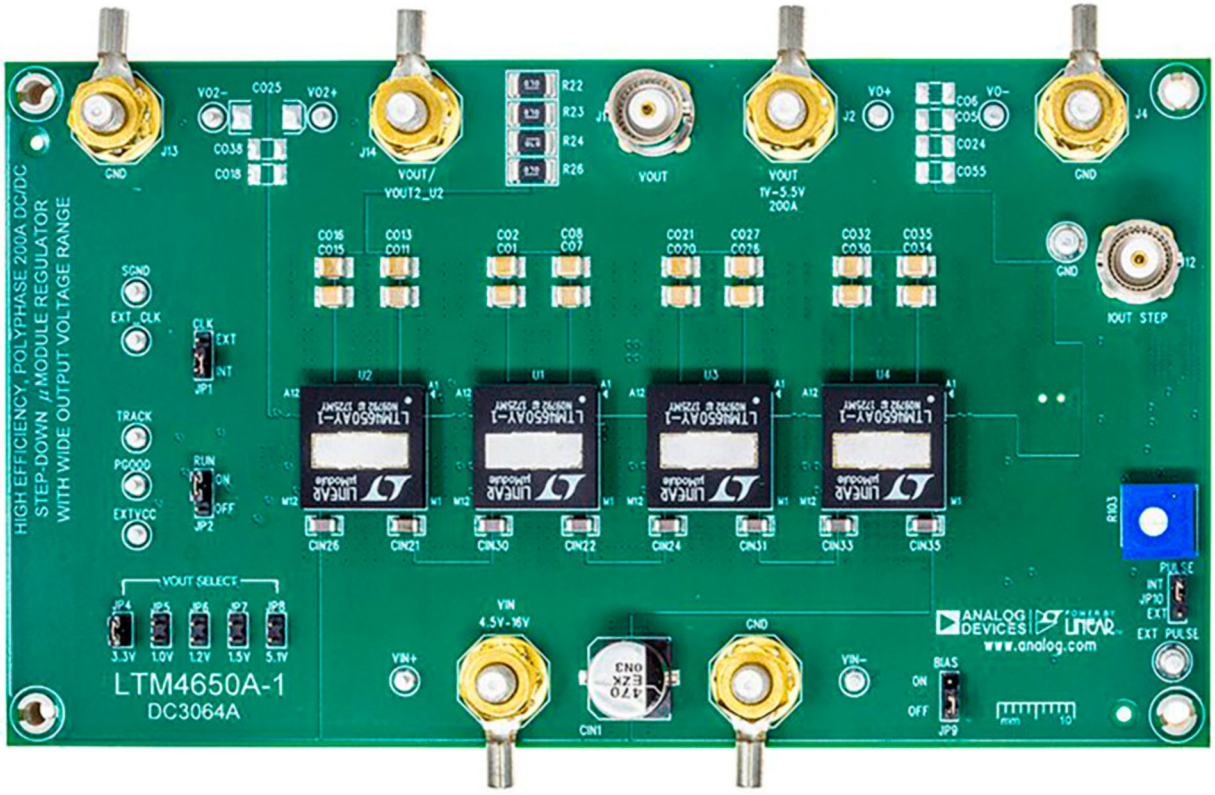


Figure 1. 4× LTM4650A-1, 200A PolyPhase LTM4650A-1/DC3064A Demo Board

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range		4.5		16	V
Output Voltage, V_{OUT}	IN = 4.5V to 16V, I_{OUT} = 0A to 200A, JP8: 5.1V		5.1 ±1% (5.049 ~ 5.151)		V
Maximum Continuous Output Current	Derating is Necessary for Certain V_{IN}, V_{OUT} and Thermal Conditions, See Data Sheet for Detail		200		A
Default Operating Frequency			780		kHz
Resistor Programmable Frequency Range		400		780	kHz
External Clock SYNC Frequency Range		400		780	kHz
Efficiency	V_{IN} = 12V, V_{OUT} = 5.1V, I_{OUT} = 200A, f_{SW} = 780kHz		95.2, See Figure 3		%
Load Transient	V_{IN} = 12V, V_{OUT} = 5.1V, I_{STEP} = 0A to 50A		<175, See Figure 4		mV

QUICK START PROCEDURE

Demonstration circuit 3064A is easy to set up to evaluate the performance of PolyPhase operation of the LTM4650AEY-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 split load current evenly between J2/J4 and J13/J14. Please refer to Figure 2 for proper measurement setup and follow the procedure below.

1. Place jumpers in the following positions for a typical 5.1V_{OUT} application:

JP1	JP2	JP4 to JP8
CLK	**RUN**	**V_{OUT} SELECT**
INT	OFF	ON JP8/5.1V

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 "VO+" and "VO–" should be 5.1V ±1% (5.049V ~ 5.151V).
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, place jumper JP10 at "EXT", and apply an adjustable pulse signal between "EXT PULSE" 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 (<3%) to limit the thermal stress on the transient load circuit.
6. (Optional): LTM4650A-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 LTM4650A-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): DC3064A can be configured to a dual outputs configuration with VO at 175A load current and VO2 at 25A load current. Stuff 0Ω resistor on R61 and 0.1µF on C14. Stuff desired compensation network on R64, C15, and C32. Remove R22, R23, R24, R26, R27, R28, R32, R33, and R35.

   Output voltage VO2 is set by R37 based on Equation 1.

   $$VO2 = 0.6V \bullet (1 + 60.4k \div R37) \quad (1)$$

QUICK START PROCEDURE

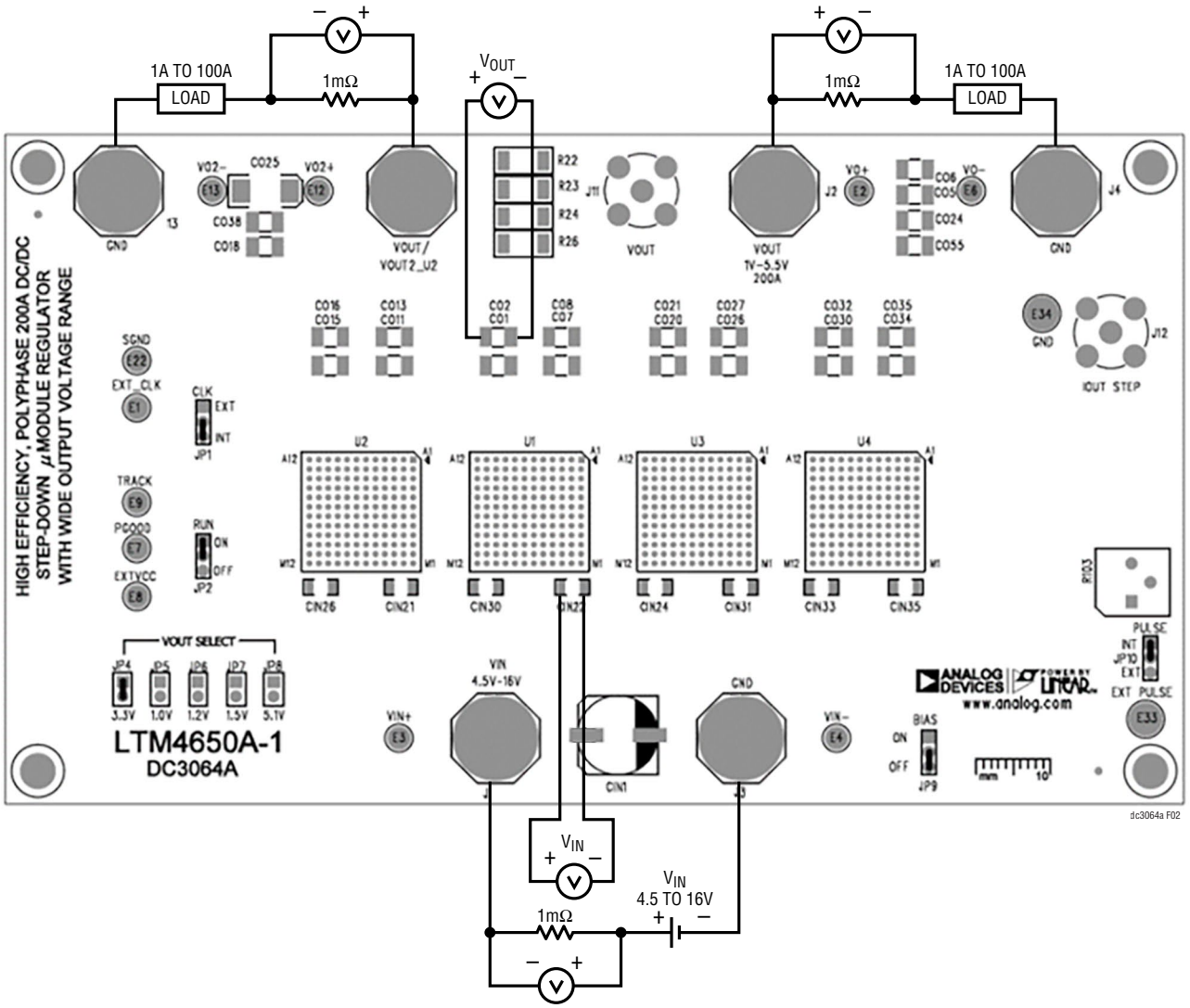


Figure 2. Proper Measurement Equipment Setup

QUICK START PROCEDURE

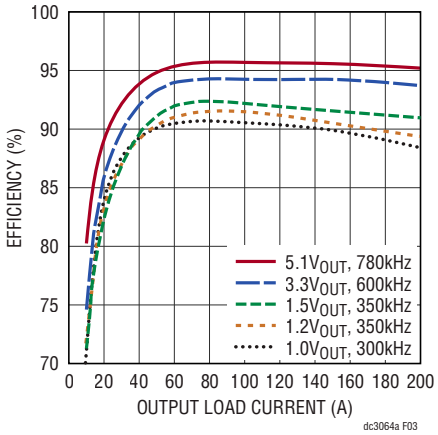


Figure 3. Efficiency vs Load Current with V_{IN} = 12V

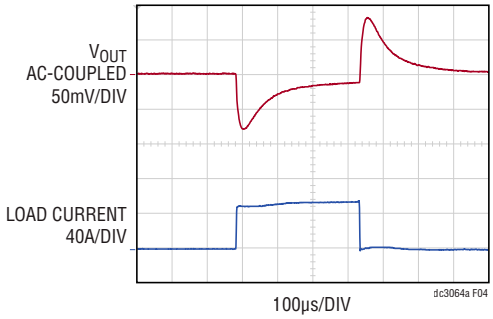


Figure 4. Load Transient 0A to 50A (V_{IN} = 12V, V_{OUT} = 5.1V, f_{SW} = 780kHz)

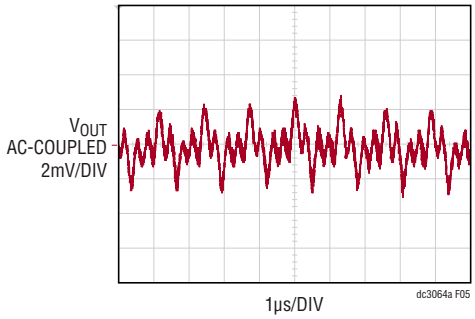


Figure 5. Output Voltage Ripple (V_{IN} = 12V, V_{OUT} = 5.1V, I_{OUT} = 200A, f_{SW} = 780kHz)

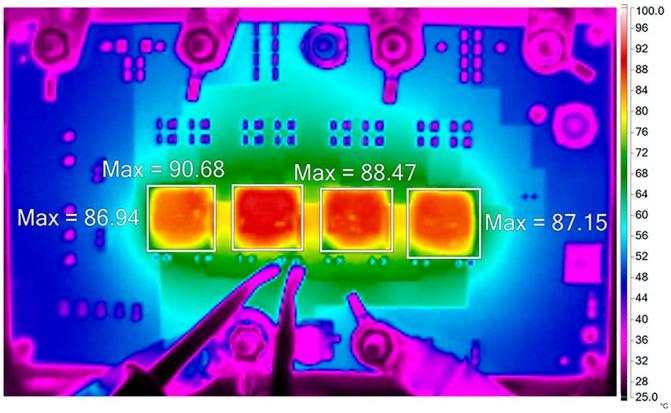


Figure 6. Thermal Measurement (V_{IN} = 12V, V_{OUT} = 5.1V, I_{OUT} = 170A, f_{SW} = 780kHz, T_A = 25°C, Airflow = 600fpm)

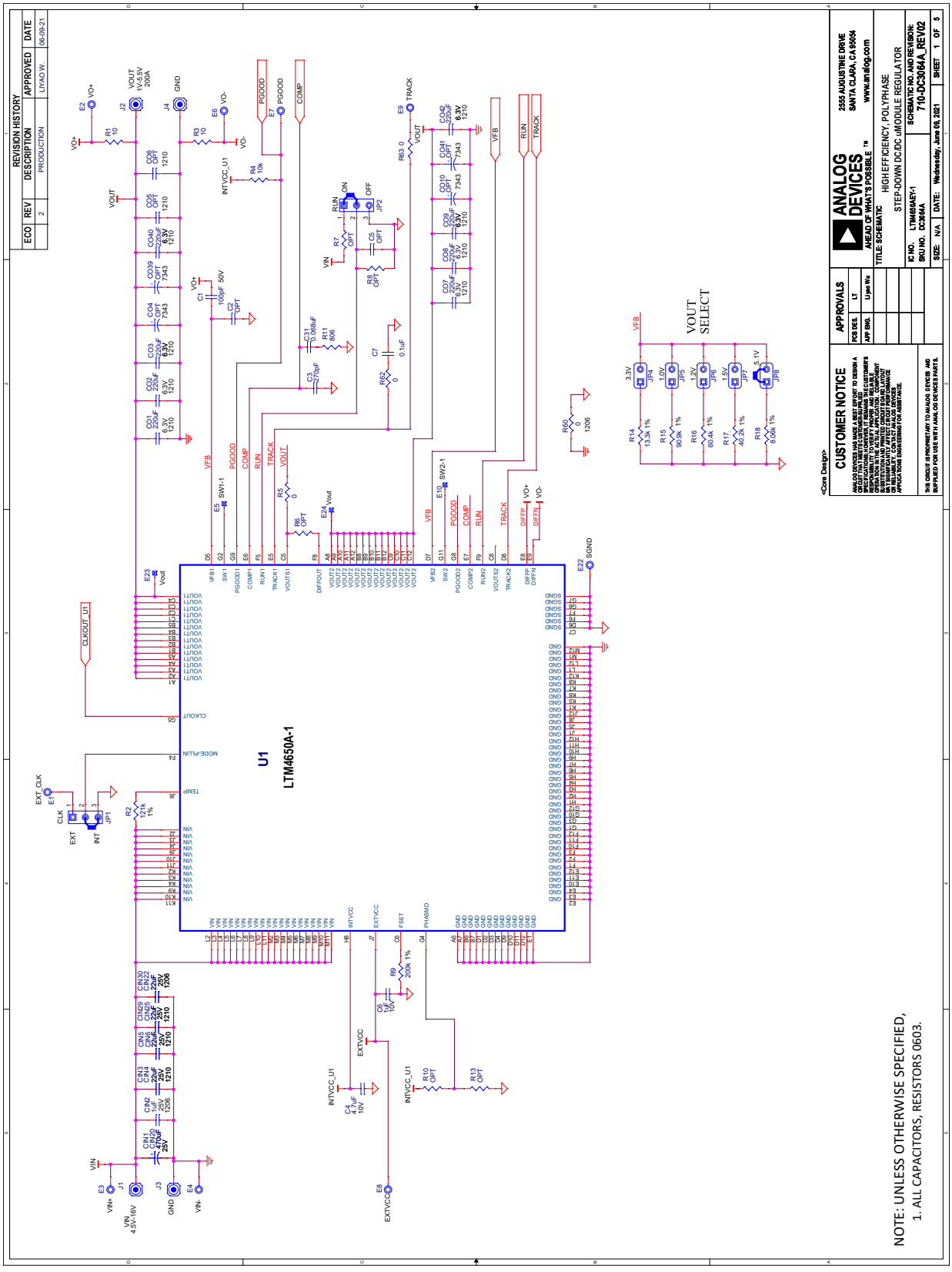
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 100pF, X7R, 50V, 10%, 0603	AVX, 06035C101KAT2A
2	1	C3	CAP., 270pF, C0G, 50V, 5%, 0603	AVX, 06035A271JAT2A
3	4	C4, C10, C18, C22	CAP., 4.7µF, X5R, 10V, 10%, 0603	AVX, 0603ZD475KAT2A
4	7	C6, C11, C19, C23, C42, C43, C56	CAP., 1µF, X7R, 10V, 10%, 0603	AVX, 0603ZC105KAT2A
5	1	C7	CAP., 0.1µF, X7R, 25V, 10%, 0603	AVX, 06033C104KAT2A
6	1	C31	CAP., 0.068µF, X5R, 25V, 10%, 0603	AVX, 06033D683KAT2A
7	1	C39	CAP., 0.1µF, X7R, 100V, 10%, 0603	AVX, 06031C104KAT2A
8	1	C40	CAP., 150pF, C0G/NP0, 50V, 5%, 0603	AVX, 06035A151JAT2A
9	2	C41, C48	CAP., 100µF, X5R, 10V, 20%, 1210	KEMET, C1210C107M8PACTU
10	38	C44, C45, C52-C55, CO1-CO3, CO7-CO9, CO11, CO13-CO17, CO20-CO22, CO26-CO28, CO30, CO32-CO36, CO40, CO42, CO45, CO46, CO48, CO50, CO52, CO54	CAP., 220µF, X5R, 6.3V, 20%, 1210, NO SUBS ALLOWED	MURATA, GRM32ER60J227ME05K
11	1	C46	CAP., 10µF, X5R, 16V, 20%, 1210	AVX, 1210YD106MAT2A
12	1	C47	CAP., 220pF, X7R, 50V, 10%, 0603	AVX, 06035C221KAT2A
13	1	C49	CAP., 0.047µF, X7R, 50V, 10%, 0603	AVX, 06035C473KAT2A
14	2	CIN1, CIN20	CAP., 470µF, ALUM POLY HYB, 25V, 20%, 10mm × 10.2mm, G, SMD, RADIAL, AEC-Q200	PANASONIC, EEHZK1E471P
15	2	CIN2, CIN11	CAP., 1µF, X7R, 25V, 10%, 1206	AVX, 12063C105KAT2A
16	24	CIN3-CIN10, CIN12-CIN19, CIN23, CIN25, CIN27-CIN29, CIN32, CIN34, CIN36	CAP., 22µF, X5R, 25V, 10%, 1210, NO SUBS ALLOWED	MURATA, GRM32ER61E226KE15K
17	8	CIN21, CIN22, CIN24, CIN26, CIN30, CIN31, CIN33, CIN35	CAP., 22µF, X6S, 25V, 20%, 1206	MURATA, GRM31CC81E226ME11L
18	6	J1-J4, J13, J14	EVAL BOARD STUD HARDWARE SET, #10-32	ANALOG DEVICES, 720-0010
19	1	L1	IND., 68µH, PWR, SHIELDED, 30%, 1.75A, 201mΩ, 10.5mm × 10.3mm SMD	SUMIDA, CDRH105RNP-680NC
20	2	Q1, Q2	XSTR., MOSFET, N-CH, 40V, 14A, D-PAK (TO-252)	VISHAY, SUD50N04-8M8P-4GE3
21	4	R1, R3, R25, R29	RES., 10Ω, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ100V
22	4	R2, R21, R39, R47	RES., 121k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF1213V
23	4	R4, R36, R41, R98	RES., 10k, 5%, 1/10W, 0603, AEC-Q200	NIC, NRC06J103TRF
24	14	R5, R19, R20, R27, R28, R32-R35, R40, R45, R62, R63, R91	RES., 0Ω, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
25	4	R9, R31, R43, R51	RES., 200k, 1%, 1/10W, 0603	NIC, NRC06F2003TRF
26	1	R11	RES., 806Ω, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F8060TRF
27	1	R14	RES., 13.3k, 1%, 1/10W, 0603	VISHAY, CRCW060313K3FKEAC
28	1	R15	RES., 90.9k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060390K9FKEA
29	1	R16	RES., 60.4k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060360K4FKEA
30	1	R17	RES., 40.2k, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F4022TRF
31	1	R18	RES., 8.06k, 1%, 1/10W, 0603	YAGEO, RC0603FR-078K06L
32	4	R22-R24, R26	RES., 0Ω, JUMPER, 75A, 2010, COPPER, SENSE	VISHAY, WSL201000000ZEA9
33	1	R60	RES., 0Ω, JUMPER, 65A, 1206, COPPER, SENSE	VISHAY, WSL120600000ZEA9

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
34	1	R89	RES., 2Ω, 1%, 1/10W, 0603	VISHAY, CRCW06032R00FNEA
35	1	R92	RES., 3.3Ω, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06033R30FKEA
36	1	R93	RES., 154k, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F1543TRF
37	1	R94	RES., 1M, 5%, 1/10W, 0603, AEC-Q200	NIC, NRC06J105TRF
38	3	R95, R96, R107	RES., 20k, 5%, 1/10W, 0603, AEC-Q200	NIC, NRC06J203TRF
39	1	R97	RES., 681k, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F6813TRF
40	1	R99	RES., 301Ω, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF3010V
41	1	R100	RES., 82.5Ω, 1%, 1/10W, 0603, AEC-Q200	NIC, NRC06F82R5TRF
42	2	R101, R102	RES., 0.01Ω, 1%, 1W, 2512, PWR, METAL, SENSE, AEC-Q200	VISHAY, WSL2512R0100FEA
43	1	R103	RES., 5k, 10%, 1/2W, THT 3/8 SQ, 1-TURN, TOP ADJ., TRIMPOT	BOURNS, 3386P-1-502LF
44	1	R104	RES., 1k, 1%, 1/10W, 0603	VISHAY, CRCW06031K00FKEA
45	1	R105	RES., 105k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603105KFKEA
46	1	R106	RES., 80.6k, 1%, 1/10W, 0603	VISHAY, CRCW060380K6FKEA
47	4	U1-U4	IC, DC/DC µModule REGULATOR, BGA-144	ANALOG DEVICES, LTM4650AEY-1#PBF
48	1	U5	OSC., 3.81Hz TO 1MHz, 5pF, 90ppm, TSOT23-6	ANALOG DEVICES, LTC6992IS6-1#TRMPBF
49	1	U6	IC, SINGLE R TO R IN/OUT OP AMP, TSOT23-5, 100V/µs, 85MHz	ANALOG DEVICES, LT1803IS5#TRMPBF
50	1	U7	IC, SYNCHR. STEP-DOWN CONVERTER, MSOP-16	ANALOG DEVICES, LTC3630EMSE#PBF
Additional Demo Board Circuit Components				
1	0	C2, C5, C8, C9, C12-C17, C20, C21, C29, C30, C32, C51	CAP., OPTION, 0603	
2	0	CO4, CO10, CO12, CO19, CO23, CO25, CO29, CO31, CO37, CO39, CO41, CO43, CO44, CO47, CO49, CO51, CO53	CAP., OPTION, 7343	
3	0	CO5, CO6, CO18, CO24, CO38, CO55-CO59	CAP., OPTION, 1210	
4	0	R6-R8, R10, R13, R30, R37, R38, R42, R44, R48-R50, R52, R53, R55, R61, R64, R87	RES., OPTION, 0603	
Hardware: For Demo Board Only				
1	11	E1-E4, E6-E9, E12, E13, E22	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	2	E33, E34	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
3	2	J11, J12	CONN., RF, BNC, RCPT, JACK, 5-PIN, ST, THT, 50Ω	AMPHENOL RF, 112404
4	4	JP1, JP2, JP9, JP10	CONN., HDR, MALE, 1×3, 2mm, VERT, ST, THT, NO SUBS. ALLOWED	WURTH ELEKTRONIK, 62000311121
5	5	JP4-JP8	CONN., HDR, MALE, 1×2, 2mm, VERT, ST, THT	WURTH ELEKTRONIK, 62000211121
6	4	MP5-MP8	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE, 8833
7	5	XJP1, XJP2, XJP4, XJP9, XJP10	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



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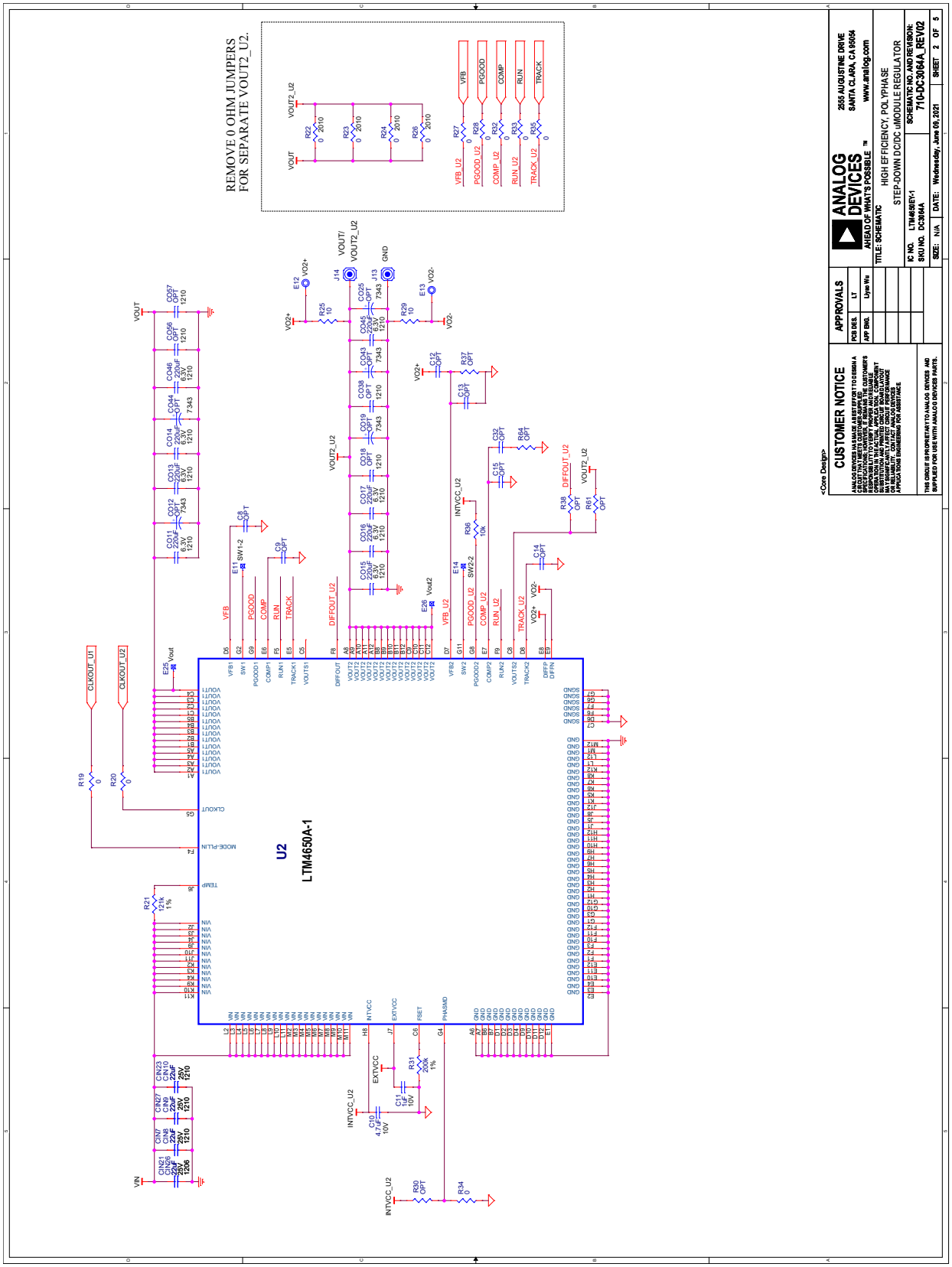

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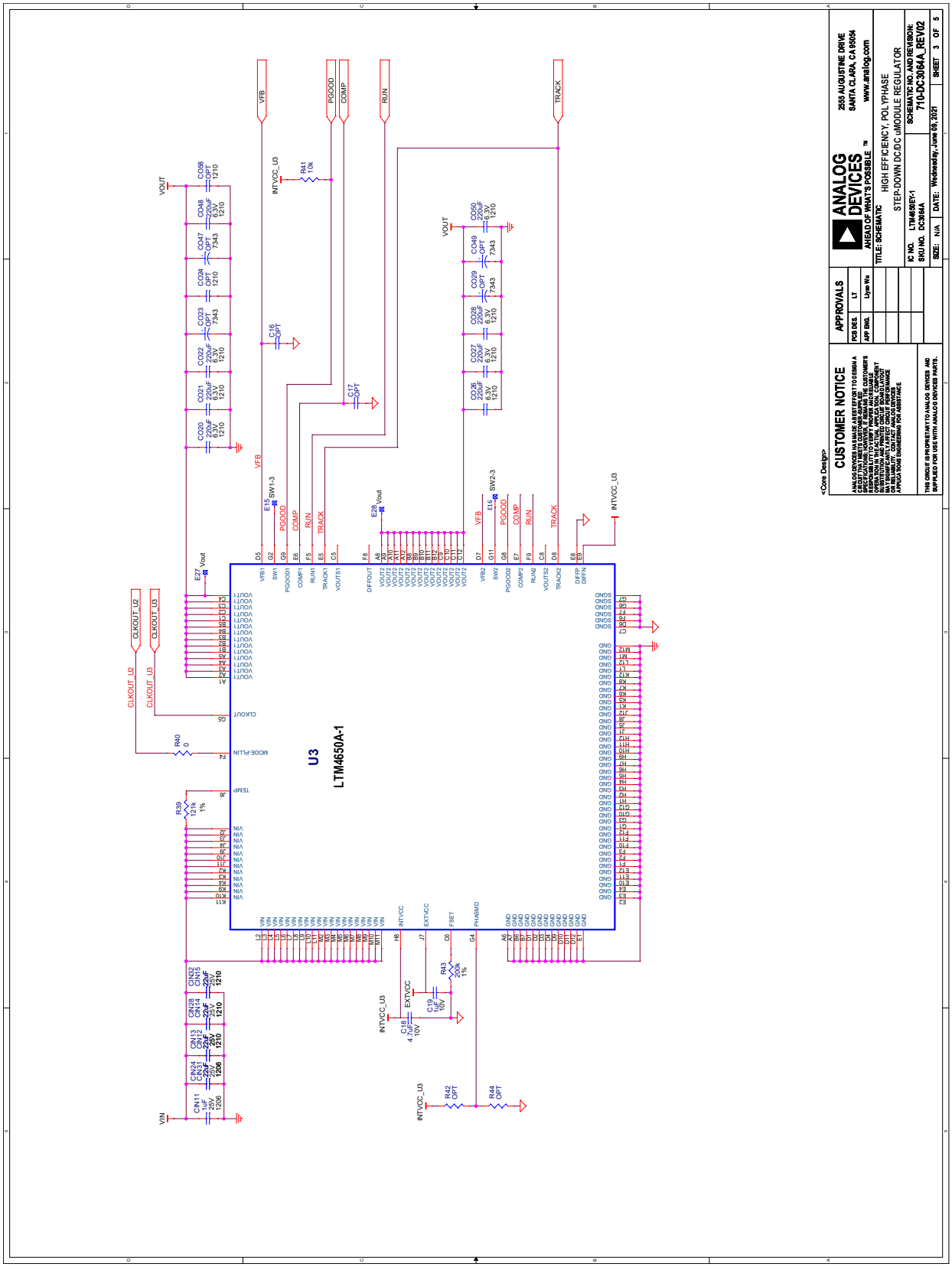

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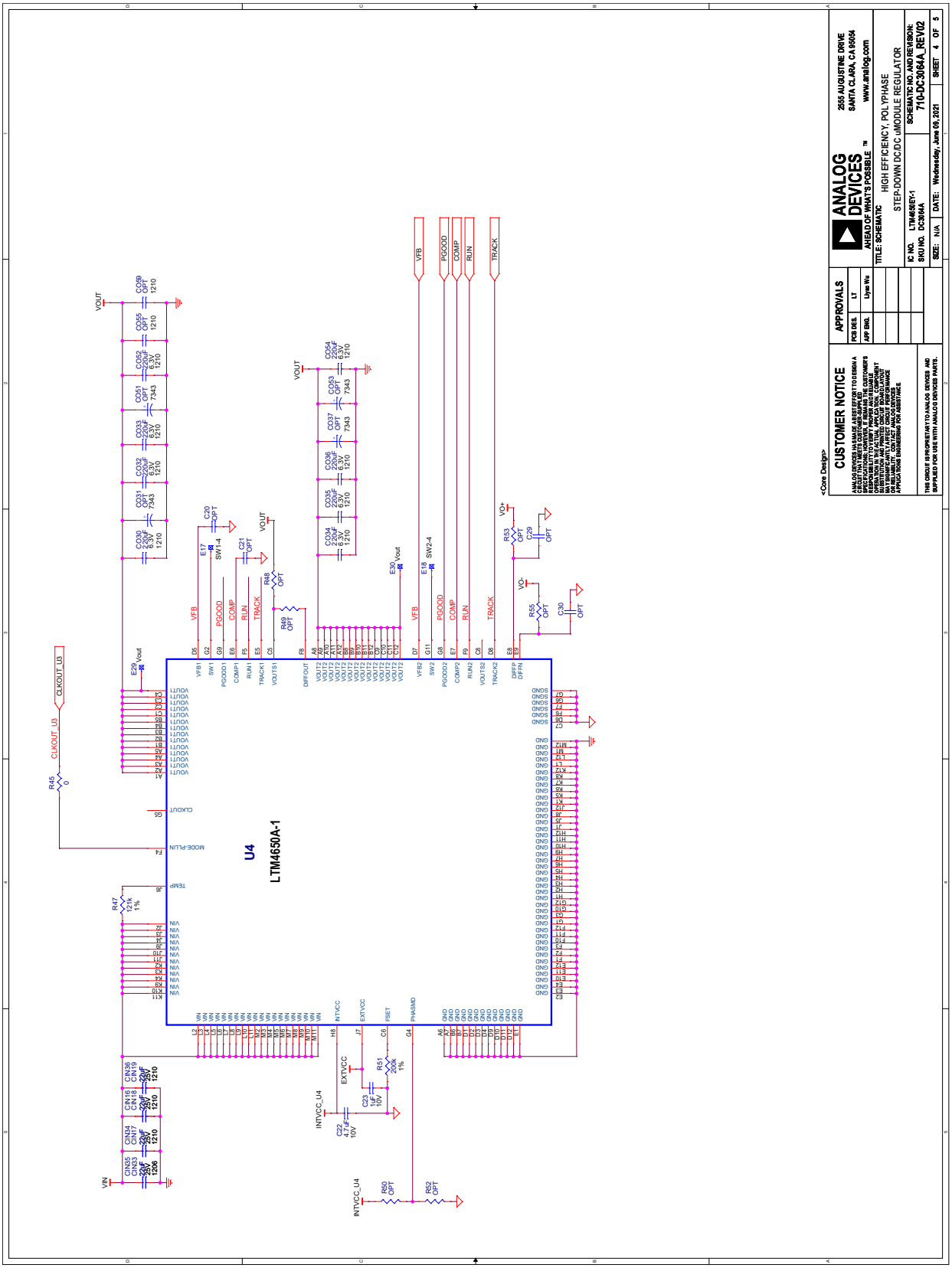

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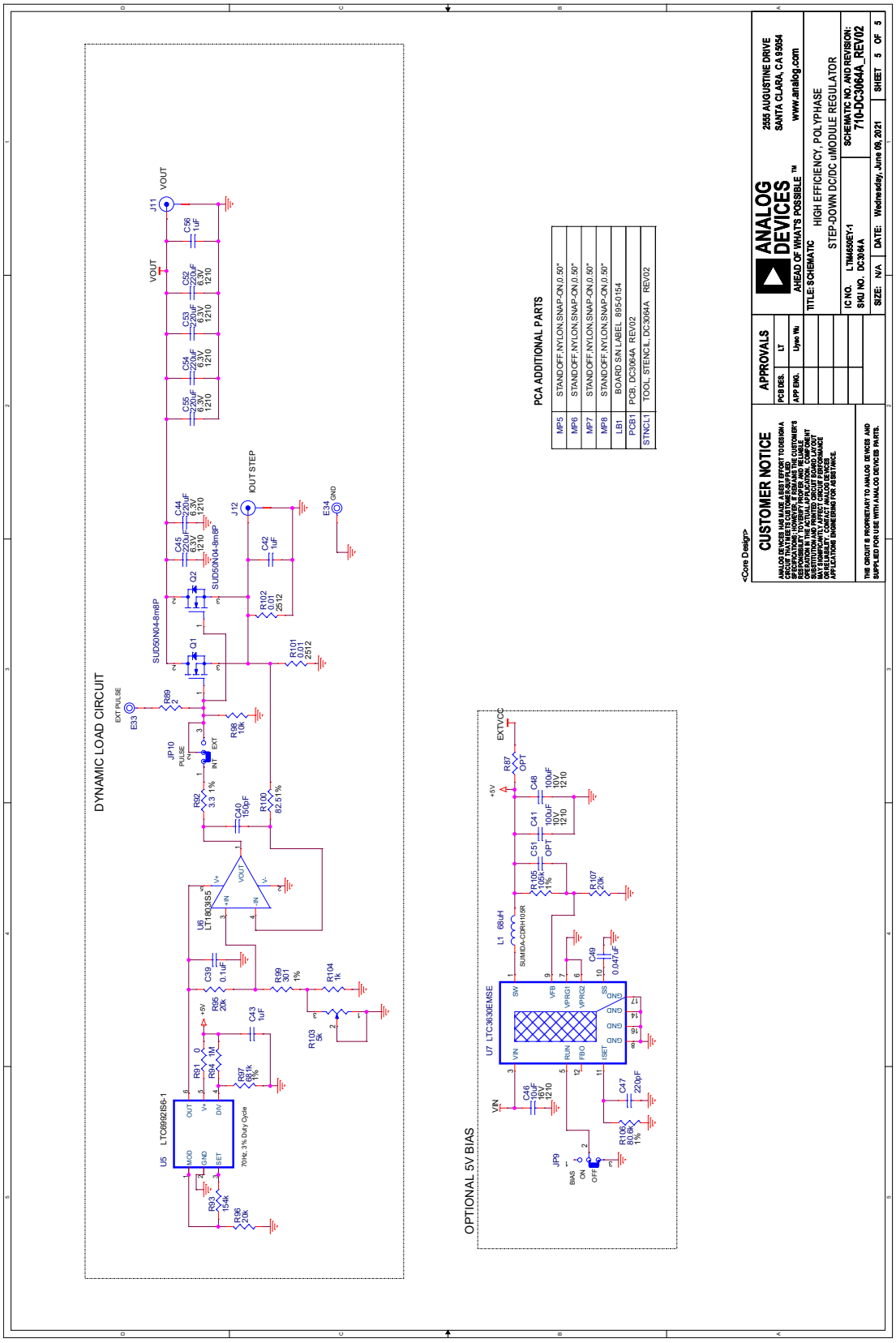

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should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

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