LTM4655 Low EMI Dual 13V to 28V$_{IN}$, +12V/4A$_{OUT}$ and –12V/2.2A$_{OUT}$ Negative µModule Regulator

DESCRIPTION

Demonstration circuit 2594A is a step-down DC/DC converter and an inverting DC/DC converter with a 13V to 28V input voltage range, +12V at 4A, and –12V at up to 2.5A outputs featuring the LTM®4655. The LTM4655 is a EN55022B compliant 40V, dual 4A or single 8A step-down or 50W inverting DC/DC µModule® Regulator.

The switching frequencies of both channels are set at 1.2MHz on DC2594A. If the output voltage collapses sufficiently due to an overload or short-circuit condition, the internal oscillator will fold-back to one-fifth of the LTM4655's programmed switching frequency, protecting the power switch from damage.

Key features of this board include:

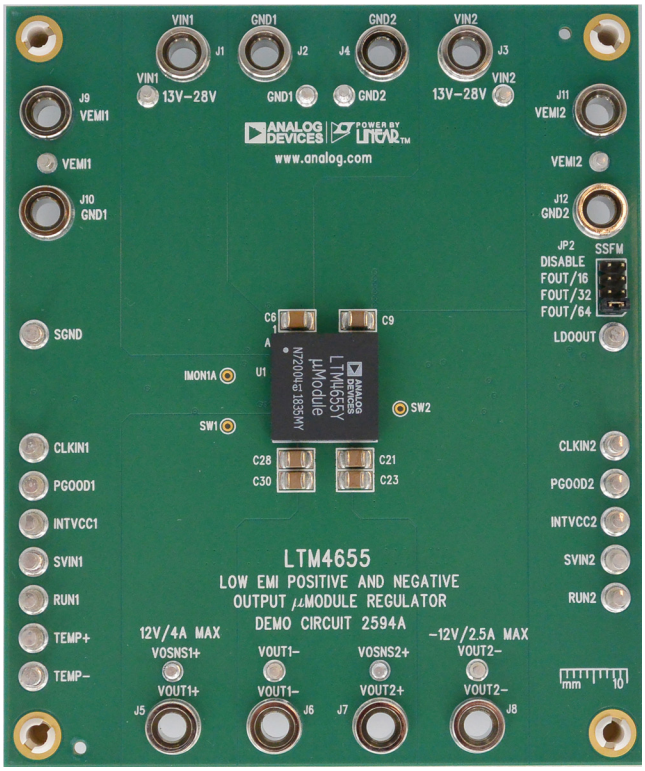
- SSFM Jumper for Spread Spectrum Options
- CLKIN Inputs for External Sync
- PGOOD Signals for Each Output

The two channels can be paralleled for higher output current. See the data sheet for more information on setting-up the board for paralleling the two outputs.

The LTM4655 data sheet gives a complete description of the device, its operation and application information. The data sheet must be read in conjunction with this demo manual prior to working on or modifying DC2594A.

Design files for this circuit board are available.

BOARD PHOTO



PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		13		28	V
f_{SW}	Switching Frequency			1.2		MHz
V_{OUT1}	Output 1 Voltage	V_{IN} = 14V – 28V, I_{OUT} = 0A – 4A	11.9	12	12.1	V
I_{OUT1}	Output 1 Current	V_{IN} = 13.5V	0		4	A
$V_{OUT1(AC)}$	Output 1 Ripple (Across C30), 20MHz	V_{IN} = 28V, I_{OUT} = 4A, 20MHz		10		mV_{P-P}
$\eta 1$	Efficiency, Output 1	V_{IN} = 28V, I_{OUT} = 4A		89.5		%
V_{OUT2}	Output 2 Voltage	V_{IN} = 14V – 28V, I_{OUT} = 0A – 2.5A	–11.9	–12	–12.1	V
I_{OUT2}	Output 2 Current	V_{IN} = 13V	0		–2.2	A
I_{OUT2}	Output 2 Current	V_{IN} = 28V	0		–2.5	A
$V_{OUT2(AC)}$	Output 2 Ripple (Across C23), 20MHz	V_{IN} = 28V, I_{OUT} = 2.5A		30		mV_{P-P}
$\eta 2$	Efficiency, Output 2	V_{IN} = 28V, I_{OUT} =2.5A		88.0		%

QUICK START PROCEDURE

Demo circuit 2594A is an easy way to evaluate the performance of the LTM4655. Refer to Figure 1 for proper measurement equipment setup, and follow the procedure below.

1. With power off, connect the input power supply "+"to V_{IN1} and V_{IN2} and "–" to GND1 and GND2. Connect the loads from V_{OUT1}^+ to V_{OUT1}^-, and V_{OUT2}^+ to V_{OUT2}^-.
2. Set voltage of the DC power supply at 14V. Turn on the power at the input.

   NOTE: Make sure that the input voltage does not exceed 28V.

3. Check for the proper output voltage between V_{OUT1}^+ and V_{OUT1}^- (V_{OUT1}^+ = 12V). Check for the proper output voltage between V_{OUT2}^+ and V_{OUT2}^- (V_{OUT2}^- = –12V).

   NOTE: If there is no output, or output voltage value is out of the spec, temporarily disconnect the load to make sure that the load is not set too high.

   NOTE: The circuit features frequency foldback to protect the power switches during a fault or output current overload.

4. Once the proper output voltage at each channel is established, adjust the load within the operating range and measure the output voltage regulation, ripple voltage, efficiency and other parameters.

   NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the V_{IN1} or V_{IN2} and GND terminals, V_{OUT1}^+ and V_{OUT1}^- terminals, or V_{OUT2}^+ and V_{OUT2}^- terminals. See Figure 2 for proper scope probe technique.

QUICK START PROCEDURE

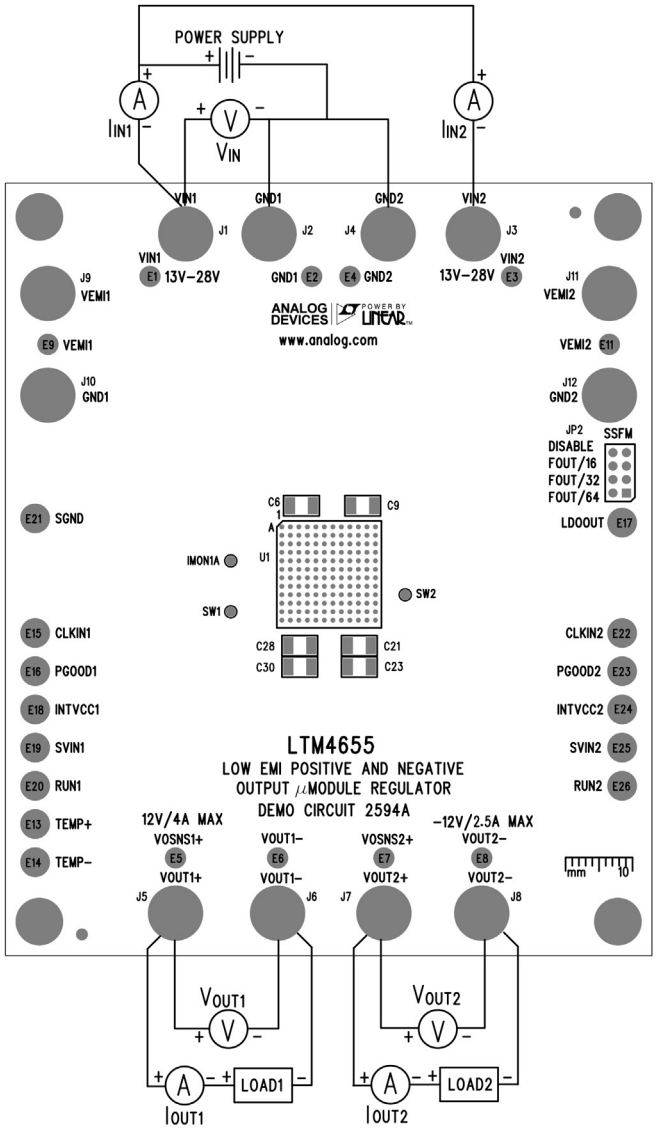


Figure 1. DC2594A Proper Equipment Setup

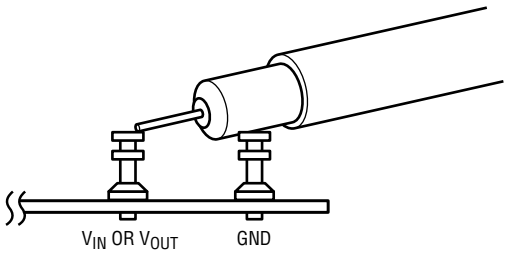


Figure 2. Measuring Input or Output Ripple

QUICK START PROCEDURE

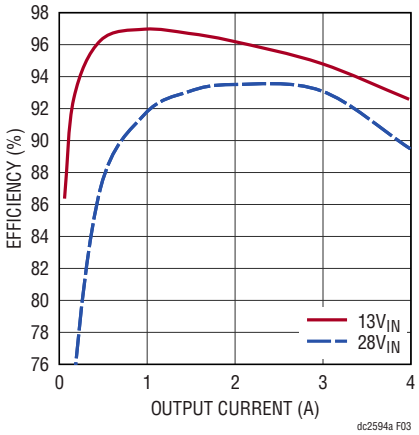


Figure 3. DC2594A +12V Output Efficiency vs Load Current (T_A = 25°C)

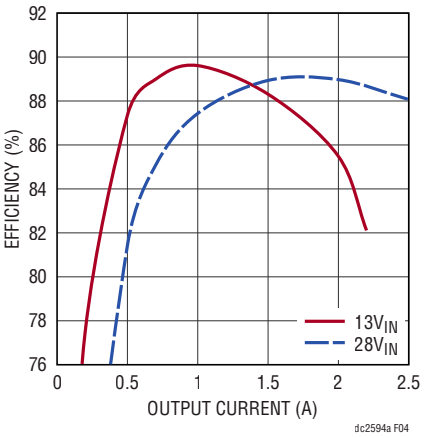


Figure 4. DC2594A –12V Output Efficiency vs Load Current (T_A = 25°C)

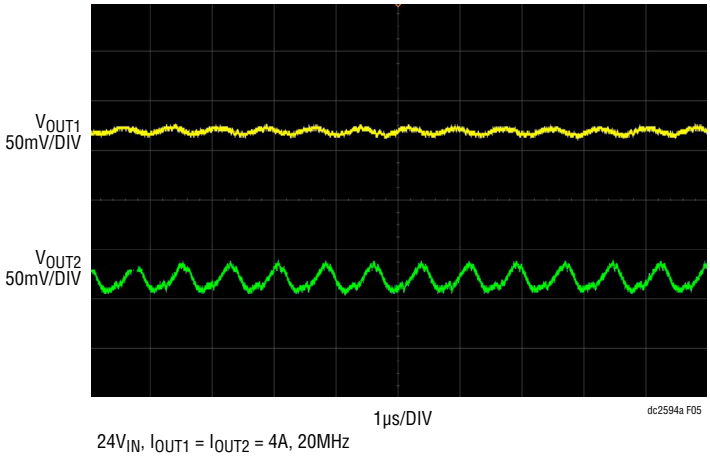


Figure 5. DC2594A Output 1 (+12V) and Output 2 (–12V) Output Ripple

QUICK START PROCEDURE

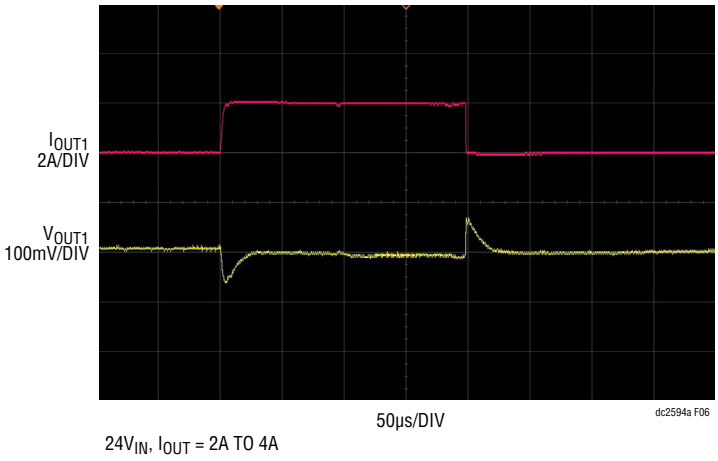


Figure 6. DC2594A +12V Output Transient Response

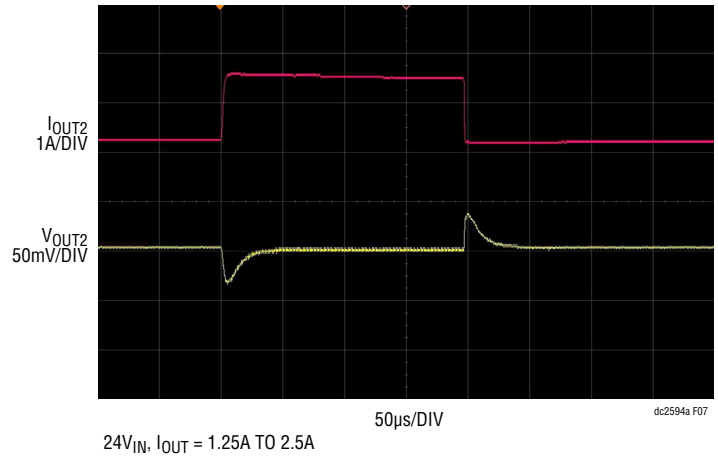


Figure 7. DC2594A –12V Output Transient Response

QUICK START PROCEDURE

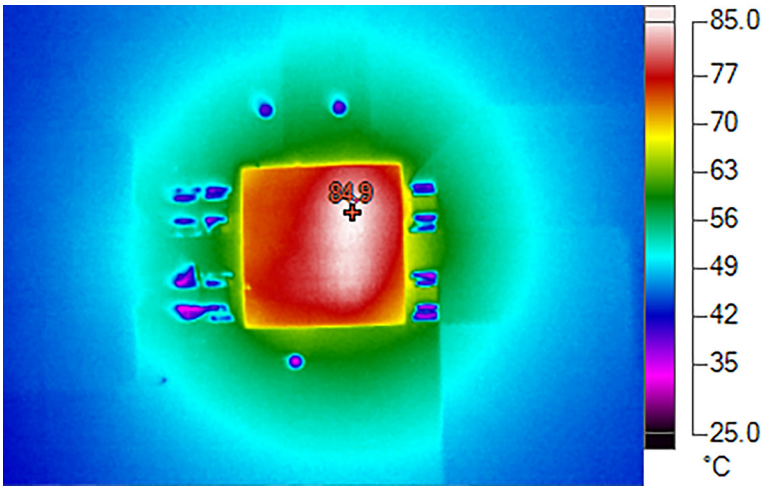


Figure 8. DC2594A Thermal Performance ($14V_{IN}$, I_{OUT1} = 3.6A, I_{OUT2} = 1.8A, T_A = 25°C, Free Air)

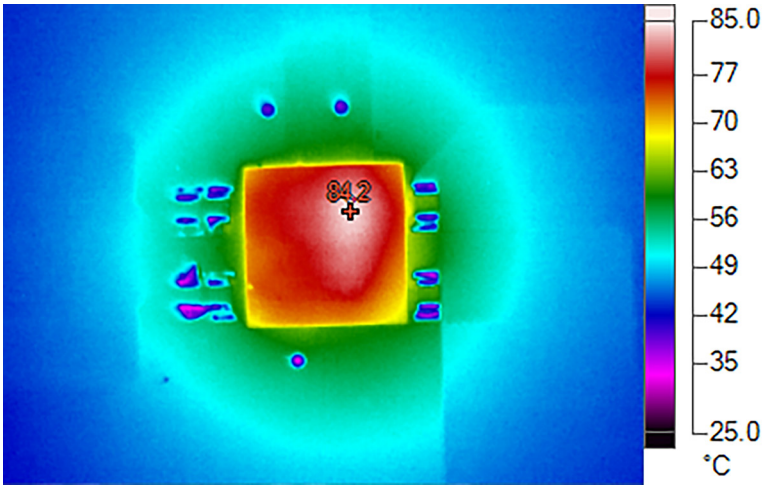


Figure 9. DC2594A Thermal Performance ($24V_{IN}$, I_{OUT1} = 3.7A, I_{OUT2} = 1.9A, T_A = 25°C, Free Air)

QUICK START PROCEDURE

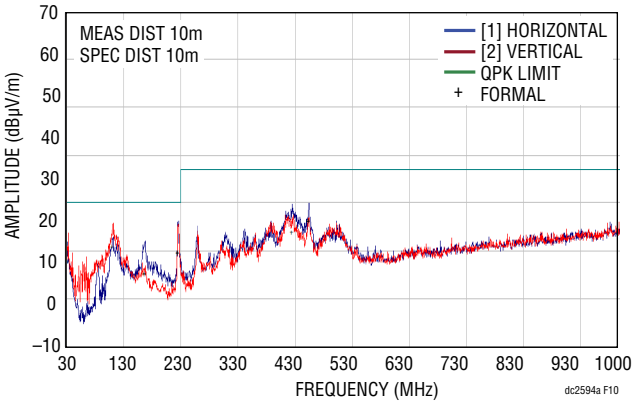


Figure 10. Radiated Emissions Scan of the LTM4655. Producing 24V_{OUT} at 7A, from 36V_{IN}. DC2898A Hardware. f_{SW} = 1.2MHz. Measured in a 10m Chamber. Peak Detect Method

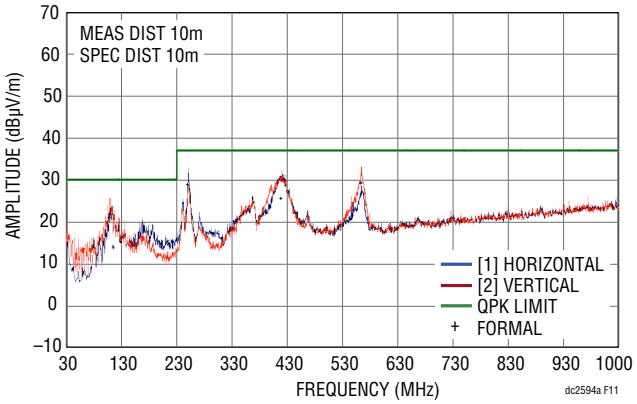


Figure 11. Radiated Emissions Scan of the LTM4655. Producing –24V_{OUT} at 2A, from 12V_{IN} , DC2899A Hardware. f_{SW} = 1.2MHz. Measured in a 10m Chamber. Peak Detect Method

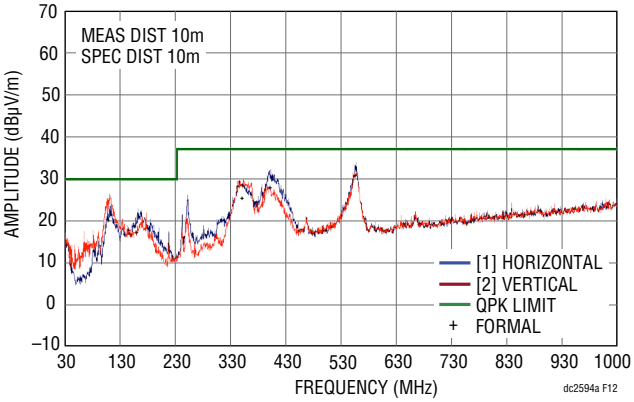


Figure 12. Radiated Emissions Scan of the LTM4655. Producing –12V_{OUT} at 4A, from 12V_{IN}. DC2899A Hardware. f_{SW} = 700kHz. Measured in a 10m Chamber. Peak Detect Method

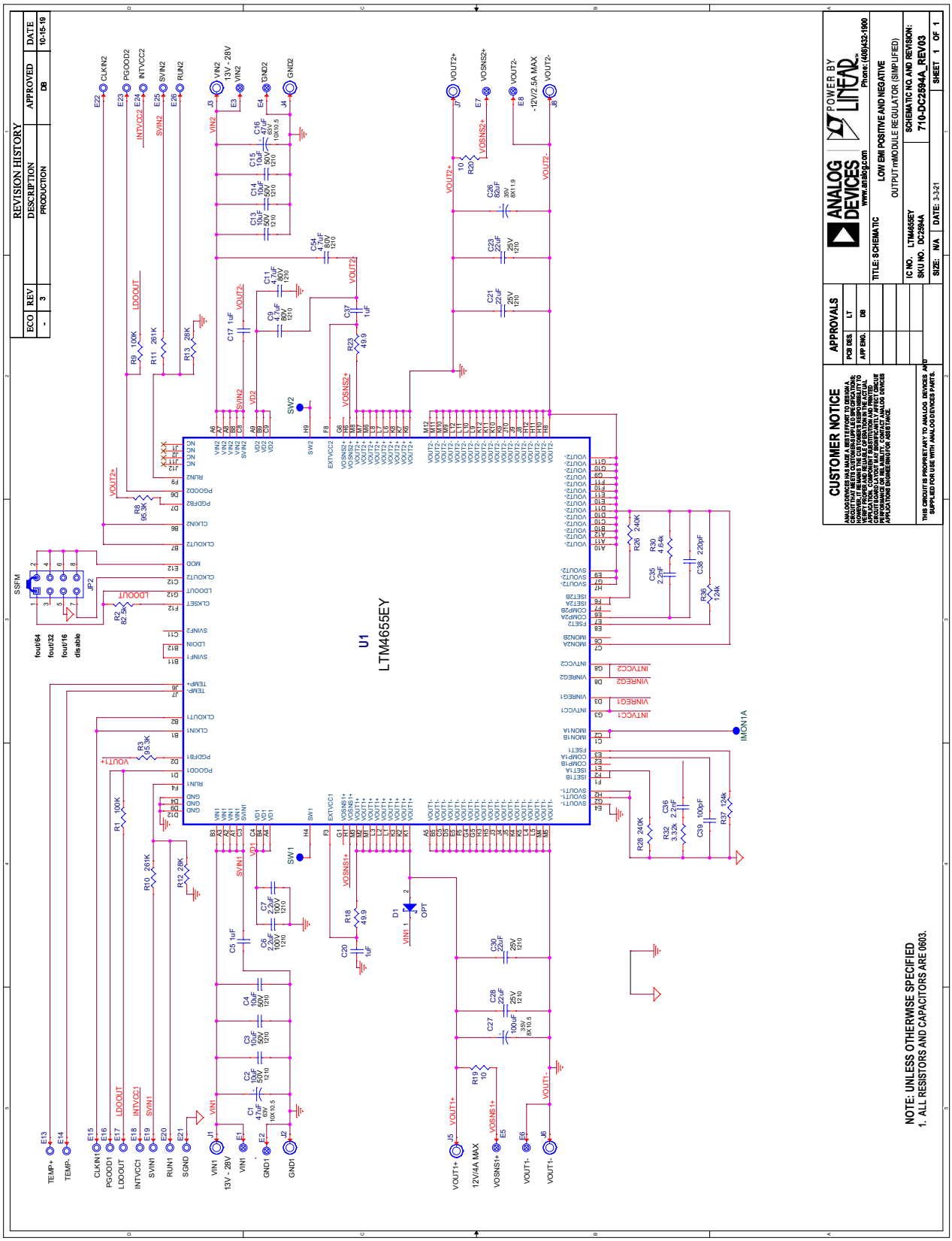
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	C1, C16	CAP., 47µF, ALUM POLY HYB, 63V, 20%, SMD 10mm × 10.5mm, AEC-Q200, HVP Series	SUN ELECTRONIC INDUSTRIES CORP., 63HVP47M
2	6	C2, C3, C4, C13, C14, C15	CAP., 10µF, X7R, 50V, 10%, 1210, NO SUBS. ALLOWED	MURATA, GRM32ER71H106KA12L
3	4	C5, C17, C20, C37	CAP., 1µF, X5R, 50V, 10%, 0603, NO SUBS. ALLOWED	MURATA, GRM188R61H105KAALD
4	2	C6, C7	CAP., 2.2µF, X7R, 100V, 10%, 1210	AVX, 12101C225KAT2A
5	3	C9, C11, C54	CAP., 4.7µF, X7R, 80V, 10%, 1210	MURATA, GRM32ER71K475KE14L
6	4	C21, C23, C28, C30	CAP., 22µF, X7R, 25V, 10%, 1210, NO SUBS. ALLOWED	SAMSUNG, CL32B226KAJNNNE
7	1	C26	CAP., 82µF, ALUM, OS-CON, 35V, 20%, SMD 8mm × 11.9mm, E12, SVPF Series	PANASONIC, 35SVPF82M
8	1	C27	CAP., 100µF, ALUM POLY HYB, 35V, 20%, SMD 8mm × 10.5mm, AEC-Q200, HVP Series	SUN ELECTRONIC INDUSTRIES CORP., 35HVP100M
9	2	C35, C36	CAP., 2200pF, X7R, 50V, 10%, 0603	AVX, 06035C222KAT2A
10	1	C38	CAP., 220pF, X7R, 50V, 10%, 0603	AVX, 06035C221KAT2A
11	1	C39	CAP., 100pF, X7R, 50V, 10%, 0603	AVX, 06035C101KAT2A
12	2	R1, R9	RES., 100k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF1003V
13	1	R2	RES., 82.5k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF8252V
14	2	R3, R8	RES., 95.3k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF9532V
15	2	R10, R11	RES., 261k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF2613V
16	2	R12, R13	RES., 28k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF2802V
17	2	R18, R23	RES., 49.9Ω, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF49R9V
18	2	R19, R20	RES., 10Ω, 1%, 1/10W, 0603	PANASONIC, ERJ3EKF10R0V
19	2	R26, R28	RES., 240k, 1%, 1/10W, 0603	VISHAY, CRCW0603240KFKEA
20	1	R30	RES., 4.64k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF4641V
21	1	R32	RES., 3.32k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF3321V
22	2	R36, R37	RES., 124k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603124KFKEA
23	1	U1	IC, DC/DC REGULATOR, BGA-144 (16mm × 16mm × 5.01mm)	ANALOG DEVICES, LTM4655EY#PBF
Additional Demo Board Circuit Components				
1	0	C8, C10, C12, C22, C24, C25, C29, C31, C32, C44, C45, C46, C49, C50, C51	CAP., OPTION, 1210	
2	0	C18, C19, C33, C34, C40, C41, C42	CAP., OPTION, 0603	
3	0	C43, C52	CAP., OPTION, 0805	
4	0	D1	DIODE, OPTION, SMA	
5	0	L1, L4	IND., OPTION, 1206	
6	0	L2, L3	IND., OPTION, IHLP3232CZ-01	
7	0	R6, R16, R17, R22, R27, R29, R31, R33, R35, R38	RES., OPTION, 0603	
8	10	R4, R5, R7, R14, R15, R21, R24, R25, R34, R39	RES., 0Ω, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
9	0	R40	RES., OPTION, 2512	

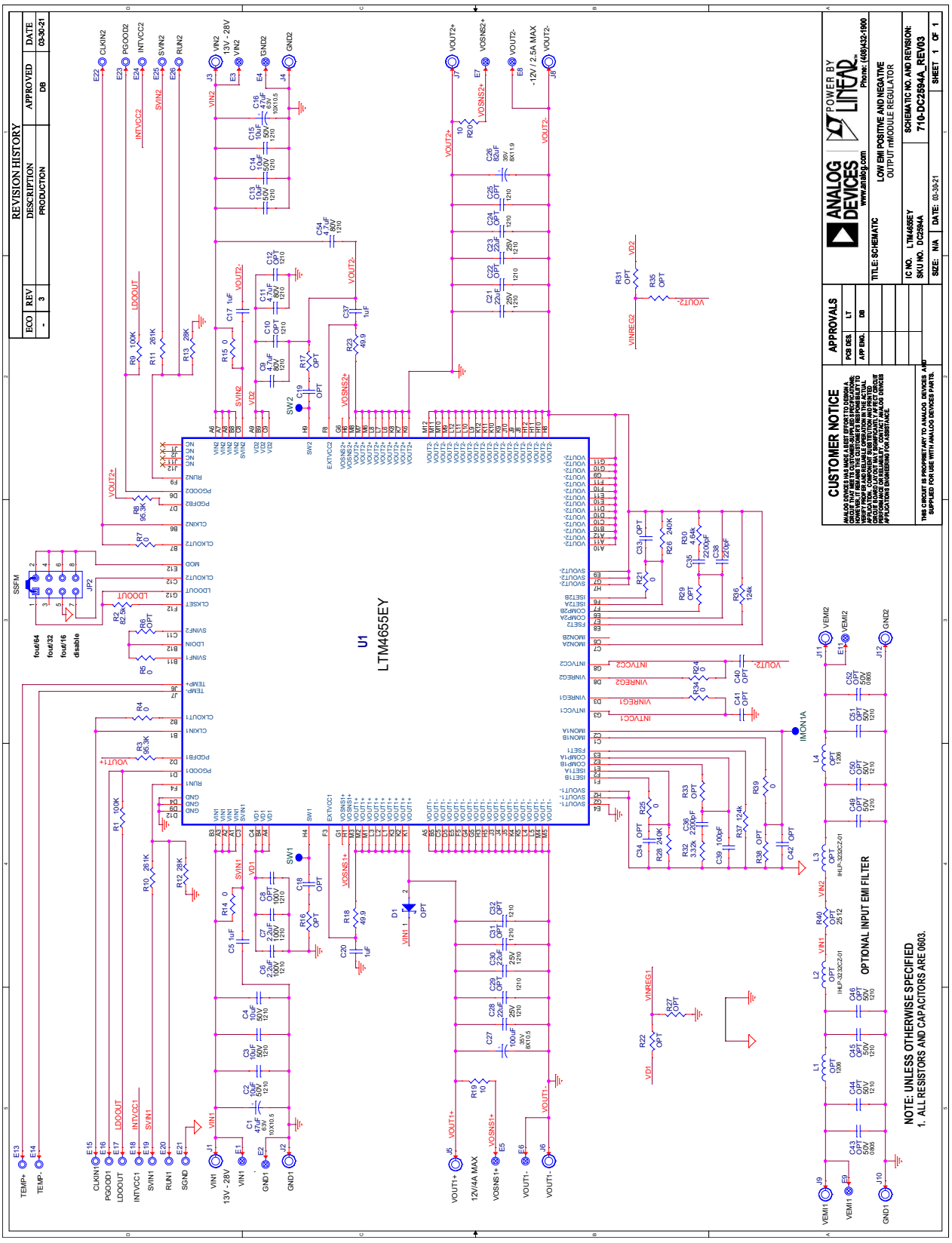
PARTS LIST

Hardware				
1	10	E1, E2, E3, E4, E5, E6, E7, E8, E9, E11	TEST POINT, TURRET, 0.064 MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	14	E13, E14, E15, E16, E17, E18, E19, E20, E21, E22, E23, E24, E25, E26	TEST POINT, TURRET, 0.094 MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
3	12	J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
4	1	JP2	CONN., HDR, MALE, 2×4, 2mm, VERT, ST, THT	WURTH, 62000821121
5	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE, 8833
6	1	XJP2	CONN., SHUNT, FEMALE, 2-POS, 2mm	WURTH, 60800213421

SIMPLIFIED SCHEMATIC DIAGRAM



FULL 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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