LTC3899EFE
Triple Output Synchronous Step-Up/ Dual Step-Down Supply

DESCRIPTION

Demonstration circuit 1898A is a triple output synchronous step-up/dual step-down supply featuring the LTC3899EFE. The circuit is using a drop-in layout: the main buck circuit components fit in an area of ¾″ × 1½″, while the main boost circuit area is ¾″ × 1¾″. The package style for the LTC3899EFE is a 38-pin exposed pad TSSOP package.

The main features of the board include rail tracking (buck channels only), an internal 5V linear regulator for bias, separate RUN pins for each output, a DRVSET jumper to set the gate drive voltage and a Mode selector that allows the converter to run in CCM, pulse skip or Burst Mode® operation. Synchronization to an external clock is also possible.

The LTC3899EFE buck outputs are supplied from the boost output. With this boost-then-buck topology, the buck outputs maintain regulation over the entire input range. The resultant wide input voltage range of 2.5V to 60V is suitable for automotive or other battery fed applications where low quiescent current is important. The LT3899EFE data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this quick start guide for demo circuit 1898A.

Design files for this circuit board are available at http://www.linear.com/demo/DC1898A

PERFORMANCE SUMMARY Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		2.5		60	V
V_{OUT1}	Output1 Voltage Range	V_{IN} = 2.5V*–60V, I_{OUT1} = 0A to 5A	4.90	5.0	5.10	V
V_{OUT2}	Output2 Voltage Range	V_{IN} = 2.5V*–60V, I_{OUT2} = 0A to 3A	8.33	8.5	8.67	V
V_{OUT3}	Output3 Voltage Range	V_{IN} = 2.5V*–10V#, I_{OUT3} = 0A to 5.5A**, $I_{OUT1,2}$ = 0A	9.70	10.0	10.30	V
f_{SW}	Typical Free Running Switching Frequency			350		kHz
	Efficiency See Figures 3,4 and 5 for Efficiency Curves	V_{IN} = 12V, V_{OUT1} = 5.0V, I_{OUT1} = 5A V_{IN} = 48V, V_{OUT1} = 5.0V, I_{OUT1} = 5A V_{IN} = 12V, V_{OUT2} = 8.5V, I_{OUT2} = 3A V_{IN} = 48V, V_{OUT2} = 8.5V, I_{OUT2} = 3A V_{IN} = 5V, V_{OUT3} = 10.0V, I_{OUT3} = 5.5A**		92.1 82.6 96.1 89.5 93.4		% % % % %

When $V_{IN} > V_{OUT3}$ Then V_{OUT3} Follows V_{IN}
* V_{IN} Needs to Be > 4.5V (DRVSET="6V") or > 8V (DRVSET="10V") to Start Up.
** Maximum Output Current Roughly Covers the Full Load from V_{OUT1} and V_{OUT2}. No Extra Current Is Allowed.

QUICK START PROCEDURE

Demonstration circuit DC1898A is easy to set up to evaluate the performance of the LTC3899EFE. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

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_{IN} or V_{OUT} and GND terminals or directly across relevant capacitor. See Figure 2 for proper scope probe technique.

1. Place jumpers in the following positions:

   JP1: ON
   JP2: ON
   JP4: ON
   JP5: Burst Mode
   JP8: 6V

2. With power off, connect the input power supply to V_{IN} and GND.
3. Turn on the power at the input.

NOTE. Make sure that the input voltage does not exceed 60V.

4. Check for the proper output voltages.

   V_{OUT1} = 4.900V to 5.100V,

   V_{OUT2} = 8.330V to 8.670V

   V_{OUT2} = 9.700V to 10.300V

NOTE. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

5. Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

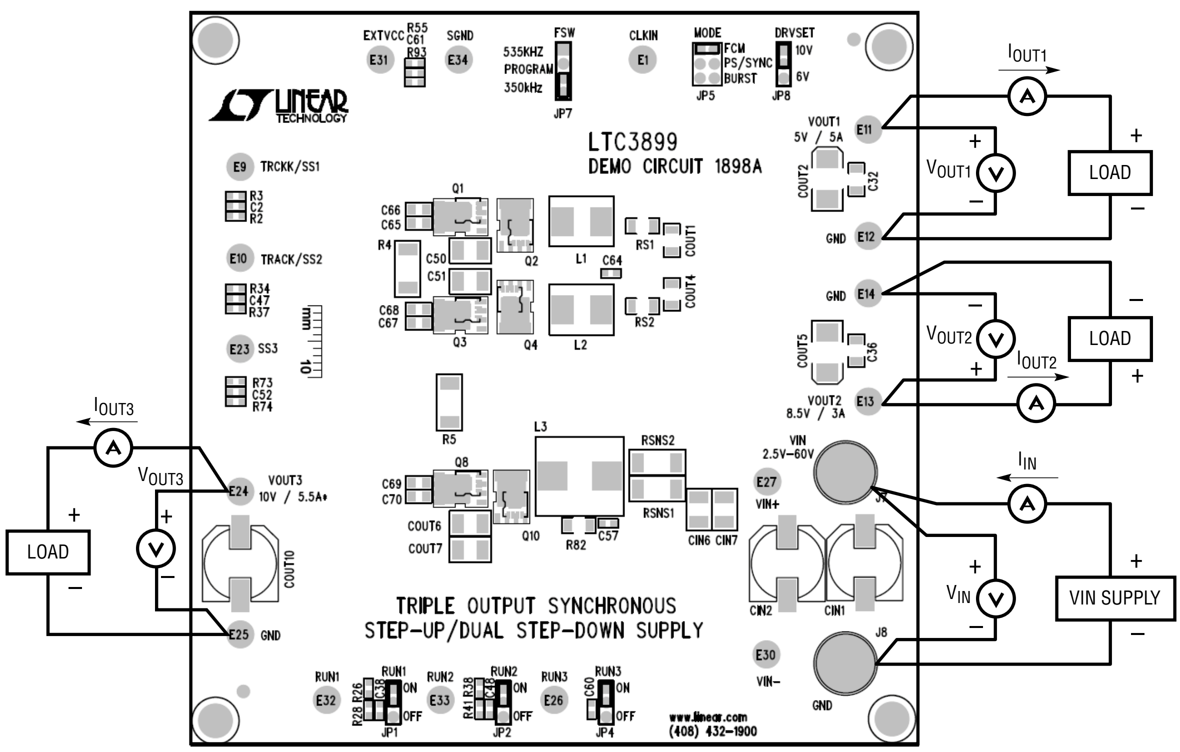


Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

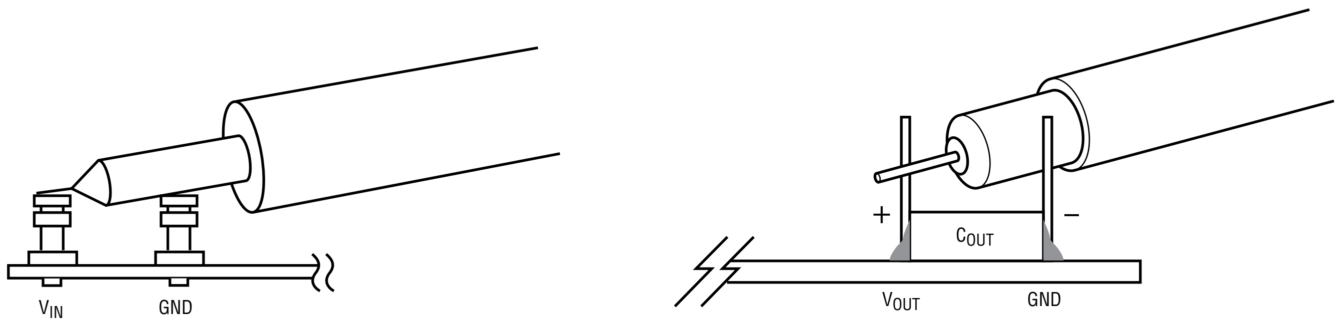


Figure 2. Measuring Input or Output Ripple Across Terminals or Directly Across Bulk Capacitor

FREQUENCY SYNCHRONIZATION AND MODE SELECTION

Demonstration circuit 1898A's Mode selector allows the converter to run in forced continuous operation, pulse skip operation, Burst Mode or be synchronizing to an external clock by changing the position of JP5.

Table 1. Mode Selection and Synchronized Operation Options

CONFIGURATION	JP5
Forced Continuous Operation	'FCM'
Pulse Skip Operation	'PS/Sync'
Synchronized to Ext. Clock Applied to CLKIN Pin	'PS/Sync'
Burst Mode Operation	'Burst'

RAIL TRACKING

Demonstration circuit 1898A is configured for an on board soft start circuit. The soft start ramp rate can be adjusted by changing the value of C2 and C47. Demonstration circuit 1898A can also be modified to track an external reference. Refer to Table 2 and Table 3 for tracking options and to the data sheet for more details.

Table 2. V_{OUT1} Tracking Options

CONFIGURATION	R2	R3	C2	TRK/SS1 CAP
Soft Start Without Tracking (Default)	OPEN	OPEN	0.1µF	Open
V_{OUT1} Tracking Scaled V_{OUT2}	Resistor	Divider	Open	Open

Table 3. V_{OUT2} Tracking Options

CONFIGURATION	R34	R37	C47	TRK/SS2 CAP
Soft Start Without Tracking (Default)	0Ω	OPEN	0.1µF	OPEN
V_{OUT2} Equals External Ramp	0Ω	OPEN	OPEN	External Ramp
V_{OUT2} Tracking Scaled External Ramp	Resistor	Divider	OPEN	External Ramp

OPTIONAL INDUCTOR DCR CURRENT SENSING

Demonstration circuit 1898A provides an optional circuit for Inductor DCR Current Sensing. Inductor DCR Current Sensing uses the DCR of the inductor to sense the inductor current instead of discrete sense resistors. The advantages of DCR sensing are lower cost, reduced board space and higher efficiency, but the disadvantage is a less accurate current limit. If DCR sensing is used, be sure to select an inductor current with a sufficiently high saturation current or use an iron powder type material.

Refer to Table 4 for Optional Inductor DCR Current Sensing setup and to the data sheet for more details.

Table 4. Tracking Options

CONFIGURATION	CHANNEL1	RS1	R29	R30	C14	R45	R47	R61
	CHANNEL2	RS2	R39	R40	C15	R51	R53	R62
	CHANNEL3	RSNS1,2	R80	R81	C56	R89	R90	R91
Current Sense Resistor (Default)		Ref. Sch.	Ref. Sch.	Ref. Sch.	Ref. Sch.	OPEN	OPEN	OPEN
Inductor DCR Current Sensing		0Ω Copper	OPEN	OPEN	Calculated Value from Data Sheet			0Ω

LOW QUIESCENT CURRENT APPLICATIONS AND MEASUREMENT

The typical quiescent current (Iq) of the LTC3899 controller is 29µA in sleep mode as specified in the LTC3899 data sheet. However, the input current of the DC1898A board can be higher than this value because of additional circuit outside of the IC. To reduce the total input current, large value FB divider resistors should be used.

TYPICAL EFFICIENCY VS LOAD CURRENT

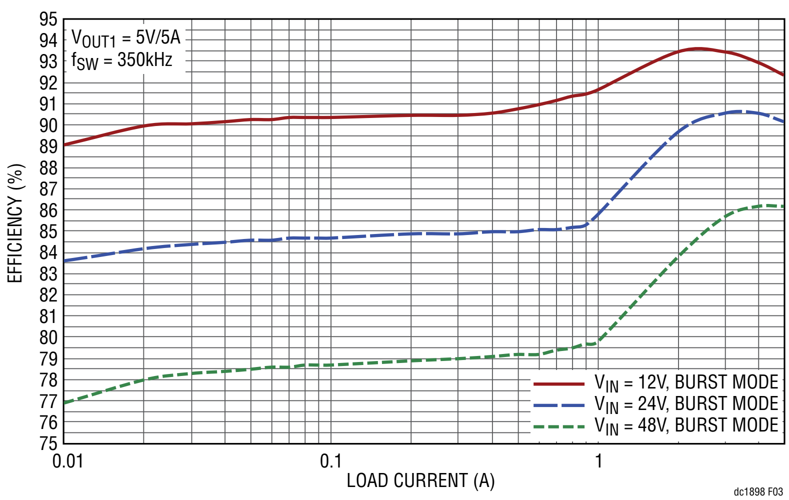


Figure 3. Channel 1 Typical Efficiency vs Load Current

TYPICAL EFFICIENCY VS LOAD CURRENT

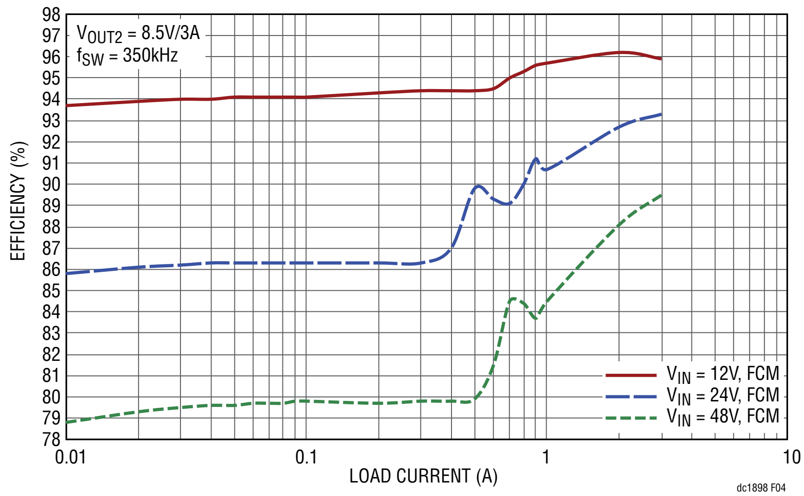


Figure 4. Channel 2 Typical Efficiency vs Load Current

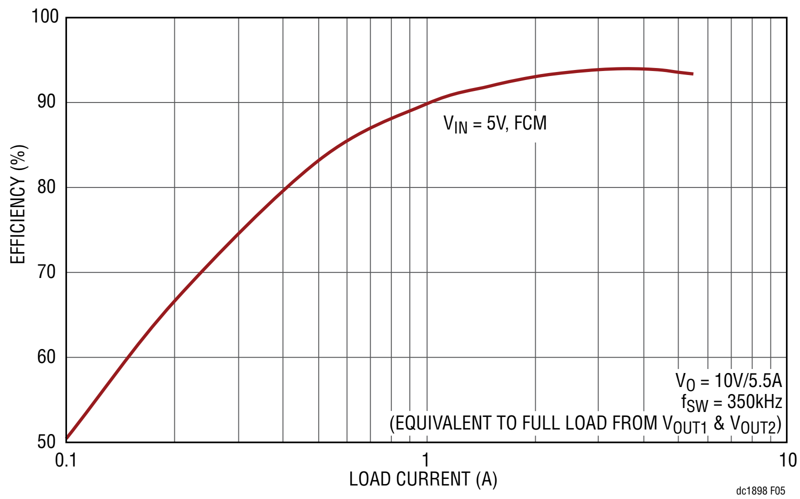


Figure 5. Channel 3 Typical Efficiency vs Load Current

TYPICAL EFFICIENCY VS LOAD CURRENT

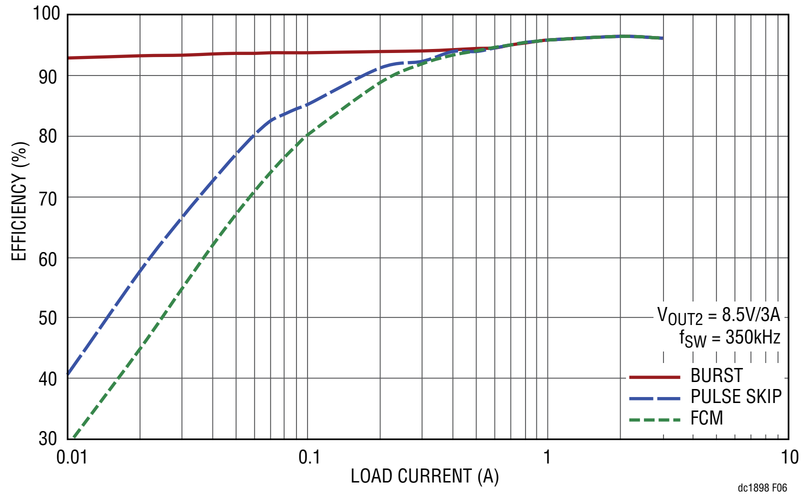


Figure 6. Channel 2 V_{IN} = 12V Efficiency vs Load Current

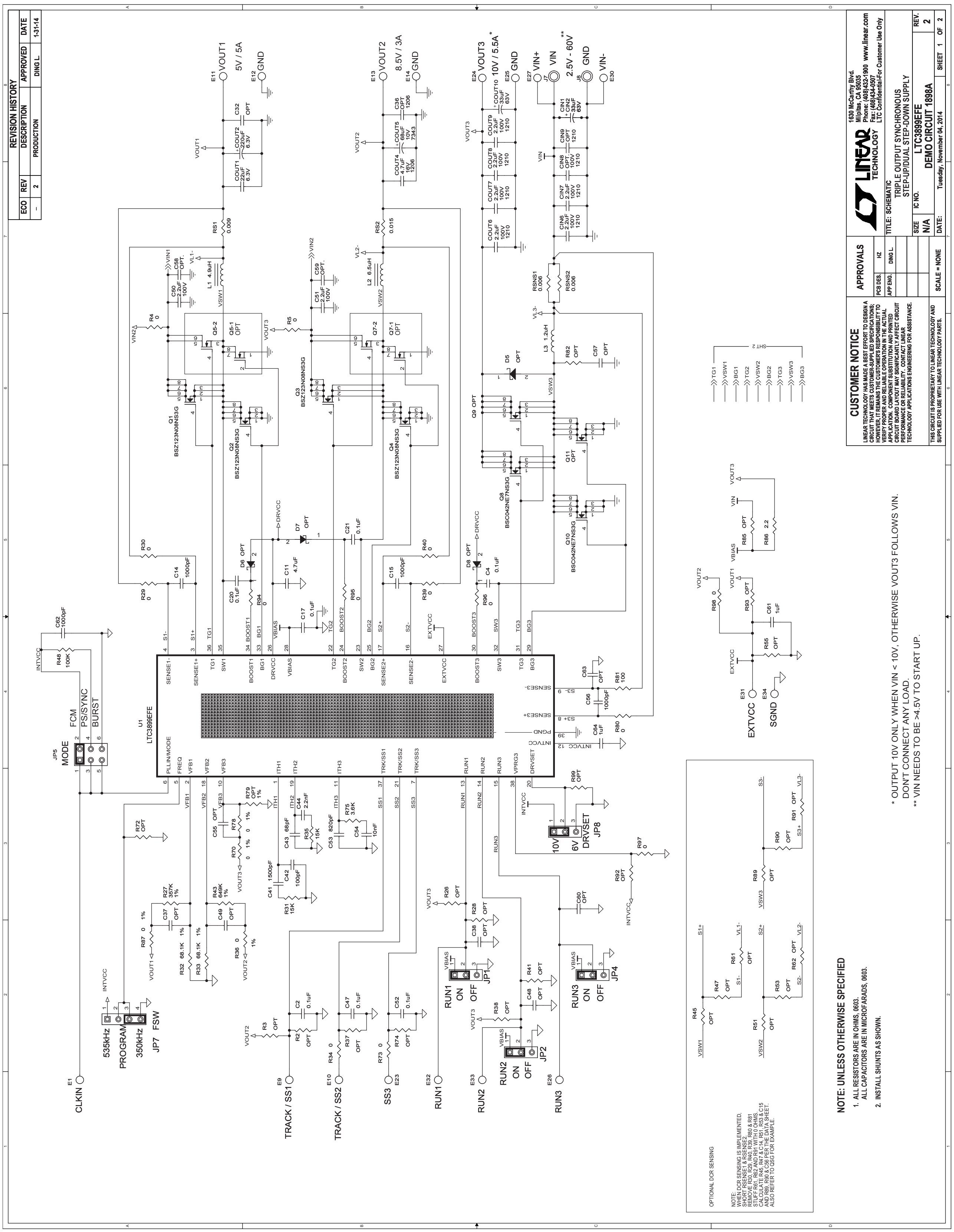
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	3	CIN1, CIN2, COUT10	CAP., ALUM., 33µF, 63V, 20%, HVP	SUN ELECT., 63HVP33M
2	8	COUT6-COUT9,	CAP., 2.2µF, X7R, 100V, 10%, 1210	AVX, 12101C225KAT2A
3		CIN6, CIN7, C50, C51		
4	1	COUT1	CAP., 22µF, X7R, 10V, 20%, 1206	TAIYO YUDEN, LMK316ABJ226ML-T
5	1	COUT2	CAP., POSCAP, 220µF, 6.3V, 20%, 7343	PANASONIC, 6TPB220ML
6	1	COUT4	CAP., 4.7µF, X7R, 16V, 20%, 1206	TDK, C3216X7R1C475M
7	1	COUT5	CAP., POSCAP, 68µF, 10V, 20%, 7343	PANASONIC, 10TPC68M
8	7	C2, C4, C17, C20, C21, C47, C52	CAP., 0.1µF, X7R, 25V, 10%, 0603	TDK, C1608X7R1E104K080AA
9	1	C11	CAP., 4.7µF, X5R, 6.3V, 10%, 0805	AVX, 08056D475KAT2A
10	4	C14, C15, C56, C62	CAP., 1000pF, X7R, 50V, 10%, 0603	AVX, 06035C102KAT2A
11	1	C41	CAP., 1500pF, X7R, 50V, 10%, 0603	AVX, 06035C152KAT2A
12	1	C42	CAP., 100pF, NP0, 5%, 50V, 0603	AVX, 06035A101JAT2A
13	1	C43	CAP., 68pF, NP0, 50V, 10%, 0603	AVX, 06035A680KAT2A
14	1	C44	CAP., 2200pF, X7R, 50V, 10%, 0603	AVX, 06035C222KAT2A
15	2	C61, C64	CAP., 1µF, X5R, 16V, 10%, 0603	AVX, 0603YD105KAT2A
16	1	C53	CAP., 820pF, NP0, 50V, 10%, 0603	AVX, 06035A821JAT2A
17	1	C54	CAP., 0.01µF, X7R, 50V, 10%, 0603	TDK, C1608X7R1H103K080AA
18	4	C65-C68	CAP., 1µF, X7R, 50V, 10%, 0805	MURATA, GRM21BR71H105KA12L
19	2	C69, C70	CAP., 0.22µF, X7R, 50V, 10%, 0805	KEMET, C0805F224K5RACTU
20	1	L1	IND, 4.9µH, 20%, HCI SMD	Würth Elektronik, 744314490
21	1	L2	IND, 6.5µH, 20%, HCI SMD	Würth Elektronik, 744314650
22	1	L3	IND, 1.2µH, 20%, HCI SMD	Würth Elektronik, 744325120
23	4	Q1, Q2, Q3, Q4	XSTR., MOSFET, N-CH, 80V, 12.3mΩ, 40A, PG-TSDSON-8	INFINEON, BSZ123N08NS3 G

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
24	2	Q8, Q10	XSTR., MOSFET, N-CH, 75V, 100A, 4.2mΩ, PG-TDSON-8	INFINEON, BSC042NE7NS3 G
25	2	RSNS1, RSNS2	RES., 0.006Ω, 1/2W, 1%, 2010	VISHAY, WSL20106L000FEA
26	1	RS1	RES., 0.009Ω, 1/4W, 1%, 1206	VISHAY, WSL12069L000FEA
27	1	RS2	RES., 0.015Ω, 1/4W, 1%, 1206	VISHAY, WSL1206R0150FEA
28	2	R4, R5	RES., 0Ω, 1/2W, 2010	VISHAY, CRCW20100000Z0EF
29	1	R86	RES., 2.2Ω, 1/10W, 5%, 0603	VISHAY, CRCW06032R20JNEA
30	1	R27	RES., 357k, 1/10W, 1%, 0603	VISHAY, CRCW0603357KFKEA
31	16	R29, R30, R34, R36, R39, R40,	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
32		R70, R73, R78, R80, R87,		
33		R94, R95, R96, R97, R98		
34	2	R35, R31	RES., 15k, 1/10W, 5%, 0603	VISHAY, CRCW060315K0JNEA
35	3	R32, R33	RES., 68.1k, 1/10W, 1%, 0603	VISHAY, CRCW060368K1FKEA
36	1	R43	RES., 649k, 1/10W, 1%, 0603	VISHAY, CRCW0603649KFKEA
37	1	R48	RES.,100k, 1/10W, 5%, 0603	VISHAY, CRCW0603100KJNEA
38	1	R75	RES., 3.6k, 1/10W, 1%, 0603	VISHAY, CRCW06033K60FKEA
39	1	R81	RES., 22Ω, 1/10W, 5%, 0603	VISHAY, CRCW060322R0JNEA
40	1	U1	I.C., LTC3899EFE#PBF	LINEAR TECH., LTC3899EFE#PBF
Additional Demo Board Circuit Components				
1	0	CIN8, CIN9, C58, C59	CAP., OPTION, 1210	OPTION
2	0	C50, C51	CAP., OPTION, 2.2µF, X7R, 100V, 10%, 1210	
3	0	C32, C36	CAP., OPTION, 1206	OPTION
4	0	C37, C38, C48, C49,	CAP., OPTION, 0603	OPTION
5		C57, C55, C60, C63		
6	0	D5 OPT (? PACKAGE TYPE)	DIODE, SCHOTTKY OPTION	OPTION
7	0	D6-D8 OPT	DIODE, OPTION, SOD-323	OPTION
8	0	Q5, Q7 (OPTION)	XSTR., MOSFET, N-CH, 40V, SO-8	VISHAY, Si4910DY-T1-GE3
9	0	Q9, Q11 OPT	XSTR., MOSFET, N-CH (? PACKAGE TYPE)	
10	0	Q12-Q15 OPT	XSTR., OPTION (WHAT PACKAGE TYPE?)	
11	0	Q16-Q19 OPT	XSTR., OPTION (WHAT PACKAGE TYPE?)	
12	0	R2, R3, R26, R28, R37,	RES., OPTION, 0603	OPTION
13		R38, R41, R45, R47, R51		
14		R53, R55, R61, R62, R72,		
15		R74, R79, R82, R85,		
16		R89, R90-R93, R98, R99		
Hardware: For Demo Board Only				
1	17	E1, E9-E14, E23-E27, E30-E34	TEST POINT, TURRET, .094" MTG. HOLE	MILL-MAX, 2501-2-00-80-00-00-07-0
2	4	JP1, JP2, JP4, JP8	CONN., HEADER, 1 × 3, 2mm, Brass, Gold Flash Overall	SULLINS, NRPN031PAEN-RC
3	1	JP7	CONN., HEADER, 1 × 4, 2mm, Brass, Gold Flash Overall	SULLINS, NRPN041PAEN-RC
4	2	J8, J7	CONN., JACK, BANANA, Non-Insulated, 0.218" Brass Nickel Plate	KEYSTONE, 575-4
5	1	JP5	CONN., HEADER, 2 × 3, 2mm, Brass, Gold Flash Overall	SULLINS, NRPN032PAEN-RC
6	1		PCB, DC1898A	DEMO CIRCUIT 1898A
7	4	JP1, JP2, JP4, JP8	SHUNT, 2mm, GOLD PLATING	SAMTEC, 2SN-BK-G
8	4		STANDOFF, NYLON, SNAP-ON, 0.500"	KEYSTONE, 8833

SCHEMATIC DIAGRAM



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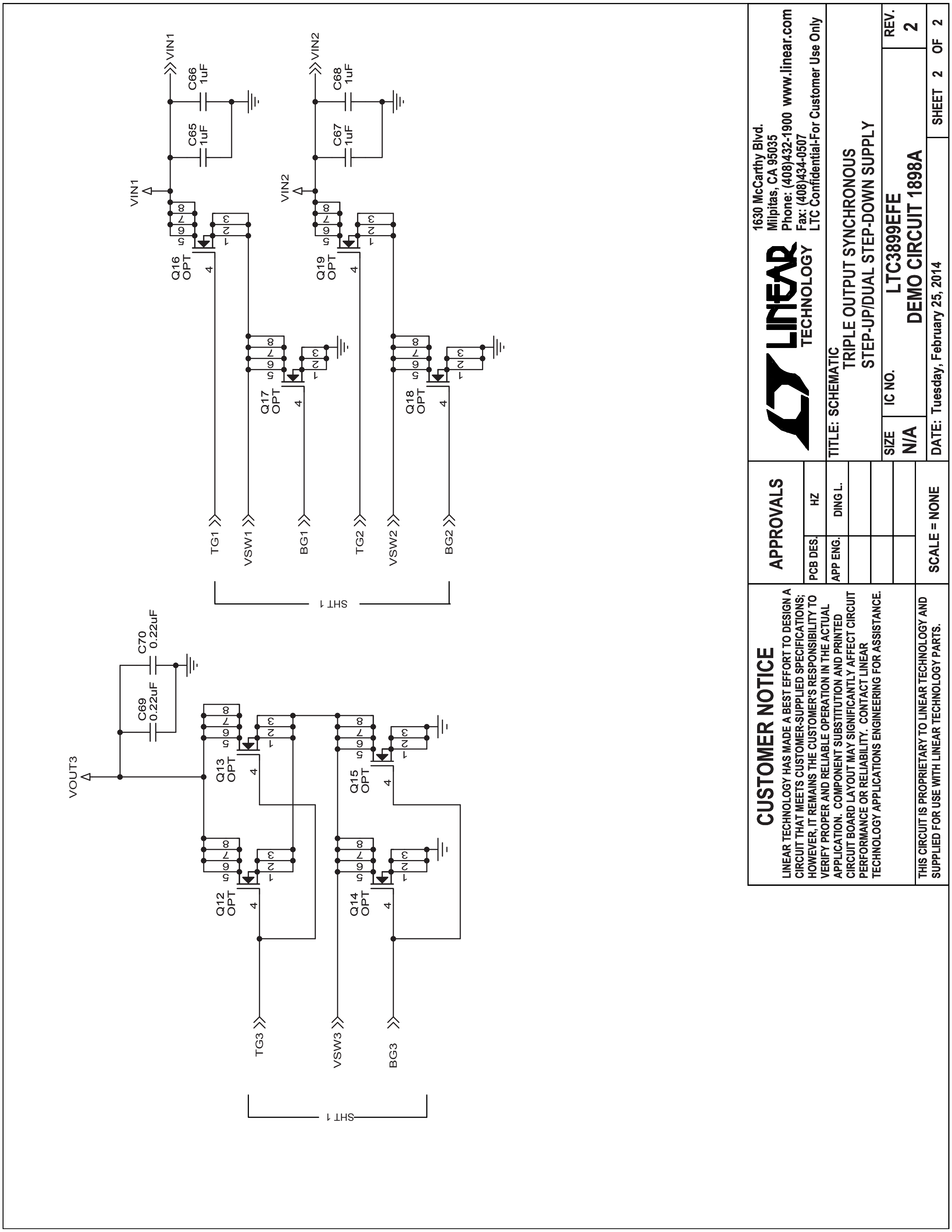

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