

# PolyPhase Synchronous Boost Converter with Input/Output Protection

## DESCRIPTION

Demonstration circuit DC2108 is DC/DC boost converter featuring the **LTC<sup>®</sup>3897** constant frequency current mode boost controller. The DC2108A operates over a 16V to 55V input and provides 4A to 12A of output current as shown in Figure 3. The 160kHz (2•160kHz at the output) constant frequency operation results in a small and efficient circuit. The converter provides high output voltage accuracy (typically  $\pm 3\%$ ) over a wide load range with no minimum load requirement. The demonstration circuit can be easily modified to generate different output voltages.

The DC2108 has small circuit footprint. It is a high performance and cost effective solution for Telecom, Automotive and Power Over Ethernet applications.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2108A>**

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## PERFORMANCE SUMMARY

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

PARAMETER	CONDITION	VALUE
Minimum Input Voltage	$I_{OUT} = 0\text{A to }4\text{A}$	16V
Maximum Input Voltage	$I_{OUT} = 0\text{A to }12\text{A}$	55V
$V_{OUT}^*$	$V_{IN} = 16\text{V to }47\text{V}, I_{OUT} = 0\text{A to }4\text{A}$	$48\text{V} \pm 3\%$
Typical Output Ripple $V_{OUT}$	$V_{IN} = 16\text{V to }47\text{V}, I_{OUT} = 4\text{A}$	$<200\text{mV}_{P-P}$
Nominal Switching Frequency		160kHz

\* Note:  $V_{OUT}$  follows  $V_{IN}$  if  $V_{IN} \geq 48\text{V}$ .

## QUICK START PROCEDURE

Demonstration circuit DC2108 is easy to set up to evaluate the performance of the LTC3897. For proper measurement equipment setup refer to Figure 1 and follow the procedure below:

**NOTE:** When measuring the input or output voltage ripple, care must be taken to minimize the length of oscilloscope probe ground lead. Measure the input or output voltage ripple by connecting the probe tip directly across the  $V_{IN}$  or  $V_{OUT}$  and GND terminals as shown in Figure 2.

1. With power off, connect the input power supply to  $V_{IN}$  and GND.
2. Keep the load set to 0A or disconnected.

3. Turn the input power source on and slowly increase the input voltage. Be careful not to exceed 55V.

**NOTE:** Make sure that the input voltage  $V_{IN}$  does not exceed 55V. If higher operating voltage is required, power components with higher voltage ratings should be used. When the input voltage is set higher than 48V the output voltage will follow the input voltage.

4. Set the input voltage to 16V and check for the proper output voltage of 48V. Set the output load to 4A. 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 voltage is established, adjust the load and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

## QUICK START PROCEDURE

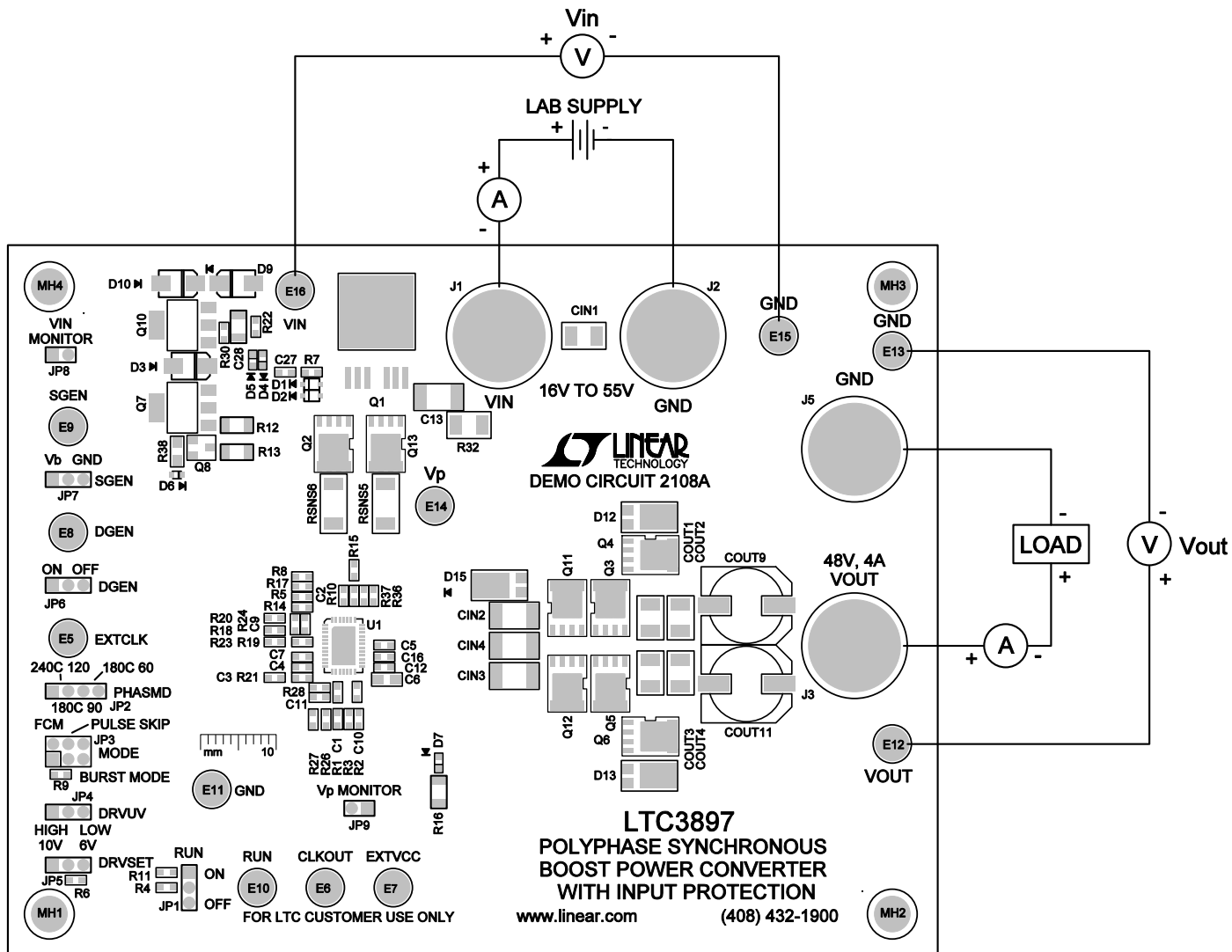


Figure 1. Proper Measurement Equipment Setup

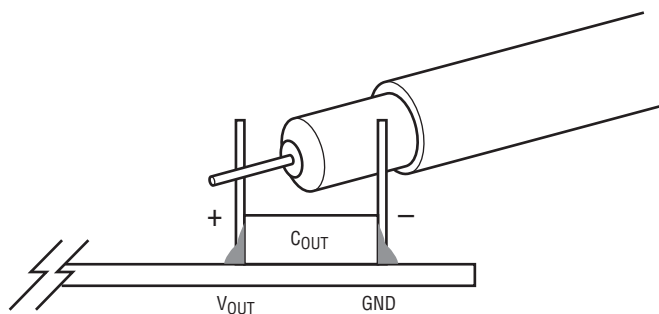


Figure 2. Measuring Input or Output Ripple

## QUICK START PROCEDURE

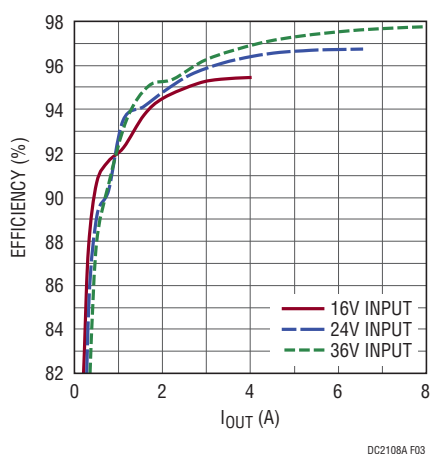
### CHANGING THE OUTPUT VOLTAGE

To set the output voltage lower than 48V, change the bottom voltage divider resistors connected to LTC3897 FB pin (see the schematic on page 4). To get higher than 48V output voltage MOSFETs and capacitors with higher voltage ratings may be required.

Note that the output voltage will start following the input voltage when input voltage is greater than the voltage set by the voltage divider. In this mode (wire mode) the synchronous output rectifier MOSFET is turned continuously ON. The only losses in this mode are due to the current sense resistors, inductors and output MOSFETs DC resistance.

### CONVERTER EFFICIENCY AND OUTPUT CURRENT

The DC2108 output current capability depends on the input voltage and proper cooling. Typical performance of DC2108A is shown in Figure 3. As can be seen from Figure 3, the output current capability depends on the input voltage. Also, when the input voltage is equal to, or higher than the output voltage setting (wire mode) the efficiency is very high (99%) since the converter is not really running and the output MOSFET is shorting  $V_{IN}$  to  $V_{OUT}$ .



**Figure 3. High Efficiency of DC2108 Allows the Board to Be Used in Thermally Critical Applications with Outputs Over 4A**

### OUTPUT LOAD STEP RESPONSE

The load step response of DC2108A is very good even though relatively small amount of output capacitance is present at the output. If higher load steps need to be handled more output capacitance can be added in order to keep the voltage transients at the desired level. The load step transients are shown in Figure 4. Also, note that the load step response even from 0% load is excellent thanks to synchronous rectification.

### SOFT-START FUNCTION

The DC2108 features soft-start circuit that controls the inrush current and output voltage ramp at startup. The SS pin capacitor (Figure 6) controls the startup period. The startup waveforms are shown in Figure 5. Please note that the  $V_{OUT}$  follows  $V_{IN}$  until boost circuit starts running at 20ms mark. While the boost converter is in off state (prior to 20ms mark) the synchronous MOSFET body diodes are dissipating about  $0.7V \cdot I_{OUT}$  or about 2.8W with 4A load. Please refer to the LTC3897 data sheet for details about proper handling of synchronous MOSFETs in your application.

### BIAS CIRCUIT

The LTC3897 can operate with input voltages up to 75V. However, depending on input voltage, operating frequency and MOSFETs that are used the power dissipation in the part may become too high. In order to provide bias power at high input voltage the DC2108 circuit is equipped with optional Q10 bias circuit.

Please, refer to the data sheet for more information about bias power.

## QUICK START PROCEDURE

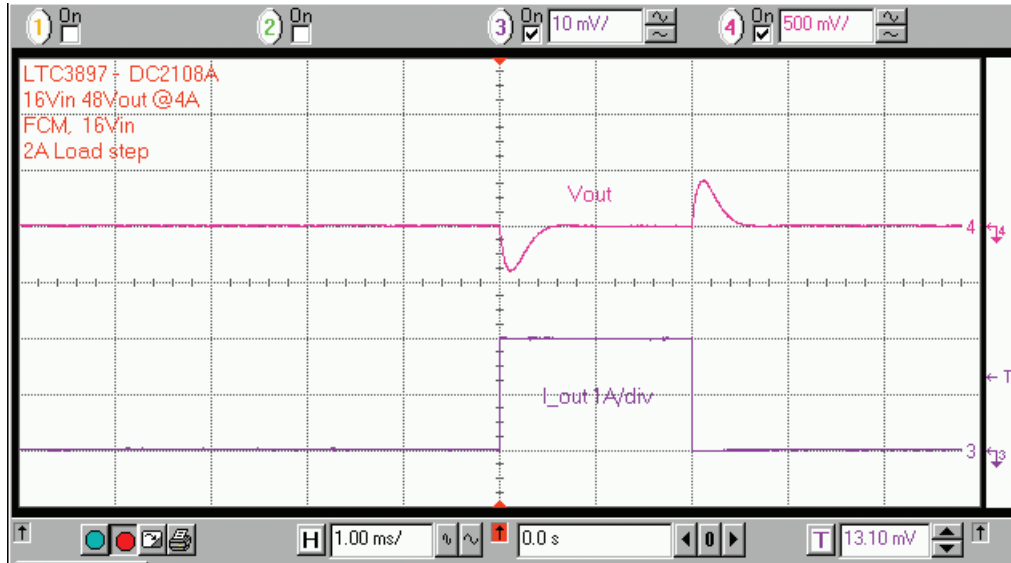


Figure 4. Fast Transient Response of DC2108 Is Achieved with a Small Amount of Output Capacitance

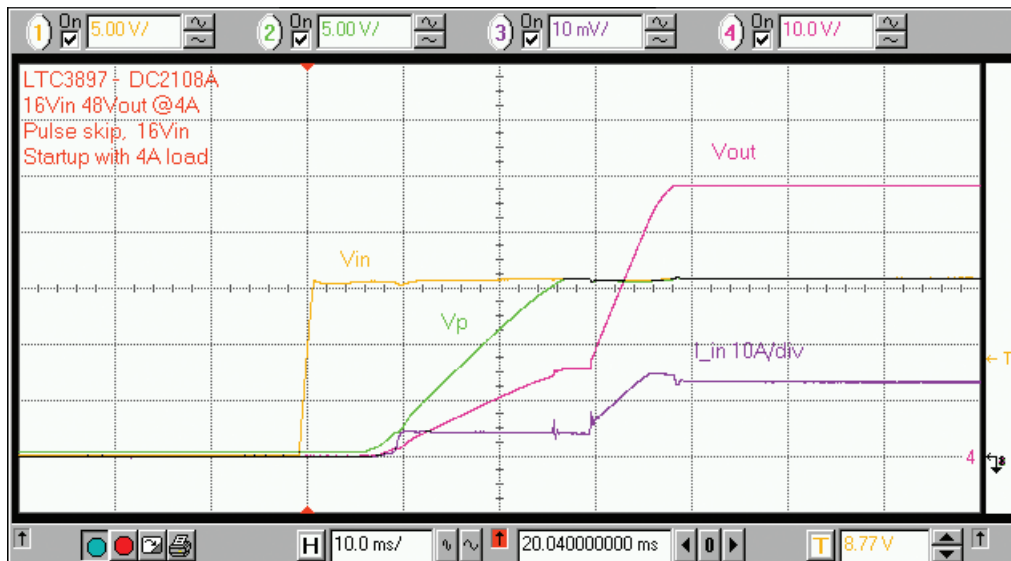


Figure 5. The DC2108 Ramps the Output Slowly at Startup without Generating an Input Current Surge

## PARTS LIST

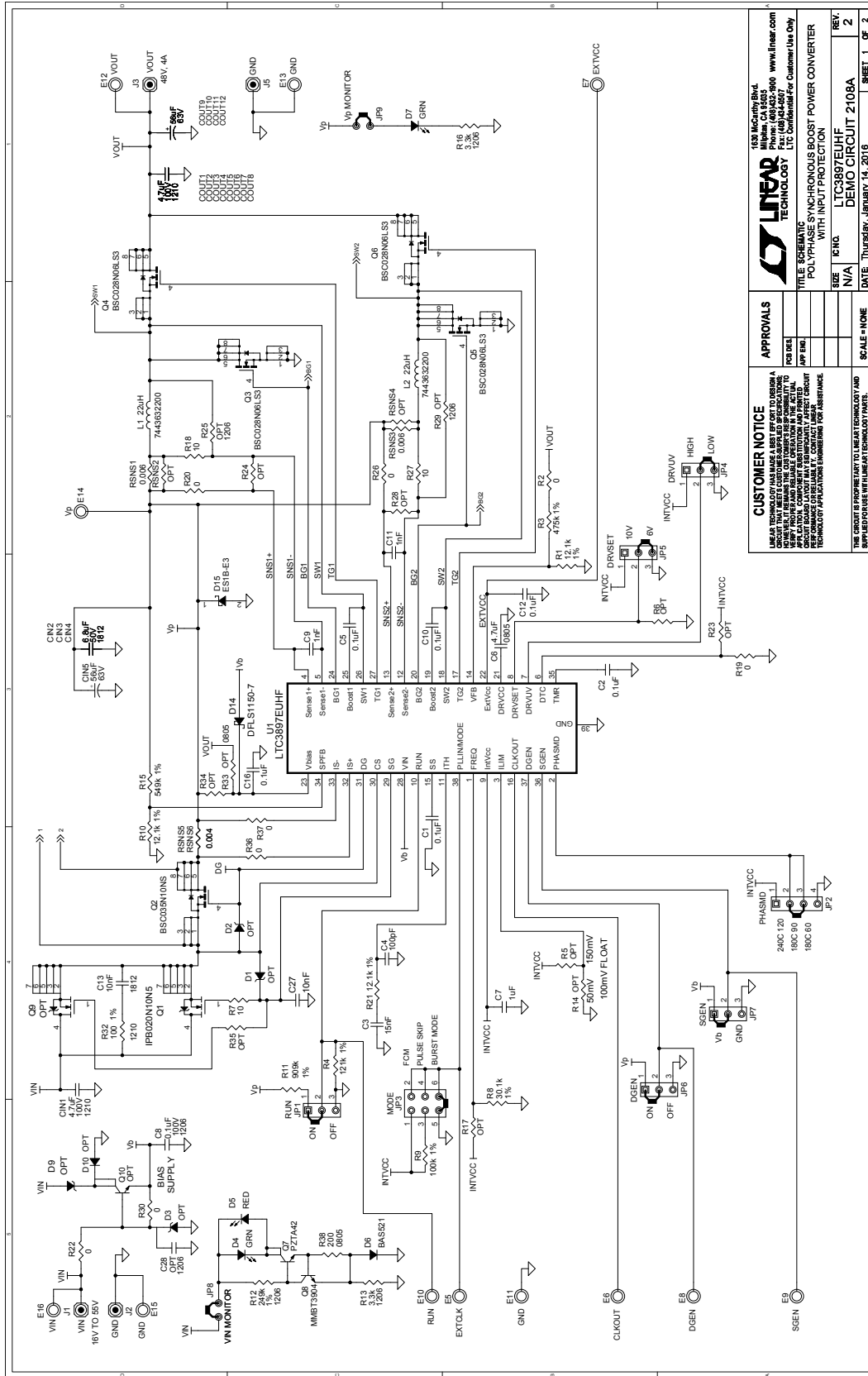
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	9	COUT1, CIN1, COUT2, COUT3, COUT4, COUT5, COUT6, COUT7, COUT8	CAP, 1210 4.7 $\mu$ F 20% 100V X7S	TDK C3225X7S2A475M
2	3	CIN2, CIN3, CIN4	CAP, 1812 6.8 $\mu$ F 10% 50V X7R	TDK C4532X7R1H685K
3	5	CIN5, COUT9, COUT10, COUT11, COUT12	CAP, 56 $\mu$ F 20% 63V ELECT	PANASONIC EEHZA1J560P
4	6	C1, C2, C5, C10, C12, C16	CAP, 0603 0.1 $\mu$ F 10% 50V X7R	AVX 06035C104KAT2A
5	1	C3	CAP, 0603 15nF 10% 25V X7R	AVX 06033C153KAT2A
6	1	C4	CAP, 0603 100pF 5% 50V NPO	AVX 06035A101JAT2A
7	1	C6	CAP, 0805 4.7 $\mu$ F 20% 16V X5R	AVX 0805YD475MAT2A
8	1	C7	CAP, 0603 1 $\mu$ F 20% 25V X5R	AVX 06033D105KAT2A
9	1	C8	CAP, 1206 0.1 $\mu$ F 10% 100V X7R	MURATA GCM319R72A104KA37D
10	2	C9, C11	CAP, 0603 1nF 10% 50V X7R	AVX 06035C102KAT
11	1	C13	CAP, 1812 10nF 5% 630V COG	TDK C4532C0G2J103J
12	1	C27	CAP, 0603 10nF 10% 25V X7R	AVX 06033C103KAT2A
13	2	D4, D7	LED, GREEN	LITE ON LTST-C193KGKT-5A
14	1	D5	LED, RED	LITE ON LTST-C193KRKT-5A
15	1	D6	DIODE, SWITCHING, HIGH VOLTAGE	DIODES INC. BAS521
16	1	D14	DIODE, SCHOTTKY	DIODES INC. DFSL1150-7
17	1	D15	DIODE, SCHOTTKY	VISHAY ES1B-E3
18	2	L1, L2	IND, 22 $\mu$ H	WURTH 7443632200
19	1	Q1	XSTR, POWER MOSFET	INFINEON IPB020N10N5
20	1	Q2	XSTR, POWER MOSFET	INFINEON BSC035N10NS
21	4	Q3, Q4, Q5, Q6	XSTR, POWER MOSFET	INFINEON BSC028N06LS3
22	1	Q7	XSTR, NPN HIGH VOLTAGE AMP	FAIRCHILD PZTA42
23	1	Q8	XSTR, NPN SMALL SIGNAL	FAIRCHILD. MMBT3904
24	2	RSNS1, RSNS3	RES, 2010 0.006 $\Omega$ 1% 1/2W	VISHAY WSL20106L000FEA
25	2	RSNS5, RSNS6	RES, 2010 0.004 $\Omega$ 1% 0.5W	VISHAY WSL20104L000FEA
26	3	R1, R10, R21	RES, 0603 12.1k $\Omega$ 1% 1/10W	VISHAY CRCW060312K1FKEA
27	8	R2, R19, R20, R22, R26, R30, R36, R37	RES, 0603 0 $\Omega$ JUMPER	VISHAY CRCW06030000Z0EA
28	1	R3	RES, 0603 475k $\Omega$ 1% 1/10W	VISHAY CRCW0603475KFKEA
29	1	R4	RES, 0603 121k $\Omega$ S 1% 1/10W	VISHAY CRCW0603121KFKEA
30	3	R7, R18, R27	RES, 0603 10 $\Omega$ 1% 1/10W	VISHAY CRCW060310R0FKEA
31	1	R8	RES, 0603 30.1k $\Omega$ 1% 1/10W	VISHAY CRCW060330K1FKEA
32	1	R9	RES, 0603 100k $\Omega$ 1% 1/10W	VISHAY CRCW0603100KFKEA
33	1	R11	RES, 0603 909k $\Omega$ 1% 1/10W	VISHAY CRCW0603909KFKEA
34	1	R12	RES, 1206 249k $\Omega$ 1% 1/4W	VISHAY CRCW1206249KFKEA
35	2	R13, R16	RES, 1206 3.3k $\Omega$ 5% 1/4W	VISHAY CRCW12063K30JNEA
36	1	R15	RES, 0603 549k $\Omega$ 1% 1/10W	VISHAY CRCW0603549KFKEA
37	1	R32	RES, 1210 100 $\Omega$ 1% 1/4W	VISHAY CRCW1210100RFKEA
38	1	R38	RES, 0805 200 $\Omega$ 5% 1/8W	VISHAY CRCW0805200RJNEA
39	1	U1	IC, POLYPHASE SYNCHRONOUS BOOST CONTROLLER	LINEAR TECH. LTC3897EUHF

# DEMO MANUAL DC2108A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Additional Demo Board Circuit Components</b>				
1	0	C28	CAP, 1206 OPTION	OPTION
2	0	D1, D2	DIODE, OPTION SOD-323	DIODES INC. DDZ9702S-7 OPTION
3	0	D3	DIODE, OPTION SMA	CENTRAL SEMI CMZ5945B OPTION
4	0	D9	DIODE, OPTION SMA	DIODES INC. SMAJ24A-13 OPTION
5	0	D10	DIODE, OPTION SMA	DIODES INC. ES1G OPTION
6	0	D12, D13	DIODE SCHOTTKY OPTION	OPTION
7	0	Q9	XSTR, OPTION	OPTION
8	0	Q10	XSTR, OPTION	FAIRCHILD PZTA42 OPTION
9	0	Q11, Q12	XSTR, POWER MOSFET OPTION	OPTION
10	0	Q13	XSTR, OPTION	INFINEON BSC060N10 OPTION
11	0	RSNS2, RSNS4	RES, 2010 OPTION	OPTION
12	0	R5, R6, R14, R17, R23, R24, R28, R34, R35	RES, 0603 OPTION	OPTION
13	0	R25, R29	RES, 1206 OPTION	OPTION
14	0	R33	RES, 0805 OPTION	OPTION
<b>Hardware: For Demo Board Only</b>				
1	12	E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16	TURRET	MILL-MAX 2501-2-00-80-00-00-07-0
2	5	JP1, JP4, JP5, JP6, JP7	HEADER, 3 PIN, 2mm	SULLINS, NRPN031PAEN-RC
3	1	JP2	HEADER, 4 PIN, 2mm	SULLINS, NRPN041PAEN-RC
4	1	JP3	HEADER, 3 PIN, DBL ROW 2mm	SULLINS, NRPN032PAEN-M456RC
5	2	JP8, JP9	HEADER, SINGLE ROW, 2 PIN, 2mm	SULLINS, NRPN021PAEN-RC
6	4	J1, J2, J3, J5	STUD, TESTPIN	PEM KFH-032-10
7	4		LUG RING, #10	KEYSTONE 8205
8	4		WASHER, #10 TIN PLATED BRASS	ANY #10 EXT BZ TN
9	9	XJP1, XJP2, XJP3, XJP4, XJP5, XJP6, XJP7, XJP8, XJP9	SHUNT, 2mm	SAMTEC 2SN-BK-G
10	4	MH1, MH2, MH3, MH4	STANDOFF, SNAP ON	KEYSTONE 8834
11	8		NUT, BRASS 10-32	ANY #10-32

## SCHEMATIC DIAGRAM



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**APPROVALS**

DESIGN	
APP. ENG.	

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**TITLE: DC2108A**  
**DESCRIPTION: POLY-PHASE SYNCHRONOUS BOOST POWER CONVERTER WITH INPUT PROTECTION**

**SIZE: K/NQ**  
**REV: 2**

**DATE: Thursday, January 14, 2010**  
**SCALE: NONE**

**DEMO CIRCUIT 2108A**  
**SHEET 1 OF 2**



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# DEMO MANUAL DC2108A

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