

# LTC3890, 60V, LOW IQ DUAL OUTPUT HIGH VOLTAGE STEP-DOWN CONVERTER

## DESCRIPTION

Demonstration circuit 2299A is a high input voltage, high efficiency synchronous dual output buck converter featuring the [LTC®3890EGN](#). The DC2299A has a wide input voltage range of 6V to 60V. The output voltages are set to 5V and 12V, however, the output voltage can go as high as 24V, with certain modifications. This demo board is capable of delivering up to 8A from the 5V output and up to 5A from the 12V output.

The DC2299A supports three operation modes: fixed frequency modulation, pulse-skipping and Burst Mode® operation. Fixed frequency operation maximizes the output current, reduces output voltage ripple, and yields a low noise switching spectrum. Burst Mode operation employs a variable frequency switching algorithm that minimizes the no-load input quiescent current and improves efficiency at light loads.

The DC2299A consumes less than 50µA of quiescent current during shutdown and less than 1mA with the outputs in regulation under a no-load condition in Burst Mode operation. The DC2299A has a standard operating

frequency of 200kHz, but can be adjusted to frequencies as high as 900kHz.

The DC2299A is designed to support multiple footprints of input/output capacitors and inductors to accommodate a wide variety of applications. The LTC3890 data sheet gives a complete description of this controller along with operation and application information, and must be read in conjunction with this demo board manual.

**Table 1. DC2299A Variants**

DC2299A VARIANTS	IC PART NUMBER	PART MARKING
2299A-A	LTC3890EGN-3	LTC3890GN-3
2299A-B	LTC3890EGN-1	LTC3890GN-1

\*See data sheet Table 1 for differences between the parts in the LTC3890 family.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2299A>**

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## PERFORMANCE SUMMARY

PARAMETER	CONDITIONS/NOTES	VALUE
Minimum Input Voltage		6V
Maximum Input Voltage		60V
Output Voltage $V_{OUT1}$ Regulation	$V_{IN} = 6V$ to 55V	5V $\pm 2\%$
Output Voltage $V_{OUT2}$ Regulation	$V_{IN} = 16V$ to 55V	12V $\pm 2\%$
Maximum Continuous Output Current	$V_{OUT1}$	8A
Maximum Continuous Output Current	$V_{OUT2}$	5A
Preset Operating Frequency		200kHz
External Clock Sync. Frequency Range		75kHz to 850kHz
Efficiency	$V_{IN} = 24V$ , $V_{OUT2} = 12V$ , $I_{OUT1} = 3A$ (See Figure 4 Efficiency Curves for Complete Operating Range)	97%
Typical Output Ripple $V_{OUT}$	$V_{IN} = 36V$ , $V_{OUT2} = 12V$ , $I_{OUT2} = 3A$ (20MHz BW)	<35mV <sub>p-p</sub>
Quiescent Current at Shut-down	$V_{IN} = 16V$ to 55V	<50µA
Input Current at No-Load	$V_{IN} = 16V$ to 55V	<1mA

## QUICK START PROCEDURE

Demonstration circuit 2299A is easy to set up to evaluate the performance of the LTC3890. For proper measurement equipment configuration, set up the circuit according to the diagram in Figure 1. Before proceeding to test, insert shunts into JP3 and JP2 (RUN1, 2) into the OFF position, which connects the RUN pins to ground (GND), and thus, shuts down the outputs. Set jumper JP1 (MODE) into FCM (Forced Counties Mode) position.

**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. See Figure 2 for proper scope probe technique.

1. With the DC2299A set up according to the proper measurement and equipment in Figure 1, apply 20V at  $V_{IN}$ . Measure  $V_{OUT}$ ; it should read 0V. If desired, one can measure the shutdown supply current at this point. The supply current will be approximately 50 $\mu$ A, or less, in shutdown.

2. Turn on  $V_{OUT1}$  of the circuit by inserting the shunt in header JP3 (RUN1) into the ON position. The output voltage should be regulating. Measure  $V_{OUT1}$ —it should measure 5.0V  $\pm$ 2% (Do not apply more than the rated maximum voltage of 60V to the board or the part may be damaged). Vary the  $V_{OUT1}$  load, which should not exceed 8A. Vary the input voltage from 6V to 55V, the  $V_{OUT}$ —it should measure 5.0V  $\pm$ 2%.
3. Turn on  $V_{OUT2}$  of the circuit by inserting the shunt in header JP2 (RUN2) into the ON position. The output voltage should be regulating. Measure  $V_{OUT2}$ —it should measure 12.0V  $\pm$ 2% (Do not apply more than the rated maximum voltage of 60V to the board or the part may be damaged). Vary the  $V_{OUT2}$  load, which should not exceed 5A. Vary the input voltage from 16V to 55V, the  $V_{OUT}$ —it should measure 12.0V  $\pm$ 2%.
4. Set output current to zero and move jumper JP1 (MODE) into Burst Mode position and measure  $V_{OUT1}$  and  $V_{OUT2}$ .
5. Set output current to zero and move jumper JP1 (MODE) into PLS SKIP position and measure  $V_{OUT1}$  and  $V_{OUT2}$ .

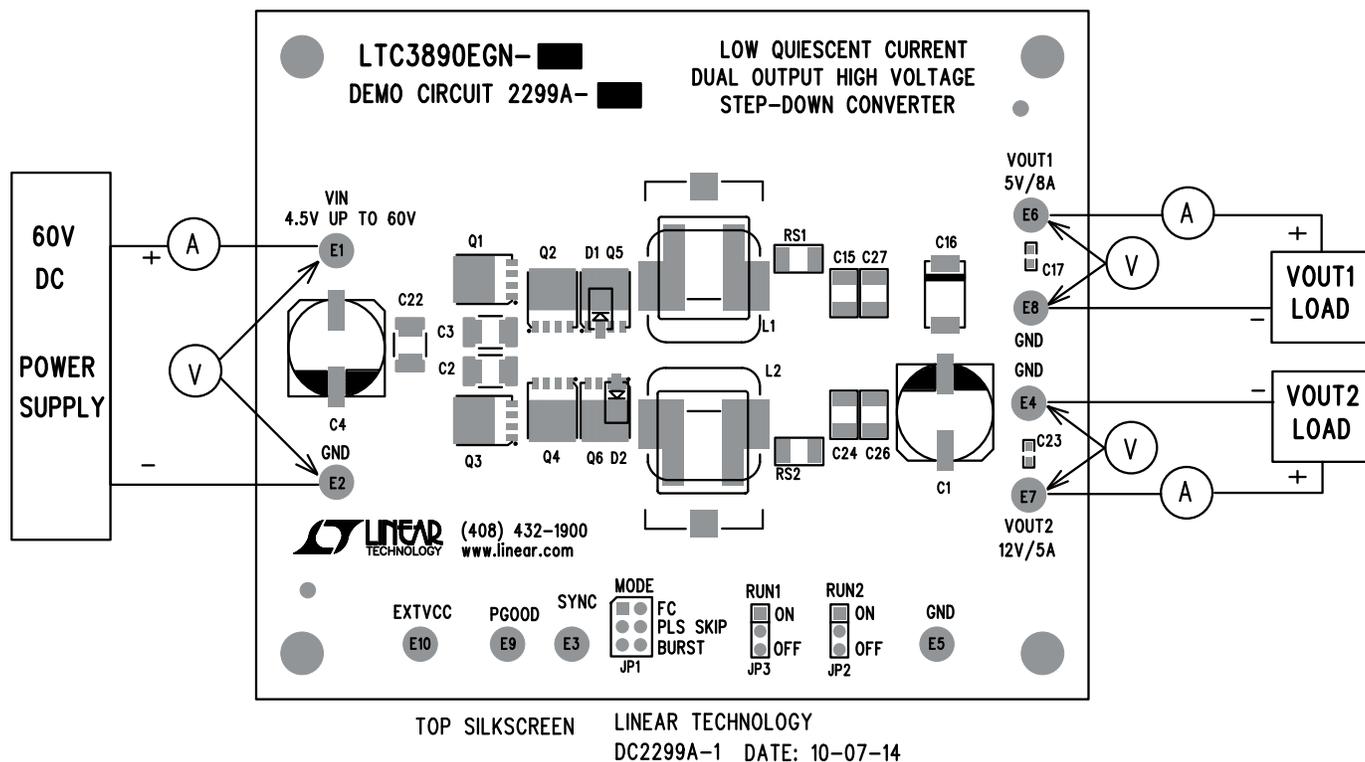
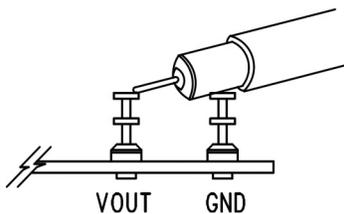
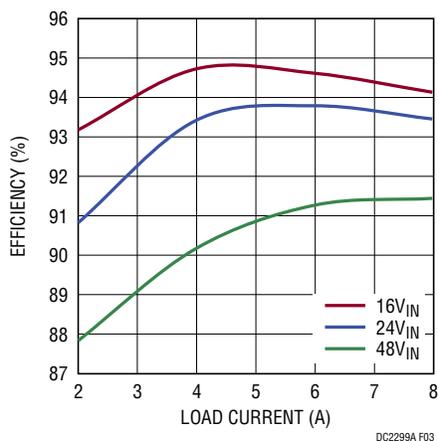


Figure 1. Proper Measurement Equipment Setup

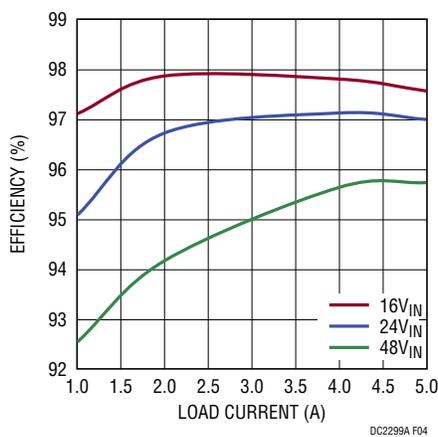
**QUICK START PROCEDURE**



**Figure 2. Measuring Output Ripple**



**Figure 3. Efficiency vs. Input Voltage for V<sub>OUT1</sub> (5V)**



**Figure 4. Efficiency vs. Input Voltage for V<sub>OUT2</sub> (12V)**

## QUICK START PROCEDURE

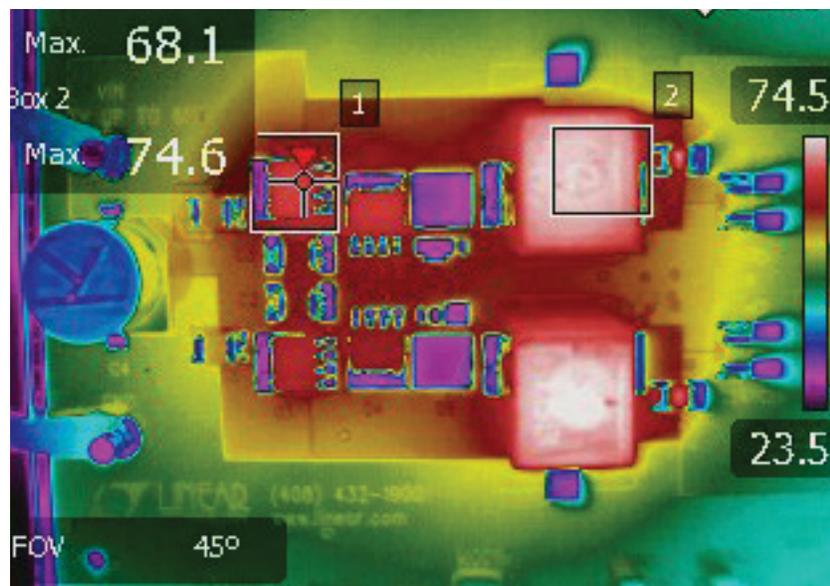


Figure 5. Thermal Map,  $V_{IN}$  48V,  $I_{OUT1}$  5V at 8A,  $I_{OUT2}$  12V at 5A No Air Flow,  $T_A = 25^\circ\text{C}$

## PARTS LIST

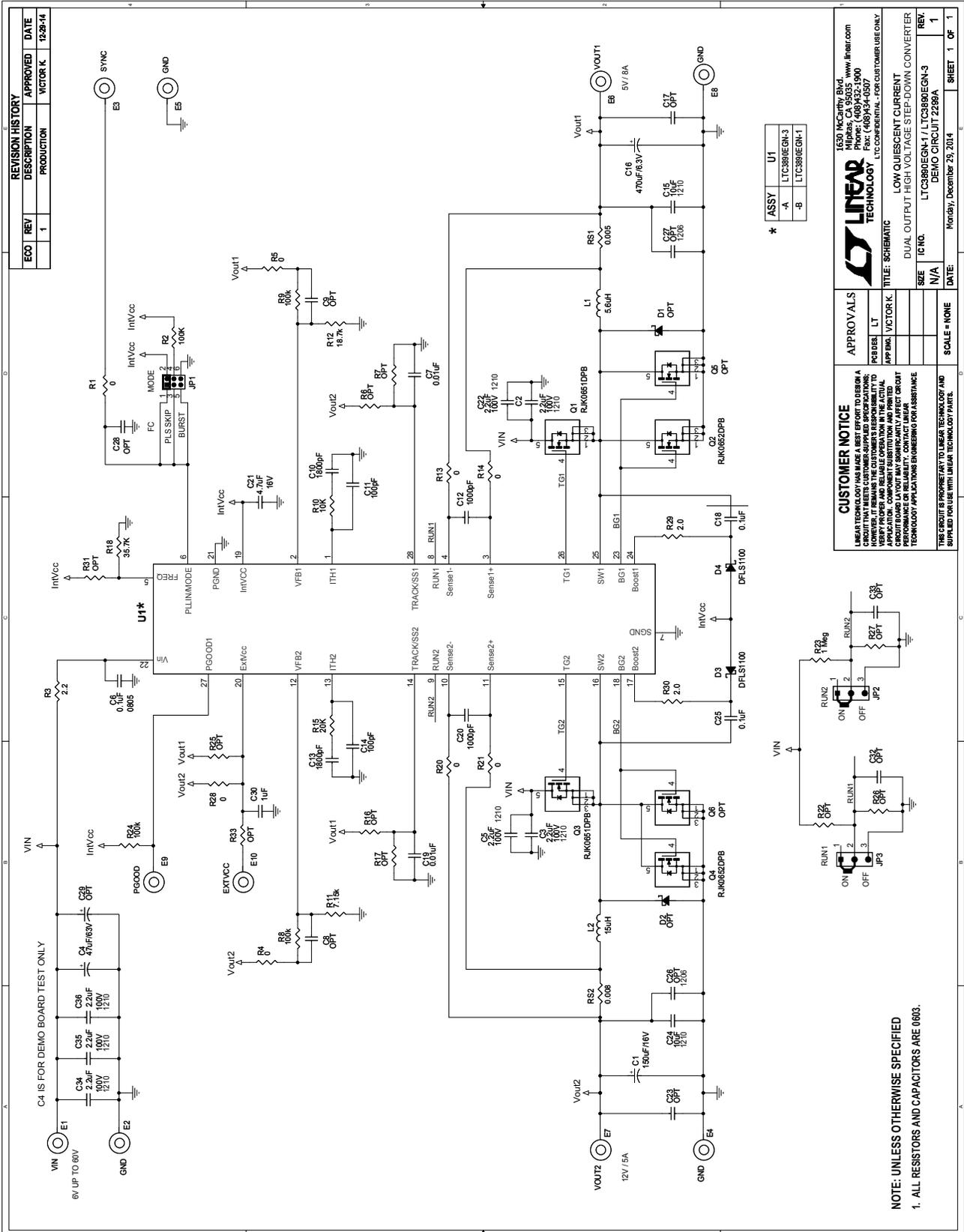
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	1	C1	CAP., POSCAP 150µF 16V 7343	PANASONIC, 16TQC150MYF
2	7	C2, C3, C5, C22, C34, C35, C36	CAP., X7R, 2.2µF 100V 10% 1210	TDK, C3225X7R1H225K
3	1	C4	CAP., ALUM., 47µF, 63V, 20%, 10 × 10.5	SUN ELEC., 63HVH47M
4	2	C18, C25	CAP., X7R, 0.1µF 50V 10% 0603	TDK, C1608X7R1H104K
5	1	C6	CAP., X7R, 0.1µF 100V 10%, 0805	MURATA, GCM21BR72A104KA37L
6	2	C7, C19	CAP., X7R, 0.01µF 100V 10% 0603	AVX, 06031C103KAT
8	2	C10, C13	CAP., NPO, 1800pF 50V 5% 0603	MURATA, GRM1885C1H182JA01D
9	2	C11, C14	CAP., NPO, 100pF 100V 10% 0603	AVX, 06031A101KAT
10	2	C12, C20	CAP., X7R, 1000pF 100V 10%, 0603	AVX, 06031C102KAT
11	2	C15, C24	CAP., X5R, 10µF 35V 20% 1210	TAIYO YUDEN, GMK325BJ106MN-T
12	1	C16	CAP., POSCAP 470µF 6.3V	PANASONIC, 6TPE470M
13	1	C21	CAP., X7R, 4.7µF 16V 10% 0805	AVX, 0805YC475KA
14	1	C30	CAP, X5R, 1µF 25V 10% 0603	AVX, 06033D105KAT2A
15	2	D3, D4	DIODE, SCHOTTKY, DFSL1100, DI-123	DIODES, INC.,DFLS1100
16	1	L1	IND., 5.6µH, 20%	COILCRAFT, XAL1010-562MED
17	1	L2	IND., 15µH, 20%	COILCRAFT, XAL1010-153MED
18	2	Q1, Q3	XSTR, POWER MOSFET LPAK	RENESAS ELECTRONIC, RJK0651DPB
19	2	Q2, Q4	XSTR, POWER MOSFET LPAK	RENESAS ELECTRONIC, RJK0652DPB
20	1	RS1	RES., 0.005Ω 1% 1/4W 1206	VISHAY, WSL12065L000FEA
21	1	RS2	RES., 0.008Ω 1% 1/4W 1206	VISHAY, WSL12068L000FEA
22	1	R18	RES., 35.7k 1% 0603	VISHAY, CRCW060335K7FKEA
23	2	R2, R24	RES., 100k 1% 0603	VISHAY, CRCW0603100KFKEA
24	1	R3	RES., 2.2Ω 1% 1206	VISHAY, CRCW12062R20FNEA
25	2	R8, R9	RES., 100k 1% 0805	VISHAY, CRCW0805100KFKEA
26	1	R10	RES., 10k 1% 0603	VISHAY, CRCW060310K0FKEA
27	1	R11	RES., 7.15k 1% 0603	VISHAY, CRCW06037K15FKEA
28	1	R12	RES., 18.7k 1% 0603	VISHAY, CRCW060318K7FKEA
29	1	R15	RES., 20k, 1%, 0603	VISHAY, CRCW060320K0FKEA
30	1	R23	RES., 1M 1% 0805	VISHAY, CRCW08051M00FKEA
31	2	R29, R30	RES., 2.0Ω 1% 0603	VISHAY, CRCW06032R00FKEA
32	1	U1, DC2299A-A	IC., LTC3890EGN-3, 28-PIN SSOP	LINEAR TECH., LTC3890EGN-3#PBF
33	1	U1, DC2299A-B	IC., LTC3890EGN-1, 28-PIN SSOP	LINEAR TECH., LTC3890EGN-1#PBF

# DEMO MANUAL DC2299A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Additional Demo Board Circuit Components</b>				
1	0	C8, C9, C17, C23, C28, C32, C33	CAP., OPT, 0603	OPT
2	0	C26, C27	CAP., OPT, 1210	OPT
3	0	C29	CAP., OPT, 10X12.5	OPT
4	2	D1, D2	DIODE, OPT, DI-123	OPT
5	0	Q5, Q6	XSTR, OPT LFPAK	OPT
6	8	R1, R4, R5, R13, R14, R20, R21, R28	RES., 0 $\Omega$ , 1% 0603	VISHAY, CRCW06030000Z0EA
7	0	R6, R7, R16, R17, R25-R27, R31, R33	RES., OPT 0603	OPT
8	0	R22	RES., OPT 0805	OPT
<b>Hardware</b>				
1	10	E1-E10	TESTPOINT, TURRET, 0.094"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	HEADER, 2 x 3 2mm	SULLINS, NRPN032PAEN-RC
3	2	JP2, JP3	HEADER, 1 x 3 2mm	SULLINS, NRPN031PAEN-RC
4	3	XJP1, XJP2, XJP3	SHUNT, 2mm	SAMTEC, 2SN-BK-G
5	4	MTGS AT 4 CORNERS	STANDOFF, NYLON 0.50	KEYSTONE, 8833(SNAP-ON)

SCHEMATIC DIAGRAM



REVISION HISTORY			
ECO	REV	DESCRIPTION	DATE
	1	PRODUCTION	1/28/14

ASSY	LT
-A	LTC3808GM-3
-B	LTC3808GM-1

**LINEAR TECHNOLOGY**  
 1630 McCarthy Blvd  
 Milpitas, CA 95035 www.linear.com  
 Phone: (408)432-1900  
 Fax: (408)434-0807  
 E-mail: LTC@linear.com; LTC@LSI.COM

**LINEAR TECHNOLOGY**  
 TITLE: SCHEMATIC  
 DUAL OUTPUT HIGH VOLTAGE STEP-DOWN CONVERTER  
 DEMO CIRCUIT 2299A

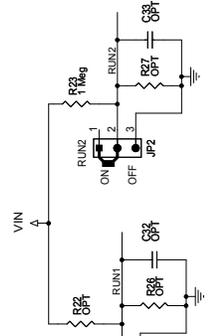
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DATE	Monday, December 23, 2014
REV.	1

APPROVALS  
 PDESIGN: LT  
 APPR: VICTOR.K.  
 SCALE = NONE

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# DEMO MANUAL DC2299A

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Linear Technology  
1630 McCarthy Blvd.  
Milpitas, CA 95035

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Тел: +7 (812) 336 43 04 (многоканальный)

Email: [org@lifeelectronics.ru](mailto:org@lifeelectronics.ru)