

## LTC3649 60V, Low IQ Monolithic High Efficiency Step-Down Regulator

### DESCRIPTION

Demonstration circuit 2112A is a high input voltage, high efficiency synchronous monolithic buck converter featuring the LTC3649 in a 28-lead UFD package. The DC2112A has wide input voltage range from 3.1V up to 60V. The output voltage of the DC2112A can be set as to 3.3V or 5V. However, the “USER SELECT” option of DC2112A allows output voltage to be as high as input voltage minus 0.5V, with certain modifications. DC2112A is capable of delivering up to 4A of output current. DC2112A supports three operation modes: Fixed-Frequency modulation and Burst Mode, user can synchronize it with an external clock also. Fixed-Frequency mode of operation maximizes the output current, reduces output voltage ripple, and yields a low noise switching spectrum. Burst Mode employs a variable frequency switching algorithm that minimizes the no-load input quiescent current and improves efficiency at light loads.

The DC2112A consumes less than 15 $\mu$ A of quiescent current during shutdown and it consumes less than 440 $\mu$ A at no load conditions in Burst Mode of operation. The DC2112A has a standard operating frequency of 500kHz, but can be adjusted in a range between 300kHz and as high as 3MHz. DC2112A is a monolithic step-down converter, LTC3649 integrates top and bottom N-channel MOSFETs, significantly reducing circuit footprint. DC2112A was designed to support multiple footprints of input/output capacitors and inductor to accommodate variety of applications. The data sheet of LTC3649 gives a complete description functionality of this regulator; also contains operation and application information and must be read in conjunction with this demo board manual for DC2112A.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2112A>**

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

PARAMETER	CONDITIONS	VALUE
Minimum Input Voltage		4V
Maximum Input Voltage		60V
Output Voltage $V_{OUT}$ Regulation	$V_{IN} = 4V - 60V$	$5V \pm 2\%$ or $3.3V \pm 2\%$
Maximum Continuous Output Current	$V_{OUT}$	4A
Preset Operating Frequency	$R10 = 200k\Omega$	500kHz
External Clock Sync. Frequency Range		300kHz – 3MHz
Efficiency	$V_{IN} = 12V, V_{OUT} = 5V$ $V_{IN} = 12V, V_{OUT} = 3.3V$	Up to 95% Up to 95%
Typical Output Ripple $V_{OUT}$	$V_{IN} = 12V, V_{OUT} = 5V, I_{OUT} = 4A$ (2MHz BW)	<15mV <sub>P-P</sub>
Quiescent Current at Shutdown	$V_{IN} = 4V - 60V$	<14 $\mu$ A
Input Current at No Load	$V_{IN} = 4V - 60V$ , Burst Mode	<430 $\mu$ A

## QUICK START PROCEDURE

Demonstration circuit 2112A is easy to set up to evaluate the performance of the LTC3649. For proper measurement equipment configuration, set up the circuit according to the diagram in Figure 1. Before proceeding to test, insert shunt into JP2 (RUN) into OFF position, which connects the RUN pin to ground (GND), and thus, shutdown the output. Set jumper JP1 (MODE) into FCC (Forced Counties Conduction Mode) position. Set jumper JP3 ( $V_{OUT}$ ) into 5.0V 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 DC2112A set up according to the proper measurement and equipment in Figure 1, apply 12V 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 14 $\mu$ A, or less, in shutdown.
2. Turn on  $V_{OUT}$  of the circuit by inserting the shunt in header JP2 (RUN) into the ON position. The output

voltage should be regulating. Measure  $V_{OUT}$  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  $V_{OUT}$  load, which should not exceed 4A. Vary the input voltage from 6V to 55V, the  $V_{OUT}$  it should measure 5.0V  $\pm$ 2%.

3. Set JP2 (RUN) into OFF and then jumper JP3 ( $V_{OUT}$ ) into 3.3V position.
4. Turn on  $V_{OUT2}$  of the circuit by inserting the shunt in header JP2 (RUN) into the ON position. The output voltage should be regulating. Measure  $V_{OUT}$  it should measure 3.3V  $\pm$ 2% (Do not apply more than the rated maximum voltage of 60V to the board or the part may be damaged). Vary the  $V_{OUT}$  load, which should not exceed 4A. Vary the input voltage from 16- 55V, the  $V_{OUT}$  it should measure 3.3V  $\pm$ 2%
5. Set output current to zero and move jumper JP1 (MODE) into BURST position and measure  $V_{OUT}$  for 3.3V.
6. Set output current to zero and move jumper JP1 (MODE) into BURST position and measure  $V_{OUT}$  for 5.0V.

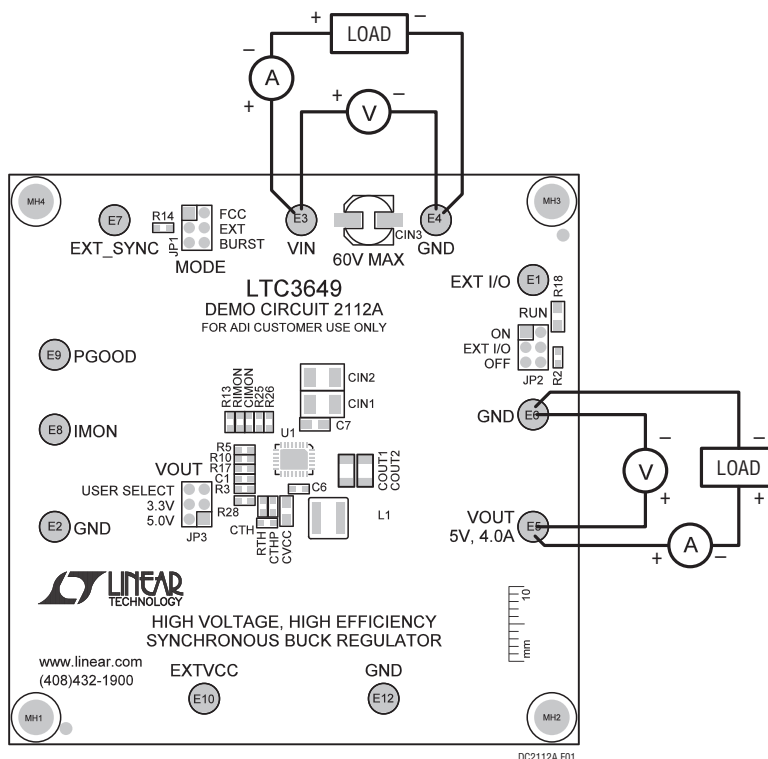
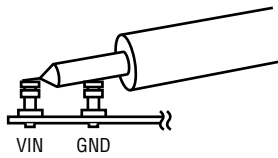
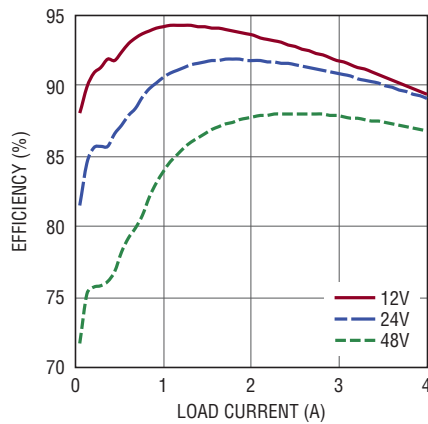


Figure 1. Proper Measurement Equipment Setup

**QUICK START PROCEDURE**

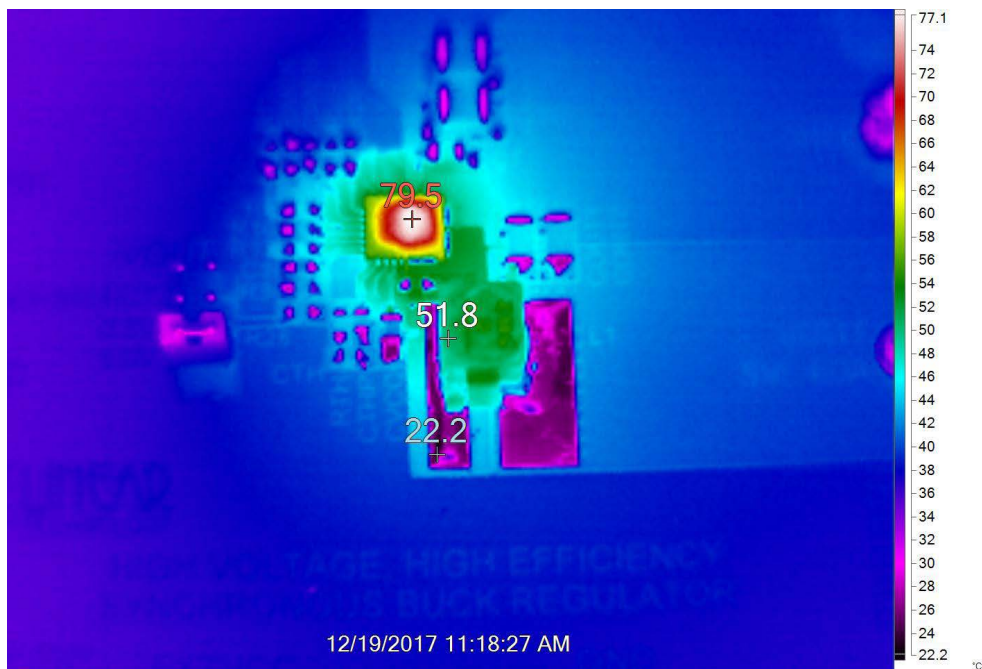


**Figure 2. Measuring Input or Output Ripple**



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**Figure 3. Efficiency vs Input Voltage and Load Current,  $V_{OUT}$  5V, Burst Mode Operation**



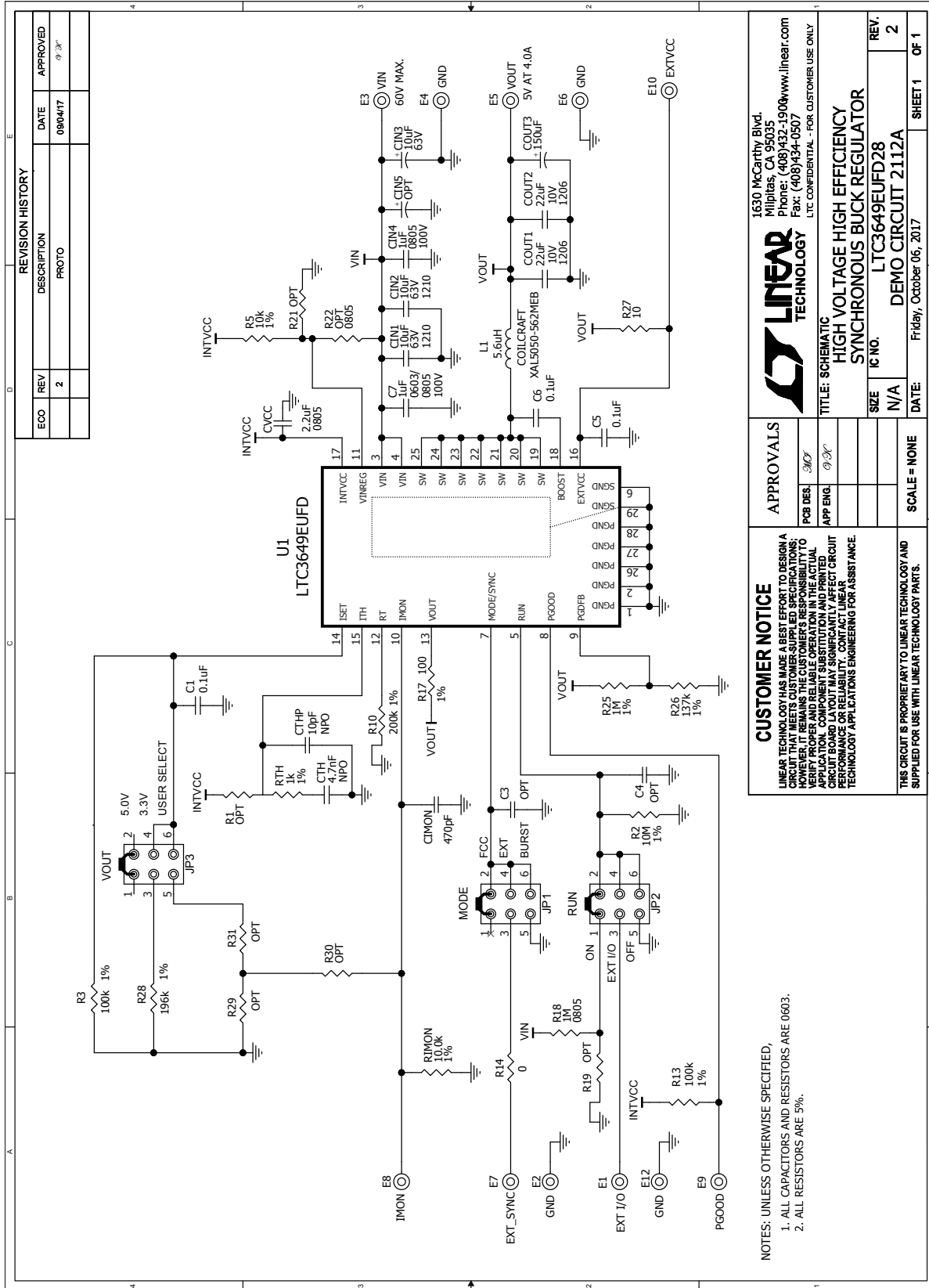
**Figure 4. Thermal Map,  $V_{IN}$  14V,  $I_{OUT}$  1 5V at 4A, No Air Flow**

# DEMO MANUAL DC2112A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	2	CIN1, CIN2	CAP, 1210 10 $\mu$ F 10% 63V X7R	MURATA GRM32ER71J106KA12L
2	1	CIN3	CAP, 10 $\mu$ F 20% 63V ELEC	SUN ELECT. 63CE10KX
3	2	CIN4, C7	CAP, 0805 1 $\mu$ F 10% 100V X7S	TDK C2012X7S2A105K
4	2	COUT1, COUT2	CAP, 1210 22 $\mu$ F 10% 25V X7R	MURATA GRM32ER71E226KE15L
5	1	COUT3	CAP, 3528 150 $\mu$ F 20% 6.3V POSCAP	PANASONIC 6TPE150MAZB
6	1	CTH	CAP, 0603 4700pF 10% 25V X7R	AVX 06033C472KAT2A
7	1	CTHP	CAP, 0603 10pF 5% 25V C0G	AVX 06033A100JAT2A
8	1	CVCC	CAP, 0805 2.2 $\mu$ F 10% 16V X7R	AVX 0805YC225KAT2A
9	1	C1	CAP, 0603 0.01 $\mu$ F 10% 50V X7R	AVX 06035C103KAT4A
10	1	C5	CAP, 0603 1 $\mu$ F 10% 16V X5R	AVX 0603YD105KAT2A
11	1	C6	CAP, 0603 0.1 $\mu$ F 10% 50V X7R	AVX 06035C104KAT2A
12	1	L1	IND, 5.6 $\mu$ H	COILCRAFT XAL5050-562MEB
13	1	RIMON	RES, 0603 10k $\Omega$ 1% 1/10W	VISHAY CRCW060310K0FKEA
14	1	RTH	RES, 0603 1.0k $\Omega$ 1% 1/10W	VISHAY CRCW06031K00FKEA
15	1	R2	RES, 0603 10M $\Omega$ 1% 1/10W	VISHAY CRCW060310M0FKEA
16	1	R3	RES, 0603 100k $\Omega$ 1% 1/10W	VISHAY CRCW0603100KFKEA
17	1	R5	RES, 0603 10k $\Omega$ 5% 1/10W	VISHAY CRCW060310K0JNEA
18	1	R10	RES, 0603 340k $\Omega$ 1% 1/10W	VISHAY CRCW0603340KFKEA
19	1	R13	RES, 0603 100k $\Omega$ 5% 1/10W	VISHAY CRCW0603100KJNEA
20	1	R14	RES, 0603 0 $\Omega$ JUMPER	VISHAY CRCW06030000Z0EA
	1	R17	RES, 0603 100 $\Omega$ 1% 1/10W	VISHAY CRCW0603100RFKEA
21	1	R18	RES, 0805 1M $\Omega$ 1% 1/8W	VISHAY CRCW08051M00FKEA
22	1	R25	RES, 0603 1M $\Omega$ 1% 1/10W	VISHAY CRCW06031M00FKEA
	1	R27	RES, 0603 10 $\Omega$ 1% 0.1W	VISHAY CRCW060310R0FKEA
23	1	R26	RES, 0603 137k $\Omega$ 1% 0.063W	VISHAY CRCW0603137KFKEA
24	1	R28	RES, 0603 196k $\Omega$ 1% 1/10W	VISHAY CRCW0603196KFKEA
25	1	U1	IC, SYNCHRONOUS BUCK REGULATOR	LINEAR TECH. LTC3649EUFD#PBF
<b>Additional Demo Board Circuit Components</b>				
		R1, R19, R21, R29, R30, R31	RES, 0603 OPTION	OPTION
		R22	RES, 0805 OPTION	VISHAY CRCW08051M00FKEA
		C3, C4	CAP, 0603 OPTION	OPTION
		CIN5	CAP, OPTION	OPTION
<b>Hardware: For Demo Board Only</b>				
	11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E12	TURRET	MILL MAX 2501-2-00-80-00-00-07-0
	3	JP1, JP2, JP3	HEADER, 3-PIN, DBL ROW 2mm	SULLINS, NRPN032PAEN
	4	MH1, MH2, MH3, MH4	STANDOFF, SNAP ON	KEYSTONE 8833
	3	XJP1, XJP2, XJP3	SHUNT	SAMTEC 2SN-BK-G

**SCHEMATIC DIAGRAM**



REVISION HISTORY			
ECO	REV	DESCRIPTION	DATE
	2	PROTO	09/04/17
			07/13*

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**LINEAR TECHNOLOGY**

TITLE: SCHEMATIC  
**HIGH VOLTAGE HIGH EFFICIENCY SYNCHRONOUS BUCK REGULATOR**

SIZE: N/A  
IC NO.: LTC3649EUF28

SCALE = NONE  
DATE: Friday, October 06, 2017

REV. 2

SHEET 1 OF 1

**CUSTOMER NOTICE**  
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THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

- NOTES: UNLESS OTHERWISE SPECIFIED,  
1. ALL CAPACITORS AND RESISTORS ARE 0603.  
2. ALL RESISTORS ARE 5%.



## 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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