LTC3862-2 Low Noise PolyPhase® SEPIC DC/DC Converter

DESCRIPTION

Demonstration circuit 1891A is a 2-phase high efficiency nonisolated SEPIC (single ended primary inductor converter) converter featuring the LTC®3862-2 switching controller. The DC1891A converts a 6V to 60V input to a 12V output and provides 6A of output current. The converter operates at 300kHz (600kHz output ripple) with efficiency around 90%. With a proper amount of airflow, the DC1891A converter can generate over 6A of output current. The DC1891A can be easily modified to generate output voltages in the range from 0.8V to 48V.

Also, the DC1891A can be optimized for specific input voltages. The narrowing of input voltage range can increase the converter's efficiency. Therefore, a narrow input voltage range is more desirable.

The LTC3862-2 can be synchronized to an external clock of up to 400kHz. Please refer to LTC3862-2 data sheet for design details and applications information.

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

PERFORMANCE SUMMARY Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	VALUE
Minimum Input Voltage	I_{OUT} = 0A to 6A	6V
Maximum Input Voltage	I_{OUT} = 0A to 6A	60V
V_{OUT}	V_{IN} = 6V to 60V, I_{OUT} = 0A to 6A	12V ±3%
Typical Output Ripple V_{OUT}	V_{IN} = 6V to 60V, I_{OUT} = 0A to 6A	100mV_{P-P}
Nominal Switching Frequency		300kHz

QUICK START PROCEDURE

Demonstration circuit 1891A is easy to set up to evaluate the performance of the LTC3862-2 circuit. 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. See Figure 2 for the proper scope probe technique.

1. With power off, connect the input power supply to V_{IN} and GND. Make sure that the input power supply has sufficient current rating at minimum input voltage for the required output load.
2. Turn on the power at the input.

   NOTE: Make sure that the input voltage does not exceed 60V.
3. Check for the proper output voltage.

   V_{OUT} = 12V, ±3%.

   If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
4. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.
5. The DC1891A is equipped with an input capacitor C_{IN4} that is optional and is used to help with filtering when the board is connected to the lab supply with long leads. The capacitor C_{IN4} can be removed if the input power source is close and has low source impedance.

CHANGING THE OUTPUT VOLTAGE

To set the output voltage lower or higher than 12V, change the bottom voltage divider resistor connected to the FB pin of U1 (see the Schematic Diagram). Also, check the MOSFET, output diode and capacitor voltage ratings if the output voltage is set higher than 12V.

The optional Q5 circuit is used to get the circuit running. Once the circuit is running, the 12V output is used to bias U1 via D2. The start-up circuit Q5 is turned off by Q6 when V_{OUT} gets to the level set by D3, R14 and R16 that activates Q6. Please contact the LTC factory for details.

QUICK START PROCEDURE

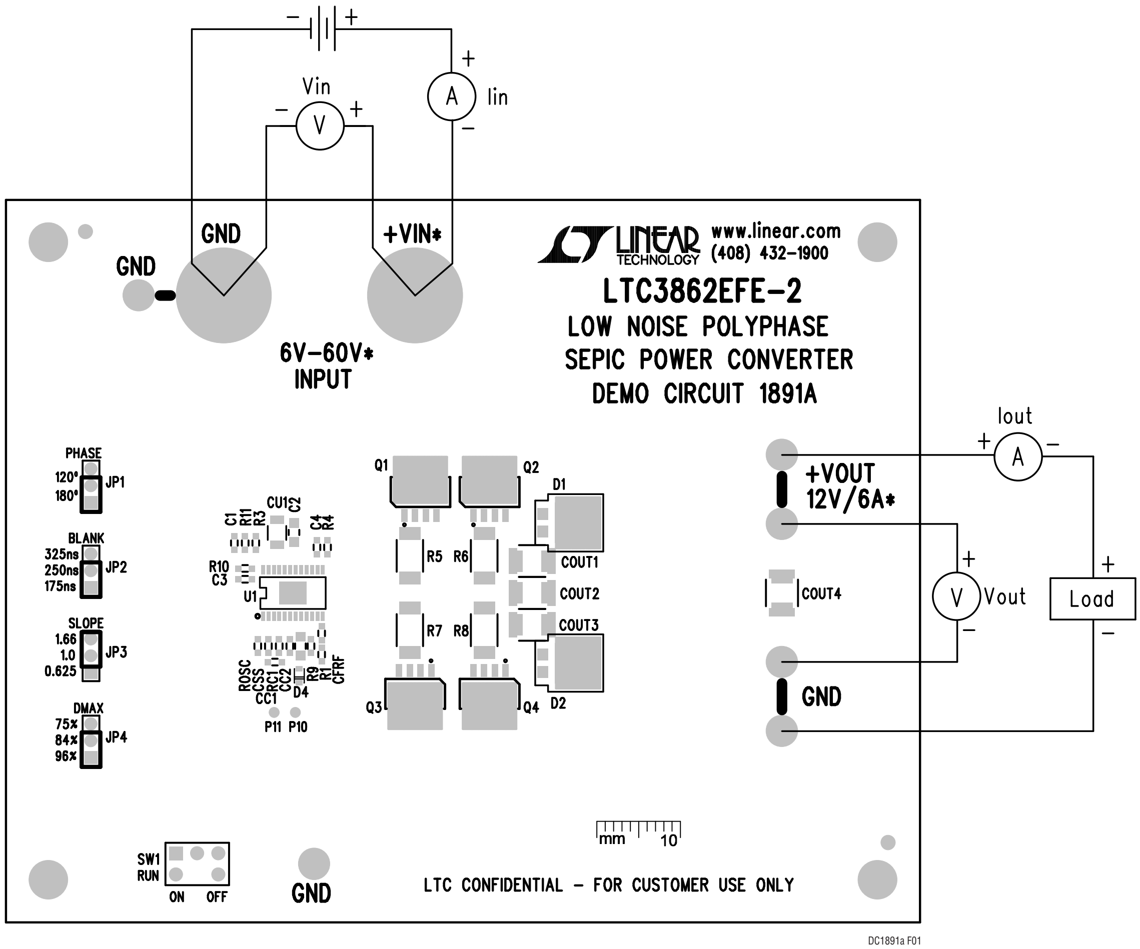


Figure 1. Proper Measurement Equipment Setup

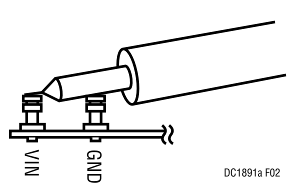


Figure 2. Measuring Input or Output Ripple

QUICK START PROCEDURE

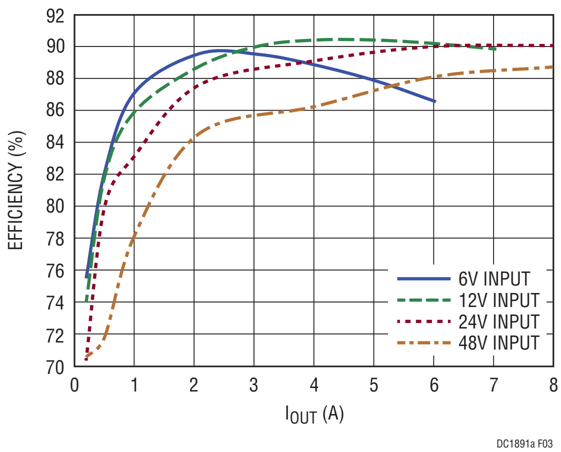


Figure 3. Reducing the Input Voltage Range and Selecting More Optimal MOSFET, Diode and Inductor Can Optimize the Efficiency of DC1891A

OUTPUT LOAD STEP RESPONSE

The load step response of DC1891A is very fast even though a relatively small amount of output capacitance is present (188µF ceramic and 440µF electrolytic). The load step transients are shown in Figure 4. To improve load step response further or to reduce the output ripple, more output capacitance can be added. Low ESR output capacitors will have the greatest effect on reducing the ripple and load step transients.

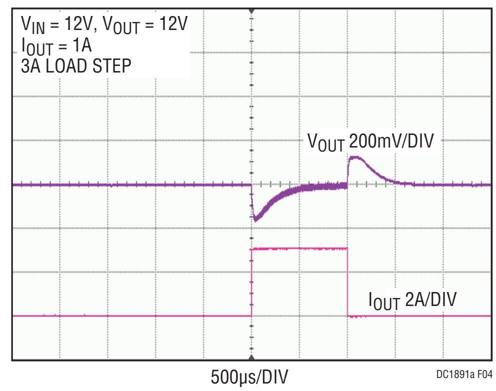


Figure 4. Fast Transient Response of DC1891A is Achieved with a Small Amount of Output Capacitance

SOFT-START FUNCTION

The DC1891A features a soft-start circuit that controls the inrush current and output voltage ramp at start-up. The capacitor C_{SS} controls the start-up period. The start-up waveforms are shown in Figure 5.

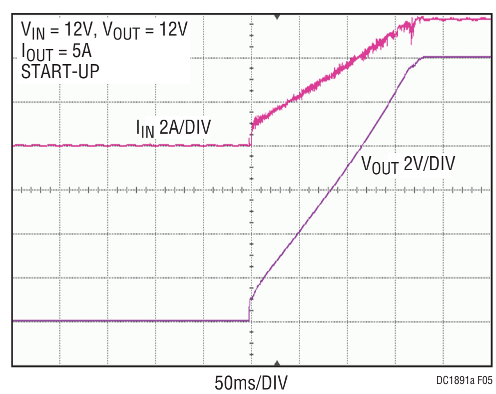


Figure 5. The DC1891A Ramps the Output Slowly at Start-Up without Generating an Input Current Surge

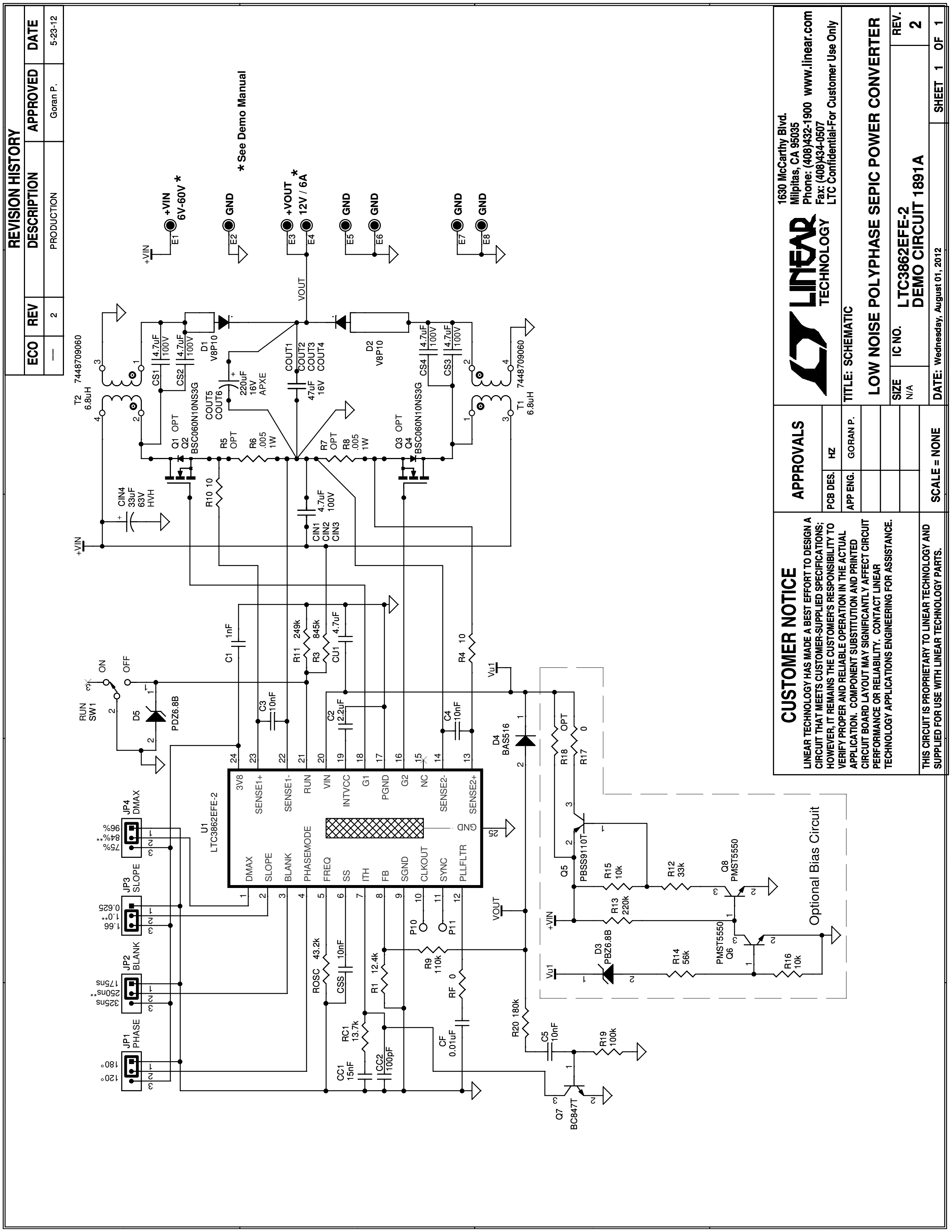
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CC2	CAP, NPO 100pF, 25V, 5%, 0603	AVX 06033A101JAT2A
2	4	C3, C4, CSS, C5	CAP, X7R 0.01µF 25V 10% 0603	AVX 06033C103KAT2A
3	1	CC1	CAP, X5R 0.015µF 25V 10% 0603	AVX 06033D153KAT2A
4	1	C1	CAP, NPO 1000pF 25V 10% 0603	AVX 06033A102JAT2A
5	1	C2	CAP, X5R, 2.2µF, 25V, 10%, 0805	AVX 08053D225KAT2A
6	1	CIN4	CAP, 33µF, 63V	SUN ELECT, 63HVH33MS
7	1	CU1	CAP, X7R 4.7µF 50V 10% 1206	MURATA GRM31CR71H475KA12L
8	7	CS1 TO CS4, CIN1 TO CIN3	CAP, X7S 4.7µF 100V 20% 1812	TDK C4532X7S2A475M
9	4	COUT1 TO COUT4	CAP, X7S 47µF 16V 20% 1812	TDK CKG45NX7S1C476M
10	2	COUT5, COUT6	CAP, 220µF 16V APXE	UNITED CHEMI-CON APX160ARA221MHA0G
11	1	CF	CAP, X7R 0.01µF 16V 10% 0603	AVX 0603YC103KAT2A
12	2	D3, D5	ZENER DIODE, SOD-323	NXP SEMI PDZ6.8B
13	1	D4	DIODE, SOD-523	NXP SEMI BAS516
14	2	D1, D2	SCHOTTKY RECTIFIER, TO-277A	VISHAY V8P10-M3/86A
15	2	Q2, Q4	POWER MOSFET, PG-TDSON-8	INFINEON BSC060N10NS3G
16	1	Q5	PNP TRANSISTOR, SOT-23	NXP SEMI PBSS9110T
17	2	Q6, Q8	NPN TRANSISTOR, SOT-323	NXP SEMI PMST5550
18	1	Q7	NPN TRANSISTOR, SC-75	NXP SEMI BC847T
19	1	RC1	RES, CHIP 13.7k, 1% 0603	VISHAY CRCW060313K7FKEA
20	1	ROSC	RES, CHIP 43.2k, 1% 0603	VISHAY CRCW060343K2FKED
21	2	R4, R10	RES, CHIP 10Ω 5% 0603	VISHAY CRCW060310R0JNEA
22	2	RF, R17	RES, CHIP 0Ω, Jumper 0603	VISHAY CRCW06030000Z0EA
23	1	R9	RES, CHIP 110k, 1% 0805	VISHAY CRCW0805110KFKEA
24	1	R1	RES, CHIP 12.4k, 1% 0603	VISHAY CRCW060312K4FKEA
25	1	R3	RES, CHIP 845k, 1% 0603	VISHAY CRCW0603845KFKEA
26	1	R11	RES, CHIP 249k, 1% 0603	VISHAY CRCW0603249KFKEA
27	2	R6, R8	RES, 0.005Ω, 1/2W, 1%, 2010	VISHAY WSL20105L000FEA
28	1	R12	RES, CHIP 33k, 1% 0603	VISHAY CRCW060333K0FKEA
29	1	R13	RES, CHIP 220k, 1% 0603	VISHAY CRCW0603220KFKEA
30	1	R14	RES, CHIP 56k, 1% 0603	VISHAY CRCW060356K0FKEA
31	2	R15, R16	RES, CHIP 10k, 1% 0603	VISHAY CRCW060310K0FKEA
32	1	R19	RES, CHIP 100k, 1% 0603	NIC NRC06F1003TRF
33	1	R20	RES, CHIP 180k, 1% 0603	VISHAY CRCW0603180KFKEA
34	2	T1,T2	COUPLED INDUCTOR, 6.8µH	WÜRTH 7448709068
35	1	U1	PWM CONTROLLER LTC3862EFE-2	LINEAR TECHNOLOGY LTC3862EFE-2

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	0	Q1, Q3 (OPT)	MOSFET, PG-TDSON-8	
2	0	R18 (OPT)	RES, CHIP 0603	
3	0	R7, R5 (OPT)	RES, CHIP 2010	
Hardware: For Demo Board Only				
1	6	E3 TO E8	TESTPOINT, TURRET, 0.094"	MILL-MAX 2501-2-00-80-00-00-07-0
2	2	E1, E2	STUD, TEST PIN	PEM KFH-032-10ET
3	4	E1, E2 (2 each)	NUT BRASS, # 10-32 M/S BR PL	ANY 10-32
4	2	E1, E2	RING, LUG # 10	KEYSTONE, 8205
5	2	E1, E2	WASHER #10, TIN PLATED BRASS	ANY #10EXT BZ TN
6	4	JP1 TO JP4	HEARDER, 3PIN 1 ROW 0.079CC	SULLINS NRPN031PAEN-RC
7	4	JP1 TO JP4	SHUNT, 0.079" CENTER	SAMTEC 2SN-BK-G
8	1	SW1	SWITCHE, SEALED TOGGLE	C&K GT11MCBE (THRU-HOLE)
9	4	STAND-OFF	STAND-OFF, NYLON 0.50" TALL	KEYSTONE 8833(SNAP ON)
10	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1891A

SCHEMATIC DIAGRAM



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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology

1630 McCarthy Blvd.

Milpitas, CA 95035

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 ● FAX: (408) 434-0507 ● www.linear.com

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