LTC3894
150V Low I_Q Step-Down DC/DC Converter with 100% Duty Cycle Capability

DESCRIPTION

Demonstration circuit 2506A is a high voltage, current-mode DC/DC step-down converter featuring the LTC3894.

The board operates from an input range of 6V to 150V, and provides a 5V, 3A output. The PMOSFET architecture allows it to operate seamlessly up to 100% duty cycle, and function as a saturated switch below the regulation threshold. This application has undervoltage lockout programmed for a 6V minimum input to assure adequate gate drive for the MOSFET. It operates at 150kHz and may be synchronized to an external clock. A soft-start feature controls output voltage slew rate at start-up, reducing current surge and voltage overshoot. Burst Mode operation that improves efficiency at light loads can be enabled with a jumper. A power good output signal is provided.

This board is suitable for a wide range of automotive, telecom, industrial, and other applications. The LTC3894 is available in a thermally enhanced 20-pin TSSOP package with skipped leads to accommodate high voltage creepage and clearance requirements. For other output requirements, see the LTC3894 data sheet or contact the LTC factory.

Design files for this circuit board are available at http://www.analog.com/DC2506A

PERFORMANCE SUMMARY Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		6		150	V
V_{OUT}	Output Voltage			5		V
I_{OUT}	Output Current Range, Continuous	Free Air	0		3	A
f_{SW}	Switching (Clock) Frequency			150		kHz
$V_{OUT\ P-P}$	Output Ripple	V_{IN} = 48V, I_{OUT} = 3A (20MHz BW)		20		$mV_{P–P}$
I_{REG}	Output Regulation	Line and Load ($6V_{IN}$ to $150V_{IN}$, $0A_{OUT}$ to $3A_{OUT}$)		±0.3		%
P_{OUT}/P_{IN}	Efficiency (see Figure 3)	V_{IN} = 12/24/48V, I_{OUT} = 3A		88/85/82		%
	Approximate Size	Component Area x Top Component Height		34 × 26 × 5		mm

QUICK START PROCEDURE

CAUTION, SHOCK HAZARD: CONTACT WITH HIGH VOLTAGE CAN RESULT IN A DANGEROUS ELECTRIC SHOCK.

Demonstration circuit 2506 is easy to set up to evaluate the performance of the LTC3894. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE: When measuring the output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip and ground ring directly across the last output capacitor as shown in Figure 1.

1. Set an input power supply that is capable of 6V to 150V to 6V. Then turn off the supply.
2. With power off, connect the supply to the input terminals $+V_{IN}$ and $–V_{IN}$.
   a. Input voltages lower than 6V can keep the converter from turning on due to the undervoltage lockout feature of the LTC3894.
   b. If efficiency measurements are desired, an ammeter capable of measuring 4ADC or a resistor shunt can be put in series with the input supply in order to measure the DC2506A's input current.
   c. A Voltmeter with a capability of measuring at least 150V can be placed across the input terminals in order to get an accurate input voltage measurement.
3. Turn on the power at the input.

   NOTE: Make sure that the input voltage never exceeds 150V.
4. Check for the proper output voltage of 5V. Turn off the power at the input.
5. Once the proper output voltage is established, connect a variable load capable of sinking 3A at 5V to the output terminals $+V_{OUT}$ and $–V_{OUT}$. Set the current for 0A.
   a. If efficiency measurements are desired, an ammeter or a resistor shunt that is capable of handling 3ADC can be put in series with the output load in order to measure the DC2506A's output current.
   b. A Voltmeter with a capability of measuring at least 5V can be placed across the output terminals in order to get an accurate output voltage measurement.
6. Turn on the power at the input.

   NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
7. Once the proper output voltage is again established, adjust the load and/or input within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other desired parameters.

QUICK START PROCEDURE

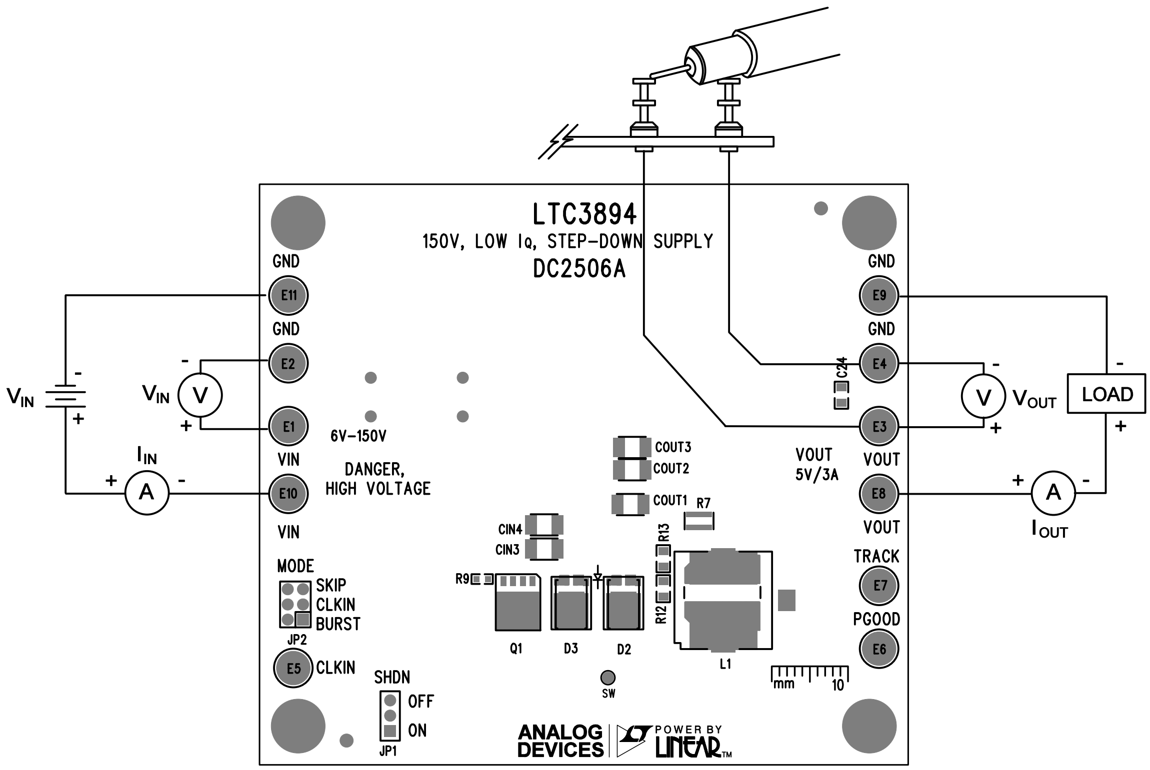


Figure 1. Proper Measurement Equipment Setup

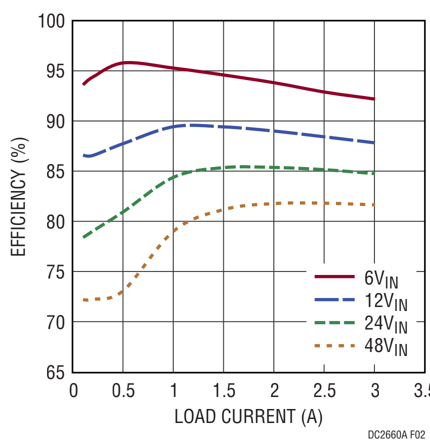


Figure 2. Efficiency with Burst Mode at Light Loads

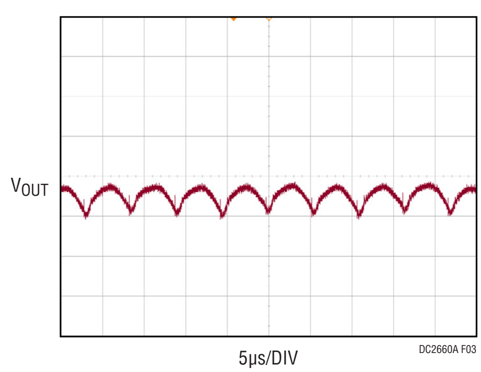


Figure 3. Output Ripple at $48V_{IN}$ and $3A_{OUT}$ (20mV, 5µs/DIV, 20MHz)

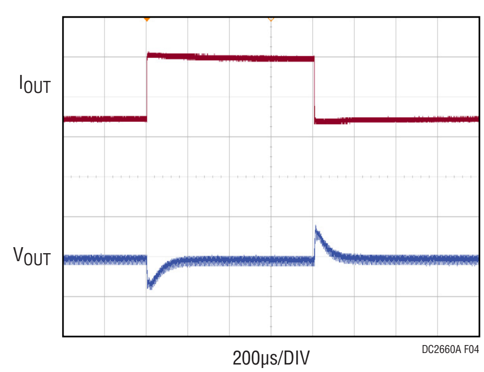
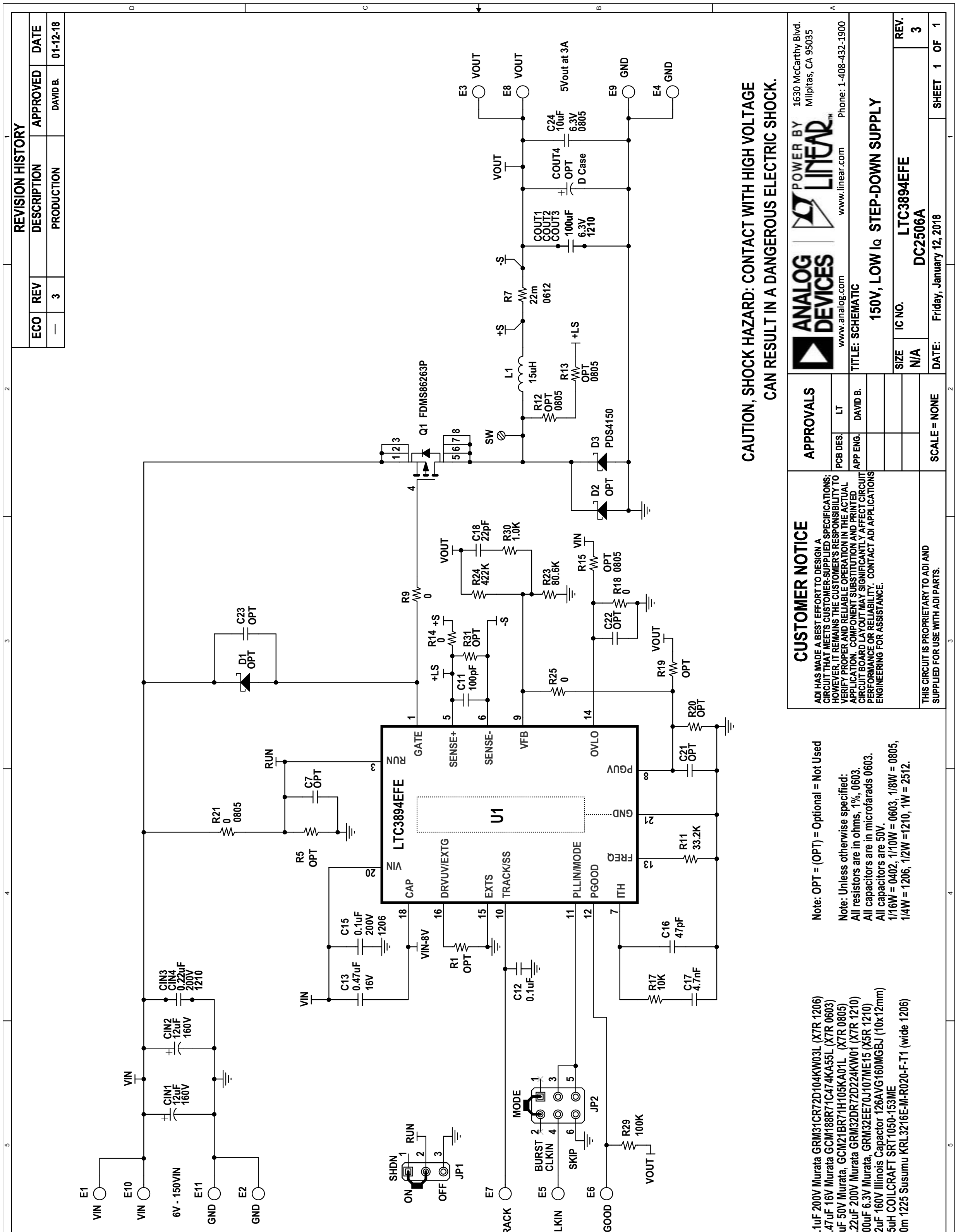


Figure 4. Transient Response Waveform at $48V_{IN}$ and $1.5–3–1.5A_{OUT}$ (1A, 100mV, 200µs/DIV)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	CIN1, CIN2	CAP., ALUM, TH,12µF, 160V, 10X12	ILLINOIS CAPACITOR, 126AVG160MGBJ
2	2	CIN3, CIN4	CAP., X7R, 0.22µF, 200V, 10%, 1210	MURATA, GRM32DR72D224KW01
3	3	COUT1, COUT2, COUT3	CAP., X5R, 100µF, 6.3V, 20%, 1210	MURATA, GRM32ER60J107ME20L
4	1	C11	CAP., COG, 100pF, 50V, 5%, 0603	MURATA, GCM1885C1H100JA16D
5	1	C12	CAP., X7R, 0.1µF, 50V, 10%, 0603	MURATA, GCM188R71H104KA57D
6	1	C13	CAP., X7R, 0.47µF, 16V, 10%, 0603	MURATA, GCM188R71C474KA55D
7	1	C15	CAP., X7R, 0.1µF, 200V, 10%, 1206	MURATA, GCM31CR72D104KW03L
8	1	C16	CAP., COG, 47pF, 50V, 5%, 0603	MURATA, GCM1885C1H47JA16D
9	1	C17	CAP., COG, 4700pF, 50V, 5%, 0603	MURATA, GCM1885C1H472JA16D
10	1	C18	CAP., COG, 22pF, 50V, 5%, 0603	MURATA, GCM1885C1H220JA16D
11	1	C24	CAP., X7R, 10µF, 6.3V, 10%, 0805	MURATA, GRM21BR70J106KE76L
12	1	D3	SCHOTTKY DIODE, 150V, 4A, POWERDI5	DIODES INC., PDS4150-13
13	1	L1	INDUCTOR, 15µH	COILCRAFT, SRT1050-153ME
14	1	Q1	MOSFET, P-CHAN.,150V, SO8-POWERPAK	FAIRCHILD, FDMS86263P
15	1	R7	RES SENSE., 22mΩ, 1W, 1%, 0612	SUSUMU, KRL3216E-C-R022-F-T1
16	1	R11	RES., 33.2k, 1/10W, 1%, 0603	VISHAY, CRCW060333K2FKEA
17	1	R17	RES., 10k, 1/0W, 1%, 0603	VISHAY, CRCW060310KFKEA
18	1	R23	RES., 80.6k, 1/10W, 1%, 0603	VISHAY, CRCW060380K6FKEA
19	1	R24	RES., 422k, 1/10W, 1%, 0603	VISHAY, CRCW0603422KFKEA
20	1	R29	RES., 100k, 1/10W, 1%, 0603	VISHAY, CRCW0603100KFKEA
21	1	R30	RES., 1k, 1/10W, 1%, 0603	VISHAY, CRCW06031KFKEA
22	1	U1	IC, LTC3894EFE TSSOP20EFE-16	LINEAR TECH.CORP. LTC3894EFE#PBF
Additional Demo Board Circuit Components				
1	0	COUT4	CAP., TANT, OPT, 7343	OPT
2	0	C7, C21, C22, C23	CAP., OPT 0603	OPT
3	0	D1	SCHOTTKY DIODE, OPT, SOD123	OPT
4	0	D2	SCHOTTKY DIODE, OPT, POWERDI5	OPT
5	0	R1, R5, R19, R20, R31	RES., OPT, 0603	OPT
6	0	R12, R13, R15	RES., OPT, 0805	OPT
7	5	R9, R14, R18, R21, R25	RES., 0Ω, 1/10W, 0603	VISHAY, CRCW06030000Z0EA
8	1	R21	RES., 0Ω, 1/10W, 0805	VISHAY, CRCW08050000Z0EA
Hardware: For Demo Board Only				
1	11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11	TESTPOINT, TURRET, .094"	MILL MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	CONN., HEADER, 1×3, 2mm	WURTH ELEKTRONIK, 62000311121
3	1	JP2	CONN., HEADER, 2×3, 2mm	WURTH ELEKTRONIK, 62000621121
4	2	XJP1, XJP2	SHUNT, 2mm	WURTH ELEKTRONIK, 60800213421
5	4	MTGS AT 4 CORNERS	STAND-OFF, SNAP ON NYLON 0.50" TALL	KEYSTONE, 8833(SNAP ON)

SCHEMATIC DIAGRAM



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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