LTC7860
High Efficiency Switching Surge Stopper/EMI Filter

DESCRIPTION

Demonstration circuit 2239A is a High Efficiency Switching Surge Stopper and EMI Filter featuring the LTC®7860.

The board operates from an input range of 3.5V to 60V, provides a 3.5V to 17.2V output at 0A to 5A and is output current limited. A soft-start feature controls output voltage slew rate at start-up, reducing current surge and voltage overshoot. The demonstration board has options for smaller MOSFET and diode packages on the back of the board for lower output current requirements.

The LTC7860 high efficiency surge stopper protects loads from high voltage transients. High efficiency compared to linear circuits permits higher currents and smaller solution sizes. During an input overvoltage event, such as a load dump in vehicles, the LTC7860 controls the gate of an external MOSFET to act as a switching DC/DC regulator (PROTECTIVE PWM mode). This operation regulates the output voltage to a safe level, allowing the loads to operate through the input over-voltage event. During normal operation (SWITCH-ON mode), the LTC7860 turns on the external MOSFET continuously, passing the input voltage through to the output with minimum power loss.

In addition, the output inductor and capacitor form an L-C EMI filter when in SWITCH-ON mode. An internal comparator limits the voltage across the current sense resistor and regulates the maximum output current to protect against overcurrent faults. An adjustable timer limits the time that the LTC7860 can spend in overvoltage or overcurrent regulation. When the timer expires, the external MOSFET is turned off until the LTC7860 restarts after a cool down period. By strictly limiting the time in PROTECTIVE PWM Mode when the power loss is higher, the components and thermal design can be optimized for normal operation and safely operate through high voltage input surges and/or overcurrent faults.

This board is suitable for a wide range of automotive, telecom, industrial, and other applications. The LTC7860 is available in a Small 12-Pin Thermally Enhanced MSOP Package. For other output requirements, see the LTC7860 data sheet or contact the LTC factory.

Design files for this circuit board are available at http://www.linear.com/demo/DC2239A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range		3.5		60	V
V_{OUT}	Output Voltage		3.5	14	17.5	V
I_{OUT}	Output Current Range, Continuous	Free Air	0		5	A
$V_{IN} – V_{OUT}$	Insertion Loss	V_{IN} =14V, I_{OUT} = 5A		245		mV
f_{SW}	Switching (Clock) Frequency	During V_{IN} Surge Only		535		kHz
T_{PWM}	PROTECTIVE PWM Mode Time Limit		0.85	1.06	1.24	s
$V_{OUT(P-P)}$	Output Ripple in PROTECTIVE PWM Mode	V_{IN} = 40V, V_{OUT} = 17.2V, I_{OUT} = 5A (20MHz BW)		200		$mV_{P–P}$
	Approximate Size	Component Area x Top Component Height		18 x 16 x 6		mm

QUICK START PROCEDURE

Demonstration circuit 2239 is easy to set up to evaluate the performance of the LTC7860. 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. Use an input power supply that is capable of 3.5V to 60V. Set its output to 5V. 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 3.5V can keep the converter from turning on due to the undervoltage lockout feature of the LTC7860.
   b. A voltmeter with a capability of measuring at least 60V 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 60V.
4. Check for the proper output voltage of 5V. Turn off the power at the input.
5. Connect a variable load capable of sinking 5A at 17.2V to the output terminals $+V_{OUT}$ and $-V_{OUT}$. Set the current for 0A.
   a. A voltmeter with a capability of measuring at least 18V 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 up to $17V_{IN}$ and observe the output voltage and other desired parameters.
8. Now apply an input between 18V and 60V and observe the output voltage and fault timer operation.
9. If desired, you may apply input transient profiles in the range of $0V_{IN}$ to $60V_{IN}$ and observe the output to illustrate operation of the circuit to prevent input surges from reaching the output.

QUICK START PROCEDURE

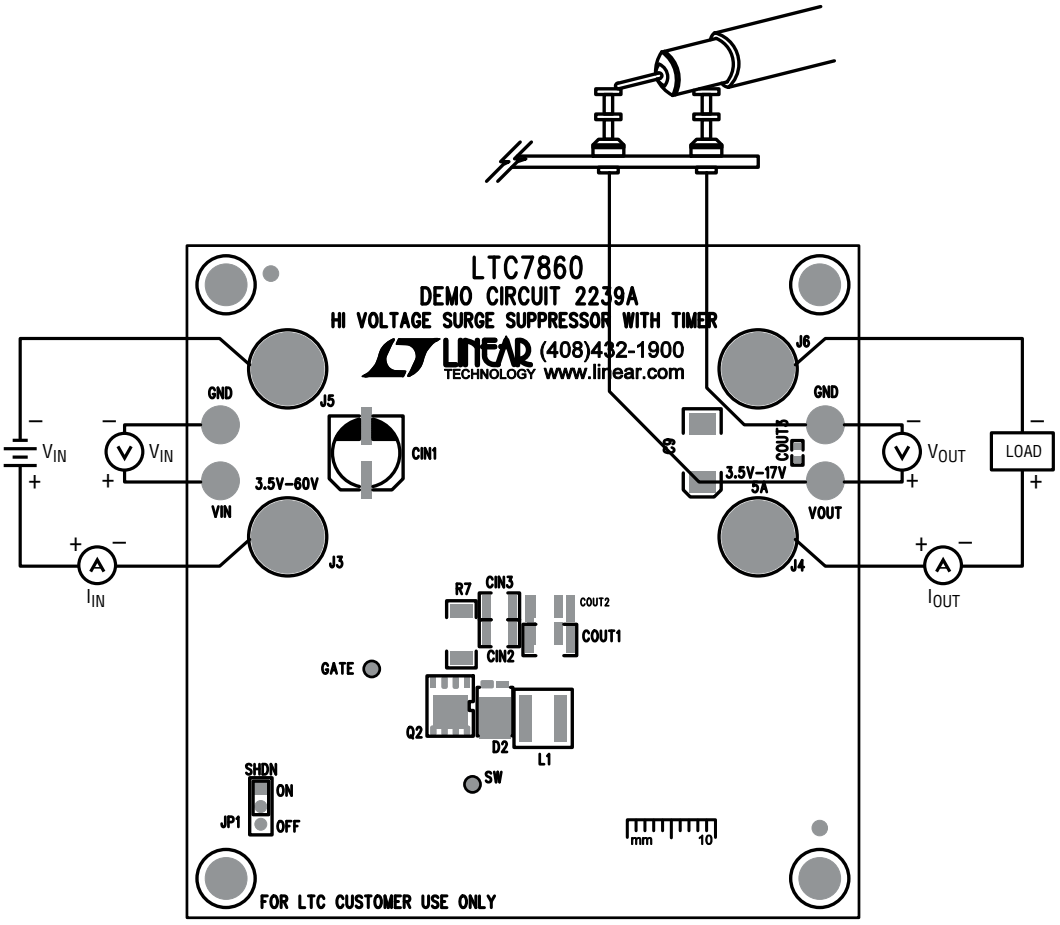

Figure 1. Proper Measurement Equipment Setup

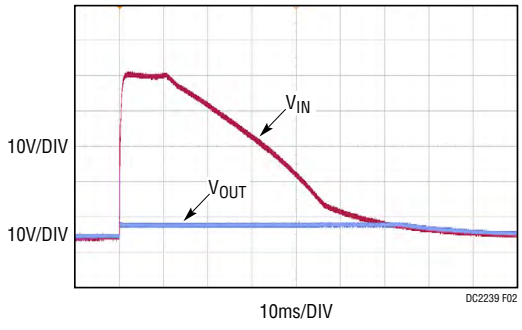

Figure 2. Output Response Waveform with 14V–60V–14V Input Surge, ($5A_{OUT}$) (10V, 10V, 10ms/Div)

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP., ALUM., 10µF, 63V, 20%, HVH Series	SUN ELECTRONIC INDUSTRIES CORPORATION, 63HVH10M
2	1	CIN2	CAP., 2.2µF, X7R, 100V, 10%, 1210	MURATA GRM32ER72A225KA35L
3	2	COUT1, COUT2	Cap., 10µF, X7R, 50V, 10%, 1210	MURATA GRM32ER71H106KA12
4	1	C1	CAP., 100pF, NP0, 25V, 5%, 0603	AVX 06033A101JAT2A
5	1	C2	CAP., 680pF, NP0, 25V, 5%, 0603	AVX 06033A681JAT2A
6	1	C4	CAP., 3.9pF, NP0, 50V, 5%, 0603	AVX 06035A3R9JAT2A
7	1	C5	CAP., 0.47µF, X5R, 16V, 20%, 0603	AVX 0603YD474MAT2A
8	1	C6	CAP., 0.1µF, X5R, 16V, 20%, 0603	AVX 0603YD104MAT2A
9	1	C7	Cap., 0.1µF, X5R, 100V, 20%, 0805	TDK, C2012X5R2A104M125AA
10	1	C8	CAP., 10pF, NP0, 50V, 5%, 0603	AVX 06035A100JAT2A
11	1	C10	CAP., 22µF, X7R, 6.3V, 10%, 1206	MURATA GRM31CR70J226KE19L
12	1	D2	DIODE, SCHOTTKY, 100V, 5A, PWRDI5	DIODES INC., PDS5100-7
13	1	D3	DIODE, ZENER, 9.1V, 500mW, SOD-123	ON SEMI., MMSZ9V1T1G
14	1	D5	DIODE, RECTIFIER, 30V, 500mA, SOD-123	DIODES INC., B0530W-7-F
15	1	L1	IND., PWR., SHIELDED, 6.8µH, 20%, XAL6060	COILCRAFT XAL6060-682MEC
16	1	Q2	XSTR., MOSFET P-CH, 60V, PWRPAK, S0-8	VISHAY Si7461DP-T1-GE3
17	1	R2	RES., 10k, 1/10W, 1%, 0603	VISHAY CRCW060310K0FKEA
18	1	R3	RES., 48.7k, 1/10W, 1%, 0603	VISHAY CRCW060348K7FKEA
19	1	R5	Res., 1M, 1/10W, 1%, 0603	VISHAY, CRCW06031M00FKEA
20	1	R7	RES., SENSE, 0.012Ω, 1/2W, 1%, 2010	VISHAY WSL2010R0120FEA
21	1	R8	RES., 1Ω, 1/10W, 1%, 0603	VISHAY, CRCW06031R00FKEA
22	1	U1	I.C., Voltage Reg. MSOP(12)-MSE	LINEAR TECH.CORP. LTC7860EMSE#PBF
Additional Demo Board Circuit Components				
1	0	CIN3	CAP., OPTION, 1210	OPT
2	0	COUT3	CAP., OPTION, 0603	OPT
3	0	C9	CAP., OPTION, D CASE	OPT
4	0	D1	DIODE, OPTION, DFN3030-8	OPT
5	0	D4	DIODE, OPTION, SOD-323	OPT
6	0	Q1	XSTR, OPTION POWER_33	OPT
7	0	R1, R9, R11	RES., OPTION, 0603	OPT
8	4	R4, R6, R10, R12	RES., 0Ω, 1/10W, 5%, 0603	VISHAY, CRCW06030000Z0EA
Hardware: For Demo Board Only				
1	4	E1, E2, E8, E9	TEST POINT, TURRET, 0.094" MTG. HOLE	MILL-MAX 2501-2-00-80-00-00-07-0
2	0	E10, E11	TEST PAD	TEST PAD
3	1	JP1	CONN., HEADER, 1X3, 2mm	SAMTEC TMM-103-02-L-S
4	4	J3, J4, J5, J6	CONN., JACK, BANANA, Non-Insulated, 0.218"	KEYSTONE, 575-4
5	1	XJP1	SHUNT, 2mm	SAMTEC 2SN-BK-G
6	4	4 CORNERS	STANDOFF, NYLON, SNAP-ON, 0.375"	KEYSTONE 8832
7	1		PCB, High Voltage Surge Suppressor with Timer	DEMO CIRCUIT 2239A

SCHEMATIC DIAGRAM

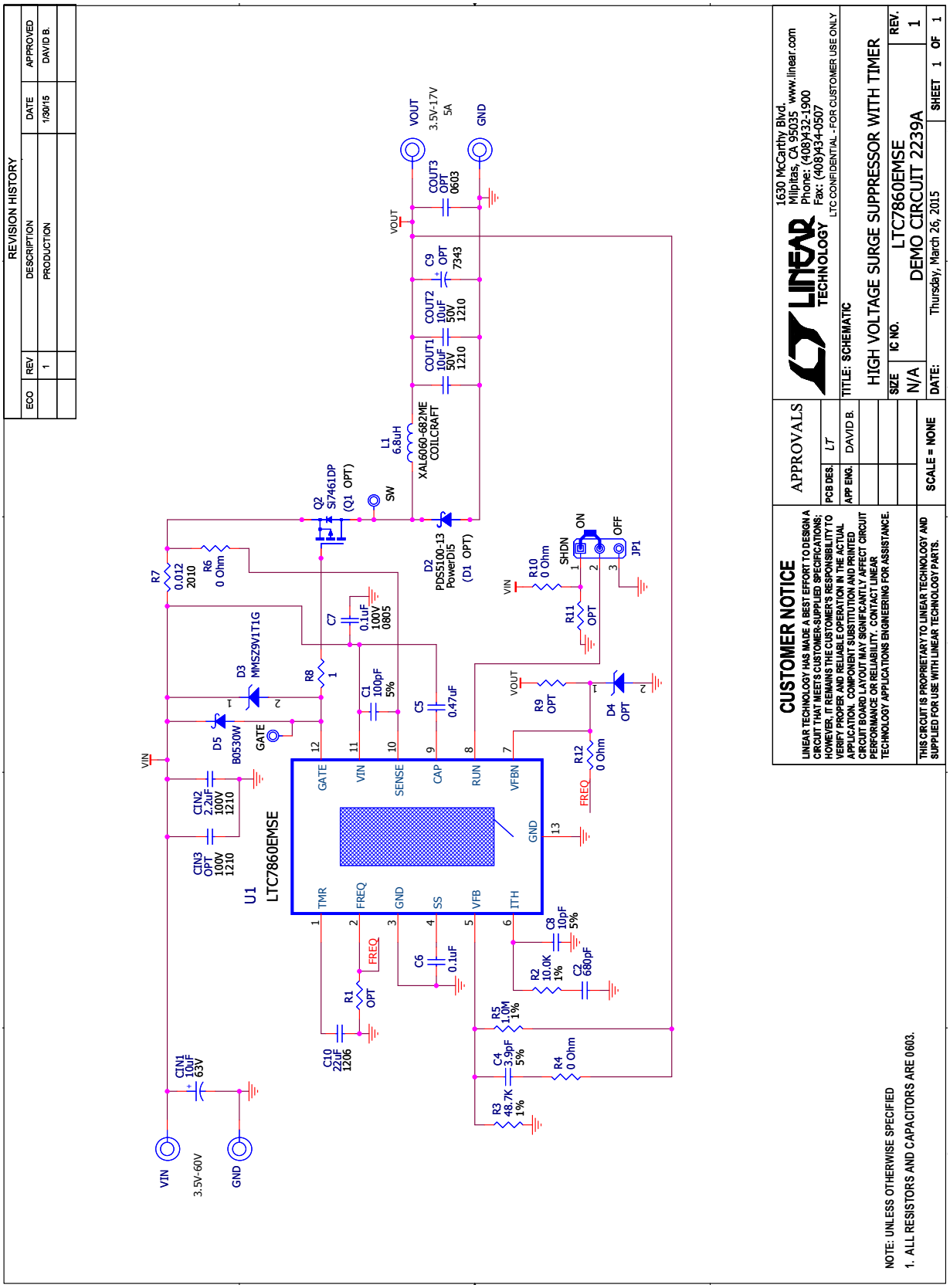

Figure 3. DC2239A Demo Circuit Schematic

DEMONSTRATION BOARD IMPORTANT NOTICE

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Please read the DEMO BOARD manual prior to handling the product. Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged**.

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

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LT 0415 • PRINTED IN USA