

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>

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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

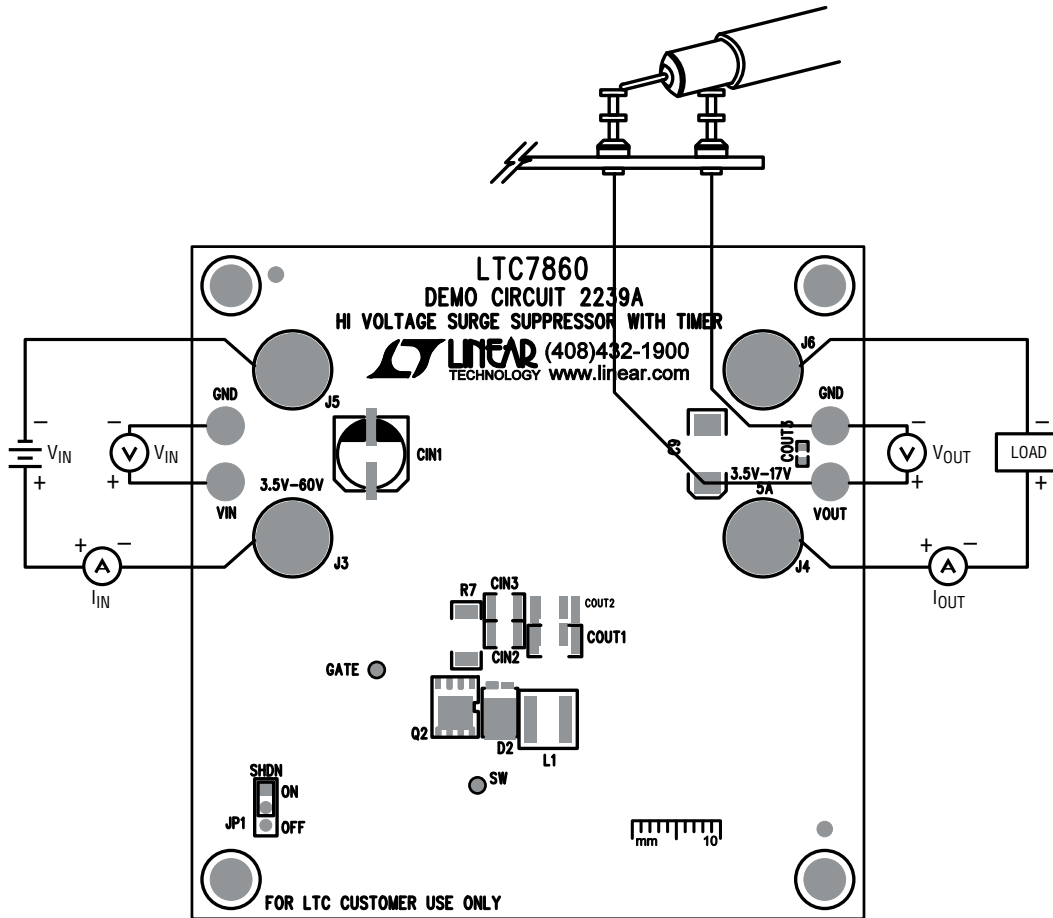


Figure 1. Proper Measurement Equipment Setup

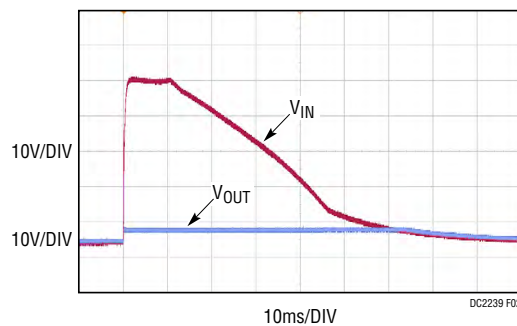


Figure 2. Output Response Waveform with 14V-60V-14V Input Surge, (5A_{OUT}) (10V, 10V, 10ms/Div)

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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, NPO, 25V, 5%, 0603 | AVX 06033A101JAT2A |
| 5 | 1 | C2 | CAP., 680pF, NPO, 25V, 5%, 0603 | AVX 06033A681JAT2A |
| 6 | 1 | C4 | CAP., 3.9pF, NPO, 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, NPO, 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

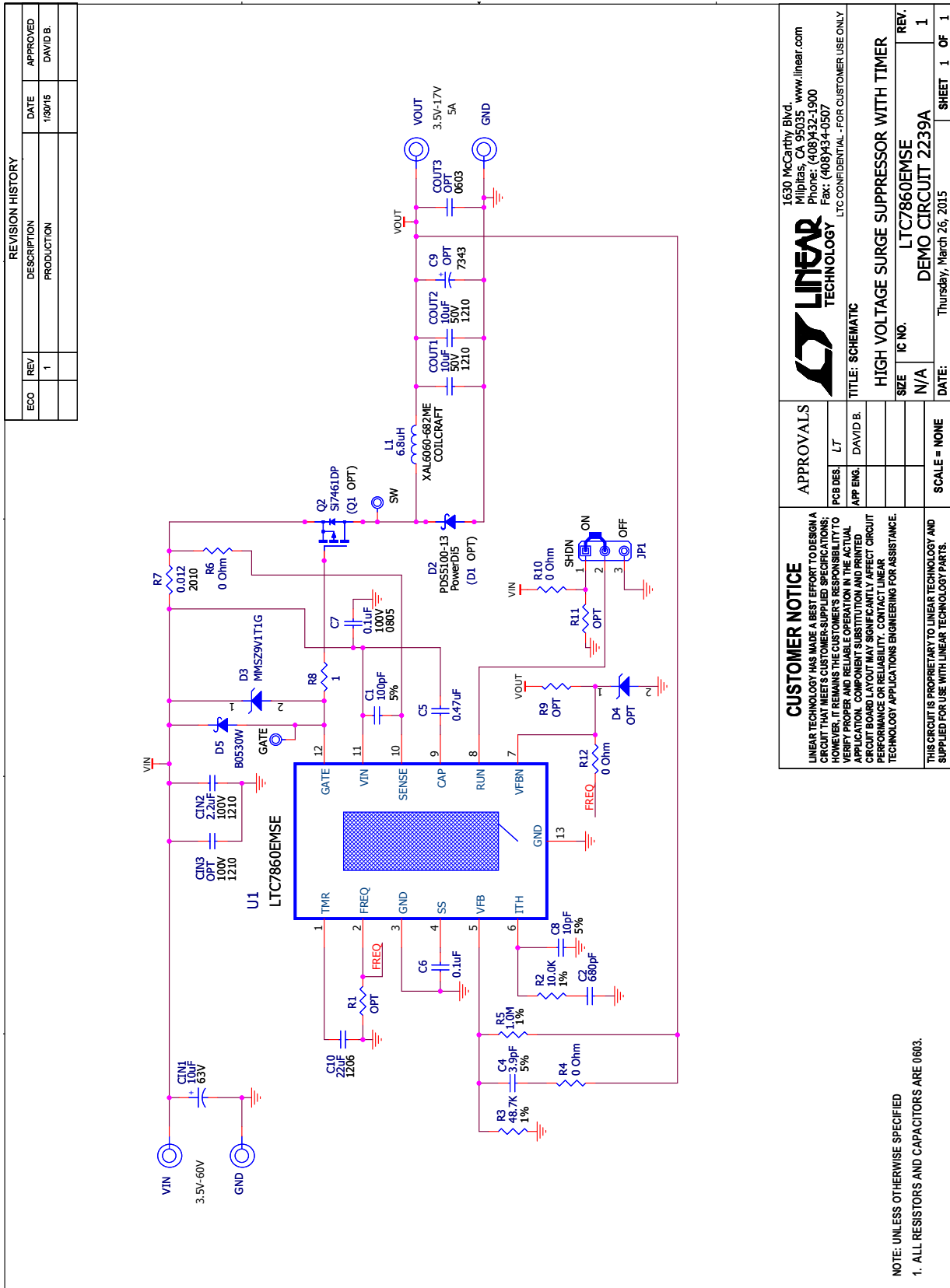


Figure 3. DC2239A Demo Circuit Schematic

DEMO MANUAL DC2239A

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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