LTC7860
High Voltage Switching Surge Stopper

DESCRIPTION

Demonstration circuit 2392A is a high efficiency switching surge stopper featuring the LTC®7860. The board operates from an input range of 7V to 100V, and provides a 7V to 34V output at 0A to 10A. Its output is current limited. A soft-start feature controls output voltage slew rate at start-up, reducing current surge and voltage overshoot. The demonstration board includes an optional reverse polarity protection MOSFET and has options for an input filter and diode to attenuate spikes. For a lower output voltage limit of less than 12V, there is an optional feedback circuit.

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 overvoltage event. During normal operation (SWITCHON mode), the LTC7860 turns on the external MOSFET continuously, passing the input voltage through to the output. 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 demo board takes advantage of the LTC7860's V_{IN}-centric PMOS architecture to float the control ground allowing operation beyond the controller's 60V rating.

This board is suitable for a wide range of automotive, military, 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/DC2392A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range	Normal Operation	7		32	V
		500ms Ride-Through	7		100	V
		DC Survival	0		100	V
V_{OUT}	Output Voltage		7	28	35	V
I_{OUT}	Output Current Range, continuous	Free Air	0		10	A
I_{LIMIT}	Current Limit	V_{IN} = 28V		13		A
I_{LIMIT}	Current Limit	V_{IN} = 40V		10.5		A
V_{IN}-V_{OUT}	Insertion Loss	V_{IN} = 28V, I_{OUT} = 10A		400		mV
F_{SW}	Switching (Clock) Frequency			350		kHz
T_{PWM}	PROTECTIVE PWM Mode Time Limit	V_{IN} > 35V	0.85	1.06	1.24	s
$V_{OUT\ P-P}$	Output Ripple	V_{IN} = 40V, V_{OUT} = 17.2V, I_{OUT} = 5A (20MHz BW)		100		mV_{P-P}
	Approximate Size	Component Area x Top Component Height		35 × 42 × 10		mm

QUICK START PROCEDURE

Demonstration circuit 2392 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. Set an input power supply that is capable of 7V to 100V to 10V. 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 7V 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 100V 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 100V.

4. Check for the proper output voltage of 10V. Turn off the power at the input.
5. Once the proper output voltage is established, connect a variable load capable of sinking 10A at 34V to the output terminals $+V_{OUT}$ and $-V_{OUT}$. Set the current for 0A.

a. A Voltmeter with a capability of measuring at least 36V 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 $33V_{IN}$ and observe the output voltage and other desired parameters.
8. Now apply an input between 35V and 100V 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 $100V_{IN}$ and observe the output to illustrate operation of the circuit to prevent input surges from reaching the output.
10. The output limit voltage can be set in accordance with the feedback notes on the schematic. The first line shows the complete formula. The second line is simplified for the use of a 2:1 divider as shown on the schematic.

QUICK START PROCEDURE

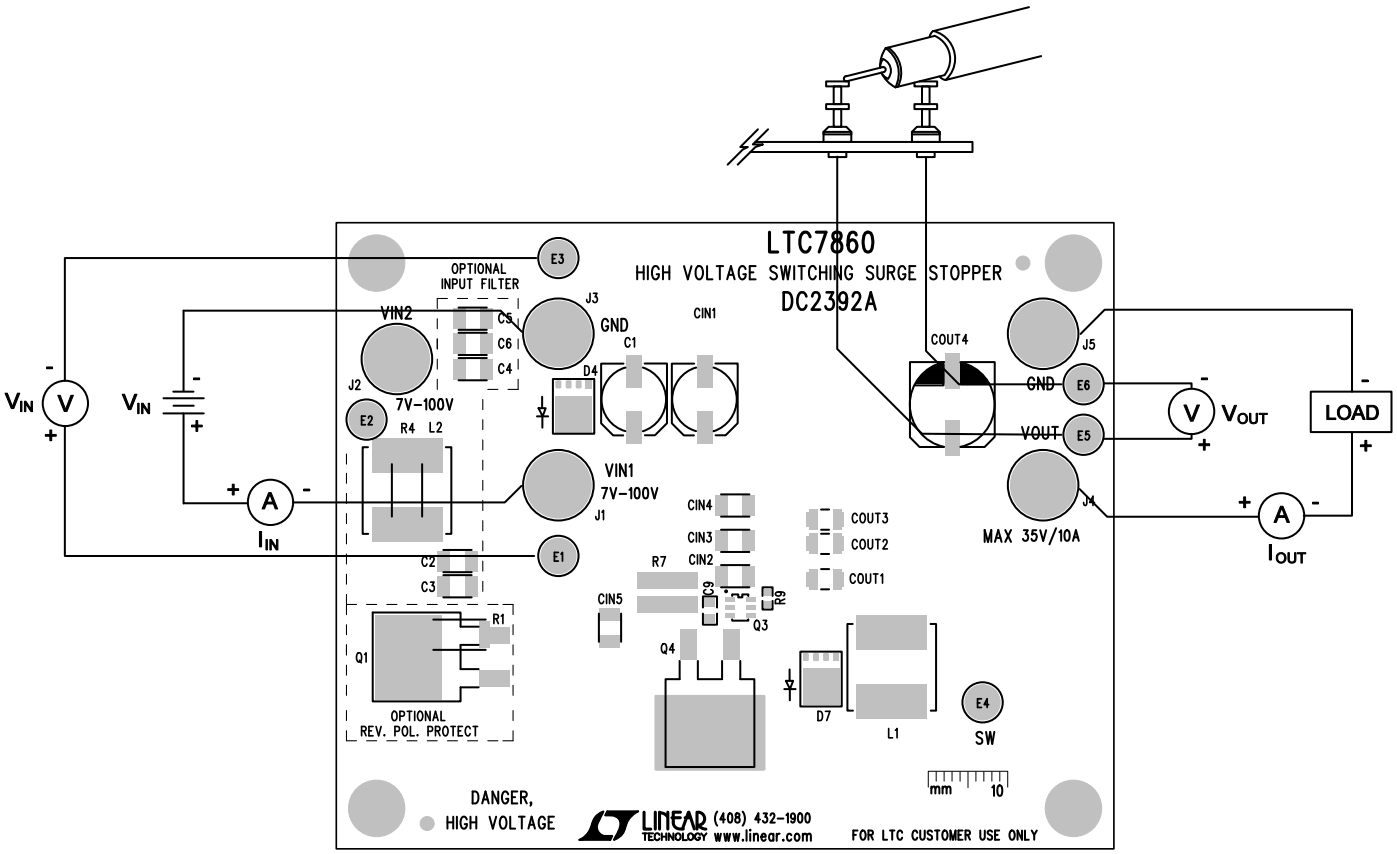


Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

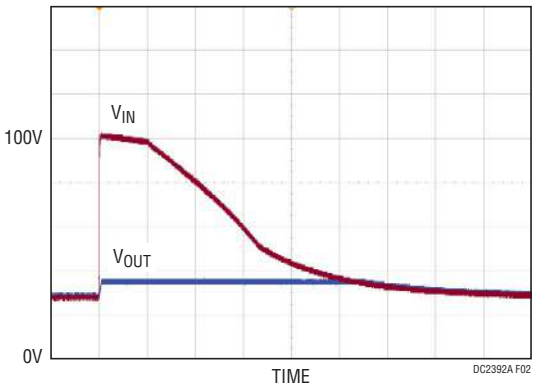


Figure 2. Output Response Waveform with 28V to 100V to 28V Input Surge, ($10A_{OUT}$) (20V, 20V, 10ms/DIV)

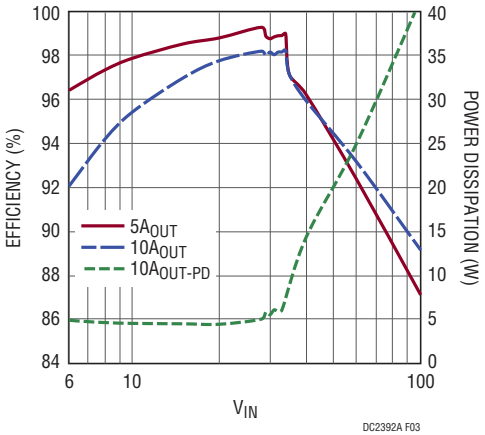


Figure 3. Efficiency and Power Dissipation

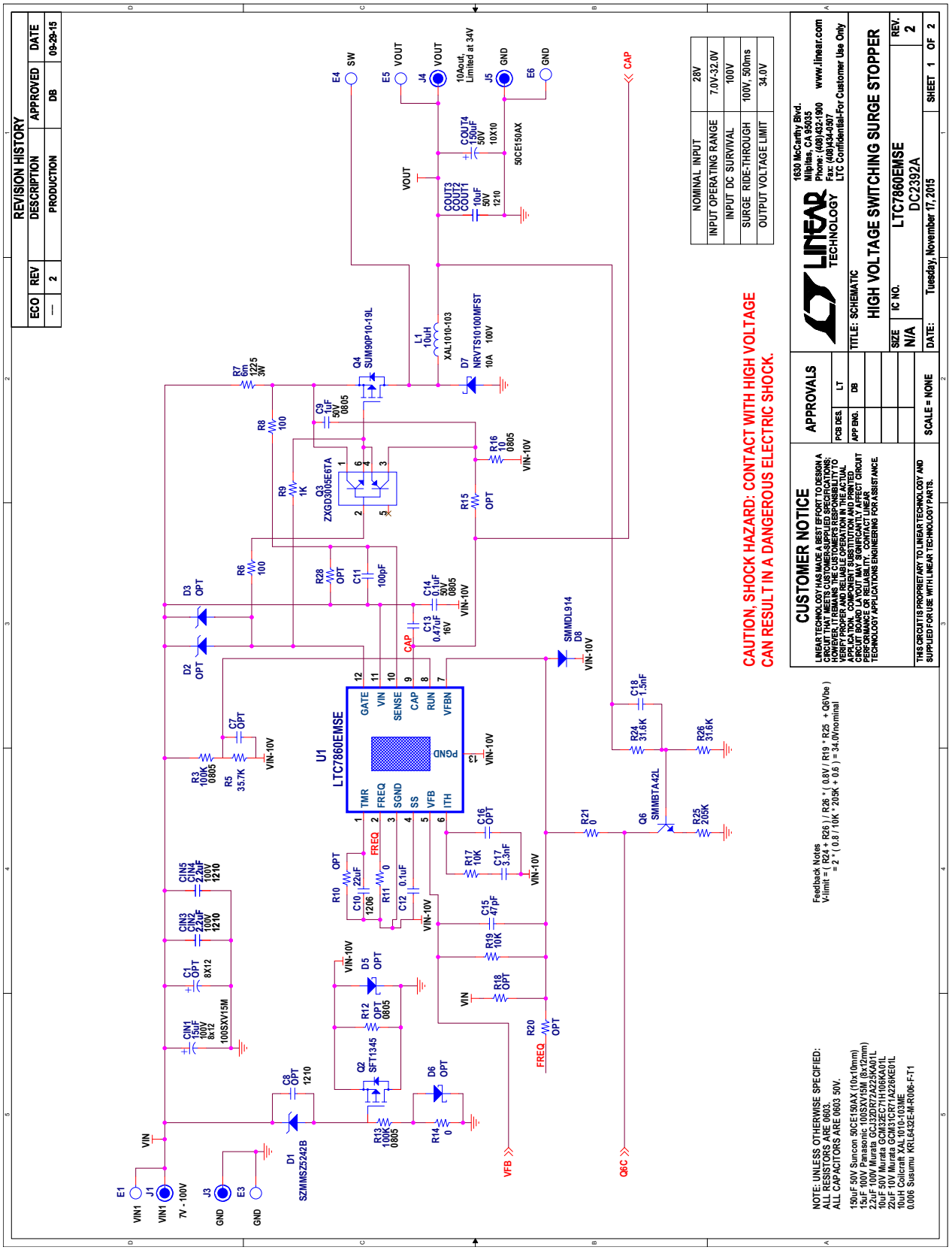
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP., ALUM, 15µF, 100V 8X12	PANASONIC, 100SXV15M
2	4	CIN2, CIN3, CIN4, CIN5	CAP., X7R, 2.2µF, 100V, 10%, 1210	MURATA, GCJ32DR72A225KA01L
3	3	COUT1, COUT2, COUT3	CAP., X7S, 10µF, 50V, 10%, 1210	MURATA, GCM32EC71H106KA01L
4	1	COUT4	CAP., ALUM 150µF 50V 10x10	SUN ELECTRONIC INDUSTRIES CORP., 50CE150AX
5	1	C9	CAP., X7R, 1µF, 50V, 10%, 0805	MURATA, GCM21BR71H105KA01L
6	1	C10	CAP., X7R, 22µF, 10V, 10%, 1206	MURATA, GCM31CR71A226KE01L
7	1	C11	CAP., NPO, 100pF, 50V, 10%, 0603	AVX, 06035A101KAT2A
8	1	C12	CAP., X7R, 0.1µF, 50V, 10%, 0603	MURATA, GCM188R71H104KA57D
9	1	C13	CAP., X7R, 0.47µF, 16V, 10%, 0603	MURATA, GCM188R71C474KA55L
10	1	C14	CAP., X7R, 0.1µF, 50V, 10%, 0805	MURATA, GCM21BR71H104KA37L
11	1	C15	CAP., COG, 47pF, 50V, 5%, 0603	MURATA, GCM1885C1H470JA16D
12	1	C17	CAP., COG, 3300pF, 50V, 5%, 0603	MURATA, GCM1885C1H332JA16D
13	1	C18	CAP, 1.5nF, X7R, 50V,10%,0603	AVX, 06035C152KAT2A
14	1	D1	ZENER DIODE, 500mW, SOD123	ON SEMI, SZMMSZ5242BT1G/T3G
15	1	D7	SCHOTTKY DIODE, 100V, 10A, DFN5-SO-8FL	ON SEMI, NRVTS10100MFST1G
16	1	D8	SWITCH DIODE, SOD323	ON SEMI., SMMDL914T1G
17	1	L1	INDUCTOR, 10µH	COILCRAFT, XAL1010-103ME
18	2	Q1, Q4	FET, P-CHAN.,100V, TO-263	VISHAY, SUM90P10-19L-E3
19	1	Q2	FET, P-CHAN., POWER, TO-252	ON SEMI, SFT1345-TL-H
20	1	Q3	DIODE, IGBT MOSFET 10A, SOT23-6	DIODES INC., ZXGD3005E6TA
21	1	Q6	FET, NPN, SOT23	ON SEMI, SMMBTA42LT1G
22	2	R3, R13	RES., 100k, 1/8W, 1%, 0805	VISHAY, CRCW0805100KFKEA
23	1	R5	RES., 35.7k, 1/10W, 1%, 0603	VISHAY, CRCW060335K7FKEA
24	2	R6, R8	RES., 100Ω, 1/10W, 1%, 0603	VISHAY, CRCW0603100RFKEA
25	1	R7	RES., 6m, 3W, 1%, 1225	SUSUMU, KRL6432E-M-R006-F-T1
26	1	R9	RES., 1.0k, 1/10W, 1%, 0603	VISHAY, CRCW06031K00FKEA
27	1	R16	RES., 10Ω, 1/10W, 5%, 0805	VISHAY, CRCW080510R0JNEA
28	2	R17, R19	RES., 10k, 1/16W, 1%, 0603	VISHAY, CRCW060310K0FKEA
29	2	R24, R26	RES., 31.6k, 1/10W, 1%, 0603	VISHAY, CRCW060331K6FKEA
30	1	R25	RES., 205k, 1/16W, 1%, 0603	VISHAY, CRCW0603205KFKEA
31	1	U1	IC, LTC7860EMSE MSE12	LINEAR TECH.CORP. LTC7860EMSE#PBF
Additional Demo Board Circuit Components				
1	0	C1	CAP., OPT 8×12	OPT
2	0	C2, C3, C4, C5, C6, C8	CAP., OPT 1210	OPT
3	0	C7, C16	CAP., OPT 0603	OPT
4	0	D2, D3, D5	ZENER DIODE, OPT SOD123	OPT
5	0	D4	DIODE, OPT, DFN5-SO-8FL	OPT
6	0	D6	ZENER DIODE, OPT, SOD323	OPT
7	0	L2	INDUCTOR, 1µH	OPT
8	0	L3	INDUCTOR, 0.6µH	OPT

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
9	0	Q4	HEATSINK, OPT, 573100D00010G	OPT
10	0	Q5	OPT, SOT363	OPT
11	0	R1, R2, R29	RES., OPT, 2512	OPT
12	3	R11, R14, R21	RES., 0Ω, 1/16W, 0603	VISHAY, CRCW06030000Z0EA
13	1	R4	RES., 1mΩ, 1%, 1W, 2512	PANASONIC, ERJ-M1WTF1M0U
14	0	R12	RES., OPT, 0805	OPT
15	0	R10, R15, R18, R20, R22, R23, R27, R28	RES., OPT, 0603	OPT
Hardware: For Demo Board Only				
1	6	E1, E2, E3, E4, E5, E6	TESTPOINT, TURRET, .094"	MILL MAX, 2501-2-00-80-00-00-07-0
2	5	J1, J2, J3, J4, J5	CONN, BANANA JACK,	KEYSTONE 575-4
3	4	MTGS AT 4 CORNERS	STAND-OFF, SNAP ON NYLON 0.50" TALL	KEYSTONE, 8833(SNAP ON)

SCHEMATIC DIAGRAM



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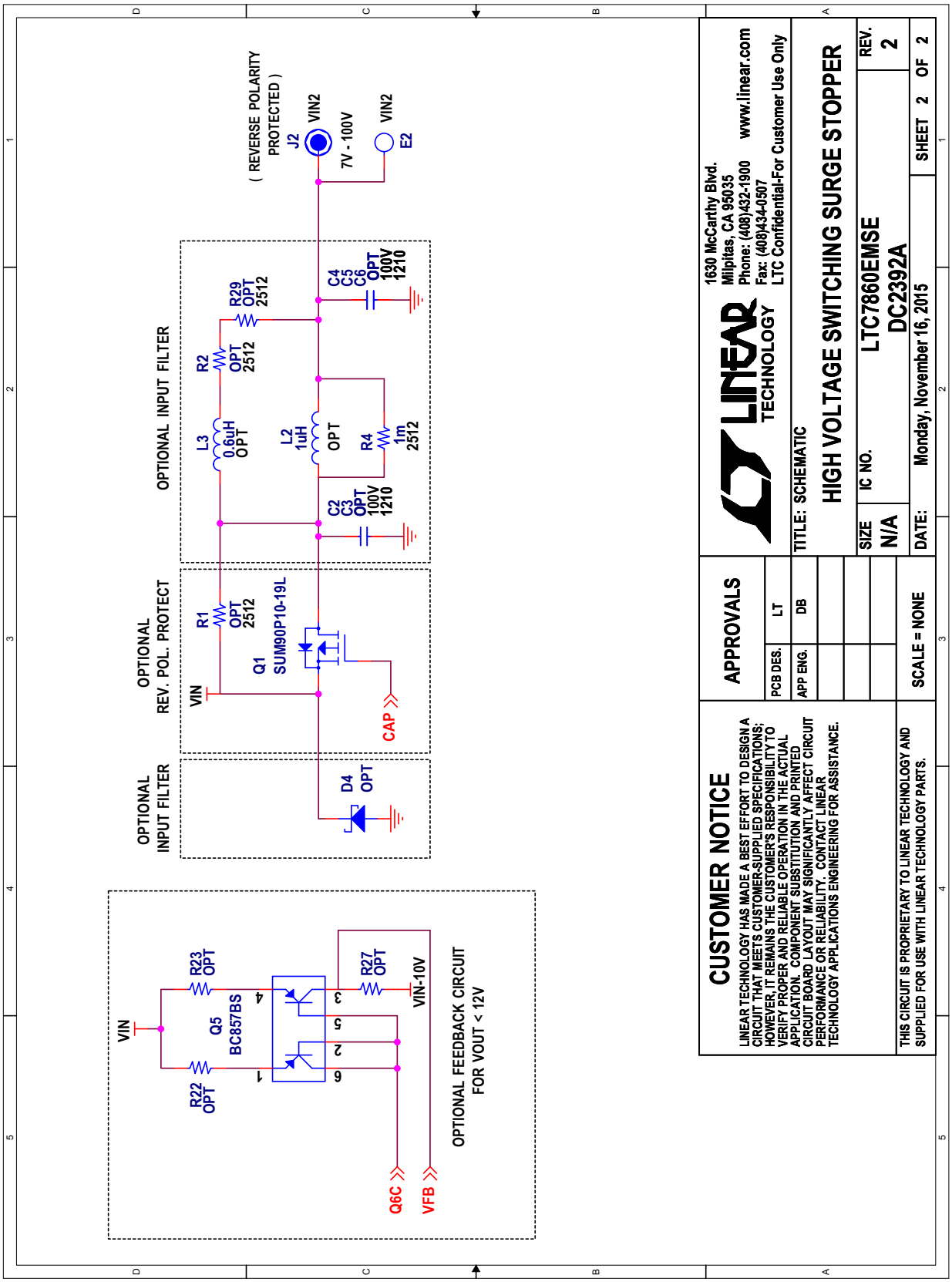
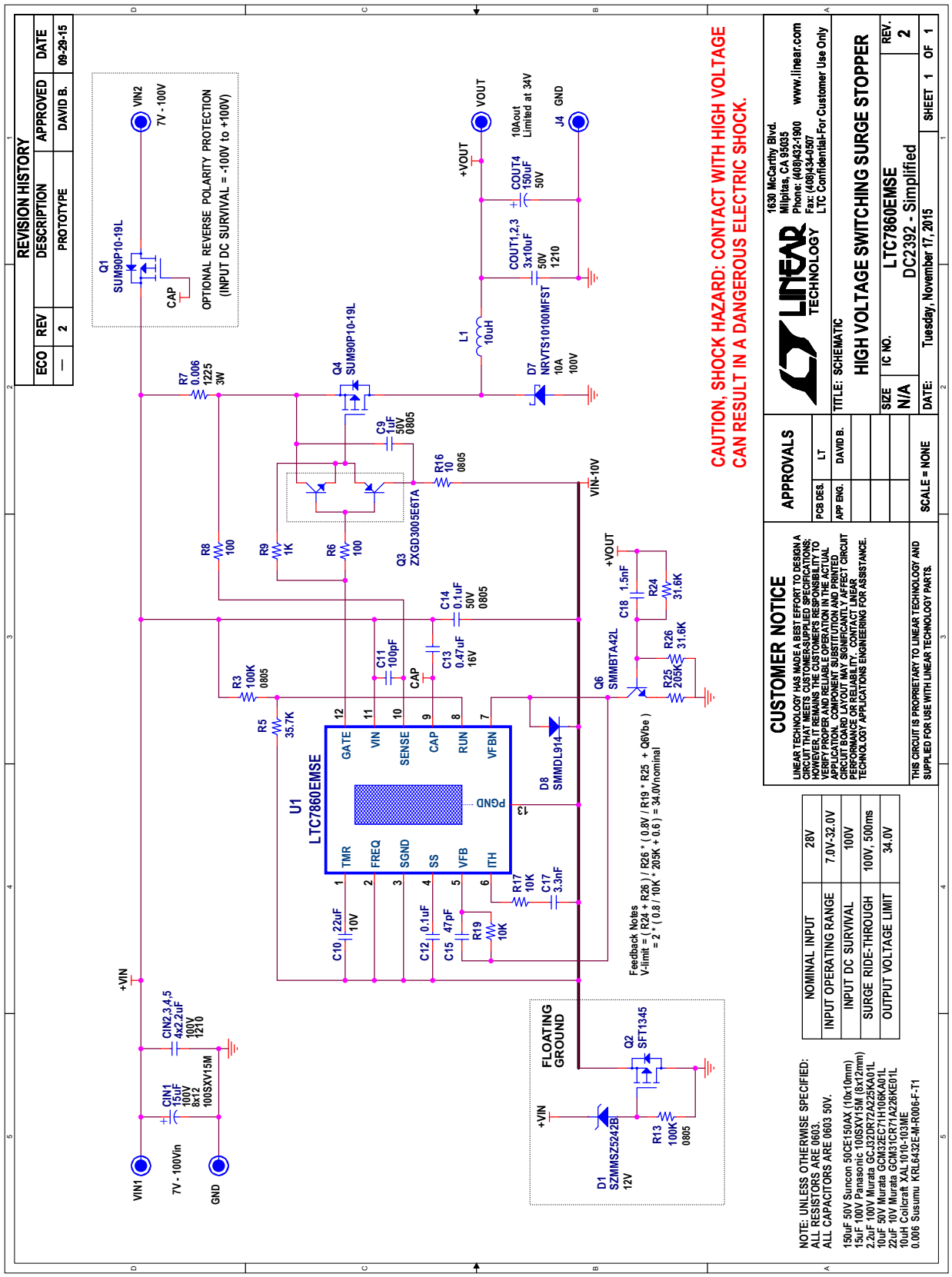


SCHEMATIC DIAGRAM



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

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