

LTC7000

Fast High Voltage Protected High Side NMOS Static Switch Driver

DESCRIPTION

Demonstration circuit 2537A is a 135V protected, high side switch featuring the [LTC®7000](#). The demo board is designed to switch a 5.5A output load from input voltages from 8V to 135V. The wide input range and low shut-down current (1µA typical) make it suitable for automotive, industrial, medical instrument and telecom applications. This board offers a low 50ns (typical) propagation delay, fast switching times (<10ns) and 100% duty cycle operation.

The LTC7000 is a fast high voltage protected high side N-channel MOSFET driver. An internal charge pump fully enhances an external N-channel MOSFET switch, allowing it to remain on indefinitely. Its powerful gate driver can drive large gate capacitance MOSFETs with very short transition times, ideal for both high frequency switching and static switch applications. The LTC7000 operates over a 3.5V to 135V input supply range. When an external current sense resistor and internal comparator sense that the switch current has exceeded a preset level, a fault flag is asserted and the switch is turned off after a period of time set by an external timing capacitor. After a cooldown period, the LTC7000 can be configured to automatically retry or remain off until input is cycled.

The demo board includes input capacitors and output diode to accommodate input and output supply inductance when switching loads. The switch can be controlled directly with external signal or using the on-board on/off switch. A single-shot pulse generator is included for evaluating switching times while limiting output power. Optional auxiliary V_{CC} input accommodates gate power associated with high frequency switching. Positions for RC delay network to control inrush current are also included.

The LTC7000 data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this demo manual for demo circuit 2537A. Proper board layout is essential for maximum thermal and electrical performance. See the data sheet sections for details. The LTC7000 is available in 16-lead MSOP package and three operating junction temperature grades (extended and industrial -40°C to 125°C , high temp automotive -40°C to 150°C and a military grade -55°C to 150°C).

Design files for this circuit board are available at <http://www.linear.com/demo/DC2537A>

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PERFORMANCE SUMMARY Specifications are at $T_A = 25^{\circ}\text{C}$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Voltage				135	V
I_{OUT}	Output Current		5.5			A
	Insertion Drop	$V_{IN} - V_{OUT}$, 5.5A Load, Input to Output Terminals		150		mV
V_{IN}	Start-Up Voltage	$V_{INP} = 4\text{V}$ 100kΩ Load		8.0 7.0		V V
V_{CCUV}	V_{CC} Undervoltage Lockout	V_{CC} Rising V_{CC} Falling Hysteresis	6.5 5.8	7.0 6.4 0.6	7.5 6.9	V V V
	Overcurrent to V_{OUT} Low	Turn-On into a 10A Resistive Load		19		µs
	Input to Output Propagation Delay	$V_{IN} = 135\text{V}$, 50Ω Load, INP = 2.2V to $V_{OUT} = 13.5\text{V}$		50		ns
	Output Rise Time	$V_{IN} = 135\text{V}$, 50Ω Load, 10% to 90%		6.5		ns

QUICK START PROCEDURE

Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE: When measuring the output voltage during switching transitions, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage by touching the probe tip and ground ring directly across the output capacitor as shown in Figure 2.

1. Place SW1 to OFF position. Move JP1 from the PULSE (default position) to ON/OFF position (load on continuously when SW1 is ON).
2. With input power supply set to zero volts and power off, connect the input power supply to +VIN and GND.
3. With power off, connect load from +VOUT to GND.
4. Turn on the input power supply and increase the input voltage slowly to 9V minimum. The input range is up to 135V but hot-plugging with long leads may result in input voltages in excess of 135V.

5. Place SW1 to ON position.
6. Check for the proper output voltage using a voltmeter. Output voltage should be close to input voltage.

NOTE: If there is no output, temporarily disconnect the load and cycle SW1 (the ON/OFF switch) or press reset pushbutton SW2. If output is good, the load may be set too high.

7. Once the proper output voltage is established, adjust the load, if desired, to test current limit.
8. Placing SW1 to OFF position, moving JP1 to PULSE position then placing SW1 in ON position will allow pulse operation. Pushing SW2 will turn the high side switch on for 300µs time.
9. Placing SW1 to OFF position, moving JP1 to INPUT position connects INPUT terminal to LTC7000 INP pin. An INPUT pin voltage of 2.2V or more will turn-on the high side switch.

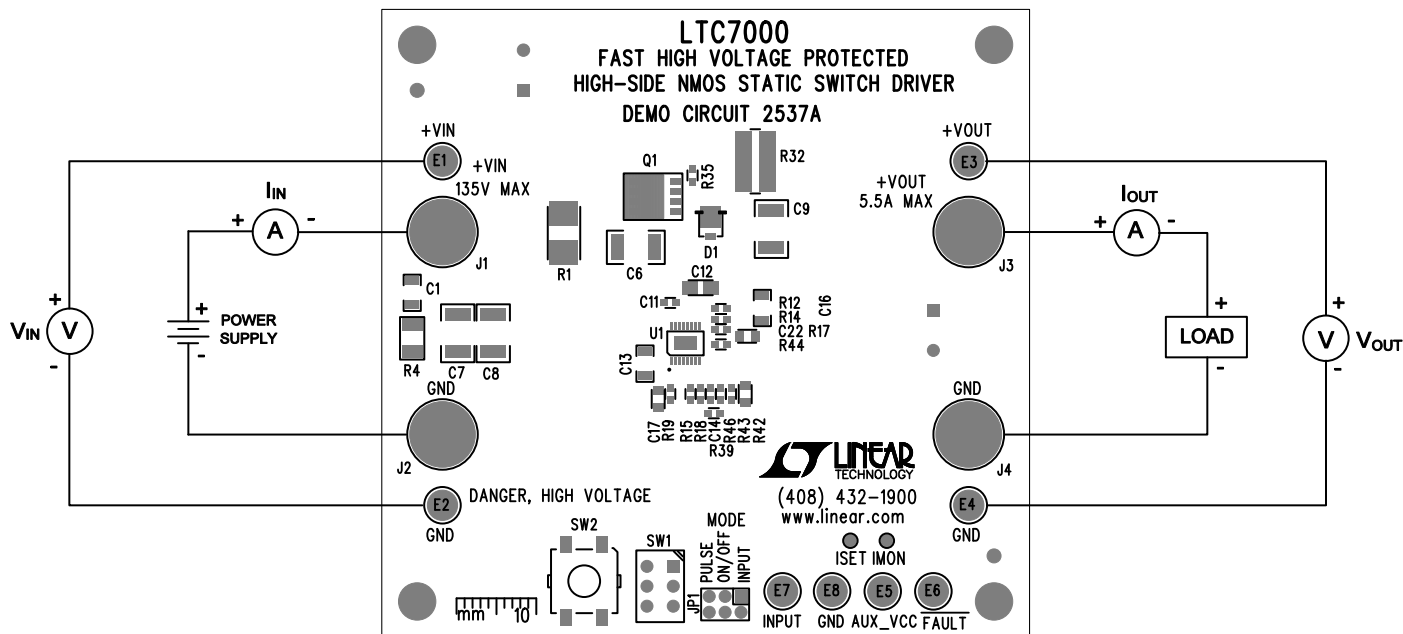


Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

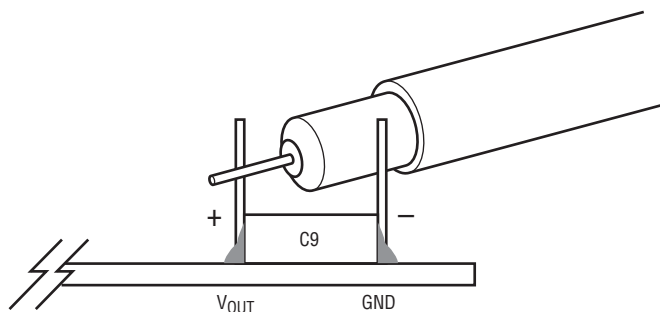


Figure 2. Measuring Output Voltage During Switching across C9. Note that C9 May Not Be Installed

TYPICAL PERFORMANCE CHARACTERISTICS

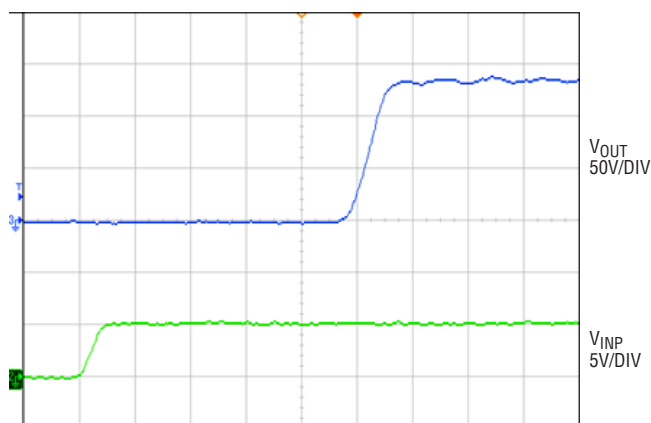


Figure 3. Rise Time into 50Ω Load ($V_{IN} = 135V$, CH4 $V_{INP} 5V/DIV$, CH3 $V_{OUT} 20V/DIV$, 10ns/DIV)

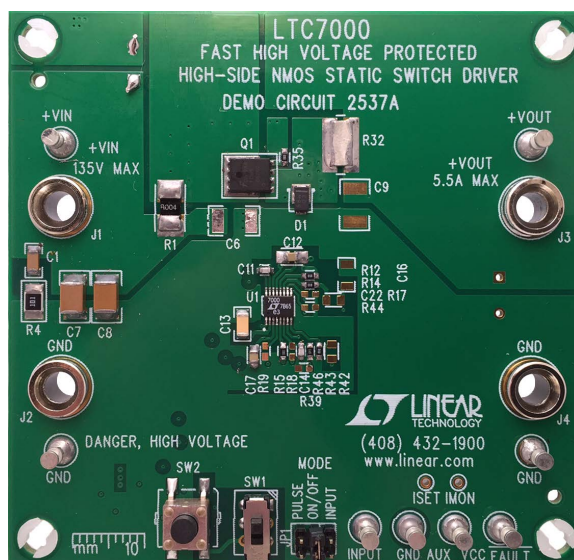


Figure 4. Board Photo

DEMO MANUAL DC2537A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	5	C3, C4, C5, C7, C8	CAP, 1 μ F, X7T, 250V, 1812	TDK, C4532X7T2E105K250KA
2	2	C11, C14	CAP, 1000pF, X7R, 25V, 10%, 0603	MURATA, GRM188R71E102KA01D
3	1	C12	CAP, 0.1 μ F, X7R, 25V, 10%, 0805	AVX, 08053C104KAT2A
4	1	C13	CAP, 0.1 μ F, X7R, 200V, 10%, 1206	AVX, 12062C104KAT2A
5	1	C17	CAP, 1 μ F, X7R, 25V, 10%, 0805	AVX, 08053C105KAT2A
6	1	D1	DIODE, ES1PD, 200V, 1A, DO-220AA	VISHAY, ES1PD-M3/84A
7	1	Q1	MOSFET, N-CH, 150V, POWERPAK-SO-8	FAIRCHILD, FDMS86250
8	1	R1	RES., SENSE, 0.004 Ω , 1W, 2%, 2512	PANASONIC, ERJM1WTF4M0U
9	2	R7	RES., 100 Ω , 1/10W, 1%, 0603	VISHAY, CRCW0603100RFKEA
10	2	R15, R46	RES., 100k, 1/10W, 1%, 0603	VISHAY CRCW0603100KFKEA
11	1	R35	RES., 10 Ω , 1/10W, 1%, 0603	VISHAY, CRCW060310R0FKEA
12	1	R40	RES., 1M, 1/10W, 1%, 0805	VISHAY, CRCW08051M00FKEA
13	1	U1	IC, LTC7000EMSE, MSE-16	LINEAR TECH., LTC7000EMSE#PBF
Additional Demo Board Circuit Components				
14	1	C1	CAP, 10nF, X7R, 200V, 10%, 1206	AVX, 12062C103KAZ2A
15	1	C2	CAP, 22 μ F, ALUM, 160V, 20%, TH C-10X12.5	SUN ELECT., 160ME22HPC
16	1	R4	RES., 100 Ω , 1/2W, 5%, 1210	NIC, NRCP25J101TRF
17	0	C6, C9	CAP, OPTIONAL, 1812	OPTIONAL
18	0	C10	CAP, OPTIONAL, TH C-10X12	OPTIONAL
19	0	C16	CAP, OPTIONAL, 1206	OPTIONAL
20	2	C18, C19	CAP, 0.1 μ F, X7R, 25V, 10%, 0603	AVX, 06033C104KAT2A
21	0	C21, C22, C23	CAP, OPTIONAL, 0603	OPTIONAL
22	0	D2, D3, D4	DIODE, OPTIONAL, SOT23	OPTIONAL
23	1	D5	DIODE, MMSZ5V1T1, SOD-123	ON SEMICONDUCTOR, MMSZ5V1T1G
24	1	D6	DIODE, MMBD4148, SOT23	DIODES INC., MMBD4148-7-F
25	0	D7	DIODE OPTION, PDS4150, POWERDI5	OPTIONAL
26	0	D8	DIODE, OPTION, BAS21, SOT23	OPTIONAL
27	0	D9	DIODE., OPTION, CMMR1U, SOD-123F	OPTIONAL
28	0	Q2	MOSFET, N-CH, 80V, PSOF08A	FAIRCHILD, FDBL86361_F085
29	0	Q3	MOSFET, OPTIONAL, POWERPAK-SO-8	OPTIONAL
30	1	Q4	XSTR, PNP, 0.2A, MMBT3906, SOT23	FAIRCHILD, MMBT3906
31	1	Q5	MOSFET, P-CH, -200V, SOT23	DIODES INC., ZXMP2120FFTA
32	1	R2	RES., 0 Ω , 1/10W, 1%, 0805	VISHAY CRCW08050000Z0EA
33	9	R6, R12, R14, R22, R25, R43, R45, R47	RES., 0 Ω , 1/10W, 0603	VISHAY CRCW06030000Z0EA
34	0	R9, R17, R41, R42	RES., OPTIONAL, 0805	OPTIONAL

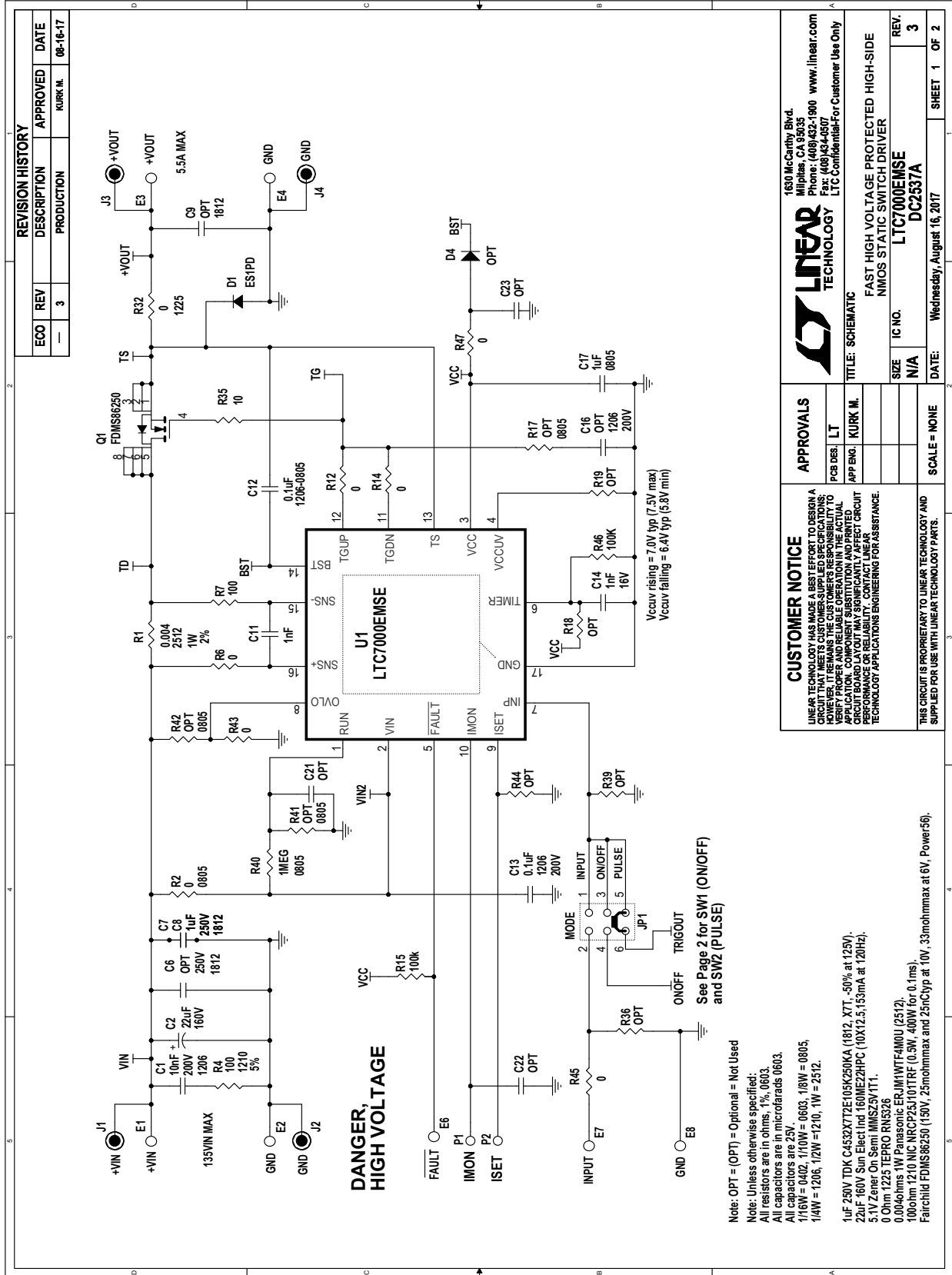
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
35	0	R13, R18, R19, R33, R34, R36, R39, R44	RES., OPTIONAL, 0603	OPTIONAL
36	3	R21, R37, R38	RES., 100k, 1/10W, 1%, 0603	VISHAY CRCW0603100KFKEA
37	1	R23	RES., 787 Ω , 1/10W, 1%, 0603	VISHAY, CRCW0603787RFKEA
38	2	R27, R31	RES., 240k, 1/10W, 1%, 0805	VISHAY CRCW0805240KFKEA
39	1	R28	RES., 976k, 1/10W, 1%, 0603	VISHAY CRCW0603976KFKEA
40	1	R29	RES., 232k, 1/10W, 1%, 0603	VISHAY CRCW0603232KFKEA
41	1	R30	RES., 182k, 1/10W, 1%, 0603	VISHAY CRCW0603182KFKEA
42	1	R32	RES., SENSE, 0 Ω , 1/2W, 1%, 1225	TEPRO, RN5326
43	1	SW1	SWITCH, SUB MINIATURE SLIDE	C&K COMPONENTS, JS202011CQN
44	1	SW2	SWITCH, MICRO MINIATURE PUSHBUTTON	TE CONNECTIVITY, FSM4JSMA
45	1	U2	IC, LTC6993CS6-3, TSOT23-6	LINEAR TECH., LTC6993CS6-3#PBF

Hardware: For Demo Board Only

46	8	E1-E8	TESTPOINT, TURRET 0.094"	MILL MAX 2501-2-00-80-00-00-07-0
47	1	JP1	CONN., HEADER, 2X3, 2mm	WURTH ELEKTRONIK, 62000621121
48	4	J1, J2, J3, J4	CONN, BANANA JACK	KEYSTONE 575-4
49	1	XJP1	SHUNT, 2MM	WURTH ELEKTRONIK, 60800213421
50	4	MTGS. AT 4 CORNERS	STAND-OFF, NYLON 0.559" tall	WURTH ELEKTRONIK, 702935500

SCHEMATIC DIAGRAM



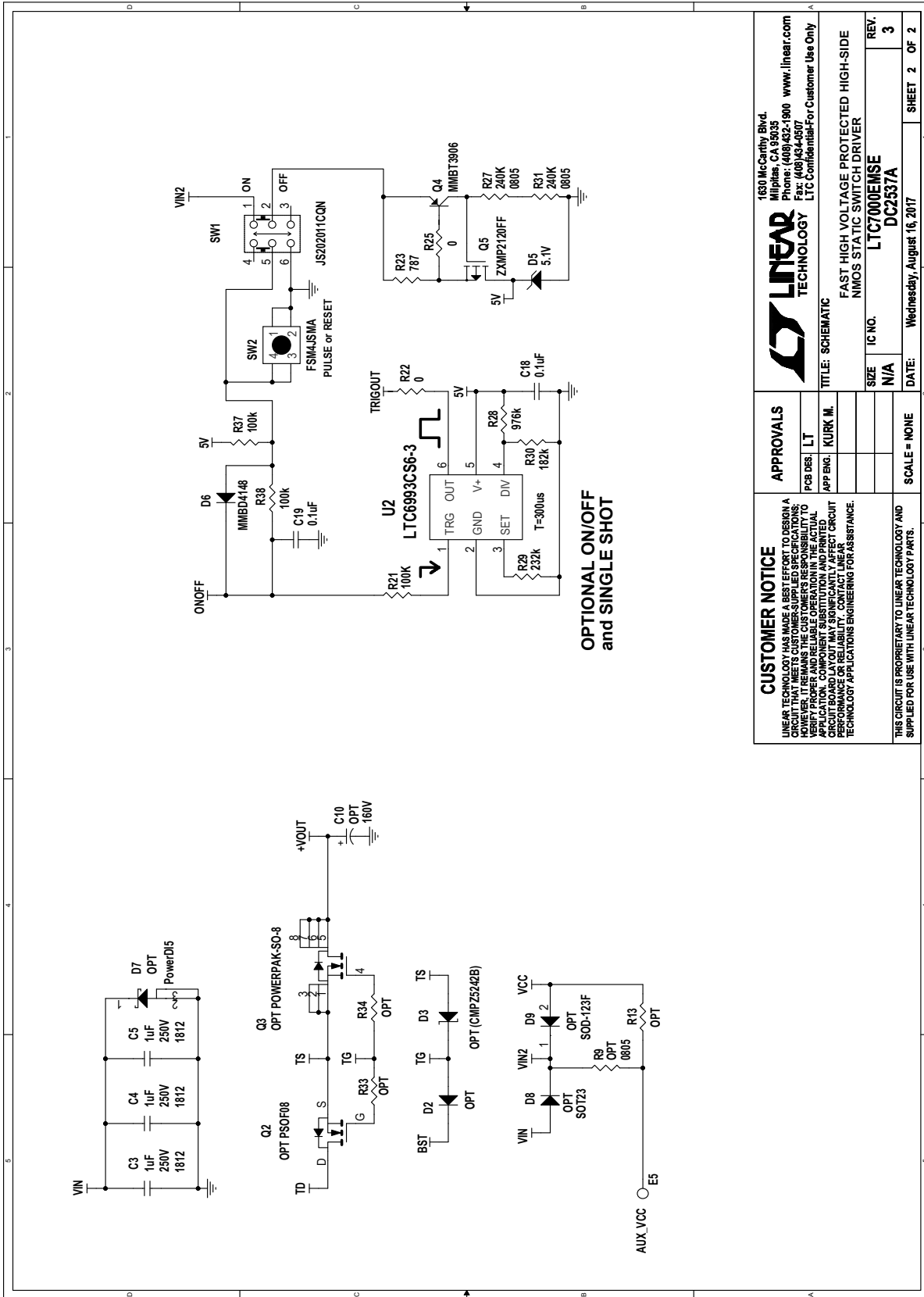
REVISION HISTORY			
ECO	REV	DESCRIPTION	APPROVED DATE
—	3	PRODUCTION	KURK M. 06-16-17

		1430 McCarty Blvd. Wilmington, MA 01897 Phone: 408-822-0900 www.linear.com Fax: 408-822-4507	
LINEAR TECHNOLOGY		LTC Confidential For Customer Use Only	
APPROVALS		TITLE: SCHEMATIC	
PCB DES: LT	APP'NG: KURK M.	FAST HIGH VOLTAGE PROTECTED HIGH-SIDE NMOS STATIC SWITCH DRIVER	
SIZE: N/A	IC NO: LTC7000EMSE	REV. 3	
SCALE: NONE	DATE: Wednesday, August 16, 2017	DC2537A	
SHEET 1 OF 2		DATE:	

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		SCALE = NONE	
		TITLE: SCHEMATIC	
		FAST HIGH VOLTAGE PROTECTED HIGH-SIDE NIMOS STATIC SWITCH DRIVER	
		1630 McCarty Blvd. Millsites, CA 95035 Phone: (408)432-1900 www.linear.com Fax: (408)434-0507 LTC Confidential-For Customer Use Only	
		SIZE N/A	
		IC NO. LTC7000EMSE	
		REV. 3	
		DATE: Wednesday, August 16, 2017	
		SHEET 2 OF 2	

DEMO MANUAL DC2537A

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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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