

LTC4364HDE-1,2 12V Surge Stopper with Ideal Diode

DESCRIPTION

Demonstration circuit 2027A showcases the [LTC®4364](#) surge stopper with ideal diode in a 12V, 1A application. DC inputs of up to 80V and transients to 250V are limited to just 28.7V at the output. Sagging and reverse-polarity inputs of up to -24V are isolated from the output by a reverse-blocking MOSFET configured as an ideal diode. Further, the output is protected against backfeeding. The output may be driven -20V to +30V without circuit damage or backfeeding into the input.

A 4.7µF timer capacitor and robust forward MOSFET permit the load to operate through ISO-7637-2 load dump

waveform 5A. Sustained overvoltage or overcurrent conditions cause the LTC4364 to turn off after a timer delay. The LTC4364-1 (DC2027A-A) latches off and is reset by pulling $\overline{\text{SHDN}}$ low for at least 100µs. The LTC4364-2 (DC2027A-B) automatically retries after a three minute cool down delay. Start-up and retry are inhibited in the presence of an input overvoltage.

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

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Limits	Operating	6.6	12	27	V
	DC Survival	-24		80	V
	1ms Transient			250	V
Output Voltage Limits	Regulation Voltage	27.2	28.7	30.3	V
	DC Backfeed Protection	-20		30	V
Output Current Capability	Operating			1	A
	Current Limit	2.125	2.5	2.875	A

QUICK START PROCEDURE

DANGER! HIGH VOLTAGE TESTING SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

As a safety precaution at least two people should be present during high voltage testing.

Board Layout

DC2027A is a 2-layer board. There are planes for input, output and ground; these are replicated on each layer. The 93mil input and output connection turrets are not swaged and may be removed for attachment of up to 12 AWG wire. Banana jacks facilitate bench testing. There are exposed conductors on the bottom of the board, and any banana

plugs present will protrude through the bottom of the board. The underlying surface should be nonconductive and clear of any wire, solder and other conductive debris.

The input plane is designed to have at least 78mil (2mm) clearance to adjacent conductors. This is adequate for 100V_{DC} standoff and transients to 250V. Spikes and surges are withstood by RLED1, QLED1, ROV1, RUV1, R4, Q1 (if present), D3, M1, RSNUB and CSNUB. These components are chosen for wide pad spacing, pulse power capability and voltage stand off, but ultimately limit the maximum transient input voltage to ~250V. The time spent above 80V is limited by the pulse power capability of R4.

QUICK START PROCEDURE

OPERATION

DC2027A has been designed for 12V operation with a load of up to 1A. M1 limits surges, spikes and transients, such as are commonly encountered in automotive applications. For positive-going events, the output is regulated at 28.7V. Spikes of up to 250V are permissible for 1ms, limited by the pulse capability of R4. The load may continue operating during positive transients, including load dump, without interruption.

Reverse inputs of up to $-24V_{DC}$ are blocked from reaching the load by M2. Beyond $-24V$, a 400W transient voltage suppressor, D4, clamps the input. Consult the SMAJ24A data sheet for specific information about peak current and time duration for spikes exceeding $-24V$.

DC2027A-A is fitted with the LTC4364-1. This device latches off after a sustained overcurrent or overvoltage fault. Operation is resumed after cycling the supply, or after pulsing \overline{SHDN} low for at least 100 μ s.

DC2027A-B is fitted with the LTC4364-2, which also shuts off the output in the presence of a sustained fault condition, but automatically retries after a cool-down delay of 180 seconds. The cool-down delay may be prematurely interrupted by pulsing \overline{SHDN} low for at least 100 μ s.

In both cases, retry is inhibited by the OV pin if the input is higher than 16.8V, as is start-up.

While a maximum load current of 1A is permitted during start-up and overvoltage conditions, current limit is set to 2.5A. This higher current level is permissible during normal (12V) operation. In short-circuit conditions where $V_{OUT} = 0V$, current limit folds back to 1.25A.

The output is protected against backfeeding over a range of $-20V$ to 30V. If the output is connected to a low impedance source of less voltage than the input, M1 will likely go into current limit and fault off. If the output is higher than the input, M2 will block backfeeding. In the case that the output is higher than the 28.7V regulation voltage, the timer will run and M1 will fault off.

Optional Components

The pulse power limitations of R4 may be avoided by adding Q1. Pads are located on the bottom of the board. Remove RVCC (a 0 Ω jumper) and increase R4 to 270k (see Figure 1). Remember that the board spacing is only 78mils, and that this is inadequate for creepage and clearance at 250V $_{DC}$.

Pads are included on the bottom of the board for optional output capacitors COUT3 and COUT4, in the event additional bypassing is desired.

Through-hole pads are included for adapting DC2027A to an off-board power stage, as shown in Figure 2.

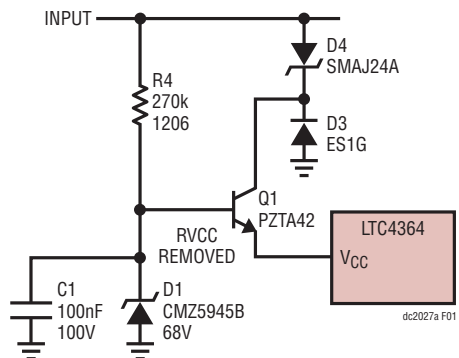


Figure 1. Remove RVCC and Add Q1 to Withstand Prolonged Inputs of Up to 250V. R4 Is Increased to 270k

QUICK START PROCEDURE

Small Turrets

No connection to any of the small turrets is necessary to make the board operate—the LTC4364 defaults to the ON state.

SHDN is pulled high internally. If this turret is left open, the board will turn on when power is applied. Short this turret to ground to turn off the LTC4364.

FLT is an open-drain output which pulls low after a TMR interval if there is a sustained input overvoltage, and does so 94ms before the output shuts down. In overcurrent there is a brief early warning delay, the exact time of which depends on the severity of the overload. There is no pull-up resistor for FLT; it must be pulled up to an external logic supply or to the output with an external resistor. FLT can sink up to 2mA.

ENOUT is an open-drain output which goes high when the output rises to within 700mV of the VCC pin. ENOUT is latched and does not pull low again until the LTC4364 output drops below 2.2V. There is no pull-up resistor for ENOUT; it must be pulled up to an external logic supply or to the output with an external resistor. ENOUT can sink up to 2mA.

TMR is made available so that its operation may be examined easily with an oscilloscope, by way of a 10MΩ probe. Do not load or short this turret to ground as the timer function will be defeated and an overload may destroy M1. TMR normally sits at ground, and charges to 1.35V in a fault condition. This turret also finds use for connecting different values of CTMR: simply remove the existing CTMR and solder substitutes between the TMR and GND turrets.

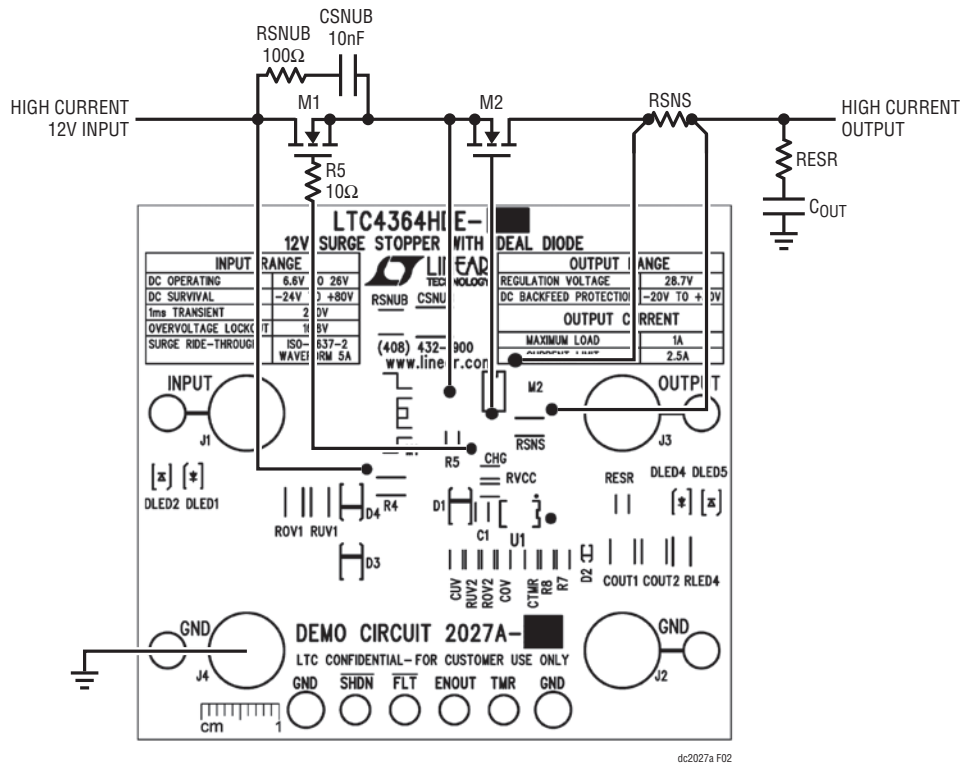


Figure 2. Connections to an Off-Board Power Stage. Remove M1, M2, RSNS, RSNUB and RESR from Board. Keep Wires Short to Avoid Parasitic Oscillations in M1

QUICK START PROCEDURE

HOW TO OPERATE DC2027A

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As a safety precaution at least two people should be present during high voltage testing.

To operate DC2027A, connect a 12V supply to the input and a 1A load to the output, as shown in Figure 3.

The circuit will turn on automatically when power is applied. Up to $-24V_{DC}$ may be applied to the input without damage to DC2027A or the load. The output may be backfed with $-20V$ to $30V$, without damage to DC2027A or backfeeding of the input.

The preferred method of coupling a transient to the input without backfeeding the 12V supply is to simply isolate the sources with blocking diodes, as shown in Figure 4.

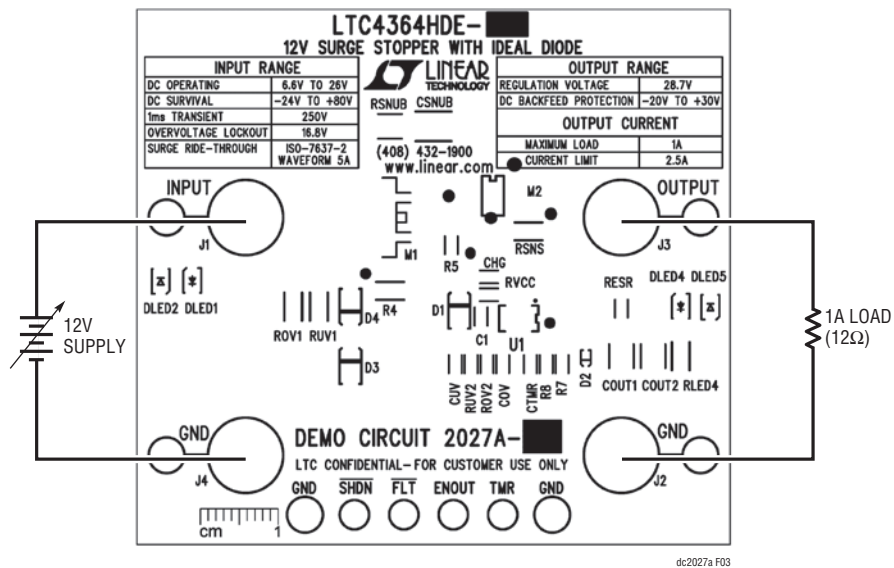


Figure 3. Basic Test Setup

QUICK START PROCEDURE

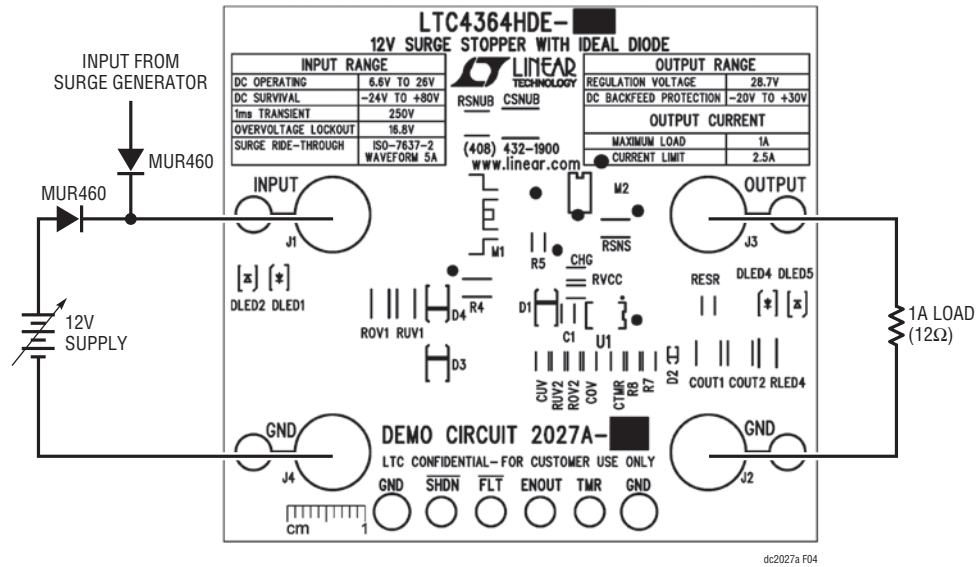


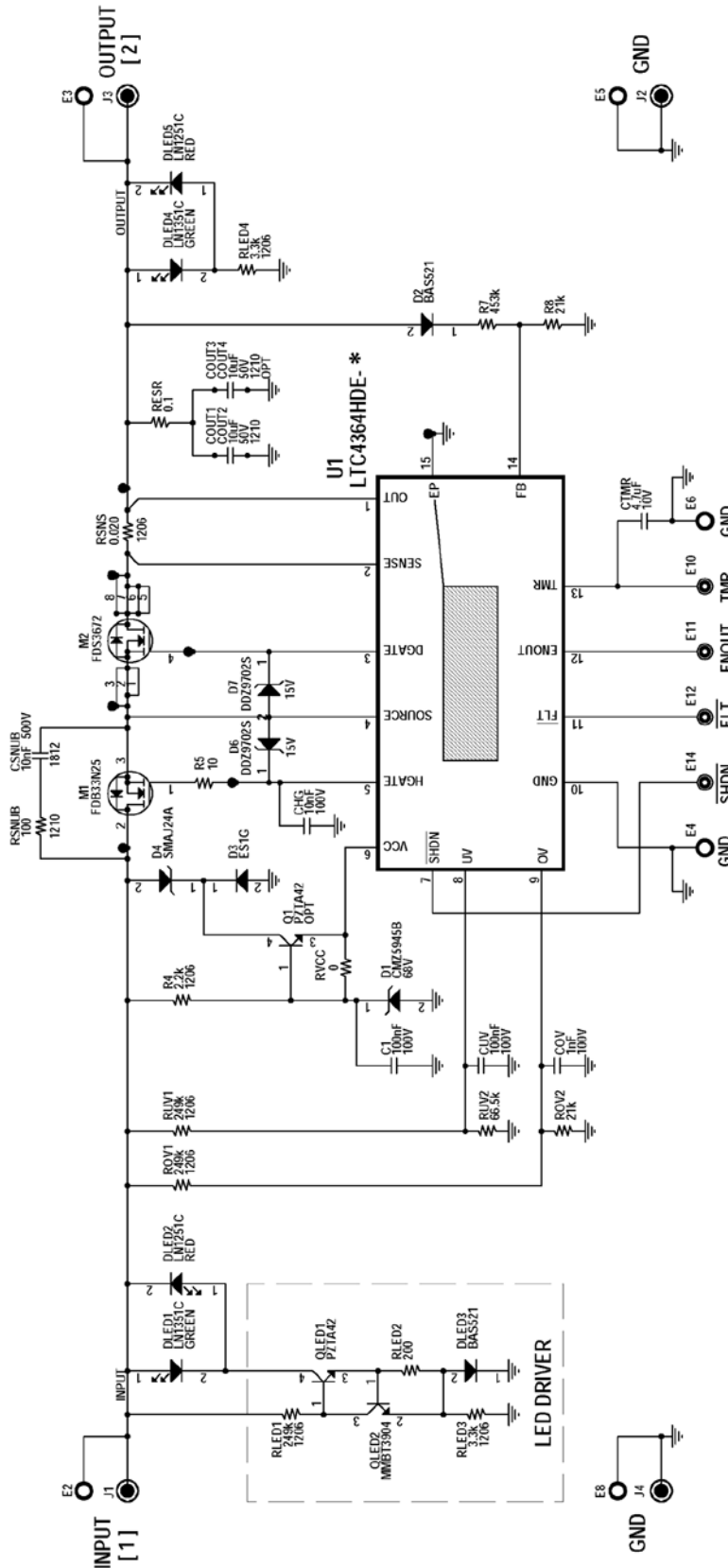
Figure 4. Simple Means of Coupling Surges, Transients and Spikes

DEMO MANUAL DC2027A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CHG	CAP., X7R, 10nF, 100V, 20%, 0805	AVX, 08051C103MAT2A
2	2	COUT1, COUT2	CAP., X7S, 10µF, 50V, 20%, 1210	TDK, C3225X7S1H106M
3	0	COUT3, COUT4	CAP., X7S, 10µF, 50V, 10%, 1210	OPT
4	1	COV	CAP., X7R, 1nF, 100V, 20%, 0805	AVX, 08051C102MAT2A
5	1	CSNUB	CAP., X5R, 10nF, 500V, 20%, 1812	AVX, 18127C103MAT2A
6	1	CTMR	CAP., X5R, 4.7µF, 10V, 10%, 0805	TDK, C2012X5R1A475K
7	2	C1, CUV	CAP., X7R, 100nF, 100V, 20%, 0805	AVX, 08051C104MAT2A
8	2	DLED1, DLED4	LED, GREEN J-TYPE, LED-LN1351C-GREEN	PANASONIC, LN1351C-TR
9	2	DLED2, DLED5	LED, RED J-TYPE, LED-LN1251C-RED	PANASONIC, LN1251C-TR
10	2	D2, DLED3	DIODE, 300V, 250mA, SOD523	DIODES/ZETEX, BAS521-7
11	1	D1	DIODE, ZENER, 68V, 1.5W, SMA-DIODE	CENTRAL SEMI., CMZ5945B
12	1	D3	DIODE, RECTIFIER, 400V, 1.0A, SMA-DIODE	DIODES INC., ES1G-13-F
13	1	D4	DIODE, TVS, 24V, 400W, SMA-DIODE	DIODES INC., SMAJ24A-13-F
14	2	D6, D7	DIODE, DDZ9702S, 15V, 200mW, SOD323	DIODES INC., DDZ9702S-7
15	6	E2, E3, E4, E5, E6, E8	TESTPOINT, TURRET, 0.094	MILL-MAX, 2501-2-00-80-00-00-07-0
16	4	E10, E11, E12, E14	TESTPOINT, TURRET, 0.064	MILL-MAX, 2308-2-00-80-00-00-07-0
17	4	J1, J2, J3, J4	BANANA JACK, NON-INSULATED	KEYSTONE, 575-4
18	1	M1	MOSFET, N-CH, 250V, D2-PAK	FAIRCHILD, FDB33N25TM
19	1	M2	MOSFET, N-CH, PWR 100V, 7.5A, SO8	FAIRCHILD, FDS3672
20	1	QLED1	TRANSISTOR, NPN, 300V, SOT223	FAIRCHILD, PZTA42
21	1	QLED2	TRANSISTOR, NPN, 40V, SOT-23	DIODES/ZETEX, MMBT3904-7-F
22	0	Q1	TRANSISTOR, PZTA42, NPN, 300V, SOT223	OPT
23	1	RESR	RES., SENSE, 0.1, 1/8W, 5%, 0805	NIC, NCST10JR100HTRF
24	3	RUV1, ROV1, RLED1	RES., CHIP, 249k, 1/4W, 1%, 1206	NIC, NRC12F2493TRF
25	1	RLED2	RES., CHIP, 200, 1/8W, 5%, 0805	NIC, NRC10J201TRF
26	2	RLED3, RLED4	RES., CHIP, 3.3k, 1/4W, 5%, 1206	NIC, NRC12J332TRF
27	2	ROV2, R8	RES., CHIP, 21k, 1/8W, 1%, 0805	NIC, NRC10F2102TRF
28	1	RSNS	RES., SENSE, 0.02, 1/4W, 5% 1206	NIC, NCST12JR020JTRF
29	1	RSNUB	RES., CHIP, 100, 1/2W, 5%, 1210	NIC, NRCP25J101TRF
30	1	RUV2	RES., CHIP, 66.5k, 1/8W, 1%, 0805	NIC, NRC10F6652TRF
31	1	RVCC	RES., CHIP, 0, 0805	NIC, NRC10Z0TRF
32	1	R4	RES., CHIP, 2.2k, 1/4W, 5%, 1206	NIC, NRCP12J222TRF
33	1	R5	RES., CHIP, 10, 1/8W, 5%, 0805	NIC, NRC10J100TRF
34	1	R7	RES., CHIP, 453k, 1/8W, 1%, 0805	NIC, NRC10F4533TRF
35	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON 0.5"	KEYSTONE, 8833 (SNAP-ON)
36	1	U1	I.C., LTC4364HDE-1, DC2027A-A	LINEAR TECHNOLOGY, LTC4364HDE-1
37	1	U1	I.C., LTC4364HDE-2, DC2027A-B	LINEAR TECHNOLOGY, LTC4364HDE-2

SCHEMATIC DIAGRAM



OUTPUT RANGE	
REGULATION VOLTAGE	-28.7V
DC BACKFEED PROTECTION	-20V TO +30V
OUTPUT CURRENT	
MAXIMUM LOAD	1A
CURRENT LIMIT	2.5A

ASSY	U1	TOP MARK	BEHAVIOR
DC2027A-A	LTC4364HDE-1	43641	LATCH OFF
DC2027A-B	LTC4364HDE-2	43642	AUTO RETRY

INPUT RANGE	
DC OPERATING	6.6V TO 26V
DC SURVIVAL	-24V TO +80V
1ms TRANSIENT	250V
OVERVOLTAGE LOCKOUT	16.8V
SURGE RIDE-THROUGH	ISO-7637-2 WAVEFORM 5A

DEMO MANUAL DC2027A

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

Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

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