LTC4381
6µA I_Q Surge Stopper with 9mΩ MOSFET

DESCRIPTION

The DC2713A circuit board enables evaluation of the LTC®4381, low quiescent current surge stopper with 9mΩ MOSFET, in 12V to 48V applications. The LTC4381 clamps the output voltage, permitting the load to operate safely through 100V transients and load dump surges such as ISO 16750-2 Test A. Current limiting protects the input supply from output overload and short-circuits. In the presence of a sustained input overvoltage or output overload, the LTC4381 shuts off after a delay to protect the internal power MOSFET.

DC2713A is available in four assembly options, from DC2713A-A to DC2713A-D. DC2713A-A/DC2713A-B employ a jumper to set the output clamp voltage to either 28.5V or 47V, to suit 12V or 24V/28V systems. DC2713A-C/DC2713A-D clamp the output to 66.5V for 48V applications. DC2713A-A/DC2713A-C latch off after a fault, whereas DC2713A-B/DC2713A-D automatically restart after a cool down delay.

Design files for this circuit board are available.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

	DC2713A-A	DC2713A-B	DC2713A-C	DC2713A-D
Surge Stopper (Top Mark)	LTC4381-1 (43811)	LTC4381-2 (43812)	LTC4381-3 (43813)	LTC4381-4 (43814)
Typical System Voltage	12V or 24V/28V		48V	
Output Clamp Select	28.5V (JP1 = 28V) or 47V (JP1 = 47V)		66.5V	
DC Operating	8V to 20V (JP1 = 28V) or 38V (JP1 = 47V)		8V to 60V	
DC Survival	100V		60V (Due to D2 TVS)	
Load Dump Survival	ISO 16750-2 Test A for 12V with 500mA Load		NA	
Current Limit	625mA (OUTPUT > 3V), 775mA (OUTPUT < 1V)		12.5A (OUTPUT > 3V), 15.5A (OUTPUT < 1V)	
Maximum Load Current	500mA		10A	
Cooldown/Retry Delay	560s (= 9min 20s)		733ms	
Fault Retry Behavior	Latch Off	Auto Retry	Latch Off	Auto Retry

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. There are exposed conductors on the bottom of the board, and any banana plugs present will protrude through the bottom of the board. Even though the board is equipped with standoffs, the underlying surface should be non-conductive and clear of any wire, solder, and other conductive debris.

A simple demonstration of DC2713A's operation is as follows:

1. For DC2713A-A/DC2713A-B, set jumper JP1 for 28V or 47V clamping. JP1 position doesn't matter for DC2713A-C/DC2713A-D due to a fixed 66.5V clamp.
2. Connect a power supply to INPUT (through a diode for Step 4) and a load to OUTPUT (initially off) as shown in Figure 1. The small turrets do not need any connections. Applying input power, above 2.5V, turns on the circuit as indicated by the green LED at the output. At rated load, the input to output voltage drop should be around 50mV for DC2713-A/DC2713A-B and 200mV for DC2713A-C/DC2713A-D. For DC2713A-C/DC2713A-D, the installed 22nF TMR capacitor starts up a 47μF load capacitor (including installed CL).
3. Connect ON to GND to turn off the output. Release it or pull above 1.1V to turn the output back on again.
4. Couple a voltage surge through a second diode to the input to test the clamping action of DC2713A-A/DC2713A-B. The diodes permit surge testing by protecting the power supply and surge generator against back-feeding.
5. To measure the LTC4381 operating quiescent current of 6μA at 12V input, disconnect any output loading and subtract DLED current (= $V_{RLED}/100k\Omega$) from the input current.

QUICK START PROCEDURE

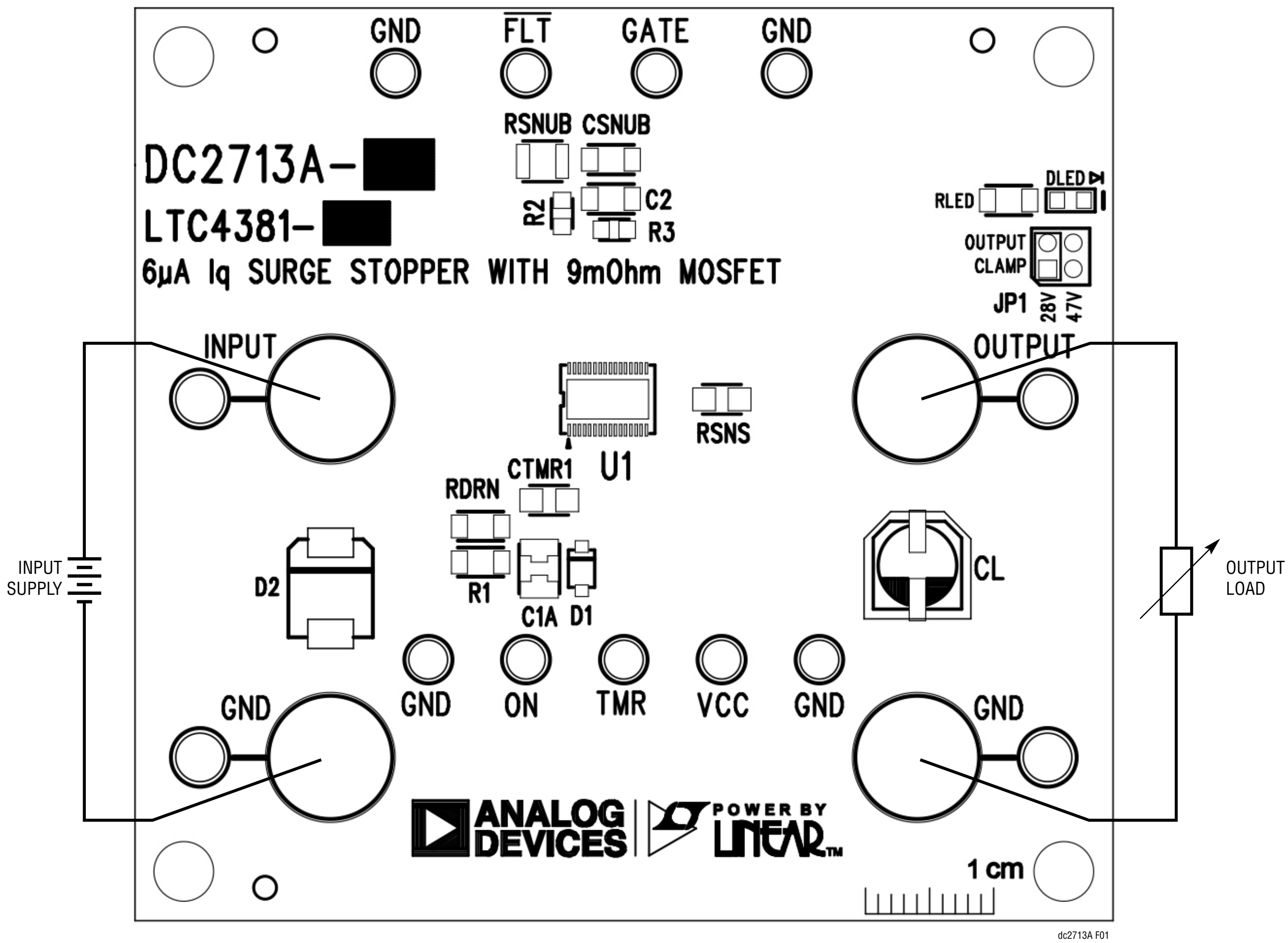

Figure 1. Measurement Equipment Setup

BOARD DESCRIPTION

Overview

DC2713A is a 2-layer board with 2oz copper on each layer. There are large planes for input, output, and ground. Where possible, the input plane is designed to have at least 79mil (2mm) clearance to adjacent conductors, to support 100V DC standoff. Spikes and surges are withstood by R1 and RDRN. These components are chosen for wide pad spacing, pulse power capability, and voltage standoff.

To ease probing, turrets are provided for TMR, V_{CC}, and GATE pins. Note that even a 10MΩ probe or voltmeter affects measurements of high impedance nodes such as GATE and TMR. Be careful not to short TMR to ground as it prevents the LTC4381 from shutting down in the event of an overvoltage or overcurrent condition, potentially damaging the LTC4381.

The vast gulf between the current capability of DC2713A-A/DC2713A-B (0.5A) and DC2713A-C/DC2713A-D (10A) illustrates a fundamental principle of surge stopper (or hot swap) application design: the current capability depends not just on MOSFET $R_{DS(ON)}$ or $I_{D(max)}$ ratings but also on the MOSFET power dissipation during stressful transients such as start-up inrush, current limiting, and output regulation during input surge. Since DC2713A-A/DC2713A-B is designed to ride-through the long duration load dump surge, its timeout has been prolonged with a 16.8μF TMR capacitor (versus 22nF on DC2713A-C/DC2713A-D), reducing its current capability.

Below is a brief description of the main components of DC2713A.

U1 – Surge Stopper

Depending on the DC2713A assembly version, U1 is LTC4381-1, LTC4381-2, LTC4381-3, or LTC4381-4 in a 32-pin 7mm × 5mm DFN package. Please refer to the LTC4381 data sheet for details on its operation and electrical specifications.

D1, C1, R1, D2 – V_{CC} Clamp

The LTC4381 V_{CC} pin's absolute maximum voltage is 80V. Power is applied from the input to the V_{CC} pin through a 10kΩ resistor (R1), filtered by a 0.1μF capacitor (C1A) and clamped by D1 to 56V. In DC2713A-C/DC2713A-D, D1 sets the output clamp voltage to 56V + 10.5V = 66.5V. The optional C1B capacitor can be used as a holdup reservoir in cold crank applications where the input voltage is expected to fall below 8V. In DC2713A-C/DC2713A-D, D2 prevents internal MOSFET avalanche during >100V spikes generated on MOSFET turn off by a long supply cable. D2 (and snubber) can be omitted for short cables or replaced with a capacitor if hot plug is not needed.

DLED – Output Voltage Indicator

A green LED indicates the presence of output voltage. If the LTC4381 faults off, DLED extinguishes. RLED is chosen so that the brightness will fluctuate with changes in output voltage, from relatively dim at 8V to very bright at 60V. The LTC4381's operating quiescent current (I_Q) is 6μA at 12V input; remove RLED or subtract DLED current to measure I_Q.

JP1 – Jumper to Select Clamp Voltage

JP1 sets the state of the SEL pin for DC2713A-A/DC2713A-B. SEL grounded corresponds to an output clamp of 28.5V; SEL tied to OUT selects an output clamp of 47V. In DC2713A-C/DC2713A-D, JP1 can be set to any position; the SEL pin has no effect and clamping is dictated by the 56V breakdown voltage of D1, i.e., output clamp = 56V + 10.5V = 66.5V.

Optional Component Pads

Some components are provided with extra unstuffed pads (C1B, CTMR2, D2, D3) to try out different values and sizes or other circuits from the LTC4381 data sheet. For instance, each RSNS, CTMR1, and CTMR2 footprint accommodates 0805 or 1206 size components; C1A and C1B footprints accommodate 0805, 1206, or 1210 sizes. D3 is an external GATE-to-OUT clamp, that may be required in some 48V applications to protect the GATE pin against discharge of C2 during output short circuit events (e.g., where C2 ≥ 100nF).

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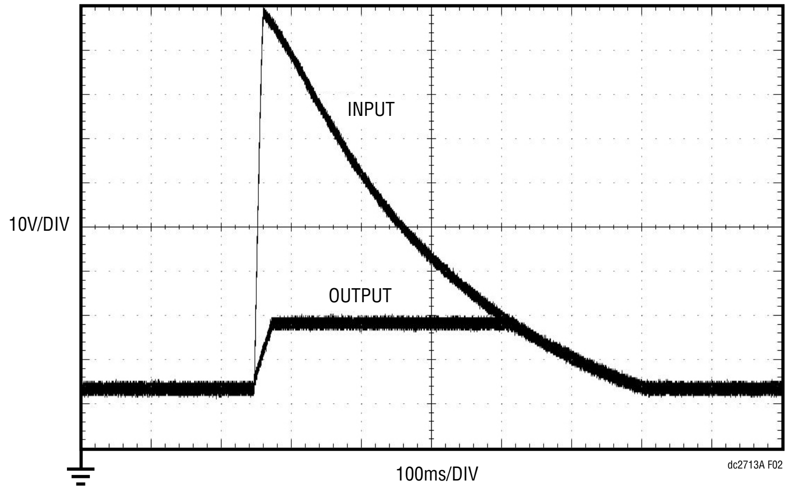

Figure 2. DC2713A-B Clamps Output to 28.5V During an ISO 16750-2 Test A Input Transient with 500mA Load

ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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