LTC4365/LTC4365-1: Overvoltage, Undervoltage and Reverse Supply Protection Controller

DESCRIPTION

Demonstration circuit DC1555C is intended to demonstrate the performance of the LTC4365 and LTC4365-1 Undervoltage, Overvoltage and Reverse Supply Protection Controllers.

The LTC®4365/LTC4365-1 protect circuits from input voltages that may be too high, too low or negative. It operates by controlling the gates of two back-to-back connected MOSFETs to keep the output in a safe range. The OV and UV protection levels are adjusted by resistive dividers at the OV and UV pins. Asserting the $\overline{SHDN}$ pin disables the MOSFETs and places the controller in a low-current shutdown state. The $\overline{FAULT}$ pin is asserted when the Controller is in shutdown mode or when the input voltage is outside of the UV or OV level.

The LTC4365 and LTC4365-1 can withstand DC voltages between –40V and +60V and have a valid operating range of 2.5V to 34V.

Regarding the supply protection parameters, the LTC4365 and LTC4365-1 are identical. The only differences are in the gate fault recovery delay time and the delay from turn-off to low-power operation. These delays are 36ms (typ, both) for the LTC4365, while they are 1ms and 0.7ms respectively for the LTC4365-1.

The DC1555C includes the controller, two back-to-back connected power MOSFETs, three jumpers and three LEDs to indicate the input and output voltages and the $\overline{FAULT}$ pin signal.

Design files for this circuit board are available at http://www.linear.com/demo/DC1555C

PERFORMANCE SUMMARY (T_A = 25°C)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Board Input Voltage Range		–30		30	V
$V_{IN(UVLO)}$	Input Supply Undervoltage Lockout	V_{IN} Rising	1.8	2.2	2.4	V
I_{VIN}	Input Supply Current	$\overline{SHDN}$ = 0V $\overline{SHDN}$ = 2.5V		10 25	50 150	µA µA
$I_{VIN(R)}$	Reverse Input Supply Current	V_{IN} = –40V, V_{OUT} = 0V		–1.2	–1.8	mA
ΔV_{GATE}	External N-Channel Gate Drive (GATE – V_{OUT})	V_{IN} = V_{OUT} = 5V, I_{GATE} = –1µA V_{IN} = V_{OUT} = 12V to 34V, I_{GATE} = –1µA	3 7.4	3.6 8.4	4.2 9.8	V V
$I_{GATE(UP)}$	External N-Channel Gate Pull-Up current	GATE = V_{IN} = V_{OUT} = 12V	–12	–20	–30	µA
$I_{GATE(FAST)}$	External N-Channel Fast Gate Pull-Down Current	Fast Shutdown, GATE = 20V, V_{IN} = V_{OUT} = 12V	31	50	72	mA
$I_{GATE(SLOW)}$	External N-Channel Gentle Gate Pull-Down Current	Gentle Shutdown, GATE = 20V, V_{IN} = V_{OUT} = 12V	50	90	150	µA
V_{UV}	UV Input Threshold Voltage	UV Falling → ΔV_{GATE} = 0V	492.5	500	507.5	mV
V_{OV}	OV Input Threshold Voltage	OV Rising → ΔV_{GATE} = 0V	492.5	500	507.5	mV
$t_{GATE(FAST)}$	External N-Channel Fast Gate Turn-Off Delay	C_{GATE} = 2.2nF, UV or OV Fault		2	4	µs
t_{FAULT}	OV, UV Fault Propagation Delay	Overdrive = 50mV, V_{IN} = V_{OUT} = 12V		1	2	µs
V_{SHDN}	$\overline{SHDN}$ Input Threshold	$\overline{SHDN}$ Falling to ΔV_{GATE} = 0V	0.4	0.75	1.2	V

OPERATING PRINCIPLES

The LTC4365/LTC4365-1 monitors the input rail voltage and disconnects downstream circuits when the input voltage is too low, too high or negative. The LTC4365 provides accurate overvoltage and undervoltage comparators to ensure that power is applied to the system only if the input supply is within the allowable voltage window. Reverse supply protection circuit automatically isolates the load from negative input voltages.

During normal operation, a high voltage charge pump enhances the gate of external N-channel power MOSFETs.

The controller consumes 10µA during shutdown and 125µA while operating.

QUICK START PROCEDURE

Demonstration circuit 1555C is easy to set up to evaluate the performance of the LTC4365/LTC4365-1. Refer to Figures 1a and 1b for proper measurement equipment setup and follow the procedure below.

Note that the circuit on the DC1555C is optimized for 12V operation. The Si4230 FET limits overvoltage and reverse voltage to 30V and –30V, respectively. Refer to the LTC4365 data sheet for applications optimized for other voltages.

Reverse Voltage Tests (Figure 1a)

1) Set JP1 to EN.

2) Set JP2 and JP3 to CONNECT LED.

3) Connect a power supply across V_{IN} and GND in a negative configuration (connect positive rail to GND and negative rail to V_{IN}).

4) Connect voltmeters at the input and output and ammeter in series with supply.

5) Ramp supply down to –30V (referenced to GND).

6) Verify that the output voltage is between 0V and –0.5V, all LEDs are off, and the input current is <1.8mA. (FET leakage or other board leakage paths can pull V_{OUT} slightly negative, but it will be clamped by the internal protection diode.)

7) Ramp supply back to 0V.

Undervoltage/Overvoltage Test (Figure 1b)

8) Reverse the polarity of power supply connection across V_{IN} to GND (connect positive rail to V_{IN} and negative rail to GND).

9) Ramp supply up to 30V and verify green V_{IN} LED, red $\overline{FAULT}$ LED, green V_{OUT} LED, and V_{OUT} according to Table 1 within the various voltage ranges.

10) Ramp supply down from 30V down to 0V and verify green V_{IN} LED, red $\overline{FAULT}$ LED, green V_{OUT} LED, and V_{OUT} according to Table 1.

11) Repeat steps 9 and 10 with 8A load connected across V_{OUT} and GND.

Table 1

V_{IN}	V_{OUT}	V_{IN} LED	V_{OUT} LED	$\overline{FAULT}$ LED
0V to 5.77V	= 0V	Off/Dim/On	Off	On
6.56V to 13.51V	= V_{IN}	On	On	Off
15.47V to 30V	= 0V	On	Off	On

Jumper Test

12) Remove load and set supply to 9V.

13) Move jumpers and verify LEDs according to Table 2.

Table 2

JP1	JP2/JP3	VIN LED	VOUT LED
EN	CONNECT LED	On	On
DIS	CONNECT LED	On	Off
EN	Open	Off	Off

QUICK START PROCEDURE

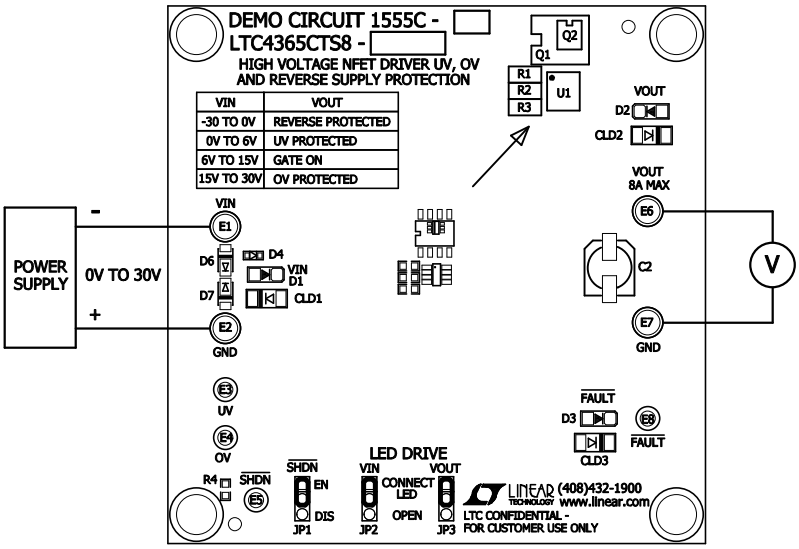


Figure 1a. Reverse Voltage Measurement

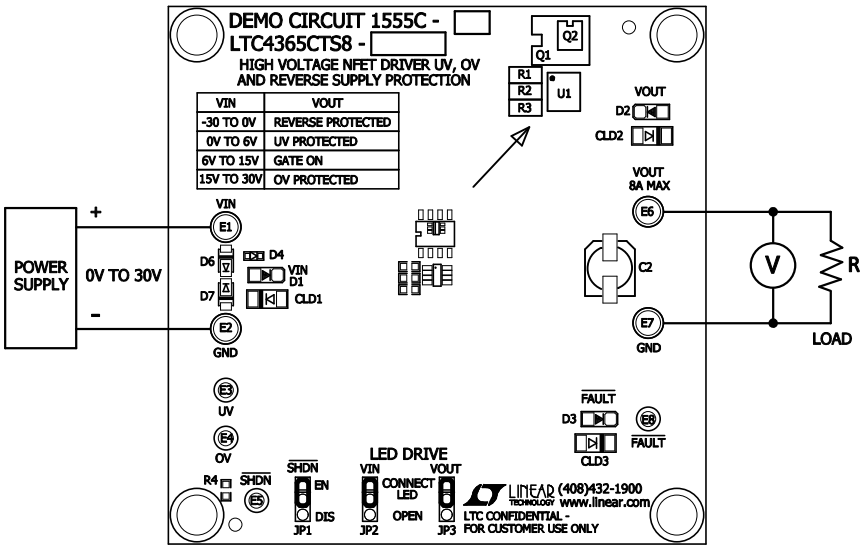
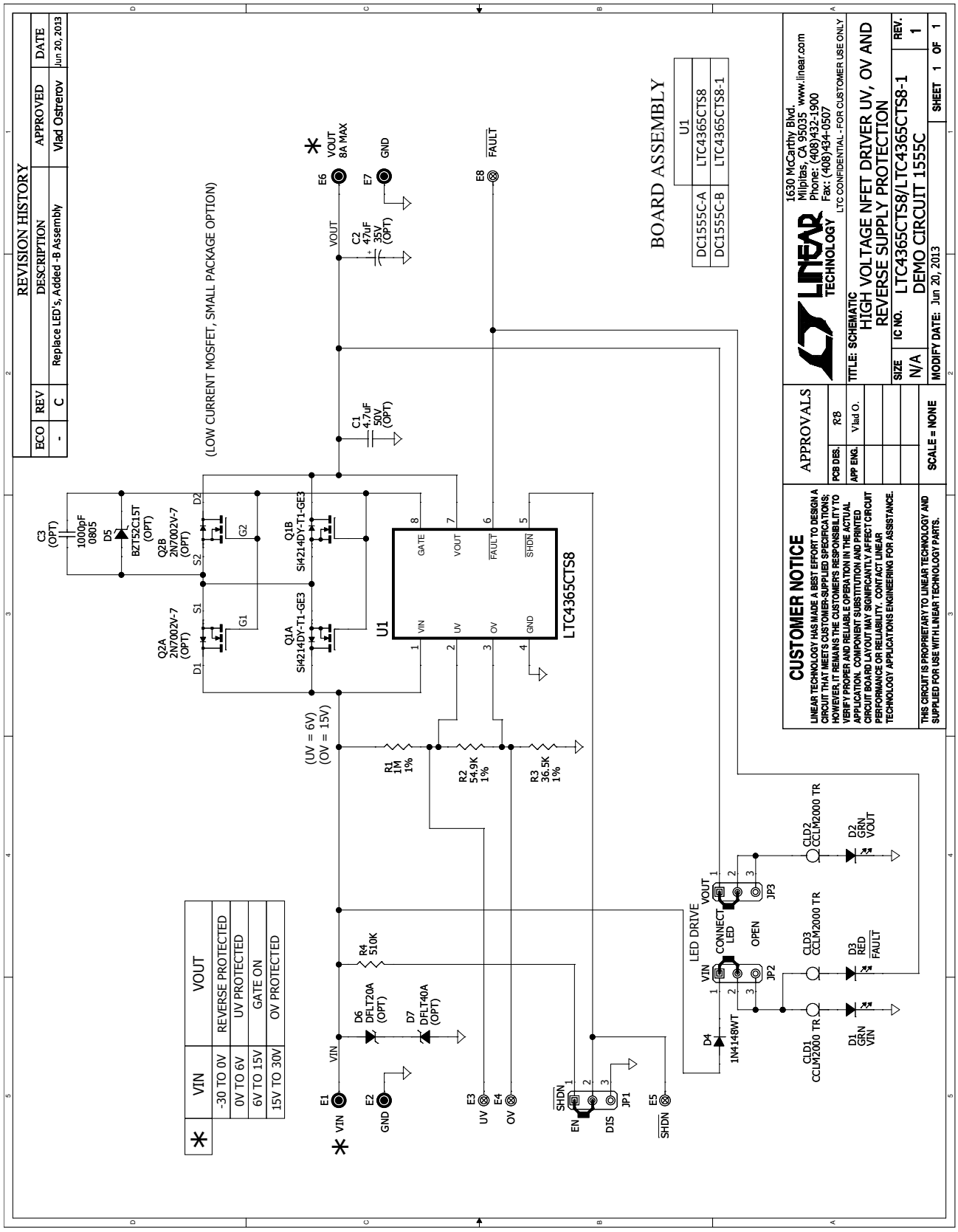


Figure 1b. Undervoltage/Overvoltage Measurement

PARTS LIST

ITEM	QUANTITY	REFERENCE	DESCRIPTION	MANUFACTURERS PART NUMBER
1	3	CLD1, CLD2, CLD3	Current Limiting, Diode SOD-80	Central Semi. Corp. CCLM2000 TR
2	0	C1 (OPT)	Cap., X5R 4.7µF 50V 20% 1210	Taiyo Yuden UMK325BJ475MM-T
3	0	C2 (OPT)	Cap., Alum 47µF 35V 10%	SANYO 35CE47AX
4	0	C3 (OPT)	Cap., X7R 1000pF 50V 10% 0805	AVX 08055C102KAT1A
5	2	D1, D2	LED, GRN	Rohm Semi. SML-010FTT86L
6	1	D3	LED, RED	Rohm Semi. SML-010VTT86L
7	1	D4	Diode, 75V/200mW SOD-523	Diodes Inc. 1N4148WT
8	0	D5 (OPT)	Zener Diode, 15V SOD-523	Diodes Inc. BZT52C15T #PBF
9	0	D6 (OPT)	Zener Diode, 20V POWERDI-123	Diodes Inc. DFLT20A #PBF
10	0	D7 (OPT)	Zener Diode, 40V POWERDI-123	Diodes Inc. DFLT40A #PBF
11	4	E1, E2, E6, E7	Turret, Testpoint	Mill Max 2501-2-00-80-00-00-07-0
12	4	E3, E4, E5, E8	Turret, Testpoint	Mill Max 2308-2-00-80-00-00-07-0
13	3	JP1, JP2, JP3	Headers, Single Row 3 Pins 2mm Ctrs.	SULLINS NRPN031PAEN-RC
14	1	Q1	Dual N-Channel, 30V SO-8	Vishay Si4214DY-T1-GE3 (ALT) Vishay SI4230DY-T1-GE3
15	0	Q2 (OPT)	Dual N-Channel, Low Current SOT-563	Diodes Inc. 2N7002V-7
16	1	R1	Res., Chip 1M 0.1W 1% 0603	Vishay CRCW06031M00FKEA
17	1	R2	Res., Chip 54.9K 0.1W 1% 0603	Vishay CRCW060354K9FKEA
18	1	R3	Res., Chip 36.5K 0.1W 1% 0603	Vishay CRCW060336K5FKEDA
19	1	R4	Res., Chip 510K 0.1W 5% 0603	Vishay CRCW0603510KJNEA
20	3	XJP1, XJP2, XJP3	Shunt, 2mm Ctrs.	Samtec 2SN-BK-G
21	4		Stand-Off, Nylon 0.25" Tall	Keystone, 8831(Snap On)
22	1	U1	I.C., Overvoltage, Undervoltage and Reverse Supply Protection Controller for DC1555C-A	Linear Technology Corp. LTC4365CTS8
22	1	U1	I.C., Overvoltage, Undervoltage and Reverse Supply Protection Controller for DC1555C-B	Linear Technology Corp. LTC4365CTS8-1

SCHEMATIC DIAGRAM



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