LTC2945
Wide Range I^{2}C Power Monitor

DESCRIPTION

Demonstration circuit 1697A features the LTC2945. The LTC2945 is a rail-to-rail system monitor that measures current, voltage, and power. It features an operating range of 2.7V to 80V and includes a shunt regulator for supplies above 80V to allow flexibility in the selection of input supply. The current common mode measurement range of 0V to 80V is independent of the input supply. An onboard 0.75% accurate 12-bit ADC measures load current, input voltage and an auxiliary external voltage. A 24-bit power value is generated by digitally multiplying the measured 12-bit load current and input voltage data. Minimum and maximum values are stored and an overrange alert with programmable thresholds minimizes the need for software polling. Data is reported via a standard I^{2}C interface. The demo board is populated for a 5A application. This can be changed by populating R1 accordingly.

Design files for this circuit board are available at http://www.linear.com/demo/DC1697A

BOARD PHOTO

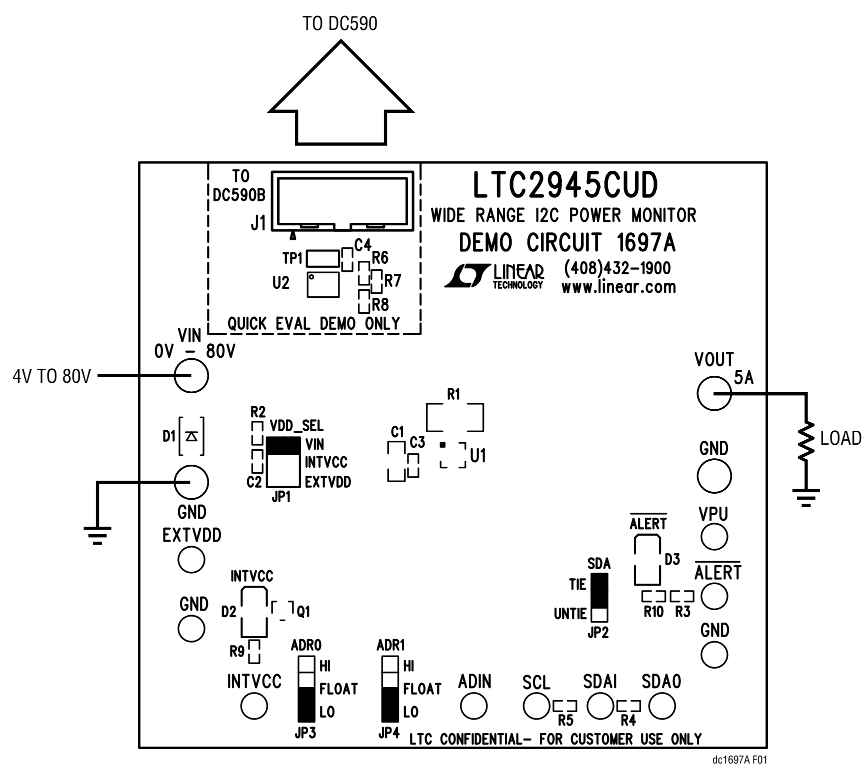


Figure 1. Proper Test Equipment Setup

QUICK START PROCEDURE

Jumper Settings

VDD_SEL: Selects the V_{DD} source. It can be set to VIN, INTVCC or EXTVDD (which requires a voltage to be present at the EXTVDD turret.) Please see Hardware Setup section for examples of how these different jumper settings are used.

SDA: Connects or separates the SDAI to SDAO pins. For use with QuikEval™, leave it on TIE. The pins can be separated in order to test applications using optoisolation.

ADR0, ADR1: Selects the I^{2}C slave address of the LTC2945. Any changes here should also be made inside of QuikEval for communications to persist.

External Connections

Signal connections are made via the row of turret posts along the edges of the board.

GND: (4 turrets)These turrets are connected directly to the ground planes.

VIN: Used as a supply and current sense input for the internal current sense amplifier. Depending on the configuration of VDD_SEL, can also be tied to EXTVDD.

EXTVDD: High Voltage Supply Input. This pin powers an internal series regulator with input voltages ranging from 5V to 80V and produces 5V for INTVCC when above 7V.

INTVCC: Internal Low Voltage Supply Input/Output. This turret is used to power internal circuitry and can be configured as a direct input, as a linear regulator from a higher voltage connected to V_{DD} or as a shunt regulator. Please see LTC2945 data sheet for more details.

ADIN: ADC input measured by the onboard ADC. Can measure between 0V and 2.048V.

VPU: Pull up voltage for the $\overline{\text{ALERT}}$ LED. Connected on this board to a 5V isolated supply on the DC590. If a DC590 is not used and the DC1697A is operated independently, a 5V supply should be provided here.

Digital Connections

SCL: I^{2}C Clock turret

SDA/SDAI: I^{2}C Bus Data input, can be tied to SDAO through the SDA Jumper.

SDAO: I^{2}C Bus Data output. Should be connected to SDAI.

$\overline{\text{ALERT}}$: Fault Alert Output. Connected to $\overline{\text{ALERT}}$ LED. Open Drain logic output that is pulled to ground after an event resulting in a fault occurs.

LEDs

$\overline{\text{ALERT}}$: Will light up red on an ALERT condition. Can also be monitored on the $\overline{\text{ALERT}}$ turret.

INTVCC: Will light up green when INTVCC is providing power.

Operating Principles

The DC1697A was designed to be connected to the DC590 and controlled through the QuikEval suite of software. All thresholds can be set and ADC registers read back through the QuikEval interface, which was designed to provide a convenient way to evaluate the LTC2945.

HARDWARE SETUP

Due to having separate V_{DD} and SENSE pins, the LTC2945 offers great flexibility in terms of supply options. The following are some examples of how to connect and set up the DC1697A based on different supply input configurations.

In order for the DC1697A to function, power must be applied. If the VDD_SEL jumper is set to VIN, then V_{DD} and V_{IN} are connected as shown in Figure 2. At this point, as long as 4V to 80V is provided at VIN the part will function correctly. However, should VDD_SEL be tied to EXTVDD then a separate voltage source should be provided at the EXTVDD turret. Should VDD_SEL be tied to INTVCC then, if VIN is less than 7V, a 5V supply should be provided at the INTVCC turret.

If the system is connected properly, the INTVCC green LED should be lit and the $\overline{\text{ALERT}}$ red LED should be off.

Jumper VDD_SEL Set to VIN to Tie V_{DD} to VIN

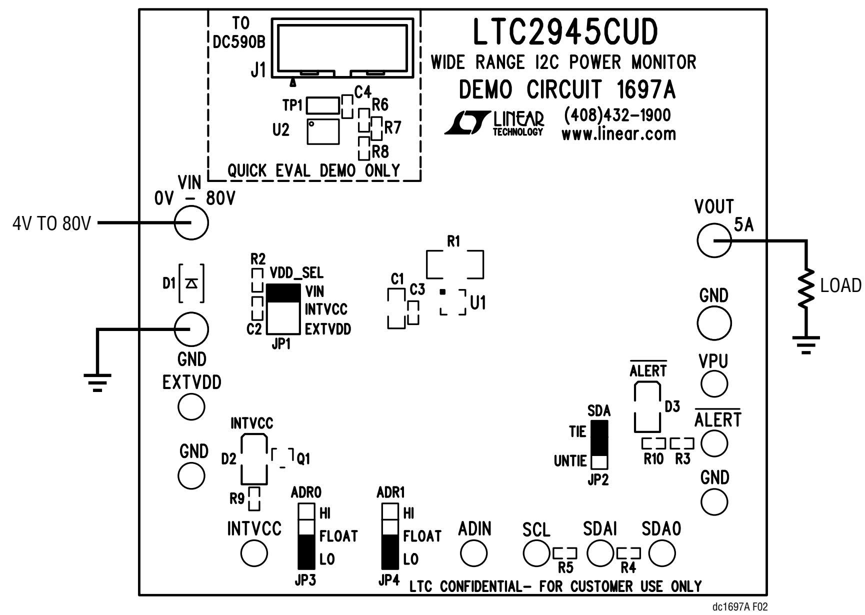


Figure 2. DC1697A Is Powered from Supply Being Monitored

HARDWARE SETUP

INTVCC can also be used as a 6.3V shunt regulator. For supplies greater than 80V, simply connect power through a shunt resister for high or low shunt configuration as shown in Figure 3 and 4 respectively. For this configuration, ensure VDD_SEL is set to INTVCC.

The 5k shunt resistor shown provides 15mA to INTVCC at 80V. The allowable range of resistance for a given input range is given by the following formula:

$$\frac{V_{S(MAX)} - 5.9V}{35mA} \le R_{SHNT} \le \frac{V_{S(MIN)} - 6.7V}{1mA + I_{LOAD(MAX)}}$$

The DC590 provides isolation and level shifting, as the I^2C interface is operating at 5.9V to 6.7V below the supply being monitored.

Jumper VDD_SEL Set to INTVCC With A Resistor Connected from DC1697 GND to Circuit Ground

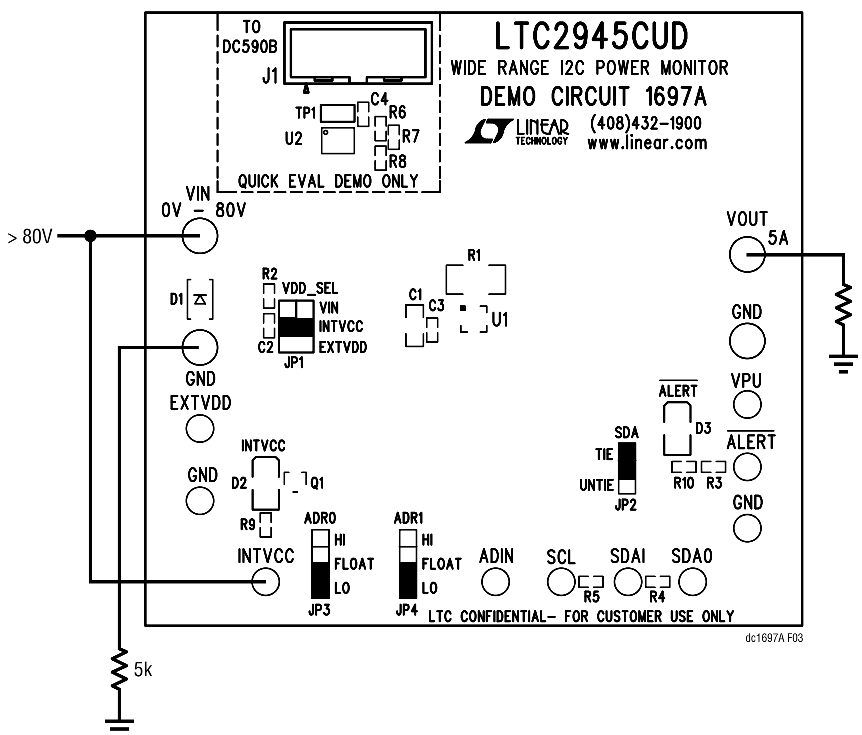


Figure 3. Powering DC1697A Using High-Side Shunt Regulator to Allow for Input Voltage Higher Than 80V

HARDWARE SETUP

Jumper VDD_SEL Set to INTVCC with a Resistor Connected to INTVCC

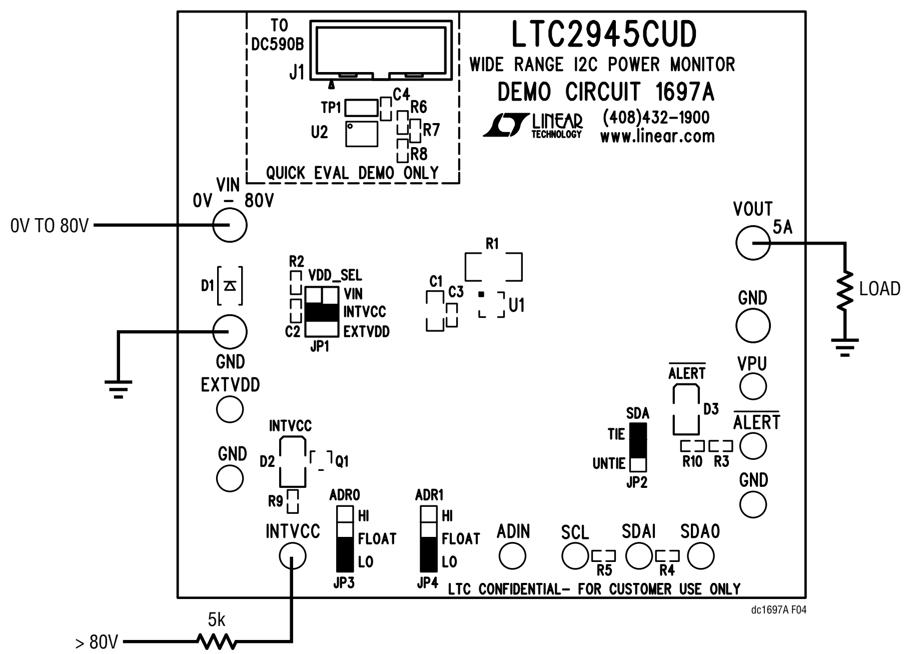


Figure 4. Powering DC1697A Through Low-Side Shunt Regulator in High-Side Current Sense Topology

HARDWARE SETUP

–48V systems can also be monitored by simply setting VDD_SEL to EXTVDD with the –48V input tied to VIN and GND and the –48V return tied to EXTVDD. The DC590 provides isolation and level shifting, as the I²C interface is operating at –48V with respect to –48V RTN, which is normally at earth ground potential.

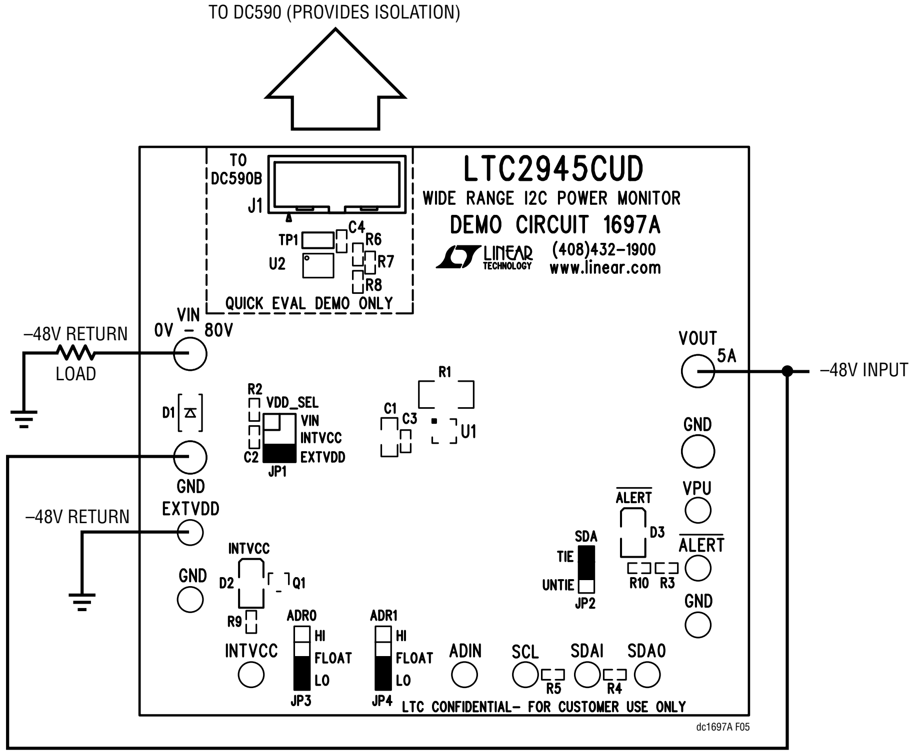


Figure 5. Current Monitoring in a –48V System with the DC590 Providing Isolation

SOFTWARE SETUP

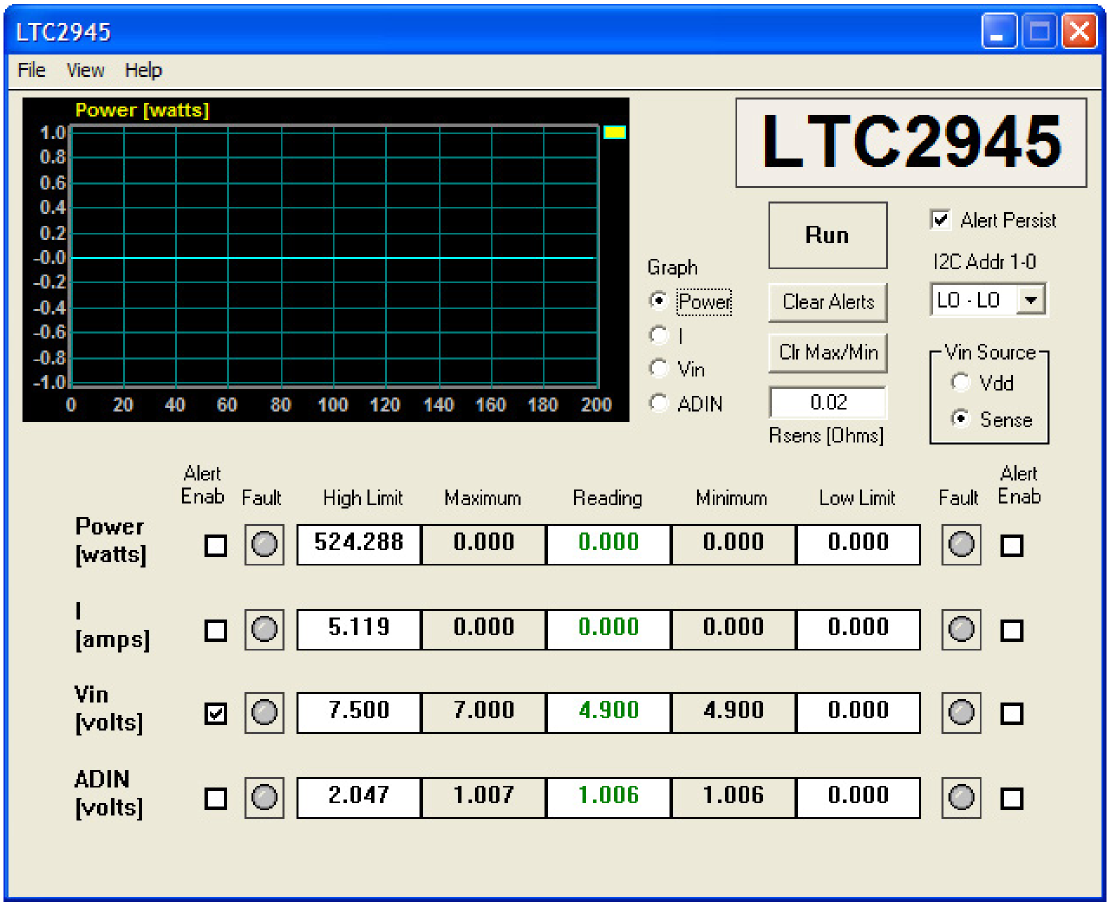


Figure 6.

The DC1697A control panel was designed to allow the user to quickly evaluate the LTC2945. The user has the ability to set fault thresholds, enable/disable and clear alerts as well as change the source for the VIN measurement. Rsens is set to 20mΩ by default on the DC1697A, should any changes be made to the board, the corresponding value should be entered into the software GUI. By pressing RUN, the software interface will begin using the DC590 for data collection.

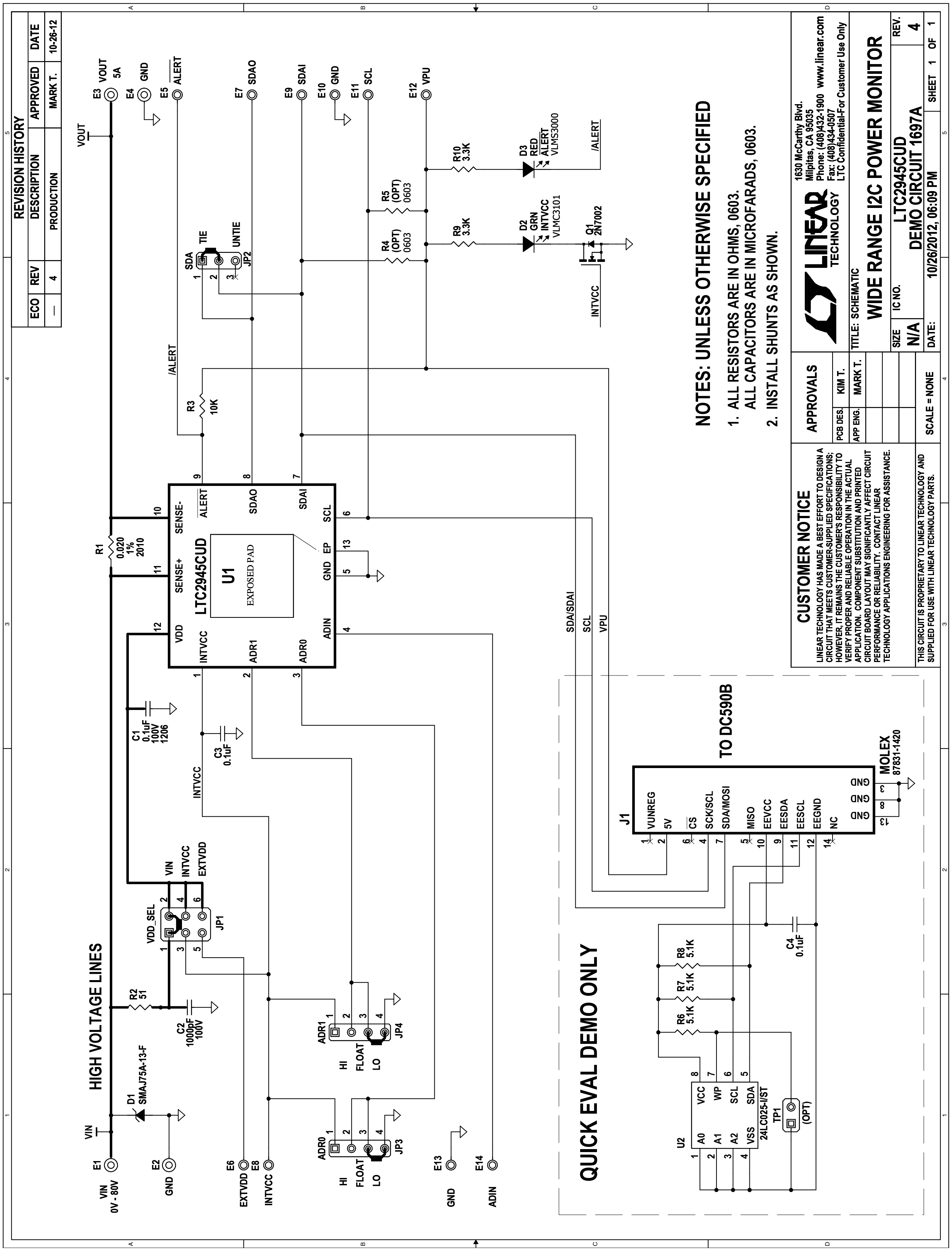
The Alert Persist option modifies how the $\overline{\text{ALERT}}$ pin and LED on the board react. With Alert Persist checked, on an ALERT the corresponding FAULT button will light up red on the software GUI. The $\overline{\text{ALERT}}$ LED should also be red on the DC1697A itself. Click the Clear Alerts button to clear all alerts.

With Alert Persist not enabled, an alert event will still light up the corresponding FAULT button, however the $\overline{\text{ALERT}}$ LED on the board will turn on briefly before turning off due to a read by the GUI from the Fault Register. The QuikEval GUI constantly polls registers in order to properly graph and monitor the part. In a real world situation, these repeated reads are not necessary. The Alert Persist option was designed to simulate real world behavior while still providing a friendly interface.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	1	C1	Cap., X7R, 0.1µF, 100V, 10%, 1206	AVX 12061C104KAT2A
2	1	C2	Cap., X7R, 1000pF, 100V, 10%, 0603	AVX 06031C102KAT2A MURATA, GRM188R72A102KA01D
3	2	C3, C4	Cap., X5R, 0.1µF, 25V, 20%, 0603	AVX 06033D104KAT2A
4	1	D1	Voltage Supressor, 75V	DIODES/ZETEX SMAJ75A-13-F
5	1	D2	LED, GRN PLCC-2 (B-Size)	VISHAY VLMC3101-GS08
6	1	D3	LED, RED PLCC-2 (B-Size)	VISHAY VLMS3000-GS08
7	4	E1, E2, E3, E4	Turret, Testpoint .062 Thick Brd.	MILL-MAX 2501-2-00-80-00-00-07-0
8	10	E5-E14	Turret, Testpoint 0.063"	MILL-MAX 2308-2-00-80-00-00-07-0
9	1	JP1	CONN., HDR., MALE, 2 × 3, 2mm, THT, STRT	SULLINS, NRPN032PAEN-RC
10	1	JP2	CONN., HDR., MALE, 1 × 3, 2mm, THT, STRT	SULLINS, NRPN031PAEN-RC
11	2	JP3, JP4	CONN., HDR., MALE, 1 × 4, 2mm, THT, STRT	SULLINS, NRPN041PAEN-RC
12	1	J1	Header, 2 mm CTRS	MOLEX, 878 31-1420
13	1	Q1	N-Channel, MOSFET SOT23	DIODES/ZETEX. 2N7002-7-F
14	1	R1	Res., LRC 0.020, 1.0W, 1%, 2010	IRC LRF20 10LF-01-R020-F
15	1	R2	Res., Chip 51, 0.1W, 5%, 0603	VISHAY CRCW060351R0JNEA
16	1	R3	Res., Chip 10k, 0.1W, 5%, 0603	VISHAY CRCW060310K0JNEA PANASONIC, ERJ3GEYJ103V
17	0	R4, R5 (OPT)	Res., 0603	OPT.
18	3	R6, R7, R8	Res., Chip 5.1k, 0.1W, 5%, 0603	VISHAY CRCW06035K10JNEA
19	2	R9, R10	Res., Chip 3.3k, 0.1W, 5%, 0603	VISHAY, CRCW06033K30JNEA NIC, NRC06J332TRF PANASONIC, ERJ3GEYJ332V
20	0	TP1 (OPT)	CONN., HDR., MALE,1X2, 2mm, THT, STRT	SULLINS, NRPN021PAEN-RC
21	1	U1	IC, Wide Range I^2C Power Monitor, QFN-12(UD)	LINEAR TECHNOLOGY CORP. LTC2945CUD
22	1	U2	I.C., Serial EEPROM TSSOP-8	MICROCHIP 24L C025-I/ST
23	4	SHUNTS AS SHOWN ON ASSY DWG	Shunt, 2mm CTRS.	SAMTEC 2SN-BK-G

SCHEMATIC DIAGRAM



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