

# Dual I<sup>2</sup>C Power Supply Monitor and Margining Controller with LTC3828 Dual DC/DC Supply

## DESCRIPTION

The DC980A and DC980B are a demonstration system that showcases the [LTC2970](#), a dual I<sup>2</sup>C power supply monitor and margining controller. The DC980A board contains the LTC2970 device and the DC980B board contains the [LTC3828](#) dual DC/DC controller. The two boards interface to each other via a 20-pin connector. The DC980B board features the LTC3828 dual output, 2-phase synchronous buck regulator. The LTC2970's two voltage-buffered, 8-bit IDACs allow highly accurate margining of the LTC3828's output voltages. The IDACs can be configured to automatically servo the power supplies to a desired voltage using the ADC for feedback. The DC980B comes preconfigured with 3.3V and 5V power supply rail voltages.

The LTC2970's low drift reference and 14-bit  $\Delta\Sigma$  A/D converter allow precise measurements of two power supply output voltages and load currents. Fault management allows ALERT# to be asserted for configurable over- and undervoltage fault conditions.

This demonstration system is supported by the LTpowerPlay™ graphical user interface (GUI) which enables complete control of all the features of the device. Together, the LTpowerPlay software and DC980A/DC980B hardware

system create a powerful development environment for designing and testing hardware configurations for the LTC2970. The software displays the LTC2970 features and provides real time measurements from the device's ADC and status registers. Telemetry also allows easy access of the fault status created by the LTC2970.

The LTC2970 features may be evaluated with the LTC3828 based power supplies, or alternatively the DC980B board may be removed and DC980A can then be connected to an external power supply circuit.

The DC980A/DC980B demo boards are powered by an external 7V to 21V power supply. Communication with the software is provided through the DC590 USB-to-I<sup>2</sup>C controller. The following is a checklist of items which can be obtained from the LTC website or LTC field sales.

- USB-to-I<sup>2</sup>C/Serial Controller (DC590)
- LTpowerPlay Software

**Design files for this circuit board are available at**  
<http://www.linear.com/demo/DC980A/DC980B>

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## PERFORMANCE SUMMARY Specifications are at T<sub>A</sub> = 25°C

PARAMETER	CONDITIONS	VALUE
12V <sub>IN</sub> Supply Input Voltage Range		8V to 15V
V <sub>DD</sub> Supply Input Voltage Range		4.5V to 5.75V
ADC Full-Scale Accuracy		±0.4%
ADC Total Unadjusted Error	V <sub>IN</sub> = 3V	±0.5%
ADC Input Range		0V to 6V
ADC Resolution	Resolution = 8.192V/16384	500mV/LSB
ADC Conversion Rate		30Hz
Margining DAC Resolution		8-Bits
Temperature Sensor Resolution		0.25°C/LSB
I <sup>2</sup> C Serial Clock Frequency		10kHz to 400kHz

### DC980A/DC980B FEATURES

- Monitors and Margins Two Power Supplies
- Two Output Voltage Monitors
- Two Input Voltage Monitors
- Two Output Current Monitors
- Telemetry Reads Back  $V_{IN}$ ,  $V_{OUT}$ ,  $I_{OUT}$ , Temperature
- Supported by LTpowerPlay GUI
- I<sup>2</sup>C Adjustable OV/UV Trip Points
- Margin or Trim Supplies to  $\pm 0.5\%$  Accuracy
- I<sup>2</sup>C/SMBus Serial Interface
- Programmable GPIO for Fault Reporting
- Powered from External Power Supply
- LTC2970 Available in 16-Lead DFN and SSOP Packages

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### GLOSSARY OF TERMS

The following list contain terms used throughout the document.

**Channel:** The collection of functions that monitor, supervise, and trim a given power supply rail.

**Margin:** Term used typically in board level testing that increases/decreases the output voltage to look for sensitivity/marginality problems.

**Monitor:** The act of measuring voltage, current, and temperature readings.

**Rail:** The final output voltage that the power supply controller manages.

**Supervise:** The act of quickly responding (warning or faulting) to a voltage, current, or temperature condition that is compared to preprogrammed values.

**Trim:** The act of adjusting the final output voltage. A servo loop is typically used to trim the voltage.

## LTpowerPlay GUI SOFTWARE

LTpowerPlay is a powerful Windows-based tool that supports Linear Technology products, including the LTC2970 dual power supply monitor and margining controller. You can use LTpowerPlay to evaluate Linear Technology ICs by connecting to a demo board system. LTpowerPlay utilizes the DC590 USB I<sup>2</sup>C/serial controller to communicate with one of many potential targets, including the DC980A/B demo system or a customer board. The software also

provides an automatic update feature to keep the software current with the latest set of device drivers and documentation. The LTpowerPlay software can be downloaded from:

<http://www.linear.com/ltpowerplay>

To access technical support documents for LTC Power System Management Products visit Help, View Online help on the LTpowerPlay menu.

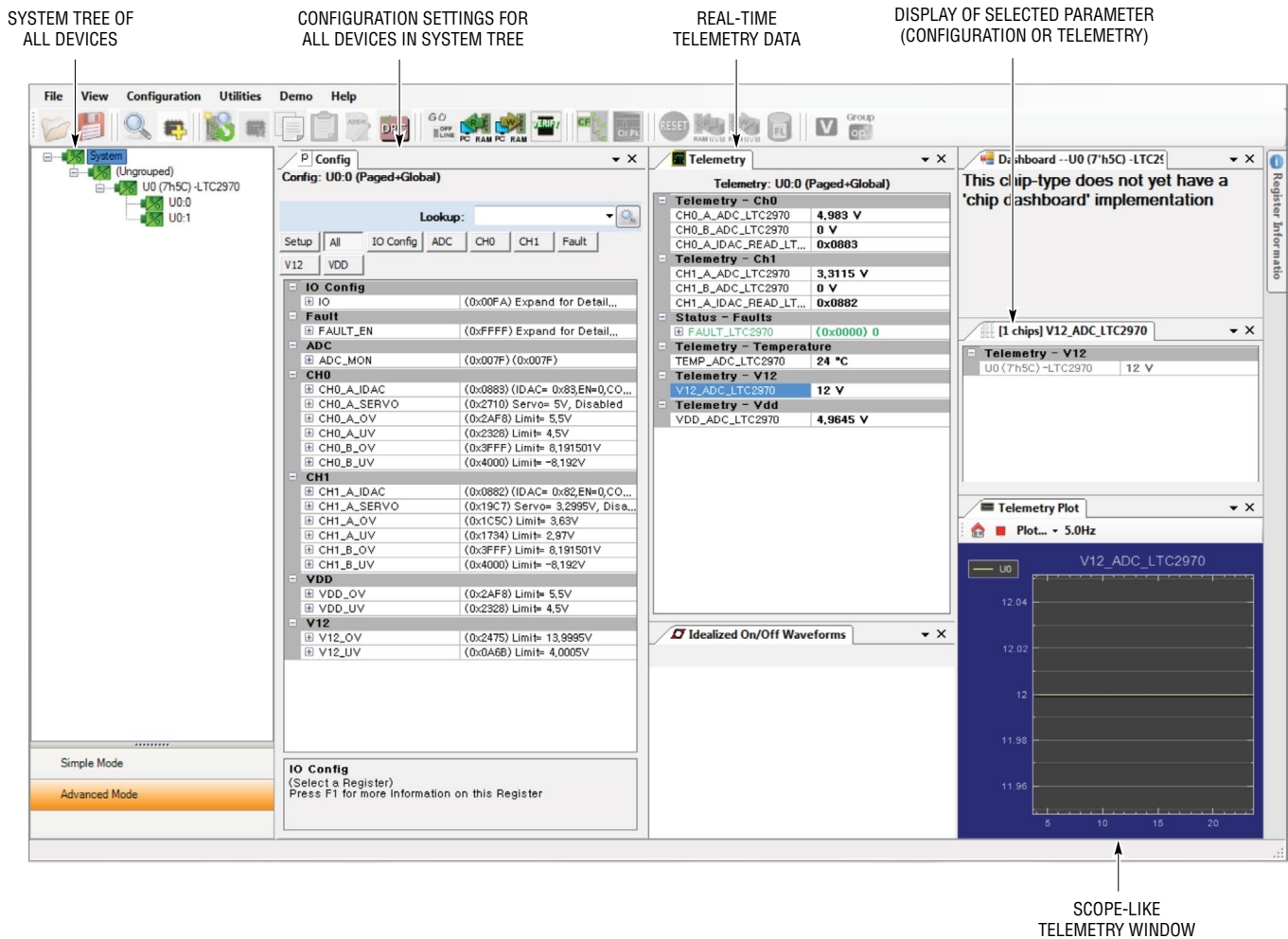


Figure 1. Screenshot of LTpowerPlay GUI

# DEMO MANUAL

## DC980A/DC980B

### QUICK START PROCEDURE

The following procedure describes how to set up a DC980A, DC980B, and DC590 for demonstration purposes or to evaluate the performance of the LTC2970.

1. Download and install the LTpowerPlay: <http://www.linear.com/ltpowerplay>
2. The default locations of DC980A's configuration jumpers are as follows:

JP1 ASELO	JP2 ASEL1	JP3 GRIO_CFG	JP4 WRITE- PROTECT	JP5 DAC1 TERMINATION	JP6 DAC0 TERMINATION	JP7 VDD SOURCE
LO	LO	GND	ON	IOUT0	IOUT1	LOCAL

3. The default locations of DC980B's configuration jumpers are as follows:

JP1 PHSMD	JP2 FSET	JP3 FCB	JP4 RUN1	JP5 RUN2	JP6 TRACK2	JP7 TRACK1
0	550kHz	CCM	ON	ON	EXT1	VOUT1

4. Connect the DC980A and DC980B boards using the 20-pin analog interface edge connector. Connect DC980A to the DC590A USB I<sup>2</sup>C/serial controller using the supplied 14-conductor ribbon cable.
5. Connect a power supply (8V to 15V) to the DC980B's VIN and GND turrets. You may jumper the DC980B's VIN to the 12VIN turret of the DC980A. Refer to Figure 2 for the connections.

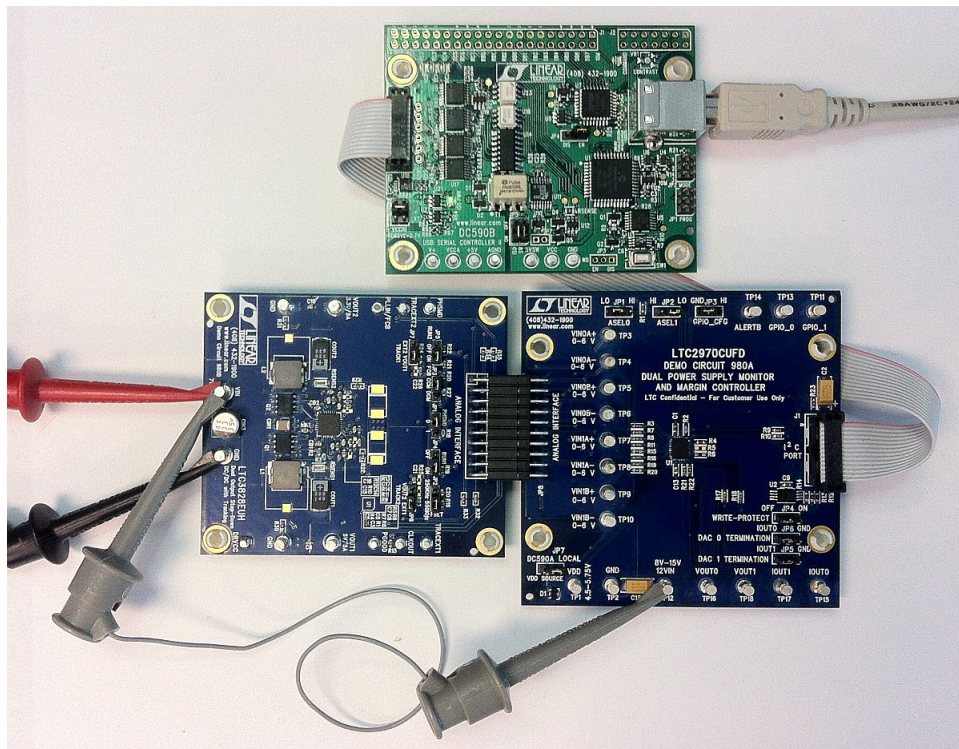
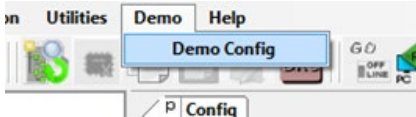


Figure 2. Connecting DC980A/DC980B Boards and the DC590 I<sup>2</sup>C/Serial Controller

dc980abf

## QUICK START PROCEDURE

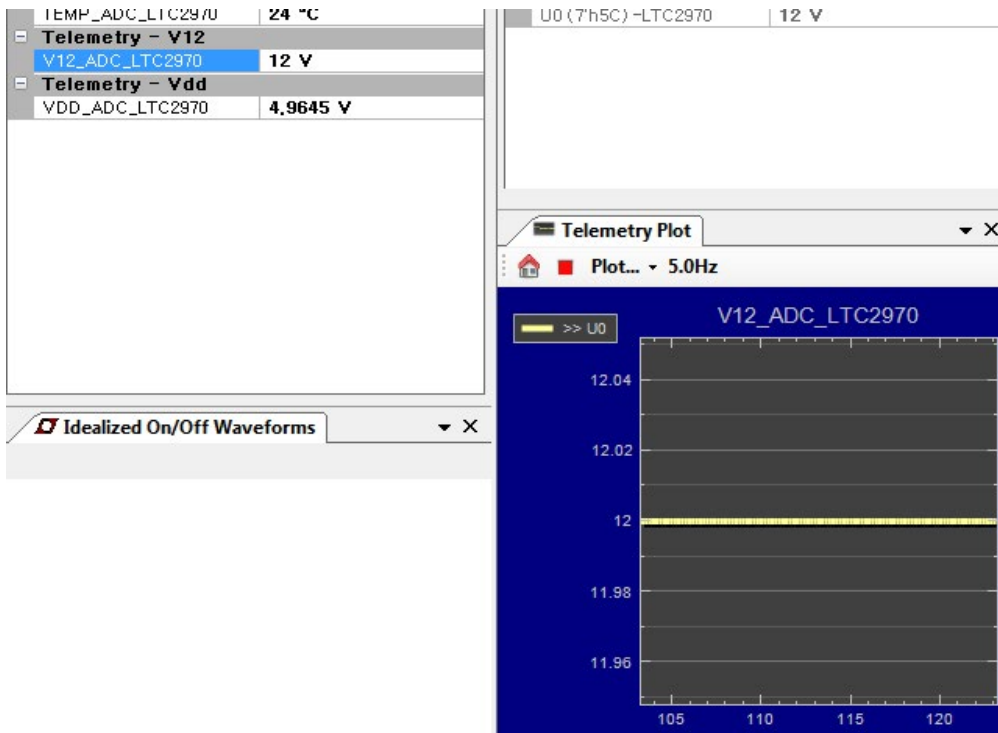
6. Apply input power to the VIN turret of the DC980B companion board. *NOTE: Make sure that the input voltage does not exceed 15V. Be sure JP7 is set to LOCAL.*
7. Connect the USB cable from the host computer to the DC590A. Launch LTpowerPlay. The software automatically identifies the DC980A and builds a system tree for the LTC2970. The GUI should appear as that shown in Figure 1.
  - a. Load default configuration into the LTC2970. From the pull-down menu select Demo > Demo Config.



- b. Check for the LTC3828 output voltages.

Telemetry - Ch0	
CH0_A_ADC_LTC2970	4.983 V
CH0_B_ADC_LTC2970	0 V
CH0_A_IDAC_READ_LT...	0x0883
Telemetry - Ch1	
CH1_A_ADC_LTC2970	3.311 V
CH1_B_ADC_LTC2970	0 V
CH1_A_IDAC_READ_LT...	0x0882

- c. Check VDD and V12 input voltages.





**D980A DETAILS**

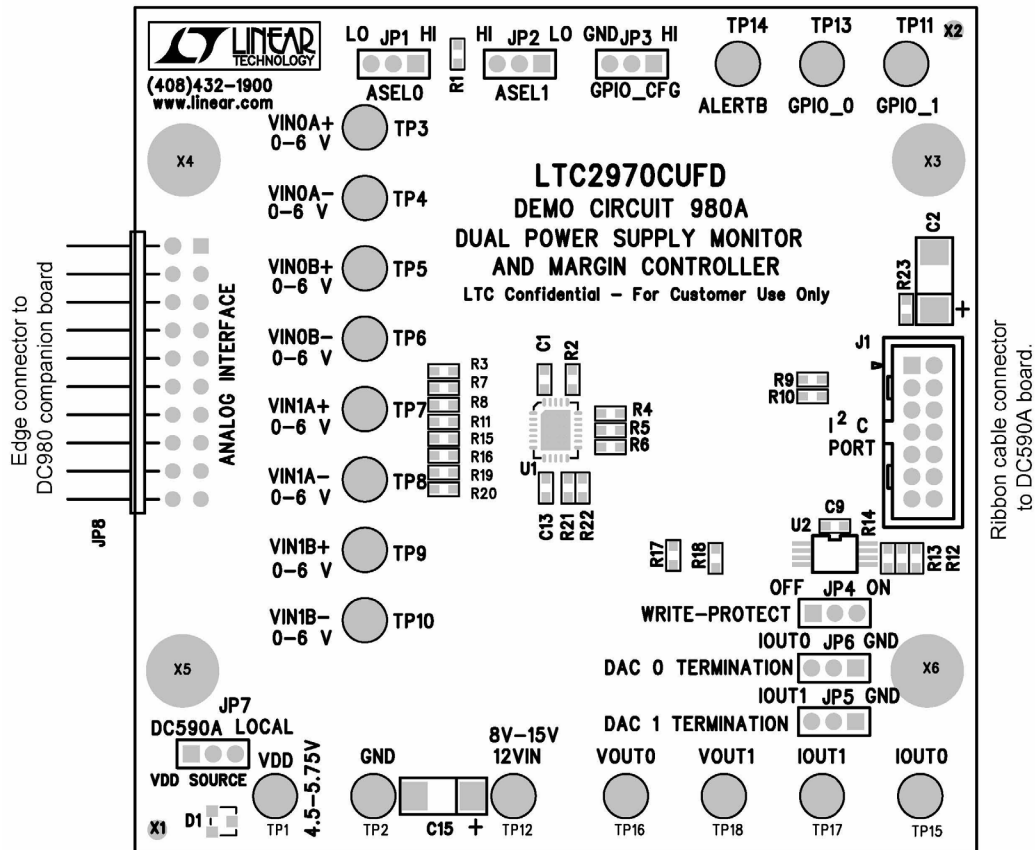


Figure 3. DC980A Board

D980B DETAILS

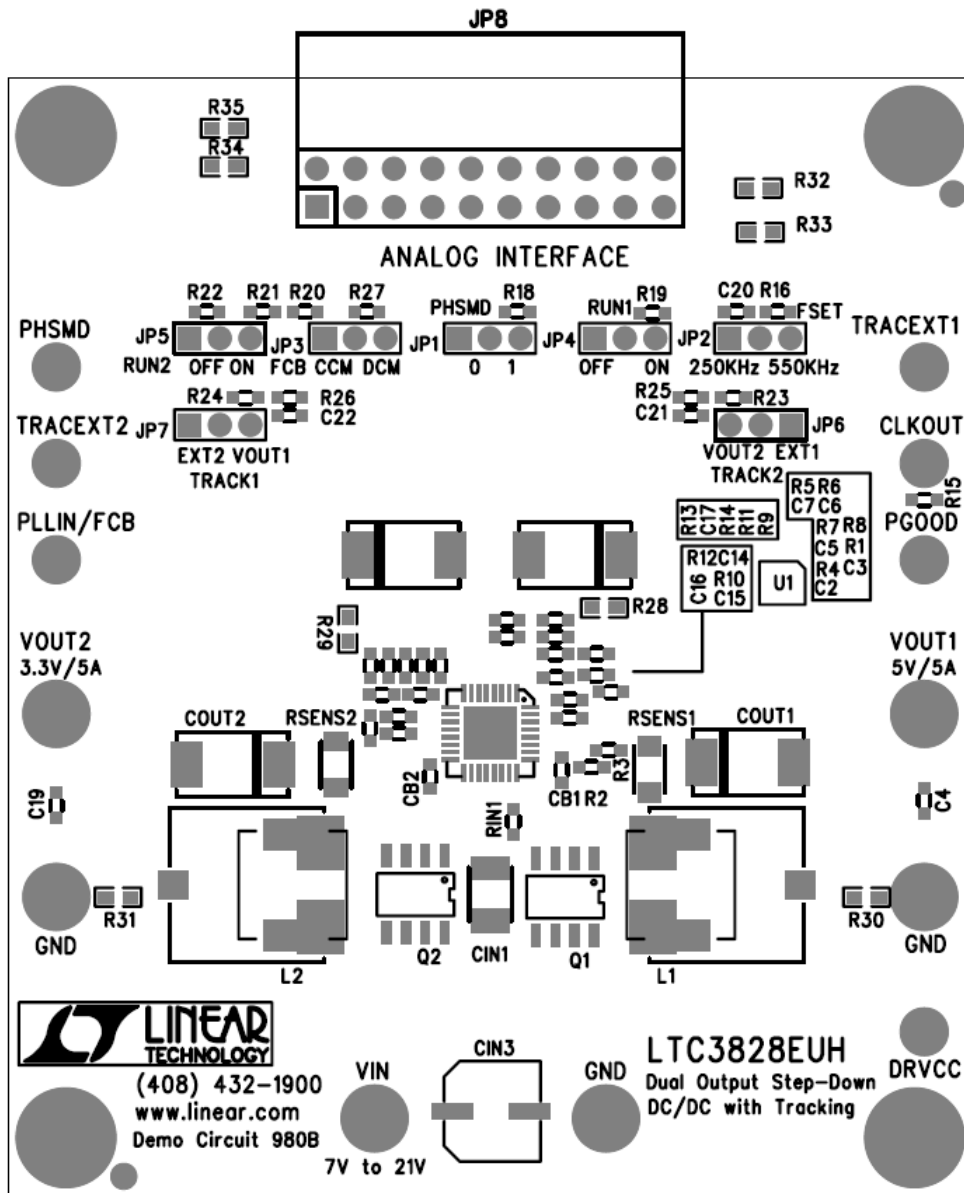


Figure 4. DC980B Board

# DEMO MANUAL

## DC980A/DC980B

### PARTS LIST—DC980A

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	1	C1	CAP CER 1 $\mu$ F 16V 20% X7R 0603	TDK C1608X7R1C105M
2	2	C2, C15	CAP TANTALUM 10 $\mu$ F 25V 20% 6032	AVX TAJW106M025R
3	2	C9, C13	CAP CER 0.1 $\mu$ F 16V 20% X7R 0603	AVX 0603YC104MAT
4	1	D1	DIODE, SCHOTTKY 200mW SOT-23	DIODES INC BAT54
5	1	R1	RES 10k $\Omega$ 0.1W 5% 0603 SMD	VISHAY CRCW0603103JRT6
6	1	R2	RES 100k $\Omega$ 0.1W 5% 0603 SMD	VISHAY CRCW0603100KFKEA
7	13	R3, R7 TO R11, R15, R16, R19 TO R23	RES 0 $\Omega$ 0.1W 0603 SMD	VISHAY CRCW0603000ZRT6
8	1	R4	RES 2k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW06032K00JNEA
9	3	R12, R13, R14	RES 4.99k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW06034K99JNEA
10	2	R17, R18	RES 6.34k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW06036K34JNEA
11	1	U1	IC, 2-CH POWER SUPPLY MONITOR AND MARGIN CONTROLLER	LINEAR TECHNOLOGY LTC2970CUFD
12	1	U2	IC, 2k-Bit I <sup>2</sup> C SERIAL EEPROM	MICROCHIP 24LC025-I/ST
<b>Additional Demo Board Circuit Components</b>				
13	0	C3, C4, C5, C8, C10 TO C12, C14 (OPT)	OPTION - DO NOT STUFF	
14	0	C6, C7 (OPT)	OPTION - DO NOT STUFF	
15	0	R5, R6 (OPT)	RES 2k $\Omega$ 0.1W 1% 0603 SMD	
<b>Hardware: For Demo Board Only</b>				
16	1	J1	2MM PIN HEADER, 2x7	MOLEX 87831-1420
17	1	JP8	CONN HEADER, 2x10 RIGHT ANGLE	MILL-MAX 802-10-020-20-001
18	7	JP1 TO JP7	2MM PIN HEADER, 1x3	SAMTEC TMM-103-02-L-S
19	4	MH1 TO MH4	STANDOFF, NYLON SNAP-ON	KEYSTONE 8831
20	7	SH1 TO SH7	SHUNT FOR 2MM PIN HEADER	SAMTEC 2SN-BK-G
21	18	TP1 TO TP18	TERM SOLDER TURRET 0.219" 0.078"L	MILL MAX 2501-2-00-80-00-00-07-0



## PARTS LIST—D980B

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	3	CB1, CB2, C12	CAP CER 0.1 $\mu$ F 16V 10% X7R 0603	MURATA GRM188R71C104KA01D
2	2	CIN2, CIN1	CAP CER 10 $\mu$ F 25V 10% X7R 1210	MURATA GRM32DR71E106KA12L
3	1	CIN3	CAP ALUM 33 $\mu$ F 25V 20% 6.3x6 SMD	NICHICON PCV1E330MCL1GS
4	1	COU1	CAP ALUM POLY 150 $\mu$ F 6.3V 7343	PANASONIC EEF-CX0J151XR
5	1	COU2	CAP ALUM POLY 180 $\mu$ F 4V 7343	PANASONIC EEF-UD0G181LR
6	2	C2, C15	CAP CER 100pF 50V 5% C0G 0603	MURATA GRM1885C1H101JA01D
7	2	C3, C16	CAP CER 470pF 50V 5% C0G 0603	MURATA GRM1885C1H471JA01D
8	3	C5, C7, C14	CAP CER 1000pF 50V 5% C0G 0603	MURATA GRM1885C1H102JA01D
9	3	C4, C10, C19	CAP CER 1 $\mu$ F 10V 10% X5R 0603	MURATA GRM188R61A105KA61D
10	2	C9, C13	CAP CER 1 $\mu$ F 25V 10% X7R 0805	TDK C2012X7R1E105K125AB
11	1	C11	CAP TANT 4.7 $\mu$ F 10V 0805	MURATA GRM21BR71A475KA73K
12	2	C20, C21	CAP CER 10nF 25V 10% X7R 0603	MURATA GRM188R71E103KA01D
13	2	D1, D3	SCHOTTKY DIODE 30V 0.1A SOD-323	CENTRAL SEMI CMDSH-3 TR
14	2	L2, L1	INDUCTOR, 2.2 $\mu$ H	WÜRTH 74437346022
15	2	Q2, Q1	MOSFET Nch DUAL PWR SW 30V 12M $\Omega$ SO8	IR IRF8313PBF
16	5	R1, R7, R11, R12, RIN1	RES 10 $\Omega$ 0.1W 5% 0603	VISHAY CRCW060310R0JNEA
17	2	R2, R16	RES 10k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW0603103JRT6
18	2	R3, R18	RES 100k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW0603100KFKEA
19	2	R4, R10	RES 42.2k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW060349K2FKEA
20	3	R5, R20, R21	RES 20k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW060320K0FKEA
21	1	R6	RES 105k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW0603105KFKEA
22	2	R13, R26	RES 30.1k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW060330K1FKEA
23	2	R14, R24	RES 95.3k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW060395K3FKEA
24	2	R19, R22	RES 8.2k $\Omega$ 0.1W 5% 0603 SMD	VISHAY CRCW06038K20FKEA
25	1	R27	RES 1k $\Omega$ 0.1W 5% 0603 SMD	VISHAY CRCW06031K00JNEA
26	1	R28	RES 147k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW0603147KFKEA
27	1	R29	RES 196k $\Omega$ 0.1W 1% 0603 SMD	VISHAY CRCW0603196KFKEA
28	2	RSENS1, RSENS2	RES 0.01 $\Omega$ 0.5W 1% 1206	STACKPOLE CSR1206FK10L0
29	1	U1	IC, 2-CH STEP DOWN CONTROLLER QFN28	LINEAR TECHNOLOGY LTC3828EUH

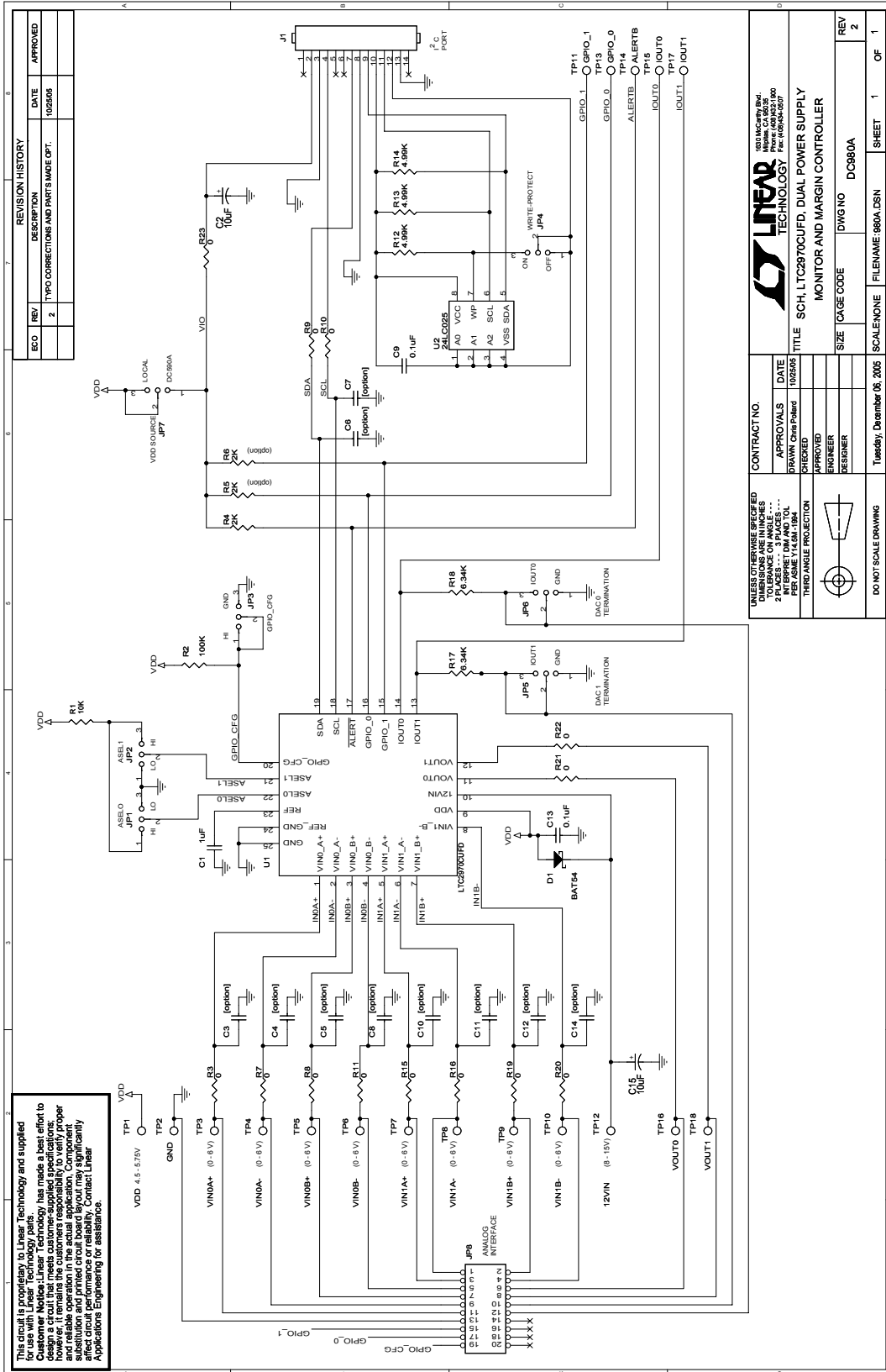
# DEMO MANUAL

## DC980A/DC980B

### PARTS LIST—D980B

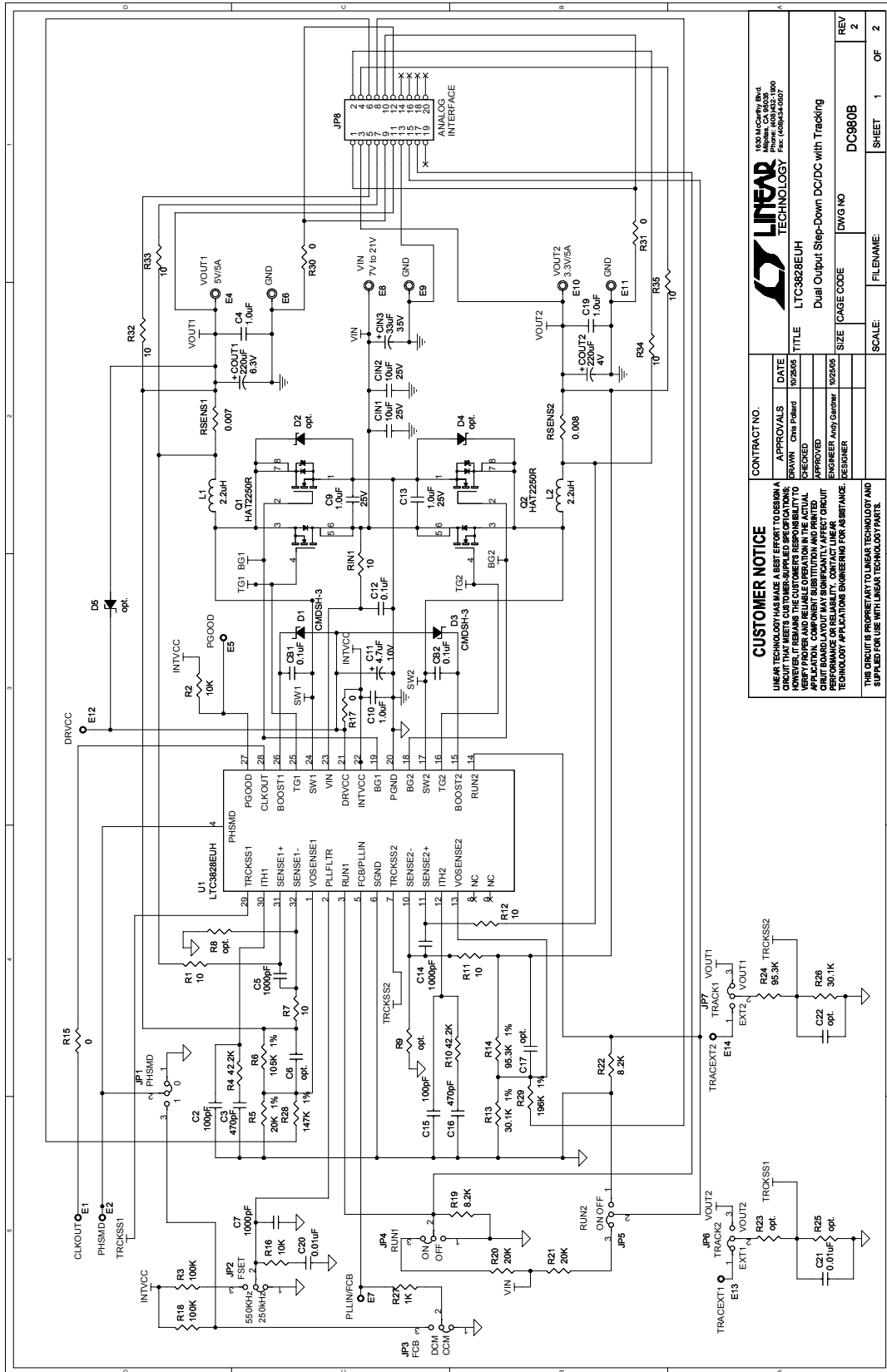
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Additional Demo Board Circuit Components</b>				
30	0	C6, C17 (OPT)	CAP CER 180PF NPO 5% 0603 (OPT)	DO NOT INSTALL
31	0	C22 (OPT)	CAP CER 10nF 25V 10% X7R 0603 (OPT)	DO NOT INSTALL
32	0	D4, D2 (OPT)	DIODE, POWERMITE (OPT)	DO NOT INSTALL
33	0	D5 (OPT)	DIODE, SOT-323 (OPT)	DO NOT INSTALL
34	0	Q3, Q4 (OPT)	MOSFET Nch DUAL PWR SW 30V SO8 (OPT)	DO NOT INSTALL
35	0	Q5, Q6 (OPT)	MOSFET Nch DUAL PWR SW 30V SO8 (OPT)	DO NOT INSTALL
36	0	R8, R9, R23, R25 (OPT)	RES USER SELECTABLE 0603 (OPT)	DO NOT INSTALL
37	4	R15, R17, R30, R31	RES 0Ω 0.1W 0603 SMD	VISHAY CRCW0603000ZRT6
38	4	R32 TO R35	RES 10Ω 1/16W 5% 0603	PANASONIC ERJ-3EKF10R0V
<b>Hardware: For Demo Board Only</b>				
39	7	E1, E2, E5, E7, E12 TO E14	TERM SOLDER TURRET 0.156"H 0.084"L	MILL MAX 2308-2-00-80-00-00-07-0
40	6	E4, E6, E8 TO E11	TERM SOLDER TURRET 0.219" 0.078"L	MILL MAX 2501-2-00-80-00-00-07-0
41	7	JP1 TO JP7	2MM PIN HEADER 1X3	WÜRTH 620 003 111 21
42	1	JP8	CONN RECEPT, 2x10 RIGHT ANGLE	MILL-MAX 803-93-020-20-001
43	4	MH1 TO MH4	STANDOFF, NYLON SNAP-ON	KEYSTONE 8831
44	7	SH1 TO SH7	SHUNT FOR 2MM PIN HEADER	WÜRTH 608 002 134 21

## SCHEMATIC DIAGRAM



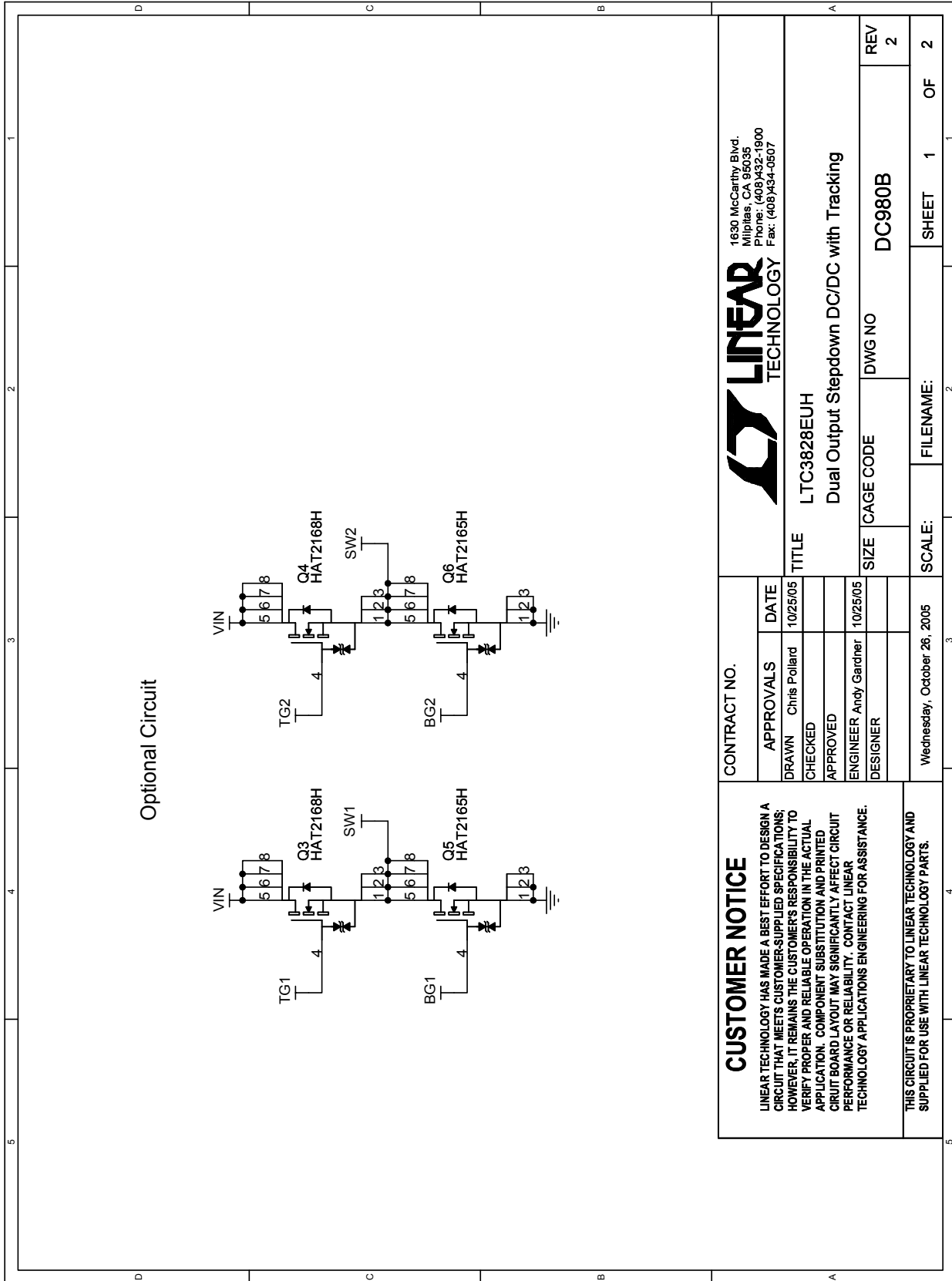
# DEMO MANUAL DC980A/DC980B

## SCHEMATIC DIAGRAM



<b>CUSTOMER NOTICE</b> LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS OUR TYPICAL SPECIFICATIONS. THE USER MUST VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD MANUFACTURING VARIATIONS MAY AFFECT PERFORMANCE. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.		<b>CONTRACT NO.</b> APPROVALS DRAWN: [ ] CHECKED: [ ] APPROVED: [ ] DESIGNER: [ ]	
LINEAR TECHNOLOGY 1000 Massachusetts Ave. Bedford, MA 01730 Phone: (603) 882-1000 Fax: (603) 882-3007		DATE: 10/20/04	
TITLE: LTC3828EUH		SCALE: [ ]	
Dual Output Step-Down DC/DC with Tracking		FILENAME: [ ]	
SIZE: [ ]		DWG NO: DC980B	
REV: 2		SHEET: 1 OF 2	

## SCHEMATIC DIAGRAM



dc980abf

# DEMO MANUAL

## DC980A/DC980B

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### DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

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LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

**Please read the DEMO BOARD manual prior to handling the product.** Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

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

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