LTC2974 Quad Digital Power Supply Manager with EEPROM

DESCRIPTION

The DC1978A is a demonstration system for the LTC®2974 quad I²C/SMBus/PMBus power supply monitor and controller with EEPROM. The DC1978A demonstrates the ability of the LTC2974 to monitor, supervise, sequence, trim, margin and log faults for four power supplies. Each power supply channel of the LTC2974 monitors current, voltage and temperature. This demonstration system is supported by the LTpowerPlay™ graphical user interface (GUI) that enables complete control of all LTC2974 features.

The DC1978A consists of two circuit boards designed to work as a pair, DC1809A and DC1810A. The DC1809A contains all the circuitry needed to insert the LTC2974 into a power system and control four power supplies. The DC1810A contains four power supplies, two LTC3860 DrMOS supplies and two LTM®4620 supplies, which are configured to be controlled by the LTC2974. Together, these two boards form a sophisticated four-channel digitally programmable power supply.

Together, the LTpowerPlay software and DC1978A hardware system create a powerful development environment for designing and testing LTC2974 configuration settings. These settings can be stored in the LTC2974 internal EEPROM or in a file. This file can later be used to order preprogrammed devices or to program devices in a production environment. The LTpowerPlay software displays all of the configuration settings and real time measurements from the LTC2974. Telemetry allows easy access and decoding of the fault log created by the LTC2974. The LTC2974 on the DC1809A board comes preprogrammed with the EEPROM values appropriate for the four power supplies used on the DC1810A. Just plug and play!

Multiple DC1978A board sets can be cascaded together to form a high channel count power supply (see Multiboard Arrays). This cascaded configuration demonstrates features of the LTC2974 which enable timing and fault information to be shared across multiple LTC2974s allowing for the formation of a single, coherent power supply control system. This cascaded configuration is supported by the LTpowerPlay GUI and allows the user to configure up to nine LTC2974s, thereby controlling up to 36 separate power supplies. Larger arrays (>9) of LTC2974s are supported through programmable I²C base address or bus segmentation.

The DC1809A/DC1810A boards are powered by an external 12V power supply. Communication with the LTpowerPlay software is via the DC1613 USB to I²C/SMBus/PMBus controller. The following is a checklist of items which can be obtained from the LTC website or LTC Field Sales.

- USB to I²C/PMBus Controller (DC1613)
- LTpowerPlay Software
- Configuration File (.proj file) for the DC1978A

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

LTC2974 Features

- I²C/SMBus Serial Interface
- PMBus Compliant Command Set
- Configuration EEPROM with CRC
- Black Box Fault Logging to Internal EEPROM
- Differential Input, 16-Bit ΔΣ ADC with Less Than ±0.25% of Total Unadjusted Error
- Four Voltage Servos Precisely Adjust Supply Voltages Using 10-Bit DACs with Soft Connect
- Monitors Four Output Voltages, Four Output Currents and One Input Voltage
- Monitors Four External Temperature Sensors and Internal Die Temperature
- 4-Channel Sequencer, Time Based or Tracking
- Programmable Watchdog Timer

DESCRIPTION

- Four OV/UV V_{OUT} and One V_{IN} Supervisor
- Four Overcurrent/Undercurrent Supervisors
- Supports Multichannel Fault Management
- Operates Autonomously without Additional Software
- Powered from 3.3V or 4.5V to 15V
- Available in 64-Lead 9mm × 9mm QFN

PERFORMANCE SUMMARY

Specifications valid over full operating temperature range.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{PWR} Supply Input Voltage Range		4.5		15	V
V_{DD33} Supply Input Voltage Range		3.13		3.47	V
ADC Total Unadjusted Error	$V_{IN\_ADC} \geq 1V$			±0.25	%
ADC Voltage Sensing Input Range	Differential Voltage: $V_{IN\_ADC} = (V_{SENSEP[n]} – V_{SENSEM[n]})$ $V_{SENSEM[n]}$	0 –0.1		6 0.1	V V
ADC Voltage Sensing Resolution			122		µV/LSB
ADC Current Sense Input Range	$I_{SENSEP[n]}$, $I_{SENSEM[n]}$ Differential Voltage: $V_{IN\_ADC} = (I_{SENSEP[n]} – I_{SENSEM[n]})$	–0.1 –170		6 170	V mV
ADC Current Sense Resolution	RSENSE(IOUT_CAL_GAIN) = 1Ω $0mV \leq \lvert V_{IN\_ADC}\rvert < 16mV$ $16mV \leq \lvert V_{IN\_ADC}\rvert < 32mV$ $32mV \leq \lvert V_{IN\_ADC}\rvert < 63.9mV$ $63.9mV \leq \lvert V_{IN\_ADC}\rvert < 127.9mV$ $127.9mV \leq \lvert V_{IN\_ADC}\rvert$		 15.265 31.25 62.5 125 250		 µA/LSB µA/LSB µA/LSB µA/LSB µA/LSB
Trim DAC Resolution			10 Bits		
Trim DAC Full Scale Output Voltage	Buffer Gain Setting 0 (MFR_CONFIG(dac_gain) = 0) Buffer Gain Setting 1 (MFR_CONFIG(dac_gain) = 1)		1.38 2.65		V V
Temperature Sensor Resolution			0.136		°C/LSB
Voltage Supervisor Input Voltage Range	Low Resolution, $V_{IN\_VS} = (V_{SENSEP[n]} – V_{SENSEM[n]})$ High Resolution, $V_{IN\_VS} = (V_{SENSEP[n]} – V_{SENSEM[n]})$ $V_{SENSEM[n]}$	0 0 –0.1		6 3.8 0.1	V V V
Voltage Supervisor Sensing Resolution	0V to 3.8V Range 0V to 6V Range		4 8		mV/LSB mV/LSB
Voltage Supervisor Total Unadjusted Error	$2V < V_{IN\_VS} < 6V$, Low Resolution Mode $1.5V < V_{IN\_VS} < 3.8V$, High Resolution Mode $0.8V < V_{IN\_VS} < 1.5V$, High Resolution Mode			±1.25 ±1.0 ±1.5	% % %
Current Supervisor Input Range	$I_{SENSEP[n]}$, $I_{SENSEM[n]}$	–0.1		6	V
	Differential Voltage: $V_{IN\_CS} = (I_{SENSEP[n]} – I_{SENSEM[n]})$	–170		170	mV
Current Supervisor Resolution	IOUT_xC_FAULT_LIMIT × IOUT_CAL_GAIN		400		µV/LSB
Current Supervisor Total Unadjusted Error	$50mV \leq V_{IN\_CS} \leq 170mV$ $V_{IN\_CS} < 50mV$			±3 ±1.5	% mV
I^2C Serial Clock Frequency		10		400	kHz

DC1978A DEMO SYSTEM SPECIFICATIONS

DC1978A Power Supply Specifications

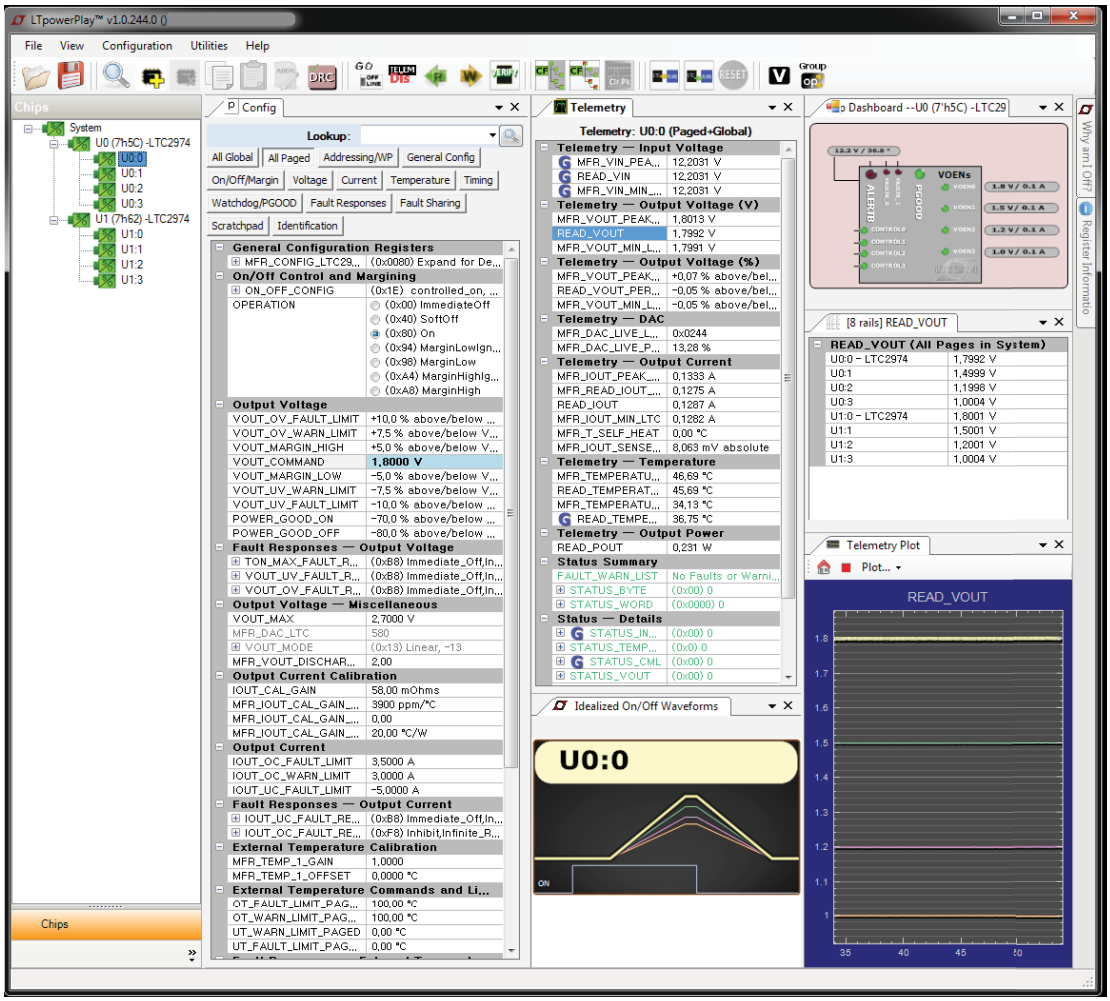
POWER SUPPLY CHANNEL	CH0	CH1	CH2	CH3
Controller	LTC3860, V_{OUT1}	LTC3860, V_{OUT2}	LTM4620, V_{OUT1}	LTM4620, V_{OUT2}
Nominal Untrimmed Output Voltage	1.8V ± 2.1 %	1.5V ± 2.1 %	1.2V ± 2.1 %	1.0V ± 2.1 %
Rated Output Current	2A	2A	5A	5A
Output Trim Range (V_{DAC_FS} = 1.38V)	13/–19 %	11 /–15%	16/–21 %	16/–21 %

LTpowerPlay GUI SOFTWARE

LTpowerPlay is a powerful Windows based development environment that supports Linear Technology digital power ICs with EEPROM, including the LTC2974 and LTC2978 quad and octal PMBus power supply managers, and the LTC3880 dual output PolyPhase® step-down DC/DC controller with digital power system management. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Linear Technology ICs by connecting to a demo board system. LTpowerPlay can also be used in an offline mode (with no hardware present) in order to build a multichip configuration file that can be saved and reloaded at a later time. LTpowerPlay provides unprecedented diagnostic and debug features. It becomes a valuable diagnostic tool during board bring up to program or tweak the power management scheme in a system or to diagnose power issues when bringing up rails. LTpowerPlay utilizes the DC1613A USB-to-SMBus controller to communicate with one of many potential targets, including the LTC2974's DC1978A 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://linear.com/ltpowerplay

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



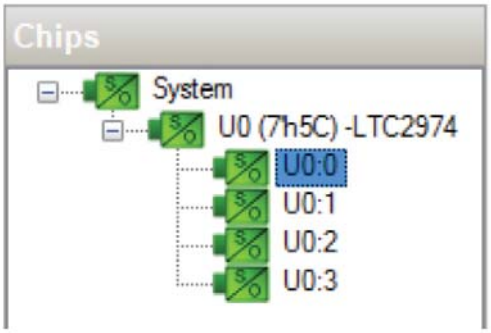
DC1978a F01

Figure 1. Interface of the LTpowerPlay GUI

QUICK START PROCEDURE

The following procedure describes how to set up a DC1978A demo system.

1. Download and install the LTpowerPlay GUI: http://linear.com/ltpowerplay
2. Remove both boards from the ESD protective bags and place them on a level surface. Connect the boards together using the 50-pin edge connector. Be especially careful not to misalign the connectors. Connect the DC1613 I^{2}C/SMBus/PMBus controller to the DC1809A board.
3. Confirm that all jumpers and switches on DC1809A are set to their defaults as follows:
   a. Set both JP1 and JP2 (Address select ASEL0 and ASEL1) to LOW to select I^{2}C address 0x5C.
   b. Set JP3 (WRITE PROTECT) to OFF to enable writing to the LTC2974 EEPROM.
   c. Set the control jumpers JP4 to JP7 to SW0 to SW3 position to connect the switches to the LTC2974 control pins.
   d. Set all control switches SW0, SW1, SW2 and SW3 to HI.
4. Confirm that all jumpers and switches on DC1810A are set to their defaults as follows.
   a. Set JP1, JP2 and JP3 to SOFT-START to enable independent startup of CH1, CH2 and CH3.
   b. Set the preload switches SW1, SW2, SW3 and SW4 to ON.
5. Plug the USB to I^{2}C/SMBus/PMBus Controller into a USB port on your PC.
6. Connect a 12V power supply with > 0.5A capacity to the V_{IN} input of the DC1810A. The board should power up and all power good outputs should be illuminated green.
7. Launch the LTpowerPlay GUI.
   a. The GUI should automatically indentify the LTC2974. The system tree on the left hand side should look like this:



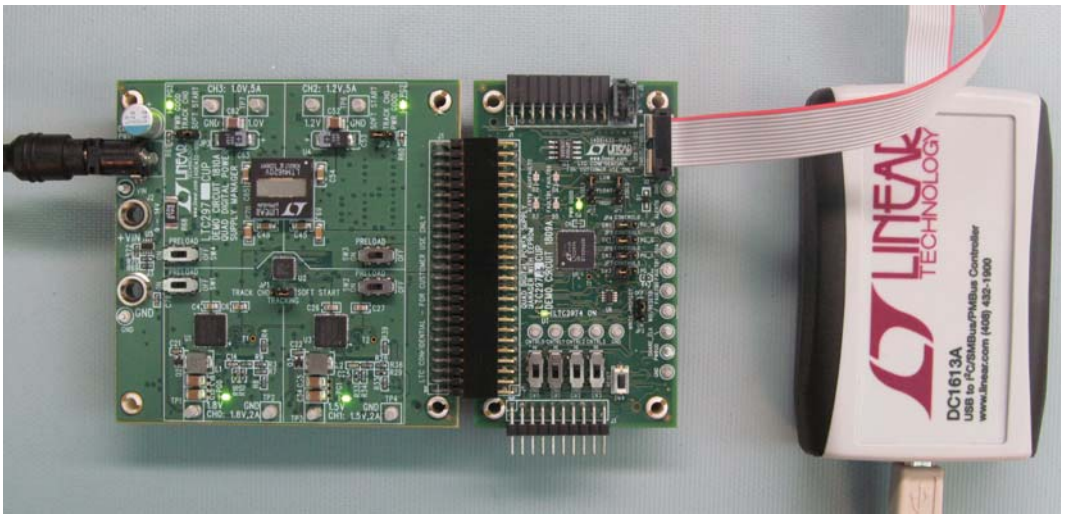
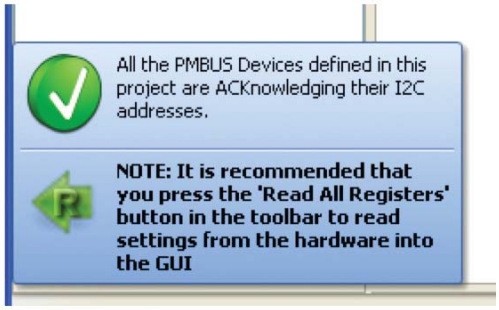


Figure 2. Connecting DC1809A/DC1810A Boards and the DC1613 I^{2}C/SMBus/PMBus Controller

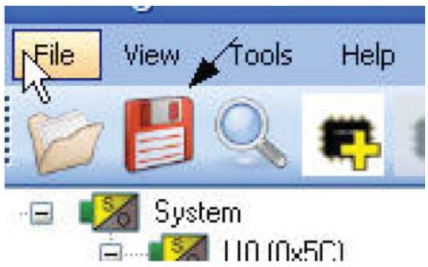
QUICK START PROCEDURE

b. A green message box shows for a few seconds in the lower left hand corner, confirming that the LTC2974 is communicating:



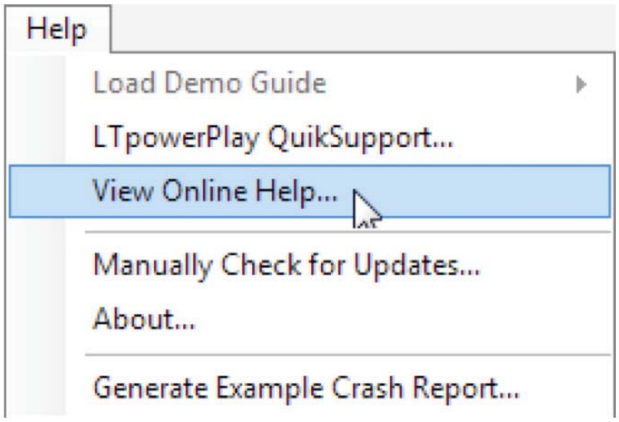
c. In the Toolbar, click the R icon to read the RAM from the LTC2974. This reads the configuration from the RAM of LTC2974 and loads it into the GUI.

d. Save the demo board configuration to a (*.proj) file. Click the Save icon and save the file. Name it whatever you want.



8. The control switches SW0 to SW3 are configured to control channels CH0 to CH3. Slide the switches to HI/GND to enable/disable the individual channels.

9. You are now ready to view one of the LTC2974 demo videos embedded in the LTpowerPlay GUI or experiment with the part on your own. To view a video or more LTC2974 information and application notes, visit the LTpowerPlay online help website from the GUI as shown here:

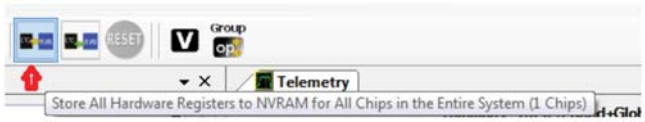


LOADING A LTC2974 CONFIGURATION (*.proj) FILE WITH THE GUI

1. In the upper left hand corner of the GUI, File > Open > browse to your *.proj file. This will load the file into the GUI.

2. Click on the  arrow. This loads the configuration into LTC2974 RAM.

3. To store the configuration in EEPROM, click on the STORE button. It is the button on the left below.



DC1978A DETAILS TOP SIDE

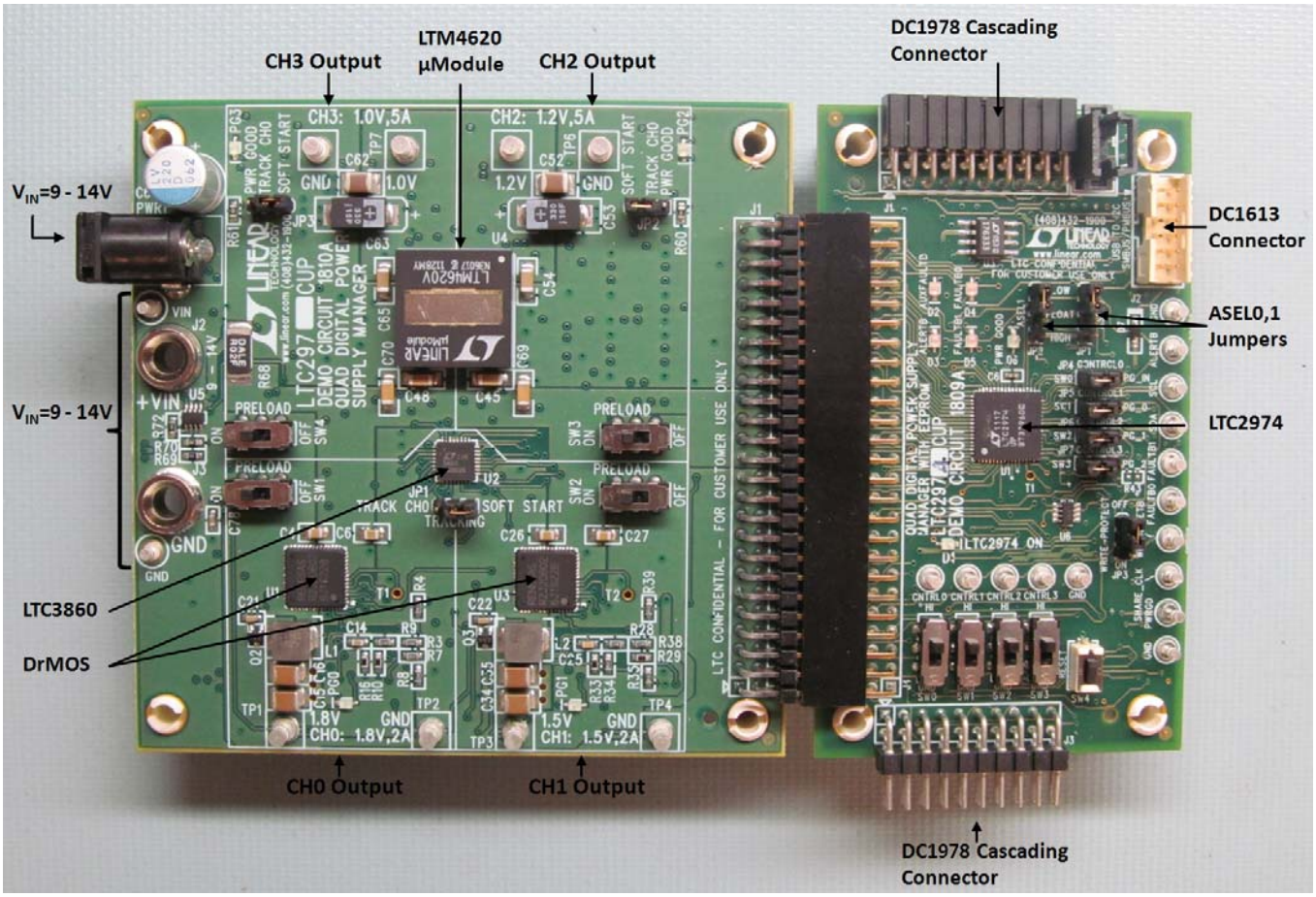


Figure 3. DC1978A Top Details

COMMON DEMO BOARD OPERATIONS

SELECTING I²C ADDRESS

The I²C/SMBus address of the LTC2974 equals the base address + N, where N is a number from 0 to 8. N can be configured by setting the ASEL0 and ASEL1 pins to V_{DD33}, GND or FLOAT. See Table 3. Using one base address and the nine values of N, nine LTC2974s can be connected together to control thirty six outputs. The base address is stored in the MFR_I2C_BASE_ADDRESS register. The base address can be written to any value, but generally should not be changed unless the desired range of addresses overlap existing addresses. Watch that the address range does not overlap with other I²C/SMBus device or global addresses, including I²C/SMBus multiplexers and bus buffers.

RESET THE LTC2974

To reset the LTC2974 and reload the EEPROM contents into operating memory (RAM), press SW4 on DC1809A.

DC1978A LEDS

The red LEDs on ALERTB, FAULTB0, FAULTB1 and AUX-FAULTB (D3, D4, D5, D2) indicate a fault has occurred. The green LED (D6) next to them is the LTC2974 PWRGD signal. Each individual channel on DC1810A also has its own green PWR GOOD LED (PG0, PG1, PG2, PG3). When the USB to I²C/SMBus/PMBus controller power or external power is applied, the green LED D1 will illuminate, indicating that the LTC2974 is powered.

FAULTING AN OUTPUT

The outputs of the power supplies CH0 to CH3 may be shorted indefinitely. This is a good way to induce UV faults. Use a jumper wire or a coin to short any output.

Table 3. Device Address Lookup Table

ADDRESS DESCRIPTION	HEX DEVICE ADDRESS		BINARY DEVICE ADDRESS BITS								ADDRESS PINS	
	7-Bit	8-Bit	6	5	4	3	2	1	0	R/W	ASEL1	ASEL0
ALERT RESPONSE	0C	19	0	0	0	1	1	0	0	1	X	X
GLOBAL	5B	B6	1	0	1	1	0	1	1	0	X	X
N = 0	5C*	B8	1	0	1	1	1	0	0	0	L	L
N = 1	5D	BA	1	0	1	1	1	0	1	0	L	NC
N = 2	5E	BC	1	0	1	1	1	1	0	0	L	H
N = 3	5F	BE	1	0	1	1	1	1	1	0	NC	L
N = 4	60	C0	1	1	0	0	0	0	0	0	NC	NC
N = 5	61	C2	1	1	0	0	0	0	1	0	NC	H
N = 6	62	C4	1	1	0	0	0	1	0	0	H	L
N = 7	63	C6	1	1	0	0	0	1	1	0	H	NC
N = 8	64	C8	1	1	0	0	1	0	0	0	H	H
	H = Tie to V_{DD33}, NC = No Connect = Open or Float, L = Tie to GND, X = Don't Care											
	* MFR_I2C_BASE_ADDRESS = 7-Bit 0x5C (Factory Default)											

COMMON DEMO BOARD OPERATIONS

FAULT SHARING SETUP IN THE GUI

Use the fault sharing setup tool to configure the fault sharing in the GUI. Before doing so, view the fault sharing demo in the GUI. Go to Tools > Fault Sharing Diagram. Also, read the section on fault sharing in the data sheet.

"WHY AM I OFF?" TOOL

Use the "Why am I Off?" tool in the LTpowerPlay GUI to diagnose the reason a power supply channel is turned off. The tool can be located in the top right corner of the GUI, next to the Register Information tab.

TRACKING BASED SEQUENCING

The LTC2974 supports tracking power supplies that are equipped with a tracking pin and configured for tracking. A tracking power supply uses a secondary feedback terminal (TRACK) to allow its output voltage to be scaled to an external master voltage. Typically, the external voltage is generated by the supply with the highest voltage in the system, which is fed to the slave track pins (see Figure 6). Any supplies that track a master supply must be enabled before the master supply comes up and disabled after the master supply comes down. Enabling the slave supplies

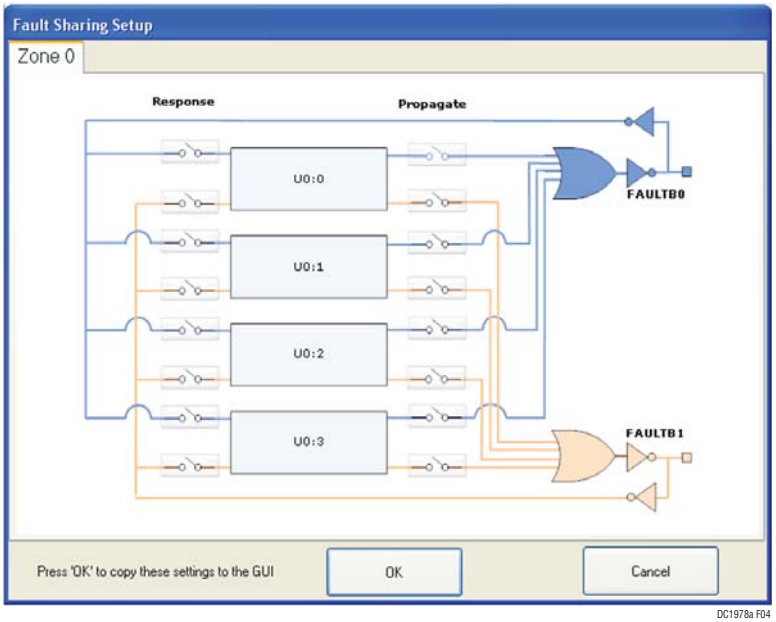


Figure 4. Fault Sharing Utility in LTpowerPlay GUI

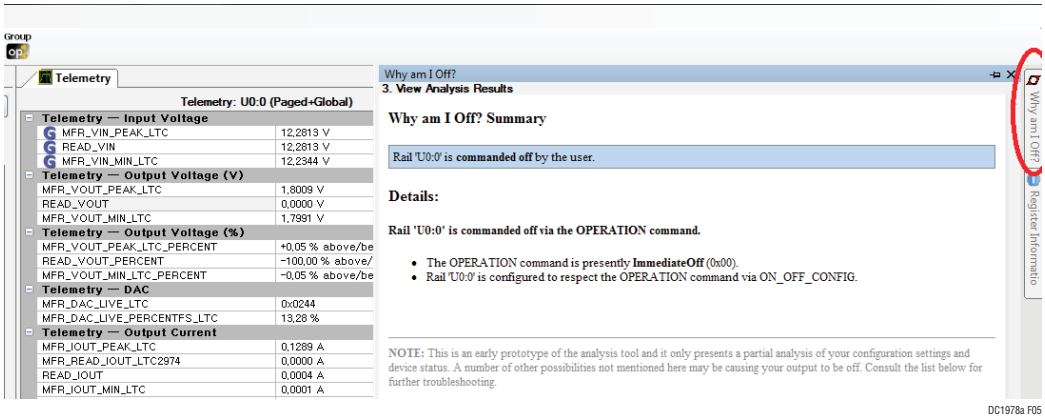


Figure 5. "Why am I Off?" tool in the LTpowerPlay GUI

COMMON DEMO BOARD OPERATIONS

when the master is down requires supervisors monitoring the slaves to disable UV detection. Slave UC detection must also be disabled when the slaves are tracking the master down to prevent false UC events. All channels configured for tracking must track off together in response to a fault on any channel or any other condition that can bring one or more of the channels down. Prematurely disabling a slave channel via its run pin may cause that channel to shut down out of sequence. The LTC2974 supports the following tracking features:

- Track channels on and off without issuing false UV/UC events when the slave channels are tracking up or down.
- Track all channels down in response to a fault from a slave or master.
- Track all channels down when V_{IN_SNS} drops below VIN_OFF, share clock is held low or RESTORE_USER_ALL is issued.
- Ability to reconfigure selected channels that are part of a tracking group to sequence up after the group has tracked up or sequence down before the group has tracked down.

To demonstrate the tracking features of LTC2974, DC1810A has three jumpers (JP1, JP2 and JP3) that can be set to connect resistive dividers from the 1.8V master supply (CH0) to the TRACK pins of channels 1 to 3.

The required timing settings and diagrams in order to enable tracking with LTC2974 are listed in the data sheet, and a brief summary is shown below:

Master channel 0

- TON_DELAY = Ton_delay_master
- TON_RISE = Ton_rise_master
- TOFF_DELAY = Toff_delay_master
- Mfr_track_en_chan0 = 0

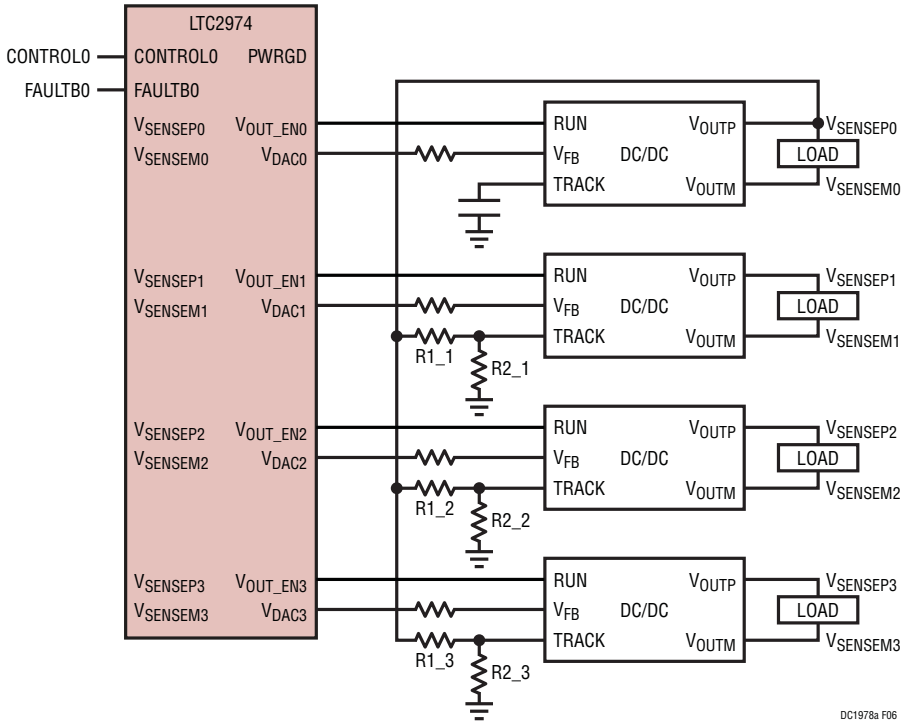


Figure 6. LTC2974 Configured to Control, Supervise and Monitor Power Supplies Equipped with Tracking Pin

COMMON DEMO BOARD OPERATIONS

Slave channel n

- TON_DELAY = Ton_delay_slave
- TON_RISE = Ton_delay_master + Ton_rise_slave
- TOFF_DELAY = Toff_delay_master + T_off_delay_slave
- Mfr_track_en_chan0 = 1

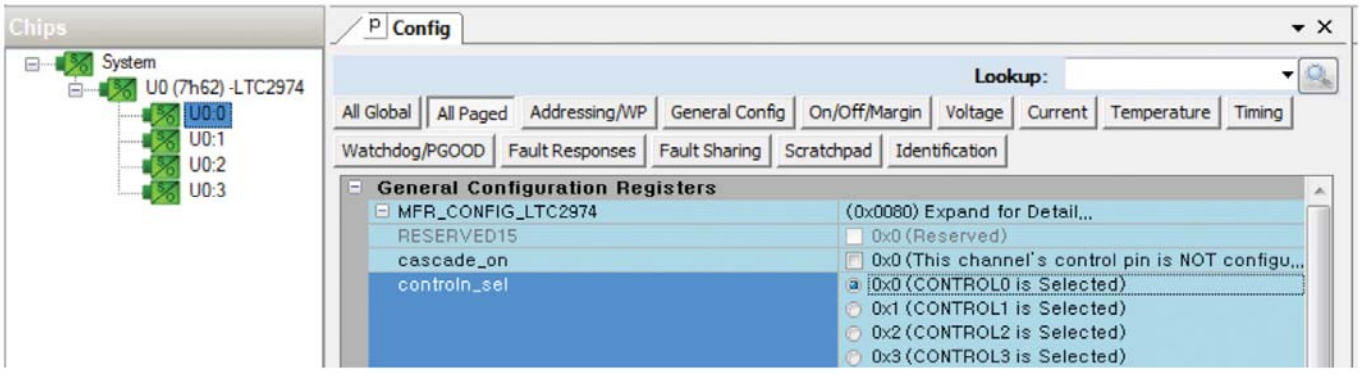
Where:

Ton_delay_master – Ton_delay_slave > RUN to TRACK setup time

Toff_delay_slave > time for master supply to fall.

PROCEDURE TO DEMONSTRATE TRACKING WITH DC1978A

1. Start with the default LTC2974 EEPROM and jumper settings for DC1978A. Set the jumpers JP1, JP2 and JP3 to TRACK CH0 position. This connects the TRACK pins of the slave supply channels to the output voltage of the master channel through resistive dividers (see Figure 6).
2. Set DC1809A jumper JP4 to SW0 position to propagate the CONTROL0 switch to the CONTROL0 pin of LTC2974.
3. Set the preload (100mA) of CH0 (SW1 to ON) and the preloads of the slave channels CH1 to CH3 to OFF (SW2 to SW4 to OFF). The absence of load for the slave channels makes improper sequencing down behavior more obvious.
4. Configure all power supplies to respond to CONTROL0, by setting the appropriate bit in the paged MFR_CONFIG register. In this case U0:0, U0:1, U0:2 and U0:3 are all controlled by CONTROL0.



COMMON DEMO BOARD OPERATIONS

5. Set the TON_DELAY of all slaves (CH1, CH2 and CH3) to 0ms and the TON_DELAY for the master channel to 20ms.

[4 rails] TON_DELAY

TON_DELAY (All Pages in System)	
U0:0 – LTC2974	20,000 ms
U0:1	0,000 ms
U0:2	0,000 ms
U0:3	0,000 ms

6. Set the TOFF_DELAY of all slaves (CH1, CH2 and CH3) to 20ms and the TOFF_DELAY for the master channel to 0ms.

[4 rails] TOFF_DELAY

TOFF_DELAY (All Pages in System)	
U0:0 – LTC2974	0,000 ms
U0:1	20,000 ms
U0:2	20,000 ms
U0:3	20,000 ms

7. Set the TON_RISE of all slaves (CH1, CH2 and CH3) to 30ms and the TON_RISE for the master channel to 10ms.

[4 rails] TON_RISE

TON_RISE (All Pages in System)	
U0:0 – LTC2974	10,000 ms
U0:1	30,000 ms
U0:2	30,000 ms
U0:3	30,000 ms

COMMON DEMO BOARD OPERATIONS

8. Set the track_en_chan1, track_en_chan2 and track_en_chan3 bits in MFR_CONFIG3 to 1.

MFR_CONFIG3_LTC2974	(0x0E) track_en_chan3, track_en_chan2,track_en_chan1
chan3_uc	0x0 (No Action on IOUT_UC)
chan2_uc	0x0 (No Action on IOUT_UC)
chan1_uc	0x0 (No Action on IOUT_UC)
chan0_uc	0x0 (No Action on IOUT_UC)
track_en_chan3	0x1 (Channel is a slave in a tracked power supply system)
track_en_chan2	0x1 (Channel is a slave in a tracked power supply system)
track_en_chan1	0x1 (Channel is a slave in a tracked power supply system)
track_en_chan0	0x0 (Channel is NOT a slave in a tracked power supply system)

9. Toggle the CONTROL0 switch and observe the synchronized tracking behavior of the power supplies.

Figure 7. Tracking Supplies Up with DC1978A

Figure 8. Tracking Supplies Down with DC1978A

COMMON DEMO BOARD OPERATIONS

CASCADE SEQUENCING

Cascade sequence ON allows a master power supply to sequence ON a series of slave supplies by connecting each power supply's power good output to the control pin of the next power supply in the chain. Please note that the power good signal is that of the power supply and not derived from the LTC2974's internal power good processing. Power good based cascade sequence OFF is not supported, OFF sequencing must be managed using immediate or time based sequence OFF. See also Tracking Based Sequencing.

Cascade sequence ON is illustrated in Figure 9. For each slave channel Mfr_config_cascade_on bit is asserted high and the associated control input is connected to the power good output of the previous power supply. In this configuration each slave channel's startup is delayed until the previous supply has powered up.

Cascade sequence OFF is not directly supported. Options for reversing the sequence when turning the supplies off include:

- Using the OPERATION command to turn off all the channels with an appropriate off delay.
- Using the FAULT pin to bring all the channels down immediately or in sequence with an appropriate off delay.

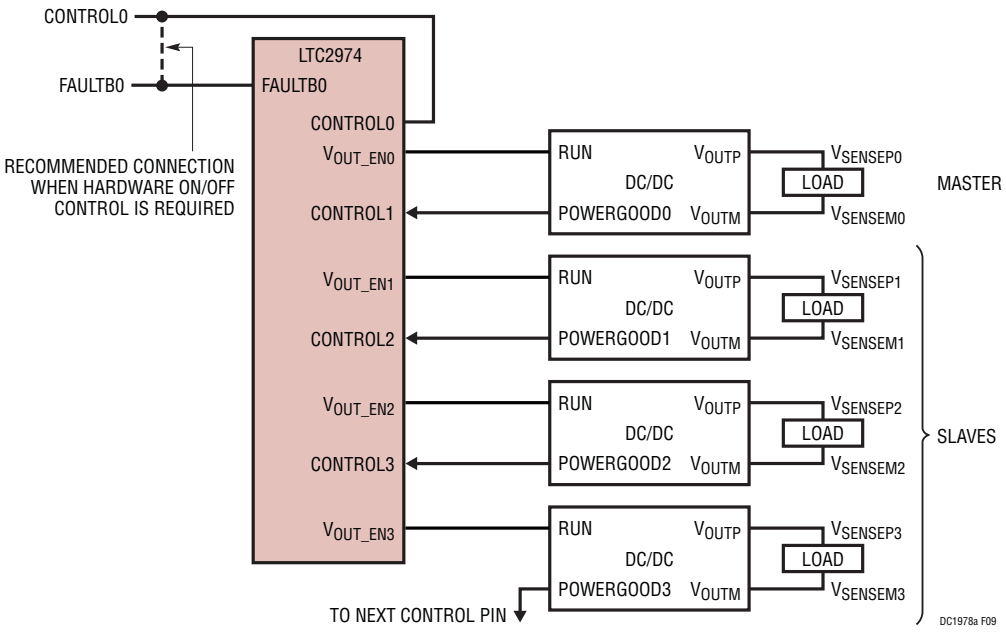


Figure 9. LTC2974 Configured to Cascade Sequence ON and Time Base Sequence OFF

COMMON DEMO BOARD OPERATIONS

PROCEDURE TO DEMONSTRATE CASCADE SEQUENCING WITH DC1978A

1. Start with the default LTC2974 EEPROM and jumper settings for DC1978A. Set the DC1809A power good cascading jumpers JP4, JP5, JP6 and JP7 to SW0, PG_0, PG_1, PG_2 positions. This connects the power good and control pins as shown in Figure 9.
2. Enable all output supply preloads on DC1810A by sliding the DC1810A switches SW1, SW2, SW3 and SW4 to ON position.
3. Set the TON_DELAY of all channels to 0ms

[4 rails] TON_DELAY

TON_DELAY (All Pages in System)	
U0:0 – LTC2974	0.000 ms
U0:1	0.000 ms
U0:2	0.000 ms
U0:3	0.000 ms

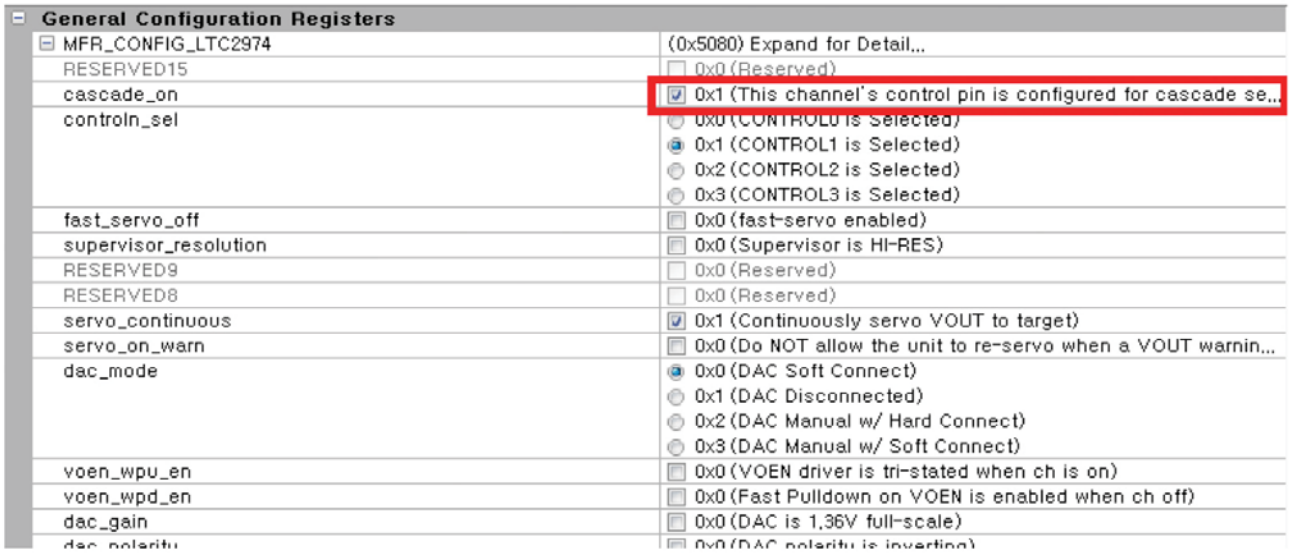
4. Set the TOFF_DELAY for the inverse shutdown sequence.

[4 rails] TOFF_DELAY

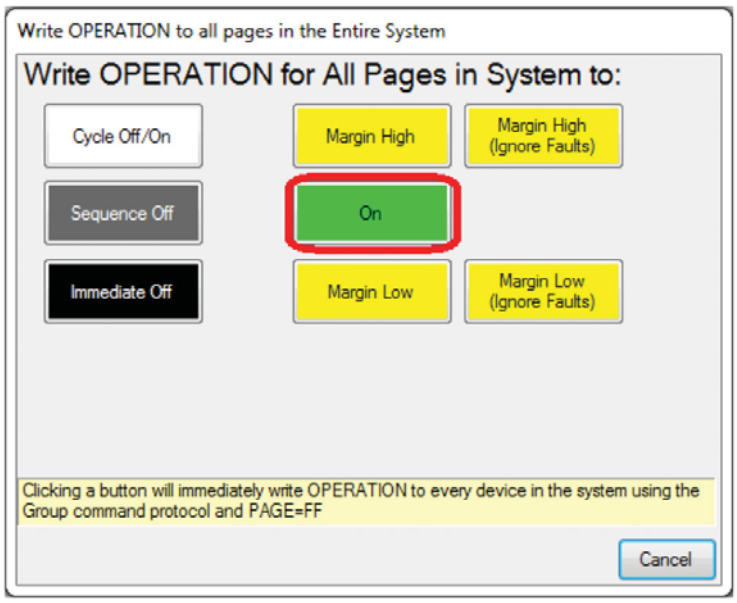
TOFF_DELAY (All Pages in System)	
U0:0 – LTC2974	30.000 ms
U0:1	20.000 ms
U0:2	10.000 ms
U0:3	0.000 ms

COMMON DEMO BOARD OPERATIONS

5. Set the cascade_on bit in MFR_CONFIG register for CH1, CH2 and CH3. The master channel has this bit cleared.

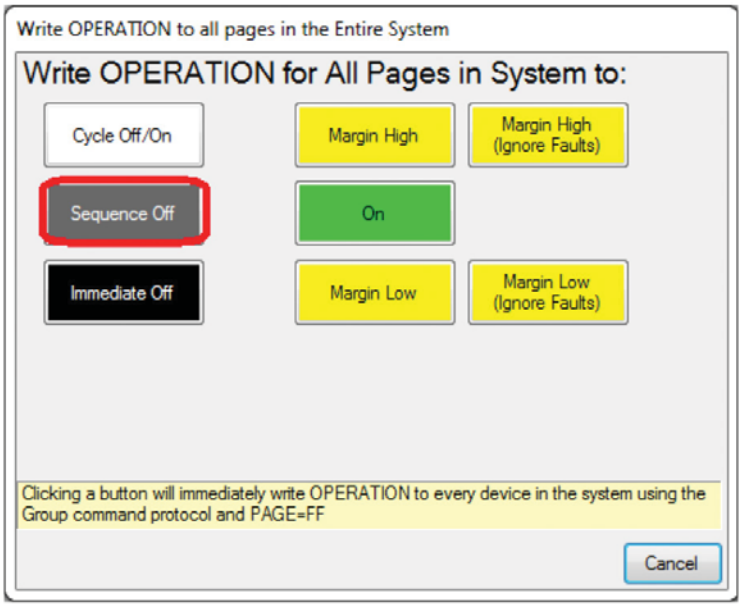


6. Use Group Operation On to power up all supplies



COMMON DEMO BOARD OPERATIONS

7. Use Group Operation “Sequence Off” to power down all supplies



8. The power supplies cascade ON/OFF as shown in Figures 10 and 11 below.

Figure 10. Cascade Sequencing Up with DC1978A

Figure 11. Time Based Sequencing Down with DC1978A

SETUP PROCEDURE FOR MULTIBOARD ARRAYS

Multiple DC1978As can be combined to control up to 36 independent power supplies. This demonstrates the coordinated fault responses and accurate time base shared across multiple LTC2974 chips.

Procedure:

1. Stack the boards together by plugging J1 of the second DC1809A board into J3 of the first DC1809A board.
2. Connect the 12V V_{IN} across the boards using the banana cables as shown in Figure 12 below. Preserve the correct polarity (connect V_{IN} to V_{IN} and GND to GND).
3. The USB to I^2C/SMBus/PMBus controller may be plugged into either board. If both LTC2974s do not show up in the GUI, click the hourglass icon to enumerate the I^2C bus and find the addresses of the parts. Make sure to set different addresses for each LTC2974.
4. The addresses of the LTC2974 are set by the jumpers JP1 and JP2 on DC1809A and the settings have to be unique for each board in the array.
5. Since the individual control lines are connected across the boards (CONTRL0 is a common bus across all boards in the array, as are CONTROL1 CONTROL2 and CONTROL3), make sure that all control pins on all DC1809A boards are set to the selected active state.
6. Relaunch LTpowerPlay. After launching, LTpowerPay will enumerate the entire board array and build a representative system tree and read all hardware settings into the GUI.

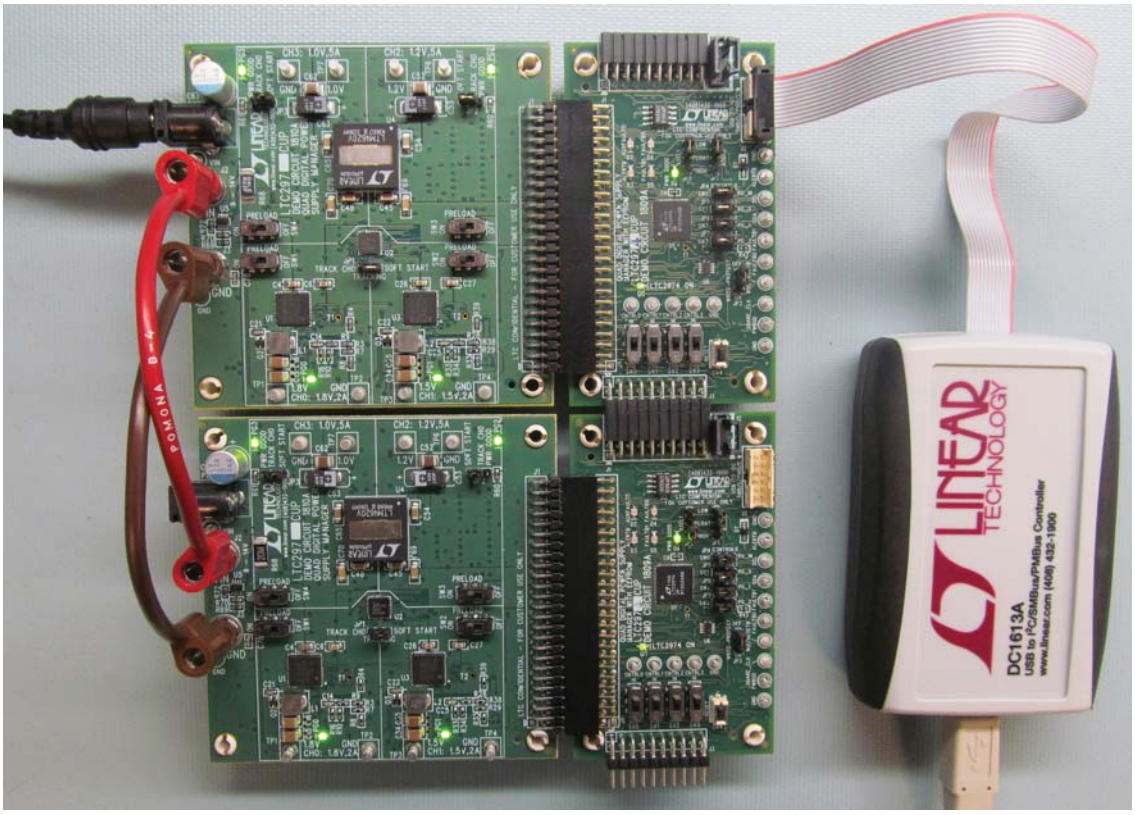


Figure 12. Array of Multiple DC1978A Demo Boards

DC1809A DETAILS TOP

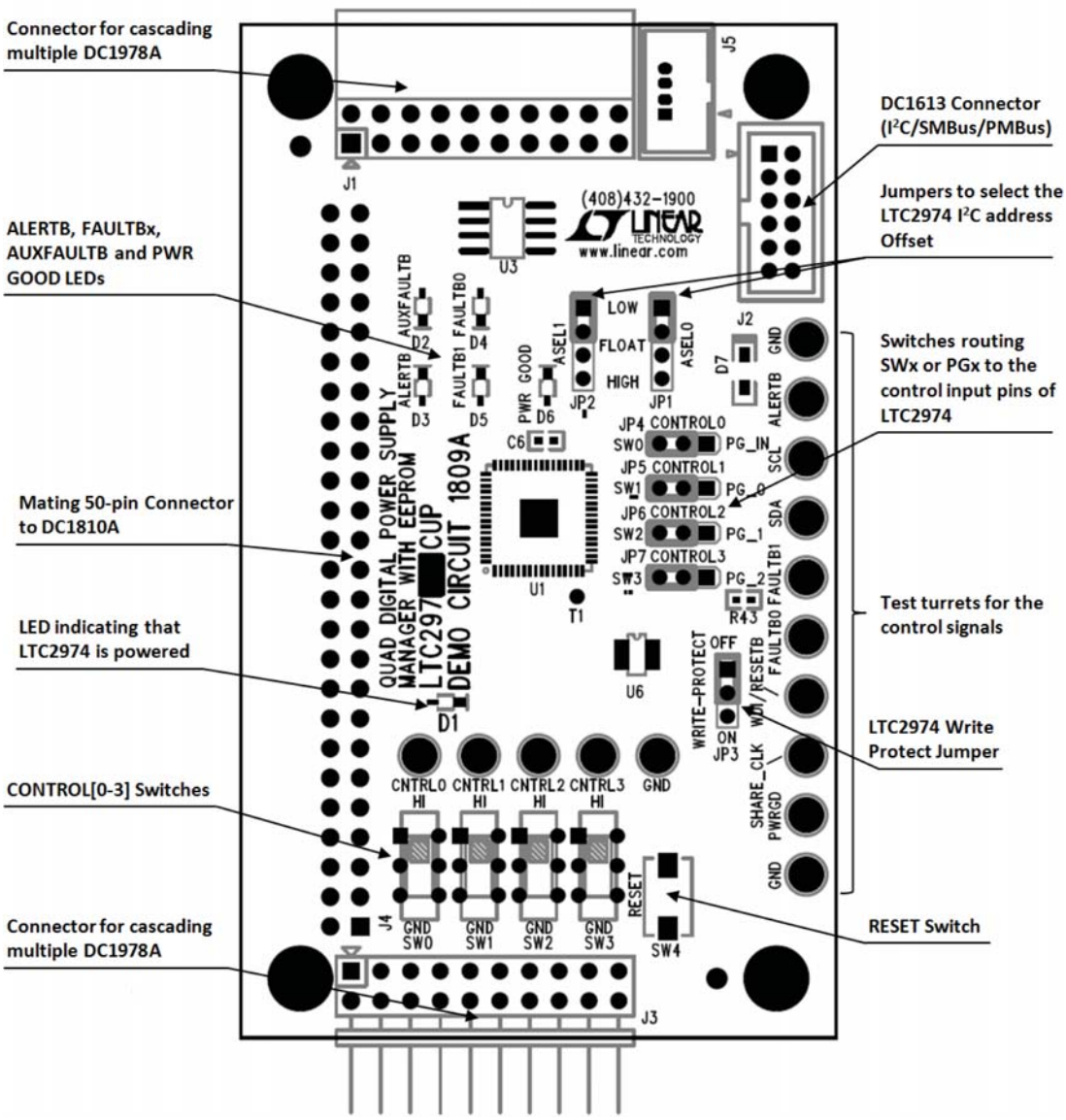
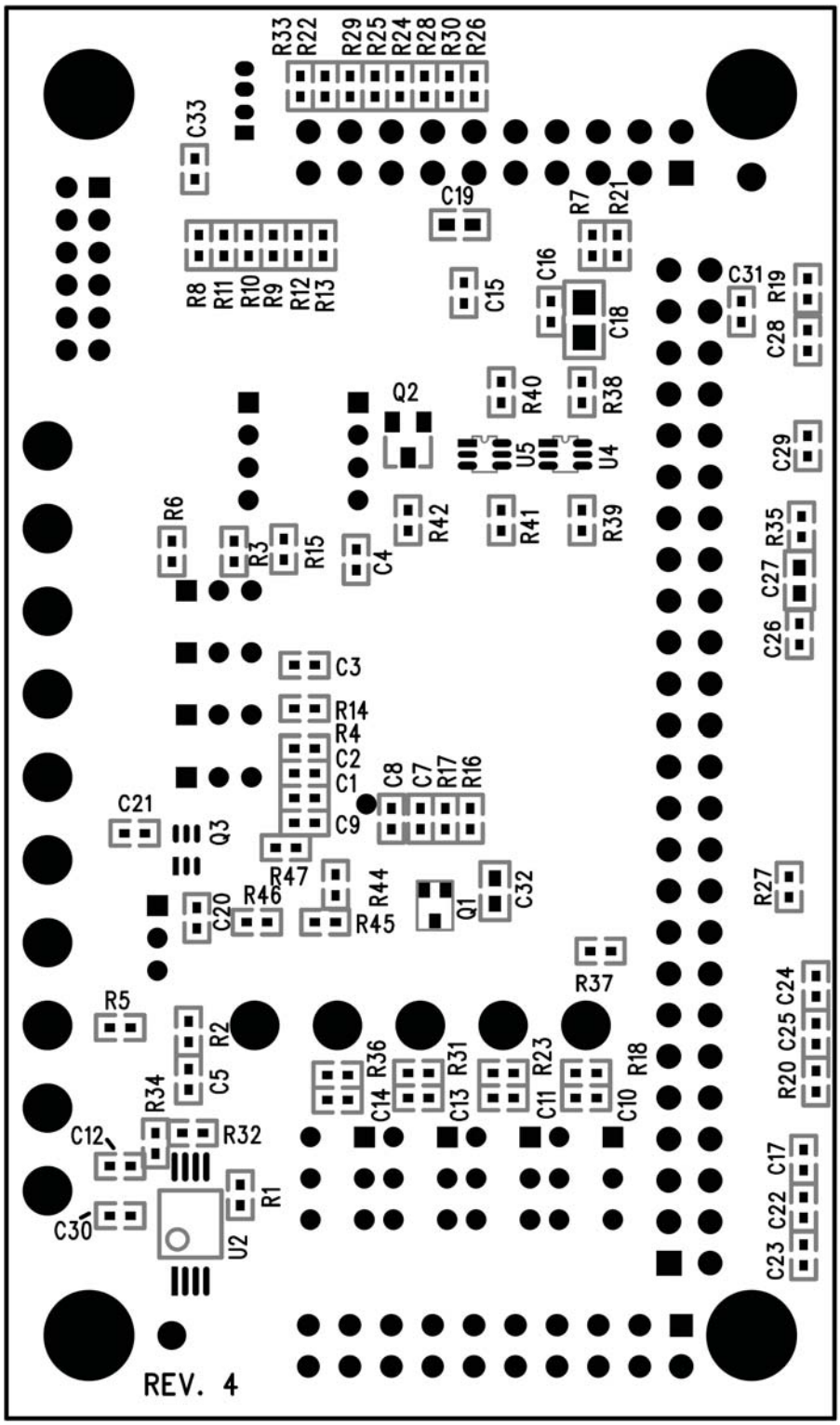


Table 4. DC1809A Default Jumper and Switch Configuration (Default Position Shown in Grey in the Figure Above)

REFERENCE DESIGNATOR	SIGNAL NAME	USAGE	DEFAULT
JP1, JP2	ASEL0, ASEL1	Set the address offset of LTC2974	LOW, LOW
JP3	WRITE PROTECT	Write protect the LTC2974 EEPROM memory	OFF
JP4, JP5, JP6, JP7	CONTROL0, CONTROL1, CONTROL2, CONTROL3	Implement cascade sequencing by connecting power good signals to the control pins, or connect the control pins directly to the SW0 to SW3 switches	SW0, SW1, SW2, SW3
SW0, SW1, SW2, SW3	CONTROL0, CONTROL1 CONTROL2, CONTROL3	Switches that can be routed to the individual CONTROL input pins of LTC2974	HI, HI, HI, HI

DC1809A DETAILS BOTTOM



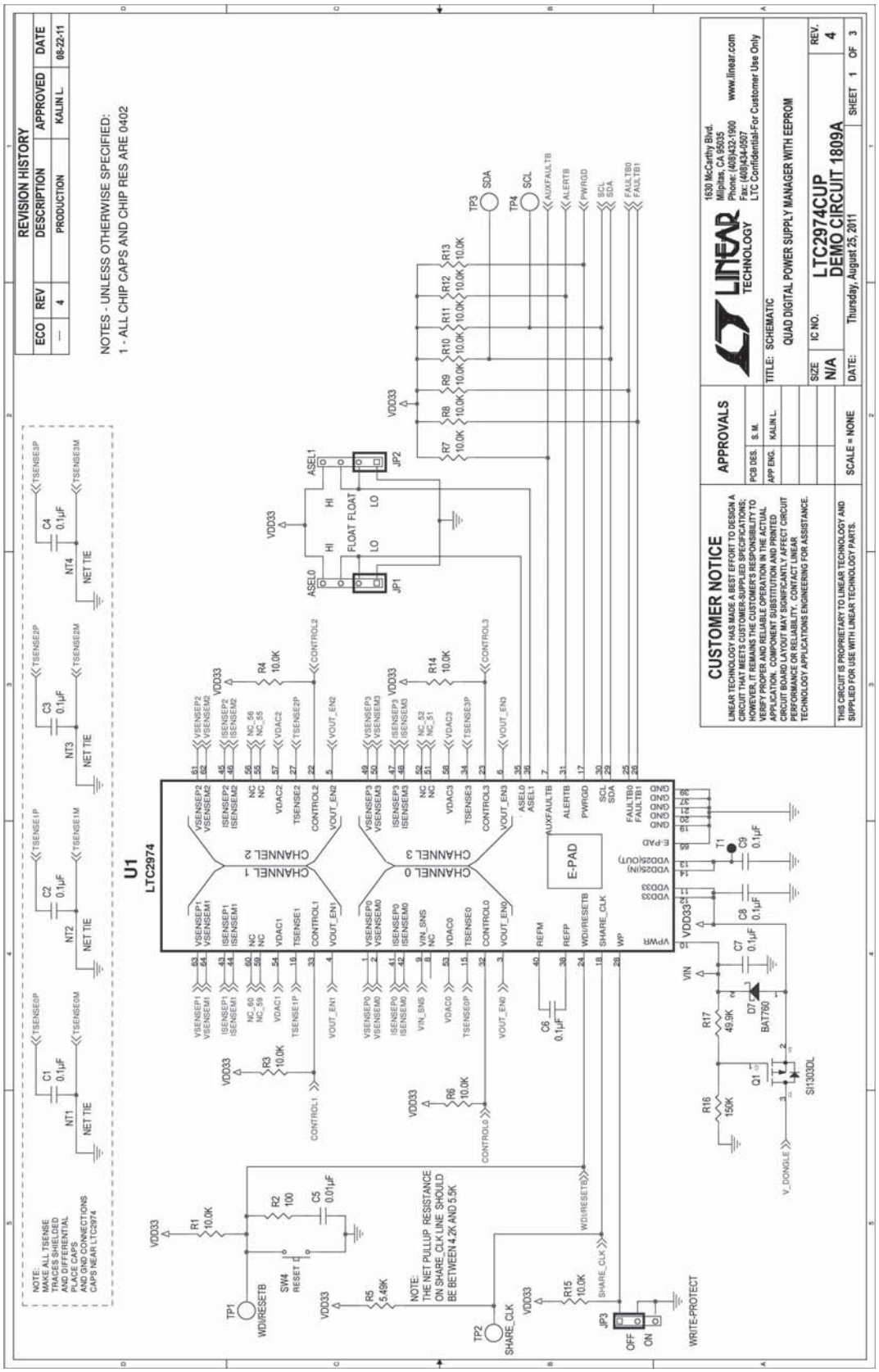
DC1809A PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	U1	LTC2974	LINEAR TECHNOLOGY LTC2974CUP
2	7	C1, C2, C3, C4, C6, C8, C9	CAP CERAMIC 0.10µF 16V X7R 0402	TDK C1005X7R1C104K
3	1	C7	CAP CER 0.10µF 25V X5R 0402	TAIYO YUDEN TMK105BJ104KV-F
4	13	R1, R3, R4, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15	RES 10k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF1002X
Additional Demo Board Circuit Components				
5	3	C12, C15, C33	CAP CERAMIC 0.10µF 16V X7R 0402	TDK C1005X7R1C104K
6	14	C5, C10, C11, C13, C14, C16, C23, C24, C25, C26, C28, C29, C30, C31	CAP 0.01µF 25V CERAMIC X7R 0402	TDK C1005X7R1E103K
7	4	C17, C20, C21, C22	CAP CER 0.10µF 25V X5R 0402	TAIYO YUDEN TMK105BJ104KV-F
8	1	C18	CAP CER 10µF 16V X5R 0805	MURATA ELECTRONICS GRM21BR61C106KE15L
9	3	C19, C27, C32	CAP CERAMIC 1µF 25V X5R 0603	AVX 06033D105KAT2A
10	2	D1, D6	LED GREEN S-GW TYPE SMD	PANASONIC - SSG LN1371SGTRP
11	4	D2, D3, D4, D5	LED RED S-TYPE GULL WING SMD	PANASONIC - SSG LN1271RTR
12	1	D7	DIODE SCHOTTKY 20V 1A SOD323	NXP SEMICONDUCTOR BAT760,115
13	1	J1	CONN SOCKET 20 DUAL ROW	MILL MAX 803-93-020-20-001
14	1	J2	CONN HEADER 12POS 2mm STR DL PCB	FCI 98414-G06-12ULF
15	1	J3	CONN PIN HEADER 20 DUAL ROW	MILL MAX 802-40-020-20-001
16	1	J4	CONN FMALE 50POS DL 0.1" R/A GOLD	SULLINS CONNECTOR SOLUTIONS PPPC252LJBN-RC
17	1	J5	CONN HEADER VERT 0.050 4POS	TYCO ELECTRONICS 5-104071-7
18	1	Q1	MOSFET P-CH 20V 670MA SOT323-3	VISHAY/SILICONIX SI1303DL-T1-E3
19	1	Q2	MOSFET N-CH 60V 115MA SOT-23	FAIRCHILD SEMICONDUCTOR 2N7002
20	1	Q3	MOSFET N-CH DUAL 20V 1.3A SC70-6	VISHAY/SILICONIX SI1922EDH-T1-E3
21	5	R2, R18, R23, R31, R36	RES 100Ω 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF1000X
22	1	R5	RES 5.49k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF5491X
23	1	R16	RES 150k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF1503X
24	1	R17	RES 49.9k 1/10W 1% 0402 SMD	VISHAY, CRCW040249K9FKED
25	6	R19, R20, R27, R35, R44, R47	RES 100k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF1003X
26	2	R21, R43	DO NOT INSTALL	DO NOT INSTALL
27	2	R22, R29	RES 0Ω 1/10W 0402 SMD	PANASONIC - ECG ERJ-2GE0R00X
28	6	R24, R25, R26, R28, R30, R33	DO NOT INSTALL	DO NOT INSTALL
29	2	R32, R34	RES 4.99k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF4991X
30	1	R37	RES 1k 1/16W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF1001X
31	5	R38, R39, R40, R41, R42	RES 300Ω 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF3000X
32	1	R45	RES 4.87k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF4871X
33	1	R46	RES 16.9k 1/10W 1% 0402 SMD	PANASONIC - ECG ERJ-2RKF1692X
34	1	SW4	SWITCH LT TOUCH 6mm x 3.5mm 100GF SMD	PANASONIC - EVQ-PES04K
35	1	U2	IC EEPROM 2k BIT 400kHz 8TSSOP	MICROCHIP TECH 24LC025-I/ST

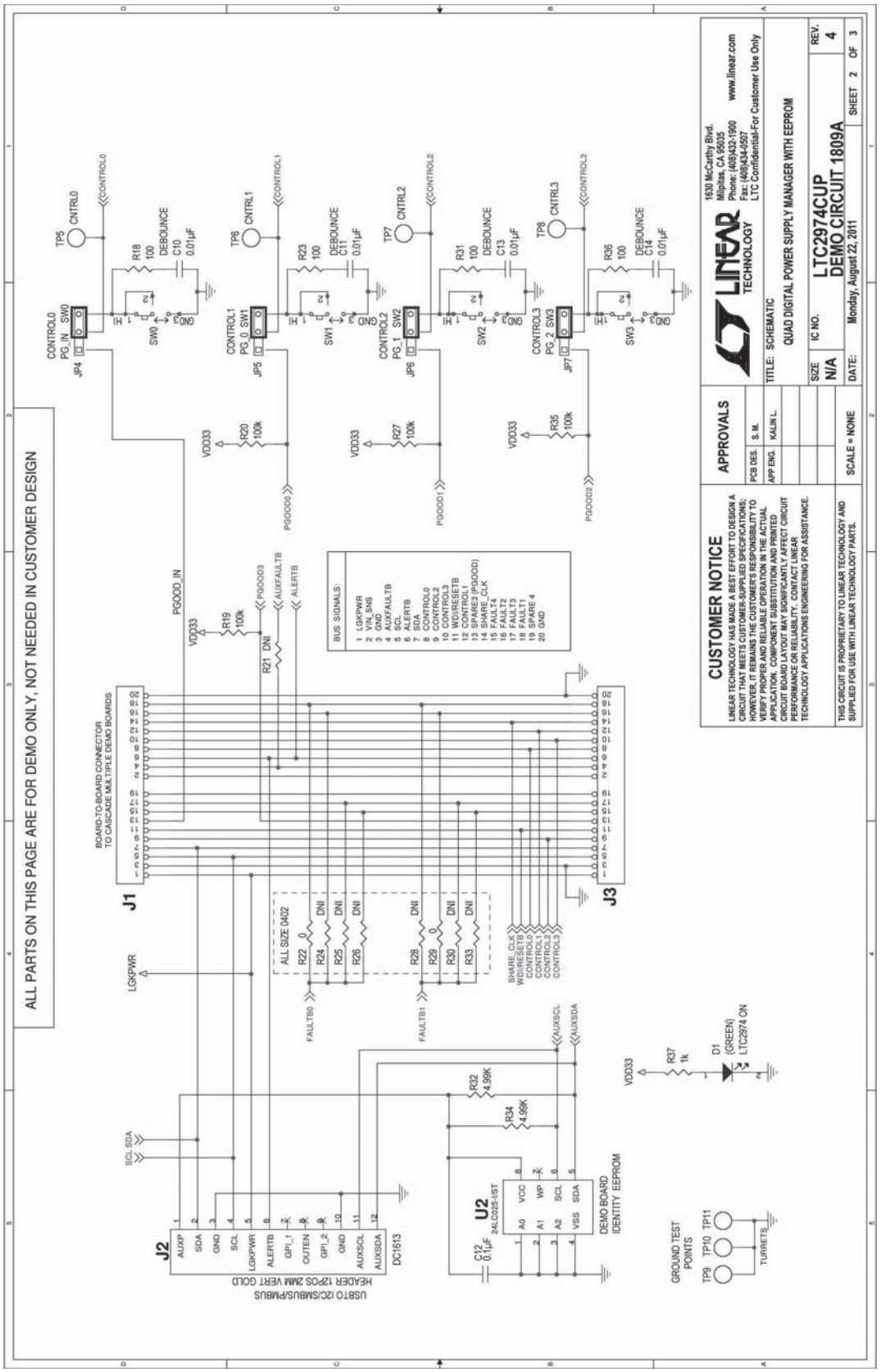
DC1809A PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
36	1	U3	LT1763 - 500mA, LOW NOISE, LDO MICROPOWER REGULATORS	LINEAR TECHNOLOGY LT1763CS8-3.3
37	2	U4, U5	IC BUFF/DVR DL NON-INV SC706	TEXAS INST SN74LVC2G07DCKR
38	1	U6	LTC4365 - UV, OV AND REVERSE SUPPLY PROTECTION CONTROLLER	LINEAR TECHNOLOGY LTC4365CTS8
Hardware/Components (For Demo Board Only)				
39	2	JP1, JP2	CONN HEADER 4POS 2mm VERT T/H	3M 951104-8622-AR
40	5	JP3, JP4, JP5, JP6, JP7	CONN HEADER 3POS 2mm VERT T/H	SULLIN, NRPN031PAEN-RC
41	4	SW1, SW2, SW3, SW0	SW SLIDE DPDT 6VDC 0.3A PCMNT	C & K COMPONENTS JS202011CQN
42	15	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15	TERMINAL TURRET DBL 0.084"L	MILL-MAX, 2308-2-00-80-00-00-07-0
43	7	SHUNT1, SHUNT2, SHUNT3, SHUNT4, SHUNT5, SHUNT6, SHUNT7	CONN SHUNT 2mm 2POS	SAMTEC 2SN-BK-G
44	4	MH1, MH2, MH3, MH4	STAND-OFF NYLON 1/2" SNAP IN	KEYSTONE 8833

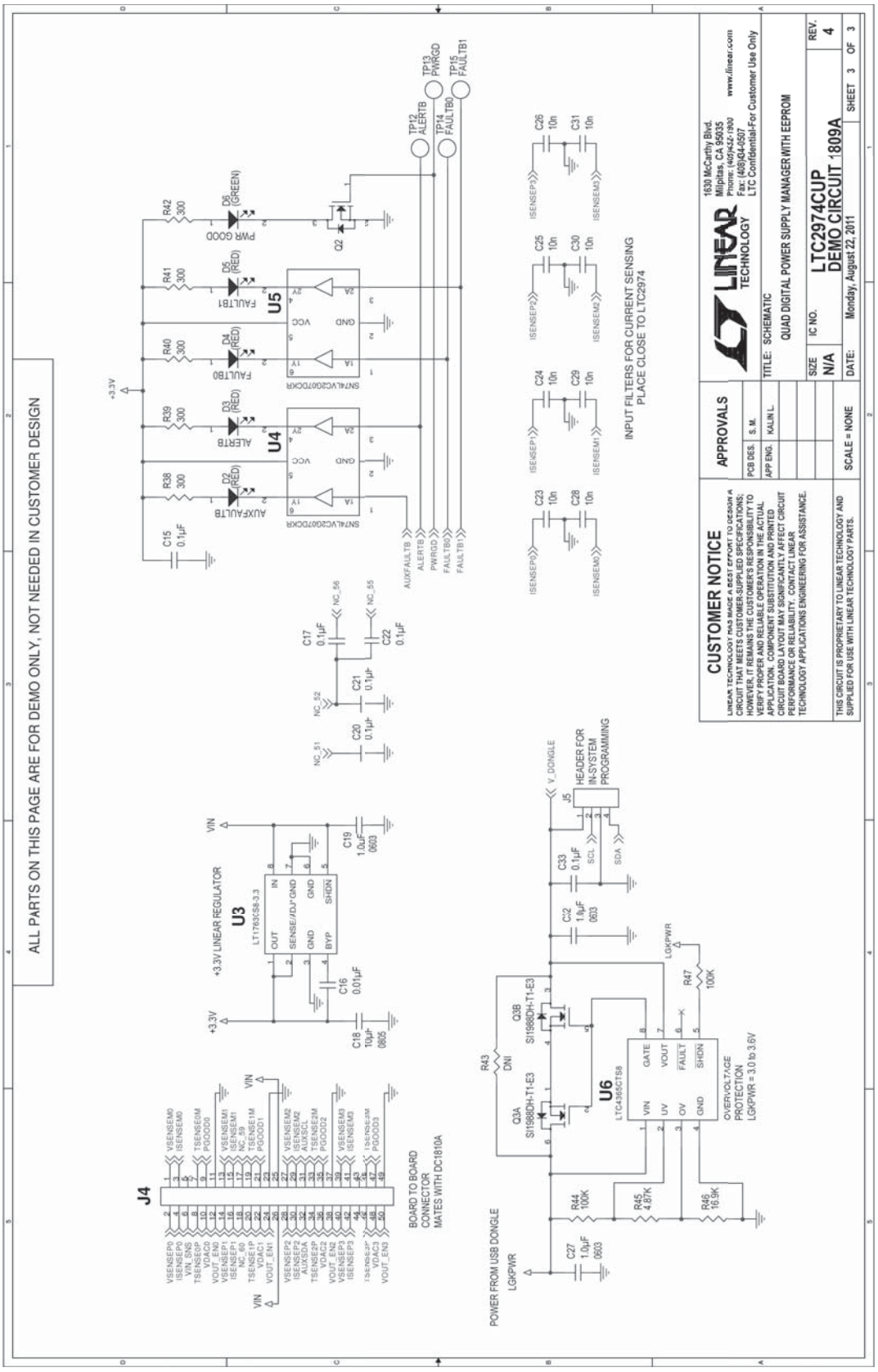
DC1809A SCHEMATIC DIAGRAM



DC1809A SCHEMATIC DIAGRAM



DC1809A SCHEMATIC DIAGRAM



DC1810A DETAILS TOP

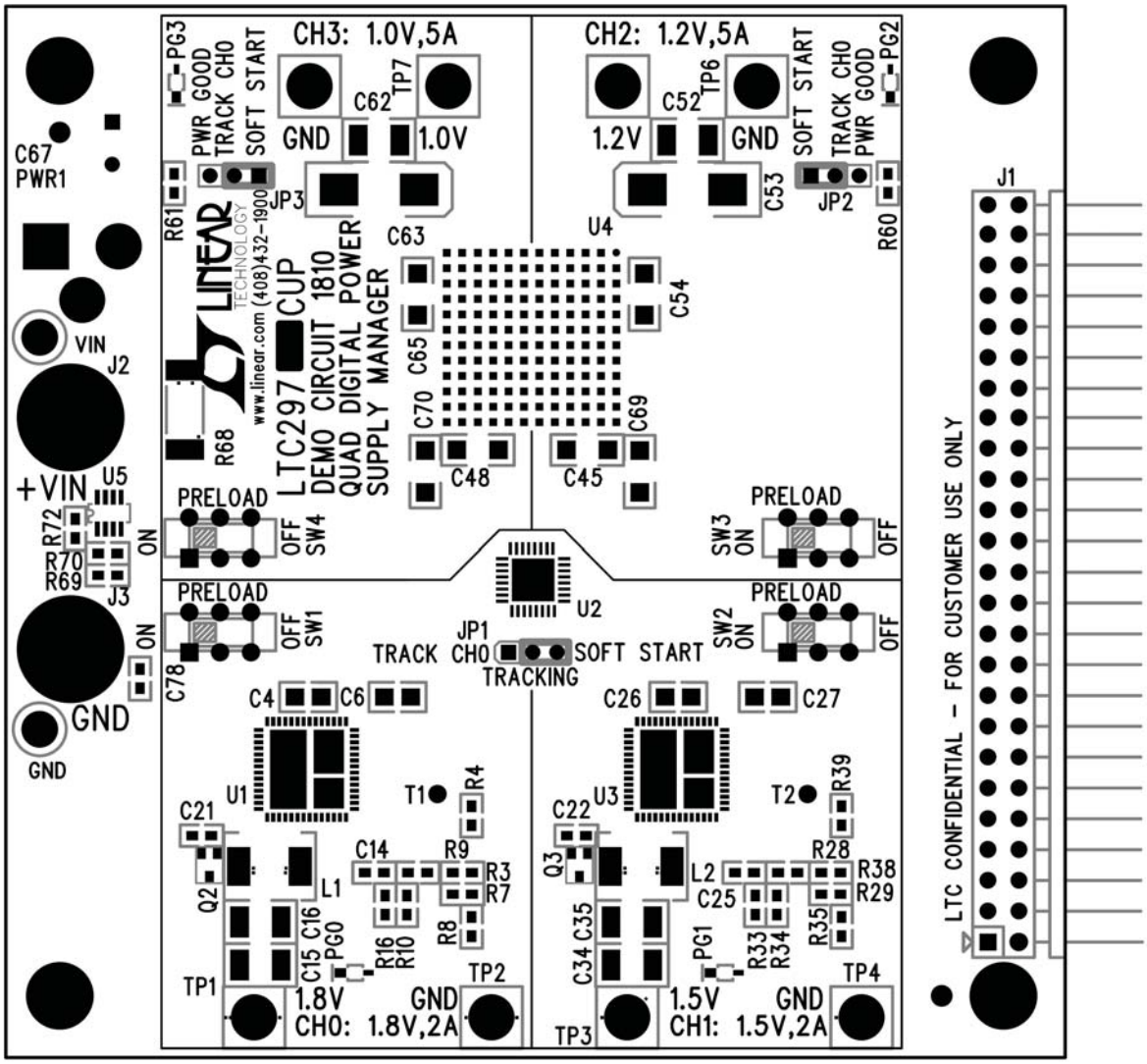
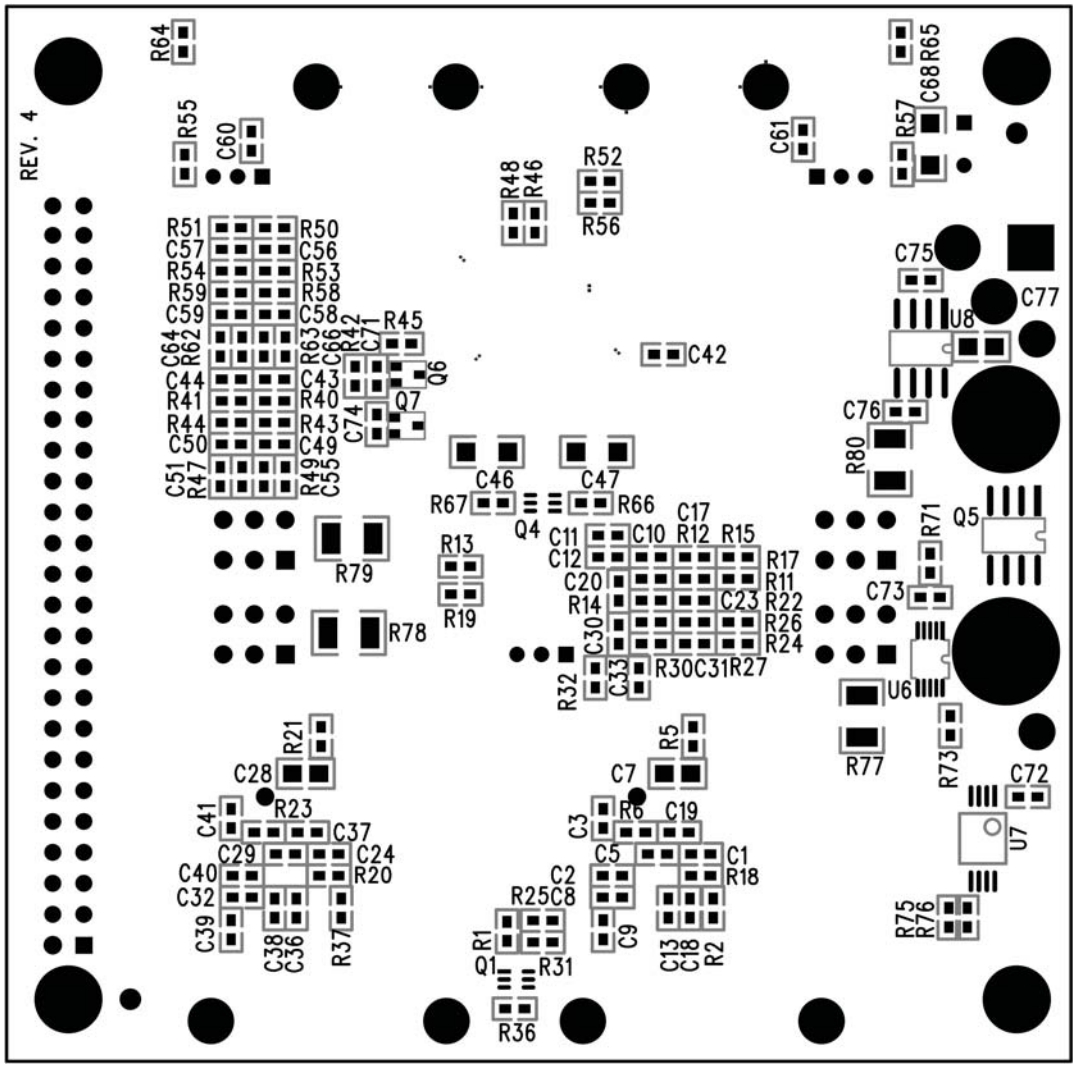


Table 5. DC1810A Default Jumper and Switch Configuration (Default Position Shown in Grey in the Figure Above)

REFERENCE DESIGNATOR	SIGNAL NAME	USAGE	DEFAULT
JP1, JP2	Track/Soft-Start	Set CH0 tracking or soft-start for CH1, CH2 and CH3	SOFT-START
SW1, SW2, SW3, SW4		Enable/Disable 100mA load on CH0, CH1, CH2, CH3 outputs	ON

DC1810A DETAILS BOTTOM



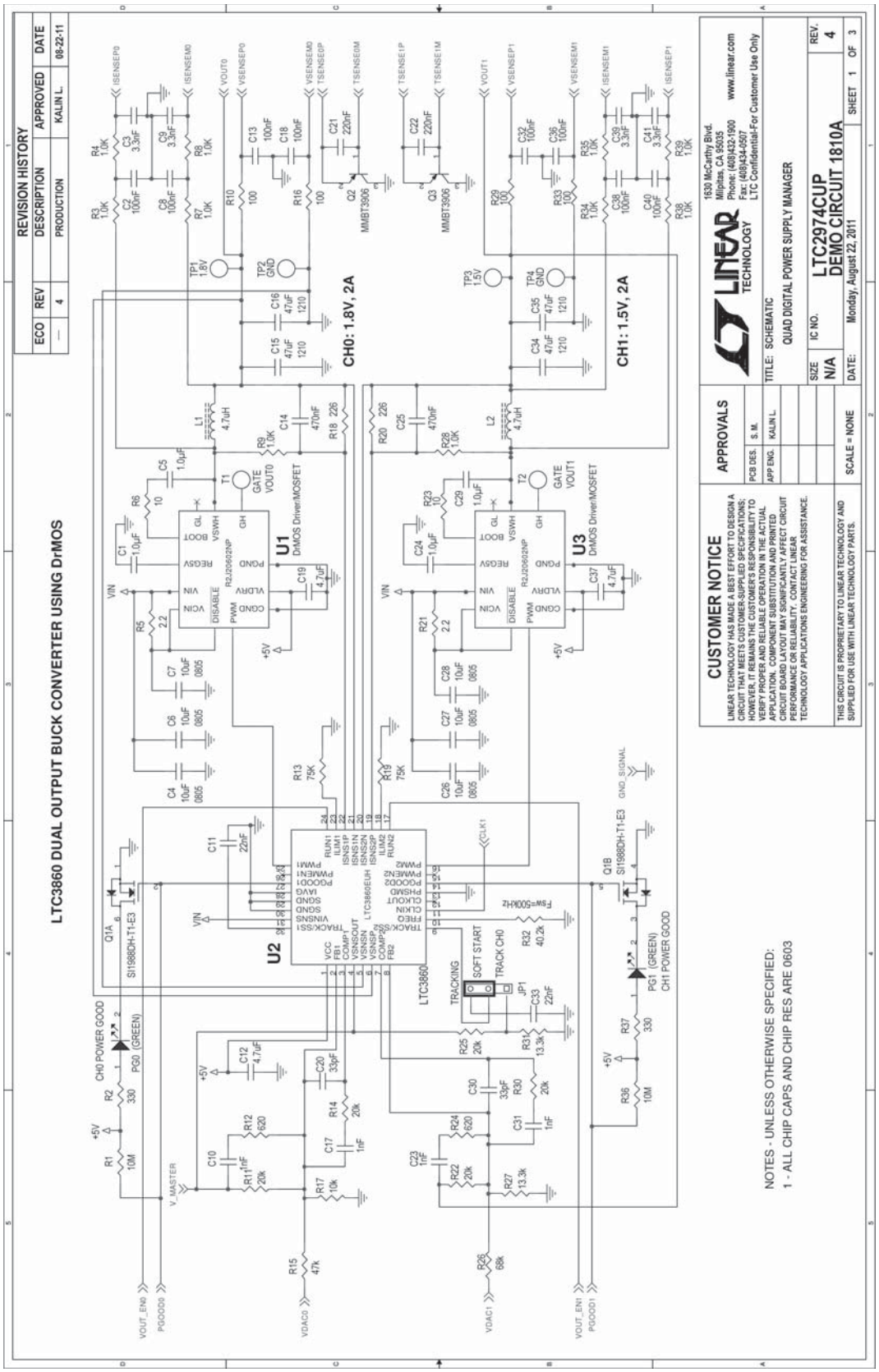
DC1810A PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	16	R3, R4, R7, R8, R34, R35, R38, R39, R40, R41, R43, R44, R53, R54, R58, R59	RES 1k 1/10W 1% 0603 SMD	PANASONIC ERJ-3EKF1001V
2	8	R10, R16, R29, R33, R47, R49, R62, R63	RES 100Ω 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF1000V
3	16	C2, C8, C13, C18, C32, C36, C38, C40, C43, C49, C51, C55, C56, C58, C64, C66	CAP CER 0.10µF 25V X7R 10% 0603	TDK CORPORATION C1608X7R1E104K
4	8	C3, C9, C39, C41, C44, C50, C57, C59	CAP 3300pF 50V CERAMIC X7R 0603	MURATA GRM188R71H332KA01D
Additional Demo Board Circuit Components				
5	8	C3, C9, C39, C41, C44, C50, C57, C59	CAP 3300pF 50V CERAMIC X7R 0603	MURATA GRM188R71H332KA01D
6	4	C21, C22, C71, C74	CAP CERM 0.22µF 10% 16V X5R 0603	AVX CORP - 0603YD224KAT2A
7	4	Q2, Q3, Q6, Q7	TRANS GP SS PNP 40V SOT323	ON SEMI - MMBT3906WT1G
8	1	R15	RES 47k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF4702V
9	1	R26	RES 68k 1/10W 1% 0603 SMD	VISHAY CRCW060368K0FKEA
10	1	R50	RES 180k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF1803V
11	1	R51	RES 220k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF2203V
12	7	C1, C5, C24, C29, C72, C73, C76	CAP CERAMIC 1µF 25V X5R 0603	AVX 06033D105KAT2A
13	7	C4, C6, C7, C26, C27, C28, C77	CAP CER 10µF 16V X5R 0805	MURATA - GRM21BR61C106KE15L
14	5	C10, C17, C23, C31, C78	CAP 1000pF 50V CERAMIC X7R 0603	NIC NMC0603X7R102K50TRPF
15	2	C11, C33	CAP 22000pF 16V CERM X7R 0603	MURATA GRM188R71C223KA01D
16	4	C12, C19, C37, C42	CAP CER 4.7µF 10V X5R 0603	TAIYO YUDEN LMK107BJ475KA-T
17	2	C14, C25	CAP CER 0.47µF 10V 20% X5R 0603	AVX 0603ZD474MAT2A
18	4	C15, C16, C34, C35	CAP CER 47µF 6.3V X5R 20% 1210	TDK CORPORATION C3225X5R0J476M
19	2	C20, C30	CAP CERAMIC 33pF 100V NP0 0603	MURATA GRM188C2A330JA01D
20	7	C45, C46, C47, C48, C68, C69, C70	CAP CER 10µF 25V X5R 1206	MURATA ELECTRONICS GRM31CR61E106KA12L
21	2	C52, C62	CAP CER 100µF 6.3V X5R 20% 1210	TDK CORPORATION C3225X5R0J107M
22	2	C53, C63	CAP TANT 330µF 6.3V 10% SMD	SANYO 6TPF330M9L
23	2	C54, C65	CAP CER 22µF 16V X5R 10% 1206	AVX CORPORATION 1206YD226KAT2A
24	3	C60, C61, C75	CAP 10000pF 16V CERM X7R 0603	MURATA GRM188R71C103KA01D
25	1	C67	CAP POLY ALUM 220µF 20V RAD	NICHICON PLV1D221MDL1TD
26	2	VIN1, GND1	TERMINAL TURRET DBL 0.084"L	MILL MAX 2308-2-00-80-00-00-07-0
27	3	JP1, JP2, JP3	CONN HEADER 3POS 2MM VERT T/H	3M 951103-8622-AR
28	1	J1	BERGSTIK	MOLEX 90122-0785
29	2	J2, J3	JACK NON-INSULATED 0.218	KEYSTONE ELECTRONICS 575-4
30	2	L1, L2	INDUCTOR POWER 4.7µH 4.5A SMD	VISHAY/DALE IHLP2020CZER4R7M11
31	4	PG1, PG2, PG3, PG0	LED GREEN S-GW TYPE SMD	PANASONIC - SSG LN1371SGTRP
32	1	PWR1	CONN POWER JACK 2.1mm	CUI INC PJ-002A
33	2	Q1, Q4	MOSFET N-CH DUAL 20V 1.3A SC70-6	VISHAY/SILICONIX SI1988DH-T1-E3
34	1	Q5	MOSFET N-CH DUAL 60V 6.5A 8-SOIC	VISHAY/SILICONIX SI4946BEY-T1-E3
35	1	R42	DO NOT INSTALL	DO NOT INSTALL
36	4	R1, R36, R66, R67	RES 10MΩ 5% 1/10W 0603 SMD	PANASONIC - ECG ERJ-3GEYJ106V
37	4	R2, R37, R64, R65	RES 330Ω 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF3300V

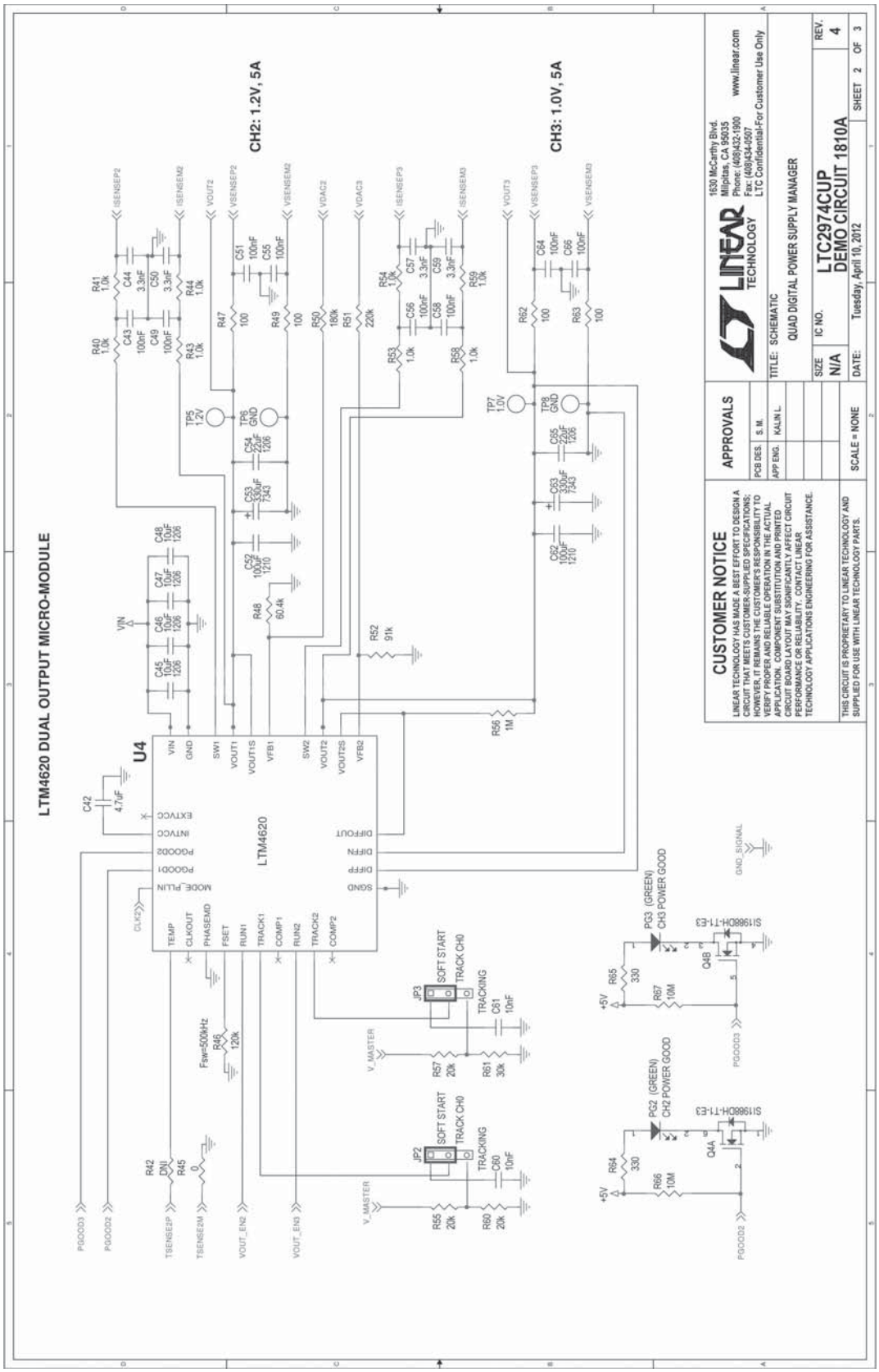
DC1810A PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
38	2	R9, R28	RES 1k 1/10W 1% 0603 SMD	PANASONIC ERJ-3EKF1001V
39	2	R5, R21	RESISTOR 2.2Ω 1/10W 5% 0603	PANASONIC - ECG ERJ-3GEYJ2R2V
40	2	R6, R23	RES 10Ω 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF10R0V
41	8	R11, R14, R22, R25, R30, R55, R57, R60	RES 20k 1/10W 1% 0603 SMD	NIC NRC06F2002TRF
42	2	R12, R24	RES 620Ω 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF6200V
43	2	R13, R19	RES 75k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF7502V
44	1	R17	RES 10k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF1002V
45	2	R18, R20	RES 226Ω 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF2260V
46	2	R27, R31	RES 13.3k 1/10W 1% 0603 SMD	YAGEO RC0603FR-0713K3L
47	1	R32	RES 40.2k 1/10W 1% 0603 SMD	VISHAY CRCW060340K2FKEA
48	1	R45	RES 0Ω 1/10W 0603 SMD	PANASONIC - ECG ERJ-3GEY0R00V
49	1	R46	RES 120k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF1203V
50	1	R48	RES 60.4k 1/10W .5% 0603 SMD	YAGEO RT0603DRD0760K4L
51	1	R52	RES 91k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF9102V
52	1	R56	RES 1MΩ 1/10W 1% 0603 SMD	NIC NRC06F1004TRF
53	1	R61	RES 30k 1/10W 1% 0603 SMD	NIC NRC06F3002TRF
54	1	R68	RESISTOR 0.020Ω 1W 1% 2512	PANASONIC - ECG ERJ-M1WSF20MU
55	2	R69, R72	RES 150k 1/10W 1% 0603 SMD	VISHAY CRCW0603150FKFEA
56	1	R70	RES 13.3k 1/10W 1% 0603 SMD	NIC NRC06F1332TRF
57	3	R71, R75, R76	RES 5.49k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF5491V
58	1	R73	RES 10k 1/10W 1% 0603 SMD	PANASONIC - ECG ERJ-3EKF1002V
59	1	R77	RES 18Ω 1/2W 5% 1210 SMD	VISHAY/DALE CRCW121018R0JNEA
60	1	R78	RES 15Ω 1/2W 5% 1210 SMD	VISHAY/DALE CRCW121015R0JNEA
61	1	R79	RES 12Ω 1/2W 5% 1210 SMD	VISHAY/DALE CRCW121012R0JNEA
62	1	R80	RES 10Ω 1/2W 5% 1210 SMD	VISHAY/DALE CRCW121010R0JNEA
63	4	SW1, SW2, SW3, SW4	SW SLIDE DPDT 6VDC 0.3A PCMNT	C & K COMPONENTS JS202011CQN
64	8	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	TERM SOLDER TURRET 0.094" HOLE	MILL MAX 2501-2-00-80-00-00-07-0
65	2	U1, U3	IC MOSFET DRVR 12V 40A 56-QFN	RENESAS - R2J20602NP#G3
66	1	U2	LTC3860 - DUAL, MULTIPHASE STEP-DOWN VOLTAGE MODE DC/DC CONTROLLER WITH CURRENT SHARING	LINEAR TECHNOLOGY LTC3860EUH#PBF
67	1	U4	LTM4620 - DUAL 13A OR SINGLE 26A DC/DC µModule® REGULATOR	LINEAR TECHNOLOGY LTM4620
68	1	U5	LTC4365 - UV, OV AND REVERSE SUPPLY PROTECTION CONTROLLER	LINEAR TECHNOLOGY LTC4365CTS8
69	1	U6	LTC6902 - MULTIPHASE OSCILLATOR WITH SPREAD SPECTRUM FREQUENCY MODULATION	LINEAR TECHNOLOGY LTC6902CMS
70	1	U7	IC EEPROM 2k BIT 400kHz 8TSSOP	MICROCHIP TECHNOLOGY 24LC025-I/ST
71	1	U8	LT1763 - 500mA, LOW NOISE, LDO MICROPOWER REGULATORS	LINEAR TECHNOLOGY LT1763CS8-5
Hardware/Components (For Demo Board Only)				
72	3	SHUNT1, SHUNT2, SHUNT3	CONN SHUNT 2mm 2POS	SAMTEC 2SN-BK-G
73	4	MH1, MH2, MH3, MH4	STAND-OFF NYLON 1/2" SNAP IN	KEYSTONE 8833

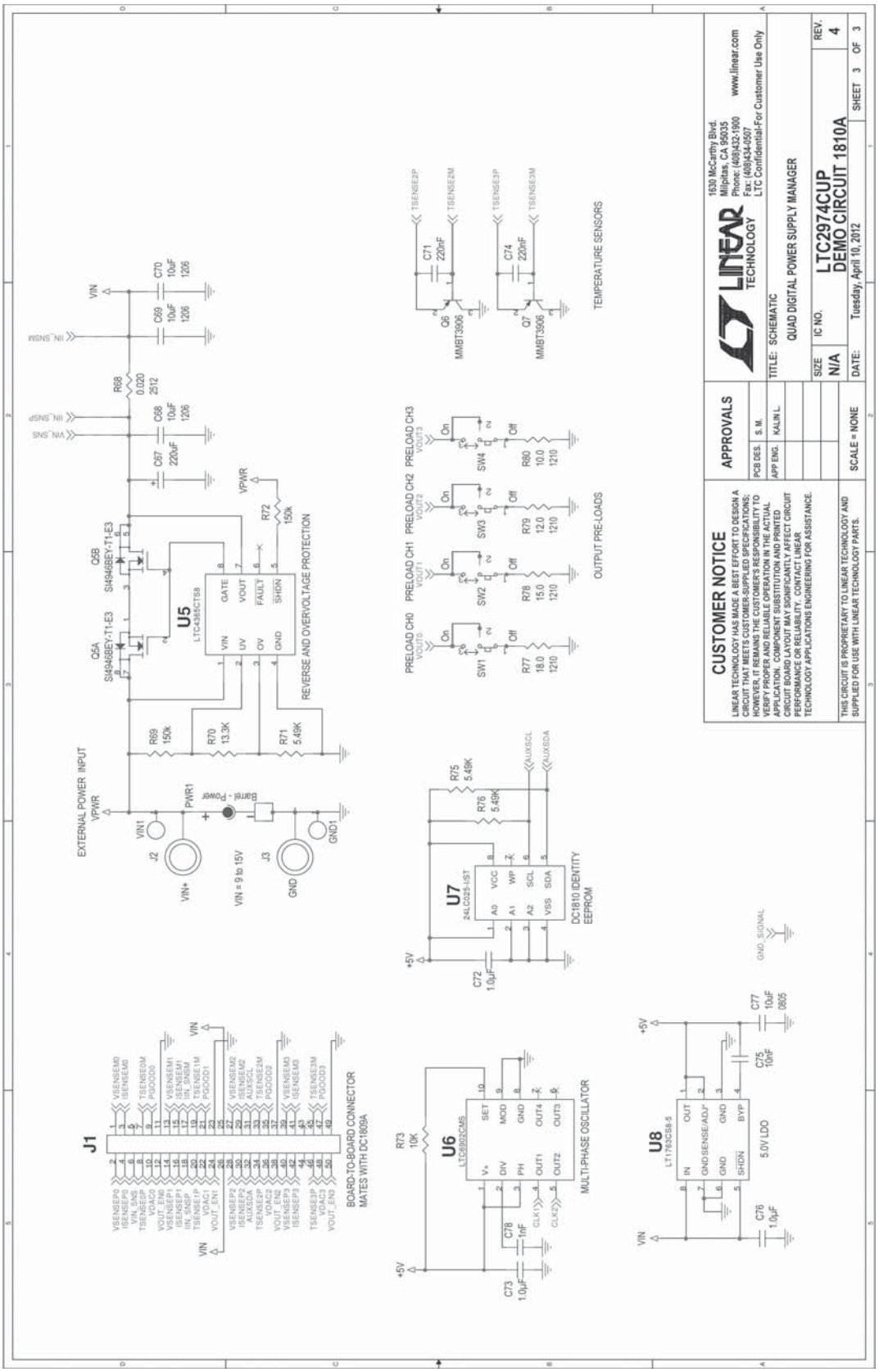
DC1810A SCHEMATIC DIAGRAM



DC1810A SCHEMATIC DIAGRAM



DC1810A SCHEMATIC DIAGRAM



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.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

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.

Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035