14-Channel Power Supply System Employing LTC3880/LTC2974/LTC2977 Power System Managers with EEPROM

DESCRIPTION

The DC1962C is a demonstration system that showcases three different Linear Technology devices—the LTC®3880, LTC2974, and LTC2977. The LTC2974 and LTC2977 devices are I²C/SMBus/PMBus power system managers with EEPROM. The LTC3880 is a dual output PolyPhase® step-down DC/DC controller with digital power system management. The LTC3880 monitors and controls 2 power supply rails, the LTC2974 monitors and controls 4 power supply rails, and the LTC2977 monitors and controls 8 power supply rails. The DC1962C demonstrates the ability of these devices to sequence, trim, margin, supervise, monitor, and log faults for fourteen power supplies. Each power supply channel's output voltage is monitored and each device monitors its own internal die temperature. Six channels have current and external temperature sensing.

The DC1962C is a single circuit board that contains fourteen independent power supply rails. The board employs twelve LTC3405A 300mA switch-mode regulators, which are configured to be controlled by the LTC2974 (4) and LTC2977 (8). The LTC3880's two channels have much of the switching regulator integrated, only requiring the external power stage (power MOSFETs), inductor, and other passives. This board provides a sophisticated fourteen channel digitally programmable power supply system. The rail voltages are programmable within the trim range shown in Table 1.

This demonstration system is supported by the LTpowerPlay™ graphical user interface (GUI) enabling complete control of the features on all three devices. Together, the LTpowerPlay software and DC1962C hardware system create a powerful development environment for designing and testing configuration settings of the LTC3880, LTC2974, and LTC2977. These settings can be stored in each of the devices' internal EEPROM or in a file. This file can later be used to order pre-programmed devices or to program devices in a production environment. The software displays all of the configuration settings and real time measurements from the three digital power ICs. Telemetry allows easy access and decoding of the fault log created by each device. The board comes pre-programmed with the EEPROM values appropriate for the fourteen power supply rails on the DC1962C. Just plug and play!

Multiple DC1962C boards can be cascaded together to form a high channel count power supply (see the Multi-Board Arrays section). This allows for the formation of a single, coherent power supply system. The user configures up to eight DC1962C boards, thereby controlling up to 112 separate power supply rails. This cascaded configuration demonstrates features of the LT power system management ICs which enable timing and fault information to be shared across multiple ICs.

The DC1962C demo board can be powered by an external power supply, such as a +12VDC supply. Communication with the software is provided through 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/SMBus/PMBus Controller (DC1613)
- LTpowerPlay Software

DC1962C 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 (±0.5% for LTC3880)
- Voltage Servos Precisely Adjust Supply Voltages
- LTC2974 and LTC2977 Utilize 10-Bit trim DACs with Soft-Connect
- Telemetry Reads Back V_{IN}, I_{IN}, V_{OUT}, I_{OUT}, Temperature (Int. and Ext.)
- Output Sequencer - Time Based or Tracking (Tracking support on LTC2974 Only)
- Supports Multichannel Fault Management
- Operates Autonomously without Additional SW
- Powered from 6V to 14V
- Packaging:
  - LTC2974/LTC2977 in 64-lead QFN
  - LTC3880 in 40-lead QFN

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

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

POWER SUPPLY CHANNEL	CH(0:1)	CH(2:5)	CH(6:13)
Manager/Controller	LTC3880	LTC2974	LTC2977
Nominal Untrimmed Output Voltages	0.85V, 1.1V (Defined by Config)	1.5V, 1.8V, 2.0V, 2.2V	0.9V, 1.0V, 1.1V, 1.2V, 2.5V, 2.7V, 3.0V, 3.3V
Rated Output Current	0.3A		
Default Margin Range	± 5%		
Output Trim Range (V_{FS_VDAC} = 1.38V)	Each Channel Is Adjustable from 0.5V to 4.5V (Note 1)	15%/–11%	15%/–11%
Temperature	1 Internal, 2 Ext.	1 Internal, 4 Ext.	1 Internal

Common Characteristics. Specifications Valid Over Full Operating Temperature Range

PARAMETER	CONDITIONS	VALUE			
		MIN	TYP	MAX	UNITS
V_{PWR} Supply Input Voltage Range		6		14	V
ADC Total Unadjusted Error	$V_{IN_ADC} \geq$ 1V, Applies to LTC2974/LTC2977			±0.25	%
	$V_{IN_ADC} \geq$ 1V, Applies to LTC3880			±0.5	%
ADC Voltage Sensing Input Range	Differential Voltage: $V_{IN_ADC} = (V_{SENSEP}n - V_{SENSEM}n)$	0		6	V

Note 1: Note that V_{OUT_MAX} limit is set to 2.5V by default. V_{OUT_MAX} clamps the voltage setpoint to 2.5V. It is recommended that you change the V_{OUT_MAX} register and associated V_{OUT} FAULT limit registers when changing V_{OUT} to prevent the channel from faulting off.

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.

EEPROM – Non-volatile memory (NVM) storage used to retain data after power is removed.

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

NVM – Non-volatile memory, see EEPROM.

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

PMBus – An industry standard power-management protocol with a fully defined command language that facilitates communication with power converters and other devices in a power system.

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

Supervise – The act of quickly responding (warning or faulting) to a voltage, current, temperature condition that is compared to pre-programmed 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 development environment that supports Linear Technology power system management ICs with EEPROM, including the LTC2974 and LTC2977 4-channel and 8-channel PMBus power system 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 multi-chip configuration file that can be saved and re-loaded at a later time. LTpowerPlay provides unprecedented system level 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 DC1613 I^{2}C/SMBus/PMBus Controller to communicate with one of many potential targets, including the DC1962C 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

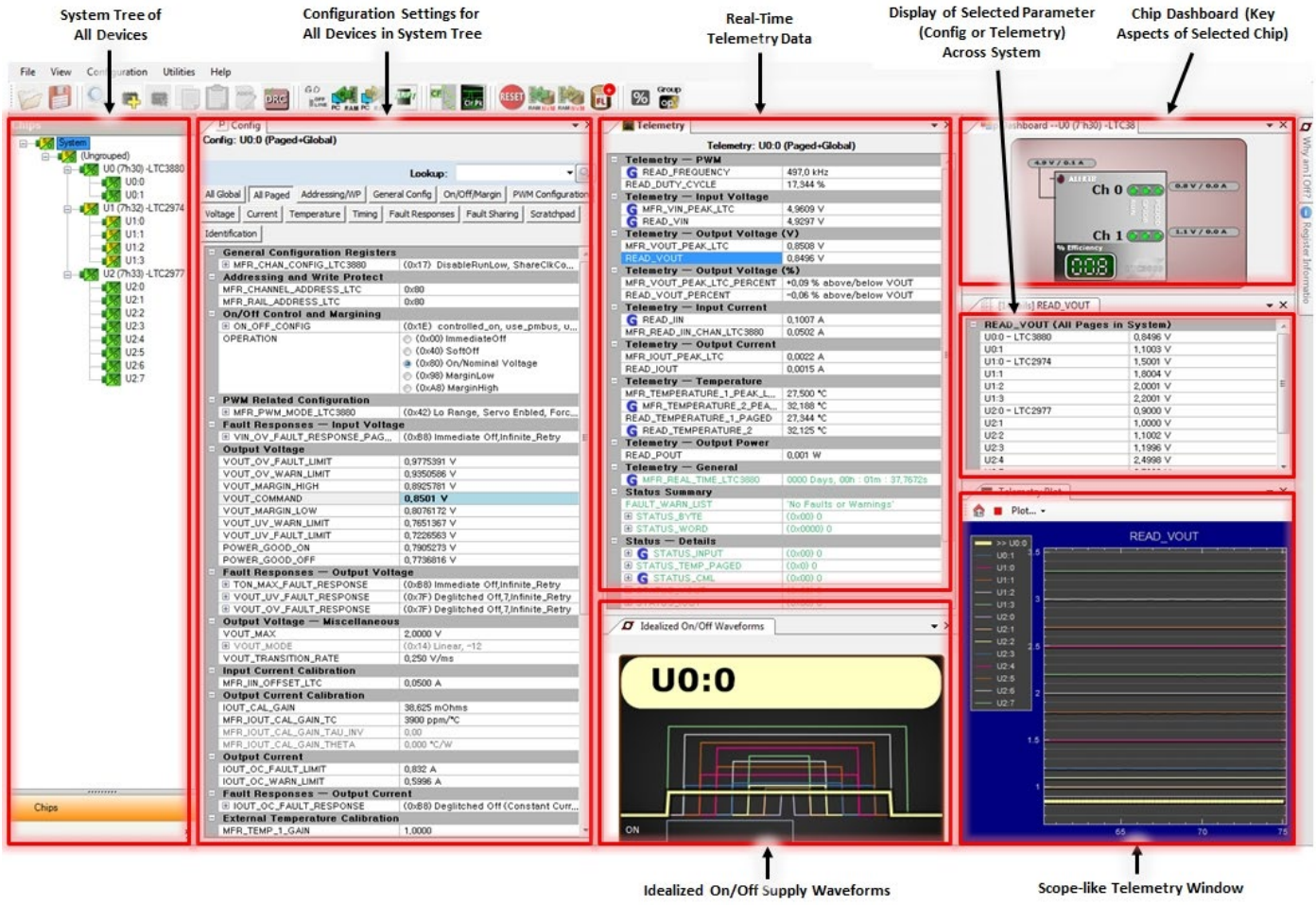


Figure 1. Screenshot of the LTpowerPlay GUI

QUICK START PROCEDURE

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

The following are examples of content available in the online help:

1. Demonstration and Tutorial Videos
   - An updated Quick Start Demonstration video of LTpowerPlay and this demo board
   - Product/Feature-specific demonstration and tutorial videos
2. Detailed Technical Documentation
   - Schematic Checklists
   - Device Programming Options
   - Firmware ‘Getting Started’ guides with sample code (margining, reading telemetry, etc.)

The following procedure describes how to set up a DC1962C demo system.

1. Download and install the LTpowerPlay GUI: www.linear.com/ltpowerplay
2. Remove the board from the ESD protective bag and place it on a level surface. Connect the DC1613 I^{2}C/SMBus/PMBus Controller to the DC1962C board using the 12-pin ribbon cable.

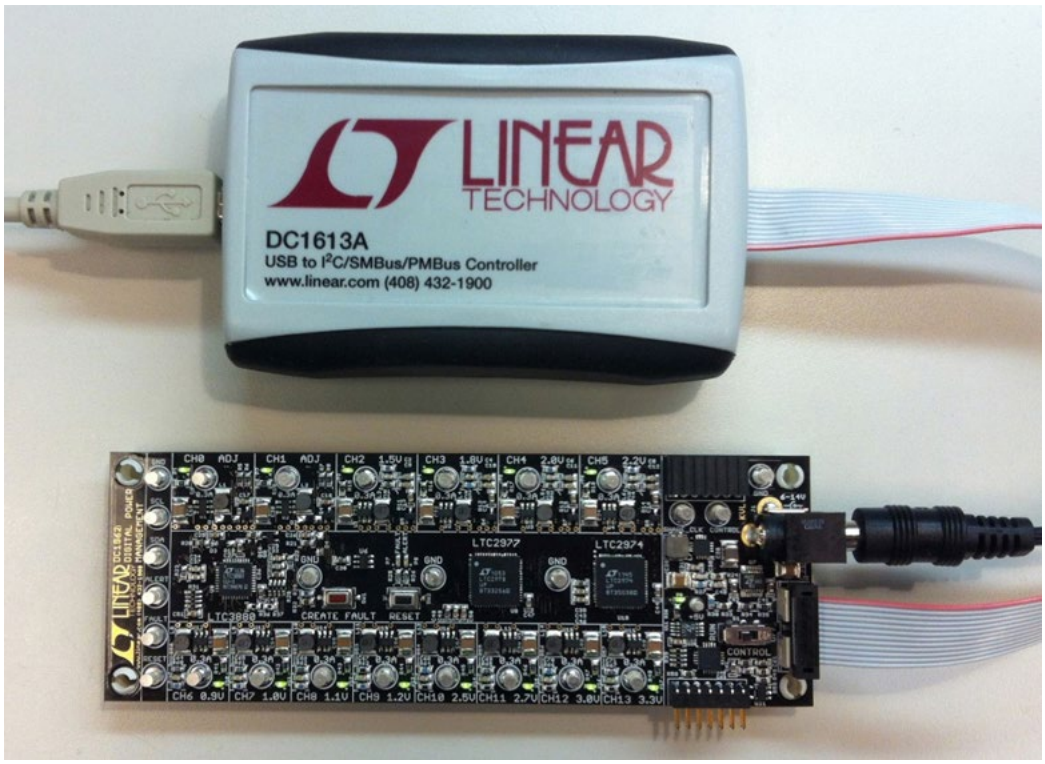
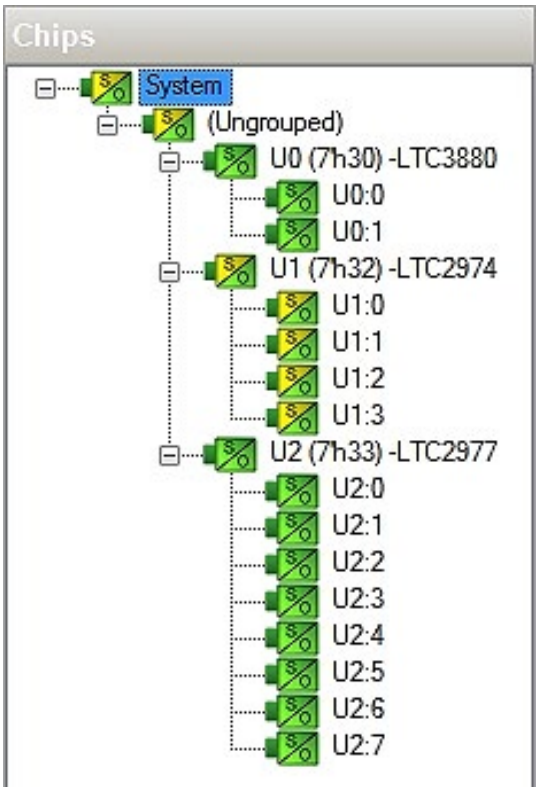


Figure 2. Connecting DC1962C Board and the DC1613 I^{2}C/SMBus/PMBus Controller

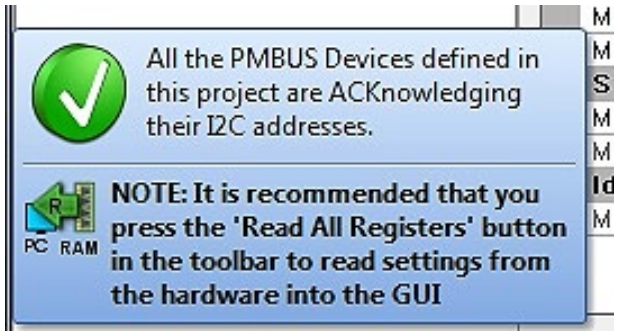
QUICK START PROCEDURE

3. Confirm that the CONTROL switch is set to the RUN position.
4. Plug the USB-to-I^{2}C/SMBus/PMBus Controller into a USB port on your PC. The board should power up with all power good LEDs and 5V LED illuminated green. The USB-to-I^{2}C/SMBus/PMBus Controller supplies ~100mA of current which should be sufficient for a single demo board.
5. Connect a 12VDC power supply with > 0.5A capacity to the V_{IN} input jack of any DC1962C, if multiple boards are being powered.
6. Launch the LTpowerPlay GUI.
   a. The GUI automatically identifies the DC1962C and builds a system tree for each power system manager. The system tree on the left hand side will look as below:

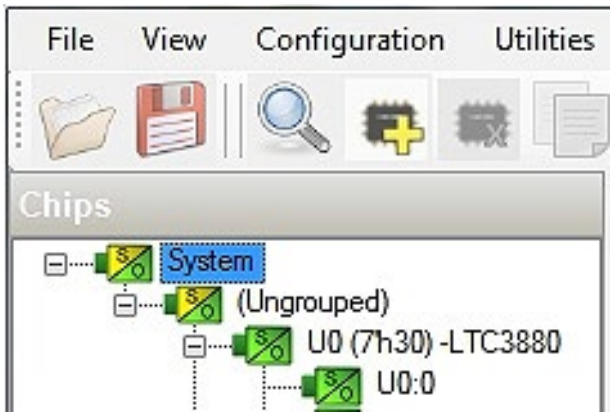
      Note: For multiple board arrays, the GUI automatically ensures each device has a unique address. In this scenario, it is recommended at this point to store these addresses to NVM (EEPROM) by clicking the "RAM to NVM" icon in the toolbar.



   b. A green message box will be displayed momentarily in the lower left hand corner confirming that the DC1962C is communicating.



   c. Save the demo board configuration to a (*.proj) file by clicking the "Save" icon. This creates a backup file. Name it whatever you want.



7. The CONTROL switch is configured to control all 14 channels. Slide the switch to RUN to enable, OFF to disable all channels. For multiple board arrays, the CONTROL switch is wired to a signal that is common across all boards. All CONTROL switches must be set to the RUN position to enable all boards.

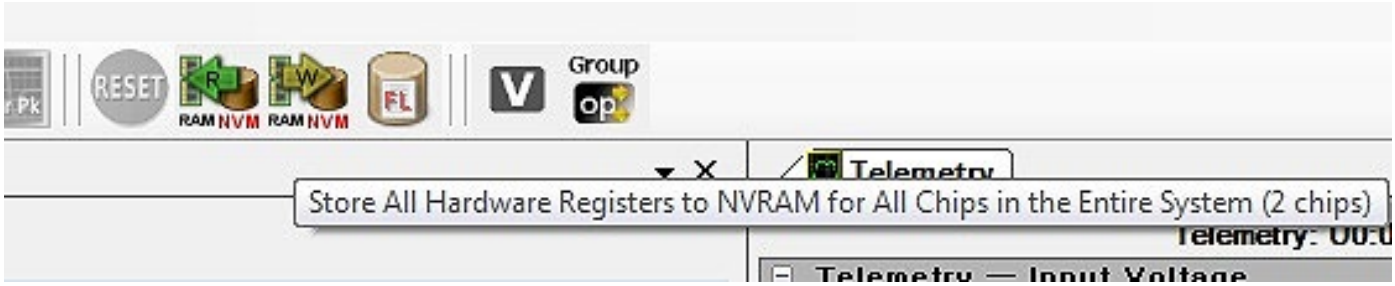
QUICK START PROCEDURE

Loading a DC1962C 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 "Go Online" icon, then click on the "PC → RAM" icon. This loads the configuration into the working RAM of the devices.

3. To store the configuration to NVM (EEPROM), click on the "RAM → NVM" icon as shown below.



DC1962C DETAILS - TOP SIDE

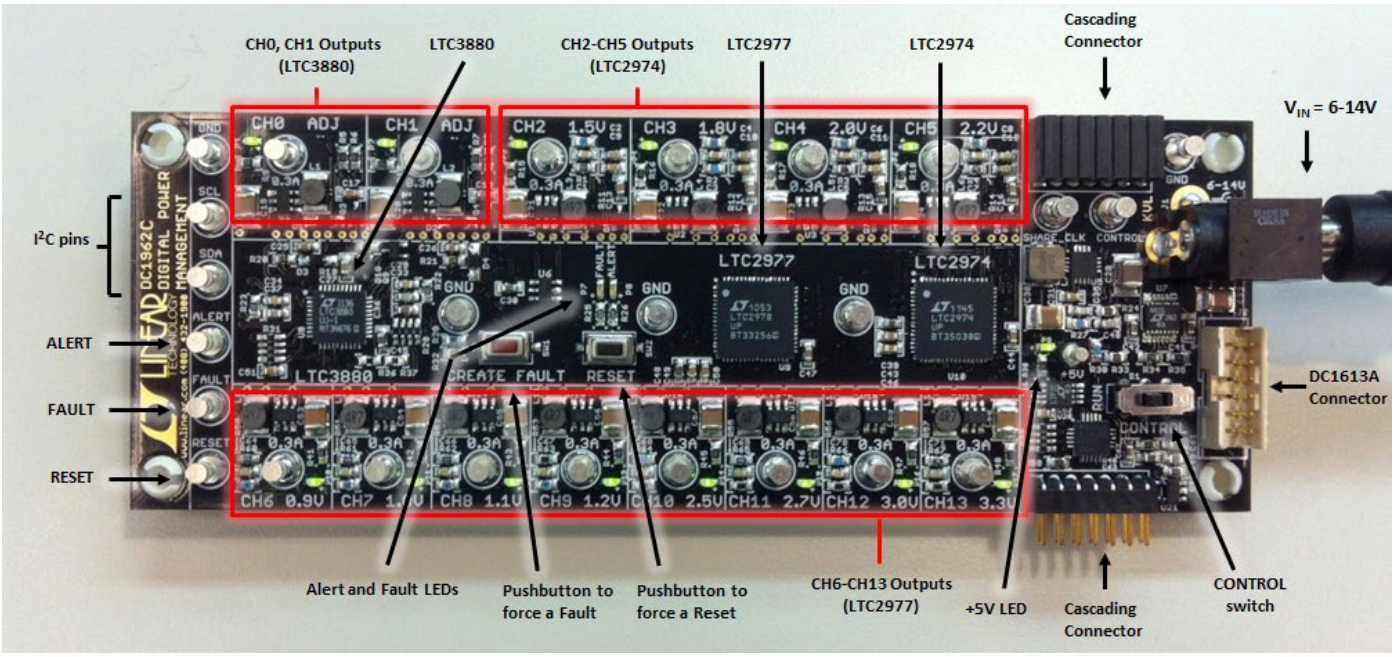


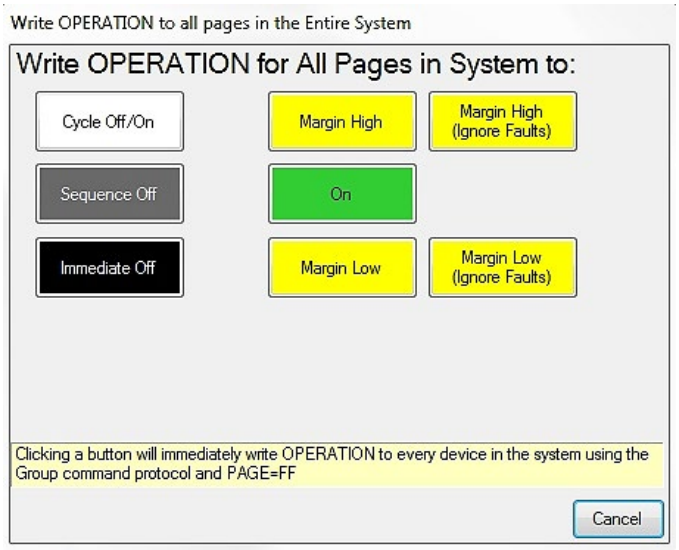
Figure 3. DC1962C Top Side Details

COMMON DEMO BOARD OPERATIONS

Margin All Rails

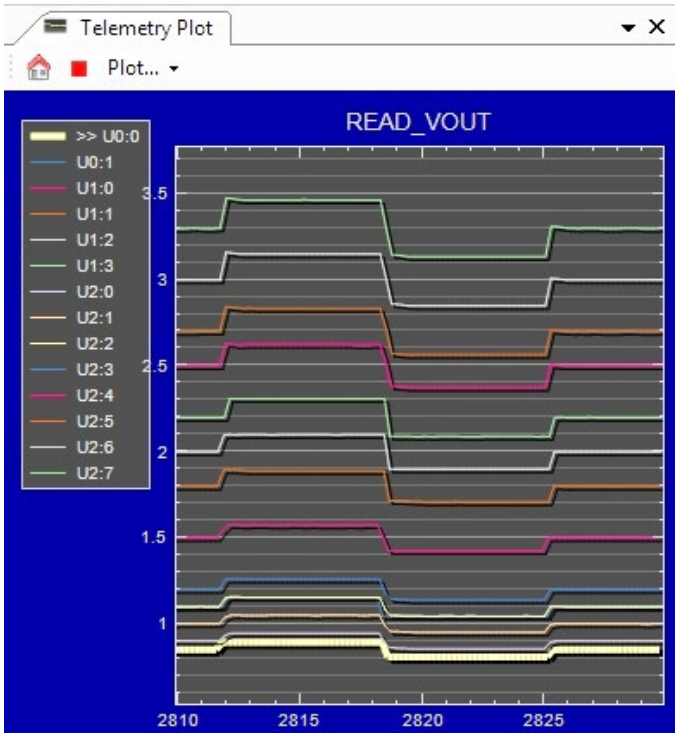
The digital power products on the DC1962C not only monitor each of their respective outputs but can margin the outputs either high or low. Margining is the operation that moves a rail either up or down for testing purposes. It allows a system to be fully characterized over supply limits without the use of external hardware or resources. The GUI provides an easy way to margin all rails high or all low by clicking one of four buttons. To invoke the margining dialog, click the GroupOp icon in the toolbar.

The buttons labeled “ignore faults” will margin without creating a fault even if the fault limits are exceeded (LTC2974 and LTC2977 only).



A look at the telemetry window shows the effect of the margin high or margin low operation. The following screen shot shows all rails going from nominal set points to margin high, margin low, and back to nominal voltages.

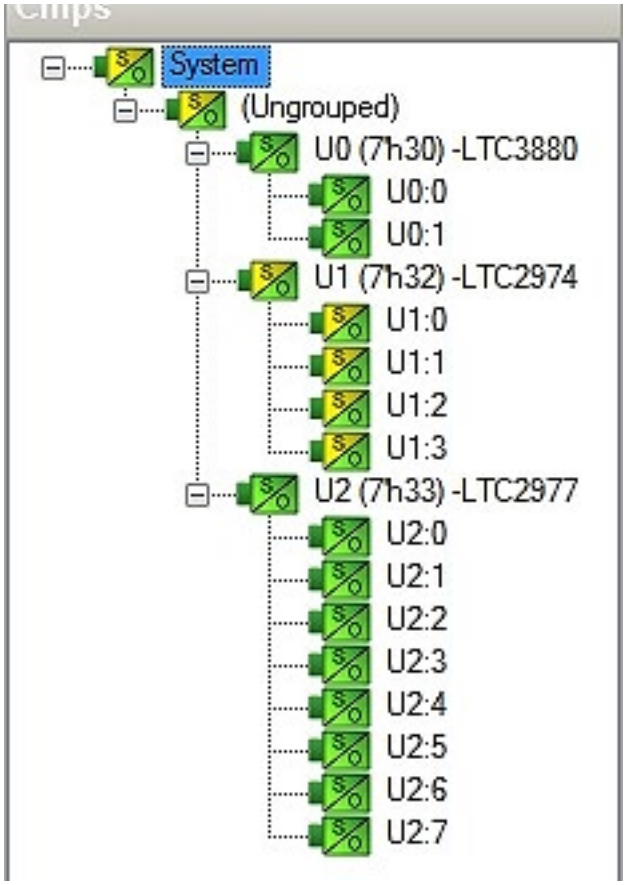
Each of the power management ICs has a multiplexed ADC that is used to provide voltage, current, and temperature readback values. The telemetry plot in the GUI is similar to a multichannel oscilloscope which is capable of displaying any parameter that is displayed in the telemetry window. Due to the nature of a multiplexed ADC converter, it has an associated ADC loop time. The total ADC loop time (~100ms to 160ms) for a given channel is dependent on the device’s configuration. See corresponding data sheet.



COMMON DEMO BOARD OPERATIONS

Creating a Fault

There is a pushbutton on the DC1962C board that is used to force a fault and demonstrate the demo board's ability to detect it and respond according to the configuration. When depressed, the pushbutton creates a fault on channel 2, the 1.5V output (GUI channel U1:0). The user should see all outputs power off, the fault LED momentarily illuminate, the alert LED illuminate continuously, and all rails sequence back on after a retry period. The user may also short any power supply output indefinitely. This is a good way to induce UV faults and shows that a shorted channel will not be damaged. Use a jumper wire or a coin to short any output.



Clearing a Fault

To clear a fault, the user may click the CF icon

in the GUI or simply push the RESET pushbutton on the demo board. In both cases, the red (+) on the CF icon and alert LED on the board will be cleared. You will notice that all rails are automatically re-enabled after a programmable retry period. The alert LED may be cleared by clicking the Clear Faults (CF) icon in the GUI. After clearing faults, the system tree may remain "yellow" if any non-volatile fault logs are present. For further information, see the Working with the Fault Log section.

Reset the DC1962C

A reset pushbutton is provided on the board. To reset all devices on the DC1962C board and reload the EEPROM contents into operating memory (RAM), press RESET (SW2) on the DC1962C. Note that the "RESET" icon in the GUI tool bar issues a software reset for any LTC3880 device in the system. It is recommended that you use the reset pushbutton on the board to provide a reset condition to the entire system.

DC1962C LEDs

Each individual channel on DC1962C also has its own green power good LED (RUN_CH0 through RUN_CH13). When USB power (DC1613 Controller) or external power (6V to 14V jack) is applied, the +5V green LED will illuminate, indicating that the power system managers are powered. The red LEDs will illuminate when an alert or a fault has occurred.

COMMON DEMO BOARD OPERATIONS

Sequencing Output Channels

The LTC3880, LTC2974, and LTC2977 have been pre-configured with different TON_DELAY values for each channel. The TON_DELAY parameter is applied to each device relative to the respective CONTROL pin (RUN on the LTC3880). On this demo board, all CONTROL/RUN pins are wire OR'd. Therefore the TON and TOFF delays are enforced relative to one edge. Figure 4 shows an oscilloscope screen capture of four output rails sequencing up.

The same applies to TOFF_DELAY values. When the CONTROL switch is set to the OFF position, all rails will power down sequentially based on each of the device's TOFF_DELAY values. Each channel has an LED which visually indicates if the channel has power. When the CONTROL pin is switched on and off, you will observe the relative on/off timing of the 14 channels. Figures 5 and 6 show TON and TOFF delays for all channels at once. You will notice in Figure 1 that the GUI shows idealized on/off waveforms. This graphical view shows the relative TON and TOFF delays in response to an on/off command, whether it comes from the CONTROL switch or PMBus command. Once a new timing value is entered, the timing change will be reflected in the idealized waveforms.

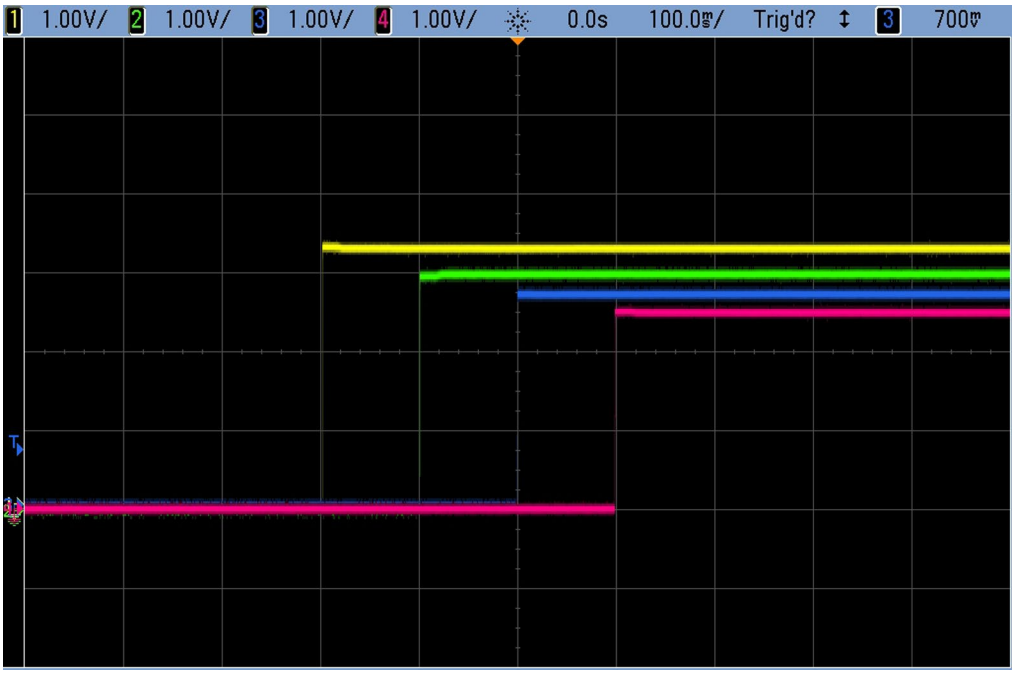


Figure 4. Sequencing Output Channels with DC1962C Using TON_DELAY

[14 rails] TON_DELAY

TON_DELAY (All Pages in System)	
U0:0 – LTC3880	0,000 ms
U0:1	100,000 ms
U1:0 – LTC2974	200,000 ms
U1:1	300,000 ms
U1:2	400,000 ms
U1:3	500,000 ms
U2:0 – LTC2977	700,000 ms
U2:1	600,000 ms
U2:2	500,000 ms
U2:3	400,000 ms
U2:4	300,000 ms
U2:5	200,000 ms
U2:6	100,000 ms
U2:7	0,000 ms

Figure 5. TON_DELAY Configuration

[14 rails] TOFF_DELAY

TOFF_DELAY (All Pages in System)	
U0:0 – LTC3880	600,000 ms
U0:1	500,000 ms
U1:0 – LTC2974	400,000 ms
U1:1	300,000 ms
U1:2	200,000 ms
U1:3	100,000 ms
U2:0 – LTC2977	0,000 ms
U2:1	100,000 ms
U2:2	200,000 ms
U2:3	300,000 ms
U2:4	400,000 ms
U2:5	500,000 ms
U2:6	600,000 ms
U2:7	700,000 ms

Figure 6. TOFF_DELAY Configuration

COMMON DEMO BOARD OPERATIONS

"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, above the Register Information tab. Hover your cursor over this tab to show the tool.

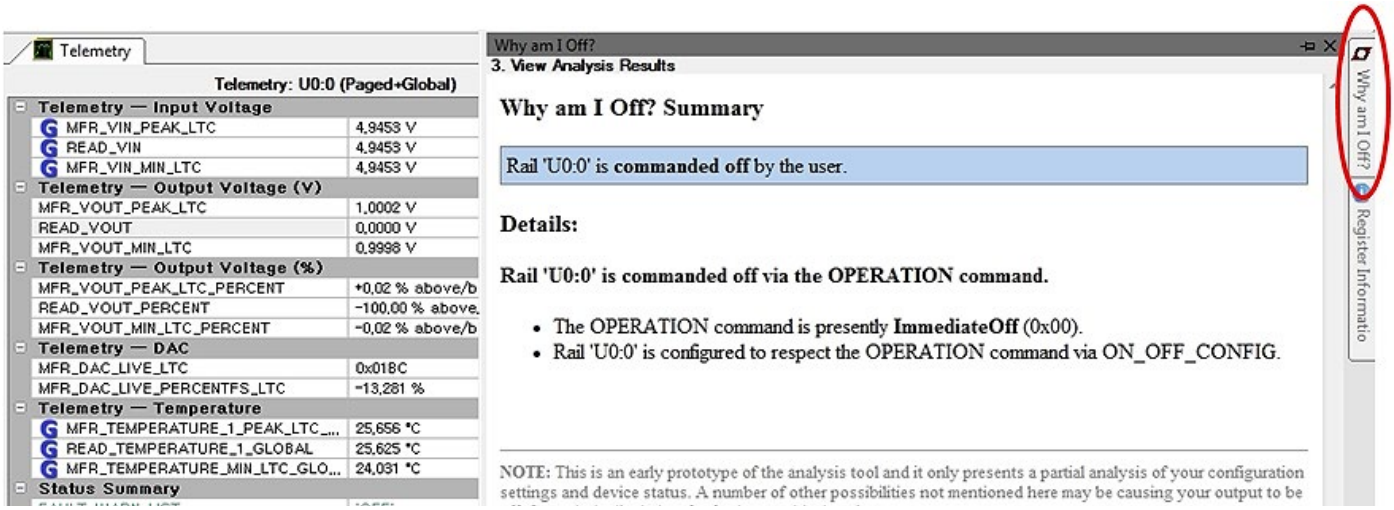


Figure 7. "Why Am I Off" Tool in the LTpowerPlay GUI

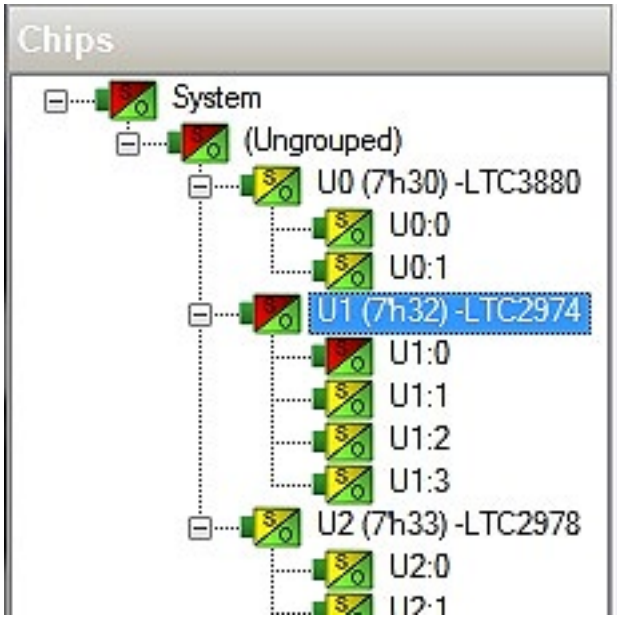
ADVANCED DEMO BOARD OPERATIONS

What Is a Fault Log?

A fault log is a non-volatile record of the power system leading up to the time of fault. It holds the most recent monitored values (uptime, voltage, current, temperature) that can be analyzed to help determine the cause of the fault. It is a powerful diagnostic feature of each of the digital power managers on the DC1962C demo board.

Create a Fault and Fault Log

To create a fault log, you must create a fault, as described in the Creating a Fault on page 8. Select the appropriate device in the system tree by clicking on the U1 LTC2974 chip. We will proceed to work with the LTC2974 fault log.

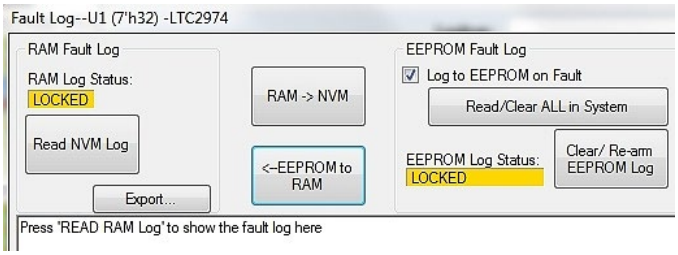


ADVANCED DEMO BOARD OPERATIONS

Working with the Fault Log

Once a fault has occurred, the Fault Log (FL) icon will show a red (+) sign on it, indicating that the GUI has detected a fault log in one of the devices. Clicking the icon will bring up a dialog box. Note that it is context sensitive. Be sure that the desired device is selected in the system tree.

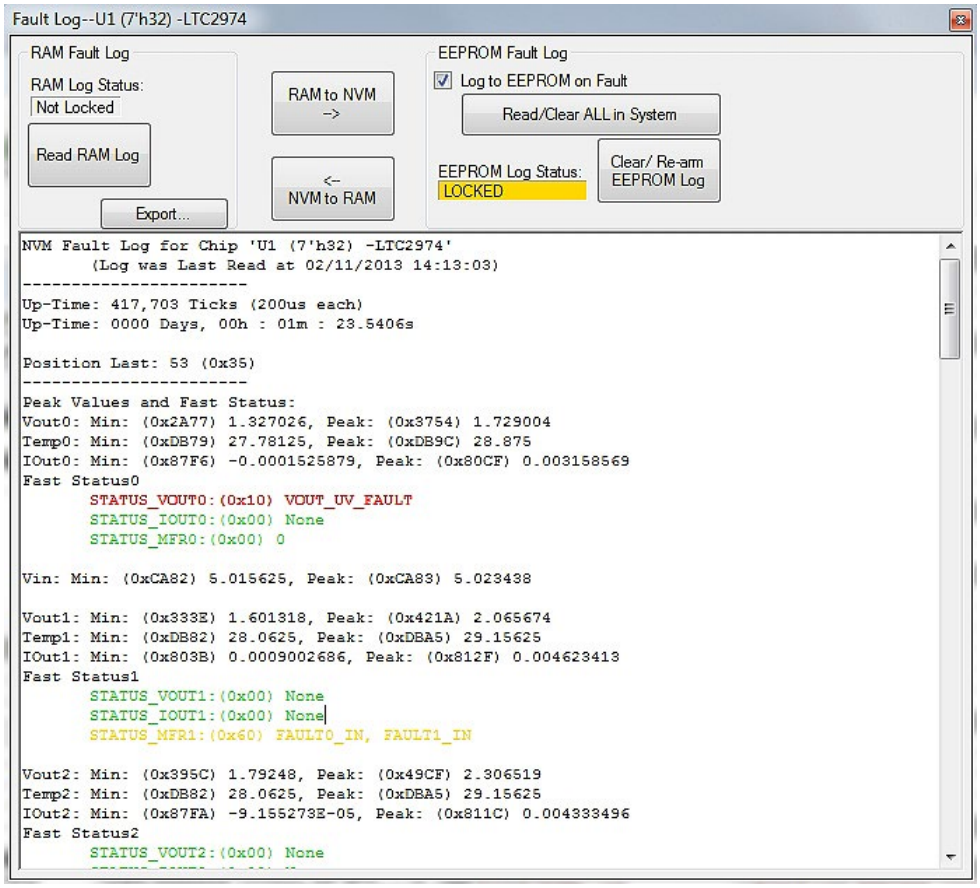
Notice that the checkbox "Log to EEPROM on Fault" is checked. Once a fault occurs, the device will automatically write the fault log data to EEPROM (NVM). At this point, the log is locked and will not change until it is cleared by the user. To read the EEPROM log data, first click the "EEPROM to RAM" button. At this point the RAM Log is locked and not updated even though the telemetry readings continue. Click the "Read NVM Log" button. The log data will appear in the text box below.



The log contains timestamp, up-time, channel voltage readings, an input voltage reading, an on-chip temperature reading, etc. There will be a number of loops; each loop contains data obtained in one ADC loop time with the most recent ADC loop data on top and the oldest data at the bottom of the log. The up-time indicates, at the time of fault, the amount of time the device has been powered up or time since the previous reset.

In this case, the fault log will show that channel U1:0 faulted due to a VOUT_UV_FAULT condition. On the previous telemetry loop, the channel voltage reading was a nominal value (1.5V).

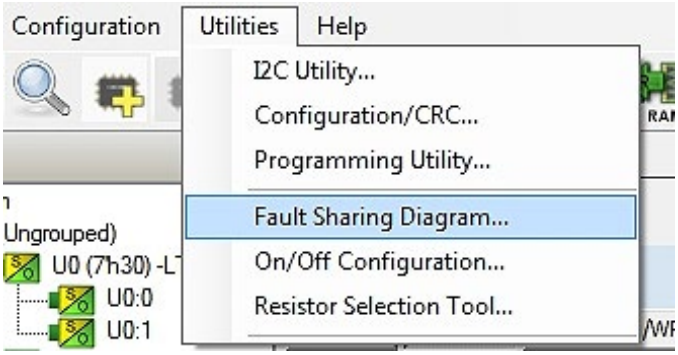
To clear the fault log, click the "Clear/Rearm EEPROM Log" button. This allows the selected device to be ready for a new fault event.



ADVANCED DEMO BOARD OPERATIONS

Fault Sharing Setup in the GUI

Fault sharing provides a means of propagating a fault detected by a power manager to other power managers via FAULT pins. Use the Fault Sharing Setup Tool to configure the fault sharing in the GUI. Select the LTC2974 in the system tree. Go to Utilities > Fault Sharing Diagram. For more details on this topic, please refer to the MFR_FAULTB propagate and response sections in the data sheet.



The LTC2974 fault sharing dialog will appear as shown in Figure 8. All Response and all Propagate switches are closed by default. In this configuration, a fault on an LTC3880 or LTC2977 channel will shut down all LTC2974 channels, and a fault on any LTC2974 channel will propagate to all channels on the DC1962C demo board since the fault pins are tied together.

NOTE: All FAULT pins on all power managers are tied together on the DC1962C demo board. These pins are open drain and have a common pull-up resistor to provide a logic high level (inactive). All FAULT pins are active low.

There are two types of actions to fault conditions: How a channel responds to another channel's fault and whether a particular channel propagates its fault to other channels. FAULT pins are bi-directional, meaning the device may drive its fault pin low (output) or may respond to the fault pin when another device drives it low (input). Because all fault pins are wire OR'd on the DC1962C, this hardware configuration allows one to program each device's fault settings on a channel-by-channel basis. By default, the LTC2974 is configured to shut down its channels if other devices fault and to propagate its own fault via the FAULT pins. The LTC2977 is configured the same as the LTC2974, however zone 1 (U2:4-U2:7) is configured to not propagate a fault. A fault on these channels will cause only that channel to fault off. You can think of the "Response" switches as "shut this channel down when another channel faults", and the "Propagate" switches as "drive a fault pin to broadcast to other channels that this channel faulted."

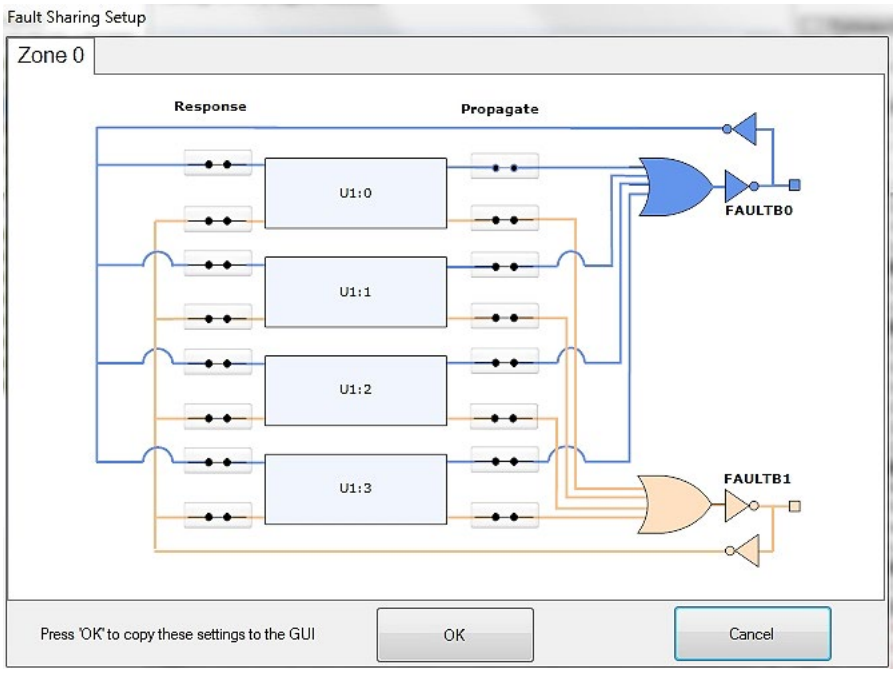


Figure 8. Fault Sharing Utility in LTpowerPlay GUI

ADVANCED DEMO BOARD OPERATIONS

Fault Configuration Example

Let's explore two different examples. Suppose we do not want channel U1:0 (CH2 1.5V rail) to propagate its fault to the other channels when U1:0 faults. And suppose we do not want channel U1:1 (CH3 1.8V rail) to shut down in response to another channel's fault. We can configure the switches as shown in Figure 9. Simply click the switches to open/close. Click OK to close the dialog box. Click the "PC → RAM" icon to write the changes to the DC1962C.

We can now create a fault on U1:0 (CH2) by shorting the output to ground. Press the CREATE FAULT button on the board. You will notice that the channel shuts off but the other channels remain powered up because its fault is not propagated to the other channels. After the retry period, channel U1:0 (CH2) will power back up. We can now observe the effect of changing the response setting on U1:1 (CH3). If you short U1:2 (CH4 2.0V rail) to ground, notice that all rails shut down except U1:1 (CH3). This is an example of a keep-alive channel that remains powered up independent of faults to other channels.

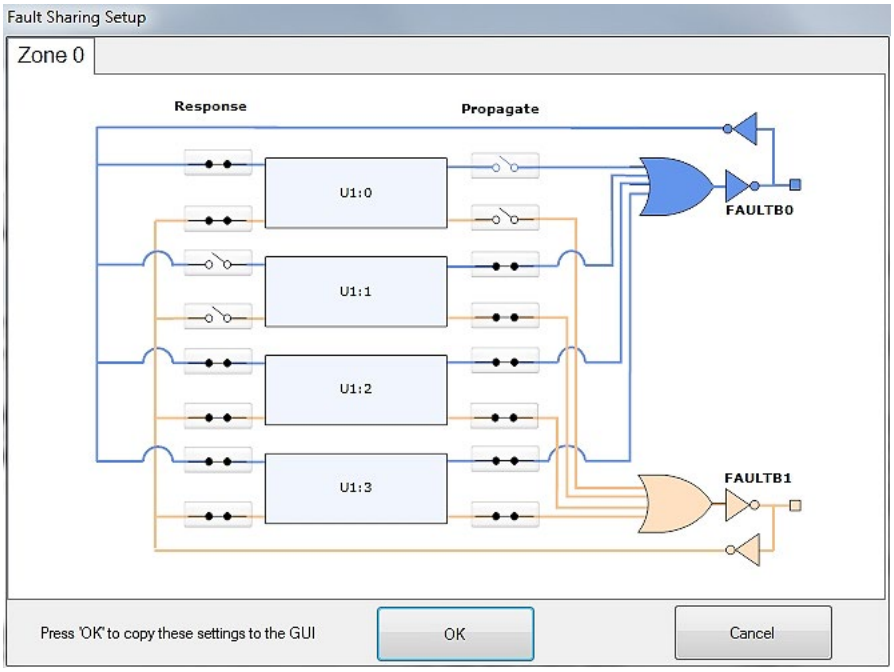


Figure 9. Updated Fault Sharing Configuration

ADVANCED DEMO BOARD OPERATIONS

The two LTC3880 channels can be uniquely configured and any fault can be propagated or not. Since the LTC3880 GPIO pins are tied together, a fault on CH0 may be used to turn off CH1. This is achieved by setting the appropriate MFR_GPIO_PROPAGATE command code and the MFR_GPIO_RESPONSE command to "inhibit."

General Configuration Registers	
⊞ MFR_CHAN_CONFIG_LTC3...	(0x17) DisableRunLow, ShareClk...
Fault Sharing — Propagation	
⊟ MFR_GPIO_PROPAGATE_...	(0x2997) TON_MAX_FAULT, INTER...
VOUT_ENABLE_WHILE_NO...	☐ (0x0) Does Not Affect on GPIO*B
SHORT_CMD_CYCLE	☐ (0x0) Does Not Affect on GPIO*B
TON_MAX_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
VOUT_BELOW_UV	☐ (0x0) Does Not Affect on GPIO*B
INTERNAL_OT_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
CHANNEL1_POWER_NOT_...	☐ (0x0) Does Not Affect on GPIO*B
CHANNEL0_POWER_NOT_...	☐ (0x0) Does Not Affect on GPIO*B
EXTERNAL_UT_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
EXTERNAL_OT_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
RESERVED6	☐ 0x0
RESERVED5	☐ 0x0
VIN_OV_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
RESERVED3	☐ 0x0
IOUT_OC_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
VOUT_UV_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
VOUT_OV_FAULT	☑ (0x1) Asserts GPIO*B low on fa...
Fault Sharing — Response	
⊟ MFR_GPIO_RESPONSE_LT...	(0xC0) Inhibit
action	○ Ignore ◉ Inhibit

SETUP PROCEDURE FOR MULTIBOARD ARRAYS

Up to eight DC1962C boards can be cascaded to control up to 112 independent power supplies. The number of boards is limited by an I/O expander chip that has three address pins, allowing 8 different combinations. This setup demonstrates the coordinated fault responses and accurate time base shared across multiple power system managers.

Procedure:

1. Stack the boards side-by-side by plugging JP1 of one board into JP2 of another DC1962C board.
2. Ensure different slave address settings for each of the boards. The address of each DC1962C board is determined by pins A2, A1 and A0 of the DIP switch JP1 on the backside of the board. The setting must be unique for each board in the array.
3. Plug in the +12V V_{IN} power into one of the boards as shown in Figure 10. Only one +12V power source is allowed.

SETUP PROCEDURE FOR MULTIBOARD ARRAYS

4. The USB-to-I²C/SMBus/PMBus Controller may be plugged into any board. If no DC1962C boards show up in the GUI, click the magnifying glass icon to enumerate the I²C bus and find the addresses of the parts. Go to step #2 to ensure that each board has a unique DIP switch setting.
5. Since the individual CONTROL lines are connected across the boards (CTRL is a common signal across all boards in the array), make sure that all CONTROL switches are set to the RUN position.
6. Re-launch LTpowerPlay. After launching, LTpowerPlay will enumerate the entire board array and build a representative system tree and read all hardware settings into the GUI.

ATTENTION: Once the GUI has launched, click the "RAM → NVM" button in the tool bar to ensure that the slave addresses are retained after a power off or reset. Otherwise you may lose communication with the slaves after a power cycle or reset event.

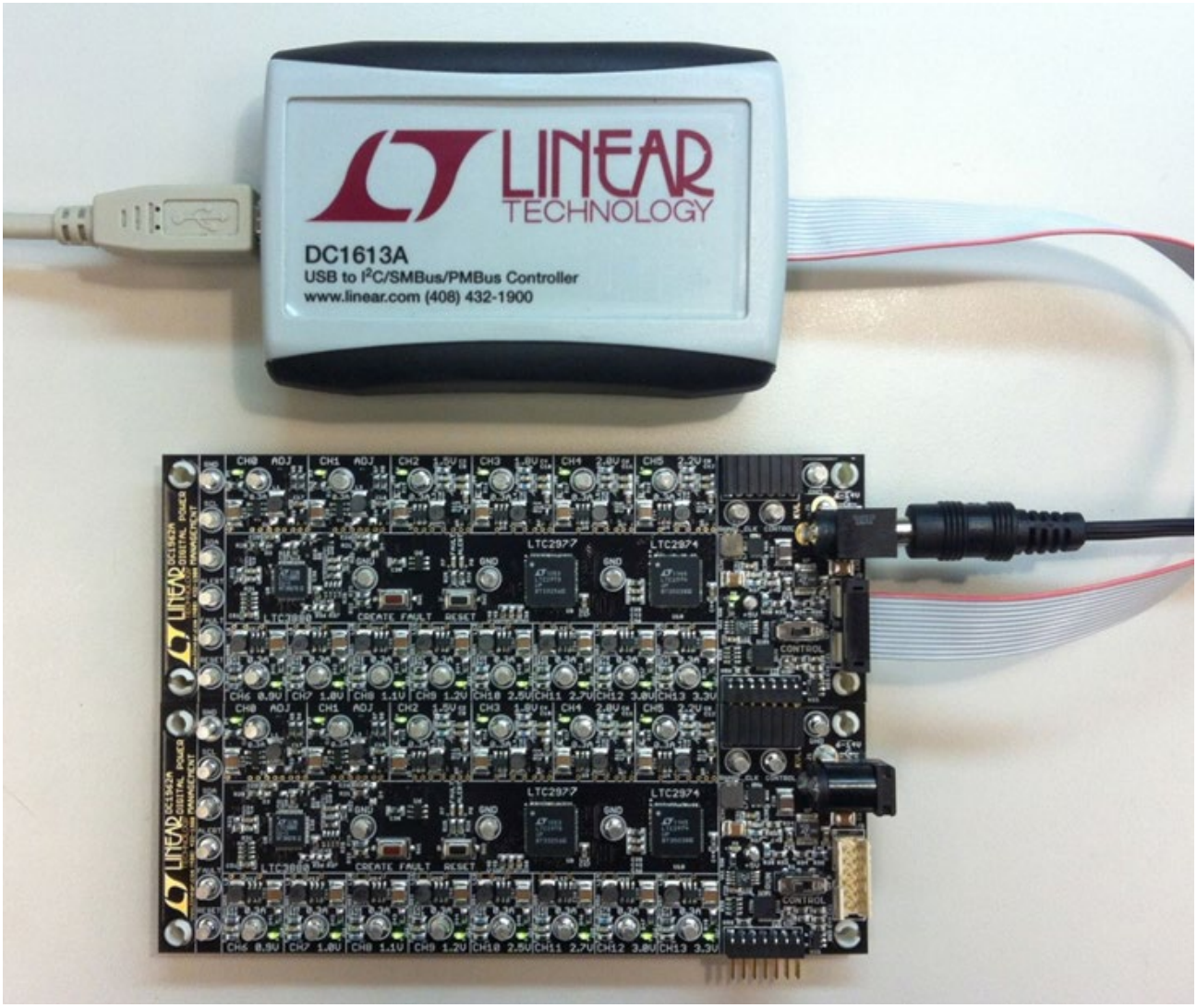


Figure 10. Array of Multiple DC1962C Demo Boards

SETUP PROCEDURE FOR MULTIBOARD ARRAYS

Ensuring Slave Addresses Do Not Conflict

There is a small DIP switch on the backside of the DC1962C. It is used to set the slave address of an I/O expander which allows the addition of multiple boards to a setup. The I/O expander has a base address of 0x20. The DIP switch settings set the offset. The three switches that may be changed are labeled A0, A1, A2. Examples below set the boards to address 0x20 and 0x27.

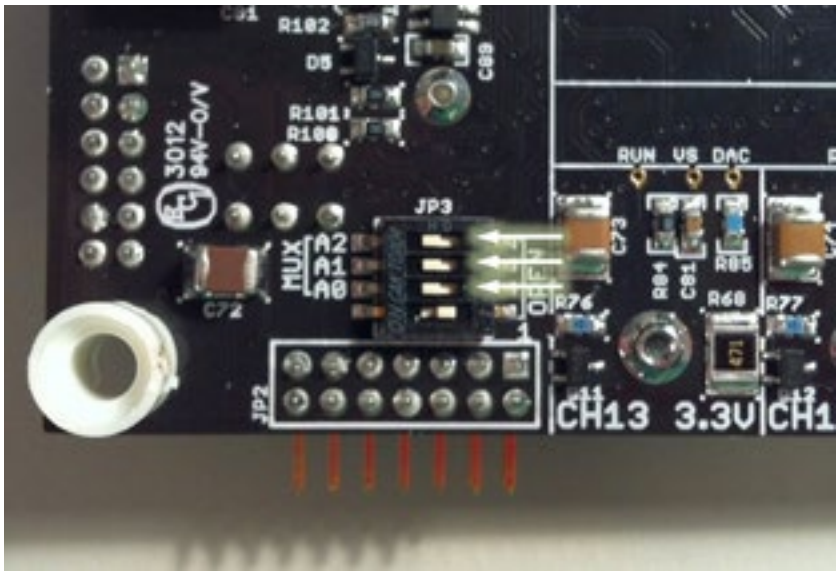


Figure 11. DIP Switch Set to All 0's

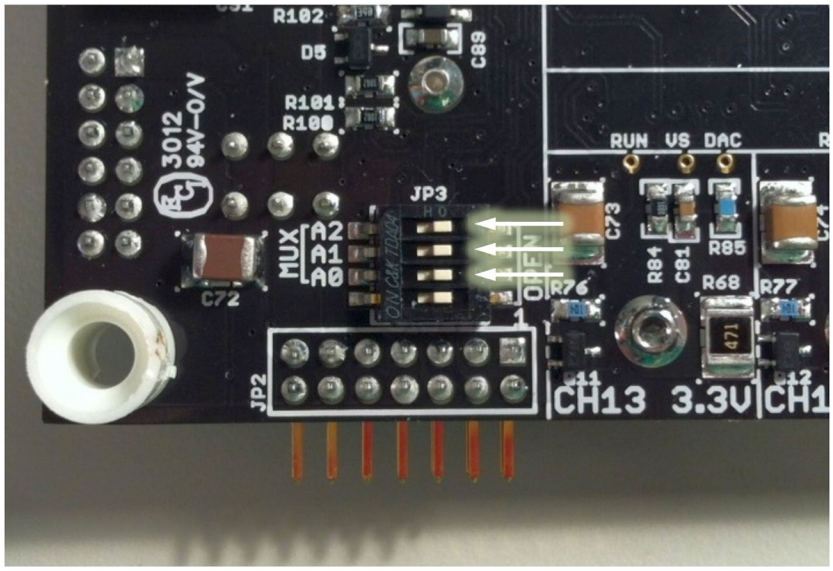


Figure 12. DIP Switch Set to All 1's

DC1962C DETAILS - TOP

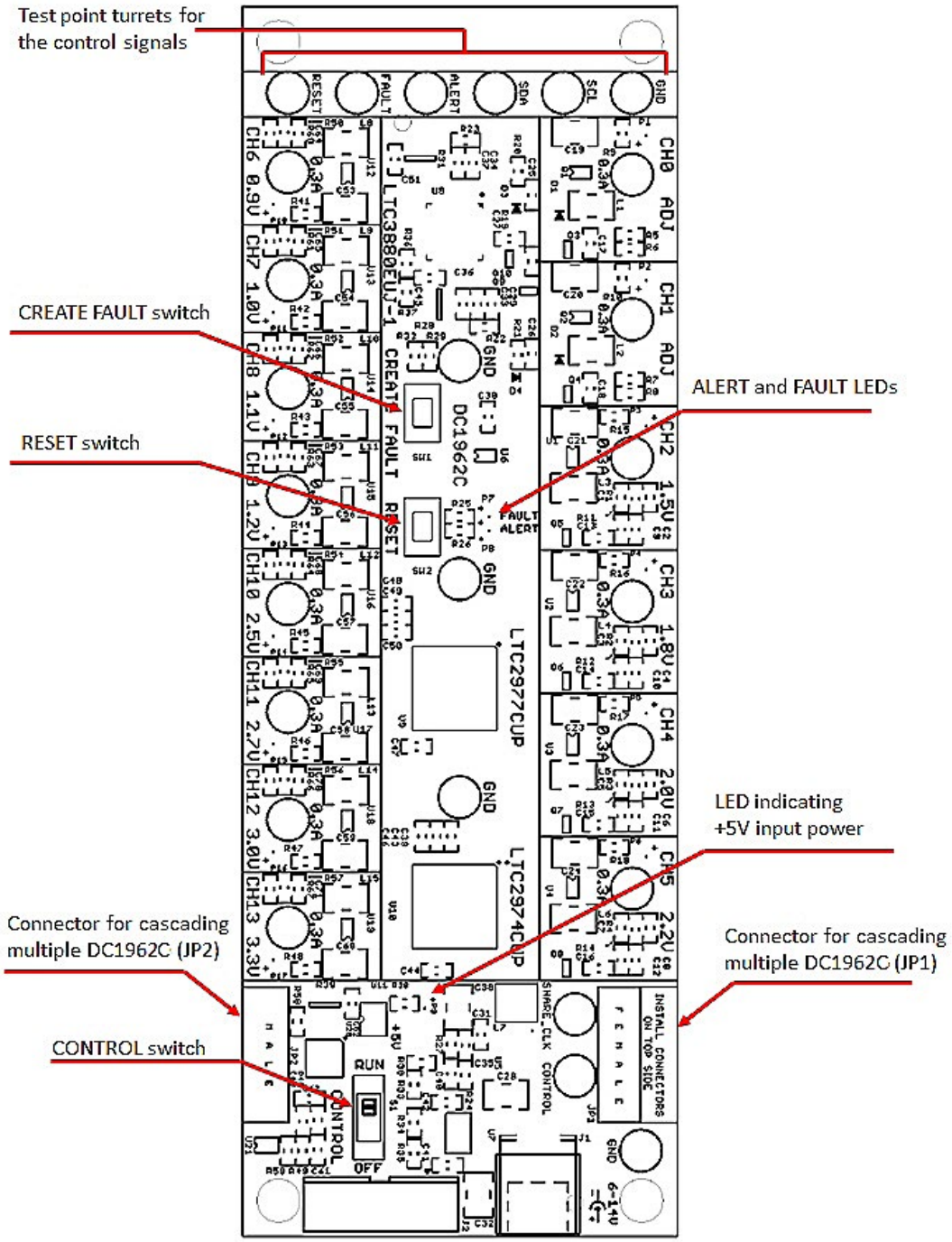
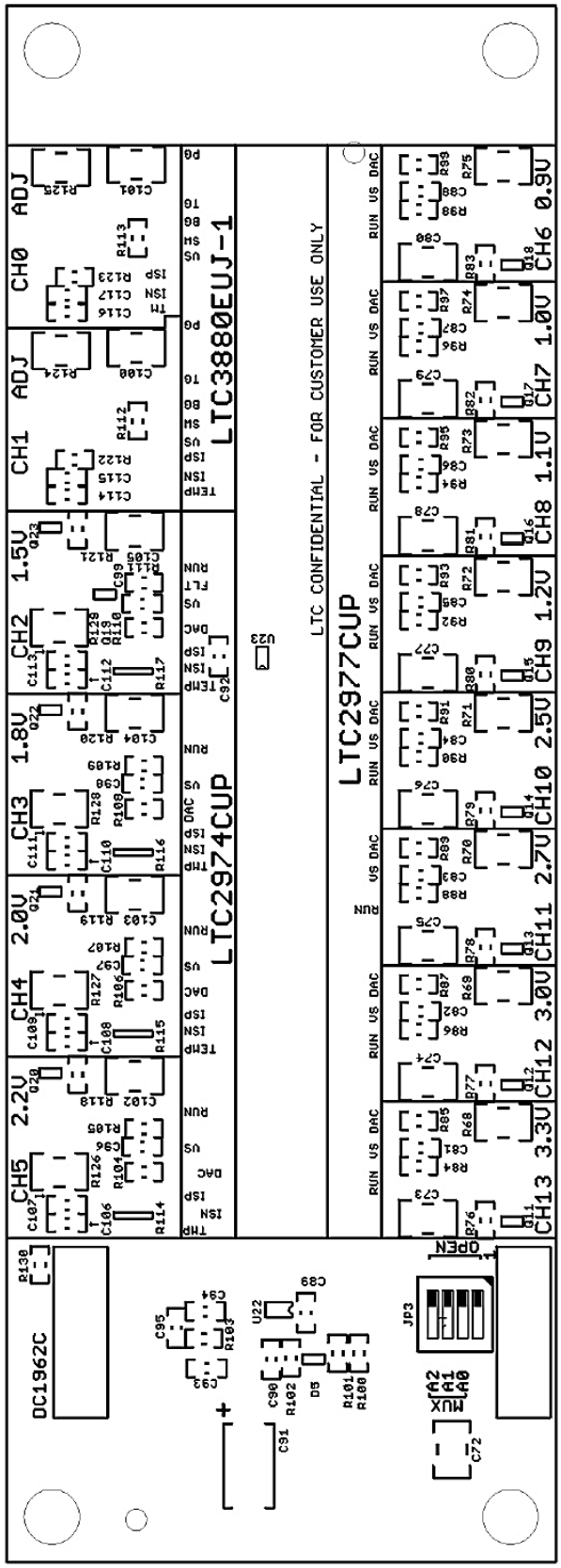


Table 3. DC1962C - Default Switch Configuration (Default Position Shown in Grey in the Figure Above)

REFERENCE DESIGNATOR	SIGNAL NAME	USAGE	DEFAULT
JP3	A0, A1, A2	DIP switch used to set the address offset	OPEN
S1	CONTROL0	Switch used to enable/disable the CONTROL0 input pin of LTC3880, LTC2974, and LTC2977	RUN

DC1962C DETAILS - BOTTOM



PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	U8	IC DUAL PolyPhase CONTROLLER 40-QFN	Linear Technology: LTC3880EUJ-1
2	1	U9	IC 8-CH PWR SYSTEM MANAGER 64-QFN	Linear Technology: LTC2977CUP
3	1	U10	IC 4-CH PWR SYSTEM MANAGER 64-QFN	Linear Technology: LTC2974CUP
Additional Demo Board Circuit Components				
4	12	C1, C3, C5, C7, C64, C65, C66, C67, C68, C69, C70, C71	CAP CER 220pF 50V 10% NPO 0603	NIC: NMC0603NPO221J50TRPF
5	8	C2, C4, C6, C8, C9, C10, C11, C12	CAP CER 2200pF 50V 20% X7R 0603	Murata: GRM188R71H222MA01D
6	30	C13, C14, C15, C16, C25, C26, C31, C43, C44, C46, C47, C49, C50, C51, C52, C81, C82, C83, C84, C85, C86, C87, C88, C92, C96, C97, C98, C99, C115, C117	CAP CER 0.1µF 16V 10% X7R 0603	NIC: NMC0603X7R104K16TRPF
7	11	C17, C18, C106, C107, C108, C109, C110, C111, C112, C113, C118	CAP CER 10000pF 50V 10% X7R 0603	TDK: C1608X7R1H103K
8	16	C19, C20, C21, C22, C23, C24, C32, C53, C54, C55, C56, C57, C58, C59, C60, C72	CAP CER 10µF 10V 10% X5R 1210	Kemet: C1210C106K8PACTU
9	3	C27, C90, C93	CAP CER 4.7µF 16V 10% X5R 0603	TDK: C1608X5R1C475K
10	1	C28	CAP CER 10µF 25V 20% X5R 1210	Taiyo Yuden: TMK325BJ106MM-T
11	2	C29, C34	CAP CER 3300pF 50V 10% X7R 0603	Murata: GRM188R71H332KA01D
12	13	C30, C36, C39, C41, C42, C45, C48, C61, C62, C63, C89, C114, C116	CAP CER 1µF 16V 10% X7R 0603	Taiyo Yuden: EMK107B7105KA-T
13	2	C33, C37	CAP CER 100pF 50V 10% X7R 0603	AVX: 06035C101KAT2A
14	2	C35, C95	CAP CER 68pF 50V 5% NPO 0603	AVX: 06035A680JAT2A
15	13	C38, C73, C74, C75, C76, C77, C78, C79, C80, C102, C103, C104, C105	CAP CER 22µF 10V 10% X5R 1210	Kemet: C1210C226K8PACTU
16	1	C40	CAP CER 47pF 50V 5% NPO 0603	AVX: 06035A470JAT2A
17	1	C91	CAP TANT 47µF 16V 20% 7343	Kemet: T520D476M016ATE035
18	1	C94	CAP CER 4.7pF 50V NPO 0603	Murata: GRM1885C1H4R7CZ01D
19	2	C100, C101	CAP CER 47µF 10V 20% X7R 1210	Murata: GRM32ER71A476ME15L
20	4	D1, D2, D3, D4	DIODE SCHOTTKY 20V 1A SOD323	NXP Semiconductors: PMEG2010EA,115
21	1	D5	DUAL SCHOTTKY DIODE 30V CC SOT-323-3	STMicroelectronics: BAT30CWFILM
22	2	L1, L2	INDUCTOR SHLD POWER 10.0µH SMD	Abracon Corporation: ASPI-0315FS-100M-T2
23	12	L3, L4, L5, L6, L8, L9, L10, L11, L12, L13, L14, L15	INDUCTOR SHLD POWER 4.7µH SMD	Abracon Corporation: ASPI-0315FS-4R7M-T2
24	1	L7	INDUCTOR POWER 2.2µH 2.85A SMD	Vishay: IHLP1616BZER2R2M01
25	15	P1, P2, P3, P4, P5, P6, P9, P10, P11, P12, P13, P14, P15, P16, P17	LED GREEN HIGH BRIGHT ESS SMD	Panasonic: LNJ337W83RA
26	2	P7, P8	LED RED HI BRT SS TYPE LO CUR SM	Panasonic: LNJ208R8ARA
27	2	Q1, Q2	MOSFET N-CH DUAL 20V SSOT-6	Fairchild Semiconductor: FDC6401N
28	1	Q10	MOSFET P-CH 8V 860MA SOT323-3	Vishay/Siliconix: SI1305DL-T1-E3
29	6	Q3, Q4, Q5, Q6, Q7, Q8	TRANS GP SS PNP 40V SOT323	ON Semiconductor: MMBT3906WT1G
30	14	Q9, Q11, Q12, Q13, Q14, Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23	MOSFET N-CH 30V 900MA SOT323-3	Vishay/Siliconix: SI1308EDL-T1-GE3

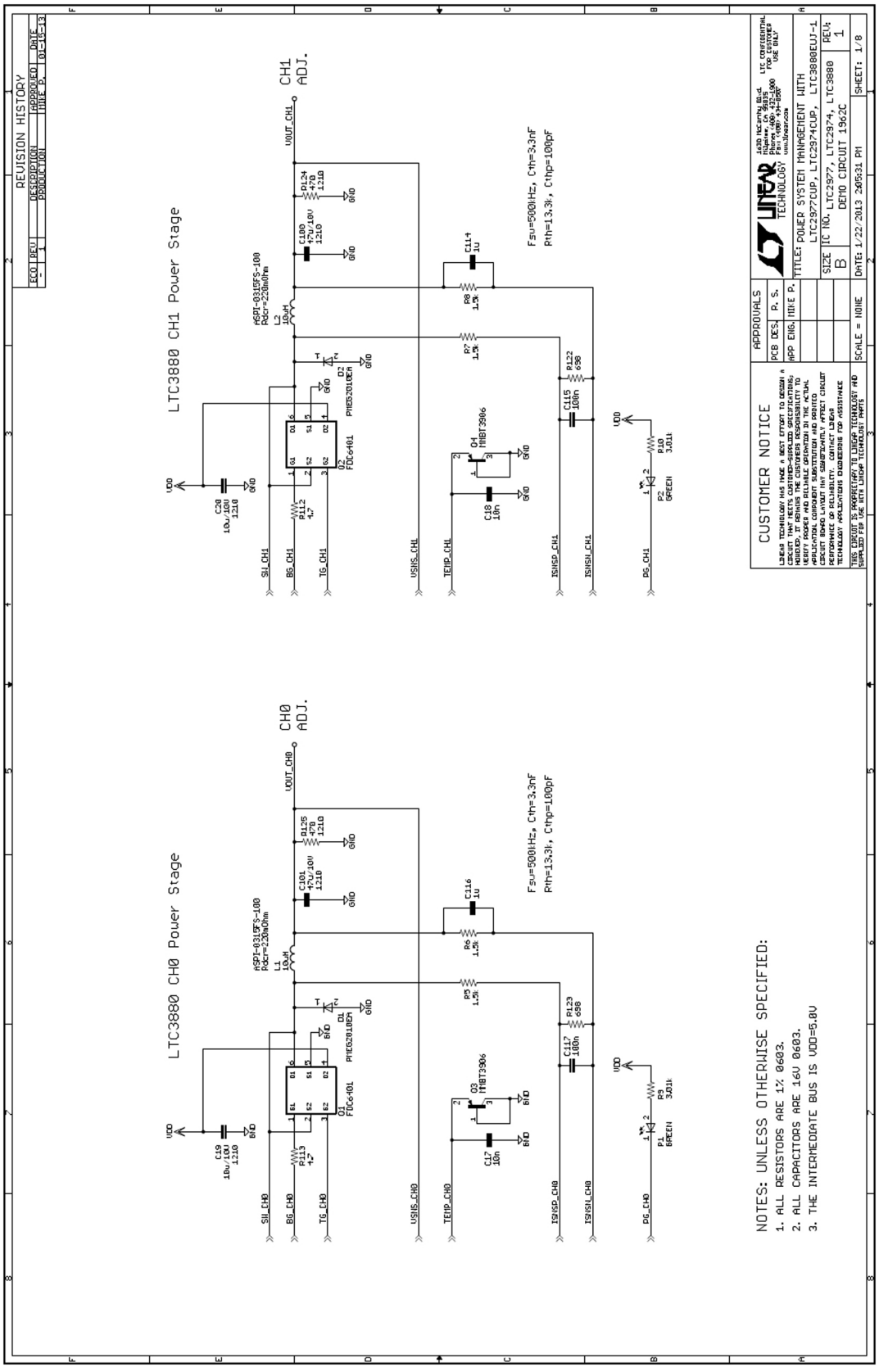
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
31	21	R1, R2, R3, R4, R29, R60, R61, R62, R63, R76, R77, R78, R79, R80, R81, R82, R83, R118, R119, R120, R121	RES 100k 1/10W 1% 0603 SMD	Vishay: CRCW0603100KFKEA
32	4	R5, R6, R7, R8	RES 1.50k 1/10W 1% 0603 SMD	Yageo: RC0603FR-071K5L
33	15	R9, R10, R15, R16, R17, R18, R38, R41, R42, R43, R44, R45, R46, R47, R48	RES 3.01k 1/10W 1% 0603 SMD	Yageo: RC0603FR-073K01L
34	1	R11	RES 115k 1/10W 1% 0603 SMD	Vishay: CRCW0603115KFKEA
35	1	R12	RES 80.6k 1/10W 1% 0603 SMD	Vishay: CRCW060380K6FKEA
36	1	R13	RES 66.5k 1/10W 1% 0603 SMD	Vishay: CRCW060366K5FKEA
37	1	R14	RES 57.6k 1/10W 1% 0603 SMD	Vishay: CRCW060357K6FKEA
38	9	R19, R24, R33, R49, R58, R59, R100, R101, R130	RES 10.0k 1/10W 1% 0603 SMD	Vishay: CRCW060310K0FKEA
39	4	R20, R21, R112, R113	RES 4.7Ω 1% 0603 SMD	Vishay: CRCW06034R70FKEA
40	2	R22, R23	RES 13.3k 1/10W 1% 0603 SMD	NIC: NRC06F1332TRF
41	4	R25, R26, R122, R123	RES 698Ω 1/10W 1% 0603 SMD	Vishay: CRCW0603698RFKEA
42	3	R27, R56, R103	RES 73.2k 1/10W 1% 0603 SMD	Vishay: CRCW060373K2FKEA
43	3	R28, R31, R39	RES ARRAY 10k 4 RES 1206	Vishay/Dale: CRA06S08310K0JTA
44	1	R30	RES 46.4k 1/10W 1% 0603 SMD	NIC: NRC06F4642TRF
45	0	R32 (OPT)	RES 10.0k 1/10W 1% 0603 SMD	N/A
46	2	R34, R40	RES 249Ω 1/10W 1% 0603 SMD	NIC: NRC06F2490TRF
47	1	R35	RES 1.00k 1/10W 1% 0603 SMD	Yageo: RC0603FR-071KL
48	0	R36, R37 (OPT)	RES 0603 OPTION	N/A
49	1	R50	RES 806k 1/10W 1% 0603 SMD	Vishay: CRCW0603806KFKEA
50	2	R51, R89	RES 402k 1/10W 1% 0603 SMD	Vishay: CRCW0603402KFKEA
51	2	R52, R106	RES 267k 1/10W 1% 0603 SMD	Vishay: CRCW0603267KFKEA
52	5	R53, R64, R65, R66, R67	RES 200k 1/10W 1% 0603 SMD	Vishay: CRCW0603200KJNEA
53	1	R54	RES 93.1k 1/10W 1% 0603 SMD	Vishay: CRCW060393K1FKEA
54	1	R55	RES 84.5k 1/10W 1% 0603 SMD	Vishay: CRCW060384K5FKEA
55	1	R57	RES 63.4k 1/10W 1% 0603 SMD	Vishay: CRCW060363K4FKEA
56	14	R68, R69, R70, R71, R72, R73, R74, R75, R124, R125, R126, R127, R128, R129	RES 470Ω 1/4W 5% 1210 SMD	Rohm Semiconductor: MCR25JZHJ471
57	12	R84, R86, R88, R90, R92, R94, R96, R98, R105, R107, R109, R111	RES 100Ω 1/10W 1% 0603 SMD	Vishay: CRCW0603100RFKEA
58	1	R85	RES 316k 1/10W 1% 0603 SMD	Vishay: CRCW0603316KFKEA
59	2	R87, R110	RES 348k 1/10W 1% 0603 SMD	Vishay: CRCW0603348KFKEA
60	1	R91	RES 422k 1/10W 1% 0603 SMD	Vishay CRCW0603422KFKEA
61	1	R93	RES 442k 1/10W 1% 0603 SMD	Vishay: CRCW0603442KFKEA
62	1	R95	RES 475k 1/10W 1% 0603 SMD	Vishay: CRCW0603475KFKEA
63	1	R97	RES 523k 1/10W 1% 0603 SMD	Yageo: RC0603FR-07523KL
64	1	R99	RES 590k 1/10W 1% 0603 SMD	Vishay: CRCW0603590KFKEA
65	1	R102	RES 2.49k 1/10W 1% 0603 SMD	Yageo: RC0603FR-072K49L
66	1	R104	RES 237k 1/10W 1% 0603 SMD	Vishay: CRCW0603237KFKEA
67	1	R108	RES 294k 1/10W 1% 0603 SMD	Vishay: CRCW0603294KFKEA

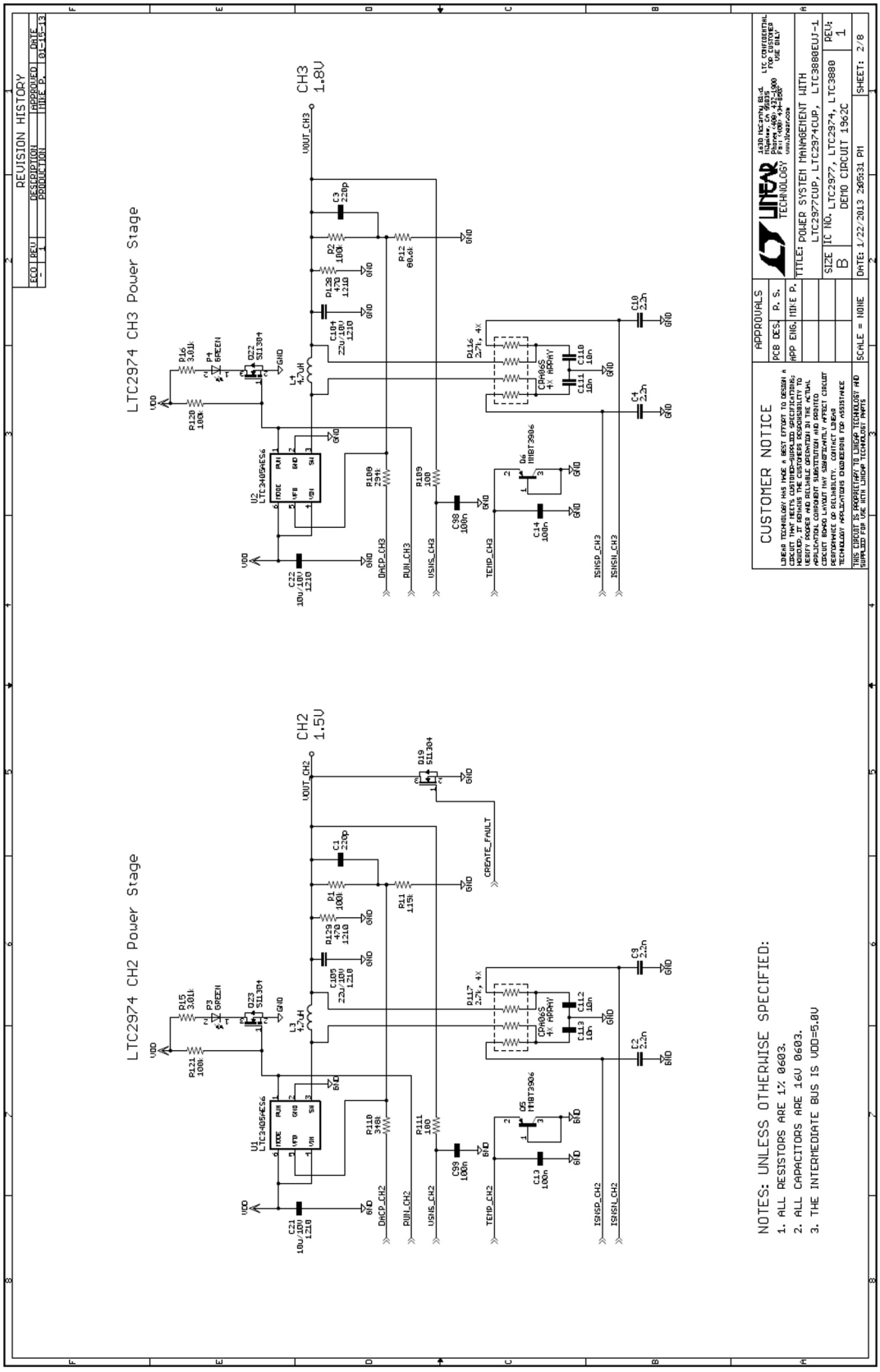
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
68	4	R114, R115, R116, R117	RES ARRAY 2.7k 4 RES 1206	Vishay/Dale: RA06S0832K70JTA
69	12	U1, U2, U3, U4, U12, U13, U14, U15, U16, U17, U18, U19	IC BUCK SYNC ADJ 0.3A SOT23-6	Linear Technology: LTC3405AES6#TRMPBF
70	1	U5	IC BUCK SYNC 2.5A 16QFN	Linear Technology: LTC3604IUD#PBF
71	1	U6	IC COMP DUAL 400MV REF TSOT23-6	Linear Technology: LT6700CS6-2#TRPBF
72	1	U7	IC DUAL 4A DIODES 16-MSOP	Linear Technology: LTC4415IMSE#PBF
73	1	U11	IC 2-WIRE BUS BUFFER 8MSOP	Linear Technology: LTC4313CMS8-2#PBF
74	1	U20	IC I/O EXPANDER I^2C 8B 20QFN	Microchip: MCP23008-E/ML
75	1	U21	IC EEPROM 2KBIT 400kHz SOT23-5	Microchip Technology: 24AA02T-I/OT
76	1	U22	IC VREF SERIES PREC TSOT-23-6	Linear Technology: LT6654BMPS6-1.25#TRMPBF
77	1	U23	IC BUFFER DUAL NON-INV SC706	TI: SN74LVC2G34DCKR
Hardware - For Demo Board Only				
78	1	J1	CONN PWR JACK 2.1X5.5MM HIGH CUR	CUI Inc: PJ-002AH
79	1	J2	CONN HEADER 12POS 2MM STR DL PCB	FCI: 98414-G06-12ULF
80	1	JP1	CONN RECEPT 2MM DUAL R/A 14POS	Sullins Connector Solutions: NPPN072FJFN-RC
81	1	JP2	CONN HEADER 14POS 2MM R/A GOLD	Molex Connector Corporation: 87760-1416
82	1	JP3	SWITCH DIP 4POS HALF PITCH SMD	C&K Components: TDA04H0SB1
83	4	MH1, MH2, MH3, MH4	SPACER STACKING #4 SCREW NYLON	Keystone: 8831
84	1	S1	SW SLIDE DPDT 6VDC 0.3A PCMNT	C&K Components: JS202011CQN
85	1	SW1	SWITCH TACTILE RED SPST-NO 0.05A 12V	C&K Components: PTS635SK25SMTR LFS
86	1	SW2	SWITCH TACTILE BLK SPST-NO 0.05A 12V	C&K Components: PTS635SL25SMTR LFS
87	26	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27	TERM SOLDER TURRET 0.219" 0.078"L	MILL-MAX: 2501-2-00-80-00-00-07-0
88	1	TP17	TERMINAL PIN TURRET 0.109" SOLDER	MILL-MAX: 2308-2-00-80-00-00-07-0

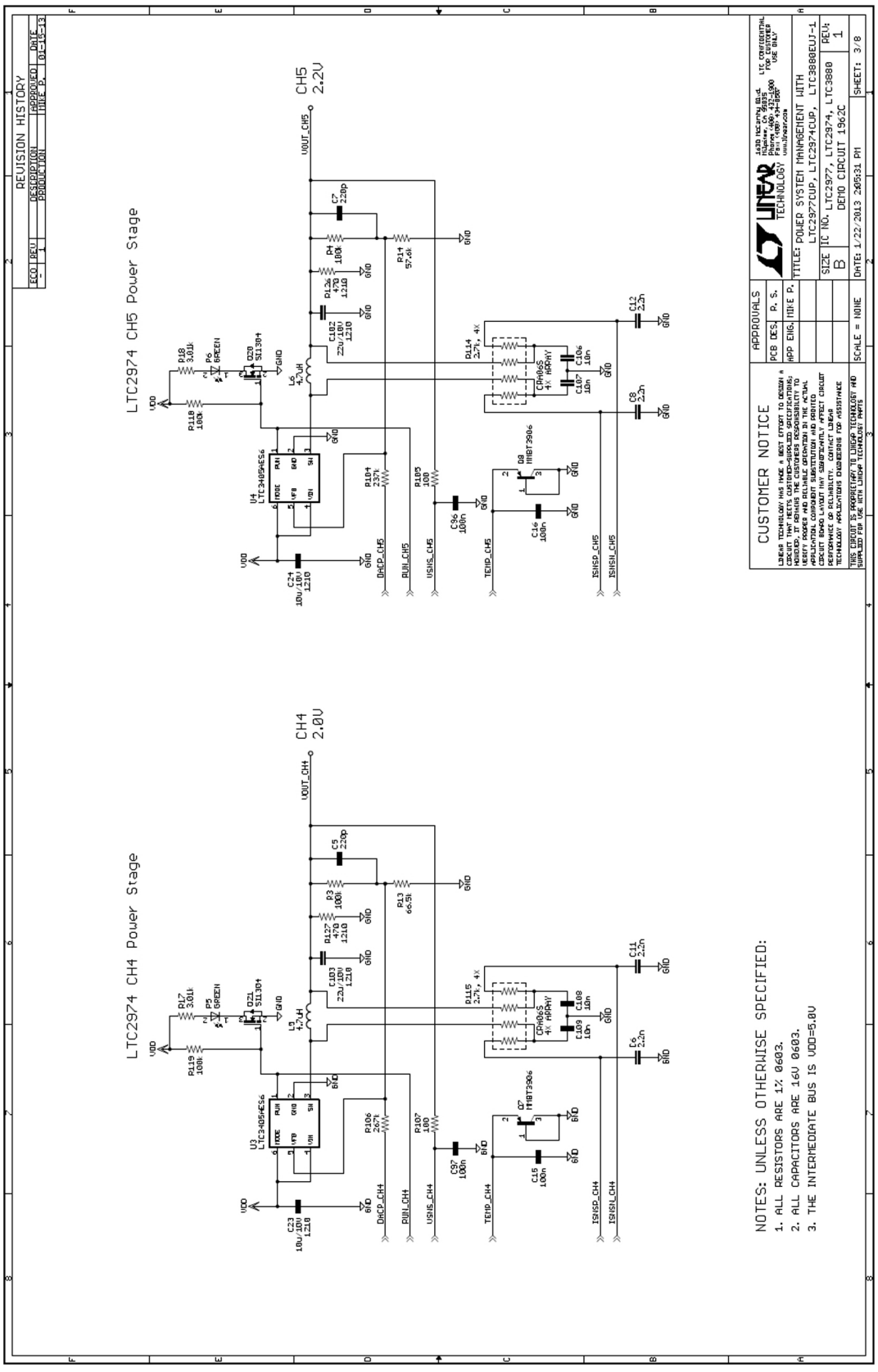
SCHEMATIC DIAGRAM



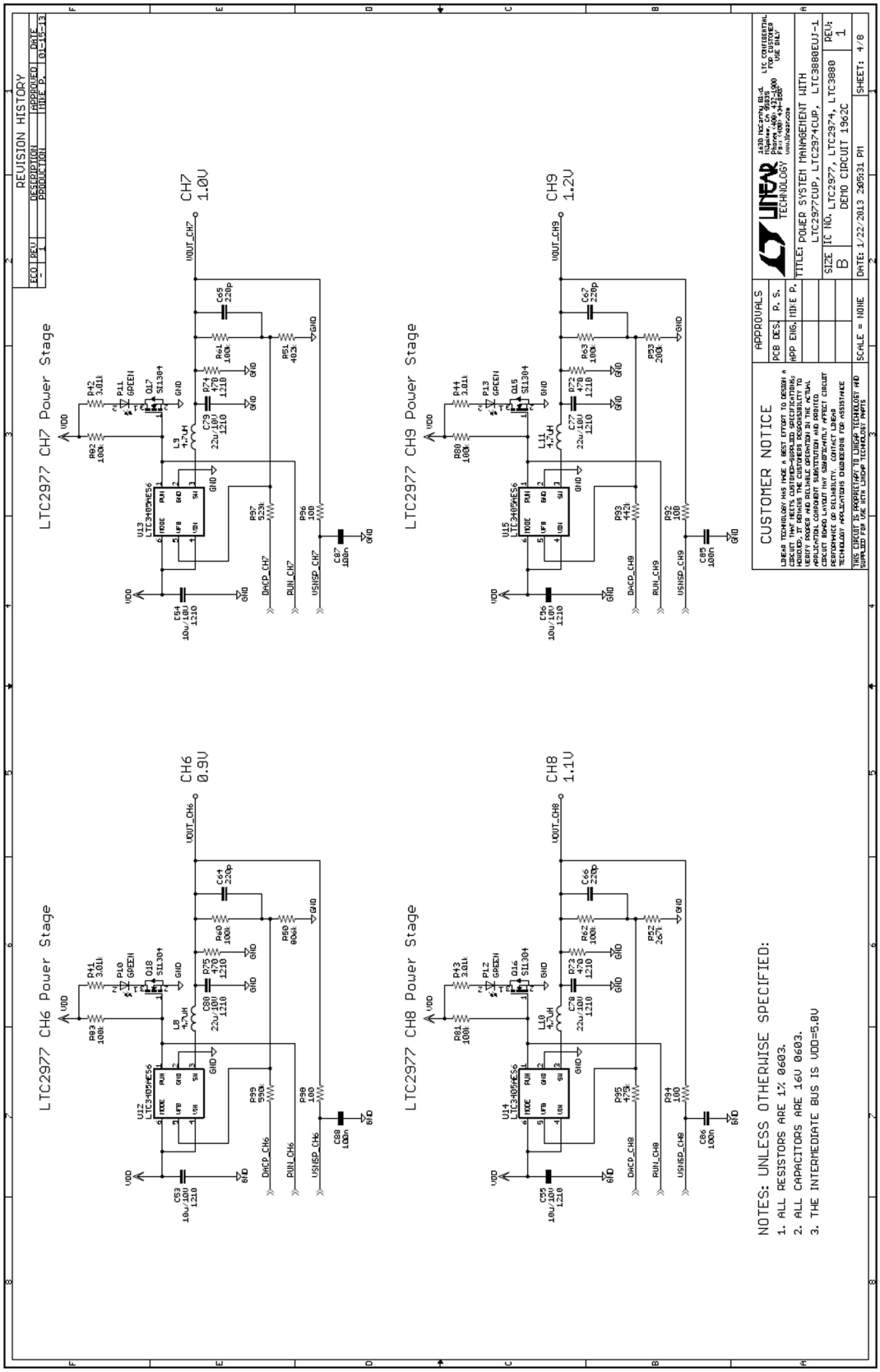
SCHEMATIC DIAGRAM



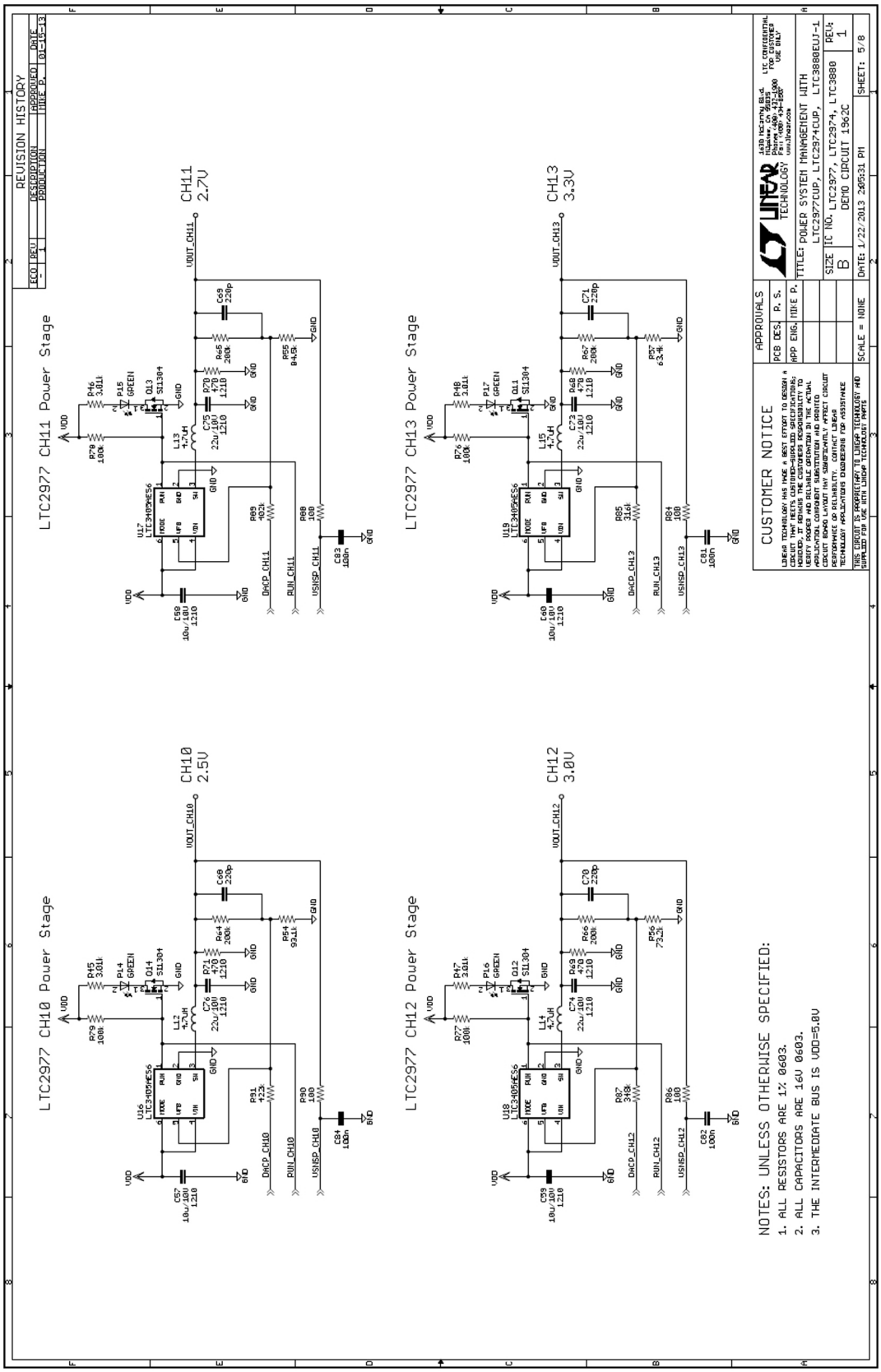
SCHEMATIC DIAGRAM



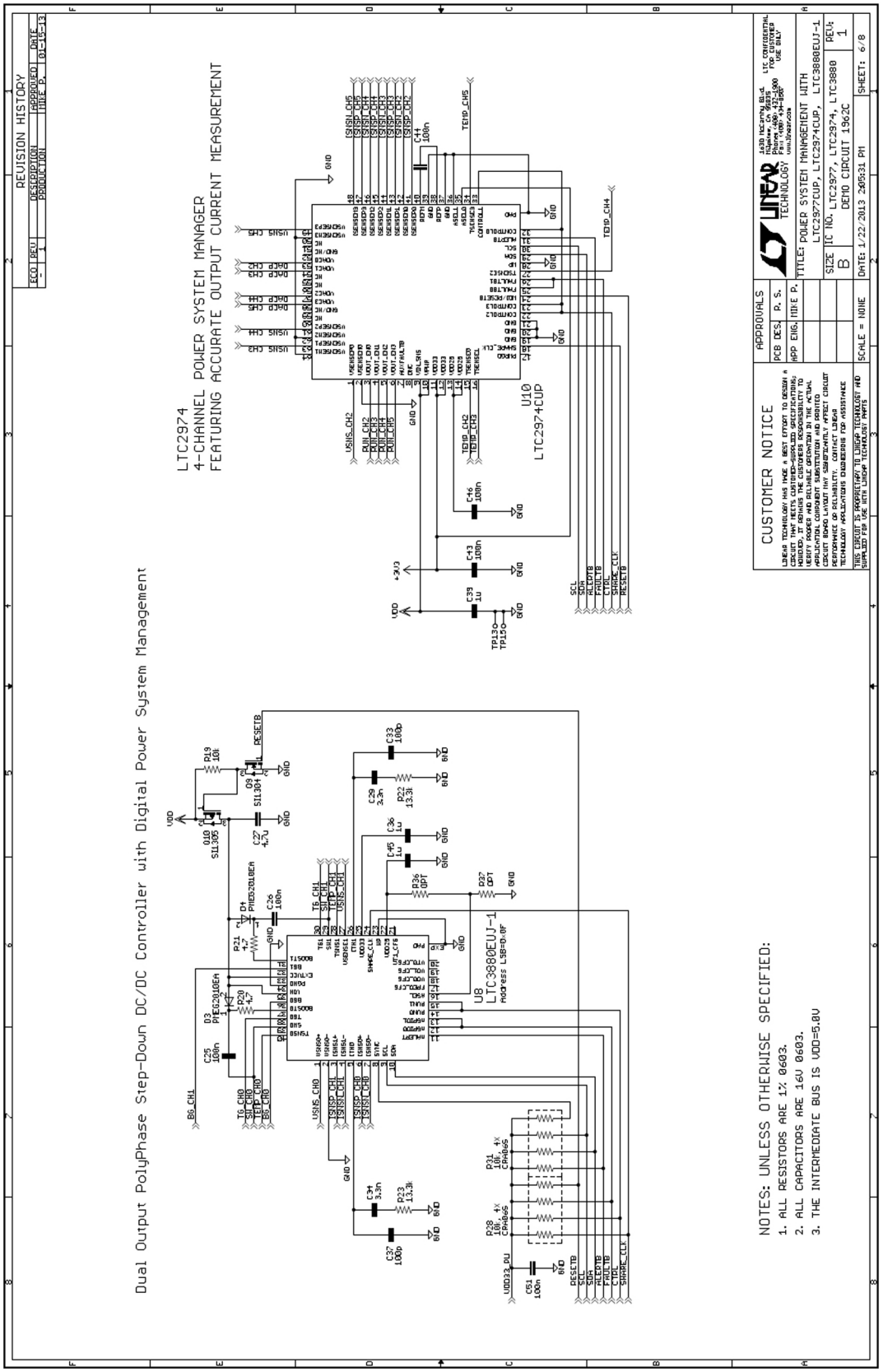
SCHEMATIC DIAGRAM



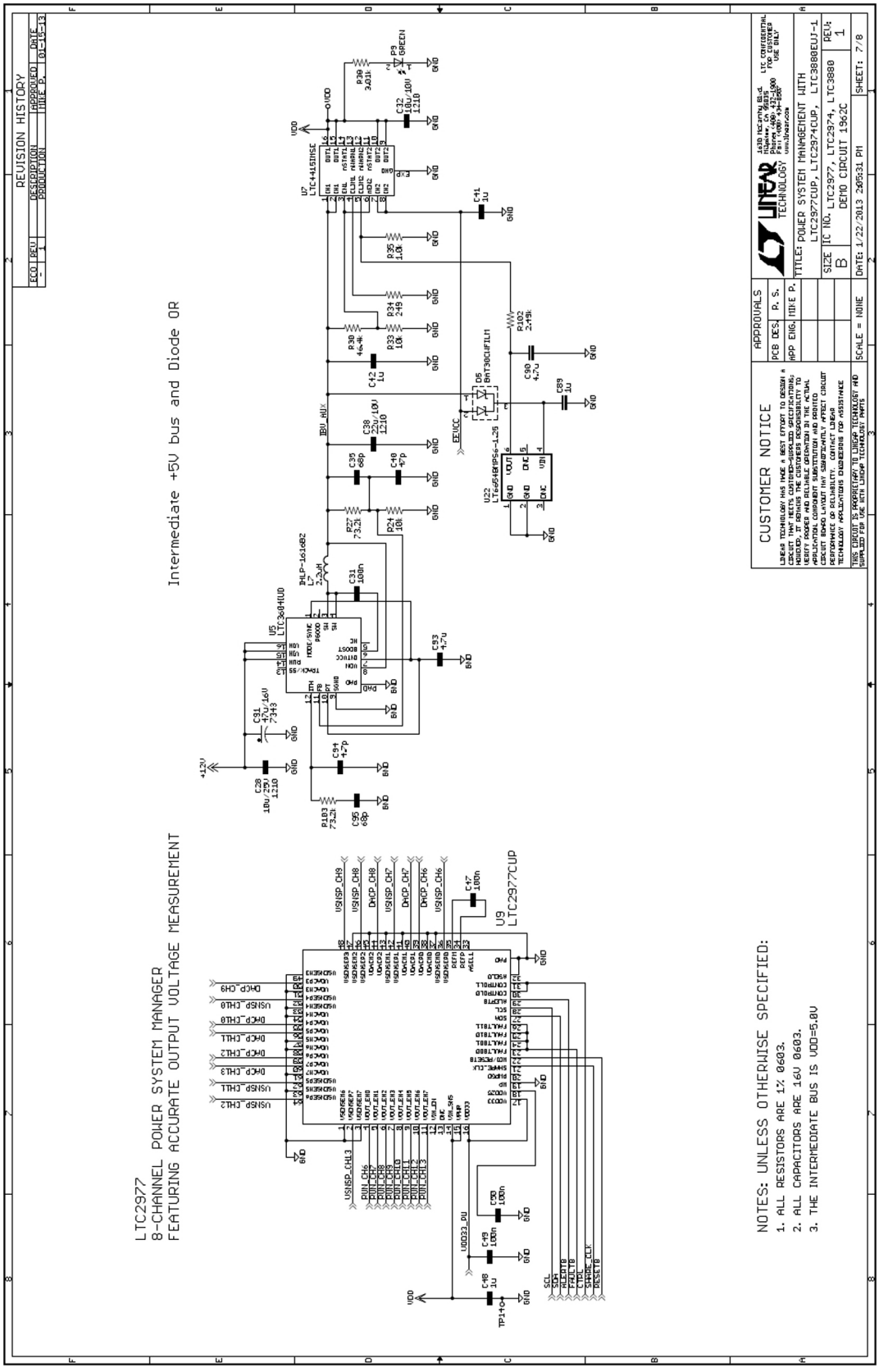
SCHEMATIC DIAGRAM



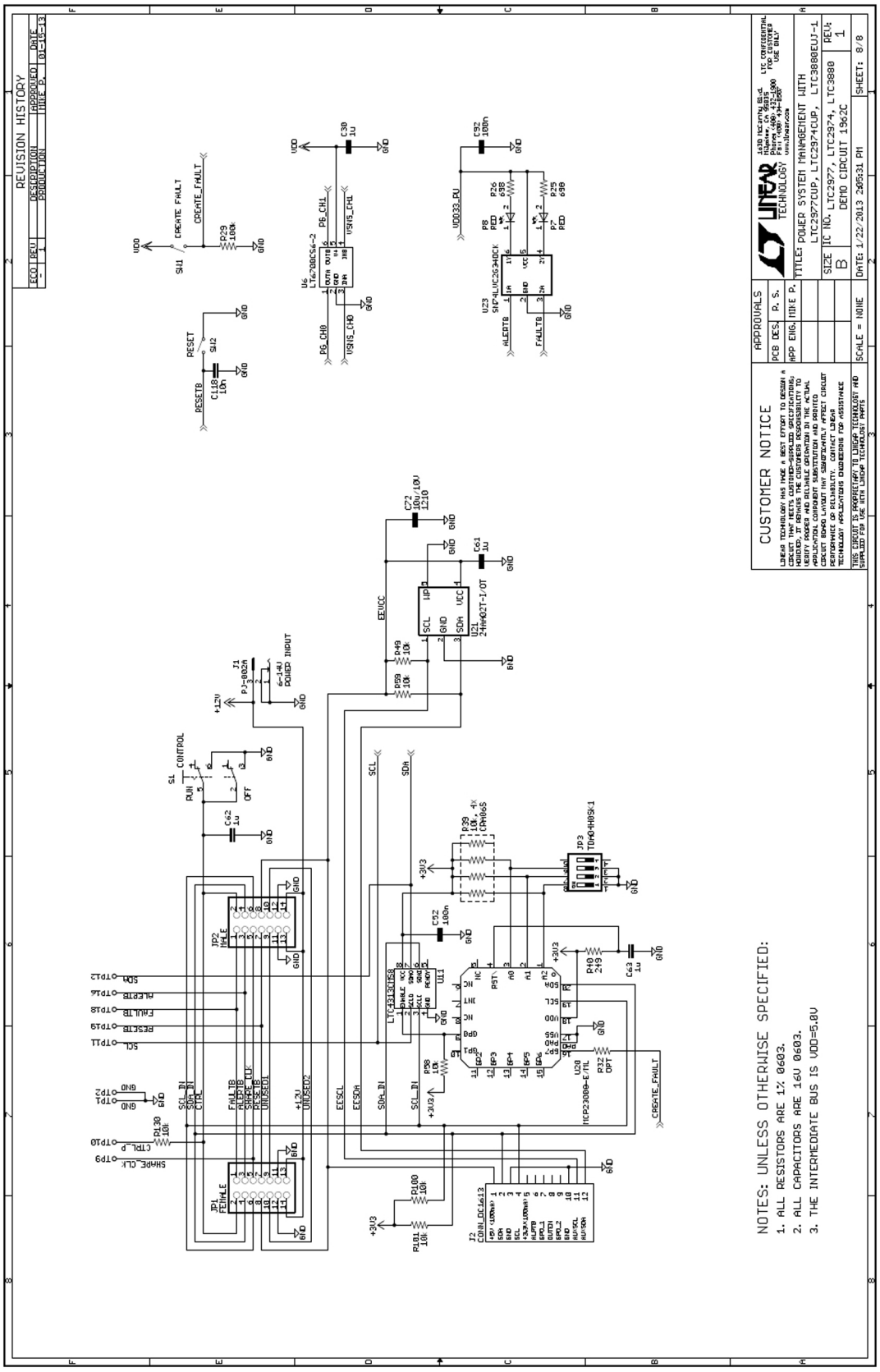
SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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DEMONSTRATION BOARD IMPORTANT NOTICE

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