LTC2978 Octal Digital Power Supply Manager with EEPROM

DESCRIPTION

The DC1540A is a demonstration system for the LTC2978 Octal I²C/SMBus/PMBus Power Supply Monitor and Controller with EEPROM. It consists of 2 circuit boards namely the DC1360A and DC1361A. The DC1360A contains all the circuitry needed to insert the LTC2978 into a power system and control eight power supplies. The DC1361A contains 8 power supplies (LTM4603EV) which are configured to be controlled by an LTC2978. Together these two boards form a sophisticated, 8 channel, digitally programmable power supply.

This demonstration system is supported by LTpowerPlay™ software and a graphical user interface (GUI) that enables complete control of all the LTC2978 features. You can obtain this GUI from the website www.ltpowerplay.com. LTpowerPlay and the DC1540A, create a powerful development environment in which you can design configuration settings for the LTC2978. The configuration settings can be stored in the LTC2978 EEPROM and also in a file, which can be used to order pre-programmed devices. LTpowerPlay displays all of the configuration settings and real time measurements that the LTC2978 performs and allows easy access to the fault log created by the LTC2978. The LTC2978 on the DC1360A comes pre-programmed with EEPROM values appropriate for the 8 power supplies used on the DC1361A. Other configuration files are available on www.ltpowerplay or in the GUI.

The LTC2978 can be configured to monitor current on odd numbered channels. In the DC1540A, this feature can be enabled on Channel 7 (see “Measuring Current”). A configuration file for this mode can be obtained on the LTpowerPlay website. Channels 1 and 2 can be configured to do coincident tracking of Channel 0 by using JP2 and JP3 (see “DC1361A Details – Top Side”). An LTC Hot Swap™ circuit on the DC1361A enables the LTC2978 to soft-start V_{IN} and shut off V_{IN} in response to output faults.

Multiple DC1540As can be cascaded together to form a high channel count power supply (see “Multi-Board Arrays”). This configuration demonstrates features of the LTC2978 which allow timing and fault information to be shared across multiple LTC2978s, allowing the formation of a single, coherent power supply control system. This configuration is easily supported by the LTpowerPlay GUI and allows the user to configure up to 9 LTC2978s, controlling up to 72 separate power supplies.

To get this demo system up and running, connect the DC1540A to your computer using a DC1427A or a DC1613A (USB to I²C/SMBus/PMBus Controller). The following is a checklist of items which you can obtain from LTpowerPlay.com, LTC website or LTC Field Sales.

- USB to I²C/SMBus/PMBus Controller (DC1427A or DC1613A)
- LTpowerPlay GUI
- DC1540A Configuration Files
- LTC2978 Resistor Selection Tool for calculating resistors values and proper DAC range settings

LTC2978 Features

- I²C/SMBus/Communication
- Configuration EEPROM
- PMBus Compliant
- Fault Logging to internal EEPROM
- Differential Input, 15-bit Δ-Σ ADC with less than ±0.25% of Total Unadjusted Error using On-Chip Reference
- Monitors Eight Output Channels and One Input Voltage
- Programmable Watchdog Timer
- 8-Channel Sequencer
- Eight 10-Bit OV/UV Supervisors
- Eight 10-Bit Margin/Trim DAC’s with Soft-Connect
- A Closed Loop Digital Servo Accurately Trims the Outputs
- Supports Multi-Channel Fault Management
- Programmable Fault Responses
- On-Chip Digital Temperature Sensor

PCB Design files for these circuit boards are available. Call the LTC factory.

Table 1. LTC2978 Performance Summary (Specifications Over Temperature –40°C ≤ T_A ≤ 85°C)

PARAMETER	CONDITION		VALUE
$V_{\overline{PWR}}$ Supply Input Voltage Range			4.5V to 15V
V_{DD33} Supply Input Voltage Range			3.13V to 3.47V
ADC Total Unadjusted Error	V_{IN} = 3V		±0.25%
ADC Voltage Sensing Input Range			–0.1V to 6V
ADC Current Sensing Input Range			–170mV to 170mV
ADC Voltage Sensing Resolution	Resolution = 8.192V/32768		122µV/LSB
ADC Current Sense Resolution	0mV <|V_{IN_ADC}| < 16mV 16mV <|V_{IN_ADC}| < 32mV 32mV <|V_{IN_ADC}| < 63.9mV 63.9mV <|V_{IN_ADC}| <127.9mV 127.9mV <|V_{IN_ADC}|		15.6µV/LSB 31.25µV/LSB 62.5µV/LSB 125µV/LSB 250µV/LSB
Voltage Buffered IDAC Resolution 10 bits	Buffer gain setting 0		1.38mV/LSB
	Buffer gain setting 1		2.65mV/LSB
Temperature Sensor Resolution			0.25°C/LSB
Voltage Supervisor Input Voltage Range (Programmable)	$V_{SENSEP[n]}$	Low resolution	0 to 6V
		High resolution	0 to 3.8V
	$V_{SENSEM[n]}$		–0.1 to 0.1V
Voltage Supervisor Sensing Resolution	0V to 3.8V range: 4.096/1024		4mV/LSB
	0V to 6V range: 8.192/1024		8mV/LSB
Voltage Supervisor Total Unadjusted Error	2V < V_{IN_VS} < 6V, Low Resolution Mode		±1.25 %
	1.5V < V_{IN_VS} < 3.8V, High Resolution Mode		±1.0 %
	0.8V < V_{IN_VS} < 1.5V, High Resolution Mode		±1.5 %
I^2C Serial Clock Frequency			10kHz to 400kHz

Demo System Specifications

Table 2. Specifications-DC1361A

V_{OUT} Name	Nominal Voltage-Untrimmed
V_{OUT_0}	3.325V ± 1.5%
V_{OUT_1}	2.497V ± 1.5%
V_{OUT_2}	1.989V ± 1.5%
V_{OUT_3}	1.804V ± 1.5%
V_{OUT_4}	1.502V ± 1.5%
V_{OUT_5}	1.200V ± 1.5%
V_{OUT_6}	0.999V ± 1.5%
V_{OUT_7}	0.799V ± 1.5%

Notes:

- Load current less than 2A on each output is recommended.
- Max current into J11 (+12V) should be < 6A max.
- Output voltages can be margined by a minimum of ±15% from nominal with the default resistor values on the DC1361A. These values can be easily changed. See section “Changing DC1361A Nominal Output Voltages. Use the LTC2978 Resistor Selection Tool, (Spreadsheet) which is accessed from LTpowerPlay.

What Can You Do With This Demo System ?

- Prototype your system. You can change the nominal V_{OUT}'s of the modules to match your system. You can also change the range and resolution of margining. Set sequencing. Set OV/UV limits. And much more!
- Create your own configuration that you can store in the EEPROM of the LTC2978 or save to a file. This file can be used to order pre-programmed parts.
- Test most conceivable fault scenarios. All outputs can be shorted.

Demo System Hardware

Hardware required:

1. PC + USB cable
2. 12V > 0.5A power supply
3. USB to I²C/SMBus/PMBus Controller
4. DC1540A = DC1360A + DC1361A

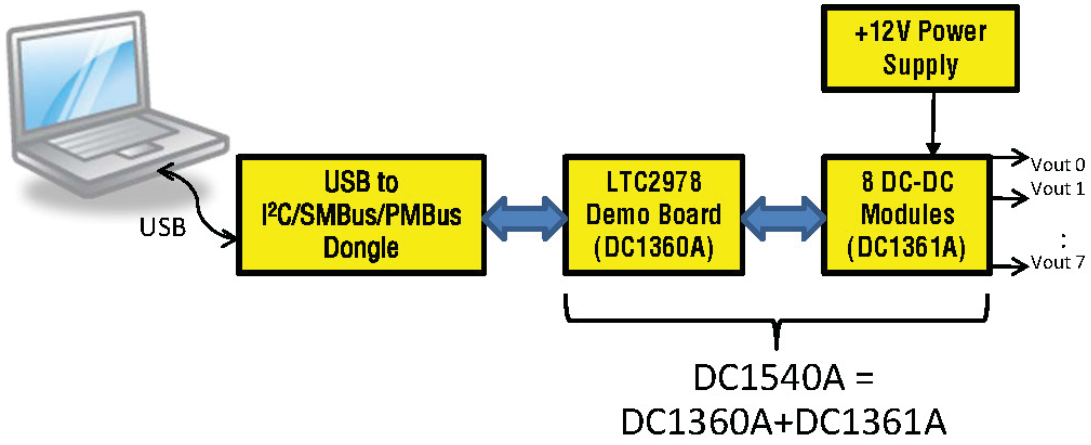


Figure 1. Single LTC2978 Demo Setup Using DC1540A

DOWNLOAD GUI TO YOUR PC

LTpowerPlay can be downloaded from www.ltpowerplay.com. Complete instructions are located there.

QUICK START PROCEDURE

The following procedure describes how to set up one DC1540A.

1. Remove both boards from bag.
2. Place boards on level surface. Connect boards together using the 54-pin edge connector. See below.

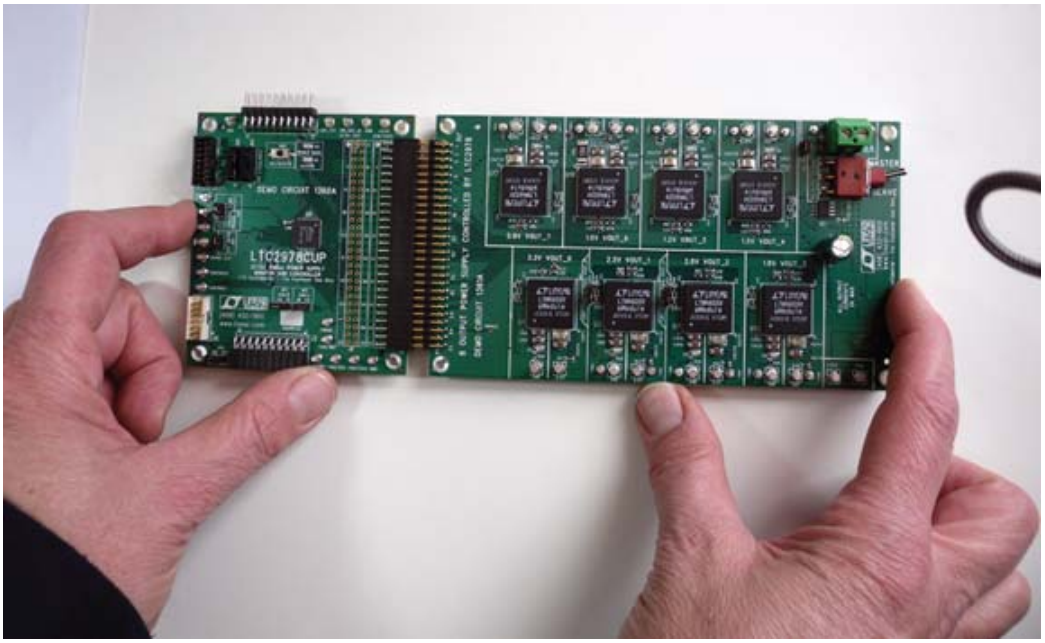


Figure 2. Plug Boards Together

3. On DC1360A, set jumpers and switches as follows. See also Table 3.
   a. Set both SW1 and SW2 (CONTROL0 and CONTROL1) to GND.
   b. Set JP5 to OFF.
   c. Make sure JP6 is installed.
   d. Set JP3 (ASEL0) to LO and JP2 (ASEL1) to LO.
   e. Set JP4 to ON.
4. On DC1361A, set jumpers and switches as follows. See also Table 3.
   a. JP1 = INSTALLED
   b. JP2, JP3 = SOFT START
   c. SW1 = MASTER
5. Plug in the USB to I^2C/SMBus/PMBus Controller into a USB port on your PC.
6. Connect a 12V power supply with > ½ Amp capacity to the V_{IN}^+ and V_{IN}^- inputs of the green terminal block J11 on DC1361A. Do not turn on 12V yet. Be careful to hook up polarity correctly! See Figure 5.

QUICK START PROCEDURE

7. If you have a DC1427A, connect to J4 on DC1360A as shown below.

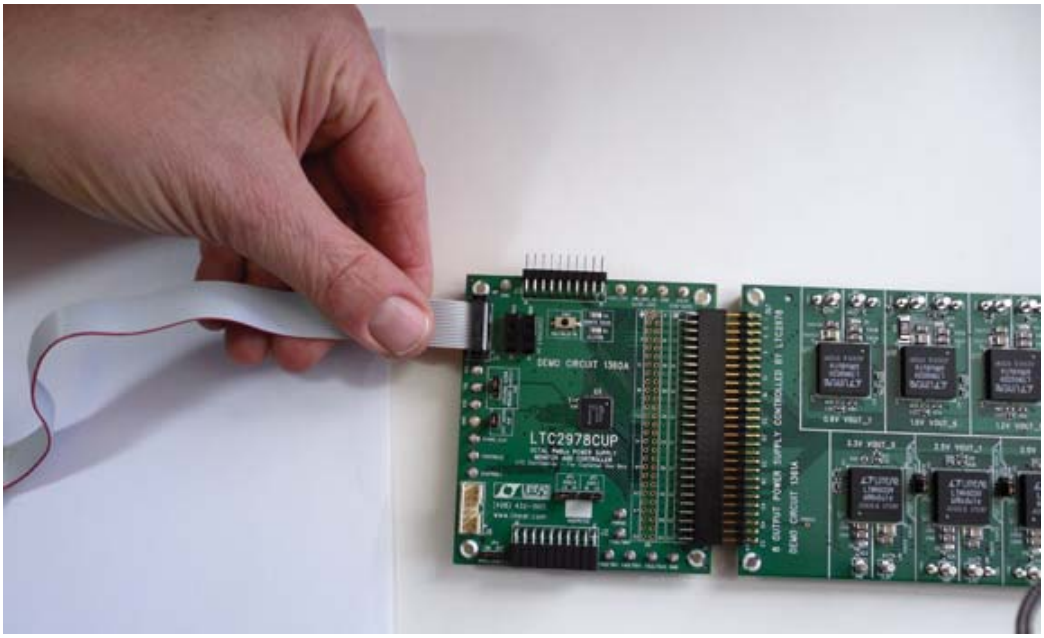


Figure 3. DC1427A Connection

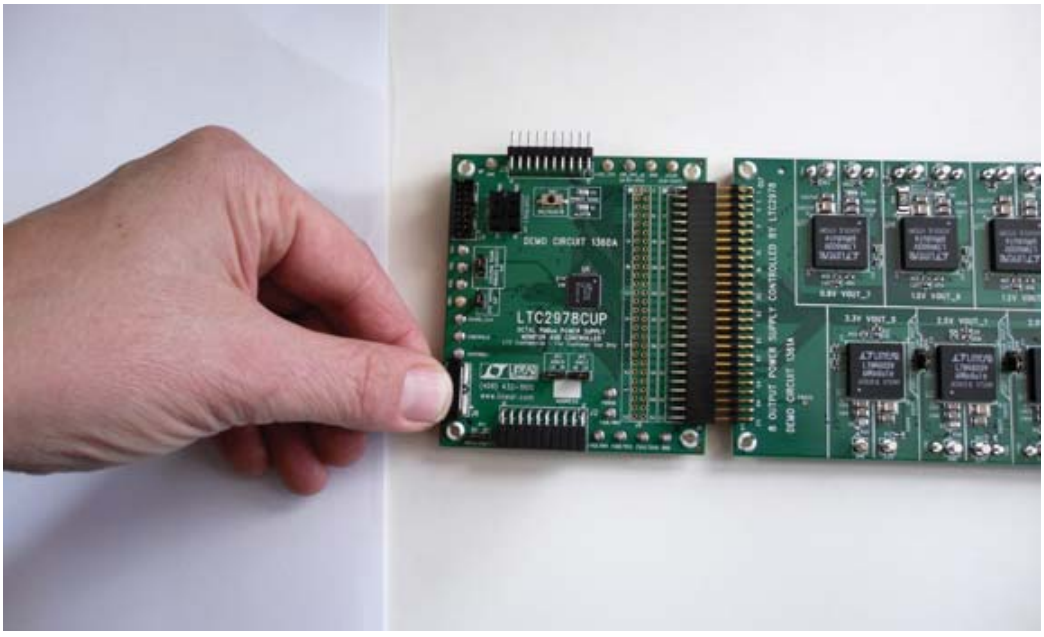
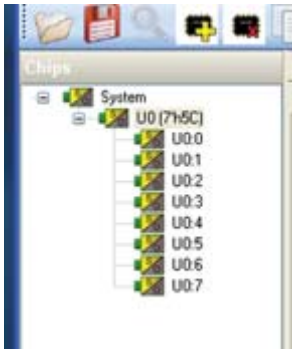


Figure 4. DC1613 Connection

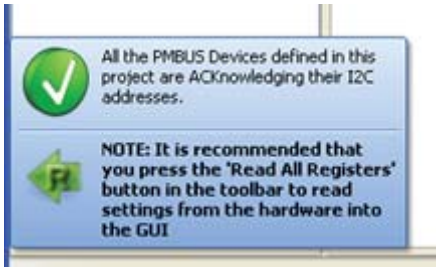
QUICK START PROCEDURE

8. Launch the LTpowerPlay GUI.

   a. The GUI should indentify the LTC2978. The system tree on the left hand side should look like:



   b. Confirm that the LTC2978 is communicating. A green message box shows for a few seconds in the lower left hand corner



   c. In the Toolbar, click the “R” icon to read the RAM from the LTC2978. This reads the default configuration from the RAM in the LTC2978 on the DC1360A and loads it into the GUI.

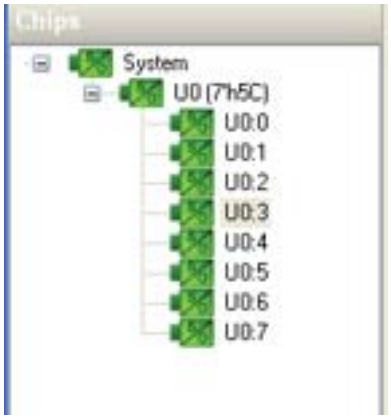
   d. Save the demo board default configuration to a (*.proj) file. Click the “Save” icon and save the file. You can chose your own filename.

9. Turn on the +12V power supply.

10. Slide the 2 black switches CONTROL 0, CONTROL 1 to the HI position. This turns on the board.

QUICK START PROCEDURE

The System Tree on the left hand side should turn all green. All 8 green LEDs on the DC1361A should illuminate.



11. You are now ready to execute one of the LTC2978 demos embedded in the GUI or experiment with the part.

LOADING A 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 file into RAM.
3. To store in EEPROM, click on the STORE button. It is the button on the left below.

NOTES:

1. To configure the jumpers and switches, see Tables 3, 4, 5 and 6. If using more than one LTC2978, use the ASELs to assign different addresses for each LTC2978.
2. On DC1361A, set the MASTER / SLAVE switch to MASTER if you want the Hot Swap chip to shut off in response to an output OV fault. To recover from shut off, you must command the channel that produced the OV off then on with the OPERATION command or you can toggle the VinShareEnable bit in MFR_CONFIG_ALL_LTC2978 to 0 then 1.
3. When the USB to I^2C/SMBus/PMBus controller power is applied, the LTC2978 will load the contents of its EEPROM into operating RAM.
4. For help on any command, highlight the command in the GUI and press F1.
5. The LTM4603 outputs may be shorted indefinitely. This is a good way to induce UV faults.
6. If the DC1360A is used without the DC1361A, it will report an overtemperature fault because its V_{SENSE} inputs are floating. This may be avoided by tying the V_{SENSE} inputs to defined voltages.

DC1540A - DETAILS (DC1360A +DC1361A)

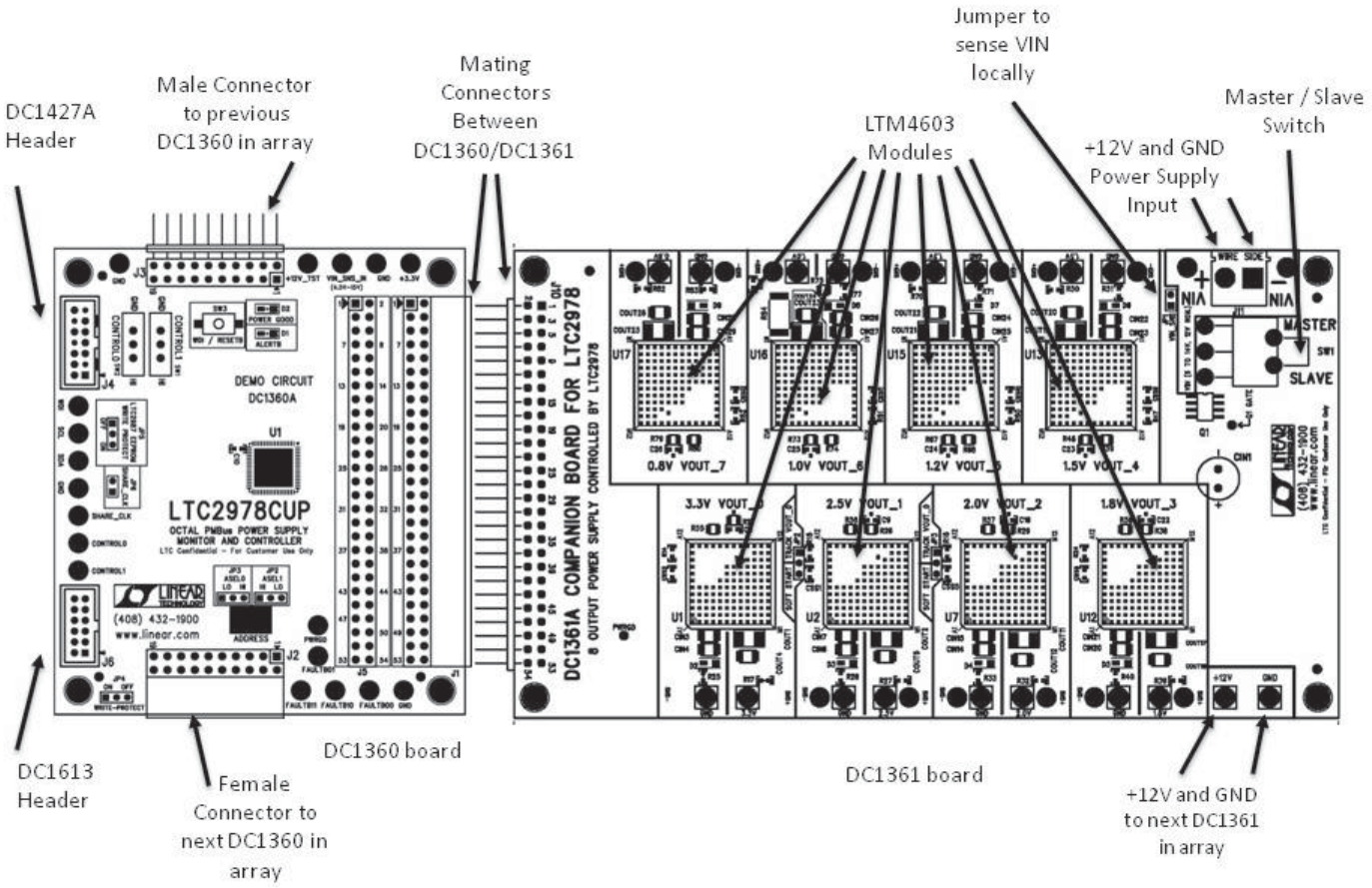


Figure 5. DC1540A Details

DC1360A DETAILS - TOP SIDE

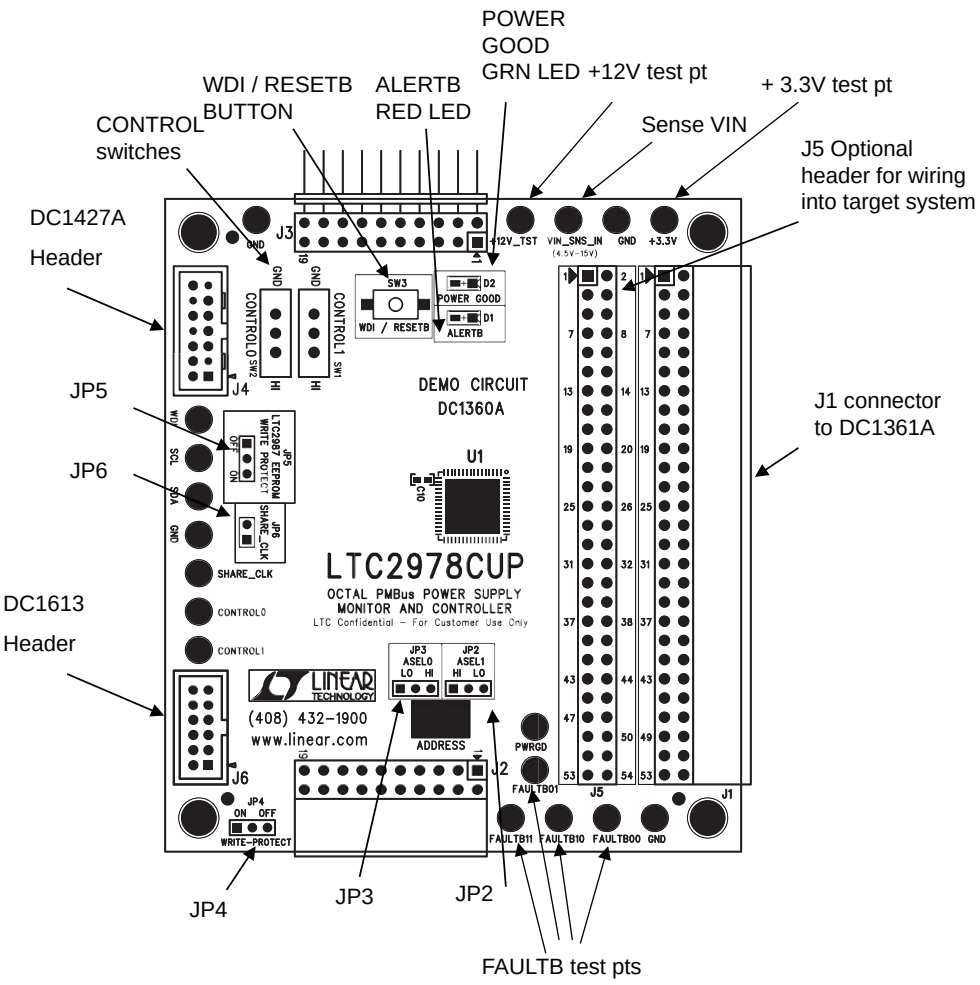


Figure 6. DC1360A Top Side

Table 3. DC1360A - Default Jumper Configuration. Use ASEL's to Select I^2C Address.

JP2 ASEL1	JP3 ASEL0	JP4 Write-Protect	JP5 LTC2978 Write Protect	JP6 Share_CLK
LO	LO	ON	OFF	Installed

DC1360A DETAILS - BOTTOM SIDE

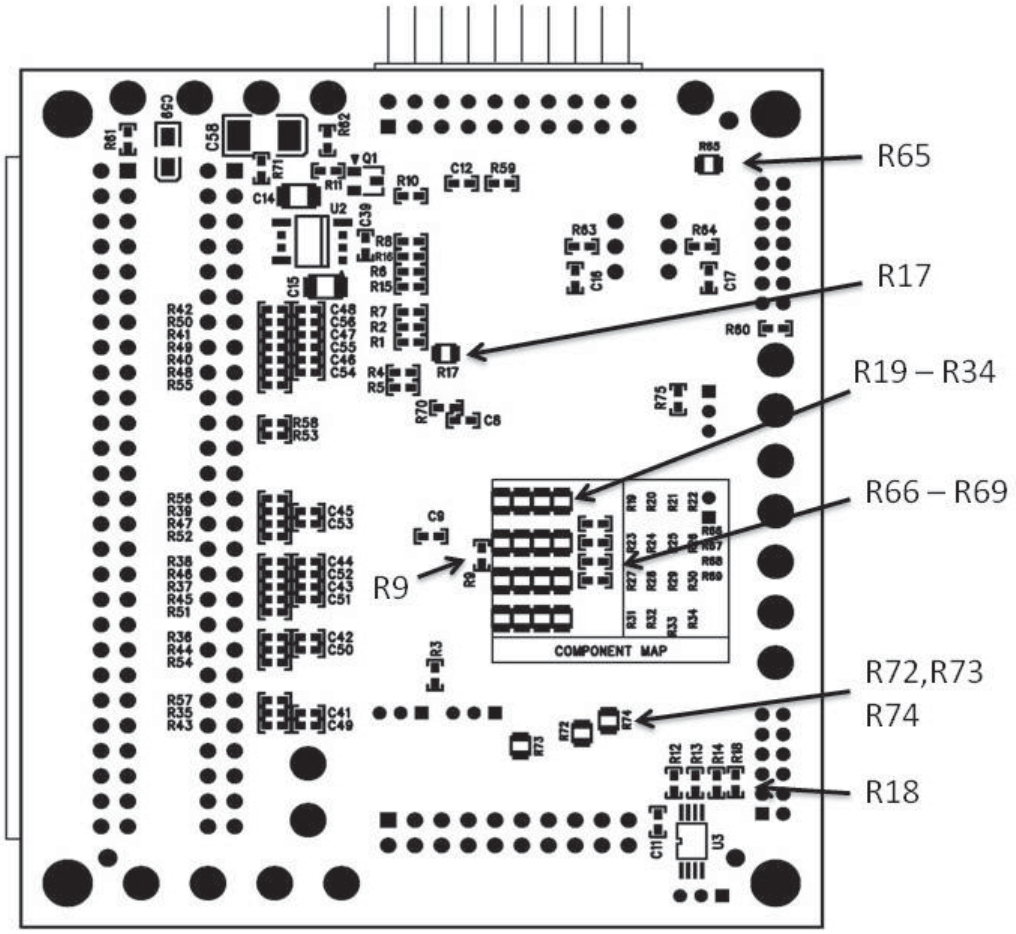


Figure 7. DC1360A Bottom Side Configuration Resistors

Configuration resistors are on the bottom side. They allow multiple ways to make fault dependencies between boards.

Table 4. Optional Configuration Resistors

REF Des	Signal	Usage	Default	Comment
R9	FAULTB10 to FAULTB01	Connect Fault Zone 0 to Fault Zone 1	INSTALLED	Allows Fault Zone 0 to Connect to Fault Zone 1
R19, R24, R29, R34	FAULT1 to FAULT4 to FAULT00 to FAULT11	Connect LTC2978's FAULTB Pin to Demo Board FAULT Lines	INSTALLED	Allows Faults to Propagate Between Boards
R21, R22, R23, R25, R26, R27, R28, R30, R31, R32, R33	FAULT 1 to FAULT 4	Connect any FAULTB Pin to any of Fault Line: FAULT 1,2,3,4	OPEN	Allows Faults to Propagate Between Boards.
R17	ALERTB	Allow DC1427A to Receive ALERTB	OPEN	
R65	WDI/RESET	DC1427A Drives WDI/RESETB	OPEN	
R18	AUXP	DC1427A Sources BIGPWR	INSTALLED	BIGPWR + LGKPWR must be <= 100mA max TOTAL
R72	WDI/RESET	DC1427A Drives WDI/RESET	OPEN	
R73	CONTROL0	DC1427A Drives CONTROL0	OPEN	
R74	CONTROL1	DC1427A Drives CONTROL1	OPEN	

DC1360A DETAILS - BOTTOM SIDE

Setting the Device Address

The LTC2978 can be configured to respond to one of 9 addresses for a given MFR_I^{2}C_BASE_ADDRESS value (the factory default value base address is 7'h5C). In addition, the LTC2978 will always respond to its global address and the PMBus Alert Response address regardless of the state of the address select pins.

By connecting each of the address inputs to V_{DD33}, GND, or by floating them, the user determines the slave address, as shown in Table 4.

Table 5. Address Look-up Table

Description	HEX Device Address		Binary Device Address								Address Pins	
	7'h	8'h	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
*0	5C	B8	1	0	1	1	1	0	0	0	L	L
1	5D	BA	1	0	1	1	1	0	1	0	L	NC
2	5E	BC	1	0	1	1	1	1	0	0	L	H
3	5F	BE	1	0	1	1	1	1	1	0	NC	L
4	60	C0	1	1	0	0	0	0	0	0	NC	NC
5	61	C2	1	1	0	0	0	0	1	0	NC	H
6	62	C4	1	1	0	0	0	1	0	0	H	L
7	63	C6	1	1	0	0	0	1	1	0	H	NC
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_I^{2}C_BASE_ADDRESS = 7'h5C (factory default). LO = L

DC1361A DETAILS - TOP SIDE

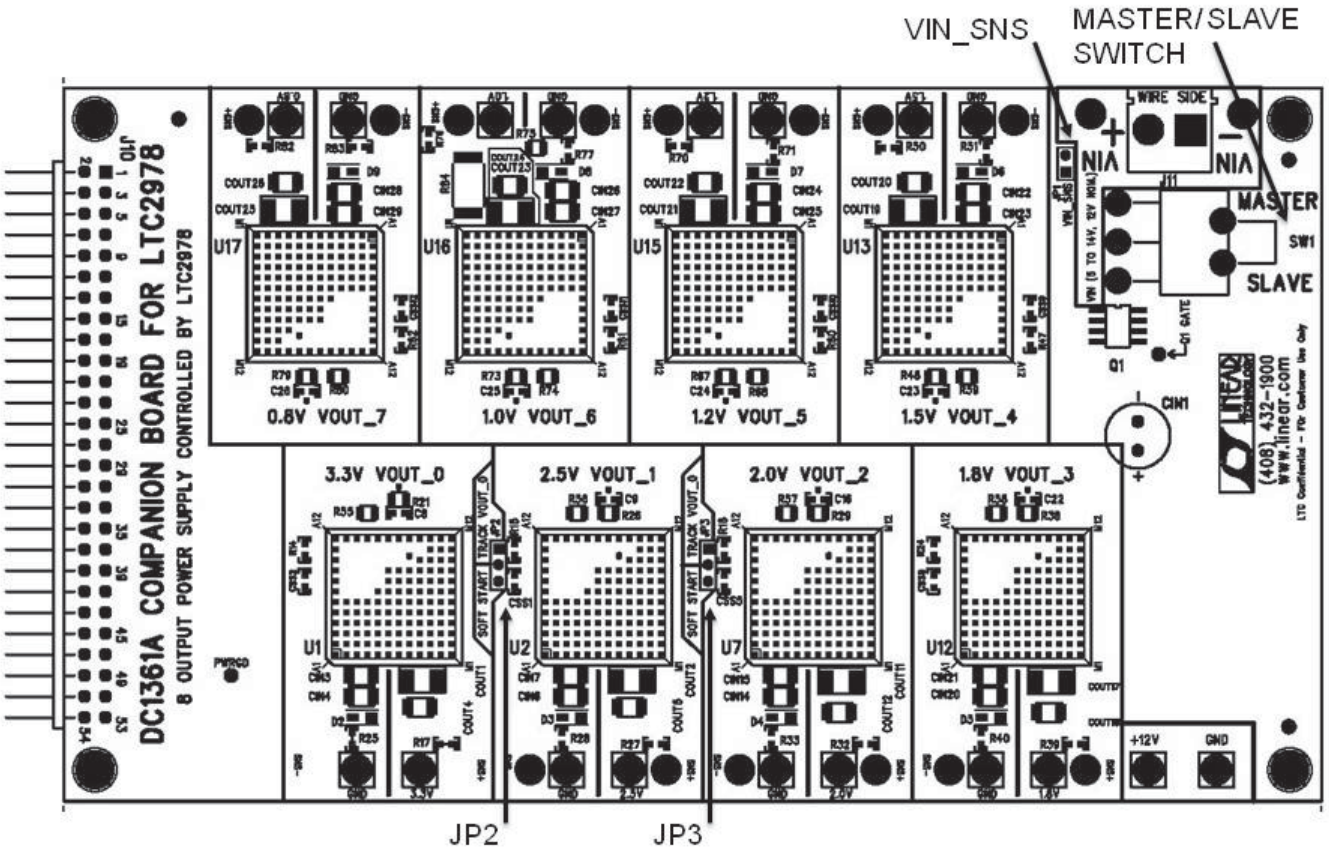


Figure 8. DC1361A Top Side

Table 6. DC1361A - Default Jumper and Switch Configurations

JP1 V_{IN_SNS}		JP2 Track V_{OUT_0}/Soft-Start	JP3 Track V_{OUT_0}/Soft-Start
Installed = Master	Removed = Slave	Soft-Start	Soft-Start

SW1	
Master	Slave

JP2, JP3 in soft start position allows V_{OUT1}, V_{OUT2} to start up with their turn on ramp determined by their soft-start caps. Their sequence position is determined by the LTC2978. In TRACK_V_{OUT_0} position, they coincident track to V_{OUT_0}. TON_DELAY for all tracking channels must be equal. SW1 in the MASTER position allows the Hot Swap circuit to ramp up the V_{IN} and also allows the LTC2978 to open the series MOSFET in case of an Overvoltage on any output. SW1 in SLAVE position defeats the hot swap and passes V_{IN} through so multiple DC1361As can be cascaded in an array.

DC1361A - CHANGING THE NOMINAL OUTPUT VOLTAGES

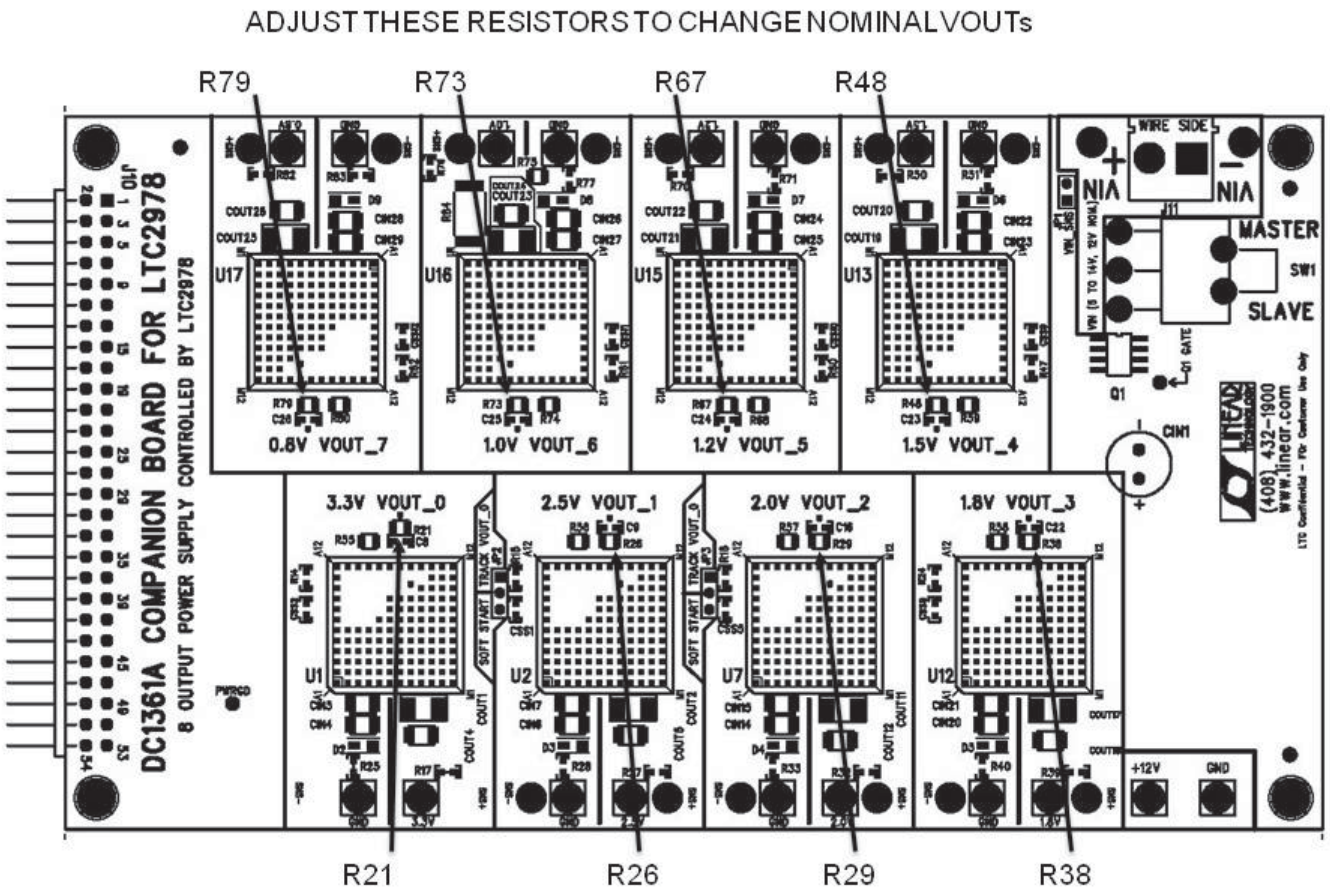


Figure 9. DC1361A Output Voltage Setting Resistor Locations

The Nominal V_{OUT} of any channel on the DC1361A can be changed by changing the R_{SET} resistor from V_{FB} to SGND. These are: R21, R26, R29, R38, R48, R67, R73, R79. See Figure 9. The value for the R_{SET} resistor is:

$R_{SET} = 60.4k/((V_{OUT}/0.6) – 1))$

See also the LTM4603 datasheet Table 2. V_{OUT0} may be adjusted up to 5V. The other channels may be adjusted up to 4V.

DC1361A – ADJUSTING THE MARGIN/TRIM RANGE AND RESOLUTION

The resolution and range can be adjusted for any output on the DC1361A by simply replacing the below resistors. Use the LTC2978 Resistor Selection Tool (spreadsheet) for calculating resistors values and proper DAC range settings.

The design tool refers to R20. This is the upper divider resistor which is 60.4kΩ inside the LTM4603.

The design tool refers to R10. This is the lower divider resistor which is R_{SET} (See Figure 9).

The design tool refers to R30. This is the margin/trim adjustment resistor.

On the DC1361A, the lower divider resistors (R10) are = R_{SET} for each channel = R21, R26, R29, R38, R48, R67, R73, R79.

On the DC1361A, the adjustment resistors (R30) are = R55, R56, R57, R58, R59, R68, R74 and R80.

CHANGE THESE RESISTORS TO ADJUST THE MARGIN RANGE/RESOLUTION

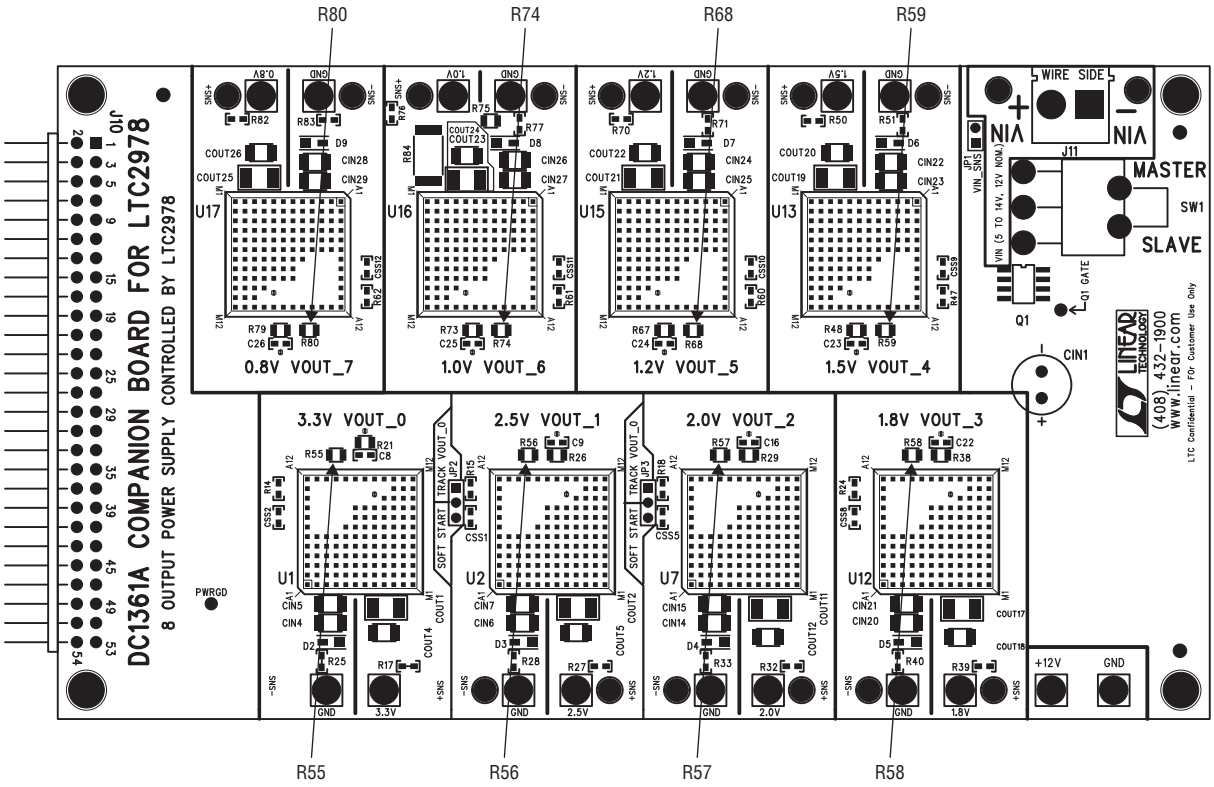
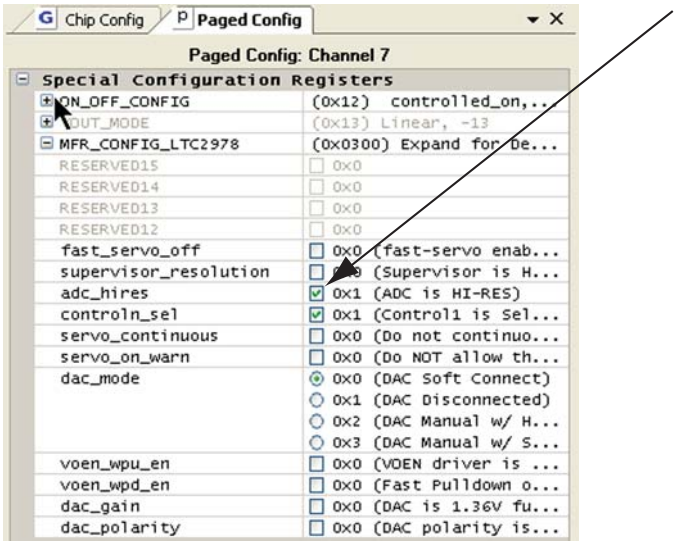


Figure 10. Margin/Trim Resistor Locations

MEASURING CURRENT

It is possible to measure the current on Channel 6 by using Channel 7 in “Hi Res” mode. Follow the instructions on pp.9 and 10 of DC1361A schematic. Remove R88, R89 and move them to R86, R87. Also remove the preload resistor R75 (top side) on DC1361A schematic p.9 to measure only the current going out of the board.

One simple checkbox in the GUI sets up Channel 7 to measure current. In the MFR_CONFIG_LTC2978 register check the box that says “adc_hires”. Apply a load between the big turrets 1.0V and GND on V_{OUT_6} and read the voltage across the 10mΩ current sense resistor on the output of Channel 6 in the GUI.



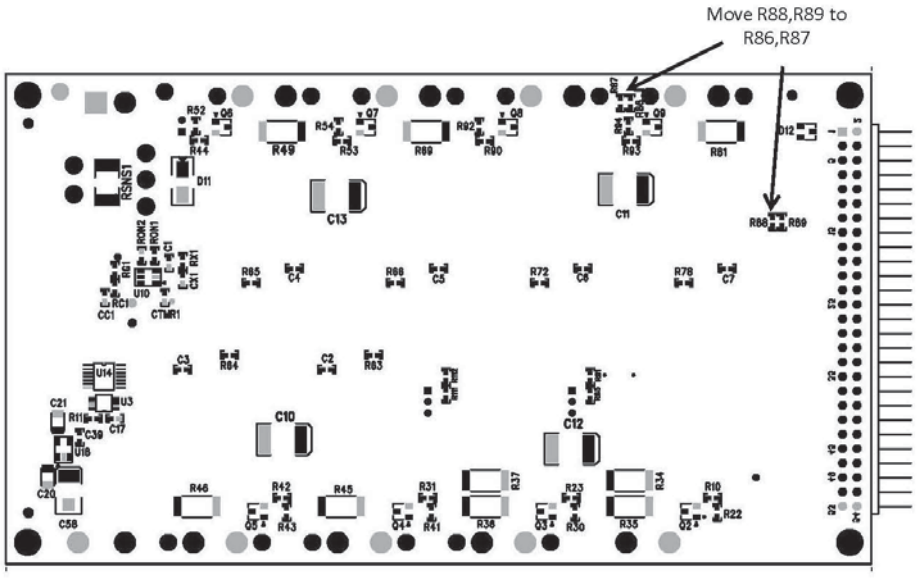


Figure 11. Current Sensing Modifications (Bottom Side of Board)

COMMON DEMO BOARD OPERATIONS

Reset the LTC2978

To reset the LTC2978 and reload the EEPROM contents into operating memory (RAM), press SW3.

DC1360A LEDs

The Red ALERTB LED indicates a fault has occurred. The Green LED indicates the status of the PWRGD signal.

DC1361A Remote Sense

Remote sense Test Points are included for channels 1-7. There is no remote sense for Channel 0.

Faulting an Output

Use a jumper wire or a coin to short any output. For an OV fault, short a lower voltage to a higher one momentarily.

Fault Sharing Setup in GUI

Use the Fault Sharing Diagram Tool to setup the fault sharing in the GUI. Before doing so, view the fault sharing Demo in the GUI. Go to Tools > Fault Sharing Diagram.

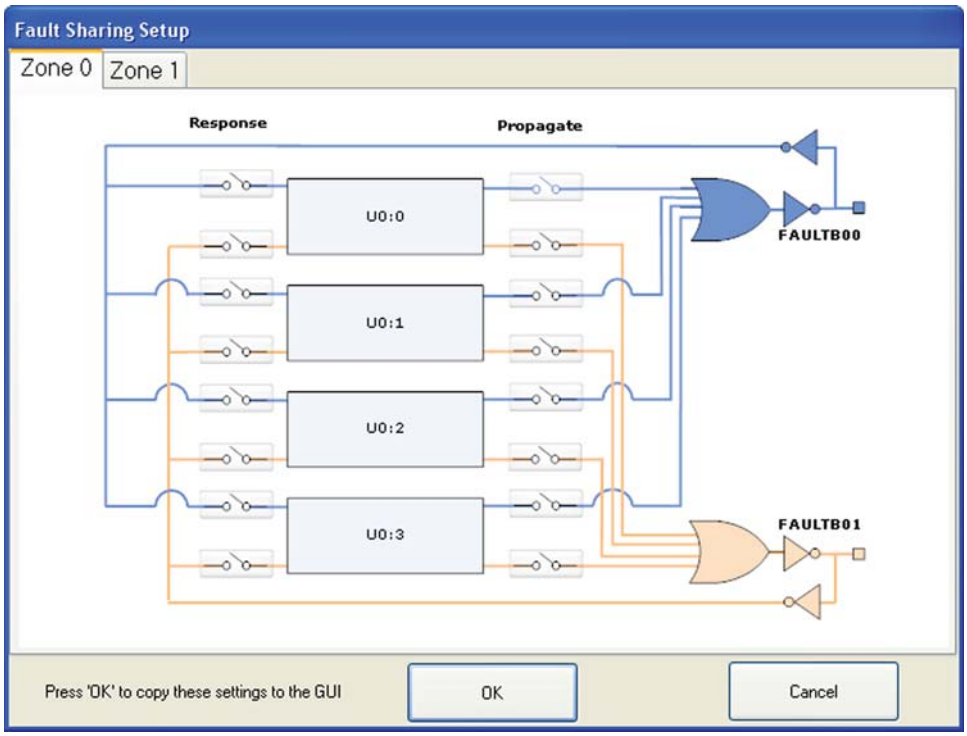


Figure 12. GUI Fault Sharing Setup Tool

FAULT ZONE CONFIGURATION AND FAULT PROPAGATION

The LTC2978 has four FAULTB pins within two fault zones. Each channel can pull FAULTB pins within its zone low. Also, any channel can shutdown in response to FAULTB pins within its zone, therefore, dependencies between any channel(s) can be established. See Applications section of the datasheet. See Figure below. Zone 0 and 1 are tied together on the DC1360A through R9. Therefore, any channel can shut off in response to any other channel on the LTC2978. Additionally, each FAULTBz pin ties to a FAULTn (n =1,2,3,4) line on the DC1360A which is bussed to other DC1360A's in a multiboard array. Therefore, it is possible for any channel in an array to shutoff in response to any other channel.

FAULTn lines are on p.2 DC1360A schematic J2, J3.

To disconnect Fault zone 0 from Fault zone 1, remove R9 on DC1360A.

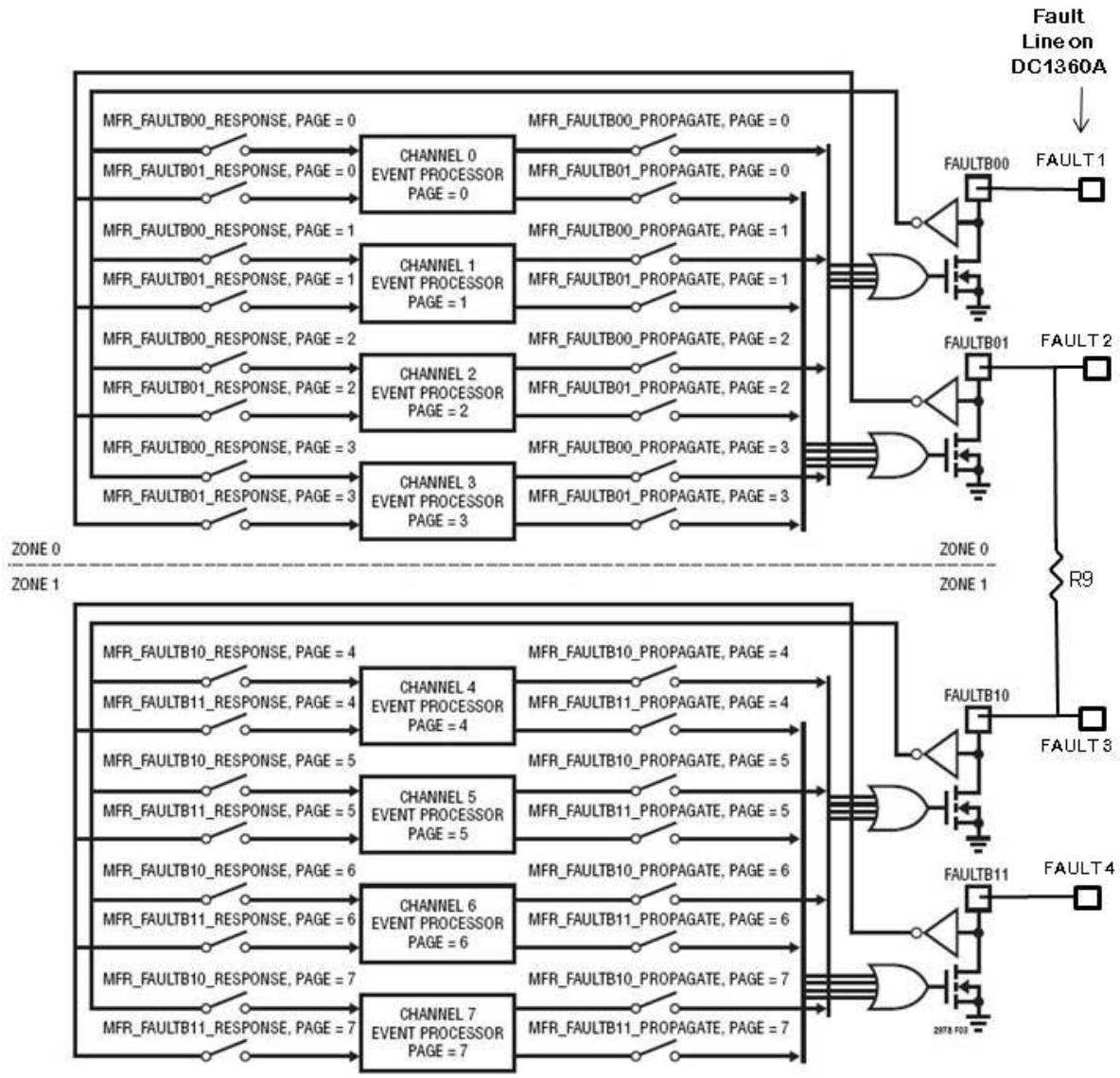


Figure 13. Fault Zones and Fault Pins on DC1360A

SETUP PROCEDURE FOR MULTI-BOARD ARRAYS

Multiple DC1540As can be combined to control as many output voltages as desired.

1. Connect DC1360A's to DC1361A's.
2. Solder wires from the +12V and GND turrets of Master DC1361A and connect into the terminal block of the Slave board.
3. Leave JP1 INSTALLED in the first (Master) board. Remove JP1 jumpers from all others (Slaves).
4. Plug DC1360A's together. J3 to J2.
5. Set the Master/Slave switch on the first DC1361A in the array to Master. Set other boards to Slave.
6. Set a unique address for each LTC2978 in the array using ASEL0 (JP3) and ASEL1 (JP2).
7. Plug the ribbon cable of the DC1427A into J4 OR DC1613 into J6 of any DC1360A.
8. Hook up power supply (5-14V, at least 0.5A times the number of boards) to J11 Terminal Block to power the array of modules.

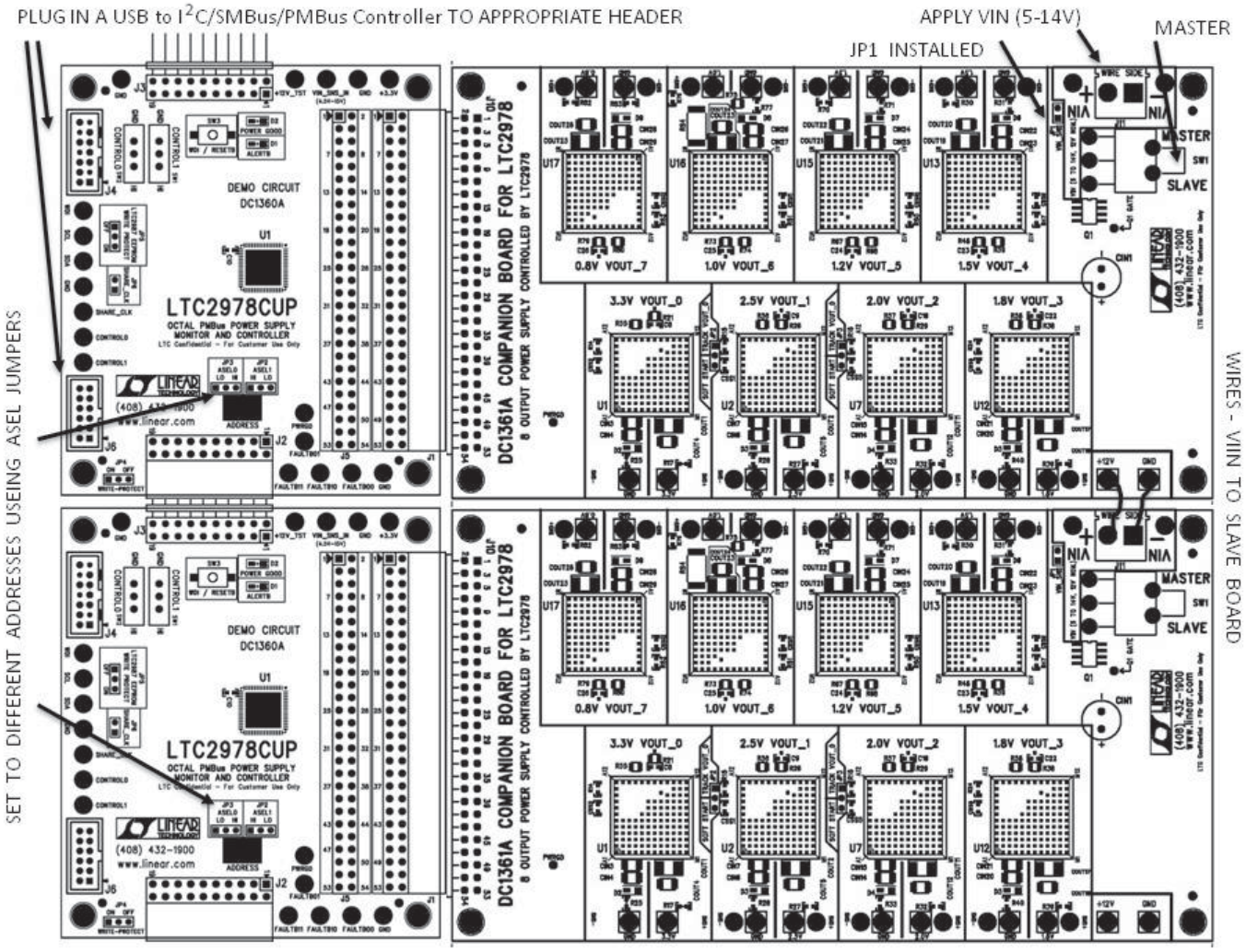
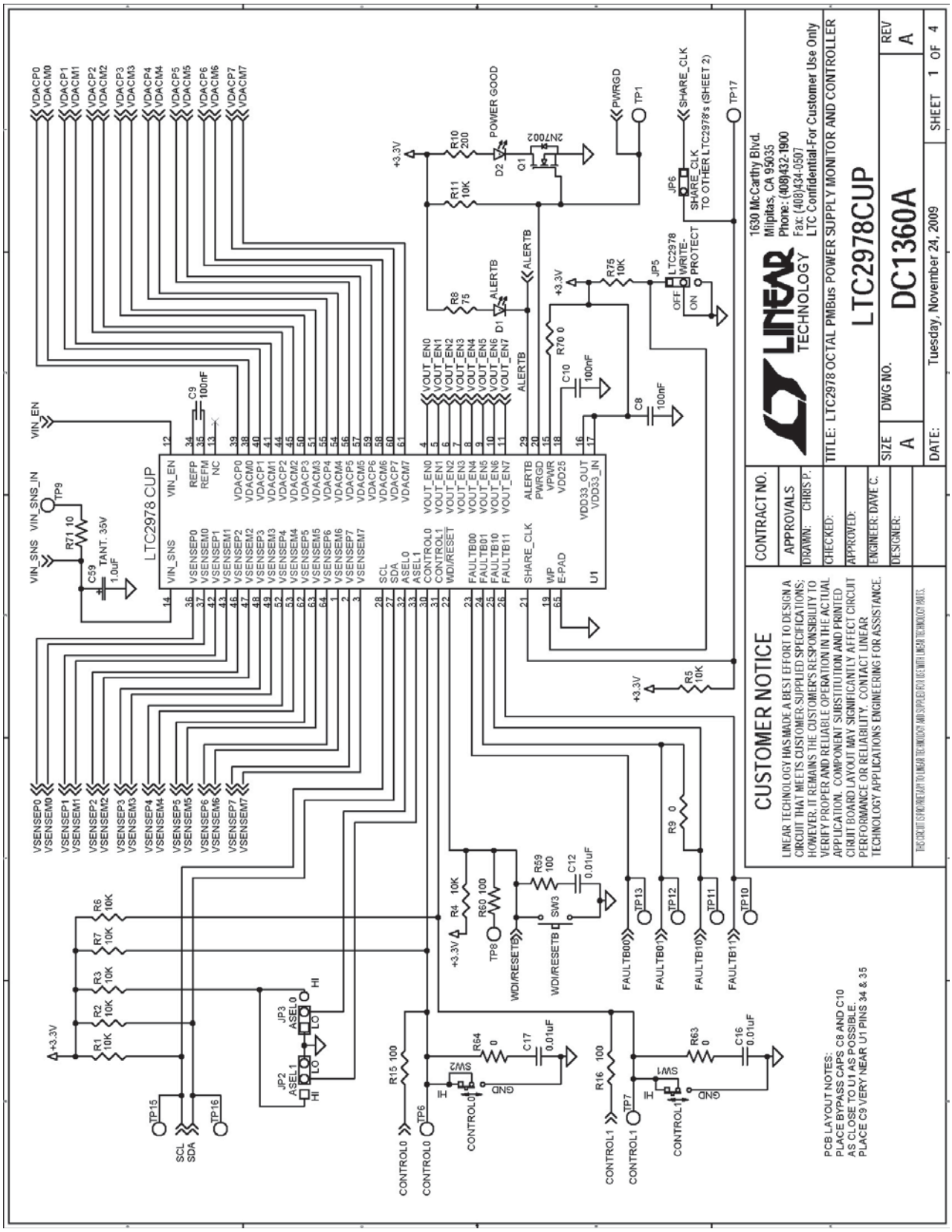


Figure 14. Array of Multiple Demo Boards

SCHEMATIC DIAGRAM



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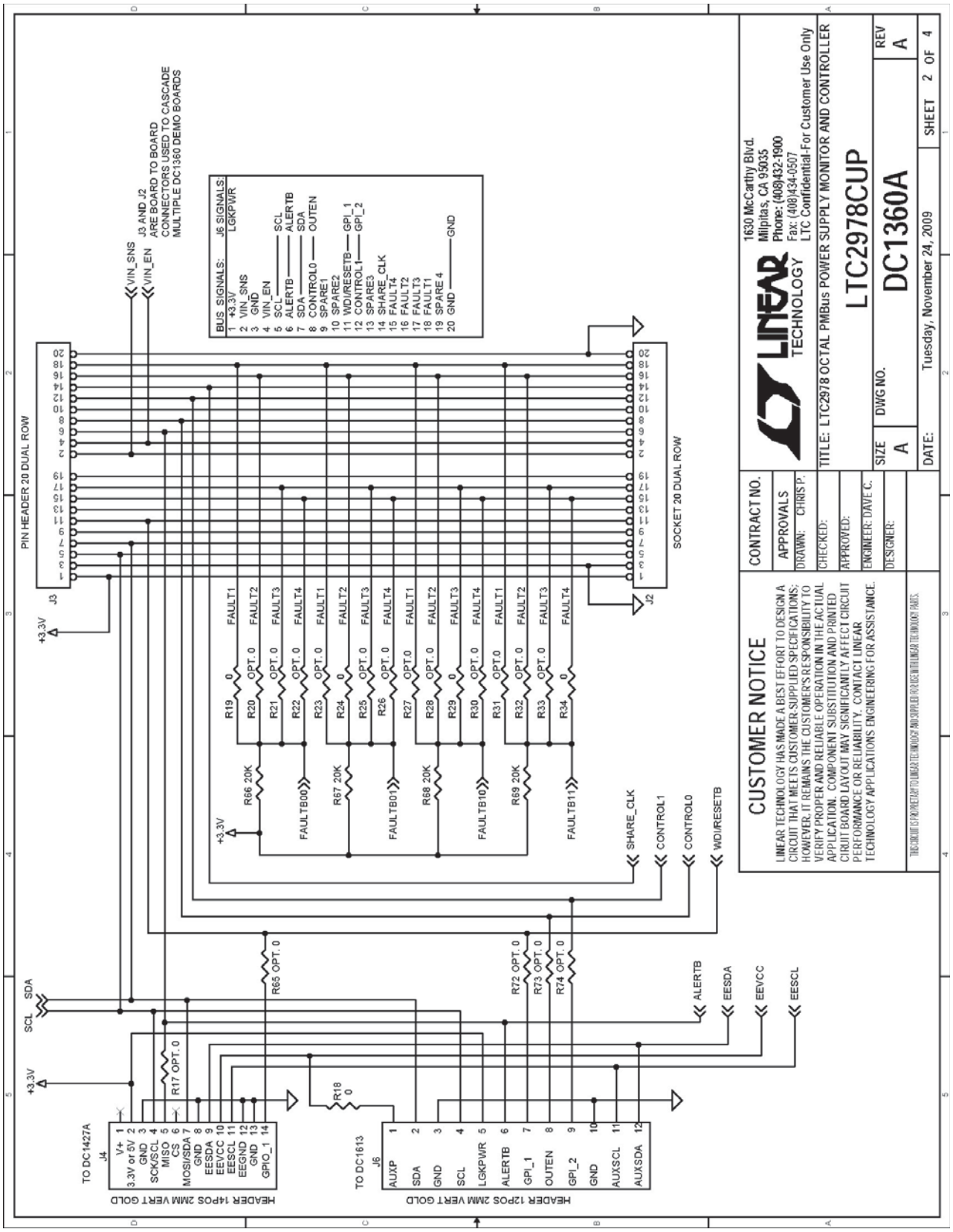

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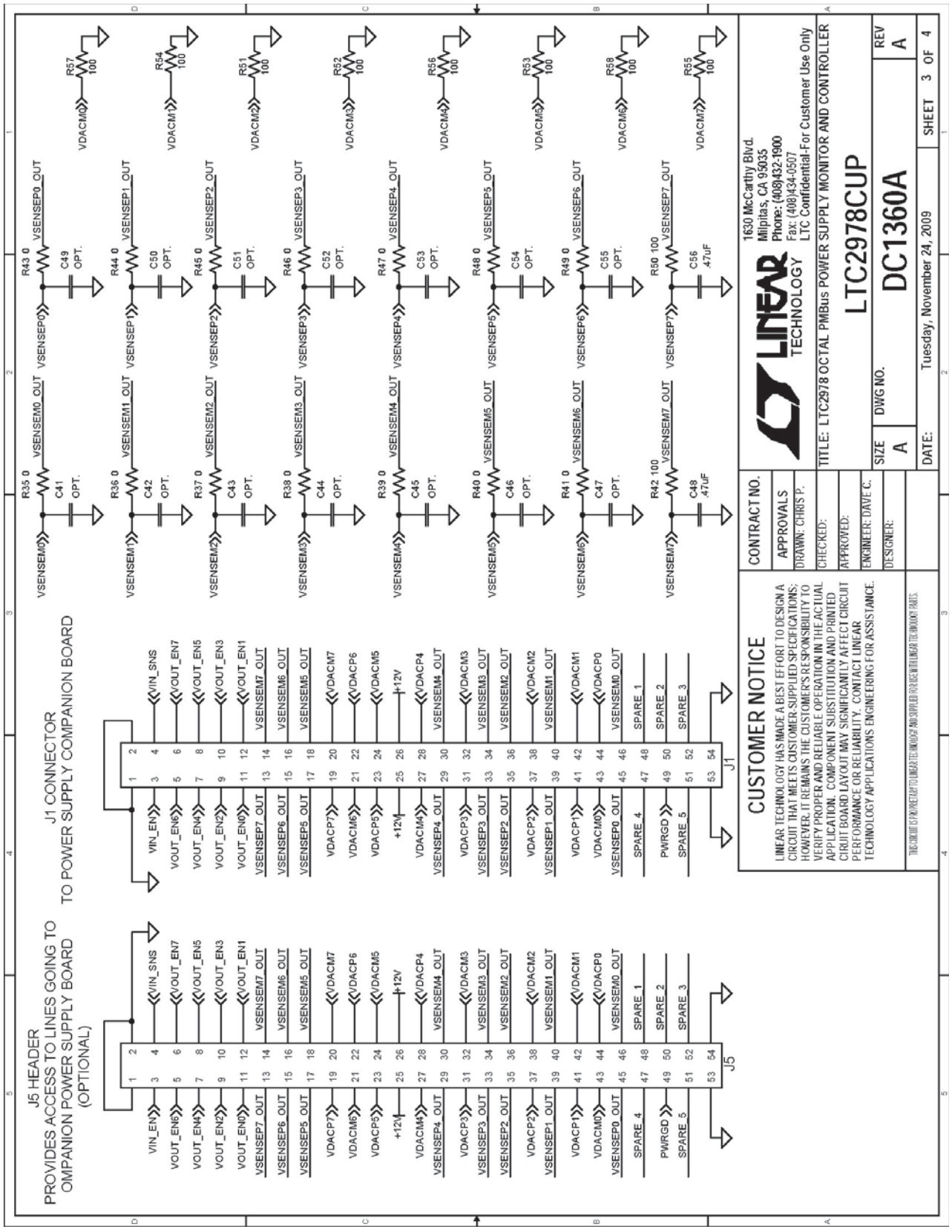
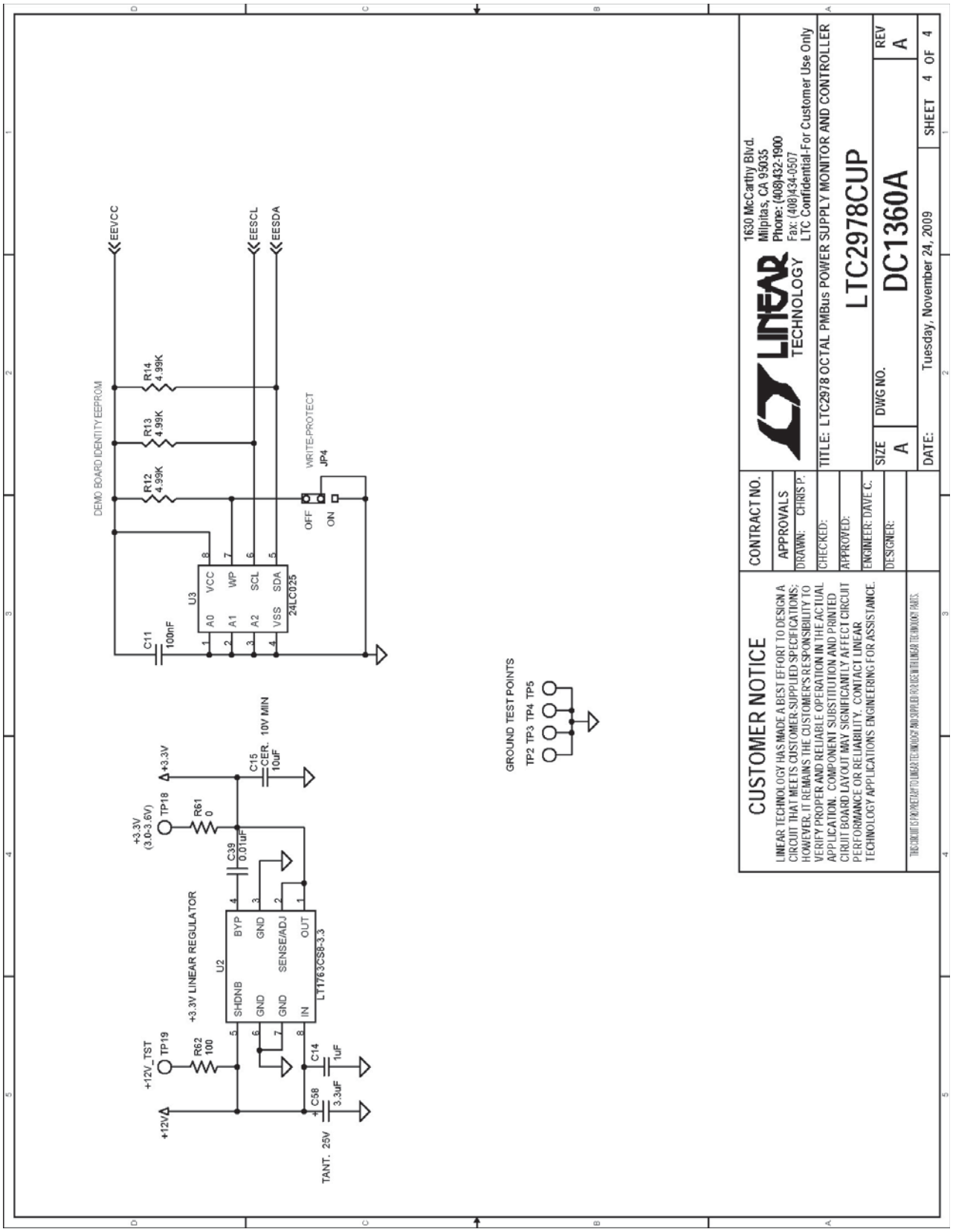


SCHEMATIC DIAGRAM



PARTS LIST

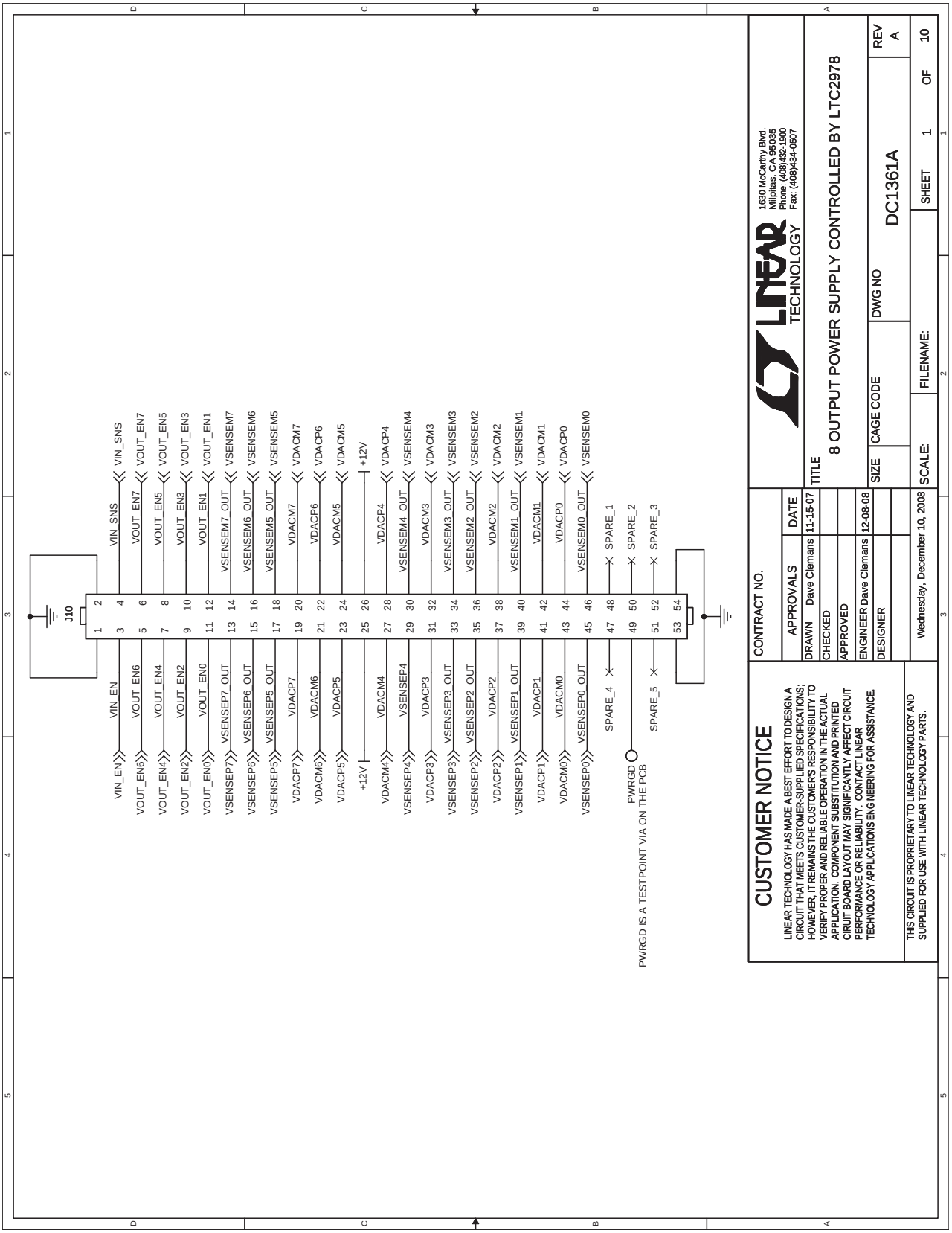
Linear Technology Corporation

LTC2978CUP

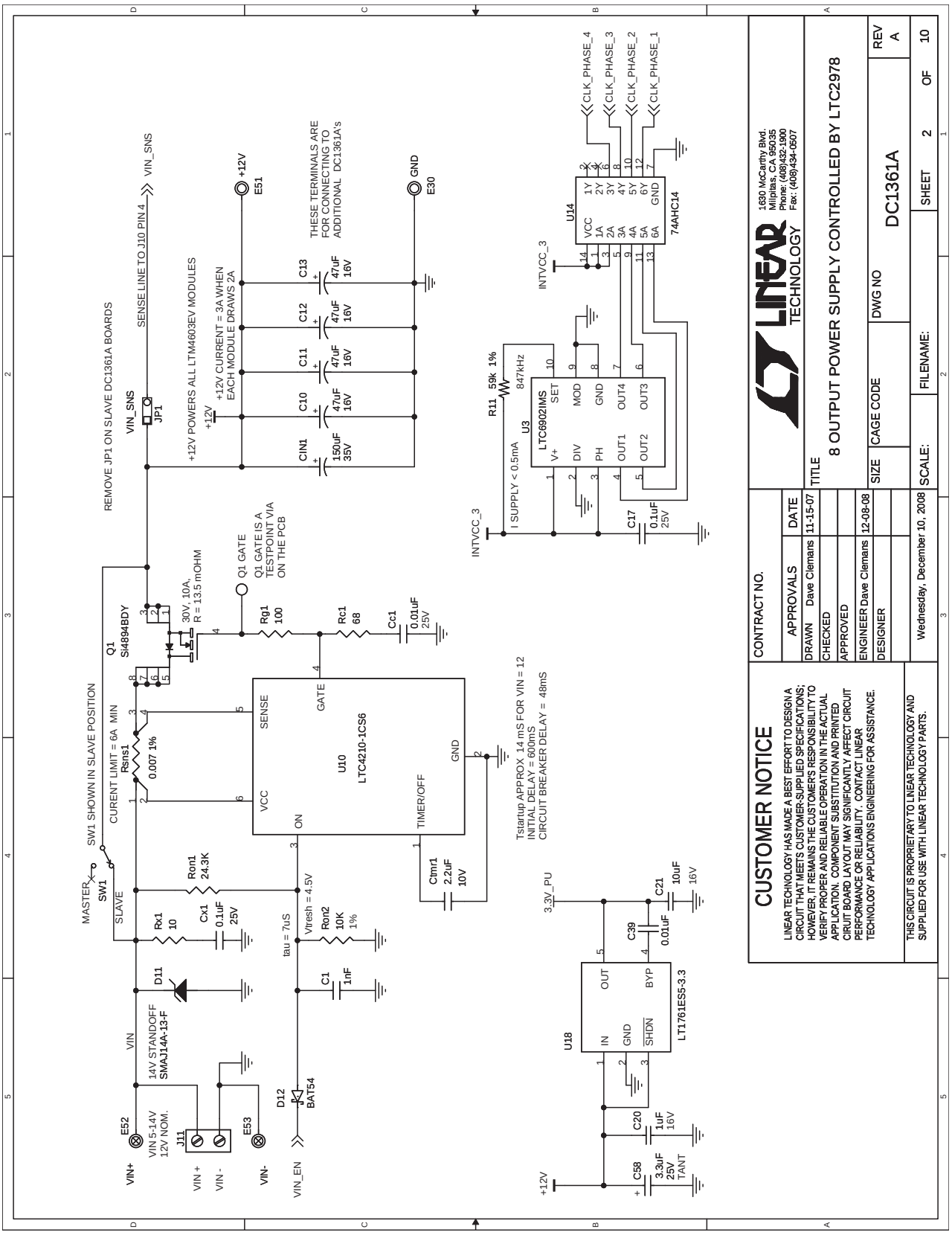
Bill Of Material
Demo Bd. #1360A

Item	Qty	Reference	Part Description	Manufacturer / Part #
REQUIRED CIRCUIT COMPONENTS[1]				
1	1	U1	IC 8CH SUPRVSR, MON, MARGIN CTRLR	LINEAR TECH LTC2978CUP
2	3	C8,C9,C10	CAP CERM .10UF 20% 16V X7R 0603	AVX 0603YC104MAT2A
3	6	R1,R2,R4,R5,R11,R75	RES 10K OHM 1/10W 5% 0603 SMD	VISHAY CRCW060310K0JNEA
ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS[2]				
4	2	C48,C56	CAP CERM .47UF 10% 16V X5R 0603	AVX 0603YD474KAT2A
5	4	C12,C16,C17,C39	CAP CERM .01UF 10% 50V X7R 0603	AVX 06035C103KAT2A
6	1	C11	CAP CERM .10UF 20% 16V X7R 0603	AVX 0603YC104MAT2A
7	2	C14,C15	CAP CERM 1UF 10% 25V X7R 1206	AVX 12063C105KAT2A
8	1	C58	CAP TANTALUM 3.3UF 25V 20% SMD	AVX TAJC335M025R
9	1	SW3	SWITCH TACT MINI PB SPST SLV GWING	C&K KSR211GLFS
10	1	D1	LED 637NM RED DIFF SMD 0805	PANASONIC LN1271RTR
11	1	D2	LED GREEN CLEAR 560NM 0805 SMD	Panasonic LN1371SGTRP
12	2	SW1,SW2	SWITCH SLIDE SPDT 30V.2A PC MNT	E-SWITCH EG1218
13	1	Q1	MOSFET N-CH 60V 115MA SOT-23	FAIRCHILD 2N7002_NL
14	1	C59	CAP TANTALUM 1.0UF 35V 20% SMD	KEMET B45196H6105M109
15	1	U2	IC REG 3.3V 100MA LDO LN SOT23-5	LINEAR TECH LT1763CS8-3.3
16	1	U3	IC, SERIAL EEPROM	MICROCHIP 24LC025-I/ST
17	19	R18,R9,R35,R36,R37,R38,R39, R40,R41,R43,R44,R45, R46,R47,R48,R49,R61, R63, R64,R70	RES 0.0 OHM 1/10W 5% 0603 SMD	Vishay CRCW06030000Z0EA
18	14	R15,R16,R42,R50-60,R62	RES 100 OHM 1/10W 1% 0603 SMD	VISHAY CRCW0603100RFKEA
19	3	R3,R6,R7	RES 10K OHM 1/10W 5% 0603 SMD	VISHAY CRCW060310K0JNEA
20	1	R71	RES 10 OHM 1/10W 1% 0603 SMD	VISHAY CRCW060310RFKEA
21	1	R10	RES 200 OHM 1/10W 1% 0603 SMD	VISHAY CRCW0603200RFKEA
22	1	R08	RES 75 OHM 1/10W 5% 0603 SMD	VISHAY CRCW060375R0JNEA
23	4	R66,R67,R68,R69	RES 20K OHM 1/10W 5% 0603 SMD	VISHAY CRCW060320K0JNEA
24	3	R12,R13,R14	RES 4.99K OHM 1/10W 1% 0603 SMD	VISHAY CRCW06034K99FKEA
25	3	R19,R24,R29,R34	RES 0.0 OHM 1/8W 5% 0805 SMD	VISHAY CRCW08050000Z0EA
HARDWARE-FOR DEMO BOARD ONLY:				
26	4	MTG1,MTG2,MTG3,MTG4	STAND-OFF NYLON 1/4" SNAP IN	KEYSTONE 8831
27	18	TP01-TP13,TP15-TP19	TP TURRET SMALL FOR .063 HOLE	MILL-MAX 2308-2-00-44-00-00-07-0
28	1	J3	PIN HEADER 20 DUAL ROW RA	MILL-MAX 802-40-020-20-001
29	1	J2	CONN SOCKET 20 DUAL ROW RA	MILL-MAX 803-93-020-20-001
30	1	J6	CONN HEADER 12POS 2MM STR DL PCB	FCI 98414-G06-12ULF
31	1	J4	HEADER 14POS 2MM VERT GOLD	MOLEX 87831-1420
32	5	JP2-SH,JP3-SH,JP4-SH, JP5-SH,JP6-SH	CONN SHUNT 2MM 2POS GOLD BLACK	SAMTEC 2SN-BK-G
33	1	J1	CONN FEMALE 54POS DL .1 R/A TIN	SULLINS PPTC272LJBN-RC
34	0	Opt	CONN HDR BRKWAY OPT	OPTION
35	0	R72,R73,R74	RES 0.0 OHM 1/8W 5% 0805 SMD	OPTION
Notes:				
	1.	Required Circuit Components are those parts that are required to implement the circuit function		
	2.	Additional Demo Board Circuit Components are those parts that provide added functionality		
		for the demo board butare not required in the actual circuit.		

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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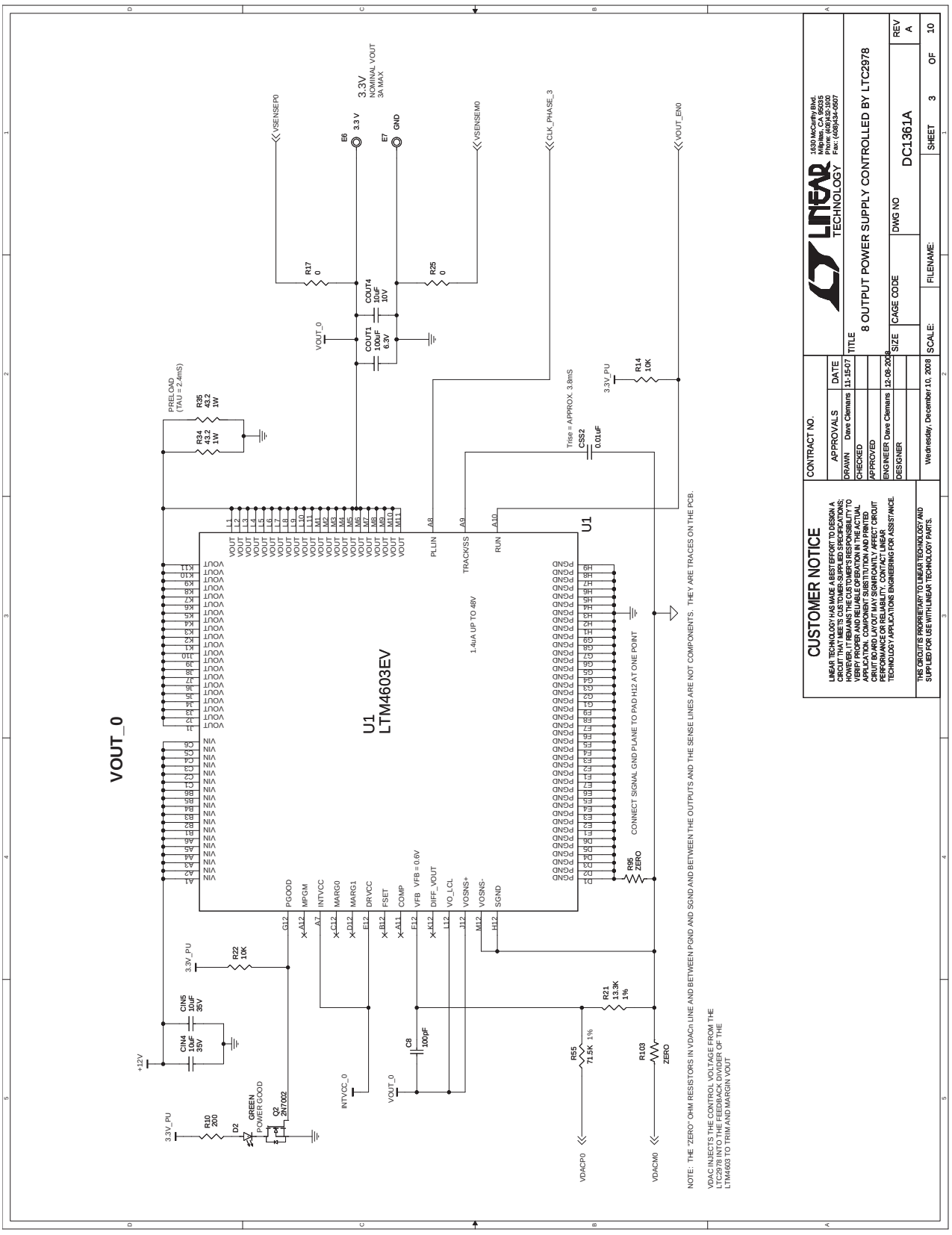
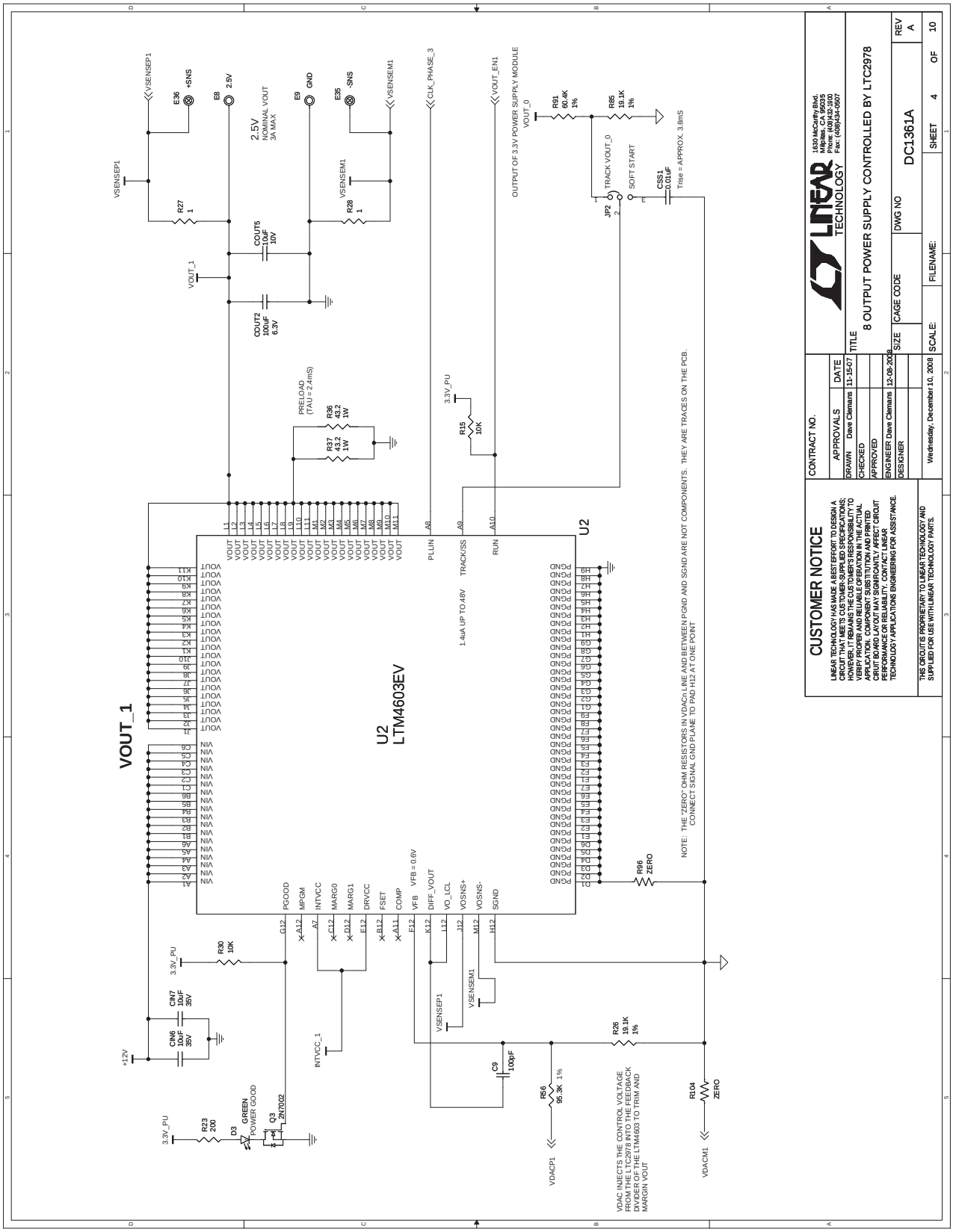
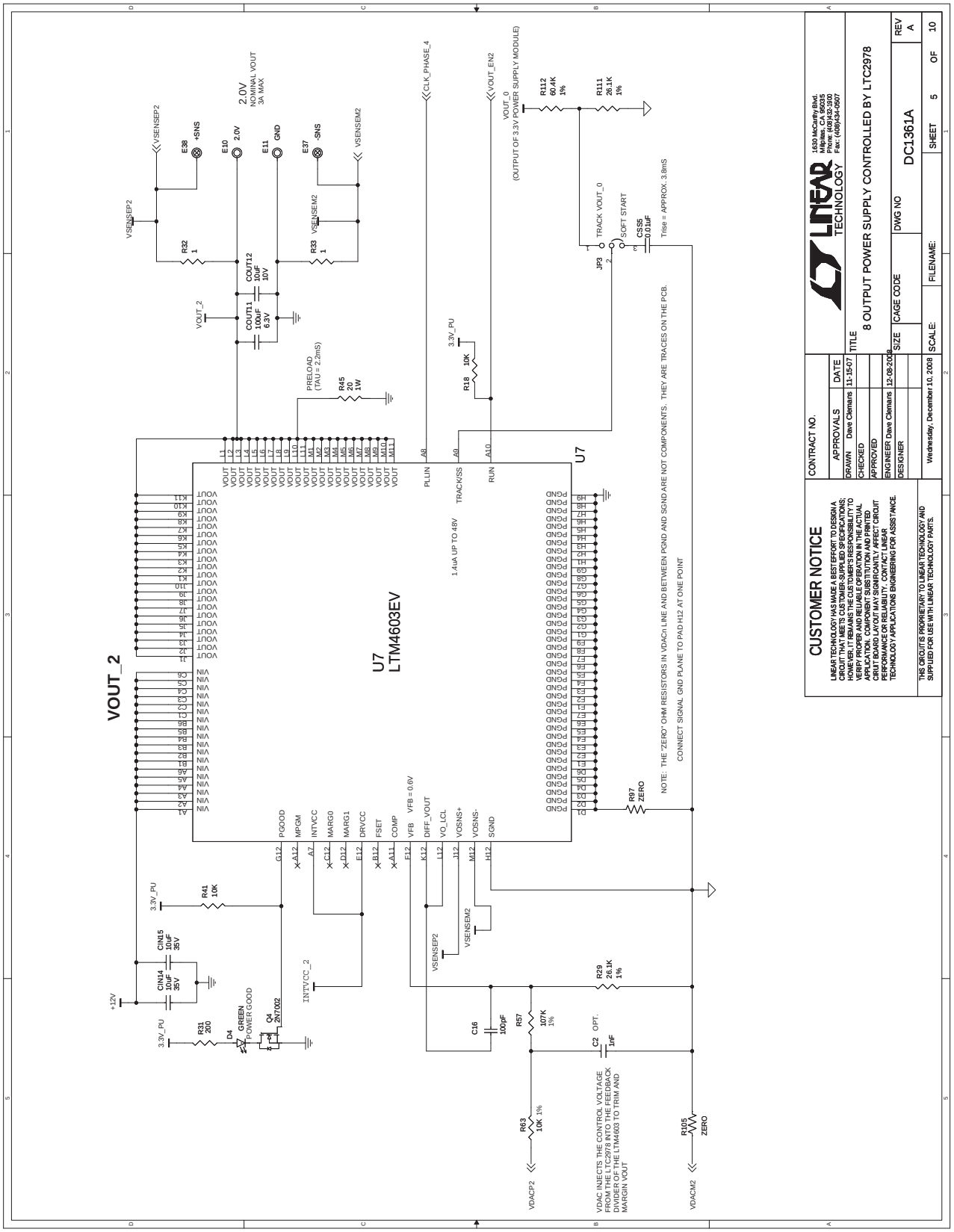


SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



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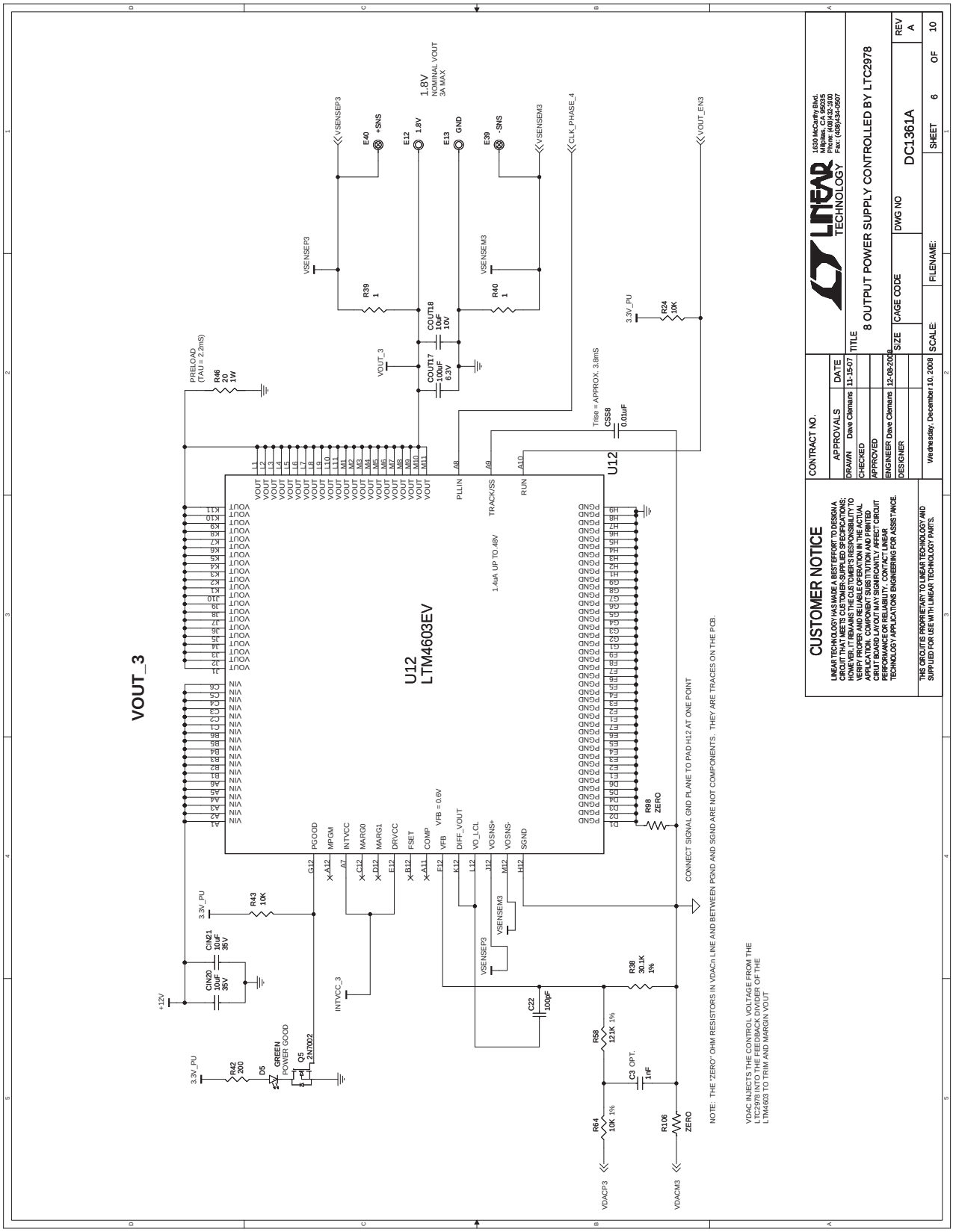

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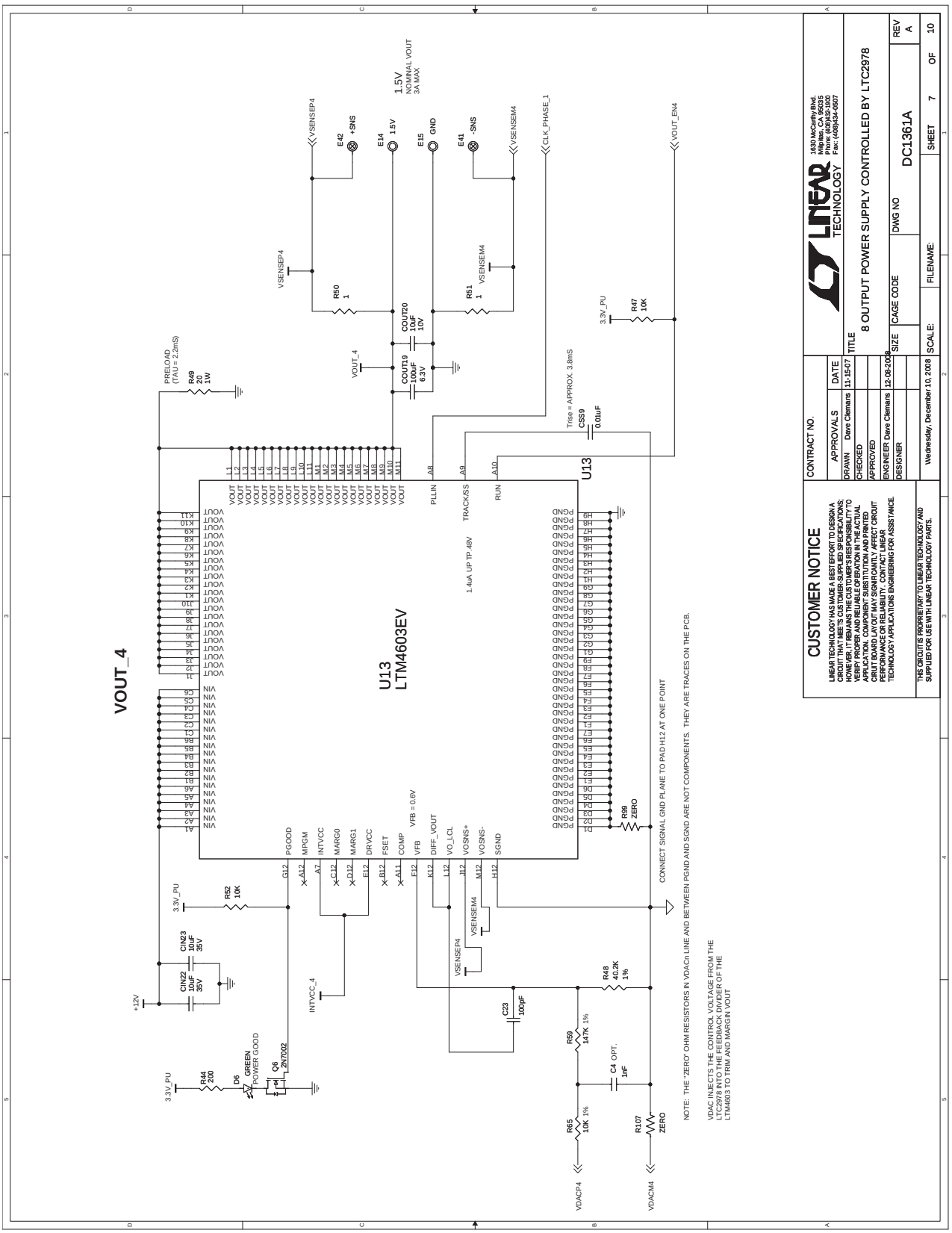

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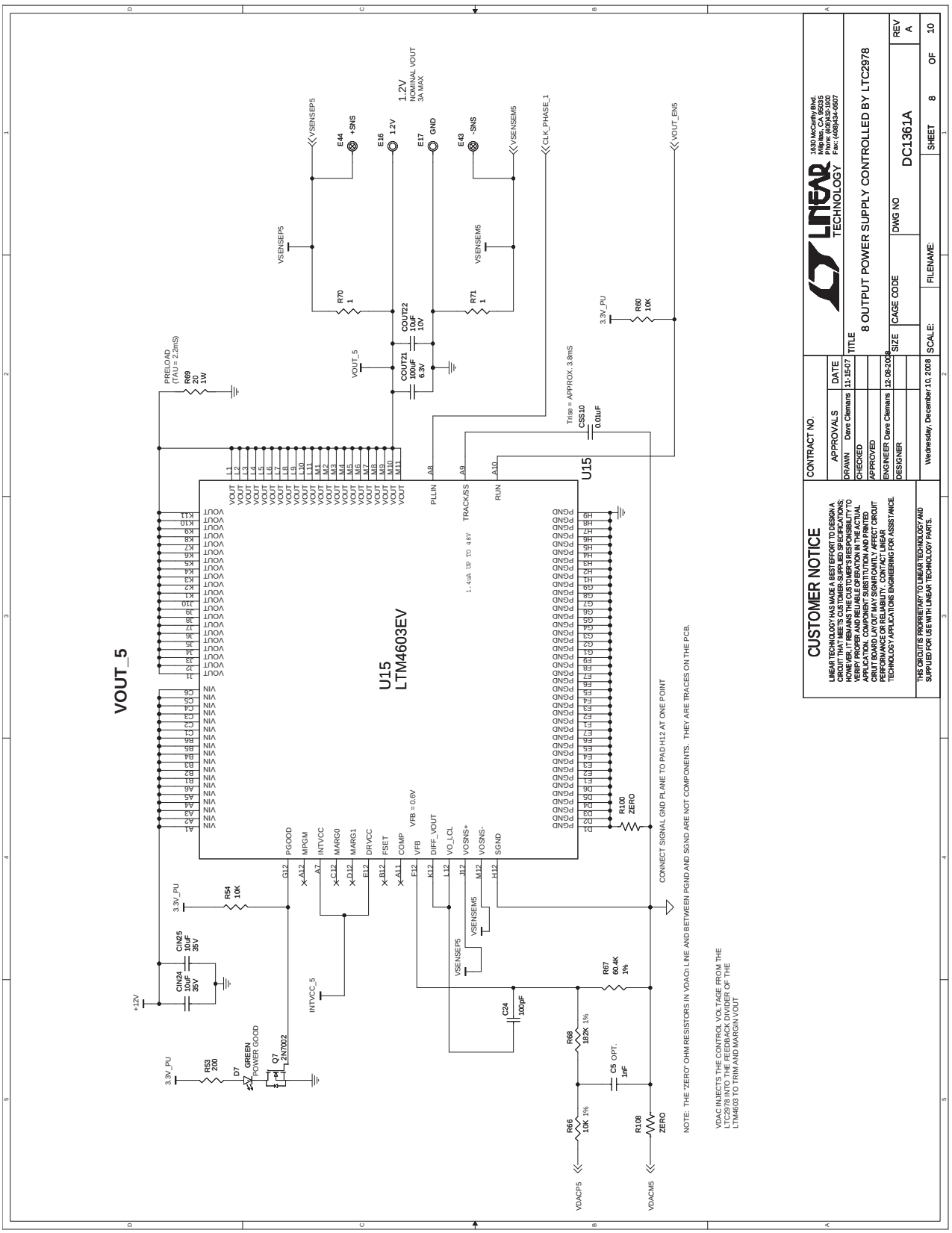

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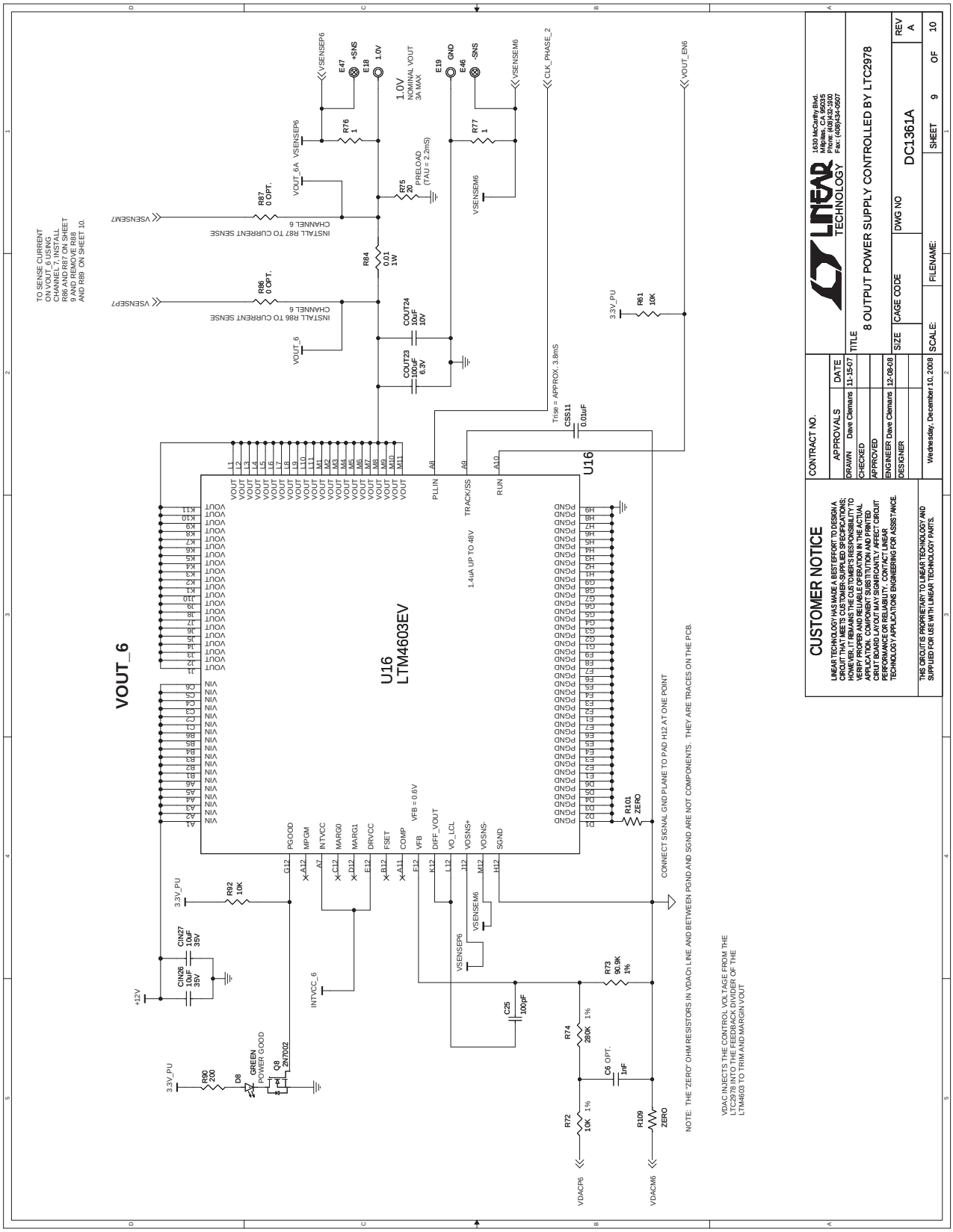

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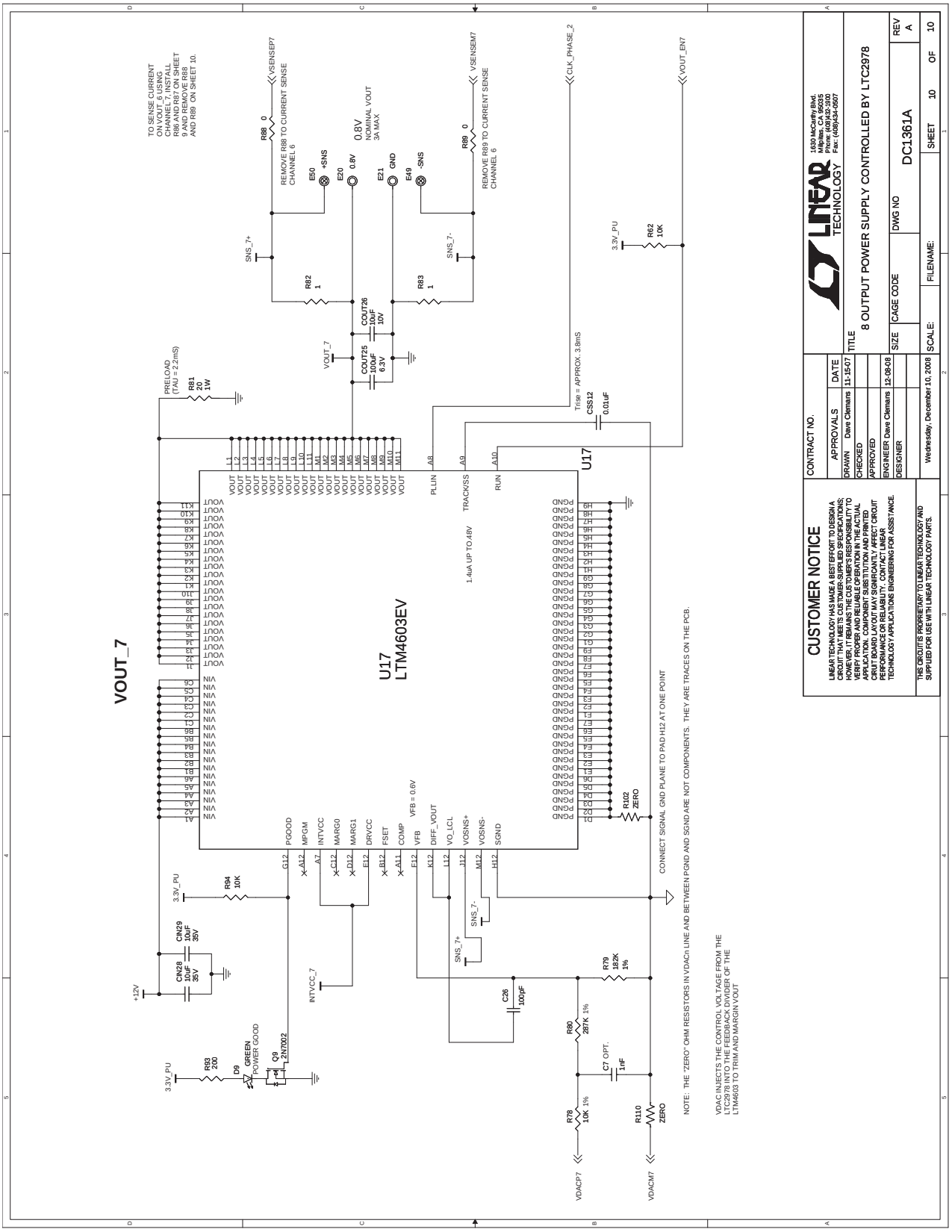

PARTS LIST

Linear Technology Corporation

Bill Of Material
Demo Bd. #1361A

Item	Qty	Reference	Part Description	Manufacturer / Part #
REQUIRED CIRCUIT COMPONENTS[1]				
	DC1361A is only a companion board to the DC1360A. None of these parts are required for LTC2978 operation.			
ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS[2]				
1	4	C10,C11,C12,C13	CAP, TANT 47UF 16V 20% SMD 7343-31	KEMET_T520D476M016ATE035
2	1	C20	CAP CERM 1.0UF 10% 16V X7R 1206	AVX_1206YC105KAT2A
3	25	C21,COUT4,CIN4,COUT5,CIN5, CIN6,CIN7,COUT12,CIN14,CIN15,COU T18,COUT20,CIN20,CIN21, COUT22,CIN22,CIN23,COUT24, CIN24,CIN25,COUT26,CIN26, CIN27,CIN28,CIN29	CAP CER 10UF 16V X7R 20% 1206	TDK_C3216X7R1C106M
4	10	C39,Cc1,CSS1,CSS2,CSS5, CSS8,CSS9,CSS10,CSS11, CSS12	CAP, 0603, .01uF 20% 25V, X7R	MURATA_GRM188R71E103KA01D
5	1	C58	CAP TANTALUM 3.3UF 25V 20% SMD	AVX_ TAJC335M025R
6	8	C8,C9,C16,C22-C26	CAP, 0603, 100pF 10% 25V, NPO	AVX_06033A101KAT2A
7	1	CIN1	CAP, 150uF 20% 35V ALUM	SANYO_35ME150WXV+TS
8	8	COUT1,COUT2,COUT11,COUT17,COU T19,COUT21,COUT23, COUT25	CAP CER 100UF 6.3V X5R 1210	AVX_12106D107KAT2A
9	1	Ctmr1	CAP CER 2.2UF 10V X7R 0603	MURATA_GRM188R71A225KE15D
10	2	Cx1,C17	CAP, 0603, .1uF 20% 25V, X5R	AVX_06033D104MKAT2A
11	1	C1	CAP, 0603, 1000pF 50V 10% X7R	AVX_06035A102KAT2A
12	1	D11	TVS UNIDIRECT 14V 400W SMA	DIODES INC._SMAJ14A-13-F
13	1	D12	DIODE SCHOTTKY 30V 200MW SOT23	DIODES INC. BAT54-7-F
14	8	D2,D3,D4,D5,D6,D7,D8,D9	LED GREEN 565NM 0805 SMD	PANASONIC_LN1371SGTRP
15	1	Q1	MOSFET N-CH 30V 8.9A 8-SOIC	VISHAY_Si4894BDY
16	8	Q2,Q3,Q4,Q5,Q6,Q7,Q8,Q9	MOSFET N-CH 60V 300MA SOT-23	VISHAY_2N7002K-T1-E3
17	8	R10,R23,R31,R42,R44,R53,R90, R93	RES 200 OHM 1/10W 5% 0603 SMD	YAGEO_RC0603JR-07200RL
18	1	R11	RES 59.0K OHM 1/10W 1% 0603 SMD	VISHAY_CRCW060359K0FKEA
19	1	R111	RES 26.1K OHM 1/10W 1% 0603 SMD	VISHAY_CRCW060326K1FKEA
20	1	R21	RES 13.3K OHM 1/10W 1% 0805 SMD	VISHAY_CRCW080513K3FKEA
21	8	R22,R30,R41,R43,R52,R54,R92, R94	RES 10K OHM 1/10W 5% 0603 SMD	YAGEO_RC0603JR-0710KL
22	1	R26	RES 19.1K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW080519K1FKEA
23	14	R27,R28,R32,R33,R39,R40,R50, R51,R70,R71,R76,R77,R82,R83	RES 1.0 OHM 1/10W 5% 0603 SMD	VISHAY_ CRCW06031R00JNEA
24	1	R29	RES 26.1K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW080526K1FKEA
25	4	R34,R35,R36,R37	RES 43.2 OHM 1W 1% 2512 SMD	PANASONIC_ ERJ-1TNF43R2U
26	1	R38	RES 30.1K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW080530K1FKEA
27	5	R45,R46,R49,R69,R81	RES 20.0 OHM 1W 1% 2512 SMD	PANASONIC_ERJ-1TNF20R0U
28	1	R48	RES 40.2K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW080540K2FKEA
29	1	R55	RES 71.5K OHM 1/8W 1% 0805 SMD	PANASONIC ERJ-6ENF7152V
30	1	R56	RES 95.3K OHM 1/8W 1% 0805 SMD	PANASONIC ERJ-6ENF9532V
31	1	R57	RES 107K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW0805107KFKEA
32	1	R58	RES 121K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW0805121KFKEA
33	1	R59	RES 147K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW0805147KFKEA
34	1	R67	RES 60.4K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW080560K4FKEA

PARTS LIST

Linear Technology Corporation

Bill Of Material
Demo Bd. #1361A

Item	Qty	Reference	Part Description	Manufacturer / Part #
35	2	R68,R79	RES 182K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW0805182KFKEA
36	1	R73	RES 90.9K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW080590K9FKEA
37	1	R74	RES 280K OHM 1/8W 1% 0805 SMD	VISHAY_ CRCW0805280KFKEA
38	1	R75	RES 20 OHM 1/8W 5% 0805 SMD	VISHAY_CRCW080520R0JNEA
39	1	R80	RES 287K OHM 1/8W 1% 0805 SMD	VISHAY_CRCW0805287KFKEA
40	1	R84	RESISTOR .010 OHM 1W 1% 2512	PANASONIC_ERJ-M1WSF10MU
41	1	R85	RES 19.1K OHM 1/10W 1% 0603 SMD	VISHAY_ CRCW060319K1FKEA
42	2	R88,R89	RES 0.0 OHM 1/10W 5% 0603 SMD	VISHAY_CRCW06030000Z0EA
43	2	R91,R112	RES 60.4K OHM 1/10W 1% 0603 SMD	VISHAY_CRCW060360K4FKEA
44	1	Rc1	RES 68 OHM 1/10W 5% 0603 SMD	VISHAY_CRCW060368R0JNEA
45	1	Rg1	RES 100 OHM 1/10W 5% 0603 SMD	VISHAY_CRCW0603100RJNEA
46	1	Ron1	RES 24.3K OHM 1/10W 1% 0603 SMD	VISHAY_CRCW060324K3FKEA
47	15	Ron2,R14,R15,R18,R24,R47,R60,R61, R62,R63,R64,R65,R66,R72, R78	RES, 10K OHM 1/10W 1% 0603 SMD	VISHAY_CRCW060310K0FKEA
48	1	Rsns1	RES .007 OHM 1W 1% 2512 SMD	VISHAY_WSL25127L000FEA
49	1	Rx1	RES 10 OHM 1/10W 5% 0603 SMD	VISHAY_CRCW060310R0JNEA
50				
51	8	U1,U2,U7,U12,U13,U15,U16,U17	IC, uMODULE, POWER SUPPLY	LINEAR TECH_LTM4603EV
52	1	U10	IC, uCIRCUIT	LINEAR TECH_LTC4210-1CS6
53	1	U14	IC, HEX SCHMITT-TRIG INV 14TSSOP	TEXAS INS._SN74AHC14PWR
54	1	U18	IC, uCIRCUIT	LINEAR TECH_LT1761ES5-3.3
55	1	U3	IC, uCIRCUIT	LINEAR TECH_LTC6902IMS
HARDWARE-FOR DEMO BOARD ONLY:				
56	3	JP1 JP2 JP3	SHUNT 2MM	SAMTEC, 2SN-BK-G
57	16	E35,E37,E39,E41,E43,E46,E49, E36,E38,E40,E42,E44,E47,E50, E52,E53	TURRET, Testpoint	MILL-MAX 2308-2-00-80-00-00-07-0
58	18	E6,E7,E8,E9,E10,E11,E12,E13, E14,E15,E16,E17,E18,E19,E20, E21,E30,E51	TURRET, Testpoint	MILL-MAX 2501-2-00-80-00-00-07-0
59	1	J10	CONN HEADER 72PS .100 R/A 15GOLD	FCI_68021-272HLF
60	1	J11	TERMINAL BLOCK 5MM 2POS PCB	ON-SHORE-TECH_ED700/2
61	1	JP1	CONN HDR 2MM MALE 1ROW 2POS	COMM CON 2802S-02G2
62	2	JP2,JP3	CONN HDR 2MM MALE 1ROW STR 3POS	COMM CON 2802S-03G2
63	4	MTG1,MTG2,MTG3,MTG4	STAND-OFF NYLON 1/4" SNAP IN	KEYSTONE 8831
64	1	SW1	SWITCH TOG. SPDT RT ANGLE	C&K_E101MD1AQE
65	3	JP1 JP2 JP3	SHUNT 2MM	SAMTEC, 2SN-BK-G
	Notes:			
	1.	Required Circuit Components are those parts that are required to implement the circuit function		
	2.	Additional Demo Board Circuit Components are those parts that provide added functionality		
		for the demo board butare not required in the actual circuit.		

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:

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