

# LTC4266A

## Quad LTPoE++ PSE Controller

### DESCRIPTION

Demonstration circuit 1815A features the **LTC®4266A** quad power sourcing equipment (PSE) controller, capable of delivering up to 90W of LTPoE++™ power to a compatible LTPoE++ powered device (PD). A proprietary detection/classification scheme allows mutual identification between an LTPoE++ PSE and LTPoE++ PD while remaining compatible and interoperable with existing Type 1 (13W) and Type 2 (25.5W) PDs. The LTC4266A feature set is a superset of the popular LTC4266. These PSE controllers utilize low  $R_{ON}$  external MOSFETs and  $0.25\Omega$  sense resistors which are especially important at the LTPoE++ current levels to maintain the lowest possible heat dissipation.

The LTC4266A is available in multiple power grades, allowing delivered PD power of 13W, 25.5W, 38.7W, 52.7W, 70W and 90W. The DC1815A has four variations DC1815A-A, DC1815A-B, DC1815A-C, and DC1815A-D which accommodate the four LTPoE++ power levels (Table 1).

Advanced power management features of the LTC4266A include: a 14-bit current monitoring ADC, DAC-programmable current limit, and versatile quick port shutdown. Advanced power management host software is available under a no-cost license. PD discovery uses a proprietary dual mode 4-point detection mechanism ensuring excellent immunity from false PD detection. The LTC4266A includes

an I<sup>2</sup>C serial interface operable up to 1MHz. Optional I<sup>2</sup>C control is accessed on the DC1815A either with test points or a 14-pin ribbon cable for DC590 QuikEval™ GUI operation.

The LTC4266A is configurable on the DC1815A as an AUTO pin high, MID pin high, autonomous midspan power injector; input data from an existing network system is sent out, along with power, to a PD. The LTC4266A autonomously detects a PD, turns power on to the port, and disconnects port power without the need for a microcontroller. OUT<sub>n</sub> LEDs indicate that port power is present. A single 55V supply is required to power the DC1815A. A simple LDO regulator circuit on the board powers the digital supply of the LTC4266A. A  $\overline{\text{SHDN}}$  pushbutton for each port shuts down the respective port and disables detection. Pre-programmed masked shutdown ports are shut down with the  $\overline{\text{MSD}}$  pushbutton. A  $\overline{\text{RESET}}$  pushbutton resets the LTC4266A to its AUTO pin logic state. Ports shut down with the SHDN or  $\overline{\text{MSD}}$  pushbutton must be re-enabled via I<sup>2</sup>C or a device reset with the AUTO pin high.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC1815A>**

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**Table 1. DC1815A Power Levels and Power Supply**

| DEMO BOARD | PSE CONTROLLER | MAX DELIVERED PD POWER | POWER SUPPLY* |
|------------|----------------|------------------------|---------------|
| DC1815A-A  | LTC4266A-1     | 38.7W                  | 300W          |
| DC1815A-B  | LTC4266A-2     | 52.7W                  | 300W          |
| DC1815A-C  | LTC4266A-3     | 70W                    | 420W          |
| DC1815A-D  | LTC4266A-4     | 90W                    | 540W          |

\*Recommended DC1815A power supply minimum to avoid drooping in a worst-case scenario with  $I_{LIM}$  current at all four ports. Set the voltage between 54.75V to 57V for LTPoE++ compliance

# DEMO MANUAL DC1815A

## QUICK START PROCEDURE

Demonstration circuit 1815A is easy to set up for evaluating the performance of the LTC4266A. Refer to Figure 1 for proper test equipment setup and follow the procedure below.

1. Set MID jumper JP5 to LO which disables midspan mode.
2. Set AUTO jumper JP4 to HI which enables AUTO pin high mode.
3. Connect a 55V to 57V power supply across AGND (+) and VEE (-). Size the power supply considering the maximum power delivered to the PDs.
4. Connect with an Ethernet cable an 802.3at Type 1 or Type 2, or LTPoE++ compatible PD to one of the four bottom ports of 2x4, RJ45 connector J1.
5. (Optional) For data tests, connect a PHY with an Ethernet cable to one of the four top ports of 2x4, RJ45 connector J1.
6. (Optional) Connect a DC590 via ribbon cable to the DC1814A and via USB to a PC. Open the QuikEval software for I<sup>2</sup>C GUI interfacing.

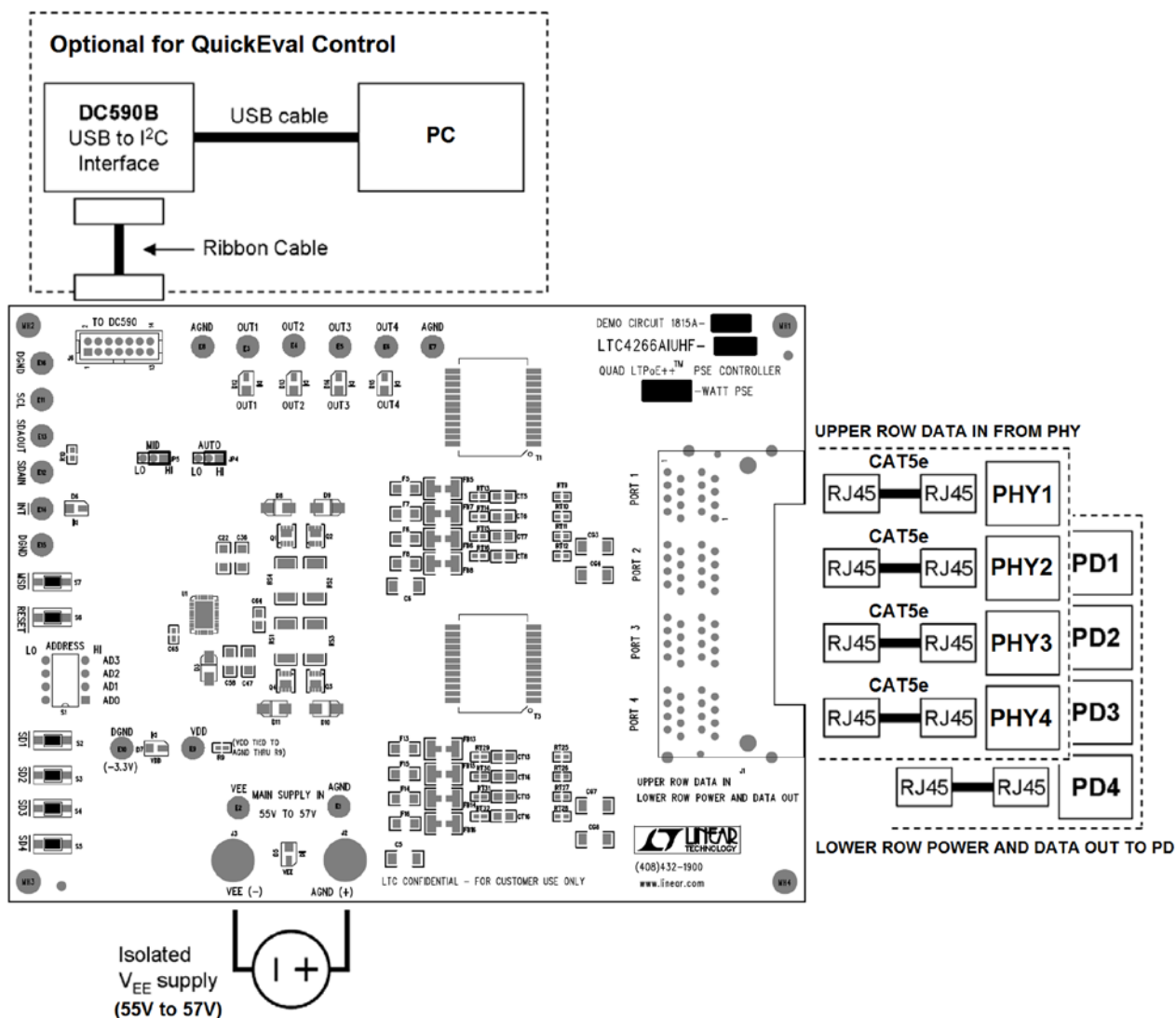


Figure 1. DC1815A Setup

dc1815afd

## OPERATION

### Introduction

The DC1815A demonstrates the features and capabilities of the LTC4266A, a quad controller for LTPoE++ power sourcing equipment. The DC1815A provides a quick and simple PSE solution requiring only a VEE supply.

### Supply Voltages

Select a VEE supply with enough power to sustain all four ports at maximum load. Table 1 shows the maximum delivered PD power of a single port as well as a recommended VEE power supply minimum to avoid drooping in a worst-case scenario with  $I_{LIM}$  current at all four ports.

The LTC4266A also requires a digital 3.3V supply. The DC1815A uses a simple LDO regulator circuit to power the 3.3V digital supply from the VEE supply. The LTC4266A VDD supply is allowed to be within 5V above or below AGND. On the DC1815A, VDD is tied to AGND and DGND is a negative voltage below AGND. D1, R5, Q5, R14, R15, and R25 generate the negative voltage referenced to AGND (Figure 2). These components are sized to handle the power required to supply the LTC4266A and LEDs on the DC1815A. Contact Linear Technology Applications for 3.3V options.

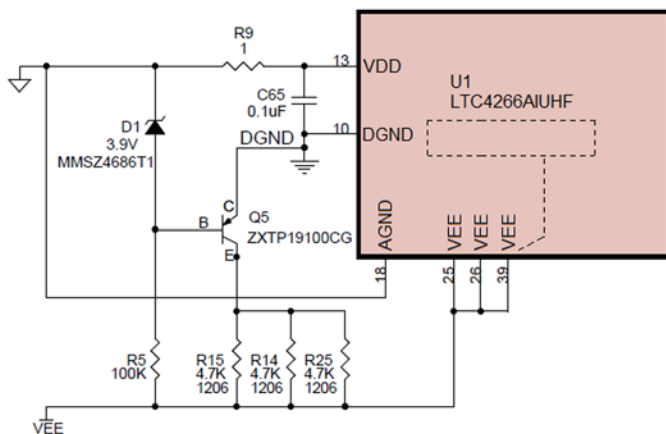


Figure 2. DC1815A LDO Circuit for the LTC4266A Digital Supply.

### AUTO Pin

The LTC4266A AUTO pin is set high or low with jumper JP4 on the DC1815A. With the AUTO pin high after a device reset or power on, the LTC4266A operates in fully autonomous mode without the need for a microcontroller. The LTC4266A will automatically detect, classify, and power on IEEE 802.3at Type 1, Type 2 and LTPoE++ PDs up to the power level rating of the LTC4266A version used. For full control via I<sup>2</sup>C, the AUTO pin is to be pulled low. Modification of the AUTO pin jumper requires a device reset or power cycle.

### Endpoint vs Midspan

The LTC4266A can be configured either for endpoint or midspan operation by setting the MID pin high or low respectively. This is selected with jumper JP5 on the DC1815A. The MID pin high state enables a two second detection back-off timer. The LTC4266A must be reset or power-cycled for the MID pin to be detected. For proper midspan operation the AUTO pin must also be high.

### I<sup>2</sup>C Control

The LTC4266A is a slave-only I<sup>2</sup>C device, and communicates with a host using a standard SMBus/I<sup>2</sup>C 2-wire interface. On the DC1815A, a host can be connected to the SCL and SDA test points. Optionally, a DC590B board can be connected with a 14-pin ribbon cable to header J6.

The LTC4266A has separate pins for SDAIN and SDAOUT to facilitate the use of opto-couplers. The SDAIN and SDAOUT lines are tied together on the DC1815A with a shunt resistor (R10) to provide a traditional bi-directional SDA line.

The 7-bit I<sup>2</sup>C address of the LTC4266A is 010A<sub>3</sub>A<sub>2</sub>A<sub>1</sub>A<sub>0</sub>b, where A<sub>3</sub> through A<sub>0</sub> are determined by pins AD3 through AD0 respectively. On the DC1815A board the state of these pins are controlled by the quad DIP switch, S1. All LTC4266 chips also respond to the global address 0110000b regardless of the state of their AD3-AD0 pins.

Interrupts are signaled by the LTC4266A to the host via the  $\overline{INT}$  pin. A red LED on the DC1815A indicates if the  $\overline{INT}$  line is being pulled low.

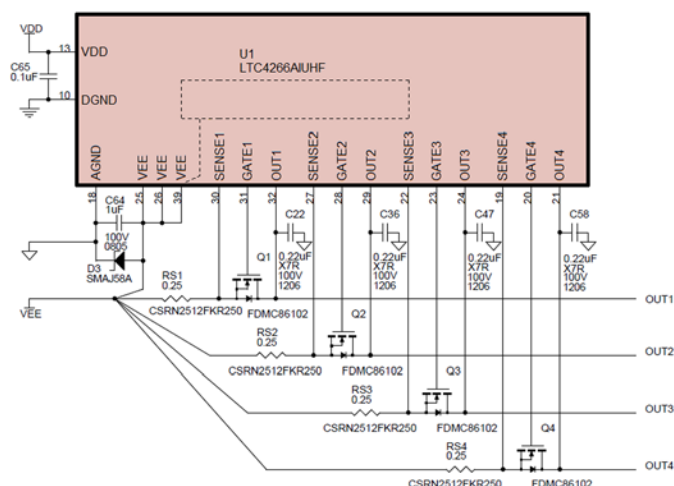
## OPERATION

### Board Layout

Proper components placement and board layout with the LTC4266A is important to provide electrical robustness and correct operation. The following mentioned components, also shown in Figure 3, must be close to their respective LTC4266A pins with no other components in between on the connection path. Place a 0.1 $\mu$ F capacitor (C1) directly across VDD and DGND. Place a 1 $\mu$ F, 100V capacitor (C4) and a SMAJ58A TVS (D3) directly across AGND and VEE. Place the OUT 0.22 $\mu$ F, 100V capacitors (C22, C36, C47, and C58) directly to their respective OUT pins all going to an AGND plane.

The power path is from VEE to the sense resistor, to the MOSFET, and out to the port. Select a trace width appropriate for the maximum current.

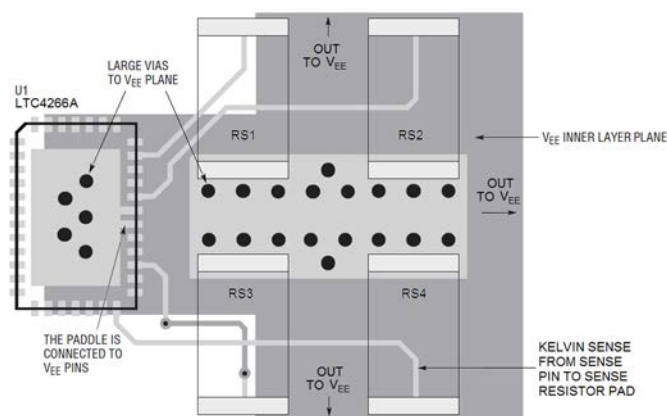
Kelvin sensing is necessary to provide accurate current readings particularly with DC Disconnect. The sense resistors used with the LTC4266A must be 0.25 $\Omega$ , 1% or better, and with a power rating that can handle the maximum DC current passed through them. A dedicated sense trace from each SENSE pin of the LTC4266A must go directly to the respective sense resistor solder pad (Figure 4). Do not connect to a copper area or trace between the sense resistor and the MOSFET.



**Figure 3. LTC4266A Key Application Components for Board Placement**

The VEE side of the sense resistor must connect to a thick VEE plane through several large vias. At the LTC4266A, the VEE pins and exposed pad tie together on the top layer and connect to the VEE plane as well through its own multiple large vias. The via size, number of vias, copper thickness, trace width, and number of layers that connect VEE between the sense resistors and the LTC4266A VEE pins must total less than 15m $\Omega$ . A 2oz. copper thickness for the VEE copper plane must be used if there is only a single VEE plane connecting the LTC4266A VEE pins to the sense resistors.

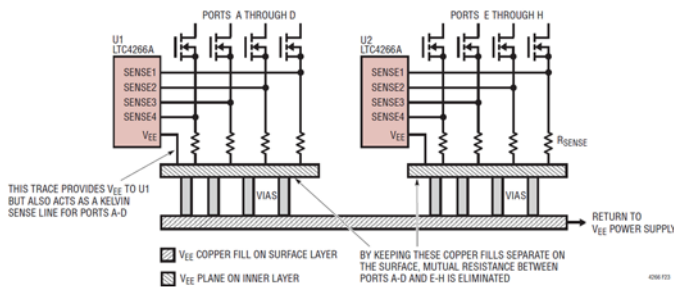
The VEE current path from the sense resistors to the main VEE power supply must be either through a copper plane, or a thick trace. If a trace is used, it must not pass under the LTC4266A. Instead the path must go out to VEE from the sense resistors as shown in Figure 4. The VEE connection is from the VEE supply to the sense resistors to the LTC4266A VEE pins and must stay in that order.



**Figure 4. LTC4266A VEE Pins and Sense Resistors Connect to a VEE Inner Layer Plane. A Kelvin Sense Trace from each SENSE Pin Runs to the Respective Sense Resistor Pad. Connect the VEE Supply Path to the Sense Resistors First, Then to the LTC4266A VEE Pins**

## OPERATION

When laying out multiple LTC4266A devices, group the four sets of port MOSFET and sense resistor with their respective LTC4266A as shown in Figure 5. Each LTC4266A has its own copper fill area on the surface that connects to the VEE plane with multiple large vias. The net effect is to reduce the layout problem down to 4-port groups; this arrangement is expandable to any number of ports.



**Figure 5. Multiple LTC4266 Layout Strategy to Reduce Mutual Resistance**

## Surge Protection

Ethernet ports can be subject to significant cable surge events. To keep PoE voltages below a safe level and protect the application against damage, protection components

are required at the main supply, at the LTC4266A supply pins and at the ports. Refer to DC1815A schematic.

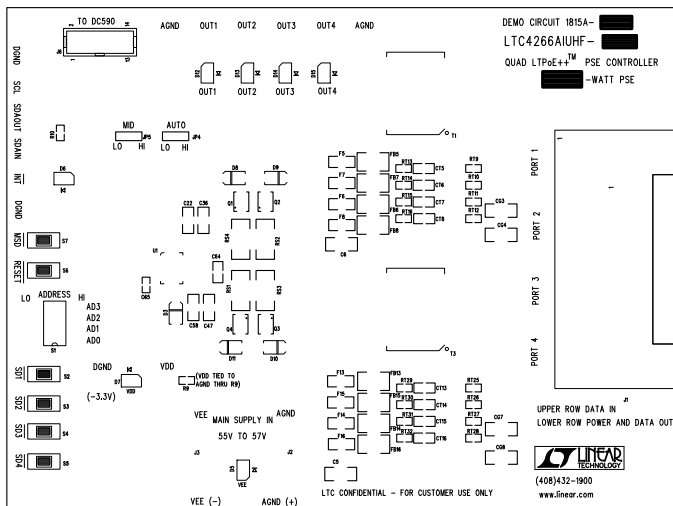
Bulk transient voltage suppression devices and bulk capacitance are required across the main PoE supply and should be sized to accommodate system level surge requirements. Across the LTC4266A AGND pin and VEE pin are an SMAJ58A, 58V TVS and a 1 $\mu$ F, 100V bypass capacitor. These components must be placed close to the LTC4266A pins.

In a high surge environment, a 10 $\Omega$ , 0805 resistor in series from supply AGND to the LTC4266A AGND and VDD pin is recommended as shown in the schematic comments. The bulk TVS and capacitance remain on the supply side of this 10 $\Omega$  resistor. The LTC4266A supply pins local TVS and capacitance remain at the LTC4266A side of this 10 $\Omega$  resistor.

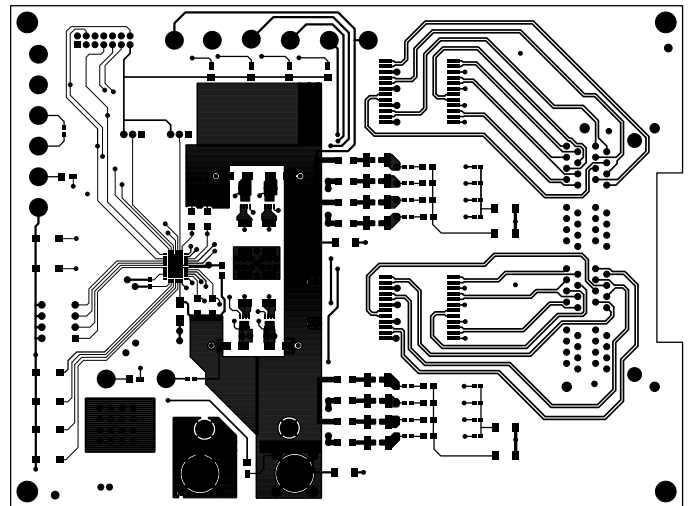
Each port requires a pair of S1B clamp diodes: one from OUT to supply AGND and one from supply VEE to OUTn. The diodes at the ports steer harmful surges into the supply rails where they are absorbed by the surge suppressors and the VEE bypass capacitance. The layout of these paths must be low impedance.

## PCB LAYOUT

### Top Silkscreen



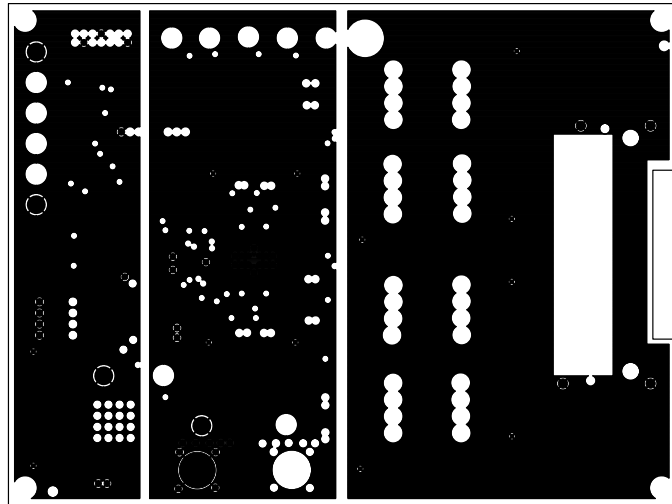
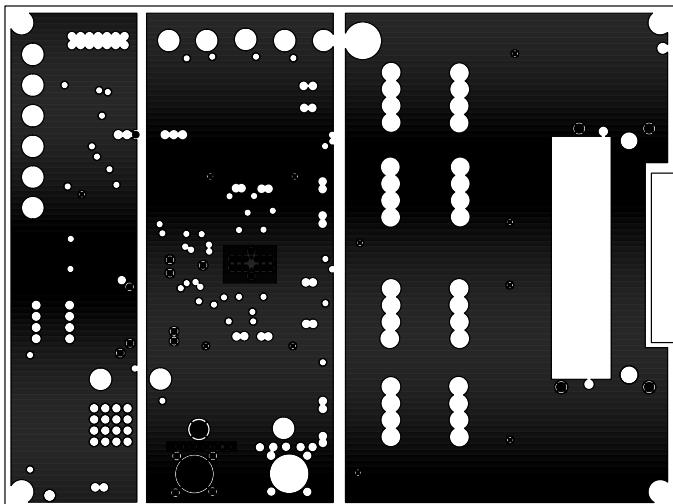
### Layer 1: Top Layer



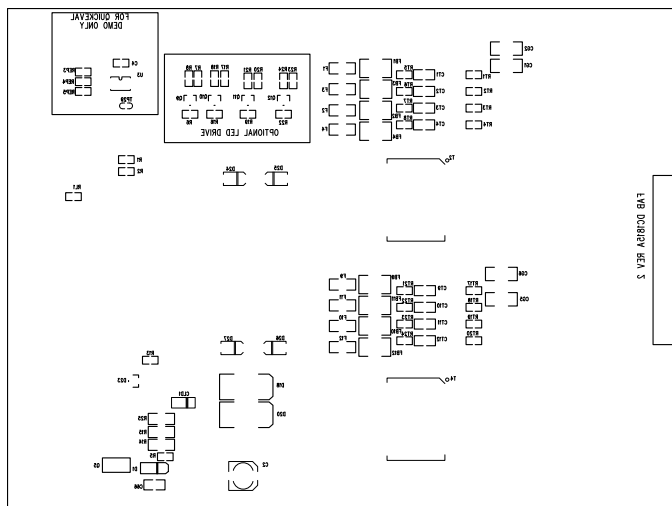
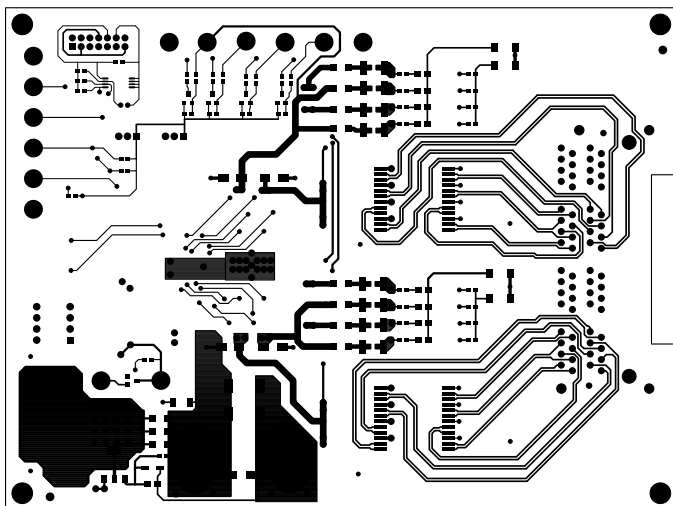


## PCB LAYOUT

### Layer 3: Plane Layer



## Bottom Silkscreen



## PARTS LIST

| ITEM | QTY | REFERENCE                   | PART DESCRIPTION                         | MANUFACTURER/PART NUMBER                      |
|------|-----|-----------------------------|------------------------------------------|-----------------------------------------------|
| 1    | 2   | C4, C65                     | CAP, 0603 0.1 $\mu$ F 10% 25V X7R        | TDK C1608X7R1E104K                            |
| 2    | 16  | CT1-CT16                    | CAP, 0805 0.01 $\mu$ F 5% 100V X7R       | AVX 0805C103JAT2A                             |
| 3    | 2   | C64, C66                    | CAP, 0805 1 $\mu$ F 10% 100V X7S         | TDK C2012X7S2A105K                            |
| 4    | 1   | C2                          | CAP, 10uF 20% 100V ALUM.                 | PANASONIC EEE-2AA100UP                        |
| 5    | 4   | C22, C36, C47, C58          | CAP, 1206 0.22 $\mu$ F 5% 100V X7R       | AVX 12061C224JAT2A                            |
| 6    | 10  | C5, C6, CG1-CG8             | CAP, 1808 1000pF 10% 2KV X7R             | TDK C4520X7R3D102K                            |
| 7    | 2   | J2, J3                      | CONN, JACK, BANANA                       | KEYSTONE 575-4                                |
| 8    | 1   | J1                          | CONN, RJ45, 8-PORT DUAL ROW SHIELDED     | TE CONNECTIVITY, 5569262-1                    |
| 9    | 1   | CLD1                        | DIODE, CURRENT LIMITING, 2.7mA, SOD-80   | CENTRAL SEMI CCLM2700                         |
| 10   | 8   | D8-D11, D24-D27             | DIODE, RECTIFIER, 100V 1A, SMA           | FAIRCHILD S1B                                 |
| 11   | 1   | D3                          | DIODE, TVS, 400W, 58V, SMA               | DIODES INC. SMAJ58A                           |
| 12   | 2   | D18, D20                    | DIODE, TVS, 5000W, 60V, SMC              | LITTLEFUSE 5.0SMDJ60A                         |
| 13   | 1   | D1                          | DIODE, ZENER 3.9V SOD-123                | ON SEMI, MMSZ4686T1G                          |
| 14   | 1   | D23                         | DIODE, ZENER, 5.6V, SOT23                | FAIRCHILD, BZX84C5V6                          |
| 15   | 1   | J6                          | HEADER, 2 $\times$ 7 2mm                 | MOLEX 87831-1420                              |
| 16   | 2   | JP4, JP5                    | HEADER, 3-PIN, 2mm                       | SAMTEC TMM-103-02-L-S                         |
| 17   | 1   | U3                          | IC, 24LC025, EEPROM, TSSOP               | MICROCHIP 24LC025-I/ST                        |
| 18   | 2   | D5, D7                      | LED, AMBER                               | ROHM SML-010DTT86L                            |
| 19   | 4   | D12-D15                     | LED, GREEN                               | ROHM SML-010FTT86L                            |
| 20   | 1   | D6                          | LED, RED                                 | ROHM SML-010VTT86L                            |
| 21   | 16  | F-1-F16                     | FUSE, 3A, 63VDC 1206                     | BEL FUSE C1Q3                                 |
| 22   | 1   | R9                          | RES, 0603 1 $\Omega$ 5% 1/10W            | VISHAY CRCW06031R00JNEA                       |
| 23   | 1   | R10                         | RES, 0603 10 $\Omega$ 5% 1/10W           | VISHAY CRCW060310R0JNEA                       |
| 24   | 1   | R5                          | RES, 0603 100k 5% 1/10W                  | VISHAY CRCW0603100KJNEA                       |
| 25   | 2   | R1, R2                      | RES, 0603 10k 5% 1/10W                   | VISHAY CRCW060310K0JNEA                       |
| 26   | 6   | R8, R13, R18, R21, R24, RL1 | RES, 0603 1.0k 5% 1/10W                  | VISHAY CRCW06031K00JNEA                       |
| 27   | 4   | R7, R17, R20, R23           | RES, 0603 10M 5% 1/10W                   | VISHAY CRCW060310M0JNEA                       |
| 28   | 4   | R6, R16, R19, R22           | RES, 0603 2M 5% 1/10W                    | VISHAY CRCW0603910KJNEA                       |
| 29   | 3   | REP3-REP5                   | RES, 0603 5.1k 5% 1/10W                  | VISHAY CRCW06035K10JNEA                       |
| 30   | 32  | RT1-RT32                    | RES, 0603 75 $\Omega$ 5% 1/10W           | VISHAY CRCW060375R0JNEA                       |
| 31   | 3   | R14, R15, R25               | RES, 1206 4.7k 5% 1/4W                   | VISHAY CRCW12064K70JNEA                       |
| 32   | 4   | RS1-RS4                     | RES, 2512, 0.25 $\Omega$ 1% 2W           | STACKPOLE, CSRN2512FKR250                     |
| 33   | 4   | MH1-MH4                     | STAND-OFF, NYLON 0.75"                   | KEYSTONE, 8834(SNAP ON)                       |
| 34   | 1   | S1                          | SWITCH, DIP 4-POSITION                   | TYCO/ALCOSWITCH ADE04                         |
| 35   | 6   | S2-S7                       | SWITCH, MOMENTARY                        | WÜRTH 434 123 050 816                         |
| 36   | 16  | E1-E16                      | TESTPOINT, TURRET, 0.094" PBF            | MILL-MAX, 2501-2-00-80-00-00-07-0             |
| 37   | 4   | T1-T4                       | TRANSFORMER, POE++<br>(OPTION)           | MIDCOM WÜRTH 749022016<br>COILCRAFT ETH1-460L |
| 38   | 4   | Q9-Q12                      | XSTR, MOSFET P-CHANNEL 30V (D-S), SOT-23 | VISHAY Si2343DS                               |
| 39   | 4   | Q1-Q4                       | XSTR, MOSFET, N-CHANNEL 100V             | FAIRCHILD FDMC86102                           |
| 40   | 1   | Q5                          | XSTR, PNP, 100V, SOT223                  | ZETEX ZXTP19100CG                             |

# DEMO MANUAL DC1815A

## PARTS LIST

| ITEM | QTY | REFERENCE  | PART DESCRIPTION           | MANUFACTURER/PART NUMBER |
|------|-----|------------|----------------------------|--------------------------|
| 41   | 3   | XJP4, XJP5 | SHUNT, 2mm                 | SAMTEC 2SN-BK-G          |
| 42   | 1   |            | FAB, PRINTED CIRCUIT BOARD | DEMO CIRCUIT 1815A-2     |
| 43   | 2   |            | STENCIL TOP & BOTTOM       | DC1815A-2                |

### DC1815A-A

|   |    |          |                                                |                       |
|---|----|----------|------------------------------------------------|-----------------------|
| 1 | 1  | DC1815A  | GENERAL BOM                                    |                       |
| 2 | 16 | FB1-FB16 | FERRITE BEAD, 1k, 0805                         | TDK MPZ2012S102A      |
| 3 | 1  | U1       | IC, LTC4274A-1, QUAD PORT 38.7W PSE CONTROLLER | LINEAR LTC4274AIUHF-1 |
| 4 | 1  |          | FAB, PRINTED CIRCUIT BOARD                     | DEMO CIRCUIT 1815A    |

### DC1815A-B

|   |    |          |                                               |                       |
|---|----|----------|-----------------------------------------------|-----------------------|
| 1 | 1  | DC1815A  | GENERAL BOM                                   |                       |
| 2 | 16 | FB1-FB16 | FERRITE BEAD, 1k, 0805                        | TDK MPZ2012S102A      |
| 3 | 1  | U1       | IC, LTC4266A-2 QUAD PORT 52.7W PSE CONTROLLER | LINEAR LTC4266AIUHF-2 |
| 4 | 1  |          | FAB, PRINTED CIRCUIT BOARD                    | DEMO CIRCUIT 1815A    |

### DC1815A-C

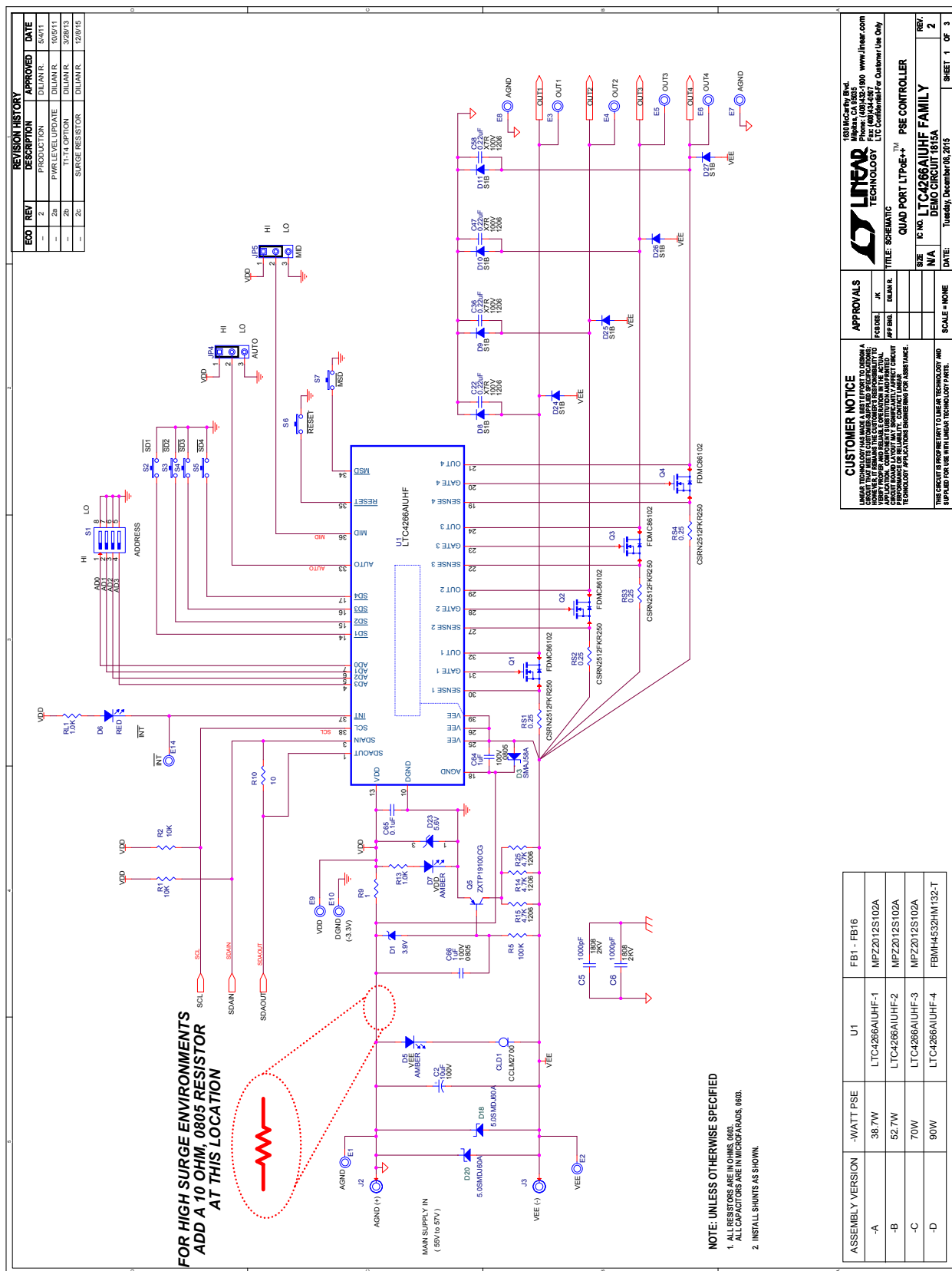
|   |    |          |                                              |                       |
|---|----|----------|----------------------------------------------|-----------------------|
| 1 | 1  | DC1815A  | GENERAL BOM                                  |                       |
| 2 | 16 | FB1-FB16 | FERRITE BEAD, 1k, 0805                       | TDK MPZ2012S102A      |
| 3 | 1  | U1       | IC, LTC4266A-3, QUAD PORT 70W PSE CONTROLLER | LINEAR LTC4266AIUHF-3 |
| 4 | 1  |          | FAB, PRINTED CIRCUIT BOARD                   | DEMO CIRCUIT 1815A    |

### DC1815A-D

|   |    |          |                                              |                             |
|---|----|----------|----------------------------------------------|-----------------------------|
| 1 | 1  | DC1815A  | GENERAL BOM                                  |                             |
| 2 | 16 | FB1-FB16 | FERRITE BEAD, 1300Ω, 1812                    | TAIYO YUDEN FBMH4532HM132-T |
| 3 | 1  | U1       | IC, LTC4266A-4, QUAD PORT 90W PSE CONTROLLER | LINEAR LTC4266AIUHF-4       |
| 4 | 1  |          | FAB, PRINTED CIRCUIT BOARD                   | DEMO CIRCUIT 1815A          |

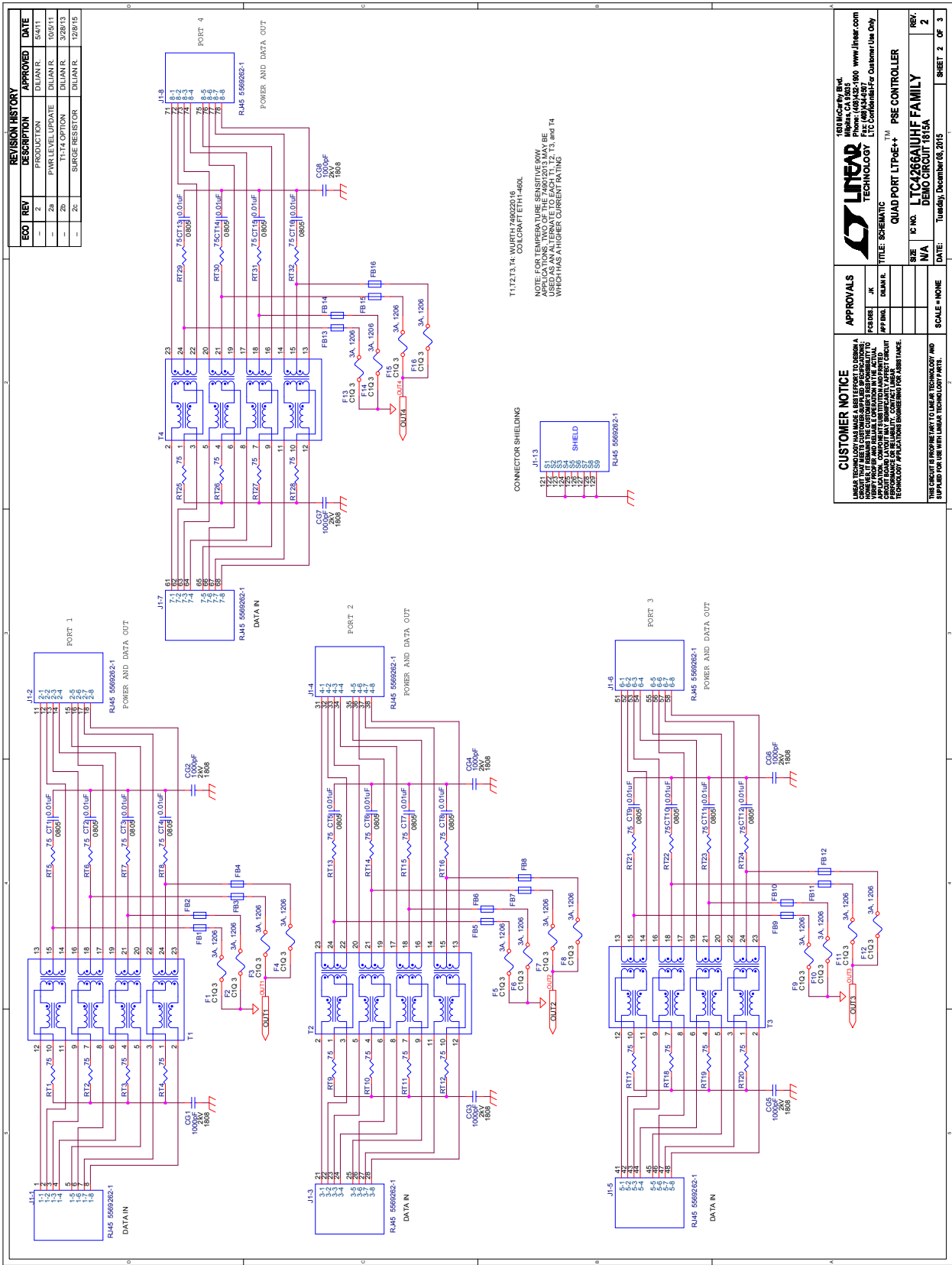


## SCHEMATIC DIAGRAM

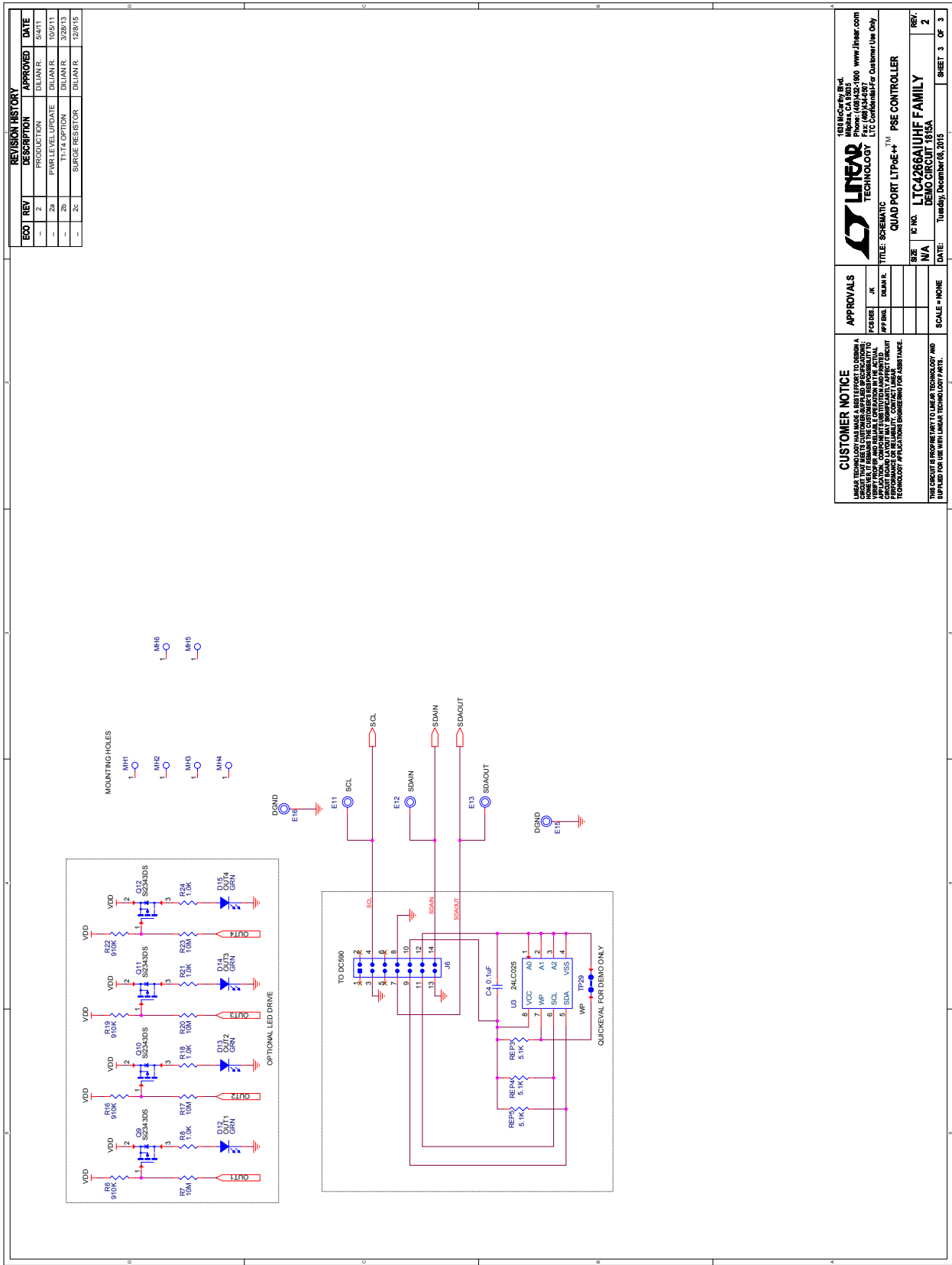


# DEMO MANUAL DC1815A

## SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM



# DEMO MANUAL

## DC1815A

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

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

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