Teridian Smart Grid Solutions

78M6618 PDU1 Evaluation Board User Manual

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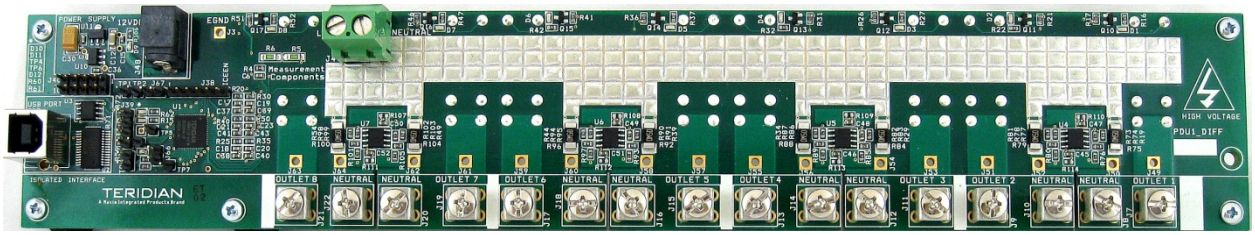
Table of Contents

Figures

Tables

1 Introduction

The Teridian™ 78M6618 PDU1 evaluation board is an example of a low-cost power distribution unit (PDU) utilizing the 78M6618 system-on-chip (SoC). The 78M6618 monitors the AC line voltage and eight load currents, and controls switching of eight internal load relays. The embedded firmware calculates the RMS line voltage and RMS load currents, watts, VAs, VARs, and power factor. The real-time data is transmitted to a PC via a USB interface for display in a Windows®-based graphical user interface (GUI). The 78M6618 UART interface is used as the communications link to an on-board isolated USB interface IC.



Included with the 78M6618 PDU1 is a Windows-based GUI for simplified access to the following measurement data and controls:

- RMS voltage and current
- Real, apparent, and reactive power and power factor
- Accumulated energy usage and expense tracking
- Line frequency
- Minimum and peak parameter tracking
- Alarm indicators
- Programmable alarm thresholds
- Internal load relay (16A) control

This document describes the evaluation board with “78M6618 PDU1_DIFF” imprinted on the board. This board is a complete replacement for (and obsoletes) the earlier 78M6618 PDU1 evaluation board.

Refer to the *GUI User Guide* for information about the GUI.

1.1 Package Contents

The 78M6618 PDU1 evaluation kit includes:

- 78M6618 PDU1_DIFF evaluation board
- Universal AC to 12 V DC power supply with international plug adapters
- ICE Adaptor board
- USB A/B cable

1.2 System Requirements

The 78M6618 PDU1 GUI requires use of a PC with the following features:

- PC (1 GHz, 1 GB) with Microsoft Windows 7, Windows XP® or Win2000, equipped with USB port
- Minimum 1024 x 768 video display resolution

1.3 Safety and ESD Notes

EXERCISE CAUTION WHEN LIVE AC VOLTAGES ARE PRESENT!

Standard ESD precautions must be taken when handling electronic equipment. The 78M6618 PDU1 contains ESD protected interfaces.

Do not connect test equipment, ICE emulators or external development boards directly to the 78M6618 hardware. Damage to the 78M6618 PDU1 and external equipment will occur due to the 78M6618's "high side" reference topology. The 78M6618's V3P3 (i.e., "high side") is connected directly to Neutral (Earth Ground) and the ground is 3.3V below neutral, creating a ground reference disparity with any properly grounded external equipment. Also, reversing the line and neutral connections at the inlet would place the board's ground reference at the AC line voltage.

Always use the isolated USB interface for connecting to a PC. Contact the factory for instructions on connecting other types of test equipment.

The board components and firmware settings are designed to operate with the following nominal AC electrical ranges:

Voltage	Current	Line Frequency
110-240 VAC	20A Max	46-64 Hz

1.4 Firmware Demo Code Introduction

The Firmware Demo Code provides the following features:

- Basic energy measurement data such as Watts, Volts, current, VAR, VA, phase angle, power factor, accumulated energy, frequency, date/time, and various alarm statuses.
- Control of alarm thresholds, calibration coefficients, temperature compensation, etc.

There are two means to facilitate performance evaluation between the user at the PC host and the firmware code in the 78M6618 PDU1 evaluation board:

- The graphical user interface (GUI). For information about the GUI, refer to the *GUI User Guide*.
- The Command Line Interface (CLI) via HyperTerminal or comparable terminal emulator on a different operating system. For information about the CLI, see the *Firmware Description Document*.

The 78M6618 PDU1 evaluation board is shipped with demonstration code loaded in the 78M6618 device and included on the CD. The code revision can be verified by entering the command **>i** via the command line interface. Firmware for the Demo Unit can be updated using either the Teridian TFP2 or an in-circuit emulator such as Signum Systems ADM51 (www.signum.com).

1.5 Testing the Evaluation Board Prior to Shipping

Before every 78M6618 PDU1 evaluation board is shipped, the following procedures have been performed at the factory:

- Full Calibration – Precise energy source equipment is used to calibrate the current and voltage. The temperature is also calibrated at the same time.
- Accuracy Test – This "bench" level test ensures the energy measurement accuracy is within +/-0.5%.

2 Installation

Figure 1 shows the basic connections to the 78M6618 PDU1 Evaluation Board. DC power is supplied to the PDU1 through the DC power jack (J48). The USB cable provides an electrically isolated communications link between the host PC and the PDU1 as well as power to the USB controller on the Evaluation Board. The AC input to the PDU is connected via the terminal block J4. The PDU1 has eight outlets that connect to the loads to be measured. Screw terminals are provided to make the line and neutral connections to the loads.

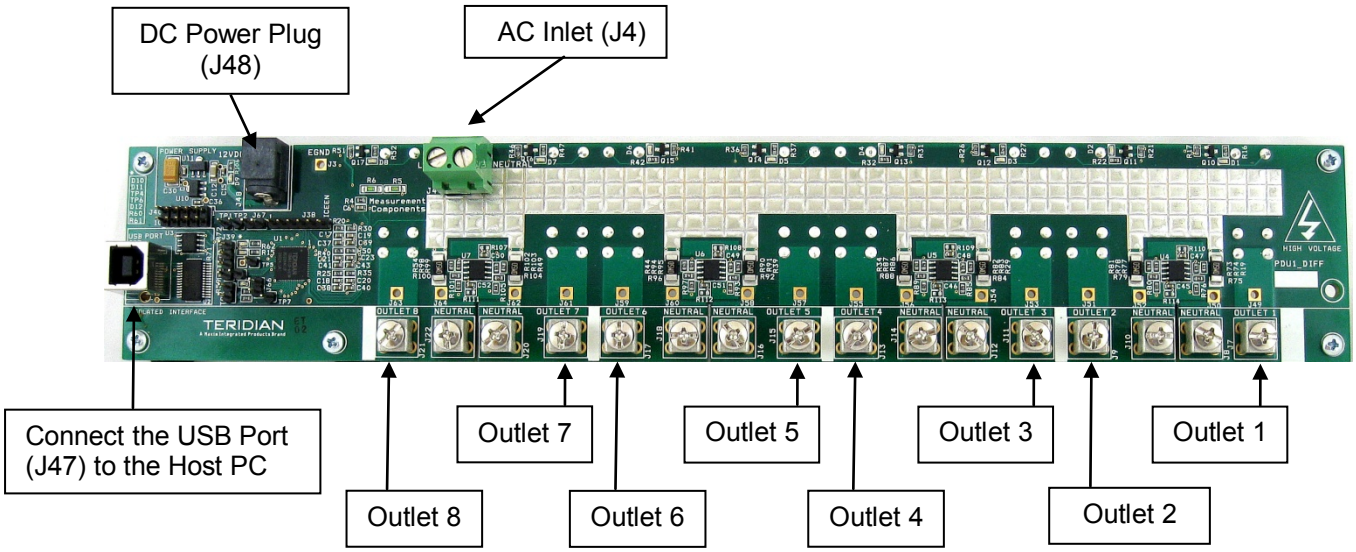


Figure 1: 78M6618 PDU1 Connections

2.1 USB Connection and Driver Installation

This evaluation kit includes an isolated USB interface for serial communications with a PC. The FTDI USB controller IC FT232R performs the USB functions. The FTDI Windows driver presents a virtual COM port for enabling serial communications. Control of the 78M6618-PDU-1 can be managed using either a terminal emulation program or using the supplied Windows Dashboard GUI. The FTDI Windows driver is a certified driver for Windows 2000 and XP.

Because the USB interface is USB powered, the USB driver installation can be completed with no other DC power supplied to the evaluation board.

1. Connect a USB AB cable between the host PC and the evaluation board.
2. Upon attaching the 78M6618-PDU-1 to the PC, the Found New Hardware Wizard automatically launches and installs the appropriate driver files. If your PC does not find the FTDI driver files on its local hard disk drive, locate and reference the FTDI USB Driver and Utilities subdirectory on the CD. The FT232R controller is powered from the USB cable and is active even when no AC power is applied to the 78M6618-PDU-1.

Note: If an older FTDI driver has been previously installed, it is recommended to remove the older version before installing this newer FTDI driver. Execute the **ftdiClean.exe** utility from the FTDI USB Driver and Utilities subdirectory.

For FTDI driver support on other operating systems, please check FTDI's website at (http://www.ftdichip.com/FTDrivers.htm).

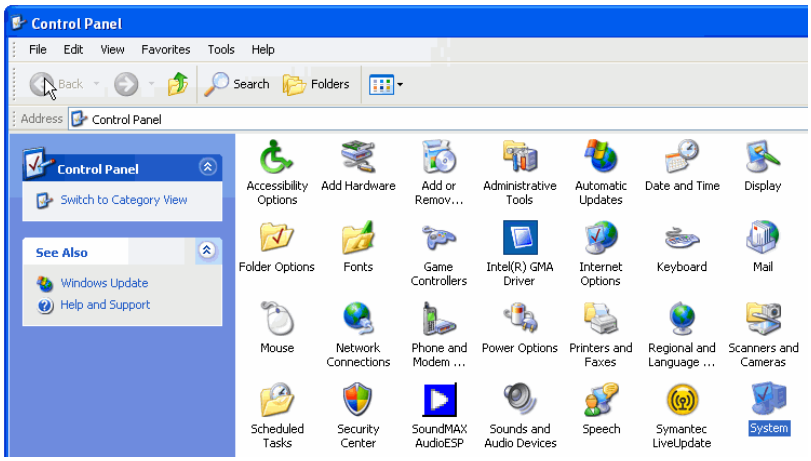
2.2 Connecting the External DC Supply

An external DC supply is provided for operation of the evaluation board. Follow these steps to connect the 78M6618 PDU1 with the external DC supply:

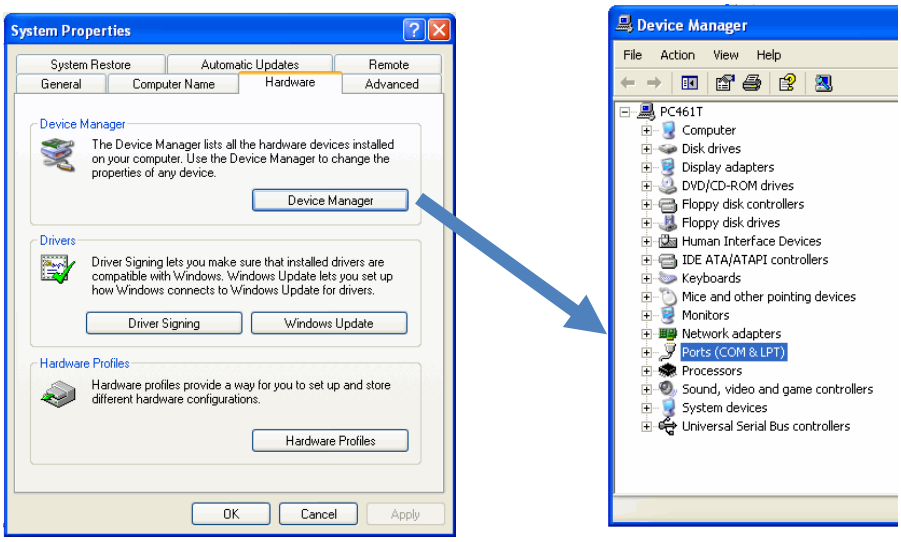
1. Select the appropriate plug for the AC adapter and snap it into place.
2. Connect the DC cable of the 12V AC adapter to J48.
3. Plug the AC adapter into an appropriate outlet.

2.3 Confirm COM Port Mapping

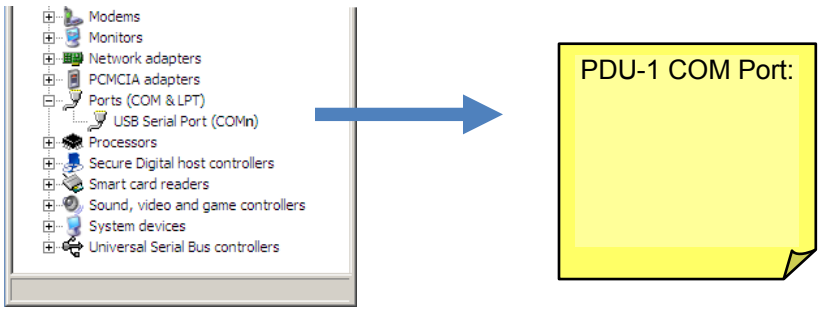
1. Launch the **Control Panel** and click on the **System** icon.



2. The **System Properties** screen appears. Click on the **Hardware** tab. Click on **Device Manager**. Under **Ports (COM & LPT)**, look for the **USB Serial Port** assignment.



3. Take note of the COM port assignment for the USB Serial Port.



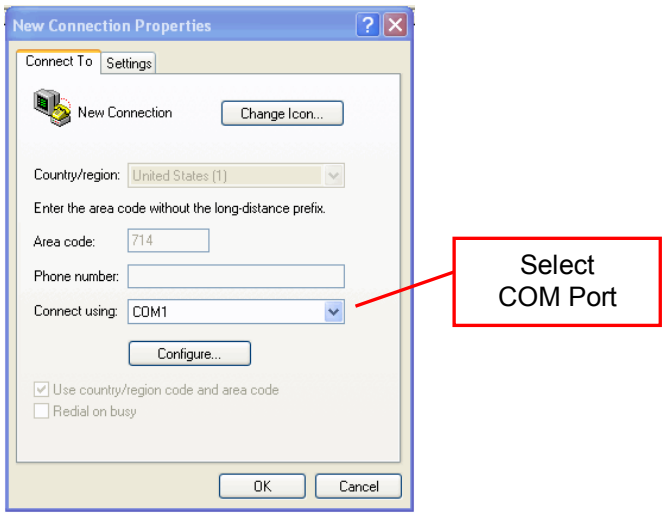
2.4 Verify Serial Connection to the PC

After connecting the USB cable from the 78M6618-PDU-1 to the host PC and powering the PDU board with the 12VDC adapter, start the HyperTerminal application (or another suitable communication program) to create a session using the communication parameters shown in Table 1. The firmware installed in your board may use a different COM port setup than what is shown here. Refer to the Firmware Description Document provided with your board for the correct setup for your firmware.

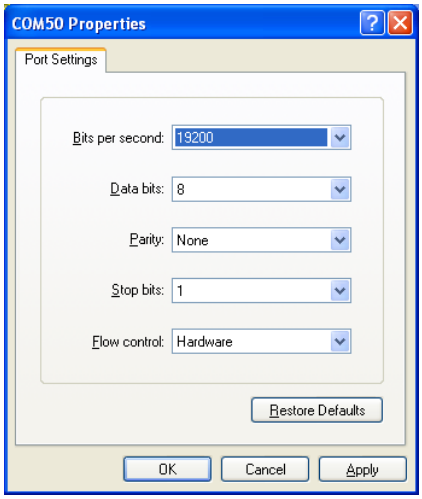
Table 1: COM Port Setup Parameters

Setup Parameter	78M6618
Port speed (baud)	38400
Data bits	8
Parity	None
Stop bits	1
Flow control	None

HyperTerminal can be found in Windows by selecting **Start →All Programs →Accessories → Communications →HyperTerminal**. The connection parameters are configured by selecting **File → Properties**. The **New Connection Properties** menu appears.



Select the appropriate COM port and click **Configure**. The **COMn Properties** menu appears.



Note that port parameters can only be adjusted when the connection is not active. It may be necessary to click the Disconnect Button (shown below) to disconnect the port.

When the terminal emulation program has connected to the correct USB COM port, verify operation of the PDU by pressing the “Enter” key on the PC. The evaluation board should respond with a “>” prompt. You should also be able to identify the firmware version programmed into your board

If communication is not established with the evaluation board, check the following:

1. Make sure that 12VDC is supplied to the board through J48.
2. Make sure that the terminal emulation program is using the correct COM port.
3. Check the serial port configuration against the configuration given in the Firmware Description Document.

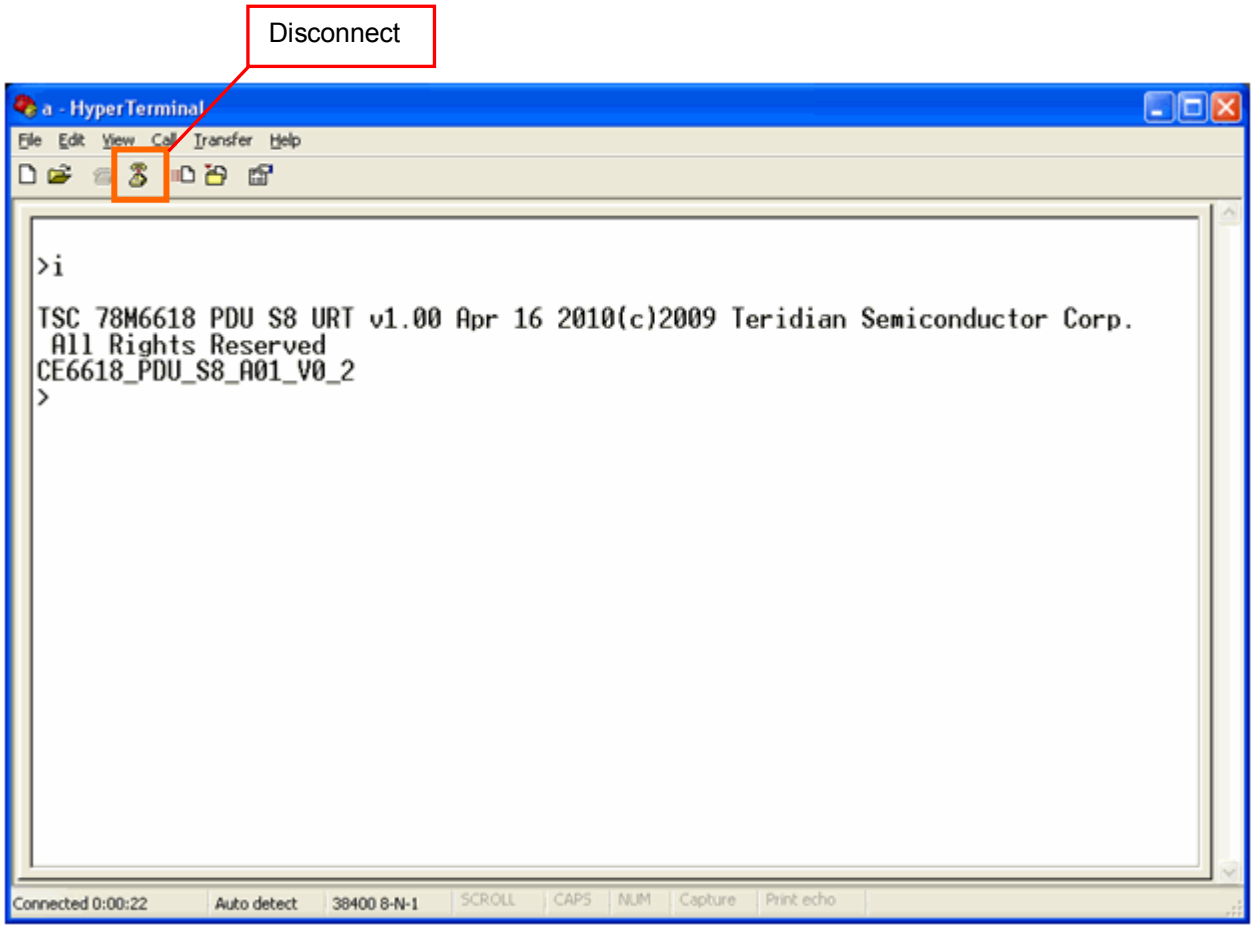


Figure 2: Serial Port Verification Screen

FTDI COM Port Trouble-Shooting

If the FTDI device driver did not install properly, there would be no assigned COM port number for the FTDI controller. Repeat the USB Driver Installation, see Section 2.1.

Microsoft Windows may associate a Ball Point device to the FTDI USB controller. When this occurs a FTDI device COM port assignment is available via HyperTerminal but there is no communications data. Verify if a Ball Point device has been added to the "Human Interface Devices" via the Device manager. Refer to Section 2.3 for access to the Device Manager. If a Ball Point device exists, delete it and unplug and replug the evaluation board's USB cable.

2.5 Connect the AC Source and Load

Connect the desired AC source to the terminal block J4. Be sure to observe the correct connections for line and neutral as they are designated on the silk screen. Terminal block J4 accepts bare wires size 24AWG to 10AWG. Be sure to select wire gauge appropriate to the total load to be applied to the board, and make sure that the screws are tightened for good electrical connection and wire retention.

The loads to be controlled and metered are connected to the screw terminals J7-J22 that are located on the bottom edge of the board. These terminals can accept bare wire, or spade terminals or ring terminals that are capable of accepting a 6-32 screw. The individual terminals are rated to carry a maximum current of 15A. As with the AC inlet connection, be sure to observe proper connection to the AC line (labeled Outlet n) and AC neutral.

3 Circuit Description and Theory of Operation

Figure 3 shows a block diagram of the PDU1 Evaluation Board. For simplicity, only one of the 8 identical channels is shown.

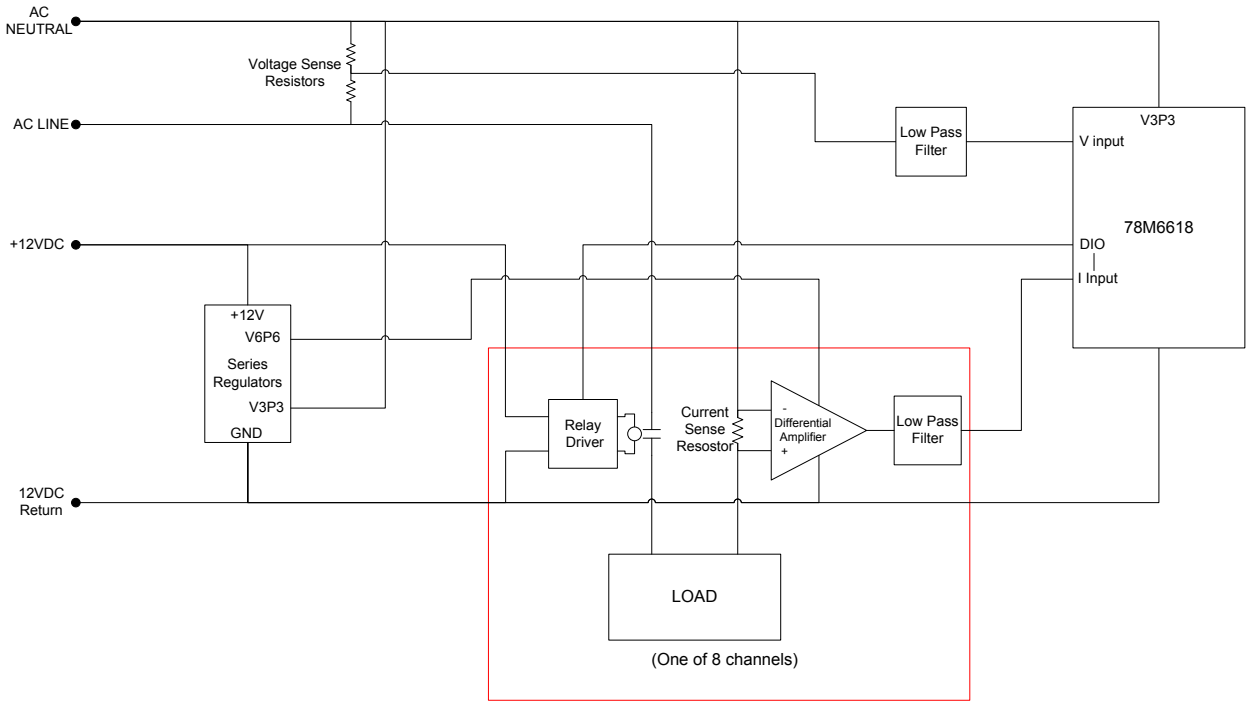


Figure 3: Differential PDU Block Diagram

The main functional blocks of the evaluation board are the 78M6618 energy measurement SoC, voltage regulators, input signal conditioning, and relay control.

3.1 78M6618

The 78M6618 is a highly integrated IC for energy monitoring and measurement. The key features of the 78M6618 include:

- A 21-bit delta sigma analog to digital converter (ADC) with 10 multiplexed analog inputs
- A 32-bit digital signal processor core (Compute Engine, or CE)
- An 8-bit microprocessor core
- 128 Kbytes flash memory
- 32,768 kHz oscillator
- Up to 19 general-purpose digital I/O pins (DIO).

For detailed information on the 78M6618, refer to the *78M6618 Data Sheet*.

3.2 Voltage Regulators

The evaluation board is powered by an external 12VDC source. The on-board relays for switching power to the 8 outlets are powered directly from the 12V supply. Linear regulators are used to provide the 3.3V supply for the 78M6618 and external logic and a 6.6V supply for the operational amplifiers that are used to amplify the voltage from the current sense resistors.

3.3 Input Signal Conditioning

Input signal conditioning includes the voltage divider used to reduce the AC line voltage to a level that can be measured by the 78M6618, the differential amplifiers that are used to remove common-mode voltage from the input signals to the ADC current channels, and the low-pass filters that block high-frequency signal content from the ADC inputs.

3.4 Relay Control

Power to each of the 12 outlets on the board is switched by a relay. The relays are individually controlled by digital I/O (DIO) lines from the 78M6618. Do to the type of relay driver circuit used on this board, the firmware Relay Config register (0x0210) is set equal to 2. This inverts the relay driver input polarity.

3.5 Theory of Operation

Before describing the operation of the PDU, it may be helpful to make note of some of the characteristics of the 78M6618 and the board design.

1. The reference for the 78M6618's ADC is its positive power supply (V3P3), not ground.
2. The 78M6618's 3.3V power supply is directly connected to the neutral side of the AC power source. As a result, the 78M6618's ground reference is actually 3.3V below the AC neutral.

3.5.1 78M6618 Operation

The analog multiplexer at the front end of the delta-sigma ADC sequentially presents the signals at the 10 analog input pins to the ADC, which converts them to digital words which are presented to the 32-bit compute engine (CE). The CE performs filtering and calculates RMS voltage and current, line frequency, real power and reactive power. The CE transfers its results to the 80515 MPU at the end of each accumulation interval. The accumulation interval, which is the period over which RMS voltage, current and power are calculated, is determined by the firmware loaded into the 78M6618's internal flash, and may be between 200 milliseconds and 1 second. The 80515 MPU performs some scaling of the CE results, calculates some additional values, and manages the communication with an external host via its integrated UART. The MPU also controls the operation of the CE.

3.5.2 Voltage and Current Measurement

As previously described, the reference voltage for the 78M6618 ADC is 3.3V. The valid input range for the ADC is 3.3V ±250 mV. A 250 mV signal corresponds to full scale on the ADC. A voltage divider is used to scale the line voltage to the ±250 mV range of the ADC. The voltage divider consists of 2 1 MΩ resistors and one 750 Ω resistor. The ADC measures the voltage across the 750Ω resistor, which is 0.0375% of the line voltage. With this ratio, the ADC can measure line voltages up to $667V_{PEAK}$, which corresponds to a sinusoidal voltage input of ~471 V_{RMS}. An RC low-pass filter at the input to the ADC limits the frequency content of the input signal to around 4,500 Hz.

The PDU uses current sense resistors, also known as shunt resistors, to sense the current flowing in the neutral or return of each outlet. The value of the current sense resistor is selected to scale the voltage drop across the resistor to the input range of the ADC. The sense resistors must also have low resistance values in order to keep voltage drop and power dissipation to acceptable levels. The 78M6618's ADC has single ended inputs referenced to V3P3. The PCB traces that are used for the line and neutral buses on the PDU board have resistances that are of the same magnitude or greater than that of the acceptable shunts. This parasitic resistance appears between the reference end of the sense resistors and the ADCs reference point, as illustrated by Figure 4. If the sense resistors are corrected directly to the ADC inputs as shown in Figure 5, it is impossible to separate the voltage across the sense resistors from the voltage across the parasitic resistance in the PCB. Because of this, current flowing in one outlet will affect the voltage at the ADC current measurement inputs for other channels, resulting in channel-to-channel crosstalk. To eliminate this problem, differential amplifiers are used between the current sense resistors and the ADC current measurement inputs, as shown in Figure 5. The differential amplifier is biased to provide an output centered at 3.3V, and rejects the voltage drop due to the PCB resistance, which appears as common mode voltage at the amplifier inputs, so that the signal presented at the ADC input is

due only to the voltage drop across the current sense resistor. An additional advantage of using the differential amplifier is that it is possible to use lower value sense resistors by increasing the gain of the differential amplifier. The PDU evaluation board uses 500 µΩ sense resistors, with an amplifier gain of 10. With this configuration, a peak current of 50A results in full-scale input to the ADC. This allows the PDU to measure 16A loads with a crest factor slightly greater than 3.

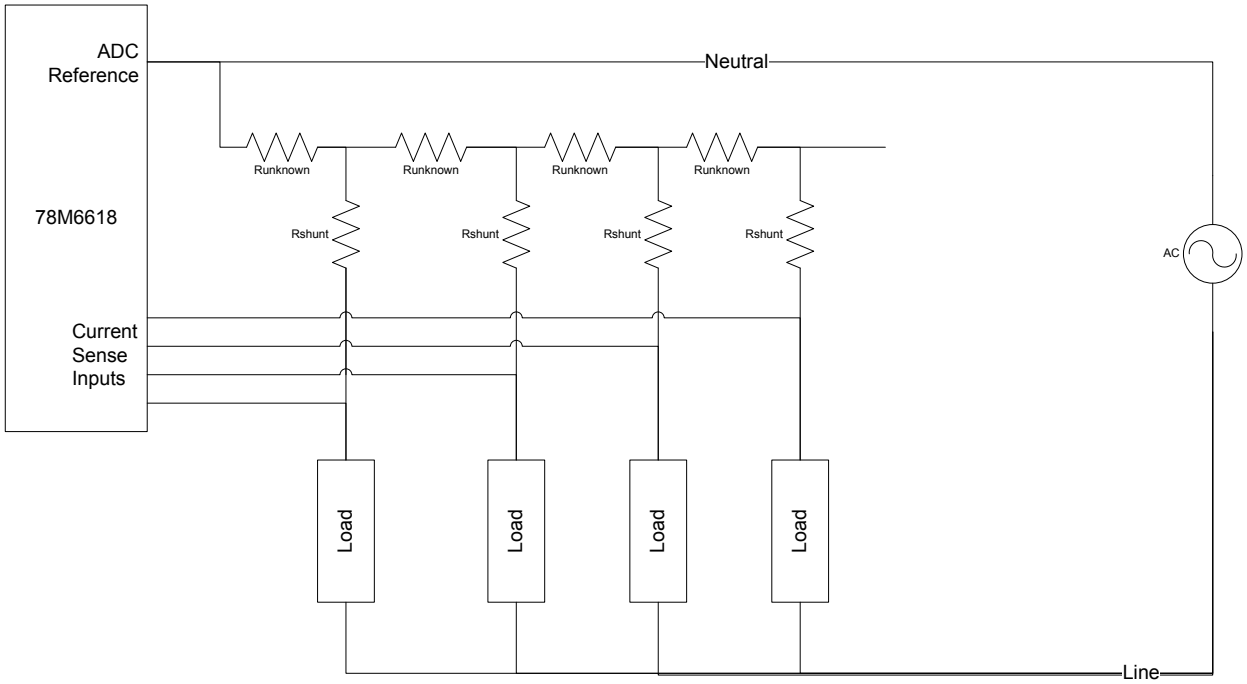


Figure 4: PCB Parasitic Resistance

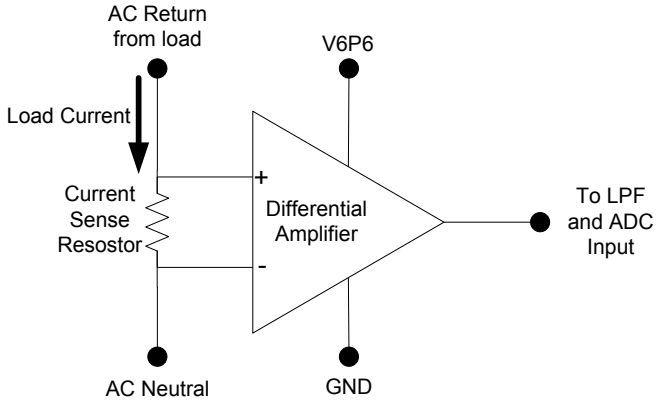


Figure 5: Differential Amplifier and Current Sense Resistor

The layout of the feedback networks for the differential amplifiers is critical to provide true differential operation and to avoid noise pickup due to the high voltages and currents present on the PDU1 board. Figure 6 shows a detail view of the current sense resistors, the dual op amp, and their feedback networks.

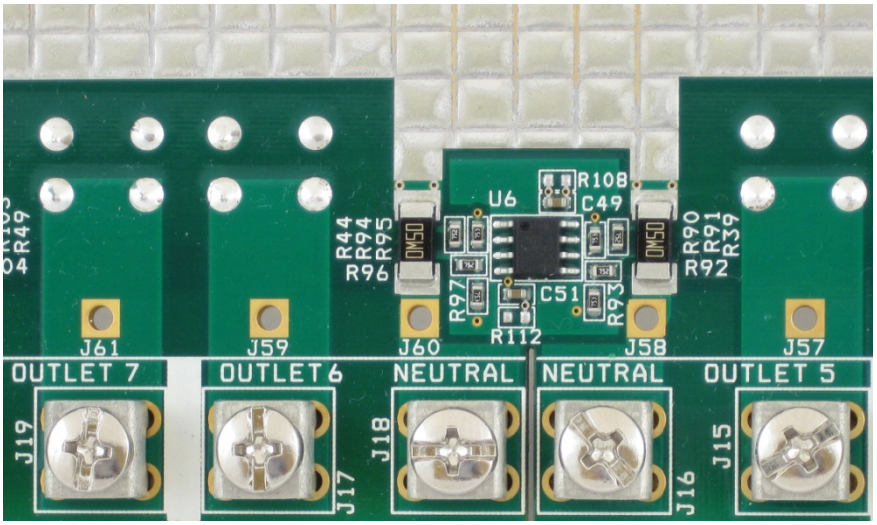


Figure 6: Detail View of Differential Amplifiers

The op amps and their feedback networks are laid out to minimize the interconnect distance between the current sense resistors and the op amp inputs. They are also located above a V3P3 plane to minimize electrical noise pickup. For more detailed information on PCB layout, refer to the application note *Designing a Differential Power Distribution Unit Using the 78M6618*.

4 In-Circuit Emulator (ICE) Adaptor

The 78M6618's firmware (stored in internal flash memory) can be updated to accommodate program enhancements. Use the Signum ADM51 or the Teridian TFP2 to download new firmware to the 78M6618. The supplied ICE Adaptor is required to interface the flat ribbon cable (provided with the ADM51 or TFP2) to the 78M6618 evaluation board.

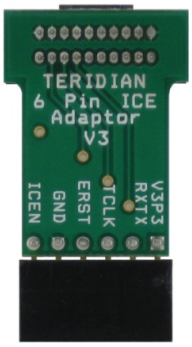


Figure 7: ICE Adaptor

Figure 3 shows how to attach the ICE Adaptor to the 78M6618 evaluation board. Please make note of the orientation of the ICE Adaptor as to how it attaches to the 78M6618 evaluation board (V3P3 ICE Adaptor pin connects to the +V Evaluation Board pin).

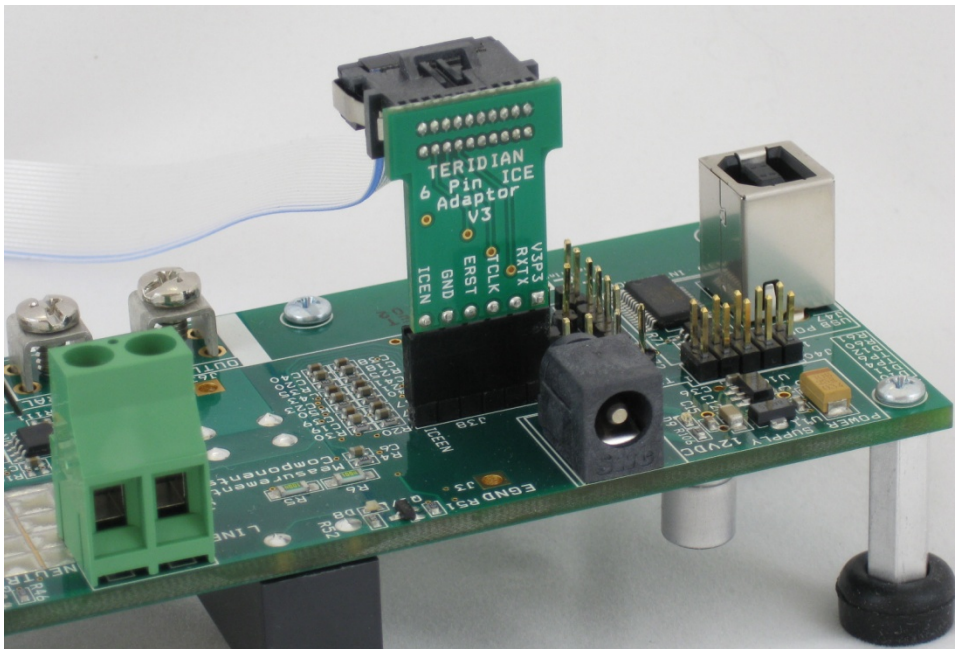


Figure 8: 78M6618 ICE Adaptor Attachment

Disconnect the 78M6618 evaluation board from live AC voltages before connecting the ADM51 or TFP2. An Earth ground disparity and high AC voltages are present on the 78M6618 evaluation board when it is connected to the AC outlet. Equipment damage to the 78M6618, ADM51/TFP2 and attached PC may occur when live AC voltages are present on the 78M6618 evaluation board. Refer to the 78M661x Safety Precautions Applications Note for additional information.

It is recommended to always use the supplied flat ribbon cable. Do not use discrete wires in place of the flat ribbon. Poor signal integrity will cause flash memory programming errors. Additional adaptors and flat ribbon cables can be ordered through Maxim.

5 Schematics, Bill of Materials, and PCB Layouts

This section includes the schematics, bill of materials and PCB layouts for the 78M6618 PDU1 evaluation board.

5.1 78M6618 PDU1 Evaluation Board Schematics

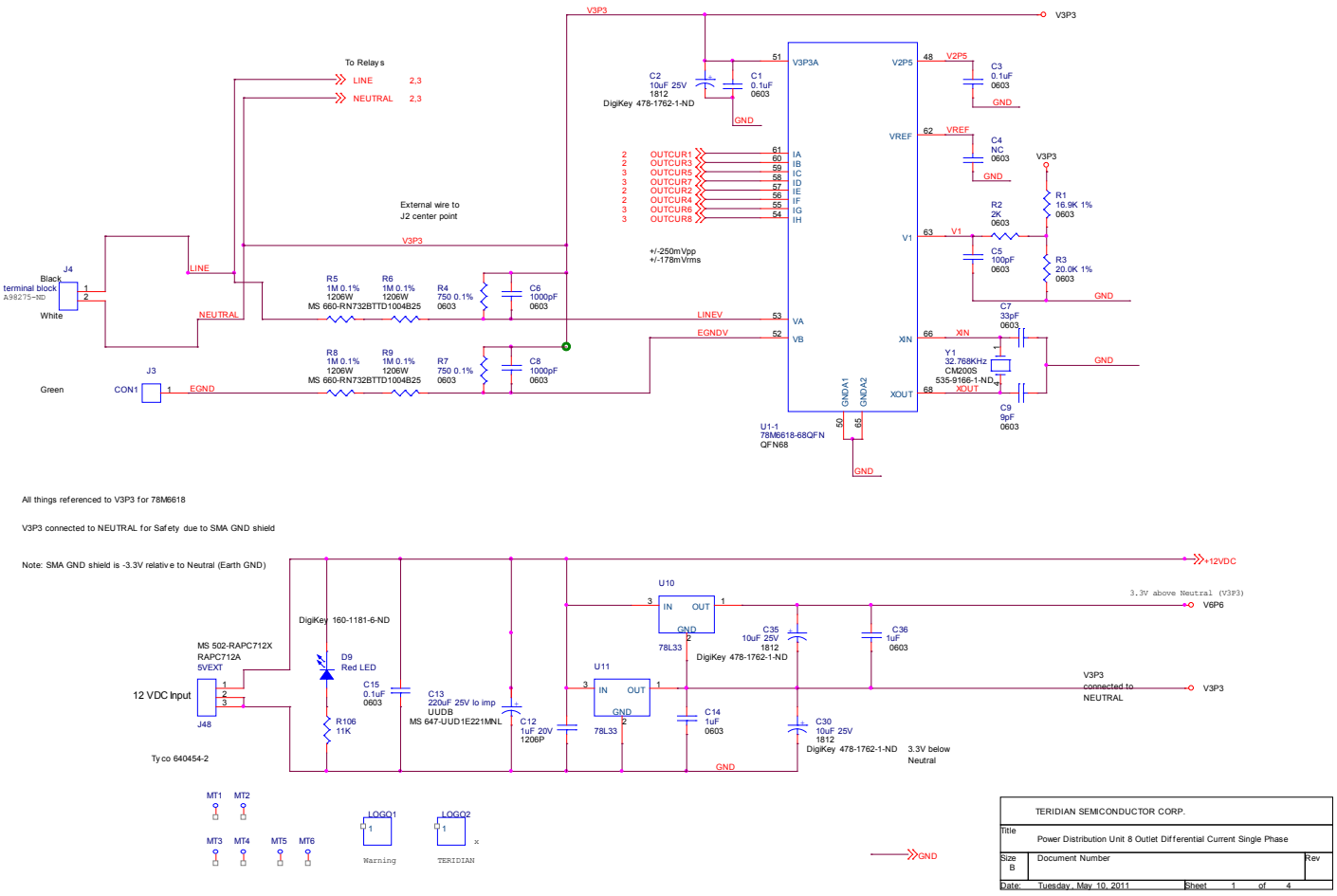


Figure 9: 78M6618 PDU1 Evaluation Board Electrical Schematic (1 of 4)

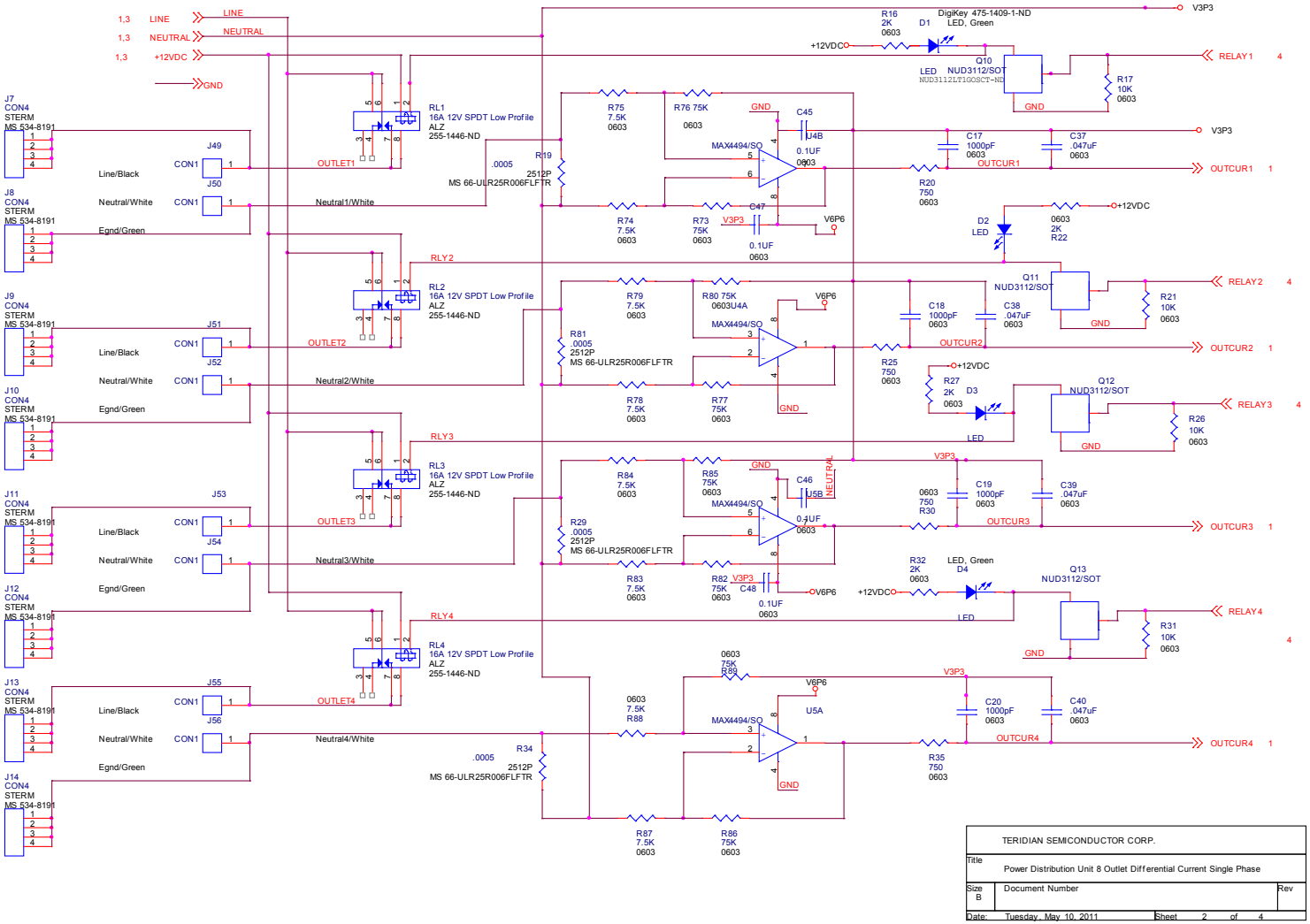


Figure 10: 78M6618 PDU1 Evaluation Board Electrical Schematic (2 of 4)

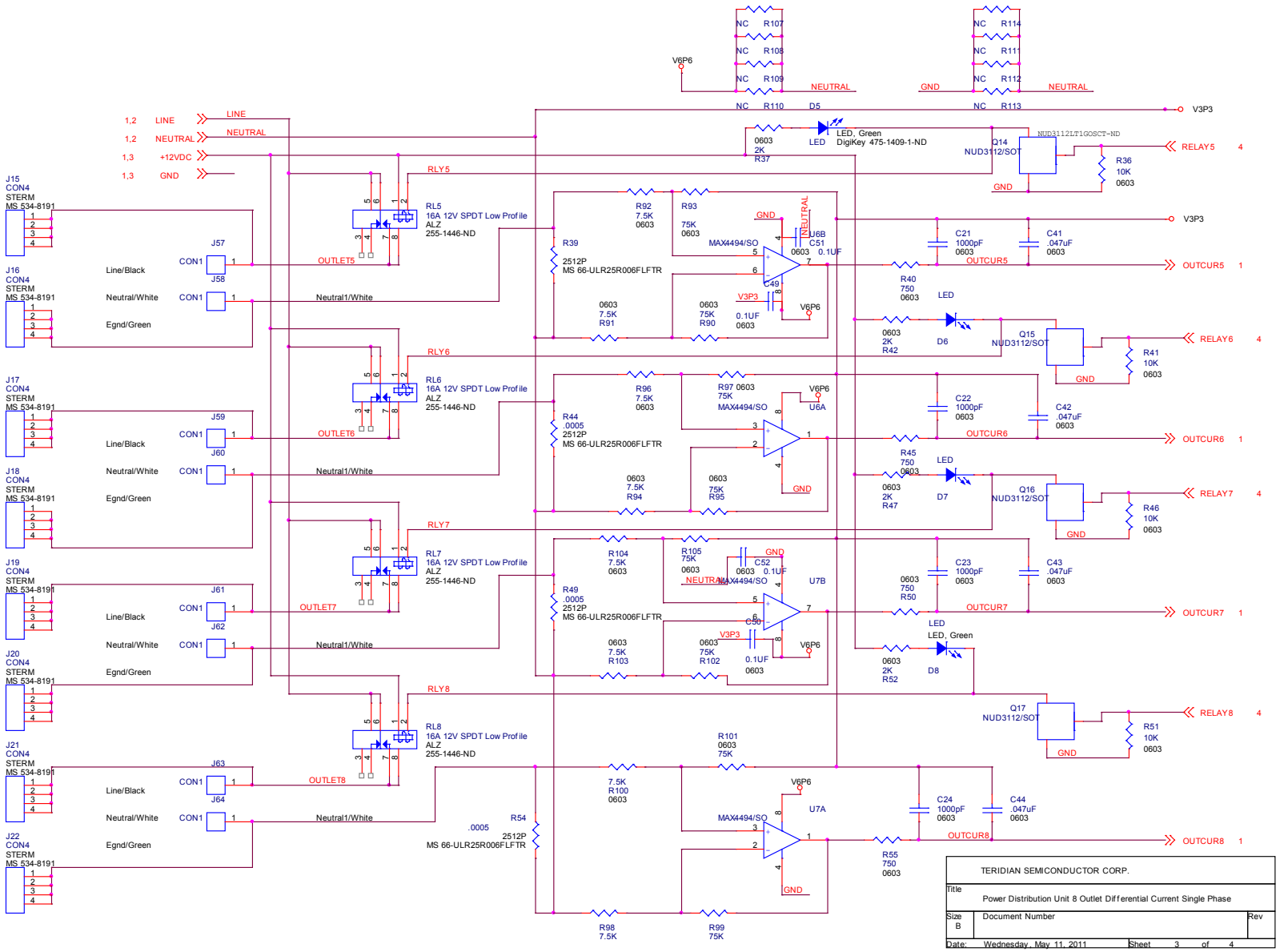


Figure 11: 78M6618 PDU1 Evaluation Board Electrical Schematic (3 of 4)

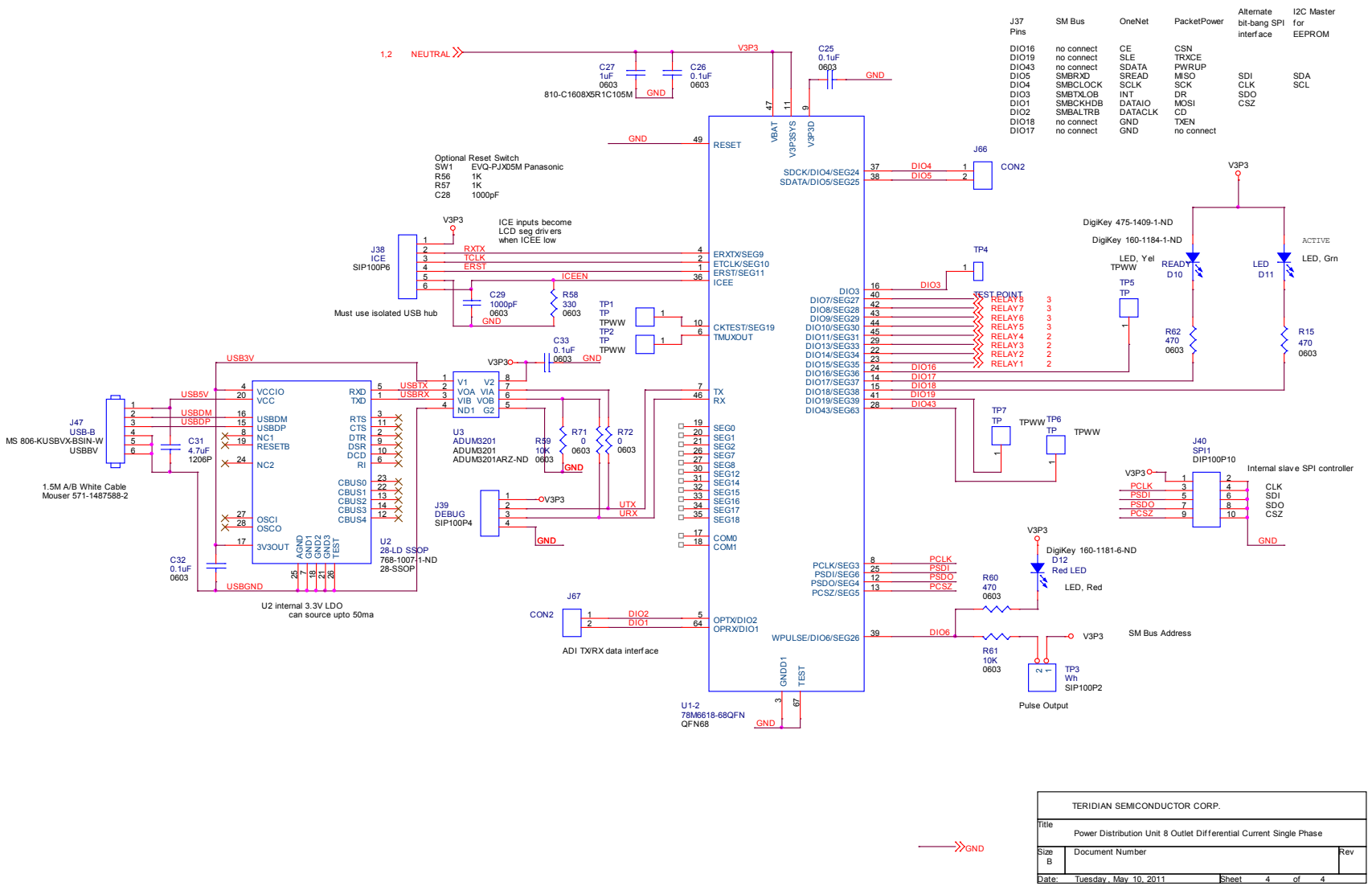


Figure 12: 78M6618 PDU1 Evaluation Board Electrical Schematic (4 of 4)

5.2 78M6618 PDU1 Evaluation Board Bill of Materials

Table 2: 78M6618 PDU1 Evaluation Board Bill of Materials

Item	Qty	Reference	Part	PCB Footprint	Digi-Key MS - Mouser	Part Number	Manufacturer	RoHS
1	15	C1,C3,C15,C25,C26,C32,C33, C45,C46,C47,C48,C49,C50, C51,C52	0.1µF	0603	399-5089-1-ND	C0603C104K5RACTU	KEMET	Yes
2	3	C2,C30,C35	10µF 25V	2312	399-3734-1-ND	T491C106K025AT	KEMET	Yes
3	1	C4		0603	DNP	—	—	—
4	1	C5	100pF	0603	445-1281-1-ND	C1608C0G1H101J	TDK Corporation	Yes
5	11	C6,C8,C17,C18,C19,C20,C21, C22,C23,C24,C29	1000pF	0603	445-1298-1-ND	C1608X7R2A102K	TDK Corporation	Yes Yes
6	1	C7	33pF	0603	399-1055-1-ND	C0603C330J5GACTU	KEMET	Yes
7	1	C9	9pF	0603	445-5046-1-ND	C1608C0G1H090C	TDK Corporation	Yes
8	1	C12	1µF 25V	1206	311-1356-1-ND	CC1206KKX7R8BB105	Yageo	Yes
9	1	C13	220µF 25V lo imp	SMD	493-2278-1-ND	UUD1E221MNL1GS	Nichicon	Yes
10	3	C14,C27,C36	1µF (0603)	0603	490-3897-1-ND	GRM188R61E105KA12D	Murata	Yes
11	1	C31	4.7µF	1206	399-4630-1-ND (1206)	T491A475M025AT	KEMET	Yes
12	8	C37,C38,C39,C40,C41,C42, C43,C44	.047µF	0603	490-1567-1-ND	GRM188F51H473ZA01D	Murata	Yes
13	9	D1,D2,D3,D4,D5,D6,D7,D8,D11	Green LED	0603	475-1409-1-ND	LG Q971-KN-1	OSRAM Opto Semiconductors	Yes
14	2	D9,D12	Red LED	0603	160-1181-6-ND	LTST-C190CKT	Lite-On Inc.	Yes
15	1	D10	Yellow LED	0603	160-1184-1-ND	LTST-C190YKT	Lite-On Inc.	Yes
16	17	J3,J49,J50,J51,J52,J53,J54, J55,J56,J57,J58,J59,J60,J61, J62,J63,J64	CON1	Through Hole	DNP	—	—	—
17	1	J4	TERM BLOCK	Through Hole	A98275-ND	796740-2	TE Connectivity	Yes
18	16	J7,J8,J9,J10,J11,J12,J13,J14, J15,J16,J17,J18,J19,J20,J21, J22	CON4	Through Hole	MS 534-8191	8191	Keystone Electronics	Yes
19	1	J38	ICE	Through Hole	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	Yes
20	1	J39	DEBUG	Through Hole	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	Yes

Item	Qty	Reference	Part	PCB Footprint	Digi-Key MS - Mouser	Part Number	Manufacturer	RoHS
21	1	J40	SPI1	Through Hole	S2011E-36-ND	PBC36DAAN	Sullins Connector Solutions	Yes
22	1	J47	USB-B	Through Hole	MS 806-KUSBVX-BS1N-B	806-KUSBVX-BS1N-B	Kycon	Yes
23	1	J48	RAPC712A	Through Hole	MS 502-RAPC712X	RAPC712X	Switchcraft	Yes
24	2	J66,J67	CON2	Through Hole	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	Yes
25	2	LOGO1,LOGO2	Logo	Silkscreen	—	—	—	—
26	5	TP1,TP2,TP5,TP6,TP7	TP	Through Hole	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	Yes
27	8	Q10,Q11,Q12,Q13,Q14,Q15,Q16,Q17	INDCT LOAD/RELAY DRVR	SOT-23-3	NUD3112LT1GOSCT-ND	NUD3112LT1G	ON Semiconductor	Yes
28	8	RL1,RL2,RL3,RL4,RL5,RL6,RL7,RL8	16A 12V SPDT Low Profile	Through Hole	255-1446-ND	ALZ12F12	Panasonic	Yes
29	1	R1	16.9K 1%	0603	P16.9KHCT-ND	ERJ-3EKF1692V	Panasonic	Yes
30	9	R2,R16,R22,R27,R32,R37,R42,R47,R52	2K	0603	P2.0KGCT-ND	ERJ-3GEYJ202V	Panasonic	Yes
31	1	R3	20.0K 1%	0603	P20.0KHCT-ND	ERJ-3EKF2002V	Panasonic	Yes
32	2	R4,R7	750 0.1%	0603	P750YCT-ND	ERA-3YEB751V	Panasonic	Yes
33	4	R5,R6,R8,R9	1M 0.1%	1206	MS 660-RN732BTTD1004B25	RN732BTTD1004B25	KOA Speer	Yes
34	3	R15,R60,R62	470	0603	P470GCT-ND	ERJ-3GEYJ471V	Panasonic	Yes
35	10	R17,R21,R26,R31,R36,R41,R46,R51,R59,R61	10K	0603	P10.0KHCT-ND	ERJ-3EKF1002V	Panasonic	Yes
36	8	R19,R29,R34,R39,R44,R49,R54,R81	0.0005	2512	MS 66-ULRB2R0005FLFSLT	ULRB22512R0005FLFSLT	IRC	Yes
37	8	R20,R25,R30,R35,R40,R45,R50,R55	750	0603	P750GCT-ND	ERJ-3GEY0R00V	Panasonic	Yes
38	1	R58	330	0603	P330HCT-ND	ERJ-3EKF3300V	Panasonic	Yes
39	2	R71,R72	0	0603	P0.0GCT-ND	ERJ-3GEY0R00V	Panasonic	Yes
40	16	R73,R76,R77,R80,R82,R85,R86,R89,R90,R93,R95,R97,R99,R101,R102,R105	75K	0603	RG16P75.0KBCT-ND	RG1608P-753-B-T5	Susumu	Yes

Item	Qty	Reference	Part	PCB Footprint	Digi-Key MS - Mouser	Part Number	Manufacturer	RoHS
41	16	R74,R75,R78,R79,R83,R84, R87,R88,R91,R92,R94,R96, R98,R100,R103,R104	7.5k	0603	RG16P7.5KBCT-ND	RG1608P-752-B-T5	Susumu	Yes
42	1	R106	11K	0603	P11KGCT-ND	ERJ-3GEYJ113V	Panasonic	Yes
43	8	R107,R108,R109,R110,R111, R112,R113,R114	2.5k	0603	DNP	—	—	—
44	1	TP3	Wh	Through Hole	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	Yes
45	1	TP4	TEST POINT	Through Hole	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	Yes
46	1	U1	78M6618-68QFN	68-QFN	—	—	Maxim	Yes
47	1	U2	FTDI 28-SSOP	28-SSOP	768-1007-1-ND	FT232RL-REEL	FTDI	Yes
48	1	U3	ADUM3201	8-SOIC	ADUM3201ARZ-ND	ADUM3201ARZ	Analog Devices	Yes
49	4	U4,U5,U6,U7	OP AMP	8-SOIC	LM2904MXCT-nd	LM2904MX	ROHM Semiconductor	Yes
50	2	U10,U11	78L33	SOT-89-3	497-1200-1-ND	L78L33ACUTR	STMicroelectronics	Yes
51	1	Y1	32.768KHz	4-SOJ	535-9166-1-ND	ABS25-32.768KHZ-T	Abracon Corporation	Yes
52	6	MT1,MT2,MT3,MT4,MT5,MT6	STANDOFFS	Through Hole	MS 534-1809	1809	Keystone Electronics	Yes
53	6	standoff bumpers	RUBBER	N/A	MS 534-720	720	Keystone Electronics	Yes
54	12	# 4 screws for stand offs	Screws	Through Hole	H346	PMS 440 0050 PH	B&F Fastener Supply	Yes

5.3 78M6618 PDU1 Evaluation Board PCB Layouts

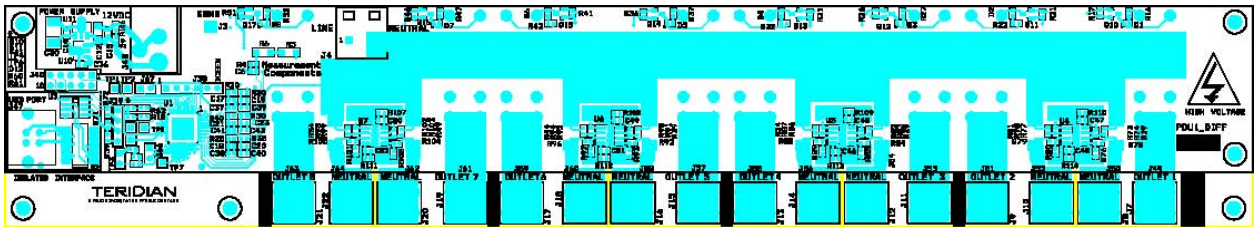


Figure 13: 78M6618 PDU1 Evaluation Board PCB Top View

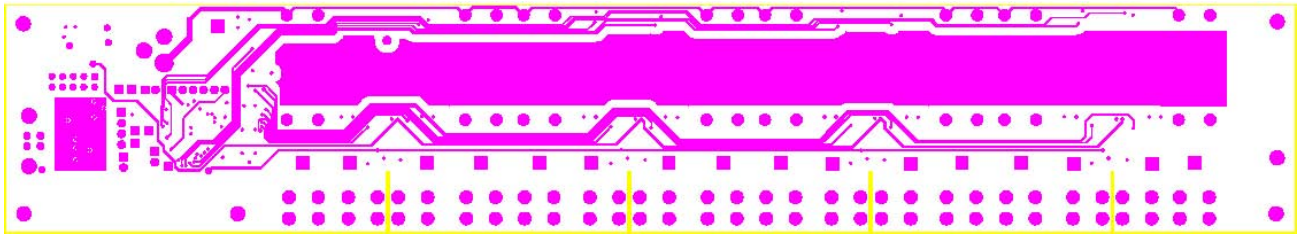


Figure 14: 78M6618 PDU1 Evaluation Board PCB Power View

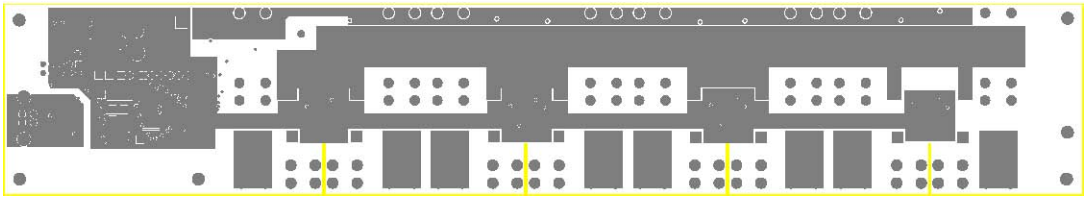


Figure 15: 78M6618 PDU1 Evaluation Board PCB GND View

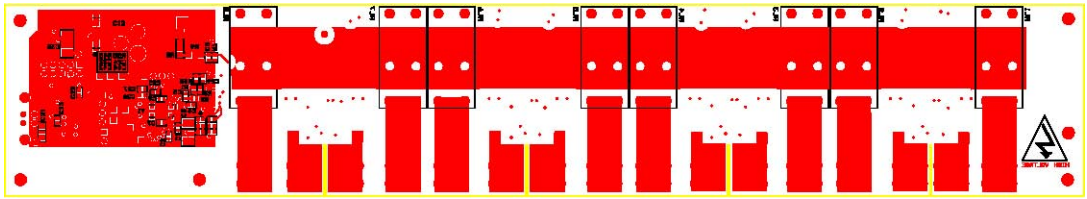


Figure 16: 78M6618 PDU1 Evaluation Board PCB Bottom View

6 Ordering Information

Part Description	Order Number
78M6618 PDU1 Evaluation Board	78M6618-PDU-1

7 Contact Information

For more information about Maxim products or to check the availability of the 78M6618, contact technical support at **www.maxim-ic.com/support**.

Appendix A - 78M6618 PDU1 Board with CTs

This appendix includes the photograph, schematics, bill of materials, and layout images for a comparable 78M6618 PDU1 evaluation board using current transformers (CTs) in place of current shunt resistors. The information on this board is provided as reference only and is not available for purchase.

A.1 78M6618 PDU-CT Evaluation Board

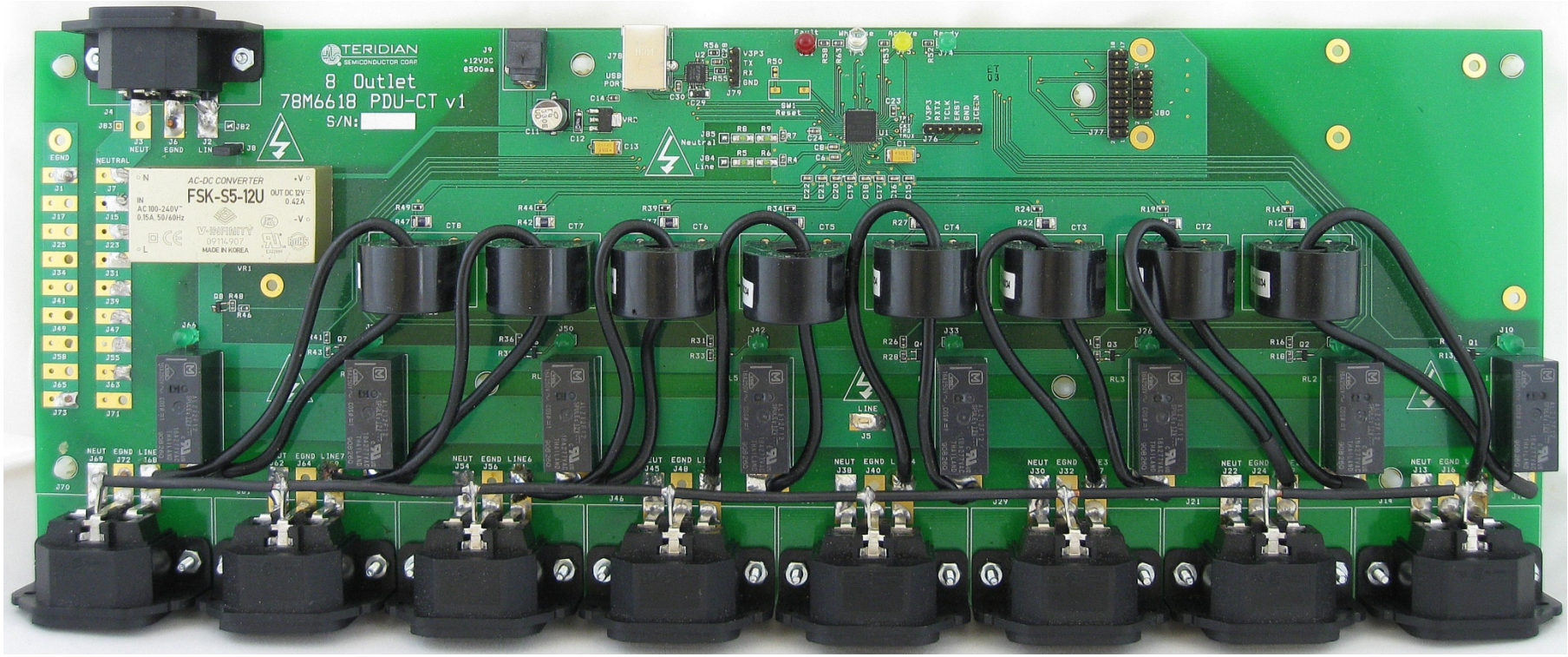


Figure 17: 78M6618 PDU-CT Evaluation Board

A.2 78M6618 PDU-CT Evaluation Board Schematics

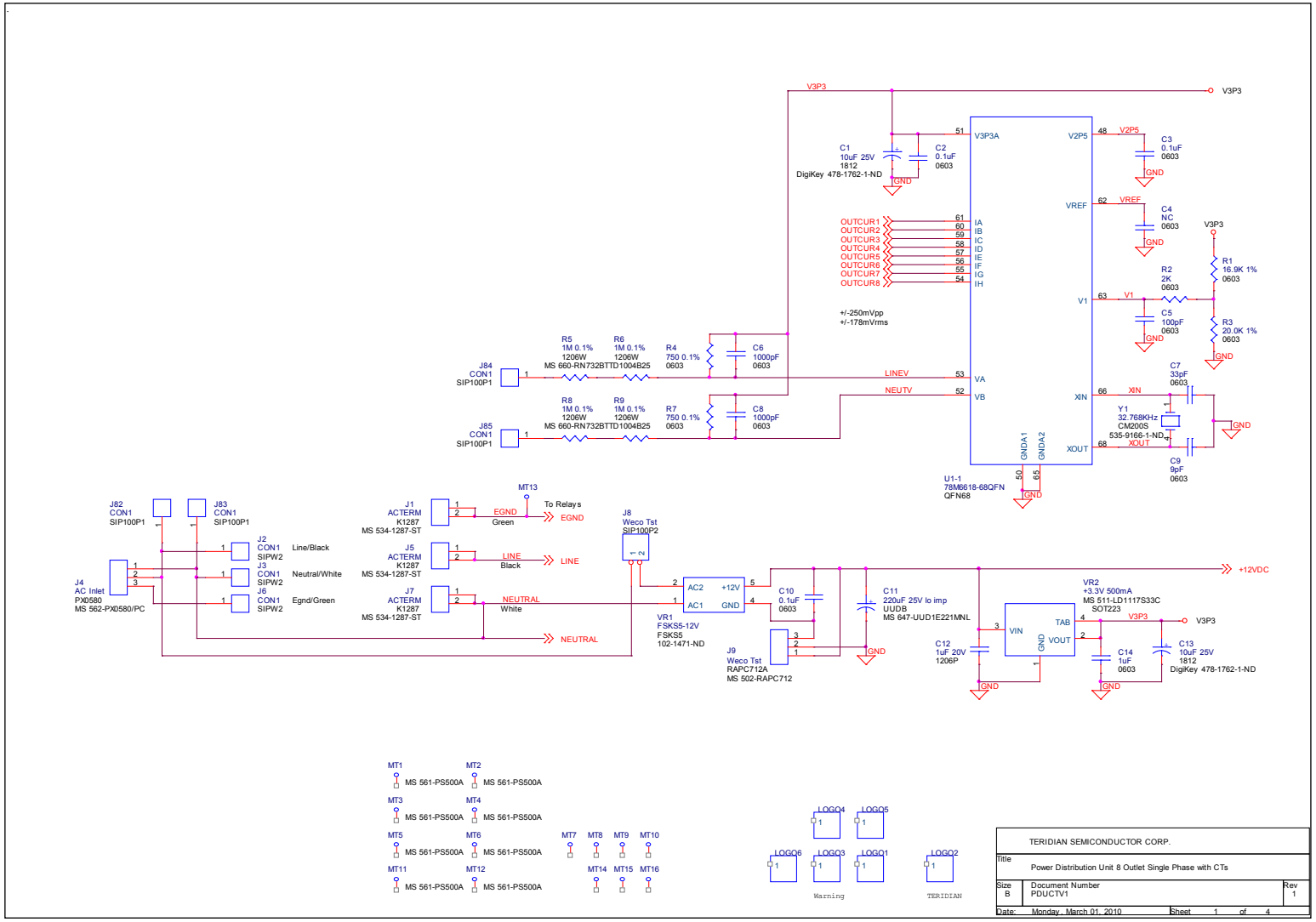


Figure 18: 78M6618 PDU-CT Evaluation Board Electrical Schematic (1 of 4)

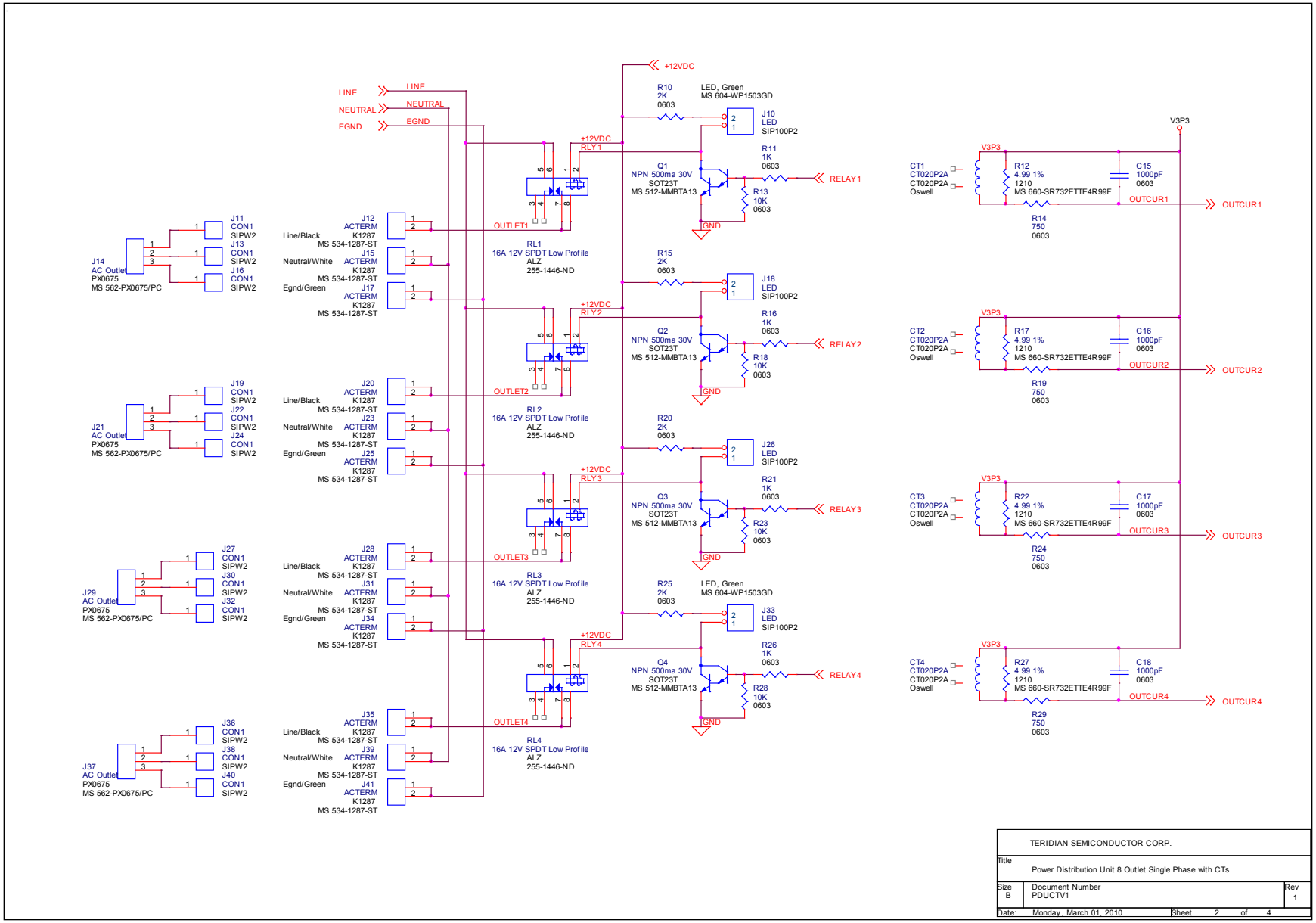


Figure 19: 78M6618 PDU-CT Evaluation Board Electrical Schematic (2 of 4)

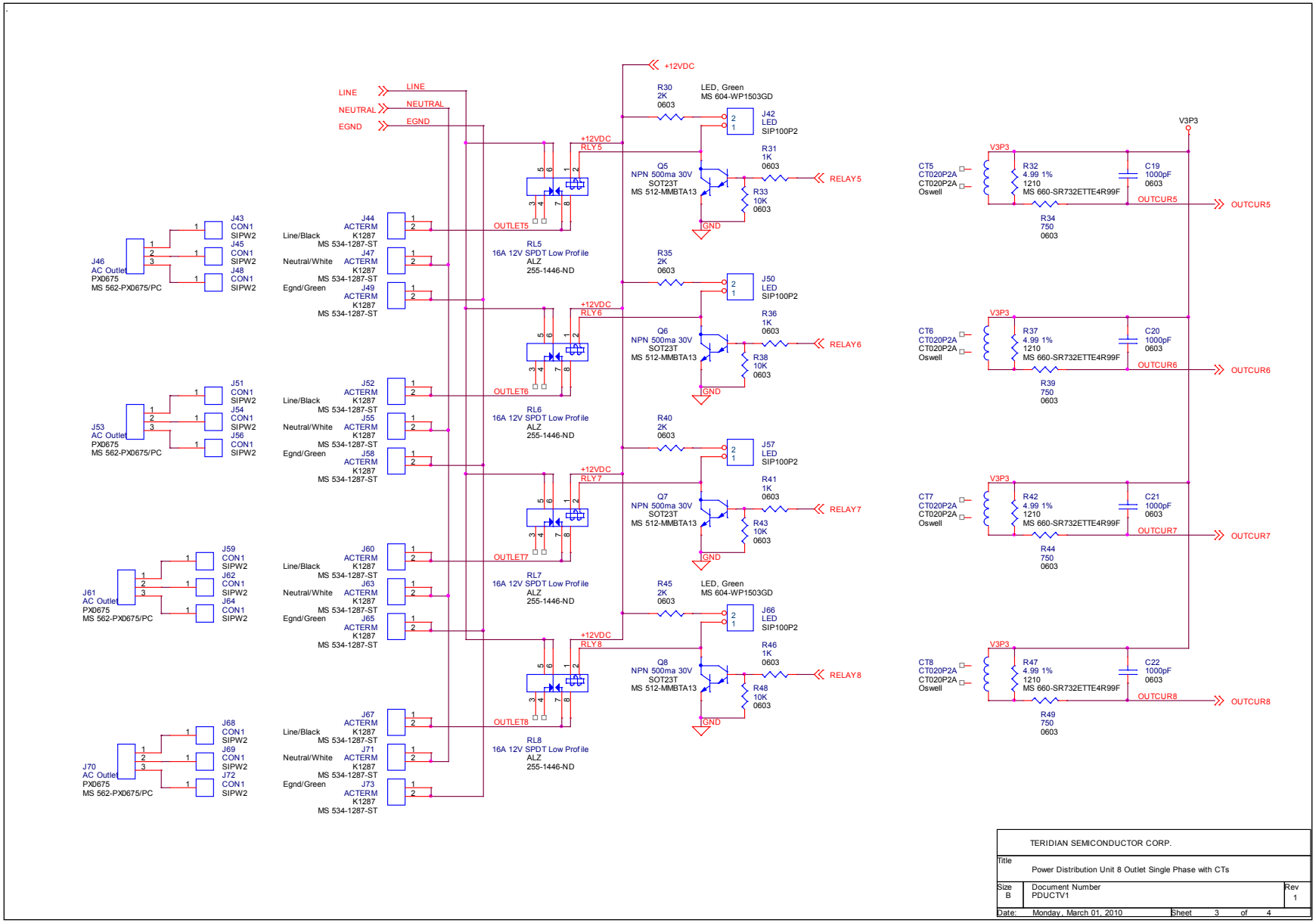


Figure 20: 78M6618 PDU-CT Evaluation Board Electrical Schematic (3 of 4)

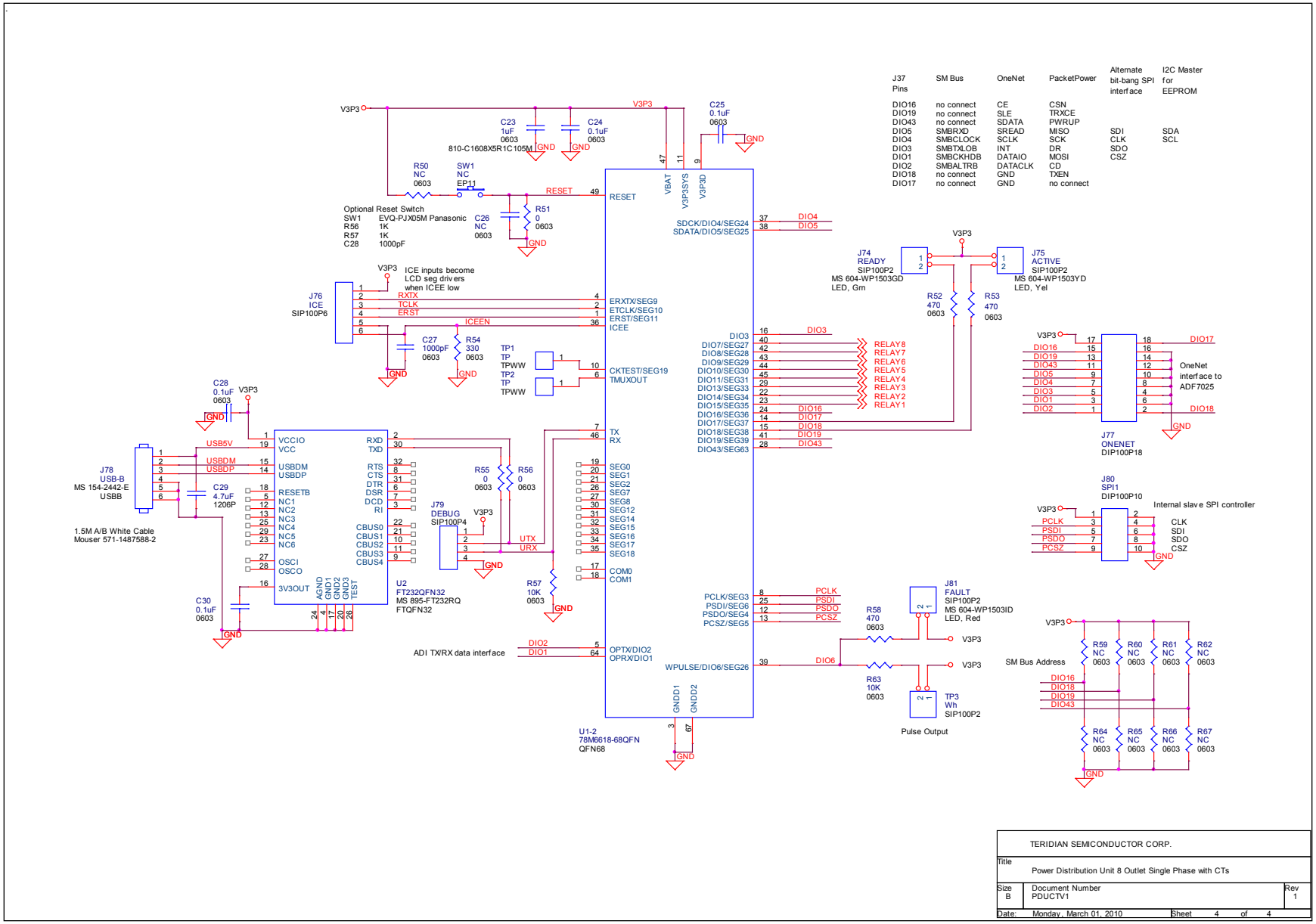


Figure 21: 78M6618 PDU-CT Evaluation Board Electrical Schematic (4 of 4)

A.3 78M6618 PDU-CT Evaluation Board Bill of Materials

Table 3: 78M6618 PDU-CT Evaluation Board Bill of Materials

Item	Q	Reference	Part	PCB Footprint	Part Number
1	8	CT1,CT2,CT3,CT4,CT5,CT6,CT7,CT8	CT020P2A	CT020P2A	582-1084-ND
2	2	C1,C13	10uF 25V	1812	478-1762-1-ND
3	7	C2,C3,C10,C24,C25,C28,C30	0.1uF	603	490-1519-1-ND
4	1	C5	100pF	603	445-1281-1-ND
5	11	C6,C8,C15,C16,C17,C18, C19,C20,C21,C22,C27	1000pF	603	445-1298-1-ND
6	1	C7	33pF	603	399-1055-1-ND
7	1	C9	9pF	603	445-5046-1-ND
8	1	C11	220uF 25V lo imp	UUDB	MS 647-UUD1E221MNL
9	1	C12	1uF 20V	1206P	445-1381-1-ND
10	2	C14,C23	1uF	603	445-1328-1-ND
11	1	C29	4.7uF	1206P	478-2396-1-ND
12	1	J4	AC Inlet	PX0580	MS 161-PX0580/PC
13	1	J8	Weco Tst	SIP100P2	S1011E-36-ND
14	1	J9	Weco Tst	RAPC712A	MS 502-RAPC712x
15	9	J10,J18,J26,J33,J42,J50,J57,J66,J74	LED,GREEN	SIP100P2	MS 604-WP1503GD
16	8	J14,J21,J29,J37,J46,J53,J61,J70	AC Outlet	PX0675	MS 161-PX0675/PC
17	1	J75	ACTIVE,YELLOW	SIP100P2	MS 604-WP1503YD
18	1	J76	ICE	SIP100P6	S1011E-36-ND
19	1	J77	ONENET	DIP100P18	S2011E-36-ND
20	1	J78	USB-B	USBB	MS 154-2442-E
21	1	J79	DEBUG	SIP100P4	S1011E-36-ND
22	1	J80	SPI1	DIP100P10	S2011E-36-ND
23	1	J81	FAULT,RED	SIP100P2	MS 604-WP1503ID
24	8	MT1,MT2,MT3,MT4,MT5,MT6,MT11,MT12	TP	MTGPS.PRT	MS 561-PS500A
25	8	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8	NPN 500ma 30V	SOT23T	MS 512-MMBTA13
26	8	RL1,RL2,RL3,RL4,RL5,RL6,RL7,RL8	16A 12V SPDT	ALZ	255-1446-ND

Item	Q	Reference	Part	PCB Footprint	Part Number
27	1	R1	16.9K 1%	603	P16.9KHCT-ND
28	9	R2,R10,R15,R20,R25,R30,R35,R40,R45	2K	603	P2.0KGCT-ND
29	1	R3	20.0K 1%	603	P20.0KHCT-ND
30	2	R4,R7	750 0.1%	603	P750YCT-ND
31	4	R5,R6,R8,R9	1M 0.1%	1206W	
32	8	R11,R16,R21,R26,R31,R36,R41,R46	1K	603	P1.00KHCT-ND
33	8	R12,R17,R22,R27,R32,R37,R42,R47	4.99 1%	1210	MS SR732ELTE4R99F
34	10	R13,R18,R23,R28,R33, R38,R43,R48,R57,R63	10K	603	P10.0KHCT-ND
35	8	R14,R19,R24,R29,R34, R39,R44,R49	750 5%	603	P750GCT-ND
36	3	R51,R55,R56	0	603	P0.0GCT-ND
37	3	R52,R53,R58	470	603	P470GCT-ND
38	1	R54	330	603	P330HCT-ND
39	1	TP3	Wh	SIP100P2	S1011E-36-ND
40	1	U1	78M6618-IM/F	QFN68	Maxim
41	1	U2	FT232QFN32	FTQFN32	MS 895-FT232RQ
42	1	VR1	FSKS5-12V	FSKS5	102-1471-ND
43	1	VR2	+3.3V 500mA	SOT223	497-1241-1-ND
44	1	Y1	32.768KHz	CM200S	535-9166-1-ND

A.4 78M6618 PDU-CT Evaluation Board PCB Layouts

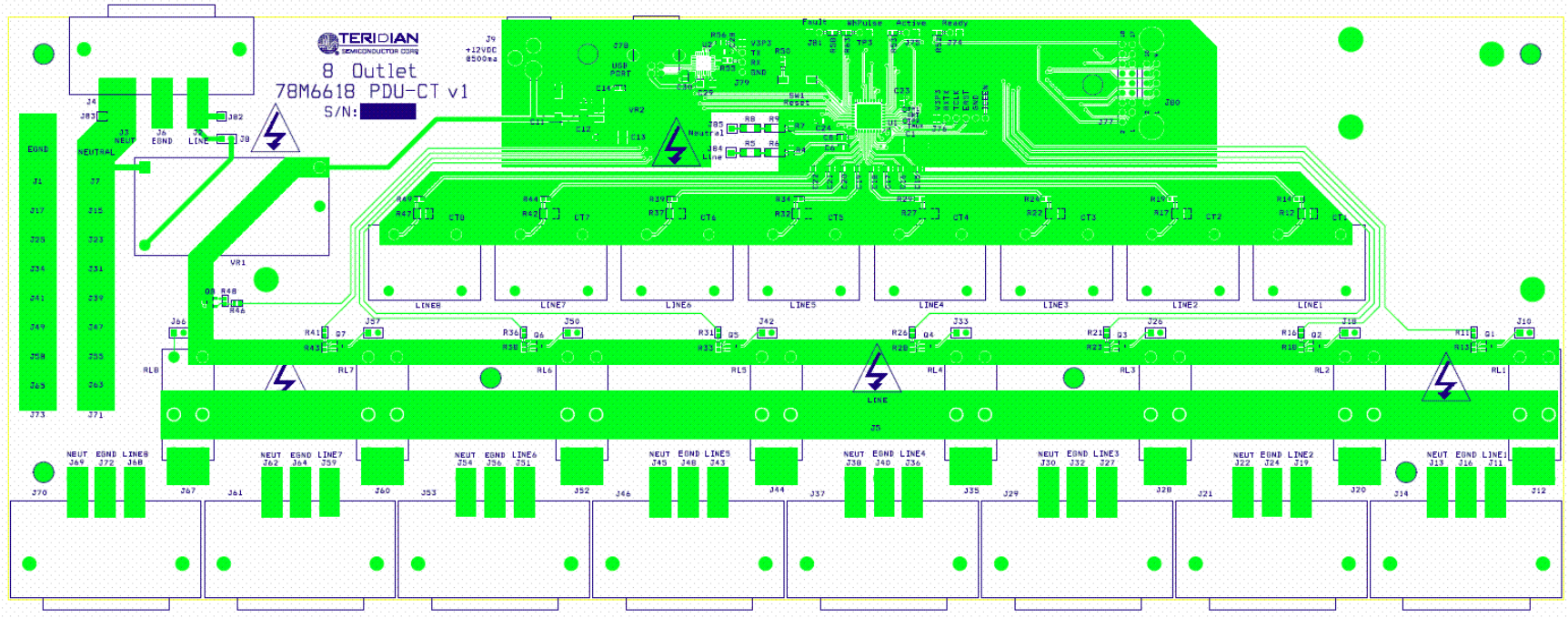


Figure 22: 78M6618 PDU-CT Evaluation Board PCB Top View

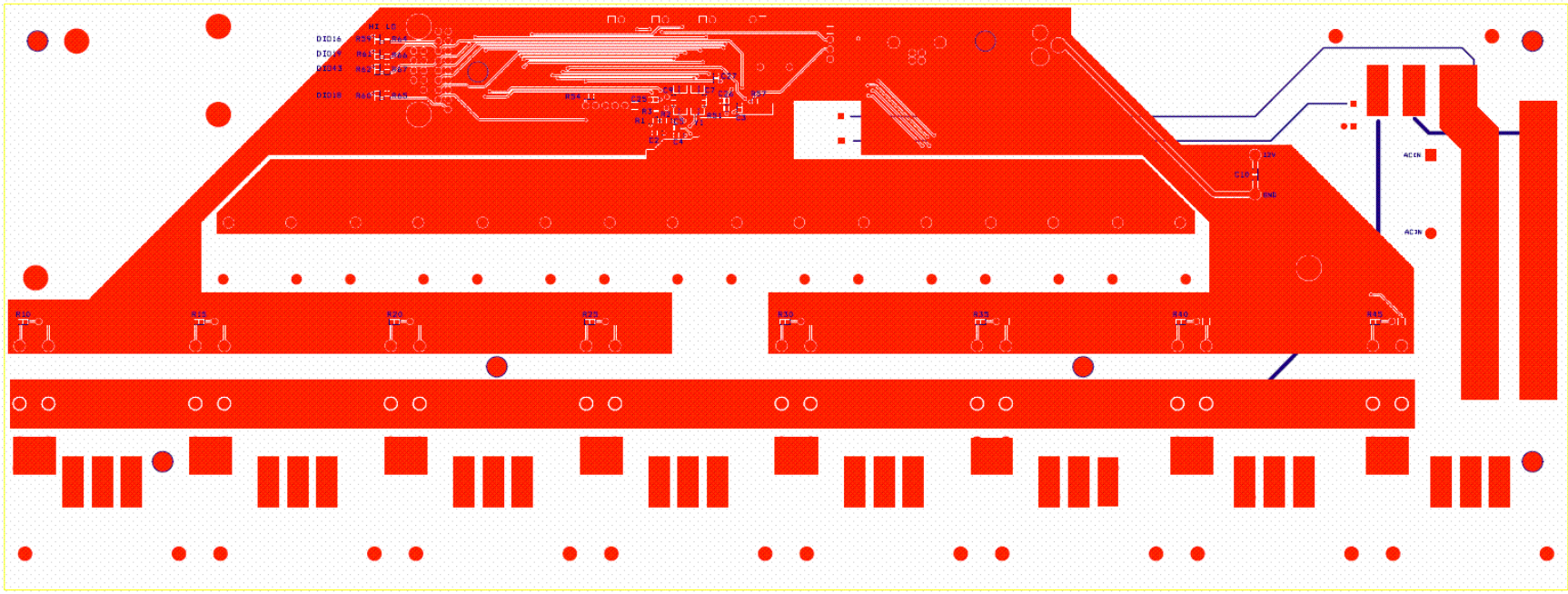
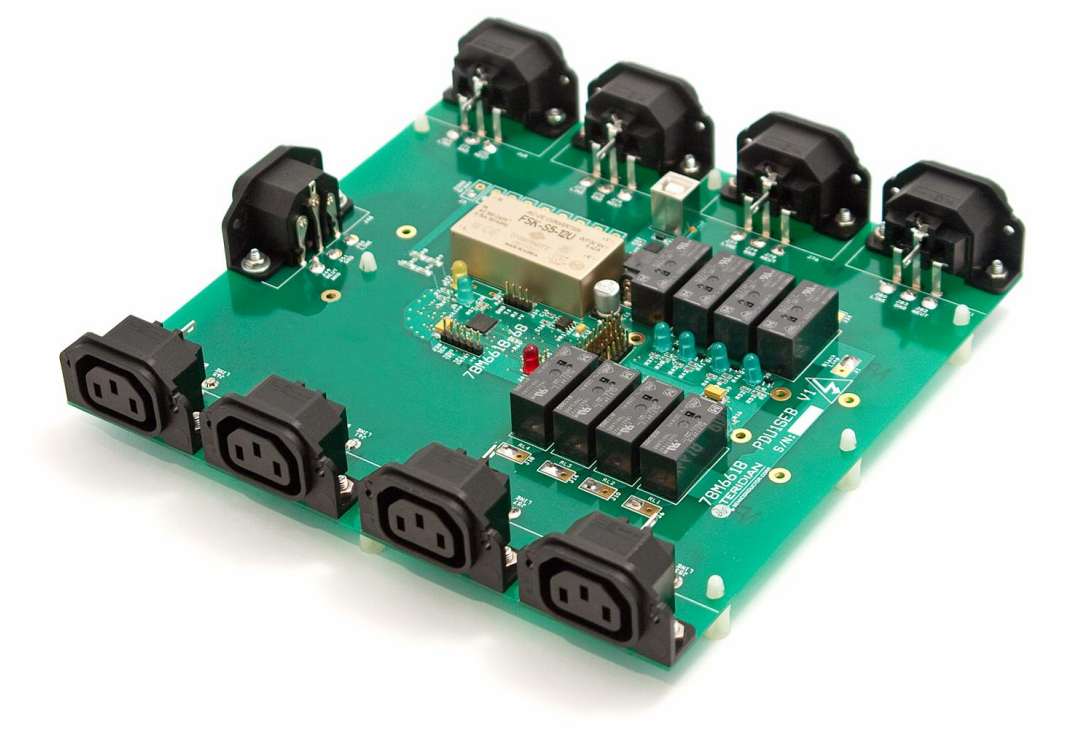


Figure 23: 78M6618 PDU-CT Evaluation Board PCB Bottom View

Appendix B – 78M6618 PDU1 Version 1 (Single-Ended Shunt)

This appendix includes a photograph of the original 78M6618 PDU1 evaluation board using a single-ended shunt topology. The user documentation for this board is available by request. This board is no longer available for purchase.



Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION
1.0	3/10/2010	First publication.
2.0	9/11	Changed the document to reflect the new board revision. Added Appendix B.
3	11/11	Removed "_DIFF" from "PDU1_DIFF" in all places except where referring to the board imprint. Deleted the NI RunTime, LabWindows, and Trouble-Shooting sections. These sections are no longer applicable. Corrected Table 1, COM Port Setup Parameters. Replaced Figure 2 with a new screenshot.