



78M6613 PSU Board User Manual

May 2011
Rev. 1.2
UM_6613_046

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1 Introduction

The Teridian Semiconductor Corporation (TSC) 78M6613 PSU Board is an electrical measurement unit for performing measurements of a single-phase AC load or power supply. It incorporates the TSC 78M6613 power- and energy-measurement IC and connects to a PC through a USB cable and a shunt adaptor board such as the one provided in the demo kit. The PSU Board demonstrates the capability of the 78M6613 energy-meter controller chip for measurement accuracy and overall system use.

The board is preprogrammed with Firmware Demo Code (file name 6613_PSU_S1_URT_V1_0.hex) in the flash memory of the 78M6613 IC that allows evaluation of the IC's capabilities.

The 78M6613 energy-measurement data and status is read back over the serial UART interface using a text-based command line interface (CLI) command set. Easy manual operation is performed using HyperTerminal. Refer to the *6613_PSU_S1_URT_V1_0 Firmware Description Document* for invocation usage of the CLI commands.



1.1 Package Contents

The 78M6613 PSU Board Demo Kit includes:

- 78M6613 PSU Board
- Shunt adaptor board
- USB Cable Assembly USB A-B 28/24 1.8M (Tyco/Amp 1487588-3)
- CD with documentation

1.2 System Requirements

The 78M6613 PSU Board requires use of a PC with the following features:

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

Windows XP is a registered trademark of Microsoft Corp.

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 78M6613 contains ESD protected interfaces.

Do not connect test equipment, ICE emulators or external development boards directly to the 78M6613 hardware. Damage to the 78M6613 and external equipment will occur due to the 78M6613's "high side" reference topology. The 78M6613's V3P3 (i.e. "high side") is connected directly to Neutral (Earth Ground) creating a ground reference disparity with any properly grounded external equipment.

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.

The following setup is used to facilitate performance evaluation between the user at the PC host and the firmware code in the board:

- The CLI through HyperTerminal or comparable terminal emulator on a different operating system. For information about the CLI, see the *6613_PSU_S1_URT_V1_0 Firmware Description Document*.

The 78M6613 is shipped with Firmware Demo Code Revision 1.0 or later loaded in the 78M6613 chip 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 the Signum Systems ADM-51 (www.signum.com).

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

Voltage	Current	Line Frequency
110-240 VAC	10 mA – 20A	46-64 Hz

1.5 Testing the 78M6613 PSU Board Prior to Shipping

Before every 78M6613 PSU Board is shipped, the following procedures have been performed at the factory:

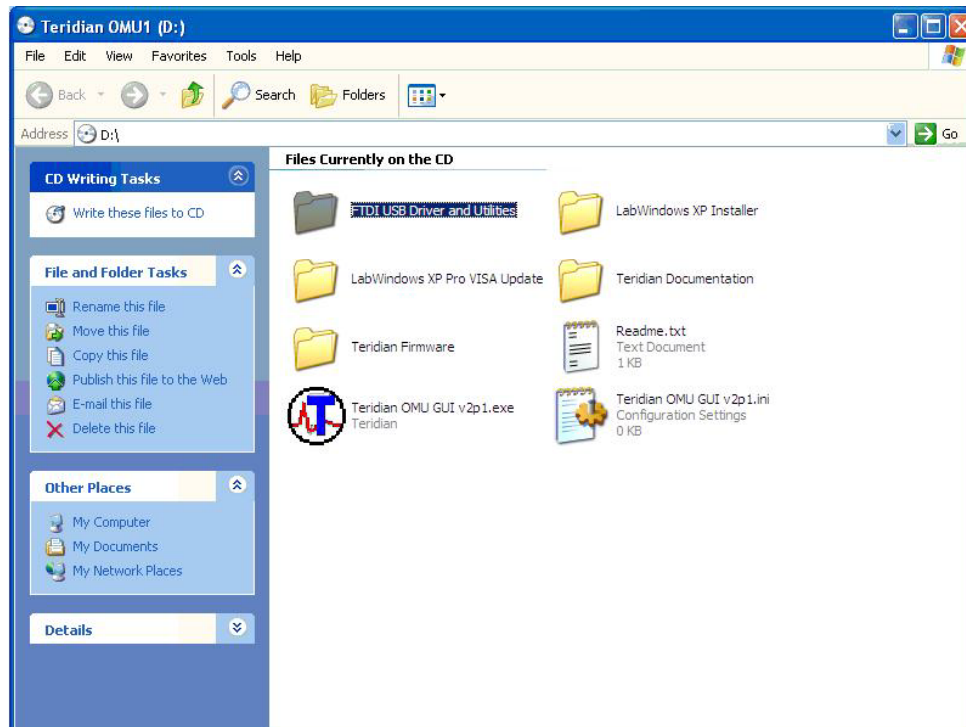
- Full Calibration – Precise energy source equipment is used to calibrate the current and voltage. The temperature is also calibrated at the same time.
- Accuracy Test – This "bench" level test ensures the energy accuracy is within $\pm 0.5\%$.

2 Installation

2.1 USB 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 driver for Windows® presents a virtual COM port for enabling serial communications. Control of the 78M6613 PSU Board can be managed using a terminal emulation program. The FTDI Windows driver is a certified driver for Windows 2000 and Windows XP.

1. After attaching the 78M6613 PSU Board 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 power is applied to the 78M6613 PSU Board.

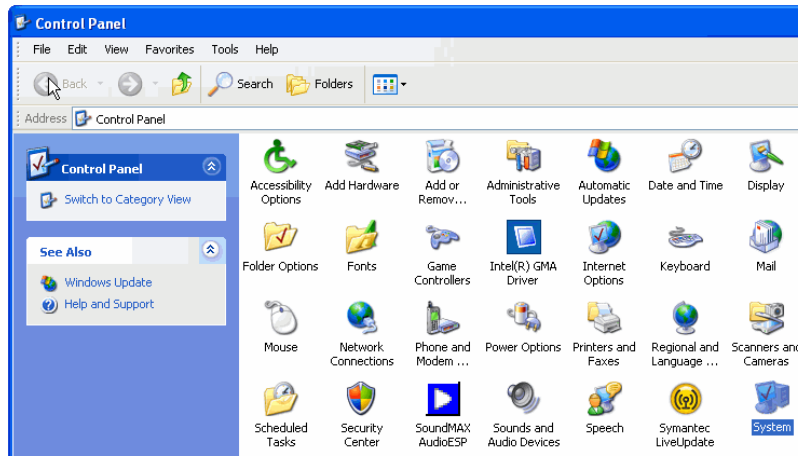


Note: If an older FTDI driver has been previously installed, it is recommended to remove the older version before installing this newer FTDI driver. Execute the **ftdiClean.exe** utility from the FTDI USB Driver and Utilities subdirectory.

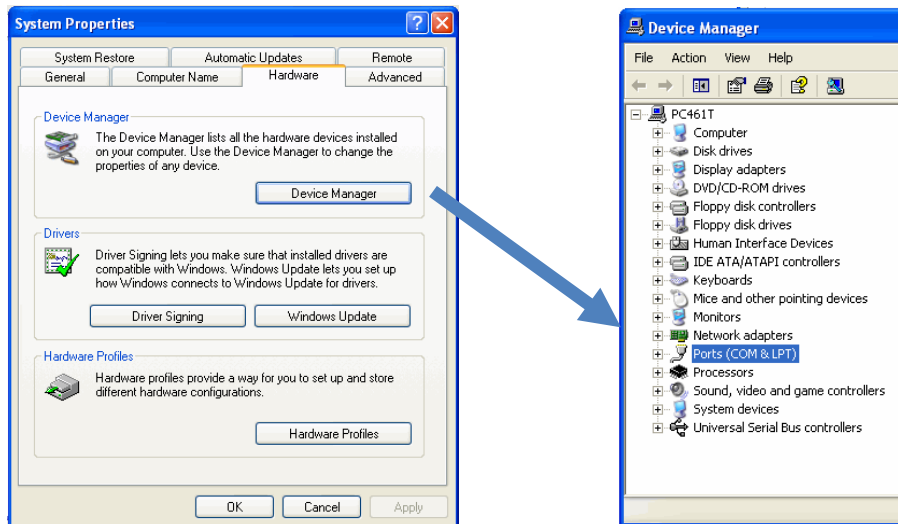
For FTDI driver support on other operating systems, refer to FTDI's website at (www.ftdichip.com/FTDrivers.htm).

2.2 Confirm COM Port Mapping

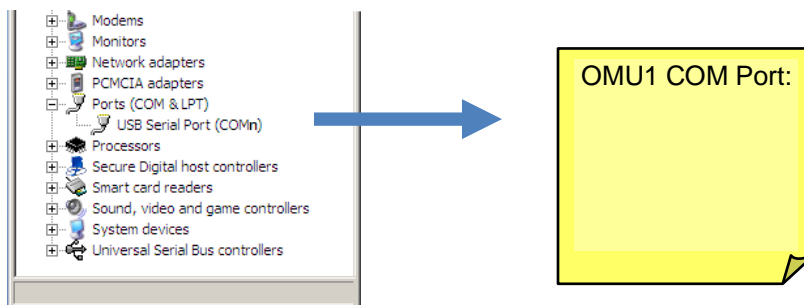
1. Launch the **Control Panel** and click on the **System** icon.



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.



2.3 Basic Connection Setup

Figure 1 shows the basic connections of the 78M6613 PSU Board for use with external equipment. The 78M6613 PSU Board is powered through the USB cable. This same USB cable provides the communications link between the host PC and the 78M6613 PSU Board. The shunt adaptor board consists of a USB serial UART controller, serial interface isolator and a DC/DC isolator, current shunt, and AC wiring terminals. Connect J2 and J3 to an external AC power source. Connect J1 and J4 to the load to be measured.

The 78M6613 PSU Board accepts 120 VAC and 230 VAC (nominal) up to 300 VAC (max).

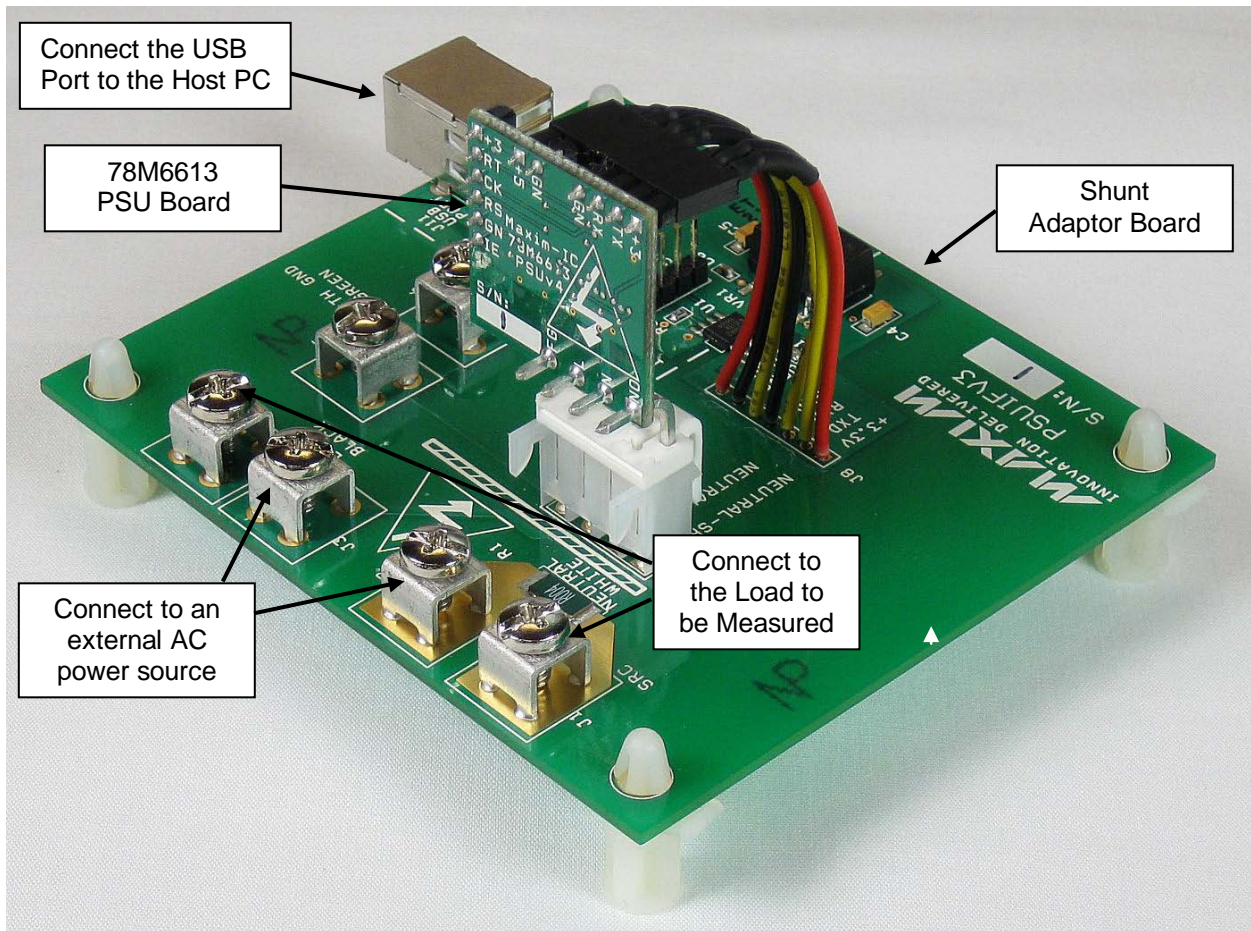


Figure 1: 78M6613 PSU Board Connections

Attach the Shunt Adaptor's J8 cable harness to the 78M6613 PDU Board's J2 and J3 pin headers as shown in Figure 1.

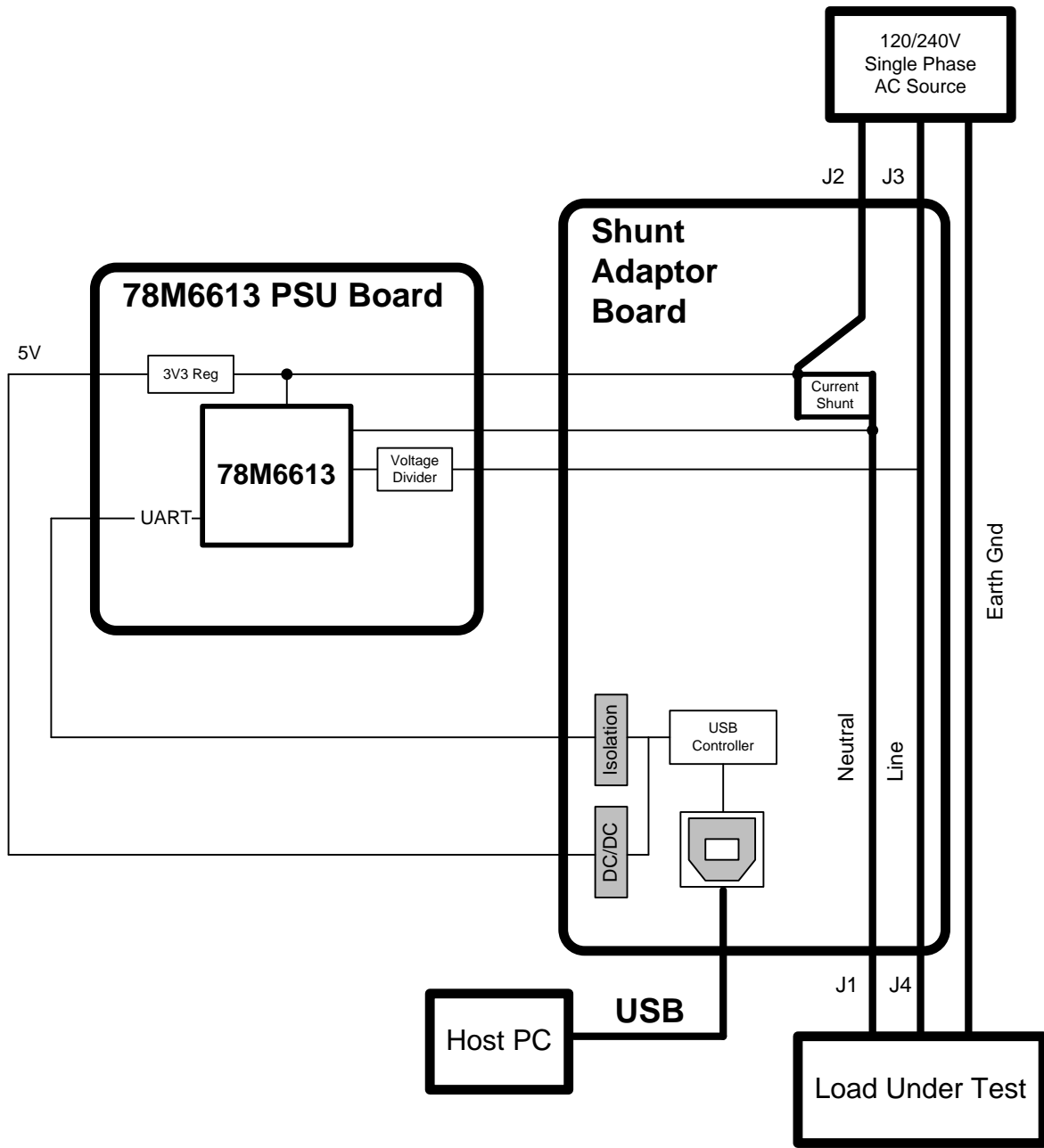


Figure 2: 78M6613 PSU Board Application Diagram

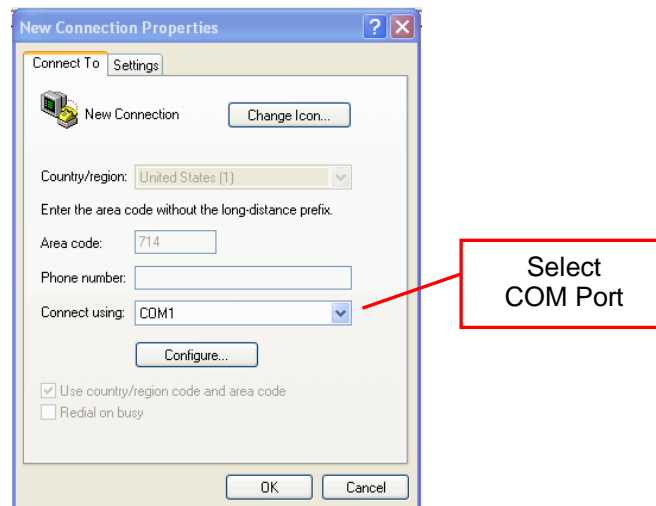
2.4 Verify Serial Connection to the PC

After connecting the USB cable from the 78M6613 PSU Board to the host PC, start the HyperTerminal application (or another suitable communication program) and create a session using the communication parameters shown in Table 1.

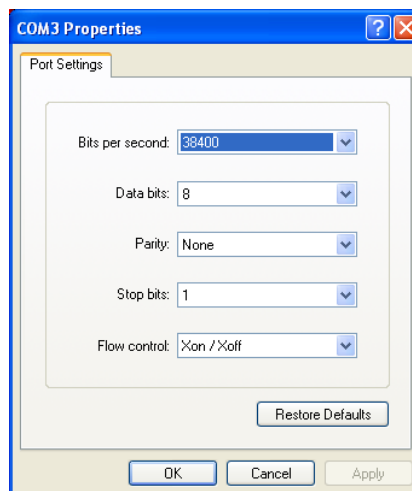
Table 1: COM Port Setup Parameters

Setup Parameter	78M6613
Port speed (baud)	38400
Data bits	8
Parity	None
Stop bits	1
Flow control	Xon/Xoff

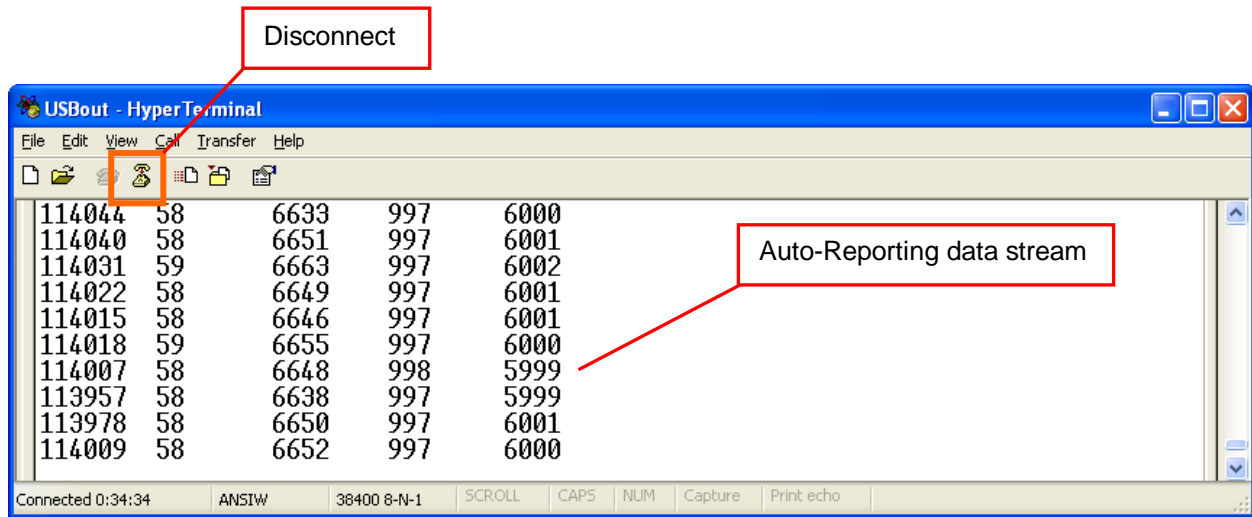
HyperTerminal can be found in Windows by selecting **Start** → **All Programs** → **Accessories** → **Communications** → **HyperTerminal**. The connection parameters are configured by selecting **File** → **Properties**. The **New Connection Properties** menu appears.



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 to disconnect the port.



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 2.2 for access to the Device Manager. If a Ball Point device exists, delete it and unplug and replug the evaluation board’s USB cable.

The 6613_PSU_S1_URT_V1_0 firmware defaults to an Auto-Reporting mode. Auto-reported AC measurement data packets consisting of Voltage, Current, Watt, Power Factor and Line Frequency are sent every accumulation cycle. Measurement data packets are sent over the UART in ASCII format followed by a line feed and carriage return.

Table 2: Auto-Reporting Data Packet Contents

Vrms	Irms	Watts	PF	Freq	LF + CR
------	------	-------	----	------	---------

Table 3 lists the measurement parameters and their respective bit resolutions (LSB) that are sent over the UART in ASCII format.

Table 3: Auto-Reporting Data Parameter Format

Measurement Parameter	Resolution (LSB)
Voltage (Vrms)	mV
Current (Irms)	mA
Active Power (Watts)	mW
Power Factor (PF)	Range between 0 and 1000. 1000 indicative of 1.0 PF
Line Frequency (Freq)	0.01 Hz

When using the CLI, disable the Auto-Reporting mode. Enter **Ctrl-Z** to toggle the Auto-Reporting mode on and off.

CLI measurement can be displayed in two different formats: human readable or twos complement. Both formats are returned as ASCII character strings. The following figure uses CLI commands to return the same data presented in the Auto-Reporting mode.

```

USBout - HyperTerminal
File Edit View Call Transfer Help
114022 58 6649 997 6001
114015 58 6646 997 6001
114018 58 6649 997 6000
114007 58 6649 997 5999
113957 58 6649 997 5999
113978 58 6649 997 6001
114009 58 6649 997 6000
>
>i
TSC 78M6613 PSU Standard V1.0, Aug 25 2008
All Rights Reserved
CE6612_0MU_1+S_F01_V1_0
>
>)26?)2A?)27?)2D?)21?
+112.383 +0.058 +6.505 +0.997 +60.00
>
>)26$)2A$)27$)2D$)21$
0001B7EA 0000003A 0000197E 000003E5 00001771
>_
Connected 0:29:00 ANSIW 38400 8-N-1 SCROLL CAPS NUM Capture Print echo
  
```

Callouts in the image:

- Red box around the first few lines of data: "Ctrl Z issued here"
- Red box around the CLI mode prompt: "CLI mode prompt"
- Red box around the command `>)26?)2A?)27?)2D?)21?`: "Use '?' for Human Readable format"
- Red box around the command `>)26$)2A$)27$)2D$)21$`: "Use '\$' for 2s-complement format"

Refer to the *6613_PSU_S1_URT_V1_0 Firmware Description Document* for a complete description of available CLI commands and their invocation usage.

2.5 In-Circuit Emulator (ICE) Adaptor

The 78M6613 firmware (stored in internal flash memory) can be updated to accommodate program enhancements. Use the Signum ADM51 or the Teridian TFP-2 to download new firmware to the 78M6613. The supplied ICE Adaptor is required to interface the flat ribbon cable (provided with the ADM51 or TFP-2) to the 78M6613 PSU Board.

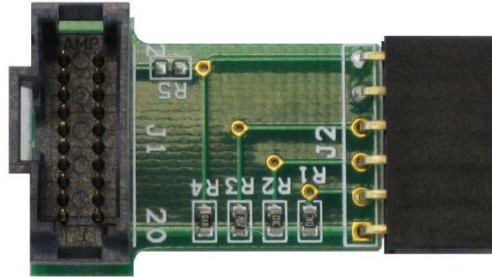


Figure 3: ICE Adaptor

Figure 4 shows how to attach the ICE Adaptor to the 78M6613 PSU Board. Make note of the orientation of the ICE Adaptor as to how it attaches to the 78M6613 PSU Board (V3P3 ICE Adaptor pin connects to the +3 PSU Board pin).

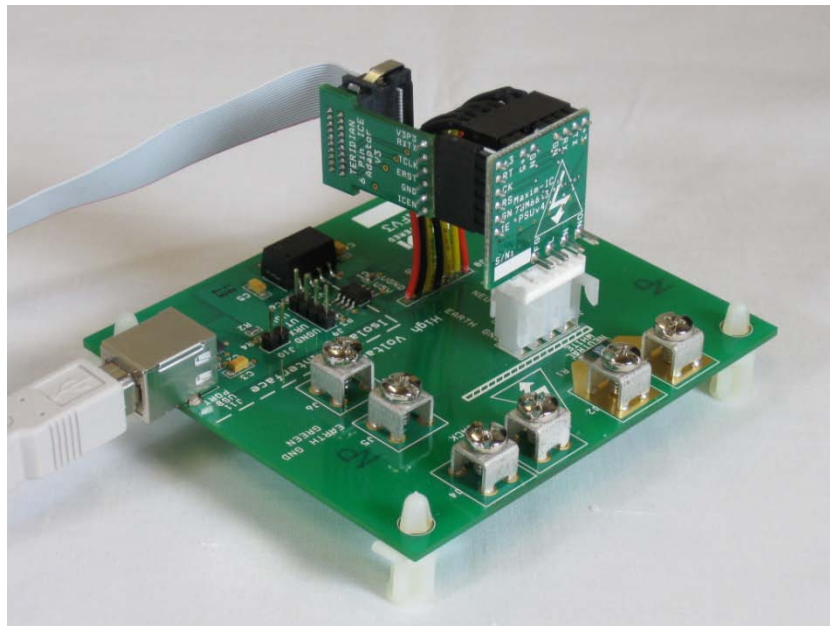


Figure 4: Attaching the ICE Adaptor

Disconnect the 78M6613 PSU Board from live AC voltages before connecting the ADM51 or TFP-2. An Earth ground disparity and high AC voltages are present on the 78M6613 PSU Board when it is connected to the AC outlet. Equipment damage to the 78M6613, ADM51/TFP-2 and attached PC may occur when live AC voltages are present on the 78M6613 PSU Board. Refer to the *78M6613 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 Teridian.

Power to the 78M6613 is provided from the USB cable attached to the shunt adaptor board. The ICE adaptor's V3P3 pin is only a sense input to the ADM51.

3 Schematics, Bill of Materials and PCB Layouts

This section includes the schematics, bill of materials and PCB layouts for the 78M6613 PSU Board and the Shunt Adaptor Board.

3.1 78M6613 PSU Board Schematics

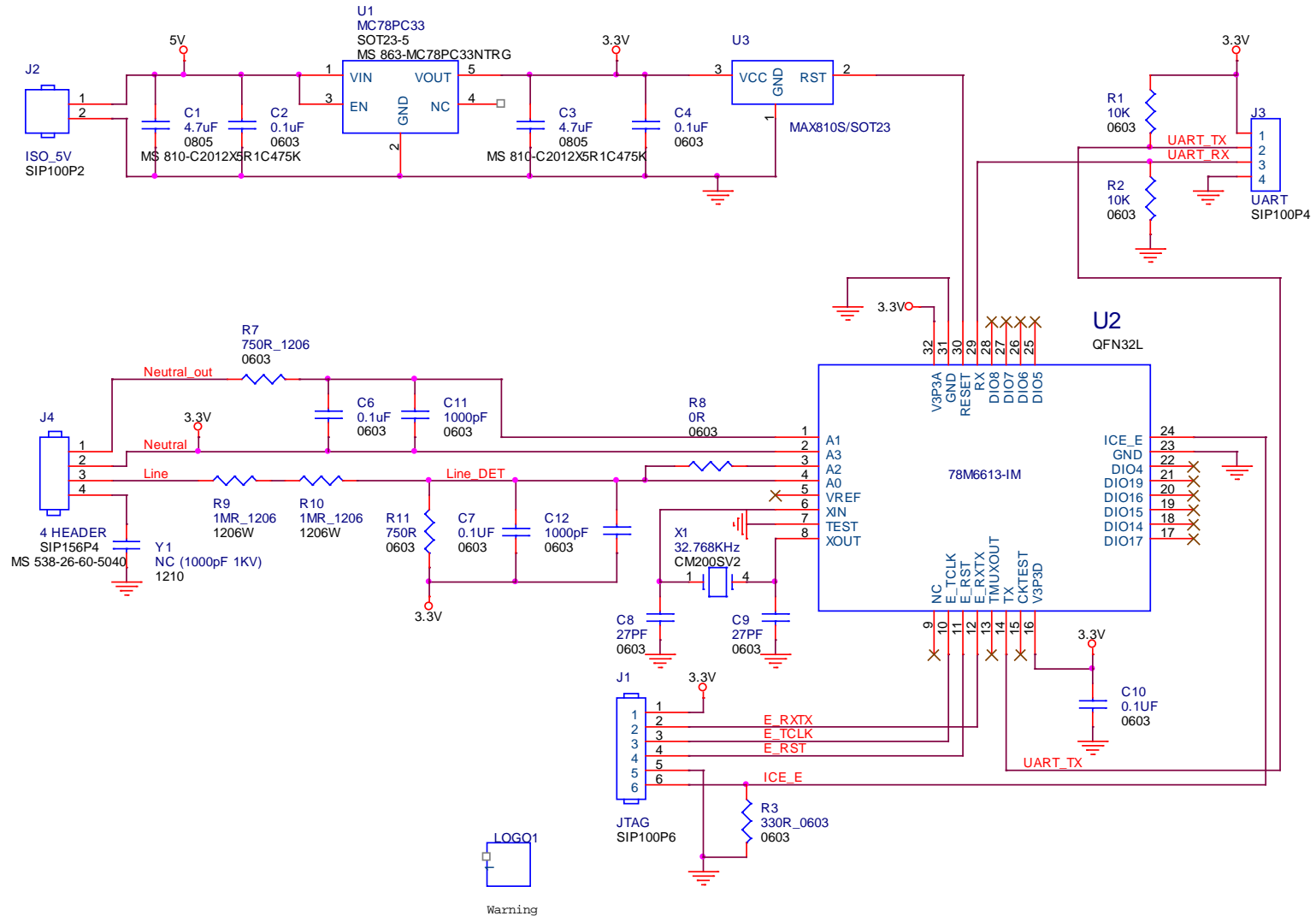


Figure 5: 78M6613 PSU Board Electrical Schematic

3.2 78M6613 PSU Board Bill of Materials

Table 4: 78M6613 PSU Board Bill of Materials

Item	Qty	Reference	Part	PCB Footprint	Digi-Key/Mouser Part Number	Part Number	Manufacturer	RoHS
1	2	C11,C12	1000pF	RC0603	445-1298-1-ND	C1608X7R2A102K	TDK	X
2	5	C2,C4,C6, C7,C10	0.1uF	RC0603	445-1314-1-ND	C1608X7R1H104K	TDK	X
3	2	C8,C9	27pF	RC0603	445-1274-1-ND	C1608C0G1H270J	TDK	X
4	2	C1,C3	4.7uF	RC1206	445-1606-1-ND	C3216X7R1E475K	TDK	X
5	1	J3	HEADER 4	4X1PIN	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	X
6	1	J1	HEADER 6	6X1PIN	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	X
7	1	J2	HEADER 6	2X1PIN	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	X
8	1	J4	HEADER 4	4X1PIN	538-26-60-5040	26-60-504	Molex	X
9	2	R7,R11	750, 0.1%	RC0603	RG16P750BCT-ND	RG1608P-751-B-T5	Susumu	X
10	2	R9,R10	1M, 0.1%	RC1206	660-RN732BTDD1004B25	RN732BTDD1004B25	KOA SPEER	X
11	1	R8	0	RC0603	P00GCT-ND	ERJ-3GEYJ000V	Panasonic	X
12	1	R3	330	RC0603	P330GCT-ND	ERJ-3GEYJ331V	Panasonic	X
13	2	R1,R2	10K	RC0603	P10KGCT-ND	ERJ-3GEYJ103V	Panasonic	X
14	1	U2	78M6613-IM/F	32QFN	-	78M6613-IM/F	Teridian	X
15	1	U1	3.3V, 100mA	SOT23	863-MC78PC33NTRG	MC78PC33NTRG	ON Semiconductor	X
16	1	Y1	32.768 KHZ SMD 12.5Pf	ABS25	535-9166-1-ND	ABS25-32.768KHZ-T	Abracon	X
17	1	U3	MAX810	SOT23	MAX810SEUR+TCT-ND	MAX810SEUR+T	Maxim	X

3.3 78M6613 PSU Board PCB Layouts

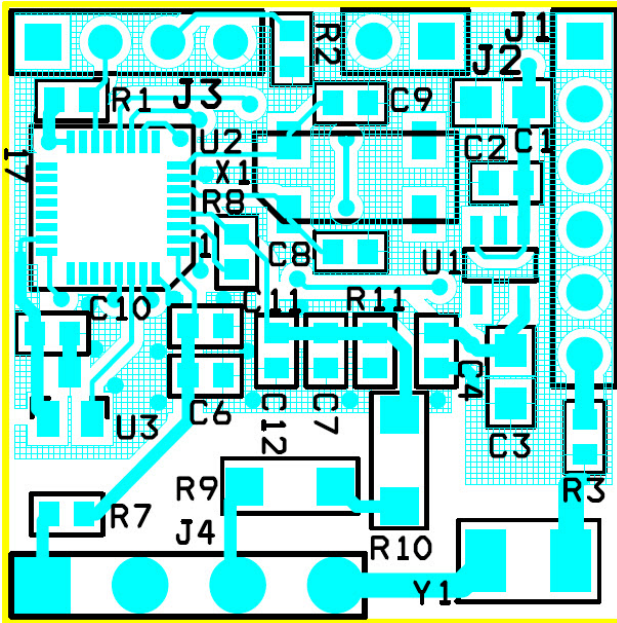


Figure 6: 78M6613 PSU Board PCB Top View

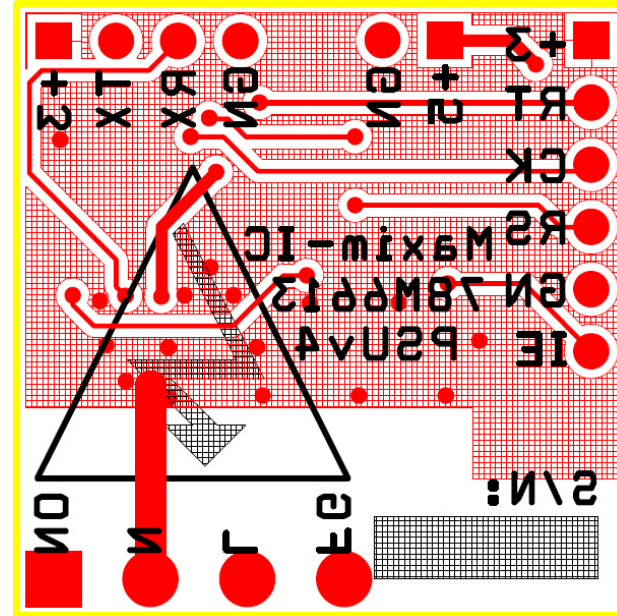


Figure 7: 78M6613 PSU Board PCB Bottom View

3.4 Shunt Adaptor Board Schematics

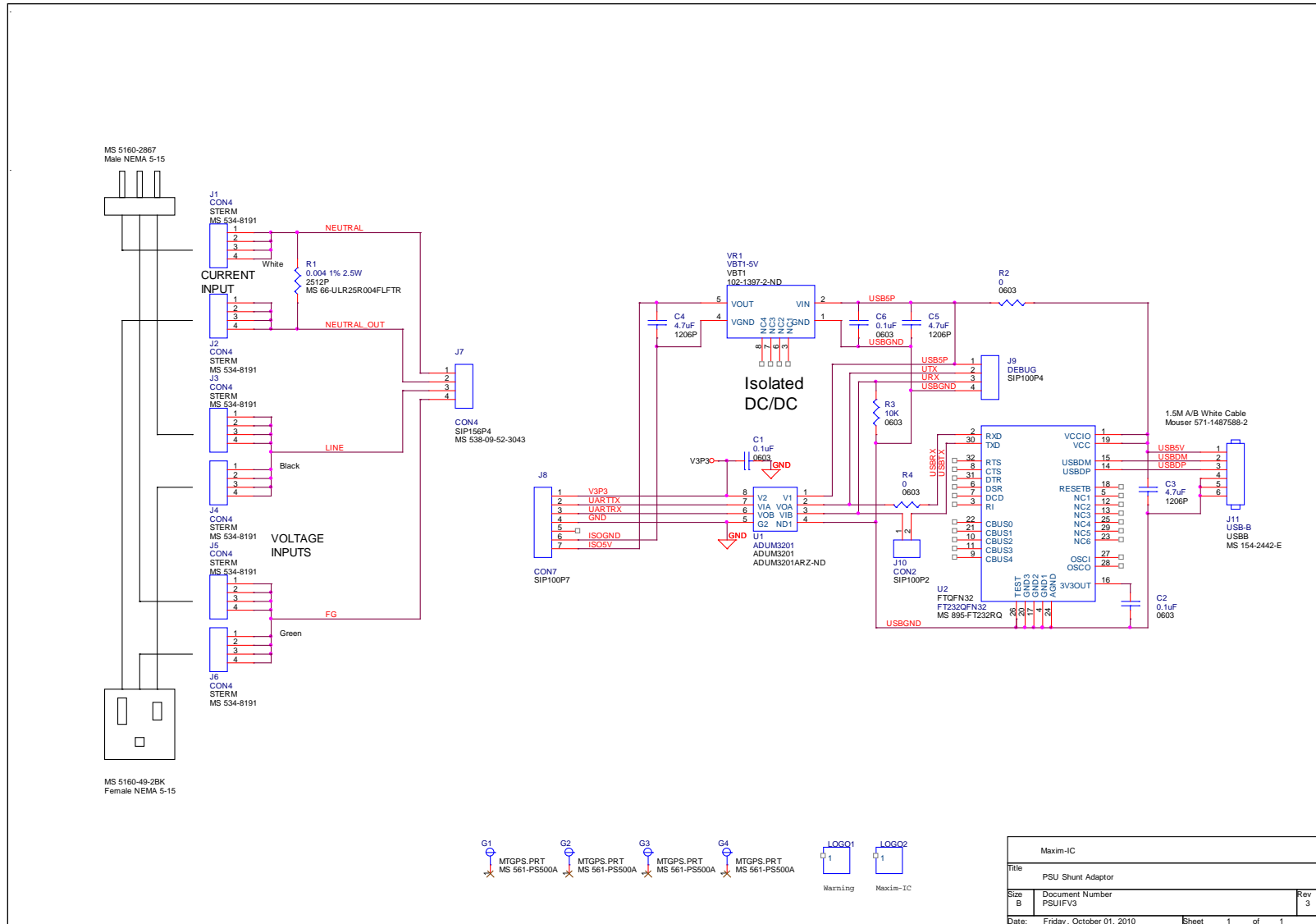


Figure 8: Shunt Adaptor Board Electrical Schematic

3.5 Shunt Apaptor Board Bill of Materials

Table 5: Shunt Adaptor Board Bill of Materials

Item	Qty	Reference	Part	PCB Footprint	Digi-Key/Mouser Part Number	Part Number	Manufacturer	RoHS
1	3	C1,C2,C6	0.1uF	603	399-5089-1-ND	C0603C104K5RACTU	Kemet	X
2	3	C3,C4,C5	4.7uF	1206P	478-2396-1-ND	TPSB475K016R1500	AVX Corporation	X
3	4	G1,G2,G3,G4	STANDOFF	MTGPS.PRT	MS 561-PS500A	561-PS500A	Eagle Plastic Devices	X
4	6	J1,J2,J3,J4,J5,J6	CON4	STERM VERTICAL	MS 534-8191	8191	Keystone Electronics	X
5	1	J7	CON4	SIP156P4	MS 538-09-52-3043	09-52-3043	Molex	X
6	1	J8	2 inch 7 wires 22 AWG directly to board to female strip	Through holes	-	-	-	X
7	1	J9	DEBUG	SIP100P4	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	X
8	1	J10	CON2	SIP100P2	S1011E-36-ND	PBC36SAAN	Sullins Connector Solutions	X
9	1	J10	2 PIN SHORTING BLOCK		S9001-ND	SPC02SYAN	Sullins Connector Solutions	X
10	1	J11	USB-B	USBB	MS 154-2442-E	154-2442-E	Kobiconn	X
11	1	R1	0.004 1% 2.5W	2512P	MS 66-ULR25R004FLFTR	ULR25R004FLFTR	IRC	X
12	2	R2,R4	0	603	P0.0GCT-ND	ERJ-3GEY0R00V	Panasonic - ECG	X
13	1	R3	10K	603	P10.0KHCT-ND	ERJ-3EKF1002V	Panasonic - ECG	X
14	1	U1	ADUM3201	ADUM3201	ADUM3201ARZ-ND	ADUM3201ARZ	Analog Devices Inc	X
15	1	U2	FT232QFN32	FTQFN32	MS 895-FT232RQ	FT232RQ-REEL	FTDI	X
16	1	VR1	VBT1-5V	VBT1	102-1397-2-ND	VBT1-S5-S5-SMT	CUI Inc	X

3.6 Shunt Adaptor Board PCB Layouts

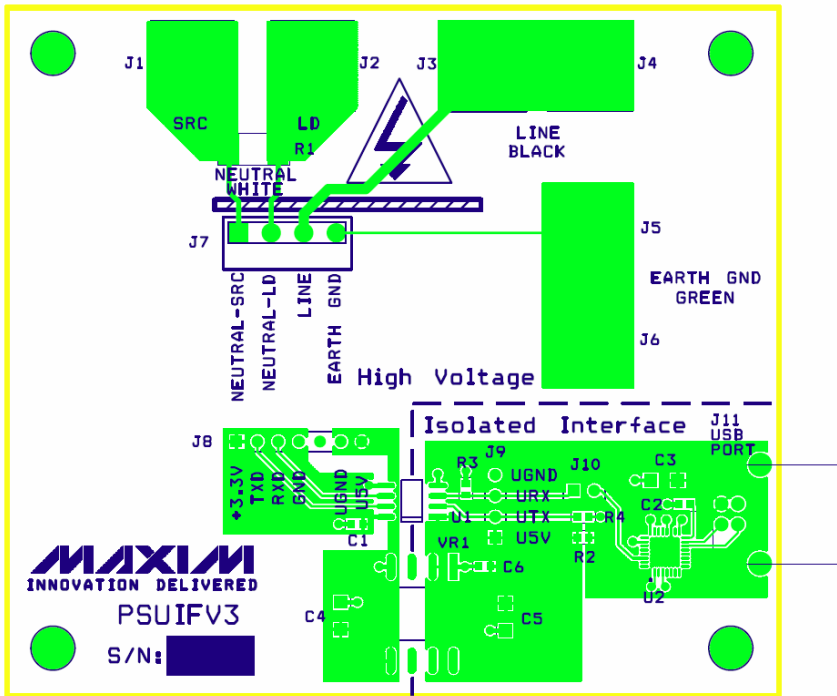


Figure 9: Shunt Adaptor Board PCB Top View

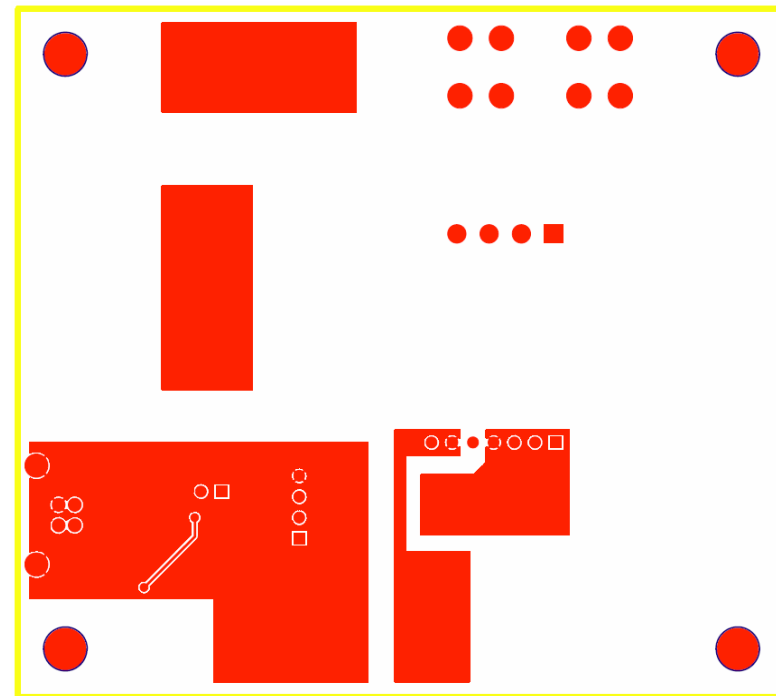


Figure 10: Shunt Adaptor Board PCB Bottom View

4 Ordering Information

Part Description	Order Number
78M6613 PSU Board	78M6613-PSU-1

5 Included Documentation

The following 78M6613 documents are included on the CD:

78M6613 Data Sheet

6613_OMU_S2_URT_V1_1x Firmware Description Document

6 Contact Information

For more information about Maxim products or to check the availability of the 78M6613, contact technical support at www.maxim-ic.com/support.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
1.0	1/11	Initial release	—
1.1	4/11	Replaced the schematic in Figure 5. The VA, IA, VB, and IB pin names in the old schematic were changed to A0, A1, A2, and A3, respectively, in the new schematic.	15
1.2	5/11	Added schematics, bill of materials, and PCB layouts for the Shunt Adaptor Board.	18, 19, 20