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TERIDIAN SEMICONDUCTOR CORP.
A Maxim Integrated Products Brand

78M6612 Split Phase Evaluation Board User Manual

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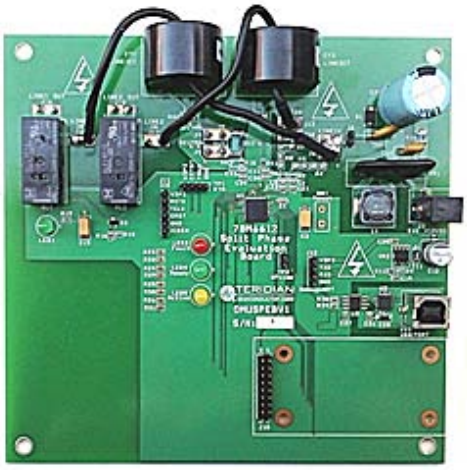
Table of Contents

Figures

Table

1 Introduction

The Teridian Semiconductor Corporation (TSC) 78M6612 Split Phase Evaluation Board is an electrical measurement unit for performing measurements from a single electrical outlet. It incorporates the TSC 78M6612 power and energy measurement IC. The 78M6612 Split Phase Evaluation Board is connected to a PC through a USB cable such as one provided in the demo kit package. Optionally, the 78M6612 UART TX & RX signals can be accessed via a header for communicating with an external controller or wireless communications module. The Evaluation Board demonstrates the capability of the 78M6612 energy meter controller chip for measurement accuracy and overall system use.



The board is pre-programmed with demo firmware (file name 6612_OUM_S2+3_URT_v114c.hex) in the flash memory of the 78M6612 IC that allows evaluation of the IC's capabilities.

The 78M6612 Split Phase energy measurement data and status is read back using an ASCII text string CLI command set. Easy manual operation is performed using HyperTerminal. Optionally, a Windows®-based Graphical User Interface (GUI) is provided for simplified access to the following measurement data and controls:

- Power, current, voltage and power factor indicator dials
- Line frequency
- Alarm indicators
- Programmable Alarm thresholds

1.1 Package Contents

The 78M6612 Split Phase Evaluation Board Demo Kit includes:

- 78M6612 Split Phase Evaluation Board
- USB Cable Assembly USB A-B 28/24 1.8M (Tyco/Amp 1487588-3)
- UART Isolator daughter card
- +12VDC@1A power supply
- CD with OMU Software and Documentation

1.2 System Requirements

The 78M6612 Split Phase Evaluation Board requires use of a PC with the following features:

- PC (1 GHz, 1 GB) with Microsoft Windows XP® or Windows 2000, equipped with USB port.
- Minimum 1024 x 768 video display resolution.

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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 78M6612 contains ESD protected interfaces.

Do not connect test equipment, ICE emulators or external development boards directly to the 78M6612 Split Phase hardware. Damage to the 78M6612 and external equipment will occur due to the 78M6612's "high side" reference topology. The 78M6612'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 Command Line Interface (CLI) via HyperTerminal or comparable terminal emulator on a different operating system. Information about the CLI is presented in Section 3.0.

The 78M6612 Split Phase Evaluation Board is shipped with Demo Code Revision 1.14c or later loaded in the 78M6612 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 Evaluation Board can be updated using either the Teridian TFP2 or an in-circuit emulator such as the Signum Systems ADM51 (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 78M6612 Split Phase Evaluation Board Prior to Shipping

Before every 78M6612 Split Phase 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 accuracy is within ±0.5%.

2 Installation

The 78M6612 Split Phase Evaluation Board is intended for use with a 3-wire single-phase distribution system. This 3-wire single-phase distribution system is typically sourced from a distribution transformer with a single-phase input (primary) winding. The distribution transformer's secondary winding has a center tap which is defined as Neutral. Line 1 and Line 2 exist on either side of Neutral exhibiting a 180° phase shift between them.

The 78M6612 is referenced to Neutral and measures both voltages present on Line1 and Line 2 with respect to Neutral. Additionally, load currents flowing in both Line 1 and Line 2 are measured. The following figure shows the 78M6612 Split Phase Evaluation Board's measurement inputs with various load configurations.

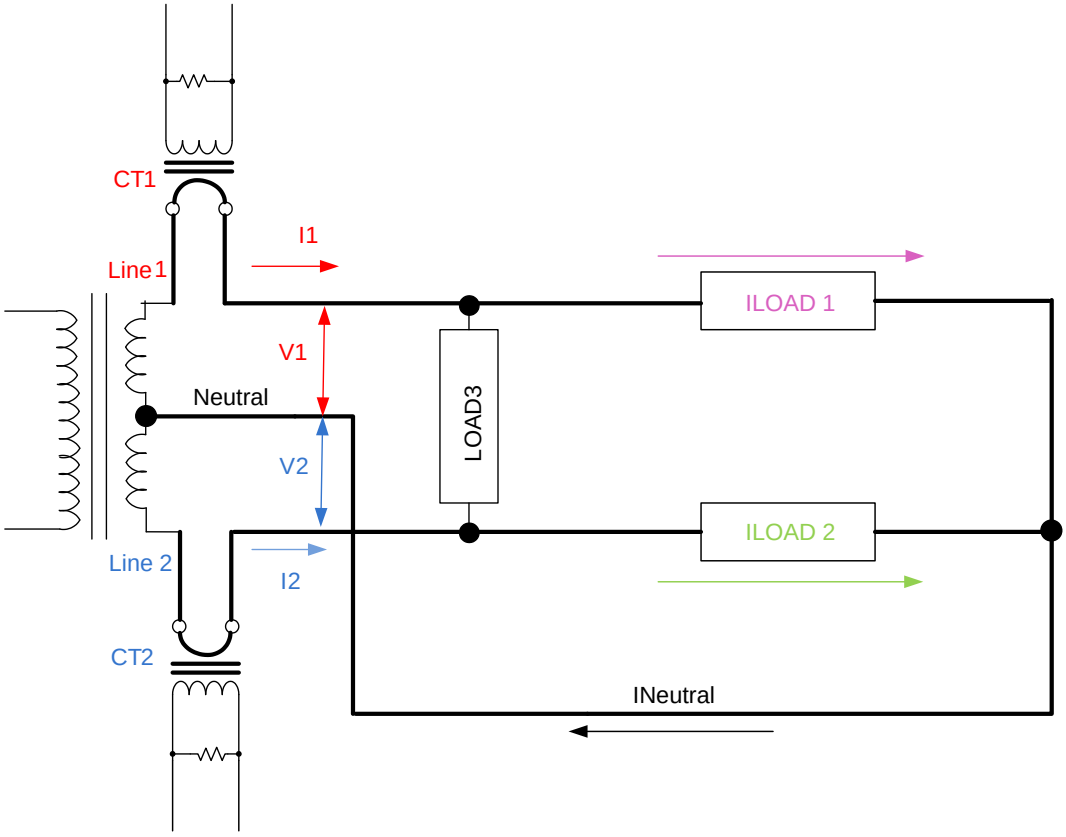


Figure 1: Split Phase Energy Measurement Configuration

2.1 Basic Connection Setup

Figure 1 and 2 show the basic connections of the 78M6612 Split Phase Evaluation Board for use with external equipment. The 78M6612 Split Phase Evaluation Board is powered either by an on-board ACDC switcher or from an external +12VDC power supply. A USB cable provides the communications link between the host PC and the 78M6612 Split Phase Evaluation Board. The high voltage AC source and load wires connect to spades mounted on the bottom side of the board.

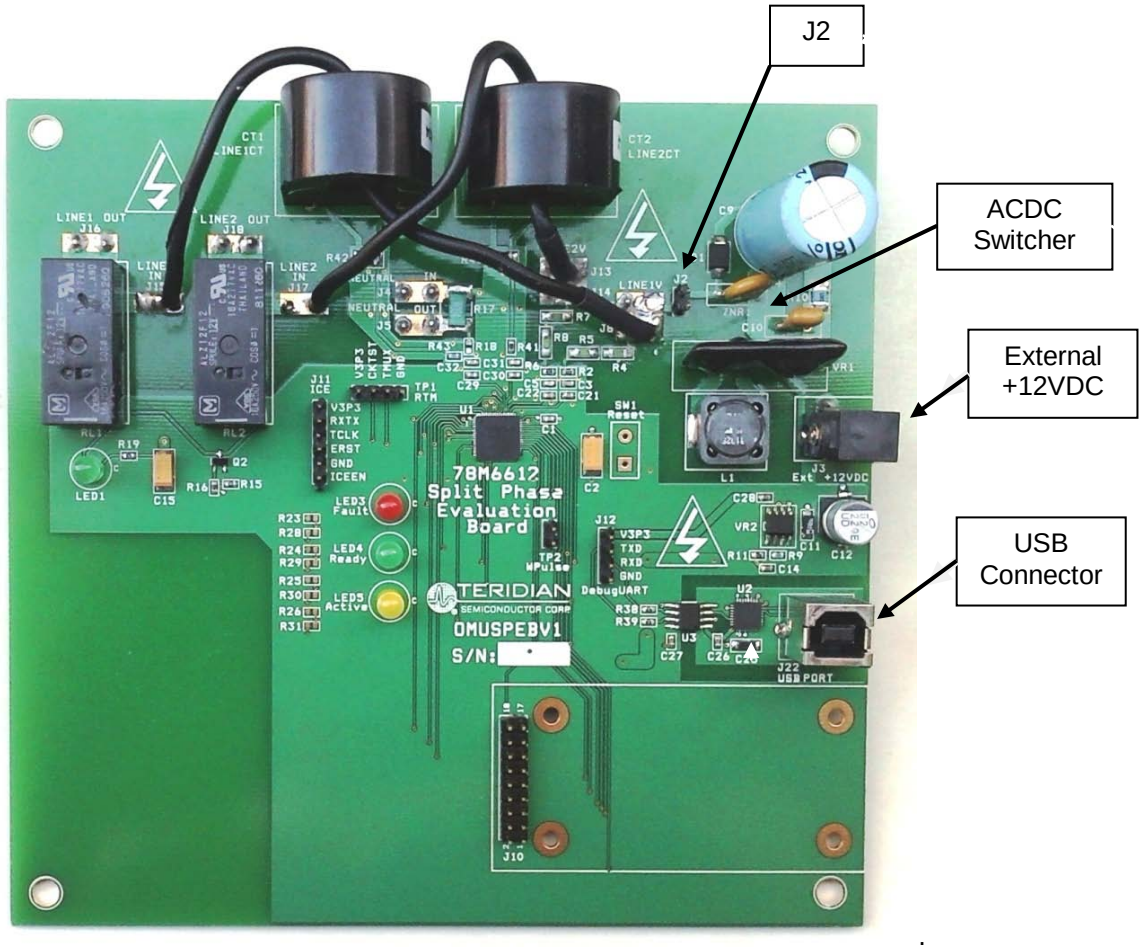


Figure 2: Top Side 78M6612 Split Phase Evaluation Board Connections

Install jumper J2 when using the on-board ACDC switcher. The switcher draws power from one of the AC inlet phase wires. Remove jumper J2 when attaching an external +12VDC power supply to disconnect the switcher from the AC inlet. The board draws less then 100ma from the external +12VDC supply. Use an external +12VDC power supply which is fully isolated.

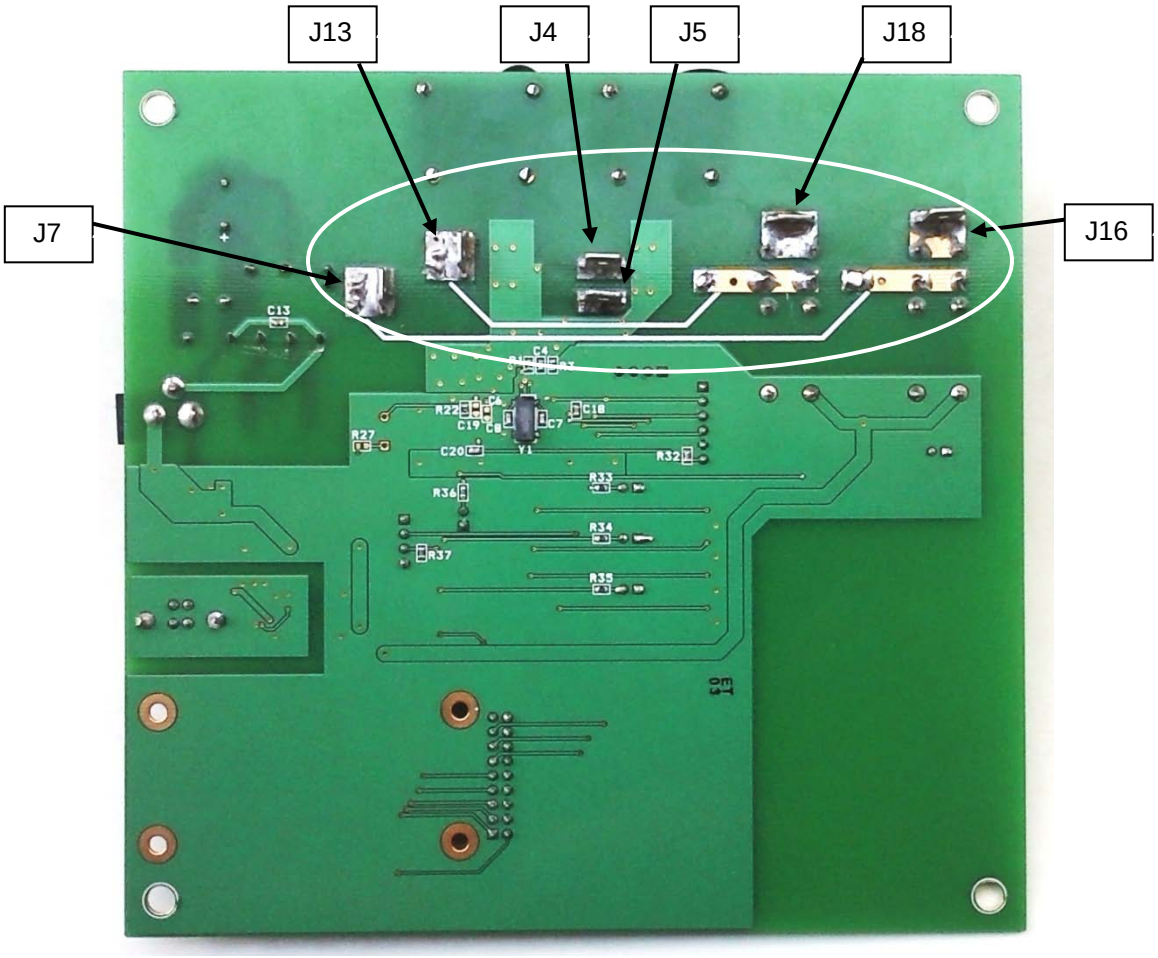


Figure 3: Bottom Side 78M6612 Split Phase Evaluation Board Connections

The high voltage AC wires attach to the spades located on the bottom side of the board. The following table describes the wiring connections.

Table 1: High Voltage AC Connections

Connector	External Circuit
J4	Neutral – from Source
J5	Neutral – to load
J7	Line 1 – from Source
J13	Line 2 - from Source
J16	Line 1 – to Load
J18	Line 2 – to Load

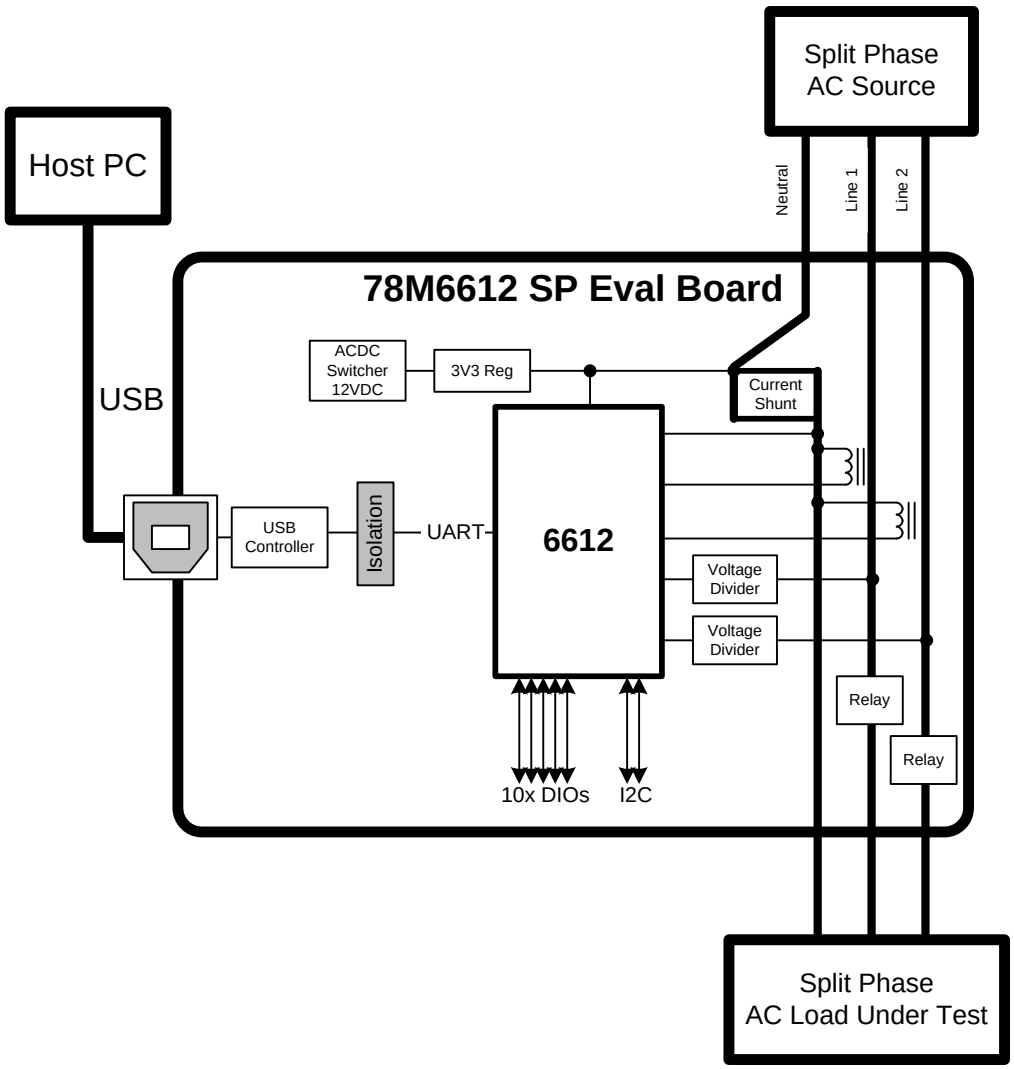


Figure 4: 78M6612 Split Phase Evaluation Board Application Diagram

The 78M6612 Split Phase Evaluation Board is preconfigured to measure the Load currents present on Line 1 and Line 2 using two current transformers (CT). Alternatively, the board has provisions the replace the Line 1 CT with a current sensing shunt in series with the Neutral wire. Two resistors (R18 and R43) provide the sensor selection. The following table provides the resistor population options for selecting the CT verses the shunt.

Table 2: Line 1 vs. Neutral Current Sensing Configuration

Sensor Configuration	R18	R43
CT – Line 1	No Component	Install 750Ω
Shunt - Neutral	Install 750Ω	No Component

Presently the firmware only supports the CT–Line1 configuration.

2.2 Optional UART Interface

The 78M6612 Split Phase Evaluation Board provides an option to bypass the on-board serial USB controller. This option is useful for communicating with an external controller or attachment of a wireless module.

The optional UART interface is accessible via connector J12. Remove the 0Ω resistor R38 to prevent TX contention with the on-board isolator's output, U3.

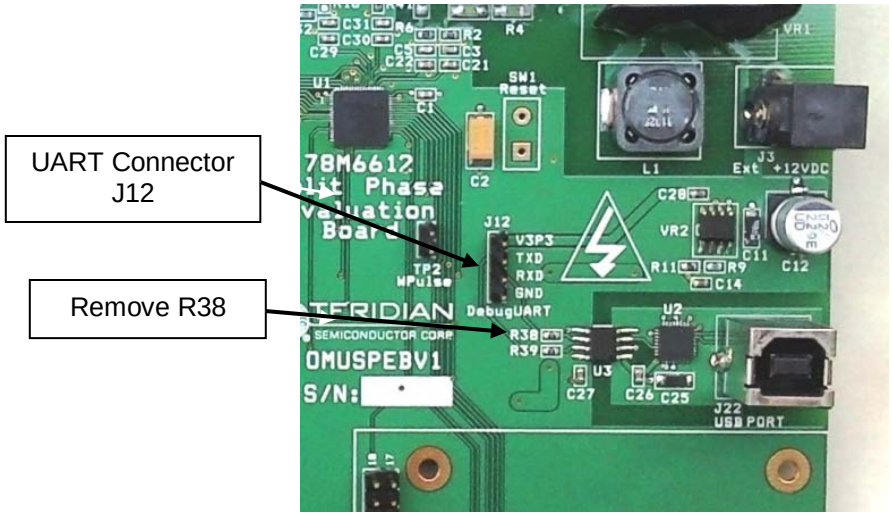


Figure 5: UART Connector

Due to the 78M6612's V3P3 being directly connected to Neutral, the Teridian supplied UART isolator must be inserted between the evaluation board and the external controller. The V3P3 to Neutral connection results in the 78M6612's GND pin being 3.3V below the external controller's GND pin. Additionally, the UART isolator board provides for galvanic isolation between the evaluation board and the external controller hardware.

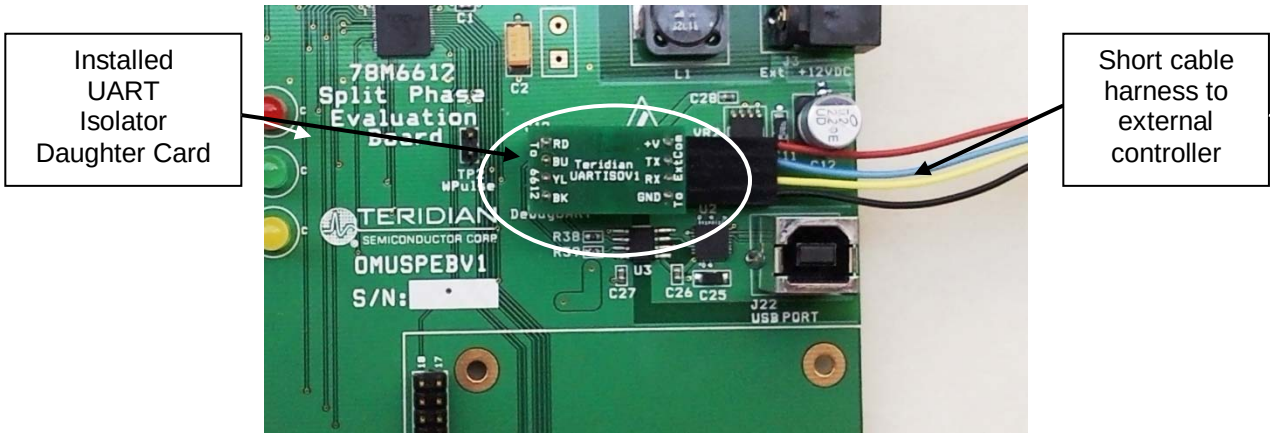


Figure 6: UART Isolator Daughter Card

Table 3: J12 UART Connector Pin Assignments

J12 Pin Number	Identifier	Function
1	V3P3	+3.3V to daughter card
2	TXD	78M6612 TXD output
3	RXD	78M6612 RXD input
4	GND	GND to daughter card

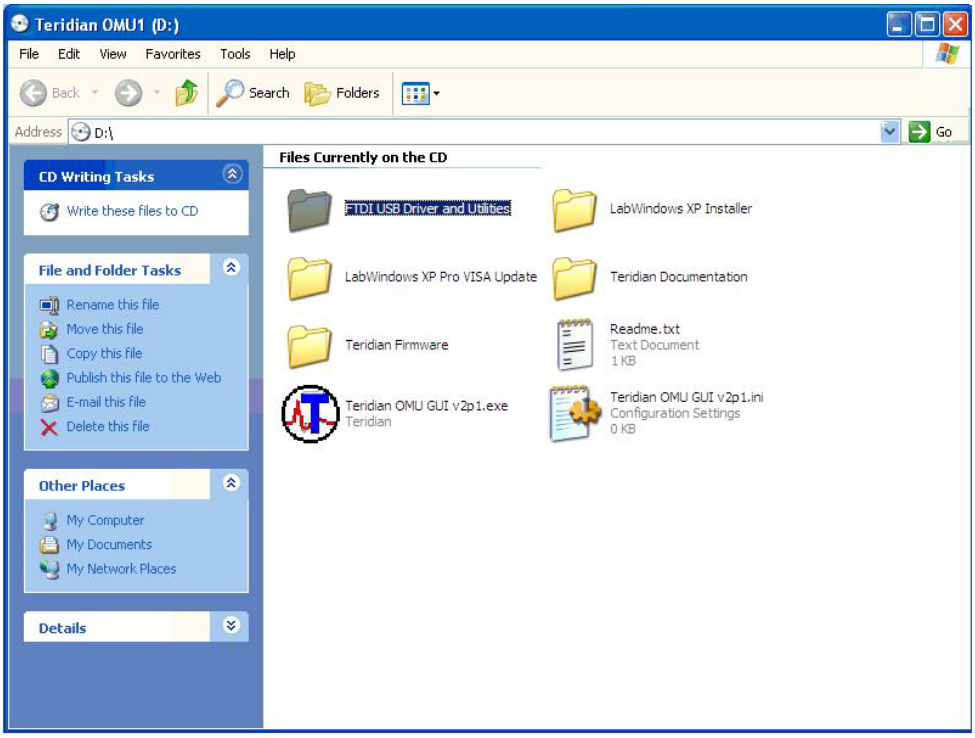
The UART Isolator daughter card maintains the same pin functions on its connector interface to the external controller.

The UART isolator board is not required when using a wireless module. However, use of an antenna with an exposed metal mounting base presents a safety hazard. The other consideration regarding use of a wireless module is the module's transmitting power consumption. The on-board switcher can provide only 100mA (at 3.3V). Use an external power supply if the transmitter's power is greater than 100mA.

2.3 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 Windows driver presents a virtual COM port for enabling serial communications. Control of the 78M6612 Split Phase Evaluation Board can be managed using either a terminal emulation program or using the supplied Windows GUI. The FTDI Windows driver is a certified driver for Windows 2000 and XP.

1. Upon attaching the 78M6612 Split Phase Evaluation 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 78M6612 Split Phase Evaluation Board.

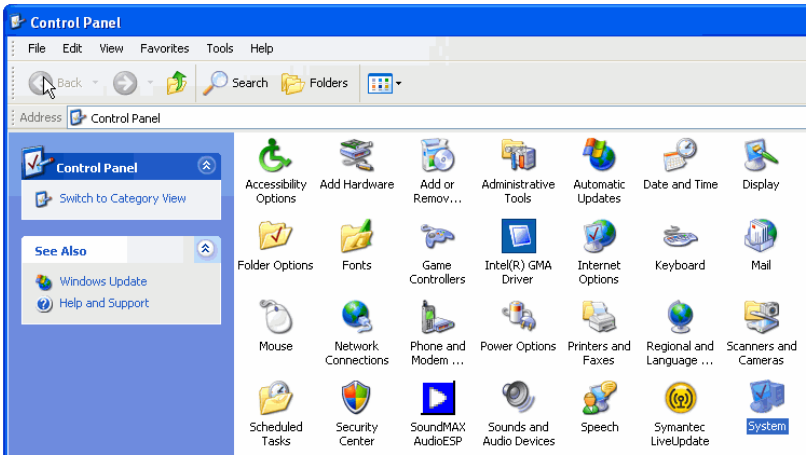


Notes: If an older FTDI driver has been previously installed, it is recommended to remove the older version before installing this newer FTDI driver. Execute the **ftdiClean.exe** utility from the FTDI USB Driver and Utilities subdirectory.

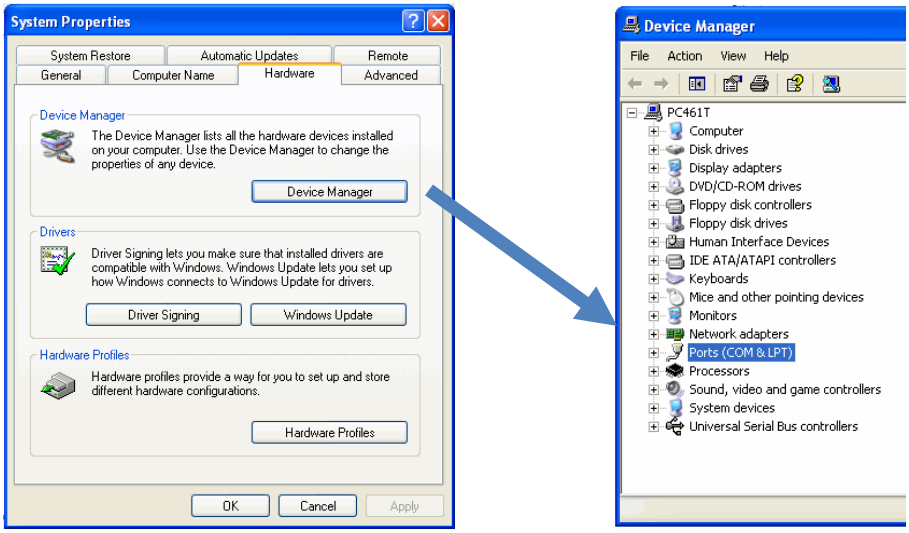
For FTDI driver support on other operating systems, please check FTDI's website at (www.ftdichip.com/FTDrivers.htm).

2.4 Confirm COM Port Mapping

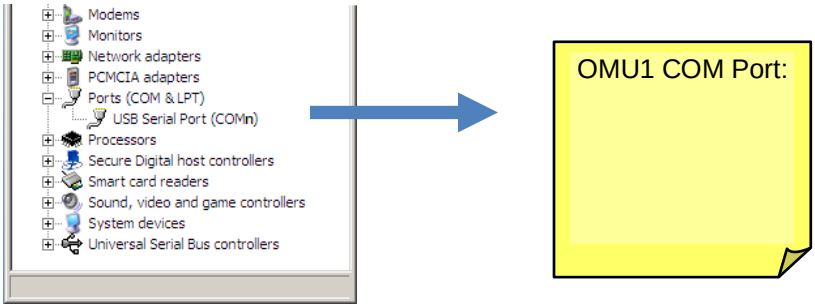
- Launch the ***Control Panel*** and click on the ***System*** icon.



- 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.



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



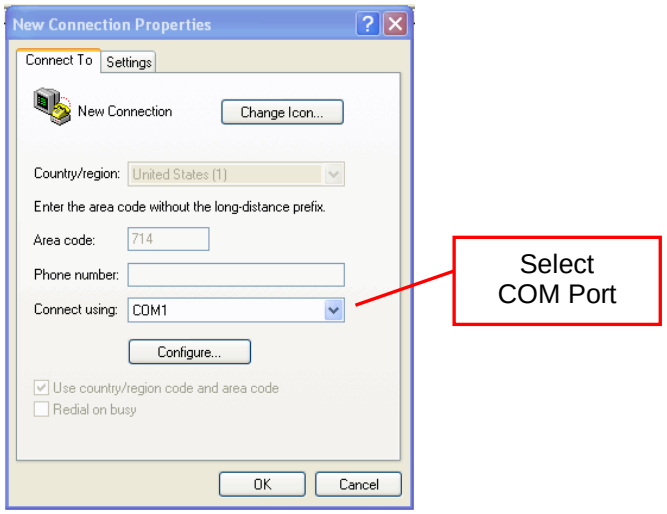
2.5 Verify Serial Connection to the PC

After connecting the USB cable from the 78M6612 Split Phase Evaluation Board to the host PC, start the HyperTerminal application (or another suitable communication program) and create a session using the communication parameters show in Table 1.

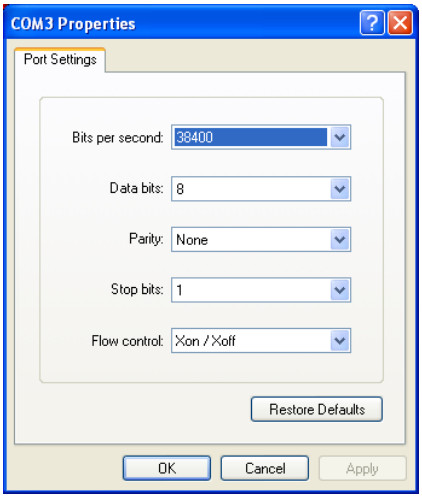
Table 4: COM Port Setup Parameters

Setup Parameter	78M6612
Port speed (baud)	38400
Data bits	8
Parity	None
Stop bits	1
Flow control	Xon/Xoff

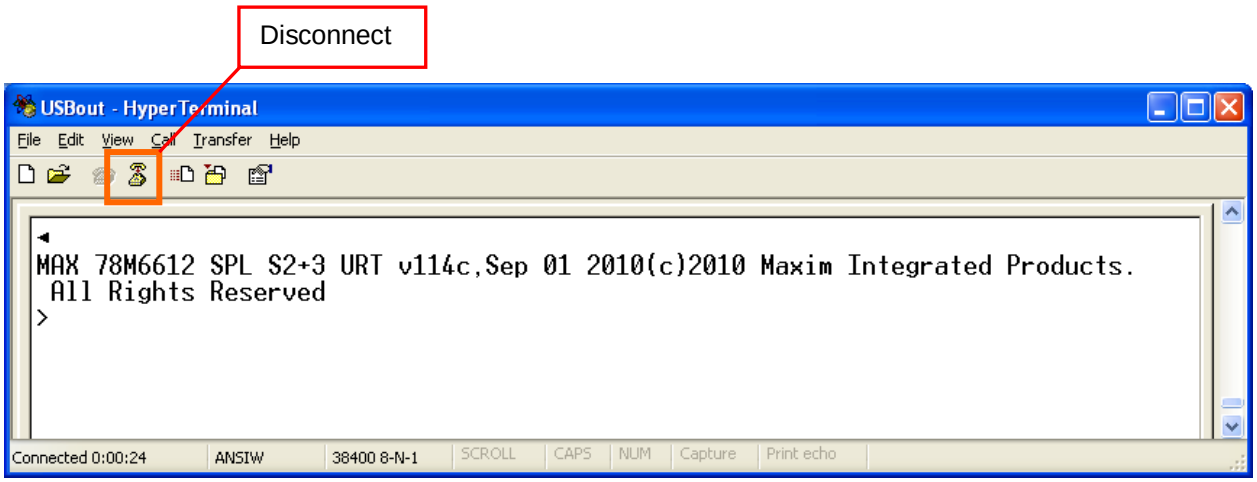
HyperTerminal can be found in Windows by selecting ***Start →All Programs →Accessories → Communications →HyperTerminal.*** The connection parameters are configured by selecting ***File → Properties***. The **New Connection Properties** menu appears.



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 2.3.

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

3 Command Line Interface (CLI)

A firmware load for the 78M6612 was developed to implement split-phase measurement for two independent phases with a phase offset of 120° or 180°. It implements 4 measurement channels (2 currents and 2 voltages) and measures RMS for each channel as well as power for 2 phases. Data is provided via the 78M6612 UART at 38400 baud using a Command Line Interface (CLI).

3.1 Identification and Information Commands

The I command is used to identify the revision of the 6612_OMU_S2+3_URT_v114c firmware code. The host sends the I command to the 78M6612 as follows:

>I<CR>

The 78M6612 replies with the following:

MAX 78M6612 SPL S2+3 URT v114c, Sep 01 2010(c)2010 Maxim Integrated Products.
All Rights Reserved
>

3.2 Reset Commands

A soft reset of the 78M6612 can be performed by using the Z command. The soft reset restarts code execution at addr 0000 and does not alter flash contents. To issue a soft reset to the 78M6612, the host sends the following:

>Z<CR>

The W command acts like a hardware reset. The energy accumulators in XRAM will retain their values.

Table 5: CLI Reset Commands

Z	**Reset**	
Description:	Allows the user to cause soft resets.	
Usage:	Z	Soft reset.
	W	Simulates watchdog reset.

3.3 Individual Address Read

The host can request the information be returned in 2s-complement hex format or human readable decimal format. $ requests information in hex, and ? requests information in decimal. When requesting information in decimal, the returned data is preceded by a + or a -.

An example of a command requesting the measured power in Watts (located at address 0x07) in human readable decimal format is as follows:

>)07?<CR>

An example of a command requesting the measured power in Watts (located at address 0x07) in 2s-complement hex format is as follows:

>)07$<CR>

3.4 Consecutive Read

The host can request information from consecutive addresses by adding an additional ? for the human readable decimal format or an additional $ for the 2s-complement hex format.

An example of requests for the contents in decimal of ten consecutive addresses starting with 0x12 is:

>)12??????????<CR>

An example of requests for the contents in hex of ten consecutive addresses starting with 0x12 would be:

>)12$$$$$$$$$$<CR>

Note: The number of characters per line is limited to no more than 60.

3.5 Block Reads

The block read command can also be used to read consecutive registers:)saddr:eaddr? For decimal format or)saddr:eaddr$ for hex format where saddr is the start address and eaddr is the final address.

The following block read command requests the returned information to be displayed in human readable decimal format:

>)20:3D?<CR>

3.6 Concatenated Reads

Multiple commands can also be added on a single line. Requesting information in human readable decimal from two locations and the block command from above are given below:

>)12?)15?)20:3D?<CR>

Note: The number of characters per line is limited to no more than 60.

3.7 Relay Control

The 78M6612 Split Phase Evaluation Board incorporates relays to cutoff current to each phase. The two relays are controlled by a single 78M6612 DIO output. The following CLI commands are used to control the relay operation:

Table 6: CLI Relay Commands

CLI Command	Relay Operation
F0=1 or TC1	Contacts Open – Load Off
F0=0 or TC0	Contacts Closed – Load On

3.8 Measurement Results Registers

Registers can be read via the command line interface by sending a ")" symbol, followed by the register address (in hexadecimal), and a carriage return <CR> character. Data is returned in hexadecimal.

Example:)26 will read the RMS voltage for Line 2.)26 is equivalent to)26$. Use)26? for the decimal format.

Table 7: CLI Measurement Results Registers

Address (hex)	Variable Name	Notes	Description
0	TEMP	Signed °C	Temperature delta from 25°C
1	FREQ	unsigned Hz	Line Frequency
2	STATUS	boolean	Alarms and other stati (see STATUS section)
6	VrmsA	unsigned mv	Line 1 RMS voltage
7	WattA	unsigned mva	Line 1 active power (W1)
26	VrmsB	unsigned mv	Line 2 RMS voltage (V2)
2A	IrmsA	unsigned ma	Line 1 RMS current (I2)
2B	VARA	unsigned mva	Line 1 reactive power
2C	VAsA	unsigned mva	Line 1 volt-amperes (Irms x Vrms)
2D	PFA	unsigned	Line 1 Power Factor (0 to 1.0)
46	Vrms3	unsigned mva	Line-to-line RMS voltage
47	WattB	unsigned mva	Line 2 active power (W2)
6A	IrmsB	unsigned ma	Line 2 RMS current
6B	VARB	unsigned mva	Line 2 reactive power
6C	VAsB	unsigned mva	Line 2 volt-amperes (Irms x Vrms)
6D	PFB	unsigned	Line 2 power factor (0 to 1.0)
80	WattT	unsigned mva	Total active power
93	IrmsT	unsigned ma	Total RMS current
94	VART	unsigned mva	Total reactive power
95	VAT	unsigned mva	Total volt-amperes

3.9 Input Registers

Registers can be written via the command line interface by sending a ")" symbol, followed by the register address (in hexadecimal), and equal sign "=", the value to be written (in hexadecimal), and a carriage return <CR> character.

Example:)A1=7 will set the Line 1 anti-creep threshold to 7 mV.)A1 is equivalent to)A1$. Use)A1? for the decimal format.

Table 8: CLI Input Registers

Address (hex)	Variable Name	Units	Default	Description
A0	VmaxA	mV rms	+471.500	Alarm limit for Line 1 rms voltage
A2	ImaxA	mA rms	+52.0	Alarm limit for Line 1 rms current
A4	ImaxB	mA rms	+52.0	Alarm limit for Line 2 rms current
D0	TempMin	°C	+0	Alarm limit for low temperature
D1	TempMax	°C	+70.0	Alarm limit for high temperature
D2	FreqMin	Hz	+59.0	Alarm limit for line frequency
D3	FreqMax	Hz	+61.0	Alarm limit for line frequency
D4	SagV	mV rms	+80.0	Alarm limit for Line 1 voltage sag
D6	Vpeak	mV rms	+140.0	Alarm limit for Line 1 peak voltage
D9	IpeakA	mA rms	+15.0	Alarm limit for Line 1 peak current
DC	PFminA		-0.70	Alarm limit for Line 1 lag
DD	PFmaxA		+0.70	Alarm limit for Line 1 lead
DF	IpeakB	mA rms	+15.0	Alarm limit for Line 2 peak current
E2	PFminB		-0.70	Alarm limit for Line 2 lag
E3	PFmaxB		+0.70	Alarm limit for Line 2 lead
E6	MASK	boolean (hex)	0x9E59FF	Mask for STATUS alarms (see STATUS Section)

3.9.1 Update Command for MPU

The U command is used for updating default values of the MPU Data permanently in the flash. Before issuing the U command, CE must first be turned off by the disable CE command. An example of a U command is as follows:

>)U

Additional examples of MPU Data Access commands are provided in the following table:

)	**MPU Data Access**	
Description:	Allows user to read from and write to MPU data space.	
Usage:	) {Starting MPU Data Address} {option}…{option}<CR>	
Command Combinations:	)saddr? <CR>	Read the register in decimal.
	)saddr?? <CR>	Read two consecutive registers in decimal.
	)saddr???<CR>	Read three consecutive registers in decimal.
	)saddr:eaddr?	Block read command in decimal format. Read consecutive registers starting with starting address saddr and ending with address eaddr. Results given in decimal.
	)saddr$<CR>	Read the register word in hex.
	)saddr$$ <CR>	Read two consecutive register words in hex.
	)saddr$$$<CR>	Read three consecutive register words in hex.
	)saddr:eaddr$	Block read command in hex format. Read consecutive registers starting with starting address saddr and ending with address eaddr. Results given in hex.
	)saddr=n<CR>	Write the value n to address saddr in hex format.
	)saddr=n=m<CR>	Write the values n and m to two consecutive addresses starting at saddr in hex format.
	)saddr=+n<CR>	Write the value n to address saddr in decimal format.
	)saddr=+n=+m<CR>	Write the values n and m to two consecutive addresses starting at saddr in decimal format.
	)U<CR>	Updates the default values of the MPU Data permanently in the flash.
Examples:	)08$<CR>	Reads data word at MPU address location 0x08 in hex format.
	)08$$<CR>	Reads data words at MPU address location 0x08, 0x09 in hex format.
	)08$$$<CR>	Reads data words at MPU address location 0x08, 0x09, 0x0A in hex format.
	)28:4D$	Read data words in hex.
	)08?<CR>	Reads data word at MPU address location 0x08 in decimal format.
	)08??<CR>	Reads data words at MPU address location 0x08, 0x09 in decimal format.
	)08???<CR>	Reads data words at MPU address location 0x08, 0x09, 0x0A in decimal format.

)	**MPU Data Access**	
	)28:4D?	Read data words at MPU address location starting 0x28 to 0x4D in decimal.
	)04=12345678<CR>	Writes 0x12345678 to MPU address location 0x04 in the hex format.
	)04=12345678=9876ABCD<CR>	Writes 0x12345678 to MPU address location 0x04 and 0x9876ABCD at MPU address location 0x05 in the hex format.
	)04=+123<CR>	Writes 123 to MPU address location 0x04 in the decimal format.
	)04=+123=-334<CR>	Writes 123 to MPU address location 0x04 and -334 to MPU address location 0x05 in the decimal format.

3.10 STATUS Section (Alarm STATUS and MASK bits)

The following table lists the bits of the STATUS and MASK registers. The user sets the MASK register to determine which bits will cause an ALARM and which is output on pin DIO20. Status bits clear automatically when the alarming condition no longer exists.

Table 9: CLI Status Registers

Bit	Name	Function
23	REV	Line-Neutral reversed
22-21		Reserved
20	MFault	Alarm for multi-fault event
19	ImaxT	Total current limit exceeded
18	PFmaxB	Line 2 power factor limit exceeded
17	PFminB	Line 2 power factor limit exceeded
16-15		Reserved
14	ImaxB	Line 2 rms current limit exceeded
13		Reserved
12	PFmaxA	Line 1 power factor limit exceeded
11	PFminA	Line 1 power factor limit exceeded
10-9		Reserved
8	ImaxA	Line 1 rms current limit exceeded
7		Reserved
6	LopenA	Line 2 open
5	LopenB	Line 1 open
4	VSag	Voltage sag event detected
3	Fmax	Line frequency limit exceeded
2	Fmin	Line frequency limit exceeded
1	Tmax	Temperature limit exceeded
0	Tmin	Temperature limit exceeded

3.11 CLI Command String Example

The following examples represent typical CLI commands to turn on the load relays and read back various measurement data. The characters following the prompt symbol **">"** are the CLI command characters. A following carriage return initiates the response.

1. Turn on the load relays:
   >TC0

2. The following ASCII text strings request the following data:
   frequency, status, LN1 voltage, LN2 voltage, LN1 current, LN2 current, LN1 watts, LN2 watts

   Human readable decimal format:

```
>)1?)2?)6?)26?)2A?)6A?)7?)47?
+60.02 +9437184 +120.012 +120.012 +1.000 +1.000 +120.008 +120.049
>
```

   2s-complement hex format:

```
>)1$)2$)6$)26$)2A$)6A$)7$)47$
00001772 00900000 0001D4C2 0001D4BF 000003E8 000003E8 0001D4D4 0001D4C6
>
```

3.12 Calibration

The 78M6612 Split Phase firmware includes built in calibration routines. An external voltage source and external current source (or load) is required. The firmware assumes an external 120VAC ± 0.5% is present on each phase and a 1A ±0.5% load current is present on each phase. The calibration routine adjusts a set of coefficients until the measured voltages and currents are within a 1% tolerance. These default target values can be changed.

The following figure shows a split phase calibration test setup.

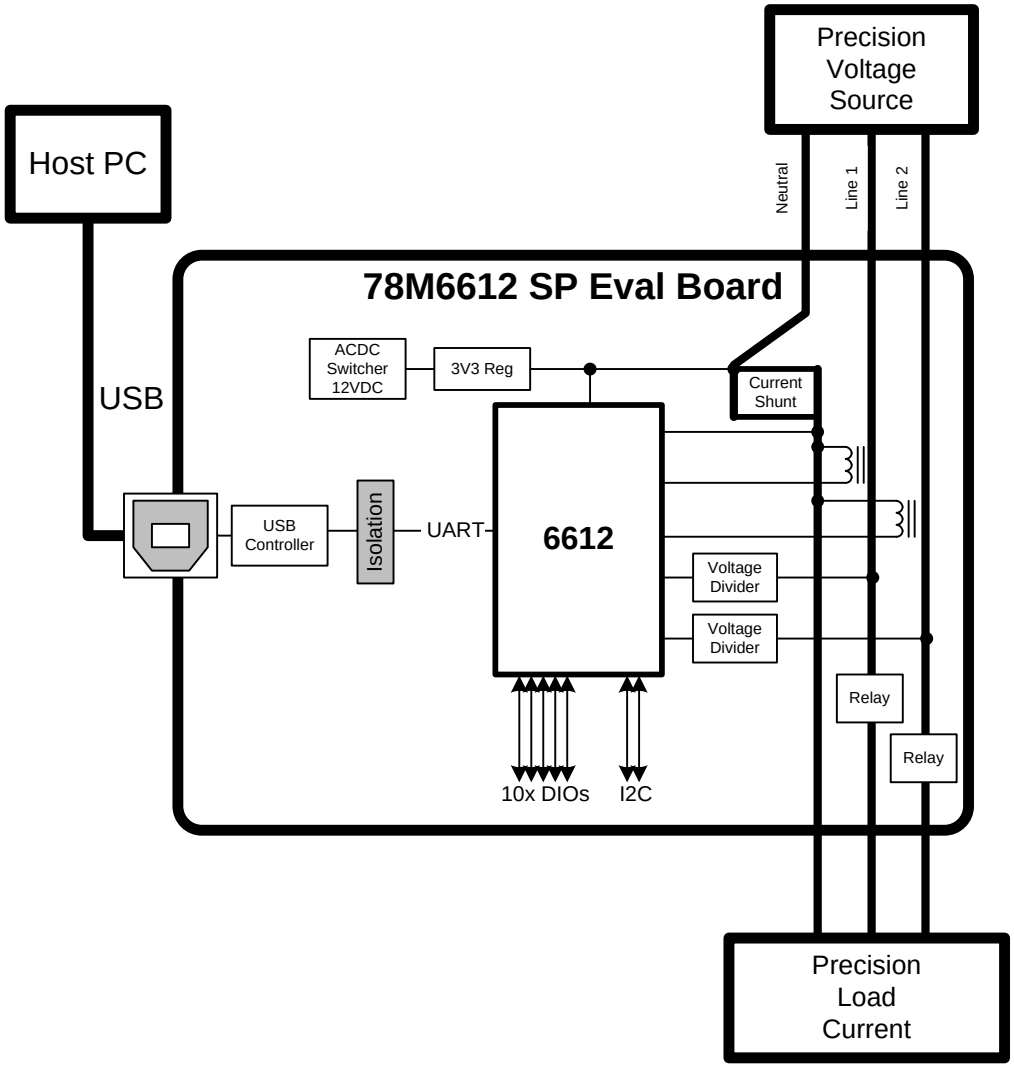


Figure 7: Split Phase Calibration Test Setup

After turning on the relays, the voltage inputs are calibrated first and then the load currents are calibrated. The voltage calibration and current calibration each take a few seconds to complete. The characters following the prompt symbol **">"** are the CLI command characters. A following carriage return initiates the response.

```
>tc0
>clv
VCal OK
>cli
ICal 1 OK2 OK
```

Once the 78M6612 Split Phase board is calibrated, it is recommended to read back and record the calibration coefficients. Should the firmware be updated in the future, the calibration coefficients can be easily restored.

There are four calibration coefficients: one for each voltage input and one for each current input. These four coefficients are read back using the ***]8????*** command.

```
>]8????
+11290 +11294 +16542 +16544
>_
```

3.12.1 U Command

The U command is used for updating default values of the CE Data permanently in the flash. Before issuing the U command, CE must first be turned off by the disable CE command.

An example of a U command is as follows:

```
>CE0
>]U
```

Additional examples of CE Data Access commands are provided in the following table:

]	**CE Data Access**	
Description:	Allows user to read from and write to CE data space.	
Usage:	] {Starting CE Data Address}{option}…{option}<CR>	
Command Combinations:	]saddr?<CR>	Read 32-bit word in decimal.
	]saddr??<CR>	Read two consecutive 32-bit words in decimal.
	]saddr???<CR>	Read three consecutive 32-bit words in decimal.
	]saddr$<CR>	Read 32-bit words in hex.
	]saddr$$<CR>	Read two consecutive 32-bit words in hex.
	]saddr$$$<CR>	Read three consecutive 32-bit words in hex.
	]U<CR>	Update default version of CE Data in FLASH. **Important: The CE must be stopped (CE0) before issuing this command! Also, remember to restart by executing the CE1 command prior to attempting measurements.**
Examples:	]40$<CR>	Reads CE data word at address location 0x40 in the hex format.
	]40$$<CR>	Reads CE data word at address location 0x40 and 0x41 in the hex format.
	]40$$$<CR>	Reads CE data word at address location 0x40,0x41 and 0x42 in the hex format.
	]40?<CR>	Reads CE data word at address location 0x40 in the decimal format.
	]40??<CR>	Reads CE data word at address location 0x40 and 0x41 in the decimal format.
	]40???<CR>	Reads CE data word at address location 0x40,0x42 and 0x43 in the decimal format.
	]7E=12345678<CR>	Writes 0x12345678 to CE address location 0x7E in the hex format.

]	CE Data Access	
	]7E=12345678=9876ABCD<CR>	Writes 0x12345678 to CE address location 0x7E and 0x9876ABCD to CE address location 0x7F in the hex format.
	]7E=+2255<CR>	Writes 2255 to CE address location 0x7E in the decimal format.
	]7E=+2255=-456<CR>	Writes 2255 to CE address location 0x7E and -456 to CE address location 0x7F in the decimal format.

To restore the four calibration coefficients, first write the four coefficients, turn off the CE, save the coefficients to internal Flash, and then turn on the CE.

```
>]8=+11290=+11294=+16542=+16544

>CE0
>]U

>CE1
>_
```

The commands that follow are included for reference only.

3.13 CE Control Commands

The most pertinent command is the CE enable command, CEn. It is mainly used to turn the CE on or off. The CE is normally enabled but in order to update the CE data entry to flash, the CE must first be turned off using the CE0 command.

3.13.1 Disable CE Command

The CE can be disabled by using the following command:

>CE0<CR>

3.13.2 Turn On CE Command

The CE can be enabled by following command:

>CE1<CR>

Additional examples of CE Control Commands are provided in the following table:

C	Compute Engine Control	
Description:	Allows the user to enable and configure the compute engine.	
Usage:	C {option} {argument}<CR>	
Command Combinations:	CEn<CR>	Compute Engine Enable (1 → Enable, 0 → Disable)
	CTn<CR>	Select input n for TMUX output pin. Enter n in hex notation.
	CREn<CR>	RTM output control (1 → Enable, 0 → Disable)
	CRSa.b.c.d<CR>	Selects CE addresses for RTM output. (maximum of four).
Examples:	CE0<CR>	Disables the CE.
	CE1<CR>	Enables the CE.
	CT1E<CR>	Selects the CE_BUSY signal for the TMUX output pin.

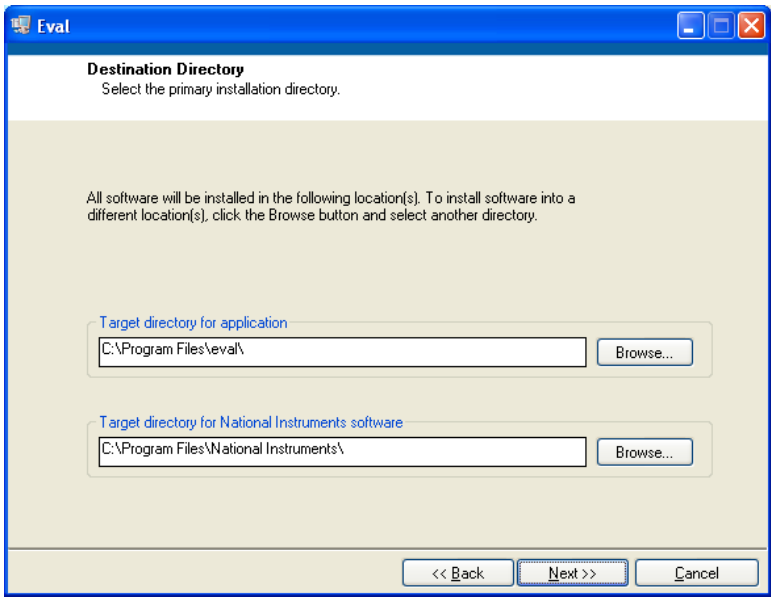
4 Windows Graphical User Interface (GUI)

The 78M6612 Split Phase GUI displays RMS voltage and current, power, volt-amperes, and power factor for two independent phases as well as totals for these parameters. A true RMS line-to-line voltage is also shown. Indicators are provided for the various alarms.

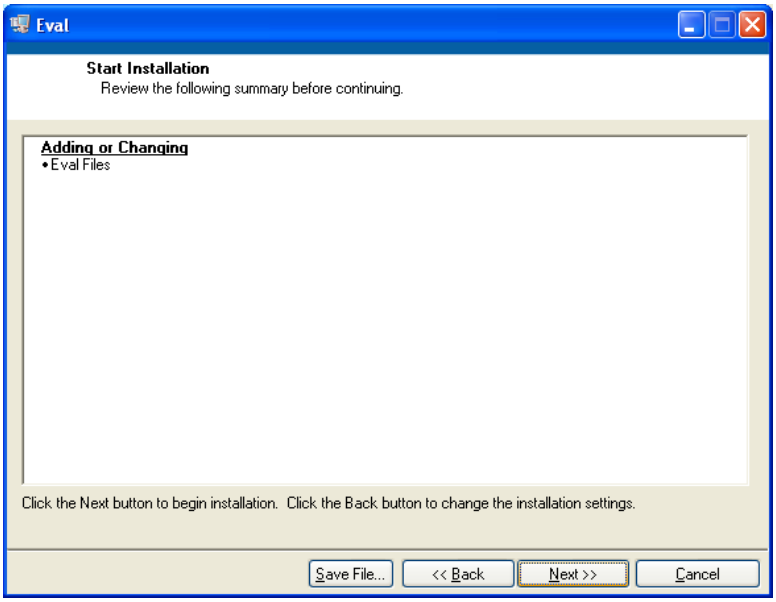
The 78M6612 Split Phase GUI is a National Instruments CVI application program. Click on the GUI ***setup.exe*** file provided on the CD to start the self installer.

4.1 Installing the GUI

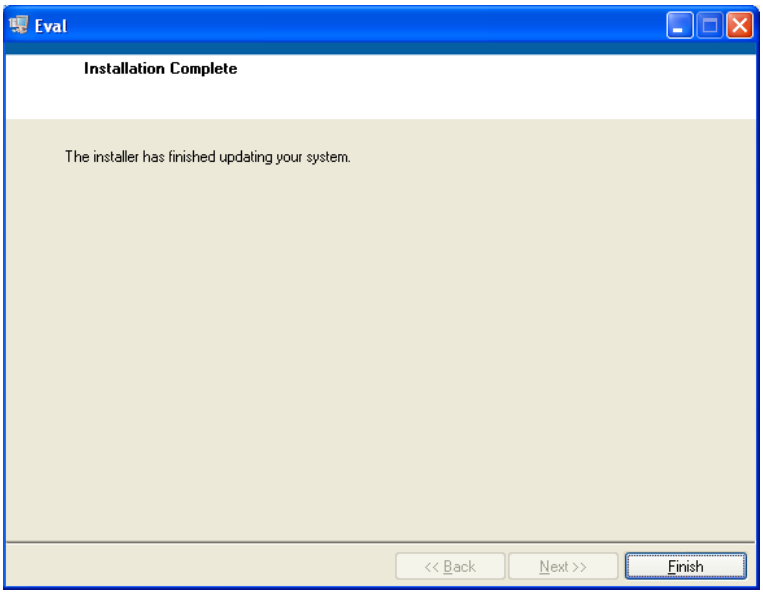
After clicking on ***setup.exe***, select the installation directories and click on ***Next***:



Confirm the installation and click on ***Next***:



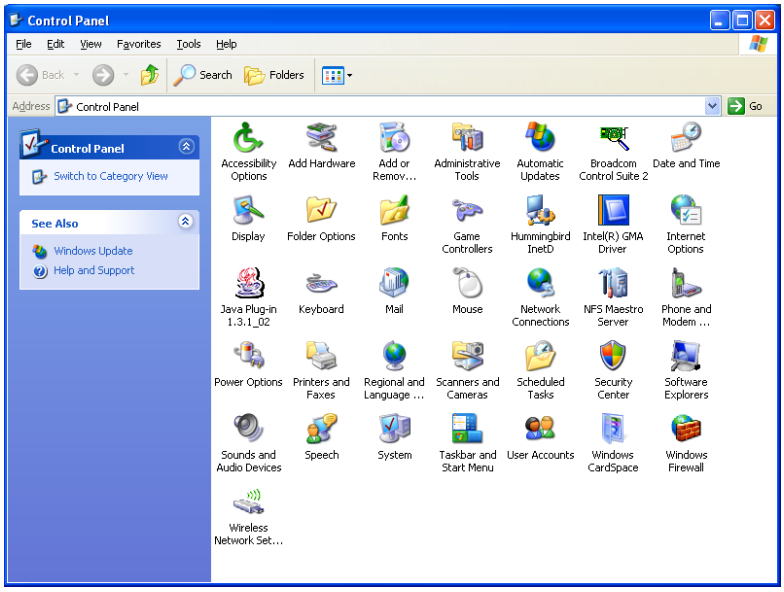
Confirm installation completion and click on ***Finish***:



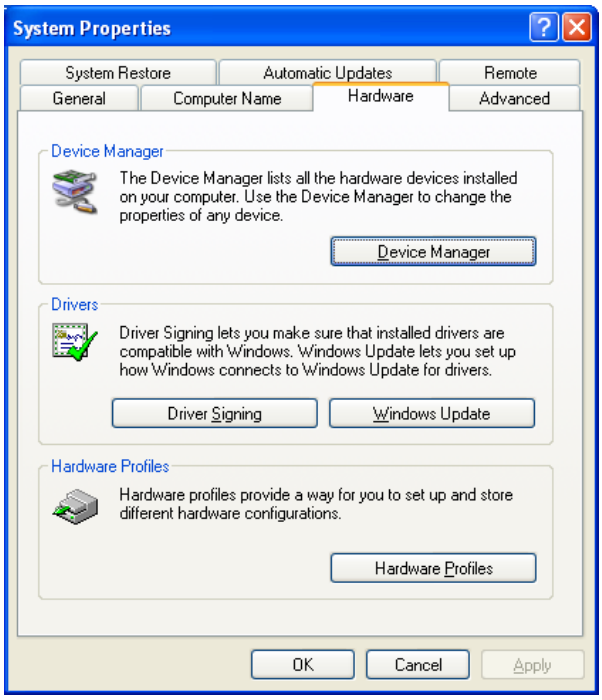
4.2 Changing the Com Port Assignment

The 78M6612 Split Phase GUI only allows for selecting Com Port assignments of COM1 through COM4. If your FTDI device is assigned a higher Com Port number, open the Device Manager and navigate to the device's Advanced Settings properties to change the Com port number.

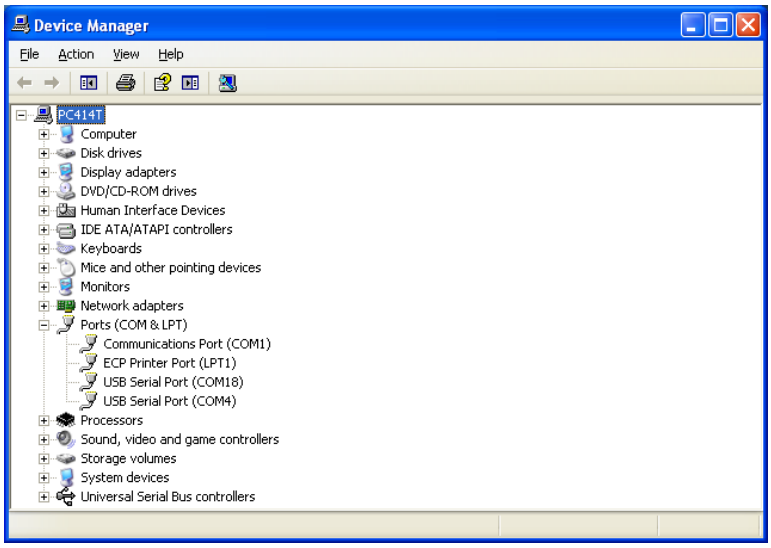
Click on the ***Device Manager*** icon:



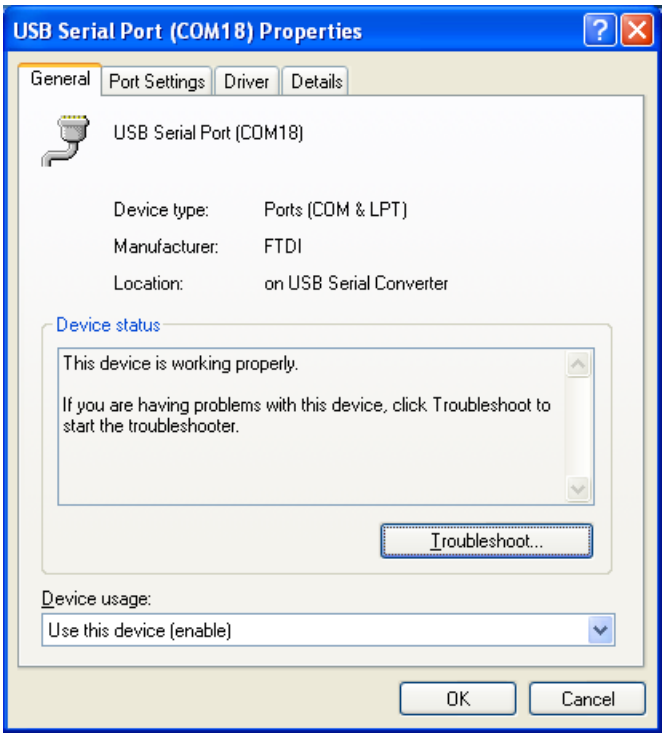
Click on the ***Device Manager*** button in the Hardware tab:



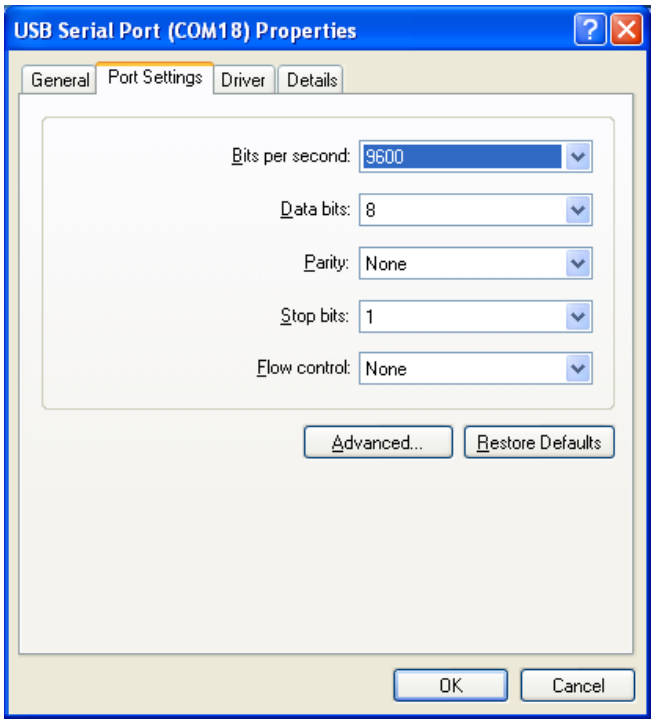
Click on the ***Ports (COM & LPT)*** line item to display all assigned ports.
Then high-light and click ***Properties*** of the desired USB Serial Port:



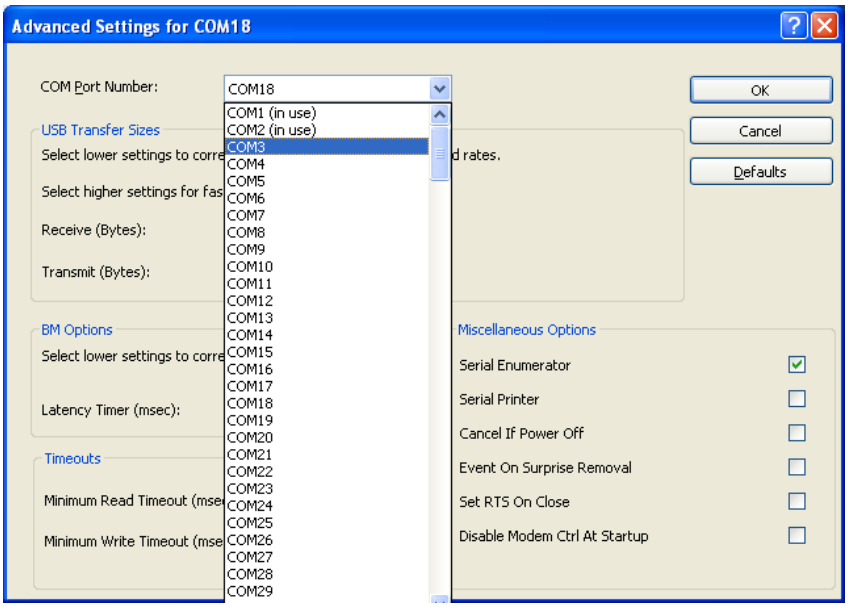
Click on the ***Port Settings*** tab:



Click on the ***Advanced*** button:



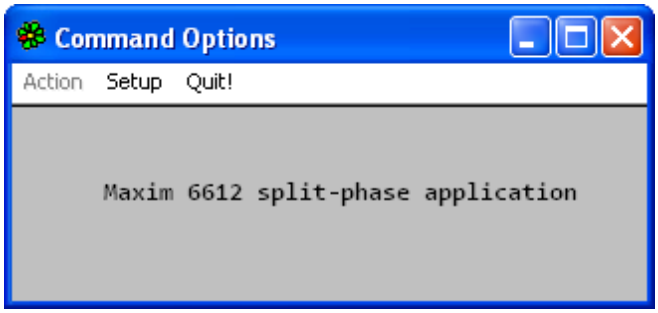
Click on the ***COM Port Number drop down arrow*** and select an available Com Port between 1 and 4:



Click OK on the various screens to accept this Com Port assignment change.

4.3 Starting the GUI

Start the 78M6612 Split Phase GUI by clicking on the GUI's ***eval.exe*** file via the Start Menu or locate the executable in the target directory selected earlier.



Click on ***Setup*** to select the Com Port assigned to the FTDI device:

Click on ***Action*** to display the Measurement panel:

Click on the ***Start*** and ***Stop*** buttons to operate the GUI:

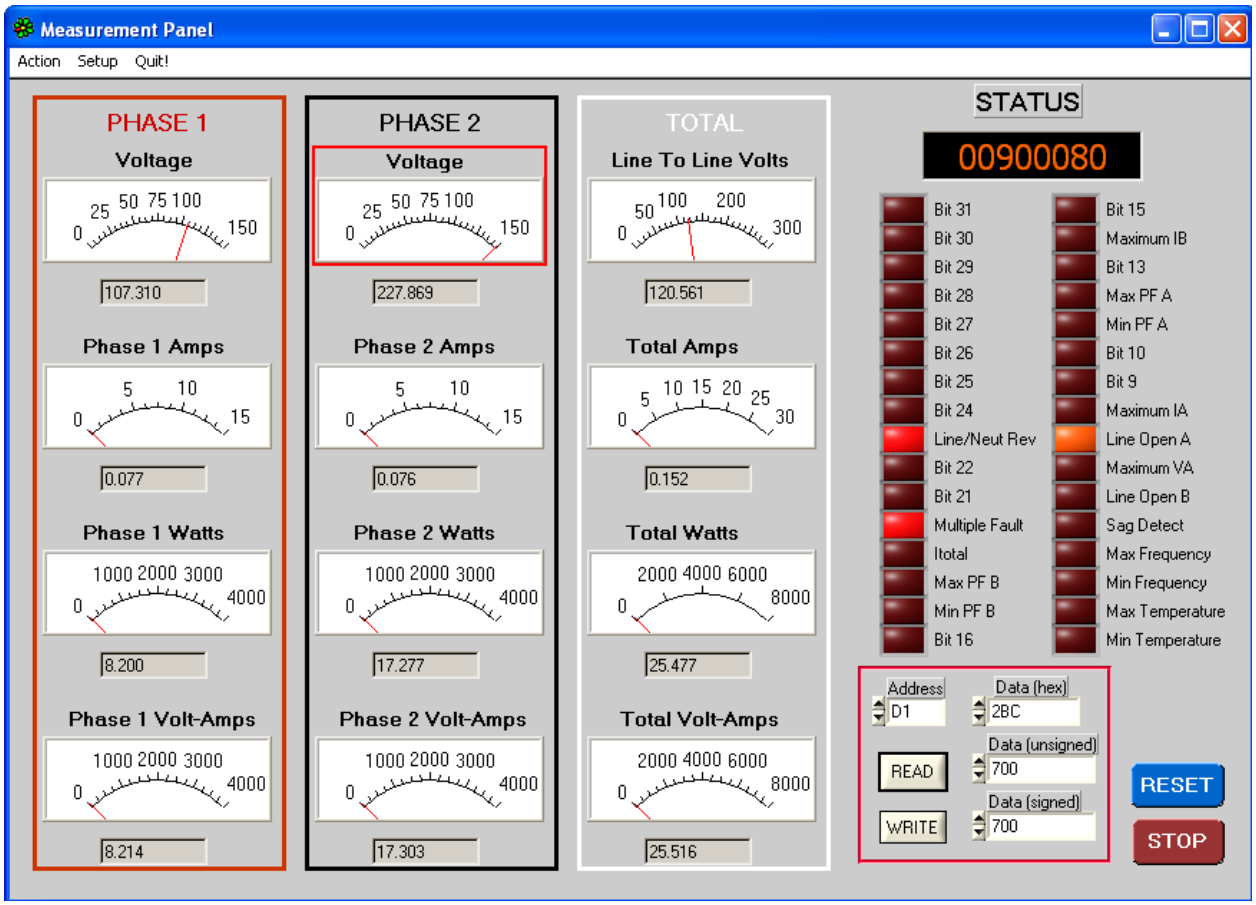


Figure 8: 78M6612 Split Phase GUI

Write address = ***F0*** and data = ***0*** to turn on the relays.

Write address = ***F0*** and data = ***1*** to turn off the relays.

5 Schematics, Bill of Materials and PCB Layouts

This section includes the schematics, bill of materials and PCB layouts for the 78M6612 Split Phase Evaluation Board.

5.1 78M6612 Split Phase Evaluation Board Schematics

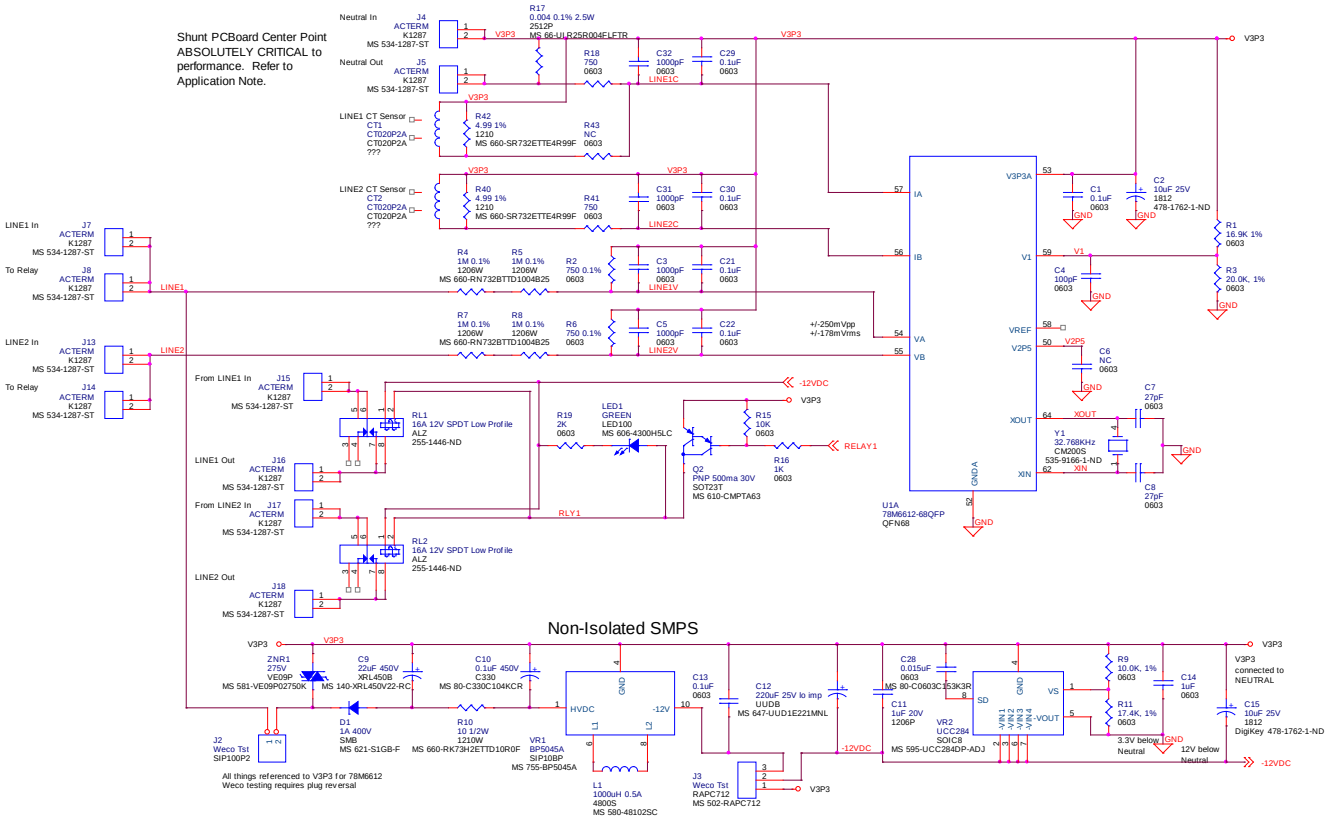


Figure 9: 78M6612 Split Phase Evaluation Board Electrical Schematic (1 of 2)

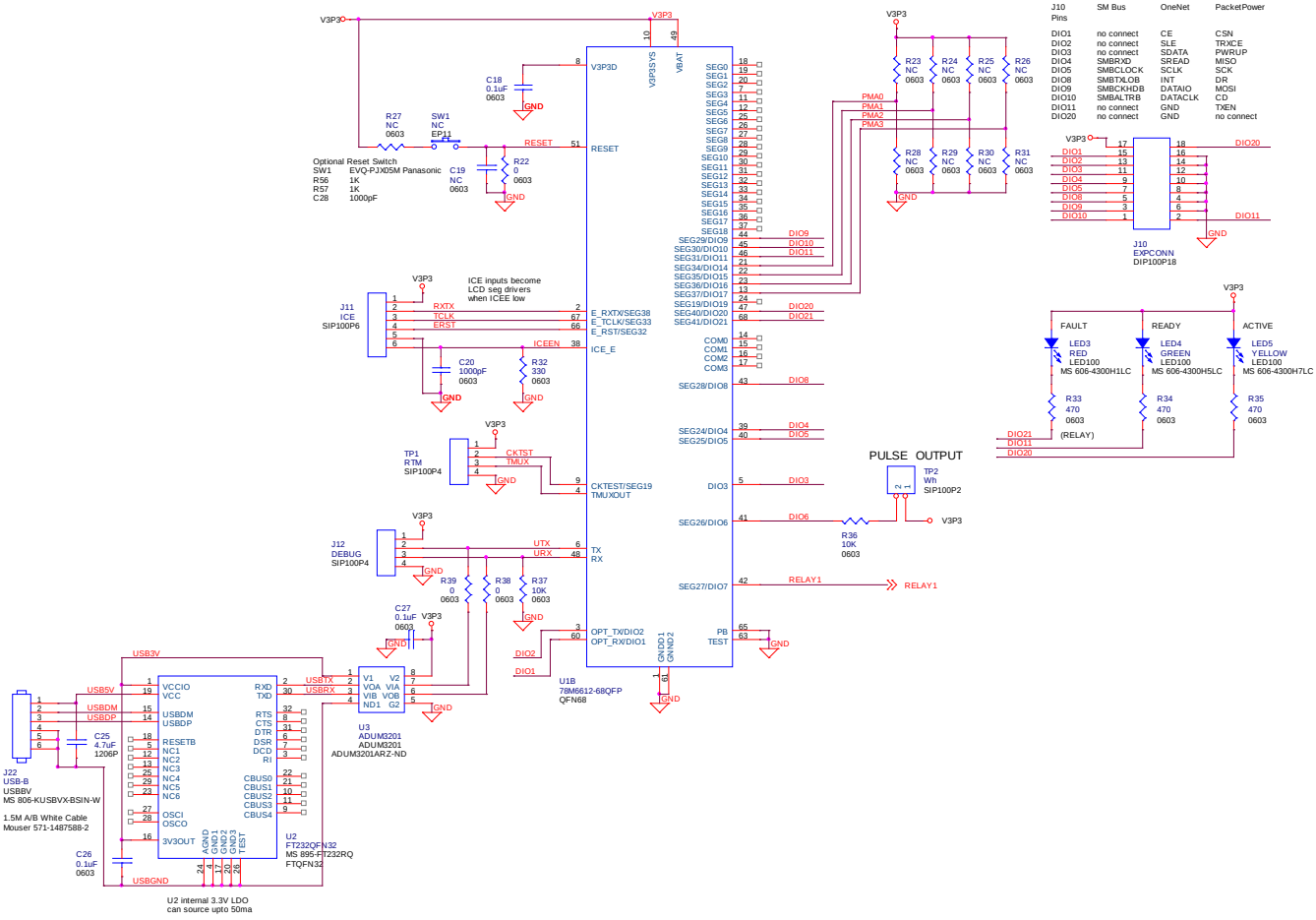


Figure 10: 78M6612 Split Phase Evaluation Board Electrical Schematic (2 of 3)

5.2 78M6612 Split Phase Evaluation Board Bill of Materials

Table 10: 78M6612 Split Phase Evaluation Board Bill of Materials

Item	Qty	Reference	Part	PCB Footprint	Digi-Key/Mouser Part Number	Part Number	RoHS	Manufacturer
1	5	C3,C5,C20, C31,C32	1000pF	RC0603	445-1298-1-ND	C1608X7R2A102K	X	TDK
2	9	C1,C13,C18, C21,C22,C26, C27,C29,C30	0.1uF	RC0603	445-1314-1-ND	C1608X7R1H104K	X	TDK
3	2	C2,C15	10uF, 25V	RC1812	478-1762-1-ND	TPSC106K025R0500	X	AVX
4	2	C7,C8	27pF	RC0603	445-1274-1-ND	C1608C0G1H270J	X	TDK
5	1	C4	100pF	RC0603	445-1281-1-ND	C1608C0G1H101J	X	TDK
6	1	C28	0.015uF	RC0603	80-C0603C153K3R	C0603C153K3RACTU	X	KEMET
7	1	C14	1uF	RC0603	445-1416-1-ND	C1608X5R1C105K	X	TDK
8	1	C25	4.7uF	RC1206	445-1606-1-ND	C3216X7R1E475K	X	TDK
9	1	C11	1uF, 20V	RC1206P	445-1592-1-ND	C3216X7R1E105K/0.85	X	TDK
10	1	C12	220uF,25V,lo imp	UUDB	647-UUD1E221MNL	UUD1E221MNL1GS	X	NICHICON
11	1	C10	0.1uF, 450V	C330	80-C330C104KCR	C330C104KCR5TA	X	KEMET
12	1	C9	22uF, 450V	XRL450B	140-REA220M2WBK1625P	REA220M2WBK-1625P	X	Lelon
13	1	J3	+5VEXT	RAPC	502-RAPC712	RAPC721A	X	Switchcraft
14	2	J12,TP1	HEADER 4	4X1PIN	S1011E-36-ND	PBC36SAAN	X	Sullins Connector Solutions
15	1	J11	HEADER 6	6X1PIN	S1011E-36-ND	PBC36SAAN	X	Sullins Connector Solutions
16	1	J10	HEADER 18	9X2PIN	S2211E-18-ND	PBC18DFAN	X	Sullins Connector Solutions
17	2	J2,TP2	HEADER 2	2X1PIN	S1011E-36-ND	PBC36SAAN	X	Sullins Connector Solutions
18	1	J22	USB	USB-B	154-2442-E	154-2442-E	X	Kobiconn
19	1	R17	0.004, 1%, 2.5W	2512	66-ULR25R004FLFTR	ULR25R004FLFTR	X	IRC/TT electronics
20	4	R2,R6, R18,R41	750, 0.1%	RC0603	RG16P750BCT-ND	RG1608P-751-B-T5	X	Susumu
21	2	R40,R42	4.99,1%	RC1210	660-SR732ETTE4R99F	SR732ETTE4R99F	X	KOA Speer
22	3	R33,R34,R35	470	RC0603	P470GCT-ND	ERJ-3GEYJ471V	X	Panasonic

Item	Qty	Reference	Part	PCB Footprint	Digi-Key/Mouser Part Number	Part Number	RoHS	Manufacturer
24	4	R4,R5,R7,R8	1M, 0.1%	RC1206	660-RN732BTTD1004B25	RN732BTTD1004B25	X	KOA Speer
25	1	R1	16.9K,1%	RC0603	660-SR732ETTE16R9F	SR732ETTE16R9F	X	KOA Speer
26	1	R11	17.4K,1%	RC0603	660-SR732ETTE17R4F	SR732ETTE17R4F	X	KOA Speer
27	1	R9	10.0K,1%	RC0603	660-SR732ETTE10R0F	SR732ETTE10R0F	X	KOA Speer
28	1	R3	20.0K,1%	RC0603	660-SR732ETTE20R0F	SR732ETTE20R0F	X	KOA Speer
29	1	R22,538,R39	0	RC0603	P00GCT-ND	ERJ-3GEYJ000V	X	Panasonic
30	1	R32	330	RC0603	P330GCT-ND	ERJ-3GEYJ331V	X	Panasonic
31	3	R15,R36,R37	10K	RC0603	P10KGCT-ND	ERJ-3GEYJ103V	X	Panasonic
32	1	R16	1K	RC0603	P1.0KGTR-ND	ERJ-3GEYJ102V	X	Panasonic
33	1	R19	2K	RC0603	P2.0KGTR-ND	ERJ-3GEYJ202V	X	Panasonic
34	1	R10	10, 1.2W	RC1210W	660-RK73H2ETTE10R0F	RK73H2ETTE10R0F	X	KOA Speer
35	2	LED1,LED2	GREEN	LED100	606-4300H5LC	4300H5LC	X	Chicago Miniature
36	1	LED3	RED	LED100	606-4300H1LC	4300H1LC	X	Chicago Miniature
37	1	LED4	YELLOW	LED100	606-4300H7LC	4300H7LC	X	Chicago Miniature
38	2	CT1,CT2	50A,1:1000	CT020P2A	582-1084-ND	CR8349-1000-N	X	CR Magnetics
40	1	RL1,RL2	16A,12V,SPDT	ALZ	255-1446-ND	ALZ12F12	X	Panasonic
41	1	L1	1000uH, 0.5A	4800S	580-48102SC	48102SC	X	Murata
42	1	D1	1A, 400V	SMB	621-S1GB-F	S1GB-13-F	X	Diodes, Inc
43	1	Q2	PNP,500MA,30V	SOT23T	610-CMPTA63	CMPTA63	X	Central Semiconductor
44	1	ZNR1	275V	VE09P	576-V07E275P	V07E275P	X	Littelfuse
45	1	U2	FT232	32QFN	895-FT232RQ	FT232QFN32	X	FTDI
46	1	U3	ADUM3201	8SOIC	ADUM3201ARZ-ND	ADUM3201	X	Analog Devices
47	1	U1	78M6612	68QFN	—	78M6612-IM	X	Teridian
48	1	VR2	UCC284	SOIC8	595-UCC284DP-ADJ	UCC284DP-ADJ	X	TI
49	1	VR1	BP5045A	SIP10BP	755-BP5045A	BP5045	X	ROHM Semiconductor
50	1	Y1	32.768 KHZ SMD 12.5pF	ABS25	535-9166-1-ND	ABS25-32.768KHZ-T	X	Abracon

5.3 78M6612 Split Phase Evaluation Board PCB Layouts

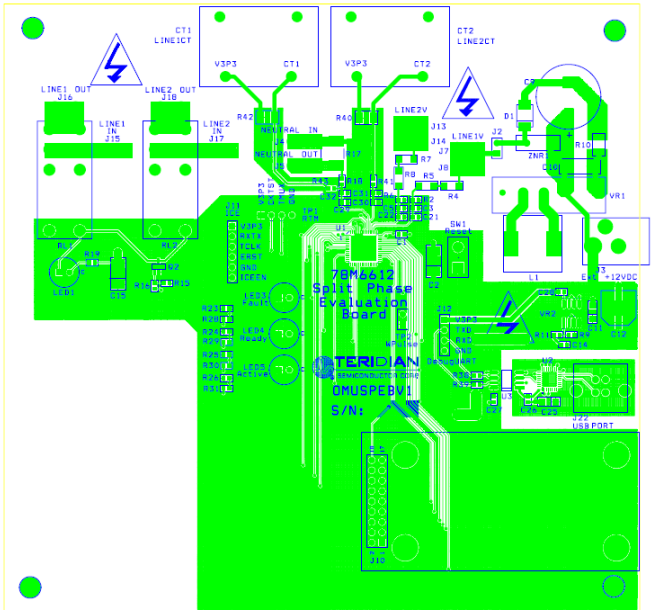


Figure 11: 78M6612 Split Phase Evaluation Board PCB Top View

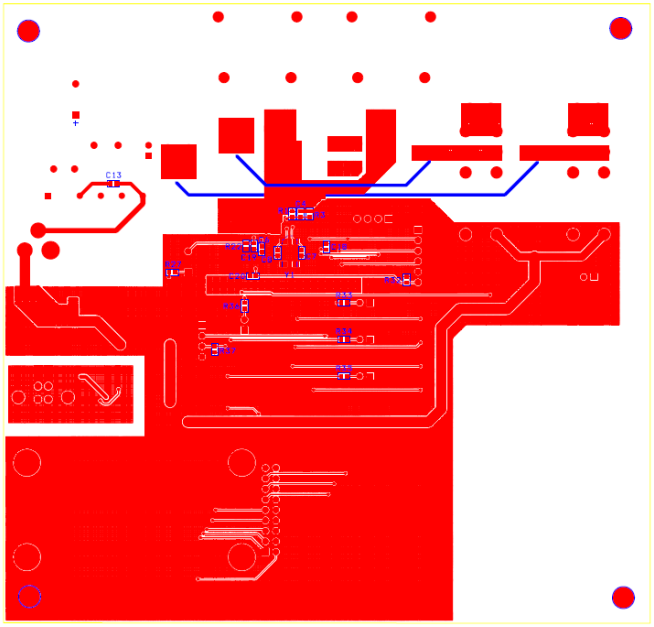


Figure 12: 78M6612 Split Phase Evaluation Board PCB Bottom View

6 Ordering Information

Part Description	Order Number
78M6612 Split Phase Evaluation Board	78M6612SP-EVM-1

7 Included Documentation

The following 78M6612 documents are included on the CD:

78M6612 Data Sheet
78M6612 Split Phase Evaluation Board User Manual

8 Contact Information

For more information about Maxim products or to check the availability of the 78M6612, contact technical support at www.maxim-ic.com/support.

Revision History

REVISION	DATE	DESCRIPTION	PAGES CHANGED
1.0	11/8/2010	Initial release	—