

User's Guide

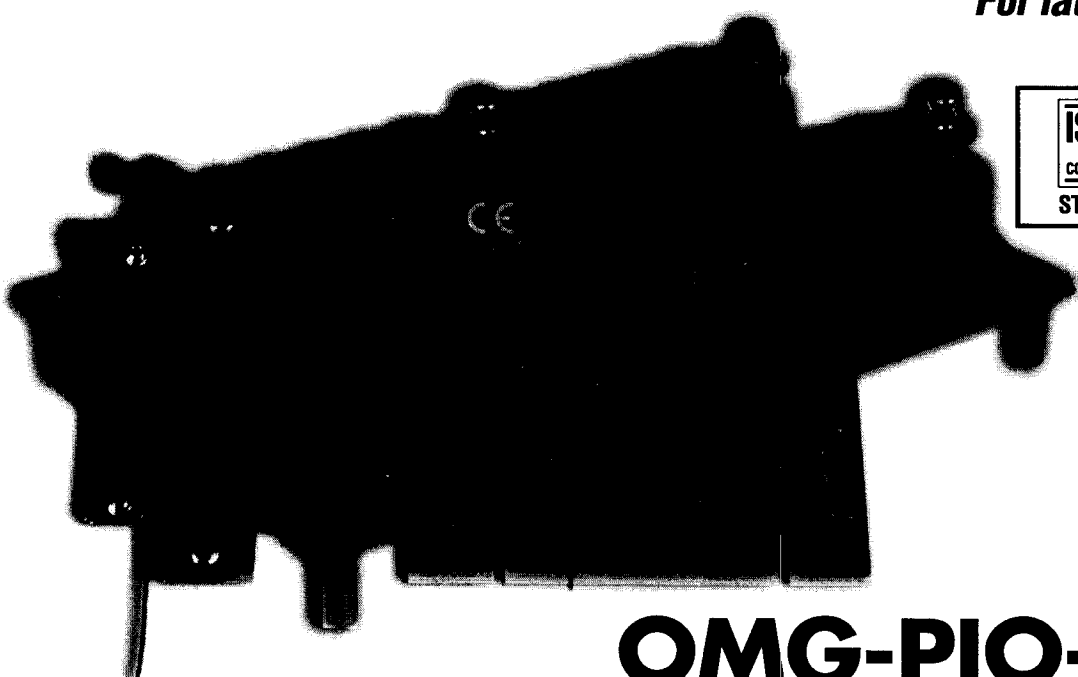
Shop online at



omega.com

e-mail: info@omega.com

*For latest product manuals:
omegamanual.info*



OMG-PIO-24-LPCI OMG-PIO-24-PCI 24 Channel Digital I/O Board



OMEGAnet® Online Service
omega.com

Internet e-mail
info@omega.com

Servicing North America:

U.S.A.:
ISO 9001 Certified

One Omega Drive, P.O. Box 4047
Stamford, CT 06907-0047
TEL: (203) 359-1660
FAX: (203) 359-7700
e-mail: info@omega.com

Canada:

976 Bergar
Laval (Quebec) H7L 5A1, Canada
TEL: (514) 856-6928
FAX: (514) 856-6886
e-mail: info@omega.ca

For immediate technical or application assistance:

U.S.A. and Canada: Sales Service: 1-800-826-6342/1-800-TC-OMEGA®
Customer Service: 1-800-622-2378/1-800-622-BEST®
Engineering Service: 1-800-872-9436/1-800-USA-WHEN®

Mexico:

En Español: (001) 203-359-7803
e-mail: espanol@omega.com
FAX: (001) 203-359-7807
info@omega.com.mx

Servicing Europe:

Czech Republic:

Frystatska 184, 733 01 Karviná, Czech Republic
TEL: +420 (0)59 6311899
FAX: +420 (0)59 6311114
Toll Free: 0800-1-66342
e-mail: info@omegashop.cz

Germany/Austria:

Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
TEL: +49 (0)7056 9398-0
FAX: +49 (0)7056 9398-29
Toll Free in Germany: 0800 639 7678
e-mail: info@omega.de

United Kingdom:

ISO 9002 Certified

One Omega Drive, River Bend Technology Centre
Northbank, Irlam, Manchester
M44 5BD United Kingdom
TEL: +44 (0)161 777 6611
FAX: +44 (0)161 777 6622
Toll Free in United Kingdom: 0800-488-488
e-mail: sales@omega.co.uk

It is the policy of OMEGA Engineering, Inc. to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

WARNING: These products are not designed for use in, and should not be used for, human applications.

Table of Contents

<u>INTRODUCTION</u>	1
<u>BEFORE YOU GET STARTED</u>	2
<u>WHAT'S INCLUDED</u>	2
<u>OPTIONAL ITEMS</u>	2
<u>SOFTWARE INSTALLATION</u>	3
<u>WINDOWS 98/ME/2000/XP INSTALLATION</u>	3
<u>LINUX INSTALLATION</u>	4
<u>PHYSICAL INSTALLATION</u>	5
<u>DIGITAL I/O INTERFACE</u>	6
<u>26-PIN HEADER CONNECTORS</u>	6
<u>PROGRAMMING FOR WINDOWS</u>	6
<u>SAMPLES AND UTILITIES</u>	6
<u>PROGRAMMING FOR LINUX</u>	6
<u>DIRECT HARDWARE CONTROL</u>	6
<u>READING THE INPUTS</u>	6
<u>READING THE OUTPUTS</u>	7
<u>OMG-CA315 50-PIN IDC CONNECTOR – PIN OUT</u>	8
<u>PROGRAMMING THE OMG-PIO-24-LPCI</u>	9
<u>PRESETTING AN OUTPUT PORT</u>	9
<u>WRITING THE OUTPUTS</u>	9
<u>REGISTER DESCRIPTION</u>	9
<u>I/O CONTROL WORD</u>	10
<u>INTERRUPT CONTROL</u>	10
<u>INTERRUPT MODE SELECT TABLE</u>	10
<u>INTERRUPT READ</u>	10
<u>ELECTRICAL CHARACTERISTICS</u>	11
<u>SPECIFICATIONS</u>	11
<u>EXAMPLE CIRCUITS</u>	12
<u>APPENDIX A - TROUBLESHOOTING</u>	13
<u>APPENDIX B - HOW TO GET ASSISTANCE</u>	14
<u>APPENDIX C – SILK SCREEN OMG-PIO-24-LPCI PCB</u>	15
<u>APPENDIX D - COMPLIANCE NOTICES</u>	16
<u>FEDERAL COMMUNICATIONS COMMISSION STATEMENT</u>	16
<u>EMC DIRECTIVE STATEMENT</u>	16

Introduction

The OMG-PIO-24-LPCI digital I/O interface provides 24 channels of buffered drive digital I/O emulating 8255 mode zero. The OMG-PIO-24-LPCI can be utilized for a variety of control and automation applications including control and monitoring of TTL devices (e.g. LEDs, small solenoids, small relays) and interfacing to solid-state relay racks (SSRs) for high-power AC or DC loads.

The OMG-PIO-24-LPCI's 24 digital I/O channels are accessed via two 26-pin header connectors that are brought out to a single 50-pin IDC connector with the included OMG-CA315 ribbon cable. The headers provide 24 bits of digital I/O divided into three eight-bit groups. Each eight-bit group may be individually configured via software command as input or output to best match your particular application requirements.

The OMG-PIO-24-LPCI is designed to be used with a variety of Operating Systems including Windows 98/NT/ME/2000/XP, Linux and DOS. The SeaI/O API (Application Programmer Interface) included on CD with the OMG-PIO-24-LPCI provides a variety of useful high-level function calls implemented as a Windows dynamic link library (DLL) and as a Linux kernel module and library. In addition to the API, SeaI/O includes sample code and utilities to simplify software development.

Before You Get Started

What's Included

The OMG-PIO-24-LPCI is shipped with the following items. If any of these items is missing or damaged please contact Omega Engineering, Inc. for replacement.

- < **OMG-PIO-24-LPCI Adapter**
- < **IDC 50 to (2) IDC 26 Pin 40" Ribbon Cable (Part Number OMG-CA315)**
- < **Sea/I/O Software CD**

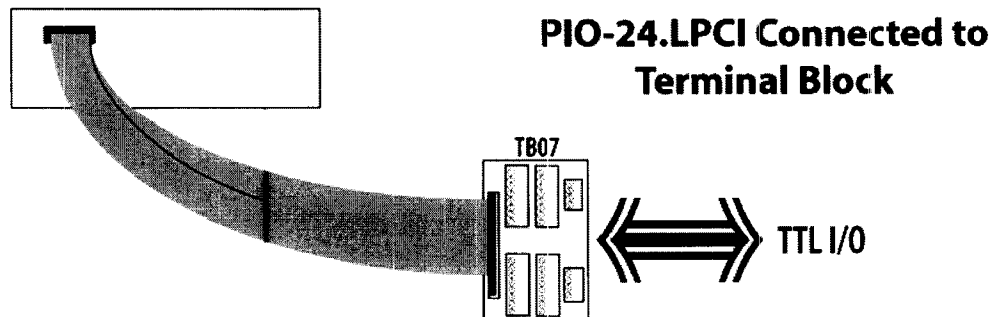
Model **OMG-PIO-24-LPCI** ships with a Low Profile PCI bracket.
Model **OMG-PIO-24-PCI** ships with a standard size PCI bracket.

Optional Items

Depending upon your application, you are likely to find one or more of the following items useful for interfacing the OMG-PIO-24-LPCI to real-world signals.

For TTL applications:

- < **IDC 50 to (2) IDC 26 Pin 40" Ribbon Cable (Part Number OMG-CA315)**
 - Connects to the two 26-pin header connectors on the OMG-PIO-24-LPCI and brings them out to a single 50-pin IDC connector, which is compatible with industry-standard relay racks.
- < **Terminal Block - (Part Number OMG-TB07)**
 - The OMG-TB07 allows you to break out 24 digital signals, +5 volts, and ground to screw terminals for easy field connection of switches, discrete solid state relays, sensors, etc.



Software Installation

Windows 98/ME/2000/XP Installation

1. Start Windows.
2. Insert the Software CD in to your CD drive.
3. If 'Auto-Start' is enabled for this drive the software will automatically launch. Otherwise, point your browser to the 'Index.htm' on the root directory of the CD
4. Select 'Install Software'.
5. Select the Part Number for your adapter from the listing.
6. Select 'Windows 98/ME/2000/XP'. The setup file will automatically detect the operating environment and install the proper components. Next (depending on your browser) select the 'Run this program from its current location' or 'Open' option. Follow the information presented on the screens that follow.
7. A screen may appear with the declaration: "The publisher cannot be determined due to the problems below: Authenticode signature not found." Please select the 'Yes' button and proceed with the installation. This declaration simply means that the Operating System is not aware of the driver being loaded. It will not cause any harm to your system.
8. During setup the user may specify installation directories and other preferred configurations. This program also adds entries to the system registry that are necessary for specifying the operating parameters for each driver. An uninstall option is also included to remove all registry/INI file entries from the system.

Windows NT Card Installation: After accomplishing the above steps, bring up the Control Panel and double-click on the SeaIO Devices icon. To install a new card, click "Add Port". Repeat this procedure for as many SeaIO cards as you wish to install.

Linux Installation

Note: You MUST have "root" privileges to install the software and drivers.

1. Login as "root".
2. Mount the CDROM by typing:

```
mount -t iso4860 /dev/hdc /cdrom
```

Note Your cdrom may not be /dev/hdc it could be /dev/hda, /dev/hdb, /dev/hdd, or if you have a SCSI drive /dev/sda, /dev/sdb, /dev/sdc, etc. You may mount the CDROM to any location, the /cdrom is just a common example.

3. Next change to the directory where you mounted the CDROM:

```
Ex. cd /cdrom/software/SeaIO/Other/linux
```

Note: The syntax is case sensitive.

4. Copy seaio.tar.gz to your home directory by typing:

```
cp seaio.tar.gz ~
```

5. Change to your home directory by typing:

```
cd
```

6. Unmount the drive and then Unzip and Untar the drivers and software by typing:

```
umount /cdrom  
tar -xvzf seaio.tar.gz
```

7. Change to the SeaIO directory by typing:

```
cd SeaIO
```

8. Now compile and prepare the drivers for use:

```
make install
```

9. With the system off and unplugged, install your SeaIO PCI card.

10. Plug system back in and boot Linux.

```
Login as "root".
```

11. Load the driver by typing:

```
SeaIO -load
```

The driver has enabled the card and is ready to use, and you now have the option to run a test utility on it. Skip to section "Using the test software" if you wish to do so at this time.

To set up Linux to automatically load the driver; refer to a Linux manual concerning your specific distribution for help.

Physical Installation

The adapter can be installed in any 3.3V or 5V Low Profile or PCI expansion slot.

Do not install the Adapter in the machine until the software has been fully installed.

1. Turn off PC power. Disconnect the power cord.
2. Remove the PC case cover.
3. Locate an available Low Profile or PCI slot and remove the blank metal slot cover.
4. Carefully route the OMG-CA315 cable thru the opening in the bracket. Connect each header to the card and secure the strain relief
5. Gently insert the PCI adapter into the slot. Make sure that the adapter is seated properly.
6. Replace the screw you removed for the blank and use it to secure the adapter into the slot. (This is required to ensure FCC Part 15 compliance.)
7. Replace the cover.
8. Connect the power cord

The OMG-PIO-24-LPCI is now ready for use.

Digital I/O Interface

The OMG-PIO-24-LPCI's 24 digital I/O channels are accessed via two (2) 26-pin header connectors. The included OMG-CA315 connects to the two 26-pin header connectors on the OMG-PIO-24-LPCI and brings them out to a single 50-pin IDC connector, which is compatible with industry-standard relay racks. The headers provide 24 bits of digital I/O divided into three eight-bit ports. Each port may be individually configured via software command as input or output.

26-pin Header Connectors

You will need to install the bracket assembly and cable to the OMG-PIO-24-LPCI prior to installing it in the PC. The OMG-PIO-24-LPCI's bracket features a unique cable clamp that provides a solid strain relief to prevent inadvertent cable removal.

The 26-pin connectors have the following pin out:

The SeaI/O software is provided to assist in the development of reliable applications for the OMG-PIO-24-LPCI digital I/O adapters. Included on the SeaI/O CD are driver functions for use in accessing the I/O as well as helpful samples and utilities.

Programming for Windows

The SeaI/O API (Application Programmer Interface) provides a variety of useful high-level function calls implemented in a Windows dynamic link library (DLL). The API is defined in the help file (Start/Programs/SeaI/O/SeaI/O Help) under "Application Programmers Interface". This help file also includes detailed information dealing with installation / removal of the software and information about latency, logic states, and device configuration.

For C language programmers we recommend using the API to access the OMG-PIO-24-LPCI. If you are programming in Visual Basic, using the ActiveX control included with SeaI/O is advised.

Samples and Utilities

A variety of sample programs and utilities (both executable and source code) are included with SeaI/O. Further documentation on these samples can be found by selecting "Start/Programs/SeaI/O/Sample Application Description". Information about where the files are physically stored on your disk is also included in this same file.

Programming for Linux

SeaI/O for Linux consists of two major parts: a kernel module and a library. The kernel module is a simple IO pass-through device, allowing the library to handle the more sophisticated functions provided to SeaI/O users. It is provided in a 'tarball' format and can easily be compiled and included in the kernel build.

Direct Hardware Control

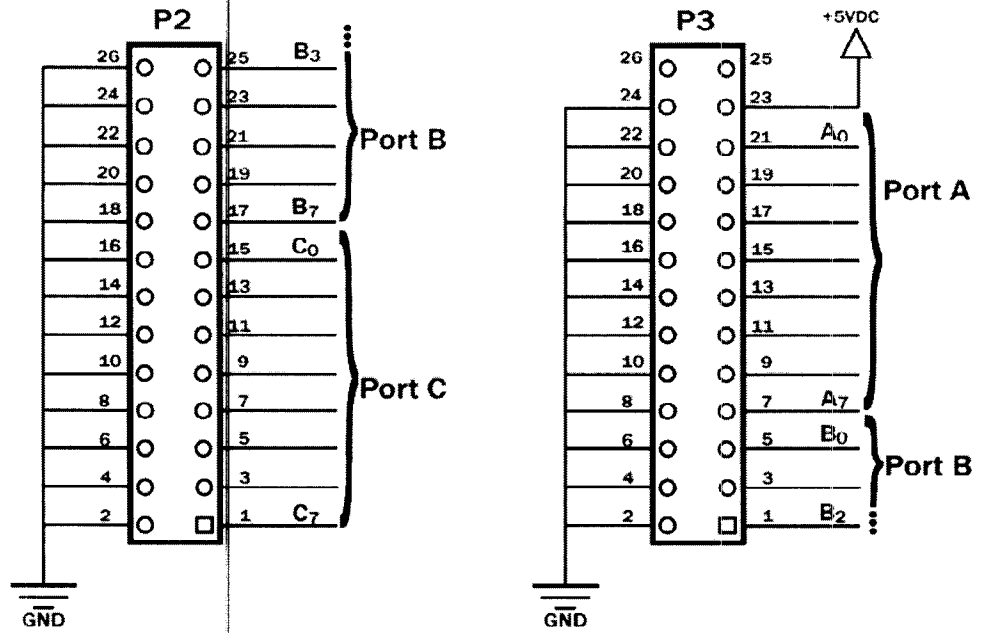
In systems where the users program has direct access to the hardware (DOS) the tables that follow give the mapping and functions that the OMG-PIO-24-LPCI provides.

Reading the Inputs

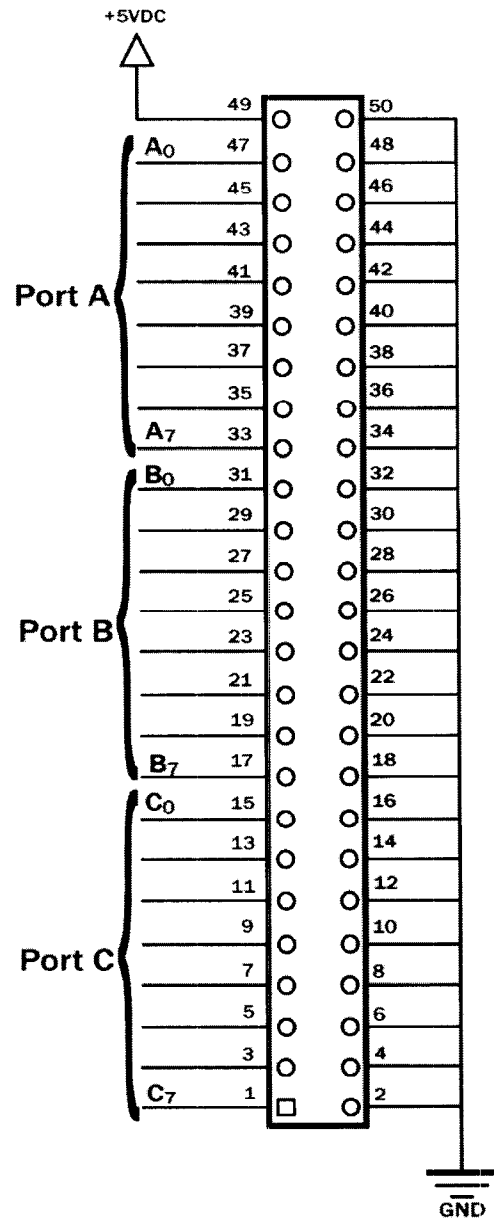
The inputs are active true. If an input is driven high (2V to 5.25 V) it will read as a logical one, if driven low (0V to 0.8V) it will read as a logical zero. If an input is not driven it will read as a one due to the 10K ohm pull up resistors on each port.

Reading the Outputs

The value that is currently being used to drive the outputs will be returned.



OMG-CA315 50-Pin IDC Connector - Pin Out



Programming the OMG-PIO-24-LPCI

Presetting an Output Port

Each port has an output register associated with it. This register may be written and retains its value whether the port is configured as an input or an output. To preset the value of an output port the program should write to the port when it is configured as an input then configure it as an output.

Writing the Outputs

The outputs are active true. Writing a one (1) corresponds to 5V while writing a zero (0) corresponds to 0V, at the output.

Register Description

Address	Mode	D7	D6	D5	D4	D3	D2	D1	D0
Base+0	RD/WR	PA1D7	PA1D6	PA1D5	PA1D4	PA1D3	PA1D2	PA1D1	PA1D0
Base+1	RD/WR	PB1D7	PB1D6	PB1D5	PB1D4	PB1D3	PB1D2	PB1D1	PB1D0
Base+2	RD/WR	PC1D7	PC1D6	PC1D5	PC1D4	PC1D3	PC1D2	PC1D1	PC1D0
Base+3	WR	CW1D7	0	0	CW1D4	CW1D3	CW1D2	CW1D1	CW1D0
Base+4	RD/WR	0	0	0	0	0	IRQEN1	IRQC11	IRQC10
Base+5	RD	0	0	0	0	0	0	0	IRQST1

0 = Not Used

I/O Control Word

Each port may be configured as either Input or Output. This is accomplished by writing the correct Control Word (CW) to the proper register.

Control Word (X = 0)								Hex Value	Port Setup			
7	6	5	4	3	2	1	0		A	B	C Upper	C Lower
1	X	X	0	0	X	0	0	80	Out	Out	Out	Out
1	X	X	0	0	X	0	1	81	Out	Out	Out	In
1	X	X	0	0	X	1	0	82	Out	In	Out	Out
1	X	X	0	0	X	1	1	83	Out	In	Out	In
1	X	X	0	1	X	0	0	88	Out	Out	In	Out
1	X	X	0	1	X	0	1	89	Out	Out	In	In
1	X	X	0	1	X	1	0	8A	Out	In	In	Out
1	X	X	0	1	X	1	1	8B	Out	In	In	In
1	X	X	1	0	X	0	0	90	In	Out	Out	Out
1	X	X	1	0	X	0	1	91	In	Out	Out	In
1	X	X	1	0	X	1	0	92	In	In	Out	Out
1	X	X	1	0	X	1	1	93	In	In	Out	In
1	X	X	1	1	X	0	0	98	In	Out	In	Out
1	X	X	1	1	X	0	1	99	In	Out	In	In
1	X	X	1	1	X	1	0	9A	In	In	In	Out
1	X	X	1	1	X	1	1	9B	In	In	In	In

Interrupt Control

When enabled interrupts are generated on port bit D0 of the A port.

$n = 1$

IRQEN _n	interrupt enable	1 = enabled	0 = disabled (0 on power up)
IRQC _{n0}	Interrupt mode select, see table below		
IRQC _{n1}	Interrupt mode select, see table below		

Interrupt mode select table

IRQC _{n1}	IRQC _{n0}	INT Type
0	0	Low level
0	1	High level
1	0	Falling edge
1	1	Rising edge

Interrupt Read

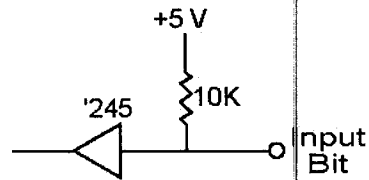
Reading the INTSTAT port (Base+5) clears any interrupt pending.

IRQST1	(D0)	interrupt status	1 = interrupt pending, 0 = none
--------	------	------------------	---------------------------------

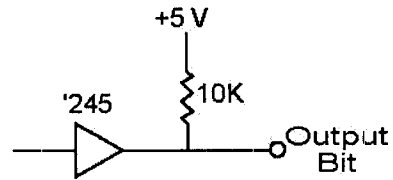
Electrical Characteristics

The OMG-PIO-24-LPCI uses 74LS245 octal bi-directional transceivers to provide TTL input/output capabilities. Each bit is pulled to +5V through a 10K ohm pull-up resistor to insure each bit is at a known state when not driven.

Input Circuit Schematic



Output Circuit Schematic



Specifications

Inputs

- < Logic High: Min 2VDC
- < Logic Low: Max 0.8VDC

Outputs

- < Logic High: Min 2VDC @ 15 mA
- < Logic Low: Max 0.5VDC @ 24 mA

Temperature Range

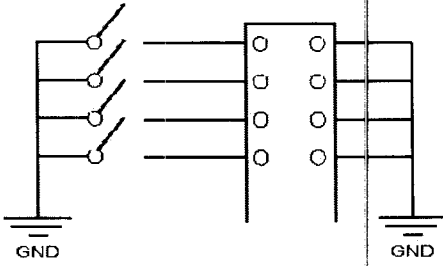
- < Operating: 0°C – 70°C
- < Storage: -50°C – 105°C

Power Requirements

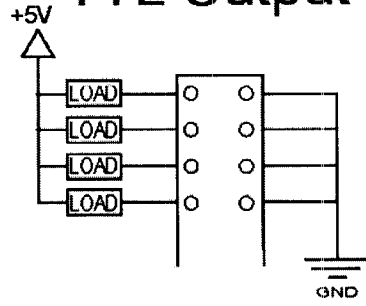
- < +5VDC @ 1A

Example Circuits

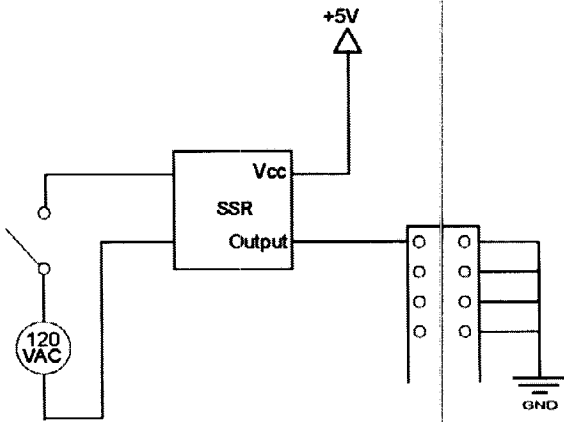
TTL Input



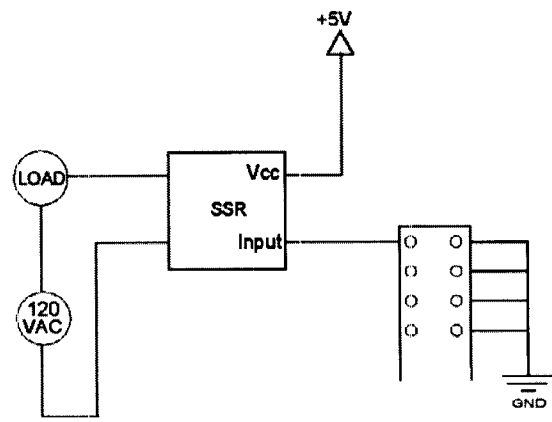
TTL Output



Solid State Relay Input



Solid State Relay Output



Appendix A - Troubleshooting

Following these simple steps can eliminate most common problems.

1. **Install software first.** After installing the software then proceed to adding the hardware. This places the required installation files in the correct locations.
2. Read this manual thoroughly before attempting to install the adapter in your system.
3. Use Device Manager under Windows to verify proper installation.
4. Use the SealIO Control Panel applet or the Device Manager's property page for card identification and configuration.
5. If these steps do not solve your problem, please call Omega's Technical Support, 1-800-872-9436. Our technical support is free and available from 8:30AM-6PM Eastern Time Monday through Friday. For email support contact das@omega.com.

Appendix B - How To Get Assistance

Begin by reading through the Trouble Shooting Guide in Appendix A. If assistance is still needed please see below.

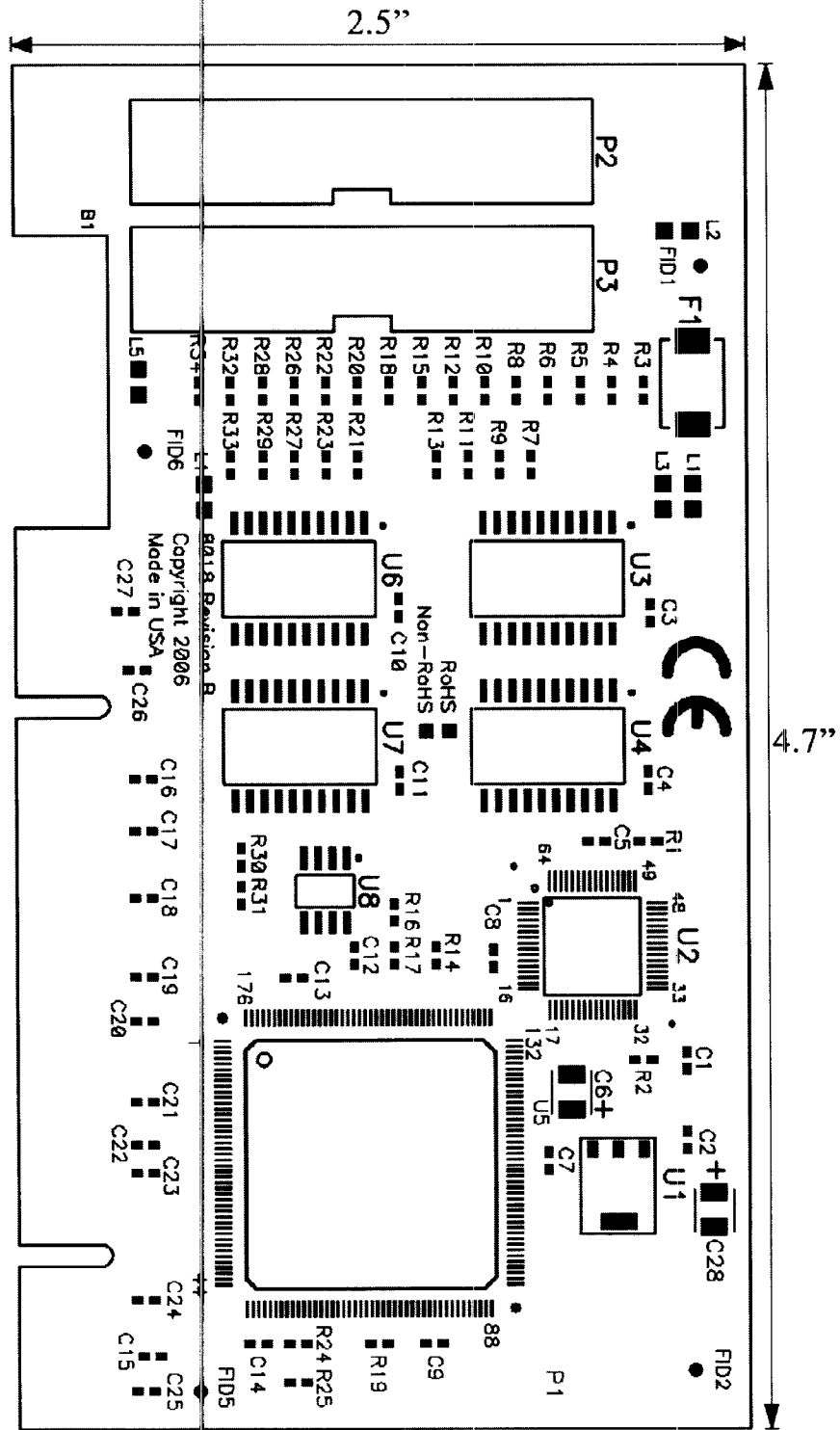
When calling for technical assistance, please have your user manual and current adapter settings. If possible, please have the adapter installed in a computer ready to run diagnostics.

Omega Engineering, Inc. maintains a Home page on the Internet. Our home page address is <http://www.omega.com>. The latest software updates, and newest manuals are available via our FTP site that can be accessed from our home page.

Technical support is available Monday to Friday from 8:30 a.m. to 6:00 p.m. eastern time. Technical support can be reached at 1-800-872-9436.

RETURN AUTHORIZATION MUST BE OBTAINED FROM OMEGA ENGINEERING, INC. BEFORE RETURNED MERCHANDISE WILL BE ACCEPTED. AUTHORIZATION CAN BE OBTAINED BY CALLING OMEGA ENGINEERING, INC. AND REQUESTING AN AUTHORIZED RETURN (AR) NUMBER.

Appendix C - Silk Screen - OMG-PIO-24-LPCI PCB



Appendix D - Compliance Notices

Federal Communications Commission Statement

FCC - This equipment has been tested and found to comply with the limits for Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in such case the user will be required to correct the interference at the users expense.

EMC Directive Statement



Products bearing the CE Label fulfill the requirements of the EMC directive (89/336/EEC) and of the low-voltage directive (73/23/EEC) issued by the European Commission.

To obey these directives, the following European standards must be met:

EN55022 Class A - "Limits and methods of measurement of radio interference characteristics of information technology equipment"

EN55024 - "Information technology equipment Immunity characteristics Limits and methods of measurement".

EN60950 (IEC950) - "Safety of information technology equipment, including electrical business equipment"

Warning

This is a Class A Product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures to prevent or correct the interference.

Always use cabling provided with this product if possible. If no cable is provided or if an alternate cable is required, use high quality shielded cabling to maintain compliance with FCC/EMC directives.



WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **61 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **five (5) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

© Copyright 2007 OMEGA ENGINEERING, INC. All rights reserved. This document may not be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine-readable form, in whole or in part, without the prior written consent of OMEGA ENGINEERING, INC.

Where Do I Find Everything I Need for Process Measurement and Control? **OMEGA...Of Course!** *Shop online at omega.com*

TEMPERATURE

- Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- Wire: Thermocouple, RTD & Thermistor
- Calibrators & Ice Point References
- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

PRESSURE, STRAIN AND FORCE

- Transducers & Strain Gages
- Load Cells & Pressure Gages
- Displacement Transducers
- Instrumentation & Accessories

FLOW/LEVEL

- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
- Totalizers & Batch Controllers

pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
- Benchtop/Laboratory Meters
- Controllers, Calibrators, Simulators & Pumps
- Industrial pH & Conductivity Equipment

DATA ACQUISITION

- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
- Datalogging Systems
- Recorders, Printers & Plotters

HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments