Pinnacle Series

Programmable SCADA Controllers

Technical Reference Manual

- Point-and-click SCADA configuration software
- Built-in open programming and protocols including ISaGRAF IEC-61131
- Multiple Loop PID Control
- Built-in Voice Alarm Dialing and/or paging
- High-capacity Data and Alarm Logging and Historical Trending
- Event and/or time initiated e-mailing with attachments
- Automatic file transfer/exchange with Host Computers
- Integrated Web Server HMI – no user license fees
- Scalable in a small panel footprint - 17 to several hundred I/Os
- High-performance 300MHz 32-Bit processor -128MB RAM
- 32-bit Integer, 64-bit Floating Point Math
- 10/100 Ethernet port
- 2 or 4 USB 2.0 compliant ports
- Up to 5 serial ports (RS-232, RS-485, RS-232/RS-485)
- Built-in sensor conditioning on high-resolution analog inputs
- Up to 4GB internal flash drive, up to 2TB external disk
- Internal LCD HMI – 4 line x 20 characters, 122 x 32 Graphics
- Remote Program updates – on-line program changes
- Modular I/O expansion to several thousand I/O points
- Programmable Power Management
- -40 C to +70 C Operating Temperature
- 3-year warranty on parts and labor
- Options:
    - Internal UPS & power monitoring
    - Expansion of internal flash disk up to 8GB
    - Internal telephone modem/voice alarm dialer

Copyright Notice

Pinnacle Series
Technical Reference Manual

Acknowledgments

ScadaFlex, ScadaFlex Plus, EtherLogic, EtherLogic LC, EtherLogic Advanta, EtherLogic Integra, EtherLogic Ultima, Pinnacle Controllers, Everest, Shasta, Lassen and Rubicon Controllers, Sprite, Solaras and Ascent I/O modules, ScadaWorks and ScadaBuilder are trademarks of Industrial Control Links, Inc.

ISaGRAF is a trademark of ICS Triplex, Inc.

Support

If you have questions or need help with an application, we hope that you'll take advantage of our free technical support. Simply call us at:

(530) 888-1800

If you need to send us a fax:

(530) 888-7017

If you prefer e-mail (we do), especially if you want to send us a sample of a program or other files, you can e-mail us at:

support@iclinks.com

For additional technical information including datasheets, manuals and software, visit our web site at:

www.iclinks.com

Certifications

Safety and Hazardous Locations Ratings – North America

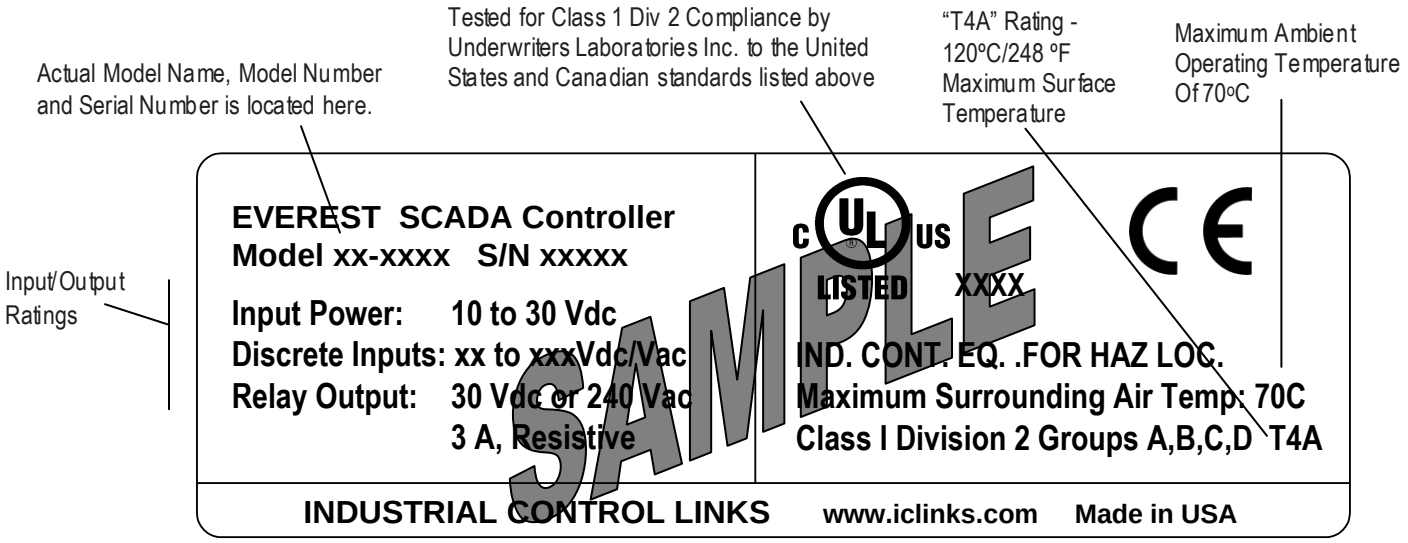
United States Standards for Industrial Control Equipment

UL 508, Seventeenth Edition, revised September 19, 2008 and ANSI/ISA 12.12.01, 2007 Edition.

Canadian Standard for Process Control Equipment

CSA C22.2 No. 142-M1987, Third Edition, Reaffirmed 2004 and CSA C22.2 No. 213-M1987 Non-incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations, First Edition.

All certified Pinnacle models come with a compliance marking tag similar to the one pictured below:



Digital Emissions and Immunity

Emissions	FCC 47 Part 15, Subpart B, Class A Verification EN61000-6-4: 2007 Electromagnetic Compatibility Generic Emission Standard Part2: Industrial Environment
Immunity	EN61000-6-2: 2005 Electromagnetic Compatibility Generic Standards Immunity for Industrial Environments
Declaration	This product conforms to the above Emissions and Immunity Standards and therefore conforms with the requirements of Council Directive 2004/108/EEC (as amended) relating to electromagnetic compatibility and is eligible to bear the CE mark. The Low Voltage Directive 73/23/EEC applies to devices operating within 50 to 1000 VDC and/or 75 to 1500 VAC. This Directive is not applicable to this product when installed according to our specifications.

Use of Equipment in Hazardous Locations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.

WARNING – EXPLOSION HAZARD – Substitution of any components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing.

WARNING – EXPLOSION HAZARD – The USB connectors are for temporary connection only. Do not use, connect, or disconnect unless area is known to be non-hazardous. Connection or disconnection in an explosive atmosphere could result in an explosion.

Special Notice Regarding Sealed Relay Devices

The following information is provided in regards to the sealed relay devices used in these products.

WARNING – Exposure to some chemicals may degrade the sealing properties of materials used in the sealed relay devices.

RECOMMENDATION – It is recommended to inspect the Sealed Relay Devices periodically and to check for any degradation of the materials and to replace the complete product, not the sealed device, if any degradation is found.

Contents

Pinnacle Series Overview

Introduction

The Pinnacle Series is a family of SCADA specific programmable controllers. They are actually multiple instruments integrated together, combining the programmability of a Programmable Logic Controller (PLC), the communications capabilities and extended operating temperature of an advanced Remote Terminal Unit (RTU), the alarm notification capabilities of an alarm dialer, the data storage and retrieval capabilities of a Data Logger, and the power monitoring and protection facilities of an Uninterruptible Power Supply (UPS). By taking advantage of the capabilities of multiple SCADA components and integrated software, Pinnacle Series controllers increase reliability with less configuration and programming time, and cost.

Pinnacle Series controllers offer both high performance and value. Their unique scalable architecture is economical for small I/O applications such as tank level monitoring and lift station controls, medium scale pumping stations, and full-sized treatment plant controls.

There are four models; Lassen, when only a few I/O points are required, Rubicon with the same footprint as Lassen, more I/O but no internal radio or telephone modem, Shasta, with a slightly larger footprint, but significantly more I/O and an optional internal telephone modem, and Everest, with the largest communications and I/O capacity. Each model features a very high-performance 32-bit processor, 128MB of RAM memory, a 512MB flash disk, a high-speed Ethernet LAN, multiple USB ports, up to 5 serial ports. The Lassen, Shasta and Everest offer the option of a built-in telephone modem and voice alarm dialing. The Lassen and Everest also offer the option of a built-in spread spectrum radio.

Base Configuration (w/o I/O expansion)	*Lassen*	*Rubicon*	*Shasta*	*Everest*
x86 32-bit CPU	*300 MHz*			
RAM Memory	*128 MB*			
Flash Disk (base configuration)	*512 MB*			
10/100 Ethernet ports	*1*	*1*	*1*	*1*
USB 2.0 (Host) ports	*2*	*2*	*2*	*4*
RS-232 serial ports	*2*	*2*	*2*	*5**
RS-485 serial ports	*1*	*1*	*1*	*1*
Built-in 4 line x 20 character + graphics LCD HMI	*1*	*1*	*1*	*1*
Universal Analog Inputs (w/sensor conditioning)	*2*	*4*	*8*	*8*
*Analog Inputs (w/o sensor conditioning, 20mA or 32Vdc) ***	*1*	*0*	*1*	*1*
Analog Outputs	*2*	*2*	*2*	*4*
Discrete Inputs/Outputs (user configurable)	*6*	*0*	*2*	*4*
Discrete Inputs	*6*	*20*	*16*	*20*
Discrete Outputs	*0*	*10*	*6*	*12*
UPS/Battery Backup & Monitoring	*-*	*-*	*option*	*option*
Telephone Modem w/Voice	*option*	*-*	*option*	*option*
Built-in spread spectrum radio	*option*	*-*	*-*	*option*
I/O Expansion Slots	*-*	*-*	*2*	*2*
Remote Distributed I/O Expansion	*yes*	*yes*	*yes*	*yes*

** - Shared w internal RS-485 port, and modem/radio options*

*** - Available if UPS option not installed*

32-bit CPU

Pinnacle Series controllers come with a fast 300MHz x86 compatible CPU with 128MB of RAM memory capable of running extremely large programs. In addition, Pinnacle controllers have a unique FRAM (Ferroelectric RAM) non-volatile memory that can store up to 2,000 32-bit register values without batteries, speed constraints or write cycle limitations suffered by other older technologies.

Networking

Pinnacle Series controllers come with a built-in 10/100 Ethernet Port that supports the standard Ethernet and Internet protocols for file transfer, e-mail, web serving and terminal access as well as standard industrial Ethernet compatible protocols such as Modbus TCP/IP and DNP 3. The built-in Ethernet capability is compatible with the latest generation of Wireless Ethernet modems including 802.11 type and cellular devices.

Serial Communications

Pinnacle Series controllers have from two to five RS-232 serial ports as well as an RS-485 serial port. In Lassen and Shasta controllers that have two RS-232 ports, these ports are independent of the other ports or internal serial options such as telephone modems and spread spectrum radios. In Everest controllers that have five RS-232 ports, the ports are shared with the RS-485 port and the internal modem and radio options, so that if these features are not used, the ports are available for use with external RS-232 compatible devices. The RS-485 port is ideal for low-cost 2-wire local networking up to 5,000 feet to go well beyond the 100 foot recommended limits of RS-232. RS-485 is useful for distributed remote I/O expansion as well as interfacing to intelligent industrial devices such as loop controllers, variable speed drives and other PLCs.

Controller	Lassen	Rubicon	Shasta	Everest
Total External Serial Ports	3	3	3	5
RS-232 ports	2	2	2	4
RS-232/RS-485 ports	0	0	0	1
RS-485 ports	1	1	1	0
Telephone/voice modem option	Yes	No	Yes	Yes
Spread Spectrum radio option	Yes	No	No	Yes
COM1	RS-232	RS-232	RS-232	RS-232
COM2	RS-485	RS-485	RS-232/RS-485	RS-232/RS-485
COM3	Radio Opt.	RS-232	Modem Opt	RS-232 or Radio Opt.
COM4	Modem Opt.	N/A	N/A.	RS-232 or Modem Opt.
COM5	RS-232	N/A	RS-232	RS-232

USB 2.0 Host Ports

Pinnacle Series controllers have from two to four USB 2.0 Host ports. These ports can be used to quickly add low-cost data storage to the controllers, or as a removable media to transfer files in and out of the controller. They will also be used to add various communications capabilities to the controller (USB radios and modems).

(Flash) Disk Storage

Pinnacle Series controllers have an internal solid-state flash disk. The capacity of the disk supplied with all Pinnacle controllers is 512MB, of which about 1MB is used to store the internal operating software of the controller. The remaining capacity is available for file storage, such as data logs, voice files, program backups, and project documents. Additional internal disk capacity may be added by upgrading the existing IDE flash disk module available in sizes up to 8GB.

Local LCD HMI

Pinnacle Series controllers have a built-in LCD display, and a simplified keypad (a 5-way navigation button and an "Escape' button) for displaying I/O status and process values, and displaying or modifying setpoints, and forcing I/O. All data types; Booleans, Integers, Reals and Strings are supported. The display is a graphical LCD type, with LED backlight, capable of showing up to 4 lines of 20 characters using normal fonts, or 2 lines of 10 characters using double-size fonts, or combinations of sizes. The display may also be used to show animation and graphics. An HMI screen builder is part of the ScadaWorks software used to configure the controller. To conserve power, the backlight can be set to turn off automatically after a configurable time period of no keyboard activity for power critical applications.

ScadaWorks Configuration Software

ScadaWorks is an integrated suite of SCADA configuration software tools for Pinnacle Series controllers. It combines the:

- ISaGRAF IEC 61131 standard programming tools
- HiBeam Graphical Web-page HMI tools
- ICL's ScadaBuilder SCADA tools

ISaGRAF IEC 61131 is the international open systems standard for industrial control programming, incorporating 6 different languages including ladder logic. Pinnacle Series controller support Version 5.2 of ISaGRAF with on-line programming changes and certified operation under the Microsoft Vista and Windows 7 32-bit operating systems.

HiBeam is an easy-to-use software tool used to build HTML Java animated web pages that are served by Pinnacle Series controllers over an Ethernet, Internet, or PPP Serial connection. The package includes a complete library of graphical components including tanks, pump, pipes, lights switches, etc. Users can easily add their own .GIF images as well.

ScadaBuilder is software for configuration of all the non-logic SCADA system functions. ScadaBuilder makes it easy to set up Ethernet, Internet and serial networking and communications with multiple protocols on individual ports, alarm handling and annunciation including voice, paging and text messaging, and configuring multiple simultaneous data and alarm logs, along with a choice of three different types of HMIs plus a local LCD HMI.

For more details on getting started, the Pinnacle Quick Start Guide may be downloaded from:

http://www.iclinks.com/Support/AppNotes/Pinnacle%20Quick%20Start%20Guide.pdf

Options

Pinnacle Series controller options add value and reduce panel size and complexity, while avoiding unnecessarily increasing the controller cost if a particular functionality is not required for a given application.

IDE Flask Disk Option

The internal disk storage can be expanded to much larger sizes by adding an IDE flash disk storage module, currently available in capacities of up to 8GB. Compared to removable USB "memory sticks", an internal IDE flash disk is faster and mechanically secure within the controller, and rated for the full operating temperature range of the controller; -40°C to +75°C.

UPS Option

Some applications require continuous operation, even when main power is lost. The Shasta and Everest controllers have the option of a built-in UPS. With the UPS option, by simply adding an external lead-acid gel-cel battery, the controller can continue to operate when main power is lost. Smart charging, battery monitoring and deep discharge protection are included.

Internal Spread Spectrum Radio Option

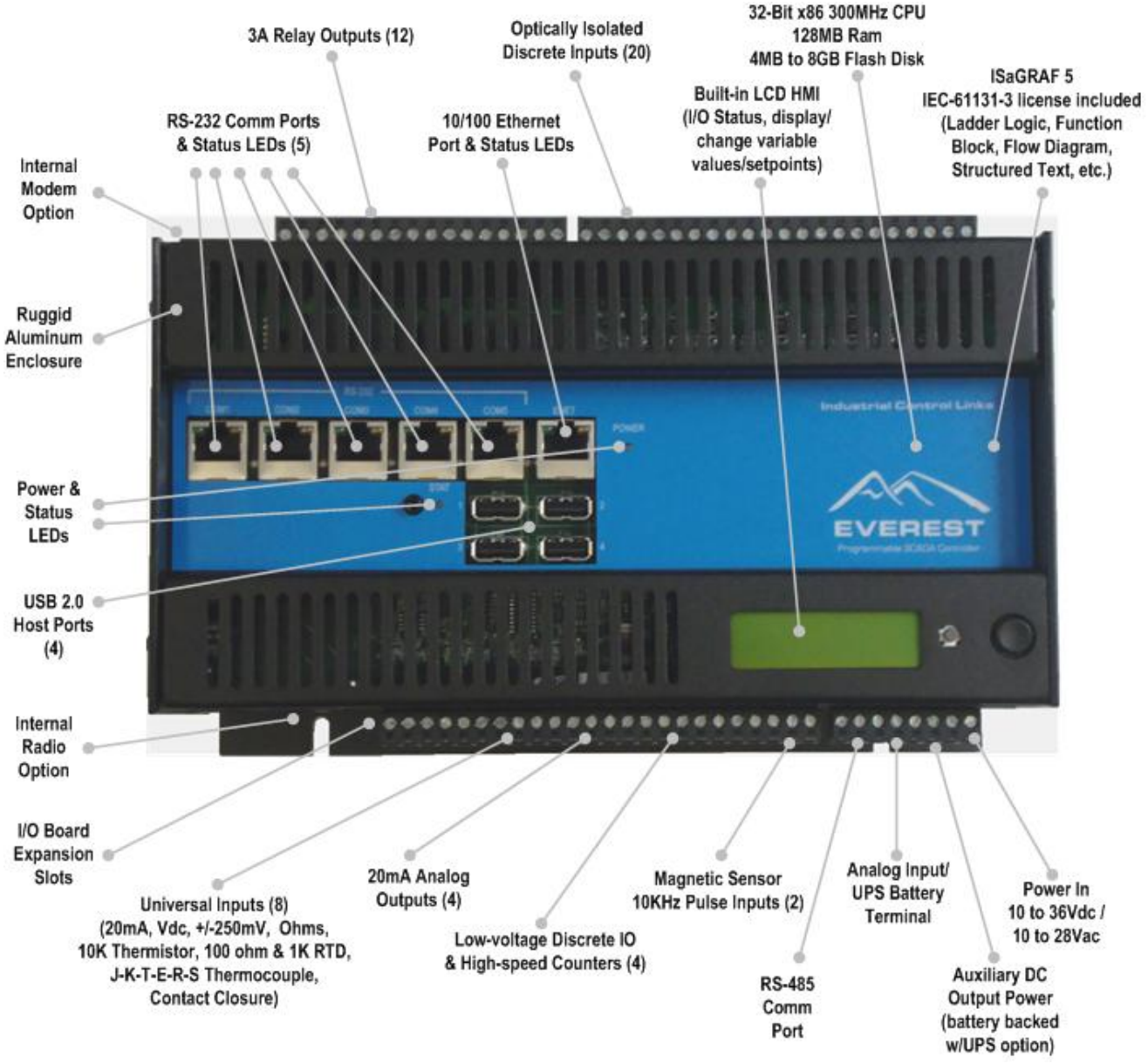
An internal 900MHz Spread Spectrum radio is available in Lassen and Everest controllers. Three brands of radios are available (Freewave, MDS and Digi/Maxstream), offering a choice of price and performance, and compatibility with existing installations.

Internal 56K baud Telephone/Voice Modem Option

Some Pinnacle Series controllers are available with an internal high-speed telephone/voice modem. With the telephone modem option, the controller can dial out to annunciate alarms (voice alarm dialer), initiate pages, perform remote file exchanges with a host computer, and send e-mails. Likewise, the controller can be dialed into to access register data and process variables interactively using a touchtone keypad, and also exchange files as well as download data logs and upload program revisions via a remote computer.

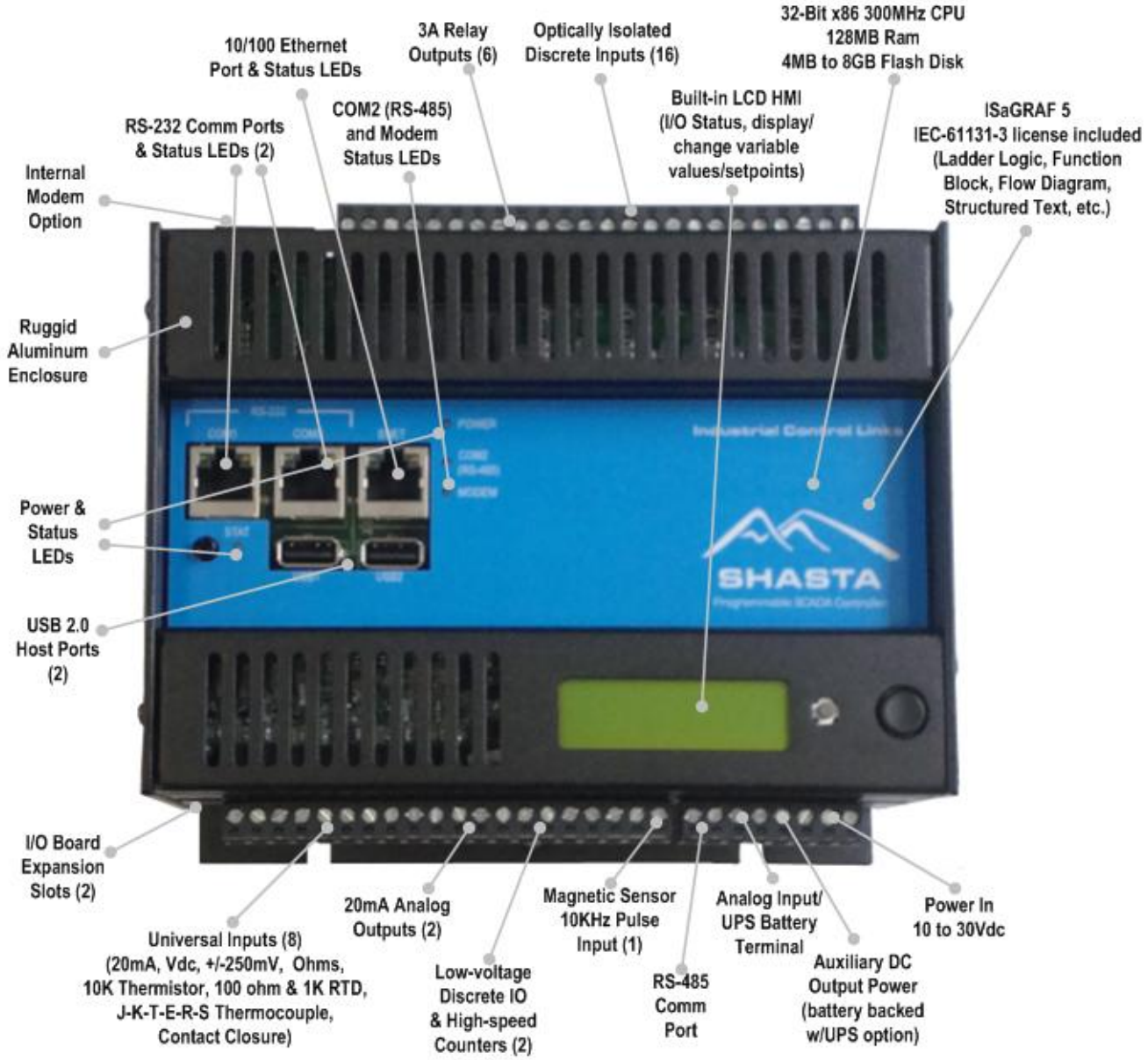
Everest Controller

1 10/100 Ethernet Port
5 RS-232 Serial Ports
1 RS-485 Serial Port (shared w/RS-232 ports)
4 USB 2.0 Host Ports
2 Internal Radio and Modem ports (shared w/RS-232 ports)
1 LCD HMI
8 Universal Inputs (Analog Inputs with Sensor Conditioning)
1 Analog Input – 0 to 32Vdc (if no UPS option)
4 Analog Outputs (20mA)
4 Low-voltage Discrete Inputs/Outputs & High-speed Counters with quadrature encoder support
2 Magnetic Pickup Inputs/High-speed Counters
20 Optically Isolated Discrete Inputs
12 Relay Discrete Outputs



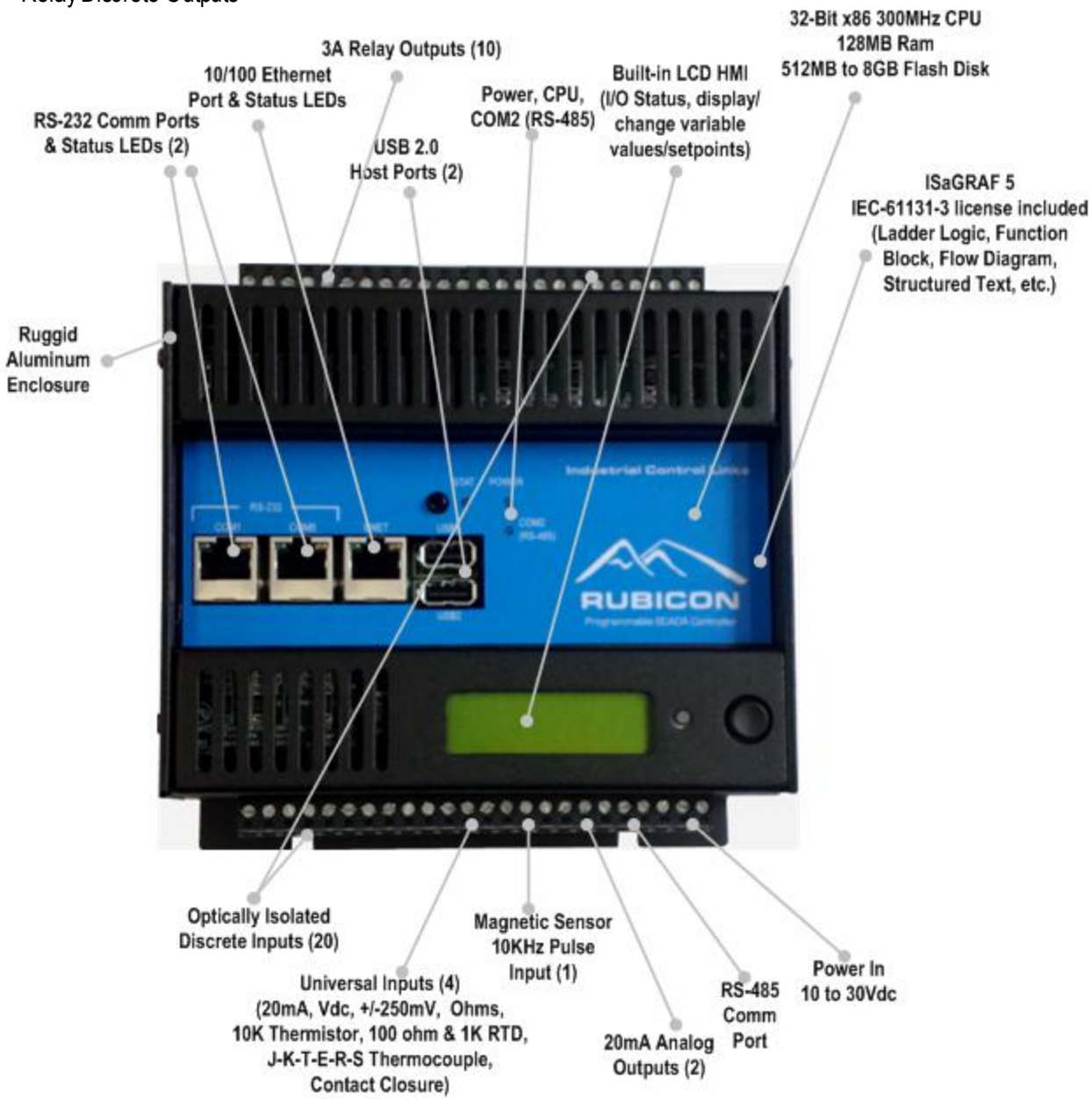
Shasta Controller

1 10/100 Ethernet Port
2 RS-232 Serial Ports
1 RS-485 Serial Port
2 USB 2.0 Host Ports
1 Internal Modem port
1 LCD HMI
8 Universal Inputs (Analog Inputs with Sensor Conditioning)
1 Analog Input – 0 to 32Vdc (if no UPS option)
2 Analog Outputs (20mA)
2 Low-voltage Discrete Inputs/Outputs & High-speed Counters with quadrature encoder support
1 Magnetic Pickup Input/High-speed Counter
16 Optically Isolated Discrete Inputs
6 Relay Discrete Outputs



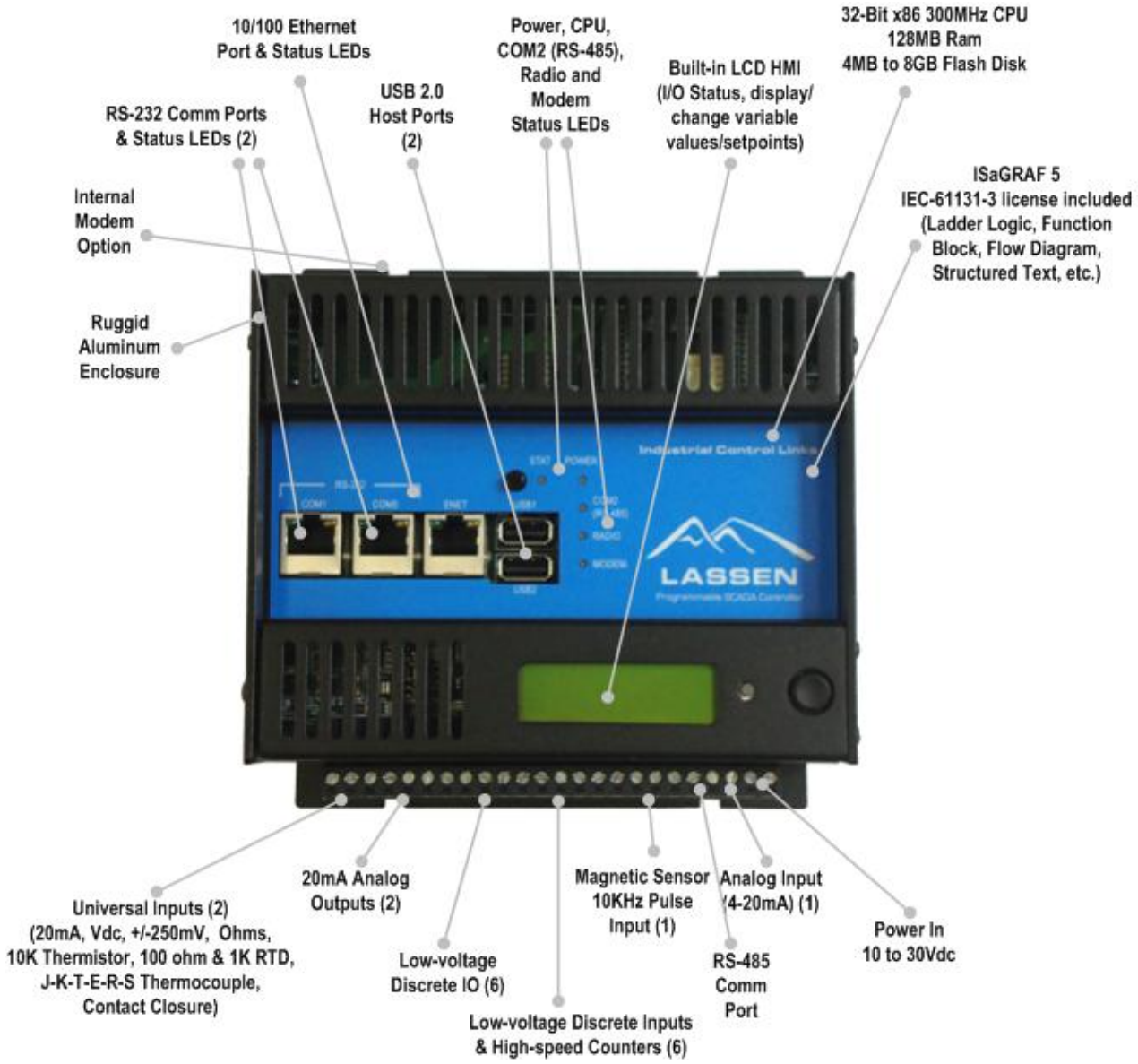
Rubicon Controller

1 10/100 Ethernet Port
2 RS-232 Serial Ports
1 RS-485 Serial Port
2 USB 2.0 Host Ports
1 LCD HMI
4 Universal Inputs (Analog Inputs with Sensor Conditioning)
2 Analog Outputs (20mA)
1 Magnetic Pickup Input/High-speed Counter
20 Optically Isolated Discrete Inputs
10 Relay Discrete Outputs



Lassen Controller

1 10/100 Ethernet Port
2 RS-232 Serial Ports
1 RS-485 Serial Port
2 USB 2.0 Host Ports
1 Optional Internal Modem Port
1 Optional Spread Spectrum Radio Port
1 LCD HMI
2 Universal Inputs (Analog Inputs with Sensor Conditioning)
1 Analog Input – 4-20mA
2 Analog Outputs (20mA)
1 Magnetic Pickup Input/High-speed Counter
6 Low-voltage Discrete Inputs/Outputs
6 Low-voltage Discrete Inputs/High-speed counters with quadrature encoder support



Status LED Indicators

Pinnacle Series controllers have two non-communications related LED status indicators.

POWER LED

(description below for Shasta/Rubicon/Everest only – for Lassen, Power LED is green for ON)

In the Lassen controller, and Shasta or Everest controllers WITHOUT the UPS option installed, the indicator labeled "POWER" is always green when power is applied. In the Shasta and Everest controllers with the UPS option installed, the indicator labeled "POWER" is a bicolor (Red/Green) LED that indicates the current power state of the controller as follows:

LED Status	Power Status	Battery Status (if UPS option installed)
SOLID GREEN	Input power OK	battery charged
FLASHING GREEN	Input power OK	battery low (< 12.0V) or disconnected
SOLID RED	Input power failed	running on battery - battery OK (> 10.5V)
FLASHING RED	Input power failed	running on battery - battery low (< 10.5V)
OFF	Controller powered OFF	

STATUS LED

The indicator labeled "STATUS" is a Green LED that flashes to indicate when a logic program is running, and to indicate USB activity and when it is OK to remove a memory stick from its USB socket. The LED can also be configured to operate under the control of a user's program.

LED Status	Status	Action
SOLID GREEN	USB stick mounted and ready	Do NOT remove.
FLASHING GREEN	Program running	
SOLID RED	USB memory mounting failed	Remove memory and try another
FLASHING RED	USB memory active	Do not remove USB memory yet
OFF	Program stopped	USB memory can be removed or inserted

USB Pushbutton

The USB pushbutton is used to initiate data transfers between the flash disk in the controller and a memory stick plugged into the first USB socket, and to signal that the user wants to remove a mounted memory stick from the system.

Memory Release

Momentarily pressing the USB pushbutton will temporarily stop data transfer from the controller to the USB memory and close any open files so that no data will be lost if the memory is removed. Normal operation will resume if the memory is not removed within ten seconds.

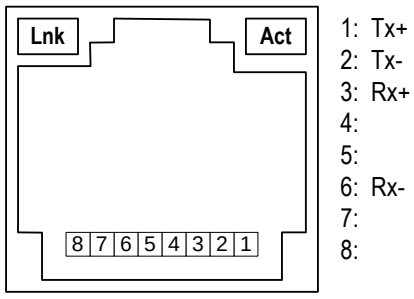
Communications

Ethernet

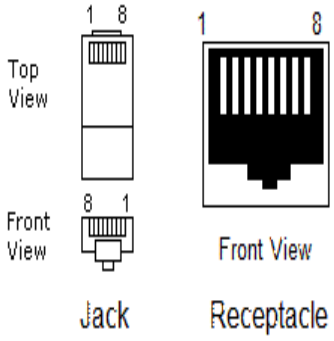
Pinnacle Controllers have a single high-speed (10/100Mb/s) Ethernet port. This port uses an industry standard RJ-45 connector that can be connected directly to a wall jack, hub or switch using standard RJ-45 Category 6 (or better) patch cables. The Ethernet port is Auto MDX compatible, so that it automatically adjusts to the signal wiring configuration, eliminating the need for a crossover cable.

The Pinnacle Series controller Ethernet connector has two LED indicators in the upper left hand and right hand corners. The GREEN LED in the upper left hand corner is the "Link Status" LED. It illuminates when an Ethernet hardware link has been established (the controller is electrically connected to an active Ethernet device). The AMBER LED in the upper right hand corner is the "Activity Status" LED. It illuminates whenever an Ethernet message is transmitted or received.

The 10/100Base-T Ethernet specification limits the maximum Ethernet cable run to 100m or 350 feet, but the actual limit is based on signal loss and the noise in the environment. This may limit the practical distance to less than 100m or 350 feet. The Ethernet cables should not be run in parallel with power or any cables that generate noise.



Pin connections and status LED locations for the Ethernet (RJ-45) port connector.



Pin connections on Ethernet RJ-45 plug.

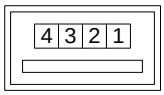
USB Ports

Pinnacle Series controllers have USB 2.0 compliant ports, supporting low-speed (1.5Mb/s) and full-speed (12Mb/s) operation. The USB ports provide for simple low-cost addition of removable flash disks (also known as "thumb drives"), external high-capacity hard disks, and the plug-in addition of peripheral devices such as HMI terminals, modems, and wireless transceivers. Most of these devices receive their power through the USB connector, and therefore require no other connections for normal operation.

Pinnacle Series controllers have either two or four USB 2.0 ports as follows:

Model	Lassen/Rubicon/Shasta	Everest
USB 2.0 Ports	2	4

The connectors used for the USB ports are compliant with the USB 2.0 specification. Each USB port is a "Host" port (type "A" receptacle), capable of supporting USB memory and peripheral devices. For bus-powered USB devices, the host port can provide up to 500mA at 5V (each).



1: VBUS
2: D +
3: D -
4: GND

Pin connections for the USB Host (type "A") port connectors.

WARNING: USB ports may be permanently used in non-hazardous applications. USB ports may be used for corrective maintenance in locations classified as hazardous but are known to be in a non-hazardous state.

Serial Communications

The most common serial communications standards in SCADA and industrial control systems are still RS-232 for short point-to-point connections and RS-485 for longer point-to-point and networked communications. Pinnacle Series controllers support both standards.

Pinnacle Series controllers have either two or five RS-232 two compatible serial communications ports on Lassen, Rubicon and Shasta; five on Everest; and one RS-485 port on all four controllers. These ports are designed for high-speed communications to 230K baud, with hardware buffering to support sustained very high-speed data transfer throughputs.

In the Everest controller, all five serial ports are available externally as RS-232 ports, which are "shared" to also support internal radios, modems and an RS-485 interface. The Lassen and Shasta controllers expose only two of the available ports externally as RS-232 interfaces; the remainder are either dedicated to an internal radio, internal modem, or an RS-485 interface.

The following table summarizes the serial port configurations of the Pinnacle Series controllers:

Model	Lassen Everest	Rubicon	Shasta	
COM1	RS-232	RS-232	RS-232	RS-232
COM2	RS-485	RS-485	RS-485	RS-232/RS-485
COM3	Radio Opt.	RS-232	RS-232	RS-232 or Radio Opt.
COM4	Modem Opt.	N/A	Modem Opt.	RS-232 or Modem Opt.
COM5	RS-232	N/A	N/A	RS-232

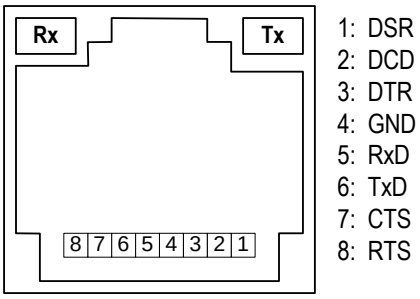
RS-232 Serial Communications Interfaces

The physical RS-232 serial port connections utilize standard RJ-45 connectors similar to Ethernet connectors (since Ethernet connections are isolated, no damage will occur if an Ethernet connector is accidently plugged into a serial port on the controller, or vice-versa). The wiring of the Pinnacle RS-232 connectors follows the EIA/TIA-561 standard. Using standard RJ-45 connectors enables low-cost Ethernet patch cables with RJ-45 to DB-9 adapters to be used as high-quality RS-232 cables. Ethernet patch cables are readily available in a variety of lengths, allowing for a variety of RS-232 cable lengths to be "built up" in the field without any soldering.

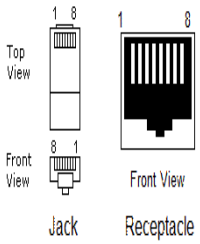
Pinnacle Series controllers support most but not all of the standard signals on a DB-9 RS-232 connector. In all cases, Ring Indicator (RI) and Data Set Ready (DSR) are not required by the controller software. Ring Indicator is not supported on any of the RS-232 ports. Data Set Ready is supported on some of the RS-232 ports.

Charts showing the supported RS-232 signals for each controller are included later in this chapter.

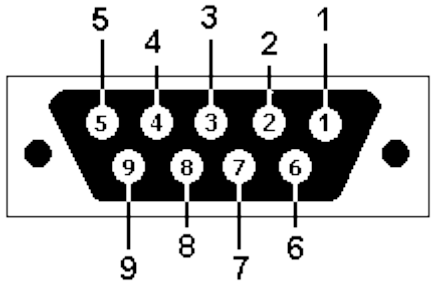
The Pinnacle Series controller RS-232 Serial Port connectors have two LED indicators in the upper left hand and right hand corners. The GREEN LED in the upper left hand corner is the "Receive Data" status LED. It illuminates when a message comes in from an RS-232 device. The AMBER LED in the upper right hand corner is the "Transmit Data" status LED. It illuminates whenever the controller sends out a message to an RS-232 device.



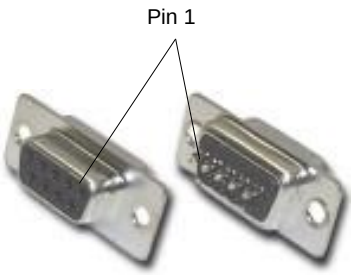
Pin connections and status LED locations for the RS-232 (RJ-45) serial port connectors.



Pin connections on RS-232 RJ-45 plug.



(view looking into front face of female connector)



DB-9S connector pinout

RS-232 DTE Cable typical wiring (RJ-45 to DB-9S)

Note: DTE refers to Data Terminal Equipment. This would be the serial port on your PC or other controller equipment. The equipment would have a DB 9 Male connection and require a DB 9 Female connector on the cable.

RJ-45 (8-pin) connections	Pinnacle Controller DTE Function	DB-9S DTE Function	DB-9S connections
4	GND	GND	5
5	RxD	TxD	3
6	TxD	RxD	2

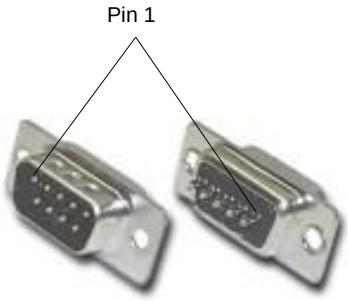
Note: Connect shield of cable to shell of DB-9S connector. Wires not lists are "no connect" on either end.

RS-232 DCE Cable typical wiring (RJ-45 to DB-9P)

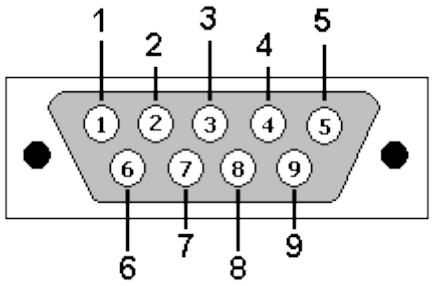
Note: DCE refers to Data Communications Equipment. This would refer to a Modem, Radio or other communication device. These typically have a DB 9 Female connector requiring the cable to have a DB 9 Male connection.

RJ-45 (8-pin) connections	Pinnacle Controller DCE Function	DB-9P DTE Function	DB-9P connections
1	DSR	DSR	6
2	DCD	DCD	1
3	DTR	DTR	4
4	GND	GND	5
5	RxD	RxD	2
6	TxD	TxD	3
7	CTS	CTS	8
8	RTS	RTS	7

Note: Connect shield of cable to shell of DB-9P connector.



DB-9P connector pinout



(view looking into front face of male connector)

High quality RS-232 modular cables are available in prewired the most common applications. The prewired cables are configured for typical connections to DTE (Data terminal Equipment) devices such as PCs, and DCE (Data Communications Devices) such as modems. The cable for DTE devices terminates in a 9-pin D FEMALE connector, while the cable for DCE devices terminates in a 9-pin D MALE connector.

The part numbers for these cables are listed in the table below:

	DTE (Female)	DCE (Male)
RJ-45 to type D, RS-232 Serial Cable Assembly, 1ft.	**99-2001**	**99-3001**
RJ-45 to type D, RS-232 Serial Cable Assembly, 2ft.	**99-2002**	**99-3002**
RJ-45 to type D, RS-232 Serial Cable Assembly, 3ft.	**99-2003**	**99-3003**
RJ-45 to type D, RS-232 Serial Cable Assembly, 5ft.	**99-2005**	**99-3005**
RJ-45 to type D, RS-232 Serial Cable Assembly, 7ft.	**99-2007**	**99-3007**
RJ-45 to type D, RS-232 Serial Cable Assembly, 10ft.	**99-2010**	**99-3010**

RS-485 Serial Communications Interface

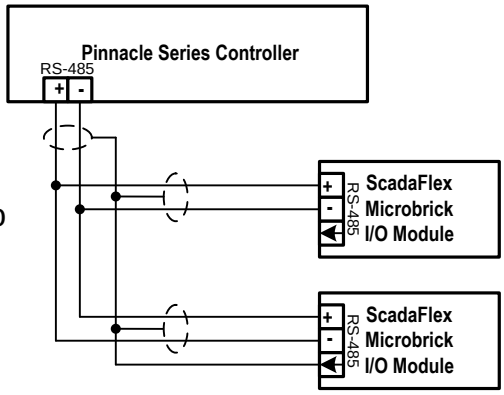
RS-485 is a 2-wire communications interface designed to span distances of up to 5,000 ft. and supporting networked operation. The Pinnacle Series' RS-485 port (COM2) is typically used for I/O expansion using MAXIO, MicroBrick, PicoBrick, and Ascent Distributed I/O modules, although many types of industrial equipment have an RS-485 interface and can be used with the Pinnacle Series controller.

Although the original RS-485 standard allowed for only 32 devices on a network, the RS-485 interfaces in Pinnacle Series controllers and ICL's Distributed I/O modules are specially designed to allow up to 256 devices to share the same network.

The Pinnacle Series RS-485 connections are on a removable terminal block. In the Shasta and Everest controllers, this is the 8-position terminal block shared with the DC power and UPS connections. On the Lassen controller, this is the main (and only) terminal block.

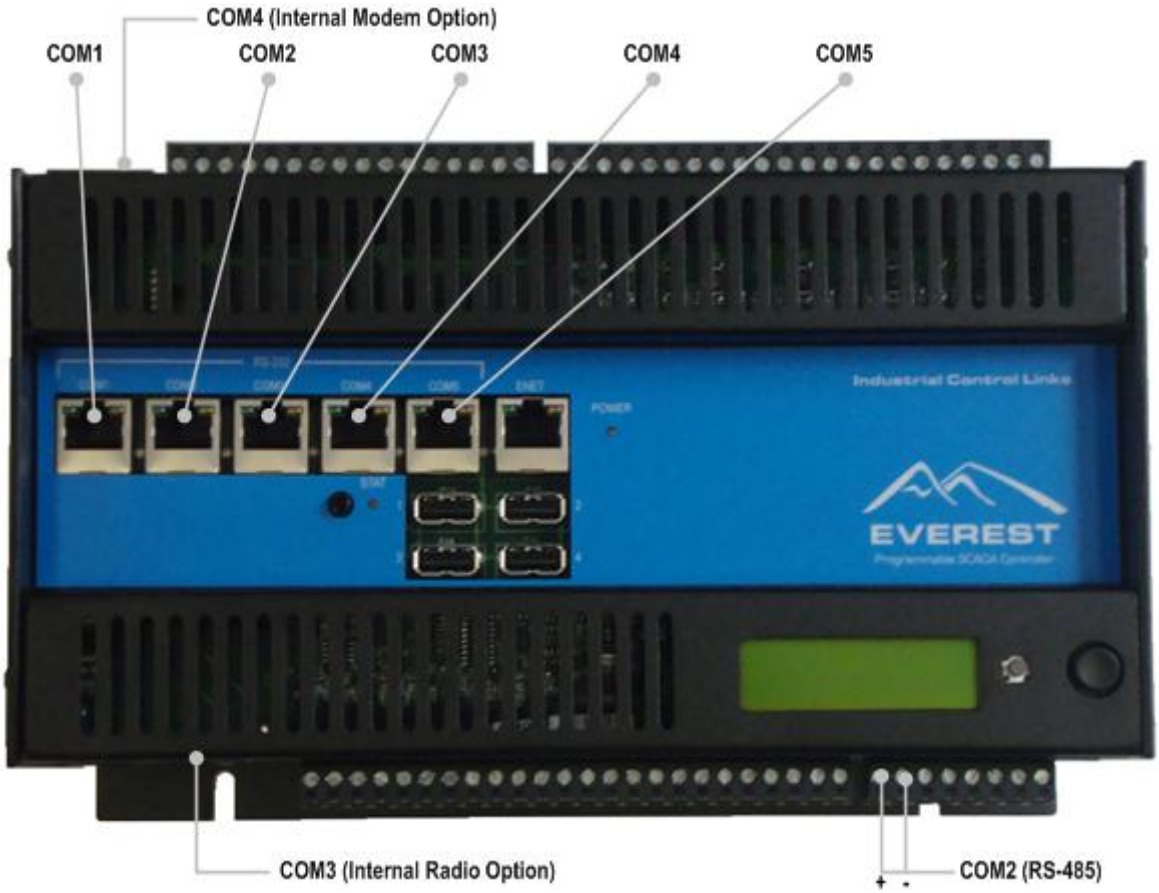
Traditionally, RS-485 networks use a 100Ω resistor termination at each end of the network. This technique does not work well with certain protocols such as Modbus that do not have a lead-in message header to eliminate garbage on the beginning of a message. ICL controllers and I/O modules have series termination resistors that eliminate this problem. In most cases, even on longer networks, separate termination is not required. If termination is used, it should be AC coupled. Call ICL technical support for additional information if you think that you need additional network termination.

Use twisted pair cable (shielded is better). Wire all devices minus to minus and plus to plus.



RS-485 - Field Wiring Example

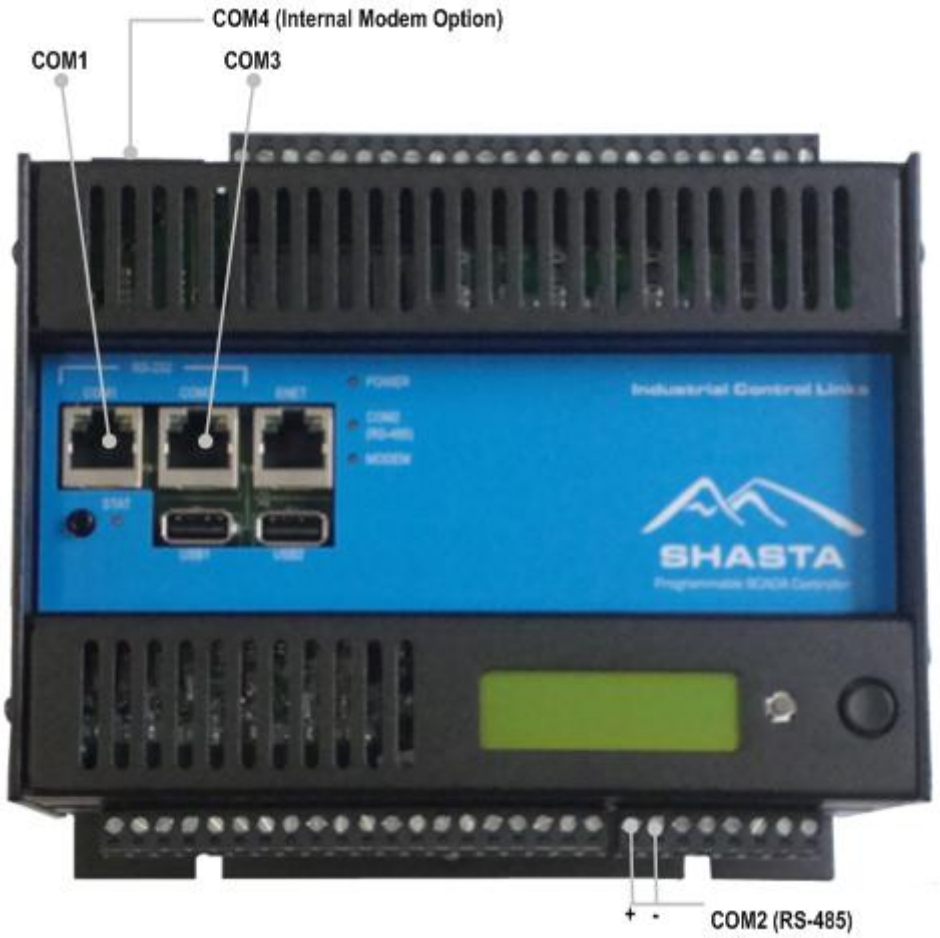
EVEREST Serial Communications Ports



Signal	Name	Pin	COM1	COM2	COM3	COM4	COM5
Data Set Ready	DSR	1	◆	◆	◆	◆	-
Carrier Detect	DCD	2	◆	◆	◆	◆	-
Data Terminal Ready	DTR	3	◆	◆	◆	ON	ON
Ground	GND	4	◆	◆	◆	◆	◆
Receive Data	RXD	5	◆	◆	◆	◆	◆
Transmit Data	TXD	6	◆	◆	◆	◆	◆
Clear to Send	CTS	7	◆	◆	◆	◆	-
Request to Send	RTS	8	◆	◆	◆	◆	ON

◆ = actively supported RS-232 signal

SHASTA Serial Communications Ports



Signal	Name	Pin	COM1	COM3
Data Set Ready	DSR	1	◆	◆
Carrier Detect	DCD	2	◆	◆
Data Terminal Ready	DTR	3	◆	◆
Ground	GND	4	◆	◆
Receive Data	RXD	5	◆	◆
Transmit Data	TXD	6	◆	◆
Clear to Send	CTS	7	◆	◆
Request to Send	RTS	8	◆	◆

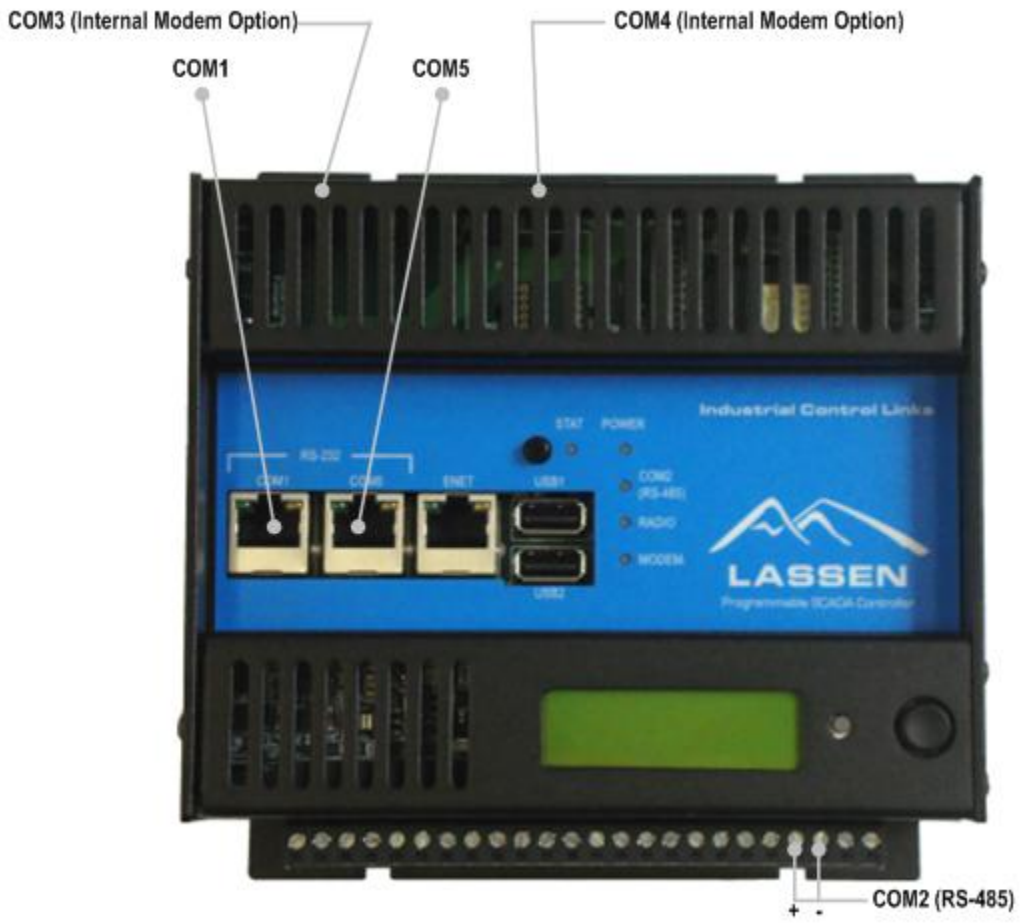
◆ = actively supported RS-232 signal

RUBICON Serial Communications Ports

Signal	Name	Pin	COM1	COM3
Data Set Ready	DSR	1	◆	-
Carrier Detect	DCD	2	◆	-
Data Terminal Ready	DTR	3	◆	ON
Ground	GND	4	◆	◆
Receive Data	RXD	5	◆	◆
Transmit Data	TXD	6	◆	◆
Clear to Send	CTS	7	◆	-
Request to Send	RTS	8	ON	ON

◆ = actively supported RS-232 signal

LASSEN Serial Communications Ports



Signal	Name	Pin	COM1	COM5
Data Set Ready	DSR	1	◆	-
Carrier Detect	DCD	2	◆	-
Data Terminal Ready	DTR	3	◆	ON
Ground	GND	4	◆	◆
Receive Data	RXD	5	◆	◆
Transmit Data	TXD	6	◆	◆
Clear to Send	CTS	7	◆	-
Request to Send	RTS	8	ON	ON

◆ = actively supported RS-232 signal

Installation

Mechanical Installation

Pinnacle Controllers are designed to be installed in a protective enclosure with the appropriate NEMA rating for the environment that the controller will be used. Typical NEMA ratings are as follows:

Indoor applications only:	NEMA 1 Indoor
Outdoor applications:	NEMA 4, 4X or 12 rated enclosures (North America)
	IP54 or IP56 rated enclosures (European Union)

The enclosure material must be a minimum of 1.14mm (0.045”) thick. Typically, the controller is mounted vertically in such an enclosure on a steel or aluminum DIN rail. If an alternative mounting scheme is used, it is recommended that the controller be mounted on a noncombustible surface.

Two snap on DIN rail mountings are located on the back of the unit. Simply slide the top side of the mountings onto the DIN rail and press down to snap the bottom into place. The spring loaded stays allow the unit to be removed by lifting up and pulling the top :”hooked” part of the mountings off of the DIN rail and lowering the unit until the spring loaded stays come free.

Two #10 set screws are supplied, that when installed, keep the unit from “rocking” on the DIN rail after mounting. The set screws are NOT a source of earth grounding.

Electrical Installation and Maintenance

All field wiring connections to and from the Pinnacle Controller, except for RS-232 and Ethernet communications are made via removable terminal blocks.

NOTE: The terminal block screws must be tightened to 7 lb-in.

Class 1 Division 2 Group A, B, C, and D Requirements

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.

WARNING – EXPLOSION HAZARD – Substitution of any components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – The area must be known to be non-hazardous before servicing/replacing the unit and before installing.

WARNING – EXPLOSION HAZARD – The USB connectors are for temporary connection only. Do not use, connect, or disconnect unless area is known to be non-hazardous. Connection or disconnection in an explosive atmosphere could result in an explosion.

Special Notice Regarding Sealed Relay Devices

The following information is provided in regards to the sealed relay devices used in these products.

WARNING – Exposure to some chemicals may degrade the sealing properties of materials used in the Sealed relay devices.

RECOMMENDATION – It is recommended to inspect the Sealed Relay Devices periodically and to check for any degradation of the materials and to replace the complete product, not the sealed device, if any degradation is found.

Diagrams in the following sections provide examples for analog and discrete I/O and power wiring. The following wiring guidelines must be followed:

- Stranded conductors from #14 to #26 AWG, or solid conductors from #12 to #26AWG

  USE COPPER CONDUCTORS ONLY

- Wires must be rated for 240V, 90ºC and suitably current rated.
- Wire insulation must be a minimum of 0.9mm (0.031") thick if subjected to movement, flexing or handling during use or maintenance.
- Route wires away from sharp edges, screw threads, burrs, fins, moving parts, drawers, and the like.
- Clamps and guides, if used, shall be provided with smooth, well-rounded edges.
- Wiring that is subject to flexing during servicing such as that from a stationary part to a part mounted on a hinged door shall be provided with additional insulation at any point where flexed.
- Additional insulation, if used, shall be insulating tubing, or a wrapping of not less than two layers of insulating tape. All must be minimum of 90ºC and 240V rated.
- All splices and connections must be mechanically secure and provide electrical continuity
- Conductors are also not to be grouped.
- Use snubbers or other appropriate arc suppression devices on all relay-type Discrete Outputs
- External surge suppression must be installed to limit all operating voltages to within 140% of signal voltage. This includes all RS-232 signals and Digital Input terminals.

  Transient suppression must be supplied externally for each active signal for the following circuits:

Signal(s)	***Maximum Operating Voltage***	***140% Transient Suppression Level.***	***Circuit Connection***
Optically Isolated Digital Inputs 120 VAC RMS/DC	300V	420VAC RMS or 420VDC	DI to DI Common
RS 232 Signals (DTR, CD, RTS, CTS, RX, and TX) *	+/-12VDC	+/- 16.8VDC	Signal to RS 232 Common

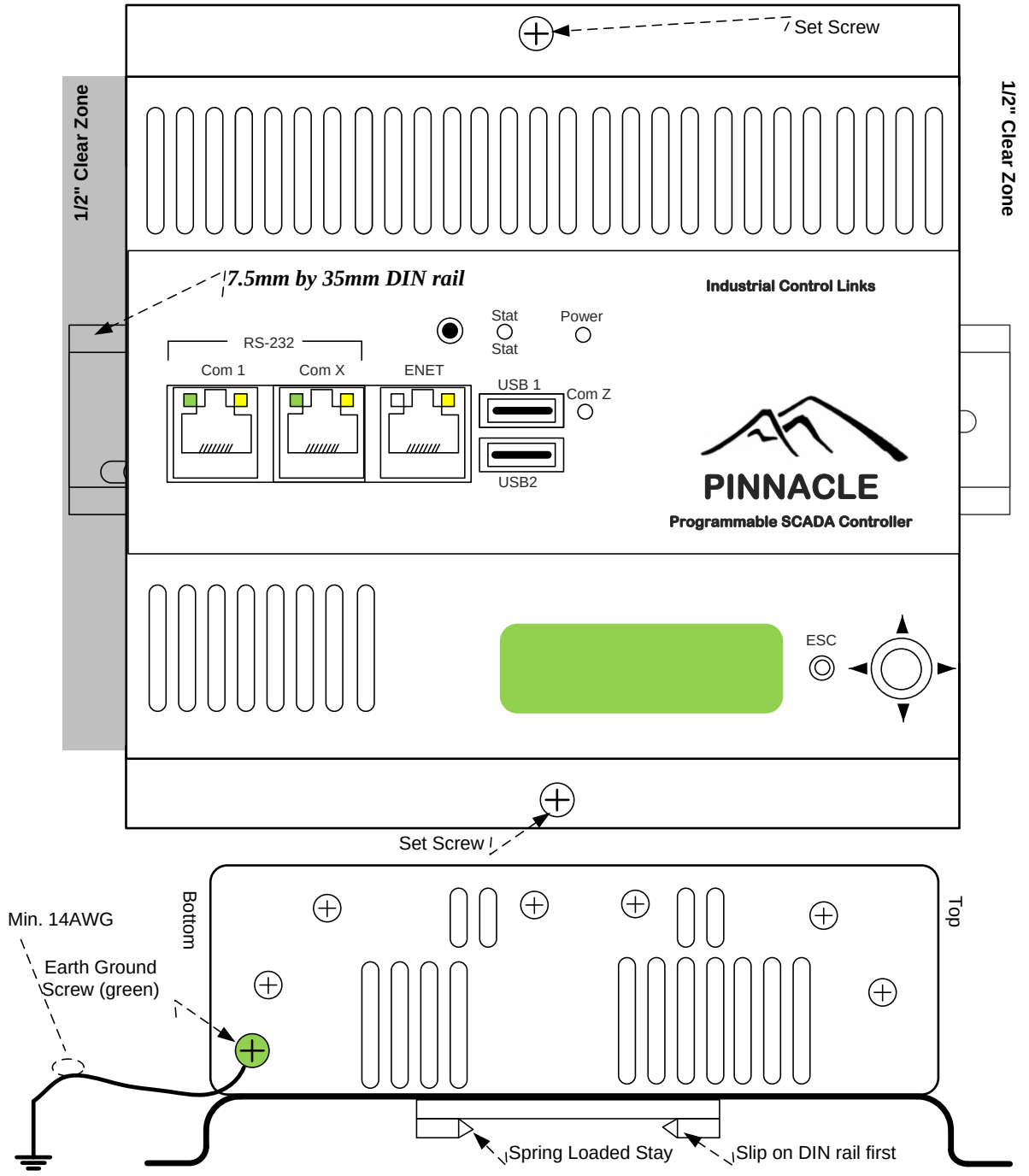
* Different RS-232 ports support different signal configurations. Some signals may not be available on some ports and therefore do not need transient protection. Refer to the RS-232 pin out table later in this document for details.

Lithium Battery

The internal Clock/Calendar circuits utilize a Lithium Coin Battery for backup power. The replacement battery must be a Rayovac BR2032-B. DO NOT USE ANY SUBSTITUTES.

Grounding

The earth ground terminal of the Pinnacle Controller must have a bonding conductor (14AWG or heavier copper wire) that connects the controller case to the enclosure with less than 0.1 ohms of resistance. See **Power Wiring** section of this manual.



Ventilation

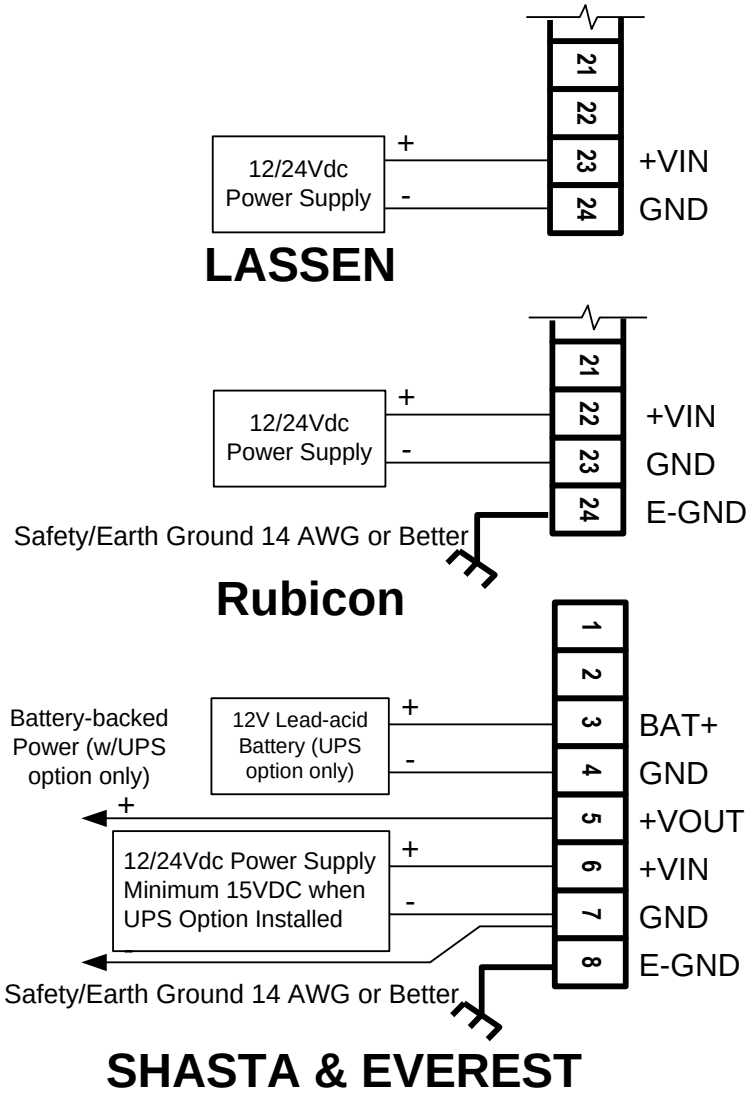
Pinnacle Controllers have ventilation slots on the sides of their case. To ensure proper free air circulation and maintain the full temperature rating, the space 1/2 inch immediately to either side of the enclosure must be clear of any other devices.

Power

Pinnacle Series controllers are designed to operate from DC power, ranging from 10 to 30Vdc. In addition, Shasta and Everest controllers have the option of a built-in UPS to support non-stop operation with an external 12-volt lead-acid or "gel-cel" battery. This option manages all battery-charging functions, and provides battery charge level monitoring information back to a control program. The UPS option also provides a battery backed power output capable of powering external equipment, up to 3A.

Note: For proper charging of the battery from the UPS option, the power supply must 15VDC or greater.

Power Wiring



Pinnacle Series Power Wiring

UPS Option

Your controller will denote the UPS option is installed by the following tag located on the underside of the controller.

The DC power wiring for each of the Pinnacle Series controllers, and optional UPS power wiring, is shown below:

Pinnacle I/O

Pinnacle Series controllers includes a full complement of analog and discrete inputs and outputs in their base configuration, and in factory installed I/O expansion boards:

Universal Inputs

High-resolution Universal Inputs handle nearly any type of analog signal or sensor without external signal conditioners required. Unconditioned signals from 20mA current, voltage, millivolt and resistance sensors (including thermocouple, thermistor and RTD temperature sensors) are supported, as well as contact closure and logic-level discrete input signals.

Analog Inputs

In addition to the Universal Inputs, Pinnacle Series controllers have an extra analog input available. In Lassen controllers, this input is pre-configured as a 20mA (0 to 20mA) current loop input. In Shasta and Everest controllers, this input supports 0 to 32Vdc for external power monitoring (available externally only if the UPS option is not installed).

Analog Outputs

Analog Outputs provide 20mA current loop control signals, or with a single external resistor, they can be adapted to provide 0 to 5V or 0 to 10V voltage control signals.

Low-voltage Discrete Inputs

Available in the Lassen Controller, low-voltage Discrete Inputs support contact closures and DC voltage levels, up to 30Vdc. They also support high-speed pulse counting, up to 10KHz, as single channels, or support quadrature (up/down counting) encoders when used in pairs.

Low-voltage Discrete Inputs/Outputs

Low-voltage Discrete Inputs/Outputs are dual function I/O points, that support contact closures and DC voltage levels, up to 30Vdc when used as inputs, an can be used as DC outputs that switch low-voltage DC loads of up to 1A per output. In the Shasta and Everest controllers, they also support high-speed pulse counting, up to 10KHz, as single channels, and quadrature encoders when used in pairs.

Optically Isolated Discrete Inputs

Discrete Inputs are optically isolated input points for sensing switch and contact closures from on/off sensors. Pinnacle Series are ordered as “12/24V” or “120/240V” models depending on the signal levels of the Discrete Inputs.

Discrete Outputs

Discrete Outputs provide relay contact outputs, up to 3A, to operate on/off type control devices. Rubicon controllers also offer a 10mS resolution PWM and one shot functionality.

High-speed Magnetic Pickup Pulse Inputs

High-speed Magnetic Pickup Pulse Inputs accept low-level fast pulse signals, typically from magnetic sensors used in low-cost flow meters. Even though some of the Low-voltage Discrete Inputs and Low-voltage Discrete Inputs/Outputs can also handle high-speed pulses, these particular inputs can do so with signals that drop too much lower and variable amplitudes.

Internal Points and Registers

Internal voltage readings (power, battery level, etc.), and status and control bits are available to controller application and are connected to registers within the controller.

Universal Inputs

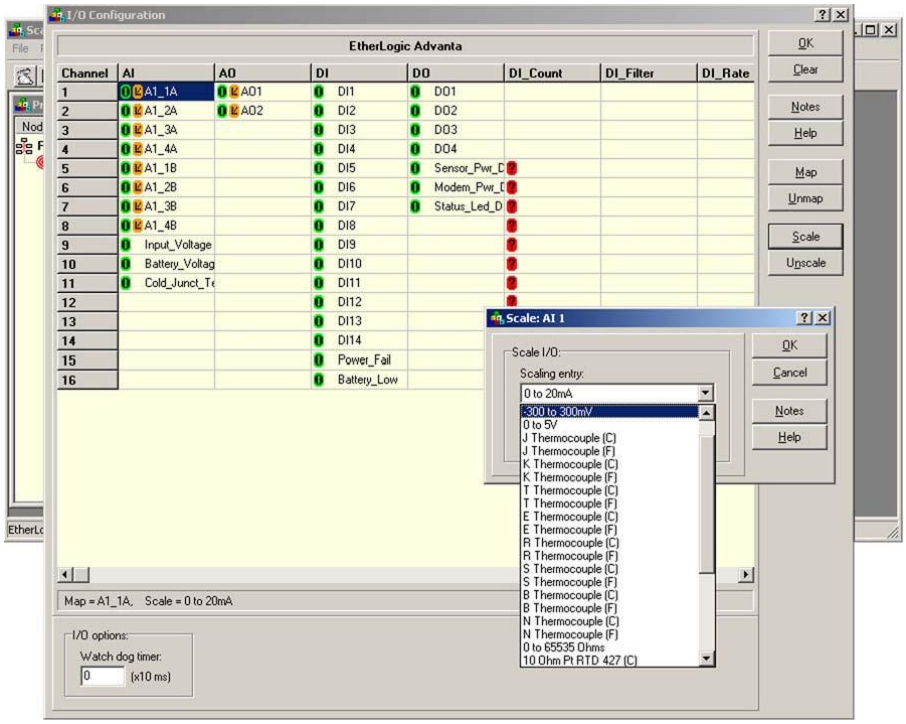
Universal Inputs accept both analog input and discrete input signals including signals from sensors that monitor levels, flows, temperatures, pressure, etc. as well as discrete input devices such as switches and relay contacts. Built-in signal conditioning for resistance and temperature sensors eliminates the need for most external signal converters. Each Universal Input channel is individually configurable for conversion speed (filtering response) and averaging to manage noisy signals and optimize individual sensor response times.

Pinnacle Series controllers have up to eight Universal Inputs in their base configuration. The operation and functionality of the Universal Inputs is identical between controller models except for the number of inputs and the conversion speed.

Model (without I/O Expansion)	Lassen	Rubicon	Shasta	Everest
Number of Universal Inputs	2	4	8	8
Maximum conversion speed	14	2,500	2,500	2,500

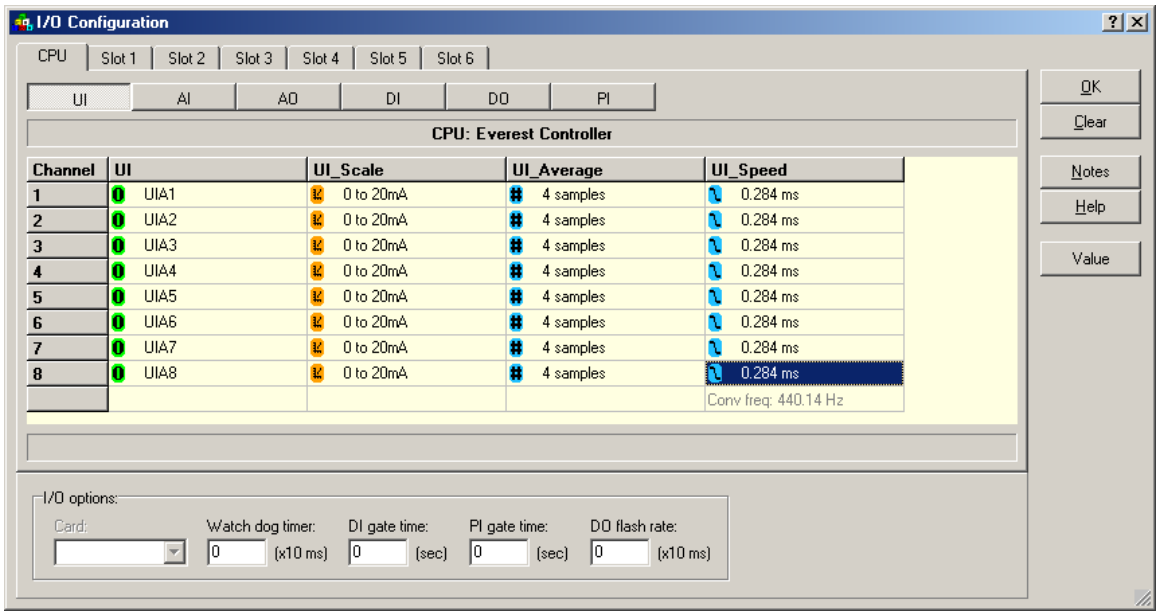
Signal Types and Levels – Mode Selection

The Pinnacle Series Universal Inputs may be configured to accept standard 20mA or voltage (2V) process control signals, thermocouples, low-level millivolt sensors, resistive sensors such as thermistors, RTDs and potentiometers, and contact closures. With an external scaling module, or a pair of external resistors, the inputs can be configured for higher voltages of either polarity (i.e. +/-10Vdc). The input mode and sensor type are determined by settings in the I/O Section of the ScadaBuilder configuration software (I/O | Configuration and I/O | Scaling). There are no mechanical DIP switches or jumpers to set.



Speed Selection

A single Analog to Digital (A/D) converter is used to sample the Universal Input channels. To optimize the throughout, each channels conversion speed is configurable, and unused channels can be shut off. In the Shasta and Everest controllers, the conversion speeds for each channel are adjustable from 0.284mS (3500Hz) to 145.4mS (7Hz). Since each channel uses the same A/D converter, the conversion speed of each channel contributes to the overall scan conversion rate for all of the channels. So for example, if each of the channels is set for the maximum speed and all eight channels are enabled, the aggregate conversion speed is 8 x 0.284mS = 2.272mS = 440Hz. The aggregate speed is totaled for you in the ScadaBuilder Universal Inputs I/O configuration window.



Even though the A/D converter is capable of being very fast, the noise rejection will be best at slower speeds. Therefore, it's good to set the conversion speeds to just fast enough to get the job done. Most applications that measure levels, flows and temperatures do not change very quickly. Typically the lower conversion rates work just fine and provide the most stable readings.

Averaging

In addition to conversion speed, averaging can be used to tailor the response time and stability of the analog readings. Each channel is independently settable from no averaging (average of 1) to averaging of up to 32 samples in increments of 2 (1, 2, 4, 8, 16, 32). For the smoothest performance, 'Boxcar' averaging is used so that each conversion, the newest reading is added into the list and the oldest reading is removed and the average is recalculated. Averaging is especially effective at reducing the effects on low-level signals such as millivolt and thermocouple readings.

Raw Mode

Raw mode bypasses all scaling and calibration in the I/O processor, providing "raw" 16-bit readings from the A/D converter. A full-scale reading of 65535 represents an input of approximately 2.25Vdc. The calculation is:

$$A/D\ Reading = (65535 * V) / 2.25$$

This mode is typically used as a diagnostic tool and should not normally be used in field deployed systems.

20mA Current Mode

Current loop sensors come in "loop powered" and "self-powered" configurations. The Universal Inputs do not source loop power for 20mA loops. If the devices are not self-powered, an external loop supply is required. Most commonly, this is the same power supply that powers the controller itself.

When configured for Milliamp Current Mode, the Pinnacle Series controllers measure signals from 0 to 22.5mA (12% over-range for "standard" 20mA signals). The I/O processor scales and performs

calibration correction on the readings, so that a full-scale reading of 22.5mA is presented to the main CPU as a value of 22500 (1,000 counts per milliamp). The milliamp mode is typically used to measure the output of 4 to 20mA sensors. The readings from these sensors will come into the Main CPU as 4000 for 4mA and 20,000 for 20mA.

Current is measured by reading the voltage drop across a 100-ohm precision resistor through which the current is flowing. These resistors are automatically enabled when the input mode is set to current in the ScadaBuilder software.

Voltage Mode

When configured for voltage measurements, the Pinnacle Series controller measures signals from 0 to 2.25 volts (2 volts plus 12% over-range) with a resolution of just over 16-bits. There is no loss of accuracy in this over-range area, so it's possible to accurately read the signal levels from slightly misadjusted sensors that run "a little hot". It's also possible to distinguish between a sensor output that is at full scale versus over-range.

The I/O processor scales and performs calibration correction on the readings, so that a full-scale reading of 2.25Vdc is presented to the main CPU as a value of 22500 (10,000 counts per volt). This provides readings that without further scaling, read out directly in 100uV increments (imagine a decimal point 4 places from the right to interpret the readings in volts). The Scaling section of ScadaBuilder can be used to change this scaling to more meaningful engineering units.

Millivolt Mode

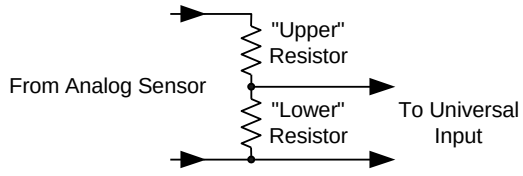
The Pinnacle Series controller can accurately measure very small signal levels like those from "bridge" type pressure transducers and low power devices such a solar radiation sensors. In the Millivolt Mode, the controller has a full-scale measurement range of +/-250mV. The I/O processor scales and performs calibration correction on the low-level readings, so that a full-scale reading of +/- 250mV is presented to the main CPU as a value of +/-25,000 (10,000 counts per 100mV).

Extended and Bipolar Voltage Measurements

Voltages in excess of 0 to 2Vdc, and sensors that supply a bipolar signal, are supported using a combination of an external precision scaling module (or resistor divider) and the Millivolt Mode. The standard scaling module available from ICL divides the input level by 50, providing a full-scale range of +/- 12.5Vdc. This is ideal for measuring +/-5V and +/-10V process signals.

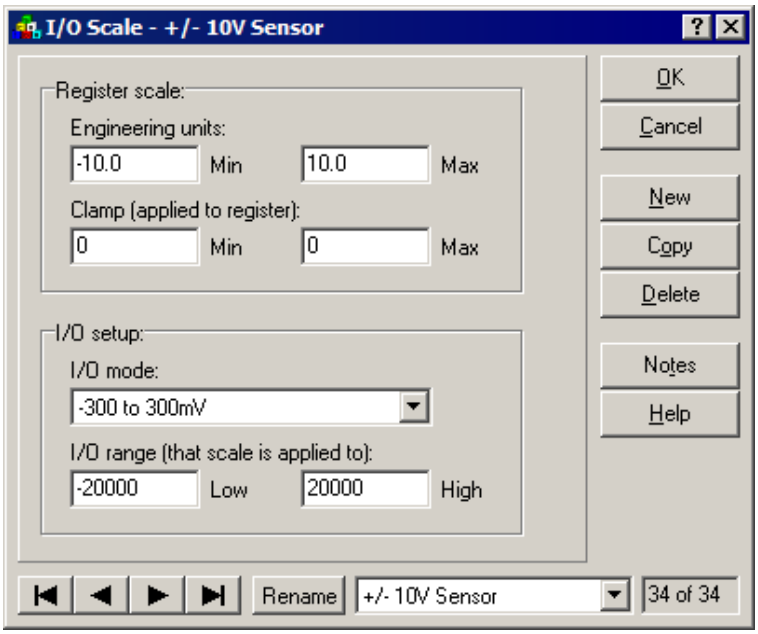
The user can create their own scaling "module" with a pair of precision low-drift resistors in a voltage divider configuration. The voltage "seen" by the Universal Input is calculated as:

Rupper/(Rupper + Rlower).



Range	"Upper" resistor	"Lower" resistor
+/-5Vdc	12.5K ohm 1%	499 ohm 1%
+/-10Vdc	24.9K ohm 1%	499 ohm 1%

Using the Scaling Section of ScadaBuilder, the +/- 25000 (+/-250.00mV) readings from the I/O processor can be easily converted to scaled values and/ or engineering units. Using the ICL voltage-scaling module, a +/- 10v signal is reduced to +/-200mV (allowing for a 25% over range headroom) or readings of –20000 to +20000 from the I/O processor. The ScadaBuilder scaling record is set so that low and high readings ranging from –20000 to +20000 are scaled to read from –10.0 to +10.0 (volts). Changing the "Engineering Units" low and high values will cause the sensor readings to be converted linearly to any desired range of integer or real (floating point) engineering values.

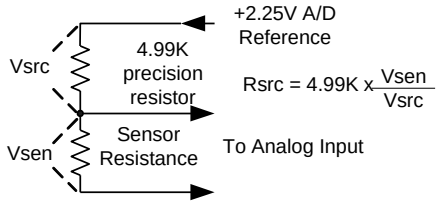


Resistance Type Sensors and Measurements

Resistance measurements and resistive type sensors such as thermistors, RTDs and potentiometers ("pots"), as well as sensing contact closures, require a current source. When a resistance type mode or sensor is selected in the ScadaBuilder software, the controller automatically "switches in" the required current source.

Resistance Mode

The Pinnacle Series controller measures resistance from 0 to 65,535 ohms. The resolution is better than 1 ohm below 13,000 ohms, and up to about 10 ohms or so towards the top of the range. The readings can be scaled by ScadaBuilder from ohms to any set of engineering units. The resistance mode is typically used to read the resistance of potentiometer sensors that indicate position or rotation.



Resistance is measured by sourcing current through a precision 4,999-ohm reference resistor that is in series with the sensor. The I/O processor measures the voltage drop at the junction of the reference resistor and the sensor and compares it to the reference voltage. The I/O processor is then able to ratio metrically calculate the sensor resistance. Note that the reference voltage of 2.25 ensures that the source current is less than 0.5mA to prevent sensor self-heating when using sensors with a low thermal mass.

Thermistor Modes

Thermistors are temperature sensors that are popular for use in HVAC, building monitoring and automotive applications. The resistance of a thermistor varies non-linearly with temperature, so the I/O

processor in the Pinnacle Series controller automatically corrects for the non-linearity and provides a calibrated reading, in degrees C or F, to the controller.

Pinnacle Series controllers have internal linearization support for Type II and III 10K ohm thermistors (resistance is 10,000 ohms at 25°C/77°F). These are some of the more come ones used for HVAC applications.

The supported temperature ranges and corresponding readings from the I/O processor are:

Sensor Mode	Temperature	From I/O processor
Type II - Deg C	-40.1°C to 203.4°C	-401 to 2034
Type II - Deg F	-40.1°F to 398.1°F	-400 to 3981
Type III - Deg C	-40.1°C to 201.1°C	-401 to 2011
Type III - Deg F	-40.1°F to 393.9°F	-400 to 3939

Other thermistor types and ranges can be supported by reading the sensor resistance (using "Resistance Mode") and running the resulting measurement value through an ISaGRAF "CHARCTRZ" block for linearization.

Thermistor Resistance versus Temperature Table

The table below shows the relationship between the resistance of industry standard Type II and Type III 10K ohm thermistors and temperature.

When using thermistors with the built-in scaling in the Pinnacle Series controllers, use the manufacturers literature to verify that the sensors that you are using match the table below. Although there is a defacto standard for 10K Type II and Type III thermistors, manufacturers are under no obligation to conform to these standards.

Note that even though the ScadaBuilder Resistance Mode measurements can only read up to 65,535 ohms, internally, the Pinnacle Series controllers can convert and linearize higher resistances (in this case, some of the temperatures below freezing).

Deg C	*Deg F*	*10K Type II - ohms*	*10K Type III – ohms*
-40	*-40*	*335,671*	*239,831*
-35	*-31*	*242,195*	*179,280*
-30	*-22*	*176,683*	*135,233*
-25	*-13*	*130,243*	*102,890*
-20	*-4*	*96,974*	*78,930*
-15	*5*	*72,895*	*61,030*
-10	*14*	*55,298*	*47,549*
-5	*23*	*42,314*	*37,316*
0	*32*	*32,650*	*29,490*
5	*41*	*25,395*	*23,462*
10	*50*	*19,903*	*18,787*
15	*59*	*15,714*	*15,136*
20	*68*	*12,493*	*12,268*
25	*77*	*10,000*	*10,000*

30	*86*	*8,056*	*8,197*
35	*95*	*6,530*	*6,754*
40	*104*	*5,324*	*5,594*
45	*113*	*4,366*	*4,656*
50	*122*	*3,601*	*3,893*
55	*131*	*2,985*	*3,271*
60	*140*	*2,487*	*2,760*
65	*149*	*2,082*	*2,339*
70	*158*	*1,751*	*1,990*
75	*167*	*1,480*	*1,700*
80	*176*	*1,256*	*1,458*
85	*185*	*1,070*	*1,255*
90	*194*	*916*	*1,084*
150	*302*	*185*	*238*

RTD Mode

RTDs are another form of resistance temperature sensor. They are frequently used in refrigeration and some HVAC applications. Unlike thermistors, the change in resistance per degree of temperature is very small. Therefore RTDs are more susceptible to errors caused by lead resistance. Pinnacle Series controllers support both 2-wire and 3-wire measurement modes for RTDs. The 2-wire mode does not compensate for lead resistance, while the 3-wire mode does. Unfortunately, the 3-wire mode uses a PAIR Universal Input channels.

Standard RTDs come in 10 ohm, 100 ohm and 1000 ohm varieties. 100 ohm and 1000 ohm RTDs are typically made from Platinum and used for precision temperature measurements. 10 ohm RTDs are made from copper and usually used to measure the internal temperature of motors for thermal protection, requiring considerably less accuracy.

Although the relationship between resistance of an RTD and temperature is considerably more linear that thermistors, the I/O processor must still linearize the readings to provide accurate calibrated values to the controller. The Pinnacle Series controller supports the following temperature ranges (and provides the following corresponding readings) for 10, 100 and 1000 ohm RTDs:

Sensor Mode	Temperature	From I/O Processor
10 ohm RTD	-190°C to 250°C	-1900 to 2500
	-310°F to 482°F	-3100 to 4820
100/1000 ohm RTDs	-198.9°C to 869.4°C	-1989 to 8694

Deg C	Deg F	10 ohm RTD	100 ohm RTD	1K ohm RTD
-40	-40	7.490	84.7	847
-30	-22	7.876	88.5	885
-20	-4	8.263	92.2	922
-10	14	8.649	96.1	961
0	32	9.035	100.0	1000
10	50	9.421	103.9	1039
20	68	9.807	107.8	1078
30	86	10.194	111.7	1117
40	104	10.580	115.5	1155

50	122	10.966	119.4	1194
60	140	11.352	123.2	1232
70	158	11.738	127.1	1271
80	176	12.124	130.9	1309
90	194	12.511	134.7	1347
100	212	12.897	138.5	1385
120	248	13.669	146.1	1461
140	284	14.442	153.6	1536
160	320	15.217	161.0	1610
180	356	15.996	168.5	1685
200	392	16.776	175.8	1758
220	428	17.555	180.9	1809
240	464	18.335	188.0	1880
250	482	18.726	191.5	1915

Thermocouple Modes

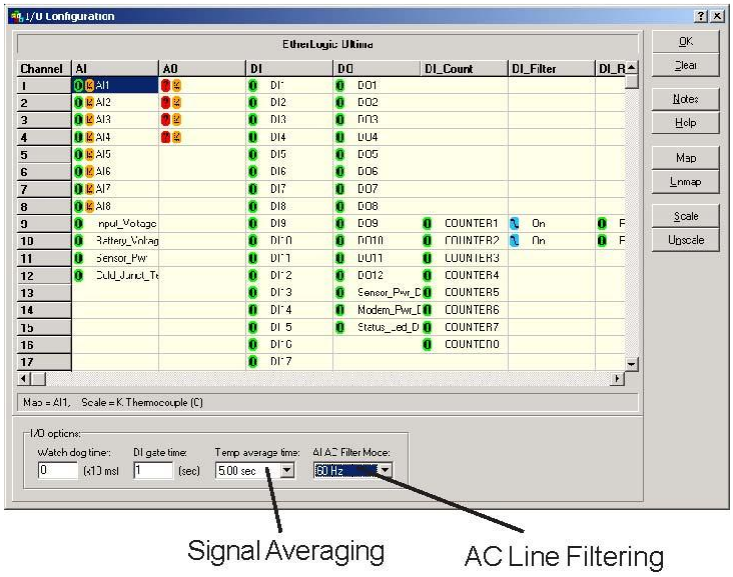
The Pinnacle Series Controller directly supports temperature measurements using thermocouple sensors. No external signal conditioners are needed for any combination of type J, K , T , E, R, S, B and N thermocouples.

Only use ungrounded type thermocouples (electrically isolated junction).

The I/O processor in the Pinnacle Series controller automatically performs linearization and cold-junction compensation to the thermocouple readings. The inputs have upscale burnout protection, forcing a maximum temperature reading for an open thermocouple sensor. The supported temperature ranges and corresponding readings from the I/O processor are:

Thermocouple	Temperature Range	From I/O Processor
Type J	Deg C -240.7°C to 1199.0°C	-2407 to 11990
Type J	Deg F -401.2°F t° 2190.2°F	-4012 to 21902
Type K	Deg C -261.2°C t° 1369.5°C	-2612 to 13695
Type K	Deg F -438.1°F to 2497.1°F	-4381 to 24971
Type T	Deg C -263.2°C to 398.8°C	-2632 to 3988
Type T	Deg F -441.7°F to 749.8°F	-4417 to 7498
Type E	Deg C -267.4°C to 999.0°C	-2674 to 9990
Type E	Deg F -449.3°F to 1830.2°F	-4493 to 18302
Type R	Deg C -43.1°C to 1759.8°C	-431 to 17598
Type R	Deg F -45.5°F to 3199.6°F	-455 to 31996
Type S	Deg C -41.3°C to 1759.1°C	-413 to 17591
Type S	Deg F -42.3°F to 3198.3°F	-423 to 31983
Type B	Deg C 253.4°C to 1792.1°C	2534 to 17921
Type B	Deg F 488.1°F to 3257.8°F	4881 to 32578
Type N	Deg C -255.4°C to 1296.8°C	-2554 to 12968
Type N	Deg F -427.7°F to 2366.2°F	-4277 to 23662

Low-level thermocouple signals can be susceptible to noise. In the I/O Section of ScadaBuilder, the I/O processor can be set to average 1 to 8 readings at a time (1 to 32 on Rubicon) to reduce noise. Since temperatures normally change slowly, averaging can be used to smooth out noisy readings. There is also a power-line frequency setting to optimize 50/60Hz noise rejection, depending of the final equipment installation location.



Contact Closure and Logic Level Discrete Inputs

In addition to analog type sensors, the Universal Inputs of the Pinnacle Series controller can accept simple discrete input signals in the form of contact closures and low-level logic signals. Unlike the controller's other discrete inputs, the universal inputs can use the built-in current sources available for resistance measurements so that no external "wetting" current is required for contact closure type sensors (switches, relay contacts, etc.). The inputs are also more sensitive so they are capable of accepting TTL and CMOS logic levels which typical run between 3 and 5Vdc (the minimum ON voltage of the "normal" discrete inputs is 9Vdc). Do NOT apply any voltage in excess of 5.5Vdc to a Universal Input, otherwise the overload protection circuitry will take over and clamp the input to approximately 6Vdc.

The I/O processor actually processes a discrete sensor on a Universal Input like any other analog sensor, so the inputs are heavily filtered and respond a little more slowly than the conventional discrete inputs. This will be mainly noticeable on Lassen controllers whose maximum A/D conversion rate is considerably slower than Shasta and Everest.

The discrete Universal Input signals are brought into the controller as UDI1 through UDI"n" where "n' is 2 for Lassen controllers and 8 for Shasta and Everest controllers. Be sure to assign Boolean tags to these inputs. If the voltage level on Universal Discrete Input is HIGH (a voltage of 2.00Vdc or greater), it is considered OFF. A LOW (a voltage from 0 to 1.2Vdc) is considered to be ON. To use contact closure type sensors, select the channels Universal Input mode as "resistance" in order to enable the internal current source. If a low-level logic signal is used, set the mode to voltage.

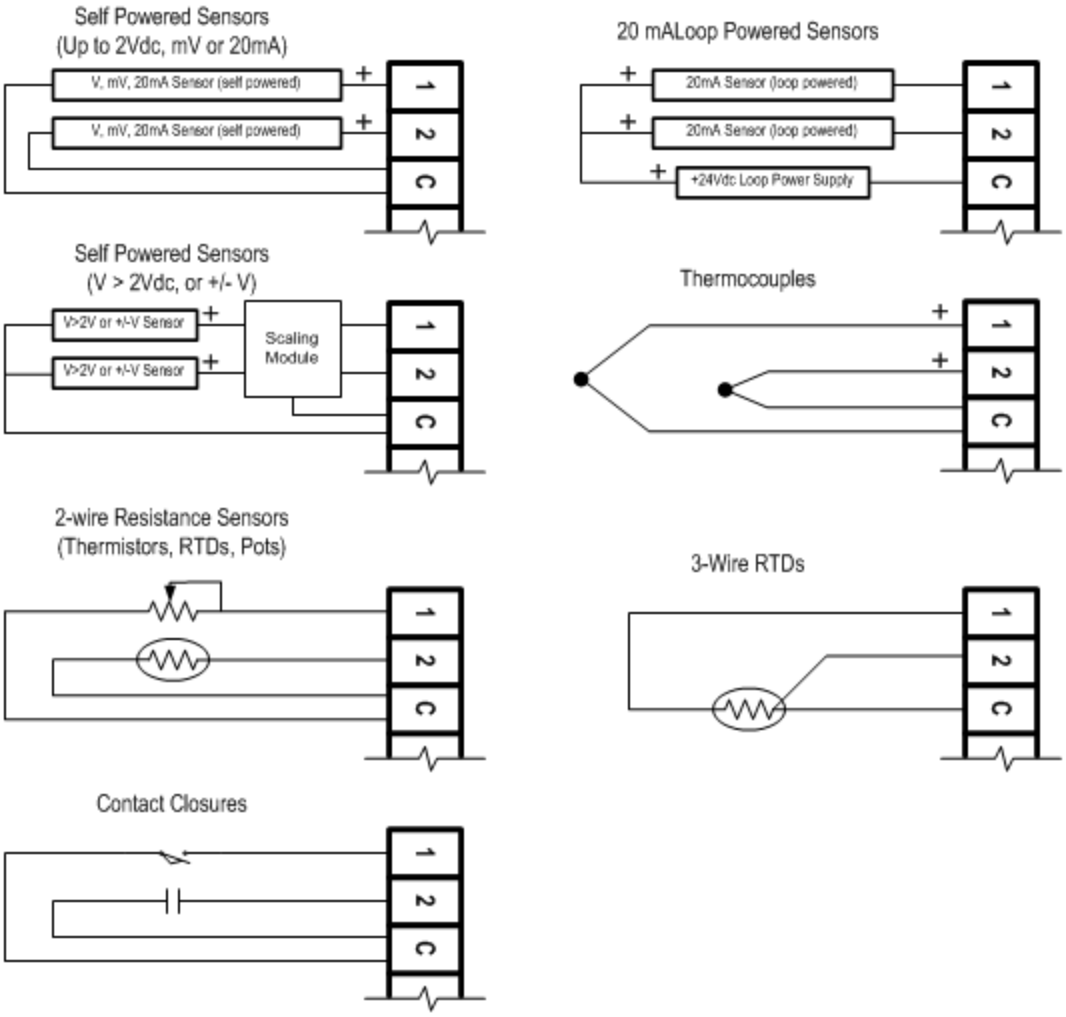
Universal Inputs Field Wiring

For current (20mA), voltage and millivolt type sensors, the Universal Inputs are passive, requiring an active signal source. 20mA current loop devices must either have their own internal loop power supplies, or an external supply must be used (such as the power supply used to power the controller). Voltage type sensors are typically self-powered anyway. It is best if self-powered devices are isolated to avoid ground loops.

Thermocouples MUST be non-grounded type (electrically isolated) to avoid ground loops.

Thermistors, RTDs and other resistive sensors are isolated by design, so no special precautions are typically required.

The typical wiring of various types of sensors to the Universal Inputs is shown below. The terminals are arranged so that 2 Universal Inputs channels share a common terminal. Note that although pairs of similar sensor types are shown in the examples, sensors can be mixed, except for 3-wire RTDs which must be wired to an adjacent pair of odd/even inputs as shown on the next page.



Universal Input Wiring

The field wiring to the Universal Inputs terminates to a removable terminal block. The location of these termination points for each Pinnacle Series controller model is pictured in Appendix A of this manual.

Analog Inputs

Every Pinnacle Series controller has a 10-bit analog input that is in addition to the Universal Inputs. This analog input is available whenever the UPS option is not installed. In Lassen, it is always available because a Lassen controller cannot have a UPS option.

In Lassen Controllers, the Analog Input is preconfigured as a 0 to 20mA current input. In Shasta and Everest controllers, the analog input is preconfigured as a 0 to 32Vdc voltage input.

Model (without I/O Expansion)	Lassen	Shasta	Everest
Analog Input – Input Type/Range	0 - 20mA	0 – 32Vdc	0 – 32Vdc

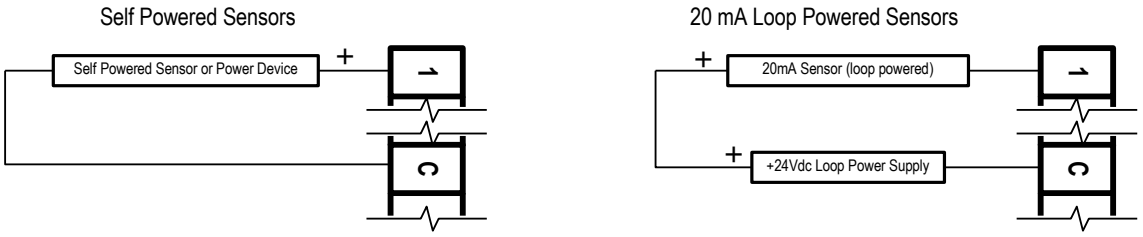
Analog Input Field Wiring

The Analog Input on Lassen Controllers is pre-configured for 20mA devices; either self-powered or loop powered (loop powered required an external power supply, that can be the same as the controller input power)

The Analog Input on Shasta and Everest controllers is preconfigured for 0 to 32Vdc operation and is only available externally on controllers that DO NOT have the UPS option installed (This input is used internally to monitor the battery voltage when the UPS is installed, and the terminal is used as the battery connection.).

The Rubicon controller has no inputs of this type.

The typical wiring to the Analog Input is shown below.



Lassen, Shasta or Everest

Lassen only

The field wiring to the Analog Input terminates on a removable terminal block. The location of these termination points for each Pinnacle Series controller model is pictured in Appendix A of this manual.

Analog Outputs

Analog outputs are used to control variable speed drives, valves, positioners and dampers as well as chart recorders and digital displays. Pinnacle Series controllers have up to four 12-bit analog outputs in their base I/O configuration.

Model (without I/O Expansion)	Lassen	Rubicon	Shasta	Everest
Number of Analog Outputs	2	2	2	4

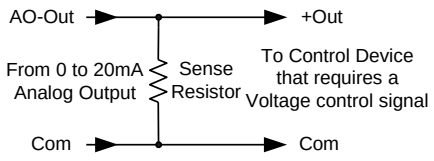
Signal Types and Levels

The analog outputs produce 0 to 20mA control signals. The common 4 mA offset required by 4 to 20mA control devices and indicators can be set up in the scaling portion of the ScadaBuilder software.

With the addition of a single external resistor (per channel), the outputs can be converted to voltage outputs (i.e. 0 to 5Vdc or 0 to 10Vdc). The resistor value can be calculated as:

Rsense = Vout / 0.02

Output Range	Sense Resistor Values
0 to 1VDC	50 Ohms (1/4 Watt or more)
0 to 5VDC	250 Ohms (1/4 Watt or more)
0 to 10VDC	500 Ohms (1/4 Watt or more)



The resistor values required for common output voltage ranges are shown in the table on the left. Standard 1% values of 49, 249 and 499 ohms may be substituted for the "ideal" values shown in the table.

The Pinnacle Series analog outputs source current from an internally boosted DC power source derived from the controller input power, or battery power when the UPS option is installed. Regardless of the input voltage, the controller will source up to about 24Vdc to a control loop.

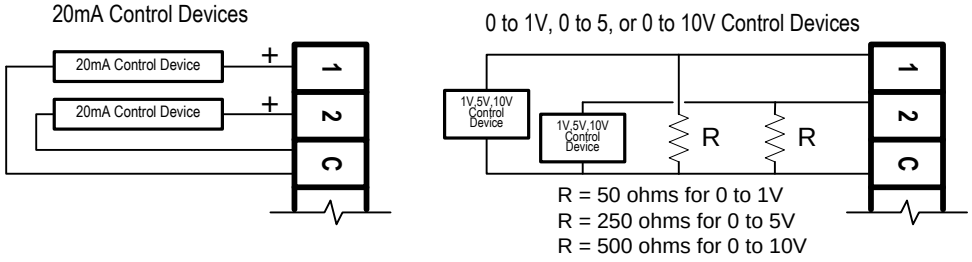
Note: The common of the analog outputs are connected to the controller's power supply input common. Control devices connected to these outputs should be isolated to avoid unforeseen ground loops.

Output Scaling

The Pinnacle Series Analog Outputs are scaled to provide a 0 to 20mA output signal with output values of 0 to 20,000 (1 count = 1uA). The outputs have an additional 5% or so of headroom, so it's possible to use values greater than 20,000 to get output levels slightly higher than 20mA. Note that since the outputs have an actual resolution of 12-bits (a "real" range of 0 to 4095), it will require an increase or decrease of several counts in the analog output value to cause a change in the actual current output. The 0 to 20,000 scaling is simply done for the convenience of system setup. If desired, the analog outputs can be rescaled by changing or adding a scaling record in the I/O section of Scadabuilder.

Analog Outputs Field Wiring

Typical wiring configurations to the Analog Outputs for both 20mA and 0 to 1V, 0 to 5V, or 0 to 10V operation are shown in the diagrams below. Note that no external loop power supply is required. Pinnacle Series Analog Outputs generate their own regulated 24Vdc loop power.



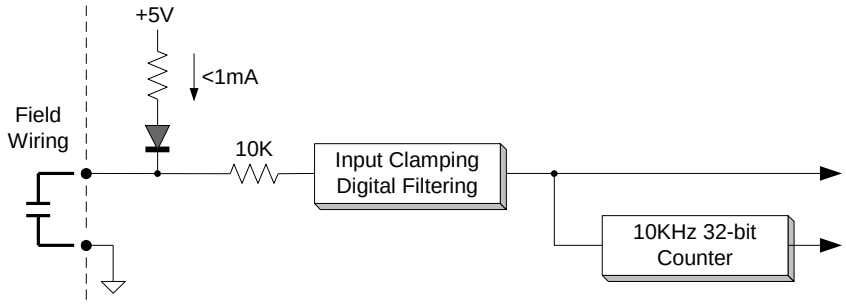
The field wiring to the Analog Outputs terminates on a removable terminal block. The location of these termination points for each Pinnacle Series controller model is pictured in Appendix A of this manual. (Note: terminal numbering will vary from the examples above from model to model.)

Low-voltage Discrete Inputs

Low-voltage Discrete Inputs are non-isolated digital inputs that accept a contact closure or a low-voltage DC input level. The inputs have their own built-in current source, so that only a simple contact closure is required to generate an input signal. The inputs are fast and have programmable filtering to eliminate noise and contact bounce. Associated with each input is a high-speed counter. Support for quadrature encoders is also provided using pairs of these inputs. The Lassen controller has six Low-voltage Discrete Inputs. Currently, this is the only Pinnacle Series controller with this input type.

Signal Types and Levels

A simple contact closure is all that is required as a sensor input signal, but the inputs are rated to accept voltage levels of up to 30Vdc. A low-level (less than 1Vdc) or contact closure to 'ground' is considered an ON; a high level (greater than 2Vdc) is considered an OFF. Above 5Vdc, the input protection circuitry 'looks' like a 10K ohm load to the input source.



Simplified Diagram of the Low-voltage Discrete Input

Digital Input Filtering

The Pinnacle Series Low-voltage Discrete Inputs have configurable digital filtering to tailor the response of the input to counter the effects of noise and/or contact bounce. The filtering may be set to time constants of 0, 1mS, 2mS, 4mS, 8mS, 16mS, or 32mS.

Pulse Totalization

The Pinnacle Series Low-voltage Discrete Inputs have built-in counters that count ON transitions, providing reliable fast pulse totalization that is not sensitive to program scan time. The responsiveness of the counter may be tailored by adjusting the digital input filtering. The pulse totalizers are 32-bit counters, meaning that the totalizers count up to 4,294,836,225 ON transitions before they "roll over" to zero again. The counters can be reset to zero at any time under program control by writing a 0 to the registers that they are mapped to. Like any other registers, totalizer registers can be declared as "retentive" (nonvolatile) so that the accumulated values will be remembered through a power failure. The built-in counting features can be used for very accurate flow and wattage totalization.

Rate Calculation

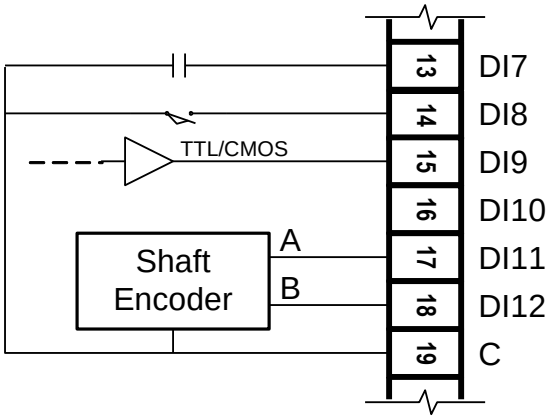
On all Low-voltage Discrete Inputs, Pinnacle Series controllers compute the incoming pulse rate based on a user settable "Gate" (sampling) time. The sampling time is set in 1-second increments in the I/O section of ScadaBuilder. Choosing a smaller gate time causes the rate value to be updated more frequently. Choosing a longer gate time reduces the update rate but increases the measurement resolution since more input pulses are sampled over the longer time period. The built-in rate calculation feature is especially useful for monitoring flow rates from pulse output flow meters.

Quadrature

Pinnacle Series Low-voltage Discrete Inputs support quadrature output shaft encoders. When enabled, an adjacent pair of inputs is used to keep track of the distance (number of pulses) traveled in a 32-bit signed integer register mapped to the first input. A signed register mapped to the second input shows a 1 or -1 to indicate the current direction of movement, or a 0 for no movement. This feature is typically is used to keep track of the movement and position of vehicles, cranes and robotic equipment.

Low-voltage Discrete Inputs Field Wiring

The typical wiring of contact closure type sensors, low-voltage TTL/CMOS logic devices, and quadrature shaft encoders to the low-voltage discrete inputs is pictured below. Note that the types of sensors wired to the discrete inputs can be mixed and connected to any of the inputs, except for shaft encoders which must be wired to an adjacent pair of odd/even inputs as shown (adjacent pairs are terminals 13/14, 15/16 and 17/18 on the Lassen controller).



Low-voltage Discrete Input/Outputs

Low-voltage Discrete Input/Outputs are non-isolated digital inputs that accept a contact closure or a low-voltage DC input level, combined with a solid-state FET output switch. Each I/O point is independent and may be used as either a discrete input or a discrete output.

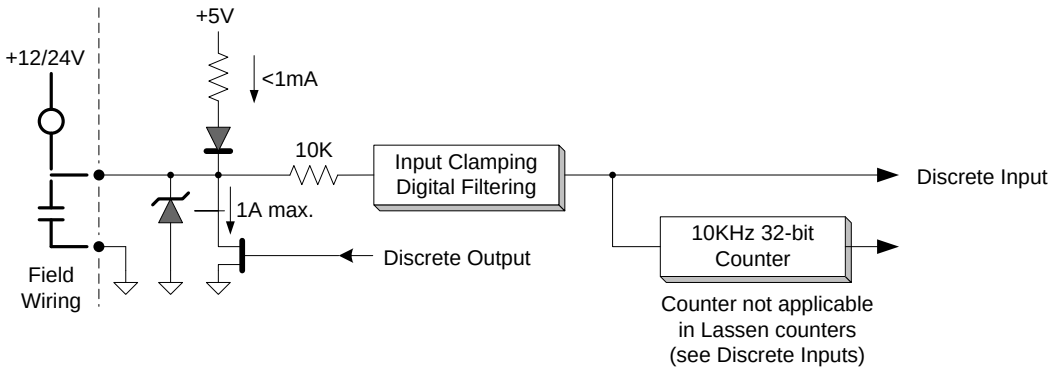
Each discrete input/output has its own built-in current source, so that only a simple contact closure is required to generate an input signal, and outputs have a moderate 'pull-up' to +5V for compatibility with devices that require a "TTL" or "CMOS" logic signal. The inputs are fast and have programmable filtering to eliminate noise and contact bounce. Associated with each input is a high-speed counter (except in Lassen controllers, which instead have high-speed counters on their discrete inputs). Support for quadrature encoders is also provided using pairs of these inputs. When used as outputs, a 3A FET transistor switches to 'ground' when turned ON. The output is transient protected to drive inductive loads. Unlike relay contacts, this output may be cycled rapidly and frequently without degrading its life, and is therefore ideal for operating metering pumps and flashing indicators.

Pinnacle Series controllers have up to six Low-voltage Discrete Input/Outputs as follows:

Model (without I/O Expansion)	Lassen Everest	Rubicon	Shasta	
Number of Discrete Input/Outputs	6	0	2	4

Signal Types and Levels

A simple contact closure is all that is required as a sensor input signal, but the inputs are rated to accept voltage levels of up to 30Vdc. A low-level (less than 1Vdc) or contact closure to 'ground' is considered an ON; a high level (greater than 2Vdc) is considered an OFF. Above 5Vdc, the input protection circuitry 'looks' like a 10K ohm load to the input source. The output section is a solid-state short-circuit protected FET switch with transient protection.



Simplified Diagram of the Low-voltage Discrete Input/Outputs

Digital Input Filtering

The Pinnacle Series Low-voltage Discrete Input/Outputs have configurable digital filtering to tailor the response of the input to counter the effects of noise and/or contact bounce. The filtering may be set to time constants of 0, 1mS, 2mS, 4mS, 8mS, 16mS, or 32mS.

Pulse Totalization (Shasta/Everest controllers only)

In the Shasta and Everest controllers, the Low-voltage Discrete Input/Outputs have built-in counters that count ON transitions, providing reliable fast pulse totalization that is not sensitive to program scan time. The responsiveness of the counter may be tailored by adjusting the digital input filtering. The pulse totalizers are 32-bit counters, meaning that the totalizers count up to 4,294,836,225 ON transitions before they "roll over" to zero again. The counters can be reset to zero at any time under program control by writing a 0 to the registers that they are mapped to. Like any other registers, totalizer registers can be declared as "retentive" (nonvolatile) so that the accumulated values will be remembered through a power failure. The built-in counting features can be used for very accurate flow and wattage totalization.

Rate Calculation (Shasta/Everest controllers only)

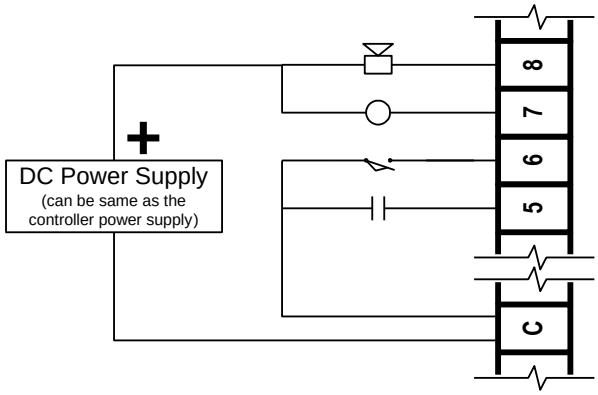
In the Shasta and Everest controllers, the Low-voltage Discrete Input/Outputs provide incoming pulse rate calculation based on a user settable "Gate" (sampling) time. The sampling time is set in 1-second increments in the I/O section of ScadaBuilder. Choosing a smaller gate time causes the rate value to be updated more frequently. Choosing a longer gate time reduces the update rate but increases the measurement resolution since more input pulses are sampled over the longer time period. The built-in rate calculation feature is especially useful for monitoring flow rates from pulse output flow meters.

Quadrature

In the Shasta and Everest controllers, the Low-voltage Discrete Input/Outputs support quadrature output shaft encoders. When enabled, an adjacent pair of inputs is used to keep track of the distance (number of pulses) traveled in a 32-bit signed integer register mapped to the first input. A signed register mapped to the second input shows a 1 or -1 to indicate the current direction of movement, or a 0 for no movement. This feature is typically is used to keep track of the movement and position of vehicles, cranes and robotic equipment.

Low-voltage Discrete/Outputs Inputs Field Wiring

The typical wiring of contact closure type sensors and low-voltage DC control devices (such as relay coils and annunciators) to the low-voltage discrete inputs/outputs is pictured below. Note that no current source is required for input devices. Output devices must be powered from a DC source connected to the common and one leg of each device, with polarity as shown.



Note: The 'C' common terminal for the Discrete Inputs/Outputs is internally connected to the Controller DC Ground (-) .

Low Voltage Input Wiring

The Low-voltage Discrete Inputs/Outputs terminate from the field on a removable terminal block. The location of these termination points for each Pinnacle controller model is pictured in Appendix A of this manual.

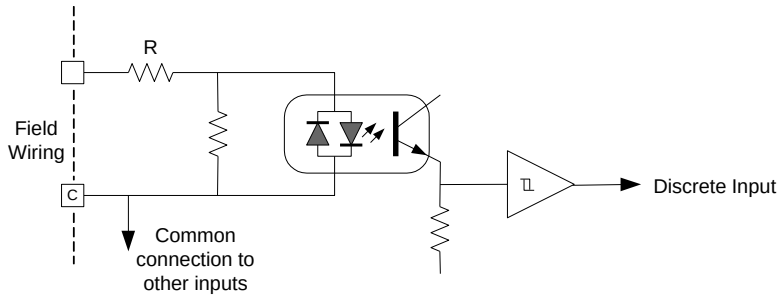
Optically Isolated Discrete Inputs

Pinnacle Series Optically Isolated Discrete Inputs are used to monitor the state of switches, relays contacts, motor starter auxiliary contacts and any other on/off type signals. The inputs are optically isolated to avoid ground loop effects and support higher voltages (120/240Vac), and prevent damage from transients and power surges on the input lines. Optically Isolated Discrete Inputs are used in Shasta and Everest controllers.

Model (without I/O Expansion)	Lassen Everest	Rubicon	Shasta
Number of Optically Isolated Discrete Inputs	0 20	20	16

Signal Types and Levels

The Pinnacle Series' Optically Isolated Discrete Inputs have a unique bipolar design that accepts both AC and DC signals. The inputs are not sensitive to signal polarity, supporting DC sensors with either "sinking" or "sourcing" output configurations as well as switch contacts with AC or DC signals.



Simplified Diagram of the Optically Isolated Discrete Inputs

The value of the input resistor 'R' is typically 8700 ohms for 12/24 volt inputs, and 100,000 ohms for 120/240 volt inputs.

Optically Isolated Discrete Inputs have hysteresis in order to improve their noise rejection. The hysteresis ensures that the voltage at which an input turns ON is higher that the voltage at which the input will turn OFF. Once the input signal reaches the ON threshold, it must drop down below the OFF threshold for the input to turn OFF. This feature combined with normal component tolerances defines the difference between the OFF and ON thresholds in the table above.

The Optically Isolated Discrete Input circuitry of Pinnacle Series controllers is purposely designed to respond to DC signals (that do not cross through 0 volts) faster than AC signals. This provides better noise rejection in systems with 50/60Hz control power, but allows for a little faster response times in equipment control applications that typically use faster sensors such as DC photo eyes and proximity switches.

Filtering Differences - Shasta versus Everest

The Optically Isolated Discrete Inputs of the Shasta and Everest controllers differ in the way that filtering is handled. In the Shasta, the filtering is fixed at approximately 20mS to accommodate 50/60Hz signals as well as DC inputs. In the Everest, the filtering is electronically switchable, 16mS for AC signals and noisy DC signals, and less than 1mS for fast DC input signals. The later is required for some machine control and similar applications.

12/24v versus 120/240v Operation

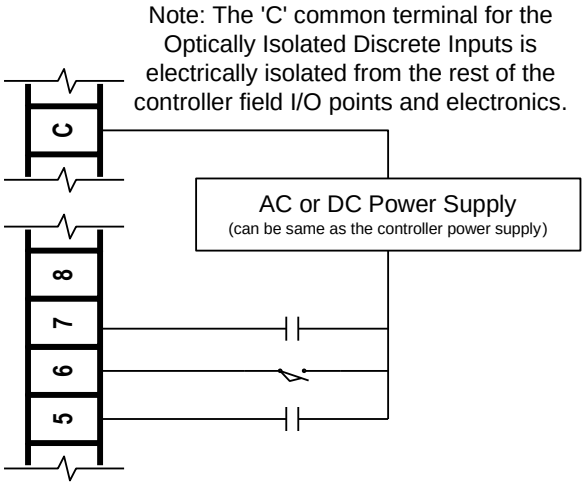
The Optically Isolated Discrete Inputs are designed to operate in 12 and 24 volt control systems, or 120V and 240V control systems depending on the model number ordered. The ON and OFF thresholds and maximum input ratings are:

Model Type	OFF Threshold	ON Threshold	Maximum Input
12 / 24V	< 6 Vdc/Vac	> 9 Vdc/Vac	50 Vdc/Vac
120V/240V	< 50 Vdc/Vac	> 75 Vdc/Vac	300 Vdc/Vac

The input current at 12V on 12/24V models, or 120V on 120/240V models is approximately 1mA, sufficient for contact “wetting”, but low enough for practical use in low-power applications, or applications that require minimal temperature rise. At 24V on 12/24V models, or 240V on 120/240V models, the input current rises to about 2.25mA for each input.

Optically Isolated Discrete Inputs Field Wiring

The typical wiring of contact closure type devices to the Optically Isolated Discrete Inputs is pictured below. Note that the inputs are passive and require an active voltage to be switched between input signal connections and the common to complete the input circuits. The inputs are isolated from the rest of the controller electronics. The inputs are not sensitive to polarity, so the power lead connected to the field sensors can be either the negative or the positive side of a DC power source, or either side of an AC power source.



The Optically Isolated Discrete Inputs terminate from the field on a removable terminal block. The location of these termination points for each Pinnacle controller model is pictured in Appendix A of this manual.

Discrete Relay Outputs

Pinnacle Series Discrete Relay Outputs are used to operate motor starters, solenoid valves, lights, and annunciators; virtually any on/off type control device. The discrete outputs are "dry" relay contacts rated to switch up to 3A loads (refer to the load ratings in the specifications for ratings for specific types of loads). These outputs can switch both low-voltage (12/24V) and high voltage (120V/240Vac); AC or DC loads, regardless of the controller model. Discrete Relay Outputs are used in Rubicon, Shasta and Everest controllers.

Model (without I/O Expansion)	Lassen	Rubicon	Shasta	Everest
Number of Discrete Relay Outputs	0	10	6	12

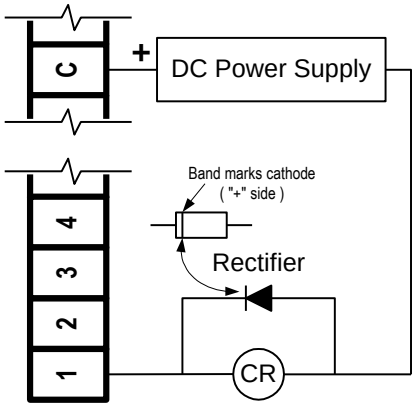
Fusing and Transient Protection

Overload and transient protection should be provided for all loads connected to the Relay Discrete Outputs, depending on the outputs device types being controlled. No overload or transient protection is provided within the controller. External protection should be included in the output circuits to protect both the controller output contacts and the loads that they drive.

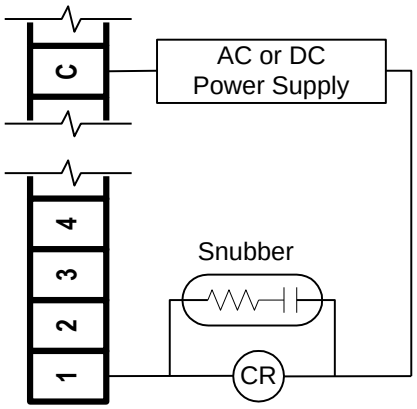
For overload protection, typically, large loads are fused individually, while smaller loads can share a fused common line.

In order to maximize relay contact life, inductive loads, no matter how large or small, should have protection against transient spikes caused by inductive loads, such as relay coils and solenoid valves.

DC loads can be protected effectively with a solid-state rectifier across the load. Be careful to observe the polarity of the connections, otherwise the rectifier will provide essentially a short circuit across the load, potentially damaging the relay contacts and destroying the rectifier itself.



Both AC and DC loads can be protected by a snubber circuit (specially designed series capacitor/resistor) across the load. Snubbers are not polarity sensitive. An MOV (varistor) may be used in place of a snubber in many applications.



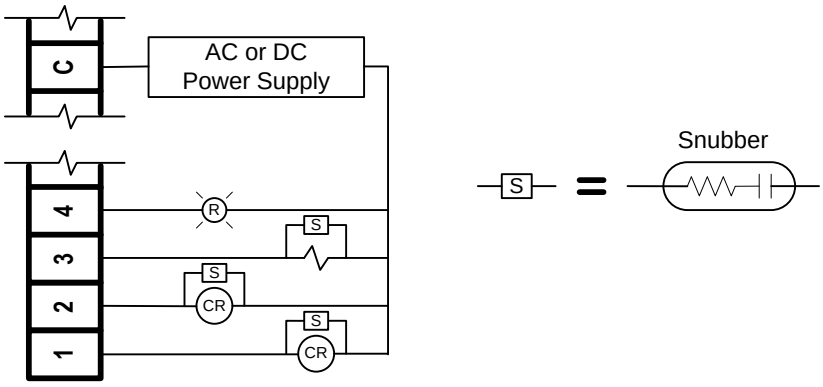
Field Wiring

The Pinnacle Series controllers have six (Shasta), ten (Rubicon) or twelve (Everest) Relay Discrete Outputs with "Form A" (normally open) contacts, in their base configuration.

To simplify field wiring, the discrete outputs are grouped into sets of six outputs; each set with its own pre-wired common (the Everest has two common terminals per group). Be careful to not exceed the 15A rating of the common terminals.

The discrete outputs are passive "dry" relay contacts that require an active supply voltage on one side of the load, while the relay output from the controller switches the other side of the load to the opposite supply leg. The relays may be used to switch AC or DC signals and power. The relays outputs are generally used for "pilot" duty; for example, the outputs must never be used to directly operate a motor, but can be used to activate a motor starter that in turn, operates a motor.

Be sure to take into consideration the rating of the relay contacts when driving high inrush current loads such as incandescent lamps.



Relay Discrete Outputs Wiring

The Relay Discrete Outputs terminate from the field on a removable terminal block. The location of these termination points for each Pinnacle controller model is pictured in Appendix A of this manual.

Discrete Output terminals may carry a load of up to 18A with the following de-ratings for voltages at the terminal block:

Current Range	Voltage
18A@	0 - 50 V
15A@	51 - 150 V
10A@	151 - 300 V
5A @	301 - 600 V

These current loads can be achieved when connecting high loads to Discrete Output Common terminals. The maximum load on a DO common pin should not exceed the above specification. These specifications are for DC resistive loads.

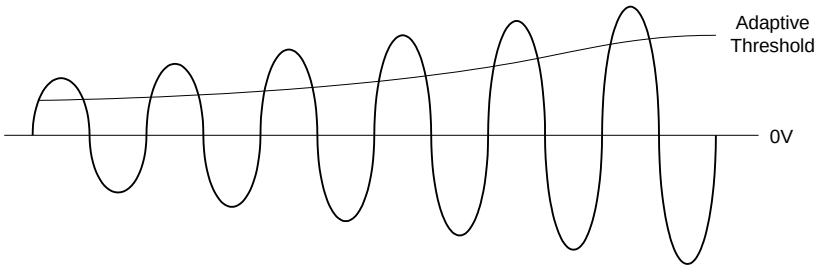
High-speed Magnetic Pickup Pulse Inputs

Pinnacle Series controllers have built-in conditioning for magnetic pickup sensors, typically used with low-cost flow meters. The signal levels from these types of sensors can vary from 10s of millivolts to tens of volts depending on the speed at pickup pulses being sensed. Pinnacle Series controllers have the conditioning electronic for these types of sensors built-in to eliminate the cost of an external signal conditioning module. These inputs will also accept logic level (TTL/CMOS) and conditioned signals.

Model (without I/O Expansion)	Lassen Everest	Rubicon	Shasta	
Number of Mag Pickup Inputs	1	1	1	2

Signal Types and Levels

The High-speed Magnetic Pickup Pulse Inputs can process sensor signals ranging from about 50mV to 108V peak-to-peak. Automatic gain adjustment circuitry automatically adjusts to varying input levels, using adaptive thresholding. Adaptive thresholding constantly adjusts the "ON" threshold based on the input amplitude, increasing noise rejection as the signal amplitude increases. The signal is considered to be OFF when the input goes below 0 volts and must go back above the variable ON threshold to be "ON" again.



Adaptive Threshold Example

Pulse Input Filtering

The Pinnacle Series High-speed Magnetic Pickup Pulse Inputs have configurable digital filtering to tailor the response of the input to counter the effects of noise and/or contact bounce. The filtering may be set to time constants of 0, 1mS, 2mS, 4mS, 8mS, 16mS, or 32mS.

Pulse Totalization (Shasta/Everest controllers only)

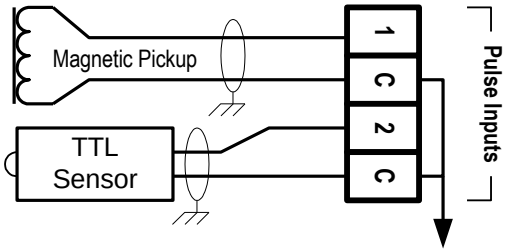
In Pinnacle Series controllers, the High-speed Magnetic Pickup Pulse Inputs have built-in counters that count ON transitions, providing reliable fast pulse totalization that is not sensitive to program scan time. The responsiveness of the counter may be tailored by adjusting the digital input filtering. The pulse totalizers are 32-bit counters, meaning that the totalizers count up to 4,294,836,225 ON transitions before they "roll over" to zero again. The counters can be reset to zero at any time under program control by writing a 0 to the registers that they are mapped to. Like any other registers, totalizer registers can be declared as "retentive" (nonvolatile) so that the accumulated values will be remembered through a power failure. The built-in counting features can be used for very accurate flow and wattage totalization.

Rate Calculation

In Pinnacle Series controllers, the High-speed Magnetic Pickup Pulse Inputs support incoming pulse rate calculation based on a user settable "Gate" (sampling) time. The sampling time is set in one second increments in the I/O section of ScadaBuilder. Choosing a smaller gate time causes the rate value to be updated more frequently. Choosing a longer gate time reduces the update rate but increases the measurement resolution since more input pulses are sampled over the longer time period. The built-in rate calculation feature is especially useful for monitoring flow rates from pulse output flow meters.

Field Wiring

The Pulse inputs are passive. The signal sources are self-powered and drive the inputs directly. A simple 2-wire connection per sensor is all that's required. Shielded cables, with the shield bonded at the controller end (only), are recommended.



The High-speed Magnetic Pickup Pulse Inputs terminate from the field on a removable terminal block. The location of these termination points for each Pinnacle controller model is pictured in Appendix A of this manual.

Internal Analog Inputs

The Pinnacle Series controllers have three internal analog inputs used to monitor internal operating voltages and temperature. Each of these can be read as an integer register value. ScadaBuilder automatically sets up default tag names when a new node (controller) is created, but these can be changed at any time. All voltages are in tenths of a volt (i.e. 254 = 25.4 volts). Temperature is in tenths of a degree F (i.e. 282 = 28.2ºF)

Input_Voltage

This register represents the current external DC input voltage (power) to the controller. Since the controller can operate on battery backup power, it is entirely possible for this value to read 0 and still be functioning under battery power!

Battery_Voltage (UPS Option – Shasta or Everest)

This register represents the current backup battery voltage level, available when the UPS option is installed (Shasta or Everest only). This is an actual battery voltage under a light load. The controller periodically turns off the internal charging circuitry and measures the battery voltage with a load resistor attached. A fully charged battery should read approximately 13.7Vdc.

Cold_Junct_Temp

This register represents the current temperature measured at the Universal Input terminals. Although this is primarily used for cold junction compensation of thermocouple sensor readings, the temperature generally represents the internal temperature of the controller. This sensor is purposely located away from heat generating components, so there may be certain locations in the controller that run somewhat warmer than the indicated temperature.

Internal Discrete Inputs

Pinnacle Series controllers have three internal discrete inputs used to monitor incoming power, battery power and sensor power status. All of these can be read as Boolean values by a logic program. ScadaBuilder automatically sets up the default names shown below when a new node (controller) is created, but these can be changed at any time.

Power_Fail (UPS Option Only)

This alarm bit is set whenever incoming power drops below 9.5 volts. The bit will remain set until the incoming power rises above 10.0 volts or the controller is reset (full power cycle).

Battery_Low (UPS Option Only)

This alarm bit has slightly different setpoints depending on whether incoming power is present or if the controller is running off of backup battery power.

When incoming power is present, this bit set whenever the backup battery voltage is less than 11.8 volts. It is turned off when the battery charges up to at least 12.5 volts. This provides an indication of the charging state of the backup battery.

When incoming power is NOT present (controller is running on backup battery power), this bit is set when the battery voltage drops below 10.5 volts. This serves as a warning, since the power from the battery will be automatically disconnected (controller shut off) when the battery voltage drops below 9.8 volts in order to avoid deep discharge damage to the battery. The alarm bit is reset when the battery rises up to at least 12.0 volts or incoming power is restored above the thresholds described previously.

Communications Options

Pinnacle Series Option Numbers (factory installed)

79-4001 Pinnacle Series - 56K Dialup Telephone Voice Modem option (Lassen, Shasta, Everest only)

79-5101 Pinnacle Series - 900MHz Freewave Spread Spectrum Radio option (Lassen, Everest only)

79-5201 Pinnacle Series - 900MHz MDS Spread Spectrum Radio option (Lassen, Everest only)

79-5301 Pinnacle Series - 900MHz Digi Xtend Spread Spectrum Radio option (Lassen, Everest only)

Internal Telephone Modem Option

Most Pinnacle Series controllers can be ordered with an internal 56K baud dial-up telephone modem. Typical applications are for systems that require simultaneous voice/alarm dialing and data access using two phone lines. With the internal telephone modem option, the controller can dial out to annunciate an alarm with synthesized voice (including "real-time" process variables), send a message to a numeric or alphanumeric pager, send a text message to a cell phone, or send an e-mail (with file attachments such as data logs). The Pinnacle Series controller can also be configured to accept incoming calls for remote PC or touchtone voice-prompted access to process variables, and to make password protected register and I/O changes, as well as for remote program debugging and updates.

The internal Pinnacle Series telephone modem is functionally similar to the high-speed modems used in PC computers, except that the Pinnacle Series internal modem has the following additional features:

- Supports voice synthesis for alarm dialing
- Supports touchtone tone recognition for remote dial-in and control
- Operates over the full controller temperature rating (-40°C to +75°C).
- Requires no additional panel space
- Is an additional com port, freeing up an external RS-232/RS-485 port
- Runs off of internal DC power from the controller, making it easy to provide long-lasting uninterruptable battery backed operation on units where the UPS option is available.

The connector accepts a standard 6-pin modular telephone plug, of which only the center two pins are used for the telephone line connection (standard telephone wiring configuration).

Your controller will denote the option is installed by the following tag located on the underside of the controller.

Internal Spread Spectrum Radio Option

Lassen and Everest controllers are available with internal Spread Spectrum Radios, requiring no additional panel space other than antenna connections.

Digi Xtend w/MMCX This option provides a Digi Xtend 1 watt 900 MHz spread spectrum radio with a miniature MMCX connector. This option supports the use of a very flexible internal cable to a cabinet bulkhead lightning arrestor. Digi Xtend radios support Point-to-Multipoint as well as Peer-to-Peer and "Mesh" operation.

Freewave MM2 This option provides a Freewave MM2 1 watt 900 MHz spread spectrum radio with a miniature MMCX connector. This option is compatible with all Freewave FGR and (older) DGR series radios. Freewave radios support Point-to-multipoint operation and have enhanced diagnostic capabilities that can be accessed simultaneous with normal I/O communications.

MDS TransNet EL806 This option provides a Microwave Data Systems (GE) 1 watt 900 MHz spread spectrum radio with a miniature MMCX connector.

All three radio options fit inside the Lassen or Everest controllers. Ordering an internal radio option does not change the controllers footprint.

Antenna and System Configuration Options

Depending on the distance and terrain between sites, there are multiple options for antenna connections to internal radio in the controller:

Option 1 – Enclosure Mounted Antenna

If the distance between sites is moderate (less than a mile), then an enclosure mounted antenna may be an option. We generally recommend a "salt shaker" style transit antenna which is omni-directional with 3dB of gain. The antenna is typically installed in a hole in the top of the box and a short internal antenna cable links the radio with the antenna. The antenna has a waterproof gasket. Generally, no lightning arrestor is needed since the antenna is only slightly above the top of the enclosure. Part numbers required for a :"salt shaker" antenna installation are:

98-6424 24" Internal Antenna Cable: MMCX to N-Male (Xtend Freewave MM2 or Xtend with MMCX)

98-3113 3dB OMNI "Salt Shaker" Transit Antenna, Type-N Female, 902 to 928 MHz

Option 2 – External Antenna

If the distance between sites is beyond the limits for the first option, then a full antenna system is recommended. This includes:

An internal antenna cable
A lightning arrestor
An external antenna cable
A Yagi (directional) or Omni (omnidirectional) elevated antenna

We also generally recommend a computer Radio Path Survey that uses GS coordinates of the radio sites along with precision topographical map data to calculate the performance of the radio system, and determine the required antenna elevations. Most commonly used components are:

Internal Antenna Cable Part Numbers

98-6424 24" Internal Antenna Cable: MMCX to N-Male (Xtend Freewave MM2 or Xtend with MMCX)

98-6524 24" Internal Antenna Cable: RPSMA-Female to N-Male (XTend)

Lightning Arrestor Part Number

98-8001 Lightning Arrestor, 900MHz, bulkhead mount, N-Female to N-Female

External Antenna Cable Part Numbers

98-4010 10ft. External Antenna Cable, LMR-400, N Male to N-Male connectors

98-4020 20ft. External Antenna Cable, LMR-400, N Male to N-Male connectors

98-4030 30ft. External Antenna Cable, LMR-400, N Male to N-Male connectors

98-4050 50ft. External Antenna Cable, LMR-400, N Male to N-Male connectors

98-4075 75ft. External Antenna Cable, LMR-400, N Male to N-Male connectors

98-4100 100ft. External Antenna Cable, LMR-400, N Male to N-Male connectors

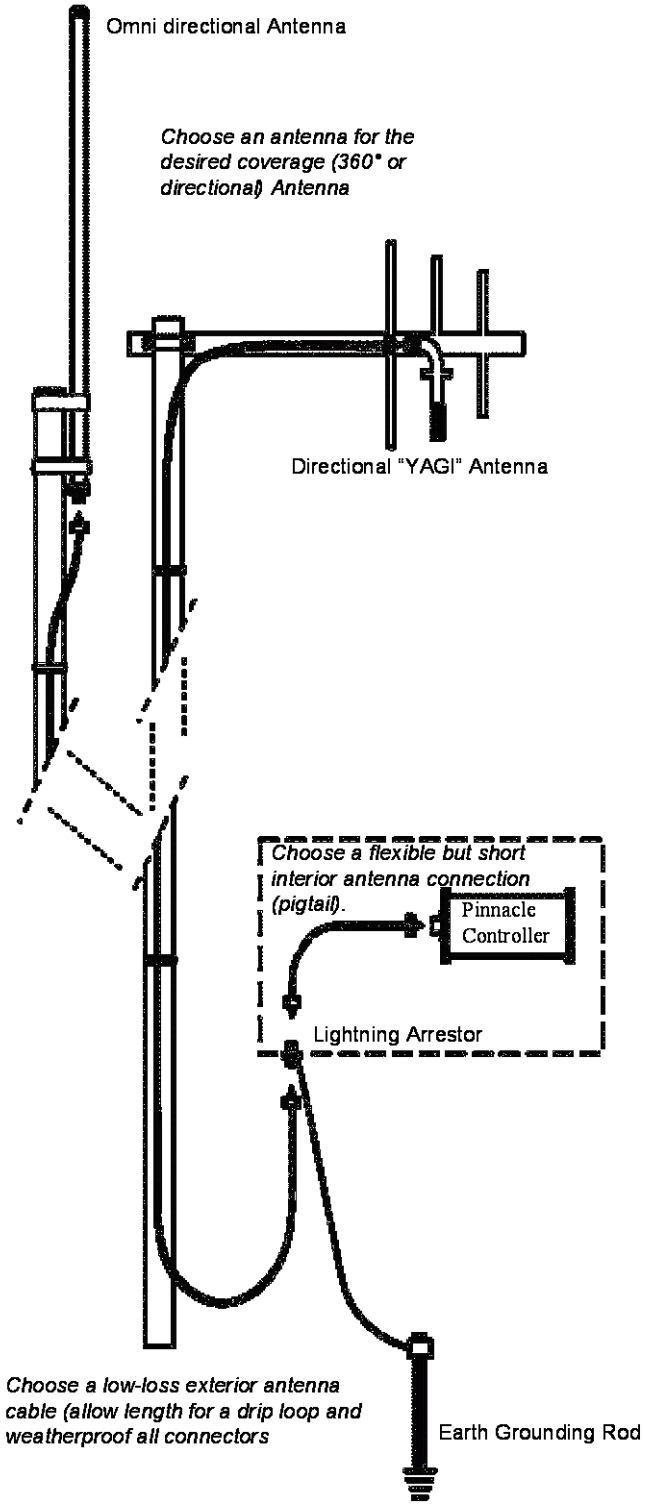
External Antenna Part Numbers

98-2106 6dB YAGI Directional Antenna, Type-N Female, 896 to 940 MHz, w/mtg hardware

98-3106 6dB OMNI Fiberglass Antenna, Type-N Female, 896 to 940 MHz, w/mtg hardware

Spread spectrum radios tend to be less affected by outside interference and are more secure than conventional radios because they are constantly changing operating frequency. If a spread spectrum radio encounters interference at a particular frequency, it simply picks up where it left off after hopping to the next frequency a few milliseconds later. The radios offer very high data reliability, utilizing a unique 32-bit error detection and correction scheme to ensure that corrupted data is never passed to the controller. This protection is above and beyond the protocol level error handling.

The radio embedded in Pinnacle Series can deliver up to one watt of RF power, the maximum allowed by law in these frequency bands. This is a lower power than other types of radios operating at fixed licensed frequencies, but these spread spectrum radios can have a range of up to 60 miles in an open area. The radios have a built-in repeater function, so that each radio can serve as a repeater to relay the messages of other radios located farther out as well as communicating the data from the controller. There is no limit, other than transmission time, to the number of repeater hops used, so spread spectrum radio networks can provide hundreds of miles of coverage.



The Pinnacle Series radios support real-time on-line diagnostics that enable a single Pinnacle Series controller to serve as a central point to examine the status of any other radio and radio link in the network while communicating. The radios can be remotely configured and can even have the microprocessor firmware updated from this Master station. The remote diagnostics capability provides immediate status information for any segment of the radio network, including repeater links. This data can include average signal strength and noise levels, as well as specific signal and noise levels for each of the hopping frequencies. Additional information such as antenna reflections (SWR), operating temperature, and data error rates are available to analyze the performance of each portion of the radio network.

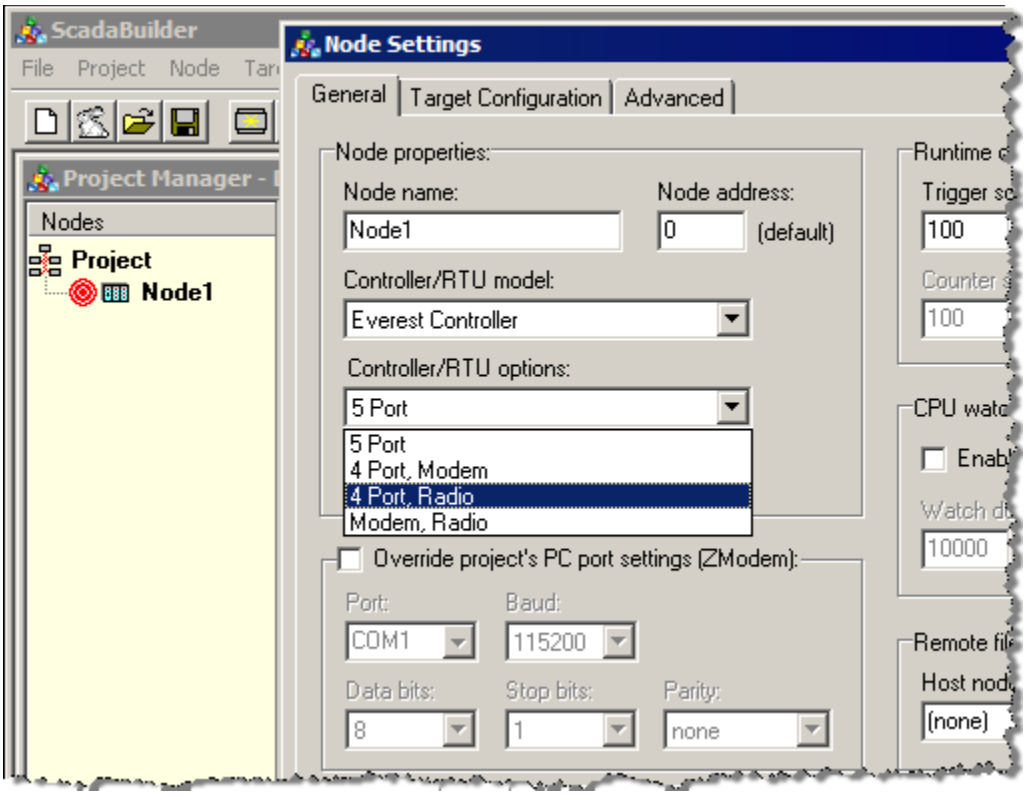
Radio Installation

The Pinnacle Series radio option uses a female "SMA" type antenna connector. The antenna connector and the radio status lights are located on upper side of the controller (see below).

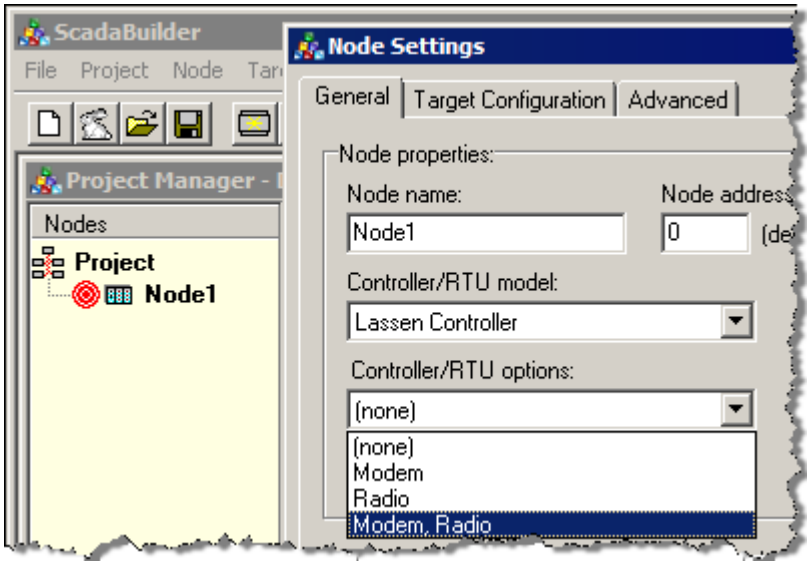
Typically, a short, lightweight cable (such as RG-223 or LMR-200) connects between the radio antenna connector and a lightning arrestor in the panel. A lightning arrestor with dedicated ground rod is required for any outdoor installation. The lightning arrestor can also serve as a bulkhead connector to pass through the cabinet wall and transition to heavier, lower-loss type exterior antenna cables such as LMR-400 and LMR-600. These cables then connect to Yagi (directional) or Omni (Omni directional) antennas. LMR-600 cable has lower loss for longer runs. LMR-400 is cheaper and more flexible, but less than 100ft. of cable can cut the signal strength in half! Heliax has the lowest loss, but is stiff and hard to work with.

Setting Up the Controller Application

In the ScadaWorks software, it is necessary to setup the controller to use the radio option. When this is done, the radio port shows up as a Network Port configuration. Go to the Node | Settings menu to get to the following dialog. Under Options, select one of the Radio options. Based on the controller, the radio/modem options are slightly different. Make sure you choose the right one for your application:



Everest Application Radio Configuration



Lassen Application Radio Configuration

Radio Device Configuration

All Radios are configured through serial port redirection from a serial port on the front panel of the controller. One port is "hijacked" temporarily to accomplish radio configuration to each of the radios. From there, a null modem cable is used to connect the configuring PC to the radio itself through the redirected serial port.

Serial Port Redirection by Model:	
Everest	Com 3
Lassen	Com 5

You will need a null modem adaptor to communicate from your PC to the controller's redirected radio diagnostic port. This is the same cable you would use to communicate directly to one of the controller's serial ports. Please see the "RS-232 DTE Cable typical wiring (RJ-45 to DB-9S)" section of this manual for connection details. You can also purchase null modem adapters from ICL with the following part numbers:

	RS-232 DTE Cables
RJ-45 to DB9 adapter plug	**99-2100**
RJ-45 Serial Cable Assembly, 1ft.	**99-2101**
RJ-45 Serial Cable Assembly, 2ft.	**99-2102**
RJ-45 Serial Cable Assembly, 3ft.	**99-2103**
RJ-45 Serial Cable Assembly, 5ft.	**99-2105**
RJ-45 Serial Cable Assembly, 7ft.	**99-2107**
RJ-45 Serial Cable Assembly, 10ft.	**99-2110**

Radio Diagnostic Port Redirection and Configuration.

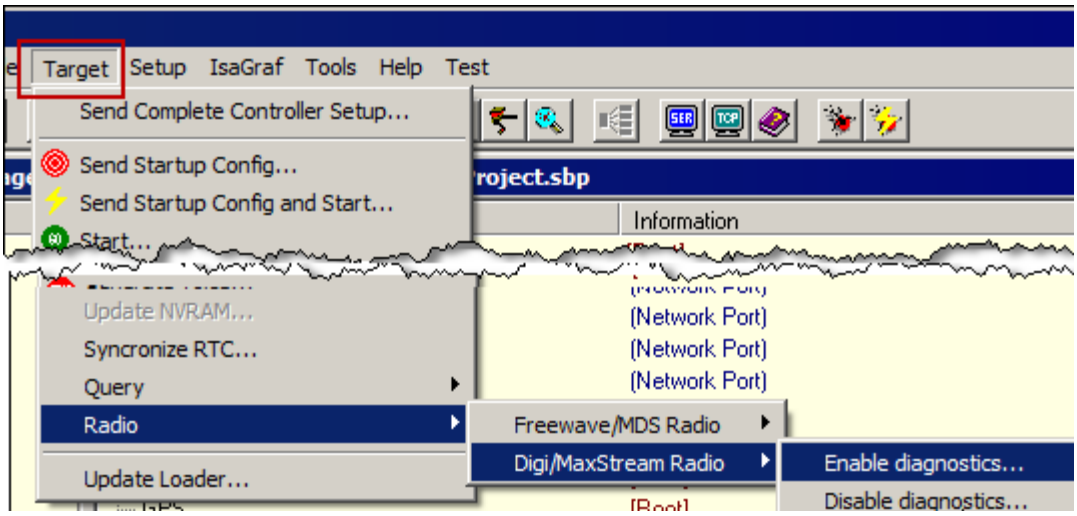
Select the application target you are configuring in ScadaBuilder. You will need to connect to your controller via TCP/IP (Ethernet) to tell it to go into diagnostic/configuration mode.

Note: You must have the original application that is on the controller. The application is responsible for security. Otherwise, you will need a serial port (null modem) to talk to com1 to redirect the radio diagnostic / configuration port.

Digi (MaxStream) Xtend Radio Configuration

Your controller will denote the option is installed by the following tag located on the under side of the controller.

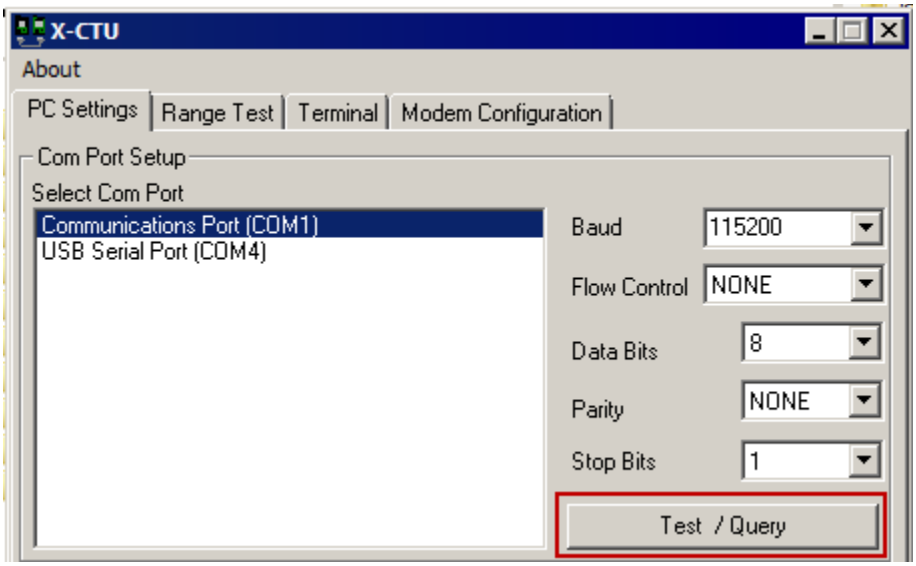
To enter configuration mode on the radio, in ScadaBuilder click on the Target | Radio | Digi/MaxStream | Enable Diagnostics.



Wait for the dialog to finish. This may take a minute depending on your radio's baud rate. Once the dialog has confirmed you are connected, connect your PC's Comport via a serial null modem cable to the proper port (see the start of this section).

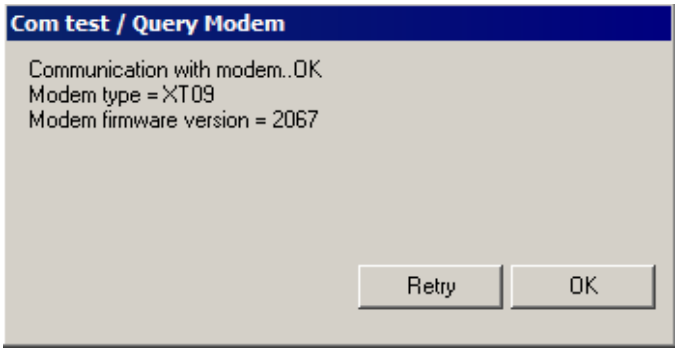
The Digi Radio uses either AT commands entered from the serial terminal in ScadaBuilder or the XCTU utility (available from the Digi or ICL web site). The web address for ICL is ftp://www.iclinks.com/TechSupport/DigiXTend/XCTU.ZIP.

Unzip and run the installer. After installing, bring up the XCTU software. Configure the Communications Port to match your PC's Comport.

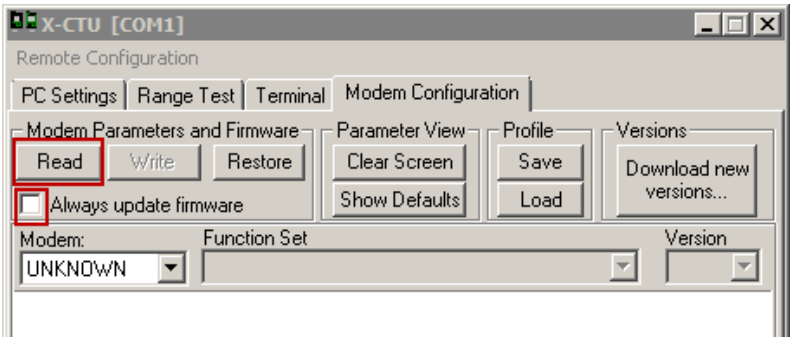


115,200 baud, no parity, 8 data bits and NO flow control

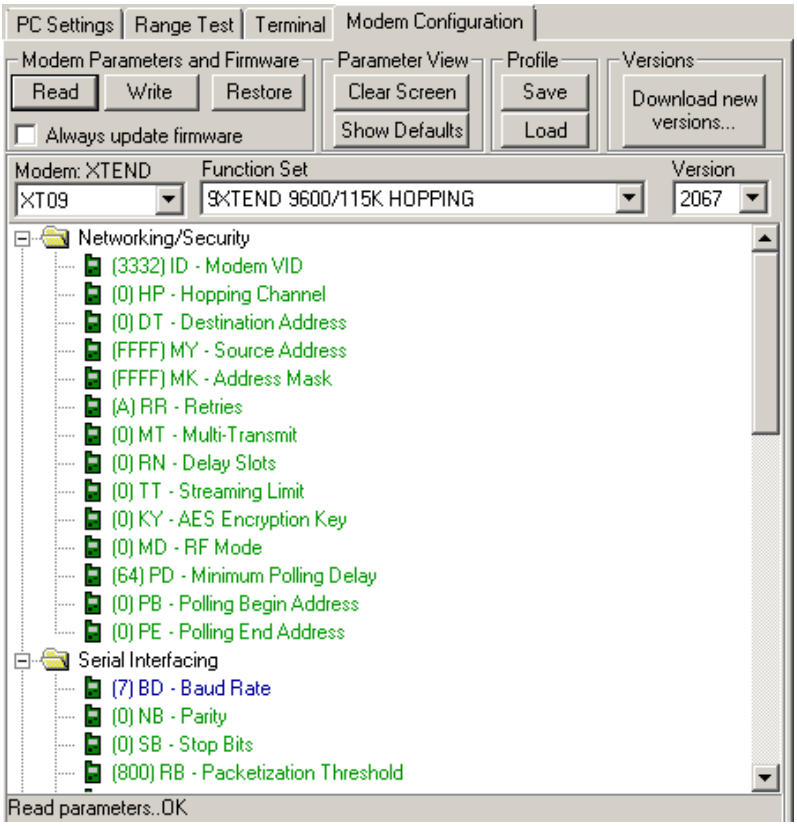
Press the Test / Query button to check communications to the radio. The response dialog should look like this:



Click OK and click on the Modem Configuration tab make sure that the "Always update firmware" checkbox is **not checked**. Click on the Read button.



You should get a parameter list like this:



The typical parameters to change are:

Hopping Channel (HP)—Must match on all radios in the system.

Multi Transmit (MT)—Radio blind retries increase the chance of successful communications at reduced throughput.

Serial Interfacing Baudrate (BD)—The radio port side baudrate which must match the baudrate of the Network Port in the Pinnacle application.

Parameter Value BAUD (bps) Configuration	
0	1200
1	2400
2	4800
3	9600
4	19200
5	38400
6	57600
7	115200
8	230400

Radio Interfacing Baudrate (BR)—Radio broadcast side baudrate which must match the baudrate of all other radios in the system.

9600 baud gives 10dB more sensitivity but increases the chance of collisions in peer-to-peer and competing spread spectrum environments. 115200 has less sensitivity but decreases the chance of collisions.

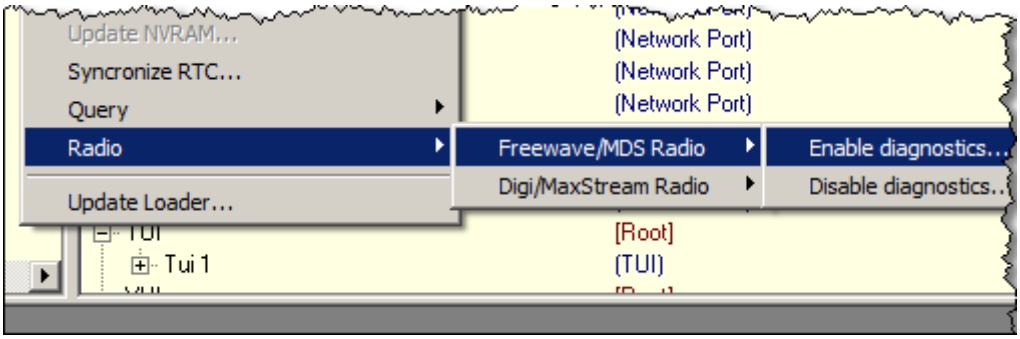
Parameter Value	BAUD (bps) Configuration
0	9600
1	115200

For further configuration information on the Digi Xtend, please see the following link:
ftp://www.iclinks.com/TechSupport/DigiXTend/DigiXtendRadioManual.pdf

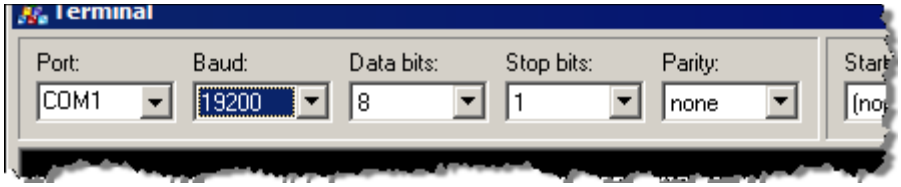
Freewave FGR Configuration

Your controller will denote this option is installed by the following tag located on the underside of the controller.

Enable the radio diagnostics (redirect the diagnostics port).



Open the ScadaBuilder Terminal by clicking the  in the ScadaBuilder Workbench. Set the comport to 19200, 8 Data bits, None Parity and 1 Stop bits and select the comport on the PC you are using to talk to the radio through the redirection port on the controller.



Click in the working area of the terminal

The configuration menus in the radio are accessed by typing "Shift U" (be sure that "Caps Lock" is OFF, then while holding down the Shift key, press the U key). You should see the menu pictured below. Pressing the Escape key several times will cause the radio to return to normal operation.

Radio Configuration - MAIN MENU

When the radio has been placed into configuration mode then the Main Menu screen will be displayed:

```
                          MAIN MENU
                      Version 2.23 11-21-2002
                         Standard Hop Table
                    Modem Serial Number 911-8743

(0)    Set Operation Mode
(1)    Set Baud Rate
(2)    Edit Call Book
(3)    Edit Radio Transmission Characteristics
(4)    Show Radio Statistics
(5)    Edit MultiPoint Parameters
(6)    TDMA Menu
```

Radio Configuration - SET OPERATION MODE

The "Set Operation Mode" screen is selected by pressing "0" at the Main Menu. In this screen, the radios basic operating mode is chosen. The screen is depicted below:

```
                          SET MODEM MODE
                        Modem Mode is    2

(0) Point to Point Master
(1) Point to Point Slave
(2) Point to MultiPoint Master
(3) Point to MultiPoint Slave
(4) Point to Point Slave/Repeater
(5) Point to Point Repeater
(6) Point to Point Slave/Master Switchable
(7) Point to MultiPoint Repeater
(F) Ethernet Options
(Esc)     Exit to Main Menu

Enter Choice
```

The current operating mode for the radio is always shown at the top of this screen just under the title header.

Of the 9 available operating modes, only three of the modes—Point to Multipoint—are typically used with the Pinnacle Series controllers.

Point to Multipoint Master

In this mode, there must be **one, and only one Master radio** in a system. All of the other radios in the network will operate as slaves to the Master. Designate one radio as the Master using selection #2.

Point to Multipoint Slave

After a single radio has been designated as the Master, the remaining radios in the network must be set as "Slaves" using selection #3 in the menu.

Point to Multipoint Slave/Repeater

To reach outlying areas in the network, the Slave radios can act as repeaters. Slave radios that will also act as repeaters are configured using selection #7 (Point to MultiPoint Repeater) in the menu. Be sure to also enable Slave/Repeater operation in Menu #5.

Return to the Main Menu

Once a radios mode has been set, press the ESC (escape key to get back to the Main Menu (only press once, or else you will end up out of diagnostic mode and will need to do the SHIFT-U operation again.

Radio Configuration - SET BAUD RATE

The "Set Baud Rate" screen is selected by pressing "1" at the Main Menu. In this screen, the radios basic serial communication parameters are chosen. The screen is depicted below:

```
                              SET BAUD RATE
                          Modem Baud is  115200

(0)    230,400
(1)    115,200
(2)    76,800
(3)    57,600
(4)    38,400
(5)    19,200
(6)    9,600
(7)    4,800
(8)    2,400
(9)    1,200
(A)    Data, Parity     0
(B)    Modbus RTU       1
(C)    RS232/485        0
(D)    Setup Port       3
(E)    Turn Off Delay   0       Turn On Delay      0
(F)    Flow Control     0
(Esc)  Exit to Main Menu
Enter Choice
```

The current communications speed (baud rate) setting for the radio is always shown at the top of this screen, just under the title header. The baud rate can be set to any one of ten standard speeds by simply typing a 0 through 9 corresponding to baud rates of 1,200 baud to 230,400. Any of these speeds may be used with the Pinnacle Series controller. The speed selected MUST match the port speed selected using the ScadaBuilder configuration software as defined in the "Radio" Network Port in the controller's application.

Parity

The radio supports the standard "Odd, Even or None" parity selections. For most applications including those using Modbus, 0 or "None" should be used.

Modbus RTU

This parameter should normally be set to "1" (enabled), forcing the radio to keep the integrity of a single message as one packet instead of using multiple packets which does not meet Modbus standard timing requirements.

Setup Port

Set this parameter to 3. This enables both radio ports for configuration. This should be set by the factory already.

Radio Configuration - EDIT RADIO PARAMETERS

The "Edit Radio Transmission Characteristics" screen is selected by pressing "3" at the Main Menu. The screen, with typical settings for a Pinnacle Series based SCADA system, is depicted below:

```
                        RADIO  PARAMETERS

WARNING:  Do  not  change  parameters  without  reading  manual

(0)      FreqKey             5
(1)      Max  Packet  Size     8
(2)      Min  Packet  Size     9
(3)      Xmit  Rate           1
(4)      RF  Data  Rate        3
(5)      RF  Xmit  Power       10
(6)      Slave  Security      0
(7)      RTS  to  CTS          0
(8)      Retry  Time  Out      255
(9)      Low  power  Mode      0
(A)      High  Noise           0
(B)      MCU  Speed            0
(C)      Remote  LED           1
(Esc)    Exit  to  Main  Menu

Enter  Choice
```

The parameters in this menu are geared towards handling special circumstances and should normally be left as shipped from the factory. One item though; "Remote LEDs", must be turned on in order to enable the status LEDs located between the COM1 connector and the address switches. Be sure this parameter is set to a 1.

Most of the other parameters in this screen are used to optimize the radios operation in the event of problems in the field. They improve the operation of the radio in close proximity with other radio networks, in high (radio) noise environments, or to optimize the operation of the radio for certain mixes of data or types of protocols. In general, the radios are plug-and-play and these parameters are best left at the factory settings unless a technical support person recommends changing them. Typically, your radio setup should match the screen pictured above.

Radio Configuration - SHOW RADIO STATISTICS

The "Show Radio Statistics" screen is selected by pressing "4" at the Main Menu. The screen is depicted below:

```
                          MODEM STATISTICS

Master-Slave Distance (m)  0083200

Number of Disconnects            0
Radio Temperature                0
Antenna Reflected Power          0
Transmit Current (mA)         0000
                             Local    Remote1    Remote2    Remote3
Average Noise Level             12
Average Signal Level             0
Overall Rcv Rate   (%)           0
C086EF

Press <ret> for Freq Table, <Esc> to return to main menu
```

The radio statistics screen shows an accumulated history of information regarding the performance of the radio and the quality of the radio link. Unlike the "real-time" updated information available at the Master, this information is a snapshot that can only be viewed while not operating, but it does provide a local tool to analyze the performance of a radio link.

Master-Slave Distance (m)

This value in meters is valid for distances over 1 Km (0.6 miles)

Radio Temperature

Should be 75 (°C) or less.

Average Noise and Signal Levels

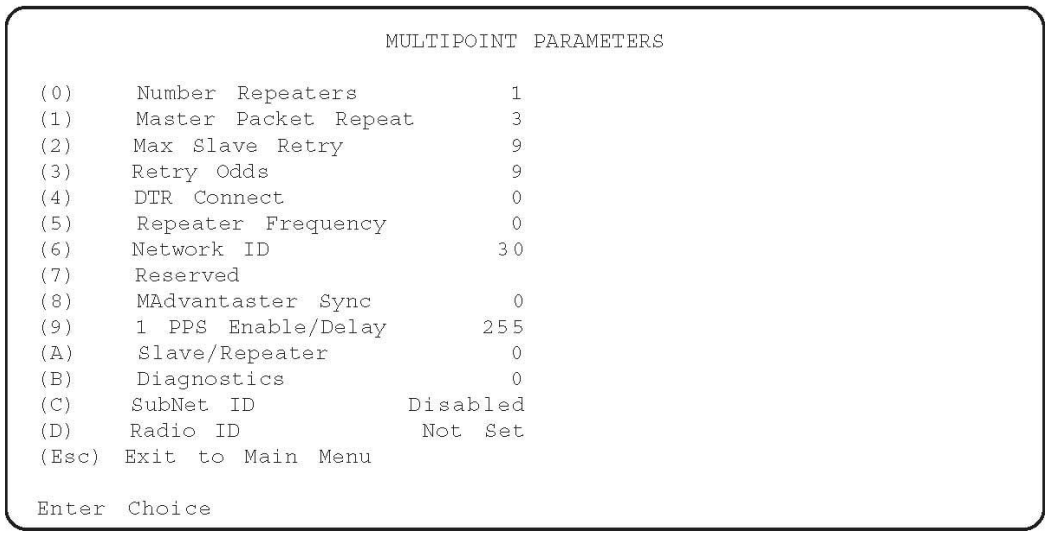
These values are an average across all frequencies. Detailed information by frequency is available by displaying the Frequency Table accessed from this screen (see lower prompt line). Ideally, the noise level should be below "30" and the signal level should be at least "15" more than the noise. Note that this is NOT in dB, but arbitrary units to provide a relative signal strength and noise measurement.

Overall Rcv Rate (%)

This value provides an indication of the quality of the radio link and the impact on data throughput. A good quality link will have an Overall Receive Rate of 75% or better. The radio will not pass erroneous data, but a lower Overall Receive Rate indicates that data throughput might be affected at higher data rates, such as 115,200 baud.

Radio Configuration - EDIT MULTIPOINT PARAMETERS

The "Editing MultiPoint Parameters" screen is selected by pressing "5" at the Main Menu. The screen, with typical settings for the Pinnacle Series, is depicted below:



Number of Repeaters

Repeaters extend the range of a radio network at the expense of speed. Any radio can also serve as a repeater. Set this parameter to 1 if you are using ANY repeaters. All radios in the network must have the same setting.

Master Packet Repeat

With a high quality link, set to 0 or 1 for maximum throughput. With a poor quality link, a higher number will improve getting individual messages though at the expense of speed and throughput. For Modbus networks, this value must be set to 3.

Network ID

This parameter helps avoid conflicts with other radio networks. All radios in the network should be set to the same ID value. Other networks must use a different value. Set this to any value below 4095, except the default (255).

Slave/Repeater

Set to 1 if this radio is a repeater as well as a node on the network. Be sure to set the Modem Mode (Menu #2) to (7) Multipoint Repeater also.

Diagnostics

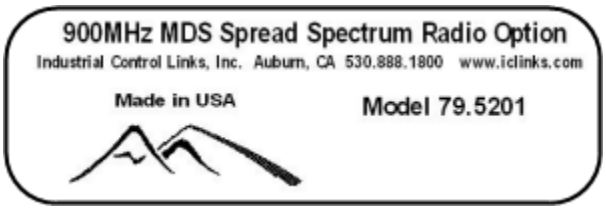
Set to 1 for this radio to provide diagnostic data back to the Master.

The Freewave FGR manual can offer detailed configuration. It can be downloaded from:

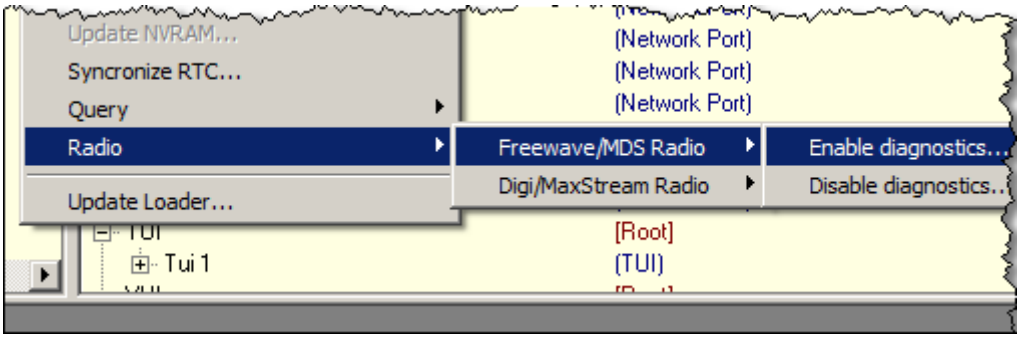
ftp://www.iclinks.com/TechSupport/Freewave /FreewaveFGR.pdf

MDS TransNet EL806

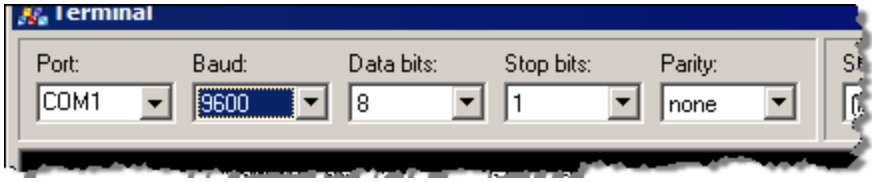
Your controller will denote the option is installed by the following tag located on the underside of the controller.



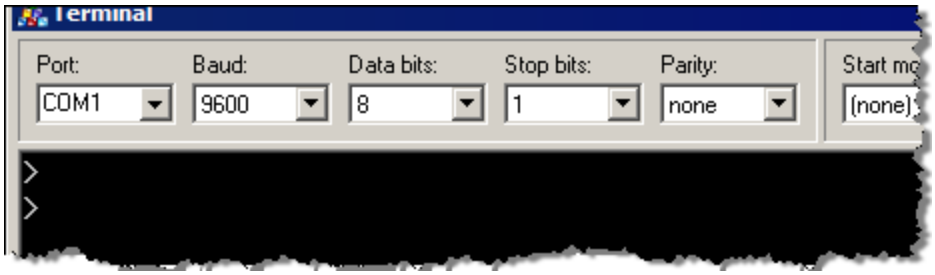
To enable radio diagnostics (redirect the diagnostics port):



Open the ScadaBuilder Terminal by clicking the  . Set the comport to 9600,8 Data bits, none parity and 1 stop bits and select the comport on the PC you are using to talk to the radio through the redirection port on the controller.



Click in the working area of the terminal. Hit the Enter key three times. You should see a small prompt cursor:



To enter new parameters, just type in one of the following typical commands and its parameter(s) and press enter. You should see the words PROGRAMMED OK back from the radio. If the command is invalid, you will see the words UNKNOWN COMMAND.

BAUD [xxxxx ABC]—Port baudrate, databits, parity and stopbits must match Radio Network Port configuration in ScadaBuilder application.

Baudrates	A (Databits)	B (Parity)	C (Stopbits)
300	8	N=None	1
600	7	O=Odd	2
1200		E=Even	
1800			
2400			
4800			
9600			
19200			
38400			
57600			
115200			

Addr (X)—X = network identification for all radios that this unit will communicate with. The value can be 1 to 65535. The factory default is 10.

Mode (Y)—M = Master, R = Remove, and X = Repeater. The factory default for Pinnacle controllers is R (Remote).

If MODE X is used, the MODE X radio should be programmed with an Extended Address (XADDR). Units that need to hear this MODE X radio must be programmed with an appropriate XPRI and/or XMAP value.

To examine any configuration parameter, simple type it with no values following the keyword and hit enter.

For further information on configuring MDS Transnet EL806, please refer to the following guide available on the ICL website:
ftp://www.iclinks.com/TechSupport/Transnet/MDSTransNetConfigurationManual.pdf

Specifications

CPU & Memory

Processors

Main CPU	32-bit x86 Microcontroller, 300MHz clock, integrated watchdog timer.
	Clock speed software programmable from 38MHz to 300MHz for power management
I/O & LCD HMI	Qty 2, 8-bit RISC co-processor, 20MHz, each with integrated watchdog timers

Memory

128MB RAM (DDR2)
8KB FRAM non-volatile memory: retained variables & counters (2000 32-bit registers)
4MB Flash Disk Std. (expandable to 8GB internally, 2TB externally)

Datalog Capacity

Standard	3MB (1.5 million words) standard
Expansion Option	up to 2TB (2,000GB max.) with internal IDE disk option or USB flash disk.

I/O (Base configuration not including I/O expansion)

Universal Inputs (UI)

Resolution	16-bit
Averaging	"boxcar" averaging - up to 32 samples per channel, individually user configurable
Measurement modes	0 to 20mA +/- 0 to 250mV 0 to 2V +/- 10V (w/optional interface module) Resistance: 0 to 65535 ohms Thermistor (10K, Type II or III) Thermocouple (type J, K, T, E, R, S, B, N) RTD (10ohm-Cu, 100 & 1K ohm-Pt, 2-wire & 3-wire – 3-wire RTDs require two inputs each) Contact closure

Accuracy

FS = Full Scale

20mA, V:	+/- 0.01% FS at 25oC (77oF), +/- 0.02% FS over full ambient temp
Ohms:	<= 10K ohms: +/- 0.1% FS over full ambient temp
	> 10K ohms: +/- 0.5% FS over full ambient temp
Thermistor	+/- 2oC at 25oC (77oF), +/- 5oC over full ambient temp
TC	+/- 2oC at 25oC (77oF), +/- 5oC over full ambient temp
RTD (3-wire)	+/- 1oC at 25oC (77oF), +/- 2oC over full ambient temp

Contact Closure Thresholds: ON: <1.0Vdc, OFF: >1.5Vdc (wetting current is 0.5mA)

	Lassen	Rubicon	Shasta	Everest
Quantity	2	4	8	8
Speed (samples/sec.)	15	2,500	2,500	2,500

Analog Inputs

(available in Shasta and Everest, when UPS option is not installed)

Resolution: 10-bit
Speed: 2 samples per second

	Lassen	Rubicon	Shasta	Everest
Quantity	1	0	1	1
Measurement Mode	0 to 20mA	None-	0 to 32Vdc	0 to 32Vdc

Analog Outputs

Output Type, Resolution	0 to 20mA, 12-bit
Accuracy	+/- 0.1% FS at 25oC (77oF), +/- 0.2% FS over full ambient temperature range
Maximum Load	1,000 ohms

	Lassen	Rubicon	Shasta	Everest
Quantity:	2	2	2	4

Discrete Input/Outputs

Each point is configurable as Low Voltage DC or contact closure input, or Low Voltage DC Output.

	Lassen	Rubicon	Shasta	Everest
Quantity:	6	0	2	4

Voltage Range (Input or Output)	24Vdc
Input Type	Contact Closure/TTL/CMOS
Input Thresholds	ON: <1.5Vdc, OFF: > 2.0 Vdc
Input Wetting Current	0.5mA, 5Vdc
Output Type	Protected FET (thermal, over-voltage and over-current protected)
Output ON Resistance/Voltage	< 0.25 ohms / 0.25Vdc @ 1A, 0.75Vdc @ 3A
Switching Current	1A max.

Discrete Inputs

	Lassen	Rubicon	Shasta	Everest
Quantity:	6	20	16	20
Input Type	0 to 30Vdc Contact Closure	12/24Vdc/Vac 120/240Vdc/Vac (opt)	12/24Vdc/Vac 120/240Vdc/Vac (opt)	12/24Vdc/Vac 120/240Vdc/Vac (opt)
Input Current	0.5mA /5Vdc	1.2mA@12Vac (120Vac)	1.2mA@12Vac (120Vac)	1.2mA @12Vac (120Vac)
Response Time:	<0.1mS	10mS	<0. 1mS/10mS	<0.1mS/10mS

Discrete Outputs

Type	Normally Open (Form A) bifurcated relay contact
Rated current	Up to 3A continuous for resistive loads
Rated voltage	Up to 240VAC (277VAC maximum switching voltage)
Braaking Capacity	750VA maximum
Minimum contact load	5V / 1mA

	Lassen	Rubicon	Shasta	Everest
Quantity	0 (see DIO)	10	6	12

High-Speed Counters

Input Levels	Magnetic/Turbine Pickup inputs (w/internal amplifier): 20mV to 50V ac/dc Standard inputs: Contact closure or 0 to 30vdc (3Vdc minimum high level)
Speed	10KHz max.
Quadrature Encoder	Supported by Standard Inputs, 2 inputs per encoder.

	Lassen	Rubicon	Shasta	Everest
Magnetic/Turbine:	1	1	1	2
Standard (non-PI):	6	20	2	4

Communications, Networking & HMI

Serial Ports

Number of serial ports: Up to 5, external and internal

	Lassen	Rubicon	Shasta	Everest
Total external serial ports	**3**	**3**	**3**	**5**
RS-232 ports	2	2	2	4
RS-232/RS-485 ports	0	0	0	1
RS-485 ports	1	1	1	0
Total internal serial ports	**2**	**0**	**1**	**2**
Telephone/voice modem option	**Yes**	**No**	**Yes**	**Yes**
900Mhz Spread Spectrum radio option	**Yes**	**No**	**No**	**Yes**
Serial port configuration by model:				
COM1	RS-232	RS-232	RS-232	RS-232
COM2	RS-485	RS-485	RS-485	RS-232/RS-485
COM3	Radio Opt.	RS-232	RS-232	RS-232 or Radio Opt.
COM4	Modem Opt.	Modem Opt.	Modem Opt.	RS-232 or Modem Opt.
COM5	RS-232	N/A	RS-232	N/A

Protocols: Modbus RTU/ASCII, DF1 DNP3, TAP (pager), NMEA (GPS), PPP, SDX

Ethernet

Quantity: 1
Type: 10/100BaseT, Auto MDX
Protocols: Modbus TCP/UDP, DNP3, FTP, HTTP, IP, ARP, UDP, ICMP, TELNET, ISaGRAF ETCP

USB

USB version: 2.0
Port Types: Type "A" (USB Host)
Speed: Standard -1.5Mb/s
Full-speed -12Mb/s

	Lassen	Rubicon	Shasta	Everest
Number of USB ports	2	2	2	4

Local HMI

Display: 122x32 Graphic LCD w/LED backlight(4 lines x 20 characters max. in small font character mode)
User Input: 5 Axis navigation Switch plus "Escape" pushbutton switch

Options

IDE Flash Disk option

Type: ATA compatible, 44-pin
Capacity: 128MB to 8GB
Data Rates (sustained): Read: 7MB/sec, Write: 1.6MB/sec.

UPS option

(Shasta & Everest only)

External Battery: 12V lead-acid Gel-Cel battery, 3 to 18 AH (customer supplied)
Charge Current: 1A charge current max.
Auxiliary Output Power: Up to 3A battery backed power to external equipment in addition to controller

Telephone Modem option

Type	56K baud, Hayes AT compatible w/voice extensions V.44, V.42bis & MNP5 data compression, V.42LAPM & MNP 2-4 Error Correction
Certifications	FCC68, CS-03 & CTR21 certified
Power	Adds 0.25W @ 12Vdc input power

Internal Radio option

(Lassen & Everest only)

Type	Spread Spectrum, frequency hopping,
Operating Frequency	902MHz to 928MHz
RF Power (maximum)	1Watt
Data Rate (maximum)	115K baud
Radio Brands	Freewave

Sensitivity: -108dBm (BER 10^{-6}), 32-bit CRC, point to multipoint, net diags, FGR-115 compatible
Adds 0.2W @ 12Vdc input power

MDS (Microwave Data Systems)

Sensitivity: -108dBm (BER 10^{-6}), 16-bit CRC, point to multipoint, net diags, Transnet compatible
Adds 2.5W @ 12Vdc input power

Digi/Maxstream
Sensitivity: -110dBm @9600 baud, -100dBm @115K baud, point to multipoint & peer to peer, DigiMesh
Adds 1.2W @ 12Vdc input power

General

Terminal Blocks
Removable, 5.02mm (0.2"), 12 to 22AWG, 15A/contact maximum

Mounting
Panel or 35mm. DIN rail

Environment
- 40oF (- 40oC) to 158oF (70 oC), 5% RH to 95% RH, non-condensing

Power
10 to 30Vdc

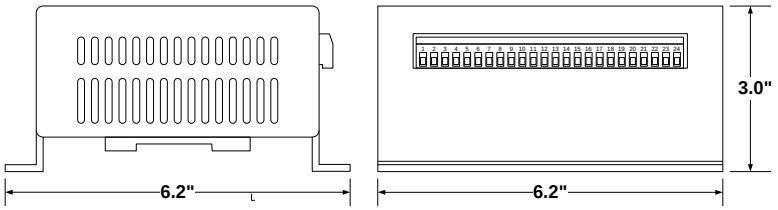
Consumption (@12V)
0.75W @ 38MHz, 2.5W @ 300MHz (base cfg, no options, all relays OFF, AO power disabled)
Add 0.25W when the LCD backlight (internal HMI) is ON
Add 0.1W per Discrete Output Relay turned ON (Shasta, Rubicon and Everest only)
Add 0.1W (Analog Output Power enabled) + 0.6W per Analog Output @ 20mA out
See specifications for telephone modem and radio options for individual power adders

Warranty
3 years, factory parts and labor

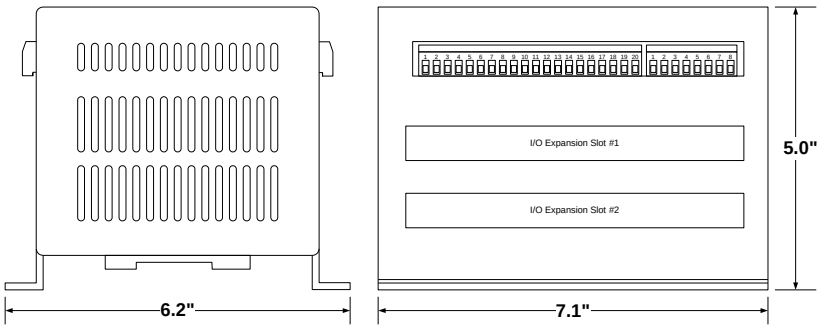
Dimensions

Lassen/Rubicon	Shasta	Everest
6.2"W x 3.0"H x 6.2"D	7.1"W x 5.0"H x 6.2"D	9.6"W x 5.0"H x 6.2"D

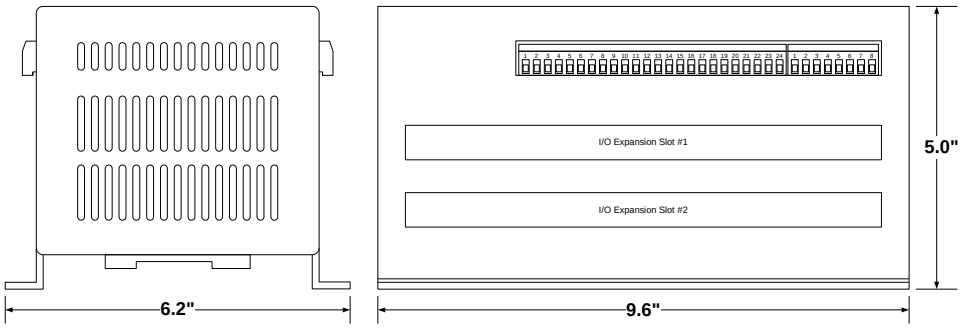
Lassen/Rubicon



Shasta

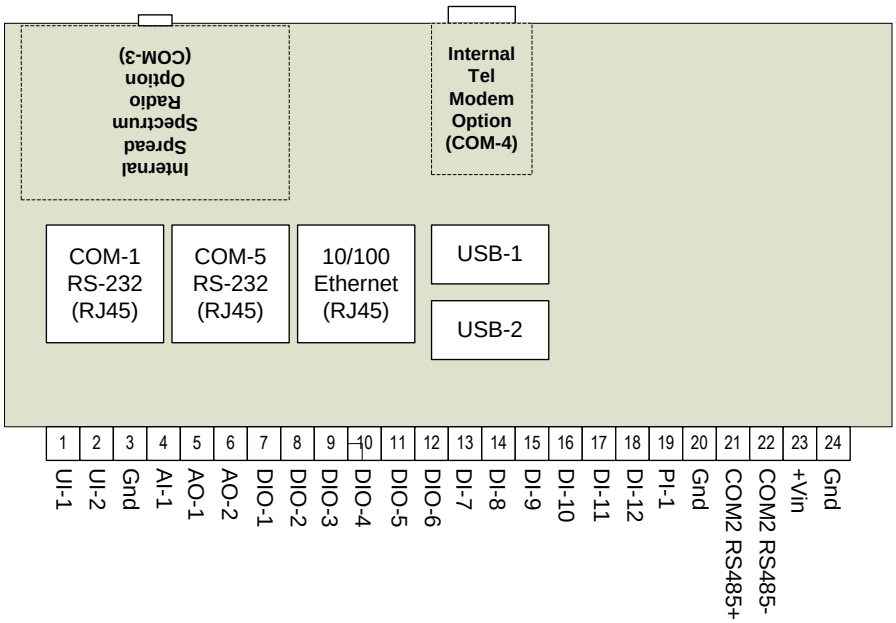


Everest



Appendix A Controller and I/O Option Pin Outs

Lassen

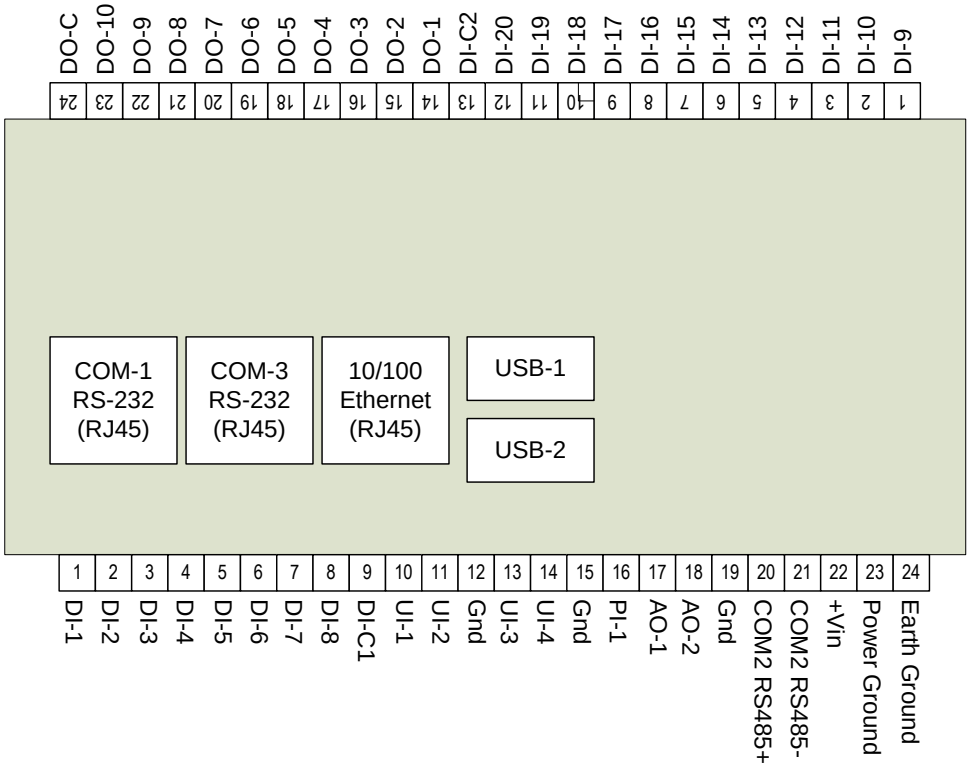


I/O terminal and connector locations

UI1 – UI2:	Universal Inputs - 20mA, 2V (5V/10V with divider), Ohms, +/- mV, TC, thermistor, Contact Closure
AI1:	Analog Input – 20mA
AO1, AO2:	Analog Outputs (0-20mA)
DIO1 - DIO6:	Low Voltage Discrete Inputs/Outputs (Contact Closure or 0 to 30Vdc IN, 0 to 30Vdc, 3A max OUT)
DI7 – DI12:	Low Voltage Discrete Inputs, High-speed counter inputs (Contact Closure or 0 to 30Vdc IN)
PI1:	Pulse Input. Internally conditioned for magnetic pickup/turbine meter.
+Vin:	Input Power, 10 to 30Vdc
COM1:	RS-232 port (RJ-45)
COM2:	RS-485 (on lower right terminal block)
COM3:	Internal Spread Spectrum Radio option (COM5 can be temporarily used as diagnostic port for radio).
COM4:	Internal Telephone Modem option
COM5:	RS-232 port (RJ-45) (COM5 RJ-45 can be temporarily set as diagnostic port for internal radio).

USB1, USB2: Type A USB 2.0 ports

Rubicon



I/O terminal and connector locations

UI1 – UI4: Universal Inputs - 20mA, 2V (5V/10V with divider), Ohms, +/- mV, TC, thermistor, Contact Closure

AO1, AO2: Analog Outputs (0-20mA)

DI1 – DI20: Low Voltage Discrete Inputs, High-speed counter inputs (Contact Closure or 0 to 30Vdc IN)

DO1 – DO10: Relay Discrete Outputs.

PI1: Pulse Input. Internally conditioned for magnetic pickup/turbine meter.

+Vin: Input Power, 10 to 30Vdc

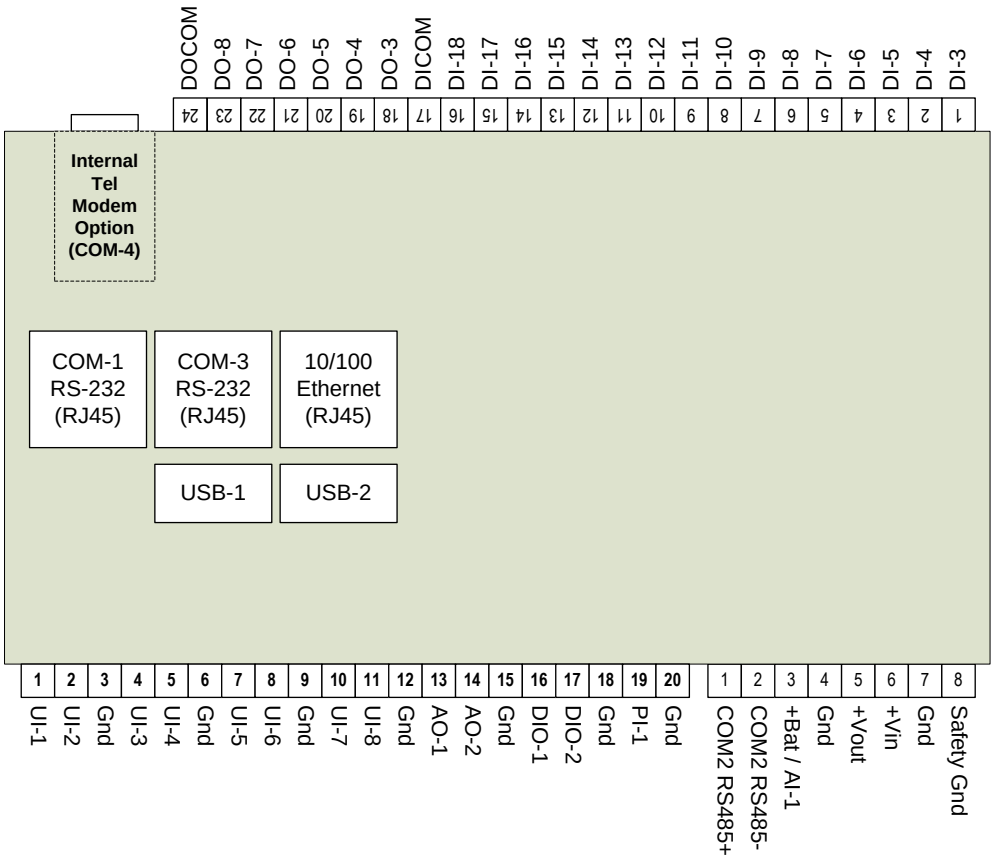
COM1: RS-232 port (RJ-45)

COM2: RS-485 (on lower right terminal block)

COM3: Internal Spread Spectrum Radio option (COM5 can be temporarily used as diagnostic port for radio).

USB1, USB2: Type A USB 2.0 ports

Shasta

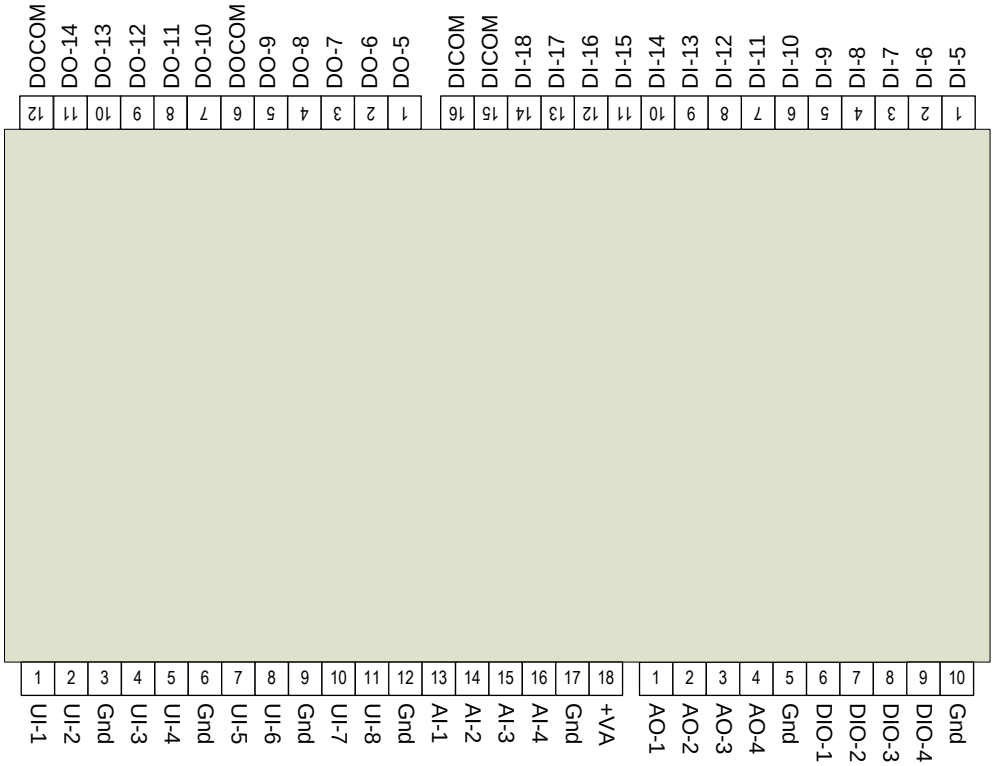


I/O terminal and connector locations

UI1 - UI8:	Universal Inputs - 20mA, 2V (5V/10V with divider), Ohms, +/- mV, TC, thermistor, Contact Closure
AO1, AO2:	Analog Outputs (0-20mA)
DIO1, DIO2:	Low Voltage Discrete Inputs/Outputs (Contact Closure or 0 to 30Vdc IN, 0 to 30Vdc, 3A max OUT)
PI1:	Pulse Input. Internally conditioned for magnetic pickup/turbine meter.
DI3 - DI18:	Optically Isolated Discrete Inputs. Order as 12/24Vac/Vdc or as 120/240Vac/Vdc
DO3 - DO8:	Relay Discrete Outputs.
+Bat/AI1:	Connect to 12Vdc SLA battery for UPS option. If no UPS option, available as 0 to 32Vdc AI.
+Vout:	With UPS option installed, provides battery backed 12Vdc power to external devices (3A maximum)
+Vin:	Input Power, 10 to 30Vdc
Safety Gnd:	Frame (Safety) Ground. Connect to quality panel/earth ground.
COM1:	RS-232 port (RJ-45)
COM2:	RS-485 (on lower right terminal block)

COM3:	RS-232 port (RJ-45)
COM4:	Internal Telephone Modem option
USB1, USB2:	Type A USB 2.0 ports

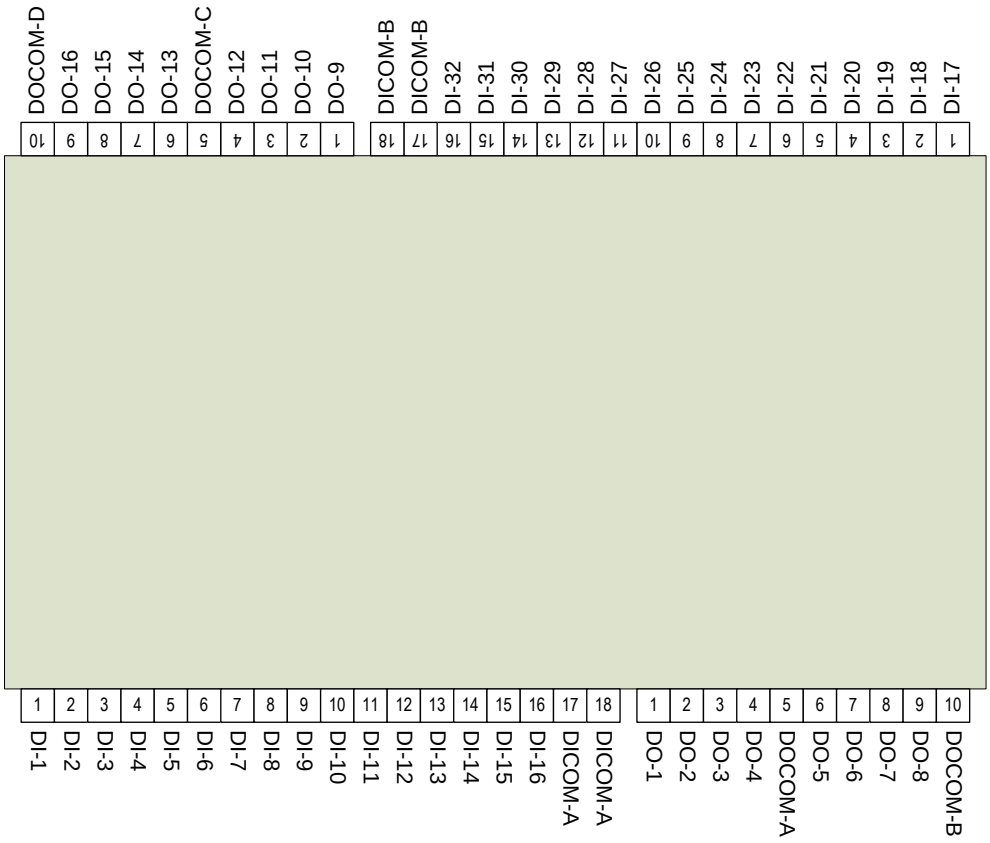
Shasta Combo I/O Expansion Bd.



I/O terminal and connector locations

UI1 - UI8:	Universal Inputs - 20mA, 2V (5V/10V with divider), Ohms, +/- mV, TC, thermistor, Contact Closure
AI1 – AI4:	Analog Inputs - 20mA (Namur compatible)
+VA:	Unregulated +8Vdc nominal (+/- 2Vdc) – 25mA max (Namur compatible)
AO1 – AO4:	Analog Outputs (0-20mA)
DIO1 – DIO4:	Low Voltage Discrete Inputs/Outputs (Contact Closure or 0 to 30Vdc IN, 0 to 30Vdc, 3A max OUT), High-speed (10KHz) Counters
DI5 - DI18:	Optically Isolated Discrete Inputs. Order as 12/24Vac/Vdc or as 120/240Vac/Vdc
DO5 – DO14:	Relay Discrete Outputs.

Shasta Discrete I/O Expansion Bd.

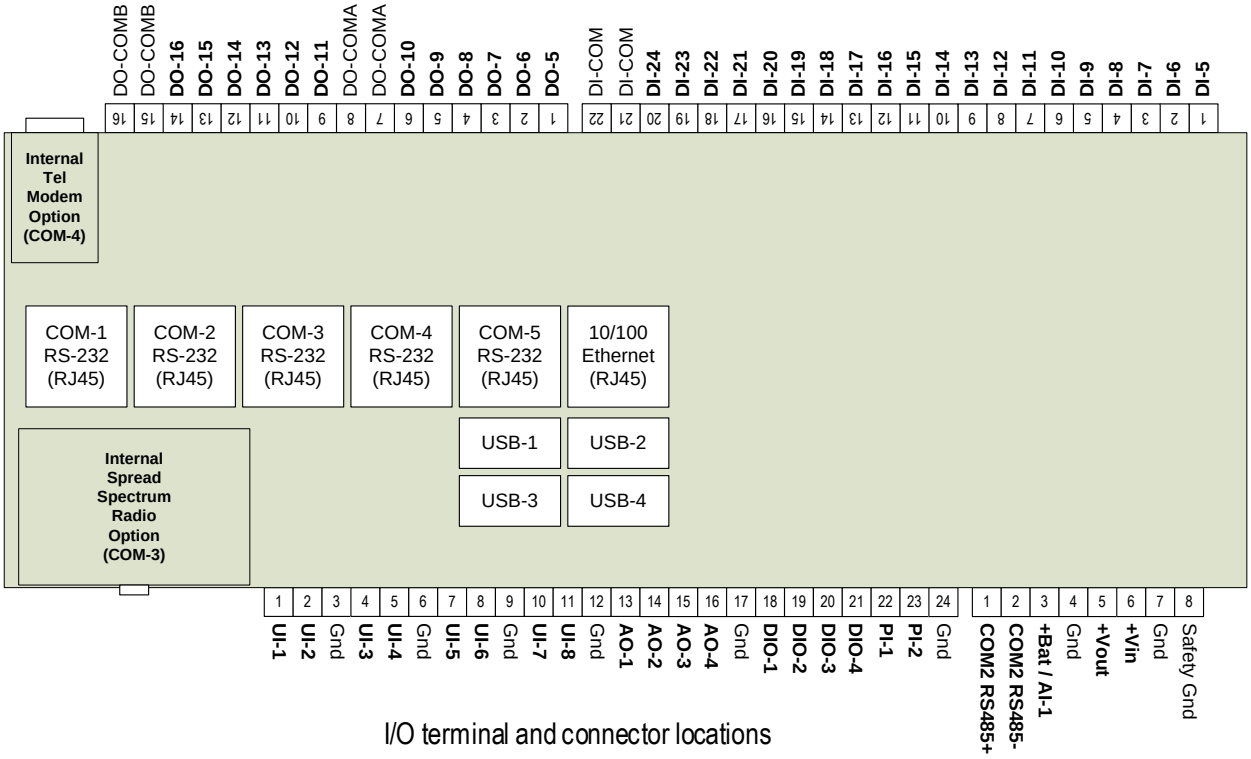


I/O terminal and connector locations

DI1 – DI32: Optically Isolated Discrete Inputs. Order as 12/24Vac/Vdc or as 120/240Vac/Vdc

DO1 – DO16: Relay Discrete Outputs.

Everest



I/O terminal and connector locations

UI1 - UI8: Universal Inputs - 20mA, 2V (5V/10V with divider), Ohms, +/- mV, TC, thermistor, Contact Closure

AO1 – AO4: Analog Outputs (0-20mA)

DIO1 – DIO4: Low Voltage Discrete Inputs/Outputs (Contact Closure or 0 to 30Vdc IN, 0 to 30Vdc, 3A max OUT)

PI1 – PI2: Pulse Inputs. Internally conditioned for magnetic pickup/turbine meter.

DI5 – DI24: Optically Isolated Discrete Inputs. Order as 12/24Vac/Vdc or as 120/240Vac/Vdc

DO5 – DO16: Relay Discrete Outputs.

+Bat/AI1: Connect to 12Vdc SLA battery for UPS option. If no UPS option, available as 0 to 32Vdc AI.

+Vout: With UPS option installed, provides battery backed 12Vdc power to external devices (3A maximum)

+Vin: Input Power, 10 to 30Vdc

Safety Gnd: Frame (Safety) Ground. Connect to quality panel/earth ground.

COM1: RS-232 port (RJ-45)

COM2: RS-232 port (RJ-45) or RS-485 (on lower right terminal block)

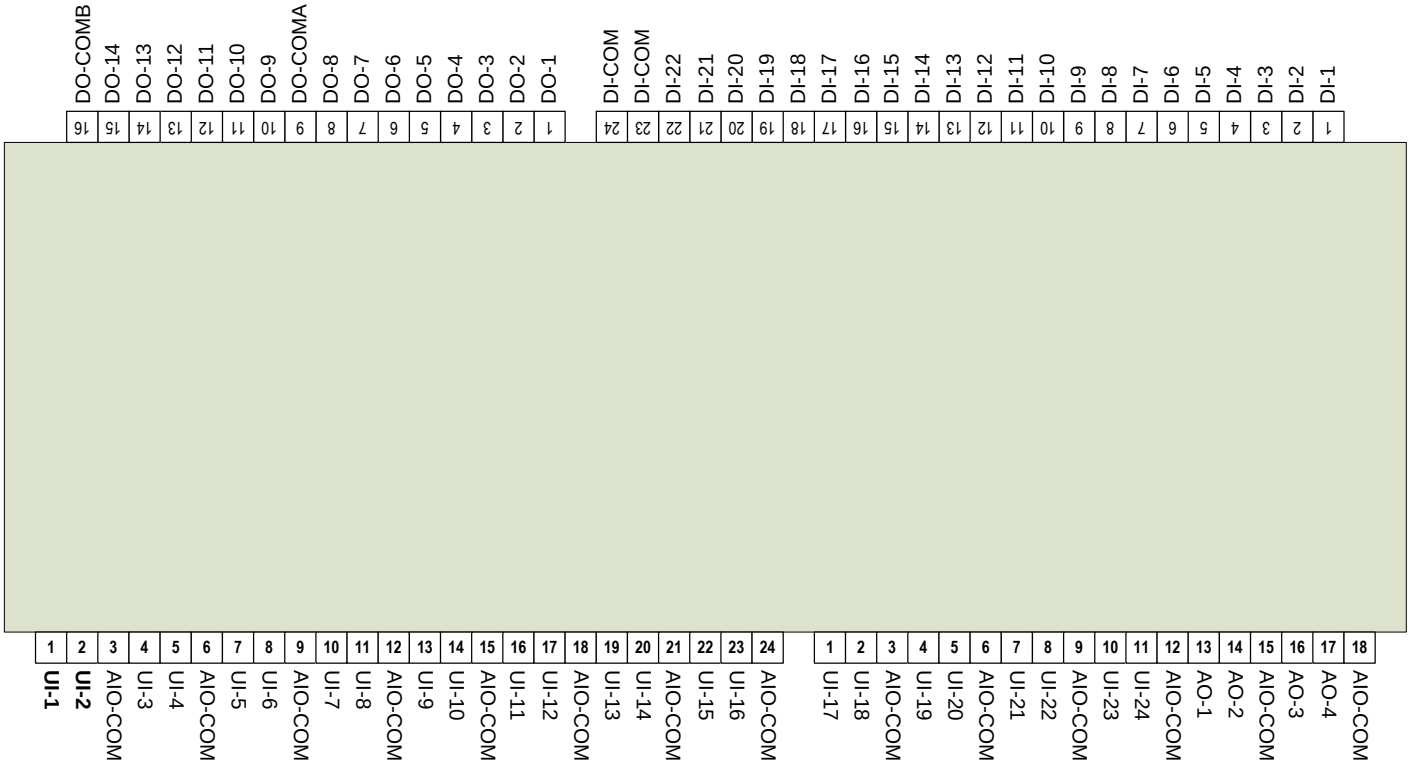
COM3: RS-232 port (RJ-45) or Internal Spread Spectrum Radio option (RJ-45 can be radio diagnostic port).

COM4: RS-232 port (RJ-45) or Internal Telephone Modem option

COM5: RS-232 port (RJ-45) (Can be temporarily set as diagnostic port for internal Freewave or MDS radios)

USB1 - USB4: Type A USB 2.0 ports

Everest Combo I/O Expansion Bd.



I/O terminal and connector locations

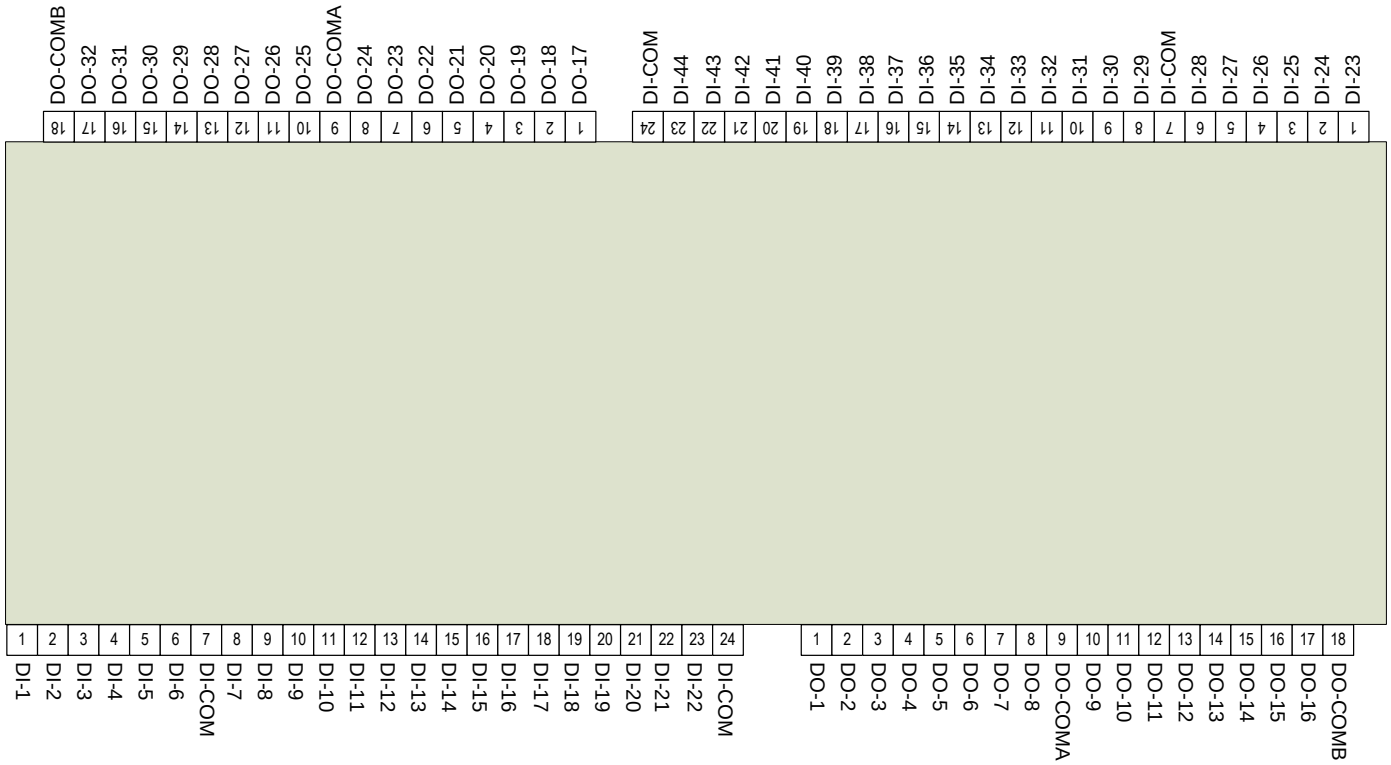
UI1 – UI24: Universal Inputs - 20mA, 2V (5V/10V with divider), Ohms, +/- mV, TC, thermistor, Contact Closure

AO1 – AO4: Analog Outputs (0-20mA)

DI1 – DI22: Optically Isolated Discrete Inputs. Order as 12/24Vac/Vdc or as 120/240Vac/Vdc

DO1 – DO14: Relay Discrete Outputs.

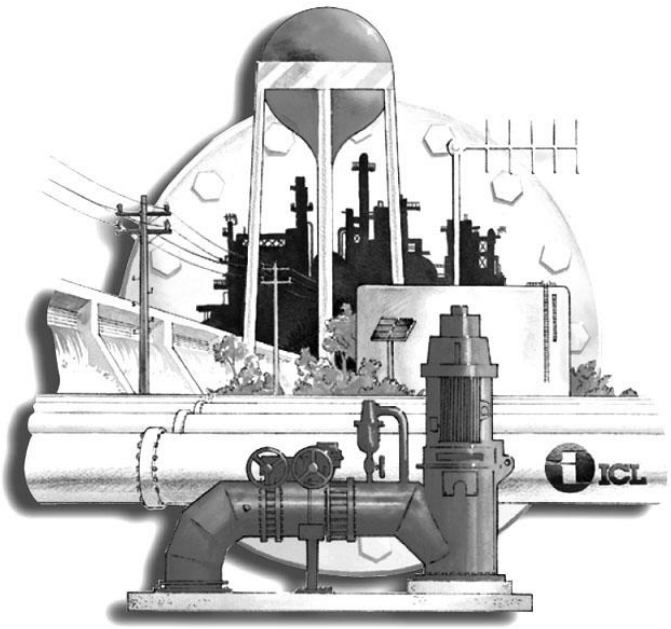
Everest Discrete I/O (DIO) Expansion Bd.



I/O terminal and connector locations

DI1 – DI32: Optically Isolated Discrete Inputs. Order as 12/24Vac/Vdc or as 120/240Vac/Vdc

DO1 – DO16: Relay Discrete Outputs.



Industrial Control Links, Inc.
12840 Earhart Ave.
Auburn, CA 95602
Telephone: **(530) 888-1800**
Fax: **(530) 888-7017**
E-mail: **support@iclinks.com**
Web-site: **www.iclinks.com**

Doc# 60923003 (Rev. C)