9009
MULTI-FUNCTION MODBUS RTU INTERFACE BOARD

DESCRIPTION

ICS's 9009 is a multi-interface board with Ethernet, GPIB and USB ports for controlling Modbus RTU slave devices. The 9009 lets the user send simple read-write messages on any interface to control and query Modbus RTU slave devices. The 9009 does all of the Modbus packet formatting and verifies the response packets. The 9009 has both RS-232 and RS-485 interfaces so it can be connected directly to a single Modbus slave device or it can be connected to multiple Modbus devices on a RS-485 network. The 9009's Ethernet interface also functions as a Modbus TCP/IP to Modbus RTU converter. Protocol conversion is automatic and does not require any effort on the user's part.

The 9009 is a small 5.5 x 5.5 inch board that is designed to be mounted on the rear panel of a host chassis or chamber so the Ethernet, GPIB and USB connectors protrude through the rear panel. Serial connections are made internally on a DE-9 male connector. The 9009 board can also be mounted on a panel or baseplate. The 9009 is powered by +5 to +15 volts so, in most cases, it can be connected an existing power supply.

Applications include connecting temperature chambers or other equipment to test systems, allowing remote control of Modbus RTU slave devices or doing Modbus TCP/IP to Modbus RTU conversion.

Ethernet Interface

The 9009's Ethernet Interface supports the VXI-11 and Modbus TCP/IP protocols as well as raw socket (telnet). As a VXI-11.3 interface, it adapts Modbus RTU devices like temperature chambers to Ethernet based test systems that incorporate LXI or VXI-11 instruments. As a Modbus TCP/IP converter, the 9009 lets Process
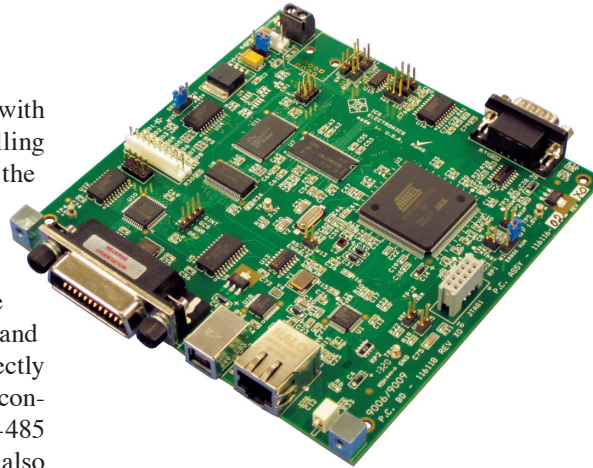
9009 Multi-Interface Board

Controllers like PLCs communicate with Modbus RTU slave devices. The raw socket capability makes it easy to write your own communication program. All network settings can be set with a web browser.

GPIB Interface

The 9009's GPIB Interface is an IEEE-488.2 compatible interface that adapts Modbus RTU devices to the GPIB bus. The 9009 responds to all of the IEEE-488.2 Common Commands and utilizes a set of simple commands to control Modbus RTU devices. The GPIB address is set internally and can be changed with a SCPI command or with a web browser.

USB Interface

The 9009's USB Interface is a USB 2.0 compatible interface that allows Modbus RTU devices to be controlled from the USB bus. The 9009 uses the Microsoft Virtual COM Driver to send command strings to the 9009 so your driver never becomes obsolete.

- Communicate to Modbus RTU devices with Ethernet, GPIB or USB.
  User has choice of three Interfaces.

- Ethernet port supports VXI-11, Raw Socket and Modbus TCP/IP.
  Supports test and process control applications.

- Simple Command Set controls all popular Modbus RTU slave devices.
  Supports 10 Modbus functions.

- Modbus serial port provides RS-232 and balanced RS-422/RS-485 signals.
  Controls one or multiple Modbus devices.

- Internal webserver includes a general Control page.
  Easy control of the 9009 or the Modbus device from any browser, pad or smart phone.

- Includes sample html control pages for Watlow F4, F4T and EZ Zone Controllers.
  Easily customized for OEM applications.

- Runs on +5 to 15 volt power.
  Uses existing power supplies in most cases.

☑ *RoHS Compliant*

Temperature Chamber

USB, GPIB or Ethernet Connection

WATLOW F4

9009

Test Computer
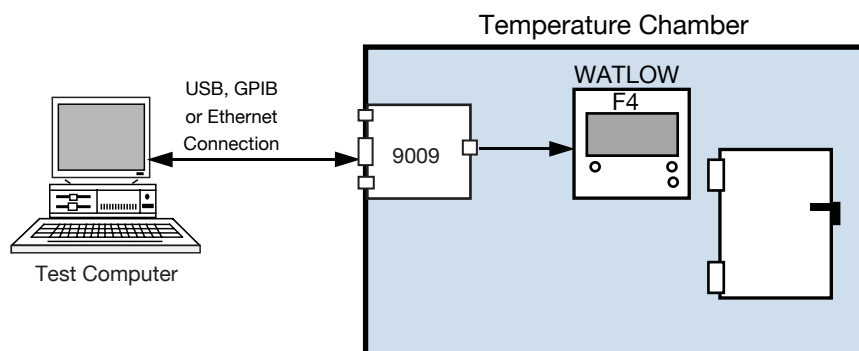
ICS ELECTRONICS
division of Systems West Inc.

7034 Commerce Circle
Pleasanton, CA 94588
Phone: **925.416.1000**
Fax: **925.416.0105**
Web: **www.icselect.com**

VXI-11 Operation

VXI-11 is a Ethernet instrument control protocol developed by the VISA committee when they established the VXI and VISA standards. VXI-11 provides GPIB like control of Ethernet instruments using RPC on TCP/IP. VXI-11 is a packet protocol designed to give the user error free communication with the instrument. Every VXI-11 command receives a response packet with command status information and the appropriate response data.

The 9009 has an expanded IEEE-488.2 Status Reporting Structure that includes a register for reporting Modbus communication faults. The 9009's Status Reporting Structure can be used to generate Service Requests using a Reverse Interrupt channel when an error occurs Alternately, the user can periodically query the Modbus Error and other register to check for command and communication errors.

Raw Socket Operation

The 9009 accepts telnet compatible, raw socket communication so that a non-VXI-11 user can send simple read-write messages over the network to control and query one or more Modbus RTU slave devices. This makes it easy to communicate with the 9009 without a VISA library. Reverse channel notification of an error is not possible with the raw socket protocol..

Remote Procedure Calls (RPC)

RPC (or Remote Procedure Calls) provides an invisible communication medium that allows the developer to concentrate on his program. RPC calls are commonly used on LINUX, UNIX, MAC OS X and all UNIX like operating systems with C language programs. However, they can be used on any operating system that includes a protocol converter utility (rpcgen). The rpcgen utility converts the RPC language description of the VXI-11 protocol in the VXI-11 Specification to generate the command libraries for writing programs with RPC calls. Because the rpcgen utility tailors the libraries to the specific machine, you never have to worry about driver problems or getting an updated driver. RPC calls can also be used to configure the 9009.

The VXI-11 Specification is available at http://www.vxibus.org or from ICS's website. For more information about RPC programming, refer to ICS's Application Notes AB80-3 and AB80-11.

Modbus TCP/IP Conversion

As a Modbus TCP/IP Converter, the 9009 lets PCLs and other devices that use the Modbus TCP/IP protocol control one or more Modbus RTU slave devices. The 9009's Modbus TCP/IP to Modbus RTU protocol conversion is a transparent process that does not require any user setup or action. The 9009 will recognize the Modbus TCP/IP packet and convert its Protocol Data Unit (PDU) into Modbus RTU Application Data Unit (ADU). Response data from the slave device is returned to the sender as a TCP/IP response packet. The TCP/IP side is the controller side and the Modbus RTU devices are Modbus slave devices. The 9009 is completely transparent and does not restrict Modbus addresses, data or function codes.

JAVA Coding

The 9009 can be programmed with JAVA and the resulting program run on any computer with JAVA capability. JAVA programming examples and library are available at SourceForge on the Internet.

Internal Webserver

The 9009 is easily controlled and configured with any web browser from a PC, iPAD or SmartPhone. When you first access the 9009, you see the Welcome Page shown below. From the Welcome Page you can access the Configuration Page, the 9009 Control Page, and the sample F4, F4T or EZ-Zone control pages. The Welcome page includes the LXI required 'blink' function.

Configuration Page

The Configuration Page lets you view or change the 9009's network, GPIB, USB and Modbus serial parameters. Any configuration changes can be saved in the 9009's flash memory and take affect when the unit is rebooted. Some of the Configuration Page settings can be read or changed with SCPI commands. A rear panel LAN Reset button restores the network settings to their factory values in case the 9009 ever gets 'lost' or was given an incorrect IP entry.

Browser Control of Modbus Devices

The 9009 includes four HTML pages that let a user control Modbus Slave Devices from any web browser or from a mobile device that can access the 9009. Three of the HTML pages are sample temperature controller pages for Watlow controllers that can be customized by an OEM for his specific product. They let a user view and control Temperature Chambers and other heating/cooling devices that use Watlow F4, F4T or EZ-Zone Controllers. These pages provide the end user with an alternate way to monitor the temperature cycle when running a test.

9009 Welcome Page

9009: APPLICATION

An engineer can have an automated test running in the lab and use a browser on his PC or MAC to access the 9009 over the company network. By bringing up the appropriate controller page, he can view the chamber's temperature, humidity and the digital values. He can do the same with the browser on his smart phone or tablet as long as he has access to the company network. The 9009 prevents conflicts between multiple clients or users by automatically locking access to the serial IO during command operations. Locking is on an atomic operation basis which means that the 9009 completes a read or write operation from one application before granting access to another user.

The 9009 webserver also includes a general purpose Control Page that lets a user enter and execute commands from his web browser. The commands go to the 9009's internal parser and can control and configure the 9009 or command and query any connected Modbus RTU Slave Device. Command response and status is updated after every command. The Control Page is a another way a user can debug Ethernet connectivity and Modbus device connections.

OEM Customization

The 9009 provides the OEM with a wide range of customizing options to integrate the 9009 into the user's system . The OEM can:
- Set the 9009's IDN message to identify the 9009 as his product.
- Modify the HTML webpages by adding his logo, by changing page color, text and page layout. Additional pages can be created for different products and unwanted pages deleted. See ICS Application Bulletin AB80-5 for modification instructions.
- Add additional html variables or functions for controlling other Modbus devices and/or other parameters. This requires custom programming by ICS.
- Use the 9009 to create a LXI certified instrument. Contact ICS for guidance before doing LXI design work.

9099 Configuration Page

Sample Watlow F4T Temperature Controller Page

.150 DIA THRU
2 PL

1.842

1.575

℄

.625

.312

DETAIL 'A'

.500

.450

DETAIL 'B'

.656

.580

DETAIL 'C'

.000
.200

1.730

3.300

4.125

4.900

5.300
5.500

.320
.218
.000
.062

.283
.225
.163
.000
.010

2X ÿ.150

ÿ.100

DETAIL 'A'

DETAIL 'B'

DETAIL 'C'
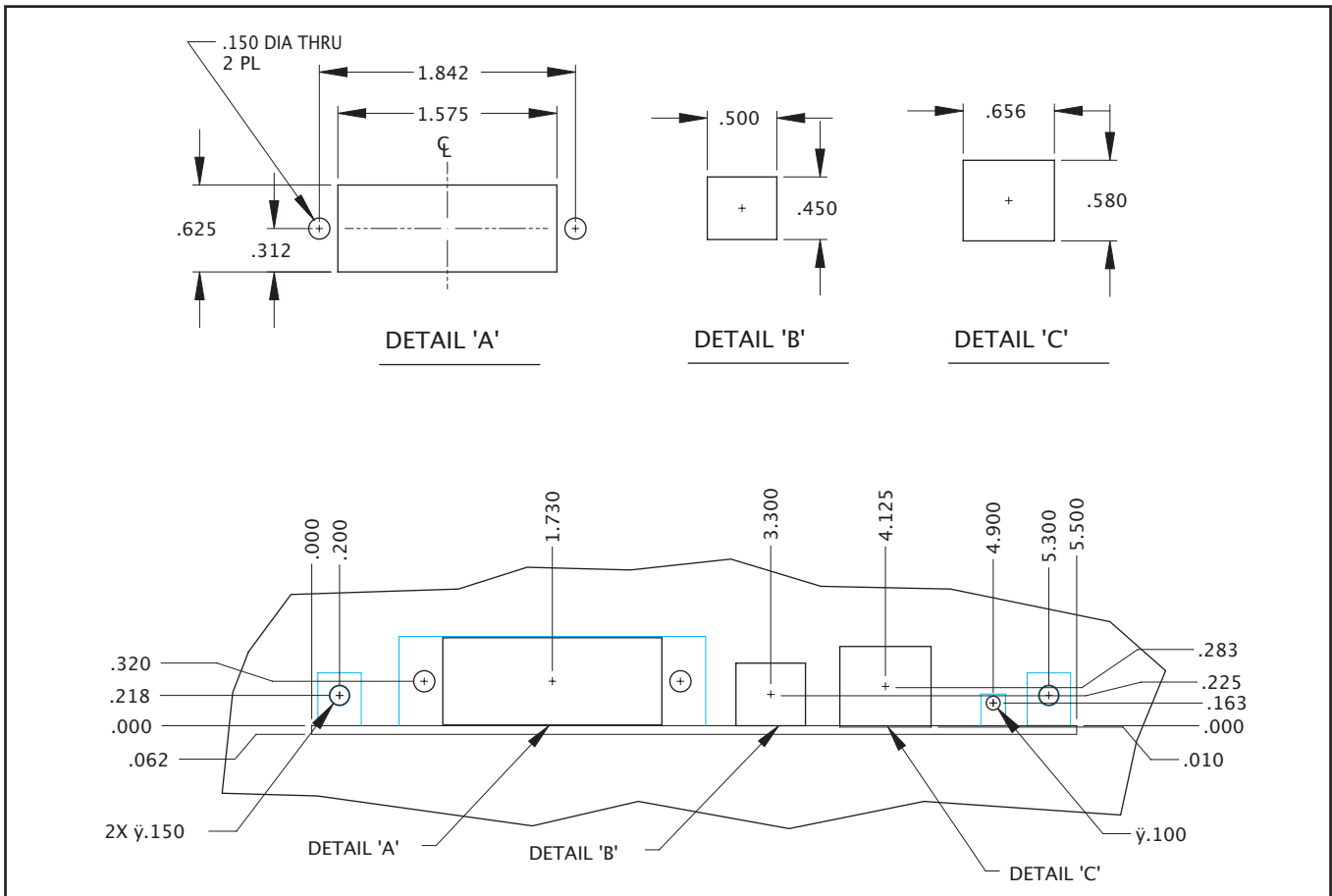
9009 Rear Panel Cutouts

Mounting Methods

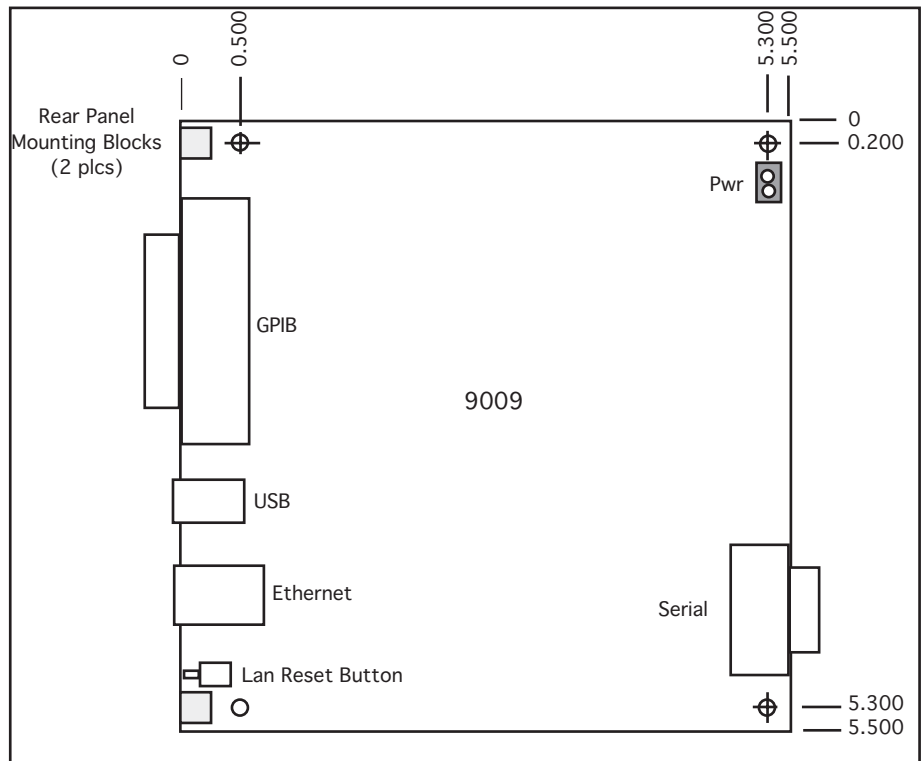The 9009 has been designed to mount easily against the rear panel of the host chassis. The illustration above shows the rear panel connector cutouts, mounting holes and reset button access hole. Rear panel mounting blocks hold the 9009 board flush against the rear panel so the connectors can protrude through the rear panel and make a good EMI/RFI seal. Alternately, the 9009 can be mounted on any panel using the four mounting holes. Only one simple cable is required to connect the 9009 to the Modbus slave device.

LAN Reset Button

The LAN Reset button restores the network settings to their factory values in case the 9099 ever gets 'lost' or was given an incorrect IP entry.

DC Power

DC power is applied to the 9009 on a two screw terminal strip. The 9009 has an on-board linear regulator that can handle up to 15 Vdc. The user can by-pass the regulator when regulated 5 Vdc is available or use the regulator when 5.5 to 15 volt power is available.

0

0.500

5.300
5.500

Rear Panel
Mounting Blocks
(2 plcs)

0
0.200

Pwr

GPIB

9009

USB

Ethernet

Serial

Lan Reset Button

5.300
5.500

9009 Outline Dimensions

Ethernet Interface

Ethernet Interface

Type	IEEE 802.3 compliant Auto MDIX
Speeds	10BaseT (10 Mb/s) 100BaseT (100 Mb/s)
Connector	RJ45
IP Address	Static or DHCP with fall-back to an AutoIP
Factory setting	192.168.0.254 Static IP
Interface name	any [inst0]
Buffers	1 kbytes

VXI-11 Capabilities:

Fully VXI-11.3 compliant

VXI-11.3	Device Interface
Sockets	15 + 1 for UDP
Channel types	Data, Abort and Interrupt
Links	64
Interface Name	inst0 for general use

RPC Protocol

Conforms to ONC RPC Version 2, VXI-11

Modbus TCP/IP Conformance:

Transparent TCP/IP to Modbus RTU conversion verified with Modbus.ORG TCP/IP Test. Command functions limited to slave device capabilities.

Sockets	10
Channel types	Data
Links	64

Raw Socket Conformance:

Access to 9009 parser for Setup and Modbus device control.

Sockets	1
Channel types	Data
Links	1

WebServer Capabilities

Provides the following HTML 4.01 compatible web pages:
Welcome
Configuration
Confirmation
Reboot
404, 500 and 501 Error pages
Watlow F4, F4T and EZ-Zone Controller pages

IEEE 488.2 Capabilities:

Same as GPIB Interface except SRQ is not generated.
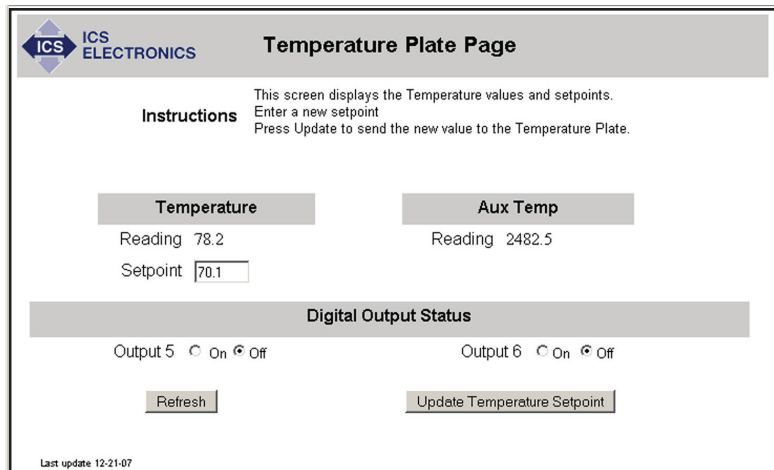
SCPI Capabilities:

Same as GPIB Interface.

LXI Conformance:

The 9009's firmware meets some of the LXI 1.4 Specification requirements for core instruments. The 9009's VXI-11.3 and IEEE-488.2 compliance exceeds the LXI requirements.

Sample EZ-Zone html Page

Sample F4 Temperature Page

USB Interface

Provides USB control through a virtual COM Port using the Microsoft's standard driver for Virtual COM Ports.

Supported Operating Systems
Windows XP (SP2) or later,
Vista and
Windows 7
Windows 8
Windows 10

Data Rates and Formats

Baud Rate:	115.2 Kbaud
Date bits	8
Parity	none
Stop bits	1

GPIB Bus Interface

The 9009's 488 Bus Interface meets IEEE STD 488.2-1987 and has the following capabilities:
    SH1, AH1, T6, L4, SR1, PP0, DC1
    RL0, DT0, C0 and E1/E2 drivers
Bus drivers incorporate power up/down protection to prevent glitching the bus during power turn-on. Standard IEEE-488 connector with metric mounting studs.

Address Capability
Primary addresses 0-30.

Buffers
GPIB Input	1 kbytes
GPIB Input	1 kbytes

Status Reporting Structure
IEEE-488.2 and SCPI Status Byte, ESR, Questionable and Operational Registers.

SRQ Generation
SRQs are generated per the IEEE-488.2 specification if the unit is not addressed to talk, if SRQs are enabled and if an enabled register bit occurs.

488.2 Common Commands
*CLS, *ESE, *ESE?, *ESR?, *IDN?, *OPC, *OPC?, *PSC, *RST, *SAV, *SRE, *SRE?, *STB, *TST?, AND *WAI.

SCPI Commands
The 9009 conforms to the SCPI 1994.0 Specification and uses SCPI commands to set:
    GPIB Bus Address
    External GPIB Address Enable
    Baud rate select
    Data bits
    Stop bits
    Parity
    Talk Format

Modbus Serial Interface

DE-9P male connector with a full-duplex serial interface with single ended RS-232 and differential RS-422 (RS-485) signals. Signal selection made by jumpers on the 9009. Internal termination network provided for RS-422 and RS-485 signals.

RS-232 Signals	TxD,RxD,RTS,CTS, DSR and DTR
RS-422 Signals	Tx and Rx pairs
Baud Rates:	300,600,1.2K,2.4K,4.8K, 9.6K, 19.2K and 38.4K baud
Data Bits	7 or 8 bits
Parity	Odd, even or none
Stop Bits	1 or 2
Buffers	256 bytes

Modbus Commands

Modbus commands accept ASCII decimal values or HEX values starting with #h. Code is the Modbus RTU command code produced by the 9009. Integer and register values from 0 to 65,535. Floating Point per IEEE-754.

Cmd	Code	Function
C n	-	Sets Device Address
RC? reg, n	0x01	Reads coils *n* from register *reg*
RI? reg, n	0x02	Reads Discrete Inputs *n* from register *reg*
R? reg, n	0x03	Reads *n* words starting with register *reg*
RF? reg	0x03	Reads floating point value from register *reg* and *reg+1*
RR? reg,n	0x04	Reads *n* words starting with register *reg*
RE?	0x07	Reads Exception value
WC reg,b	0x05	Writes boolean *b* to coil
W reg, w	0x06	Writes word *w* to a single register *reg*
WB reg, n, w...w		
	0x10	Writes multiple words *n* to a single register *reg*
WF reg, n	0x10	Writes a floating point value *n* to register *reg* and *reg+1*
L w	0x08	Performs loopback test
D time		Sets serial timeout in ms
E?		Queries Modbus Error Register

Physical

Size, L x W x H
139.7 x 139.7 x 17.8 mm
(5.5 x 5.5 x 0.7 inches)

Connectors:
GPIB:	24-pin IEEE connector
Serial:	9-pin DE-9P male
Ethernet	RJ45
USB	B type

LED Indicators:
PWR, LAN, ACT, RDY, TALK, LSTN, SRQ and ERR

Temperature:
Operation	-10° C to +55° C
Storage	-40° C to +85° C

Humidity:
0-90% RH without condensation

Power: +5 to + 15 Vdc
400 mA (typical)

Supplied Accessories

Instruction Manual
Support CD

Compatible Modbus Controllers

The following is a partial list of compatible Modbus RTU Slave Controllers:
    Watlow F4, F4T, 96, SD and EZ Zone
            PM series
    Cincinnati SubZero EZT550

ORDERING INFORMATION