

# MODBUS INTERFACES

## 9099 ETHERNET TO MODBUS INTERFACE

### DESCRIPTION

ICS's Model 9099 Ethernet to Modbus Interface provides a user with multiple ways to control Modbus RTU slave devices in test systems or from a PLC. The 9099's Ethernet Interface supports the VXI-11, Raw-Socket and Modbus TCP/IP protocols and includes a webserver with HTML control pages for the more popular temperature controllers. Protocol conversion is automatic and does not require any effort on the user's part.

9099's Ethernet port can control a wide variety of Modbus RTU devices with a proven, easy to use command set. The command set is accessible with the VXI-11 or Raw Socket and through the internal web server's Control page. Modbus TCP/IP to Modbus RTU conversion is automatic and does not require any special programming.

Applications include connecting temperature chambers or other equipment to test systems, allowing remote control of Modbus RTU slave devices or controlling Modbus RTU slave devices from a PLC.

### Test System Applications

The 9099 and its companion Modbus slave device appear as a virtual instrument to the application and are easily controlled by the different programming techniques that are in common use with today's Test and Measurement systems.

If you program with LabVIEW, National Instruments' VISA library recognizes VXI-11.3 instruments like the 9099 as a TCPIP resource. NI's Measurement and Automation Explorer finds and communicates with the 9099 as with any other VXI-11.3 compliant device.

If you include the 9099 in a LXI system, it and its companion Modbus slave device will appear as



9099 Ethernet-Modbus RTU Interface

an LXI compatible instrument and can be found with the VXI-11 Discovery procedure.

If you program with VEE, Keysight's (Agilent) IO Library treats the 9099 as any other LAN instrument and makes it available to your program. Many of the 9099's firmware features are imported from our LXI firmware efforts.

If you are a Visual Basic or C/C++ programmer, your program can be written to make calls to any VXI-11 compatible VISA library such as those from Agilent, Kikusui and National Instrument's. You can also write your program using a Raw Socket connection to the 9099 and telnet to it.

If you use Linux or any flavor of UNIX such as SunOS, IBM-AIX, HP-UX, or Apple's OS X, you can communicate with the 9099 through RPC over TCP/IP.

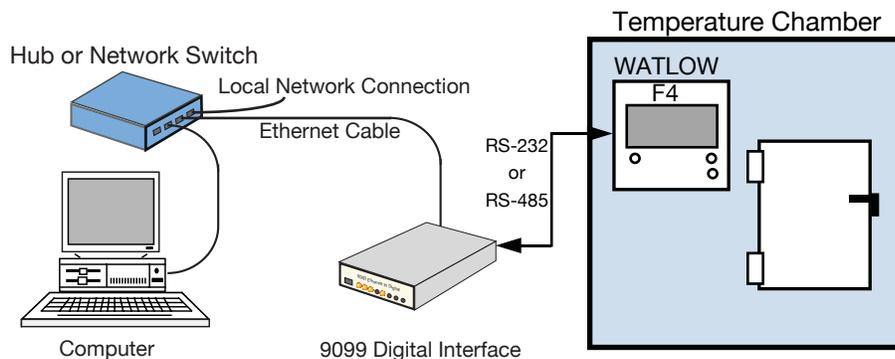
### Modbus TCP/IP to RTU Conversion

The 9099 automatically detects Modbus TCP/IP packets and transparently performs the TCP/IP to Modbus RTU conversion. PLCs with Modbus drivers that support the functions in the Modbus slave device will have no difficulty controlling the Modbus slave device.

- Control Modbus RTU slave devices with VXI-11, Raw Socket or Modbus TCP/IP. Adds Modbus RTU devices to Ethernet test systems and to PLC controllers.
- ICS's easy to use Command Set controls all popular Modbus RTU slave devices. Easy migration from ICS's GPIB to Modbus interfaces.
- Transparent Modbus TCP/IP to Modbus RTU conversion. No programming required.
- Internal webserver includes sample html control pages for Watlow F4, F4T and EZ Zone Controllers. Starter html pages for OEM customization.
- Internal webserver includes a general purpose control page. Easy control of the 9099 or Modbus device from any browser, pad or smart phone.
- Application Notes and utility programs for debugging and uploading html pages. Quick start aids for OEM customization.

CE Approved

RoHS Compliant



A 9099 controlling a Temperature Chamber



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## 9099: Application

### Internal Webserver

The 9099's internal webserver lets the user view its current status, change the 9099's configuration settings and control the 9099 and the Modbus slave device. The Welcome (index) page displays status information about the 9099 and links to the Configuration page, to the Control page and to the sample pages. The Configuration pages lets the user change the network and serial settings. The general purpose Control page gives the user a way to directly control the 9099 and of all attached Modbus RTU devices. Sample HTML pages are supplied for the F4, F4T and EZ-Zone Watlow Controllers.

All of the html pages can be easily modified by an OEM to make the 9099 part of his system. The user can use any HTML editing program to change the page background, substitute logos, and re-layout the pages to make the 9099 his product. ICS supplies a VXI-11HTML utility for uploading the user's graphics and modified HTML pages to the 9099.

### 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.

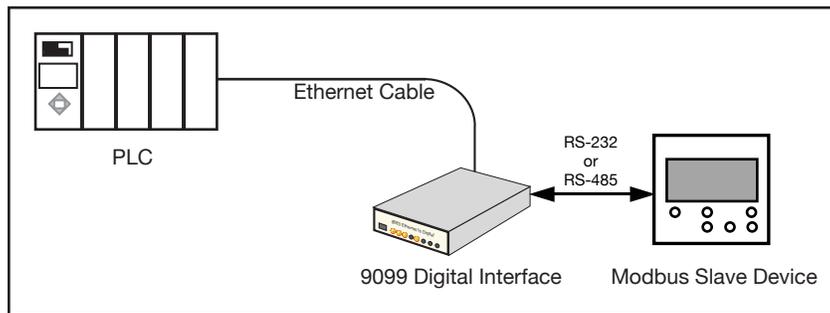
The 9099 has an expanded IEEE-488.2 Status Reporting Structure that includes a register for reporting Modbus communication faults. The 9099's Status Reporting Structure can be used to generate Service Requests using a Reverse Interrupt channel when an error occurs. Alternately, the user can periodically query the Modbus Error and other register to check for command and communication errors.

### Raw Socket Operation

The 9099 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 9099 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



Using a 9099 as a Modbus TCP/IP to Modbus RTU Converter

have to worry about driver problems or getting an updated driver. RPC calls can also be used to configure the 9099.

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 9099 lets PLCs and other devices that use the Modbus TCP/IP protocol control one or more Modbus RTU slave devices. The 9099's Modbus TCP/IP to Modbus RTU protocol conversion is a transparent process that does not require any user setup or action. The 9099 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 9099 is completely transparent and does not restrict Modbus addresses, data or function codes.

### JAVA

The 9099 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.

The screenshot shows the Model 9099 Welcome Page. At the top left is the ICS ELECTRONICS logo. The page title is "Model 9099 Welcome Page". Below the title is a section titled "Current Setup" with a description: "This screen displays the unit's current settings. Use the Configuration Page to change the Network Settings, and User Description". The current setup information is as follows:

Instrument Model	9099	Serial Number	905099	Revision	Rev x0.04 Ver 15.09.29
MAC Address	40-D8-55-17-05-42				
IP Address	192.168.0.254				
User Description					
Status					

Below the setup information is a section for the RDY LED: "To blink the RDY LED select an action and press Activate". There are two radio buttons: "Blink" (unselected) and "No Blink" (selected). An "Activate" button is next to the "No Blink" radio button. Below this are five buttons: "Go to Configuration Page", "F4 PAGE", "F4T PAGE", "Go to Control Page", and "EZ ZONE PAGE". At the bottom left, it says "Last update 09-21-2015".

## 9099: APPLICATION

### VXI-11 Application Notes

ICS has developed several Application Notes that describe the VXI-11 protocol and how to program VXI-11 devices. They include RPC examples and information on how to customize the HTML pages served by the 9099's webserver. These Application Notes are available at [http://www.icselect.com/ab\\_note](http://www.icselect.com/ab_note).

### Easy Configuration

The 9099 is easily controlled and configured with any web browser from a PC, PAD or Smart Phone. When you first access the 9099, you see the Welcome Page shown above. From the Welcome Page you can access the Configuration Page, the 9099 Control Page, and the sample F4, F4T or EZ-Zone control pages.

The Configuration Page lets you view or change the 9099's network and serial parameters. Any configuration changes can be saved in the 9099'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 9099 ever gets 'lost' or was given an incorrect IP entry.

### Browser Control of Modbus Devices

An engineer can have an automated test running in the lab and use a browser on his PC or MAC to access the 9099 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 9099 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 9099 completes a read or write operation from one application before granting access to another user.

The fourth HTML page is a general purpose Control Page that lets a user enter 9099 commands from his web browser. The commands go to the 9099's internal parser and can control and configure the 9099 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 to debug Ethernet connectivity and Modbus device connections.

### OEM Customization

The 9099 provides the OEM with a wide range of customizing options to integrate the 9099 into the user's system . The OEM can:

- Set the IDN message to identify the 9099 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. See ICS Application Bulletin AB80-5 for modification instructions.
- Add a custom front panel overlay with the OEM's colors, logo and model number.

The screenshot shows the 'Temperature-Humidity Chamber Page' from ICS Electronics. It features a header with the ICS logo and the page title. Below the header is an 'Instructions' section with text: 'This screen displays the Temperature-Humidity Chamber values and setpoints. Enter a new setpoint or click to set a new Digital Output. Press Update to send the new values to the Chamber.' The main content area is divided into three columns: 'Temperature' (Reading: 77, Setpoint: 120), 'Humidity' (Reading: 0, Setpoint: 89), and 'Aux Temp' (Reading: 0). Below these is a 'Digital Outputs' section with eight rows, each containing an output number and 'On'/'Off' radio buttons. At the bottom, there are 'Refresh' and 'Update' buttons, and a footer indicating 'Last update 03-27-2013'.

### Prototype Watlow F4 Temperature Chamber Page

The screenshot shows the 'Temperature Plate Page' from ICS Electronics. It features a header with the ICS logo and the page title. Below the header is an 'Instructions' section with text: 'This screen displays the Temperature values and setpoints. Enter a new setpoint. Press Update to send the new value to the Temperature Plate.' The main content area is divided into two columns: 'Temperature' (Reading: 78.2, Setpoint: 70.1) and 'Aux Temp' (Reading: 2482.5). Below these is a 'Digital Output Status' section with two rows, each containing an output number and 'On'/'Off' radio buttons. At the bottom, there are 'Refresh' and 'Update Temperature Setpoint' buttons, and a footer indicating 'Last update 12-21-07'.

### Prototype Watlow EZone Temperature Plate Page

The screenshot shows the 'Model 9099 Control Page' from ICS Electronics. It features a header with the ICS logo and the page title. Below the header is an 'Instructions' section with text: 'This screen displays the current Modbus Slave Device address and last ESR and Modbus Error Register values. Use the C n command to change the Slave Device address. Check Auto Query to automatically read a response if the command is a query. Enter a 9099 or Device Command and click Send to send it. Responses are shown in the Device Response window.' The main content area is divided into two main sections: 'Command Entry' and 'Device Response'. The 'Command Entry' section contains fields for 'Slave Device Address' (value: 1), 'ESR Register', and 'Modbus Error Register'. Below these is a 'Device Command' field with a 'Send' button. The 'Device Response' section contains a large text area with a 'Read' button. At the bottom, there is a 'Return to the Welcome Page' button and a footer indicating 'Last update 06-17-2013'.

### 9099 Control Page

## 9099: SPECIFICATIONS

### Supported Standards

#### 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	intr0 for general use.

#### Raw Socket

Telnet compliant, uses port 23.

#### RPC Protocol

Conforms to ONC RPC Version 2, VXI-11

#### Ethernet Interface

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

#### 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:

Runs all required 488.2 Common Commands, incorporates an extended IEEE-488.2 Status Reporting Structure and the Message Exchange Protocol.

#### SCPI Capabilities:

The 9099 conforms to the SCPI 1994.0 Specification.

#### LXI Conformance:

The 9099 generally conforms to the LXI 1.4 Specification for core instruments except the 9099 does not support mDNS or SDNS. The 9099's VXI-11.3 and IEEE-488.2 compliance exceeds the LXI requirements.

#### 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.

### Serial Interface

Serial interface with single ended RS-232 and 2 or 4-wire differential RS-485 signals. RS-485 interface includes 2/4-wire selection and an internal termination network. RS-485 half-duplex operation enabled with a SCPI command.

RS-232 Signals	TxD, Rx D, RTS, CTS, DSR and DTR
RS-485 Signals	Tx and Rx pairs
Termination	Jumper enabled.
Baud Rates:	300, 600, 1.2K, 2.4K, 4.8K, 9.6K, 19200, 28800, 38400, 57600, 76800, and 115200.
Data Bits	7 or 8 bits
Parity	Odd, even or none
Stop Bits	1 or 2

### Modbus RTU Commands

Modbus commands accept ASCII decimal values or HEX values starting with #. Code is the Modbus RTU command code produced by the 9099. 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 <i>n</i> from register <i>reg</i>
RI? reg, n	0x02	Reads Discrete Inputs <i>n</i> from register <i>reg</i>
R? reg, n	0x03	Reads <i>n</i> words starting with register <i>reg</i>
RF? reg	0x03	Reads floating point value from register <i>reg</i> and <i>reg+1</i>
RR? reg, n	0x04	Reads <i>n</i> words starting with register <i>reg</i>
RE?	0x07	Reads Exception value
WC reg, b	0x05	Writes boolean <i>b</i> to coil
W reg, w	0x06	Writes word <i>w</i> to a single register <i>reg</i>
WB reg, n, w...w	0x10	Writes multiple words <i>n</i> to a single register <i>reg</i>
WF reg, n	0x10	Writes a floating point value <i>n</i> to register <i>reg</i> and <i>reg+1</i>
L w	0x08	Performs loopback test
D time		Sets serial timeout in ms
E?		Queries Modbus Error Register

### Compatible Controllers

The following is a partial list of compatible Modbus RTU Slave Controllers:

Watlow F4, F4T, 96, SD and EZ Zone series  
Cincinnati SubZero EZT550

### Indicators

PWR	Indicates power on
LAN	Unit connected to an active LAN Blinks to identify the unit.
ACT	Transferring messages to/from the network
RDY	Unit has passed self test
TALK	Unit asked to send data
LSTN	Unit sent a command or data
SRQ	Service Request asserted
ERR	Blinks for a soft VXI-11 error and On for command errors

### Controls

Power	Front panel switch
LAN Reset	Rear panel push-button that resets the network settings.

### Physical

**Size, L x W x H**  
7.29 x 5.57 x 1.52 inches  
(185.2 x 141.5 x 38.6 mm)

**Weight** 3 lbs. (1.4 kg.)

**Construction** Lead Free

#### Connector and Headers

Serial I/O:	DE-9P male connector with lock studs
Ethernet:	RJ-45

#### Temperature

Operation	-10° C to +55° C
Storage	-40° C to +70° C

#### Humidity

0-90% RH without condensation

#### Power

9 to 32 Vdc @ 3 VA

#### Approvals Pending

EEC Standards EN 61000-6-4:2001, EN 61000-6-2:2001, EN 55024:2003, and EN 55022:2003.

### Included Accessories

Instruction Manual  
LAN Crossover Cable.  
Support CD-ROM with VXI-11 Utilities.  
UL/CSA/VDE approved AC power Adapters  
US - 115 ±10% Vac, 60 Hz (std.)  
-U - 100-240 ±10% Vac, 50-60 Hz

## ORDERING INFORMATION

Ethernet to Modbus Interface (Includes Instruction Manual and Configuration Disk)

9099

Ethernet to Modbus Interface with 100-240Vac universal adapter with UK/Europe/US and Australia/China plugs.

9099-U