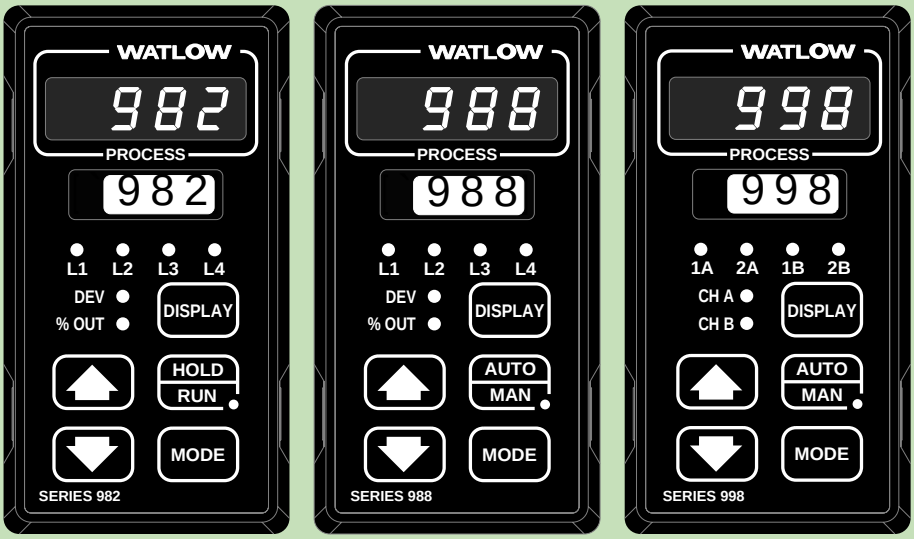
Data Communications with the Watlow Series 988 Family of Controllers

User's Manual

Includes:
981-984 Ramping
986-989 Temperature or Process
996-999 Dual Channel

User Level Targeted:

Installer:



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Winona, Minnesota USA

WATLOW
Watlow Controls

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About This Manual

How to Use this Manual

We have designed this user's manual to be a helpful guide to your new Watlow controller. The headlines in the upper right and left corners indicate which tasks are explained on that page. If you are a new user, we suggest that your read the first four chapters of this manual.

Notes, Cautions and Warnings

We use notes, cautions and warnings throughout this book to draw your attention to important operational and safety information.

A bold text **"NOTE"** marks a short message in the margin to alert you to an important detail.

A bold text **"CAUTION"** safety alert appears with information that is important for protecting your equipment and performance. **Be especially careful to read and follow all cautions that apply to your application.**

A bold text **"WARNING"** safety alert appears with information that is important for protecting you, others and equipment from damage. **Pay very close attention to all warnings that apply to your application.**

The ⚠ symbol (an exclamation point in a triangle) precedes a general CAUTION or WARNING statement.

The ⚠ symbol (a lightning bolt in a triangle) precedes an electric shock hazard CAUTION or WARNING safety statement.

Technical Assistance

If you encounter a problem with your Watlow controller, review all of your configuration information for each step of the setup, to verify that your selections are consistent with your applications.

If the problem persists after checking all the steps, call for technical assistance: Watlow Controls, (507) 454-5300, between 7:00 a.m. and 5:00 p.m. Central Standard Time. Ask for an applications engineer. When you call, have the following information ready:

- the controller's model number (the 12-digit number is printed on the top of the stickers on each side of the controller case and on the right hand or top circuit board);
- this user's manual;
- all configuration information;
- the Diagnostics Menu readings.

Comments and Suggestions

We welcome your comments and opinions about this user's manual and the Series 988 family of controllers. Send them to the Technical Editor, Watlow Controls, 1241 Bundy Boulevard, P.O. Box 5580, Winona, MN 55987-5580. Or call (507) 454-5300 or fax them to (507) 452-4507.

Warranty and Returns

For information about the warranty covering the Series 988 family of controllers see the Appendix.

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Data Communications with the Watlow Series 988 Family of Controllers

NOTES

Chapter 1 Introduction to Data Communications

NOTE:
This manual applies only to controllers with the data communications option (9___-____-_R__ or 9___-____-_S__ or 9___-____-_U__). Please use it in conjunction with the user's manuals.

Machine-to-Machine Communication

Humans use basic components to exchange messages. Computers and controllers also use certain elements in order to communicate: a character set; a common data link, or interface; and a protocol, to prevent confusion and errors.

Serial communication is the exchange of data one bit at a time on a single data line or channel. Serial contrasts with "parallel" communication, which sends several bits of information simultaneously over multiple lines or channels. Not only is serial data communication typically simpler than parallel, it generally costs less.

Computers need a connecting **interface** over which to communicate. They may use one pair of wires to send information in one direction and another pair to send in the opposite direction (full duplex). Or, they may use one pair to send in both directions (half duplex).

Bit is simply the contraction of "binary digit," either a "1" or a "0." A **byte** is a string of seven or eight bits, which a computer treats as a single "character." The ASCII (pronounced "asky") character set uses a unique, seven-bit byte to represent each letter, digit and punctuation mark.

Protocol

Now we need a few rules to "talk" by. Protocol determines who gets to talk when. A protocol is a set of standards for formatting and timing information exchange between electronic systems.

Protocol describes how to initiate an exchange. It also prevents two machines from attempting to send data at the same time. There are a number of different data communications protocols, just as there are different human cultural protocols that vary according to the situation.

A Protocol Example

Let's assume that we have a computer and controllers linked together. They all use ASCII and are connected via a common interface. In process control applications, one device often has greater function and memory capability than the devices it is communicating with. This "master" device always initiates exchanges between it and the connected "remote" devices.

Here's what happens: Imagine "PC-1," the master computer, sitting at the end of a long hallway with nine doors in it. Each door has a remote device behind it. PC-1 has a telephone line to all the devices. The remote devices are busy controlling heaters to specific set points. PC-1 monitors and changes the instructions that each remote device uses to control its heaters.

By your request PC-1 wants to talk with device "D-2" to change a set point. PC-1 must first identify D-2 on the line and inquire whether D-2 has time to talk. This electronic knocking on D-2's door is the "connection."

One of three scenarios may occur when PC-1 calls:

1) D-2 answers saying, "This is D-2, go ahead," and PC-1 begins to talk.
2) D-2 answers and says, "I'm too busy to talk now. Wait until I tell you I'm finished."
3) D-2 does not answer, which indicates a possible system malfunction.

Let's take the best-case scenario. Here is a simple version of what happens: D-2 answers and hears PC-1 say, "Hello, D-2. Do you have time to talk?"

D-2 acknowledges PC-1 with a "D-2 here, go ahead."

PC-1 then sends an ASCII-encoded message instructing D-2 to change a set point to 1,000°F. (message)

When PC-1 is finished with its message, it says in effect, "That's all, your turn."

D-2 replies, "OK," and carries out the instruction. D-2 then takes the protocol lead, and tells PC-1, "The new set point is 1,000°F." (message)

PC-1 says, "OK."

D-2 says, "That's all, your turn."

PC-1 then takes the protocol lead and says, "Thank you, that's all."

D-2 hangs up. (disconnect)

That's basically how the connect, message and disconnect protocols work in Watlow data communications.

The hallway in this example is really a communications bus — a common connection among a number of separate devices. A communications system with multiple devices on a common bus is called a multidrop system.

The exact connect-message-disconnect procedure assures that you are talking to the correct device.

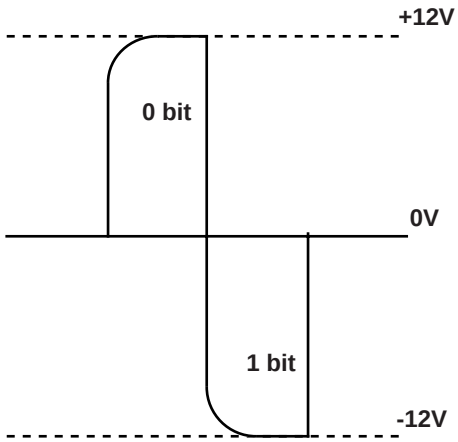
Protocol maintains system integrity by requiring a response to each message. It's like registered mail — you know that your letter has been received because the post office sends you a signed receipt.

In Watlow data communications, a dialog will continue successfully as long as the messages are in the correct form and responses are returned to the protocol leader. If the operator enters an incorrect message, or interference comes on to the data line, there will be no response. In that case the operator or the master must retransmit the message or go to a recovery procedure. If an operator continues to enter an incorrect message or interference continues on the data line, the system will halt until the problem is resolved.

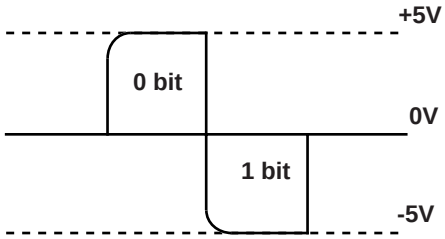
EIA-232, EIA-485 and EIA-422 Interfaces

The three interfaces we're concerned with on this controller are EIA-232, EIA-485 and EIA-422.

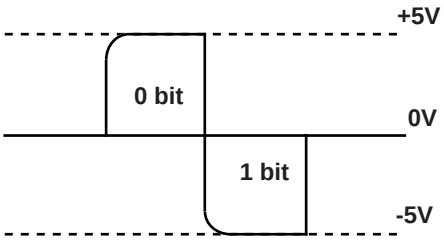
An EIA-232 interface uses three wires: a single transmit wire; a single receive wire; and a common line. Only two devices can use an EIA-232 interface. A -12 volt signal indicates a 1 and a +12 volt signal indicates a 0. The EIA-232 signal is referenced to the common line rather than to a separate wire, as in EIA-485 and EIA-422. An EIA-232 cable is limited to 50 feet, due to noise susceptibility.



Bit signals on an EIA-232 interface.



Bit signals on an EIA-485 interface.



Bit signals on an EIA-422 interface.

Figure 1.3 - Interface bit signals.

An EIA-485 interface uses three wires: a T+/R+; a T-/R-; and a common line. A -5-volt signal is interpreted as a 1, a +5-volt signal as a 0. Up to 32 remote devices can be connected to a master on a multi-drop network up to 4,000 feet long.

The EIA-422 interface uses five wires: a "talk" pair; a "listen" pair; and a common line. It can handle one master and up to ten remote devices in a multidrop network up to 4,000 feet long. EIA-422 uses the difference in voltage between the two wires to indicate a 1 or a 0 bit. A 1 is a difference of -5 volts, while a 0 is a difference of +5 volts.

Of these three interfaces, EIA-485 has the lowest impedance, a multiple-device capability, greatest noise immunity and the longest distance capability — up to 4,000 feet of total network cable length.

	Maximum Net Length	Maximum Controllers	Cable Type
EIA-232	50 feet	1	3-wire
EIA-485	4,000 feet	32	3-wire
EIA-422	4,000 feet	10	5-wire

Table 1.4 - Comparing Interfaces.

NOTE:
The Modbus feature on the Series 988 controllers allows up to 247 controllers to share one EIA-485 network, by using network bridges. See Chapter 6 for more information on Modbus.

ASCII

The ASCII code defines 128 separate 7-bit characters — one for each letter, digit and punctuation mark. ASCII also includes control characters similar to those we find on computer keys, like "backspace," "shift" and "return." It also has ten communications control characters for "identification," "enquiry" (inquiry), "start of text," "end of text," "end of transmission," "acknowledge," "negative acknowledge" and "escape."

The ASCII code is sometimes written in a base-16 number system, called hexadecimal or "hex" for short. The first ten digits of this system are represented by the numbers 0 through 9, and the final six digits are represented by the letters A through F. The 128 ASCII character code with the decimal and hexadecimal equivalents is listed in the Appendix.

Parity Bit

Remember that ASCII is a seven- or eight-bit code. What about that eighth bit? It's called the "parity" bit. A parity bit is added to the ASCII character to verify the accuracy of the first seven bits. Here's how: We are declaring that the number of 1s in the 8-bit character frame will be either always odd or always even. To do that, about half the time we'll have to add another 1 to get an odd or an even number of ones. The other half of the time we'll need to add a 0 so we don't change the total number of 1s.

This way we can detect a single error in the seven-bit group. Take a look at the representation of the transmitted upper case "W." In this case we have selected "odd" parity. The number of 1s in the first seven bits, plus the parity bit, must always total an odd number. The total number of 1s in the binary character 1010111 (W) is 5, already an odd number. Thus our parity bit will be a 0.

If we were transmitting the lower case "w" (binary 1110111), the parity bit would be a 1 because the total number of 1's in the character frame is 6, an even number. Adding the parity bit makes it odd, and consistent with the odd parity rule.

If a noise spike came onto the data line and changed the signal voltage level enough to reverse a 1 to a 0 in the character frame, the receiver would detect that

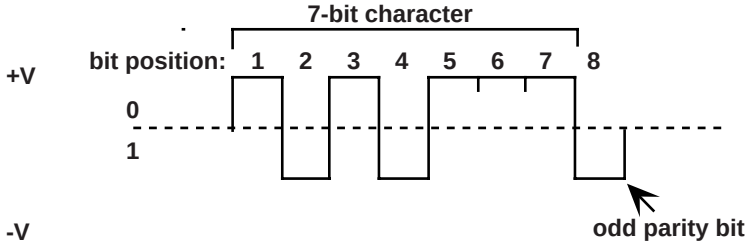


Figure 1.4 - ASCII upper case "W" (1010111).

error. The total number of 1s would be even and a violation of the odd-parity rule.

At Watlow, we use odd, even and no parity.

Odd parity sets the parity bit to 0 if there are an odd number of 1s in the first seven bits.

Even parity sets the parity bit to 0 if there are an even number of 1s in the first seven bits.

No parity ignores the parity bit.

Start and Stop Bits

A "start" bit informs the receiving device that a character is coming, and a "stop" bit tells it that one is complete. The start bit is always a 0. The stop bit is always a 1. We've added the start and stop bits to the transmitted "W" example.

The human speaking equivalent of these bits could be a clearing of the throat to get someone's attention (start bit); and a pause at the end of a phrase (stop bit). Both help the listener understand the message.

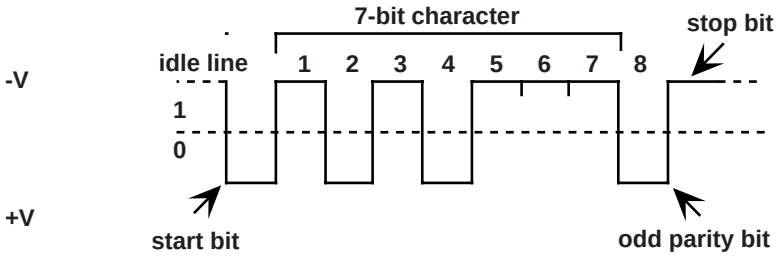


Figure 1.5 - ASCII upper case "W" with start and stop bits.

Baud Rate

The baud rate refers to the speed of data transmission. When a change in signal represents one data bit, baud rate is equal to bits per second (bps). Our rates on the 988 Family of controllers are 300, 600, 1200, 2400, 4800 and 9600 baud.

Computer Languages

Computer languages are simply sets of symbols and rules for their use. There are many computer languages and a wide variety of applications for them. Programmers use languages to enable computers to do real work. We're providing a pilot program written in Quick BASIC to demonstrate data communications with Watlow controllers. You can download the MS-DOS™ version files ("comms4.zip" and "comms4tm.zip" and com5set.exe) from the Watlow BBS, (507) 454-3958.

Syntax

Syntax for a natural language dictates how we put words together to make phrases and sentences. In data communications, syntax also dictates how we order the parts of a message.

For example, the Series 986-989 parameter for set point information is SP1. The controller's panel will normally display SP1 and set point information whenever you physically press the DISPLAY key to reach SP1 in the parameter sequence. For a computer linked to a controller, "SP1" is part of the syntax for data communications.

If you type just "SP1" on the computer keyboard, the controller won't respond to your computer with the current set point 1 data. The syntax requires spaces and "fields" of specific size to be complete.

Plus, we need to add the protocol. It's like putting a message in an envelope and addressing it. The entire syntax of the SP1 command includes the message protocol's STX (Start of Text) control character, SP1, space, up to four decimal places of set-point data, and a protocol ETX (End of Text) control character.

The whole phrase would look like this:

<STX> SP1 0500 <ETX>

ASCII Control Character Definitions

ENQ Enquiry (inquiry): Request for a data link.

ACK Acknowledge: Affirmative response from the receiver.

NAK Negative Acknowledge: Negative response from the receiver.

STX Start of Text: Precedes any message from the sender.

ETX End of Text: Follows any message from the sender.

EOT End of Transmission: Tells the other device that it is its turn to send a message.

DLE Data Link Escape: Disconnect signal from the master to devices on the network.

A Data Communications Conversation

Now that you have a general grasp of the basic ideas and terms behind data communications, we'll take the example further to see how an actual conversation would take place.

The example on the next page follows the exchange between a computer (master) and a controller (remote) as the computer sends a set point data command to the controller.

That's really all there is to it. Remember — only the "master" may initiate exchanges and every message requires a response.

An Example of a Data Communication Conversation

The computer (the master) initiates an exchange with controller #2 (the remote).	*computer* **2 <ENQ>**	(#2, are you there?)
	controller **2 <ACK>**	(I'm #2, I'm here.)
The computer tells the controller to change its set point.	*computer* **<STX> = <space> SP1 <space> 500 <return> <ETX>**	("Here comes a message." "Make SP1 = 500°." "I'm done with the message.")
	controller **<ACK>**	("I understand.")
The computer queries the controller for the new set point.	*computer* **<STX> ? <space> SP1 <return> <ETX>**	("Here comes a message." "What is SP1 value?" "I'm done with the message.")
	controller **<ACK>**	("I understand [the question].")
	computer **<EOT>**	("That's all, go ahead.")
The controller confirms that the new set point.	*controller* **<STX> 500 <ETX>**	("Here comes the answer." "The value is 500°." "I'm done with the answer.")
	computer **<ACK>**	("I understand [the answer].")
	controller **<EOT>**	("That's all, go ahead.")
The computer ends the session.	*computer* **<DLE> <EOT>**	("Disconnect, please. That's all." [master waits])

Notes

Chapter 2 Hardware and Wiring

Serial Hardware Interfaces

The Series 981-984, 986-989 and 996-999 controllers are factory-configured to function in a broad variety of applications. The specifics of each controller's configuration is encoded in its model number. Depending on your unit's model number, you have one of three hardware interfaces:

NOTE:
This manual applies only to controllers with the data communications option (9___-____-_R__ or 9___-____-_S__ or 9___-____-_U__). Please use it in conjunction with the user's manuals.

1) **EIA-232** (9___-____-_R__) provides one-on-one communication with a maximum network length of 50 feet connecting one controller to one computer.

2) **EIA-485** (9___-____-_S__) provides a "multidrop" or multiple-device network with up to 32 addresses with a 4,000-foot network length limit. **EIA-422** provides a multidrop network for up to ten devices with a 4,000-foot network length limit. **To select the multidrop interface**, enter the **Setup Menu** SEt. Use the up-arrow or down-arrow key to advance to the **Communications Menu** COMM. Press the **MODE** key until the **interface prompt** IntF appears. Select either **485 or 422**.

3) **EIA-232/EIA-485** (9___-____-_U__) If your controller is supplied with a "U" board, you can select via the comms menu either EIA-232 or EIA-485 operation. The IntF parameter is defaulted to EIA-232. **To select the multidrop interface**, enter the **Setup Menu** SEt. Use the up-arrow or down-arrow key to advance to the **Communications Menu** COMM. Press the **MODE** key until the **interface prompt** IntF appears. (Controllers equipped with the EIA-232 interface do not require an interface selection.)

Your Computer's Serial Interface

You can connect a data communication-equipped Series 981-984, 986-989 or 996-999 to any computer with an EIA-422, EIA-232 or EIA-485 serial interface. A personal computer with an EIA-232 serial output card, for instance, can talk to a single EIA-232 equipped controller.

For a multiple-controller network with one personal computer, you'll need a converter to act as a bus, or multiple connection point.

For data communications serial interface converters for EIA-232 (RS-232), we recommend either of these two suppliers:

- **DATAFORTH Corp.** (formerly supplied by Burr-Brown):
  3331 E. Hemisphere Loop, Tuscon, AZ 85706
  Tel: 1-800-444-7644, or (520) 741-1404 or Fax: (520) 741-0762
  For EIA-422 (RS-422), part number: LDM 422
  with a power supply and the correct 25 pin connector for your computer.
  For EIA-485 (RS-485), part number: LDM 485
  with a power supply and the correct 25 pin connector for your computer.

- **B & B Electronics Manufacturing Company**
  707 Dayton Road, PO Box 1040, Ottawa, IL 61350
  Tel: (815) 433-5100 or Fax: (815) 434-7094 or Web: http://www.bb-elec.com
  For EIA-422/ EIA-485 (RS-422/ RS-485), part number: 485OIC
  with a power supply and the correct 25 pin connector for your computer.

Communications Wiring

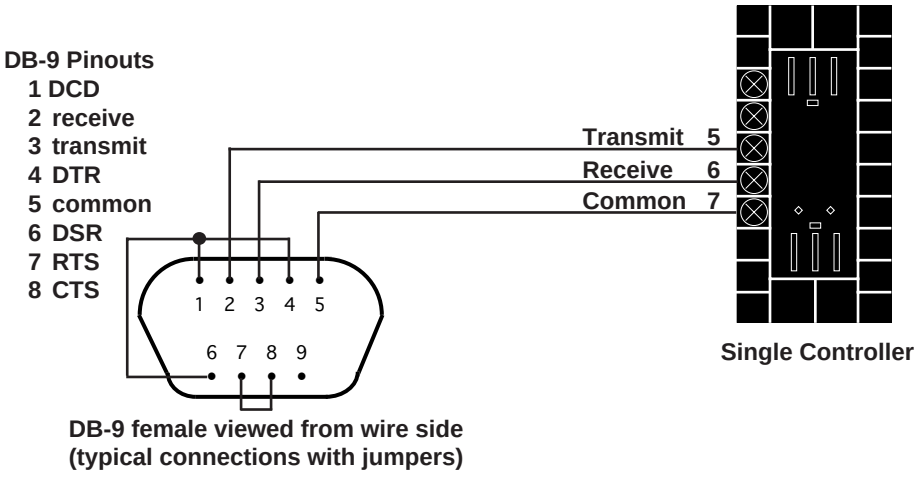
The rest of the chapter explains how to connect your controller to a computer. Consult the instruction manual for your computer's serial port or serial card for detailed serial port pin information. Industrial environments often contain a lot of electrical noise. Take care to isolate your control system.

NOTE:
The Electronic Industry Association (EIA) RS-232 standard recommends a maximum 50-foot total point-to-point distance.

EIA-232 Interface Wiring

The EIA/-232 communications uses a three-wire, full-duplex system. There is a separate line for transmitting data, a line for receiving data and a common line between the computer and the controller. With EIA-232 you can have only one controller connected to a single computer.

This diagram is a **typical** wiring example. The connections on the host computer may vary, depending on the model. Refer to your computer or serial card user's manual for specific information.



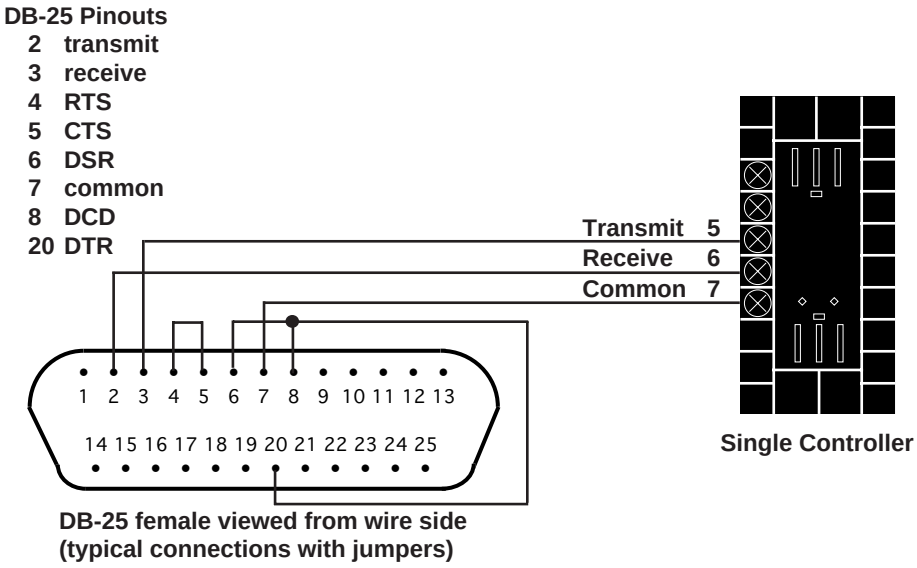


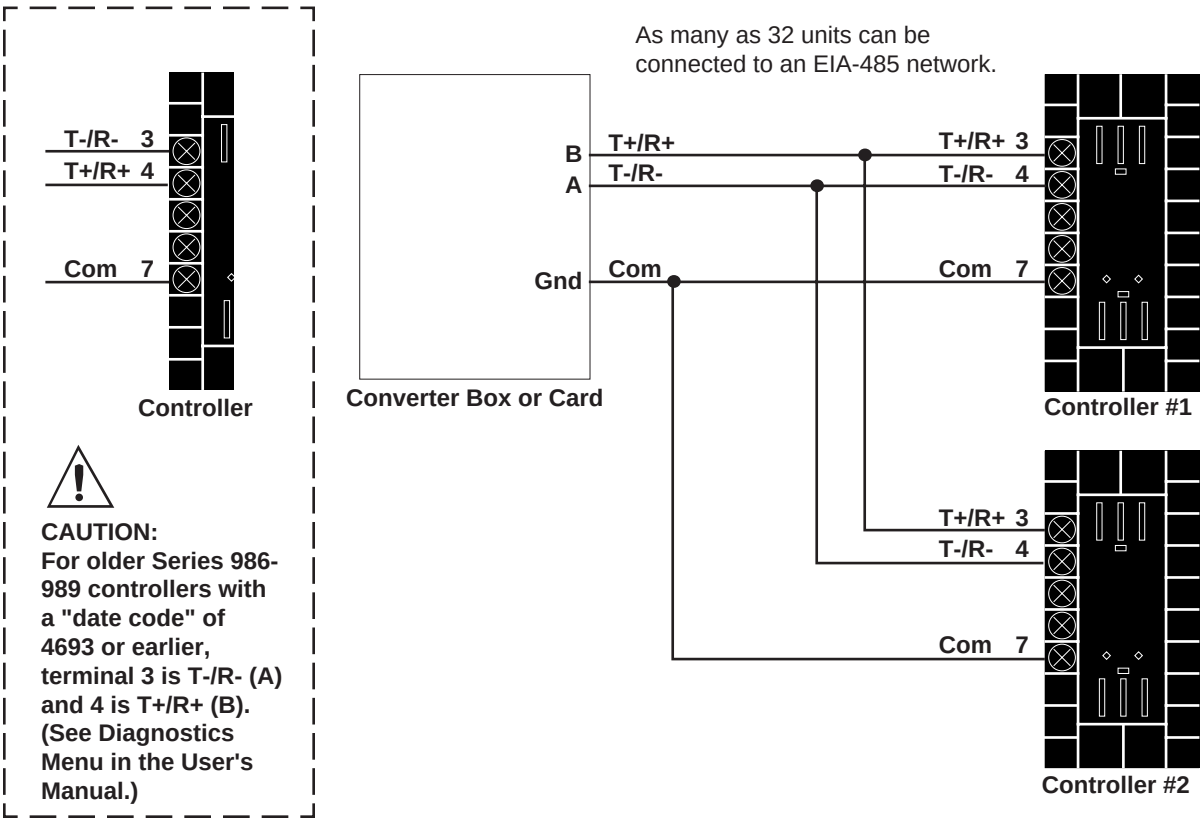
Figure 2.2 - EIA-232 Interface Wiring Diagrams.

EIA-485 Interface Wiring

The EIA-485 communications uses a three-wire, half-duplex system. There are two lines for transmitting and receiving and a common line. Only one device, the computer or a controller, can be speaking at a time. **The controller requires at least a 7-millisecond delay between transmission and receipt of data.** With EIA-485 you can have from one to thirty-two controllers connected to a computer.

NOTE:
The Electronic Industry Association EIA-485 standard recommends a maximum total network distance of 4,000 feet.

This diagram is a **typical** wiring example for units shipped after 1993 (**see ⚠ Caution on this page**). The connections on the host computer may vary, depending on the model. Refer to your computer user's manual for specific information.



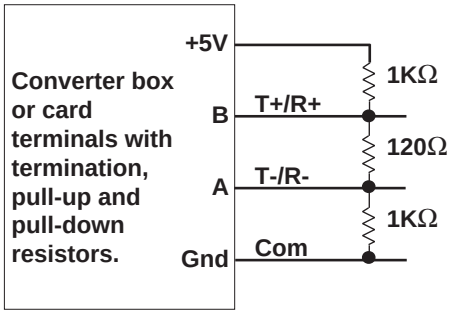


Figure 2.3 - EIA-485 Interface Wiring Diagrams.

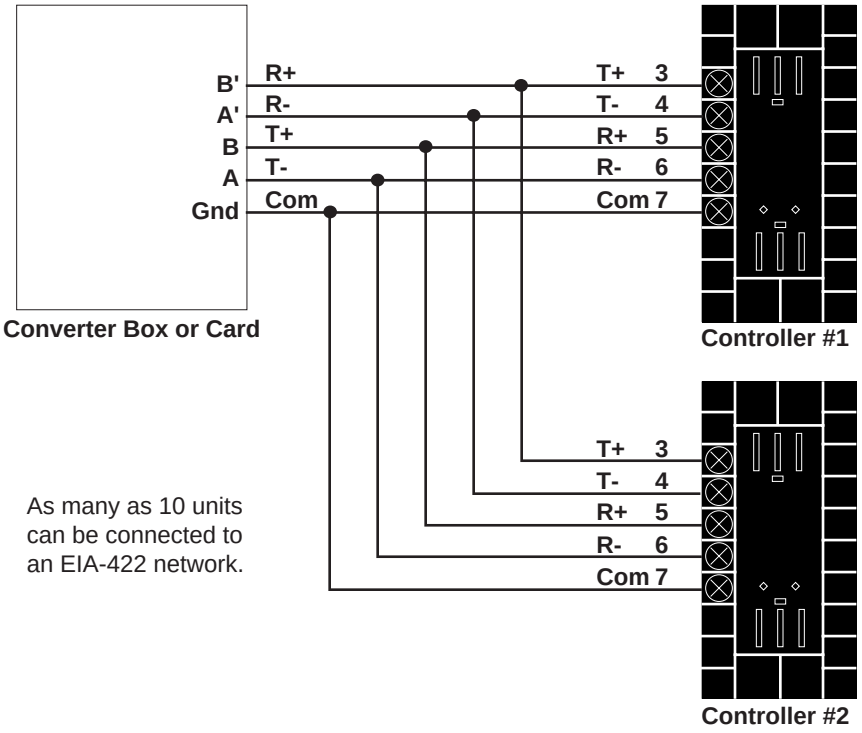
If the system does not work properly it may need termination resistors at each end of the network. A typical installation would require a 120-ohm resistor across the transmit/receive terminals (3 and 4) of the last controller in the network and the converter box or serial card. Pull-up and pull-down resistors may be needed to maintain the correct voltage during the idle state.

EIA-422 Interface Wiring

The EIA-422 communications uses a five-wire, full-duplex system. There are two separate lines for transmitting, two lines for receiving and a common line between the computer and the controller. With EIA-422 you can connect from one to ten controllers to a single computer.

This diagram is a **typical** wiring example for units shipped after 1993 (**see ⚠ Caution on this page**). The connections to the converter box or computer may vary, depending on the model. Refer to the documentation for specific information.

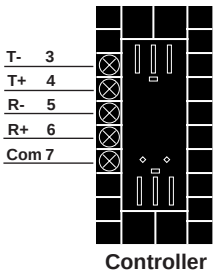
NOTE:
The Electronic Industry Association (EIA) RS-422 standard recommends a maximum network distance of 4,000 feet.

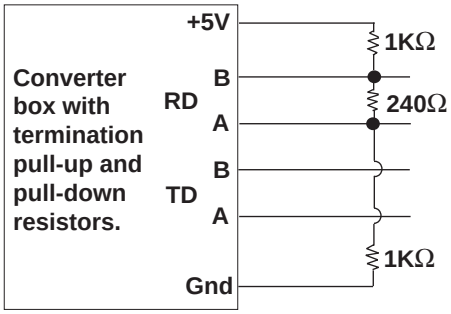


As many as 10 units can be connected to an EIA-422 network.

Figure 2.4 - EIA-422 Interface Wiring Diagrams.

CAUTION:
For older Series 986-989 controllers with a "date code" of 4693 or earlier, terminal 3 is T-, 4 is T+, 5 is R- and 6 is R+. (See Diagnostics Menu in the User's Manual.)





If the system does not work properly it may need termination resistors across the receive A and B terminals at the converter. A typical value would be 240Ω. Pull-up and pull-down resistors may be needed to maintain the correct voltage during the idle state.

Chapter 3 Communications Setup

Connecting the Controller and the Computer

Remove power from both the controller and your computer before connecting them together. Assemble a cable and the appropriate wiring at your computer. Refer to the wiring in Chapter 2. As soon as you connect the data communications lines, you may apply power to your system.

Software Protocols and Device Addresses

There are three communications protocols you may use. Depending on the type of network you need, you must use the correct combination of interface and protocol. Modbus works with all three interfaces.

To run a network with multiple devices Watlow uses the **ANSI X3.28 Protocol** (based on ANSI X3.28 - 1976 Subcategories 2.2, and A.3) with the EIA-422 and EIA-485 interface. ANSI X3.28 Protocol provides a response to every message. It will also work with the EIA-232 interface, but you are limited to one controller and a host computer.

To run a two-device network with an EIA-232 interface, you can also use **XON/XOFF Protocol**, a simpler protocol. XON/XOFF will also work with the EIA-422 and EIA-485 interface, **but the network is limited to two devices** — one computer and one controller. XON/XOFF Protocol does not require a device to respond to messages it receives.

To select the protocol, go to the Setup Menu SEt; use the up-arrow or down-arrow key to advance to the Communications Menu COMM. Press the MODE key until the protocol prompt Prot appears. Select either FULL, for ANSI X3.28 2.2 - A.3, On for XON/XOFF, or rtu, for Modbus RTU.

If you are using ANSI X3.28 Protocol, choose an address number for each controller using the address prompt Addr, which follows the protocol prompt Prot. This prompt will only appear if Prot is set to FULL or rtu.

Communications Software

Watlow offers a Windows based configuration and monitoring software package for the 988/989 controllers. We also offer a simple MS-DOS™ communications demonstration program for the Series 981-984, 986-989, and 996-999. Ask your Watlow field sales representative for a copy of the "Comm 4" program, or you can download the files ("comms4.zip" and "comms4tm.zip" and com5set.exe) from the Watlow BBS, (507) 454-3958.

(Communications)

Baud rate

Data bits and parity

Protocol type

Address

Interface type

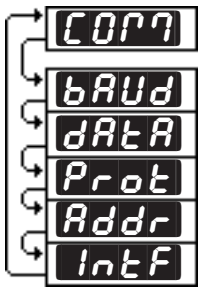


Figure 3.2 - The Communications Menu.

Setup at the Controller's Front Panel

- Press the ▼ and ▲ keys simultaneously for three seconds.
- The SEt prompt appears in the lower display.
- Press the ▼ or ▲ key until the COM prompt appears.
- Press the MODE key to advance through the Communications Menu.
- Press the ▼ or ▲ key to select communications values from the table below.
- Document the setup parameters for each device on your network and label each device.
- Press the DISPLAY key to exit.

NOTE: Selecting rtu automatically sets dAtA to 8n.

Prompt	Appears if…	Range	Factory default
bAUd	comms unit	(Baud rate) 300, 600, 1200, 2400, 4800, 9600	9600
dAtA	comms unit	7o = 7 data bits, odd parity 7E = 7 data bits, even parity 8n = 8 data bits, no parity (Start bit = 1) (Stop bit = 1)	7o (see note) (Fixed) (Fixed)
Prot	comms unit	FULL = ANSI X3.28 2.2 - A.3 On = XON / XOFF rtu = Modbus	FULL
Addr	Prot = FULL or Prot = rtu	0 to 31 (ASCII) if IntF = 485 0 to 9 (ASCII) if IntF = 422 1 to 247 if IntF = rtu	0 0 1
IntF	"S" hardware	485 = EIA-485 Interface type 422 = EIA-422 Interface type	485
IntF	"U" hardware	232 = EIA-232 Interface type 485 = EIA-485 Interface type	232

Table 3.2 - Communications Menu Prompts and Descriptions.

Chapter 4 Sending Commands

General Message Syntax

As soon as you link the devices, you can talk to the controllers using ASCII characters. They will respond to any Setup or Operation menu prompt, plus some others. The controller will respond to either upper or lower case ASCII characters from your computer.

Both protocol/interface combinations will respond to the general syntax if the commands or queries are correctly transmitted. However, the ANSI X3.28 Protocol requires beginning and ending characters, and the XON/XOFF protocol requires ending characters.

Message Syntax

Messages from your computer to a controller must take this general form.

Command <space> data.1 <space> data.2 <space> data.3... data.N

"Command" is a character string. The brackets "<" and ">" enclose a non-literal description. The space character, <space> or <sp>, is simply a delimiter, an ASCII space character (hex 20). "Data fields" are prompts and values specific to the command. The number of data fields depends on the particular command. The first argument or parameter is abbreviated, "data.1," the next is "data.2," and so on.

In the syntax explanations that follow, we show you the specific arguments for each command. It will speed the process if you remember this general syntax.

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the controller's EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

Data Rules

Data fields are prompts and values specific to particular commands. Specific data for each command for each type of controller is listed after this chapter. These rules govern their use:

- Data will include the characters 0 through 9; a decimal point if needed; or a positive or negative sign.
- Data can include up to seven characters. A "+" or "-" sign, if used, must be first.
- Data can use leading zeros, up to the seven-character limit.
- The data.1 portion of message can be up to four total characters.

Command List

These commands, represented by their respective ASCII characters, will enable you to program the controller from your computer. More detailed descriptions of the commands are in Chapters 5, 6 and 7.

? Returns the value of a specific prompt from the controller.
= Sets a specific prompt in the controller to a specific value.

Example Format

This manual presents command examples in a consistent format. Information bracketed by < > indicates a description, rather than literal characters. We show each ASCII character that you must transmit to the controller, including space between the characters. (A <space>, or <sp>, is itself an ASCII character, hex 20).

For instance, in the example below, you want to set the Alarm 2 Low A2LO prompt to 500°. Notice how the syntax uses the "=" command.

= <space> A2LO <space> 500 <carriage return>

To send this message, key the ASCII characters into your computer, or write them into your program. Remember, your computer will send the ASCII character string for the number, not an actual number. The hex string for the line looks like this: 3D2041324C4F203530300D.

Notice that we have not mentioned protocol here, or any characters added to this syntax by a protocol. With XON/XOFF, the message above can be transmitted with only an additional carriage return <cr> (hex 0D) character at the end. However, the ANSI X3.28 Protocol requires an envelope of Start of Text <STX> (hex 02) and End of Text <ETX> (hex 03) characters around the information you see above. You will learn how to do that in the following pages.

XON/XOFF Protocol for EIA-232

XON/XOFF (flow control) protocol allows a communicating device (either a controller or the host) to suspend transmission of all messages from the other device, and then to continue transmission when it's again ready.

The device that needs to suspend transmission sends the XOFF character (hex 13) to stop the other device's transmission, and XON (hex 11) to restart it. Any character will restart the transmission, but to avoid confusion use only the XON character.

Messages transmit according to the syntax described in the XON/XOFF formats that follow for each command.

The XON/XOFF protocol requires a carriage return <cr> character (hex 0D) at the end of every message.

How To Communicate Using XON/XOFF

XON/XOFF protocol is used when one master is networked with only one controller. Your personal computer must generate the master's messages.

"=" Command Example

Master: **= <sp> A2LO <sp> 500 <cr>** (Set the A2LO prompt value to 500.)

Remote: **<XOFF>** (This will be returned once the device starts processing. The master must stay off line.)

Remote: **<XON>** (Processing is done. The master may send a new message. Note: The commands IN1, IN2 and CF may take up to two seconds to return this character. **Do not send another message until this character is received.**)

"?" Command Example"

Master: **? <sp> A2LO <cr>** (Request the A2LO prompt value.)

Remote: **<XOFF>** (The remote is preparing the response. The master must stay off-line.)

Remote: **<XON> 500 <cr>** (The value is returned and **the master may send another message once the <cr> is received.**)

or

<XON> (The message was not understood. The master may send a new message.)

For maximum communications speed:

- Do not use a typical delay to wait before looking for a response.
- Scan for returned characters until the correct response is received.
- Use a time out to end a session if a correct response is not received in three seconds.

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the controller's EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

How to Communicate Using ANSI X3.28

The ANSI X3.28 protocol provides high quality communications by requiring a response to every message. With a multiple-device or "multidrop" network, this protocol prevents confusion among the separate devices. Furthermore, if noise occurs somewhere in the system, no prompt will change because noise cannot comply with the protocol.

By placing messages inside a protocol envelope, the messages are protected. In the following examples you'll see how this works.

ANSI X3.28 protocol rules:

- Every remote device must have a unique address.
- Only the master can initiate a communication session, by addressing a specific remote device.
- Every message must be framed with an <STX> (start of transmission) character and an <ETX> (end of transmission) character.
- The master must wait for the remote device to respond to every message within a reasonable period. If no response occurs, retry the connection or pursue error recovery.

Device Addresses

A Watlow EIA-422 multidrop network can handle up to 10 devices with this protocol. EIA-485 can handle up to 32 devices. Set the address number of the controller with the address prompt Addr under the Setup Menu SEt.

Address	ASCII Equivalent
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	A
11	B
12	C
13	D
14	E
15	F
16	G
17	H
18	I
19	J
20	K
21	L
22	M
23	N
24	O
25	P
26	Q
27	R
28	S
29	T
30	U
31	V

Table 4.4 - Address to ASCII Conversion for ANSI X3.28 Protocol.

ANSI X3.28 Protocol Example

This example demonstrates communication between a master device and a remote device at address 4. Your personal computer must generate the master's messages.

Establish Communications Link

Master: **4 <ENQ>** (Attempt to link with device 4.)
Remote: **4 <ACK>** (The link is established.)

End Communications Link

Master: **<DLE> <ENQ>** (End data link.)
Remote: No response.

"=" Command Example

Master: **<STX> = <sp> A2LO <sp> 500 <ETX>** (Set A2LO prompt value to 500.)
Remote: **<ACK>** (This will be returned once the unit has completed the value change. Note: The commands IN1, IN2 and CF may take up to 2 seconds to return this character. Do not send another message until this character is received.)

"?" Command Example

Master: **<STX> ? <sp> A2LO <ETX>** (Request the A2LO prompt value.)
Remote: **<ACK>** (This will be returned once the device has the response ready. Do not send the <EOT> until this character has been received.)
or
<NAK> (The command was not understood. Re-send corrected message.)

Master: **<EOT>** (The host gives the device permission to respond.)
Remote: **<STX> 500 <ETX>** (The device sends back the requested value. Do not send a response until the <ETX> has been received.)

Master: **<ACK>** (The host received the message correctly.)
or
<NAK> (The host did not understand the response.Device will re-send it.)
Remote: **<EOT>** (The device returns control to the host. Do not send a new message until this character has been received.)

For maximum communications speed:

- Do not use a typical delay to wait before looking for a response.
- Scan for returned characters until the correct response is received.
- Use a time out to end a session if a correct response is not received in three seconds. Try again later.
- Protocols are not flexible. Outside of the <STX> <ETX> framing only the defined protocol characters are allowed. Some programming languages add <cr> to the end of transmissions. This must be disabled.
- End the communications link and re-establish it with <DLE> and <ENQ> only when changing to a new device at a different address. The master can communicate repeatedly with a specific device once the initial data link is established.

Modbus Remote Terminal Unit (RTU)

Modbus RTU, available on the 988 family of controllers, expands the communications ability of the controller by enabling a computer to read and write directly to registers containing the controller's parameters.

Because of the wide array of choices available for setting up the 988 family of controllers, only a subset of the prompts contain parameters in a given situation. The Series 982, 988 and 998 User's Manuals explain the interrelations between prompts. If you try to write to an inactive prompt the controller will return an illegal data address message (02). (See "Exception Responses," pg. 4.9.)

If you already have a software application that uses Modbus, you can simply skip to the Temperature/process Controller Prompt Table or the Modbus RTU Address Table in this chapter for the address information your program will need. The rest of this section on the Modbus provides information for writing a software application that uses Modbus.

Writing a Modbus Application

NOTE:
Modbus register addresses are listed in the Controller Prompt Table later in this chapter and in the Modbus RTU Address Table at the end of this chapter.

You need to code messages in eight-bit bytes, with no parity bit. Negative parameter values must be written in two's complement format. Parameters are stored in two-byte registers accessed with read and write commands to a relative address. Messages are sent in packets that are delimited by a pause at least as long as the time it takes to send 30 bits. To determine this time in seconds, divide 30 by your baud rate.

Because changing some parameters automatically changes or defaults other parameters, use the Complete Parameter Download Sequence table in this chapter to order write commands.

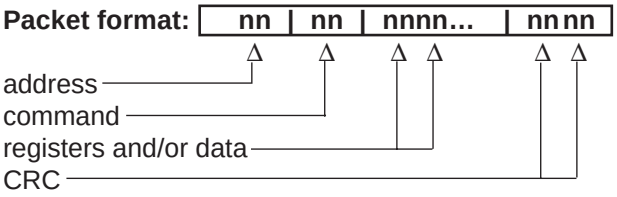
Using a controller address of 0x00 for a write command broadcasts that command to all the controllers in the network. This is a powerful feature if all the controllers on a network use all or most of the same parameters. No response is given to broadcast messages. Be sure to read each control to ensure it has received the command.

Packet Syntax

Each message packet begins with a one-byte controller address, from 0x01 to 0xF7. The second byte in the message packet identifies the message command: read (0x03 or 0x04); write (0x06 or 0x10); or loop back (0x08).

The next n bytes of the message packet contain register addresses and/or data.

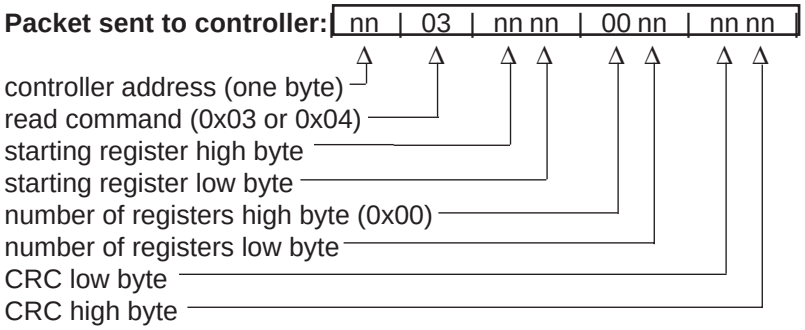
The last two bytes in the message packet contain a two-byte Cyclical Redundancy Checksum (CRC) for error detection.



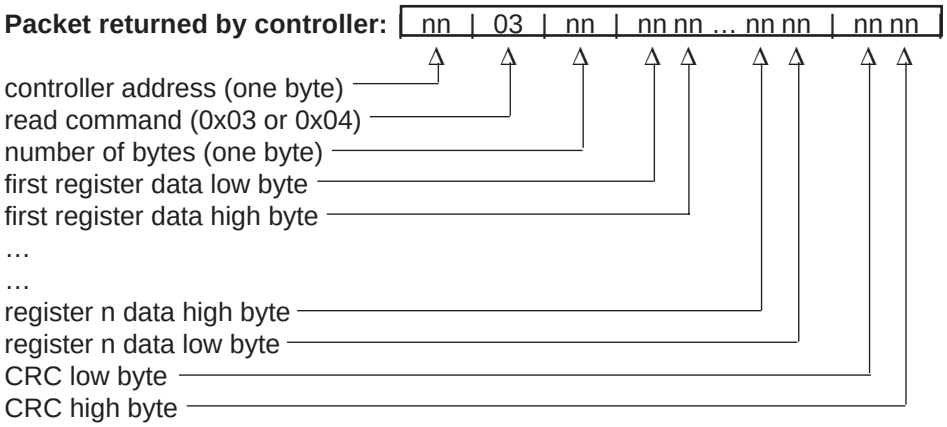
Read Multiple Registers Command (0x03 or 0x04)

This command returns from 1 to 32 registers.

Packet sent to controller:



Packet returned by controller:



NOTE:
Because the read command can only read 32 registers, the high byte for the number of registers will always be 0.

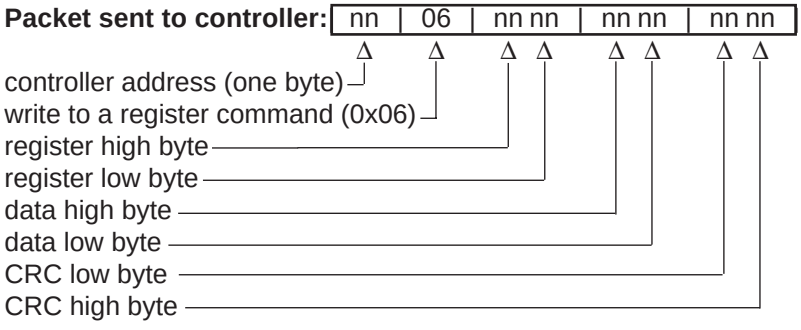
Example (988 only): Read register 0 (model number) of the controller at address 1.
Sent: `01 03 00 00 00 01 84 0A`
Received: `01 03 02 03 DC B9 2D`
Message: 988 (0x03DC).

Example (988 only): Read register 1 and 2 (Process 1 and 2 values) of controller at address 5.
Sent: `05 03 00 01 00 02 94 4F`
Received: `05 03 04 00 64 00 C8 FF BA`
Message: 100 (0x0064) and 200 (0x00C8).

Write to a Single Register Command (0x06)

This command writes a parameter to a single register. The controller will echo back the command. An attempt to write to a read-only parameter returns an illegal data address error (0x02). (See “Exception Responses,” pg. 4.9.)

Packet sent to controller:



Example (988 only): Set register 7 (SPI) to 200 (0x00C8) on controller at address 9.
Sent: `09 06 00 07 00 C8 38 D5`
Received: `09 06 00 07 00 C8 38 D5`

Write to Multiple Registers Command (0x10)

This command actually writes a parameter to only a single register. An attempt to write to a read-only parameter returns an illegal data address error (0x02). (See "Exception Responses," pg. 4.9.)

Packet sent to controller:

nn	10	nn nn	00 01	02	nn nn	nn nn

- controller address (one byte)
- write to multiple registers command (0x10)
- starting register high byte
- starting register low byte
- number of registers to write high byte (0x00)
- number of registers to write low byte (must be 0x01)
- number of data bytes (must be 0x02)
- data high byte
- data low byte
- CRC low byte
- CRC high byte

NOTE:
Because the read command can only read 32 registers, the high byte for the number of registers will always be 0.

Packet returned by controller:

nn	10	nn nn	00 01	nn nn

- controller address (one byte)
- write to multiple registers command (0x10)
- starting register high byte
- starting register low byte
- number of registers to write high byte (0x00)
- number of registers to write low byte (must be 0x01)
- CRC low byte
- CRC high byte

Loop Back Command (0x08)

This command simply echoes the message. This serves as a quick way to check your wiring.

Packet sent to controller:

nn	08	nn nn	nn nn

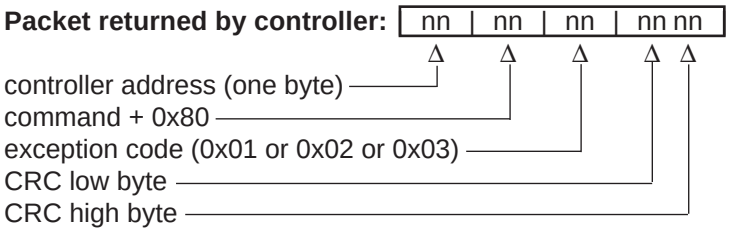
- controller address (one byte)
- loop back command (0x08)
- data high byte
- data low byte
- CRC low byte
- CRC high byte

Example: Run loop back test on controller at address 40 (0x28).
Sent: `28 08 55 66 77 88 31 B7`
Received: `28 08 55 66 77 88 31 B7`

Exception Responses

When a controller cannot process a command it returns an exception response and sets the high bit (0x80) of the command.
0x01 illegal command
0x02 illegal data address
0x03 illegal data value

Packet returned by controller:



Messages with the wrong format, timing or CRC are ignored. A read command sent to an inactive parameter returns 0x0000.

Example: Exception 01 - Command 02 is not supported.
Sent: `01 02 00 01 00 02 A8 0B`
Received: `01 82 01 81 60`

Example: Exception 02 - The parameter at register 45 (0x002D) is inactive.
Sent: `01 06 00 2D 00 01 D8 C3`
Received: `01 86 02 C3 A1`

Example: Exception 03 - Cannot write 12,000 (0x2EE0) to register 7, out of range, illegal data value.
Sent: `01 06 00 07 2E E0 24 23`
Received: `01 86 03 02 61`

Cyclical Redundancy Checksum (CRC) Algorithm

This C routine, calc_crc(), calculates the cyclical redundancy checksum, CRC, for a string of characters. The CRC is the result of dividing the string by 0xA001. Modbus applications calculate the packet's CRC then append it to the packet.

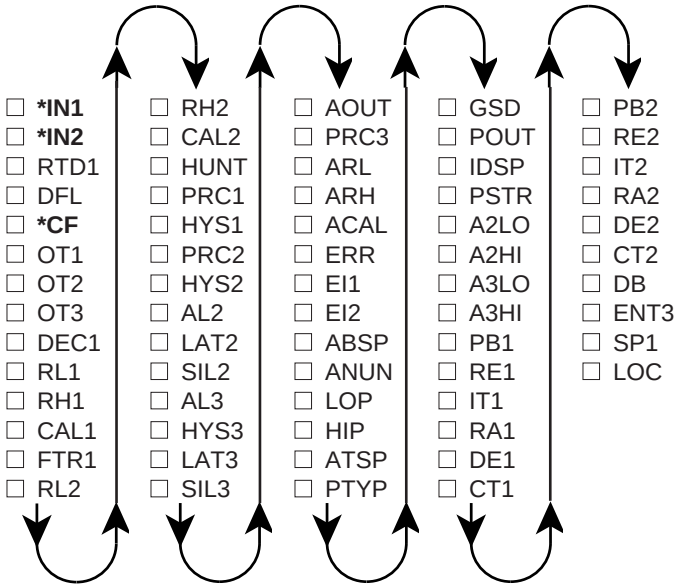
NOTE:
When the CRC is added to the message packet be sure to put the low byte before the high byte.

```
#define POLYNOMIAL 0xA001;

unsigned int calc_crc(unsigned char *start_of_packet, unsigned char
*end_of_packet)
{
     unsigned int crc;
     unsigned char bit_count;
     unsigned char *char_ptr;

/* Start at the beginning of the packet */

     char_ptr = start_of_packet;

/* Intitialize CRC */

     crc = 0xffff;

/* Loop through the entire packet */

     do{

/* Exlusive-OR the byte with the CRC */

          crc ^= (unsigned int)*char_ptr;

/* Loop through all 8 data bits */

          bit_count = 0;
          do{

/* If the LSB is 1, shift the CRC and XOR the poynomial mask with the CRC */

               if(crc & 0x0001){
                    crc >>= 1;
                    crc ^= POLYNOMIAL;
               }

/* If the LSB is 0, shift the CRC only */

               else{
                    crc >>= 1;
               }
          } while(bit_count++ < 7);
     } while(char_ptr++ < end_of_packet);
return(crc);
}
```

Chapter 5 Command Summary of the Series 981-984

Complete Parameter Download Sequence

When you download a complete set of parameters to a controller, **you must load them in this order**. The user's manual has more information about prompt interaction.



CAUTION: Entering commands out of sequence will produce unexpected results, because some prompts change the values of other prompts. Copy this page and use the checkboxes.

Table 5.1 - Download Sequence.

*** Wait at least two seconds after executing this command before going on to the next command.**

Run/Hold Mode and Prompt Accessibility

Most Series 981-984 prompts are accessible via data communications while the controller is in its hold mode. Several are accessible when the controller is in either run or hold. A few are accessible only in the run mode. You can monitor the controller's mode with the RHS command.

Table 5.2 identifies the prompts accessible in run or hold, and those available in run only. Others not specifically identified are accessible in the hold mode only.

CAUTION: Sending the Series 981-984 an invalid prompt for its present mode (run or hold) will result in a data communication error code ER2. Use the RHS prompt to monitor the controller mode.

RUN Only Mode	RUN or HOLD MODE
? CSP	? ALM
? EJC	? C1
? ENSP	? C2
? MTR*	? ENT3
= HOLD 1	? ENT4
	? ER
	? ER2
	? RHS
	? SP1
	? DEV**
	? MTR**
	? PWR**
	= MOD x
	= SP1

Table 5.2 - Run/Hold Mode Commands.

Resetting the communication parameters is valid only in the hold mode.
* This command is accessible only in the run mode for software revisions before and including REV H.
** These commands are accessible in the run and hold modes for software revisions after and including REV I.

Ramping Controller Prompt Table

Command Summary Series 981-984 Data Communications

Table 5.3 -
A2HI to AMB

Name data.1 / Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
A2HI 322	**Output 2 Alarm High**	? <sp> A2HI <cr> = <sp> A2HI <sp> data.2 <cr>	Process: A2LO to sensor high range Deviation: 0 to 9999° Rate: 0 to 9999°/minute Default: RH, 999°, or 999°/min.
A2LO 321	**Output 2 Alarm Low**	? <sp> A2LO <cr> = <sp> A2LO <sp> data.2 <cr>	Process: sensor low range to A2HI Deviation: -999 to 0° Rate: -999 to 0°/minute Default: RL, -999°, or -999°/min.
A3HI 341	**Output 3 Alarm High**	? <sp> A3HI<cr> = <sp> A3HI <sp> data.2 <cr>	Process: A3LO to sensor high range Deviation: 0 to 9999° Rate: 0 to 9999°/minute Default: RH, 999°, or 999°/min.
A3LO 340	**Output 3 Alarm Low**	? <sp> A3LO <cr> = <sp> A3LO <sp> data.2 <cr>	Process: sensor low range to A3HI Deviation: -999 to 0° Rate: -999 to 0°/minute Default: RL, -999°, or -999°/min.
ABSP 1211	**Abort Set Point**	? <sp> ABSP <cr> = <sp> ABSP <sp> data.2 <cr>	off RL to RH
ACAL 746	**Calibration Offset for Retransmit Output**	? <sp> ACAL <cr> = <sp> ACAL <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C 999 to 999 units Default: 0°F, 0°C, or 0 units
AL2 719	**Alarm 2 Type**	? <sp> AL2 <cr> = <sp> AL2 <sp> data.2 <cr>	0 = Process Alarm, Input 1 1 = Deviation Alarm, Input 1 2 = Rate Alarm, Input 1 Default: 0
AL3 736	**Alarm 3 Type**	? <sp> AL3 <cr> = <sp> AL3 <sp> data.2 <cr>	0 = Process Alarm, Input 1 1 = Deviation Alarm, Input 1 2 = Rate Alarm, Input 1 Default: 0
ALM 106 or 110	**Alarm Status** (Writing a 0 clears next alarm.)	? <sp> ALM <cr> = <sp> ALM <sp> 0 <cr>	0 = No alarms occurring (0000 0000) Bit 1 = A2LO (0000 0001) Bit 2 = A2HI (0000 0010) Bit 3 = A3LO (0000 0100) Bit 4 = A3HI (0000 1000) 106 = Alarm 2 0 = off 1 = HI 2 = LO 110 = Alarm 3 0 = off 1 = HI 2 = LO
AMB 1500	**Ambient Terminal Temperature**	? <sp> AMB <cr>	Input 1 terminals in 0.0°F

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Ramping Controller Prompt Table

Table 5.4 -
ANUN to DE1

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Name data.1 / Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
ANUN 725	**Alarm Annunciation**	? <sp> ANUN <cr> = <sp> ANUN <sp> data.2 <cr>	0 = off 1 = on Default: on
AOUT 743	**Analog Output 3 Retransmit Function**	? <sp> AOUT <cr> = <sp> AOUT <sp> data.2 <cr>	0 = Retransmit Process Input 1 1 = Retransmit Set Point 1 2 = off 3 = Retransmit Process Input 2 Default: 0
ARH 745	**Retransmit Range High**	? <sp> ARH <cr> = <sp> ARH <sp> data.2 <cr>	ARL to 9999 Default: RH1 or RH2 per AOUT
ARL 744	**Retransmit Range Low**	? <sp> ARL <cr> = <sp> ARL <sp> data.2 <cr>	-999 to ARH Default: RL1 or RL2 per AOUT
ATSP 304	**Auto-tune Set Point %**	? <sp> ATSP <cr> = <sp> ATSP <sp> data.2 <cr>	50 to 150% Default: 90%
AUT 305	**Auto-tune**	? <sp> AUT <cr> = <sp> AUT <sp> data.2 <cr>	0 = No auto-tuning 1 = Tune PID Default: off
C1 100	**Input 1 Value**	? <sp> C1 <cr>	Based on IN1 range ; RL1 to RH1
C2 104	**Input 2 Value**	? <sp> C2 <cr>	Based on IN2 range ; RL2 to RH2
CAL1 605	**Input 1 Calibration Offset**	? <sp> CAL1 <cr> = <sp> CAL1 <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0
CAL2 615	**Input 2 Calibration Offset**	? <sp> CAL2 <cr> = <sp> CAL2 <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0
CF 901	**Degrees Select Display Loop**	? <sp> CF <cr> = <sp> CF <sp> data.2 <cr>	0 = Display °F 1 = Display °C Default: 0
CSP 1202	**Current Profile Set Point**	? <sp> CSP <cr>	RL1 to RH1
CT1 506	**Cycle Time Output 1**	? <sp> CT1 <cr> = <sp> CT1 <sp> data.2 <cr>	S.S. relay or open col: 0.0 = Burst firing, or 0.1 to 999.9 sec. (time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 10.0 sec.
CT2 516	**Cycle Time Output 2**	? <sp> CT2 <cr> = <sp> CT2 <sp> data.2 <cr>	S.S. relay or open col: 0.0 = Burst firing, or 0.1 to 999.9 sec. (time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 10.0 sec.
DATE 5	**Factory Test Date**	? <sp> DATE <cr>	xxyy xx = week yy = year
DB 505	**Dead Band PID Heat/Cool**	? <sp> DB <cr> = <sp> DB <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0°F, 0°C, or 0 units
DE1 503	**Derivative Output 1 PID**	? <sp> DE1 <cr> = <sp> DE1 <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00

Ramping Controller Prompt Table

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
DE2 513	**Derivative Output 2 PID**	? <sp> DE2<cr> = <sp> DE2 <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DEC1 606	**Decimal Point Process Input 1**	? <sp> DEC1 <cr> = <sp> DEC1 <sp> data.2 <cr>	0 = Decimal point 0 1 = Decimal point 0.0 2 = Decimal point 0.00 3 = Decimal point 0.000 Default: 0
DEV 211	**Process Deviation Display Loop (IN 1)**	? <sp> DEV <cr>	Difference between SP1 and C1
DFL 900	**Default Unit Type**	? <sp> DFL <cr> = <sp> DFL <sp> data.2 <cr>	0 = US units 1 = Standard international units
EI1 1060	**Event Input 1 Function**	? <sp> EI1 <cr> = <sp> EI1 <sp> data.2 <cr>	0 = None 1 = Lock out keyboard 2 = Alarm reset 3 = Turn control outputs off 4 = Hold profile 5 = Start file 1 6 = Start file 2 7 = Start file 3 8 = Start file 4 9 = ABSP 10 = Pause 11 = Waitfor Event Default: 0
EI1S 201	**Event Input 1 Status**	? <sp> EI1S <cr>	0 = Open (off) 1 = Closed (on)
EI2 1062	**Event Input 2 Function**	? <sp> EI2 <cr> = <sp> EI2 <sp> data.2 <cr>	0 = None 1 = Lock out keyboard 2 = Alarm reset 3 = Turn control outputs off 4 = Hold profile 5 = Start file 1 6 = Start file 2 7 = Start file 3 8 = Start file 4 9 = ABSP 10 = Pause 11 = Waitfor Event Default: 0
EI2S 213	**Event Input 2 Status**	? <sp> EI2S <cr>	0 = Open (off) 1 = Closed (on)
EJC 1203	**Elapsed Jump Count**	? <sp> EJC <cr>	0 to 255
ENSP 1204	**End Set Point**	? <sp> ENSP <cr>	RL1 to RH1
ENT3 1268	**Event 3 Output State**	? <sp> ENT3 <cr> = <sp> ENT3 <sp> data.2 <cr>	0 = off 1 = on
ER 209	**Error, Analog Input** (Multiple errors possible.)	? <sp> ER <cr>	0 = No error 1 = Input 1 A-D overflow 2 = Input 1 overrange 3 = Input 1 underrange 4 = Input 1 A-D underflow 5 = Input 2 A-D overflow 6 = Input 2 overrange 7 = Input 2 underrange 8 = Input 2 A-D underflow 9 = Ambient error

Table 5.5 -
DE2 to ER

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CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Ramping Controller Prompt Table

Table 5.6 -
ER2 to HYS3

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
ER2 **n/a**	**Error, Communications**	? <sp> ER2 <cr>	0 = No error 1 = Transmit buffer overflow 2 = Receive buffer overflow 3 = Framing error 4 = Overrun error 5 = Parity error 6 = Talking out of turn 7 = Invalid reply error 8 = Noise error 20 = Command not found 21 = Prompt not found 22 = Incomplete command line 23 = Invalid character 24 = Number of chars. overflow 25 = Input out of limit 26 = Read only command 27 = Write allowed only 28 = Prompt not active 30 = Request to RUN invalid 31 = Request to HOLD invalid 32 = Command invalid in RUN Mode 33 = Command invalid in HOLD Mode 34 = Output 3 is not an Event 35 = Output 4 is not an Event 38 = Asterisk not allowed 39 = Infinite loop error
ERR 607	**Error, Latching Enable**	? <sp> ERR <cr> = <sp> ERR <sp> data.2 <cr>	0 = Errors latching 1 = Errors non-latching Default: 1
FTR1 604	**Filter Time Constant Process Input 1**	? <sp> FTR1 <cr> = <sp> FTR1 <sp> data.2 <cr>	-60 to 60 seconds Default: 0
GSD 1205	**Guaranteed Soak Deviation**	? <sp> GSD <cr> = <sp> GSD <sp> data.2 <cr>	0°F to 999°F 0°C to 999°C 0 to 999 units 0 = (disabled) Default: 0°F, 0°C, or 0 units
HIP 714	**High Power Limit**	? <sp> HIP <cr> = <sp> HIP <sp> data.2 <cr>	LOP (%) to 100% Default: 100 (heat/cool) Default: 0 (cool only)
HOLD 1210	**Simulate HOLD Key Press**	= <sp> HOLD <sp> data.2 <cr>	1 = Holds current file# and step#
HUNT 1905	**Slidewire Dead Band %**	? <sp> HUNT <cr> = <sp> HUNT <sp> data.2 <cr>	0.1% to 100.0% Default: 1.0%
HYS1 507	**Output 1 Hysteresis**	? <sp> HYS1 <cr> = <sp> HYS1 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C, or 3 units
HYS2 517 720	**Output 2 Hysteresis**	? <sp> HYS2 <cr> = <sp> HYS2 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C, or 3 units
HYS3 737	**Output 3 Hysteresis**	? <sp> HYS3 <cr> = <sp> HYS3 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C, or 3 units

Ramping Controller Prompt Table

Table 5.7 - **IDSP to LAT3**

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
IDSP 308	**Idle Set Point After Power Outage**	? <sp> IDSP <cr> = <sp> IDSP <sp> data.2 <cr>	RL1 to RH1
IN1 601	**Input 1 Type** **Caution: Writing to IN1 or IN2 resets most prompts to their default values.**	? <sp> IN1 <cr> = <sp> IN1 <sp> data.2 <cr>	1 = J t/c; 32 to 1500°F/0 to 816°C 2 = K t/c; -328 to 2500°F/-200 to 1371°C 3 = T t/c; -328 to 750°F/-200 to 399°C 4 = N t/c; 32 to 2372°F/0 to 1300°C 5 = E t/c; -328 to 1470°F/-200 to 799°C 6 = C t/c (W3); 32 to 4200°F 0 to 2316°C 7 = D t/c (W5); 32 to 4200°F/0 to 2316°C 8 = Pt 2; 32 to 2543°F/0 to 1395°C 10 = R t/c; 32 to 3200°F/0 to 1760°C 11 = S t/c; 32 to 3200°F/0 to 1760°C 12 = B t/c; 1598 to 3300°F/870 to 1816°C 14 = 1° RTD (DIN); -328 to 1472°F/-200 to 800°C 15 = 0.1° RTD (DIN); -99.9 to 999.9°F/-99.9 to 700.0°C 17 = 4-20mA; -999 to 9999 units 18 = 0-20mA; -999 to 9999 units 19 = 0-5V⎓ (dc); -999 to 9999 units 20 = 1-5V⎓ (dc); -999 to 9999 units 21 = 0-10V⎓ (dc); -999 to 9999 units 23 = 0-50mV⎓ (dc); -999 to 9999 units 24 = 0-100mV⎓ (dc); -999 to 9999 units
IN2 611	**Input 2 Type**	? <sp> IN2 <cr> = <sp> IN2 <sp> data.2 <cr>	26 = Slidewire off 27 = Slidewire; 100 to 1200 32 = Event input 2 off 33 = Event Input 2 on
IT1 501	**Integral for Output 1**	? <sp> IT1 <cr> = <sp> IT1 <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 10.00 minutes per repeat
IT2 511	**Integral for Output 2**	? <sp> IT2 <cr> = <sp> IT2 <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 10.00 minutes per repeat
ITY1 8	**Input 1 Hardware Type**	? <sp> ITY1 <cr>	0 = None 1 = t/c only 4 = Input off 5 = Universal RTD 6 = Universal high gain t/c 7 = Universal low gain t/c 8 = Universal millivolts 9 = Universal process
ITY2 9	**Input 2 Hardware Type**	? <sp> ITY2 <cr>	0 = None 3 = Slidewire 4 = Input off 10 = Event input
LAT2 721	**Alarm 2 Latching**	? <sp> LAT2 <cr> = <sp> LAT2 <sp> data.2 <cr>	0 = Latching alarms 1 = Non-latching alarms Default: 1
LAT3 738	**Alarm 3 Latching**	? <sp> LAT3 <cr> = <sp> LAT3 <sp> data.2 <cr>	0 = Latching alarms 1 = Non-latching alarms Default: 1

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting.

NOTE:
(RTD setting)
For JIS curve, go to rtd1 prompt after selecting In1.

Ramping Controller Prompt Table

Table 5.8 -
LOC to OT3

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
LOC 1300	**Keyboard Lockout**	? <sp> LOC <cr> = <sp> LOC <sp> data.2 <cr>	0 = No lockout 1 = Lock out PID Menu and auto-tune prompt 2 = Lock out System, PID and Program Menus 3 = Lock out System, PID and Program Menus; and set point 1 slewing Default: 0
LOP 715	**Low Power Limit**	? <sp> LOP <cr> = <sp> LOP <sp> data.2 <cr>	-100% to HiP (%) Default: -100% (heat/cool) Default: 0% (heat only)
LRNH 1907	**Learn High Slide-wire Resistance**	? <sp> LRNH <cr> = <sp> LRNH <sp> data.2 <cr>	0 = No function 1 = Learn Default: 0
LRNL 1906	**Learn Low Slide-wire Resistance**	? <sp> LRNL <cr> = <sp> LRNL <sp> data.2 <cr>	0 = No function 1 = Learn Default: 0
MDL 0	**Model Number**	? <sp> MDL <cr>	982 (981-984 ramping unit)
MOD 1900	**Mode Key Action**	= <sp> MOD <sp> data.2 <cr>	0 = Mode to previous prompt 1 = Mode to next prompt
MTR 1200	**Monitor the currently running step.** This key command responds with all step information for these step types: • Set Point (time) • Set Point (rate) • Soak These step types have zero-time duration; they will never respond to an MTR query: • Jump-loop • Link File • End Step	? <sp> MTR <cr>	See Key Command, "MTR," at the end of this chapter for full response syntax.
OT1 700	**Output 1 Action**	? <sp> OT1 <cr> = <sp> OT1 <sp> data.2 <cr>	0 = Heat 1 = Cool
OT2 717	**Output 2 Action**	? <sp> OT2 <cr> = <sp> OT2 <sp> data.2 <cr>	0 = Heat 1 = Cool 2 = None 3 = Alarm 2 4 = Alarm 2 reverse acting
OT3 734	**Output 3 Action**	? <sp> OT3 <cr> = <sp> OT3 <sp> data.2 <cr>	0 = None 1 = Alarm 3 2 = Alarm 3 reverse acting 3 = Event 3 (ENT3)

Ramping Controller Prompt Table

Table 5.9 - **OTY1 to PSTR**

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
OTY1 16 **OTY2** 17 **OTY3** 18 **OTY4** 19	**Output 1 Hardware** **Output 2 Hardware** **Output 3 Hardware** **Output 4 Hardware**	? <sp> <OTY1> <cr> ? <sp> <OTY2> <cr> ? <sp> <OTY3> <cr> ? <sp> <OTY4> <cr>	0 = None 1 = SSR 0.5A 2 = SSR 0.5A with suppression 5 = Dual SSR form A 6 = Switched dc 7 = Dual switched dc 8 = Relay 5A form C 9 = Relay 5A form C with suppression 10 = Relay 5A form A/B 11 = Relay 5A form A/B with suppr. 12 = Dual Relay form A 13 = Process output 14 = Voltage retransmit 15 = Current retransmit 16 = Power supply 17 = Comms EIA-232 18 = Comms EIA-485 / EIA-422 19 = Comms EIA-485 / EIA-232
PB1 500	**Proportional Band Output 1**	? <sp> PB1 <cr> = <sp> PB1 <sp> data.2 <cr>	if DFL = 0 and CF = 1, then 0 to 555°C if DFL = 0 and CF = 0, then 0 to 999°F if DFL = 0 and In1 = a process value, then 0 to 999 units if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units, or 3.0%
PB2 510	**Proportional Band Output 2**	? <sp> PB2 <cr> = <sp> PB2 <sp> data.2 <cr>	if DFL = 0 and CF = 1, then 0 to 555°C if DFL = 0 and CF = 0, then 0 to 999°F if DFL = 0 and In1 = a process value, then 0 to 999 units if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units, or 3.0%
POUT 1206	**Power Outage Response**	? <sp> POUT <cr> = <sp> POUT <sp> data.2 <cr>	0 = Continue 1 = Hold (HOLD) 2 = Abort 3 = Idle set point (IDSP) 4 = Reset
PRC1 701	**Process Range Output 1**	? <sp> PRC1 <cr> = <sp> PRC1 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PRC2 718	**Process Range Output 2**	? <sp> PRC2 <cr> = <sp> PRC2 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PRC3 735	**Process Range Output 3**	? <sp> PRC3 <cr> = <sp> PRC3 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PSTR 1207	**Program Start Point**	? <sp> PSTR <cr> = <sp> PSTR <sp> data.2 <cr>	0 = Start @ current process value 1 = Start @ hold mode set point Default: 1

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Ramping Controller Prompt Table

Table 5.10 -
PTYP to SOFT

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
PTYP 1208	**Program Type; Time-based, or Ramp rate-based**	? <sp> PTYP <cr> = <sp> PTYP <sp> data.2 <cr>	0 = Time-based; hour:min:sec 1 = Ramp rate-based; °/minute Default: 0
PWR 103	**Percent Power Present Output**	? <sp> PWR <cr>	-100% to 100% Default: n/a
RA1 504	**Rate Output 1**	? <sp> RA1 <cr> = <sp> RA1 <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA2 514	**Rate Output 2**	? <sp> RA2 <cr> = <sp> RA2 <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RE1 502	**Reset Output 1**	? <sp> RE1 <cr> = <sp> RE1 <sp> data.2 <cr>	0.00 to 9.99 repeats/min. Default: 0.10 repeats/min.
RE2 512	**Reset Output 2**	? <sp> RE2 <cr> = <sp> RE2 <sp> data.2 <cr>	0.00 to 9.99 repeats/min. Default: 0.10 repeats/min.
RESU 1209	**Resume a Program**	= <sp> RESU <sp> data.2 <cr>	1 = Resumes current file# and step#
RH1 603	**Range High Input 1**	? <sp> RH1 <cr> = <sp> RH1 <sp> data.2 <cr>	min. IN1 range to max. IN1 range Default: sensor high range
RH2 613	**Range High Input 2**	? <sp> RH2 <cr> = <sp> RH2 <sp> data.2 <cr>	min. IN2 range to max. IN2 range Default: sensor high range
RHS 200	**Run/Hold Status**	? <sp> <RHS> <cr>	0 = Hold 1 = Run 2 = Pre-run
RL1 602	**Range Low Input 1**	? <sp> RL1 <cr> = <sp> RL1 <sp> data.2 <cr>	min. IN1 range to max. IN1 range Default: sensor low range
RL2 612	**Range Low Input 2**	? <sp> RL2 <cr> = <sp> RL2 <sp> data.2 <cr>	min. IN2 range to max. IN2 range Default: sensor low range
RTD1 609	**RTD Calibration Curve Input 1**	? <sp> RTd1 <cr> = <sp> RTd1 <sp> data.2 <cr>	0 = JIS 1 = DIN Default: 1
SIL2 722	**Alarm 2 Silence**	? <sp> SIL2 <cr> = <sp> SIL2 <sp> data.2 <cr>	0 = off/disabled 1 = on/enabled Default: 0
SIL3 739	**Alarm 3 Silence**	? <sp> SIL3 <cr> = <sp> SIL3 <sp> data.2 <cr>	0 = off/disabled 1 = on/enabled Default: 0
SRNB 2	**Serial Number Bottom Display** Read the six-digit unit serial number in two segments, SNxx and xxxx, i.e., upper and lower front panel displays.	? <sp> SRNB <cr>	xxxx = 0000 to 9999
SRNT 1	**Serial Number Top Display**	? <sp> SRNT <cr>	SNxx = 00 to 99
SOFT 4	**Software Revision**	? <sp> SOFT <cr>	0 = Rev A 1 = Rev B 2 = Rev C 3 = Rev D 4 = Rev E 5 = Rev F 6 = Rev G 7 = Rev H 8 = Rev I 9 = Rev J 10 = Rev K 11 = Rev L 12 = Rev M 13 = Rev N etc.....

Ramping Controller Prompt Table

Table 5.11 - **SP1 to TOUT**

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
SP1 300	**Set Point 1**	? <sp> SP1 <cr> = <sp> SP1 <sp> data.2 <cr>	RL1 to RH1 Default: per IN1 and hardware set SP1 to RL1-1 to turn all outputs off
SHYS 1904	**Slidwire Hysteresis**	? <sp> SHYS <cr> = <sp> SHYS <sp> data.2 <cr>	0 to Hunt
STP Read: 1201 Write: 1250	**Program a File Step.** This key command programs or queries all step information for all step types: • Set Point (time) • Set Point (rate) • Soak • Jump-loop • Link File • End	? <sp> <STP> <sp> <FILE> <cr> = <sp> <STP> <sp> <FILE> data.2 <sp> ... data.n <cr> **See Key Command, "STP," at the end of this chapter for full syntax and data. See p. 5.14**	
STRT 1250	**Start a File**	= <sp> STRT <sp> data.2 <sp> data.3 <sp>	data.2: 1 = File 1, 2 = File 2, 3 = File 3, 4 = File 4 data.3: 1 = Step 1, 2 = Step 2, 3 = Step 3, 4 = Step 4, 5 = Step 5, 6 = Step 6
TOUT 1514	**Test Outputs**	= <sp> TOUT <sp> data.2 <cr>	0 = All off 1 = Output 1 on 2 = Output 2 on 3 = Output 3 on 4 = Output 4 on

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1 or IN1 setting. (This does not apply to Modbus Protocol.)

Ramping Controller MTR Command

Vertical lines represent <space> characters. Final vertical line represents a <space> and a <carriage return>. Each field must have data.

	data.1	data.2	data.3	data.4	data.5	data.6	data.7	data.8	data.9	data.10	data.11

Monitor the Current Step for Current Process Information; response will parallel step type syntax below.

?	**MTR** (Query current step info)	

MTR Response for a Set Point Step, Time-based (PTYP = TI) Syntax

<FILE#>	**<STEP#>**	**<STYP>**	**<SP>**	**<HOUR>**	**<MIN>**	**<SEC>**	**<ENT3>**	**<ENT4>**
1 to 4	1 to 6	(Step Type) 1= SP (Set Point)	RL to RH DFLT: 75°F/ 25°C/75 units, or RL if > the above.	0 to 99	0 to 59	0 to 59	(Event 3 Status) **"*"= disabled or unavailable** 0=off 1=on	(Event 4 Status) **"*"= disabled or unavailable**

MTR Response for a Set Point Step, Ramp Rate-based (PTYP = RATE) Syntax

<FILE#>	**<STEP#>**	**<STYP>**	**<SP>**	**<RATE>**	**<ENT3>**	**<ENT4>**
1 to 4	1 to 6	(Step Type) 1= SP (Set Point)	RL to RH DFLT: 75°F/ 25°C/75 units, or RL if > the above.	0 to 360°F, 0 to 200°C, or 0 to 360 units	(Event 3 Status) **"*"= disabled or unavailable** 0=off 1=on	(Event 4 Status) **"*"= disabled or unavailable**

NOTE:
You must send an "*" if disabled or unavailable.

MTR Response for a Soak Step Syntax

<FILE#>	**<STEP#>**	**<STYP>**	**<HOUR>**	**<MIN>**	**<SEC>**	**<ENT3>**	**<ENT4>**	**<WE>**	**<WPR>**
1 to 4	1 to 6	(Step Type) 2= SOAH (Soak)	0 to 99	0 to 59	0 to 59	(Event 3 Status) **"*"= disabled or unavailable** 0=off 1=on	(Event 4 Status) **"*"= disabled or unavailable**	(Wait for Event) **"*"= disabled or unavailable** 0=off 1=on	(Wait for Process) **"*"= disabled or unavailable** Range: RL1 to RH1

Note: MTR responses for Jump-loop, Link File and End Steps do not exist. These are zero time steps. The MTR will wait for next available set point or soak step type information.

Table 5.12 -
Key Command, MTR.

CAUTION:
Excessive use of the Monitor (MTR) command can slow Series 981-984 input sampling and output update rates. Avoid sending the MTR command more than once every five seconds.

CAUTION:
Avoid writing (=) continuously, such as ramping set points or repetitive loops, to the Series 981-984 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

Ramping Controller STP Command

Vertical lines represent <space> characters. Final vertical line represents a <space> and a <carriage return>. Each field must have data.

	data.1	data.2	data.3	data.4	data.5	data.6	data.7	data.8	data.9	data.10	data.11

Query any Step for Programmed Information; response will parallel step type syntax below.

?	**STP** (Query step info)	**<FILE#>** 1 to 4	**<STEP#>** 1 to 6

Program any Step per the Step Types below.

Set Point Step, Time-based (PTYP = TI) Syntax

=	**STP** (Program a step)	**<File #>** 1 to 4	**<STEP#>** 1 to 6	**<STYP>** (Step Type) 1= SP (Set Point)	**<SP>** RL to RH DFLT: 75°F/ 25°C/ 75 units	**<HOUR>** 0 to 23	**<MIN>** 0 to 59	**<SEC>** 0 to 59	**<ENT3>** (Event 3 Status) **"*"= disabled or unavailable** 0=off 1=on	**<ENT4>** (Event 4 Status) **"*"= disabled or unavailable**

Set Point Step, Ramp Rate-based (PtyP = rAtE) Syntax

=	**STP** (Program a step)	**<FILE#>** 1 to 4	**<STEP#>** 1 to 6	**<STYP>** (Step Type) 1= SP (Set Point)	**<SP>** RL to RH DFLT: 75°F/ 25°C/ 75 units	**<RATE>** 0 to 360°F, 0 to 200°C or 0 to 360 units	**<ENT3>** (Event 3 Status) **"*"= disabled or unavailable** 0=off 1=on	**<ENT4>** (Event 4 Status) **"*"= disabled or unavailable**	**NOTE:** **You must send an "*" if disabled or unavailable.**

Soak Step Syntax

=	**STP** (Program a Step)	**<FILE#>** 1 to 4	**<STEP#>** 1 to 6	**<STYP>** (Step Type) 2= SOAH (Soak)	**<HOUR>** 0 to 23	**<MIN>** 0 to 59	**<SEC>** 0 to 59	**<ENT3>** (Event 3 Status) **"*"= disabled or unavailable** 0=off 1=on	**<ENT4>** (Event 4 Status) **"*"= disabled or unavailable**	**<WE>** (Wait for Event) **"*"= disabled or unavailable** 0=DSBL 1=on 2=off	**<WPR>** (Wait for Process) **"*"= disabled or unavailable** Range: RL1 to RH1; (RLI-1) =DSBL

Jump-loop Step Syntax

=	**STP** (Program a Step)	**<FILE#>** 1 to 4	**<STEP#>** 1 to 6	**<STYP>** (Step Type) 3= JL (Jump-loop)	**<JF>** (Jump to File) 1 to 4 DFLT: current file	**<JS>** (Jump to Step) 1 to 5 DFLT: 1 Must be lower than current step #.	**<JC>** (Jump Count) Repeat 0 to 255 times 0 = infinite counts

Table 5.13 -
Key Command, STP.

Link File Step Syntax

=	**STP** (Program a Step)	**<FILE#>** 1 to 4	**<STEP#>** 1 to 6	**<STYP>** (Step Type) 4= LFIL (Link File)	**<LFIL>** 1 = FIL1 2 = FIL2 3 = FIL3 4 = FIL4

End Step Syntax

=	**STP** (Program a Step)	**<FILE#>** 1 to 4	**<STEP#>** 1 to 6	**<STYP>** (Step Type) 0= End	**<END>** (End Status) 0 = Hold 1 = off

Ramping Controller Commands

MONITOR (MTR) Command

READ only

Register: 1200 (You must request 23 registers)

NOTE: "*" means the parameter is not available. The value will be -9999.

MTR response for a Set Point Step, Time-based(PTYP = TI)

Register #	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210
Parameter	File	Step	Type	SP	Hour	Min	Sec	*	*	*	*

MTR response for a Set Point Step, Rate-based(PTYP = RATE)

Register #	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210
Parameter	File	Step	Type	SP	*	*	*	Rate	*	*	*

MTR response for a Soak Step

Register #	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210
Parameter	File	Step	Type	*	Hour	Min	Sec	*	*	*	*

START (STRT) Command

WRITE only

Register: 1250 1251 1252

Value: 1 File # Step #

SET command, sets the current profile FILE and STEP.

WRITE only

Register: 1250 1251 1252

Value: 3 File # Step #

STEP (STP) Command

READ the current file and step

Register: 1201 (You must request 23 registers)

Response will be the same as the PROGRAM commands below, (1201 = 1251, 1202 = 1252 etc.)

WRITE (program) the specified file and step.

(You must send a "*" (-9999) if a register is disabled or unavailable)

NOTE: "*" means the parameter is not available. The value will be -9999.

PROGRAM command for a Set Point Step, Time-based(PTYP = TI)

Register #	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
Parameter	2	File	Step	Type	SP	Hour	Min	Sec	*	*	*

PROGRAM command for a Set Point Step, Rate-based(PTYP = RATE)

Register #	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
Parameter	2	File	Step	Type	SP	*	*	*	Rate	JF	*

PROGRAM command for a Soak Step

Register #	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
Parameter	2	File	Step	Type	*	Hour	Min	Sec	*	*	*

PROGRAM command for a Jump Loop Step

Register #	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
Parameter	2	File	Step	Type	*	*	*	*	*	JF	JS

PROGRAM command for a Link File Step

Register #	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
Parameter	2	File	Step	Type	*	*	*	*	*	*	*

PROGRAM command for an End Step Step

Register #	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260
Parameter	2	File	Step	Type	*	*	*	*	*	*	*

1211 *	1212 *	1213 *	1214 *	1215 *	1216 *	1217 ES3	1218 *	1219 *	1220 *	1221 *	1222 *

1211 *	1212 *	1213 *	1214 *	1215 *	1216 *	1217 ES3	1218 *	1219 *	1220 *	1221 *	1222 *

1211 *	1212 *	1213 WE	1214 WP	1215 *	1216 *	1217 ES3	1218 *	1219 *	1220 *	1221 *	1222 *

1261 *	1262 *	1263 *	1264 *	1265 *	1266 *	1267 *	1268 ES3	1269 *	1270 *	1271 *	1272 *	1273 *

1261 *	1262 *	1263 *	1264 *	1265 *	1266 *	1267 *	1268 ES3	1269 *	1270 *	1271 *	1272 *	1273 *

1261 *	1262 *	1263 *	1264 WE	1265 WP	1266 *	1267 *	1268 ES3	1269 *	1270 *	1271 *	1272 *	1273 *

1261 JC	1262 *	1263 *	1264 *	1265 *	1266 *	1267 *	1268 *	1269 *	1270 *	1271 *	1272 *	1273 *

1261 *	1262 LF	1263 *	1264 *	1265 *	1266 *	1267 *	1268 *	1269 *	1270 *	1271 *	1272 *	1273 *

1261 *	1262 *	1263 ES	1264 *	1265 *	1266 *	1267 *	1268 *	1269 *	1270 *	1271 *	1272 *	1273 *

Table 5.16 - **Modbus RTU Addresses**

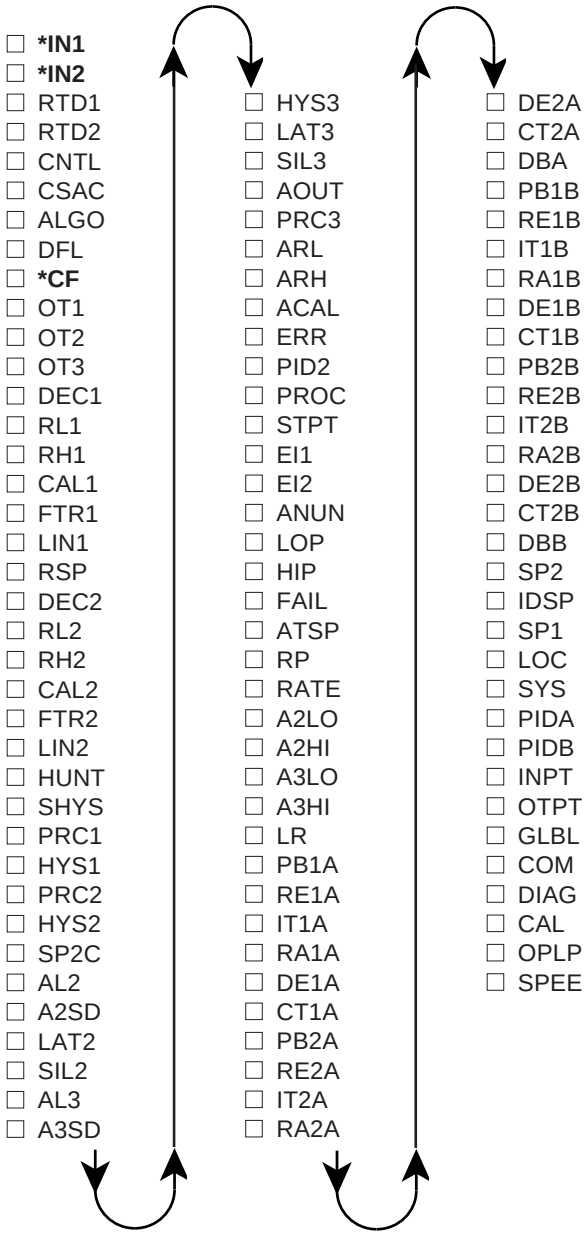
Table 5.16 - 982 Modbus RTU Addresses

Absolute Address	Relative Address	Parameter
40001	0	MDL (982)
40002	1	SRNT
40003	2	SRNB
40005	4	SOFT
40006	5	DATE
40009	8	ITY1
40010	9	ITY2
40017	16	OTY1
40018	17	OTY2
40019	18	OTY3
40020	19	OTY4
40101	100	C1
40104	103	PWR
40105	104	C2
40107	106	ALM
40111	110	ALM
40201	200	RHS
40202	201	EI1S
40210	209	ER
40212	211	DEV
40214	213	EI2S
40301	300	SP1
40305	304	ATSP
40306	305	AUT
40309	308	IDSP
40322	321	A2LO
40323	322	A2HI
40341	340	A3LO
40342	341	A3HI
40501	500	PB1
40502	501	IT1
40503	502	RE1
40504	503	DE1
40505	504	RA1
40506	505	DB
40507	506	CT1
40508	507	HYS1
40511	510	PB2
40512	511	IT2
40513	512	RE2
40514	513	DE2
40515	514	RA2
40517	516	CT2
40518	517	HYS2
40602	601	IN1
40603	602	RL1
40604	603	RH1
40605	604	FTR1
40606	605	CAL1
40607	606	DEC1
40608	607	ERR
40610	609	RTD1
40612	611	IN2
40613	612	RL2
40614	613	RH2
40616	615	CAL2
40701	700	OT1
40702	701	PRC1
40715	714	HIP
40716	715	LOP
40718	717	OT2
40719	718	PRC2
40720	719	AL2
40721	720	HYS2
40722	721	LAT2
40723	722	SIL2
40726	725	ANUN
40735	734	OT3
40737	736	AL3
40738	737	HYS3
40739	738	LAT3
40740	739	SIL3
40736	735	PRC3
40744	743	AOUT
40745	744	ARL
40746	745	ARH
40747	746	ACAL
40901	900	DFL
40902	901	CF
41061	1060	EI1
41063	1062	EI2
41201	1200	MTR
41202	1201	STP
41203	1202	CSP
41204	1203	EJC
41205	1204	ENSP
41206	1205	GSD
41207	1206	POUT
41208	1207	PSTR
41209	1208	PTYP
41210	1209	RESU
41211	1210	HOLD
41212	1211	ABSP
41269	1268	ENT3
41301	1300	LOC
41501	1500	AMB
41515	1514	TOUT
41901	1900	MOD
41902	1901	DISP
41905	1904	SHYS
41906	1905	HUNT
41907	1906	LRNL
41908	1907	LRNH

Chapter 6 Command Summary of the Series 986-989

Complete Parameter Download Sequence

When you download a complete set of parameters to a controller, **you must load them in this order**. The user's manual has more information about prompt interaction.



☐ ***IN1**	☐ HYS3	☐ DE2A
☐ ***IN2**	☐ LAT3	☐ CT2A
☐ RTD1	☐ SIL3	☐ DBA
☐ RTD2	☐ AOUT	☐ PB1B
☐ CNTL	☐ PRC3	☐ RE1B
☐ CSAC	☐ ARL	☐ IT1B
☐ ALGO	☐ ARH	☐ RA1B
☐ DFL	☐ ACAL	☐ DE1B
☐ ***CF**	☐ ERR	☐ CT1B
☐ OT1	☐ PID2	☐ PB2B
☐ OT2	☐ PROC	☐ RE2B
☐ OT3	☐ STPT	☐ IT2B
☐ DEC1	☐ EI1	☐ RA2B
☐ RL1	☐ EI2	☐ DE2B
☐ RH1	☐ ANUN	☐ CT2B
☐ CAL1	☐ LOP	☐ DBB
☐ FTR1	☐ HIP	☐ SP2
☐ LIN1	☐ FAIL	☐ IDSP
☐ RSP	☐ ATSP	☐ SP1
☐ DEC2	☐ RP	☐ LOC
☐ RL2	☐ RATE	☐ SYS
☐ RH2	☐ A2LO	☐ PIDA
☐ CAL2	☐ A2HI	☐ PIDB
☐ FTR2	☐ A3LO	☐ INPT
☐ LIN2	☐ A3HI	☐ OTPT
☐ HUNT	☐ LR	☐ GLBL
☐ SHYS	☐ PB1A	☐ COM
☐ PRC1	☐ RE1A	☐ DIAG
☐ HYS1	☐ IT1A	☐ CAL
☐ PRC2	☐ RA1A	☐ OPLP
☐ HYS2	☐ DE1A	☐ SPEE
☐ SP2C	☐ CT1A	
☐ AL2	☐ PB2A	
☐ A2SD	☐ RE2A	
☐ LAT2	☐ IT2A	
☐ SIL2	☐ RA2A	
☐ AL3		
☐ A3SD		

CAUTION: Entering commands out of sequence will produce unexpected results, because some prompts change the values of other prompts. Copy this page and use the checkboxes.

Table 6.1 - Download Sequence.

*** Wait at least two seconds after executing this command before going on to the next command.**

Temperature/process Controller Prompt Table

Table 6.2 -
A2HI to ALM

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
A2HI 14	**Output 2 Alarm High**	? <sp> A2HI <cr> = <sp> A2HI <sp> data.2 <cr>	Process: A2LO to sensor high range Deviation: 0 to 9999° Rate: 0 to 9999°/minute Default: RH, 999°, or 999°/min.
A2LO 13	**Output 2 Alarm Low**	? <sp> A2LO <cr> = <sp> A2LO <sp> data.2 <cr>	Process: sensor low range to A2HI Deviation: -999 to 0° Rate: -9999 to 0°/minute Default: RL, -999°, or -999°/min.
A3HI 16	**Output 3 Alarm High**	? <sp> A3HI<cr> = <sp> A3HI <sp> data.2 <cr>	Process: A3LO to sensor high range Deviation: 0 to 9999° Rate: 0 to 9999°/minute Default: RH, 999°, or 999°/min.
A3LO 15	**Output 3 Alarm Low**	? <sp> A3LO <cr> = <sp> A3LO <sp> data.2 <cr>	Process: sensor low range to A3HI Deviation: -999 to 0° Rate: -999 to 0°/minute Default: RL, -999°, or -999°/min.
ACAL 94	**Analog Offset**	? <sp> ACAL <cr> = <sp> ACAL <sp> data.2 <cr>	-999 to 999°F -555 to 555°C -999 to 999 units Default: 0°F, 0°C, 0 units
AL2 74	**Alarm 2 Type**	? <sp> AL2 <cr> = <sp> AL2 <sp> data.2 <cr>	0 = Deviation Alarm, Input 2 1 = Process Alarm, Input 2 2 = Process Alarm, Input 1 3 = Deviation Alarm, Input 1 4 = Rate Alarm, Input 1 Default: 2
AL3 79	**Alarm 3 Type**	? <sp> AL3 <cr> = <sp> AL3 <sp> data.2 <cr>	0 = Deviation Alarm, Input 2 1 = Process Alarm, Input 2 2 = Process Alarm, Input 1 3 = Deviation Alarm, Input 1 4 = Rate Alarm, Input 1 Default: 2
ALGO 100	**Algorithm**	? <sp> ALGO <cr> = <sp> ALGO <sp> data.2 <cr>	0 = two sets of PID prompts [Pid2] 1 = one set of PID prompts [Pid] 2 = prop/derivative w/manual reset [Pdr] 3 = 1 process output both heat or cool [dUPL] Default: 1
ALM 3	**Alarm Status** (Writing a 0 clears next alarm.)	? <sp> ALM <cr> = <sp> ALM <sp> 0 <cr>	0 = No alarms occurring (0000 0000) Bit 1 = A2LO (0000 0001) Bit 2 = A2HI (0000 0010) Bit 3 = A3LO (0000 0100) Bit 4 = A3HI (0000 1000)

Temperature/process Controller Prompt Table

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
AMB 125	**Ambient Terminal Temperature**	? <sp> AMB <cr>	Input 1 terminals in 0.0°F
ANUN 106	**Alarm Annunciation**	? <sp> ANUN <cr> = <sp> ANUN <sp> data.2 <cr>	0 = off 1 = on Default: on
AOUT 90	**Analog Output 3 Retransmit Function**	? <sp> AOUT <cr> = <sp> AOUT <sp> data.2 <cr>	0 = Retransmit Process Output 1 1 = Retransmit Set Point 1 2 = off 3 = Retransmit Process Output 2 Default: 0
ARH 93	**Retransmit Range High**	? <sp> ARH <cr> = <sp> ARH <sp> data.2 <cr>	ARL to 9999 Default: RH1 or RH2 per AOUT
ARL 92	**Retransmit Range Low**	? <sp> ARL <cr> = <sp> ARL <sp> data.2 <cr>	-999 to ARH Default: RL1 or RL2 per AOUT
ATM 10	**Auto-Manual Key** (Any data.2 toggles ATM, like the pressing the AUTO/MAN key.)	? <sp> ATM <cr> = <sp> ATM <sp> data.2 <cr>	0 = Auto mode 4 = Manual mode Default: n/a Disabled if LOC = 2 or 3
AUT 19	**Auto-tune**	? <sp> AUT <cr> = <sp> AUT <sp> data.2 <cr>	0 = No auto-tuning 1 = Tune PID Set A 2 = Tune PID Set B Default: off
ATSP 109	**Auto-tune Set Point %**	? <sp> ATSP <cr> = <sp> ATSP <sp> data.2 <cr>	50 to 150% Default: 90%
C1 1	**Input 1 Value**	? <sp> C1 <cr>	Based on IN1 range ; RL1 to RH1
C2 2	**Input 2 Value**	? <sp> C2 <cr>	Based on IN2 range ; RL2 to RH2
CAL 121	**Lockout Calibration Menu**	? <sp> CAL <cr> = <sp> CAL <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
CAL1 51	**Input 1 Calibration Offset**	? <sp> CAL1 <cr> = <sp> CAL1 <sp> data.2 <cr>	-999 to 9999 Default: 0
CAL2 59	**Input 2 Calibration Offset**	? <sp> CAL2 <cr> = <sp> CAL2 <sp> data.2 <cr>	-999 to 9999 Default: 0
CF 95	**Degrees Select Display Loop**	? <sp> CF <cr> = <sp> CF <sp> data.2 <cr>	0 = Display °F 1 = Display °C Default = 0
CNTL 98	**Control Function**	? <sp> CNTL <cr> = <sp> CNTL <sp> data.2 <cr>	0 = Normal 1 = Cascade 2 = Ratio 3 = Differential Default = 0
COM 119	**Lockout Comms Menu**	? <sp> COM <cr> = <sp> COM <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
CSAC 99	**Cascade Action**	? <sp> CSAC <cr> = <sp> CSAC <sp> data.2 <cr>	0 = direct action 1 = reverse action

Table 6.3 -
AMB to CSAC

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Temperature/process Controller Prompt Table

Table 6.4 -
CT1A to DIAG

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
CT1A 26	**Cycle Time** **Output 1 PID Set A**	? <sp> CT1A <cr> = <sp> CT1A <sp> data.2 <cr>	S.S. relay or open col: 0.0 = Burst firing, or 0.1 to 999.9 sec. (time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 10.0 sec.
CT1B 39	**Cycle Time** **Output 1 PID Set B**	? <sp> CT1B <cr> = <sp> CT1B <sp> data.2 <cr>	S.S. relay or open col: 0.0 = Burst firing (brSt), or 0.1 to 999.9 sec. (time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 10.0 sec.
CT2A 32	**Cycle Time** **Output 2 PID Set A**	? <sp> CT2A <cr> = <sp> CT2A <sp> data.2 <cr>	S.S. relay or open col: 0.0 = Burst firing (brSt), or 0.1 to 999.9 sec. (time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 10.0 sec.
CT2B 45	**Cycle Time** **Output 2 PID Set B**	? <sp> CT2B <cr> = <sp> CT2B <sp> data.2 <cr>	S.S. relay or open col: 0.0 = Burst firing (brSt), or 0.1 to 999.9 sec. (time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 10.0 sec.
DATE 122	**Factory** **Test Date**	? <sp> DATE <cr>	xxyy xx = week yy = year
DBA 33	**Deadband** **PID Set A**	? <sp> DBA <cr> = <sp> DBA <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0°F, 0°C, or 0 units
DBB 46	**Deadband** **PID Set B**	? <sp> DBB <cr> = <sp> DBB <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0°F, 0°C, or 0 units
DE1A 25	**Derivative** **Output 1 PID Set A**	? <sp> DE1A <cr> = <sp> DE1A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DE2A 31	**Derivative** **Output 2 PID Set A**	? <sp> DE2A <cr> = <sp> DE2A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DE1B 38	**Derivative** **Output 1 PID Set B**	? <sp> DE1B <cr> = <sp> DE1B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DE2B 44	**Derivative** **Output 2 PID Set B**	? <sp> DE2B <cr> = <sp> DE2B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DEC1 48	**Decimal Point** **Process Input 1**	? <sp> DEC1 <cr> = <sp> DEC1 <sp> data.2 <cr>	0 = Decimal point 0 1 = Decimal point 0.0 2 = Decimal point 0.00 3 = Decimal point 0.000 Default: 0
DEC2 56	**Decimal Point** **Process Input 2**	? <sp> DEC2 <cr> = <sp> DEC2 <sp> data.2 <cr>	0 = Decimal point 0 1 = Decimal point 0.0 2 = Decimal point 0.00 3 = Decimal point 0.000 Default: 0
DEV 5	**Process Deviation** **Display Loop (IN 1)**	? <sp> DEV <cr>	Difference between SP1 and C1
DFL 140	Default Unit Type	? <sp> DFL <cr> = <sp> DFL <sp> data.2 <cr>	0 = US units 1 = Standard International units
DIAG 120	**Lockout** **Diagnostics Menu**	? <sp> DIAG <cr> = <sp> DIAG <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0

Temperature/process Controller Prompt Table

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
EI1 11	**Event Input 1 Function**	? <sp> EI1 <cr> = <sp> EI1 <sp> data.2 <cr>	Software Revision thru M N and later 0 0 = Switch PID Sets 1 1 = None 2 2 = Lock out keyboard 3 3 = Alarm reset N/A 4 = Auto/manual select 4 5 = Turn control outputs off 5 6 = Reverse Output 1 6 7 = Activate Idle Set Point 7 8 = Activate Remote Set Pt Default: 1
EI1S 104	**Event Input 1 Status**	? <sp> EI1S <cr>	0 = off (open) 1 = on (closed)
EI2 12	**Event Input 2 Function**	? <sp> EI2 <cr> = <sp> EI2 <sp> data.2 <cr>	Software Revision thru M N and later 0 0 = Switch PID Sets 1 1 = None 2 2 = Lock out keyboard 3 3 = Alarm reset N/A 4 = Auto/manual select 4 5 = Turn control outputs off 5 6 = Reverse Output 1 6 7 = Activate Idle Set Point 7 8 = Activate Remote Set Pt Default: 1
EI2S 105	**Event Input 2 Status**	? <sp> EI2S <cr>	0 = off (open) 1 = on (closed)
ER 4	**Error, Analog Input** (Multiple errors possible.)	? <sp> ER <cr>	0 = No error 1 = Input 1 A-D overflow 2 = Input 1 overrange 3 = Input 1 underrange 4 = Input 1 A-D underflow 5 = Input 2 A-D overflow 6 = Input 2 overrange 7 = Input 2 underrange 8 = Input 2 A-D underflow 9 = Ambient error 10 = Heater 11 = Open loop
ER2 n/a	**Error, Communications**	? <sp> ER2 <cr>	0 = No error 1 = Transmit buffer overflow 2 = Receive buffer overflow 3 = Framing error 4 = Overrun error 5 = Parity error 6 = Talking out of turn 7 = Invalid reply error 8 = Noise error 20 = Command not found 21 = Prompt not found 22 = Incomplete command line 23 = Invalid character 24 = Number of chars. overflow 25 = Input out of limit 26 = Read only command 27 = Write allowed only 28 = Prompt not active
ERR 97	**Error, Latching Enable**	? <sp> ERR <cr> = <sp> ERR <sp> data.2 <cr>	0 = Errors latching 1 = Errors non-latching Default = 1
FAIL 96	**Sensor Failure Output Function**	? <sp> FAIL <cr> = <sp> FAIL <sp> data.2 <cr>	Bumpless = LOP - 1% Heat/cool manual = -100 to 100% Heat only manual = 0% to 100% Cool only manual = -100% to 0% Default = Bumpless

Table 6.5 -
EI1 to FAIL

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Temperature/process Controller Prompt Table

Table 6.6 -
FTR1 to IN1

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting.

NOTE:
(RTD setting)
For JIS curve, go to rtd1 prompt after selecting In1.

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
FTR1 53	**Process Input 1 Filter Time Constant**	? <sp> FTR1 <cr> = <sp> FTR1 <sp> data.2 <cr>	-60 to 60 seconds Default: 0
FTR2 63	**Process Input 2 Filter Time Constant**	? <sp> FTR2 <cr> = <sp> FTR2 <sp> data.2 <cr>	-60 to 60 seconds Default: 0
GLBL 118	**Lockout Global Menu**	? <sp> GLBL <cr> = <sp> GLBL <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
HIP 108	**High Power Limit**	? <sp> HIP <cr> = <sp> HIP <sp> data.2 <cr>	LOP (%) to 100% Default: 100 (Heat / cool) Default: 0 (Cool only)
HUNT 65	**Slidewire Deadband %**	? <sp> HUNT <cr> = <sp> HUNT <sp> data.2 <cr>	0.1% to 100.0% Default: 1.0%
HYS1 69	**Output 1 Hysteresis**	? <sp> HYS1 <cr> = <sp> HYS1 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C, or 3 units
HYS2 72	**Output 2 Hysteresis**	? <sp> HYS2 <cr> = <sp> HYS2 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C, or 3 units
HYS3 81	**Output 3 Hysteresis**	? <sp> HYS3 <cr> = <sp> HYS3 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C, or 3 units
IDSP 9	**Idle Set Point**	? <sp> IDSP <cr> = <sp> IDSP <sp> data.2 <cr>	RL1 to RH1
IN1 47	**Input 1 Type** (Caution: Writing to IN1 resets most prompts to their default state.)	? <sp> IN1 <cr> = <sp> IN1 <sp> data.2 <cr>	1 = J t/c; 32 to 1500°F/0 to 816°C 2 = K t/c; -328 to 2500°F/-200 to 1371°C 3 = T t/c; -328 to 750°F/-200 to 399°C 4 = N t/c; 32 to 2372°F/0 to 1300°C 5 = E t/c; -328 to 1470°F/-200 to 799°C 6 = C t/c (W3); 32 to 4200°F 0 to 2316°C 7 = D t/c (W5); 32 to 4200°F/0 to 2316°C 8 = Pt 2; 32 to 2543°F/0 to 1395°C 10 = R t/c; 32 to 3200°F/0 to 1760°C 11 = S t/c; 32 to 3200°F/0 to 1760°C 12 = B t/c; 1598 to 3300°F/870 to 1816°C 14 = 1° RTD (DIN); -328 to 1472°F/ -200 to 800°C 15 = 0.1° RTD (DIN); -99.9 to 999.9°F/ -99.9 to 700.0°C 17 = 4-20mA; -999 to 9999 units 18 = 0-20mA; -999 to 9999 units 19 = 0-5V⎓ (dc); -999 to 9999 units 20 = 1-5V⎓ (dc); -999 to 9999 units 21 = 0-10V⎓ (dc); -999 to 9999 units 23 = 0-50mV⎓ (dc); -999 to 9999 units 24 = 0-100mV⎓ (dc); -999 to 9999 units 34 = 0-50mV⎓ (dc); -999 to 9999 units

Temperature/process Controller Prompt Table

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
IN2 55	**Input 2 Type** (Caution: Writing to IN2 resets most prompts to their default state.)	? <sp> IN2 <cr> = <sp> IN2 <sp> data.2 <cr>	0 = t/c Low Gain off 1 = J t/c; 32 to 1500°F/0 to 816°C 2 = K t/c; -328 to 2500°F/-200 to 1371°C 3 = T t/c; -328 to 750°F/-200 to 399°C 4 = N t/c; 32 to 2372°F/0 to 1300°C 5 = E t/c; -328 to 1470°F/-200 to 799°C 6 = C t/c (W3); 32 to 4200°F 0 to 2316°C 7 = D t/c (W5); 32 to 4200°F/0 to 2316°C 8 = Pt 2; 32 to 2543°F/0 to 1395°C 9 = t/c High Gain off 10 = R t/c; 32 to 3200°F/0 to 1760°C 11 = S t/c; 32 to 3200°F/0 to 1760°C 12 = B t/c; 1598 to 3300°F/870 to 1816°C 13 = RTD off 14 = 1° RTD (DIN); -328 to 1472°F/ -200 to 800°C 15 = 0.1° RTD (DIN); -99.9 to 999.9°F/ -99.9 to 700.0°C 16 = Process off 17 = 4-20mA; -999 to 9999 units 18 = 0-20mA; -999 to 9999 units 19 = 0-5V⎓ (dc); -999 to 9999 units 20 = 1-5V⎓ (dc); -999 to 9999 units 21 = 0-10V⎓ (dc); -999 to 9999 units 22 = Millivolts off 23 = 0-50mV⎓ (dc); -999 to 9999 units 24 = 0-100mV⎓ (dc); -999 to 9999 units 26 = Resistance off 27 = Slidewire; 100 to 1200Ω 28 = Potentiometer; 0 to 1200Ω 29 = Heater current off 30 = Heater Current; 0 to 50A 31 = Open loop detect 32 = Event input 2 off 33 = Event input 2 on
INPT 116	**Lockout Input Menu**	? <sp> INPT <cr> = <sp> INPT <sp> data.2 <cr>	0 = No input menu lockout 1 = Read only 2 = No read or write allowed Default: 0
IT1A 24	**Integral for Output 1 PID Set A**	? <sp> IT1A <cr> = <sp> IT1A <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
IT2A 30	**Integral for Output 2 PID Set A**	? <sp> IT2A <cr> = <sp> IT2A <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
IT1B 37	**Integral for Output 1 PID Set B**	? <sp> IT1B <cr> = <sp> IT1B <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
IT2B 43	**Integral for Output 2 PID Set B**	? <sp> IT2B <cr> = <sp> IT2B <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
INSP 144	**Cascade Inner SP**	? <sp> INSP <cr>	RL1 to RH1, or if CNTL = 2 (ratio), then 0.0 to 20.0 if CNTL = 3 (differential), then -999 to 999 if ATM = 1, then 0 to 100% Default: per IN1 and hardware
ITY1 130	**Input 1 Hardware Type**	? <sp> ITY1 <cr>	0 = None 1 = t/c only 2 = Current 3 = Slide wire 4 = Input off 5 = Universal RTD 6 = Universal high gain t/c 7 = Universal low gain t/c 8 = Universal millivolts 9 = Universal process

Table 6.7 -
IN2 to ITY1

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
(RTD setting)
For JIS curve, go to rtd1 prompt after selecting In1.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting.

Temperature/process Controller Prompt Table

Table 6.8 -
ITY2 to OT2

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
ITY2 131	**Input 2 Hardware Type**	? <sp> ITY2 <cr>	0 = None 1 = t/c only 2 = Current 3 = Slide wire 4 = Input off 5 = Universal RTD 6 = Universal high gain t/c 7 = Universal low gain t/c 8 = Universal millivolts 9 = Universal process 10 = Event input
LAT2 76	**Alarm 2 Latching**	? <sp> LAT2 <cr> = <sp> LAT2 <sp> data.2 <cr>	0 = Latching alarms 1 = Non-latching alarms Default: 1
LAT3 82	**Alarm 3 Latching**	? <sp> LAT3 <cr> = <sp> LAT3 <sp> data.2 <cr>	0 = Latching alarms 1 = Non-latching alarms Default: 1
LIN1 54	**Linearization Process Input 1**	? <sp> LIN1 <cr> = <sp> LIN1 <sp> data.2 <cr>	0 = None 1 = Square root extraction Default: 0
LIN2 64	**Linearization Process Input 2**	? <sp> LIN2 <cr> = <sp> LIN2 <sp> data.2 <cr>	0 = None 1 = Square root extraction Default: 0
LOC 112	**Keyboard Lockout**	? <sp> LOC <cr> = <sp> LOC <sp> data.2 <cr>	0 = No lockout 1 = Lock out mode key 2 = Lock out mode and auto/manual keys 3 = Lock out all single keys Default: 0
LOP 107	**Low Power Limit**	? <sp> LOP <cr> = <sp> LOP <sp> data.2 <cr>	-100% to HIP (%) Default: -100% (Heat / cool) Default: 0% (Heat only)
LRNH 62	**Learn High Slide-wire Resistance**	? <sp> LRNH <cr> = <sp> LRNH <sp> data.2 <cr>	0 = No function 1 = Learn Default: 0
LRNL 61	**Learn Low Slide-wire Resistance**	? <sp> LRNL <cr> = <sp> LRNL <sp> data.2 <cr>	0 = No function 1 = Learn Default: 0
LR 20	**Local-Remote Set Point Select**	? <sp> LR <cr> = <sp> LR <sp> data.2 <cr>	0 = Local set point 1 = Remote set point Default: 0
MDL 0	**Model Number**	? <sp> MDL <cr>	988 (986-989 units)
OT1 67	**Output 1 Action**	? <sp> OT1 <cr> = <sp> OT1 <sp> data.2 <cr>	0 = Heat 1 = Cool
OT2 70	**Output 2 Action**	? <sp> OT2 <cr> = <sp> OT2 <sp> data.2 <cr>	0 = Heat 1 = Cool 2 = None 3 = Alarm 2 4 = Alarm 2 reverse acting

Temperature/process Controller Prompt Table

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
OT3 78	**Output 3 Action**	? <sp> OT3 <cr> = <sp> OT3 <sp> data.2 <cr>	0 = None 1 = Alarm 3 2 = Alarm 3 reverse acting
OTPT 117	**Lockout Output Menu**	? <sp> OTPT <cr> = <sp> OTPT <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
OTY1 132 **OTY2** 133 **OTY3** 134 **OTY4** 135	**Output 1 Hardware** **Output 2 Hardware** **Output 3 Hardware** **Output 4 Hardware**	? <sp> OTY1 <cr> ? <sp> OTY2 <cr> ? <sp> OTY3 <cr> ? <sp> OTY4 <cr>	0 = None 1 = SSR 0.5A 2 = SSR 0.5A with suppression 6 = Switched dc 8 = Relay 5A Form C 9 = Relay 5A Form C with suppr. 10 = Relay 5A Form A/B 11 = Relay 5A Form A/B with suppr. 13 = Process output 14 = Voltage retransmit 15 = Current retransmit 16 = Power supply 17 = Comms EIA-232 18 = Comms EIA -485 / EIA-422 19 = Comms EIA-485 / EIA-232
PB1A 21	**Proportional Band Output 1 PID Set A**	? <sp> PB1A <cr> = <sp> PB1A <sp> data.2 <cr>	if DFL = 0, then 0 to 9999 if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units or 3.0%
PB1B 34	**Proportional Band Output 1 PID Set B**	? <sp> PB1B <cr> = <sp> PB1B <sp> data.2 <cr>	if DFL = 0, then 0 to 9999 if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units or 3.0%
PB2A 27	**Proportional Band Output 2 PID Set A**	? <sp> PB2A <cr> = <sp> PB2A <sp> data.2 <cr>	if DFL = 0, then 0 to 9999 if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units or 3.0%
PB2B 40	**Proportional Band Output 2 PID Set B**	? <sp> PB2B <cr> = <sp> PB2B <sp> data.2 <cr>	if DFL = 0, then 0 to 9999 if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units or 3.0%
PIDA 114	**Lockout PID Set A Menu**	? <sp> PIDA <cr> = <sp> PIDA <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
PIDB 115	**Lockout PID Set B Menu**	? <sp> PIDB <cr> = <sp> PIDB <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0

Table 6.9 -
OT3 to PIDB

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Temperature/process Controller Prompt Table

Table 6.10 -
PID2 to RH2

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
PID2 101	**PID Set Crossover Source Selection**	? <sp> PID2 <cr> = <sp> PID2 <sp> data.2 <cr>	0 = Process 1 = Set point 2 = None Default: 0
PRC1 68	**Process Range Output 1**	? <sp> PRC1 <cr> = <sp> PRC1 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PRC2 71	**Process Range Output 2**	? <sp> PRC2 <cr> = <sp> PRC2 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PRC3 91	**Process Range Output 3**	? <sp> PRC3 <cr> = <sp> PRC3 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PROC 102	**Process Value for PID A <-> B Switch**	? <sp> PROC <cr> = <sp> PROC <sp> data.2 <cr>	RL1 to RH1 Default: per IN1 and hardware
PWR 6	**Percent Power Present Output**	? <sp> PWR <cr>	-100% to 100% n/a
RA1A 23	**Rate Output 1 PID Set A**	? <sp> RA1A <cr> = <sp> RA1A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA1B 36	**Rate Output 1 PID Set B**	? <sp> RA1B <cr> = <sp> RA1B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA2A 29	**Rate Output 2 PID Set A**	? <sp> RA2A <cr> = <sp> RA2A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA2B 42	**Rate Output 2 PID Set B**	? <sp> RA2B <cr> = <sp> RA2B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RE1A 22	**Reset Output 1 PID Set A**	? <sp> RE1A <cr> = <sp> RE1A <sp> data.2 <cr>	if ALGO = 0, 1, or 3, then 0.00 to 9.99 repeats/min. if ALGO = 2, then -100.0% to 100.0% Default: 0.00 repeats/min. or 0.0%
RE1B 35	**Reset Output 1 PID Set B**	? <sp> RE1B <cr> = <sp> RE1B <sp> data.2 <cr>	if ALGO = 0, 1, or 3, then 0.00 to 9.99 repeats/min. if ALGO = 2, then -100.0% to 100.0% Default: 0.00 repeats/min. or 0.0%
RE2A 28	**Reset Output 2 PID Set A**	? <sp> RE2A <cr> = <sp> RE2A <sp> data.2 <cr>	if ALGO = 0, 1, or 3, then 0.00 to 9.99 repeats/min. if ALGO = 2, then -100.0% to 100.0% Default: 0.00 repeats/min. or 0.0%
RE2B 41	**Reset Output 2 PID Set B**	? <sp> RE2B <cr> = <sp> RE2B <sp> data.2 <cr>	if ALGO = 0, 1, or 3, then 0.00 to 9.99 repeats/min. if ALGO = 2, then -100.0% to 100.0% Default: 0.00 repeats/min. or 0.0%
RH1 50	**Range High Input 1**	? <sp> RH1 <cr> = <sp> RH1 <sp> data.2 <cr>	min. IN1 range to to max. IN1 range Default: Sensor high range
RH2 58	**Range High Input 2**	? <sp> RH2 <cr> = <sp> RH2 <sp> data.2 <cr>	min. IN2 range to to max. IN2 range Default: Sensor high range

Temperature/process Controller Prompt Table

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
RL1 49	**Range Low Input 1**	? <sp> RL1 <cr> = <sp> RL1 <sp> data.2 <cr>	min. IN1 range to to max. IN1 range Default: Sensor low range
RL2 57	**Range Low Input 2**	? <sp> RL2 <cr> = <sp> RL2 <sp> data.2 <cr>	min. IN2 range to to max. IN2 range Default: Sensor low range
RP 110	**Ramping Initiation**	? <sp> RP <cr> = <sp> RP <sp> data.2 <cr>	0 = off 1 = on startup 2 = on startup and set point change Default: 0
RSP 142	**Remote Set Point**	? <sp> RSP <cr> = <sp> RSP <sp> data.2 <cr>	0 = off 1 = on Default: 0
RATE 111	**Ramp Rate**	? <sp> RATE <cr> = <sp> RATE <sp> data.2 <cr>	0 to 9999°/minute Default: 100°/minute
RTD1 52	**RTD Calibration Curve Input 1**	? <sp> RTD1 <cr> = <sp> RTD1 <sp> data.2 <cr>	0 = JIS 1 = DIN Default: 1
RTD2 60	**RTD Calibration Curve Input 2**	? <sp> RTD2 <cr> = <sp> RTD2 <sp> data.2 <cr>	0 = JIS 1 = DIN Default: 1
SHYS 66	**Slidewire Hysteresis**	? <sp> SHYS <cr> = <sp> SHYS <sp> data.2 <cr>	0 to HUNT
SIL2 77	**Alarm 2 Silence**	? <sp> SIL2 <cr> = <sp> SIL2 <sp> data.2 <cr>	0 = off/disabled 1 = on/enabled Default: 0
SIL3 83	**Alarm 3 Silence**	? <sp> SIL3 <cr> = <sp> SIL3 <sp> data.2 <cr>	0 = off/disabled 1 = on/enabled Default: 0
SRNB 124	**Serial Number Bottom Display** Read the six-digit unit serial number in two segments, "SNxx" and "xxxx," i.e., as in the upper and lower front panel displays.	? <sp> SRNB <cr>	xxxx = 0000 to 9999
SRNT 123	**Serial Number Top Display**	? <sp> SRNT <cr>	SNxx = 00 to 99
SOFT 141	**Software Revision**	? <sp> SOFT <cr>	0 = Rev A, 1 = Rev B, 2 = Rev C, 3 = Rev D, 4 = Rev E, 5 = Rev F, 6 = Rev G, 7 = Rev H, 8 = Rev I, 9 = Rev J, 10 = Rev K, 11 = Rev L, 12 = Rev M, 13 = Rev N, 14 = Rev O, 15 = Rev P, 16 = Rev Q, 17 = Rev R, 18 = Rev S, 19 = Rev T, 20 = Rev U etc.
SP1 7	**Set Point 1**	? <sp> SP1 <cr> = <sp> SP1 <sp> data.2 <cr>	RL1 to RH1, or if CNTL = 2 (ratio), then 0.0 to 20.0 if CNTL = 3 (differential), then -999 to 999 if ATM = 1, then 0 to 100% Default: per IN1 and hardware

Table 6.11 -
RL1 to SP1

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Temperature/process Controller Prompt Table

Table 6.12 -
SP2 to TOUT

Name data.1 Modbus address	Description	Read (?) and/or Write (=) Syntax	Range data.2
SP2 8	**Set Point 2 Heat/Heat or Cool/Cool Only**	? <sp> SP2 <cr> = <sp> SP2 <sp> data.2 <cr>	RL1 to RH1 Default: per input range (?)
SP2C 73	**Set Point 2 Type**	? <sp> SP2C <cr> = <sp> SP2C <sp> data.2 <cr>	0 = Process 1 = Deviation Default: 0
SPEE 143	**Write Set Point to EEPROM**	? <sp> SPEE <cr> = <sp> SPEE <sp> data.2 <cr>	0 = Saves set point in EEPROM 1 = Does not save set point in EEPROM Default: 0 **(See Note 1)**
STPT 103	**Set Point Value PID A <-> B Switch**	? <sp> STPT <cr> = <sp> STPT <sp> data.2 <cr>	RL1 to RH1 Default: Sensor type low range
SYS 113	**Lockout System Menu**	? <sp> SYS <cr> = <sp> SYS <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
TOUT 137	**Test Outputs**	= <sp> TOUT <sp> data.2 <cr>	1 = Output 1 on 2 = Output 2 on 3 = Output 3 on 4 = Output 4 on

NOTE 1:
Turning the controller off and on again resets SPEE to 0 and restores the last stored set point.

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 986-989 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE 2:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Table 6.13 - 988 Modbus RTU Addresses

Absolute Address	Relative Address	Parameter
40001	0	MODEL (988)
40002	1	C1 (input 1 value)
40003	2	C2 (input 2 value)
40004	3	ALM (alarm status)
40005	4	ER (system error)
40006	5	PROCESS DEVIATION
40007	6	OUTPUT POWER
40008	7	SP1
40009	8	SP2
40010	9	IDSP
40011	10	ATM (A/M mode)
40012	11	EI1
40013	12	EI2
40014	13	A2LO
40015	14	A2HI
40016	15	A3LO
40017	16	A3HI
40020	19	AUT
40021	20	L R
40022	21	PB1A
40023	22	RE1A
40024	23	RA1A
40025	24	IT1A
40026	25	DE1A
40027	26	CT1A
40028	27	PB2A
40029	28	RE2A
40030	29	RA2A
40031	30	IT2A
40032	31	DE2A
40033	32	CT2A
40034	33	DBA
40035	34	PB1B
40036	35	RE1B
40037	36	RA1B
40038	37	IT1B
40039	38	DE1B
40040	39	CT1B
40041	40	PB2B
40042	41	RE2B
40043	42	RA2B
40044	43	IT2B
40045	44	DE2B
40046	45	CT2B
40047	46	DBB
40048	47	IN1
40049	48	DEC1
40050	49	RL1
40051	50	RH1
40052	51	CAL1
40053	52	RTD1
40054	53	FTR1
40055	54	LIN1
40056	55	IN2
40057	56	DEC2
40058	57	RL2
40059	58	RH2
40060	59	CAL2
40061	60	RTD2
40062	61	LRNL
40063	62	LRNH
40064	63	FTR2
40065	64	LIN2
40066	65	HUNT
40067	66	SHYS
40068	67	OT1
40069	68	PRC1
40070	69	HYS1
40071	70	OT2
40072	71	PRC2
40073	72	HYS2
40074	73	SP2C
40075	74	AL2
40076	75	A2SD
40077	76	LAT2
40078	77	SIL2
40079	78	OT3
40080	79	AL3
40081	80	A3SD
40082	81	HYS3
40083	82	LAT3
40084	83	SIL3
40091	90	AOUT
40092	91	PRC3
40093	92	ARL
40094	93	ARH
40095	94	ACAL
40096	95	C F
40097	96	FAIL
40098	97	ERR
40099	98	CNTL
40100	99	CSAC
40101	100	ALGO
40102	101	PID2
40103	102	PROC
40104	103	STPT
40105	104	EI1 STATUS
40106	105	EI2 STATUS
40107	106	ANUN
40108	107	LOP
40109	108	HIP
40110	109	ATSP
40111	110	RP
40112	111	RATE
40113	112	LOC
40114	113	LOCK SYS
40115	114	LOCK PIDA
40116	115	LOCK PIDB
40117	116	LOCK INPT
40118	117	LOCK OTPT
40119	118	LOCK GLBL
40120	119	LOCK COM
40121	120	LOCK DIAG
40122	121	LOCK CAL
40123	122	DATE
40124	123	SN TOP
40125	124	SN BOTTOM
40126	125	AMB TEMP, °F
40127	126	AMB COUNTS
40128	127	GND COUNTS
40129	128	CH 1 COUNTS
40130	129	CH 2 COUNTS
40131	130	ITY1
40132	131	ITY2
40133	132	OTY1
40134	133	OTY2
40135	134	OTY3
40136	135	OTY4
40137	136	DISP
40138	137	TOUT
40139	138	OPLP
40140	139	RST
40141	140	DFL
40142	141	SOFT
40143	142	RSP
40144	143	SPEE
40145	144	INSP

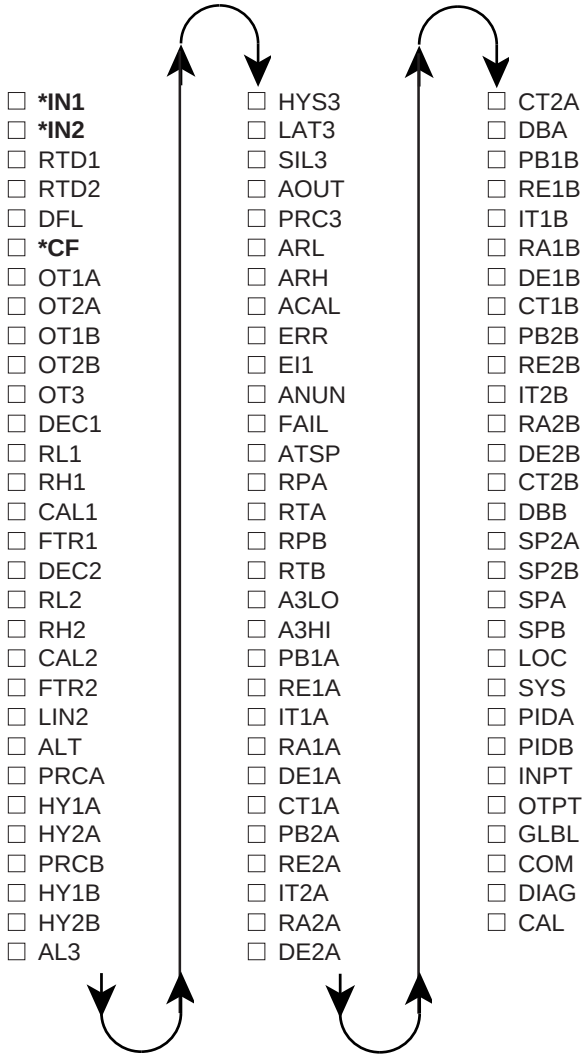
Notes

Chapter 7 Command Summary of the Series 996-999

Complete Parameter Download Sequence

When you download a complete set of parameters to a controller, **you must load them in this order.** The user's manual has more information about prompt interaction.

Table 7.1 - **Download Sequence**



☐ ***IN1**	☐ HYS3	☐ CT2A
☐ ***IN2**	☐ LAT3	☐ DBA
☐ RTD1	☐ SIL3	☐ PB1B
☐ RTD2	☐ AOUT	☐ RE1B
☐ DFL	☐ PRC3	☐ IT1B
☐ ***CF**	☐ ARL	☐ RA1B
☐ OT1A	☐ ARH	☐ DE1B
☐ OT2A	☐ ACAL	☐ CT1B
☐ OT1B	☐ ERR	☐ PB2B
☐ OT2B	☐ EI1	☐ RE2B
☐ OT3	☐ ANUN	☐ IT2B
☐ DEC1	☐ FAIL	☐ RA2B
☐ RL1	☐ ATSP	☐ DE2B
☐ RH1	☐ RPA	☐ CT2B
☐ CAL1	☐ RTA	☐ DBB
☐ FTR1	☐ RPB	☐ SP2A
☐ DEC2	☐ RTB	☐ SP2B
☐ RL2	☐ A3LO	☐ SPA
☐ RH2	☐ A3HI	☐ SPB
☐ CAL2	☐ PB1A	☐ LOC
☐ FTR2	☐ RE1A	☐ SYS
☐ LIN2	☐ IT1A	☐ PIDA
☐ ALT	☐ RA1A	☐ PIDB
☐ PRCA	☐ DE1A	☐ INPT
☐ HY1A	☐ CT1A	☐ OTPT
☐ HY2A	☐ PB2A	☐ GLBL
☐ PRCB	☐ RE2A	☐ COM
☐ HY1B	☐ IT2A	☐ DIAG
☐ HY2B	☐ RA2A	☐ CAL
☐ AL3	☐ DE2A	

CAUTION: Entering commands out of sequence will produce unexpected results, because some prompts change the values of other prompts. Copy this page and use the checkboxes.

996, 997, 998, 999

*** Wait at least two seconds after executing this command before going on to the next command.**

Dual Channel Controller Prompt Table

Command Summary Series 996-999 Data Communications

Table 7.2 -
A3HI to ARL

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
A3HI 341	**Output 3 Alarm High**	? <sp> A3HI<cr> = <sp> A3HI <sp> data.2 <cr>	Process: A3LO to sensor high range Deviation: 0 to 9999° Default: RH or 999°
A3LO 340	**Output 3 Alarm Low**	? <sp> A3LO <cr> = <sp> A3LO <sp> data.2 <cr>	Process: sensor low range to A3HI Deviation: -999 to 0° Default: RL or -999°
ACAL 746	**Analog Offset**	? <sp> ACAL <cr> = <sp> ACAL <sp> data.2 <cr>	-999 to 999°F -555 to 555°C -999 to 999 units Default: 0°F, 0°C, 0 units
AL3 736	**Alarm 3 Type**	? <sp> AL3 <cr> = <sp> AL3 <sp> data.2 <cr>	0 = Process Alarm, Input 2 (CH B) 1 = Deviation Alarm, Input 2 (CH B) 2 = Process Alarm, Input 1 (CH A) 3 = Deviation Alarm, Input 1 (CH A) Default: 2
ALM 110	**Alarm Status** (Writing a 0 clears next alarm.)	? <sp> ALM <cr> = <sp> ALM <sp> 0 <cr>	0 = No alarms occurring (0000 0000) Bit 3 = A3LO (0000 0100) Bit 4 = A3HI (0000 1000) 110 = Alarm 3 0 = off 1 = HI 2 = LO
ALT 1902	**Altitude Compensation**	? <sp> ALT <cr> = <sp> ALT <sp> data.2 <cr>	0 = 0 1 = 2500 feet 2 = 5000 feet default: 0
AMB 1500	**Ambient Terminal Temperature**	? <sp> AMB <cr>	Input 1 terminals in 0.0°F
ANUN 742	**Alarm Annunciation**	? <sp> ANUN <cr> = <sp> ANUN <sp> data.2 <cr>	0 = off 1 = on Default: on
AOUT 743	**Analog Output 3 Retransmit Function**	? <sp> AOUT <cr> = <sp> AOUT <sp> data.2 <cr>	0 = Retransmit Process Channel A 1 = Retransmit Set Point Channel A 2 = off 3 = Retransmit Process Channel B 4 = Retransmit Set Point Channel B Default: 0
ARH 745	**Retransmit Range High**	? <sp> ARH <cr> = <sp> ARH <sp> data.2 <cr>	ARL to 9999 Default: RH1 or RH2 per AOUT
ARL 744	**Retransmit Range Low**	? <sp> ARL <cr> = <sp> ARL <sp> data.2 <cr>	-999 to ARH Default: RL1 or RL2 per AOUT

Dual Channel Controller Prompt Table

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
ATM 301	**Auto-Manual Key**	? <sp> ATM <cr> = <sp> ATM <sp> data.2 <cr>	0 = Auto Mode Channels A and B 1 = Manual Mode Chan. A, Auto Chan. B 2 = Manual Mode Chan. B, Auto Chan. A 3 = Manual Mode Channels A and B Default: n/a Disabled if LOC = 2 or 3
ATSP 304	**Auto-tune Set Point %**	? <sp> ATSP <cr> = <sp> ATSP <sp> data.2 <cr>	50 to 150% Default: 90%
AUT 305	**Auto-tune**	? <sp> AUT <cr> = <sp> AUT <sp> data.2 <cr>	0 = No auto-tuning 1 = Tune Channel A PID 2 = Tune Channel B PID Default: off
C1 100	**Input 1 Value**	? <sp> C1 <cr>	Based on IN1 range ; RL1 to RH1
C2 104	**Input 2 Value**	? <sp> C2 <cr>	Based on IN2 range ; RL2 to RH2
CAL 1305	**Lockout Calibration Menu**	? <sp> CAL <cr> = <sp> CAL <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
CAL1 605	**Input 1 Calibration Offset**	? <sp> CAL1 <cr> = <sp> CAL1 <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 Units to 999 Units Default: 0
CAL2 615	**Input 2 Calibration Offset**	? <sp> CAL2 <cr> = <sp> CAL2 <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 Units to 999 Units Default: 0
CF 901	**Degrees Select Display Loop**	? <sp> CF <cr> = <sp> CF <sp> data.2 <cr>	0 = Display °F 1 = Display °C Default = 0
COM 1312	**Lockout Comms Menu**	? <sp> COM <cr> = <sp> COM <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
CT1A 506	**Cycle Time Output 1 PID Channel A**	? <sp> CT1A <cr> = <sp> CT1A <sp> data.2 <cr>	S.S. relay or open collector: 0.9 = Burst firing, or 1.0 to 999.9 sec. (Time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 30.0 sec.
CT1B 526	**Cycle Time Output 1 PID Channel B**	? <sp> CT1B <cr> = <sp> CT1B <sp> data.2 <cr>	S.S. relay or open collector: 0.9 = Burst firing, or 1.0 to 999.9 sec. (Time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 30.0 sec.
CT2A 516	**Cycle Time Output 2 PID Channel A**	? <sp> CT2A <cr> = <sp> CT2A <sp> data.2 <cr>	S.S. relay or open collector: 0.9 = Burst firing, or 1.0 to 999.9 sec. (Time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 30.0 sec.
CT2B 536	**Cycle Time Output 2 PID Channel B**	? <sp> CT2B <cr> = <sp> CT2B <sp> data.2 <cr>	S.S. relay or open collector: 0.9 = Burst firing, or 1.0 to 999.9 sec. (Time prop) Mech relay: 5.0 to 999.9 sec. Default: 1.0 or 30.0 sec.
DATE 5	**Factory Test Date**	? <sp> DATE <cr>	xxyy xx = Week yy = Year

Table 7.3 -
ATM to DATE

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Dual Channel Controller Prompt Table

Table 7.4 -
DBA to ER

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)`

Name data.1 / Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
DBA 505	**Deadband PID Channel A**	? <sp> DBA <cr> = <sp> DBA <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0°F, 0°C, or 0 units
DBB 525	**Deadband PID Channel B**	? <sp> DBB <cr> = <sp> DBB <sp> data.2 <cr>	-999°F to 999°F -555°C to 555°C -999 units to 999 units Default: 0°F, 0°C, or 0 units
DE1A 503	**Derivative Output 1 PID Channel A**	? <sp> DE1A <cr> = <sp> DE1A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DE1B 523	**Derivative Output 1 PID Channel B**	? <sp> DE1B <cr> = <sp> DE1B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DE2A 513	**Derivative Output 2 PID Channel A**	? <sp> DE2A <cr> = <sp> DE2A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DE2B 533	**Derivative Output 2 PID Channel B**	? <sp> DE2B <cr> = <sp> DE2B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
DEC1 606	**Decimal Point Process Input 1**	? <sp> DEC1 <cr> = <sp> DEC1 <sp> data.2 <cr>	0 = Decimal point 0 1 = Decimal point 0.0 2 = Decimal point 0.00 3 = Decimal point 0.000 Default: 0
DEC2 616	**Decimal Point Process Input 2**	? <sp> DEC2 <cr> = <sp> DEC2 <sp> data.2 <cr>	0 = Decimal point 0 1 = Decimal point 0.0 2 = Decimal point 0.00 3 = Decimal point 0.000 Default: 0
DFL 900	**Default Unit Type**	? <sp> DFL <cr> = <sp> DFL <sp> data.2 <cr>	0 = US units 1 = Standard International units Default: 0
DIAG 1313	**Lockout Diagnostics Menu**	? <sp> DIAG <cr> = <sp> DIAG <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
EI1 1060	**Event Input 1 Function**	? <sp> EI1 <cr> = <sp> EI1 <sp> data.2 <cr>	0 = No 1 = LOC 2 = Alarm reset 3 = Toggle Auto/manual 4 = Turn control outputs off Default: No
EI1S 201	**Event Input 1 Status**	? <sp> EI1S <cr>	0 = off (open) 1 = on (closed)
ER 209	**Error, Analog Input** (Multiple errors possible.)	? <sp> ER <cr>	0 = No error 1 = Input 1 A-D overflow 2 = Input 1 overrange 3 = Input 1 underrange 4 = Input 1 A-D underflow 5 = Input 2 A-D overflow 6 = Input 2 overrange 7 = Input 2 underrange 8 = Input 2 A-D underflow 9 = Ambient error

Dual Channel Controller Prompt Table

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
ER2 **n/a**	**Error, Communications**	? <sp> ER2 <cr>	0 = No error 1 = Transmit buffer overflow 2 = Receive buffer overflow 3 = Framing error 4 = Overrun error 5 = Parity error 6 = Talking out of turn 7 = Invalid reply error 8 = Noise error 20 = Command not found 21 = Prompt not found 22 = Incomplete command line 23 = Invalid character 24 = Number of chars. overflow 25 = Input out of limit 26 = Read only command 27 = Write allowed only 28 = Prompt not active
ERR 607	**Error, Latching Enable**	? <sp> ERR <cr> = <sp> ERR <sp> data.2 <cr>	0 = Errors latching 1 = Errors non-latching Default: 1
FAIL 902	**Sensor Failure Output Function** Failure mode can be bumpless transfer or manual (% Power) control. See user's manual, Error Code Actions.	? <sp> FAIL <cr> = <sp> FAIL <sp> data.2 <cr>	Bumpless = LOP - 1% Heat/cool manual = -100 to 100% Heat only manual = 0% to 100% Cool only manual = -100% to 0% Default: Bumpless
FTR1 604	**Process Input 1 Filter Time Constant**	? <sp> FTR1 <cr> = <sp> FTR1 <sp> data.2 <cr>	-60 to 60 seconds Default: 0
FTR2 614	**Process Input 2 Filter Time Constant**	? <sp> FTR2 <cr> = <sp> FTR2 <sp> data.2 <cr>	-60 to 60 seconds Default: 0
GLBL 1311	**Lockout Global Menu**	? <sp> GLBL <cr> = <sp> GLBL <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
HY1A 507	**Output 1A Hysteresis**	? <sp> HY1A <cr> = <sp> HY1A <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C or 3 units
HY1B 527	**Output 1B Hysteresis**	? <sp> HY1B <cr> = <sp> HY1B <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C or 3 units
HY2A 517	**Output 2A Hysteresis**	? <sp> HY2A <cr> = <sp> HY2A <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C or 3 units
HY2B 537	**Output 2B Hysteresis**	? <sp> HY2B <cr> = <sp> HY2B <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C or 3 units
HYS3 737	**Output 3 Hysteresis**	? <sp> HYS3 <cr> = <sp> HYS3 <sp> data.2 <cr>	0°F to 999°F 0°C to 555°C 0 units to 999 units Default: 3°F, 2°C or 3 units

Table 7.5 -
ER2 to HYS3

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Dual Channel Controller Prompt Table

Table 7.6 -
IN1 to INPT

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting.

NOTE:
(RTD setting)
For JIS curve, go to rtd1 prompt after selecting In1.

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
IN1 601	**Input 1 Type** (Caution: Writing to IN1 resets most prompts to their default state.)	? <sp> IN1 <cr> = <sp> IN1 <sp> data.2 <cr>	1 = J t/c; 32 to 1500°F/0 to 816°C 2 = K t/c; -328 to 2500°F/-200 to 1371°C 3 = T t/c; -328 to 750°F/-200 to 399°C 4 = N t/c; 32 to 2372°F/0 to 1300°C 5 = E t/c; -328 to 1470°F/-200 to 799°C 6 = C t/c (W3); 32 to 4200°F 0 to 2316°C 7 = D t/c (W5); 32 to 4200°F/0 to 2316°C 8 = Pt 2; 32 to 2543°F/0 to 1395°C 10 = R t/c; 32 to 3200°F/0 to 1760°C 11 = S t/c; 32 to 3200°F/0 to 1760°C 12 = B t/c; 1598 to 3300°F/870 to 1816°C 14 = 1° RTD (DIN); -328 to 1472°F/ -200 to 800°C 15 = 0.1° RTD (DIN); -99.9 to 999.9°F/ -99.9 to 700.0°C 17 = 4-20mA; -999 to 9999 units 18 = 0-20mA; -999 to 9999 units 19 = 0-5V⎓ (dc); -999 to 9999 units 20 = 1-5V⎓ (dc); -999 to 9999 units 21 = 0-10V⎓ (dc); -999 to 9999 units 23 = 0-50mV⎓ (dc); -999 to 9999 units 24 = 0-100mV⎓ (dc); -999 to 9999 units
IN2 611	**Input 2 Type** (Caution: Writing to IN2 resets most prompts to their default states.)	? <sp> IN2 <cr> = <sp> IN2 <sp> data.2 <cr>	0 = t/c Low Gain off 1 = J t/c; 32 to 1500°F/0 to 816°C 2 = K t/c; -328 to 2500°F/-200 to 1371°C 3 = T t/c; -328 to 750°F/-200 to 399°C 4 = N t/c; 32 to 2372°F/0 to 1300°C 5 = E t/c; -328 to 1470°F/-200 to 799°C 6 = C t/c (W3); 32 to 4200°F 0 to 2316°C 7 = D t/c (W5); 32 to 4200°F/0 to 2316°C 8 = Pt 2; 32 to 2543°F/0 to 1395°C 10 = R t/c; 32 to 3200°F/0 to 1760°C 11 = S t/c; 32 to 3200°F/0 to 1760°C 12 = B t/c; 1598 to 3300°F/870 to 1816°C 14 = 1° RTD (DIN); -328 to 1472°F/ -200 to 800°C 15 = 0.1° RTD (DIN); -99.9 to 999.9°F/ -99.9 to 700.0°C 17 = 4-20mA; -999 to 9999 units 18 = 0-20mA; -999 to 9999 units 19 = 0-5V⎓ (dc); -999 to 9999 units 20 = 1-5V⎓ (dc); -999 to 9999 units 21 = 0-10V⎓ (dc); -999 to 9999 units 23 = 0-50mV⎓ (dc); -999 to 9999 units 24 = 0-100mV⎓ (dc); -999 to 9999 units
INPT 1309	**Lockout Input Menu**	? <sp> INPT <cr> = <sp> INPT <sp> data.2 <cr>	0 = No input menu lockout 1 = Read only 2 = No read or write allowed Default: 0

Dual Channel Controller Prompt Table

Name data.1 / Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
IT1A 501	**Integral for Output 1 PID Channel A**	? <sp> IT1A <cr> = <sp> IT1A <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
IT1B 521	**Integral for Output 1 PID Channel B**	? <sp> IT1B <cr> = <sp> IT1B <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
IT2A 511	**Integral for Output 2 PID Channel A**	? <sp> IT2A <cr> = <sp> IT2A <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
IT2B 531	**Integral for Output 2 PID Channel B**	? <sp> IT2B <cr> = <sp> IT2B <sp> data.2 <cr>	0.00 to 99.99 minutes per repeat Default: 0.00 minutes per repeat
ITY1 8	**Input 1 Hardware Type**	? <sp> ITY1 <cr>	0 = None 1 = t/c only 4 = Input off 5 = Universal RTD 6 = Universal high gain t/c 7 = Universal low gain t/c 8 = Universal millivolts 9 = Universal process
ITY2 9	**Input 2 Hardware Type**	? <sp> ITY2 <cr>	0 = None 1 = t/c only 4 = Input off 5 = Universal RTD 6 = Universal high gain t/c 7 = Universal low gain t/c 8 = Universal millivolts 9 = Universal process
LAT3 738	**Alarm 3 Latching**	? <sp> LAT3 <cr> = <sp> LAT3 <sp> data.2 <cr>	0 = Latching alarms 1 = Non-latching alarms Default: 1
LIN2 618	**Linearization Process Input 2**	? <sp> LIN2 <cr> = <sp> LIN2 <sp> data.2 <cr>	0 = None 1 = Wet bulb 2 = Vaisala HMM-30C 3 = Rotronic H260 Default: 0
LOC 1300	**Keyboard Lockout**	? <sp> LOC <cr> = <sp> LOC <sp> data.2 <cr>	0 = No lockout 1 = Lock out mode key 2 = Lock out mode & auto/man keys 3 = Lock out all single keys Default: 0
MDL 0	**Model Number**	? <sp> MDL <cr>	998 (996 - 999 dual channel unit)
MOD 1900	**Mode Key Action**	= <sp> MOD <sp> 1 <cr>	0 = Mode to previous prompt 1 = Mode to next prompt
OT1A 700	**Output 1 Channel A Action**	? <sp> OT1A <cr> = <sp> OT1A <sp> data.2 <cr>	0 = Heat 1 = Cool 2 = None
OT1B 717	**Output 1 Channel B Action**	? <sp> OT1B <cr> = <sp> OT1B <sp> data.2 <cr>	0 = Heat 1 = Cool 2 = None
OT2A 716	**Output 2 Channel A Action**	? <sp> OT2A <cr> = <sp> OT2A <sp> data.2 <cr>	0 = Heat 1 = Cool 2 = None
OT2B 733	**Output 2 Channel B Action**	? <sp> OT2B <cr> = <sp> OT2B <sp> data.2 <cr>	0 = Heat 1 = Cool 2 = None
OT3 734	**Output 3 Action**	? <sp> OT3 <cr> = <sp> OT3 <sp> data.2 <cr>	0 = None 1 = Alarm 3 2 = Alarm 3 reverse acting

Table 7.7 -
IT1A to OT3

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Dual Channel Controller Prompt Table

Table 7.8 -
OT3S to PB2B

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
OT3S 1903	**Output 3 Status**	? <sp> OT3S <cr>	0 = off 1 = on
OTPT 1310	**Lockout Output Menu**	? <sp> OTPT <cr> = <sp> OTPT <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
OTY1 16 **OTY2** 17 **OTY3** 18 **OTY4** 19	**Output 1 Hardware** **Output 2 Hardware** **Output 3 Hardware** **Output 4 Hardware**	? <sp> OTY1 <cr> ? <sp> OTY2 <cr> ? <sp> OTY3 <cr> ? <sp> OTY4 <cr>	0 = None 1 = SSR 0.5A 2 = SSR 0.5A with suppression 5 = Dual SSR Form A 6 = Switched dc 7 = Dual Switched dc 8 = Relay 5A Form C 9 = Relay 5A Form C with suppression 10 = Relay 5A Form A/B 11 = Relay 5A Form A/B with suppression 12 = Dual Relay Form A 13 = Process output 14 = Voltage retransmit 15 = Current retransmit 16 = Power supply 17 = Comms EIA-232 18 = Comms EIA -485 / EIA 422 19 = Comms EIA -485 / EIA-232
PB1A 500	**Proportional Band Output 1 PID Channel A**	? <sp> PB1A <cr> = <sp> PB1A <sp> data.2 <cr>	if DFL = 0 and CF = 1, then 0 to 555°C if DFL = 0 and CF = 0, then 0 to 999°F if DFL = 0 and IN1 = a process value, then 0 to 999 units if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units, or 3.0%
PB1B 520	**Proportional Band Output 1 PID Channel B**	? <sp> PB1B <cr> = <sp> PB1B <sp> data.2 <cr>	if DFL = 0 and CF = 1, then 0 to 555°C if DFL = 0 and CF = 0, then 0 to 999°F if DFL = 0 and IN1 = a process value, then 0 to 999 units if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units, or 3.0%
PB2A 510	**Proportional Band Output 2 PID Channel A**	? <sp> PB2A <cr> = <sp> PB2A <sp> data.2 <cr>	if DFL = 0 and CF = 1, then 0 to 555°C if DFL = 0 and CF = 0, then 0 to 999°F if DFL = 0 and IN1 = a process value, then 0 to 999 units if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units, or 3.0%
PB2B 530	**Proportional Band Output 2 PID Channel B**	? <sp> PB2B <cr> = <sp> PB2B <sp> data.2 <cr>	if DFL = 0 and CF = 1, then 0 to 555°C if DFL = 0 and CF = 0, then 0 to 999°F if DFL = 0 and IN1 = a process value, then 0 to 999 units if DFL = 1, then 0.0 to 99.9% of span Default: 25°F, 14°C, 25 units, or 3.0%

Dual Channel Controller Prompt Table

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
PIDA 1307	**Lockout Channel A** **PID Menu**	? <sp> PIDA <cr> = <sp> PIDA <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
PIDB 1308	**Lockout Channel B** **PID Menu**	? <sp> PIDB <cr> = <sp> PIDB <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0
PRCA 701	**Process Range** **Output Channel A**	? <sp> PRCA <cr> = <sp> PRCA <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PRCB 718	**Process Range** **Output Channel B**	? <sp> PRCB <cr> = <sp> PRCB <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
PRC3 735	**Process Range** **Output 3**	? <sp> PRC3 <cr> = <sp> PRC3 <sp> data.2 <cr>	0 = 4-20mA 1 = 0-20mA 2 = 0-5V⎓ (dc) 3 = 1-5V⎓ (dc) 4 = 0-10V⎓ (dc) Default: 0
RA1A 504	**Rate Output 1** **PID Channel A**	? <sp> RA1A <cr> = <sp> RA1A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA1B 524	**Rate Output 1** **PID Channel B**	? <sp> RA1B <cr> = <sp> RA1B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA2A 514	**Rate Output 2** **PID Channel A**	? <sp> RA2A <cr> = <sp> RA2A <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RA2B 534	**Rate Output 2** **PID Channel B**	? <sp> RA2B <cr> = <sp> RA2B <sp> data.2 <cr>	0.00 to 9.99 minutes Default: 0.00
RE1A 502	**Reset Output 1** **PID Channel A**	? <sp> RE1A <cr> = <sp> RE1A <sp> data.2 <cr>	0.00 to 9.99 repeats/minute Default: 0.10 repeats/minute
RE1B 522	**Reset Output 1** **PID Channel B**	? <sp> RE1B <cr> = <sp> RE1B <sp> data.2 <cr>	0.00 to 9.99 repeats/minute Default: 0.10 repeats/minute
RE2A 512	**Reset Output 2** **PID Channel A**	? <sp> RE2A <cr> = <sp> RE2A <sp> data.2 <cr>	0.00 to 9.99 repeats/minute Default: 0.10 repeats/minute
RE2B 532	**Reset Output 2** **PID Channel B**	? <sp> RE2B <cr> = <sp> RE2B <sp> data.2 <cr>	0.00 to 9.99 repeats/minute Default: 0.10 repeats/minute
RH1 603	**Range High** **Input 1**	? <sp> RH1 <cr> = <sp> RH1 <sp> data.2 <cr>	min. IN1 range to to max. IN1 range Default: Sensor high range
RH2 613	**Range High** **Input 2**	? <sp> RH2 <cr> = <sp> RH2 <sp> data.2 <cr>	min. IN2 range to to max. IN2 range Default: Sensor high range
RL1 602	**Range Low** **Input 1**	? <sp> RL1 <cr> = <sp> RL1 <sp> data.2 <cr>	min. IN1 range to to max. IN1 range Default: Sensor low range
RL2 612	**Range Low** **Input 2**	? <sp> RL2 <cr> = <sp> RL2 <sp> data.2 <cr>	min. IN2 range to to max. IN2 range Default: Sensor low range

Table 7.9 -
PIDA to RL2

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Dual Channel Controller Prompt Table

Table 7.10 -
RPA to SYS

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
RPA 1100	**Ramping Initiation Channel A**	? <sp> RPA <cr> = <sp> RPA <sp> data.2 <cr>	0 = off 1 = On startup 2 = On startup and set point change Default: 0
RPB 1104	**Ramping Initiation Channel B**	? <sp> RPB <cr> = <sp> RPB <sp> data.2 <cr>	0 = off 1 = On startup 2 = On startup and set point change Default: 0
RTA 1101	**Ramp Rate Channel A**	? <sp> RTA <cr> = <sp> RTA <sp> data.2 <cr>	0 to 9999°/minute Default: 100°/minute
RTB 1105	**Ramp Rate Channel B**	? <sp> RTB <cr> = <sp> RTB <sp> data.2 <cr>	0 to 9999°/minute Default: 100°/minute
RTD1 609	**RTD Calibration Curve Input 1**	? <sp> RTD1 <cr> = <sp> RTD1 <sp> data.2 <cr>	0 = JIS 1 = DIN Default: 1
RTD2 619	**RTD Calibration Curve Input 2**	? <sp> RTD2 <cr> = <sp> RTD2 <sp> data.2 <cr>	0 = JIS 1 = DIN Default: 1
SIL3 739	**Alarm 3 Silence**	? <sp> SIL3 <cr> = <sp> SIL3 <sp> data.2 <cr>	0 = off / disabled 1 = on / enabled Default: 0
SRNB 2	**Serial Number Bottom Display** Read the six-digit unit serial number in two segments, "SNxx" and "xxxx," i.e., as in the upper and lower front panel displays.	? <sp> SRNB <cr>	xxxx = 0000 to 9999
SRNT 1	**Serial Number Top Display**	? <sp> SRNT <cr>	SNxx = 00 to 99
SOFT 4	**Software Revision**	? <sp> SOFT <cr>	0 = Rev A 7 = Rev H 1 = Rev B 8 = Rev I 2 = Rev C 9 = Rev J 3 = Rev D 10 = Rev K 4 = Rev E 11 = Rev L 5 = Rev F 12 = Rev M 6 = Rev G 13 = Rev N etc.
SPA 300	**Set Point Channel A**	? <sp> SPA <cr> = <sp> SPA <sp> data.2 <cr>	RL1 to RH1 Default: per IN1 and hardware
SPB 319	**Set Point Channel B**	? <sp> SPB <cr> = <sp> SPB <sp> data.2 <cr>	RL2 to RH2 Default: per IN1 and hardware
SP2A 309	**Set Point 2 Channel A** Heat/Heat or Cool/Cool Only	? <sp> SP2A <cr> = <sp> SP2A <sp> data.2 <cr>	RL1 to RH1 Default: per input range
SP2B 328	**Set Point 2 Channel B** Heat/Heat or Cool/Cool Only	? <sp> SP2B <cr> = <sp> SP2B <sp> data.2 <cr>	RL2 to RH2 Default: per input range
SYS 1306	**Lockout System Menu**	? <sp> SYS <cr> = <sp> SYS <sp> data.2 <cr>	0 = No lockout 1 = Read only 2 = No read or write Default: 0

Name data.1 Modbus Address	Description	Read (?) and/or Write (=) Syntax	Range data.2
TOUT 1514	**Test Outputs**	= <sp> TOUT <sp> data.2 <cr>	0 = All off 1 = Output 1A on 2 = Output 2A on 3 = Output 1B on 4 = Output 2B on 5 = Output 3 on 6 = Output 4 on

Table 7.11 -
SYS to TOUT

CAUTION:
Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the Series 996-999 EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

NOTE:
The number of decimal places returned by many of these commands is determined by the DEC1, DEC2, IN1 or IN2 setting. (This does not apply to Modbus Protocol.)

Table 7.12 - 998 Modbus RTU Addresses

Table 7.12 - **Modbus RTU Addresses**

Absolute Address	Relative Address	Parameter
40001	0	MDL (998)
40002	1	SRNT
40003	2	SRNB
40005	4	SOFT
40006	5	DATE
40009	8	ITY1
40010	9	ITY2
40017	16	OTY1
40018	17	OTY2
40019	18	OTY3
40020	19	OTY4
40025	24	SPEE
40101	100	C1
40105	104	C2
40111	110	ALM
40202	201	EI1S
40210	209	ER
40301	300	SPA
40302	301	ATM
40305	304	ATSP
40306	305	AUT
40310	309	SP2A
40320	319	SPB
40329	328	SP2B
40341	340	A3LO
40342	341	A3HI
40501	500	PB1A
40502	501	IT1A
40503	502	RE1A
40504	503	DE1A
40505	504	RA1A
40506	505	DBA
40507	506	CT1A
40508	507	HY1A
40511	510	PB2A
40512	511	IT2A
40513	512	RE2A
40514	513	DE2A
40515	514	RA2A
40517	516	CT2A
40518	517	HY2A
40521	520	PB1B
40522	521	IT1B
40523	522	RE1B
40524	523	DE1B
40525	524	RA1B
40526	525	DBB
40527	526	CT1B
40528	527	HY1B
40531	530	PB2B
40532	531	IT2B
40533	532	RE2B
40534	533	DE2B
40535	534	RA2B
40537	536	CT2B
40538	537	HY2B
40602	601	IN1
40603	602	RL2
40604	603	RH1
40605	604	FTR1
40606	605	CAL1
40607	606	DEC1
40608	607	ERR
40610	609	RTD1
40612	611	IN2
40613	612	RL2
40614	613	RH2
40615	614	FTR2
40616	615	CAL2
40617	616	DEC2
40619	618	LIN2
40620	619	RTD2
40701	700	OT1A
40702	701	PRCA
40717	716	OT2A
40718	717	OT1B
40719	718	PRCB
40734	733	OT2B
40735	734	OT3
40737	736	AL3
40738	737	HYS3
40739	738	LAT3
40740	739	SIL3
40743	742	ANUN
40736	735	PRC3
40744	743	AOUT
40745	744	ARL
40746	745	ARH
40747	746	ACAL
40901	900	DFL
40902	901	C F
40903	902	FAIL
41061	1060	EI1
41101	1100	RPA
41102	1101	RTA
41105	1104	RPB
41106	1105	RTB
41301	1300	LOC
41306	1305	CAL
41307	1306	SYS
41308	1307	PIDA
41309	1308	PIDB
41310	1309	INPT
41311	1310	OTPT
41312	1311	GLBL
41313	1312	COM
41314	1313	DIAG
41501	1500	AMB
41515	1514	TOUT
41901	1900	MOD
41902	1901	DISP
41903	1902	ALT
41904	1903	OT3S

Appendix

Handling Communication Error Codes (ER2)

All communications-related error codes are ER2 error codes, that is, they are not considered cause for a shutdown of the unit itself. There is always a communications error code generated when a <NAK> character is sent under ANSI X3.28 protocol. With XON/XOFF flow control, error codes may be generated, but there will be no standard indication of this fact.

When your message is "not acknowledged" (NAK) in EIA-422 or EIA-485 with ANSI X3.28 Protocol, you may clear ER2 codes by reading it. Use the " ? <sp> ER2 <cr>" command.

Then try the message again; you may have made a syntax error. See the ER2 error code list in Chapters 5, 6 and 7.

With XON/XOFF protocol and the EIA-232 interface, the Series 981-984, 986-989 and 996-999 sends no feedback on commands. Therefore, you may want to query the status of ER2 after each command you send.

CAUTION: Sending commands to a particular controller for which it is not equipped may cause damage to equipment and/or processes.

CAUTION: Avoid writing <=> continuously, such as ramping set points or repetitive loops, to the controller's EEPROM memory. Continuous writes may result in premature control failure, system downtime and damage to processes and equipment.

User Responsibility 

Users must refrain from altering prompts that do not appear on the controller's front panel or are not included on the specific model. For example, do not send an A2LO command to a unit not equipped with an alarm for output 2.

Warranty

The Watlow Series 988 family of controllers is warranted to be free of defects in material and workmanship for 36 months after delivery to the first purchaser for use, providing that the units have not been misapplied. Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse or abuse.

ASCII

ASCII Character Set

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
00	00	NUL	16	10	DLE	32	20	SP	48	30	0
01	01	SOH	17	11	DC1	33	21	!	49	31	1
02	02	STX	18	12	DC2	34	22	"	50	32	2
03	03	ETX	19	13	DC3	35	23	#	51	33	3
04	04	EOT	20	14	DC4	36	24	$	52	34	4
05	05	ENQ	21	15	NAK	37	25	%	53	35	5
06	06	ACK	22	16	SYN	38	26	&	54	36	6
07	07	BEL	23	17	ETB	39	27	'	55	37	7
08	08	BS	24	18	CAN	40	28	(	56	38	8
09	09	HT	25	19	EM	41	29	)	57	39	9
10	0A	LF	26	1A	SUB	42	2A	*	58	3A	:
11	0B	VT	27	1B	ESC	43	2B	+	59	3B	;
12	0C	FF	28	1C	FS	44	2C	,	60	3C	<
13	0D	CR	29	1D	GS	45	2D	-	61	3D	=
14	0E	SO	30	1E	RS	46	2E	.	62	3E	>
15	0F	SI	31	1F	US	47	2F	/	63	3F	?

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
64	40	@	80	50	P	96	60	`	112	70	p
65	41	A	81	51	Q	97	61	a	113	71	q
66	42	B	82	52	R	98	62	b	114	72	r
67	43	C	83	53	S	99	63	c	115	98	s
68	44	D	84	54	T	100	64	d	116	74	t
69	45	E	85	55	U	101	65	e	117	75	u
70	46	F	86	56	V	102	66	f	118	76	v
71	47	G	87	57	W	103	67	g	119	77	w
72	48	H	88	58	X	104	68	h	120	78	x
73	49	I	89	59	Y	105	69	i	121	79	y
74	4A	J	90	5A	Z	106	6A	j	122	7A	z
75	4B	K	91	5B	[	107	6B	k	123	7B	{
76	4C	L	92	5C	\	108	6C	l	124	7C	|
77	4D	M	93	5D	]	109	6D	m	125	7D	}
78	4E	N	94	5E	^	110	6E	n	126	7E	~
79	4F	O	95	5F	_	111	6F	o	127	7F	DEL

Table A.2a - ASCII Character Set.

ASCII Control Characters (Partial Set)

ASCII Char.	Ctrl Key Equiv.	Definition	Dec. Equiv.	Hex. Equiv.
ENQ	Ctrl E	Enquiry	5	05
ACK	Ctrl F	Acknowledge	6	06
NAK	Ctrl U	Neg. Acknowledge	21	15
STX	Ctrl B	Start of Text	2	02
ETX	Ctrl C	End of Text	3	03
EOT	Ctrl D	End of Transmission	4	04
DLE	Ctrl P	Data Link Escape	16	10
CR	Ctrl M	Carriage Return	13	0D
DC1	Ctrl Q	XON	17	11
DC3	Ctrl S	XOFF	19	13

Table A.2b - ASCII Control Characters (Partial Set).

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