SERIES CN2200 and CN2400

MODBUS® AND DIGITAL COMMUNICATIONS HANDBOOK

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CHAPTER 1 INTRODUCTION

This chapter describes the scope of this handbook and how to use it.

OVERVIEW

This handbook is written for the people who need to use a digital communications link and MODBUS® or JBUS® communication protocols to supervise Omega Series CN2200 and CN2400 instruments.

It has been assumed that the reader has some experience of communication protocols and is familiar with Series CN2200 and CN2400 instruments. The relevant instrument handbook gives a full description of how to use the instruments, configuration options and definition of parameters.

Chapter 2 of this document is a guide to cabling and the basic physical environment of digital communications.
Chapter 3 is a general description of the MODBUS® and JBUS® protocols.
Chapter 4 lists Series CN2200 and CN2400 parameter addresses and mnemonics.
Chapter 5 covers advanced topics such as access to full resolution floating point data and user interface permissions.
Appendix A is a Glossary of Terms.
Omega accepts no responsibility for any loss or damage caused by application of the information contained in this document.

JBUS® is a registered trademark of APRIL.
MODBUS® is a registered trademark of Gould Inc.

JBUS® V MODBUS®

- MODBUS® is a serial communications protocol defined by Gould Inc.
  April developed JBUS® as a special case of MODBUS®.
- The two protocols use the same message frame format.
- The function codes used by Series CN2200 and CN2400 instruments are a subset of JBUS® and MODBUS® function codes.
- Series CN2200 and CN2400 JBUS® addresses are exactly the same as MODBUS® addresses.
- In this document reference will be made to MODBUS®, however all information applies equally to JBUS®.

REFERENCES

Refer to the documents below for further information;

Gould	MODBUS® Protocol Reference Guide, PI-MBUS-300
April	JBUS® Specification
EIA Standard RS-232-C (EIA-232-C)	Interface Between Terminal Equipment and Data Communication Equipment Employing Serial Binary Interchange
EIA Standard RS-422 (EIA-422)	Electrical Characteristics of Balanced Voltage Digital Interface Circuits
EIA Standard RS-485 (EIA-485)	Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multipoint Systems

CHAPTER 2 DIGITAL COMMUNICATIONS HARDWARE

This chapter defines the differences between the RS-232 (EIA-232), RS-422 (EIA-422) and RS-485 (EIA-485) digital communications standards. Details of configuration, cabling and termination will help to establish basic communications.

RS-232 (EIA-232), RS-422 (EIA-422) AND RS-485 (EIA-485) TRANSMISSION STANDARDS

The Electrical Industries Association, (EIA) introduced the Recommended Standards, RS-232 (EIA-232), RS-422 (EIA-422) and RS-485 (EIA-485). These standards define the electrical performance of a communications network. The table below is a summary of the different physical link offered by the three standards.

EIA Standard	RS-232C (EIA-232C)	RS-422 (EIA-422)	RS-485 (EIA-485)
Transmission mode	Single ended	Differential	Differential
Electrical connections	3 wire	5 wire	3 wire
No. of drivers and receivers per line	1 driver, 1 receiver	1 driver, 10 receivers	32 drivers, 32 receivers
Maximum data rate	20k bits/s	10M bits/s	10M bits/s
Maximum cable length	50ft, (15M)	4000ft, (1200M)	4000ft, (1200M)

Note: RS-232 (EIA-232)C has been abbreviated to RS-232 (EIA-232). The RS-232 (EIA-232) standard allows a **single** instrument to be connected to a PC, a Programmable Logic Controller, or similar devices using a cable length of less than **15M (50ft)**.

The RS-485 (EIA-485) standard allows **one or more** instruments to be connected (multi-dropped) using a two wire connection, with cable length of less than **1200M (4000ft)**. 31 Instruments and one ‘master’ may be connected in this way. The balanced differential signal transmission is less prone to interference and should be used in preference to RS-232 (EIA-232) in noisy environments. RS-422 (EIA-422/485) is recommended for plant installation. Although RS-485 (EIA-485) is commonly referred to as a ‘two wire’ connection, a ground return/shield connection is provided as a ‘common’ connection for Series CN2200 and CN2400 Instruments, and in general this should be used in installations to provide additional protection against noise.

Strictly speaking, RS-422 (EIA-422) is a standard permitting ‘point to point’ connection of two pieces of equipment using a full duplex, differential signal on two pairs of wires. In principle, therefore, an RS-422 (EIA-422) link only allows a single instrument to be connected to a PC. However, Series CN2200 and CN2400 instruments provide an enhanced version of RS-422 (EIA-422) that also meets the full electrical requirements of RS-485 (EIA-485) described above. This allows up to 31 instruments to be connected on the same network, but only with a **5 wire** electrical connection. The transmission and reception of data use two pairs of twisted cable, with a separate cable provided for common. The optional shield will provide additional noise immunity.

The 2 wire RS-485 (EIA-485) should be used where possible for new installations where multi-drop capability is required. RS-422 (EIA-422) is provided for compatibility with existing Omega instruments.

Using RS-232 (EIA-232) or RS-422 (EIA-422)/485, the Series CN2200 and CN2400 instruments operate in a half duplex mode that does not allow the simultaneous transmission and reception of data. Data is passed by an alternating exchange.

Most PC's provide an RS-232 (EIA-232) port for digital communications. This unit is also used to buffer an RS-422/485 (EIA-422/485) network when it is required to communicate with more than 32 instruments on the same bus, and may also be used to bridge 2 wire RS-485 (EIA-485) to 4 wire RS-422 (EIA-422) network segments.

SELECTING RS-232 (EIA-232) OR RS-422/485 (EIA-422/485)

Changing between RS-232 (EIA-232), RS-422 (EIA-422), and RS-485 (EIA-485) is possible for CN2400 Series instruments by replacing the plug-in ‘H’ Module with a communications module of the required type.

CN2200 Series communications hardware is a fixed build and must be specified when the instrument is being ordered.

CABLE SELECTION

The cable selected for the digital communications network should have the following electrical characteristics:

- Less than 100 ohm / km nominal dc resistance. Typically 24 AWG or thicker.
- Nominal characteristic impedance at 100 kHz of 100 ohms.
- Less than 60 pF / m mutual pair capacitance, (the capacitance between two wires in a pair).
- Less than 120 pF / m stray capacitance, (the capacitance between one wire and all others connected to ground).
- For RS-422/485 (EIA-422/485) applications, use twisted pair cables.

The selection of a cable is a trade off between cost and quality factors such as attenuation and the effectiveness of shielding. For applications in an environment where high levels of electrical noise are likely, use a cable with a copper braid shield, (connect the shield to a noise free ground). For applications communicating over longer distances, choose a cable that also has low attenuation characteristics.

In low noise applications and over short distances it may be possible to use the grounded shield as the common connection. Connect the common to the grounded shield via a 100 ohm, 1/4W carbon composition resistor at the PC and all instruments.

For RS-422/485 (EIA-422/485), it is possible to operate the system with unshielded twisted data pairs, ground is used as the common connection. Connect the common to ground via a 100 ohm, 1/4W carbon composition resistor at the PC and all instruments. This system is not recommended.

The following list is a selection of cables suitable for RS 422/485 (EIA-422/EIA485) communication systems, listed in order of decreasing quality.
Cables marked '*' are suitable for use with the wiring descriptions that follow.
Cables marked '**' use a different color coding from that used in the wiring descriptions.

Part number	
Belden	Description
9842	2 twisted pairs with aluminium foil shield plus a 90% coverage copper shield **
9843	3 twisted pairs with aluminium foil shield plus a 90% coverage copper shield **
9829	2 twisted pairs with aluminium foil shield plus a 90% coverage copper shield
9830	3 twisted pairs with aluminium foil shield plus a 90% coverage copper shield *
8102	2 twisted pairs with aluminium foil shield plus a 65% coverage copper shield
8103	3 twisted pairs with aluminium foil shield plus a 65% coverage copper shield *
9729	2 twisted pairs with aluminium foil shield
9730	3 twisted pairs with aluminium foil shield *

The following are a selection of cables suitable for RS-232 (EIA-232) communication systems listed in order of decreasing quality;

Part number		
Alpha	Belden	Description
	8102	2 twisted pairs with aluminium foil shield plus a 65% coverage copper shield**
5472	9502	2 twisted pairs with aluminium foil shield*
2403	8771	3 separate wires with aluminium foil shield **

GROUNDING

Ensure all ground points are noise free.

To reduce interference from external electrical signals, ground the cable shield at a single ground point. There must not be multiple ground paths in a single cable run. When using a Communications Adapter unit, do not connect the shield from one side of the interface to the other. Rather, ground each of the cables separately at a local ground point.

The digital communication outputs of all Series CN2200 and CN2400 instruments are isolated. To avoid common mode noise problems, connect the common line to ground at one point through a 100 ohm, 1/4W, carbon composition resistor. The resistor will limit the ground current.

WIRING GENERAL

Route communications cables in separate trunking to power cables. Power cables are those connecting power to instruments, relay or AC SSR ac supplies and wiring associated with external switching devices such as contactors, relays or motor speed drives.

Communication cables may be routed with control signal cables if these signal cables are not exposed to an interference source. Control signals are the analog or logic inputs and analog or DC Pulse outputs of any control instrument.

Do not use redundant wires in the communications cable for other signals.

Ensure cable runs have sufficient slack to ensure that movement does not cause abrasion of the insulating sheath. Do not over tighten cable clamps to avoid accidental multiple grounding of the shield conductors.

Ensure that the cable is 'daisy chained' between instruments, i.e. the cable runs from one instrument to the next to the final instrument in the chain.

WIRING RS-232 (EIA-232)

To use RS-232 (EIA-232) the PC will be equipped with an RS-232 (EIA-232) port, usually referred to as COM 1.

To construct a cable for RS-232 (EIA-232) operation use a three core shielded cable.

The terminals used for RS-232 (EIA-232) digital communications are listed in the table below. Some PC's use a 25 way connector although the 9 way is more common.

Standard Cable	PC socket pin no.		PC Function *	Instrument Terminal	Instrument
Color	9 way	25 way			Function
White	2	3	Receive (RX)	HF	Transmit (TX)
Black	3	2	Transmit (TX)	HE	Receive (RX)
Red	5	7	Common	HD	Common
Link together	1 4 6	6 8 11	Rec'd line sig. detect Data terminal ready Data set ready		
Link together	7 8	4 5	Request to send Clear to send		
Shield		1	Ground		

- These are the functions normally assigned to socket pins. Please check your PC manual to confirm.

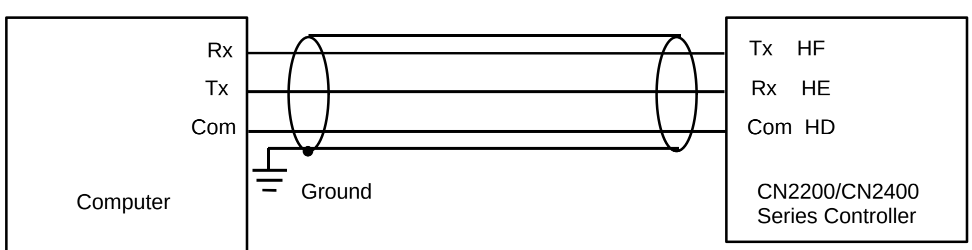


Figure 2-1 RS-232 (EIA-232) connections

WIRING RS-422 (EIA-422) OR 4-WIRE RS-485 (EIA-485)

To use RS-422 (EIA-422), buffer the RS-232 (EIA-232) port of the PC with a suitable RS-232/422 (EIA-232)/422) converter. A suitable commercially available Communications Converter unit is recommended for this purpose. Instruments on an RS-422 (EIA-422) communication network should be chain connected and not star connected.

To construct a cable for RS-422 (EIA-422) operation use a shielded cable with two twisted pairs plus a separate core for common. Although common or shield connections are not necessary, their use will significantly improve noise immunity.

The terminals used for RS-422 (EIA-422) digital communications are listed in the table below.

Standard Cable Color	PC socket pin no. 25 way	PC Function *	Instrument Terminal CN2400	Instrument Function
White	3	Receive (RX+)	HE	Transmit (TX+)
Black	16	Receive (RX-)	HF	Transmit (TX-)
Red	12	Transmit (TX+)	HB	Receive (RX+)
Black	13	Transmit (TX-)	HC	Receive (RX-)
Green	7	Common	HD	Common
Shield	1	Ground		

- These are the functions normally assigned to socket pins. Please check your PC manual to confirm.

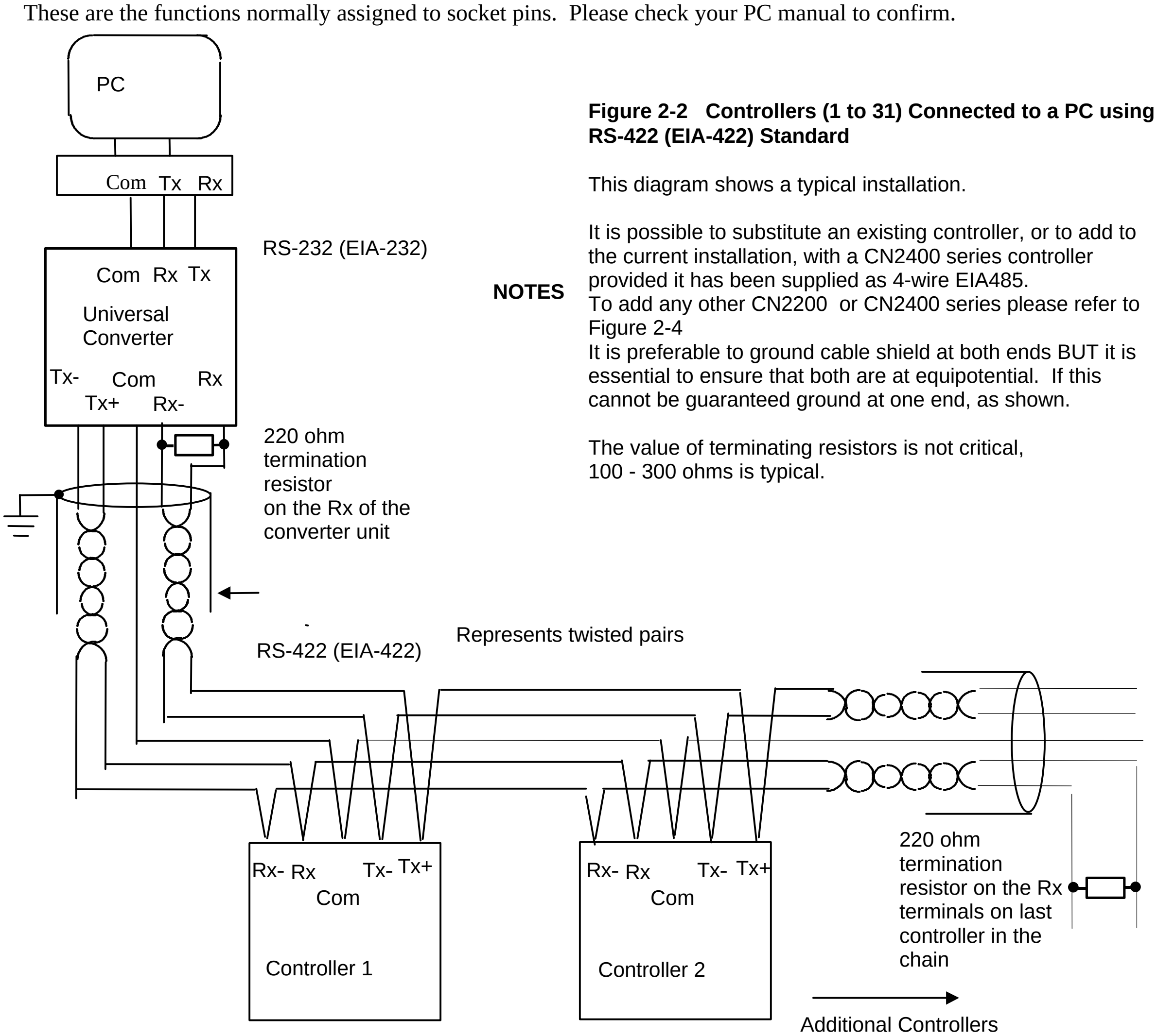


Figure 2-2 Controllers (1 to 31) Connected to a PC using RS-422 (EIA-422) Standard

This diagram shows a typical installation.

NOTES

It is possible to substitute an existing controller, or to add to the current installation, with a CN2400 series controller provided it has been supplied as 4-wire EIA485.
To add any other CN2200 or CN2400 series please refer to Figure 2-4
It is preferable to ground cable shield at both ends BUT it is essential to ensure that both are at equipotential. If this cannot be guaranteed ground at one end, as shown.

The value of terminating resistors is not critical, 100 - 300 ohms is typical.

WIRING 2-WIRE RS-485 (EIA-485)

To use RS-485 (EIA-485), buffer the RS-232 (EIA-232) port of the PC with a suitable RS-232/485 (EIA-232)/485) converter. Omega does not recommend the use of a RS-485 (EIA-485) board built into the computer since this board is unlikely to be isolated, which may cause noise problems, and the Rx terminals are unlikely to be biased correctly for this application.

To construct a cable for RS-485 (EIA-485) operation use a shielded cable with one RS-485 (EIA-485)) twisted pair plus a separate core for common. Although common or shield connections are not necessary, their use will significantly improve noise immunity.

The terminals used for RS-485 (EIA-485) digital communications are listed in the table below.

Standard Cable Color	PC socket pin no. 25 way	PC Function *	Instrument Terminal	Instrument Function
White	3	Receive (RX+)	HF (b) or (B+)	Transmit (TX)
Black	16	Receive (RX-)		
Red	12	Transmit (TX+)	HE (A) or (A+)	Receive (RX)
Black	13	Transmit (TX-)		
Green	7	Common	HD	Common
Shield	1	Ground		

* These are the functions normally assigned to socket pins. Please check your PC manual to confirm .

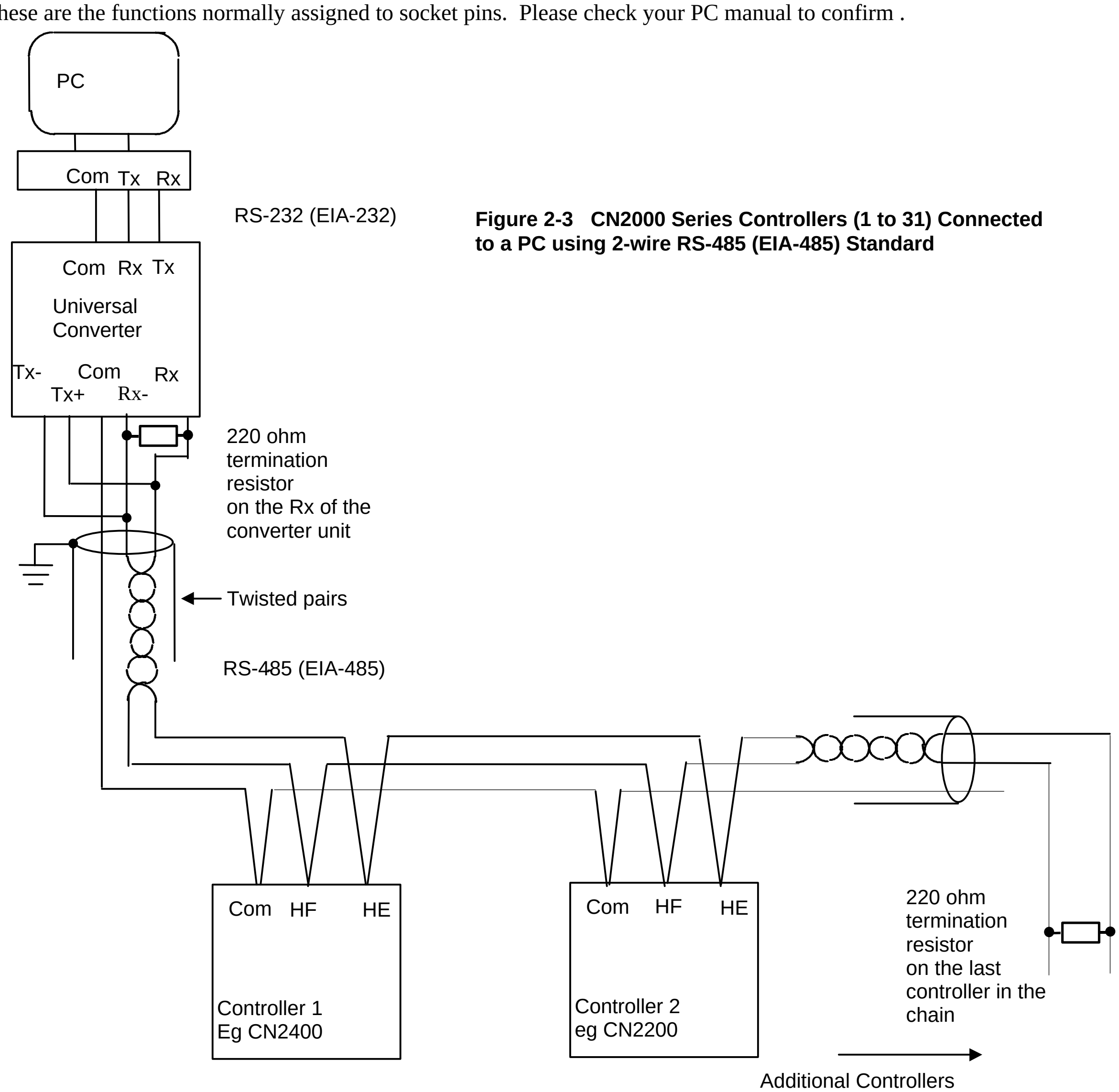


Figure 2-3 CN2000 Series Controllers (1 to 31) Connected to a PC using 2-wire RS-485 (EIA-485) Standard

WIRING RS-422 (EIA-422) AND RS-485 (EIA-485) CONTROLLERS

It is generally not possible to connect controllers using a 2-wire standard to controllers on a 4-wire standard. This may be required, for example, if the CN2200 or CN2400 series controllers are to be added to an existing installation. It is possible, however, to modify the existing communications link by adding a universal communications converter. This is shown in figure 2-4 below.

The converter unit that converts from 232 to 4-wire 485 uses this link to communicate to the existing Omega controllers. The second universal converter is a special version which converts from 4-wire to 2-wire 485 communications. It’s input side behaves to the 4-wire link as another controller would on an existing system, while at the same time the communications messages from the computer are passed onto the output side of this unit. This is connected to the 2-wire communications link that will contain the series CN2200 controllers. Any responses from controllers on this link will cause data to be placed on to the 4-wire link and then will be passed back to the computer.

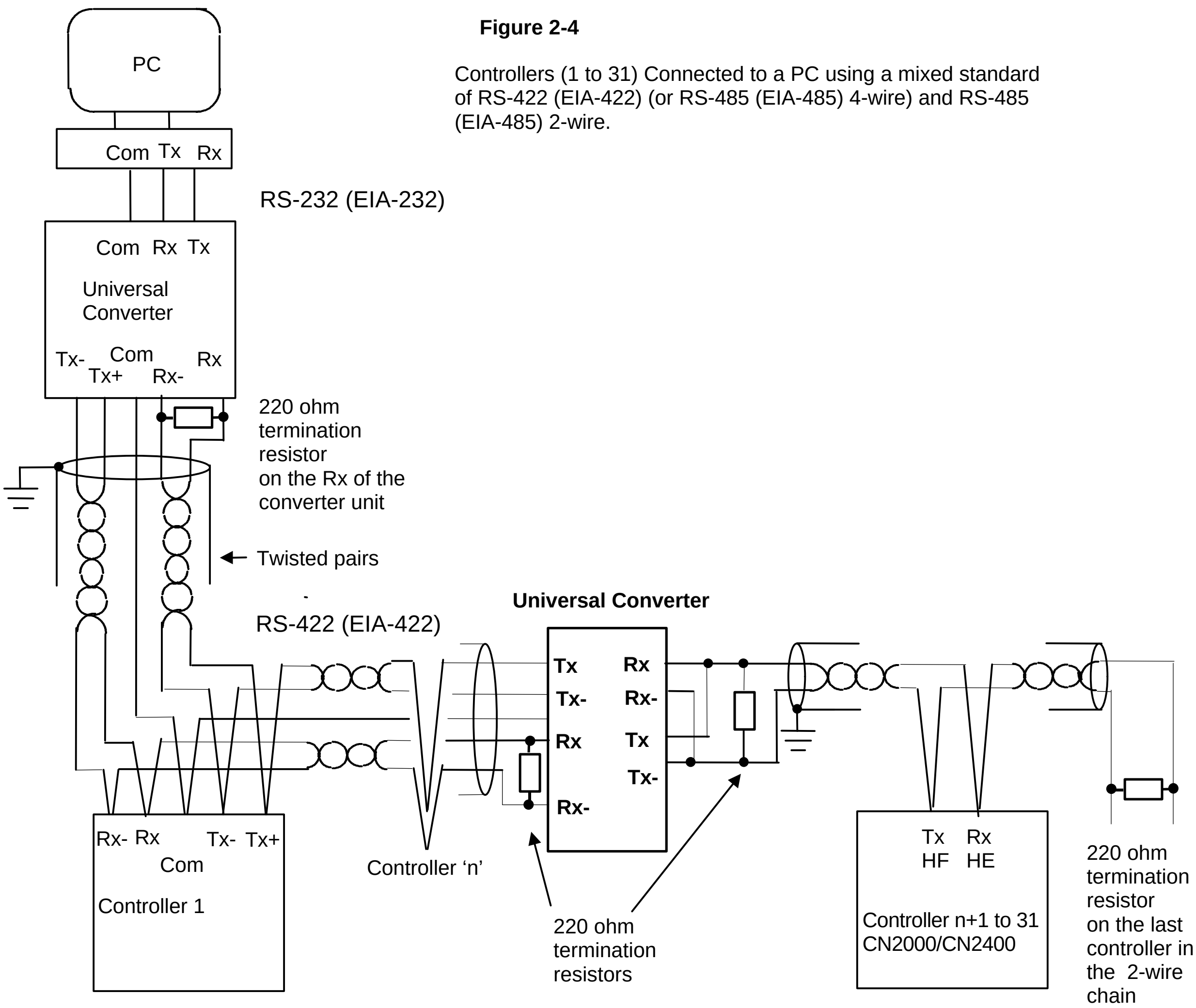


Figure 2-4

Controllers (1 to 31) Connected to a PC using a mixed standard of RS-422 (EIA-422) (or RS-485 (EIA-485) 4-wire) and RS-485 (EIA-485) 2-wire.

CONNECTIONS FOR UP TO 63 CONTROLLERS

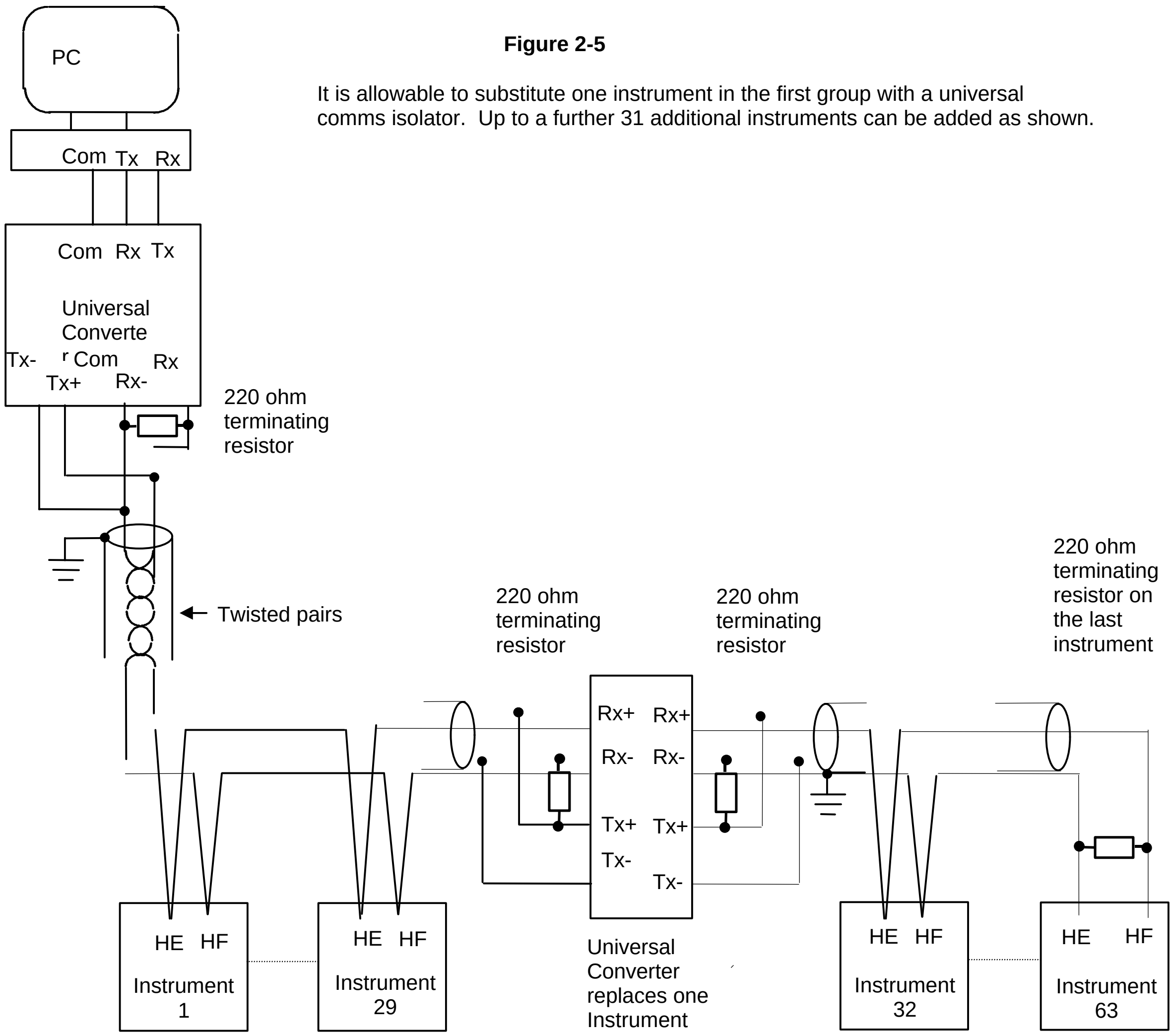


Figure 2-5

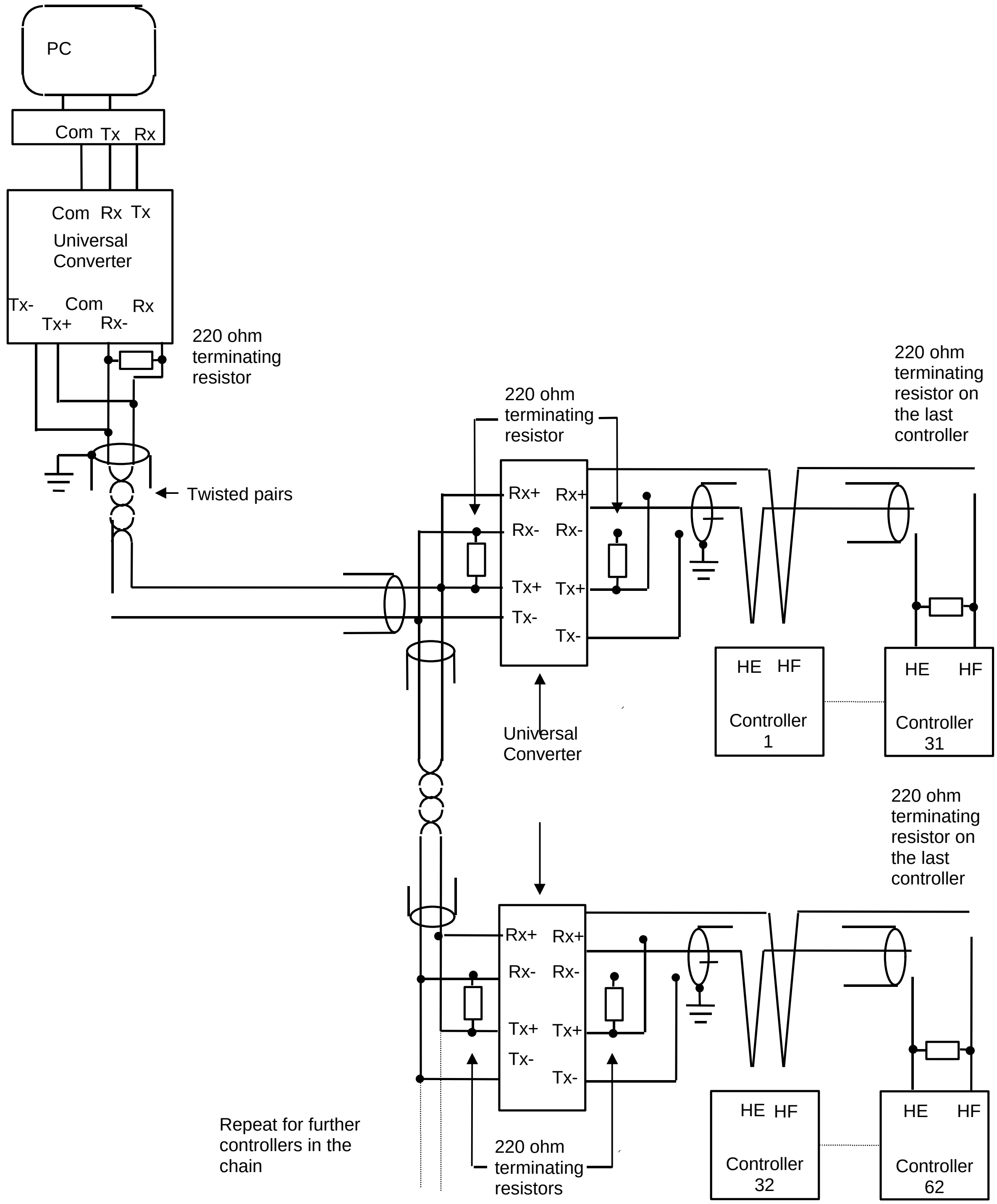
It is allowable to substitute one instrument in the first group with a universal comms isolator. Up to a further 31 additional instruments can be added as shown.

LARGE RS-422/485 (EIA422/485) NETWORKS

Networks with more than 32 instruments will require buffering of the communication lines. A commercialy available Universal Converter unit is recommended for this purpose. The universal converter sets the transmit line to non-tristate.

NOTE Large networks using RS-422 (EIA-422) 4-wire controllers could use a Universal Converter Unit To set the transmit lines to non tristate check the manual of the Universal Converter Unit. Contact Omega for further information when specifying large networks Instruments on a RS-422/485 (EIA422/485) communication network should be chain connected and not star connected.

The diagram below illustrates the wiring of a network communicating with a large number of CN2200 and CN2400 Series controllers.



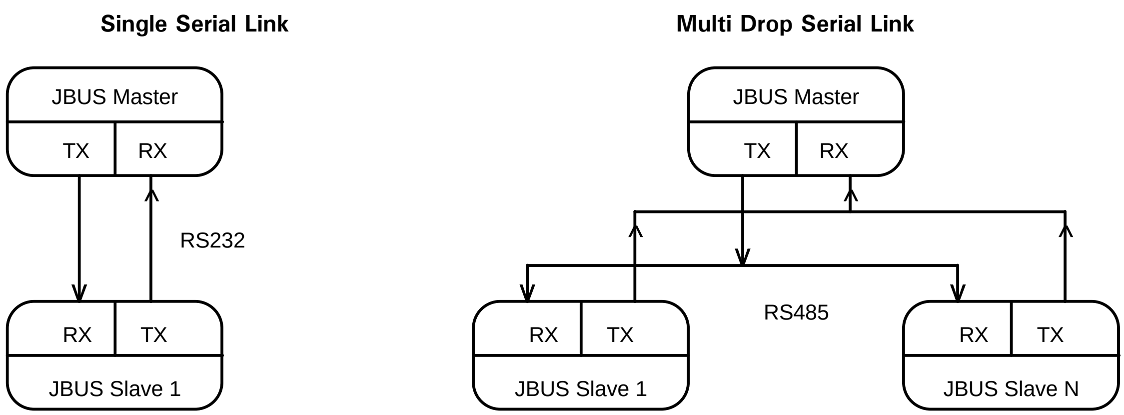
CHAPTER 3 MODBUS® AND JBUS® PROTOCOL

This chapter introduces the principles of the MODBUS® and JBUS® communication protocols. Note that in the Series CN2200/CN2400 the two protocols are identical, and both will be referred to as MODBUS® for the descriptions that follow.

PROTOCOL BASICS

A data communication protocol defines the rules and structure of messages used by all devices on a network for data exchange. This protocol also defines the orderly exchange of messages, and the detection of errors.

MODBUS® defines a digital communication network to have only one MASTER and one or more SLAVE devices. Either a single or multi-drop network is possible. The two types of communications networks are illustrated in the diagram below;



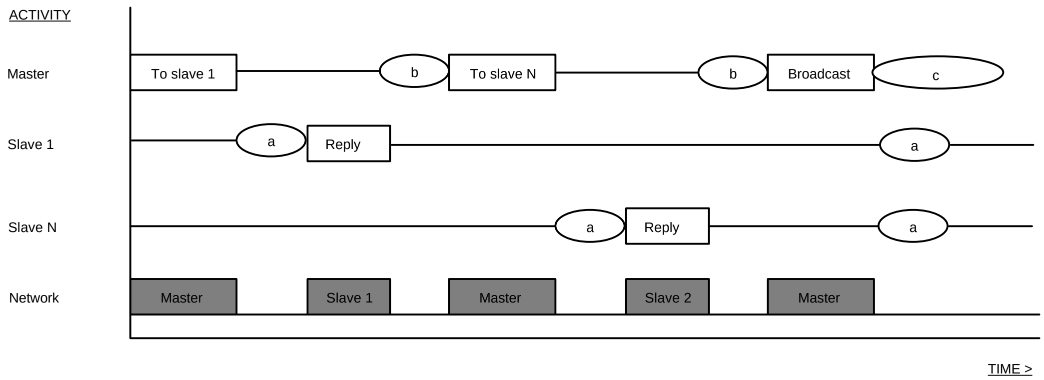
A typical transaction will consist of a request sent from the master followed by a response from the slave.
The message in either direction will consist of the following information;

Device Address Function Code Data Error Check Data End of Transmission

- Each slave has a unique 'device address'
- The device address 0 is a special case and is used for messages broadcast to all slaves. This is restricted to parameter write operations.
- Series CN2200 and CN2400 support a subset of Modbus® function codes.
- The data will include instrument parameters referenced by a 'parameter address'
- Sending a communication with a unique device address will cause only the device with that address to respond. That device will check for errors, perform the requested task and then reply with its own address, data and a check sum.
- Sending a communication with the device address '0' is a broadcast communication that will send information to all devices on the network. Each will perform the required action but will not transmit a reply.

TYPICAL TRANSMISSION LINE ACTIVITY

This diagram is to illustrate typical sequence of events on a Modbus® transmission line.



Period 'a' The processing time, (latency), required by the slave to complete the command and construct a reply.

Period 'b' The processing time required by the master to analyze the slave response and formulate the next command.

Period 'c' The wait time calculated by the master for the slaves to perform the operation. None of the slaves will reply to a broadcast message.

For a definition of the time periods required by the network, refer to 'Wait Period' in the section 'Error Response'.

DEVICE ADDRESS

Each slave has a unique 8 bit device address. The Gould MODBUS® Protocol defines the address range limits as 1 to 247. Series CN2200/CN2400 instruments will support an address range of 1 to 254. The device address used by the instrument is set using the Addr parameter in the CmS LiSt, which is available in operator mode. Note that this list may only be accessible when using the FuLL user interface: refer to the manual supplied with the instrument for more details on how to set this parameter.

Device address 0 is a special case that will broadcast a message to all slave devices simultaneously.

PARAMETER ADDRESS

Data bits or data words exchange information between master and slave devices. This data consists of parameters. All parameters communicated between master and slaves have a 16 bit parameter address.

The MODBUS® parameter address range is 0001 to FFFF..

Parameter definitions for Series CN2200/CN2400 instruments are in Chapter 5.

PARAMETER RESOLUTION

JBUS® and MODBUS® protocol limit data to 16 bits per parameter. This reduces the active range of parameters to 65536 counts. In Series CN2200 and CN2400 instruments this is implemented as -32767 (8001h) to +32767 (7FFFh).

The protocol is also limited to integer communication only.   Series CN2200 and CN2400 instruments allow the user to configure either integer or full resolution.   In integer mode all parameters will be rounded to the nearest integer value, whereas in full resolution mode the decimal point position will be implied so that 100.01 would be transmitted as 10001. From this, and the 16 bit resolution limitation, the maximum value communicable with 2 decimal place resolution is 327.67. The parameter resolution will be taken from the slave user interface, and the conversion factor must be known to both master and slave when the network is initiated.

MODE OF TRANSMISSION

The mode of transmission describes the structure of information within a message and the number coding system used to exchange a single character of data.

The JBUS® and MODBUS® Protocols define a mode of transmission for both ASCII and RTU modes of transmission. Omega Engineering Series CN2200 and CN2400 instruments **only** support the **RTU** mode of transmission.

The RTU definition of the mode of transmission for a single character is;

A start bit, eight data bits, a parity bit and one or two stop bits

All Omega Series CN2200 and CN2400 instruments use 1 stop bit.
Parity may be configured to be NONE, ODD or EVEN.
If parity is configured to be NONE, no parity bit is transmitted.

The RTU mode of transmission for a single character is represented as follows:

Start	d7	d6	d5	d4	d3	d2	d1	d0	Parity	Stop

MESSAGE FRAME FORMAT

A message consists of a number of characters sequenced so that the receiving device can understand. This structure is known as the message frame format.

The following diagram shows the sequence defining the message frame format used by JBUS® and MODBUS®:

Frame start   Device address   Function code   Data   CRC   EOT
3 bytes   1 byte   1 byte   n bytes   2 byte   3 bytes

The frame start is a period of inactivity at least 3.5 times the single character transmission time.
For example, at 9600 baud a character with 1 start, 1 stop and 8 data bits will require a 3.5ms frame start.
This period is the implied EOT of a previous transmission.

The device address is a single byte (8-bits) unique to each device on the network.

Function codes are a single byte instruction to the slave describing the action to perform.

The data segment of a message will depend on the function code and the number of bytes will vary accordingly.
Typically the data segment will contain a parameter address and the number of parameters to read or write.

The Cyclic Redundancy Check, (CRC) is an error check code and is two bytes, (16 bits) long.

The End of Transmission segment, (EOT) is a period of inactivity 3.5 times the single character transmission time. The EOT segment at the end of a message indicates to the listening device that the next transmission will be a new message and therefore a device address character.

CYCLIC REDUNDANCY CHECK

The Cyclic Redundancy Check, (CRC) is an error check code and is two bytes, (16 bits) long. After constructing a message, (data only, no start, stop or parity bits), the transmitting device calculates a CRC code and appends this to the end of the message. A receiving device will calculate a CRC code from the message it has received. If this CRC code is not the same as the transmitted CRC there has been a communication error. ***Series CN2200 and CN2400 instruments do not reply if they detect a CRC error in messages sent to them.***

The CRC code is formed by the following steps:

1 Load a 16 bit CRC register with FFFFh.

2 Exclusive OR (⊕) the first 8 bit byte of the message with the with the high order byte of the CRC register.
Return the result to the CRC register.

3 Shift the CRC register one bit to the right.

4 If the over flow bit, (or flag), is 1, exclusive OR the CRC register with A001 hex and return the result to the CRC register.

4a If the overflow flag is 0, repeat step 3.

5 Repeat steps 3 and 4 until there have been 8 shifts.

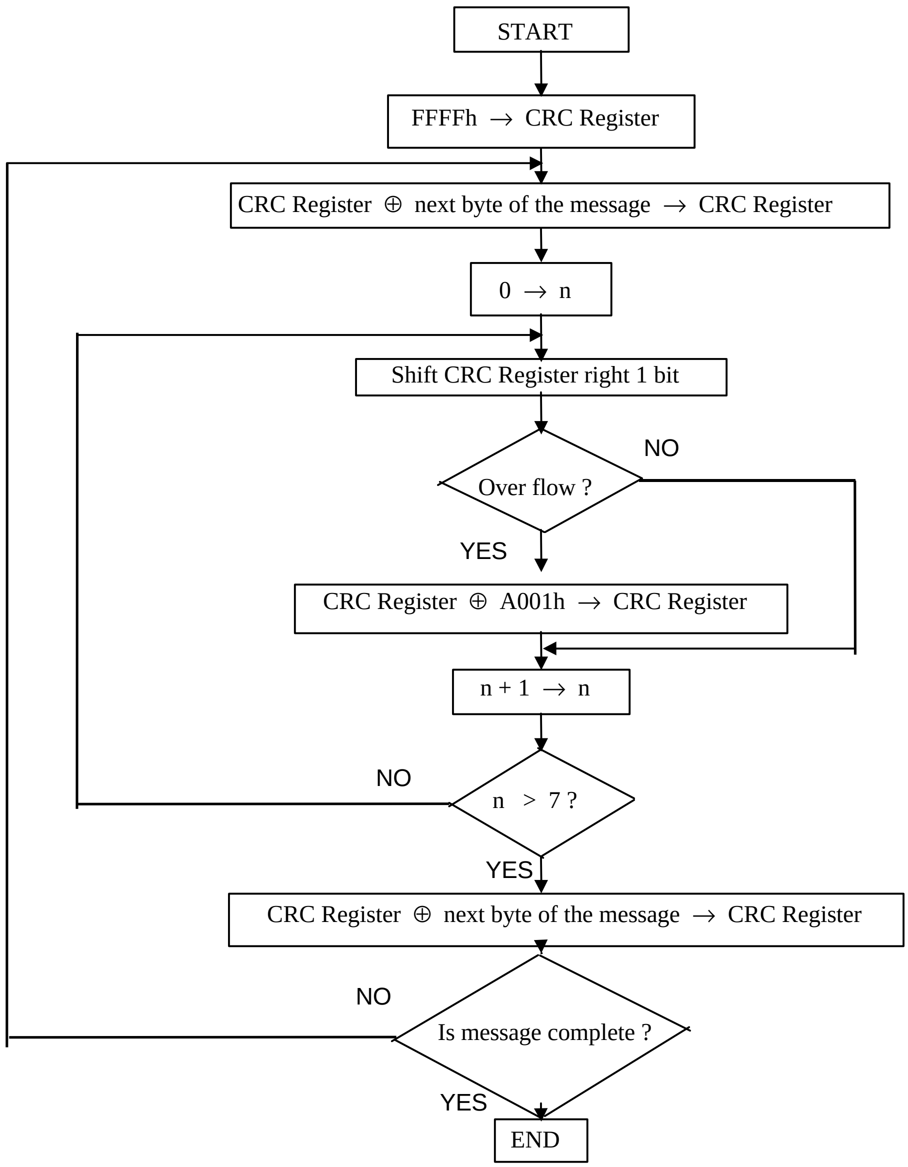
6 Exclusive OR the next 8 bit byte of the message with the high order byte of the CRC register.

7 Repeat step 3 through to 6 until all bytes of the message have been exclusive OR with the CRC register and shifted 8 times.

8 The contents of the CRC register are the 2 byte CRC error code and are added to the message with the most significant bits first.

The flow chart below illustrates this CRC error check algorithm.

The '⊕' symbol indicates an 'exclusive OR' operation. 'n' is the number of data bits.



EXAMPLE OF A CRC CALCULATION

This example is a request to read from the slave unit at address 02, the fast read of the status (07).

Function	16 Bit Register				Carry flag
	LSB		MSB		
Load register with FFFF hex	1111	1111	1111	1111	0
First byte of the message (02)			0000	0010	
Exclusive OR	1111	1111	1111	1101	
1st shift right	0111	1111	1111	1110	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1101	1111	1111	1111	
2nd shift right	0110	1111	1111	1111	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1100	1111	1111	1110	
3rd shift right	0110	0111	1111	1111	0
4th shift right (carry = 0)	0011	0011	1111	1111	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1001	0011	1111	1110	
5th shift right	0100	1001	1111	1111	0
6th shift right (carry = 0)	0010	0100	1111	1111	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1000	0100	1111	1110	
7th shift right	0100	0010	0111	1111	0
8th shift right (carry = 0)	0010	0001	0011	1111	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1000	0001	0011	1110	
Next byte of the message (07)			0000	0111	
Exclusive OR (shift = 8)	1000	0001	0011	1001	
1st shift right	0100	0000	1001	1100	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1110	0000	1001	1101	
2nd shift right	0111	0000	0100	1110	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1101	0000	0100	1111	
3rd shift right	0110	1000	0010	0111	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1100	1000	0010	0110	
4th shift right	0110	0100	0001	0011	0
5th shift right (carry = 0)	0011	0010	0000	1001	1
A001	1010	0000	0000	0001	
Exclusive OR (carry = 1)	1001	0010	0000	1000	
6th shift right	0100	1001	0000	0100	0
7th shift right (carry = 0)	0010	0100	1000	0010	0
8th shift right (carry = 0)	0001	0010	0100	0001	0
CRC error check code	12h		41h		

The final message transmitted, including the CRC code, is as follows;

Device address		Function code		CRC MSB		CRC LSB	
02h		07h		41h		12h	
0000	0010	0000	0111	0100	0001	0001	0010

↑ First bit Transmission order Last bit ↑

EXAMPLE OF A CRC CALCULATION IN THE 'C' LANGUAGE

This routine assumes that the data types 'uint16' and 'uint8' exists. These are unsigned 16 bit integer (usually an 'unsigned short int' for most compiler types) and unsigned 8 bit integer (unsigned char). 'z_p' is a pointer to a Modbus® message, and z_message_length is its length, excluding the CRC. Note that the Modbus® message will probably contain 'NULL' characters and so normal C string handling techniques will not work.

```
uint16 calculate_crc(byte *z_p, uint16 z_message_length)

/* CRC runs cyclic Redundancy Check Algorithm on input z_p */
/* Returns value of 16 bit CRC after completion and        */
/* always adds 2 crc bytes to message                      */
/* returns 0 if incoming message has correct CRC           */

{
   uint16 CRC= 0xffff;
   uint16 next;
   uint16 carry;
   uint16 n;
   uint8 crch, crcl;

   while (z_message_length--) {
      next = (uint16)*z_p;
      CRC ^= next;
      for (n = 0; n < 8; n++) {
          carry = CRC & 1;
          CRC >>= 1;
          if (carry) {
             CRC ^= 0xA001;
          }
      }
      z_p++;
   }
   crch = CRC / 256;
   crcl = CRC % 256
   z_p[z_message_length++] = crcl;
   z_p[z_message_length] = crch;
   return CRC;
}
```

Example of a CRC Calculation in BASIC Language

```
Function CRC(message$) as long
'' CRC runs cyclic Redundancy Check Algorithm on input message$
'' Returns value of 16 bit CRC after completion and
'' always adds 2 crc bytes to message
'' returns 0 if incoming message has correct CRC

  '' Must use double word for CRC and decimal constants

  crc16& = 65535
  FOR c% = 1 to LEN(message$)
    crc16& = crc16& XOR ASC(MID$(message$, c%, 1))
    FOR bit% = 1 to 8
      IF crc16& MOD 2 THEN
        crc16& = (crc16& \ 2) XOR 40961
      ELSE
        crc16& = crc16& \ 2
      END IF
    NEXT BIT%
  NEXT c%
  crch% = CRC16& \ 256: crcl% = CRC16& MOD 256
  message$ = message$ + CHR$(crcl%) + CHR$(crch%)
  CRC = CRC16&
END FUNCTION CRC
```

FUNCTION CODES

Function codes are a single byte instruction to the slave describing the action to perform.

The following communication functions are supported by Series CN2200 and CN2400 instruments:

Function code	Function
01 or 02	Read n bits
03 or 04	Read n words
05	Write a bit
06	Write a word
07	Fast Read of Status
08	Loopback
16	Write n words

It is recommended that function code 3 is used for reads and function code 16 is used for writes. This includes Boolean data. Other codes are supplied for purposes of compatibility.

Only the write function codes 05, 06 and 16 will work with a 'broadcast mode' address. ***Series** CN2200 and CN2400 **instruments will not reply if they receive a request including a unsupported function code.***

Data bits or data words exchange information between master and slave devices. This data consists of parameters.

Parameter definitions for the Series CN2200 and CN2400 instruments are provided later in this document.

The sections that follow explain the message frame format for each function code.

READ N BITS

Function code: 01 or 02, (01h or 02h)

Command:

Device address	Function code 01 or 02	Address of first bit		Number of bits to read		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Reply:

Device address	Function code 01 or 02	Number of bytes read	First byte of data	....	Last byte of data	CRC	
1 byte	1 byte	1 byte	1 byte	....	1 byte	MSB	LSB

The first data byte contains the status of the first 8 bits, with the least significant bit being the first bit. The second data byte contains the status of the next 8 bits, etc.. Unused bits are set to zero.

Example: From the instrument at device address 19, read 14 bits, beginning at parameter address 2.

Command:

Device address	Function code	Address of first bit		Number of bits to read		CRC	
13	01	00	02	00	0E	1F	7C

Reply:

Device address	Function code	Number of bytes read	First byte of data	Second byte of data	CRC	
13	01	02	01	01	C1	AF

An expansion of the data bytes illustrates the relationship between data and the parameter addresses. The reply indicates that the instrument is in sensor break and manual mode.

Data byte	1st byte (40h)								2nd byte (02h)							
Param. address	9	8	7	6	5	4	3	2	17	16	15	14	13	12	11	10
Bit values	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1

Parameter addresses 16 and 17 are set to zero.

READ N WORDS

Function code: 03 or 04, (03h or 04h)

Command:

Device address	Function code 03 or 04	Address of first word		Number of words to read		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

The maximum number of words that may be read is 125 for CN2400 Series instruments and 32 for the CN2200

Reply:

Device address	Function code 03 or 04	Number of bytes read	Value of the first word		....	Value of the last word		CRC	
1 byte	1 byte	1 byte	MSB	LSB	....	MSB	LSB	MSB	LSB

Example: From CN2200 and CN2400 Series slave at device address 2, read 2 words from parameter address 1 (Process Variable and Target Setpoint).

Command:

Device address	Function code	Address of first word		Number of words to read		CRC	
02	03	00	01	00	02	95	F8

Reply: (If the instrument is configured with **integer** resolution and PV = 18.3, SP = 21.6)

Device address	Function code 03 or 04	Number of bytes read	Value of the first word		Value of the last word		CRC	
02	03	04	00	12	00	16	E8	F8

Reply: (If the instrument is configured with **full** resolution and PV = 18.3, SP = 21.6)

Device address	Function code 03 or 04	Number of bytes read	Value of the first word		Value of the last word		CRC	
02	03	04	00	B2	00	D8	69	4E

As the decimal point is not transmitted, the master must scale the response; 183=5.0, 216=10.0.

WRITE A BIT

Function code: 05, (05h)

Command:

Device address	Function code 05	Address of bit		Value of bit		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

The LSB of 'Value of bit' is always set to 00. The MSB is used to write the value of the addressed bit. To set a bit value of 1, either transmit 01h or FFh. To set a bit value of 0 transmit 00h.

A device address 00 will broadcast the data to all devices on the network.

Reply: (There will be no reply to a command broadcast to the device address 00.)

Device address	Function code 05	Address of bit		Value of bit		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

The reply to function 05 is the same as the command. See the section on 'Error Response' below for details of the reply if the operation fails.

Example: Write to the Series CN2200 and CN2400 instrument at device address 2 and set the instrument to manual. (The bit at parameter address 2 is set).

Command:

Device address	Function code	Address of bit		Value of bit		CRC	
02	05	00	02	01	00	6D	A9

Reply:

Device address	Function code	Address of bit		Value of bit		CRC	
02	05	00	02	01	00	6D	A9

WRITE A WORD

Function code: 06, (06h)

Command:

Device address	Function code 06	Address of word		Value of word		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

A device address 00 will broadcast the data to all devices on the network.

Reply: (There will be no reply to a command broadcast to the device address 00.)

Device address	Function code 06	Address of word		Value of word		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

The reply to function 06 is the same as the command. See the section on 'Error Response' below for details of the reply if the operation fails.

Example: Write to the Series CN2200 and CN2400 slave at device address 2 and change the setpoint to 25.0°C (address 2). The instrument is configured with full resolution, therefore the required value is 250.

Command:

Device address	Function code	Address of word		Value of word		CRC	
02	06	00	02	00	FA	A8	7A

Reply:

Device address	Function code	Address of word		Value of word		CRC	
02	06	00	02	00	FA	A8	7A

FAST READ OF STATUS

Function code: 07, (07h)

The fast read of status command is short to allow a rapid transaction to obtain one byte of frequently needed status information.

Command

Device address	Function code 07	CRC	
1 byte	1 byte	MSB	LSB

Reply:

Device address	Function code 07	Fast read status byte	CRC	
1 byte	1 byte	1 byte	MSB	LSB

The table below defines the status byte information used by Series CN2200 and CN2400 instruments.

Parameter		Modbus® CN2400	Modbus® CN2200	Display
Summary Output Status Word		75	75	-
BIT	**DESCRIPTION**			
0	Alarm 1 State (0 = Safe, 1 = Alarm)		Alarm 1 State (0 = Safe, 1 = Alarm)	
1	Alarm 2 State (0 = Safe, 1 = Alarm)		Alarm 2 State (0 = Safe, 1 = Alarm)	
2	Alarm 3 State (0 = Safe, 1 = Alarm)		Alarm 3 State (0 = Safe, 1 = Alarm)	
3	Alarm 4 State (0 = Safe, 1 = Alarm)		Alarm 4 State (0 = Safe, 1 = Alarm)	
4	Manual Mode (0 = Auto, 1 = Manual)		Manual Mode (0 = Auto, 1 = Manual)	
5	Sensor Break (0 = Good PV, 1 = Sensor Broken)		Sensor Break (0 = Good PV, 1 = Sensor Broken)	
6	Loop Break (0 = Good closed loop, 1 = Open Loop)		Loop Break (0 = Good Closed Loop, 1 = Open Loop)	
7	Heater Fail (0 = No Fault, 1 = Load fault detected)		Heater Fail (0 = No Fault, 1 = Load Fault Detected)	
8	Tune Active (0 = Auto Tune disabled, 1 = Auto Tune active)		Load Fail (0 = No Fault, 1 = Load Fault Detected)	
9	Ramp/Program Complete (0 = Running/Reset, 1 = Complete)		Ramp/Program Complete (0 = Running/Reset, 1 = Complete)	
10	PV out of range (0 = PV within table range, 1 = PV out of table range)		PV out of range (0 = PV within table range, 1 = PV out of table range)	
11	DC control module fault (0= Good,. 1= BAD)		SSR Fail (0 = No fault, 1 = Load fault detected)	
12	Programmer Segment Synchronize (0 = Waiting, 1 = Running)		New Alarm	
13	Remote input sensor break (0 = Good, 1 = Bad)		Remote input sensor break (0 = Good, 1 = Bad)	

Example: Fast read the status byte from a Series CN2200 and CN2400 instrument at device address 02.

Command:

Device address	Function code	CRC	
02	07	41	12

Reply:

Device address	Function code	Fast read status byte	CRC	
02	07	30	D2	24

In this example the value of status byte (30h) has the following information;

PV is in sensor break

Instrument is in Manual mode

DIAGNOSTIC LOOPBACK

Function code: 08, (08h)

This function provides a means of testing the communications link by means of a 'loopback' operation. The data sent to the instrument is returned unchanged. Only diagnostic code 0 from the Gould Modicon Specification is supported

Command:

Device address	Function Code 08	Diagnostic Code 0000		Loopback Data		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Reply:

The reply to function 08 is the same as the command

Example: Perform a loopback from the Series CN2200 and CN2400 instrument at address 2, using a data value of 1234h.

Command:

Device address	Function Code 08	Diagnostic Code 0000		Loopback Data		CRC	
02	08	00	00	12	34	ED	4F

Reply:

Device address	Function Code 08	Diagnostic Code 0000		Loopback Data		CRC	
02	08	00	00	12	34	ED	4F

WRITE N WORDS

Function code: 16, (10h)

Command:

Device address	Function code 10	Address of first word		Number of words to write		Number of data bytes (n)	Data	CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	1 byte	n bytes	MSB	LSB

The maximum number of words that can be transmitted is

Series CN2200: 32
Series CN2400: 125 words, which corresponds to 250 bytes of data

The first two bytes are data with the required value of the first parameter, MSB first. Following pairs of bytes are data for the consecutive parameter addresses.

A device address 00 will broadcast the data to all devices on the network.

NB: *Blocks of data written using Modbus® function 16 containing values in positions corresponding to the addresses of unconfigured parameters are not generally rejected, although the values of any unconfigured parameters are discarded. This allows relatively large blocks of parameter data to be written in a single operation, even if the block contains a little 'empty' space. This is particularly useful for operations such as downloading ramp/dwell programs, recipes, or instrument cloning. However, this also leads to a potential pitfall: if the block of data contains only a single parameter, and the destination address refers to an unconfigured or unused Modbus® address, the write operation will appear to be successful, although the instrument will have discarded the value.*

Attempts to write to read only parameters over Modbus®, even when they are embedded within a block of data, will be rejected with a Modbus® 'data error'. Any subsequent values in the block will also be discarded.

Reply: There will be no reply to a command broadcast to the device address 00. See the section on 'Error Response' below for details of the reply if the operation fails.

Device address	Function code 10	Address of first word		Number of words written		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Example: Write to the Series CN2200 and CN2400 slave at device address 2 which is configured with full resolution.
Setpoint 3 = 12.3 (123) parameter address 164
Setpoint 4 = 15.0 (150) parameter address 165
Setpoint 5 = 25.0 (250) parameter address 166

Command:

Device address	Function code	Address of first word		Number of words to write		Number of data bytes	Data	CRC	
02	10	00	A4	00	03	06	See below	20	71

Data (123) for address 164		Data (150) for address 165		Data (250) for address 166	
01	7B	03	96	00	FA

Reply:

Device address	Function code	Address of first word		Number of words written		CRC	
02	10	00	A4	00	03	C1	D8

ERROR RESPONSE

The JBUS® and MODBUS® protocol define the response to a number of error conditions. A slave device is able to detect a corrupted command or, one that contains an incorrect instruction, and will respond with an error code.

With some errors the slave devices on the network are unable to make a response. After a wait period the master will interpret the failure to reply as a communication error. The master should then re-transmit the command.

A slave device that has detected a corrupted command or a command that contains an incorrect instruction, will respond with an error message. The error message has the following syntax.

Device address	Function code	Error response code	CRC	
1 byte	1 byte	1 byte	MSB	LSB

The Function code byte contains the transmitted function code but with the most significant bit set to 1.
(This is the result of adding 128 to the function code.)

ERROR RESPONSE CODES

The error response code indicates the type of error detected.
Series CN2200 and CN2400 instruments support the following error response codes:

Code	Error	Description
02	Illegal Data Address	The address referenced in the data field is not an allowable address for the slave
03	Illegal Data Value	The value referenced in the data field is not allowable in the addressed slave location

WAIT PERIOD

There are several errors for which the slave devices on the network are unable to make a response:

- If the master attempts to use an invalid address then no slave device will receive the message.
- For a message corrupted by interference, the transmitted CRC will not be the same as the internally calculated CRC. The slave device will reject the command and will not reply to the master.

After a wait period, the master will re-transmit the command.

A wait period is also required after a broadcast communication to device address 0.
Caution: Failure to observe the wait period after a broadcast will negate the broadcast message.

The wait period should exceed the instrument latency plus the message transmission time. Typical wait periods, for a single parameter read, are 20ms for Series CN2400 and 50 to 100ms for Series CN2200.

LATENCY

The time taken for the Series CN2200/CN2400 instruments to process a message and **start** the transmission of a reply is called the latency. This does not include the time taken to transmit the request or reply.

The parameter functions read 1 word (function 03h), write 1 word (function 06h), write 1 bit (function 05h), fast read of status (function 07h), and loopback (function 08h) are processed within a latency of between 2 and 10ms.

For the parameter functions, read n bits (function 01h), read n words (function 03h), and write n words (function 10h) the latency is indeterminate. The latency will depend on the instrument activity and the number of parameters being transferred and will take from 2 to 500ms, for Series CN2400, and 50 to 500ms, for Series CN2200.

It is possible to artificially increase the latency by setting the 'Comms Delay' parameter in the Mod HA configuration list. This is sometimes required to allow a guaranteed gap between requests and responses, needed by some RS-485 (EIA-485) adaptors to switch from transmit to receive states.

MESSAGE TRANSMISSION TIME

The time required to transmit a message will depend on the length of the message and the baud rate.

$$\text{Message transmission time} = \frac{(\text{Number of bytes in the message} + 3.5) * \text{Number of bits per character}}{\text{Baud rate}}$$

To find the number of bytes, refer to the relevant function code. The three extra bytes are for the End of Transmission, (EOT), characters.

The number of bits per character will be ten, or eleven if a parity bit is used. (1 start bit, 8 data bits, an optional parity bit and 1 stop bit. See Mode of Transmission).

For example reading a single word with the function code 03 at 19200 baud, (no parity bit);

$$\text{Command transmission time} = \frac{(8 + 3.5) * 10}{19200} = 6 \text{ ms}$$

$$\text{Reply transmission time} = \frac{(9 + 3.5) * 10}{19200} = 6.5 \text{ ms}$$

The wait period for this transaction will exceed 22.5 ms, (6 + 6.5 + 10.0).

For a broadcast command, (device address 0), the master would not expect a reply. In this case, the wait period will exceed 16 ms, (6 +10.0).

CHAPTER 4 MODBUS® AND ADDRESSES

MODBUS® ADDRESS

This section of the manual provides a list of all parameters in Series CN2200 and CN2400 controllers that are available over the communications link. As far as possible, it follows the same organization as the controller user interface itself. Definitions of parameters and status information not available via the controller display are also provided.

Series CN2200 and CN2400 controllers may be configured for a wide variety of functions and some parameters will only be available if the related function is configured. Modbus® addresses that are not supported have no parameter assigned. In normal operating mode all configuration parameters are read only. To be able to write to these parameters, the controller must be in configuration mode.

If the Modbus® protocol is used to read a parameter that is not configured, an undefined value will be returned.

Modbus® function 6 single parameter write operations to unconfigured or read only parameters will be rejected with a Modbus® ‘data error’ return code.

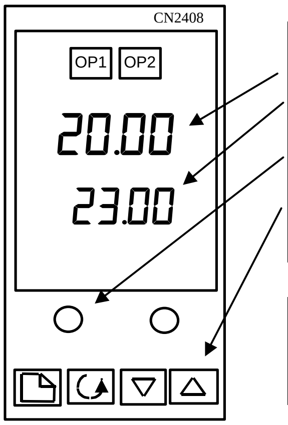
NB: *Blocks of data written using Modbus® function 16 containing values in positions corresponding to the addresses of unconfigured parameters are not generally rejected, although the values of any unconfigured parameters are discarded. This allows relatively large blocks of parameter data to be written in a single operation, even if the block contains a little ‘empty’ space. This is particularly useful for operations such as ramp/dwell program downloading, recipes, or instrument cloning. However, this also leads to a potential pitfall: if the block of data contains only a single parameter, and the destination address refers to an unconfigured or unused Modbus® address. The write operation will appear to be successful, although the controller will have discarded the value.*

Attempts to write to read only parameters over Modbus®, even when they are embedded within a block of data, will be rejected with a Modbus® ‘data error’. Any subsequent values in the block will also be discarded.

Rules for read and write operation in the Modbus® IEEE are dealt with in Chapter 3.

OPERATING MODE PARAMETERS

It is often only necessary to access a limited number of the most common parameters, where, for example, it is required to emulate the front panel of a controller in a mimic diagram. The following table shows a summary of common parameters:



Example 1 PID Controller	
Parameter	Modbus® Address
Read Process value	1
Change Setpoint	2 - (enter new value)
Raise Setpoint	2 - (new value in repeated steps)
Select Manual Mode	273 - (enumerator 1)
Change Output Power	3 - (new value)
Raise Output Power	3 - (new value in repeated steps)
Read Output Power	3

Parameter	Modbus® address
To Select Manual	273 - (enumerator 1)
To Change Output Position	60 - (new value)
To Read Output Position	53

MODBUS® TABLES

Notes: The following notes apply throughout this section

1. Issued software versions to date are CN2400: 1.03, 2.04, 3.04 and 3.05 and 2200: 1.00, 1.20, 1.30 and 2.10.
2. Greyed out cells indicate parameter not available

	Home list	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
	Process Variable	1		1	
OP	% Output level	3		3	
uPoS	Valve position			53	
SP	Target setpoint (if in Manual mode)	2		2	
m-A	Auto-man select 0: Auto 1: Manual	273		273	
AmPS	Heater current (With PDLINK mode 2)	80		80	
Cid	Customer defined identification number	629		629	
w.SP	Working set point. Read only: use Target set point or currently selected set point (1 to 16) to change the value	5		5	
OP	Control output (on/off controller). Not writable unless the controller is in 'manual' mode. 0: -100% 1: 0% 2: 100%	85	See Note 1 above		
-	VP Manual Output (alterable in Man only)	60			
-	Valve Posn (computed by VP algorithm)	53			
diSP	Display 0: Standard 1: Load current 2: Output power 3: Program state 5: Blank 6: Valve position			106	

run	**Run List**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
PrG	Current program running (active prog no.)	22			
StAt	Program Status 1: Reset 2: Run 4: Hold 8: Holdback 16: Complete	23			
PSP	Programmer setpoint	163			
CYC	Program cycles remaining	59			
SEG	Current segment number	56			
StYP	Current segment type 0: End 1: Ramp (Rate) 2: Ramp (Time to target) 3: Dwell 4: Step 5: Call	29			
SEGt	Segment time remaining	36			
tGt	Target setpoint (current segment)	160			
rAtE	Ramp rate	161			
PrGt	Program time remaining	58			
FASt	Fast run 0: No 1: Yes	57			
out.1	Logic 1 output (current program) 0: Off (applies to all 8 logic outputs) 1: On (applies to all 8 logic outputs)	464			
out.2	Logic 2 output (current program)	465			
out.3	Logic 3 output (current program)	466			
out.4	Logic 4 output (current program)	467			
out.5	Logic 5 output (current program)	468			
out.6	Logic 6 output (current program)	469			
out.7	Logic 7 output (current program)	470			
out.8	Logic 8 output (current program)	471			
SYnc	Segment synchronization 0: No 1: Yes	488			
SEG.d	Flash active segment in lower display	284			

AL	**Alarm List**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
1---	Alarm 1setpoint value	13		13	
2---	Alarm 2setpoint value	14		14	
3---	Alarm 3setpoint value	81		81	
4---	Alarm 4setpoint value	82		82	
HY 1	Alarm 1 hysteresis	47		580	
HY2	Alarm 2 hysteresis	68		580	
HY3	Alarm 3 hysteresis	69		580	
HY4	Alarm 4 hysteresis	71		580	
Lbt	Loop break time 0: Off	83		83	
di AG	Enable diagnostic messages 0: No Diagnostics 1: Diagnostics	282			

AtUn	Autotune List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
tUnE	Autotune enable 0: No Tune 1: Tune	270		270	
drA	Adaptive tune enable 0: No Adaptive Tune 1: Tune	271			
drA.t	Adaptive tune trigger level	100			
Adc	Automatic droop compensation (manual reset) 0: Manual reset 1: Calculated	272		272	

Pid	PID List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
G.SP	Gain scheduler setpoint	153			
SEt	Current PID set (read only if gain scheduling is selected) 0: Set 1 1: Set 2	72			
Pb	Proportional band PID1	6		6	
ti	Integral time PID1 0: Off	8		8	
td	Derivative time PID1 0: Off	9		9	
rES	Manual reset PID1	28		28	
Hcb	Cutback high PID1 0: Auto	18		18	
Lcb	Cutback low PID1 0: Auto	17		17	
rEL.c	Relative cool gain PID1	19		19	
Pb2	Proportional band PID2	48			
ti2	Integral time PID2 0: Off	49			
td2	Derivative time PID2 0: Off	51			
rES.2	Manual reset PID2	50			
Hcb2	Cutback high PID2 0: Auto	118			
Lcb2	Cutback low PID2 0: Auto	117			
rEL2	Relative cool gain PID2	52			
Pb.c	Cool proportional band	90			
db.c	Cool deadband	91			
FF.Pb	Feedforward proportional band	97			
FF.tr	Feedforward trim	98			
FF.du	Feedforward trim limit	99			

On.OF	On/Off List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
hYS.H	Heat hysteresis	86	These parameters appear in the output list in 2400 series	86	
hYS.C	Cool hysteresis	88		88	
HC.db	Heat/cool deadband	16		16	
Sb.OP	On/Off sensor break output power 0: -100% 1: 0% 2: 100%	40			

mtr	Motor List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
tm	Valve travel time	21			
I n.t	Valve inertia time	123			
bAc.t	Valve backlash time	124			
mP.t	Minimum pulse time	54			
u.br	Bounded sensor break strategy	128			
Sb.oP	VP Bounded sensor break	62	VP b (feedback) controllers only		

mtr	Motor List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
cYc.t	VP Cycle time	132			
I nu	VP Raise inertia 0: Off	123			
I nd	VP Lower inertia 0: Off	130			
bAc.u	VP Raise backlash 0: Off	124			
bAc.d	VP Lower backlash 0: Off	129			
UEL.u	VP Raise velocity limit	125			
UEL.d	VP lower velocity limit	126			
Pot.L	VP Position low limit	42			
Pot.H	VP Position high limit	43			
Sb.OP	Boundless sensor break o/p 0: Rest 1: Up 2: Down	128			

SP	Setpoint list	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
SSEL	Select setpoint 0: SP1 1: SP2	15	SP1 & SP2 available in standard controller	15	SP1 & SP2 available in standard controller
	2: SP 3 3: SP 4 4: SP 5 5: SP 6 6: SP 7 7: SP 8 8: SP 9 9: SP 10 10: SP 11 11: SP 12 12: SP13 13: SP14 14: SP15 15: SP16		SP1 to SP16 available to order in the 16 setpoint option		
L-r	Local or remote setpoint select 0: Local 1: Remote	276		276	
SP 1	Setpoint 1	24		24	
SP 2	Setpoint 2	25		25	
SP 3	Setpoint 3	164			
SP 4	Setpoint 4	165			
SP 5	Setpoint 5	166			
SP 6	Setpoint 6	167			
SP 7	Setpoint 7	168			
SP 8	Setpoint 8	169			
SP 9	Setpoint 9	170			
SP 10	Setpoint 10	171			
SP 11	Setpoint 11	172			
SP 12	Setpoint 12	173			
SP 13	Setpoint 13	174			
SP 14	Setpoint 14	175			
SP 15	Setpoint 15	176			
SP 16	Setpoint 16	177			
rm.SP	Remote setpoint	485		26	
rmt.t	Remote setpoint trim	486			
rAt	Ratio setpoint	61			
Loc.t	Local setpoint trim	27		27	
SP L	Setpoint 1 low limit	112		112	SP 1.L
SP H	Setpoint 1 high limit	111		111	SP 1.H
SP2.L	Setpoint 2 low limit	114		114	
SP2.H	Setpoint 2 high limit	113		113	
Loc.L	Local setpoint trim low limit	67		67	
Loc.H	Local setpoint trim high limit	66		66	
SPrr	Setpoint rate limit 0: Off	35		35	
Hb.tY	Holdback type for setpoint rate limit 0: Off 1: Low 2: High 3: Band	70			
Hb	Holdback value for setpoint rate limit	65			
SP	Setpoint List	CN2400		CN2200	

		Modbus®	Notes	Modbus®	Notes
	Dwell segment 0: Off			62	
	Go to state at end of program 0: Dwell 1: Reset 2: Hold 3: Standby			517	End.t
	Program state write 1: Reset 2: Run			57	ProG
	Program state read 1: Off 2: Run 4: Hold 16 End 32: Dwell 64 Ramp			23	StAt

iP	**Input List**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
FiLt	Input 1 filter time constant 0: Off	101		101	
FiLt.2	Input 2 filter time constant 0: Off	103			
F.1	Derived input function factor 1	292			
F.2	Derived input function factor 2	293			
Hi.1P	Switchover transition region high	286	Input		
Lo.1P	Switchover transition region low	287	switching		
Emis	Emmisivity	38	Custom		
Emis.2	Emmisivity input 2	104	pyrometers		
PV.iP	Select input 1 or input 2	288			
CAL	User calibration enable 0: Factory 1: User	110		110	
CAL.S	Selected calibration point 0: None 1: Input 1 low 2: Input 1 high 3: Input 2 low 4: Input 2 high	102		108	0: None 1: Adj low 2: Adj hi 3: N/A 4: N/A
CAL.L	Transducer Low Cal enable 0: No 1: Yes	109			
AdJ.L	Adjust low calibration point	145			
CAL.H	Transducer High Cal enable 0: No 1: Yes	108			
AdJ.H	Adjust high calibration point	144			
AdJ	User calibration adjust input 1	146		63	
AdJ	User calibration adjust input 2	148			
OFS.1	Input 1 calibration offset	141		127	OFSt
OFS.2	Input 2 calibration offset	142			
mV.1	Input 1 measured value	202		202	mV
mV.2	Input 2 measured value	208			
CJC.1	Input 1 cold junction temp. reading	215		215	CJC
CJC.2	Input 2 cold junction temp. reading	216			
Li.1	Input 1 linearized value	289			
Li.2	Input 2 linearized value	290			
PV.SL	Currently selected setpoint	291			

oP	Output List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
OP.Lo	Low power limit	31		31	
OP.Hi	High power limit	30		30	
rOP.L	Remote low power limit	33			
rOP.H	Remote high power limit	32			
OPrr	Output rate limit 0: Off	37			
FOP	Forced output level	84			
CYC.H	Heat cycle time	10		10	
hYS.H	Heat hysteresis (on/off output)	86			
ont.H	Heat output minimum on time 0: Auto	45		45	
CYC.C	Cool cycle time	20		20	
hYS.C	Cool hysteresis (on/off output)	88			
ont.C	Cool output minimum on time 0: Auto	89		89	
HC.db	Heat/cool deadband (on/off output)	16			
Sb.OP	Sensor break output power	34		34	

cmS	Comms. List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
Addr	Communications address	131		131	

iNFo	Information List	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
di SP	Configuration of lower readout display 0: Standard 1: Load current 2: Output power 3: Status 4: Program time 5: None 6: Valve position 7: Process value 2 8: Ratio setpoint 9: Selected program number 10: Remote setpoint	106			
LoG.L	PV minimum	134			
LoG.H	PV maximum	133			
LoG.A	PV mean value	135			
LoG.t	Time PV above threshold level	139			
LoG.u	PV threshold for timer log	138			
rES.L	Logging reset 0: Not reset 1: Reset	140			
mCt	Processor utilization factor	201			
w.OP	Working output	4			
SSr	PDLINK SSR status 0: Good 1: Load fail 2: Open 3: Heater fail 4: SSR fail 5: Sn fail	79			
FF.OP	Feedforward component of output	209			
P OP	Proportional component of output	214			
I OP	Integral component of output	55			
d OP	Derivative component of output	116			
VEL	VP velocity signal	219			
uP S	VP motor calibration state 0: Start 1: Waiting 2: Open valve 3: BLUp/InDn 4: Ttup 5: Overshoot 6: InUp/BLDn 7: TT down 8: Open 9: Low lim 10: Stopping 11: Raise 12: Inert up 13: Lower 14: Low lim 15: Stopping 16: Lower 17: InDn/BL 99: Abort	210			

MISCELLANEOUS STATUS AND COMMS-ONLY PARAMETERS

		CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
	Remote input comms access parameter	26			
	Process error	39		39	
	Setpoint rate limit holdback status 0: inactive 1: Active	41			
	System error logged flag 0: No error 1: Error	73			
	Ramp rate disable	78			
	Slave controller target setpoint	92			
	Slave controller ramp rate	93			
	Slave controller synch signal	94			
	Remote SRL hold	95			
	BCD input value	96			
	Controller version number Format: >XXYY (hex) where XX is major version number, and YY is minor version number. Eg. >0304 corresponds to V3.04	107		107	
	CNOMO Manufacturers identifier	121		121	
	Controller identifier in format >ABCD (hex), A = 2 (series CN2000) B = Range number 2: CN2200 4: CN2400 C = Size 3: 1/32 din 6: 1/16 din 8: 1/8 din 4: ¼ din D = Type 0: PID/on-off 2: VP	122		122	
	Bisynch comms status 0: No error 1: Invalid mnemonic 2: Parameter is read only 7: Incorrect message 8: Limit error	-			
	DIN rail remote par	151			
	VP low limit switch - open	120			
	VP high limit switch- open	119			
	VP motor calibrate enable 0: Off 1: On	46			
	Instrument mode **NOTE: WRITING OTHER VALUES TO THIS PARAMETER MAY CAUSE DAMAGE TO CALIBRATION OR CONTROLLER CONFIGURATION!** 0: Normal 1: Standby 2: Configuration	199	The controller address changes to ‘00’ when Instrument mode is changed to configuration	199	

MISCELLANEOUS STATUS AND COMMS-ONLY PARAMETERS *(CONTINUED)*

		CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
	PV millivolts from comms	203		203	
	Input test point enable	205		205	
	Sensor break sourced from Test	206		206	
	Filter initialization flag	207		207	
	Maximum number of segments (8 or 16): Read only	211			
	Edit program	-			
	Freeze control flag 0: Controlling 1: Hold	257			
	Sensor break status flag 0: Good 1: Sensor break	258		258	
	Power failed flag 0: Good 1: Power fail detected	259			
	Loop break status flag 0: Good 1: Loop break	263			
	Integral hold status flag 0: Good 1: Integral hold	264			
	Acknowledge all alarms 0: Good 1: Acknowledge all alarms	274		274	
	Setpoint rate limit active status 0: No setpoint rate limit 1: setpoint rate limit active	275			
	Setpoint rate limit complete status 0: Setpoint rate limit incomplete 1: Setpoint rate limit complete	277			
	Holdback disable 0: Holdback enabled 1: Holdback disabled	278			
	Disable keys 0: Keys enabled 1: Keys disabled	279		279	
	Remote input status 0: Good 1: Fault	280			
	Sync/Continue flag 0: Continue 1: Awaiting sync	281			
	DC input remote fault 0: good 1: Fault	283			
	Maximum input value in engineering units	548			
	Minimum input value in engineering units	549			
	Setpoint span	552			

STATUS WORDS

Status words group together commonly accessed parameters in convenient categories so that they may be read (or occasionally written to) as a single transaction. Their main use is to allow the most commonly required process conditions to be read quickly. Examples are:
Alarm states
Auto/Manual selection
Remote/Local selection
Disable front panel keys etc.

Individual parameters exist for all status indicators that may be changed over the communications link, and these should be used for 'write operations'. The exception is the digital output telemetry status word, which may be written to set digital outputs, provided their function is configured to 'No Func'.

The CN2200 series contains two Status Words
1. Summary Output Status Word
2. Control Status Word

These are both shown in the table below.
Note, the detailed differences in the bit definitions between CN2200 & CN2400 in the Summary Output Status Word.

Parameter		**Modbus® CN2400**	**Modbus® CN2200**	**Display**
Fast Status byte. Read Only (Also available via Modbus® Function 7)		74	74	-
BIT	DESCRIPTION			
Bit 0	Alarm 1 State (0 = Safe 1 = Alarm)		Alarm 1 State (0 = Safe 1 = Alarm)	
Bit 1	Alarm 2 State (0 = Safe 1 = Alarm)		Alarm 2 State (0 = Safe 1 = Alarm)	
Bit 2	Alarm 3 State (0 = Safe 1 = Alarm)		Alarm 3 State (0 = Safe 1 = Alarm)	
Bit 3	Alarm 4 State (0 = Safe 1 = Alarm)		Alarm 4 State (0 = Safe 1 = Alarm)	
Bit 4	Manual Mode (0 = Auto 1 = Manual)		Manual Mode (0 = Auto 1 = Manual)	
Bit 5	Sensor Break (0 = Good PV 1 = Sensor Broken)		Sensor Break (0 = Good PV 1 = Sensor Broken)	
Bit 6	Loop Break (0 = Good closed loop 1 = Open Loop)		Loop Break (0 = Good closed loop 1 = Open Loop)	
Bit 7	Heater Fail (0 = No Fault 1 = Load fault detected)		Heater Fail (0 = No Fault 1 = Load fault detected)	

Parameter		**Modbus® CN2400**	**Modbus® CN2200**	**Display**
Summary Output Status Word		75	75	-
BIT	DESCRIPTION			
0	Alarm 1 State (0 = Safe, 1 = Alarm)		Alarm 1 State (0 = Safe, 1 = Alarm)	
1	Alarm 2 State (0 = Safe, 1 = Alarm)		Alarm 2 State (0 = Safe, 1 = Alarm)	
2	Alarm 3 State (0 = Safe, 1 = Alarm)		Alarm 3 State (0 = Safe, 1 = Alarm)	
3	Alarm 4 State (0 = Safe, 1 = Alarm)		Alarm 4 State (0 = Safe, 1 = Alarm)	
4	Manual Mode (0 = Auto, 1 = Manual)		Manual Mode (0 = Auto, 1 = Manual)	
5	Sensor Break (0 = Good PV, 1 = Sensor Broken)		Sensor Break (0 = Good PV, 1 = Sensor Broken)	
6	Loop Break (0 = Good closed loop, 1 = Open Loop)		Loop Break (0 = Good Closed Loop, 1 = Open Loop)	
7	Heater Fail (0 = No Fault, 1 = Load fault detected)		Heater Fail (0 = No Fault, 1 = Load Fault Detected)	
8	Tune Active (0 = Auto Tune disabled, 1 = Auto Tune active)		Load Fail (0 = No Fault, 1 = Load Fault Detected)	
9	Ramp/Program Complete (0 = Running/Reset, 1 = Complete)		Ramp/Program Complete (0 = Running/Reset, 1 = Complete)	
10	PV out of range (0 = PV within table range, 1 = PV out of table range)		PV out of range (0 = PV within table range, 1 = PV out of table range)	
11	DC control module fault (0= Good,. 1= BAD)		SSR Fail (0 = No fault, 1 = Load fault detected)	
12	Programmer Segment Synchronize (0 = Waiting, 1 = Running)		New Alarm	
13	Remote input sensor break (0 = Good, 1 = Bad)		Remote input sensor break (0 = Good, 1 = Bad)	
14	IP1 Fault (PV Input)		Reserved	
15	Reserved		Reserved	

Parameter		Modbus® CN2400	Modbus® CN2200	Display
Control Status Word		76	76	-
BIT	DESCRIPTION			
0	Control algorithm Freeze		Control algorithm Freeze	
1	PV input sensor broken		PV input sensor broken	
2	PV out of sensor range		PV out of sensor range	
3	Self Tune failed		Self Tune failed	
4	PID servo signal		PID servo signal	
5	PID debump signal		PID debump signal	
6	Fault detected in closed loop behavior (loop break)		Fault detected in closed loop behavior (loop break)	
7	Freezes the integral accumulator		Freezes the integral accumulator	
8	Indicates that a tune has completed successfully		Indicates that a tune has completed successfully	
9	Direct/reverse acting control		Direct/reverse acting control	
10	Algorithm Initialization flag		Algorithm Initialization flag	
11	PID demand has been limited.		PID demand has been limited.	
12	Autotune enabled			
13	Adaptive tune enabled		Adaptive tune enabled	
14	Automatic Droop compensation enabled		Automatic Droop compensation enabled	
15	Manual / Auto mode switch		Manual / Auto mode switch	

Parameter		Modbus® CN2400	Modbus® CN2200	Display
Instrument Status Word		77		-
BIT	DESCRIPTION			
0	Config/Oper mode switch			
1	Disables limit checking			
2	SRL ramp running (Read Only)			
3	Remote setpoint active			
4	Alarm acknowledge switch.			
5	Reserved			
6	Reserved			
7	Reserved			
8	Reserved			
9	Reserved			
10	Reserved			
11	Reserved			
12	Reserved			
13	Reserved			
14	Reserved			
15	Reserved			

Parameter	Modbus® CN2400	Modbus® CN2200	Display
Digital Input Status Word Note that the order of LA and LB is reversed relative to what might be expected.	87		-

BIT	DESCRIPTION
0	H Interface module (0 = Off, 1 = On)
1	J Interface module (0 = Off, 1 = On)
2	1A module (0 = Off, 1 = On)
3	LB logic input (0 = Off, 1 = On)
4	LA logic input (0 = Off, 1 = On)
5	1B module telemetry (0 = Off, 1 = On)
6	1C module (0 = Off, 1 = On)
7	2A module (0 = Off, 1 = On)
8	2B module (0 = Off, 1 = On)
9	2C module (0 = Off, 1 = On)
10	3A module (0 = Off, 1 = On)
11	3B module (0 = Off, 1 = On)
12	3C module (0 = Off, 1 = On)
13	Reserved
14	Reserved
15	Reserved

Parameter	Modbus® CN2400	Modbus® CN2200	Display
Digital Output Telemetry Parameter Note that the order of LA and LB is reversed relative to what might be expected.	551		-

BIT	DESCRIPTION
0	H Interface module telemetry (0 = Off, 1 = On)
1	J Interface module telemetry (0 = Off, 1 = On)
2	1A module telemetry (0 = Off, 1 = On)
3	LB logic telemetry (0 = Off, 1 = On)
4	LA logic telemetry (0 = Off, 1 = On)
5	1B module telemetry (0 = Off, 1 = On)
6	1C module telemetry (0 = Off, 1 = On)
7	2A module telemetry (0 = Off, 1 = On)
8	2B module telemetry (0 = Off, 1 = On)
9	2C module telemetry (0 = Off, 1 = On)
10	3A module telemetry (0 = Off, 1 = On)
11	3B module telemetry (0 = Off, 1 = On)
12	3C module telemetry (0 = Off, 1 = On)
13	AA relay telemetry (0 = Off, 1 = On)
14	Reserved
15	Reserved

Parameter	Modbus® CN2400	Modbus® CN2200	Display
Program DC Pulse Outputs	162		-

BIT	DESCRIPTION
0	Program Output 1 (0 = OFF 1 = ON)
1	Program Output 2 (0 = OFF 1 = ON)
2	Program Output 3 (0 = OFF 1 = ON)
3	Program Output 4 (0 = OFF 1 = ON)
4	Program Output 5 (0 = OFF 1 = ON)
5	Program Output 6 (0 = OFF 1 = ON)
6	Program Output 7 (0 = OFF 1 = ON)
7	Program Output 8 (0 = OFF 1 = ON)
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

MODBUS® BIT ADDRESSABLE PARAMETERS

A few bit addressable parameters are provided to conform to the CNOMO Modbus® standard, but in general status information should be obtained via the status words or single status parameters in the Modbus® word address space.

Parameter	Modbus® Bit (Coil) Address
Auto/Manual Mode 0: Auto 1: Manual	2
Alarm 1 Status 0: No Alarm 1: Alarm	5
Sensor Break Status 0: OK 1: Sensor Break	10

CONFIGURATION MODE PARAMETERS

To write parameters in this group, it is first necessary to set the instrument mode parameter (Modbus® 199) to the value 2 to set the controller into configuration mode. Note this will disable all normal control action and the controller outputs will be switched to a safe state.

It is not necessary to set any ‘password’ parameters to enter configuration mode.

To exit from configuration mode, simply write 0 to instrument mode. This will reset the controller, a process that takes around 5 seconds. During this period it will not be possible to communicate with the controller.

NOTE: For CN2200 and CN2400 series, the Configuration Password is Modbus® ‘Pc’.

WARNING:
Be very careful not to write values other than 0 or2 to instrument mode, since this parameter is also used clear non-volatile memory and to perform various factory calibration procedures. Writing an incorrect value can, therefore, damage your controller.

InSt	**Instrument Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
unit	Instrument unit 0: °C 1: °F 2: °K 3: None		See PV conf	516	
dEc.P	Decimal places in the displayed value 0: nnnn. 1: nnn.n 2: nn.nn		See PV conf	525	
CtrL	Control type 0: PID 1: On/Off 2: Manual 3: VP (No feedback) 4: VP b (Feedback)	512	‘Manual’ does not appear in Control Type list	512	‘Manual’ does not appear in Control Type list. VP b not available
Act	Control action 0: Reverse 1: Direct	7		7	
CooL	Type of cooling 0: Linear 1: Oil 2: Water 3: Fan 4: Proportional to error 5: On/Off	524		524	4: N/A 5: N/A
ti.td	Integral and Derivative time units 0: Seconds 1: Minutes 2: Hours	529			
dtYP	Derivative action on: 0: PV 1: Error	550			
m-A	Front panel Auto/Manual button 0: Enabled 1: Disabled	530			

InSt	**Instrument Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
r-h	Front panel Run/Hold button 0: Enabled 1: Disabled	564			
Fwd.t	Feed forward type 0: None 1: Power feedforward 2: Setpoint feedforward 3: PV feedforward	532			
Pd.tr	Manual/Auto transfer PD control 0: No 1: Yes	555		555	0: Hold 1: Track
Sbr.t	Sensor break output 0: Sensor break (go to set value) 1: Hold (output)	553		553	
FOP	Forced manual output 0: No 1: Trac (returns to last value) 2: Step (steps to forced output level)	556		556	2: N/A
bcd	BCD input function 0: None 1: Select program number 2: Select SP number	522			
GSch	Gain schedule enable 0: No (disabled) 1: Yes (enabled)	567			

PV	**Process Value Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
unit	Instrument units 0: ^oC 1: ^oF 2: ^oK 3: None	516			See InSt ConF list
dEc.P	Decimal places in displayed value 0: nnnn 1: nnn.n 2: nn.nn	525			See InSt ConF list
rnG.L	Low range limit	11			See iP List
rnG.H	High range limit	12			

iP	Input Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
inPt	Input type 0: J Type 1: K Type 2: L Type 3: R Type 4: B Type 5: N Type 6: T Type 7: S Type 8: PL 2 9: Custom (factory) ***** 10: RTD ***** 11: Linear mV (+/- 100mV) 12: Linear V (0-10V) 13: Linear Ma 14: Square root V 15: Square root mA 16: Custom mV 17: Custom V 18: Custom mA	12290		12290	0: J Type 1: K Type 2: L Type 3: R Type 4: B Type 5: N Type 6 T Type 7: S Type 8: PL 2 9: RTD ***** 10: Cust. ***** 11: Lin mV 12: Lin V 13: N/A 14: N/A 15: N/A 16: N/A 17: N/A 18: N/A
*** Note change in order for the two parameters**					
CJC	Cold junction compensation 0: Auto 1: 0^oC 2: 45^oC 3: 50^oC 4: Off	12291		12291	4: N/A
ImP	Sensor break impedance 0: Off (disabled - linear inputs only) 1: Auto 2: Hi (> 5K) 3: Hi (>15K)	12301		578	
inP.L	Input value low	12307		12307	
inP.h	Input value high	12306		12306	
UAL.L	Displayed reading low	12303		12303	
UAL.H	Displayed reading high	12302		12302	
rnG.L	Low range limit		See PV	11	
rnG.H	High range limit		List	12	

The following parameters are only present if a custom curve has been factory downloaded					
in 1	Custom linearization input 1	601			
UAL.1	Display value corresponding to input 1	621			
in 2	Custom linearization input 2	602			
UAL.2	Display value corresponding to input 2	622			
in 3	Custom linearization input 3	603			
UAL.3	Display value corresponding to input 3	623			
in 4	Custom linearization input 4	604			
UAL.4	Display value corresponding to input 4	624			
in 5	Custom linearization input 5	605			
UAL.5	Display value corresponding to input 5	625			
in 6	Custom linearization input 6	606			
UAL.6	Display value corresponding to input 6	626			
in 7	Custom linearization input 7	607			
UAL.7	Display value corresponding to input 7	627			
in 8	Custom linearization input 8	608			
UAL.8	Display value corresponding to input 8	628			

SP	Setpoint Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
nSP	Number of setpoints	521			
rm.tr	Remote tracking 0: Off 1: Track	526			
m.tr	Manual tracking 0: Off 1: Track	527			
Pr.tr	Programmer tracking 0: Off 1: Track	528			
rmP.U	Setpoint rate limit units 0: /Sec 1: /Min 2: /Hour	531			
rmt	Remote setpoint configuration 0: None 1: Remote setpoint 2: Remote setpoint + local trim 4: Remote trim + local setpoint	535			

AL	Alarm Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
AL 1	Alarm 1 type 0: Off 1: Full scale low 2: Full scale high 16: Deviation band 17: Deviation high 18: Deviation low 34: Load current low 35: Load current high 36: Input 2 full scale low 37: Input 2 full scale high 38: Working output low 39: Working output high 40: Working setpoint low 41: Working setpoint high	536		536	36: N/A 37: N/A 38: N/A 39: N/A 40: N/A 41: N/A
Ltch	Latching 0: No 1: Yes 2: Event 3: Manual reset	540		540	2: N/A 3: N/A
bLoc	Blocking 0: No 1: Yes	544		544	
AL 2	Alarm 2 type (types as alarm 1)	537		537	
Ltch	Latching (types as alarm 1)	541		541	
bLoc	Blocking (types as alarm 1)	545		545	
AL 3	Alarm 3 type (types as alarm 1)	538		538	
Ltch	Latching (types as alarm 1)	542		542	
bLoc	Blocking (types as alarm 1)	546		546	
AL 4	Alarm 4 type (types as alarm 1) plus 64: Rate of change	539		539	Rate of change not available in CN2200 series
Ltch	Latching (types as alarm 1)	543		543	
bLoc	Blocking (types as alarm 1)	547		547	

PrOG	Programmer Configuration	CN2400	CN2200

		Modbus®	Notes	Modbus®	Notes
PtYP	Programmer type 0: None 1: Single program 4: Four programs 20: Twenty programs	517			
HbAc	Holdback 0: Applies to whole program 1: Applies to each segment	559			
Pwr.F	Power fail recovery 0: Ramp back 1: Reset 2: Continue	518			
Srvo	Servo 0: Servo to PV 1: Servo to SP	520			
out	Programmable event outputs Version 1 controllers: 0: None 3: Three 6: Six 8: Eight Versions 2 and 3 controllers: 0: None 1: Eight	558			
SYNC	Synchronization of programs 0: No 1: Yes	557			

INPUT/OUTPUT MODULES

The following tables list all possible hardware module and fixed output identifiers. There are physical restrictions on the types of modules that may be fitted in particular slots. For example it is not possible to place an RS-485 (EIA-485) comms module in slot 1A of of a series CN2200 or series CN2400. Refer to the relevant instrument Installation and Operation Handbook for full details.

In general it is possible to perform writes to Module Identifier comms addresses if (and only if) there are no hardware modules fitted other than the communications adapter. This allows controllers to be configured in the absence of hardware modules.

LA	Digital Input 1 Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Identity 4: Logic	12352		12352	
Func	Input functions	12355		12355	
	192: None				192: None
	193: Manual mode select				193: Man
	194: Remote setpoint select				194: Rem
	195: Setpoint 2 select				195: SP 2
	196: PID set 2 select				
	197: Integral hold				197: Int Hld
	198: One-shot self tune enable				
	199: Adaptive tune enable				
	200: Acknowledge alarms				200: Ack
	201: Select full access level				
	202: Keylock				202: K/lock
	203: Up button				
	204: Down button				
	205: Scroll button				
	206: Page button				
	207: Run				
	208: Hold				
	209: Run/Hold				
	210: Reset				210: Reset
	211: Skip				
	212: Holdback enabled				
	213: Least significant BCD digit				
	214: 2nd digit				
	215: 3rd digit				
	216: 4th digit				
	217: 5th digit				
	218: Most significant digit				
	219: Setpoint rate limit enable				
	220: Prog. waits at end of segment				
	223: Run/Hold				
	224: Reset/Run				
	225: Standby				225: Stby
	226: PV select				
	227: Advance to end of segment				
	240: Amps				240: Amps

Lb	Digital Input 2 Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Identity 4: Logic	12416		12416	
Func	Input functions, as LA above	12419		12419	240: Not available
VAL.L	Low scalar	12431			
VAL.H	High scalar	12430			

AA	**Alarm Relay Configuration (CN2400) Output 3 Configuration (CN2200)**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module identity	12480		12480	1: Relay CN2208/CN2204 only
Func	Module function 0: None 1: Digital 2: Heat (CN2208/04 only) 3: Cool (CN2208/04 only)	12483		12483	
diGF	For Func = diG the following appear in CN2200 series controllers: 0: Alarm 1 1: Alarm 2 2: Alarm 3 3: Alarm 4 4: Manual 5: Sensor break 6: Loop break 7: Heater fail 8: Load fail 9: 10: PV out of range 11: SSR fail 12:			12486	0: Alarm 1 1: Alarm 2 2: Alarm 3 3: Alarm 4 4: Manual 5: Sens break 6: Loop break 7: Htr fail 8: Load fail 9: Prog end 10: PV out rng 11: SSR fail 12: New alarm
SEnS	Sense of output 0: Normal 1: Inverted	12489		12489	
	If Func = diG the following appear Alarm 1 Alarm 2 Alarm 3 Alarm 4 Controller in manual Sensor break PV out of range Loop break Load failure Tuning in progress Voltage or mA output open circuit PDLINK module connection O/C New alarm End of program (or SP rate limit) Program synchronization active Program event output active				
	Summary of AA configuration	12486			
	Program summary OP AA configuration	12503			

HA	Comms Module Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Module identity 0: None 7: Digital comms 8: PDLINK output	12544		12544	
Func	Module function For id = cmS 64: None 65: Modbus®	12547		12547	
bAud	Baud rate 0: 9600 1: 19200 2: 4800 3: 2400 4: 1200	12548		12548	
dELY	Delay. This introduces a short delay between messages to allow certain 'intelligent' RS-485 (EIA-485) converters to switch between RX and TX modes. 0: No - 0mS 1: Yes - 10mS	523			
PrtY	Parity (Modbus® only) 0: None 1: Even 2: Odd	12549		12549	
rES	Resolution (Modbus® only) Changes are effective immediately 0: Full 1: Integer	12550		12550	rESn

JA	Comms Module 2 Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Module identity 0: None 8: PDLINK output 9: PDLINK input	12608			
Func	Module function	12611			

1A	Output 1A Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Module identity 0: None 1: Relay output 2: DC output non-isolated 3: DC pulse/PDLINK output 4: Logic input 5: AC SSR output 10: Error/Bad module 11: DC retransmission 12: DC output isolated	12672		12672	0: None 1: Relay 2: DC out 3: DC pulse 5: AC SSR 10: Bad
Func	Module function For id = rELY LoG or SSr 0: None 1: Digital output 2: Heating output 3: Cooling output 4: Open motorized valve 10: PDLINK mode 1 heating 11: PDLINK mode 2 heating For id = dc.rE or dc.OP 16: None 17: Heating output 18: Cooling output 19: Retransmission of PV 20: Retransmission of SP 21: Retransmission of error 22: Retransmission of OP power For id = LoGi Use the enumerators in LA Config. list	12675		12675	0: None 1: Dig o/p 2: Heat 3: Cool DC pulse only 4: SSR1 5: SSR2 DC output 16: None 17: Heat 18: Cool
diGF	For Func = diG the following appear in CN2200 series controllers: 0: Alarm 1 1: Alarm 2 2: Alarm 3 3: Alarm 4 4: Manual 5: Sensor break 6: Loop break 7: Heater fail 8: Load fail 10: PV out of range 11: SSR fail 13: Remote fail			12678	As CN2400 plus 9: Prog end 12: New alarm
VAL.L	% PID or Retran value giving min. o/p	12687			
VAL.H	% PID or Retran value giving max. o/p	12686			
unit	Units 1: Volts 2: mA	12684			
Out.L	Minimum electrical output	12689		12689	
Out.H	Maximum electrical output	12688		12688	
SEnS	Sense of output 0: Normal 1: Inverted	12681		12681	
	Summary output 1A configuration	12678			
	DC output 1A telemetry parameter	12694			
	Program summary output 1A config	12695			

1b	**Output 1B Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module 1B identity	12673			
Func	Module 1B function	12676			
SEnS	Sense of output (nor/inv as1A)	12682			
	Summary of 1B configuration	12679			
	Summary program O/P 1B config.	12696			

1C	**Output 1C Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module 1C identity	12674			
Func	Module 1C function	12677			
VAL.L	Module 1C value giving min output	12699			
VAL.H	Module 1C value giving max output	12698			
Out.L	Module 1C Minimum electrical output	12701			
Out.H	Module 1C Maximum electrical output	12700			
SEnS	Sense of output (nor/inv as 1A)	12683			
	Summary of 1C configuration	12680			
	Summary program O/P 1C config.	12697			

2A	Output 2A Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Module identity 0: None 1: Relay output 2: DC output non-isolated 3: DC pulse/PDLINK output 4: Logic input 5: AC SSR output 10: Error/Bad module 11: DC retransmission 12: DC output isolated 13: Transmitter power supply 14: Potentiometer input (V position)	12736		12736	Only the following are relevant: 0: None 1: Relay 3: DC pulse 5: AC SSR 10: Bad
Func	Module function For id = rELY LoG or SSr 0: None 1: Digital output 2: Heating output 3: Cooling output 5: Close motorized valve For id = dc.rE or dc.OP 16: None 17: Heating output 18: Cooling output 19: Retransmission of PV 20: Retransmission of SP 21: Retransmission of error 22: Retransmission of OP power For id = Pot 160: None 161: Remote setpoint 162: Feedforward input 163: Remote OP power high 164: Remote OP power low 165: Valve position	12739		12739	Only the following are relevant: 0: None 1: Dig o/p 2: Heat 3: Cool 193: Man enab 194: Rem SP 195: 2nd SP 197: Int hold 200: Ack alms 202: Key lock 210: Reset prg 225: Standby
diGF	For Func = diG see 1A list for enumerators			12742	
VAL.L	% PID or Retran value giving min. o/p	12751			
VAL.L	Potentiometer input low scalar	12763			
VAL.H	% PID or Retran value giving max. o/p	12750			
VAL.H	Potentiometer input high scalar	12762			
unit	Units 1: Volts 2: mA	12748			
Out.L	Minimum electrical output	12753			
Out.H	Maximum electrical output	12752			
SEnS	Sense of output 0: Normal 1: Inverted	12745		12745	
	Summary output 2A configuration	12742			
	DC output 2A telemetry parameter	12758			
	Program summary output 2A config	12759			

2b	**Output 2B Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module 2B identity	12737			
Func	Module 2B function	12740			
SEnS	Sense of output (nor/inv as 2A)	12746			
	Summary of 2B configuration	12743			
	Summary program O/P 2B config.	12760			

2C	**Output 2C Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module 2C identity	12738			
Func	Module 2C function	12741			
SEnS	Sense of output (nor/inv as 2A)	12747			
	Summary of 2C configuration	12744			
	Summary program O/P 2C config.	12761			

3A	Output 3A Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
id	Module identity 0: None 1: Relay output 2: DC output non-isolated 3: DC pulse/PDLINK output 4: Logic input 5: AC SSR output 6: DC input 10: Error/Bad module 11: DC retransmission 12: DC output isolated 13: Transmitter power supply 14: Potentiometer input (V position)	12800		12800	0: None 1: Relay
Func	Module function For id = rELY LoG or SSr 0: None 1: Digital output 2: Heating output 3: Cooling output For id = dcrE or dc.OP 16: None 17: Heating output 18: Cooling output 19: Retransmission of PV 20: Retransmission of SP 21: Retransmission of error 22: Retransmission of OP power For id = Pot 160: None 161: Remote setpoint 162: Feedforward input 163: Remote OP power high 164: Remote OP power low 165: Valve position For id = dCiP 32: None 33: Remote setpoint 34: Feedforward input 35: Remote output power max. 36: Remote output power min. 37: PV = highest of ip1 or ip2 38: PV = lowest of ip1 or ip2 39: Derived function 40: Select ip1 or ip2 41: Transition of control - ip1 to ip2	12803		12803	0: None 1: Dig o/p 2: Heat 3: Cool
diGF	For Func = diG see 1A list for enumerators			12806	
inPt	input type (input 2) Refer to input configuration for all types + HiIn	12830			
CJC	Cold junction compensation (input 2) Refer to input configuration for types	12831			
imP	Sensor break impedance (input 2) Refer to input configuration for types	12813			
inP.L	Input value low	12819			
inP.H	Input value high	12818			
VAL.L	Input module 3A low value	12829			
VAL.H	Input module 3A high value	12828			
VAL.L	Module 3A low value	12815			
VAL.L	Potentiometer input 3A low scalar	12827			
3A	**Output 3A Configuration *(cont…)***	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes

VAL.H	Module 3A high value	12814			
VAL.H	Potentiometer input 3A high scalar	12826			
unit	Units 3A 1: Volts 2: mA	12812			
Out.L	Minimum electrical output	12817			
Out.H	Maximum electrical output	12816			
SEnS	Sense of output 0: Normal 1: Inverted	12809		c9	
	Summary output 3A configuration	12806			
	DC output 3A telemetry parameter	12822			
	Program summary output 3A config	12823			

3b	**Output 3B Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module 3B identity	12801			
Func	Module 3B function	12804			
SEnS	Sense of output (nor/inv as 3A)	12810			
	Summary of 3B configuration	12807			
	Summary program O/P 3B config.	12824			

3C	**Output 3C Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module 3C identity	12802			
Func	Module 3C function	12805			
SEnS	Sense of output (nor/inv as 3A)	12811			
	Summary of 3C configuration	12808			
	Summary program O/P 3C config.	12825			

4A	**Output 4A Configuration**	**CN2400**		**CN2200**	
		Modbus®	Notes	Modbus®	Notes
id	Module identity 0: None 1: Relay output	12864	Not available in 2416	12864	2204 only 0: None 1: Relay
Func	Module function 0: None 1: Digital output 2: Heating output 3: Cooling output	12867	Not available in 2416	12867	2204 only 0: None 1: Dig o/p 2: Heat 3: Cool
diGF	For Func = diG see 1A list for enumerators			12870	2204 only
VAL.L	Input module 4A low value	12879	Not 2416		
VAL.H	Input module 4A high value	12878	Not 2416		
Out.L	Minimum electrical output	12881	Not 2416		
Out.H	Maximum electrical output	12880	Not 2416		
SEnS	Sense of output (nor/inv as 3A)	12873	Not 2416	12873	2204 only
	Summary output 4A configuration	12870	Not 2416		
	Program summary output 4A config	12887	Not 2416		

CAL	Calibration Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
rcAL	Calibration node select 0: None 1: PV 1 2: PV 2 3: DC output high - module 1 4: DC output low - module 1 5: DC output high - module 2 6: DC output low - module 2 7: DC output high - module 3 8: DC output low - module 3	533			
PV	PV Calibration state 0: Idle 1: Select 0mV cal point 2: Select 50mV cal point 3: Select 0V cal point 4: Select 10V cal point 5: Select 0°C CJC cal point 6: Select 400 ohms cal point 7: Select 0V high impedance cal pt 8: Select 1V high impedance cal pt 9: Restore factory calibration 10: Busy	534			
GO	Start calibration No Yes Busy Done Fail	65535			
CAL.H	Module 1A output calibration high trim	12692			
CAL.H	Module 2A output calibration high trim	12756			
CAL.H	Module 3A output calibration high trim	12820			
CAL.L	Module 1A output calibration low trim	12693			
CAL.L	Module 2A output calibration low trim	12757			
CAL.L	Module 3A output calibration low trim	12821			
UCAL	User calibration enable 0: No 1: Yes	566		566	AdJ
Pt1.L	Low calibration point for input 1	563		563	Pnt.L
Pt1.H	High calibration point for input 1	562		562	Pnt.H
OF1.L	Offset low for input 1	561		561	OFS.L
OF1.H	Offset high for input 1	560		560	OFS.H
Pt2.L	Low calibration point for input 2	571			
Pt2.H	High calibration point for input 2	570			
OF2.L	Offset low for input 2	569			
OF2.H	Offset high for input 2	568			

PASS	Password Configuration	CN2400		CN2200	
		Modbus®	Notes	Modbus®	Notes
ACC.P	Full or edit level password	514		514	
cnF.P	Configuration level password	515		515	

RAMP/DWELL PROGRAMMER DATA – MODBUS®

This Section Applies To CN2400 Series Controllers only

Program Data Organization

A CN2400 series controller can contain multiple "programs", each consisting of up to 16 segments. The data for each program starts at the base Modbus® address given by the following table:

Program	Base Address (Decimal)	Base Address (Hex)
Program 0 (Currently Running Program - changes permitted only in hold, and are not permanently stored)	8192	2000
Program 1	8328	2088
Program 2	8464	2110
Program 3	8600	2198
Program 4	8736	2220
Program 5	8872	22A8
Program 6	9008	2330
Program 7	9144	23B8
Program 8	9280	2440
Program 9	9416	24C8
Program 10	9552	2550
Program 11	9688	25D8
Program 12	9824	2660
Program 13	9960	26E8
Program 14	10096	2770
Program 15	10232	27F8
Program 16	10368	2880
Program 17	10504	2908
Program 18	10640	2990
Program 19	10776	2A18
Program 20	10912	2AA0

The parameters used to describe a program are organized into 17 blocks, each of 8 words in length, starting at the base address for the program. There is one block for general program data, such as the units to be used for ramp and dwell times, and 16 further blocks for the segment data itself. To obtain the Modbus® address of the data block for a given program, add the block offset given in the next table to the program

Contents	Offset (Decimal)	Offset (Hex)
Program General Data	0	0
Segment 1	8	8
Segment 2	16	10
Segment 3	24	18
Segment 4	32	20
Segment 5	40	28
Segment 6	48	30
Segment 7	56	38
Segment 8	64	40
Segment 9	72	48
Segment 10	80	50
Segment 11	88	58
Segment 12	96	60
Segment 13	104	68
Segment 14	112	70
Segment 15	120	78
Segment 16	128	80

Program General Data

The offsets of each parameter within the program general data block is given by the next table:

Address Offset	Parameter
0	HoldbackType 0: None 1: Low 2: High 3: Band
1	HoldbackValue
2	Ramp Units 0: Secs 1: Mins 2: Hours
3	Dwell Units 0: Secs 1: Mins 2: Hours
4	Program Cycles
5	Reserved
6	Reserved
7	Reserved

Program Segment Data

Program segment data is specified using 8 Modbus® addresses, with the contents varying depending on the type of the segment. The format per segment is detailed in the following table, which gives the offset from the start of a segment data block for each item.

Address Offset	Segment Types					
	STEP	DWELL	RAMP RATE	RAMP TIME TO TARGET	CALL	END
0	Segment Type	Segment Type	Segment Type	Segment Type	Segment Type	Segment Type
1	Target Setpoint		Target Setpoint	Target Setpoint		End Power
2		Duration	Rate	Duration		
3					Program Number	End Type
4	Logic O/P's	Logic O/P's	Logic O/P's	Logic O/P's	Call Cycles	Logic O/P's
5						
6						
7						

Example Address calculations

Program 1, Segment 4, Segment Type = 8328 + 32 + 0 = 8360 (20A8 Hex)
Program 2, Holdback Value = 8464 + 0 + 1 = 8465 (2111 Hex)
Program 4 Segment 16, End Type = 8872 + 128 + 3 = 9003 (232B Hex)

CHAPTER 5 ADVANCED TOPICS

ACCESS TO FULL RESOLUTION FLOATING POINT AND TIMING DATA (MODBUS® ONLY)

One of the main limitations of Modbus® is that only 16 bit integer representations of data can normally be transferred. In most cases, this does not cause a problem, since appropriate scaling can be applied to the values without losing precision. Indeed all values displayable on the 4 digit Series CN2200 and CN2400 front panel may be transferred in this way. However, this has the significant drawback that the scaling factor to be applied needs to be known at both ends of the communications link.

One further problem is that certain ‘time’ parameters, notably those used for the programmer function are always returned over the communications link in seconds. It is possible for long durations to overflow the 16 bit Modbus® limit.

To overcome these problems, a sub protocol has been defined, using the upper portion of the Modbus®address space (8000h and upwards), allowing full 32 bit resolution floating point and timer parameters. The upper area is known as the IEEE region.

This sub-protocol provides two consecutive Modbus® addresses for all parameters. The base address for any given parameter in the IEEE region can easily be calculated by taking its normal Modbus® address, doubling it, and adding 8000h. For example, the address in the IEEE region of the Target Setpoint (Modbus® address 2) is simply

2 x 2 + 8000h = 8004h = 32772 decimal

This calculation applies to any parameter that has a Modbus® address.

Access to the IEEE area is made via block reads (Functions 3 & 4) and writes (Function 16). Attempts to use the ‘Write a Word’ (Function 6) operation will be rejected with an error response. Furthermore, block reads and writes using the IEEE region should only be performed at even addresses, although no damage to the instrument will result in attempting access at odd addresses. In general, the ‘number of words’ field, in the Modbus® frame, should be set to 2 times what it would have been for ‘normal’ Modbus®.

The rules governing how the data in the two consecutive Modbus® addresses are organised depending on the ‘data type’ of the parameter.

DATA TYPES USED IN SERIES CN2200 AND CN2400 INSTRUMENTS

- Enumerated parameters are parameters which have a textual representation for their value on the user interface, for example, ‘Auto’ or ‘Manual’, ‘On’ or ‘Off’, ‘SP1’, ‘SP2’, ...,‘SP16’, etc. A full list is included in the parameter tables in the previous chapter.
- Status words are generally only available over communications, and are used to group binary status information.
- Integer parameters are those that never include a decimal point, however the instrument is configured, and do not refer to a time period or duration. These include such values as the instrument communications address and values used to set passwords, but not Process Variable and Setpoint related parameters, even if the display resolution of the instrument is set to no decimal places.
- Floating point parameters are those having a decimal point (or those which may be configured to have a decimal point), with the exception of parameters relating to time periods and duration. This includes Process Variable, Setpoints, Alarm Setpoints, etc.
- Time Type parameters measure durations, and include Integral and Derivative times, program durations, etc.

ENUMERATED, STATUS WORD, AND INTEGER PARAMETERS

These use only the first word of the 2 Modbus® addresses assigned to them in the IEEE area. The second word is padded with a value of 8000 hex.

Although ‘Write a Word’ (Function 6) is not permitted, this type of parameter may be written as a single 16 bit word using a Modbus® ‘Block Write’ (Function 16). It is not necessary to add a padding value in the second address. Similarly, such parameters may be read using a Modbus® ‘Block Read’ (Function 3 & 4) as single words, in which case the padding word will be omitted.

It is, however, necessary to pad the unused word when writing this sort of data types as part of a block containing other parameter values.

FLOATING POINT PARAMETERS

These use the IEEE format for floating point numbers, which is a 32 bit quantity. This is stored in consecutive Modbus®addresses. When reading and writing to floats, it is necessary to read or write both words in a single block read or write. It is not possible, for example, to combine the results of two single word reads.

This format is used by most high level programming languages such as ‘C’ and BASIC, and many SCADA and instrumentation systems allow numbers stored in this format to be decoded automatically. The format is as follows:

BIT 31 30 23 22 0

Sign	2^7 ... 2^0	2^{-1} 2^{-2} ... 2^{-23}

{--- -------EXPONENT--------}{---------------------------FRACTION-----------------------------}

where value = $(-1)^{Sign} \times 1.F \times 2^{E-127}$

Note that in practice, when using C, IEEE floats may usually be decoded by placing the values returned over comms into memory and ‘casting’ the region as a float, although some compilers may require that the area be byte swapped high to low before casting. Details of this operation are beyond the scope of this manual.

The format used to transfer the IEEE number is as follows

Lower Modbus®Address		Higher Modbus® Address	
MSB	LSB	MSB	LSB
Bits 31 - 24	Bits 16 - 23	Bits 15 - 8	Bits 7 - 0

For example, to transfer the value 1.001, the following values are transmitted (hexadecimal).

Lower Modbus® Address		Higher Modbus® Address	
MSB	LSB	MSB	LSB
3F	80	20	C5

TIME TYPE PARAMETERS

Time durations are represented as a 32 bit integer number of milliseconds in the IEEE area. When reading and writing to time types, it is necessary to read or write both words in a single block read or write. It is not possible, for example, to combine the results of two single word reads.

The data representation is as follows.

Lower Modbus® Address		Higher Modbus® Address	
MSB	LSB	MSB	LSB
Bits 31 - 24	Bits 16 - 23	Bits 15 - 8	Bits 7 - 0

To create a 32 bit integer value from the two Modbus® values, simply multiply the value at the lower Modbus® address by 65536, and add the value at the Higher address. Then divide by 1000 to obtain a value in seconds, 60000 for a value in minutes, etc.

For example, the value of 2 minutes (120000 mS) is represented as follows:

Lower Modbus® Address		Higher Modbus® Address	
MSB	LSB	MSB	LSB
00	01	D4	C0

USER INTERFACE ACCESS PERMISSIONS (MODBUS)

In the Series CN2200 and CN2400 instruments, some of the operating parameters may be hidden, made read only, or promoted to the 'main' scroll list. Additionally, certain parameter lists may be hidden. In Modbus®, this operation may be performed by writing values to the address range 16384 to 32627.

To calculate the address used to set user interface permissions, take the normal Modbus® address of the parameter involved, and add 16384 to it. List headers and 'special' user interface parameters are listed at the end of the parameter addresses in chapter 5 of this manual. You must be in configuration mode to write to the user interface access parameters, which use the following enumerations:

Parameters:

0	Hide Parameter
1	Promote Parameter to main scroll list
2	Parameter is read only
3	Display Parameter with default read/write status

List Headers

0	Hide List
3	Display List

USER INTERFACE ACCESS PERMISSIONS

In the Series CN2200 and CN2400 instruments, some of the operating parameters may be hidden, made read only, or promoted to the 'main' scroll list. Additionally, certain parameter lists may be hidden. List headers and 'special' user interface parameters are listed at the end of the parameter addresses in chapter 5 of this manual. You must be in configuration mode to write to the user interface access parameters, which use HEX format, and the following enumerations:

Parameters:

0	Hide Parameter
1	Promote Parameter to main scroll list
2	Make parameter read only
3	Display Parameter with default read/write status

List Headers

0	Hide List
3	Display List

PROGRAMMABLE LOGIC CONTROLLERS AND CN24XX SERIES INSTRUMENTS

Modbus®

There are many ways of connecting CN2200 and CN2400 Series Instruments to Programmable Logic Controllers using Modbus®, for example the ProSoft 3100/3150 MCM module for Allen Bradley PLC/5 and SLC/5. It is usually best to avoid the use of Basic modules which may result in very slow communications. Omega will often be able to advise on a solution for a particular make of Programmable Logic Controller, but if requesting information from third party vendors, note that the CN2200 and CN2400 Series support standard Modbus® RTU, allowing use of function 16 for block write operations, and functions 3 and 4 for reads.

Because Modbus® modules often allow a restricted number of block operations, it is sometimes useful to create large blocks containing all the data to be written for a given instrument. Because the Series CN2200 and CN2400 contain a mixture of read/write and read-only data, this can be difficult to achieve. Therefore, for Series CN2200, and CN2400 firmware versions 3.00 and greater, a facility has been provided that allows block writes to continue even if values in the block are not currently writeable (the values that are not writeable are ignored, and there is no error return).

To switch this facility on, write a value of 1 to the instrument Modbus® register 220. The setting of this register is held in non-volatile memory and so you only need perform this operation once. To cancel the facility, write 0 to register 220.

APPENDIX A. GLOSSARY OF TERMS

ASCII	American Standards Committee for Information Interchange. In normal usage this refers to the character code defined by this committee for the exchange of information between devices.
Baud	The number of line signal variations per second. Used to indicate the rate at which data are transmitted on a line.
Bus	A common electrical network allowing devices, (computers, instruments) to communicate with each other.
CRC	Cyclic Redundancy Check. The CRC is an error check code and is two bytes, (16bits) long calculated from the preceding message. From a comparison of the calculated CRC and the received CRC the validity of the message can be determined.
Duplex (full duplex)	A communication channel capable of operating in both directions simultaneously.
EIA	Electrical Industries Association, the standards body that has defined electrical requirements of communications systems such as RS232 (EIA-232), RS422 (EIA-422) and RS 485 (EIA-485).
eot	The End of Transmission segment is a period of inactivity 3.5 times the single character transmission time. The EOT segment at the end of a message indicates to the listening device that the next transmission will be a new message and therefore a device address character.
Half duplex	A communication channel capable of operating in both directions, but not simultaneously.
Message frame	A message is made up of a number of characters sequenced so that the receiving device can understand. This structure is called a message frame.
MSB	Most significant byte
LSB	Least significant byte
Non synchronous	A data channel in which no timing information is transferred between communicating devices.
Parity	A mechanism used for the detection of transmission errors when single characters are being transmitted. A single binary digit known as the parity bit has a value of 0 or 1 depending on the number of '1's in a data message. This allows single bit error detection in the receiver.
RTU	Remote Terminal Unit. This refers to the code used for the exchange of information between devices.
RS422 (EIA-422)	This refers to the electrical standard used for signalling information on a serial communications link.
RX	Receiver on a communication bus.
Simplex	A communication channel capable of operating in one direction only.
Start bit	A voltage level used to signal the start of a character transmission frame
Stop bit	A voltage level used to signal the end of a character transmission frame
TX	Transmitter on a communication bus

APPENDIX B. ASCII CODES

ASCII Codes	ASCII - HEX
STX - Start of Text	02
ETX - End of Text	03
EOT - End of Transmission	04
ENQ - Enquiry	05
ACK - Positive Acknowledge	06
NAK - Negative Acknowledge	15
Space	20
- Minus Sign	2D
. Decimal Point	2E
0	30
1	31
2	32
3	33
4	34
5	35
6	36
7	37
8	38
9	39
> (Greater Than)	3E

HEX-ASCII TABLE - complete list											
00	NUL	15	NAK	2B	+	40	@	56	V	6B	k
01	SOH	16	SYN	2C	,	41	A	57	W	6C	l
02	STX	17	ETB	2D	-	42	B	58	X	6D	m
03	ETX	18	CAN	2E	.	43	C	59	Y	6E	n
04	EOT	19	EM	2F	/	44	D	5A	Z	6F	o
05	ENQ	1A	SUB	30	0	45	E	5B	[	70	p
06	ACK	1B	ESC	31	1	46	F	5C	\	71	q
07	BEL	1C	FS	32	2	47	G	5D	]	72	r
08	BS	1D	GS	33	3	48	H	5E	^	73	s
09	HT	1E	RS	34	4	49	I	5F	-	74	t
0A	LF	1F	US	35	5	4A	J	60	`	75	u
0B	VT	20	space	36	6	AB	K	61	a	76	v
0C	FF	21	!	37	7	4C	L	62	b	77	w
0D	CR	22	“	38	8	4D	M	63	c	78	x
0E	SO	23	£	39	9	4E	N	64	d	79	y
0F	SI	24	$	3A	:	4F	O	65	e	7A	z
10	DLE	25	%	3B	;	50	P	66	f	7B	{
11	DC1(X-ON	26	&	3C	<	51	Q	67	g	7C	|
12	DC2	27	‘	3D	=	52	R	68	h	7D	}
13	DC3(X-OFF)	28	(	3E	>	53	S	69	I	7E	~
14	DC4	29	)	3F	?	54	T	6A	j	7F	DEL
		2A	*			55	U				