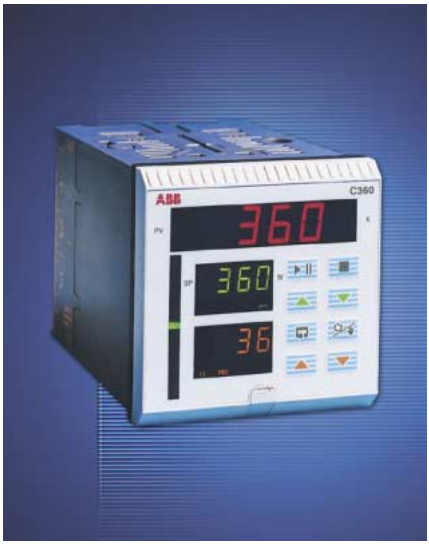
User Guide Supplement –
Modbus™ Serial Communications

IM/C350–MOD_8

¼ DIN Process Controllers

C350 and C360



ABB

The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The UKAS Calibration Laboratory No. 0255 is just one of the ten flow calibration plants operated by the Company, and is indicative of our dedication to quality and accuracy.

EN ISO 9001:2000

Cert. No. Q5907

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 "Safety requirements for electrical equipment for measurement, control, and laboratory use". If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

Symbols

One or more of the following symbols may appear on the equipment labelling:

	**Warning** – Refer to the manual for instructions
	**Caution** – Risk of electric shock
	Protective earth (ground) terminal
	Earth (ground) terminal

	Direct current supply only
	Alternating current supply only
	Both direct and alternating current supply
	The equipment is protected through double insulation

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

1 INTRODUCTION

This Operating Guide describes the COMMANDER 350 and 360 series of instruments Modbus™ serial data communications options and must be used in conjunction with the standard *User Guide* (part no. IM/C351, IM/C355 or IM/C360) supplied with the instrument.

Warnings.

- If the equipment is used in a manner not specified by the Company, the protection provided by the equipment may be impaired.
- All equipment connected to the instrument's terminals must comply with local safety standards (CEI/IEC 61010-1:2001-2).

Notes.

The MODBUS option provides the following facilities:

- Standard RS422/485 communications.
- MODBUS RTU protocol – for master (host computer) to slave (COMMANDER 350 or 360) system.
- 500V d.c isolation from external connections to the instrument.
- Two-wire or four-wire communication.
- 2400 or 9600 baud transmission rate.
- Parity-checking – odd, even or none.

2 ELECTRICAL INSTALLATION

This section describes the connection of serial data transmission cables between the master (host computer) and slave COMMANDER 350 series or 360 series of instruments on a Modbus serial link. All connections other than those used for serial communication are shown in Section 5 of the relevant *User Guide*.

2.1 Host Computer Serial Communications

An RS422/485 communications driver must be fitted to the host computer. It is strongly recommended that the interface has galvanic isolation to protect the computer from lightning damage and increase signal immunity to noise pick-up.

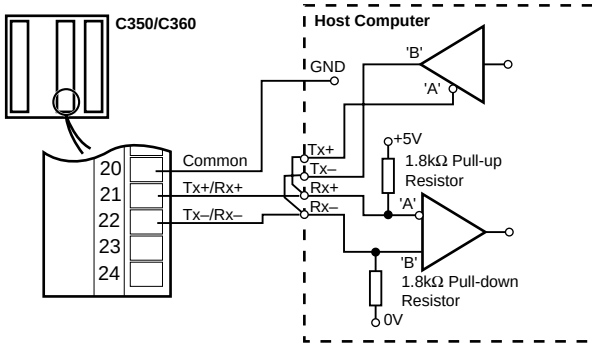
2.2 OPTO22 Boards for use with Personal Computers

Where a personal computer is used as the host computer, the following OPTO22 boards are recommended for use with the COMMANDER 350 and 360 series of instruments:

Part No.	Computer Type
AC24 AT	AT Bus IBM PC compatible
AC34	Microchannel IBM PC

2.3 Two-wire and Four-wire Connection – Figs. 2.1 and 2.2

Modbus serial communications must be configured as either two-wire or four-wire serial links – see Figs. 2.1 and 2.2. Two-/four-wire operation must also be selected in the Configuration Mode – see Section 3.1.



Refer to page 2

Fig. 2.1 Pull-up and Pull-down Resistors (Two-wire Operation)

2.4 Pull-up and Pull-down Resistors – Figs. 2.1 and 2.2

To prevent false triggering of slaves when the master (host computer) is inactive, pull-up and pull-down resistors must be fitted to the RS422/485 interface in the host computer – see Figs. 2.1 and 2.2.

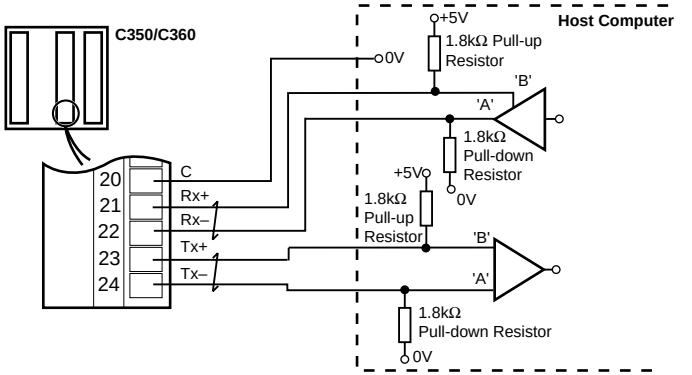


Fig. 2.2 Pull-up and Pull-down Resistors (Four-wire Operation)

2.5 Termination Resistor – Fig. 2.3

For long transmission lines, a 120Ω termination resistor must be fitted to the last slave in the chain – see Fig. 2.3.

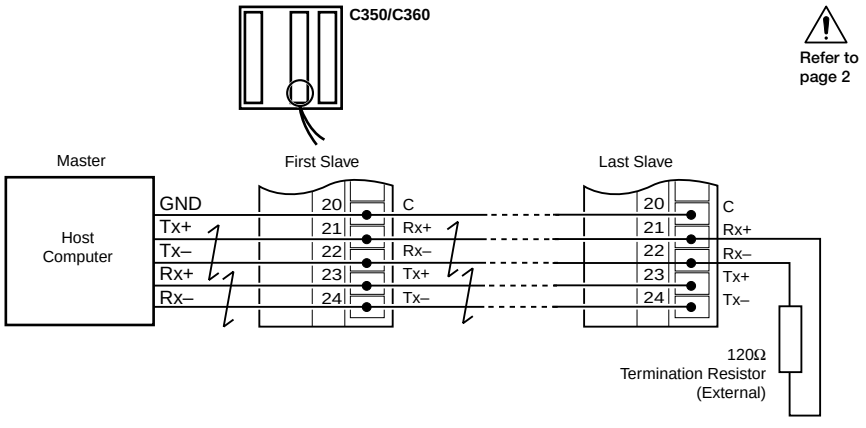


Fig. 2.3 Connecting Multiple Slaves

2.6 Serial Connections – Figs. 2.1 to 2.4

Notes.
- Up to **10** slaves can be connected to a single **RS422** adaptor card on a PC.
- Up to **32** slaves can be connected to a single **RS485** adaptor card on a PC.

The number of slaves can be increased if the driver's serial port permits.

Connections to the Modbus serial board must be made as shown in Figs. 2.1, 2.2 or 2.4. Connections on links with multiple slaves must be made in parallel, as shown in Fig. 2.3. When connecting cable screens, ensure that no 'ground loops' are introduced.

The maximum serial data transmission line length for both **RS422** and **RS485** systems is 1200m. The types of cable that can be used are determined by the total line length:

Up to 6m – standard screened or twisted pair cable.

Up to 300m – twin twisted pair with overall foil screen and an integral drain wire, e.g. Belden 9502 or equivalent.

Up to 1200m – twin twisted pair with separate foil screens and integral drain wires, e.g. Belden 9729 or equivalent.

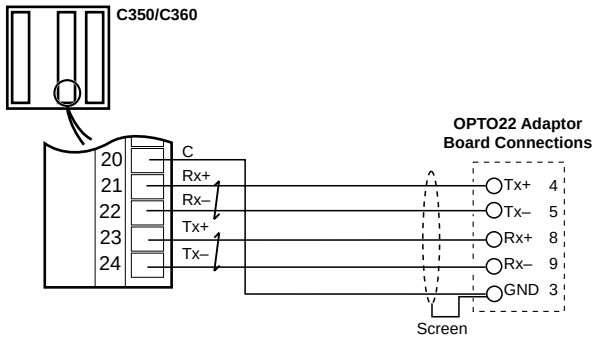
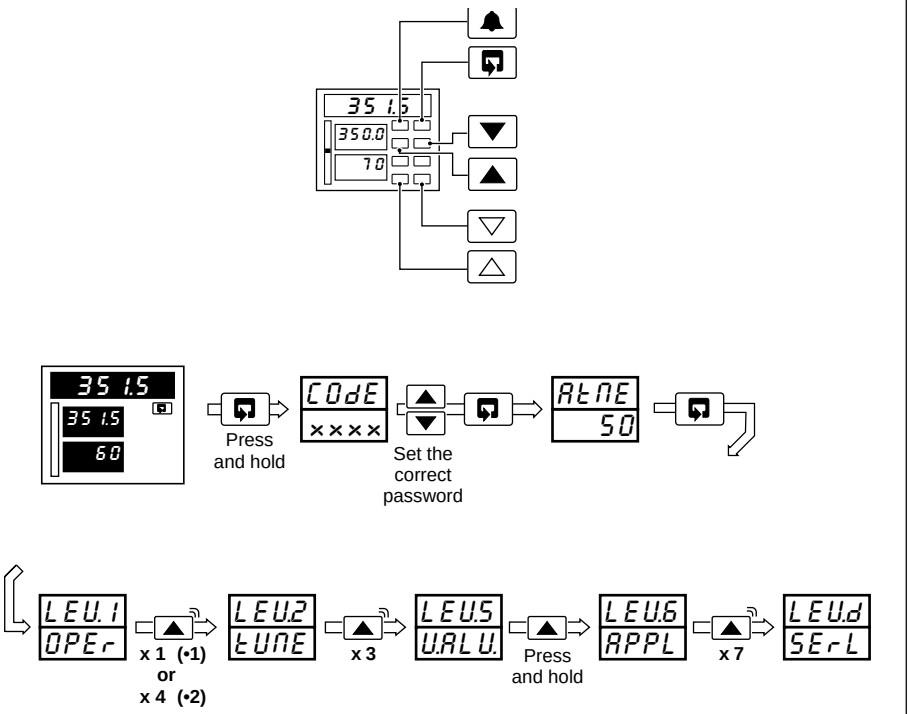


Fig. 2.4 OPTO22 Board Connections

Notes.
- Programmable baud rate – 2400 or 9600 baud.
- Selectable parity – odd, even or none.
- Address range – 1 to 99.

For Modbus communications to operate correctly, each COMMANDER 350 or 360 must be configured with the correct serial transmission parameters and assigned a unique address.

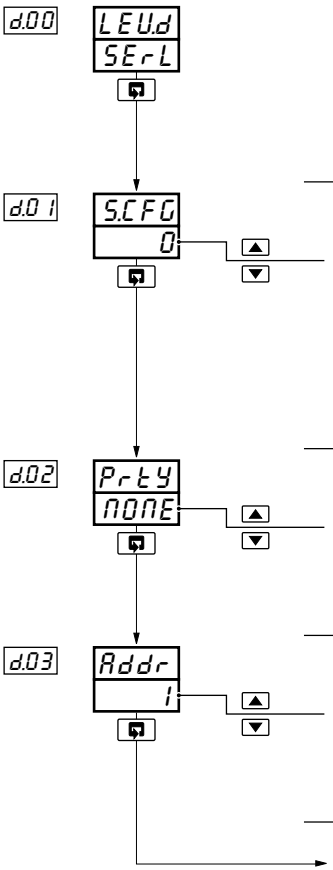
3.1 Accessing the Serial Configuration Displays



•**1** COMMANDER 351 or COMMANDER 355 with ramp/soak disabled.
•2 COMMANDER 360 or COMMANDER 355 with ramp/soak enabled.

Fig. 3.1 Access to Serial Configuration Displays

3.2 Setting the Serial Transmission Parameters



Level d – Serial Communications Configuration

Note. To select this frame from anywhere in this page, press the ⊡ key for a few seconds.

Serial Configuration

0 – OFF
1 – 2-wire connection, 2400 baud rate
2 – 4-wire connection, 2400 baud rate
3 – 2-wire connection, 9600 baud rate
4 – 4-wire connection, 9600 baud rate
5 – 2-wire connection, 19200 baud rate
6 – 4-wire connection, 19200 baud rate

Parity

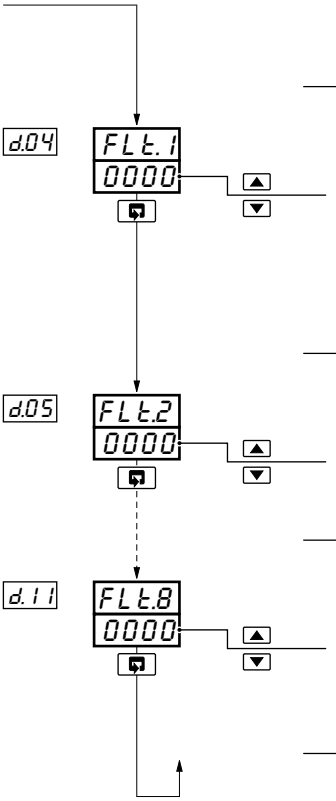
NONE
Odd
EUEN

Modbus address

[1 to 99]

Continued...

3.3 Configuration of 32-bit IEEE Float Values



IEEE Float Value 1 Register Source

Enter the Modbus address of the variable to be accessed as a 32-bit IEEE floating point value at Modbus addresses 16385 and 16386.

IEEE Float Value 2 Register Source

Enter the Modbus address of the variable to be accessed as a 32-bit IEEE floating point value at Modbus addresses 16387 and 16388.

IEEE Float Value 8 Register Source

Enter the Modbus address of the variable to be accessed as a 32-bit IEEE floating point value at Modbus addresses 16399 and 16400.

Return to top of page.

Notes.

- The COMMANDER 350 and 360 operates as a MODBUS, Remote Terminal Unit (RTU) slave.
- Parity checking – detects transmission errors in individual characters.
- Cyclic redundancy checking – detects errors in the master messages and slave responses.

4.1 Introduction

Modbus communication uses the master/slave principle to send messages to one or more slaves. Each slave is given a unique identity address (between 1 and 99).

A broadcast address (address zero) can be used to write to all slave devices simultaneously, using one command. In this instance there is no slave acknowledgment.

Slaves cannot accept new messages until the current message has been processed and a reply sent to the master (maximum response time 125ms). The slave monitors the elapsed time between receipt of characters. If the elapsed time without a new character is $3^1/_2$ character times, the slave assumes the next character received is the start of a new message.

Note. MODBUS RTU requires 1 start bit, 8 data bits, 1 parity bit (optional) and 1 or 2 stop bits.

4.2 Modbus Function Codes

The function code instructs the addressed slave which function to perform. Table 4.1 shows the function codes, and describes the action they initiate.

Function Code	Function Title	Description
01	Read Coil Status	Read up to 32 consecutive discrete (Boolean) points from a specific starting point. The COMMANDER 350/60 returns zeros for points which do not contain defined data and NAKs* any request for point numbers greater than 60.
03	Read Holding Register	Read up to 8 consecutive registers from a specific starting register. The COMMANDER 350/60 returns zeros for points which do not contain defined data and NAKs* any request for point numbers greater than 220.
05	Force Single Coil	Write one discrete (Boolean) point. The COMMANDER 350 NAKs* this if the point is not currently writeable.
06	Preset Single Register	Write one register. This code also applies any existing limits to the register before storage in the instrument. The COMMANDER 350/60 NAKs* if the register is not currently writeable.
08	Loop Back	Echo the message. Only 'Return of Query' is supported.
15	Preset Multiple Coils	Write up to 32 coils at a time. The COMMANDER 350/60 NAKs* if any of the coils are not currently writeable, but carries out all the writes which are valid.
16	Preset Multiple Registers	Write up to eight consecutive registers from a specified starting register. The COMMANDER 350/60 NAKs* if any of the registers are not currently writeable, but carries out all the writes which are valid, applying any existing limits to the value before storage in the instrument.

*NAK = Negative Acknowledgment

Table 4.1 Modbus Function Codes

5 MODBUS FUNCTIONS

This section shows typical examples of Modbus function codes 01, 03, 05, 06, 08, 15 and 16.

5.1 Read Coil Status – Function Code 01

5.1.1 Read Coil Status Query

This function obtains the ON/OFF status of logic coils used to control discrete outputs from the addressed slave. Broadcast mode is not supported with this function code. In addition to the slave address and function fields, the information field must contain the initial coil offset address (starting address) and the number of each location to be interrogated.

Note. The coil offset address is one less than the coil number, e.g. to start at coil 10 the start address must be set to 09 (09H).

Address	Function	Coil Start Offset		No. of Coils		Error Check Field (CRC16)	
		High	Low	High	Low		
01	01	00	09	00	10	ED	C4

Example. Read 16 coils from slave (01) starting at coil 10 (alarm state 1).

5.1.2 Read Coil Status Response

The data is packed one bit for each coil (1 = ON, 0 = OFF). The response includes the slave address, function code, quantity of data characters, the data characters and error checking. The low order bit of the first character contains the first addressed coil and the remainder follow. For coil quantities that are not multiples of eight, the last characters are packed with zeros at the high order end.

Example

Alarms A3, A4, A5, A6 & A7 active
Alarms A1, A2, & A8 inactive
Alarms A3 & A4 are unacknowledged
Alarms A1, A2, A5, A6, A7 & A8 are acknowledged

Address	Function	Byte Count	Data Coil Status 10 to 17	Data Coil Status 18 to 25	Error Check Field (CRC16)	
01	01	02	7C	0C	99	39

5.2 Read Holding Register – Function Code 03

5.2.1 Read Holding Register Query

The Read Holding Register Query obtains the contents of up to eight holding registers in the addressed slave.

Note. The data start register must contain the offset address of the first register to be accessed, e.g. to start at register 1 the data start register must contain 00 (00H).

Broadcast mode is not supported by Function Code 03.

Example. Read two holding registers from slave (01) starting at holding address 01 (process variable input).

Address	Function	Register Offset		No. of Registers		Error Check Field (CRC16)	
		High	Low	High	Low		
01	03	00	00	00	02	C4	0B

5.2.2 Read Holding Register Response

The addressed slave responds with its address and function code, followed by the information field. The information field contains one byte describing the quantity of data bytes to be returned. Two bytes are used to return each register requested, the first byte containing the high order bits and the second the low order bits.

Example

PV input (two registers) – 270
PV decimal places – 1

Address	Function	Byte Count	Holding Register 01		Holding Register 02		Error Check Field (CRC16)	
			High	Low	High	Low		
01	03	04	0A	8E	00	01	D3	CC

5.3 Force Single Coil – Function Code 05

5.3.1 Force Single Coil Query

This message forces a single coil either ON or OFF. The data value 65,280 (FF00 HEX) sets the coil ON and the value zero turns it OFF. All other values are illegal and have no effect on coil status.

Note. To write to a coil its offset address (one less than the coil number) must be used, e.g. to write to coil 39, the coil address 38 (26H) is transmitted.

The use of slave address zero (broadcast mode) forces all attached slaves to modify the desired coil.

Example. Switch ON coil address 39 (auto/manual state) in slave 01.

Address	Function	Coil Start Offset		Data Value		Error Check Field (CRC16)	
		High	Low	High	Low		
01	05	00	26	FF	00	6D	F1

5.3.2 Force Single Coil Response

The response is confirmation of the query after the coil state has been altered.

Example

Address	Function	Coil Start Offset		Data Value		Error Check Field (CRC16)	
		High	Low	High	Low		
01	05	00	26	FF	00	6D	F1

5.4 Preset Single Register – Function Code 06

5.4.1 Preset Single Register Query

The Preset Single Register Query modifies the contents of a holding register.

> **Note**. Function codes 05, 06, 15 and 16 are the only messages that are recognized as valid for broadcast.

Example. Write the value 500 to holding register address 104 (proportional band 1 – heat) in slave 01.

> **Note**. To write to a register, its offset address (one less than the register number) must be used, e.g. to write to register 104, the offset address 103 (67H) is transmitted.

Address	Function	Register Offset		Data Value		Error Check Field (CRC16)	
		High	Low	High	Low		
01	06	00	67	01	F4	38	02

5.4.2 Preset Single Register Response

The response to a Preset Single Register Response request is to retransmit the query message after the register has been altered.

Example

Address	Function	Register Offset		Data Value		Error Check Field (CRC16)	
		High	Low	High	Low		
01	06	00	67	01	F4	38	02

5.5 Loopback Test – Function Code 08

5.5.1 Loopback Test Query

The Loopback Test Query tests the Modbus system and does not affect the operation of the slave. Variations in the response may indicate faults in the Modbus system. The information field contains two bytes for the designation of the diagnostic code followed by two bytes to designate the action to be taken.

Example

Address	Function	Data Diagnostic Code		Data*	Data*	Error Check Field (CRC16)	
		High	Low				
01	08	00	00	A5	37	DA	8D

5.5.2 Loopback Test Response

The Loopback Test Response always echoes the query, only diagnostic code 0 (bytes 3 and 4) can be used.

Example

Address	Function	Data Diagnostic Code		Data*	Data*	Error Check Field (CRC16)	
		High	Low				
01	08	00	00	A5	37	DA	8D

5.6 Force Multiple Coils – Function Code 15

5.6.1 Force Multiple Coils Query

This message is used to force up to 32 coils at a time to the ON or OFF state. When used with slave address zero (broadcast mode) all slave controllers force the selected coils to the state(s) specified.

Note. To write to a coil, its offset address (one less than the register number) must be used, e.g. to write to coil 39, the offset address 38 (26H) is transmitted.

Example. Force coil 39 to ON (Select manual mode) and coil 40 to OFF (Select Local Set Point mode).

Address	Function	Coil Start Offset		Number of Coils		Byte Count	Data Coil Status	Error Check Field (CRC16)	
		High	Low	High	Low				
01	0F	00	26	00	02	01	01	16	90

5.6.2 Force Multiple Coils Response

The Force Multiple Coils Response confirms slave identification, function code, starting register address and quantity only.

Example

Address	Function	Coil Start Offset		No. of Coils		Error Check Field (CRC16)	
		High	Low	High	Low		
01	0F	00	26	00	02	35	C1

5.7 Write Multiple Registers – Function Code 16

5.7.1 Write Multiple Registers Query

This message is used to change the contents of up to eight holding registers at a time. When used with slave address zero (broadcast mode) all slave controllers load the selected registers with the contents specified.

Note. To write to a register, its offset address (one less than the register number) must be used, e.g. to write to register 104, the offset address 103 (67H) is transmitted.

Example. Write the value 500 to the register address 104 (proportional band 1 – heat) and the value 100 to the register address 105 (integral action time) in slave 01.

Addr	Funct	Register Start Offset		Number of Registers		Byte Count	Holding Register 104		Holding Register 105		Error Check Field (CRC16)	
		High	Low	High	Low		High	Low	High	Low		
01	10	00	67	00	02	04	01	F4	00	64	F5	84

5.7.2 Write Multiple Registers Response

The Write Multiple Registers Response confirms slave identification, function code, starting register address and quantity only.

Example

Address	Function	Register Start Offset		No. of Registers		Error Check Field (CRC16)	
		High	Low	High	Low		
01	10	00	67	00	02	FA	17

6 EXCEPTION RESPONSES

The exception response codes sent by the slave are shown in Table 6.1. When a slave detects one of these errors, it sends a response message to the master consisting of slave address, function code, error code and error check fields.

Exception Response Code	Exception Response Name	Exception Response Definition
01	Illegal Function	The message function received is not an allowable function on the COMMANDER 350/360.
02	Illegal Data Address	The address reference in the data field is not an allowable address for the COMMANDER 350/360.
03	Illegal Data Value	The value referenced in the data field is not allowable on the addressed slave location.
07	Negative Acknowledgement	The function just requested cannot be performed.
08	Memory Parity Error	Parity check indicates an error in one or more of the characters received.

Table 6.1 Exception Response Codes

6.1 Examples

A Read Register Request to read holding register address 300 of Slave 01 (undefined address for Slave, beyond address limit).

Address	Function	Register Start Offset		No. of Registers		Error Check Field (CRC16)	
		High	Low	High	Low		
01	03	01	2B	00	06	B4	3C

The slave replies with an exception response signifying an ‘illegal data address’. To indicate that the response is a notification of an error, the most significant bit of the function code is set to 1.

Address	Function	Exception	Error Check Field (CRC16)	
01	83	02	C0	F1

7 ADDRESSABLE PARAMETERS

7.1 Coils

Coil No.	Variable Label	Read/Write	Limits/Values	
01	Process variable fail state	R	0=Pass; 1=Fail; 2=Not Ready; 3=CJ Fail	
02	Remote set point fail state	R	1=Failed	
03	Analog input 1 fail state	R	1=Failed	
04	Analog input 2 fail state	R	1=Failed	
05	Analog input 3 fail state	R	1=Failed	
06	Loop Break Monitor 1	R	1=Failed	
07	Reserved	–		
10	Alarm A1 state	R	1=Active	
11	Alarm A2 state	R	1=Active	
12	Alarm A3 state	R	1=Active	
13	Alarm A4 state	R	1=Active	
14	Alarm A5 state	R	1=Active	
15	Alarm A6 state	R	1=Active	
16	Alarm A7 state	R	1=Active	
17	Alarm A8 state	R	1=Active	
18	Alarm acknowledge A1 state	R	1=Active	
19	Alarm acknowledge A2 state	R	1=Active	
20	Alarm acknowledge A3 state	R	1=Active	
21	Alarm acknowledge A4 state	R	1=Active	
22	Alarm acknowledge A5 state	R	1=Active	
23	Alarm acknowledge A6 state	R	1=Active	
24	Alarm acknowledge A7 state	R	1=Active	
25	Alarm acknowledge A8 state	R	1=Active	
27	Digital input 1 state	R	1=Active	
28	Digital input 2 state	R	1=Active	
29	Digital input 3 state	R	1=Active	
30	Digital input 4 state	R	1=Active	
31	Digital output 1 state	R	1=Active	
32	Reserved	–		
33	Relay 1 state	R	1=Energized	
34	Relay 2 state	R	1=Energized	
35	Relay 3 state	R	1=Energized	
36	Relay 4 state	R	1=Energized	
37	On/off state output 1 (heat)	R	1=On	
38	On/off state output 2 (cool)	R	1=On	
39	Auto/manual state	R/W	0=Auto; 1=Manual	•1
40	Set point mode	R/W	0=Local; 1=Remote	

•1 Not applicable to cascade controllers – see coil 55

Continued…

...7 ADDRESSABLE PARAMETERS

...7.1 Coils

Coil No.	Variable Label	Read/Write	Limits/Values	
41	Logic equation 1 state	R	1=Active	
42	Logic equation 2 state	R	1=Active	
43	Logic equation 3 state	R	1=Active	
44	Logic equation 4 state	R	1=Active	
45	Logic equation 5 state	R	1=Active	
46	Logic equation 6 state	R	1=Active	
47	Real time alarm 1 state	R	1=Active	
48	Real time alarm 2 state	R	1=Active	
49	Delay timer 1 state	R	1=Active	
50	Delay timer 2 state	R	1=Active	
51	MODBUS™ signal 1	R/W	1=Active	
52	MODBUS™ signal 2	R/W	1=Active	
53	MODBUS™ signal 3	R/W	1=Active	
54	MODBUS™ signal 4	R/W	1=Active	
55	Auto / manual state	R/W	0=Auto; 1=Manual	•1
56 to 60	Not Used	–		
61	Program time units	R/W	0=minutes; 1=hours	•2
62	Select ramp type	R/W	0=ramp rate; 1=ramp time	•2
63	Self-seeking set point enable	R/W	0=no; 1=yes	•2
64	Current time event state 1	R	0=inactive; 1=active	•2
65	Current time event state 2	R	0=inactive; 1=active	•2
66	Current time event state 3	R	0=inactive; 1=active	•2
67	Current time event state 4	R	0=inactive; 1=active	•2

•1 Cascade controllers only (Templates 11, 12 and 13)

•2 COMMANDER 355 and 360 only

7.2 Analog Input Registers

Register No.	Variable Label	Read/Write	Limits/Values
1	Process variable	R	–999 to 9999
2	PV decimal places (dp)	R	0 to 3 decimal places
3	Remote set point input	R	–999 to 9999
4	Remote set point dp	R	0 to 3 decimal places
5	Analog input 1	R	–999 to 9999
6	Analog input 1 dp	R	0 to 3 decimal places
7	Analog input 2	R	–999 to 9999
8	Analog input 2 dp	R	0 to 3 decimal places
9	Analog input 3	R	–999 to 9999
10	Analog input 3 dp	R	0 to 3 decimal places

7.3 Single Loop Parameters (Templates 1 and 2)

Register No.	Variable Label	Read/Write	Limits/Values
20	PV	R	–999 to 9999
21	Control set point	R#	–999 to 9999
22	Output 1 (Heat)	R/W*	0 to 1000 (= 0.0 to 100.0%)
23	Output 2 (Cool)	R/W*	0 to –1000 (= 0.0 to –100.0%)
25	Remote set point ratio	R/W	0.001 to 9.999
26	Remote set point bias	R/W	–999 to 9999

To change a set point value, write to the local set point value

* Write in manual mode only

7.4 Auto/manual Station and Analog Backup Parameters (Templates 3 to 6)

Register No.	Variable Label	Read/Write	Limits/Values
30	PV	R	–999 to 9999
31	Master output	R	0 to 1000 (representing 0.0 to 100.0%)
32	Control output	R/W*	0 to 1000 (representing 0.0 to 100.0%)
33	Control set point	R	–999 to 9999

* Write: manual mode only

7.5 Indicator and Manual Loader Station Parameters (Templates 7 and 8)

Register No.	Variable Label	Read/Write	Limits/Values
35	PV1	R	–999 to 9999
36	PV2	R	–999 to 9999
37	Control Output	R/W	0 to 1000 (representing 0.0 to 100.0%)

7.6 Feedforward Parameters (Templates 9 and 10)

Register No.	Variable Label	Read/Write	Limits/Values
40	PV	R	–999 to 9999
41	Control set point	R#	–999 to 9999
42	Output 1	R/W*	0 to 1000 (representing 0.0 to 100.0%)
43	Output 2	R/W*	0 to 1000 (representing 0.0 to 100.0%)
44	Disturbance variable	R	0 to 1000 (representing 0.0 to 100.0%)
45	Feedforward signal	R	0 to 1000 (representing 0.0 to 100.0%)
46	Remote set point ratio	R/W	0.001 to 9.999
47	Remote set point bias	R/W	–999 to 9999
48	Feedforward gain	R/W	0.1 to 999.9
49	Feedforward bias	R/W	–1000 to 1000 (representing –100.0 to 100.0%)

\# To change set point value write to the local set point values

* Write in manual mode only

7.7 Cascade Parameters (Templates 11 and 12)

Register No.	Variable Label	Read/Write	Limits/Values
50	Master PV	R	–999 to 9999
51	Master Control set point	R#	–999 to 9999
52	Master Control output	R/W*	0 to 1000 (representing 0.0 to 100.0%)
53	Slave PV	R	–999 to 9999
54	Slave set point	R/W*	–999 to 9999
55	Remote set point ratio	R/W	0.001 to 9.999
56	Remote set point bias	R/W	–999 to 9999
57	Slave set point ratio	R/W	0.001 to 9.999
58	Slave set point bias	R/W	–999 to 9999
59	Slave output 1 (heat)	R/W*	0 to 1000 (representing 0.0 to 100.0%)
60	Slave output 2 (cool)	R/W*	0 to 1000 (representing 0.0 to 100.0%)

To change set point value write to the local set point values

* Write in manual mode only

7.8 Cascade with Feedforward Parameters (Template 13)

Register No.	Variable Label	Read/Write	Limits/Values
65	Master PV	R	–999 to 9999
66	Master control set point	R#	–999 to 9999
67	Master control output	R/W*	0 to 1000 (representing 0.0 to 100.0%)
68	Slave PV	R	–999 to 9999
69	Slave setpoint	R/W*	–999 to 9999
70	Disturbance variable	R	0 to 1000 (representing 0.0 to 100.0%)
71	Feedforward signal	R	0 to 1000 (representing 0.0 to 100.0%)
72	Remote set point ratio	R/W	0.001 to 9.999
73	Remote set point bias	R/W	–999 to 9999
74	Slave set point ratio	R/W	0.001 to 9.999
75	Slave set point bias	R/W	–999 to 9999
76	Slave output 1 (heat)	R/W*	0 to 1000 (representing 0.0 to 100.0%)
77	Slave output 2 (cool)	R/W*	0 to 1000 (representing 0.0 to 100.0%)
78	Feedforward gain	R/W	0.1 to 999.9
79	Feedforward bias	R/W	–1000 to 1000 (representing –100.0 to 100.0%)

To change set point value write to the local set point values

* Write in manual mode only

7.9 Ratio Station and Controller Parameters (Templates 14 to 17)

Register No.	Variable Label	Read/Write	Limits/Values
80	Process variable	R	–999 to 9999
81	Actual ratio	R	0.001 to 9.999
82	Desired ratio	R	0.001 to 9.999
83	Wild variable	R	–999 to 9999
84	Bias	R/W	–999 to 9999
85	Control set point	R	–999 to 9999
86	Control output	R/W*	0 to 1000 (representing 0.0 to 100.0%)
87	Local ratio	R/W	–999 to 9999
88	Remote ratio	R	–999 to 9999

* Write in manual mode only

7.10 Control Monitor

Register No.	Variable Label	Read/Write	Limits/Values
90	Rate of approach	R	0 to 9999 in eng units/minute
91	Overshoot	R	0 to 1000 (representing 0 to 100% of the step change)
92	Decay ratio	R	0 to 9999 (representing 0.00 to 99.99)
93	Settling time	R	0 to 9999 seconds
94	Error integral	R	0 to 9999 in eng units

7.11 Tuning Parameters

Register No.	Variable Label	Read/Write	Limits/Values
100	Cycle time 1	R/W	1.0 to 300.0 or 0.9 (on/off)
101	Cycle time 2	R/W	1.0 to 300.0 or 0.9 (on/off)
102	On/off hysteresis 1	R/W	0 to 9999
103	On/off hysteresis 2	R/W	0 to 9999
104	Prop band 1	R/W	0.1 to 999.9
105	Integral action time 1	R/W	0 to 7200
106	Derivative action time 1	R/W	0.0 to 999.9
107	Manual reset value	R/W	–1000 to 1000 (representing –100.0 to 100.0%)
108	Prop band 2	R/W	0.1 to 999.9
109	Integral action time 2	R/W	0 to 7200
110	Derivative action time 2	R/W	0.0 to 999.9
111	Prop band 3	R/W	0.1 to 999.9
112	Integral action time 3	R/W	0 to 7200
113	Prop band 4	R/W	0.1 to 9.999
114	Integral action time 4	R/W	0 to 7200
115	Feedforward gain	R/W	0.001 to 9.999
116	Feedforward bias	R/W	–999 to 9999
117	Control deadband	R/W	–999 to 9999
118	Heat/cool output 1 start	R/W	0 to 1000 (representing 0.0 to 100.0%)
119	Heat/cool output 2 start	R/W	0 to 1000 (representing 0.0 to 100.0%)

7.12 Set Point Parameters

Register No.	Variable Label	Read/Write	Limits/Values
120	Local set point 1 value	R/W	–999 to 9999
121	Local set point 2 value	R/W	–999 to 9999
122	Local set point 3 value	R/W	–999 to 9999
123	Local set point 4 value	R/W	–999 to 9999
124	Ramp rate	R/W	0 to 9999

7.13 Alarm Parameters

Register No.	Variable Label	Read/Write	Limits/Values
130	Alarm A1 type	R	0 None; 1 High Process, PV; 2 Low Process, PV; 3 High Latch, PV; 4 Low Latch, PV; 5 High Deviation; 6 Low Deviation; 7 High Process I/P1; 8 Low Process I/P1; 9 High Process I/P2; 10 Low Process I/P2; 11 High Process I/P3; 12 Low Process I/P3; 13 High Output; Low Output; 14 Math Block 1 High; 15 Math Block 1 Low; 16 Math Block 2 High; 17 Math Block 2 Low; 18 Math Block 3 High; 19 Math Block 3 Low; 20 Math Block 4 High; 21 Math Block 4 Low
131	Alarm A1 trip	R/W	–999 to 9999
132	Alarm A1 hysteresis	R/W	0 to 9999 in eng units
133	Alarm A1 time hysteresis	R/W	0 to 9999 seconds
134	Alarm A2 type	R	0 to 21
135	Alarm A2 trip	R/W	–999 to 9999
136	Alarm A2 hysteresis	R/W	0 to 9999 in eng units
137	Alarm A2 time hysteresis	R/W	0 to 9999 seconds
138	Alarm A3 type	R	0 to 21
139	Alarm A3 trip	R/W	–999 to 9999
140	Alarm A3 hysteresis	R/W	0 to 9999 in eng units
141	Alarm A3 time hysteresis	R/W	0 to 9999 seconds
142	Alarm A4 type	R	0 to 21
143	Alarm A4 trip	R/W	–999 to 9999
144	Alarm A4 hysteresis	R/W	0 to 9999 in eng units
145	Alarm A4 time hysteresis	R/W	0 to 9999 seconds

Continued…

...7.13 Alarm Parameters

Register No.	Variable Label	Read/Write	Limits/Values
146	Alarm A5 type	R	0 to 21
147	Alarm A5 trip	R/W	–999 to 9999
148	Alarm A5 hysteresis	R/W	0 to 9999 in eng units
149	Alarm A5 time hysteresis	R/W	0 to 9999 seconds
150	Alarm A6 type	R	0 to 21
151	Alarm A6 trip	R/W	–999 to 9999
152	Alarm A6 hysteresis	R/W	0 to 9999 in eng units
153	Alarm A6 time hysteresis	R/W	0 to 9999 seconds
154	Alarm A7 type	R	0 to 21
155	Alarm A7 trip	R/W	–999 to 9999
156	Alarm A7 hysteresis	R/W	0 to 9999 in eng units
157	Alarm A7 time hysteresis	R/W	0 to 9999 seconds
158	Alarm A8 type	R	0 to 21
159	Alarm A8 trip	R/W	–999 to 9999
160	Alarm A8 hysteresis	R/W	0 to 9999 in eng units
161	Alarm A8 time hysteresis	R/W	0 to 9999 seconds

7.14 Motorized Valve Parameters

Register No.	Variable Label	Read/Write	Limits/Values
170	Valve position	R	0 to 1000 (representing 0.0 to 100.0%)
171	Desired valve position	R/W*	0 to 1000 (representing 0.0 to 100.0%)
172	Motorized valve ratio	R/W	1 to 1000 (representing 0.01 to 10.00)
173	Motorized valve bias	R/W	–1000 to 1000 (representing –100.0 to 100.0%)
174	Motorized valve deadband	R/W	0 to 1000 (representing 0.0 to 100.0%)
175	Regulator travel time	R/W	0 to 5000 seconds

* Write in manual mode only

7.15 Basic Configuration

Register No.	Variable Label	Read/Write	Limits/Values
180	Template application	R	1 Single loop with local set point; 2 Single loop with remote set point; 3 Auto/Manual station with low signal selection; 4 Auto/Manual station with digital selection; 5 Analog backup with low signal selection; 6 Analog backup with digital selection; 7 Single indicator/manual loader; 8 Double indicator/manual loader; 9 Single loop with feedforward and local set point; 10 Single loop with feedforward and remote set point; 11 Cascade with local set point; 12 Cascade with remote set point; 13 Cascade with feedforward and local set point; 14 Ratio controller; 15 Ratio controller with external ratio; 16 Ratio station; 17 Ratio station with external ratio

Continued…

...7.15 Basic Configuration

Register No.	Variable Label	Read/Write	Limits/Values
181	Output type	R	0 None; 1 Analog output (COP = ao1); 2 Relay output (COP = RLY1); 3 Digital output (COP = do1); 4 Motorized valve with feedback; 5 Motorized valve without feedback; 6 Heat/cool with OP1 = relay, OP2 = relay; 7 Heat/cool with OP1 = relay, OP2 = digital output; 8 Heat/cool with OP1 = digital output, OP2 = relay; 9 Not Used; 10 Heat/cool with OP1 = analog, OP2 = relay; 11 Not Used; 12 Heat/cool with OP1 = analog, OP2 = analog
182	Control action	R	0 OP1 = Reverse; 1 OP1 = Direct; 2 OP1 = Reverse, OP2 = Direct; 3 OP1 = Reverse, OP2 = Reverse 4 OP1 = Direct, OP2 = Reverse; 5 OP1 = Direct, OP2 = Direct

7.16 Math Blocks

Register No.	Variable Label	Read/Write	Limits/Values
210	Math block 1 result	R	–999 to 9999
211	Math block 2 result	R	–999 to 9999
212	Math block 3 result	R	–999 to 9999
213	Math block 4 result	R	–999 to 9999
214	Math block 1 dp's	R	0 to 3
215	Math block 2 dp's	R	0 to 3
216	Math block 3 dp's	R	0 to 3
217	Math block 4 dp's	R	0 to 3

7.17 Ramp/Soak Program Parameters (COMMANDER 355 and 360 Instruments Only)

Register No.	Variable Label	Read/Write	Limits/Values	
300	Program 1 Begin	R/W	0=off; 1 to 99	
301	Program 1 End	R/W	1 to 99	
302	Program 1 Repeats	R/W	0 to 99; 100 = Infinity	
303	Program 1 Guaranteed ramp hysteresis	R/W	0 to 9999	
304	Program 1 Guaranteed soak hysteresis	R/W	0 to 9999	
305	Program 1 Source	R/W	0 to number of digital sources – see Table 7.1	
306 to 309	Not Used	–	–	
310 to 315	Program 2 Parameters	R/W	See Program 1 Parameters (Registers 300 to 305)	•1
320 to 325	Program 3 Parameters			•1
330 to 335	Program 4 Parameters			•1
340 to 345	Program 5 Parameters			•1
350 to 355	Program 6 Parameters			•1
360 to 365	Program 7 Parameters			•1
370 to 375	Program 8 Parameters			•1
380 to 385	Program 9 Parameters			•1
390 to 395	Program 10 Parameters			•1
400 to 405	Program 11 Parameters			•1
410 to 415	Program 12 Parameters			•1
420 to 425	Program 13 Parameters			•1
430 to 435	Program 14 Parameters			•1
440 to 445	Program 15 Parameters			•1
450 to 455	Program 16 Parameters			•1
460 to 465	Program 17 Parameters			•1
470 to 475	Program 18 Parameters			•1
480 to 485	Program 19 Parameters			•1
490 to 495	Program 20 Parameters			•1

•1 COMMANDER 360 only

Note. On the instrument display, programs 10 to 20 are represented by the letters A to L (excluding I).

7.18 Ramp/Soak Segment Parameters

Register No.	Variable Label	Read/Write	Limits/Values	
500	Segment 1 Start Value	R/W	0 to 9999 in engineering units, no dp. 100.0 is entered as 1000, 25.10 as 2510	
501	Segment 1 End Value	R/W	0 to 9999 in engineering units	
502	Segment 1 Soak Time / Ramp Rate	R/W	Depends on settings of Coils 61 and 62: 0 to 1680 (= 0.0 to 168.0 hours) or 0 to 9999 (= 0.0 to 999.9 minutes) or 1 to 9999 Engineering units* /hr or /min *one more decimal place than the control set point, up to a maximum of 3 d.p.	
503	Segment 1 Guaranteed ramp hysteresis enable	R/W	0=off; 1=hysteresis above set point only; 2=hysteresis below set point only; 3=hysteresis above and below set point.	
504	Time Event State	R/W	Event 1 On = 1 Event 2 On = 2 Event 3 On = 4 Event 4 On = 8 E.g. To make events 2 and 4 active, set this register to 8 + 2 = 10_{10} (A_{16})	
505	Not Used	–		
506	Segment 2 End Value	R/W	See Segment 1 Parameters	
507	Segment 2 Soak Time / Ramp Rate	R/W		
508	Segment 2 Guaranteed ramp hysteresis enable	R/W		
509	Time Event State	R/W		
510	Not Used	–		
511 to 515 : 646 to 650 651 to 655 : 991 to 995	Segment 3 parameters : Segment 30 parameters Segment 31 parameters : Segment 99 Parameters	R/W		•1 •1 •1
996	Soak time adjust value	R/W	0 to 1000, representing 0.0 to 100.0 in time units selected	
997	Retort	R/W	0=off; 1=Type A; 2=Type B	
998	Ramp Soak – Run current program	R or R/W	1 to 20 Programs *or* only when run/hold action = 'STOP'	
999	Ramp Soak – Run current segment	R	1 to 99	
1000	Current Run/Hold Action	R	0 = Operator Hold 1 = Stop 2 = Run 3 = End 4 = Manual Hold 5 = Holdback Hold	

•1 COMMANDER 360 only

7.19 Floating Point Values

7.19.1 Modbus Addresses

32-bit IEEE values should be read as a double register pair – see table below.

Modbus Addresses	Variable Label
16385 & 16386	IEEE Floating point value 1
16387 & 16388	IEEE Floating point value 2
16389 & 16390	IEEE Floating point value 3
16391 & 16392	IEEE Floating point value 4
16393 & 16394	IEEE Floating point value 5
16395 & 16396	IEEE Floating point value 6
16397 & 16398	IEEE Floating point value 7
16399 & 16400	IEEE Floating point value 8

Note. Up to 8 values can be accessed as 32-bit IEEE floating point values.

7.19.2 Configuration

To determine which variables can be accessed as floating point values it is necessary to configure the IEEE Float Value Register Source for each value. The float value register source should be set to the Modbus Register address of the variable to be accessed as a 32-bit float value, see examples below.

Example

The modbus address of analogue input 2 is 7.
To access analogue input 2 as a floating point value at registers 16385 & 16386 then IEEE Float Value 1 Register Source must be set to 7.

The modbus address of Control output 1 is 22.
To access Control output 1 as a floating point value at registers 16387 & 16388 then IEEE Float Value 2 Register Source must be set to 22.

The modbus address of the remote setpoint ratio is 25.
To access the remote setpoint ratio as a floating point value at registers 16388 & 16389 then IEEE Float Value 3 Register Sorce must be set to 25.

7.19.3 Data Format

Byte 1	Byte 2	Byte 3	Byte 4
SXXX XXXX	XMMM MMMM	MMMM MMMM	MMMM MMMM

Modbus address n | Modbus address n+1

Where:

S =SignBit
X...X =8-bit exponent
M...M =23-bit mantissa

7.19.4 Read/Write Access

Registers 16385 to 16400 can be read as single registers or as multiple registers.

An attempt to write to a single register or to more than 2 registers within the range 16385 to 16400 will result in a negative acknowledgement exception response. Writing these registers can only be performed as a write to 2 associated registers, ie.

Multiple register write to 16385 & 16386
Multiple register write to 16387 & 16388 etc.

An attempt to write to two registers not associated with the same 32-bit IEEE Floating point value will result in a negative acknowledgement exception response.

Normal read/write restrictions also apply to variables accessed as floating point values, eg.

The Modbus address of analogue input 2 is 7.

To access analogue input 2 as a floating point value at registers 16385 & 16386 then **IEEE Float Value 1 Register Source** must be set to 7.
Since Modbus register 7 is read only then registers 16385 & 16386 will become read only. Attempting to write will result in a negative acknowledgement exception response.

The Modbus address of Control output 1 is 22.

To access Control output 1 as a floating point value at registers 16387 & 16388 the **IEEE Float Value 2 Register Source** must be set to 22.
Sive Modbus register 22 can only be written to whilst the controller is in manual mode then registers 16385 & 16386 can only be written to whilst the controller is in manual mode. Attempting to write whilst in auto mode will result in a negative acknnowledgement exception response.

The Modbus address of the remote setpoint ratio is 25.

To access the remote setpoint ratio as a floating point value at registers 16388 & 16389 then **IEEE Float Value 3 Register Source** must be set to 25.
Since Modbus register 25 is read/write then registers 16385 & 16386 will become read/write only.

Digital Source No.	Description
0	Off signal – always False
1	Control output 1 (heat)
2	Control output 2 (cool)
3	Motorized valve Open Relay
4	Motorized valve Close Relay
5	Alarm 1 active
6	Alarm 2 active
7	Alarm 3 active
8	Alarm 4 active
9	Alarm 5 active
10	Alarm 6 active
11	Alarm 7 active
12	Alarm 8 active
13	Alarm 1 acknowledge
14	Alarm 2 acknowledge
15	Alarm 3 acknowledge
16	Alarm 4 acknowledge
17	Alarm 5 acknowledge
18	Alarm 6 acknowledge
19	Alarm 7 acknowledge
20	Alarm 8 acknowledge
21	Digital input 1
22	Digital input 2
23	Digital input 3
24	Digital input 4
25	Manual control mode
26	Auto control mode
27	Local setpoint / Local control selected
28	Remote setpoint / Remote control selected
29	Input 1 failed
30	Input 2 failed
31	Input 3 failed
32	Loop break analog o/p 1
33	Not Used
34	Watchdog active
35	Power fail
36	Logic equation 1 true
37	Logic equation 2 true
38	Logic equation 3 true
39	Logic equation 4 true
40	Logic equation 5 true
41	Logic equation 6 true

Digital Source No.	Description	
42	Real time alarm 1	
43	Real time alarm 2	
44	Delay timer 1	
45	Delay timer 2	
46	Modbus signal 1	
47	Modbus signal 2	
48	Modbus signal 3	
49	Modbus signal 4	
50	On signal – always True	
51	Time event state 1	
52	Time event state 2	
53	Time event state 3	
54	Time event state 4	
55	End of program event	
56	Program event state 1	
57	Program event state 2	
58	Program event state 3	
59	Program event state 4	
60	Program event state 5	
61	Program event state 6	
62	Program event state 7	
63	Program event state 8	
64	Program event state 9	
65	Program event state 10 (A)	•1
66	Program event state 11 (B)	•1
67	Program event state 12 (C)	•1
68	Program event state 13 (D)	•1
69	Program event state 14 (E)	•1
70	Program event state 15 (F)	•1
71	Program event state 16 (G)	•1
72	Program event state 17 (H)	•1
73	Program event state 18 (J)	•1
74	Program event state 19 (K)	•1
75	Program event state 20 (L)	•1
76	Segment event state 1	
:	:	
105	Segment event state 30	
106	Segment event state 31	•1
:	:	•1
174	Segment event state 99	•1
175	Program Running	
176	Holdback Program Hold	
177	Operator Program Hold	
178	On signal – always True	

•1 COMMANDER 360 only

Table 7.1 Digital Sources

NOTES

PRODUCTS & CUSTOMER SUPPORT

Products

Automation Systems

- ***for the following industries:***
  - Chemical & Pharmaceutical
  - Food & Beverage
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Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification.
Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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