ADVANCE INFORMATION

C2302/3/4/5C
Modbus Interface Modules
Advanced Technical information

1. REVISION HISTORY

Rev	Date	Description of changes
1	02/09/98	Initial draft
2	29/09/98	C2304 and C2305 added to the range
3	08/02/2006	Added Modbus Master to the User Manual.

2. SCOPE

This document provides advanced information for Omniflex's new products designed to interface to the existing Omni16 annunciator family to SCADA, DCS and computer systems using the familiar Modbus interface de facto standard.

This information is published to allow system planning for future projects. While every attempt has been made to ensure accuracy of the information, Omniflex reserves the right to change any aspect of this specification prior to product release.

It is assumed that the reader is familiar with the company's current products and as such no explanations for existing technical concepts are provided.

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3. GENERAL DESCRIPTION

The C2302C, C2303C, C2304C and C2305C Omni16B/Modbus Interface Modules are DIN rail mount devices powered from 24Vdc. Their function is to provide input from and output to the existing Omniflex Omni16 alarm annunciators and auxiliary I/O by computer or SCADA systems via RS232/RS485 serial communications using the Modbus(Master or Slave) protocol.

The C2302C and C2303C Omni16/Modbus Input Modules read 16 inputs/lamps/pushbuttons over Modbus. The C2302C is equipped with a 20 way ribbon header suitable to connect directly to any existing Omni8 or Omni16 Annunciator input or lamp repeat socket. The C2303C is equipped with screw terminals for connecting up to 16 hard-wired general purpose inputs.

The C2304C and C2305C Omni16/Modbus Output Modules write 16 outputs over Modbus to an Omni16 remote display or annunciator. The C2304C is equipped with a 20 way ribbon header suitable to connect directly to any existing Omni16 remote display or to the Ribbon Header Input Terminal Board fitted to any Omni8/16 annunciator. The C2305C is equipped with screw terminals for connecting up to 16 hard-wired general purpose open collector transistor outputs.

Each module is equipped with a 9 pin D sub-miniature connector to connect the unit to the serial port of the computer/SCADA system. Both RS232 and RS485 are supported.

Each module can act as a MODBUS(Master or Slave), depending on the user selection, device in either ASCII or RTU mode, providing a single data register where the status of the 16 inputs can be read/written.

Each unit is equipped with a single 8 way DIP switch on which the parameters for the Modbus serial port are selected. These parameters include the MODBUS slave address, ASCII/RTU mode, baud rate and parity settings.

Using the modules in RS485 mode, up to 32 of these units may be daisy-chained from a single Modbus Master. In this configuration, up to 512 I/O (ie up to 32 Omni16's) may be monitored/controlled from a single Modbus Master.

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4. C2302/3/4/5C TERMINAL LAYOUT

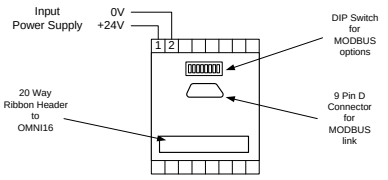


Figure 4.1 Layout of Electrical Terminations forC2302C and C2304C

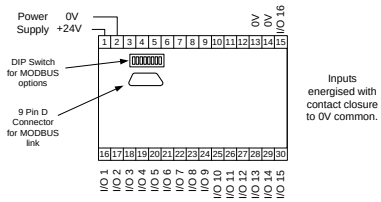
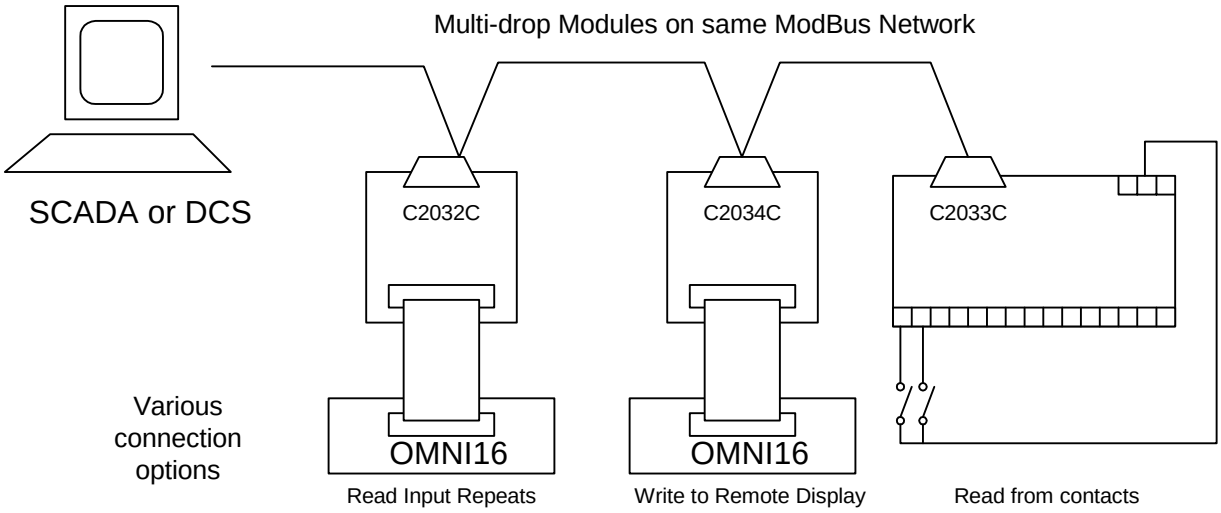


Figure 4.2 Layout of Electrical Terminations forC2303C and C2305C

5. TYPICAL SYSTEM DIAGRAM



Typical System Diagram showing various connection options.

6. C2302/3/4/5C MECHANICAL SPECIFICATIONS

	C2302/4C	C2303/5C
MODULE WIDTH (along DIN Rail)	55mm	100mm
MODULE HEIGHT	75mm	
MODULE DEPTH (away from panel)	110mm	
MOUNTING	35mm x 7.5mm DIN Rail (EN50 022) or wall-mounting.	
TERMINAL WIRE CROSS SECTION	4mm^2 maximum	
HOUSING MATERIAL	Polycarbonate UL 94 V-1	
TERMINAL MATERIAL	Polycarbonate UL 94 V-2	
COLOUR	Light Grey	

7. C2302/3/4/5C - ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE	0 to +60 °C (-13 to 140 °F)
STORAGE TEMPERATURE	-40 to +70 °C (-40 to +158 °F)
HUMIDITY	5% to 95% at 40 °C (104°F) (non-condensing)
VIBRATION	10Hz – 150Hz 1G (9,8m/s^2)
MASS EXCLUDING PACKAGING	To be determined g (oz.)
MASS INCLUDING PACKAGING	To be determined g (oz.)

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8. C2302/3C - ELECTRICAL SPECIFICATIONS

Input Supply Voltage	24Vdc +/- 15%
Power Requirements	To be determined
Input Type	Voltage free contact / Open Collector NPN transistor switch to 0V to turn on inputs
Input High Voltage	> 5Vdc
Input Low Voltage	< 1Vdc
Input Wetting Current	7.5mA max at Supply Voltage = 24Vdc
Input Isolation	None – shares 0V common with 24Vdc supply
Serial Port Isolation	1500Vac between serial port and 24Vdc system.
Memory Storage	Any configuration parameters stored in non-volatile EEPROM

9. C2304/5C - ELECTRICAL SPECIFICATIONS

Input Supply Voltage	24Vdc +/- 15%
Power Requirements	To be determined
Output Type	Open Collector NPN transistor switches to 0V
Maximum Output Current	50mA max
Output Voltage when off	40Vdc max
Output Voltage when on	< 1V at 50mA
Input Isolation	None – shares 0V common with 24Vdc supply
Serial Port Isolation	1500Vac between serial port and 24Vdc system.
Memory Storage	Any configuration parameters stored in non-volatile EEPROM

10. C2302/3/4/5C - SERIAL PORT CONNECTION

Pin	Mode selected	
Number	**RS232**	**RS485**
1	No connection	Rx Data+
2	Rx Data	Rx Data-
3	Tx Data	No connection
4	No connection	Tx Data+
5	Ground	Ground
6	No connection	No connection
7	RTS	No connection
8	CTS	No connection
9	No connection	Tx Data -

11. FRONT PANEL LED STATUS INDICATORS

Diagnostic Indicators (LEDs)	
Module OK (green)	ON = Module healthy FLASHING = Module not operating correctly. OFF = Power Off or Module Faulty
Serial Tx (red)	ON = data is waiting in transmit queue OFF = transmit queue is empty
Serial Rx (amber)	ON = data is waiting in receive queue OFF = receive queue is empty

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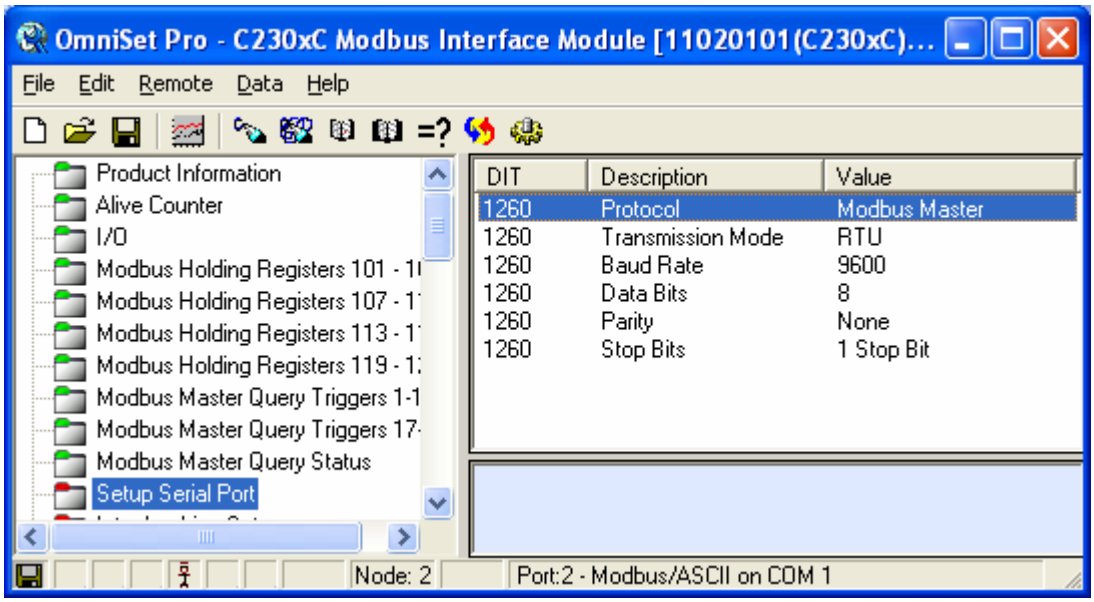
12. MODBUS SERVICES

Transmission Modes	ASCII or RTU Slave Mode
Number of Data Registers	1
Data Register Address	1
Modbus Functions Supported	C2302/4C (Input Module):2, 3, 4 C2303/5C (Output Module): 1,5, 6, 15
Baud Rates Supported	1200 baud 2400 baud 4800 baud 9600 baud
Worst Case Response time	To be determined

13. MODBUS MASTER PROTOCOL

Modbus Master Protocol is not available as a default communications option but is setup through Omniset or Omniset Pro using the "Setup Serial Port" group, including ASCII and RTU mode, Baud Rate, Parity, number of Data bits and Stop bits etc.



Once the protocol selection has been made, it is necessary to configure some general parameters that control the polling regime required in a different group called "Setup Modbus Master Parameters", whereafter the required Modbus Master Queries can be setup for polling Modbus Slave devices.

14. MODBUS MASTER OPERATION EXPLAINED

Introduction to Modbus Master Driver

The Modbus Master Driver supports up to 32 Queries to read and write data from third party devices. These queries can be any combination of One-shot Queries and Cyclic Queries. In order to use the Modbus Master Driver, the serial port must be configured for this use, otherwise none of the Modbus Master configuration changes will take effect. Please refer to Section 13, MODBUS Master Protocol to set up the serial port in this way.

The Modbus Master Driver is extremely flexible to adapt to the many variances found in the Modbus Slave protocols found in third party devices. These variances include query response times and general performance i.e. how often a device can be polled for data. It is possible to adjust the poll rate per query, the delay between queries as well as the delay between the entire polling cycle.

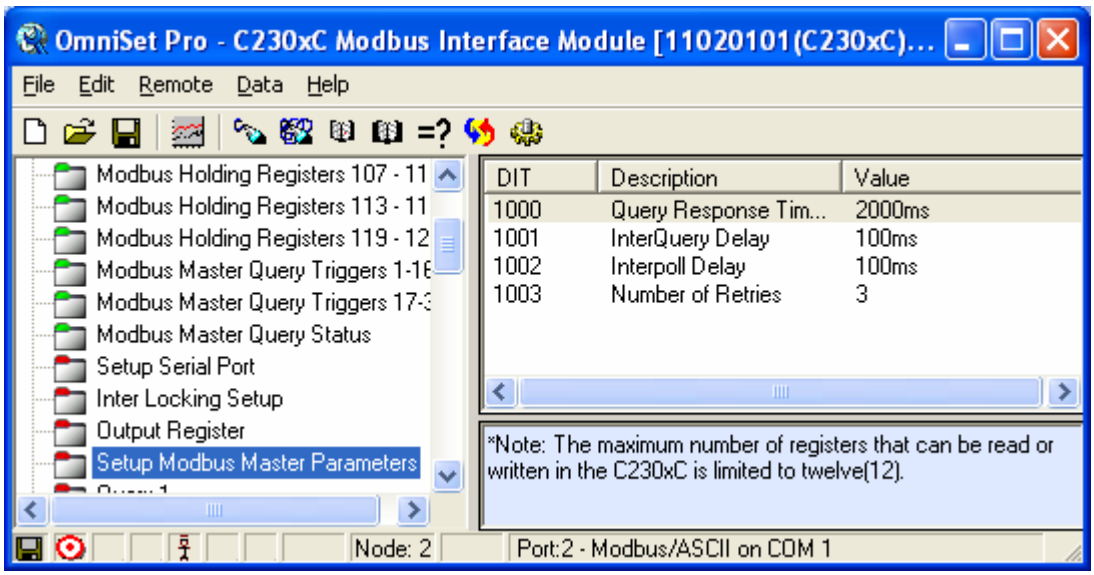
The status of each query is stored in the DIT in bit format, 1 bit for each query, thereby providing open diagnostics to both application program and any remotely connected devices.

How to engage Modbus Master Mode

To configure your Modbus Interface Module for Modbus Master operation, you will first need to connect to the Modbus Interface module in Slave mode(refer to the instruction guide for the relevant Slave settings), then follow the steps below to configure your Modbus Interface Module for Modbus Master operation. Once you configuration has been written to the Modbus Interface Module set all dipswitches to the ON position(refer to the instruction guide) to enable Modbus Master operation.

Modbus Master Parameters

These are some general parameters that control the manner in which queries are processed. They are configured via Omniset using the "Setup Modbus Master Parameters" group as shown below:



Query Response Timeout

When a query has been sent to a slave device, the slave device must respond before this time period. If not, the Modbus Master Driver will assume an error and will either re-transmit the query or flag an error for that device.

The timeout period must be specified in milliseconds. e.g. if a timeout of 2 seconds is required then the timeout must be set to 2000. This parameter is common to one-shot polling.

Number of Retries

When a query has failed i.e. the Modbus Master driver did not receive a reply within the Query Response Timeout period specified, the driver will check the number of retries setup and will re-transmit the query according to the number of retries configured. This feature is extremely useful in overcoming spurious transmission line interference as it allows the driver to recover a lost query before flagging an error. The error is flagged only if all retry attempts have failed.

Inter-query Delay

A delay may be configured if it is necessary to pause between each query to the Modbus Slave devices. The Inter-query delay enables the user to slow down the rate at which the Master polls the Slaves between each query. This is sometimes essential if the Slave device cannot cope with queries sent at full rate.

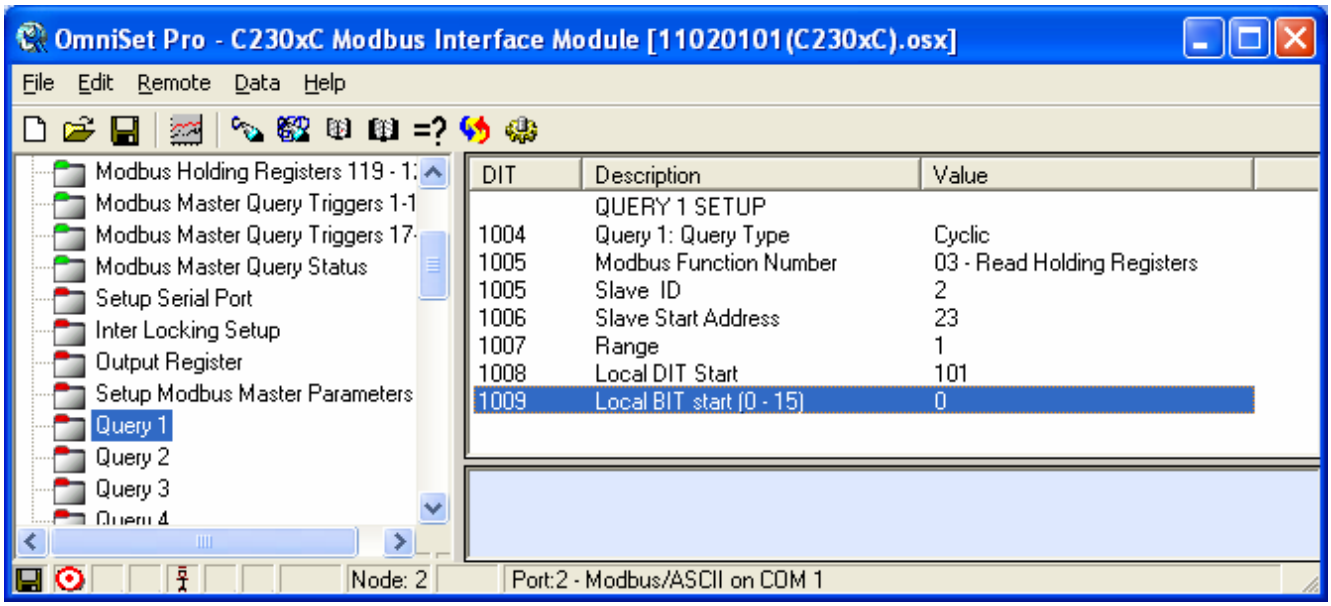
This delay must be specified in milliseconds. E.g. if a delay of 100ms is required then the register must be set to 100.

Inter-poll Delay

After a round of Cyclic and One-shot queries has been completed, a delay may be configured before the next round resumes. This delay is specified in milliseconds. E.g. if a delay of 2 seconds is required then the register must be set to 2000.

Query Configuration

Up to 32 query messages may be configured. These Queries are configured using the "Setup Modbus Master Queries…" group using Omniset. There are four groups, 8 queries per group. The figure below shows the group for queries 1 to 8.



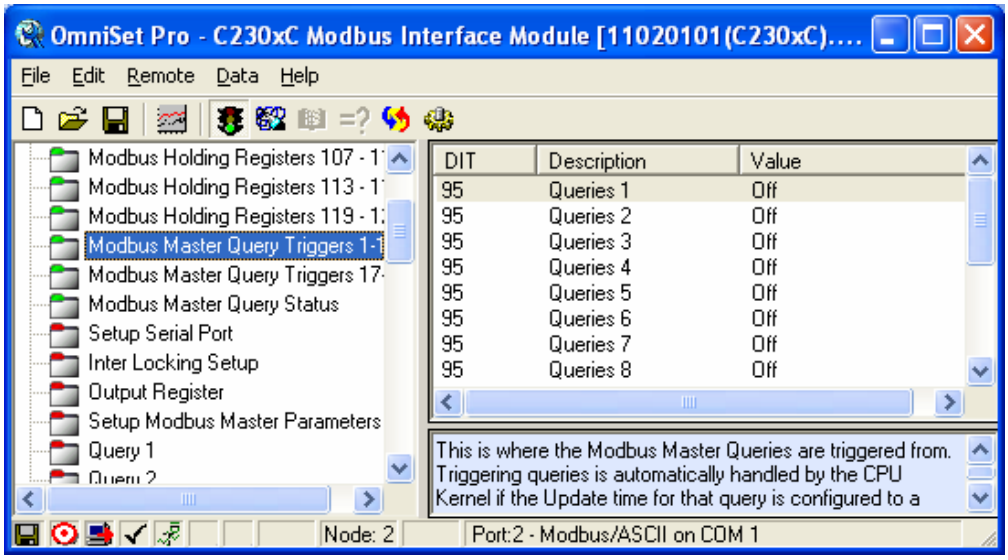
Below is a table of information required to setup Modbus Master Queries

Name	Value(s)	Description
Query Type	Disabled One-shot Cyclic	Set disable to ensure the query is not executed at all. Set One-shot if its to be triggered manually Set Cyclic option for queries to be polled periodically.
Slave ID	1 - 32	The Modbus Slave address to whom this query is sent.
Modbus Function	1, 2, 3, 4, 5, 6, 15 and 16	The Modbus function to be performed needs to be specified here.
Slave Start Address	Any legal address in the slave address map.	Modbus Slave start register address (referenced to zero). E.g. if the desired register address of the Slave started at 30101, then the value entered here would be 100.
Range	1 (5, 6) 1 to 120 (3,4,16) 1 to 480 (1,2,15)	The number of coils/registers read or written. Legal values vary according to the Functions shown in the Value(s) column.
DIT Start register	100 to 1257	Where the Modbus Interface Module must either start retrieving data from or start saving data to in the DIT
DIT Start Bit	0 to 15	The DIT start bit specifies where in the DIT start register the digital functions (1,2,5 and 15) begin accessing the desired bits.

Table 7.1 Modbus Master Query Settings

Query Triggers

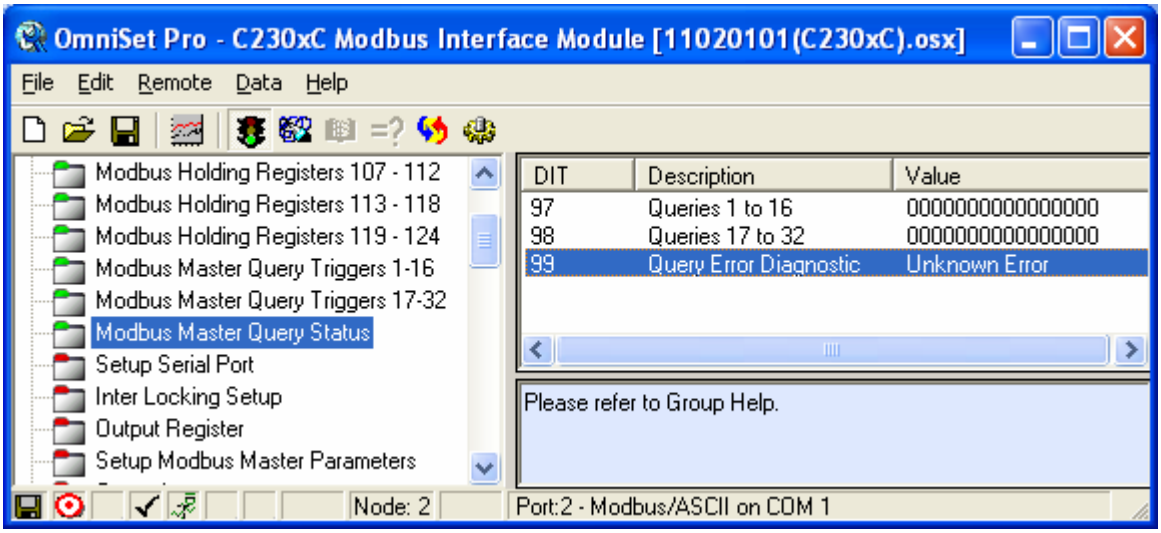
Query Triggers are the mechanism by which all queries are sent. One-shot queries are triggered manually, either by user application or by another device or PC connected to the Modbus Interface Module. Cyclic queries are triggered automatically by the operating system of the Modbus Interface Module. A single bit in the DIT table is allocated per query and when this bit is set, the query is triggered. The query trigger mechanism can be tested by setting the One-shot query bits using the "Modbus Master Query Triggers" group in Omniset.



Please refer to the detailed DIT layout for more information.

Status DIT Registers

Each Modbus query, whether Cyclic or One-shot has a status bit associated with it. This allows the user to quickly debug any problems with a particular query. These status bits are available in the DIT table.



There are a number of error responses for queries that allow accurate diagnosis of query problems. Many of which include the exception responses returned by a Slave device when the query message is received without communication errors but cannot be handled by the Slave device for some reason. This will be reflected in the Query Error Diagnostic register for the Last Failed Query. Refer to the Detailed DIT Layout for the DIT Location of this status register.

The Table below lists the various status codes for any given query.

Status	Description
0	Query Message successful – no errors
1-8	Modbus exception code as returned by Slave device- summary follows: 1 – Illegal Function Code 2 – Illegal Data Address 3 – Illegal Data Value 4 – Slave Device Failure 5 – Acknowledge 6 – Slave Device Busy 7 – Negative Acknowledge 8 – Memory Parity Error in Slave device
1000	Timed out waiting for response
1001	ID in response doesn't match ID in query
1002	Modbus function in response doesn't match function in query
1003	Received different number of coils/registers to what expected
1004	Invalid response to write query (functions 5,6,15 and 16)
65535	Invalid Configuration

Table 14.2 Modbus Master Query Error Codes

15. APPENDIX: MODBUS INTERFACE MODULE DETAILED DIT LAYOUT:

Modbus Interface Module Dynamic Data Area DIT Register Assignment

(DIT Registers 0 – 1257)

DIT Number	Description
0 – 23	**Modbus Interface Module System Information**
0	**Product Code** Unique Number in BCD format that reflects the type of product as follows: 220 – C2302 MIB Ribbon Input Module 221 – C2303 MIB Terminal Input Module 222 – C2304 MIB Ribbon Output Module 223 – C2305 MIB Terminal Output Module
1	**DIT Revision Number** Version Number of the DIT Layout supported by the Modbus Interface Module.
2	**Kernel Version Number** Version number of the Modbus Interface Module Kernel. BCD format.
4-7	**User Tag** User configurable string of DIT registers in ASCII format. The user is able to write up to 8 ASCII characters into these DIT registers (two characters per register) to uniquely identify each Modbus Interface Module.
23	**Alive Counter** Free running counter in the Modbus Interface Module. Useful for communications diagnostics. While this register is incrementing, the Operating System is running. If this register is static, the Modbus Interface Module has halted or communications has failed.
95	**Modbus Master Query Triggers 1 to 16** Set this trigger register only when One Shot Queries are been used. Refer to the 1102xxxx(C230xC).osx file for further information.
96	**Modbus Master Query Triggers 17 to 32** Set this trigger register only when One Shot Queries are been used. Refer to the 1102xxxx(C230xC).osx file for further information.
97 – 98	**Modbus Master Query Status** When a configured Modbus Master query has had a successful poll then the appropriate bit is cleared for that Query. If the Query was unsuccessful or if no queries are configured then the bit will be set .
97	Query 1 to 16 Bit Status
98	Query 17 to 32 Bit Status
99	Query Error Diagnostic Register.

DIT Number	Description
101 – 124	**User Data Area**

Modbus Interface Module Configuration Data Area DIT Register Assignment

(DIT Registers 1000 – 1260)

This DIT area is maintained in the Modbus Interface Module as non-volatile memory. All configuration of Modbus Interface Module functions is therefore implemented here so that configuration is not lost during power down.

DIT Number	Description
1260	**Setup Serial Port** The serial port configuration only applies when Modbus Master mode has been selected after configuration i.e all switches are in the ON position after the Modbus Interface Module has been configured.
1000 – 1003	**Setup Modbus Master Parameters** These registers contain data that allows the Modbus Interface Module to act as a Modbus Master to other Modbus Slave Devices. Upto to 32 Modbus Queries can be configured for this port. ***Note Remember to setup the Serial Port for Modbus Master operation in the Setup Serial Port Group when you require the use of this feature**.
1000	**Query Response Timeout** Enter a value in the range of 0 to 65535ms in this register for the response timeout. This configuration is used to allow the Master to wait for this time for a response from the Slave device. In the event that the Slave device does not reply within this timeout then the Modbus Master engine will flag a Timeout error.
1001	**InterQuery Delay** Enter a value in the range of 0 to 65535ms in this register for the InterQuery delay. This will cause the Modbus Master engine to wait for the specified time before sending the next Query.
1002	**Interpoll Delay** Enter a value in the range of 0 to 65535ms in this register for the Interpoll Delay. This will cause the Modbus Master engine to wait for the specified time before sending the first query.
1003	**Number of Retries** Enter a number in the range of 0 to 65535 in this register for the Number of Retries. This will cause the Modbus Master engine to send the same query for the specified number of retries entered in this register until the Slave responds or the Number of retries for that query has elapsed, before sending the next query.
1004	**Query1 Type**
1005	**Modbus Function Number/Slave ID** *Note: Refer to the 1102xxxx(C230xC).osx file for further information.

DIT Number	Description
1006	**Slave Start Address**
1007	**Range**
1008	**Local DIT Start**
1009	**Local BIT start (0-15)**
1012 – 1017	***Query2 Setup***
1020 – 1025	***Query3 Setup***
1028 – 1033	***Query4 Setup***
1036 – 1041	***Query5 Setup***
1044 – 1049	***Query6 Setup***
1052 – 1057	***Query7 Setup***
1060 – 1065	***Query8 Setup***
1068 – 1073	***Query9 Setup***
1076 – 1081	***Query10 Setup***
1084 – 1089	***Query11 Setup***
1092 – 1097	***Query12 Setup***
1100 – 1105	***Query13 Setup***
1108 – 1113	***Query14 Setup***
1116 – 1121	***Query15 Setup***
1124 – 1129	***Query16 Setup***
1132 – 1137	***Query17 Setup***
1140 – 1145	***Query18 Setup***
1148 - 1153	***Query19 Setup***
1156 - 1161	***Query20 Setup***
1164 – 1169	***Query21 Setup***
1172 – 1177	***Query22 Setup***
1180 – 1185	***Query23 Setup***
1188 – 1193	***Query24 Setup***
1196 – 1201	***Query25 Setup***
1204 – 1209	***Query26 Setup***
1212 – 1217	***Query27 Setup***
1220 – 1225	***Query28 Setup***
1228 - 1233	***Query29 Setup***

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DIT Number	Description
1236 – 1241	***Query30 Setup***
1244 – 1249	***Query31 Setup***
1252 – 1257	***Query32 Setup***

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