MODBUS/DeviceNet Master Software Development Guide

For Network Programmable
Model 777-P2, CIO-DN-P, CIO-120-DN-P

PG-777P2-MBDN-B

TABLE OF CONTENTS

INTRODUCTION

This guide is addressed to systems integrators who will be developing software for a master device to communicate with the Model 777-P2[1] family of products.

The master device would typically be a Programmable Logic Controller (PLC) or a Personal Computer (PC) that will communicate with one or more slave devices. A PLC normally would have the command protocols and Cyclic Redundancy Check (CRC) word calculation routines built into it, so the programmer would not have to develop them. If programming a Personal Computer, these would have to be developed.

If programming a PC, it may be worth noting that it is the responsibility of the master controller to initiate communication. In other words, the master controller must be programmed to periodically poll the slave devices and initiate a request for data or to issue a command to the Model 777-P2 to stop or reset the Model 777-P2's control relay. When the Model 777-P2 responds with the requested data or confirmation of the stop command, it is the responsibility of the master controller to determine if the information arrived correctly with no communication errors. If there are communication errors or if there is a time-out waiting for a response, it is the responsibility of the master controller to reissue the command to the slave device. If the response arrives correctly, the master controller is then required to further process the data to put it in a form suitable for viewing by an operator.

DEFINITIONS AND SETPOINTS

The following sections contain brief descriptions of the types of runtime information and setpoints available. Additional information and default settings may be found in the tables later in this document.

Identity Information
The identity information is used to identify the firmware, current range and voltage range of the device.

- Major/minor software revision
- Product code

Measurements
The overload measures the following electrical parameters:

Line Voltage
Line voltages are sent over the network as volts.

- Voltage from L1 to L2
- Voltage from L2 to L3
- Voltage from L3 to L1
- Average voltage

Phase currents
Phase currents are sent over the network as actual amps x current scale factor.

- Current in phase A
- Current in phase B
- Current in phase C
- Average current

Power factor angle
Power factor measurements are sent over the network as degrees.

Kilowatts
Kilowatt measurements are sent over the network as actual kilowatts x 100.

Ground fault current
Ground fault current measurements are sent over the network as actual ground fault current x GF scale factor.

Current unbalance
Current unbalance measurements are sent over the network as percent.

Voltage unbalance
Voltage unbalance measurements are sent over the network as percent.

Frequency
Frequency measurements are a measurement of the electrical frequency present on the voltage input terminals, these measurements are sent over the network as frequency x 10.

Thermal capacity remaining
This measurement is the relative amount of temperature rise of the motor due to an overcurrent condition. This parameter is sent over the network as a percentage which decreases from 100% to 0 as the relative motor temperature rises.

[1] Model 777-P2 may refer to any of the 777-P2 series of products

Faults and Trips

Over load status bits
These bits are used to determine the status of the control relay and if there are any pending faults, pending faults will clear after the unit trips.

Trip reason bits
These bits are used to determine the reason that the Model 777-P2 tripped.

Enable/disable bits
This parameter allows the user to disable, a value of 0, a trip feature without changing the setpoint of that trip. In this register there are eight bits to control individual trip parameters. If a trip is disabled with this register, the front panel will show the disabled value for that setpoint even though the value of the setpoint is preserved. If the trip setpoint is disabled from the front panel and the user enables the trip with this register, the enable will have no effect, and the trip will still be disabled.

Voltage Hold-Off/Voltage Fault Enable
This register allows the user to configure the device to hold off or allow the relay to energize for specific voltage faults.

Overcurrent (OC)
An OC condition is present when any phase current is greater than or equal to the OC setpoint.

overcurrent setpoint
This parameter is sent over the network as actual amps x current scale factor. When OC trip is disabled from the network, oFF will be displayed on OC setpoint.

trip class (TC) setpoint
This parameter is used to set the NEMA trip class for the motor that is being protected. This parameter is the time to trip on OC if the maximum phase current is equal to the 600% of the OC setpoint. The trip time is 90% of the TC setpoint without a J prefix.

linear OC trip delay
This parameter controls the trip time for an overcurrent condition. If any phase current is greater than or equal to the overcurrent setpoint for the duration set by this parameter, the device will trip on overcurrent. A setting of 255 will turn this feature off.

hot overcurrent percentage
This percentage is used to decrease the trip time for a hot motor. One minute after starting, the hot overcurrent feature will reduce the trip time of overcurrent by the percentage set in the hot overcurrent percentage parameter.

Stall/Jam
Jam condition occurs when any measured phase current is greater than or equal to 400% of the OC setpoint. The jam condition is ignored one minute after motor start. If a jam condition exists, the Model 777-P2 will de-energize the control relay in two seconds.

The jam feature is enabled by setting the TC parameter to trip class with a J prefix. Enabling jam from the network is done by selecting a value between 128 and 255.

The Model 777-P2 also provides two independent jam/stall trips. The following parameters are used to control this feature:

Stall 1/ Stall 2 Percentage
This parameter sets the current threshold for the jam/stall condition. A jam/stall condition exists if any phase current is greater than or equal to the Jam/Stall percentage x OC setpoint. This parameter is sent over the network as a percentage.

Stall 1/ Stall 2 Trip Delay
This parameter is the time that the jam/stall condition must be present before the Model 777-P2 trips on overcurrent. This parameter is sent over the network in half-second increments.

Stall 1/ Stall 2 Inhibit Delay
This parameter is the amount of time that the Jam/Stall feature is inactive after a motor start. This parameter is sent over the network in half-second increments.

Stall 1/ Stall 2 enable
These features are enabled by setting bits 10 and 11 of configuration control (cfgCtrl) parameter.

Undercurrent (UC)
An undercurrent condition is present if the average current is less than or equal to the undercurrent setpoint. The overload relay will trip if this condition exists for the duration of the undercurrent trip setpoint.

undercurrent setpoint
This parameter is sent over the network as actual amps x current scale factor. If this parameter is set to ‘0’, the undercurrent trip feature is disabled.

undercurrent trip delay setpoint
This parameter is the time that the UC condition must be present before the Model 777-P2 will trip. This parameter is sent over the network as seconds.

Current unbalance (CUB)
A current unbalance condition is present if the incoming currents are more than a certain percentage out of balance. The default curve is given below, but the user can change the curve by adjusting the CUBTD.

current unbalance setpoint
A CUB condition exists if the measured CUB is greater than or equal to the CUB setpoint. This parameter is sent over the network as percentage. Setting this parameter to 255 will disable the current unbalance trip feature.

% of CUB setpoint	Trip Time
100%	30 seconds
101%	15 seconds
102%	10 seconds
103%	7.5 seconds
104%	6 seconds
105%	5 seconds
106%	4 seconds
110%	2 seconds
115%	2 seconds

Table 1 - CUB Trip Time, CUBTD=60

current unbalance trip delay
This parameter is used with the following equations to set the CUB trip time:

CUBTT (seconds) = (CUBTD/(CUBM-(CUBSP-1))) / 2
CUBTD = (CUBTT x 2) x (CUBM-(CUBSP-1))

CUBTT = current unbalance trip delay in seconds
CUBTD = current unbalance trip delay setpoint
CUBM = current unbalance measured
CUBSP = current unbalance setpoint

Low Power (LPR)
A low power condition exists if the load is less than the LPR setpoint. This parameter is enabled or disabled via the network via the Trip Enable bits.

High Power (HPR)
A high power condition exists if the load is greater than the HPR setpoint. This parameter is enabled or disabled via the network via the Trip Enable bits.

Ground fault (GF)
A GF condition is present, if the measured GF current is greater than or equal to the GF setpoint.

ground fault setpoint
Setting this parameter to 65535 will turn the GF feature off. This parameter is sent over the network as actual amps x GF scale factor. The ground fault trip delay is show in Table 2 below:

Ground Fault Reading (as Percentage of Setpoint)	Trip Time
101% - 200%	8 seconds ± 1 second
201% - 300%	4 seconds ± 1 second
301% - 400%	3 seconds ± 1 second
401% or Greater	2 seconds ± 1 second

Table 2 - GF Trip Delay Time

ground fault trip delay
A GF trip will occur, if a ground fault condition is present for the time period set by this parameter. This parameter is sent over the network as seconds. The ground fault trip curve can be altered by writing to the GF trip delay location, 1x,2x,3x,4x above setpoint GF Trip Time = (GFTD/Xfactor) * 0.5 Seconds.

ground fault inhibit delay
This parameter is the amount of time that the GF feature is inactive after a motor start. This parameter is sent over the network in half-second increments.

Current Single Phase (cSP)
A current single-phase condition occurs, if the measured CUB is greater than or equal to 50%. Setting the CUB setpoint to 255 will disable this feature.

Voltage Unbalance (VUB)
A VUB condition exists when the measured VUB is greater than or equal to the VUB setpoint.

voltage unbalance setpoint
The Model 777-P2 will not trip on VUB if the motor is running. Setting this value to 255 will disable this trip. This parameter is sent over the network as percentage.

voltage single phase (vSP)
A vSP condition exists when the measured VUB is greater than or equal to 25%.

Contact Failure (CF)
A CF condition occurs if there is a CUB condition present, but no VUB condition. Setting the CUB setpoint to 255 will disable this feature.

High Voltage Setpoint (HV)
A HV condition exists when the measured average voltage is greater than or equal to the HV setpoint. The Model 777-P2 will not trip on HV if the motor is running. This parameter is sent over the network as volts.

Low Voltage Setpoint (LV)
A LV condition exists when the measured average voltage is less than or equal to the LV setpoint. The Model 777-P2 will not trip on LV if the motor is running. This parameter is sent over the network as volts.

Reverse Phase (RP)
A RP condition exists when the phase rotation on L1, L2, and L3 is not in A, B, C sequence. The direction of phase that keeps the relay from energizing can be set by bit 12 of the cfgCtrl setpoint. The Model 777-P2 will not trip on RP if the motor is running.

Low Control Voltage (cLO)
A cLO condition exists if the measured average voltage is less than or equal to the LV setpoint x LCV percentage.

low control voltage percentage
This parameter is sent over the network in percentage.

low control voltage trip delay
A cLO trip will occur if a cLO condition is present for the time period set by this parameter. This parameter is sent over the network in seconds.

Trip Inhibit
This feature will allow the user to inhibit the Model 777-P2 from tripping on specific faults. By writing the correct mask to this location the Model 777-P2 will ignore tripping on the fault as long as the mask is written as 1s. The mask is cleared every 0.5 seconds, so the user must continually write the mask for the fault to be inhibited. Note that each trip counter for the inhibited fault is cleared, so all trip delays start from the beginning once the user has stopped writing the inhibit register.

Warnings

Global Warning
Global warning is an OLSTAT bit. The global warning bit is enabled when any one or more of the warning status bits are “high”.

Warning enable bits
This parameter can be used to enable/disable each individual warning. Setting these bits to ‘1’ will enable the warnings.

Warning status bits
This parameter shows the status of each warning. If the bit is a ‘1’ the warning is present, if the bit is ‘0’ there is no warning. The warning delay must be satisfied before the warning bit will change state. High and low frequency warnings do not have warning delay parameters.

warning level – low voltage
A LV warning condition exists if the measured average voltage is less than or equal to the LV warning level.

warning level – high voltage
A HV warning condition exists if the measured average voltage is greater than or equal to the HV warning level.

warning level – voltage unbalance
A VUB warning condition exists if the measured VUB is greater than or equal to the VUB warning level.

warning level – overcurrent
An OC warning condition exists if any measured phase current is greater than or equal to the OC warning level.

warning level – undercurrent
An UC warning condition exists if the measured average current is less than or equal to the UC warning level.

warning level – current unbalance
A CUB warning condition exists if any measured CUB is greater than or equal to the CUB warning level.

warning level – ground fault
A GF warning condition exists if the measured GF current is greater than or equal to the GF warning level.

warning level – high frequency (HF)
A HF warning condition exists if the measured frequency is greater than or equal to the HF warning level.

warning level – low frequency (LF)
A LF warning condition exists if the measured frequency is less than or equal to the LF warning level.

warning level – high power (HPR)
A HPR warning condition exists if the measured power is greater than or equal to the HPR warning level.

warning level – low power (LPR)
A LPR warning condition exists if the measured power is less than or equal to the LPR warning level.

Warning delays
These registers are used to delay the change of state of the warning status register. The units on the warning delay parameters are half-seconds. For example, a setting of 113 is a 56.5 second delay. The following warnings have a warning delay register:

- low voltage
- high voltage
- voltage unbalance
- overcurrent
- undercurrent
- current unbalance
- ground fault
- high power
- low power

Motor acceleration control
These bits are used to enable/disable trip conditions during the motor acceleration period. The following trip conditions can be disabled for the motor acceleration time:

- contact failure
- undercurrent/low power
- ground fault
- current unbalance
- current single phase
- high KW (when enabled)
- low control voltage

Motor acceleration trip delay
If a motor acceleration control bit is enabled, the Model 777-P2 will ignore tripping on selected faults during the motor acceleration trip delay time. The normal trip delay for a fault applies if the fault is still present or occurs after the motor acceleration trip delay has expired. This parameter is sent over the network in half-seconds.

Fault/Start history
Up to four run durations and the number of starts are recorded in ten registers These registers are a rolling set where the most recent fault is stored in Run Duration 1 (lower byte) and the oldest fault is stored in Run Duration 4 (lower byte). Start count is stored in Start count (upper byte).

- Run duration 1
- Run duration 2
- Run duration 3
- Run duration 4

These registers are writable, but will only accept a value of '0'. If any register is written to '0', all registers will be reset to '0'.

Ten registers are used to store the last ten faults. These registers are a rolling set where the most recent fault is stored in Last Fault and the oldest fault is stored in Last fault 10.

- Last Fault
- Second to last fault
- Third to last fault
- Fourth to last fault
- Last Fault 5

- Last Fault 6
- Last Fault 7
- Last Fault 8
- Last Fault 9
- Last Fault 10

Start count
This parameter keeps a running count of motor starts.

Motor run hours
This parameter is the total run hours of the motor. This register is writable, but will only accept a value of '0'. Writing '0' to this register will clear the motor run hours.

Restarts
The restart delays can be set and displayed in either minutes or seconds depending on cfgCtrl Setpoint.

The following faults always require a manual reset:
- Ground fault
- Contact failure

Restart delay 1 (RD1)
The following conditions will use the RD1 timer to restart:
- Low control voltage fault
- Motor stop, can be disabled in cfgCtrl
- Power up, can be disabled in cfgCtrl

restart delay 1 setpoint
This parameter sets the time for RD1. A setting of zero disables RD1 for all three of the above conditions.

Restart delay 2 (RD2)
The following conditions will use the RD2 timer to restart:
- OC fault (If OC is included in #RF)
- CUB fault
- cSP fault
- HPR
- cLO

restart delay 2 setpoint
This parameter sets the time for RD2.

Restart delay 3 (RD3)
The following condition will use the RD3 timer to restart:
- UC fault
- Low Power fault

restart delay 3 setpoint
This parameter sets the time for RD3.

The Automatic Dry-Well Recovery Calculator
The feature allows the Model 777-P2 to automatically select a restart delay based on the run time of the last run cycle. Table 3 shows the next restart delay vs. run time. In general, a longer run time produces a shorter restart delay. Setting RD3 to 65535 will enable this feature.

Run Time	Next Restart Delay (minutes)	Starts/Hr
> 1Hr	6	10
30 min.- 59.99 min.	15	4
15 min.- 29.99 min.	30	2
< 15 min.	60	1

Table 3 - Auto Dry-well Recovery Times

Remaining RD time
These parameters report the time remaining on the RD1, RD2, and RD3 timers and are sent over the network in either seconds x 2 or minutes x 120 depending on the cfgCtrl settings.

#RU setpoint
This parameter is the number of restarts that are allowed after UC or Low Power fault before the Model 777-P2 will lock out on manual reset. The running reset count will be set to '0' after a minute of running. If this parameter is set to 255 the Model 777-P2 will restart indefinitely.

#RF setpoint
This parameter is the number of restarts that are allowed after faults that are not listed in #RU before the Model 777-P2 will lock out on manual reset. The running reset count will be set to 0 after a minute of running. If this parameter is set to 10 or 11 the Model 777-P2 will restart indefinitely. The following faults are checked with this feature:

- Overcurrent (only if #RF = 3, 57,9,11 or the display is set to have an 'oc' prefix)
- Current single phase
- Current unbalance
- Low control voltage
- High power

Scaling Factors

Current Multiplier Setpoint
The Current Multiplier (MULT) is a read/write single byte value at location 0x67 which can be interpreted as an integer with a value 1 to 255 decimal. This value is multiplied by actual measured current and will affect the reported A, B, C phase currents and the GF current.

Current Divisor Setpoint
The Current Divisor (Div) is a read/write single byte value at location 0x66 which can be interpreted as an integer with a value 1 to 255 decimal. The actual measured current is divided by this value and will affect the reported A, B, C phase currents and the GF current.

When the user sets the MULT Setpoint from the front panel, the valid range is 1-10, 100,150,200,300,400,500,600,700,800. This setpoint is not directly changeable from the network; however Multiplier and Divisor parameters are used to set MULT from the network. As a general rule when setting multiplier and divisor parameters, the multiplier is equal to the CT ratio and the divisor is equal to the number of passes through the 777-P2 windows; *see 777-P2 Installation Instructions*). Note: the display will not necessarily show the values of the Multiplier and Divisor parameters.

Together MULT and Div should represent the external wiring of the device. For example the 777-P2 is set up with 150:5 CTs with 5 passes of the CT secondary wires through the round holes. The user would then set up the unit as follows:

MULT= (150/5) =30
Div=5 passes

The 777 will now read 150A when 150A are running through the primary of the external CT.

Current Scale Factor
The value is used to scale OC, UC and real-time currents. Scale factor is automatically selected based on the model identified and can be read at runtime 0x04.

Example:
The user is configuring a Model 777-P2
Actual Current = Raw Current / Scale Factor
1.8A = 18A / 10

Ground Fault Current Scale Factor
Intended for use with the 777-LR-HRG-P2 for greater sensitivity reading for the zero sequence CT; can be written to 1, 10, 100, or 1000. This register is used to scale ground fault readings, and trip/warning setpoints.

Command line
The command lines are used to control the operation of the Model 777-P2. The following commands can be sent:

Enable network programming
This command will enable network programming of the Model 777-P2 parameters.

Disable network programming
This command will disable network programming of the Model 777-P2 parameters.

Clear motor run hours
This command will set the motor run hour count to '0'.

Clear last fault
This command will set the last fault parameter to Clr.

Enable network watchdog timer
This command will enable the network watchdog. The network watchdog feature will de-energize the Model 777-P2 fault relay after ten seconds of no network communications.

Disable network watchdog timer
This command will disable the network watchdog.

Reset Command
This command will attempt to reset the Model 777-P2 fault relay. If voltage faults are present, the fault relay will not energize when this command is sent.

Off Command
De-energize the Model 777-P2 fault relay, and displays oFF on screen.

Configuration/Control
This section describes cfgCtrl control bits not already addressed in their related sections. See **Faults, Restarts** and **Jam/Stall** for additional information.

Single-phase voltage device
Setting bit 6 of configuration control setpoint will configure the device for single-phase voltage systems. The following applies:

- Voltage unbalance and voltage single-phase protection disabled.
- Reverse-phase protection disabled
- Contact failure trip disabled

Single-phase current device
Setting bit 7 of configuration control setpoint will configure the device for single-phase current systems. The following applies:

- Measured current average calculated as (A+B+C)/2
- Contact failure trip disabled
- Ground fault trip disabled
- Current unbalance and current single-phase trip disabled

If both single-phase current and single-phase voltage bits are set, the product will also calculate power as measured average voltage x measured average current x power factor angle.

Zero L3-L2 Voltages
When enabled, L3 and L2 voltages are zeroed.

Emergency Run
When enabled, pressing the reset button during a fault or bad voltage condition shall energize the relay after a 4-second delay. The display will flash “o r” and the relay shall remain energized as long as the button is pressed.

Network Settings

Modbus device address setpoint
This parameter is the primary Modbus device address of the Model 777-P2.

Communication parameters bits
These bits set the Model 777-P2 communication format. The Model 777-P2 supports the following formats:

C00 = 9600,N,1 9600 baud, No parity, and 1 stop bit (duplicated for compatibility)
C01 = 9600,O,1 9600 baud, Odd parity, and 1 stop bit
C02 = 9600,N,1 9600 baud, No parity, and 1 stop bit
C03 = 9600,E,1 9600 baud, Even parity, and 1 stop bit
C04 = 19200,N,1 19200 baud, No parity, and 1 stop bit (duplicated for compatibility)
C05 = 19200,O,1 19200 baud, Odd parity, and 1 stop bit
C06 = 19200,N,1 19200 baud, No parity, and 1 stop bit
C07 = 19200,E,1 19200 baud, Even parity, and 1 stop bit

Network status bits
This parameter is used to enable/disable the Network Watchdog, Network Programming and Front Panel Programming features of the Model 777-P2.

Modbus back door address
This parameter is the secondary Modbus device address of the Model 777-P2.

Network and Local Command Differences

The Model 777-xxx-KW/HP-P2 allows setting LP and PWS parameters from the front panel. UC and UCTD can only be set over a network. Users programming the device by hand should reference the *Installation Instructions* for available options.

MODBUS[2] CONFIGURATION

MODBUS Protocol on an RS-485 Network

The Model 777-P2 uses the MODBUS protocol in Remote Terminal Unit (RTU) mode to receive commands and send information as a slave device on an RS-485 network. The RTU mode essentially means that the characters sent between the master and slave devices are binary numbers, not ASCII digits.

RS-485 uses a differential voltage signal to represent the zeros and ones. The RS-485 standard allows a single network to contain up to 4000 feet of shielded twisted-pair network cable when used with an isolated power supply. The cable only needs to be 22 or 24 gauge to transmit 4000 feet at 9600 baud. Refer to SymCom's *Installation Instructions* for the communications module for more information.

The MODBUS standard allows up to 255 devices on a single network, but the address restrictions of the Model 777-P2 allow only 99 different addresses. In a practical sense, it is difficult to scan more than 20 or 30 devices in a timely manner.

Model RS485MS-2W Communication Module

The Model RS485MS-2W communications module serves two very important functions. The module galvanically isolates the communications network from the high voltages present in the Model 777-P2 and also converts the communications signals from the microcontroller's 5 volt levels into RS-485 levels. The Model RS485MS-2W also provides a power source for a remotely mounted Model RM-1000.

NOTE: Model RS485MS-2W only supports Modbus RTU.

Model CIO MODBUS Communications Modules

The CIO modules also serve to isolate the communications network from high voltages in the 777-P2. The CIO MODBUS modules shall assume the address of the 777-P2. In addition, the modules support limited commands and provide four (4) digital inputs and two (2) AC/DC rated relay outputs.

Note: Selected models support Modbus TCP.

Additional Information

NOTE: Each Model 777-P2 requires a communication module to connect to the RS-485 network. It is important to recognize that the nine-pin connector on the Model 777-P2 is NOT an RS-232 connector! A converter is required to change the RS-485 signal to RS-232.

The Model 777-P2 is connected to high AC voltages with a floating ground circuit. As long as there are three balanced line voltages present, the resulting ground level will often be near case ground. However, if one phase is lost or if the line voltages become unbalanced, the floating ground may be as much as 480 volts above the case ground. The communication module has two high speed optical isolation chips on the Receive and Transmit pins and a low speed opto-isolator on the Transmit/Receive pin to isolate the communication network from the AC line voltages. In addition, a separate isolated power supply system provides power for the transceiver used for RS-485 level conversion.

IMPORTANT

DO NOT PLUG A MODEM OR ANY OTHER PC-COMPATIBLE SERIAL DEVICE INTO THE 9-PIN CONNECTOR OF THE PRODUCT!

Master Device I/O Port

Your MODBUS master device should have an RS-485 port. If your master device only has RS-232 ports, an RS-232 to RS-485 converter will be required. Before ordering a converter, you may need to know if you can program your master device to independently control the RTS (Request-To-Send) line. Some RS-232 to RS-485 converters use the RS-232 signal called RTS to turn on the RS-485 lines before transmitting a command. If your master device cannot control the RTS line, you will need to order an RS-232 to RS-485 converter that automatically turns on the RS-485 line whenever a command is being written.

Communication Parameters

See **Configuration/Control.**

Bench Testing Communications

The battery programming cable cannot be used for remote programming. Minimum operating voltage for the device must be used to test the communications with the Model RS485MS-2W connected. If you only have 120 volt power available, you may need to use a 2:1 step up transformer to supply 240VAC to conduct the communications test. For instructions on configuring 777-P and earlier 777 models refer to the 777-P *Programming Guide* and *Installation Instructions*.

Note that the Model 777-P2 will not start with only L1 and L2 connected, but you can read the voltage registers to test the communications.

[2] MODBUS in this document may refer to MODBUS/TCP and/or MODBUS/RTU.

MODBUS Memory and Data Location Terminology / Register vs. Address

The MODBUS standard defines a memory location in terms of registers and addresses. The "register" numbering system starts Xxxxxx1 and goes up to X65536, where the leading X is a reference number that designates a register type. The "address" numbering system starts at 0 rather than 1 and does not contain a prefix. The prefix indicates which read and write functions should be used to get or set the corresponding location. The Modicon MODBUS Protocol Reference Guide refers to these XX references, such as 4X reference for holding registers. However, the MODBUS standard that can be found at **www.MODBUS-ida.org** does not use these "references".

Older standards and products tend to use a 5-digit numbering system for registers. (Ex: 40,001 for the first holding register) However, other documentation is written using a 6-digit numbering system; MODBUS supports registers up to 65536. (Ex: 400,001 for the first holding register).

The "address" numbering system is defined in the standard to describe the message that is actually sent to the physical communications bus. By starting the addresses at 0 rather than 1 and by truncating the register type prefix or reference, the number of usable memory or data locations is maximized. This document will use the terms "address" and "location" interchangeably to refer to the actual address placed on the bus to get the intended piece of data.

Supported MODBUS Message Function Codes

The following four function codes are supported. The 03 Read and 04 Read functions can be used on any register. Broadcast is not supported.

1. **INSTRUCTION CODE 03 Read Holding Registers**: Block read
2. **INSTRUCTION CODE 04 Read Input Registers**: Block read
3. **INSTRUCTION CODE 06 Preset Single Register**: Write one value
4. **INSTRUCTION CODE 16 (0x10) Preset Multiple Registers**: Write message; supports a register quantity of 1

Read Command Example

A typical request for a Model 777-P2 would be to ask for the 4 voltages starting at address 23, or 17 hexadecimal, which are the Voltage in Phase C-A, the Voltage in Phase B-C, the Voltage in Phase A-B, and the Average Voltage. In the example below, the values will be returned as 481, 476, 483 and 480 volts for these variables.

Assume that the Model 777-P2 has been programmed with a device address of A02. The MODBUS command message from the master device to a slave device would look like:

Byte	Contents	Example (in Hex)	
1	Address of Slave Device	02	
2	Command to Slave Device	03	
3	High Byte of Address	00	(Address of VCA)
4	Low Byte of Address	17	
5	High Byte of Number of Words	00	(Read 4 words)
6	Low Byte of Number of Words	04	
7	LOW Byte of CRC word	34	
8	HIGH Byte of CRC word	32	

The above sequence would be a request to read 4 words (8 bytes) starting at address 43. The normal response from the slave device to the master device would look something like:

Byte	Contents	Example (in Hex)	
1	Address of Slave Device	02	
2	Echo of Command to Slave Device	03	
3	Number of Bytes sent back	08	
4	High Byte of Word at 0017	01	(VCA = 481)
5	Low Byte of Word at 0017	E1	
6	High Byte of Word at 0018	01	(VBC = 476)
7	Low Byte of Word at 0018	DC	
8	High Byte of Word at 0019	01	(VAB = 483)
9	Low Byte of Word at 0019	E3	
10	High Byte of Word at 001A	01	(VAVG = 480)
11	Low Byte of Word at 001A	E0	
12	LOW Byte of CRC word	8A	
13	HIGH Byte of CRC word	41	

The voltage values listed would be values that might be expected from a 480 volt system.

***Note*:** The CRC (Cyclic Redundancy Check) word is sent with the Low byte first followed by the High byte.

The CRC bytes are sent in a different order from the order of the Address and Number-Of-Words-To-Send words. The Address and Number-Of-Words-To-Send words are sent with the high byte first followed by the low byte.

Write Command Example

NOTE: "Reserved" bits setpoints should be maintained as 0.

If a Model 777-P2 has been programmed with a device address of A01, the command to turn off the relay would be:

Byte	Contents	Example (in Hex)	
1	Address of Slave Device	01	
2	Command to Slave Device	06	
3	High Byte of Address	00	(Address of COMLINE)
4	Low Byte of Address	64	
5	High Byte of Value to write	00	(Sending STOP command)
6	Low Byte of Value to write	DD	
7	LOW Byte of CRC word	08	
8	HIGH Byte of CRC word	4C	

The above sequence would be a request to write 1 byte starting at address 100, or 64 hexadecimal, which is the address of the command word, COMLINE. Refer to Appendix A for more information about Model 777-P2 commands. The normal response from the Model 777-P2 is to echo the same byte sequence back to the master device. This is a confirmation that the command was carried out.

CRC Testing

If you need to test your CRC calculations, you can generate a STOP command exactly like the one above and compare the CRC bytes that your program generates with the CRC bytes listed above. If you set the Model 777-P2's address to A01 and send the above string, the Model 777-P2 should turn off its relay and the display should show "oFF". If the first six bytes are exactly like the above sequence, the Model 777-P2 will ONLY respond correctly if the CRC bytes are also exactly like the above sequence. If the Model 777-P2 receives any other CRC bytes, it will assume a communication error occurred and will NOT turn off its relay.

NOTE: If you are using an oscilloscope to capture the sequence of bits that are being transmitted, note that MODBUS RTU specifies that the LEAST significant bit of each byte is transmitted first. Thus, for the sequence above, you would see a Start bit, followed by a high, then low, low, low, then low, low, low, low, followed by the Parity and Stop bits for the first byte (01 hex) sent.

Similarly, the command to reset the same Model 777-P2 would be:

Byte	Contents	Example (in Hex)	
1	Address of Slave Device	01	
2	Command to Slave Device	06	
3	High Byte of Address	00	(Address of COMLINE)
4	Low Byte of Address	64	
5	High Byte of Value to write	00	(Sending RESET command)
6	Low Byte of Value to write	AA	
7	LOW Byte of CRC word	48	
8	HIGH Byte of CRC word	6A	

Again, note the CRC bytes. These STOP and RESET command examples are excellent test commands to verify CRC calculations and communication problems since the only thing that will change in a particular installation is the address of the Model 777-P2 and, of course, the CRC bytes. For example, if the Model 777-P2 has been programmed with device address A11, then the series of bytes would be:

Byte	Contents		Example (in Hex)
1	Address of Slave Device	0B	
2	Command to Slave Device	06	
3	High Byte of Address	00	(Address of COMLINE)
4	Low Byte of Address	64	
5	High Byte of Value to write	00	(Sending RESET command)
6	Low Byte of Value to write	AA	
7	LOW Byte of CRC word	48	
8	HIGH Byte of CRC word	C0	

Notice that in this example, only the Address of the Model 777-P2 and the CRC bytes have changed from the series of bytes sent to the Model 777-P2 at device address A01.

Special Notes When Using the 4X Addresses

Some software packages, such as Human-Machine-Interface (HMI) software packages for PLCs, can only use registers from 400001 to 465536 in the MODBUS 03 and 06 commands.

If this is the case, add 400001 to the hexadecimal addresses in the tables to select the start of the data to read. Many of these software packages will automatically subtract the 400001 part of the address before sending the actual address in the MODBUS command.

777-P2 MODBUS MEMORY MAP

The 777-P2 uses a 16-bit memory map; all setpoints and real-time values will be read and written as 2 byte numbers. See the table below for address and bit details.

NOTE: "Reserved" bit setpoints should be maintained as 0.

The 777-xxx-P2 supports the legacy memory map that contains both 16 bit and 8 bit parameters. Because of this difference when reading OC, UC, GF setpoint from the legacy memory map, in some cases the values will not match the front panel display. This is caused by rounding by converting from an 8-bit memory map to a 16-bit memory map. All trip conditions are based on what is displayed on the front panel.

Table 4-Run Time Information (777-P2)

DeviceNet C,I,A	16 Bit Modbus Address		Code and Description	Notes
	Hex	Dec		
29,01,A7	0x01	40002	Major: Minor Software Revision	
			777-P2	0xrr04
			777-HVR-P2	0xrr27
			777-575-P2	0xrr05
			777-LR-P2	0xrr02
			777-HVR-LR-P2	0xrr07
			777-575-LR-P2	0xrr08
			777-MV-P2	0xrr38
			777-KW/HP-P2	0xrr47
			777-575-KW/HP-P2	0xrr50
			777-HVR-KW/HP-P2	0xrr52
			777-LR-KW/HP-P2	0xrr48
			777-MLR-KW/HP-P2	0xrr 64
			777-HRG-P2	0xrr 81
			777-575-HRG-P2	0xrr 84
			777-LR-HRG-P2	0xrr 82
			777-575-LR-HRG-P2	0xrr 85
29,01,A6	0x02	40003	Product Code	
			777-P2	1
			777-HVR-P2	2
			777-575-P2	3
			777-LR-P2	11
			777-HVR-LR-P2	12
			777-575-LR-P2	13
			777-MV-P2	31
			777-KW/HP-P2	41
			777-575-KW/HP-P2	43
			777-HVR-KW/HP-P2	42
			777-LR-KW/HP-P2	51
			777-MLR-KW/HP-P2	64
			777-HRG-P2	81
			777-575-HRG-P2	84
			777-LR-HRG-P2	82
			777-575-LR-HRG-P2	85
29,01,A6	0x03	40004	MODELCD Model Code	778
2C,01,64	0x04	40005	Current Scale Factor	777-xxx-P2 = 10, 777-xxx-LR-P2 =100
0F,21,01 29,01,C1	0x05	40006	OLSTAT OLSTAT bits	Bit 0: LV detected Bit 1: HV detected Bit 2: VUB detected Bit 3: UC detected or LPR Bit 4: RP detected Bit 5: CUB detected Bit 6: vSP detected Bit 7: cSP detected Bit 8: OC detected Bit 9: GF detected Bit 10: HPR detected Bit 11: LCV detected Bit 12: ABC Phase Rotation Bit 13: LPR Only Bit 14: Global Warning Bit 15: Fault Relay Closed

Table 4-Run Time Information (777-P2)				
DeviceNet C,I,A	**16 Bit Modbus Address**		**Code and Description**	**Notes**
	Hex	**Dec**		
0F,20,01 29,01,C0	0x06	40007	TRIPRN Trip Reason bits	Bit 0: Man. Reset required Bit 1: Off command issued Bit 2: Tripped on CF Bit 3: Tripped on UC or LPR Bit 4: Tripped on OC Bit 5: Tripped on GF Bit 6: Tripped on CUB Bit 7: Tripped on cSP Bit 8: Tripped on PTC Bit 9: Tripped on Hpr Bit 10: Tripped on LCV Bit 11: Reserved Bit 12: Low Power Trip Only Bit 13: Reserved Bit 14: Reserved Bit 15: Reserved
NA	0x07	40008	LF1 Last Fault	Code Definition 0 Cleared 1 Reserved 2 Reserved 4 Contactor Failure 6 Single Phased Current 7 Ground Fault 8 Current Unbalance 9 Reserved 10 Overcurrent 11 Undercurrent 12 Reserved 13 Reserved 14 Reserved 15 Low Kilowatt Trip (Low Power) 16 PTC Off 17 High Kilowatt Trip (High Power) 18 Reserved 19 Low control voltage trip
NA	0x08	40009	LF2 Second to Last Fault	
NA	0x09	40010	LF3 Third to Last Fault	
NA	0x0A	40011	LF4 Fourth to Last Fault	
0F,15,01 29,01,AA	0x0B	40012	RD1R Remaining RD1 time	RD1 (Seconds)=Raw Value/2 RD1 (Minutes)=Raw Value/120
0F,16,01 29,01,AB	0x0C	40013	RD2R Remaining RD2 time	RD2 (Seconds)=Raw Value/2 RD2 (Minutes)=Raw Value/120
0F,17,01 29,01,AC	0x0D	40014	RD3R Remaining RD3 time	RD3 (Seconds)=Raw Value/2 RD3 (Minutes)=Raw Value/120
0F,0A,01 2C,01,07 2C,01,6F	0x0E	40015	Capacity Thermal Capacity Remaining	%
0F,1F,01 77,01,08	0x0F	40016	PFANGLE Power factor angle	Degrees
0F,19,01 29,01,B2	0x10	40017	RTKW Kilowatts	Actual KW=Raw Value/100
0F,0B,01 2C,01,6E	0x11	40018	GFCUR Ground Fault Current	Actual GF Amps=Raw Value/GF Scale Factor
2C,01,67	0x12	40019	IC Current in Phase C	Actual Amps=Raw Value/Current Scale Factor
2C,01,66	0x13	40020	IB Current in Phase B	Actual Amps=Raw Value/Current Scale Factor
2C,01,65	0x14	40021	IA Current in Phase A	Actual Amps=Raw Value/Current Scale Factor
2C,01,68	0x15	40022	IAVG Average Current	Actual Amps=Raw Value/Current Scale Factor
0F,2F,01 0F,0C,01 2C,01,72 2C,01,06	0x16	40023	CUNBAL Current Unbalance	%
0F,1C,01 77,01,06	0x17	40024	VCA Voltage from Phase C to Phase A	Volts
0F,1B,01 77,01,05	0x18	40025	VBC Voltage from Phase B to Phase C	Volts
0F,1A,01 77,01,04	0x19	40026	VAB Voltage from Phase A to Phase B	Volts
		Notes	1. Reserved bits state is undefined	

Table 4-Run Time Information (777-P2)				
DeviceNet C,I,A	**16 Bit Modbus Address**		**Code and Description**	**Notes**
	Hex	**Dec**		
0F,1D,01 77,01,03	0x1A	40027	VAVG Average Voltage	Volts
0F,1E,01 0F,30,01 77,01,07	0x1B	40028	VUNBAL Voltage Unbalance	%
29,01,96 0F,31,01	0x1C	40029	WarnStat Warning Status Register	Bit 0:LV Warning Bit 1:HV Warning Bit 2:VUB Warning Bit 3:OC Warning Bit 4:UC Warning Bit 5:CUB Warning Bit 6:GF Warning Bit 7:Reserved Bit 8:Low Frequency Warning Bit 9:High Frequency Warning Bit 10: LPR warning Bit 11: HPR warning
77,01,19 0F,32,01	0x1D	40030	Measured Line Frequency	Hz * 10
26,01,71	0x1E	40031	OC Time to trip	0-65535 (half-seconds)
	0x1F	40032	Last fault 5	Bit 0: Clear Bit 1: High voltage Bit 2: Low voltage Bit 3: Run Bit 4: Contact failure Bit 5: Reverse phase Bit 6: Single phase Bit 7: Ground fault Bit 8: Unbalance Bit 9: Off Bit 10: Overcurrent Bit 11: Undercurrent Bit 13: High frequency Bit 14: Low frequency Bit 15: Low power Bit 16: PTC Bit 17: High power Bit 18: Reserved Bit 19: Low control voltage
	0x20	40033	Last fault 6	
	0x21	40034	Last fault 7	
	0x22	40035	Last fault 8	
	0x23	40036	Last fault 9	
	0x24	40037	Last fault 10 (Oldest fault)	
	0x25	40038	Sub minor software rev	0-255
		Notes	1. Reserved bits state is undefined	

Table 5-Limit (Setpoint) Values

DeviceNet C,I,A	16 Bit Modbus Address		Code and Description	Range	Default
	Hex	Register			
29,01,92	0x64	40101	ComLine Command Line	0x33: PTC Fault and Turn Model 777-P2 OFF 0x44: Enable Network Programming 0x55: Disable Network Programming 0x66: Clear Motor Run Hours 0x77: Clear Last Fault 0x88: Enable Network Watchdog Timer 0x99: Disable Network Watchdog Timer 0xAA: Reset Model 777-P2 0xDD: Turn Model 777-P2 OFF	0
2C,01,B0	0x66	40103	Divisor Divisor	1-255	1
2C,01,B1	0x67	40104	MULT Multiplier	1-255	1
2C,01,89	0x68	40105	GF Ground Fault 777-xxx-P2 777-xxx-LR-P2 777-xxx-HRG-P2 777-xxx-LR-HRG-P2	 0.30-640 Amps 0.15-640 Amps 1-10 Amps 1-10 Amps	 10 1
2C,01,93	0x69	40106	UC Undercurrent 777-xxx-P2 777-xxx-LR-P2	 0.10-1120.0 Amps 0.10-1120.0 Amps	 35 3.5
2C,01,03	0x6A	40107	OC Overcurrent 777-xxx-P2 777-xxx-LR-P2	 1.0-1120.0 Amps 0.10-1120.0 Amps	 60 6.0
2C,01,97	0x6B	40108	CUB Current Unbalance	2-50 %,Off (255)	7
2C,01,81	0x6C	40109	TC Trip Class	2-127 (Non JAM) 128-255 (JAM enabled)	10
77,01,14	0x6D	40110	LV Low Voltage 777-xxx-P2 777-HVR-xxx-P2 777-575-xxx-P2 777-MV-xxx-P2	 170-524 Volts 340-523 Volts 450-649 Volts 85-262 Volts	 200 340 450 80
77,01,15	0x6E	40111	HV High Voltage 777-xxx-P2 777-HVR-xxx-P2 777-575-xxx-P2 777-MV-xxx-P2	 172-528 Volts 172-528 Volts 451-660 Volts 86-264 Volts	 500 500 600 240
77,01,07	0x6F	40112	VUB Voltage Unbalance	2-25 %,Off (255)	6
29,01,AD	0x73	40116	RD1 Rapid-Cycling Restart Delay	0-999 seconds	10
29,01,AE	0x74	40117	RD2 Restart Delay after OC fault	2-500 seconds	8
29,01,AF	0x75	40118	RD3 Restart Delay after UC fault	2-500 seconds, A (65535)	20
2C,01,92	0x76	40119	UCTD Undercurrent Trip Delay	2-999 seconds	5
29,01,B0	0x77	40120	#RU Number of restarts after UC fault	0, 1, 2, 3, 4, A (automatic) **RU Values** 0–4 0–4 A 255	1
29,01,B1	0x78	40121	#RF Number of restarts after OC,cSP,CUB,LCV,HPR fault	0, 1, oc1, 2, oc2, 3, oc3, 4, oc4, A, ocA 0 = manual, A = continuous, oc = automatic restart after RD2 expires **RF Value** **Decimal Value** 0 1 1 2 oc1 3 2 4 oc2 5 3 6 oc3 7 4 8 oc4 9 A 10 ocA 11	OC1
		Notes	2. Read-only bits		

Table 5-Limit (Setpoint) Values

DeviceNet C,I,A	16 Bit Modbus Address		Code and Description	Range	Default
	Hex	Register			
NA	0x79	40122	ADDR Modbus device address	1-255	1
NA	0x7A	40123	ComParam Communication Parameter Bits	**Bit 4: Post-bias/Post-polarization Enabled** **Bit 3: Pre-bias/Pre-polarization Enabled** **Communications Value(Bits 0:2) Display** 9600,N,1 0x18 C02 9600,E,1 0x1B C03 9600,O,1 0x19 C01 19200,N,1 0x1C C06 19200,E,1 0x1F C07 19200,O,1 0x1D C05	Front and Back Porch Enabled 9600,E,1
2C,01,B9	0x7B	40124	ENDIS Enable/Disable bits	Bit 0: GF Trip Enabled Bit 1: VUB Trip Enabled Bit 2: CUB Trip Enabled Bit 3: UC Trip Enabled Bit 4: OC Trip Enabled Bit 5: Reserved Bit 6: LPR Trip Enabled Bit 7: HPR Trip Enabled	31
29,01,C3	0x7C	40125	NETST Network Status bits	Bit 0: Network Watchdog Enabled Bit 1: Network Program Disabled Bit 2: Front panel locked Bit 3: Reserved Bit 4: Reserved Bit 5: Reserved Bit 6: Reserved Bit 7: Reserved	0
29,01,A9	0x7D	40126	MRH Motor Run Hours	0-65535 Hours	0
29,01,BF	0x80	40129	LKW Low Kilowatt Trip Limit	Off (0),0.01-655.35 KW	0
29,01,BE	0x81	40130	HKW High KW trip limit	0.01-655.34 KW, Off (65535)	65535
2C,01,BA	0x82	40131	KWS KW Scale Factor	0-4=LKW displayed as KW 5-8=LKW displayed as HP	2
2C,01,BB	0x83	40132	LCV_DLY Low Control Voltage Trip Delay	1-120 seconds	5
2C,01,BC	0x84	40133	LCV_Pcnt Low Control Voltage Percentage	0-120 %	100
29,01,C4	0x85	40134	cfgCtrl Configuration Control bits	Bit 0: UCTD/LPRTD in minutes Bit 1: RD1 in minutes Bit 2: RD2 in minutes Bit 3: RD3 in minutes Bit 4: HPR TD in minutes Bit 5: Zero L3 L2 Voltages Bit 6: Single-phase voltage device Bit 7: Single-phase current device Bit 8: Disable RP hold-off Bit 9: Enable low control voltage trip Bit 10: Stall 1 Enable Bit 11: Stall 2 Enable Bit 12: CBA Phase Rotation not at fault Bit 13: RD1 invoked on power up Bit 14: RD1 invoked on current loss Bit 15: Enable emergency run	24588
29,01,B9	0x87	40136	LIN Linear OC Trip Delay	0-254 half-seconds, Off (255)	255
2C,01,BD	0x8D	40142	CUBTD CUB Time Delay	1-240	60
2C,01,BE	0x8E	40143	MACtrl Motor Acceleration Control Bits	Bit 0: Reserved Bit 1: Reserved Bit 2: Motor acceleration trip delay applies to CF trip Bit 3: Motor acceleration trip delay applies to UC/LPR trip Bit 4: Reserved Bit 5: Motor acceleration trip delay applies to GF trip Bit 6: Motor acceleration trip delay applies to CUB trip Bit 7: Motor acceleration trip delay applies to cSP trip Bit 8:Reserved Bit 9: Motor acceleration trip delay applies to HKW trip[1] Bit 10: Motor acceleration trip delay applies to LCV trip Bit 11: Reserved Bit 12: Reserved Bit 13: Reserved Bit 14: Reserved Bit 15: Reserved	0
		Notes	2. Read-only bits		

Table 5-Limit (Setpoint) Values

DeviceNet C,I,A	16 Bit Modbus Address		Code and Description	Range	Default
	Hex	Register			
2C,01,BF	0x8F	40144	MATD Motor Acceleration Time Delay	0-255 half-seconds	0
2C,01,C0	0x90	40145	HPRTD High Power Trip Delay	0-255 seconds	5
2C,01,C1	0x91	40146	StrCntU Start Count Upper Byte	0 Starts	0
2C,01,C1	0x92	40147	StrCntHL Start Count High: Low Bytes	0 Starts	0
2C,01,C2	0x93	40148	StrDur1U Start Duration 1 Upper Byte	0 Minutes	0
2C,01,C2	0x94	40149	StrDur1HL Start Duration 1 High: Low Byte	0 Minutes	0
2C,01,C3	0x95	40150	StrDur2U Start Duration 2 Upper Byte	0 Minutes	0
2C,01,C3	0x96	40151	StrDur2HL Start Duration 2 High: Low Byte	0 Minutes	0
2C,01,C4	0x97	40152	StrDur3U Start Duration 3 Upper Byte	0 Minutes	0
2C,01,C4	0x98	40153	StrDur3HL Start Duration 3 High: Low Byte	0 Minutes	0
2C,01,C5	0x99	40154	StrDur4U Start Duration 4 Upper Byte	0 Minutes	0
2C,01,C5	0x9A	40155	StrDur4HL Start Duration 4 High: Low Byte	0 Minutes	0
2C,01,C7	0x9B	40156	HotOCPer Hot Overcurrent Percentage	1-115%	100
NA	0x9C	40157	Backdoor Modbus address	0-255	127
B4,01,8D B4,01,8E	0xA1	40162	Inhibit Bits	Bit 0: Reserved Bit 1: Reserved Bit 2: Inhibit CF Trip Bit 3: Inhibit UC/LPR Trip Bit 4: Inhibit OC Trip Bit 5: Inhibit GF Trip Bit 6: Inhibit CUB Trip Bit 7: Inhibit cSP Trip Bit 8: Inhibit HPR Trip Bit 9: Reserved Bit 10: Inhibit LCV Trip	0
29,01,97	0xA2	40163	Warn Enable Bits	Bit 0: Enable LV Warning Bit 1: Enable HV Warning Bit 2: Enable VUB Warning Bit 3: Enable OC Warning Bit 4: Enable UC Warning Bit 5: Enable CUB Warning Bit 6: Enable GF Warning Bit 7:Reserved Bit 8:Enable Low Frequency Warning Bit 9:Enable High Frequency Warning Bit 10:Enable LPR Warning Bit 11:Enable HPR Warning	0
29,01,98	0xA3	40164	LV Warn Delay	0-255 half-seconds	0
29,01,99	0xA4	40165	HV Warn Delay	0-255 half-seconds	0
29,01,9A	0xA5	40166	VUB Warn Delay	0-255 half-seconds	0
29,01,9B	0xA6	40167	OC Warn Delay	0-255 half-seconds	0
29,01,9C	0xA7	40168	UC Warn Delay	0-255 half-seconds	0
29,01,9D	0xA8	40169	CUB Warn Delay	0-255 half-seconds	0
29,01,9E	0xA9	40170	GF Warn Delay	0-255 half-seconds	0
29,01,A0	0xAA	40171	LV Warn Setpoint	0-65535 Volts	200 Volts
29,01,A1	0xAB	40172	HV Warn Setpoint	0-65535 Volts	400 Volts
29,01,A2	0xAC	40173	VUB Warn Setpoint	0-255%	5 %
29,01,B6	0xAD	40174	OC Warn Setpoint	(0-65535 / Scale Factor) Amps	50 Amps
29,01,B5	0xAE	40175	UC Warn Setpoint	(0-65535 / Scale Factor) Amps	40 Amps
29,01,B8	0xAF	40176	CUB Warn Setpoint	0-255%	5 %
29,01,B7	0xB0	40177	GF Warn Setpoint	(0-65535 / 1000) Amps	1 Amps
2C,01,99	0xB1	40178	Stall 1 Trip Delay	0-255 half-seconds	0
2C,01,9A	0xB2	40179	Stall 1 Inhibit Delay	0-255 half-seconds	0
2C,01,9B	0xB3	40180	Stall 1 Percentage	0-65535 %	0 %
2C,01,9C	0xB4	40181	Stall 2 Trip Delay	0-255 half-seconds	0
2C,01,9D	0xB5	40182	Stall 2 Inhibit Delay	0-255 half-seconds	0
2C,01,9E	0xB6	40183	Stall 2 Percentage	0-65535 %	0 %
2C,01,73	0xB7	40184	Ground Fault Trip Delay	0-251	16
2C,01,74	0xB8	40185	High Frequency Warn Setpoint	0-100 * 10 Hz	70 Hz
2C,01,75	0xB9	40186	Low Frequency Warn Setpoint	0-100 * 10 Hz	50 Hz
		Notes	2. Read-only bits		

Table 5-Limit (Setpoint) Values

DeviceNet C,I,A	16 Bit Modbus Address		Code and Description	Range	Default
	Hex	Register			
29,01,C6	0xBA	40187	GF CT Ratio	0-10000	777-XXX-P2 =1250 777-LR-xxx-P2=625 777-HRG-P2 =500
77,01,18	0xBB	40188	Voltage Hold-Off Enable	Bit 0:Low voltage hold-off enabled Bit 1:High voltage hold-off enabled Bit 2:VUB hold-Off Enabled Bit 3:Reserved Bit 4:Reverse phase hold-off enabled Bit 5:Reserved Bit 6:Voltage single phase hold-off enabled Bit 7:Reserved Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved	81
	0xBC	40189	Ground fault scale factor	1-1000	777-xxx-P2 =100 777-xxx-HRG-P2=10
	0xBD	40190	Ground fault inhibit delay	1-999 seconds (only used on 777-xxx-HRG-P2 models)	0
	0xBE	40191	Low power warning setpoint	0-65535 x 100 KW	0
	0xBF	40192	Low power warning delay	0-255 half-seconds	0
	0xC0	40193	High power warning setpoint	0-65535 x 100 KW	0
	0xC1	40194	High power warning delay	0-255 half-seconds	0
	0xC2	40195	Fault count	0-65535	Can only be written to 0 to clear
NA	0x2153	48532	MBAssebmly500Wrd1	0-255	2
NA	0x2154	48533	MBAssebmly500Wrd2	0-255	3
NA	0x2155	48534	MBAssebmly500Wrd3	0-255	4
NA	0x2156	48535	MBAssebmly500Wrd4	0-255	5
NA	0x2157	48536	MBAssebmly500Wrd5	0-255	6
NA	0x2158	48537	MBAssebmly500Wrd6	0-255	7
NA	0x2159	48538	MBAssebmly500Wrd7	0-255	8
NA	0x215A	48539	MBAssebmly500Wrd8	0-255	9
NA	0x215B	48540	MBAssebmly500Wrd9	0-255	10
NA	0x215C	48541	MBAssebmly500Wrd10	0-255	11
NA	0x215D	48542	MBAssebmly500Wrd11	0-255	12
NA	0x215E	48543	MBAssebmly500Wrd12	0-255	13
NA	0x215F	48544	MBAssebmly500Wrd13	0-255	14
NA	0x2160	48545	MBAssebmly500Wrd14	0-255	15
NA	0x2161	48546	MBAssebmly500Wrd15	0-255	16
NA	0x2162	48547	MBAssebmly500Wrd16	0-255	17
NA	0x2163	48548	MBAssebmly500Wrd17	0-255	18
NA	0x2164	48549	MBAssebmly500Wrd18	0-255	19
NA	0x2165	48550	MBAssebmly500Wrd19	0-255	20
NA	0x2166	48551	MBAssebmly500Wrd20	0-255	21
NA	0x2167	48552	MBAssebmly500Wrd21	0-255	22
NA	0x2168	48553	MBAssebmly500Wrd22	0-255	23
NA	0x2169	48554	MBAssebmly500Wrd23	0-255	24
NA	0x216A	48555	MBAssebmly500Wrd24	0-255	25
NA	0x216B	48556	MBAssebmly500Wrd25	0-255	26
NA	0x216C	48557	MBAssebmly500Wrd26	0-255	27
NA	0x216D	48558	MBAssebmly500Wrd27	0-255	28
NA	0x216E	48559	MBAssebmly500Wrd28	0-255	29
NA	0x216F	48560	MBAssebmly500Wrd29	0-255	30
NA	0x2170	48561	MBAssebmly500Wrd30	0-255	31
NA	0x2171	48562	MBAssebmly500Wrd31	0-255	102
NA	0x2172	48563	MBAssebmly500Wrd32	0-255	103
NA	0x2173	48564	MBAssebmly500Wrd33	0-255	104
NA	0x2174	48565	MBAssebmly500Wrd34	0-255	105
NA	0x2175	48566	MBAssebmly500Wrd35	0-255	106
NA	0x2176	48567	MBAssebmly500Wrd36	0-255	107
NA	0x2177	48568	MBAssebmly500Wrd37	0-255	108
NA	0x2178	48569	MBAssebmly501Wrd1	0-255	109
NA	0x2179	48570	MBAssebmly501Wrd2	0-255	110
NA	0x217A	48571	MBAssebmly501Wrd3	0-255	111
NA	0x217B	48572	MBAssebmly501Wrd4	0-255	112
NA	0x217C	48573	MBAssebmly501Wrd5	0-255	113
		Notes	2. Read-only bits		

Table 5-Limit (Setpoint) Values

DeviceNet C,I,A	16 Bit Modbus Address		Code and Description	Range	Default
	Hex	Register			
NA	0x217D	48574	MBAssebmly501Wrd6	0-255	114
NA	0x217E	48575	MBAssebmly501Wrd7	0-255	115
NA	0x217F	48576	MBAssebmly501Wrd8	0-255	116
NA	0x2180	48577	MBAssebmly501Wrd9	0-255	117
NA	0x2181	48578	MBAssebmly501Wrd10	0-255	118
NA	0x2182	48579	MBAssebmly501Wrd11	0-255	119
NA	0x2183	48580	MBAssebmly501Wrd12	0-255	120
NA	0x2184	48581	MBAssebmly501Wrd13	0-255	121
NA	0x2185	48582	MBAssebmly501Wrd14	0-255	122
NA	0x2186	48583	MBAssebmly501Wrd15	0-255	123
NA	0x2187	48584	MBAssebmly501Wrd16	0-255	124
NA	0x2188	48585	MBAssebmly501Wrd17	0-255	125
NA	0x2189	48586	MBAssebmly501Wrd18	0-255	126
NA	0x218A	48587	MBAssebmly501Wrd19	0-255	127
NA	0x218B	48588	MBAssebmly501Wrd20	0-255	128
NA	0x218C	48589	MBAssebmly501Wrd21	0-255	129
NA	0x218D	48590	MBAssebmly501Wrd22	0-255	130
NA	0x218E	48591	MBAssebmly501Wrd23	0-255	131
NA	0x218F	48592	MBAssebmly501Wrd24	0-255	2
NA	0x2190	48593	MBAssebmly501Wrd25	0-255	3
		Notes	2. Read-only bits		

DEVICENET CONFIGURATION

The CIO DeviceNet I/O Module can be configured using a software tool such as SymCom's *Solutions* software, *RSNetworx* or *CHStudio*. See **Software Configuration** for additional details.

Equipment Setup

NOTE: For detailed setup instructions, reference the *Installation Instructions* for the communications module.

1. Connect the DeviceNet trunk cable to the DeviceNet scanner interface being used.
2. Connect the CIO DeviceNet I/O Module to the network using the DeviceNet terminals on the front of the unit.
3. Check that the 24VDC power supply disconnect switch is ON and that 24VDC is present on the DeviceNet network cable (V+ and V- at any location).

Accessing Variables

Variables on the node are accessed using a Path, which is composed of:

- Class ID
- Instance ID
- Attribute ID

The classes available in the solid-state overload relay are grouped into three parts:

- Classes required for all equipment connected to the DeviceNet network, whatever their functionality
- Classes relating to the overload relay profile, as defined by ODVA
- Classes relating to the 777-P2 overload relay, allowing access to all internal variables: configuration, adjustment, monitoring, etc

NOTE: "Reserved" bits setpoints should be maintained as 0.

Software Configuration

EDS and ICO Files

EDS (electronic data sheet) files are required for DeviceNet network and DeviceNet master software configuration. An EDS file contains information about configurable attributes for a device, including object addresses of each parameter.

The ICO file includes a SymCom 777-P2 icon to personalize the configuration software.

The EDS and ICO files are available on our website, www.symcom.com. Upload the EDS file to your system to access relevant files.

DeviceNet Communications Modules Features

Flexible Addressing Enabled

When flexible addressing is enabled the DeviceNet module can be in either of the modes below:

Fixed Addressing

On power up of the DeviceNet module, if the Modbus address of the overload is < 64 then the DeviceNet module will set the DeviceNet address to the overload address and this address cannot be set from the DeviceNet network.

Variable Addressing

On power up of the DeviceNet module, if the Modbus address of the overload is > 63, then the DeviceNet module will use the last valid DeviceNet address, and this address can be set from the DeviceNet network.

Flexible Addressing Disabled

The DeviceNet address can only be set from the DeviceNet network.

Fault/Warning Links

The CIO-DN-P and CIO-120-DN-P modules can be configured to link the B relay to specific faults and warning conditions. If the B relay is linked then network watchdogs and network control of that relay will be overridden by the fault and warning link.

777-P2 DEVICENET MEMORY MAP

Classes for CIO-DN-P, CIO-120-DN-P

Table 6-Class Attributes (Class ID 01hex)

Attribute ID	Access Rule	Name	Data Type	Value	Details
1	Get	Revision	UINT	1	--

Table 7-ID Class (Class ID 01hex)

Attribute ID	Access Rule	Name	Data Type	Value	Details
1	GET	Vendor ID	UINT	958	SymCom Inc.
2	GET	Product Type	UINT	0 3 7	Generic Device () Motor Overload General Purpose Discrete I/O*
3	GET	Product Code	UINT	0 2050 2052 2053 2055 2056 2075 2086 2095 2096 2098 2100 2112 2129 2130 2132 2133	Standalone CI0-DN-P* 777-LR-P2 w/CIO-DN-P 777-P2 w/CIO modules 777-575-P2 w/CIO modules 777-HVR-LR-P2 w/CIO modules 777-575-LR-P2 w/CIO modules 777-HVR-P2 w/CIO modules 777-MV-P2 w/CIO modules 777-KW/HP-P2 w/CIO modules 777-LR-KW/HP-P2 w/CIO modules 777-575-KW/HP-P2 w/CIO modules 777-HVR-KW/HP-P2 w/CIO modules 777-MLR-KW/HP-P2 777-HRG-P2 777-LR-HRG-P2 777-575-HRG-P2 777-575-LR-HRG-P2
4	GET	Revision			
		Major Revision	USINT		
		Minor Revision	USINT		
5	GET	Status	WORD		
6	GET	Serial Number	UDINT		
7	GET	Name	SHORT_STRING		
8	GET	State	USINT		
		Notes	* Applies to CIO modules		

DeviceNet Objects (Class ID 03_{HEX})

The DeviceNet Object provides the status and configuration of a DeviceNet node.

Table 8 - Class Attributes (Class ID 03hex)

Attribute ID	Access Rule	Name	Data Type	Value	Details
1	GET	Revision	UINT	1	--
2	GET	Max Instances	UINT	1	1 defined instance

Table 9 - Instance Attributes (Class ID 03hex)

Attribute ID	Access	Name	Data Type	Value	Details
1	GET/SET	MAC ID	USINT	0-63	Ref = 63
2	GET/SET	Baud rate	USINT	0-2	0 = 125k 1 = 250 k 2 = 500 k
3	GET/SET	BOI (BusOff interrupt)	BOOL	--	Upon BusOff event: 0: CAN component remains in BusOff 1: Component is reset—communication resumes
4	GET/SET	BusOff counter	USINT	0-255	Number of occurrences of BusOff state
5	GET	Allocation information	BYTE USINT	-- 0-63	Allocation choice Master address (255 not allocated)

Table 10 - Class Service (Class ID 03hex)

Service Code	Service Name	Description
OE_{hex}	Get_Attribute_Single	Read an attribute

Table 11 - Instance Service (Class ID 03hex)

Service Code	Service Name	Description
OE_{hex}	Get_Attribute_Single	Read an attribute
10_{hex}	Set_Attribute_Single	Write an attribute
$4B_{hex}$	Allocate Master/Slave Connection Set	Allocation connection master/slave
$4C_{hex}$	Release Master/Slave Connection Set	Release connection master/slave

Assembly Object Class Code 0x04 Bit Definition

Output Assemblies

Output Assemblies allow control of the CIO modules using a polled message. These assemblies allow the CIO modules to reset the 777-P2 relay and open and close the output relays.

Table 12 - Bit Definition		
Bit	**Description**	
Fault Reset	0	No change
	1	Reset fault relay
Fault Relay	0	Close Fault Relay
	1	Open Fault Relay
OutA	0	Open output A relay
	1	Close output A relay
OutB	0	Open output B relay
	1	Close output B relay
In 1	0	Input 1 open
	1	Input 1 closed
In 2	0	Input 2 open
	1	Input 2 closed
In 3	0	Input 3 open
	1	Input 3 closed
In 4	0	Input 4 open
	1	Input 4 closed

Assemblies for Stand Alone CIO module

Output Assemblies

Table 13 - Assembly Object Class Instance 32							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
						Out B*	Out A*
Notes			* Applies to CIO modules				

Input Assemblies

Table 14 - Assembly Object Class Instance 3							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
				In 4*	In 3*	In 2*	In 1*
Notes			* Applies to CIO modules				

Table 15 - Assembly Object Class Instance 190		
Data Type	**Description**	**Units**
UINT	Operating Status	Bit 0:A relay closed* Bit 1:B relay closed* Bit 2:Reserved Bit 3:Reserved Bit 4:Input 1 closed* Bit 5:Input 2 closed* Bit 6:Input 3 closed* Bit 7:Input 4 closed* Bit 8:Reserved Bit 9:Reserved Bit 10:Tripped Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:MAC ID fixed from overload Bit 15:Reserved
Notes		* Applies to CIO modules

Assemblies for CIO module (with overload)

Table 16 - Bit Definitions		
Bit	**Description**	
Fault Reset	0	No change
	1	Reset fault relay
Fault Relay	0	Fault relay open
	1	Fault relay closed
Out A	0	Output A is open
	1	Output A is closed
Out B	0	Output B is open
	1	Output B is closed
In 1	0	Input 1 open
	1	Input 1 closed
In 2	0	Input 2 open
	1	Input 2 closed
In 3	0	Input 3 open
	1	Input 3 closed
In 4	0	Input 4 open
	1	Input 4 closed
Faulted	0	Overload is not faulted
	1	Overload is faulted
Warning	0	No Pending Trip
	1	Pending Trip

Output Assemblies

Table 17 - Assembly Object Class Instance 2							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
					Fault Reset		

Table 18 - Assembly Object Class Instance 101							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
							Out A*
Notes	* Applies to CIO modules						

Table 19 - Assembly Object Class Instance 103							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
					Fault Reset		Out A*
Notes	* Applies to CIO modules						

Table 20 - Assembly Object Class Instance 104							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
						Out B*	Out A*
Notes	* Applies to CIO modules						

Table 21 - Assembly Object Class Instance 105							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
					Fault Reset	Out B*	Out A*
Notes	* Applies to CIO modules						

Table 22 - Assembly Object Class Instance 110							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
					Fault Relay	Out B*	Out A*
Notes	* Applies to CIO modules						

Input Assemblies

Table 23 - Assembly Object Class Instance 50							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
							Faulted

Table 24 - Assembly Object Class Instance 51							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
						Warning	Faulted

Table 25 - Assembly Object Class Instance 106							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
			In2*	In1*	Out A*	Warning	Faulted
Notes	* Applies to CIO modules						

Table 26 - Assembly Object Class Instance 107							
Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	In4*	In3*	In2*	In1*	Faulted	Out B*	Out A*
Notes	* Applies to CIO modules						

Class Code 0x04 Instances

Table 27 - Assembly Object Class Instance 120		
Data Type	**Description**	**Units**
UINT	Average Current * 10	Amps
UINT	Average Voltage	Volts
UINT	Measured Kilowatts	KW*100
UINT	Operating Status	Bit 0:A relay closed* Bit 1:B relay closed* Bit 2:Fault relay closed Bit 3:Reserved Bit 4:Input 1 closed* Bit 5:Input 2 closed* Bit 6:Input 3 closed* Bit 7:Input 4 closed* Bit 8:Reserved Bit 9:Current is flowing Bit 10:Tripped Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:MAC ID fixed from overload Bit 15:Modbus comm. failure
	Notes	* Applies to CIO modules

Table 28 - Assembly Object Class Instance 121		
Data Type	**Description**	**Units**
UINT	Average Current * 10	Amps
UINT	Average Voltage	Volts
UINT	Measured Kilowatts	KW*100
UINT	Measured GF * 10	Amps
USINT	Measured Current Unbalance	%
USINT	Measured Voltage Unbalance	%
UINT	Error Code	Bit 0: LV detected Bit 1: HV detected Bit 2: VUB detected Bit 3: UC detected Bit 4: RP detected Bit 5: CUB detected Bit 6: vSP detected Bit 7: cSP detected Bit 8: OC detected Bit 9: GF detected Bit 10: HPR detected Bit 11: LCV detected Bit 12: Reserved Bit 13: Reserved Bit 14: Reserved Bit 15: Fault Relay Closed
UINT	Operating Status	Bit 0:A relay closed* Bit 1:B relay closed* Bit 2:Fault relay closed Bit 3:Reserved Bit 4:Input 1 closed* Bit 5:Input 2 closed* Bit 6:Input 3 closed* Bit 7:Input 4 closed* Bit 8:Reserved Bit 9:Current is flowing Bit 10:Tripped Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:MAC ID fixed from overload Bit 15:Modbus comm. failure
	Notes	* Applies to CIO modules

Table 29 - Assembly Object Class Instance 190		
Data Type	**Description**	**Units**
UINT	Operating Status	Bit 0:A relay closed* Bit 1:B relay closed* Bit 2:Fault relay closed Bit 3:Reserved Bit 4:Input 1 closed* Bit 5:Input 2 closed* Bit 6:Input 3 closed* Bit 7:Input 4 closed* Bit 8:Reserved Bit 9:Current is flowing Bit 10:Tripped Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:MAC ID fixed from overload Bit 15:Modbus comm. failure
	Notes	* Applies to CIO modules

The CIO modules support two custom input assemblies. These assemblies are configured by selecting parameters. For input assembly 100, program attributes 7-10 of Class 0xB4 by selecting parameter instances from the Parameter Object Table see Table 42. To end the list, set the parameter instance to “0”. The process is the same for input assembly 150, except attributes 25-74 of Class 0xB4 are used.

Table 30 - Object Model Definitions for CIO-DN-P, CIO-120-DN-P					
Object Class	**Class ID**	**Need**	**No. of Instances**	**Effect on Behavior**	**Interface**
Identity	0x01	Req.	1	Supports the reset service	Message Router
Message Router	0x02	Opt.	1	No effect	Explicit Message Connection
DeviceNet	0x03	Req.	1	Configures node attributes	Message Router
Assembly	0x04	Req.	3	Defines I/O data format	Message Router, Assembly, or Parameter Object
DeviceNet Connection	0x05	Req	2	Logical ports into or out of the device	I/O connection or Message Router
Control Supervisor	0x29	Req.	1	Manages SSOLR functions, operational states, and control	Message Router, Assembly, or Parameter Object
Overload	0x2C	Req.	1	Provides SSOLR configuration	Message Router, Assembly, or Parameter Object
Acknowledge Handler	0x2B	Opt.	1		I/O Connection or Message Router

Table 31 - Assembly Object Class Code 0x04				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 32 - Assembly Object--Class Code 0x04, Explicit				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
3	SET	Data	Array of Byte	

Table 33 - Connection Object Class Code 0x05				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 34 - Connection Object--Class Code 0x05, Instance 1 Explicit				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	State	USINT	0 = Nonexistent 1 = Configuring 3 = Established 4 = Timed Out
2	GET	Instance type	USINT	0 = Explicit
3	GET	Transport class trigger	BYTE	--
4	GET	Produced connection ID	UINT	10xxxxxx011xxxxxx = Node address
5	GET	Consumed connection ID	UINT	10xxxxxx011xxxxxx = Node address
6	GET	Initial comm. characteristics	BYTE	--
7	GET	Produced connection size	UINT	8
8	GET	Consumed connection size	UINT	7
9	GET/SET	Expected packet rate	UINT	--
12	GET/SET	Watchdog timeout action	USINT	--
13	GET	Produced connection path length	UINT	--
14	GET/SET	Produced connection path	EPATH	--
15	GET	Consumed connection path length	UINT	--
16	GET/SET	Consumed connection path	EPATH	--

Table 35 - Connection Object Class Code 0x05				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 36 - Connection Object--Class Code 0x05, Instance 2 Polled				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	State	USINT	0 = Nonexistent 1 = Configuring 3 = Established 4 = Timed Out
2	GET	Instance type	USINT	1 = I/O
3	GET	Transport class trigger	BYTE	--
4	GET	Produced connection ID	UINT	10xxxxxx011 xxxxxx = Node address
5	GET	Consumed connection ID	UINT	10xxxxxx011 xxxxxx = Node address
6	GET	Initial comm. characteristics	BYTE	--
7	GET	Produced connection size	UINT	1-50
8	GET	Consumed connection size	UINT	0-8
9	GET/SET	Expected packet rate	UINT	--
12	GET/SET	Watchdog timeout action	USINT	--
13	GET	Produced connection path length	UINT	--
14	GET	Produced connection path	EPATH	--
15	GET	Consumed connection path length	UINT	--
16	GET	Consumed connection path	EPATH	--
100	GET/SET	Output Assembly	USINT	
101	GET/SET	Input Assembly	USINT	

Table 37 - Discrete Input Class Code 0x08				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 38 - Discrete Input Point Object – Class Code 0x08					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	3	GET	BOOL	Input 1	1=Closed, 0=Open*
2	3	GET	BOOL	Input 2	1=Closed, 0=Open*
3	3	GET	BOOL	Input 3	1=Closed, 0=Open*
4	3	GET	BOOL	Input 4	1=Closed, 0=Open*
		Notes	* Applies to CIO modules		

Table 39 - Discrete Output Class Code 0x09				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 40 - Discrete Output Point Object – Class Code 0x09					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	3	GET	BOOL	Fault Relay	1=Closed, 0=Open
2	3	GET/SET	BOOL	Output A	1=Closed, 0=Open*
3	3	GET/SET	BOOL	Output B	1=Closed, 0=Open*
4	3	GET/SET	BOOL	Fault Relay	1=Closed, 0=Open
		Notes	* Applies to CIO modules		

Table 41 - Parameter Object – Class 0x0F, All Instances				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Value	--	Actual value of parameter
2	GET	Link Path Size	USINT	6
3	GET	Link Path	EPATH	Depends on instance
4	GET	Descriptor	UINT	Depends on instance
5	GET	Data type	UINT	Depends on instance
6	GET	Data size	UINT	2

Table 42 - Parameter Class Code 0x0F				
Instance	**Services**	**Variable Type**	**Description**	**Value**
1	GET	UINT	Phase A current x 10	Amps
2	GET	UINT	Phase B current x 10	Amps
3	GET	UINT	Phase C current x 10	Amps
4	GET	UINT	Average current x 10	Amps
5	GET	UINT	GF current x 10	Amps
6	GET	UINT	Phase A current % of FLA	%
7	GET	UINT	Phase B current % of FLA	%
8	GET	UINT	Phase C current % of FLA	%
9	GET	UINT	Average current % of FLA	%
10	GET	UINT	% Thermal capacity	%
		Notes	* Applies to CIO modules	
11	GET	UINT	Raw GF current x 100 Raw GF current x 1000^2	Amps Amps
12	GET	UINT	% CUB Measured	%
13	GET	UINT	Time to reset	.5 seconds
14	GET	UINT	Trip Status	BIT 0:Reserved Bit 1:OC Warn/Trip Bit 2:cSP Warn/Trip Bit 3:GF Warn/Trip Bit 4:Reserved Bit 5:Reserved Bit 6:UC Warn/Trip Bit 7:Reserved Bit 8:CUB Warn/Trip Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
15	GET	UINT	Warn Status	
16	GET	UINT	Trip Bits 0	Bit 0:Reserved Bit 1:Overcurrent trip Bit 2:Current single phase trip Bit 3:Ground fault trip Bit 4:Reserved Bit 5:Reserved Bit 6:Undercurrent trip Bit 7:PTC trip Bit 8:Current unbalance trip Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
17	GET	UINT	Trip Bits 1	
18	GET	UINT	Trip Bits 2	
19	GET	UINT	Trip Bits 3	
20	GET	UINT	Device Status	Bit 0:Tripped Bit 1:Warning Bit 2:Out A is closed Bit 3:Out B is closed Bit 4:Input 1 is closed Bit 5:Input 2 is closed Bit 6:Input 3 is closed Bit 7:Input 4 is closed Bit 8:Motor is running Bit 9:Ground Fault Bit 10:Mobus comm. good Bit 11:PTC tripped Bit 12:Reserved

Table 42 - Parameter Class Code 0x0F				
Instance	**Services**	**Variable Type**	**Description**	**Value**
				Bit 13:Reserved Bit 14:Reserved Bit 15:Fault relay closed
21	GET	UINT	RD1 remaining	0.5 seconds
22	GET	UINT	RD2 reaming	0.5 seconds
23	GET	UINT	RD3 remaining	0.5 seconds
24	GET	UINT	Run Hours	Hours
25	GET	UINT	Measured KW	KW * 100
26	GET	UINT	Voltage L1-L2	Volts
27	GET	UINT	Voltage L2-L3	Volts
28	GET	UINT	Voltage L3-L1	Volts
29	GET	UINT	Average Voltage	Volts
30	GET	UINT	% VUB measured	%
31	GET	UINT	PF Angle	Degrees
		Notes	* Applies to CIO modules	
32	GET	UINT	Trip Reason	Bit 0: Man. Reset required Bit 1: Off command issued Bit 2: Tripped on CF Bit 3: Tripped on UC/LPR Bit 4: Tripped on OC Bit 5: Tripped on GF Bit 6: Tripped on CUB Bit 7: Tripped on cSP Bit 8: Tripped on PTC Bit 9: Tripped on Hpr Bit 10: Tripped on LCV Bit 11: Reserved Bit 12: Reserved Bit 13: Reserved Bit 14: Reserved Bit 15: Reserved
33	GET	UINT	Error Code	Bit 0: LV detected Bit 1: HV detected Bit 2: VUB detected Bit 3: UC/LPR detected Bit 4: RP detected Bit 5: CUB detected Bit 6: vSP detected Bit 7: cSP detected Bit 8: OC detected Bit 9: GF detected Bit 10: HPR detected Bit 11: LCV detected Bit 12: ABC Phase Rotation Bit 13: Reserved Bit 14: Global Warning Bit 15: Fault Relay Closed
34	GET	UINT	DeviceNet Module Status	Bit 0:A relay closed* Bit 1:B relay closed* Bit 2:Fault relay closed Bit 3:Reserved Bit 4:Input 1 closed* Bit 5:Input 2 closed* Bit 6:Input 3 closed* Bit 7:Input 4 closed* Bit 8:Reserved Bit 9:Current is flowing Bit 10:Tripped Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:MAC ID fixed from overload Bit 15:Modbus comm. failure
35	GET	UINT	Scale Factor	1,10,100
36	GET	UINT	Input Assembly 3 Value	Bit 0:Input 1 closed* Bit 1:Input 2 closed* Bit 2:Input 3 closed* Bit 3:Input 4 closed*
37	GET	USINT	Input Assembly 50 Value	Bit 0:Overload faulted
38	GET	USINT	Input Assembly 51 Value	Bit 0:Overload faulted Bit 1:Pending fault
39	GET	USINT	Input Assembly 106 Value	Bit 0:Overload faulted Bit 1:Pending fault Bit 2:Out A closed*

Table 42 - Parameter Class Code 0x0F				
Instance	**Services**	**Variable Type**	**Description**	**Value**
				Bit 3:Input 1 closed* Bit 4:Input 2 closed*
40	GET	USINT	Input Assembly 107 Value	Bit 0:Out A closed* Bit 1:Out B closed* Bit 2:Fault relay closed Bit 3:Input 1 closed* Bit 4:Input 2 closed* Bit 5:Input 3 closed* Bit 6:Input 4 closed*
41	GET	DINT	Start Count	Starts
42	GET	DINT	Start Duration 1	Minutes
43	GET	DINT	Start Duration 2	Minutes
		Notes	* Applies to CIO modules	
44	GET	DINT	Start Duration 3	Minutes
45	GET	DINT	Start Duration 4	Minutes
46	GET	USINT	Scale Factor	
47	GET	USINT	Current Unbalance	%
48	GET	USINT	Voltage Unbalance	%
49	GET	USINT	Warning Status Bits	Bit 0:Low Voltage Warning Bit 1:High Voltage Warning Bit 2:VUB Warning Bit 3:OC Warning Bit 4:UC Warning Bit 5:CUB Warning Bit 6:GF Warning Bit 7:Reserved Bit 8:Low Frequency Warning Bit 9:High Frequency Warning
50	GET	USINT	Measured Line Frequency	Hz*10
		Notes	* Applies to CIO modules	

Table 43 - Control Supervisor Class Code 0x29				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 44 - Control Supervisor Object – Class Code 0x29					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	3	GET/SET	BOOL	Output A	1=Output A energized* 0=Output A de-energized*
1	4	GET/SET	BOOL	Output B	1=Output B energized* 0=Output B de-energized*
	6	GET	USINT	Control Supervisor State	**Value** **State** 2 Not Ready 3 Ready 7 Faulted
1	7	GET	BOOL	Forward Running	1=Current is flowing and Output A* is energized 0=Current is not flowing or Output A* is de-energized
1	8	GET	BOOL	Reverse Running*	1=Current is flowing and Output B is energized 0=Current is not flowing or Output B is de-energized
	10	GET	BOOL	Fault Status	1=Overload is faulted 0=Overload is not faulted
1	12	GET/SET	BOOL	Fault Reset	0->1 = Fault Reset 0 = No Action
1	13	GET	UINT	Fault Code	Special DeviceNet Codes
1	14	GET	UINT	Control Supervisor Warn Code	**Value** **Fault** 21=OC Overcurrent 22=SP Current Single Phase 26=CUB Current Unbalance 27=GF Ground Fault
1	17	SET	BOOL	Force Fault	0->1 Force a fault—open 777 relay 1->0 No Change
1	100	GET	UINT	Run Hrs	Run Hours
1	114	GET	WORD	Trip Status	BIT 0:Reserved Bit 1:OC Warn/Trip Bit 2:cSP Warn/Trip Bit 3:GF Warn/Trip Bit 4:Reserved Bit 5:Reserved Bit 6:UC Warn/Trip Bit 7:Reserved
1	115	GET	WORD	Warning Status	Bit 8:CUB Warn/Trip Bit 9:Reserved

Table 44 - Control Supervisor Object – Class Code 0x29					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
					Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	116	GET	WORD	Trip Log 0 Last trip to occur	BIT 0:CUB Trip BIT 1:Reserved BIT 2:Reserved BIT 3:Reserved BIT 4:Reserved BIT 5:Reserved BIT 6:Reserved BIT 7:Reserved BIT 8:Reserved BIT 9:OC Trip BIT 10:SP Trip BIT 11:GF Trip BIT 14:UC Trip BIT 15:Reserved
1	117	GET	WORD	Trip Log 1 Second last trip to occur	
1	118	GET	WORD	Trip Log 2 Third last trip to occur	
1	119	GET	WORD	Trip Log 3 Fourth last trip to occur	
1	121	GET	WORD	Device Status	Bit 0:Tripped Bit 1:Warning Bit 2:Out A is closed* Bit 3:Out B is closed* Bit 4:Input 1 is closed* Bit 5:Input 2 is closed* Bit 6:Input 3 is closed* Bit 7:Input 4 is closed* Bit 8:Motor is running Bit 9:Ground Fault Bit 10:Mobus comm. good Bit 11:PTC tripped Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Fault Relay Closed
		Notes	* Applies to CIO modules		
1	124	GET	WORD	Trip Enable	Bit 0:GF trip enable Bit 1:VUB trip enabled Bit 2:CUB trip enabled Bit 3:UC trip enabled Bit 4:OC trip enabled Bit 5:Reserved Bit 6:LPR trip enabled Bit 7:HPR trip enabled Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	126	GET/SET	BOOL	Trip Reset	0->1 = Fault Reset 0 = No Action
1	127	GET/SET	BOOL	Force Fault	0->1 = Force Fault 0= No Action
1	128	GET/SET	BOOL	Force Fault Status	1=Force Fault Overload 0=No Action
1	146	GET/SET	UINT	Comline	**Value** **Command** 0x33 PTC High Temp Shut OFF (HIC) 0x44 Network Program Enable 0x55 Network Program Disable 0x66 Clear Run Hours 0x88 Clear Fault History 0x99 Enable Network Watchdog Timer 0xAA Start 0xDD Stop
1	148	GET/SET	BOOL	Remote Host Watchdog/Idle trip	1=Idle condition
1	149	GET	WORD	DeviceNet Watchdog Status	Bit 0:Remote host watchdog Bit 1:Idle State Bit 2:Slave watchdog Bit 3:Reserved Bit 4:Reserved Bit 5:Reserved Bit 6:Reserved Bit 7:Reserved Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved

Table 44 - Control Supervisor Object – Class Code 0x29					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
					Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	150	GET	UINT	Warning Status Bits[2]	Bit 0:LV Warning Bit 1:HV Warning Bit 2:VUB Warning Bit 3:OC Warning Bit 4:UC Warning Bit 5:CUB Warning Bit 6:GF Warning Bit 7:Reserved Bit 8:Low Frequency Warning Bit 9:High Frequency Warning
1	151	GET/SET	UINT	Warning Enable Bits[2]	Bit 0:LV Warning Enable Bit 1:HV Warning Enable Bit 2:VUB Warning Enable Bit 3:OC Warning Enable Bit 4:UC Warning Enable Bit 5:CUB Warning Enable Bit 6:GF Warning Enable Bit 7:Reserved Bit 8:Low Frequency Warning Enable Bit 9:High Frequency Warning Enable
1	152	GET/SET	UINT	LV Warning Delay[2]	0-255 half-seconds
1	153	GET/SET	UINT	HV Warning Delay[2]	0-255 half-seconds
1	154	GET/SET	UINT	VUB Warning Delay[2]	0-255 half-seconds
1	155	GET/SET	UINT	OC Warning Delay[2]	0-255 half-seconds
1	156	GET/SET	UINT	UC Warning Delay[2]	0-255 half-seconds
1	157	GET/SET	UINT	CUB Warning Delay[2]	0-255 half-seconds
1	159	GET/SET	UINT	GF Warning Delay[2]	0-255 half-seconds
1	160	GET/SET	UINT	LV Warning Setpoint[2]	0-65535 Volts
		Notes	* Applies to CIO modules		
1	161	GET/SET	UINT	HV Warning Setpoint[2]	0-65535 Volts
1	162	GET/SET	UINT	VUB Warning Setpoint[2]	0-255%
1	164	GET	UINT	Unit Type	
1	165	GET	UINT	Unit ID	**Value** Hardware 1 777-P2 2 777-HVR-P2 3 777-575-P2 11 777-LR-P2 12 777-HVR-LR-P2 13 777-575-LR-P2 31 777-MV-P2 41 777-KW/HP-P2 43 777-575-KW/HP-P2 42 777-HVR-KW/HP-P2 64 777-MLR-KW/HP-P2
1	166	GET	UINT	Model Code	
1	167	GET	UINT	Overload Software Revision	**Value** **Device** 0xmr04 777-P2 0xmr27 777-HVR-P2 0xmr05 777-575-P2 0xmr02 777-LR-P2 0xmr07 777-HVR-LR-P2 0xmr08 777-575-LR-P2 0xmr38 777-MV-P2 0xmr47 777-KW/HP-P2 0xmr50 777-575-KW/HP-P2 0xmr52 777-HVR-KW/HP-P2 0xmr
1	169	GET/SET	UINT	Motor Run Hours	
1	170	GET	UINT	RD1 Remaining	Rapid-Cycle Timer (.5 seconds)
1	171	GET	UINT	RD2 Remaining	Motor Cool-Down Timer (.5 seconds)
1	172	GET	UINT	RD3 Remaining	Dry-Well Recovery Timer (.5 seconds)
1	173	GET/SET	UINT	RD1 Setting Rapid-Cycle Timer setting	0-999 seconds
1	174	GET/SET	UINT	RD2 Setting Motor Cool-Down Timer setting	2-500 minutes
1	175	GET/SET	UINT	RD3 Setting Dry-Well Recovery Timer setting	2-500,A (65535) minutes
1	176	GET/SET	UINT	#RU Number of restart attempt after Undercurrent fault	0, 1, 2, 3, 4, A (automatic) **RU Values** 0–4 0–4 A 255
		Notes	* Applies to CIO modules		

Table 44 - Control Supervisor Object – Class Code 0x29					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	177	GET/SET	UINT	#RF Number of Restart attempts after all faults except UC	0, 1, oc1, 2, oc2, 3, oc3, 4, oc4, A, ocA 0 = manual, A = continuous, oc = automatic restart after RD2 expires **Value** **#RF** 1 0 2 1 3 OC1 4 2 5 OC2 6 3 7 OC3 8 4 9 OC4 10 A 11 OCA
1	178	GET	UINT	Power KW * 100	Measured power
1	179	GET	UINT	Power	Power in Horsepower
1	181	GET/SET	UINT	UC Warning Setpoint	Amps * Param 46
1	182	GET/SET	UINT	OC Warning Setpoint	Amps * Param 46
1	183	GET/SET	UINT	GF Warning Setpoint	Amps * 1000
1	184	GET/SET	UINT	CUB Warning Setpoint	%
1	185	GET/SET	UINT	OC Linear Trip Setpoint	254 ½ seconds 255 (Off)
1	190	GET/SET	UINT	High Power Setpoint	0-655.34 KW (65535) Off
1	191	GET/SET	UINT	Low Power Setpoint	Off (0),1-655.35 KW
1	192	GET	WORD	Trip Status	Bit 0:Manual Reset Required Bit 1:Off command issued Bit 2:Tripped on CF Bit 3:Triped on UC or LPR Bit 4:Tripped on OC Bit 5:Tripped on GF Bit 6:Tripped on CUB Bit 7:Triped on cSP Bit 8:Tripped on PTC Bit 9:Tripped on HPR Bit 10:Tripped on LCV Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	193	GET	WORD	Pending Trip Status	Bit 0:LV Pending Bit 1:HV Pending Bit 2:VUB Pending Bit 3:UC/LPR Pending Bit 4:RP Pending Bit 5:CUB Pending Bit 6:vSP Pending Bit 7:cSP Pending Bit 8:OC Pending Bit 9:GF Pending Bit 10:HPR Pending Bit 11:LCV Pending Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Fault Relay Closed
1	195	GET/SET	WORD	Modbus Network Status Bits	Bit 0:Modbus network watchdog enabled Bit 1:Modbus program disabled Bit 2:Front panel locked Bit 3:Reserved Bit 4:Reserved Bit 5:Reserved Bit 6:Reserved Bit 7:Reserved Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
		Notes	* Applies to CIO modules		

Table 44 - Control Supervisor Object – Class Code 0x29					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	196	GET/SET	WORD	Device Configuration Bits	Bit 0:UCTD in minutes Bit 1:RD1 in minutes Bit 2:RD2 in minutes Bit 3:RD3 in minutes Bit 4:HPRTD in minutes Bit 5:Reserved Bit 6:Single-phase voltage device Bit 7:Single-phase current device Bit 8:Disable RP hold-off Bit 9:Enable LCV Trip Bit 10:Stall 1 Enabled Bit 11:Stall 2 Enabled Bit 12:BAC Phase rotation not a fault Bit 13:RD1 loaded on power up Bit 14:RD1 loaded on current loss Bit 15:Enable emergency run
		Notes	* Applies to CIO modules		

Table 45 - Connection Object Class Code 0x2C				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 46 - Overload Object – Class Code 0x2C

Instance	Attribute	Services	Variable Type	Description	Notes
1	3	GET/SET	INT	Overcurrent Trip Setting 777-xxx-P2 777-LR-xxx-P2	 1.0-1120.0 Amps * Param 46 0.10-1120 Amps * Param 46
1	4	GET/SET	USINT	Trip Class without Jam prefix	2-127
1	5	GET	INT	Average Current X 10	
1	6	GET	USINT	% Current Unbalance (measured)	
1	7	GET	USINT	% Thermal Capacity Remaining	
1	8	GET	INT	CurrentL1 (Amps)	Phase 1 Current X 10
1	9	GET	INT	CurrentL2 (Amps)	Phase 2 Current X 10
1	10	GET	INT	CurrentL3 (Amps)	Phase 3 Current X 10
1	11	GET	INT	GF Current (Amps)	Ground Fault Current X 10
1	100	GET	UINT	Scale Factor	Current Scale Factor 1, 10, or 100
1	101	GET	INT	L1 Current (Amps)	L1 Current X attribute 100
1	102	GET	INT	L2 Current (Amps)	L2 Current X attribute 100
1	103	GET	INT	L3 Current (Amps)	L3 Current X attribute 100
1	104	GET	INT	Average Current (Amps)	Average Current X attribute 100
1	105	GET	INT	L1 %OC	Current L1 as % of OC Trip Setting
1	106	GET	INT	L2 %OC	Current L2 as % of OC Trip Setting
1	107	GET	INT	L3 %OC	Current L3 as % of OC Trip Setting
1	108	GET	INT	Avg Current %OC	Average Current as % of OC Trip Setting
1	110	GET	INT	GF Current (Amps)	Ground Fault Current X 100 Ground Fault Current X 1000
1	111	GET	USINT	%Therm	%Thermal Capacity Remaining
1	113	GET	UINT	OL Time to Reset (0.5 Seconds)	Time remaining before 777 resets
1	114	GET	INT	%CUB	% Current Unbalance (measured)
1	115	GET/SET	UINT	GF Trip Delay	0-251
1	116	GET/SET	UINT	High Frequency Warning Setpoint	0-100 Hz * 10
1	117	GET/SET	UINT	Low Frequency Warning Setpoint	0-100 Hz * 10
1	129	GET/SET	USINT	TC Setting Trip Class without Jam prefix	2-127
1	130	GET/SET	BOOL	Jam Enabled	1=Jam Enabled 0=Jam Disabled
1	131	GET/SET	BOOL	Ground Fault Trip Enabled	1=Ground Fault Trip Enabled 0=Ground Fault Trip Disabled
1	132	GET/SET	BOOL	Undercurrent Trip Enabled	1=Undercurrent Trip Enabled 0=Undercurrent Trip Disabled
1	133	GET/SET	BOOL	CUB Trip Enabled	1=Current Unbalance Trip Enabled 0=Current Unbalance Trip Disabled
1	137	GET/SET	UINT	GF Setting Ground Fault Trip Setting 777-xxx-P2 777-LR-xxx-P2	 0.30-640 Amps * 100 0.15-640 Amps *100
1	146	GET/SET	UINT	UCTD/LPR Undercurrent Trip Delay	2-999 Seconds
1	147	GET/SET	UINT	UC Setting Undercurrent Trip Setting 777-xxx-P2 777-LR-xxx-P2	 1-1120 Amps * Param 46 0.10-1120 Amps * Param 46
1	151	GET/SET	UINT	CUB Limit Current Unbalance Setting	2-50 %
1	153	GET/SET	UINT	Jam/Stall 1 Trip Delay	0-255 half-seconds
1	154	GET/SET	UINT	Jam/Stall 1 Inhibit Delay	0-255 half-seconds
1	155	GET/SET	UINT	Jam/Stall 1 Trip Percentage	0-65535%
1	156	GET/SET	UINT	Jam/Stall 2 Trip Delay	0-255 half-seconds
1	157	GET/SET	UINT	Jam/Stall 2 Inhibit Delay	0-255 half-seconds
1	158	GET/SET	UINT	Jam/Stall 2 Trip Percentage	0-65535%
Notes			* Applies to CIO modules		

Table 46 - Overload Object – Class Code 0x2C					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	176	GET/SET	UINT	Divisor	1-255
1	177	GET/SET	UINT	Multiplier	1-255
1	181	GET/SET	BOOL	GF Enable	1=GF Trip Enabled 0=GF Trip Disabled
1	182	GET/SET	BOOL	TC Jam 1 Enable	1=JAM Trip Enabled 0=JAM Trip Disabled
1	183	GET/SET	BOOL	UC Enable	1=UC Trip Enabled 0=UC Trip Disabled
1	184	GET/SET	BOOL	CUB Enable	1=CUB Trip Enabled 0=CUB Trip Disabled
1	185	GET/SET	WORD	Enable/Disable Bits	Bit 0:GF Trip Enabled Bit 1:VUB Trip Enabled Bit 2:CUB Trip Enabled Bit 3:UC Trip Enabled Bit 4:OC Trip Enabled Bit 5:Reserved Bit 6:Low Power Trip Enabled Bit 7:High Power Trip Enabled Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	186	GET/SET	UINT	KW Scale Factor	1-8 1-4 LPR Setpoint front displayed as KW 5-8 LPR Setpoint front displayed as HP
1	187	GET/SET	UINT	Low Control Voltage Trip Delay	0-120 seconds
1	188	GET/SET	UINT	Low Control Voltage Percentage	1-120 %
1	189	GET/SET	UINT	CUB Trip Delay	1-240
1	190	GET/SET	WORD	Motor Acceleration Config Bits	Bit 0:Reserved Bit 1:Reserved Bit 2:MATD applies to CF trip Bit 3:MATD applies to UC,LPR trip Bit 4:Reserved Bit 5:MATD applies to GF trip Bit 6: MATD applies to CUB trip Bit 7: MATD applies to cSP trip Bit 8:Reserved Bit 9: MATD applies to HKW trip Bit 10: MATD applies to LCV trip Bit 11: MATD applies to HOT trip Bit 12:Reseved Bit 13:Reserved Bit 14:Reseverd Bit 15:Reserved
1	191	GET/SET	UINT	Motor Acceleration Trip Delay	0-255 half-seconds
1	192	GET/SET	UINT	High Power Trip Delay	2-255 Seconds
1	193	GET	DWORD	Start Count	0
1	194	GET	DWORD	Start Duration 1	0
1	195	GET	DWORD	Start Duration 2	0
1	196	GET	DWORD	Start Duration 3	0
1	197	GET	DWORD	Start Duration 4	0
1	198	GET/SET	UINT	Start Count/Duration Clear Control	Bit 0: Clear Start Count Bit 1: Clear Start Duration 1 Bit 2: Clear Start Duration 2 Bit 3: Clear Start Duration 3 Bit 4: Clear Start Duration 4 Bit 5: Clear start (low register) Bit 6: Last clear operation had one or more NAKs Bit 7: Last clear operation has finished
1	199	GET/SET	UINT	Hot OC Percentage	100
		Notes	* Applies to CIO modules		

Table 47 - Connection Object Class Code 0x77				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 48 - Voltage Monitor Object – Class Code 0x77					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	3	GET	UINT	Voltage Average Average Voltage (measured)	 Volts
1	4	GET	UINT	Voltage L1-L2 Voltage from L1 to L2	 Volts
1	5	GET	UINT	Voltage L2-L3 Voltage from L2 to L3	 Volts
1	6	GET	UINT	Voltage L3-L1 Voltage from L3 to L1	 Volts
1	7	GET	UINT	%VUB % Voltage Unbalance (measured)	 %
1	8	GET	UINT	PF Angle Power Factor Angle	 °
1	20	GET/SET	UINT	LV Setting Low Voltage Limit 777-xxx-P2 777-MV-xxx-P2 777-575-xxx-P2 777-HVR-xxx-P2	 170-524V 85-262V 450-649V 340-523V
1	21	GET/SET	UINT	HV Setting High Voltage Limit 777-xxx-P2 777-MV-xxx-P2 777-575-xxx-P2 777-HVR-xxx-P2	 172-528V 86-264V 451-660V 341-528V
1	22	GET/SET	UINT	VUB Setting %Voltage Unbalance Limit	 2-25%
1	23	GET/SET	BOOL	VUB Enable	1=Enable 0=Disable
1	24	GET/SET	UINT	Voltage hold off enable bits	Bit 0:Low voltage hold-off enabled Bit 1:High voltage hold-off enabled Bit 2:VUB hold-Off Enabled Bit 3:Reserved Bit 4:Reverse phase hold-off enabled Bit 5:Reserved Bit 6:Voltage single phase hold-off enabled Bit 7:Reserved Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	25	GET	UINT	Measured Line Frequency	Hz * 10
		Notes			

Table 49 - Connection Object Class Code 0x78				
Attribute ID	**Access Rule**	**Name**	**Data Type**	**Value**
1	GET	Revision	UINT	1

Table 50 - DeviceNet Object – Class Code 0x78					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	3	GET	UINT	Input Assembly 3	See input assembly section for details
1	50	GET	UINT	Input Assembly 50	See input assembly section for details
1	51	GET	UINT	Input Assembly 51	See input assembly section for details
1	106	GET	UINT	Input Assembly 106	See input assembly section for details
1	107	GET	UINT	Input Assembly 107	See input assembly section for details
1	190	GET	UINT	Input Assembly 190	See input assembly section for details

Table 51 - DeviceNet Object – Class Code 0xB4					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	5	GET/SET	USINT	Fragmented Explicit Acknowledgment Timeout	(10 ms)
1	7	GET/SET	USINT	Input Assembly 100, Word0	
1	8	GET/SET	USINT	Input Assembly 100, Word1	
1	9	GET/SET	USINT	Input Assembly 100, Word2	
1	10	GET/SET	USINT	Input Assembly 100, Word3	
1	16	GET/SET	USINT	Output Assembly Output Assembly Instance No.	
1	17	GET/SET	USINT	Input Assembly Input Assembly Instance No.	
1	23	GET/SET	WORD	DeviceNet Watchdog Control	Bit 0:Send Off on DeviceNet watchdog Bit 1:Relay A opens on DeviceNet watchdog* Bit 2:Relay B opens on DeviceNet watchdog* Bit 3:Reserved Bit 4:Reserved Bit 5:Reserved Bit 6:Reserved Bit 7:Reserved Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	24	GET/SET	WORD	CIO Relay Control	Bit 0:Reserved Bit 1:Reserved Bit 2:Reserved Bit 3:Reserved Bit 4:Invert A relay* Bit 5:Invert B relay* Bit 6:Reserved Bit 7:B relay warning/fault link enable Bit 8:Reserved Bit 9:Reserved Bit 10:Reserved Bit 11:Reserved Bit 12:Reserved Bit 13:Reserved Bit 14:Reserved Bit 15:Reserved
1	25	GET/SET	USINT	Input Assembly 150, Word0	
1	26	GET/SET	USINT	Input Assembly 150, Word1	
1	27	GET/SET	USINT	Input Assembly 150, Word2	
1	28	GET/SET	USINT	Input Assembly 150, Word3	
1	29	GET/SET	USINT	Input Assembly 150, Word4	
1	30	GET/SET	USINT	Input Assembly 150, Word5	
1	31	GET/SET	USINT	Input Assembly 150, Word6	
1	32	GET/SET	USINT	Input Assembly 150, Word7	
1	33	GET/SET	USINT	Input Assembly 150, Word8	
1	34	GET/SET	USINT	Input Assembly 150, Word9	
1	35	GET/SET	USINT	Input Assembly 150, Word10	
1	36	GET/SET	USINT	Input Assembly 150, Word11	
1	37	GET/SET	USINT	Input Assembly 150, Word12	
1	38	GET/SET	USINT	Input Assembly 150, Word13	
1	39	GET/SET	USINT	Input Assembly 150, Word14	
1	40	GET/SET	USINT	Input Assembly 150, Word15	
1	41	GET/SET	USINT	Input Assembly 150, Word16	
1	42	GET/SET	USINT	Input Assembly 150, Word17	
1	43	GET/SET	USINT	Input Assembly 150, Word18	
1	44	GET/SET	USINT	Input Assembly 150, Word19	
1	45	GET/SET	USINT	Input Assembly 150, Word20	
		Notes	* Applies to CIO modules		

Table 51 - DeviceNet Object – Class Code 0xB4					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	46	GET/SET	USINT	Input Assembly 150, Word21	
1	47	GET/SET	USINT	Input Assembly 150, Word22	
1	48	GET/SET	USINT	Input Assembly 150, Word23	
1	49	GET/SET	USINT	Input Assembly 150, Word24	
1	50	GET/SET	USINT	Input Assembly 150, Word25	
1	51	GET/SET	USINT	Input Assembly 150, Word26	
1	52	GET/SET	USINT	Input Assembly 150, Word27	
1	53	GET/SET	USINT	Input Assembly 150, Word28	
1	54	GET/SET	USINT	Input Assembly 150, Word29	
1	55	GET/SET	USINT	Input Assembly 150, Word30	
1	56	GET/SET	USINT	Input Assembly 150, Word31	
1	57	GET/SET	USINT	Input Assembly 150, Word32	
1	58	GET/SET	USINT	Input Assembly 150, Word33	
1	59	GET/SET	USINT	Input Assembly 150, Word34	
1	60	GET/SET	USINT	Input Assembly 150, Word35	
1	61	GET/SET	USINT	Input Assembly 150, Word36	
1	62	GET/SET	USINT	Input Assembly 150, Word37	
1	63	GET/SET	USINT	Input Assembly 150, Word38	
1	64	GET/SET	USINT	Input Assembly 150, Word39	
1	65	GET/SET	USINT	Input Assembly 150, Word40	
1	66	GET/SET	USINT	Input Assembly 150, Word41	
1	67	GET/SET	USINT	Input Assembly 150, Word42	
1	68	GET/SET	USINT	Input Assembly 150, Word43	
1	69	GET/SET	USINT	Input Assembly 150, Word44	
1	70	GET/SET	USINT	Input Assembly 150, Word45	
1	71	GET/SET	USINT	Input Assembly 150, Word46	
1	72	GET/SET	USINT	Input Assembly 150, Word47	
1	73	GET/SET	USINT	Input Assembly 150, Word48	
1	74	GET/SET	USINT	Input Assembly 150, Word49	
1	127	GET/SET	USINT	Set to standalone*	Write this to 0 to set to standalone
1	128	GET/SET	USINT	B Relay Warn Link Mask Hi	Bit 0: Low Frequency Warn Link Bit 1: High Frequency Warn Link Bit 2: Reserved Bit 3: Reserved Bit 4: Reserved Bit 5: Reserved Bit 6: Reserved Bit 7: Reserved
1	129	GET/SET	USINT	B Relay Warn Link Mask Lo	Bit 0: LV Warn Link Bit 1: HV Warn Link Bit 2: VUB Warn Link Bit 3: OC Warn Link Bit 4: UC Warn Link Bit 5: CUB Warn Link Bit 6: GF Warn Link Bit 7: Reserved
1	130	GET/SET	USINT	B Relay Fault Link Mask Hi	Bit 0: Reserved Bit 1: Reserved Bit 2: Reserved Bit 3: Reserved Bit 4: Reserved Bit 5: Reserved Bit 6: Reserved Bit 7: Reserved
1	131	GET/SET	USINT	B Relay Fault Link Mask Lo	Bit 0: Reserved Bit 1: Reserved Bit 2: CF Fault Link Bit 3: UC Fault Link Bit 4: OC Fault Link Bit 5: GF Fault Link Bit 6: CUB Fault Link Bit 7: cSP Fault Link
1	140	GET/SET	USINT	Power Up Options	Bit 0: Flex Addressing Enabled
		Notes	* Applies to CIO modules		

Table 51 - DeviceNet Object – Class Code 0xB4					
Instance	**Attribute**	**Services**	**Variable Type**	**Description**	**Notes**
1	141	GET/SET	USINT	Trip Inhibit High Byte*	Bit 0: Reserved Bit 1: HPR Trip Inhibit Bit 2: LCV Trip Inhibit
1	142	GET/SET	USINT	Trip Inhibit Low Byte*	Bit 2: CF Trip Inhibit Bit 3: UC Trip Inhibit Bit 4: OC Trip Inhibit Bit 5: GF Trip Inhibit Bit 6: CUB Trip Inhibit Bit 7: cSP Trip Inhibit
1	143	GET/SET	USINT	CIO Setup*	Bit 0: Input 1 is used as trip inhibit
			Notes	* Applies to CIO modules	

APPENDIX A: SOLUTIONS FOR MODBUS NETWORKS

The Modbus assembly allows the master controller to read setpoints and real-time data in any order independently of the published memory map. To configure the assemblies, use *Solutions* to write parameters MBAssem500WrdXX and MBAssem501WrdXX. The parameters that can be entered into MBAssem500WrdXX and MBAssem501WrdXX can be found in Table 4 and Table 5. The value entered into each parameter is the Modbus address of the parameter that the user desires to view. Figure 2 show a Modbus assembly configured for 23,24,25,26 which if the user reads 0x500 for 4 word the assembly will return Vca, Vbc, Vab, and Average Voltage respectively.

Assembly 0x500

Assembly 500 allows a read of 37 parameters. To read, generate a Modbus read with 0x500 as the read address and then number of registers field will specify how many parameters.

Assembly 0x501

Assembly 501 allows a read of 25 parameters. To read, generate a Modbus read with 0x501 as the read address and then number of registers field will specify how many parameters.

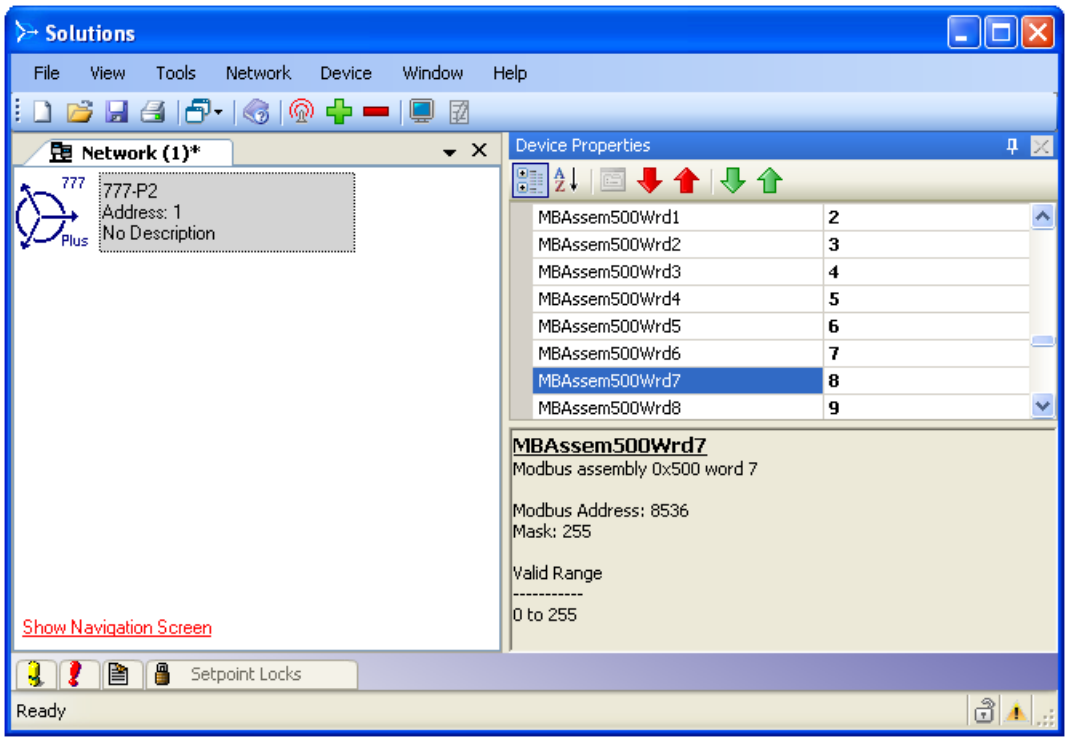


Figure 1 - Modbus Assembly

Step 1. Start *Solutions*
Step 2. Select **Modbus RTU** from the **Select Network Connection Type** dialog box.

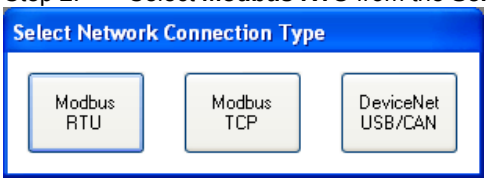


Figure 2 - Network Connection

Step 3. Click **Auto Detect Units** on left hand navigation pane.

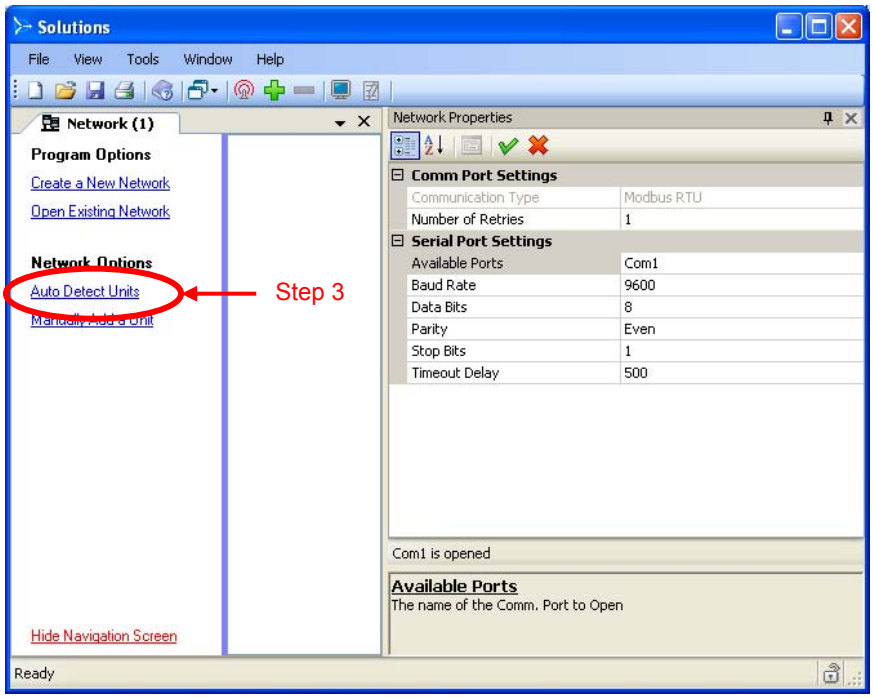


Figure 3 - Empty Network View

Step 4. Click the desired device to edit the device parameters.

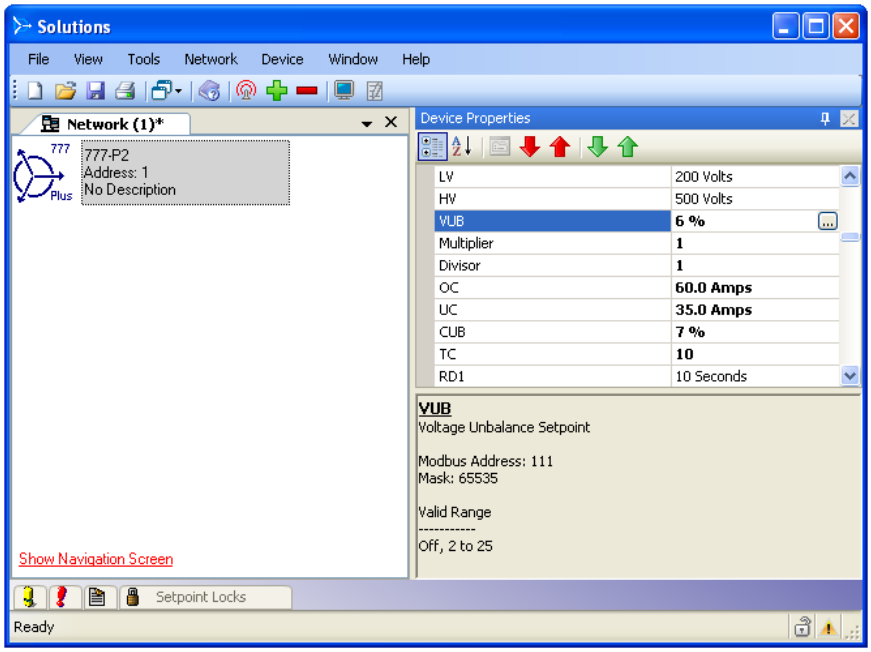


Figure 4 - Modbus Parameters

APPENDIX B: SYMCOM SOLUTIONS FOR DEVICENET NETWORKS

Setup Using EDS Files

Each CIO-DN-P, CIO-120-DN-P, overload pair must use a DeviceNet EDS file to work with SymCom *Solutions.* Each EDS file has an icon associated with it. These EDS and icon files can be found at www.symcom.com. Table 52 below shows the device and required EDS and ICON files.

Table 52 - EDS Files

Overload	CIO Module		Icon File
777-P2	777-P2_CIO_xxxx.eds		777Plus.ico
777-575-P2	777-575-P2_CIO_xxxx.eds		777Plus.ico
777-HVR-P2	777-HVR-P2_CIO_xxxx.eds		777Plus.ico
777-KW/HP-P2	777-KWHP-P2_CIO_xxxx.eds		777Plus.ico
777-HVR-KWHP-P2	777-HVR-KWHP-P2_CIO_xxxx.eds		777Plus.ico
777-575-KWHP-P2	777-575-KWHP-P2_CIO_xxxx.eds		777Plus.ico
777-LR-P2	777-LR-P2_CIO_xxxx.eds		777Plus.ico
777-575-LR-P2	777-575-LR-P2_CIO_xxxx.eds		777Plus.ico
777-HVR-LR-P2	777-HVR-LR-P2_CIO_xxxx.eds		777Plus.ico
777-KWHP-LR-P2	777-LR-KWHP-P2_CIO_xxxx.eds		777Plus.ico
777-MV-P2	777-MV-P2_CIO_xxxx.eds		777Plus.ico
777-MLR-KWHP-P2	777-MLR-KWHP-P2_CIO_xxxx.eds		777Plus.ico
777-HRG-P2	777-HRG-P2_CIO_xxxx.eds		777Plus.ico
777-LR-HRG-P2	777-LR-HRG-P2_CIO_xxxx.eds		777Plus.ico
777-575-HRG-P2	777-575-HRG-P2_CIO_xxxx.eds		777Plus.ico
777-575-LR-HRG-P2	777-575-LR-HRG-P2_CIO_xxxx.eds		777Plus.ico

Configuring Devices using SymCom Solutions software

Step 1. Start *Solutions*
Step 2. Click the **DeviceNet USB/CAN** button

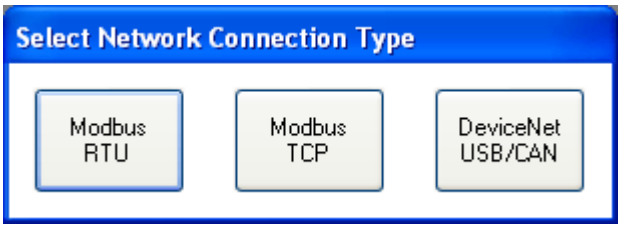


Figure 5 - Network Select

Step 3. Select **Tools** > **Device Manager.** *Solutions* Studio will bring up the dialog to import EDS files.

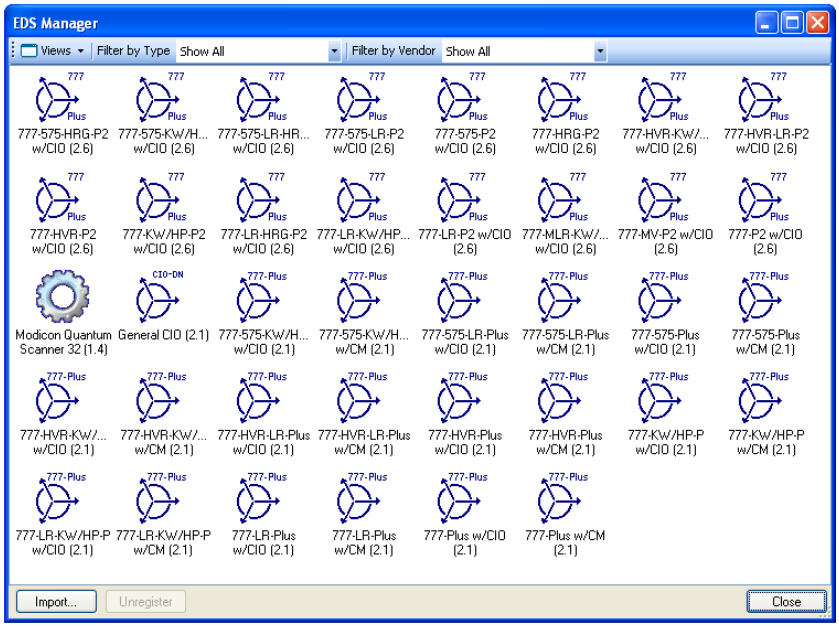


Figure 6 - EDS Manager

Step 4. Click the **Import…** button to bring up the **Import EDS** dialog box. Select the EDS files downloaded and click the **Open** button.

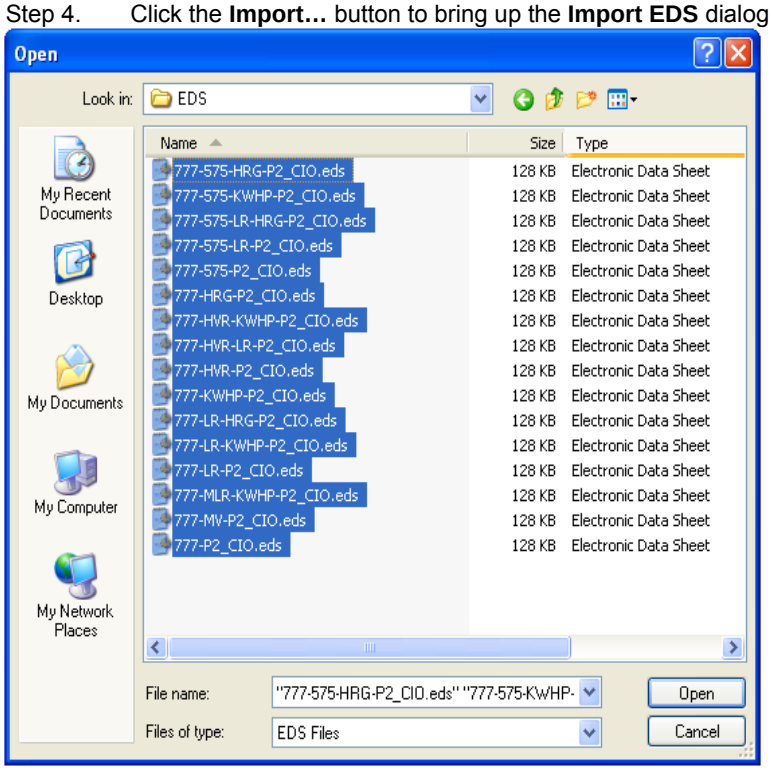


Figure 7 - EDS Open

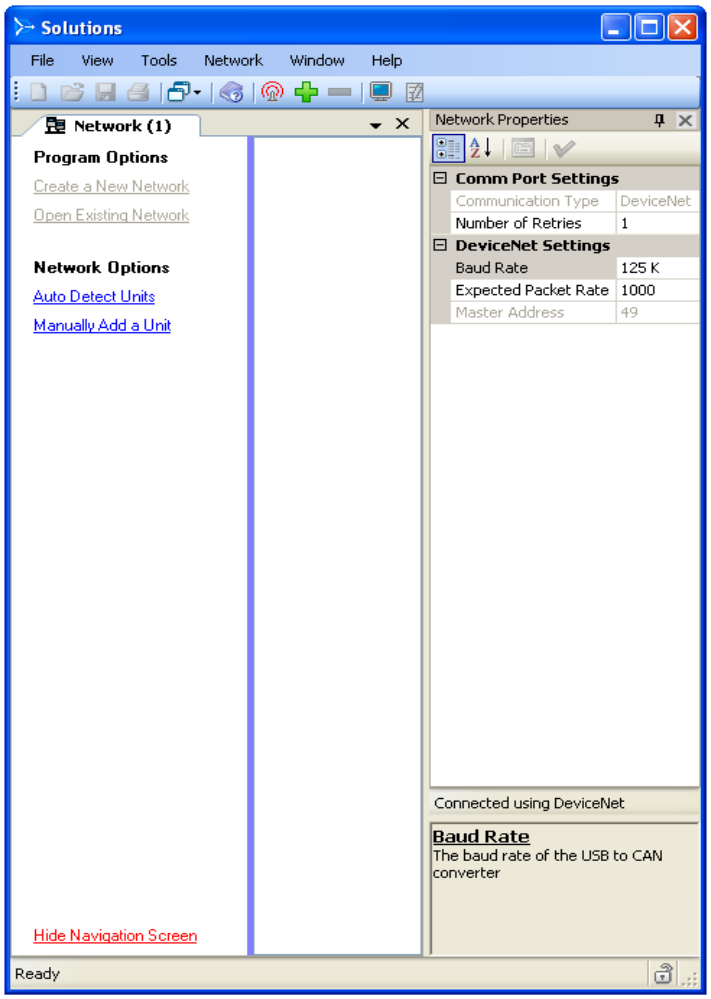


Figure 9 - Network View

Step 5. Click **Auto Detect Units** button in the **Navigation Screen**

Step 6. The first time a DeviceNet network is commissioned all nodes will be at the same address and appear to a configuration tool as faulted devices. When a device is faulted, *Solutions* will show the dialog in Figure 8.

Figure 8 - Faulted Unit Recovery

By click Send ICF Request the user can identify the faulted device and assign it an appropriate address. The CIO modules will identify themselves by flashing alternate red and green LEDs.

Step 7. Change the address of the device by clicking **Recover this Device**.

Step 8. Repeat Step 6 and Step 7 for all faulted devices.

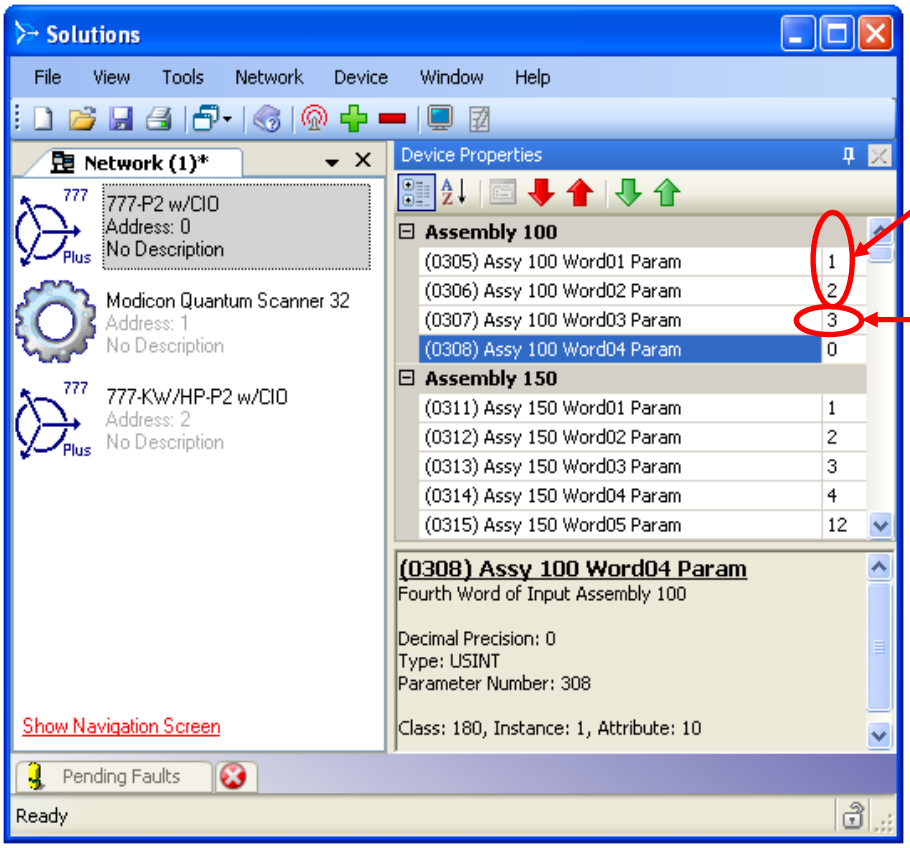


Figure 10 - Variable Input Assembly

Step 9. Configuring Variable Assembly

Step a. Click on a device to edit the parameters of the device

Step b. Enter Parameters to monitor with a poll. In this case, parameters 1, 2, 3 are L1, L2, L3 voltages respectively. These values must match values in the parameter class (see Table 42).

Step c. End the list of parameters with 0.

Step d. Setup input assembly for assembly 100.
Step e. Setup output assembly for desired relay control (see Table 17 through Table 21).

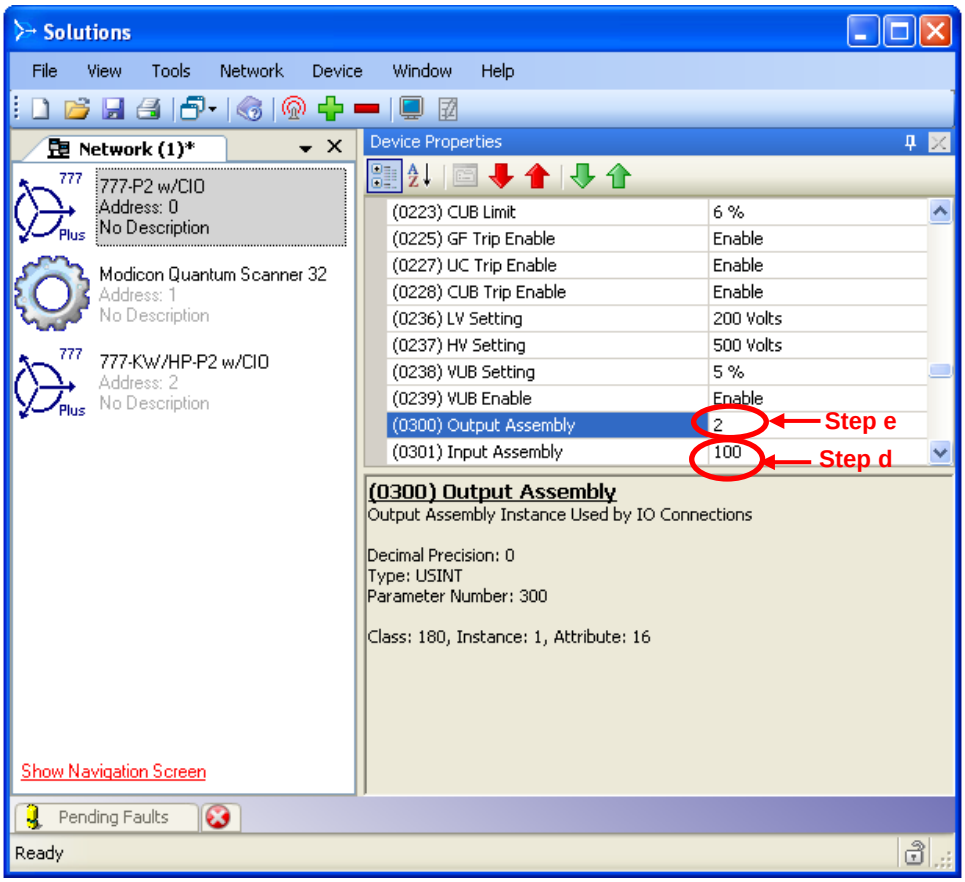


Figure 11 - Variable Input Assembly

Step 10. Click the scanner icon, and click **Download From Scanner** button on the **Scanner Settings** tab.

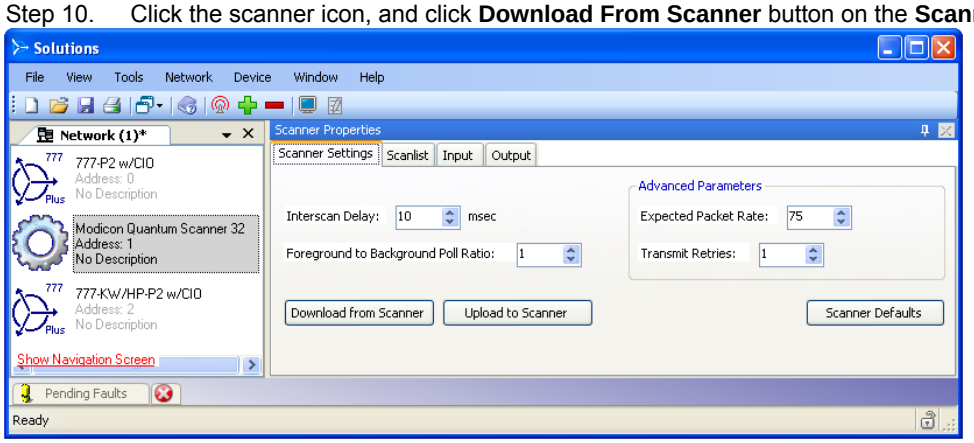


Figure 12 - Scanner Settings

Step 11. Click the **Scanlist** tab, and select the device to scan from the **Available Devices:** window.
Step 12. Click the **>** button to move the selected device to the **Scanlist:** window.

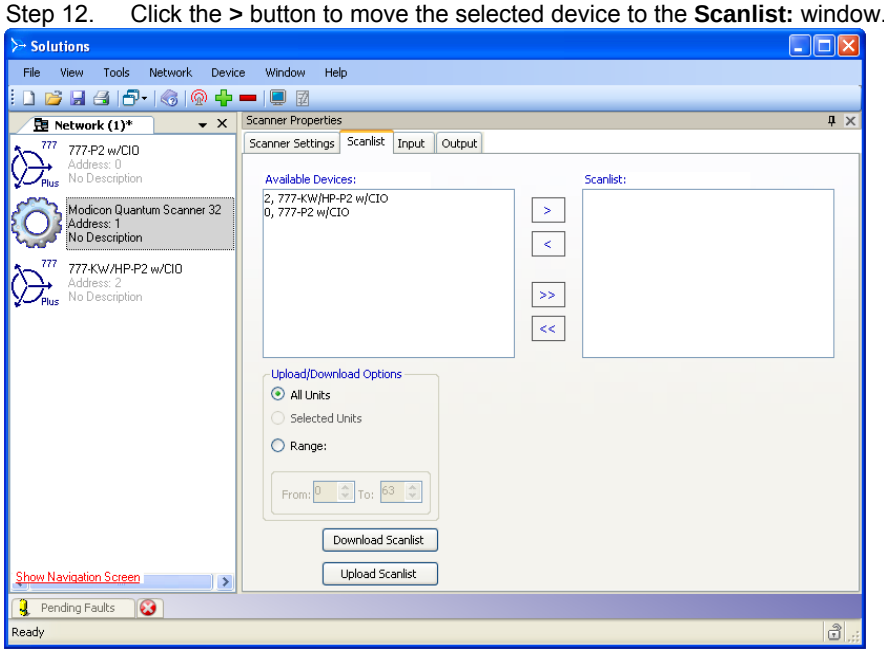


Figure 13 - Scanlist

Step 13. Click the device in the **Scanlist:** window, Verify that the scan parameters are correct for the device; these should automatically be imported from the device EDS file.

Step 14. Click **Download Scanlist** button to download the **Scanlist:** windows devices to the scanner.

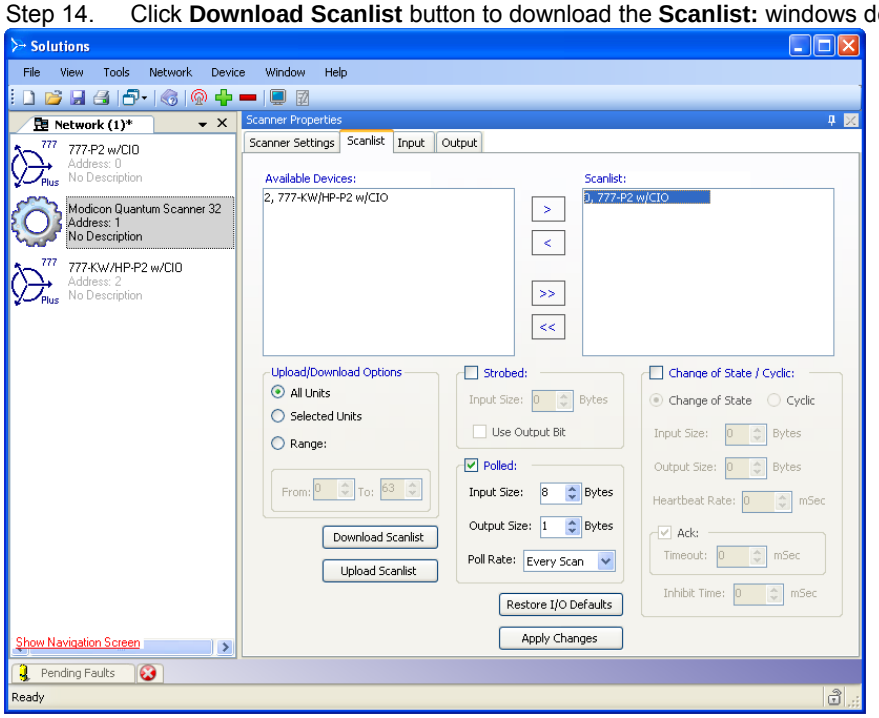


Figure 14 - Scanlist

Step 15. Click the **Input** tab in the **Scanner Properties** window. Setting up the input and output map in this example we will assume using input assembly 100 which is 8 bytes and we will be using output assembly 104 see Table 20 which is 1 byte.

Step 16. Select the device to be configured.

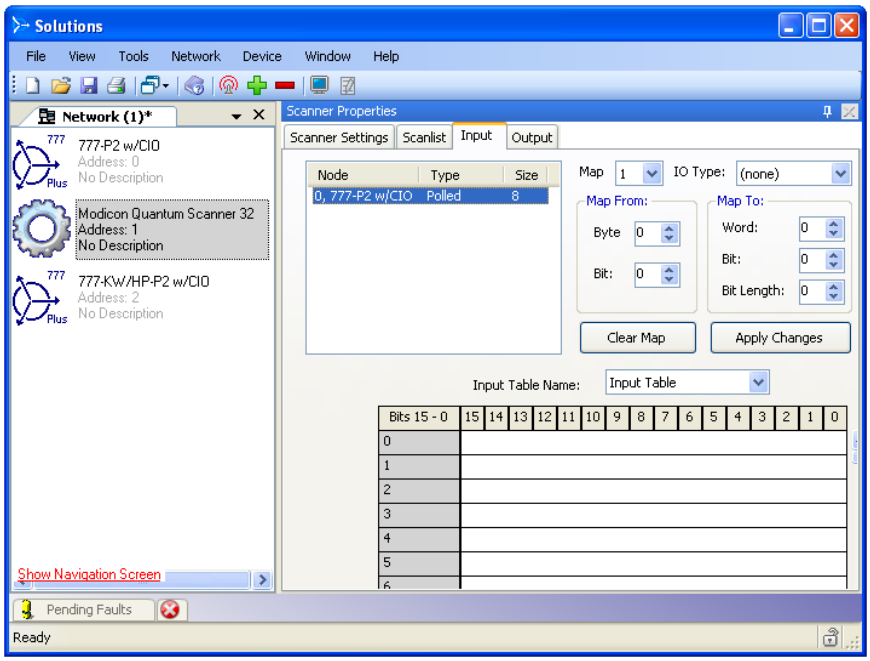


Figure 15 - Input Empty

Step 17. Select the Map number from the **Map** drop down box. *Solutions* allows up to 4 maps.
Step 18. Select **Polled** from the **IO Type** drop down box.
Step 19. Select the Byte number in the **Byte** drop down box in the **Map From:** panel. For example, using assembly 100 we look at the first word in the parameter view. See Table 42. In this case the first word is 1 which is L1 current * 10, see Table 46. We know that each parameter is 2 bytes longs so when selecting the **Byte** from the **Map From:** panel, always use even number to get both the high and low bytes of that parameter.
Step 20. Adjust the **Word:** drop down box in the **Map To:** panel, to match the word number where the scanner will store the data coming in from the poll command.
Step 21. Adjust the **Bit Length** drop down box to 16. All parameter are 2 bytes or 16 bits in length.
Step 22. Click the Apply Changes button to commit map changes.
Step 23. Repeat Step 17 through Step 22 for all parameter to be mapped. In the case of input assembly 100 the user could map all 4 parameters; this is shown in Figure 16.

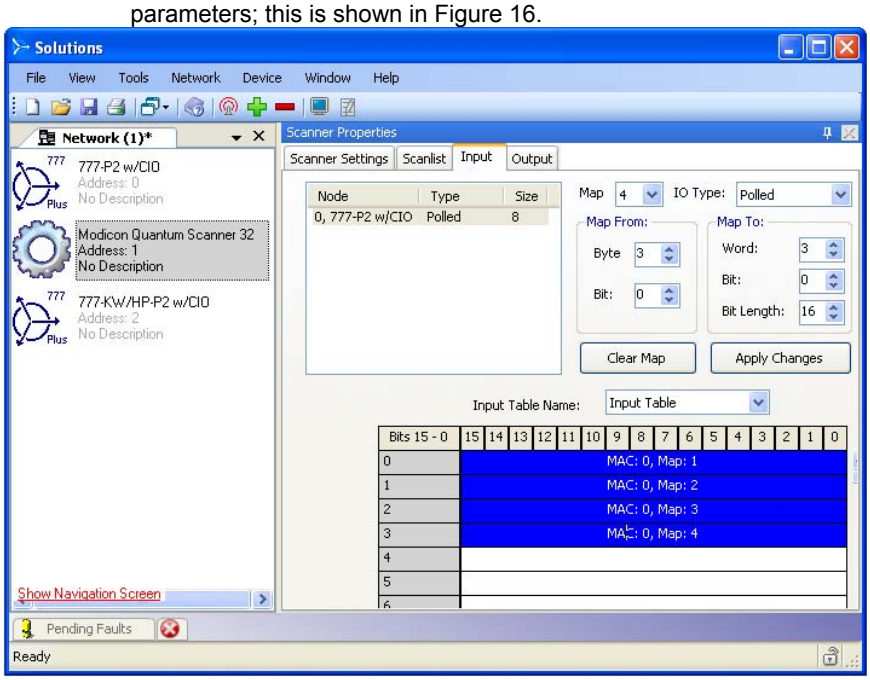


Figure 16 - Input Map

Step 24. Click the Output tab in the Scanner Properties window. In this example we will be using output assembly 4 which is 1 byte long and controls the A and B relays of the CIO module.
Step 25. Select the device to be configured.

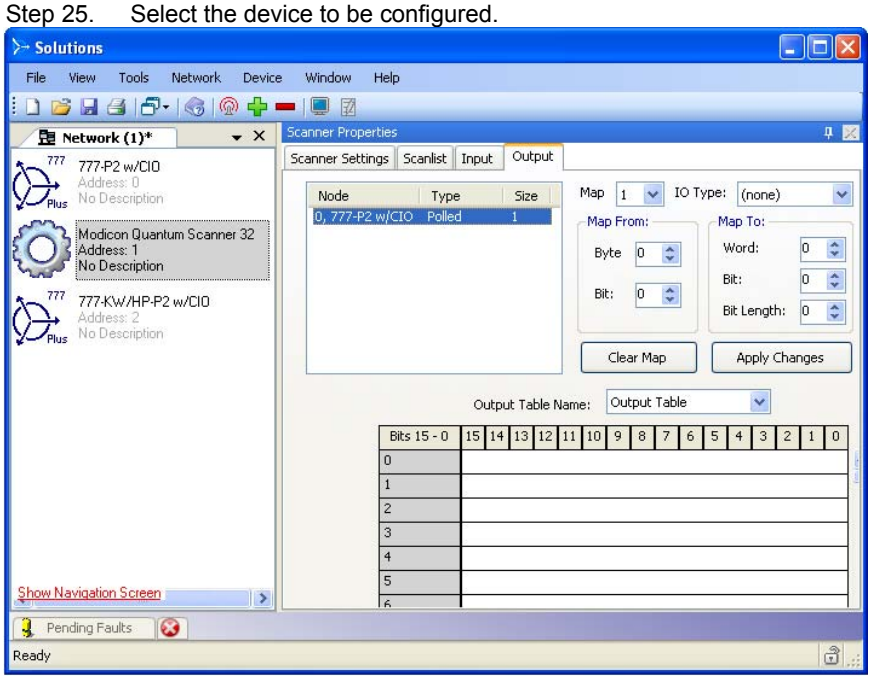


Figure 17 - Output Empty

Step 26. Select the Map number from the **Map** drop down box. *Solutions* allows up to 4 maps.
Step 27. Select **Polled** from the **IO Type** drop down box.
Step 28. Select the Byte number in the **Byte** drop down box in the **Map From:** panel. For example: Using output assembly 104, this has 2 bits, bits 0 controls relay A , bit 1 controls relay B see Table 20.
Step 29. Adjust the **Bit:** drop down box in the **Map From:** panel, to matches the bit number for the relay to be controlled.
Step 30. Adjust the **Word:** drop down box in the **Map To:** panel to 0.
Step 31. Adjust the **Bit:** drop down box to match the bit of the relay to be controlled.
Step 32. Adjust the **Bit Length** drop down box to 1.
Step 33. Click the **Apply Changes** button to commit map changes.
Step 34. Repeat Step 26 through Step 33 for all parameter to be mapped. In the case of output assembly 4 there are only 2 relay bits to map as shown in Figure 18.

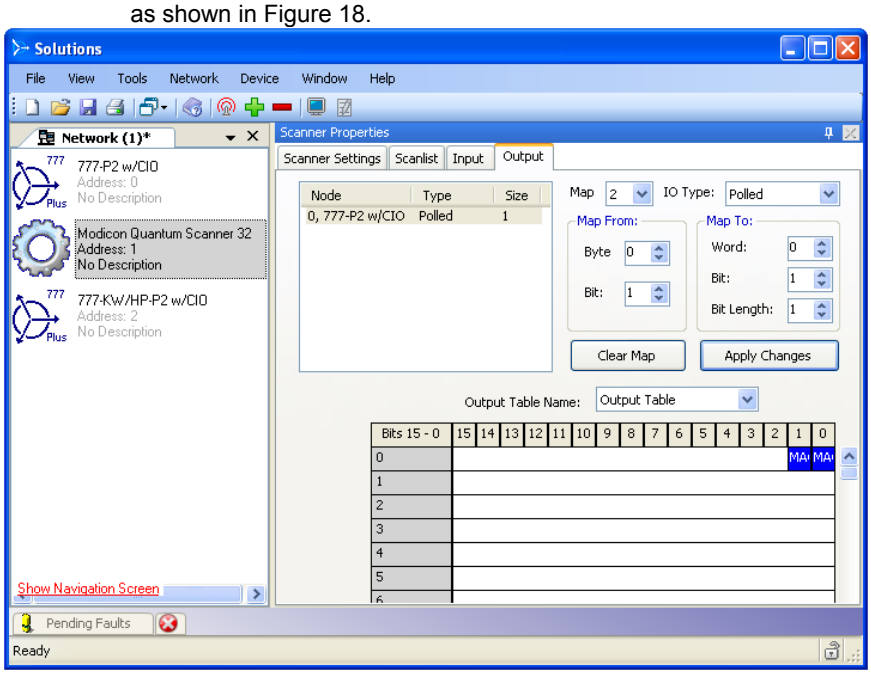


Figure 18 - Output Map

Step 35. Click the Scanlist tab in the Scanner Properties window.
Step 36. Select the target device.
Step 37. Click the **Upload Scanlist** button to commit the mapping changes to the scanner.

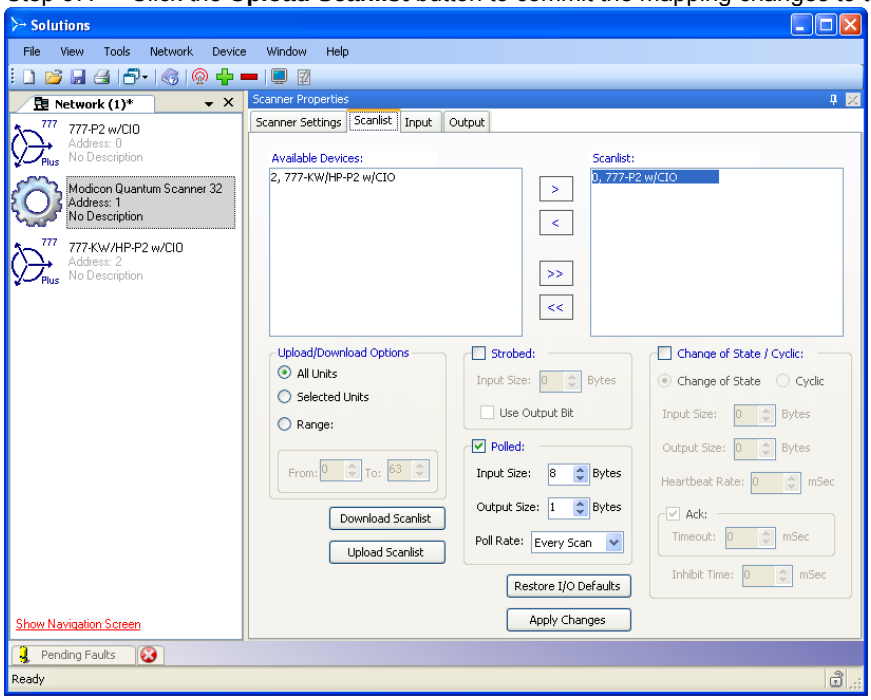


Figure 19 - Scanlist Upload

GLOSSARY

BOOL: Boolean. This is a true/false or on/off value.

DINT: Double, signed integer value. It is a signed, 32-bit (4 byte) number that can have a value of -2,147,483,648 to +2,147,483,647

DWORD: Double word value. It is a 32-bit (4-byte) number that can have up to 32 bits (on/off) defined within it.

EDS: Electronic data sheet. File with information about configurable attributes for a device, including object addresses for each parameter.

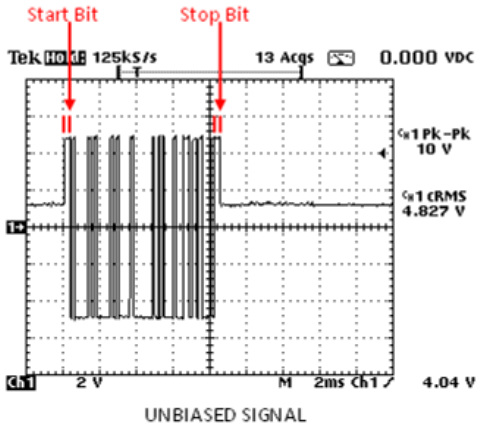
EPATH: Encoded path descriptor. Sometimes referred to as "Abstract Syntax Encoding for Segment Types". Used to describe arbitrary combinations of Logical Segments, Symbolic Segments, and Data Segments. EPATH may be used as a descriptor of the Class-Instance-Attribute information.

ICO: Icon file extension. Icon files may be used to customize the icon used by an installation of the *Solutions* software.

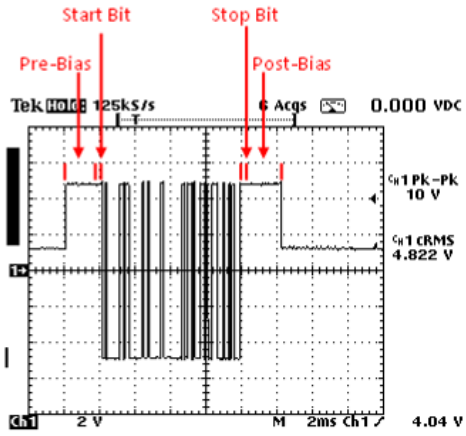
INT: Signed integer value. It is a signed, 16-bit (2-byte) number that can have a value of −32,768 to +32,767.

NAK: Negative-Acknowledge Character. Used to indicate that an error was detected in the previously received block and that the receiver is ready to accept retransmission of that block.

Pre- and Post- Bias: The pre-biasing of a signal is the delay from RTS active to the start bit of a message. The post-biasing of a signal is the delay from the stop bit of a message to RTS inactive. A biased signal helps eliminate the effects of ringing of output current or by other equipment that are also connected to the same network.



UNBIASED SIGNAL



BIASED SIGNAL

Signed: Can represent both positive and negative numbers.

Unsigned: Can only represent positive numbers.

UINT: Unsigned integer. It is an unsigned, 16-bit (2-byte) number that can have a value of 0 to +65,535.

USINT: Unsigned short integer. It is an unsigned, 8-bit (1-byte) number that can have a value of 0 to +255.