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Mega_Link 2

APPLICATION NOTE AN032
Using Modbus RTU Slave Mode on COM3A/3B

Summary

In addition to transferring 'Real-World' physical data, Mega_Link 2 can also interface directly to a PLC, SCADA system or third-party telemetry system over the COM3A/3B serial port (RS232/RS485) using the Modbus RTU protocol.

This is often used for a system with multiple outstations with many analogue and digital inputs. Rather than present the data as physical I/O using multiple expansion modules it can be more convenient to transfer the gathered input data via Modbus.

This document outlines the supported options for accessing this information with the Mega_Link 2 operating in Slave mode. (For Master mode see AN033 Using Modbus RTU Master Mode on COM3A/3B).

This document assumes that the user has already established the communications network of Mega_Link 2 modules via UHF radio or 4G communications or Ethernet TCP/IP.

For the sake of simplicity this document assumes each item of third-party equipment is a PLC. However, it could equally be a SCADA system, a regional telemetry outstation, an HMI display or an intelligent instrument.

Ref. 1 AN030 Modbus Register Address Mapping

Ref. 2 AN031 Modbus Register Address Listing

Churchill Controls Ltd._Unit 30 Wellington Business Park, Dukes Ride, Crowthorne, RG45 6LS

Tel: +44 (0)1344 750233 e-mail: sales@churchill-controls.co.uk

1. Introduction

Many PLCs have the ability to communicate with other devices via a Modbus RTU serial link. This is generally done using one of two electrical interface standards – RS232 or RS485. The PLC manufacturer defines the protocol (language) used for communication. The Mega_Link 2 unit to which it is linked, along with the data rate and format must match this.

The Modbus RTU protocol operates on a master/slave basis, whereby a master device can 'talk' to one or more slaves. All communication is instigated by the master, and each slave responds only to the commands addressed to it.

Mega_Link 2 has been designed to interface using Modbus RTU. The COM3A/COM3B serial interface port is included within each Mega_Link 2, and is named Fieldbus/Bus_Link to signify that it is a general-purpose port for communication with various PLC busses. It can be configured to operate using the Modbus RTU protocol in either master or slave mode, in various different data rates and serial format, and can use either RS232 or RS485 signal levels.

This document describes using the Mega_Link 2 operating in Modbus RTU **slave** mode.

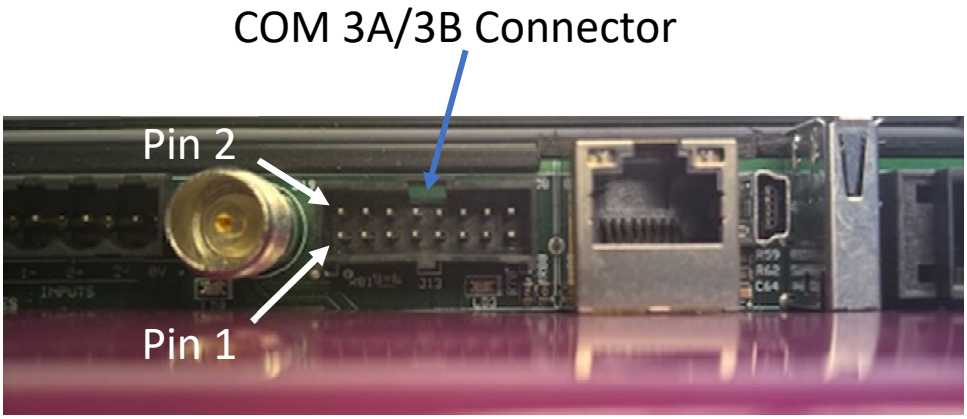
2. Protocol and Interface

2.1 Fieldbus/Bus_Link Connections

The Fieldbus/Bus_link port on COM 3A/3B of the Mega_Link 2 is used for communication with PLC's, SCADA systems and larger telemetry schemes. It is configured through the DCD2 software, and presented in either RS232 or RS485 format.

The RS232 and RS485 interfaces are provided through a 16-pin header socket as shown.

The Mega_Link 2 can be made directly connector compatible with Mega_Link 1 (and Micro_Link) using an adapter is available to make it directly compatible with the RJ45 style connector as used on Mega_Link1 and Micro_Link.



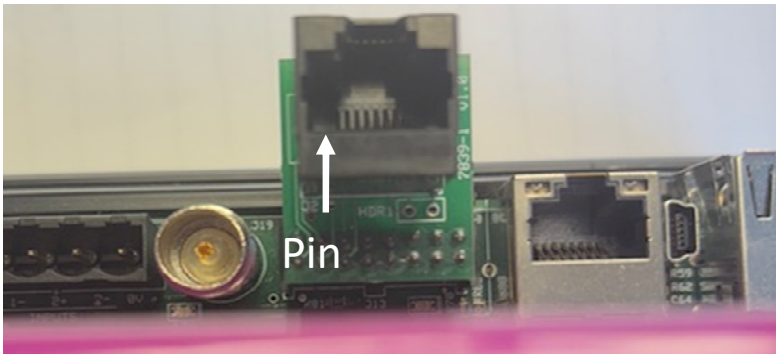
Wire Connector type: 16-pin Female Connector, MOLEX 90142-0016 and crimp terminal 90119-2120

Pin	Function	Notes
1	0V	Ground
2	RS485 B (D+)	Differential In/Out
3	RS485 T	Termination Resistor (connect to RS485 B if used)
4	RS485 A (D-)	Differential In/Out
5	RS232 TXD	Output from Mega_Link 2

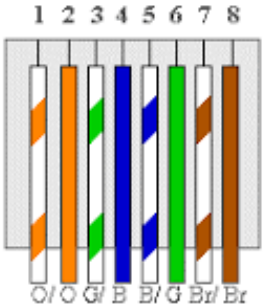
6	RS232 RXD	Input to Mega_Link 2
7		
8		
9		
10		
11		
12		
13		
14		
15		
16	0V	Ground

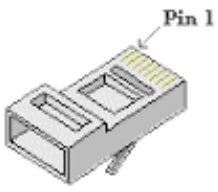
Mega_Link 2 COM 3 Adaptor Board, part number 7839-1.

COM 3A/3B



Pin	Function	CAT5 Colour	Notes
1	0V	White/Orange	Ground
2	RS485 B (D+)	Orange	Differential In/Out
3	RS485 T	White/Green	Termination Resistor (connect to RS485 B if used)
4	RS485 A (D-)	Blue	Differential In/Out
5	RS232 TXD	White/Blue	Output from Mega_Link 2
6	RS232 RXD	Green	Input to Mega_Link 2



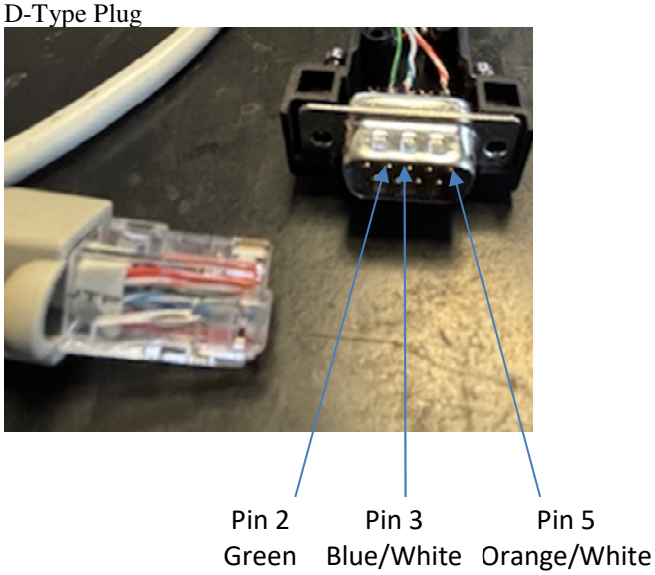


RJ-45 Plug

2.2 RS232

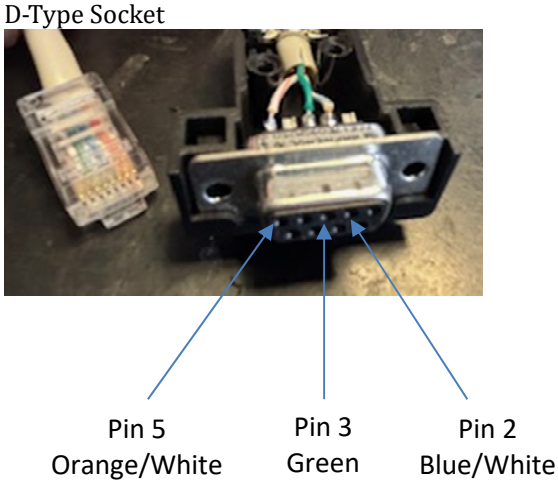
Typical Cable Wiring details are as follows:

D-Type Plug



Colour	Pin Number	Signal
Green	2	Mega_Link 2 IN
Blue/White	3	Mega_Link 2 OUT
Orange/White	5	0V

D-Type Socket



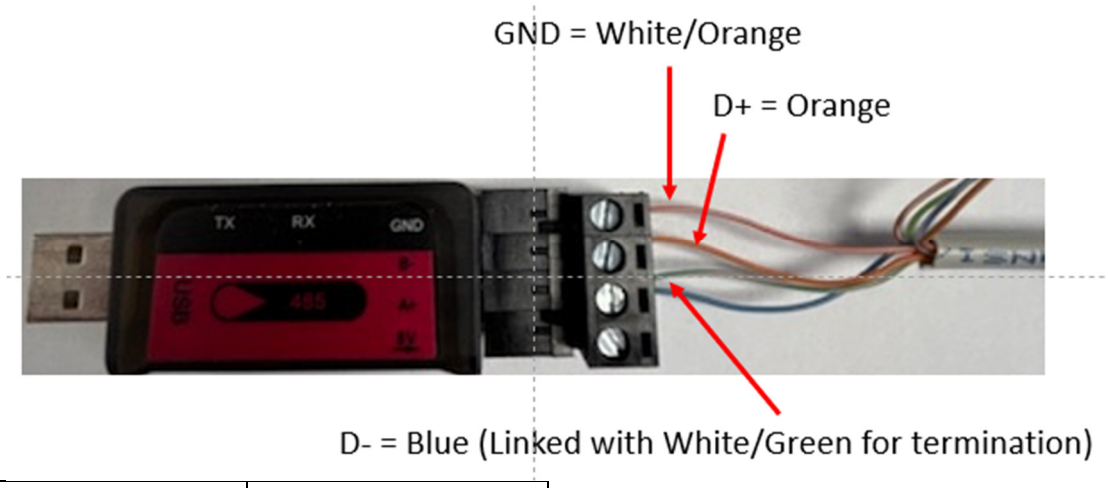
Colour	Pin Number	Signal
Blue/White	2	Mega_Link 2 OUT
Green	3	Mega_Link 2 IN
Orange/White	5	0V

2.3 RS485

RS485 is a 2-wire interface that can link multiple devices together. The A (D-) legs of all devices should be connected together, as should be B (D+) legs. For short links the type of wire used is unimportant. However, if the cable is more than 5m long it should be a twisted-pair communications cable with a characteristic impedance of around 120Ω.

If Mega_Link 2 is located at one end of the cable an internal 120Ω terminating resistor can be connected by linking terminal RS485T to RS485B.

Typical Cable Wiring details are as follows:



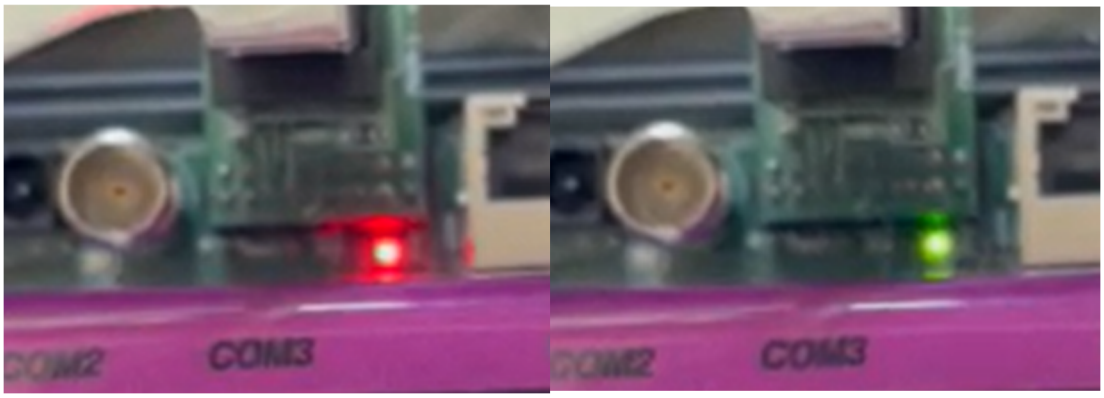
Colour	Signal
Orange	Mega_Link 2 D+
Blue	Mega_Link 2 D-
Green/White	Mega_Link 2 Term
Orange/White	0V

2.4 Diagnostics LEDs

An LED indicator is included on Mega_Link 2 to monitor the COM3A/3B port. When Mega_Link 2 is operating as a slave, it flashes red when Mega_Link 2 is receiving a request and green when it is transmitting a response.

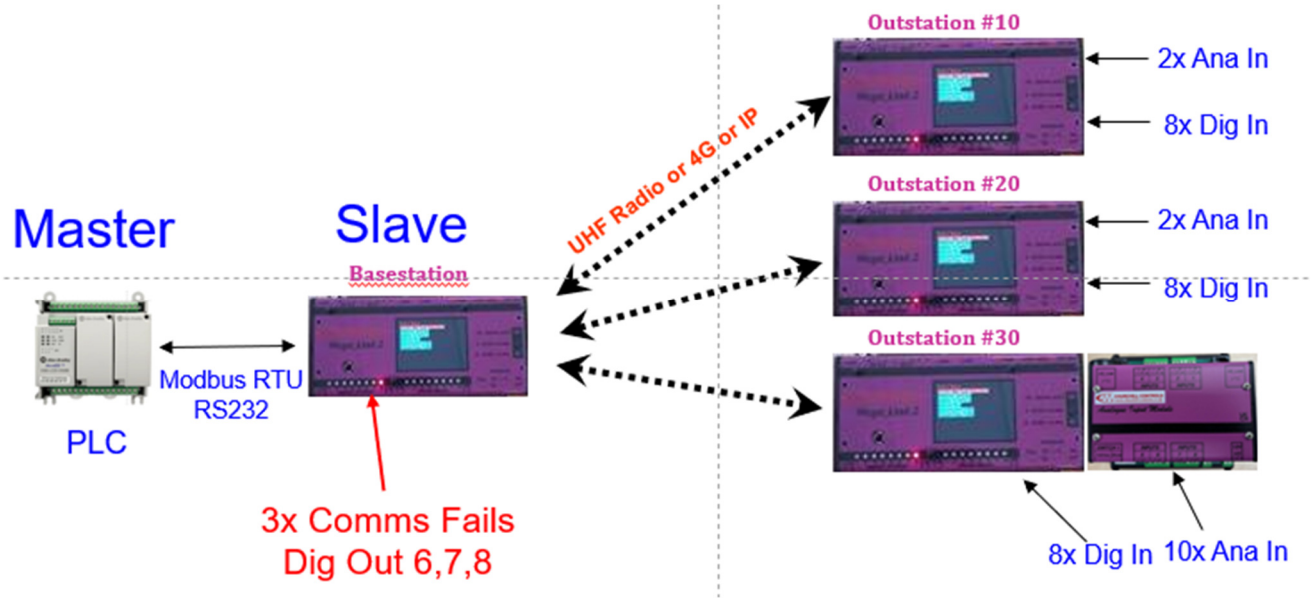
Furthermore, Mega_Link 2 includes very powerful diagnostics via the DCD2 USB port. This allows a PC to be connected to configure and monitor all aspects of its operation. When set to monitor the Fieldbus/Bus_Link communications it can display every message sent to/from Mega_Link 2 when in slave mode.

Receiving a Request **Transmitting a Response**



3. Example with Inputs From 3 Outstations (1 with expansion)

Example 1: A PLC master gathering real world inputs from remote outstations.



Each outstation is configured with a Mega_Link 2 address, #10, #20 and #30.

The Mega_Link 2 Basestation **slave** must be configured with a slave ID, in this example Slave ID = 1.

The PLC master must be configured to pass data to/from specific database locations within the Basestation.

The PLC programmer/user needs to understand the structure of the Mega_Link 2 database to determine which database address locations to use.

3.1 Example Requirements

In this example there are three outstation sites.

Outstation #10 – 8x Digital Inputs, 2x Analogue Inputs

Outstation #20 – 8x Digital Inputs, 2x Analogue Inputs

Outstation #30 – 8x Digital Inputs, 10x Analogue Inputs

3.2 Basestation Configuration

In this example system the analogue input signals will be gathered together at the Basestation and transferred to the PLC using Modbus.

The Basestation configuration is very simple.

It is recommended that basic outstation comms fail alarms be set as described.

3.3 General

All software configuration of Fieldbus/Bus_Link is carried out using the DCD2 software that is supplied on a memory stick with every Mega_Link 2 system. Alternatively, it can be downloaded from our website on www.churchill-controls.co.uk .

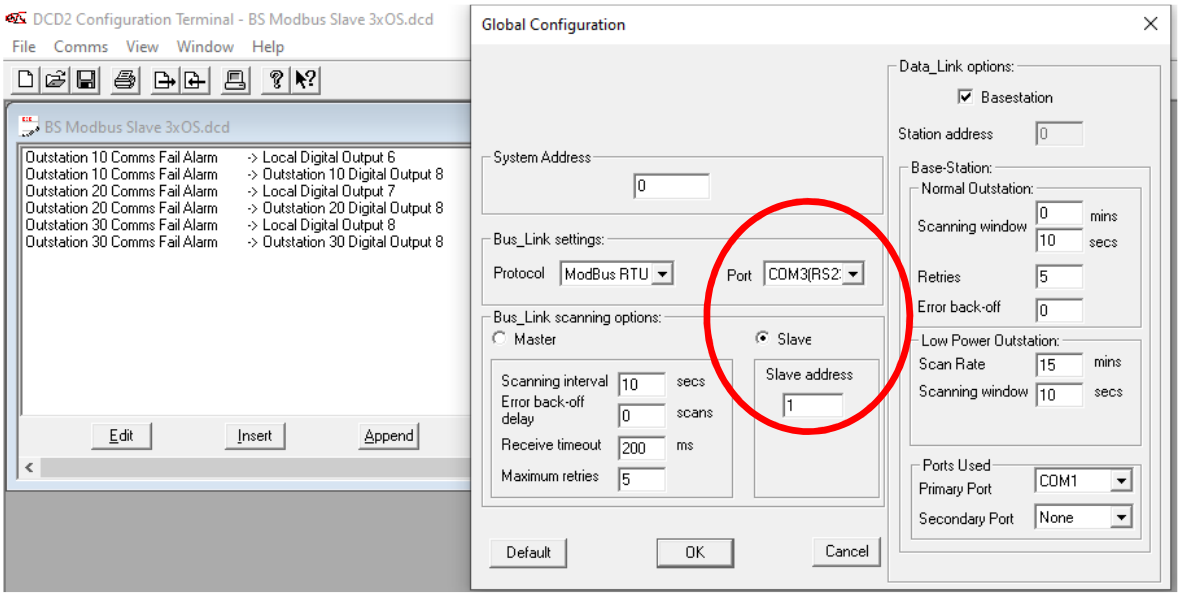
When DCD2 is running, a configuration can be created either by opening an existing file, creating a new file or uploading the configuration from a Mega_Link 2. Each configuration creates a new window.

3.4 Protocol Selection

These settings can be chosen by clicking on the ‘Global’ button. This will open a dialog box called 'Global Configuration' as follows:

This example is setting Modbus RTU mode via COM3(RS232).

It has set Slave mode and the Slave address ID = 1.

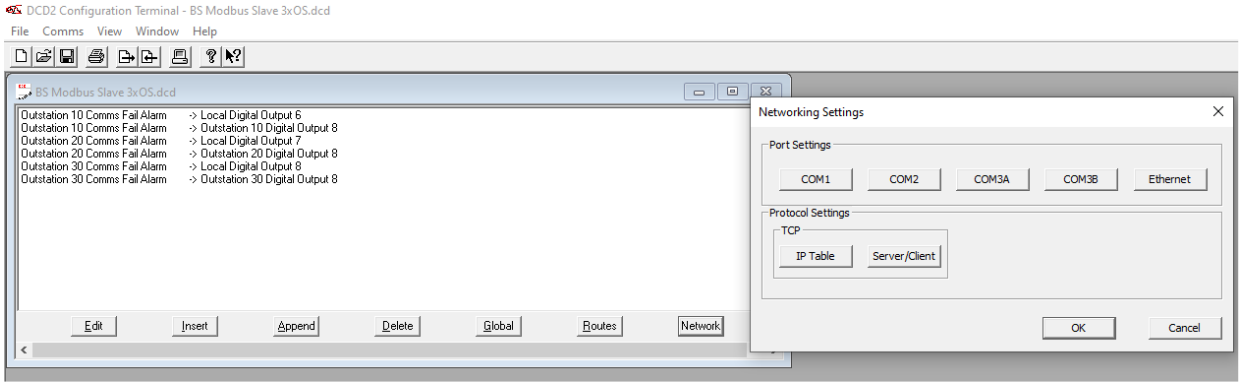


For RS485 choose COM3(RS485) instead.

3.5 Protocol Parameters

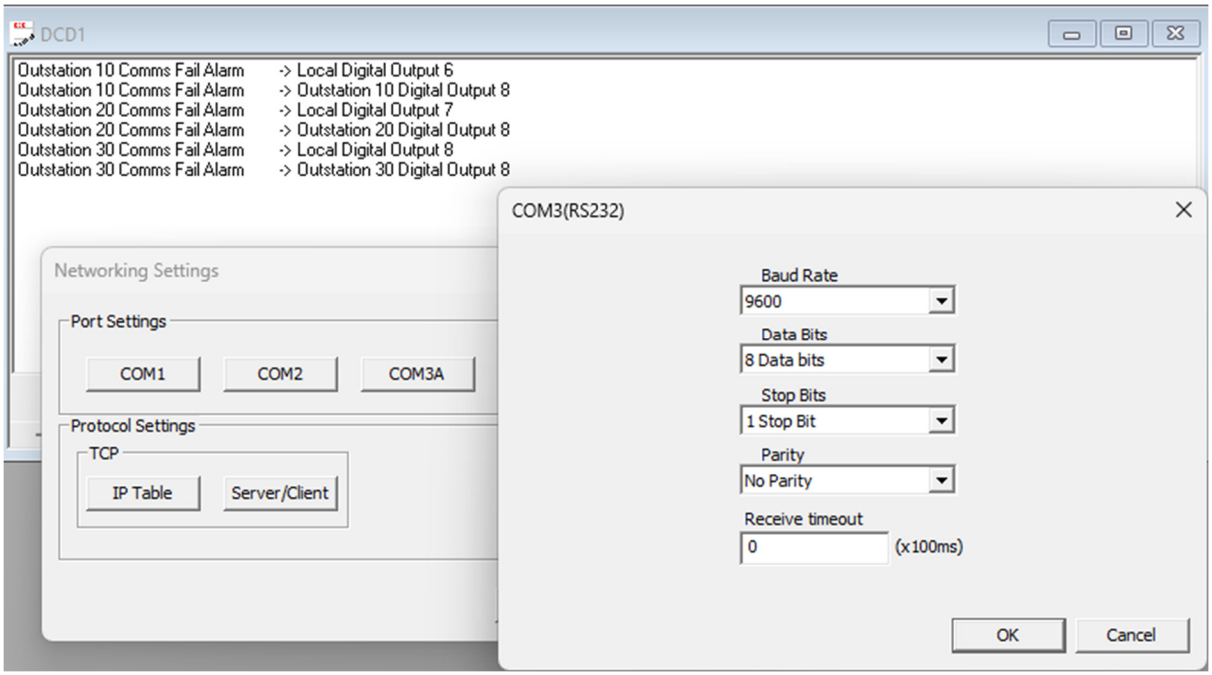
When linking the two pieces of equipment together, their data formats must be matched. That is, both units must be working on the same protocol, at the same data speed, using the same number of data bits, the same number of stop bits and the same parity.

These settings can be chosen by clicking on the ‘Network’ button. This will open a dialog box called 'Network Setting' as follows:



Click on the ‘COM3A’ tab (For RS232).

The parameters shown should be self-explanatory, and must match those of the PLC.



The “Receive timeout” parameter is not relevant for Modbus mode.

For RS485 push the COM3B button instead and enter similar parameters.

3.6 Mega_Link 2 Database

The Mega_Link 2 Basestation unit maintains a database of 2000 input registers, 2000 output registers, 8000 digital inputs and 8000 digital outputs. Mega_Link 2 maps all the I/O from the Basestation and outstations into this database in a well-defined, structured way. DCD2 knows the structure and simplifies identification of each I/O point into simple terminology, such as ‘Outstation 10 Digital Input 1’.

With Mega_Link 2 configured as a Fieldbus/Bus_Link slave, the user needs to know the database format so they can access the relevant registers.

The Database register addressing is explained in the following documents.

Ref. 1 AN030 Modbus Register Address Mapping

Ref. 2 AN031 Modbus Register Address Listing

Outstation #10

02 Read Discrete Inputs (1x)	Address	04 Read Input Registers (3x)	Address
Digital I/P #1	328	Analogue I/P #1	86
Digital I/P #2	329	Analogue I/P #2	87
Digital I/P #3	330		
Digital I/P #4	331		
Digital I/P #5	332		
Digital I/P #6	333		

Digital I/P #7	334		
Digital I/P #8	335		

Outstation #20

02 Read Discrete Inputs (1x)	Address	04 Read Input Registers (3x)	Address
Digital I/P #1	648	Analogue I/P #1	166
Digital I/P #2	649	Analogue I/P #2	167
Digital I/P #3	650		
Digital I/P #4	651		
Digital I/P #5	652		
Digital I/P #6	653		
Digital I/P #7	654		
Digital I/P #8	655		

Outstation #30

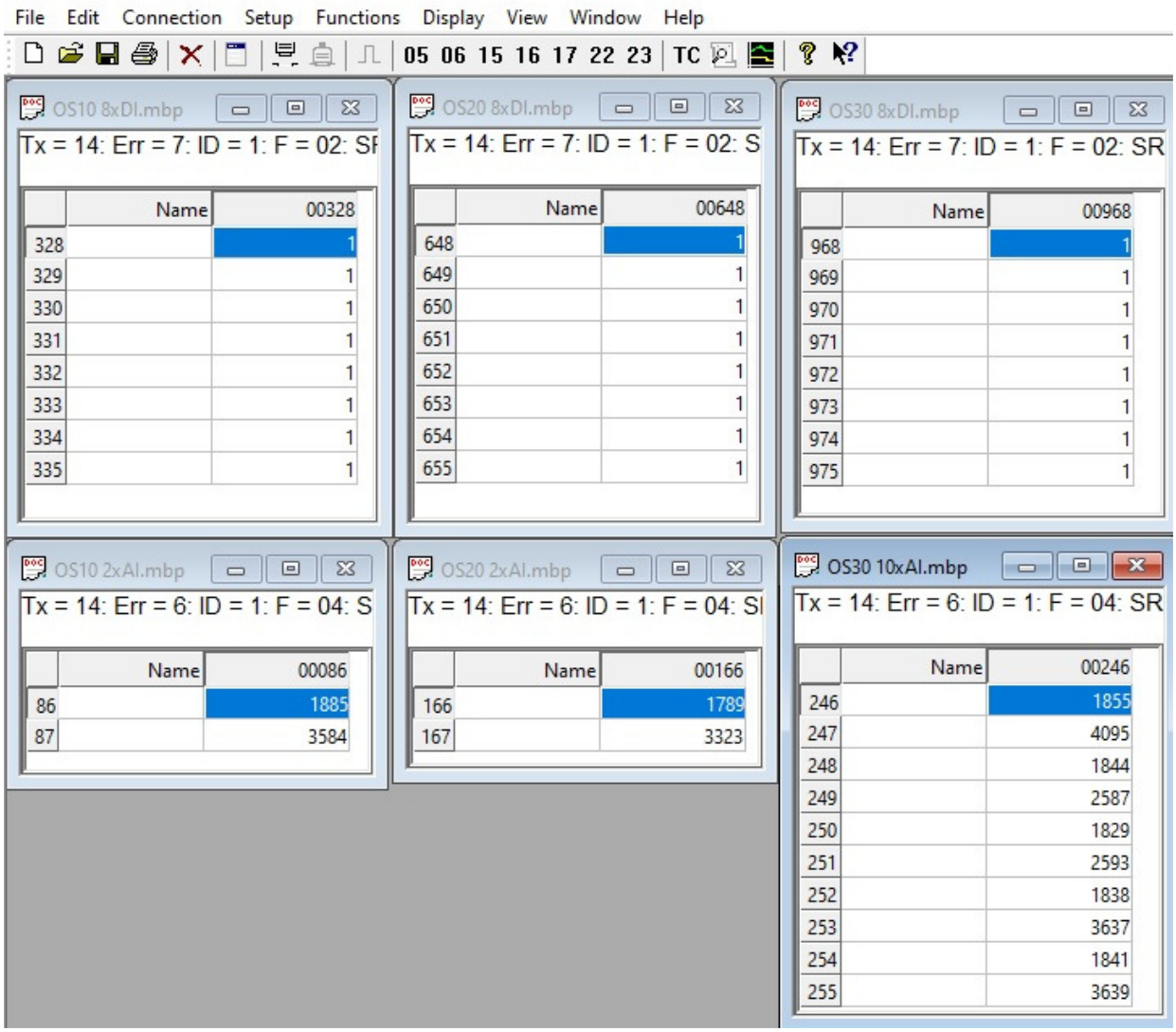
02 Read Discrete Inputs (1x)	Address	04 Read Input Registers (3x)	Address
Digital I/P #1	968	Analogue I/P #1	246
Digital I/P #2	969	Analogue I/P #2	247
Digital I/P #3	970	Analogue I/P #3	248
Digital I/P #4	971	Analogue I/P #4	249
Digital I/P #5	972	Analogue I/P #5	250
Digital I/P #6	973	Analogue I/P #6	251
Digital I/P #7	974	Analogue I/P #7	252
Digital I/P #8	975	Analogue I/P #8	253
		Analogue I/P #9	254
		Analogue I/P #10	255

3.7 Using Modbus Poll to Simulate the Master PLC

Multiple Modbus Poll windows are used to gather digital inputs and analogue inputs from the three outstations. The detailed window set-ups are shown in annex 1.

Below shows the result of Modbus Poll screen in operation.

Top Left	8 Digital Inputs from Outstation #10 (starting at add 328)
Top Middle	8 Digital Inputs from Outstation #20 (starting at add 648)
Top Right	8 Digital Inputs from Outstation #30 (starting at add 968)
Bottom Left	2 Analogue Inputs from Outstation #10 (starting at add 86)
Bottom Middle	2 Analogue Inputs from Outstation #20 (starting at add 166)
Bottom Right	10 Analogue Inputs from Outstation #30 (starting at add 246)



Looking at address 86 above, the data reading is 1885. This works out as 20 x 1885/4000 = 9.42 mA.

Looking at the register values in section 3.10 below, at address 86 this was 9.42 mA.

3.8 Diagnostic View of Mega_Link Communications

Below is the “D” command at the Basestation using the diagnostics terminal feature of DCD 2.

You can see that the Basestation polls Outstation #10, then 10 seconds later it polls Outstation #20 then another 10 seconds later it polls Outstation #30 and then 10 seconds after this is polls Outstation #31 which is the Analogue Input expansion module connected to Outstation #30.

```
Outstation: 10
09:02:57  TX: 01 1A 00 00 0A 0C 00 20 00 00 00 00 00 00 00 00 00 00 00 00 AF FF 00 00 00 00 0A 04 C1 C9 C2 09 01 3C
Time-out set to 4700ms.
Primary comms rcvd pkt
09:02:59  RX: 01 16 00 0A 00 0D 7F FF 00 00 11 00 11 00 0E 00 10 00 01 07 B3 FF 54 07 F2 0D 01 00 C1 DE
    2800ms left. Good reply.


1 sec to next poll.

Outstation: 20
09:03:07  TX: 01 1A 00 00 14 0C 00 80 00 00 00 00 00 00 00 00 00 00 00 00 AF FF 00 00 00 00 0A 04 CB C9 C2 09 B1 37
Time-out set to 4700ms.
Primary comms rcvd pkt
09:03:09  RX: 01 16 00 14 00 0D 7F FF 00 00 02 00 02 00 02 00 02 00 12 07 AF FF 55 07 F5 0D 01 00 3F F1
    2800ms left. Good reply.


1 sec to next poll.

Outstation: 30
09:03:17  TX: 01 1A 00 00 1E 0C 00 80 00 00 00 00 00 00 00 00 00 00 00 00 B1 FF 00 00 00 00 0A 04 D5 C9 C2 09 10 96
Time-out set to 4700ms.
Primary comms rcvd pkt
09:03:19  RX: 01 16 00 1E 00 0D 7F FF 00 00 01 00 01 00 01 00 02 00 0A 07 B1 FF FA 06 EC 0C 01 00 29 C4
    2900ms left. Good reply.


1 sec to next poll.

Outstation: 31
09:03:27  TX: 01 04 00 00 1F 03 DF C9 C2 09 CE E5

RequestingOutstation: 31 (expansion module) Time-out set to 4700ms.
Primary comms rcvd pkt
09:03:29  RX: 01 16 00 1F 00 02 00 00 00 00 38 07 20 0A 3C 07 41 0A 35 07 3E 0E 35 07 3F 0E 02 00 46 41
    3100ms left. (expansion module)  Good reply.


End of fast scan. Scanning every 10 secs
Scanned 4 Outstations with 0 failures
```

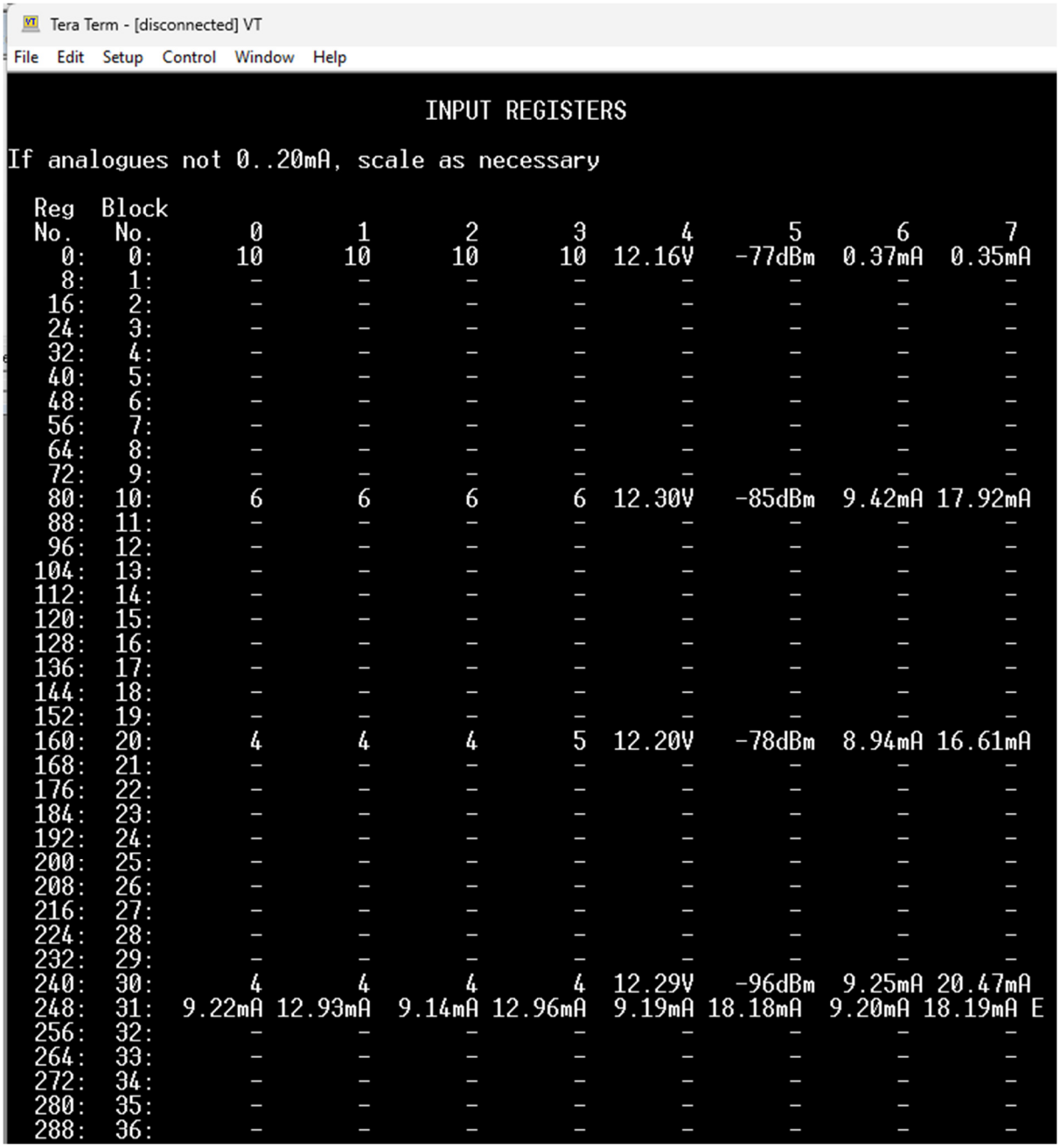
3.9 Diagnostic View of Mega_Link 2 Digital Inputs

Using the ID (Display Input Digitals) command at the Basestation using the diagnostics terminal feature of DCD2.

```
                                INPUT DIGITALS

Alarm Flags:
 C: Mega_Link2 Comms Fail
 B: Battery Low
 H: Hardware Fail
 M: Field_Bus Fail
 F: Complete Comms Fail
 A: Batt not charging
 P: Primary Comms Fail
 S: Secondary Comms Fail

  Reg  Block
  No.   No. 0             15 16            31 0             15 16            31
    0:    0: _______Soooooooo oooooooooooooooo ---------------- ----------------
   64:    2: ---------------- ---------------- ---------------- ----------------
  128:    4: ---------------- ---------------- ---------------- ----------------
  192:    6: ---------------- ---------------- ---------------- ----------------
  256:    8: ---------------- ---------------- ---------------- ----------------
  320:   10: _______S11111111 oooooooooooooooo ---------------- ----------------
  384:   12: ---------------- ---------------- ---------------- ----------------
  448:   14: ---------------- ---------------- ---------------- ----------------
  512:   16: ---------------- ---------------- ---------------- ----------------
  576:   18: ---------------- ---------------- ---------------- ----------------
  640:   20: _______S11111111 oooooooooooooooo ---------------- ----------------
  704:   22: ---------------- ---------------- ---------------- ----------------
  768:   24: ---------------- ---------------- ---------------- ----------------
  832:   26: ---------------- ---------------- ---------------- ----------------
  896:   28: ---------------- ---------------- ---------------- ----------------
  960:   30: _______S11111111 oooooooooooooooo oooooooooooooooo oooooooooooooooo
 1024:   32: ---------------- ---------------- ---------------- ----------------
 1088:   34: ---------------- ---------------- ---------------- ----------------
 1152:   36: ---------------- ---------------- ---------------- ----------------
 1216:   38: ---------------- ---------------- ---------------- ----------------
 1280:   40: ---------------- ---------------- ---------------- ----------------
 1344:   42: ---------------- ---------------- ---------------- ----------------
 1408:   44: ---------------- ---------------- ---------------- ----------------
 1472:   46: ---------------- ---------------- ---------------- ----------------
 1536:   48: ---------------- ---------------- ---------------- ----------------
 1600:   50: ---------------- ---------------- ---------------- ----------------
 1664:   52: ---------------- ---------------- ---------------- ----------------
 1728:   54: ---------------- ---------------- ---------------- ----------------
 1792:   56: ---------------- ---------------- ---------------- ----------------
 1856:   58: ---------------- ---------------- ---------------- ----------------
 1920:   60: ---------------- ---------------- ---------------- ----------------
 1984:   62: ---------------- ---------------- ---------------- ----------------
```

3.10 Diagnostic View of Mega_Link 2 Analogue Inputs

Using the IR (Display Input Registers) command at the Basestation using the diagnostics terminal feature of DCD2.



3.11 Diagnostic View of Modbus Communications

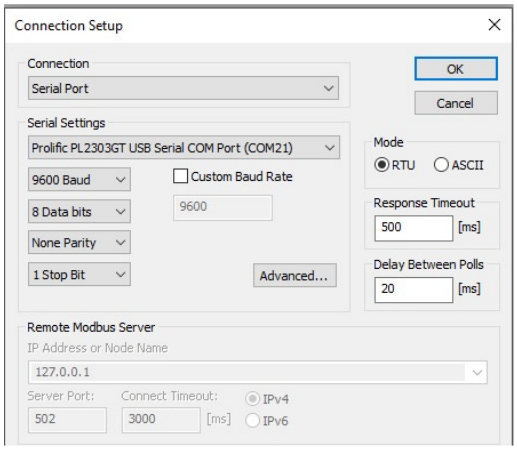
Here is the view of communications at Modbus Poll on the PC.

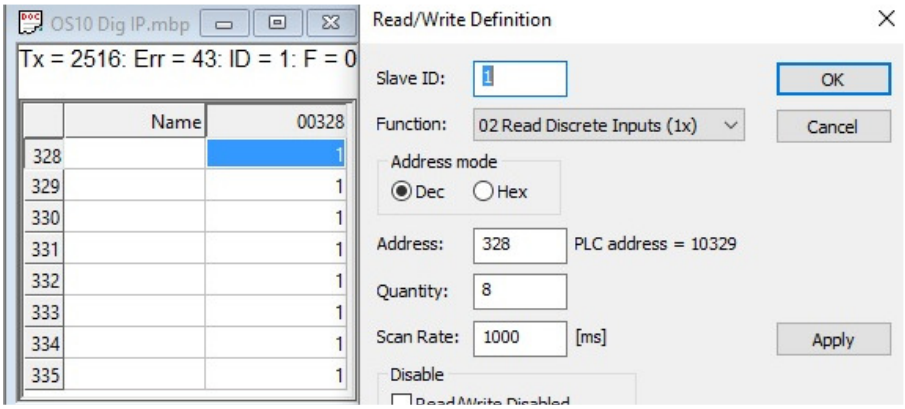
17	09:08:02.201	8	Tx	01 04 00 56 00 02 91 DB
18	09:08:02.669	9	Rx	01 04 04 07 54 0D F2 3E 35
19	09:08:03.185	8	Tx	01 04 00 A6 00 02 91 E8
20	09:08:03.669	9	Rx	01 04 04 07 56 0D F5 DE 37
21	09:08:04.185	8	Tx	01 04 00 F6 00 0A 90 3F
22	09:08:04.684	25	Rx	01 04 14 06 FA 0C ED 07 37 0A 20 07 3B 0A 40 07 34 0E 3E 07 35 0E 3F DC 9B
23	09:08:05.200	8	Tx	01 02 01 48 00 08 F8 26
24	09:08:05.669	6	Rx	01 02 01 FF E1 C8
25	09:08:06.184	8	Tx	01 02 02 88 00 08 F8 5E
26	09:08:06.668	6	Rx	01 02 01 FF E1 C8
27	09:08:07.184	8	Tx	01 02 03 C8 00 08 F8 76
28	09:08:07.668	6	Rx	01 02 01 FF E1 C8

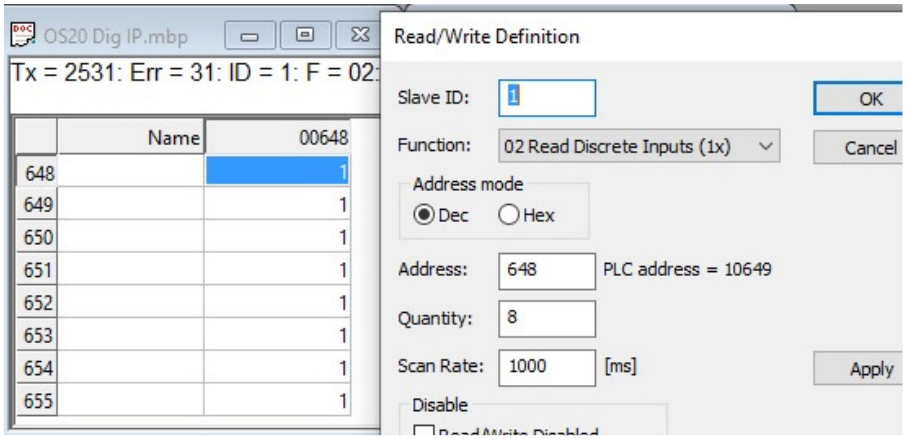
Here is the “B” command at the Basestation using the diagnostics terminal feature of DCD 2.

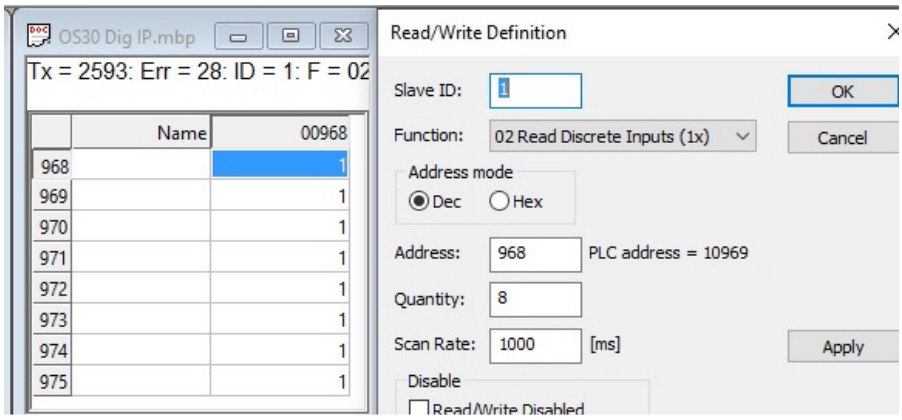
```
                        FIELD_BUS SLAVE (Modbus RTU)

16:14:18  RX: 01 04 00 56 00 02 91 DB  Read input registers 86..87
16:14:18  TX: 01 04 04 07 55 0D F5 2E 37
16:14:19  RX: 01 04 00 A6 00 02 91 E8  Read input registers 166..167
16:14:19  TX: 01 04 04 07 59 0D F6 AE 35
16:14:20  RX: 01 04 00 F6 00 0A 90 3F  Read input registers 246..255
16:14:20  TX: 01 04 14 06 FC 0C F2 07 3A 0A 23 07 3D 0A 43 07 36 0E 41 07 37 0E 43 38 B0
16:14:21  RX: 01 02 01 48 00 08 F8 26  Read input status 328..335
16:14:21  TX: 01 02 01 FF E1 C8
16:14:22  RX: 01 02 02 88 00 08 F8 5E  Read input status 648..655
16:14:22  TX: 01 02 01 FF E1 C8
16:14:23  RX: 01 02 03 C8 00 08 F8 76  Read input status 968..975
16:14:23  TX: 01 02 01 FF E1 C8
```

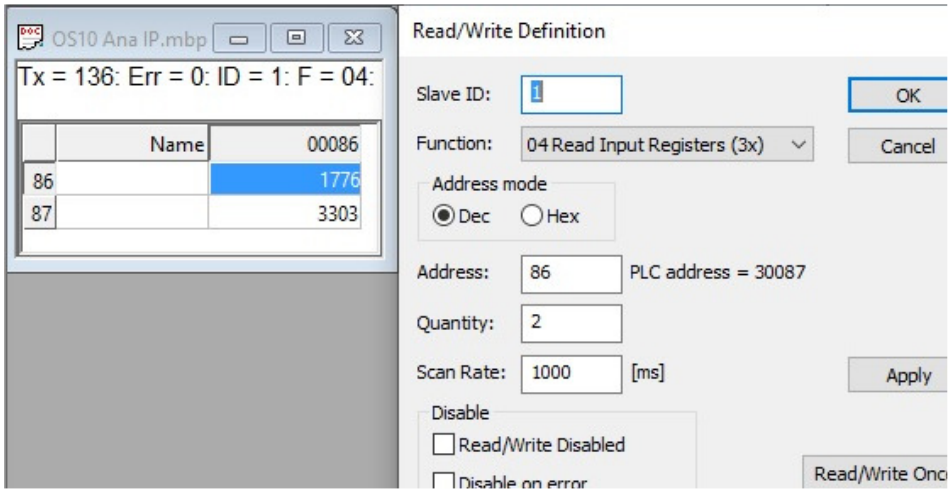
Annex 1 **Modbus Poll Command Window Set-Ups for Example 1**

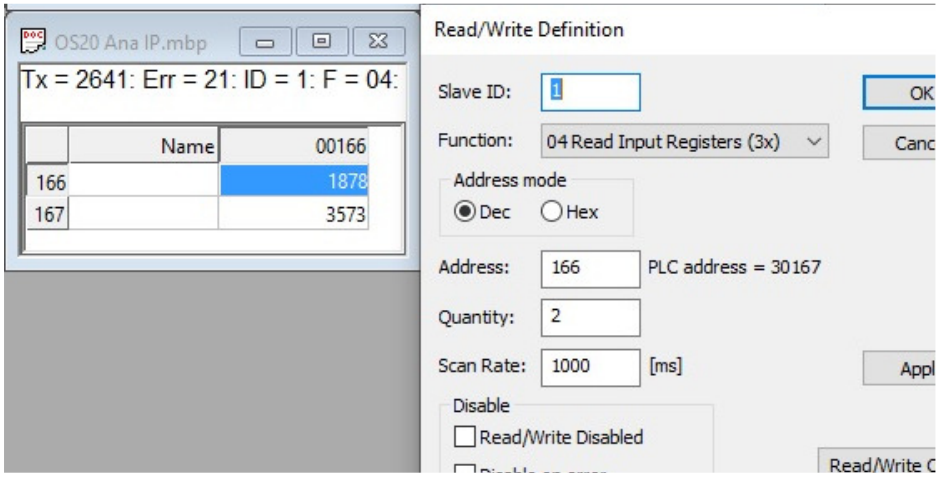


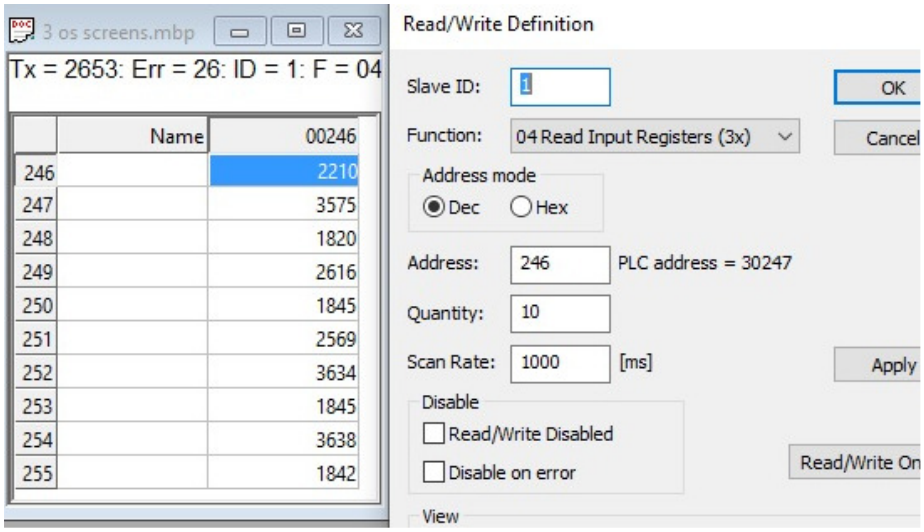







OS10 Ana IP.mbp
Tx = 136: Err = 0: ID = 1: F = 04:
Name
00086
86
1776
87
3303
Read/Write Definition
Slave ID:
1
OK
Function:
04 Read Input Registers (3x)
Cancel
Address mode
Dec
Hex
Address:
86
PLC address = 30087
Quantity:
2
Scan Rate:
1000
[ms]
Apply
Disable
Read/Write Disabled
Disable on error
Read/Write Onc


OS20 Ana IP.mbp
Tx = 2641: Err = 21: ID = 1: F = 04:
Name
00166
166
1878
167
3573
Read/Write Definition
Slave ID:
1
OK
Function:
04 Read Input Registers (3x)
Canc
Address mode
Dec
Hex
Address:
166
PLC address = 30167
Quantity:
2
Scan Rate:
1000
[ms]
Appl
Disable
Read/Write Disabled
Read/Write C


3 os screens.mbp
Tx = 2653: Err = 26: ID = 1: F = 04
Name
00246
246
2210
247
3575
248
1820
249
2616
250
1845
251
2569
252
3634
253
1845
254
3638
255
1842
Read/Write Definition
Slave ID:
1
OK
Function:
04 Read Input Registers (3x)
Cancel
Address mode
Dec
Hex
Address:
246
PLC address = 30247
Quantity:
10
Scan Rate:
1000
[ms]
Apply
Disable
Read/Write Disabled
Disable on error
Read/Write On
View

End.