

Mega_Link 2

APPLICATION NOTE AN033 ***Using Modbus RTU Master 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 Master mode. (For Slave mode see AN032 Using Modbus RTU Slave 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.

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 **master** mode.

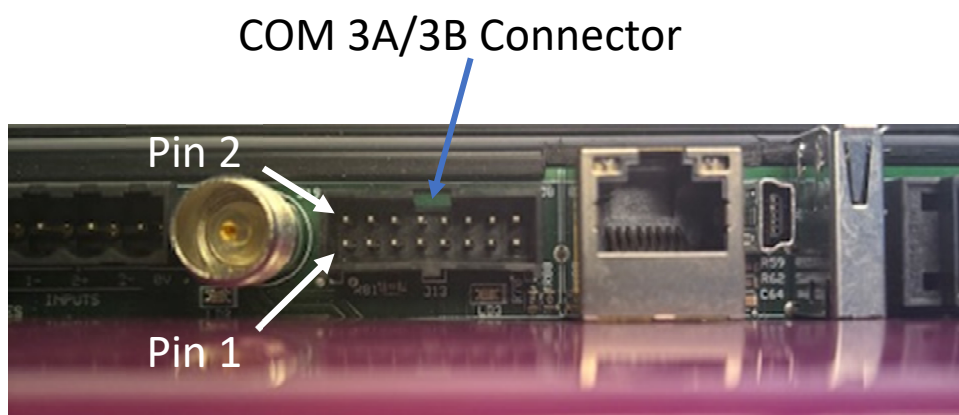
2. Protocol and Interface

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

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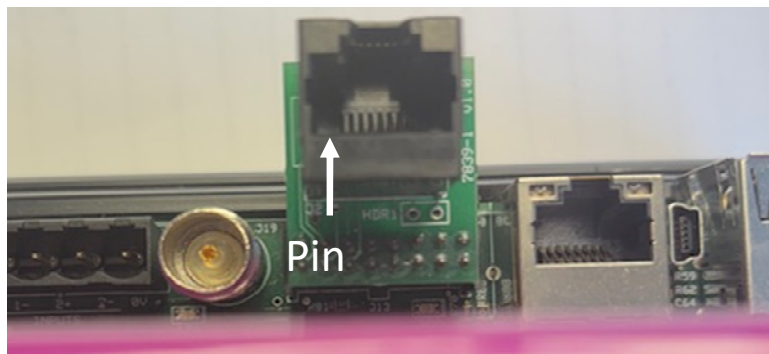
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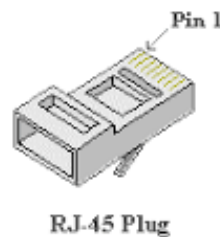
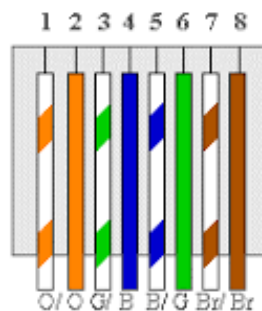
6	RS232 RXD	Input to Mega_Link 2
7		
8		
9		
10		
11		
12		
13		
14		
15		
16	0V	Ground

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



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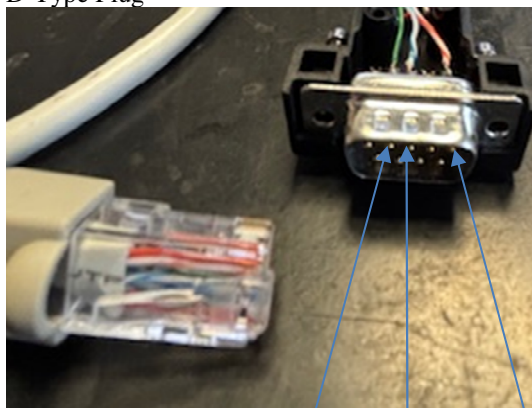
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2.2 RS232

Typical Cable Wiring details are as follows:

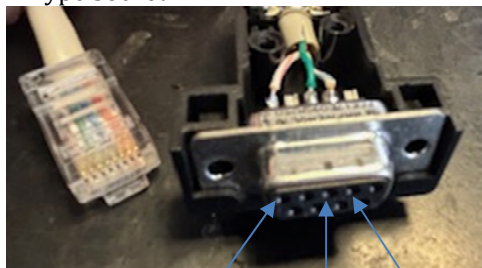
D-Type Plug



Pin 2 Pin 3 Pin 5
Green Blue/White Orange/White

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

D-Type Socket



Pin 5 Pin 3 Pin 2
Orange/White Green Blue/White

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

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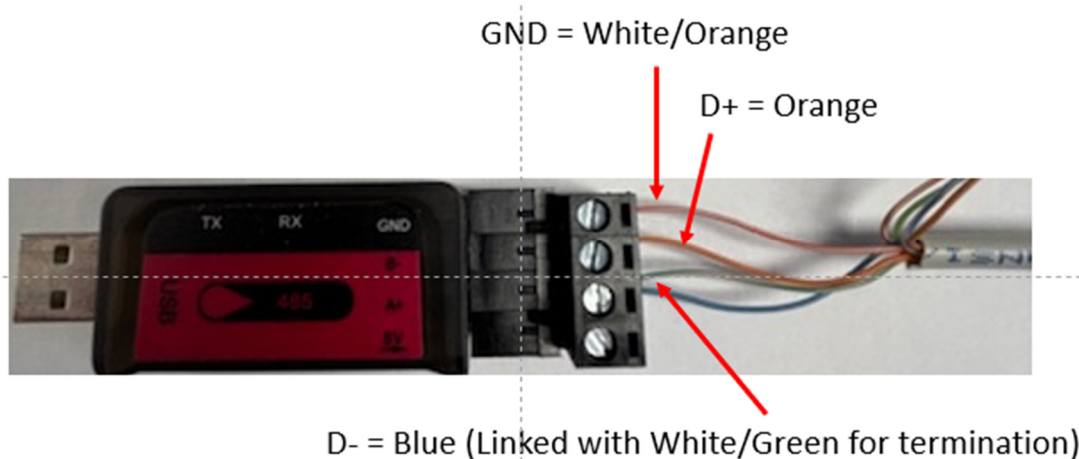
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2.3 RS485

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 **master**, it flashes green when Mega_Link 2 is transmitting a request and red when it is receiving 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 master mode.

Transmitting a Request



Receiving a Response



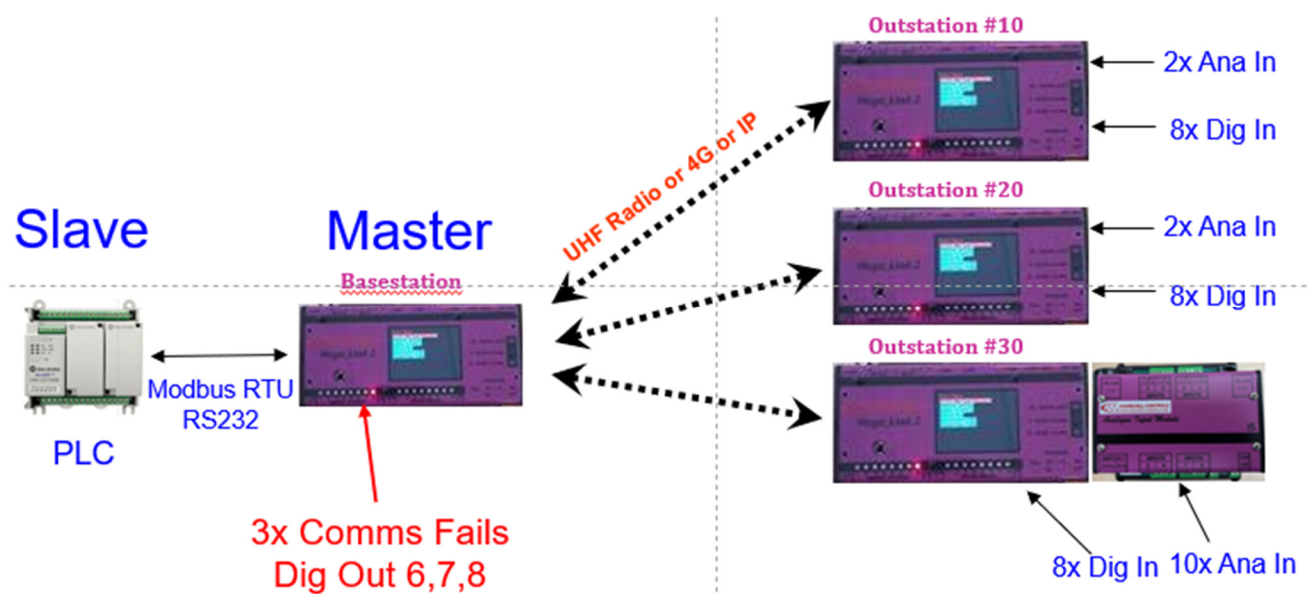
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3. Example with Inputs From 3 Outstations (1 with expansion)

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 master must be configured to pass data to/from specific register locations within the PLC slave. The PLC slave needs to be configured with a slave ID, in this example Slave ID = 1.

Unlike when the PLC is acting as a master (AN032 Using Modbus RTU Slave Mode on COM3A/3B) the PLC programmer/user does not need to understand the structure of the Mega_Link 2 database.

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 configuration in the Basestation master is required to control the transfer of analogue and digital inputs to the PLC slave.

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.

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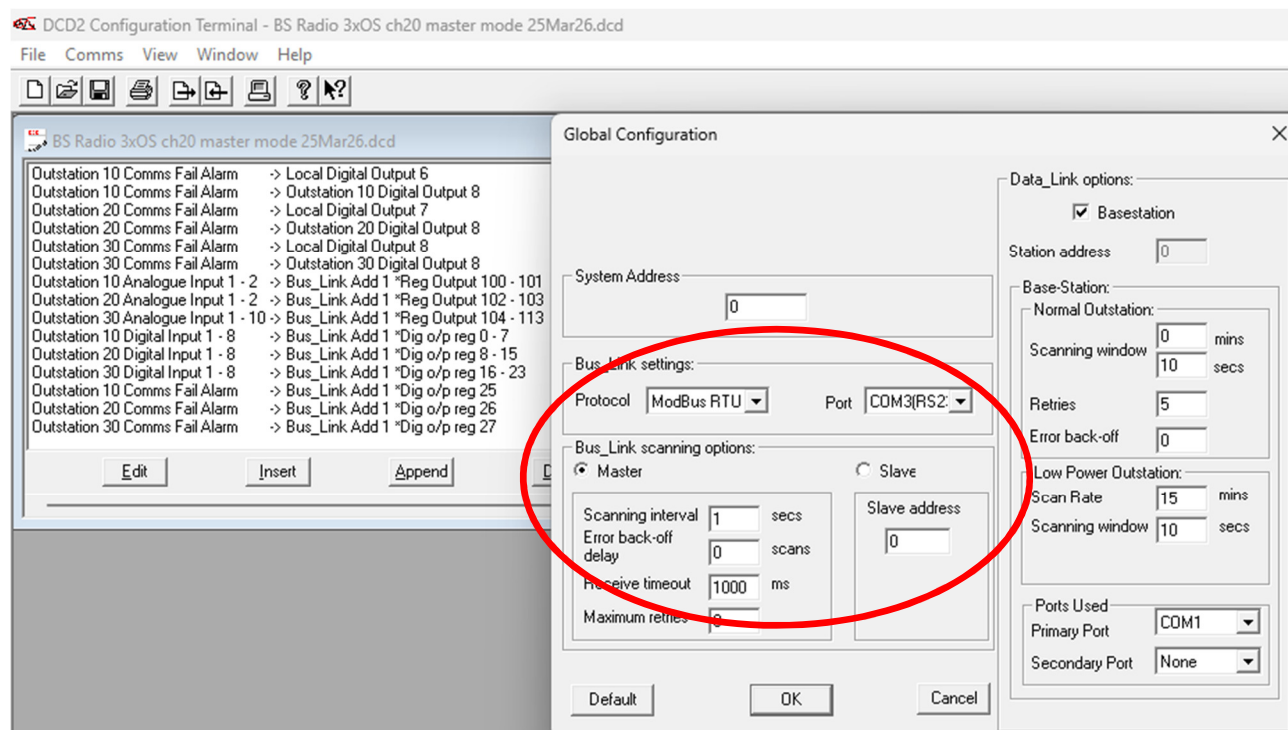
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3.4 Protocol Selection

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 been set in **Master** mode and the scanning interval is 1 secs, Receive timeout=1000 ms with no retries.

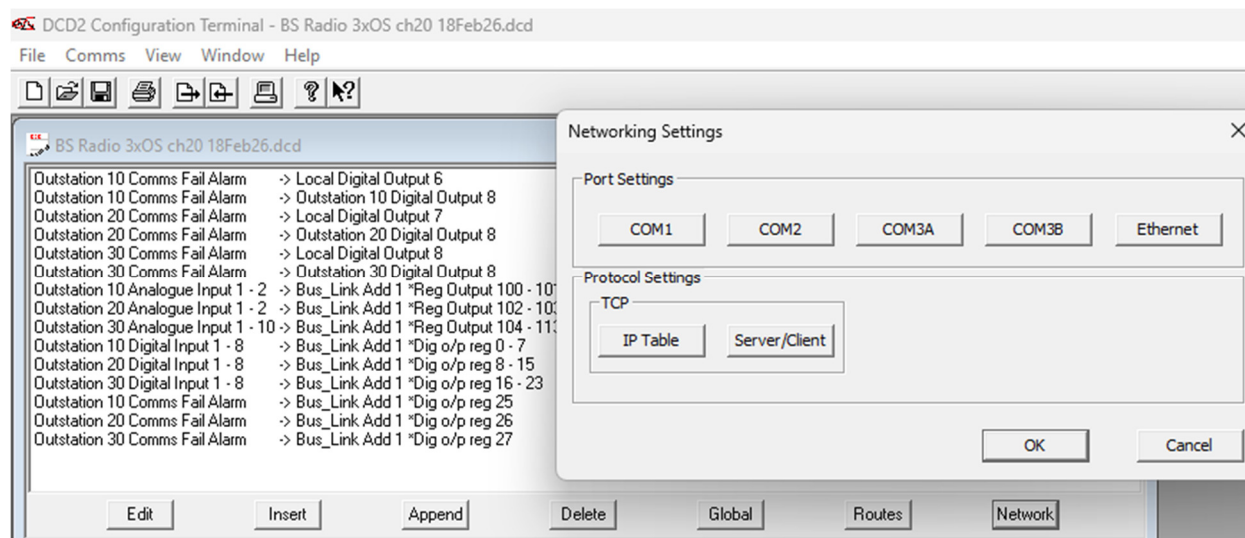


For RS485 choose COM3(RS485) instead.

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:



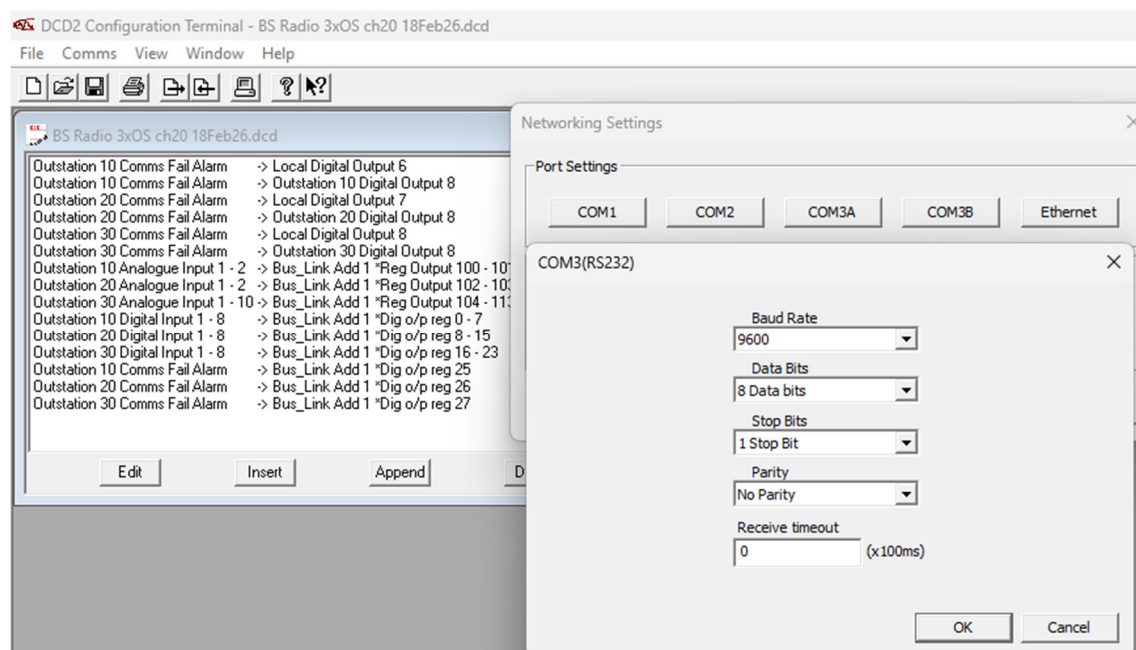
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Click on the 'COM3A' tab (For RS232).

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 Configuration

The Mega_Link 2 Basestation unit configuration must include entries to command the relevant analogue and digital input transfer to the PLC.

Analogue Inputs

Line 8 - Outstation 10 Analogue Input 1 - 2 -> Bus_Link Add 1 *Reg Output 100 - 101
Line 9 - Outstation 20 Analogue Input 1 - 2 -> Bus_Link Add 1 *Reg Output 102 - 103
Line 10 - Outstation 30 Analogue Input 1 - 10 -> Bus_Link Add 1 *Reg Output 104 - 113

Line 8 will send Outstation 10 Analogue Inputs 1-2 to PLC slave ID=1 into addresses 100 – 101

Line 9 will send Outstation 20 Analogue Inputs 1-2 to PLC slave ID=1 into addresses 102 – 103

Line 10 will send Outstation 30 Analogue Inputs 1-10 to PLC slave ID=1 into addresses 104 – 113

Outstation 30 has an analogue input expansion module fitted, hence 2 + 8 = 10 inputs available.

Digital Inputs

Line 11 - Outstation 10 Digital Input 1 - 8 -> Bus_Link Add 1 *Dig o/p reg 0 - 7
Line 12 - Outstation 20 Digital Input 1 - 8 -> Bus_Link Add 1 *Dig o/p reg 8 - 15
Line 13 - Outstation 30 Digital Input 1 - 8 -> Bus_Link Add 1 *Dig o/p reg 16 - 23

Line 11 will send Outstation 10 Digital Inputs 1-8 to PLC slave ID=1 into addresses 0 – 7

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Line 12 will send Outstation 20 Digital Inputs 1-8 to PLC slave ID=1 into addresses 8 – 15

Line 13 will send Outstation 30 Digital Inputs 1-8 to PLC slave ID=1 into addresses 16 – 23

Comms Fails

Line 14 - Outstation 10 Comms Fail Alarm -> Bus_Link Add 1 *Dig o/p reg 25

Line 15 - Outstation 20 Comms Fail Alarm -> Bus_Link Add 1 *Dig o/p reg 26

Line 16 - Outstation 30 Comms Fail Alarm -> Bus_Link Add 1 *Dig o/p reg 27

Line 14 will send Outstation 10 Comms Fail Alarm to PLC slave ID=1 into addresses 25

Line 15 will send Outstation 20 Comms Fail Alarm to PLC slave ID=1 into addresses 26

Line 16 will send Outstation 30 Comms Fail Alarm to PLC slave ID=1 into addresses 27

3.7 Using Modbus Slave to Simulate the Slave PLC

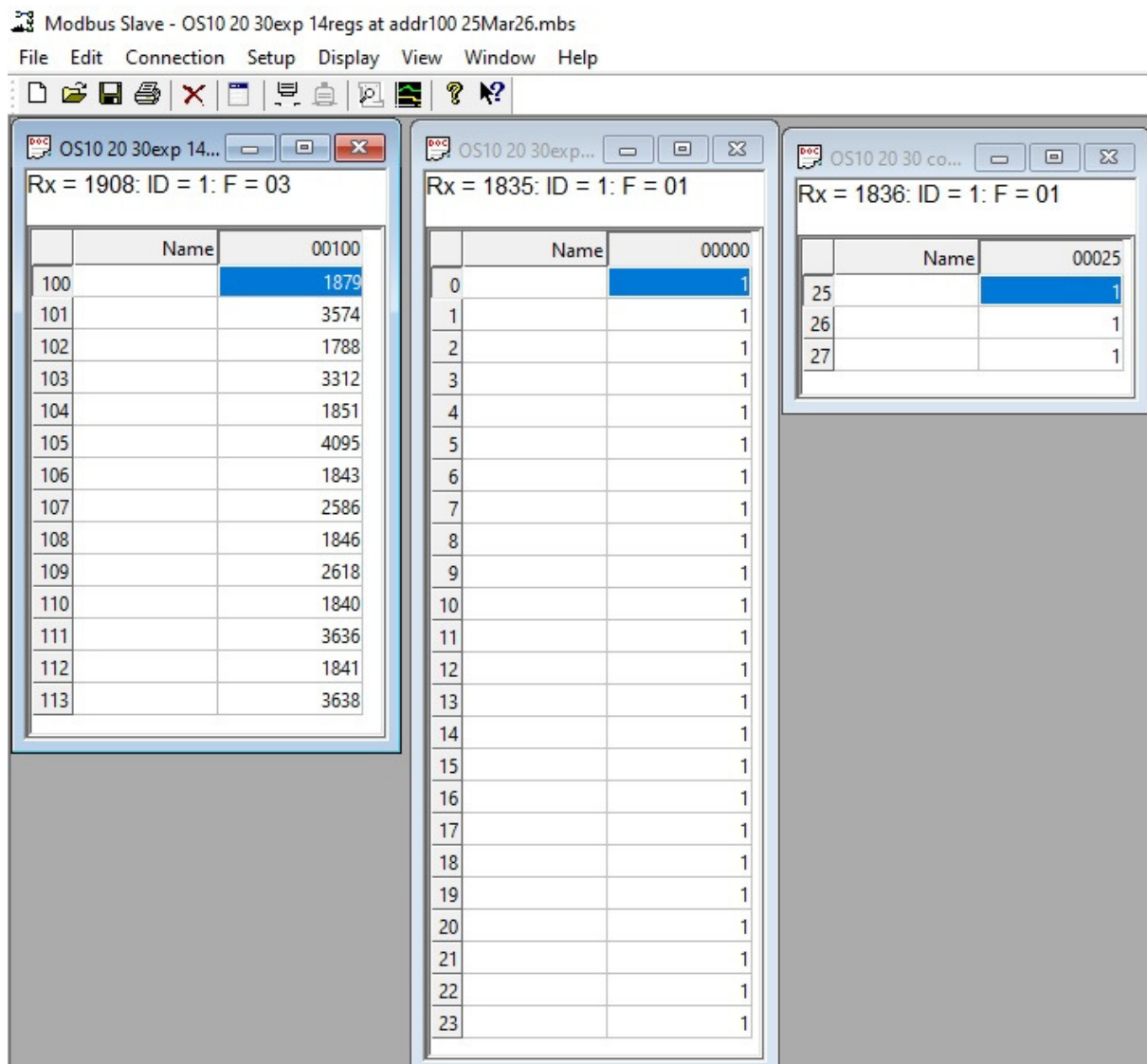
Modbus Slave windows are used to act as destination registers and coils.

The detailed window set-ups are shown in annex 1.

- Left hand window**
- 2 Analogue Inputs from Outstation #10 (starting at address 100)
 - 2 Analogue Inputs from Outstation #20 (starting at address 102)
 - 10 Analogue Inputs from Outstation #30 (starting at address 104)

- Middle window**
- 8 Digital Inputs from Outstation #10 (starting at address 0)
 - 8 Digital Inputs from Outstation #20 (starting at address 8)
 - 8 Digital Inputs from Outstation #30 (starting at address 16)

- Left hand window**
- 1 Comms Fail Alarm from Outstation #10 (at address 25)
 - 1 Comms Fail Alarm from Outstation #20 (at address 26)
 - 1 Comms Fail Alarm from Outstation #30 (at address 27)



Looking at address 100 above, the data reading is 1879. This works out as $20 \times 1879/4000 = 9.39$ mA.

Looking at the register values in section 3.10 below, at address 86 this was 9.39 mA.

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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 it 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 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 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 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 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
```

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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:  ___M___S00000000 0000000000000000  -----  -----
64:  2:  -----  -----  -----  -----
128: 4:  -----  -----  -----  -----
192: 6:  -----  -----  -----  -----
256: 8:  -----  -----  -----  -----
320: 10: _____S11111111 0000000000000000  -----  -----
384: 12:  -----  -----  -----  -----
448: 14:  -----  -----  -----  -----
512: 16:  -----  -----  -----  -----
576: 18:  -----  -----  -----  -----
640: 20: _____S11111111 0000000000000000  -----  -----
704: 22:  -----  -----  -----  -----
768: 24:  -----  -----  -----  -----
832: 26:  -----  -----  -----  -----
896: 28:  -----  -----  -----  -----
960: 30: _____S11111111 0000000000000000 0000000000000000 0000000000000000
1024: 32:  -----  -----  -----  -----
1088: 34:  -----  -----  -----  -----
1152: 36:  -----  -----  -----  -----
1216: 38:  -----  -----  -----  -----
1280: 40:  -----  -----  -----  -----

```

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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.

INPUT REGISTERS									
If analogues not 0..20mA, scale as necessary									
Reg No.	Block No.	0	1	2	3	4	5	6	7
0:	0:	10	10	10	10	12.14V	-74dBm	0.37mA	0.35mA
8:	1:	-	-	-	-	-	-	-	-
16:	2:	-	-	-	-	-	-	-	-
24:	3:	-	-	-	-	-	-	-	-
32:	4:	-	-	-	-	-	-	-	-
40:	5:	-	-	-	-	-	-	-	-
48:	6:	-	-	-	-	-	-	-	-
56:	7:	-	-	-	-	-	-	-	-
64:	8:	-	-	-	-	-	-	-	-
72:	9:	-	-	-	-	-	-	-	-
80:	10:	6	6	6	6	12.35V	-81dBm	9.39mA	17.87mA
88:	11:	-	-	-	-	-	-	-	-
96:	12:	-	-	-	-	-	-	-	-
104:	13:	-	-	-	-	-	-	-	-
112:	14:	-	-	-	-	-	-	-	-
120:	15:	-	-	-	-	-	-	-	-
128:	16:	-	-	-	-	-	-	-	-
136:	17:	-	-	-	-	-	-	-	-
144:	18:	-	-	-	-	-	-	-	-
152:	19:	-	-	-	-	-	-	-	-
160:	20:	4	4	4	5	12.14V	-79dBm	8.94mA	16.55mA
168:	21:	-	-	-	-	-	-	-	-
176:	22:	-	-	-	-	-	-	-	-
184:	23:	-	-	-	-	-	-	-	-
192:	24:	-	-	-	-	-	-	-	-
200:	25:	-	-	-	-	-	-	-	-
208:	26:	-	-	-	-	-	-	-	-
216:	27:	-	-	-	-	-	-	-	-
224:	28:	-	-	-	-	-	-	-	-
232:	29:	-	-	-	-	-	-	-	-
240:	30:	4	4	4	4	12.27V	-88dBm	9.25mA	20.47mA
248:	31:	9.21mA	12.93mA	9.23mA	13.09mA	9.20mA	18.18mA	9.20mA	18.19mA E
256:	32:	-	-	-	-	-	-	-	-
264:	33:	-	-	-	-	-	-	-	-
272:	34:	-	-	-	-	-	-	-	-
280:	35:	-	-	-	-	-	-	-	-
288:	36:	-	-	-	-	-	-	-	-

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3.11 Diagnostic View of Modbus Communications

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

```
-----  
FIELD_BUS MASTER (Modbus RTU)  
13:00:14 TX: 01 10 00 64 00 02 04 07 5D 0E 00 60 B2 Presetting Multiple registers 100..101 of Modbus address  
1  
13:00:14 RX: 01 10 00 64 00 02 00 17  
13:00:15 TX: 01 10 00 66 00 02 04 06 FD 0C FB A0 56 Presetting Multiple registers 102..103 of Modbus address  
1  
13:00:15 RX: 01 10 00 66 00 02 A1 D7  
13:00:15 TX: 01 10 00 68 00 0A 14 07 3E 0F FF 07 32 0A 19 07 36 0A 39 07 2F 0E 33 07 30 0E 35 62 61  
Presetting Multiple registers 104..113 of Modbus address 1  
13:00:16 RX: 01 10 00 68 00 0A C1 D2  
13:00:16 TX: 01 0F 00 00 00 08 01 FF BE D5 Force Multiple coils 0..7 of Modbus address 1  
13:00:17 RX: 01 0F 00 00 00 08 54 0D  
13:00:17 TX: 01 0F 00 08 00 08 01 FF 5F 14 Force Multiple coils 8..15 of Modbus address 1  
13:00:18 RX: 01 0F 00 08 00 08 D5 CF  
13:00:18 TX: 01 0F 00 10 00 08 01 FF 7F 16 Force Multiple coils 16..23 of Modbus address 1  
13:00:18 RX: 01 0F 00 10 00 08 55 C8  
13:00:19 TX: 01 0F 00 19 00 01 01 01 F2 95 Force Multiple coils 25 of Modbus address 1  
13:00:19 RX: 01 0F 00 19 00 01 45 CC  
13:00:20 TX: 01 0F 00 1A 00 01 01 01 B6 95 Force Multiple coils 26 of Modbus address 1  
13:00:20 RX: 01 0F 00 1A 00 01 B5 CC  
13:00:20 TX: 01 0F 00 1B 00 01 01 01 8B 55 Force Multiple coils 27 of Modbus address 1  
13:00:21 RX: 01 0F 00 1B 00 01 E4 0C
```

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

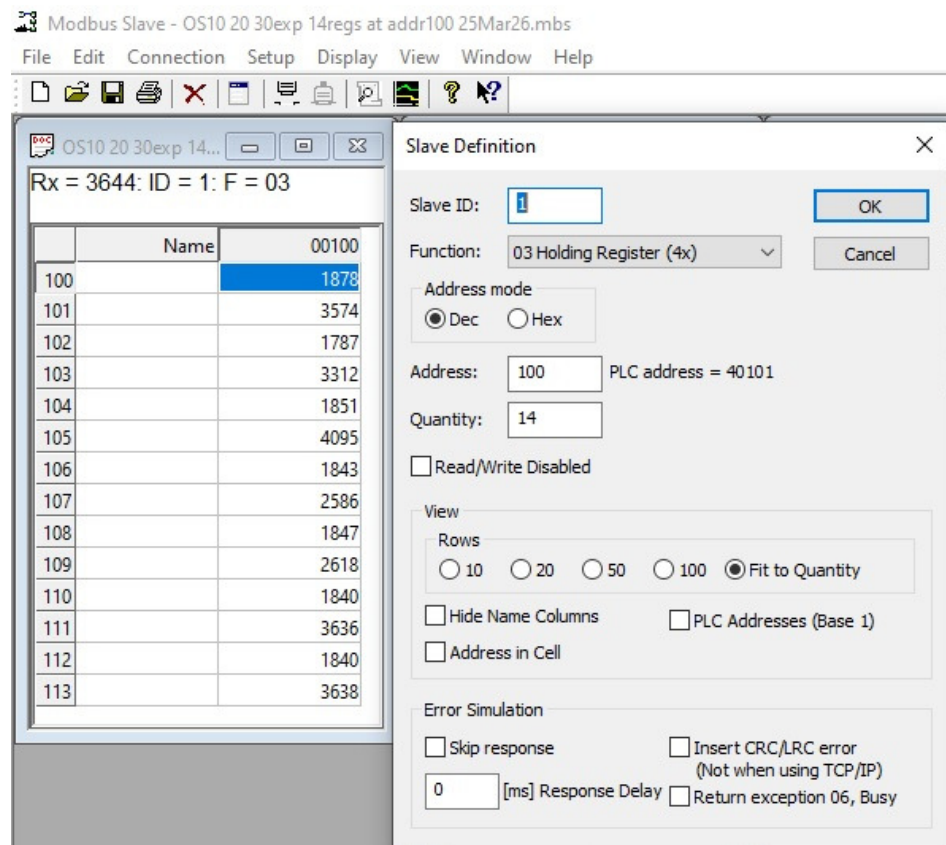
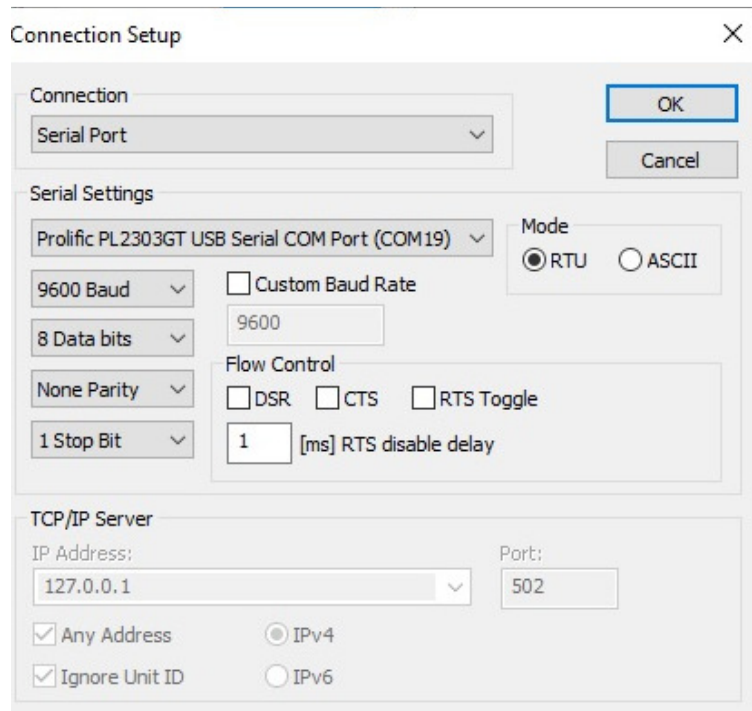
24	13:37:55.034	13	Rx	01 10 00 64 00 02 04 07 56 0D F8 10 02
25	13:37:55.034	8	Tx	01 10 00 64 00 02 00 17
26	13:37:55.743	13	Rx	01 10 00 66 00 02 04 06 FB 0C F0 01 90
27	13:37:55.743	8	Tx	01 10 00 66 00 02 A1 D7
28	13:37:56.687	29	Rx	01 10 00 68 00 0A 14 07 3B 0F FF 07 33 0A 1A 07 36 0A 3A 07 30 0E 34 07 31 0E 3...
29	13:37:56.687	8	Tx	01 10 00 68 00 0A C1 D2
30	13:37:57.410	10	Rx	01 0F 00 00 00 08 01 FF BE D5
31	13:37:57.410	8	Tx	01 0F 00 00 00 08 54 0D
32	13:37:58.120	10	Rx	01 0F 00 08 00 08 01 FF 5F 14
33	13:37:58.120	8	Tx	01 0F 00 08 00 08 D5 CF
34	13:37:58.831	10	Rx	01 0F 00 10 00 08 01 FF 7F 16
35	13:37:58.831	8	Tx	01 0F 00 10 00 08 55 C8
36	13:37:59.544	10	Rx	01 0F 00 19 00 01 01 01 F2 95
37	13:37:59.544	8	Tx	01 0F 00 19 00 01 45 CC
38	13:38:00.474	10	Rx	01 0F 00 1A 00 01 01 01 B6 95
39	13:38:00.474	8	Tx	01 0F 00 1A 00 01 B5 CC
40	13:38:01.412	10	Rx	01 0F 00 1B 00 01 01 01 8B 55
41	13:38:01.412	8	Tx	01 0F 00 1B 00 01 E4 0C

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Annex 1 Modbus Slave Command Window Set-Ups for Example 1



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OS10 20 30exp... OS10 20 30exp... OS10 20 30exp... OS10 20 30exp...

Rx = 3226: ID = 1: F = 01

	Name	00000
0		1
1		1
2		1
3		1
4		1
5		1
6		1
7		1
8		1
9		1
10		1
11		1
12		1
13		1
14		1
15		1
16		1
17		1
18		1
19		1
20		1
21		1
22		1
23		1

Slave Definition ×

Slave ID: OK

Function: 01 Coil Status (0x) Cancel

Address mode
 Dec Hex

Address: PLC address = 00001

Quantity:

Read/Write Disabled

View

Rows
 10 20 50 100 Fit to Quantity

Hide Name Columns PLC Addresses (Base 1)

Address in Cell

Error Simulation

Skip response Insert CRC/LRC error (Not when using TCP/IP)

[ms] Response Delay Return exception 06, Busy

OS10 20 30 co... OS10 20 30 co... OS10 20 30 co... OS10 20 30 co...

Rx = 3003: ID = 1: F = 01

	Name	00025
25		1
26		1
27		1

Slave Definition ×

Slave ID: OK

Function: 01 Coil Status (0x) Cancel

Address mode
 Dec Hex

Address: PLC address =

Quantity:

Read/Write Disabled

View

Rows
 10 20 50 100 Fit to Quantity

Hide Name Columns PLC Addresses (Base 1)

Address in Cell

Error Simulation

Skip response Insert CRC/LRC error (Not when using TCP/IP)

[ms] Response Delay Return exception 06, Busy

01 Coil status accepts write functions 05 and 15. 03 Holding register accepts write functions 06, 16, 22 and 23.

End.

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