Application Note

DATRAN XL4 RTU Modbus Interface

Introduction

The DATRAN RTU Modbus interface is a powerful feature that opens up a huge range of possibilities to interface many types of third party equipment, or "smart devices" into new or existing DATRAN RTU installations. Typical uses are to integrate equipment such as:

- PLCs
- Chlorine Treatment Plants
- Touch Screen Displays
- Motor Drives
- UV Treatment Reactors
- Pump Station Controllers

Any of these devices can be connected to a DATRAN XL4 RTU to provide integration opportunities via RS232 or Ethernet connections.

The DATRAN RTU is capable of either Modbus Master or Modbus Slave operation.

Prerequisites

- XL4 RTU
- Firmware: v6.04 or later recommended
- Workbench Configuration Software v1.6 or later
- Both Modbus master and slave support are optional extras that require an unlock code, purchased from QTech

MODBUS Function Codes used by the XL4 RTU

Function Codes Supported by "RTU as Slave":

READ COILS	0x01
READ DISCRETE INPUTS	0x02
READ HOLDING REGISTERS	0x03
READ INPUT REGISTERS	0x04
WRITE SINGLE COIL	0x05
WRITE SINGLE REGISTER	0x06
WRITE MULTIPLE COILS	0x0F
WRITE MULTIPLE REGISTERS	0x10

Function codes used by the "RTU as Master":

READ DISCRETE INPUTS	0x02
READ INPUT REGISTERS	0x04
WRITE MULTIPLE COILS	0x0F
WRITE MULTIPLE REGISTERS	0x10

The table below summarises how the MODBUS data model is mapped to the DATRAN data model. Note that the mapping is different depending on whether the RTU is a MODBUS Master or a MODBUS Slave.

MODBUS Data Type	MODBUS Address Range	MODBUS Alt Address Name	DATRAN Data Type (RTU is Slave)	DATRAN Data Type (RTU is Master)
Coils	00001 to 00250	%M0000 to %M0249	RDI	RDO
Discrete Inputs	10001 to 10250	%I0000 to %I0249	RDO	RDI
Input Registers	30001 to 30250	%IW0000 to %IW0249	RAO	RAI
Holding Registers	40001 to 40250	%MW0000 to %MW0249	RAI	RAO

For example, if the XL4 RTU is configured as a MODBUS Master, the data contained in the response to the READ DISCRETE INPUTS command, will be copied by the XL4 RTU into its Real Digital Inputs memory. The data is then available to the DATRAN Base station as Telemetry Digital Inputs.

Another example, if the XL4 RTU is configured as a MODBUS Slave, and it receives a READ DISCRETE INPUTS command, the response will contain the values of its Real Digital Outputs data. This is slightly non-intuitive, but is implemented this way to allow the RTU to "push" data values to the master via its DLP. Basically, the XL4 RTU sees the MODBUS Master as a virtual IPB expansion module, and normally IPB expansion modules are slaves of the RTU, but in this case the expansion module is actually a master.

Note that the storage locations of the 4 data blocks in the RTU (RDI, RDO, RAI, and RAO) are not overlapping. Each block is accessed with different MODBUS commands.

Physical Communications Media Supported

RS232 & Ethernet.
The RS485 port on the XL4 RTU **cannot** be used for MODBUS.

Protocol variants supported

MODBUS RTU, MODBUS ASCII, MODBUS TCP.

Modbus TCP default TCP port is 502 but this can be reconfigured if needed.

Limitations:

The XL4 RTU can only have one connected MODBUS device of each type (master or slave) on one physical port at a time. For example if the RTU is configured as a MODBUS slave using the Ethernet port, it can only have one MODBUS master connected to that port, and the RS232 ports then can't be configured to have a different MODBUS Master connected.

The XL4 does not accept commands which are sent to the MODBUS broadcast address of 255.

The XL4 supports RS232 port baud rates up to 19,200bps.
The XL4 is now fully Modbus compliant for its port settings (reference: Modicon Modbus Protocol Reference Guide, PI-MBUS-300 Rev. J, June 1996, page 13).
The port settings should specify 8 data bits and either; parity with one stop bit or; no parity and two stop bits.
Both the XL4 and the Modbus device it is connected to must have the same settings.

⚠️*Compatibility Note – Port settings & parity*

As of XL4 firmware v6.08, a no parity and one stop bit option was introduced. We don't recommend this being used as it could lead to long term compatibility issues when devices are replaced. We recommend using parity and one stop bit or no parity and two stop bits.

Previous Q03 powered RTUs (QRTU and eXcel) allowed a setting of no parity and one stop bit (non-compliant). When doing a Q03 (QRTU and eXcel) to XL4 upgrade it is important to check the port settings. This may involve approaching the PLC/Modbus supplier or system integrator.

The XL4 RTU does not have a shielded RJ45 female connector as required by the specification. Refer to page 10 for the specific pin out of the XL4 RJ45 RS232 port as it differs from the specification.
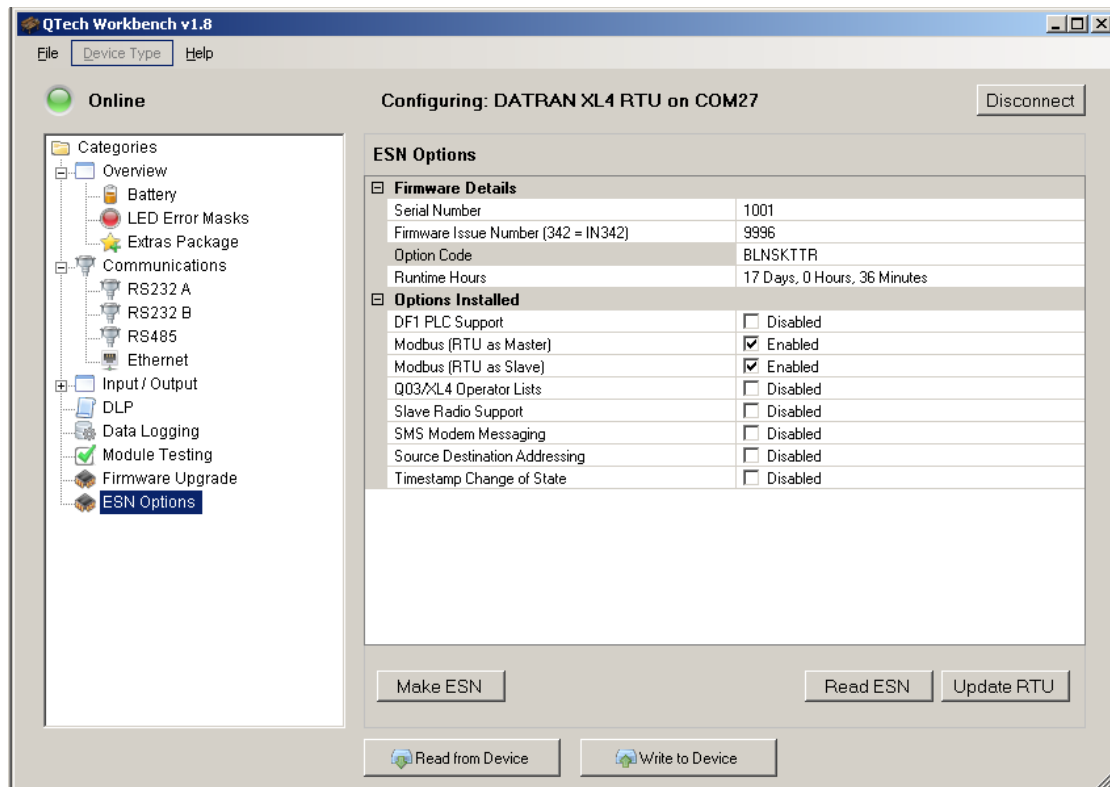

Configuration

Enabling MODBUS functionality on the XL4 RTU
Typically XL4 RTUs are ordered with the MODBUS option specified.
Existing XL4 RTU can however have MODBUS enabled in the field.
Obtain an "Option Code" from QTech. The Option Code is keyed against the RTUs serial number, so have that ready. Enter the Option Code in the ESN Options section of Workbench.

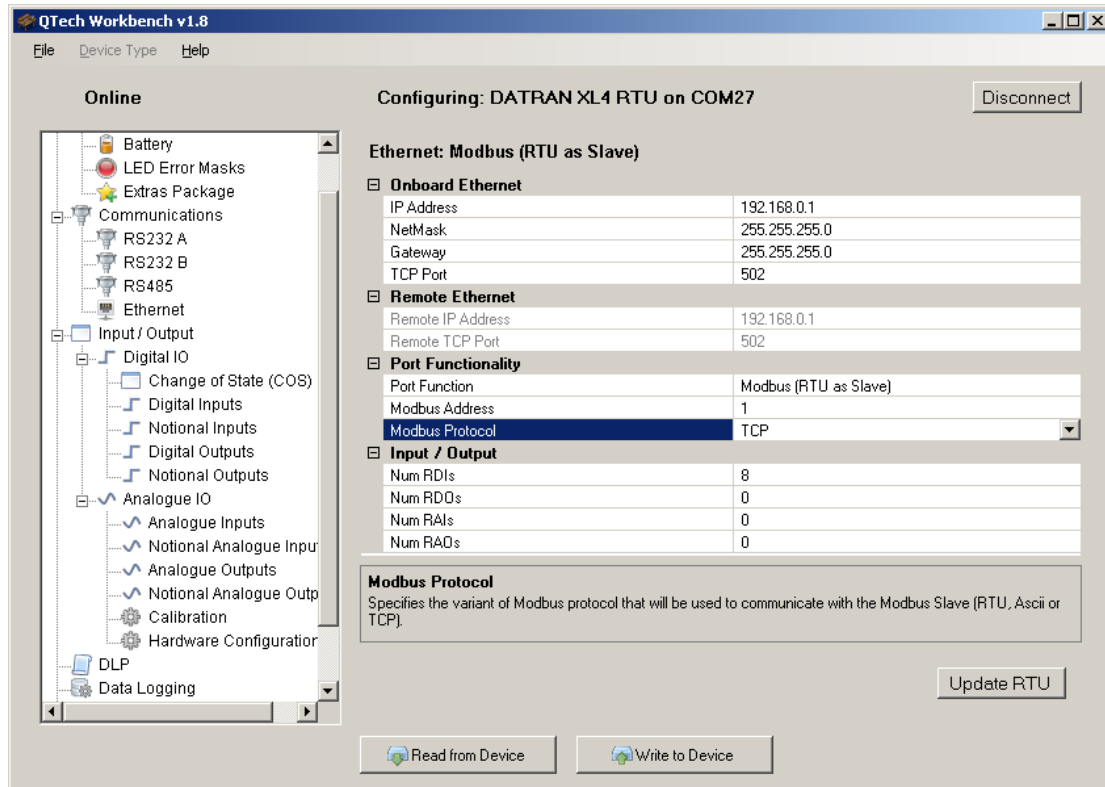## Configuring the RTU as a MODBUS Slave via RS232

Select which physical port (A or B) is to be connected to the MODBUS Master device. Click on the Port Function field and select Modbus (RTU as Slave). Edit the Baud Rate, Parity, Modbus Address, and Protocol values as needed. Enter values for the number of I/O points. These allocate how much data the RTU will make available to the MODBUS Master device.
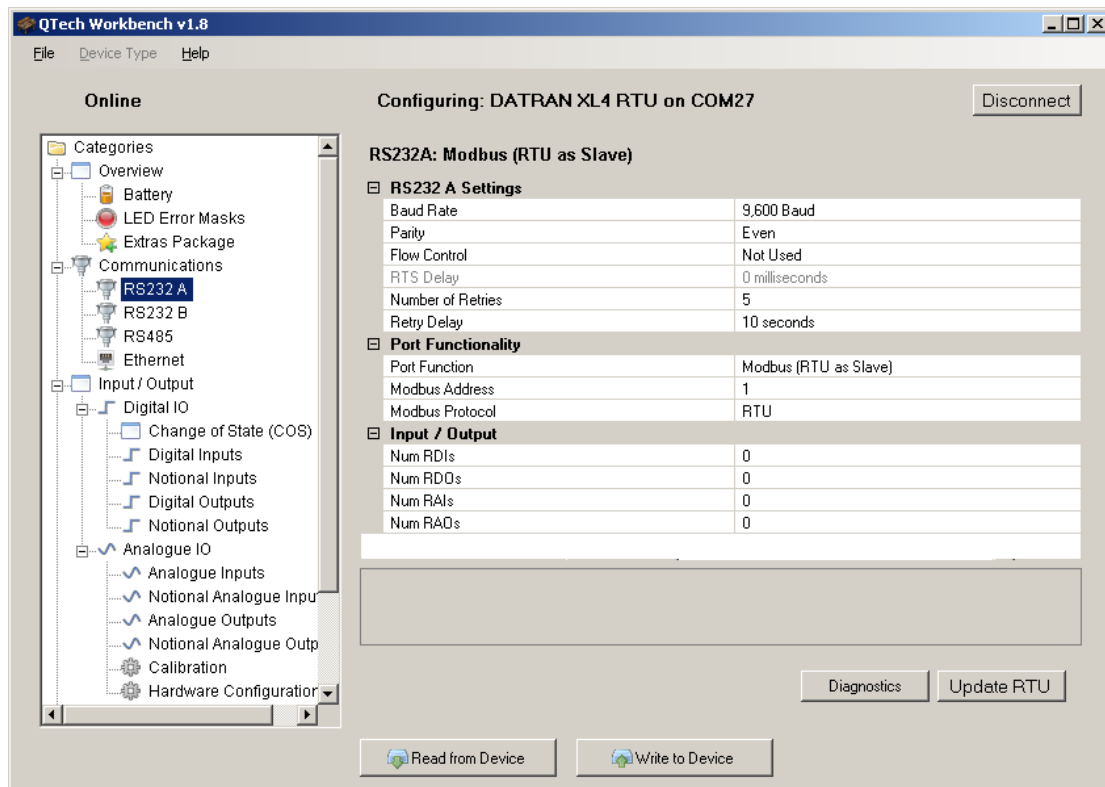
Configuring the RTU as a MODBUS Slave via Ethernet

If you want to use MODBUS TCP communications, then edit the settings under the Ethernet port section instead of the RS232 port section. Most likely you will want to change the Modbus Protocol value to TCP. It is possible for the XL4 to use MODBUS RTU communications over TCP, but that would only be recommended for a scenario such as connecting via a RS232-TCP bridge to a device that only supported the Modbus RTU protocol.

Give the XL4 an IP Address, Net Mask, and Gateway in the section labelled Onboard Ethernet. Also specify which TCP Port the RTU should listen on (normally use port 502).
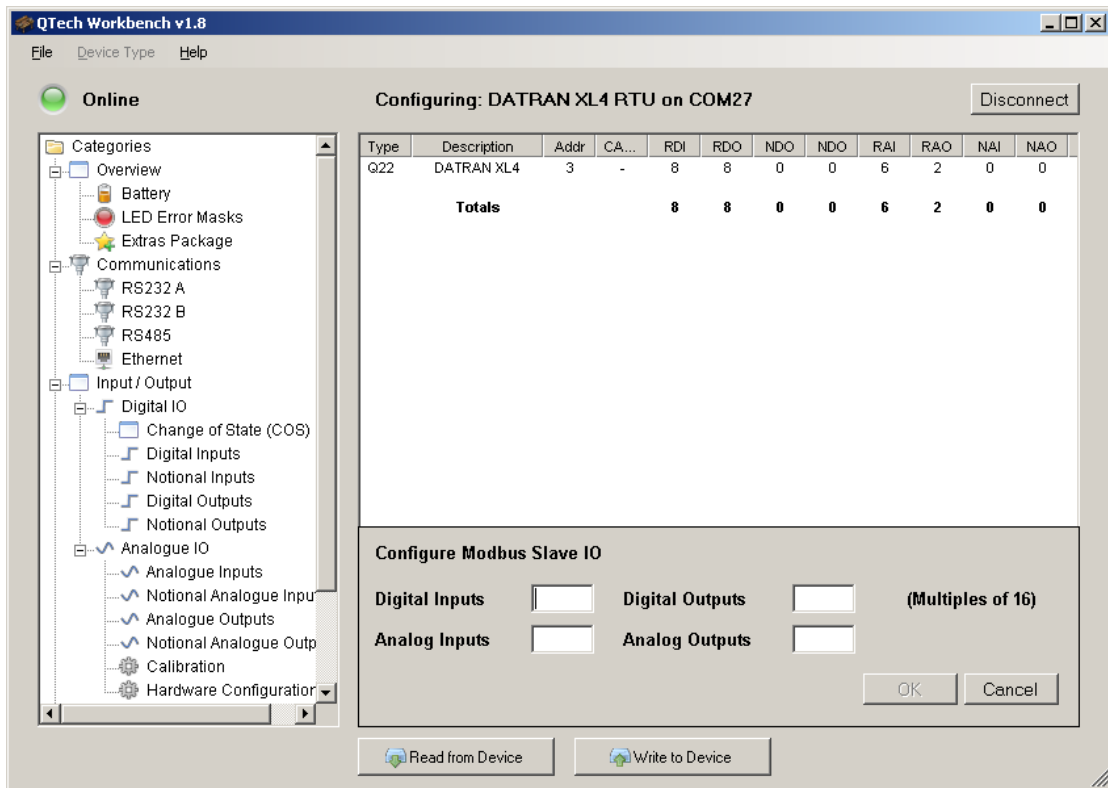
Configuring the RTU as a MODBUS Master via RS232

Select which physical port (A or B) is to be connected to the MODBUS Slave device(s). Click on the Port Function field and select Modbus (RTU as Master). Edit the Port settings values as needed. Select the MODBUS Protocol type as needed. The Modbus Poll Period value specifies how often the RTU will poll each connected slave.

Next, go to the Input/Output section and click on the Add Module button. Enter the Modbus address of the slave in the Unique Module Address box and select the Module Type to be QF5-Modbus Slave Loop.
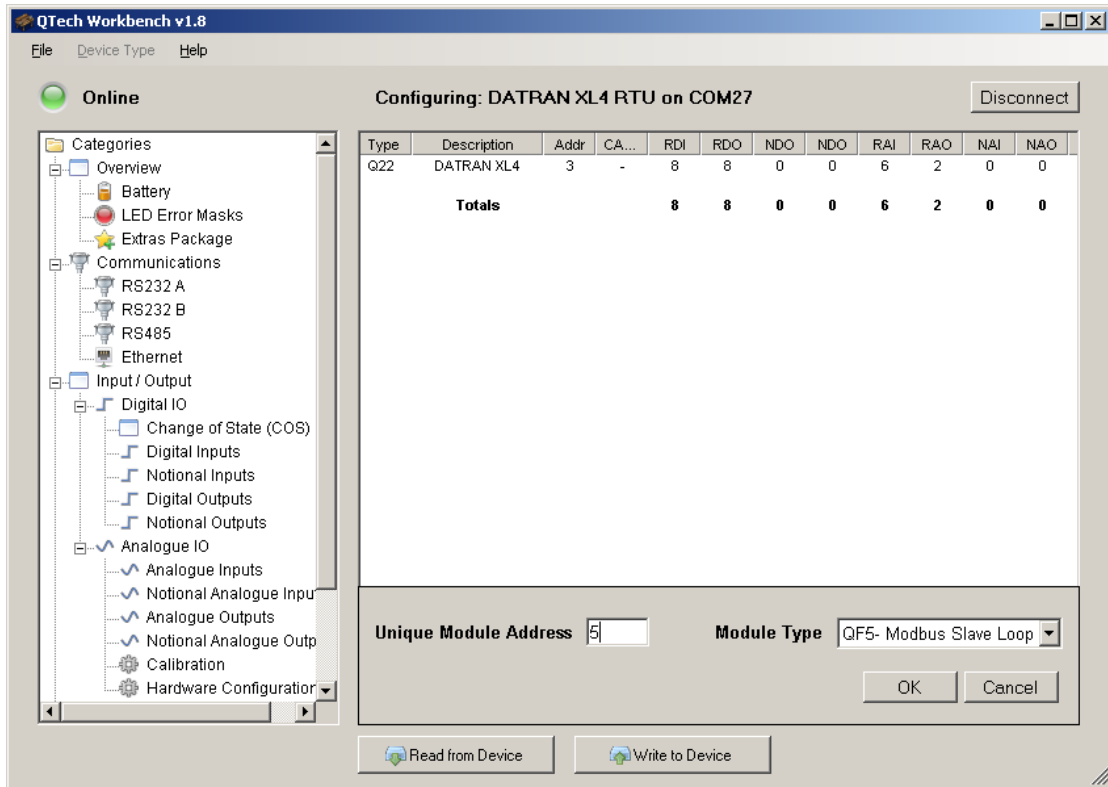
Now enter values for how much of each type of I/O the RTU is to communicate with the slave.

Configuring the RTU as a MODBUS Master via Ethernet

To configure the RTU as a MODBUS TCP Master, edit the Ethernet Ports Port Function value to be Modbus (RTU as Master). Specify the RTUs IP Address, Net Mask, and Gateway values in the Onboard Ethernet section. Specify the IP Address of the MODBUS Slave device, and which TCP Port to connect to (normally Port 502), in the Remote Ethernet section.

In the current manifestation, only one slave can be configured (there is no way to specify more than one Remote IP Address).

Then add a QF5-Slave Loop device as described in the previous section.

I/O Mapping

The RTU will map I/O from the MODBUS interface as a continuation of its own I/O table. The order that I/O from different modules appears in the data table is determined by the DATRAN IPB address of each module, with the RTUs native (onboard) I/O always appearing first.

When the RTU is configured as a MODBUS Slave, the MODBUS Interface is assigned a virtual IPB address of 242. When the RTU is a MODBUS master, each slave is mapped into the I/O table according to its MODBUS address.

Below is an example of how the digital inputs are mapped for a site consisting of an XL4 RTU with a Q23 expansion module. The XL4 + Q23 combination is configured as a MODBUS slave with 16 MODBUS digital inputs.

I/O Description	DATRAN I/O Reference
RTU Native Digital Input #1	RDI 1
RTU Native Digital Input #2	RDI 2
RTU Native Digital Input #3	RDI 3
RTU Native Digital Input #4	RDI 4
RTU Native Digital Input #5	RDI 5
RTU Native Digital Input #6	RDI 6
RTU Native Digital Input #7	RDI 7
RTU Native Digital Input #8	RDI 8
Q23 Expansion Module Digital Input #1	RDI 9
Q23 Expansion Module Digital Input #2	RDI 10
Q23 Expansion Module Digital Input #3	RDI 11
Q23 Expansion Module Digital Input #4	RDI 12
Q23 Expansion Module Digital Input #5	RDI 13
Q23 Expansion Module Digital Input #6	RDI 14
Q23 Expansion Module Digital Input #7	RDI 15
Q23 Expansion Module Digital Input #8	RDI 16
Modbus %M0000	RDI 17
Modbus %M0001	RDI 18
Modbus %M0002	RDI 19
Modbus %M0003	RDI 20
Modbus %M0004	RDI 21
Modbus %M0005	RDI 22
Modbus %M0006	RDI 23
Modbus %M0007	RDI 24
Modbus %M0008	RDI 25
Modbus %M0009	RDI 26
Modbus %M0010	RDI 27
Modbus %M0011	RDI 28
Modbus %M0012	RDI 29
Modbus %M0013	RDI 30
Modbus %M0014	RDI 31
Modbus %M0015	RDI 32

DATRAN XL4 RTU Serial Port Pinout

The pinout of an RS232 port cable suitable for the XL4 RTU is as shown below.
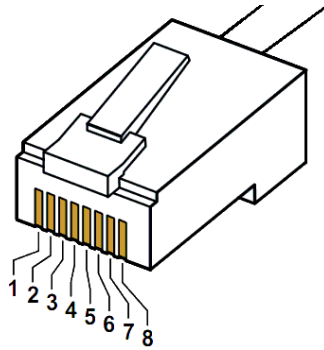
RJ45 End		D9 Female End	
2	RTS	8	CTS
3	CTS	7	RTS
4	GND	5	GND
5	RX	3	TX
6	TX	2	RX
7	DCD	3	CD

All other pins are not connected

QTech supply a 1m length RJ45-D9 serial cable with each RTU supplied for MODBUS comms. Given the diversity of usage in the field, we can't guarantee the connectivity will suit your application.
Please terminate the cable to suit, having confirmed with the manufacturer of the device you are interfacing to.