


X-gateway Interface Addendum Modbus RTU Slave Interface

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HMS Industrial Networks AB


Germany +49 - 721 - 96472 - 0
Japan +81 - 45 - 478 - 5340
Sweden +46 - 35 - 17 29 20
U.S.A +1 - 773 - 404 - 3486


ge-sales@hms-networks.com
jp-sales@hms-networks.com
sales@hms-networks.com
us-sales@hms-networks.com



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About This Document

How To Use This Document

This document describes the various features of the Modbus RTU Slave interface, basic network installation procedures and various network specific details. General information and operating instructions for the X-gateway is available in the Anybus X-gateway User Manual.

The reader of this document is expected to be familiar with the Modbus RTU networking system, and communication systems in general.

For further information, documentation etc., please visit the HMS website, 'www.anybus.com'.

Important User Information

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The examples and illustrations in this document are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular implementation, HMS cannot assume responsibility or liability for actual use based on these examples and illustrations.

- | | |
|------------------|---|
| Warning: | This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures. |
| ESD Note: | This product contains ESD (Electrostatic Discharge) sensitive parts that may be damaged if ESD control procedures are not followed. Static control precautions are required when handling the product. Failure to observe this may cause damage to the product. |

Conventions & Terminology

The following conventions are used throughout this document:

- Numbered lists provide sequential steps
- Bulleted lists provide information, not procedural steps
- The term 'X-gateway' is used when referring to the Anybus X-gateway
- The term 'Slave interface' is used when referring to the Modbus RTU Slave interface.
- The term 'user manual' is used when referring to the Anybus X-gateway User Manual.
- Hexadecimal values are written in the format NNNNh, where NNNN is the hexadecimal value.
- 16/32 bit values are generally stored in Motorola (big endian) format unless otherwise stated.

Support

HMS Sweden (Head Office)

E-mail: support@hms-networks.com
Phone: +46 (0) 35 - 17 29 20
Fax: +46 (0) 35 - 17 29 09
Online: www.anybus.com

HMS America

E-mail: us-support@hms-networks.com
Phone: +1-773-404-2271
Toll Free: 888-8-Anybus
Fax: +1-773-404-1797
Online: www.anybus.com

HMS Germany

E-mail: ge-support@hms-networks.com
Phone: +49-721-96472-0
Fax: +49-721-964-7210
Online: www.anybus.com

HMS Japan

E-mail: jp-support@hms-networks.com
Phone: +81-45-478-5340
Fax: +81-45-476-0315
Online: www.anybus.com

About the Modbus RTU Slave Interface

General Description

The Modbus-RTU Slave Interface for the X-gateway implements a passive Modbus-RTU slave node for the X-gateway platform. As a slave node, it can respond to Query's from a Modbus RTU Master, but will not initiate communication on its own.

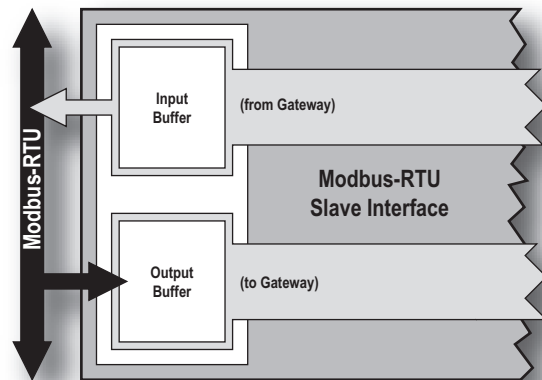
The interface exchanges data through two buffers as follows:

- **Input Buffer**

This buffer holds data forwarded *from* the other network, and can be read by the Modbus Master.

- **Output Buffer**

This buffer is forwarded *to* the other network, and can be both read and written by the Modbus Master. Note however that the unidirectional nature of the X-gateway means it will still only be forwarded *to* the other network, never the other way around (for that purpose, use registers associated with the Input Buffer instead).



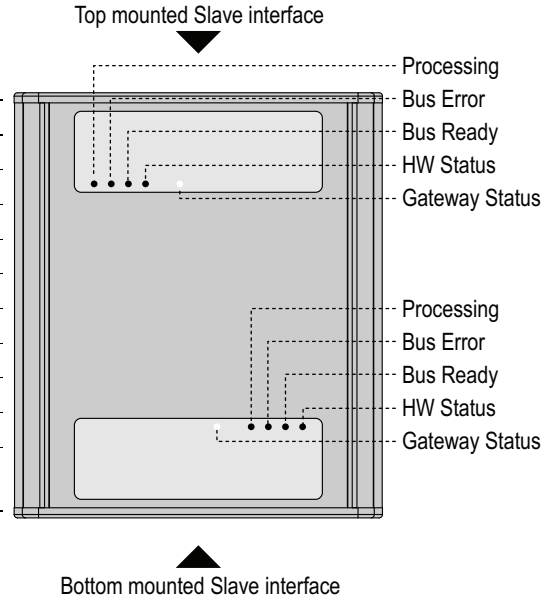
Features

- Modbus-RTU compliant, passive slave node operation
- Modbus diagnostics
- Up to 256 Modbus registers in each direction
- RS485 or RS232 operation
- Baudrates from 1200bps to 57600bps
- On-board configuration switches
- Galvanically isolated bus electronics

External View

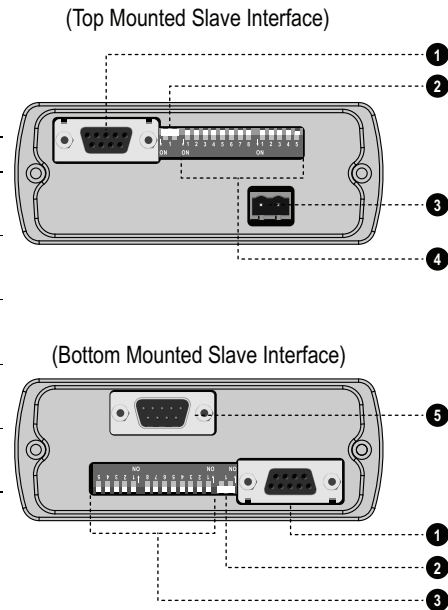
Modbus RTU Status LEDs

LED	Colour	Indication
Processing	Green	Processing message
	Off	Not processing
Bus Error	Red	Bus error
	Off	Normal operation
Bus Ready	Green	Normal operation
	Red	Bus timeout error
	off	Bus not running
HW Status	Red	Configuration switch error
	Off	-
Gateway Status	(Consult the user manual for further details)	



Connectors and Switches

#	Description
1	Modbus RTU network connector (see A-1 "Modbus RTU Connector Pinout")
2	Termination Switch (see 2-2 "Network Termination")
3	Gateway power connector (consult the user manual for further details)
4	Configuration switches (see 2-1 "Installation and Configuration")
5	Gateway config connector (consult the user manual for further details)



Installation and Configuration

Node ID Configuration

Each node on a Modbus RTU network must be assigned a unique node ID. Seven switches are used to set the Modbus node ID of the Slave interface in binary form. The switches are read once during startup, i.e. the gateway must be restarted for any changes to have effect.

Switch 1	Switch 2	Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8 ^a	Node ID
OFF	OFF	OFF	OFF	OFF	OFF	OFF	-	(invalid)
OFF	OFF	OFF	OFF	OFF	OFF	ON		1
OFF	OFF	OFF	OFF	OFF	ON	OFF		2
...
ON	ON	ON	ON	ON	ON	ON		127

a. See 2-1 "Baudrate Configuration"

Example:

In this example, the Modbus node ID will be 42.



Note: Depending on if the Slave interface is top or bottom mounted, the orientation of the switches are different.

Baudrate Configuration

The standard baudrate of Modbus RTU is 19.2kbit/s. The Slave interface does however allow baudrates from 1.2kbit/s to 57.6kbit/s to be selected via the baudrate switches. The switches are read once during startup, i.e. the gateway must be restarted for any changes to have effect.

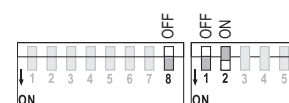
Switch 1-7 ^a	Switch 8	Switch 1	Switch 2	Switch 3 ^b	Switch 4 ^b	Baudrate
-	OFF	OFF	OFF	-	-	(invalid)
	OFF	OFF	ON			1.2kbit/s
	OFF	ON	OFF			2.4kbit/s
	OFF	ON	ON			4.8kbit/s
	ON	OFF	OFF			9.6kbit/s
	ON	OFF	ON			19.2kbit/s (standard)
	ON	ON	OFF			38.4kbit/s
	ON	ON	ON			57.6kbit/s

a. These switches are used for Node ID configuration, see previous section.

b. This switch is used for Parity configuration, see next section.

Example:

In this example, the baudrate will be 1.2kbit/s.



Note: Depending on if the Slave interface is top or bottom mounted, the orientation of the switches are different.

Parity and Stop Bits Configuration

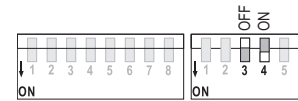
The Slave interface allows different parity settings to be selected via the parity switches. The switches are read once during startup, i.e. the gateway must be restarted for any changes to have effect.

Switch 1 ^a	Switch 2 ^a	Switch 3	Switch 4	Switch 5 ^b	Parity	Stop bits
-	-	OFF	OFF	-	(invalid)	(invalid)
-	-	OFF	ON	-	None (Standard)	2 (standard)
-	-	ON	OFF	-	Even	1
-	-	ON	ON	-	Odd	

- a. See 2-1 “Baudrate Configuration”
- b. See 2-2 “Physical Interface”

Example:

2 stop bits, no parity (Modbus RTU standard)



Physical Interface

The Slave interface supports RS232 and RS485 communication standards.

Switch 1 ^a	Switch 2 ^a	Switch 3 ^b	Switch 4 ^b	Switch 5	Physical Interface
-	-	-	-	OFF	RS485
-	-	-	-	ON	RS232

- a. See 2-1 “Baudrate Configuration”
- b. See 2-2 “Parity and Stop Bits Configuration”

Example:

In this example, the physical interface is set to RS232.

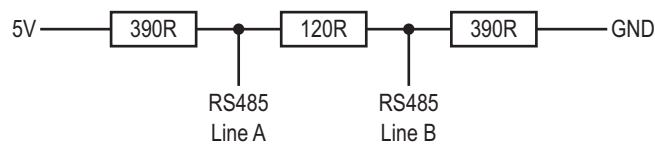


Network Termination

The end nodes of a RS485-based Modbus RTU network must be terminated in order to avoid reflections on the bus line. The Slave interface features a termination switch, which is used to enable internal termination resistors.

Switch Position	Internal Termination
OFF	Disabled
ON	Enabled

The figure below shows the connection and the values of the internal termination and bias resistors. If the values does not match the network termination convention, external termination must be used.



Gateway Config Interface

The Gateway Config Interface features the following Modbus RTU-specific settings:

```

-----
Change configuration
-----
Modbus RTU Slave (Upper)

Input I/O data size (bytes):                20
Output I/O data size (bytes):                20
Offline option (+/-):                        Clear
Control / Status word (+/-):                 Disabled
Offline timeout (ms/0=disabled):             0
-----

```

- **Input I/O data size (bytes)**
Specifies the amount of Input Data to exchange on Modbus-RTU.
- **Output I/O data size (bytes)**
Specifies the amount of Output Data to exchange on Modbus-RTU.
- **Offline option**
(Consult the Anybus X-gateway User Manual for further information).
- **Control / Status word**
This settings enables/disables representation of the Control/Status word on Ethernet.
(Consult the Anybus X-gateway User Manual for further information).

See also...

- 3-1 “Data Exchange”
- 3-2 “Coil & Register Map”

Data Exchange

General Information

The Slave Interface acts as a passive node and as such it responds to incoming Queries and accepts broadcast messages. It will not initiate communication autonomously.

In the Anybus implementation, several Modbus functions are associated with the very same data. While this may appear confusing at first, it allows data to be manipulated in a very flexible manner (e.g. it is possible to manipulate individual bits of a register by accessing coils associated with the same memory location).

The following functions can be used to access data in the Slave Interface:

Modbus Function	Function Code	Direction	Associated with Buffer
Read Coil	1	Gateway to Modbus	Input- and Output Buffers
Read Input Discretes	2		
Read Holding Registers	3		
Read Input Registers	4		
Write Coil	5	Modbus to Gateway	Output Buffer
Write Single Register	6		
Force Multiple Coils	15		
Force Multiple Registers	16		
Mask Write Register	22	Bidirectional	Input- and Output Buffers
Read/Write Registers	23		

See also...

- 3-2 “Coil & Register Map”

Modbus Exceptions

With the exception of broadcast messages, the Modbus Master expects its slaves to respond within a certain defined time period. If no response is received (e.g. due to a transmission error), this eventually triggers a timeout condition in the Master.

If the Slave Interface receives a Query from the Master, but for some reason is unable to process it (e.g. the Master tries to access a non-existent Register), an Exception is returned to inform the Master of the nature of the problem.

The Slave Interface may issue the following Exception responses:

#	Meaning	Description
01h	Illegal Function	The Query contains an illegal or unsupported function call
02h	Illegal Data Address	The Query contains an illegal data address
03h	Illegal Data Value	The Query contains invalid data

Coil & Register Map

The Input & Output Buffers are mapped to coils and registers as follows:

Register #	Coil #	Buffer	Location in Buffer	Comments	
1	1... 16	Input Buffer	000... 001h	Applicable Modbus functions: - Read Coil - Read Input Discretes - Read Holding Registers - Read Input Registers - Read/Write Registers	
2	17... 32		002... 003h		
3	33... 48		004... 005h		
4	49... 64		006... 007h		
5	65... 80		008... 009h		
6	81... 96		00A... 00Bh		
7	97... 112		00C... 00Dh		
...		
255	4065... 4080		1FC... 1FDh		
256	4081... 4096		1FE... 1FFh		
257... 1024	4097... 16384	-	-	(reserved)	
1025	16385... 16400	Output Buffer	000... 001h	Applicable Modbus functions: - Read Coil - Read Input Discretes - Read Holding Registers - Read Input Registers - Write Coil - Write Single Register - Force Multiple Coils - Force Multiple Registers - Mask Write Register - Read/Write Registers	
1026	16401... 16416		002... 003h		
1027	16417... 16432		004... 005h		
1028	16433... 16448		006... 007h		
1029	16449... 16464		008... 009h		
1030	16465... 16480		00A... 00Bh		
1031	16481... 16496		00C... 00Dh		
...		
1279	20449... 20464				1FC... 1FDh
1280	20465... 20480				1FE... 1FFh
1281...	20481...		-		-

Note: Coils are mapped MSB first, i.e. coil 0 corresponds to bit 15 of register 0.

Modbus Diagnostics

The Modbus RTU interface features several diagnostic counters which increments each time the interface encounters certain pre-defined events. These counters may provide valuable clues when troubleshooting the Modbus communication, and can be accessed through the standard Modbus Diagnostic function (function code 08h).

The following sub-functions are implemented:

#	Meaning	Description
00h	Return Query Data	Loopback; instructs the slave to return the data from the Query
0Ah	Clear Counters and Diagnostic Register	Clears all diagnostic counters
0Ch	Return Bus Communication Error Count	Returns the no. of detected CRC-errors
0Dh	Return Bus Exception Error Count	Returns the no. of exception responses previously returned by the slave
0Eh	Return Slave Message Count	Returns the number of messages addressed to the slave interface (broadcast included)

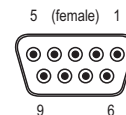
Technical Specification

Modbus RTU Interface Details

- **Media:** RS485 or RS232 (specified via on-board switches)
- **Cable:** Shielded copper cable, twisted pair
- **Topology:** Master-slave communication
- **Isolation:** Galvanically isolated bus electronics
- **Baudrates:** 1.2kbit/s - 57.6kbit/s (specified via on-board switches)
- **Node ID Range:** 1 - 127 (specified via on-board switches)
- **Data size:** Up to 256 registers in each direction
- **Implemented Functions:**
 - 01h - “Read Coil”
 - 02h - “Read Input Discretes”
 - 03h - “Read Holding Registers”
 - 04h - “Read Input Registers”
 - 05h - “Write Coil”
 - 06h - “Write Single Register”
 - 08h - “Diagnostics” (Sub-functions 0,10,12,13 and 14)
 - 0Fh - “Force Multiple Coils”
 - 10h - “Force Multiple Registers”
 - 16h - “Mask Write Register”
 - 17h - “Read/Write Registers”

Modbus RTU Connector Pinout

#	Signal
housing	Cable shield
1	-
2	RS232 Tx
3	RS232 Rx
4	-
5	Signal Ground ^a
6	+5V Output (50mA max.) ^a
7	RS485 Line B
8	RS485 Line A
9	-



a. These pins can be used to power external bias/termination circuitry, or external equipment such as media converters etc. The maximum current consumption of such equipment must not exceed 50mA.

