Installation and Start-up guide

RS485 Modbus adapter

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ABB

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1 INTRODUCTION

1.1 Intended audience

This manual is intended for installers, commissioning people, network managers who need to install an RS485 network, start or maintain a super-vision system based on the Modbus protocol.

1.2 Before you start

This manual describes the RS485 Modbus adapter.

To be able to access data of the Power^{IT} Power Factor Controller RVT consistently, a basic knowledge of it is needed. Functionality of the RVT, meaning of various measurements, logging of data are some particular aspects that should be familiar.

If not, please refer to the RVT Installation and operating Instructions to get the sufficient knowledge.

To know more about the RVT data access, please refer to the RVT Modbus data table.

As other devices may be connected through the RS485 Modbus adapter, the term "controller" will be used here to define the device.

1.3 How to use this manual

Chapter 2 is a short description of the Modbus adapter.
Chapter 3 contains a description of the physical layer. Connection to a controller is described.
Chapter 4 gives all technical details concerning the Modbus adapter.
Chapter 5 is an overview of the Modbus protocol and how Modbus is implemented in the controller.
Chapter 6 contains the table reference and formats to access data.
Chapter 7 is a reference in case of problems
Chapter 8 is dedicated to annexes

2 OVERVIEW

This chapter contains a short description of the Modbus protocol and the RS485 interface.

2.1 Introduction to Modbus

Modbus is a serial, asynchronous protocol. The Modbus protocol does not specify the physical interface. The typical physical interfaces are RS-232 and RS-485. The Interface Module uses the RS-485 interface.

Modbus is designed for integration with PLCs or other automation devices, and the services closely correspond to the PLC architecture.

The Modbus commands and services supported by the Modbus adapter are discussed in Chapter 5.

2.2 The Modbus adapter

The Modbus adapter is an optional device for ABB Power[IT] Power Factor Controller RVT which enables the connection of the RVT to a Modbus system. The controller is considered as a slave unit in the Modbus network.

Through the Modbus adapter it is possible to:

• Read measurements and logged values
• Read and write parameters settings of the controller
• Activate output relays
• Read status information
• Read device identification and type numbers
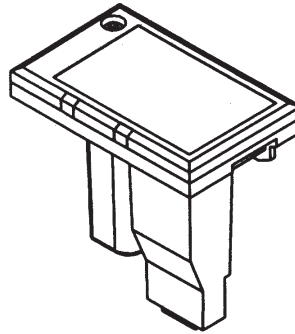
2.3 Compatibility

The Modbus adapter is compatible with any ABB Power[IT] Power Factor Controller RVT of version 1.6 or higher. Other ABB controllers may be connected with the adapter.
The Modbus protocol is compatible with all master stations that support the Modicon-defined Modbus serial communication protocol.

3 SERIAL INTERFACE CONSIDERATIONS

The Modbus protocol communicates with the instrumentation by means of an industry standard serial interface. This interface may be RS-232, RS-422 or RS-485. Some systems may also support the protocol over other busses or networks, such as Ethernet.

An RS-232 interface allows only two devices to be connected together.

RS-422 supports 1 driver and up to 10 receivers on a single network.

For bi-directional communications, special tri-state circuitry is provided. RS-485 supports up to 32 driver/receiver pairs. With special hardware, the RS-422 and RS-485 limits can be expanded to allow as many as 248 devices on a single network. Each device on a network must have a unique address, which may be soft configured. Address zero is reserved for broadcast messages from the host to all slaves.

All devices on a network must also be configured with the same parameters, such as baud rate and parity. In designing the communication architecture, one should consider communications performance when deciding how many devices to connect to a host port. Generally, nearly twice the performance can be achieved by splitting the devices from one port, onto two ports.

3.1 Communication mode

MODBUS protocol uses half-duplex communications, regardless of the hardware.
Half-duplex hardware shares the same lines for transmit and receive, whereas, full-duplex hardware has dedicated transmit and receive lines.

3.2 SINGLE ENDED versus DIFFERENTIAL data transmission

- Single-ended transmission is performed on one signal line, and the logical state is interpreted with respect to ground. The main disadvantage of the single-ended solution is its poor noise immunity.

- For differential transmission, a pair of signal lines is necessary for each channel. On one line, a true signal is transmitted, while on the second one, the inverted signal is transmitted. The receiver detects voltage difference between the inputs and switches the output depending on which input line is more positive. Differential data transmission schemes are less susceptible to common-mode noise than single-ended schemes.

Point to point – single ended

Point to point – differential

Multi point – differential

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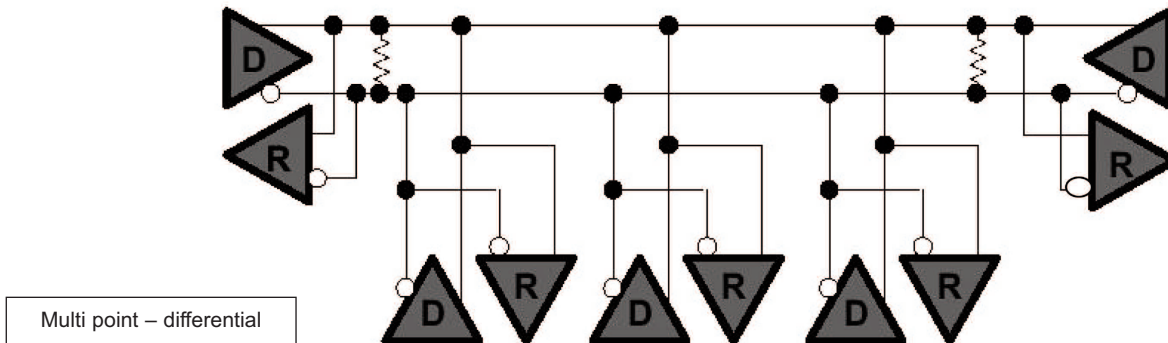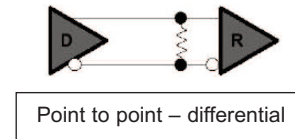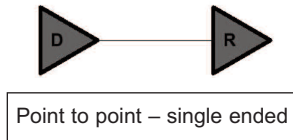
3.3 RS-232 interface

An RS-232 interface is rated for distances up to 15 meters (50 feet). At least three wires are required for an RS-232 interface. Wires are required for Transmit, Receive and Signal Ground. Some devices support additional wires for communication handshaking. RS-232 hardware is a full-duplex configuration, having separate Transmit and Receive lines.

Each signal that transmits in an RS-232 data transmission system appears on the interface connector as a voltage with reference to a signal ground. The RS-232 receiver typically operates within the voltage range of +3 to +12 and -3 to -12 volts.

3.4 RS-422 interface

An RS-422 interface requires at least four wires. Two wires each are used for Transmit and Receive. A fifth wire is usually required for Signal Ground, when connecting non-isolated devices together. Handshaking lines may also be supported by some hardware. This interface is full duplex, allowing use of the same software drivers as for RS-232. The differential drivers allow for distances up to 1200 meters (4000 feet). The receivers of an RS-422 device are always enabled.

3.5 RS-485 interface

For multi-drop operation, drivers must be capable of tri-state operation.

An RS-485 interface requires at least two wires. In a two-wire configuration, the same pair of wires is used for Transmit and Receive. The two-wire configuration utilizes half-duplex communications. Transmit driver circuits are always taken off-line or tri-stated, when not in use. This tri-state feature reduces the load on the network, allowing more devices, without the need of special hardware. This interface also uses differential drivers, supporting distances up to 1200 meters (4000 feet).

In a differential system the voltage produced by the driver appears across a pair of signal lines that transmit only one signal. A differential line driver will produce a voltage from 2 to 6 volts across its A and B output terminals and will have a signal ground (C) connection. Although proper connection to the signal ground is important, it isn't used by a differential line receiver in determining the logic state of the data line.

A differential line receiver senses the voltage state of the transmission line across two signal input lines, A and B. It will also have a signal ground (C) that is necessary in making the proper interface connection. If the differential input voltage Vab is greater than +200 mV the receiver will have a specific logic state on its output terminal. If the input voltage is reversed to less than -200 mV the receiver will create the opposite logic state on its output terminal.

3.6 Bias resistors

RS-422 and RS-485 networks often require bias, or pull-up and pull-down resistors. These resistors are used to stabilize the network. By definition, in a MODBUS RTU network, it is the responsibility of the Master to provide this function.

Some systems may function without these stabilizing resistors, but may be more susceptible to communication errors. Though the pull-up and pull-down resistors are the same, the value of these resistors varies from device to device. The actual recommended resistance may be calculated, and varies with the number of devices on the bus.

3.7 Termination resistors

Termination resistors are often used to reduce reflections on the network. This problem occurs most with long wires and high baud rates. Due to variations in wire and equipment, whether or not to use these terminators is usually determined by system testing. The general rule is to add them only if needed. The resistors are typically 120 ohms, and installed across the Transmit and Receive wire pairs. Normally, one resistor is installed at each end of each pair of wires.
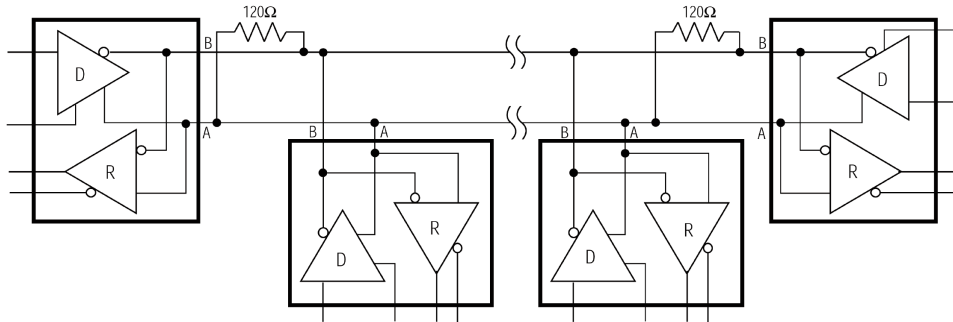
3.8 Shielding and grounding considerations

The signal ground conductor is often overlooked when ordering cable. An extra twisted pair must be specified to have enough conductors to run a signal ground. A two-wire system then requires two twisted pairs.

It is often hard to quantify if shielded cable is required in an application or not. Since the added cost of shielded cable is usually minimal it is worth installing the first time.

3.9 Cable requirements

The type of wire to use will vary with required length. Wire with twisted pairs and an overall shield is used most often. The shield is tied to earth ground or chassis, and typically at one end only (generally at the Modbus Master side). The shield is not to be used as a signal common or ground. The table below lists typical cable recommendations.

RS-232
Up to 15m (50ft) virtually any standard shielded twisted pair with drain (Belden 9502 or equivalent)
RS-422 and RS-485
Up to 1200m (4000ft) 24 AWG twisted pair with foil shield and drain wire on each pair
(Belden 9841 for 2-wire and 9729 for 4-wire or equiv.)

3.10 Network topology

Various kind of network topologies may be done on the basis of an RS485 Modbus network.

The Modbus network may be managed by a computer collecting data. Typically this computer runs an OPC server connected to a plant intranet. OPC client applications may present these information to any supervision program who will perform the Human Machine Interface, data logging, data setting, …

Plant intranet

Modbus network

| Controller 1 | Controller 2 | Controller N |
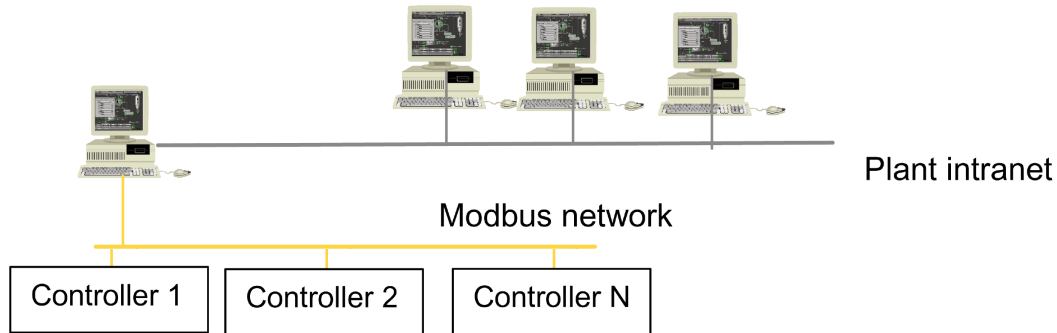
It is also possible to manage the RS485 Modbus network through a PLC.

Modbus network

| Controller 1 | Controller 2 | Controller N |
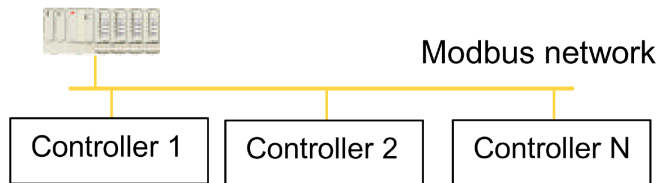
Various kind of RS485 to RS232 converters exists.

To bridge the Modbus network to another kind of software protocol, various kind of protocol converters may be used. They are often called 'protocol gateway: Modbus to Profibus, Ethernet, CAN, …

4 RS485 MODBUS ADAPTER

The RS485 Modbus adapter enables the connection of the controller to an RS485 Modbus network.

4.1 Main features

The adapter is self powered through the power supply of the controller

➔ Advantage: an external power supply is not needed.

➔ Advantage: low power consumption

The adapter is fixed directly on the back side of the RVT

➔ Advantage: the Modbus adapter does not need any rail DIN or such fixation methods.

The adapter is electrically isolated from the RVT power supply

➔ Advantage: the RVT is protected against common mode voltage levels applied on the RS485 network

➔ Advantage: no ground loop

The adapter has an integrated terminator resistance which may be connected with a switch

➔ Advantage: no external device to be added

The adapter contains transient voltage suppressors

➔ Advantage: the device and the network are protected against voltage surges

The adapter is fitted with transmission and reception indication LED's

➔ Advantage: it allows visualizing Modbus queries and Modbus answers.

The controller allows a software adjustment of communication parameters

➔ Advantage: no multiple hardware dipswitches to handle

➔ Advantage: permits self-tuning of communication parameters with a higher level software application

4.2 Physical dimensions

The Modbus adapter is especially suitable for application where space requirements are important.

57 mm

Fixing screw

TX - RX led's

35 mm

Resistor termination switch

48 mm

Screwed terminal for bus cable connection

Extra depth to the controller max. 10mm
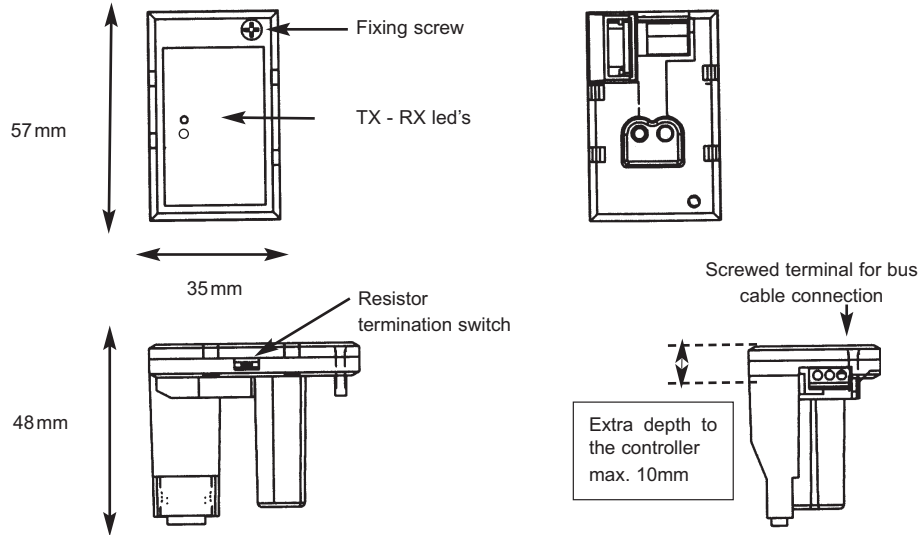
4.3 Mounting

The Modbus adapter is specially shaped to fit the controller case and to plug into its dedicated connectors without any other additional fixation part than just a screw.

3D view inserted in back plate

3D view:

Controller optical transceiver

Controller power supply connector
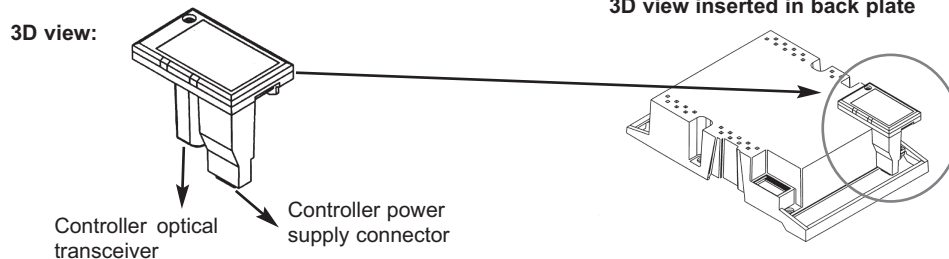
4.4 Technical data

- Operating ambient temperature: -20 to +70 °C
- Number of nodes (Tx drive): 32 max
- Rx loading: receiver impedance is 1 unit load per RS485 Modbus adapter
- Size of the Link: 247 stations including repeaters (31 stations and 1 repeater per segment)
- Medium: Shielded, twisted pair RS485 cable (Belden 9841 typical)
- Maximum Bus Length: 1200 m
- Topology: Multi-drop
- Serial Communication Type: Asynchronous, 2 wires half Duplex
- Baud rate: 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 bauds selectable by the user (can be adjusted through the controller menus)
- Termination resistor: built in, selectable by a switch. A 120 ohms resistor is needed at both end of the line and must be switched or not depending on the location in the Modbus network topology.
- Transient voltage suppressors
- Screwed terminals on the RS485 side
- TX – RX Led indication for easy debugging and troubleshooting
- Slew-Rate Limited for Error-Free Data Transmission (minimizing EMI and reducing reflections caused by improperly terminated cables)
- Drivers are short-circuit current limited
- The receiver input has a fail-safe feature in case of broken connection
- Compatible Devices: Any Modbus device capable of Modbus communication as a master.
- Speed reply time: better than 5 ms @ 57600 bauds
- Max data packet: Any complete table provided in the Modbus data table

4.5 Commissioning process

To install the RS485 Modbus adapter, follow the hereafter commissioning process.
- Disconnect power supply from the controller
- Wait the required time to ensure all capacitors are discharged
- Connect the signal ground (if present) to GND
- Connect the twisted pair to the A and B connections
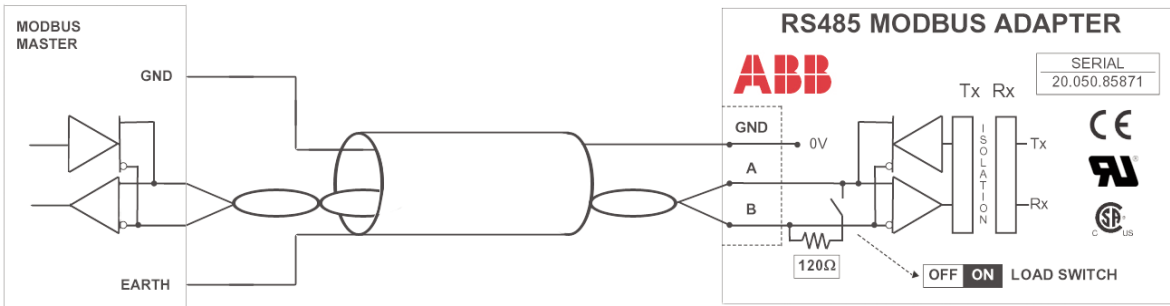
Insert the RS485 Modbus adapter in the controller
- Fix it with the appropriate screw
- Ensure that all connections are tight.
- If the RS485 modbus adapter is one of the two ending station on the communication line put the load termination switch in the ' ON ' position. If not, put it in the ' OFF ' position.
- Make sure all other modbus stations (master and slaves) are properly connected
- Apply power on the controller
- Enter the protocol selection menu under:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - PROTOCOL
    - Select: MODBUS
- Enter the MODBUS menu under:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - MODBUS
    - Select the right communication speed (baud rate)
    - Select the right parity checking
    - Select the right number of stop bits
    - Choose a slave address (the address must be unused in the Modbus network it is inserted in)
- The modbus slave is now ready to receive modbus queries from the modbus master and to send modbus response accordingly
- If something goes wrong, see the trouble shooting section hereafter

4.6 To set the MODBUS LOCK parameter

- If the RVT's parameters should be changed only from the modbus network, set the Modbus lock item as locked. It can be found under the following menu:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - MODBUS
    - Set the Modbus lock parameter to 'Locked'

4.7 To test the communication

Depending on the way the controller is connected to the Modbus network, different ways of testing may be chosen.

A small PC interface is provided with the documentation in order to check the communication with the RS485 Modbus adapter: see CheckModbusComm.exe.

In case of problem, please refer to the troubleshooting paragraph.

5 MODBUS PROTOCOL OVERVIEW

5.1 Overview

MODBUS RTU is a non-proprietary serial communications protocol that is widely used in the process control industry. The protocol was developed by Modicon for PLC communications and later released for public use.

This protocol is available in all major Human Machine Interface (HMI) software packages and terminals. Many of the major controller and PLC manufacturers also offer MODBUS protocol as a standard or optional protocol in their instrumentation.

The hardware over which MODBUS RTU communications are performed is not defined by the protocol. MODBUS RTU is supported on RS-232, RS-422, RS-485, Ethernet and other electrical standards. It should be noted that MODBUS RTU, MODBUS ASCII and MODBUS Plus are unique communication formats, and are not compatible with each other. This document will discuss MODBUS RTU only.

5.1.1 Transactions on Modbus Networks

Modbus protocol uses a master–slave technique, in which only one device (the master) can initiate transactions (called 'queries'). The other devices (the slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host processors and programming panels. Typical slaves include programmable controllers.

The master can address individual slaves, or can initiate a broadcast message to all slaves.

Slaves return a message (called a 'response') to queries that are addressed to them individually. Responses are not returned to broadcast queries from the master.

The Modbus protocol establishes the format for the master's query by placing into it the device (or broadcast) address, a function code defining the requested action, any data to be sent, and an error–checking field. The slave's response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and an error–checking field. If an error occurred in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as its response.

5.1.2 Serial Transmission Mode

The transmission mode defines the bit contents of message fields transmitted serially on the networks. It determines how information will be packed into the message fields and decoded.

Modbus defines two transmission modes: ASCII or RTU.

Only RTU mode will be used here. The mode and serial parameters must be the same for all devices on a Modbus network.

5.2 Data Addresses in Modbus Messages

Modbus defines 4 address spaces: 2 address spaces for bit addressable data and 2 address spaces for 16 bits addressable data.

Address space	data	readable / writable	Modbus name
0XXXX	Output bit	read & write	Coil Status
1XXXX	Input bit	read	Input Status
3XXXX	Input word	read	Input Register
4XXXX	Output word	read & write	Holding Register

5.3 Supported function codes

The following table gives the Modbus functions, which are implemented and supported.

The code is the one used in function field of the Modbus message.

The address space concerned and the purpose of the function are given below.

Code	Function	Address range / Remark
1	Read Coil Status	0XXXX Reads the on/off status of discrete outputs
2	Read Input Status	1XXXX Reads the on/off status of discrete inputs
3	Read Holding Registers	4XXXX Reads contents of output registers
4	Read Input Registers	3XXXX Reads contents of input registers
5	Force Single Coil	0XXXX Sets the status of a discrete output
6	Preset Single Register	4XXXX Sets the value of a holding register
7	Read Exception Status	device specific (see Modbus data table of the device)
8	Diagnostics	Checks the communication system between the master and the slave
11	Fetch Comm. Event Ctr.	Returns amount of successful read/write operations on data points
12	Fetch Comm. Event Log	Returns log registers of communication events
15	Force Multiple Coils	0XXXX Sets the status of multiple discrete outputs
16	Preset Multiple Registers	4XXXX Sets the value of multiple holding registers
17	Report Slave ID	device specific (see Modbus data table of the device)
22	Mask Write 4X registers	4XXXX And / Or write of a holding register
23	Read/Write 4X registers	4XXXX Reads a set of holding registers and writes a set of holding registers in one query

6 DATA ACCESS

6.1 Access levels

Some access levels must be set to allow parameters to be changed. Here are some access levels used in the RVT.

SET MODE: The RVT must be in the Set Mode to allow parameter modifications.

LOCKING SWITCH: the locking switch has to be released

BANK SETTINGS: the parameter bank settings must be set as Unlocked.

(for more information on these settings, please refer to the RVT Installation and Operating manual).

Another parameter (MODBUS LOCK) is used to add access rights to Modbus users.

The access levels of the Modbus writings are coded in the Modbus data table.

6.2 Minimum and maximum values

Variables have a limited range. If a write operation to a variable exceeds the minimum and maximum allowable values, the variable will be overridden with its minimum or maximum value.

An ILLEGAL DATA VALUE exception error is sent back.

See the Modbus data table for more details.

6.3 Modbus Data table

Data are arranged in several tables for convenience. Individual tables contain similar information. Table data may be read only or read/write access.

Data in each table is pointed to in a Modbus command by two consecutive data address bytes. The first byte defines the table number, and the second byte the offset of the data in the table. These two bytes are what is called the 'Modbus address' or the 'Modbus register'.

A specific Modbus data table is dedicated to a specific product type.

Access (read or write) to a non-referenced Modbus address result in an ILLEGAL DATA ADDRESS exception error.

The Modbus Data table gives all information on the various data and how to access them.

To handle RVT data, please refer to the RVT Modbus Data table.

7 TROUBLE SHOOTING

7.1 Preferred method of testing

In most cases the Modbus Master (usually a PC software package) will be running on a personal computer or on hardware which has RS232 communications ports. In these instances a converter will be needed to convert the RS232 signals to the RS485 standard used by the controller. Only when the Modbus Master is running on hardware fitted with RS485 ports is a converter unnecessary.

The preferred method of testing communications configuration is to operate with a single controller located close to the Master (PC, PLC etc) and minimum cable length.

Once cable connections, controller configuration and Modbus Master configuration have been successfully tested the system may be connected to the final installation (multiple slaves and extended cabling systems as needed to meet user requirements). Full system configuration and testing can then take place.

The software used to provide the Modbus Master functionality is not supplied. The commissioning engineer should be familiar with the use of the software both while testing connection to controllers and during full system configuration. In general software used during testing can be classed as either application software or Modbus test software, the principal differences between these two types are as follows.

Application software (such as Data Loggers or SCADA systems) is intended to use Modbus devices to perform a measurement, control or logging function. It often provides tools for quick configuration of known types of instrument. Such packages make it easy for a user to start a system without needing to know Modbus commands, but may not provide the tools for a commissioning engineer to diagnose problems when a system does not respond as anticipated.

A **Modbus test software** normally allows Modbus commands to be generated as required and the responses analysed. Some knowledge of the Modbus protocol and the instrument register addresses will be required before using such a package. Test packages will assist a commissioning engineer in diagnosing communication problems.

7.2 Check of identical Slave – Master configuration

In any case the master must have the same communication parameters as the controller:
- Enter the protocol selection menu under:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - PROTOCOL
    - Select: MODBUS
- Enter the MODBUS menu under:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - MODBUS
    - Select the right communication speed (baud rate)
    - Select the right parity checking
    - Select the right number of stop bits
    - Choose a slave address

7.3 Check the cabling of the RS485

- The non-inverting and the inverting output wires should be cabled respectively on non-inverting and inverting input respectively. No communication will take place if non-inverting wires are mixed with inverting wires.
- Load termination resistors are important at both end of the network to avoid distortion due to reflections in the communication line. Check that the 'Load switch' is at the right position (ON or OFF) according to the network configuration.
- Connection of a ground wire and presence of a shielding will improve reliability.

7.4 Check the Transmit – Receive indicators

This is a convenient way to check the presence of TX – RX signals:
- The Receive Led (yellow Led) indicates that a Modbus query is being received by the RS485 Modbus adapter.
- The Transmit Led (green Led) indicates that a Modbus response is being transmitted from the RS485 Modbus adapter.

• If the Rx Led and the Tx Led never lit, the problem may come from:
  - The wires of the RS485 cable are not properly fixed or cabled
  - The query is not sent (see the application software)
  - The controller and then the RS485 are not powered

Remark: To check if the RS485 Modbus adapter is powered, set the printer protocol and print settings. This will activate the Tx Led repeatedly without any query coming from the Modbus system.

- Enter the protocol selection menu under:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - PROTOCOL
    - Select: PRINTER
- Enter the print settings functionality under:
  - SETTINGS
    - Select: PRINT SETTINGS

• If only the Tx Led never lit, the problem may come from:
  - The controller settings are not correct (check communication parameters settings)
  - The controller entered the 'listen only' mode (reset the controller or send the required command to disable the 'listen only' mode.)
  - The master send Broadcast messages (address 0) which are to be acted on by all connected devices and do not require a reply.

• If the Tx Led is flashing without any query from the master:
  - The Modbus protocol is not selected and printing functionality is activated.

- Enter the protocol selection menu under:
  - SETTINGS - I/O CONFIGURATION – COMMUNICATION - PROTOCOL
    - Select: MODBUS

7.5 Check the function called and the register addresses

To ensure that a read or write message to a Modbus address will produce a normal response, check that the register address corresponds exactly to the desired data requested.

In Modbus register addressing there are several categories of register, including holding registers (numbered from 40001 upwards) and input registers (numbered from 30001 upwards). The category of register addressed is implicit in the Modbus function used, e.g. function 03 addresses holding registers and function 04 addresses input registers.

Irrespective of the function used, the register address 30001 or 40001 would be addressed in the transmitted message as register 0, 30002 or 40002 as register 1, 30010 or 40010 as register 9 and so on.

In the Modbus communications all these register addresses are not active and doesn't contain valid information. A read or write to an unused register address will produce an exception error.

7.6 Check the data access level and the limited range of data

To ensure that a write message to a Modbus address will produce a normal response, check that the data value and access level is valid.

Writings in the controller memory though Modbus are restricted to the setting of some access levels which need to be set. Look at:

- SET MODE
- LOCKING SWITCH
- BANK SETTINGS

Writings in the controller memory through Modbus are restricted to a limited range applied on that data. An exception error is sent in case of a writing exceeding the allowed limited range of a data.

7.7 Counters and Loopback diagnostics

Modbus offers some interesting functions to help the user to locate errors:

Fetch comm event counter (function 11) to catch successful messages.

Fetch comm event log (function 12) to look at the history of errors.

Diagnostics function and subfunctions (function 8)

Loopback diagnostics (subfunction 0) returns a response identical to the query

Restart communication (subfunction 1)

Force Listen only mode (subfunction 4)

Read various diagnostic counters

7.8 Debugging tool and documents

A small software interface is given with the documentation to help the user to test the hardware and the wirings: see CheckModbusComm.exe. This application sends a query, analyse the response and display an OK or not OK status.

Look in the documentation of the controller and the corresponding Modbus data table for appropriate information.

Look in the Modbus protocol for more information on Modbus.

8 APPENDIX

8.1 List of abbreviations

ASCII	American Standard Code for Information Interchange
Baud rate	Unit for measuring transmission speed in bits/s;
Bit	A binary digit, representing a one or zero
Bus	An electrical circuit over which data is transmitted
Byte	A whole number value represented by eight bits (0 to 255)
Chassis or Chassis Ground	A connection to an electrically conductive housing or frame of a device. It may or may not be connected to Earth Ground.
Coil	The telegram structure for Modbus transmission is implemented in registers (WORD) or coils (bits). A coil may be either 8 or 16 bits in length.
Common	The voltage reference point of a circuit. It may or may not be connected to earth ground, though it is generally assumed to be at zero volts, unless otherwise indicated. In floating circuits, the common is sometimes at a relatively high potential. This term is sometimes used interchangeably with the term "Ground" or GND.
CRC	Cyclic Redundancy Check. Complex error checking on a message block.
CTS	ClearToSend hardware handshaking signal. Used with RequestToSend.
Earth or Earth Ground	Global zero voltage reference point. Physical connection is made to the earth through a grounding rod, water pipe or other reliable connection.
Ground Voltage reference point of a circuit	
	It may or may not be connected to earth ground, though it is generally assumed to be at zero volts. Sometimes used interchangeably with the term "Common".
Handshaking	method of data flow control for serial communications
Hexadecimal or HEX	A number system using a decimal 16 as its base. A single digit number in HEX ranges from 0 to 15, represented by 0 to 9 and A to F.
HMI	Human-Machine Interface (formerly MMI)
Industrial^{IT}	Umbrella concept for ABB's vision for enterprise automation.
Industrial^{IT} Architecture	The architecture of the Industrial ^{IT} system. The architecture defines how the system is built, in terms of basic concepts, underlying technologies, system topology, modularity, and mechanisms for interaction between different parts of the system. It also defines concepts, rules, and guidelines that a component must comply with in order to fit in the Industrial^{IT} system. A central feature of the IIT architecture is that information and functions are centered on Aspect Objects.
Industrial^{IT} Enabled	A product that is Industrial ^{IT} enabled has been verified according to the process of Industrial ^{IT} certification. It has the right to use the "Industrial ^{IT} enabled" symbol.

Loopback	A test used for checking functionality of a serial port, utilizing a test plug that connects send, receive and handshaking signals
Long Integer	Analog value consisting of two consecutive 16-bit registers
LRC	Longitudinal Redundancy Check
Measurement	A measurement is a value computed by the controller through its analog and digital inputs. Measurements can be read from the controller front plate, or through the Modbus protocol.
Modbus adapter	It is an optional small interface module through which the controller is connected to an external Modbus serial communication bus. It performs an optical to RS485 conversion. The communication with the Modbus adapter is activated with a parameter.
OPC	OLE™ for Process Control. OPC is Plug-n-Play in the field of Automation and HMI. OLE™ for Process Control (OPC™) is the most standard way for connecting hardware and data devices with HMI client applications.
	OPC is a concept agreed upon by a committee of members from the OPC foundation. Most automation companies in the market place including ABB are members of this foundation. OPC uses state-of-the art technologies like COM, DCOM, ActiveX of Microsoft and makes development and programming easier.
	In the OPC world, there are two major types of applications:OPC Servers and OPC Clients.
OPC Servers	OPC Server applications are used to collect data from the data sources like hardware devices. At the bottom level, the servers are mainly for reading inputs and writing outputs of the data sources. At the upper level, the servers make the data available in a standard way to the OPC client applications.
OPC Clients	The OPC Client applications can communicate directly with the OPC servers and get the data. This way OPC enhances the interface between client and server applications by providing a standard mechanism to communicate data from a data source to any client application.
Parameter	A parameter is an operating data for the controller. Parameters can be read and programmed with the front plate of the controller, or through the Modbus protocol.
Parity	Simple method of data error checking performed at the byte level. May be user-specified as Odd, Even or None with most equipment and software.
PC	Personal Computer
PLC	Programmable Logic Controller
Power^{IT} Power Factor Controller RVT	
	Microprocessor based controller from the ABB industrial controller range. The Power^{IT} Power Factor Controller RVT is intended to switch capacitor in order to compensate the power factor of the electrical network.
Receive	Incoming communication signal. (Rx)
RTS	RequestToSend hardware handshaking signal. Used with ClearToSend.
RTU	Remote Terminal Unit
RVT	see Power^{IT} Power Factor Controller RVT

Rx	See Receive
Signed Integer	Whole number value represented by 16 bits (-32768 to 32767)
Time-out	Parameter specifying the max. wait time in ms. waiting for a response in the range 0..10000 ms.
Transmit	Outgoing communication signal. (Tx)
Tri-State	The ability of a communications transmitter to turn its circuitry off, reducing the load on the network
Tx	see Transmit
Unsigned Integer	Positive whole number value represented by 16 bits (0 to 65535)
Word	A group of 16 bits
Xon/Xoff	Software implementation of data flow control

8.2 References

- Modbus Data Table (RVT Modbus Data Table for the RVT)
- RVT Installation and Operating Instructions
- Modicon Modbus Protocol Reference Guide (PI–MBUS–300 Rev. J)

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