MODBUS Protocol

Technical Manual for the
ADVC Controller Range

Schneider Electric™

Scope of this document

Describes the MODBUS Protocol Implementation on ADVC controller range.

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1. Introduction

This document describes the MODBUS implementation for ADVC Controller Range. It describes the MODBUS implementation within the controller and its panel interface. For more information about MODBUS input/output point map, point descriptions and attributes per point refer to the WSOS5 configuration protocol mapping tool (CPMT) and its documentation.

2. Scope

The controller combines the functions of protection relay and switchgear controller into a single intelligent electronic device (IED).

The controller provides a user friendly operator interface on a LCD control panel that allows configuration and control of the switchgear.

Electricity supply utilities frequently link the controller into their SCADA systems as a Remote Terminal Unit (RTU).

To make this simple the controller provides:

- Mounting room for a radio or modem in the control cubicle
- Power supply for the radio or modem in the control cubicle
- Embedded protocol handler for the required SCADA protocol in the controller firmware.

The MODBUS protocol allows digital and analog data exchange between the controller and the SCADA system.

2.1 Operator Interfaces

The MODBUS protocol can be fully configured via WSOS or the Operator Interface.

The two styles of OI on the controller, setVUE and flexVUE provide access to the MODBUS configuration menus. For more information on how to use the different operator interfaces refer to the ADVC Controller Operations Manual.

2.1.1 setVUE

```
-------- MODBUS COMMUNICATIONS
---------C
Port RS232-B          RUNNING
MODBUS Standard ACR
RTU Address 1
```

2.1.2 flexVUE

```
MAIN MENU
      → ENGINEERING MENU
         → TELEMETRY MENU
            → CONFIGURE COMMS
               → MBUS MENU
```

MODBUS MENU	
MBUS COMMS MBUS COMM STATS MBUS IP NETWORKING	↕

2.2 Password Protection

All MODBUS panel fields require password entry unless described as ‘Display only’ or otherwise stated. For more information on operator control panel usage refer to the ADVC Controller Operations Manual.

3. Applicability

3.1 Control Cubicle Software

This manual applies to ADVC controllers with A44-15.01 and later software versions.

To determine the version of the firmware on the controller refer to the ADVC Controller Range Operations Manual.

3.2 MODBUS Protocol

The protocol version implemented is described in the following documents:

- MODBUS Protocol Specification, v1.1b
- MODBUS Serial Line Protocol and Implementation Guide, v1.02
- MODBUS Messaging on TCP/IP Implementation Guide, v1.0b.

4. Protocol Configuration

When the MODBUS protocol handler is made available in the controller, a submenu is added to the Communication menu. The MODBUS submenu pages fall into the following categories

- Communications
- IP Networking.

All protocol configuration settings can be viewed, modified and stored on a personal computer with the WSOS utility.

4.1 MODBUS Options

These pages configure MODBUS feature availability and PTCC compatibility.

setVUE Options – Communications 1 page

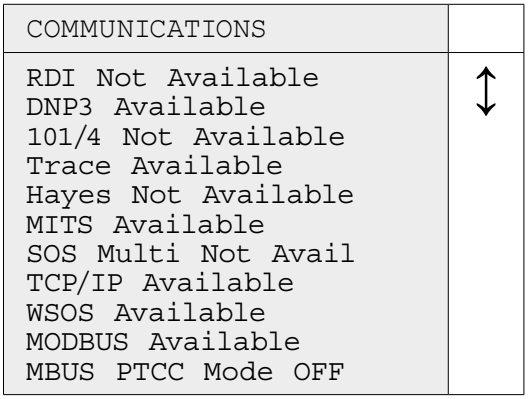
```
-----   OPTIONS  -  COMMUNICATIONS  1   ----
C
WSOS  Available          DNP3  Available
MITS  Available          MODBUS  Available

101/4  Not  Available  MBUS  PTCC  Mode  OFF
```

Setting	Description
MODBUS Available/ MODBUS Not Available	MODBUS Availability This setting enables/disables the MODBUS feature in the controller. Range : Available, Not Available *Factory default is Not Available*
MODBUS PTCC Mode **Note 1**	MODBUS PTCC Compatibility Mode This setting turns on/off PTCC compatibility mode. If this mode is ON, function code 0x03 has the same processing as function code 0x04, and all other functions are processed as per the standard; if this mode is OFF, all of the functions are processed normally. Range : ON, OFF *Factory default is OFF*

Notes
1. This field is invisible when MODBUS is not available.

flexVUE Communications page



4.2 Communications

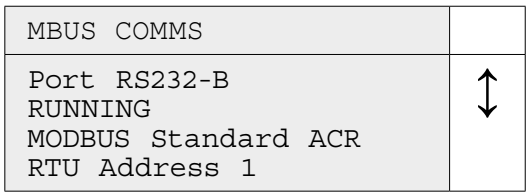
Below are the MODBUS communications pages. Note, and they are only viewable when MODBUS is made Available as per section 4.1.

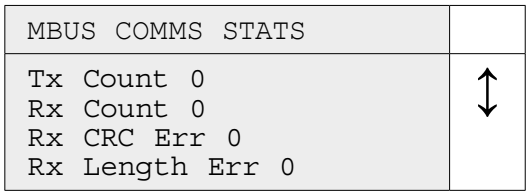
setVUE MODBUS communication pages

```
-------- MODBUS COMMUNICATIONS
---------C
Port RS232-B           RUNNING
MODBUS Standard ACR
RTU Address 1
```

```
--- MODBUS COMMUNICATIONS STATISTICS --
C
Tx Count 0             Rx Count 0
Rx CRC Err 0           Rx Length Err 0
```

flexVUE MODBUS communication pages





Setting	Description
Port Selection **Note 1**	**Port Selection** The communication port that the protocol handler is assigned to use. Range: Port NONE, RS232-PORT-A, RS232-PORT-B, RS232-PORT-C, RS232-PORT-D, RS-485, V23, 10BaseT *Factory default is Port NONE*
INACTIVE RUNNING	**Protocol Handler Status** Indication of the current status of the MODBUS protocol handler. INACTIVE means that the protocol handler is either configured as *Port NONE* or the protocol handler has been assigned to a port that has already been assigned exclusive use by another application in the controller or the protocol IO map is invalid. RUNNING means that the protocol handler has a valid IO map, has successfully attached itself to a port and is running normally. Display only status. Range: INACTIVE/RUNNING
Protocol Map	**MODBUS Input/Output Map** Displays the name of the currently loaded MODBUS Input/Output map. Different IO maps can be created using the WSOS CPMT tool and loaded into the controller. If the loaded map is corrupt then an “Invalid Map” message is shown. Reload the required map if this is seen. Display only status. *Factory default is “MODBUS Standard ACR” or “MODBUS Standard LBS” depending on the switchgear function*
RTU Address	**MODBUS RTU Address** MODBUS RTU address of the controller. Range: 1-247 in serial mode; 1-247, 255 in TCP mode. RTU address 255 means that MODBUS requests received with any slave ID will be processed. *Factory default is 1*

Setting	Description
Tx Count **Note 2,3,4**	**Transmission Message Count** The number of MODBUS messages transmitted from this controller to the master station. Range: 0 to 99999
Rx Count **Note 2,3,4**	**Receive Message Count** The number of MODBUS messages received by this controller from the master station. Range: 0 to 99999
Rx Length Err **Note 2,3,4**	**Receive Message Length Error Count** The number of message packets received with a length error Range: 0 to 99999
Rx CRC Err **Note 2,3,4**	**Receive Message CRC Error Count** The number of MODBUS messages received by this controller from the master station with a CRC error Range: 0 to 99999

Notes

1. The controller does not have all of its communications ports available at any one time. A port selection feature in WSOS determines the ports available for the protocol handler to use. Refer to the WSOS help file or the ADVC Controller Operation Manual for more information. Unavailable ports are not displayed in this setting field.
2. Communication statistic counters are display status fields only.
3. All communication statistics counters are zeroed when any of the following occur:
   - the controller is reset
   - a configuration parameter is changed that triggers a protocol handler restart
   - the 'Reset All' button is selected in WSOS.
   - the OI select key is pressed twice (not password protected)
4. The counts rollover to 1 when 99999 is reached.

4.3 MODBUS Over IP

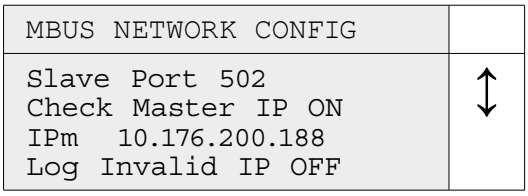
These pages allow the SCADA engineer to configure MODBUS to operate on top of an IP network. To make these pages visible, enable MODBUS protocol as per section 4.1 and select the communication port as 10BaseT.

4.3.1 MODBUS IP Networking

setVUE MODBUS IP Networking

```
-------- MODBUS IP NETWORKING  --------
C
Check Master IP ON   IPm 10.176.200.188
Slave Port 502       Log Invalid IP OFF
```

flexVUE MODBUS IP Networking Configuration



Setting	Description
Check Master IP **Note 1**	**Check Master IP Address** This setting is used to improve the security of the MODBUS protocol. **ON:** Only the IP address specified by the Master IP address parameter is authorised to connect to the controller. **OFF:** Any IP address can connect to the controller. Range : ON, OFF *Factory Default is OFF*
IPm **Note 1**	**Master IP address** The station IP address. This is used for authorising the IP address of received messages. Only used if Check Master IP is ON. Range: Any valid IP address *Factory Default is 127.0.0.1*
Slave Port **Note 1**	**TCP Slave Port** The TCP port used by the controller to listen to MODBUS requests. Range: 1 to 65535 *Factory Default is 502*
Log Invalid IP	**Log Invalid Incoming IP Address** This setting is used to control logging of invalid incoming IP address. **ON:** The invalid IP, if any, is logged in the event log. It is only logged once per IP address. **OFF:** The invalid IP, if any, is not logged in the event log. Range: ON, OFF *Factory Default is OFF*

Notes

1. Changing this setting will cause the MODBUS handler task to perform a restart. This will mean a re-initialisation of all communication. A temporary loss of communications with the master station may occur.

4.3.2 MODBUS TCP Keep-Alive

TCP Keep-Alive is a mechanism to detect if a connection is alive or not. It works by sending probe messages and if the messages are not acknowledged in a period of time, the connection is declared dead and will be closed.

If TCP Keep-Alive mechanism is deactivated, dead connections can not be closed until the MODBUS task is restarted; therefore TCP Keep-Alive should not be deactivated.

Please refer to http://en.wikipedia.org/wiki/Keepalive for more information on TCP Keep-Alive.

setVUE MODBUS TCP KEEP-ALIVE

```
-------   MODBUS TCP KEEP-ALIVE   -------
C
Keep-Alive ON          Idle Timer #####s
Interval ####s         Max Attempts ##
```

flexVUE MODBUS TCP KEEP-ALIVE

```
MBUS TCP KEEP-ALIVE
Keep-Alive ON
Idle Timer #####s
Interval ####s
Max Attempts ##
```

Setting	Description
Keep-Alive	**TCP Connection Keep-Alive** This setting activates/deactivates TCP Keep-Alive mechanism. ON: Keep-Alive is activated. OFF: Keep-Alive is deactivated. Range : ON, OFF *Factory Default is ON*
Idle Timer	**Idle Timer** This is the time (in seconds) before sending the first probe message. Range: 1 to 86400 *Factory Default is 7200*
Interval	**Interval Timer** This is the time (in seconds) between two probe messages. Range: 1 to 7200 *Factory Default is 75*
Max Attempts	**Maximum Attempts** This is the maximum number of unacknowledged probe messages to send before considering the connection dead. Range: 1 to 20 *Factory Default is 8*

4.3.3 MODBUS TCP Keep-Alive

TCP Keep-Alive is a mechanism to detect if a connection is alive or not. It works by sending probe messages and if the messages are not acknowledged in a period of time, the connection is declared dead and will be closed.

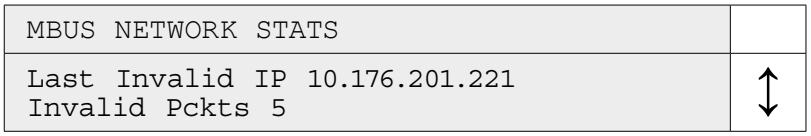
If TCP Keep-Alive mechanism is deactivated, dead connections can not be closed until the MODBUS task is restarted; therefore TCP Keep-Alive should not be deactivated.

Please refer to http://en.wikipedia.org/wiki/Keepalive for more information on TCP Keep-Alive.

setVUE MODBUS IP
Networking Stats displayed with an invalid connection attempt

```
-------   MODBUS NETWORK STATS   --------C
Last Invalid IP          10.176.201.221
Invalid Packet Count    5
```

flexVUE MODBUS Network Stats pages displayed with an invalid connection attempt



Setting	Description
Last Invalid IP **Note 1**	**Last Invalid IP address** Only visible when Check Master IP is ON This field displays the IP address of the last unauthorised machine that tries to connect to the controller MODBUS TCP port. The user can press SELECT on this page to make a message page appear. Another press of “SELECT” will reset the page and set this field to “NONE”, while “Menu” key pressed will cancel the whole operation. Display only status. Range : NONE or IP address of an unauthorised machine
Invalid Packet Count	**Invalid Packet Count** Only visible when Check Master IP is ON This field displays the number of connection tries of the last unauthorised machine. If a new invalid connection is attempted from a different machine, the Last Invalid IP is updated and the count is reset to 1. The user can press SELECT on this page to make a menu appear. Another press of “SELECT” will reset the page and set this field to “NONE”, while “Menu” key pressed will cancel the whole operation. Display only status. Range : 0 to 99999

Notes
1. This field on the flexVUE scrolls to display the full text.

4.4 Data Configuration

The controller has two default protocol configuration mapping files named “MODBUS Standard ACR” and “MODBUS Standard LBS”.

If the user wishes to change the selection of points and/or attributes of a point there is a configuration tool available. This functionality applies to WSOS 5.13.00 and later software versions.

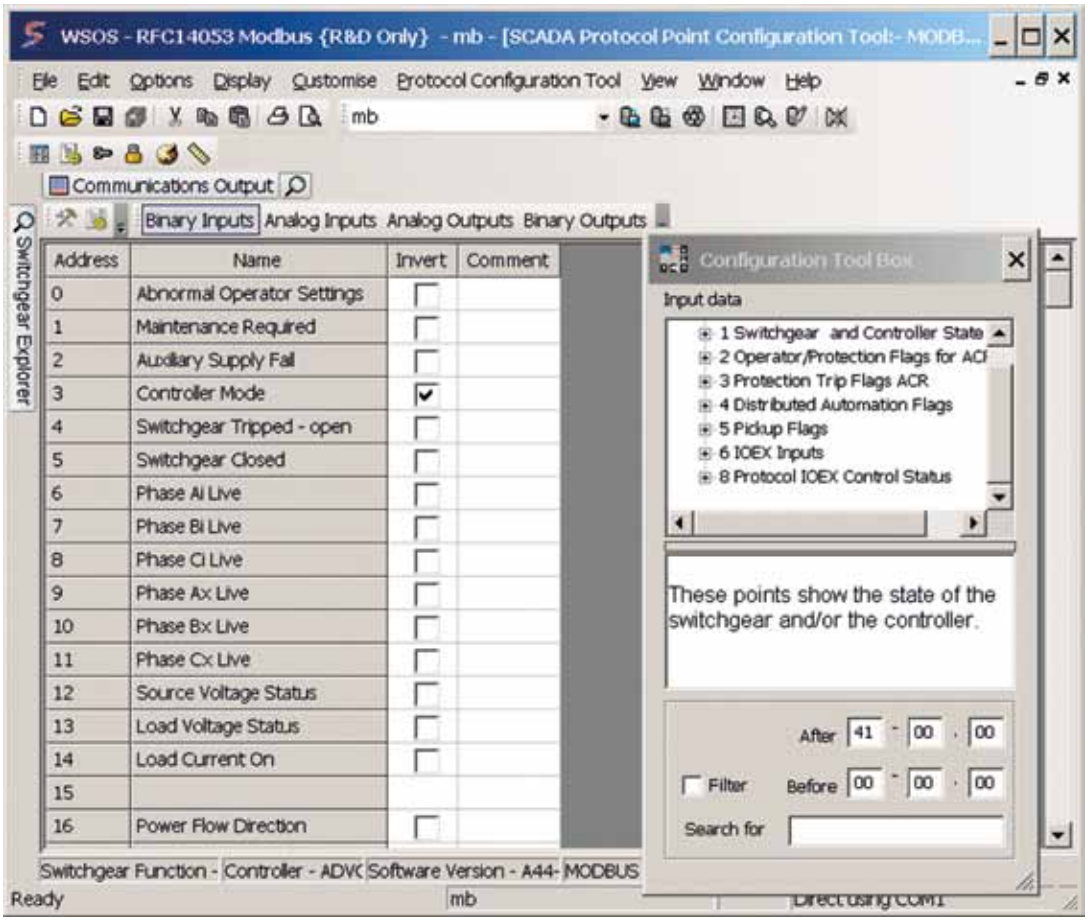


Figure 1 - WSOS MODBUS CPMT tool

Examples of configuration that can be performed per MODBUS data type are:

- Binary Inputs – point selection and invert logic
- Analog Inputs – point selection, scaling and conversion
- Binary Outputs – point selection and invert logic
- Analog Outputs – point selection.

For more information refer to the WSOS5 MODBUS Configuration Tool manual WSOS01-DOC-102.pdf

To list all of the controller’s IO that can be mapped, refer to the ADVC-PTCL-331.html points list which is available in the help menu of the WSOS5 CPMT tool. The default maps can also be viewed in the tool.

Note: The MODBUS Standard ACR/LBS map reflects points that are available with default settings in the controller. If a feature is made available via configuration then the user is required to manually add any related points to the IO list as required.

Appendix A MODBUS Implementation Table

MODBUS in firmware version A44-15.01++ implements the following subset of the Modbus function codes:

Supported Function Codes

Function Code		Meaning	Support
Dec	Hex		
01	01	Read Coil Status (Read Discrete Output)	Yes
02	02	Read Input Status (Read Discrete Inputs)	Yes
03	03	Read Holding Registers (Read Multiple Registers)	Yes **Note 1**
04	04	Read Input Registers	Yes
05	05	Force Single Coil (Write Single Output)	Yes
06	06	Preset Single Register (Write Single Register)	Yes
07	07	Read Exception Status	No
08	08	Loopback Diagnostic Test	No
09	09	Program	No
10	0A	Poll Program Complete	No
11	0B	Get Communications Event Counter	No
12	0C	Get Communications Event Log	No
13	0D	Program	No
14	0E	Poll Program Complete	No
15	0F	Write Multiple Outputs	Yes
16	10	Write Multiple Registers	Yes
17	11	Report Slave ID	No
18	12	Program	No
19	13	Reset Communications Link	No
20	14	Read General Reference	No
21	15	Write General Reference	No
43/15	2B/0E	Read Device Identification	Yes **Note 2**

Notes

1. In PTCC mode, this function code has the same processing as function 0x04.
2. Supported conformity level is 0x82: regular identification (stream access and individual access). Supported objects are:

Object ID	Object Name
0x00	VendorName
0x01	ProductCode
0x02	MajorMinorRevision
0x03	VendorUrl
0x04	ProductName
0x05	ModelName

Notes

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