NOJA POWER®

Modbus User Guide

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Revision History

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1 Introduction

The Modbus Protocol is commonly used network protocol in the industrial manufacturing environment. This manual describes support for the Modbus Protocol in the NOJA Power Recloser series of controllers (RC10/15/20).

1.1 Applicability

Support for the MODBUS Protocol was included in firmware versions 1.26.y.0 onwards for the RC10/15 and firmware version 2.0 onwards for the RC20. If you have a software version earlier than this, then this document does not apply. Please contact your NOJA Power representative for further information.

2 Implementation

Within the NOJA Power devices, the Modbus Protocol is implemented through Smart Grid Automation (SGA). It supports Modbus RTU for serial communication and Modbus TCP for use over ethernet. The NOJA Power controller can be configured as a Modbus Server device, accepting requests from a Modbus Client device.

2.1 Data Access and Types

A Modbus Client will make a request to a Modbus Server to read information from the Server or write information to the Server. The following standard Modbus object types are supported:

Object	Size	Access	Comments
Discrete Input	Single bit	Read-Only	This type of data can be provided by an I/O system.
Coils	Single bit	Read-Write	This type of data can be alterable by an application program.
Input Registers	16-bit word	Read-Only	This type of data can be provided by an I/O system
Holding Registers	16-bit word	Read-Write	This type of data can be alterable by an application program.

2.2 Serial Channel Multi-Protocol

When using Modbus RTU, multiple protocols can be configured to use the same serial channel. Where a protocol contains a leading magic marker, the RC can detect the magic marker and route the traffic to the correct application. Modbus serial communications does not contain a magic marker. The following table outlines the effect when multiple protocols are configured to use the same serial channel.

Running Protocol	Protocol becomes Enabled	Action
2179	Modbus	2179 disabled with change log showing the disable
CMS	Modbus	Modbus disabled with change log showing the disable
DNP	Modbus	No action, both can run
60870	Modbus	No action, both can run
P2P	Modbus	No action, both can run
HMI	Modbus	Modbus will not receive data, no change log
Modbus	2179	Modbus disabled with change log showing the disable
Modbus	CMS	Modbus disabled with change log showing the disable
Modbus	DNP	No action, both can run
Modbus	60870	No action, both can run
Modbus	P2P	No action, both can run
Modbus	HMI	Modbus will not receive data, no change log

2.3 Reading/writing of double-word (32-bits) values

Modbus only supports single bit and 16-bit (registers) reading and writing. Double-word (32-bits) values are divided into two 16-bit parts, a suffix "_Lo" (low-order word) and a suffix "_Hi" (high-order word). The final 32-bit value is the concatenation of the two 16-bit parts, [“_Hi”][“_Lo”].

2.4 Supported Function Codes

The listing below shows the function codes supported by this Modbus implementation. Codes are listed in decimal. 'Yes' indicates that the function is supported. 'No' indicates that it is not supported.

Code	Name	Supported
01	Read Coil Status	Yes
02	Read Input Status	Yes
03	Read Holding Registers	Yes
04	Read Input Registers	Yes
05	Write Single Coil	Yes
06	Write Single Register	Yes
07	Read Exception Status	No
08	Diagnostics	No
09	Program 484	No
10	Poll 484	No
11	Fetch Comm. Event Ctr.	No
12	Fetch Comm. Event Log	No
13	Program Controller	No
14	Poll Controller	No
15	Write Multiple Coils	Yes
16	Write Multiple Registers	Yes
17	Report Server ID	No
18	Program 884/M84	No
19	Reset Comm. Link	No
20	Read General Reference	No
21	Write General Reference	No
22	Mask Write 4X Register	No
23	Read/Write 4X Registers	No
24	Read FIFO Queue	No

2.4.1 Function 01 Read Coil Status

Reads the ON/OFF status of discrete outputs (0X references, coils) in the client.

Broadcast is not supported.

The query message specifies the starting coil and quantity of coils to be read.

Coils are addressed starting at zero: coils 1–16 are addressed as 0–15.

The coil status in the response message is packed as one coil per bit of the data field. Status is indicated as: 1 = ON; 0 = OFF.

The list of coils is given in Section 3.1.

2.4.2 Function 02 Read Input Status

Reads the ON/OFF status of discrete inputs (1X references) in the server.

Broadcast is not supported.

The query message specifies the starting coil and quantity of coils to be read.

Coils are addressed starting at zero: coils 1–16 are addressed as 0–15. The coil status in the response message is packed as one coil per bit of the data field. Status is indicated as: 1 = ON; 0 = OFF.

The list of inputs is given in Section 3.2.

2.4.3 Function 03 Read Holding Registers

Read the contents of holding registers (4X references) in the server.

Broadcast is not supported.

The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting at zero: registers 1–16 are addressed as 0–15.

The list of holding registers is given in Section 3.4.

2.4.4 Function 04 Read Input Registers

Read the binary contents of input registers (3X references) in the server.

Broadcast is not supported.

The query message specifies the starting register and quantity of registers to be read. Registers are addressed

starting at zero: registers 1–16 are addressed as 0–15.
The List of input registers is given in Section 3.3.

2.4.5 Function 05 Write Single Coil

Forces a single coil (0X reference) to either ON or OFF. When broadcast, the function forces the same coil reference in all attached servers.

If an error occurs in the processing of a broadcast request, the exception response is not formed. The setting of coils does not occur with the appearance of exception.

The list of coils is given in Section 3.1.

Notes:

- The setting of coil in Address 0 will not result in any changes in the RC.
- The setting of "Reserved" coil in 0 or 1 will not result in any changes in the RC.

2.4.6 Function 06 Write Single Register

Writes a value into a single holding register (4X reference). When broadcast, the function writes the same register reference in all attached servers.

If there is an error in the processing of a broadcast request, the exception response is not formed.

The list of holding registers is given in Section 3.4.

2.4.7 Function 15 (0F Hex) Write Multiple Coils

Forces each coil (0X reference) in a sequence of coils to either ON or OFF. When broadcast, the function forces the same coil references in all attached servers.

If there is an error in the processing of a broadcast request, the exception response is not formed.

The setting of coils does not occur with the appearance of exception.

The list of coils is given in Section 3.1.

Notes:

- The setting of coil in Address 0 will not result in any changes in the RC.
- The setting of "Reserved" coil in 0 or 1 will not result in any changes in the RC.

2.4.8 Function 16 (10 Hex) Write Multiple Registers

Writes values into a sequence of holding registers (4X references). When broadcast, the function writes the same register references in all attached servers.

If there is an error in the processing of a broadcast request, the exception response is not formed.

The list of holding registers is given in Section 3.4.

2.5 Modbus Exception Responses

The exception response message has two fields that differentiate it from a normal response:

Function Code Field: In a normal response, the server echoes the function code of the original request in the function code field of the response. All function codes have a most–significant bit (MSB) of 0 (their values are all below 80 hexadecimal). In an exception response, the server sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response.

With the function code's MSB set, the client's application program can recognize the exception response and can examine the data field for the exception code.

Data Field: In a normal response, the server may return data or statistics in the data field (any information that was requested in the request). In an exception response, the server returns an exception code in the data field, defining the server condition that caused the exception.

This Modbus implementation returns the exception codes shown below.

MODBUS Exception Codes

Code	Name	Meaning
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the server. If a Poll Program Complete command was issued, this code indicates that no program function preceded it. This error can arise with the demand of the unsupported function
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the server. This error can arise in such a case when a nonexistent data object address is used in the request.
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for the server. This error can arise during an attempt to set values at the moment when the RC is set in the Remote Off (Local) mode.
04	SERVER DEVICE FAILURE	An unrecoverable error occurred while the server was attempting to perform the requested action.
05	ACKNOWLEDGE	The server accepted the service invocation, but the service requires a relatively long time to execute. The server therefore returns only an acknowledgement of the service invocation receipt.
06	SERVER BUSY	The server was unable to accept the MB Request PDU. The client application has the responsibility of deciding if and when to re-send the request.

3 Datapoints

3.1 Coils (0X Reference)

Address	Settings	Description
00001	Trip(All)	Trip all phases(1). Trip control will always return exception code 0x05 Acknowledge.
00002	Close(All)	Close all phases(1). Close control will always return exception code 0x05 Acknowledge.
00003	On (Grp1)	Switch Group1 On
00004	On (Grp2)	Switch Group2 On
00005	On (Grp3)	Switch Group3 On
00006	On (Grp4)	Switch Group4 On
00007	On (Prot)	Switch protection On
00008	Off (Prot)	Switch protection Off
00009	On (EF)	Switch earth fault overcurrent element On
00010	Off (EF)	Switch earth fault overcurrent element Off
00011	On (SEF)	Switch sensitive earth fault element On
00012	Off (SEF)	Switch sensitive earth fault element Off
00013	On (AR)	Switch autoreclosing element On
00014	Off (AR)	Switch autoreclosing element Off
00015	On (LL)	Switch live line element On
00016	Off (LL)	Switch live line element Off
00017	On (CLP)	Switch cold load pickup element On
00018	Off (CLP)	Switch cold load pickup element Off
00019	On (UV)	Switch undervoltage element On
00020	Off (UV)	Switch undervoltage element Off
00021	On (UF)	Switch underfrequency load shed element On
00022	Off (UF)	Switch underfrequency load shed element Off
00023	On (ABR)	Switch ABR element On
00024	Off (ABR)	Switch ABR element Off
00025-00030	On/Off (IO1, Outputs 1–6)	Switch IO1 Module (Outputs 1–6) On/Off
00031-00036	On/Off (IO2, Outputs 1–6)	Switch IO2 Module (Outputs 1–6) On/Off
00037-00038	On/Off (IO1, Outputs 7–8)	Switch IO1 Module (Outputs 7–8) On/Off
00039-00040	On/Off (IO2, Outputs 7–8)	Switch IO2 Module (Outputs 7–8) On/Off
00041-00072	VAR1 – VAR32	Logic output Variables 1 – 32

Notes:

1. Individual phases for single triple are not natively supported. Individual phases can be implemented through logic with VARs.
2. Attempting to read/write to a coil not in the above range will result in an error.

3.2 Discrete Inputs (1X Reference)

Address	Settings	Description
	GENERAL	
10001	Lockout	All AR OCEF, AR SEF, AR SEF, ABR elements are set in O1 state
10002	Reserved	
10003	Local Control	Control mode is set Local
10004	AR initiated	Any of AR OCEF, AR SEF, AR UV or ABR elements set in one of O2, O3 or O4 states
10005	Prot initiated	Logical OR of AR initiated and Pickup signals
10006	Group 1 Trip	Group 1 was active during ANY of protection trips
10007	Group 2 Trip	Group 2 was active during ANY of protection trips
10008	Group 3 Trip	Group 3 was active during ANY of protection trips
10009	Group 4 Trip	Group 4 was active during ANY of protection trips
	PICKUP	
10010	Pickup	Pickup output, any of protection elements activated
10011	P(OC1+)	Pickup output of OC1+ activated
10012	P(OC2+)	Pickup output of OC2+ activated
10013	P(OC3+)	Pickup output of OC3+ activated
10014	P(OC1-)	Pickup output of OC1- activated
10015	P(OC2-)	Pickup output of OC2- activated
10016	P(OC3-)	Pickup output of OC3- activated
10017	P(OCLL)	Pickup output of OCLL activated
10018	P(EF1+)	Pickup output of EF1+ activated
10019	P(EF2+)	Pickup output of EF2+ activated
10020	P(EF3+)	Pickup output of EF3+ activated
10021	P(EF1-)	Pickup output of EF1- activated
10022	P(EF2-)	Pickup output of EF2- activated
10023	P(EF3-)	Pickup output of EF3- activated
10024	P(EFLL)	Pickup output of EFLL activated
10025	P(SEF+)	Pickup output of SEF+ activated
10026	P(SEF-)	Pickup output of SEF- activated
10027	P(UV1)	Pickup output of UV1 activated
10028	P(UV2)	Pickup output of UV2 activated
10029	P(UV3)	Pickup output of UV3 activated
10030	P(UF)	Pickup output of UF activated
10031	P(Uabc>)	Pickup output of Uabc> activated
10032	P(Urst>)	Pickup output of Urst> activated
10033	P(Uabc<)	Pickup output of Uabc< activated
10034	P(Urst<)	Pickup output of Urst< activated
	OPEN	
10035	Open (All)	PS=0 irrespective of source. Open all phases. Individual phases can be implemented with VARs for single triple.
10036	Open (Prot)	Open due to any protection trip
10037	Open (OC1+)	Open due to OC1+ tripping
10038	Open (OC2+)	Open due to OC2+ tripping
10039	Open (OC3+)	Open due to OC3+ tripping
10040	Open (OC1-)	Open due to OC1- tripping
10041	Open (OC2-)	Open due to OC2- tripping

Address	Settings	Description
10042	Open (OC3-)	Open due to OC3- tripping
10043	Open (OCLL)	Open due to OCLL tripping
10044	Open (EF1+)	Open due to EF1+ tripping
10045	Open (EF2+)	Open due to EF2+ tripping
10046	Open (EF3+)	Open due to EF3+ tripping
10047	Open (EF1-)	Open due to EF1- tripping
10048	Open (EF2-)	Open due to EF2- tripping
10049	Open (EF3-)	Open due to EF3- tripping
10050	Open (EFLL)	Open due to EFLL tripping
10051	Open (SEF+)	Open due to SEF+ tripping
10052	Open (SEF-)	Open due to SEF- tripping
10053	Open (UV1)	Open due to UV1 tripping
10054	Open (UV2)	Open due to UV2 tripping
10055	Open (UV3)	Open due to UV3 tripping
10056	Open (UF)	Open due to UF tripping
10057	Open (Remote)	Open due to a remote request
10058	Open (SCADA)	Open due to SCADA control signal
10059	Open (I/O)	Open due to I/O control signal
10060	Open (Local)	Open due to Panel, CMS control signal or manual tripping
10061	Open (HMI)	Open due to HMI control signal
10062	Open (PC)	Open due to PC control signal
10063	Open (Manual)	Open due to manual tripping (no origin discovered)
ALARM		
10064	Alarm	Alarm output of any of protection alarm activated
10065	A(OC1+)	Alarm output of OC1+ activated
10066	A(OC1-)	Alarm output of OC1- activated
10067	A(EF1+)	Alarm output of EF1+ activated
10068	A(EF1-)	Alarm output of EF1- activated
10069	A(SEF+)	Alarm output of SEF+ activated
10070	A(SEF-)	Alarm output of SEF- activated
10071	A(UV1)	Alarm output of UV1 activated
10072	A(UV2)	Alarm output of UV2 activated
10073	A(UV3)	Alarm output of UV3 activated
10074	A (UF)	Alarm output of UF activated
CLOSED		
10075	Closed (All)	Position Status of OSM is Closed irrespective of origin. Closed all phases. Individual phases can be implemented with VARs for single triple.
10076	Closed (AR)	Closed due to any AR control signal
10077	Closed (AR OCEF)	Closed due to AR OCEF reclosing
10078	Closed (AR SEF)	Closed due to AR SEF reclosing
10079	Closed (AR UV)	Closed due to AR UV reclosing
10080	Closed (ABR)	Closed due to ABR closing
10081	Closed (Remote)	Closed due to SCADA or I/O control signal
10082	Closed (SCADA)	Closed due to SCADA control signal
10083	Closed (I/O)	Closed due to I/O control signal
10084	Closed (Local)	Closed due to Panel, CMS control signal or undefined closed

Address	Settings	Description
10085	Closed (HMI)	Closed due to HMI control signal
10086	Closed (PC)	Close due to PC control signal
10087	Closed (undef)	Closed state recognized after power up
	STATUS	
10088	Prot On	Protection is switched on
10089	Group1 On	Active Group 1
10090	Group2 On	Active Group 2
10091	Group3 On	Active Group 3
10092	Group4 On	Active Group 4
10093	EF On	Earth overcurrent element is switched on
10094	SEF On	Sensitive Earth fault element is switched on
10095	UV On	Undervoltage element is switched on
10096	UF On	Underfrequency element is switched on
10097	CLP On	Cold load pickup element is switched on
10098	LL On	Live line element is switched on
10099	AR On	AR reclosing elements is switched on
10100	ABR On	Automatic backfeed restoration is switched on
	MALFUNCTION	
10101	Malfunction	Any malfunction signal activated
10102	Ext load SC	External load short circuit found
10103	SIM driver Q503	SIM actuator driver has failed
10104	Reserved	
10105	OSM coil SC	OSM coil short circuit found
10106	Excessive T_o	Opening time exceeded or no confirmation received that open command was executed successfully.
10107	Excessive T_c	Closing time exceeded or no confirmation received that close command was executed successfully.
10108	Relay Module Fault	Internal fault of Relay Module detected
10109	SIM Comms Error	Communication error with SIM
10110	SIM Module Fault	SIM Module Fault detected
10111	RTC Hardware Fault	Real Time Clock hardware failure
10112	Reserved	
10113	I/O1 Comms Error	No communication with I/O module I/O1
10114	I/O2 Comms Error	No communication with I/O module I/O2
10115	CAN Bus Malfunction	Communication problem between SIM and Relay
10116	I/O1 Fault	Internal fault detected in module I/O1
10117	I/O2 Fault	Internal fault detected in module I/O2
	WARNING	
10118	Warning	Any warning signal activated
10119	Reserved	
10120	AC Off (On Battery Supply)	No AC Supply available
10121	Battery Off (On AC Supply)	No battery supply is available
10122	SIM Caps Not Charged	SIM Module capacitors are not fully charged
10123	Reserved	
10124	OSM Disconnected	OSM Disconnected
	IO Modules(1)	

Address	Settings	Description
10125-10130	IO1 Inputs 1 – 6	IO1 Inputs 1 – 6 signals activated
10131-10136	IO2 Inputs 1 – 6	IO2 Inputs 1 – 6 signals activated
10137-10142	IO1 Outputs 1 – 6	IO1 Outputs 1 – 6 signals activated
10143-10148	IO2 Outputs 1 – 6	IO2 Outputs 1 – 6 signals activated
10149	Open (AutoABR)	Open due to AutoABR tripping
10150	Closed (AutoABR)	Closed due to AutoABR reclosing
10151-10152	IO1 Inputs 7 – 8	IO1 Inputs 7 – 8 signals activated
10153-10154	IO2 Inputs 7 – 8	IO2 Inputs 7 – 8 signals activated
10155-10156	IO1 Outputs 7 – 8	IO1 Outputs 7 – 8 signals activated
10157-10158	IO2 Outputs 7 – 8	IO2 Outputs 7 – 8 signals activated
Variables		
10159-10190	VAR1 – VAR32	Logic output Variables 1 – 32

Notes:

1. The following conditions are necessary to perform control of IO Modules from SCADA:
   - IO mode is enabled in I/O settings;
   - IO Output# has Type equal to Disable in I/O settings;
   - IO faults are absent.
2. Attempting to read/write to a coil not in the above range will result in an error.

3.3 Input Registers (3X Reference)

Address	Settings	Description	Range	Resolution
Phase currents				
30001	Ia	Phase currents Ia	0 – 16000 A	1 A
30002	Ib	Phase currents Ib	0 – 16000 A	1 A
30003	Ic	Phase currents Ic	0 – 16000 A	1 A
Neutral current				
30004	In	Residual current	0 – 16000 A	1 A
Phase to earth voltages				
30005	Ua	Phase to earth voltages Ua	0 – 22000 V	1 V
30006	Ub	Phase to earth voltages Ub	0 – 22000 V	1 V
30007	Uc	Phase to earth voltages Uc	0 – 22000 V	1 V
30008	Ur	Phase to earth voltages Ur	0 – 22000 V	1 V
30009	Us	Phase to earth voltages Us	0 – 22000 V	1 V
30010	Ut	Phase to earth voltages Ut	0 – 22000 V	1 V
Line to line voltages				
30011	Uab	Line to line voltages Uab	0 – 38000 V	1V
30012	Ubc	Line to line voltages Ubc	0 – 38000 V	1V
30013	Uca	Line to line voltages Uca	0 – 38000 V	1V
30014	Urs	Line to line voltages Urs	0 – 38000 V	1V
30015	Ust	Line to line voltages Ust	0 – 38000 V	1V
30016	Utr	Line to line voltages Utr	0 – 38000 V	1V
Single and three phase total, active and reactive power				
30017	A kVA	A kVA	0 – 65535	1
30018	B kVA	B kVA	0 – 65535	1
30019	C kVA	C kVA	0 – 65535	1
30020	A kW	A kW	0 – 65535	1

Address	Settings	Description	Range	Resolution
30021	B kW	B kW	0 – 65535	1
30022	C kW	C kW	0 – 65535	1
30023	A kVAr	A kVAr	0 – 65535	1
30024	B kVAr	B kVAr	0 – 65535	1
30025	C kVAr	C kVAr	0 – 65535	1
30026	KVA	KVA	0 – 65535	1
30027	KVAr	KVAr	0 – 65535	1
30028	KW	KW	0 – 65535	1
Single and three phase total and reactive energy related to forward and reverse power flow directions				
30029	A+kVA*h	A+kVA*h_Hi	0 – 999999999	1
30030	A+kVA*h	A+kVA*h_Lo	0 – 999999999	1
30031	B+kVA*h	B+kVA*h_Hi	0 – 999999999	1
30032	B+kVA*h	B+kVA*h_Lo	0 – 999999999	1
30033	C+kVA*h	C+kVA*h_Hi	0 – 999999999	1
30034	C+kVA*h	C+kVA*h_Lo	0 _ 999999999	1
30035	A+kVAr*h	A+kVAr*h_Hi	0 – 999999999	1
30036	A+kVAr*h	A+kVAr*h_Lo	0 – 999999999	1
30037	B+kVAr*h	B+kVAr*h_Hi	0 – 999999999	1
30038	B+kVAr*h	B+kVAr*h_Lo	0 – 999999999	1
30039	C+kVAr*h	C+kVAr*h_Hi	0 – 999999999	1
30040	C+kVAr*h	C+kVAr*h_Lo	0 – 999999999	1
30041	+kVA*h	+kVA*h_Hi	0 – 999999999	1
30042	+kVA*h	+kVA*h_Lo	0 – 999999999	1
30043	+kVAr*h	+kVAr*h_Hi	0 – 999999999	1
30044	+kVAr*h	+kVAr*h_Lo	0 _ 999999999	1
30045	A-kVA*h	A-kVA*h_Hi	0 – 999999999	1
30046	A-kVA*h	A-kVA*h_Lo	0 – 999999999	1
30047	B-kVA*h	B-kVA*h_Hi	0 – 999999999	1
30048	B-kVA*h	B-kVA*h_Lo	0 – 999999999	1
30049	C-kVA*h	C-kVA*h_Hi	0 – 999999999	1
30050	C-kVA*h	C-kVA*h_Lo	0 – 999999999	1
30051	A-kVAr*h	A-kVAr*h_Hi	0 – 999999999	1
30052	A-kVAr*h	A-kVAr*h_Lo	0 – 999999999	1
30053	B-kVAr*h	B-kVAr*h_Hi	0 – 999999999	1
30054	B-kVAr*h	B-kVAr*h_Lo	0 _ 999999999	1
30055	C-kVAr*h	C-kVAr*h_Hi	0 – 999999999	1
30056	C-kVAr*h	C-kVAr*h_Lo	0 – 999999999	1

Address	Settings	Description	Range	Resolution
30057	-kVA*h	-kVA*h_Hi	0 – 999999999	1
30058	-kVA*h	-kVA*h_Lo	0 – 999999999	1
30059	-kVAr*h	-kVAr*h_Hi	0 – 999999999	1
30060	-kVAr*h	-kVAr*h_Lo	0 – 999999999	1
Frequency from ABC and RST				
30061	Fabc	Fabc	45 – 65 Hz	0.01 Hz
30062	Frst	Frst	45 – 65 Hz	0.01 Hz
Phase sequence from ABC and RST sides				
30063	ABC/ACB/?	ABC/ACB/?	0x00 = ACB 0x01 = ABC 0x02 = ?	
30064	RST/RTS/?	RST/RTS/?	0x00 = RTS 0x01 = RST 0x02 = ?	
OC, EF, SEF power flow direction				
30065	OC	OC	0x00 = Forward 0x01 = Reverse 0x02 = ?	
30066	EF	EF		
30067	SEF	SEF		
Single phase and three phase power factor				
30068	3phase	3phase	0 – 1	0.001
30069	A phase	A phase	0 – 1	0.001
30070	B phase	B phase	0 – 1	0.001
30071	C phase	C phase	0 – 1	0.001
Lifetime counters				
30072	CO Total	CO Total		
30073	Mech.wear,%	Mech.wear,%		
30074	Contact wear,%	Contact wear,%		
Fault counters				
30075	OC A trips	OC A trips		
30076	OC B trips	OC B trips		
30077	OC C trips	OC C trips		
30078	EF trips	EF trips		
30079	SEF trips	SEF trips		
30080	UV trips	UV trips		
30081	UF trips	UF trips		
30082	Inmax Trip	Maximum In current prior to any OCEF elements trip		
30083	Iamax Trip	Maximum phase A current prior to any OCEF element trip		
30084	Ibmax Trip	Maximum phase B current prior to any OCEF element trip		
30085	Icmax Trip	Maximum phase C current prior to any OCEF element trip		

Address	Settings	Description	Range	Resolution
30086	UVmin Trip	Minimum voltage prior to any UV elements trip		
30087	UFmin Trip	Minimum frequency prior to UF element trip		
User Configurable Analogue Values				
30088-30099	Configurable Analogue Value 1 - 12	Configurable Analogue Value 1 - 12		

Notes:

- In order to obtain the value of frequency in Hz the value obtained from Modbus must be multiplied by 0.001.
- If a situation occurs where it is not possible to conduct the calculation of power factor or frequency then Modbus returns value equal 0x7FFF.
- In order to obtain power factor the value obtained from Modbus must be multiplied by 0.001.
- Attempting to read/write to a coil not in the above range will result in an error.

3.4 Holding Registers (4X Reference)

Address	***Settings***	***Description***
Data and time		
40001	Date and time	Date and time Hi
40002	Date and time	Date and time Lo

Notes:

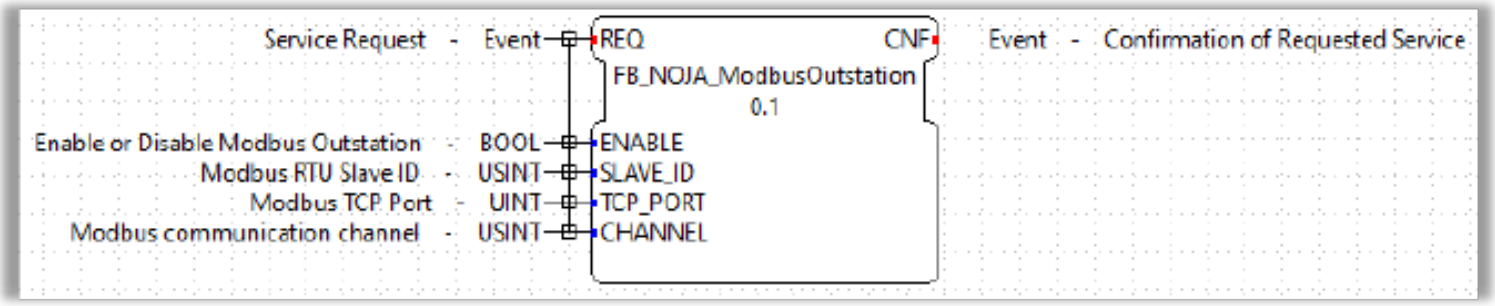
- Attempting to read/write to a coil not in the above range will result in an error.

4 Configuration

Modbus is configured through SGA. It is important to note that this function is only used to start, stop and configure the Modbus Protocol. The protocol itself runs in a separate instance within the relay, meaning it is not affected by SGA Throttling.

4.1 SGA Function Block

Modbus can be enabled and configured via SGA. The following Function Block, FB_NOJA_ModbusOutstation, is used.



Function block settings

SLAVE_ID	Server ID used for addressing the controller when using Modbus RTU
TCP_PORT	TCP port for connections made via Modbus TCP
CHANNEL	A numeric value which represents the communication channel to use. The channel selection will also determine if Modbus will communicate over serial or ethernet. See below for channels and associated Modbus mode.

Channel	Port	Modbus Mode	RC Model
0	RS232	Modbus RTU	RC01 / RC02 / RC15 / RC20
1	Usb A	See Note	RC01 / RC02 / RC15 / RC20
2	Usb B	See Note	RC01 / RC02 / RC15 / RC20
3	Usb C	See Note	RC01 / RC02
10	LAN	Modbus TCP	RC02 / RC15 / RC20
11	WLAN	Modbus TCP	RC15 / RC20
12	Mobile Network	Modbus TCP	RC15 / RC20
14	LAN 2	Modbus TCP	RC20

Note: The following table shows the Modbus mode for various USB port setttings

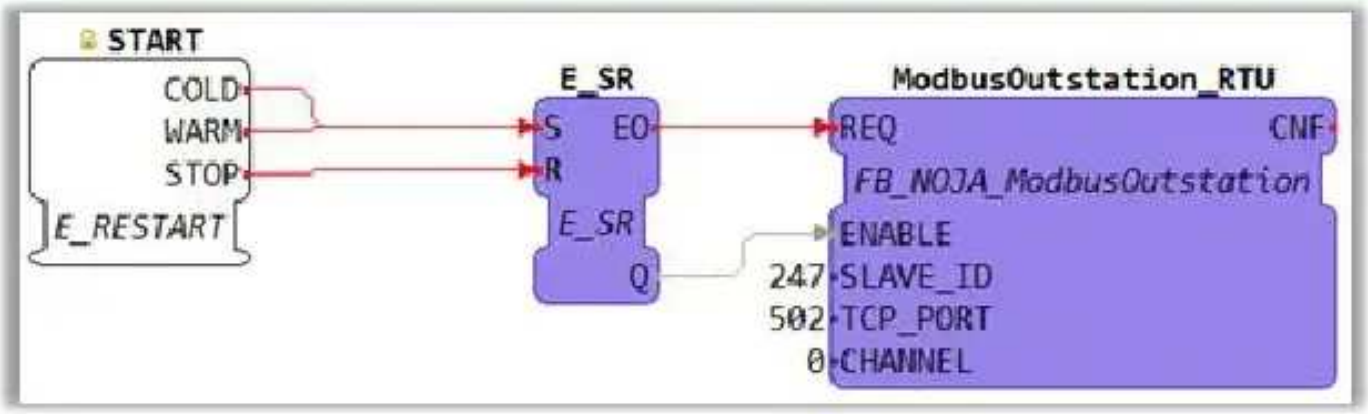
USB Port Setting	Modbus Mode
Disabled	Disabled
Serial	Modbus RTU
SerialModem	Disabled
SerialRadio	Disabled
GPRS	Disabled
LAN	Modbus TCP
WLAN	Modbus TCP

The Modbus Outstation function block differs from all other function blocks in that it is not event driven on delete.

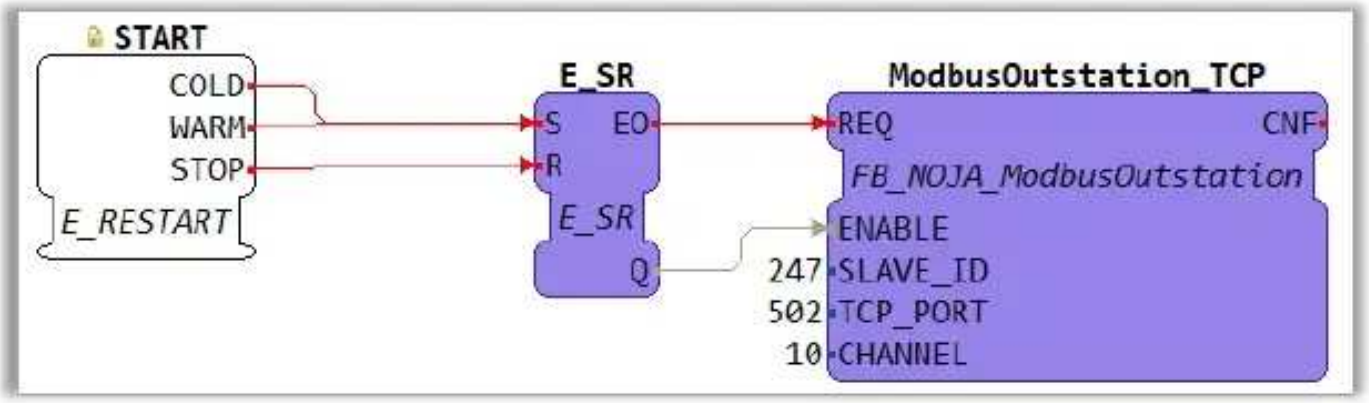
- When the Modbus FB receives an event the configuration settings on the input of the function block will be applied.
- When the Modbus FB is deleted, Modbus will be disabled.

- If multiple Modbus FB's are in resources, there will be no interaction/interlocking between the multiple instances.
- On power up Modbus will assume its last state until changed by the Modbus FB.
- If Modbus is disabled by another process (for example, misconfiguration with CMS over serial), the Modbus FB will not automatically enable Modbus once the issue is resolved

The Modbus FB can be correctly deployed via SGA as shown. In the first instance, the Modbus channel is set to use RS232, placing the protocol in Modbus RTU mode. The Slave_ID is specified as 247, but can be changed to suit the specific Modbus network as required. The TCP_Port value is not used and will be ignored.



The following instance shows Modbus channel set to 10, indicating LAN communication port and Modbus TCP mode. In this case, the TCP_Port is specified as 502, the default for Modbus.



It can be seen from the above examples that the only difference between the two is the “Channel” setting. This is the overriding setting required to ensure the correct Modbus mode is activated within the device.

4.2 Loading the SGA application

Once you have created the SGA project, it must be loaded onto the relay. Please refer to NOJA-5019-06 SGA User Guide for a detailed guide on creating and deploying an application to the relay.

4.3 Port configuration

Before Modbus can function, the selected port must be enabled in comms settings. Please refer to NOJA-565-14 SCADA Interface Description and the User Manual for more details on port configuration.