COMMUNICATIONS

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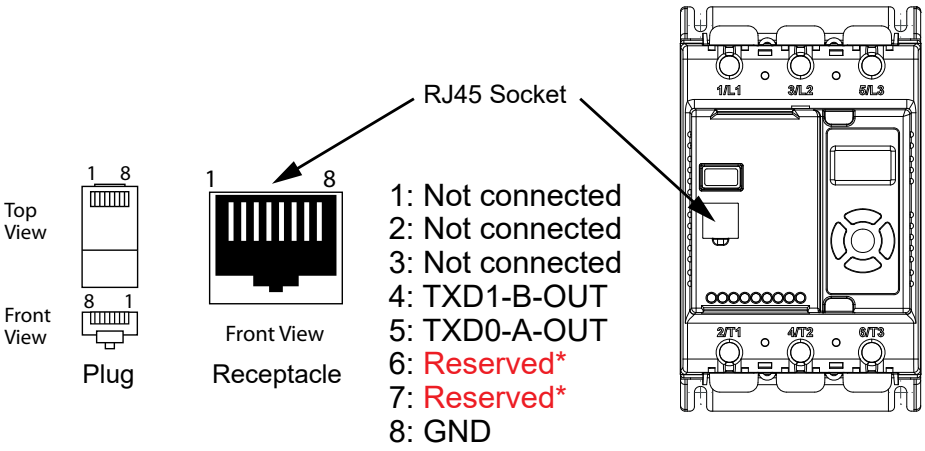
Modbus RTU Serial Communications

Modbus RTU Communications Interface

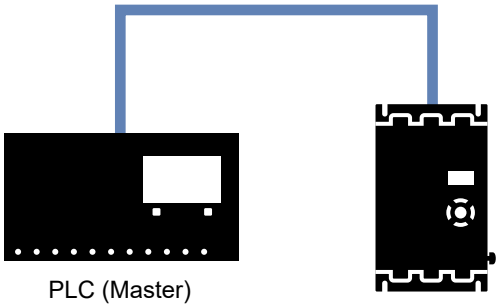
All SR35 soft starters support Modbus RTU as standard. The RS-485 communications are accessible from the RJ45 connector (see below).



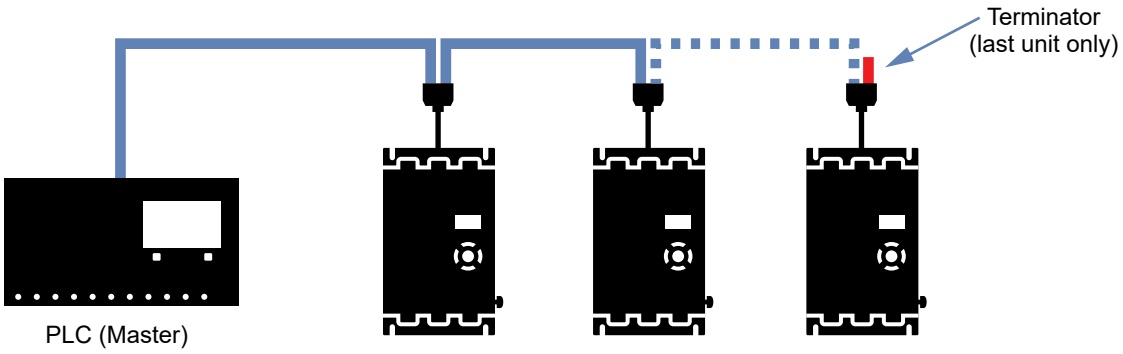
WARNING: To avoid damage to the unit or to the RS-485 master, do NOT connect to these pins!

Modbus RTU Connections

Single SR35 RS-485 network



Multiple SR35 RS-485 network



NOTE: Each SR35 starter must have a unique Modbus station address and all units must share identical parity and baud rate settings

Modbus Communications Configuration

The Modbus communication settings may be configured from the Device menu:

Device >> Networks >> Modbus Network Settings >> Address (1 – 32)

Device >> Networks >> Modbus Network Settings >> Baud (9600 – 115200)

Device >> Networks >> Modbus Network Settings >> Parity (Odd / Even)

(Data bits = 8, Stop bits = 1)

The communication parameters should be set before connecting the Modbus master.

Transmission Modes

ASCII and RTU transmission modes are defined in the Modbus protocol specification. SR35 uses only the RTU mode for the message transmission.

Message Structure For RTU Mode

The Modbus RTU structure uses a master-slave system for message exchange. In the case of the SR35 system, it allows up to 32 slaves, and one master. Every message begins with the master making a request to a slave, which responds to the master in a defined structure. In both messages (request and answer), the used structure is the same:

- *Master (request message):*

Address (1 byte)	Function (1 byte)	Request Data (n bytes)	CRC (2 bytes)

- *Slave (response message):*

Address (1 byte)	Function (1 byte)	Response Data (n bytes)	CRC (2 bytes)

Address

The master initiates the communication by sending a byte with the address of the destination slave. When responding, the slave also initiates the message with its own address. Broadcast to address 0 (zero) is not supported.

Function Code

This field contains a single byte, where the master specifies the type of service or function requested to the slave (reading, writing, etc.). According to the protocol, each function is used to access a specific type of data.

Data Field

The format and contents of this field depend on the function used and the transmitted value.

CRC

The used method is the CRC-16 (Cyclic Redundancy Check). This field is formed by two bytes; where first the least significant byte is transmitted (CRC-), and then the most significant (CRC+). The CRC calculation form is described in the Modbus RTU protocol specification.

Supported Functions

Modbus RTU specification defines the functions used to access different types of data.

SR35 parameters are defined as ***holding type registers***.

For Modbus RTU/TCP Client devices that use Modicon style addressing, place a 4 as the high digit followed by the Modbus address defined in the parameter mapping table. Note that SR35 Modbus addressing starts at zero; not 1 as some devices do.

SR35 32-bit parameters are High Word/Low Word in Modbus format.

The following services are available:

Read Holding Registers

Description: reading register blocks of holding register type (block R/W limited to 8 registers).

Function code: 03 example

Modbus Function 03 Transaction Table			
Query		Response	
Field	Hex Byte	Field	Hex Byte
Slave address	01	Slave address	01
Function	03	Function	03
Start address Hi	00	Byte count	02
Start address Lo	01	Data Hi	01
No of registers Hi	00	Data Lo	2C
No of registers Lo	01	CRC Lo	B8
CRC Lo	D5	CRC Hi	09
CRC Hi	CA		

Write Single Register

Description: writing in a single register of the holding type.

Function code: 06 example

Modbus Function 06 Transaction Table			
Query		Response	
Field	Hex Byte	Field	Hex Byte
Slave address	01	Slave address	01
Function	06	Function	06
Address Hi	00	Address Hi	02
Address Lo	0C	Address Lo	0C
Data Hi	00	Data Hi	00
Data Lo	09	Data Lo	09
CRC Lo	48	CRC Lo	88
CRC Hi	0C	CRC Hi	77

Write Multiple Registers

Description: writing register blocks of holding register type (block R/W limited to 8 registers).

Function code: 16 example

Modbus Function 16 Transaction Table			
Query		Response	
Field	Hex Byte	Field	Hex Byte
Slave address	01	Slave address	01
Function	10	Function	10
Address Hi	00	Address Hi	00
Address Lo	01	Address Lo	01
# Words Hi	00	# Words Hi	00
# Words Lo	01	# Words Lo	01
# Bytes	02	CRC Lo	50
Data Hi	00	CRC Hi	09
Data Lo	02		
CRC Lo	26		
CRC Hi	40		

Memory Map

SR35 Modbus communication is based on reading or writing equipment parameters from or to the holding registers. The data addressing is zero offset, such that the parameter Modbus address corresponds to the register number.

Modbus Address Memory Map		
Parameter Modbus Address	Modbus Data Address	
	Decimal	Hex
0000	0	0000h
0001	1	0001h
•	•	•
•	•	•
•	•	•
•	•	•
0128	128	0080h
•	•	•
•	•	•
	•	•
•	•	•

Message Timing

In the RTU mode there is no specific start or stop byte that marks the beginning or the end of a message. Indication of when a new message begins or when it ends is achieved by the absence of data transmission for a minimum period of 3.5 times the transmission time of a data byte. Thus, in case a message is transmitted after this minimum time has elapsed; the network elements will assume that the first received character represents the beginning of a new message.

Modbus Parameter Values

Parameter Values					
PNU 16 (P0.6)	**Auto Application**	**PNU 24 (P0.6)**	**Status**	**PNU 77–85 (P17.1-P17.9)**	**Trip Status**
0	Default	***20***	Starting	***100***	Ph Loss
1	Heavy	***22***	Fire Mode	***200***	Thermal
2	Agitator	***25***	Limit Start	***300***	Ph/SCR
3	Compressor 1	***35***	Limit Stop	***400***	Mot Side
4	Compressor 2	***40***	Stopping	***500***	Freq
5	Conveyor Loaded	***60***	Running	***600***	Uc Low
6	Conveyor Unloaded	***128***	Ready	***700***	SCR Sen
7	Crusher	***140***	Tripped	***800***	Fan
8	Fan High Inertia	***200***	Disabled	***1000***	SCR S/C
9	Fan Low Inertia	***250***	Initialization	***1100***	Low Amp
10	Grinder	***-***	-	***1200***	Limit
11	Mill	***-***	-	***1300***	Overload
12	Mixer	***-***	-	***1400***	Shear
13	Moulding M/C	***-***	-	***1500***	PTC
14	Press Flywheel	***-***	-	***1600***	External
15	Pump 1	***-***	-	***1700***	Comms
16	Pump 2	***-***	-	***1800***	Bypass
17	PumpJack	***-***	-	***1900***	FireMode
18	Saw-Band	***-***	-	***2000***	Remote
19	Saw-Circular	***-***	-	***2100***	Rotation
20	Screen Vibrating	***-***	-	***2200***	Op1
21	Shredder	***-***	-	***2300***	CT Fault
22	Woodchipper	***-***	-	***1100***	Op2 Pnu
-	-	***-***	-	***1200***	Op2 Mod
-	-	***-***	-	***13000***	Op2 Mon
-	-	***-***	-	***14000***	Op2 Men
-	-	***-***	-	***15000***	Op2 Keys
-	-	***-***	-	***16000***	Op2 Motr
-	-	***-***	-	***17000***	Op2 Log
-	-	***-***	-	***18000***	Op2 Disk

Special Modbus Registers

List of special Modbus registers, descriptions, and usage.

Window registers

There is a section of Modbus registers that can be used for special (user programmable) purposes.

Register Name	Reg Num (PNU)	Description
Window View	157	Selects what is viewed through the window 0 – Patched Registers 1 – Log Records
Window Code	158	Log Record function 0 – None 1 – Report 2 – Rewind 3 – Unwind 4 – Seek Absolute 5 – Seek Relative 6 – Next Record 16 – Auto Increment
Reserved	159	For future functionality
Patch Address 1 to 16	160 to 175	16 place holders for the registers that need to be patched
Window 1 to 24	176 to 199	Either: If Window View set to 0 16 data holders related to the selected addresses in the Patch Address section (in Window 1 to 16 only) Or For Window View set to 1 All 24 words to hold the currently select log record

Currently there are two uses for this group of Modbus registers. (1) Register patching and (2) Log record access.

REGISTER PATCHING

Register patching is enabled when the Window View register (address 157) is set a to Patched Registers (value 0).

It allows the user to patch (re-map) a selection of disparate registers into a contiguous register section or window, so that retrieval of the most requested data can be handled in more efficient single block reads by a host controller (PLC). When the address of a register is placed in the Patch section (addresses 160 to 175) then the corresponding 16 bit WORD(s) in the Window section (addresses 176 to 192) will mirror the data and function of those registers.

For example, if address 24 (Motor State) is set into register 160 (first Patch Address) then the value report at 176 (first Window address) will be the Motor State from then on.

Register Name	Register Number (PNU)	Register Value
Motor State	24	128

→

Patch Register (PNU)	Patch Value	Window Register (PNU)	Window Value
160	24	176	128

Consideration needs to be given to registers that produce multiple WORD data. For example, address 22 (Unit Amps) produces a 32 bit or 2 WORD datum. To mirror both of those WORDs into the Window both registers 22 and 23 will need to be assigned (side by side) in to the corresponding Patch Address section.

Register Name	Register Number (PNU)	Register Value
Unit Amps	22	0
		5500

→

Patch Register (PNU)	Patch Value	Window Register (PNU)	Window Value
160	22	176	0
161	23 0r 0	177	5500

It follows that the entire 16 Aliases can be populated with a mixture of the required data, that can then be queried from (or set to, with writable registers) with a 16 word Modbus transaction frame.

Register Name	Register Number (PNU)	Register Value
Serial Number	7	0x0041
		0x3132
		0x3334
		0x3536
Motor State	24	128
Unit Amps	22	0
		5500

→

Patch Register (PNU)	Patch Value	Window Register (PNU)	Window Value
160	7	176	0x0041
161	8 or 0	177	0x3132
162	9 or 0	178	0x3334
163	10 or 0	179	0x3536
164	24	180	128
165	22	181	0
167	23 0r 0	182	5500

LOG RECORD ACCESS.

Log record access is enabled when the Window View register (PNU 157) is set a to Log Records (value 1).

When Log record access is selected these can be accessed by assigning Window Code Register (PNU 158) with a one of the function code values described here.

Report (PNU 158 set to value 1)

If Window Code is set to 1, the Window registers are filled with information about the first and last record in the event log, in the following arrangement.

Window Register Numbers (PNU)	Description of data copied
176,177	Index number of first record
178,179,180	Date and Time when the event was recorded of first record. See date Time format in Appendix
181,182	Index number of last record
183,184,185	Date and Time when the last event was recorded. See date Time format. TBD

Rewind (2)

Setting Window Code (PNU 158) to 2 will rewind the log record pointer to the first record. Subsequently when the Next Record is requested the data from the first record will be placed into the Window registers.

Unwind (3)

Setting Window Code (PNU 158) to 3 will set the log record pointer to the last created record. Subsequently when the Next Record is requested the data from the last record will be placed into the Window registers.

Seek Absolute (4)

Setting Window Code (PNU 158) to 4 along with setting Window 1 and 2 to the required record pointer will prepare the Next Record request to return the record with that record number.

Seek Relative (5)

When setting Window Code (PNU 158) to 5, the signed number set into Window 1 and 2 will added to the current pointer so the Next Record request will return the record whose position is offset by that number.

Next Record (6)

Setting Window Code (PNU 158) to 6 will cause the log record with the position of the current record pointer to be copied into the Window registers (PNU 176 to 199). These will then contain the following information.

Generic Word Register number (PNU)	Data Description
176,177	Record Index number
178,179,180	Date and Time when the event was recorded. See date Time format. See appendix
181	Event type. See event type codes. See appendix
181 to 199	Event data. See event data. See appendix

Auto Increment (16)

If this value can be added (OR'ed) in with Next record (6 + 16 = 22) then each Modbus read of the Window 1 register (PNU 176), with or without a block read of the following 23 registers, will automatically increment the record pointer so that the next read will return information from the next record. This avoids the need to do a Next Record request before each record read. Note that if register Window 1 is read as one Modbus transaction, then subsequent reads of the other higher Window registers will be from the next record. Block reads of all 24 registers are required for Auto Increment to function successfully.

When an event row is requested, following a "Next Record" or "Auto Increment" function, the values recorded for that record are placed in the Window addresses, PNU 176–199 as in the table below.

Generic Word Register number (PNU)	Data Description
176,177	Record Index number
178,179,180	Date and Time when the event was recorded. See date Time format
181	Event type. See event type codes
182 to 199	Event data. See event data

The Date and Time is recorded in three consecutive registers. This is true for Modbus registers Date, Time, Saved Date, Saved Time and the Time stamps shown in the table below:

Register Ordinal	Description	Detail Bit Layout of each 16 bit words	
1	Date	Bits 0 - 4	Day (1 – 31)
		Bits 5 - 8	Month (1 – 12)
		Bits 9 - 15	Year (00 – 127) -> (2000 - 2127)
2	Time 1 (Hours, Minutes)	Bits 0 - 5	Minute (0 – 59)
		Bits 6 - 10	Hour (0 – 23)
		Bits 11 - 15	Unused
3	Time 2 (Milliseconds)	Bits 0 - 9	Milliseconds (0 – 999)
		Bits 10 - 15	Seconds (0 – 59)

Event Type Codes represent what kind of event the proceeding data represents.

Code	Meaning
1	Initialize (boot up)
10	Power Off
50	Start Signal
100	Motor Run
300	Motor Dwell
600	Motor Stop
900	Motor Tripped

Depending on the event type code the register addresses PNU 182–197 will contain data that is described in the following table.

Addr (PNU)	Event Type						
	Initialize	Power Off	Start Signal	Motor Run	Motor Dwell	Motor Stop	Motor Tripped
182	Version	Version	Version	Start Delay	Irms	Irms	Irms
183	Model No	AGY100 Ver	Model Number	Frequency	I1 rms	I1 rms	StopCodeFile
184	Unit Amps	AGY200 Ver	Unit Amps	Rot Degrees	I2 rms	I2 rms	StopCodeFile_1
185	Rated Amps	AGY300 Ver	Rated Amps	Rotation	I3 rms	I3 rms	StopCodeFile
186	Motor Amps	AGY400 Ver	Motor Amps	Trip Class	Stop Time	I Stop	StopCodeFile_1
187	MenuBuild	ODB Type	MenuBuild	Initial Volts	I Limit Stop	T Stop	StopCodePos
188	Motor State Save	OverloadSave	Op Mode	Start Time	Limit Amps	Diagnostic 1	StopCodePos_1
189	OverloadSave	Diagnostic 2	Fire Mode	StartsHr	Limit Time	Diagnostic 2	I Start
190	Keypad Pwr	Diagnostic 3	Trip Class	Limit Amps	I Start	Diagnostic 3	T Start
191	Trip Class	Diagnostic 4	Application	Limit Time	T Start	Diagnostic 4	I Stop
192	Application	Diagnostic 5	Cntrl Mode	Shear Amps	Initial Temp	Diagnostic 5	T Stop
193	Language	Diagnostic 6	Cntrl Funct	Shear Time	I Low Amps	Diagnostic 6	CommsTime
194	I Low	Phase Loss	Relay 21 22	Ovld Amps	I Low Time	Delay Angle	Delay Angle
195	Shearpin	Sensor Loss	Reset Attempts	HS Temp	HS Temp	HS Temp	HS Temp
196	Hz HighLow	Ph/SCR	AR Attempts	Trip Sens	Overload	Overload	Overload
197	Overload	CT Fault	Kick Start	Overload	Last Warn	Last Warn	Last Trip

Memory Probes

Each register WORD is used as two BYTEs. Each byte showing the current amount of available memory for each designation. These are used within the firmware to record and respond to low memory situations in the device operating system. Note that these have a maximum value of 0xff or 255. 0xff could mean a value greater than 0xff, so it works as a soft limit. In normal and stressed operation, it is desirable that these values never reach zero.

Register Name	Reg Num (PNU)	Size	Description Free Memory
Main Memory Free	212	2 x BYTE	MSByte – Main Stack LSByte – Main Heap
Task 1&2 Free Stack	213	2 x BYTE	MSByte – Task 1 Stack (Monitor) LSByte – Task 2 Stack (IDLE)
Task 3&4 Free Stack	214	2 x BYTE	MSByte – Task 3 Stack (Keys) LSByte – Task 4 Stack (Menu)
Task 5&6 Free Stack	215	2 x BYTE	MSByte – Task 5 Stack (PNU) LSByte – Task 6 Stack (Modbus)
Task 7&8 Free Stack	216	2 x BYTE	MSByte – Task 7 Stack (Disk) LSByte – Task 8 Stack (Log)
Task 9&10 Free Stack	217	2 x BYTE	MSByte – Task 9 Stack (Reserved) LSByte – Task 10 Stack (Motor)

Modbus PNU Alphabetical Cross Reference

PNU	Name	PNU	Name	PNU	Name	PNU	Name	PNU	Name
148	Address	53	Hz HighLow	283	Operation 1		Reset Delay	79	Trip 2
48	AGY100 Ver	266	HzHighLow	109	Operation 2	37	Rotation	80	Trip 3
103	AGY200 Ver	273	I Limit	293	Operation10		Rotation	81	Trip 4
104	AGY300 Ver	59	I Limit Start	285	Operation2		RX Bytes	82	Trip 5
153	AGY400 Ver	242	I Limit Stop	286	Operation3		RX Errors	83	Trip 6
16	Application	272	I Low	287	Operation4		RX Frames	84	Trip 7
297	AR Attempts	58	I Low	288	Operation5		RX TMO Er	85	Trip 8
296	AR Delay	239	I Low Amps	289	Operation6	33	Save Log	17	Trip Class
295	AR Exceeded	241	I Low Time	290	Operation7		ScrFire	261	Trip Free Time
294	AR Pending	25	I rms	291	Operation8		Scroll	152	Trip Sens
299	AR Trip Event	94	I Start	292	Operation9		SCRSen	229	TX Bytes
298	AR Trip Free	96	I Stop	27	Overload	50	Sensor Loss	231	TX Errors
258	Auto Reset	41	I1 rms	60	Overload	7	Serial No	230	TX Frames
150	Baud	251	I1 rms	274	Overload		Service No	267	UcLow
72	Boot Ver	43	I2 rms	218	Ovld Amps		Shear Amps	22	Unit Amps
279	Bypass	252	I2 rms	149	Parity		Shear Time	14	Version
74	Cntrl Funct	45	I3 rms	160	Patch Addr 1	61	Shearpin	176	Window 1
1	Cntrl Mode	253	I3 rms	169	Patch Addr 10		Shearpin	185	Window 10
278	Comms	248	Initial Temp	170	Patch Addr 11	6	Start Delay	186	Window 11
64	Comms	2	Initial Volts	171	Patch Addr 12	4	Start Time	187	Window 12
147	CommsTime	250	Irms	172	Patch Addr 13		StartsHr	188	Window 13
280	Control	243	Keypad Pwr	173	Patch Addr 14	5	Stop Time	189	Window 14
67	CT Fault	87	Kick Level	174	Patch Addr 15		StopCodeFile	190	Window 15
284	CT Fault	89	Kick Start	175	Patch Addr 16		StopCodeFile_1	191	Window 16
34	Date	88	Kick Time	161	Patch Addr 2		StopCodePos	192	Window 17
151	DateFormat	223	L1L2L3	162	Patch Addr 3		StopCodePos_1	193	Window 18
47	Delay Angle	224	L1L3L2	163	Patch Addr 4	95	T Start	194	Window 19
212	Diagnostic 1	220	Language	164	Patch Addr 5	97	T Stop	177	Window 2
213	Diagnostic 2	69	Limit Amps	165	Patch Addr 6	145	TempUnit	195	Window 20
214	Diagnostic 3	236	Limit Amps	166	Patch Addr 7	263	Thermal	196	Window 21
215	Diagnostic 4	71	Limit Time	167	Patch Addr 8	35	Time	197	Window 22
216	Diagnostic 5	238	Limit Time	168	Patch Addr 9	90	To USB	198	Window 23
217	Diagnostic 6	86	MenuBuild	51	Ph/SCR	98	Total Events	199	Window 24
146	Disp Time	119	Modbus Enable	265	Ph/SCR	204	Total Runs	178	Window 3
277	External	121	Modbus Reset	49	Phase Loss	221	Total Starts	179	Window 4
31	Factory Rst	120	Modbus Start	262	Phase Loss	206	Total Stops	180	Window 5
269	Fan	11	Model No	20	Rated Amps	210	Total Trips	181	Window 6
143	Fire Mode	18	Motor Amps	300	Relay 13 14	106	Total Uc On	182	Window 7
30	Frequency	24	Motor State	154	Relay 21 22	202	Total Us Off	183	Window 8
91	From USB	159	ODB Type	66	Remote	200	Total Us On	184	Window 9
39	HS Temp	75	Op Mode	281	Remote (AR)	77	Trip 0	158	Window Code
40	HS Temp	68	Operation 1		Reset Attempts	78	Trip 1	157	Window View