SIEMENS 7SR45 Communication Protocol User Manual

Contents

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SIEMENS 7SR45 Communication Protocol

Product Information

- **Product Name:** Reyrolle 7SR5 device family
- **Document Version:** C53000-L7040-C101-3.0
- **Product Version:** V03.00
- **Target Audience:** Protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operational crew in electrical installations and power plants.
- **Scope:** This manual applies to the Reyrolle 7SR5 device family.
- **Description:** The Reyrolle 7SR5 device family is a protection device used in electrical installations and power plants. It includes communication modules that support Modbus RTU and IEC 60870-5-103 protocols for communication within the device family and to higher-level network control centers.

Product Usage

The Reyrolle 7SR5 device family is designed to be used by protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operational crew in electrical installations and power plants. The device family includes communication modules that support Modbus RTU and IEC 60870-5-103 protocols for communication within the device family and to higher-level network control centers.

Before using the device, users should read the user manual carefully to understand the safety instructions and warnings contained in the document. Users should also ensure that they have the appropriate knowledge and training to operate the device.

The device manual describes the functions and applications of the Reyrolle 7SR5 device, while the hardware manual describes the hardware building blocks and device combinations of the device family. The operating manual provides the basic principles and procedures for operating and installing the devices, while the communication protocol manual contains a description of the protocols for communication within the device family

and to higher-level network control centers. The security manual describes the security features of the devices and Reydisp Manager 2, while the engineering guide describes the essential steps when engineering with Reydisp Evolution.

If users have any questions about the system or need additional support, they can contact their Siemens sales partner or the Customer Support Center, which provides a 24-hour service by phone or email.

Preface

Purpose of the Manual

This manual contains information about:

- Communication within the Reyrolle 7SR5 device family and to higher-level control centers
- Setting parameters in Reydisp Manager
- Information on commissioning

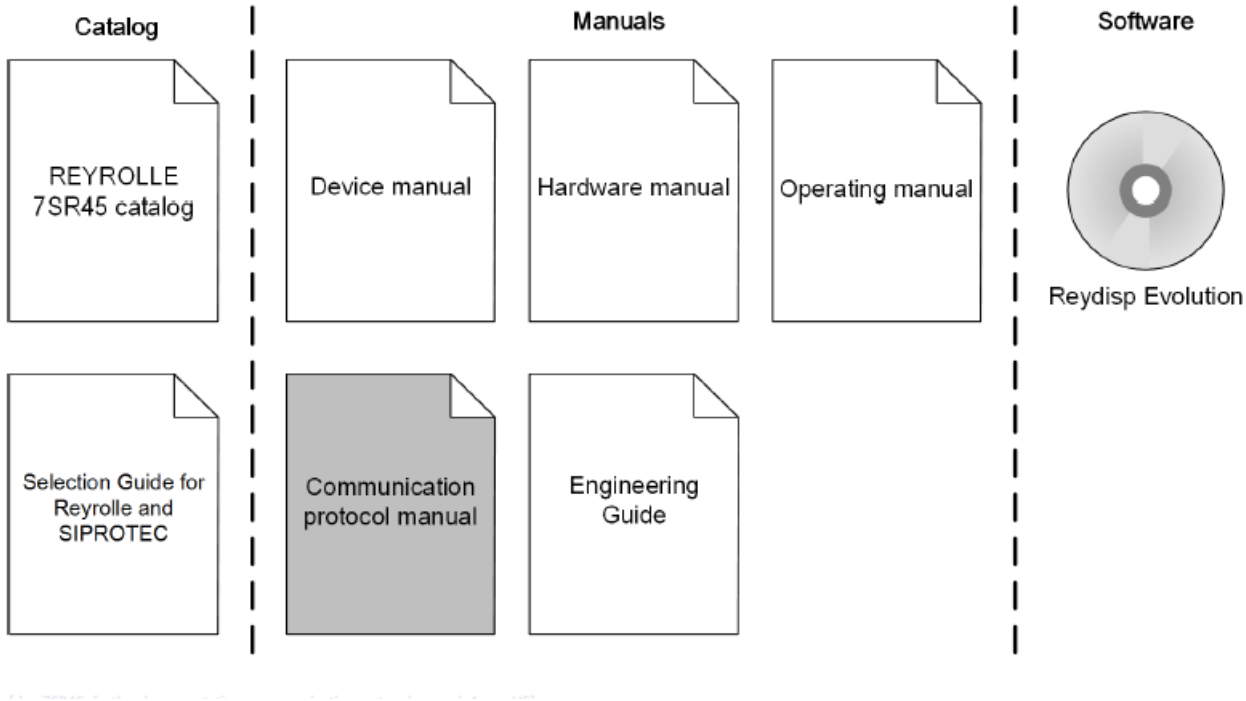
Target Audience

This manual is mainly intended for protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operational crew in electrical installations and power plants.

Scope

This manual applies to the Reyrolle 7SR5 device family.

Further Documentation



- **Device manual**

  The device manual describes the functions and applications of the Reyrolle 7SR45 device. The printed manual for the device has the same informational structure.
- **Hardware manual**

  The hardware manual describes the hardware building blocks and device combinations of the Reyrolle 7SR45 device family.

- **Operating manual**
  The operating manual describes the basic principles and procedures for operating and installing the devices of the Reyrolle 7SR45 range.
- **Communication protocol manual**
  The communication protocol manual contains a description of the protocols for communication within the Reyrolle 7SR45 device family and to higher-level network control centers.
- **Security manual**
  The security manual describes the security features of the Reyrolle 7SR45 devices and Reydisp Manager 2.
- **Engineering Guide**
  The engineering guide describes the essential steps when engineering with Reydisp Evolution. In addition, the engineering guide shows you how to load a planned configuration to a Reyrolle Communication Protocol device and update the functionality of the Reyrolle Communication Protocol device.
- **Reyrolle 7SR45 catalog**
  The Reyrolle 7SR45 catalog describes the system features and the devices of Reyrolle 7SR45.
- **Selection guide for Reyrolle and SIPROTEC**
  The selection guide offers an overview of the device series of the Siemens protection devices, and a device selection table.

Additional Support
For questions about the system, contact your Siemens sales partner.

Customer Support Center
Our Customer Support Center provides a 24-hour service.

- Siemens AG
  - **Smart Infrastructure – Digital Grid Phone:** +49 911 2155 4466
  - **Customer Support Center E-mail:** energy.automation@siemens.com

Training Courses
Inquiries regarding individual training courses should be addressed to our Training Center:

- **Siemens AG**
  - Siemens Power Academy TD **Phone:** +49 911 9582 7100
  - **Humboldtstraße 59 E-mail:** poweracademy@siemens.com
  - **90459 Nuremberg Internet:** www.siemens.com/poweracademy

Notes on Safety
This document is not a complete index of all safety measures required for operation of the equipment (module or device). However, it comprises important information that must be followed for personal safety, as well as to avoid material damage. Information is highlighted and illustrated as follows according to the degree of danger:

- **DANGER** means that death or severe injury will result if the measures specified are not taken.
  - Comply with all instructions, in order to avoid death or severe injuries.
- **WARNING** means that death or severe injury may result if the measures specified are not taken.
  - Comply with all instructions, in order to avoid death or severe injuries.
- **CAUTION** means that medium-severe or slight injuries can occur if the specified measures are not taken.

    - Comply with all instructions, in order to avoid moderate or minor injuries.
- **NOTICE** means that property damage can result if the measures specified are not taken.
    - Comply with all instructions, in order to avoid property damage.
- **NOTE** Important information about the product, product handling or a certain section of the documentation which must be given attention.

OpenSSL
This product includes software developed by the OpenSSL Project for use in OpenSSL Toolkit (**http://www.openssl.org/**).
This product includes software written by Tim Hudson (**tjh@cryptsoft.com**).
This product includes cryptographic software written by Eric Young (**eay@cryptsoft.com**).

Open Source Software

The product contains, among other things, Open Source Software developed by third parties. The Open Source Software used in the product and the license agreements concerning this software can be found in the Readme_OSS. These Open Source Software files are protected by copyright. Your compliance with those license conditions will entitle you to use the Open Source Software as foreseen in the relevant license. In the event of conflicts between Siemens license conditions and the Open Source Software license conditions, the Open Source Software conditions shall prevail with respect to the Open Source Software portions of the software. The Open Source Software is licensed royalty-free. Insofar as the applicable Open Source Software License Conditions provide for it you can order the source code of the Open Source Software from your Siemens sales contact – against payment of the shipping and handling charges – for a period of at least 3 years after purchase of the product. We are liable for the product including the Open Source Software contained in it pursuant to the license conditions applicable to the product. Any liability for the Open Source Software beyond the program flow intended for the product is explicitly excluded. Furthermore, any liability for defects resulting from modifications to the Open Source Software by you or third parties is excluded. We do not provide any technical support for the product if it has been modified.
The ReadmeOSS documents for the product can be found here: **www.siemens.com/reyrolle**.

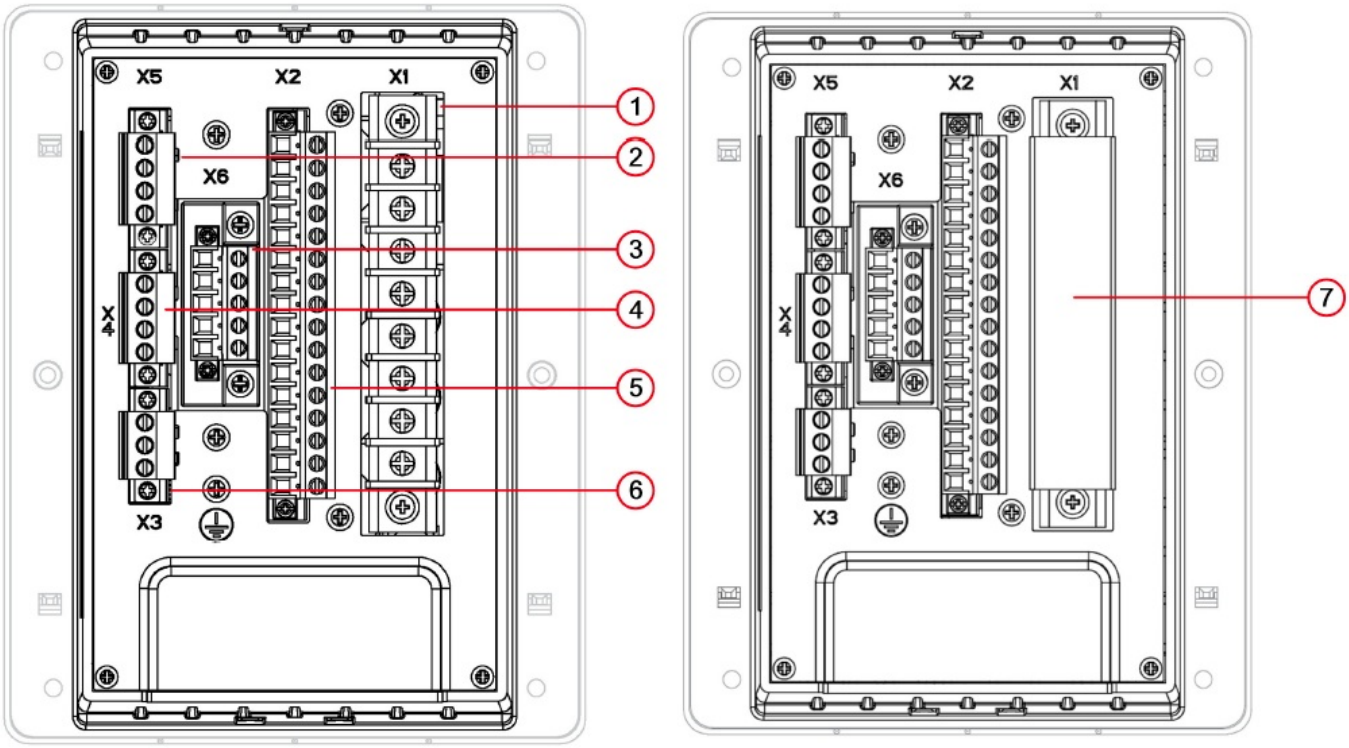
Communication Modules

Overview
The relay data communication facility is compatible with control and automation systems and PCs running Reydisp software. The relay can provide the following:

- Operational information
- Post-fault analysis
- Settings interrogation
- Editing facilities

This section describes how to use the communication interface with a control system or interrogating computer. An appropriate software application within the control system or on the interrogating computer (for example, Reydisp Evolution) is required to access the interface. The relay data communication facility incorporates the protocols selected by you and provides compatibility with control and automation systems. This section specifies connection details and lists the events, commands, and measurand available in the IEC 60870-5-103 and Modbus RTU protocols. The communication interface for dialog communication by the protection engineer is provided by the Reydisp Evolution software packages using the IEC 60870-5-103 protocol. You can download the configuration software from **www.siemens.com/reyrolle**. This section specifies connection details and lists the information available through the individual protocols.

NOTE The 7SR45 Argus Dual Powered Relay variant supports the data communication.



1. Current inputs
2. Additional binary inputs
3. Additional binary outputs
4. Rear communication port
5. Binary inputs/binary outputs/flag output/pulse output
6. Auxiliary power supply
7. IP20 Cover for current terminals

The relay range provides 1 front USB communication interface (Com2) on the fascia and 1 RS485 (Com1) on the rear. The access to the communication settings for the USB port & the RS485 port is available from the relay front via the keypad setting COMMUNICATION menu. The communication settings for the RS485 port can also be done through Reydisp Evolution via the USB connections.

Communication interface

- The Com2-USB port can be used for IEC 60870-5-103 or Modbus RTU communication. The Com2-USB port is used for IEC 60870-5-103 (default setting) communication with the Reydisp Evolution software. The ASCII protocol allows to update the firmware via the front connection.
- **Com1-RS485**
  The Com1-RS485 port can be used for IEC 60870-5-103 or Modbus RTU communications to a substation SCADA, integrated control system, or engineer remote access.

Any or all serial ports can be mapped to the IEC 60870-5-103 or MODBUS RTU protocol at any one time, protocols available will depend upon relay model. When connecting to Reydisp Evolution software, Siemens recommends setting the IEC 60870-5-103 protocol for the relevant port.

USB Communication Interface (Com2)
The USB communication port is connected to the relay using a standard USB cable type B and to the PC using a standard USB cable type A. When Reydisp Evolution software is installed, a suitable USB driver is installed in the

PC automatically. When Reydisp Evolution software is running with the USB cable connected to a device, an additional connection is shown in the Reydisp connection window. The connections to these devices are not shown when they are not connected. The USB communication interface on the relay and its associated settings are located in the COMMUNICATION menu. When connecting to Reydisp Evolution using this connection, the default settings can be used without changing any settings.

Table 1-1 USB Interface (Com2)

Setting Name	Range/Options	Default	Setting	Notes
USB-Protocol	OFF IEC60870-5-103 MODBUS-RTU	IEC60870-5-103	–	The Reydisp Evolution soft - ware requires IEC60870-5-103.
USB-Stn Addr	0 to 254 for IEC60870-5-103 1 to 247 for MODBUS-RTU	1	–	To identify the relay, provid e an address within the ran ge of the relevant protocol. Each relay in a network mu st have a unique address.
USB-Mode	Local Local or Remote Remote	Local or Remote	–	–

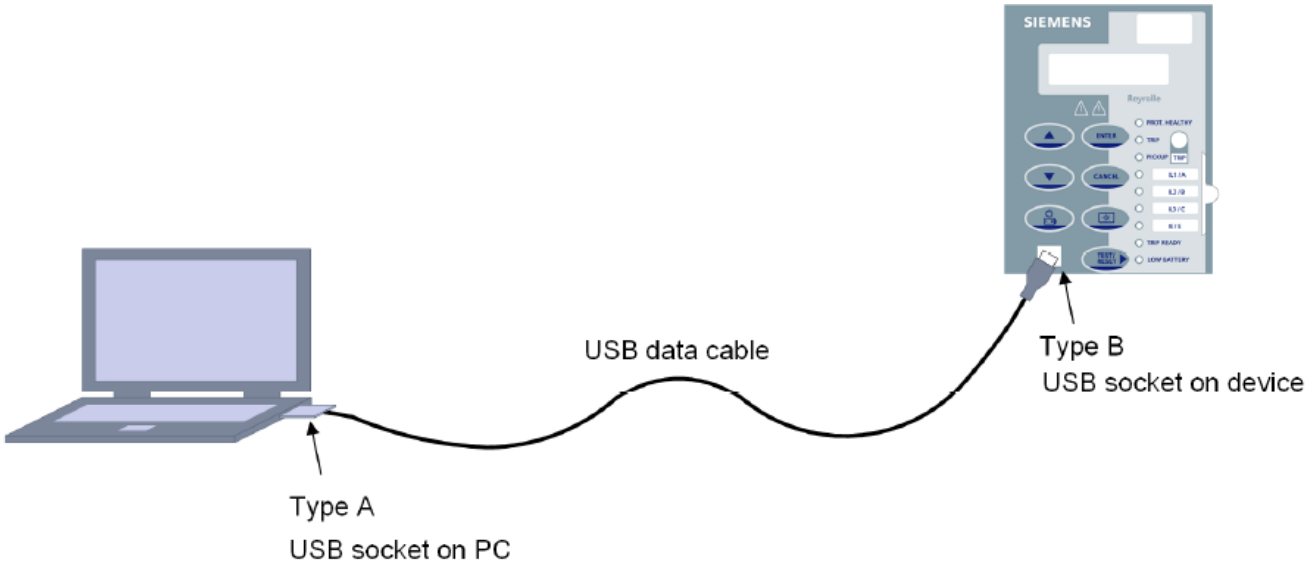


Figure 1-2 Communication to Front USB Port

RS485 Connection (Com1)

The 2 wire RS485 communication port is located on the rear of the relay and can be connected using a suitable RS485 120 Ω shielded twisted pair cable.

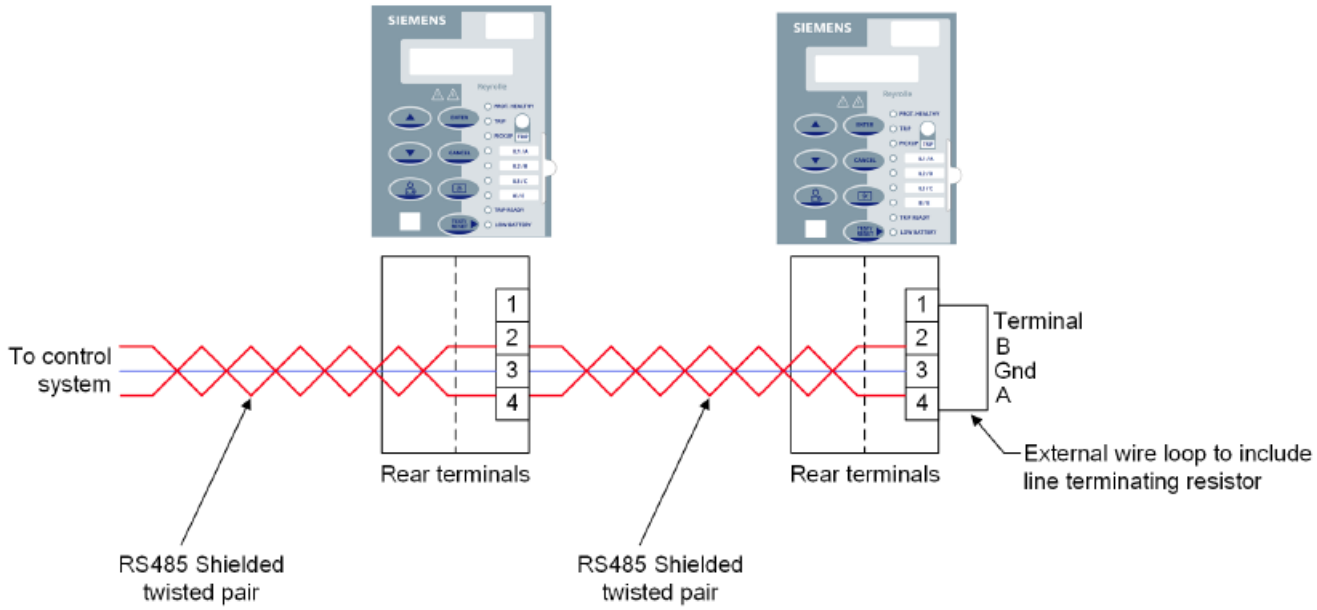
The RS485 electrical connection can be used in a single or multi-drop configuration. The RS485 master must support and use the Auto Device Enable (ADE) feature. The last device in the connection must be terminated correctly in accordance with the master device driving the connection. The connection can be done via the internal 120 Ω load resistor, which can be connected between (A) and (B) by fitting an external wire loop between terminals 1 and 4 on the X4 connector.

The polarity of the signal terminals is marked as A and B which is in line with the RS485 standard. When the bus

is in the idle state and no communication is taking place, the polarity of terminal A is more positive than that of terminal B. These terminals can be used to identify the polarity of any equipment to be connected, typically measured at each terminal in turn to earth. Figure 1-3 shows the connection of the device to a termination network at the end of the bus and suits the idle state.
The polarity marking is often found to be reversed or marked as ± on other equipment, so care is required. If the devices are connected in reverse, then communication to all devices is disturbed without any damage. If problems are experienced during commissioning, perform the connections in reverse. The maximum number of relays that can be connected to the bus is 32.
When using the RS485 interface, you must configure the following settings in the following settings on the COMMUNICATION menu:

Table 1-2 RS485 Interface (Com1)

Setting Name	Range/Options	Default	Setting	Notes
RS485–Protocol	OFF IEC60870–5–103 MOD BUS–RTU	MODBUS–RTU	–	The protocol is used to co mmunicate on the standard RS485 connec- tion.
RS485–Stn Addr	0 to 254 for IEC60870–5– 103 1 to 247 for MODBUS–RTU	1	–	To identify the relay, provid e an address within the ran ge of the relevant protocol. Each relay in a network mu st have a unique address.
RS485–Baud Ra te	1200 2400 4800 9600 19200 38400 57600	19200	–	The baud rate set on all the relays connected to the co ntrol system must be the same as the one set in acc ordance with the master de vice.
RS485–Parity	None Odd Even	None	–	The parity set on all the rel ays connected to the contr ol system must be the sam e as the one set in accorda nce with the master device.
RS485–Mode	Local Local or Remote Remote	Local or Remote	–	–



[dw_7SR45 typical RS485 connection, 2, en_US]

Figure 1-3 Communication to Multiple Devices using RS485 (Standard Port)

Modbus RTU

Protocol Characteristics

Description

This section describes the Modbus RTU protocol implementation in the 7SR45 Argus relay. The Modbus RTU protocol is used for communication with a suitable control system. The Modbus RTU protocol can be set to use any number of relay hardware interfaces (USB, RS485) where it is installed. The relay can communicate simultaneously on all ports regardless of the protocol used. To enable the communication, set the station address of the port used to a suitable address within a range of 1 to 247. You can set the station address using the xxxxx-Stn Addr setting under COMMUNICATION menu.

- **Protocol Structure**
  - **Modbus Registers**

    Modbus registers are 16-bit registers which do not have any standard for use. Multiple registers are used to hold a data value. This section describes the Modbus data types. If a data type occupies more than 1 register, it is required that the number of consecutive registers are reserved. For example, if a 2 register data point starts at 30101, then it is required that register 30102 is also reserved so that the next available register would be 30103. The following table shows the number of registers required for each data type.

Data Type	Registers Required
EVENTCOUNT	1
EVENT	8
FP_32BITS_3DP	2
UINT16	1
UINT32	2
STR32	16
STR64	32
TIME_METER	4

- **Data Types**
  - **EVENTCOUNT**

    A single register containing the number of event records stored.
  - **EVENT**

    Modbus does not define a method for extracting the events, therefore a private method has been defined based on that defined by in IEC 60870-5-103.

    The EVENTCOUNT register contains the current number of events in the relays operational log. The EVENT register contains the earliest event record available. The event record is 8 registers (16 bytes) of information and the format is described under Format , Page 21. When this record is read, then the event is replaced by the next available record. Event records must be read completely, therefore the quantity value must be set to 8 before reading.
    - **FP_32BITS_3DP**

      A real value transmitted as a 32-bit integer scaled and fixed point to 3 decimal places. For example, 123.456 would be sent as 123456.
    - **UINT16**

      A 16-bit integer.
    - **UINT32**

      A 32-bit integer.
    - **STR32**

      A 32 byte string.
    - **STR64**

      A 64 byte string.
    - **TIME_METER**

      Table 2-1 shows 4 register (8 byte) time meter formatted.

      Table 2-1 Fields in the Time Meter

Byte	Key	Description
0	ms L	Milliseconds low byte
1	ms H	Milliseconds high byte
2	Mi	Minutes (MSB = invalid, time not set > 23 h)
3	Ho	Hours (MSB – daylight saving time flag)
4	Da	Days
5	Mo	Months
6	Ye L	Years low byte
7	Ye H	Years high byte (If not used = 0)

- **Modbus Address**

  Each data type has an address between 0001 and 9999 with a single digit prefix defining the data type.

  0xxxx = Coils

  1xxxx = Inputs (Read only)

  3xxxx = Status registers (Read only)

  4xxxx = Holding registers

  The following example coils (0xxxx) are of requests and responses. If an invalid address is sent or the data is not available, an exception code is returned. The coils listed are read and written by functions 1 (Read coil status) and 5 (Write coil status) respectively. Use a Modbus command to write a coil. For example, closing a standard relay.

  Read coil status

- The Read coil status function returns an exception code 2 if any of the addresses in a range are invalid. The addresses listed with a (*) sign cannot be read (polled) as their value is indeterminable. They are listed as write-only coils for sending commands to the device.

  Write coil status

- The Write coil status function returns an exception code 2 if the address is invalid or if the command cannot be executed. Some addresses listed above are ON commands, rather than ON/OFF. Sending OFF to these addresses will also return exception code 2.

Modbus Register Data Types

1. **FLOAT_IEEE_754**

   The float data type conforms to the IEEE 754 floating-point definition. The float data type specifies that 32 bits of data is formatted as a sign bit in the most significant bit (MSB) followed by an 8-bit exponent then a 23-bit mantissa, down to the least significant bit (LSB).

MSB																													LSB
Sign	Exponent								Mantissa																				

2. **FP_32BITS_3DP**

   The FP_32BITS_3DP is a 32-bit integer fixed-point number containing 3 decimal places of information. It is used to send a real value to 3 decimal places as an integer. For example, if the value in a device is 123.456, it is sent as 123456. As it is an integer, negative numbers are sent as two's complement.

   - **FP_32BITS_3DP and MODBUS**

     In this Modbus implementation, the 32 bit value is stored in two 16-bit registers in big-endian format. For example, if you consider the hex representation of 123456, you have 1E240h. The following table shows how the registers 30001 and 30002 are stored.

     Table 2-2 FP_32BITS_3DP and Modbus

Address	Value
30001	1
30002	E240

3. **UINT32**

   The UINT32 is a signed 32-bit integer. As it is an integer, negative numbers are sent as two's complement.

   - **UINT32 & MODBUS**

     In this Modbus implementation, the 32 bit value is stored in two 16-bit registers in big-endian format. As an example, if you consider the hex representation of -123456, in two's complement, you have FFFE1DC0h. The following table shows how the registers 30001 and 30002 are stored.

Address	Value
30001	FFFE
30002	1DC0

4. **UINT16**

   The UINT16 is a signed 16-bit integer. As it is an integer, negative numbers are sent as two's complement.

   - **UINT16 & MODBUS**

     In this Modbus implementation, the 16-bit value is stored in a 16-bit register in big-endian format. For example, if you consider the hex representation of 5678, you have 162Eh.

     Table 2-3 UINT16 and Modbus

Address	Value
30001	162E

   - **Truncation**

     The calculations are performed as 32-bit value. The 16-bit value is the lowest 16 bits of the 32-bit value.

Therefore, when values overflow, the returned value is the lowest 16 bits of the calculated value. For example, if the value is 85400 = 14D98h, then the value returned would be the lowest 16 bits = 4D98h which equals 19864.

5. **EVENT**

Modbus does not define a method for extracting the events, therefore a private method has been defined based on IEC 60870-5-103. The EVENT register contains the earliest event record available. The following format describes the event record as 8 registers (16 bytes) of information. When this record is read, it is replaced with the next available record. Event records must be read completely, therefore the quantity value must be set to 8 before reading. A failure to read, results in an exception code 2. If no event record is present, then exception code 2 is returned. The master polls the EVENT register regularly. The EVENTCOUNT register can be checked periodically to determine how many events are stored.

- **Format**

  The format of the event record is defined by the 0 byte. It signifies the type of record which is used to decode the event indications. The 0 byte can be one of the following:

  Table 2-4 Format

Type	Description
1	Event
2	Event with relative time
4	Measurand event with relative time

  The following table describes the fields in the event record.

  Table 2-5 Event Record

Key	Description
FUN	Function type, as defined for IEC 60870-5-103
INF	Information number, as defined for IEC 60870-5-103
DPI	Measurand event with relative time, values: 1 = OFF 2 = ON
ms L	Time stamp in milliseconds low byte
ms H	Time stamp in milliseconds high byte
Mi	Time stamp in minutes (MSB = invalid, time not set > 23 h)
Ho	Time stamp in hours (MSB = Daylight saving time flag)
RT L	Relative time low byte
RT H	Relative time high byte
F# L	Fault number low byte

Key	Description
F# H	Fault number high byte
Meas	Measurand format R32.23, sent least significant byte first

The following tables show the fields in the different event records as they are returned:

Table 2-6 Event Type 1 Format

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	1	0	FUN	INF	DPI	0	0	0	0	0	0	0	ms L	ms H	Mi	Ho

Table 2-7 Event Type 2 Format

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	1	0	FUN	INF	DPI	RT L	RT H	F # L	F # H	0	0	0	ms L	ms H	Mi	Ho

Table 2-8 Event Type 4 Format

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	1	0	FUN	INF	Meas				0	0	0	0	msL	msH	Mi	Ho

6. **EVENTCOUNT**

   The EVENTCOUNT register contains the current number of events in the relays operational log. On reception, the register is intepreted as a 16-bit integer.

7. **TIME_METER**

   The TIME_METER register contains the devices time. The time is read or written in one step, therefore the quantity is 4 registers. The failure to read or write results in an exception code 2. The following table shows the time format is 8 bytes and describes the fields in the time.

   Table 2-9 Time Meter

Key	Description
ms L	Time stamp in milliseconds low byte
ms H	Time stamp in milliseconds high byte
Mi	Time stamp in minutes (MSB = invalid, time not set > 23 h)
Ho	Time stamp in hours (MSB = Daylight saving time flag)
Da	Time stamp in days
Mo	Time stamp in months
Ye L	Time stamp in years low byte
Ye H	Time stamp in years high byte (Not used)

   The following table shows the time fields as return.

   Table 2-10 Event Type 1 Format

Byte	0	1	2	3	4	5	6	7
Content	ms L	ms H	Mi	Ho	Da	Mo	Ye L	Ye H

8. **STR32 and STR64**

   - **BITSTRING**

     A bit string (or bit-array) is a method of compactly storing a number of bits of data. In this instance, you can store up to 16 bit values, for example the states of binary inputs in a single 16-bit register. The first bit value is stored in the least significant bit (LSB) of the register. The 16th value is stored in the most significant bit (MSB). The bit values can only be 0 or 1. Any unused bits are set to 0. In Modbus implementation, the 16-bit value is stored in a 16-bit register in big-endian format. For example, if the bits 1, 3, 9, and 12 are set, then the binary representation is 0000100100000101 giving a hex representation of 0905h.

The following table shows how the register 30001 is stored:

Table 2-11 Bit String

Address	Value
30001	0905

On reception, the register is intepreted in the correct order as a 16-bit integer.

9. **Points List**

- **Coils (Read/Write Binary Values)**

  The following table shows the default configuration. You can modify the default configuration using the Communications Configuration Editor tool.

  Table 2-12 Coils (Read/Write Binary Values)

Address	Description
00001	Binary output 1
00002	Binary output 2
00003	Binary output 31
00004	Binary output 41
00100	LED reset (write-only)
00101	Settings group 1
00102	Settings group 2
00155	Remote mode
00156	Out of Service mode
00157	Local mode
00158	Local and Remote mode
00216	Reset Thermal Level
00240	Battery data reset (write-only)

- **Inputs (Read-Only Binary Values)**

  Table 2-13 Inputs (Read-Only Binary Values)

Address	Description
10001	Binary input 1
10002	Binary input 2

Address	Description
10003	Binary input 32
10004	Binary input 42
10102	Remote mode
10103	Out of service mode
10104	Local mode
10105	Local or Remote mode
10112	A Starter
10113	B Starter
10114	C Starter
10115	General starter
10119	Start/pickup N
10122	51-1
10123	50-1
10124	51N-1
10125	50N-1
10126	51G-1
10127	50G-1
10129	50-2
10131	50N-2
10133	50G-2
10147	49 Alarm
10148	49 Trip
10290	General alarm 1
10291	General alarm 2
10292	General alarm 3
10293	General alarm 4

10335	81HBL2
10372	50LC
10390	Trip PhA
10391	Trip PhB
10392	Trip PhC
10601	LED 1
10602	LED 2
10603	LED 3
10604	LED 4
10605	LED 5
10606	LED 6
10607	LED 7
10608	LED 8
10609	LED 9
10800	Cold start
10801	Warm start
10802	Restart
10803	Power on
10804	Expected restart

Address	**Description**
10805	Unexpected restart
10975	Reclose inhibit
11120	Trip pulse output

- **Registers**

  Table 2-14 Registers

Address	**Name**	**Format**	**Multiplier**	**Description**

30001	Event Count	EVENTCOUNT	0	Events counter
30002	Event	EVENT	0	8 registers
30064	Phase A Primary Current	FP_32BITS_3DP	1	Ia A
30066	Phase B Primary Current	FP_32BITS_3DP	1	Ib A
30068	Phase C Primary Current	FP_32BITS_3DP	1	Ic A
30070	Phase A Secondary Current	FP_32BITS_3DP	1	Ia A
30072	Phase B Secondary Current	FP_32BITS_3DP	1	Ib A
30074	Phase C Secondary Current	FP_32BITS_3DP	1	Ic A
30076	Phase A RMS Current	FP_32BITS_3DP	1	Secondary Ia RMS A
30078	Phase B RMS Current	FP_32BITS_3DP	1	Secondary Ib RMS B
30080	Phase C RMS Current	FP_32BITS_3DP	1	Secondary Ic RMS C
30088	In Primary Current	FP_32BITS_3DP	1	In A
30090	In Secondary Current	FP_32BITS_3DP	1	In A
30094	Ig Primary Current	FP_32BITS_3DP	1	Ig A
30096	Ig Secondary Current	FP_32BITS_3DP	1	Ig A
30152	Thermal Level	UINT32	10	Thermal Level
30167	Fault Records	UINT16	1	Fault Records
30168	Event Records	UINT16	1	Event Records

30301	Ia Last Trip Current	FP_32BITS_3DP	1	Ia fault
30303	Ib Last Trip Current	FP_32BITS_3DP	1	Ib fault
30305	Ic Last Trip Current	FP_32BITS_3DP	1	Ic fault
30313	In Last Trip Current	FP_32BITS_3DP	1	In fault
30315	Ig Last Trip Current	FP_32BITS_3DP	1	Ig fault
30341	LED1-n	BITSTRING	0	LED 1 to 16 status
30343	INP1-n	BITSTRING	0	Input 1 to 16 status
30345	OUT1-n	BITSTRING	0	Output 1 to 16 status
30600	Device on battery power	UINT32	1	Device on battery power
30602	Backlight on battery power	UINT32	1	Backlight on battery power
30604	BO operations on battery power	UINT32	1	BO operations on battery power
30606	BI operations on battery power	UINT32	1	BI operations on battery power
30618	Last fault info	UINT32	1	Last fault latch information
30620	Last fault phase info	UINT16	1	Last fault phase latch information

The following registers 30618 and 30620 are explained in bitwise details:

Table 2-15 Register 30618

00															15
50-1	50-2	X	50N-1	50N-2	X	50G-1	50G-2	X	51-1	X	51N-1	X	51G-1	X	50LC
16															31
49	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2-16 Register 30620

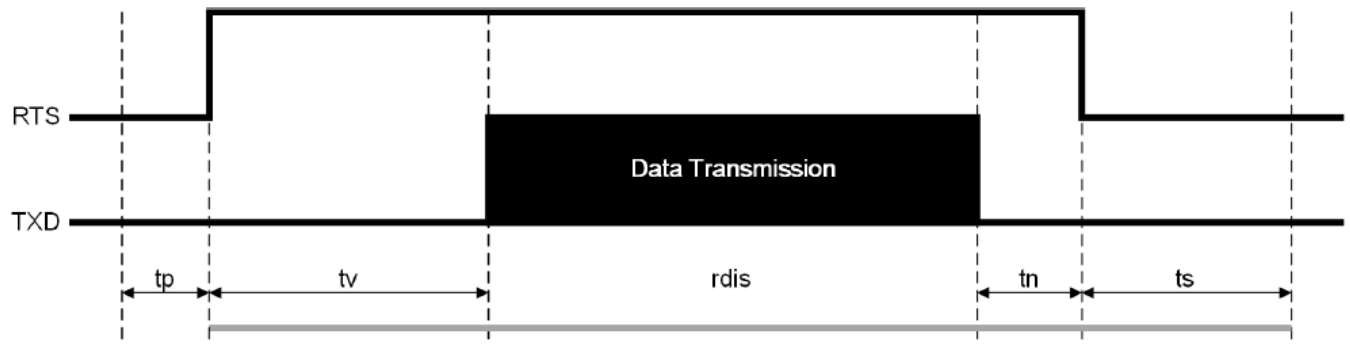
00														15
Ph-A	Ph-B	Ph-C	G	N	X	X	X	X	X	X	X	X	X	X

- **Holding Registers (Read/Write Registers)**

  Table 2-17 Holding Registers (Read/Write Registers)

Address	Name	Format	Multiplier	Description
40001	Time	TIME_METER	0.000000	Time

NOTE In the RTU mode, message frames are separated with a silent interval of at least 3.5 character times and the time interval is also called t3.5. The Modbus RTU master provides the t3.5 delay for responding to another query.
The following silent interval time equation is implemented in the 7SR45 Argus Relay:
t delay required = 11 bits · 3.5/b
Where,
b = baud rate in bit/s
tdelay for 7SR45 = tdelay required + 10 ms tolerance



[dw_time-setting_message-frame, 1, en_US]
Figure 2-1 Time Settings for Message Frame

tp = Pause time (pause before RTS = ON)
tv = Setup time (transmission delay after RTS = ON)
tn = Hold time (pause time after sending before RTS = OFF)
ts = Hold receiver disabled after RTS = OFF
rdis = Disable receiver when using half duplex protocol (Only active when ts = 0)

NOTE Only tp or ts must be equal to tdelay for the 7SR45 Argus Relay.

IEC 60870-5-103

Protocol Characteristics

Description

This section describes the IEC 60870-5-103 protocol implementation in the relays. The IEC 60870-5-103 protocol is used for the communication with the Reydisp Evolution software and can also be used for communication with a suitable control system. In the system, the control system or local PC acts as the master and the relay operating as a slave responds to the master commands. The implementation provides:

- Event message
- Time synchronization
- Commands
- Measurand
- Transfer of fault records

The IEC 60870-5-103 protocol can be used in any or all of the relays hardware interfaces (USB, RS485) where it is fitted. The USB interface uses the IEC 60870-5-103 protocol as the standard protocol. The relay can communicate simultaneously on all ports regardless of the protocol used. To enable communication, set the station address of the port being used to a suitable address within the range 0 to 254. You can set the station address using the xxxxx-Stn Addr setting under COMMUNICATION menu.

Application Service Data Unit (ASDU) Type

The following table lists the possible Application Service Data Unit (ASDU) of the Information Number and Function returned for a point.

Table 3-1 Application Service Data Unit Type

ASDU	Description
1	Time-tagged message (monitoring direction)
2	Time-tagged message (relative time; monitoring direction)
4	Time-tagged measurand with relative time
5	Identification message
6	Time synchronization
7	General-interrogation initialization
9	Measurands II
20	General command

Cause of Transmission

The cause of transmission (COT) column of the Information Number and Function table lists the possible causes of transmission for these frames.

Table 3-2 Cause of Transmission

Abbreviation	Description
SE	Spontaneous event
GI	General interrogation
Loc	Local operation

Abbreviation	Description
Rem	Remote operation
Ack	Command acknowledge
Nak	Negative command acknowledge

NOTE The events listing a GI cause of transmission can be raised and cleared and other events are raised only.

Point List
Event Function (FUN) & Information (INF) Numbers
The following table lists the data points available via the IEC 60870-5-103 protocol.

NOTE Not all the events are available on all the 7SR45 relay variants.

Table 3-3 Event Function (FUN) & Information (INF) Numbers

FUN	INF	Description	ASDU	COT
60	4	Remote mode	1	SE,GI
			20	Ack, Nak
60	5	Out of Service mode	1	SE,GI
			20	Ack, Nak
60	6	Local mode	1	SE,GI
			20	Ack, Nak
60	7	Local or Remote mode	1	SE,GI
			20	Ack, Nak
60	13	Command received	1	SE
60	128	Cold start	1	SE, GI
60	129	Warm start	1	SE, GI
60	130	Restart	1	SE, GI
60	131	Expected restart	1	SE, GI
60	132	Unexpected restart	1	SE, GI
60	137	Clear fault records	1	SE
60	138	Clear event records	1	SE
60	145	CT input	1	SE, GI
60	147	Aux input	1	SE, GI
60	149	IRF	1	SE, GI
60	153	Battery voltage low	1	GI
60	158	Battery voltage critical	1	GI
60	170	General alarm 1	1	SE, GI
60	171	General alarm 2	1	SE, GI
60	172	General alarm 3 3	1	SE, GI
60	173	General alarm 4 3	1	SE, GI

FUN	INF	Description	ASDU	COT
80	1	Binary output 1	1	SE,GI
			20	Ack, Nak
80	2	Binary output 2	1	SE,GI
			20	Ack, Nak
80	3	Binary output 3 3	1	SE,GI

			20	Ack, Nak
80	4	Binary output 4 3	1	SE,GI
			20	Ack, Nak
80	66	Trip pulse output	1	SE, GI
90	1	LED 1	1	GI
90	2	LED 2	1	GI
90	3	LED 3	1	GI
90	4	LED 4	1	GI
90	5	LED 5	1	GI
90	6	LED 6	1	GI
90	7	LED 7	1	GI
90	8	LED 8	1	GI
90	9	LED 9	1	GI
160	2	Reset FCB	5	SE
160	3	Reset CU	5	SE
160	4	Start/Restart	5	SE
160	5	Power on	1	SE, GI
160	19	LEDs reset (Reset flag and outputs)	1	SE
			20	Ack, Nak
160	22	Settings changed	1	SE
160	23	Settings group 1 select	1	SE, GI
			20	Ack, Nak
160	24	Settings group 2 select	1	SE, GI
			20	Ack, Nak
160	27	Binary input 1	1	SE, GI
160	28	Binary input 2	1	SE, GI
160	29	Binary input 3 3	1	SE, GI
160	30	Binary input 4 3	1	SE, GI
160	64	Start/pickup L1	2	SE, GI
160	65	Start/pickup L2	2	SE, GI
160	66	Start/pickup L3	2	SE, GI
160	67	Start/pickup N	2	SE, GI
160	69	Trip L1	2	SE, GI

160	70	Trip L2	2	SE, GI
160	71	Trip L3	2	SE, GI
160	84	General start/pickup	2	SE, GI
160	90	Trip I>	2	SE
160	91	Trip I>>	2	SE
160	92	Trip In>	2	SE
160	93	Trip In>>	2	SE
183	0	Data lost	1	SE

FUN	INF	Description	ASDU	COT
183	10	51-1	2	SE, GI
183	11	50-1	2	SE, GI
183	12	51N-1	2	SE, GI
183	13	50N-1	2	SE, GI
183	14	51G-1	2	SE, GI
183	15	50G-1	2	SE, GI
183	17	50-2	2	SE, GI
183	19	50N-2	2	SE, GI
183	21	50G-2	2	SE, GI
183	35	49 Alarm	2	SE, GI
183	36	49 Trip	2	SE, GI
183	96	81HBL2	1	SE, GI
183	225	50LC	2	SE, GI
183	239	In fault current	4	SE
183	240	Ia fault current	4	SE
183	241	Ib fault current	4	SE
183	242	Ic fault current	4	SE
183	243	Ig fault current	4	SE
185	107	Reclose inhibit	2	SE, GI
185	123	Reset thermal level	1	SE
			20	Ack, Nak
255	0	Time synchronization	6	Time synchronization
255	0	GI initiation	7	GI
255	0	End of GI	8	End of GI

NOTE For the list of events raised, refer to A.2 Events Raised.

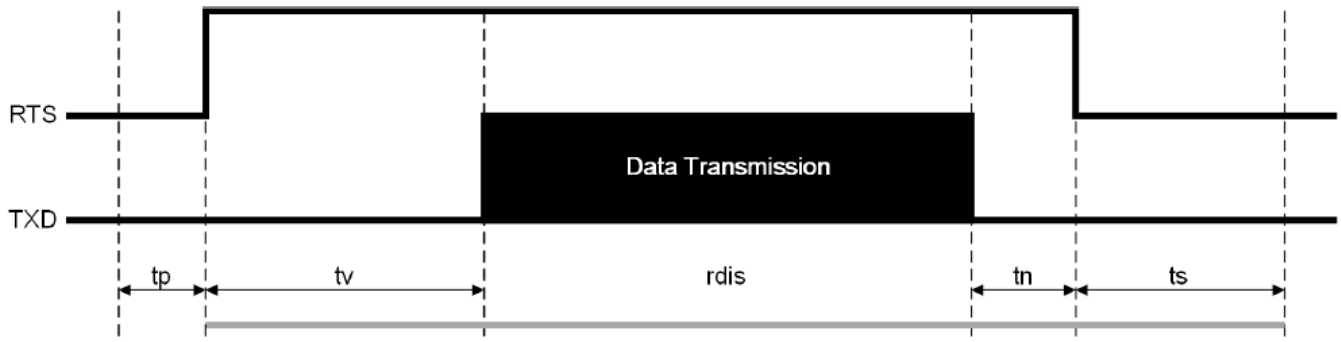
Measurands

The following measurands and INF numbers apply to the 7SR45 Argus Relay.

Table 3-4 Measurands

FUN	INF	Description	ASDU	COT
183	148	Measurand IL1, 2, 3 — IL1 (2.4x) IL2 (2.4x) IL3 (2.4x)	9	Cyclic – refresh rate 5 s

NOTE In the IEC 60870-5-103, message frames are separated with a silent interval of at least 3.5 character times and the time interval is also called t3.5. The IEC 60870-5-103 master provides the t3.5 delay for responding to another query.
The following silent interval time equation is implemented in the 7SR45 Argus Relay:
t delay required = 11 bits · 3.5/b
Where
b = baud rate in bit/s
tdelay for 7SR45 = tdelay required + 10 ms tolerance



[dw_time-setting_message-frame, 1, en_US]
Figure 3-1 Time Settings for Message Frame

tp = Pause time (pause before RTS = ON)
tv = Setup time (transmission delay after RTS = ON)
tn = Hold time (pause time after sending before RTS = tOFF)
ts = Hold receiver disabled after RTS = OFF
rdis = Disable receiver when using half duplex protocol (Only active when ts = 0)

Troubleshooting

- **Relays do not communicate in a multi-drop network**
  - Siemens recommends proceeding as follows:
    - Check that all relays are powered up with auxiliary power supply.
    - Check the polarity of rear communication terminal and connection.
    - Check that all relays have unique addresses.
    - Check if RS485 terminating resistor is required and in circuit.
- **Cannot communicate with the relay through Reydisp Evolution**
  - Siemens recommends proceeding as follows:
    - Check the communication cable is connected properly.
    - Check that the USB driver is installed correctly.

- In Reydisp Evolution, verify that Do NOT Check Communications Connection is selected in the Advanced properties.
- In Reydisp Evolution, check that the relay address is set as 1 in the Relay menu.
- Ensure that IEC 60870-5-103 is specified for the connected port (COM1 or COM2).

Appendix

Operating Mode
The 7SR45 Argus relay has 4 operating modes:

- Local
- Remote
- Local or Remote
- Out of service

The following table identifies the operation of the function in each mode. You can select the modes in the following methods:
SETTING MODE > SYSTEM CONFIG > Operating Mode, a binary input, or command through rear/front communication protocols.

Table A-1 Operating Mode

Operation Control	Remote Mode	Local Mode	Out of Service Mode
USB/Rear ports set to REMOTE4	Enabled	Disabled	Disabled
USB/Rear ports set to LOCAL4	Disabled	Enabled	Disabled
USB/Rear ports set to LOCAL or REMOTE4	Enabled	Enabled	Disabled
Binary inputs	Enabled	Enabled	Enabled
Binary outputs	Enabled	Enabled	Disabled
Reporting			
Spontaneous			
IEC60870-5-103	Enabled	Enabled	Disabled
General interrogation			
IEC60870-5-103	Enabled	Enabled	Disabled
MODBUS-RTU	Enabled	Enabled	Enabled
Change of settings			
USB/Rear ports set to REMOTE 4	Enabled	Disabled	Enabled
USB/Rear ports set to LOCAL 4	Disabled	Enabled	Enabled
USB/Rear ports set to LOCAL or REMOTE4	Enabled	Enabled	Enabled
Fascia	Enabled	Enabled	Enabled
Historical Information			
Event records	Enabled	Enabled	Enabled
Fault information	Enabled	Enabled	Enabled
Setting information	Enabled	Enabled	Enabled

The communication port modes can be selected at: SETTING MODE > COMMUNICATION.

Events Raised

- **Cold Start Raised**

  The cold start event is raised for any setting conditions in the absence of main battery.
- **Warm Start Raised**

  The warm start event is raised when the device goes from the sleep mode to wake-up mode.
- **Restart**

  The restart event is raised whenever any of the following event occurs:

- Expected restart
- Unexpected restart
- Cold start

- **Expected Restart**

  The expected restart event is raised when an expected restart occurs.
- **Unexpected Restart**

  The unexpected restart event is raised when an unexpected restart occurs. Both the expected and unexpected restart cannot occur at the same time.
- **Power on**

  The power on event is raised when the battery is discharged completely.

Revision History
Software Revision History:

2020/09	2438H80001R2f-1b	Software maintenance
2020/08	2438H80001R2f-1a	• Protection function 51-1 setting range change to 0.1 · Irated to 2.0 · Irated • User-Programmable LED feature added
2020/05	2438H80001R2e-1b	Software maintenance
2019/12	2438H80001R2e-1a	Thermal overload protection function (49) added
2019/05	2438H80001R2c-1b	Software maintenance to suit customer requirements
2018/11	2438H80001R2c-1a	Supervision function (81HBL2) added
2018/06	2438H80001R1f-1a	Third Release
2018/06	2438H80001R2b-1b	Third Release
2018/04	2438H80001R2a-1a	Second Release
2017/08	2438H80001R1e-1a	Software maintenance to suit customer requirements

2017/01	2438H80001R1d-1a	• Protection function 50, 50N, 50G setting range change to 0.2 · Irated to 20 · Irated in step of 0.1 · Irated • Protection function 50, 50N, 50G reset ratio changed to 90 % for setting below 1 · Irated and 94 % for setting above 1 · Irated
2016/10	2438H80001R1c-1a	Software maintenance to suit customer requirements
2016/09	2438H80001R1b-1a	• Faster response times on 1 phase (t + 100 ms max) in 0.2 to 0.3 ranges. • IRF functionality.
2015/08	2438H80001R1a-1a	First Release

Hardware Revision History:

2021/11	7SR450/HH	V1 obsolete and UL certified
2020/09	7SR450/GG	Fourth Release (with conformal coating PCBA)
2018/06	7SR450/FF	Third Release (with reduced front cover and housing height)
2018/04	7SR450/EE	Second Release (with Aux. Power supply, remote flag and local flag, RS 485, additional AC/DC BIs and BOs)
2017/02	7SR450/DD	Hardware maintenance
2016/09	7SR450/CC	Circuit changes to improve signal conditioning
2015/08	7SR450/BB	First Release

Software and Hardware Versions Compatibility
Table A-2 Software Compatibility for MLFB Variants 7SR450[1/3]-[1/2]GA10-1AA0

Software Version	Hardware Version					
	7SR4501/BB	7SR4501/CC	7SR4501/DD	7SR4501/EE	7SR450[1/3]/FF	7SR450[1/3]/GG
2438H80001R1a-1a	■					
2438H80001R1b-1a	■	■	■	■		
2438H80001R1c-1a	■	■	■	■		
2438H80001R1d-1a	■	■	■	■		
2438H80001R1e-1a	■	■	■	■		
2438H80001R1f-1a			■	■	■	■

Table A-3 Software Compatibility for MLFB Variants: 7SR450[1/2/3/4]-[1/2][H/J][A/B]20-1A[A/B]0, 7SR450[1/2/3/4]-[1/2][H/J][A/B]20-1A[A/B]0

Software Version	Hardware Version			
	7SR450[1/2]/EE	7SR450[1/2/3/4]/FF	7SR450[1/2/3/4]/GG	7SR450[1/2/3/4]/HH
2438H80001R2a-1a	■			
2438H80001R2b-1b	■	■		
2438H80001R2c-1a	■	■		
2438H80001R2c-1b	■	■		
2438H80001R2e-1a	■	■		
2438H80001R2e-1b	■	■		
2438H80001R2f-1a	■	■		
2438H80001R2f-1b	■	■	■	■

NOTE The firmware for the MLFB 7SR450[1/3]-[1/2]GA10-1AA0 is migrated from the R1x series to R2x series from the HH hardware. The firmware series are not interchangeable and Siemens recommends to follow the guidelines mentioned in the Table A-2 and Table A-3.

Glossary

- **Baud rate**

  Data transmission speed.
- **Bit**

  The smallest measure of computer data.
- **Bits per second (Bit/s)**

  Measurement of data transmission speed.

- **Data bits**

  Several bits containing the data. Sent after the start bit.
- **Parity**

  Method of error checking by counting the value of the bits in a sequence and adding a parity bit to make the outcome. For example, even.
- **Parity bit**

  Bit used for implementing parity checking. Sent after the data bits.
- **RS485**

  Serial Communications Standard. Electronic Industries Association Recommended Standard Number 485.
- **Start bit**

  Bit (logical 0) sent to signify the start of a byte during data transmission.
- **Stop bit**

  Bit (logical 1) sent to signify the end.
- **USB**

  Universal Serial Bus standard for the transfer of data.

Disclaimer of Liability

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Edition: 11.2021
Version of the product described: V03.00

Documents / Resources

	SIEMENS 7SR45 Communication Protocol [pdf] User Manual 7SR45 Communication Protocol, 7SR45, Communication Protocol

References

- /index.html
- Training and consulting for power transmission & distribution - Energy automation and smart grid - Global
- Protection relays for digital substation - Energy automation and smart grid - Global