RTC48 Communication Quick Start Guide

03/2013

Safety Information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, or maintain it.
The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

⚠ CAUTION

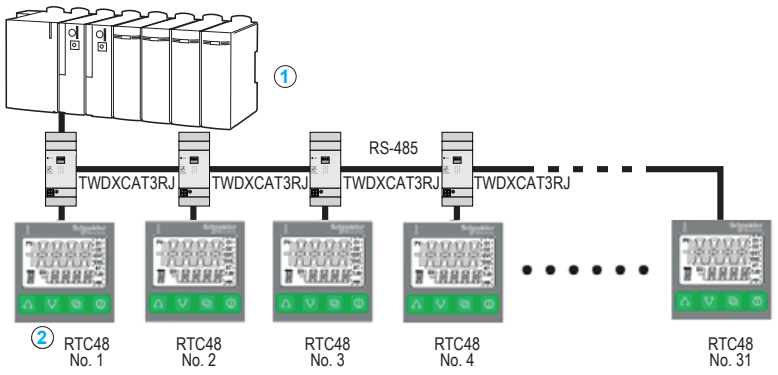
CAUTION indicates a potentially hazardous situation, which, if not avoided, can result in injury or equipment damage.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material. This document is not intended as an instruction manual for untrained persons.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

1. Integration in a Network (Serial Communication)



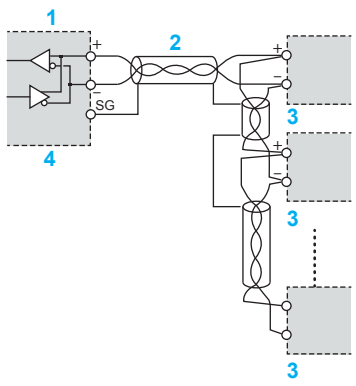
Item	Name
1	Programmable logic controller
2	RTC48 Temperature controller (Can connect up to 31 RTC48 units in serial communication (Modbus))

Tap junction box (Line end adapter and Line Pre-polarisation)

The tap junction box TWDXCAT3RJ (sold separately) has a built-in line end adapter (RC 120 Ω, 1 nF). The junction box is Din Rail Mounting. This junction box is for easy set up of RJ45 terminal and for line end termination.

Step	Action
1	Connect the coaxial cable on the port L1 of the Modbus TAP (TWDXCAT3RJ) junction. The port L2 is used to connect the temperature controller. The port L3 is used to connect the port L1 of the second Modbus TAP junction. Use the switches of the tap configure the end line impedance and polarization.
2	Repeat the above step for each device.
3	Use the switches of the TAP as integrated end line of the device for the end line of the last device.

2. Wiring



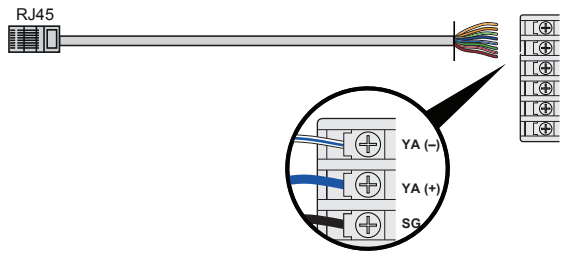
1 Master
2 Shielded twist per cable
3 Zelio Temperature Controller
4 RS485 Interface

2.1 Shielded wire

If both sides of the shielded wire are connected to the SG terminal, the circuit is closed between the shielded wire and the ground. As a result, current will run through the shielded wire and this may cause noise. Be sure to ground the SG terminal.

⚠ CAUTION

UNINTENDED EQUIPMENT OPERATION
Connect only 1 side of the shielded wire (TWDXCAFJ010) to the Shielding Ground (SG) terminal so that current cannot flow to the shielded wire.
Failure to follow this instruction can result in equipment damage.



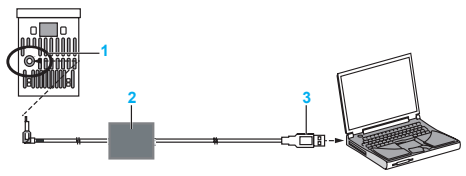
Controller	Terminal block pin		
	YA (-)	YB (+)	SG
RTC48	16	17	18

2.2 Specifications

Specifications	Description
Cable length	1.2 km (maximum) Cable resistance: 50 Ω or less (terminators are not necessary, but if used, use 120 Ω or more on one side.)
Communication line	EIA RS485
Communication method	Half-duplex communication
Communication speed	9600 bps (2400, 4800, 19200 bps) selectable by keypad
Synchronization method	Start-stop synchronization
Code	ASCII, Hexadecimal value
Error correction	LRC (Modbus ASCII), CRC-16 (Modbus RTU)

3. Configuration with PC (Console communication)

RTC48 bottom view

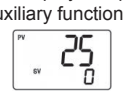
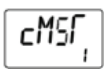


Item	Name
1	RTC48 console port
2	RTCCBL communication cable
3	PC USB port

Note: Console communication only allows 1 temperature controller to be connected at a time.

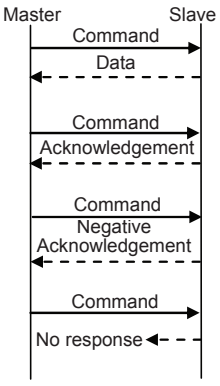
4. Parameters Setting Procedure

The following proceduce explains how to change the settings of each communication parameter.

Step	Action	Remarks
1	Press the key for approx. 3 seconds while pressing the key in the PV/SV display mode.	The display unit proceeds to Auxiliary function setting mode. 
2	Press the key twice.	The display unit proceeds to Communication protocol selection. 
3	Use the keys to set the following communication protocol: PRTC : RTC protocol (Default) ModA : Modbus ASCII mode ModR : Modbus RTU mode.	
4	Press the key, then use the keys to set the instrument number of the controller individually when communicating by connecting plural instruments. 0...95 (Default: 0).	
5	Press the key to confirm the setting.	–
6	Use the keys to set the communication speed equal to that of the host computer. □□24 : 2400 bps □□48 : 4800 bps □□96 : 9600 bps □192 : 19200 bps (Default)	
7	Press the key, then use the keys to set the data bit and parity. 8NoN : 8 bits/No parity 7NoN : 7 bits/No parity 8EVN : 8 bits/Even (Default) 7EVN : 7 bits/Even 8odd : 8 bits/Odd 7odd : 7 bits/Odd	
8	Press the key, then use the keys to set the stop bit. □□□1 : 1 (Default) □□□2 : 2	
9	Press the key to confirm the setting and to return to PV/SV display mode.	–

5. Communication procedure

Communication starts with command transmission from the host computer (Master) and ends with the response of the RTC48 (Slave).



- **Response with data**
  When the master sends the reading command, the slave responds with the corresponding set value or current status.
- **Acknowledgement**
  When the master sends the setting command, the slave responds by sending the acknowledgement after the processing is terminated.
- **Negative acknowledgement**
  When the master sends non-existent command or value out of the setting range, the slave returns the negative acknowledgement.
- **No response**
  The slave does not respond to the master in the following cases:
  - Global address, Broadcast address (Modbus protocol) is set.
  - Communication error (framing error, parity error)
  - Checksum error (RTC48 protocol)
  - LRC discrepancy (Modbus ASCII mode)
  - CRC-16 discrepancy (Modbus RTU mode)

5.1 RS-485 communication timing

Master side (Notice on programming)

Set the program so that the master can disconnect the transmitter from the communication line within a 1 character transmission period after sending the command in preparation for reception of the response from the slave.

To avoid the collision of transmissions between the master and the slave, send the next command after carefully checking that the master received the response.

Slave side

When the slave starts transmission through the RS-485 communication line, the slave is arranged so as to provide an idle status (mark status) transmission period of 1 or more characters before sending the response to ensure the synchronization on the receiving side.

The slave is arranged so as to disconnect the transmitter from the communication line within a 1 character transmission period after sending the response.

6. Modbus protocol

6.1 Transmission mode

There are 2 transmission modes (ASCII and RTU) in Modbus protocol.

6.2 ASCII mode

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.

Data format	Start bit	: 1 bit
	Data bit	: 7 bits
	Parity	: Even (No parity/Odd), Selectable
	Stop bit	: 1 bit (2 bits), Selectable
	Error detection	: LRC (Longitudinal Redundancy Check)
	Data interval	: 1 second or less

(1) Message configuration

ASCII mode message is configured to start by Header [: (colon)(3AH)] and end by Delimiter [CR (carriage return) (0DH) + LF (Line feed)(0AH)].

Header (:)	Salve address	Function code	Data	Error check LRC	Delimiter (CR)	Delimiter (LF)

Slave address

Slave address is an individual instrument number on the slave side and is set within the range 0 to 95 (00H to 5FH). The master identifies slaves by the slave address of the requested message.
The slave informs the master which slave is responding to the master by placing its own address in the response message. Slave address 0 (00H, broadcast address) can identify all the slaves. However slaves do not respond.

Function code
The function code is the command code for the slave to undertake the following action types.

Function code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.
When acknowledgement is returned, the slave simply returns the original function code. When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.
For example, when the master sends request message setting 10H to the function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.
For negative acknowledgement, the exception codes below are set to the data of response message and returned to the master in order to inform it of what kind of error has occurred.

Exception Code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	RTC48 error code 4 (Staus unable to be set, for example, AT is performing)
18 (12H)	RTC48 error code 5 (During setting mode by keypad operation)

Data
Data depends on the function code.
A request message from the master is composed of data item, number of data and setting data.
A response message from the slave is composed of number of bytes, data, and exception code in negative acknowledgements.
The number of data to be dealt with in one message is “1”. Therefore, the number of data is fixed as (30H) (30H) (30H) (31H).
Effective range of data is -32768 to 32767 (8000H to 7FFFH).
Error check : 2-character data to detect communication errors.
Refer to (2) Error check of ASCII mode below.
(2) Error check of ASCII mode
After calculating LRC (Longitudinal Redundancy Check) from the slave address to the end of data, the calculated 8-bit data is converted to two ASCII characters and are appended to the end of message.

How to calculate LRC

Step	Action
1	Create a message in RTU mode.
2	Add all the values from the slave address to the end of data. This is assumed as X.
3	Make a complement for X (bit reverse). This is assumed as X.
4	Add a value of 1 to X. This is assumed as X.
5	Set X as an LRC to the end of the message.
6	Convert the whole message to ASCII characters.

6.3 RTU mode
8-bit binary data in command is transmitted as it is.
Data format Start bit : 1 bit
Data bit : 8 bits
Parity : Even parity (default), No parity, and Odd parity (Selectable)
Stop bit : 1 bit (2 bits), Selectable
Error detection : CRC-16 (Cyclic Redundancy Check)
Data interval : 3.5 characters transmission time or less

(1) Message configuration
RTU mode is configured to start after idle time is processed for more than 3.5 character transmissions and end after idle time is processed for more than 3.5 character transmissions.

3.5 idle characters	Salve address	Function code	Data	Error check CRC-16	3.5 idle characters

Slave address : The same as that of ASCII mode.
Function code : The same as that of ASCII mode.
Data : Data depends on the function code.
A request message from the master is composed of data item, number of data and setting data.
A response message from the slave is composed of number of bytes, data and exception codes in negative acknowledgement.
The number of data to be dealt with in one message is “1”. Therefore the number of data is fixed as 0001H. The number of response byte is 02H.
Effective range of data is -32768 to 32767 (8000H to 7FFFH).
Error check : 16-bit data to detect communication errors. Refer to (2) Error check of RTU mode.

(2) Error check of RTU mode
After calculating CRC-16 (Cyclic Redundancy Check) from the slave address to the end of data, the calculated 16-bit data is appended to the end of message in sequence from low order to high order.

How to calculate CRC-16
In the CRC-16 system, the information is divided by polynomial series. The remainder is added to the end of the information and transmitted. The generation of polynomial series is as follows. (Generation of polynomial series: $X^{16} + X^{15} + X^2 + 1$) :

Step	Action
1	Initialize the CRC-16 data (assumed as X) (FFFFH).
2	Calculate exclusive OR (XOR) with the 1st data and X. This is assumed as X.
3	Shift X one bit to the right. This is assumed as X.
4	When a carry is generated as a result of the shift, XOR is calculated by X of 3 and the fixed value (A001H). This is assumed as X. If a carry is not generated, go to step 5.
5	Repeat steps 3 and 4 until shifting 8 times.
6	XOR is calculated with the next data and X. This is assumed as X.
7	Repeat steps 3 to 5.
8	Repeat steps 3 to 5 up to the last data.
9	Set X as CRC-16 to the end of the message in sequence from low order to high order.

7. Data Address Mapping

Modbus Function Code	Parameter Names	Description	Relative Address	Holding Register	Setting Range
03H/06H	SV	SV	0001H	40002	Set value, Decimal point ignored
03H/06H	AT	AT/Auto-reset	0003H	40004	0000H: Cancel 0001H: Perform
03H/06H	P	OUT1 proportional band	0004H	40005	0...1000 °C (32...1832 °F) Decimal point ignored
03H/06H	P2	OUT2 proportional band	0005H	40006	0...1000 °C (32...1832 °F) Decimal point ignored
03H/06H	I	Integral time	0006H	40007	0...1000
03H/06H	d	Derivative time	0007H	40008	0...300
03H/06H	c	OUT1 proportional cycle	0008H	40009	1...120
03H/06H	c2	OUT2 proportional cycle	0009H	40010	1...120
03H/06H	A1	Alarm 1 value	000BH	40012	Set value, Decimal point ignored
03H/06H	A2	Alarm 2 value	000CH	40013	Set value, Decimal point ignored
03H/06H	LocK	Set value lock	0012H	40019	0000H: Unlock 0002H: Lock 2 0001H: Lock 1 0003H: Lock 3
03H/06H	So	Sensor correction	0015H	40022	-100.0...100.0 °C Vdc voltage, current input: -1000...1000
03H/06H	db	Overlap/Dead band	0016H	40023	-100.0...100.0 °C Vdc voltage, current input: -1000...1000
03H/06H	STLH	Scaling high limit	0018H	40025	-2000...10000 °C, Decimal point ignored
03H/06H	STLL	Scaling low limit	0019H	40026	-2000...10000 °C, Decimal point ignored
03H/06H	dP	Decimal point place	001AH	40027	0000H: xxxx 0002H: xx.xx 0001H: xxx.x 0003H: x.xxx
03H/06H	FILT	PV filter time constant	001BH	40028	0.0...10.0 s, Decimal point ignored

Modbus Function Code	Parameter Names	Description	Relative Address	Holding Register	Setting Range
03H/06H	oLH	OUT1 high limit	001CH	40029	OUT1 low limit value...100%
03H/06H	oLL	OUT1 low limit	001DH	40030	0...OUT1 low limit value %
03H/06H	HYS	OUT1 ON/OFF hysteresis	001EH	40031	0.1...100.0 °C, Vdc voltage 1...1000, current input, Decimal point ignored
03H/06H	cAcT	OUT2 cooling mode	001FH	40032	0000H: Air cooling 0001H: Oil cooling 0002H: Water cooling
03H/06H	oLH2	OUT2 high limit	0020H	40033	OUT2 low limit value...100%
03H/06H	oLL2	OUT2 low limit	0021H	40034	0...OUT2 low limit value %
03H/06H	HYSb	OUT2 ON/OFF hysteresis	0022H	40035	0.1...100.0 °C, Vdc voltage 1...1000, current input, Decimal point ignored
03H/06H	AL1T	Alarm 1 type	0023H	40036	0000H: No alarm action 0001H: High limit alarm 0002H: Low limit alarm 0003H: H/L limits alarm 0004H: H/L limit range 0005H: Process high alarm 0006H: Process low alarm 0007H: High limit w/standby 0008H: Low limit w/standby 0009H: H/L limits w/standby
03H/06H	AL2T	Alarm 2 type	0024H	40037	The same as Alarm 1 type
03H/06H	A1HY	Alarm 1 hysteresis	0025H	40038	0.1...100.0 °C, Vdc voltage 1...1000, current input, Decimal point ignored
03H/06H	A2HY	Alarm 2 hysteresis	0026H	40039	0.1...100.0 °C, Vdc voltage 1...1000, current input, Decimal point ignored
03H/06H	A1dY	Alarm 1 delay time	0029H	40042	0...10000 s
03H/06H	A2dY	Alarm 2 delay time	002AH	40043	0...10000 s
03H/06H	PSV	Indication when output OFF	0032H	40051	0000H: OFF indication 0001H: No indication 0002H: PV indication 0003H: PV+ Alarm action
03H/06H	RATU	SV rise rate	0033H	40052	Set value, Decimal point ignored
03H/06H	RATd	SV fall rate	0034H	40053	Set value, Decimal point ignored
03H/06H	dIIN	Control OUT/OFF function	0037H	40056	0000H: Control output ON 0001H: Control output OFF
03H/06H	MANU	Auto/Manual control	0038H	40057	0000H: Automatic control 0001H: Manual control
03H/06H	-	Manual control MV	0039H	40058	Set value
03H/06H	A1LM	Alarm 1 Energized/ De-energized	0040H	40065	0000H: Energized 0001H: De-energized
03H/06H	A2LM	Alarm 2 Energized/ De-energized	0041H	40066	0000H: Energized 0001H: De-energized

Modbus function code	Parameter Names	Description	Relative Address	Holding Register	Setting Range
03H/06H	SENS	Input type	0044H	40069	0000H: K -200...1370 °C 0001H: K -200.0...400.0 °C 0002H: J -200...1000 °C 0003H: R 0...1760 °C 0004H: S 0...1760 °C 0005H: B 0...1820 °C 0006H: E -200...800 °C 0007H: T -200.0...400.0 °C 0008H: N -200...1300 °C 0009H: PL-Ⅱ 0...1390 °C 000AH: C(W/Re5-26) 0...2315 °C 000BH: Pt100 -200.0...850.0 °C 000CH: JPt100 -200.0...500.0 °C 000DH: Pt100 -200...850 °C 000EH: JPt100 -200...500 °C 000FH: K -320...2500 °F 0010H: K -320.0...750.0 °F 0011H: J -320...1800 °F 0012H: R 0...3200 °F 0013H: S 0...3200 °F 0014H: B 0...3300 °F 0015H: E -320...1500 °F 0016H: T -320.0...750.0 °F 0017H: N -320...2300°F 0018H: PL-Ⅱ 0...2500°F 0019H: C(W/Re5-26) 0 to 4200 °F 001AH: Pt100 -320.0...1500.0 °F 001BH: JPt100 -320.0...900.0 °F 001CH: Pt100 -320...1500 °F 001DH: JPt100 -320...900 °F 001EH: 4...20 mA -2000...10000 001FH: 0...20 mA -2000...10000 0020H: 0...1 V -2000...10000 0021H: 0...5 V -2000...10000 0022H: 1...5 V -2000...10000 0023H: 0...10 V -2000...10000
03H/06H	coNT	Direct/Reverse action	0045H	40070	0000H: Reverse action 0001H: Direct action
03H/06H	AT_b	AT bias	0047H	40072	Set value
03H/06H	ARW	ARW	0048H	40073	Set value
03H/06H	oRAT	OUT1 rate-of-change	004AH	40075	0...100
03H/06H	dPTM	Backlight	0050H	40081	0000H: All are backlit 0001H: PV display backlit 0002H: SV display backlit 0003H: Action indicators backlit 0004H: PV+SV displays backlit 0005H: PV+Action indicators backlit 0006H: SV+Action indicators backlit
03H/06H	coLR	PV color	0051H	40082	0000H: Green 0001H: Red 0002H: Orange 0003H: When Alarm ON: Green → Red 0004H: When Alarm ON: Orange → Red 0005H: PV continuous change 0006H: PV continuous change+ Alarm ON, Red
03H/06H	cLRG	PV color range	0052H	40083	Set value, Decimal point ignored
03H/06H	dPTM	Backlight time	0053H	40084	0...99
06H	-	Key operation change flag clearing	0070H	40113	0000H: No action 0001H: Clear all
03H	-	PV (Process Variable)	0080H	40129	Current PV (Process variable), Decimal point ignored
03H	-	OUT1 MV	0081H	40130	OUT1 MV, Decimal point ignored
03H	-	OUT2 MV	0082H	40131	OUT2 MV, Decimal point ignored
03H	-	SV (When SV rises or falls)	0083H	40132	Current SV (Desired value), Decimal point ignored
03H	-	Status flag	0085H	40134	2^0 : OUT1 0: OFF, 1: ON (DC current output: Not fixed) 2^1 : OUT2 0: OFF, 1: ON 2^2 : Alarm 1 output 0: OFF, 1: ON 2^3 : Alarm 2 output 0: OFF, 1: ON 2^6 : Heater burnout alarm output 0: OFF, 1: ON (When sensor burnout, 0: OFF) 2^8 : Overscale 0: OFF, 1: ON 2^9 : Underscale 0: OFF, 1: ON 2^{10} : Control output OUT/OFF 0: ON, 1: OFF 2^{11} : During AT/Auto-reset 0: OFF, 1: During AT/Auto-reset 2^{12} : OUT/OFF key function 0: OUT/OFF function 1: Auto/Manual control 2^{14} : Auto/Manual control 0: Auto, 1: Manual 2^{15} : Change in key operation 0: No, 1: Yes 2^4, 2^5, 2^7, 2^{13} Not used, Always 0