

SIO-RTD MANUAL

INPUT MODULE

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Revision 2



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1. FEATURES

- Eight inputs per module
- Individually selectable RTD types (Pt100, Ni100, Ni120, Cu10) and 4-20 mA inputs
- Solid-state multiplexing
- Up to sixty three modules, 504 inputs, per network
- Remote operation up to 1.2 km (4,000')
- Powered by user-supplied 24-Vdc power supply
- Industry-standard Modbus® RTU communications protocol
- Selectable notch filter for noise rejection

2. DESCRIPTION

The SIO-RTD Input Module is a microprocessor-based data-acquisition system for measuring temperatures and monitoring 4-20-mA analog-output devices in industrial environments. It uses resistance temperature detectors

(RTD's) as sensors and it provides the necessary calibration for accurate readings throughout the temperature range specified.

The SIO-RTD Input Module contains a microprocessor, A/D converter, and analog multiplexers to monitor up to eight inputs. The measuring circuits are isolated from the Modbus network and each input is scanned every second. RTD linearization, open/short detection, and lead compensation are performed by the SIO-RTD module. RTD-temperature and 4-20-mA data is transmitted to the Modbus master for further processing.

SIO-RTD modules communicate on a two-wire multiplex RS/EIA/TIA-485 network using the Modbus® RTU communications protocol.

3. INSTALLATION

Outline and mounting details for the SIO-RTD Input Module are shown in Fig. 1. The SIO-RTD can be surface or DIN-rail mounted.

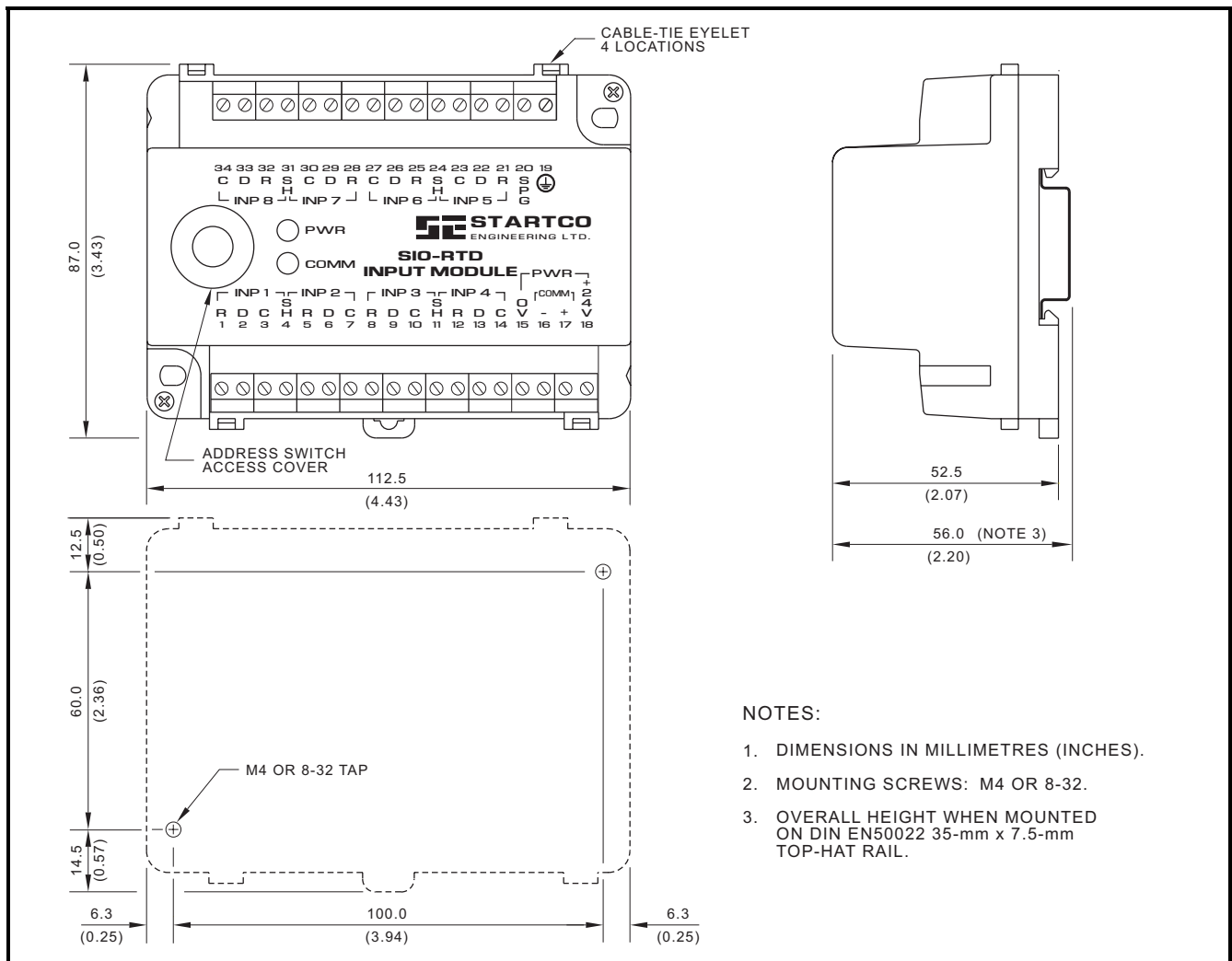


FIGURE 1. SIO-RTD Outline and Mounting Details.

4. CONNECTIONS

Connect up to sixty-three SIO-RTD modules to a Modbus system or a personal computer (PC) using shielded cable (Belden 3124A or equivalent) as shown in Fig. 2. The 24 Vdc supply for the SIO-RTD modules must be supplied by the user. See Technical Specifications Section 6 to determine the ratings of the required power supply. If the SIO-RTD's are connected to a PC, a TIA-485-to-232 converter is required. A Startco SE-485-DIN converter can be used. Overall communications-line length must not exceed 1.2 km (4,000').

For line lengths exceeding 10 m (33'), 150 Ω terminations are required at the cable ends.

Connect RTD's and 4-20-mA outputs to an SIO-RTD module as shown in Fig. 3. Input 1 must be used. Input lead shielding may not be required for short input leads. SIO-RTD terminal blocks accept 24 to 12 AWG (0.2 to 2.5 mm²)

Connect surge-protection (SPG) terminal 20 to terminal 19 (⊕) and ground terminal 19.

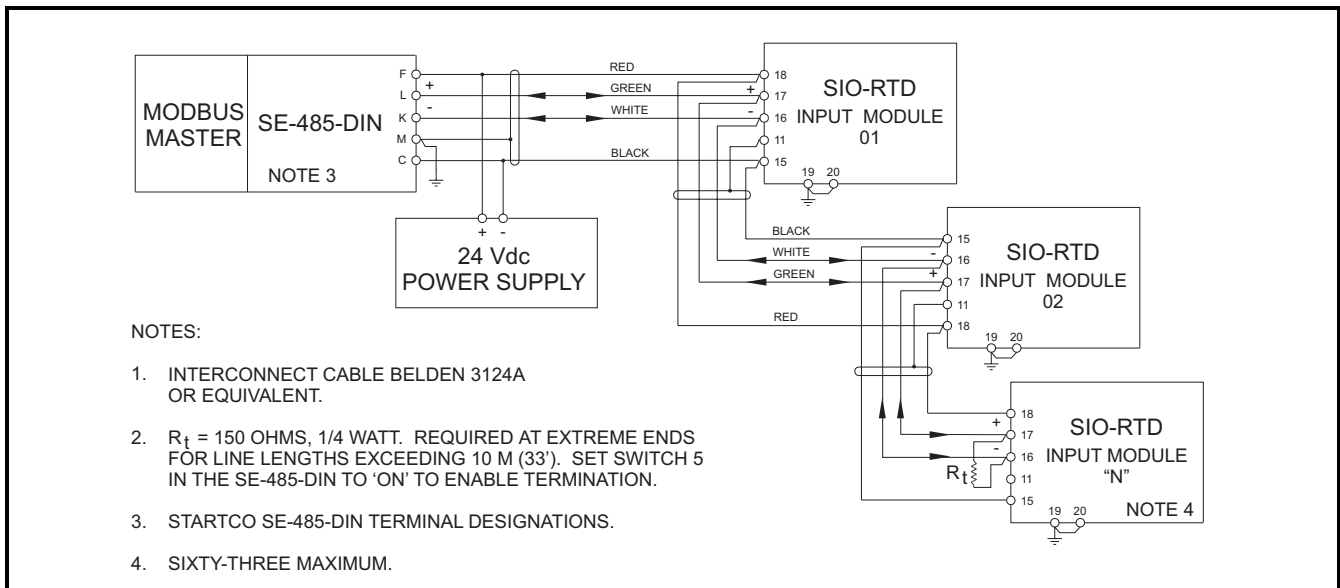


FIGURE 2. Network Connection Diagram.

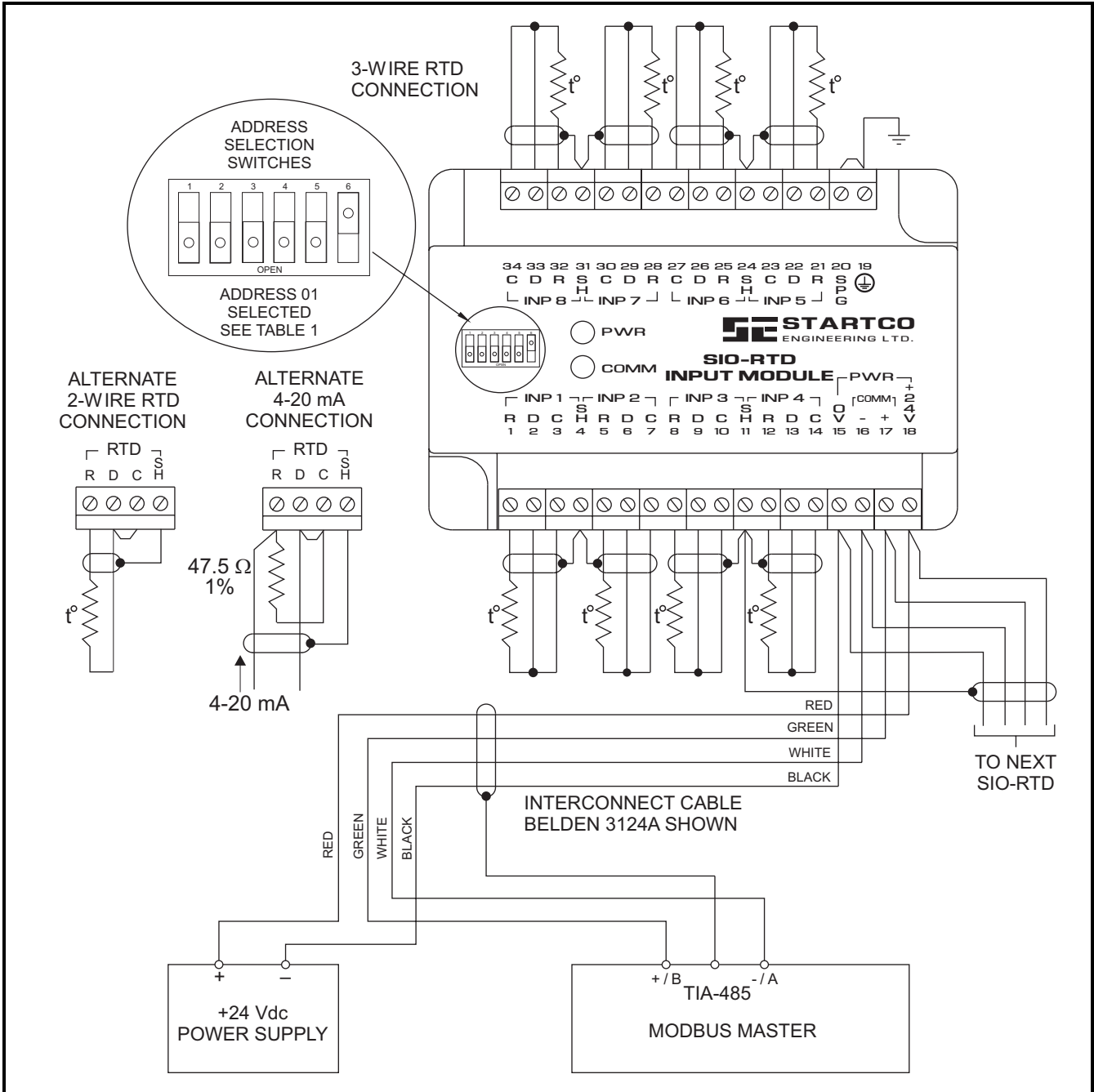


FIGURE 3. SIO-RTD Typical Connection Diagram.

5. MODBUS PROTOCOL

5.1 GENERAL

The SIO-RTD has a TIA-485 communications interface that uses the Modbus-RTU communications protocol. Each SIO-RTD is a slave device and up to sixty-three slaves can be connected to a single master.

The SIO-RTD configuration registers are write-only registers mapped to the Modbus address of 40001 (Register Address 0). The Modbus write-multiple-

registers command (Code 16) is used to configure these registers. The temperature or analog-input data is read starting at address 40017 (Register Address 16). The Modbus read-multiple-registers command (Code 3 or 4) is used to read the data.

For 60 Hz applications using Pt100 sensors, configuration commands are not required. To acquire data using a PLC, the following procedure is used:



- On the SIO-RTD module, set the slave address using the DIP switches. See Section 5.2 and Table 1.
- In the PLC, use the read-multiple-register message. Set the slave address to match the SIO-RTD slave address DIP-switch setting, set the starting register to 40017, and set the number of registers to read as 8.

The eight register words read from the SIO-RTD module are in signed integer format and described in Section 5.4.

The communication data rate is 19.2 kbit/s and CRC error checking is used.

SE-Comm-RTD software can be used with a PC to configure and monitor up to sixty-three SIO-RTD Input Modules and to log monitored data. SE-Comm-RTD is available at www.startco.ca.

5.2 MODBUS ADDRESS SELECTION

The SIO-RTD has six DIP switches to select its Modbus network address. Up to sixty-three modules can be connected to each network and each module address must be unique. Remove the address switch access cover and select the address. See Fig. 3. The address is set relative to a base address of 00 and increments in binary. See Table 1. The resulting Modbus address range is 01 to 63 where address 00 is the offline address. The SIO-RTD module will not respond when address 00 is selected.

TABLE 1 MODBUS ADDRESS

SWITCH 1	SWITCH 2	SWITCH 3	SWITCH 4	SWITCH 5	SWITCH 6	ADDRESS
Open	Open	Open	Open	Open	Open	00 (off line)
Open	Open	Open	Open	Open	Closed	01
Open	Open	Open	Open	Closed	Open	02
Open	Open	Open	Open	Closed	Closed	03
Open	Open	Open	Closed	Open	Open	04
Open	Open	Open	Closed	Open	Closed	05
Open	Open	Open	Closed	Closed	Open	06
Open	Open	Open	Closed	Closed	Closed	07
Open	Open	Closed	Open	Open	Open	08
Open	Open	Closed	Open	Open	Closed	09
Open	Open	Closed	Open	Closed	Open	10
Open	Open	Closed	Open	Closed	Closed	11
Open	Open	Closed	Closed	Open	Open	12
Open	Open	Closed	Closed	Open	Closed	13
Open	Open	Closed	Closed	Closed	Open	14
Open	Open	Closed	Closed	Closed	Closed	15
...	16-48
Closed	Closed	Open	Open	Open	Closed	49
Closed	Closed	Open	Open	Closed	Open	50
Closed	Closed	Open	Open	Closed	Closed	51
Closed	Closed	Open	Closed	Open	Open	52
Closed	Closed	Open	Closed	Open	Closed	53
Closed	Closed	Open	Closed	Closed	Open	54
Closed	Closed	Open	Closed	Closed	Closed	55
Closed	Closed	Closed	Open	Open	Open	56
Closed	Closed	Closed	Open	Open	Closed	57
Closed	Closed	Closed	Open	Closed	Open	58
Closed	Closed	Closed	Open	Closed	Closed	59
Closed	Closed	Closed	Closed	Open	Open	60
Closed	Closed	Closed	Closed	Open	Closed	61
Closed	Closed	Closed	Closed	Closed	Open	62
Closed	Closed	Closed	Closed	Closed	Closed	63



5.3 CONFIGURATION MESSAGE (CODE 16)

SIO-RTD configuration registers are write-only registers. Configuration registers are used to define the input type and to set the notch-filter frequency. For operation with the default values of Pt100 and 60 Hz, writing configuration registers is not required.

Input type is configured using the Modbus Write Multiple Registers command. A typical Modbus message requires the slave address, starting register number and number of words to be written. For the SIO-RTD, a total of 4 words consisting of the Table 2 Input Type Code are written starting at Modbus register address 40001 (Modbus Holding Register 0). One word contains the configuration for two inputs. For example, the first word is coded as INP1:INP2 followed by INP3:INP4, INP5:INP6, and INP7:INP8.

Type codes are not stored in non-volatile memory and for type code values other than the default of Pt100, the type code must be written to the SIO-RTD module each time the module supply is cycled. Writing configuration registers causes the module to perform a calibration. This operation can take up to five seconds. In a system where the preference is to write the configuration registers on a continuous basis as part of the read cycle, a five-second delay is required between the configuration write command and the input read command. In this case, use the following sequence: *Configuration Write, Delay 5 s, Input Read, Configuration Write, Delay 5 s, Input Read, Configuration Write.....*

NOTE: The SIO-RTD data-update interval is two seconds.

The notch filter frequency is set using a Write Single Word Register to Modbus register address 86253. This parameter is stored in non-volatile memory and is retained on loss of control voltage. The factory default value is 60 (60 Hz).

Set the notch filter frequency to the system fundamental frequency. Use the 10-Hz setting for noisy applications. Control voltage must be cycled to enable the new notch-filter setting.

Tables 4, 5, 6, and 7 are the byte formats for the Modbus messages supported by the SIO-RTD. These are generated by the Modbus master and SIO-RTD slave and are provided for reference only. These tables are useful when building Modbus software to support the SIO-RTD modules and for trouble shooting.

TABLE 2 INPUT TYPE CODE

INPUT TYPE CODE	INPUT TYPE
0	Input not used
1	Pt100 RTD
2	Ni100 RTD
3	Ni120 RTD
4	Cu10 RTD
5	4–20 mA analog

TABLE 3 NOTCH FILTER CODE

NOTCH-FILTER CODE		NOTCH FREQUENCY
MSB	LSB	
01	10	10 Hz (20, 30, ...)
01	50	50 Hz (100, 150, ...)
01	60	60 Hz (120, 180, ...)

TABLE 4 MODBUS WRITE MULTIPLE REGISTERS (CODE 16)

DESCRIPTION	BYTE INDEX	VALUE
Slave Address	0	Range 01 to 63
Function Code	1	16 (Fixed)
MSB of Modbus Address 40001	2	0 (Fixed)
LSB of Modbus Address 40001	3	0 (Fixed)
MSB of Quantity	4	0 (Fixed)
LSB of Quantity	5	4 (Fixed)
Byte Count	6	8 (Fixed)
MSB of Data Word 0	7	INP1 Input Type Code
LSB of Data Word 0	8	INP2 Input Type Code
MSB of Data Word 1	9	INP3 Input Type Code
LSB of Data Word 1	10	INP4 Input Type Code
MSB of Data Word 2	11	INP5 Input Type Code
LSB of Data Word 2	12	INP6 Input Type Code
MSB of Data Word 3	13	INP7 Input Type Code
LSB of Data Word 3	14	INP8 Input Type Code
Byte 1 of 16-Bit CRC	15	Byte 1 of 16-Bit CRC
Byte 2 of 16-Bit CRC	16	Byte 2 of 16-Bit CRC



TABLE 5 MODBUS WRITE SINGLE WORD REGISTER (CODE 16)

DESCRIPTION	BYTE INDEX	VALUE
Slave Address	0	Range 01 to 63
Function Code	1	16 (Fixed)
MSB of Modbus Address 86253	2	180 (Notch Filter Address, fixed)
LSB of Modbus Address 86253	3	172 (Notch Filter Address, fixed)
MSB of Quantity	4	0 (Fixed)
LSB of Quantity	5	1 (Fixed)
Byte Count	6	2 (Fixed)
MSB of Data Word	7	0 (Notch Filter Code, fixed)
LSB of Data Word	8	Notch Filter Code from Table 3
Byte 1 of 16-Bit CRC	15	Byte 1 of 16-Bit CRC
Byte 2 of 16-Bit CRC	16	Byte 2 of 16-Bit CRC

TABLE 6 MODBUS WRITE MULTIPLE REGISTERS RESPONSE

DESCRIPTION	BYTE INDEX	VALUE
Slave Address	0	Slave Address
Function Code	1	16 (Fixed)
MSB of Modbus Address 40001	2	0 (Fixed)
LSB of Modbus Address 40001	3	0 (Fixed)
MSB of Quantity	4	0 (Fixed)
LSB of Quantity	5	4 (Fixed)
Byte 1 of 16-Bit CRC	6	Byte 1 of 16-Bit CRC
Byte 2 of 16-Bit CRC	7	Byte 2 of 16-Bit CRC

TABLE 7 MODBUS WRITE SINGLE REGISTER RESPONSE

DESCRIPTION	BYTE INDEX	VALUE
Slave Address	0	Slave Address
Function Code	1	16 (Fixed)
MSB of Modbus Address 86253	2	180 (Notch Filter Address, fixed)
LSB of Modbus Address 86253	3	172 (Notch Filter Address, fixed)
MSB of Quantity	4	0 (Fixed)
LSB of Quantity	5	1 (Fixed)
Byte 1 of 16-Bit CRC	6	Byte 1 of 16-Bit CRC
Byte 2 of 16-Bit CRC	7	Byte 2 of 16-Bit CRC



5.4 DATA REQUEST MESSAGE (CODE 3 OR 4)

The read registers command (Code 3 or 4) is used to read the SIO-RTD data. A typical Modbus message requires the slave address, starting register number and number of words to be read. For the SIO-RTD, a total of 8 words are read starting at Modbus register address 40017 (Modbus Holding Register 16).

The data consists of eight 16-bit words starting with INP1. Each input value is a signed 16-bit integer and coded as follows:

- 20000: Unused input
- 21000: Open RTD
- 22000: Shorted RTD
- 400 to 2000: RTD Data
{RTD Temp. in °C = RTD Data ÷ 10}
- 20 to 220: Analog Data
{Value in mA = Analog Data ÷ 10}

Tables 8 and 9 are byte formats for the read commands. These are all generated by the Modbus master and SIO-RTD slave and shown for reference only. These tables are useful when building Modbus software to support the SIO-RTD modules and for trouble shooting.

TABLE 8 MODBUS READ MULTIPLE REGISTERS (CODE 3 or 4)

DESCRIPTION	BYTE INDEX	VALUE
Slave Address	0	Range 01 to 63
Function Code	1	3 or 4
MSB of Modbus Address 40017	2	0 (Fixed)
LSB of Modbus Address 40017	3	16 (Fixed)
MSB of # of Registers	4	0 (Fixed)
LSB of # of Registers	5	8 (Fixed)
Byte 1 of 16-Bit CRC	6	Byte 1 of 16-Bit CRC
Byte 2 of 16-Bit CRC	7	Byte 2 of 16-Bit CRC

TABLE 9 MODBUS READ MULTIPLE REGISTERS RESPONSE

DESCRIPTION	BYTE INDEX	VALUE
Slave Address	0	Range 01 to 63
Function Code	1	3 or 4
Byte Count	2	16 (Fixed)
MSB of Data Word 1	3	INP1 Data
LSB of Data Word 1	4	INP1 Data
MSB of Data Word 2	5	INP2 Data
LSB of Data Word 2	6	INP2 Data
MSB of Data Word 3	7	INP3 Data
LSB of Data Word 3	8	INP3 Data
MSB of Data Word 4	9	INP4 Data
LSB of Data Word 4	10	INP4 Data
MSB of Data Word 5	11	INP5 Data
LSB of Data Word 5	12	INP5 Data
MSB of Data Word 6	13	INP6 Data
LSB of Data Word 6	14	INP6 Data
MSB of Data Word 7	15	INP7 Data
LSB of Data Word 7	16	INP7 Data
MSB of Data Word 8	17	INP8 Data
LSB of Data Word 8	18	INP8 Data
Byte 1 of 16-Bit CRC	19	Byte 1 of 16-Bit CRC
Byte 2 of 16-Bit CRC	20	Byte 2 of 16-Bit CRC



6. TECHNICAL SPECIFICATIONS

Supply	2 W, 18 to 32 Vdc
Configuration	8 inputs, 3 wire RTD and 4–20 mA
RTD Types	Pt100 (Default) Ni100, Ni120, Cu10
RTD Measurement Range	-40 to 200°C with open and short detection
Analog Measurement Range	4-20 mA
RTD Sensor Current.....	2 mA
RTD Lead Compensation	20 Ω maximum
Notch Filter	10, 50, 60 Hz (Default)
Induced-Noise Tolerance (In-Band)	1 V RMS
Data-Output Interval:	
50- & 60-Hz settings	1.5 s
10-Hz setting	6.5 s
Accuracy:	
Pt100, Ni100, Ni120 RTD... 1°C	
Cu10 RTD	3°C
4–20 mA.....	0.1 mA
Network Communications:	
Configuration	TIA-485 2 wire, multi-drop
Baud Rate.....	19.2 kbit/s
Parity	None
Number of Bits.....	8
Stop Bits.....	1
Protocol	Modbus® RTU
Length	1.2 km (4,000') maximum
Interconnection Cable:	
Type	Belden 3124® or equivalent
Supplied length.....	4 m (13')
Dimensions:	
Height.....	87.0 mm (3.43")
Width.....	112.5 mm (4.43")
Depth.....	56.0 mm (2.20") includes top-hat rail
Shipping Weight.....	0.4 kg (0.9 lb.)

PWB Conformal Coating.....	MIL-1-46058 qualified UL QMJU2 recognized.
Environment:	
Operating Temperature	-40 to 60°C
Storage Temperature.....	-55 to 80°C
Humidity.....	85% Non-Condensing
Surge Withstand.....	ANSI/IEEE 37.90.1-1989 (Oscillatory and Fast Transient)
Certification	CSA, Canada and USA



Hazardous Location	Class I Zone 2 Ex nA II T6
To:	
CSA C22.2 No. 14 Industrial Control Equipment	
UL 508 Industrial Control Equipment	
CSA E60079-15:02 Electrical Apparatus for Explosive Gas Atmospheres	
UL 60079-15 Electrical Apparatus for Explosive Gas Atmospheres	

7. ORDERING INFORMATION

SIO-RTD:	
SIO-RTD-02-00	Input Module, includes 4 m (13') interconnection cable.
Accessories:	
Belden® 3124A	Interconnection cable
SE-485-DIN.....	Serial converter, isolated
SE-485PP	Serial converter, port powered
SE-Comm-RTD	PC communications Software ⁽¹⁾

⁽¹⁾ Available at www.startco.ca

8. WARRANTY

The SIO-RTD Input Module is warranted to be free from defects in material and workmanship for a period of five years from the date of purchase.

Startco Engineering Ltd. will (at Startco's option) repair, replace or refund the original purchase price of an SIO-RTD that is determined by Startco to be defective if it is returned to the Startco factory, freight prepaid, within the warranty period. This warranty does not apply to repairs required as a result of misuse, negligence, an accident, improper installation, tampering, or insufficient care. Startco Engineering Ltd. does not warrant products repaired or modified by non-Startco Engineering Ltd. personnel.