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# Model 3810B

## Digital Temperature Sensor String

### Instruction Manual





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## 1. INTRODUCTION

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GEOKON Model 3810B Digital Temperature Sensor Strings are temperature sensors that combine high accuracy sensors with digital Modbus RTU communication for ease of setup and use. Each sensor contains a small printed circuit board assembly (PCBA) with circuitry for communication and temperature measurement. These sensors are assembled with cable using customer-specified spacing. Then each sensor is encapsulated in a protective housing, creating a finished string.

The temperature sensor in the 3810B is a factory calibrated monolithic CMOS integrated circuit capable of 14-bit resolution. The accuracy and interchangeability of the sensor used on the 3810B is  $\pm 0.2\text{ }^{\circ}\text{C}$ , within the temperature range of  $-40\text{ }^{\circ}\text{C}$  to  $+80\text{ }^{\circ}\text{C}$ .

The cable consists of two twisted pairs, each wrapped with aluminized Mylar foil and a single drain wire. There are four conductors: power, ground, and the two differential RS-485 lines for communication. A short-circuit between any of the four conductors will render all sensors in the string inoperable. Likewise, a break in the cable would render inoperable all sensors below the break.

The sensors are polled individually via industry standard Modbus RTU (Remote Terminal Unit) commands.



**FIGURE 1:** Model 3810B Digital Temperature Sensor String



**FIGURE 2:** Model 3810B Digital Temperature Sensor

## 2. INSTALLATION

### 2.1 SENSOR STRING

Uncoil the sensor string and place it in the installation medium. For installations in which the string will be in contact with soil, rock, etc., take care to prevent damage to the cable and sensor. The termination assembly at the end of the string is made with a 1/4-20 x 1/2" deep threaded hole in it. This allows for a weight or cord/rope to be attached for assisting with the installation. The maximum pulling force that can safely be applied to the string is 20 lb.



**FIGURE 3:** Model 3810B-3 End Terminator

### 2.2 HARDWARE REQUIREMENTS

**Communications:** RS-485, half-duplex

**Baud Rate:** 115200

**Power:** 12 V  $\pm$ 20% (12V Nominal) @ 4.8 mA/sensor (during reading)

### 2.3 READOUT

If your data logger has built-in RS-485 communications, connect the readout cable using the table below. (The data logger must have the appropriate port available.)

| Data Logger | Sensor Conductor Color |
|-------------|------------------------|
| 485+        | WHITE                  |
| 485-        | GREEN                  |
| 12V         | RED                    |
| GND         | BLACK                  |
| SHD         | BARE                   |

**TABLE 1:** Data Logger with RS-485 Communications to Sensor Wiring Table

If your data logger does not have built-in RS-485 communications, the converter below can be utilized.

#### **MODEL 8020-38 ADDRESSABLE BUS CONVERTER**

The Model 8020-38 Addressable Bus Converter (Figure 4) allows addressable strings to be connected to personal computers, readouts, data loggers, and programmable logic controllers. The converter acts as a bridge using the TTL or USB protocols between readers and the GEOKON RS-485-enabled sensor strings.



**FIGURE 4:** Model 8020-38 RS-485 to TTL/USB Converter

If utilizing a Model 8020-38 to connect the string to a readout, wire the connections as shown. (The data loggers must have the appropriate port available.)

| Data Logger Connection | Conductor Color | 8020-38 Connection |
|------------------------|-----------------|--------------------|
| V+                     | RED             | 12 V (IN)          |
| TX                     | WHITE           | TX (IN)            |
| RX                     | GREEN           | RX (OUT)           |
| GND                    | BLACK           | GND                |
| SHD                    | BARE            | SHIELD             |

**TABLE 2:** Data Logger to Model 8020-38 Wiring

| 8020-38 Connection | Sensor Conductor Color |
|--------------------|------------------------|
| 12 V (OUT)         | RED                    |
| 485+               | WHITE                  |
| 485-               | GREEN                  |
| GND                | BLACK                  |
| SHIELD             | BARE                   |

**TABLE 3:** Model 8020-38 to Sensor Wiring

For more information, please refer to the Model 8020-38 Instruction Manual ([geokon.com/8020-38](http://geokon.com/8020-38)).

### 3. MODBUS RTU PROTOCOL

#### 3.1 INTRODUCTION TO MODBUS

Model 3810B Digital Temperature Sensors use the industry standard Modbus Remote Terminal Unit (RTU) protocol to communicate with the chosen readout method. As the name suggests, Modbus was designed to work on what is known as a **bus network**, meaning that every device receives every message that passes across the network. The Modbus standard does not specify a physical layer (connection type), but it will work with any interface that can communicate asynchronously with multiple devices (e.g., RS-485, RS-422, optical, radio, etc.). Model 3810B strings use RS-485 as the electrical interface because of its prevalence, simplicity, and success as a robust, industrial physical layer.

More information about Modbus can be found at the following website:

<http://www.modbus.org/specs.php>

#### 3.2 MODBUS RTU OVERVIEW

The Modbus RTU protocol uses packets (messages made up of multiple sections) to communicate and transfer data between devices on the network. The general format of these packets is as follows:

1. Modbus Address (one byte) – The address of the specific device on the bus. (Labeled on the sensors as #1, #2, #3, etc.)
2. Function Code (one byte) – The action to be carried out by the server device.
3. Data (multi-byte) – The payload of the function code being sent.
4. Cyclic Redundancy Check or CRC (two bytes): A 16-bit data integrity check calculated over the other bytes in the packet.

#### 3.3 MODBUS TABLES

The most recent sensor reading is stored in a table. The reading is presented in different formats in different sections of the table. The register location and size of these variables are described in the table below.

| Variable    | Type (Modbus Message) | HEX    | Decimal | Description                                 |
|-------------|-----------------------|--------|---------|---------------------------------------------|
| Temperature | float32               | 0x0104 | 258     | Temp °C                                     |
| Trigger     | uint16                | 0x0118 | 280     | Write nonzero value to initiate measurement |

**TABLE 4:** RAM Storage

#### 3.4 READING 3810B SENSORS

While Modbus RTU supports roughly 20 different function codes, the simple functionality of a bused temperature sensor, such as the GEOKON 3810B, eliminates the need for all but two of them. Only the Write Holding Register (0x06) function code and Read Holding Registers (0x03) are needed to read the sensors.

First, use the Write Holding Register function to refresh the temperature measurement. The command initiates multiple analog-to-digital (ADC) conversions that are averaged to optimize precision and resolution. The updated measurements will be ready approximately 0.25 seconds after the request. An example request is shown in the table below.

|                   | Device Address | Function Code | Data Address | Register Value | CRC    |
|-------------------|----------------|---------------|--------------|----------------|--------|
| HEX <sub>16</sub> | 02             | 06            | 0118         | 0001           | C9C2   |
| DEC <sub>10</sub> | 2              | 6             | 280          | 1              | 51,650 |

**TABLE 5:** Example Query - Trigger Measurement

The Read Holding Registers function can be used to read one or more 16-bit registers (two bytes each), starting at the Data Address that was sent in the command packet. Temperature can be retrieved as 32-bit floating point (decimal) number. An example of this query and response is shown in the tables below.

|                   | Device Address | Function Code | Data Address | Register Value | CRC   |
|-------------------|----------------|---------------|--------------|----------------|-------|
| HEX <sub>16</sub> | 01             | 03            | 104          | 0002           | 8436  |
| DEC <sub>10</sub> | 1              | 3             | 260          | 2              | 33846 |

**TABLE 6:** Example Query - Floating Point Temperature Reading

|                   | Device Address | Function Code | Byte Count | Lower 16-bits         | Upper 16-bits | CRC   |
|-------------------|----------------|---------------|------------|-----------------------|---------------|-------|
| HEX <sub>16</sub> | 02             | 03            | 04         | 0B84                  | 41BB          | C81D  |
| DEC <sub>10</sub> | 2              | 3             | 4          | floating point result |               | 51229 |

**TABLE 7:** Example Response - Floating Point Temperature Reading

#### PC TERMINAL PROGRAM SCREEN CAPTURE

```
10/7/2026 11:07:42.322 [TX] - 01 03 01 04 00 02 84 36
10/7/2026 11:07:42.329 [RX] - 01 03 04 0B 84 41 BB C8 1D
```

The above shows the IEEE-754 floating-point response as two parts—each one is composed of two bytes. Because of how this information is stored in memory, the two parts are received in reverse order; the complete floating-point number in HEX is 0x41BB0B84 (23.38 °C).

## 4. SOFTWARE

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Model 3810B Digital Temperature Sensor Strings can be read by GEOKON “Addressable String Reader” software. You can download this software at [geokon.com/Software](https://geokon.com/Software)

The Addressable String Reader application (ASR) is designed to help the user quickly connect to and read a GEOKON addressable string. The ASR will automatically detect the type of string connected and will configure the display accordingly. The three types of strings currently supported are the Digital Temperature Sensor String (3810B), the Addressable VW (Vibrating Wire) Sensor String (8020-30), and the Addressable MEMS String (6150E and 6151E).

The ASR contains the following features:

- Communication via Windows COM Ports
- Selection of all drops, individual drops, or a combination of drops
- Recording of data in rows either by button click or cyclic, at selectable intervals
- Recorded data rows are viewable in list form
- Recorded data rows can be saved in CSV (comma-separated values) format

For more information, run the program and click the blue  button to display the software’s Online Help.

## 5. TAKING READINGS

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### 5.1 COMPATIBLE DATA LOGGERS

GEOKON can provide several data logger options. Devices compatible with this product are listed below. For further details and instruction consult the corresponding Manual(s) at [geokon.com/Dataloggers](http://geokon.com/Dataloggers).

#### **DATA LOGGERS:**

##### ■ **GeoNet Series**

The GeoNet Data Logger series is designed to collect and transfer data from vibrating wire, RS-485, and analog instruments. GeoNet offers a wide range of telemetry options, including LoRa, cellular, Wi-fi, satellite, and local. Data loggers can work together to operate in a network configuration, or be used separately as standalone units. GeoNet devices arrive from the factory ready for deployment and may commence with data acquisition in minutes.

Data is transferred to a secure cloud-based storage platform where it can be accessed through the GEOKON OpenAPI. Industry leading data visualization software, such as the free GEOKON Agent Software, can be used with the OpenAPI for data viewing and reporting. Data loggers without network capabilities are also available.

##### ■ **8600 Series**

The Model 8600 Series Data Logger is designed to support the reading of a large number of GEOKON instruments for various unattended data collection applications using GEOKON Model 8032 Multiplexers. Weatherproof packaging allows the unit to be installed in field environments where inhospitable conditions prevail. The Nema 4X enclosure also has a provision for locking to limit access to responsible field personnel.

## 6. TROUBLESHOOTING

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Maintenance and troubleshooting of Model 3810B Digital Temperature Sensor String is confined to periodic checks of the cable connections. The sensors are sealed and there are no user serviceable parts.

Should difficulties arise, consult the list of possible solutions shown below. Visit [geokon.com/Technical-Support](http://geokon.com/Technical-Support) for additional troubleshooting help.

### ***SYMPTOM: SENSOR READINGS FAIL TO READ***

- ☐ Is there a source of electrical noise nearby? Most probable sources of electrical noise are motors, generators, and antennas.
- ☐ Check all cable connections, terminals, and plugs.
- ☐ Water may have penetrated the interior of the sensors. Contact GEOKON.

## APPENDIX A. SPECIFICATIONS

### A.1 POWER

|                    |                                        |
|--------------------|----------------------------------------|
| Power Supply       | 12 V $\pm$ 20%                         |
| Current Per Sensor | During Reading: 4.8 mA<br>Idle: 1.2 mA |

**TABLE 8:** Power Specifications

### A.2 COMMUNICATION

|                     |                                               |
|---------------------|-----------------------------------------------|
| Interface           | RS-485, half-duplex                           |
| Baud Rate           | 115200 bits/second                            |
| Query Response Time | 0.266 seconds (trigger write to values ready) |

**TABLE 9:** Communication Specifications

### A.3 MECHANICAL

|                              |                                                                               |
|------------------------------|-------------------------------------------------------------------------------|
| Minimum Spacing              | 200 mm (7.9")                                                                 |
| Maximum Cable Length         | 1000 m (3,280 ft)                                                             |
| Housing                      | PVC, Nylon                                                                    |
| Length x Diameter            | Sensor: 146 x 22 mm (5.8 x 0.9")<br>Terminal Sensor: 158 x 22 mm (6.2 x 0.9") |
| Working Load <sup>1</sup>    | 9.1 kg (20 lbs)                                                               |
| Breaking Strength            | 22.7 kg (50 lbs)                                                              |
| Pressure Rating <sup>2</sup> | 150 psig (1 MPa)                                                              |
| Sensors                      | Wired: 248 maximum<br>Wireless: 30 maximum                                    |

**TABLE 10:** Mechanical Specifications

#### Note:

1 Some configurations require an additional mechanical support cable. Contact GEOKON for more details.

2 Please contact GEOKON for other ranges.

### A.4 MEASUREMENTS

|                                         |                                    |
|-----------------------------------------|------------------------------------|
| System Resolution (0 °C to +50 °C)      | 0.002 °C (nonlinear; largest step) |
| System Repeatability (-20 °C to +80 °C) | 0.002 °C (99% confidence interval) |
| Sensor Type                             | Digital                            |
| Range                                   | -40 °C to +80 °C                   |
| Accuracy                                | $\pm$ 0.2 °C                       |
| Resolution                              | 14-bit                             |

**TABLE 11:** Measurement Specifications

## APPENDIX B. MODBUS ADDRESSABLE SYSTEM

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### B.1 MODBUS COMMUNICATIONS PARAMETERS

| Port Setting    | Required Value |
|-----------------|----------------|
| Bits per Second | 115200         |
| Data bits       | 8              |
| Parity          | None           |
| Stop bits       | 1              |

**TABLE 12:** Modbus Communications Parameters

### B.2 ERROR CODES

| Number | Name                      | Cause                                                                                       | Remedy                                                    |
|--------|---------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 2      | Temperature Sensor Range  | Measured temperature out of range. Temperature sensor may be too hot, too cold, or damaged. | Use adjacent sensors to validate or estimate temperature. |
| 4      | Temperature Sensor Verify | Secondary temperature sensor differed too much from high accuracy primary sensor.           | Use adjacent sensors to validate or estimate temperature. |
| 8      | System Reset              | Unexpected interruption in prior measurement cycle.                                         | Ensure supply voltage is sufficient.                      |

**TABLE 13:** Error Codes

**Note:** The sensor stores the errors as a bit field to compact the information. If two errors occur in one measurement cycle, the resulting code will be the sum of the error numbers, e.g., error 4 plus error 8 appears as number 12.

## APPENDIX C. MODBUS & CAMPBELL SCIENTIFIC DATA LOGGERS

### C.1 DESCRIPTION

Model 3810B sensor strings can be easily read using Campbell data loggers that support ModBus RTU commands. Campbell data loggers such as the CR6 and CR1000Xe can read half-duplex RS-485 on select RS-485 digital I/O pairs. This allows the 3810B string to be connected directly at the data logger.

The Model 8020-38 Addressable Bus Converter enables Model 3810B sensor strings to work with Campbell data loggers that do not support direct RS-485 communications, such as the CR800 and CR1000X. The Model 8020-38 is a RS-485 to TTL converter, used with select TTL digital I/O pairs.

CRBasic is the programming language used with Campbell Scientific CRBasic data loggers. Campbell Scientific's LoggerNet software is typically used when programming in CRBasic.

### C.2 SAMPLE CR6 PROGRAM

The following sample program reads one 3810B string with five addressable thermistors. The string in this example communicates with the CR6 through the control ports C1 (green) and C2 (white), which are set up as ComC1:

```
Public ErrorCode           'Result of ModbusClient communications attempt
Public Temp(5) As Float    'Temperature as type float
Public Count               'Counter to increment through temperature sensors

'Define Data Tables
DataTable(Test,1,-1)
  Sample(5,Temp( ),IEEE4)
EndTable

'Main Program
BeginProg
  'Open COM port with RS-485 communications at 115200 baud rate
  SerialOpen (ComC1,115200,16,0,50,4)
  'Read all 5 sensors in string every 10 seconds
  Scan (10,Sec,0,0)
  'Loop to read each thermistor
  For Count = 1 To 5
    'Reset temporary storage for next reading
    Temp(Count) = 0
    'Flush Serial between readings
    SerialFlush (ComC1)
    'Write to register 0x118 to trigger temperature sensor
    'NOTE: ModbusClient won't send 0x118 unless "&H119" is entered
    ModbusClient (ErrorCode,ComC1,115200,Count,6,1,&H119,1,3,50,0)
    'Delay after triggering the measurement
    Delay (1,1,Sec)
    'Use Modbus command to retrieve temperature
    ModbusClient (ErrorCode,ComC1,115200,Count,3,Temp(Count),&H105,1,3,50,0)

    'If error code occurs data is not valid. NAN for modbus communication failure.
    If ErrorCode <> 0 Then
      Temp(Count) = NAN
    EndIf
  Next
  'Call Table to store Data
  CallTable Test
NextScan
EndProg
```



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