METER

BARO MODULE

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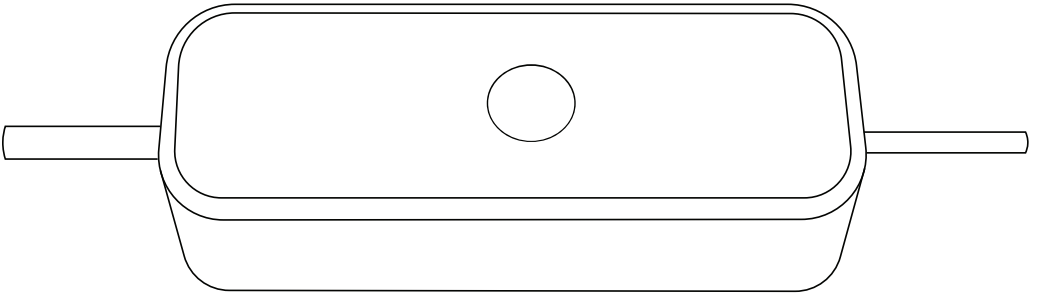


1. INTRODUCTION

Thank you for choosing the BARO Module sensor from METER Group.

The BARO Module is designed to be connected to a TEROS 31, or a TEROS 32 tensiometer as a reference sensor to compensate for barometric pressure. In addition to a reference sensor, the BARO Module can also be used as a standalone sensor to measure atmospheric pressure at the measuring site.

METER ZL6 data loggers are already equipped with a barometric reference sensor. For non-METER (third-party) data loggers, the BARO Module sensor or similar reference sensor is necessary to compensate for barometric pressure.

The BARO Module has different connector types available to cover all variants of METER tensiometer connectors. The BARO Module's precise pressure sensor guarantees an accurate barometric compensation of the soil water potential measurement.

This manual guides the customer through the BARO Module sensor features and describes how to use the sensor successfully.

METER recommends testing the sensors with the data logging device and software before installation in the field. Prior to use, verify the sensor arrived in good condition.

2. OPERATION

Please read all instructions before operating the BARO Module to ensure it performs to its full potential.

⚠ PRECAUTION

METER sensors are built to the highest standards, but misuse, improper protection, or improper installation may damage the sensor and possibly void the manufacturer's warranty. Before integrating BARO Module into a system, make sure to follow the recommended installation instructions and have the proper protections in place to safeguard sensors from damage. If installing sensors in a lightning-prone area with a grounded data logger, see the application note, Lightning surge and grounding practices (meter.ly/lightning-surge-grounding-practices).

2.1 INSTALLATION

It is important to remember that the BARO Module must be installed at a site in contact with the ambient air. The BARO Module must not be buried or set under water.

To set up the BARO Module, follow the steps listed in Table 1. Table 1 briefly describes different measurement tasks and the corresponding installation method. For more information about the best installation method for specific applications, please contact METER Customer Support.

Table 1 Installation methods

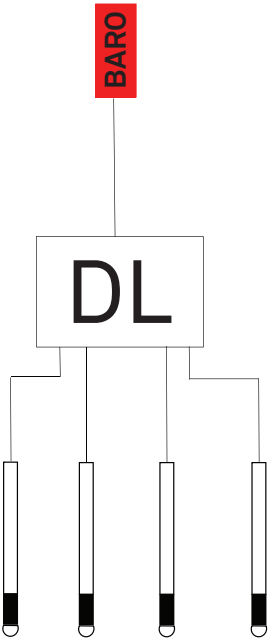
Multiple tensiometers with one data logger and a standalone BARO Module sensor		
A standalone BARO Module is connected to a data logger. The barometric pressure value can be used to compensate for all tensiometer values at the measuring site.		The barometric pressure value of the BARO Module can compensate for all water potential values of the tensiometers. The compensation can be applied by the data logger or updated later in the data.

Table 1 Installation methods (continued)

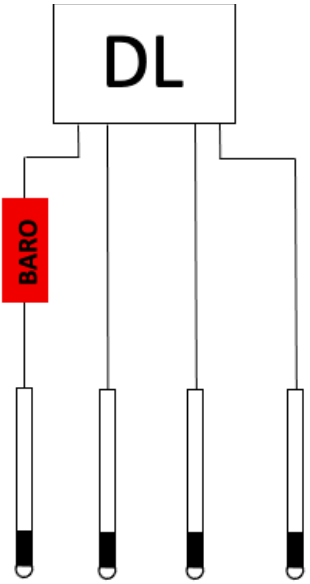
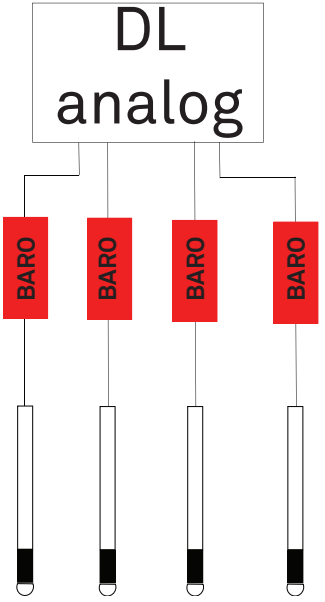
One BARO Module to compensate multiple tensiometers at one data logger		
One tensiometer with a BARO Module placed between the tensiometer and the data logger. All other tensiometers are connected to the data logger without the BARO Module.		The BARO Module provides a compensated water potential signal for the attached tensiometer. All other tensiometers can be compensated by calculation inside the data logger or later in the data.
One BARO Module at every tensiometer as a digital/analog converter		
A BARO Module with analog outputs can be used simultaneously as a digital/analog converter and to compensate for the tensiometer values.		Serial output tensiometers can be connected to a data logger with analog input channels with a BARO Module. The BARO Module provides a compensated analog water potential value. This combination can be used as a T8 replacement.

Table 1 Installation methods (continued)

Controlling tensiometer for Vacuum Station (VS)		
A BARO Module with analog outputs combined with a TEROS 32 tensiometer can be used as a controlling tensiometer for a vacuum station (VS) (only 8-pin output connector - see Figure 4).		METER tensiometers can be used to control a vacuum station (TENS mode). This combination can be used as a T8 replacement using a vacuum station. There is no replacement for T4 tensiometers as controlling tensiometers on a vacuum station.

2.2 CONNECTING

The BARO Module is built to compensate METER tensiometers connected to non-METER data loggers. The **Integrator Guide** provides more detailed instructions on how to integrate the sensors into third-party loggers.

BARO Module sensors require an excitation voltage in the range of 3.6 to 28.0 VDC and operate at a 3.6-VDC level for data communication. The BARO Module can be integrated using the SDI-12, Modbus™ RTU, and tensioLink protocols. See **the Integrator Guide** for details on interfacing with data acquisition systems.

BARO Module sensors come with various plug connectors (Table 2) depending on the application.

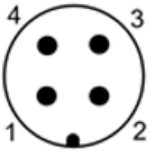
Table 2 Connector combinations

Item number	Input connector	Output connector
M010530	no connector	M12 4-pin male plug
M010531	3.5 mm stereo female plug	M12 4-pin male plug
M010532	3.5 mm stereo female plug	M12 8-pin male plug
M010533	M12 4-pin female plug	M12 8-pin male plug
M010534	3.5 mm stereo female plug	4-pin open wire ends
M010535	M12 4-pin female plug	8-pin open wire ends
M010536	no connector	4-pin open wire ends

2.2.1 CONNECT TO DATA LOGGER

The BARO Module can be used with non-METER (third-party) data loggers or data acquisition systems. The third-party logger manual provides details on logger communications, power supply, and ground ports. The **Integrator Guide** provides detailed instructions on connecting sensors to non-METER loggers.

Refer to Figure 1 for details on the M12 4-pin connector.

Wiring connections M12 4-pin				
Signal	**Wire**	**Pin**	**Function**	
V_{in}	brown	1	Supply +3 to +28.0 V_{DC}	
RS485-A/ SDI-12	white	2	RS485-A 2-wire or SDI-12	
GND	blue	3	Supply minus	
RS485-B	black	4	RS485-B 2-wire	

4-pin male plug

Figure 1 M12 4-pin output connector

Connect pigtail BARO Module wires to the data logger as illustrated in Figure 2 and Figure 3, depending on the desired protocol. For RS-485, the power supply wire (brown) will be connected to the excitation, the digital communication positive (+) wire (white) to a digital input (high), the digital communication negative (–) wire (black) to a digital input (low), and the ground wire (blue) to ground. For SDI-12, both the digital communication negative (–) and ground wires will be connected to ground.

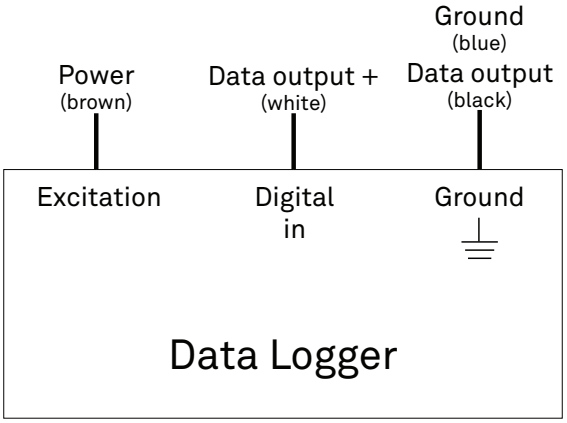


Figure 2 Wiring diagram SDI-12 4-pin connector

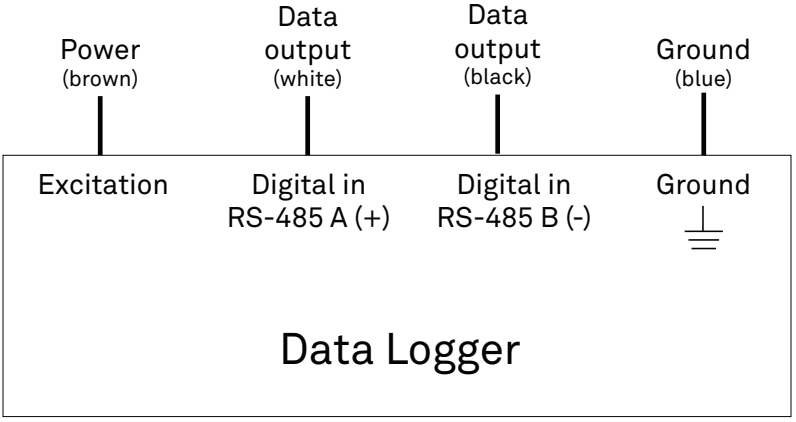


Figure 3 Wiring diagram RS-485 4-pin connector

NOTE: The acceptable range of excitation voltage is from 3.6 to 28.0 VDC. To read BARO Module with Campbell Scientific data loggers, power the sensor from a switched 12V port or a 12V port if using a multiplexer.

8-pin connector M12:

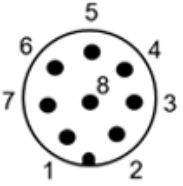
Wiring connections M12 8-pin				
Signal	**Wire**	**Pin**	**Function**	 8-pin male plug
V_{in}	white	1	Supply +3 to +28.0 V_{DC}	
GND	brown	2	Supply minus	
A-OUT+1	green	3	Analog output 1 (matric potential)	
A-OUT-	yellow	4	Analog minus	
digital OUT	grey	5	Digital switching channel	
RS485-A / SDI-12	pink	6	RS485-A 2-wire or SDI12	
RS485-B	blue	7	RS485-B 2-wire	
A-OUT+2	red	8	Analog output 2 (temperature)	

Figure 4 M12 8-pin output connector

Connect pigtail BARO Module wires to the data logger as illustrated in Figure 5 and Figure 6, depending on the desired protocol. For RS-485, the power supply wire (white) will be connected to the excitation, the digital communication positive (+) wire (pink) to a digital input (high), the digital communication negative (–) wire (blue) to a digital input (low), and the ground wire (brown) to ground. For SDI-12, both the digital communication (–) and ground wires will be connected to ground.

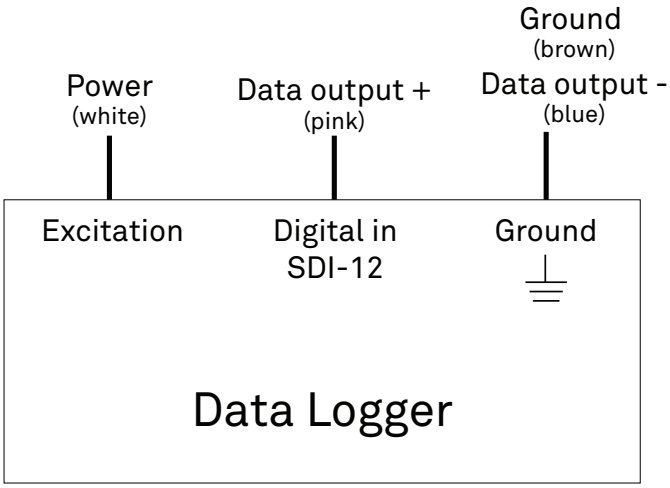


Figure 5 Wiring diagram SDI-12 8-pin connector

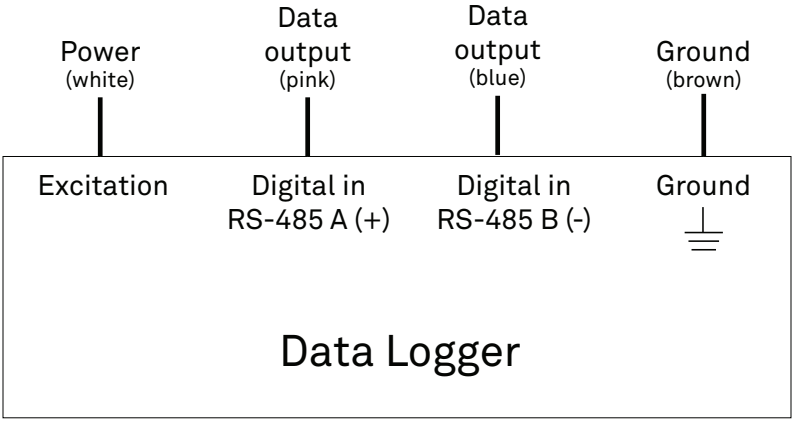


Figure 6 Wiring diagram RS-485 8-pin connector

Connect pigtail BARO Module wires to analog data logger channels, as illustrated in Figure 7. The power supply wire (white) will be connected to the excitation and the ground wire (brown) to ground.

The BARO Module has two analog outputs: one for matric potential (green), and one for temperature (red). Connect the BARO Module to an analog data logger using two negative wires to connect to the terminal clamps and complete the following steps (see also Figure 7):

1. Connect the analog output 1+ wire (green) to a positive terminal input of the analog data logger.

2. Connect the analog output 1- wire (yellow) to the corresponding negative terminal input of the analog data logger.
3. Connect the analog output 2+ wire (red) to another positive terminal of the analog data logger.
4. Couple both negative terminals with an additional wire bridge.

NOTE: It is important that the negative output is wired to one of the logger's two negative terminal clamps and that a wire bridge is used to link from one negative terminal clamp to the other.

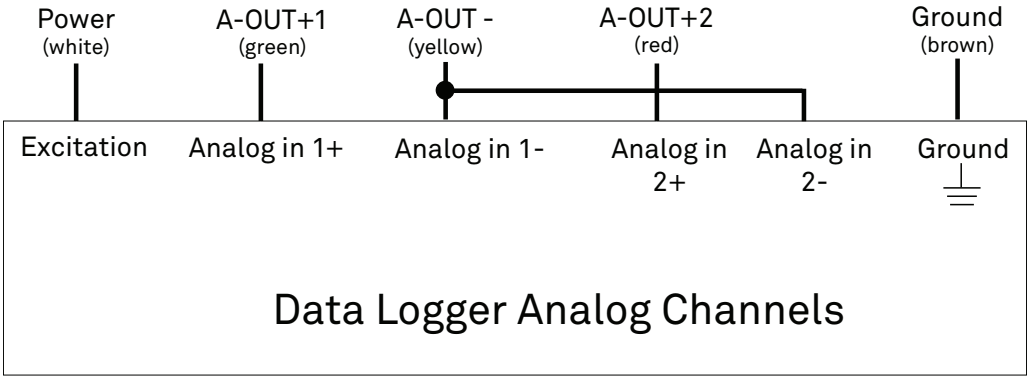


Figure 7 Wiring diagram analog channels 8-pin connector

2.2.2 COMMUNICATION

The BARO Module communicates using different methods:

- SDI-12 communication protocol
- RS-485 tensioLINK
- RS-485 Modbus™ RTU

Refer to the **Intgegrator Guide** for detailed instructions for these methods.

SDI-12 protocol requires that all sensors have a unique address.

NOTE: Address options include 0–9, and A–Z.

Detailed information can also be found in the applicate note Setting SDI-12 addresses on METER digital sensors using Campbell Scientific data loggers and LoggerNet (meter.ly/set-SDI-12-addresses).

3. SYSTEM

This section describes the BARO Module sensor.

3.1 SPECIFICATIONS

MEASUREMENT SPECIFICATIONS

Barometric Pressure	
Range	+85 kPa to +105 kPa
Resolution	±0.0012 kPa
Accuracy	±0.05 kPa
Temperature	
Range	–30 to +60 °C
Resolution	±0.01 °C
Accuracy	±0.5 °C

COMMUNICATION SPECIFICATIONS

Output

SDI-12 communication protocol

TensioLINK communication protocol

Modbus™ RTU communication protocol

Data Logger Compatibility

Data loggers or any data acquisition system capable of 3.6- to 28.0-VDC power and SDI-12, Modbus™ RTU, or tensioLINK communication.

PHYSICAL SPECIFICATIONS

Dimensions	
Width	80 mm (3.15 in)
Depth	29 mm (1.14)
Height	30 mm (1.18 in)
Operating Temperature Range	
Minimum	–30 °C
Typical	NA
Maximum	50 °C
Sensor body materials	
PA12	
Connector Types	
3.5mm stereo plug	
M12 4-pin	
M12 8-pin	
4-pin stripped and tinned wire ends	
8-pin stripped and tinned wire ends	

ELECTRICAL AND TIMING CHARACTERISTICS

Supply Voltage (VCC) to GND	
Minimum	3.6 V
Typical	12.0 V
Maximum	28.0 V

COMPLIANCE

Manufactured under ISO 9001:2015

EM ISO/IEC 17050:2010 (CE Mark)

3.2 THEORY

The following sections explain the theory of soil water potential measurements.

3.2.1 WATER POTENTIAL MEASUREMENTS

All soil water potential measurement techniques measure the potential energy of water in equilibrium with water in the soil. The Second Law of Thermodynamics states that connected systems with differing energy levels move toward an equilibrium energy level. When an object, such as a tensiometer ceramic tip, comes into hydraulic contact with the soil, the water potential of the object comes into equilibrium with the soil water potential.

The water in the tensiometer ceramic transmits the total potential from the soil water through the porous ceramic to the pressure transducer. The ceramic tip acts as a semipermeable diaphragm with very high water conductivity. Getting good capillary contact with the surrounding soil is very important.

Equation 1 gives the component variables for determining total soil water potential (Ψ_t).

$$\Psi_t = \Psi_p + \Psi_g + \Psi_o + \Psi_m$$

Equation 1

where:

Ψ_p is atmospheric pressure

Ψ_g is gravitations potential

Ψ_o is osmotic potential

Ψ_m is matric potential

For tensiometer applications, Ψ_g is generally insignificant. Ψ_p should be measured by a reference sensor (BARO Module). Ψ_o arises from dissolved salts in the soil and becomes important only if a semipermeable barrier is present that prevents ionic movement. The METER tensiometer ceramics have a pore size of r = 0.3 μm and cannot block ions, so the osmotic potential is negligible. Ψ_m arises from water attraction to the soil particles and is the most important component of water potential in most soils. Tensiometers respond to the matric potential of the soil (Ψ_m).

3.2.2 BAROMETRIC COMPENSATION

Tensiometers measure the sum of matric potential and atmospheric pressure potential ($\Psi_p + \Psi_m$). To extract the matric potential, the barometric pressure should also be registered with a reference sensor. METER ZL6 and EM60 data loggers include a barometric pressure sensor and convert the signal into soil water potential. One atmospheric pressure sensor at every measuring site is enough to convert all tensiometer measurements at the site.

A barometric sensor (BARO Module) is needed at the measuring site if using a non-METER data logger.

4. SERVICE

This section contains information about calibration, maintenance guidelines, customer support contact information, and terms and conditions.

4.1 CALIBRATION AND MAINTENANCE

METER software tools automatically apply factory calibrations to the sensor output data.

The BARO Module may be returned to METER for maintenance in the following areas:

- system inspection
- instrument cleaning

Replacement parts can also be ordered from METER. Contact Customer Support for more information.

4.2 CUSTOMER SUPPORT

NORTH AMERICA

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 7:00 am to 5:00 pm Pacific time.

Email: support.environment@metergroup.com
sales.environment@metergroup.com

Phone: +1.509.332.5600

Fax: +1.509.332.5158

Website: metergroup.com

EUROPE

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 8:00 to 17:00 Central European time.

Email: support.europe@metergroup.com
sales.europe@metergroup.com

Phone: +49 89 12 66 52 0

Fax: +49 89 12 66 52 20

Website: metergroup.com

If contacting METER by email, please include the following information:

Name	Email address
Address	Instrument serial number
Phone	Description of the problem

NOTE: For products purchased through a distributor, please contact the distributor directly for assistance.

4.3 TERMS AND CONDITIONS

By using METER instruments and documentation, you agree to abide by the METER Group, Inc. Terms and Conditions. Please refer to metergroup.com/terms-conditions for details.

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