METER

INTEGRATOR GUIDE
ATMOS 41 ALL-IN-ONE WEATHER STATION

SENSOR DESCRIPTION

The ATMOS 41 All-in-One Weather Station is designed for continuous monitoring of environmental variables, including all standard weather measurements (see Measurement Specifications). All sensors are integrated into a single unit, requiring minimal installation effort. Ultra-low power consumption and a robust, no moving parts design that prevents errors because of wear or fouling make the ATMOS 41 ideal for long-term, remote installations.

APPLICATIONS

• Weather monitoring

• Microenvironment monitoring

• Spatially distributed environmental monitoring

• Crop weather monitoring

• Fire danger monitoring/mapping

• Weather networks

ADVANTAGES

• Robust, no moving parts design

• Small form factor

• Integrated design for easy installation

• Low-input voltage requirements

• Low-power design supports battery-operated data loggers

• Supports the SDI-12 three-wire interface

• Tilt sensor informs user of out-of-level conditions

• No configuration necessary

• Measures all standard weather variables (plus several others)

PURPOSE OF THIS GUIDE

METER Group provides the information in this integrator's guide to help ATMOS 41 All-in-One Weather Station customers establish communication between these sensors and their data acquisition equipment or field data loggers. Customers using data loggers that support SDI-12 sensor communications should consult the data logger user manual. METER sensors are fully integrated into the METER system of plug-and-play sensors, cellular-enabled data loggers, and data analysis software.

COMPATIBLE FIRMWARE VERSIONS

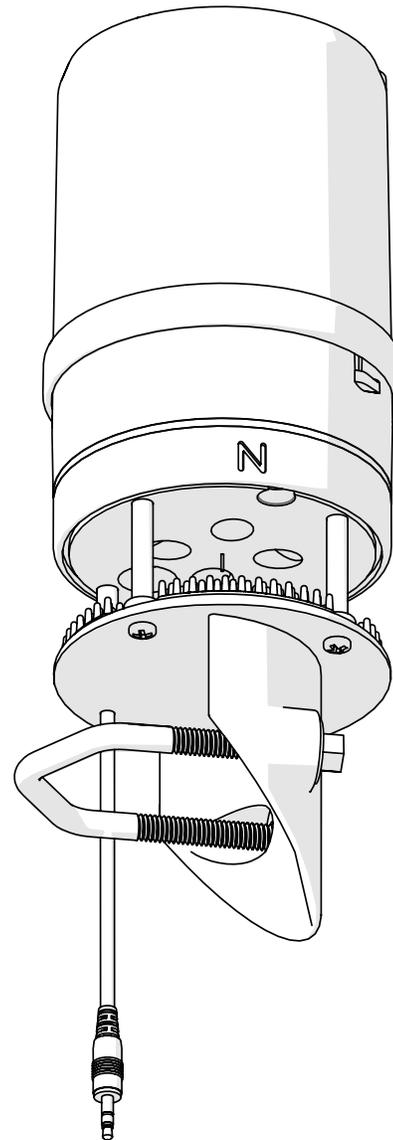This guide is compatible with firmware versions 4.61 or newer.

Figure 1   ATMOS 41 All-in-One Weather Station

SPECIFICATIONS
MEASUREMENT SPECIFICATIONS

Solar Radiation

Range:	0 to 1750 W/m^2
Resolution:	1 W/m^2
Accuracy:	±5% of measurement typical

Precipitation

Range:	0 to 400 mm/h
Resolution:	0.017 mm
Accuracy:	±5% of measurement from 0 to 50 mm/h

Vapor Pressure

Range:	0 to 47 kPa
Resolution:	0.01 kPa
Accuracy:	Varies with temperature and humidity, ±0.2 kPa typical below 40 °C

Relative Humidity

Range:	0 to 100%
Resolution:	0.1%
Accuracy:	Varies with temperature and humidity, ±3% RH typical

Air Temperature

Range:	−40 to 50 °C
Resolution:	0.1 °C
Accuracy:	±0.6 °C

Humidity Sensor Temperature

Range:	−40 to 50 °C
Resolution:	0.1 °C
Accuracy:	±1.0 °C

Barometric Pressure

Range:	50 to 110 kPa
Resolution:	0.01 kPa
Accuracy:	±0.1 kPa

Horizontal Wind Speed

Range:	0 to 30 m/s
Resolution:	0.01 m/s
Accuracy:	The greater of 0.3 m/s or 3% of measurement

Wind Gust

Range:	0 to 30 m/s
Resolution:	0.01 m/s
Accuracy:	The greater of 0.3 m/s or 3% of measurement

Wind Direction

Range:	0° to 359°
Resolution:	1°
Accuracy:	±5°

Compass Heading

Range:	0° to 359°
Resolution:	1°
Accuracy:	±5°

Tilt

Range:	0° to 180°
Resolution:	0.1°
Accuracy:	±1°

Lightning Strike Count

Range:	0 to 65535 strikes
Resolution:	1 strike
Accuracy:	Variable with distance, >25% detection at <10 km typical

Lightning Average Distance

Range:	0 to 40 km
Resolution:	3 km
Accuracy:	Variable

Dimensions

10 cm diameter x 34 cm height (includes rain gauge filter)

Cable Length

5 m (custom cable lengths are available for an additional cost)

ELECTRICAL AND TIMING CHARACTERISTICS

Supply Voltage (VCC) to GND	
Minimum	3.6 VDC continuous
Typical	
Maximum	15.0 VDC continuous

Digital Input Voltage (logic high)	
Minimum	2.8 V
Typical	3.0 V
Maximum	15.0 V

Digital Input Voltage (logic low)	
Minimum	−0.3 V
Typical	0.0 V
Maximum	0.8 V

Power Line Slew Rate	
Minimum	1.0 V/ms
Typical	
Maximum	

Current Drain (during measurement)	
Minimum	0.2 mA
Typical	8.0 mA
Maximum	16.0 mA

Current Drain (while asleep)	
Minimum	0.2 mA
Typical	0.3 mA
Maximum	0.4 mA

Operating Temperature Range	
Minimum	−40 °C
Typical	
Maximum	50 °C

Power Up Time (SDI Ready)—aRx! Commands	
Minimum	
Typical	10 s
Maximum	

Power Up Time (SDI Ready)—Other Commands	
Minimum	
Typical	800 ms
Maximum	

Measurement Duration	
Minimum	
Typical	110 ms
Maximum	3000 ms

COMPLIANCE

Manufactured under ISO 9001:2015

EM ISO/IEC 17050:2010 (CE Mark)

EQUIVALENT CIRCUIT AND CONNECTION TYPES

Refer to Figure 2 and Figure 3 to connect the ATMOS 41 to a logger. Figure 2 provides a low-impedance variant of the recommended SDI-12 specification.
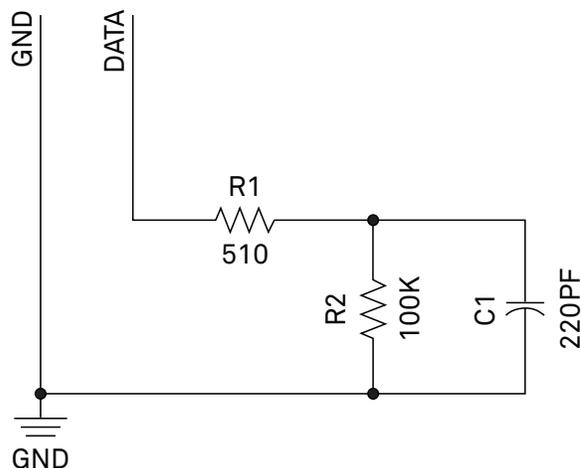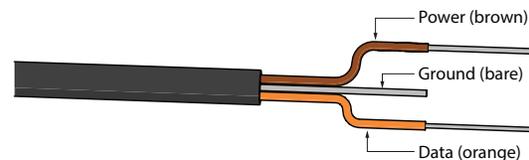

Figure 2   Equivalent circuit diagram

PIGTAIL CABLE

NOTE: Some early ATMOS 41 units may have the older Decagon wiring scheme where the power supply is white, the digital out is red, and the bare wire is ground.

STEREO CABLE

Figure 3   Connection types

⚠ SAFETY PRECAUTIONS

METER sensors are built to the highest standards, but misuse, improper protection, or improper installation may damage the sensor and possibly void the warranty. Before integrating sensors into a sensor network, follow the recommended installation instructions and implement safeguards to protect the sensor from damaging interference.

SURGE CONDITIONS

Sensors have built-in circuitry that protects them against common surge conditions. Installations in lightning-prone areas, however, require special precautions, especially when sensors are connected to a well-grounded third-party logger.

Visit metergroup.com for articles containing more information.

CABLES

Improperly protected cables can lead to severed cables or disconnected sensors. Cabling issues can be caused by many factors, including rodent damage, driving over sensor cables, tripping over the cable, not leaving enough cable slack during installation, or poor sensor wiring connections. To relieve strain on the connections and prevent loose cabling from being inadvertently snagged, gather and secure the cable travelling between the ATMOS 41 and the data acquisition device to the mounting mast in one or more places. Install cables in conduit or plastic cladding when near the ground to avoid rodent damage. Tie excess cable to the data logger mast to ensure cable weight does not cause sensor to unplug.

SENSOR COMMUNICATIONS

METER digital sensors feature a 3-wire interface following SDI-12 protocol for communicating sensor measurements.

SDI-12 INTRODUCTION

SDI-12 is a standards-based protocol for interfacing sensors to data loggers and data acquisition equipment. Multiple sensors with unique addresses can share a common 3-wire bus (power, ground, and data). Two-way communication between the sensor and logger is possible by sharing the data line for transmit and receive as defined by the standard. Sensor measurements are triggered by protocol command. The SDI-12 protocol requires a unique alphanumeric sensor address for each sensor on the bus so that a data logger can send commands to and receive readings from specific sensors.

Download the SDI-12 Specification v1.3 and learn more about the SDI-12 protocol.

DDI SERIAL INTRODUCTION

The DDI serial protocol is the method used by the METER family of data loggers for collecting data from the sensor. This protocol uses the data line configured to transmit data from the sensor to the receiver only (simplex). Typically, the receive side is a microprocessor UART or a general-purpose IO pin using a bitbang method to receive data. Sensor measurements are triggered by applying power to the sensor. When the ATMOS 41 is set to address 0, a DDI serial string is sent on power up, identifying the sensor.

INTERFACING THE SENSOR TO A PC

The serial signals and protocols supported by the sensor require some type of interface hardware to be compatible with the serial port found on most personal computers (or USB-to-serial adapters). There are several SDI-12 interface adapters available in the marketplace; however, METER has not tested any of these interfaces and cannot make a recommendation as to which adapters work with METER sensors. METER data loggers and the ProCheck hand-held device can operate as a computer-to-sensor interface for making on-demand sensor measurements. For more information, please contact Customer Support.

METER SDI-12 IMPLEMENTATION

METER sensors use a low-impedance variant of the SDI-12 standard sensor circuit (Figure 2). During the power-up time, sensors output some sensor diagnostic information and should not be communicated with until the power-up time has passed. After the power up time, the sensors are compatible with all commands listed in the SDI-12 Specification v1.3 except for the continuous measurement commands (aR0–aR9 and aRC0–aRC9) and the concurrent measurement commands (aC–aC9 and aCC0–aCC9). M, R, and C command implementations are found on pages 7–9.

Out of the factory, all METER sensors start with SDI-12 address 0 and print out the DDI serial startup string during the power up time. This can be interpreted by non-METER SDI-12 sensors as a pseudo-break condition followed by a random series of bits.

The ATMOS 41 All-in-One Weather Station will omit the DDI serial startup string (sensor identification) when the SDI-12 address is nonzero.

Because of the complexity of the ATMOS 41 internal measurement sequence, the ATMOS 41 should not be read more frequently than every 2 min. **Issuing the aM!, aR0!, aR3!, and aC! commands more frequently than every 2 min can compromise the measurement sequence, resulting in the ATMOS 41 outputting error codes instead of valid data**. Please see ATMOS 41 Internal Measurement Sequence for more details.

ATMOS 41 INTERNAL MEASUREMENT SEQUENCE

While powered up, the ATMOS 41 takes solar radiation, precipitation, wind, and air temperature measurements every 10 s and logs the values internally. Orientation, compass, vapor pressure, atmospheric pressure, and relative humidity are measured every 60 s and also logged internally. The aR4! command will output instantaneous measurements of these parameters and must be used at intervals of 10 s or greater for the response to be returned within the SDI-12 specification of 15.0 ms.

The aM!, aR0!, aR3!, and aC! commands (and subsequent D commands when necessary) will compute and output the averages, accumulations, or maximums of these measurements (and derived measurements) and reset internal averaging counters and accumulators. Hence, it is not necessary to oversample the ATMOS 41 and compute averages, accumulations, and maximums in external data acquisition systems. Less frequent sampling has the additional benefit of decreasing data acquisition system and ATMOS 41 power consumption. **Issuing the aM!, aR0!, aR3!, and aC! commands more frequently than every 2 min can compromise the measurement sequence, resulting in the ATMOS 41 outputting error codes instead of valid data**. The ATMOS 41 has two error codes available—general error code −9999 and invalid wind measurement error code −9990.

SENSOR BUS CONSIDERATIONS

Because of the complexity and substantial number of measurements, METER advises against the use of the ATMOS 41 in a bus configuration. The recommended usage is to connect it to a dedicated port on the logger.

SDI-12 CONFIGURATION

Table 1 lists the SDI-12 communication configuration.

Table 1   SDI-12 communication configuration

Baud Rate	1200
Start Bits	1
Data Bits	7 (LSB first)
Parity Bits	1 (even)
Stop Bits	1
Logic	Inverted (active low)

SDI-12 TIMING

All SDI-12 commands and responses must adhere to the format in Figure 4 on the data line. Both the command and response are preceded by an address and terminated by a carriage return line feed combination and follow the timing shown in Figure 5.
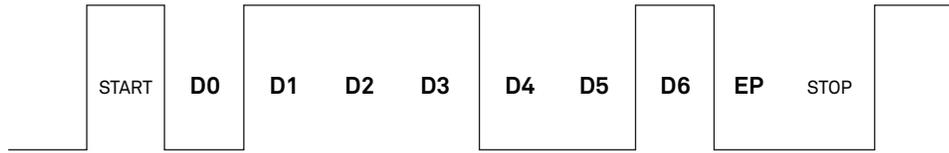
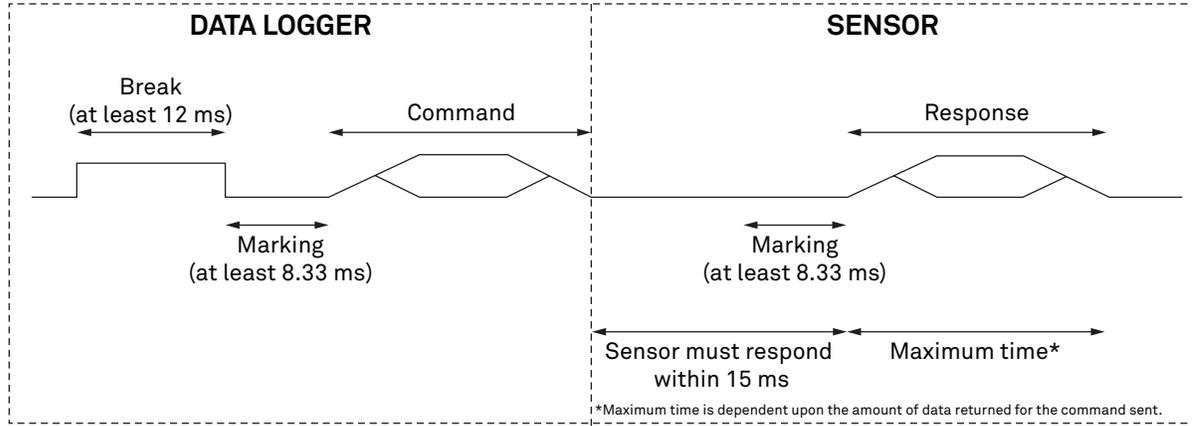Figure 4   Example SDI-12 transmission of the character 1 (0x31)

Figure 5   Example data logger and sensor communication

COMMON SDI-12 COMMANDS

This section includes tables of common SDI-12 commands that are often used in an SDI-12 system and the corresponding responses from METER sensors.

IDENTIFICATION COMMAND (`aI!`)

The Identification command can be used to obtain a variety of detailed information about the connected sensor. An example of the command and response is shown in Example 1, where the command is in **bold** and the response follows the command.

Example 1   **1I!**113METER␣␣␣ATM41␣404631800001

Parameter	Fixed Character Length	Description
1I!	3	Data logger command Request to the sensor for information from sensor address 1.
1	1	Sensor address Prepended on all responses, this indicates which sensor on the bus is returning the following information.
13	2	Indicates that the target sensor supports SDI-12 Specification v1.3
METER␣␣␣	8	Vendor identification string (METER and three spaces ␣␣␣ for all METER sensors)
ATM41␣	6	Sensor model string This string is specific to the sensor type. For the ATMOS 41, the string is ATM41␣.
404	3	Sensor version This number divided by 404 is the METER sensor version (e.g., 404 is version 4.04).
631800001	≤13, variable	Sensor serial number This is a variable length field. It may be omitted for older sensors.

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CHANGE ADDRESS COMMAND (aAB!)

The Change Address command is used to change the sensor address to a new address. All other commands support the wildcard character as the target sensor address except for this command. All METER sensors have a default address of 0 (zero) out of the factory. Supported addresses are alphanumeric (i.e., a−z, A−Z, and 0−9). An example output from a METER sensor is shown in Example 2, where the command is in **bold** and the response follows the command.

Example 2   **1A0!**0

Parameter	Fixed Character Length	Description
1A0!	4	Data logger command
		Request to the sensor to change its address from 1 to a new address of 0.
0	1	New sensor address.
		For all subsequent commands, this new address will be used by the target sensor.

ADDRESS QUERY COMMAND (?!)

While disconnected from a bus, the Address Query command can be used to determine which sensors are currently being communicated with. Sending this command over a bus will cause a bus contention where all the sensors will respond simultaneously and corrupt the data line. This command is helpful when trying to isolate a failed sensor. Example 3 shows an example of the command and response, where the command is in **bold** and the response follows the command. The question mark (?) is a wildcard character that can be used in place of the address with any command except the Change Address command.

Example 3   **?!**0

Parameter	Fixed Character Length	Description
?!	2	Data logger command
		Request for a response from any sensor listening on the data line
0	1	Sensor address.
		Returns the sensor address to the currently connected sensor.

COMMAND IMPLEMENTATION

The following tables list the relevant Measurement (M), Continuous (R), and Concurrent (C) commands and subsequent Data (D) commands when necessary.

MEASUREMENT COMMANDS IMPLEMENTATION

Measurement (M) commands are sent to a single sensor on the SDI-12 bus and require that subsequent Data (D) commands are sent to that sensor to retrieve the sensor output data before initiating communication with another sensor on the bus.

Please refer to Table 2 and Table 3 for an explanation of the command sequence and see Table 8 for an explanation of response parameters.

Table 2 `aM!` command sequence

COMMAND	RESPONSE
This command reports average, accumulated, or maximum values.	
Do not issue this command more frequently than every 2 min, or the ATMOS 41 measurements may be compromised. Please see ATMOS 41 Internal Measurement Sequence for more details.	
`aM!`	`atttn`
`aD0!`	`a+<solar>+<precipitation>+<strikes>`
`aD1!`	`a+<windSpeed>+<windDirection>+<gustWindSpeed>`
`aD2!`	`a±<airTemperature>+<vaporPressure>+<atmosphericPressure>`

NOTE: The measurement and corresponding data commands are intended to be used back to back. After a measurement command is processed by the sensor, a service request a `<CR><LF>` is sent from the sensor signaling the measurement is ready. Either wait until `ttt` seconds have passed or wait until the service request is received before sending the data commands. See the SDI-12 Specifications v1.3 document for more information.

Table 3 `aM1!` command sequence

COMMAND	RESPONSE
This command reports instantaneous values.	
`aM1!`	`atttn`
`aD0!`	`a±<xOrientation>±<yOrientation>+<compassHeading>`

NOTE: The measurement and corresponding data commands are intended to be used back to back. After a measurement command is processed by the sensor, a service request a `<CR><LF>` is sent from the sensor signaling the measurement is ready. Either wait until `ttt` seconds have passed or wait until the service request is received before sending the data commands. See the SDI-12 Specifications v1.3 document for more information.

CONCURRENT MEASUREMENT COMMANDS IMPLEMENTATION

Concurrent (`C`) measurement commands are typically used with sensors connected to a bus. Because of the complexity of the measurement scheme in the ATMOS 41 and how the SDI-12 communication is affected by it, **the ATMOS 41 should not be used on a bus with other sensors**.

Please refer to Table 4 for an explanation of the command sequence and see Table 8 for an explanation of response parameters.

Table 4 `aC!` measurement command sequence

COMMAND	RESPONSE
This command reports average, accumulated, or maximum values.	
Do not issue this command more frequently than every 2 min, or the ATMOS 41 measurements may be compromised. Please see ATMOS 41 Internal Measurement Sequence for more details.	
`aC!`	`atttnn`
`aD0!`	`a+<solar>+<precipitation>+<strikes>+<strikeDistance>`
`aD1!`	`a+<windSpeed>+<windDirection>+<gustWindSpeed>`
`aD2!`	`a±<airTemperature>+<vaporPressure>+<atmosphericPressure>+<relativeHumidity>±<humiditySensorTemperature>`
`aD3!`	`a±<xOrientation>±<yOrientation>+<compassHeading>`
`aD4!`	`a±<NorthWindSpeed>±<EastWindSpeed>+<gustWindSpeed>`

NOTE: Please see the SDI-12 Specifications v1.3 document for more information.

CONTINUOUS MEASUREMENT COMMANDS IMPLEMENTATION

Continuous (`R`) measurement commands trigger a sensor measurement and return the data automatically after the readings are completed without needing to send a `D` command.

The `aR4!` command must be used at intervals of 10 s or greater for the response to be returned within 15.0 ms as defined in the SDI-12 standard.

`aR0!`, `aR3!`, and `aR4!` return more characters in their responses than the 75-character limitation called out in the SDI-12 Specification v1.3. It is recommended to use a buffer that can store at least 116 characters.

Please refer to Table 5 through Table 7 for an explanation of the command sequence and see Table 8 for an explanation of response parameters.

Table 5   `aR0!` measurement command sequence

COMMAND	RESPONSE
This command reports average, accumulated, or maximum values.	
Do not issue this command more frequently than every 2 min, or the ATMOS 41 measurements may be compromised. Please see ATMOS 41 Internal Measurement Sequence for more details.	
`aR0!`	`a+<solar>+<precipitation>+<strikes>+<strikeDistance>+<windSpeed>` `+<windDirection>+<gustWindSpeed>±<airTemperature>+<vaporPressure>` `+<atmosphericPressure>+<relativeHumidity>±<humiditySensorTemperature>` `±<xOrientation>±<yOrientation>+<compassHeading>±<NorthWindSpeed>` `±<EastWindSpeed>`

NOTE: This command does not adhere to the SDI-12 response timing. See METER SDI-12 Implementation for more information.

Table 6   `aR3!` measurement command sequence

COMMAND	RESPONSE
This command reports average, accumulated, or maximum values.	
Do not issue this command more frequently than every 2 min, or the ATMOS 41 measurements may be compromised. Please see ATMOS 41 Internal Measurement Sequence for more details.	
`aR3!`	`a<TAB><solar> <precipitation> <strikes> <strikeDistance> <NorthWindSpeed>` `<EastWindSpeed> <gustWindSpeed> <airTemperature> <vaporPressure>` `<atmosphericPressure> <xOrientation> <yOrientation> <compassHeading>` `<humiditySensorTemperature><CR><sensortype><Checksum><CRC>`

NOTE: This command does not adhere to the SDI-12 response format. However, it does adhere to SDI-12 timing if it is sent at intervals ≥2 min. See METER SDI-12 Implementation for more information.

Table 7   `aR4!` measurement command sequence

COMMAND	RESPONSE
This command reports instantaneous values.	
`aR4!`	`a<TAB><solar> <precipitation> <strikes> <strikeDistance> <NorthWindSpeed>` `<EastWindSpeed> <gustWindSpeed> <airTemperature> <vaporPressure>` `<atmosphericPressure> <xOrientation> <yOrientation> <compassHeading>` `<humiditySensorTemperature><CR><sensortype><Checksum><CRC>`

NOTE: This command does not adhere to the SDI-12 response format. However, it does adhere to SDI-12 timing if it is sent at intervals ≥10 s. See METER SDI-12 Implementation for more information.

PARAMETERS

Table 8 lists the parameters, unit measurement, and a description of the parameters returned in command responses for ATMOS 41.

Table 8   Parameter Descriptions

PARAMETER	UNIT	DESCRIPTION
±	—	Positive or negative sign denoting sign of the next value
a	—	SDI-12 address
n	—	Number of measurements (fixed width of 1)
nn	—	Number of measurements with leading zero if necessary (fixed width of 2)
ttt	s	Maximum time measurement will take (fixed width of 3)
<TAB>	—	Tab character
<CR>	—	Carriage return character

Table 8   Parameter Descriptions (continued)

PARAMETER	UNIT	DESCRIPTION
`<LF>`	—	Line feed character
`<solar>`	W/m²	Solar radiation (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<precipitation>`	mm	Rainfall since the last measurement
`<strikes>`	—	Number of lightning strikes detected since last measurement
`<strikeDistance>`	km	Average strike distance from sensor since last measurement
`<NorthWindSpeed>`	m/s	Wind speed from the northerly direction (negative values denote southerly direction) (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<EastWindSpeed>`	m/s	Wind speed from the easterly direction (negative values denote westerly direction) (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<windSpeed>`	m/s	Combined wind speed magnitude of the `<NorthWindSpeed>` and `<EastWindSpeed>` (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<gustWindSpeed>`	m/s	Maximum measured `<windSpeed>` since the last measurement
`<windDirection>`	°	Wind heading clockwise from north reference (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<airTemperature>`	°C	Air temperature (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<vaporPressure>`	kPa	Vapor pressure (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<atmosphericPressure>`	kPa	Atmospheric pressure (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<relativeHumidity>`	RH	Relative humidity as computed with either average or instantaneous values of `<vaporPressure>` and `<airTemperature>`, depending on SDI-12 command used
`<humiditySensor Temperature>`	°C	Internal temperature measured with the relative humidity sensor (average since the last measurement or instantaneous value depending on SDI-12 command used)
`<xOrientation>`	°	X orientation angle (0 is level) (last measured value)
`<yOrientation>`	°	Y orientation angle (0 is level) (last measured value)
`<compassHeading>`	°	Compass heading clockwise from north reference (last measured value)
`<sensortype>`	—	ASCII character denoting the sensor type For ATMOS 41, the character is the right square bracket] character
`<Checksum>`	—	METER serial checksum
`<CRC>`	—	METER serial 6-bit CRC

COMPASS CONFIGURATION COMMAND (?Xg!)

When this setting is set to 1, the wind direction is corrected for magnetic north. To correct to true north, an offset in software to correct the data from magnetic declination at the installation location is required. Setting this value to 0 (default condition) disables the correction and requires that the sensor be oriented to north according to the **N** on the sensor housing. Below are examples of the commands and responses in Example 4, where the commands are in bold and the responses follow the commands.

NOTE: Mounting the ATMOS 41 on ferrous (magnetic) hardware will invalidate the compass heading, so instruments mounted on steel poles should have the compass correction disabled.

Example 4   **?Xg!**0

To get the magnetic north correction setting for wind direction state:

aXg!a␣1

To disable the magnetic north correction for wind direction:

aXg0!aOK

To enable the magnetic north correction for wind direction:

aXg1!aOK

Parameter	Fixed Character Length	Description
a	1	SDI-12 address.
Xg	2	Compass configuration command.
1	1	Magnetic north correction for wind direction state. 1 = correction is enabled 0 = correction is disabled. If this value is omitted, then the current setting is returned.
!	1	Termination character for command.

NOTE: If an invalid parameter is communicated, ERROR will be returned instead of OK.

DDI SERIAL CHECKSUM

These checksums are used in the continuous commands R3 and R4 as well as DDI serial response. The legacy checksum is computed from the start of the transmission to the sensor identification character.

Legacy checksum example input is **<TAB>**0**<CR>]** and the resulting checksum output is C.

```c
char LegacyChecksum(char * Response)
{
      int length, sum = 0, i, crc;

      // Finding the length of the response string
      length = strlen(Response);

      // Adding characters in the response together
      for( i = 0; i < length; i++ ){
          sum += Response[i];
      }

      // Converting checksum to a printable character
      crc = sum % 64 + 32;

      return crc;
}
```

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The more robust CRC6, supported in firmware version 4.61 or newer, utilizes the CRC-6-CDMA2000-A polynomial with the value 48 added to the results to make this a printable character and is computed from the start of the transmission to the legacy checksum character.

CRC6 checksum example input is **<TAB>0<CR>]C** and the resulting checksum is the character k.

```c
unit8_t CRC6_Offset (uint8_t * buffer, uint16_t bytes)
{
    uint16_t byte;
    uint8_t bit;
    uint8_t crc = 0xfc;   // Set upper 6 bits to 1's

    // Loop through all the bytes in the buffer
    for(byte = 0; byte < bytes; byte++)
    {

     // Get the next byte in the buffer and XOR it with the crc
     crc ^= buffer[byte];

        // Loop through all the bits in the current byte
        for(bit = 8; bit > 0; bit--)
        {
            // If the uppermost bit is a 1...
            if(crc & 0x80)
            {
                // Shift to the next bit and XOR it with a polynomial
                crc = (crc << 1) ^ 0x9c;
            }
            else
            {

                // Shift to the next bit
                crc = crc << 1;
            }
        }
    }

    // Shift upper 6 bits down for crc
    crc = (crc >> 2);

    // Add 48 to shift crc to printable character avoiding \r \n and !
    return (crc + 48);
}
```

CUSTOMER SUPPORT

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 8 am–5 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

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

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

NOTE: For ATMOS 41 All-in-One Weather Stations purchased through a distributor, please contact the distributor directly for assistance.

REVISION HISTORY

The following table lists document revisions.

Revision	Date	Compatible Firmware	Description
01	12.7.2017	4.61	Added Concurrent (C) command. Reduced wind speed specification. Added CRC6.
00	10.27.2017	4.49	Initial release.