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METER

SOLYX 14 INTEGRATOR GUIDE

SENSOR DESCRIPTION

The SOLYX 14 Complex Dielectric sensor measures volumetric water content (VWC), temperature, and electrical conductivity (EC). The SOLYX 14 determines VWC using complex dielectric technology. The sensor uses a 70 MHz frequency, which minimizes textural and salinity effects, making the SOLYX 14 accurate in most mineral soils. The SOLYX 14 uses an embedded thermistor to measure temperature, and electrical conductivity and VWC from the complex permittivity.

For a more detailed description of how this sensor makes measurements, refer to the SOLYX 14 User Manual (meter.ly/solyx14-um).

APPLICATIONS

- Volumetric water content (VWC) measurement
- Soil/substrate water balance
- Irrigation management
- Soil electrical conductivity (EC) measurement
- Soil/substrate temperature measurement
- Solute/fertilizer movement
- Plant growth research

ADVANTAGES

- Three-wire sensor interface: power, ground, and data
- Digital sensor communicates multiple measurements over a serial interface
- Robust thermistor for accurate temperature measurements
- Low-input voltage requirements
- Low-power design supports battery-operated data loggers
- Robust epoxy encapsulation resists corrosive environments
- Supports SDI-12 or DDI Serial communications protocols
- Modern design optimized for low-cost sensing

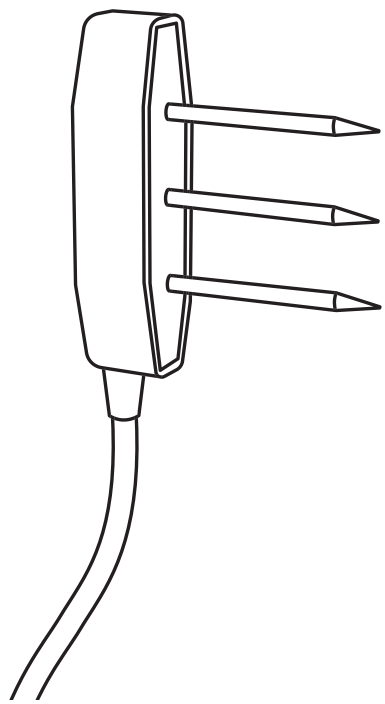

Figure 1 SOLYX 14 sensor

PURPOSE OF THIS GUIDE

METER Group provides the information in this integrator guide to help SOLYX 14 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's manual. This sensor is fully integrated into the METER system of plug-and-play sensors, cellular-enabled data loggers, and data analysis software. For more information about METER integrated systems, please contact Customer Support.

COMPATIBLE FIRMWARE VERSIONS

This guide is compatible with firmware versions 1.00 or newer.

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SPECIFICATIONS

MEASUREMENT SPECIFICATIONS

Volumetric Water Content (VWC)	
Range	
Mineral Soil Calibration	0.00–0.72 m^3/m^3
Real dielectric permittivity (ε_r)	1 (air) to 80 (water)

NOTE: The VWC range is dependent on the media, the sensor is calibrated to. A custom calibration will accommodate the necessary ranges for most substrates.

Resolution	0.001 m^3/m^3
Accuracy	
Generic calibration	±0.03 m^3/m^3 typical in mineral soils
Medium specific calibration	±0.01 m^3/m^3 in any porous medium
Real dielectric permittivity (ε_r)	± 1 ε_r (unitless)

Dielectric Measurement Frequency

70 MHz

Temperature	
Range	−40 to +60 °C
Resolution	0.1 °C
Accuracy	±0.3 °C from 0 to 60 °C ±1 °C from −40 to 0 °C

NOTE: Temperature measurement for applicable sensor may not be accurate if sensor is not fully immersed in the medium of interest due to longer equilibration time.

Bulk Electrical Conductivity (EC)	
Range	0–20 dS/m (bulk)
Resolution	0.001 dS/m
Accuracy	±(5% + 0.1 dS/m) from 0–10dS/m ±8% from 10–20 dS/m

COMMUNICATION SPECIFICATIONS

Output

DDI Serial or SDI-12 communications protocol

Data Logger Compatibility

METER ZL6 data loggers and any data acquisition system capable of 4.0 to 15 VDC power and serial or SDI-12 communications.

PHYSICAL SPECIFICATIONS

Dimensions	
Length	8.9 cm (3.50 in)
Width	2.5 cm (0.98 in)
Height	7.5 cm (2.96 in)

Prong Length

5.5 cm (2.17)

IP Rating

IP 65 and 67

Operating Temperature Range	
Minimum	−40 °C
Typical	N/A
Maximum	60 °C

NOTE: Sensors may be used at higher temperatures under certain conditions; contact Customer Support for assistance.

Cable Length

5 m (standard)
75 m (maximum custom cable length)

NOTE: Contact Customer Support if a nonstandard cable length is needed.

Cable Diameter

0.54 ±0.01 cm (0.212 ±0.004 in) with minimum jacket of 0.076 cm (0.030 in)

Connector Types

3.5-mm stereo plug connector or stripped and tinned wires

Conductor Gauge

20-AWG / 22-AWG drain wire

ELECTRICAL AND TIMING CHARACTERISTICS

Supply Voltage (power to ground)	
Minimum	4.0 VDC continuous
Typical	N/A
Maximum	15.0 VDC continuous

Digital Input Voltage (logic high)	
Minimum	2.8 V
Typical	3.6 V
Maximum	5.0 V

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

Digital Output Voltage (logic high)	
Minimum	N/A
Typical	3.6 V
Maximum	N/A
Power Line Slew Rate	
Minimum	1.0 V/ms
Typical	N/A
Maximum	N/A
Required Supply Current	
Minimum	16.0 mA
Typical	N/A
Maximum	N/A
Current Drain (during measurement)	
Minimum	N/A
Typical	4.43 mA NOTE: 372 ms ?M! command
Maximum	N/A
Current Drain (while asleep)	
Minimum	N/A
Typical	0.03 mA
Maximum	0.06 mA

Power Up Time (DDI Serial)	
Minimum	N/A
Typical	100 ms
Maximum	350 ms
Power Up Time (SDI-12)	
Minimum	N/A
Typical	260 ms
Maximum	N/A
Power Up Time (SDI-12, DDI disabled)	
Minimum	N/A
Typical	170 ms
Maximum	N/A
Measurement Duration	
Minimum	N/A
Typical	50 ms
Maximum	N/A

COMPLIANCE

EM ISO/IEC 17050:2010 (CE Mark) CE (DoC upon request)
2014/30/EU (EMC) via EN 61326-1:2013
2011/65/EU(RoHS) via EN 63000:2018
CISPR 11:2024 Group 2 Class A

COMPLIANCE STATEMENTS

This device complies with Canadian ICES-001 (Group 2 Class A).

This device has been tested and found to comply with the limits for Industrial, Scientific, and Medical (ISM) equipment pursuant to Part 18 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in commercial, industrial, or business environments.

This equipment generates, uses and can radiate radio frequency energy and may cause harmful interference to radio communications. If this device does cause harmful interference to radio or television reception, which can be determined by turning the device off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the device and receiver.

Responsible Party: METER Group Inc, 2365 NE Hopkins Ct, Pullman, WA, 99163, USA, +1-509-332-2756

EQUIVALENT CIRCUIT AND CONNECTION TYPES

Refer to Figure 2 and Figure 3 to connect the SOLYX 14 to a data logger.

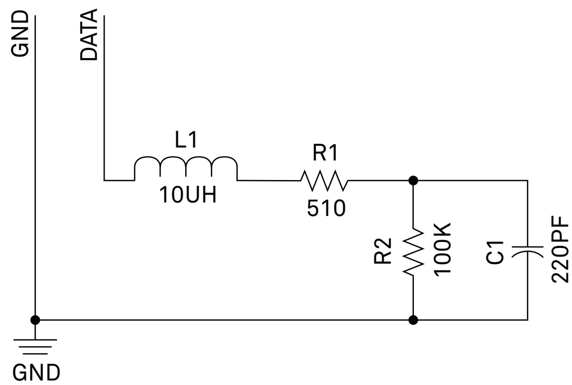

Figure 2 Equivalent circuit diagram

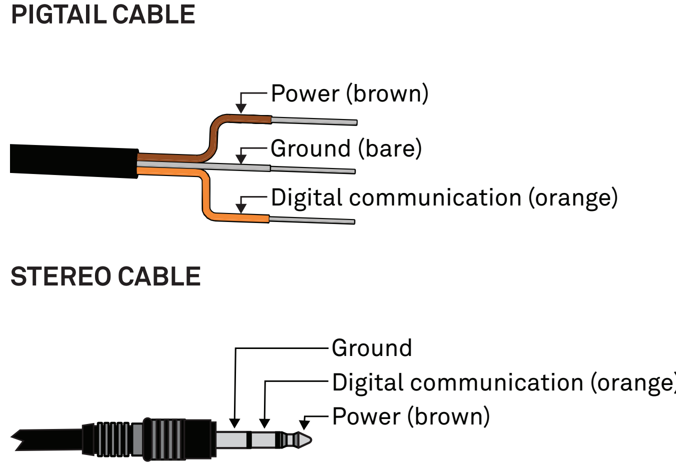

Figure 3 Connection types

⚠ 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.

Read the application note Lightning surge and grounding practices on the METER website for more information.

POWER AND GROUNDING

Ensure there is sufficient power to simultaneously support the maximum sensor current drain for all the sensors on the bus. The sensor protection circuitry may be insufficient if the data logger is improperly powered or grounded. Refer to the data logger installation instructions. Improper grounding may affect the sensor output as well as sensor performance.

Read the application note Lightning surge and grounding practices on the METER website for 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 SOLYX 14 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 serial interface which can receive commands and transmit measurements over the same data wire (Figure 3). The sensor supports two different protocols: SDI-12 and DDI Serial. Each protocol has implementation advantages and challenges. Please contact Customer Support if the protocol choice for the desired application is not obvious.

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 v1.4 to learn more about the SDI-12 protocol.

DDI SERIAL INTRODUCTION

The DDI Serial protocol is the method used by the METER 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 I/O pin using a bitbang method to receive data. Sensor measurements are triggered by applying power to the sensor.

INTERFACING THE SENSOR TO A COMPUTER

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 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 ZSC handheld devices 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 fully compatible with all commands listed in the SDI-12 Specification v1.4 except for the continuous measurement commands (`aC` – `aC9` and `aCC0` – `aCC9`). `M`, `R`, and `C` command implementations are found on pages 8–9.

Out of the factory, all METER sensors are configured 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 SOLYX 14 will omit the DDI Serial startup string when the SDI-12 address is nonzero. Changing the address to a nonzero address is recommended for this reason.

SENSOR BUS CONSIDERATIONS

SDI-12 sensor buses require regular checking, sensor upkeep, and sensor troubleshooting. If one sensor goes down, that may take down the whole bus even if the remaining sensors are functioning normally. Power cycling the SDI-12 bus when a sensor is failing is acceptable, but METER does not recommend scheduling power cycling events on an SDI-12 bus more than once or twice per day. Many factors influence the effectiveness of the bus configuration. Visit metergroup.com for articles and virtual seminars containing more information.

SENSOR ERROR CODES

The SOLYX 14 has three error codes:

`-9999` is output in place of the measured value if the sensor detects that the measurement function has been compromised and the subsequent measurement values have no meaning

`-9992` is output in place of the measured value if the sensor detects corrupt or lost calibrations

`-9991` is output in place of the measured value if the sensor detects insufficient voltage to perform the measurement

SDI-12 CONFIGURATION

Table 1 lists the SDI-12 communications configuration.

Table 1 SDI-12 communications configuration

Baud Rate (bps)	1,200
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 and line feed combination (`<CR><LF>`) and follow the timing shown in Figure 5.

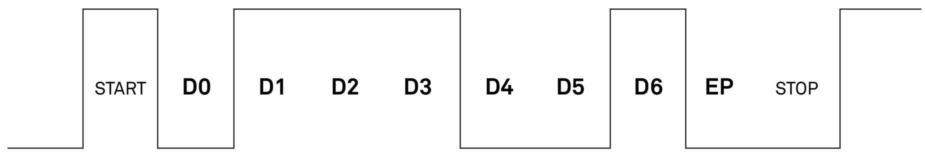

Figure 4 Example SDI-12 transmission of the character 1 (`0x31`)

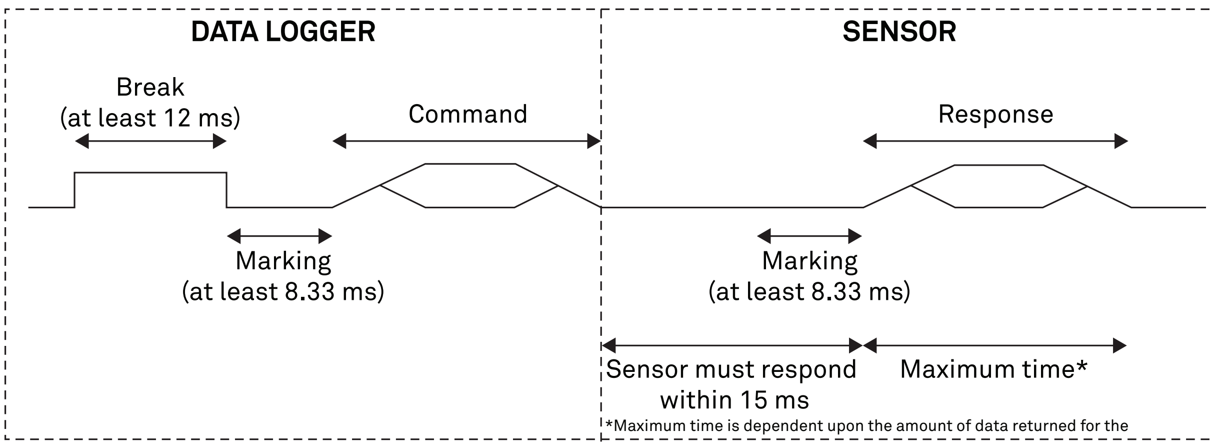

Figure 5 Example data logger and sensor communication

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!114METER␣␣␣SLYX14␣114631800001`

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.
14	2	Indicates that the target sensor supports SDI-12 Specification v1.4.
METER␣␣␣	8	Vendor identification string. (METER and three spaces ␣␣␣ for all METER sensors)
SLYX14␣	6	Sensor model string. This string is specific to the sensor type. For the SOLYX 14, the string is SLYX14␣.
114	3	Sensor version. This number divided by 100 is the METER sensor version (e.g., 114 is version 1.14).
631800001	≤13, variable	Sensor serial number. This is a variable length field. It may be omitted for older sensors.

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.

NOTE: SDI-12 commands `MC`, `CC`, and `RC` that request the sensor response include cyclical redundancy check characters may also be used.

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 for an explanation of the command sequence and to Table 7 for an explanation of response parameters.

Table 2 `aM!` command sequence

Command	Response
This command reports average, accumulated, or maximum values.	
`aM!`	`atttn`
`aD0!`	`a+<dielectricPermittivity>±<temperature>+<electricalConductivity>`
`aD1!`	`a+<VWC>`

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 Measurement (`C`) commands are typically used with sensors connected to a bus. `C` commands for this sensor deviate from the standard `C` command implementation. First, send the `C` command, wait the specified amount of time detailed in the `C` command response, and then use `D` commands to read its response prior to communicating with another sensor.

Please refer to Table 3 for an explanation of the command sequence and to Table 7 for an explanation of response parameters.

Table 3 `aC!` measurement command sequence

Command	Response
This command reports instantaneous values.	
`aC!`	`atttnn`
`aD0!`	`a+<dielectricPermittivity>±<temperature>+<electricalConductivity>`
`aD1!`	`a+<VWC>`

NOTE: Please see the SDI-12 Specifications v1.4 document for more information.

VERIFICATION COMMAND IMPLEMENTATION

The Verification (`V`) command is intended to give users a means to determine information about the current state of the sensor. The `V` command is sent first, followed by `D` commands to read the response.

Table 4 `aV!` measurement command sequence

Command	Response
`aV!`	`atttnn`
`aD0!`	`a±<meta>`

EXTENDED COMMAND IMPLEMENTATION

Extended (X) commands provide sensors with a means of performing manufacturer-specific functions. Additionally, the extended commands are utilized by METER systems and use a different response format than standard SDI-12 commands. X commands are required to be prefixed with the address and terminated with an exclamation point. Responses are required to be prefixed with the address and terminated with <CR><LF>.

METER implements the following X commands:

- aXRx! to trigger a sensor measurement and return the data automatically after the readings are completed without needing to send additional commands.
- aXO! (with capital O) to suppress the DDI Serial string.

Please refer to Table 5 and Table 6 for an explanation of the command sequence and see Table 7 for an explanation of response parameters.

Table 5 aXO! measurement command sequence

Command	Response
aXO!	a␣<suppressionstate>
aXO␣<suppressionState>!	aOK

NOTE: Command uses capital O as in oscar (not a zero).

Table 6 aXRO! measurement command sequence

Command	Response
aXRO!	a+<dielectricPermittivity>±<temperature>+<electricalConductivity>

NOTE: This command does not adhere to the SDI-12 response format or timing. The values in this command are space delimited. As such a + sign is not assigned between values, and a - sign is only present if the value is negative. See METER SDI-12 Implementation for more information.

PARAMETERS

Table 7 lists the parameters, unit measurement, and a description of the parameters returned in command responses for SOLYX 14.

Table 7 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
<LF>	—	Line feed character
<dielectricPermittivity>	—	Measured dielectric permittivity
<temperature>	°C	Air temperature
<electricalConductivity>	µS/cm	Bulk electrical conductivity normalized to 25 °C
<electricalConductivityDS>	dS/m	Bulk electrical conductivity with units of Decisiemens per Meter. Used in DDI Serial message.
<VWC>	m^3/m^3	Volumetric water content (mineral soil calibration)
<meta>	—	Auxiliary sensor information. See Table #

Table 7 Parameter Descriptions (continued)

<suppressionState>	—	0 : DDI Serial message present at power up 1 : DDI Serial message suppressed at power up
<Checksum>	—	METER serial checksum
<CRC>	—	METER 6-bit CRC

SENSOR METADATA VALUE

The sensor metadata value contains information to help alert users to sensor-identified conditions that may compromise optimal sensor operation. The output of the `aV!` , `aD0!` sequence will output a `<meta>` integer value. This integer represents a binary bitfield, with each individual bit representing an error flag.

Table 8 lists the possible error flags that can be set by the SOLYX 14. If multiple error flags are set, the sensor metadata integer value will be the sum of the individual values. To decode an integer value not explicitly in Table 8, find the largest error flag value that will fit in the integer value and accept that error as being present. Then, subtract that error flag value from the integer value and repeat the process on the remainder until the result is zero. For example, a sensor metadata integer value of 192 is the sum of the individual error flag values 64 + 128, so this sensor has a faulty thermistor and corrupt firmware.

Table 8 Error flag values and issue resolution

Error Flag Value	Issue Present	Resolution
64	Sensor thermistor is broken and sensor is using a backup measurement	Contact Customer Support to replace sensor
128	Sensor firmware is corrupt	Contact Customer Support for instructions on reloading firmware

DDI SERIAL COMMUNICATION

The DDI Serial communications protocol is ideal for systems that have dedicated serial signaling lines for each sensor or use a multiplexer to handle multiple sensors. The serial communications are compatible with many TTL serial implementations that support active-high logic levels using 0- to 3.6-V signal levels. When the sensor is first powered, it automatically makes measurements of the integrated transducers then outputs a response over the data line. Systems using this protocol control the sensor excitation to initiate data transfers from the sensor. This protocol is subject to change as METER improves and expands the line of digital sensors and data loggers. SOLYX 14 will omit the DDI Serial startup string when the SDI-12 address is nonzero. The DDI string will also be omitted if it is supressed using the `aX0!` command.

NOTE: Out of the factory, all METER sensors start with SDI-12 address `0` and print out the startup string when power cycled.

DDI SERIAL TIMING

Table 9 lists the DDI Serial communications configuration.

Table 9 DDI Serial communications configuration

Baud Rate	1,200
Start Bits	1
Data Bits	8 (LSB first)
Parity Bits	0 (none)
Stop Bits	1
Logic	Non-inverted (idle state high)

At power up, the sensor will pull the data line high within 100 ms to indicate that the sensor is taking a reading (Figure 6). When the reading is complete, the sensor will send the DDI string over serial. The response is transmitted as ascii characters, the format is described in Table 10 . Example 4 shows caputred output from an actual SOLYX 14 sensor.

NOTE: Sometimes the signaling from the sensor can confuse typical microprocessor UARTs. The sensor holds the data line low while taking measurements. The sensor raises the line high to signal the logger that it will send a measurement. Then the sensor may take some additional measurements before starting to clock out the first data byte starting with a typical start bit (low). Once the first start bit is sent, typical serial timing is valid; however, the signal transitions before this point are not serial signaling and may be misinterpreted by the UART.

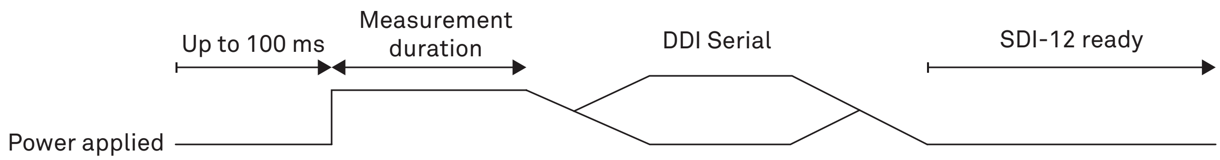

Figure 6 Data line DDI Serial timing

DDI SERIAL RESPONSE

Table 10 details the DDI Serial response.

Table 10 DDI Serial response

COMMAND	RESPONSE
NA	`<TAB><dielectricPermittivity>␣<temperature>␣<electricalConductivityDS><CR><sensorType><Checksum><CRC>`

NOTE: There is no actual command. The response is returned automatically upon power up.

An example DDI string is given below:

Example 4 `<TAB>24.02␣19.0␣1.02<CR>2'h`

This examples DDI string shows a SOLYX 14 sensor reporting a dilectric of 24.02, a temperature of 19.0 °C, and an EC of 1.02 dS/m (1020 uS/cm).

The character, `2` , following the carriage return indicates this sensor is a SOLYX14. The legacy checksum calculated is the apostrophe charter `'` , and the CRC6 is the character `h` .

DDI SERIAL CHECKSUM

These checksums are used in the DDI Serial response. The legacy checksum is computed from the start of the transmission to the sensor identification character, excluding the sensor address.

SOLYX 14 LEGACY CHECKSUM EXAMPLE

Example input is `<TAB>24.02␣19.0␣1.02<CR>2` and the resulting checksum output is `'`.

```c
uint8_t LegacyChecksum(const char * response)
{
    uint16_t length;
    uint16_t i;
    uint16_t sum = 0;

    // 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];
        if(response[i] == '\r')
        {
            // Found the beginning of the metadata section of the response
            break;
        }
    }

    // Include the sensor type into the checksum
    sum += response[++i];

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

    return sum;
}
```

SOLYX 14 CRC6

The more robust `CRC6` 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, excluding the sensor address.

`CRC6` checksum example input is `<TAB>24.02␣19.0␣1.02<CR>2'` and the resulting checksum output is `h` .

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

    // Calculate total message length—updated once the metadata section is found
    bytes = strlen(buffer);

    // 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;
            }
        }
        if(buffer[byte] == '\r')
        {
            // Found the beginning of the metadata section of the response
            // both sensor type and legacy checksum are part of the crc6
            // this requires only two more iterations of the loop so reset
            // "bytes"

            // bytes is incremented at the beginning of the loop, so 3 is added
            bytes = byte + 3;
        }
    }

    // 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

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
Address
Phone number
Email address
Instrument serial number
Description of problem

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

REVISION HISTORY

The following table lists document revisions.

Revision	Date	Compatible Firmware	Description
00	2.2026	1.00	Initial release