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W W W . I N - S I T U . C O M

Technical Note

SDI-12 Commands and Aqua TROLL® Responses

The In-Situ Aqua TROLL® supports the SDI-12 Version 1.3 commands and the extensions listed below. Data recorders that support SDI-12 Version 1.3 can usually send standard commands to an SDI-12 "sensor" like the Aqua TROLL automatically. Additional information may be found in an SDI-12 reference, such as that listed at the end of this document. Or consult your SDI-12 data recorder documentation.

Sensor Defaults

The Aqua TROLL leaves the factory with the following settings:

Sensor address:	0
Pressure units:	PSI
Temperature units:	degrees Celsius
Actual Conductivity units:	µS/cm
Specific Conductivity units:	µS/cm
Salinity units:	PSU

The Aqua TROLL supports software-changeable addresses.

Sensor Identification

In response to the "send identification" command, the Aqua TROLL will respond as follows:

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013IN-SITU AT200 100 0000069295
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- Serial number
- Firmware version (100 = 1.00)
- Sensor (Aqua TROLL) model
- Manufacturer (In-Situ Inc.)
- SDI-12 compatibility (version 1.3)
- Sensor address

SDI-12 V 1.3 Command Set

Name	Command	Response & Comments
Address Query	?!	a<CR><LF> The wildcard address '?' character is supported only for the Address Query command. It is ignored as an invalid address for all other commands.
Acknowledge Active	a!	a<CR><LF> Basic address characters in the range '0' to '9' and extended address characters in the ranges 'A' to 'Z' and 'a' to 'z' are supported. All other characters are ignored as an invalid address. Default address is '0'.
Change Address	aAb!	b<CR><LF> Software changeable addresses and the Change Address command are supported.
Send Identification	aI!	a13IN-SITU AT200 vvv xxxxxxxxxx<CR><LF> where: vvv = device firmware version × 100 (120 = 1.20) xxx = 10-digit device serial number with leading zeroes
Start Verification	aV!	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+n<CR><LF> where: n = lower 16 bits of device status (0-65535)
Additional Data	aD1!...aD9!	a<CR><LF> No values are returned after an Additional Data command.

SDI-12 V 1.3 Command Set

Name	Command	Response & Comments
Start Measurement	aM!	a001n<CR><LF>
Start Measurement CRC	aMC!	n parameters will be available for reading by the Send Data command within 1 second. A service request (a<CR><LF>) will be sent when the parameters are ready. The number of parameters returned is determined by the SDI-12 configuration file. The default value for n is 3.
Send Data	aD0!	a<values><CR><LF> or a<values><CRC><CR><LF> The number and type of parameters returned is determined by the SDI-12 configuration file. The default values are pressure in PSI followed by temperature in °C and actual conductivity in µS/cm. At most 3 parameters are returned in a Send Data command. If more than 3 parameters are output, they are returned using the additional data command.
Additional Data	aD1!...aD9!	a<values><CR><LF> or a<values><CRC><CR><LF> At most 3 parameters are returned per additional data request.
Additional Measurements	aM1!...aM9!	a0000<CR><LF>
Additional with CRC	aMC1!...aMC9!	No additional measurements are started by the device.
Send Data	aD0!	a<CR><LF> or a<CRC><CR><LF>
Additional Data	aD1!...aD9!	No values are returned after an Additional Measurement command.
Start Concurrent	aC!	a001nn<CR><LF>
Start Concurrent CRC	aCC!	nn parameters will be available for reading by the Send Data command within 1 second. No service request will be sent when the parameters are ready. The number of parameters returned is determined by the SDI-12 configuration file in the same manner as a Start Measurement command.
Send Data	aD0!	a<values><CR><LF> or a<values><CRC><CR><LF> The number and type of parameters returned is determined by the SDI-12 configuration file in the same manner as a Start Measurement command.
Additional Data	aD1!...aD9!	a<values><CR><LF> or a<values><CRC><CR><LF> The number and type of parameters returned is determined by the SDI-12 configuration file in the same manner as a Start Measurement command.
Additional Concurrent	aC1!...aC9!	a00000<CR><LF>
Additional with CRC	aCC1!...aCC9!	No additional concurrent measurements are started by the device.
Send Data	aD0!	a<CR><LF> or
Additional Data	aD1!...aD9!	a<CRC><CR><LF> No values are returned after an additional Concurrent Measurement command.
Continuous Measurement	aR0!...aR9!	a<CR><LF>
Continuous with CRC	aRC0!...aRC9!	No values are returned after a Continuous Measurement command.

SDI-12 Extended Commands

Name	Command	Response & Comments
ISCO Compatibility	aXPR0!	aIxIxIxIx<CR><LF> where each Ix is a character pair identifying the parameter and units for each measurement. The number of Ix pairs equals the number of data values returned for the Start Measurement and Start Concurrent commands. The following pairs are supported: Pressure, PSIA = "d0" Level, feet = "I1" Pressure, PSIG = "d2" Actual conductivity, mS/cm = "B0" Pressure, mmHg = "d3" Actual conductivity, µS/cm = "B1" Temperature, °C = "A0" Specific conductivity, mS/cm = "C0" Temperature, °F = "A1" Specific conductivity, µS/cm = "C1" Level, meters = "I0" Resistivity, ohm-cm = "c2" If not listed above, all other parameter and unit combinations will return "??".

SDI-12 Extended Commands

Name	Command	Response & Comments
ISCO Additional	aXPR1...XPR9!	a<CR><LF> No values are returned after an additional ISCO compatibility command.
Set Output Sequence	aXOnnn! where: nnn = one or more parameter characters in the required output order: P = pressure T = temperature L = level A = actual conductivity C = specific conductivity S = salinity D = total dissolved solids R = resistivity p = set density of water	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Set Pressure Units	aXPUnn! where: nn = the pressure units id (same values as specified for Modbus register 40041).	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid units id or an attempt to change units while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Set Temperature Units	aXTUnn! where: nn = the temperature units id (same values as specified for Modbus register 40049).	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid units id or an attempt to change units while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an Additional Data command.
Set Level Units	aXLUnn! where: nn = the level units id (same values as specified for Modbus register 40057).	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid units id or an attempt to change units while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an Additional Data command.
Set Level Mode	aXLMnn! where: nn = the level parameter id (same values as specified for Modbus register 40056).	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid units id or an attempt to change the mode while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an Additional Data command.

SDI-12 Extended Commands

Name	Command	Response & Comments
Set Conductivity Units	aXCUnn! where: nn = the conductivity units id (same values as specified for Modbus registers 40065 and 40073). The setting applies to both the actual and specific conductivity parameters.	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid units id or an attempt to change units while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an Additional Data command.
Set TDS Units	aXDUnn! where: nn = the TDS units id - 100 (the last two digits of the values specified for Modbus register 40089).	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid units id or an attempt to change units while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an Additional Data command.
Set Specific Gravity	aXSGpd.d! where: pd.d = specific gravity p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional)	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters or an attempt to change the specific gravity while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Set Local Gravity Constant	aXPGpd.d! where: pd.d = local gravity constant p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional)	a0001<CR><LF> The result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters or an attempt to change the local gravity constant while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Zero Pressure	aXPZ!	a0011<CR><LF> One value will be available for reading by the Send Data command within 1 second. A service request (a<CR><LF>) will be sent when the parameter is ready.
Send Data	aD0!	A+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.

SDI-12 Extended Commands

Name	Command	Response & Comments
Set Level Reference	AXLRpd.d! where: pd.d = reference level in current units p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional)	a0011<CR><LF> One value will be available for reading by the Send Data command within 1 second. A service request (a<CR><LF>) will be sent when the parameters are ready.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Set Cell Constant	aXKpd.d! where: pd.d = cell constant p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional)	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters or an attempt to change the cell constant while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Set Specific Conductivity Alpha	aXCApd.d! where: pd.d = alpha in percent (e.g. 1.91%) p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional)	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters or an attempt to change alpha while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Set TDS Conversion Factor	aXDFpd.d! where: pd.d = conversion factor to ppt p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional)	a0001<CR><LF> One result is available immediately for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = invalid parameter characters or an attempt to change the conversion factor while the device is logging.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.
Communication Diagnostics	aXCD!	a+A+C<CR><LF> where: A = contents of Modbus device address register 49200, C = contents of Modbus serial communication configuration register 49201.

Device Status

The device status register holds general status information. Each set bit represents a status value. There are a limited number of standardized predefined status values that all devices will support. These predefined status values are contained in the lower register. The upper register is reserved for device specific status values.

Device Status Bit Values

Bit	Category	Description
0	Alarm	Sensor high alarm
1	Warning	Sensor high warning
2	Warning	Sensor low warning
3	Alarm	Sensor low alarm
4	Warning	Sensor calibration warning
5	Alarm	Sensor malfunction
6-7	N/A	Reserved
8	Status	Power management disabled
9	Status	Device off line
10	Alarm	Device hardware reset occurred
11	Alarm	Device malfunction
12	Status	No external power
13	Warning	Low battery – battery capacity < 5%
14	Warning	Low memory – data log memory capacity < 5%
15	N/A	Reserved
16-31	N/A	Available for device-specific status

Bits 0-7 of the device status register are reserved for sensor status. These bits are the logical OR of bits 0-7 of the sensor status register in each sensor connection.

Bits 8-15 of the device status register are reserved for common device status. Any bit in this range that is not applicable to a device will be set to zero.

Bits 16-31 of the device status register are available for device-specific status. Any bit in this range that is not utilized by a device will be set to zero.

SDI-12 Configuration File

The device's SDI-12 configuration file may be edited with a serial connection and Win-Situ 5 software.

This dialog allows you to change the device's SDI-12 address and specify the parameter reporting order for SDI-12 communications.

1. While connected to a device in Win-Situ 5, click the **Setup tab**, then click the **SDI-12 Setup** button. A dialog box like this will open.

2. Address Character. The device's current SDI-12 address is shown (factory default: 0). Enter the desired address character to change the address.

3. Select the sensor to report. All sensors supported by the connected device are available in the drop-down list.

4. Select the parameter to report. All parameters supported by the selected sensor are available in the drop-down list.

5. Click **Add** to add the parameter to the Output Order. Repeat for all desired parameters.

   If you wish to change the reporting order, select a parameter in the list and click the up arrow or the down arrow to change its position in the output order list.

6. Click **OK** when done. The software will write the SDI-12 configuration to the device.

Reference

SDI-12, A Serial-Digital Interface Standard for Microprocessor-Based Sensors, version 1.3. SDI-12 Support Group, Logan, Utah, September 17, 2002. Available at www.sdi-12.org.

In-Situ Modbus Communication Protocol. Bill Bonner, Senior Software Engineer, In-Situ Inc., Fort Collins, CO, January 2007. Available at www.In-Situ.com.