In-Situ Inc.

TECHNICAL NOTE
SDI-12 Communications

SDI-12 Commands and RDO® PRO Sensor Responses

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Overview

The In-Situ RDO® PRO optical dissolved oxygen sensor 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 RDO PRO sensor 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.
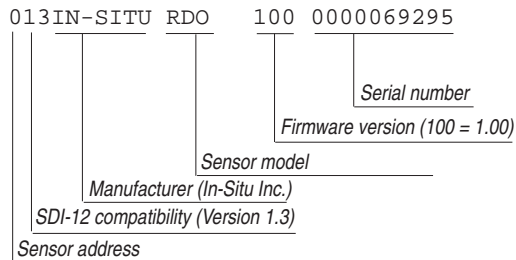
Sensor Defaults

The RDO PRO sensor leaves the factory with the following settings:

Sensor address: 0
DO concentration: mg/L
DO saturation units: %
Temperature units: degrees Celsius

Sensor Identificaton

In response to the "send identification" command, the RDO PRO will respond as follows:

```
013IN-SITU RDO   100 0000069295
```

Serial number
Firmware version (100 = 1.00)
Sensor model
Manufacturer (In-Situ Inc.)
SDI-12 compatibility (Version 1.3)
Sensor address

SDI-12 Version 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 RDO 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 Version 1.3 Command Set

Name	Command	Response & Comments
Start Measurement	aM!	a002n<CR><LF>
Start Measurement CRC	aMC!	n parameters will be available for reading by the Send Data command within 2 seconds. 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 DO concentration in mg/L followed by DO percent saturation and temperature in °C. 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<CR><LF> or a<CRC><CR><LF> No values are returned after an Additional Data command.
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> No values are returned after an Additional Measurement command.
Additional Data	aD1!...aD9!	a<CR><LF> or a<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 shall be 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 measurement command.
Start Concurrent	aC!	a002nn<CR><LF>
Start Concurrent CRC	aCC!	nn parameters will be available for reading by the Send Data command within 2 seconds. 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 shall be 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 shall be returned after a continuous measurement command.

SDI-12 Extended Commands

Name	Command	Response & Comments
ISCO Compatibility	aXPR0!	alxlxlxlx<CR><LF> where each lx is a character pair identifying the parameter and units for each measurement. The number of lx pairs must equal the number of data values returned for the Start Measurement and Start Concurrent commands. The following pairs are supported: DO Concentration, mg/L = "F0" Temperature, °C = "A0" Temperature, °F = "A1" DO % Saturation = "F1" If not listed above, all other parameter and unit combinations will return "??".
ISCO Additional	aXPR1…XPR9!	a<CR><LF> No values are returned after an additional ISCO compatibility command.

Name	Command	Response & Comments
Set Output Sequence	aXOnnn!	a0001,CR><LF> where nnn = one or more parameter characters in required output order (C = DO concentration, T = Temperature, S = DO % saturation, P = oxygen partial pressure), in the required output order.
Send Data	aD0!	One result is available immediately for reading by the Send Data command. 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 Concentration Units	aXCUnnn!	a0001<CR><LF> where: nnn = the concentration units id (same values as specified for Modbus register 40041). Three digits are required. 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	a0001<CR><LF> where: nnn = the temperature units id (same values as specified for Modbus register 40049). Three digits are required. 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 Calibration Slope	aXCSpd.d!	a0001<CR><LF> where: pd.d = cell constant p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional) 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 Calibration Offset	aXCOpd.d!	a0001<CR><LF> where: pd.d = conversion factor to ppt p = polarity sign (+ or -) d = digits (1 to 7) . = decimal point (optional) 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.
Set Factory Defaults	aXFD	a0011<CR><LF> One result is available in 1 second for reading by the Send Data command.
Send Data	aD0!	a+s<CR><LF> where: s = command status, 1 = command successful, 0 = command failed.
Additional Data	aD1! … aD9!	a<CR><LF> No values are returned after an additional data command.

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.

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	N/A	Reserved
9	Status	Device off line
10	Alarm	Device hardware reset occurred
11	Alarm	Device malfunction
12	Status	No external power
13	N/A	Reserved
14	N/A	Reserved
15	N/A	Reserved

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.

References

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, November, 2008. Available at www.In-Situ.com.

For more information contact In-Situ Inc.

221 East Lincoln Avenue
Fort Collins, CO 80524
1-800-446-7488 (toll-free in U.S. & Canada
1-970-498-1500 (international & domestic)
Internet: www.in-situ.com

In-Situ Inc.