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Specifications

Power supply voltage: 9.0 – 16.0VDC
Power supply current – Active: 3mA Ave / 10mA Peak
Power supply current – Sleep: 150uA
Measurement Latency: Approx. 1.3s
Default SDI-12 Address: 0

SDI-12 Command Nomenclature

a= Sensor address
{crc} = SDI-12 compatible 3-character CRC
<cr> = ASCII carriage return character
<lf> = ASCII line feed character
highlighted values indicate variable data

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SDI-12 Commands

Setup Commands

Name	Command	Response
Sensor Identification	aI!	a13 INWUSA PT120.8sssssssss<cr><lf> *Note: 0.8 will change to reflect current firmware revision, sssssssss = device serial #*
Acknowledge Active	a!	a<cr><lf>
Address Query	?!	a<cr><lf>
Change Address	aAb!	b<cr><lf> Change address from a to b
Set Duration for Averaging	aXAttt!	attt<cr><lf> *Set duration of averaged data for M4, MC4, C4, and CC4 commands (ttt = 1..997 seconds)*
Set number of significant digits	aXSt!	at<cr><lf> *Set # of significant digits for SDI-12 report (t =1..7)*

Field Calibration Commands

Name	Command	Response
Read/Set Calibration Values	aXCnn! aXCnn=*value*! *Where nn is register number*	a*value*<cr><lf> (Value is current value) a*value*<cr><lf> (Value is new value) *Sample*: a+1.591600e-5<cr><lf>
Read Field Pressure Slope	aXC09!	a*value*<cr><lf> Value is current field calibration pressure slope
Set Field Pressure Slope	aXC09=*value*!	a*value*<cr><lf> Value is new field calibration pressure slope
Read Field Pressure Offset	aXC10!	a*value*<cr><lf> Value is current field calibration pressure offset
Set Field Pressure Offset	aXC10=*value*!	a*value*<cr><lf> Value is new field calibration pressure offset
Read Field Temperature Slope	aXC11!	a*value*<cr><lf> Value is current field calibration temperature slope
Set Field Temperature Slope	aXC11=*value*!	a*value*<cr><lf> Value is new field calibration temperature slope
Read Field Temperature Offset	aXC12!	a*value*<cr><lf> Value is current field calibration temperature offset
Set Field Temperature Offset	aXC12=*value*!	a*value*<cr><lf> Value is new field calibration temperature offset

Engineering Units Conversion Commands

By default Pressure is returned in psi and Temperature is returned in degree Celsius. With firmware versions 0.11 and higher, these units can be changed using the following commands. If you have requested different units at time of purchase, these may be pre-set at the factory. (For versions with firmware earlier than 0.11, contact INW, if you need different units.)

See conversion gain and offset values below for the most common units.

Name	Command	Response
Read/Set Calibration Values	aXCnn! aXCnn=*value*! *Where nn is register number*	a*value*<cr><lf> (Value is current value) a*value*<cr><lf> (Value is new value) *Sample*: a+1.591600e-5<cr><lf>
Read Pressure Units Gain	aXC16!	a*value*<cr><lf> Value is current pressure units gain
Set Pressure Units Gain	aXC16=*value*!	a*value*<cr><lf> Value is new pressure units gain
Read Pressure Units Offset	aXC17!	a*value*<cr><lf> Value is current pressure units offset
Set Pressure Units Offset	aXC17=*value*!	a*value*<cr><lf> Value is new pressure units offset
Read Temperature Units Gain	aXC18!	a*value*<cr><lf> Value is current temperature units gain
Set Temperature Units Gain	aXC18=*value*!	a*value*<cr><lf> Value is new temperature units gain
Read Temperature Units Offset	aXC19!	a*value*<cr><lf> Value is current temperature units offset
Set Temperature Units Offset	aXC19=*value*!	a*value*<cr><lf> Value is new temperature units offset

Note: *See later in this document for complete list of calibration registers.*

To convert pressure from psi to:

Units	Gain	Offset
Feet H2O	2.3067	0
Inches H2O	27.684	0
Meters H2O	0.703089	0
CM H2O	70.3089	0
mBars	68.95	0

To convert Temperature from degrees Celsius to:

Units	Gain	Offset
Degrees F	1.8	32
Degrees K	1	273.15

Measurement Commands

Request Measurement

Name	Command	Response
Request measurement: • pressure • temperature • power supply voltage	aM!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0023<cr><lf>
Read results	aD0!	aValue1Value2Value3<cr><lf> *Value1 = pressure* *Value2 = temperature (ºC)* *Value3 = power supply voltage (V)* *Sample*: a+7.15863+25.0000+12.0512<cr><lf>
Request measurement: • pressure	aM1!	atttn<cr><lf> *"n" values available after "ttt" seconds* Sample: a0021<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = pressure* *Sample*: a+7.15863<cr><lf>
Request measurement: • temperature	aM2!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0021<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = temperature (ºC)* *Sample*: a+25.0000<cr><lf>
Request measurement: • power supply voltage	aM3!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0021<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = power supply voltage (V)* *Sample*: a+12.0512<cr><lf>
Request measurement: • averaged pressure • maximum pressure • minimum pressure • averaged temperature	aM4!	atttn<cr><lf> *"n" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* *Sample:* a0104<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4<cr><lf> *Value1 = averaged pressure* *Value2 = maximum pressure* *Value3 = minimum pressure* *Value4 = averaged temperature (ºC)* *Sample*: a+7.15863+7.23215+7.05128+25.0000<cr><lf>

Request measurement: • barometrically compensated down-hole pressure • down-hole temperature • surface temperature	aM5!	atttn<cr><lf> *"n" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only!*** *Sample:* a0033<cr><lf>
Read results	aD0!	aValue1Value2Value3<cr><lf> *Value1 = barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface temperature* *Sample: a+9.60908+22.2500+23.7500<cr><lf>*
Request measurement: • non-barometrically compensated down-hole pressure • down-hole temperature • surface pressure • surface temperature	aM6!	atttn<cr><lf> *"n" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only!*** *Sample:* a0034<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4<cr><lf> *Value1 = non-barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface pressure* *Value4 = surface temperature* *Sample: a+23.64118+22.3125+14.0321+23.1250<cr><lf>*
Request measurement: • averaged barometrically compensated pressure	aM7!	atttn<cr><lf> *"n" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* ***For use on PT12-BV/PT12 combinations only*** *Sample:* a0031<cr><lf>
Read results	aD0!	aValue1<*cr*><lf> *Value1 = average barometrically compensated pressure* *Sample: a+7.12050<cr><lf>*

Request Measurement with CRC

Name	Command	Response
Request measurement w/CRC: • pressure • temperature • power supply voltage	aMC!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0023<cr><lf>
Read results	aD0!	aValue1Value2Value3{crc}<cr><lf> *Value1 = pressure* *Value2 = temperature (ºC)* *Value3 = power supply voltage (V)* *Sample*: a+7.15863+25.0000+12.0512{crc}<cr><lf>

Request measurement w/CRC: • pressure	aMC1!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0021<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = pressure* *Sample*: a+7.15863{crc}<cr><lf>
Request measurement w/CRC: • temperature	aMC2!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0021<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = temperature (ºC)* *Sample*: a+25.0000{crc}<cr><lf>
Request measurement w/CRC: • power supply voltage	aMC3!	atttn<cr><lf> *"n" values available after "ttt" seconds* *Sample:* a0021<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = power supply voltage (V)* *Sample*: a+12.0512{crc}<cr><lf>
Request measurement w/CRC: • averaged pressure • maximum pressure • minimum pressure • averaged temperature	aMC4!	atttn<cr><lf> *"n" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* *Sample:* a0104<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4{crc}<cr><lf> *Value1 = averaged pressure* *Value2 = maximum pressure* *Value3 = minimum pressure* *Value4 = averaged temperature (ºC)* *Sample*: a+7.15863+7.23215+7.05128+25.0000{crc}<cr><lf>
Request measurement w/CRC: • barometrically compensated down-hole pressure • down-hole temperature • surface temperature	aMC5!	atttn<cr><lf> *"n" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only!*** *Sample:* a0033<cr><lf>
Read results	aD0!	aValue1Value2Value3{crc}<cr><lf> *Value1 = barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface temperature* *Sample: a*+9.60908+22.2500+23.7500{crc}*<cr><lf>*

Request measurement w/CRC: • non-barometrically compensated down-hole pressure • down-hole temperature • surface pressure • surface temperature	aMC6!	atttn<cr><lf> *"n" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only*** *Sample:* a0034<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4*{crc}*<cr><lf> *Value1 = non-barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface pressure* *Value4 = surface temperature* *Sample:* a+23.64118+22.3125+14.0321+23.1250*{crc}*<cr><lf>

Concurrent Measurement

Name	Command	Response
Request measurement: • pressure • temperature • power supply voltage	aC!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00203<cr><lf>
Read results	aD0!	aValue1Value2Value3<cr><lf> *Value1 = pressure* *Value2 = temperature (ºC)* *Value3 = power supply voltage (V)* *Sample*: a+7.15863+25.0000+12.0512<cr><lf>
Request measurement: • pressure	aC1!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* Sample: a00201<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = pressure* *Sample*: a+7.15863<cr><lf>
Request measurement: • temperature	aC2!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00201<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = temperature (ºC)* *Sample*: a+25.0000<cr><lf>
Request measurement: • power supply voltage	aC3!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00201<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = power supply voltage (V)* *Sample*: a+12.0512<cr><lf>

Request measurement: • averaged pressure • maximum pressure • minimum pressure • averaged temperature	aC4!	atttnn<cr><lf> *"nn" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* *Sample:* a01004<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4<cr><lf> *Value1 = averaged pressure* *Value2 = maximum pressure* *Value3 = minimum pressure* *Value4 = averaged temperature (ºC)* *Sample*: a+7.15863+7.23215+7.05128+25.0000<cr><lf>
Request measurement: • barometrically compensated down-hole pressure • down-hole temperature • surface temperature	aC5!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only!*** *Sample:* a00303<cr><lf>
Read results	aD0!	aValue1Value2Value3<cr><lf> *Value1 = barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface temperature* *Sample: a+9.60908+22.2500+23.7500<cr><lf>*
Request measurement: • non-barometrically compensated down-hole pressure • down-hole temperature • surface pressure • surface temperature	aC6!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only!*** *Sample:* a00304<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4<cr><lf> *Value1 = non-barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface pressure* *Value4 = surface temperature* *Sample: a+23.64118+22.3125+14.0321+23.1250<cr><lf>*
Request measurement • average barometrically compensated pressure	aC7!	atttnn<cr><lf> *"nn" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* ***For use on PT12-BV/PT12 combinations only*** *Sample:* a00301<cr><lf>
Read results	aD0!	aValue1<cr><lf> *Value1 = average barometrically compensated pressure* *Sample: a+7.12050<cr><lf>*

Concurrent Measurement with CRC

Name	Command	Response
Request measurement w/CRC: • pressure • temperature • power supply voltage	aCC!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00203<cr><lf>
Read results	aD0!	aValue1Value2Value3{crc}<cr><lf> *Value1 = pressure* *Value2 = temperature (ºC)* *Value3 = power supply voltage (V)* *Sample*: a+7.15863+25.0000+12.0512{crc}<cr><lf>
Request measurement w/CRC: • pressure	aCC1!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00201<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = pressure* *Sample*: a+7.15863{crc}<cr><lf>
Request measurement w/CRC: • temperature	aCC2!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00201<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = temperature (ºC)* *Sample*: a+25.0000{crc}<cr><lf>
Request measurement w/CRC: • power supply voltage	aCC3!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* *Sample:* a00201<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = power supply voltage (V)* *Sample*: a+12.0512{crc}<cr><lf>
Request measurement w/CRC: • averaged pressure • maximum pressure • minimum pressure • averaged temperature	aCC4!	atttnn<cr><lf> *"nn" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* Sample: a01004<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4{crc}<cr><lf> *Value1 = averaged pressure* *Value2 = maximum pressure* *Value3 = minimum pressure* *Value4 = averaged temperature* (ºC) Sample: a+7.15863+7.23215+7.05128+25.0000{crc}<cr><lf>

Request measurement w/CRC: • barometrically compensated down-hole pressure • down-hole temperature • surface temperature	aCC5!	atttnn<cr><lf> "nn" values available after "ttt" seconds ***For use on PT12-BV/PT12 combinations only!*** Sample: a00303<cr><lf>
Read results	aD0!	aValue1Value2Value3{crc}<cr><lf> *Value1 = barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface temperature* Sample: a+9.60908+22.2500+23.7500{crc}<cr><lf>
Request measurement w/CRC: • non-barometrically compensated down-hole pressure • down-hole temperature • surface pressure • surface temperature	aCC6!	atttnn<cr><lf> *"nn" values available after "ttt" seconds* ***For use on PT12-BV/PT12 combinations only!*** Sample: a00304<cr><lf>
Read results	aD0!	aValue1Value2Value3Value4{crc}<cr><lf> *Value1 = non-barometrically compensated down-hole pressure* *Value2 = down-hole temperature* *Value3 = surface pressure* *Value4 = surface temperature* Sample: a+23.64118+22.3125+14.0321+23.1250{crc}<cr><lf>
Request measurement w/CRC: • average barometrically compensated pressure	aCC7!	atttnn<cr><lf> *"nn" values available after "ttt" seconds – "ttt" will vary depending on programmed averaging duration* ***For use on PT12-BV/PT12 combinations only*** Sample: a00301<cr><lf>
Read results	aD0!	aValue1{crc}<cr><lf> *Value1 = average barometrically compensated pressure* Sample: a+7.12050{crc}<cr><lf>

Reading via Modbus® RTU

Power Consideration

If your sensor is not powered continuously by an auxiliary power supply, then you must turn power on to the sensor at least two seconds before a reading is to be taken to allow the sensor to warm up.

Register Definitions

Communication settings and Modbus® functions
The PT12 is configured to communicate with 8 data bits, one stop bit, and no parity. Default baud rate is 19200.

A Word about Register Addressing

The physical register addresses on the PT12 start numbering from zero – the first address is 0, the second is 1, etc. On the other hand, Modbus protocol considers the first logical address to be 1, the second logical address to be 2, etc. For example, to take a pressure reading you have to read the physical address 0.

Some programs and equipment when asked to read address 0 will read that physical address. Others however will read that logical address, which is actually the physical address -1 (which does not exist). With these programs and equipment you must add a one to the address – thus in this example you would request a read at address 1.

Still other programs and equipment require the addition of 40,000 or 400,000 to the address to indicate reading holding registers. These usually also require the addition of one to the physical address. Check with your program and/or equipment documentation to determine what style of register addressing is required.

Like many common Modbus devices the PT12 returns readings starting at register address 0 (or 1 if using one-based addressing). For compatibility with other INW Smart Sensor equipment, the PT12 also returns these same readings starting at a register address 62592 (or 62593 if using one-based addressing).

All readings are obtained using Modbus function 03-Read Holding Registers. Readings are located in two registers each. The data is returned as a 32-bit IEEE floating-point value, high word first, also referred to as big-endian, float inverse, or Float AB CD.

Parameter Registers Using Standard Addressing

	Zero-Based	*One-Based*	*+40,001*	*+400,001*
Pressure	0	1	40001	400001
Temperature	2	3	40003	400003
Power Supply Voltage	4	5	40005	400005
Averaged Pressure	6	7	40007	400007
Maximum Pressure	8	9	40009	400009
Minimum Pressure	10	11	40011	400011
Averaged Temperature	12	13	40013	400013

Parameter Registers Using High Addressing to Match INW Smart Sensors
(Available with firmware 0.13 and higher)

	Zero-Based	*One-Based*	*+40,0001*
Pressure	62592	62593	462593
Temperature	62594	62595	462595
Power Supply Voltage	62596	62597	462597
Averaged Pressure	62598	62599	462599
Maximum Pressure	62600	62601	462601
Minimum Pressure	62602	62603	462603
Averaged Temperature	62604	62605	462605

Calibration and conversion constants

The data is returned as a 32-bit IEEE floating-point value, high word first, also referred to as big-endian, float inverse, or Float AB CD.

Zero-Based	*One-Based*	*+40,001*	*Description*
200-01	201-02	40201-02	Factory Calibration* - Pressure Scale
202-03	203-04	40203-04	Factory Calibration* - Pressure Linearization 1
204-05	205-06	40205-06	Factory Calibration* - Pressure Linearization 2
206-07	207-08	40207-08	Factory Calibration* - Pressure Slope 0
208-09	209-10	40209-10	Factory Calibration* - Pressure Slope 1
210-11	211-12	40211-12	Factory Calibration* - Pressure Slope 2
212-13	213-14	40213-14	Factory Calibration* - Pressure Offset 0
214-15	215-16	40215-16	Factory Calibration* - Pressure Offset 1
216-17	217-18	40217-18	Factory Calibration* - Pressure Offset 2
218-19	219-20	40219-20	Field Calibration - Pressure Slope
220-21	221-22	40221-22	Field Calibration - Pressure Offset
222-23	223-24	40223-24	Field Calibration - Temperature Slope
224-25	225-26	40225-26	Field Calibration - Temperature Offset
226-27	227-28	40227-28	Factory Calibration* - Temperature Alpha
228-29	229-30	40229-30	Factory Calibration* - Temperature Offset
230-31	231-32	40231-32	Factory Calibration* - Tempearture Slope
232-33	233-34	40233-34	Pressure Units - Conversion Slope
234-35	235-36	40235-36	Pressure Units - Conversion Offset
236-37	237-38	40237-38	Temperature Units - Conversion Slope
238-39	239-40	40239-40	Temperature Units - Conversion Offset

Field calibration values and units conversion values can be set by user. If set, these values will be applied to readings before values are returned.

*Factory calibration values are set at the factory.
Writing to Factory Calibration registers will void calibration!!

Sensor configuration/control

Zero-Based	*One-Based*	*+40,001*	*Description*
300=n	301=n	40301=n	Set **averaging**: This enables sensor for n seconds. Each second, the statistical data registers will be updated to contain new averages, max and min. At the completion of n seconds, the final statistical values will be left in the registers, and the sensor will be put to sleep. n = 0..10,800. If n = 0, the sensor is put to sleep, and the statistical data values are not updated.
400=a	401=a	40401=a	Set **sensor address** = a (Write Only)
500=b	501=b	40501=b	Set **baud rate** = b (Write only) 0=38400, 1=19200 (default), 2=9600, 3=4800, 4=2400, 5=1200
600=w	601=w	40601=w	Set **auto-enable**. Causes sensor to be enabled automatically for w seconds after a read of any parameter data register. W=0 disables auto-enable. (This is normally set to 10 seconds at the factory.) For lowest power usage, set this to zero. For fastest readings while still retaining as much power savings as possible, set slightly longer than your read frequency. See section on next page for information on how this setting affects your readings.
700=L	701=L	40701=L	Set **serial number**. L= unsigned longword value 0x0000000 .. 0xFFFFFFF (0 .. 4,294,967,295)
800	801	40801	Read **sensor firmware revision**. Word MSB = Major revision, LSB = minor revision. E.g., 0013 = revision 0.13

Readings and the Auto-Enable Setting

When a reading is requested, four things happen:

1. The sensor wakes up.
2. The current value in the register is returned.
3. The sensor turns on the analog portion, begins sampling, and begins putting the new values in the registers.

4a. If auto-enable is set to a positive value *w*, the sensor stays awake for *w* seconds, sampling and moving values into the registers all the while, and then goes to sleep.

4b. If auto-enable is set to zero, the sensor immediately goes to sleep after putting the reading in the register.

If your read frequency is less than the auto-enable value, the sensor will stay on continuously, and your readings will always be fresh, with the exception of the very first reading.

If your read frequency is greater than the auto-enable value, the following reading sequence is recommended:

1. Request a reading. This begins the wakeup process on the sensor and returns the value currently in the register, which will be old data. Throw this value away.
2. Wait one second, then take another reading. This reading will have fresh data. Record this reading.

Note: This sequence applies only to Modbus® direct read. If reading the sensor via SDI-12, the warmup timing is automatically taken care of.