TD 258 OPERATING MANUAL
PRESSURE SENSOR 4017/4117

AADI ®SEAGUARD
AANDERAA DATA INSTRUMENTS • www.aadi.no
Reliable Solutions

1st Edition 29 April 2005

2nd Edition 24 June 2005

3rd Edition 13 December 2006

Contact information:

Aanderaa Data Instruments AS
PO BOX 34, Slåtthaug
5851 Bergen, NORWAY

Visiting address:
Nesttunbrekken 97
5221 Nesttun, Norway

TEL: +47 55 604800
FAX: +47 55 604801

E-MAIL: info@aadi.no

WEB: http://www.aadi.no

Table of Contents

INTRODUCTION

Purpose and scope

This document is intended to give the reader knowledge of how to operate and maintain the Aanderaa Pressure Sensor 4017/4117.

It also aims to give insight in how the sensor works and how the pressure measurement can be converted to depth.

Document Overview

This document starts by giving a short description of the sensor.

A chapter about RS-232 communication is found next.

Then the procedure for installation on recording instruments is given. An overview of the product test and calibration follows, and at the end an appendix is included with information about the sensor's mechanical design, construction and calculation of seawater depth from pressure measurement.

Applicable Documents

V-9273	Assembly Drawing
V-8699	Sensor Cable 3854
V-8700	Sensor Cable 3855
Form 679	Test & Specification Sheet, Pressure Sensor 4017
Form 699	Calibration Certificate, Pressure Sensor 4017/4117
D 357	Data sheet

References

[1] Fofonoff, N.P. and R.C.Millard (1983) *Algorithms for Computations of FundamentalProperties of Seawater*, Unesco Technical Papers in Marine Science 44.

Abbreviations

ADC	Analog to Digital Converter
ASCII	American Standard Code for Information Interchange
CAN	Controller Area Network - sometimes referred to as CANbus
DSP	Digital Signal Processor
EPROM	Erasable Programmable Read Only Memory
HCL	Hydrochloric acid (Muriatic acid)
MSB	Most significant bit
RTC	Real Time Clock
UART	Universal Asynchronous Transmitter and Receiver
UNESCO	- the United Nations Educational, Scientific and Cultural Organization
USB	Universal Serial Bus

Figure 0-1-1 Pressure Sensor 4017 mounted on an RCM 9 Mk II

CHAPTER 1 Short Description and Specifications

Description

In most measuring system used in the sea, pressure is a vital parameter. For pelagic moored instrument the pressure can be used for determining the actual depth of the instrument. For instrumentation on the seabed the pressure can be used for deriving water level. The pressure is also essential when deriving other parameters as density and speed of sound.

The Pressure Sensor 4017/4117 is a compact yet intelligent pressure sensor designed for use on Aanderaa Dataloggers as well as in other measuring systems. The sensor is based on a silicon piezoresistive bridge sampled and temperature compensated by an advanced Digital Signal Processor.

Since all calibration and temperature compensation data is stored inside, the pressure can be presented directly in engineering units without any external calculation.

The 4017 version fits directly on to the Top End Plate of Aanderaa Recording Current Meters (RCM 9 MkII, RCM 9 LW, RCM 9 IW, RCM 11) as well as on RDCP 600. The sensor may also be used as a stand-alone RS-232 sensor for other applications.

Two SR10 channels are available; one for Pressure and one for the temperature measurement. The user may configure the range on both SR10 outputs. This allows for a possibility to zoom in on the range of interest.

The 4117 version is equipped with both RS232 and CANbus and is designed for the Aanderaa ®SEAGUARD platform.

Both sensor may also be used as a stand-alone RS-232 sensor for other applications.

The sensor is designed to operate down to 6000 meters.

Specifications for Pressure Sensor 4017/4117

Refer to Datasheet D357 and D362 or go to our web site. You will always find the latest versions of our documents on our web.

CHAPTER 2 Pressure Setup Software 4047

The Pressure Sensor 4017 may output RS-232, SR10 or analog data. The Pressure Sensor 4117 may output RS-232 and CANbus. The RS-232 port is also used for configuration of the sensors. This may be done by use of a terminal program (refer page 31), however we recommend using the Pressure Setup Program 4047 described in this chapter.

First, check that your system supports the requirements given below. Install the Pressure Setup Program 4047 as described in subchapter called Installation, and connect the Pressure Sensor to your PC using cable 3855 (refer to Figure 2-1). You may start the program and select the correct COM port to which you have connected the sensor.

A list of Parameters and units are shown in Table 2-1. Instructions to the different configuration possibilities, RS232/SR10 (Aanderaa signal)/Analog and RS232/CANbus output are given on page 13 to page 19.

System requirements

- 600 MHz or faster Pentium or compatible
- 100 Mb of free HD space
- MS Windows98 or later versions
- 64 Mb of RAM
- SVGA (640x480) colour display or better
- Local CD-ROM Drive

Installation

A CD-ROM is delivered together with the sensors. The CD includes the operating manual for the pressure sensor 4017/4117, TD 258, and installation setup for the Pressure Setup Program 4047.

Installation procedure:

- Insert the CD-ROM and open the Windows explorer or similar.
- Go to *Pressure Setup Program 4047/Installer/setup.exe* and double-click on the setup.exe icon.
- Follow the installation instruction in the setup guide that appears.
- If you answer yes to all the questions, the program will be installed in the folder *C:\ProgramFiles\Pressure Setup Program* and an icon will be added to the START menu; *Start - Program Files - AADI – Pressure Setup Program*

Connection to PC

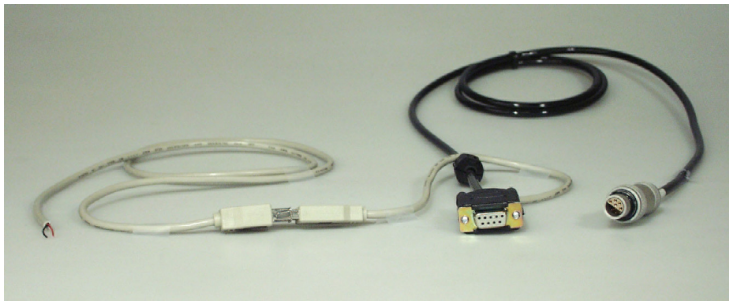


Figure 2-1 Sensor Cable 3855

A 1.5 meter cable, Sensor Cable 3855, is used for connection between the Sensor and the PC. By using a Cable Coupler 3472 and a standard Connecting Cable 3282 this connection can be extended to 15 meters.

The 10-pin receptacle in the Pressure Sensor's foot mates with an Aanderaa 3216A plug.

This cable has a watertight 10-pin plug at the sensor end, and a 9 pin D-Sub plug at the PC-end. An additional USB plug is used for providing power to the sensor. Power may also be connected to an included extension to the USB plug.

A drawing of Sensor Cable 3855 is given in Figure 2-2:

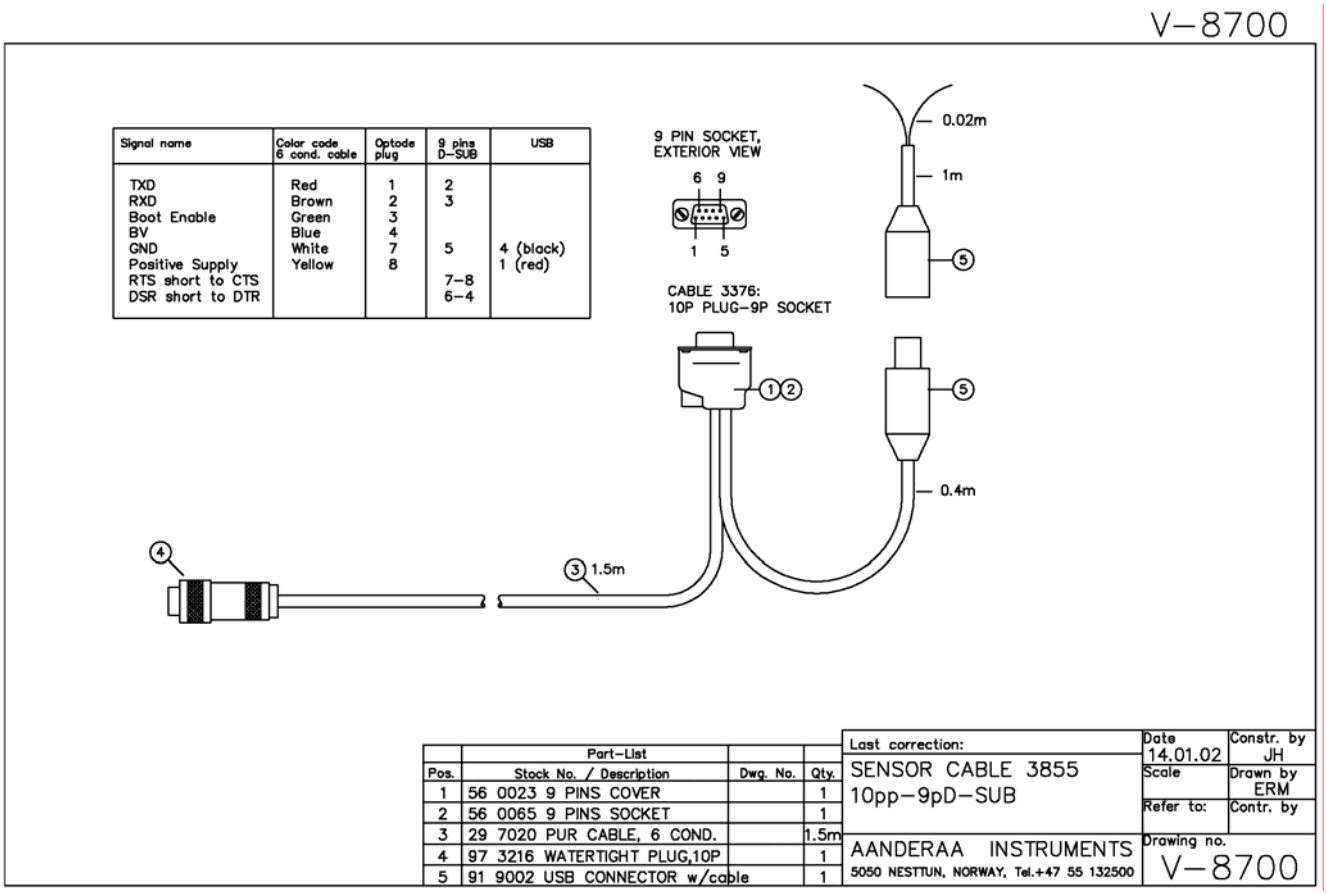


Figure 2-2 Sensor Cable 3855

Configuration of sensor using setup programme 4047

When the correct COM port has been selected, to which the sensor is connected (refer to Figure 2-3), the current sensor settings are read into the program automatically. Sensor properties are listed in the lower left part of the window, and the last measured data for pressure and

temperature are presented as *Last Reading*. The sensor will perform a measurement when powered. The measured temperature will be slightly higher than the surrounding air temperature due to self-heating of the sensor.

Note! When a section is greyed, it means that these properties are disabled.

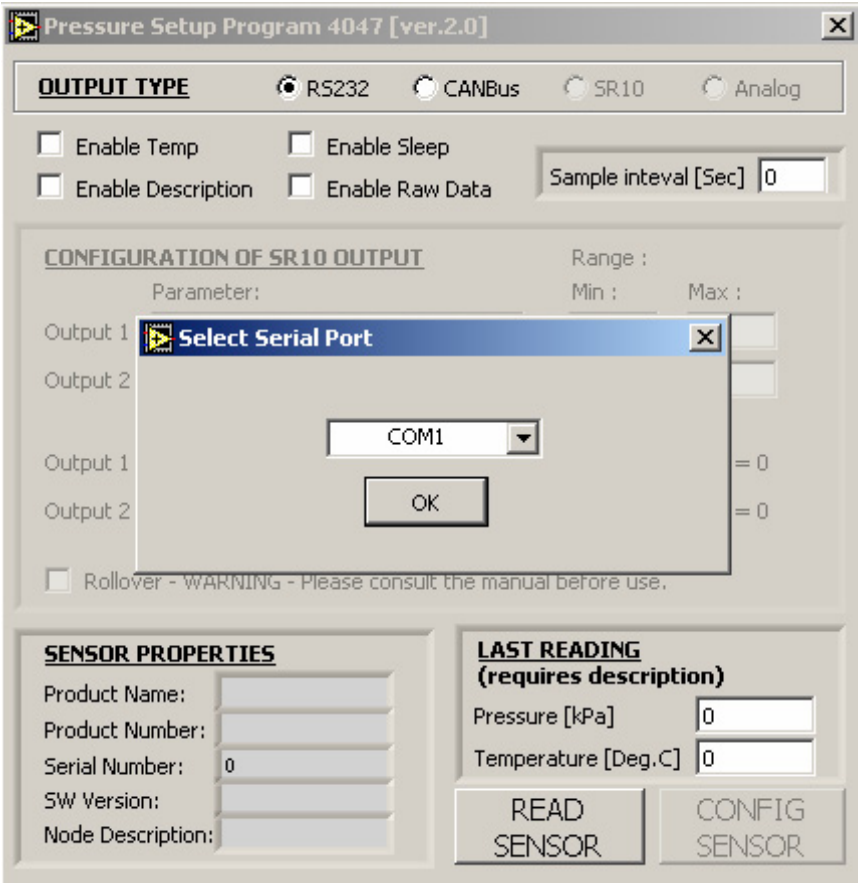


Figure 2-3 Select correct COM Port

Pressure Sensor 4017

At start up of setup programme 4047, the button *Configure Sensor* is disabled, since the sensor settings are as shown in the software window (the sensor settings has been read from the sensor into the setup programme).

Refer to page 13 to 15 for RS232/SR10/Analog configuration. When setup has been completed, press the *Configure Sensor* button in the lower, right part of the window to store your settings.

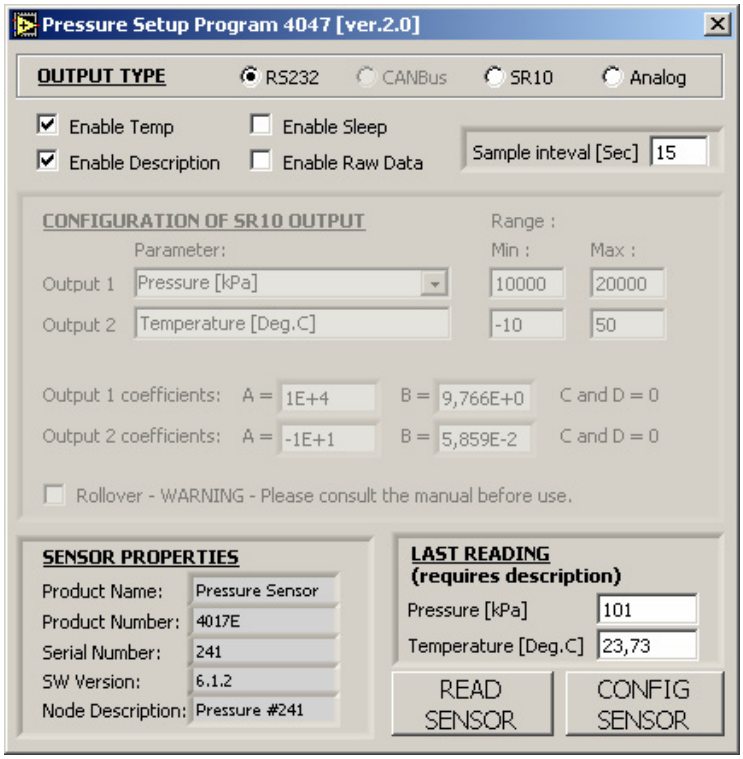


Figure 2-4 The Pressure Setup Program 4047

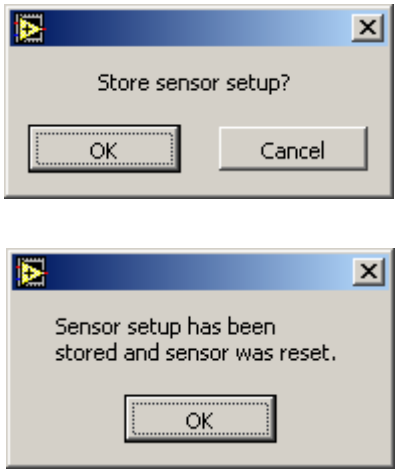


Figure 2-5 Storing configuration settings

A button with *Store Sensor setup?* will appear. Click *OK*, and a button with *Sensor setup has been stored and was reset* appears. Click *OK*.

To load the last stored sensor settings (from the sensor) click the *Read Sensor* button. *Read Sensor* button can also be used to poll Last Readings from the sensor.

Parameters and units

The parameters and units are shown in Table 2-1:

Table 2-1 Parameters and units

Parameter	Unit
Pressure	kPa
Temperature	deg. C
Interval	sec

Configuration of RS-232 Output

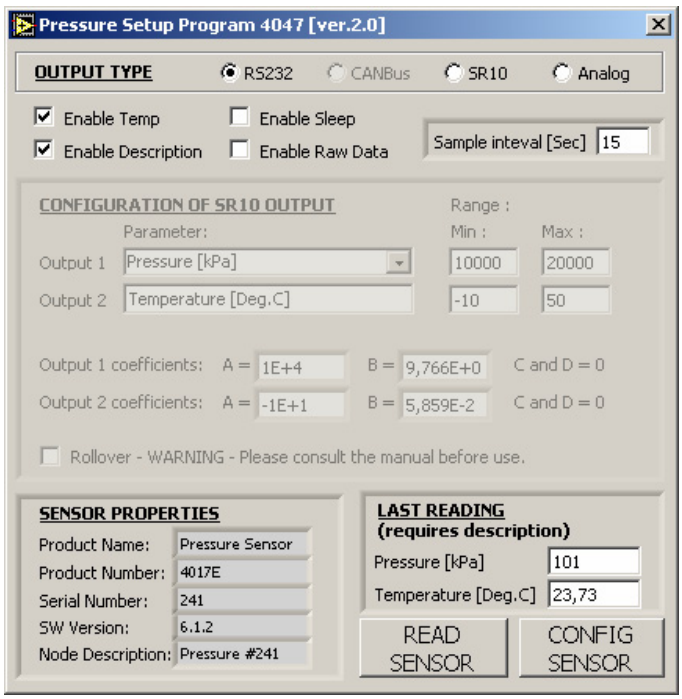


Figure 2-6 Configuration of RS232 Output

To configure the RS-232 output, check *RS232* as shown in Figure 2-6.

You may now choose parameters, i.e. *Enable Temp, Enable Description, Enable Sleep and Enable Raw Data*, as shown in Figure 2-6.

Enter the *sample interval* in seconds.

If you check the option *Enable description*, the output will include parameter information. The output string will then start with the word MEASUREMENT followed by the sensor's product and serial number:

Example of output string:

```
MEASUREMENT    4017E    241    Pressure(kPa)  9.937686E+01 Temperature(DegC)
    2.556020E+01
```

If you uncheck *Enable description* the output string will become:

```
4017E    241    9.935515E+01    2.671693E+01
```

When *Enable Temp* is checked the output string will become:

```
4017E    241    9.935515E+01    2.671693E+01
```

If *Enable Sleep* is checked the sensor will go in "sleep mode" between measurements.

If Enable Raw Data is checked the output string becomes:

```
4017E    241    9.938061E+01    101525    7689598
```

When setup has been completed, press the *Configure Sensor* button in the lower, right part of the window to store your settings, refer to page 12.

Configuration of SR10 Output

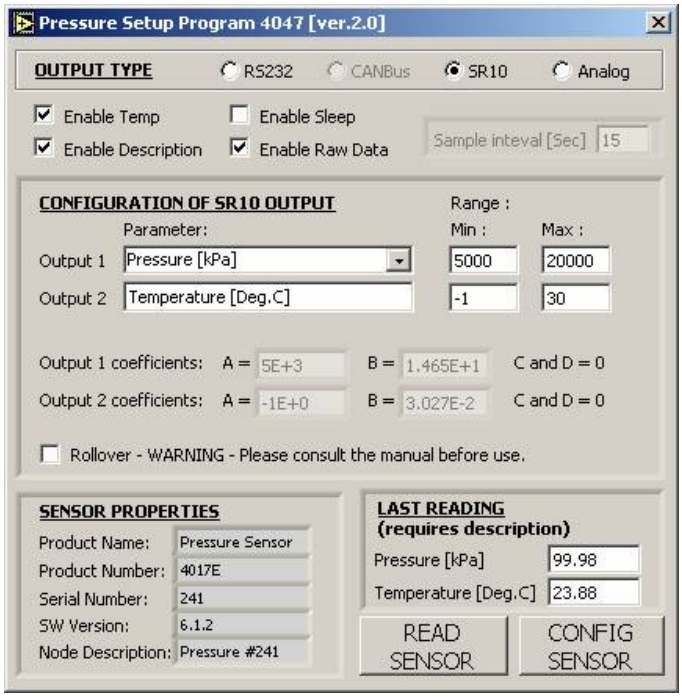


Figure 2-7 Configuration of SR10 Output

To configure SR10 Output, check the *SR10* option. The *Sample Interval* will now be disabled and turn grey.

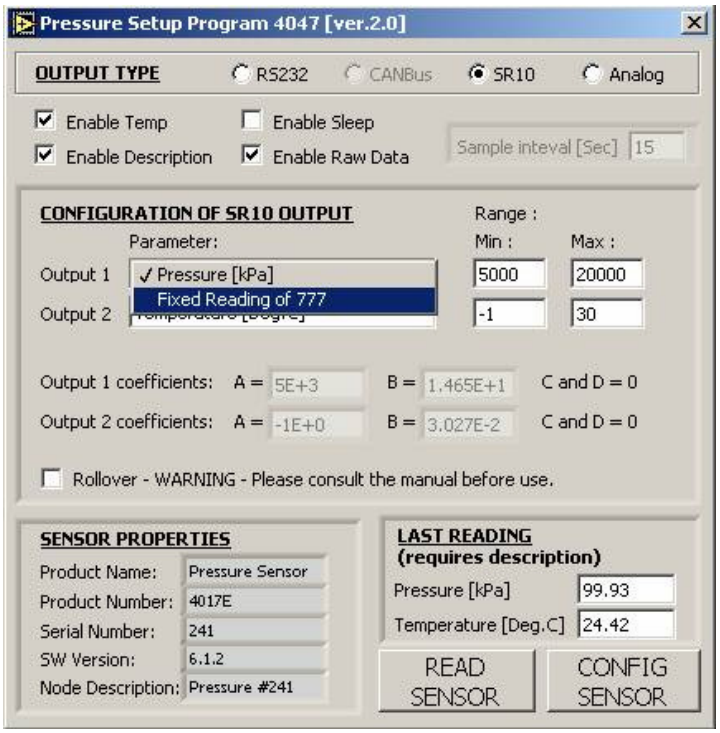


Figure 2-8 Configuration of SR10 Output, range settings

As Output 1 you may choose between *Pressure* and *fixed reading of 777*. Fixed reading is used for test purposes only. Output 2 is always *Temperature*.

Set the range of the output parameters.

The output 1 and output 2 coefficients are calculated based on the parameter range. The coefficients are automatically updated when the range has been set.

An option called *Rollover*, may also be used. Selecting *Rollover* the SR10 reading will take zero as the next value when the reading passes the upper SR10 limit and vice versa continue at 1023 when the reading passes the lower SR10 limit.

By allowing Rollover, you can set a shorter range than without the rollover feature, and achieve a better resolution for your measurements. It should however be used with caution since the user has to determine which range interval the reading actually is in.

Press the *Configure Sensor* button to store your settings, refer to page 12.

Fixed reading for test purposes

When setting the output 1 parameter to Fixed Reading of 777, the SR10 reading should be raw data reading of 777. This verifies that the sensor is actually sending SR10 data, and that there are communication between the sensor and the data storage unit.

Test procedure:

1. Configure the sensor with Fixed Reading of 777
2. Connect the sensor to your systems datalogger (e.g. an AADI RCM)
3. Perform one measurement
4. Read stored data to verify a raw data reading of 777.

Configuration of Analog Output

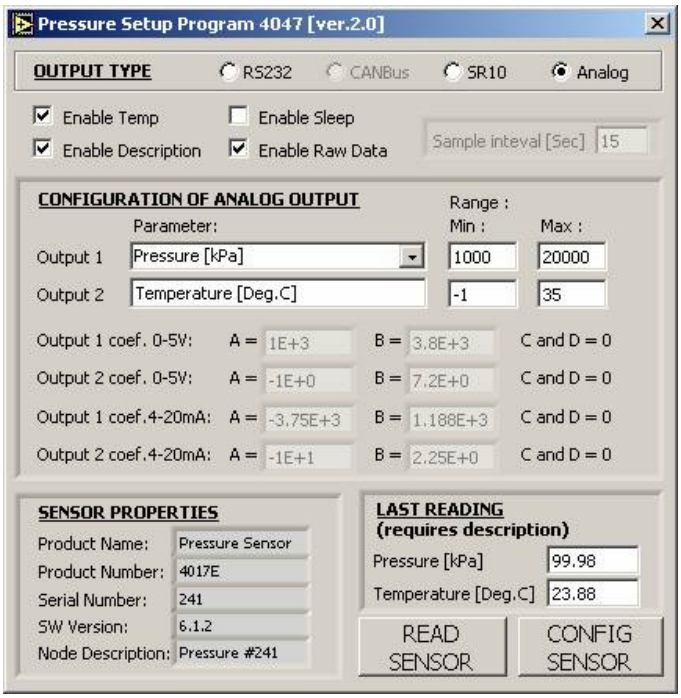


Figure 2-9 Configuration of Analog Output

For analog output, select *Analog*.

As Output 1 you may choose between *Pressure*, *fixed reading 4V/16.8mA* and *fixed reading 1V/7.2mA* (refer to Figure 2-10). Fixed reading is used for test purposes only. Output 2 is *Temperature* when *Pressure* is chosen for output 1.

When one of the fixed readings are chosen for output 1, output 2 is automatically set to the other of the two fixed readings!

Set the range of the output parameters (not an option if fixed readings are chosen).

The output 1 and output 2 coefficients are calculated based on the parameter range. The coefficients are automatically updated when the range has been set.

Press the *Configure Sensor* button to store your settings, refer to page 12.

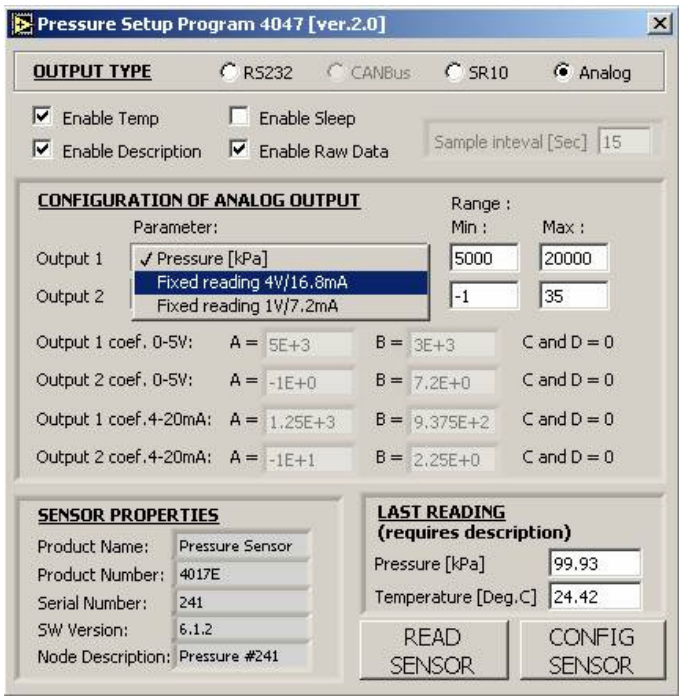


Figure 2-10 Configuration of Analog Output

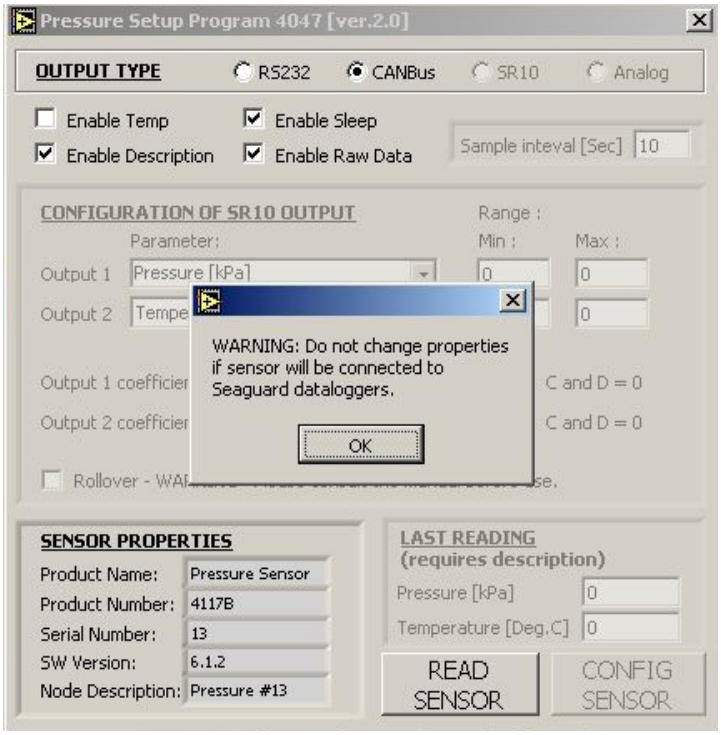
Fixed reading for test purposes

When setting the output 1 parameter to one of the fixed readings, the analog reading should be according to the input. A fixed reading of 4V/16.8mA gives a higher reading than 1V/7.2mA. This verifies that the sensor is actually sending analog data, and that there are communication between the sensor and the data storage unit.

Test procedure:

1. Configure the sensor with output 1 parameter to a Fixed Reading of e.g. 4V/16.8mA
2. Connect the sensor to your receiver system
3. Perform one measurement
4. Read the received data: Output 1 and output 2 should give a Voltage/Current reading corresponding to the configuration

Pressure Sensor 4117



If the Pressure Sensor 4117 is setup in CANbus mode, you will immediately after start up of the program get warned to not change properties if sensor will be connected to ®SEAGUARD data logger.

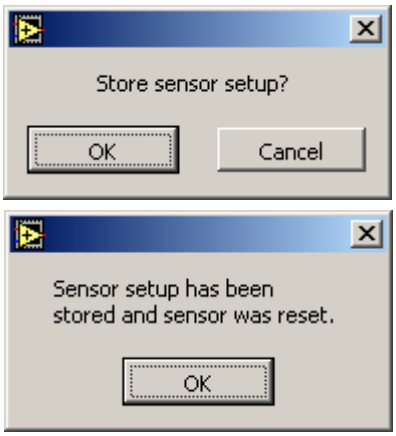
Click *OK* and do the configuration of the sensor.

Figure 2-11 Start-up of Pressure Setup Program with Pressure Sensor 4117 connected.

Important! Do not change the sensor's properties if it will be connected to a ®SEAGUARD *data logger.*

At start up of setup programme 4047, the button *Configure Sensor* is disabled, since the sensor settings are as shown in the software window (the sensor settings has been read from the sensor into the setup programme).

Refer to page 18 to 19 for RS232/CANbus configuration. When setup has been completed, press the *Configure Sensor* button in the lower, right part of the window to store your settings.



A button with *Store Sensor setup?* will appear. Click *OK*, and a button with *Sensor setup has been stored and was reset* appears. Click *OK*.

Figure 2-12 Storing configuration settings

To load the last stored sensor settings (from the sensor) click the *Read Sensor* button. When CANbus output is selected, polling data is not possible.

Parameters and units

The parameters and units are shown in Table 2-2:

Table 2-2 Parameters and units

Parameter	Unit
Pressure	kPa
Temperature	deg. C
Interval	sec

Configuration of RS-232 Output

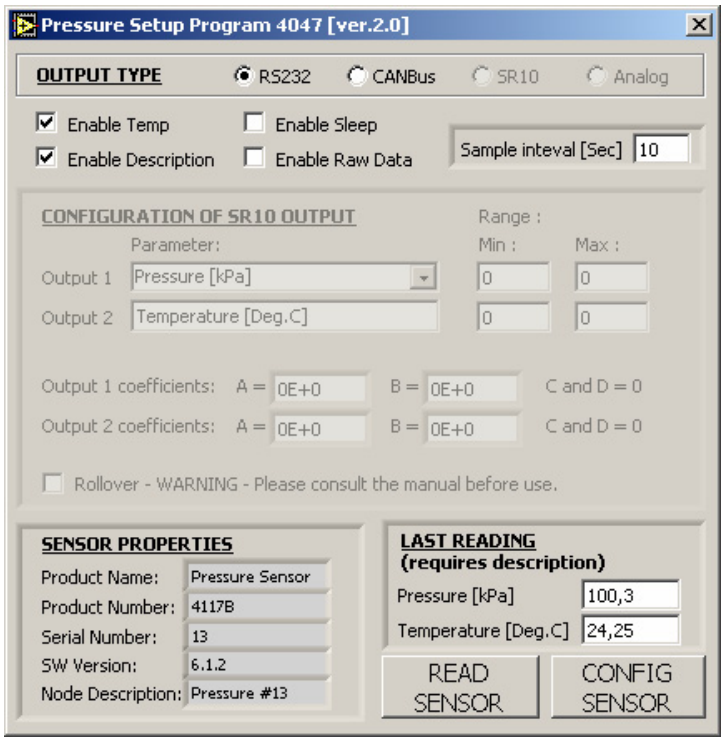


Figure 2-13 Configuration of RS-232 output

To configure the RS-232 output, check *RS232* as shown in Figure 2-13.

You may now choose parameters, i.e. *Enable Temp, Enable Description, Enable Sleep and Enable Raw Data*, as shown in Figure 2-13.

Enter the *sample interval* in seconds.

If you have checked the option *Enable description,* the output will include parameter information. The output string will then start with the word MEASUREMENT followed by the sensor's product and serial number:

Example of output string:

```
MEASUREMENT     4117B 13        Pressure(kPa)  9.937686E+01Temperature(DegC)
        2.556020E+01
```

If you uncheck *Enable description* the output string will become:

```
4117B 13                9.935515E+01          2.671693E+01
```

If *Enable Temp* is checked the output string will become:

```
4117B 13                9.935515E+01          2.671693E+01
```

If *Enable Sleep* is checked the sensor will go in "sleep mode" between measurements.

If *Enable Raw Data* is checked the output string will become:

```
4117B 13                9.938061E+01          101525                7689598
```

When setup has been completed, press the *Configure Sensor* button in the lower, right part of the window to store your settings, refer to page 12.

Configuration of CANbus Output

When the sensor is set to output CANbus, the Pressure Setup Program will not output any readings after configuring. When READ SENSOR is pressed you get the same warning message as shown in Figure 2-11.

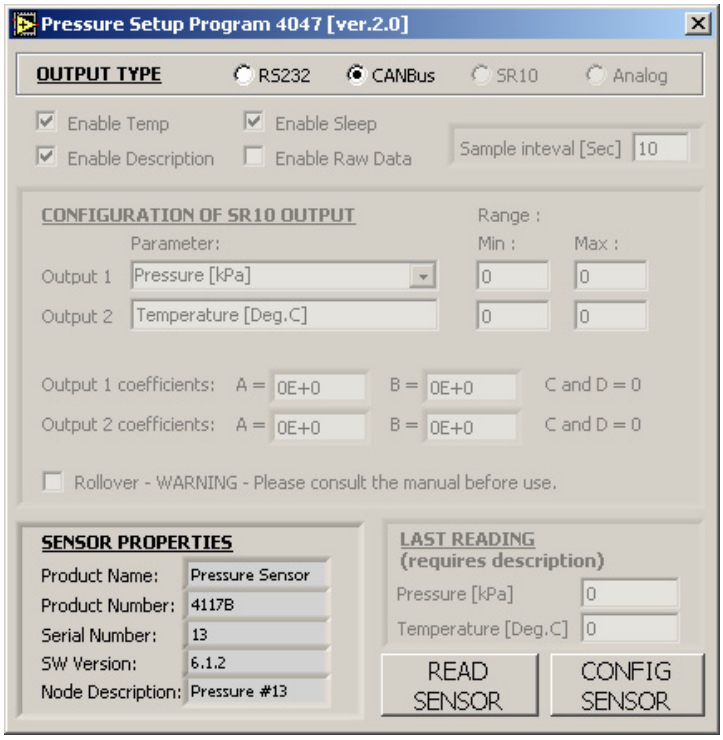


Figure 2-14 Configuration of CANbus output

Error management

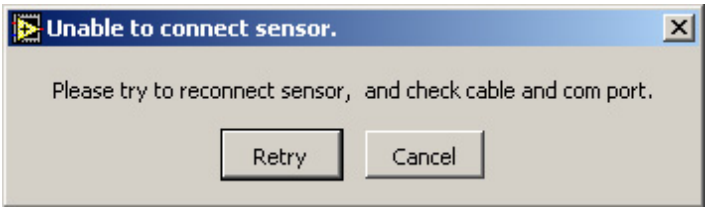


Figure 2-15 Error Management

If the box *Unable to connect to Sensor* appears, you have lost connection with the sensor.

Check that both the USB and the serial connectors are connected to your computer. If you have more than one COM port, check that you are using the correct COM port.

Then click *Retry*.

NOTE!

- *If the sensor does not respond when you try to shift output mode (e.g. from RS 232 to CANbus), try to reset the sensor by disconnect and reconnect the sensor.*
- *If the software is not responding during configuration, disconnect and reconnect the sensor and/or reopen Pressure Setup Program 4047.*

CHAPTER 3 Firmware

The firmware's main task is to sample raw data, compute calibrated temperature compensated and linearized pressure, and present the result at the different interfaces.

All calibration coefficients and settings are called sensor properties, and are stored in the DSP flash-memory. These properties can be displayed and changed using the RS-232 port (see RS-232 Protocol for how to communicate with the sensor).

Calculation

The software calculates the pressure and temperature in engineering values based on the sampled raw-data and a set of stored (*flashed*) coefficients.

The pressure is presented in kPa and the temperature in degrees centigrade.

RS232 Operation

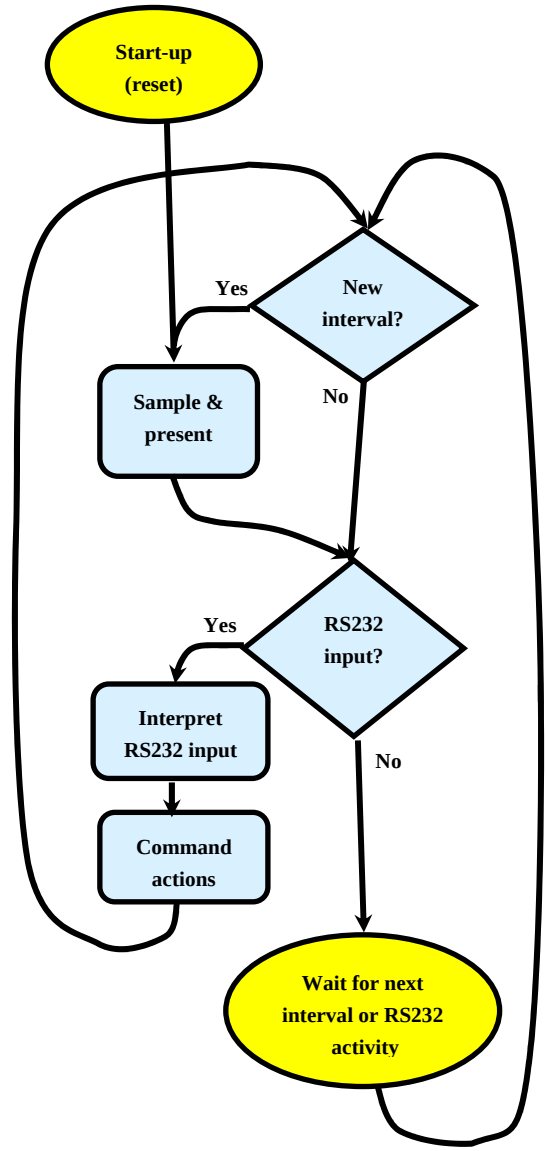


Figure 3-1 Software, RS232 Operation Sequence

When used in RS232 mode the sensor will always start by doing a sample. If the output is enabled this data will be presented within 2 second from powering up the sensor. If the internal interval timer is enabled the sensor will repeat the sampling and data presentation at a regular interval (non-polled mode). By disabling the interval timer (value 0), successive sampling and data presentation will only be performed on request (polled mode). When configured to non-polled mode the sensor can be used in systems with one-way communication.

In order to minimize the current consumption the sensor normally enters a power down mode after each sampling. In this mode the sensor can be awakened by any characters on the RS232 input, and will stay awake for approximately 1 minute.

See CHAPTER 4 for details regarding the RS232 protocol.

CANbus Operation

The sensor is equipped with a CANbus interface supporting the Aanderaa AiCaP(Automated idle line CANbus Protocol) protocol. This standard ensures easy plug and play connection to all Aanderaa ®SEAGUARD dataloggers.

When connected to a CANbus network the sensor will at power up report its capabilities and specifications to the datalogger. The datalogger then assembles the information and provides the user with the possibility to configure the instrument based on the present node. The solution provides for great flexibility in both use and design of the different elements within the system.

Configuration

All settings and configuration that determines the behaviour of the sensor are called properties and are stored in a persistent memory block (flash). One property can contain several data elements of equal type (Boolean, character, integer etc.). The different properties also have different access levels. The following table list all user accessible properties for Pressure Sensor 4017/4117:

Table 3-1 Properties

Properties	Type	No. of elements	Use	AiCaP Category[1)]	Access Protection[2)]
Product Name	String	31	AADI Product name	FA	Read Only
Product Number	String	6	AADI Product number	FA	Read Only
Serial Number	Int	1	Serial Number	FA	Read Only
SW Version	Int	3	Software version (Major,Minor,Built)	FA	Read Only
Node Description	String	31	User text for describing node, placement etc.	SC	No
Temp coeffs	Float	6	Curve fitting coefficients for the temperature measurement	SC	High
PT coeffs 0	Float	4	Temperature coefficients for Pressure coeff. 0	SC	High
PT coeffs 1	Float	4	Temperature coefficients for Pressure coeff. 1	SC	High
PT coeffs 2	Float	4	Temperature coefficients for Pressure coeff. 2	SC	High
PT coeffs 3	Float	4	Temperature coefficients for Pressure coeff. 3	SC	High
PT coeffs 4	Float	4	Temperature coefficients for Pressure coeff. 4	SC	High
Interval	Int	1	Sampling Interval in seconds	H	No
Enable Temperature	Bool	1	Controls inclusion of Temperature in the output string	SC	Low

Enable Rawdata	Bool	1	Controls inclusion of raw data in the output string	SC	Low
Enable Text	Bool	1	Controls the insertion of descriptive text, i.e. parameter names	SC	Low
Enable Sleep	Bool	1	Enable sleep mode	SC	Low
SR10 PressureLimit	Float	2	SR10 range limits for Pressure in kPa	No	Yes
SR10 TempLimit	Float	2	SR10 range limits for Temperature	No	Yes
Analog Coef	Float	2	Offset and Slope coefficient for data to Analog Adaptor	No	Yes
Output	Char	1	Selects RS232, CANBus, SR10 or I2C operation, value 0 enables RS232 only operation value -200 enables CANBus operation (model 4117) value -1 enables SR10 operation (model 4017) value -101 enables I2C operation (model 4017)	H	Low

1) FA=Factory Configuration, SC=System Configuration, H=Hidden

2) See chapter CHAPTER 4 for access level functionality when communication by use of RS232.

In AiCaP systems the properties are divided into 3 categories, Deployment settings, User Configuration and System Configuration. The properties of the different category is displayed and edited under separate menus.

A screenshot of the menu used for editing the *Enable Rawdata* property on the ®SEAGUARD datalogger is given in Figure 3-2.

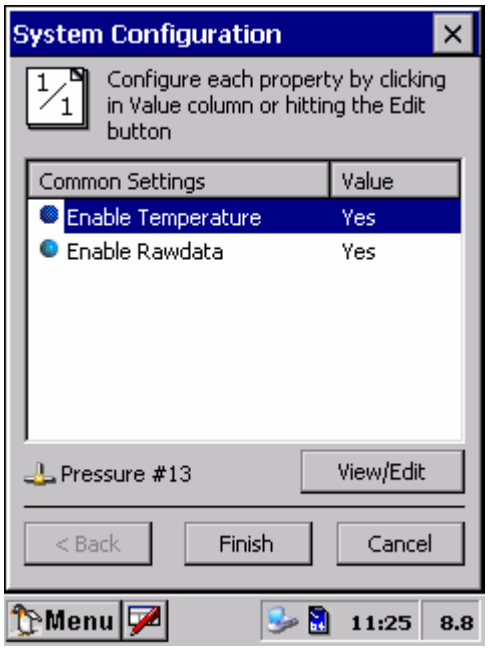


Figure 3-2 System Configuration; Output Settings.

When the *Interval* property is set zero the internal interval timer is disabled. Apart from the initial sample that are executed at power up, all sampling then have to be initiated by use of the Do Sample command. The *Interval* property is not used in CANbus operation.

In RS232 operation an output string is presented after each sample. The properties *Enable Temperature*, *Enable Derived Parameters*, *Enable Rawdata* controls the content of this string and also the parameters that are collected in AiCaP operation.

The *Output* property is used to select either the CANbus or RS232 operation. When the *Output* Property is set to 200, CAN operation is selected. Any other value will enable RS232 operation.

Output Control

A property called *Output* controls the presentation of the measured data.

When set to a negative value the *Output* property enables either the SR10 outputs or the I2C output to the Analog Adaptor (only for 4017 versions)

Output =	Data presented on the SR10 output Channel 2[1)]	Unit	Data presented on the SR10 output Ch. 3	Unit	Remark
-1	Pressure	kPa	Temperature	Deg.C	No roll over
-11	Pressure	kPa	Temperature	Deg.C	Roll over
-100	Test, fixed reading of 777		Temperature	Deg.C	

[1)] *Channel 1 not used*

Each of the SR10 parameters also has a property that determines the range that is used at the SR10 and the I2C output. The *SR10 PressureLimit* property controls the range of the Pressure while the *SR10 TempLimit* controls the range of the Temperature parameter. These properties must be set to the desired range limits for the SR10 output.

Example:

Set_Protect

Set_SR10 Pressure Limit(2000,4000)

Save

Result: The range of Pressure reading presented at the SR10 output is set to 2000kPa to 4000 kPa.

Rollover: if the *Output* property is set to –11, the SR10 reading will roll over when the limit of the range is exceeded, refer to page 14. For the above example this means that the SR10 reading will take zero as the next value when the reading passes 4000 kPa, and 1023 as the next value when the reading is lower than 2000 kPa. By allowing Rollover, you can set a shorter range than without the rollover feature, and achieve a better resolution for your SR10 output. It should however be used with caution since the user has to determine which range interval the reading actually is in.

When equipped with the Analog Adaptor 3966 the readings are converted to 0-5 Volt or 4-20 mA. The following table show the possible configuration for the data presented to the adaptor:

Output =	Data presented to the Analog Adaptor output 1	Unit	Data presented on the Analog Adaptor output 2	Unit
-101	Pressure	kPa	Temperature	Deg.C
-110	Test, fixed reading 4V/16.8mA		Test, fixed reading 1V/7.2mA	
-111	Test, fixed reading 1V/7.2mA		Test, fixed reading 4V/16.8mA	

The selection between voltage and current output is done by setting dip-switches on the Analog Adaptor board (refer to Appendix 3).

Note that the measurement range presented on the I2C signal is also controlled by the *SR10 PressureLimit* and the *SR10 TempLimit* properties.

When the SR10 or analog output is enabled data are also presented at the RS232 port. After the first sample, additional information on setting and scaling coefficients are presented:

Example:

```
Mode SR10

MEASUREMENT      4117C      18      Pressure(kPa)      1.014425E+02      Temperature(DegC)
    2.421629E+01    Rawdata Pressure      251454  Rawdata Temperature     9214956

SR10 Pressure      0 use A:= 2.000000E+01 B:= 3.222656E-02

SR10 Temperature   855 use A:=-5.000000E+00 B:= 3.906250E-02
```

CHAPTER 4 RS-232 Protocol

The RS-232 protocol describes how to communicate with the sensor.

For connection to a Personal computer (PC) the 1.5-meter Sensor Cable 3855 can be used.

Most terminal programs, such as the HyperTerminal*) by Hilgraeve Inc (included in Microsoft's operating systems), can be used for manual communication.

The following RS-232 setup should be used:

9600 Baud

8 Data bits

1 Stop bit

No Parity

Xon/Xoff Handshake

**) Note! The options "Send line ends with line feeds" and "Echo line ends with line feeds" in the HyperTerminal ASCII setup must be selected.*

All communication is ASCII coded with following syntax rules:

- All inputs to the sensor are given as commands with the following format:

  MainCmd_SubCm or MainCmd_Property(Value.., Value)

- The main command (*MainCmd*) is followed by an optional subcommand (*SubCmd*) or sensor property (*Property*).
- The *MainCmd* and the *SubCmd/Property* must be separated with the underscore character '_' or a space ' ' character.
- When entering new settings the *Property* is followed by parentheses containing comma-separated values.
- The command string must be terminated by a Line Feed character (ASCII code10). Termination with Carriage Return followed by Line Feed is also allowed.
- The command string is not case sensitive (UPPER/lower-case)
- A valid command string is acknowledged with the character '#' while the character '*' indicates an error. Both are followed by Carriage Return/Line Feed (*CRLF*). For most errors a short error message is also given subsequent to the error indicator.

The following commands are available in the Pressure Sensor:

Table 4-1 Available Commands in the Pressure Sensor

Command	Meaning
Do Sample	Execute Sampling, present enabled parameters
Get *Property*	Output value(s) of one *Property*
Get All	Output all property values
Get All Parameters	Output all parameters
Get Passkey	Get encrypted passkey
Get ConfigXML	Outputs info on available properties on XML format
Get DataXML	Outputs info on available(enabled) parameters on XML format
Set Property(*Value*,..*Value*)	Set *Property* to *Value*,.. *Value*
Set Passkey	Set passkey to change access level
Save	Store current settings
Load	Load stored settings
Reset	Resets the node(sensor), loads stored setting
Help	Print help information
;	Comment string, following characters are ignored
//	Comment string, following characters are ignored

The *Get* command is used for reading the value/values of a property.

The command name Get, is followed by *Property* and returns a string on following format:

Property ProductNo SerialNo Value, ..Value

#

The string starts with the name of the property (*Property*), continues with the product number and serial number of the sensor, and finally the value or values of the property.

All names and numbers are separated by tabulator spacing (ASCII code 9). The string is terminated by Carriage Return and Line Feed (ASCII code 13 & 10).

Example:

Get Interval

Returns: Interval 4017 116 30

#

A special version, *Get_All*, reads out all available properties in the sensor.

The *Set* command is used for changing a property.

Example:

Set Interval(30)

Returns: #

Float values may be entered on normal decimal form or exponential form, either with 'e' or 'E' leading the exponent. Extra "Space" characters in front or after a value are allowed.

See chapter CHAPTER 3 for a description of available properties.

After changing one or more of the sensor properties, the *Save* command will store the new configuration in the internal flash memory. If a *Load* command is executed instead, the previous stored setting will be reloaded, and any changes to the configuration will be disregarded.

To avoid accidental change, most of the properties are write-protected. There are five level of access protection:

Table 4-2 Access protection levels

Output	Passkey	Description
No		No Passkey needed for changing property
Low	1	The Passkey must be set to 1 prior to changing property
High	1000	The Passkey must be set to 1000 prior to changing property This Passkey value also give read access to factory properties that usually are hidden
Read Only		The user have only read access, no passkey needed
Factory Write	XXXX	Sensor specific code for factory level access

The Passkey is always at lowest level after power up or after the Save, Load or reset command is executed.

The same syntax as for Set Property is used in order to change access level.

The Get Passkey returns an encrypted passkey for factory level access.

Output Control

When powered up the sensor will start by prompting the output mode:_

Mode Rs232

Successively a sample is taken and corresponding data are presented. After this 'power up'-sample, sampling is initiated either by the *Do_Sample* command or the internal interval timer. All enabled parameters will be included in this string.

Example:

```
MEASUREMENT    4117C    18    Pressure(kPa)    1.014425E+02    Temperature(DegC)
    2.421629E+01    Rawdata Pressure    251454  Rawdata Temperature    9214956
```

The *Enable OutputText* property controls whether or not the text is included in the output string.

When enabled (yes) the output string always start by the keyword MEASUREMENT followed by the node's (sensor's) product number and serial number By disabling this property (no), this keyword and all parameter names are excluded from the string.

Example:

```
4117C   18    1.014425E+02    2.421629E+01    251454    9214956
```

All words and numbers are followed by a tabulator spacing (ASCII code 9). The string is terminated by Carriage Return and Line Feed (ASCII code 13 & 10).

Scripting

Often it may be usefully to collect more than one command in a text file e.g. the following text can be written in an ordinary text editor and saved as a text file.

```
// Set sampling interval to 30 seconds

Set_Protect(1)

Set_Interval(30)

Save

Get_All
```

This file can then be sent to the sensor in one operation. The first line is a comment line that is disregarded by the Pressure Sensor. Strings starting with either '//' or ';' are ignored by the software, and do not produce any errors or acknowledge.

Sleep

After approximately 60 second without any RS232 input the Pressure Sensor will enter a sleep mode. The character '%' indicates this.

In this mode the electronics requires approximately 3 ms start up time.

Any character will cause the electronics to return to the normal operation.

After the Pressure Sensor has responded with the character '#', new commands may be entered.

When sending text file the sensor can be awakened by sending a string of comment leads characters:

```
//////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////

//////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////

// Wake up test

Get_All
```

This will provide time for the sensor to wake and be ready before the next string appears.

The sleep indicator '%' and the wake up indicator '#' are not followed by Carriage Return and Line Feed. By setting the *Enable Sleep* property to 'No' the sleep mode will be disabled.

CHAPTER 5 Installation on RCM9/11

The Pressure Sensor 4017 can easily be installed on all Aanderaa Recording Instruments with 16mm boreholes in the top-end plate (RCM 9 MkII, RCM 9 LW, RCM 9 IW, RCM 11, RDCP600 etc.).

The best position will on most instruments be opposite to the temperature sensor, refer to Figure 5-1.

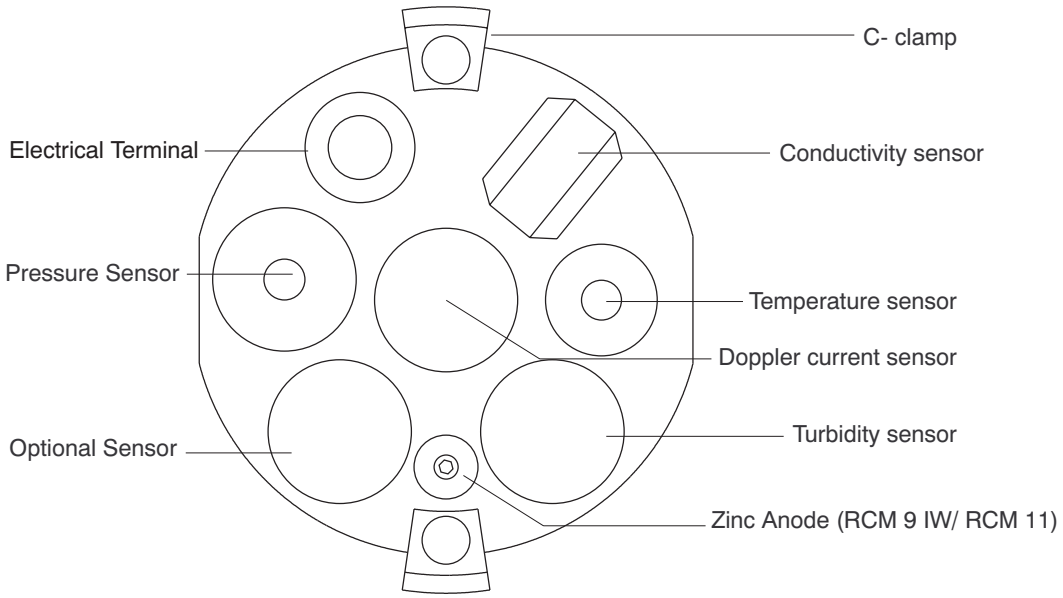


Figure 5-1 Illustration of top end plate of RCM 9 MkII/RCM 9 LW/RCM 9 IW/RCM 11/RDCP 600. Note! The sensors may be placed differently than illustrated here.

Before installing connect the Sensor Cable 3854 to the sensor foot. Inspect the surface of the hole in the top end plate of the instrument; it must be clean and without scratches. Check also that the O-rings at the Sensor foot are free from dust and particles and greased with silicon grease.

A small stainless steel ball is used for orientation of the Sensor. Place the orientation ball in the dimple next to the hole in the top end plate. Insert the Pressure Sensor, and secure it with a nut on the inside of the top end plate. Apply Tectyl 506 (included in recommended spares) in the slit between the Sensor and the top end plate. This will prevent crevice corrosion of the top end plate.

The other end of the Sensor Cable 3854 can now be connected to a free sensor input at the main board. Usually the input labelled “PRESSURE CHANNEL 6” is used.

Note! If the instrument is to be used at higher pressure than the range of the pressure sensor, the pressure port must be closed by use of the Swagelok plug SS-200-P (stock no. 840017). Unscrew the pressure port cap and ensure that the surface of the port face is clean and smooth. Fasten the plug until it mates and add ¼ of a turn.

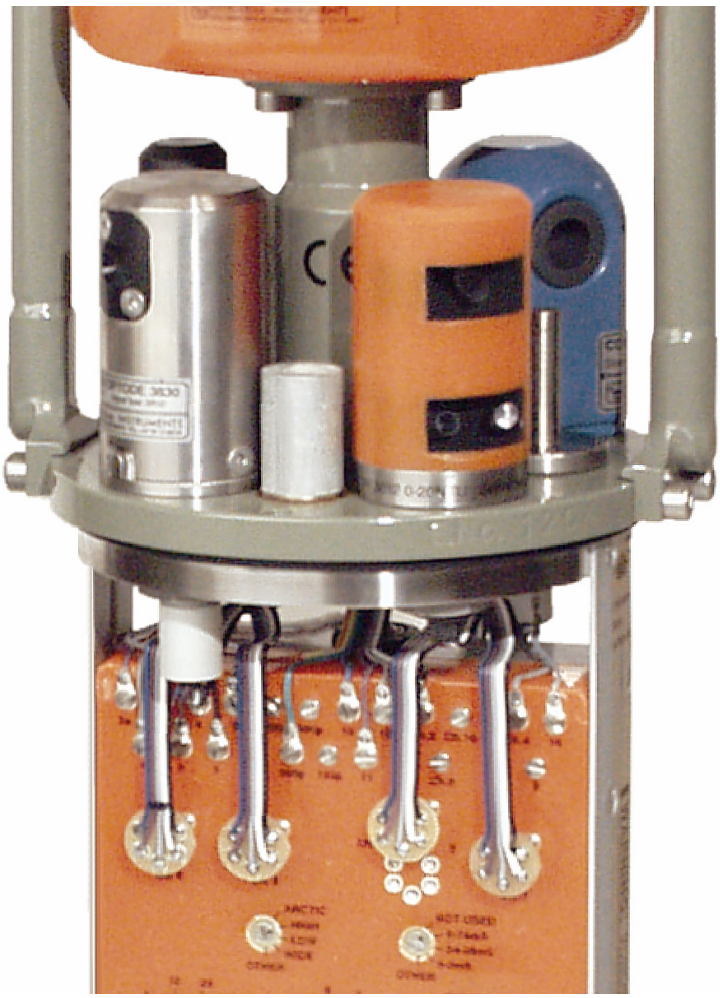
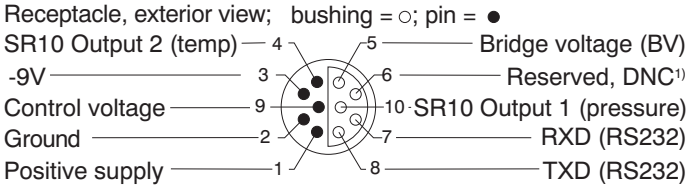


Figure 5-2: Pressure Sensor (behind the Oxygen Optode) and other sensors connected to RCM 9 MkII

The pin configuration for Pressure Sensor 4017 is given in Figure 5-3.

PIN CONFIGURATION

Receptacle, exterior view; bushing = ○; pin = ●



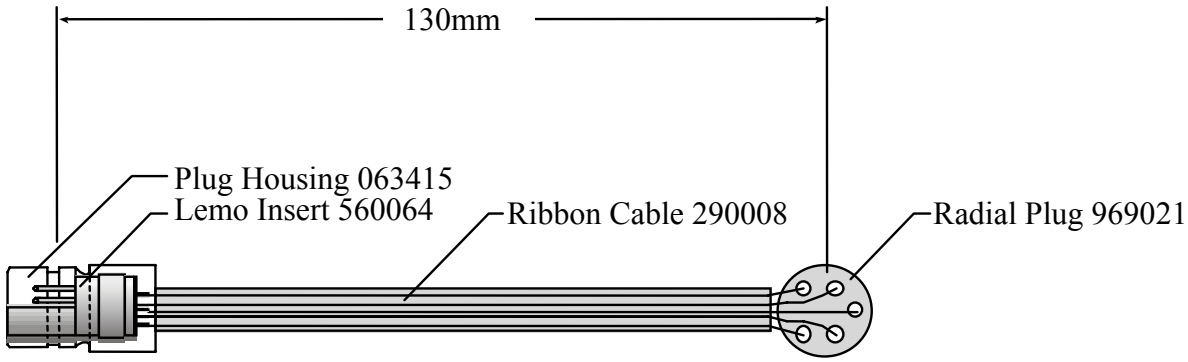
1) DNC: Do Not Connect

Figure 5-3 Pin configuration (receptacles) of Pressure Sensor 4017

Sensor cable

A short cable called Sensor Cable 3854 is used for connection between the sensor and Aanderaa Current meters and RDCP 600 (Figure 5-4 and Figure 5-5).

Figure 5-4 Sensor Cable 3854



Signal name	Colour	Sensor Plug	Cell Plug
BV	Blue	4	1
Control voltage	Violet	10	2
Positive Supply	Grey	8	3
–9V	White	6	4
SR10	Black	9	5

SENSOR CABLE 3854 10pp – Radial Plug (V8699A)

Figure 5-5 Sensor Cable 3854

CHAPTER 6 Installation on ®SEAGUARD datalogger

The Pressure Sensor 4117 can easily be installed on Aanderaa Seaguard data loggers.

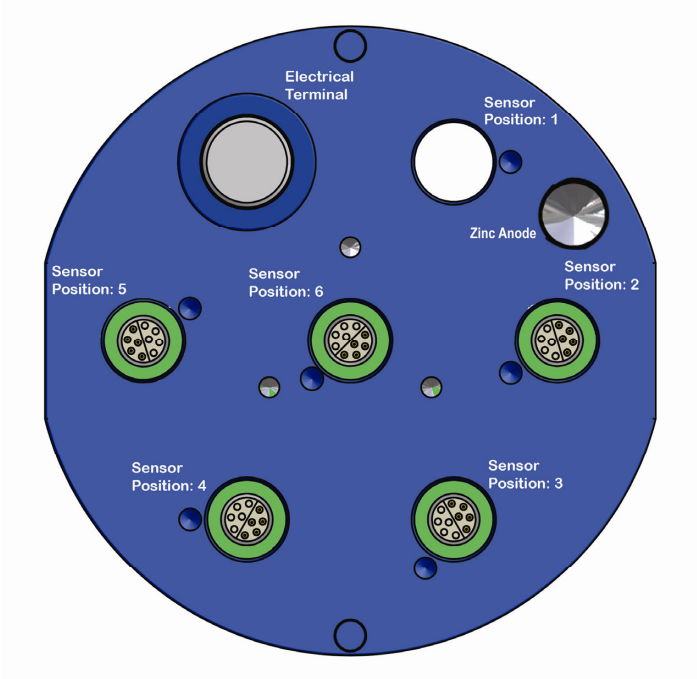


Figure 6-1 Illustration of top end plate of Seaguard

The best position for the pressure sensor will on most instruments be next to the Electrical terminal, Sensor Position 2, refer to Figure 6-1.

All sensor and sealing plugs except for the centre position are secured by us of a setscrew in the side of the top end plate. Start by unscrewing the setscrew for the wanted position (the setscrew will stop when sufficiently extracted). Pull out the sealing plug (or sensor) by inserting a screwdriver in the slot between the plug and the top end plate, see Figure 6-2.

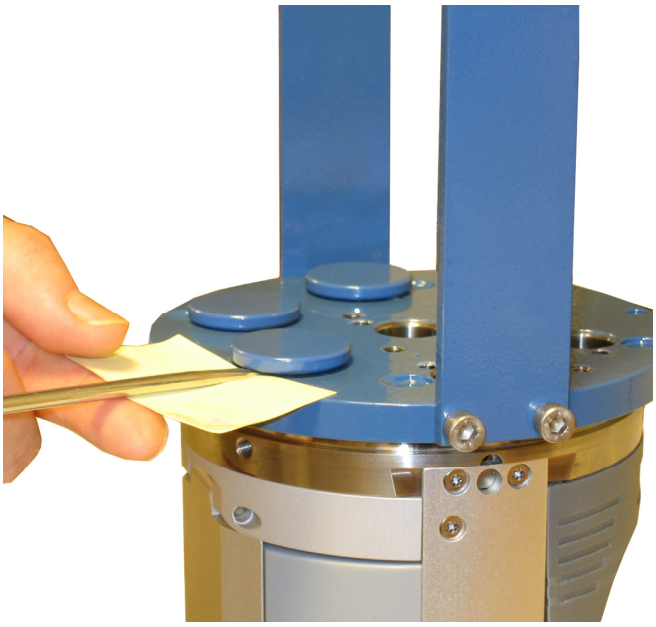


Figure 6-2: Removal of sealing plug. Use a small bit of paper/cardboard to protect the top-end plate

Make sure that the surface in the hole is clean and smooth and check also that the O-rings at the Sensor foot are free from dust and particles and greased with silicon grease. Align the orientation pin in the sensor foot with the orientation hole in the top end plate, and carefully insert the sensor.

When fully seated at the top end plate, tighten the setscrew with only moderate force.

Note! Always replace O-rings when connecting to a sensor or a sealing plug.

Apply Tectyl 506 (included in maintenance kit) in the slit between the Sensor and the top end plate, refer Figure 6-4. This will prevent crevice corrosion of the top end plate.

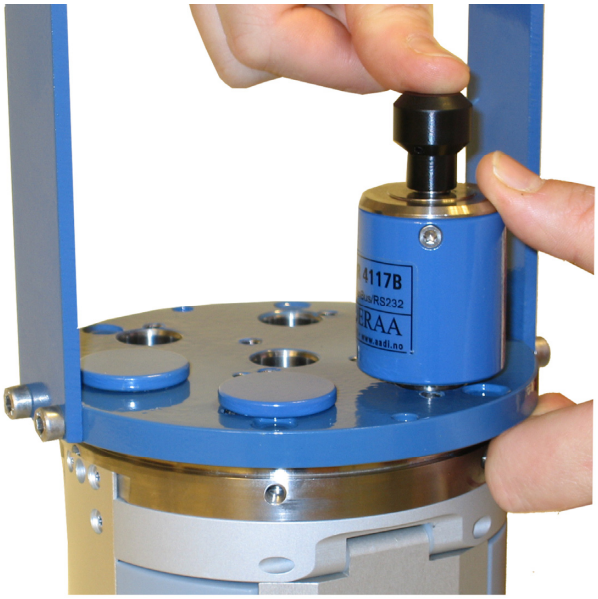


Figure 6-3 Connect pressure sensor to top end plate in position 2. Please note that the picture shows pressure in position 3.

Connect the pressure sensor to top end plate in position 2, refer Figure 6-1.

Figure 6-4 Apply Tectyl in the slit between the Sensor and the top end plate. (Example showing tectyl around the electrical terminal).

Note! If the sensor is installed in one of the positions without connector in the hub, patch cable 3969492 is needed for the electrical connection.

Figure 6-5 Pressure Sensor on ®SEAGUARD

CHAPTER 7 Quality assurance, maintenance and calibration

Aanderaa Instruments have Proven Reliability. With over 30 years of producing instruments for the scientific community around the world, you can count on our reputation for designing the most reliable products available.

We are guided by three underlying principles: quality, service, and commitment. We take these principles seriously, for they form the foundation upon which we provide lasting value to our customers. Our unmatched quality is based on a relentless program of continuous monitoring to maintain the highest standards of reliability.

In order to assure the quality of this sensor, critical properties are tested during production. A special form, named "Test and Specification Sheet" (refer to) lists the required tests and the result of these tests and checkpoints.

Maintenance

The Pressure Sensor 4017/4117 requires modest maintenance. For deployments where the water contains high concentrations of sediment or where the organic fouling is extensive it is important to check that the pressure port is not clogged. Unscrew the pressure port cap, inspect the holes of the cap and clean it if necessary. Before replacing the pressure port cap, inspect that there is silicon oil in the pressure port.

To avoid clogging the pressure port is filled with high viscous silicon oil. After long time use this oil may vanish. If no oil can be seen in the pressure port we recommend that the sensor is returned to the factory for refilling.

The sensor housing will tolerate most cleaning agents. Often 30% Hydrochloric acid (HCL) (Muriatic acid) will be useful for removing barnacles and similar fouling.

Be sure to follow the safety precaution for such acids.

Calibration

Each Pressure Sensor is calibrated by use of highly accurate instruments that are traceable international standards.

For most versions of the pressure sensor this involves 6 pressure points at 4 different temperatures.

From this calibration the 20 calibration coefficients are calculated and stored in each sensor.

AANDERAA DATA INSTRUMENTS

TEST & SPECIFICATIONS

Form No. 679, Dec 2005

Layout No: 1349, 1350, 1351
Circuit Diagram No: V-3964C, V-3965B
Program Version: 3B71

Product: Pressure Sensor 4017F
Serial No: 184

1. Visual and Mechanical Checks:
   1.1. Soldering quality
   1.2. Visual surface
   1.3. Galvanic isolation between housing and electronics

2. Current Drain and Voltages:

2.1. DSP IO voltage, J4.7 (3.3 ±0.07 V)	3.29 V
2.2. DSP Core voltage, J4.6 (1.8 ±0.04 V)	1.80 V
2.3. Analog voltage, TP2 (3.3 ±0.15 V)	3.31 V
2.4. Average current drain at 0.5 Hz sampling (Max.: 7 mA)	3.7 mA
2.5. Current drain in sleep (Max.: 220 µA)	130 µA
2.6. Quiescent current drain from –9V (Max.: 1 µA)	0.00 µA

3. Electronic performance test:

3.1. Raw data pressure reading at air pressure (-500000 to +1000000 LSB)	-58994 LSB
3.2. Raw data temperature reading in room temp (4000000 to 13000000 LSB)	8276332 LSB
3.3. Noise on raw data pressure readings (max.: 230 LSB)	10 LSB
3.4. Noise on temperature reading (max.: 5000 LSB)	974 LSB

Date: 22 September 2006

Sign:

Helge Soltveit

Helge Soltveit, Production Engineer

AANDERAA DATA INSTRUMENTS AS

5851 BERGEN, NORWAY Tel. +47 55 60 48 00 Fax. +47 55 60 48 01 E-mail: info@aadi.no Web: http://www.aadi.no

AANDERAA DATA INSTRUMENTS

CALIBRATION CERTIFICATE

Form No. 680, Jan 2006
Page 1 of 2

Certificate No:4017F_1_38922
Range: 0 - 60MPa

Product: Pressure Sensor 4017F
Serial No: 1
Calibration Date:24 July 2006

This is to certify that this product has been calibrated using the following instruments:

ASL Digital Thermometer model F25	Serial No.1103-14
Platinum Resistance Thermometer	Serial No.SV1915/D
Calibration Bath model FNT 321-1-40	
Budenberg Dead-Weight Tester 280 D	Serial No.11570

Parameter: Temperature

Calibration points and readings:

Temperature (°C)	1.026	13.920	26.900	39.850
Reading (LSB)	12370161	10360019	8231224	6273577

Giving these coefficients

Index	0	1	2	3
TempCoef	2.59230E+01	-5.19161E+01	8.20907E+00	-1.96859E+01

Parameter: Pressure

Giving these coefficients

Index	0	1	2	3
R1Coef0	4.24932E+01	4.10113E+00	-1.60986E+00	1.02140E+01
R1Coef1	7.88729E+03	-9.09709E+02	3.97280E+02	-9.32389E+02
R1Coef2	1.70260E+02	-1.12558E+02	-2.33084E+03	5.59780E+03
R1Coef3	2.57142E+02	4.69891E+02	6.99756E+03	-1.71544E+04
R1Coef4	-5.06434E+01	-5.54196E+02	-6.64568E+03	1.65031E+04

AADI
AANDERAA DATA INSTRUMENTS

CALIBRATION CERTIFICATE

Form No. 680, Jan 2006
Page 2 of 2

Certificate No: 4017F_184_38996
Range: 0 to 60000

Product: Pressure Sensor 4017F
Serial No: 184
Calibration Date: 6 October 2006

Parameter: SR10/I2C outputs

	Output 1	Output 2
Parameter:	Pressure	Temperature
Notes:		
Unit	kPa	Deg.C
Range	0 to 60000	-5.00 to 35.00
A	0.000E+00	-5.000E+00
B	5.859E+01	3.906E-02
C	0.000E+00	0.000E+00
D	0.000E+00	0.000E+00
Formula	Pressure (kPa) = $A + BN + CN^2 + DN^3$ where N is SR10 raw data reading	Temperature (Deg.C) = $A + BN + CN^2 + DN^3$ where N is SR10 raw data reading

The ranges at both SR10/I2C outputs are user configurable.
This table shows the configuration from factory.

Note that different scaling coefficients must be used for different configurations.

Date: 6 October 2006

Sign:
Arne Insteba,
Calibration & Production Engineer

AANDERAA DATA INSTRUMENTS AS

5851 BERGEN, NORWAY Tel. +47 55 60 48 00 Fax. +47 55 60 48 01 E-mail: info@aadi.no Web: http://www.aadi.no

Figure 7-1 Calibration Sheet

Appendix 1 Mechanical Design

Figure A 1 Pressure Sensor 4017/4117

The Pressure Sensor 4017/4117 is housed in a rugged titanium cylinder.

The sensor foot holds the electrical connector and O-rings for bulk head mounting. The pressure port at the other end is equipped with a Swagelok™ $^{1}/_{8}$ inch compression fitting, allowing easy connection to calibration and test equipment.

In order to avoid clogging the pressure inlet is filled with high viscous silicon oil.

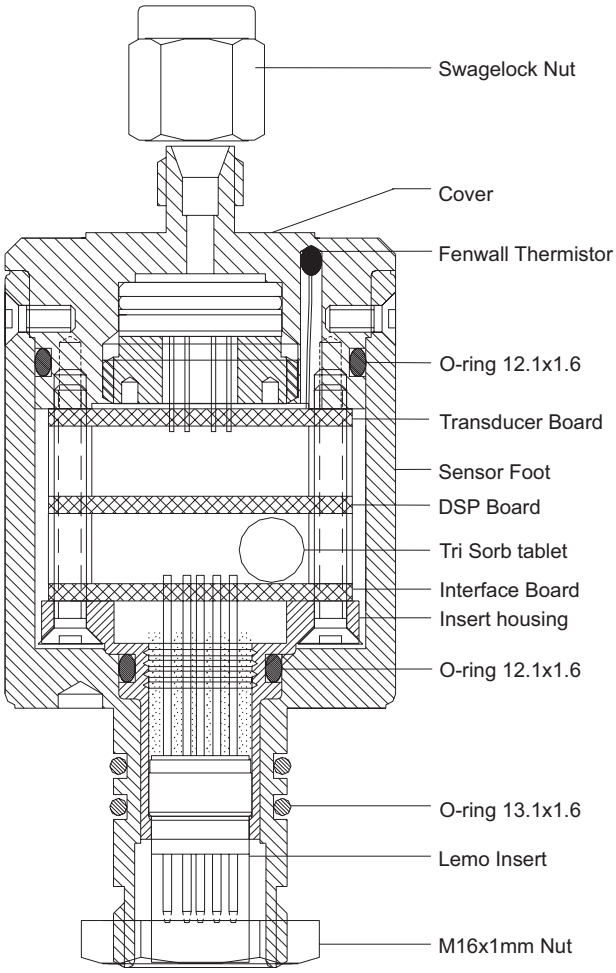


Figure A 2 Drawing of Pressure Sensor 4017/4117

Appendix 2 Construction

The Pressure Sensor 4017/4117 is base on a piezoresistive bridge. This bridge is consists of 4 resistors implemented on a silicon diaphragm. One side of the diaphragm is exposed to the water pressure, while the other is facing a vacuum chamber. When the diaphragm is flexed by the pressure the resistance of the resistors will change. By applying a constant voltage over the bridge, a voltage that varies with the pressure is generated. This voltage is sampled by a high resolution analog to digital converter (ADC) controlled by a digital signal processor (DSP). A thermistor sensing the water temperature is also sampled by this ADC.

All pressure transducer have a temperature drift. By calibration the sensor at different temperature, this drift can be found. The DSP stores the data from the calibration and are thus able to temperature compensate sampled pressure data, as well as also convert the data to linear calibrated data in engineering unit.

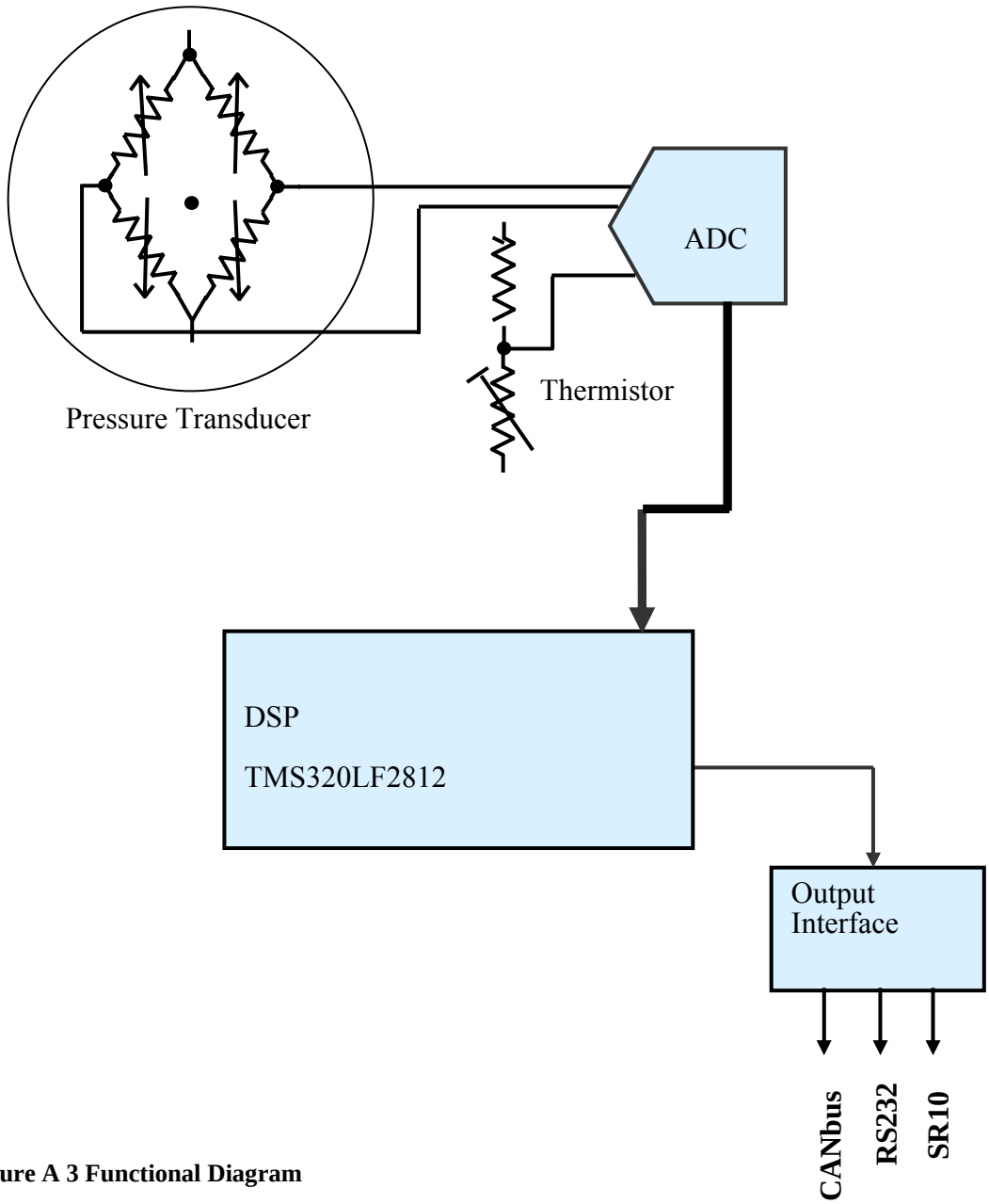


Figure A 3 Functional Diagram

Appendix 3 Analog Adaptor 3966

The Pressure Sensor 4017/4117 can be used with third party dataloggers, e.g. CTD's, ARGO floats, ROV's, PLC's, process industry controllers, recorders, and data acquisition and control systems. Refer to the specific systems Operating Manual for connection of sensors to these systems. When equipped with Analog Adaptor 3966 the pressure sensor will provide analog signal for such integration.

Analog Adaptor 3966 switch settings 0 - 5 V and 4 – 20 mA

When the switch is in the upper position the dipswitch contact is *OFF*. The three valid settings are shown in Figure A 4 , Figure A 5 , and Figure A 6 .

Note! When the Analog Adaptor 3966 is switched off by setting contact no. 8 in the OFF position, the sensor connected to the adaptor is still powered.

The RS232 lines are wired straight through the analog adaptor and are thus not affected by the switch settings. Refer to '' on page 32 and the following page for channel output.

Table 7-1 Switch settings for Pressure Sensor 4017/4117

Switch	Function	Remarks
1	Enable 4 – 20mA	Output 1
2	Enable 0 – 5V	
3	Power, 4 – 20mA transmitter	
4	Enable 4 – 20mA	Output 2
5	Enable 0 – 5V	
6	Enable 4 – 20mA voltage ref	
7	Enable 0 – 5V voltage ref.	
8	Power	

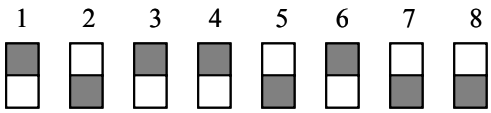


Figure A 4 Switch setting for 0 – 5 V analog output (the dark square represents the switch). Upper position is OFF.

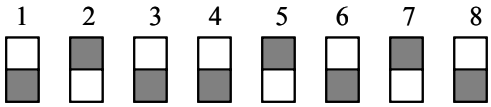


Figure A 5 Switch setting for 4 – 20 mA analog output (the dark square represents the switch). Upper position is OFF.

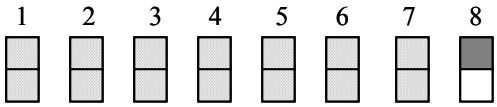


Figure A 6 Switch setting for switching the analog adaptor off (the dark square represents the switch). Upper position is OFF.

Appendix 4 Calculating Seawater Depth from Pressure Measurements

To convert the pressure measurements to depth, the Unesco standard ocean depth formula [1] can be used:

$z=D/g_a$

where

z is depth in meters,

g_a = average gravity at site = $g(Ø) + ½ \gamma P_g$

where

P_g = pressure in kPa

Ø = latitude in degrees

$g(Ø)$ = local gravity at latitude = $9.780318\ (1.0 + 5.2788e\text{-}3\ \sin^2(Ø) + 2.36e\text{-}5\ \sin^4(Ø))$

$\gamma = 2.226\ E\text{-}7$

D = geopotential distance = $C_1 P + C_2P^2 + C_3 P^3 + C_4P^4$

where

P_g = Pressure in kPa

$C_1 = 9.72659E\text{-}1$

$C_2 = -2.2512\ E\text{-}7$

$C_3 = 2.279\ E\text{-}13$

$C_4 = -1.82\ E\text{-}19$

The formula is derived using a water density profile at a salinity S = 35, a temperature T = 0 °C, and a compressibility correction of second order.

The P_g is the gauge pressure. Since the Pressure Sensor 4017/4117 measures the absolute pressure, the atmospheric pressure must be subtracted:

$P_g = P_a – 0.1P_0$

where

P_g = gauge pressure in kPa

P_a = gauge pressure in kPa

P_0 = atmospheric pressure in HPa, standard pressure =1013.25 Hpa

For maximum accuracy the atmospheric pressure should be measured simultaneously above the pressure sensor. However at greater depths subtracting a fixed atmospheric pressure (standard pressure =1013.25 HPa) is usually sufficient.