PRODUCT MANUAL

TD-Diver™ & Baro-Diver® – DI8xx Series

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The presence of the Waste Electrical and Electronic Equipment (WEEE) marking on the product indicates that the device is not to be disposed via the municipal waste collection system of any member state of the European Union. For products under the requirement of WEEE directive (2012/19/EU), please contact your distributor or local Van Essen Instruments B.V. office for the proper decontamination information and take back program, which will facilitate the proper collection, treatment, recovery, recycling, and safe disposal of the device.

CE COMPLIANCE STATEMENT (EUROPE)

We hereby declare that the device(s) described below are in conformity with the directives listed. In the event of unauthorized modification of any devices listed below, this declaration becomes invalid.

Type: Datalogger
Product Model: TD-Diver (DI801, DI802, DI805, DI810), Baro-Diver (DI800)

Relevant EC Directives and Harmonized Standards:

1999/5/EC R&TTE Directive for Radio and Telecommunications Terminal Equipment in accordance to annex III to which this directive conform to the following standards:

> **Low Voltage Directive per EN60950-1 (2006)+A11 (2011)** for Product Safety testing standard for "Information Technology Equipment"
>
> **EMC Directive EN 301 489-1 V1.8.1 / EN 301 489-17 V1.3.2** Electromagnetic emission and immunity for "Information Technology Equipment"

2004/108/EC Electromagnetic Compatibility directive, as amended by EN61326-1:2013

The product(s) to which this declaration relates is in conformity with the essential protection requirements of 2004/108/EC Electromagnetic Compatibility directive. The products are in conformity with the following standards and/or other normative documents:

> **EMC: Harmonized Standards: EN 61326-1:2013 Lab Equipment, EMC**
>
> IEC61000-6-3:2007 Emission standard for residential, commercial and light-industrial environments
> IEC61000-4-2:2009 Electrostatic discharge immunity test
> IEC61000-4-3:2006 Radiated, radio-frequency, electromagnetic field immunity test
> IEC61000-4-4:2012 Electrical fast transient/burst immunity test
> IEC61000-4-5:2006 Surge immunity test
> IEC61000-4-6: 2014 Immunity to conducted disturbances, induced by radio-frequency fields
> IEC61000-4-11:2004 Voltage dips, short interruptions and voltage variations immunity tests

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The items comply with all applicable Essential Requirements of the Directives.

Contents

1 Introduction

The TD-Diver™ is a compact, groundwater monitoring instrument for continuously measuring level and temperature in groundwater, surface water, and industrial waters. The data collected can be used to manage water resources, estimate hydraulic conductivity and other aquifer conditions. Examples of applications are:

- monitor potable water recharge areas for water supply,
- monitor tailings ponds, dewatering activities and water supply levels of mines,
- general site investigations for construction, and
- contaminant plume monitoring on spill sites, remediation sites, chemical storage facilities, landfill sites and hazardous waste storage sites.

The TD-Diver is an easy-to-use datalogger featuring state-of-the-art electronics and a robust high precision pressure sensor for long term accuracy. The absolute pressure sensor requires minimal maintenance and re-calibration.

The Diver® is a datalogger housed in a cylindrical casing with a suspension eye at the top. The suspension eye can be unscrewed and is designed to install the Diver into the monitoring well. The suspension eye also protects the optical connector. The electronics, sensors and battery are installed maintenance-free into the casing. The Diver is not designed to be opened.

The name of the datalogger, the model number, the measurement range and the serial number are clearly identified on the side of the Diver. This information is etched using a laser and is consequently chemically neutral and not erasable.

1.1 About this Manual

This manual contains information about Van Essen Instruments' TD-Diver with part number DI8xx, see section 2.5, and Baro-Diver® with part number DI800, an instrument designed to measure groundwater levels and temperature and atmospheric pressure and temperature, respectively.

This chapter contains a brief introduction to the Diver's measurement principles. Chapter 2 contains the technical specifications for the TD-Diver and Baro-Diver as well as guidelines for Diver maintenance. Chapter 3 covers the deployment of Divers. This includes programming the Diver with the Diver-Office software. Subsequently, installation of Divers in monitoring wells and in surface water is discussed. There are three appendices that describe the use of Divers at varying elevation, the Diver communication protocol and a list of Diver accessories.

1.2 Operating Principle

The Diver is a datalogger designed to measure water pressure and temperature. Measurements are subsequently stored in the Diver's internal memory. The Diver consists of a pressure sensor designed to measure water pressure, a temperature sensor, and a battery that powers the electronics that takes and stores the measurements. The Diver is an autonomous datalogger that can be programmed by the user. The Diver has a completely sealed enclosure. The communication between Divers and Laptops/field devices is based on optical communication.

The Divers measures the absolute pressure. This means that the pressure sensor not only measures the water pressure, but also the air pressure pushing on the water surface. If the air pressure varies, the measured water pressure will thus also vary, without varying the water level. The air pressure can be measured by a Baro-Diver and subsequently be used in the Diver-Office software to convert the Diver pressure readings into water level data.

1.3 Measuring Water Level

All Divers establish the height of a water column by measuring the water pressure using the built-in pressure sensor. As long as the Diver is not submerged in water it measures atmospheric pressure, just like a barometer. Once the Diver is submerged this is supplemented by the water's pressure: the higher the water column the higher the measured pressure. The height of the water column above the Diver's pressure sensor is determined on the basis of the measured pressure.

To measure these variations in atmospheric pressure a Baro-Diver is installed for each site being measured. The barometric compensation for these variations in atmospheric pressure can be done using the Diver-Office software, see www.vanessen.com for a free download. It is also possible to use alternative barometric data such as data made available online.

The barometrically adjusted water values can be related to a reference point such as the top of the monitoring well or Mean Sea Level (MSL) or any other vertical reference datum.

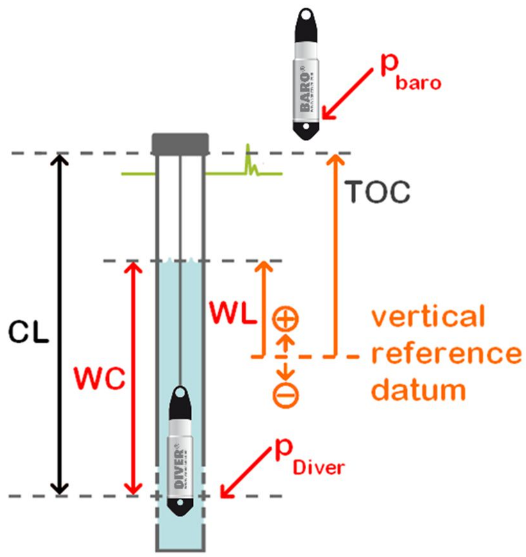
1.3.1 Converting Diver Data into Water Level

This section explains how to calculate the water level in relation to a vertical reference datum using the Diver and Baro-Diver's measurements.

The figure below represents an example of a monitoring well in which a Diver has been installed. In this case we are therefore interested in the height of the water level (WL) in relation to the vertical reference datum. If the water level is situated above the reference datum it has a positive value and a negative value if it is situated below the reference datum.

The top of casing (TOC) is measured in relation to the vertical reference datum and is denoted in the diagram below as TOC. The Diver is suspended with a cable with a length CL. If the cable length is not exactly known, it can be calculated from a manual measurement as described in section 1.3.2.

The Baro-Diver measures the atmospheric pressure (p_{baro}) and the Diver measures the pressure exerted by the water column (WC) above the Diver and the atmospheric pressure (p_{Diver}).



The water column (WC) above the Diver can be expressed as:

$$WC = 9806.65 \frac{p_{Diver} - p_{baro}}{\rho \cdot g} \quad (1)$$

where p is the pressure in cmH_2O, g is the acceleration due to gravity (9.80665 m/s^2) and ρ is the density of the water (1,000 kg/m^3).

The water level (WL) in relation to the vertical reference datum can be calculated as follows:

$$WL = TOC - CL + WC \quad (2)$$

By substituting WC from equation (1) in equation (2) we obtain:

$$WL = TOC - CL + 9806.65 \frac{p_{Diver} - p_{baro}}{\rho \cdot g} \quad (3)$$

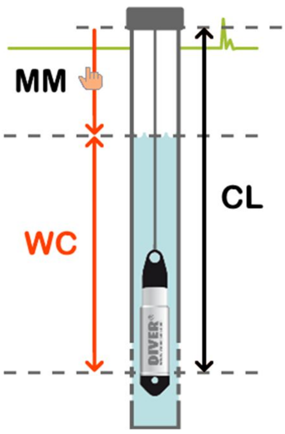
1.3.2 Calculating the Cable Length from a Manual Measurement

If the cable length is not exactly known, it can be determined using a manual measurement, see the figure below. The manual measurement (MM) is taken from the top of casing to the water level. The value of the water level is positive unless, in exceptional circumstances, the water level is situated above the top of casing.

The cable length can now be calculated as follows:

$$CL = MM + WC \quad (4)$$

where the water column (WC) is calculated on the basis of the measurements taken by the Diver and the Baro-Diver.



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Notes:

- If the pressure measured by the Diver and the Baro-Diver is measured at different points in time, it is necessary to interpolate. The Diver-Office software automatically performs this interpolation.
- It is possible to enter manual measurements into the Diver-Office software. The software subsequently automatically calculates the cable length.

1.3.3 Example

The top of casing is measured to be 150 cm above the Mean Seal Level (MSL): TOC = 150 cm. The cable length is not exactly known and therefore a manual measurement is taken. It turns out to be 120 cm: MM = 120 cm.

The Diver measures a pressure of 1,170 cmH_2O and the Baro-Diver measures a pressure of 1,030 cmH_2O. Substituting these values into equation (1), results in a water column of 140 cm above the Diver: WC = 140 cm.

Substituting the values of the manual measurement and the water column in equation (4) results in the following cable length: CL = 120 + 140 = 260 cm.

The water level in relation to MSL can now be easily calculated using equation (2): WL = 150 – 260 + 140 = 30 cm above MSL.

1.4 Measuring Temperature

All Divers measure the groundwater temperature. This can, for example, provide information about groundwater flows.

The temperature is measured using a semiconductor sensor. This sensor not only measures the temperature, but also uses the value of the temperature to at the same time compensate the pressure sensor and electronics for the effects of temperature to ensure the best possible performance.

1.5 Diver Models

The Diver models described in this manual are from the DI8xx Series: the TD-Diver and the Baro-Diver. Both models measure absolute pressure and temperature. The summary below describes the two models.

TD-Diver

This Diver is manufactured using a stainless steel (316 L) casing with a 22 mm diameter. The TD-Diver is capable of storing a maximum of 72,000 measurements (date/time, pressure and temperature) in its working memory and 72,000 measurements in its backup memory.

The TD-Diver samples pressure and temperature at fixed length intervals and stores these values in fixed length or continuous memory.

The TD-Diver is available in the following pressure ranges: 10 m, 20 m, 50 m and 100 m.

Baro-Diver

The Baro-Diver is manufactured using a stainless steel (316 L) casing with a 22 mm diameter. The Baro-Diver is capable of storing a maximum of 72,000 measurements (date/time, pressure and temperature) in its working memory and 72,000 measurements in its backup memory.

The Baro-Diver measures atmospheric pressure and is used to compensate for the variations in atmospheric pressure measured by the other Divers. The Baro-Diver can also be used for measuring shallow water levels up to 1 meter.

The Baro-Diver samples pressure and temperature at fixed length intervals and stores these values in fixed length or continuous memory.

1.6 Factory Calibration Procedure

Each Diver is individually calibrated and tested at a number of temperature and pressure values to ensure superior performance. The Diver is calibrated for the life-time of the instrument, as long as it is used within its specified range. A calibration certificate is available upon request.

2 Technical Specification

2.1 General

The Baro-Diver is used for atmospheric pressure and temperature measurements. There are four TD-Diver models with different pressure ranges for pressure and temperature measurements. The table below lists the general specifications of the Baro-Diver and TD-Diver.

Diameter	Ø 22 mm
Length (incl. suspension eye)	~ 110 mm
Weight	~ 104 grams
Materials	
Casing	Pickled and passivated 316L stainless steel
Pressure sensor	Alumina (Al_2O_3)
Suspension eye	Nylon PA6 glass fiber reinforced 30%
nose cone	ABS
O-rings	Viton®
Communication	
Interface	Optically separated
Protocol	Serial RS232, a limited set of commands is available as specified in Appendix II
Memory capacity	144,000 measurements
working	72,000 measurements
backup	72,000 measurements
Memory	Non-volatile memory. A measurement consists of date/time/pressure/temperature continuous and fixed length memory
Battery life*	Up to 10 years, depending on use
Theoretical battery capacity	10.5 million measurements + 1000× full memory readouts + 2000× programming
Clock accuracy	Better than ± 1 minute per year at 25 °C
	Better than ± 5 minutes per year within the operating temperature range
CE marking	EMC in accordance with the 89/336/EEC directive Basic EN 61000-4-2 standard
Emissions	EN 55022 (1998) + A1 (2000) + A2 (2003), Class B
Immunity	EN 55024 (1998) + A1 (2000) + A2 (2003)

* **The Diver is always in stand-by when not making a measurement.** The power consumption of the integrated battery is dependent on the temperature and usage.

If the Diver is used, stored or transported for extended periods of time under high temperature, this will adversely affect the life of the battery. The battery's capacity at lower temperatures is reduced, but this is not permanent. This is normal behavior for batteries.
Excessive programming, high frequency sampling and data reading will reduce the battery capacity.

** The accuracy of the clock is highly dependent on temperature. The clock is actively compensated for temperature in all models.

2.2 Environmental

Ingress protection	IP68, 10 years continuously submerged in water at 100 m

2.3 Transportation

Suitable for transportation by vehicles, ships and airplanes in the supplied packaging.

Resistance to vibration	In accordance with MIL-STD-810.
Mechanical shock test	In accordance with MIL-STD-810, for light-weight equipment
Temperature	-20 °C to 80 °C (affects battery life)

2.4 Temperature

Measurement range	-20 °C to 80 °C
Operating Temperature (OT)	TD-Diver: 0 °C to 50 °C Baro-Diver: -10 °C to 50 °C ambient temperature
Accuracy (max)	± 0.2 °C
Accuracy (typical)	± 0.1 °C
Resolution	0.01 °C
Response time (90% of final value)	3 minutes (in water)

2.5 Pressure

The specifications for atmospheric and water pressure measurements vary by type of Diver. The specifications below apply at operating temperature.

TD-Diver	**DI801**	**DI802**	**DI805**	**DI810**	**Unit**
Water column measurement range	10	20	50	100	mH_2O
Accuracy (max)	± 2.0	± 4.0	± 10.0	± 20.0	cmH_2O
Accuracy (typical)	± 0.5	± 1.0	± 2.5	± 5.0	cmH_2O
Long-term stability	± 2	± 4	± 10	± 20	cmH_2O
Resolution	0.2	0.4	1	2	cmH_2O
Display resolution	0.058	0.092	0.192	0.358	cmH_2O
Overload pressure	15	30	75	150	mH_2O

Baro-Diver	**DI800**	**Unit**
Water column measurement range	1.5	mH_2O
Accuracy (max)	± 2.0	cmH_2O
Accuracy (typical)	± 0.5	cmH_2O
Long-term stability	± 2	cmH_2O
Resolution	0.1	cmH_2O
Display resolution	0.058	cmH_2O
Overload pressure	15	mH_2O

2.5.1 Water Column Measurement Range

The height of water above the Diver that can be measured.

2.5.2 Accuracy (maximum)

Accuracy is the proximity of measurement results to the true value. Algebraic sum of all the errors that influence the pressure measurement. These errors are due to linearity, hysteresis and repeatability. During the Diver calibration process a Diver is rejected if the difference between the measured pressure and the applied pressure is larger than the stated accuracy.

2.5.3 Accuracy (typical)

At least 68% of the measurements during the calibration check are within 0.05% FS of the measurement range.

2.5.4 Long-term Stability

The stability of the measurement over a period of time when a constant pressure is applied at a constant temperature.

2.5.5 Resolution

The smallest change in pressure that produces a response in the Diver measurement.

2.5.6 Display Resolution

The smallest increment in pressure that the Diver can measure.

2.5.7 Overload Pressure

The pressure at which the Diver pressure sensor will catastrophically fail.

2.6 Sample Interval and Methods

The minimum and maximum sample interval plus the various sample methods available for the TD-Diver and Baro-Diver are listed below.

Sample interval	0.5 sec to 99 hours
Sample method	Fixed interval

2.6.1 Fixed Length Memory

The Diver will take measurements at a sample interval set by the user, for example every hour. When the number of samples reaches 72,000, i.e. the memory is full, the Diver will stop measuring.

2.6.2 Continuous Memory

The Diver will take measurements at a preset sample interval data. When the memory fills up, new samples begin overwriting the oldest records.

3 Diver Installation and Maintenance

3.1 Introduction

In practice the Diver is suspended in a monitoring well and the Baro-Diver is installed at the surface for recording barometric pressure. Atmospheric pressure data must be used to compensate the pressure measurements recorded by the Divers for variations in atmospheric pressure. In principle, a single Baro-Diver is sufficient for an area with a radius of 15 kilometers depending on terrain conditions. Also see Appendix I *Use of Divers at Varying Elevation*. A 10-meter change in elevation is the equivalent of a barometric pressure change of approx. 1 cmH2O or 1 mbar.

The following sections describe how to install the Diver and Baro-Diver.

3.2 Configuring and Reading the Diver

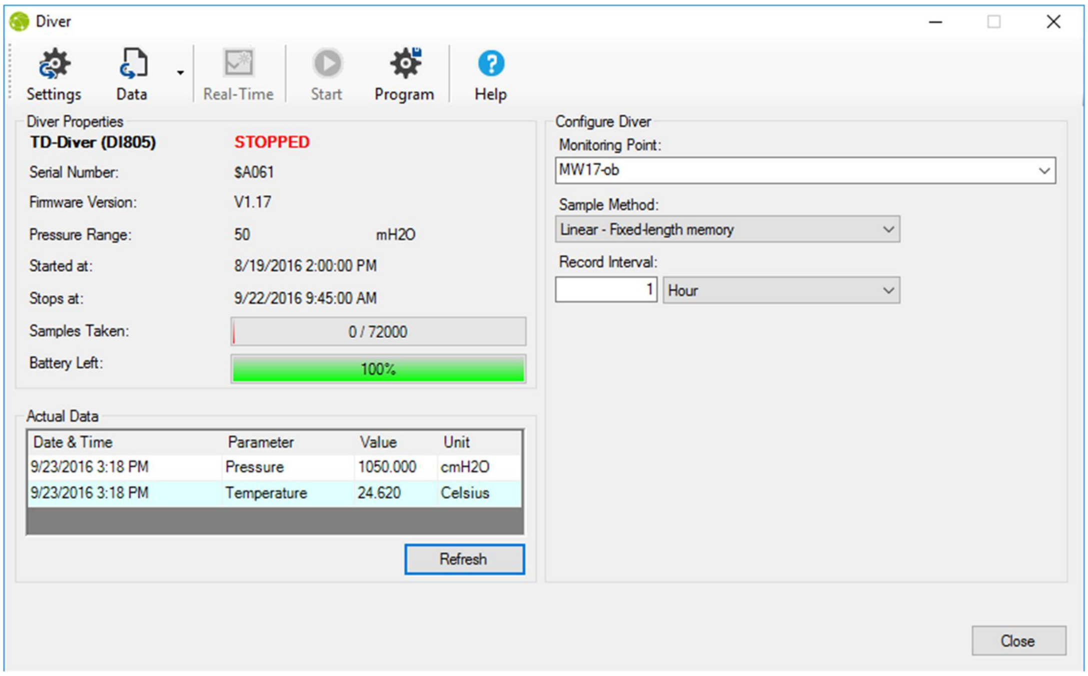
A Diver must be programmed with the desired sample method, sample interval, and monitoring point name before it is deployed. The Divers can be programmed, started, stopped and its data read using the Diver-Office software. The latest version of Diver-Office can be downloaded for free from www.vanessen.com. Once the software is installed, a Diver can be connected to the computer through a USB Reading Unit (part no AS330), a USB Interface Cable (part no. AS327) or the Diver-Gate(M) (part no. AS345).

3.2.1 Configuring a Diver

Open the Diver-Office software and click the **Diver** button to open the Diver window. See the image below for an example where the following

- monitoring point name: “MW17-ob”,
- sample method: “Fixed – Fixed-length memory”
- record interval:1 hour.

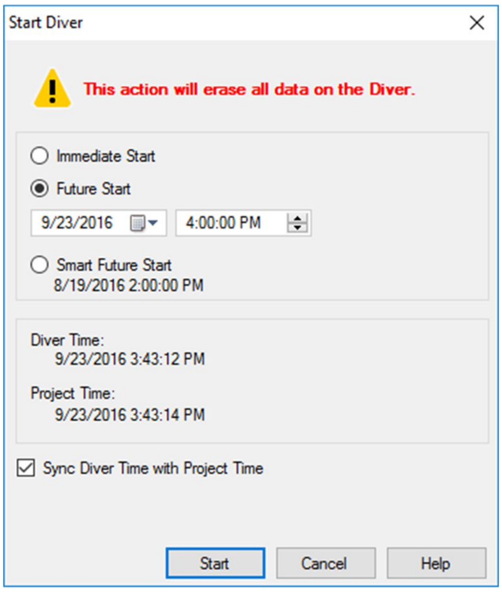
After entering the settings, the Diver must be programmed by clicking the **Program** button.



Once the settings are successfully programmed into the Diver the **Start** button will be enabled. Clicking the **Start** button opens the **Start Diver** dialog as shown below. Here you can select from the following three start methods:

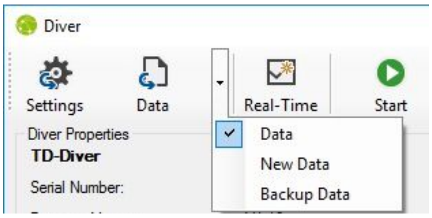
- Immediate Start - Select this option to start the Diver immediately. Upon clicking **[Start],** the Diver will begin to take and record samples, as defined in the Diver settings
- Future Start - Select this option to start the Diver at a specified time in the future. Use the date and time boxes to enter the desired future start time.
- Smart Future Start - This option is useful in situations where you want to stop the Diver, download its data and then continue collecting data at the specified sample interval.

After selecting the desired start method, click the **[Start]** button to save the start settings to the Diver.



3.2.2 Reading Data from a Diver

Click the **Data** button to download data from the Diver. Click the down arrow next to the **Data** button to change the mode/type of data download:



Depending on the sample interval the following 3 options are available:

- Data - download all the data recorded by the Diver.
- New Data - download only newly recorded data (since the last data download). This option is not available when the sample interval is 5 seconds or less.
- Backup Data - download data from the previous monitoring session.

During the data download the progress is indicated by a progress bar. Once the data has been downloaded it will be exported if this option is selected in the Project Settings. Subsequently, the program will jump to the tree view where the downloaded time series will be selected and a graph/table of the data will be shown.

3.3 Installation in a Monitoring Well

Divers are normally installed below the water level/table in a monitoring well. The depth at which a Diver can be suspended depends on the instrument's measurement range. Further information about the Diver's range is contained in the chapter 2 *Technical Specification*.

First determine the length of the non-stretch suspension cable (part no MO500) based on the lowest groundwater level. Provide for the required additional length for attaching the cable to the suspension eye of the Diver and at the upper end when you cut the wire to size.

Next use cable clips (part no MO310) to attach the ends of the cable to the monitoring well's end cover and the Diver's suspension eye, respectively.

To determine the distance of the pressure sensor in the monitoring well requires the precise length of the cable to be known, to which the distance to the location of the pressure sensor in the Diver must be added to obtain the overall effective cable length. This is depicted in the diagram below.

It is also possible to install the Diver with a communication cable (part no AS2xxx/AS6xxxx). This cable allows you to readout the Diver at the top of the monitoring well by using a USB interface cable (part no AS327).

Note that in small diameter wells the installation and removal of the Diver may affect the water level.

If the TD-Diver replaces a Mini-Diver (part no DI5xx), Micro-Diver (part no DI6xx) or Cera-Diver (part no DI7xx), the effective cable length must be decreased by 19 mm so that the position of the measuring point, i.e. the pressure sensor, remains at the identical elevation.

3.4 Installation in Surface Water

If a Diver is used in surface water it is important that there is sufficient circulation around the Diver's sensor.

Sedimentation, algae and plant growth should be minimized as much as possible to ensure the Diver measures the surrounding water level.

Position the Divers deep enough so that they remain below a possible ice layer.

A steel protective cover that can be locked should be used to prevent vandalism or theft of the Diver.

In the picture on the right a steel protective cover attached to a wooden post is shown. Inside the protective cover is a monitoring tube/screen containing a Diver to measure the lake's water level.

Divers can also be used to indirectly measure discharge. In this case, the Diver is installed in a monitoring tube/screen next to a weir. The picture below shows a Diver installed next to a V weir to measure discharge.

3.5 Use of Divers at Varying Elevation

Divers can be used at any elevation ranging from 300 meters below sea level to 5,000 meters above sea level. Appendix I contains further information on the use of Divers at varying elevation.

3.6 Baro-Diver

The Baro-Diver must be installed in such a way that it only measures atmospheric pressure under all conditions. A location that is not subject to rapid temperature variations is preferred.

3.7 Use in Seawater

Do not use the TD-Diver in seawater.

The TD-Diver is made of 316L stainless steel. This material is not suited for brackish and/or seawater because it is subject to corrosion. Corrosion is caused by the salt content, and can be enhanced by temperature and the other substances in the water.

We recommend the Cera-Diver (part no DI7xx) and/or CTD-Diver (part no DI27x) for use in semi-saline water/seawater. These Divers have a ceramic casing that does not corrode.

3.8 Diver Maintenance

When installed, the Diver does not require any maintenance. The casing can be cleaned with a soft cloth. Calcium and other deposits can be removed with a commercially available acidic cleaner such as white vinegar. The flow-through opening can also be rinsed with water and/or a diluted acidic solution.

Notes:

- Only use diluted acidic solutions if the Diver severe build-up of for example lime scale and other cleansers are not effective.
- Never use any hard brushes, abrasives or sharp objects for cleaning the Diver and always rinse it properly with clean water after cleaning, particularly near the flow-through openings. Do not use any powerful jets. This could damage the pressure sensor.

4 Appendix I – Use of Divers at Varying Elevations

Divers can be used at any elevation ranging from 300 meters below sea level to 5,000 meters above sea level. It is however recommended that all Divers and the Baro-Diver forming part of the same network be used at the same elevation (whenever possible).

The relationship between atmospheric pressure variations and elevation is exponential, rather than linear:

$$P_H = P_0 \cdot \exp[-(M \cdot g \cdot H)/(R \cdot T)]$$

where

P_H = atmospheric pressure at elevation height H

P_0 = atmospheric pressure at reference height

$M = 28.8 \cdot 10^{-3}$ kg/mol (molecular mass of air)

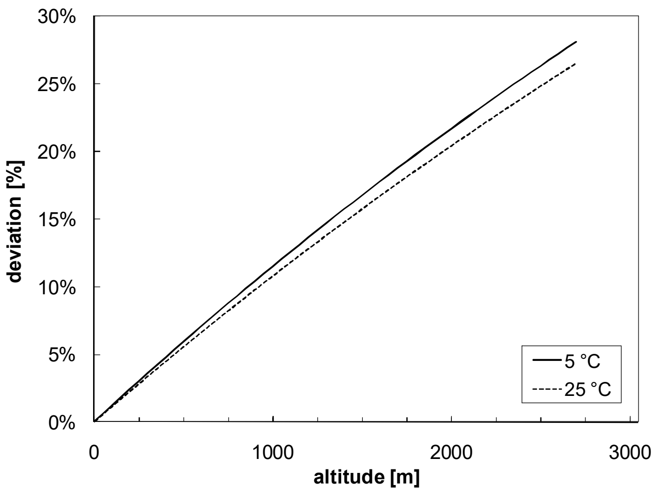
$g = 9.81$ m/s^2 (standard gravity)

H = height in meters

R = 8.314 J/mol/K (gas constant)

T = temperature in Kelvin

If the Baro-Diver is placed at a different elevation from the other Divers in a monitoring network, it is possible for a deviation to occur in the barometrically compensated data due to the relationships referred to above. The graph below illustrates the deviation in the barometric data as a function of the variation in elevation at 5 °C and 25 °C.



To determine the relative barometric pressure deviation relative to P_0 at 5 °C (T = 278.15°K) at a height differential of H, the above referenced formula can be used:

$$(P_H - P_0) / P_0 = 1 - \exp[-(M \cdot g \cdot H)/(R \cdot T)] \times 100\% \qquad (5)$$

By substituting the data, a relative deviation of 1.2 % at a height differential of 100 m is obtained. At a height differential of 1,000 m this increases to 11.5 %.

We therefore recommend that all Divers and the Baro-Divers in a network be placed such that the mutual height differentials are minimized.

If necessary, multiple Baro-Divers can be deployed to avoid the abovementioned issues.

5 Appendix II – Diver Communication Protocol

5.1 Introduction

The TD-Diver supports a set of commands that allows the user to communicate with the Diver through other software than Diver-Office. The following commands are available:

- reading measured/stored data
- read date/time
- read serial number
- read monitoring point name
- real-time pressure and temperature value including time stamp
- read sample mode (record method and interval)
- read product ID, name, and firmware version
- read remaining battery capacity
- read status: started, stopped, future start, free memory

5.2 Serial Port Settings

Bitrate:	9600
Parity:	None
Databits:	8
Stopbits:	1

5.3 Frame Format

The frame format for commands and the response are:

STX (1 byte)	Length (1 byte)	OC (2 bytes)	Payload (n bytes)	CC (1 byte)

field	size	description	remarks
STX	1 byte	Start of text, value is 02Hex	Used to identify start of command
Length	1 byte	Length of frame	Number of bytes in frame including STX and Checksum
OC	2 bytes	OpCode	Identifies the OpCode type
Payload	n bytes	Data field (n bytes)	Data in command or response
CC	1 byte	Checksum	Ones' complement of the low byte of the sum of all bytes excluding CC

Time-out:

- All characters/bytes should be send with a maximum time of 30 ms between the bytes.
- When the maximum time exceeds 30 ms, a communication error response will be sent.

Response:

- Response will only follow when STX is detected.
- Response will follow the command with a delay of 0 to 500 ms (depending on OpCode and/or other Diver actions).
- Communication error will follow when STX is detected, but frame format is not correct, OpCode is not supported or checksum is not correct.

5.4 List of Commands

5.4.1 Read Date/Time

Read the date/time of the Diver clock.

Command:

STX	5	CL	None	CC

Response:

STX	22	CL	YY/MM/DD HH:MM:SS	CC

Data field length exactly 17 characters per described format

YY/MM/DD HH:MM:SS = Date/time format 17 characters

5.4.2 Read Monitoring Point Name

Read the name of the monitoring point programmed by the user.

Command:

STX	5	MP	None	CC

Response:

STX	25	MP	XXXXXXXXXXXXXXXXXXXX	CC

Data field length exactly 20 characters

XXXXXXXXXXXXXXXXXXXX = Monitoring point name 20 characters

Example	Description
PB_007.1_Delft______	20 characters (all ASCII)

5.4.3 Read Serial Number

Read the unique serial number of the Diver.

Command:

STX	5	SN	None	CC

Response:

STX	15	SN	XXXXXXXXXX	CC

Data field length exactly 10 characters

XXXXXXXXXX = Serial number 10 characters

Example	Description
AA123_____	10 characters (all ASCII)

5.4.4 Read Real Time Pressure and Temperature Value

Read a real-time pressure and temperature value of the Diver including a time stamp. If this command is given the Diver will take a reading immediately whether the Diver is logging or not. This data will not be stored in the Diver memory.

Command:

STX	5	RT	none	CC

Response:

STX	42	RT	YY/MM/DD HH:MM:SSXXXXXX.XXXZZZZZZZ.ZZZ	CC

Data field length exactly 37 characters per described format

YY/MM/DD HH:MM:SS = Date/time format 17 characters

XXXXXX.XXX = value Level (in CM H2O and with 3 decimal) 10 characters

ZZZZZZZ.ZZZ = value Temperature (in [°C] and with 3 decimals) 10 characters

Example	Description
16/03/23_12:00:00__1422.125____12.835	37 characters (all ASCII)

5.4.5 Read Recorded Pressure and Temperature

Read the data recorded by the Diver. Each data record consisting of a time stamp, pressure and temperature value must be read separately.

Command:

STX	15	SD	XXXXXXXXXX	CC

Data field length exactly 10 characters per described format

XXXXXXXXXX = Record number 10 characters (first record is record number 1; last record number is 72,000)

Example	Description
10000_____	10 characters (all ASCII)

Response:

STX	42	SD	YY/MM/DD HH:MM:SSXXXXXX.XXXZZZZZZ.ZZZ	CC

Data field length exactly 37 characters per described format

YY/MM/DD HH:MM:SS = Date/time format 17 characters

XXXXXX.XXX = value Level (in cmH_2O and with 3 decimal) 10 characters
ZZZZZZ.ZZZ = value temperature (in degrees Celsius and with 3 decimal) 10 characters

Example	Description
16/01/01_12:00:00__1344.750____12.123	37 characters (all ASCII)

5.4.6 Read Product ID, Name and Firmware Version

Command:

STX	5	PI	none	CC

Response:

STX	25	PI	PP:XXXXXXXXXX:VVVVVV	CC

Data field length exactly 20 characters per described format

PP = Diver type 2 characters; type 19 for TD-Diver and Baro-Diver

XXXXXXXXXX = Product name Diver 10 characters

VVVVVV = Firmware version number 6 characters

Example	Description
19:TD-DIVER__:_V1.19	20 characters (all ASCII)

5.4.7 Read Product Status and Free Memory

Read the logging status and the free memory of the Diver. The logging status is either STARTED, STOPPED, or FUTURE START. The free memory indicates how many records (time stamp, pressure and temperature value) can be read until the Diver memory is full.

Command:

STX	5	PS	None	CC

Response:

STX	25	PS	XXXXXXXXXXXXX:MMMMMM	CC

Data field length exactly 20 characters per described format

XXXXXXXXXXXXX = Logging status Diver (STARTED, STOPPED, FUTURE START) 13 characters

MMMMMM = Free memory 6 characters from 0 to 72,000

Example	Description
STARTED______:_62788	20 characters (all ASCII)

5.4.8 Read Sample Method and Interval

Read the Diver's sample method and interval. The available sample methods are fixed time interval – continuous (FIXED_RING) and fixed time interval – fixed length memory (FIXED_____), i.e. the Diver will stop logging when its memory is full.

Command:

STX	5	RS	None	CC

Response:

STX	35	RS	XXXXXXXXXX:YYYYYYYYY:ZZZZZZZZZ	CC

Data field length exactly 30 characters per described format

XXXXXXXXXX = Record method 10 characters

YYYYYYYYY = Record interval 9 characters

ZZZZZZZZZ = 9 spaces (not used)

XXXXXXXXXX	YYYYYYYYY	ZZZZZZZZZ	
FIXED_____	xx_SEC___	_________	
FIXED_RING	xx_MIN___	_________	

5.4.9 Read Remaining Battery Capacity

Read how much capacity of the battery is left from the initial capacity (%). Note that this is an estimated and calculated value and not a measured value.

Command:

STX	5	BC	None	CC

Response:

STX	15	BC	XXXXXXXXXX	CC

Data field length exactly 10 characters per described format

XXXXXXXXXX = Remaining battery capacity in percentage 10 characters

Example	Description
________58	42 % battery capacity used and 58 % battery capacity remaining

5.4.10 Failure/Error Response

A Diver error response will be returned in the following format:

STX	15	FL	XXXXXXXXXX	CC

Data field length exactly 10 characters per described format

XXXXXXXXXX = Failure/error description 10 characters

Results	Description
TIME-OUT__	Time-out occurs when still expecting characters
UNKNOWN_OC	OpCode not recognized
ERROR_CC__	Checksum received not correct
WRONG_LEN_	Length byte value not correct
ERROR_DATA	Data field not correct (value not correct)

6 Appendix III – Diver Accessories

6.1 Diver-Office software

Program Diver dataloggers and download measurements onto your PC. Export the data to a spreadsheet or modeling program. Diver-Office is a flexible “project-based” measurement software package designed for exchanging Diver data. Diver-Office is easy-to-use and has an intuitive user interface.

- Barometric compensation
- Units: Metric and U.S.
- 7 languages: Dutch, English, French, German, Polish, Portuguese and Spanish

Free download from www.vanessen.com

6.2 USB Reading Unit

The Diver USB Reader can be used for programming or reading the Diver. Connect the USB Reader to the USB port of your PC or Laptop. Simply insert the Diver into the base of the USB Reading Unit and you are ready to communicate with your Diver.

The USB Reading Unit can be used in the field or the office.

Part no: AS330

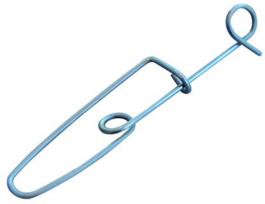
6.3 Stainless Steel Cable

Divers may be suspended on a stainless steel wireline. This is an inexpensive method of deployment, and if in a well, allows the Diver to be easily locked out of sight and inaccessible.

Part no: MO500

6.4 Cable Clip

The cable clip provides an easy way to connect a Diver to a stainless steel cable. The cable clip can also be used to attach the stainless steel cable with the Diver to the top of casing.



Part no: MO310 (10 pcs)

6.5 USB Interface Cable

The Diver USB Interface Cable allows you to communicate with a Diver that has been deployed with the Diver Data Cable. The Diver USB Interface has a mating connection for the Diver Data Cable on one end, and a standard USB port on the other, for connection to a laptop computer.

The Diver USB Interface Cable allows for data download, programming settings, or starting/stopping the Diver while in the field.

Part no: AS327

6.6 Communication Cable

Deploying a Diver on a Diver communication cable saves time on downloading and provides real time data from a Diver. Connect your laptop equipped with Diver-Office to the Diver Data Cable using the USB Interface Cable to program and read data from the Diver.

Available in lengths from 1 meter to 500 meter.

Part no: AS2xxx

xxx = length in meter, e.g 10 meter cable is AS2010

6.7 Diver-Mate

The Diver-Mate is designed for simple and fast download of data, increasing download efficiency while reducing data transfer errors.

The Diver-Mate can store Diver data from hundreds of Divers. Used in combination with a Diver communication cable, this downloading unit stores data in a non-volatile memory drive, meaning that even if the battery is empty the data will still be available. A full battery can support more than 10 days of operational use and a LED will indicate when the battery voltage is low.

Part no: DI420

6.8 Diver-DXT

If access to the well is limited by for example fences or water the Diver-DXT can be installed to wirelessly collect Diver data up to a distance of 500 meter.

The Diver-DXT is a battery powered radio device to acquire data and adjust Diver settings wirelessly from the Diver to the Diver-Gate. A built-in barometric datalogger is used to convert pressure data into accurate groundwater levels.

Part no: AS40x

6.9 Diver-Gate(M)

The Diver-Gate(M) is a portable low-power device that communicates wirelessly with the Diver-DXT to retrieve data from Diver dataloggers within a range of 500 meters. The Diver-Gate(M) is connected to a laptop equipped with Diver-Office.

See www.vanessen.com/diver-netz for more information.

Part no: AS345

6.10 Diver-Gate(S)

The Diver-Gate(S) collects data from Divers deployed with a Diver-DXT within a range of 500 meters. The collected data is then automatically transferred to the Diver-HUB web portal for visualisation.

The Diver-Gate(S) is a low-power device that can be powered by various sources such as lithium battery pack, rechargeable batteries with a solar panel or mains power.

See www.vanessen.com/diver-netz for more information.

Part no: AS340