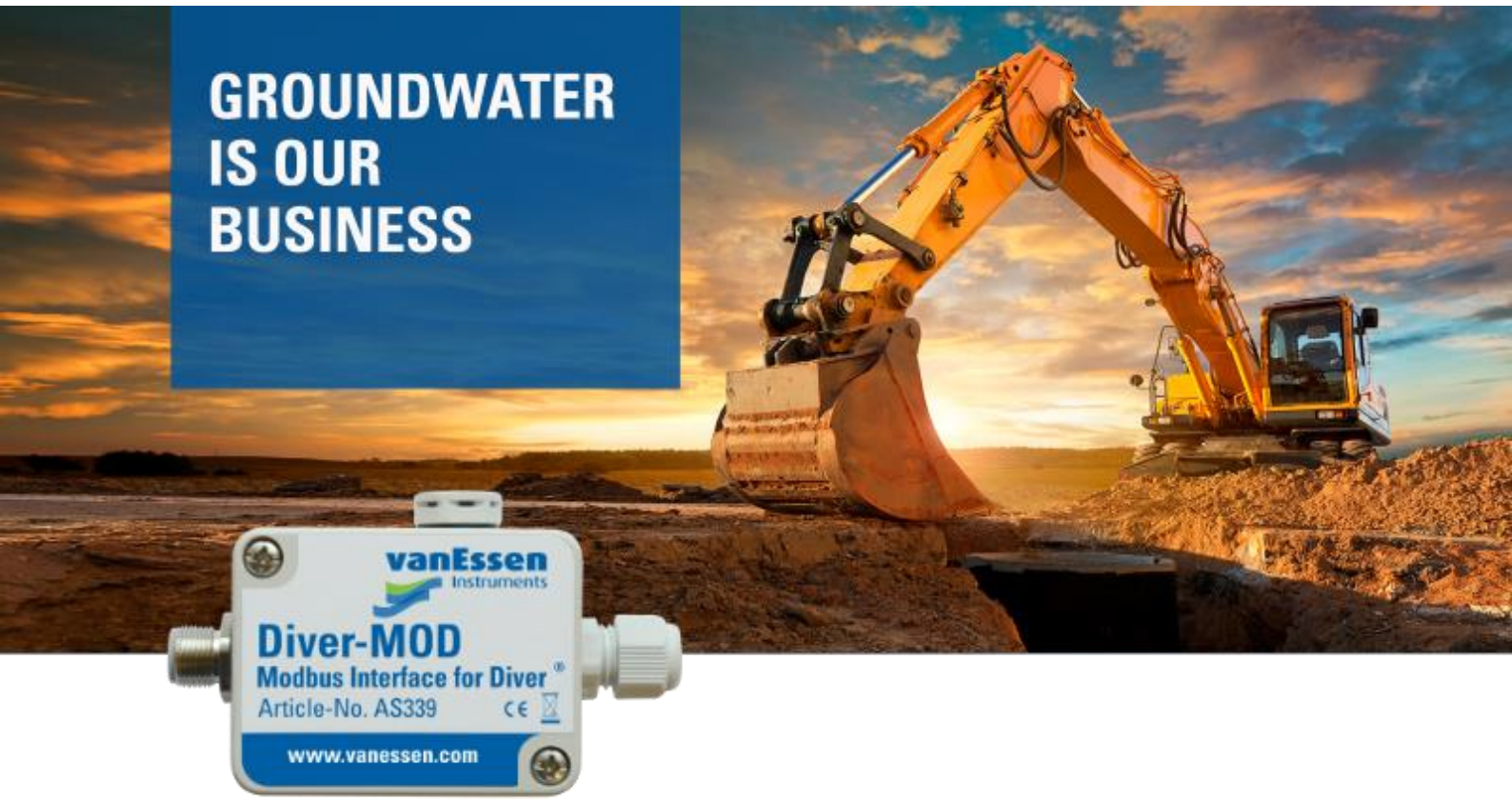

PRODUCT MANUAL

Diver-MOD – AS339

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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: Diver interface
Product Model: Diver-MOD (AS399)

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.

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1 Introduction

The Diver-MOD is a Modbus interface for Divers and can be used to connect Divers to a RS485 network using the Modbus/RTU protocol. The Diver-MOD features a barometric sensor, which can be used to convert the Diver pressure into a water level.

The Diver-MOD is shown in Figure 1. The Diver-MOD casing has an M12 connector (left) and a cable gland (right) and an air vent with a Gore-Tex® membrane. The M12 connector on the left is connected to a Diver communication cable (part no. AS2xxx) that on its turn is connected to a Diver (DI5xx, DI6xx, DI7xx, DI8xx, DI27x, DI28x).

Figure 1 top view of the Diver-MOD (part no AS339).

The cable gland on the right side of the casing is used to connect the Diver-MOD to the Modbus interface through a 4-conductor cable. This cable is used for power supply and data transfer.

The air vent ensures that the pressure inside the casing is equal to the outside air pressure. The built-in barometric pressure sensor allows to convert Diver pressure data into water level data.

1.1 Features

The Diver-MOD features:

- Real-time Diver pressure, temperature and conductivity* data.
- Real-time barometric pressure and temperature data.
- Reading the Diver memory.
- Programming of the Diver sample interval, setting the Diver clock, etc.
- Starting/stopping of the Diver.

(* CTD-Diver DI27x and DI28x only)

The Diver-MOD contains a barometric sensor but has no built-in datalogger to store the barometric data. Compensated pressure is not available as this can be done by the back-end software.

This manual outlines all the features and operating principles of the Diver-MOD. The next chapter gives an overview of the supported equipment, installation procedures and configuration.

1.2 System Overview

A typical Modbus configuration is depicted in Figure 2. In the schematic two Diver-MODs are connected to a PC/PLC. This connection includes both data communication and power. The maximum Modbus cable length depends on the baud rate, the cable (gauge, capacitance or characteristic impedance), the number of loads on the daisy chain, and the network configuration (2-wire or 4-wire). For a maximum baud rate of 9600 and AWG26 or wider gauge, the maximum length is 1000 meters.

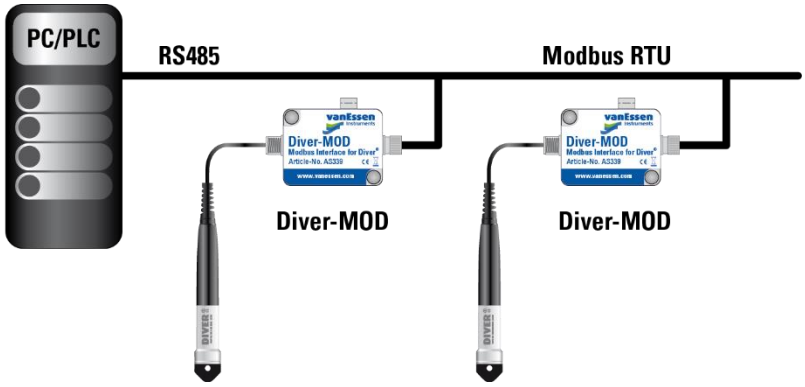

Figure 2 example Modbus network with PC/PLC and 2 Diver-MODs.

Each Diver-MOD is connected to a Diver through a Diver communication cable. The maximum length of the Diver communication cable is 500 meters.

Each Diver-MOD must be programmed with a unique address (0 to 247). Messages sent to the address 0 will be accepted by all Diver-MODs. The Diver-MOD acts as a slave for the PLC/PC that requests the data from each Diver-MOD.

Up to 8 Diver-MODs can be used per Modbus network. The Diver-MOD is powered by the Modbus network. Each Diver-MOD is equipped with a 120 Ω (1/4 W) termination resistor that can be used by applying the termination jumper.

The Diver-MOD is in accordance with the *Modbus Application Protocol Specification V1.1b3* and enables to interface Divers in a RS485 network using the Modbus/RTU protocol. The Modbus TCP/IP is not supported.

2 Getting Started

2.1 Supported Equipment

The Diver-MOD can be connected to a Diver via a Diver Cable AS2xxx using the M12 connector. The following Divers can be used with the Diver-MOD:

- TD and Baro-Diver (model DI8xx),
- Mini and Baro-Diver (model DI5xx),
- Micro-Diver (model DI6xx),
- Cera-Diver (model DI7xx), and
- CTD-Diver (model DI27x, DI28x).

Detailed information about supported equipment can be found in Appendix D.

2.2 Installation

Connect the Diver-MOD to a Diver through a Diver communication cable (AS2xxx). Connect the Diver communication cable to the Diver-MOD by attaching it to the M12 connector.

Connect the PC or PLC to the Diver-MOD using a 4-conductor cable. The 4-conductors are for

- 5-volt power supply
- ground
- RS485-A
- RS485B

Feed the Modbus communication and power supply cable into the enclosure through the cable gland and connect the wires as depicted in Figure 3. The cable gland provides an IP67 sealing for Modbus cables with a diameter from 3.5 to 7 mm.

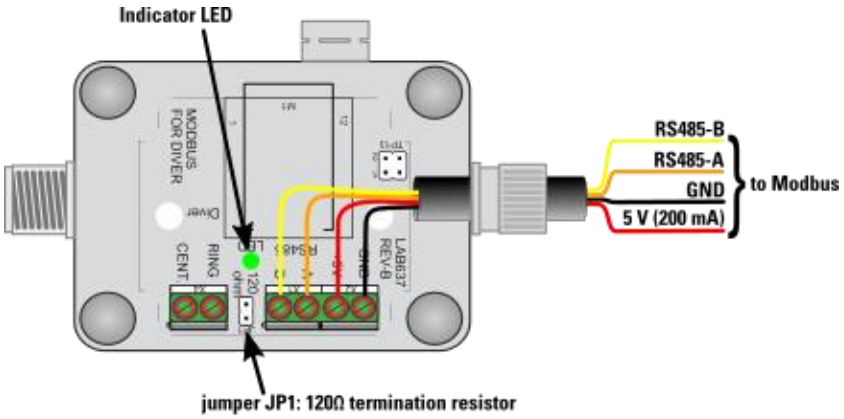

Figure 3 Diver-MOD connection to Modbus/RTU (cable colors may vary).

The Diver-MOD must be externally powered with +5VDC (4.5 Volt to 5.5 Volt). During communication the peak current is 50 mA and the effective current is 20 mA. The stand-by current of the Diver-MOD is 2 mA.

If the Diver-MOD is the last device in the RS485 network, the A and B line should be terminated with a 120 Ω termination resistor. This can be done by placing jumper JP1, see Figure 3.

There is one signal indicator (LED) which will light up briefly when the Diver-MOD is powered on. In addition, the LED will blink when there is activity on the RS485 communication line. When the Diver-MOD is in standby, the LED will be off.

2.3 Configuration

Diver-MOD is designed to communicate on a Modbus network using RTU (Remote Terminal Unit) mode. The ASCII (American Standard Code for Information Interchange) mode is not supported by the Diver-MOD.

The default serial settings are 9,600 bps, no parity and 1 stop bit. If the serial settings are changed by Modbus function codes, the changes take place after repowering.

The default Diver-MOD address is 1. If the slave address is changed by Modbus function codes, the change takes place immediately.

The master issues a Modbus request to the slaves in two modes:

- In unicast mode, the master addresses an individual slave. After receiving and processing the request, the slave returns a message (a 'reply') to the master. In that mode, a Modbus transaction consists of 2 messages: a request from the master, and a reply from the slave. Each slave must have a unique address (from 1 to 247) so that it can be addressed independently from other nodes.
- In broadcast mode, the master can send a request to all slaves. No response is returned to broadcast requests sent by the master. The broadcast requests are necessarily writing commands. All devices must accept the broadcast for writing function. The address 0 is reserved to identify a broadcast exchange.

The Modbus RTU frame format for the Diver-MOD is shown in Figure 4. The client that initiates a Modbus transaction builds the Modbus Protocol Data Unit (PDU) represented by the green blocks in Figure 4, and then adds the address and error check(CRC) to build the appropriate communication PDU.

A master addresses a slave by placing the slave address in the address field of the message. When the slave returns its response, it places its own address in the response address field to let the master know which slave is responding.

The function code indicates to the server what kind of action to perform. The function code can be followed by a data field that contains request and response parameters.

All Diver-MOD commands contain checksum information (CRC), to enable detection of transmission errors. Error checking field is the result of a "Redundancy Checking" calculation that is performed on the message contents. The Diver-MOD uses the RTU calculation method for the CRC.

Details about the different fields of the Modbus frame for the Diver-MOD can be found in Table 1. The Diver-MOD interface supports the function codes listed in Table 2.

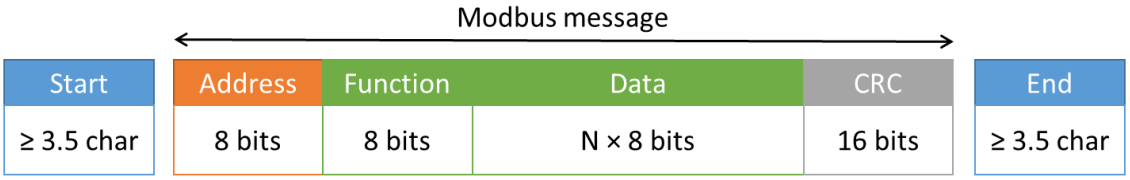

Figure 4 Modbus message frame for the Diver-MOD on a serial line.

Table 1 Diver-MOD frame format.

Name	Length (bits)	Function
Start	28	At least 3½ characters times of silence (mark condition)
Address	8	Slave address
Function	8	Indicates the function code; e.g., read coils/inputs
Data	N × 8	Data + length will be filled depending on the message type
CRC	16	Checksum
End	28	At least 3½ character times of silence between frames

Table 2 Diver-MOD function codes.

Function name	Function code	Function type
Read Coils	0x01 (decimal 1)	Internal Bits or Physical Coils
Write Single Coil	0x05 (decimal 5)	Internal Bits or Physical Coils
Read Input Registers	0x04 (decimal 4)	Physical Input Registers
Read Holding Registers	0x03 (decimal 3)	Internal Registers or Physical Output Registers
Write Single Register	0x06 (decimal 6)	Internal Registers or Physical Output Registers
Write Multiple Registers	0x10 (decimal 16)	Internal Registers or Physical Output Registers

2.4 Transmission Mode

The format for each byte (11 bits) for the Diver-MOD is:

- Coding System: 8–bit binary
- Bits per Byte: 1 start bit
  8 data bits, least significant bit sent first
  1 bit for parity completion
  1 stop bit

2.5 Operation

The Diver-MOD acts as an interface between the Diver and a Modbus network, i.e. it converts the Modbus commands to Diver commands and vice-versa. There is no direct communication between the Modbus supervisory computer and the Diver. The Diver-MOD acts as a buffer between the supervisory computer and the Diver. For example, to get a real-time value from the Diver, first a command must be sent from the supervisory computer to the Diver-MOD. Then the Diver-MOD will retrieve the real-time values from the Diver and store them in its internal memory. Finally, the supervisory computer can send a command to the Diver-MOD to retrieve the real-time values.

3 Modbus Registers

All the supported Modbus registers of the Diver-MOD are listed in Appendix B. A more detailed description of the most important registers is given below. Refer to Table 2 for the definition of the function code.

All registers in this document are 1-based. This means the actual packets sent to the Diver-MOD must have a data address 1 less than what the register number is in this document.

3.1 Reg. 30002, 30012: Firmware Version and Serial Number Diver-MOD

The firmware version and serial number of the Diver-MOD are stored in register 30001 and 30011

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Read firmware version of Diver-MOD	0x04	30002	10	-	Register 30002, convert to string (20 characters).
2	Read serial number of Diver-MOD	0x04	30012	10	-	Register 30012, convert to string (20 characters).

3.2 Reg. 30220: Real-time Barometric Data from Diver-MOD

The real-time data from the barometric sensor in the Diver-MOD is stored in register 30220 and 30230.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Read real-time values barometric sensor (long)	0x04	30221	2	-	Register 30221, convert to longs (two registers for long).
2	Read real-time values barometric sensor (float)	0x04	30231	2	-	Register 30231, convert to single float (two registers for single float).

3.3 Reg. 40001: Change Slave Address of Diver-MOD

Register 40001 contains the slave address of the Diver-MOD. The default slave address is 1. The slave address can be set from 1 to 247.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Change slave address	0x06	40001	1	<1-247>	Data field is new address. Register 40001 will take effect immediately.

3.4 Reg. 40002: Change Baudrate of the RS485 port

Register 40002 contains the baudrate at which the Diver-MOD operates. The default baudrate is 9,600 bps. The data field must have a value from 1 to 8, which corresponds to the following baudrate:

- 0 = 300 bps
- 1 = 1,200 bps
- 2 = 2,400 bps
- 3 = 4,800 bps
- 4 = 9,600 bps
- 5 = 19,200 bps
- 6 = 38,400 bps
- 7 = 57,600 bps
- 8 = 115,200 bps

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Change baudrate	0x06	40002	1	<1-8>	Register 40002, will take effect after reboot (reset).

3.5 Reg. 40003: Change Parity of the RS485 port

Register 40003 contains the parity of the RS485 port. The default is no parity. The data field must have a value from 0 to 3, which corresponds to the following parity:

- 0 = none
- 1 = even
- 2 = odd
- 3 = mark

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Change parity	0x06	40003	1	<0-3>	Register 40003, will take effect after reboot (reset).

3.6 Reg. 00001: Update Real-Time Data from Diver

Setting this register forces the Diver-MOD to get real-time values, i.e. pressure, temperature and conductivity (if applicable), from the connected Diver. The updated real-time values must be read from registers 30201 – 30216.

The type of conductivity is either normal conductivity or specific conductivity at 25 °C depending on the setting in the CTD-Diver.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Update real-time values from Diver, i.e. copy values to Diver-MOD	0x05	00001	1	0xFF00	Register 00001 can also be a broadcast (address 0) to all Diver-MODs. In case of a broadcast, wait at least 500 ms before the next instruction.
2	Read real-time values from all channels (longs)	0x04	30201	6	-	Register 3020x, convert to longs (two registers per long)
3	Read real-time values from all channels (float)	0x04	30211	6	-	Register 3021x, convert to single floats (two registers per single float)
4	Go to step 1					When used in a loop

3.7 Reg. 00002: Get Diver Data

Setting this register will force the Diver-MOD to copy all recorded data from the connected Diver to the Diver-MOD's internal memory. After this the Diver data can be obtained using registers 30301 – 40000.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Instruct Diver-MOD to copy recorded data from the connected Diver	0x05	00002	1	0xFF00	Register 00002 can also be a broadcast (address 0) to all Diver-MODs.
2	Read Diver data					See appendix C

3.8 Reg. 00003: Update General Diver Information

Setting this register forces the Diver-MOD to retrieve all general information from the connected Diver. After this register is set, the latest recorded pressure and temperature measurements from the Diver can be obtained from registers 30022 – 30243. This action is only needed when the Diver settings are changed after powering up the Diver-MOD.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Instruct Diver-MOD to update general information from connected Diver	0x05	00002	1	0xFF00	Register 00003, not required if Diver was connected before power up.
2	Read serial number of the Diver	0x04	30022	18	-	Register 30022, convert to string (36 characters).
3	Read reference and ranges from all channels of the Diver	0x04	30101	6	-	Register 30101, all integers (one integer per register)

3.9 Reg. 00004: Force to accept new connected Diver

When the Diver-MOD is continuously powered, it will not automatically recognize if a Diver is connected, replaced or reprogrammed. Setting register 00004 forces the Diver-MOD to connect to the Diver. Any Diver data in the Diver-MOD memory will be erased and replaced by the data from the newly connected Diver. Moreover, the Diver settings in the Diver-MOD will be refreshed.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Force the Diver-MOD to update the settings and data from the connected Diver	0x05	00004	1	0xFF00	Not required if the Diver was connected during power up.

3.10 Reg. 00011: Start/Stop Logging of Diver

Setting register 00011 to 0xFF00 will start logging of the Diver and setting this register to 0x0000 will stop logging of the Diver.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Set the real-time clock of the Diver	0x03	40103	6	YY,MM,DD, HH,MM, SS	First register 40103 is YEAR (YY)
2	Set the sample interval of the Diver	0x03	40101	2	tt,xx	FI: Register 40101 =01(tt) and Register 40102=30(xx) gives 30 second sample interval
3	Set the monitoring point name of the Diver	0x03	40109	10	20 chars	Register 40109 - 40118
4	Start the Diver	0x05	00011	1	0xFF00	Register 11: 0xFF00 is start

3.11 Reg. 30241: Number of Records Recorded by Diver

This register contains the number of records recorded by the Diver. First set register 00001 to update this register in the Diver-MOD with the most recent value.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Update settings from Diver in Diver-MOD	0x05	00001	1	0xFF00	
2	Read the number of records recorded by the Diver	0x04	30241	1	-	Register 30241, integer value from 0 to 48,000

3.12 Reg. 30242: Maximum Number of Records for Diver

This register contains the maximum number of records that can be recorded by the connected Diver.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Read the Diver's memory capacity in records	0x04	30242	1	-	Register 30242, integer value 24,000 or 48,000 records

3.13 Reg. 30243: Remaining Battery Capacity Diver

This register returns the remaining battery capacity of the connected Diver as a percentage of its full capacity. This value is only an indication! If the remaining battery capacity comes close to zero, the Diver needs to be replaced to prevent lost data!

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Read the remaining battery capacity of Diver	0x04	30243	1	-	Register 30243, integer value 0-100% remaining battery capacity

4 Reading Diver Data

The data from the connected Diver is copied to the internal memory of the Diver-MOD. This is a background process of the Diver-MOD. The update interval for this process can be set in register 00002. Because the data is stored in the Diver-MOD, the Diver data can be retrieved much faster from the Diver-MOD than if it must be read from the Diver.

The Diver data consists of two parts: the header information and the time series data.

4.1 Header Information

The header information is stored in registers 30301 to 30481. The data is stored in ASCII. The header information is required to obtain the time series data in engineering units. The header information contains specific information about each parameter (channel) measured by the Diver, the Diver serial number, the monitoring point name (location), etc.

The following data is required to obtain the time series data in engineering units.

Start Date/Time

The start date/time must be read from 9 registers starting at 30464. The returned string has the following format:

ss:mm:HH dd/MM/yy

For example, the returned string is “00:00:01 10/08/15”, which equals 1:00:00 AM on August 10, 2015.

Sample Interval

The sample interval must be read from 7 registers starting at 30455. The returned string has the following format:

DD HH:mm:ss f

Where DD is number of days and f is tenths of a second; f will be 0 or 5. For example, the returned string is “00 01:00:00 0”, which equals a sample interval of 1 hour.

Pressure Reference and Range

The pressure data is stored in channel 1. The unit of pressure is cmH2O (conventional). By definition 1 cmH2O equals 98.0665 Pascal.

The pressure reference is defined as the value (offset) in cmH2O from which the Diver starts measuring pressure. For all supported Divers this is 400 cmH2O. The pressure reference can be read from register 30101. The returned value is a signed 16 bit integer, for example “400”.

The pressure range is defined as the span of the pressure in cmH2O over which the Diver can measure pressure. The pressure range can be read from register 30104. The returned value is a signed 16-bit integer, for example “1750”.

The returned value depends on the water column that the Diver can measure. The Diver part numbers and corresponding ranges are listed in Table 3.

Table 3 Divers and pressure range

Part No	Water column /meter	Range /cmH2O
DI500	1.5	750
DI501, DI601, DI701, DI271, DI281	10	1750
DI502, DI602, DI702	20	2750
DI505, DI605, DI705, DI272, DI282	50	5750
DI510, DI610, DI710, DI273, DI283	100	10750
DI284	200	20750

Temperature Reference and Range

The temperature data is stored in channel 2. The unit of temperature is degree Celsius.

The temperature reference is defined as the value (offset) in degree Celsius from which the Diver starts measuring temperature. For all the supported Divers this is -20 °C. The temperature reference can be read from register 30102. The returned value is a signed 16-bit integer, for example “-20”.

The temperature range is defined as the span of the temperature in degree Celsius over which the Diver can measure temperature. For all the supported Divers this is 100 °C. The temperature range can be read from register 30105. The returned value is a signed 16-bit integer, for example “100”.

Conductivity Reference and Range

This section applies to the CTD-Diver only. The conductivity data is stored in channel 3. The unit of conductivity is milli Siemens per centimeter (mS/cm).

The conductivity reference is defined as the value (offset) in mS/cm from which the CTD-Diver starts measuring conductivity. For the CTD-Diver this is 0 mS/cm. The conductivity reference can be read from register 30103. The returned value is a signed 16-bit integer, for example “0”.

The conductivity range is defined as the span of the conductivity in mS/cm over which the Diver can measure conductivity. This range can be adjusted by the user to (30, 120 or 300) mS/cm. The conductivity range can be read from register 30106. The returned value is a signed 16-bit integer, for example “120”.

Note: If a regular Diver, i.e. not a CTD-Diver, is connected to the Diver-MOD the returned values for the conductivity reference and range will be “0”.

4.2 Time Series Data

Each Diver data record consists of a timestamp, a pressure value, a temperature value and a conductivity value (CTD-Diver only). Each Diver data record is stored in the Diver-MOD in 4 registers as depicted in Figure 5.

Diver data record

Register k	Register k + 1	Register k + 2	Register k + 3
time <0..250>	channel 1 pressure <0..30,000>	channel 2 temperature <0..30,000>	channel 3 conductivity <0..30,000>

Figure 5 A Diver data record is stored in four registers in the Diver-MOD memory

Timestamp

The first or time register has a value from 0 to 250. Only the first Diver data record will have a 0 for the time register. The time register will be 1 if the Diver sample method is set to *fixed* or *averaging*. For other sample methods, the time ranges from 1 to 250.

The timestamp of the first Diver data record is equal to the start time form the header information. For each subsequent Diver data record the timestamp value can be calculated from:

Timestamp of previous Diver data record + sample interval × time register

Pressure

The second or pressure register has decimal values from 0 to 30,000 (P_{DEC}). Use the pressure reference and range from the header information to convert these values to engineering units (P_{ENG}):

$$P_{ENG} = P_{DEC} / 30000 \times range + reference$$

If the pressure must be converted to a different unit then refer to Appendix C for conversion factors.

Temperature

The third or temp register has decimal values from 0 to 30,000 (T_{DEC}). Use the temperature reference and range from the header information to convert these values to engineering units (T_{ENG}):

$$T_{ENG} = T_{DEC} / 30000 \times range + reference$$

Conductivity

The fourth or conductivity register has decimal values from 0 to 30,000 (C_{DEC}). Use the pressure reference and range from the header information to convert these values to engineering units (C_{ENG}):

$$C_{ENG} = C_{DEC} / 30000 \times range + reference$$

Time Series Data

The Diver time series data is stored in the Diver-MOD in memory blocks of 2,000 records each. The memory block is selected by setting register 40041 from 0 to 35 in. Subsequently, the 2,000 records from the specified block can be read from register 32001 to 40000. A functional block diagram of this workflow is shown in Figure 6.

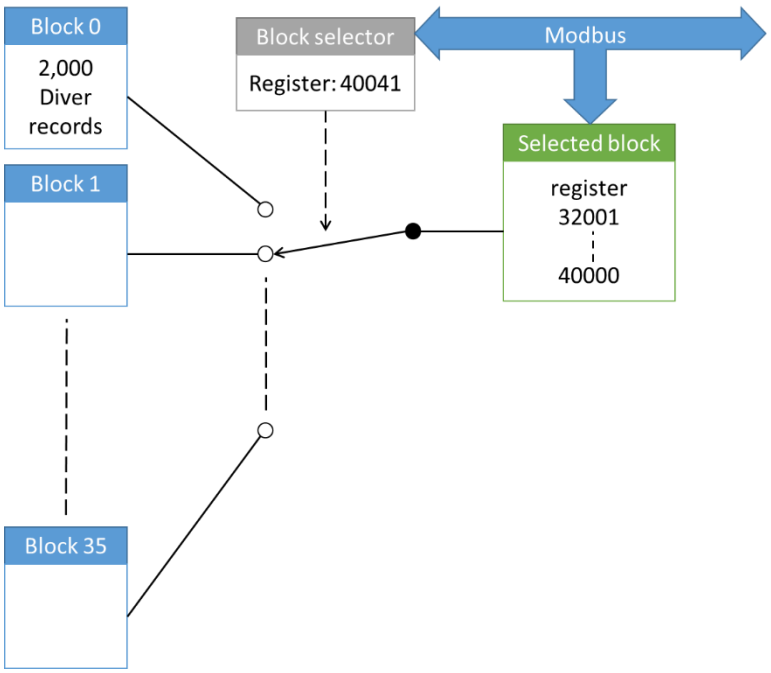

Figure 6 Functional block diagram of how Diver data is stored in the Diver-MOD and can be accessed

Registers must be read until one or more registers contain the value 0xFFFF. The last Diver data record is proceeded by 4 registers all containing 0xFFFF.

Example:

	Description	Function code	Register	Size (registers)	Data field	Remark
1	Read general header information	0x04	30301	28	-	Read 28 registers, starting at register 30301, to get the general header information.
2	Read channel 1 header information	0x04	30329	24	-	Read 24 registers, starting at register 30329, to get the channel 1 header information.
3	Read channel 2 header information	0x04	30371	24	-	Read 24 registers, starting at register 30371, to get the channel 2 header information.
4	Read channel 3 header information	0x04	30413	24	-	Read 24 registers, starting at register 30413, to get the channel 3 header information. CTD-Diver only.
5	Read timing header information	0x04	30455	27	-	Read 27 registers, starting at register 30455, to get the timing header information.
6	Set block number to read	0x03	40041	1	j <0-35>	Set register 40041 to select the block number to read.

	Description	Function code	Register	Size (registers)	Data field	Remark
7	Read 2,000 Diver data records	0x04	32001	8,000	-	Read from register 32001 in increments of 100 registers. Stop reading if one or more registers contain 0xFFFF.
8	Continue reading data next 2,000 Diver records. Go to step 6.					Increment j by 1.

5 Appendix A – Specifications

5.1 Casing

Dimensions (L × W × H)	65 mm × 50 mm × 35 mm
Weight	~82 g
Material	ABS
Protection classification	IP65

5.2 Connections

Diver Cable	M12 connector (connect to AS2xxx cable) Length: 0.5 to 500 meter
Modbus	Cable Gland PG-7
Compatible Diver models	Mini-Diver (DI5xx), Micro-Diver (DI6xx), Cera-Diver (DI7xx), CTD-Diver (DI27x, DI28x), TD-Diver (DI8xx)

5.3 Power Consumption

External supply voltage	5 VDC
Standby current	2 mA
Maximum current	10 mA

5.4 Modbus

Communication	RS485 half-duplex, single pair, 300 bps to 115,200 bps
Multi-drop	yes, max 8 devices per communication link
Address	user programmable: 1 to 247
Modbus features:	Real-time Diver conductivity (CTD-Diver only) pressure and temperature reading. Read Diver memory Read/write Diver sample interval Read/write monitoring point name of Diver Start/stop Diver (no future start) Read memory status: total memory and memory used

5.5 Pressure

Range	400 to 1100 cmH2O
Accuracy[+]	±2.0 cmH_2O
Resolution	0.06 cmH_2O

5.6 Temperature

Range	-20 to 80 °C
Calibrated	0 to 50 °C
Accuracy[+]	±1 °C
Resolution	0.2 °C

[+] maximum

5.7 Environmental

Storage/Transport temperature	-20 to 80 °C
Storage humidity range	0 to 100 %

6 Appendix B - Diver-MOD Register Map

Diver-MOD uses a part of the available Modbus register range. The tables below give all the active registers for Diver-MOD.

6.1 Coils – Status Registers

For the Read/Write discrete output or coils – status registers:

For the Read/Write discrete output or coils – status registers:

Modbus Register	Number of Modbus Registers	Description	Format	Properties
00001	1	Update real-time values of Diver	UINT16	Write
00002	1	Update for recorded data from Diver	UINT16	Write
00003	1	Update for general information Diver	UINT16	Write
00004	1	Force to accept new connected Diver	UINT16	Write
00011	1	Start/stop Diver (immediate starting and stopping)	UINT16	Write

6.2 Read Only Registers

For the Read input registers – 16 bit registers:

Modbus Register	Number of Modbus Registers	Description	Format	Properties
30001	1	Firmware version number	UINT16	Read
30002 - 30011	10	Firmware version number (ASCII string of 20 character)	STRING	Read
30012 - 30021	10	Serial number Diver-MOD (ASCII string of 20 character)	STRING	Read
30022 - 30039	18	Serial number of connected Diver (ASCII string of 36 character)	STRING	Read
30101	1	Diver pressure reference	SINT16	Read
30102	1	Diver temperature reference	SINT16	Read
30103	1	Diver reference conductivity	SINT16	Read
30104	1	Diver pressure range	SINT16	Read
30105	1	Diver temperature range	SINT16	Read
30106	1	Diver conductivity range	SINT16	Read

Modbus Register	Number of Modbus Registers	Description	Format	Properties
30201, 30202	2	Diver real-time pressure × 10	SINT32	Read
30203, 30204	2	Diver real-time temperature × 100	SINT32	Read
30205, 30206	2	Diver real-time conductivity × 1000†	SINT32	Read
30211, 30212	2	Diver real-time pressure	FLOAT	Read
30213, 30214	2	Diver real-time temperature	FLOAT	Read
30215, 30216	2	Diver real-time conductivity†	FLOAT	Read
30221, 30222	2	Baro real-time pressure × 10	SINT32	Read
30223, 30224	2	Baro real-time temperature × 100	SINT32	Read
30231, 30232	2	Baro real-time pressure	FLOAT	Read
30233, 30234	2	Baro real-time temperature	FLOAT	Read
30241, 30242	1	Number of records recorded by Diver (0 to 24000, 0 to 48000 records or 0 to 72000 records)	SINT32	Read
30243, 30244	1	Maximum number of records for this Diver	SINT32	Read
30245	1	Remaining battery capacity Diver (0 to 100%)	UINT16	Read

† The type of conductivity is either normal conductivity or specific conductivity at 25 °C depending on the setting in the CTD-Diver.

6.3 Reading Diver Memory

For the Read input registers – 16 bit registers:

(Registers for reading the Diver records)

Registers	Number of Modbus Registers	Description	Format	Properties
30301 - 30310	10	Diver header Location Code (20 bytes)	STRING	Read
30311 - 30328	18	Diver header Instrument Number (36 bytes)	STRING	Read
30329 - 30338	10	Diver header Identification channel 1 (20 bytes)	STRING	Read
30339 - 30346	8	Diver header Reference channel 1 (16 bytes)	STRING	Read
30347 - 30354	8	Diver header Range channel 1 (16 bytes)	STRING	Read
30355 - 30362	8	Diver header Reserved channel 1 (16 bytes)	STRING	Read
30363 - 30370	8	Diver header Reserved channel 1 (16 bytes)	STRING	Read
30371 - 30380	10	Diver header Identification channel 2 (20 bytes)	STRING	Read
30381 - 30388	8	Diver header Reference channel 2 (16 bytes)	STRING	Read
30389 - 30396	8	Diver header Range channel 2 (16 bytes)	STRING	Read
30397 - 30404	8	Diver header Reserved channel 2 (16 bytes)	STRING	Read
30405 - 30412	8	Diver header Reserved channel 2 (16 bytes)	STRING	Read
30413 - 30422	10	Diver header Identification channel 3 (20 bytes)	STRING	Read
30423 - 30430	8	Diver header Reference channel 3 (16 bytes)	STRING	Read
30431 - 30438	8	Diver header Range channel 3 (16 bytes)	STRING	Read
30439 - 30446	8	Diver header Reserved channel 3 (16 bytes)	STRING	Read
30447 - 30454	8	Diver header Reserved channel 3 (16 bytes)	STRING	Read
30455 - 30461	7	Diver header Sample rate (14 bytes)	STRING	Read

Registers	Number of Modbus Registers	Description	Format	Properties
30462 - 30463	2	Diver header Sample mode (4 bytes)	STRING	Read
30464 - 30472	9	Diver header Start date/time (18 bytes)	STRING	Read
30473 - 30481	9	Diver header Stop date/time (18 bytes)	STRING	Read
32001 - 40000	Max 100	Diver data block Read 4 registers per record. Select block first using register 40041	Read n × 4 registers (data block)	Read

For the Read/Write holding registers – 16 bits registers:

Registers	Number of Modbus Registers	Description	Format	Properties
40001	1	Modbus slave address as integer. valid values: 1-247	UINT16	Read/write
40002	1	Modbus baudrate settings as integer. valid values: 0=300, 1=1200, 2=2400, 3=4800, 4=9600, 5=19200, 6=38400, 7=57600, 8=115200 bps	UINT16	Read/write
40003	1	Modbus parity settings as integer. valid values: 0=None, 1=Even, 2=Odd, 3=Mark (is 2 stop bits)	UINT16	Read/write
40041	1	Select Diver data block to read. valid values: 0=first block to max 23	UINT16	Read/write
40042	1	Select Diver data synchronization time. valid values: 1 – 1000 minutes automatically set to optimal value after Diver start	UINT16	Read/write
40101, 40102	2	Set Sample Rate Diver valid values register 40101: 1=Seconds, 2=Minutes, 3=Hours valid values register 40102: 1 – 59	UINT16	Read/write
40103 - 40108	6	Set real-time clock Diver (Format register 40103 to 40108: YY, MM, DD, HH, MM, SS)	UINT16	Read/write

Registers	Number of Modbus Registers	Description	Format	Properties
40109 - 40118	10	Set Location Code Diver (20 ASCII characters)	STRING	Read/write
40119 - 40128	10	Set Instrument number Diver (20 ASCII characters)	STRING	Read/write

7 Appendix C – Pressure Conversion Table

To convert from cmH2O to …	Multiply by
hecto Pascal (hPa)	0.980665
kilo Pascal (kPa)	0.0980665
millibar (mbar)	0.980665
inch of mercury (inHg)	0.028959020848
pounds-per-square-inch (psi)	0.014223343334

8 Appendix D – Diver Equipment

8.1 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

8.2 TD-Diver

This Diver is manufactured using a stainless steel (316 L) casing with a 22 mm diameter. The TD-Diver can store 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.

Part no: DI8xx

8.3 Baro-Diver

The Baro-Diver is manufactured using a stainless steel (316 L) casing with a 22 mm diameter. The Baro-Diver can store 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.

Part no: DI800

8.4 Cera-Diver

The ceramic-shelled Cera-Diver is specifically designed for monitoring water levels under potentially corrosive conditions, such as brackish water and seawater.

The Cera-Diver has a 22 mm diameter ceramic (zirconium-oxide) casing and can store 48,000 measurements (date/time, pressure and temperature).

The Cera-Diver hade the following sample methods: fixed length intervals, event dependent, averaging and pumping test.

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

Part no: DI7xx

8.5 Micro-Diver

The Micro-Diver is the smallest Diver measuring only 18 mm in diameter. It is specifically designed for monitoring wells or drive-points too small to accommodate larger dataloggers. This Diver is suitable for pipes with a diameter of at least 20 mm.

The Micro-Diver has a stainless steel (316 L) casing and can store 48,000 measurements (date/time, pressure and temperature).

The Micro-Diver hade the following sample methods: fixed length intervals, event dependent, averaging and pumping test.

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

Part no: DI6xx

8.6 CTD-Diver

Where there is a need to monitor groundwater levels and salt water intrusion , injected wastewater, or contamination from chemical discharges and landfill sites, the CTD-Diver with its 22 mm diameter rugged, corrosion proof ceramic (zirconium-oxide) housing, is the instrument of choice.

The CTD-Diver is equipped with a four-electrode conductivity sensor that measures electrical conductivity from 0 to 120 mS/cm. There are two options for measuring conductivity: true or specific conductivity at 25 °C.

The CTD-Diver can store 144,000 measurements (date/time, pressure, temperature and conductivity).

The CTD-Diver hade the following sample methods: fixed length intervals, event dependent, averaging and pumping test.

The CTD-Diver is available in the following pressure ranges: 10 m, 50 m, 100 m and 200 m.

Part no: DI28x