NORTEK MANUALS

DVL Integrator’s Guide

500 | 1000kHz

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1 Introduction

The primary objective of this manual is to provide the information needed to control the DVL. It is aimed at system integrators and engineers with interfacing experience, but it also includes examples on how to configure and start the instrument for more unexperienced integrators. The document's scope is limited to interfacing and does not address general performance issues of the instrument. For a more thorough understanding about how to operate the instrument, we recommend the Operation Manual.

The document is complete in the sense that it describes all available commands and modes of communication. As always, these types of documents are subject to change. We recommend that you check www.nortekgroup.com or contact Nortek to ensure you have the all the latest information and versions of any software you plan to use. If you have any comments or suggestions on the information given here, please let us know. Your comments are always appreciated; our general e-mail address is inquiry@nortek.no.

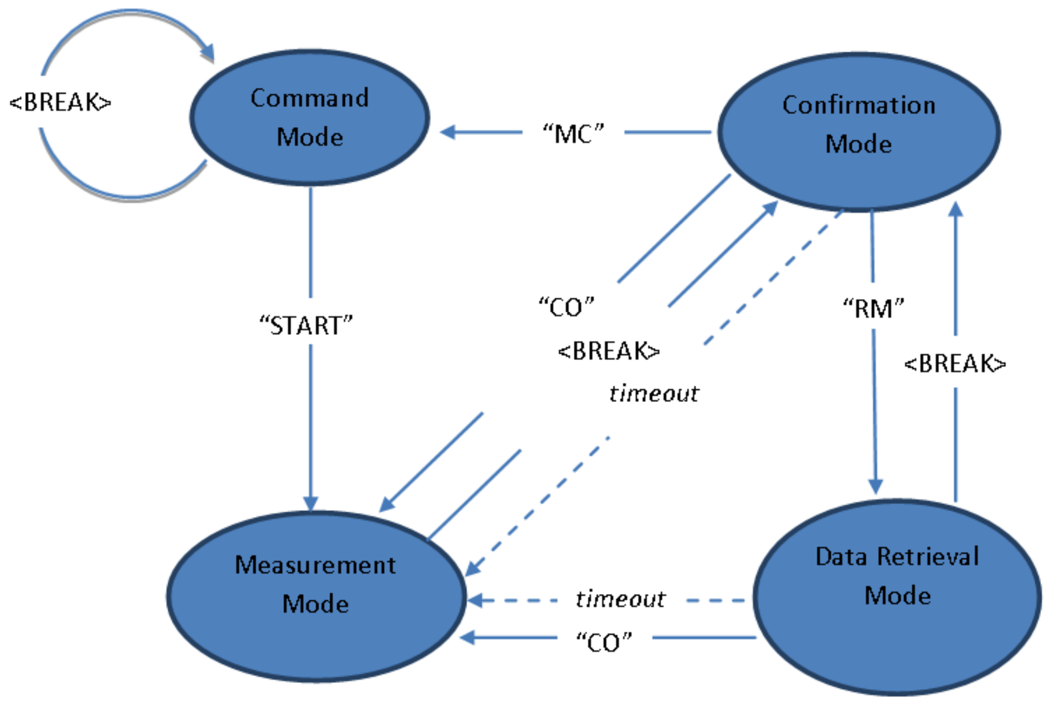
Document Revisions

First official release	03.2016
Update of format	05.2016
Version 2	11.2016
Version 3	05.2017
Version 4	07.2017
Version 5	11.2017
Version 6	10.2018

2 Basic interface concept

The Nortek DVL is based on the AD2CP hardware platform. It operates in distinct modes. These modes will have several explicit commands in order control the instrument. The majority of the commands are initiated from the Command mode. The possible modes for the instrument are:

- Command — Command and control
- Data Retrieval — Data download from recorder
- Measurement — Data collection mode
- Confirmation — Confirmation mode



Instrument modes of operation

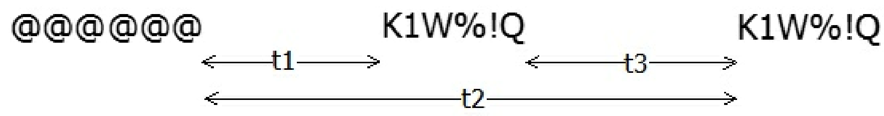
Initializing communication with the instrument is performed by sending a < BREAK >, which is defined below. The <BREAK> will either set the instrument in Confirmation mode or restart Command mode. The options for changing mode depends on the present mode of the instrument (see diagram above for clarity).

<BREAK> over the serial RS232/RS422 interface is defined as:

@@@@@@ <delay 100 milliseconds> K1W%!Q <delay 300 milliseconds> K1W%!Q

The @@@@@@ are used to wake up the processor when it is in sleep mode since the instrument will only be able to monitor activity on the serial line when it sleeps. The second sequence of the actual break characters is there to ensure that a break is detected even when the instrument is waking up due to some other cause (e.g. alarm from the real time clock). This ensures that the processor will interpret the following command correctly.
<BREAK> Timing Specification

The figure and the table below show the specified timing of the BREAK sequence.



Symbol	Parameter	Min	Max	Unit
t1	Time from end of @-sequence to start of first K1W%!Q-sequence.	100		ms
t2	Time from end of @-sequence to start of second K1W%!Q-sequence.		2000	ms
t3	Time between first and second K1W%!Q-sequence.	300		ms

Default values are not listed for all commands in this document as some of them depend on the actual instrument in use. Default parameters can be retrieved be setting default configuration (SETDEFAULT, CONFIG) and reading out the desired parameter through the appropriate GET command.

The same is the case for some of the minimum and maximum values that depend on the actual instrument in use. The parameter range for the various arguments can be retrieved through the appropriate GETxxxLIM command, e.g. GETDVLLIM,SR to read the valid range of cell sizes.

All command parameters should be set explicitly, e.g.

```
SETDVL,SR=1.0,SA=35.0
OK
```

A configuration of the instrument should always start with setting the default configuration, e.g.

```
SETDEFAULT,CONFIG
OK
```

3 Interfaces

In addition to the traditional serial port interface for real time data output there are several options for communication over Ethernet. The Ethernet communication is handled by a dedicated processor in the instrument. This network processor runs a Linux operating system, which makes it possible to connect to the instrument via telnet, raw connections and FTP. The network processor mainly provides Ethernet connectivity. The other processor in the instrument, called the Doppler processor, is where the commands end up and where they are used to perform the measurements as specified. Below are some details:

3.1 Command interface

The command interface makes it possible to communicate with a Signature instrument using terminal software, the serial port and a set of commands. The interface is also available over Telnet. Some highlights:

- ASCII based and line oriented. Commands are terminated with CR/LF
- Optional capsulation of commands using NMEA style prefix and checksum to ensure data integrity
- NMEA style commands will return argument names in their response
- Argument limits can be retrieved through commands
- Comprehensive validation and error handling is implemented.
- Invalid configurations return the erroneous argument with limits directly, so that each subsequent error can be handled until a valid configuration is achieved
- A single command can be used to retrieve the complete configuration of the instrument with optional output to file
- Commands to set default parameters
- External controllers can use commands to store data in the raw data file (e.g. GPS position)

3.2 Ethernet Operation

The AD2CP uses TCP (transmission control protocol) for both command processing and data transmission. The Internet Protocol uses a combination of the IP address and port to uniquely identify a communications channel between two computers. For the AD2CP, different ports represent different means of communicating with the instrument. TCP ports 9001, 2002, 9004 are assigned for the following uses:

- Port 9000 is a telnet-protocol ASCII interface (require username / password authentication)
- Port 9001 is a raw (binary) interface (requires username / password authentication)
- Port 9002 is a binary data only channel (no input accepted)
- Port 9004 is an ASCII data only channel (no input accepted).
- Port 9010/9011 - Additional Output Data Format. See chapter SETAODF.

The password entry is ignored if password authentication, as shown in the web page configuration, is disabled (so any input, including an empty password, is accepted). The command and data record formats for the interfaces are the same as for the serial port.

3.3 Telnet Connection

The telnet interface (TCP/IP port 9000) is used for user interaction with the instrument. This dedicated port can be used for entering commands and getting human readable responses (ASCII). The supported command set is available in the Commands section. The Windows telnet client can be used to connect into the instrument using the command line telnet ip_address 9000. You will get prompted for a username (nortek) and password (hit Enter if password protection hasn't been enabled via the Web interface).

```
Signature Username: nortek
Password:
Nortek Signature Command Interface
```

The interface is very similar to the direct serial interface over RS232/RS422 but some additions are made to simplify the interfacing. Most notable is the ability to send a <break> to the Doppler processor just by using Ctrl-C (ASCII 0x03). The internal application takes care of waking up the Doppler DSP and timing the delivery of the break string. The telnet server is not configured to echo characters, so users wishing to see and/or edit commands before sending them to the instrument should enable local echo and local line editing. If those features are desired, a telnet client capable of supporting local echo and local line editing must be used (e.g. PuTTY).

Port 9000 is dedicated for ASCII only communication whereas the ports described in the next section provide the complete set of data, including binary output of the measurements. A telnet client should not be used to access these ports. Read more about this in the next section.

To terminate the telnet connection, enter **Ctrl-X** (ASCII 0x18).

3.4 Raw Connections

A port can be understood as a address point between two communicating parts. When first connecting to a data listening port, the string "\r\nNortek name Data Interface\r\n" (name is replaced by the instrument host name) is sent to identify the instrument that has responded to the connection request. TCP ports 9001, 9002 and 9004 are assigned for the following uses:

- Port 9001 is used for machine driven control. This port requires username/password. The serial port data is translated directly into TCP/ IP over Ethernet. Binary data generated in measurement mode is visible on this port. Standard streaming record delineation techniques must be used in order to make sure that the received data is properly synchronized for decoding. A break can be sent by sending the string K1W%!Q<CR><LF> to the instrument or a Ctrl-C character (ASCII 0x03) (Ctrl-C has to be sent on its own and not embedded in any command). The internal application takes care of the appropriate timing of the break sent over the internal serial port. This port require username / password authentication. Refer to previous section for example. The password entry is ignored if password authentication, as shown in the web page configuration, is disabled (so any input, including an empty password, is accepted). The command and data record formats for the interfaces are the same as for the serial port.
- Port 9002 is a data only channel which will output all data that is configured for serial output. This can, for example, be used by display only software while configuration is done by another application.
- Port 9004 outputs ASCII data (no binary) that is configured for serial output.

A telnet client should not be used to access these ports. Telnet incorporates its own binary protocol which is neither interpreted nor sent via the raw connection. Using a telnet client on these ports will result in extraneous characters being sent and certain binary characters being interpreted by the client.

3.5 FTP

The internal data recorder is accessed over Ethernet using a standard FTP (File Transfer Protocol) client. FTP serves as a simple way to download measured data from the instrument.

When an FTP connection is active, the internal state of the machine is changed so that commands are no longer processed (and an error is returned when commands are entered). Terminating the FTP connection or sending a BREAK followed by the CO command will switch the instrument back to the mode it was in before the FTP session began. If a break command is sent while an FTP transaction is in progress, the FTP connection will be forcibly terminated.

If an FTP connection is done when the instrument is in measurement mode (see Figure 1), the FTP connection is made through data retrieval mode. When the FTP connection is terminated, the instrument will then return to measurement mode. If there is no data transferred or FTP commands sent for 120 seconds, the FTP connection will terminate and the instrument will return to measurement mode.

3.6 HTTP

HTTP (Hypertext transfer protocol) can also be used for data transmission. For organizations with strong security / firewall restrictions, FTP access to the instrument may not be permitted. For that reason, a web page allowing individual data files to be downloaded has been implemented in the Ethernet processor. The web page can be accessed by clicking on the “Data Download (HTTP)” link from the main web page.

3.7 UDP

UDP (user datagram protocol) can also be used for data transmission. When using UDP, the data collection software simply waits for data to be sent from the instrument without having to establish a connection first. This may be useful for cases in which instrument power is intermittently interrupted and re-connecting to the instrument is not desirable. One downside to UDP communications is that transmission of the data is not guaranteed. On a noisy / errorprone connection, it is possible that the occasional datagram may be dropped. If every data record must be received, then TCP is recommended.

Multicast operation is also supported over UDP if data should be distributed to multiple clients. This is enabled by entering an UDP address in the multicast address range.

In order to use UDP in a power-safe configuration, the IP address of the data collection software and port must first be configured using the web interface. The IP address identifies the client to which the data is to be sent and the port may be used to uniquely identify the instrument to the application. The same port may be used for all instruments if the data collection software examines the IP address of the received datagram to identify the instrument. Once this information has been configured, the Ethernet processor will automatically send real-time data records to the configured address / port. An instrument in measurement mode re-enters measurement mode shortly after a power-cycle, so the data collection software will immediately receive new data without having to re-establish a connection.

3.8 Time Synchronization

Time Synchronization allows the internal clocks used for data collection to be synchronized to an external source. Either NTP (Network Time Protocol) or PTP (Precision Tim Protocol) can be selected.

Precision Time Protocol (IEEE-1588) is a standard used for distributing a high-resolution absolute time throughout an Ethernet network. The DVL can be configured to act as a slave to an existing PTP master clock (customer supplied) located in the same Ethernet LAN. The instrument contains a high-resolution clock which is synchronized and conditioned using PTP when enabled. The timestamps contained within the data records are then generated from this clock. When synchronized, these timestamps are typically aligned to within +/- 1 microseconds.

The PTP master clock must use UDP (layer three) and be configured for two-step operation with an end-to-end delay mode in order to be compatible with the DVL's PTP implementation. Using PTP does not affect the choice of UDP or TCP for the transport of data.

Network Time Protocol is a purely software based Internet time synchronization protocol. In comparison to PTP, NTP will typically take 1-2 minutes to fully achieve sync and will generally synchronize to within 1 ms for a local server. While there are no special requirements for the NTP time server in terms of hardware, synchronization is strongly affected by the network path between the server and the client and, for that reason, it is strongly recommended that the NTP server be located on the same local Ethernet network as the instrument.

Setting up time synchronization can be done through the web site, and the commands for enabling time synchronization is described in the Commands section.

Data collection cannot occur if the internal time has not been synchronized to the master clock.

4 List of Commands

Command	Description	Scope
START	Go in measurement mode	Command mode
MC	Go in command mode ("Message Confirmed")	Confirm mode
RM	Go in data retrieval mode	Confirm mode
CO	Continue in measurement mode.	Confirm mode, Data retrieval mode
INQ	Inquiry instrument state	All modes
SETINST/ GETINST/ GETINSTLIM	Set/Get Main Instrument Settings Get Instrument Setting Limits	Command mode
SETCLOCK/ GETCLOCK	Set/Get Real Time Clock	Command mode, Data retrieval mode
GETCLOCKMS	Get Real Time Clock (including milliseconds)	Command mode, Data retrieval mode
SETCLOCKSTR/ GETCLOCKSTR	Set/Get Real Time Clock using a string argument	Command mode, Data retrieval mode
GETCLOCKRMS	Get Real Time Clock string (including milliseconds)	Command mode, Data retrieval mode
SETCURPROF/ GETCURPROF/ GETCURPROFLIM	Set/get Current Profiling Mode Settings Get Current Profiling Mode Settings	Command mode
SETUSER/ GETUSER/ GETUSERLIM	Set/Get User Settings	Command mode
SETDEFAULT	Reload default settings	Command mode
SAVE	Save current settings for next measurement	Command mode
POWERDOWN	Go in power down	Command mode
GETERROR	Return a full description of the last error	All modes
GETERRORNUM	Get last error number	All modes
GETERRORSTR	Get last error string	All modes
ERASE	Erase the recorder	Command mode
FORMAT	Format the recorder	Command mode
RECSTAT	Returns Recorder Statistics	Command mode, Data retrieval mode
SETBT/ GETBT/ GETBTLIM	Set/Get Bottom Track Settings Get Bottom Track Limits	Command mode
SETAODF/ GETAODF/	Set/Get Additional Output Data Format Get Additional Output Data Format Limits	Command mode

Command	Description	Scope
GETAODFLIM		
SETDVL/ GETDVL/ GETDVLLIM	Set DVL parameters	Command mode
GETALL	Retrieves all relevant configuration information for the instrument.	Command mode
READCFG	Retrieves all configuration information from the instrument	Command mode
TAG	Write a Tag to output file and data output	Command mode, Confirmation mode, Measurement mode and Data retrieval mode

5 Configuration examples

5.1 Example: Internal 4 Hz trigger

Internal trigger at 4 Hz using measured sound velocity calculated using a salinity of 35.0 ppt. Velocity range 5 m/s along beam and a range of 10 meters:
(Since the instrument is in measurement mode, the first step is to get it into Command Mode)

```
Send Break
CONFIRM
MC
DVL - NORTEK AS.
Version 4041_10 (Nov 15 2017 14:38:16)
COMMAND MODE
OK

SETDEFAULT,CONFIG
OK
SETDVL,CP=0,TRIG="INTSR",SR=4.0,FN="",SV=0.0,SA=35.0
OK
SETBT,RANGE=10.00,VR=5.00,NB=4,CH=0,DF=21,PL=-2.0,WT="OFF",WTDF=22,BD=0.01,
PLMODE=”MAX”
OK
SAVE,CONFIG
OK
START
OK
```

5.2 Example: External trigger, rising edge

External, rising edge, TTL trigger using fixed sound velocity at 1500.0 m/s. Velocity range 2.5 m/s along beam and a range of 30 meters. This example also shows retrieval of argument limits and checking error conditions as the range is here first set erroneously to 100 meters: (Since the instrument is in measurement mode, the first step is to get it into Command Mode)

```
Send Break
CONFIRM
MC
DVL - NORTEK AS.
Version 4041_10 (Nov 15 2017 14:38:16)
COMMAND MODE
OK

SETDEFAULT,CONFIG
OK
GETDVLLIM,TRIG
("INTSR";"TTLEDGE";"TTLRISE";"TTLFALL";"RS485EDGE";"RS485RISE";"RS485FALL";
```

```
"SERIAL")
OK
SETDVL,CP=0,TRIG="TTLRISE",SV=1500.0
OK
SETBT,RANGE=100.00,VR=2.50,NB=4,CH=0,DF=21,PL=-2.0,WT="OFF",WTDF=22,
BD=0.02,PLMODE=”MAX”
OK
SAVE,CONFIG
ERROR
GETERROR
261,"Invalid setting: Bottom track range invalid","SETBT,RANGE=
([5.00;30.00])"
OK
SETBT,RANGE=30.0
OK
SAVE,CONFIG
OK
START
OK
```

6 Commands

6.1 SETINST/GETINST/GETINSTLIM

Set/get main instrument settings and limits.

Argument	Description	Default Value	Valid Range
BR	Baud Rate	9600	300 – 115000
RS	Serial protocol	232	232 or 422
LED	Enable/disable LED blink in head. When set to “ON24H” the LED will illuminate the first 24 hours of the measurement.	“ON”	“ON” “OFF” “ON24H”
ORIENT	Not used for the DVL.		
CMTOUT	Command mode timeout [seconds]. In Serial mode the system is powered down after this timeout after the last command. Not used in Ethernet mode	300	300 - 3600
DMTOUT	Data retrieval mode timeout [seconds].	60	60 - 3600
CFMTOUT	Confirmation retrieval mode timeout [seconds].	60	60 -300

The SAVE,INST command must be sent to save changes in USER parameters.

Example:

```
$PNOR,GETINST*79
$PNOR,GETINST,BR=460800,RS=232,LED="ON",ORIENT="AUTOZUPDOWN",
CMTOUT=300,DMTOUT=60,CFMTOUT=60*23
$PNOR,OK*2B
```

6.2 SETCLOCK/GETCLOCK

Set or retrieve the Real Time Clock. Note that all parameters must be set when using the SETCLOCK command.

Argument	Description	Default Value	Valid Range
YEAR	Year		1970-
MONTH	Month		1-12
DAY	Day		1-31
HOUR	Hours (24 hour format)		0-23
MINUTE	Minutes		0-59
SECOND	Seconds		0-59

Scope:
Command mode and Data retrieval mode

6.3 GETCLOCKMS

Retrieve the Real Time Clock with milliseconds resolution. If this command is sent directly after an instrument reboot, there may be a delay up to 1 second before the response. Otherwise, the normal latency is below 10 ms. When comparing clocks over the serial interface, the receiving side should capture its local clock when start bit of the first character in the returned message is detected. This will ensure minimum latency between comparing the local clock with the instrument clock. Over an Ethernet interface, there will be some milleseconds latency using this method. To achieve the best precision in a system using Ethernet, PTP should be used, as described in the PTP section.

Argument	Description	Default Value	Valid Range
YEAR	Year		1970-
MONTH	Month		1-12
DAY	Day		1-31
HOUR	Hours (24 hour format)		0-23
MINUTE	Minutes		0-59
SECOND	Seconds		0-59
MSEC	Minutes		0-999

Scope:
Command mode and Data retrieval mode

Example:

```
$PNOR,GETCLOCKMS*2F
$PNOR,GETCLOCKMS,YEAR=2016,MONTH=11,DAY=9,HOUR=9,MINUTE=18,
SECOND=27,MSEC=183*08
$PNOR,OK*2B
```

6.4 SETCLOCKSTR/GETCLOCKSTR

Set or retrieve the Real Time Clock using a string. The format must be exactly as shown.

Argument	Description	Default Value	Valid Range
TIME	yyyy-mm-dd hh:mm:ss		

Scope:
Command mode and Data retrieval mode

6.5 GETCLOCKSTRMS

Retrieve the Real Time Clock with milliseconds resolution. If this command is sent directly after an instrument reboot, there may be a delay up to 1 second before the response. Otherwise, the normal latency is below 10 ms. When comparing clocks over the serial interface, the receiving side should capture its local clock when start bit of the first character in the returned message is detected. This will ensure minimum latency between comparing the local clock with the instrument clock. Over an Ethernet interface, there will be some milleseconds latency using this method. To achieve the best precision in a system using Ethernet, PTP should be used, as described in the PTP section.

Argument	Description	Default Value	Valid Range
TIME	yyyy-mm-dd hh:mm:ss.sss		

Scope:
Command mode and Data retrieval mode

Example:

```
GETCLOCKSTRMS
"2016-11-09 09:21:26.924"
OK
```

6.6 SETDVL/GETDVL/GETDVLLIM

The DVL parameters specify which type(s) of measurements that will be measured and how the measurements are initiated/trigged.

Argument	Description	Default Value	Valid Range
CP	Collect Current Profile every Nth Bottom Track ping, 0 to disable Current Profile	0	0 – 20
TRIG	Specifies trigger type	"INTSR"	"TTLRISE", "TTLFALL", "TTLEDGE", "SERIAL", "INTSR","RS485RISE", "RS485FALL","RS485EDGE"
SR	Internal sampling rate if enabled	1.0	DVL1000: 1.0 to 8.0 Hz DVL500: 1.0 to 8.0 Hz
FN	File name	""	30 characters a-z, A-Z, 0-9 . and _.
SV	Sound velocity (m/s)	0.0	1300.00-1700.00 0 will set sensor to use measured sound velocity
SA	Salinity (ppt)	35.0	0.0-50.0
ALTI	Unused	-	-

Example:

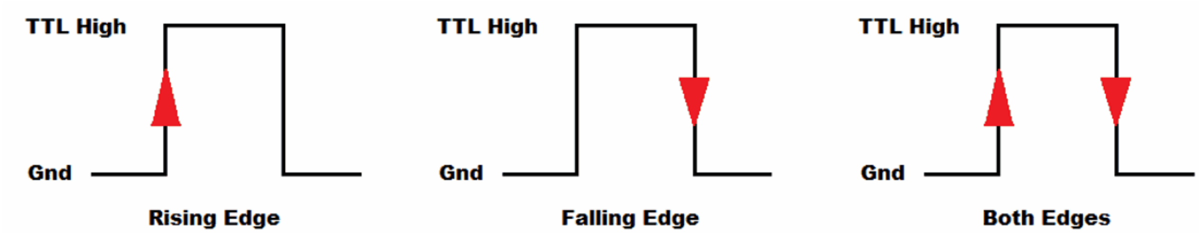
```
$PNOR,GETDVL*27
$PNOR,GETDVL,CP=0,TRIG="INTSR",SR=4.0,FN="",SV=0.0,SA=35.0,
ALTI=0*6D
$PNOR,OK*2B
$PNOR,SETDVL,TRIG="TTLRISE"*6B
$PNOR,OK*2B
$PNOR,GETDVL*27
$PNOR,GETDVL,CP=0,TRIG="TTLRISE",SR=4.0,FN="",SV=0.0,SA=35.0,
ALTI=0*7E
$PNOR,OK*2B
```

6.6.1 Triggers

The DVL offers four main types of triggers: Internal Sampling, TTL trigger, RS-485 trigger and trig on command.

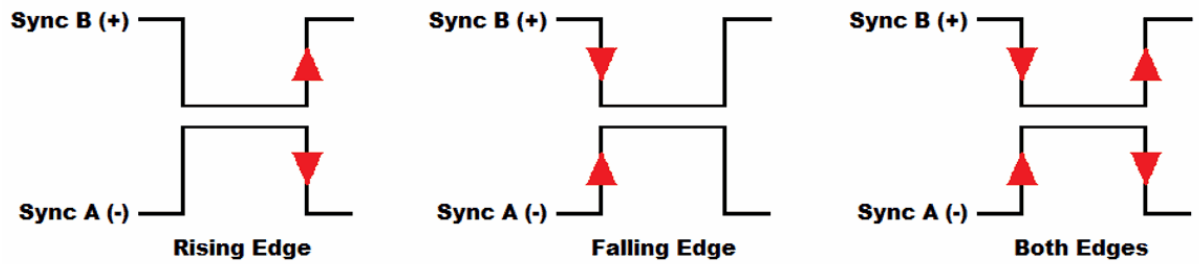
Internal Sampling (INTSR)
Sampling rates from 1 to 8 Hz are available. For long ranges the maximum sampling rate is reduced. The command GETMISCLIM,BTENDRANGE can be used to find the maximum range for the given sampling rate.

TTL Trigger
The DVL can trig on either Rising Edge, Falling Edge or Both Edges of a TTL Signal. When triggered the instrument will perform a complete ping (Tx and Rx) before it goes back to monitoring the trigger. Any triggers asserted during an ongoing ping will be ignored. The requirements for the TTL input is Vlow <0.7V and Vhigh>2.5V. The TTL input tolerate voltages between 0-5.5 V. The pulse length should be minimum 1 ms, the latency (trigger to start of transmit pulse) is 8.4 ms, and the max length of transmit pulse is 13.3 ms for the DVL1000, and 26.6 ms for the DVL500. The actual length of the transmit pulse varies with the distance to the bottom.



DVL trigger types

RS-485 Trigger
A RS-485 signal can be used to trig the DVL. The DVL can trig on either Rising Edge, Falling Edge or Both Edges of a RS-485 Signal. The following figure shows the polarities of the differential RS-485 signal pair for the trigger types. When triggered the instrument will perform a complete ping (Tx and Rx) before it goes back to monitoring the trigger. Any triggers asserted during an ongoing ping will be ignored. The pulse length should be minimum 1 ms, the latency (trigger to start of transmit pulse) is 8.4 ms, and the max length of transmit pulse is 13.3 ms for the DVL1000, and 26.6 ms for the DVL500. The actual length of the transmit pulse varies with the distance to the bottom.



DVL RS-485 Trigger types

Trig on Command
When the TRIG parameter of the SETDVL command is set to “SERIAL” the DVL is trigged by sending a “TRIG[CrLf]” command. The trigger time will be when the end of the [CrLf] is received.

6.7 PTPSET/PTPGET

SAVE,PTP saves the PTP parameters

Argument	Description	Default Value	Valid Range
EN	Enable		
OFFSET	Given in µs		
CL	time t -Value representing the number of seconds elapsed since 00:00 hours, Jan 1, 1970 UTC		

6.8 NETSETTIMESYNC

Time Synchronization

NETSETTIMESYNC,NTP	Enables Network Time Protocol time synchronization.
NETSETTIMESYNC,PTP	Enables Precision Time Protocol time synchronization.
NETSETTIMESYNC,NONE	Disables network time synchronization.
NETSETTNPSERVER, ip_address	The numeric IP address of the NTP server to use for syncing. Note: The instrument is not capable of DNS name resolution. In order to retrieve the IP address associated with a name, use the "nslookup" tool from the computer command line.
NETGETNTPSERVER	Get IP address of the NTP server to use for syncing.
NETREBOOT,9999	This reboots the system. Connection to host will be lost.

6.9 SETCURPROF/GETCURPROF/GETCURPROFLIM

The CURPROF command configures the optional Current Profile measurements.

The valid range for the various arguments should be verified using the GETCURPROFLIM command, also for the values listed here as they may change with firmware versions and instrument frequencies. Current profile always use a broad bandwidth.

The current profile functionality is licensed option and is noted in by the license field "AVERAGE MODE" in the licenselist when a GETALL command is issued. A single cell is made available when the end user would like to perform a functionality test of the transducers (See DVL Operations Manual).

The current profile is not the same as Water Track; Water Track is always available with each Bottom Track ping.

Argument	Description	Default Value	Valid Range
NC	Number of cells		1-200
CS	Cell Size (m)		
BD	Blanking Distance (m)		
CY	Coordinate System		”XYZ“ “BEAM”
PL	Power Level [dB]		-100 dB to switch off transmit -20.0 dB to 0.0 dB

Argument	Description	Default Value	Valid Range
VP	Velocity Precision		Not yet supported.
VR	Velocity range along beam [m/s]		1.0 – 5.0 m/s
DF	Data Format	3	3 - Nortek Binary format 100 - Prolog NMEA format 101 - NMEA format 1 102 - NMEA format 2 103 - NMEA format 3 104 - NMEA format 4 150 - RDI PD0 - RDI documentation
NB	Number of beams	4	Select number of beams; 0 disables all beams. Maximum number of beams equals number of transducers on sensor head.
CH	Beam selection	0	Select beams, 0 selects all beams in ascending order Example: 134 select the three beams 1, 3 and 4

The actual valid range for the various parameters for the firmware version is used can be found by using the GETCURPROFLIM command. This command has the same arguments as the SETCURPROF/ GETCURPROF commands shown in the list above. The output format for limits is described in Data Limit Formats.

6.10 SETALTI/GETALTI/GETALTILIM

The altimeter is an optional hardware configuration available for select Nortek custom DVLs.
The ALTI command configures the optional Altimeter measurements.
The valid range for the various arguments should be verified using the GETALTILIM command, also for the values listed here as they may change with firmware versions and instrument frequencies.

Argument	Description	Default Value	Valid Range
BD	Blanking Distance (m)		
RANGE	Measurement Range (m)		
PL	Power level [dB]		-100 dB to switch off transmit -20.0 dB to 0.0 dB
DF	Data format	3	

The actual valid range for the various parameters for the firmware version is used can be found by using the GETALTILIM command. This command has the same arguments as the SETALTI/GETALTI commands shown in the list above. The output format for limits is described in Data Limit Formats.

6.11 SETBT/GETBT/GETBTLIM

The BT command configures the Bottom Track measurements and the Water Track measurements. The valid range for the various arguments should be verified using the GETBTFLIM command, also for the values listed here as they may change with firmware versions and instrument frequencies.

Argument	Description	Default Value	Valid Range
RANGE	Bottom track range		DVL100 Max 50 meters; DVL500 Max 200 meters
VR	Velocity range along beam		1.0 – 6.25 m/s
NB	Number of beams	4	Select number of beams; 0 disables all beams. Maximum number of beams equals number of transducers on sensor head.
CH	Beam selection	0	Select beams, 0 selects all beams in ascending order. Example: 134 select the three beams 1, 3 and 4
DF	Data Format	20	21 – Bottom Track Data Record version 1. 150 - RDI PD0 - RDI documentation 154 - RDI PD4 - RDI documentation 156 - RDI PD6 – RDI Documentation. 350 - NMEA $PNORBT1 including tags. 351 - NMEA $PNORBT0 (same as DF350 but no tags) 354 - NMEA $PNORBT3 including tags. 355 - NMEA $PNORBT4 (same as DF354 but no tags) 356 - NMEA $PNORBT6 including tags. 357 - NMEA $PNORBT7 (same as DF356 but no tags) 358 - NMEA $PNORBT8 (sensors) including tags. 359 - NMEA $PNORBT9 (Sensors) (same as DF358 but no tags)
PL	Power Level	0.0	0.0 – -20.0dB. -100 dB to switch off transmit
WT	Measure Water Track velocity.	“OFF”	“OFF”, [“ON”)
WTDF	Water Track Data format		
BD	Blanking Distance (m)		
PLMODE	Power Level Mode	“MAX”	“MAX”, “USER”

Lower power is sometimes desirable if there is an interest in reducing power consumption or if the DVL will only be operating close to the bottom. The maximum power level is range dependent, so the user may either let the firmware select the maximum (MAX) given the current configuration or choose a value (USER). If USER is selected, a power level of 0 dB represents maximum power output. Power is decreased by entering negative values.

Example:

```
GETBT*6F
GETBT,RANGE=70.00,VR=5.00,NB=4,CH=0,DF=21,PL=0.0,WT="ON",WTDF=22,
BD=0.02,PLMODE="MAX"*64
OK
GETBTLIM
GETBTLIM,RANGE=([2.00;200.00]),VR=([5.00;5.00]),NB=([0;4]),CH=
([0;4321]),DF=(21;150;154;156;350;351;354;355;356;357;358;359),PL=
([-20.00;0.00]),WT=("ON";"OFF"),WTDF=
(22;150;154;156;404;405;406;407;408;409),BD=([0.02;10.00]),PLMODE=
("USER";"MAX")
OK
SETBT,RANGE=100.0
OK
GETBT
GETBT,RANGE=100.00,VR=5.00,NB=4,CH=0,DF=21,PL=0.0,WT="ON",WTDF=22,
BD=0.02,PLMODE="MAX"
OK
```

6.12 SETUSER/GETUSER/GETUSERLIM

Set/get user settings.

Argument	Description	Default Value	Valid Range
POFF	Pressure offset [dbar] Set the offset value of the pressure sensor.	9.50	0.0-11.000
ROTXY	Alignment offset [deg]. Equivalent to the Webpage Mounting Angle	0.0 deg	-180.0 – 180 deg
DECL	Not used for DVL		
HX	Not used for DVL		
HY	Not used for DVL		
HZ	Not used for DVL		

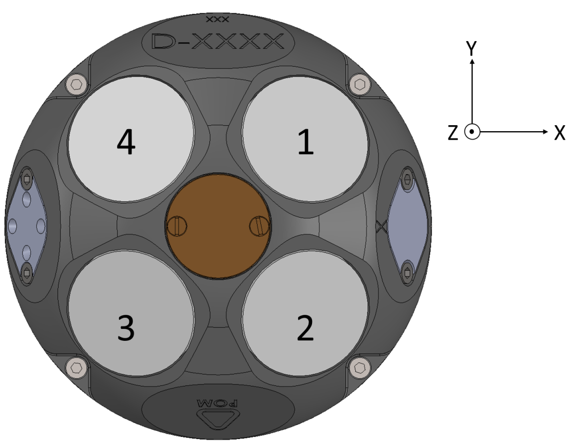
A rotation of the XY coordinate system (about the z-axis) can be done using the ROTXY parameter. The new coordinate system X'Y'Z' is given by the following.

$$\begin{bmatrix} X' \\ Y' \\ Z' \end{bmatrix} = \begin{bmatrix} cosd(rotxy) & -sind(rotxy) & 0 \\ sind(rotxy) & cosd(rotxy) & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

The SAVE,USER command must be sent to save changes in USER parameters

Example:

```
SETUSER,ROTXY=15.0
OK
SAVEUSER
OK
```



DVL beam numbering and Axes convention. Note that positive Z is pointing out of the page.

6.13 SETAODF/GETAODF/GETAODFLIM

The additional online data formats provide a means of producing two independent data streams with user selectable data formats that are different from those used in the main stream (e.g. the main stream could contain Nortek formatted data while the AODF streams could contain PDx formatted data). These two data streams (AODFA and AODFB) are only available when Ethernet is used for communications. The streams can be read from a client computer by either connecting to the associated instrument TCP/IP port (9010 for AODFA and 9011 for AODFB) or by configuring and enabling the associated UDP/IP data client information for the stream.

Each stream (AODFA/AODFB) can contain Bottom Track, Water Track, and/or Current Profile data with the selected format. If UDP transmission is selected and configured, the instrument will automatically transmit UDP data records to the client address / port as it is received.

Argument	Description	Default Value	Valid Range
DFBTA	AODFA – Data format for Additional Bottom Track Data.	0 - Off	Use GETAODFLIM to retrieve valid range.
DFWTA	AODFA – Data format for Additional Water Track Data.	0 - Off	Use GETAODFLIM to retrieve valid range.
DFCPA	AODFA – Data format for Additional Current Profile Data.	0 - Off	Use GETAODFLIM to retrieve valid range.
DFALTIA	Unused	0 - Off	Use GETAODFLIM to retrieve valid range.
DFBTB	AODFB – Data format for Additional Bottom Track Data.	0 - Off	Use GETAODFLIM to retrieve valid range.
DFWTB	AODFB – Data format for Additional Water Track Data.	0 - Off	Use GETAODFLIM to retrieve valid range.
DFCPB	AODFA – Data format for Additional Current Profile Data.	0 - Off	Use GETAODFLIM to retrieve valid range.
DFALTIB	Unused	0 - Off	Use GETAODFLIM to retrieve valid range.

6.14 SETDEFAULT

Argument	Description	Default Value	Valid Range
CONFIG	Restore all settings below except USER and INST to default values. Legacy argument ALL acts as CONFIG.	No value	No value
CP	Restore CURPROF default.	No value	No value
INST	Restore INST default.	No value	No value
BT	Restore BT default.	No value	No value
USER	Restore USER default.	No value	No value
DVL	Restore DVL default.	No value	No value

6.15 SAVE

Save current settings for next measurement.

Argument	Description	Default Value	Valid Range
CONFIG	Save all settings below except INST and USER settings to nonvolatile memory. Legacy argument ALL acts as CONFIG.	No value.	No value.
CP	Save CURPROF parameters.	No value	No value
INST	Save INST parameters.	No value	No value
USER	Save USER parameters.	No value	No value
BT	Save BT parameters.	No value	No value
DVL	Save DVL setting parameters.	No value	No value

At least one argument must be specified for the SAVE command.

6.16 POWERDOWN

Power down the instrument to set it in sleep mode.

6.17 ERASE

Argument	Description	Default Value	Valid Range
CODE	Code should be 9999	No value.	9999

Erase all files on the recorder.

6.18 FORMAT

Argument	Description	Default Value	Valid Range
CODE	Code should be 9999	No value.	9999

Format the recorder. Note that this can take minutes depending on the recorder size.

6.19 INQ

The INQ command inquires the instrument state. Note that when operating over RS232 or RS422 serial lines, it should be preceded with @@@@@@ <delay 400 ms> and a flush of the input buffer in case the instrument is in power down.

Example (in command mode) :

```
08:43:31    INQ<CR><LF>
08:43:31    0002<CR><LF>
```

Example (in measurement mode) :

```
08:43:31    INQ<CR><LF>
08:43:31    0001<CR><LF>
```

Example (in confirmation mode) :

```
08:43:31    INQ<CR><LF>
08:43:31    0005<CR><LF>
```

Example (in data retrieval mode) :

```
08:43:31    INQ<CR><LF>
08:43:31    0004<CR><LF>
```

Example (in firmware upgrade mode) :

```
08:43:31    INQ<CR><LF>
08:43:31    0000<CR><LF>
```

6.20 GETERROR

GETERROR retrieves a full description of the last error condition to occur. The error number is returned first followed by a string with the text description of the last error condition. A second string is also returned which contains information on the valid range of the failing argument, see example below.

Argument	Description	Default Value	Valid Range
NUM	Integer error value		
STR	Text description		

Example:

```
SETDVL,sa=90.0
OK
SAVE,CONFIG
ERROR
GETERROR
310,"Invalid setting: DVL Salinity","GETDVLLIM,SA=([0.0;50.0])"
OK
```

6.21 GETERRORNUM

GETERRORNUM retrieves the integer error value for the last error condition.

Argument	Description	Default Value	Valid Range
NUM	Integer error value	-	-

6.22 GETERRORSTR

GETERRORSTR retrieves a text description of the last error condition.

Argument	Description	Default Value	Valid Range
STR	Text description	-	-

6.23 GETALL

GETALL retrieves all relevant configuration information for the instrument. This information can either be displayed on the command line or saved to a data file.

Argument	Description	Default Value	Valid Range
FN	Write the output to this file.		30 characters a-z, A-Z, 0-9 . and _.

Example :

```
GETALL
GETCLOCKSTR,"2016-03-11 08:31:13"
ID,"NortekDVL",200012
GETHW,4033,159,"H-0","D-0","C-4","D-0",19,1
BOARDSENSGET,3,4,1000,2.0000,0.0000
GETDVL,0,"INTSR",8.0,"",0.0,35.0
GETBT,30.00,5.00,4,0,21,-2.0,"OFF",22,0.01,"MAX"
GETXFBT,4,4,0.836579,0.836579,-0.836579,-0.836579,0.836579,-
0.836579,-
0.836579,0.836579,0.551689,0.000000,0.551689,0.000000,0.000000,0.55
1689,0.000000,0.551689
GETUSER,9.50,0.000,1.000,0.000,0.000,0.000,1.000,0.000,0.000,0.000,
1.000
GETINST,9600,232,"ON","AUTOZUPDOWN",300,60,60
GETCOMPASSCAL,199,-33,68,29794,-512,-215,637,29296,79,7,-136,32767
BEAMCFGLIST,1,25.00,45.00,1000,25,1,1,60.00
BEAMCFGLIST,2,25.00,-45.00,1000,25,1,2,60.00
BEAMCFGLIST,3,25.00,-135.00,1000,25,1,3,60.00
BEAMCFGLIST,4,25.00,135.00,1000,25,1,4,60.00
BEAMIMPLIST,1,1.00000e+02,0.00000e+00,0.00000e+00,0.00000e+00,0.000
00e+00,0.00000e+00
BEAMIMPLIST,2,1.00000e+02,0.00000e+00,0.00000e+00,0.00000e+00,0.000
00e+00,0.00000e+00
BEAMIMPLIST,3,1.00000e+02,0.00000e+00,0.00000e+00,0.00000e+00,0.000
00e+00,0.00000e+00
BEAMIMPLIST,4,1.00000e+02,0.00000e+00,0.00000e+00,0.00000e+00,0.000
00e+00,0.00000e+00
LISTLICENSE,"LR9UFYGLM518D","Averaging Mode",1
LISTLICENSE,"KKEXGJ74M518D","Burst Mode",2
LISTLICENSE,"YGD79C6Z38Y0B","Bottom Track",3
OK

GETALL,FN=”getallFilename.txt”
OK
```

6.24 RECSTAT

Return Recorder Statistics

Argument	Description	Description
SS	SectorSize	# of Bytes in a Sector.
CS	ClusterSize	# of Bytes in one Cluster
FC	Free Clusters	# of Bytes in Free Clusters
TC	Total Clusters	Total # of bytes in Clusters
VS	Volume Size	Volume Size in bytes

6.25 READCFG

Read current configuration. If a filename parameter is given the current configuration is stored to a file. If no parameter is given the current configuration is written to console.

The output of this command can be used to configure the instrument to a known configuration.

Argument	Description	Description
FN	Filename	30 characters a-z, A-Z, 0-9 . and _.

Example :

```
$PNOR,READCFG*7F
$PNOR,SETDEFAULT,CONFIG*4B
$PNOR,SETDVL,CP=8,TRIG="INTSR",SR=8.0,FN="",SV=0.0,SA=35.0*4C
$PNOR,SETCURPROF,NC=60,CS=0.50,BD=0.10,CY="XYZ",PL=0.0,VP=0.000,
VR=2.50,DF=3,NB=4,CH=0*4F
$PNOR,SETBT,RANGE=30.00,VR=5.00,NB=4,CH=0,DF=21,PL=-2.0,WT="ON",
WTDF=22,BD=0.01,PLMODE="MAX"*58
$PNOR,SAVE,CONFIG*43
$PNOR,OK*2B
```

6.26 Data Limit Formats

The limits for the various arguments are returned as a list of valid values, and/or ranges, enclosed in parenthesis (). An empty list, (), is used for arguments that are unused/not yet implemented. Square brackets [] signify a range of valid values that includes the listed values. String arguments are encapsulated with “”, like for normal parameter handling. A semicolon, ;, is used as separator between limits and values.
The argument format can also be inferred from the limits, integer values are shown without a decimal point, floating point values are shown with a decimal point and strings are either shown with the string specifier, “”, or as a range of characters using ‘’ for specifying a character.

Examples:
[1;128] – Integer value, valid from 1 to 128
([1300.00;1700.00];0.0) – Floating point value, valid values are 0.0 and the range from 1300.00 to 1700.00.
(['0';'9'];['a';'z'];['A';'Z'];'.') – String argument with valid characters being and the character ranges a-z, A-Z, 0-9 .
("BEAM") – String argument with BEAM being the only valid string.
(0;1) – Integer value with two valid values, 0 and 1.

NMEA interface example:

```
$PNOR,GETCURPROFLIM*7E
$PNOR,GETCURPROFLIM,NC=([1;200]),CS=([0.50;4.00]),BD=
([0.50;68.00]),CY=("BEAM";"XYZ"),PL=([-20.0;0.0];-100.0),VP=(),VR=
([1.00;5.00]),DF=(3;100;101;102;103;104;150),NB=([0;4]),CH=
([0;4321])*2B
$PNOR,OK*2B
```

Regular interface example:

```
GETDVLLIM
(0;[2;20]),
("INTSR";"TTLEDGE";"TTLRISE";"TTLFALL";"RS485EDGE";"RS485RISE";"RS4
85FALL";"SERIAL"),(1.0;2.0;3.0;4.0;5.0;6.0;7.0;8.0),(['0';'9'];
['a';'z'];['A';'Z'];'_';'.'),([1300.00;1700.00];0.0),([0.0;50.0])
OK
```

6.27 TAG

The TAG command adds a tag to the both the output file and the output data, if enabled. The output is a String Record as defined in the FWRITE command. The ID of the String Record Data packet is 19 (dec)

Argument	Description	Default Value	Valid Range
STR	Tag String		Maximum 200 bytes
CLK	Add clock in tag?	0	0/1

Example:

```
$PNOR,TAG,STR="This is a test tag.",CLK=1*4A
a5 0a a0 10 2f 00 42 8c 42 5d  // Binary header
13 // String Record ID = 19 (dec)

32 30 31 37 2d 30 31 2d 32 34 20 30 38 3a 34 32 // "2017-01-24
08:42"
3a 35 37 2e 34 34 39 20 2d 20 54 68 69 73 20 69 // ":57.449 - This
i"
73 20 61 20 74 65 73 74 20 74 61 67 2e 00       // "s is a test
tag."
$PNOR,OK*2B
```

Scope:
Command mode, Confirmation mode, Measurement mode and Data retrieval mode.
(Remember to use the BBPWAKEUP command when sending commands to an instrument in Measurement mode, when using Ethernet)

7 Output Data Formats

This section describes the output data formats. This chapter is divided into three part; Bottom Track data formats, Water Track data formats and Current Profile data formats. Each of these chapter are divided into two chapters, Binary output formats and ASCII output formats.

7.1 Bottom Track Data Formats

The data format of the Bottom Track mode is controlled by the SET/GETBT command. The DF parameter of this command sets the data format

Binary:

Data format (DF)	Description
21	Nortek DVL Bottom Track data format.
150	RDI PD0 – RDI Documentation.
154	RDI PD4 – RDI Documentation.

Table 1 Available Binary Data formats for Bottom Track measurements.

ASCII:

Data format (DF)	Description
156	RDI PD6 – RDI Documentation.
350	NMEA $PNORBT1 including tags.
351	NMEA $PNORBT0 (same as DF350 but no tags)
354	NMEA $PNORBT3 including tags.
355	NMEA $PNORBT4 (same as DF354 but no tags)
356	NMEA $PNORBT6 including tags.
357	NMEA $PNORBT7 (same as DF356 but no tags)
358	NMEA $PNORBT8 (sensors) including tags.
359	NMEA $PNORBT9 (Sensors) (same as DF358 but no tags)

Table 2 Available ASCII Data formats for Bottom Track measurements.

7.2 Water Track Data Formats

The data format of the Water Track mode is controlled by the SET/GETBT command. The WTDF parameter of this command sets the data format

Binary:

Data format (DF)	Description
22	Nortek DVL Water Track data format.
150	RDI PD0 – RDI Documentation.
154	RDI PD4 – RDI Documentation.

Table 3 Available Binary Data formats for Water Track measurements.

ASCII:

Data format (DF)	Description
156	RDI PD 6– RDI Documentation.
404	NMEA $PNORWT3 including tags.
405	NMEA $PNORWT4 (same as DF404 but no tags)
406	NMEA $PNORWT6 including tags.
407	NMEA $PNORWT7 (same as DF406 but no tags)
408	NMEA $PNORWT8 (sensors) including tags.
409	NMEA $PNORWT9 (Sensors) (same as DF408 but no tags)

Table 4 Available ASCII Data formats for Water Track measurements.

7.3 Current Profile Data Formats

The data format of the Current Profiling mode is controlled by the SET/GETCURPROF command. The DF parameter of this command sets the data format.

Binary:

Data format (DF)	Description
3	Nortek Current Profile data format.
150	RDI PD0 – RDI Documentation.

Table 5 Available Binary Data formats for Current Profile measurements.

ASCII:

Data format (DF)	Description
100	NMEA Nortek Prolog format (see Prolog documentation)
101	NMEA $PNORI1, $PNORS1, $PNORC1, No tags
102	NMEA $PNORI2, $PNORS2, $PNORC2, Including tags
103	NMEA $PNORH3, $PNORS3, $PNORC3, Including tags
104	NMEA $PNORH4, $PNORS4, $PNORC4, No tags

Table 6 Available ASCII Data formats for Current Profile measurements.

7.4 Altimeter Data Formats

The data format of the Altimeter is controlled by the SET/GETALTI command. The DF parameter of this command sets the data format.

Binary:

Data format (DF)	Description
3	Nortek Altimeter data format.

Table 7 Available Binary Data formats for Altimeter measurements.

ASCII:

Data format (DF)	Description
200	NMEA $PNORA
201	NMEA $PNORA including tags
202	NMEA $SDDBT

Table 8 Available ASCII Data formats for Altimeter measurements.

8 Binary Data formats

Note: All binary data of the DVL interface are stored/sent as Little Endian.
Each output data packet sent/stored by the AD2CP consists of a Header part and a Data Record part:

Header Synchronization, ID, length and Checksums.
Data Record Data

The following chapters describe the format of the Header and the different variants of the Data Record.

8.1 Header Definition

The Header consists of the following fields:

Field	Size	Description
Sync	8 bits	Always 0xA5
Header Size	8 bits	Size (number of bytes) of the Header
ID	8 bits	Defines type of the following Data Record. 0x15 – Burst Data Record. 0x16 – Average Data Record. 0x17 – Bottom Track Data Record. 0x18 – Interleaved Burst Data Record (beam 5). 0x1B – DVL Bottom Track 0x1D – DVL Water Track 0xA0 - String Data Record, eg. GPS NMEA data, comment from the FWRITE command.
Family	8 bits	Defines the Instrument Family. 0x10 – AD2CP Family
Data Size	16 bits	Size (number of bytes) of the following Data Record.
Data Checksum	16 bits	Checksum of the following Data Record.
Header Checksum	16 bits	Checksum of all fields of the Header (excepts the Header Checksum itself).

8.1.1 C-Style Header Struct Definitions

```
typedef struct
{
      unsigned char  sync;
      unsigned char  hdrSize;
      unsigned char  ID;
      unsigned char  family;
      unsigned short dataSize;
      unsigned short dataChecksum;
      unsigned short hdrChecksum;
} CommandHeader_t;
```

8.1.2 Checksum Definitions

The Checksum is defined as a 16-bits unsigned sum of the data (16 bits). The sum shall be initialized to the value of 0xB58C before the checksum is calculated.

C-code for Checksum calculations:

```
unsigned short calculateChecksum(unsigned short *pData, unsigned
short size)
{
    unsigned short checksum = 0xB58C;
    unsigned short nbshorts = (size >> 1);
    int i;
    for (i = 0; i < nbshorts; i++)
    {
        checksum += *pData;
        size  -= 2;
        pData++;
    }
    if (size > 0)
    {
        checksum += ((unsigned short)(*pData)) << 8;
    }
    return checksum;
}
```

8.2 DF3 - Current Profile Data Record Definition

<table>
<tr><th>Field</th><th>Size</th><th>Format</th><th>Resolution/ Unit</th><th colspan="2">Description</th></tr>
<tr><td>Version</td><td>8 bits</td><td></td><td></td><td colspan="2">Version number of the Data Record Definition. (3)</td></tr>
<tr><td>offsetOfData</td><td>8 bits</td><td>Unsigned</td><td>#Bytes</td><td colspan="2">Number of bytes from start of record to start of data (velocity/amplitude/correlation)</td></tr>
<tr><td rowspan="17">Configuration</td><td rowspan="17">16 bits</td><td rowspan="17"></td><td rowspan="17"></td><td colspan="2">Record Configuration Bit Mask</td></tr>
<tr><td>Bit 0</td><td>Pressure sensor value valid.</td></tr>
<tr><td>Bit 1</td><td>Temperature sensor value valid.</td></tr>
<tr><td>Bit 2</td><td>Compass sensor values valid.</td></tr>
<tr><td>Bit 3</td><td>Tilt sensor values valid.</td></tr>
<tr><td>Bit 4</td><td>-</td></tr>
<tr><td>Bit 5</td><td>Velocity data included</td></tr>
<tr><td>Bit 6</td><td>Amplitude data included</td></tr>
<tr><td>Bit 7</td><td>Correlation data included.</td></tr>
<tr><td>Bit 8</td><td>Altimeter data included</td></tr>
<tr><td>Bit 9</td><td>Altimeter Raw data included</td></tr>
<tr><td>Bit 10</td><td>AST data included</td></tr>
<tr><td>Bit 11</td><td>Echo Sounder data included</td></tr>
<tr><td>Bit 12</td><td>AHRS data included</td></tr>
<tr><td>Bit 13</td><td>Percentage Good data included</td></tr>
<tr><td>Bit 14</td><td>Std. Dev. data included</td></tr>
<tr><td>Bit 15</td><td>Unused</td></tr>
<tr><td>Serial Number</td><td>32 bits</td><td>Unsigned</td><td></td><td colspan="2"></td></tr>
<tr><td>Year</td><td>8 bits</td><td>Unsigned</td><td>1 Year</td><td colspan="2">Years since 1900 (see struct tm definition)</td></tr>
<tr><td>Month</td><td>8 bits</td><td>Unsigned</td><td>1 Month</td><td colspan="2">Jan =0, Feb= 1, etc.(see struct tm definition)</td></tr>
<tr><td>Day</td><td>8 bits</td><td>Unsigned</td><td>1 Day</td><td colspan="2">(see struct tm definition)</td></tr>
</table>

Field	Size	Format	Resolution/ Unit	Description	
Hour	8 bits	Unsigned	1 Hour	(see struct tm definition)	
Minute	8 bits	Unsigned	1 Minute	(see struct tm definition)	
Seconds	8 bits	Unsigned	1 Second	(see struct tm definition)	
Microsec100	16 bits	Unsigned	100 µsec		
Speed of Sound	16 bits	Unsigned	0.1 m/s		
Temperature	16 bits	Signed	0.01 Degree Celsius		
Pressure	32 bits	Unsigned	0.001 dBar		
Heading	16 bits	Unsigned	0.01 Deg		
Pitch	16 bits	Signed	0.01 Deg		
Roll	16 bits	Signed	0.01 Deg		
#Beams & Coordinate system & #Cells	16 bits			Definition:	
				Bit 9 - 0	Number of Cells (NC)
				Bit 11 - 10	Coordinate system, b01 : XYZ b10 : BEAM b11 : -
				Bit 15 – 12	Number of Beams (NB)
Cell Size	16 bits	Unsigned	1 mm		
Blanking	16 bits	Unsigned	1 mm		
Nominal Correlation	8 bits	Unsigned	%	The nominal correlation for the configured combination of cell size and velocity range.	
Temperature Pressure Sensor	8 bits	Unsigned	0.2 Deg Celsius	Temperature of Pressure sensor: T = (Val/5) - 4.0	
Battery Voltage	16 bits	Unsigned	0.1 Volt		
Magnetometer Raw(X-axis)	16 bits	Signed		Magnetometer Raw, X axis value in last measurement interval.	
Magnetometer Raw(Y-axis)	16 bits	Signed		Magnetometer Raw, Y axis value in last measurement interval.	
Magnetometer Raw(Z-axis)	16 bits	Signed		Magnetometer Raw, Z axis value in last measurement interval.	
Accelerometer Raw (X-axis)	16 bits	Signed		Accelerometer Raw X axis value in last measurement interval. (16384 = 1.0)	

<table>
<tr><th>Field</th><th>Size</th><th>Format</th><th>Resolution/ Unit</th><th colspan="2">Description</th></tr>
<tr><td>Accelerometer Raw (Y-axis)</td><td>16 bits</td><td>Signed</td><td></td><td colspan="2">Accelerometer Raw Y axis value in last measurement interval. (16384 = 1.0)</td></tr>
<tr><td>Accelerometer Raw (Z-axis)</td><td>16 bits</td><td>Signed</td><td></td><td colspan="2">Accelerometer Raw Z axis value in last measurement interval. (16384 = 1.0)</td></tr>
<tr><td rowspan="4">Ambiguity Velocity</td><td rowspan="4">16 bits</td><td rowspan="4">Unsigned</td><td colspan="3">Standard Definition</td></tr>
<tr><td>10^ (Velocity Scaling) m/s</td><td colspan="2">Ambiguity velocity, corrected for sound velocity, scaled according to Velocity Scaling</td></tr>
<tr><td colspan="3">Echo Sounder Definition</td></tr>
<tr><td></td><td colspan="2">Number of Echo Sounder Cells</td></tr>
<tr><td rowspan="5">Data Set Description</td><td rowspan="5">16 bits</td><td rowspan="5"></td><td rowspan="5"></td><td>Bits</td><td>Description</td></tr>
<tr><td>0-3</td><td>Physical beam used for 1st data set.</td></tr>
<tr><td>4-7</td><td>Physical beam used for 2nd data set.</td></tr>
<tr><td>8-11</td><td>Physical beam used for 3th data set.</td></tr>
<tr><td>12-16</td><td>Physical beam used for 4th data set.</td></tr>
<tr><td>Transmit Energy</td><td>16 bits</td><td>Unsigned</td><td></td><td colspan="2"></td></tr>
<tr><td>Velocity Scaling</td><td>8 bits</td><td>Signed</td><td></td><td colspan="2">Used to scale velocity data.</td></tr>
<tr><td>Power level</td><td>8 bits</td><td>Signed</td><td>dB</td><td colspan="2">Configured power level</td></tr>
<tr><td>Magnetometer Temperature</td><td>16 bits</td><td>Signed</td><td>Uncalibrated</td><td colspan="2">Magnetometer temperature reading</td></tr>
<tr><td>Real Time Clock Temperature</td><td>16 bits</td><td>Signed</td><td>0.01 Degree Celsius</td><td colspan="2">Real time clock temperature reading</td></tr>
<tr><td>Error</td><td>16 bits</td><td></td><td></td><td colspan="2">See Error Description (version 1)</td></tr>
<tr><td rowspan="4">Status 0</td><td rowspan="4">16 bits</td><td rowspan="4"></td><td rowspan="4"></td><td>Bit 0</td><td>ProcIdle3 - Indicates that the processor Idles less than 3 percent</td></tr>
<tr><td>Bit 1</td><td>ProcIdle6 - Indicates that the processor Idles less than 6 percent</td></tr>
<tr><td>Bit 2</td><td>ProcIdle12 - Indicates that the processor Idles less than 12 percent</td></tr>
<tr><td>Bit 3-14</td><td>_Unused</td></tr>
</table>

Field	Size	Format	Resolution/ Unit	Description		
				Bit 15	Status0 in use. If this bit is set the rest of the word should be interpreted	
Status	32 bits			Bit 31-28	Wakeup State	10 = break 11 = RTC alarm 00 = bad power 01 = power applied
				Bit 27-25	Orientation	
				Bit 24-22	Auto orientation	
				Bit 21-18	Previous Wakeup State	10 = break 11 = RTC alarm 00 = bad power 01 = power applied
				Bit 17	Last measurement low voltage skip	0=normal operation 1=last measurement skipped due to low input voltage
				Bit 16	Active configuration	
				Bit 15-12	Echo Sounder Index	
				Bit 11	Telemetry data	
				Bit 10	Boost Running	
				Bit 9-5	Echo Sounder Frequency Bin	
				Bit 4	_Unused	
				Bit 3	_Unused	
				Bit 2	_Unused	
				Bit 1	bdScaling, Set bit indicates cm scaling of	

Field	Size	Format	Resolution/ Unit	Description	
				blanking distance	
				Bit 0 _Unused	
Ensemble counter	32 bits	Unsigned		Counts the number of ensembles in both averaged data and burst data	
Velocity data	NB*NC * 16 bits	Signed	10^ (Velocity Scaling) m/s	This field exists if the *Velocity data included* bit of the *Config* byte is set.	
Amplitude data	NB*NC * 8 bits	Unsigned	1 Count	This field exists if the *Amplitude data included* bit of the *Config* byte is set.	
Correlation data	NB*NC * 8 bits	Unsigned	[0 – 100]	This field exists if the *Correlation data included* bit of the *Config* byte is set.	
Altimeter distance	32 bits	Float	Meters		This field exists if the *Altimeter data included* bit of the *Config* byte is set.
Altimeter quality	16 bits				
Altimeter status	16 bits			Bit 0 Pitch or Roll > 5 deg Bit 1 Pitch or Roll > 10 deg	
AST distance	32 bits	Float	Meters		This field exists if the *AST data included* bit of the *Config* byte is set.
AST quality	16 bits	Unsigned			
AST_offset_100us	16 bits	Signed	100us	Offset in step of 100us from AST measurement to velocity measurement	
AST pressure	32 bits	Float	dBar	Pressure value measured during the AST/altimeter ping	
Altimeter spare	8*8 bits			spares	
Altimeter Raw Data - Number of Samples	32 bits	Unsigned			This field exists if the *Altimeter Raw data included* bit of the *Config* byte is set.
Altimeter Raw Data - Sample distance	16 bits	Unsigned	0.1mm	Distance between samples	
Altimeter Raw Data - Samples	16 bits	Signed fract			

Value	Instrument Vertical Definition	Description
0	“XUP”	Instrument x-axis defined up, heading reference axis is Z positive
1	“XDOWN”	Instrument x-axis defined down, heading reference axis is Z positive
4	“ZUP”	Instrument z-axis defined up, heading reference axis is X positive
5	“ZDOWN”	Instrument z-axis defined down, heading reference axis is X positive

Table 7 Orientation Description

Value		Description
0		Fixed orientation
1		Auto Up Down

Table 8 Automatic Orientation Detection Status

<u>Error Description</u>

Bit	Field	Description
15	Tag Error Beam 3 (Quadrature-phase)	1 = Error / 0 = OK.
14	Tag Error Beam 3 (In-phase)	1 = Error / 0 = OK.
13	Tag Error Beam 2 (Quadrature-phase)	1 = Error / 0 = OK.
12	Tag Error Beam 2 (In-phase)	1 = Error / 0 = OK.
11	Tag Error Beam 1 (Quadrature-phase)	1 = Error / 0 = OK.
10	Tag Error Beam 1 (In-phase)	1 = Error / 0 = OK.
9	Tag Error Beam 0 (Quadrature-phase)	1 = Error / 0 = OK.
8	Tag Error Beam 0 (In-phase)	1 = Error / 0 = OK.
7	Not used	
6	Not used	
5	Sensor read failure	1 = Error / 0 = OK.
4	Data retrieval Samples missing.	1 = Error / 0 = OK. The Measurement and data storage/transmit didn’t finish before next measurement started.
3	Data retrieval Underrun.	1 = Error / 0 = OK.
2	Data retrieval Overflow	1 = Error / 0 = OK.
1	Data retrieval Overflow	1 = Error / 0 = OK.
0	Data retrieval FIFO error.	1 = Error / 0 = OK.

8.2.1 DF3 VelocityData Record Struct Definition (C99 standard)

```
typedef struct
{
   unsigned short beamData1      : 4;
   unsigned short beamData2      : 4;
   unsigned short beamData3      : 4;
   unsigned short beamData4      : 4;
} t_DataSetDescription4Bit;

typedef struct
{
   unsigned long _empty1         : 21;
   unsigned long prevWakeUpState : 1;
   unsigned long autoOrient      : 3;
   unsigned long orientation     : 3;
   unsigned long wakeupstate     : 4;
} t_status;

typedef struct
{
   unsigned short procIdle3 : 1;
   unsigned short procIdle6 : 1;
   unsigned short procIdle12 : 1;
   unsigned short _empty1 : 12;
   unsigned short stat0inUse : 1;
} t_status0;


#define VERSION_DATA_STRUCT_3   3

/* Data field */
typedef struct {
       unsigned char version;             // 3
       unsigned char offsetOfData;        // offsetof(BurstData3_t, data)
       struct
       {
              unsigned short pressure            : 1; // 0
              unsigned short temp                : 1; // 1
              unsigned short compass             : 1; // 2
              unsigned short tilt                : 1; // 3
              unsigned short _empty              : 1; // 4
              unsigned short velIncluded         : 1; // 5
              unsigned short ampIncluded         : 1; // 6
              unsigned short corrIncluded        : 1; // 7
              unsigned short altiIncluded        : 1; // 8
              unsigned short altiRawIncluded     : 1; // 9
              unsigned short ASTIncluded         : 1; // 10
              unsigned short echoIncluded        : 1; // 11
              unsigned short ahrsIncluded        : 1; // 12
              unsigned short PGoodIncluded       : 1; // 13
              unsigned short stdDevIncluded      : 1; // 14
              unsigned short _unused : 1;
```

```
        } headconfig;

        unsigned long serialNumber;
        unsigned char year;
        unsigned char month;
        unsigned char day;
        unsigned char hour;
        unsigned char minute;
        unsigned char seconds;
        unsigned short microSeconds100;
        unsigned short soundSpeed;          /* resolution: 0.1 m/s */
        short temperature;                  /* resolution: 0.01 degree Celsius */
        unsigned long pressure;
        unsigned short heading;
        short pitch;
        short roll;
        union
        {
               unsigned short beams_cy_cells;     ///< bit 15-12: Number of beams,
               ///< bit 11-10: coordinate system,
               ///< bit 9-0: Number of cells.
               unsigned short echo_cells;         ///< OR, Number of echo sounder
        cells.
        }; unsigned short cellSize;
        unsigned short blanking;
        unsigned char nominalCorrelation;
        unsigned char pressTemp;
        unsigned short battery;
        short magnHxHyHz[3];         ///< Magnetometer Min data
        short accl3D[3];             ///< Accelrometer Data
        union
        {
               unsigned short ambVelocity;
               unsigned short echoFrequency;
        };
        t_DataSetDescription4Bit DataSetDescription4bit; /* unsigned short */
        unsigned short transmitEnergy;
        char velocityScaling;
        char powerlevel;
        short magnTemperature;
        short rtcTemperature;
        unsigned short error;
        t_status0 status0;   /* Unsigned short */
        t_status status;     /* Unsigned long */
        unsigned long ensembleCounter;
        unsigned char data[SIZE_VAR_DATA];
        ///< actual size of the following =
        ///< int16_t hVel[nBeams][nCells]; // velocity
        ///< uint8_t cAmp[nBeams][nCells]; // amplitude
        ///< uint8_t cCorr[nBeams][nCells]; // correlation (0-100)
} OutputData3_t;
```

8.3 DF21/DF22 - DVL Bottom Track & Water Track Data Record Definitions

Data format DF21 is used for Bottom Track measurements. Data format DF22 is used for Water Track measurements. The binary definition of the data record is equal. The ID of the record header is used to differ.

Valid data is indicated by the Status field as described in table 9; the associated invalid values are listed in the Description.

Field	Size	Format	Resolution/ Unit	Description
Version	8 bits	Unsigned		1
offsetOfData	8 bits	Unsigned	#Bytes	Number of bytes from start of record to start of data (velBeam[0])
Serial number	32 bits	Unsigned		
Year	8 bits	Unsigned	1 Year	Years since 1900 (see struct tm definition)
Month	8 bits	Unsigned	1 Month	Jan =0, Feb= 1, etc.(see struct tm definition)
Day	8 bits	Unsigned	1 Day	(see struct tm definition)
Hour	8 bits	Unsigned	1 Hour	(see struct tm definition)
Minute	8 bits	Unsigned	1 Minute	(see struct tm definition)
Seconds	8 bits	Unsigned	1 Second	(see struct tm definition)
Microsec100	16 bits	Unsigned	100 µsec	
#beams	16 bits	Unsigned		Number of beams
Error	32 bits	Unsigned		
Status	32 bits	Unsigned		See Table 9 DVL Status Bit Description.
Sound Speed	32 bits	Float	m/s	
Temperature	32 bits	Float	°Celsius	
Pressure	32 bits	Float	Bar	
Velocity Beam 0	32 bits	Float	m/s	[invalid estimates set to -32.768]
Velocity Beam 1	32 bits	Float	m/s	[invalid estimates set to -32.768]
Velocity Beam 2	32 bits	Float	m/s	[invalid estimates set to -32.768]
Velocity Beam 3	32 bits	Float	m/s	[invalid estimates set to -32.768]
Distance Beam 0	32 bits	Float	m	Vertical Distance [invalid estimates set to 0.0]
Distance Beam 1	32 bits	Float	m	Vertical Distance [invalid estimates set to 0.0]
Distance Beam 2	32 bits	Float	m	Vertical Distance [invalid estimates set

Field	Size	Format	Resolution/ Unit	Description
				to 0.0]
Distance Beam 3	32 bits	Float	m	Vertical Distance [invalid estimates set to 0.0]
FOM beam 0	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
FOM beam 1	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
FOM beam 2	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
FOM beam 3	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
DT1 Beam 0	32 bits	Float	s	
DT1 Beam 1	32 bits	Float	s	
DT1 Beam 2	32 bits	Float	s	
DT1 Beam 3	32 bits	Float	s	
DT2 Beam 0	32 bits	Float	s	
DT2 Beam 1	32 bits	Float	s	
DT2 Beam 2	32 bits	Float	s	
DT2 Beam 3	32 bits	Float	s	
Time Vel Est Beam 0	32 bits	Float	s	Duration of velocity estimate for each beam.
Time Vel Est Beam 1	32 bits	Float	s	Duration of velocity estimate for each beam.
Time Vel Est Beam 2	32 bits	Float	s	Duration of velocity estimate for each beam.
Time Vel Est Beam 3	32 bits	Float	s	Duration of velocity estimate for each beam.
Velocity X	32 bits	Float	m/s	[invalid estimates set to -32.768]
Velocity Y	32 bits	Float	m/s	[invalid estimates set to -32.768]
Velocity Z1	32 bits	Float	m/s	Vertical calculated from beams 1 & 3 [invalid estimates set to -32.768]
Velocity Z2	32 bits	Float	m/s	Vertical calculated from beams 2 & 4 [invalid estimates set to -32.768]
FOM X	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
FOM Y	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
FOM Z1	32 bits	Float	m/s	Figure of Merit [invalid estimates set to

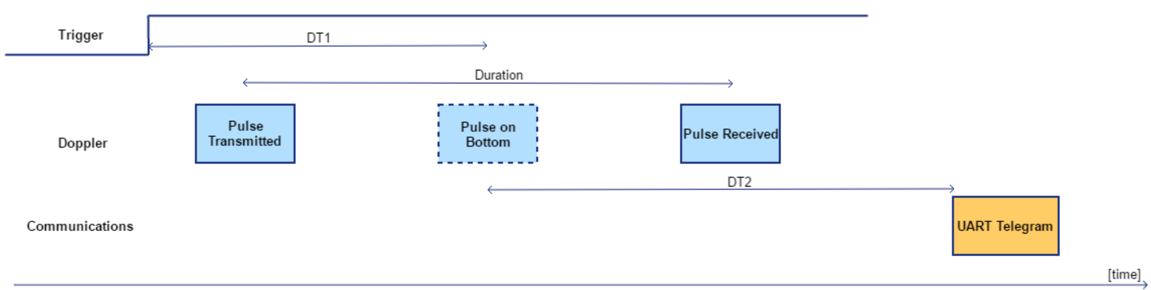
Field	Size	Format	Resolution/ Unit	Description
				10.0]
FOM Z2	32 bits	Float	m/s	Figure of Merit [invalid estimates set to 10.0]
DT1 X	32 bits	Float	s	
DT1 Y	32 bits	Float	s	
DT1 Z1	32 bits	Float	s	
DT1 Z2	32 bits	Float	s	
DT2 X	32 bits	Float	s	
DT2 Y	32 bits	Float	s	
DT2 Z1	32 bits	Float	s	
DT2 Z2	32 bits	Float	s	
Time Vel Est X	32 bits	Float	s	Duration of velocity estimate for each component.
Time Vel Est Y	32 bits	Float	s	Duration of velocity estimate for each component.
Time Vel Est Z1	32 bits	Float	s	Duration of velocity estimate for each component.
Time Vel Est Z2	32 bits	Float	s	Duration of velocity estimate for each component.

Bit #	Description
0	Beam 1 Velocity Valid
1	Beam 2 Velocity Valid
2	Beam 3 Velocity Valid
3	Beam 4 Velocity Valid
4	Beam 1 Distance Valid
5	Beam 2 Distance Valid
6	Beam 3 Distance Valid
7	Beam 4 Distance Valid
8	Beam 1 Figure of Merit Valid
9	Beam 2 Figure of Merit Valid
10	Beam 3 Figure of Merit Valid
11	Beam 4 Figure of Merit Valid
12	X Velocity Valid
13	Y Velocity Valid

Bit #	Description
14	Z1 Velocity Valid
15	Z2 Velocity Valid
16	X Figure of Merit Valid
17	Y Figure of Merit Valid
18	Z1 Figure of Merit Valid
19	Z2 Figure of Merit Valid
20	Less than 3% processing capacity left
21	Less than 6% processing capacity left
22	Less than 12% processing capacity left
28-31	Wakeup State: 0010 = break 0011 = RTC alarm 0000 = bad power 0001 = power applied

Table 9 DVL Status Bit Description

Timing information



The DT1 parameter is the time from the trigger to the centre of the bottom echo that estimates the bottom track velocity.
The DT2 parameter is the time from the start of the NMEA output message to the centre of the bottom echo. This will thus be a negative value.

8.3.1 DF21/22 Bottom Track/Water Track Record Struct Definition (C99 standard)

```
typedef struct
{
   unsigned char  version;
   unsigned char  offsetOfData;
   unsigned long  serialNumber;
   unsigned char  year;              ///< Trigger time
   unsigned char  month;
   unsigned char  day;
   unsigned char  hour;
   unsigned char  minute;
   unsigned char  seconds;
   unsigned short microSeconds100;
   unsigned short nBeams;
   unsigned long  error;
   t_DVLstatus    status;            /* Unsigned long */
   float          soundSpeed;        ///< [m/s]
   float          temperature;       ///< [Celsius]
   float          pressure;          ///< [Bar]

   /* Beam data */
   float    velBeam[4];           ///< Velocities for each beam. [m/s]
   float    distBeam[4];          ///< Distances for each beam. [m  ]
   float    fomBeam[4];           ///< FOM for each beam.  [m/s]
   float    timeDiff1Beam[4];     ///< DT1 for each beam.  [s  ]
   float    timeDiff2Beam[4];     ///< DT2 for each beam.  [s  ]
   float    timeVelEstBeam[4];    ///< Duration of velocity estimate for each beam.
[s  ]

   /* XYZ data */
   float    velX;          ///< Velocity X.    [m/s]
   float    velY;          ///< Velocity Y.    [m/s]
   float    velZ1;         ///< Velocity Z1.   [m/s]
   float    velZ2;         ///< Velocity Z2.   [m/s]
   float    fomX;          ///< FOM X.          [m/s]
   float    fomY;          ///< FOM Y.          [m/s]
   float    fomZ1;         ///< FOM Z1.         [m/s]
   float    fomZ2;         ///< FOM Z2.         [m/s]
   float    timeDiff1X;    ///< DT1 X.         [s  ]
   float    timeDiff1Y;    ///< DT1 Y.         [s  ]
   float    timeDiff1Z1;   ///< DT1 Z1.        [s  ]
   float    timeDiff1Z2;   ///< DT1 Z2.        [s  ]
   float    timeDiff2X;    ///< DT2 X.         [s  ]
   float    timeDiff2Y;    ///< DT2 Y.         [s  ]
   float    timeDiff2Z1;   ///< DT2 Z1.        [s  ]
   float    timeDiff2Z2;   ///< DT2 Z2.        [s  ]
   float    timeVelEstX;   ///< Duration of velocity estimate for each component. [s ]
   float    timeVelEstY;   ///< Duration of velocity estimate for each component. [s ]
   float    timeVelEstZ1;  ///< Duration of velocity estimate for each component. [s ]
```

```
   float    timeVelEstZ2;  ///< Duration of velocity estimate for each component. [s ]
} DVLformat21_t;


typedef struct
{
   unsigned long beam1VelValid  : 1;  // BIT( 0)
   unsigned long beam2VelValid  : 1;  // BIT( 1)
   unsigned long beam3VelValid  : 1;  // BIT( 2)
   unsigned long beam4VelValid  : 1;  // BIT( 3)
   unsigned long beam1DistValid : 1;  // BIT( 4)
   unsigned long beam2DistValid : 1;  // BIT( 5)
   unsigned long beam3DistValid : 1;  // BIT( 6)
   unsigned long beam4DistValid : 1;  // BIT( 7)
   unsigned long beam1FOMValid  : 1;  // BIT( 8)
   unsigned long beam2FOMValid  : 1;  // BIT( 9)
   unsigned long beam3FOMValid  : 1;  // BIT(10)
   unsigned long beam4FOMValid  : 1;  // BIT(11)
   unsigned long xVelValid      : 1;  // BIT(12)
   unsigned long yVelValid      : 1;  // BIT(13)
   unsigned long z1VelValid     : 1;  // BIT(14)
   unsigned long z2VelValid     : 1;  // BIT(15)
   unsigned long xFOMValid      : 1;  // BIT(16)
   unsigned long yFOMValid      : 1;  // BIT(17)
   unsigned long z1FOMValid     : 1;  // BIT(18)
   unsigned long z2FOMValid     : 1;  // BIT(19)
   unsigned long procIdle3      : 1;
   unsigned long procIdle6      : 1;
   unsigned long procIdle12     : 1;
   unsigned long _empty1        : 5;
   unsigned long wakeupstate    : 4;  // BIT(28-31)
} t_DVLstatus;
```

9 ASCII Data Formats

9.1 DVL Bottom Track ASCII formats

Invalid estimates of Velocity are set to set to -32.768.
Invalid estimates of Range are set to 0.0.
Invalid estimates of FOM are set to 10.0.

9.1.1 DF350/DF351 – NMEA $PNORBT1/$PNORBT0

The NMEA formats 350/351 have the following fields:

Field/TAG	Description	Data format	Example
BEAM	Beam number	n	BEAM=2
DATE	Date	DDMMYY	DATE=110916
TIME	Time	hhmmss.ssss	TIME=112034.0346
DT1	Time from the trigger to the centre of the bottom echo. [ms]	s.sss	DT1=55.717
DT2	Time from the start of the NMEA output message to the centre of the bottom echo. [ms]	s.sss	DT2=-157.912
BV	Beam Velocity	f.fffff	BV=0.15630
FM	Figure of Merit [m/s]	f.fffff	FM=0.00146
DIST	Vertical Distance to bottom. [m]	f.ff	DIST=26.92
STAT	Status (see Table 9)	0xHHHHHHHH	STAT=0x000FFFFF

Table 10 PNORBT0/1 NMEA sentence parameter description.

There is one text line output per beam so a four beam system will output four lines for each bottom track sample.

The DT1 parameter is the time from the trigger to the centre of the bottom echo that estimates the bottom track velocity. The DT2 parameter is the time from the start of the NMEA output message to the centre of the bottom echo. This will thus be a negative value.

Example (DF=350):

```
$PNORBT1,BEAM=1,DATE=110916,TIME=112034.0346,DT1=55.717,DT2=-
157.789,BV=0.15633,FM=0.00066,DIST=26.92,STAT=0x000FFFFF*2A
$PNORBT1,BEAM=2,DATE=110916,TIME=112034.0346,DT1=55.717,DT2=-
157.912,BV=0.15630,FM=0.00146,DIST=26.92,STAT=0x000FFFFF*25
$PNORBT1,BEAM=3,DATE=110916,TIME=112034.0346,DT1=55.717,DT2=-
158.034,BV=-0.14928,FM=0.00165,DIST=26.92,STAT=0x000FFFFF*0D
$PNORBT1,BEAM=4,DATE=110916,TIME=112034.0346,DT1=54.892,DT2=-
158.981,BV=-0.14925,FM=0.00359,DIST=26.92,STAT=0x000FFFFF*0E
```

9.1.2 DF354/DF355 – NMEA $PNORBT3/$PNORBT4

The NMEA formats 354/355 have the following fields:

Field/TAG	Description	Data format	Example
DT1	Time from the trigger to the centre of the bottom echo. [ms]	s.sss	DT1=1.234
DT2	Time from the start of the NMEA output message to the centre of the bottom echo. [ms]	s.sss	DT2=-1.234
SP	Speed over ground [m/s]	f.fff	SP=1.234
DIR	Direction [deg]	f.f	DIR=23.4
FOM	Figure of Merit [m/s]	f.fffff	FOM=12.34567
D	Vertical Distance to bottom. [m]	ff.f	D=12.3

Table 11 PNORBT3/4 NMEA sentence parameter description.

DF354 outputs the tags. DF355 minimizes the number of character to be transmitted by discarding the tags in the outputted sentence.

Example (DF=354):
```
$PNORBT3,DT1=1.234,DT2=-1.234,SP=1.234,DIR=23.4,FOM=12.34567,
D=12.3*65
```

Example (DF=355):
```
$PNORBT4,1.234,-1.234,1.234,23.4,12.34567,12.3*09
```

9.1.3 DF356/DF357 – NMEA $PNORBT6/$PNORBT7

The NMEA formats 356/357 have the following fields:

Field/TAG	Description	Data format	Example
TIME	Ping time [POSIX time]	s.ssss	TIME=1452244916.7508
DT1	Time from the trigger to the centre of the bottom echo. [ms]	s.sss	DT1=1.234
DT2	Time from the start of the NMEA output message to the centre of the bottom echo. [ms]	s.sss	DT2=-1.234
VX	Speed in X direction [m/s]	f.ffff	VX=0.1234
VY	Speed in Y direction [m/s]	f.ffff	VY=0.1234
VZ	Speed in Z direction [m/s]	f.ffff	VZ=0.1234
FOM	Figure of Merit [m/s]	f.fffff	FOM=12.34567
D1	Beam 1: Vertical Distance to bottom. [m]	f.ff	D1=23.45
D2	Beam 2: Vertical Distance to bottom. [m]	f.ff	D2=23.45
D3	Beam 3: Vertical Distance to bottom. [m]	f.ff	D3=23.45
D4	Beam 4: Vertical Distance to bottom. [m]	f.ff	D4=23.45

Table 12 PNORBT6/7 NMEA sentence parameter description.

DF356 outputs the tags. DF357 minimizes the number of character to be transmitted by discarding the tags in the outputted sentence.

Example (DF=356):
```
$PNORBT6,TIME=1452244916.7508,DT1=1.234,DT2=-1.234,VX=0.1234,
VY=0.1234,VZ=0.1234,FOM=12.34567,D1=23.45,D2=23.45,D3=23.45,
D4=23.45*6A
```

Example (DF=357):
```
$PNORBT7,1452244916.7508,1.234,-
1.234,0.1234,0.1234,0.1234,12.34,23.45,23.45,23.45,23.45*39
```

9.1.4 DF358/DF359 – NMEA $PNORBT8/$PNORBT9

The NMEA formats 358/359 have the following fields:

Field/TAG	Description	Data format	Example
TIME	Ping time [POSIX time]	s.ssss	TIME=1452244916.7508
DT1	Time from the trigger to the centre of the bottom echo. [ms]	s.sss	DT1=1.234
DT2	Time from the start of the NMEA output message to the centre of the bottom echo. [ms]	s.sss	DT2=-1.234
VX	Speed in X direction [m/s]	f.ffff	VX=0.1234
VY	Speed in Y direction [m/s]	f.ffff	VY=0.1234
VZ	Speed in Z direction [m/s]	f.ffff	VZ=0.1234
FOM	Figure of Merit [m/s]	f.ff	FOM=12.34
D1	Beam 1: Vertical Distance to bottom. [m]	f.ff	D1=23.45
D2	Beam 2: Vertical Distance to bottom. [m]	f.ff	D2=23.45
D3	Beam 3: Vertical Distance to bottom. [m]	f.ff	D3=23.45
D4	Beam 4: Vertical Distance to bottom. [m]	f.ff	D4=23.45
BATT	Battery Voltage [V]	f.f	BATT=23.4
SS	Speed of sound in Water [m/s]	f.f	SS=1567.8
PRESS	Pressure [dBar]	f.f	PRESS=1.2
TEMP	Water temperature [deg C]	f.f	TEMP=12.3
STAT	Status (see Table 9)	0xHHHHHHHH	STAT=0x000FFFFF

Table 13 PNORBT8/9 NMEA sentence parameter description.

DF358 outputs the tags. DF359 minimizes the number of character to be transmitted by discarding the tags in the outputted sentence.

Example (DF=358):

```
$PNORBT8,TIME=1452244916.7508,DT1=1.234,DT2=-1.234,VX=0.1234,
VY=0.1234,VZ=0.1234,FOM=12.34,D1=23.45,D2=23.45,D3=23.45,D4=23.45,
BATT=23.4,SS=1567.8,PRESS=1.2,TEMP=12.3,STAT=0x000FFFFF*1E
```

Example (DF=359):

```
$PNORBT9,1452244916.7508,1.234,-
1.234,0.1234,0.1234,0.1234,12.34,23.45,23.45,23.45,23.45,23.4,1567.
8,1.2,12.3,0x000FFFFF*1E
```

9.2 DVL Water Track ASCII formats

Invalid estimates of Velocity are set to set to -32.768.
Invalid estimates of Range are set to 0.0.
Invalid estimates of FOM are set to 10.0.

9.2.1 DF404/DF405 – NMEA $PNORWT3/$PNORWT4

The NMEA formats 404/405 have the following fields:

Field/TAG	Description	Data format	Example
DT1	Time from the trigger to the centre of the water track cell. [ms]	s.sss	DT1=1.234
DT2	Time from the start of the NMEA output message to the centre of the water track cell. [ms]	s.sss	DT2=-1.234
SP	Speed [m/s]	f.fff	SP=1.234
DIR	Direction [deg]	f.f	DIR=23.4
FOM	Figure of Merit [m/s]	f.ff	FOM=12.34
D	Vertical Distance to water track cell. [m]	ff.f	D=12.3

Table 14 PNORWT3/4 NMEA sentence parameter description.

DF404 outputs the tags. DF405 minimizes the number of character to be transmitted by discarding the tags in the outputted sentence.

Example (DF=404):
```
$PNORWT3,DT1=1.2345,DT2=-1.2345,SP=1.234,DIR=23.4,FOM=12.34,
D=12.3*44
```

Example (DF=405):
```
$PNORWT4,1.2345,-1.2345,1.234,23.4,12.34,12.3*1C
```

9.2.2 DF406/DF407 – NMEA $PNORWT6/$PNORWT7

The NMEA formats 406/407 have the following fields:

Field/TAG	Description	Data format	Example
TIME	Ping time [POSIX time]	s.ssss	TIME=1452244916.7508
DT1	Time from the trigger to the centre of water track cell. [ms]	s.sss	DT1=1.234
DT2	Time from the start of the NMEA output message to the centre of the water track cell. [ms]	s.sss	DT2=-1.234
VX	Speed in X direction [m/s]	f.ffff	VX=0.1234
VY	Speed in Y direction [m/s]	f.ffff	VY=0.1234
VZ	Speed in Z direction [m/s]	f.ffff	VZ=0.1234
FOM	Figure of Merit [m/s]	f.ff	FOM=12.34
D1	Beam 1: Vertical Distance to water track cell. [m]	f.ff	D1=23.45
D2	Beam 2: Vertical Distance to water track cell. [m]	f.ff	D2=23.45
D3	Beam 3: Vertical Distance to water track cell. [m]	f.ff	D3=23.45
D4	Beam 4: Vertical Distance to water track cell. [m]	f.ff	D4=23.45

Table 15 PNORWT6/7 NMEA sentence parameter description.

DF406 outputs the tags. DF407 minimizes the number of character to be transmitted by discarding the tags in the outputted sentence.

Example (DF=406):
```
$PNORWT6,TIME=1452244916.7508,DT1=1.234,DT2=-1.234,VX=0.1234,
VY=0.1234,VZ=0.1234,FOM=12.34,D1=23.45,D2=23.45,D3=23.45,
D4=23.45*4B
```

Example (DF407):
```
$PNORWT7,1452244916.7508,1.234,-
1.234,0.1234,0.1234,0.1234,12.34,23.45,23.45,23.45,23.45*2C
```

9.2.3 DF408/DF409 – NMEA $PNORWT8/$PNORWT9

The NMEA formats 408/409 have the following fields:

Field/TAG	Description	Data format	Example
TIME	Ping time [POSIX GMT time]	s.ssss	TIME=1452244916.7508
DT1	Time from the trigger to the centre of the water track cell. [ms]	s.sss	DT1=1.234
DT2	Time from the start of the NMEA output message to the centre of the water track cell. [ms]	s.sss	DT2=-1.234
VX	Speed in X direction [m/s]	f.ffff	VX=0.1234
VY	Speed in Y direction [m/s]	f.ffff	VY=0.1234
VZ	Speed in Z direction [m/s]	f.ffff	VZ=0.1234
FOM	Figure of Merit [m/s]	f.ff	FOM=12.34
D1	Beam 1: Vertical Distance to water track cell. [m]	f.ff	D1=23.45
D2	Beam 2: Vertical Distance to water track cell. [m]	f.ff	D2=23.45
D3	Beam 3: Vertical Distance to water track cell. [m]	f.ff	D3=23.45
D4	Beam 4: Vertical Distance to water track cell. [m]	f.ff	D4=23.45
BATT	Battery Voltage [V]	f.f	BATT=23.4
SS	Speed of sound in Water [m/s]	f.f	SS=1567.8
PRESS	Pressure [dBar]	f.f	PRESS=1.2
TEMP	Water temperature [deg C]	f.f	TEMP=12.3
STAT	Status (see Table 9)	0xHHHHHHHH	STAT=0x000FFFFF

Table 16 PNORBWT8/9 NMEA sentence parameter description.

DF408 outputs the tags. DF409 minimizes the number of character to be transmitted by discarding the tags in the outputted sentence.

Example (DF=408):
```
$PNORWT8,TIME=1452244916.7508,DT1=1.234,DT2=-1.234,VX=0.1234,
VY=0.1234,VZ=0.1234,FOM=12.34,D1=23.45,D2=23.45,D3=23.45,D4=23.45,
BATT=23.4,SS=1567.8,PRESS=1.2,TEMP=12.3,STAT=0x000FFFFF*0B
```

Example (DF=409):
```
$PNORWT9,1452244916.7508,1.234,-
1.234,0.1234,0.1234,0.1234,12.34,23.45,23.45,23.45,23.45,23.4,1567.
8,1.2,12.3,0x000FFFFF*0B
```

9.3 DVL Current Profile ASCII formats

9.3.1 DF100 - Prolog NMEA Format

See Prolog Data Format Description.

9.3.2 DF101/DF102 - NMEA Format 1 and 2

Information Data:
Identifier:
PNORI1 for DF = 101
PNORI2 for DF = 102

Field	Description	TAG	Data format	Example
Instrument type	4 = Signature75	IT	N	IT=4
Head ID		SN	N	SN=123456
Number of Beams		NB	N	NB=3
Number of Cells		NC	N	NC=30
Blanking Distance	[m]	BD	dd.dd	BD=1.00
Cell Size	[m]	CS	dd.dd	CS=5.00
Coordinate System		CY	ENU,BEAM,XYZ	CY=BEAM

Table 17 PNORI1/2 NMEA sentence parameter description

Example (DF=101):
```
$PNORI1,4,123456,3,30,1.00,5.00,BEAM*5B
```

Example (DF=102):
```
$PNORI2,IT=4,SN=123456,NB=3,NC=30,BD=1.00,CS=5.00,CY=BEAM*68
```

Sensors Data:
Identifier:
PNORS1 for DF = 101
PNORS2 for DF = 102

Field	Description	TAG	Data format	Example
Date		DATE	MMDDYY	DATE=083013
Time		TIME	hhmmss	TIME=132455
Error Code		EC	N	EC=0
Status Code		SC	hhhhhhhh	SC=34000034
Battery Voltage	[V]	BV	dd.d	BV=23.9
Sound Speed	[m/s]	SS	dddd.d	SS=1500.0
Heading	[deg]	H	ddd.d	H=123.4

Field	Description	TAG	Data format	Example
Heading Std.Dev.	[deg]	HSD	dd.dd	HSD=0.02
Pitch	[deg]	PI	dd.d	PI=45.6
Pitch Std.Dev	[deg]	PISD	dd.dd	PISD=0.02
Roll	[deg]	R	dd.d	R=23.4
Roll Std.Dev.	[deg]	RSD	dd.dd	RSD=0.02
Pressure	[dBar]	P	ddd.ddd	P=123.456
Pressure StdDev	[dBar]	PSD	dd.dd	PSD=0.02
Temperature	[deg C]	T	dd.dd	T=24.56

Table 18 PNORS1/2 NMEA sentence parameter description

Example (DF=101):
`$PNORS1,083013,132455,0,34000034,23.9,1500.0,123.4,0.02,45.6,0.02,`
`R=23.4,0.02,123.456,0.02,24.56*39`

Example (DF=102):
`$PNORS2,DATE=083013,TIME=132455,EC=0,SC=34000034,BV=23.9,SS=1500.0,`
`H=123.4,HSD=0.02,PI=45.6,PISD=0.02,R=23.4,RSD=0.02,P=123.456,`
`PSD=0.02,T=24.56*3F`

Current Data:
Identifier:
PNORC1 for DF = 101
PNORC2 for DF = 102

The current data is output for each measurement cell.

Field	Description	TAG	Data format	Example
Date	Date	DATE	MMDDYY	DATE=083013
Time	Time	TIME	hhmmss	TIME=132455
Cell Number	#	CN	dd	CN=3
Cell Position	[m]	CP	dd.d	CP=11.0
Velocity East	[m/s] Only if CY=ENU	VE	dd.ddd	VE=0.332
Velocity North	[m/s] Only if CY=ENU	VN	dd.ddd	VN=0.332
Velocity Up	[m/s] Only if CY=ENU and #beams >= 3	VU	dd.ddd	VU=0.332
Velocity Up2	[m/s] Only if CY=ENU and #beams = 4	VU2	dd.ddd	VU2=0.332
Velocity X	[m/s] Only if CY=XYZ	VX	dd.ddd	VX=0.332

Field	Description	TAG	Data format	Example
Velocity Y	[m/s] Only if CY=XYZ	VY	dd.ddd	VY=0.332
Velocity Z	[m/s] Only if CY=XYZ and #beams >= 3	VZ	dd.ddd	VZ=0.332
Velocity Z2	[m/s] Only if CY=XYZ and #beams = 4	VZ2	dd.ddd	VZ2=0.332
Velocity Beam 1	[m/s] Only if CY=BEAM	V1	dd.ddd	V1=0.332
Velocity Beam 2	[m/s] Only if CY=BEAM and #beams >=2	V2	dd.ddd	V2=0.332
Velocity Beam 3	[m/s] Only if CY=BEAM and #beams >=3	V3	dd.ddd	V3=-0.332
Velocity Beam 4	[m/s] Only if CY=BEAM and #beams =4	V4	dd.ddd	V4=-0.332
Amplitude Beam 1	[dB]	A1	ddd.d	A1=78.9
Amplitude Beam 2	[dB] Only if #beams >=2	A2	ddd.d	A2=78.9
Amplitude Beam 3	[dB] Only if #beams >=3	A3	ddd.d	A3=78.9
Amplitude Beam 4	[dB] Only if #beams =4	A4	ddd.d	A4=78.9
Correlation Beam 1	[%]	C1	dd	C1=78
Correlation Beam 2	[%] Only if #beams >=2	C2	dd	C2=78
Correlation Beam 3	[%] Only if #beams >=3	C3	dd	C3=78
Correlation Beam 4	[%] Only if #beams =4	C4	dd	C4=78

Table 19 PNORC1/2 NMEA sentence parameter description

Example (DF=101 (ENU, 3 beams):

```
$PNORC1,083013,132455,3,11.0,0.332,0.332,0.332,78.9,78.9,78.9,78,78
,78*46
```

Example (DF=102 (ENU, 3 beams):

```
$PNORC2,DATE=083013,TIME=132455,CN=3,CP=11.0,VE=0.332,VN=0.332,
VU=0.332,A1=78.9,A2=78.9,A3=78.9,C1=78,C2=78,C3=78*6D
```

Example (DF=102 (BEAM, 4 beams):

```
$PNORC2,DATE=083013,TIME=132455,CN=3,CP=11.0,V1=0.332,V2=0.332,V3=-
0.332,V4=-0.332,A1=78.9,A2=78.9,A3=78.9,A4=78.9,C1=78,C2=78,C3=78,
C4=78*49
```

9.3.3 DF103/DF104

Header Data:
Identifier:
PNORH3 for DF = 103
PNORH4 for DF = 104

Field	Description	TAG	Data format	Example
DATE	Date	DATE	YYMMDD	DATE=161109
TIME	Time	TIME	HHMMSS	TIME=143459
EC	Error Code	EC	D	EC=0
SC	Status Code (hex)	SC	HHHHHHHH	SC=204C0002

Table 20 PNORH3/4 NMEA sentence parameter description

Example (DF=103):
```
$PNORH3,DATE=161109,TIME=143459,EC=0,SC=204C0002*28
```

Example (DF=104):
```
$PNORH4,161109,143459,0,204C0002*38
```

Sensors Data:
Identifier:
PNORS3 for DF = 103
PNORS4 for DF = 104

Field	Description	TAG	Data format	Example
Battery Voltage	[Volts]	BV	ff.f	BV=23.6
Speed of Sound	[m/s]	SS	ffff.f	SS=1530.2
Heading	[deg]	H	f.f	H=56.7
Pitch	[deg]	PI	f.f	PI=3.4
Roll	[deg]	R	f.f	R=-3.4
Pressure	[dBar]	P	f.fff	P=6.789
Temperature	[deg C]	T	f.ff	T=23.30

Table 21 PNORS3/4 NMEA sentence parameter description

Example (DF=103):
```
$PNORS3,BV=23.6,SS=1530.2,H=0.0,PI=0.0,R=0.0,P=0.000,T=23.30*64
```

Example (DF=104):
```
$PNORS4,23.6,1530.2,0.0,0.0,0.0,0.000,23.30*66
```

Current Data:
Identifier:
PNORC3 for DF = 103
PNORC4 for DF = 104

The current data is output for each measurement cell.

Field	Description	TAG	Data format	Example
Cell Position	[meters]	CP	f.f	CP=1.5
Speed	[m/s]	SP	f.fff	SP=1.395
Direction	[deg]	DIR	f.f	DIR=227.1
Correlation	[%]	AC	u	AC=32
Amplitude	[dB]	AA	u	AA=32

Table 22 PNORC3/4 NMEA sentence parameter description

Example (DF=103):

```
$PNORC3,CP=1.5,SP=1.395,DIR=227.1,AC=32,AA=32*0D
$PNORC3,CP=2.5,SP=1.275,DIR=228.1,AC=35,AA=32*09
$PNORC3,CP=3.5,SP=1.256,DIR=240.9,AC=35,AA=32*0F
```

Example (DF=104):

```
$PNORC4,1.5,1.395,227.1,32,32*7A
```