

# 10.006 DWLR, FLOAT WITH SHAFT ENCODER

Approval Date: 20 January 2000

Reviewed on : 23 October 2007

Version: 5

## Purpose

The Digital Water Level Recorder (DWLR) is to record readings of water level versus time in rivers, lakes and reservoirs. The water level is sensed by a float-counter weight assembly, and digitised by a shaft encoder. Optionally, the actual level reading could be shown on a LCD display.

## Conditions & Requirements

Throughout this specification conditions and requirements are preceded by a dot (•).

- The instrument shall be of such a design that it operates reliably and accurately under the prevailing environmental conditions.
- The instrument shall be easy to operate and maintain.
- All materials on the instrument exterior shall be non-corrosive.
- The instrument zero shall be adjustable to zero of gauge.
- The instrument will be installed in a stilling well.
- A float counter weight assembly sensor shall measure the water level.
- The size of float and counter weight shall allow free movement in a (stilling) well. The inner well diameter shall allow for a free space around float and counter weight of 50 mm or more.
- All batteries associated with the DWLR, i.e. the batteries for normal operation and the backup batteries, shall be easily replaceable.
- During battery replacement the instrument settings and data shall be retained.
- The instrument shall be supplied with the accessories as needed for effective deployment.
- The instrument shall have an expected technical lifetime of not less than 10 years.
- The instrument shall be capable to operate at least 6 months without any servicing.
- Calibration data and test certificate shall be part of the delivery for each DWLR.
- The water level readings shall be recorded in data logger memory.
- Data retrieval and other communication shall be possible through a Data Retrieval System (DRS), i.e. a Palmtop Computer or a Handheld Terminal (not included in the scope of the DWLR supply) loaded with dedicated software.
- For communication with the DRS an RS232C serial interface shall be available.
- The delivery shall include cables for connecting the DWLR to the DRS and to a serial port of a PC.
- For some DWLR implementations, interface adapters, e.g. for IrDA or RS485, are needed to communicate with the DRS and/or PC. These adapters, including manuals, software, cables and all other required accessories shall accompany each DRS, both for communication between DWLR and DRS and between DWLR and PC.
- The communication between DWLR and DRS and PC shall be suitable for the cable lengths involved.
- An error monitoring communication protocol shall be used. The protocol shall ascertain error free data exchange between DWLR and DRS/PC. The protocol shall function in both directions. Commands, programs, water level records and all other data are exchanged under control of the protocol and data may only be accepted if they are error free.
- The communication protocol shall be based on packet wise data exchange; the packets shall be accompanied by a CRC code for checking at the receiving end. Defective or not received packets shall be retransmitted upon request by the receiving end.
- The DWLR shall be capable to measure the voltage of the internal battery(ies).

- A simple and accurate tool to assess remaining battery lifetime shall be made available. The tool shall enable proper planning of battery replacement, without risk of data loss due to unexpected depletion. The tool may be implemented in the DWLR or alternatively, in the DRS. The operator may be prompted to enter specific parameters.
- Operator's and maintenance manuals, related to the type and model of the instrument, shall be part of the delivery.
- Comprehensive operators and maintenance training for respectively field observers and instrument specialists shall be part of the delivery.
- The proper functioning of each instrument shall be demonstrated at delivery.
- All hardware, firmware, software and data shall be fully Y2K compliant.

## Specifications

The purchaser may execute his judicious discretion in the choice of configuration and options.

### 1. Sensor

**sensor type** shaft encoder with float and counter weight  
**measuring range** 0 to xx m water column (e.g. 0 to 10 or 0 to 20 m)

- The Schedule of Requirements gives the numbers to be quoted for and their associated ranges and is attached to this document. The Bidder shall specify for the closest standard range of the offered product with respect to the required measuring range. The quoted range shall be equal or larger than the required range.

**suspension** perforated tape or beaded wire  
**pulley** fitted with matching sprockets for perforated tape or matching cavities for beaded wire

**overall accuracy** 0.005 m

- The accuracy also includes the longitudinal properties of the float suspension and the shaft encoder accuracy. The positioning of perforations/beads shall comply with the accuracy requirement.

**long term stability** 0.002 m/year

- Stability shall also cover the longitudinal tape/wire properties, e.g. elongation and creep of the suspension at the specified length.

**reproducibility** 0.001 m

**resolution** 0.001 m

**rate of rotation** 0.5 m/s

- The sensor shall keep track of rapid water level movements without suffering from missing increments due to too slow operation.

**enclosure material** FRP, sheet metal or similar

- The sensor enclosure and all its components that are exposed to the environment shall be of corrosion proof material.
- Moreover, in particular the interface from the pulley axle to the shaft encoder electronics requires specific attention; it is of great importance that the shaft encoder electronics are fully protected against ingress of water, moisture, dust, etc.
- The shaft rotation shall not be hampered by the ingress protection.

**ingress protection** the electronics section of the sensor, its enclosure and cable passage(s) shall comply with IP65 protection

**operating temperature** 0 to 60°C

**humidity** 100%

## 2. Data logger

**measuring interval** pre-set at 1 hours, adjustable from 10 minutes to 24 hours.

- The measuring interval shall be user adjustable, recordings shall be executed at 'integer times'. Example, if the measuring interval is 30 minutes, then recording should take place at 00h00, 00h30, 01h00, etc.
- The first record after initiation of the instrument, should be made at the first instant of 00 or 30 minutes in the hour.

**date** day, month, year in the following format: DD/MM/YYYY with leading zero's (01/03/2001 for 1<sup>st</sup> of March 2001)  
the logger and software shall be Y2K compliant

**time** hh:mm:ss (0 to 23 hours, 0 to 59 minutes, 0 to 59 seconds)  
with leading zero's (08:05:07)

The specification given above is only valid for the way date and time are presented to the user and does not apply to the way the data loggers handles these.

**recording capacity** minimum of 20,000 water level readings.

- The recorded data shall also contain an instrument serial number and/or station identification code and information on date and time of recorded water levels readings.
- The instrument serial number shall be uniquely attached to the data logger.
- The station identification code shall be uniquely attached to the data logger at installation and shall not be added after data retrieval by user interference.
- The memory shall have a ring organisation (endless loop).
- No recorded data shall be erased due to change of logger program or logger setting(s).
- The memory shall be protected against accidental erasure by a password or equivalent.

**error marking** error code, i.e. -99.999

- Out of range data and errors shall be clearly and unambiguously marked and be distinguishable from valid data. The error mark is an impossible value, which cannot be generated by valid measurements.

**recording resolution** 0.001 m or better

**memory type** non volatile memory or volatile memory

- Volatile memory (RAM) shall be protected from data loss by a Lithium backup battery.
- The battery capacity shall be sufficient to retain memory contents more than one year after main power disconnection (removal of the supply batteries).

**set-up memory** all settings, such as shaft encoder zero and scale as well as the program settings, shall be retained in non-volatile memory

### ***Lithium batteries***

**power supply** in-built standard Lithium batteries, like AA, C or D size

OR

### ***Alkaline batteries***

**power supply** in-built standard Alkaline batteries, like AA, C or D size

- Preferably, the batteries are kept inside a separate enclosure, inside the stilling well above the maximum water level, close to the wellhead. Alternatively, batteries may be kept inside the data logger enclosure. However, wherever the batteries are kept, they shall be easily replaceable, on site.

- The delivery shall include sufficient batteries for at least one year of operation under the following conditions:
- a recording interval of 30 minutes
- monthly access of the DWLR for data retrieval and monitoring purposes which may affect the power autonomy

**remaining battery lifetime** indication on DRS and/or calculation scheme  
**data offload power use** the power consumption shall allow for entire data offload of a completely filled memory  $\geq 6$  times per annum during the rated battery lifetime, and this including the normal data recording and service visits. E.g. if rated battery capacity is 5 years then  $\geq 30$  full offloads shall be supported in that 5 years.

**communication interface** serial RS232 C at DRS / PC end

- The communication hardware between DWLR and DRS and PC shall be suitable for the cable lengths involved.

**baud rate** 9600 or more

**operating temperature** 0 to 60°C.

- The operating temperature range specification applies to all components of the DWLR, like: sensor, wire/tape, data logger, batteries, etc. The temperature effect on sensor reading (zero and scale effects) and wire/tape length shall be specified separately.

**built in clock** time keeping better than 1 minute per month

**time resolution** 1 second

**over-voltage protection** on all i/o lines, regardless mode of connection during deployment

- Built-in over-voltage protection is required on the electronics unit, in particular on all external connections, e.g. sensor supply and signal (also on optional sensors, e.g. for water quality), external power supply and data communication interface.

**water level indication** LCD display with 0.001 m resolution (optional)

### 3. Enclosure for shaft encoder and data logger

- The sensor electronics, data logger, electronics, batteries and all other electrical components shall be contained in one or more protective enclosures. The enclosure(s) shall comply with the following specifications.
- All DWLR materials and combinations thereof shall be corrosion proof.

**dimensions** not specified

**material** FRP, sheet metal or similar.

- The enclosure and all its external components that are exposed to the environment shall be of corrosion proof and UV resistant material.

**ingress protection** the enclosure and cable assembly shall have IP65 protection

**operating temperature** 0 to 60°C.

**humidity** 100%

### 4. DRS software

- The DRS software shall support functions for conversion of the collected data into ASCII (text) tables, and for efficient visualisation of the time series in tabular and graphical form.
- Graphical axes shall be generated automatically and be manually adjustable. Units along the axes shall not be awkward but intuitive and easily understandable.
- All axes shall have sufficient graduation.

- The labels along the time axis shall be in sensible time intervals, i.e. hh:mm for relatively short periods and dates, e.g.: DD/MM/YYYY, for long periods. The same applies for the level axis.
- The unit-labels shall not (partly) cover each other.
- To enhance readability, adequate gridlines, both along time and level axes, shall be generated automatically by the graphics functions, approximately 5 gridlines per axis.
- The gridlines shall also be user adjustable.
- The user interface shall support efficient functions to select and visualise subsets of the time series, e.g. a single day or several days somewhere out of many weeks of data.
- Efficient window functions shall be available to visualise the data in the required resolution, i.e. the level scale shall be user adjustable.
- Software that can only display sample counts or total duration or does not support axis and grid adjustment is not permitted.
- The DRS software shall support error free transfer of the retrieved data to a PC.
- Note that in particular the graphics capabilities are a major reason to apply a palmtop computer as DRS.

## **5. PC Software**

- PC software shall be part of the delivery and will be used in the office, e.g. on a desktop PC.
- The PC software shall transfer the collected data efficiently, reliably and error free from the DRS to the PC environment.
- The PC software shall have functions for conversion of the collected data into ASCII (text) tables for display.
- The PC software shall have functions for conversion of the collected data into ASCII (text) files. The tabular data will be imported by other software packages, e.g. for analysis and presentation in a spreadsheet and for storage in a database.
- The export file format is specified in Chapter 6.
- The PC software shall support the same and more tabular and graphical presentation functions as specified under DRS software.
- The PC software shall be fully compatible with MS-Windows 95/98.
- The PC software shall basically be mouse driven.

## **6. Standard DWLR text file format**

- The text file is the intermediate data representation that is used for loading of the data into the hydrological data base system.
- The PC based software shall have a facility to generate a text file with waterlevel data in the standardised format.
- The text file formatting function may be part of the standard proprietary PC software. Alternatively, the function may be implemented in a separate, MS-Windows95/98 based program.
- The text file facility shall be easy to use.
- Only SI-units shall be presented, i.e. m and °C for levels and temperature respectively.
- Non-SI units like feet, inches, °F are not permitted.
- The text file shall have a section with header lines.
- The header lines shall precede the data lines.
- The header lines shall contain instrument serial number, reference level that was used to convert from instrument reading in to water level.
- In case a software wave attenuation filter is implemented, the averaging number and the sampling interval shall be presented in the header.
- The header may contain other data such as measuring range, station ID, installation depth, top of casing reference relative to MSL, station co-ordinates and similar data.

- For each specific instrument make and model, the number of the header lines must be fixed, i.e. all instruments of that make and model shall always generate the same number of header lines, in the same format.
- The contents of the header lines is for use by the operator but will not be automatically assessed by the Data Entry Software (SW/GW DES).
- All header lines shall be terminated by a <CR><LF> sequence.
- The data shall be organised in columns
- column 1: date in dd/mm/yyyy  
Leading zero's shall be included, i.e. 06 February 2001 will be expressed as 06/02/2001. The </> character may be omitted, then the format becomes ddmmyyyy.
- column 2: time in hh:mm:ss  
Time shall be expressed in 24 hours. The AM/PM representation is not permitted. Leading zero's shall be included, i.e. 6 o'clock in the morning shall be represented by 06:00:00. The <:> character may be omitted, then the format becomes hhmmss.
- column 3: water level in metres with millimetre resolution, e.g. 49.640 m.
- column 4: in case temperature is measured then temperature shall be expressed in °C with 0.1°C resolution, e.g. 32.8 °C.
- Alternative data sequences are not permitted.
- If a parameter can be negative, then a character position for the minus sign shall be reserved.
- The column separator shall be one of the following: <space>, <tab>, <comma>, or <semicolon>.
- Only one type of separator may be applied.
- End-of-line is indicated by <CR><LF> sequence.
- All data lines shall comply with this column format, empty lines or intermediate partly filled lines, e.g. with date and/or time only, are not permitted.
- All columns shall be complete, i.e. each field in a column shall always contain data. If no temperature data are measured, then column 4 may be omitted.
- Erroneous or missing water level data shall be indicated by -99.999.
- Erroneous or missing temperature data shall be indicated by -99.9.

Examples of data lines:

30/05/1998	11:00:00	9.875	28.7
30/05/1998	12:00:00	-99.999	28.7
30/05/1998	13:00:00	9.989	-99.9
30/05/1998	14:00:00	10.380	28.8
30/05/1998	15:00:00	10.800	28.7

The four columns contain date, time, water level and temperature data respectively.

## Accessories

- tools
- spares and tape/wire
- signal, power and communication cables as required for all normal user operations
- 220 VAC  $\pm 25\%$ , 47 to 53 Hz, charger for NiCd, NiMH or Li-ion battery pack

## Consumables

- batteries for the instrument
- desiccator for electronics wherever recommended by the manufacturer

# 10.006 DWLR, FLOAT WITH SHAFT ENCODER

*As per HP-I*

**Approval Date: 20 January 2000**

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## **Purpose**

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- The instrument shall be of such a design that it operates reliably and accurately under the prevailing environmental conditions.
- The instrument shall be easy to operate and maintain.
- All materials on the instrument exterior shall be non-corrosive.
- The instrument zero shall be adjustable to zero of gauge.
- The instrument will be installed in a stilling well.
- A float counter weight assembly sensor shall measure the water level.
- The size of float and counter weight shall allow free movement in a (stilling) well. The inner well diameter shall allow for a free space around float and counter weight of 50 mm or more.
- All batteries associated with the DWLR, i.e. the batteries for normal operation and the backup batteries, shall be easily replaceable.
- During battery replacement the instrument settings and data shall be retained.
- The instrument shall be supplied with the accessories as needed for effective deployment.
- The instrument shall have an expected technical lifetime of not less than 10 years.
- The instrument shall be capable to operate at least 6 months without any servicing.
- Calibration data and test certificate shall be part of the delivery for each DWLR.
- The water level readings shall be recorded in data logger memory.
- Data retrieval and other communication shall be possible through a Data Retrieval System (DRS), i.e. a Palmtop Computer or a Handheld Terminal (not included in the scope of the DWLR supply) loaded with dedicated software.
- For communication with the DRS an RS232C serial interface shall be available.
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- The communication protocol shall be based on packet wise data exchange; the packets shall be accompanied by a CRC code for checking at the receiving end. Defective or not received packets shall be retransmitted upon request by the receiving end.
- The DWLR shall be capable to measure the voltage of the internal battery(ies).
- A simple and accurate tool to assess remaining battery lifetime shall be made available. The tool shall enable proper planning of battery replacement, without risk of data loss due

to unexpected depletion. The tool may be implemented in the DWLR or alternatively, in the DRS. The operator may be prompted to enter specific parameters.

- Operator's and maintenance manuals, related to the type and model of the instrument, shall be part of the delivery.
- Comprehensive operators and maintenance training for respectively field observers and instrument specialists shall be part of the delivery.
- The proper functioning of each instrument shall be demonstrated at delivery.
- All hardware, firmware, software and data shall be fully Y2K compliant.

## Specifications

The purchaser may execute his judicious discretion in the choice of configuration and options.

### 7. Sensor

**sensor type** shaft encoder with float and counter weight  
**measuring range** 0 to xx m water column (e.g. 0 to 10 or 0 to 20 m)

- The Schedule of Requirements gives the numbers to be quoted for and their associated ranges and is attached to this document. The Bidder shall specify for the closest standard range of the offered product with respect to the required measuring range. The quoted range shall be equal or larger than the required range.

**suspension** perforated tape or beaded wire  
**pulley** fitted with matching sprockets for perforated tape or matching cavities for beaded wire

**overall accuracy** 0.005 m

- The accuracy also includes the longitudinal properties of the float suspension and the shaft encoder accuracy. The positioning of perforations/beads shall comply with the accuracy requirement.

**long term stability** 0.002 m/year

- Stability shall also cover the longitudinal tape/wire properties, e.g. elongation and creep of the suspension at the specified length.

**reproducibility** 0.001 m

**resolution** 0.001 m

**rate of rotation** 0.5 m/s

- The sensor shall keep track of rapid water level movements without suffering from missing increments due to too slow operation.

**enclosure material** FRP, sheet metal or similar

- The sensor enclosure and all its components that are exposed to the environment shall be of corrosion proof material.
- Moreover, in particular the interface from the pulley axle to the shaft encoder electronics requires specific attention; it is of great importance that the shaft encoder electronics are fully protected against ingress of water, moisture, dust, etc.
- The shaft rotation shall not be hampered by the ingress protection.

**ingress protection** the electronics section of the sensor, its enclosure and cable passage(s) shall comply with IP65 protection

**operating temperature** 0 to 60°C

**humidity** 100%

## 8. Data logger

**measuring interval** pre-set at 1 hours, adjustable from 10 minutes to 24 hours.

- The measuring interval shall be user adjustable, recordings shall be executed at 'integer times'. Example, if the measuring interval is 30 minutes, then recording should take place at 00h00, 00h30, 01h00, etc.
- The first record after initiation of the instrument, should be made at the first instant of 00 or 30 minutes in the hour.

**date** day, month, year in the following format: DD/MM/YYYY with leading zero's (01/03/2001 for 1<sup>st</sup> of March 2001)

**time** the logger and software shall be Y2K compliant  
hh:mm:ss (0 to 23 hours, 0 to 59 minutes, 0 to 59 seconds)  
with leading zero's (08:05:07)

The specification given above is only valid for the way date and time are presented to the user and does not apply to the way the data loggers handles these.

**recording capacity** minimum of 20,000 water level readings.

- The recorded data shall also contain an instrument serial number and/or station identification code and information on date and time of recorded water levels readings.
- The instrument serial number shall be uniquely attached to the data logger.
- The station identification code shall be uniquely attached to the data logger at installation and shall not be added after data retrieval by user interference.
- The memory shall have a ring organisation (endless loop).
- No recorded data shall be erased due to change of logger program or logger setting(s).
- The memory shall be protected against accidental erasure by a password or equivalent.

**error marking** error code, i.e. -99.999

- Out of range data and errors shall be clearly and unambiguously marked and be distinguishable from valid data. The error mark is an impossible value, which cannot be generated by valid measurements.

**recording resolution** 0.001 m or better

**memory type** non volatile memory or volatile memory

- Volatile memory (RAM) shall be protected from data loss by a Lithium backup battery.
- The battery capacity shall be sufficient to retain memory contents more than one year after main power disconnection (removal of the supply batteries).

**set-up memory** all settings, such as shaft encoder zero and scale as well as the program settings, shall be retained in non-volatile memory

### ***Lithium batteries***

**power supply** in-built standard Lithium batteries, like AA, C or D size

OR

### ***Alkaline batteries***

**power supply** in-built standard Alkaline batteries, like AA, C or D size

- Preferably, the batteries are kept inside a separate enclosure, inside the stilling well above the maximum water level, close to the wellhead. Alternatively, batteries may be kept inside the data logger enclosure. However, wherever the batteries are kept, they shall be easily replaceable, on site.
- The delivery shall include sufficient batteries for at least one year of operation under the following conditions:

- a recording interval of 30 minutes
- monthly access of the DWLR for data retrieval and monitoring purposes which may affect the power autonomy

**remaining battery lifetime** indication on DRS and/or calculation scheme  
**data offload power use** the power consumption shall allow for entire data offload of a completely filled memory  $\geq 6$  times per annum during the rated battery lifetime, and this including the normal data recording and service visits. E.g. if rated battery capacity is 5 years then  $\geq 30$  full offloads shall be supported in that 5 years.

**communication interface** serial RS232 C at DRS / PC end

- The communication hardware between DWLR and DRS and PC shall be suitable for the cable lengths involved.

**baud rate** 9600 or more

**operating temperature** 0 to 60°C.

- The operating temperature range specification applies to all components of the DWLR, like: sensor, wire/tape, data logger, batteries, etc. The temperature effect on sensor reading (zero and scale effects) and wire/tape length shall be specified separately.

**built in clock** time keeping better than 1 minute per month

**time resolution** 1 second

**over-voltage protection** on all i/o lines, regardless mode of connection during deployment

- Built-in over-voltage protection is required on the electronics unit, in particular on all external connections, e.g. sensor supply and signal (also on optional sensors, e.g. for water quality), external power supply and data communication interface.

**water level indication** LCD display with 0.001 m resolution (optional)

## 9. Enclosure for shaft encoder and data logger

- The sensor electronics, data logger, electronics, batteries and all other electrical components shall be contained in one or more protective enclosures. The enclosure(s) shall comply with the following specifications.
- All DWLR materials and combinations thereof shall be corrosion proof.

**dimensions** not specified

**material** FRP, sheet metal or similar.

- The enclosure and all its external components that are exposed to the environment shall be of corrosion proof and UV resistant material.

**ingress protection** the enclosure and cable assembly shall have IP65 protection

**operating temperature** 0 to 60°C.

**humidity** 100%

## 10. DRS software

- The DRS software shall support functions for conversion of the collected data into ASCII (text) tables, and for efficient visualisation of the time series in tabular and graphical form.
- Graphical axes shall be generated automatically and be manually adjustable. Units along the axes shall not be awkward but intuitive and easily understandable.
- All axes shall have sufficient graduation.

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- Software that can only display sample counts or total duration or does not support axis and grid adjustment is not permitted.
- The DRS software shall support error free transfer of the retrieved data to a PC.
- Note that in particular the graphics capabilities are a major reason to apply a palmtop computer as DRS.

#### **11. PC Software**

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- The export file format is specified in Chapter 6.
- The PC software shall support the same and more tabular and graphical presentation functions as specified under DRS software.
- The PC software shall be fully compatible with MS-Windows 95/98.
- The PC software shall basically be mouse driven.

#### **12. Standard DWLR text file format**

- The text file is the intermediate data representation that is used for loading of the data into the hydrological data base system.
- The PC based software shall have a facility to generate a text file with waterlevel data in the standardised format.
- The text file formatting function may be part of the standard proprietary PC software. Alternatively, the function may be implemented in a separate, MS-Windows95/98 based program.
- The text file facility shall be easy to use.
- Only SI-units shall be presented, i.e. m and °C for levels and temperature respectively.
- Non-SI units like feet, inches, °F are not permitted.
- The text file shall have a section with header lines.
- The header lines shall precede the data lines.
- The header lines shall contain instrument serial number, reference level that was used to convert from instrument reading in to water level.
- In case a software wave attenuation filter is implemented, the averaging number and the sampling interval shall be presented in the header.
- The header may contain other data such as measuring range, station ID, installation depth, top of casing reference relative to MSL, station co-ordinates and similar data.

- For each specific instrument make and model, the number of the header lines must be fixed, i.e. all instruments of that make and model shall always generate the same number of header lines, in the same format.
- The contents of the header lines is for use by the operator but will not be automatically assessed by the Data Entry Software (SW/GW DES).
- All header lines shall be terminated by a <CR><LF> sequence.
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Leading zero's shall be included, i.e. 06 February 2001 will be expressed as 06/02/2001. The </> character may be omitted, then the format becomes ddmmyyyy.
- column 2: time in hh:mm:ss  
Time shall be expressed in 24 hours. The AM/PM representation is not permitted. Leading zero's shall be included, i.e. 6 o'clock in the morning shall be represented by 06:00:00. The <:> character may be omitted, then the format becomes hhmmss.
- column 3: water level in metres with millimetre resolution, e.g. 49.640 m.
- column 4: in case temperature is measured then temperature shall be expressed in °C with 0.1°C resolution, e.g. 32.8 °C.
- Alternative data sequences are not permitted.
- If a parameter can be negative, then a character position for the minus sign shall be reserved.
- The column separator shall be one of the following: <space>, <tab>, <comma>, or <semicolon>.
- Only one type of separator may be applied.
- End-of-line is indicated by <CR><LF> sequence.
- All data lines shall comply with this column format, empty lines or intermediate partly filled lines, e.g. with date and/or time only, are not permitted.
- All columns shall be complete, i.e. each field in a column shall always contain data. If no temperature data are measured, then column 4 may be omitted.
- Erroneous or missing water level data shall be indicated by -99.999.
- Erroneous or missing temperature data shall be indicated by -99.9.

Examples of data lines:

30/05/1998	11:00:00	9.875	28.7
30/05/1998	12:00:00	-99.999	28.7
30/05/1998	13:00:00	9.989	-99.9
30/05/1998	14:00:00	10.380	28.8
30/05/1998	15:00:00	10.800	28.7

The four columns contain date, time, water level and temperature data respectively.

## Accessories

- tools
- spares and tape/wire
- signal, power and communication cables as required for all normal user operations
- 220 VAC  $\pm 25\%$ , 47 to 53 Hz, charger for NiCd, NiMH or Li-ion battery pack

## Consumables

- batteries for the instrument
- desiccator for electronics wherever recommended by the manufacturer
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