SVASEK HYDRAULICS

Questionnaire with regard to wave measurement instruments

All the questions listed below refer to the wave measurement instruments which are suitable for measurements at the IJsselmeer and Slotermeer (see accompanying letter). So if your company sells more then one wave measurement instrument suitable for these measurements please answer all the questions for each wave measurement instrument.

1. *Company specifications:*

Company name:	Qmetrix BV
Address:	P.O.Box 7435 2701 AK Zoetermeer
Phone:	+31 79 3165314
E-mail:	Sicco.kamminga@qmetrix.nl
Filled in by:	Sicco Kamminga

2. *Which wave measurement instrument(s) does your company sell?*

Nortek – AWAC,
Nortek AquaDopp,
Nortek – AquaDopp Profiler,
Nortek - Vector

3. *Give a short description of the functions of the(se) wave measurement instrument(s)?*

All instruments are deployed from the bed and measure acoustically.

AWAC: measures a current profile and wave full directional spectrum acoustically using the Maximum Likelihood method and a vertical acoustic beam

AquaDopp, AquaDopp Profiler and Vector measure current and a wave full directional spectrum using the PUV method.

The difference is that the AWAC can measure also short waves while it is deployed in coastal waters up to 50m deep. We will focus on the AWAC here.

4. *What is the brand(s) of the(se) wave measurement instrument(s) (if your company sells more than three different brands of one instrument, then please list only the three most suitable for wave measurements on the IJsselmeer or Slotermeer (see accompanying letter)):*

Nortek

5. *The wave measurement instrument(s) consists of:*

The instrument itself in a Delrin housing, underwater cables and as an option a battery container.

5. *Which materials the wave measurement instrument(s) consist of?*

Delrin housing, titanium screws and urethane transducers The cables are polyurethane.

6. *What are the physical specifications of the wave measurement instrument(s)?*

See attached drawing

7. *What is the energy use of the wave measurement instrument(s)?*

The energy consumption depends strongly on the instrument configuration.

8. *How many days can the wave measurement instrument(s) measure non-stop with internal batteries and memory (so if autonomously)?*

On the extreme would be 45 days of continuous 4 Hz sampling with a wave averaging interval of 20 minutes. The instrument would then acquire 150 Mbytes of data and use 500 Wh of energy (large container, double large container is available)

9. *How sensitive is the wave measurement instrument(s) for damage of storm, ice, driftwood or vandalism?*

Hardly, but there are limits of course. When the instrument is mounted at the seabed in a structure which protects the instrument chances of damage are very low.

10. *What is (are) the price(s) of the wave measurement instrument(s) (include the technical specifications)?*

Price start at euro 21.000, ex VAT and shipping, for a single instrument. A brochure with specifications is attached.

11. *Is the wave measurement instrument(s) available for trails/purchase in the short term?*

Yes, we at Qmetrix have a unit available for trials or lease. Standard delivery time is 2 weeks after purchase ex Norway.

12. *What does the output data consist of (e.g date, wave height, wave direction, etc)?*

Standard output is raw data, meaning measured velocities and surface elevations. An internal computational board is available (at extra costs) which computes wave parameters in the instrument.

13. Is it possible to transfer the output data (for example with GSM/Satel transmitters (9600 Bps)) without interruption of the measurements?

Yes. Standard raw data output is quite a lot for a 9600 Bps modem. Then a computational board is required.

14. Does the wave measurement instrument(s) measure continuously (3600sec/h and 24h/day)?

The instrument measures in wave bursts. A burst is f.e. a measurement during 1024 s and sampling at 4 Hz. In between wave burst a current profile is measured with f.e. an averaging period of 60s. The wave interval could be 1200s or larger in this case.

15. How much output data does the wave measurement instrument(s) produce in one day (MB)?

Depends strongly on configuration. Up to 3 Mbytes per day.

16. How much output data can be stored by the wave measurement instrument(s) (MB)?

154 MByte (2 MByte is standard)

17. Please specify any critical assumptions and conversions to evaluate the waves from raw signal which may effect the accuracy of the end results?

The instrument should be mounted nicely flat and stable.
Site selection is always important, it is hard to measure waves close to structures.

Wave height is being measured with a vertical beam. This method is robust.
Wave direction measurements have limits in measuring short waves.

18. What is the accuracy of the wave measurement instrument(s) (wave periods (e.g Tp,Tm01) and wave heights), please specify ?

Wave Height accuracy is better than 1 cm.

Period estimates are 0.1 s or better.

Accuracy of estimated parameters depends on conditions, especially wave shape.

19. Can the wave measurement instrument(s) accurately measure at a sample frequency of 4 Hz? If not is it possible to adjust the instrument(s) to such a frequency?

The vertical acoustic beam (wave height) samples at 4 Hz. The other beams sample at 2 Hz.

20. What are the resolution and range (cm) of the wave measurement instrument(s) and do they fit into the requirements of a resolution (raw signal) which does not exceed 5 cm and a range (Hm0) of 5-200 cm?

Accuracy of surface elevations is typically 2-3 mm with a range of 0.5 cm to 10 m.

21. What is the wave frequency range of the wave measurement instrument(s)?

The minimum wave frequency is 2 Hz. The maximum wave frequency depends on configuration. Maximum wave averaging interval is 2048 s.

22. How robust is/are the wave measurement instrument(s) (like how large is the risk that the instrument(s) or its electronics fails or becomes unreliable during a storm)?

Nortek instruments are very reliable. Basically the same electronics is used for deployments in deep oceans where costs of deployment are high so requirements on reliability are high.

23. Can any measuring or processing errors be expected during asymmetric or breaking waves? If so, how large are those errors, and what type?

Asymmetry does not necessarily give measurement errors. The AWAC can measure in waves with a height / length ratio of 1/7. Asymmetry may lead to processing errors as the inherent wave model is then not adequate.

Breaking waves are in principle a problem as bubbles may be entrained in the water column. In practice, loss of data is limited to 1 or 2 %, see attached memos (Gabbard memo and memo Oceans2002) and does not significantly influent final results.

24. Is it possible to check the performance and accuracy of the wave measurement instrument(s) in the field without removing it, and if so how?

If the instrument is operated online all data is available to the user and checks can be made.

25. How large is the expected drift in the calibration after a given period of time, and after how much time would a re-calibration be needed?

None and no re-calibration is necessary either.

26. What approach would you suggest to obtain mean water level data and wind data in order to interpret the wave data obtained with your instrument(s)?

We can supply the AWAC with the computational board. In this case we could acquire data from other sensors.

27. After how many days should the wave measurement instrument(s) be cleaned in order to function properly and keep measuring accurately?

The instrument has no moving mechanical parts. The housing is of Delrin material which is very smooth and generally is not very sensitive to fouling. Generally when mounted at the bed it is good to clean the instrument periodically without removing it.

29. Are there any reference customers we could approach for an user interview?

We could give you the full address of the users which have cooperated in the test as attached.

30. Is there any other relevant information about the wave measurement instrument(s) we need to know for finding the best wave measurement instrument(s) for measurements at the IJsselmeer and Slotermeer?

The AWAC can now configure itself based on its own measurement data. Deployment is not difficult anymore.

The instrument has additional sensors for water temperature, pressure and instrument orientation (Pitch, Roll, Heading).

Software is available for configuration, data acquisition and post-processing.

SVASEK HYDRAULICS

Questionnaire with regard to wave measurement instruments

All the questions listed below refer to the wave measurement instruments which are suitable for measurements at the IJsselmeer and Slotermeer (see accompanying letter). So if your company sells more then one wave measurement instrument suitable for these measurements please answer all the questions for each wave measurement instrument.

1. *Company specifications:*

Company name:	General Acoustics GmbH
Address:	Dorfstraße 57 24107 Ottendorf/Germany
Phone:	++49 (0) 431 – 5 80 81 81
E-mail:	hbalzerek@generalacoustics.com
Filled in by:	Dr. Heiko Balzerek

2. *Which wave measurement instrument(s) does your company sell?*

LOG_aLevel®: Autonomous Remote Sensing of Water Levels and Waves

3. *Give a short description of the functions of the(se) wave measurement instrument(s)?*

It is a complete, remote sensing, stand-alone wave and water level gauge on the basis of air ultrasound (optional with solar power supply and wind generator).
The system works automatically and is independent of any external connections. Via telephone line or wireless data transmission all measurements are available online.
With a help of a terminal program the measurement system can be monitored and controlled remotely.
To guarantee the highest measurement and data security, a level of redundancy can be built into the system (e.g. buffer battery, data logger, etc.).
Data deriving from external sensors - as there are anemometer, rain gauge or others – can be saved, processed and exported together with the recorded wave data.
High performance ultrasonic sensors guarantee robust, reliable, fast and precise measurements of all kinds of waves and their dynamic – up to very steep waves.

4. *What is the brand(s) of the(se) wave measurement instrument(s) (if your company sells more than three different brands of one instrument, then please list only the three most suitable for wave measurements on the IJsselmeer or Slotermeer (see accompanying letter)):*

LOG_aLevel®

5. *The wave measurement instrument(s) consists of:*

- Ultrasound sensor: With elaborated features - e.g. narrowed sound beam, high emitting power, receiving sensitivity, practically free of side lobes.
- Controller in stainless steel housing: Combining all functions - e.g. operation control, sound velocity gauging and calibration of the total system, data processing, time stamping, data storage/interface, data transmission, system control, energy function, etc.
- Power supply: 12/24 V DC; 230 V AC (standard); solar panel, wind generator, backup battery (accessories)

5. *Which materials the wave measurement instrument(s) consist of?*

Housings: stainless steel

6. *What are the physical specifications of the wave measurement instrument(s)?*

Depending on detailed specification:

- Housing (without battery 200x200x150/ with battery from 300x300x150 mm up to 600x600x300)
- Sensor (100x50 mm in size) needs clearance of 1,50 m form disturbing reflectors within the signal path
- Sound velocity gauging (size 200 mm)

7. *What is the energy use of the wave measurement instrument(s)?*

Depending on specification: starting from 3 W (smallest package)

8. *How many days can the wave measurement instrument(s) measure non-stop with internal batteries and memory (so if autonomously)?*

Depending on battery size, equipment components and measurement task up to 1 year

9. *How sensitive is the wave measurement instrument(s) for damage of storm, ice, driftwood or vandalism?*

Due to the fact of contactless measuring from above the water level the system is free of icing, soiling and pollution as well as independent of driftwood. The small size of the system – especially the tiny sensor, which can hide easily – and the high security lock for the housing makes the whole gauge saver than other measurement systems.

10. *What is (are) the price(s) of the wave measurement instrument(s) (include the technical specifications)?*

The basis price is 4,820. It consist of:
- Stainless steel casing 200x200x150mm, IP 66 (optional 69k)
- Ultrasound sensor IP 68; connector cable 2 m
- Sound velocity reference gauge (sensor REF 200)

- Controller module for signal processing and sensor control/data acquisition (incl. timer)
- Digital data transfer via interface RS 232

11. Is the wave measurement instrument(s) available for trails/purchase in the short term?

yes

12. What does the output data consist of (e.g date, wave height, wave direction, etc)?

Data stream consist of a header and data row. Both are ASCII format and directly readable:

- Header: time (e.g. 00:33' 50" 280 ms), date, sample frequency, GPS pps availability, system status in Volt,
- Data row: wave height in respect to a reference point (e.g. mean sea level)

13. Is it possible to transfer the output data (for example with GSM/Satel transmitters (9600 Bps)) without interruption of the measurements?

Yes
GPRS also possible

14. Does the wave measurement instrument(s) measure continuously (3600sec/h and 24h/day)?

yes

15. How much output data does the wave measurement instrument(s) produce in one day (MB)?

Depending on the sample rate
5 Hz: approximately 24 MB

16. How much output data can be stored by the wave measurement instrument(s) (MB)?

Depending on the size of the PCMCIA card (64 MB up to 2 GB)

17. Please specify any critical assumptions and conversions to evaluate the waves from raw signal which may effect the accuracy of the end results?

Single potential mavericks – being labelled as such outlier – should be eliminated before calculation.

18. What is the accuracy of the wave measurement instrument(s) (wave periods (e.g Tp,Tm01) and wave heights),please specify ?

Resolution up to 1 mm
Accuracy up to 1 cm (depending on measurement range) ???
The row data must be analysed by post-processing in order to achieve Tp and Tm01 etc.
In case of a demand the post-processing software can be offered, too. In addition, service can be offered by General Acoustics.

19. Can the wave measurement instrument(s) accurately measure at a sample frequency of 4 Hz? If not is it possible to adjust the instrument(s) to such a frequency?

Yes, The sample rate can be increased up to 8 Hz.

20. What are the resolution and range (cm) of the wave measurement instrument(s) and do they fit into the requirements of a resolution (raw signal) which does not exceed 5 cm and a range (Hm0) of 5-200 cm?

Range: 6000 mm. Resolution: 1 mm
Yes, the measurement system not only fulfils the requirements but exceeds them

21. What is the wave frequency range of the wave measurement instrument(s)?

Regarding the Nyquist theorem the maximum wave frequency may be half the sample frequency. Wave frequency range = 4 Hz

22. How robust is/are the wave measurement instrument(s) (like how large is the risk that the instrument(s) or its electronics fails or becomes unreliable during a storm)?

The system is extremely reliable, robust and all weather proof. It measured the last storm tide season 2003-2004 at the Harbour of Hamburg without a breakdown – the data received are of outstanding quality.

23. Can any measuring or processing errors be expected during asymmetric or breaking waves? If so, how large are those errors, and what type?

Steep waves can be measured with a rate of 1 : 11. That means that the smallest roughness of every single wave supports the signal reflection.
In case of especially abruptness a lost of isolated pings might be possible. But a higher sample rate measurement serves as a kind of redundancy.

24. Is it possible to check the performance and accuracy of the wave measurement instrument(s) in the field without removing it, and if so how?

Yes. The data header, which can be received by telemetric transmission together with the logged data also carries status information, informing about the performance.

25. How large is the expected drift in the calibration after a given period of time, and after how much time would a re-calibration be needed?

By using a timing module – which we recommend – working with a high accuracy GPS (pps, 1 ms accuracy) a time drift won't appear.

In order to calibrate the fluctuation of temperature, air humidity and the changes of air pressure a sound velocity gauging – done by a special sensor – is taking place to probe the speed of sound, which depends on these described factors. The results are permanently calibrating the measurement system.
The main gauging always measures the distance to the water surface. A drift doesn't exist for the logged data.

26. What approach would you suggest to obtain mean water level data and wind data in order to interpret the wave data obtained with your instrument(s)?

Within the menu it is possible to determine the averaging value (none, 10s, 30s, 1 min., 5 min., or 10 min.). The data output only gives the averaged mean water level. In order to measure waves, the averaging value has to switched off. In that case all data logged are a constant flow of raw data in respect to every single wave. A post-processing is utterly necessary to obtain the mean water level additionally.
We propose to measure the wind data by using a sophisticated high resolution 2D ultrasound anemometer, which can be integrated to our station. The data concerning to the wind direction and speed as well as the air temperature (0.5°C accuracy!) will be logged within the LOG_aLevel station. Together with the wave data the wind information appear in the header.

27. After how many days should the wave measurement instrument(s) be cleaned in order to function properly and keep measuring accurately?

Not necessary

29. Are there any reference customers we could approach for an user interview?

Yes.

Amt für Strom und Hafenbau Hamburg:
Name: Dipl.-Ing. Strothmann
Phone: 0049 (0) 40 42 84 72 463

30. Is there any other relevant information about the wave measurement instrument(s) we need to know for finding the best wave measurement instrument(s) for measurements at the IJsselmeer and Slotermeer?

None.

SVASEK HYDRAULICS

Questionnaire with regard to wave measurement instruments

All the questions listed below refer to the wave measurement instruments which are suitable for measurements at the IJsselmeer and Slotermeer (see accompanying letter). So if your company sells more then one wave measurement instrument suitable for these measurements please answer all the questions for each wave measurement instrument.

1. *Company specifications:*

Company name:	Sonar Research and Development (SRD)
Address:	Unit 1B Grovehill Ind Estate Beverley East Yorkshire HU17 0LF United Kingdom
Phone:	+44 (o)1482 869559
E-mail:	alan.mccloud@srduk.com
Filled in by:	Alan McCloud

2. *Which wave measurement instrument(s) does your company sell?*

Digital Tide Monitor

3. *Give a short description of the functions of the(se) wave measurement instrument(s)?*

Although designed as a tide monitor, a wave meter function is to be added within 6 months. Its specification will be designed beyond the requirements as specified by yourselves

4. *What is the brand(s) of the(se) wave measurement instrument(s) (if your company sells more than three different brands of one instrument, then please list only the three most suitable for wave measurements on the IJsselmeer or Slotermeer (see accompanying letter)):*

Digital Tide Monitor

5. *The wave measurement instrument(s) consists of:*

An electronics display/control unit and remote transducer. Because this is an acoustic system, we strongly advise that the transducer be operated within a tube.

6. *Which materials the wave measurement instrument(s) consist of?*

The electronics control unit is manufactured from impact resistant Polycarbonate and sealed to IP65. The transducer is manufactured from Black Ertalon.

6. *What are the physical specifications of the wave measurement instrument(s)?*

Control Unit: 213mm (width) x 185 (height) x 117 (depth)
Transducer w/o ref bar: 165 (dia) x 160mm (height)
Transducer with ref bar: 165 (dia) x 910mm (height)

7. *What is the energy use of the wave measurement instrument(s)?*

0.3A at 220v AC
0.15A at 12v DC

8. *How many days can the wave measurement instrument(s) measure non-stop with internal batteries and memory (so if autonomously)?*

Internal battery is only 1.2Ah and can only supply power for 8 hours
12v DC options are available for external battery supply.

9. *How sensitive is the wave measurement instrument(s) for damage of storm, ice, driftwood or vandalism?*

We recommend fibreglass/stainless steel marina cabinet installation of the control unit. The transducer will be mounted on a tube.

10. *What is (are) the price(s) of the wave measurement instrument(s) (include the technical specifications)?*

Standard Digital Tide Monitor (up to 12 metres range): £3,500

Mounting tube (MDPE, up to 12 metres in length): £600

11. *Is the wave measurement instrument(s) available for trails/purchase in the short term?*

Will be available before February 2005 (earlier if urgently required)

12. *What does the output data consist of (e.g date, wave height, wave direction, etc)?*

Site ID, date, time, tide height, chart datum and extensive engineering information is currently transmitted from the tide monitor. The wave meter will be similar but not as extensive.

The wave meter function will not be able to indicate wave direction.

13. *Is it possible to transfer the output data (for example with GSM/Satel transmitters (9600 Bps)) without interruption of the measurements?*

Yes

14. Does the wave measurement instrument(s) measure continuously (3600sec/h and 24h/day)?

Yes

15. How much output data does the wave measurement instrument(s) produce in one day (MB)?

To be determined but will be in the region of 8 Mbytes. Data stream can be modified to suit customer requirements. This may mean more than or less than 8 Mbytes

16. How much output data can be stored by the wave measurement instrument(s) (MB)?

Currently 128 Kbyte with the tide monitor but this will be expanded for the wave meter.

17. Please specify any critical assumptions and conversions to evaluate the waves from raw signal which may effect the accuracy of the end results?

None

18. What is the accuracy of the wave measurement instrument(s) (wave periods (e.g Tp,Tm01) and wave heights),please specify ?

TBD

19. Can the wave measurement instrument(s) accurately measure at a sample frequency of 4 Hz? If not is it possible to adjust the instrument(s) to such a frequency?

Yes

20. What are the resolution and range (cm) of the wave measurement instrument(s) and do they fit into the requirements of a resolution (raw signal) which does not exceed 5 cm and a range (Hm0) of 5-200 cm?

Resolution is currently one centimetre but capable of one millimetre resolution.
Range is 1.5m to 12m

21. What is the wave frequency range of the wave measurement instrument(s)?

TBD

22. How robust is/are the wave measurement instrument(s) (like how large is the risk that the instrument(s) or its electronics fails or becomes unreliable during a storm)?

When used within a tube, the transducer is quite robust. The control unit however, should be placed in a protective marina cabinet (or local building)

23. Can any measuring or processing errors be expected during asymmetric or breaking waves? If so, how large are those errors, and what type?

Information unavailable as yet

24. Is it possible to check the performance and accuracy of the wave measurement instrument(s) in the field without removing it, and if so how?

Built in calibration bar has proven over many years that the system never has to be removed for calibration.

25. How large is the expected drift in the calibration after a given period of time, and after how much time would a re-calibration be needed?

See 25 (above)

26. What approach would you suggest to obtain mean water level data and wind data in order to interpret the wave data obtained with your instrument(s)?

We can supply our own weather station wind data to process along with tide monitor data. The data would then be processed in a PC program for user access/data storage.

27. After how many days should the wave measurement instrument(s) be cleaned in order to function properly and keep measuring accurately?

Never. Our systems are maintenance free

29. Are there any reference customers we could approach for an user interview?

We have sold over 300 of these systems around the UK coastline. ABP (Hull) have a networked chain of our units.

30. Is there any other relevant information about the wave measurement instrument(s) we need to know for finding the best wave measurement instrument(s) for measurements at the IJsselmeer and Slotermeer?

SVASEK HYDRAULICS

Questionnaire with regard to wave measurement instruments

All the questions listed below refer to the wave measurement instruments which are suitable for measurements at the IJsselmeer and Slotermeer (see accompanying letter). So if your company sells more then one wave measurement instrument suitable for these measurements please answer all the questions for each wave measurement instrument.

1. *Company specifications:*

Company name:	Bakker & Co
Address:	Gildenweg 3 3334 KC Zwijndrecht
Phone:	078-6101666
E-mail:	Espoelder@bakker-Co.nl
Filled in by:	Edwin Spoelder, sales engineer

2. *Which wave measurement instrument(s) does your company sell?*

De afdeling IME van Baker & Co verkoopt sensoren, systemen en meetoplossingen op het gebied van klimaat en meteorologie.
Het succes van Bakker & Co is dat wij beschikken over een gericht leverancier pakket waaruit klantgericht meetoplossingen worden samengesteld en aangeboden.

3. *Give a short description of the functions of the(se) wave measurement instrument(s)?*

Voor golfmetingen hebben wij robuuste hoognauwkeurige druksensoren in ons productenpakket. (0,01% nauwkeurigheid FS en een verwaarloosbaar kleine hysterese)
De druksensoren zijn een goede basis voor een dergelijk systeem.

4. *What is the brand(s) of the(se) wave measurement instrument(s) (if your company sells more than three different brands of one instrument, then please list only the three most suitable for wave measurements on the IJsselmeer or Slotermeer (see accompanying letter)):*

Paroscientific (<http://www.paroscientific.com/>)

5. *The wave measurement instrument(s) consists of:*

1. Een of enkele hoog nauwkeurige druksensoren
2. Apparatuur voor data acquisitie, distributie en analyse

6. *Which materials the wave measurement instrument(s) consist of?*

Paroscientific heeft haar sensoren applicatiespecifiek ingedeeld.
(Zie bijgesloten specificatie)

7. *What are the physical specifications of the wave measurement instrument(s)?*

De sensor (meetbereik, model, uitgangsignaal etc) wordt klantspecifiek bepaald.
(Zie bijgesloten specificatie)

8. *What is the energy use of the wave measurement instrument(s)?*

6 tot 25 volt DC, 1,3 mA
(Zie bijgesloten specificatie)

9. *How many days can the wave measurement instrument(s) measure non-stop with internal batteries and memory (so if autonomously)?*

NVT, Paroscientific is enkel alleen de sensor.

10. *How sensitive is the wave measurement instrument(s) for damage of storm, ice, driftwood or vandalism?*

Praktijk heeft uitgewezen dat de sensor zeer robuust is.

11. *What is (are) the price(s) of the wave measurement instrument(s) (include the technical specifications)?*

De investering van een enkele Paroscientific sensor begint bij ca € 3.500.

12. *Is the wave measurement instrument(s) available for trails/purchase in the short term?*

De sensoren worden klantspecifiek gemaakt. Levertijden zijn in overleg. In de praktijk is dit ca. 6 weken.

13. *What does the output data consist of (e.g date, wave height, wave direction, etc)?*

De sensor is beschikbaar met twee verschillende uitgangsignalen:
- Een frequentie uitgangsignaal met een amplitude van 6 volt piek-piek (Deze frequentie varieert als functie van de gemeten druk)
- Een RS232 of RS485 signaal. Middels een communicatieprotocol worden de meetgegevens verstuurd.

14. *Is it possible to transfer the output data (for example with GSM/Satel transmitters (9600 Bps)) without interruption of the measurements?*

NVT

15. Does the wave measurement instrument(s) measure continuously (3600sec/h and 24h/day)?

NVT

16. How much output data does the wave measurement instrument(s) produce in one day (MB)?

NVT

17. How much output data can be stored by the wave measurement instrument(s) (MB)?

NVT

18. Please specify any critical assumptions and conversions to evaluate the waves from raw signal which may effect the accuracy of the end results?

NVT

19. What is the accuracy of the wave measurement instrument(s) (wave periods (e.g Tp,Tm01) and wave heights),please specify ?

NVT

20. Can the wave measurement instrument(s) accurately measure at a sample frequency of 4 Hz? If not is it possible to adjust the instrument(s) to such a frequency?

Ja, de Paroscientific sensor met een frequentie-spanning als uitgang kan met een hogere frequentie meten.

21. What are the resolution and range (cm) of the wave measurement instrument(s) and do they fit into the requirements of a resolution (raw signal) which does not exceed 5 cm and a range (Hm0) of 5-200 cm?

Ja. Meetbereik van 10 meter waterdruk: Een absolute nauwkeurigheid van < 0,01% resulteert in een absolute nauwkeurigheid van 1 mm. Een resolutie van 0,0001% in 0,01 mm.

22. What is the wave frequency range of the wave measurement instrument(s)?

NVT

23. How robust is/are the wave measurement instrument(s) (like how large is the risk that the instrument(s) or its electronics fails or becomes unreliable during a storm)?

Erg robuust. Voorbeeld: De sensor wordt met success toegepast in een Tsunami detectie systeem. <http://www.paroscientific.com/tsunameter.htm>

24. Can any measuring or processing errors be expected during asymmetric or breaking waves? If so, how large are those errors, and what type?

NVT

25. Is it possible to check the performance and accuracy of the wave measurement instrument(s) in the field without removing it, and if so how?

NVT

26. How large is the expected drift in the calibration after a given period of time, and after how much time would a re-calibration be needed?

Verwaarloosbaar klein. Het bijgesloten boekje beschrijft deze stabiliteit.

27. What approach would you suggest to obtain mean water level data and wind data in order to interpret the wave data obtained with your instrument(s)?

Voor registratie van de meteogegevens zijn legio oplossingen te verzinnen. Bakker & Co heeft ruime ervaring hierin met Lambrecht meteo sensoren en systemen. (www.lambrecht.net)

Voordat wij een voorstel doen willen wij eerst meer weten van de gewenste toepassing.

28. After how many days should the wave measurement instrument(s) be cleaned in order to function properly and keep measuring accurately?

NVT

29. Are there any reference customers we could approach for an user interview?

Ja.

30. Is there any other relevant information about the wave measurement instrument(s) we need to know for finding the best wave measurement instrument(s) for measurements at the IJsselmeer and Slotermeer?

De website van Paroscientific heeft diverse praktijkvoorbeelden en studiebeschrijvingen.

<http://www.paroscientific.com/>

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All the questions listed below refer to the wave measurement instruments which are suitable for measurements at the IJsselmeer and Slotermeer (see accompanying letter). So if your company sells more then one wave measurement instrument suitable for these measurements please answer all the questions for each wave measurement instrument.

1. *Company specifications:*

Company name:	Datawell b.v.
Address:	Zomerluststraat 4 2012 LM Haarlem the Netherlands
Phone:	+31 23 5316053
E-mail:	sales@Datawell.nl
Filled in by:	Henny Joosten

2. *Which wave measurement instrument(s) does your company sell?*

1 Waverider SG
2 Directional Waverider MKIII
3 Directional Waverider GPS

3. *Give a short description of the functions of the(se) wave measurement instrument(s)?*

1. Waverider SG: flexible moored buoy, with internal stabilized platform and accelerometer.

2. Direction Waverider MKIII flexible moored buoy, with internal stabilized platform and accelerometer in combination with horizontal accelerometers and compass. By measuring the orbital motion of the water particles the wave height and wave direction are determined.

3. Direction Waverider GPS flexible moored buoy which measures the wave height and wave direction by following the orbital motion of the water particles and detecting this motion via the GPS-system.

4. What is the brand(s) of the(se) wave measurement instrument(s) (if your company sells more than three different brands of one instrument, then please list only the three most suitable for wave measurements on the IJsselmeer or Slotermeer (see accompanying letter)):

All 3 instrument types are made by Datawell b.v.

5. The wave measurement instrument(s) consists of:

1. Waverider SG:
Stainless steel hull, batteries, vertical reference unit and vertical accelerometer, plus analogue electronics, digital electronics data-logger GPS receiver HF transmitter LED-flashlight .

2. Direction Waverider MKIII
Stainless steel hull, batteries, vertical reference unit and vertical accelerometer, horizontal accelerometer compass, plus analogue electronics, digital electronics data-logger GPS receiver HF transmitter LED-flashlight, sea water temperature sensor.

3. Direction Waverider GPS
Stainless steel hull, batteries, GPS receiver, digital electronics, data-logger HF transmitter LED-flashlight, sea water temperature sensor.

6. Which materials the wave measurement instrument(s) consist of?

1. Waverider SG:
2. Direction Waverider MKIII:
3. Direction Waverider GPS :

All buoys are made of stainless steel AISI 316. Optional the hull can be supplied from Cunifer-10, which does neither pit nor foul.

7. What are the physical specifications of the wave measurement instrument(s)?

1. Waverider SG:
2. Direction Waverider MKIII:
3. Direction Waverider GPS :

All buoys are spheres with a diameter of 0.7 m, with a 2 m HF-antenna on the hatch cover. Weight: 100 Kg. Hulls with a diameter of 0.9 with longer lifetime are available as well.

8. What is the energy use of the wave measurement instrument(s)?

WR SG	0.27 Watt including HF-transmission
DWR MKIII	0.38 Watt including HF-transmission
DWR-G	0.90 Watt including HF-transmission

9. How many days can the wave measurement instrument(s) measure non-stop with internal batteries and memory (so if autonomously)?

Buoy diameter:	0.7 m	0.9 m
1. Waverider SG	1.5 year	3 year
2. Direction Waverider MKIII	1.0 year	3 year
3. Direction Waverider GPS	0.7 year	1.7 year

10. How sensitive is the wave measurement instrument(s) for damage of storm, ice, driftwood or vandalism?

The design is solid and reliable. Waveriders have been in use by Rijkswaterstaat in the IJsselmeer for many years in the 1970-s and early 1980-s without problems. In order to confirm the success of the instrument at this location consult the location "Den Oever" Person to address: Luc Overmars (retired a couple of years ago).

Waverider are in use in Finland and Island for many years without problems.

11. What is (are) the price(s) of the wave measurement instrument(s) (include the technical specifications)?

1. Waverider SG	€ 11,700
2. Direction Waverider MKIII	€ 22,500
3. Direction Waverider GPS	€ 17,200

Prices are for the 0.7 m diameter versions incl. datalogger, HF-transmission, LED-flashlight, GPS receiver.

12. Is the wave measurement instrument(s) available for trails/purchase in the short term?

Yes

13. What does the output data consist of (e.g date, wave height, wave direction, etc)?

Wave data are presented along three lines of approach:
Displacement data: Beside a plot of the heave time series, the heave distribution is shown (versus Gaussian distribution). A table of statistical moments and correlations for all displacement signals is presented.
Spectral data: The wave spectrum is plotted as function of either wave frequency or wave period. The MEM (3D) spectrum is shown as a contour plot or a 3D surface plot. Tables of buoy parameters and spectral parameters, among which the significant steepness Ss, the spectral band width parameters , and <, and Goda's peakedness parameter Qp, are presented.
Wave-statistical data: the zero-upcross waves are plotted chronologically or sorted by height (versus Rayleigh distribution). A contour plot of Wave height vs wave period is shown. A table of Hmax, H1/10, H1/3, Hav and associated wave periods is presented.

14. Is it possible to transfer the output data (for example with GSM/Satel transmitters (9600 Bps)) without interruption of the measurements?

Yes, data transmission options are HF 27 – 40 MHz
GSM
Argos
Orbcomm

15. Does the wave measurement instrument(s) measure continuously (3600sec/h and 24h/day)?

Yes

16. How much output data does the wave measurement instrument(s) produce in one day (MB)?

The total amount of Data produced is 1.41 Mb per day

17. How much output data can be stored by the wave measurement instrument(s) (MB)?

Up to 1 Gb

18. Please specify any critical assumptions and conversions to evaluate the waves from raw signal which may effect the accuracy of the end results?

The Datawell data processing has no critical assumption. The raw data is transmitted and stored on logger ready for the customer. In this way the customer is able to do his own conversion.

19. What is the accuracy of the wave measurement instrument(s) (wave periods (e.g Tp,Tm01) and wave heights),please specify ?

1. Waverider SG	0.5% of measured value
2. Direction Waverider MKIII	heave measurements: 0.5% of measured value
3. Direction Waverider GPS	1-2 cm

All (heave) measurements are made with the above accuracy. Based on these measurements the wave statistics are preformed.

20. Can the wave measurement instrument(s) accurately measure at a sample frequency of 4 Hz? If not is it possible to adjust the instrument(s) to such a frequency?

1. Waverider SG	10.24	Hz
2. Direction Waverider MKIII	3.84	Hz
3. Direction Waverider GPS	10	Hz

21. What are the resolution and range (cm) of the wave measurement instrument(s) and do they fit into the requirements of a resolution (raw signal) which does not exceed 5 cm and a range (Hm0) of 5-200 cm?

1. Waverider SG	resolution 1 cm range -20m +20 m
2. Direction Waverider MKIII	resolution 1 cm range -20m +20 m
3. Direction Waverider GPS	resolution 1 cm range -50m +50 m

22. What is the wave frequency range of the wave measurement instrument(s)?

1. Waverider SG	1s – 30 s	1 Hz – 0.033 Hz
2. Direction Waverider MKIII	1.6 s – 30 s	0.6 Hz – 0.033 Hz
3. Direction Waverider GPS	1.6 s – 100 s	0.6 Hz – 0.01 Hz

23. How robust is/are the wave measurement instrument(s) (like how large is the risk that the instrument(s) or its electronics fails or becomes unreliable during a storm)?

Thousands of these instruments have been sold for the sea marked applied in severe storms in the southern Atlantic (Argentina) to the storms around Island. No problems! The GPS buoy (3) however loses contact with the GPS satellites when spray is washed over the GPS-antenna.

24. Can any measuring or processing errors be expected during asymmetric or breaking waves? If so, how large are those errors, and what type?

The Directional Waverider SG stops measuring when spilled over by breaking waves. Within seconds measurements start again when GPS antenna is clear.

For the Waverider SG and the Directional Waverider measurements are not effected.

Please note; Breaking waves are of different types (Spilling, Plunging Collapsing and Surging). No errors occur with the spilling, collapsing and surging waves. In case of plunging waves the buoy can not follow the water surface correctly since at a certain time 3 water/air interfaces are above each other. The Waverider SG/ Directional Waverider measure the lowest one (correctly!)

Furthermore, note that at extreme conditions (breaking waves, but even with some serious white capping of the waves) The definition of "the" water level is not straight forward. Going upwards the sea water is first more and more filled with air bubbles, slowly changing in air which is filled with spray and foam. The effective water level is not easily detected by means of remote-sensing; however a floating buoy by definition has the correct effective water level.

25. Is it possible to check the performance and accuracy of the wave measurement instrument(s) in the field without removing it, and if so how?
Checking the motion with the crane on the deck of a ship with a handheld receiver is straight forward.

26. How large is the expected drift in the calibration after a given period of time, and after how much time would a re-calibration be needed?

Calibration is recommended every 3 to 6 year
Drift is from 0.5 % gain error to 2% gain error of measured value.

27. What approach would you suggest to obtain mean water level data and wind data in order to interpret the wave data obtained with your instrument(s)?

We recommend the average water level to be measured with Radac (www.radac.nl) equipment, based on radar technology. The RM Young anemometer is regarded as a standard in harsh environment.

28. After how many days should the wave measurement instrument(s) be cleaned in order to function properly and keep measuring accurately?

No cleaning is needed.

29. Are there any reference customers we could approach for an user interview?

RIKZ Den Haag,

Theo Sijben T.G.M.Sijben@rikz.rws.minvenw.nl
Martijn Andernach M.Andernach@rikz.rws.minvenw.nl

30. Is there any other relevant information about the wave measurement instrument(s) we need to know for finding the best wave measurement instrument(s) for measurements at the IJsselmeer and Slotermeer?

The requirement of measuring waves up to 0.7 s requires some attention. The wavelength ($\lambda=gT^2/(2\pi)$) is 0.7 m. In order to measure this wave correctly the sensitive part of the instrument (diameter of the buoy/footprint of the radar/sonar) should be far less then λ. For a buoy, or in general for sensors which can survive in harsh conditions and measure up to 5 m wave height this is a serious challenge.

What could be done is using a very small buoy to study high frequency waves, and use a large buoy for the storm conditions. (Datawell's 40 cm diameter DWR-GPS buoy can measure waves up to 1 Hz.)

Transmission range of the HF_transmitter is specified 50 Km in seawater. In fresh water this reduces to approximately 20 Km.

On the other side of the afsluitdijk, at the wadden zee at e.g. Dove balg 90 cm Waveriders and Directional Waveriders are and will be used by RIKZ.

In general we recommend RIZA to cooperate with RIKZ for measuring waves. RIKZ has decades of experience with Waveriders, and other wave sensors (ADCP of RDI and Stappen baak of Etrometa), and has, just like Datawell, in-door test facilities, storage of consumables and spare part. Furthemore a lot of experience in handling of this equipment.

SVASEK HYDRAULICS

Questionnaire with regard to wave measurement instruments

All the questions listed below refer to the wave measurement instruments which are suitable for measurements at the IJsselmeer and Slotermeer (see accompanying letter). So if your company sells more then one wave measurement instrument suitable for these measurements please answer all the questions for each wave measurement instrument.

1. *Company specifications:*

Company name:	Etrometa B.V.
Address:	Kerkewal 49 8401 CH Gorredijk
Phone:	0513 463435
E-mail:	jbleenhouts@etrometa.demon.nl
Filled in by:	John B. Leenhouts

2. *Which wave measurement instrument(s) does your company sell?*

Stepgauge.

3. *Give a short description of the functions of the(se) wave measurement instrument(s)?*

Measuring instantaneous waterlevel, resulting in both waterlevel and wave height.

4. *What is the brand(s) of the(se) wave measurement instrument(s) (if your company sells more than three different brands of one instrument, then please list only the three most suitable for wave measurements on the IJsselmeer or Slotermeer (see accompanying letter)):*

Etrometa stepgauge.

5. *The wave measurement instrument(s) consists of:*

1 Stepgauge electronics unit, SGE, E 50000
Options to the SGE; - Tide calculation, E 50021
- Analog output, E 50140
- Calculation of Wind-direction, -velocity and -gust, E 50580
- Wind sensors for direction and velocity.

1 Stepgauge Head with cable, E 46450
n Modular stepgauge sections E 46300
1 Mechanical installation packet, in accordance with the number n, (optional)
1 Software WTPRS or WTWIS (optional)

6. Which materials the wave measurement instrument(s) consist of?

The stepgauge sections and gauge head: Watertight PVC-inner tube covered with fiberglass reïnforced polyester.
SGE: Polyester box IP65.

7. What are the physical specifications of the wave measurement instrument(s)?

See enclosed manual "STEPGAUGE FOR WAVE AND TIDE MEASUREMENT facultative with wind option E 46400 BL.55E, 9906"

8. What is the energy use of the wave measurement instrument(s)?

SGE + Gaugehead: 65 mW.
Stepgauge sections are powered by built-in battery for life time (10 years)

9. How many days can the wave measurement instrument(s) measure non-stop with internal batteries and memory (so if autonomously)?

The SGE has no internal batteries. The SGE basically has no memory but is prepared to accommodate options. Options will be made in accordance with customer requirements. Already available options are specified under 5.

10. How sensitive is the wave measurement instrument(s) for damage of storm, ice, driftwood or vandalism?

The construction of the instrument as such is very robust so it is very insensitive to external dangers. Above that the mechanical installation packet gives the instrument, provided it is adequately installed, protection against collisions with service vessels, yachts, wreckage etc.

11. What is (are) the price(s) of the wave measurement instrument(s) (include the technical specifications)?

See enclosed price list "PRICE LIST WAVE & TIDE STEPGAUGE E 46400", 2004.

12. Is the wave measurement instrument(s) available for trails/purchase in the short term?

Yes.

13. What does the output data consist of (e.g date, wave height, wave direction, etc)?

See figure 4 of the manual.

14. Is it possible to transfer the output data (for example with GSM/Satel transmitters (9600 Bps)) without interruption of the measurements?
Yes.

15. Does the wave measurement instrument(s) measure continuously (3600sec/h and 24h/day)?

Yes.

16. How much output data does the wave measurement instrument(s) produce in one day (MB)?

With a sampling rate of 2,56 Hz this will amount 1,77 Mb, in case it's not time labeled. It will be roughly the double with time labeling.

17. How much output data can be stored by the wave measurement instrument(s) (MB)?

To be defined in accordance with customers requirements. Mind that, in case of temporarily off-line operation, real-time labeling of measured samples will be necessary. This can be performed in the option as well.

18. Please specify any critical assumptions and conversions to evaluate the waves from raw signal which may effect the accuracy of the end results?

Right from the foremost physical contact with the water surface the measuring immediately takes place digital. There are no signal conversions at all. Further there is no cumulative error like a percentage of an end of scale, because the instrument actually consists of discrete sensing elements every 5 cm over its whole range. Finally there are several error checks in the sensor as well as in the data processing.

1. Error checks in the sensor:

1.1. Distinction is made between "green water" and splash water in wave crests.

1.2. Should one individual electrode fail this only affects one reading sample when the water level is precisely the level of that electrode. In other words the missing of an electrode is neither cumulating (positive or negative) nor repeating in the readings of other electrodes.

2. For error checks in the software, see the enclosed document: Note 0223.

19. What is the accuracy of the wave measurement instrument(s) (wave periods (e.g Tp,Tm01) and wave heights),please specify ?

On the level of sampling the resolution of the measurement of the instantaneous waterlevel is + 2,5 cm.

20. Can the wave measurement instrument(s) accurately measure at a sample frequency of 4 Hz? If not is it possible to adjust the instrument(s) to such a frequency?

4 Hz: is standard available.
Adjustability: The sampling(rate) can be triggered from the data collection system up to a maximum of 10 Hz.

21. What are the resolution and range (cm) of the wave measurement instrument(s) and do they fit into the requirements of a resolution (raw signal) which does not exceed 5 cm and a range (Hm0) of 5-200 cm?

The resolution of each individual sample is + 2,5 cm. This is independent from the range of the instrument, so it fits the requirements.

22. What is the wave frequency range of the wave measurement instrument(s)?

Concerning the sensor:
We make the assumption that one full wavecycle of the shortest waves can be adequately captured by 4 measuring samples. In case of a sampling rate of 2.56 Hz this results in a minimum period time of 1,5625 sec hence in a maximum wave frequency of 0,64 Hz. The minimum measurable wave frequency is 0 Hz.
Concerning the wave data processing software WTPRS:
The range of the presentation runs from 0,5 Hz to 0,03 Hz.

23. How robust is/are the wave measurement instrument(s) (like how large is the risk that the instrument(s) or its electronics fails or becomes unreliable during a storm)?

The stepgauge is an extremely robust sensor with a proven long term stability.

24. Can any measuring or processing errors be expected during asymmetric or breaking waves? If so, how large are those errors, and what type?

See answers to question nr. 18.

25. Is it possible to check the performance and accuracy of the wave measurement instrument(s) in the field without removing it, and if so how?

Yes.You can simly monitor the actual waterlevel by human reading and compare it with reading on the display of the instrument. The part of the sections of the instrument above the actual waterlevel can easily simulated being under water, the instruments display shows than the simulated waterlevel. Unskilled people can do this work.

26. How large is the expected drift in the calibration after a given period of time, and after how much time would a re-calibration be needed?

There is principally no drift in the instrument. The instrument does't require re-calibration at all. Care has to be taken to the stability of the instrument's suspension as well as to subsidence with regard to the bearing construction.

27. What approach would you suggest to obtain mean water level data and wind data in order to interpret the wave data obtained with your instrument(s)?

For waterlevel determination there are two possibilities available.
1) A standard "tide-option" can be plugged-in into the SGE and provides averages over, either 10 seconds or 60 seconds.

2) The data processing system WTPRS provides besides wave data processing, tide data as well.
Concerning wind data there is a standard "wind-option" for the SGE available complete with wind data processing. The addition of wind data processing turns WTPRS into WTWIS.

28. After how many days should the wave measurement instrument(s) be cleaned in order to function properly and keep measuring accurately?

In common seawater one cleaning in the springtime of each year is sufficent. Cleaning can be done with a brush on a stick from just above the water level. Experiences with fresh water applications are not ready available. They can be investigated if desired. Mind there are just e few available. (Rivers Scheldt and Loire) Re-painting the stepgauge sections anti fouling paint: once every 3 years. Sections to be re-painted can be simply exchanged by spare ones thanks the mechanical installation packet. The latter also grants maintaining of the elevation of exchanged sections because the mechanical installation packet contains a fixed and stable footsupport to which the bottom end of the lowest section is catched. So there will not appear any step in data series after exchanging sections

29.Are there any reference customers we could approach for an user interview?

Yes, The governments of The Netherlands, Belgium and the United Kingdom.

30.Is there any other relevant information about the wave measurement instrument(s) we need to know for finding the best wave measurement instrument(s) for measurements at the IJsselmeer and Slotermeer?

In general a determining feature for high reliability, low maintenance demanding and long lasting off-shore instrumentation is **low power consumption.** Besides this feature even is of great positive influence to the infra structure costs of off-shore stations.

APPENDIX E INTERVIEWS

Name: Bas Blok **Company: WL-Delft Hydraulics** **Phone: +31(0)152858585** **Mail: Bas.blok@wldelft.nl** **Date: 31 August 2004**	Subject: Shallow water wave measurement systems. Bas Blok is the successor of Jan van de Bunt and is chief of the "meetdienst" of WL-Delft Hydraulics. In the past (1989-1990) the software, written by Bas Blok, is used on behalf of the wave measurements with regard to the Datawell wave buoy. Bas Block' s opinion: "The Vlissingen stepgauge" delivered by DCI, Zeeland Etrometa has probably a 2 cm stepgauge also (beside 5 cm). The laser looks like a wave measurement instrument which will function well for these specific measurements, but this instrument has probably problems in situations with rain or fog. He did not have any other suggestions to measure high frequency waves at shallow water in addition to the capacitance probe, the step gauge and the pressure sensors.
Name: Van Doorn **Company: RWS,RIKZ** **Phone: +31(0)703114606** **Mail: jhm.vdoorn@rikz.rws.minvenw.nl** **Date: 31 August 2004**	Subject: Measurements at the platform "Noordwijk" on behalf of the WACSIS project. Mr van Doorn was already informed about our project by J. Strake. He was very surprised that this project was not solved internally but boarded out. His remarks about the wave measurement systems used at the WACSIS experiment were: • "The Vlissingen step gauge" was the first one, succeeded by "The Marine 300" (this gauge is actually the same as the Vlissingen step gauge only this gauge consists of different parts). Subsequently Etrometa has developed a better design of this kind of step gauge. The production of the first two step gauges (Vlissingen and Marine 300) has stopped. • The *EMI Laser* was produced by the company "EMI" (LP, records). This company does not exist any more and the successor is unknown. • The *Baylor wave staff* is not known by Mr van Doorn. • The *Saab radar* is still on the market only the producer is changed to "WS ocean systems". His experience with the Saab Radar is not undivided positive. A lot of reflection (dispersive) of the signal occurs at rough weather resulting in a unclear receiving signal. This instrument has a preferential value for the flanks of the waves (beamwidth). • He expects this problem with The RADAC system as well. He suggests contacting Jos Kokke in order to get more information about the radar measurement technique (mapping also).

	• The Marex Radar is probably not available any more (outdated). • He suggested contacting Rinus Schoevers and IMAU for information about the ADCP systems.
Name: Evert Bouws **Company: KNMI** **Phone: +31(0)302206888** **Mail:** **bouws@knmi.nl** **Date: 6 september 2004**	Subject: Wave measurements at the Dutch lake Markermeer Evert Bouws has performed wave measurements at the Dutch lake Markermeer near by Lelystad (1983-1984) (see memorandum 1986, provisional results of a wind wave experiment in a shallow lake). This experiment is almost the only experience of him with wav measurements. During the wave measurements at the Dutch lake Markermeer throughout the winter, a capacitance probe was used for the wave measurements. These measurements were calibrated with a Datawell waverider. Mr Bouws has no direct involvement with wave measurements any more. He subscribes the importance of continuously wave measurement at shallow water. Mr. Bouws himself has no experience with wave measurements where a laser is used, but from combined activities with various researchers in COST-connection, he noticed that a laser can be a wave measurement instrument which can function very well for wave height measurements and especially for measurement of very short waves (because of the small footprint). He thinks that several disadvantages can be found also by using a laser and he advised to contact dr. Harald Krogstad (Trontheim). Mr Krogstad (harald.krogstad@math.ntnu.no) has written about the laser as a wave height measurement and probably has some documentation about this.
Jos Kokke **Company: RIKZ (RWS)** **Phone: +31(0)703114515** **Mail:j.m.m.kokke@rikz.rws.minvenw.nl** **Date: 6 September 2004**	Subject: Radar level and Radar "mapping" as a measurement technique As a result of the conversation with Mr. Van Doorn we have contacted Jos Kokke again in order to get more information about experience with Radar level and Radar "mapping" equipment. Measurements at the North Sea are carried with *the Saab Radar* (at least ten years). Mr Kokke advised to contact Herman Peters who is working at the Directorate North Sea and he has a lot of experience with this instrument and also with the laser as a wave measurement instrument (070-3666666). Soon a report will be published written by Jos Kokke. This report describes laboratory tests also. *Radar wave mapping* FEL/TNO is working on a field experiment of measurements b

	means of a shipradar measuring the wave height and direction. At the end of 2004 a report of this experiment will be published. Jur Vogelzang (AGI) has written a report about Radar "mapping" of the wave measurements at Petten (MD-GAR-2001-14).
Name: Harald Krogstad **Company: Scientific advisor** **Mail:** harald.krogstad@math.ntnu.no	Svašek: We (Svašek Hydraulics) are currently working on a project for the Dutch Ministry of Public Works to investigate shallow water wave measuring equipment. One of the requirements is that the system should be able to measure short waves (as from 0.75 m in wave length) with short wave periods (as from +/- .7 seconds). A relative small footprint is required. One of the options is to measure the water level from above using a laser. We are looking for a laser based, downward looking, water level monitoring system which is able to measure water level at 4 Hz interval. The system should be used to measure waves and water levels. From a pile(approximately 3 m above still water). We are interested if such a system is feasible also in respect of rainfall, spray and other weather related effects. Reaction: The short answer to your question is the Optec Range finder Laser which is currently also in use at the Ekofisk field in the North Sea (http://www.optech.on.ca/). There used also to be European equivalents produced by Thorn/EMI, but I do not know the present status of their product. The Thorn/EMI laser worked very well from the Meetpost Noordwijk platform during the WACSIS experiment (see attachment). Finally, Tom Van der Vlugt has developed a radar-based instrument that could be interesting (http://www.radac.nl/). No problem with the Optec laser at least. At Ekofisk the sampling is 5Hz and the distance to the surface is about 20m. The footprint of laser is of the order of cm-s. Svašek: We are interested if such a system is feasible also in respect of rainfall, spray and other weather related effects? Reaction: That is a bit more uncertain. We do have frequent occasional data drops, and I have no experience how much better this will be for shorter ranges, probably not a major problem.

	The measuring principle is, however, that 80 pulses are sampled at 2000Hz and the final data value is an average of those (the good ones). My immediate guess is that the Optec laser would work fine fc you, but I have not been involved in the set up and the data aquisition system and how much work is needed for that. Hope this may be of some help to you Yours Harald Krogstad
Name: Herman Peters **Company: North Sea Directorate (RWS)** **Phone: +31(0)703366666** **Mail: h.c.peters@dnz.rws.minven w.nl**	As a result of the telephone conversation with Mr. Kokke we have contacted Herman Peters. Herman Peters has a lot of experience with Radar level measurements. He refers to the report on RADAC measurements written by J Kokke. He advised to take the Radar level measurement instrument of Endress Hausser into consideration. His knowledge and experience of the wave measurements wit a laser in relation with the Radar level measurement instruments can be found in the following e-mail from H. Peter and J. Kokke: *Hai Jos,* *uit mijn hoofd zeggend (ik herinner me nog een EMI laser op de meetpost noordwijk) een tweetal aspecten:* *1) relatief sterke potentieel negatieve invloed (signaal verlies doo absorptie en verstrooiing) van de tussenliggende luchtweg door bijvoorbeeld mist, waterdamp, sneeuw, regen, opspattend water etc. Voor een laser met een golflengte van een paar honderd nanometer is die invloed veel sterker dan voor een mikrogolfradar met een golflengte van enkele cm's (scheelt in golflengte een factor 100.000 of zo). Dit aspect zorgt, met name voor een buitenopstelling in soms ruw weer, voor een slechtere betrouwbaarheid (door uitval!) en nauwkeurigheid (variatie van de lichtsnelheid) van de hoogtemeting. Je merkt al dat de hoogfrequentere radars boven 10 GHz onrustiger zijn dan de laagfrequentere radars met een frequentie van pakweg enkele GHz.* *2) de bundelbreedte is vaak veel kleiner dan bij een mikrogolfradar. Dat is gedeeltelijk een voordeel, want je kan er beter de kortere watergolven (zelfs de korte capillaire golfjes!) mee meten, maar het maakt golfmetingen door de kleine belichte vlek ook erg onrustig. Voor waterstanden op buitenwater is het dus eigenlijk zeer ongunstig, want het signaal is daardoor van nature door het gebrek aan middeling erg instabiel.* *3) het licht reflecteert niet volledig aan het wateroppervlak, want is (afhankelijk van de golflengte) ook nog een aanzienlijke*

	transmissie in het water. Dat maakt de echo van het wateroppervlak minder goed detecteerbaar. Bij mikrogolffrequenties is de overgang lucht/water zo extreem dat nagenoeg volledige reflectie optreedt. *4) voor intense, coherente laserstraling (met name in het zichtbare venster) is het menselijk oog erg gevoelig en er worden bepaalde normen voor de maximale stralingsintensiteit gesteld. Dat beperkt wellicht deels (weet ik niet zeker...) de praktische inzetbaarheid. Ik herinner me in ieder geval dat dit aspect belangrijk was bij de toepasbaarheid van airborne laser bathymetry boven open water, want iemand zou op zee per ongeluk in de laserbundel kunnen kijken en oogbeschadiging op kunnen lopen.* *Samenvattend zou je kunnen zeggen dat de laser een uitstekend precisie instrument is (met in potentie een zeer hoge resolutie en nauwkeurigheid) voor gebruik in een laboratorium of buiten onder perfecte weersomstandigheden aan stilstaande waterspiegels en onder begeleiding van een goed opgeleide technicus. Maar voor langdurige autonome buitenmetingen zonder enig menselijk toezicht is het voor waterstandsmetingen eigenlijk ongeschikt. Jos, kun je hier iets mee? ik had net een telefoontje van iemand bij bureau Svasek (geinteresseerd in radars en lasers voor golfmetingen op ondiep water) en stuur hem een CC 'tje om hem ook te informeren.* *Groeten,* *Herman.*
Name:Jur Vogelzang **Company: RWS, AGI** **Phone: +31(0)152757575,** **Mail:** j.vogelzang@agi.rws.minvenw.nl **Date: 9 September 2004**	Mr. Vogelzang (AGI RWS) is involved with an experiment where a radar system (WAMOS) was used for wave measurements performed at Petten in the Netherlands. These measurements are compared with the DIWAR measurements, His conclusion was that the radar system was a good and reliable especially at extreme circumstances (11BF). At the IJsselmeer a test is performed and WAMOS expected that storm conditions could be measured very well. However the wave lengths have to be bigger in comparison with the radar resolution. Mr. Vogelzang expects big problems if you want to measure the wave growth.
Name: Remco Kleine **Company: RDIJ (RWS)** **Phone: +31(0)320264242** **Mail:** **R.Kleine@rdij.rws.minvenw.nl** **Date: 11 September 2004**	Subject: The present measurements at the Dutch lake IJsselmeer and Slotermeer Remco Kleine is a staff member of the instrumentation of the wave measurements at the IJsselmeer and Slotermeer. He has only experience with the capacitance probe and the stepgauges. The experience about the capacitance probe is described in the reports of "the Wave measurements at the Dutch IJsselmeer and Slotermeer lakes" so we have discussed

	about the stepgauge only. The disadvantages of the stepgauges in his opinion were the following: • Sticks to the sensor Because of marine growth at the step gauge it often happened that one sensor was covered with a marine string which resulted in a registration of the sensor as a wet sensor in spite of a lower water level. • Discrete instrument This instrument has sensors at an equal distance of each other (discrete) therefore the instrument could not measure between the sensors • Electronics This was the biggest problem with this instrument. It was very sensitive to failure because of the many convention strokes. The conclusion of the conversation was that the step gauge probably would not be a suitable instrument for the measurements. He had non additional suggestions about our instrument selection.
Name: B.G. Ruessink **Company: IMAU** **Phone: +31(0)302532405** **Mail:** **g.ruessink@geog.uu.nl** **Date: 17 September 2004**	Subject: Pressure based wave measurements The interview with Mr. Ruessink was related to the report that IMAU recently wrote for RIKZ. The title of this report was Directional wave spectra from ADCP's. IMAU is using pressure sensors for wave measurements in the coastal waters. To the opinion of Mr. Ruessink, these pressure gauges are not a good option for the short waves at the IJsselmeer. The position should be to close to the water surface which is probably not feasible. The RDI wave gauges are probably also not capable of measuring short waves. He suggested laser measurements or staffgauges. The contact person to approach in respect of laser measurements was Mr. Ap van Dongeren from WL- Delft.
Name: A. van Dongeren **Company: WL Delft Hydraulics** **Phone: +31(0)152858585** **Mail:** Ap.vanDongeren@wldelft.nl **Date: 17 September 2004**	Subject: Laser based wave measurements Related to the telephone conversation with Mr. G. Ruessink. Mr. Ruessink advised to call Ap van Dongeren because he would be related to laser based wave measurements. Mr. van Dongeren explained that his experiences were related to laboratory scale wave measurements in which laser was combined with video to record wave heights. He did not have experience on shallow water measurements. And considers the Video-Laser option as not usable.

Name: E. Cornelissen **Company:** **Meetdienst Directie Zeeland (RWS)** **Phone: +31(0)118686469** **Mail:** e.w.f.cornelissen@dzl.rws.minvenw.nl **Date: 20 September 2004**	Subject: Advice about our preliminary selection After explaining our project including the objective and the preliminarily results he did not have other suggestions about the wave measurement instruments. He only had some remarks about three instruments he worked with. - The pressure sensor: They did not use this measurement instrument because it depends a lot on the water column above the pressure sensor. - The buoy: The buoy has proven itself over the years - Step gauge: is reliable
Name: A. Verhagen **Company: LogicaCMG** **Phone: +31(0)703029302** **Mail:** louis.verhagen@logicalcmg.com **Date: 29 September 2004**	Subject: Lake George experiment Dr Louis Verhagen (LogicaCMG) was approached related to his extensive measurement knowledge on shallow water waves. His doctoral thesis was titled "Growth of Wind Waves in Finite Water depth". His thesis work is based on a 3 year measurement program conducted on Lake George, Australia. Lake George is a lake width the approximate dimensions of 24 km long, 12 km width and 2 m deep. In Lake George 8 wave gauges were set up to measure differential wave growth. His main findings in regards to the instrument selection and measurement program in Lake IJsselmeer and Slotermeer are: • The Zwarts Wave Pole has been a very reliable, relatively cheap instrument, which has proven to function nearly continuously during the 3 year measurement program. The choice for the Zwarts Pole was among others related to the excellent behaviour of measuring high frequency waves (sampling rate 8 Hz). The poles use the dielectrical properties of the inner and outer pole to determine the water height. Marine growth was a minor problem and did not affect the measurement principle. It could however close the holes through which water was supposed to enter freely. The instruments were cleaned once per 6 month's. Most probably, marine growth could have been prevented, using an antifouling paint. This system had a nearly perfect linear response on water level fluctuations. Re-calibration showed no change in performance during the measurement period. • He considers the capacitance staff gauge as a good "laboratory" tool. However due to sensitivity for marine growth and their limited robustness the instrument requires much maintenance and re-calibration to be considered for a long term unattended field operations. • The RIZA wave measurement program requires in respect

	of the measurement for differential wave growth studies a modified set-up. The present measurement locations are near the boundary of Lake IJsselmeer. In this respect the measurements are to be considered as stand alone measurements. This is fine if RIZA only wants wave measurements at those specific sites for e.g. the validatior of a numerical model of the IJsselmeer. In the Lake Georg set up, the development of the wave field could be addressed since the wave field passes along an array of instruments. To Dr. Verhagen's opinion, depending on the results which are required by RIZA, measurement locations could be discussed and the most suitable locations can be defined • If one of the main purposes of the measurement program i the validation of wave models in general, then it would be recommendable to have scientific participation (Delft University) in the project as well. • Due to the rapid advancement of the technology and instruments the last decade, it would be well worthwhile (time and budget permitting) to consider a trial with two or three instruments in one site. This can be justified in costs considering the large scale deployment in the IJsselmeer. I would also help with getting to know the limitations of the instruments. There is no substitute for field testing of the instruments.
Name: Dr. H.D. Niemeyer **Instituut: Niedersächsisches Landesamt für Ökologie (Forschungsstelle Küste)** **Phone: +49(0)4932916141** **Mail:** hanz-dieter.niemeyer@nloe.niedersachsen.de **Date: 7 October 2004**	Dr. H.D. Niemeyer had some remarks with respect to our study: • He advised not to use the pressure sensors because of the presence of sharp waves. • Nice experience with the radar gauge (see report of Joska Andorka Gál, RWS/RIKZ) • He has also good experience with the wire gauges (they were very reliable), only fouling was one of the problems

SVASEK HYDRAULICS

APPENDIX F SPECIFICATIONS WAVE MEASUREMENT INSTRUMENTS

SVASEK HYDRAULICS

STEPGAUGE (ETROMETA)

SPECIFICATIONS STEPGAUGE (ETROMETA)

Stepgauge section

Housing/Material : Square PVC profile coated with reinforced glassfibre. Electrodes are of manganese bronze.
Dimensions : Profile 86 x 86 mm, length L = 3 m minus 5 mm for spacing between the sections.
Weight of 3 m section : Circa 16 kg, section floats in water due to an upward force of ca 23 kg.
Number of electrodes : 60 + 2 earth electrodes.
Distance between : DH = 50 mm, heart to heart. Information about alternative electrodes electrode distances is provided on request.
Distance between : Nominal 5 mm, max. 10 mm. sections
Max. number of sections : 7 for one gauge
Relation sampling rate/ distance between electrodes/range :

	DH = 50 mm (L = 3 m)	
Sampling	Number of sections	Range (max.)
2 x per sec.	7	21 m
2,56 x per sec.	5	15 m
4 x per sec.	3	9 m
Other, special combinations of sampling rates and thereby possible maximum number of gauge sections are provided on request.		

Switching point wet/dry : Lies standard at ca. 6 g NaCl/l, is adjustable at production (is not alterable after production).
Electronics : Internal, powered with Li batteries (life expectancy ca. 15 years, sufficient for total lifetime of stepgauge section) Note: p.c. board and batteries are not attainable.
Data transmission : Bidirectional, serial by inductive transducers at the top and base of each section.
Temperature range : Operating - 20 °C to + 60 °C.

Gaugehead and cable

Mounting	:	On top of the uppermost section of a stack of step- gauge sections.
Material	:	Head, identical to gauge section. Cable with a screen, 4 x 0.5 mm□ cores with polyurethane cover.
Dimensions	:	Head 86 x 86 x 80 mm, cable length standard ca. 10 m. (longer cable on request, max. 50 m.)
Weight	:	Ca. 1 kg.
Distance between gaugehead and section	:	Nominal 0 mm, max. 10 mm.
Electronics	:	A small p.c. board is encapsulated in the head, powered by the electronics unit.
Data transmission	:	See stepgauge section.
Temperature range	:	Operating - 20 □C to + 60 □C.

Electronics unit

Housing	:	According to IP 65, an outer housing or room (unconditioned) for protection against weather influences is recommended.
Material	:	Aluminium (AlSi12) sealed / colour: grey - RAL 7001
Dimensions	:	W x h x d = 160 x 260 x 100 mm.
Weight	:	Ca. 3.7 kg.
Output signal:		
- Format	:	See figure 3.
- Code	:	ASCII
- Sample rate [1])	:	Internal, 2, 2.56 or 4 samples per sec. External, via sync input (see below)
- Baud rate [3])	:	300 Bd (not allowed at 4 samples per sec.) 600 Bd 1200 Bd 2400 Bd 4800 Bd 9600 Bd
- Signal [3])	:	RS 232C / RS422 or FSK FSK: CCITT V23 600 baud 1300, 1700 Hz 1200 baud 1300, 2100 Hz

[1] Jumper selectable on print.

output via tranformer, 600 Ohm, level -6 dBm

- Connector : OUT, Binder type 09.0232.00.04 4p female
  1 - OV or FSK
  2 - RS 232C / RS422 signal or FSK.

Sync input [3] : An extra input offers the possibility of external control of the sample rate.
Specifications isolated by the use of an opto coupler.
Input: TTL levels, "1" max. 0.5 mA
"0" 0 mA
Connections: on PWR connector
3 - sync.
4 - OV (sync.)

Power supply:
- Voltage : +8V ... +18V
- Power consumption : typ. 65 mW (12V), 90 mW with loaded RS 232C / RS422 output
- Connector : PWR Binder type 09.0231.00.04 4p male
  1 - OV
  2 - +8V ... +18V.

Display : 4 digits LCD showing the instantaneous water level in cm referred to a plane 25 mm (1/2 DH) below the lowest electrode of the lowest section.
Useful for checking purposes.

Normal/Service switch : Provides the output signal with a status indication concerning the relevance of the measurement data.

Wave/Tide switch : Has no significance without the "tide" option.

Data transmission to stepgauge sections : Bidirectional, serial to gauge head via SG connector. Binder type 09.0236.00.07 7p female.

Relative humidity : 0% ... 100%.

Temperature range : - 20 °C to + 60 °C.

"Tide" option

For this option a second printed circuit board is placed in the gauge's electronic unit where a space has been reserved. With the standard unit the wiring is also provided for this option. The average water level is calculated with this printed circuit board over a period of 60 sec. The number of measured values used to determine the average is determined by the sample rate. Every 60 sec. the result is given through the OUT connector.

Specifications:

[3] Jumper selectable on print.

- Format : see figure 4.
- Code, baudrate, signal : as with 2.3
- Output : OUT connector (see 2.3)
  3 - OV or FSK
  4 - RS 232C / RS422 or FSK.
- Power supply : as with 2.3, consumption:
  ca. 110 mW total, RS 232C / RS422 outputs unloaded.
  ca. 160 mW both RS 232C / RS422 outputs loaded.

- Display : depending on the position of the wave/tide switch the display indicates the instantaneous water level or average water level respectively.

"Analog output" option

For this option a second printed circuit board is placed in the gauge's electronic unit where a space has been reserved. With the standard unit the wiring is also provided for this option. The measured instantaneous water level is convertered to an analog signal. This signal is present on the OUT connector.

Specifications:

-Output : OUT connector (see 2.3)
3- OV
4- standard
0 ... +5V correspondending with resp. bottomside gauge en upperside gauge.
other available ranges are;
0 ... +1V
0 ... +2V
4 ... 20 mA
inaccuracy due to:
- not lineairity of the DAC
- temperature -20 ... +60 °C max. ± 1‰
- power +10 ... +18V

-Power supply : - +10 ... +18V (different from 2.3)
- consumption ca 175 mW, unloaded.

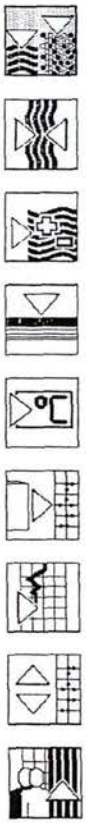
SVASEK HYDRAULICS

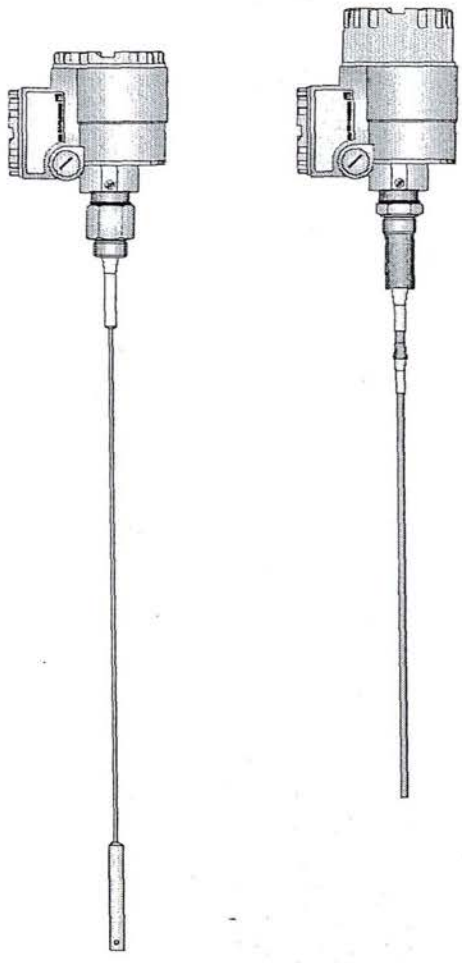
STAFFGAUGE (ENDRESS & HAUSSER)

Technical
Information
TI 243F/00/en

Level Probes
multicap DC 11/16/21/26 AN
multicap DC 11/16/21/26 AS

Fully and partially insulated rod and rope probes for capacitive level measurement and limit detection (North American certificates)





Application
Multicap probes are designed for continuous level measurement and limit detection, primarily in liquids. The DC 11 and DC 16 rod probes are also suitable for use in light bulk solids.

The probe rod or probe rope and insulation are made of corrosion-resistant materials able to withstand extremely aggressive products. The tried-and-tested rugged construction is gas-tight for pressure from vacuum to 1450 psi. Seal and insulation materials enable probes to be used at operating temperatures in the vessel of -110°F to +390°F.

Features and Benefits
Certificates from many North American approval authorities
= the probes have universal use

Versions for a wide range of applications
= ideally adapted to your application at a cost effective price

Screened against condensation in the nozzle
= reliable function even with condensation

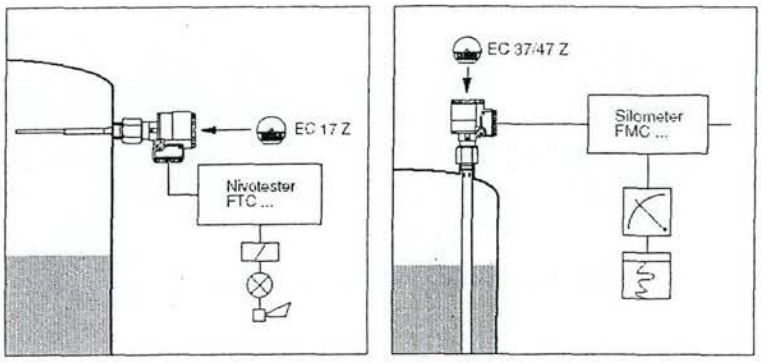
Active build-up compensation for limit detection
= steady and accurate switchpoint even with heavy contamination on the probe, no cleaning or recalibration

Endress+Hauser
The Power of Know How

Measuring System

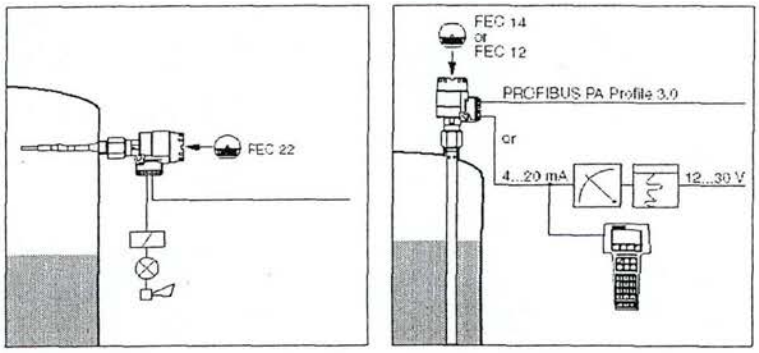
Left: Limit detection with separate Nivotester switching unit

Right: Level measurement with separate Silometer transmitter

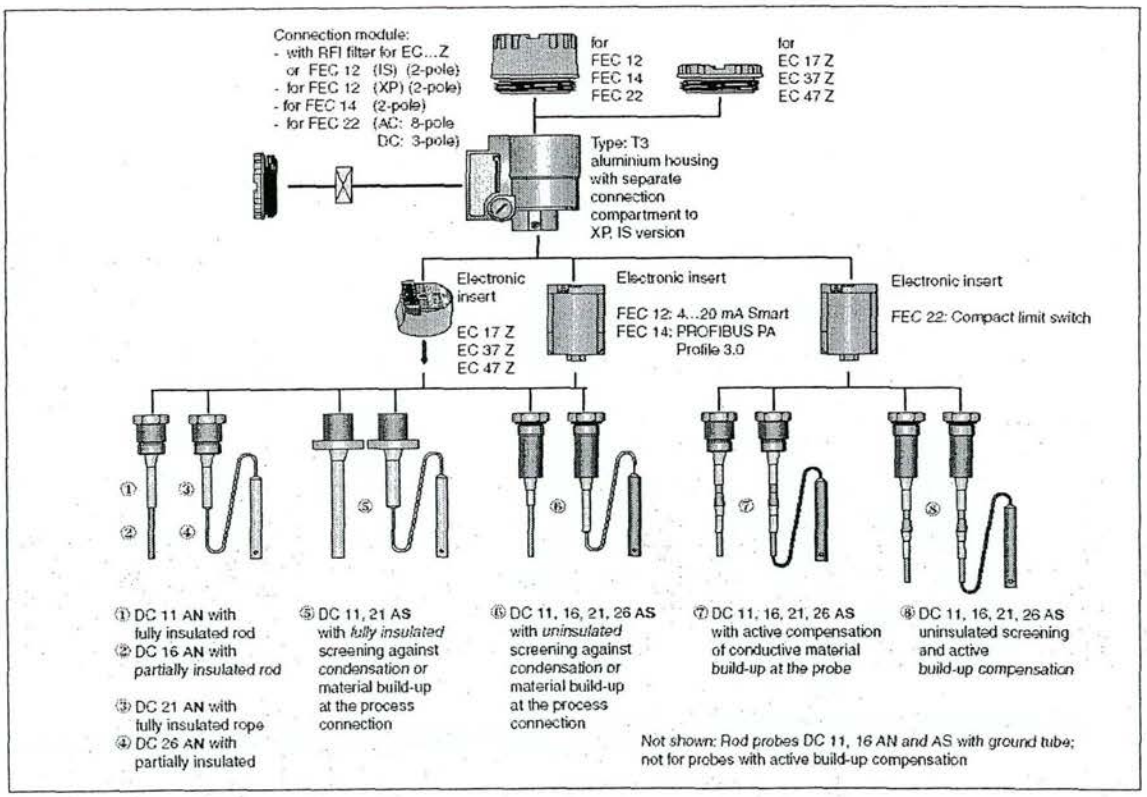


Left: Compact level switch with relay or transistor output

Right: Compact level measurement system with standard 4...20 mA current output and superimposed communications signal. FEC 12: "Smart electronic insert" which allows remote calibration over two-wire cabling (HART protocol) FEC 14: Communication and commissioning with PROFIBUS PA



Probe Selection

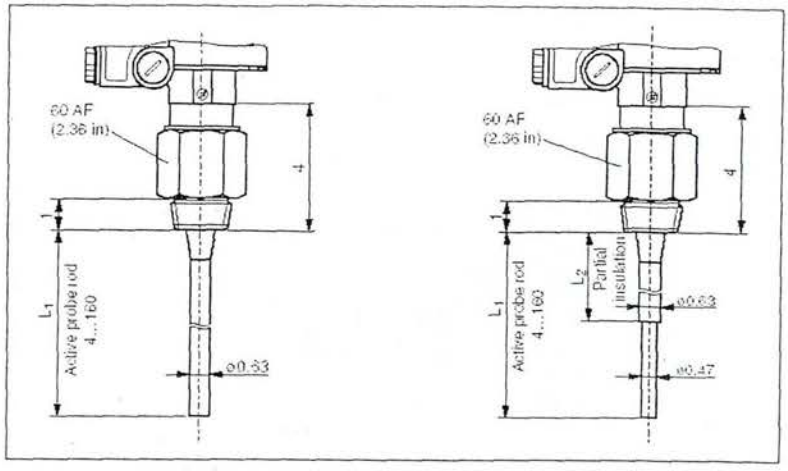


Dimensions

DC 11/16/21/26 AN

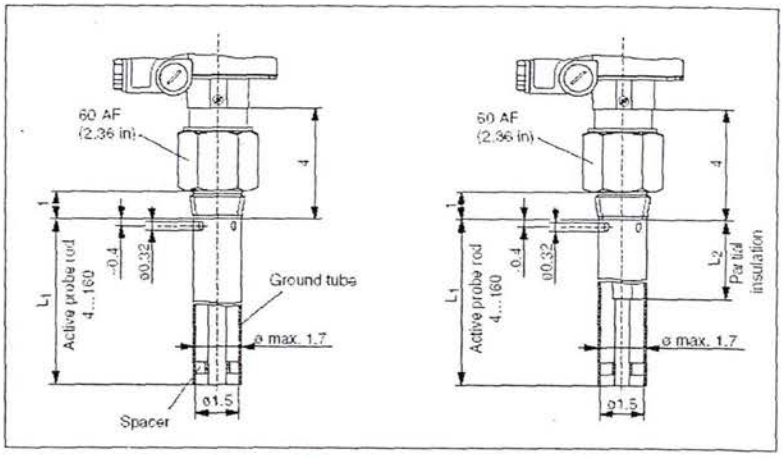
All dimensions in inches.
Threaded process connections: 1½ - 11½ NPT
see Page 6 for other process connections and housing dimensions

L1 = Length of active probe rod or probe rope
L2 = Length of partial insulation
minimum: 3 in
maximum: length L1 minus 2 in



Left: DC 11 AN,
fully insulated rod probe

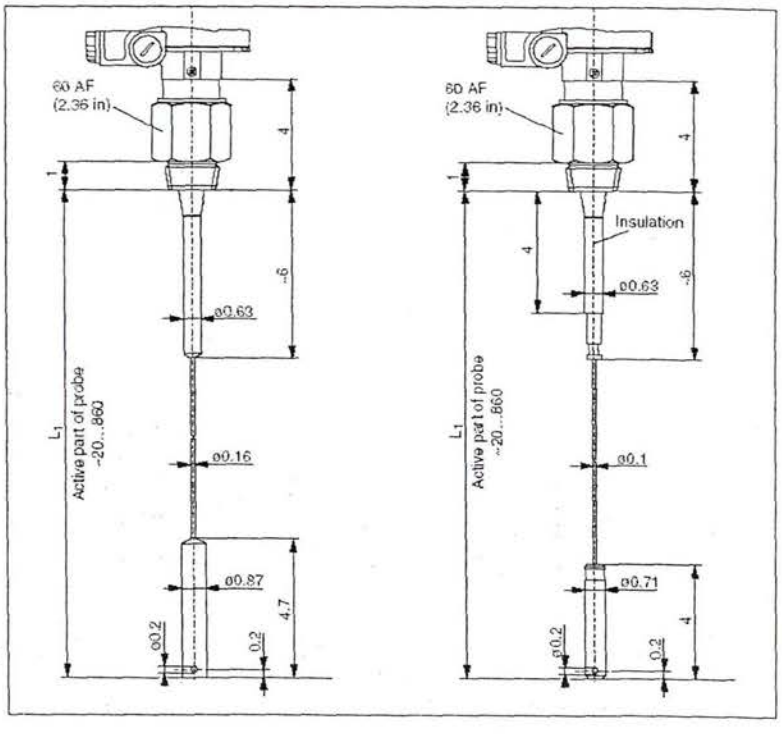
Right: DC 16 AN,
partially insulated rod probe



Left: DC 11 AN,
fully insulated rod probe
with ground tube

Right: DC 16 AN,
partially insulated rod probe
with ground tube

Spacers
every 40 in, of PFA



Left: DC 21 AN,
fully insulated rope probe

Right: DC 26 AN,
partially insulated rope probe

Tensioning weight always
with anchor hole

Dimensions

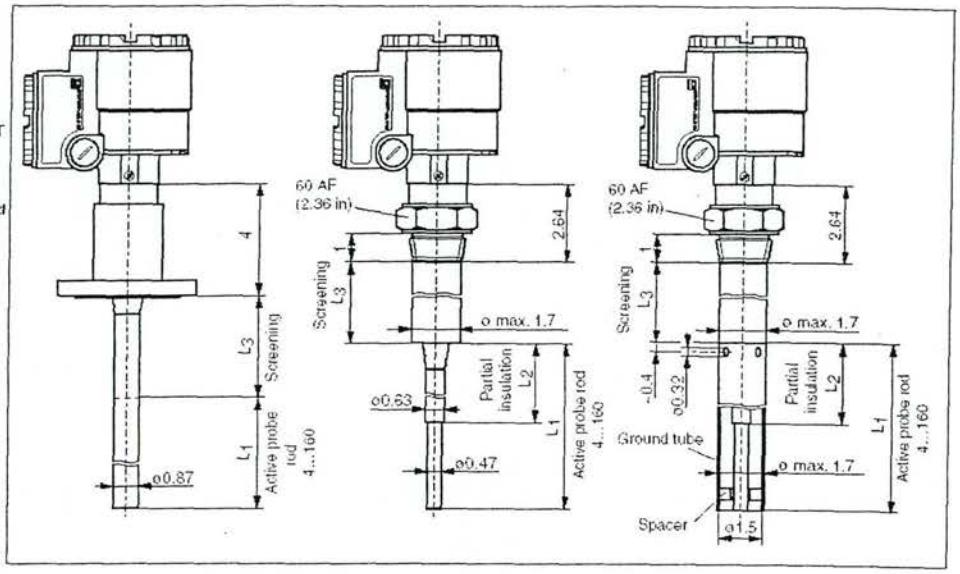
DC 11/16/21/26 AS

All dimensions in inches.
Threaded process connections 1½ - 11½ NPT

Probe with screening L3 *against condensation* and material build-up at the process connection
(inactive section)

see Page 6 for other process connections

L1 = Length of active probe rod or probe rope
L2 = Length of partial insulation
minimum: 3 in
maximum: length L1 minus 2 in

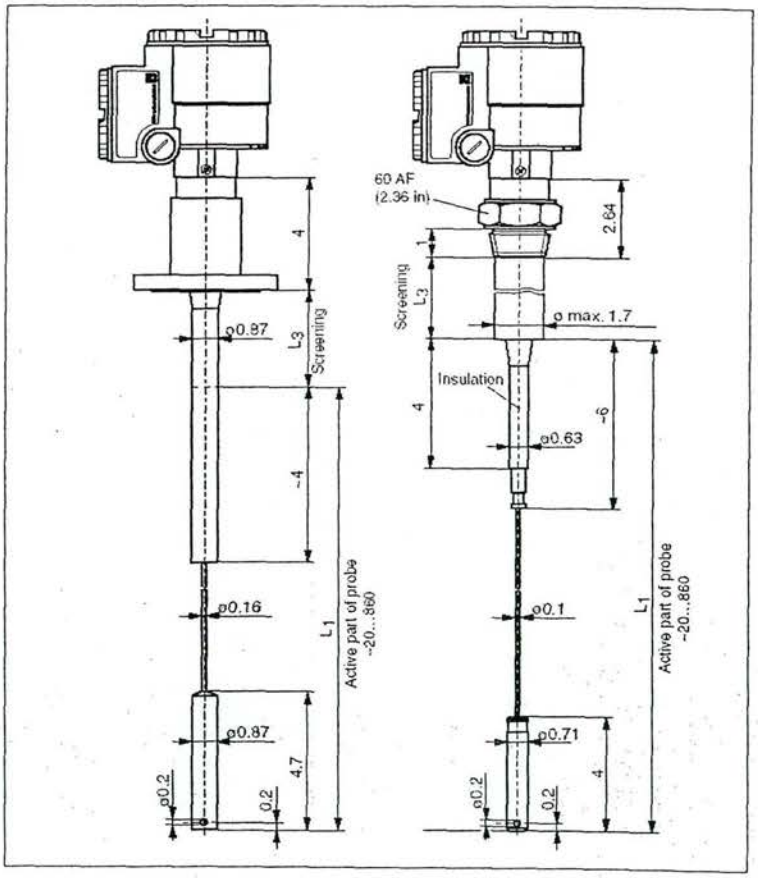


Above left: DC 11 AS, *fully* insulated rod probe with **fully** insulated screening and plastic coated flange

Above, centre and right: rod probes with uninsulated screening, with partially insulated rod with full insulation also available:

DC 11 AS, ully insulated
DC 16 AS, partially insulated

With ground tube
DC 11 AS, fully insulated
DC 16 AS, partially insulated



Left: DC 21 AS, fully insulated rope probe with **fully** insulated screening and *plastic coated flange*

Right: DC 26 AS, partially insulated rope probe with uninsulated screening, uninsulated rope and uninsulated tensioning weight (as shown)

With fully insulated *active section this probe* is designated DC 21 AS

L3
The screening (protection against condensation) is *available in three* standard lengths:
L3 = 6 in
L3 = 9 in
L3 = 20 in

Other lengths on request
L3 *min.* 4 in
L3 max. 160 in (uninsulated screening)
L3 max. 80 in (fully insulated screening)

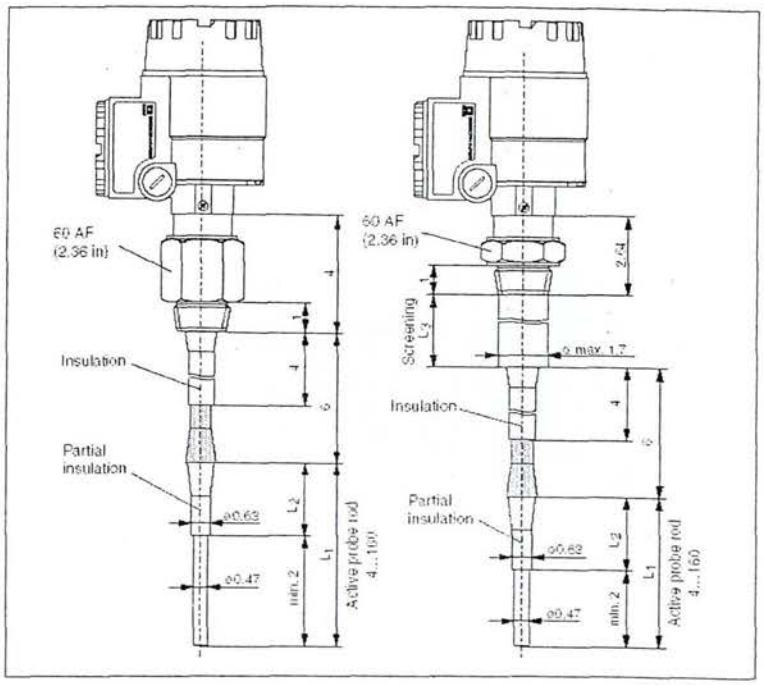
Dimensions

DC 11/16/21/26 AS
Continued

All dimensions in inches.
Threaded process connections: 1½ - 11½ NPT

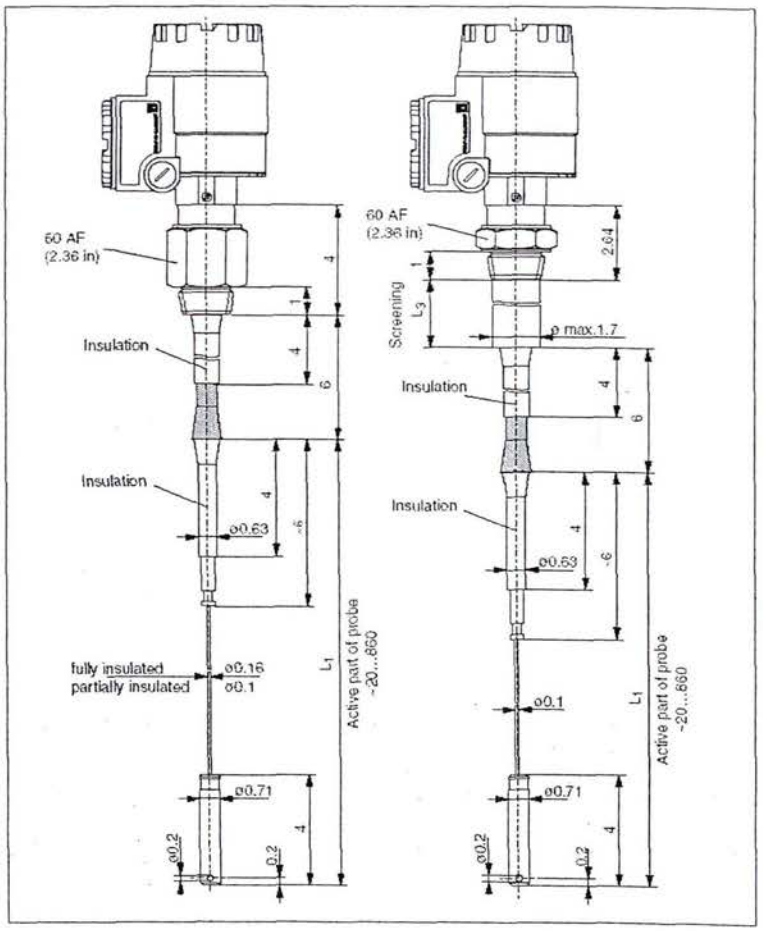
Probes with active build-up compensation
(for limit detection, length always 6 in)

Partially insulated probes shown but fully insulated probes also available where the active part of build-up compensation is always uninsulated. Not available with ground tube.



Left: Rod probe DC 11 AS (fully insulated) or DC 16 AS (partially insulated)

Right: active build-up compensation combined with screening L3



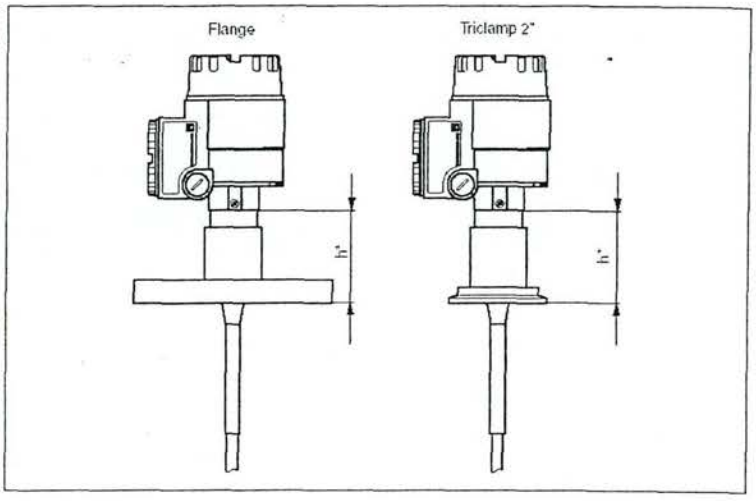
Left: Rope probe DC 21 AS (fully insulated) or DC 26 AS (partially insulated)

Right: active build-up compensation combined with screening L3

L3
The screening (protection against condensation) is available in three standard lengths:
L3 = 6 in
L3 = 9 in
L3 = 20 in

Other lengths on request
L3 min. 4 in
L3 max. 160 in

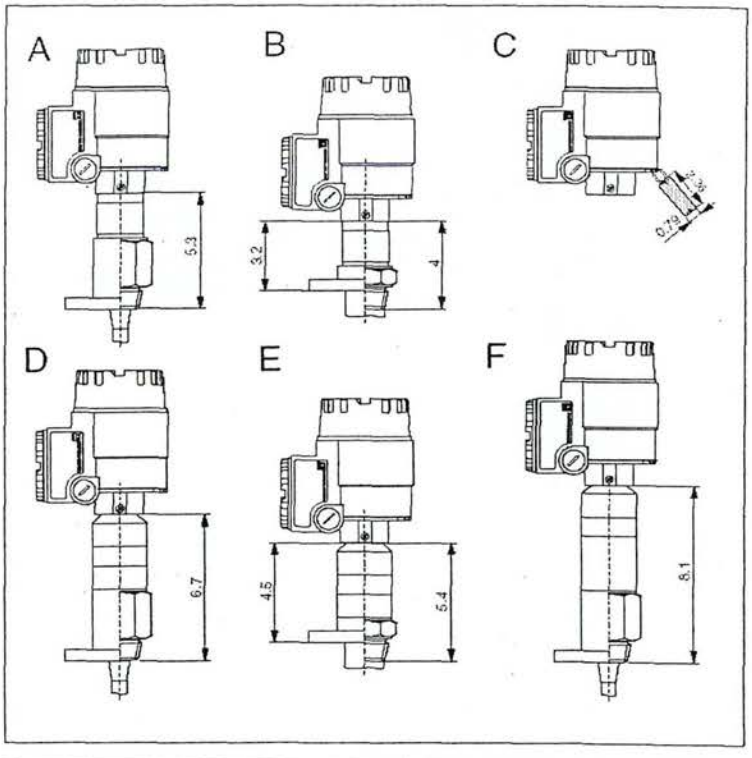
Additional Process Connections and Accessories



Other process connections:
- Flange
- Triclamp 2"

*h = 4 in for probes
- DC...AN
- DC...AS with fully insulated screening (protection against condensation)
- DC...AS with active build-up condensation

*h = 1.85 in for probes
- DC...AS with uninsulated screening (protection against condensation)
- DC...AS with uninsulated screening and active build-up compensation



Additional equipment:

A Temperature spacer for probes
- DC...AN
- DC...AS with fully insulated screening (protection against condensation)
- DC...AS with active build-up condensation

B Temperature spacer for probes
- DC...AS with uninsulated screening (protection against condensation)
- DC...AS with uninsulated screening and active build-up compensation

C Corrosion-resistant steel tag

D Gas-tight gland for probes
- DC...AN
- DC...AS with active build-up condensation

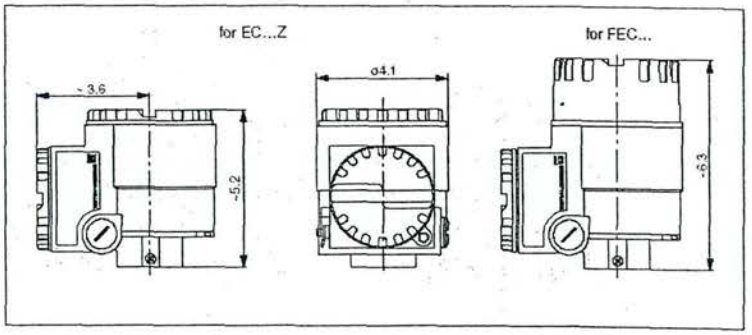
E Gas-tight gland for probes
- DC...AS with uninsulated screening (protection against condensation)
- DC...AS with uninsulated screening and active build-up compensation

F Gas-tight gland for probes
- DC...AS with fully insulated screening (protection against condensation)

Housing Dimensions

Housings in aluminium (Type T3) with separate connection compartment:
- RFI filter with small electronic inserts EC 17 Z, EC 37 Z, EC 47 Z and FEC 12 (IS),
- safety barriers with FEC 12 (XP).
- terminal connection module for FEC 22

With low cover for small electronic inserts EC...Z, with raised cover for electronic inserts FEC 12, FEC 14, FEC 22 with two cable entries, one sealed with a blind plug



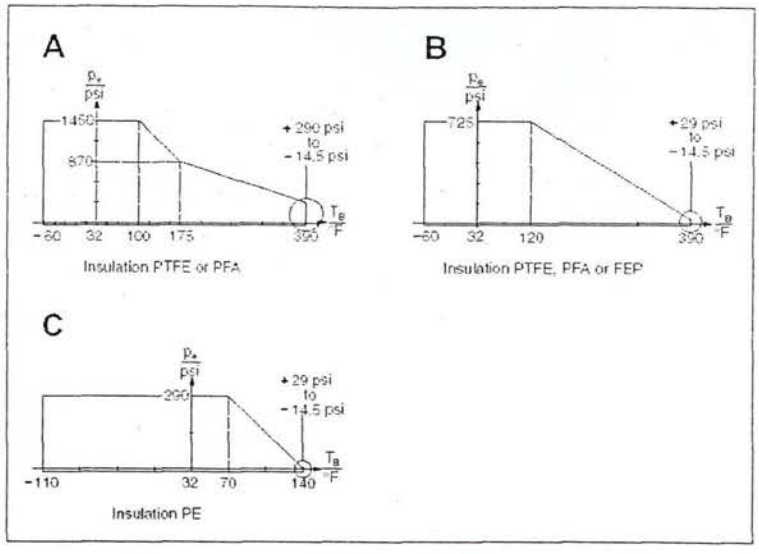
Technical Data

General information

Manufacturer	Endress+Hauser GmbH+Co. D-79689 Maulburg
Instrument family	Multicap
Instrument types	DC 11, 16, 21, 26 AN / AS
Function	Probes for capacitive level measurement and limit detection

Operating data

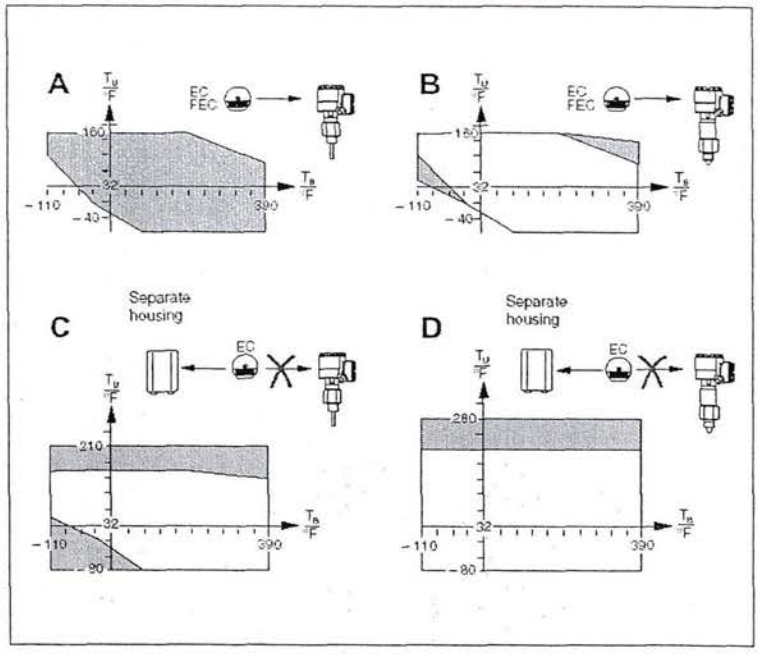
Operating pressure	to 1450 psi depending on material - see below
Operating temperature	to 390 °F, depending on material - see below
Testing pressure	to 2175 psi / temperature 70 °F by repetitive test as requested



Permitted operating pressures p_e and temperatures T_B

The graph **A do not** applys to:
- DC 21 AN / DC 21 AS,
- DC 26 AN / DC 26 AS,
- probes with active build-up compensation,
- probes with fully insulated screening.

The graph **B** applys to:
- DC 21 AN / DC 21 AS,
- DC 26 AN / DC 26 AS,
- probes with active build-up compensation,
- probes with fully insulated screening.



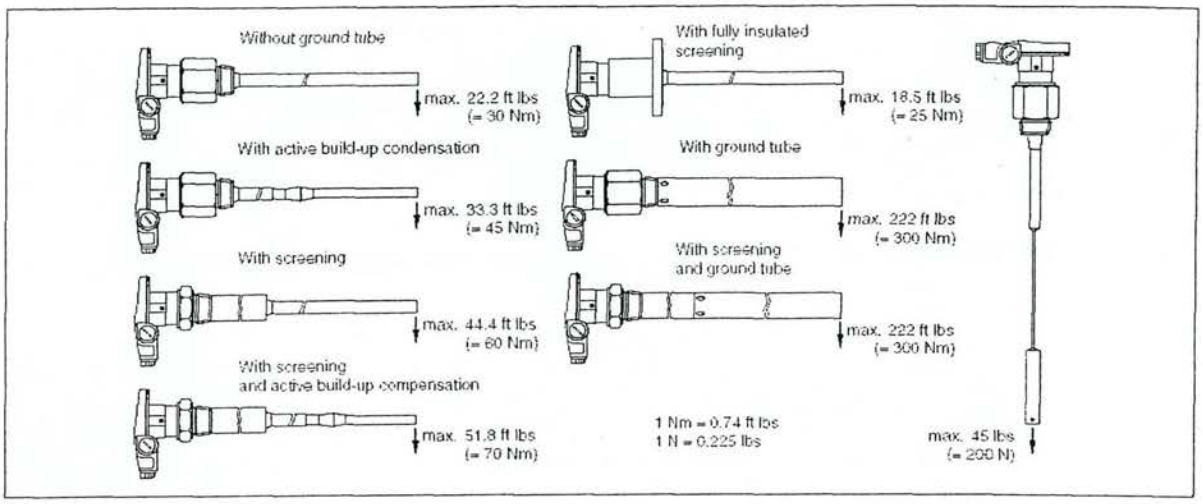
Mounting of the electronic insert as a function of operating temperature T_B and ambient temperature T_U:
- A Probe without temperature spacer
- B Probe with temperature spacer or gas-tight gland
- C Electronic insert in separate housing
- D Probe with temperature spacer or gas-tight gland and electronic insert in separate housing

The graphs A and B apply to all electronic inserts.

The graphs C and D apply to the small electronic inserts EC 17 Z, EC 37 Z, EC 47 Z

Other Operating Data

Lateral load on the probe rod	see below
Strain on the probe rope	45 lbs at 70 °F, static



Permissible lateral load on the probes

Probe lengths

Total length of a rod probe	min. 4 in, max. 230 in, see dimensions
Total length of a rope probe	min. 20 in, max. 1020 in, see dimensions

Capacitance values of the probe

Basic capacitance	approx. 30 pF
Temperature spacer	approx. 20 pF
Air-tight entry	approx. 20 pF
Active build-up compensation	approx. 10 pF

Additional capacitances

Probe 10 in from a conductive vessel wall	insulated probe rod	in air approx. 0.33 pF/in, in water approx. 9.5 pF/in
	uninsulated probe rod	in air approx. 0.33 pF/in
	insulated probe rope	in air approx. 0.25 pF/in, in water approx. 5 pF/in
	unisulated probe rope	in air approx. 0.25 pF/in
	insulated tensioning weight	in air approx. 2 pF in water approx. 60 pF
	uninsulated tensioning weight	in air approx. 2 pF
Rod probe in ground tube	insulated probe rod	in air approx. 1.4 pF/in, in water approx.8.8 pF/in
	uninsulated probe rod	in air approx. 1.3 pF/in
Uninsulated screening	approx. 0.8 pF/in	
Fully insulated screening	approx. 1.5 pF/in	

Probe lengths for continuous measurement in conducting liquids

EC with $C_{max.}$ = 2000 pF (EC 47 Z, FEC 12)	rope probe up to 315 in (up to 1020 in in non-conducting liquids) rod probe up to 230 in
EC with $C_{max.}$ = 4000 pF (EC 37 Z)	rope probe up to 780 in (up to 1020 in in non-conducting liquids) rod probe up to 230 in

Other Operating Data

Accuracy

Length tolerances	up to 40 in:	+0 in,	-0.2 in rod probe, -0.4 in rope probe
	up to 120 in:	+0 in,	-0.4 in rod probe, -0.8 in rope probe
	up to 240 in:	+0 in,	-0.8 in rod probe, -1.2 in rope probe
	up to 1020 in:	+0 in,	-1.6 in rope probe
The following specifications only apply to the capacitance of fully insulated probes when used in conductive liquids. **The deviation is insignificant for applications in non-conductive materials.**			
Linearity error in water	< 1 % at 40 in length		
Temperature dependence of the probe rod	< 0.1 % per K		
Pressure dependence of the probe rod	approx. 1.4 % per 100 psi		
Temperature dependence of the probe rope	< 0.1 % per K		
Pressure dependence of the probe rope	< 0.7 % per 100 psi		

Process connections

Parallel thread 1½ - 11½ NPT	ANSI B 1.20.1
Triclamp coupling	ISO 2852
ANSI flanges	ANSI B 16.5

Materials

Aluminium housing (Type T3)	GD-Al Si 10 Mg, DIN 1725, with plastic coating (blue / grey)
Seal for housing cover	O-ring of EPDM (elastomer)
Temperature spacer	Stainless steel AISI 304 or similar
Gas-tight gland	Stainless steel AISI 304
Further material specifications	see Product Structure on Page 10...11

Accessories

- Slip-on sheet for partially insulated probes for increasing the switching safety for limit detection
  see Technical Information "Probe accessories"
- Rope shortening kit for fully insulated probes
- Rope shortening kit for partially insulated probes

Supplementary Documentation

Technical Information

- Probe accessories
  Technical Information TI 229F/00/en
- Electronic insert FEC 12
  Technical Information TI 250F/00/en
- Electronic insert FEC 14
  Technical Information TI 376F/00/en
- Electronic insert FEC 22
  Technical Information TI 251F/00/en
- Electronic insert EC 17 Z
  Technical Information TI 268F/00/en
- Electronic insert EC 37 Z, EC 47 Z
  Technical Information TI 271F/00/en
- Transmitters for limit detection and continuous level measurement on request

Certificates

See product structure on page 10.

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Endress+Hauser
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TI 243F/00/en/06.03

SVAŠEK HYDRAULICS

WAVERIDERS (DATAWELL)

Waverider SG 0.7m
Directional waverider 0.7 m
Directional waverider MKIII
Directional waverider GPS
Mini directional waverider GPS

Waverider SG 0.7 m

Datawell - Oceanographic Instruments

Continuing the 36-year success of the original Waverider, Datawell introduces the Waverider SG offering more options and accuracy

The new Waverider SG 0.7 m (WR-7) is a real-time non-directional wave-height measuring buoy. Wave-height is measured with a resolution of 1 cm using the well-proven stabilized platform sensor that accurately tracks the vertical component of the orbital wave motion. In the WR-7, the platform mounting of the sensor has been reinforced, significantly increasing the robustness of the buoy. Also, newly developed digital sensor circuits offer better accuracy.

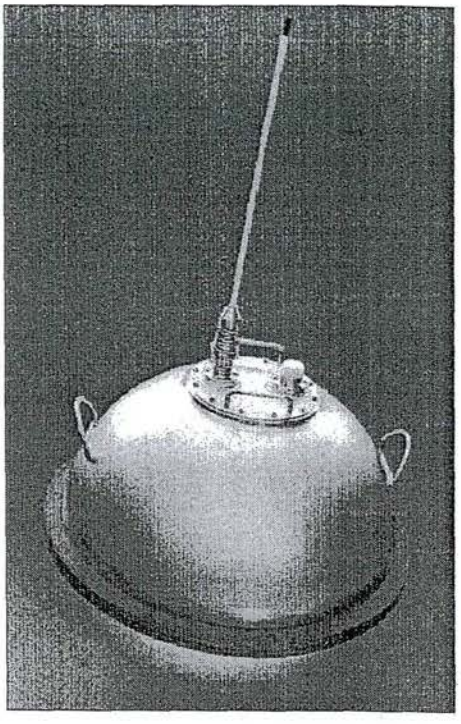
The WR-7 uses the same processing hardware as the directional DWR-MkIII and DWR-G buoys. This gives the WR-7 some new features and options that were not possible on the original model:

- Standard integrated **data logger**. Flash cards up to 2 GByte store all measured data.
- Standard **GPS position** monitoring. Position monitoring allows for drift alarm possibility and easy retrieval of a buoy adrift.
- A **LED flash light** mounted at the top of the antenna. The high mounted flashing light increases visibility significantly.
- Additionally, the WR-7 can be equipped with a water temperature sensor and is prepared for **future** meteorological **sensors** such as air temperature, wind direction and wind speed.

The buoy comes standard with Datawell's unique HF link. This link suffices for ranges up to 50 Km. If larger transmitting ranges are desired, the HF link can be combined or replaced with Argos or Orbcomm satellite communication. For near-shore applications, an easy to use GSM communication option will be available soon.

For larger service intervals, e.g. at remote locations, the new Waverider is also available in a 0.9 m hull diameter (WR-9). The WR-9 holds twice the amount of batteries and can operate for 3 years continuously.

To acquire, store and analyze the measured data, Datawell offers the W@ves21 software package. See our brochure on W@ves21 for more information.



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Waverider SG 0.7 m

Datawell - Oceanographic Instruments

Continuing the 36-year success of the original Waverider, Datawell introduces the Waverider SG offering more options and accuracy

The new Waverider SG 0.7 m (WR-7) is a real-time non-directional wave-height measuring buoy. Wave-height is measured with a resolution of 1 cm using the well-proven stabilized platform sensor that accurately tracks the vertical component of the orbital wave motion. In the WR-7, the platform mounting of the sensor has been reinforced, significantly increasing the robustness of the buoy. Also, newly developed digital sensor circuits offer better accuracy.

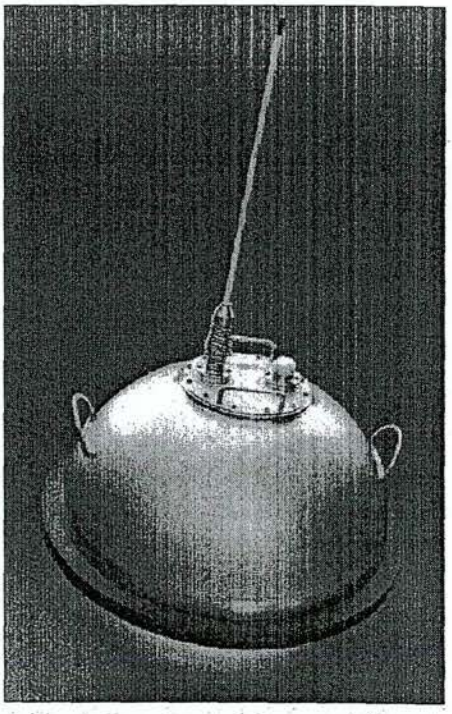
The WR-7 uses the same processing hardware as the directional DWR-MkIII and DWR-G buoys. This gives the WR-7 some new features and options that were not possible on the original model:

- Standard integrated **data logger**. Flash cards up to 2 GByte store all measured data.
- Standard **GPS position** monitoring. Position monitoring allows for drift alarm possibility and easy retrieval of a buoy adrift.
- A **LED flash light** mounted at the top of the antenna. The high mounted flashing light increases visibility significantly.
- Additionally, the WR-7 can be equipped with a water temperature sensor and is prepared for **future** meteorological **sensors** such as air temperature, wind direction and wind speed.

The buoy comes standard with Datawell's unique HF link. This link suffices for ranges up to 50 Km. If larger transmitting ranges are desired, the HF link can be combined or replaced with Argos or Orbcomm satellite communication. For near-shore applications, an easy to use GSM communication option will be available soon.

For larger service intervals, e.g. at remote locations, the new Waverider is also available in a 0.9 m hull diameter (WR-9). The WR-9 holds twice the amount of batteries and can operate for 3 years continuously.

To acquire, store and analyze the measured data, Datawell offers the W@ves21 software package. See our brochure on W@ves21 for more information.



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Directional Waverider 0.7 m

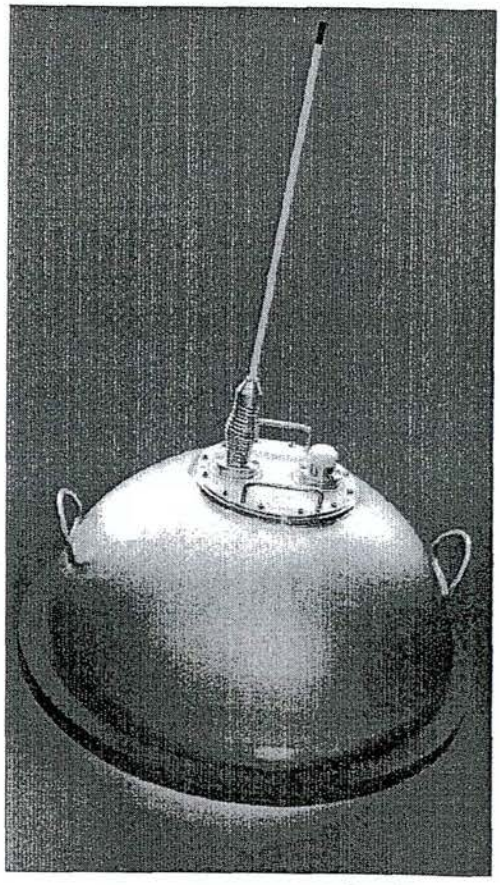
Datawell - Oceanographic Instruments

A compact directional wave buoy with over 1 year continuous operation

The MkIII redesign has increased operational life to 3 years for 0.9 m diameter directional wave buoys. At the same time this redesign offered the possibility of an easy-to-handle 0.7 m diameter directional wave buoy with over 1 year operational life.

Now you can have all the advantages of the MkIII Directional Waverider in a compact buoy:

- The heart of the buoy is still the **well-proven** Datawell stabilized platform wave sensor
- 27 mm rubber cords for **appropriate mooring** of 0.7 m diameter directional wave buoys
- Transmission ranges extend to **50 Km** and even further with the standard HF link
- Standard integrated **data logger** will secure all measured wave data in the buoy
- High-energy batteries guarantee over **1 year** continuous operation under all wave conditions and weather circumstances
- High-intensity **LED flash light**, mounted at the top of the antenna for improved visibility
- **GPS position** monitoring for drift alarms and easy retrieval
- Standard sea surface **water temperature** sensor



- Optional **Argos** satellite communication for operation on the open ocean
- Idem **Orbcomm** satellite communication
- Optional **GSM** communication for near shore operation

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Directional Waverider 0.7 m

Datawell - Oceanographic Instruments

Specifications

Heave	Range	–20 m - +20 m
	Resolution	1 cm
	Scale accuracy (gain error)	< 0.5% of measured value after calibration < 1.0% of measured value after 3 year
	Period time	1.6 s - 30 s
Direction	Range	0° - 360°
	Resolution	1.5°
	Buoy heading error	0.4° - 2° (depending on latitude) typical 0.5°
	Reference	magnetic north
	Period time (free floating)	1.6 s - 30 s
Standard features	HF transmitter	frequency range 27 MHz - 40 MHz transmission range 50 Km (RX-D receiver)
	Data logger	type 1 Compact Flash Module, size 64 MB - 2 GB
	Flash light	4 LEDs, colour yellow (590 nm), pattern 5 flashes every 20 s
	GPS position	every 30 min, precision 10 m
	Water temperature	range –5 °C - +46 °C, resolution 0.05 °C, accuracy 0.2 °C
Options	Argos	satellite communication
	Orbcomm	satellite communication (available soon)
	GSM	mobile communication (available soon)
General	Hull diameter	0.7 m (excluding fender)
	Material	stainless steel AISI316/Cunifer10
	Weight	approx. 105 Kg
	Batteries	operational life 1 year, 1 section of 20 batteries, type Leclanché 4931670.0 (black)
	Mooring	standard, 30 m of 27 mm rubber cords
	Processing	32 bits
	Temperature range	operating –5 °C - +35 °C storage –5 °C - +40 °C (+ 55 °C short term, weeks only)
	Receiver	RX-D or Warec (older Warecs may need modification)

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Directional Waverider MkIII

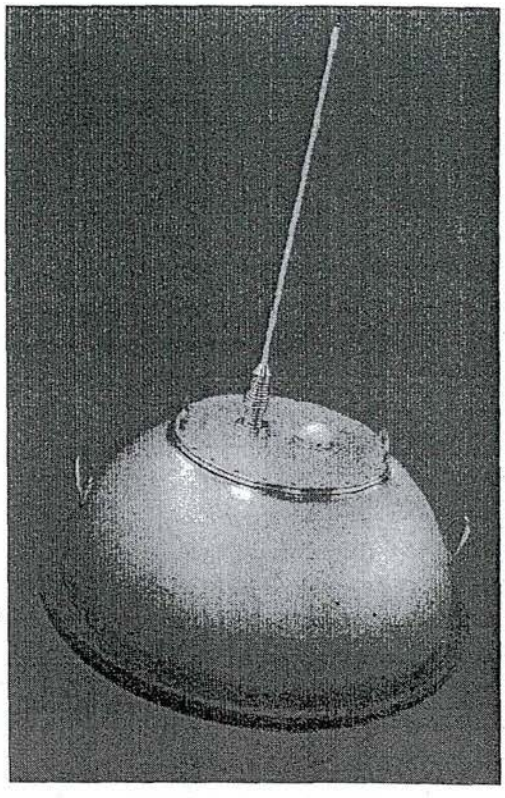
Datawell - Oceanographic Instruments

The Directional Waverider DWR-MkIII: Three years of continuous operation

The Directional Waverider hardly needs an introduction: it is the world's standard for measuring wave height and wave direction. Its success is due to the accurate and well-proven stabilized platform sensor, enabling wave height measurements by a single accelerometer. For the wave direction, direct pitch and roll measurements are performed needing no integration. In the DWR-MkIII, this sensor is still the heart of the instrument. The redesign comprises updated peripheral electronics, new battery technology, a more robust flash light and modular mechanics.

- The most striking feature of the new mark is its **LED flash light** that makes the glass housing obsolete. Mounted at the top of the antenna, it increases the buoy's visibility to passing ships. To increase visibility even further, an optional radar reflector for the 90 cm version will be available soon.
- A **GPS receiver** for buoy positioning has now become a standard feature of the DWR-MkIII, and facilitates its retrieval.
- Standard integrated **data logger** based on the latest flash card technology.
- Ongoing developments in **battery** technology have produced a non-magnetic alkaline R40-cell containing 100% more energy than its Zinc-Carbon predecessor. These new cells keep the DWR-MkIII operating under all wave conditions and weather circumstances for three years without replacement.
- An accurate onboard **energy meter** monitors the actual energy consumption of the buoy, and reports a reliable estimate of the remaining operating life.
- The DWR-MkIII is equipped with a water temperature sensor and is prepared for **future** meteorological **sensors** such as air temperature, wind direction and wind speed.

The DWR-MkIII comes standard with Datawell's unique HF link for ranges up to 50 Km. For larger ranges the HF link can be combined or replaced with Argos or Orbcomm satellite communication. A GSM communication option will be available soon.
The MkIII is also available in a 70 cm hull offering easier handling and 1 year of continuous operation.



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Directional Waverider MkIII

Datawell - Oceanographic Instruments

Specifications

Heave	Range	–20 m - +20 m
	Resolution	1 cm
	Scale accuracy (gain error)	< 0.5% of measured value after calibration < 1.0% of measured value after 3 year
	Period time	1.6 s - 30 s
Direction	Range	0° - 360°
	Resolution	1.5°
	Buoy heading error	0.4° - 2° (depending on latitude) typical 0.5°
	Reference	magnetic north
	Period time (free floating)	1.6 s - 30 s
Standard features 	HF transmitter	frequency range 27 MHz - 40 MHz transmission range 50 Km (RX-D receiver)
	Data logger	type 1 Compact Flash Module, size 64 MB - 2 GB
	Flash light	4 LEDs, colour yellow (590 nm), pattern 5 flashes every 20 s
	GPS position	every 30 min, precision 10 m
	Water temperature	range –5 °C - +46 °C, resolution 0.05 °C, accuracy 0.2 °C
Options	Argos/Orbcomm	satellite communication (not yet available on DWR-7)
	GSM	mobile communication (available soon)
General	Hull diameter	0.9 m (0.7 m) (excluding fender)
	Material	stainless steel AISI316/Cunifer10
	Weight	approx. 225 Kg (105 Kg)
	Batteries	operational life 3 years (1 year), 5 (1) sections of 13 (20) batteries, type Leclanché 4931670.0 (black)
	Processing	32 bits
	Temperature range	operating –5 °C - +35 °C storage –5 °C - +40 °C (+ 55 °C short term, weeks only)
	Receiver	RX-D or Warec (older Warecs may need modification)
	Upgrading	from MkII to MkIII simply by replacing hatchcover

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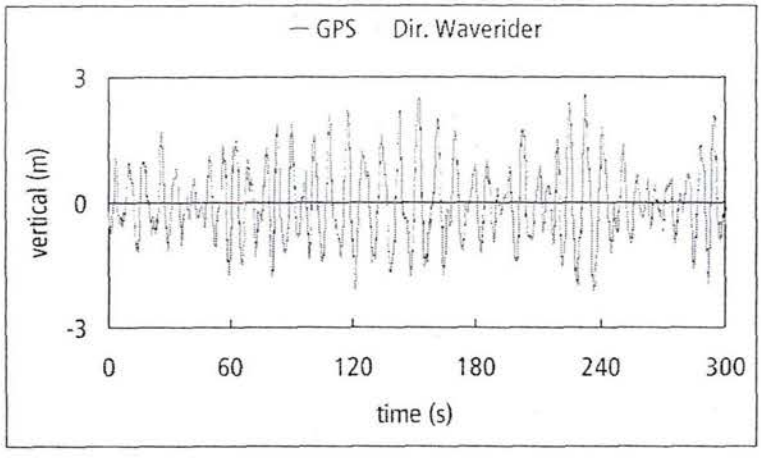
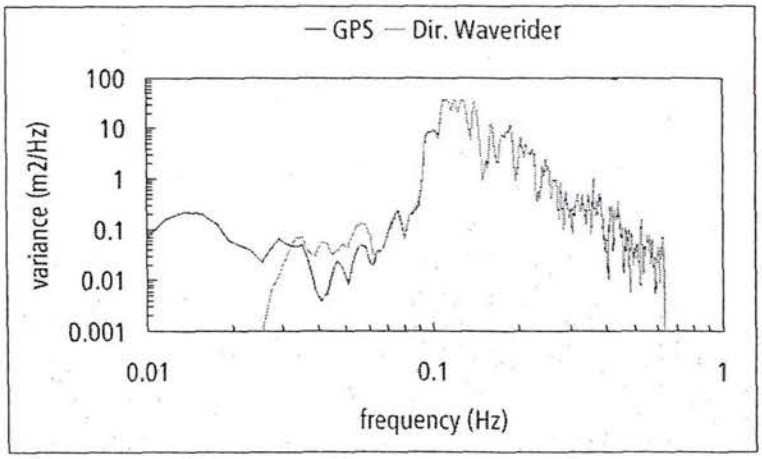
Directional Waverider GPS

Datawell - Oceanographic Instruments

Measuring waves with GPS

With the DWR-G wave buoy Datawell introduces a revolutionary concept of measuring waves with a single GPS (Global Positioning System) receiver, not differential GPS. The DWR-G features a patented algorithm and custom-made GPS receiver that will challenge existing, conventional wave buoys based on inertial sensors such as accelerometers and magnetic compass (see specifications on other side).
To convince potential users of this unorthodox method the new DWR-G buoy has been tested against the standard in the field of wave measurement:: the Datawell Directional Waverider (MkII). The graphs below show that the conventional Directional Waverider and the new GPS-based wave buoy merged in one single hull, produce identical heave and Fourier spectra within specifications. For more information refer to the December 2003 issue of Sea Technology, visit our website or contact Sales.





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Directional Waverider GPS

Datawell - Oceanographic Instruments

Specifications

Wave motion sensor	Sensor	single GPS (not differential)	
	Precision	1-2 cm	free floating, all directions (1σ)
		1-2 cm + 0.5 %	moored, vertical (1σ)
		–	moored, horizontal, depends on current and wave frequency (excluding GPS antenna pitch and roll motion)
	Range	–50 m - +50 m	
	Periods	1.6 s - 100 s	
	Calibration	not required ever	
	Exclusion	GPS signals do not penetrate through water, occasional data gaps may occur	
	Exclusion	not resistant to SA (Selective Availability, may be switched on by US Department of Defence for strategic reasons)	
Wave data	Data	north, west, vertical	
	Resolution	1 cm (north 2 cm, LSB "north" is GPS data gap indicator)	
	Range	–20 m - +20 m	
	Rate	1.28 Hz	
	Reference	WGS84	
Spectral data	Frequency resolution	0.005 Hz below 0.10 Hz and 0.010 Hz above	
	Frequency range	0.025 Hz - 0.60 Hz	
	Direction resolution	1.5°	
	Direction range	0° - 360°	
Standard features	HF transmitter	frequency range 27 MHz - 40 MHz, transmission range 50 Km	
	Data logger	type 1 Compact Flash Module 64 Mb (up to 2 Gb optional)	
	Flash light	4 high intensity LEDs, colour yellow (590 nm), pattern 5 flashes every 20 s	
	GPS position	every 30 min, precision 10 m	
Options	Argos/Orbcomm	satellite communication	
	GSM	mobile communication (available soon)	
	Water temperature	range –5 °C - +46 °C, resolution 0.05 °C, accuracy 0.2 °C	
General	Hull diameter	0.9 m (0.7 m), excluding fender	
	Material	stainless steel (AISI316), Cunifer optional	
	Weight	225 Kg (95 Kg)	
	Mooring	standard, 30 m of 35 mm (27 mm) rubber cords	
	Batteries	operational life 1.7 year (0.7 year) 10 (4) sections of 13 batteries type Leclanché 4931/668 (green)	
	Receiver	RX-D (recommended) or Warec	
	Compatibility	DWR-G hatchcovers are compatible with MkII buoys	

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SVASEK HYDRAULICS

mini Directional Waverider GPS

Datawell - Oceanographic Instruments

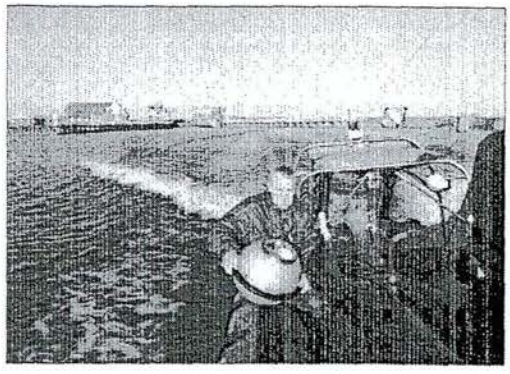
The smallest directional wave measuring buoy on the market

With a 40 cm mini-buoy version Datawell completes its range of GPS buoys: DWR-G9, DWR-G7 and DWR-G4, with 0.9 m, 0.7 m and 0.4 m diameters, respectively.

Just like its larger equivalents the DWR-G4 relies on the Datawell principle of measuring waves with a single Global Positioning System receiver (GPS). By now this technique is well-established in oceanography as evidenced by several publications and well-pleased users in the field.

Small though it is, the DWR-G4 offers full-functionality and full-compatibility with other Datawell equipment. Data links and formats, RX-D and Warec receiver, W@ves21 software, batteries, etc. are all the same or compatible.

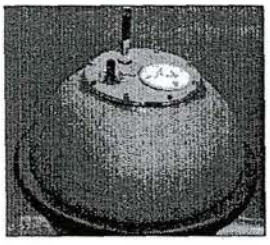
Weighing 17 Kg only the DWR-G4 may be readily deployed and recovered by hand from an inflatable boat with outboard engine. Via HF link, directional and spectral wave data are transmitted, e.g. to a portable, compact RX-D receiver connected to a laptop running the W@ves21-software. The LED flasher and/or the HF-transmitted GPS position facilitate tracking or locating the buoy.



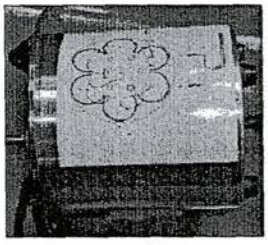
Alternatively, a GSM link will be available soon for near-shore or in-shore use. In the near future an Argos satellite link will be introduced for application in a drifting buoy. GSM and Argos will transmit compressed spectra only, but the logger (standard) will always secure the full set of wave data.

The DWR-G4 may be put to good use as:

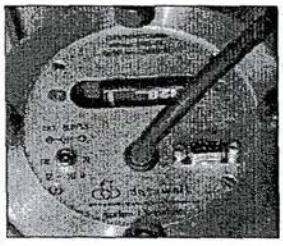
- an evaluation buoy to select long-term deployment sites
- a sea-state monitoring buoy during dredging, construction, etc. operations
- a drifting buoy



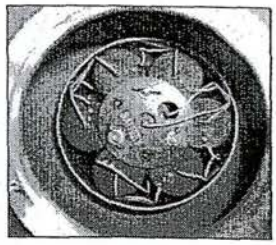
hatchcover with antennas



electronics unit (side)



(bottom)



hull with batteries

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mini Directional Waverider GPS

Datawell - Oceanographic Instruments

Specifications

Wave motion sensor	Sensor	single GPS (not differential)
	Precision	1-2 cm free floating, all directions (1σ) (excluding GPS antenna pitch and roll motion)
	Range	–50 m - +50 m
	Periods	1.6 s - 100 s
	Calibration	not required ever
	Exclusion	GPS signals do not penetrate through water, occasional data gaps may occur
	Exclusion	not resistant to SA (Selective Availability, may be switched on by US Department of Defence for strategic reasons)
Wave data	Data	north, west, vertical
	Resolution	1 cm (north 2 cm, LSB "north" is GPS data gap indicator)
	Range	–20 m - +20 m
	Rate	1.28 Hz
	Reference	WGS84
Spectral data	Frequency resolution	0.005 Hz below 0.10 Hz and 0.010 Hz above
	Frequency range	0.025 Hz - 0.60 Hz
	Direction resolution	1.5°
	Direction range	0° - 360°
Standard features	HF transmitter	frequency range 33 MHz - 36 MHz, transmission range 10 Km (hand-held receiver) 25 Km (receiver with ground-plane antenna)
	Data logger	type 1 Compact Flash Module 64 Mb
	Flash light	4 high intensity LEDs, color yellow (590 nm), pattern 5 flashes every 20 seconds
	GPS position	every 30 min, precision 10 m
Options	GSM	mobile communication (available soon)
	Argos	satellite communication (not available yet)
	Water temperature	range –5 - +46 °C, resolution 0.05 °C, accuracy 0.2 °C
General	Hull diameter	0.40 m (0.46 including fender)
	Material	stainless steel (AISI316)
	Weight	17 Kg
	Mooring	no mooring, use free floating
	Batteries	operational life 2 weeks 1 section of 7 batteries, type Leclanché 4931/668 (green)
	Receiver	RX-D (recommended) or Warec

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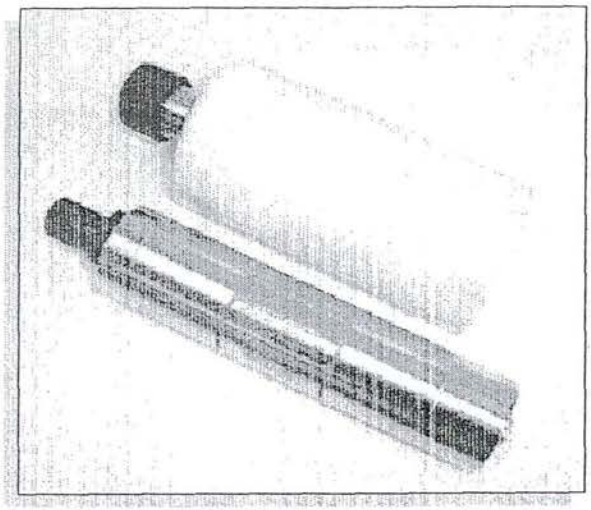
SVASEK HYDRAULICS

PRESSURE SENSOR (BAKKER &CO)

Submersible depth sensor series 8000
Intelligent transmitters series 1000 , 6000 & 9000

Submersible Depth Sensors — Series 8000

Digiquartz® Technology



Digiquartz® Depth Sensors provide the ultimate precision in water level measurements. Typical application **accuracy of 0.01%** is achieved even under difficult environmental conditions. Desirable characteristics include excellent long-term stability, **1 x 10^{-8} resolution**, low power consumption, and high reliability.

The remarkable performance of these depth sensors is achieved through the use of a precision quartz crystal resonator whose frequency of oscillation varies with pressure-induced stress. A quartz crystal temperature signal is provided to thermally compensate the calculated pressure and achieve high accuracy over a broad range of temperatures. The depth sensors include waterproof housings with integral shock protection.

High accuracy, resolution, and stability make Digiquartz® Depth Sensors ideal for applications such as Tsunami detection, wave and tide gauges, platform leveling, underwater pipe laying, and as depth sensors in ROVs and AUVs.

All Depth Sensor ranges are available with either frequency outputs or integral intelligent electronics with bi-directional digital communications.

RANGES

Absolute

0-10 m H_2O to 0-7000 m H_2O

0-30 psia to 0-10,000 psia

Gauge

0-10 m H_2O to 0-140 m H_2O

0-15 psig to 0-200 psig

FEATURES

- 0.01% Accuracy
- 1 x 10^{-8} Resolution
- Unique Anti-Fouling Port
- Low Power Consumption
- High Stability and Reliability
- Fully Calibrated and Characterized
- ISO 9001 Quality System – NIST Traceable
- Frequency Outputs or Dual RS-232 and RS-485 Interfaces

APPLICATION AREAS

- Hydrology
- Oceanography
- Tsunami Detection
- Wave and Tide Gauges
- Offshore Platform Leveling
- Dam and Reservoir Level Sensing
- Underwater Pipe Laying and Surveying
- Remotely Operated and Autonomous Underwater Vehicles

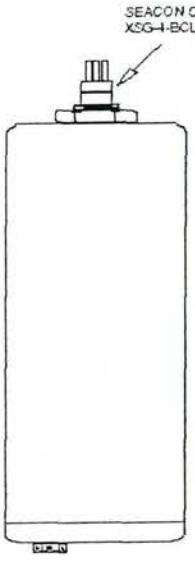
Dual RS-232 and RS-485 interfaces allow complete remote configuration and control of all operating parameters, including resolution, sample rate, and choice of engineering units, integration time, and sampling requests. Commands include: Single sample and send, synchronized sample and hold, continuous sample and send, and special burst sampling modes.

New and enhanced features include support for both serial loop and multi-drop networking, selectable baud rates up to 115,200 baud, synchronization of measurements with time-based integration, 2 or 4 wire RS-485 transmission distances greater than 1 kilometer, improved high-speed continuous pressure measurements, a power management "sleep" mode, data formatting features, and unit identification commands.

All Digiquartz® transducers come with a limited five-year warranty with the first two years covered at 100%.

Paroscientific,Inc.
Digiquartz® Pressure Instrumentation

Depth Sensors - Frequency Output Series 8000



Series 8DP (0-700 meters)

Series 8B (0 to 7,000 meters)

PERFORMANCE CHARACTERISTICS

Pressure Performance	Accuracy typically better than 0.01% Full Scale (See SCD)
Calibrated Temperature	-2C to +40C
Hysteresis:	8B =± 0.01% Full Scale 8DP =± 0.005% Full Scale
Repeatability:	8B=± 0.01% Full Scale 8DP=± 0.005% Full Scale
Over Pressure:	1.2 times Full Scale
Thermal Sensitivity:	<0.0008% Full Scale /deg C
Pressure Signal:	Nominal Frequency 37 to 42 KHz
Temperature Signal:	Nominal Frequency 172 KHz

ELECTRICAL CHARACTERISTICS

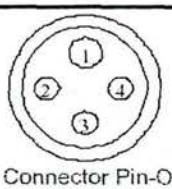
Input Voltage:	+6 (Min) to +25 VDC
Current Consumption:	1.3 mA @ 6VDC (Typical)
Output Signal:	Nominal square wave of 4 volts amplitude peak-to-peak, capacity coupled with source impedance <1,000 Ohms.

ENVIRONMENTAL CHARACTERISTICS

Weight:	8B Dry: 2.55 lbs (1.156 Kg) Max 8DP Dry: 3.48 lbs (1.58 Kg) Max 8DP 700m Dry: 5.00 lbs (2.26 Kg) Max
Housing Materials/Wetted:	8B - Stainless Steel 8DP-PVC Type 1 or Acetal, White

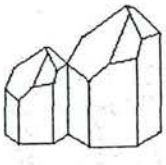
OTHER ACCESSORIES AVAILABLE

- Intelligent Interface Board
- Cables with Mating Connectors



Connector Pin-Out

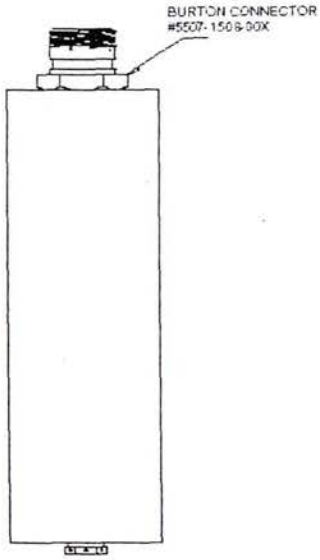
PIN	SIGNAL
1	Temperature Signal
2	Pressure Signal
3	Power/Signal Ground
4	Power



Digiquartz® Pressure Instrumentation

Depth Sensors - Intelligent Output Series 8000

Series 8CDP (0 to 700 meters)



Series 8CB (0 to 7,000 meters)

PERFORMANCE CHARACTERISTICS

Pressure Performance	Accuracy typically better than 0.01% Full Scale (See SCD)
Calibrated Temperature Range:	-2C to +40C
Hysteresis:	8CB =± 0.01% Full Scale 8CDP =± 0.005% Full Scale
Repeatability:	8CB=± 0.01% Full Scale 8CDP=± 0.005% Full Scale
Over Pressure:	1.2 times Full Scale
Thermal Sensitivity:	<0.0008% Full Scale / deg C

ELECTRICAL CHARACTERISTICS

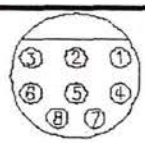
Input Voltage:	+6 (Min) to +16 VDC
Current Consumption:	16.5 mA Quiescent, 32 mA max @ +6 VDC
Output Signal:	RS-232 meets EIA/TIA specs RS-485 meets EIA/TIA specs

ENVIRONMENTAL CHARACTERISTICS

Weight:	8CB Dry: 2.94 lbs (1.33 Kg) Max 8CDP Dry: 3.48 lbs (1.58 Kg) Max 8CDP 700m Dry: 5.0 lbs (2.26 Kg) Max
Housing Materials/Wetted:	8CB - Stainless Steel 8CDP-PVC Type 1 or Acetal, White

OTHER ACCESSORIES AVAILABLE

- Model 715 Remote LCD Display
- Cables with Mating Connectors
- Power Module Kit



Connector Pin-Out

PIN	SIGNAL
1	RS-232 to Computer
2	RS-232 from Computer
3	Power/Signal Ground
4	Power
5	RS-485 RX+
6	RS-485 RX-
7	RS-485 TX+
8	RS-485 TX-

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Depth Sensors

Series 8000

Depth	Frequency Outputs				Intelligent			
Meters of H_2O	Model	Part Number	Dimensions inch (cm) Dia.	Length	Model	Part Number	Dimensions inch (cm) Dia.	Length
	Series 8DP Absolute Depth Sensors*				Series 8CDP Intelligent Depth Sensors			
0-10	8DP010-2	1116-004-0	3.50(8.9)	8.92(22.7)	8CDP010-I	1705-001-0	3.50(8.9)	8.55(21.7)
0-20	8DP020-2	1116-006-0	3.50(8.9)	8.92(22.7)	8CDP020-I	1705-002-0	3.50(8.9)	8.55(21.7)
0-60	8DP060-2	1116-008-0	3.50(8.9)	8.92(22.7)	8CDP060-I	1705-003-0	3.50(8.9)	8.55(21.7)
0-130	8DP130-2	1116-010-0	3.50(8.9)	8.92(22.7)	8CDP130-I	1705-004-0	3.50(8.9)	8.55(21.7)
0-200	8DP200-2	1116-012-0	3.50(8.9)	8.92(22.7)	8CDP200-I	1705-005-0	3.50(8.9)	8.55(21.7)
0-270	8DP270-2	1116-014-0	3.50(8.9)	8.92(22.7)	8CDP270-I	1705-006-0	3.50(8.9)	8.55(21.7)
0-700	8DP700-2	1116-035-0	3.50(8.9)	14.51(36.8)	8CDP700-I	1705-007-0	3.50(8.9)	10.50(26.7)
	Series 8DP Gauge Depth Sensors*				Series 8CDP Intelligent Depth Sensors			
0-10	8DP010-GV-2	1117-002-0	3.50(8.9)	8.92(22.7)	8CDP010-GVI	1706-001-0	3.50(8.9)	8.80(22.4)
0-15	8DP015-GV-2	1117-010-0	3.50(8.9)	8.92(22.7)	8CDP015-GVI	1706-002-0	3.50(8.9)	8.80(22.4)
0-20	8DP020-GV-2	1117-004-0	3.50(8.9)	8.92(22.7)	8CDP020-GVI	1706-003-0	3.50(8.9)	8.80(22.4)
0-70	8DP070-GV-2	1117-006-0	3.50(8.9)	8.92(22.7)	8CDP070-GVI	1706-004-0	3.50(8.9)	8.80(22.4)
0-100	8DP100-GV-2	1117-012-0	3.50(8.9)	8.92(22.7)	8CDP100-GVI	1706-005-0	3.50(8.9)	8.80(22.4)
0-140	8DP140-GV-2	1117-008-0	3.50(8.9)	8.92(22.7)	8CDP140-GVI	1706-006-0	3.50(8.9)	8.80(22.4)
	Series 8B High Pressure Absolute Depth Sensors*				Series 8CB High Pressure Intelligent Depth Sensors			
0-1400	8B1400-2	1036-002-0	1.61(4.0)	9.85(25.0)	8CB1400-I	1700-001-0	1.61(4.0)	10.83(27.5)
0-2000	8B2000-2	1036-004-0	1.61(4.0)	9.85(25.0)	8CB2000-I	1700-002-0	1.61(4.0)	10.83(27.5)
0-4000	8B4000-2	1036-006-0	1.61(4.0)	9.85(25.0)	8CB4000-I	1700-003-0	1.61(4.0)	10.83(27.5)
0-7000	8B7000-2	1036-008-0	2.17(5.5)	10.68(27.1)	8CB7000-I	1700-004-0	2.17(5.51)	10.83(27.5)

* Non-Temperature Compensated Versions Optionally Available

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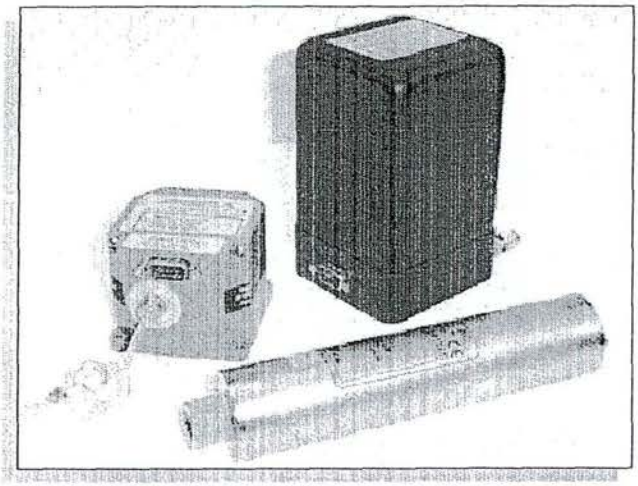
Intelligent Transmitters Series 1000, 6000 & 9000

Digiquartz® Technology



RANGES

Absolute	0-15 psia to 0-40,000 psia
Gauge	0-15 psig to 0-200 psig
Differential	0-3 psid to 0-18 psid

FEATURES

- 0.01% Accuracy
- 1 x 10^{-8} Resolution
- High Stability and Reliability
- Dual RS-232 and RS-485 Interfaces
- Fully Calibrated and Characterized
- ISO 9001 Quality System – NIST Traceable

APPLICATION AREAS

Metrology	Oceanography
Hydrology	Process Control
Aerospace	Energy Exploration
Meteorology	Wind Tunnel Instrumentation

Paroscientific Intelligent Transmitters consist of a Digiquartz® pressure transducer and a digital interface board in an integral package. Commands and data requests are sent via two-way RS-232 or RS-485 serial interfaces. Digital outputs are provided directly in engineering units with typical accuracy of **0.01%** over a wide temperature range. Output pressure is fully thermally compensated using a quartz crystal temperature signal. All intelligent transmitters are preprogrammed with calibration coefficients for full plug-in interchangeability.

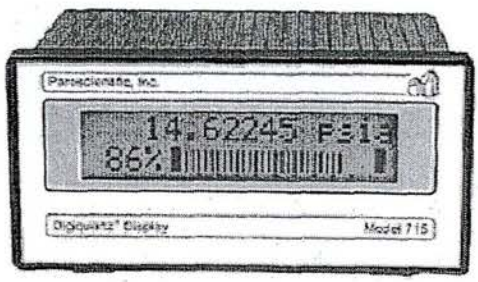
Intelligent Transmitters are available in 19 absolute pressure ranges from 15 psia (0.10 MPa) to 40000 psia (276 MPa), 6 gauge pressure ranges from 15 psig to 200 psig, and differential pressure ranges of 3, 6, and 18 psid. Dual RS-232 and RS-485 interfaces allow complete remote configuration and control of all operating parameters, including resolution, sample rate, choice of engineering units, integration time, and sampling requests. Commands include: Single sample and send, synchronized sample and hold, continuous sample and send, and special burst sampling modes.

New and enhanced features include support for both serial loop and multi-drop networking, selectable baud rates up to 115,200 baud, synchronization of measurements with time-based integration, 2 or 4 wire RS-485 transmission distances greater than 1 kilometer, improved high-speed continuous pressure measurements, a power management "sleep" mode, data formatting features, and unit identification commands.

Free software is included for setup, configuration, sampling, display, data logging, and plotting.

The Model 715 displays pressure and temperature data from all Paroscientific Intelligent transmitters that have Dual RS-232 and RS-485 interfaces. The two-line, 16 character, alphanumeric, backlit, liquid crystal display is user configurable with included software. Display functions include pressure and temperature values with engineering units, overpressure warning, tare indicator, user defined text messages, and a horizontal analog bar graph showing percentage of full-scale pressure.

The Model 715 Display will respond to display commands from the Transmitter, a computer, or other serial host on either the RS-232 or RS-485 port. For stand-alone operation, it displays data whenever power is applied to the transmitter.



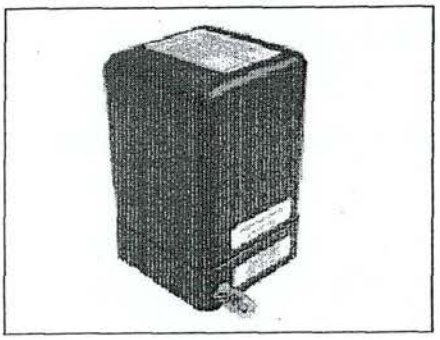
All Digiquartz® Transducers come with a limited 5-year warranty with the first 2 years covered at 100%.

Paroscientific, Inc.
Digiquartz® Pressure Instrumentation

SVASEK HYDRAULICS

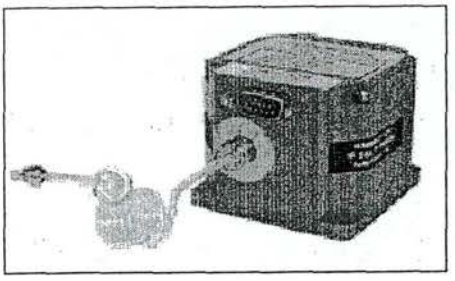
Digiquartz® Pressure Instrumentation

Series 1000



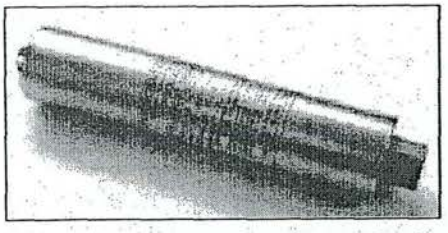
- Ranges Available:
  15 Absolute Pressure Ranges:
  From 0-15 psia (0.10 MPa) to 0-10,000 psia (69 MPa).
  6 Gauge Pressure Ranges:
  From 0-15 psig (0.10 MPa) to 0-200 psig (1.38 MPa)
  3 Differential Pressure Ranges: 0-3, 0-6, 0-18 psid (0.12 MPa)
- Integral Microprocessor Electronics
- Digiquartz® Transducer with Integral Shock Mount
- Fully Temperature Compensated and Linearized Outputs
- Dual RS-232 and RS-485 Interface
- User Selectable Parameters Include:
  Resolution, Sample Rate, Engineering Units, Integration Time, Sampling Commands, Software Recalibration Features, and Baud Rate
- Compatible with the Model 715 Display

Series 6000

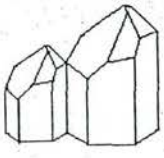


- Ranges Available:
  10 Absolute Pressure Ranges:
  From 0-15 psia (0.10 MPa) to 0-500 psia (3.45 MPa).
  6 Gauge Pressure Ranges:
  From 0-15 psig (0.10 MPa) to 0-200 psig (1.38 MPa)
- Miniaturized Integral Microprocessor Electronics
- Digiquartz® Transducer with Integral Shock Mount
- Fully Temperature Compensated and Linearized Outputs
- Dual RS-232 and RS-485 Interface
- User Selectable Parameters Include:
  Resolution, Sample Rate, Engineering Units, Integration Time, Sampling Commands, Software Recalibration Features, and Baud Rate
- Compatible with the Model 715 Display

Series 9000

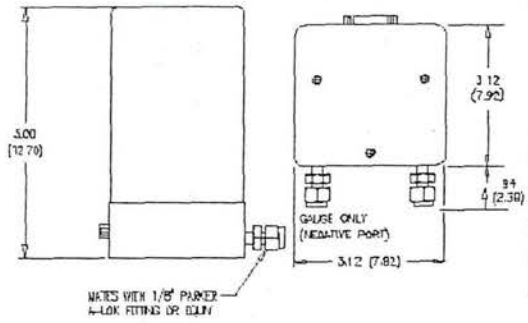


- Ranges Available:
  9 Absolute Pressure Ranges:
  From 0-1000 psia (6.89 MPa) to 0-40,000 psia (276 MPa).
- Miniaturized Integral Microprocessor Electronics
- Digiquartz® Transducer with Integral Shock Mount
- Fully Temperature Compensated and Linearized Outputs
- Dual RS-232 and RS-485 Interface
- User Selectable Parameters Include:
  Resolution, Sample Rate, Engineering Units, Integration Time, Sampling Commands, Software Recalibration Features, and Baud Rate
- Compatible with the Model 715 Display



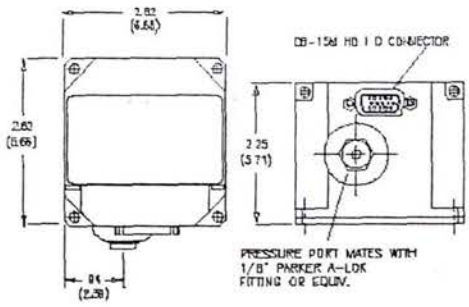
Digiquartz® Pressure Instrumentation

Intelligent Transmitters Series 1000, 6000 & 9000



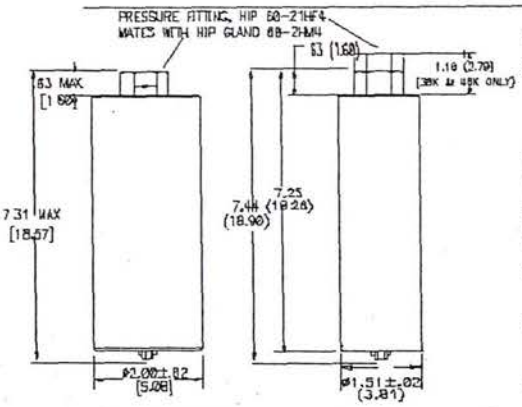
Side View Bottom View

Pressure Performance:	Typically better than 0.01% Full Scale*
Operating Temperature Range:	
Low Pressure and Gauge Ranges (≤1000 psi):	-40°C to +70°C
High Pressure Ranges (>2000 psi):	0°C to +70°C
Barometric Range:	-40°C to +50°C
Differential Pressure Ranges:	0°C to +40°C
Typical Current Consumption at +6 VDC:	16.5 mA
Typical Resolution at 1 sample/sec:	1 ppm
Engineering Units:	8 Standard or User-defined
Baud Rate Selection:	300 to 115200
Overpressure:	1.2 x Full Scale 1000-16B to 18 psia
Weight:	29 oz (822 g) Max
RS-232 & RS-485 Communication:	Compatible with EIA/TIA RS-232 Compatible with EIA/TIA RS-485



Top View Side View

Pressure Performance:	Typically better than 0.01% Full Scale*
Operating Temperature Range:	
Barometric Range:	-54°C to +60°C
Other Ranges:	-54°C to +70°C
Typical Current Consumption at +6 VDC:	16.5 mA
Typical Resolution at 1 sample/sec:	1 ppm
Engineering Units:	8 Standard or User-defined
Baud Rate Selection:	300 to 115200
Overpressure:	1.2 x Full Scale 6000-500A 1 x Full Scale 6000 - 16B to 18 psia
Weight:	15.9 oz (450 g) Max
RS-232 & RS-485 Communication:	Compatible with EIA/TIA RS-232 Compatible with EIA/TIA RS-485



Model 9000-1K-101 Other Series 9000 Models

Pressure Performance:	Typically better than 0.01% Full Scale*
Operating Temperature Range:	1K -40°C to +70°C 2K to 10K 0°C to +70°C 15K to 40 K 0°C to +50°C
Typical Current Consumption at +6 VDC:	16.5 mA
Typical Resolution at 1 sample/sec:	1 ppm
Engineering Units:	8 Standard or User-defined
Baud Rate Selection:	300 to 115200
Overpressure:	1.2 x Full Scale 30K & 40K Only– 1.1 x Full Scale
Weight:	2K to 40K - 10.83 oz (307 g) Max 1K - 21.36 oz (606 g) Max
RS-232 & RS-485 Communication:	Compatible with EIA/TIA RS-232 Compatible with EIA/TIA RS-485

* Consult transducer SCD for detailed specifications.

Dimensions are in inches - parenthesized dimesions are in centimeters.

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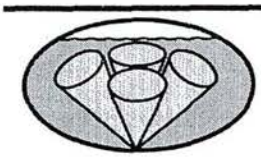
SVASEK HYDRAULICS

WORKHORSE WAVE ARRAY (AQUA VISION)

Use of RDI ADCP Waves Array Multi-Directional Wave Measurements



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April 22, 2003

Multi-Directional Wave Gauging, our newest series of RDI products, can be ideal for increasing your field measurement productivity and for renovating your understanding of complex wave fields. Applying ADCP technology, the Multi-Directional Waves Array is a breakthrough in method and logistics for accurately resolving waves while profiling water currents at the same time...and this patented technology is available as an upgrade to ADCPs already in the field. This document summarizes the capability of the ADCP Waves array including:

1.0 ADVANTAGES OF ADCP WAVES ARRAY METHOD

The Multi-directional Waves Array replaces the traditional PUV and buoy methods with the more precise and accurate ADCP technology. This array measurement unambiguously resolves waves incident from multiple directions while accounting for distortion due to the near-surface current field. While deployed on the seabed, the ADCP Waves Array measures a total of 12 radial velocity measurements to quantify the near surface orbital fluctuations at three different depth levels as input for the directional array processing and also the primary non-directional spectra measurement. As redundant measurements of the non-directional spectra, the adcp also provides spectra that are based upon the 4x acoustic range to surface and pressure sensor time series measurements. The near surface velocity array that is utilized by the ADCP waves not only avoids the well-known limitations of the familiar wave-measuring technologies, but opens up a wider range of water depths for measuring waves

RDI's ADCPs are distinguished by providing quality and value to their owners. Just as in modern telecommunications, RDI's BroadBand information results in higher definition, sharper images—you see more of what you are measuring. Unlike competing devices, which are unable to use this patented BroadBand technology, RDI's impressive visual results stem from our focusing on the signal rather than averaging out noise. When RD Instruments previously attempted to perform directional analysis with our un-patented NarrowBand technology, the measurements were too noisy to adequately define the directional distribution of the energy, resolving only directional waves with resolution that is

comparable to PUV or buoy techniques. A key step in increasing your understanding of complex wave fields will be the deployment of RDI's Multi-Directional Wave Gauge ADCP. Thank you very much for your interest in the RD Instruments ADCP waves array. The Multi-Directional Wave Gauge is designed to be run by the people who work for you right now. Reliability and ease of operation are built in. The software wizard aids instrument setup and impressive data displays are created automatically. Support staff is readily available at RDI. Enjoy low lifetime costs of our durable, long-lived equipment

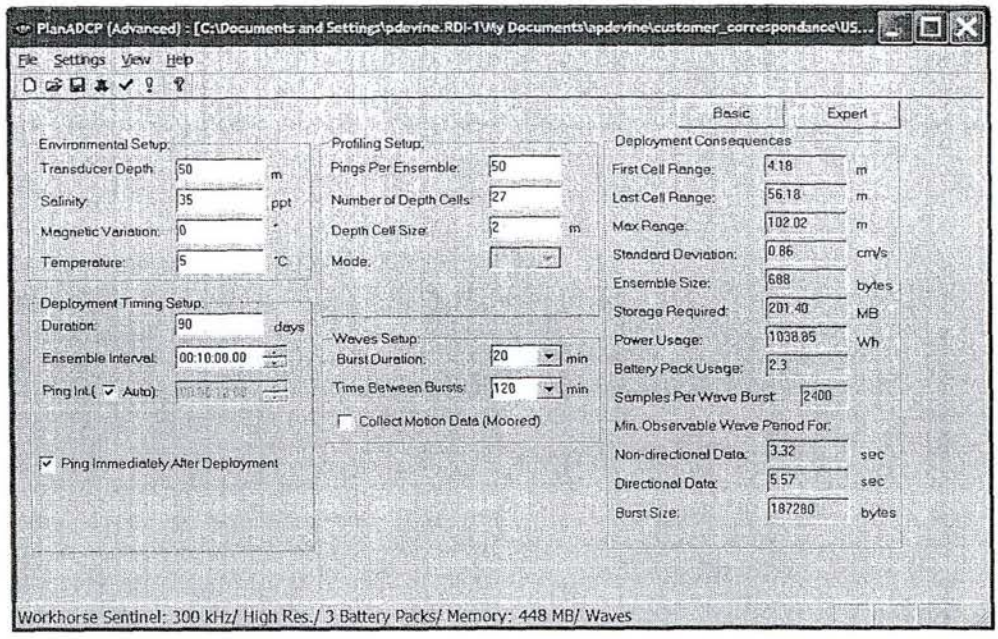
2.0 SUMMARY OF ADCP WAVES ARRAY FEATURES

Feature	RDI Workhorse	Remark
Wave Measurement Technique	Array	Array processing provides un-biased measurements in many conditions where PUV measurements provide biased measurements. If swell is incident from NW and SW, a PUV or wave following device will report one biased energy source from the W, while Array Techniques have the potential to indentify both energy sources.
Signal processing	Broadband	Broad band Technology is 7x Higher precision than narrow Band resulting in higher quality directional waves data. Acoustic systems that use a "noisy" NarrowBand signal processing will produce directional wave results of equal to or lesser quality than traditional methods.
Number of Sensors in Wave Array	12	More sensors in the array result in more degrees of freedom in the analysis and realistic distributions in the directional spectra. Systems with only 3 or 4 sensors are limited to results that are equivalent to PUV or buoy measurement techniques.
Simultaneous Wave + Current Measurements	YES	RDI allows full water column current measurements during the wave burst. Without the capability to simultaneously collect wave and current data, you are limited to recording a Maximum of 1 current measurement per 30 minute period when sampling waves.
Primary measurement of Height Spectra	Near Surface Velocity	Bottom mounted RDI ADCPs place the velocity array near the water surface to avoid faulty data from aerated water that can occur during storm events. Near surface measurements "sense" more of the wave energy than a sensor that is placed close to the bottom. If a near bottom pressure sensor is used in 17 meters water depth, errors in Hs of up to 25% could be experienced due to attenuation of the high frequency wave energy. Use of near surface velocity sensors capture the high frequency signal to avoid these errors.
Redundant Measurements of Height Spectra	"Surface track" + Pressure	Two additional quality assurance checks of the height spectra are available from the 4x remote echo range to surface "surface tracking" measurements as well as the customary pressure sensor method.
Maximum Memory Capacity	2000 Mb	More memory allows for longer deployments and sampling of more raw data for improved data QA after the deployment is over

Feature	RDI Workhorse	Remark
PCMCIA Memory	YES	RDI Uses standard off the shelf PCMCIA Memory cards that can be purchased at any electronics warehouse, not expensive memory chips that must be installed at the factory
Manufacturer ISO9001 certificate	YES	International Standards Organization ensures repeatable quality products
Beam Angle	20 degrees	The beam angle defines how close to the surface you can measure without experiencing side lobe interference. RDI's BroadBand precison allow for narrower beam angles and measurements 4% closer to the surface than systems that rely on NarrowBand techniques with 25 degree beam angles.
Number of Acoustic beams for velocity measurement	4	RDI ADCP has four transducers for automatic rejection of biased data for quantitative quality assurance that cannot be realized from systems with only 3 beams for velocity measurement.
1 Ping Data Rejection	YES	1 Ping data rejection is required for screening biased data due to fish contamination. Systems that perform multiple ping averages over time may average in biases from contamination from fish and may also loose the high frequency portion of the spectra.

3.0 EXAMPLE OF PLANNING SOFTWARE

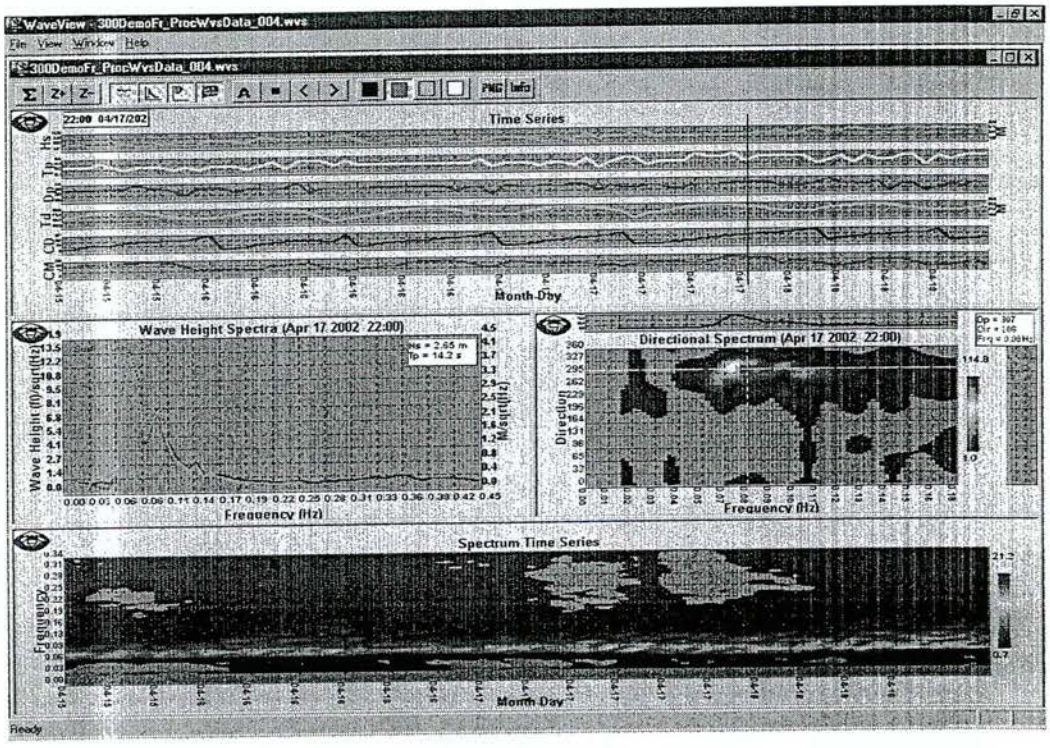
RDI's planning software is intuitive and ready to use by you or your field technicians today. The following are screen dumps of RD Instruments waves plan software that calculates the expected ADCP performance for a deployment depth of 50 meters. Please verify that the minimum observable wave periods are acceptable. If higher frequency wave information are required, the ADCP must be moved into shallower water.



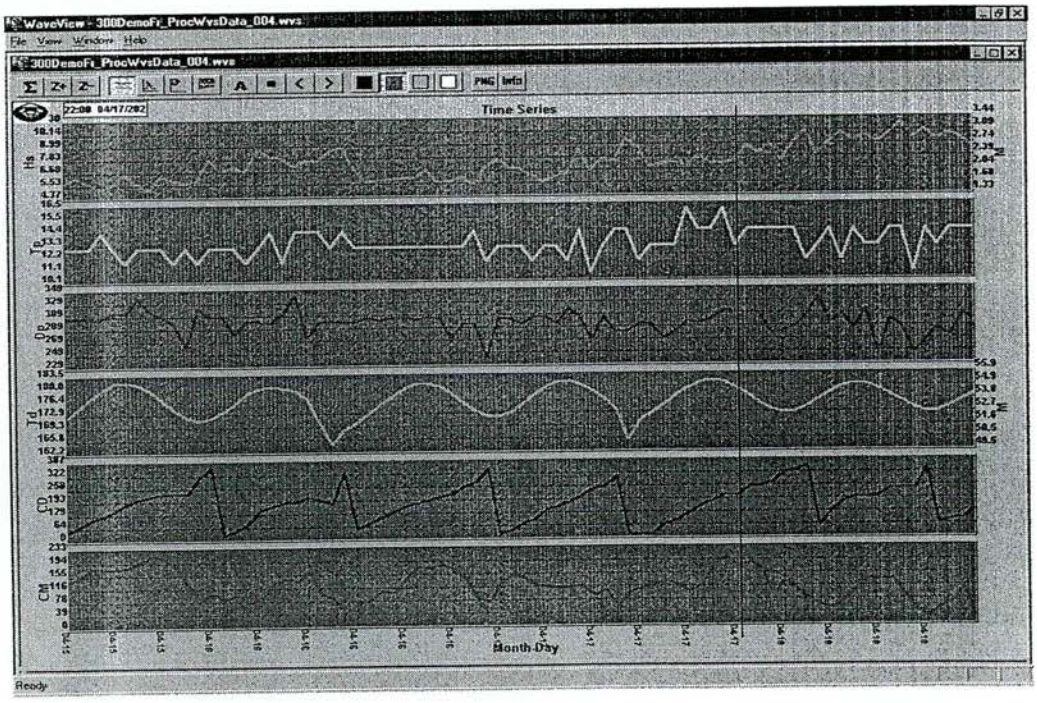
4.0 EXAMPLE DATA OUTPUT (50 meter depth deployment)

The following screen dumps correspond to a similar, deep water deployment of a 300kHz WorkHorse Sentinel that was deployed in ~52 meters mean water depth off of the coast of France. Surface tracking data is valid for periods of ~2 seconds.

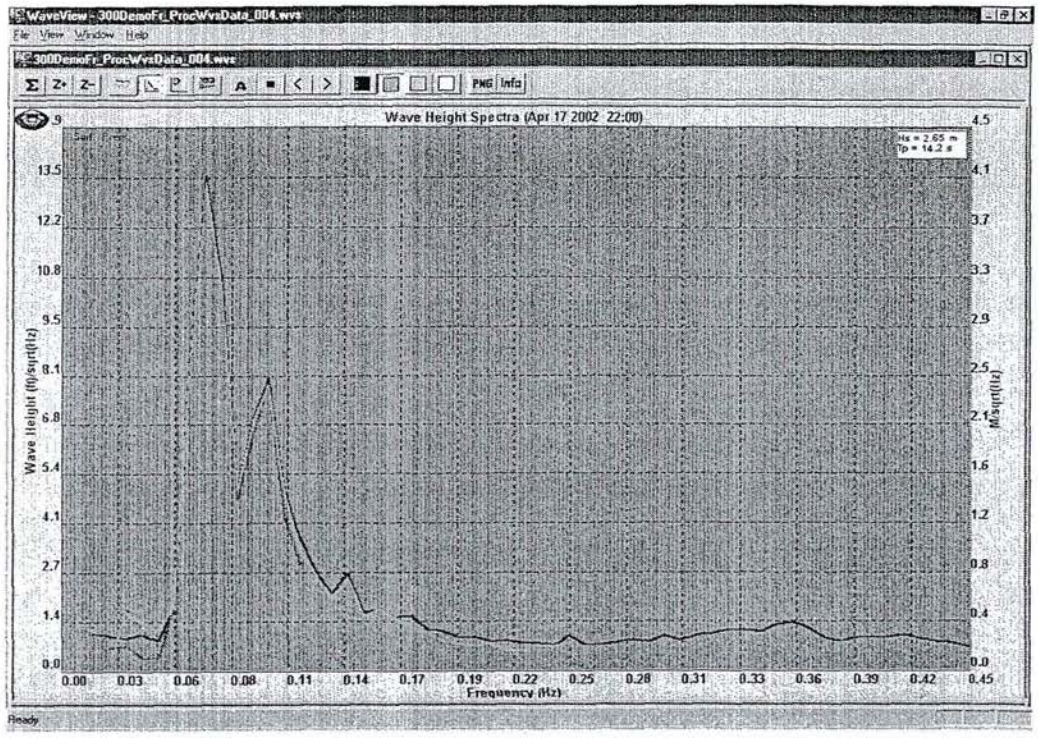
WavesView Composite Screen:



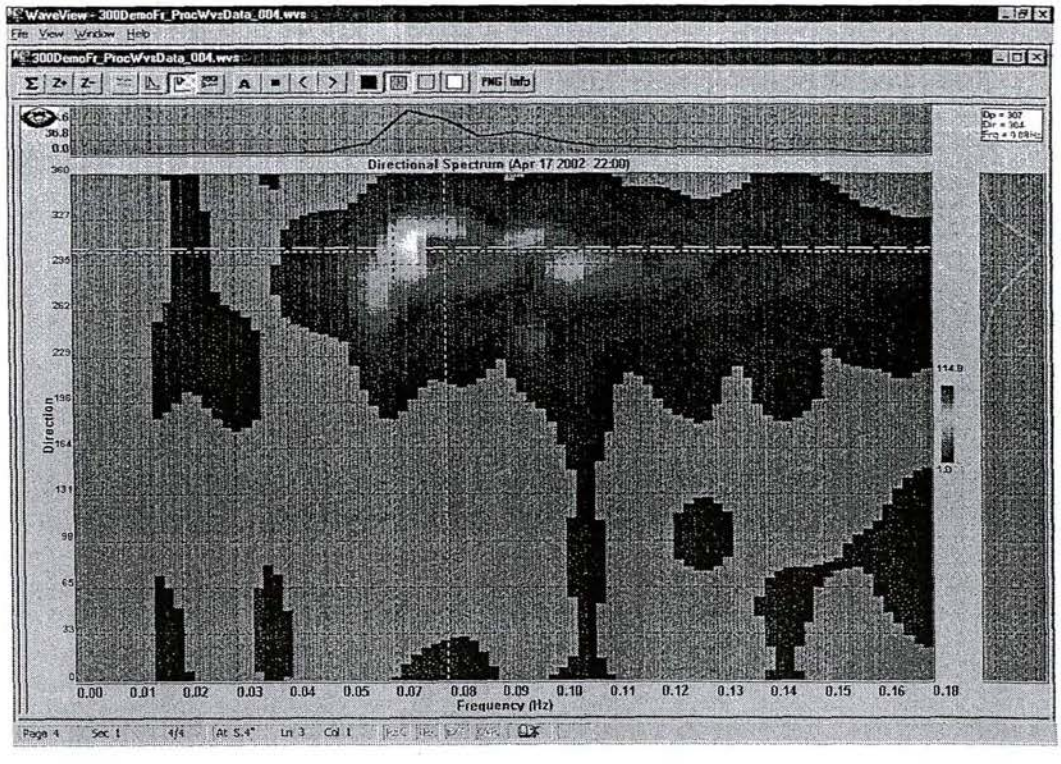
Summary Parameters:



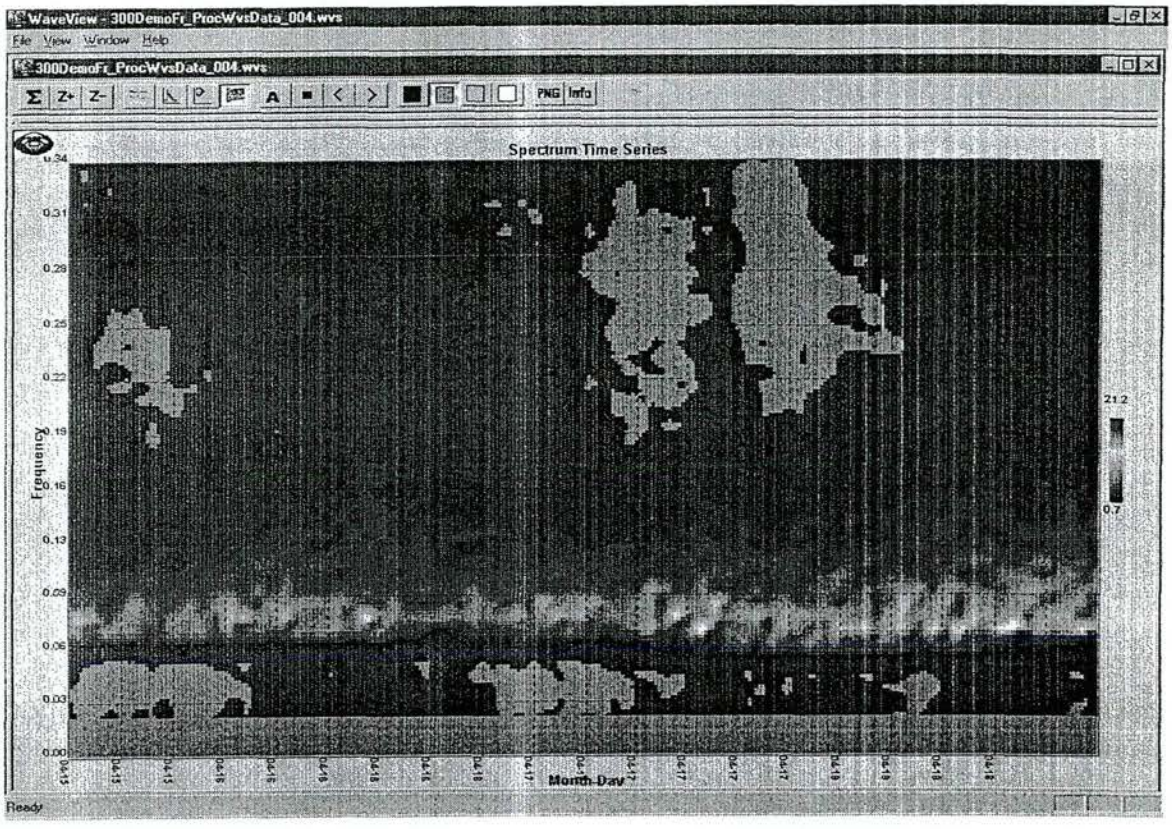
Non-Directional Spectra – showing three redundant measurements (note: measurements to 0.45 hz in 50 meters water depth).



Directional Spectra – showing quality directional data to 0.25 hz in 50 meters water depth.



Non-Directional "stack plot" – Showing time evolution of non-directional spectra



AWAC (QMETRIX)

SVASEK HYDRAULICS

AWAC™

- Wave height and direction
- Full current profile

...All with a single instrument

With the Nortek AWAC, you get a current profiler and a wave directional system in one unit. You can measure the current speed and direction in 1-m thick layers from the bottom to the surface and you can measure long waves, storm waves, short wind waves, or transient waves generated by local ship traffic.

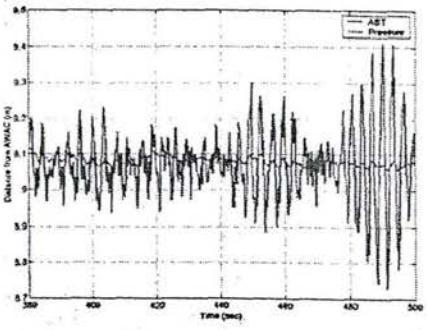
The AWAC is designed as a coastal monitoring system. It is small, rugged, and suitable for multi-year operation in tough environments. It can be operated online or in stand-alone mode with an internal recorder and batteries.

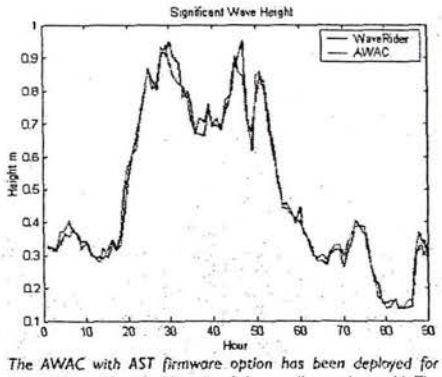
The sensor is usually mounted in a frame on the bottom, protected from the harsh weather and passing ship traffic.

The mechanical design is all plastic and titanium to avoid corrosion. Online systems can be delivered with protected cables, interface units on shore, and backup batteries and recorder. In stand-alone use, the raw data are stored to the internal data logger and power comes from an external battery pack. A variety of options are available with maximum deployment lengths of 4 months with hourly wave data (8 months with Lithium batteries).

AST breakthrough

With the optional Acoustic Surface Tracking (AST) firmware you can measure the long waves (swell), storm waves and the short waves generated from local winds. Moreover, the AST also gives you the ability to derive wave parameters based on times series analyses, which is a major advantage relative to the classical bottom mounted systems that derive the wave parameters from spectral estimates of pressure or velocity. This means that AWAC can directly measure wave parameters such as H_{max}, $H_{1/10}$, T_{mean}, etc. which other bottom mounted systems simply cannot.





The AWAC with AST firmware option has been deployed for comparison with wave (directional) buoys all over the world. The short segment shows a test conducted by Nortek partner Thetis SA off the south coast of France.

Software

The AWAC software is used to configure the instrument for deployment, retrieve the data and convert all data files to ASCII, and view all the measured current profiles and wave data. In order to calculate the wave parameters, the non-graphical WaveExtract software will generate ASCII files with all the interesting wave parameters.

For long term projects with multiple deployments and/or multiple stations, please contact Nortek to receive the latest information on the Nordis generation software For system integrators, individual DLL and ActiveX® elements are available for integration into Windows® or Windows® CE applications.

NORTEK AS

www.nortek-as.com

Specifications

System

Acoustic frequency	1 MHz or 600 kHz
Acoustic beams	4 beams, one vertical, three slanted at 25°
Operational modes	Stand-alone or long term monitoring

Current profile

Maximum range	30 m (1MHz), 50 m (600kHz) (depends on local conditions)
Depth cell size	0.4 – 4.0 m (1 MHz) 0.5 – 8.0 m (600 kHz)
Number of cells	Typical 20–40, max. 128
Maximum output rate	1s

Wave data

Maximum depth	40 m (1MHz), 60 m (600kHz)
Data types	Pressure, one velocity cell along each slanted beam, distance to surface
Cell size	0.4 – 4.0 m (1MHz) 0.5 – 8.0 m (600 kHz)
Sampling rate (output)	1 Hz/2 Hz, 2 Hz (4 Hz AST)
No. of samples per burst	512, 1024, or 2048

Velocity measurements

Velocity range	±10 m/s horizontal, ±5 m/s along beam (inquire for higher ranges)
Accuracy	1% of measured value ±0.5 cm/s
Doppler uncertainty	
- Waves	3.5 cm/s at 1 Hz for 2 m cells
- Current profile	1 cm/s (typical)

Sensors

Temperature	*Thermistor embedded in head* - Range: –4°C to 40°C - Accuracy/ Resolution: 0.1°C/ 0.01°C - Time constant: <10 min
Compass	*Flux-gate with liquid tilt* - Maximum tilt: 30° - Accuracy/Resolution: 2°/0.1° for tilt <20°
Tilt	*Liquid level* - Accuracy/Resolution: 0.2°/0.1° - Up or down: Automatic detect
Pressure	*Piezoresistive* - Range: 0–50 m (standard) - Accuracy/Resolution: 0.5% of full scale/ Better than 0.005% of full scale per sample

Data Recording

Capacity (standard)	2 MB, expandable to 26/82/154MB
Profile record	#cells×9 + 120
Wave record	#samples×24 + 46

Data Communication

I/O	RS-232 or RS-422
Baud rate	300–115200
User control	Handled via "AWAC" software or ActiveX® controls

Power

DC input	10–16 ±10% VDC
Peak current	2A
Operating power consumption	1W (typical)

Online applications

The AWAC is designed with long term monitoring in mind. The optional 48-Volt interface unit can be used to drive cables that are 5 km long and contains options for a variety of communication interfaces. This includes direct links using cable or radio as well as interfaces for GSM or analog telephone with automatic download from the internal recorder. Batteries and internal recorder can be used in conjunction with online systems for backup purposes.

Wave measurements

The AWAC provides three independent methods for measuring waveheight and period. The three methods utilize the pressure, orbital velocity, and acoustic surface tracking (optional). These three independent measurements provide an internal check so that the processed estimates can be checked against each other.

Directional estimates are derived from the projected array of velocity measurement cells. The processing technique is known as the *Maximum Likelihood Method* (MLM). This advanced approach of estimating wave direction allows for wave events from independent directions to be resolved, unlike standard single point measurement methods.

Standard Output Parameters for systems with AST: $H_{1/3}$, $H_{1/10}$, H_{max}, $T_{1/3}$, $T_{1/10}$, T_{max}, T_{mean}, T_{peak}, $L_{1/3}$, $L_{1/10}$, L_{max}, Peak Direction, Mean Direction, Directional Spreading, Unidirectivity Index

Specifications:

Height Resolution:	1 mm
Height Accuracy:	1 cm
Height Range:	0–20 m
Period Resolution:	0.01 sec
Period Accuracy:	0.1 sec
Period Range:	0.5–100 sec
Direction Accuracy:	2°
Direction Resolution:	1°

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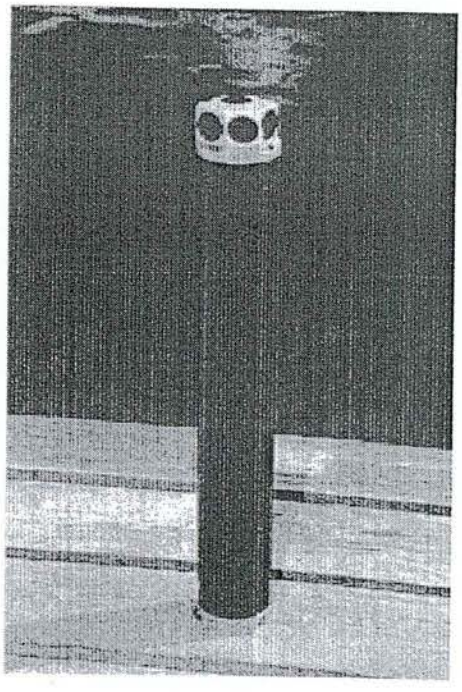
AQUADOPP (Qmetrix)

Aquadopp™

Open water Current Meter (3D)



Imagine an ocean current meter without need for recalibration, without moving parts, with the ability to withstand fouling and with the sampling volume moved away from the mounting structure. These are among the factors making the Aquadopp™ family the most versatile ocean current meters available.

Leading oceanographers and engineers all over the world use the Aquadopp. Typical applications are:

- Self-contained deployments
- Permanent monitoring stations
- Real time data collection on buoys, ROVs, offshore platforms, etc.

The Aquadopp is usually configured from a PC but it can be operated from any third-party controller using the RS-232/RS-422 interface (binary or ASCII) or analog outputs.

Software

The Aquadopp comes standard with Windows software both for real time data collection and for controlling autonomous deployments. Different views and menus guide you through the process from configuration to data conversion. The software has an on-line help section and requires no special skills.

New firmware versions from Nortek can be loaded into the Aquadopp using the standard software, removing the need for opening the canister and replacing components.

The effect of magnetic deployment frames can be eliminated in the on-line compass calibration procedure.

The Aquadopp has several significant advantages when compared to other open water current meters:

- All plastic and titanium parts stops corrosion
- Small and light weight (less than 3kg!)
- No moving parts that can be blocked or sensitive parts that are easily damaged
- Low power consumption for long deployments
- A variety of sensor heads and the ability to move the sampling volume away from the mounting structure assure undisturbed measurements in all situations

In the final analyses, the Aquadopp offers great value through the combined use of advanced Doppler technology and a flexible system design.

Wave directional spectra

The Aquadopp can be configured to collect wave directional data at the same time as it measures the mean current.

Nortek provides postprocessing software that allows you to calculate the wave spectra from the raw data.

Diagnostic mode

The diagnostic mode is unique for Aquadopp. It allows the user to intersperse the average data with periods of rapid sampling (1 Hz). Diagnostic data are typically used to analyze mooring motion or to gather information about surface waves or internal waves.

www.nortek-as.com

Water Velocity Measurement

Range	± 5 m/s (inquire for higher ranges)
Accuracy	1% of measured value ± 0.5 cm/s
Maximum sampling rate (output)	1Hz, 2 or 4Hz on request
Internal sampling rate	23 Hz

Measurement area

Measurement cell size	0.75 m
Measurement cell position (user selectable)	0.35–5.0 m
Default position (along beam)	0.35–1.8 m

Doppler uncertainty (noise)

Typical uncertainty for default configurations	0.5–1.0 cm/s
Uncertainty in U,V at 1 Hz sampling rate	1.5 cm/s

Echo Intensity

Acoustic frequency	2 MHz
Resolution	0.45 dB
Dynamic range	90 dB

Sensors

Temperature	Thermistor embedded in head
• *Range*	-4°C to 40°C
• *Accuracy/Resolution*	0.2°C/0.01°C
• *Time response*	10 min
Compass	Flux-gate with liquid tilt
• *Maximum tilt*	30°
• *Accuracy/Resolution*	2°/0.1° for tilt <20°
Tilt	Liquid level
• *Accuracy/Resolution*	0.2°/0.1° for tilt <20°
• *Up or down*	Automatic detect
Pressure	*Piezoresistive*
• *Range*	0–200m (standard)
• *Accuracy/Resolution*	0.5% / Better than 0.005% of full scale per sample

Analog inputs

Number of channels	2
Voltage supply	12V. Hardware can be modified to provide 5V or battery voltage
Voltage input	16 bit A/D

Data Communication

I/O	RS-232, RS-422, or analog outputs
Baud rate	300–115200
User control	Handled via WIN32 software, ActiveX function calls, or direct commands with binary or ASCII data output

Software ("Aquadopp")

Operating system	WIN95, 98, 2000, NT 4.0, XP
Functions	Deployment planning, start with alarm, data retrieval, ASCII conversion. Online data collection and graphical display. Test modes.

Data Recording

Capacity (standard)	2 MB, expandable to 22MB or 78MB
Data record	40 bytes
Diagnostic record	40 bytes

Power

DC input	9–16 VDC
Peak current	2A at 12VDC (user adjustable)
Max. consumption, 1 Hz	0.2–1.0 W
Avg. consumption,	
0.02 Hz	0.1 W
0.002 Hz	0.01 W
Sleep consumption	0.0013 W
Battery capacity	50 Wh. Extended 6000 m version has two battery packs (i.e. double capacity)
New battery voltage	13.5 VDC
Data collection (alkaline)	6 months at 10-min, ± 1.5 cm/s noise
Data collection (lithium)	18 months at 10-min, ± 1.5 cm/s noise

Connectors

Bulkhead (impulse)	LPMBH-5-FS (bronze - titanium optional)
Cable	LPMIL-5-MP on 5m neoprene cable

Materials

Standard model	Delrin® and polyurethane plastics with titanium screws

Environmental

Operating temperature	-5°C to 45°C
Storage temperature	-15°C to 60°C
Shock and vibration	IEC 721-3-2
Pressure rating	300m (pressure sensor OK to 1.5×range)

Antifouling paint

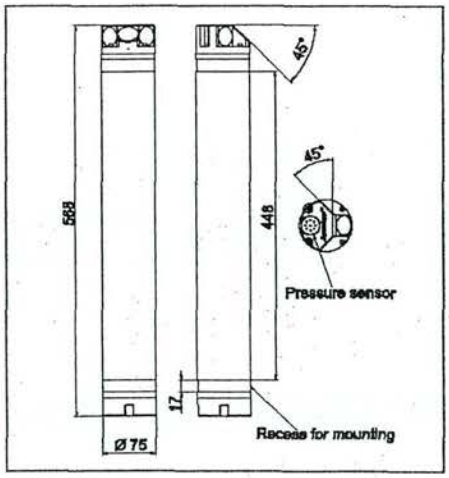
May be applied to all surfaces

Dimensions

Cylinder	Diameter: 75mm
	Length: 550mm with batteries or 450mm
Weight in air	3.5kg
Weight in water	Neutral

Options

Acoustic beams	Several different sensor heads available. See separate specification sheet
Battery	Lithium or rechargeable Li-Ion batteries available
External battery	4 battery packs in 75mm diameter, 500mm length. External canister
Connectors	LPMBH-8-FS with PLPMIL-8-MP on 10m polyurethane cable for optional RS422 or RS232 with analog input.



SVAŠEK HYDRAULICS

DIRECTIONAL WAVEGUIDE (RADAC)

TERMS & CONDITIONS

Prices	:	Euro's, Net, Excluding V.A.T.
Quotation validity	:	90 days.
Delivery time	:	6 weeks after written receipt of order.
Packing	:	Estimated packing details for SmartRadar WaveGuide: - Net weight : 15 kg - Gross weight : 20 kg - Volume : 0.12 m^3
Payment	:	60% at moment of order 40% within 30 days after delivery
Guarantee	:	12 months after delivery .
Country of origin	:	The Netherlands.

SVASEK HYDRAULICS

Wave & Tide monitor WaveGuide

General description:

To measure the waterlevel accurate while the water surface varies millimeters on a yearly scale (sealevel rising) to many meters on a seconds scale (sea waves) requires a robust and accurate sensor with very good zero point stability. The WaveGuide fulfills these requirements.
Recently the Dutch government (Rijkswaterstaat) evaluated the Radar Level Gauges available at the market. They concluded in their final report that the measuring principle is that stable and accurate that it can replace their stilling wells (standard equipment for measuring sealevel rising and tides) and their stepgauges (the standard for measuring waves).

The WaveGuide is based upon Enraf's Smartradar. Stability and durability for uninterrupted operation is guaranteed by the large quantities sold in the petrochemical industry and the harsh environment the sensors are designed for.

The WaveGuide range of products consist of sensors, software and additional hardware.

The WaveGuide sensor (Enraf's Smartradar):

1. *Application of advanced and proven technologies:*

   SmartRadar is a level gauge originally developed for accurate tank inventory measurement. Enraf has obtained a large number of certificates for SmartRadar under which approvals for custody transfer. Over 2000 units have been installed under sometimes extreme conditions, which makes it a proven technology.

2. *Also suitable for huge waves*

   The SmartRadar is a FMCW radar. With each radar sweap (up to 5.12 Hz) a radar reflection diagram over the total range of the instrument is generated. No filtering techniques are used to keep focussed on the level. Other manufacturers use a moving frequency window to follow level. When the level changes to fast it can happen that the their wave radar 'looses' level. With the WaveGuide this cannot happen because no filtering windows are used.

3. *Remote service facilities*

   Via the Service Tool the WaveGuide can be serviced via all kind of facilities. Direct connection with a laptop, dial in via GSM modem and via a TCP/IP network with the WaveGuide Server.

4. *Low Power*

   The sensor uses less than 6 W, allowing it to be powered from solar panel

5. *Planar antenna technology:*

   SmartRadar WaveGuide is equipped with a 8" planar radar antenna (F08).
   Planar antennas are the most advanced antenna types available today, giving optimal measuring results.

6. *Excellent long term stability, no recalibration required*

   SmartRadar WaveGuide uses 100% digital signal processing. The lack of analog components guarantees long term stability. With SmartRadar used for custody transfer, long term stability of 3 mm over a prolonged period is required!
   SmartRadar WaveGuide does not require compensation/correction for changes in temperature, humidity or other factors.

7. *Explosion-proof certified*

   Standardisation on WaveGuide is not limited to safe areas. WaveGuide complies with international standards for use in hazardous areas. CENELEC, FM and many other certificates are available.

8. *No maintenance*

   The WaveGuide has no direct sea contact nor any moving parts, which limits maintenance requirements to the absolute minimum.

9. *Safe and reliable under all weather conditions*

   WaveGuide is provided with a unique lightning protection system using galvanic separation to avoid damage during thunderstorms.

10. *High reliability*

    WaveGuide has extended self diagnostics continuously guarding the reliability of the measurement. Preventive maintenance or service is not required. Using WaveGuide is a matter of install and forget.

WaveGuide Server

WaveGuide can be connected via a WaveGuide Server (WGS). The WGS (a small box with an embedded PC running Linux) couples the Waveguide to the outside world (eg. Via a radiolink, GSM modem or standard TCP/IP network). This gives all the facilities of remote operation as:

- Remote service (trouble shooting and software updates from any location) via a standard webbrowser
- Processing at datalogging at the WaveGuide Server. Archiving and presentation at any computer within the network via a standard webbrowser (e.g. Internet Explorer). The analysis software includes the SWAP program (Standard Wave Analysis Program) in accordance with the Rijkswaterstaat and E&P forum requirements. Data can be stored in dayfiles. Actual and historical data can be downloaded and presented anywhere within the network.
- Datadistribution. A user can subscribe himself to real time data (raw data or processed parameters). The data will be send by the network (TCP/IP messages) , via a comport or over 50km via a HF radiolink
- More Waveguides can be added easily by adding more comports.
- A GPS receiver (optional) for exact time stampling and synchronisation of measurements. (A must for wavedirection measurements).
- A GSM modem (optional) for communication via SMS messages.

Technical description

SmartRadar LT level gauge type MRAG973YZBR1205.

(WaveGuide for Waves and Tide) SmartRadar consists of one compact housing with antenna The instrument accuracy is better than +/- 1 cm.

- Weight	: 11 kg
- Dimensions	: diameter 250 mm x 400 mm
- Cable entries	: 3 pieces 3/4" NPT
- Mains supply	: 110-220 V, 50/60 Hz (24-64 V-DC also available) 6W
- Explosion proof	: Class 1, Division 1, Groups B,C.D T4, according to NEMA Type 4
- Housing material	: chromatized aluminum
- Lightning protection	: fully galvanic separation via transformers
- Field communication	: RS232 (RS485 also available)
- Ambient temp. range	: -40°C to +65°C
- Storage temp. range	: -50°C to +85°C Antenna Unit:
- Operating frequency	: X-band (9.15 to 10.85 GHz)
- Signal processing	: Digital Signal Processing (DSP)
- Planar antenna	: F08 for mounting in free space
- Antenna material	: stainless steel AISI 316 and FEP
- The antenna stem length	: 5 cm.
- Measuring principle	: FM synthesized pulse reflectometer
- Measuring resolution	: 3 mm
- Transmitting resolution	: 10 mm
- Measuring range is	: 0 - 60 m
- Sample frequency	: 2 or 2.56 Hz

WaveGuide Server

The WaveGuide Server couples the Radar to the computer of the user via, compact Flash card, LAN, comport, telephone line, mobile telephone or HF radio,. The unit is not explosion proof, so it shall be installed in a weather protected and safe area. The WGS has a CAN, RS-485 or 232 input for connection with a WaveGuide sensor a RS232 port (for connection with a laptop or GSM modem) and a standard network connection (RJ45) for linking into a TCP/IP network. More WaveGuide sensors can be added to one WaveGuide server by adding an extra comport.

WaveGuide Server option " tide processing/datalogging "

- Real time processing to waterlevel parameters: Several averaging periods selectable.
- Datalogging at a Compact Flash card (up to 1 Gigabyte of data)
- Real time data transfer to registered users.
- Presentation and archiving on several computers in the network via a standard webbrowser.

WaveGuide Server option " Wave and tide processing/datalogging "

Same as the " tide processing/datalogging " option

+

- Processing to wave parameters (mean wave height, significant wave height, maximum wave height and energy density spectrum a.o.) the standard Rijkswaterstaat method is used.
- Subsets of parameters can be selected for storage and distribution.
- The user can adjust the period (20 minutes is standard) and the interval (1 minute is the minimum).

Price summery

Item	Type	Euro (ex VAT)
1	WaveGuide Waterlevel/ Tide with F08antenna	6.200,--
2	WaveGuide Waves and Tide with F08antenna	14.265,--
3	WaveGuide Server	2.200,--
4	WaveGuide Server option "tide processing/ datalogging"	1.200,--
5	WaveGuide Server option "wave and tide processing/ datalogging "	2.500,--

TERMS & CONDITIONS

Prices	:	Euro's, Net, Excluding V.A.T.
Quotation validity	:	90 days.
Delivery time	:	6 weeks after written receipt of order.
Packing	:	Estimated packing details for SmartRadar WaveGuide: - Net weight : 15 kg - Gross weight : 20 kg - Volume : 0,12 m^3
Payment	:	60% at moment of order 40% within 30 days after delivery
Guarantee	:	12 months after delivery .
Country of origin	:	The Netherlands.

SVASEK HYDRAULICS

SM 050 MkIII (MIROS)

SVAŠEK HYDRAULICS

SM 050 MkIII (MIROS)

MIROS

UNIQUE CONCEPT

The SM-050 Wave and Current Radar is a unique high performance remote sensor for measurement of directional wave spectra and surface current. It is the only sensor in the world utilizing dual footprint pulse Doppler method for wave measurements, and microwave dual frequency method for measuring surface current.

PROVEN TECHNOLOGY

The radar was originally developed in the early 1980's. It has been thoroughly tested and kept continuously updated to meet latest requirements.

MkIII ENHANCEMENTS

The present Mk III version encompasses a new Digital Signal Processor and upgraded Cabinet for the SM-050/3, improving performance and reliability of the radar. The software is in addition totally redesigned with improved algorithms and user interface.

VERIFIED ACCURACY

The accuracy of the sensor has been verified in a number of independent comparisons. The data quality is at the same level as high performance buoys, but with higher availability.

PENETRATES PRECIPITATION

The selected frequency of operation ensures a very high degree of penetration through precipitation and sea spray, and provides accurate measurements in all harsh weather situations. This is a unique feature of the SM-050. Remote wave measuring systems based on other technics, such as marine X-band radars, do have operational limitations during precipitation periods.

HIGH RELIABILITY

The previous Mk II version has proved to be a reliable sensor. Mk III enhancements will bring the sensor one significant step further.

EASE OF OPERATION

The radar operates fully automatic. Operators will within short time be familiar with the radar user interface.

EXCELLENT SERVICE ACCESS

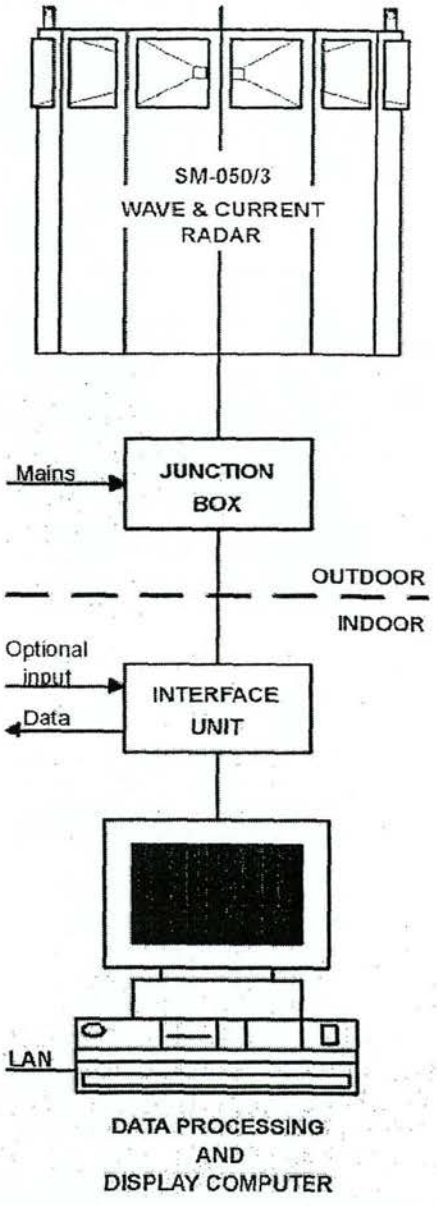
All major components in the radar are easily accessible. Comparable sensors are normally deployed in the sea, making service tedious and expensive.

LOW OPERATING COST

The radar is all solid state without magnetron or high frequency tubes. It has (except for a few fans) no rotating parts. Operating cost is consequently very low.

FLOATING STRUCTURES

The SM-050/3 has to be fitted with an optional Motion Reference Unit (MRU) when applied on floating structures such as semis, drill ships, FPSOs, FSUs etc. The radar with MRU is designed for use on stationary units, but reasonable measurements may be obtained during transit at speeds up to 6-8 knots. The MRU may also be utilized for motion monitoring. (Motion Monitoring Systems, including Helideck Monitoring are available from Miros A/S.)

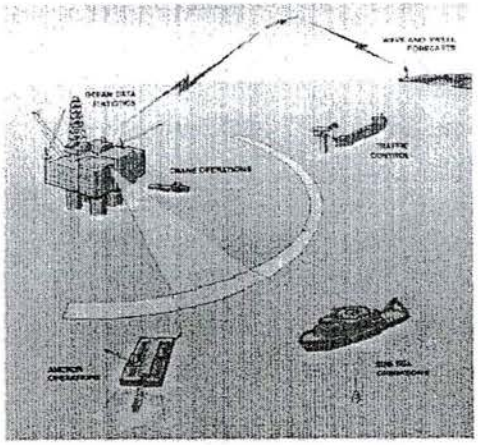


PRINCIPLES OF OPERATION

The radar observes the ocean surface in a semi-circle at a distance of 180-450 m depending on the installation height. Recommended mounting height for the SM-050/3 is 20 to 100 m above sea level, on a location which provides a minimum of 180° clear view of the ocean surface.

Six 30° sectors are scanned in sequence. The observation footprint is 75 m deep (horizontally). Obstructions between the radar and the footprint (supply vessels etc) should be avoided.

The radar frequency has been chosen to obtain a strong echo from the capillary waves. They are normally present at wind speed above 2 m/s.



RADAR INSTALLATION

The SM-050/3 is easy to install. The unit is fitted with 5 m cable tails which enables installation without accessing the interior of the radar. Optional Pedestal and mounting Skid are available to optimize the installation and hence reduce installation time.

OPTIONAL SHOCK ABSORBER

An optional Shock Absorber Kit is available for the SM-050/3. The kit is recommended for vessels with heavy motions.

OPTIONAL COOLING

An optional Sun Shield is available to reduce solar heating of the radar. An active Cooling Unit may additionally be installed when ambient temperature exceeds 30°C.

COMPUTER

The Wave & Current Radar Processing & Display Computer is a standard PC with connection to the Interface Unit and a LAN connection to external systems which may access files for realtime use. Real time data may in addition be transmitted on a serial line. The PC is equipped with CD-RW device for historical data archiving. Marinized and/or 19" rack mount versions of the computer are available on request.

SOFTWARE

The SM-050 MkIII software package is highly modular and encompasses sophisticated algorithms for filtering and processing of data. A single user data display application is included.

OPTIONAL INPUTS

The Computer may receive heading, speed, time and position data on NMEA format for logging with the measured wave and current data by use of optional software.

USER INTERFACE

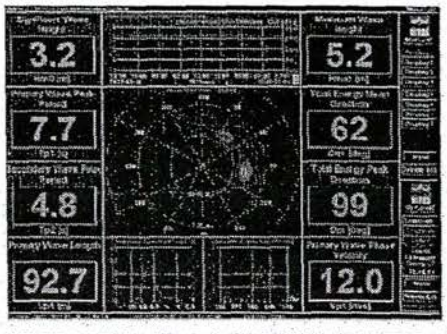
The user interface is configurable and provides different types of visualisation, such as large single parameter windows, parameter tables, historical graphs with zooming capabilities, 2D & 3D directional spectrum, frequency spectrum etc.

SYSTEM MONITORING

Alarms and system status are presented to the operator. Maintenance personnel will find useful information for fault location and rectification.

UPGRADE POTENTIAL

Optional software will enable expansion to a full MetOcean system with interfaces to a number of sensors. The upgrade includes full integration with an SQL database (Oracle) and easy to implement LAN/WAN presentation of data to a high number of users.



Typical Display configuration suitable for daily planning of activities influenced by the sea state.

SVASEK HYDRAULICS

Measurement Performance

Directional Spectra

Directions:	36
Directional Resolution:	10°
Frequencies:	32
Frequency Resolution:	0.01 Hz
Frequency Range:	0.0 - 0.3 Hz *
Update Interval:	2.5 minutes
Averaging Time:	45 minutes default

* Frequency Bins 0 - 3 (0.0 - 0.03 Hz) are not used for wave calculations.

Wave Data From Directional Spectra *

	Range	Error	Resolution
Height:	0 - 30 m	± 5%	0.1 m
Period:	3 - 30 s	± 5%	0.1 s
Direction:	1 - 360°	± 7°	1°

Surface Current

	Range	Error	Resolution
Magnitude:	0 - 2.5 m/s	± 0.05 m/s	0.01 m/s
Direction:	1 - 360°	± 7°	1°

Update Interval: 15 minutes.
Averaging Time: 90 minutes default.

SM-050/3 Specification

Physical Specification

Height:	870 mm	(900 mm *)
Width:	900 mm	(1100 mm *)
Depth:	700 mm	(980 mm *)
Weight:	85 kg	(125 kg*)
Material:	Aluminum Al 57S	
Finish:	Enamelled	
Colour:	Gray RAL 7035	

Environmental Specification

Temperature:	-15 to +30°C (+40°C *)
Humidity:	0 - 100 %RH
Cabinet:	IEC IP-66
Wind Rating:	< 75 m/s

Electrical Specifications

Frequency of operation:	5.8 GHz
Pulse Bandwidth:	20 MHz
Antenna Beamwidth:	24° (3 dB)
Antenna Gain:	18 dB
Number of Antennas:	6
Transmitted Power:	10 W peak, 275 mW average
Power Requirements:	110 - 230 VAC, 47 - 400 Hz
Power Consumption:	< 300 W (< 500 W *)
EMC:	EN 50081-2:1993 (Emission) EN 50082-2:1995 (Immunity)

* With optional Cooling Unit and Sun Shield.

Interface Specification

Serial Output

RS-422 ASCII coded, 9600 b/s
Miros DF-022 format

Files available via LAN

Raw Data:	Miros DF-025 format
Spectrum:	Miros DF-038 format
Scalar Parameters:	Miros DF-037 format

Optional Inputs

Heading:	RS-422 NMEA (HDT sentence)
Position:	RS-422 NMEA (GLL/GGA sentence)
Track & Speed:	RS-422 NMEA (VTG sentence)
Date & Time:	RS-422 NMEA (ZDA sentence)

Scope of Delivery

Standard System Delivery includes

Wave & Current Radar SM-050/3
Outdoor Junction Box (JB)
Indoor Interface Unit (IU)
Data Processing and Display Computer with Software
Single User Data Display Software Licence
One set of Handbooks
Software and Handbooks on CD (for software re-installation)
5 m Cables from Radar to JB
5 m Cables from IU to Computer

Available Services

Installation and Commissioning
Remote Supervision via Internet
Post processing, verification and analysis of data

Optional Items for SM-050/3

Motion Compensation Kit (MRU)
Cooling Unit
Sun Shield
Shock Absorber Unit
Pedestal
Skid

System Options

Cables from JB to IU and from JB to mains
Marinized Computer
19" rack solution for Computer and IU
Spare parts
Upgrade to full MetOcean System incl Motion Monitoring

MIROS

Miros A/S, Solbråveien 32, P.O. Box 364,
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E-mail: office@miros.no - Web site: www.miros.no

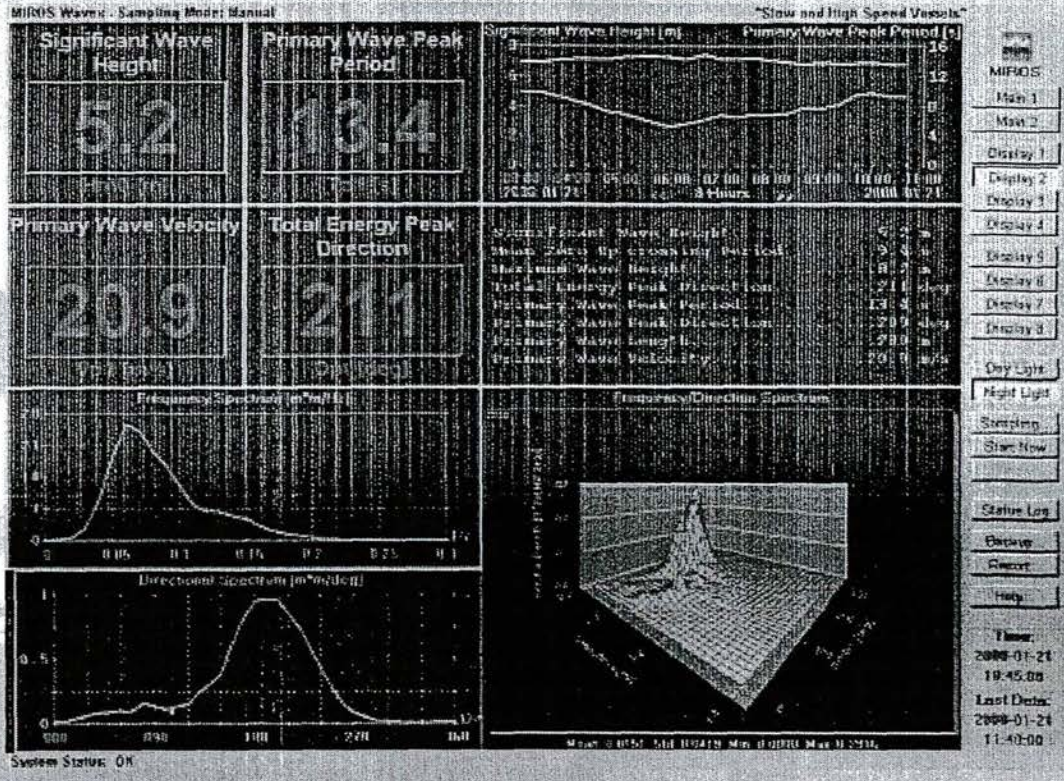
1100/DB/003, rev. 2

SVAŠEK HYDRAULICS

WAVEX (MIROS)

MIROS

DATA PRESENTATION
BY
USER ORIENTED SOFTWARE



WAVEX GUI is a MIROS Windows-NT based wave data presentation program.

WAVEX provides historic and real time wave data for:

- Significant wave height
- Maximum wave height
- Mean zero up-crossing period
- Primary wave peak period
- Primary wave velocity
- Primary wave length
- Primary wave peak direction
- Total energy peak direction
- Total energy directional spread

A number of data windows can be arranged in any combination, and the set-up saved for easy availability:

- Up to 8 "large" single parameter windows
- Up to 4 double parameter history diagrams
- Parameter list
- Parameter time series
- Frequency spectrum
- Directional spectrum
- Polar and/or Cartesian radar image
- Radar image
- Frequency / Direction spectrum

Eight screen presets or user configurations are available with the push of a button. An "unlimited" number of custom made configurations can be stored and accessed with a few mouse clicks.
Surface current data are optionally available for shore based and stationary installations.

RANGE FINDERS (MIROS)

MIROS

SM-094 RANGE FINDER

The MIROS Range Finder is designed for measurement of
- Airgap and draught
- Ocean wave profiles and tidal variations
- Water level in dams, rivers, canals, lakes etc.

The sensor emits a microwave FM chirp signal and receives the echo from the water surface. The signal propagation delay given by the distance from the antenna to the water surface causes a beat signal in the receiver. By means of advanced signal processing the beat frequency is converted to an accurate distance.

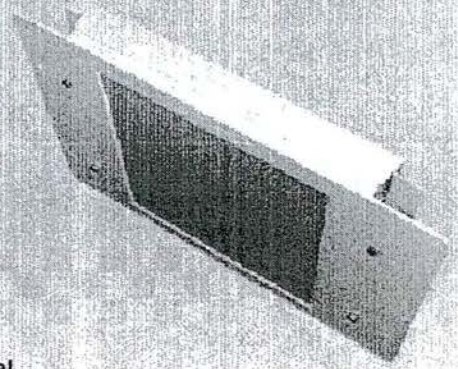
The planar patch antenna results in small physical dimensions and low weight.

The FM chirp is generated by a digitally synthesized frequency sweep oscillator with absolute frequency linearity and high stability. The sensor therefore provides accurate range measurements and high long term stability.

Due to the low frequency of operation (compared to laser sensors), fog, rain and water spray will not cause measurement problems.

The sensor signal processing is performed by a micro-controller. The sensor provides the measured range as well as an averaged range with 1 mm resolution. Averaging time constant may be selected by user. The signal output may either be continuous at selected rate, or single measurements in response to user request.

SM-094 is available in different range versions with different antenna beam width.



Specifications

Microwave Transceiver

Modulation:	Triangular FM
Frequency:	9.4 - 9.8 GHz
Output power:	0.25 mW (-6 dBm)

Wide Beam Antenna

Beam width:	10° (-3 dB one way)	
Gain:	> 18 dB	
Range:	SM-094/10:	1 - 10 m
	SM-094/20W:	1 - 20 m

Narrow Beam Antenna

Beam width:	5° (-3 dB one way)	
Gain:	> 24 dB	
Range:	SM-094/20N:	3 - 20 m
	SM-094/50:	3 - 50 m
	SM-094/85:	3 - 85 m

Measurement Error

Individual measurements:	< 1 cm
Averaged measureements:	< 1 mm

Power Requirements

Voltage:	22 - 32 VDC (nominal 24 VDC)
Current:	0.2 A

Environmental

Temperature:	-30 - +50 °C
Humidity:	10 - 100 %RH

Housing

Material:	Aluminium AL57S
Finish:	Enamelled
Colour:	Gray, RAL 7035
Ingress protection:	Designed to meet IEC IP66

Physical

Dimensions:	70 x 510 x 420 mm (HxWxD)
Weight:	7 kg

Digital Signal Output

Interface:	RS-422 (optionally RS-232)
Code:	ASCII
Baud rate:	9600
Data bits:	8
Stop bits:	1
Parity:	None
Data rate:	SM-094/10: 2*, 4 or 8 Hz SM-094/20: 2* or 4 Hz SM-094/50: 2 Hz SM-094/85: 2 Hz or polling mode
Data format:	aa.aaa<HT>rr.rr<CR><LF> aa.aaa is measured range [m] rr.rr is 10 min averaged* range [m]

Analogue Signal Output (optional)

Range:	0 - 10 V (0 m to full range*)
Load:	> 1200 ohms
Current:	< 10 mA
Band width:	2 Hz

* factory settings, user programmable

Note: Specifications are subject to change without prior notice.

DB/095 rev. 03

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E-mail: office@miros.no, Web site: www.miros.no

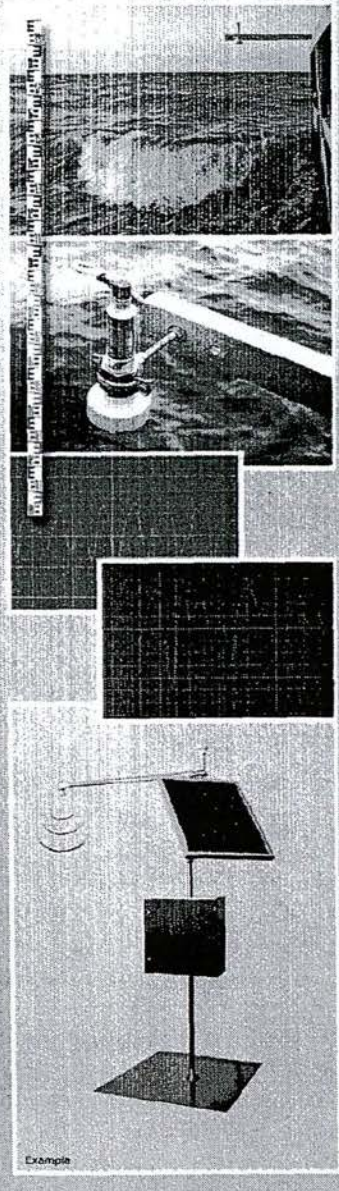
SVAŠEK HYDRAULICS

LOG_aLEVEL (GENERAL ACOUSTICS)

GENERAL ACOUSTICS

LOG_aLevel®

Autonomous Remote Sensing of Water Level and Waves



LOG_aLevel® is a complete, remote sensing, stand-alone water level gauge on the basis of ultrasonic sensors with solar power supply (optional wind generator) and wireless data transmission.

The system works automatically and is independent of any external connections.

High performance ultrasonic sensors guarantee robust, reliable, fast and precise measurements of all kinds of water level and its dynamics (up to steep waves).

To guarantee the highest measurement and data security, a level of redundancy can be built into the system.

Application:

- Water level monitoring
- Wave measurement
- Flood warning and prediction
- Tide monitoring
- Reservoir control
- Environmental monitoring

Advantages of LOG_aLevel® in opposition to mechanical water level gauges

- Cost effective
- Robust, compact, highly flexible and easy to install
- Always reliable even in flood and ice drift conditions
- Weather proof and storm tide tested
- Non sensitive to erosion, pollution and thermal fluctuation
- Fast detection of slightest water level change
- Reduced risk of malfunction by gauging of steep waves

These facts make the **LOG_aLevel®** system an interesting and economic alternative to conventional level monitoring and wave measurement system.

LOG_aLevel®

GENERAL ACOUSTICS

LOG_aLevel®

Autonomous Remote Sensing
of Water Level and Waves

Features

Data acquisition:	Low power datalogger with non-volatile memory or PCMCIA-Card up to 512 Mbyte
Housing:	500x500x200mm stainless steel with lock, seawater resistant IP class up to 69 K, flood-secure
Mounting:	Seawater resistant pole (anodized aluminium or stainless steel) with base plate

Specifications

Measuring range:	up to 6 m (wider ranges on request)
Sampling rates:	from 10 Hz up to 1 value/day
Resolution:	up to 1 mm
Accuracy:	up to 1 cm
Solar panel:	41 Wp up to 180 Wp (if required), seawater resistant with high efficiency MPP-charge regulator
Backup battery:	Maintenance free lead gel battery, 12 V 45 Ah up to 140 Ah (if required)

Options

Data transmission:	Radio, telephone modem, GPRS (ranging from remote on/off over status monitoring up to a complete remote control with data transmission over a transparent line and data server @www)
Further sensors:	Wind gauge (acoustical or mechanical), (other sensors on request)
Time:	High accuracy GPS - date and time (pps, 1 ms accuracy)
Power supply:	Wind generators 25 W up to 75 W @ 20 knots wind speed

Architecture

Standard equipment	Equipment accessories
Controller	Power supply module
Ultrasonic level sensor	Data storage module
Sound velocity probe	Communication module
Interfaces output/input	Timing Module

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Germany

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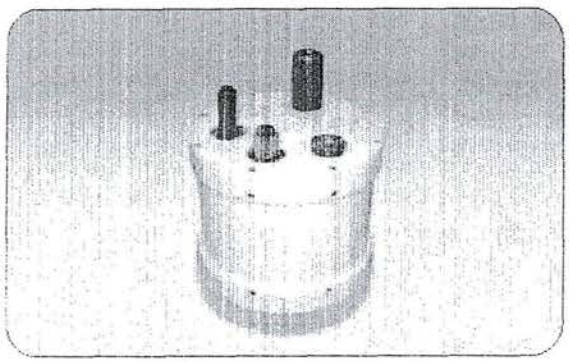
SVAŠEK HYDRAULICS

MIDAS WTR (VALEPORT)

SVASEK HYDRAULICS

VALEPORT



MIDAS WTR

The MIDAS WTR replaces the old Model 730 Wave Recorder. Whilst continuing to use the proven Linear Wave Theory wave analysis method, the MIDAS WTR benefits from Valeport's latest sensor measurement technology, together with 64 bit data processing, and an improved range of sampling options. USB data upload, quick change battery carousel and intuitive operating software make the MIDAS WTR one of the most versatile yet easy to use pressure based wave recorders available.

Sensors

The MIDAS WTR is fitted with a choice of resonant quartz or strain gauge pressure sensors, and a fast response PRT temperature sensor as standard. Note that whilst the resonant quartz sensor offers a higher absolute accuracy, the quality of wave data owes more to deployment location and sampling pattern than to sensor performance. Optional additional sensors include Conductivity and Turbidity (others available on request).

Sensor	Type	Range	Accuracy	Resolution
Pressure high accuracy)	Resonant Quartz	65psi (35m water)	±0.01%	0.001%
Pressure (standard)	Strain Gauge	50dBar (40m water)	±0.1%	0.001%
Temperature	PRT	-5 to +35°C	±0.01°C	0.005°C
Conductivity (optional)	Inductive Coils	0 - 80 mS/cm	±0.01 mS/cm	0.004 mS/cm
Turbidity (optional)	Seapoint STM	0 - 2000 FTU	±2%	0.005% Scale

Data Acquisition

In order to correctly measure wave activity, Linear Wave Theory requires a specific number of data points to be sampled over a period of time. These data points are then processed on board the instrument to generate an accurate summary of the wave activity during the measured period. The MIDAS WTR therefore operates in a strict pattern of "sample, process, sleep", with the user controlling the number of samples and the sampling rate, together with the duration of the sleep period. This may be minimised for almost continuous sampling, but obviously at the expense of battery and memory usage.

Sample Rate: 1, 2, 4 or 8Hz.
No of Samples: Powers of 2, 128 - 4096 (more samples = better data)
Cycle Time: Minimum cycle time is nearest whole number of minutes after processing has finished.
Delay Start: Instrument can be programmed to begin sampling at a specific time.
Conditional: Wave Sampling only occurs if pressure activity exceeds a defined level.

Electrical

Internal: 32 x D cells, 1.5v alkaline or 3.6v lithium
External: 9 - 30vDC
Power: 0.7W (sampling), <1mW (sleeping)
Battery Life: Depends on sampling setup, typically:
>2 months operation (alkaline)
>5 months operation (lithium)
Connector: Subconn Titanium MCBH10F

Communications

The instrument will operate autonomously, with setup and data extraction performed by direct communications with PC before and after deployment. It also operates in real time, with a choice of communication protocols for a variety of cable lengths, all fitted as standard and selected by pin choice on the output connector:

USB For rapid upload or laptops without serial port
RS232 Up to 200m cable, direct to serial port.
RS485 Up to 1000m cable, addressable half duplex comms
RS422 Up to 1500m cable, addressable full duplex comms
Baud Rate: 2400 - 115200 (USB 460800)
Protocol: 8 data bits, 1 stop bit, No parity, No flow control

Memory

The MIDAS WTR is fitted with 64Mb solid state non-volatile FLASH memory. Total capacity depends on setup. User may save any or all of the following:

- Raw sensor data from each burst
- Summary statistics of wave burst
- Tide & additional sensor data
- Spectral analysis of wave burst

If all data is saved, memory will typically record over 4000 data bursts. Sampling once per hour, this is over 5 months data.

Physical

Materials: Acetal housing, optional stainless steel (316) cage
Depth Rating: Housing rated to 500m, pressure sensor may be less
Size: 300mmØ x 290mm deep
Cage Size: 950 x 950 x 400mm

Software

System supplied with WaveLog 400 Windows based PC software, for instrument setup, data extraction and display. All data in text format for easy export to other packages.

Ordering

0730033	MIDAS WTR Wave Recorder, resonant quartz type, supplied with WaveLog 400 software, RS232 and USB data leads, operating manual and transit case)
0730034	MIDAS WTR Wave Recorder, strain gauge type, supplied with WaveLog 400 software, RS232 and USB data leads, operating manual and transit case)
0730037	Stainless steel deployment cage
0400011	Optional Conductivity Sensor
0400021	Optional Turbidity Sensor

MIDAS WTR is compatible with the Model 750 telemetry buoy.

Datasheet Reference Number: MIDAS WTR v1A

Valeport Limited, St. Peter's Quay, Totnes, Devon TQ9 5EW UK
Tel: +44 (0)1803 869292 Fax: +44 (0)1803 869293 E-mail: sales@valeport.co.uk Web: www.valeport.co.uk

APPENDIX G POSTAL ADRESSES OF THE INTERVIEWERS

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Phone	+4766987500	+31(0)235518853	+31(0)302459872
Mail	office@miros.no	info@radac.nl	info@aquavision.nl

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Mail	j.m.m.kokke@rikz.rws.minvenw.nl	Herald.krogstad@math.ntnu.no	h.c.peters@dnz.rws.minvenw.nl
Name	J. Vogelzang	R. Kleine	B. Ruessink
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Phone	+31(0)152757575	+31(0)320264242	+31(0)302532405
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Phone	+31(0)152858585	+31(0)118686469	+31(0)703029302
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SVAŠEK
HYDRAULICS
COASTAL, HARBOUR AND RIVER CONSULTANTS