HAM.NODE
Modular Hydro Acoustic Modem

The developic hydro acoustic modem HAM.NODE is a powerful and reliable underwater communication system designed to meet the requirements of research and exploration, proven in various subsea communication projects.

Flexible modulation and coding, a wide variety of available transducers in different frequency bands, high maximum transmit power, power efficiency and flexible interfaces ensure a powerful solution for demanding subsea communication tasks. Combined with a customizable application layer allowing for direct connection of a wide variety of sensors and the mechanical robustness and superior corrosion resistance of our synthetics pressure housings, the overall performance of HAM.NODE exceeds competing systems and allows for subsea communication tasks not solvable so far.

Additional options, such as our medium and high load HAM.R Release Modules, our HAM.ISBD and HAM.IRDS Iridium Satellite Communication Modules and dedicated battery housings, are further building blocks of integrated, convenient solutions for data communication from the ocean floor to your office desktop.

developic has been chosen as the sole provider of hydro acoustic communication solutions for the German Indonesian Tsunami Early Warning System (GITEWS) after extensive bench marking of various international competitors.

Multiple HAM.NODE long range systems, deployed in the Fram Strait between Svalbard and Greenland as part of the European DAMOCLES project, transmit ocean current data between moorings across distances of up to 30,000m.

A PACT system, deployed in November 2007 near the Canary Islands as part of the GITEWS project, proved a transmission reliability rate of better than 98% during the entire deployment period of 6 months even under heavy weather conditions across ~3,900m distance. This system is equipped with a HAM.NODE OEM modem communicating with the DOLAN surface buoy. A HAM.ISBD Iridium Satellite Communication Module relays the bottom sensor data to the German Alfred Wegener Institute for Polar and Marine Research in Bremerhaven.

System Details

HAM.NODE provides a communication layer highly adaptive to the present acoustic channel. Vertical configurations or channels with limited multi-path complexity can be covered at high transmission speeds with an advanced OFDM-mDPSK modulation scheme with or without decision feedback equalizer. For demanding long range configurations in shallow water or within acoustic channels an alternative, very robust n-mFSK modulation scheme is available.

Features like convolutional error correction with variable coding rates, Doppler compensation and data compression are implicit.

The high level, multi node capable communication protocol, featuring handshake and automatic retransmission, ensures absolute reliable data transmission, provided a transmission is possible at all. The user data will be available at the receiving unit without any bit errors, i.e. incoming data from the receiving unit does not need to be verified.

The default system configuration includes two serial ports capable of operating either in RS422 or RS232 mode with or without handshake at baud rates up to 230kbaud. Additional serial ports as well as a CAN-bus module are optionally available.
User Interface and Extended Functionality

The HAM.NODE system offers a user interface with extensive functionality, including a user accessible FAT32 file system on a SDHC-card (exchangeable, also used for system configuration and logging purposes), extensive diagnostic functions, access to data of integrated sensors (3-axis acceleration, temperatures, optionally housing pressure and humidity, voltages, etc.).

The user interface provides three data transmission modes: If switched to fully transparent mode, all data sent via a host interface is transmitted to the remote side. The advanced telegram mode allows full control of data transmission. File based data transmission provides functionality to record user data (e.g. from sensors) in files on the integrated SDHC card, which then can be transmitted at either a prescheduled time, triggered by the local host system or retrieved by the remote system.

An optional high precision time base, algorithmically compensated to provide less than 0.03 ppm drift per year, is available.

The factory customizable application layer allows for convenient interfacing of 3rd party sensor systems without the need for additional interface boxes. Examples include Aanderaa current meters, Paroscientific pressure sensors, RBR data loggers and others.

Also available is a telecommand software extension allowing interaction of HAM.NODE systems with selected 3rd party acoustic releases without the need of having a telecommand deck unit.

Electrical Characteristics

The HAM.NODE system requires a supply voltage between 5V and 33V. The minimum supply voltage for active data transmission is 12V.

Depending on the selected transducer option and the selected output level, the maximum transmit power (electrical output into transducer) is 200W using the standard power amplifier. Usual medium range power settings are 30W to 80W typically.

Depending on the system configuration, the sleep mode power consumption can be lower than 3mW with 9mW in acoustic standby mode.

Depending on the installed battery capacity the mean time between servicing can be as long as 60 months.

Acoustic and Transmission Characteristics

The HAM.NODE system is available with three standard transducer configurations:

- **MF omnidirectional**: Carrier band 8-13kHz, 240° -3dB beam width, suitable for low and medium speed transmissions in flexible channels.
- **MF directional**: Carrier band 11-20kHz, 65° -3dB beam width, suitable for high speed transmission in vertical channels up to more than 6,000m.
- **M HF directional**: Carrier band 17-29kHz, 60° -3dB beam width, suitable for high speed transmission in vertical channels up to 4,000m.
- **LF** configurations are available upon request.

Examples for net user data rates range from 145bps @ 30,000m horizontal (n-mFSK) over ~3,400bps @ 6,000m vertical (OFDM-mDPSK) to >7,000bps @ 1,950m vertical (OFDM-mDPSK).
HAM.NODE systems are available with two standard housing configurations:

1. Shallow Water Modular Composite Housing (SW.MCH), tested to 750m. Outer shell made of fibre reinforced synthetics with high strength hard coated aluminium inlays in the housing caps (not in contact with sea water). The housing cap plates are made from synthetics and are easily exchangeable.

   Inner diameter: 110mm, inner usable length: 480mm.

2. Deep Water Modular Composite Housing (DW.MCH), tested to 6,000m. Outer shell made of fibre reinforced synthetics with high strength hard coated aluminium inlays in the housing caps and the pressure tube (not in contact with sea water). The housing cap plates (mounting area for connectors etc.) are made of titanium and are easily exchangeable.

   Inner diameter: 110mm, inner usable length: 480mm.

Both housings are long term corrosion proof - there is no metal in contact with seawater at all using the shallow water housing and only titanium and composite synthetics when using the deep water housing. Our housings also offer superior compatibility to instrument platforms or mooring frames with stainless steel or titanium pars, as the synthetics outer shell reliably prevents galvanic corrosion.

Transducer base plates are available in either titanium or synthetics. Other materials are available upon request.

Besides the modem electronics, each housing can take a 28 cell [D-size] battery pack. Standard battery pack options include 21 cells NiMh 9.5Ah rechargeable, 28 cells Li-SOCl2 or 28 cells Alkaline.

We offer OEM modems without housings or systems integrated into Vitrovex housings upon request. Our pressure housings are available as separate units - also with custom dimensions.

### Product Specification

**Data Transmission Characteristics**
- Broadband data transmission via OFDM-­mDPSK with optional FS-­DF equalizer or via n-­mFSK
- Data compression
- Two-phase Doppler compensation for relative movements up to ±12m/s and acceleration up to 1g
- Convolutional forward error correction and checksum validation
- Automatic retransmission of damaged data packets in bidirectional communication mode

**Frequency Bands**
- 2.5-­4.5kHz [LF]
- 8-­13kHz [MF]
- 11-­20kHz [MF]
- 17-­29kHz [MHF]

**Transducer Options**
- Mounting direct to housing or detached (optional)
- LF: toroidal
- MF: omnidirectional, 240° -3dB beam width
- MF: directional, 65° -3dB beam width
- MHF: directional, 60° -3dB beam width
# HAM.NODE

## Product Specification

### Net User Data Rates

Real-Life Values:
- $\geq 7000$ bps @ 1,950m vertical (OFDM-mDPSK)
- $\approx 3400$ bps @ 6,000m vertical (OFDM-mDPSK)
- $\approx 145$ bps @ 30,000m horizontal (n-mFSK)

### User Date Bit Error Rate

0, provided a transmission is possible at all.

### Data Storage

- SDHC card, exchangeable, up to 32 GB storage
- Remote file browsing and transfer
- User accessible FAT32 file system

### Internal Sensors and Features

- Precision time base, <0.03ppm drift per year (optional)
- 3-axis acceleration sensor
- Housing pressure, temperature, humidity (optional)
- Supply voltages (optional)
- Further options are available upon request

### Customizable Functionality

- Scheduled and event based transmission triggering
- Data logging of attached instruments on internal SDHC card
- Passive recording and active polling of sensor data
- Intelligent data filtering and reduction (e.g. AADI Seaguard XML-filter)
- Remote configuration of attached devices
- Further options are available upon request

### Interfaces

- 2 serial ports, SUBCONN ® BH10F connectors
- RS232 / RS422 (software selectable)
- Baud rate up to 230kbaud (software selectable)
- CAN-bus module (optional)
- Additional interfaces are available upon request (e.g. Seabird inductive modem interface)

### Electrical Characteristics

- Supply voltage 5 to 33V DC (up to 54V optional)
- Sleep mode power consumption < 3mW; acoustic standby mode < 30mW
- Up to 250W transmit power into transducer (adjustable in 1% steps)
- Mean time between servicing > 60 months with our dedicated external battery housing

### Weights and Dimensions

- Housing options:
  - Modular Composite Housing SW.MCH (750m) / DW.MCH (6,000m)
- Housing dimensions (w/o transducer and connectors attached):
  - SW.MCH / DW.MCH: $D=153$ mm, $L=630$ mm
- Weight in air (w/ transducer and connector, w/o batteries):
  - SW.MCH: 13.6 kg / DW.MCH: 17.5 kg
- Displacement (w/ transducer and connector):
  - SW.MCH / DW.MCH: 10.2 l
HAM.Base

Compact Hydro Acoustic Modem

HAM.Base is the compact version of the modular HAM.NODE communication system optimized for transmission ranges up to approx. 1000m in its basic HF version. It is also available with all HAM.Node transducer options. The compact composite corrosion proof housing is rated to 800m depth. Also available are compact deep water housings (rated to 6000m) and standard MCH housing solutions (required for the lower frequency transducer options).

The standard HF Base modem is able to operate with carrier frequencies between 40 and 65kHz. This relatively high frequency band is significantly less affected by environmental acoustic emission and therefore – together with the proven efficiency of the modulation and coding algorithms of our HAM.NODE systems – enables new applications requiring transmission performance not available up to now.

The system electronics are designed to work within a bandwidth of 2.5kHz to 70kHz with a maximum transducer drive voltage of 780Vpp and is able to deliver up to 200W electric power to the transducer. As the power amplifier is a direct drive, transformerless design, transducer tuning is usually not necessary.

The standard version already includes two combined RS232/422 + two RS232 only communication ports with configurable supply to external sensors and our SDHC data logging solution – interfacing to many oceanographic sensors like current meters/profilers, CTD-probes etc. is already supported or easily configurable.

The HAM.Base modem is available with or without integrated battery compartment. The version with integrated power pack is a complete solution for acquiring and transmitting submarine sensor data up to several months. Additional MCH battery housings provide energy for long term deployments.

For OEM customers we offer a customization package including C++ libraries and all necessary documentation enabling the customer to implement his own communication algorithms on the HAM.Base platform.

### Communication

Modulation and Coding
- Non coherent n-mFSK modulation for maximum performance in shallow water transmission channels
- m-DPSK for highest communication performance in channels with limited multipath complexity.
- Variable rate convolutional forward error correction
- Doppler correction up to 10 m/s and 1g acceleration
- Bidirectional, handshaked transmission for maximum transmission reliability
- Transparent data compression
- Compatible with HAM.NODE systems within same frequency band
- User data rates up to 10kbps (HF 40-65kHz / 4-DPSK)

**HF Standard Transducer**
- hemispherical directivity
- 40kHz - 65kHz carrier band
- SPL max. 190 dB re 1uPa/1m
- Range up to 1200m with standard transducer
- Other transducers available upon request (2.5-4kHz, 8-13kHz, 11-19kHz, 18-28kHz)

Networking Capabilities
- IP based Network protocol with routing
HAM.Base

Product Specification

System Electronics

Interfaces:
• 4 serial interfaces (2xRS232/422, 2xRS232)
• Configurable supply for external sensors (5V, 9V, 12V)
• System Extension bus

Data Logger & Storage
• max. 32GB SDHC

CPU
• Texas Instruments TMS320C67xx floating point DSP, 300MHz
• 2xMSP430 for low power system management & wakeup processing
• 32MB RAM, 2MB Flash

Power Supply:
• 11V to 50V (down to 6V in receive/standby mode)
• 10mW power consumption in standby mode, up to 250W during transmit

• OEM electronics board available: 80x180mm

Pressure Housing

• Composite compact housing - absolute corrosion resistance backed by 5 years warranty
• Depth rated to 750m or 6000m

Accessories

Mooring Frame
• Stainless steel mooring frame, 10kN safe operating load

Surface Cable
• Rugged surface interface and suspension cable

Configuration and Control Software
• Delivered with configuration, control and data management software

Customization package
• C++ libraries, documentation