





# CATALOGUE

STANDARD TRANSDUCERS  
AND HYDROPHONES



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## Transducers & Hydrophones Overviews

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## Transducers & Hydrophone Specifications, Typical Beam Patterns and Curves

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This catalogue is for informational purposes only. RESON assumes no liability whatsoever for designs and applications or other uses based solely upon information, specifications and formulae shown in this catalogue.



# Introduction

## CONTENTS AND SCOPE OF THIS CATALOGUE

Thank you for your interest in RESON transducers and hydrophones. This catalogue presents our line of standard transducers and hydrophones for use in underwater acoustics. The transducers fall within the following main categories:

### 1000 series

Hemispherical, broad band. Typical applications are for Transponders, Pingers and Acoustic Telemetry.

### 2000 series

Directional low/mid frequencies. Typical applications are for Echosounders and Side Scan Systems.

### 3000 series

Directional, high frequency. Typical applications are for Sound Velocity Probes, NDT.

### 4000 series

Omnidirectional. Typical applications are for Reference Hydrophones, Reference Projectors, Sonar Arrays and Positioning Systems.

Our catalogue has been designed to facilitate your choice of relevant transducers for your application needs in a quick and straight-forward manner. Detailed specifications will be found in Section 3 and 4 of this catalogue, while a quick guide is presented in the following overviews and entries:



*RESON main office in Denmark*

### Table I

Applications reference list, page 7.

### Table II

Short form specifications for transducers and hydrophones, page 9.

In the Short Form Specifications, the following terms and abbreviations are used for general categorisation of RESON transducers:

### Type:

The transducers are categorised according to their general function as hydrophones and/or projectors.

### Hydro:

The transducer may be used as a passive hydrophone, (i.e. sound receiver in liquid).

### Proj:

The transducer may be used as a projector, (i.e. sound source in liquid).

### Frequency:

Categorisation according to the serial resonant frequency of the transducers or, for the 4000 series, the maximum usable frequency.

### Depth:

While RESON transducers are survival tested to greater depths, the figures quoted are maximum operating depths in meters.

### Beam pattern:

The beam patterns or directional response of the transducers are shown according to the categories below. Where applicable, opening angles are quoted as -3dB angles in degrees at the resonant frequency of the transducers (or at the stated frequency of the 4000 series).

### Conical:

Transducers with conical beam patterns possess opening angles as shown in the vertical directional response column.

### Omni/Hemi:

Transducers in this category have omnidirectional or hemispherical beam patterns.





# Introduction

**Narrow:**

Transducers in this category have an opening angle of less than  $10^\circ$  in either the horizontal or the vertical plane.

**Horiz.:**

Figures in this column are horizontal opening angles for transducers which do not have a conical beam pattern.

**Vert.:**

Figures in this column are vertical opening angles for all transducers including those with conical beam patterns.

**Power:**

In general, values quoted are maximum electrical power loads in Watts with a duty cycle of max. 1% at the resonant frequency. However, for hydrophones which can be used as calibrated projectors, the values quoted are the maximum voltage that may be used over the whole frequency band.

**Weight:**

Values shown are dry weight in kilograms. This weight includes the cable, where this is supplied as standard.

**Housing:**

Materials and standard cable lengths are shown. Cables may be supplied in lengths to suit individual requirements.

**Documentation:**

Possible documentation includes plots of Impedance (Z), Receiving response (RR), Transmitting response (TR),

Horizontal directional response (DR-H) and Vertical directional response (DR-V). These columns indicate standard and optional test documentation available for each transducer. Documentation shown in brackets is optional. For all transducers a Certificate of Conformity may be supplied upon request.

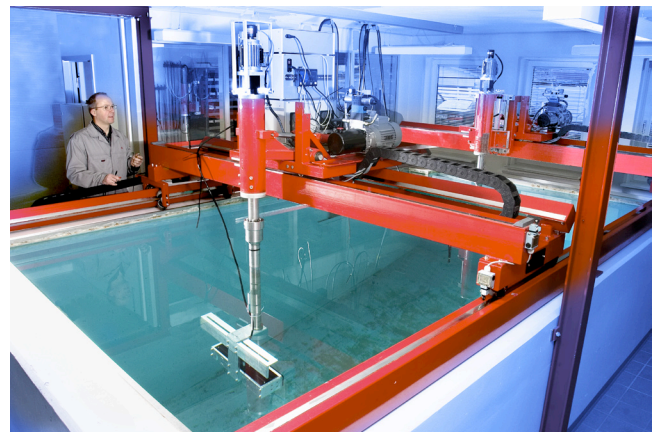
We also welcome enquiries on purpose-designed transducers in larger quantities to meet customer-specific needs. For presentation and quantification of your specific requirements, please refer to our Transducer and Hydrophone Questionnaire, which you will find on our home page at [www.reson.com](http://www.reson.com).

## CALIBRATION METHOD

RESON's acoustic test facility is a completely integrated package to document all acoustic products in the frequency range 3kHz to 5MHz. It includes an advanced report generator for: Directional response plots, Transmitting/Receiving response plots, Impedance/Admittance plots plus Reciprocity Calibration. The test facility further encompasses high pressure tanks with pressure ranges up to 700 bar.

The standard calibration method using a reference is performed on virtually all of the transducers and hydrophones in this catalogue. The reference hydrophones used in the standard calibration method have all been reciprocity calibrated. In this method three hydrophones are set up equidistant from each other and are measured. This method is available on all our of standard reference hydrophones as an option.

In order to avoid reflections in the tank, pulsed measurements are made. Voltage, current and impedance are all measured within the same gated pulse. The pulse length is only limited by its wavelength and the size of the tank. At RESON A/S, the calibration tank is 4.5 x 2.5 x 3 m.



*Complete calibration test facility at RESON in Denmark*

For the most exacting applications, RESON also provides calibrations traceable to national standards established at the National Physical Laboratory, UK.

## INTERPRETATION OF CALIBRATION PLOTS

### Directional Response Plot

The directional response plot shows the ratio between the acoustic power in a selected direction and the acoustic power of a simple source emitting the same power as the directive source. (Dimensionless).

### Response Plot

The response plot utilises the “comparison method” to measure the response (transmitting and receiving) of the transducer or hydrophone. This is performed against a reference hydrophone, and a plot of the response against frequency over the selected frequency range is produced. The receiving response is determined in dB re  $V/\mu\text{Pa}$ , and the transmitting response in dB re  $1 \mu\text{Pa}/V$  at 1 metre.

### Impedance Plot

The impedance plot shows the input impedance of a transducer used as a projector. A plot of the impedance (showing real and imaginary parts separately) against frequency over the selected frequency range is produced. The impedance is measured using a burst signal. This avoids the creation of standing waves in the test tank which distort the measurement.



*Certified assemblers are trained in a wide variety of flexible manufacturing processes for both high and low volume productions.*

## COMPANY BACKGROUND

RESON was founded in 1976 and has since grown to become one of the global leaders in design and manufacture of underwater acoustic sensors and multidisciplinary measuring systems. The corporate headquarters are located in Denmark, and wholly owned subsidiaries have been established in California; United Kingdom; Germany; South Africa; Singapore; The Netherlands; and in Italy. Quality is a key word for all RESON activities, and all standard products are produced, documented and tested according to our ISO 9001: 2000 quality system.



*High pressure test tank. Pressure range up to 700 bar.*

## CAPABILITIES

RESONs line of advanced, high quality products, from transducers to real-time, multi-beam profiling and imaging sonar systems, is based upon a continuing research and development effort.

RESON spends some 30% of its annual turnover on R&D covering technologies such as acoustic and finite element transducer modelling, signal processing, software and electronics hardware.

These activities are carried out, in many cases, in collaboration with universities and other research



establishments both nationally and worldwide. Over the last years, RESON has been the industrial partner in a considerable number of R&D projects sponsored by the European Community. This collaboration has resulted in the development of new reference hydrophones and has included studies on European acoustic calibration facilities.

The RESON R&D and quality assurance groups are staffed by engineers and technicians highly qualified in all the pertinent engineering disciplines, from acoustics to mechanical and electronic engineering. The certified production assemblers are trained in a wide variety of flexible manufacturing processes to cover both high and low volume productions.

## RESOURCES AND FACILITIES

All RESON transducers and other products are manufactured and tested to meet the most stringent demands for quality, reliability and durability.

In order to meet these standards, RESON has invested in the latest technology and resources to support design, development, production and quality management.

These include:

- Computer aided design workstations.
- Automatic acoustic test tank (RESONs own design for on-site high precision acoustic calibration, including advanced facilities for data acquisition, storage and presentation.
- High-pressure tanks with pressure ranges up to 700 bars.
- Full testing facilities and laboratories for testing, quality assurance and production, in accordance to our ISO 9001: 2000 quality system.

## WARRANTY

All RESON products are sold with a twelve month warranty covering any defects in materials and workmanship or failure to meet the given tolerances and specifications.

If a product upon inspection by RESON or its authorised representatives is found to be defective, excepting damage or fair wear and tear, RESON, at the company's discretion, will repair or replace the product free of charge. Transportation costs shall be to the account of the Customer.

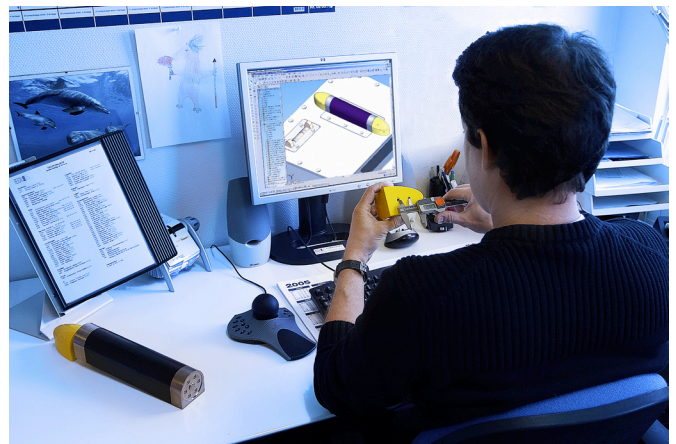
RESON shall not be liable for any loss or damage arising out of or in connection with the use of its products.

## TECHNICAL SERVICE

RESON operates a full technical service function for inspection, adjustment and repair of all its standard products.

Service contracts are available, ensuring RESONs customers optimum utilization, maintenance and performance of their RESON products.

Also, RESONs service function undertakes assistance pertaining to on-site trouble shooting, installation and training.



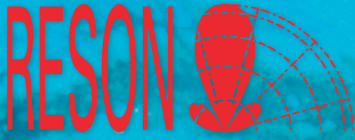
*Technical service function for inspection, adjustment and repair of all standard products.*



# Table I

## Applications Reference List

| Product No.   | TC 1010 | TC 1012 | TC 1026 | TC 1035 | TC 1037 | TC 2003 | TC 2016 | TC 2024 | TC 2046 | TC 2078 | TC 2084 | TC 2103 | TC 2111 | TC 2115 | TC 2116 | TC 2120 | TC 2122 | TC 2127 | TC 2129 | TC 2132 | TC 2135 |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Underwater positioning and navigation, long base line | •       | •       |         | •       |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         | •       |         |
| Acoustic telemetry                                    | •       | •       |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Underwater telephone systems                          | •       | •       |         | •       | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Distress pingers                                      | •       | •       |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Pinger/Transponder systems                            | •       | •       |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Pinger location                                       |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Echo sounding systems                                 |         |         |         |         | •       | •       | •       | •       | •       | •       | •       |         | •       | •       | •       | •       | •       | •       | •       | •       | •       |
| Pulse echo measurement                                |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Side scan systems                                     |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Submarine/bottom/mine equipment                       | •       | •       |         | •       | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Subbottom profiling                                   |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Sound velocity meters                                 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| High resolution distance measurements                 |         |         |         |         |         |         | •       | •       |         |         | •       |         |         | •       | •       |         |         |         |         |         |         |
| Calibration   |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Reference measurements (Conformance)                  |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Reference projectors                                  |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Ship, flow and turbulent noise measurements           |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Low noise measurements                                |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Acoustic near field measurements                      |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Audio recording                                       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Laboratory application                                |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Dolphins and whales                                   |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| High frequency measurements                           |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Offshore structure monitoring                         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
| Marine biology  |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |



# Table I

## Applications Reference List

| Product No.   | TC 2144 | TC 2145 | TC 2149 | TC 2150 | TC 2166 | TC 2170 | TC 2178 | TC 3021 | TC 3027 | TC 3029 | TC 4013 | TC 4014 | TC 4032 | TC 4033 | TC 4034 | TC 4035 | TC 4037 | TC 4038 | TC 4040 | TC 4042 | TC 4043 | TC 4050 |   |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---|
| Underwater positioning and navigation, long base line |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Acoustic telemetry                                    |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Underwater telephone systems                          |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Distress pingers                                      |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Pinger/Transponder systems                            |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Pinger location                                       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Echo sounding systems                                 | •       | •       | •       |         |         | •       | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Pulse echo measurement                                |         |         |         |         |         |         |         |         | •       | •       |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Side scan systems                                     |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Submarine/bottom/mine equipment                       |         |         |         | •       | •       |         |         |         |         | •       |         | •       |         | •       |         |         |         |         |         |         |         |         |   |
| Subbottom profiling                                   |         |         |         |         | •       | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Sound velocity meters                                 |         |         |         |         |         |         |         | •       | •       | •       |         |         |         |         |         |         |         |         |         |         |         |         |   |
| High resolution distance measurements                 | •       |         |         |         |         | •       |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |   |
| Calibration   |         |         |         |         |         |         |         |         | •       | •       | •       |         |         | •       | •       |         |         | •       | •       |         | •       |         |   |
| Reference measurements (Conformance)                  |         |         |         |         |         |         |         |         |         |         | •       | •       | •       | •       | •       | •       |         | •       | •       | •       | •       |         |   |
| Reference projectors                                  |         |         |         |         |         |         |         |         |         |         | •       |         |         | •       | •       |         |         | •       | •       |         | •       |         |   |
| Ship, flow and turbulent noise measurements           |         |         |         |         |         |         |         |         |         |         |         |         | •       |         | •       |         | •       |         | •       | •       |         |         | • |
| Low noise measurements                                |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         | •       | •       |         |         | •       |         |         | • |
| Acoustic near field measurements                      |         |         |         |         |         |         |         |         |         |         |         |         |         |         | •       | •       |         | •       |         |         |         |         |   |
| Audio recording                                       |         |         |         |         |         |         |         |         |         |         | •       |         | •       | •       |         |         | •       |         | •       | •       | •       |         |   |
| Laboratory application                                |         |         |         |         |         |         |         |         |         |         | •       | •       |         | •       | •       | •       |         | •       | •       |         | •       | •       | • |
| Dolphins and whales                                   |         |         |         |         |         |         |         |         |         |         | •       | •       | •       | •       | •       |         |         |         | •       | •       | •       |         |   |
| High frequency measurements                           |         |         |         |         |         |         |         |         |         |         |         | •       |         |         | •       | •       |         | •       |         |         |         |         |   |
| Offshore structure monitoring                         |         |         |         |         |         |         |         |         |         |         | •       | •       |         | •       |         |         | •       |         |         | •       | •       |         | • |
| Marine biology  |         |         |         |         |         |         |         |         |         |         |         | •       |         | •       | •       |         |         |         | •       | •       |         |         |   |



# Table II

## Short Form Specifications

| Model  | Type  |      | Resonance Frequency / Usable Band |              |        | Depth (m) |        |     | Beam (°)  |         |        |                |                      |
|--------|-------|------|-----------------------------------|--------------|--------|-----------|--------|-----|-----------|---------|--------|----------------|----------------------|
|        | Hydro | Proj | High                              | Medium       | Low    | High      | Medium | Low | Omni/Hemi | Conical | Narrow | Horizontal     | Vertical             |
| TC1010 | •     | •    |                                   |              | 12kHz  |           | 800    |     | •         |         |        | Omni           | 200                  |
| TC1012 | •     | •    |                                   |              | 12kHz  |           | 800    |     | •         |         |        | Omni           | 200                  |
| TC1026 | •     | •    |                                   | 36kHz        |        | 6000      |        |     |           |         |        | Omni           | ±35° from hori. plan |
| TC1035 | •     | •    |                                   |              | 9.5kHz | 3000      |        |     |           |         |        | Omni           | ±35° from hori. plan |
| TC1037 | •     | •    |                                   |              | 6kHz   |           | 600    |     |           | •       |        |                | 80                   |
| TC2003 |       |      |                                   | 200kHz       |        |           |        | 30  |           | •       |        |                | 2.6                  |
| TC2016 | •     | •    |                                   | 200kHz       |        |           |        | 30  |           | •       | •      |                | 9                    |
| TC2024 | •     | •    |                                   | 200kHz       |        |           |        | 30  |           | •       | •      |                | 9.5                  |
| TC2046 | •     | •    |                                   | 200kHz       |        |           |        | 30  |           | •       |        |                | 18                   |
| TC2078 | •     | •    | 300kHz                            |              |        |           | 400    |     |           | •       | •      |                | 2,6                  |
| TC2084 | •     | •    |                                   | 33kHz        |        |           |        | 30  |           | •       |        |                | 20                   |
| TC2103 |       |      |                                   | 50kHz        |        |           | 600    |     |           | •       |        |                | 35                   |
| TC2111 |       |      |                                   | 200kHz       |        |           |        | 30  |           | •       |        |                | 18                   |
| TC2115 |       |      |                                   | 30kHz        |        |           |        | 30  |           | •       |        |                | 23                   |
| TC2116 |       |      |                                   | 50kHz        |        |           |        | 30  |           | •       |        |                | 13.5                 |
| TC2120 |       |      |                                   | 50kHz        |        |           |        | 30  |           | •       |        |                | 13.2                 |
| TC2122 |       |      |                                   | 33/200kHz    |        |           |        | 30  |           | •       | •      |                | 20/9                 |
| TC2127 |       |      | 600kHz                            |              |        |           |        | 30  |           | •       |        |                | 3,2                  |
| TC2129 |       |      |                                   | 38kHz        |        |           |        | 30  |           | •       |        |                | 17                   |
| TC2132 |       |      |                                   | 300kHz       |        |           |        | 30  |           | •       | •      |                | 2.6                  |
| TC2135 |       |      |                                   | 15/200kHz    |        |           |        | 30  |           | •       |        |                | 23/9                 |
| TC2144 | •     | •    |                                   | 24/200kHz    |        |           |        | 30  |           | •       |        |                | 28/9                 |
| TC2145 | •     | •    |                                   | 200kHz       |        |           |        | 30  |           | •       | •      |                | 4.2                  |
| TC2149 | •     | •    |                                   | 50/200kHz    |        |           |        | 30  |           | •       | •      |                | 13.9/9               |
| TC2150 | •     | •    |                                   | 66kHz        |        |           |        | 30  |           | •       |        |                | Conical              |
| TC2166 | •     | •    |                                   | 200kHz       |        |           |        | 25  |           | •       | •      | Across 2x47    | Along track 1.1      |
| TC2170 | •     | •    |                                   |              | 12kHz  |           |        | 10  |           | •       |        |                | 19                   |
| TC2178 | •     | •    |                                   | 33/200kHz    |        |           |        | 30  |           | •       | •      |                | 20/9                 |
| TC3021 | •     | •    | 2000kHz                           |              |        |           | 700    |     |           | •       | •      |                | 2.2                  |
| TC3027 | •     | •    | 1000kHz                           |              |        |           | 500    |     |           | •       | •      |                | 5.8                  |
| TC3029 | •     | •    | 500kHz                            |              |        |           |        | 300 |           | •       |        |                | 11                   |
| TC4013 | •     | •    |                                   | 1Hz-170kHz   |        |           | 700    |     | •         |         |        | Omni           | 270 at 200kHz        |
| TC4014 | •     |      | 15Hz-470kHz                       |              |        |           | 900    |     | •         |         |        | Omni           | 270 at 200kHz        |
| TC4032 | •     |      |                                   | 5Hz-120kHz   |        |           | 600    |     | •         |         |        | Omni to 100kHz | 270 at 15kHz         |
| TC4033 | •     | •    |                                   | 1Hz-160kHz   |        |           | 900    |     | •         |         |        | Omni           | 270 at 100kHz        |
| TC4034 | •     | •    | 1Hz-470kHz                        |              |        |           | 900    |     | •         |         |        | Omni           | 270 at 300kHz        |
| TC4035 | •     | •    | 10kHz-800kHz                      |              |        |           |        |     | •         |         |        | Omni           | 120 at 250kHz        |
| TC4037 | •     |      |                                   | 1Hz-100kHz   |        | 1500      |        |     | •         |         |        | Omni           | 270 at 40kHz         |
| TC4038 | •     | •    | 10Hz-800kHz                       |              |        |           |        | 20  | •         |         |        | Omni           |                      |
| TC4040 | •     | •    |                                   | 1Hz-120Hz    |        |           |        | 400 | •         |         |        | Omni           |                      |
| TC4042 | •     |      |                                   | 5Hz-85kHz    |        |           | 1000   |     | •         |         |        | Omni           | 270 at 40kHz         |
| TC4043 | •     |      |                                   | 2Hz-100kHz   |        |           | 800    |     | •         |         |        | Omni           |                      |
| TC4050 | •     |      |                                   | 6,3Hz-100kHz |        |           | 400    |     | •         |         |        | Omni           |                      |





# Table II

## Short Form Specifications

| Power     |          | Dimensions (mm) |           | Weight (kg) | Housing         |                |                  | Documentation |    |    |      |      | Page |
|-----------|----------|-----------------|-----------|-------------|-----------------|----------------|------------------|---------------|----|----|------|------|------|
| High      | Low      | Max Length      | Max Width | Dry         | Type            | Active Surface | Cable Length (m) | Z             | RR | TR | DR-H | DR-V |      |
|           | 300W     | 187 (77)        | 130 (109) | 3.2         | Stainless Steel | Chloroprene    | Optional         | •             | •  | •  | •    |      | 12   |
|           | 300W     | 75              | 108       | 3.2         | Stainless Steel | Chloroprene    | Optional         | •             | •  | •  | •    |      | 14   |
|           | 100W     | 100             | 107       | 0.5         | Stainless Steel | Chloroprene    | Optional         | •             | •  | •  | •    | •    | 16   |
| 1000W     |          | 248             | 156.5     | 9.6         | Stainless Steel | Chloroprene    | Optional         | •             | •  | •  | •    | •    | 18   |
|           | 400W     | 198             | 115.5     | 5.8         | Stainless Steel | Chloroprene    | Optional         | •             | •  | •  | •    |      | 20   |
| 1500W     |          | 66              | 260       | 7.1         | PVC             | PVC            | 18               | •             | •  | •  | •    |      | 22   |
|           | 300W     | 60              | 90        | 1.8         | PVC             | PVC            | 20               | •             | •  | •  | •    |      | 24   |
|           | 450W     | 61              | 110       | 2.3         | PVC             | PVC            | 20               | •             | •  | •  | •    |      | 26   |
| 50W       |          | 107             | 37.8      | 0.5         | PVC             | PVC            | 10               | •             | •  | •  | •    |      | 28   |
| 1000W     |          | 156,5           | 148       | 7,8         | Stainless Steel | NBR            | N/A              | •             | •  | •  | •    |      | 30   |
| 1000W     |          | 130             | 180       | 5.0         | PVC             | PVC            | 18               | •             | •  | •  | •    |      | 32   |
|           | 500W     | 105             | 80        | 0.425       | Polyurethane    | DO             | 0.6              | •             | •  | •  | •    |      | 34   |
|           | 50W      | 50              | 31.8      | 0.4         | PVC             | PVC            | 10               | •             | •  | •  | •    |      | 36   |
| 1000W     |          | 130             | 180       | 5.0         | PVC             | PVC            | 33               | •             | •  | •  | •    |      | 38   |
| 1000W     |          | 130             | 180       | 5.0         | PVC             | PVC            | 33               | •             | •  | •  | •    |      | 40   |
| 2000W     |          | 130             | 180       | 5.0         | PVC             | PVC            | 33               | •             | •  | •  | •    |      | 42   |
| 1000/450W |          | 130             | 180       | 5.0         | PVC             | PVC            | 33               | •             | •  | •  | •    | •    | 44   |
|           | 150W     | 110             | 61        | 2,2         | PVC             | PVC            | 20               | •             | •  | •  | •    |      | 46   |
| 1000W     |          | 120             | 130       | 5           | PVC             | PVC            | 33               | •             | •  | •  | •    |      | 48   |
| 1000W     |          | 130             | 180       | 4.0         | PVC             | PVC            | 18               | •             | •  | •  | •    |      | 50   |
| 2000/300W |          | 196             | 346       | 36          | PVC             | PVC            | 33               | •             | •  | •  | •    |      | 52   |
| 1000/450W |          | 180             | 130       | 5.0         | PVC             | PVC            | 33               | •             | •  | •  |      | •    | 54   |
| 1500W     |          | 160             | 50        | 3.0         | PVC             | PVC            | 6                | •             | •  | •  |      | •    | 56   |
| 1000/450W |          | 160             | 130       | 5.0         | PVC             | PVC            | 33               | •             | •  | •  |      | •    | 58   |
|           | 500W     | 140             | 124       | 6.0         | PVC             | PVC            | 33               | •             | •  | •  |      | •    | 60   |
| 3000W     |          | 655             | 120       | 9.0         | PVC             | PUR            | 12               |               |    |    |      | •    | 62   |
| 6000W     |          | 156             | 550       | 80          | PUR             | PUR            | 18               | •             | •  | •  |      | •    | 64   |
| 1000/450W |          | 320             | 151       | 9.7         | PVC             | PVC            | 18               | •             | •  | •  | •    | •    | 66   |
|           | 5W       | 32              | 30        | 0.075       | PVC             | EP             | 1.5              | •             | •  | •  | •    |      | 68   |
|           | 10W      | 32              | 30        | 0.075       | PVC             | EP             | 1.5              | •             | •  | •  | •    |      | 70   |
|           | 5W       | 32              | 30        | 0.045       | PVC             | EP             | 1.5              | •             | •  | •  | •    |      | 72   |
|           | 100Vrms  | 50              | 9.5       | 0.075       | Stainless Steel | NBR            | 6                | •             | •  | •  | •    |      | 74   |
|           | 12-24VDC | 273             | 38        | 0.650       | Alu-bronzo      | NBR            | Optional         |               | •  |    | •    | •    | 76   |
|           | 24VDC    | 284.5           | 38        | 0.720       | Alu-bronzo      | NBR            | Optional         |               | •  |    | •    | •    | 78   |
|           | 100Vrms  | 138             | 25        | 1.5         | Alu-bronzo      | NBR            | 10               | •             | •  | •  | •    | •    | 80   |
|           | 100Vrms  | 138             | 16        | 1.6         | Alu-bronzo      | NBR            | 10               | •             | •  | •  | •    | •    | 82   |
|           |          | 168             | 10        | 0.410       | Stainless Steel | NBR            | Optional         | •             | •  | •  | •    | •    | 84   |
|           | 10-24VDC | 75              | 36        | 0.086       | Titanium        | NBR            |                  |               | •  |    | •    | •    | 86   |
|           | 100Vrms  | 58              | 4         | 0.020       | Stainless Steel | PU             | 2                |               | •  |    | •    | •    | 88   |
|           | 100Vrms  | 120             | 21        | 1.600       | Titanium        | NBR            | 10               | •             | •  | •  | •    |      | 90   |
|           |          | 220             | 36        | 0.45        | Alu-bronze      | NBR            |                  |               | •  |    | •    | •    | 92   |
|           | 1Vrms    | 159             | 9,5       |             | Stainless Steel | NBR            | 10               |               | •  |    | •    | •    | 94   |
|           |          | 39              | 0,2       | 0,7         | Stainless Steel | NBR            | 10               |               | •  |    |      | •    | 96   |



# Transducer TC1010

Low Frequency Broad Band Transducer



## TC1010

Rugged underwater telephone and distress pinger transducer.  
Low frequency broad band transducer. (Option without cage – TC1012).

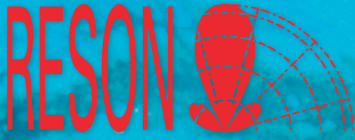
- Protection cage
- Excellent long term stable ceramics
- Ideal for deep water operations
- Optional cable TL8009

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 12kHz $\pm$ 1kHz                                     |
| Transmitting Sensitivity:    | 133dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m)              |
| Receiving Sensitivity:       | -183dB $\pm$ 3dB (re 1V/ $\mu$ Pa)                   |
| Impedance:                   | 1250ohm $\pm$ 30% at 12kHz                           |
| Vertical Directivity:        | 200°   |
| Horizontal directivity:      | Omnidirectional                                      |
| Max input power:             | 300W (1% duty cycle)                                 |
| Operating Depth:             | 800m   |
| Survival Depth:              | 900m   |
| Operating Temperature Range: | -2°C to +50°C  |
| Storage Temperature Range:   | -40°C to +70°C                                       |
| Housing:                     | Special formulated NBR                               |
| Weight in Air:               | 3.2kg  |
| Cable optional:              | Connector + 5m cable pigtail, RESON order no. TL8009 |

Please note that this product requires a minimum quantity per order

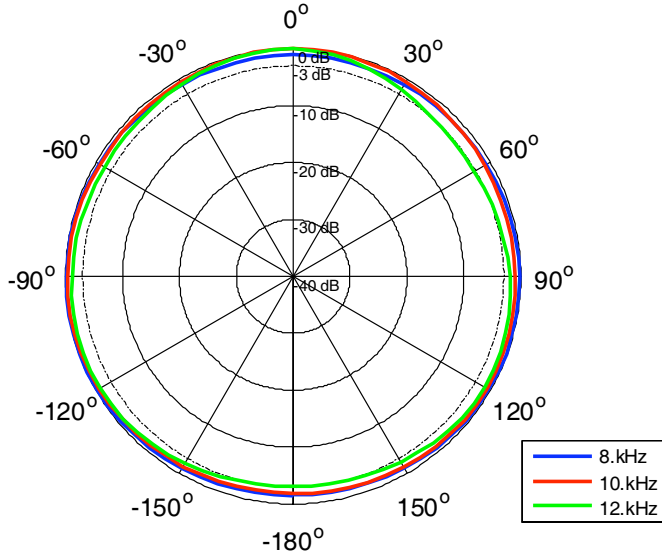




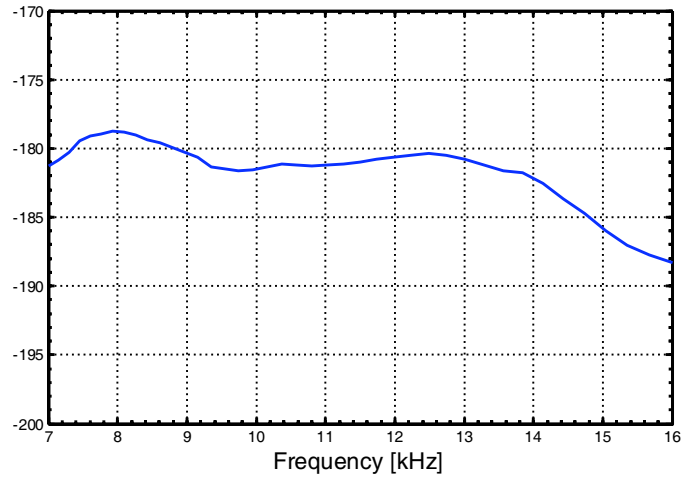
# Transducer TC1010

Low Frequency Broad Band Transducer

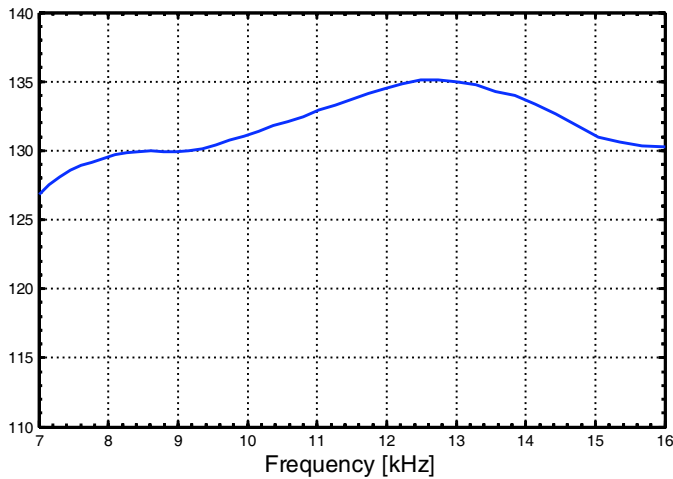
Horizontal Directivity Pattern



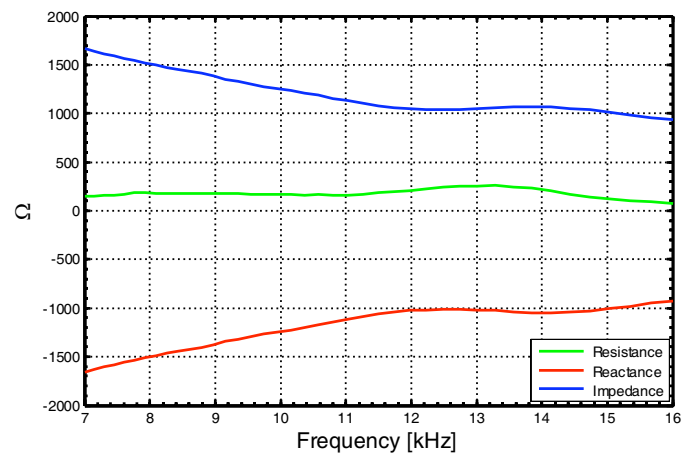
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance

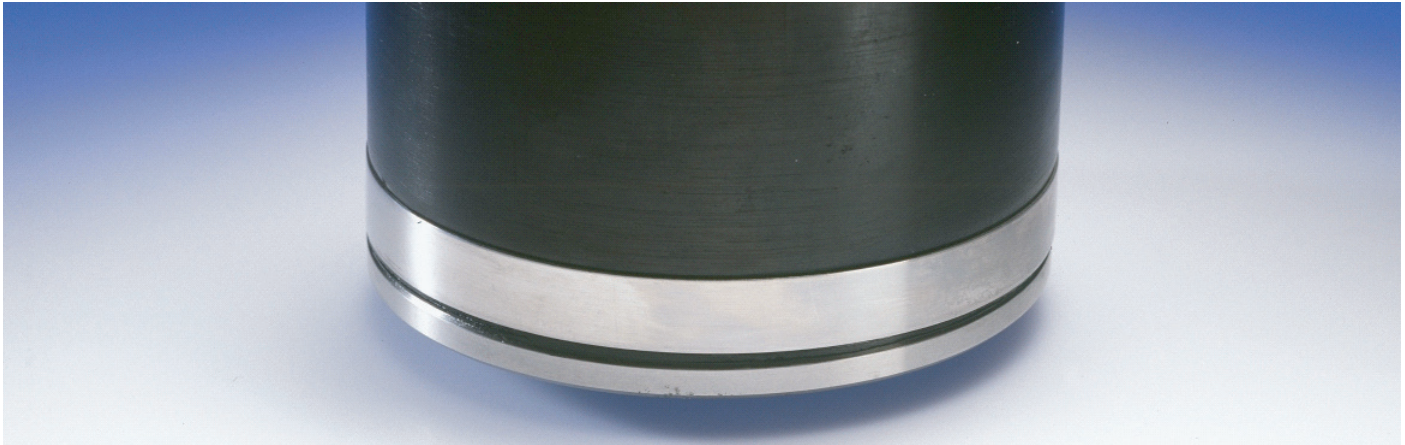






# Transducer TC1012

Low Frequency Broad Band Transducer



## TC1012

- Excellent long term stable ceramics
- Ideal for deep water operations

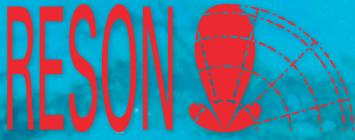
Rugged Underwater telephone and distress pinger transducer.  
Low frequency broad band transducer

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 12kHz $\pm$ 1kHz                           |
| Transmitting sensitivity:    | 133dB $\pm$ 3dB (dB re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -183dB $\pm$ 3dB (re 1V/ $\mu$ Pa)         |
| Impedance:                   | 1250ohm $\pm$ 30% at 12kHz                 |
| Horizontal directivity:      | Omnidirectional                            |
| Vertical directivity:        | 200°                                       |
| Max input power:             | 300W (1% duty cycle)                       |
| Operating temperature range: | -2°C to +50°C                              |
| Storage temperature range:   | -40°C to +70°C                             |
| Operating depth:             | 800m                                       |
| Survival depth:              | 900m                                       |
| Housing:                     | Special formulated NBR                     |
| Weight (air) incl. Cable:    | 2.3kg                                      |

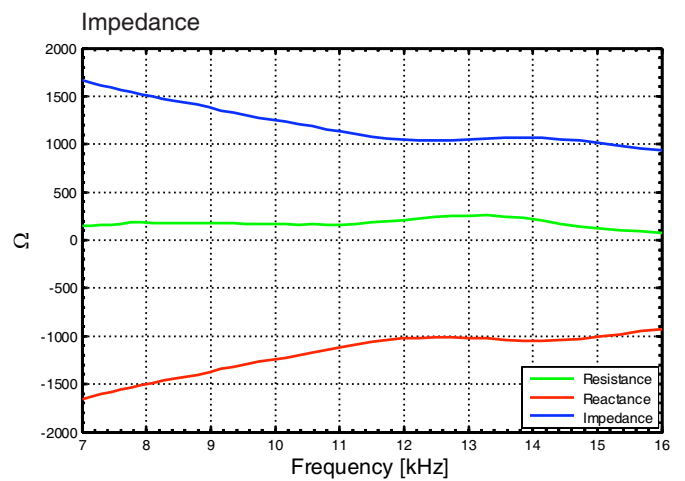
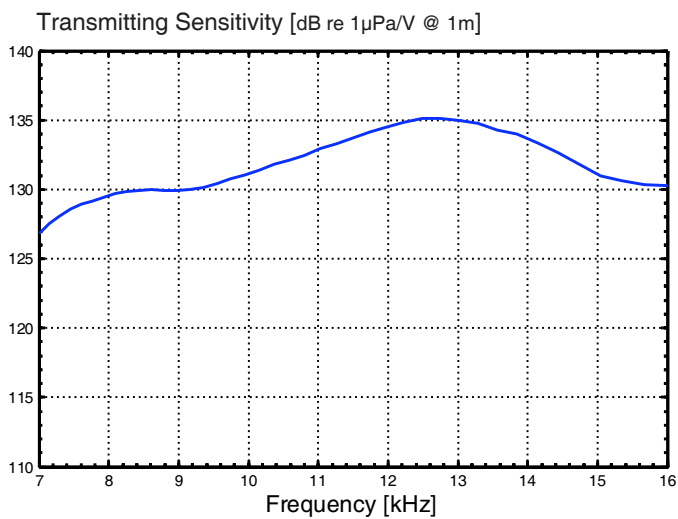
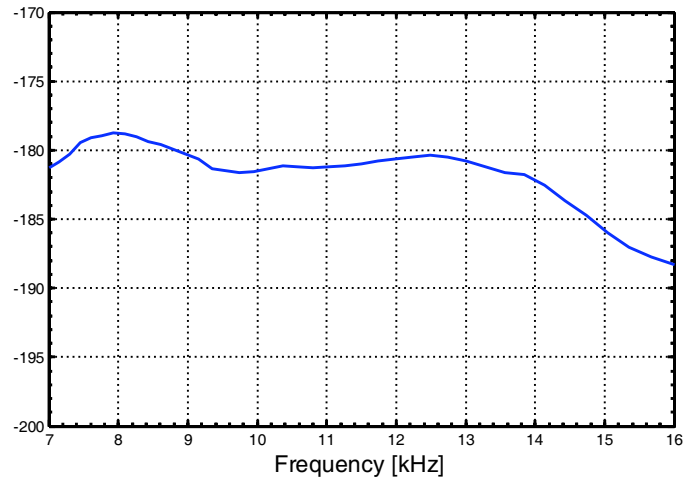
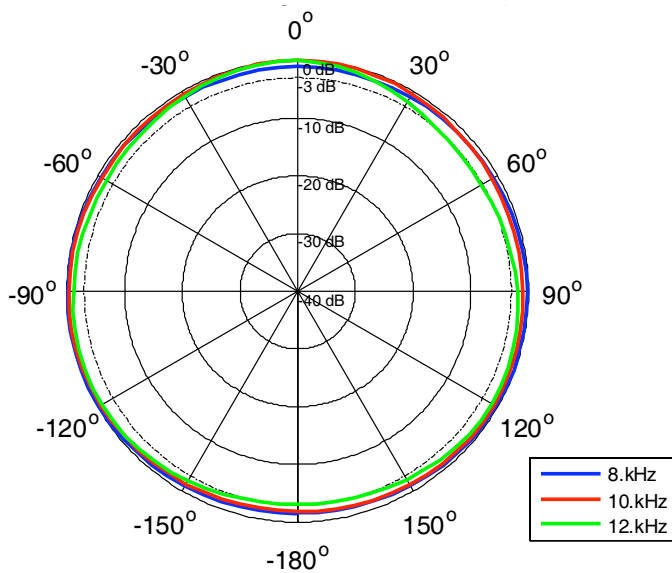
Please note that this product requires a minimum quantity per order

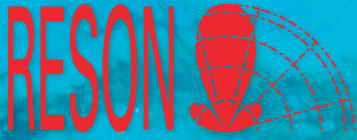




# Transducer TC1012

Low Frequency Broad Band Transducer





# Transducer TC1026

## High Power Communications Transducer



### TC1026

- 36 kHz compact
- High efficient ceramic
- Easy to install
- Long life time

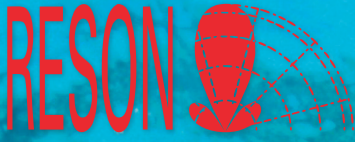
The TC1026 is a high power communication transducer for long/short base line measurement, pinger/transponder systems, acoustic telemetry systems and telephone systems.

#### TECHNICAL SPECIFICATIONS

|                                  |  |
|----------------------------------|--|
| Resonant frequency:              | 36kHz $\pm$ 2kHz (34-38kHz)                    |
| Transmitting sensitivity:        | 137dB $\pm$ 3dB at 36kHz (re $\mu$ Pa/V at 1m) |
| Receiving sensitivity:           | -193dB $\pm$ 3dB at 36kHz (re 1V/ $\mu$ Pa)    |
| Impedance:                       | 630ohm $\pm$ 10% 81° phase $\pm$ 10% at 36kHz  |
| Vertical directivity pattern:    | Typically $\pm$ 35° from horizontal plane      |
| Horizontal directivity pattern:  | Omnidirectional                                |
| Max input power: (1% duty cycle) | 100W   |
| Operating depth:                 | 6000m  |
| Survival depth:                  | 6000m  |
| Operating temperature range:     | -2° to +30°C                                   |
| Storage temperature range:       | -30° to +70°C                                  |
| Cable (Optional)                 | Two single wires                               |
| Housing:                         | Special formulated NBR                         |
| Weight (air) incl. cable:        | 0.5kg  |



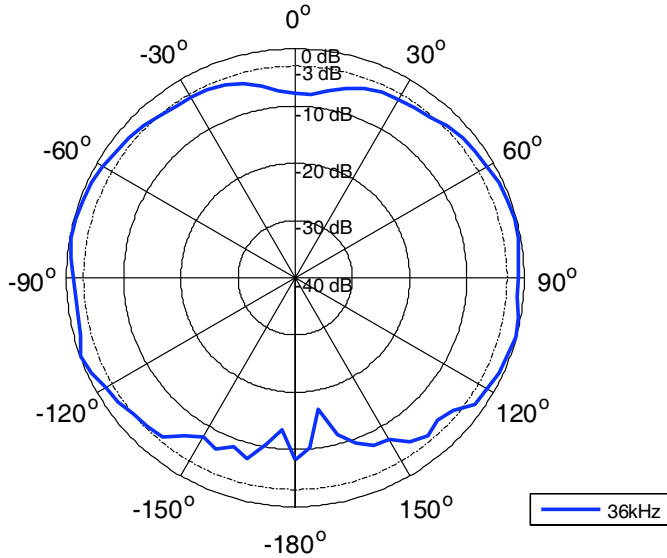




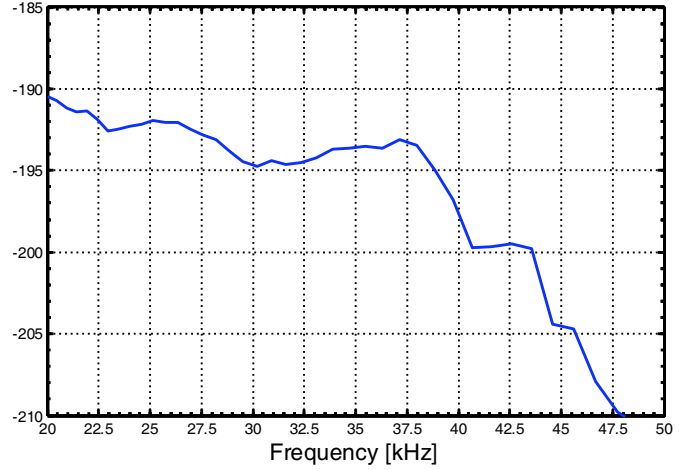
# Transducer TC1026

High Power Communications Transducer

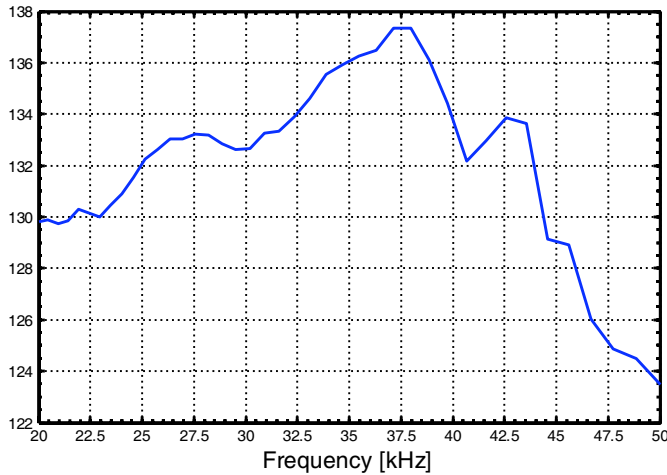
Vertical Directivity Pattern



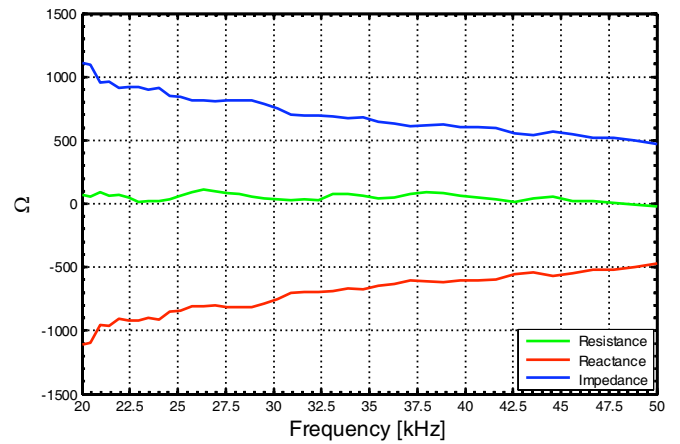
Receiving Response [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



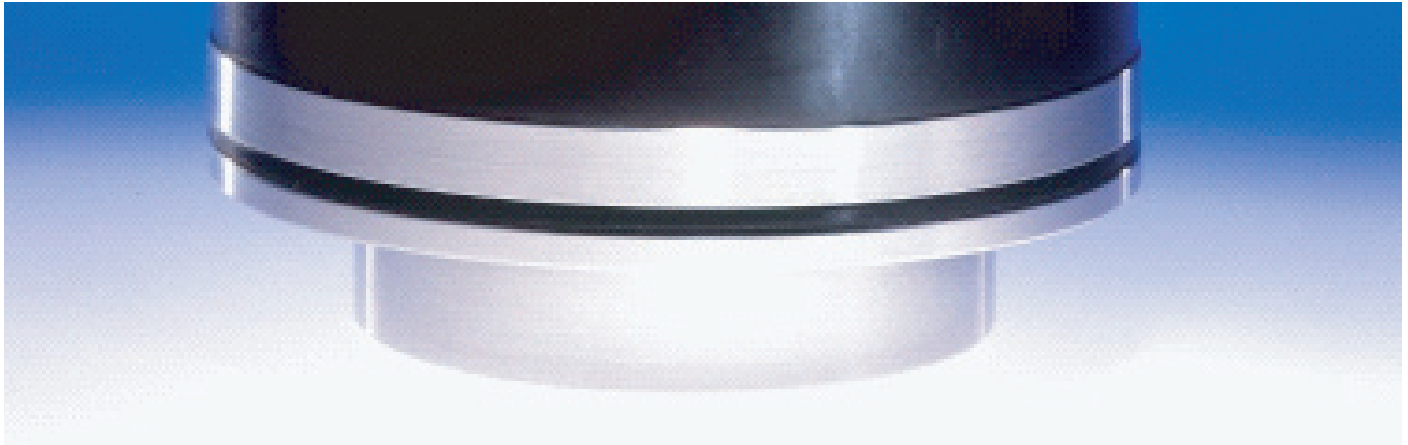
Impedance





# Transducer TC1035

High Power Low Frequency Communication



- 9.5kHz compact High efficient ceramic
- Easy to install
- Long life time
- Optional cable and connectors TL8043 and TL8038

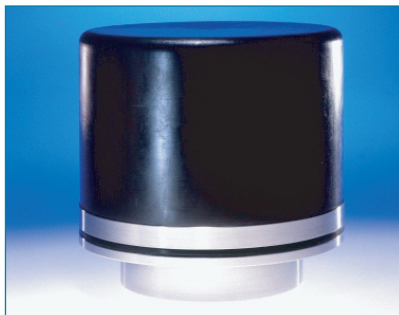
## TC1035

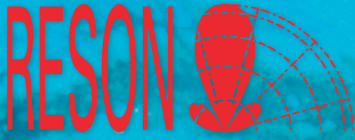
The TC1035 High power, low frequency, communication transducer for long/short base line measurement, pinger/transponder systems, acoustic telemetry systems and telephone systems.

### TECHNICAL SPECIFICATIONS

|                                    |   |
|------------------------------------|---|
| Resonant Frequency:                | 9.5kHz $\pm$ 1kHz (8-11kHz)               |
| Transmitting Sensitivity:          | 148dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m)   |
| Receiving Sensitivity:             | -184dB $\pm$ 3dB (re 1V/ $\mu$ Pa)        |
| Impedance:                         | 100ohm $\pm$ 30% at 9,5kHz                |
| Vertical directivity pattern:      | Typically $\pm$ 35° from Horizontal plane |
| Horizontal directivity pattern:    | Omnidirectional                           |
| Max input power: (1% duty cycle)   | 1000W                                     |
| Operating depth:                   | 3000m                                     |
| Survival depth:                    | 4000m                                     |
| Operating temperature range:       | -2°C to +30°C                             |
| Storage temperature range:         | -30°C to +70°C                            |
| Cable, length and type (optional): | Connector + 9m cable pigtail              |
| Housing:                           | Special formulated NBR                    |
| Weight (air) incl. cable:          | 9.6kg.                                    |

Please note that this product requires a minimum quantity per order





# Transducer TC1035

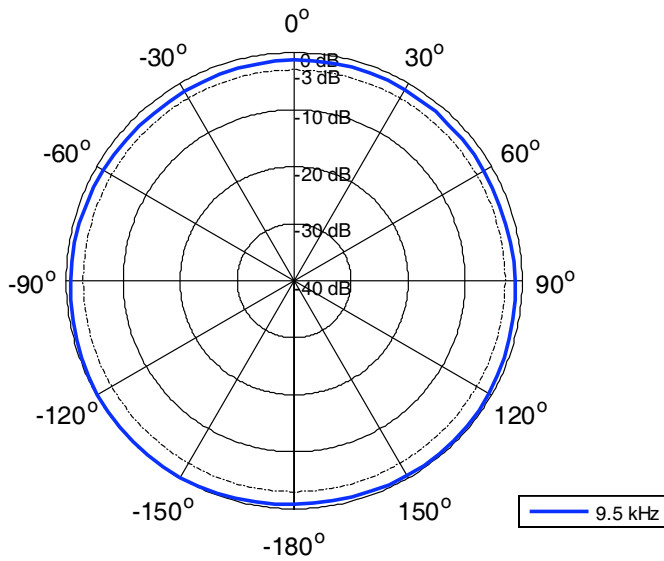
High Power Low Frequency Communication

**Documentation:**  
Horizontal Directivity Pattern

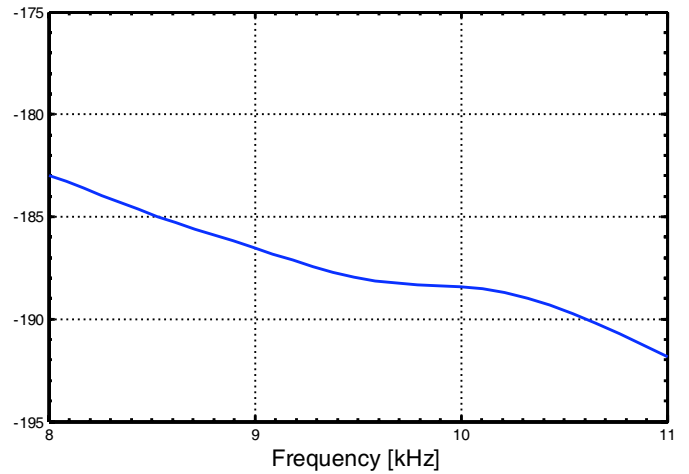
Directivity:  
Omnidirectional

Vertical Directivity Pattern:  
 $\pm 35^\circ$  from horizontal plane

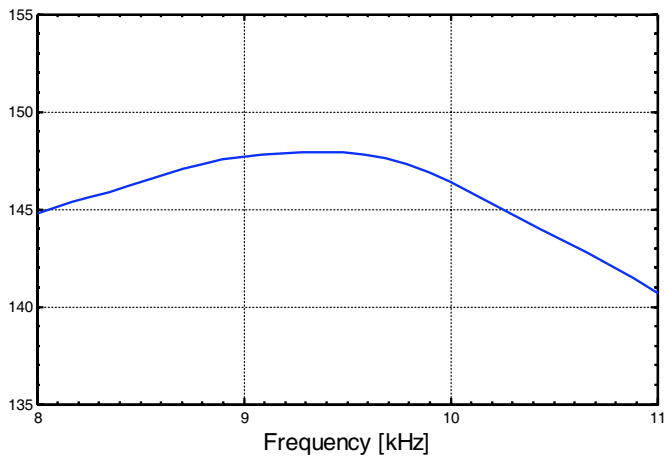
Horizontal Directivity Pattern



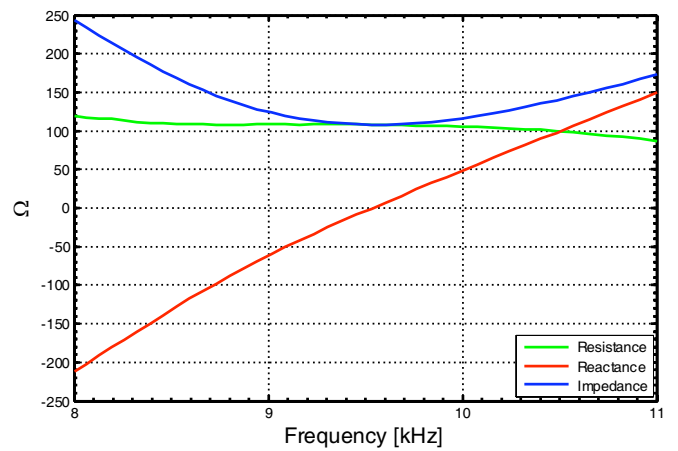
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



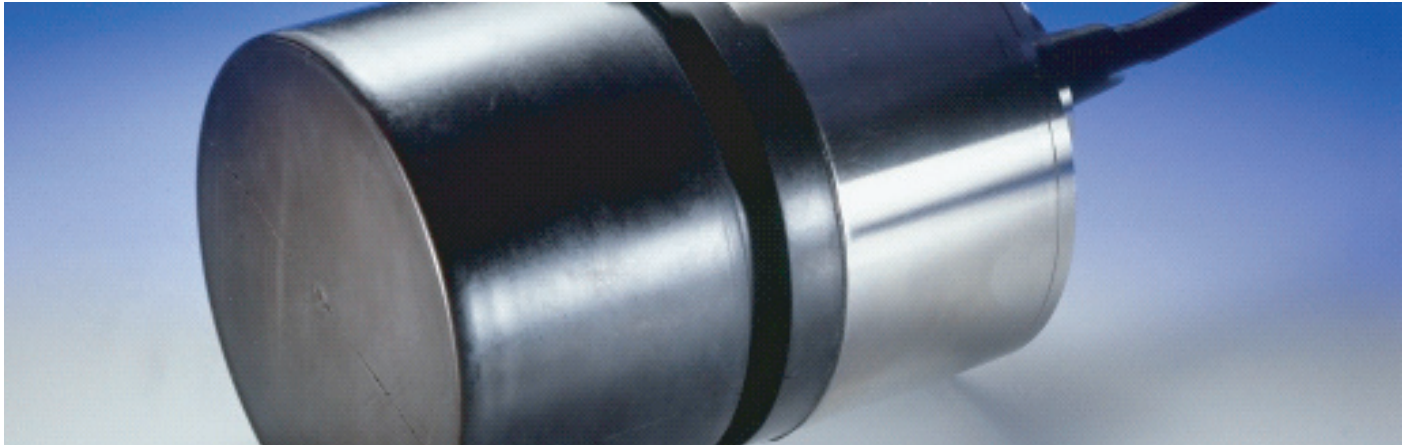
Impedance





# Transducer TC1037

Directional Telephone Transducer



- High performance low frequency transducer
- Ideal for installation due to steel housing and threaded guide
- Optional cable termination TL8038

Please note that this product requires a minimum quantity per order



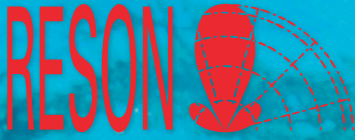
## TC1037

The TC1037 is a rugged directional transducer with low frequency. It is specifically designed for underwater telephone systems. Can be used as a building block in special long range sonars or in sub bottom penetration single or multibeam systems.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Usable frequency band:       | 6kHz to 15kHz                                   |
| Transmitting sensitivity:    | 145dB $\pm$ 3dB at 7,3kHz (re $\mu$ Pa/V at 1m) |
| Receiving sensitivity:       | -169dB $\pm$ 3dB at 7,3kHz (re 1V/ $\mu$ Pa)    |
| Impedance:                   | 860ohm $\pm$ 250ohm at 7,3kHz                   |
| Beam shape:                  | Conical   |
| Beam width:                  | 80° at 8kHz                                     |
| Max input power:             | 400W (1% duty cycle)                            |
| Operating depth:             | 600m  |
| Survival depth:              | 800m  |
| Operating temperature range: | -2°C to +35°C                                   |
| Storage temperature range:   | -40°C to +70°C                                  |
| Cable (Optional)             | Connector and 9m cable, pigtail                 |
| Housing:                     | Special formulated NBR                          |
| Weight (air) incl. cable:    | 5,8kg   |

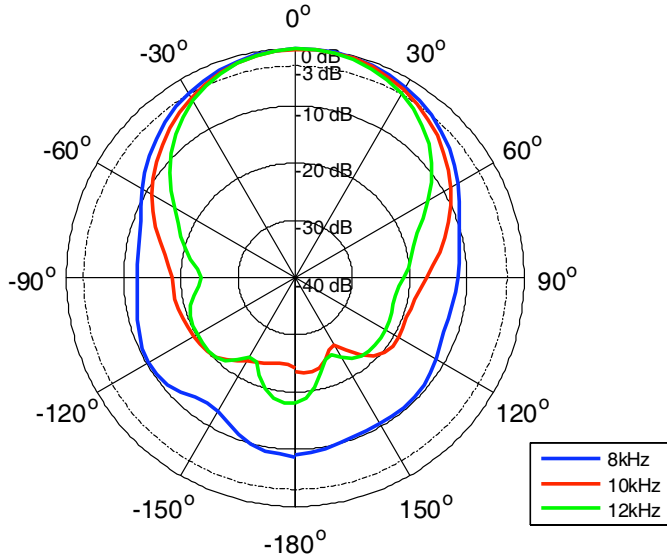




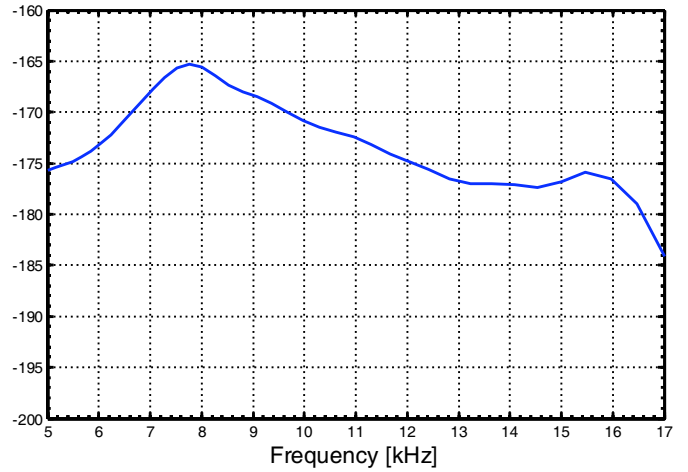
# Transducer TC1037

Directional Telephone Transducer

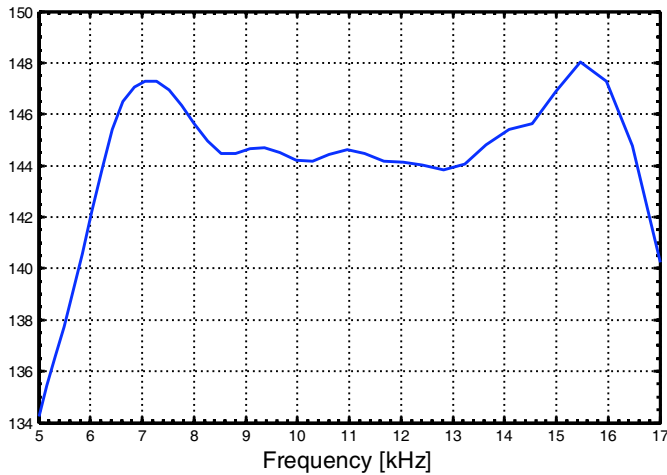
Horizontal Directivity Pattern



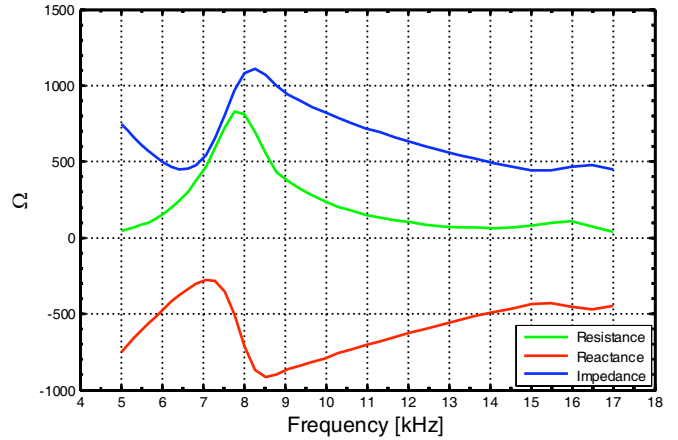
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



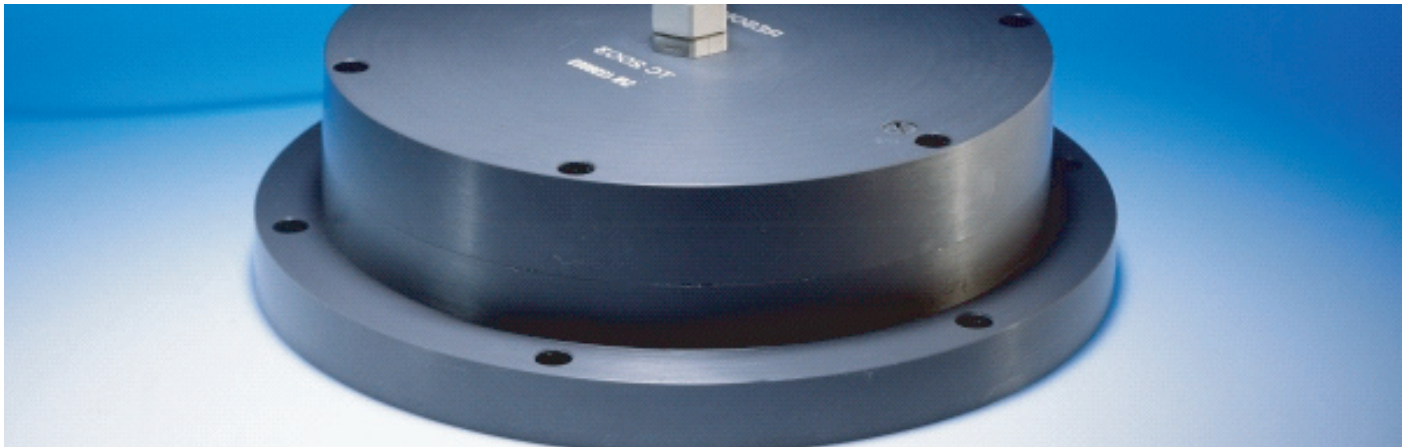
Impedance





# Transducer TC2003

Narrow Beam Hydrographic Transducer



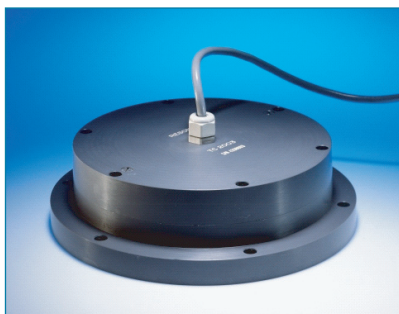
- Narrow conical beam
- High power input
- Low weight

## TC2003

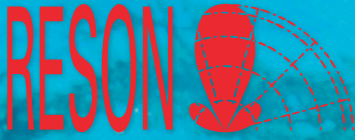
Narrow beam transducer for precise bottom recognition Ideal for all echo sounders working in the frequency band from 190–210kHz.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 200kHz $\pm$ 10kHz                                |
| Transmitting Sensitivity:    | 180dB $\pm$ 3dB at 200kHz (dB re $\mu$ Pa/V @ 1m) |
| Receiving Sensitivity:       | -180 dB $\pm$ 3dB at 200kHz (dB re V/ $\mu$ Pa)   |
| Impedance:                   | 100ohm $\pm$ 30ohm                                |
| Beam width:                  | 3.0° $\pm$ 0.2, Conical                           |
| Max input power:             | 1500W at 1% duty power                            |
| Operating depth:             | 30m   |
| Survival depth:              | 50m   |
| Operating temperature range: | -2°C to +30°C                                     |
| Storage temperature range:   | -30°C to +50°C                                    |
| Weight with cable:           | 7.1kg   |
| Cable:                       | 18m Munflex 2*1 (O.D. 7mm) - pigtail              |



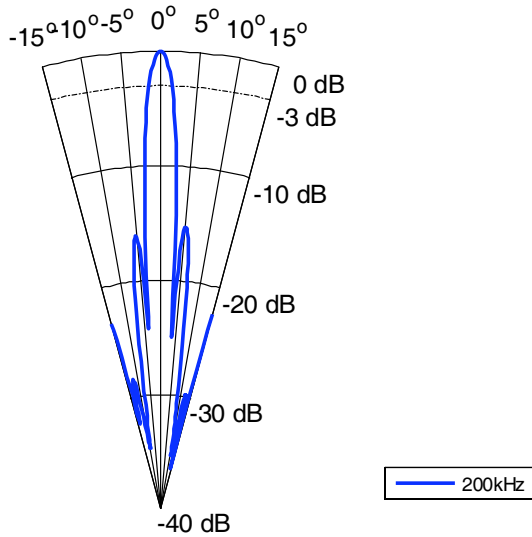




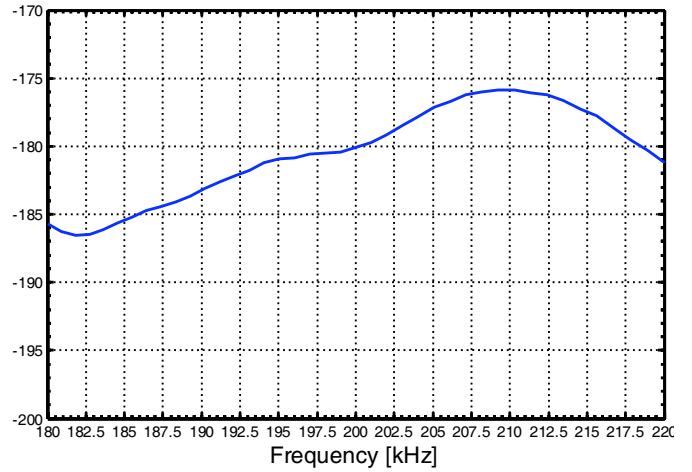
# Transducer TC2003

Narrow Beam Hydrographic Transducer

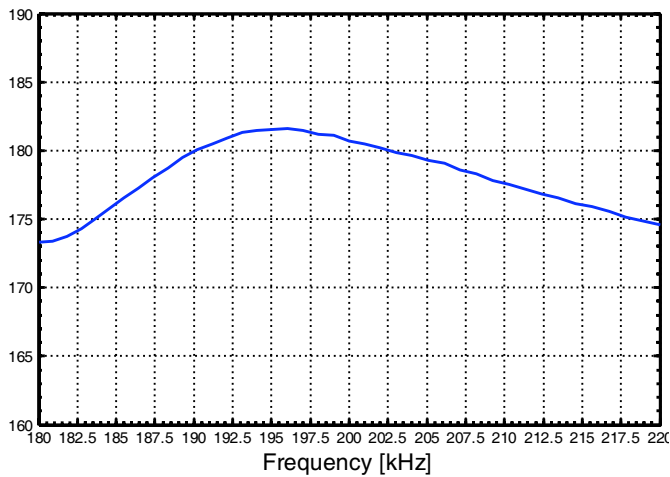
Horizontal Directivity Pattern



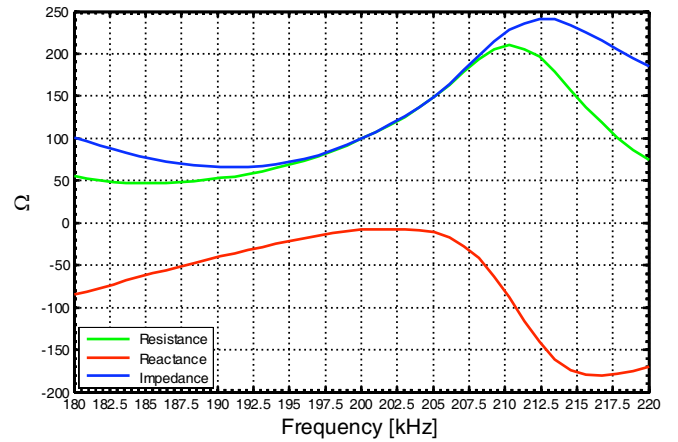
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance





# Transducer TC2016

Echo Sounder Transducer



## TC2016

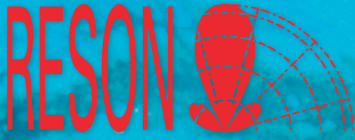
- Standard echosounder transducer
- Easy installation

200 kHz echosounder transducer 9° opening angle.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 200kHz $\pm$ 10kHz                                 |
| Transmitting Sensitivity:    | 173dB $\pm$ 3dB at 200kHz (dB re $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -187dB $\pm$ 3dB at 200kHz (dB re V/ $\mu$ Pa)     |
| Impedance:                   | 100ohm $\pm$ 30ohm at 200kHz                       |
| Beam width:                  | 9° $\pm$ 0.9°, Conical                             |
| Efficiency:                  | 30%  |
| Max input power:             | 300W at 1% Duty cycle                              |
| Operating depth:             | 30m  |
| Survival depth:              | 50m  |
| Operating temperature range: | -2°C to +30°C                                      |
| Storage temperature range:   | -30°C to +50°C                                     |
| Cable (length and type):     | 20m Munflex 2*1 (O.D. 7mm) - pigtail               |
| Housing:                     | PVC  |
| Weight with cable, (dry):    | 1,8kg  |

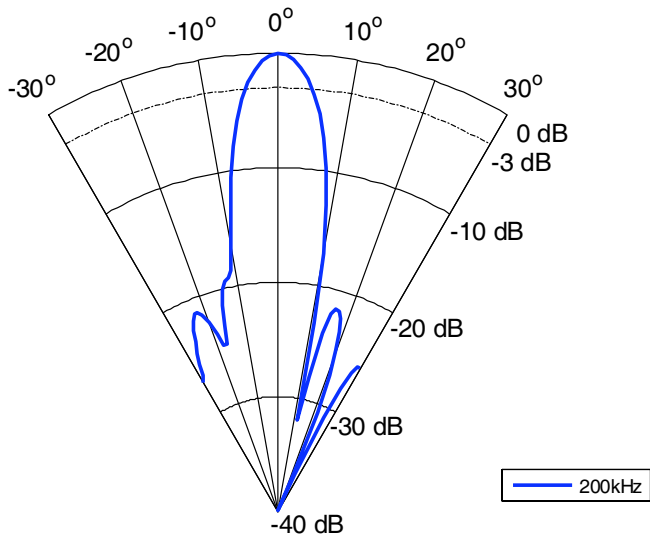




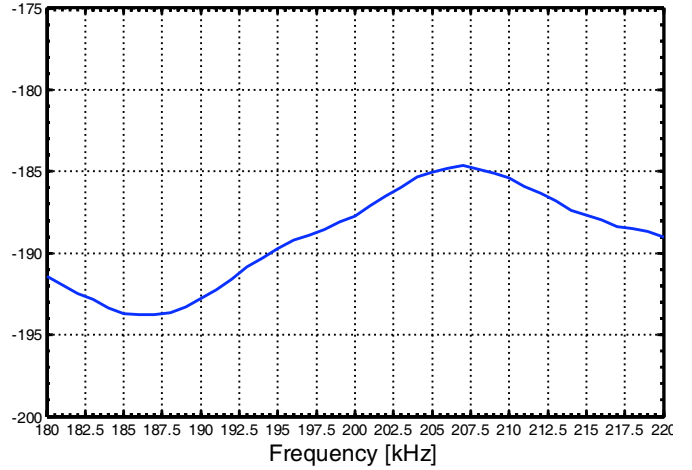
# Transducer TC2016

Echo Sounder Transducer

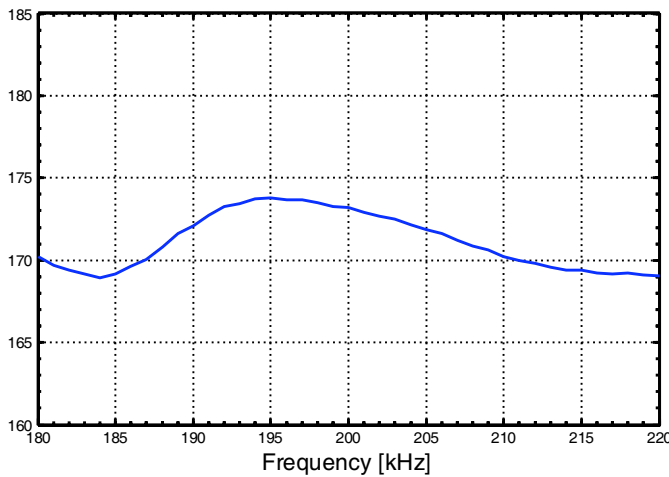
Horizontal Directivity Pattern



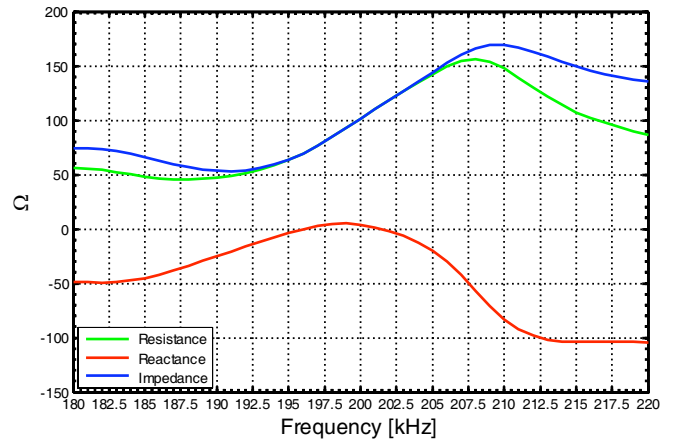
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance







# Transducer TC2024

Survey Transducer for Echosounder



- 200kHz transducer
- Compact design
- Excellent performance
- Robust piezo ceramic
- Electrical compatible with most echosounder systems

## TC2024

General purpose 200kHz echosounder transducer for shallow water applications: 0-100m

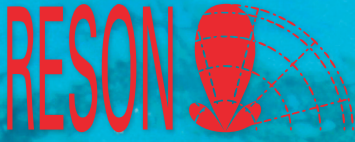
The TC2024 is ideal for navigation, hydrographic echosounding in shallow waters, and high resolution distance measurements.

For outboard mounting, RESON steel housing mounts are available. The standard housing of the TC2024 is also compatible with ATLAS SW 6014 mounts.

### TECHNICAL SPECIFICATIONS

|                              |                                       |
|------------------------------|---------------------------------------|
| Resonant Frequency:          | 200kHz $\pm$ 10kHz                    |
| Transmitting Sensitivity:    | 173dB $\pm$ 3dB re 1 $\mu$ Pa/V at 1m |
| Receiving Sensitivity:       | -187dB $\pm$ 3dB re 1V/ $\mu$ Pa      |
| Impedance :                  | 100ohm $\pm$ 30ohm at 200kHz          |
| Beam width:                  | 9.5° $\pm$ 1°, Conical                |
| Max input power:             | 450W at 1% duty cycle                 |
| Operating depth:             | 30m                                   |
| Survival depth:              | 50m                                   |
| Operating temperature range: | -2°C to +30°C                         |
| Storage Temperature:         | -30°C to +50°C                        |
| Cable (length and type):     | 20m Munflex 2*1 (O.D. 7mm) - pigtail  |
| Housing:                     | PVC                                   |
| Weight (air) incl. Cable:    | 2.3kg                                 |

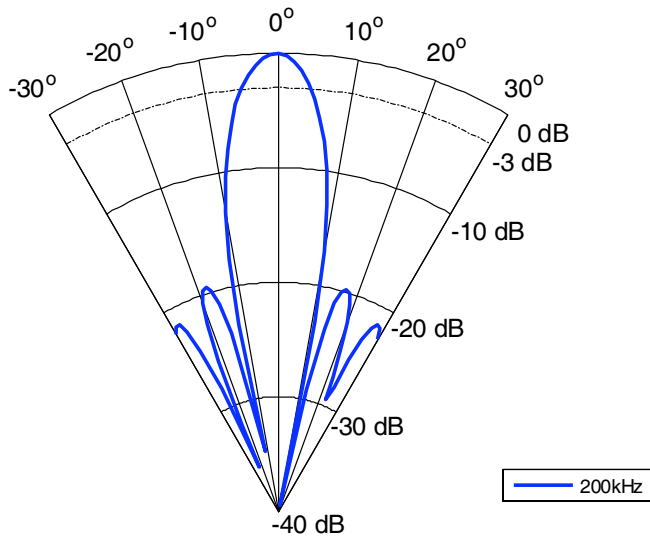




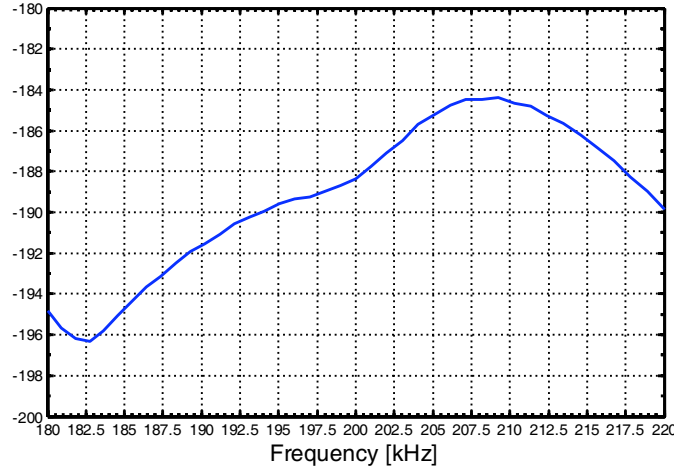
# Transducer TC2024

Survey Transducer for Echosounder

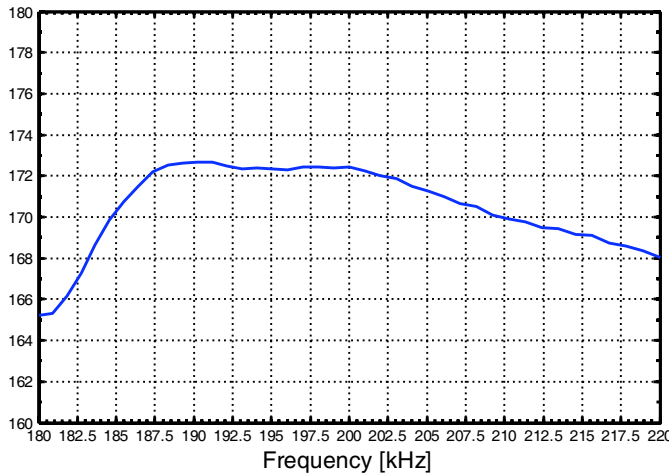
Horizontal Directivity Pattern



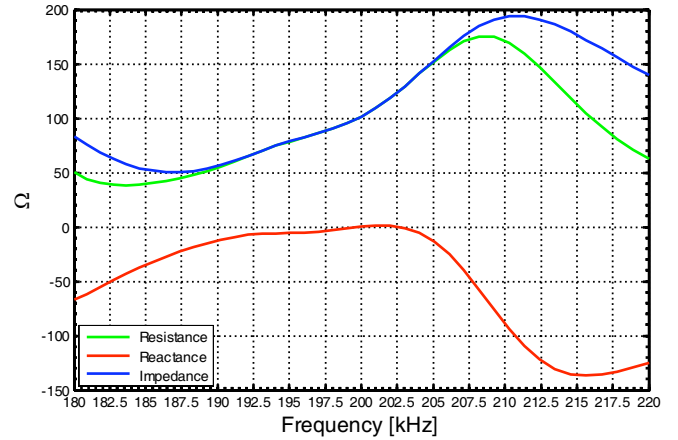
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance





# Transducer TC2046

Low Cost Compact Echosounder Transducer



- Small compact design
- Good piezo ceramics

## TC2046

General purpose, compact 200kHz echosounder transducer for short range applications: 0 – 50 m.

The TC2046 is ideal for navigation, echosounding and fish-finder systems. They fit into the hull penetrator, easily mounted and exchanged.

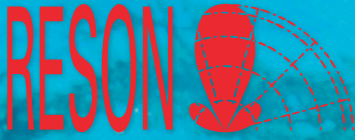
### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 200kHz $\pm$ 3kHz                      |
| Transmitting Sensitivity:    | 163dB $\pm$ 3dB dB re $\mu$ Pa/V at 1m |
| Receiving Sensitivity:       | -191dB $\pm$ 3dB dB re $\mu$ Pa/V      |
| Beam width:                  | 18° $\pm$ 3°                           |
| Beam shape:                  | Conical beam                           |
| Impedance:                   | 200ohm $\pm$ 60ohm at 200kHz           |
| Operating depth:             | 30m                                    |
| Survival depth:              | 50m                                    |
| Operating temperature range: | +2°C to +35°C                          |
| Storage temperature range:   | -30°C to +50°C                         |
| Max input Power:             | 50W (1% Duty Cycle)                    |
| Cable:                       | 10m Coax 2*1 (O.D. 5mm) - pigtail      |
| Weight in Air (incl. cable): | 0,5Kg                                  |

Please note that this product requires a minimum quantity per order



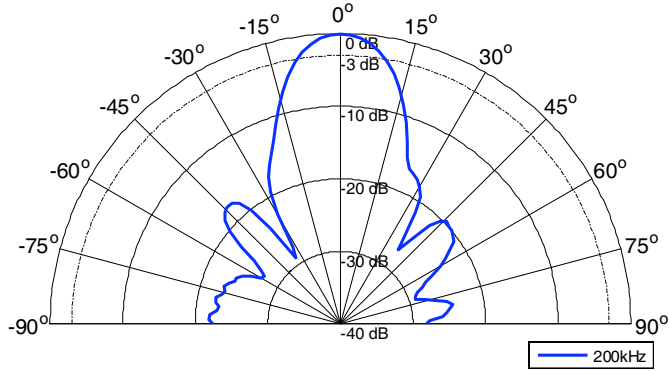




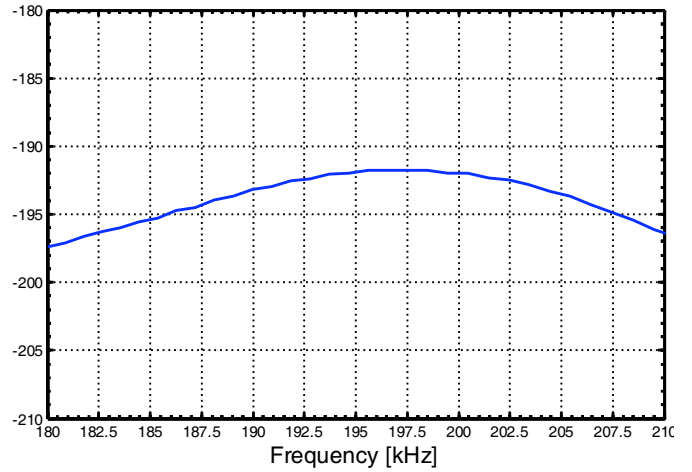
# Transducer TC2046

Low Cost Compact Echosounder Transducer

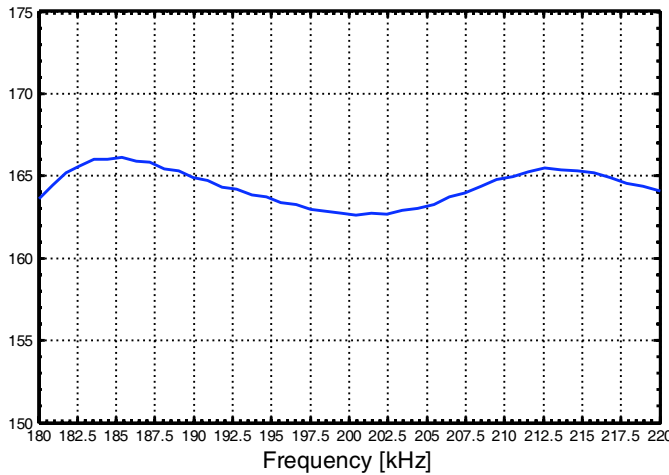
Horizontal Directivity Pattern



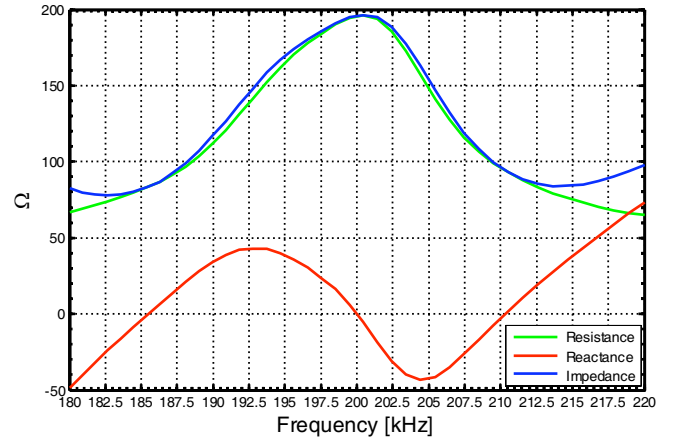
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



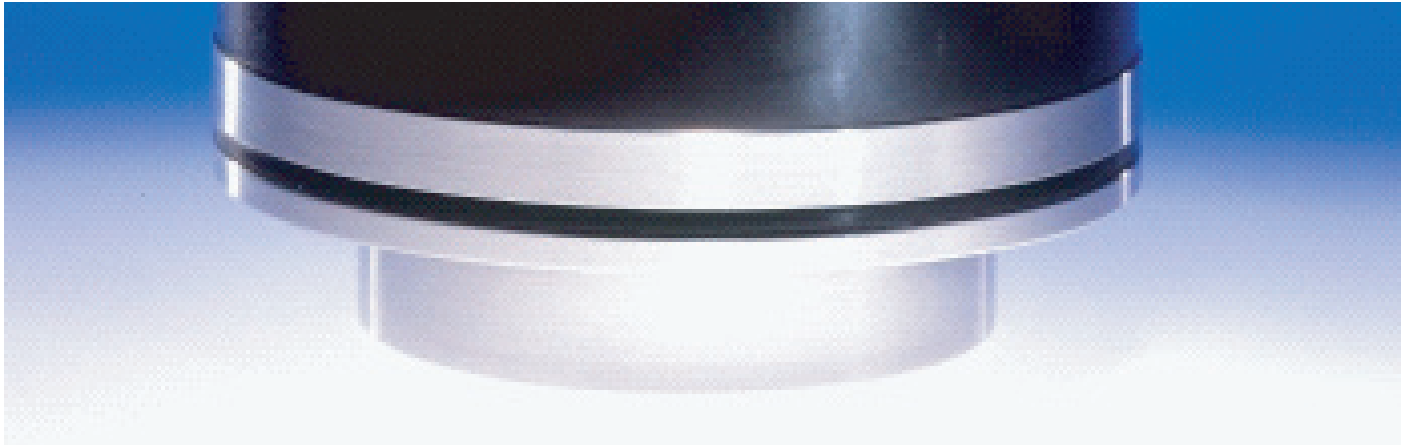
Impedance





# Transducer TC2078

Narrow Beam Echosounder Transducer



- 300kHz transducer
- Narrow beam
- Excellent piezo-ceramics element
- Transducer fits into ATLAS SW60/28/6029 housing

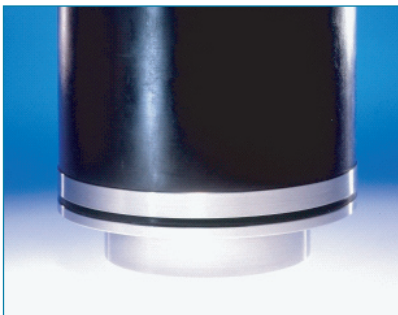
## TC2078

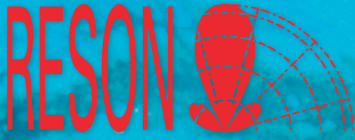
Universal 300kHz narrow beam transducer ideal for navigation and hydrographic echosounding.

The TC2078 can be fitted into Atlas SW 60/28/6029 housings and RESON steel housings for full mounting on vessels.

### TECHNICAL SPECIFICATIONS

|                              |                                       |
|------------------------------|---------------------------------------|
| Resonant Frequency:          | 300kHz $\pm$ 15kHz                    |
| Transmitting Sensitivity:    | 179dB $\pm$ 3dB re 1 $\mu$ PA/V at 1m |
| Receiving Sensitivity:       | -184dB $\pm$ 3dB re 1V/ $\mu$ Pa      |
| Impedance:                   | 100ohm $\pm$ 30ohm at 300kHz          |
| Beam width                   | 2.6° $\pm$ 0.3°                       |
| Beam shape:                  | Conical beam                          |
| Max input Power:             | 1000W at 1% duty cycle                |
| Operating depth:             | 400m                                  |
| Operating temperature range: | +2°C to +35°C                         |
| Storage temperature range:   | -40°C to +50°C                        |
| Housing:                     | Special Formulated NBR                |
| Weight in Air Incl. cable:   | 7.8kg                                 |

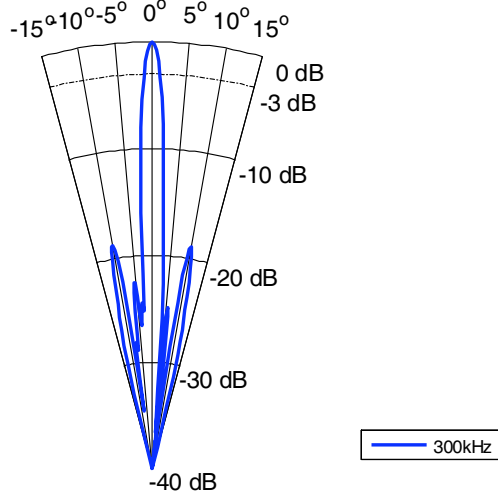




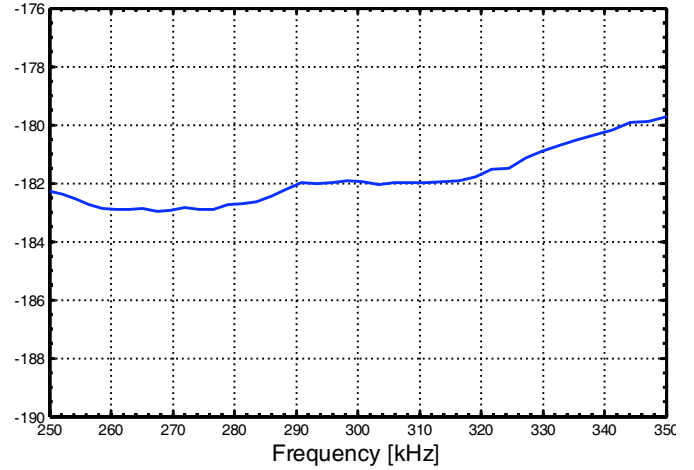
# Transducer TC2078

Narrow Beam Echosounder Transducer

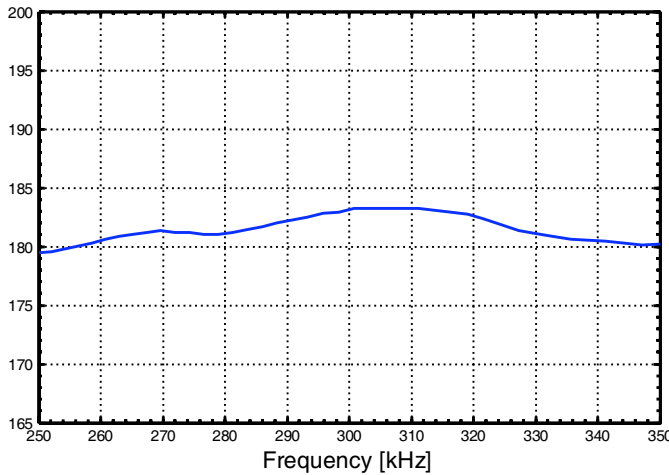
Horizontal Directivity Pattern



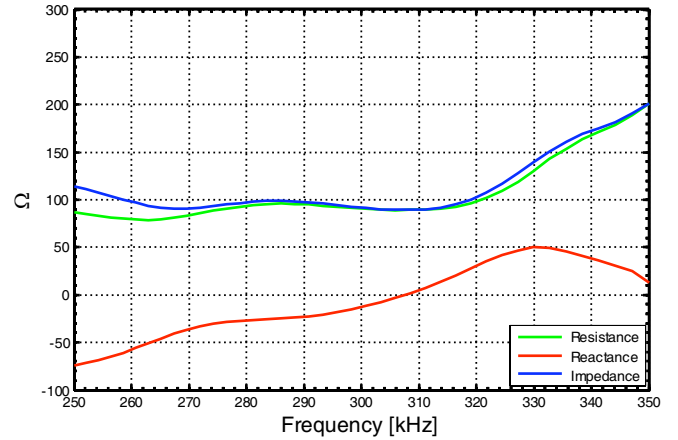
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



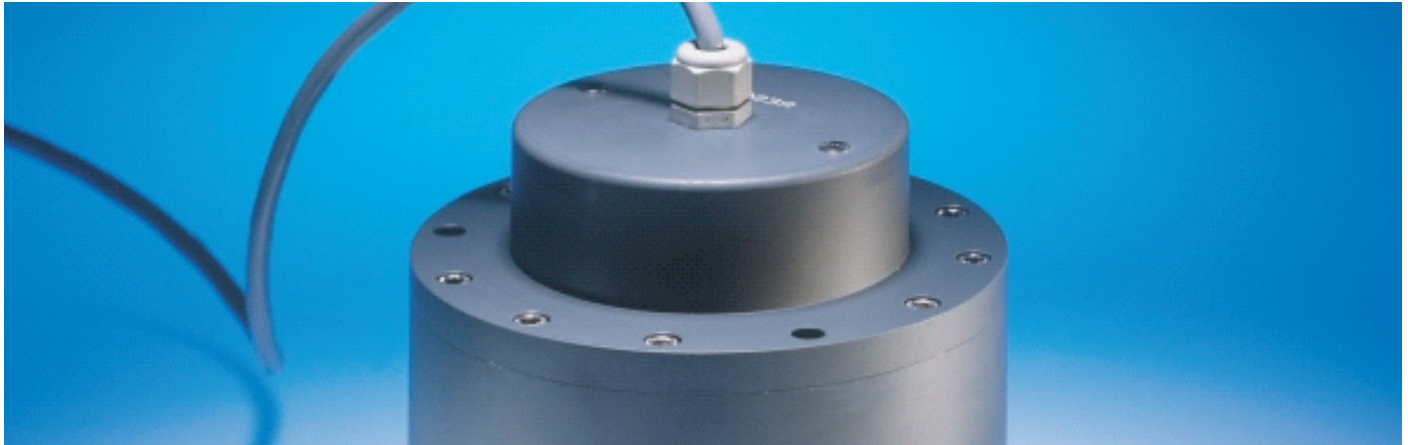
Impedance





# Transducer TC2084

High Power Broad Band Echosounder



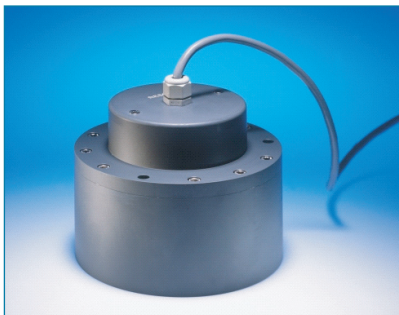
- 33kHz transducer
- Fits into existing SW60/28/6029 housings
- Electrical compatible with almost all other 33kHz echosounders
- Compact design

## TC2084

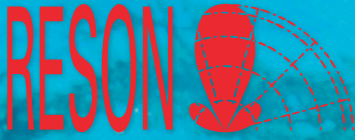
Universal 33kHz High-Power, broad band transducer. This transducer is ideal for navigation and hydrographic echo sounders. The transducer can be fitted into ATLAS SW 60/28/6029 housings and RESON steel housings.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 33kHz $\pm$ 2kHz                       |
| Transmitting Sensitivity:    | 166dB $\pm$ 3dB dB re $\mu$ Pa/V at 1m |
| Receiving Sensitivity:       | -178dB $\pm$ 3dB re $\mu$ Pa/V         |
| Impedance :                  | 100ohm $\pm$ 30ohm at 33kHz            |
| Beam width:                  | 20° $\pm$ 2°                           |
| Beam shape:                  | Conical                                |
| Efficiency:                  | >40%                                   |
| Q-factor:                    | <8                                     |
| Max input power:             | 1000W at 1% duty cycle                 |
| Operating depth:             | 30m                                    |
| Survival depth:              | 50m                                    |
| Operating temperature range: | -2°C to +35°C                          |
| Storage temperature range:   | -30°C +50°C                            |
| Cable (length and type):     | 33m Munflex 2*1 (O.D. 7mm) - pigtail   |
| Housing:                     | PVC                                    |
| Weight (air) incl. cable:    | 5kg                                    |
| Nato stock no.:              | 5845-22-284-4961                       |



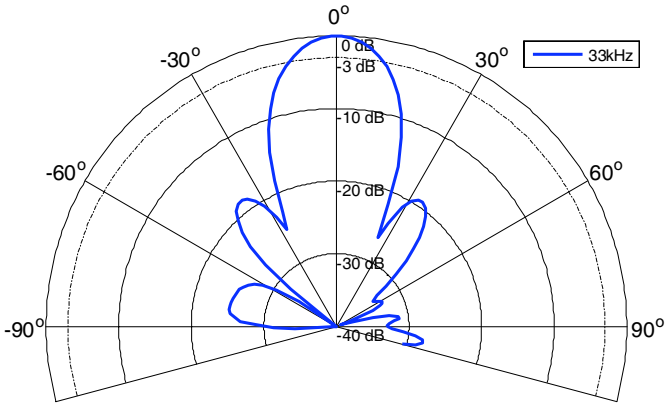




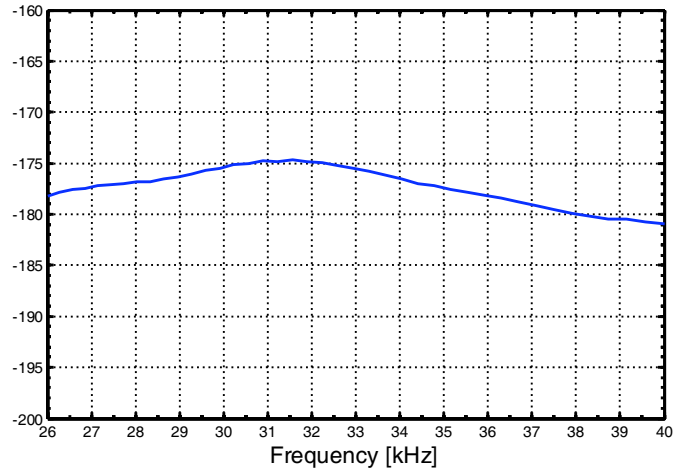
# Transducer TC2084

High Power Broad Band Echosounder

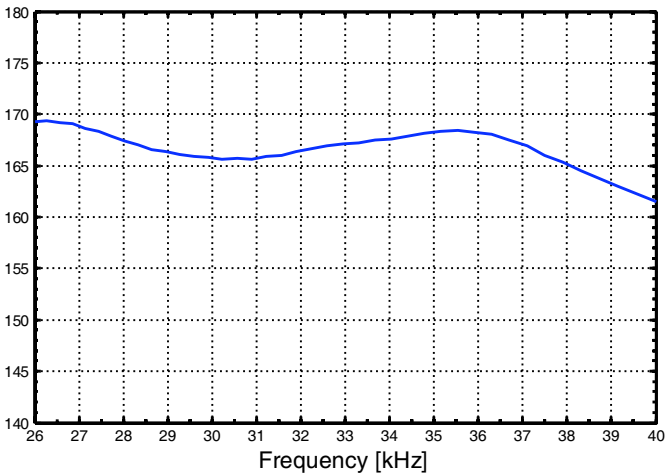
Horizontal Directivity Pattern



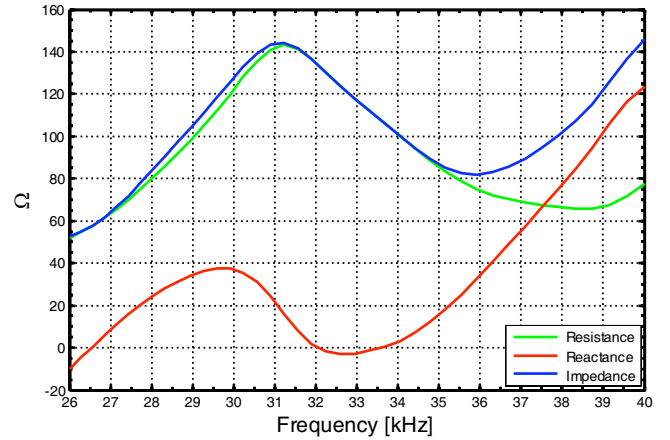
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance





# Transducer TC2103

## Net Eye Transducer



- 50kHz transducer
- Electrical compatible with almost all other
- 50kHz echosounders

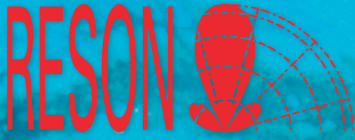
### TC2103

This net eye transducer is ideal for all deep sea trawling, which demands high quality transducer for depth sounding on the net rope.

#### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 50kHz $\pm$ 2kHz                                  |
| Transmitting Sensitivity:    | 166dB $\pm$ 3dB at 50kHz (dB re $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -189 $\pm$ 3dB at 50kHz (dB re V/ $\mu$ Pa)       |
| Impedance :                  | 50ohm $\pm$ 15ohm at 50kHz                        |
| Beam width:                  | 35° $\pm$ 5°                                      |
| Beam shape:                  | Conical   |
| Max input power:             | 500W at 1% duty cycle                             |
| Operating depth:             | 600m  |
| Survival depth:              | 750m  |
| Operating temperature range: | +1°C to +30°C                                     |
| Storage temperature range:   | -10°C to +30°C                                    |
| Weight, dry:                 | 425g  |
| Housing:                     | Polyurethane                                      |

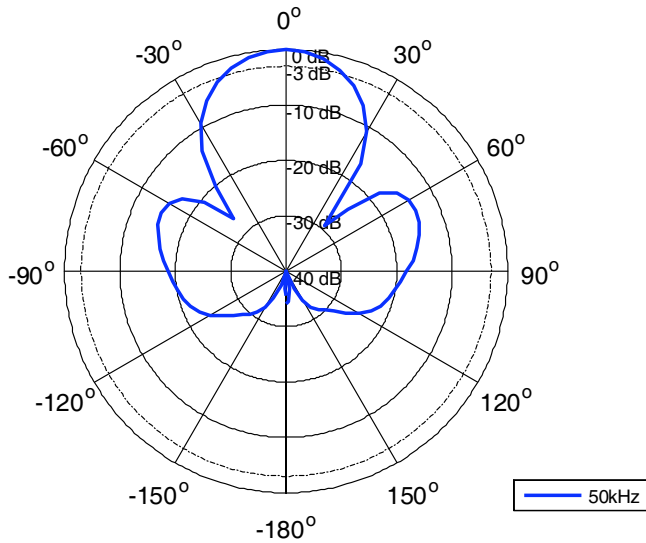




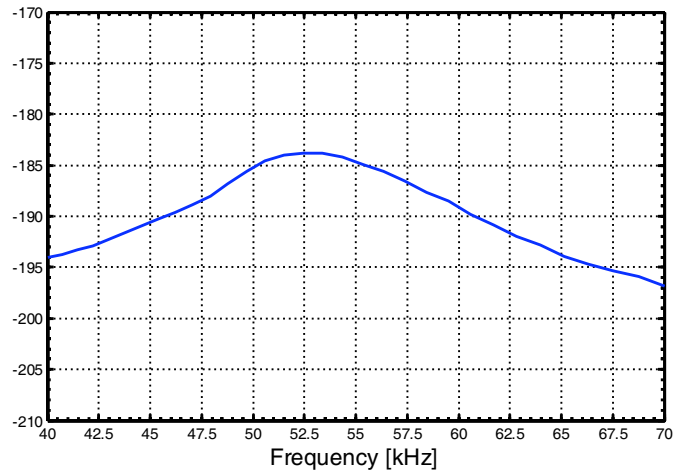
# Transducer TC2103

Net Eye Transducer

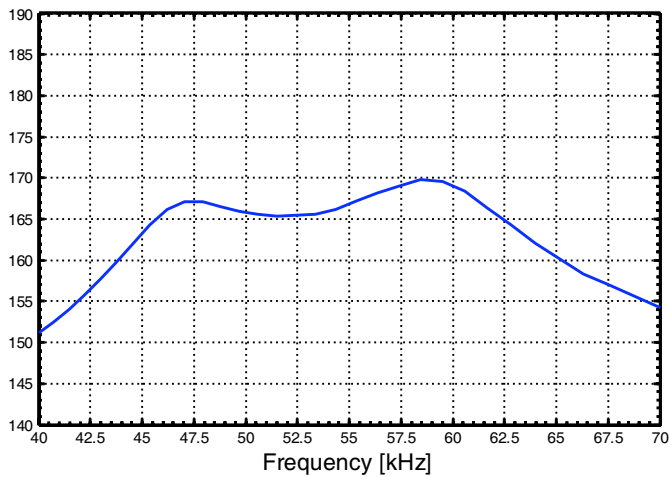
Horizontal Directivity Pattern



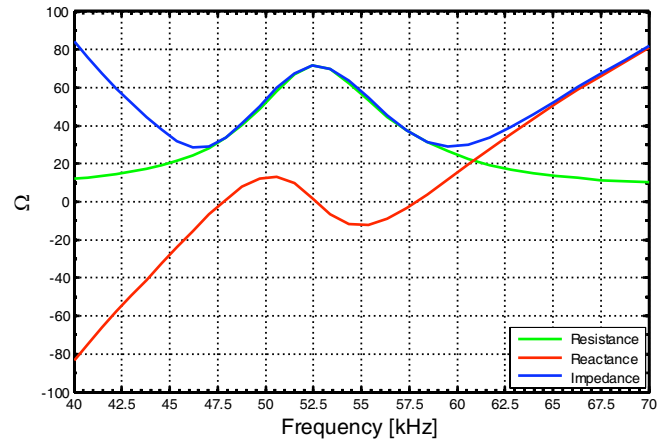
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance







# Transducer TC2111

Compact Echosounder Transducer



- Small compact design
- Good piezo ceramics

## TC2111

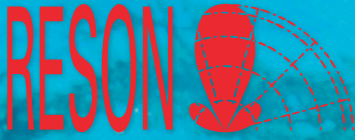
Compact echo sounder transducer

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 200kHz $\pm$ 3kHz                       |
| Transmitting sensitivity:    | 163dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -190dB $\pm$ 3dB (re 1V/ $\mu$ Pa)      |
| Impedance:                   | 200ohm $\pm$ 60ohm at 200kHz            |
| Beam width:                  | 18° $\pm$ 3°                            |
| Beam shape:                  | Conical                                 |
| Max input power:             | 50W (at 1% duty cycle)                  |
| Operating depth:             | 30m                                     |
| Survival depth:              | 50m                                     |
| Operating temperature range: | +2°C to +35°C                           |
| Storage temperature range:   | -30°C to +50°C                          |
| Cable (length and type):     | 10m Coax 2*1 (O.D. 5mm) - pigtail       |
| Weight in air, with cable:   | 0,4kg                                   |
| Housing:                     | PVC with union nut                      |



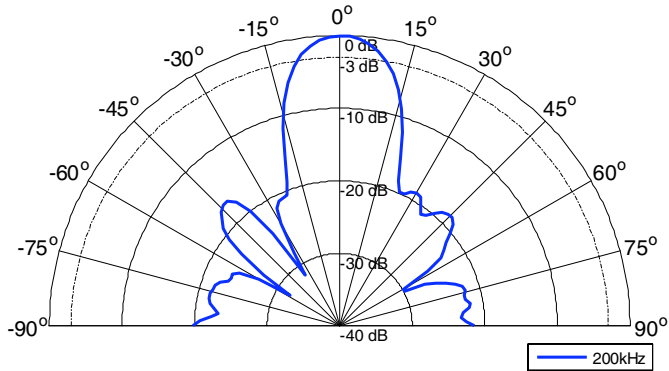




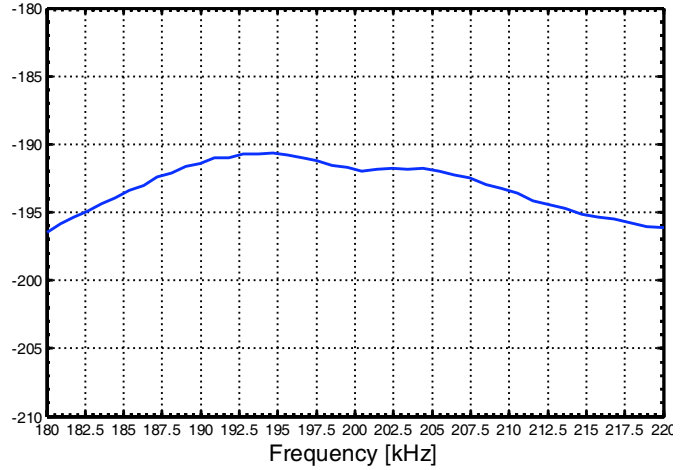
# Transducer TC2111

Compact Echosounder Transducer

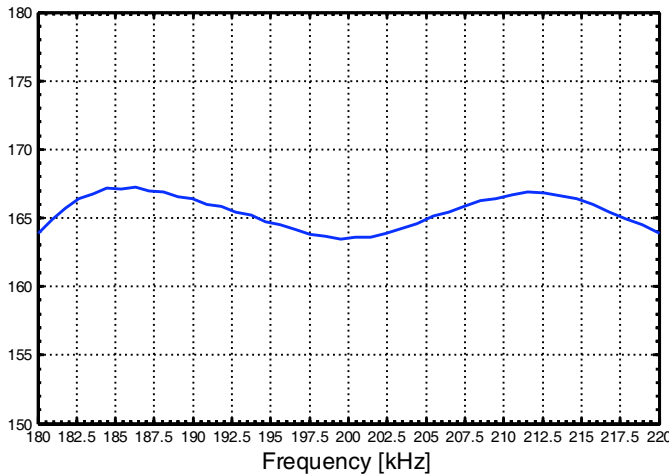
Horizontal Directivity Pattern



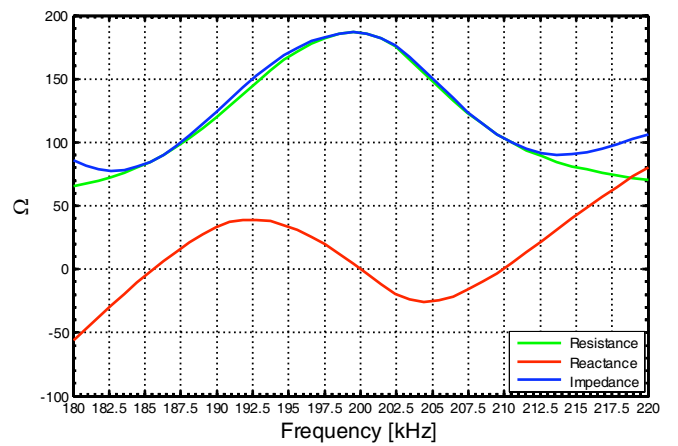
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



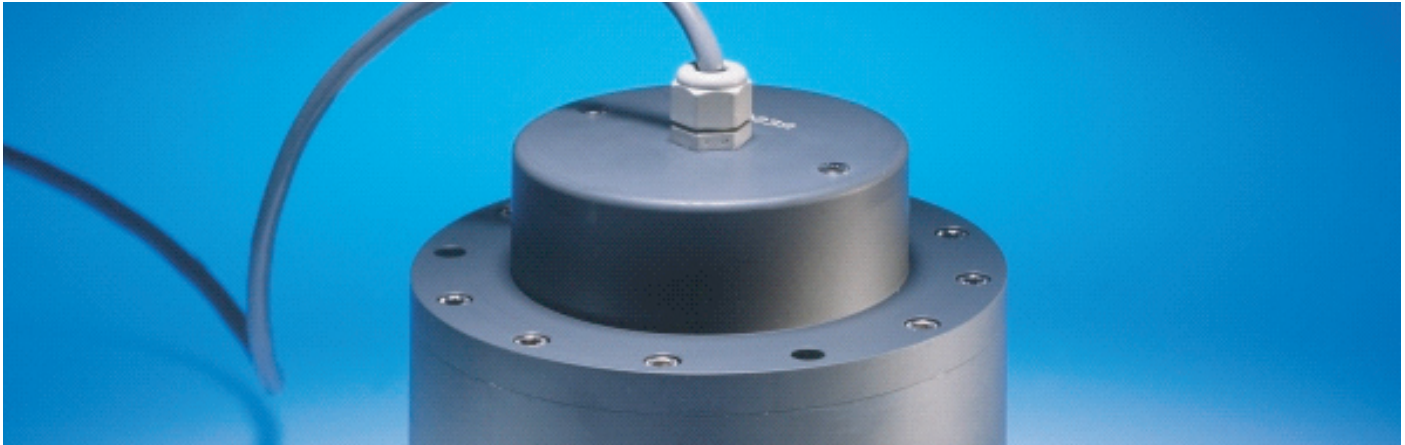
Impedance





# Transducer TC2115

High-power Broad-band Echosounder



- 30kHz transducer
- Fits into existing SW60/28/6029 housings
- Electrical compatible with almost all other 30kHz echosounders.
- Can be operated in the frequency range from 28 – 34kHz
- Compact design

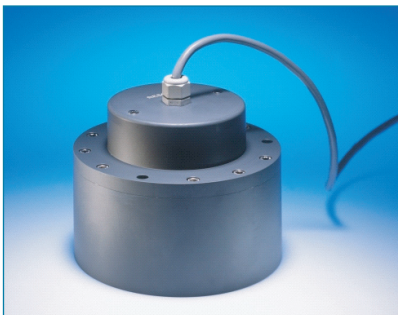
## TC2115

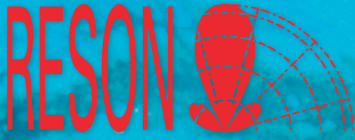
Universal 30kHz high power, broadband transducer for medium range echosounding applications: 700m.

The TC2115 can be operated in the frequency range 25-40kHz. This transducer is ideal for navigation and hydrographic echo sounders. RESON steel housing mounts are available for outboard mounting. Its standard potting is also compatible with Atlas SW 6028/6029 mounts.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 30kHz $\pm$ 2kHz                       |
| Transmitting Sensitivity:    | 168dB $\pm$ 3 dB re 1 $\mu$ Pa/V at 1m |
| Receiving Sensitivity:       | -178dB $\pm$ 3 dB re 1V/ $\mu$ Pa      |
| Impedance:                   | 80ohm $\pm$ 24ohm at 30kHz             |
| Beam width:                  | 23° $\pm$ 2°, conical                  |
| Max input power:             | 1000W at 1% duty cycle                 |
| Operating depth:             | 30m                                    |
| Survival depth:              | 50m                                    |
| Operating temperature range: | -2°C to +35°C                          |
| Storage temperature range:   | -30°C to +50°C                         |
| Cable (length and type):     | 33m Munflex 2*1 (O.D. 7mm) - pigtail   |
| Weight with cable:           | 5kg                                    |

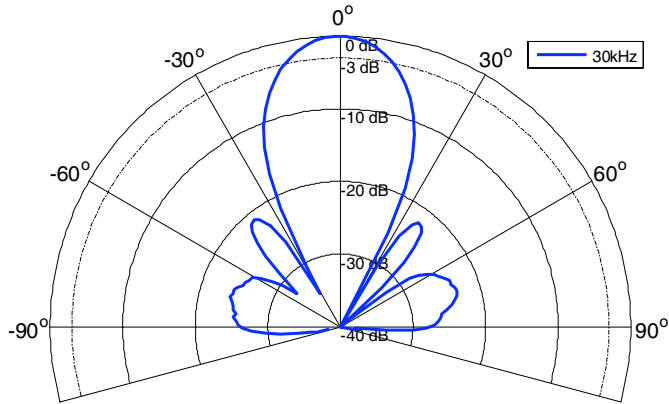




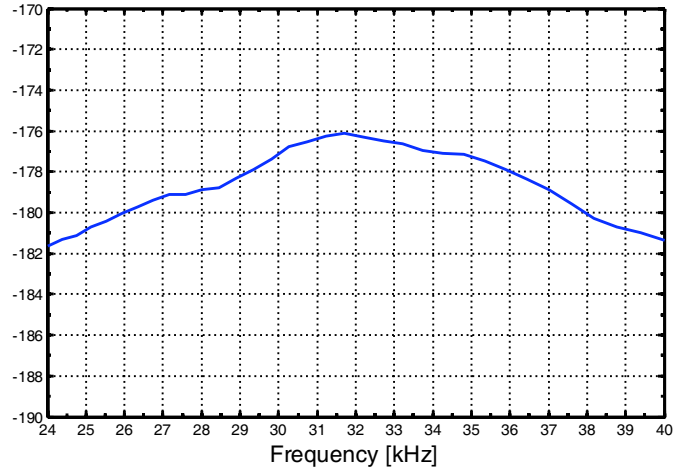
# Transducer TC2115

High-power Broad-band Echosounder

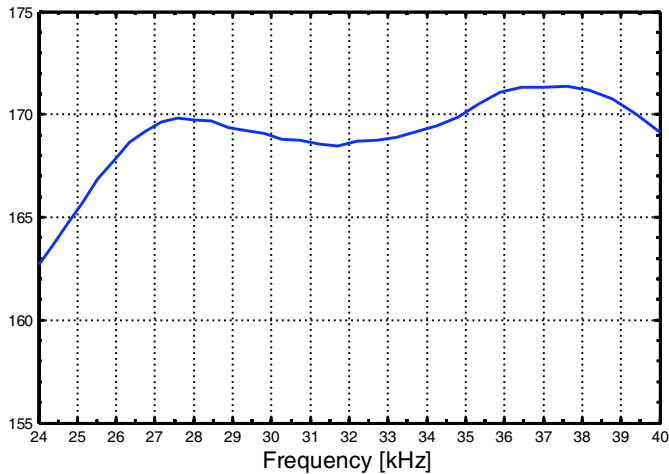
Horizontal Directivity Pattern



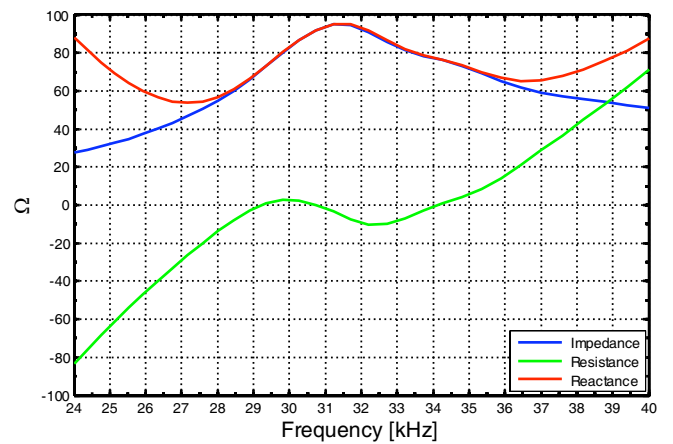
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance

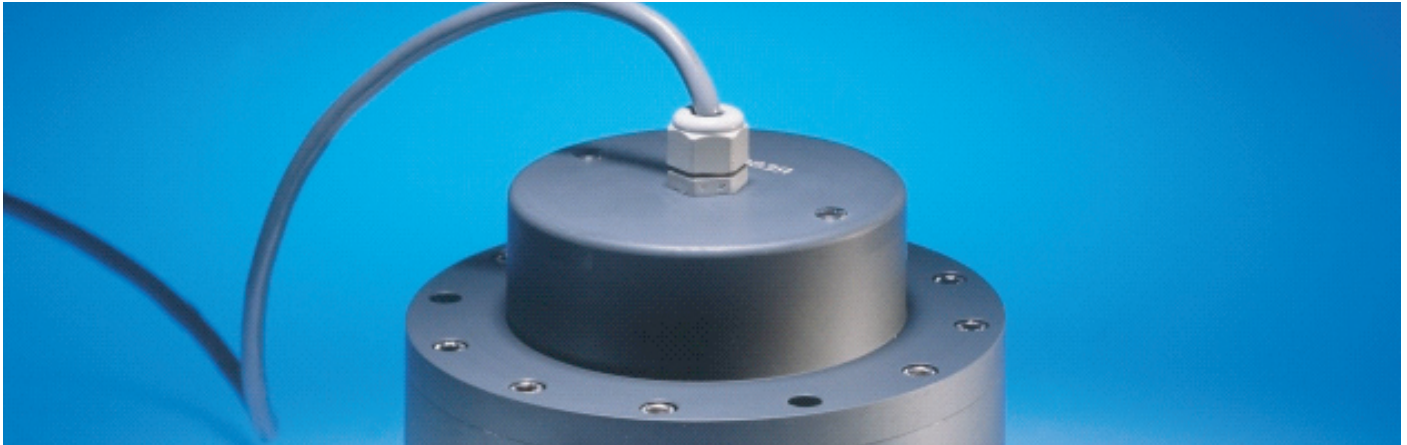






# Transducer TC2116

Broad band High power Transducer



## TC2116

- 50kHz transducer
- Fits into existing SW60/28/6029 housings
- Can be operated in the frequency range from 40kHz to 100kHz
- Electrical compatible with almost all other 50kHz echosounders

Please note that this product requires a minimum quantity per order



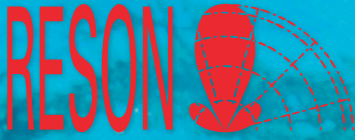
Universal 50kHz High-Power, broad band transducer. Operational frequency range is 40kHz to 100kHz.

This transducer is ideal for navigation and hydrographic echo sounders. The transducer has excellent piezo ceramic elements which ensure the highest reliability in quality echosounding. RESON steel housing mounts are available for outboard mounting. Its standard housing is also compatible with Atlas SW 6028/6029 mounts.

### TECHNICAL SPECIFICATIONS

|                              |                                       |
|------------------------------|---------------------------------------|
| Resonant Frequency:          | 50kHz $\pm$ 2kHz                      |
| Transmitting Sensitivity:    | 172dB $\pm$ 3dB re 1 $\mu$ Pa/V at 1m |
| Receiving Sensitivity:       | -177dB $\pm$ 3dB re 1V $\mu$ Pa       |
| Impedance :                  | 80ohm $\pm$ 24ohm                     |
| Beam width:                  | 13.5° $\pm$ 2°, conical               |
| Max input power:             | 1000W at 50kHz 1% duty cycle          |
| Operating depth:             | 30m                                   |
| Survival depth:              | 40m                                   |
| Operating temperature range: | +2°C to +35°C                         |
| Storage temperature range:   | -30°C to +50°C                        |
| Cable : (length and type)    | 33m Munflex 2*1 (O.D. 7mm) - pigtail  |
| Housing:                     | PVC                                   |
| Weight (air) incl..cable:    | 5kg                                   |
| NATO stock no.:              | 5845-22-284-4961                      |

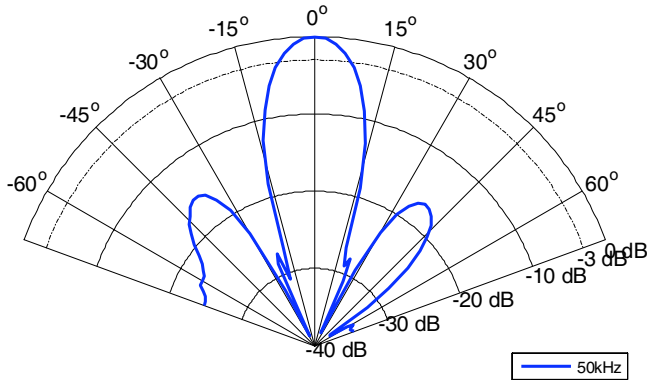




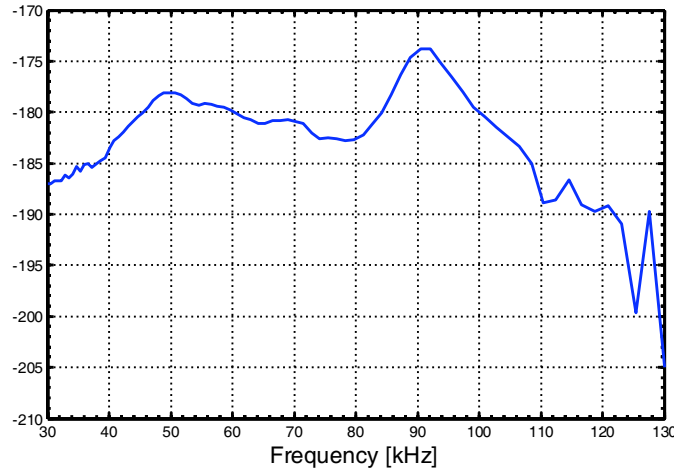
# Transducer TC2116

Broad band High power Transducer

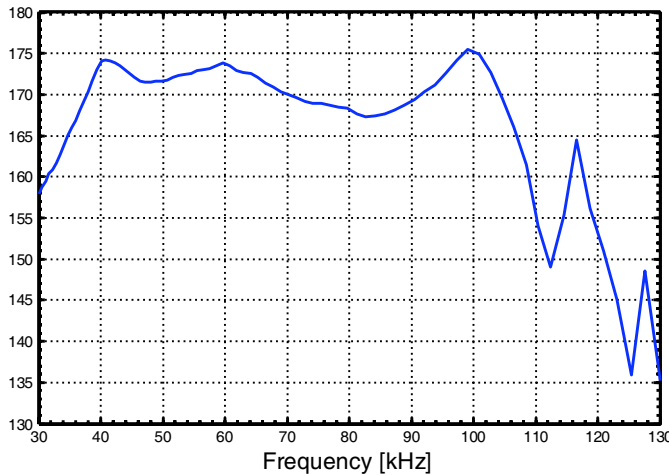
Horizontal Directivity Pattern



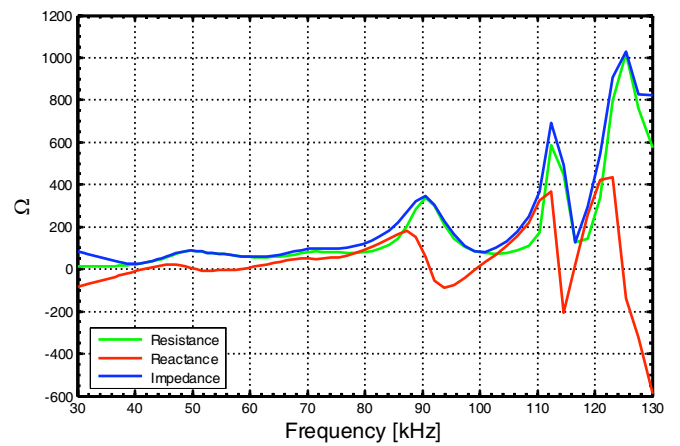
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



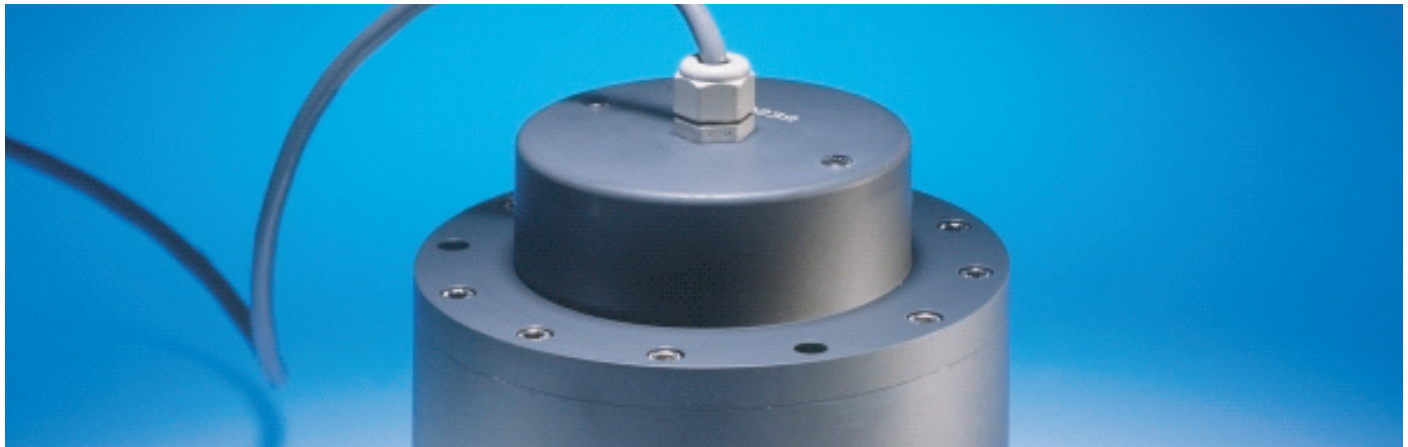
Impedance





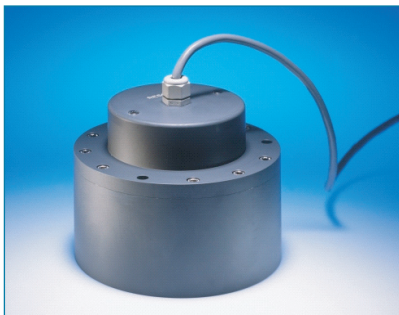
# Transducer TC2120

High Power Echosounder Transducer



- 50kHz transducer.
- Fits into existing SW60/28/6029 housings
- Electrical compatible with almost all other 50kHz echosounders
- Compact design.

Please note that this product requires a minimum quantity per order



## TC2120

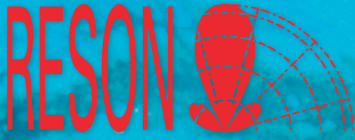
Universal 50kHz High-Power, broad band transducer.

This transducer is ideal for navigation, hydrographic echosounding, and fishing applications where exact picture or depth is needed. The transducer has excellent piezoceramic elements which ensure the highest reliability in quality echosounding.

Capable of being driven with 2000W. The transducer can be fitted into ATLAS SW 60/28/6029 housings and RESON steel housings.

### TECHNICAL SPECIFICATIONS

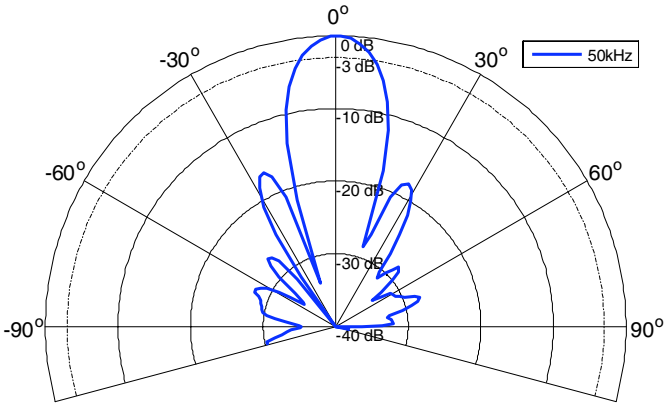
|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 50kHz $\pm$ 2kHz                        |
| Transmitting sensitivity:    | 172dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -178dB $\pm$ 3dB (re 1V/ $\mu$ Pa)      |
| Impedance:                   | 80ohm $\pm$ 24ohm                       |
| Beam width:                  | 13,2 $^{\circ}$ $\pm$ 2 $^{\circ}$      |
| Beam shape:                  | Conical                                 |
| Max input power:             | 2000W (at 1% duty cycle)                |
| Operating depth:             | 30m                                     |
| Survival depth:              | 50m                                     |
| Operating temperature range: | -2 $^{\circ}$ C to +35 $^{\circ}$ C     |
| Storage temperature range:   | -30 $^{\circ}$ C to +50 $^{\circ}$ C    |
| Weight in air, with cable:   | 5kg                                     |
| Cable: (Length and type)     | 33m Munflex 2*1 (O.D. 7mm) - pigtail    |



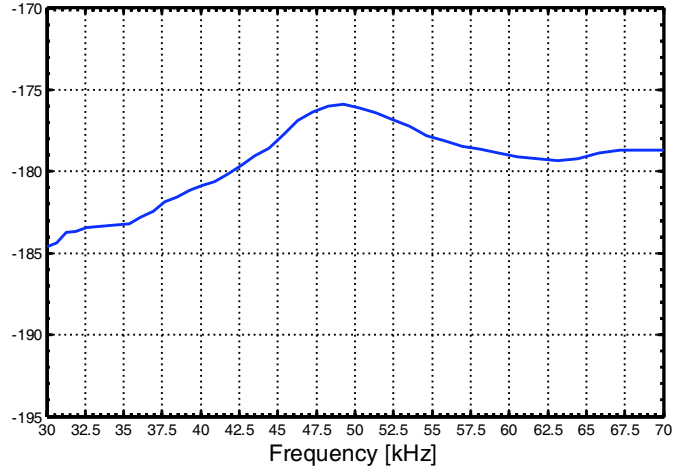
# Transducer TC2120

High Power Echosounder Transducer

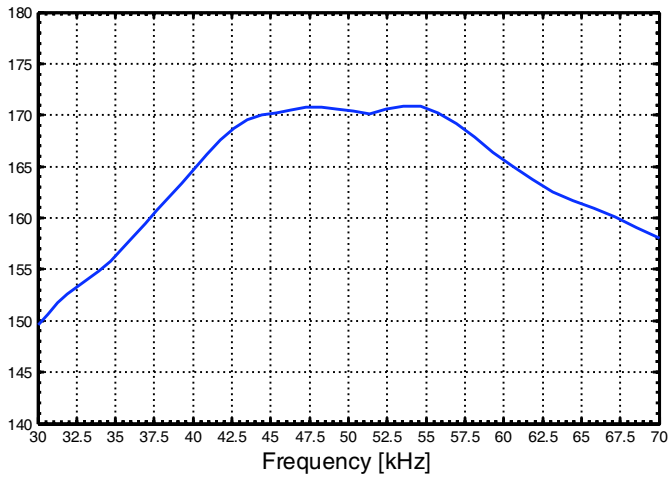
Horizontal Directivity Pattern



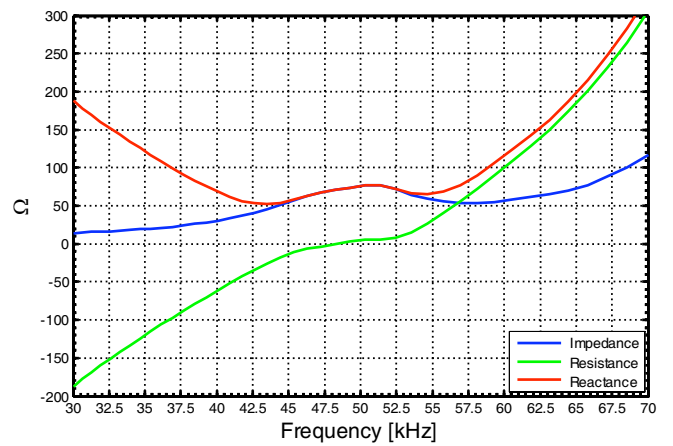
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance







# Transducer TC2122

Dual-Frequency Survey Echosounder Transducer



## TC2122

- **Narrow beams**
- **High acoustical performance**
- **Compact design**
- **Compatible with ATLAS SW60/28/6029 housing.**
- **Electrical compatible with most 33kHz and 200kHz echosounders.**

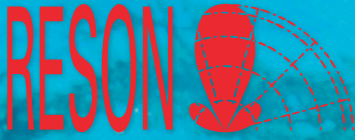
Model TC2122 is a 33kHz and 200kHz dual frequency transducer ideal for navigation and hydrographic echosounder systems. The transducer has excellent piezoceramic elements which will ensure the highest reliability and quality in echosounding. The transducer will fit ATLAS SW 60/28/6029 housing and RESON steel housings.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 33kHz $\pm$ 2kHz 200kHz $\pm$ 5kHz   |
| Transmitting sensitivity:    | 168dB $\pm$ 3dB at 33kHz 174dB $\pm$ 3dB at 200kHz (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -177dB $\pm$ 3dB at 33kHz -187dB $\pm$ 3dB at 200kHz (re 1 $\mu$ Pa/V)     |
| Impedance:                   | 80ohm $\pm$ 24ohm at 33kHz and 200kHz                                      |
| Beam width:                  | 22° $\pm$ 2° at 33kHz 9,5° $\pm$ 1° at 200kHz                              |
| Beam shape:                  | Conical  |
| Max input power:             | 1000W at 33kHz 450W at 200kHz (at 1% duty cycle)                           |
| Operating depth:             | 30m  |
| Survival depth:              | 50m  |
| Operating temperature range: | -2°C to +35°C  |
| Storage temperature range:   | -30°C to +50°C   |
| Weight in air, with cable:   | 5kg  |
| Cable: (length and type)     | 33m Munflex 4*1 (O.D. 9mm) - pigtail                                       |
| Housing:                     | PVC  |



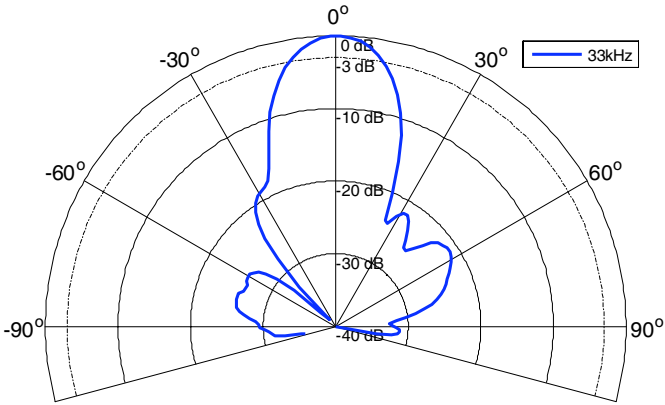




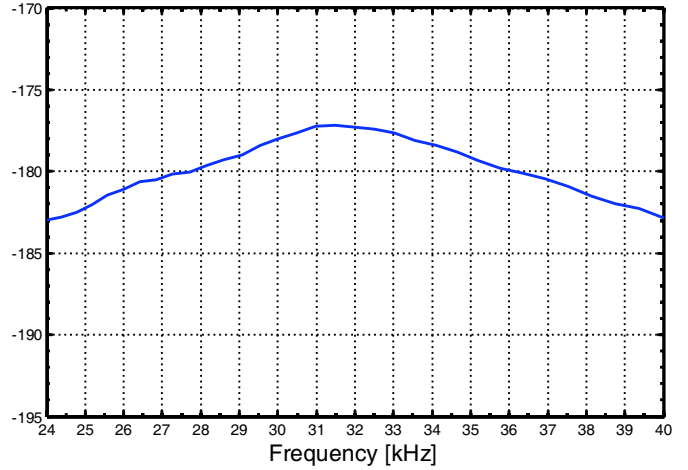
# Transducer TC2122

Dual-Frequency Survey Echosounder Transducer

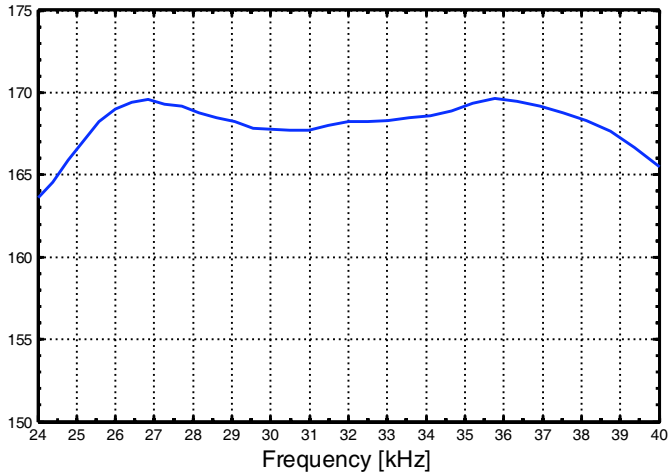
Horizontal Directivity Pattern



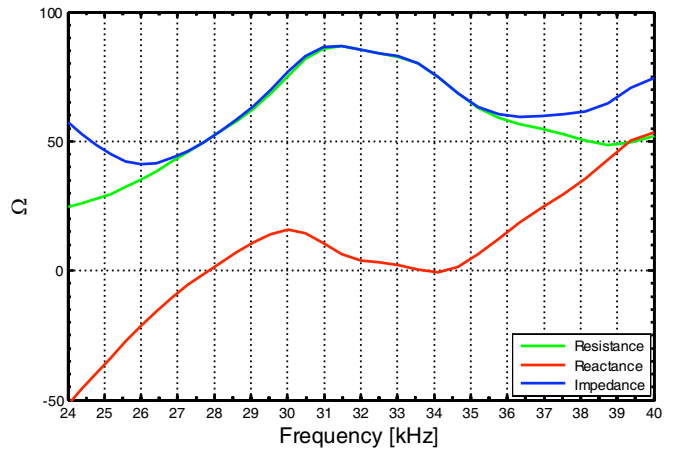
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance





# Transducer TC2127

Narrow Beam Echosounder Transducer



## TC2127

- 600kHz transducer
- Compact design
- Excellent performance
- Robust piezo ceramic
- Electrical compatible with most echosounder systems

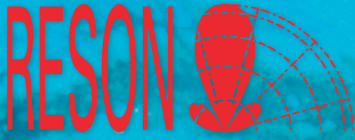
General purpose narrow beam 600kHz transducer. Ideal for shallow water navigation and hydrographic echo sounders. Compatible with Atlas SW 6014 housing or RESON steel housings.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 600kHz                                  |
| Transmitting Sensitivity:    | 181.5dB $\pm$ 3dB re 1 $\mu$ Pa/V at 1m |
| Receiving Sensitivity:       | -187.5dB $\pm$ 3dB re 1V/ $\mu$ Pa      |
| Impedance:                   | 100ohm $\pm$ 30ohm, at 600kHz           |
| Beam width:                  | 3,2° $\pm$ 3°, Conical                  |
| Max input power:             | 150W at 1% duty cycle                   |
| Operating depth:             | 30m                                     |
| Survival depth:              | 50m                                     |
| Operating temperature range: | -2°C to +30°C                           |
| Storage temperature range:   | -30°C to +50°C                          |
| Cable (length and type):     | 20m Munflex 2*1 (O.D. 7mm) - pigtail    |
| Housing:                     | PVC                                     |
| Weight with cable:           | 2,2kg                                   |

Please note that this product requires a minimum quantity per order

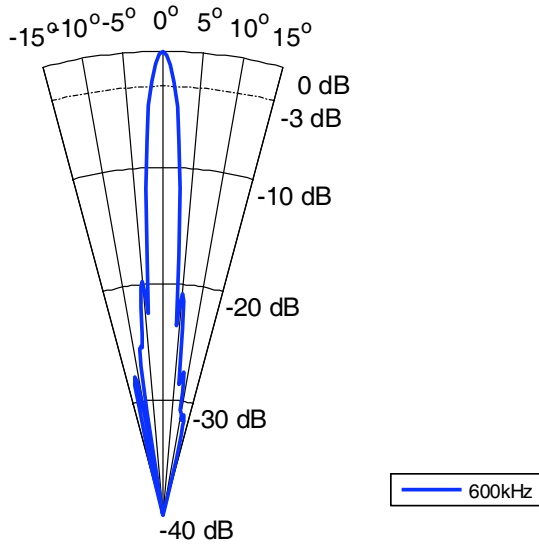




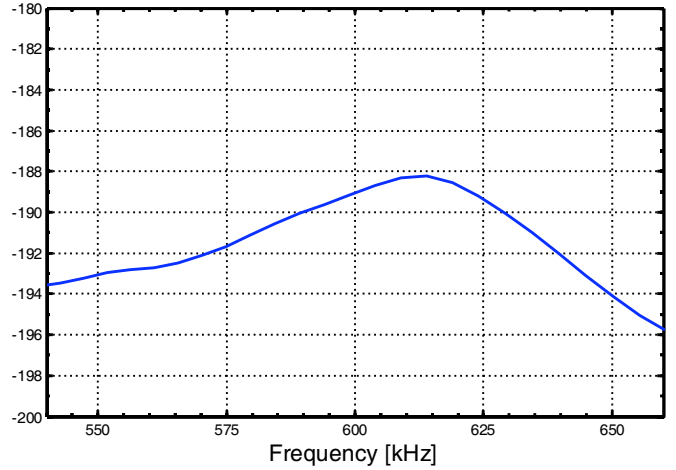
# Transducer TC2127

Narrow Beam Echosounder Transducer

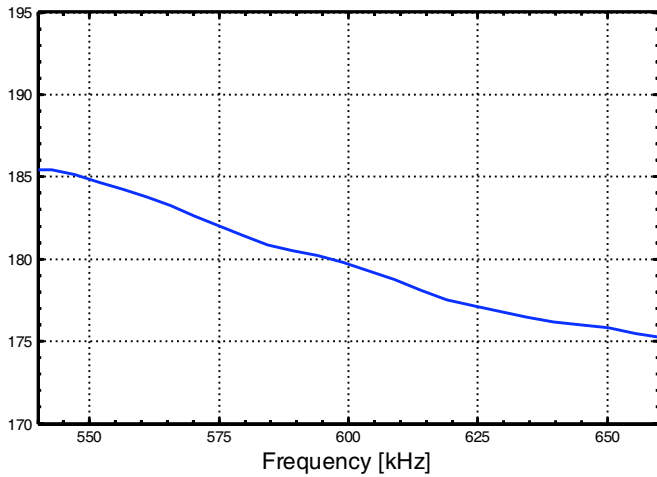
Horizontal Directivity Pattern



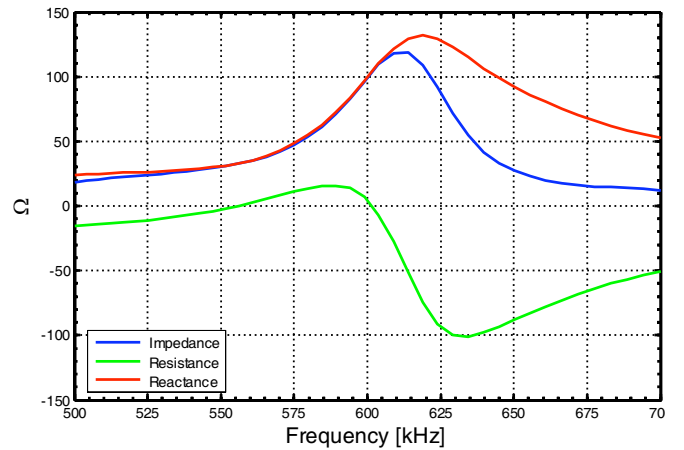
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



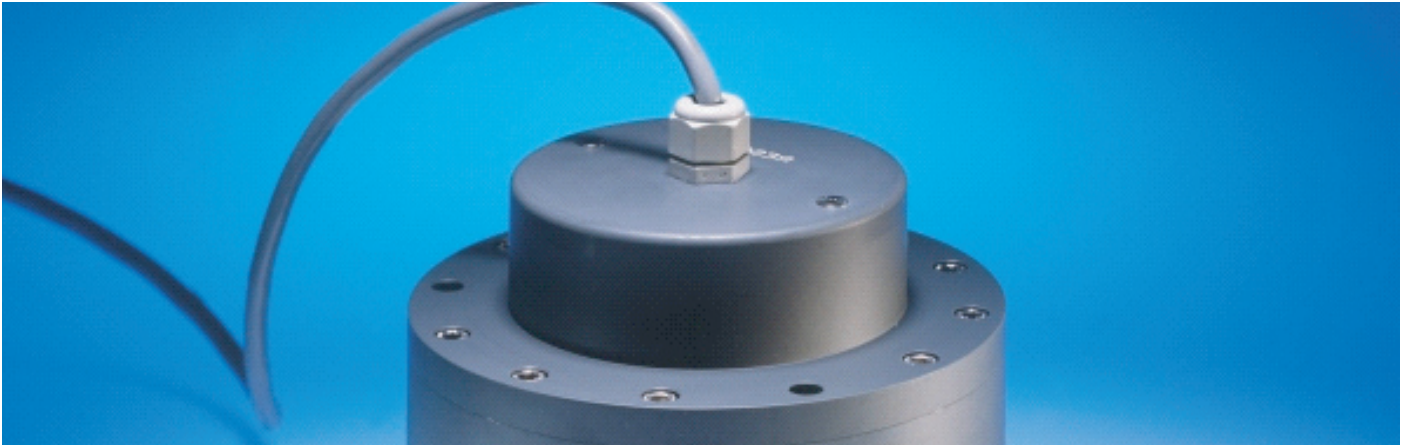
Impedance





# Transducer TC2129

High Power Echosounder Transducer



- **38kHz transducer**
- **Fits into existing ATLAS SW60/28/6029 housings**
- **Electrical compatible with almost all other 38kHz echosounders**
- **Compact design for easy installation**

## TC2129

Universal 38kHz high-power transducer usable for medium range echosounding applications: 30m.

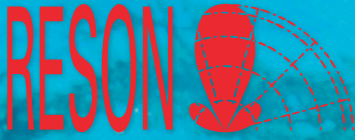
This transducer is ideal for navigation, hydrographic echosounding, and fishing. RESON steel housing mounts are available for outboard mounting. Its standard housing is also compatible with Atlas SW 60/28/6029 mounts.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 38kHz $\pm$ 2kHz                        |
| Transmitting sensitivity:    | 168dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -178dB $\pm$ 3dB (re 1V/ $\mu$ Pa)      |
| Impedance:                   | 80ohm $\pm$ 24ohm                       |
| Beam width:                  | 17° $\pm$ 2°                            |
| Beam shape:                  | Conical                                 |
| Max input power:             | 1000W (at 1% duty cycle)                |
| Operating depth:             | 30m                                     |
| Survival depth:              | 50m                                     |
| Operating temperature range: | +2°C to +35°C                           |
| Storage temperature range:   | -30°C to +50°C                          |
| Weight in air, with cable:   | 5kg                                     |
| Cable: (length and type)     | 33m, Munflex 2x1 cable pigtail          |
| Housing:                     | PVC                                     |



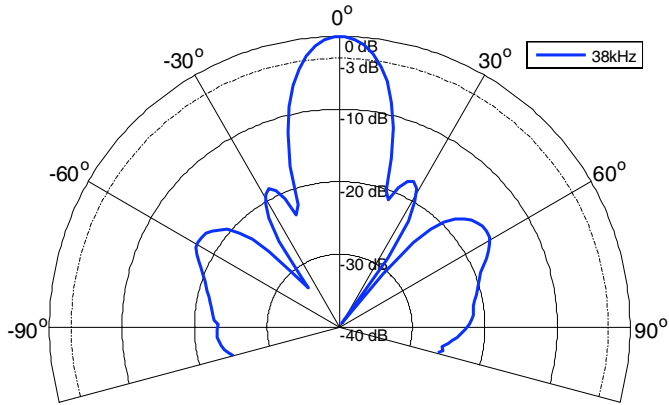




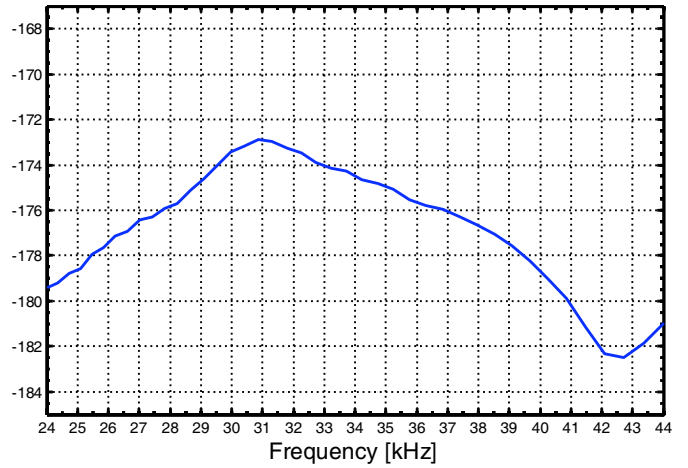
# Transducer TC2129

High Power Echosounder Transducer

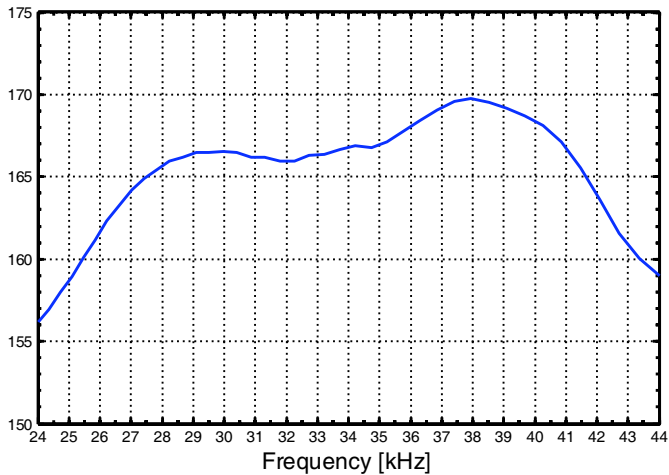
Horizontal Directivity Pattern



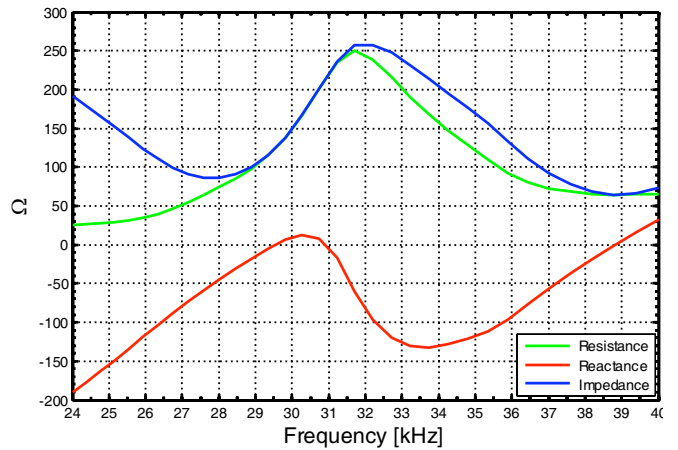
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance





# Transducer TC2132

Narrow Beam Echosounder



- **Narrow conical beam 2.6 deg.**
- **Ideal for crisp sea floor survey and inspection**
- **Fits into Atlas 6028/6020 steel housing**

## TC2132

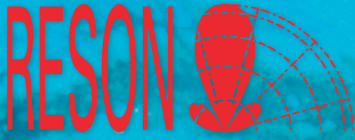
The TC2132 is a narrow beam echosounder transducer, which is ideal for survey and high accuracy sounding. The transducer is compatible with ATLAS SW60/28/6029 or RESON's steel housing.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 300kHz $\pm$ 15kHz                       |
| Transmitting sensitivity:    | +181dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -181dB $\pm$ 3dB (re 1V/ $\mu$ Pa)       |
| Impedance:                   | 100ohm $\pm$ 30ohm                       |
| Beam width:                  | 2.6° $\pm$ 0.3°                          |
| Beam shape:                  | Conical                                  |
| Max input power:             | 1000W (at 1% duty cycle)                 |
| Operating depth:             | 30m                                      |
| Survival depth:              | 50m                                      |
| Operating temperature range: | +2°C +35°C                               |
| Storage temperature range:   | -40°C +50°C                              |
| Weight in air, with cable:   | 4kg                                      |
| Cable (length and type):     | 18m Munflex 2*1 (O.D. 7mm) - pigtail     |
| Housing:                     | PVC                                      |

Please note that this product requires a minimum quantity per order

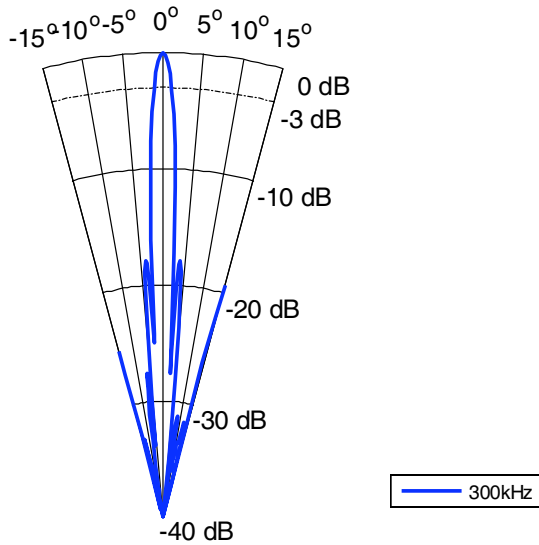




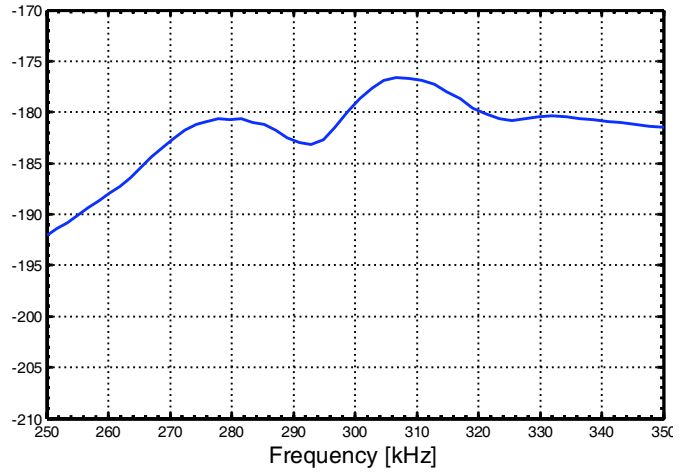
# Transducer TC2132

Narrow Beam Echosounder

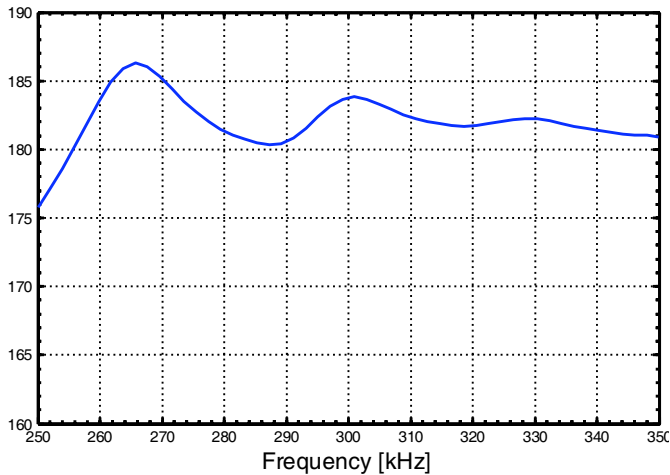
Horizontal Directivity Pattern



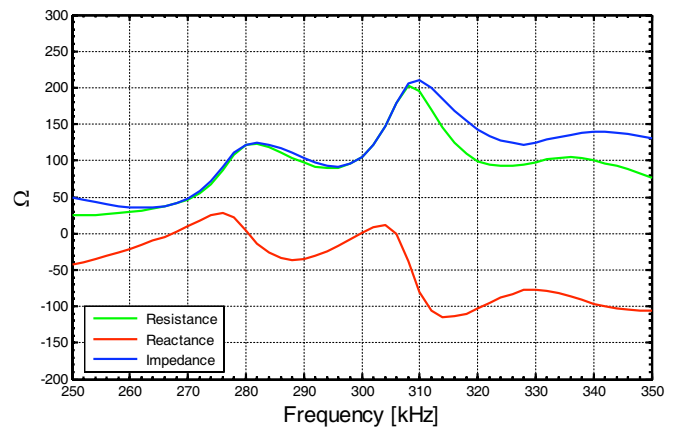
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance







# Transducer TC2135

Broad Band Dual-Frequency Survey



- 15kHz/200kHz dual frequency transducer
- Narrow beams at both frequencies
- Excellent acoustical performance
- Electrically compatible with most echosounder systems
- Rugged design

Please note that this product requires a minimum quantity per order



## TC2135

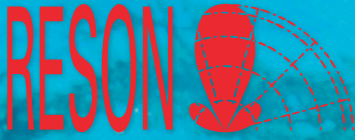
Model TC2135 is a 15kHz and 200kHz dual frequency transducer ideal for sedimentation measurements and hydrographic echo sounder systems. Both operating frequencies exhibit broad band characteristics making the TC2135 even more flexible.

The transducer has excellent piezoceramic elements, which ensure the highest reliability and quality in echosounding.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 15kHz $\pm 2$ kHz 200kHz $\pm 5$ kHz                                       |
| Usable frequency range:      | 15kHz: 13 to 18kHz 200kHz: 190 to 220kHz                                   |
| Transmitting Sensitivity:    | 168dB $\pm 3$ dB at 15kHz 172dB $\pm 3$ dB at 200kHz (re $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -172dB $\pm 3$ dB at 15kHz -189dB $\pm 3$ dB at 200kHz (re 1V/ $\mu$ Pa)   |
| Directivity Pattern:         | 23° $\pm 2$ ° at 15kHz, 9° $\pm 1$ ° at 200kHz                             |
| Beam shape:                  | Conical beam   |
| Impedance:                   | 80ohm $\pm 24$ ohm at 15kHz and 200kHz                                     |
| Max Input power:             | 2000W at 15kHz 300W at 200kHz (1% duty cycle)                              |
| Operating depth:             | 30m  |
| Survival depth:              | 50m  |
| Operating temperature range: | -2°C to +35°C  |
| Storage: temperature range:  | -30°C to +50°C   |
| Weight in air with cable:    | 33kg   |
| Cable:                       | 33m Munflex 4*1 (O.D. 9mm) - pigtail                                       |
| Housing:                     | PVC  |

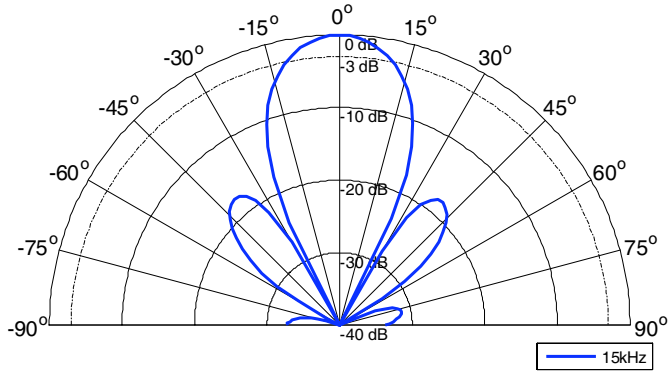




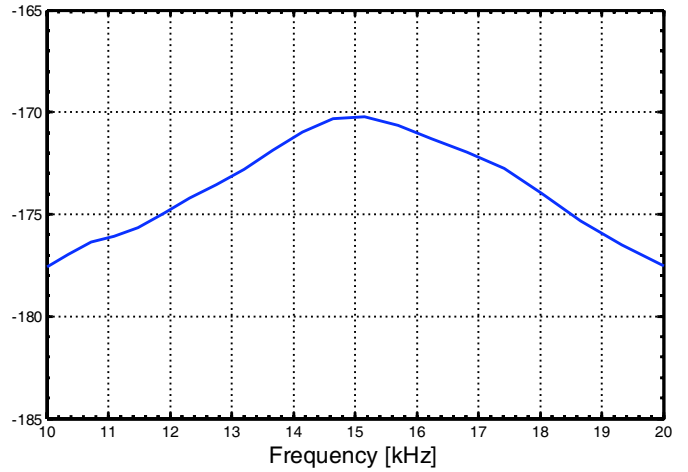
# Transducer TC2135

Broad Band Dual-Frequency Survey

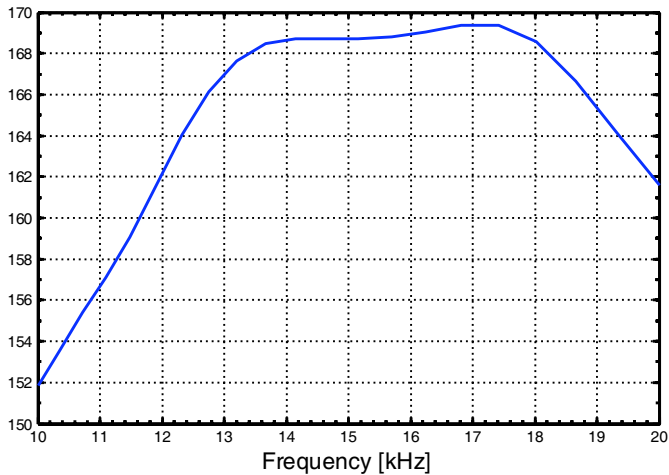
Horizontal Directivity Pattern



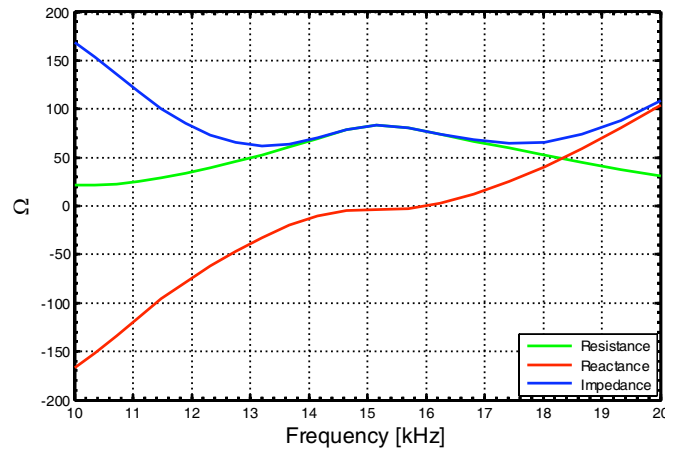
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



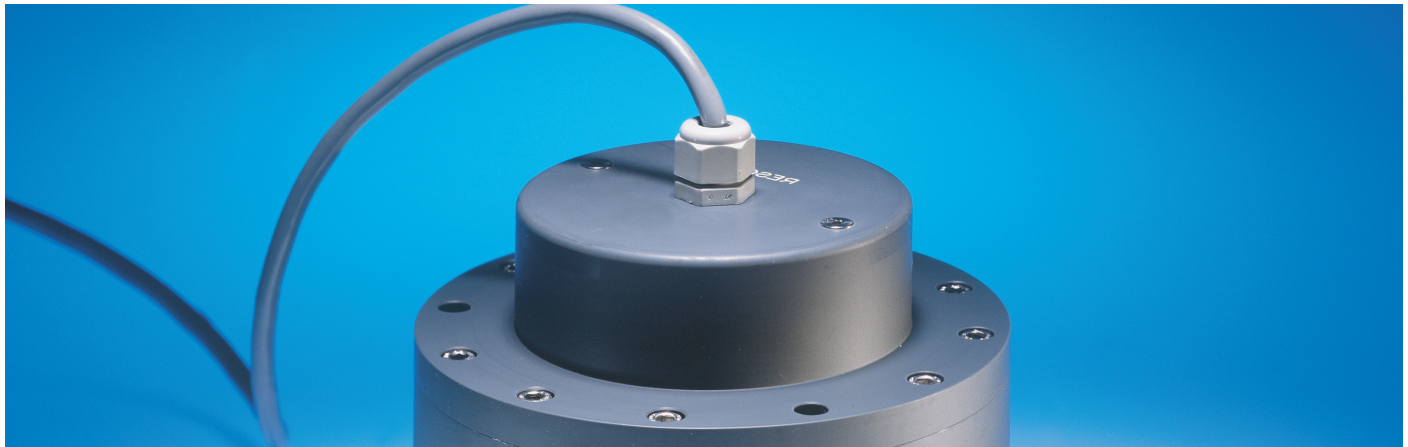
Impedance





# Transducer TC2144

Dual frequency survey Echosounder



- **Narrow beams**
- **High acoustical performance**
- **Compact design**
- **Compatible with ATLAS SW60/28/6029 housing**
- **Electrical compatible with most 24kHz and 200kHz echosounders**

## TC2144

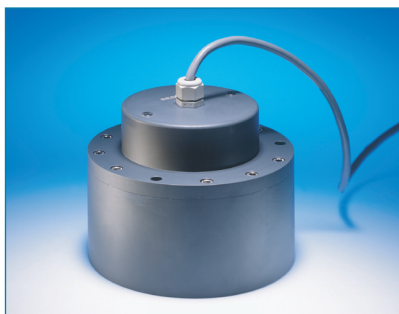
Model TC2144 is a 24kHz and 200kHz dual frequency transducer ideal for navigation and hydrographic echosounder systems.

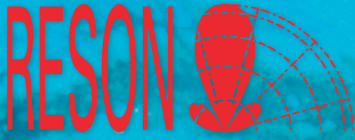
The transducer has excellent piezoceramic elements, which will ensure the highest reliability and quality in echosounding.

The transducer will fit ATLAS SW 60/28/6029 housing and RESON steel housings.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 24kHz $\pm$ 2kHz 200kHz $\pm$ 5kHz  |
| Transmitting sensitivity:    | 168dB $\pm$ 3dB at 24kHz, 170dB $\pm$ 3dB at 200kHz (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -178dB $\pm$ 3dB at 24kHz, -190dB $\pm$ 3dB at 200kHz (re 1 $\mu$ Pa/V)     |
| Impedance:                   | 80ohm $\pm$ 24ohm at 24kHz and 200kHz                                       |
| Beam width:                  | 28° $\pm$ 2° at 24 kHz, 9° $\pm$ 1° at 200 kHz                              |
| Beam shape:                  | Conical   |
| Max input power:             | 1000W at 24kHz 450W at 200kHz (at 1% duty cycle)                            |
| Operating depth:             | 30m   |
| Survival depth:              | 50m   |
| Operating temperature range: | -2°C to +35°C   |
| Storage temperature range:   | -30°C to +50°C  |
| Weight in air, with cable:   | 5kg   |
| Cable: (length and type)     | 33m Munflex 4*1 (O.D. 9mm) - pigtail  |
| Housing:                     | PVC   |

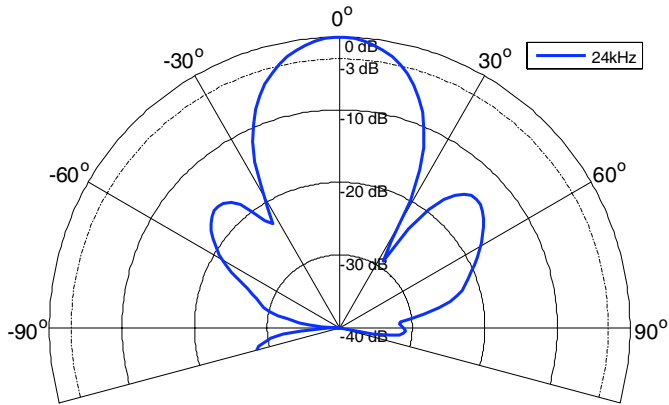




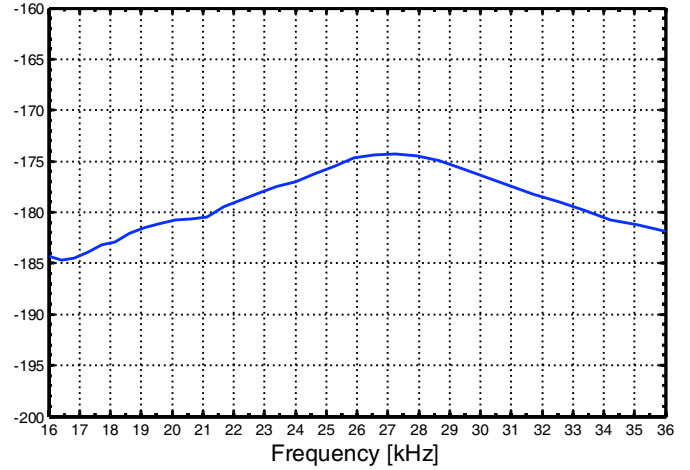
# Transducer TC2144

Dual frequency survey Echosounder

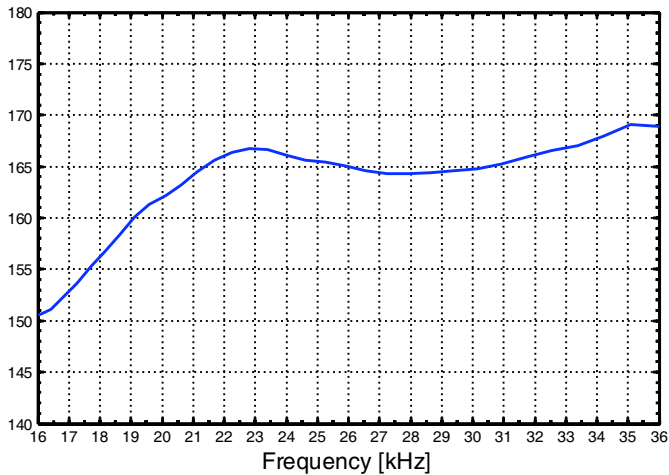
Horizontal Directivity Pattern



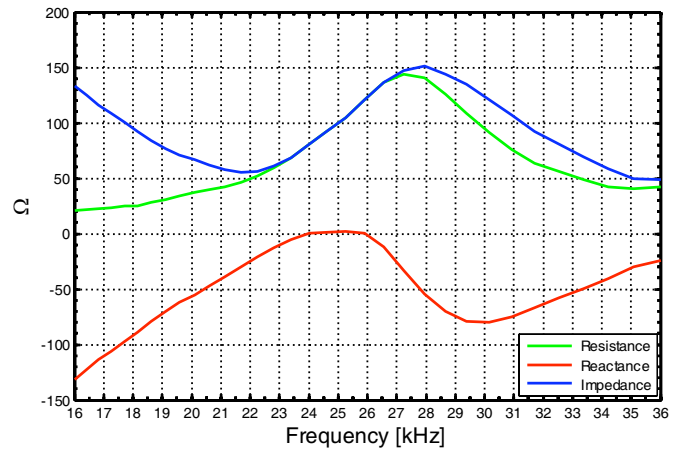
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance







# Transducer TC2145

Survey Transducer Echosounder



## TC2145

- **Narrow conical beam**
- **High-Power input**
- **Compact design**
- **FURONO 200B-12h compatible**

Narrow beam 200kHz transducer for standard echosounders, hydrographic echosounders and fishfinders. The transducer has a beam width of 4.2 degree. The transducer is high power rated to 1500Watt.

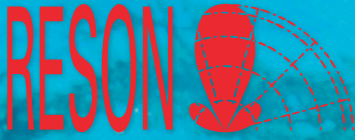
### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Resonant Frequency:          | 200kHz $\pm$ 10kHz   |
| Transmitting sensitivity:    | 181.5dB $\pm$ 3dB at 200kHz (re 1 $\mu$ Pa/V at 1m)        |
| Receiving Sensitivity:       | -178,5dB $\pm$ 3dB at 200kHz (re 1V/ $\mu$ Pa)             |
| Impedance:                   | 100ohm $\pm$ 30ohm at 200kHz                               |
| Beam width:                  | 4.2 $^{\circ}$ $\pm$ 1 $^{\circ}$ , Conical                |
| Max input power:             | 1500W (at 1% duty cycle)                                   |
| Operating depth:             | 30m  |
| Survival depth:              | 50m  |
| Operating temperature range: | -2 $^{\circ}$ C to +30 $^{\circ}$ C                        |
| Storage temperature range:   | -30 $^{\circ}$ C to +50 $^{\circ}$ C                       |
| Weight in air, with cable:   | 3kg  |
| Cable: (length and type)     | 6m (optional 10m, 20m), neopren 2*1 (O.D. 9.6mm) - pigtail |
| Housing:                     | PVC  |

Please note that this product requires a minimum quantity per order



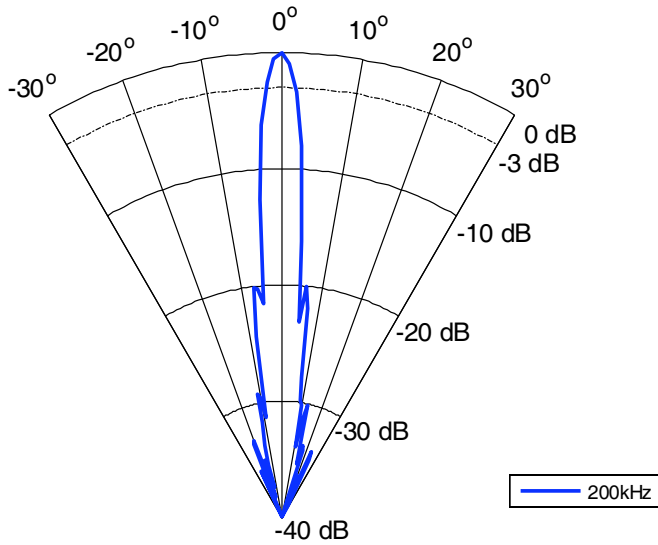




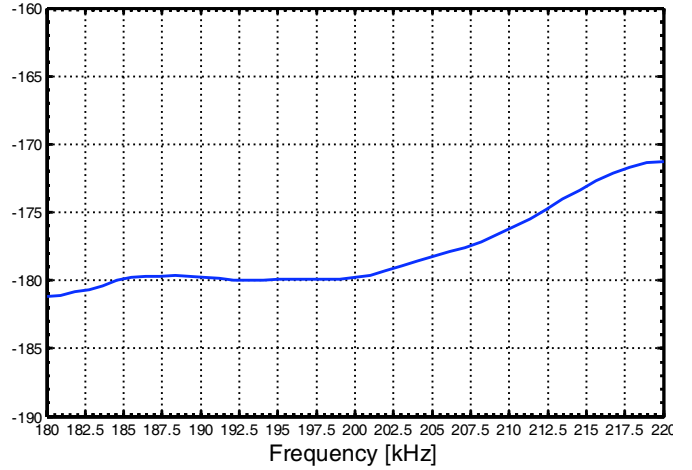
# Transducer TC2145

Survey Transducer Echosounder

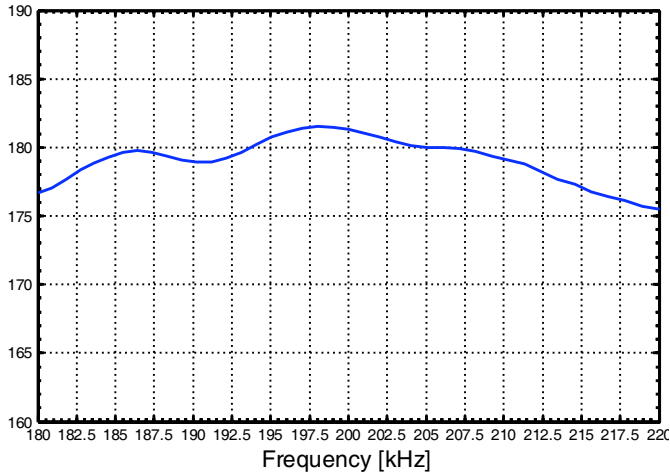
Horizontal Directivity Pattern



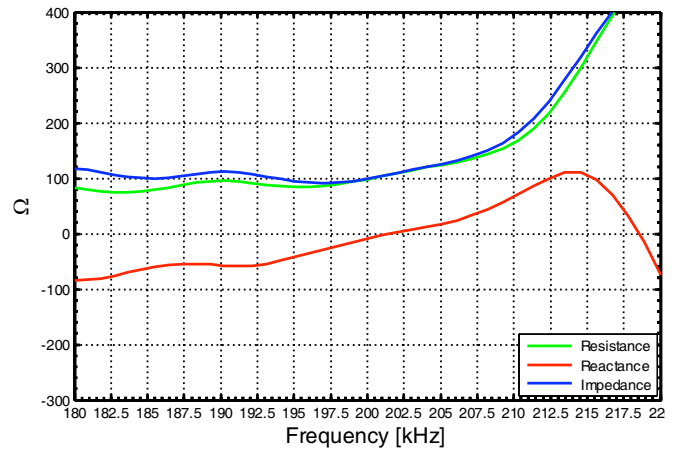
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



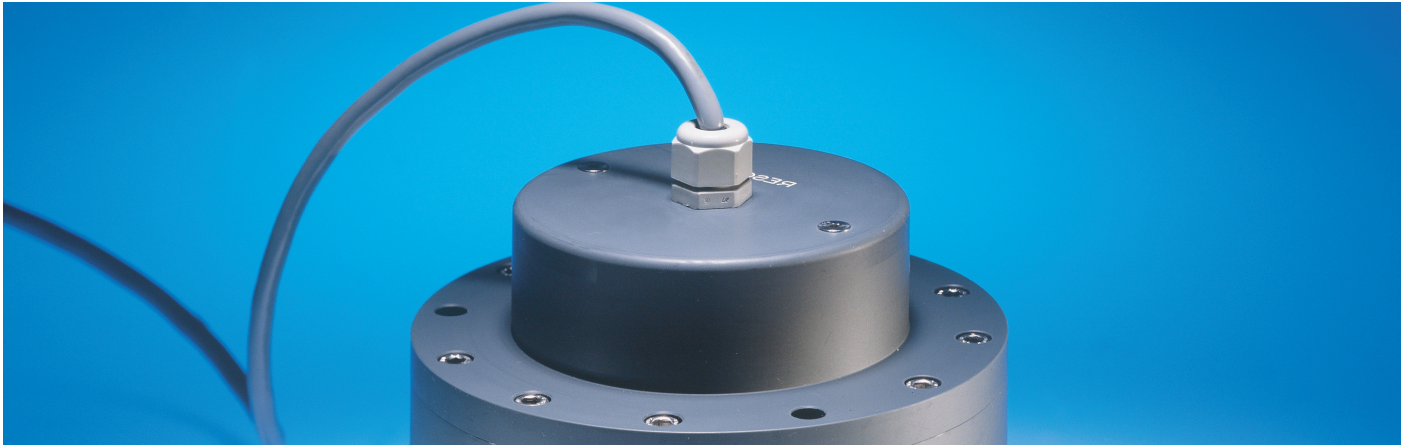
Impedance





# Transducer TC2149

Dual-Frequency Survey Echosounder



- 50kHz and 200kHz transducer
- Narrow beams
- Compact design
- Electrical compatible with almost all other 50kHz and 200kHz echosounders

## TC2149

Model TC2149 is a 50kHz and 200kHz dual frequency transducer is ideal for navigation and hydrographic echosounders.

The transducer has excellent piezoceramic elements, which will ensure the highest reliability and quality in echosounding.

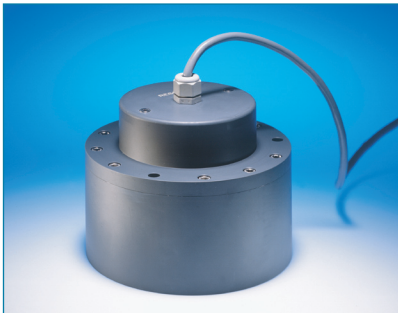
The transducer will fit:

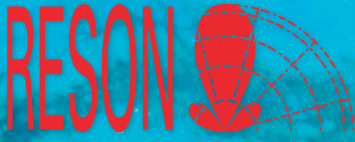
ATLAS SW 60/28/6029 housing and RESON steel housing.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 50kHz at $\pm 2$ kHz<br>200kHz at $\pm 5$ kHz   |
| Transmitting sensitivity:    | 172dB $\pm 3$ at 50kHz (re 1 $\mu$ Pa/V at 1m)<br>172dB $\pm 3$ at 200kHz (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -177dB $\pm 3$ at 50kHz (re 1V/ $\mu$ Pa)<br>-187dB $\pm 3$ at 200kHz (re 1V/ $\mu$ Pa)           |
| Impedance:                   | 80ohm $\pm 24$ ohm at 50kHz and 200kHz  |
| Beam width:                  | 13.9 $^{\circ}$ $\pm 2^{\circ}$ at 50kHz, 9 $^{\circ}$ $\pm 1^{\circ}$ at 200kHz                  |
| Beam shape:                  | Conical   |
| Max input power:             | 600W at 50kHz 450W at 200kHz (at 1% duty cycle)   |
| Operating depth:             | 30m   |
| Survival depth:              | 50m   |
| Operating temperature range: | -2 $^{\circ}$ C to + 35 $^{\circ}$ C  |
| Storage temperature range:   | -30 $^{\circ}$ C to + 50 $^{\circ}$ C   |
| Weight in air, with cable:   | 5kg   |
| Cable: (length and type)     | 33m Munflex 4*1 (O.D. 9mm) - pigtail  |
| Housing:                     | PVC   |

Please note that this product requires a minimum quantity per order

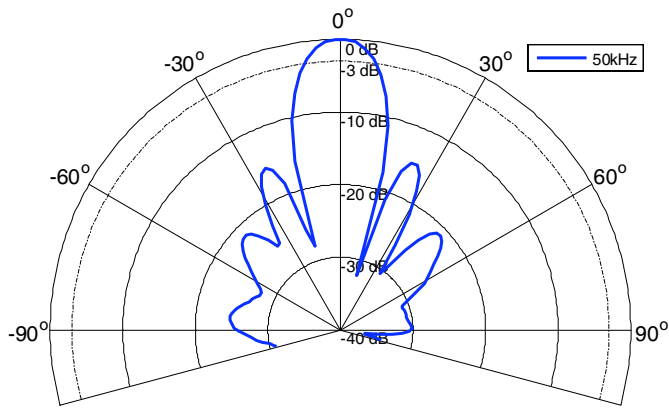




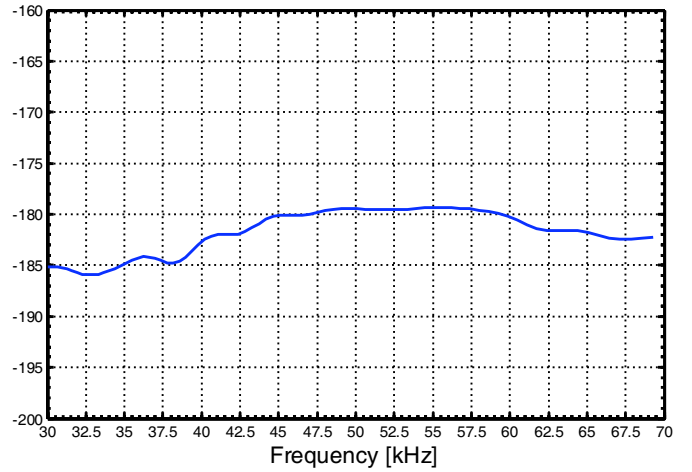
# Transducer TC2149

Dual-Frequency Survey Echosounder

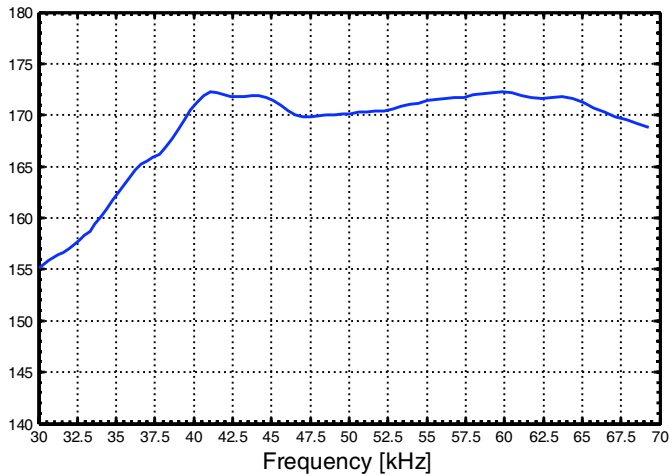
Horizontal Directivity Pattern



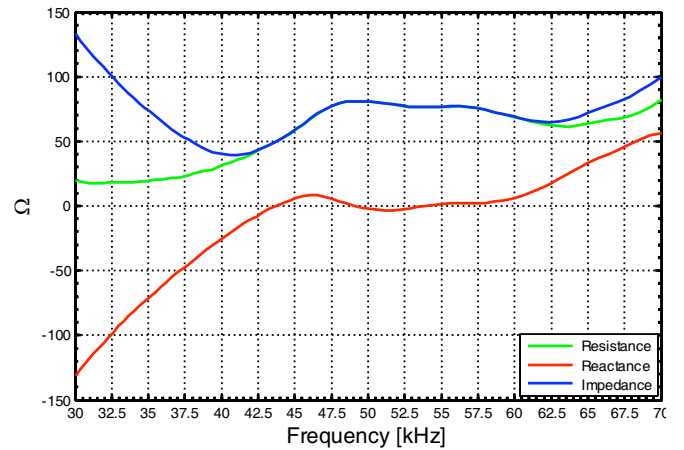
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance







# Transducer TC2150

## Dual-Frequency Survey Echosounder



### TC2150

- Broad-band transducer
- Echosounder application
- Can be operated in the frequency range from 50-80kHz

Universal high-power 66kHz transducer.

This transducer is ideal for navigation and hydrographic echosounders. The transducer has excellent piezoceramic elements, which ensure the highest reliability in quality echosounding. Compatible with Atlas SW6043.

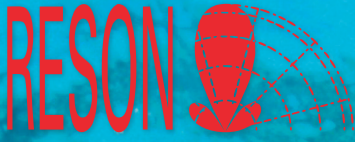
#### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 66kHz $\pm$ 2kHz                        |
| Transmitting sensitivity:    | 171dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -182dB $\pm$ 3dB (re 1V/ $\mu$ Pa)      |
| Impedance:                   | 100ohm $\pm$ 30ohm                      |
| Beam width:                  | 15° $\pm$ 2°                            |
| Beam shape:                  | Conical                                 |
| Max input power:             | 500W at 50kHz (at 1% duty cycle)        |
| Operating depth:             | 30m                                     |
| Survival depth:              | 40m                                     |
| Operating temperature range: | -2 to +35°Celsius                       |
| Storage temperature range:   | -30 to +50°Celsius                      |
| Weight in air,with cable:    | 6kg                                     |
| Cable: (length and type)     | 33m neopren 2*1 (O.D. 9.6mm) - pigtail  |
| Housing:                     | PVC                                     |

Please note that this product requires a minimum quantity per order



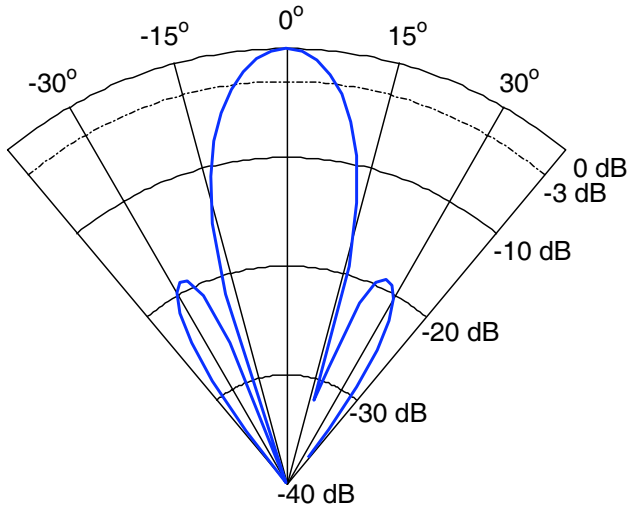




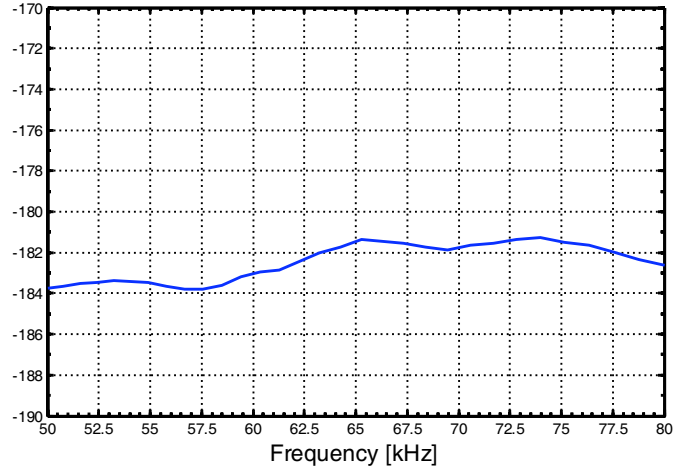
# Transducer TC2150

Dual-Frequency Survey Echosounder

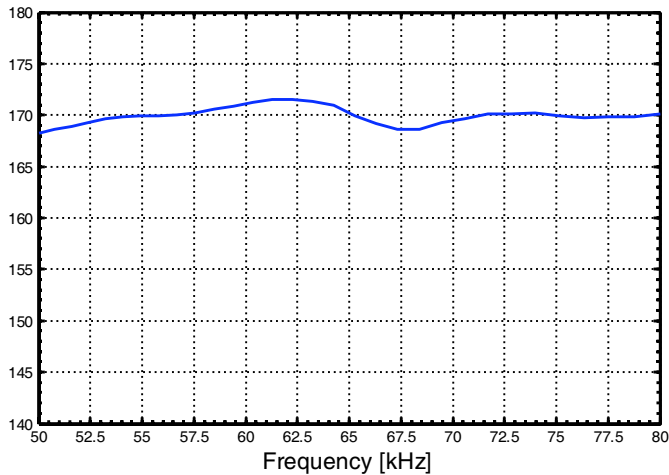
Horizontal Directivity Pattern



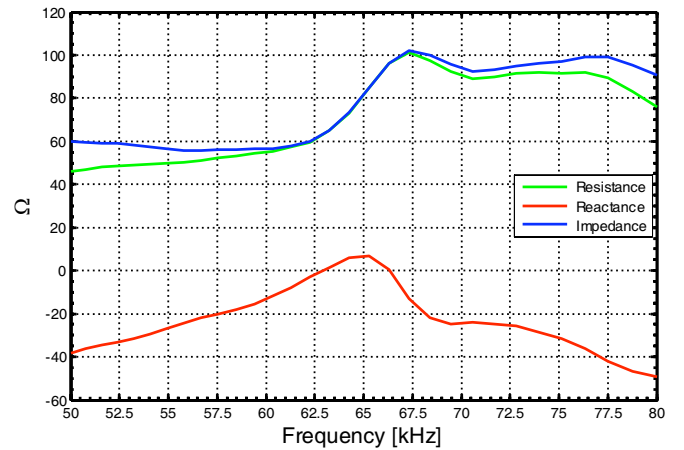
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



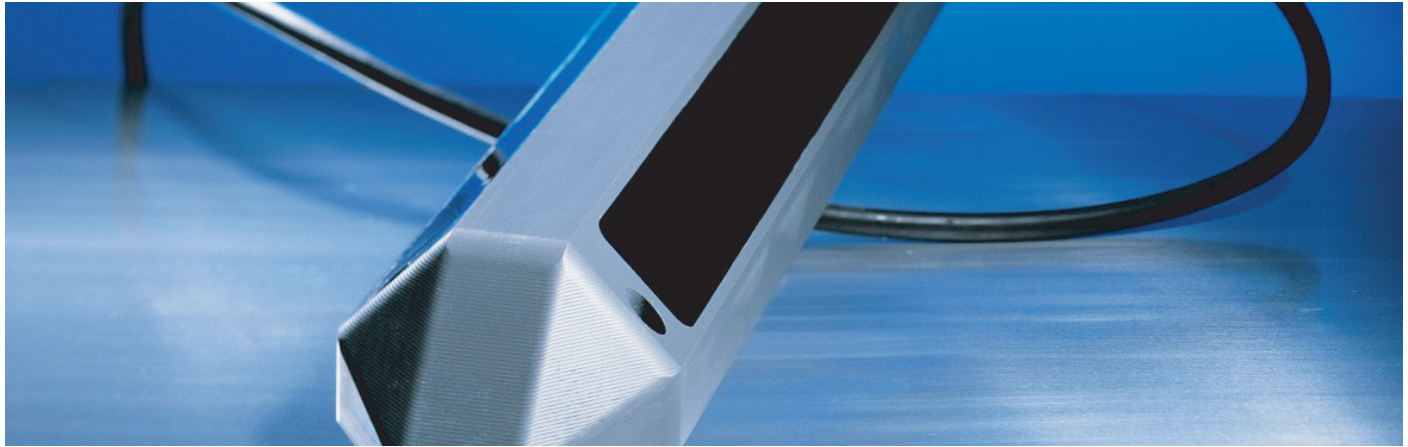
Impedance





# Transducer TC2166

Dual-sided side looking sonar transducer



- 200kHz transducer
- Excellent performance
- Robust piezo ceramic
- Electrical compatible with most echosounder systems

## TC2166

Model TC2166 is a dual-side 200kHz side looking sonar transducer ideal for seafloor mapping and checking, harbour investigations etc. The transducer is very easy to install and has good hydrodynamic properties because of its streamlined design.

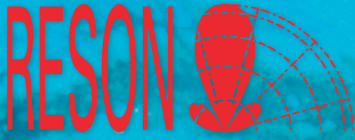
The transducer has excellent piezoceramic elements which will ensure the highest reliability and quality in acoustical performance. The along track beam width is very narrow. The across track coverage is wide with minimal overlap between the two beams and no disturbing side lobes.

The TC2166 is electrical compatible with most echosounder systems and can be used as “plug and play” with NaviSound echosounders.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 200kHz $\pm$ 3%                                   |
| Transmit Voltage Response:   | 171dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m)           |
| Open Circuit Response:       | -187dB $\pm$ 3dB (re 1V/ $\mu$ Pa)                |
| Impedance:                   | 100ohm $\pm$ 30ohm                                |
| Beam width, across track:    | 2 x 44° $\pm$ 4°(dualsided, 90° separation angle) |
| Beam width, along track:     | 1.1° $\pm$ 0.3°                                   |
| Max input power:             | 1000W (at 1% duty cycle)                          |
| Operating depth:             | 30m   |
| Survival depth:              | 50m   |
| Operating temperature range: | -2°C to +30°C                                     |
| Survival temperature range:  | -30°C to +50°C                                    |
| Weight in air, with cable:   | 9kg   |
| Cable: (length and type)     | 12m neopren 4*1 (O.D. 12.2mm) - pigtail           |
| Housing:                     | PVC   |

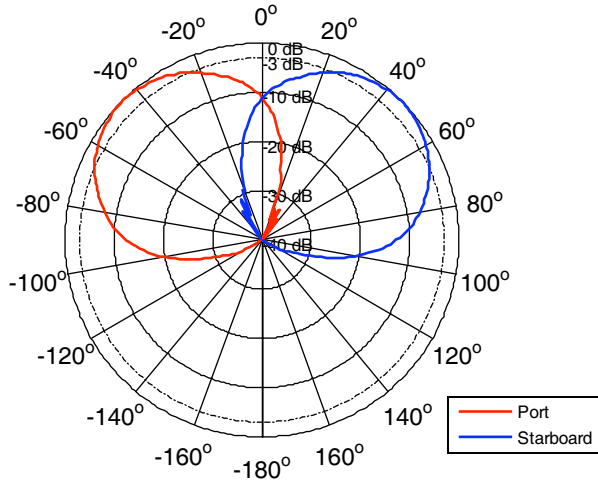




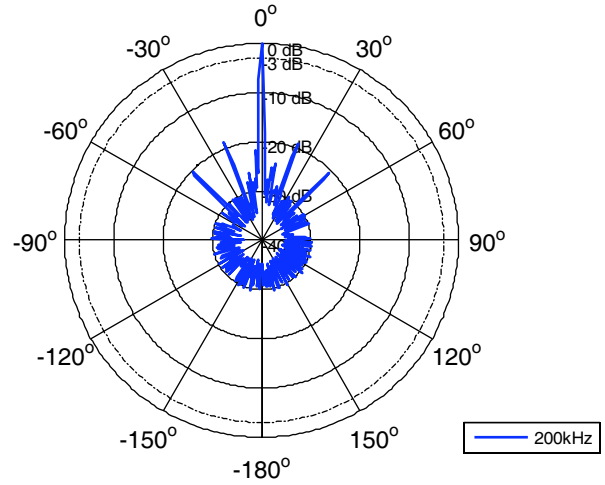
# Transducer TC2166

Dual-sided side looking sonar transducer

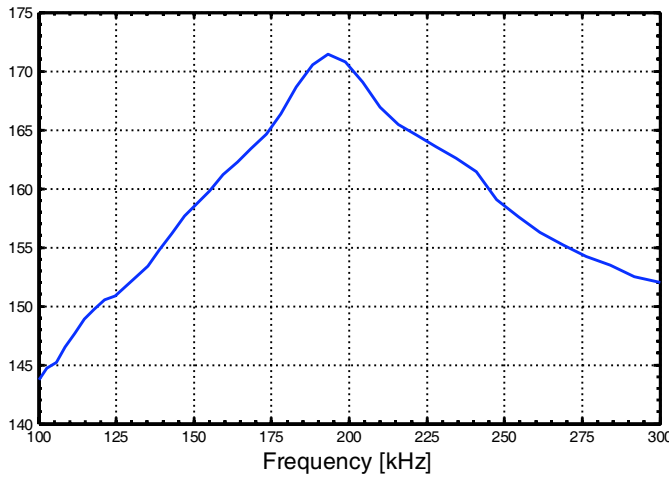
Across track directivity pattern



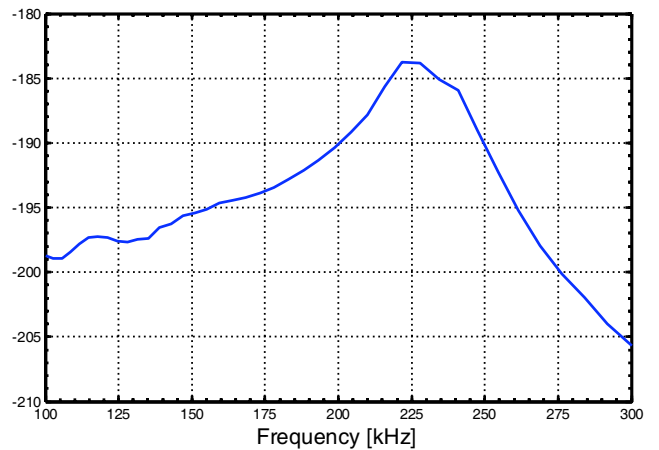
Along track directivity pattern



Transmit Voltage Response [dB re 1 $\mu$ Pa/V @ 1m]



Open Circuit Response [dB re 1V/ $\mu$ Pa @ 1m]







# Transducer TC2170

High performance transducer



- 12kHz transducer
- Excellent performance
- Robust piezo ceramic
- Electrical compatible with most echosounder systems

## TC2170

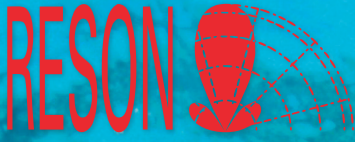
The TC2170 is a high performance transducer capable of handling up to 6000W. Because of the high performance it makes it possible to reach depth up to 6000m. The transducer has excellent piezo ceramic elements, which ensure the highest reliability in quality echo sounding. The TC2170 is electrical compatible with most echosounder systems and can be used as “plug and play” with NaviSound echosounders.

### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 12kHz $\pm$ 0.5kHz                      |
| Transmit Voltage Response:   | 170dB $\pm$ 3dB (re 1 $\mu$ Pa/V at 1m) |
| Open Circuit Response:       | -165dB $\pm$ 3dB (re 1V/ $\mu$ Pa)      |
| Impedance:                   | 100ohm $\pm$ 30ohm                      |
| Beam width, vertical:        | 17.5° $\pm$ 1°                          |
| Max input power:             | 6000W (at 1% duty cycle)                |
| Operating depth:             | 10m                                     |
| Survival depth:              | 25m                                     |
| Operating temperature range: | -2°C to +35°C                           |
| Survival temperature range:  | -30°C to +50°C                          |
| Weight in air, with cable:   | 80kg                                    |
| Cable: (length and type)     | 18m neopren 2*1 (O.D. 9.6mm) - pigtail  |
| Housing:                     | PUR                                     |



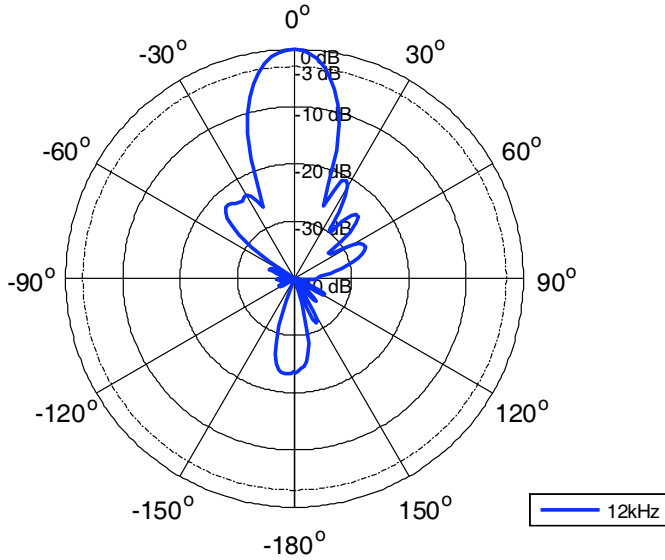




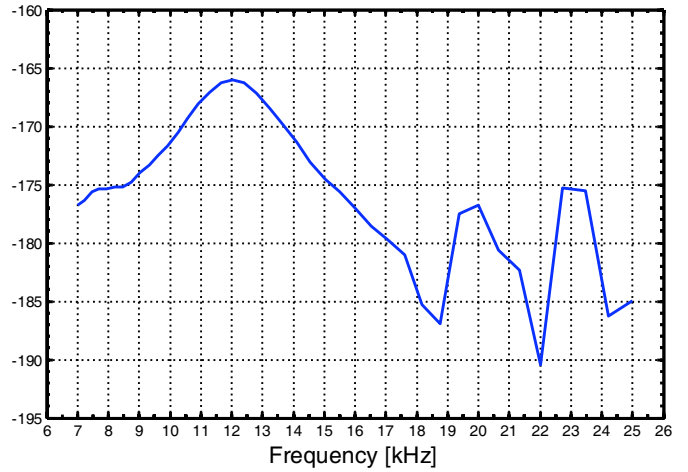
# Transducer TC2170

High performance transducer

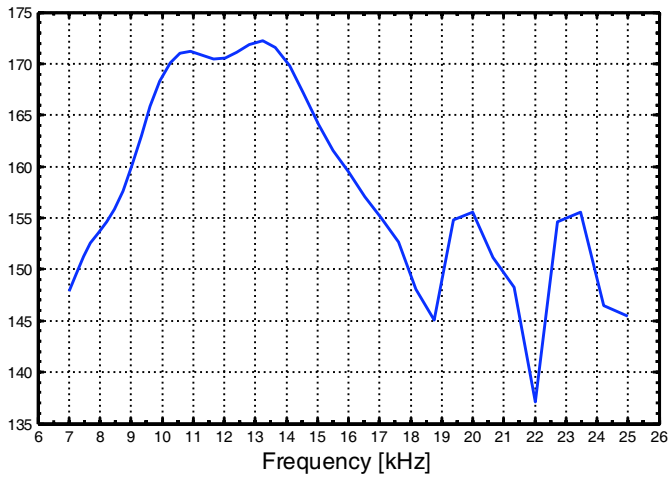
Vertical directivity pattern



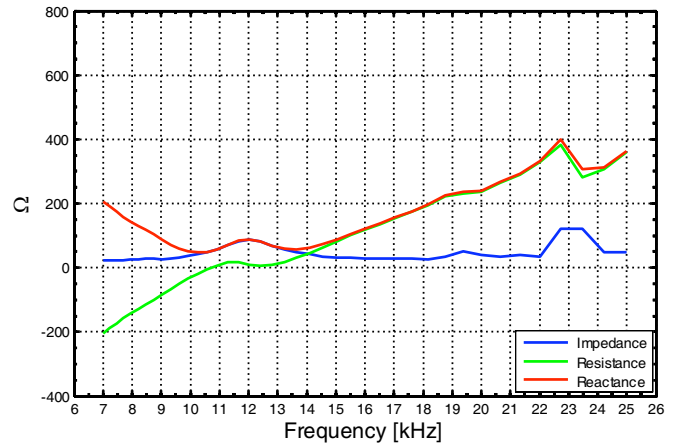
Open Circuit Response (OCR) [dB re 1V/μPa @ 1m]



Transmit Voltage Response [dB re 1μPa/V @ 1m]



Impedance





# Transducer TC2178

## Dual Frequency Transducer



- Hydrodynamic shape
- Narrow beams
- High acoustical performance
- Compact design
- Electrical compatible with most 33 kHz and 200 kHz echosounders.
- Can be mounted directly on outboard rig.

### TC2178

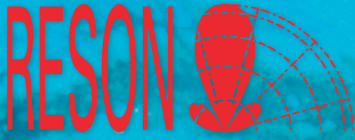
Model TC2178 is an optimized and hydrodynamic 33 kHz and 200 kHz dual frequency transducer ideal for navigation and hydrographic echo sounder systems.

The transducer has excellent piezoceramic elements which will ensure the highest reliability and quality in echosounding.

#### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 33kHz $\pm$ 2kHz<br>200kHz $\pm$ 5kHz   |
| Transmitting sensitivity:    | 168dB $\pm$ 3dB at 33kHz (re 1 $\mu$ Pa/V at 1m)<br>174dB $\pm$ 3dB at 200kHz (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -177dB $\pm$ 3dB at 33kHz (re 1V/ $\mu$ Pa)<br>-187dB $\pm$ 3dB at 200kHz (re 1V/ $\mu$ Pa)           |
| Impedance:                   | 80 ohm $\pm$ 24ohm at 33kHz and 200kHz  |
| Beam width:                  | 22 $^{\circ}$ $\pm$ 2 $^{\circ}$ at 33kHz<br>9.5 $^{\circ}$ $\pm$ 1 $^{\circ}$ at 200kHz              |
| Beam shape:                  | Conical   |
| Max input power:             | 1000W at 33kHz (at 1% duty cycle)<br>450W at 200kHz (at 1% duty cycle)                                |
| Operating depth:             | 30m   |
| Survival depth:              | 50m   |
| Operating temperature range: | -2 $^{\circ}$ C to +35 $^{\circ}$ C   |
| Storage temperature range:   | -30 $^{\circ}$ C to +50 $^{\circ}$ C  |
| Weight in air, with cable:   | 9.7kg   |
| Cable:                       | 18m, Munflex 4x1, pigtail   |
| Housing:                     | PVC   |



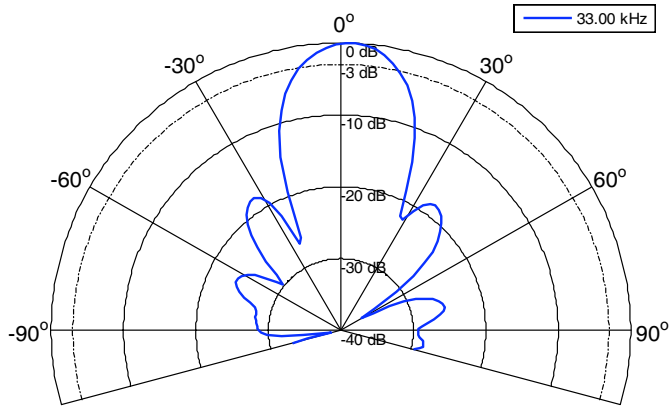


# Transducer TC2178

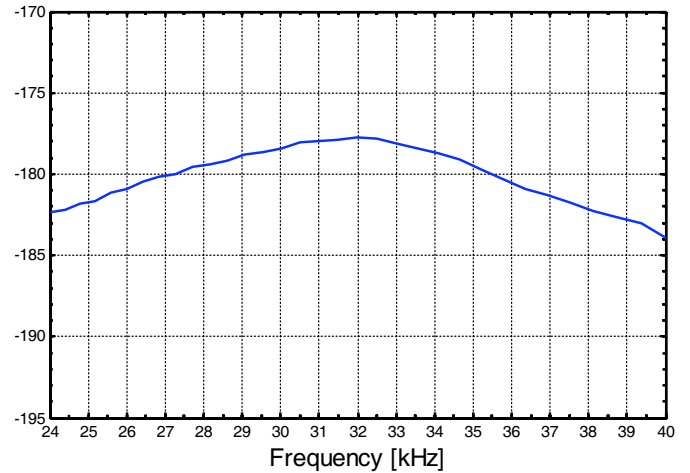
## Dual Frequency Transducer

Typical graphs 33kHz

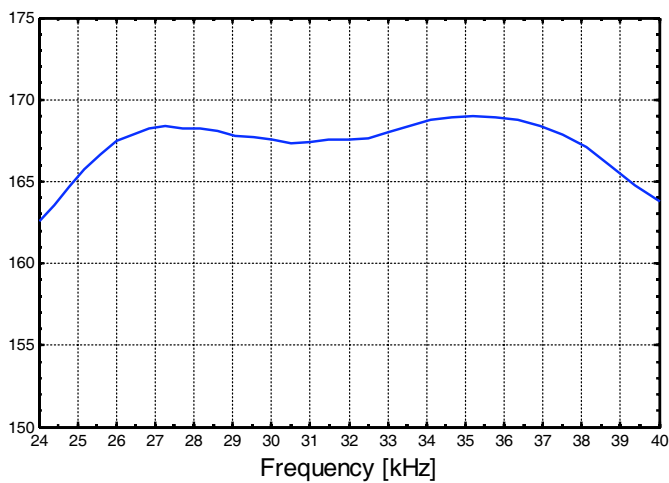
Vertical directivity pattern



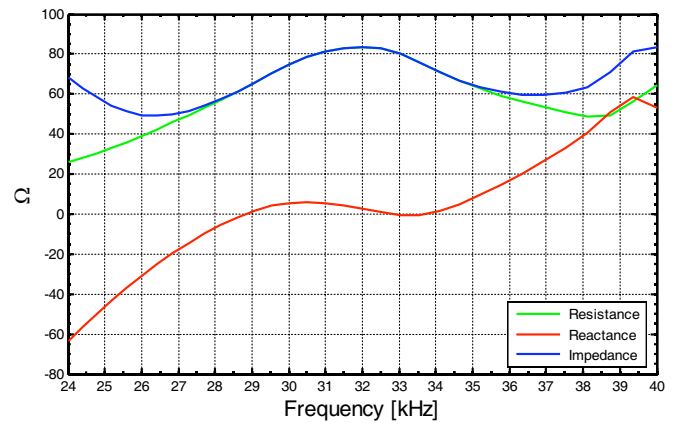
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance





# Transducer TC3021

Low Cost Universal 2MHz Transducer



- Depth rating 700m operating
- Extreme narrow beam width

## TC3021

Universal 2MHz transducer ideal for short range high precision sound velocity measurements.

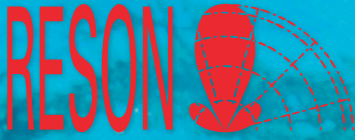
### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 2MHz  |
| Transmitting Sensitivity:    | 184dB $\pm$ 3dB at 2MHz (re $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -207dB $\pm$ 3dB at 2MHz (re V/ $\mu$ Pa)     |
| Impedance:                   | 23ohm $\pm$ 11ohm at 2MHz                     |
| Phase:                       | 0° $\pm$ 30° at 2MHz                          |
| Beam shape                   | Conical                                       |
| Beam width:                  | 2,2°  |
| Side lobe Suppression        | Better than -12dB                             |
| Max input power:             | 5W (1% duty cycle)                            |
| Operating depth:             | 700m  |
| Survival depth:              | 1000m   |
| Operating temperature range: | +2°C to +35°C                                 |
| Storage temperature range:   | -30°C to +50°C                                |
| Cable: (Length and type)     | 1.5m, Coax cable RG 174/u                     |
| Housing:                     | PVC – black                                   |
| Weight (air) incl. cable:    | 35g   |

Please note that this product requires a minimum quantity per order



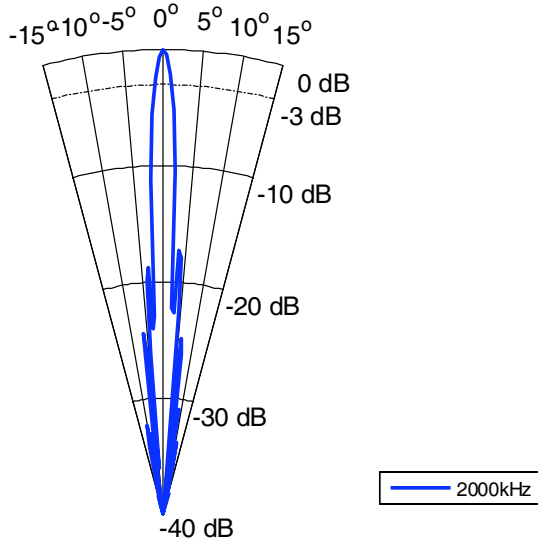




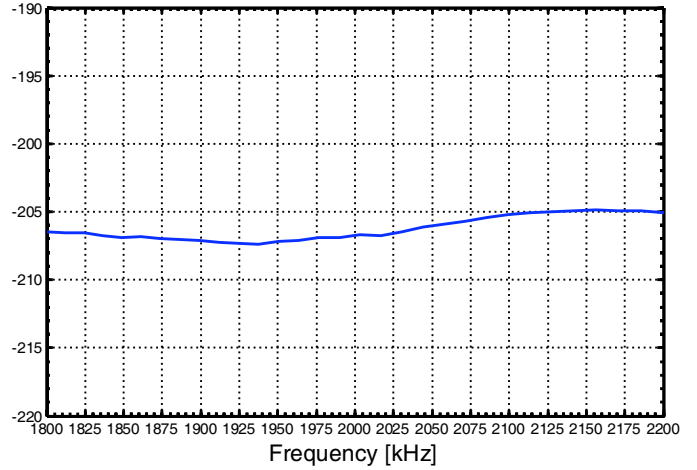
# Transducer TC3021

Low Cost Universal 2MHz Transducer

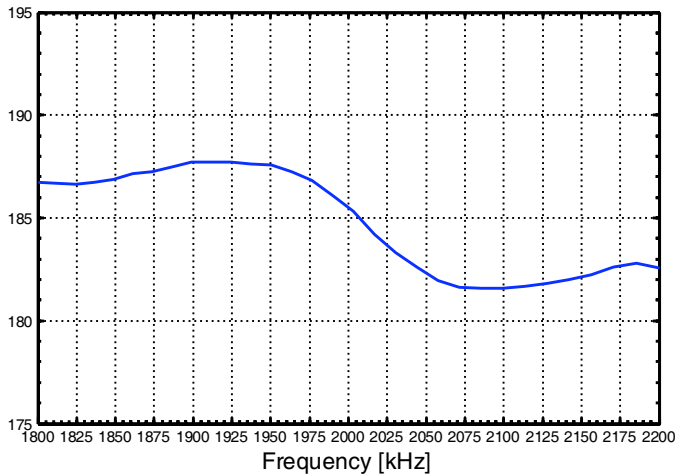
Horizontal directivity pattern



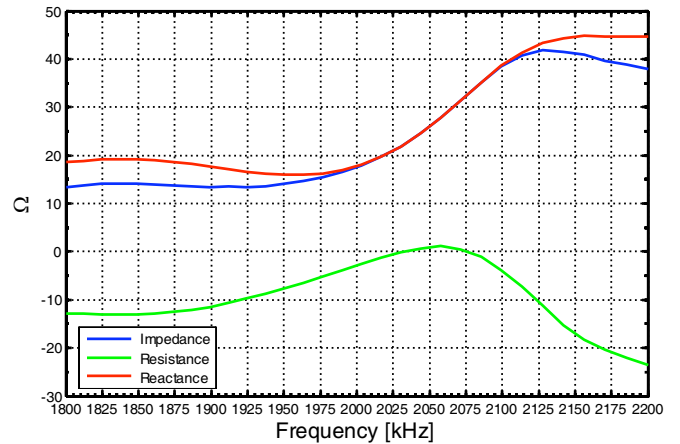
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance





# Transducer TC3027

Universal 1MHz Transducer



- Side lobe suppression better than -23dB
- Small compact housing
- Ideal for watertight installation, due two double o-ring seal.

## TC3027

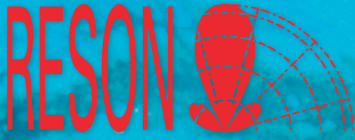
The TC3027 is a Universal 1MHz transducer ideal for sound velocity measurements and short range applications.

### TECHNICAL SPECIFICATIONS

|                                  |   |
|----------------------------------|---|
| Resonant Frequency:              | 1MHz  |
| Transmitting Sensitivity:        | 170dB $\pm$ 3dB at 1MHz (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:           | -201dB $\pm$ 3dB at 1MHz (re 1V/ $\mu$ Pa)      |
| Impedance:                       | 140ohm $\pm$ 30 % at 1MHz                       |
| Directivity Pattern:             | 5.8°  |
| Beam shape:                      | Conical   |
| Side lobe Suppression:           | Better than -23dB                               |
| Max input power: (1% duty cycle) | 10W   |
| Operating depth:                 | 500m  |
| Survival depth:                  | 800m  |
| Operating temperature range:     | -2°C to +50°C                                   |
| Storage temperature range:       | -30°C to +50°C                                  |
| Cable: (Length and type)         | 1.5m coax cable RG174/u, pigtail                |
| Housing:                         | PVC - black                                     |
| Weight (air) incl. cable:        | 40g   |

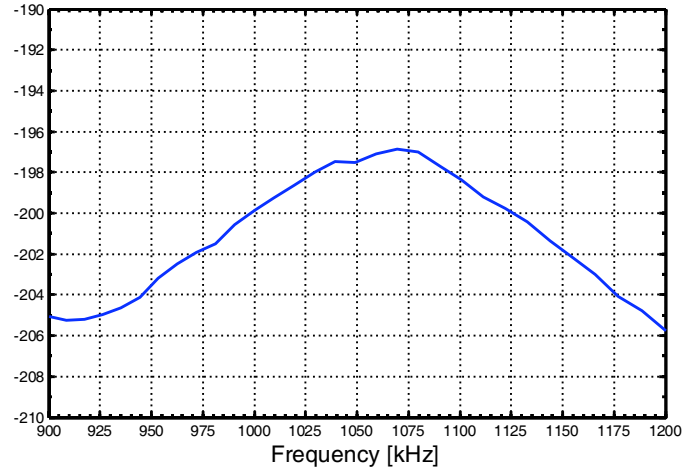
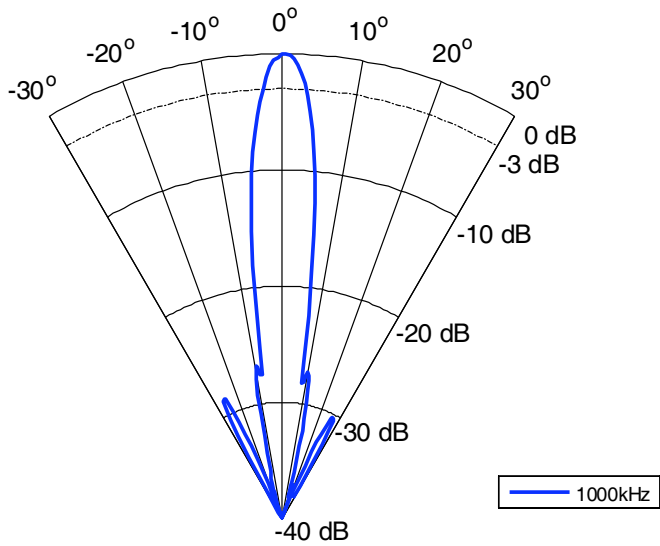
Please note that this product requires a minimum quantity per order



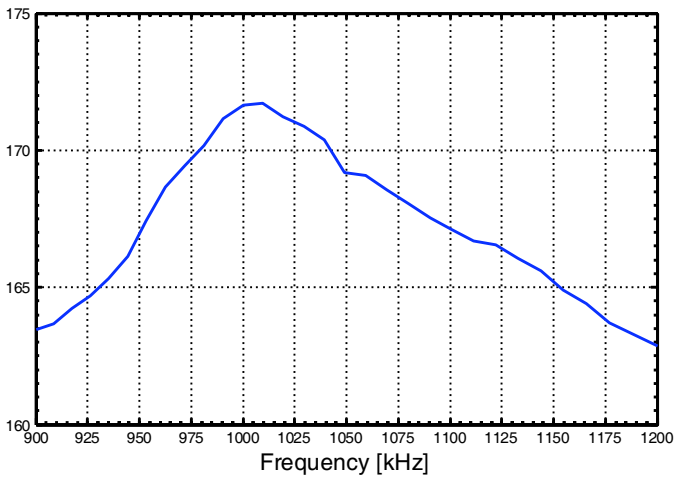


# Transducer TC3027

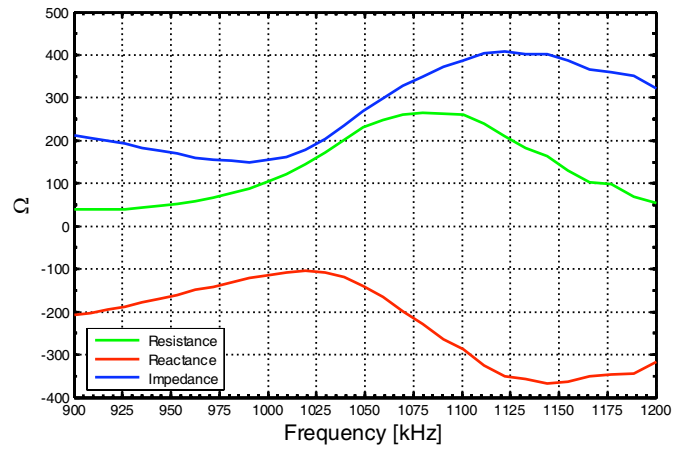
Universal 1MHz Transducer



Transmitting sensitivity



Impedance







# Transducer TC3029

Universal High Frequency Transducer



- **Small compact housing**
- **Ideal for watertight installation, due two double o-ring seal.**

## TC3029

The TC3029 is a universal 500kHz transducer ideal for high frequency measurements.

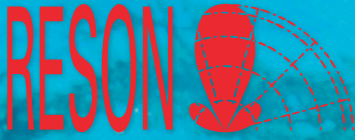
### TECHNICAL SPECIFICATIONS

|                              |   |
|------------------------------|---|
| Resonant Frequency:          | 500kHz  |
| Transmitting Sensitivity:    | 164dB $\pm$ 3dB at 500kHz (re 1 $\mu$ Pa/V at 1m) |
| Receiving Sensitivity:       | -193dB $\pm$ 3dB at 500kHz (re 1V/ $\mu$ Pa)      |
| Impedance:                   | 325ohm $\pm$ 45ohm at 500kHz                      |
| Beam width:                  | 11°   |
| Beam shape:                  | Conical   |
| Max input power:             | 5W (1% duty cycle)                                |
| Operating depth:             | 300m  |
| Survival depth:              | 500m  |
| Operating temperature range: | +2°C to +35°C                                     |
| Storage temperature range:   | -30°C to +50°C                                    |
| Cable: (Length and type)     | 1.5m Coaxial cable RG174/u, pigtail               |
| Housing:                     | PVC - black                                       |
| Weight (air) incl. cable:    | 45g   |

Please note that this product requires a minimum quantity per order



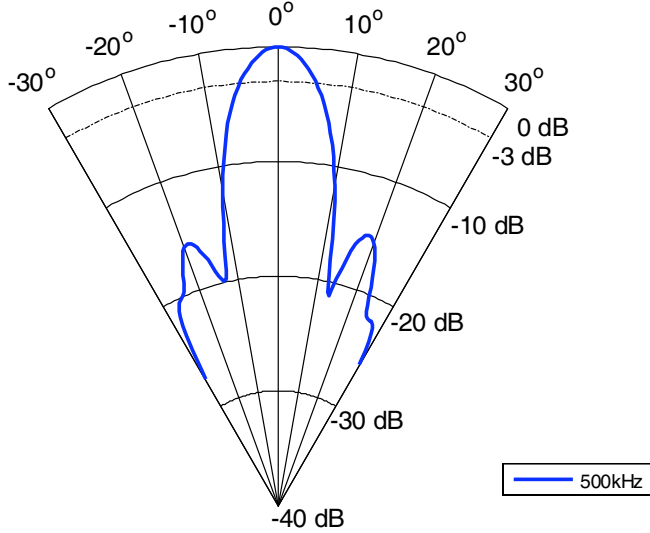




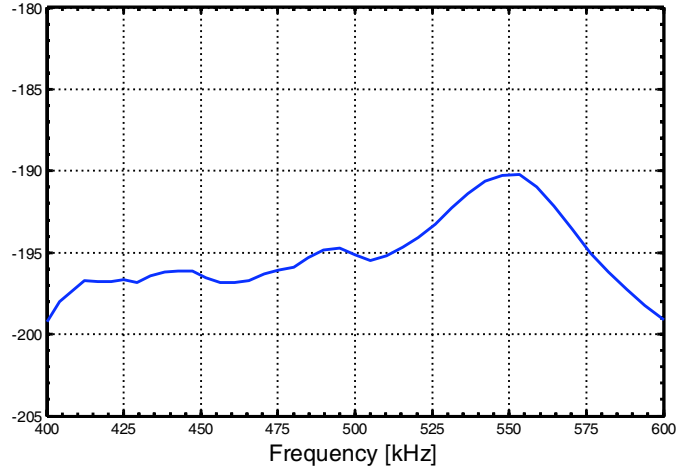
# Transducer TC3029

Universal High Frequency Transducer

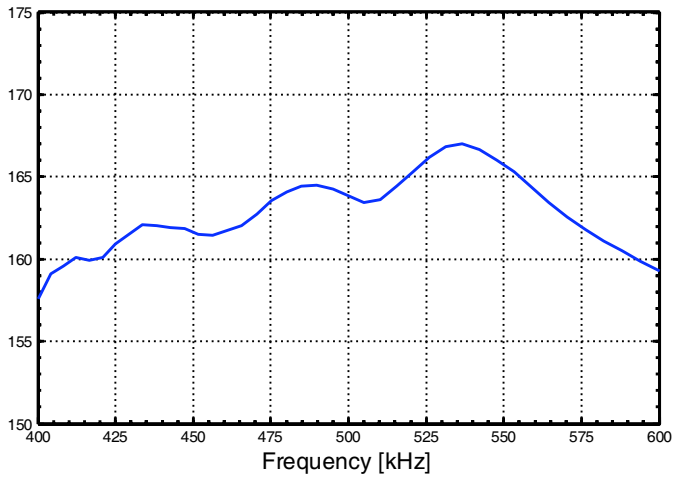
Horizontal directivity pattern



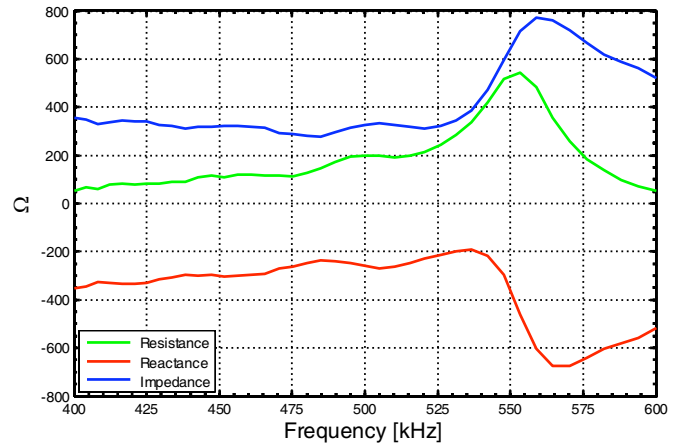
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



Impedance





# Hydrophone TC4013

Miniature Reference Hydrophone



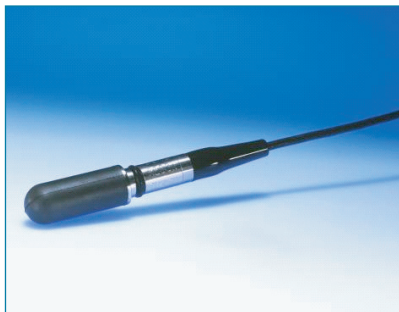
- High sensitivity
- Omnidirectional to high frequencies
- Broad banded
- O-ring sealed mounting
- Individually calibrated

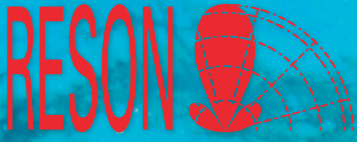
## TC4013

The TC4013 offers a usable frequency range of 1Hz to 170kHz and a high sensitivity relative to its size. It further-more provides uniform omnidirectional sensitivities in both horizontal and vertical planes up to high frequencies. The TC4013 is an excellent transducer for making absolute sound measurements and calibrations within a broad frequency range. It can also be applied as an omnidirectional reference projector. The overall characteristics makes TC4013 extremely applicable for laboratory as well as industrial uses.

### TECHNICAL SPECIFICATIONS

|                                 |  |
|---------------------------------|--|
| Usable Frequency range:         | 1Hz to 170kHz  |
| Receiving Sensitivity:          | -211dB $\pm$ 3dB re 1V/ $\mu$ Pa                               |
| Transmitting Sensitivity:       | 130dB $\pm$ 3dB re 1 $\mu$ Pa/V at 1m at 100kHz                |
| Horizontal Directivity Pattern: | Omnidirectional $\pm$ 2dB at 100kHz                            |
| Vertical Directivity Pattern:   | 270° $\pm$ 3dB at 100kHz                                       |
| Nominal capacitance:            | 3.4nF  |
| Operating depth:                | 700m   |
| Survival depth:                 | 1000m  |
| Operating temperature range:    | -2°C to +80°C  |
| Storage temperature range:      | -40°C to +80°C   |
| Weight (in air):                | 75g  |
| Cable length:                   | Standard length 6m Optional cable lengths available on request |

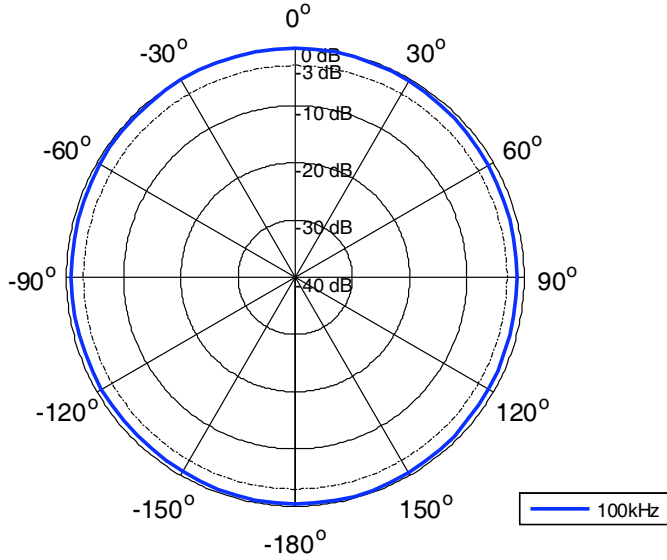




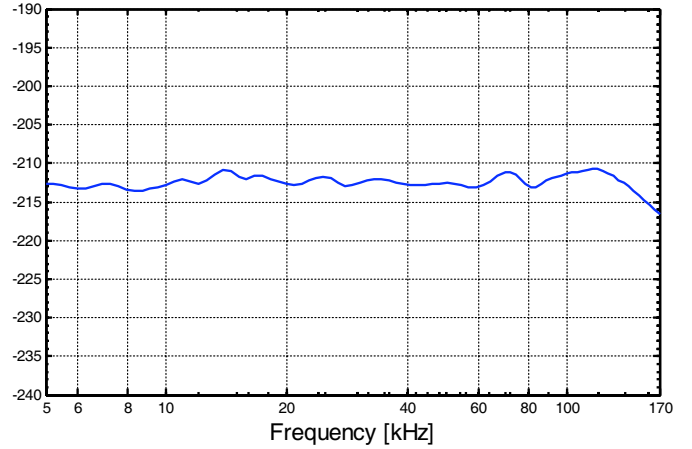
# Hydrophone TC4013

Miniature Reference Hydrophone

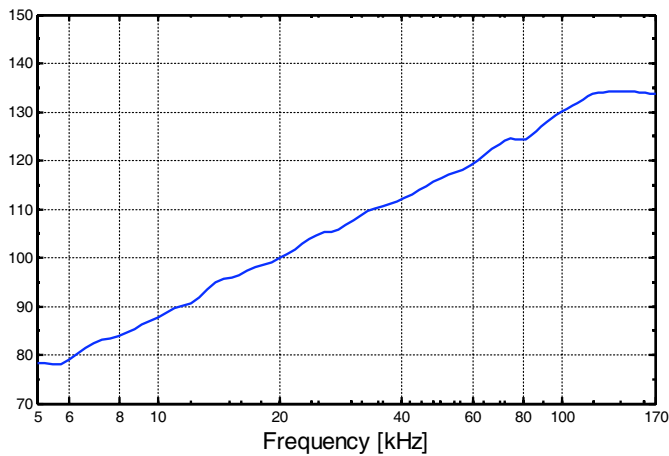
Horizontal directivity pattern



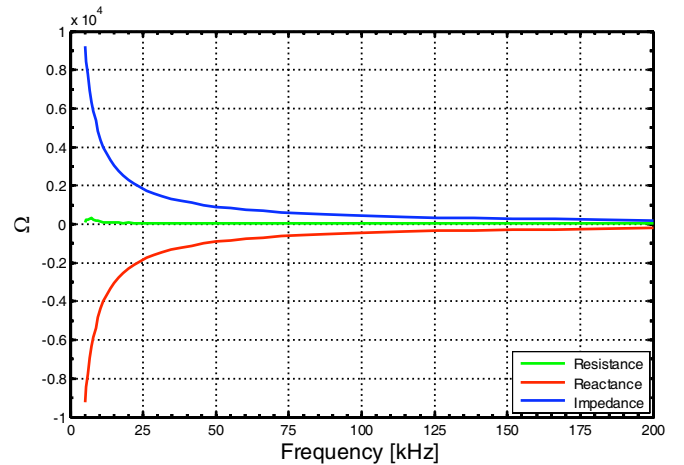
Receiving Sensitivity [dB re 1V/μPa @ 1m]



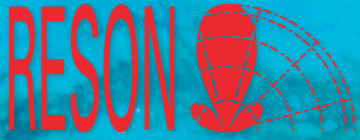
Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance

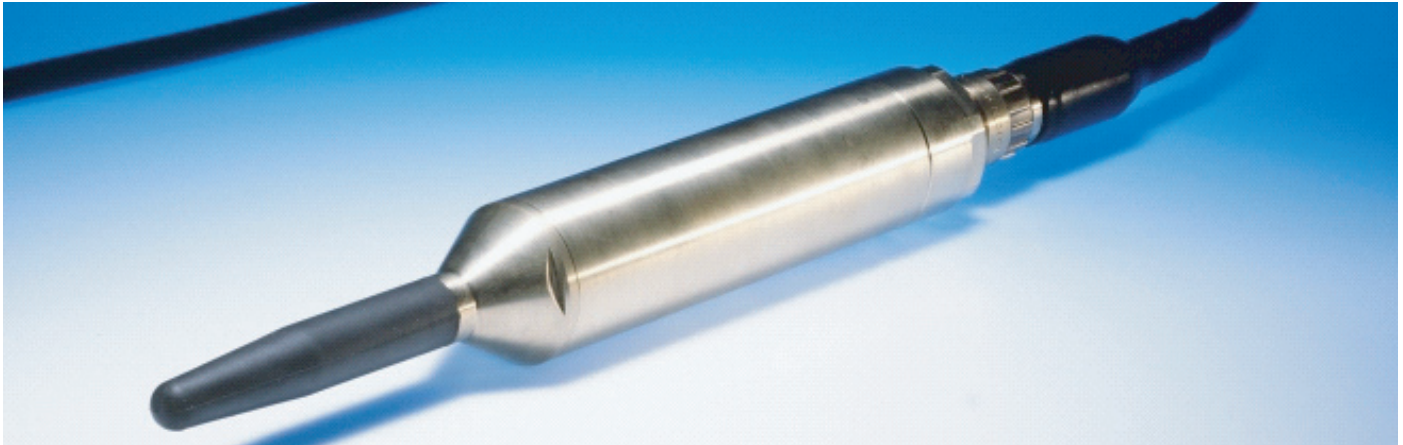






# Hydrophone TC4014

## Broad Band Spherical Hydrophone



### TC4014

- Wide usable frequency range
- Omnidirectional in all planes
- Built-in low noise preamplifier
- Long term stability
- Individually calibrated
- Available with differential output

The TC4014 broad band spherical hydrophone offers a very wide usable frequency range with excellent omnidirectional characteristics in all planes. The overall receiving characteristics makes the TC4014 an ideal transducer for making absolute underwater sound measurements up to 480kHz. The wide frequency range also makes the TC4014 perfect for calibration purposes, particularly in higher frequencies. The TC4014 incorporates a low-noise 26dB preamplifier providing signal conditioning for transmission over long underwater cables.

The TC4014 features an insert calibration facility, which allows for a reliable test of the hydrophone. The TC4014 is available with integrated SUBCON BGH MGP connector. Ask for TC4039.

The sensor element is permanently encapsulated in Special formulated NBR to ensure long term reliability. The rubber has been specially compounded to ensure acoustic impedance close to that of water. The hydrophone and connector housing are made of corrosion resistant aluminum-bronze.

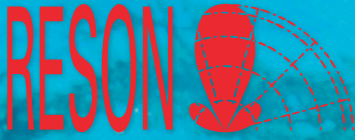
The TC4014 is also available in versions with differential output - the standard differential is TC4014-5. The differential output versions are an advantage where long cables are used in an electrically noisy environment.

#### TECHNICAL SPECIFICATIONS

|                               |   |
|-------------------------------|---|
| Usable Frequency range:       | 15Hz to 480kHz  |
| Linear Frequency range:       | 30Hz to 100kHz $\pm 2$ dB 25Hz to 250kHz $\pm 3$ dB                             |
| Receiving Sensitivity:        | -186dB $\pm 3$ dB re 1V/ $\mu$ Pa (TC4014-5: -180dB $\pm 3$ dB re 1V/ $\mu$ Pa) |
| Horizontal directivity:       | Omnidirectional $\pm 2$ dB at 100kHz  |
| Vertical directivity:         | 270° $\pm 2$ dB at 100kHz   |
| Operating depth:              | 900meter  |
| Survival depth:               | 1200meter   |
| Operating temperature range:  | -2°C to +55°C   |
| Storage temperature range:    | -40°C to +80°C  |
| Weight in (air):              | 650g without cable  |
| Max. output voltage:          | $\geq 2.8$ Vrms (at 12VDC)  |
| Preamplifier gain:            | 26dB  |
| Supply voltage:               | 12 to 24VDC   |
| High pass filter:             | 15Hz -3dB   |
| Calibration path attenuation: | at 10kHz 14dB   |
| Current consumption:          | <28mA at 12VDC <34 mA at 24VDC  |
| Max. output effect:           | 50mW  |







# Hydrophone TC4014

## Broad Band Spherical Hydrophone

### NBR means Nitrile Rubber

The NBR rubber is first of all resistant to sea and fresh water but also resistant to oil. It is limited resistant to petrol, limited resistant to most acids and will be destroyed by base, strong acids, halogenated hydrocarbons (carbon tetrachloride, trichloroethylene), nitro hydrocarbons (nitrobenzene, aniline), phosphate ester hydraulic fluids, Ketones (MEK, acetone), Ozone and automotive brake fluid.

### Documentation:

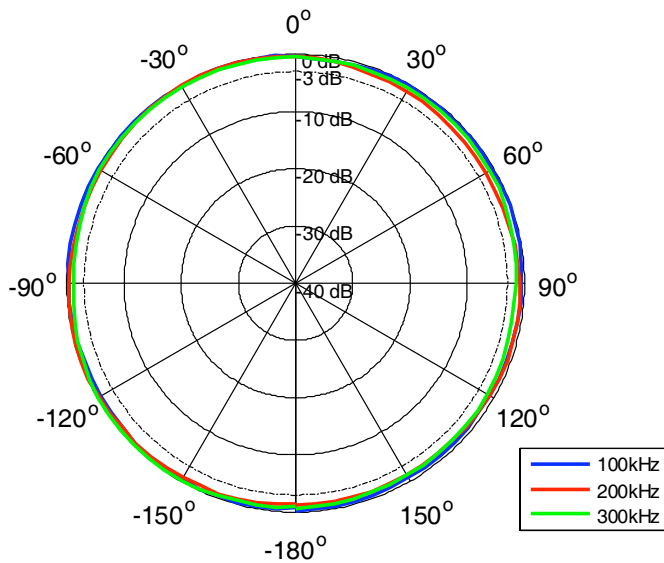
Receiving sensitivity: At 5 kHz to 500 kHz

Sensitivity at ref.: frequencies: 250 Hz

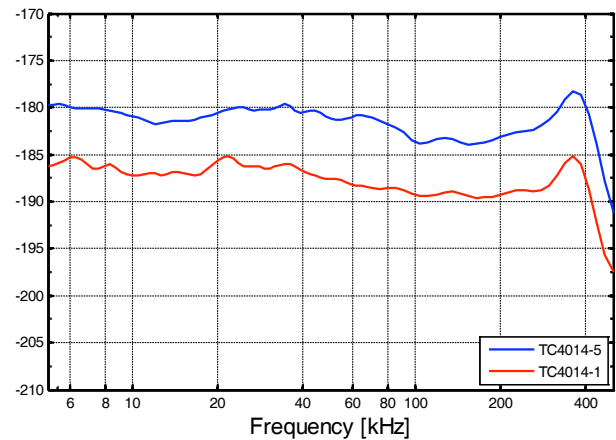
Horizontal directivity: At 100, 200, 300 kHz

Vertical directivity: At 100, 200, 300 kHz

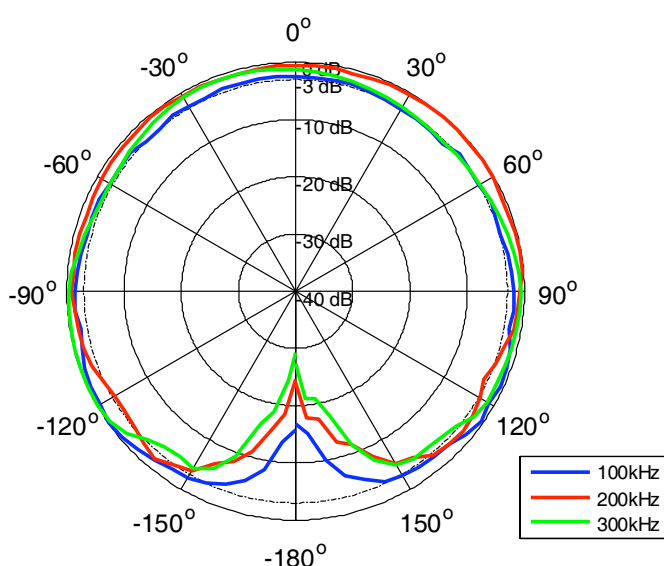
Horizontal directivity pattern



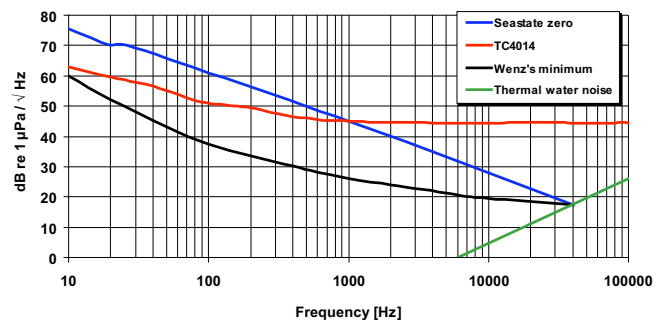
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Vertical directivity pattern



Typical equivalent noise pressure curve



Valid for all versions of TC4014



# Hydrophone TC4032

Low Noise Sea-State Zero Hydrophone



- Low noise performance
- High sensitivity
- Wide frequency range
- Flat frequency response
- Long term stability
- Individually calibrated

## TC4032

The TC4032 general purpose hydrophone offers a high sensitivity, low noise and a flat frequency response over a wide frequency range.

The high sensitivity and acoustic characteristics makes TC4032 capable of producing absolute sound measurements and detecting even very weak signals at levels below "Sea State 0".

The TC4032 incorporates an electrostatically shielded highly sensitive piezoelectric element connected to an integral low-noise 10dB preamplifier. The TC4032 preamplifier is capable of driving long cables of more than 1.000 meters, and the preamplifier features an insert calibration facility.

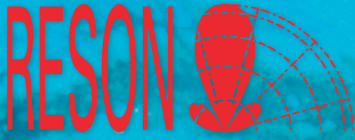
Per default the amplifier is provided with differential output. The differential output is an advantage where long cables are used in an electrically noisy environment. For use in single ended mode: Use positive output pin together with GND.

Versions with different filter characteristics are available: 4032-1 5Hz to 120 kHz, 4032-2 1Hz to 120 kHz and 4032-5 100Hz to 120 kHz.

### TECHNICAL SPECIFICATIONS

|                              |  |
|------------------------------|--|
| Usable Frequency range:      | 5Hz to 120kHz  |
| Linear Frequency range:      | 15Hz to 40kHz $\pm 2$ dB<br>10Hz to 80kHz $\pm 2.5$ dB |
| Receiving Sensitivity:       | -170dB re 1V/mPa (-164dB with differential output)     |
| Horizontal directivity:      | Omnidirectional $\pm 2$ dB at 100kHz                   |
| Vertical directivity:        | 270° $\pm 2$ dB at 15kHz                               |
| Operating depth:             | 600m   |
| Survival depth:              | 700m   |
| Operating temperature range: | -2°C to +55°C  |
| Storage temperature range:   | -30°C to +70°C   |
| Weight in Air:               | 720g without cable                                     |
| Preamplifier gain:           | 10dB   |
| Max. output voltage:         | 3.5Vrms at 12VDC                                       |
| Supply voltage:              | 12 to 24VDC  |
| High pass filter:            | 7Hz -3dB   |
| Quiescent supply current:    | $\leq 19$ mA at 12VDC<br>$\leq 22$ mA at 24VDC         |
| Encapsulating material:      | Special formulated NBR                                 |
| Housing material:            | Alu Bronze - AlCu10Ni5Fe4                              |





# Hydrophone TC4032

Low Noise Sea-State Zero Hydrophone

## NBR means Nitrile Rubber

The NBR rubber is first of all resistant to sea and fresh water but also resistant to oil. It is limited resistant to petrol, limited resistant to most acids and will be destroyed by base, strong acids, halogenated hydrocarbons (carbon tetrachloride, trichloroethylene), nitro hydrocarbons (nitrobenzene, aniline), phosphate ester hydraulic fluids, Ketones (MEK, acetone), Ozone and automotive brake fluid

## Documentation:

Individually calibration curves: 250 kHz

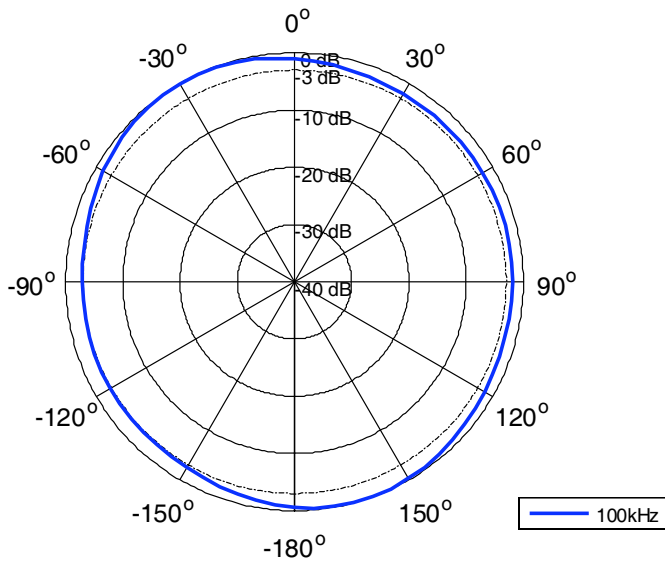
Receiving sensitivity: At 5 kHz to 100 kHz

Vertical directivity: At 15 kHz

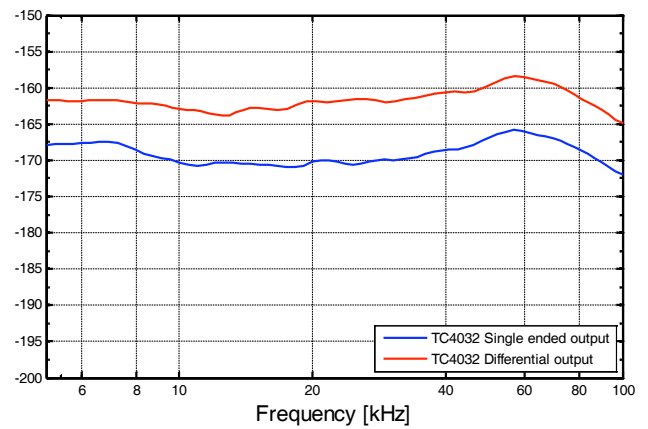
Sensitivity at ref.: frequencies: 250 kHz

Horizontal directivity: At 100 kHz

Horizontal directivity pattern

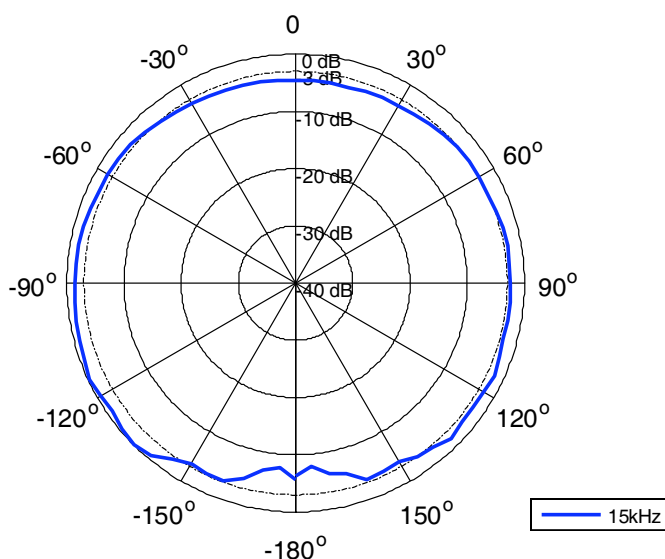


Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]

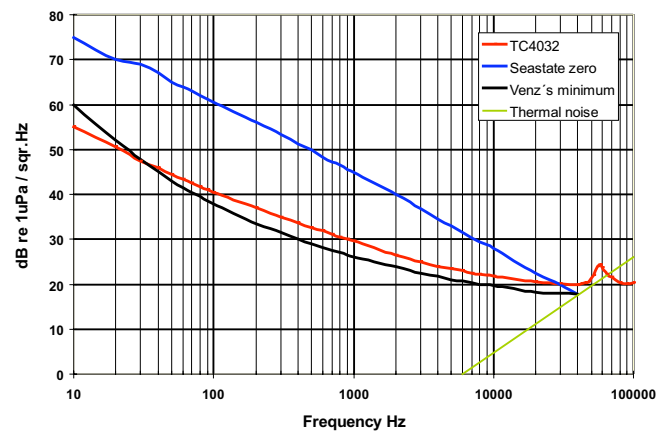


The OCR curve shown above is for single ended output

Vertical directivity pattern



Typical equivalent noise pressure curve



Valid for all versions of TC4032





# Hydrophone TC4033

## Robust Spherical Reference Hydrophone



- **Omnidirectional in the full frequency range**
- **Wide frequency range**
- **Durable construction**
- **Long term stability**
- **Individually calibrated**

### TC4033

The TC4033 provides uniform omnidirectional characteristics within the full frequency range of 1Hz to 140kHz.

The Typical sensitivity of  $-203\text{dB re } 1\text{V}/\mu\text{Pa}$  and the capacitance of  $7\text{nF}$ , ensure an excellent signal to noise ratio, thereby allowing TC4033 to be used with extension cables with only a limited reduction in sensitivity.

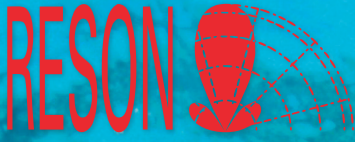
The TC4033 offers excellent acoustic characteristics and durability, which makes it ideal for a wide range of applications and for calibration purposes.

#### TECHNICAL SPECIFICATIONS

|                                   |   |
|-----------------------------------|---|
| Usable Frequency range:           | 1Hz to 140kHz   |
| Linear Frequency range:           | 1Hz to 80kHz  |
| Receiving Sensitivity:            | $-203\text{dB } \pm 2\text{dB re } 1\text{V}/\mu\text{Pa}$ at 250Hz                       |
| Transmitting Sensitivity:         | $144\text{dB } \pm 2\text{dB re } 1\mu\text{Pa/V}$ at 1m at 100kHz                        |
| Directivity, Horizontal:          | Omnidirectional $\pm 2\text{dB}$ at 100kHz  |
| Vertical Directivity:             | $270^\circ \pm 2\text{dB}$ at 100kHz  |
| Nominal Capacitance:              | $7,8\text{nF}$ (incl. 10m cable)  |
| Operating depth:                  | 900m  |
| Operating Temperature range:      | $-2^\circ\text{C}$ to $+80^\circ\text{C}$   |
| Storage Temperature range:        | $-40^\circ\text{C}$ to $+80^\circ\text{C}$  |
| Weight incl. 10m cable, (in air): | 1.5kg   |
| Cable (length and type):          | Standard 10m shielded pair DSS-2/MIL-C-915.<br>Optional cable length available on request |
| Connector type:                   | BNC   |
| Encapsulating material:           | Special formulated NBR  |
| Metal body:                       | Aluminum bronze<br>AlCu10Ni5Fe4   |







# Hydrophone TC4033

## Robust Spherical Reference Hydrophone

### Documentation:

Individually calibration curves:

Sensitivity at ref.: frequencies:  
250 kHz

Receiving sensitivity:  
At 5 kHz to 200 kHz

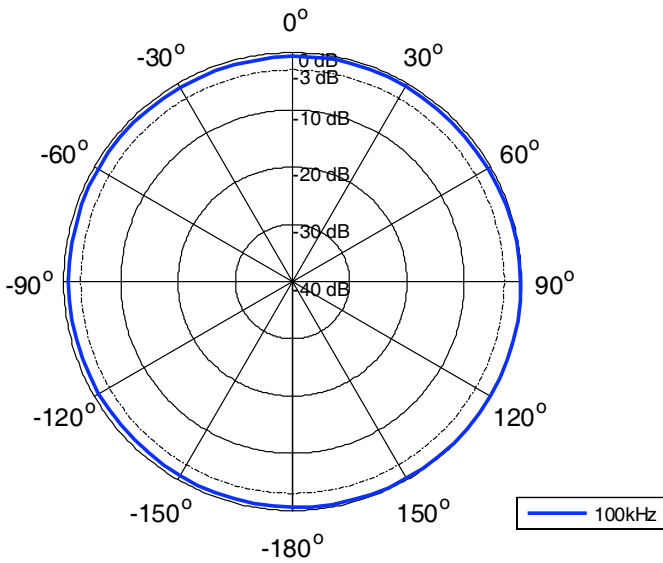
Impedance:  
5 kHz to 200kHz

Horizontal directivity:  
At 100 kHz

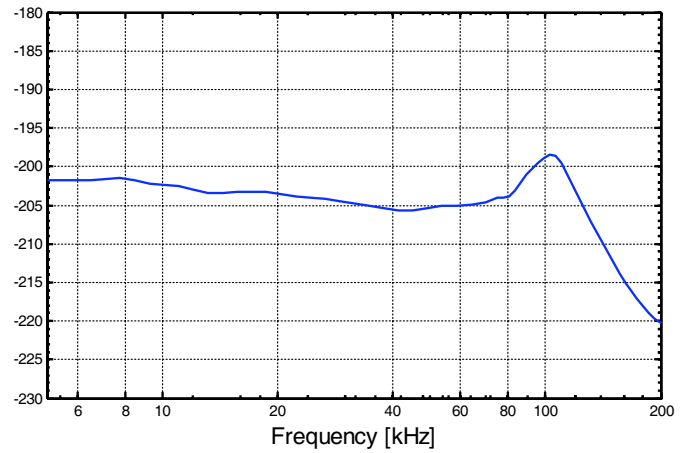
Vertical directivity:  
At 100 kHz

Transmitting sensitivity:  
5 kHz to 200 kHz

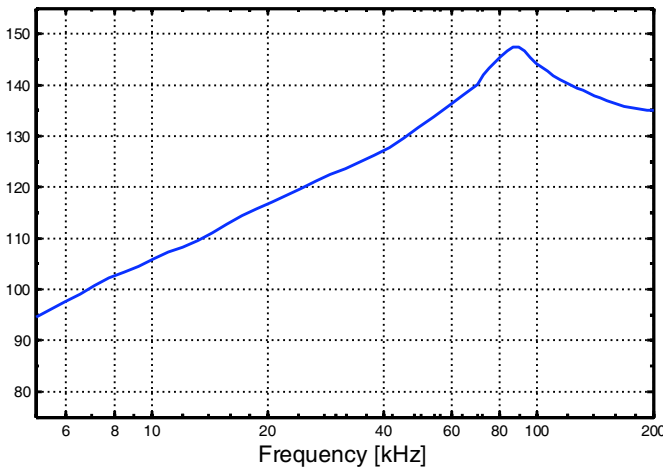
Horizontal directivity pattern



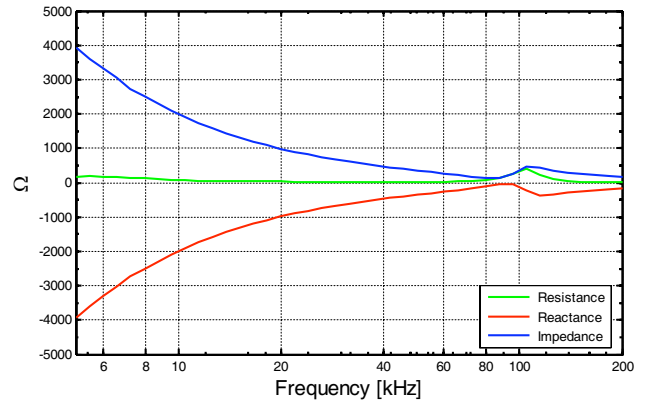
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



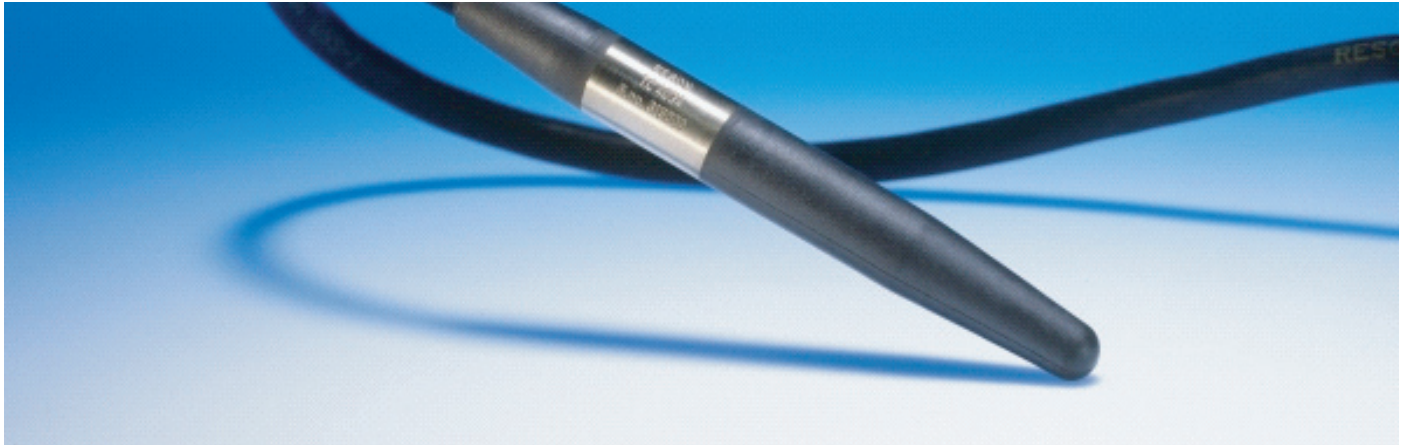
Impedance





# Hydrophone TC4034

Ultra Broad-band Spherical



- Omnidirectional in the full frequency range
- Long term stability
- Extreme Wide frequency range
- Durable construction
- Individually calibrated

## TC4034

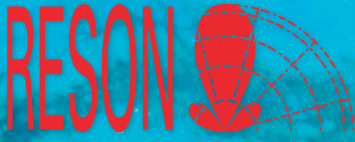
The TC4034 broad band spherical hydrophone provides uniform omnidirectional characteristics over a wide frequency range of 1Hz to 480kHz.

The overall receiving characteristics makes the TC4034 an ideal transducer for making absolute underwater sound measurements up to 480kHz. The wide frequency range also makes the TC4034 perfect for calibration purposes, particularly in higher frequencies.

### TECHNICAL SPECIFICATIONS

|  |   |
|--|---|
| Usable Frequency range:                  | 1Hz to 470kHz (+3, -10dB)   |
| Linear Frequency range:                  | 1Hz to 250kHz (+2, -4dB)  |
| Receiving Sensitivity: (re 1V/ $\mu$ Pa) | -218dB $\pm$ 3dB (at 250Hz)   |
| Horizontal directivity:                  | Omnidirectional $\pm$ 2dB (at 100kHz)   |
| Transmitting sensitivity:                | 122dB $\pm$ 3dB re 1 $\mu$ Pa/V at 1m at 100kHz   |
| Vertical directivity:                    | >270° $\pm$ 3dB (at 300kHz)   |
| Nominal Capacitance:                     | 3nF   |
| Operating Depth:                         | 900m  |
| Survival Depth:                          | 1000m   |
| Operating Temperature range:             | -2°C to +80°C   |
| Storage Temperature range:               | -40°C to +80°C  |
| Weight incl. cable,(in air):             | 1.6kg   |
| Cable (length and type):                 | Standard 10m shielded pair DSS-2MIL-C915.<br>Optional cable length available on request |
| Encapsulating Material:                  | Special formulated NBR  |
| Metal body:                              | Alu-bronze<br>AlCu10Ni5Fe4  |
| Connector type:                          | BNC   |





# Hydrophone TC4034

Ultra Broad-band Spherical

## Documentation:

Vertical directivity:  
At 250 kHz 100,200,300 kHz

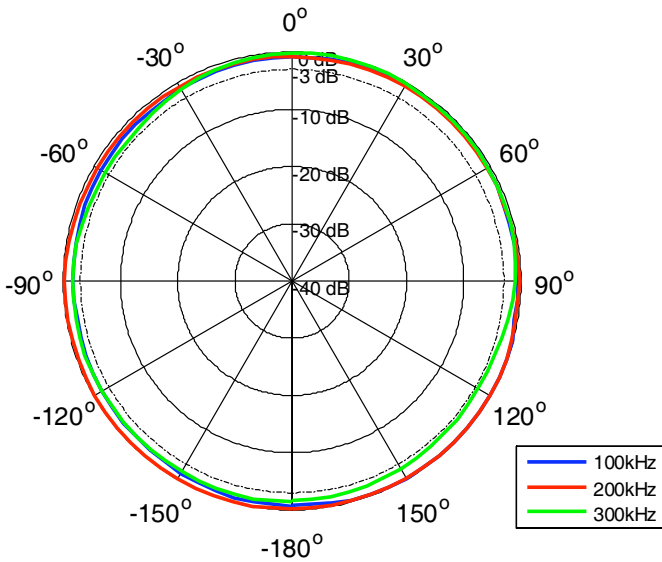
Receiving sensitivity:  
5 kHz to 500 kHz

Transmitting sensitivity:  
5 kHz to 500 kHz

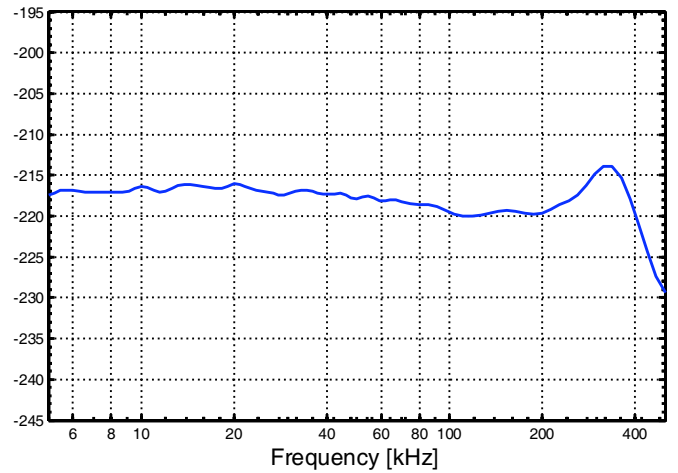
Horizontal directivity:  
At 100, 200, 300 kHz

Impedance:  
5 kHz to 500 kHz

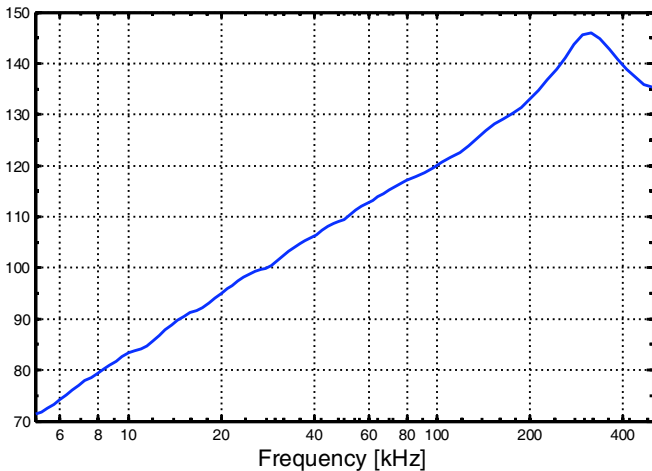
Horizontal directivity pattern



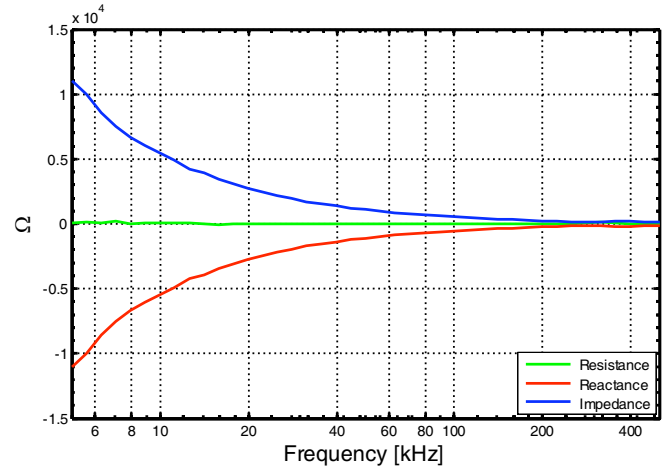
Receiving Sensitivity [dB re 1V/μPa @ 1m]



Transmitting Sensitivity [dB re 1μPa/V @ 1m]



Impedance

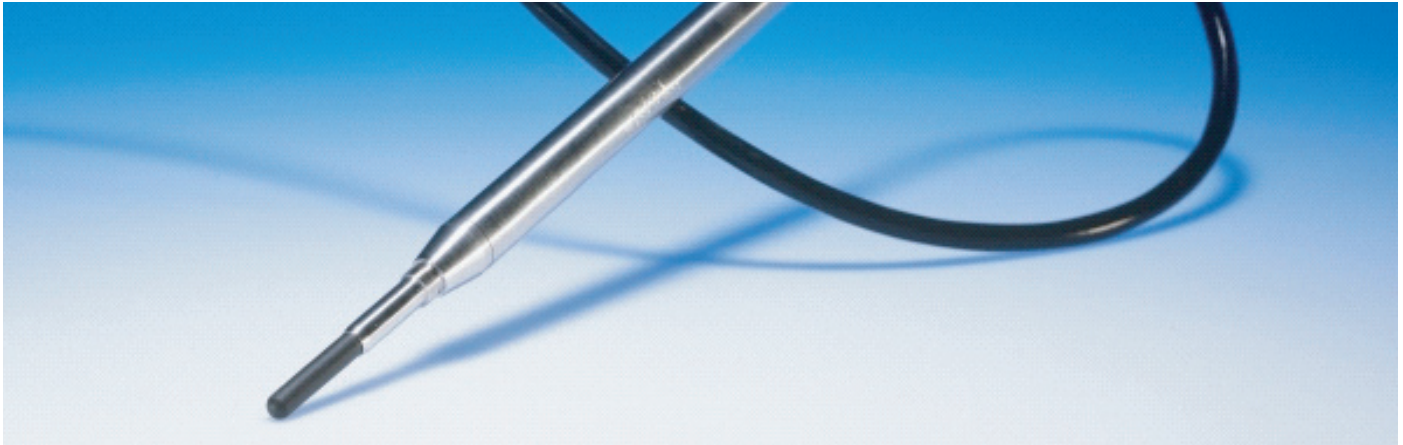






# Hydrophone TC4035

## Broad Band Miniature Probe Hydrophone



### TC4035

- Reference hydrophone for high frequencies
- Linear receiving response from 100kHz to 500kHz
- Long term stable sensitivity
- Individually calibrated
- Calibration as standard reference hydrophone traceable to national standards established at NPL

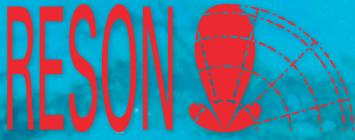
The TC4035 is a miniature probe hydrophone specifically designed as a standard reference hydrophone for sound measurements in the frequency range 100 to 500kHz. The hydrophone incorporates a 10dB low-noise pre-amplifier, which includes an insert calibration circuit for convenient electrical testing of the hydrophone condition. The pre-amp has a drive capability for cable length up to 25 meters.

The hydrophone offers a useable frequency range from 10 to 800kHz with good omnidirectional characteristics in the horizontal and the vertical plane.

#### TECHNICAL SPECIFICATIONS

|                                |   |
|--------------------------------|---|
| Receiving Sensitivity Typical: | -214dB $\pm$ 2dB re 1V/ $\mu$ Pa (at 100kHz)                                  |
| Linear Frequency Range:        | 100kHz to 500kHz $\pm$ 3dB  |
| Usable Frequency Range:        | 10kHz to 800kHz   |
| Horizontal Directivity:        | Omnidirectional $\pm$ 2dB (at 250kHz)   |
| Vertical Directivity:          | 60° to 120° $\pm$ 3dB (at 250kHz)   |
| Operating Pressure:            | 300m  |
| Survival Pressure              | 400m  |
| Max. Sound Pressure:           | -4dB distortion level 210dB re 1 $\mu$ Pa at 12V supply                       |
| Equivalent noise:              | 80dB re 1 $\mu$ Pa ( $\sqrt{H}$ at 1 kHz)                                     |
| Weight (in air):               | 410 grams (LEMO receptacle incl.)   |
| Max. Output Voltage :          | 1Vrms at 12VDC<br>2Vrms at 24VDC  |
| Operating Temperature Range:   | -2°C to +40°C   |
| Storage Temperature Range:     | -30°C to +50°C  |
| Supply Voltage:                | 10VDC to 24VDC  |
| Preamplifier Gain:             | 10dB  |
| Output Drive Capability:       | 25m cable at 1M Ohm input   |
| Insert cal. attenuation:       | -30dB   |
| Quiescent Current:             | 15mA at 12VDC<br>20.5mA at 18VDC  |
| Housing Material:              | Stainless Steel AISI 316  |
| Cable:                         | Standard 10m 4 cond.+ shielded<br>Optional cable lengths available on request |
| Connector:                     | LEMO Series E four-pole watertight  |





# Hydrophone TC4035

Broad Band Miniature Probe Hydrophone

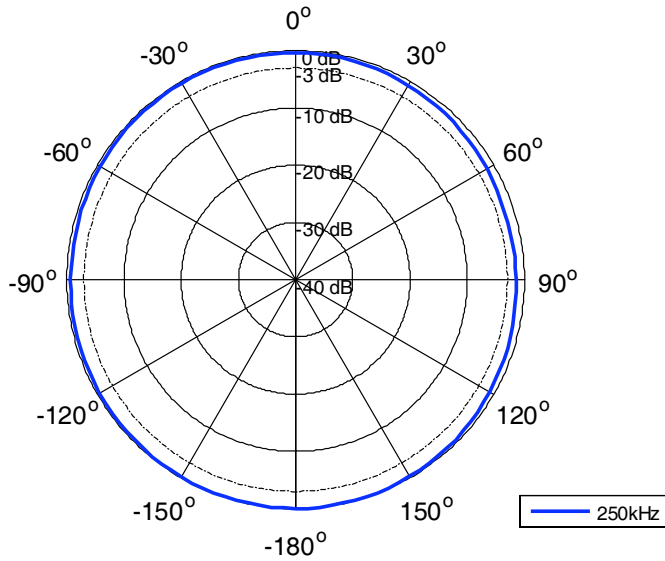
## Documentation:

Horizontal directivity:  
At 250 kHz

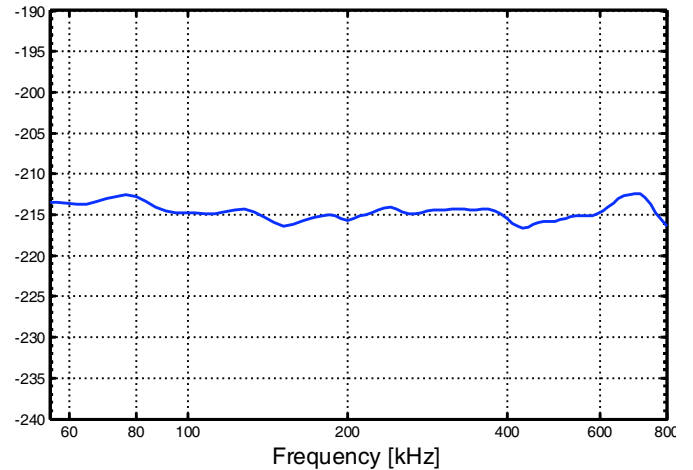
Receiving sensitivity:  
50 kHz to 800 kHz

Vertical directivity:  
At 250 kHz

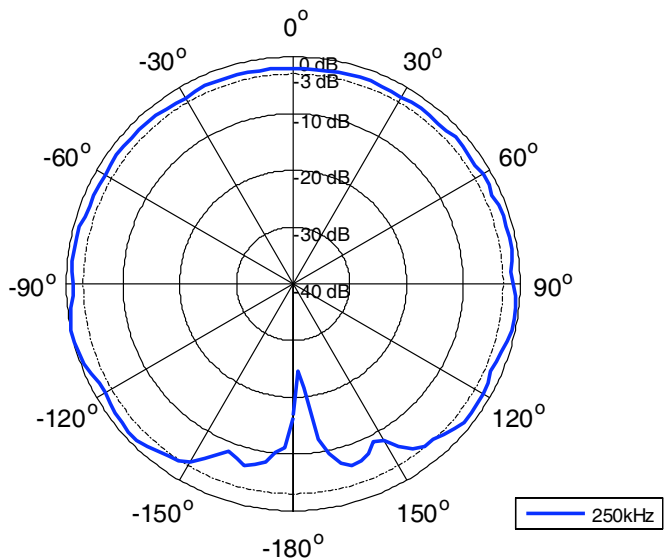
Horizontal directivity pattern



Receiving Sensitivity [dB re 1V/μPa @ 1m]



Vertical directivity pattern



### Accessories included: LEMO fixed socket no. ERA.1E.304.CNL

The TC4035 is a high quality hydrophone designed for use as a transfer standard hydrophone. The sensor element has excellent stability over time, - which ensure reliable sensitivity over long periods.

**Connecting the TC4035:** The TC4035 is supplied with a 4-pole LEMO plug and a receptacle for individual panel mounting.

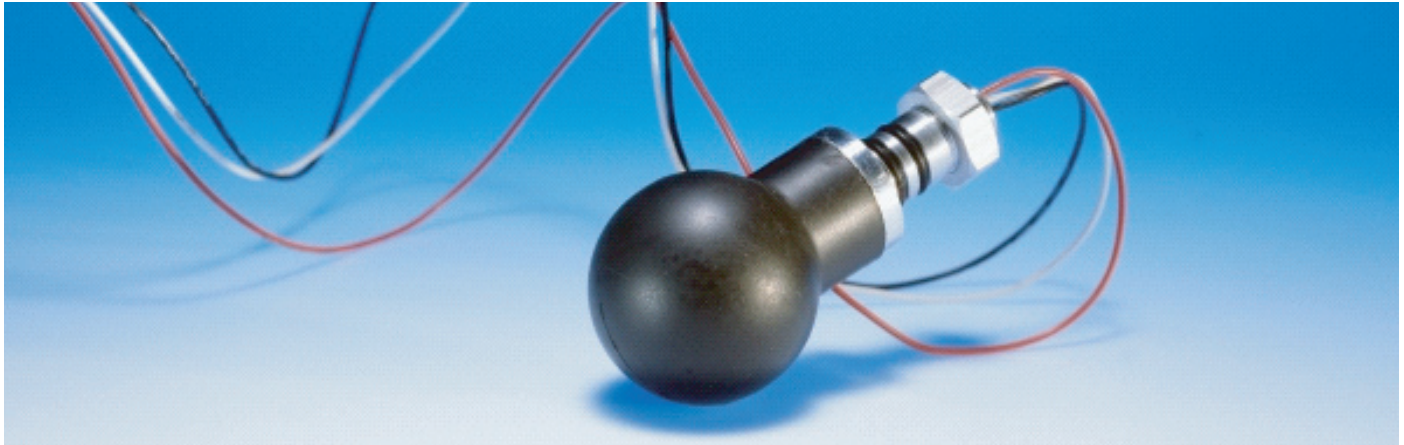
The EC6073 input module is a universal junction unit for connections of hydrophones. The TC6073 is equipped with the connectors required for: input output, voltage supply and insert calibration signal.

**Insert voltage calibration:** The insert calibration is an electrical simulation of a signal received from the acoustic sensor element.

Injecting a signal to the calibration line input performs insert calibration. The responding signal received on the hydrophone output terminal is attenuated -30 dB typical.

The recommended max. insert voltage signal for TC4035 is 2 Vpp.

**WARNING!** Exceeding the recommended calibration voltage may cause damage to the calibration resistor.



- High receiving voltage sensitivity
- Differential signal output
- Wide useable frequency
- Long term stability
- Omnidirectional in all planes
- Resistant to high static pressure
- Individually calibrated

## TC4037

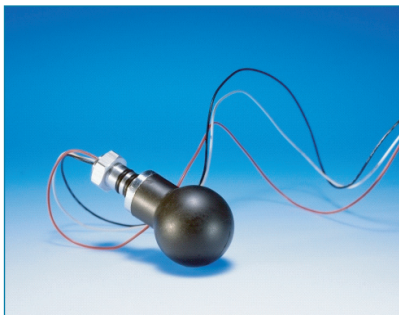
The TC4037 hydrophone sensor module provides a differential balanced output signal. It has been designed especially for operation with a differential preamplifier.

The use of differential sensor signals offers advantages such as, limitation of DC offset and fluctuation. It further adds 6dB more sensor sensitivity, -reduces noise distortion and makes the sensor less sensitive to vibration, temperature.

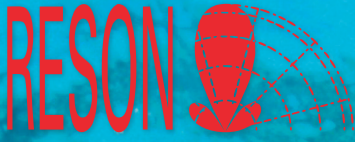
The mounting support is equipped with sealing o-rings that allows for convenient waterproof mounting.

### TECHNICAL SPECIFICATIONS

|                                |   |
|--------------------------------|---|
| Usable Frequency range:        | 1Hz to 100kHz   |
| Linear Frequency range:        | 1Hz to 50kHz $\pm 3$ dB   |
| Receiving Sensitivity nominal: | -193dB re 1V/ $\mu$ Pa at 250Hz (with differential pre-amp 0dB) |
| Directivity, Horizontal plane: | Omnidirectional $\pm 2$ dB at 40kHz                             |
| Vertical plane:                | 270° $\pm 3$ dB at 40kHz  |
| Capacitance nominal:           | 2 x 4,5nF   |
| Leakage resistance:            | $\geq 1$ Gohm   |
| Operating temperature range:   | -2°C to +55°C (with preamplifier)                               |
| Storage temperature range:     | -40°C to +80°C  |
| Operating depth:               | 1500m   |
| Survival depth:                | 2000m   |
| Terminating wires:             | 3 x AWG 22, length 0.5m   |
| Weight in air:                 | 86g   |
| Encapsulating mat.:            | Special formulated NBR  |
| Metal body:                    | Aluminum alloy Al Mg1Si   |







# Hydrophone TC4037

Spherical Reference Hydrophone

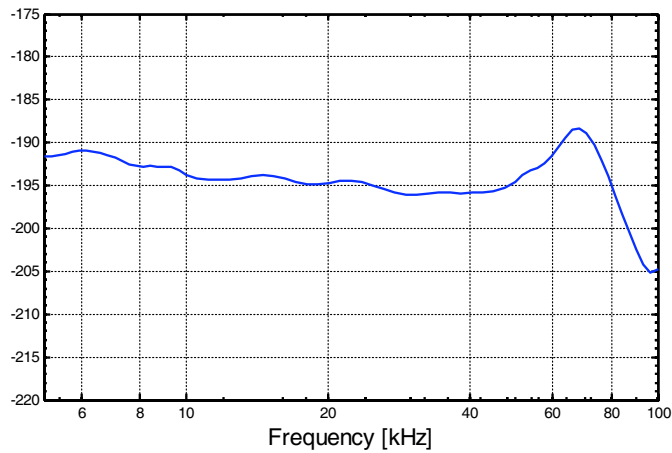
## Documentation:

Receiving sensitivity:  
5 kHz to 100 kHz

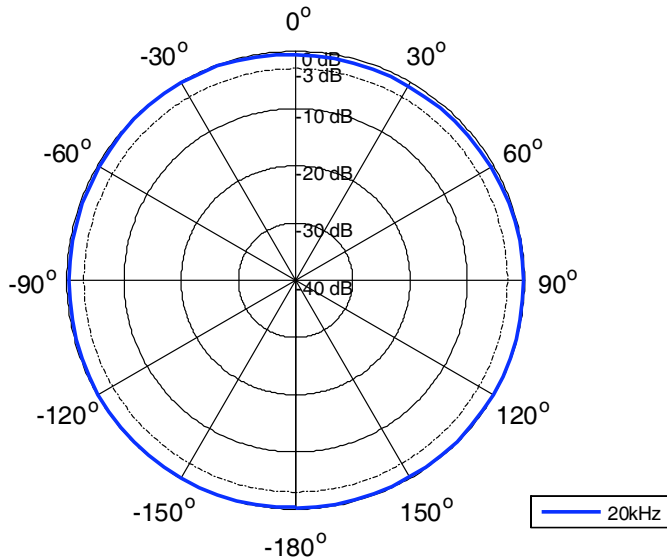
Horizontal directivity:  
20 kHz

Vertical directivity:  
20 kHz

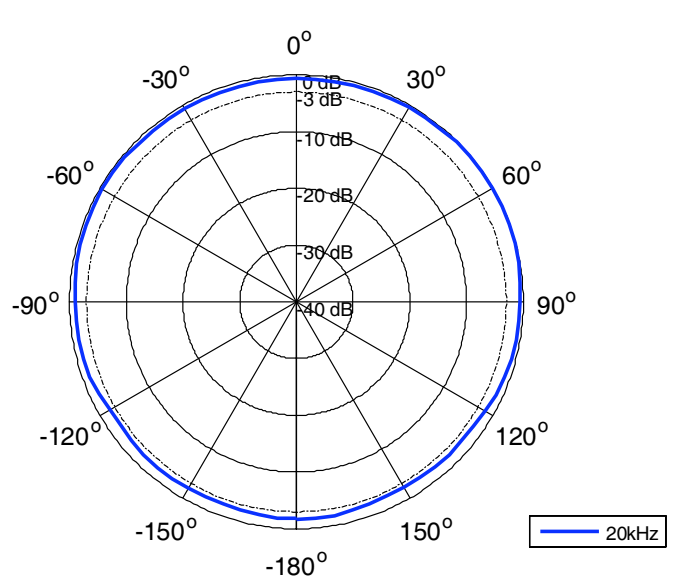
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Horizontal directivity pattern



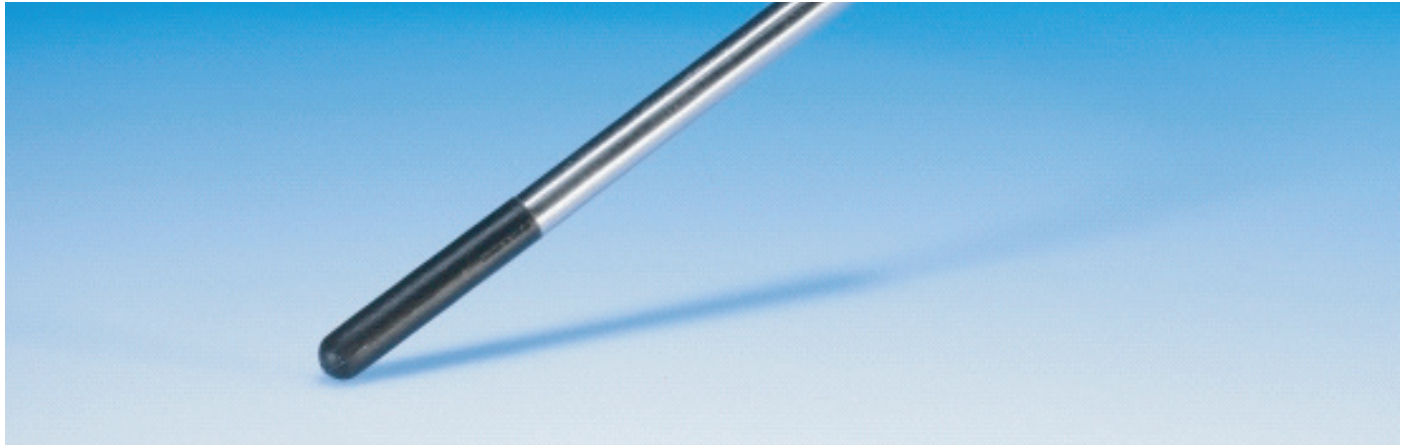
Vertical directivity pattern





# Hydrophone TC4038

Broad Band Miniature Probe Hydrophone



- Reference hydrophone for high frequencies
- Linear receiving response from 100kHz to 500kHz
- Individually calibrated
- Calibration as standard reference hydrophone traceable to national standards established at NPL, UK

## TC4038

The TC4038 is a miniature probe hydrophone, specifically designed as a standard reference hydrophone for high frequencies in the range: 100kHz to 500kHz.

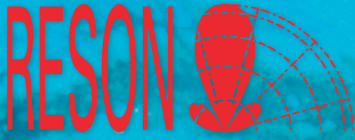
The TC4038 provides a flat frequency response and omnidirectional characteristics in the specified frequency range. The sensor element has excellent stability, which ensures reliable sensitivity over long periods of time.

Because of its small size, the TC4038 is an ideal hydrophone for acoustic measurements in near fields.

### TECHNICAL SPECIFICATIONS

|                                 |   |
|---------------------------------|---|
| Usable Frequency range:         | 10kHz - 800kHz  |
| Linear Frequency range:         | 100 to 500kHz $\pm 3$ dB  |
| Receiving Sensitivity nominal:  | -228dB $\pm 2$ dB re 1V/ $\mu$ Pa (at 100kHz)                               |
| Horizontal Directivity Pattern: | Omnidirectional $\pm 2$ dB (at 100kHz)                                      |
| Vertical Directivity Pattern:   | 60° to 120° $\pm 3$ dB (at 100kHz)  |
| Max. Operating Pressure:        | 0,2MPa = 2atm   |
| Max. Operating Depth:           | 20m   |
| Max. Survival Depth:            | 30m   |
| Equivalent noise:               | 80dB re 1 $\mu$ Pa (with VP1000 Pre-amp $\sqrt{Hz}$ at 1 kHz)               |
| Max. Sound Pressure:            | 0,3M Pa   |
| Operating Temperature range:    | -2°C to +40°C   |
| Storage Temperature range:      | -30°C to +50°C  |
| Leakage Resistance:             | >2Gohm  |
| Impedance:                      | 100Mohm<br>(Min. input for min. noise down to 10 kHz lower frequency limit) |
| Weight in Air:                  | 20grams   |
| Cable (length and type):        | 2m double shielded low noise FEP. Insulated OD 1,65mm                       |





# Hydrophone TC4038

Broad Band Miniature Probe Hydrophone

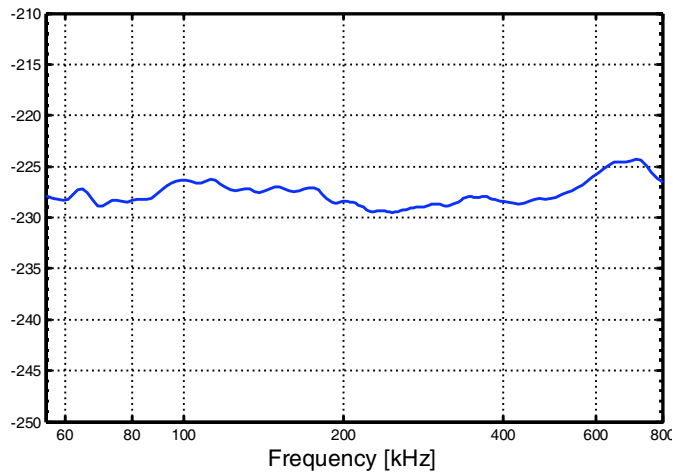
## Documentation:

Receiving sensitivity:  
5 kHz to 100 kHz

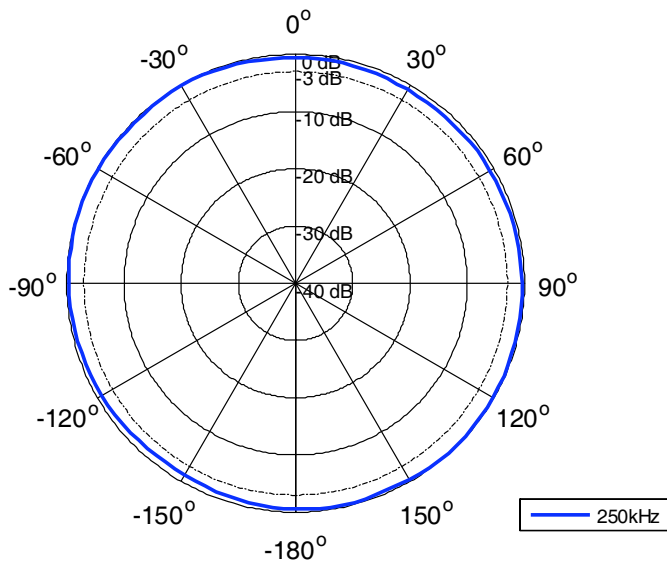
Horizontal directivity:  
20 kHz

Vertical directivity:  
20 kHz

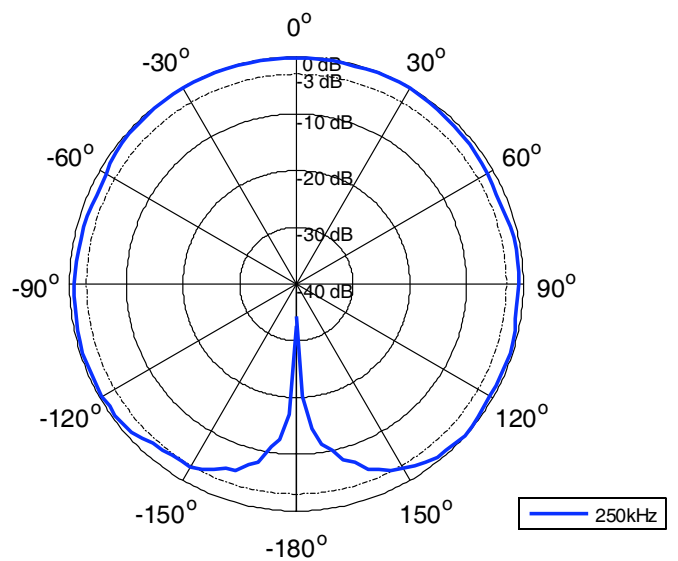
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Horizontal directivity pattern



Vertical directivity pattern







# Hydrophone TC4040

Reference Hydrophone



- **Wide operating frequency range**
- **Flat response over a wide frequency range**
- **Titanium mounting support**
- **Individually calibrated**
- **Water blocked cable to Mil: C-915**

## TC4040

The TC4040 is an ideal standard reference hydrophone for calibration of transducers, hydrophones and underwater acoustic measurement systems.

The TC4040 offers flat frequency receiving response over a wide frequency range and the relatively high transmitting sensitivity makes it very useful within many areas of underwater acoustic research, tests and measurements.

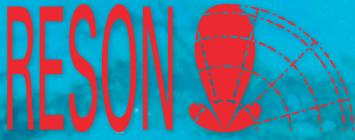
The TC4040 utilises sensor element technology that ensures a high stability with time and excellent performance.

The ceramic sensor element is encapsulated in Special formulated NBR. The metallic support made of titanium, allows for precise mounting in suspension hangers.

### TECHNICAL SPECIFICATIONS

|                                |   |
|--------------------------------|---|
| Usable Frequency range:        | 1Hz to 120kHz +2 –10dB  |
| Linear Frequency range:        | 1Hz to 80kHz $\pm 2$ dB   |
| Receiving voltage Sensitivity: | -206dB re 1V/ $\mu$ Pa ( $\pm 3$ dB) 56 $\mu$ V/Pa (nominal)                              |
| Charge Sensitivity:            | 0.42pC/Pa (nominal)   |
| Transmitting sensitivity:      | 132dB re 1 $\mu$ Pa/V at 1m (at 100kHz)   |
| Horizontal directivity:        | Omnidirectional $\pm 2$ dB at 100kHz (Typical)  |
| Vertical directivity:          | 270° $\pm 2$ dB at 50kHz (Typical)  |
| Capacitance:                   | 8.3nF (nominal)   |
| Leakage resistance:            | >2Gohm  |
| Operating depth:               | 400m  |
| Survival depth:                | 500m  |
| Operating temperature range:   | -2°C to +80°C   |
| Storage temperature range:     | -40°C to +80°C  |
| Weight incl. Cable, (in air):  | 1.6kg   |
| Cable (length and type):       | 10m shielded twisted pair, DSS-2 MIL-C-915<br>Optional cable lengths available on request |
| Encapsulating material:        | Special formulated NBR  |
| Metal body:                    | Titanium  |

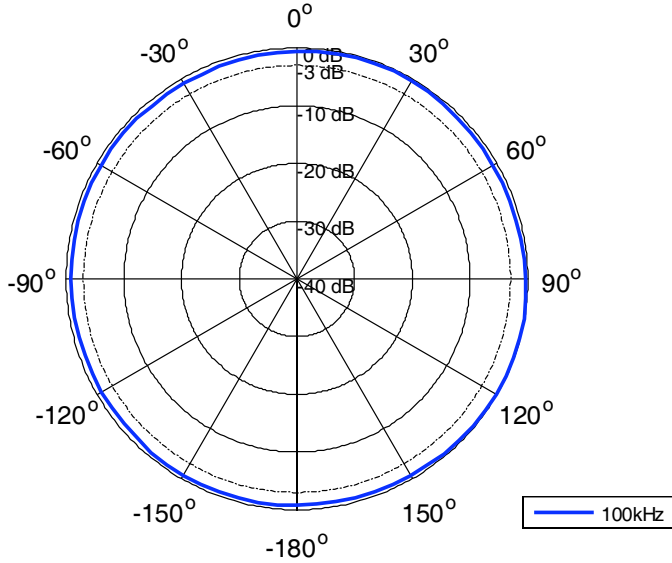




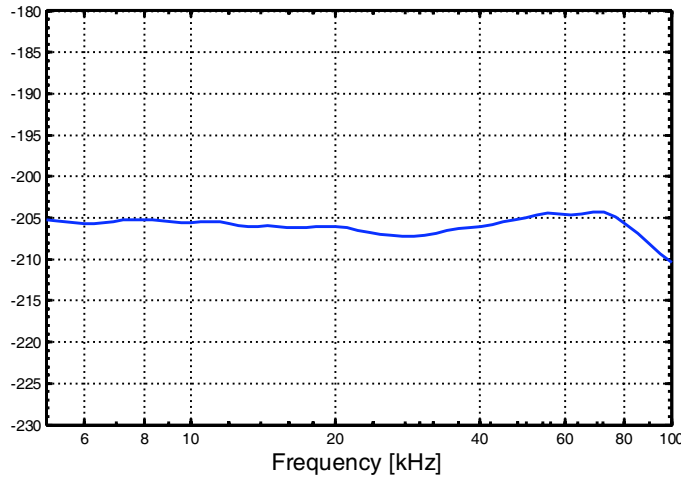
# Hydrophone TC4040

Reference Hydrophone

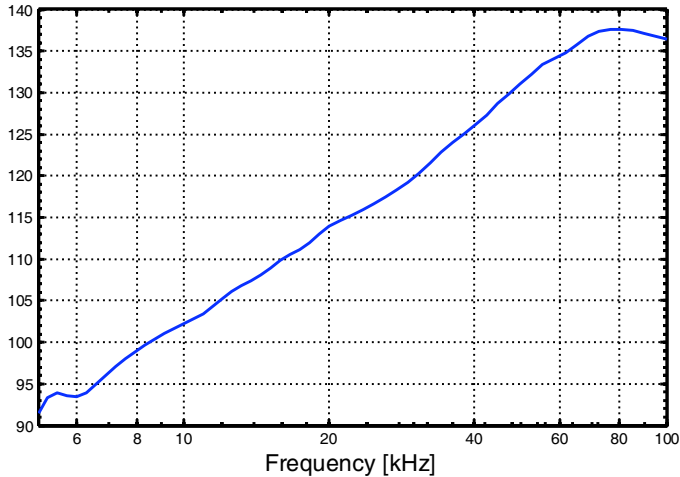
Horizontal Directivity Pattern



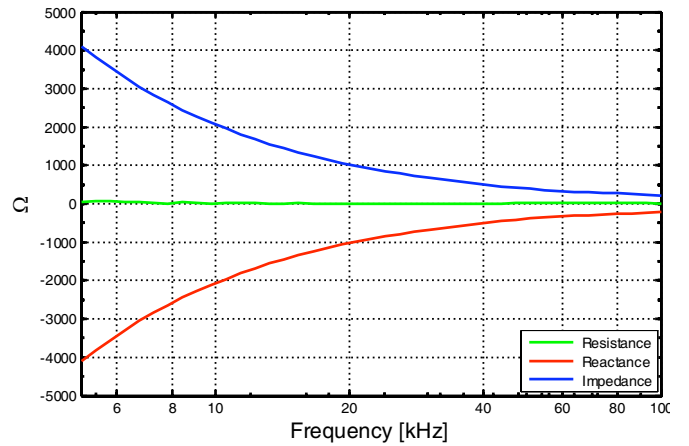
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Transmitting Sensitivity [dB re 1 $\mu$ Pa/V @ 1m]



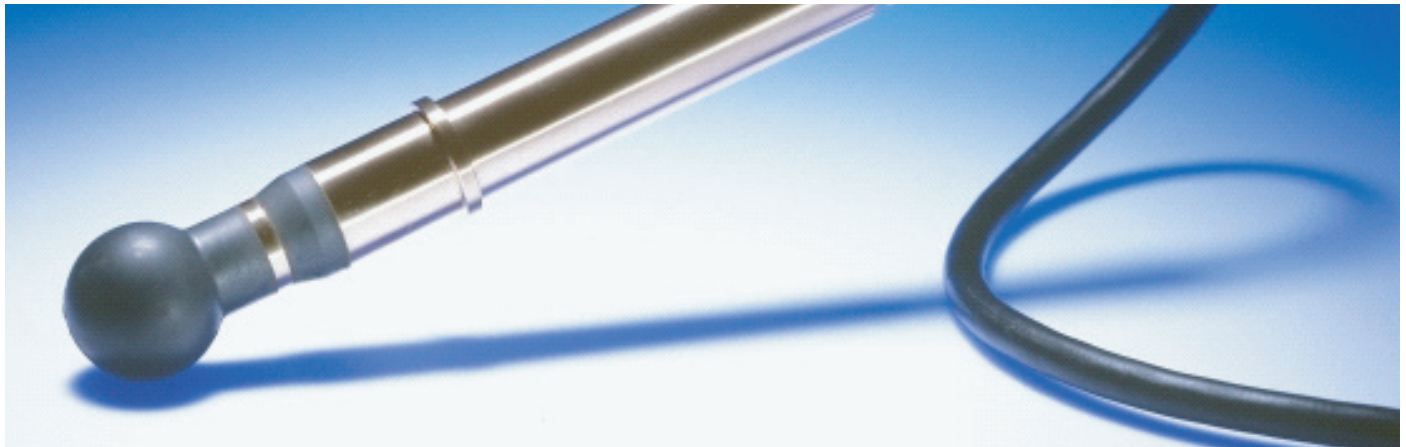
Impedance





# Hydrophone TC4042

## Low-Noise Spherical Hydrophone



- Wide frequency range
- Spherical differential sensor
- Differential in/output amplifier
- Single or differential output
- Self supporting cables to 1000m
- IVC calibration

### TC4042

The TC4042 is a spherical, low-noise hydrophone with 20dB differential pre-amplifier. The hydrophone provides a single output mode.

The single-end output mode is established with a four conductor cable. The built-in preamplifier has the capability of driving cables of more than 1km.

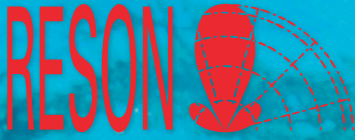
The TC4042 features an insert voltage calibration facility (IVC), which enables remote testing of the hydrophone condition.

#### TECHNICAL SPECIFICATIONS

|                                 |   |
|---------------------------------|---|
| Receiving Sensitivity, typical: | -173dB re 1V/uPa (2.2 mV/Pa)                |
| Useable frequency range:        | 5Hz to 85kHz                                |
| Linear frequency range:         | 15Hz to 45kHz +1/-5dB                       |
| Horizontal directivity:         | ±2dB at 40kHz                               |
| Vertical directivity:           | ±3dB at 40kHz over 270 deg.                 |
| Max. operating depth:           | 1000m                                       |
| Survival depth:                 | 1200m                                       |
| Operating temperature range:    | -2°to +55°C                                 |
| Storage temperature range:      | -30°to +70°C                                |
| Preamplifier gain:              | +20dB                                       |
| Max. voltage output:            | 3Vrms (at 12V supply) 7Vrms (at 24V supply) |
| Current consumption:            | ≤9mA (at 12V supply) ≤22mA (at 24V supply)  |
| Output impedance:               | 10Ohms + 100µF                              |
| High pass filter:               | 15Hz (-3dB)                                 |
| Low-pass filter:                | 150kHz (-3dB)                               |
| Hydrophone weight:              | 450g  |
| Housing material:               | Alu Bronze AlCu10Ni5Fe4                     |
| Encapsulating polymer:          | Chloroprene                                 |







# Hydrophone TC4042

Low-Noise Spherical Hydrophone

## Documentation:

Individually calibration curves:

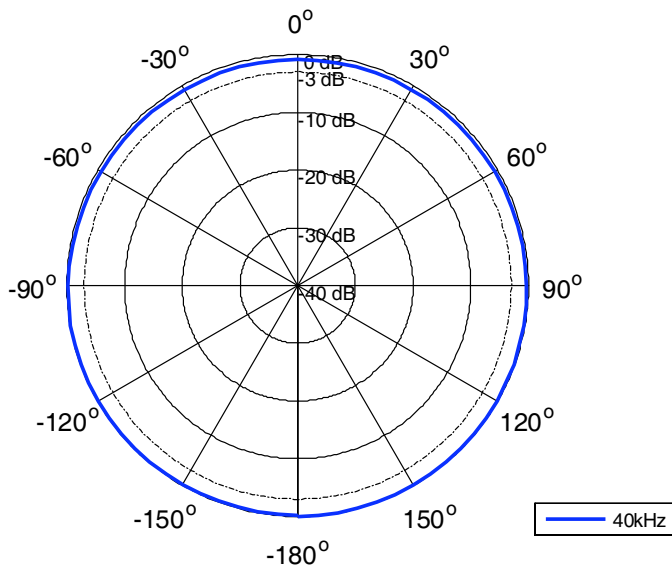
Receiving sensitivity:  
At 5kHz to 90kHz

Horizontal directivity:  
At 40kHz

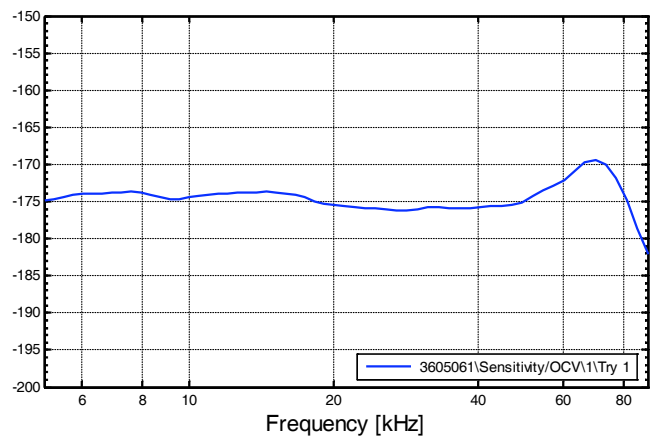
Sensitivity at ref.: frequency:  
250Hz

Vertical directivity:  
At 40kHz

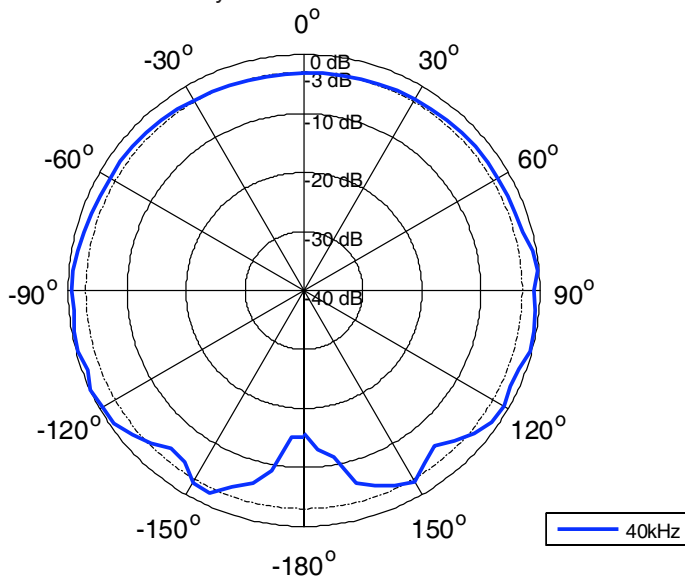
Horizontal Directivity Pattern



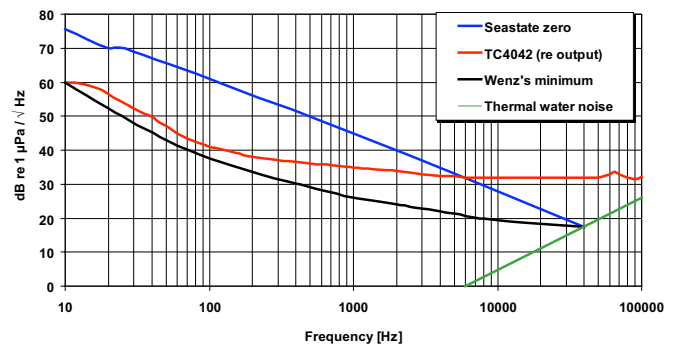
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Vertical Directivity Pattern



Typical Equivalent Noise Pressure Curve





# Hydrophone TC4043

Miniature hydrophone



- **Wide frequency range, 2Hz to 160kHz**
- **Flat receiving response from 2Hz to 100kHz**
- **Omnidirectional to 100kHz**
- **Built-in low- noise preamplifier**
- **Insert voltage calibration**
- **Individually calibrated**

Please note that this product requires a minimum quantity per order



## TC4043

The TC4043 Miniature hydrophone offers a wide frequency range from 2Hz to over 160kHz. The frequency response is flat from 2Hz to 100kHz.

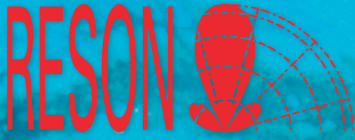
The hydrophones directivity is typically omnidirectional up to 100kHz.

The TC4043 incorporates a high quality 10dB low-noise preamplifier that provides optimal conditions for signal transmission over long cables. This preamplifier features an insert voltage calibration circuit allowing the hydrophone to be reliably tested.

The hydrophone is supplied with an integral 10m for conductor shielded cable. The cable is terminated with a four pole LEMO connector.

### TECHNICAL SPECIFICATIONS

|                                 |   |
|---------------------------------|---|
| Receiving Sensitivity:          | -201dB re 1V/uPa $\pm$ 2dB (at 250Hz typical) |
| Useable frequency range:        | 2Hz to 160kHz                                 |
| Linear frequency range:         | $\pm$ 3dB 2 Hz to 80kHz                       |
| Horizontal directivity pattern: | Omnidirectional $\pm$ 2dB at 100kHz 360°      |
| Vertical directivity pattern:   | $\pm$ 2dB at 100kHz 0 $\pm$ 165°              |
| Max. operating depth:           | 700m  |
| Survival depth:                 | 800m  |
| Operating temperature range:    | -2°to +50°C                                   |
| Storage temperature range:      | -30°to +70°C                                  |
| Supply voltage:                 | 10 to 18VDC (nominal 12VDC)                   |
| Max output voltage:             | 1Vrms   |
| Output drive capability:        | 100m cable                                    |
| Insert voltage:                 | 2Vrms (calibration signal recommended)        |
| Insert attenuation:             | 30dB  |
| Quiescent current:              | 15mA at 12VDC                                 |
| Housing material:               | Stainless steel, AISI 316                     |
| Sensor enclosure:               | Special formulated NBR                        |
| Cable:                          | Four conductors shielded with PUR jacket.     |
| Connector:                      | LEMO series E four-pole watertight connector  |



# Hydrophone TC4043

Miniature hydrophone

## Documentation:

Individually calibrated curves:

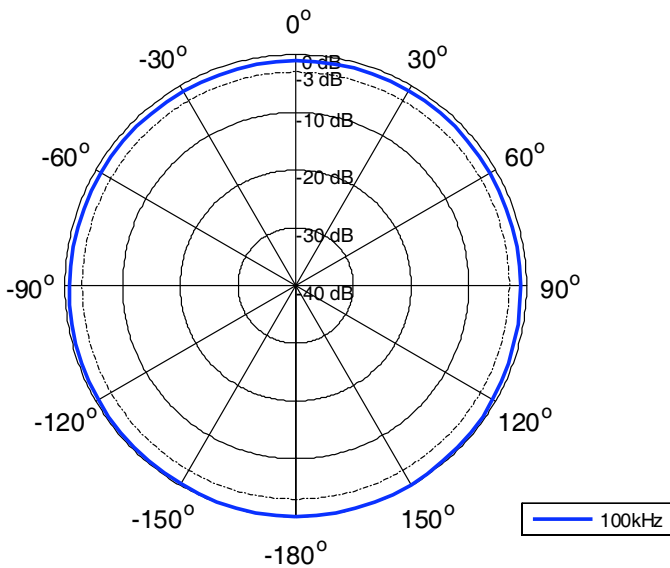
Sensitivity at ref. frequency:  
250Hz

Receiving sensitivity:  
5kHz to 200kHz

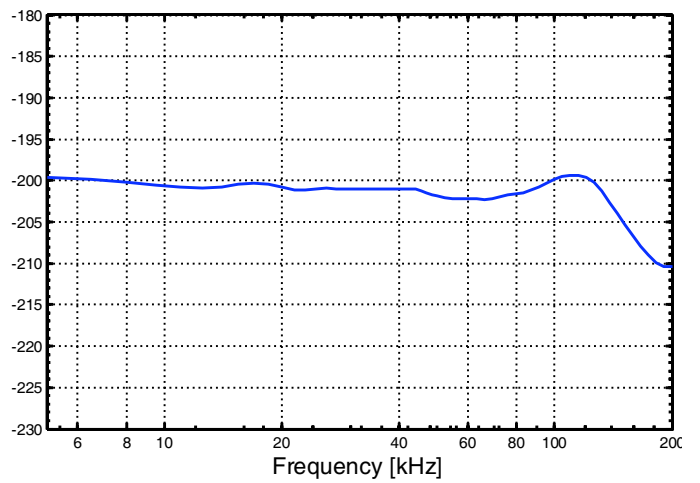
Horizontal directivity:  
At 100kHz

Vertical directivity:  
At 100kHz

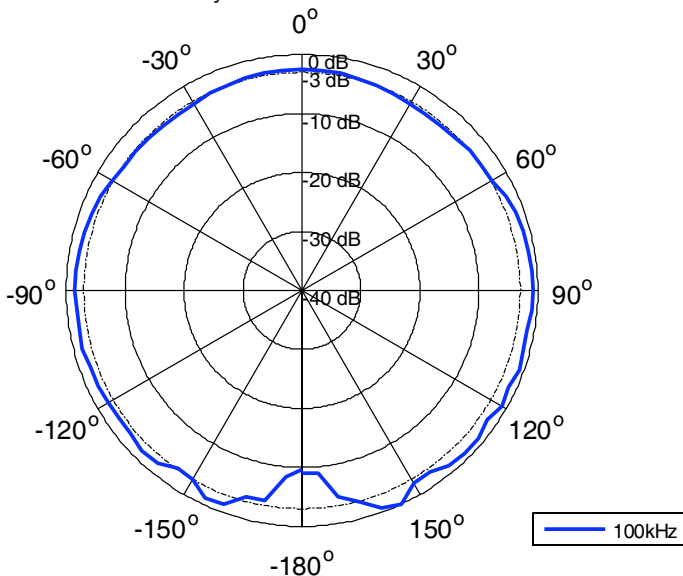
Horizontal Directivity Pattern



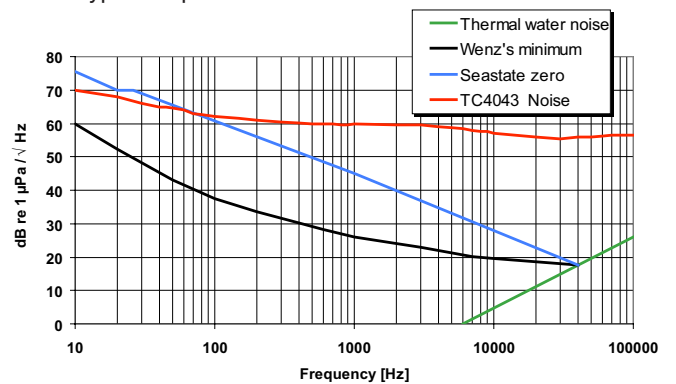
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Vertical Directivity Pattern



Typical Equivalent Noise Pressure Curve







# Hydrophone TC4047

With Wet Mating Connector



- High Sensitivity
- Omnidirectional
- Broad banded
- Wet mating connector
- Individually calibrated

Please note that this product requires a minimum quantity per order



## TC4047

The TC4047 miniature hydrophone offers a useable frequency range from 1kHz to 170kHz. The hydrophone incorporates a high quality 20dB low-noise pre-amplifier which provides optimal conditions for signal transmission. The high sensitivity provides excellent signal to noise ratio and immunity against induced cable noise.

The hydrophone is omnidirectional up-to 100kHz and has uniform receiving characteristic from 1kHz to 100kHz. An insert calibration circuit enables remote testing of the hydrophone condition. The hydrophone comes with a SEACON connector.

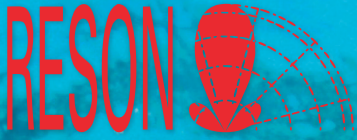
The sensor element is permanently encapsulated in Special formulated NBR to ensure long term reliability. The rubber has been specially compounded to ensure acoustic impedance close to that of water.

The strainrelief and outer jacket of the cable is made of high density polyurethane.

TC4047 can be used in sea or fresh water.

### TECHNICAL SPECIFICATIONS

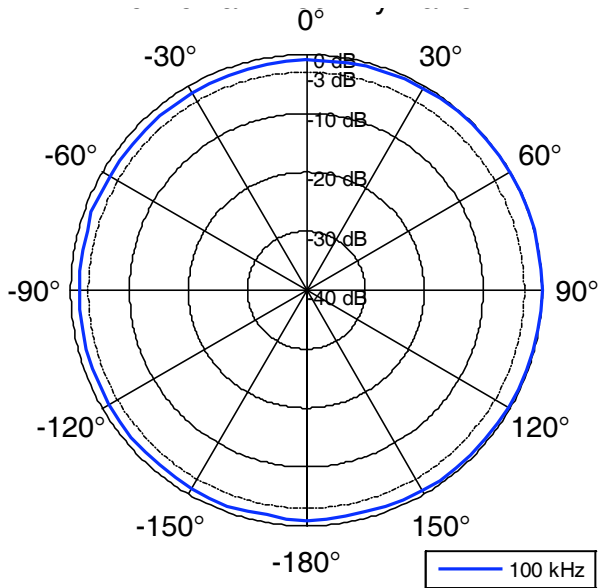
|                                 |                                     |
|---------------------------------|-------------------------------------|
| Useable frequency range:        | 1Hz to 170kHz                       |
| Receiving sensitivity:          | -191 $\pm$ 3dB re 1V/ $\mu$ Pa      |
| Horizontal directivity pattern: | Omnidirectional $\pm$ 3dB at 100kHz |
| Vertical directivity pattern:   | 270° $\pm$ 3dB at 100kHz            |
| Preamplifier gain:              | +20dB $\pm$ 0.5dB @ 10kHz           |
| Filter characteristic:          | 6dB / octave                        |
| Current consumption:            | <15mA @ 12VDC                       |
| DC supply:                      | +12V to +24V                        |
| Output impedance:               | 40Ohm                               |
| Output voltage:                 | Max. 2Vrms with 24VDC supply        |
| Connector type:                 | 6 pin Seacon connector              |
| Operating depth:                | 700m                                |
| Survival depth:                 | 800m                                |
| Operating temperature range:    | -2°C to +55°C                       |
| Storage temperature range:      | -40°C to +80°C                      |



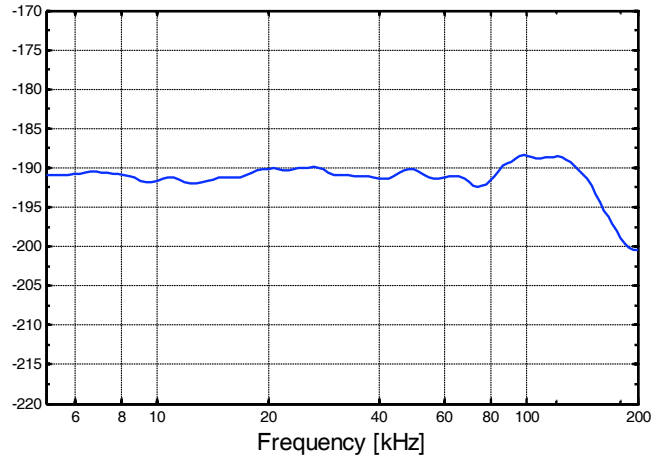
# Hydrophone TC4047

With Wet Mating Connector

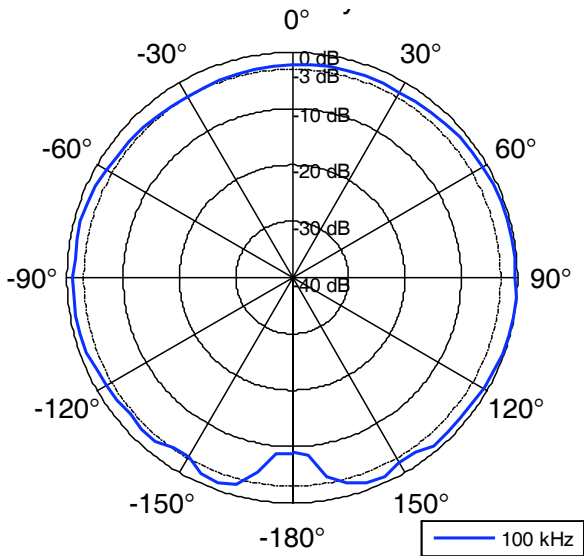
Horizontal Directivity Pattern

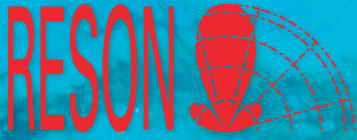


Receiving Sensitivity [dB re 1V/μPa @ 1m]



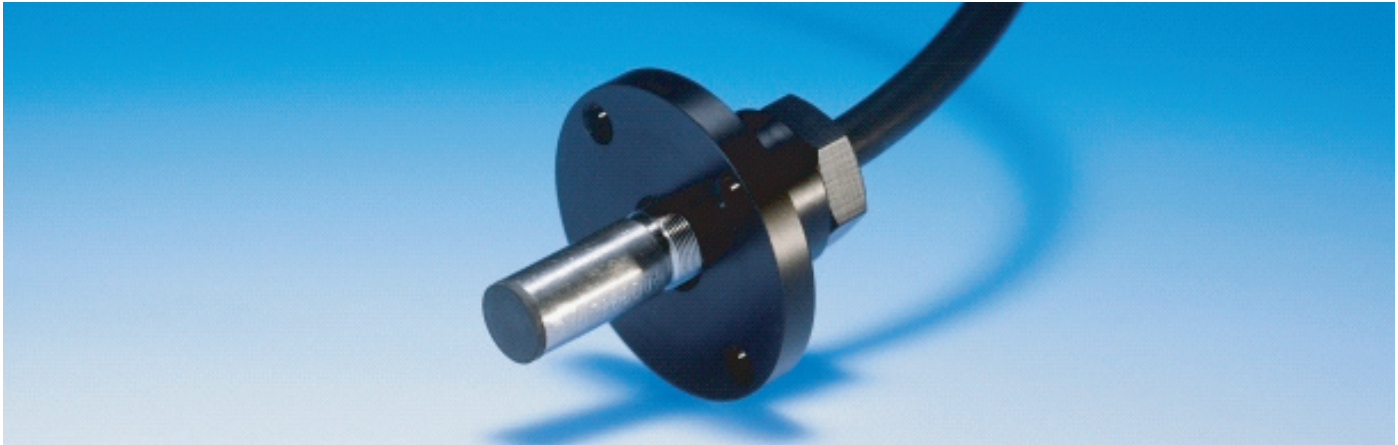
Vertical Directivity Pattern





# Hydrophone TC4050

Miniature Flush-Mounted Probe Hydrophone



- Small active sensor surface
- High sensitivity
- Omnidirectional to high frequencies
- Wide frequency range
- High sensor capacitance
- Stainless steel housing
- Chloroprene encapsulated

Please note that this product requires a minimum quantity per order



## TC4050

The TC4050 is a miniature flushmounted hydrophone, which has a flat frequency response and is omnidirectional over the complete lower frequency range.

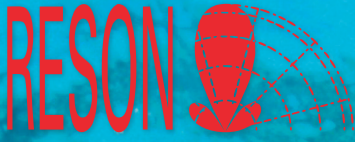
The high capacitance and sensitivity of the sensor element allow for direct connection to an oscilloscope or recording apparatus. Still, a high input impedance or a charge amplifier is required for low frequency measurements.

The small active surface area of the sensor element makes it ideal for observing eddying and cavitation. The short rise time, permits measurements of accurate pressure profile of transient shock fronts.

### TECHNICAL SPECIFICATIONS

|                                  |   |
|----------------------------------|---|
| Usable Frequency range:          | 0.3Hz to 100kHz                         |
| Linear Frequency range:          | 0.3Hz to 40kHz $\pm 5$ dB               |
| Receiving Sensitivity, nominal:  | -217dB re 1V/ $\mu$ Pa                  |
| Horizontal directivity, Pattern: | Omnidirectional $\pm 2$ dB at 20kHz     |
| Vertical directivity, Pattern:   | 180° $\pm 2$ dB at 25kHz                |
| Nominal capacitance:             | 2.45nF (1.45nF) (end of cable - sensor) |
| Charge sensitivity:              | 0.04pC/Pa                               |
| Operating pressure:              | 0.05bar to 40bar                        |
| Survival pressure:               | 40bar                                   |
| Operating temperature range:     | -2°C to +80°C                           |
| Storage temperature range:       | -40°C to +80°C                          |
| Rise time:                       | 5 $\mu$ sec                             |
| Weight (in air):                 | 700g                                    |
| Housing material:                | SS AISI 316                             |
| Leakage resistance:              | $\geq 2$ Gohms                          |
| Equivalent noise pressure level: | 64dB re 1 $\mu$ Pa/ $\sqrt$ Hz at 1kHz  |





# Hydrophone TC4050

Miniature Flush-Mounted Probe Hydrophone

## Documentation:

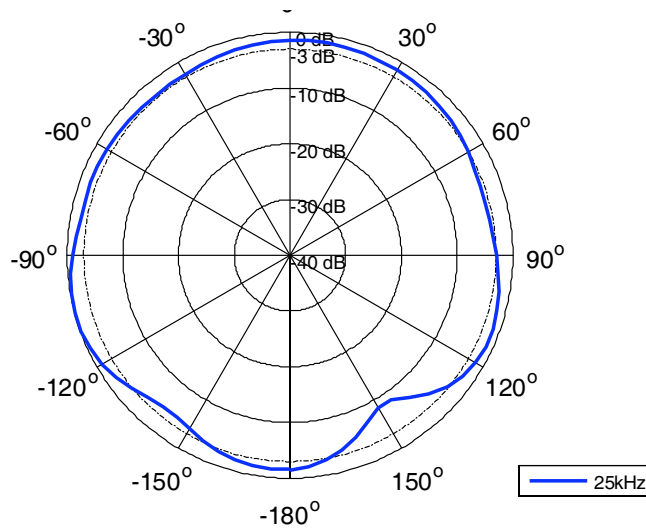
Voltage sensitivity:  
at 250Hz

Receiving sensitivity:  
5kHz to 100kHz

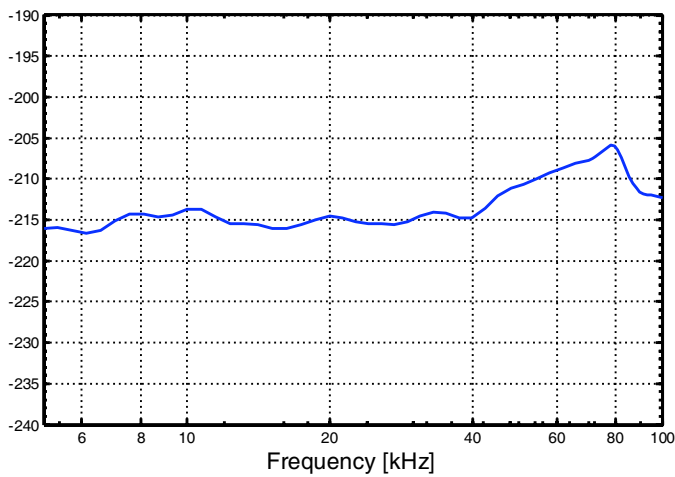
Vertical directivity:  
at 25kHz

Impedance:  
5kHz to 200kHz

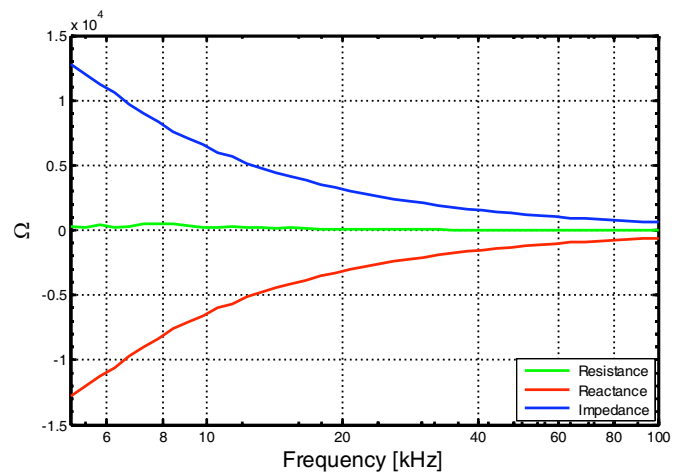
Vertical directivity pattern

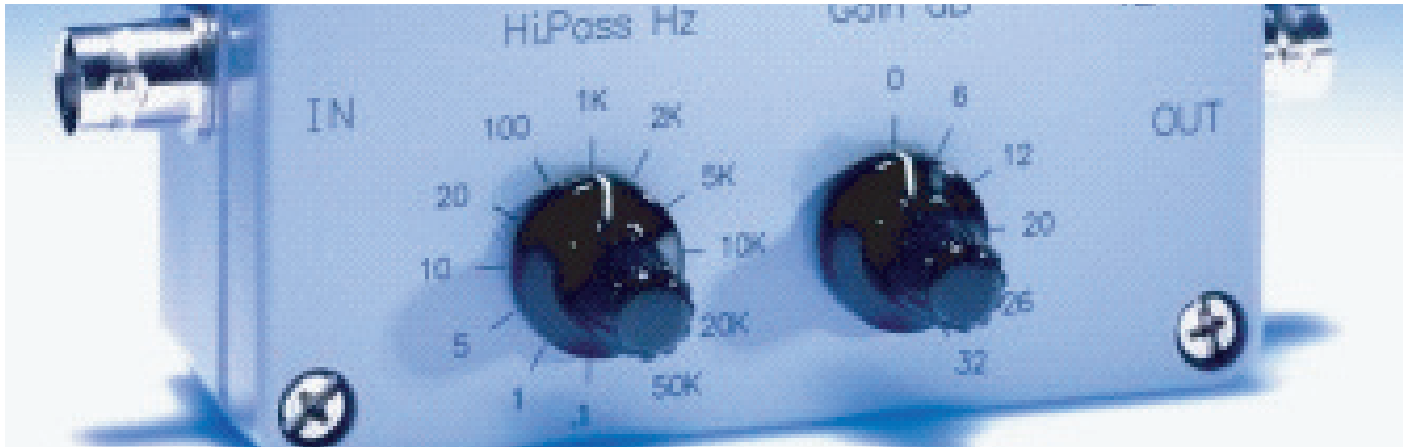


Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



Impedance





- 1Hz to 1MHz bandwidth  
Hi-pass filter options
- 6 level gain selection
- 100Mohm input impedance
- Excellent low-noise characteristic

## EC6061

The VP1000 is a 1MHz bandwidth single ended voltage preamplifier, designed for use with piezoelectric hydrophone and a variety of transducers. VP1000 offers excellent low-noise performance, gain selection in 6 levels and options of 12 Hi-Pass filters.

The high input impedance of 100Mohm allow for low frequency measurements with even very small sensor element capacities.

Encapsulated in aluminum box The VP1000 is water stain resistant.

### TECHNICAL SPECIFICATIONS

#### Input:

|             |                       |
|-------------|-----------------------|
| Impedance:  | 100Mohm/2.5pF         |
| Max. level: | 2.8Vrms at 12V supply |

#### Output:

|                    |                                   |
|--------------------|-----------------------------------|
| Impedance:         | 10ohm/100µF                       |
| Max. level:        | 2.8Vrms at 0dB gain               |
| Max. load:         | 10nF ≈ 100m cable                 |
| DC offset Phase @: | 0mVdc (capacitive coupling) -180° |

#### Gain:

|                |                         |
|----------------|-------------------------|
| Gain settings: | 0, 6, 12, 20, 26, 32 dB |
| Tolerance:     | ±0.5dB                  |

#### Bandwidth

|  |               |
|--|---------------|
| Operating frequency range -3dB at 20dB gain: | 0.5Hz to 1MHz |
|--|---------------|

#### Noise:

|                               |                    |
|-------------------------------|--------------------|
| Power spectrum density noise: | 20nV/√Hz (at 1kHz) |
|-------------------------------|--------------------|

#### Hi-Pass Filters:

|                                      |                   |
|--------------------------------------|-------------------|
| 1.5, 10, 20, 100, 1k, 2k, -3dB @ Hz: | 5k, 10k, 20k, 50k |
| -12dB @ Hz:                          | 0.1               |

#### Power supply:

|                    |                     |
|--------------------|---------------------|
| 12Vdc              |                     |
| Voltage nominal:   | min 9Vdc, max 18Vdc |
| Current quiescent: | 12mA @ 12Vdc        |

#### Weight:

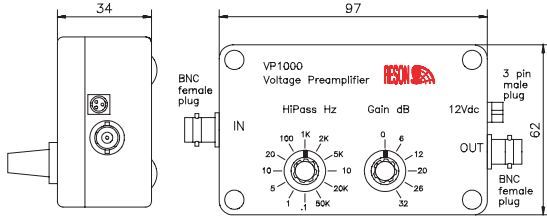
|   |
|---|
| 305g (with supply cable and LEMO adaptor) |
|---|

#### Accessories included:

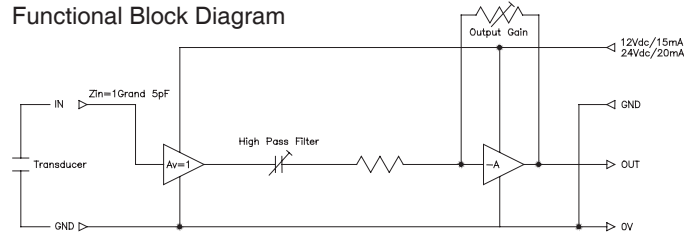
|                      |
|----------------------|
| Supply cable TL 8088 |
|----------------------|



### VP1000 outline dimensions and layout



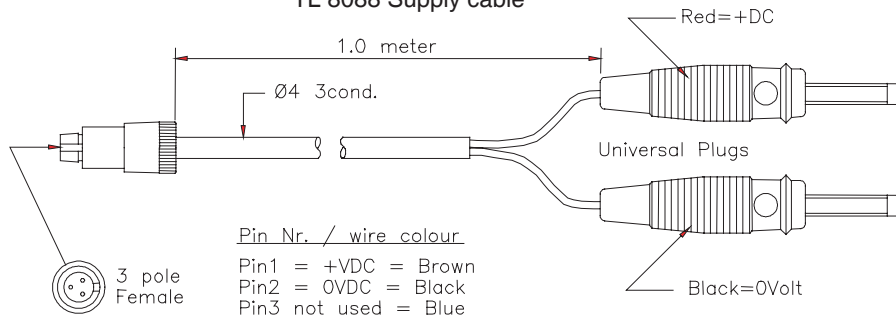
### Functional Block Diagram



Transducer Capacitance: 1nF nominell, Range: 100pF to 10nF  
 High Pass Filter: 0.1Hz/-6dB, 1Hz to 50KHz/-3dB  
 Gain: 0dB to +32dB, Output signal max: +/-3V peak

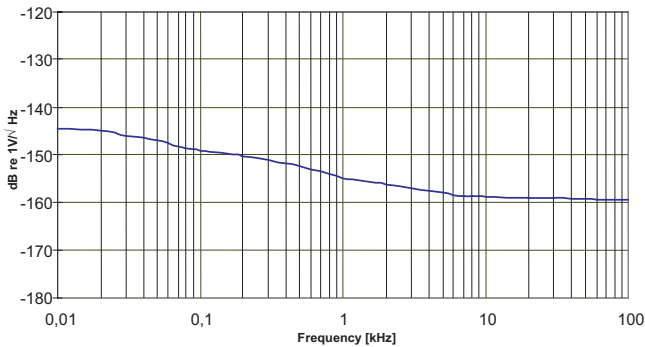
Upper Limit Frequency / worst case=1MHz at gain +32dB  
 Roll-off=6dB at 1MHz at Load max. 600ohm and/or 10nF and output signal max.  
 -6dBm=387mVrms

### TL 8088 Supply cable



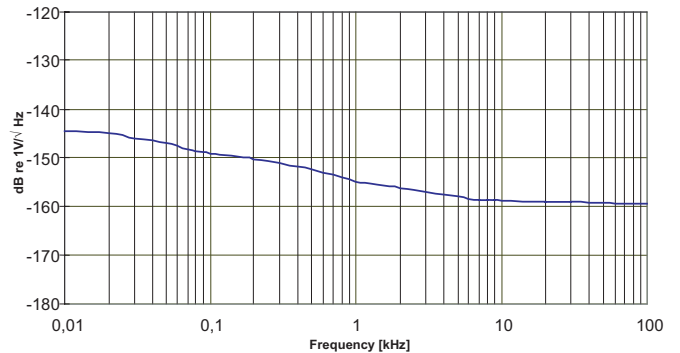
### Noise power density spectrum re input

Input load 1nF, gain 20dB, 0.1Hz filter

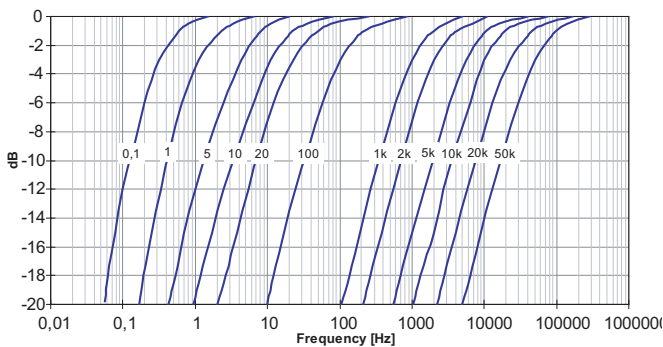


### Voltage preamplifier VP1000

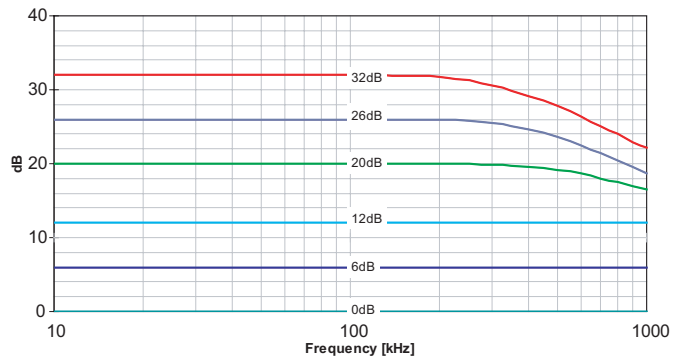
Phase shift with 0.1Hz filter at 0dB and 20dB gain



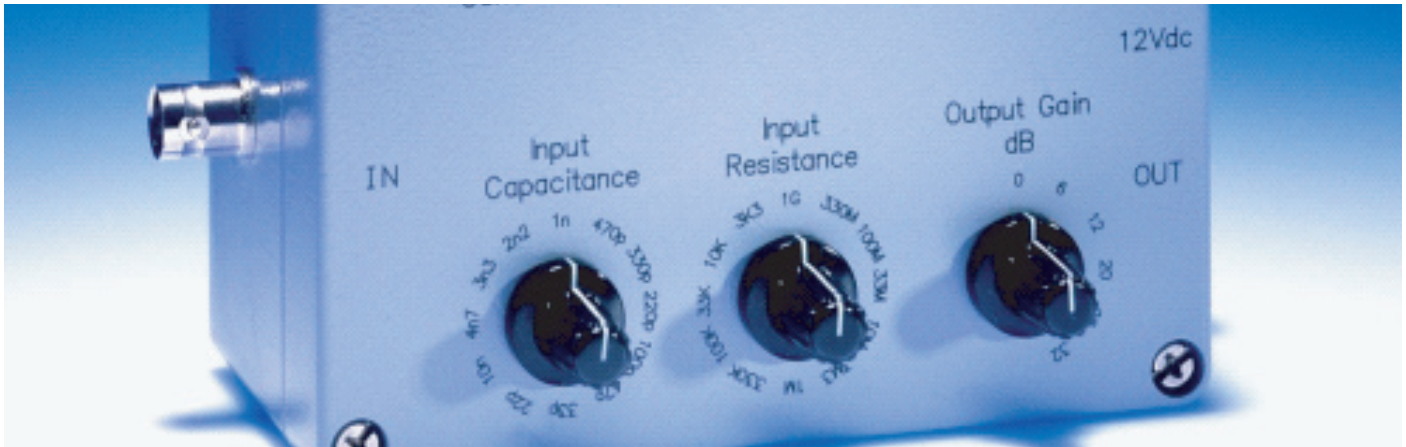
### VP1000 filter characteristics



### VP1000 Frequency roll-off versus gain







- 1Hz to 1MHz bandwidth Input capacitance, selectable
- Lower frequency limit, selectable
- 6 levels voltage gain 0 to 32dB
- Water stain resistant

### EC6067

The CCA 1000 is a compact low-noise conditioning charge amplifier designed for use with piezoelectric hydrophones and other piezoelectric detectors. The CCA 1000 enables the uses of long cables between hydrophone and amplifier without affecting the hydrophone sensitivity.

The input capacitance can be selected to match the hydrophone capacitance for close unity gain or to achieve input gain up to 20dB. The input resistance, control the lower frequency limit -3dB break frequency. The output gain can be selected from 0 to 32dB.

#### TECHNICAL SPECIFICATIONS

##### Input:

|                             |  |
|-----------------------------|--|
| Impedance max.:             | 1Gohm  |
| Max input at (unity gain):  | 2V <sub>p</sub>                                |
| Estimating Input gain:      | (dB) = 20 log C <sub>tr</sub> /C <sub>in</sub> |
| Input capacitance selector: | 12 steps: 22pF to 10nF                         |
| Input resistance selector:  | 12 steps: 3.3kohm to 1Gohm                     |

##### Output:

|                               |                        |
|-------------------------------|------------------------|
| Output gain settings 6 steps: | 0, 6, 12, 20, 26, 32dB |
| Signal output, max:           | 2V <sub>p</sub>        |
| Output impedance:             | 20ohm                  |
| DC off-set:                   | 0                      |

##### Bandwidth:

|  |             |
|--|-------------|
| Operating -3dB Frequency range at 20dB gain: | 1Hz to 1MHz |
|--|-------------|

##### Noise:

|                                     |                            |
|-------------------------------------|----------------------------|
| Input termination:                  | 1nF to GND                 |
| Output noise with selector settings |                            |
| 1nF/1GOhm/0dB:                      | 2-4μV <sub>rms</sub> /A    |
| 10nF/1GOhm/20dB:                    | 8-10μV <sub>rms</sub> /A   |
| 1nF/1GOhm/20dB:                     | 14-20μV <sub>rms</sub> /A  |
| 100pF/1GOhm/20dB:                   | 80-110μV <sub>rms</sub> /A |

##### Power supply:

|                      |                     |       |
|----------------------|---------------------|-------|
| Voltage:             | min.:               | 12VDC |
|                      | max.:               | 24VDC |
| Current consumption: | 40mA ±10mA at 12Vdc |       |



### TECHNICAL SPECIFICATIONS

#### Lower frequency limit:

Frequency limits (-3dB) versus input resistance at 1nF

input load:

|         |        |
|---------|--------|
| 1GOhm   | 0.3Hz  |
| 330Mohm | 0.5Hz  |
| 100Mohm | 1.5Hz  |
| 33Mohm  | 4.5Hz  |
| 10Mohm  | 15Hz   |
| 3.3Mohm | 45Hz   |
| 1ohm    | 150Hz  |
| 330kOhm | 450Hz  |
| 100kOhm | 1.5kHz |
| 33kOhm  | 4.5kHz |
| 10kOhm  | 15kHz  |
| 3.3kOhm | 45kHz  |

#### Weight:

Including supply cable: 530g

**Accessories included:** Supply cable TL 8088 at one end.

#### Input capacitance settings:

To obtain close unity input gain from a hydrophone, - set the input capacitance selector to a capacitance value close as possible to the hydrophone (end of cable capacitance).

The input gain is then calculated from:  $\text{transducer capacitance } C_{tr} \text{ divided by the input capacitance } C_{in} \times 20 \log = \text{dB gain}$

#### Example:

a.  $20 \log (1\text{nF}/1\text{nF}) = 0\text{dB}$

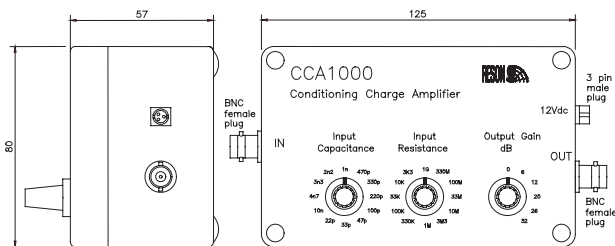
b.  $20 \log (8\text{nF}/4.7\text{nF}) = +4.62 \text{ dB gain}$

### USER INSTRUCTIONS

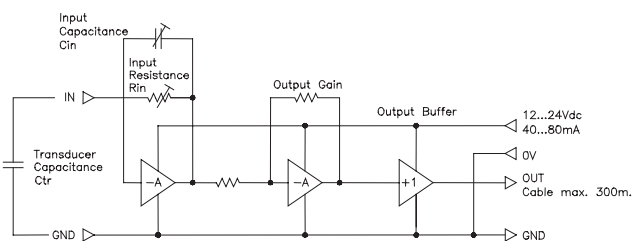
#### Voltage supply:

Connect the supply cable to a battery or AC powered DC supply. The required voltage is 12 to 24VDC. DC supply common/ground should be connected to water for min. noise.

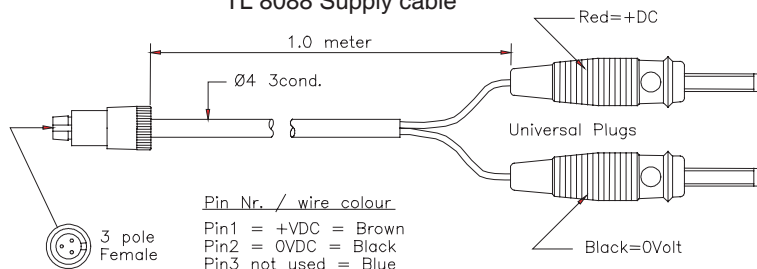
CCA 1000 outline dimensions and layout



Simplified block diagram



TL 8088 Supply cable





# EC6068

Battery Module Rechargeable



- Sealed EMI/RFI shielded aluminum box
- Battery charge condition indicator
- ON/OFF switch exposing red for ON
- Internal automatic 0.5A fuse

## EC6068

Underwater sound measurements at sea or in the field often require hydrophones with built-in preamplifiers with a portable DC voltage supply.

The TC6068 Battery Module provides an ideal portable and compact DC source for the hydrophones and the conditioning amplifiers VP1000 and CCA 1000.

The EC6068 consists of a 12 Volt/1.2Ah Ni-Ca high quality battery enclosed in a sealed EMI/RFI shielded aluminum case.

### TECHNICAL SPECIFICATIONS

|                                    |                                |
|------------------------------------|--------------------------------|
| Battery voltage:                   | 12Volt                         |
| Battery capacity:                  | 1.2Ah                          |
| Typical recharge time:             | 10 hours (avoid over charging) |
| Operating time w. Hydrophone type: |                                |
| TC4032:                            | >12 hours                      |
| TC4035:                            | > 20 hours                     |
| Temperature range:                 |                                |
| Operating:                         | -10 to +50°C                   |
| Storage:                           | -30 to +50°C                   |
| Battery type:                      | Ni Ca                          |
| Accessories included:              | TL8084 DC Supply cable         |
| Dimensions:                        | L.w.h.125 x 80 x 60mm          |
| Weight including cable:            | 1.4kg                          |



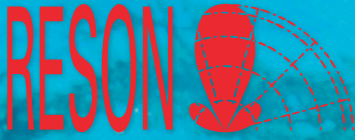
The battery condition is displayed on the indicator with a red and green field. The battery is fully charged when the pointer centered in the green field.

The ON/OFF switch is exposing a red mark in ON position to remind the user to shut off the module when not in use.

The EC 6068 battery can be recharged by use of EC 6072 battery charger connected with, a TL 8084 cable.

The EC6068 output is short circuit protected at 0.5 A. The reset time is approximately 2 sec.

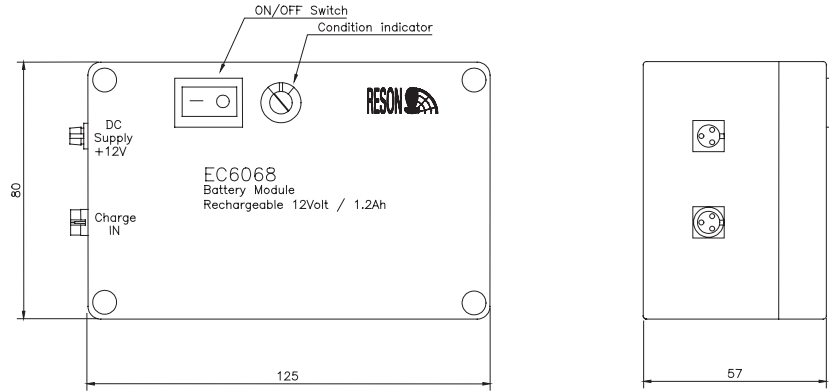




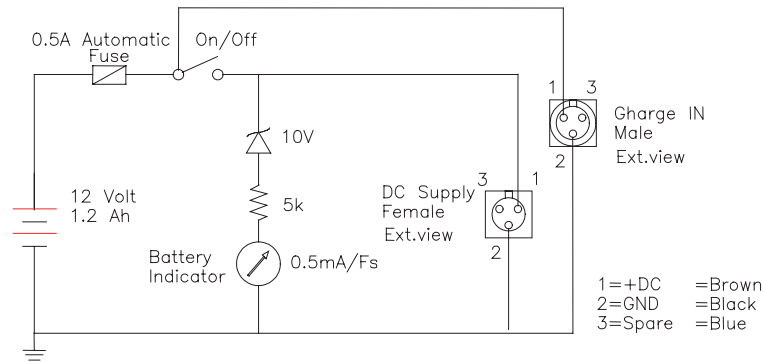
# EC6068

## Battery Module Rechargeable

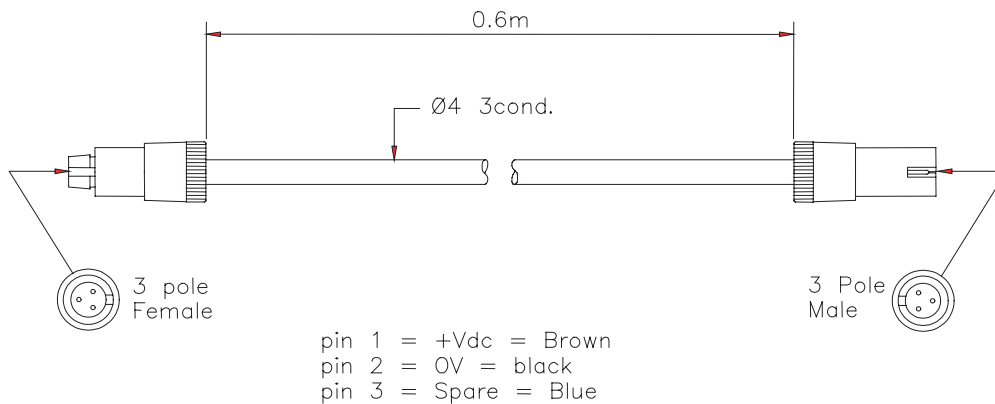
### EC 6068 Outline dimensions and layout



### Circuit Diagram



### DC supply cable TL 8084





# EC6069

Battery Module Dry Cell 2 x 9 V



- Sealed EMI/RFI shielded aluminum box
- Battery charge condition indicator
- ON/OFF switch exposing red for ON
- Easy replaceable 9V 6F22/PP3 batteries

## EC6069

Underwater sound measurements in the field often require hydrophones with built-in preamplifiers or they are connected to conditioning amplifiers that requires portable DC voltage supply.

The EC6069 Battery Module supplies 18VDC from two exchangeable dry cell batteries. EC6069 is an ideal DC voltage source for hydrophones and for the preamplifiers VP1000 and CCA1000.

The EC6069 consists of a sealed EMI/RFI shielded aluminum case that encloses 2 x 9 Volt Alkaline batteries type IEC 6 LR 61 9Volt 0.55ah.

### TECHNICAL SPECIFICATIONS

|   |                              |
|---|------------------------------|
| Battery voltage:  | 18Volt (2 x 9 Volt) Dry Cell |
| Operating time for long life batteries supplying Hydrophone type: |                              |
| TC4032:   | >10 hours                    |
| TC4035:   | >16 hours                    |
| Temperature range:  |                              |
| Operating:  | -10 to +50°C                 |
| Storage:  | -30 to +50°C                 |
| Battery type:   | IEC 9V 6LR 61 0.55 ah        |
| Dimensions (L.w.h.):  | 125 x 80 x 60mm              |
| Weight including cable:   | 0.56kg.                      |
| Accessories included:   | DC supply cable TL 8084      |

The battery condition is displayed on the indicator with a red and green field. The battery is fully charged when the pointer is in center of the green field.

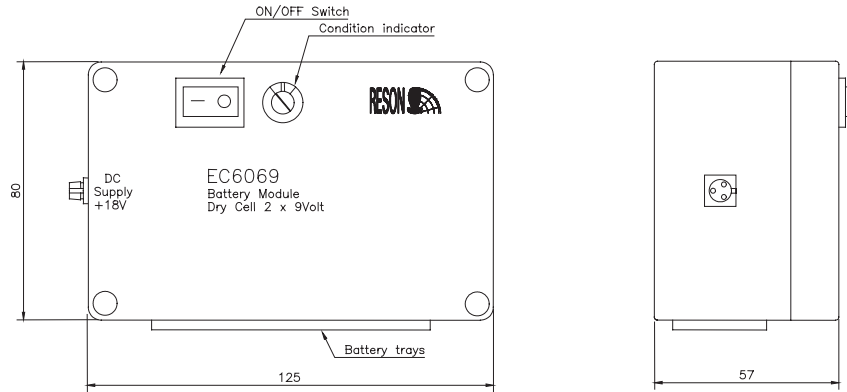
The battery condition indicator measures the actual voltage on the battery cells.

The indicator should be read with load applied.

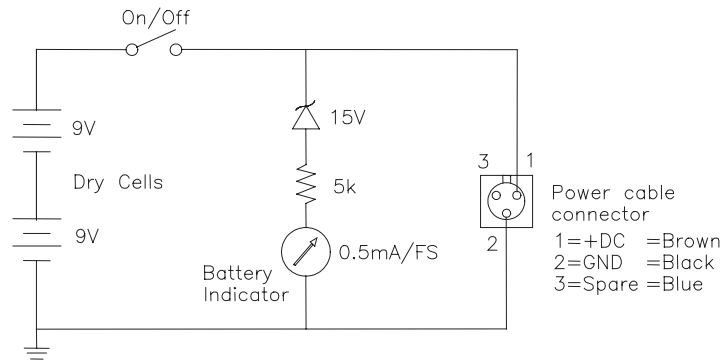
The ON switch is exposing a red mark in ON position to remind the user to shut the battery supply off when not in use.



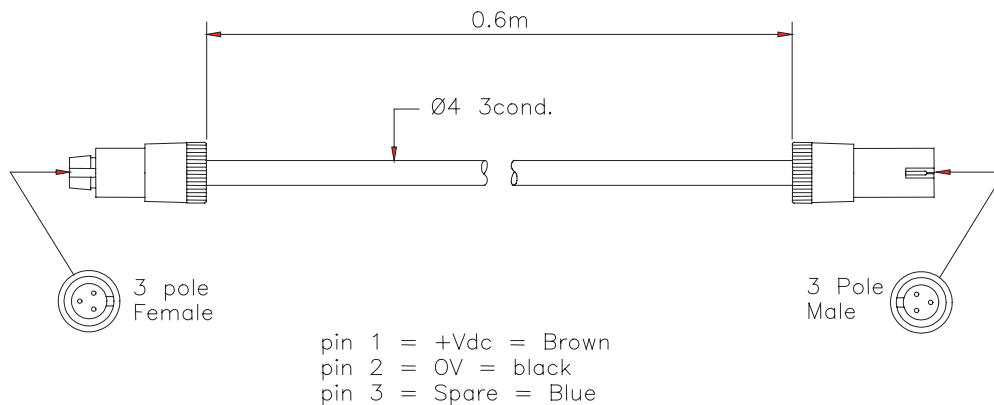
### Outline dimensions and layout



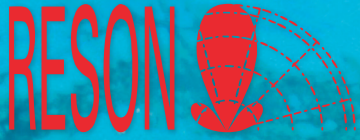
### Circuit Diagram



### DC supply cable TL 8084







# EC6070

Hydrophone Audio Amplifier



## EC6070

- Bandwidth up to 700kHz
- Total signal amplification up to 90 dB
- Input selector for two types of Hydrophones
- Individual input and output gain settings
- Input low frequency sea wave cut-off filter
- Build-in envelope sonar detector
- Build-in Loudspeaker amplifiers
- Build-in Headphone amplifier
- Individual volume controls
- Recording and Playback switch
- Input and Output's both on BCN's and mini jack's
- Supplied with Loudspeakers and Headphones
- Supplied with Cables
- Battery powered 24 Volt (Battery not supplied)

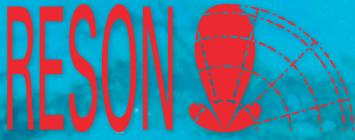


RESON's EC 6070 is a sophisticated preamplifier and audio amplifier system with loudspeakers designed for monitoring underwater acoustic signals from 10Hz to 700kHz.

This system is ideal for listening and recording both low frequency whale vocalization and high-frequency echo-location sonar signals of dolphins and porpoises. A selectable envelope modulation detector converts high frequency signals to human-audible range. The versatility and user-friendly operation of the EC 6070 make it a beneficial addition to many acoustic research laboratories, aquariums, and bioacoustic programs. It operates on 24VDC, with several stages of adjustable input and output gain, built-in high-pass filter options, convenient output lines for oscilloscopes, analyzing equipment, or recorders (tape, minidisc, etc), and input lines for playback.

### TECHNICAL SPECIFICATIONS

|                                    |                              |                       |
|------------------------------------|------------------------------|-----------------------|
| Frequency range $\pm 3\text{dB}$ : | 10Hz to 700kHz               |                       |
| Ultrasound detector range:         | 20kHz to 200kHz              |                       |
| Input gain:                        | -20 to +30dB                 |                       |
| Output gain:                       | -20 to +30dB                 |                       |
| Envelope detector gain:            | -20 to +30dB                 |                       |
| Output power:                      | 2x10Watt/8ohm                |                       |
| Line output level:                 | 100mV to 1Vrms               |                       |
| Line input level:                  | 100mV to 1Vrms               |                       |
| Voltage supply:                    | 24Volt (2x12 Volt Batteries) |                       |
| Current consumption/standby:       | 0.14Amp                      |                       |
| Current consumption/maximum:       | 4Amp                         |                       |
| Rack case 19":                     | Dimensions:                  | 19"x12"x3.5" (w.d.h.) |
| Weight:                            | 4.3kg                        |                       |
| Loudspeaker :                      | Impedance: 8ohm              |                       |
| Effect:                            | 60Watt                       |                       |
| SPL/W:                             | 86dB                         |                       |
| Dimensions w.d.h.:                 | 160x160x230                  |                       |
| Weight:                            | 3.5kg each                   |                       |
| Accessories delivered with EC6070: |                              |                       |
| Loudspeakers:                      | Monacor type LSP-60-2 pcs    |                       |
| Headphones:                        | 1 set                        |                       |
| Loudspeaker Cables:                | 1x5 meter                    |                       |
| Battery Cable:                     | 1x2 meter                    |                       |



# EC6070

## Hydrophone Audio Amplifier

### Description

The EC6070 Audio Amplifier is designed for detection of underwater acoustic sounds. It contains a low noise broadband Hydrophone preamplifier combined with a loudspeaker power amplifier in the same case. The amplifier has been designed especially for optimum operation with the RESON TC4032 and TC4033 Hydrophones.

The TC4032 has a built in low-noise preamplifier and should be used generally where long cables and/or extremely low-noise are required. The TC4033 without pre-amplifier is a spherical type and provides a broad frequency range up to very high-frequencies.

The Hydrophones are connected directly to the input connectors located at the rear panel. The BNC input connector for the TC4033 incorporates an extra 30dB amplifier in order to match the level of the TC4032.

The EC6070 provides high quality real-time reproduction of sound from marine mammals such as whales dolphins and porpoises.

With the sonar detector engaged are frequencies above 20kHz envelope detected and reproduced in the audible frequency range of the human ear.

The wide frequency range of this amplifiers from 10Hz to 700kHz enables detection of sound from low audible frequencies to high ultrasound frequencies.

The EC6070 is supplied with two loudspeakers and a set of headphone for monitoring.

The loudspeakers supplied with the system are for usage in sheltered/indoor areas only.

The sound level of the speakers should be sufficient for most indoor applications.

For outdoor applications under ambient (often humid and noisy) conditions the use of water-resistant horn loudspeakers is recommended. Common horn speakers may deliver up to 10 times the sound pressure level of that of the indoor speakers. The EC6070 is contained in a 19 inch. rack case which enables permanent mounting in laboratories / research stations or other facilities where fixed installations are required.

The input and output BNC connectors on the front panel enables direct connection to oscilloscopes, spectrum analyzers or other storage equipment.

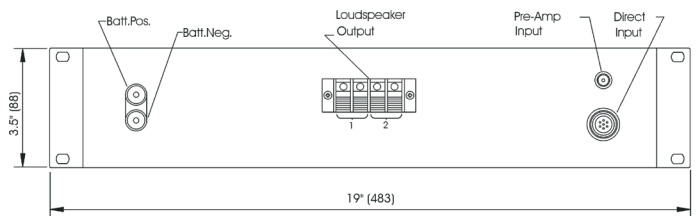
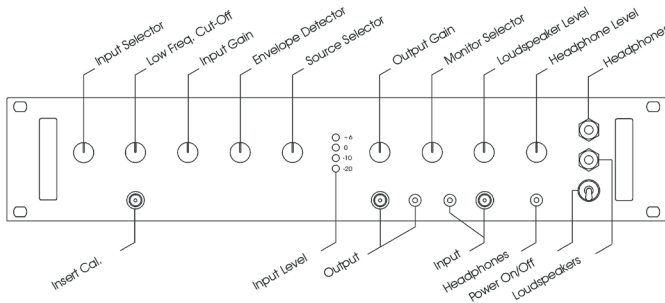
The output signal covers the full frequency range of the Hydrophone at line level for recording and analyzing.

Line input and outputs are available on mini jack connectors enabling recording and Playback from common Tape recorders or Mini Disk recorders.

The insert Cal. BNC connector on the front panel, enables connection of an insert voltage signal for calibration of the TC4032 with the EC6070.

The EC6070 is to be powered from external 24Volt batteries.

**Schematic drawing of the EC6070 front and rear panel, showing the function title and location of the selector knobs, indicator diodes and connectors.**







# EC6072

## Battery Charger



- Sealed durable aluminum box
- EMI/RFI shielding Charging of two batteries simultaneously
- Useable as DC Voltage supply

## EC6072

The EC6072 Battery Charger has been designed for recharging of the EC6068 Battery Module.

Two EC6068 Battery Modules can be connected to EC6072 and recharged simultaneously.

Furthermore, the EC6072 can be used as DC voltage supply for hydro-phones with built-in preamplifiers and for the VP1000 Voltage Amplifier or the CCA1000 Charge Conditioning Amplifier.

### TECHNICAL SPECIFICATIONS

|                     |   |
|---------------------|---|
| Mains supply:       | 110/220 VAC (Auto-setting)                    |
| DC output:          | 15 Volt/0.12 A                                |
| Temperature range:  |   |
| Operating:          | -10 to +50°C                                  |
| Storage:            | -30 to +50°C                                  |
| Dimensions:         | 125 x 80 x 60mm (L.w.h.)                      |
| Weight:             | 0.6kg   |
| Accessory included: | IEC Mains cable 2 pcs DC supply cable TL 8084 |

The EC6072 is equipped with an ON/OFF switch displaying a red mark in ON position.

A red light is shown when 110/220V mains is on.

A green light is shown when the charger is active.

EC6072 accepts both 110 and 220V mains. The voltage level is internally detected and automatically switched to the right setting.

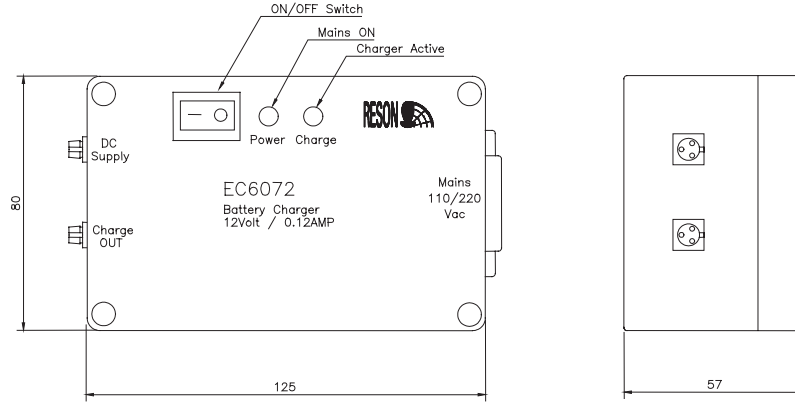
The DC charge voltage is supplied to the batteries or the preamplifiers through the DC charger cable TL8084 when connected to the 3 pole connector.

EC6072 is current limited @ 0,12A mains fuse 0.1A inside box.

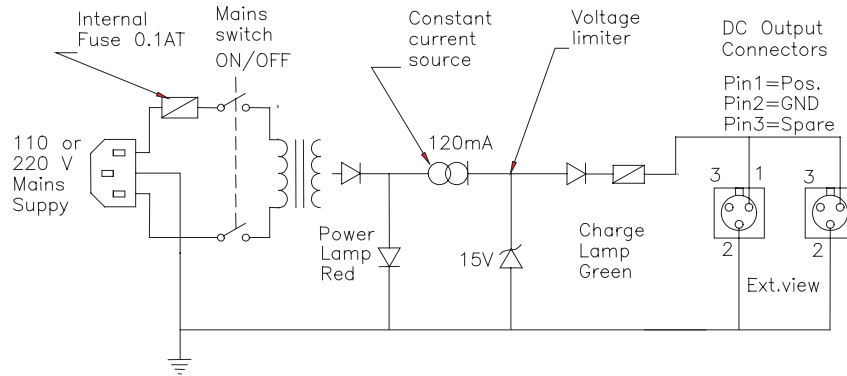




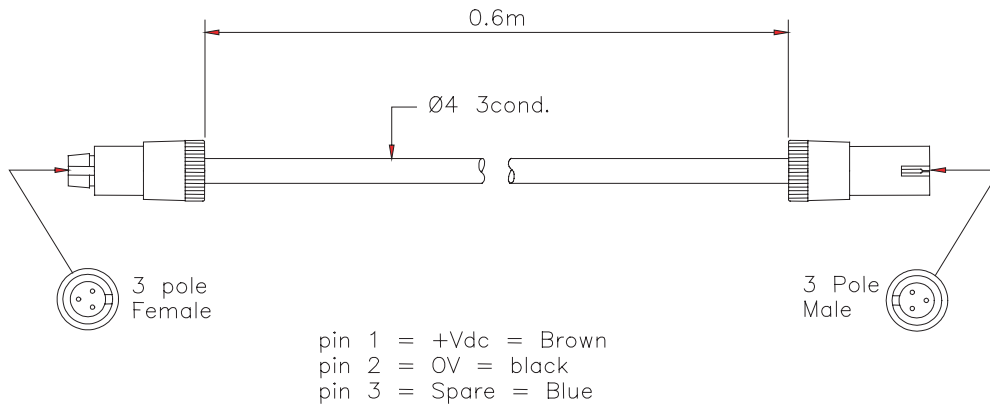
### Outline dimensions and layout



### Circuit Diagram



### DC supply cable TL 8084 (2 pcs.)





# EC6073

Input Module



- Sealed EMI/RFI shielded aluminum box
- Dual input
- DC supply from battery modules
- Insert calibration
- BNC Output Connector

## EC6073

The EC6073 Input Module is equipped with two input connectors that provides connection for RESON hydrophones terminated with either Jupiter or LEMO connectors.

A four-pole connector required for TC4014 connectors can be optionally supplied on request.

The EC6073 distributes and terminates the hydrophone cable connections to DC supply, signal output and insert calibration.

### TECHNICAL SPECIFICATIONS

EC6073 Connections:

TL4032 connection JUPITER M 10 7 polereceptacle

TC4014 connection. Not standard, 4 poleinsert is available on request.

TC4035 connection LEMO 4 polereceptacle.

Signal output on BNC connector.

Insert Voltage Calibration on BNC connector

DC-supply to hydrophones on 3 pole connector

Weight: 0.55kg

Dimensions: L.w.h. 125 x 80 x 60mm

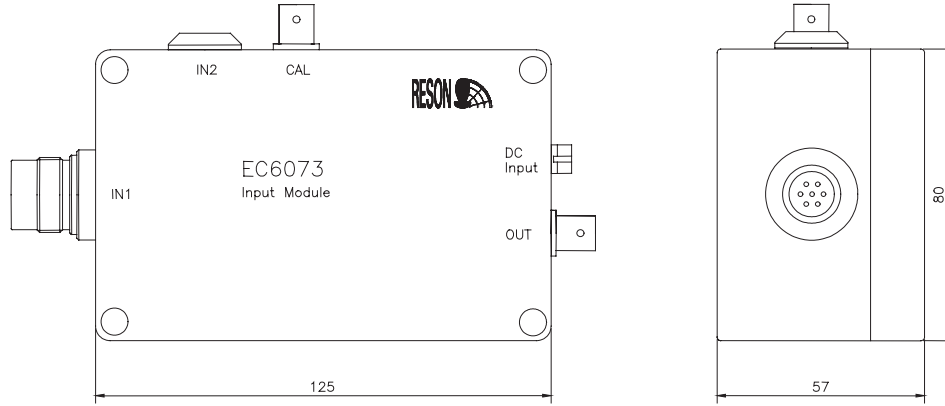
Accessories included: Supply cable TL8088

Insert voltage calibration of hydrophones can be performed by connecting CAL. (BNC connector) to a Sine-generator and the hydro- phone output from OUT connector to scope or voltmeter measures the response.

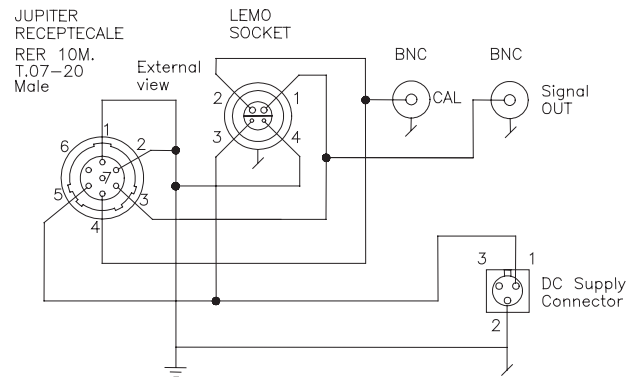
DC voltage supply to the hydrophone preamplifiers can be supplied either from the portable Battery Modules EC6068 or EC6069 or from the EC6072 battery charger if mains are available. The TL8084 cable is used for DC supply connections.



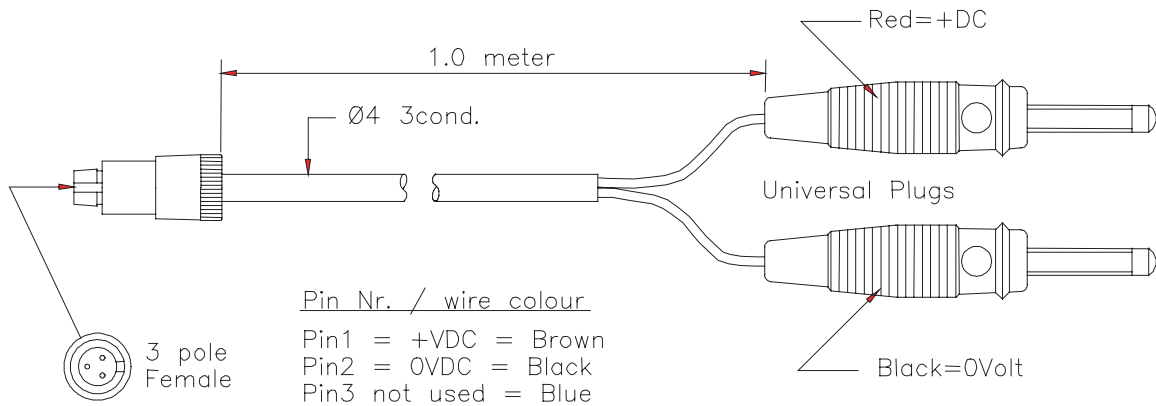
### Outline dimensions and layout



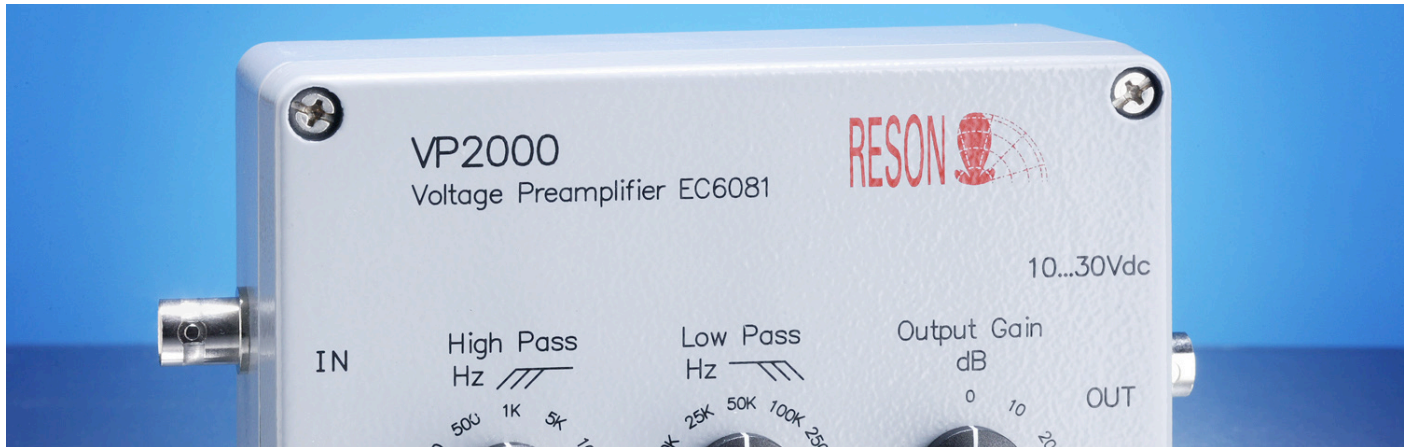
### Circuit Diagram



### TL 8088 Supply Cable







- 1Hz to 1MHz bandwidth
- Gain selection From 0 to 50dB
- Options of 12 high-pass filters and 12 low-pass filters
- Excellent low-noise characteristic

### EC6081

The VP2000 is a 1MHz bandwidth voltage preamplifier designed for uses in conjunction with piezoelectric hydrophones.

VP2000 offers excellent low-noise performance over the entire frequency range; gain selections in 6 levels from 0 to 50dB.

A range of 12 high-pass and 12 low-pass filters are available, - these allow ideal band pass filter settings.

The VP2000 has a high input impedance which allow the measurements at frequencies below 1Hz with even very small hydrophones sensor capacities.

#### TECHNICAL SPECIFICATIONS

##### Input:

|             |                       |
|-------------|-----------------------|
| Impedance:  | >100Mohm's            |
| Max. level: | 2.4Vrms at 12V supply |

##### Output:

|             |  |
|-------------|--|
| Impedance:  | 10ohm//100µF                           |
| Max. level: | 2.4Vrms at 12Vdc 5.4Vrms at 24V supply |
| Max. load:  | 10nF (100m cable)                      |

##### Gain:

|                            |                  |
|----------------------------|------------------|
| Gain settings, 6 steps dB: | 0-10-20-30-40-50 |
|----------------------------|------------------|

##### Bandwidth

|                 |                      |
|-----------------|----------------------|
| Frequency range | -3dB 0.5Hz to 0.5MHz |
| with 20dB gain: | -6dB 1MHz)           |

##### Noise:

|                              |                       |
|------------------------------|-----------------------|
| Power spectrum density noise | 20nV/√Hz (at 1kHz)    |
| Hi-Pass Filters:             | 1-10-50-100-500-1k-5k |
| -3dB @ Hz (6dB/oct):         | 10k-25k-50k-100k-250k |
| Lo-Pass Filters:             | 1k-5k-10k-20k-25k-50k |
| -3dB @ Hz (6dB/oct):         | 100k-250-500k-750-1M  |

##### Power supply:

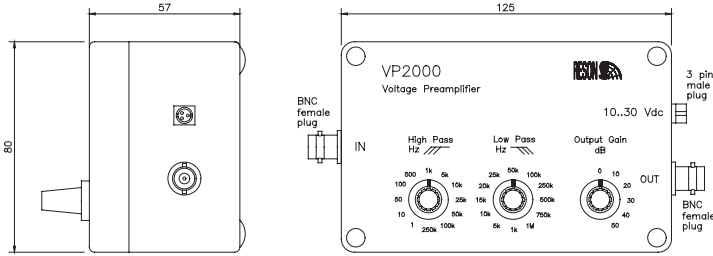
|                                |   |
|--------------------------------|---|
| 12Vdc (min. 10Vdc, max. 30Vdc) |   |
| Voltage nominal:               | 15mA @ 12Vdc  |
| Current quiescent:             | 20mA @ 24Vdc  |
| Enclosure case, dimensions:    | 125, 80, 60mm. (l w, h) (Splash proof aluminum box) |

**Accessory included:** Supply cable TL8088 for laboratory. Vdc supply.

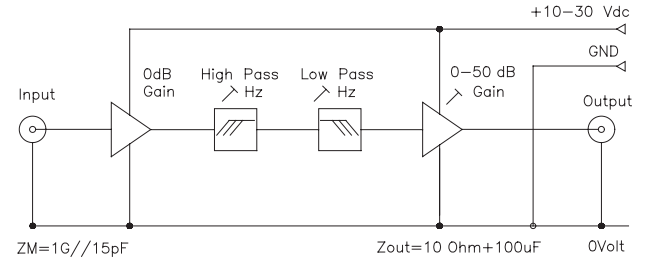
**Accessory available:** See page 2



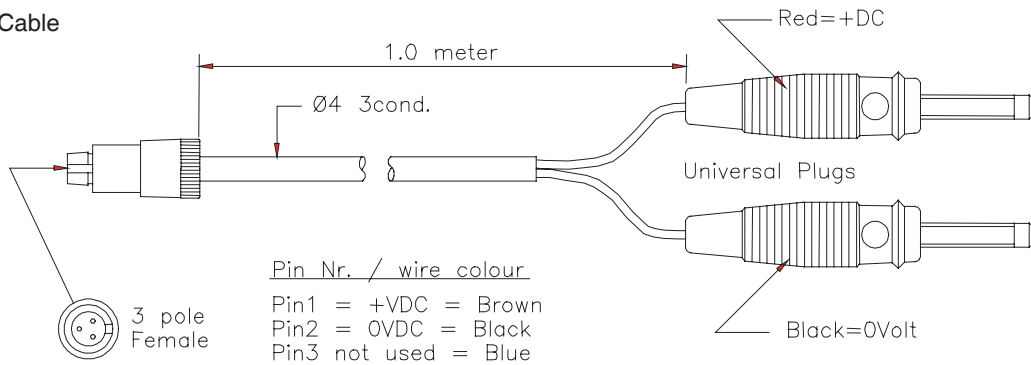
### Outline dimensions and layout



### Functional Block Diagram

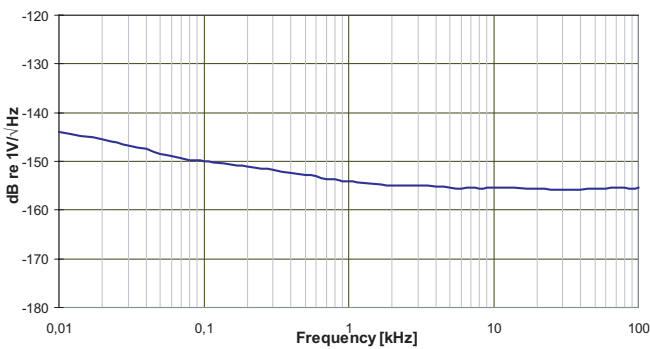


### TL 8088 Supply Cable



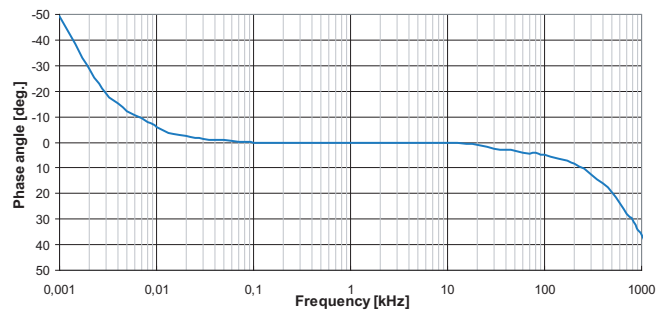
### Noise power density spectrum re input

Input load 1nF, gain 0dB, 1Hz filter

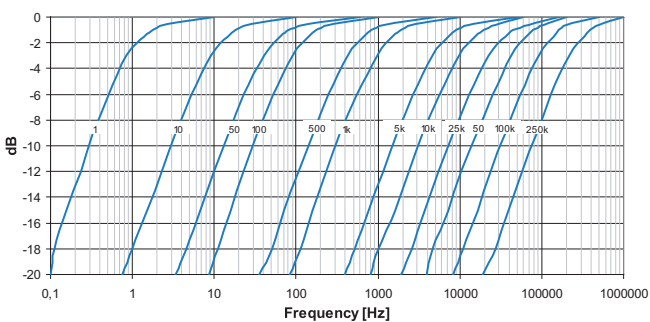


### Phase shift

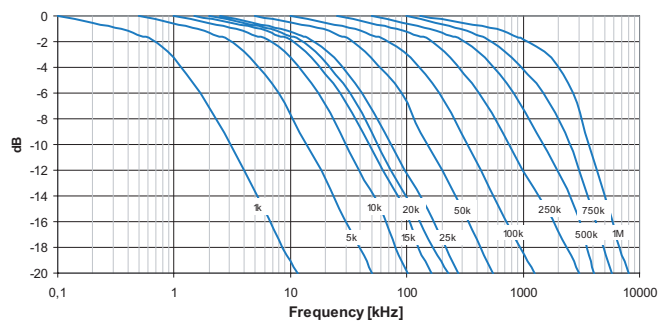
With 1 Hz filter at 0dB and 0dB gain



### High Pass filter characteristics



### Low Pass filter characteristics

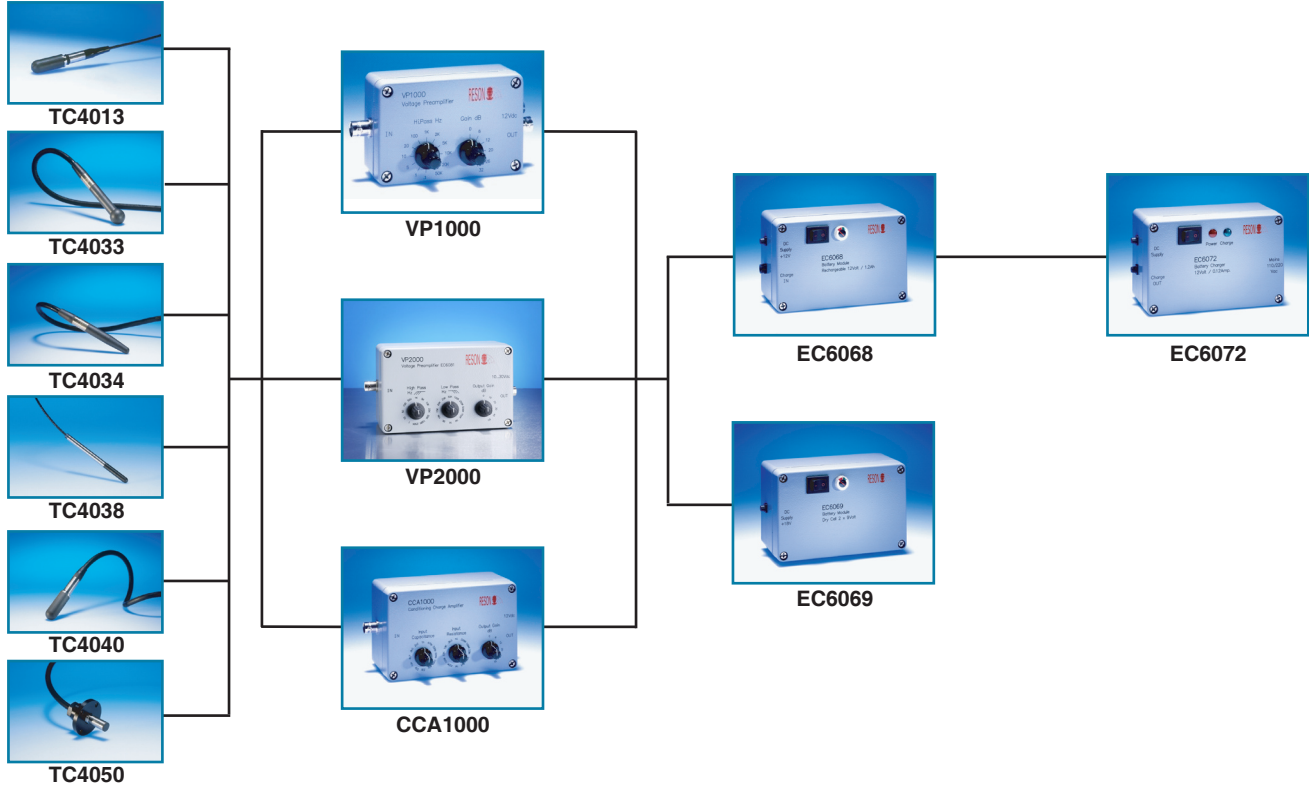


**HYDROPHONES**

**PREAMPLIFIERS**

**DC-SUPPLY**

**CHARGER**



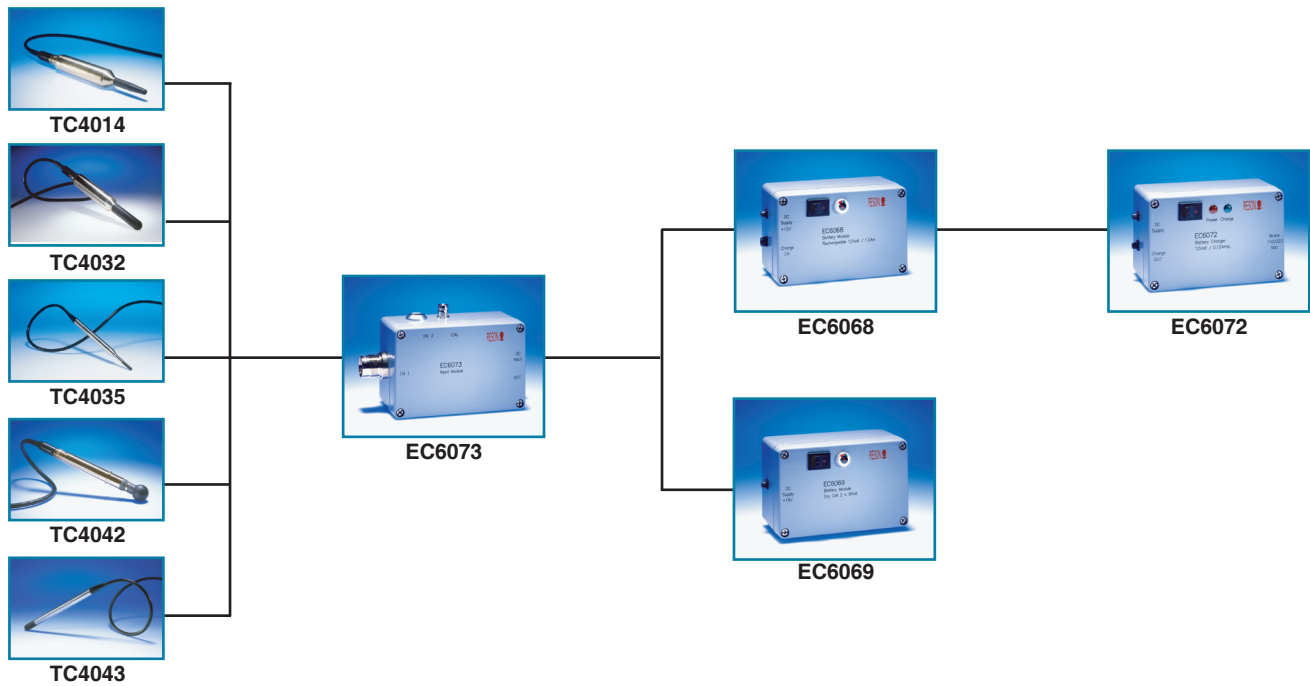
**Hydrophones with integrated preamplifiers, -connections of, for portable use:**

**HYDROPHONES**

**INPUT MODULE**

**DC-SUPPLY**

**CHARGER**

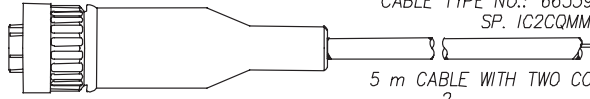




| Model  | Cables  |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---|
|        | TL 8009 | TL 8038 | TL 8042 | TL 8043 | TL 8044 | TL 8045 | TL 8056 | TL 8058 | TL 8059 | TL 8069 | TL 8070 | TL 8078 | TL 8084 | TL 8085 | TL 8086 | TL 8087 | TL 8088 | TL 8089 | TL 8090 | TL 8091 | TL 8092 | TL 8116 |   |
| TC1010 | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| TC1012 | •       |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| TC1026 |         | •       |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| TC1035 |         |         |         | •       | •       | •       |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |   |
| TC1037 |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2024 |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2084 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2115 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2116 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2120 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2122 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2132 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2144 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2149 |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |   |
| TC2170 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | • |
| TC4014 |         |         | •       |         |         |         | •       |         |         |         |         |         |         |         |         |         |         |         |         |         |         | •       |   |
| TC4032 |         |         |         |         |         |         |         | •       | •       |         |         |         |         | •       | •       |         |         |         |         | •       |         |         |   |
| TC4042 |         |         |         |         |         |         |         | •       | •       |         |         |         |         |         | •       | •       |         |         |         | •       |         |         |   |
| TC4043 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |   |
| EC6061 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |   |
| EC6067 |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |   |
| EC6068 |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |   |
| EC6069 |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |   |
| EC6081 |         |         |         |         |         |         |         |         |         |         |         |         | •       |         |         |         |         |         |         |         |         |         |   |

## TL8009

JUPITER RECEPTACLE  
FED F 10 M. T. 04-16. A. 092  
(FEMALE)



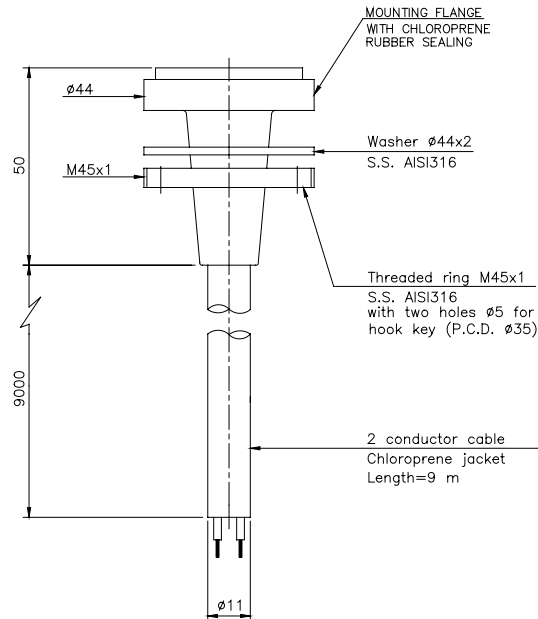
CABLE TYPE NO.: 6635950639  
SP. IC2CQMMU9E

5 m CABLE WITH TWO CONDUCTORS  
2x1 mm<sup>2</sup> AND SHIELD

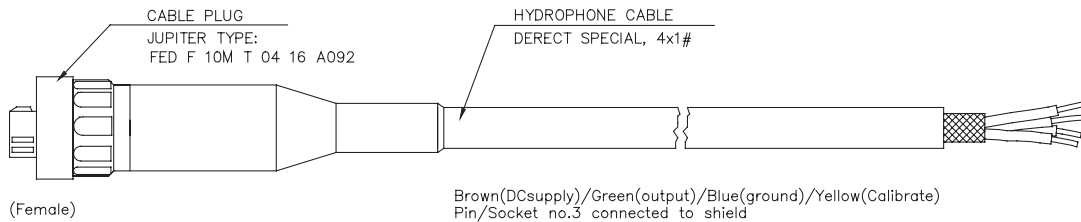
ACCESSORIES:  
(OPTIONAL)

TL8009  
5 m PIGTAIL

## TL8038/8044

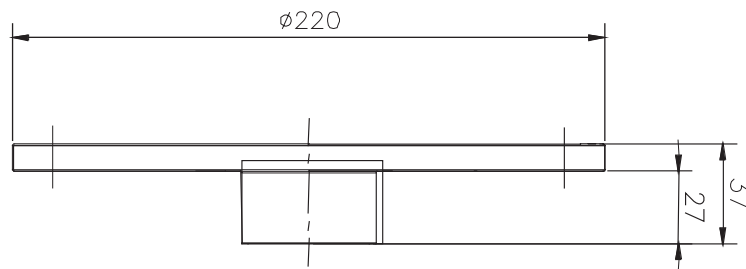


## TL8042



## TL8043

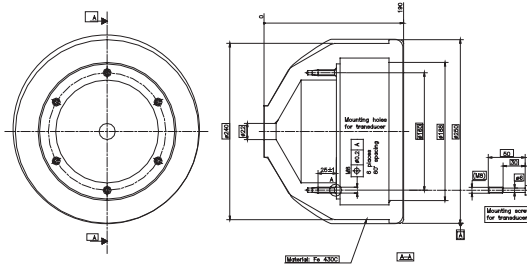
Universal flanges for TC1012 and TC1035



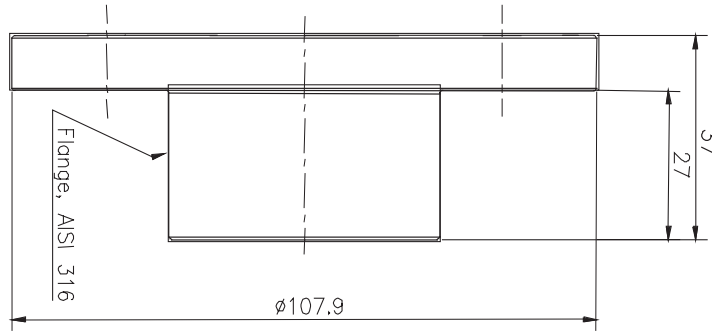




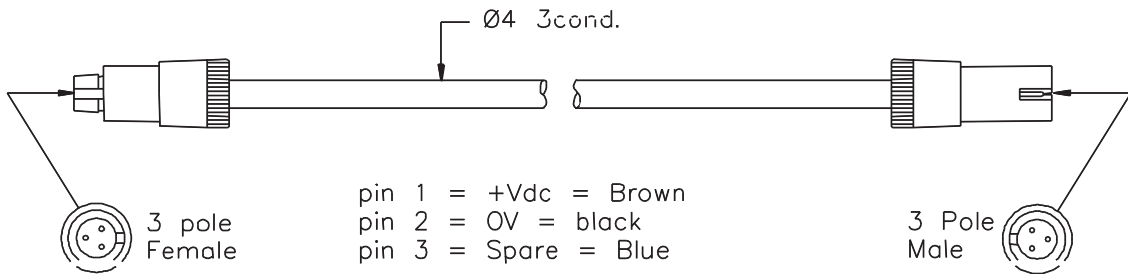
TL8070  
Transducer Housing, large



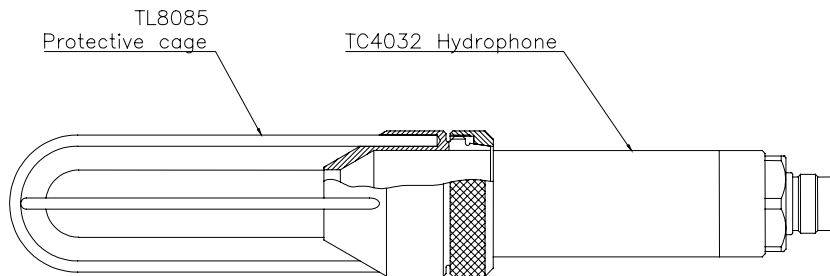
TL8078  
Flange for TC1035



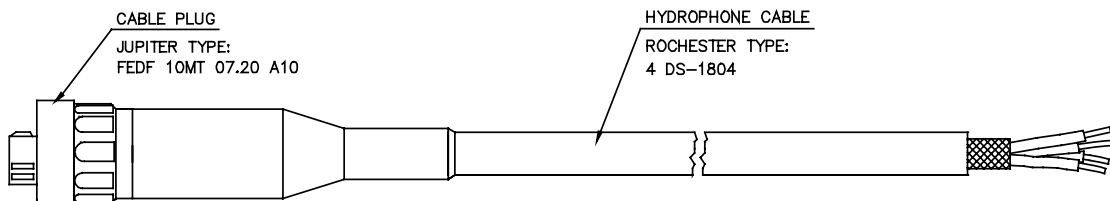
TL8084



TL8085  
Protectiv Cage for TC4032



TL8086





## Electro-Acoustic Properties

| Name                             | Symbol             | Unit                                       | Quick Formula  | Explanation   |
|----------------------------------|--------------------|--|--|---|
| Frequency                        | $f_{\text{kHz}}$   | kHz  | -  | Frequency is cycles per time unit   |
| Input Voltage                    | $V_{\text{in}}$    | Volt-rms                                   | -  | Input voltage at the transducer terminals in rms-value while transmitting   |
| Output Voltage                   | OCV                | Volt-rms                                   | -  | Open Circuit Voltage. Output voltage at the transducer terminals in rms-value while receiving when no current passes its terminals  |
| Electric Impedance               | $Z$                | Ohm  | $Z=V/I= Z \angle\varphi$<br>$ Z ^2=R^2+X^2$                                      | The transducer's impedance, which is the ratio between voltage $V$ and current $I$ . $Z$ is a complex number $Z=R+jX$ with modulus $ Z $ and phase $\varphi$  |
| Electric Phase                   | $\varphi$          | deg  | $\tan(\varphi)=X/R$  | The transducer's phase. The phase angle between the current and the voltage   |
| Electric Resistance              | $R$                | Ohm  | $R= Z \cos(\varphi)$   | Equivalent series resistance. Real part of $Z$ ,  |
| Electric Reactance               | $X$                | Ohm  | $X= Z \sin(\varphi)$   | Equivalent series reactance. Imaginary part of $Z$ ,  |
| Conductance                      | $G_p$              | $\text{Ohm}^{-1}$                          | $R/(R^2+X^2)$  | Equivalent parallel conductance. $G_p=R/ Z ^2 = \cos(\varphi)/ Z $  |
| Electric Power                   | $P_e$              | Watt                                       | $P_{e,\text{in}}=V_{\text{in}}^2 \cdot G_p$                                      | Electrical power at the transducer terminals  |
| Speed of Sound                   | $c$                | m/s  | -  | About ~1500m/s for water  |
| Density                          | $\rho$             | $\text{kg/m}^3$                            | -  | About ~1000 $\text{kg/m}^3$ for water   |
| Pressure                         | $P$                | Pa   | -  | The rms-amplitude of a sound wave. For plane waves in compressible medias $p=\rho \cdot c \cdot u$ where $u$ is the particle velocity.  |
| Acoustic Intensity               | $I_a$              | $\text{Watt/m}^2$                          | $I_a=p^2/(\rho c)$   | Acoustic power per area. Loudness of sound.   |
| Acoustic Power                   | $P_a$              | Watt                                       | $P_a=I_a \cdot A_a$  | Acoustic power  |
| Acoustic Area                    | $A_a$              | $\text{m}^2$                               | Square: $L^2$<br>Circle: $\pi r^2$<br>Sphere: $4\pi r^2$<br>Cylinder: $2\pi r h$ | Any area, through which acoustic energy is transferred. Often used to describe the size of the active sound-emitting parts of a transducer  |
| Efficiency                       | $\eta_{\text{ea}}$ | -  | $\eta_{\text{ea}} = P_{a,\text{out}} / P_{e,\text{in}}$                          | Electric to acoustic efficiency   |
| Directivity Index                | DI                 | dB   | -  | The directivity index is the ratio (in dB) of the maximum intensity produced by the transducer compared to a point source, which is putting out the same acoustic power.  |
| Source Level                     | SL                 | dB re $1\mu\text{Pa}@1\text{m}$            | $SL=TRV+20\log(V_{\text{in}})$   | The source level is the ratio (in dB) of the maximum intensity produced by the transducer at 1m distance compared to the intensity of a plane wave with rms-amplitude $1\mu\text{Pa}$ ( $0.667 \cdot 10^{-18}\text{W/m}^2$ ). |
| Transmitting Response to Voltage | TRV                | dB re $1\mu\text{Pa}/V@1\text{m}$          | -  | Transmit response with respect to voltage taken at the reference distance 1m  |
| Transmitting Response to Current | TRC                | dB re $1\mu\text{Pa}/\text{Amp}@1\text{m}$ | -  | Transmit response with respect to current taken at the reference distance 1m  |
| Receiving Response               | RR                 | dB re $1V/\mu\text{Pa}$                    | $RR=20\log(\text{OCV})-IL$   | Open circuit voltage response with respect to $1\mu\text{Pa}$ . Also called receiving sensitivity.  |
| Intensity Level                  | IL                 | dB re $1\mu\text{Pa}$                      | $IL=20\log(p/1\mu\text{Pa})$   | The intensity level is the ratio (in dB) of an intensity compared to the reference intensity of a plane wave with rms-amplitude $1\mu\text{Pa}$ ( $0.667 \cdot 10^{-18}\text{W/m}^2$ ).                                       |
| Transmitting Loss                | TL                 | dB   | $TL=20\log(r)+\alpha(r-1)$   | The drop in acoustic intensity caused by spherical spreading and attenuation  |



## Electro-Acoustic Equations

| Name                         | Equation (reciprocal transducers)                    | Unit                        |
|------------------------------|--|-----------------------------|
| Source Level                 | $SL = 10\log(P_e) + 10\log(\eta_{ea}) + DI + 170.8$  | [dB re 1 $\mu$ Pa @ 1m]     |
| Transmit Response to Voltage | $TRV = 10\log(G_P) + 10\log(\eta_{ea}) + DI + 170.8$ | [dB re 1 $\mu$ Pa/V @ 1m]   |
| Transmit Response to Current | $TRC = 20\log( Z ) + TRV$                            | [dB re 1 $\mu$ Pa/Amp @ 1m] |
| Receiving Response           | $RR = TRC - 354 - 20\log(f_{kHz})$                   | [dB re 1V/ $\mu$ Pa]        |

## Unit Conversion

| Property | Conversions   |
|----------|---|
| Pressure | $1\text{Pa} = 10^6\mu\text{Pa} = 10^{-5}\text{bar} = 0.145 \cdot 10^{-3}\text{psi} \approx 10^{-5}\text{atm}$ |
| Length   | $1\text{m} = 1.094\text{yd} = 39.4\text{inch}$  |
| Weight   | $1\text{kg} = 2.205\text{lb}$   |

| Unit to convert from        | Unit to convert to          | Conversion formula   |
|-----------------------------|-----------------------------|--|
| X [ $^{\circ}$ C]           | Y [ $^{\circ}$ F]           | $Y = 1.8 \cdot X + 32$   |
| X [dB re 1 $\mu$ Pa]        | Y [ $\text{W}/\text{m}^2$ ] | $Y = 0.667 \cdot 10^{-18} \text{W}/\text{m}^2 \cdot 10^{(X/10)}$           |
| X [ $\text{W}/\text{m}^2$ ] | Y [Pa] rms                  | $Y = (X \cdot 1000\text{kg}/\text{m}^3 \cdot 1500\text{m}/\text{s})^{1/2}$ |
| X [Decibel]                 | Y [Nepers]                  | $X = 8.686 \cdot Y$  |

| Word  | Symbol | Factor     | dB   |
|-------|--------|------------|------|
| tera  | T      | $10^{12}$  | +120 |
| giga  | G      | $10^9$     | +90  |
| mega  | M      | $10^6$     | +60  |
| kilo  | k      | $10^3$     | +30  |
| hekto | h      | $10^2$     | +20  |
| deca  | da     | $10^1$     | +10  |
| -     | -      | $10^0$     | 0    |
| deci  | d      | $10^{-1}$  | -10  |
| centi | c      | $10^{-2}$  | -20  |
| milli | m      | $10^{-3}$  | -30  |
| mikro | $\mu$  | $10^{-6}$  | -60  |
| nano  | n      | $10^{-9}$  | -90  |
| pico  | p      | $10^{-12}$ | -120 |

| Property    | SI/unit      | Symbols         | Comment                |
|-------------|--------------|-----------------|------------------------|
| Length      | Meter        | 1m              | -                      |
| Area        | Square meter | 1m <sup>2</sup> | -                      |
| Volume      | Cubic meter  | 1m <sup>3</sup> | -                      |
| Weight      | Kilograms    | 1kg             | -                      |
| Time        | Seconds      | 1s              | -                      |
| Temperature | Celsius      | 1 $^{\circ}$ C  | or Kelvin              |
| Energy      | Joule        | 1J              | -                      |
| Charge      | Coulomb      | 1C              | -                      |
| Voltage     | Volts        | 1V              | -                      |
| Impedance   | Ohm          | 1 $\Omega$      | Electrical             |
| Impedance   | Rayl         | 1Rayl           | Acoustical             |
| Current     | Ampere       | 1A              | 1C/s                   |
| Conductance | Siemens      | 1S              | $\Omega^{-1}$          |
| Power       | Watt         | 1W              | 1J/s                   |
| Force       | Newton       | 1N              | 1kg · m/s <sup>2</sup> |
| Pressure    | Pascal       | 1Pa             | 1N/m <sup>2</sup>      |

## Definitions, References and Decibels

### The Decibel:

A decibel is, regardless of the sort of application, always ten times the logarithmic (base ten denoted log<sub>10</sub> or simply log) function of a number. That is:

$$x_{dB} \equiv 10 \log_{10}(x)$$

The decibel is often used when the range of x is very broad – say from 0.0001 to 10000 – and the advantage is that the decibel “compresses” x. The table below shows some examples.

|                 |        |       |      |     |   |    |     |      |       |
|-----------------|--------|-------|------|-----|---|----|-----|------|-------|
| x               | 0.0001 | 0.001 | 0.01 | 0.1 | 1 | 10 | 100 | 1000 | 10000 |
| x <sub>dB</sub> | -40    | -30   | -20  | -10 | 0 | 10 | 20  | 30   | 40    |

The logarithmic function, and therefore also the decibel, is only defined for dimensionless x, which means that x cannot have a unit like e.g. meters or Watt. Because of this, x is very often a fraction of two numbers with units; the numerator being the quantity of interest and the denominator being the *reference*.

$$x_{dB} = 10 \log$$

The reference concept is very important for the proper understanding of decibels because it uniquely determines what the decibel number is referring to. An example should clarify this point. If for example “a” is the length of a stick, say a=1.3m, we cannot give the length of a in decibels before we choose a reference distance simply because log(a) doesn’t make sense when “a” has a unit. However, if we choose 1m as the reference we can express “ $\frac{1.3m}{1m}$ ” dB relative to 1m. That is:

$$a_{dB} = 10 \log \left( \frac{1.3m}{1m} \right) = 10 \log(1.3) = 1.14dB \text{ re } 1m$$

Notice that the result “1.14dB re 1m” specifically points out that the chosen reference is 1m, which enable the reverse calculation back to a=1.3m from the dB. Therefore, even when the reference is left out in formulas to save time and writing, all dB numbers refer to references and any dB number only makes sense if it is clear what the reference is.

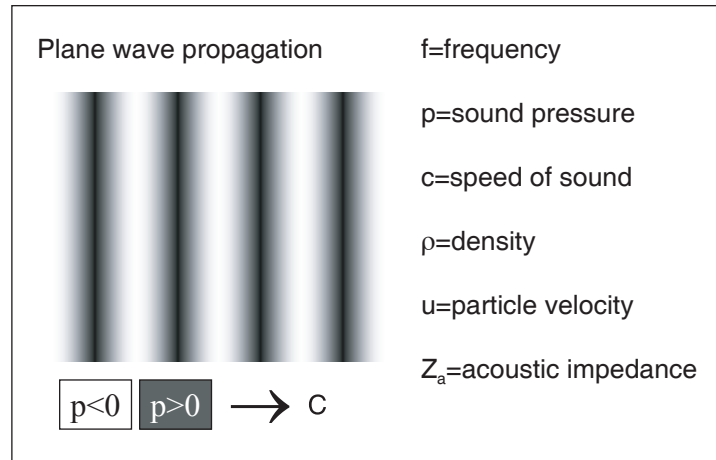
The decibel and other logarithmic functions have some nice properties whereof the most important is that multiplication becomes summation. The laws of logarithmic functions are:

$$\begin{aligned} \log_k(a \cdot b) &= \log_k(a) + \log_k(b) \\ \log_k(a/b) &= \log_k(a) - \log_k(b) \\ \log_k(a^n) &= n \log_k(a) \end{aligned}$$

The last rule is often applied when the property “a” can be expressed as e.g. the square of some pressure, voltage or distance. A missing subscript k usually refers to the logarithm with base ten k=10, but it can also mean the natural logarithm ln(x) with base k=e=2.7183.

## Underwater sound:

Sound is disturbances of the medium – here water – travelling in a 3 dimensional manner as the disturbance propagate with the speed of sound. The sound is defined as a plane wave when the sound propagates in a single direction i.e. the lines for uniform phase are straight.



Acoustic impedance is perhaps the most basic concepts of underwater sound because its definition is a constitutive equation (one from which others are derived) for underwater sound propagation. The relation is:

$$p \equiv Z_a \cdot u \quad , \text{and for a plane wave } Z_a = \rho \cdot c$$

This definition is analogous to Ohm's law for electrical circuits i.e.  $V=R \cdot I$  and you can often think of particle velocity, acoustic impedance and sound pressure in the same way. Mechanical engineers may think of Newton's law  $F=m \cdot a$  as an analogy. It shows that particle velocity and pressure are in phase in a plane sound wave.

Acoustic intensity – power ( $P_a$ ) per unit area ( $A_a$ ) or energy flux - is used to describe levels of underwater sound like e.g. an echo, a whale's call or a signal from a remote transducer. The intensity of a plane harmonic wave is:

$$I_a = \frac{P_{rms}^2}{\rho \cdot c} = \frac{P_a}{A_a}$$

The daily term “a high sound” refers to a sound with a high intensity. A reference intensity  $I_{ref}$  has been defined in order to enable direct comparison of the loudness of sounds and the reference intensity used in underwater acoustics is that of a plane harmonic wave with an rms-pressure of  $1\mu Pa$ , which for ordinary seawater with  $c \approx 1500m/s$  and  $\rho \approx 1000kg/m^3$  gives

$$I_{ref} = \frac{(1 \mu Pa)^2}{1000 \frac{kg}{m^3} \cdot 1500 \frac{m}{s}} = \frac{10^{-12}}{1.5 \cdot 10^6} \frac{W}{m^2} = 0.667 \cdot 10^{-18} \frac{W}{m^2}$$

The intensity level (IL=how high a sound is) is the intensity of the sound wave taken in decibels relative to the reference intensity of  $1\mu Pa$  plane wave rms-pressure (which is shortened to “re  $1\mu Pa$ ”):

$$IL = 10 \log \left( \frac{I}{0.667 \cdot 10^{-18} \frac{W}{m^2}} \right) dB \text{ re } 1\mu Pa$$

The intensity level is thus the loudness of a sound at a field point, which is different from the loudness of a source of sound because the intensity level decreases as the distance to the source increases. The intensity level of a sound is for example 200dB re  $1\mu Pa$ , which is the same as  $I = I_{ref} \cdot 10^{(200dB/10)} = 66.7W/m^2$ .



## Beam patterns and Directivity:

The beam pattern of a transducer contains information about the transducer's spatial response i.e. how it transmits or receives in different directions. Transducers that are very small compared to the wavelength have omnidirectional beams, which means that the energy is not concentrated in any particular direction. Transducers that are large compared to the wavelength have a very directive beam pattern, which means that their energy is concentrated in a specific direction.

The beam width, which is the angle subtended by the points where the intensity has dropped 3dB below the maximum on-axis response, is often used as an indicator of how concentrated the energy is for a specific transducer in a given cross section.

The directivity index of a transmitter describes how concentrated the transmitted energy is at the maximum response point and for receivers the directivity index indicates the ability to discriminate a signal from an ambient background noise, both cases relative to an omnidirectional transducer.

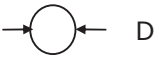
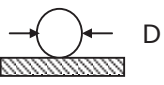

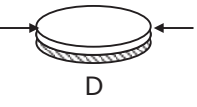
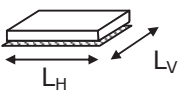
| Source Type           | -3dB Beam Width  | Directivity Index   | Sketch   | Beam Shape            | Validity Conditions   |
|-----------------------|--|---|--|-----------------------|---|
| Point                 | 360°   | ≈ 0dB   |    | Spherical             | $D \ll \lambda$   |
| Point (baffled)       | 180°   | ≈ 3dB   |    | Half spherical        | $D \ll \lambda$   |
| Line (baffled)        | $\beta \approx \frac{76200}{f_{kHz} \cdot L_{mm}}$   | $DI \approx 10 \log \left( \frac{100}{\beta} \right)$   |   | Toroidal              | $L > \lambda$<br>L in [mm]<br>f in [kHz]<br>$\beta$ in [deg]<br>DI in [dB]                            |
| Disc (baffled)        | $\beta \approx \frac{91440}{f_{kHz} \cdot D_{mm}}$   | $DI \approx 10 \log \left( \frac{36000}{\beta^2} \right)$   |  | Conical               | $D > \lambda$<br>D in [mm]<br>f in [kHz]<br>$\beta$ in [deg]<br>DI in [dB]                            |
| Rectangular (baffled) | $\beta_H \approx \frac{76200}{f_{kHz} \cdot L_H}$<br>$\beta_V \approx \frac{76200}{f_{kHz} \cdot L_V}$ | $DI \approx 10 \log \left( \frac{31600}{\beta_H \cdot \beta_V} \right)$                                 |  | Shell-like or conical | $L_H, L_V > \lambda$<br>$L_H, L_V$ in [mm]<br>f in [kHz]<br>$\beta_H, \beta_V$ in [deg]<br>DI in [dB] |
| Arbitrary (baffled)   | $\beta_H, \beta_V$   | $DI \approx 10 \log \left( \frac{2.455}{\sin(\frac{\beta_H}{2}) \cdot \sin(\frac{\beta_V}{2})} \right)$ |  | Shell-like or conical | $\beta_H < 180^\circ$<br>$\beta_V < 180^\circ$<br>$\beta_H, \beta_V$ in [deg]<br>DI in [dB]           |

Table 1: Approximations to far-field beam width and directivity index for various sources. Formulas for finding beam widths assume that the speed of sound is  $c \approx 1500\text{m/s}$  ( $c = \lambda \cdot f$ ). Notice that the beam width of a transducer is the same whether it is transmitting or receiving.

The nearfield (or Fresnel field) of a transducer is characterized by irregularity and changes due to refraction effects leading to the fact that the interference pattern (the beam) has not yet been fully formed. The Rayleigh distance  $r_0$  can approximate the nearfield extension:

$$r_0 \approx A_{\text{active}} / \lambda$$

$A_{\text{active}}$  is the active area of the transducer's face. For line arrays, cylindrical arrays and the like it is often better to use  $A_{\text{active}} = (L_{\text{max}})^2$  where  $L_{\text{max}}$  is the longest dimension found on the active face of the transducer. The farfield (Fraunhofer field) precedes the nearfield after a transition region and is characterized by spherical spreading and regular beam patterns.

## Underwater Sound Transmission:

Sounds originating from acoustic sources are measured in intensity level, which decreases as the distance to the source is increased due to transmission loss (TL) i.e. spreading and absorption:

$$IL = SL - TL = SL - \underbrace{20\log(r)}_{\text{Spreading}} - \underbrace{\alpha \cdot (r-1m)}_{\text{Attenuation}}$$

The formula assumes spherical spreading for the transmission loss i.e. the sound is unbounded and spreads out like it was originating from a point – the acoustic center of the source.

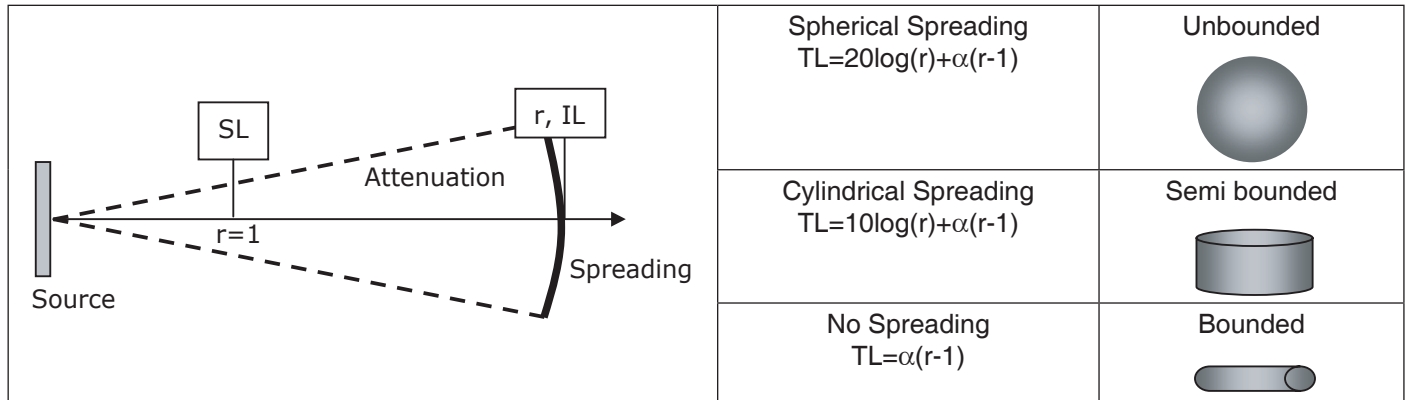


Figure 1: Schematics of sound transmission with different kind of spreading

Spherical spreading is most common and is valid in the far field required that the source is placed far enough from any large structure. Cylindrical spreading occurs for example in shallow waters when the bottom and the surface reflects the sound and forces it to spread like a cylinder. When the sound is completely bounded (e.g. inside a pipe) it cannot spread and only absorption remains in the formula for transmission loss.

The last term of the transmission loss is the attenuation, which increases very significantly with the frequency and furthermore varies with pressure, temperature, salinity and acidity. Accurate approximations are hard to come by, but the following approximation may be used:

| Description  | Equation   | Remarks   |
|--|--|---|
| Absorption coefficient of sound in seawater at the sea surface | $\alpha_0 \approx A \cdot S \cdot \frac{f_T \cdot f^2}{f_T^2 + f^2} + B \cdot \frac{f^2}{f_T}$ | $\alpha_0$ =attenuation [dB/m]<br>A=2.34·10 <sup>-6</sup> Np/m (Empirical constant)<br>B=3.38·10 <sup>-6</sup> Np/m (Empirical constant)<br>f=frequency [kHz]<br>f <sub>T</sub> =relaxation frequency [kHz]<br>S=salinity [ppt] |
| Correction for Temperature                                     | $F_T = 21.9 \cdot 10 \left( 6 - \frac{1520}{T+273} \right)$                                    | f <sub>T</sub> =relaxation frequency [kHz]<br>T=temperature [°C]<br>T=20°C: f <sub>T</sub> =142kHz  |
| Correction for depth   | $\alpha_d = \alpha_0 (1 - 6.33 \cdot 10^{-5} \cdot D)$   | $\alpha_d$ =attenuation at depth d>0m [dB/m]<br>$\alpha_0$ =attenuation at d=0m [dB/m]<br>D=depth [m]   |

Table 2: Approximate formula by Schulkin & Marsh for the sound attenuation in seawater<sup>1</sup>

<sup>1</sup> Reference: Schulkin, M., and H. W. Marsh: "Absorption of sound in seawater", J. Brit. IRE, 25:493 (1963). Also, "Sound Absorption in Sea Water", J. Acoust. Soc. Am., 34:864 (1962).

Following Schulkin & Marsh's approximate expressions, the special case of freshwater ( $S \approx 0$ ppt) at room temperature ( $T=20^\circ\text{C}$ ) and surface pressure ( $D=0$ m) gives the very simple formula for  $\alpha$ [dB/m] as a function of the frequency  $f$ [kHz]:

$$\alpha \approx 2.06 \cdot 10^{-7} \frac{dB}{m \cdot kHz^2} \cdot f^2_{kHz}$$

It should be noted that the effect of having saltwater (North Atlantic  $S \approx 35$ ppt) instead of freshwater ( $S \approx 0$ ppt) is significant.

The speed of sound is a very important parameter in any echo-sounding system where a range is determined based upon the elapsed time and the speed of sound. The speed of sound can be approximated with a simple formula:

| Description                | Equation  | Remarks   | Limits   |
|----------------------------|---|---|--|
| Speed of sound in seawater | $c \approx 1449.2 + 4.6T$<br>$- 5.5 \cdot 10^{-2}T^2 + 2.9 \cdot 10^{-4}T^3$<br>$+ (1.34 - 10^{-2}T)(S - 35)$<br>$+ 1.6 \cdot 10^{-2}D$ | $c$ =speed of sound [m/s]<br>$T$ =temperature [ $^\circ\text{C}$ ]<br>$S$ =salinity [ppt]<br>$D$ =depth [m] | $0 \leq T \leq 35^\circ\text{C}$<br>$0 \leq S \leq 45$ ppt<br>$0 \leq d \leq 1000$ m |

Table 3: Approximate formula by Medwin for the speed of sound in seawater<sup>2</sup>

If we take the special case of freshwater ( $S \approx 0$ ppt) at room temperature ( $T=20^\circ\text{C}$ ) and surface pressure ( $D=0$ m) again Medwin's formula yields:

$$c \approx 1482 \text{ m/s}$$

The corresponding result for North Atlantic seawater ( $S \approx 35$ ppt,  $T=20^\circ\text{C}$ ,  $D=0$ m) would leave a higher speed of sound  $c \approx 1522$ m/s. The speed of sound is by definition the frequency multiplied with the wavelength:

$$c \approx f \cdot \lambda$$

The frequency cannot change, which implies that when the speed of sound changes the wavelength changes accordingly and this forces the sound to refract ("bend") in order to enable the change in wavelength – see Figure 2.

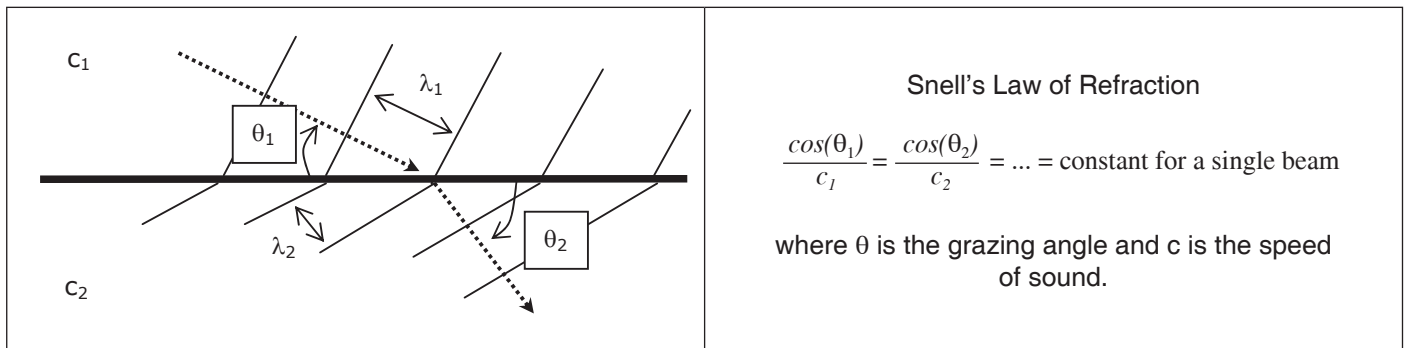


Figure 2: Sketch of refraction (ray bending).

Snell's Law of refraction gives the bending angle of the sound "ray" i.e. that particular grazing angle indicating the change in the ray propagation direction. Ray bending is only significant when the speed of sound changes and then usually only at large ranges. For more information on sound refraction and ray bending see Urlick<sup>3</sup>.

<sup>2</sup> Reference: Medwin, H.: "Speed of Sound in Water For Realistic Parameters", J. Acoust. Soc. Am. 58:1318 (1975)

<sup>3</sup> Urlick, Robert J.: "Principles of underwater sound, 3rd edition". McGraw-Hill Book Company, 1983

## Sound levels:

The source level of an acoustic source compares the intensity emitted by the acoustic source to a reference source. This of course, also enables direct comparison of acoustic sources with each other i.e. which one is the most powerful? The reference source is an omni directional source (DI=0dB) with an acoustic output power of 1W taken at the reference distance  $r=1m$  from the acoustic center. In terms of acoustic intensity the reference source has an acoustic intensity  $I_0$ :

$$I_0 = \frac{P_{a,0}}{A_{sphere}} = \frac{1W}{4\pi(1m)^2} = 0.0796W/m^2 @ 1m$$

In dB relative to the reference intensity  $I_{ref}$  this is

$$I_{0,dB} = 10\log\left(\frac{I_0}{I_{ref}}\right) = 10\log\left(\frac{0.0796W/m^2}{0.667 \cdot 10^{-18}W/m^2}\right) = 170.8 \text{ dB re } 1\mu Pa @ 1m$$

This is where the (to some well-known) reference level 170.8dB re 1 $\mu$ Pa @ 1m derives from and it should be noted that the “dB re 1 $\mu$ Pa @ 1m” should be understood as “the intensity level relative to the intensity of a plane wave with an rms-pressure of 1 $\mu$ Pa taken at the reference distance 1m from the source”. Most acoustic sources have an acoustic power output different from 1W and they are not always omni-directional. To find the source level of such a more generic source we simply add (in dB) the directivity and the ratio of power output relative to 1W:

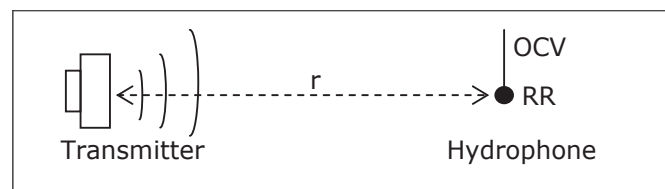
$$SL = 10\log(P_a) + DI + 170.8dB \text{ re } 1\mu Pa @ 1m$$

In this formula, and in many similar, it is always understood that Pa is relative to unity with the proper unit assigned i.e. 1W. So “Pa” is really an abbreviation for “Acoustic output power relative to 1W” just like “DI” is short for directivity relative to an omni-directional source. The transmit response to voltage, TRV, is defined in such a way that the source level can be calculated from:

$$SL = TRV + 20\log(V_{in})$$

The TRV value is, however, often measured at low power and since the electric-to-acoustic efficiency can drop significantly with increased power levels it is often best to use the TRV relation with caution. It should be emphasized that the number and term source level refers to an acoustic source, not to the level of a particular sound, and that a source level is merely a practical definition.

The source level of a transmitter can be estimated (ignoring attenuation) by measuring the output voltage of a hydrophone submerged in the vicinity of the transmitting transducer, see the sketch below.



$$SL = 20\log(OCV) - RR + 20\log\left(\frac{r}{1m}\right)$$

For an example, the hydrophone has a receive response  $RR=-190dB$  re 1V/ $\mu$ Pa with an open circuit (output) voltage  $OCV=2.4V_{rms}$  on its terminals. This means that the intensity level at the hydrophone is  $IL=20\log(2.4V_{rms}) - (-190dB \text{ re } 1V/\mu Pa) = 197.6dB \text{ re } 1\mu Pa$  and if the distance between the hydrophone and the transmitter is  $r=4m$  the source level is calculated from  $SL=IL+ 20\log(4m/1m)=209.6dB \text{ re } 1\mu Pa @ 1m$ .