

UNIVERSIDAD POLITECNICA DE VALENCIA

ESCUELA POLITECNICA SUPERIOR DE GANDIA

Grado en Ing. Sist. de Telecom., Sonido e Imagen

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UNIVERSIDAD  
POLITECNICA  
DE VALENCIA



ESCUELA POLITECNICA  
SUPERIOR DE GANDIA

**“Estudio de la calibración de sensores acústicos por el método de reciprocidad para diferentes geometrías. Aplicación a la evolución temporal de la sensibilidad de los hidrófonos en instalaciones *in situ*.”**

**TRABAJO FINAL DE GRADO**

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**GANDIA, 2016**

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## 7. ANEXOS

### 7.1. Hojas de características de los fabricantes

A continuación se muestran las hojas de características facilitadas por los fabricantes.

#### 7.1.1. SX30FR

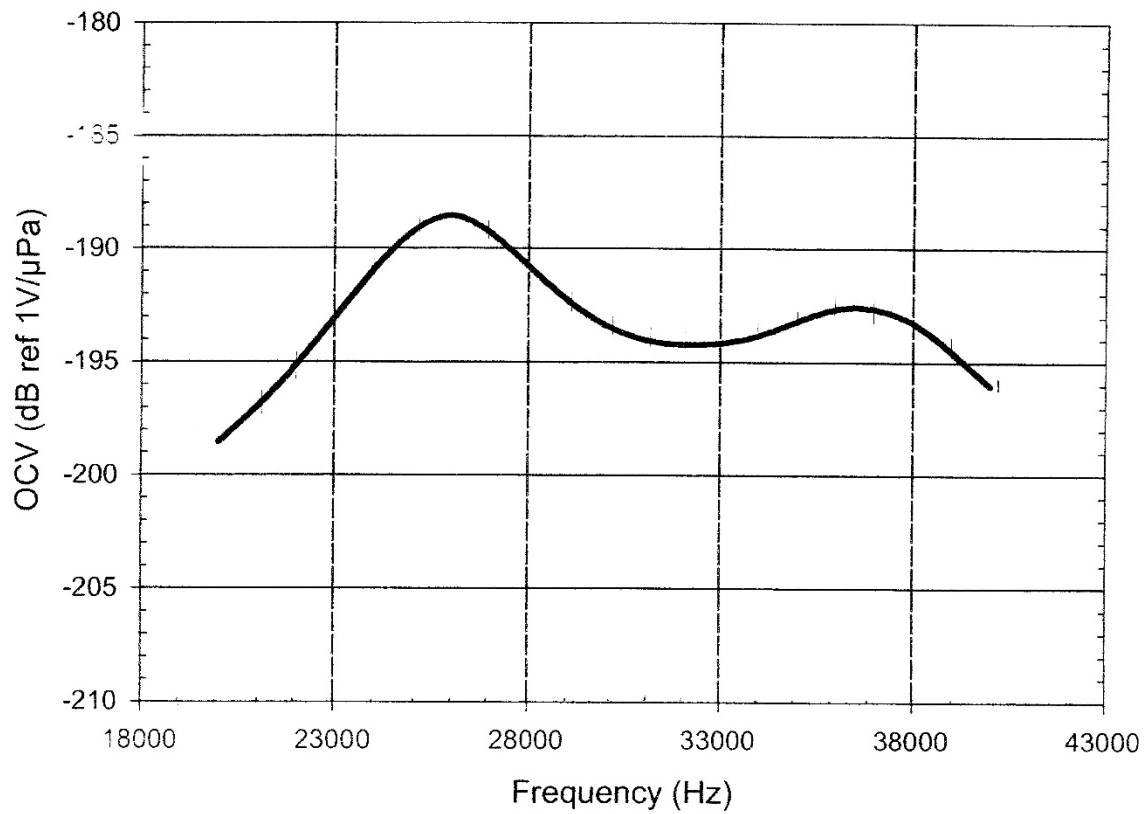
		Sensor Technology Limited		
Free Flooded Rings		TRANSDUCERS		
<div style="display: flex; justify-content: space-around;">   </div>				
<b>FREE FLOODED RINGS</b>				
Free flooded rings are efficient transducers that provide reasonable power levels over wide range of frequencies and deep ocean capability. These transducers are simple radiators and yet have the advantage that the output is virtually independent of depth. Its radiation pattern is omni-directional in the plane perpendicular to the axis of the ring, while the directivity in the other planes depends on the length of the cylinder.				
Sensor Technology Limited manufactures free flooded transducers from a wide range of ceramic rings and sizes. These transducers can be supplied from 10kHz to over 60kHz.				
Please contact our <a href="#">technical support</a> for further details or to discuss your specific needs.				
Characteristics	SX30	SX60		
<b>Resonance Frequency</b> ( kHz )	30	60		
<b>Transmit Voltage Response, TVR</b> ( dB Ref. 1 $\mu$ Pa/Volt@1 metre )	133	132		
<b>Receive Voltage Response, OCV</b> ( dB Ref. 1 Volt/ $\mu$ Pa )	-193	-200		
<b>Useable Frequency Range</b> ( kHz )	20-40	40-70		
<b>Beam Pattern</b> - Radial - Axial	Omni Toroidal (60°)	Omni Toroidal (60°)		
<b>Efficiency</b> ( % min )	50	50		
<b>Input Power</b> ( 2% Duty Cycle )	300W	300W		
<b>Operating Depth</b> ( Metres )	Unlimited	Unlimited		
<b>Cable</b>	1N2	1N2		



20 Stewart Rd, Collingwood, ON, Canada L9Y 4K1  
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[www.sensortech.ca](http://www.sensortech.ca)    [techsupport@sensortech.ca](mailto:techsupport@sensortech.ca)

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## Receiving Voltage Response

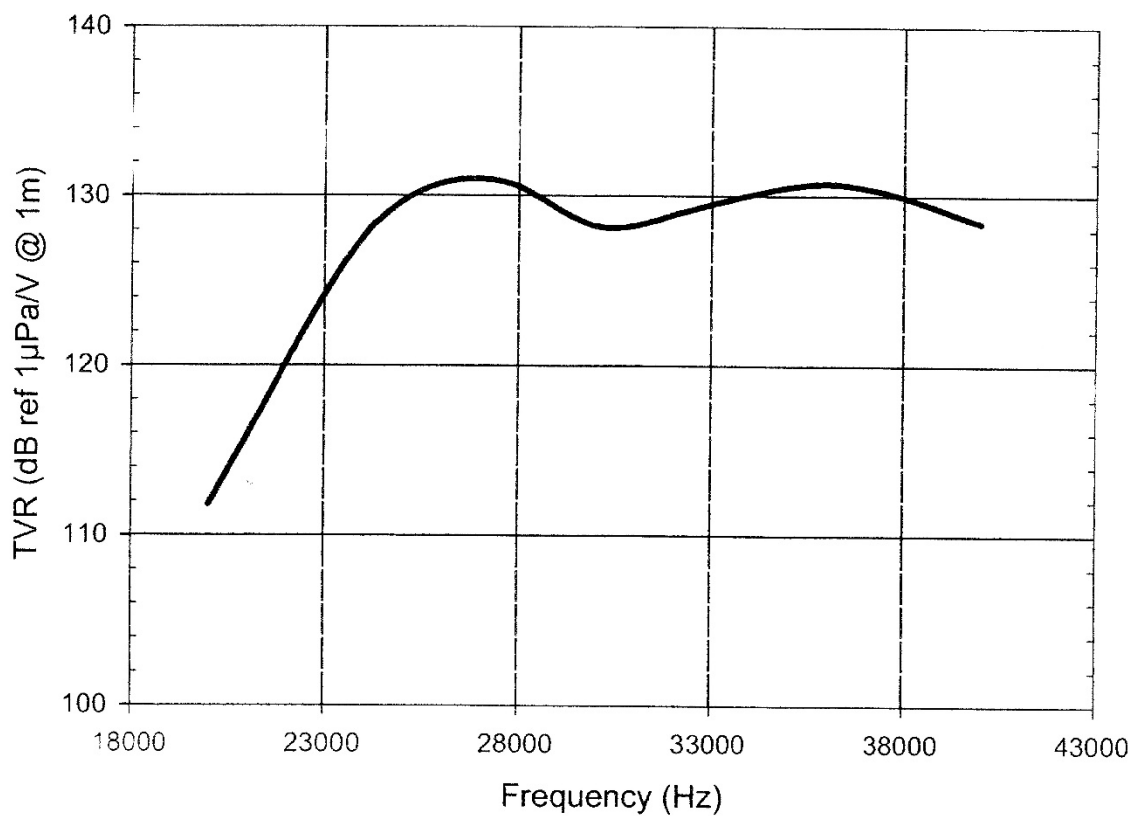


Date: June 6, 2008  
Acoustic Test Facility: Sensor Technology Limited  
Transducer Model: SX30FR  
Serial Number: 08195-530  
Water Temperature: 20°C (68°F)  
Test Frequency: 20 to 40 kHz  
Spacing: 0.7 meters  
Depth: 0.6 meters  
Plane: XY

**SENSOR**

Sensor Technology Limited

## Transmitting Voltage Response



Date: June 6, 2008  
Acoustic Test Facility: Sensor Technology Limited  
Transducer Model: SX30FR  
Serial Number: 08195-530  
Water Temperature: 20°C (68°F)  
Test Frequency: 20 to 40 Hz  
Spacing: 0.74 meters  
Depth: 0.6 meters  
Plane: XY

**SENSOR**

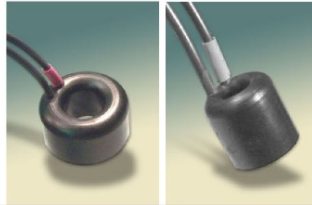
Sensor Technology Limited

## 7.1.2. SX60FR

**SENSOR**

Sensor Technology Limited

Free Flooded Rings

**TRANSDUCERS****FREE FLOODED RINGS**

Free flooded rings are efficient transducers that provide reasonable power levels over wide range of frequencies and deep ocean capability. These transducers are simple radiators and yet have the advantage that the output is virtually independent of depth. Its radiation pattern is omni-directional in the plane perpendicular to the axis of the ring, while the directivity in the other planes depends on the length of the cylinder.

Sensor Technology Limited manufactures free flooded transducers from a wide range of ceramic rings and sizes. These transducers can be supplied from 10kHz to over 60kHz.

Please contact our [technical support](#) for further details or to discuss your specific needs.

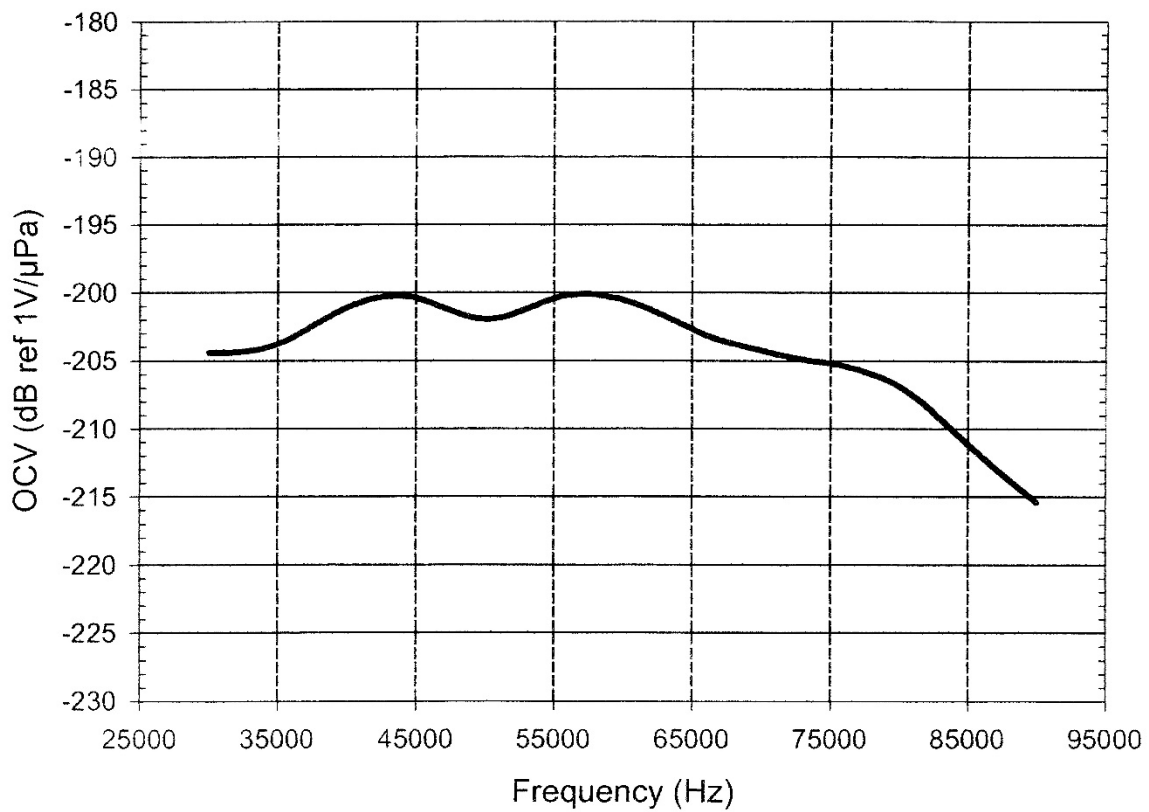
Characteristics	SX30	SX60
<b>Resonance Frequency</b> ( kHz )	30	60
<b>Transmit Voltage Response, TVR</b> ( dB Ref. 1 $\mu$ Pa/Volt@1 metre )	133	132
<b>Receive Voltage Response, OCV</b> ( dB Ref. 1 Volt/ $\mu$ Pa )	-193	-200
<b>Useable Frequency Range</b> ( kHz )	20-40	40-70
<b>Beam Pattern</b> - Radial - Axial	Omni Toroidal (60°)	Omni Toroidal (60°)
<b>Efficiency</b> ( % min )	50	50
<b>Input Power</b> ( 2% Duty Cycle )	300W	300W
<b>Operating Depth</b> ( Metres )	Unlimited	Unlimited
<b>Cable</b>	1N2	1N2



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## Receiving Voltage Response

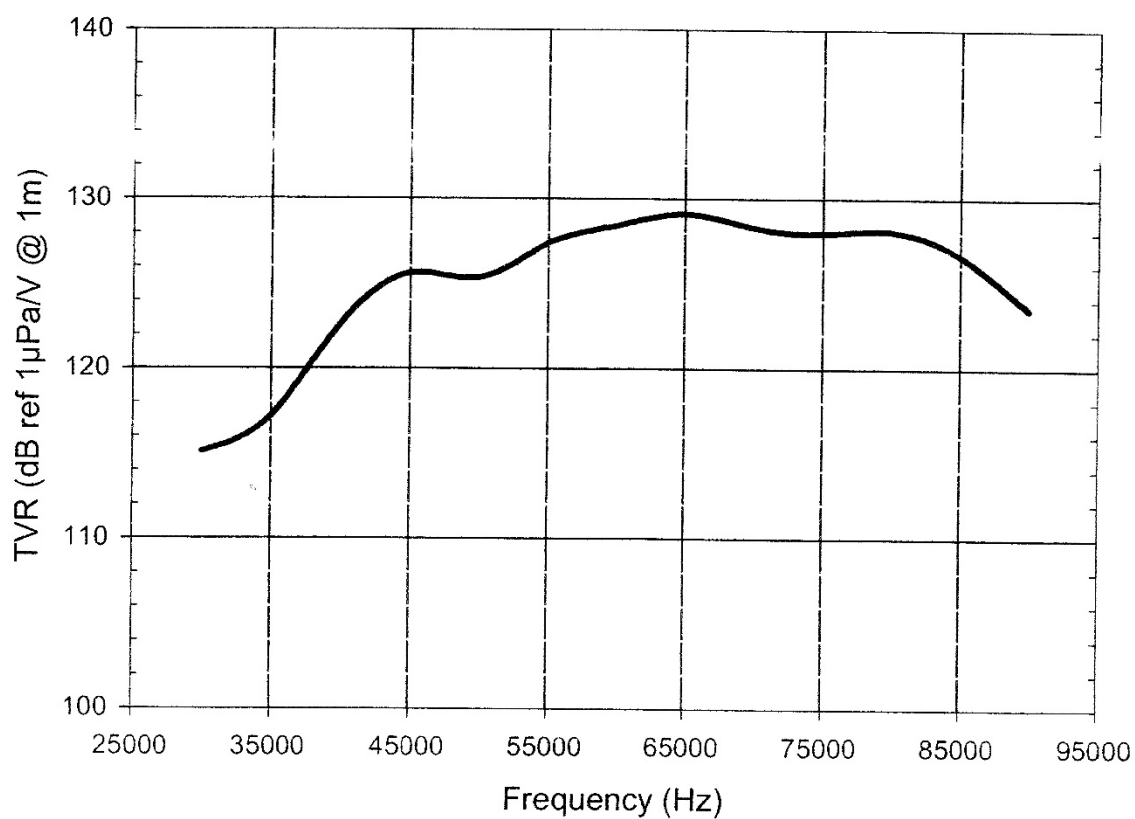


Date: June 6, 2008  
Acoustic Test Facility: Sensor Technology Limited  
Transducer Model: SX60FR  
Serial Number: 08194-525  
Water Temperature: 20°C (68°F)  
Test Frequency: 30 to 90 kHz  
Spacing: 0.74 meters  
Depth: 0.6 meters  
Plane: XY



Sensor Technology Limited

## Transmitting Voltage Response



Date: June 6, 2008  
Acoustic Test Facility: Sensor Technology Limited  
Transducer Model: SX60FR  
Serial Number: 08194-525  
Water Temperature: 20°C (68°F)  
Test Frequency: 30 to 90 Hz  
Spacing: 0.74 meters  
Depth: 0.6 meters  
Plane: XY



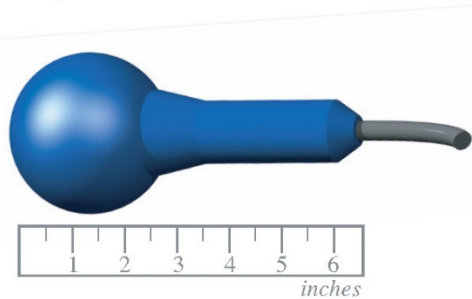
Sensor Technology Limited



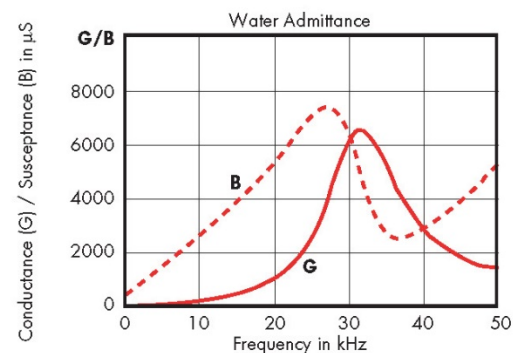
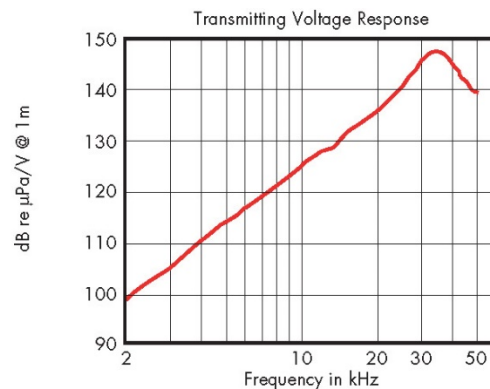
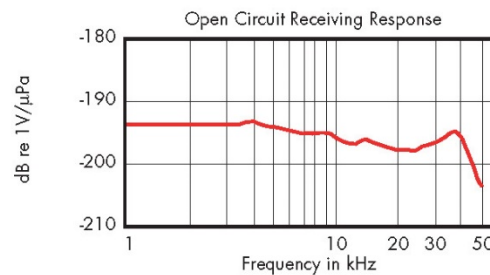
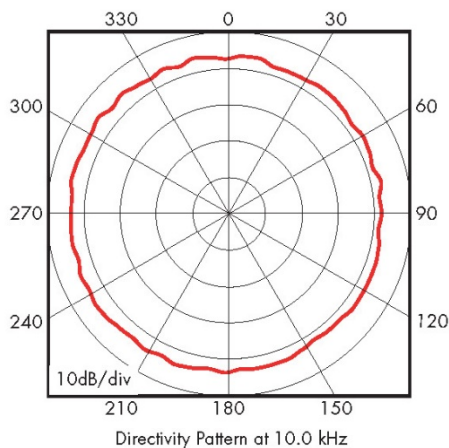
## 7.1.3. ITC-1032

**Model ITC-1032***Deep Water  
Omnidirectional Transducer*

**The Model ITC-1032** spherical transducer offers broadband omnidirectional transmitting and receiving response with efficiencies of over 50%. This transducer is fabricated of Channelite-5400 lead zirconate titanate ceramic and is particularly well suited for noise sources as a broadband hydrophone and applications where an omnidirectional response is required.

**Specifications (Nominal)**

<b>Type</b>	Projector/Hydrophone
<b>Resonance Frequency <math>f_r</math></b>	33 kHz
<b>Depth</b>	1250 meters
<b>Envelope Dimensions (in.)</b>	2.7D
<b>TVR at <math>f_r</math></b>	149 dB// $\mu\text{Pa}/\text{V}@1\text{m}$
<b>Midband OCV</b>	-194 dB// $1\text{V}/\mu\text{Pa}$
<b>Suggested Band</b>	.01 - 50 kHz
<b>Beam Type</b>	Spherical
<b>Input Power</b>	800 watts



International Transducer Corporation

869 Ward Drive, Santa Barbara, CA 93111  
805.683.2575 • 805.967.8199 FAX

[www.itc-transducers.com](http://www.itc-transducers.com)

Model ITC-1032

## 7.1.4. TC4034



## TC4034

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

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 100 kHz)
Transmitting sensitivity:	122dB $\pm$ 3dB (typical) 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):	1.6 kg
Cable (length and type):	Standard 10m shielded pair DSS-2MIL-C915. Optional cable length available on request
Encapsulating Material:	Special formulated NBR
Metal body:	Alu-bronze - AlCu10Ni5Fe4
Connector type:	BNC



## 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:**

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

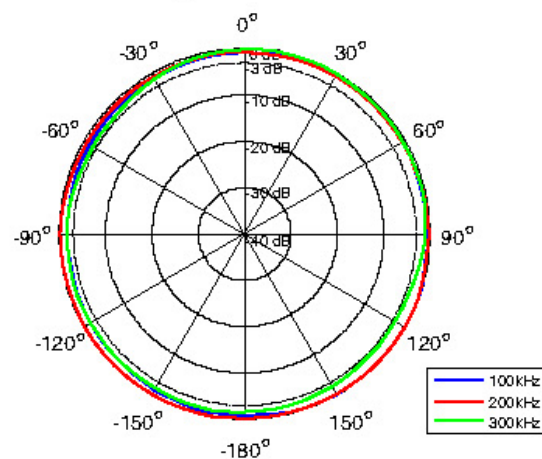
Receiving sensitivity:  
5 kHz to 600 kHz

Transmitting sensitivity:  
5 kHz to 600 kHz

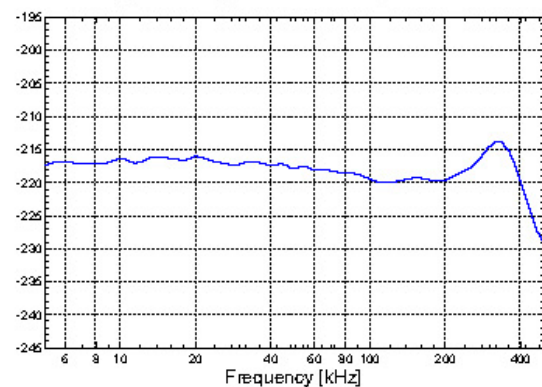
Horizontal directivity:  
At 100, 200, 300 kHz

Impedance:  
5 kHz to 600 kHz

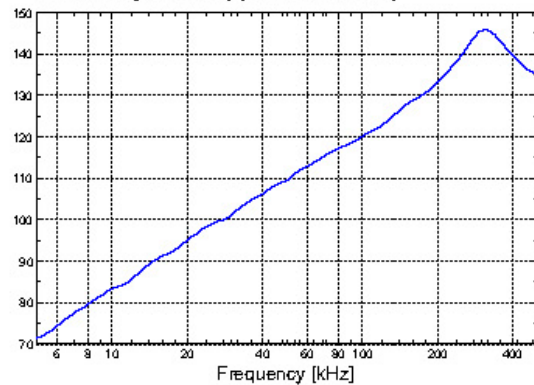
Horizontal directivity pattern



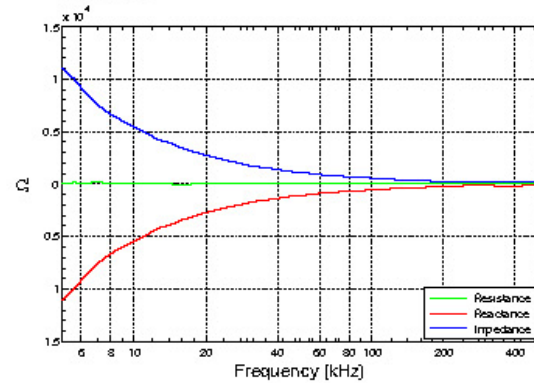
Receiving Sensitivity [dB re 1V/ $\mu$ Pa @ 1m]



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



Impedance



## Hydrophone TC4034

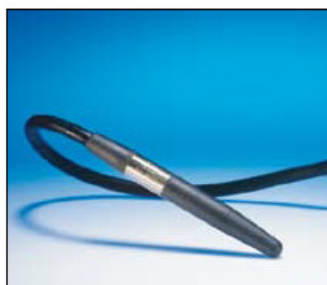
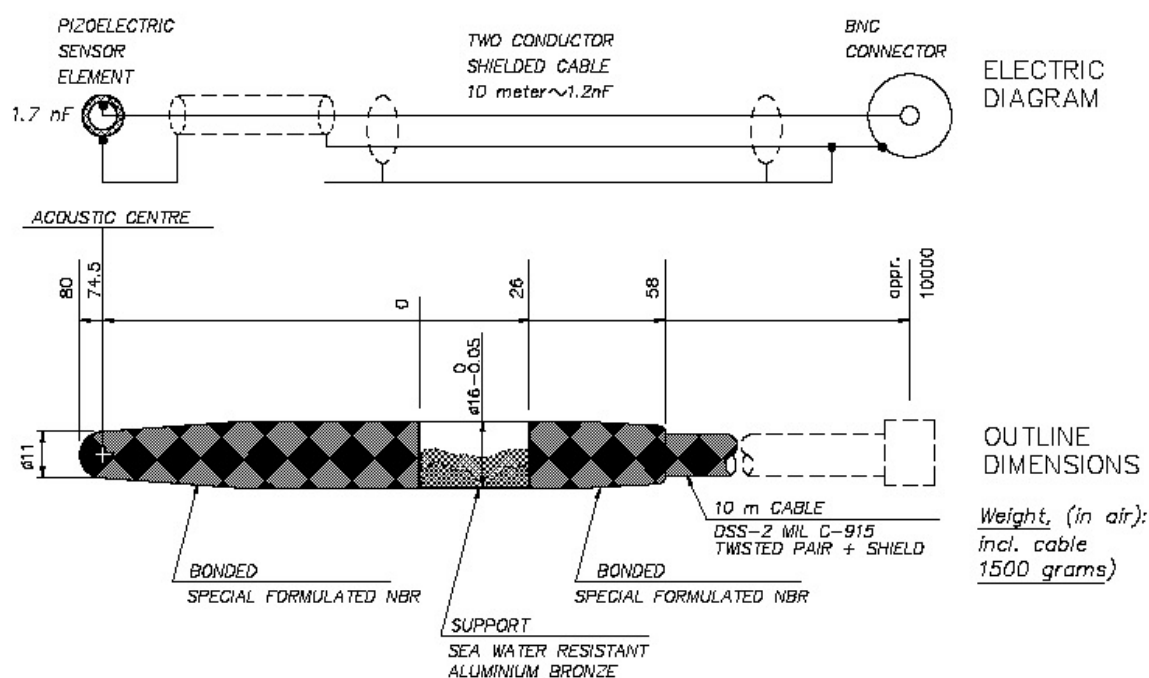
## Ultra Broad-band Spherical

**Documentation:**

The hydrophone is permanently encapsulated in Special formulated NER to provide long term reliability. The rubber has been specially compounded to ensure an acoustic impedance close to that of water.

The TC4034 is supplied with an integral water blocked two conductor shielded cable, type DSS-2, which complies with Mil C915

## Electrical Diagram and Outline Dimensions



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Version: B112 070627 / Add

## **7.2. Scripts .m desarrollados**

Los tres scripts desarrollados se encuentran en el archivo “Ficheros anexos.zip”.