POLYAMP

- A secure part of your system

Underwater Electric field sensors and amplifiers for UEP/ELFE applications

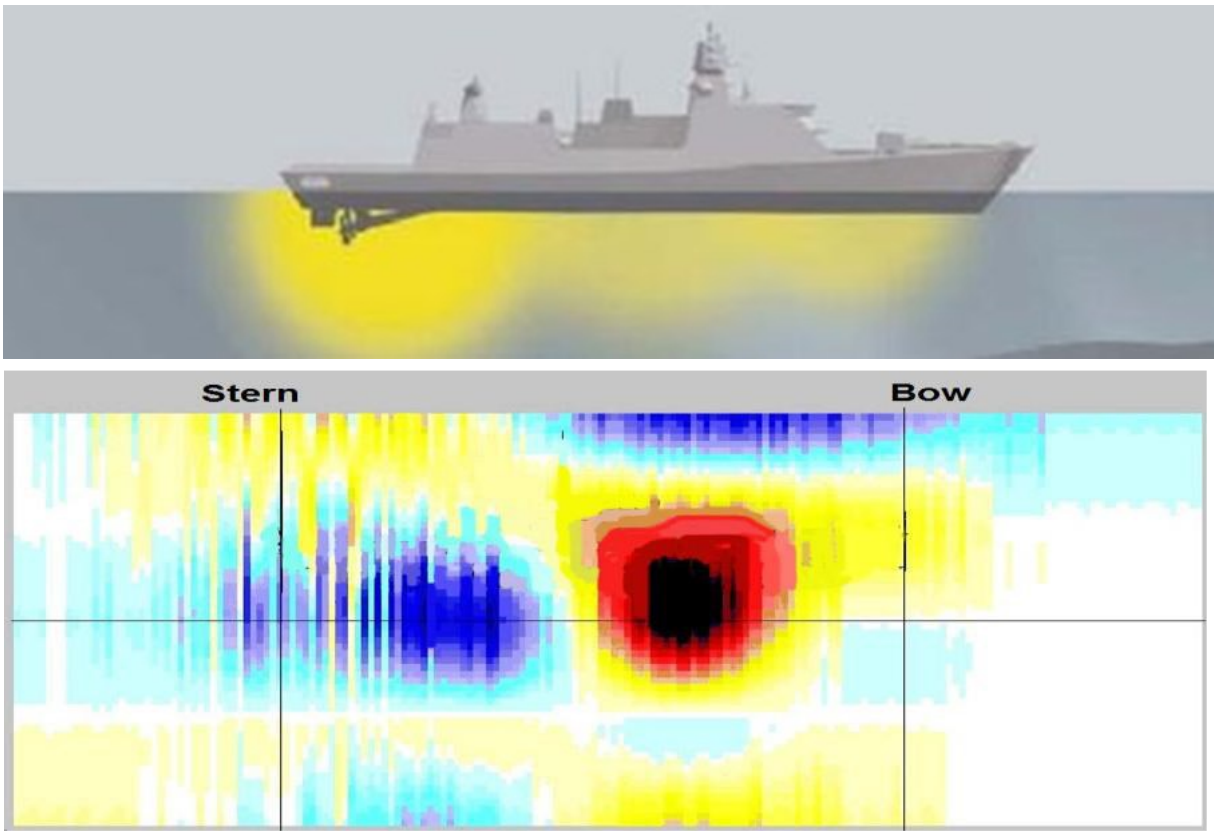


Illustration of a combined ULF / ELFE signature of a vessel

Underwater Electric Potentials (UEP) is produced by corrosion currents in the ship or submarine hull and also from propeller or other dissimilar metallic materials in contact with the salt/sea water. A ship's electric signature is behaving in a similar way as the magnetic signature. Therefore this can also be used as an input or trigger signal in an influence mine.
The hull of the ship and the propulsion also produces a modulation of the corrosion currents called Extra Low Frequency Electric field (ELFE) that can be used for positioning, target evaluating or for reconnaissance. The behavior is then more like acoustic signatures.

Polyamp has designed a range of sensors and sensor platforms for the measurement of these electric signatures (as well as other signatures) for use in:

- Oil and Gas exploration applications
- Upgrading conventional sea ranges
- Transportable sea ranges
- Reconnaissance, fixed or mobile equipment's
- Influence sea mines
- Part of Harbor protection systems
- Underwater Environmental assessments (Wave analyses, Tectonic activities, Culture noise and Ionosphere surveys)

COMMERCIAL in CONFIDENCE Specification can be changed without further notice

Head office
Polyamp AB
Hovslagarevägen 3
SE-19254 SOLLENTUNA
Main residence: Sollentuna, Sweden

Factory
Polyamp AB
Bäckgatan 10
SE-59753 ÅTVIDABERG

Contact
Tel:+46 8 59469300 (Head)
Tel:+46 120 85400 (Factory)
info@polyamp.se
https://polyamp.com

Registrations
EU VAT: SE556103276301
DUNS: 35 430 3372
NCAGE: A163N
ISO 9001:2015

1 nV Differential amplifier specifications

The PA3004 differential amplifier meets demand of small footprint for underwater platform integration with the flexibility of different type of measurements.

PA3004 is optimised for both our Carbon fibre type of sensors as well as AgAgCl electrodes.

The very wide bandwidth meets the ELFE frequency definition of 0-3000 Hz.

However , even at near field measurements e.g. ELFE signatures, very seldom detects usable frequencies above 500 Hz. The emphasise for signal analyses are actually the sensitivity and noise levels at frequencies below 500 Hz.

Key Features

- Optimised input between Carbon fibre or AgAgCl sensors by jumper setting
- Intended for integration in underwater measurement platform
- Very low noise +80/+86 dB amplification
- Noise level 1 nV/√Hz @ 1 Hz
- Selectable 80/60dB amplification by relay (-15V)
- Insulation amplifier provides excellent axis separation and common mode noise suppression
- Up to 4 km analogue signal transfer with an optional Line driver system.

PA3004 amplifier board with 9-pole in- and out D-SUB connectors

Model	Partno	Amp	Feature
PA3004	890104	66/86 dB	Standard
PA3004	890106	60/80 dB	Optimized
PA3004B	890107	60/80 dB	No connectors No line driver
PA3004A	890103	86 dB	5 - 20 kHz (1)

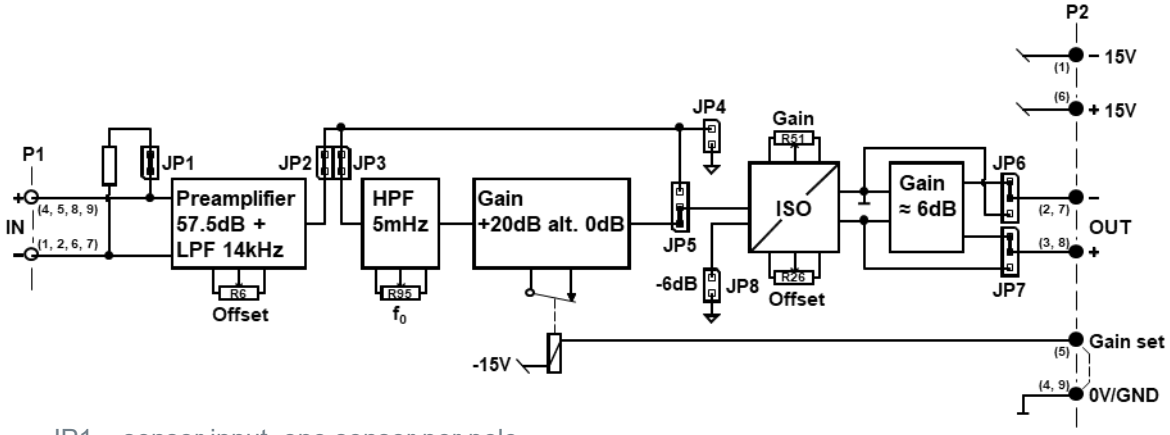
(1) Intended for acoustic sensor due to the linearity performance. Analogue signal galvanic insulation up to 65 kHz.

White Noise level		
Hz	**dB(2)**	**nV**
0.001	-157	14
0.01	-162	8
0.1	-174	2
1- 10000	-180	1.0

(2) dB relative 1 nV in 1 Hz band, noise knee at 2 Hz

Amplifier specification	
Total amplification	+80/86 dB
Low gain amplification	When relay activated +60/66 dB (-15 V)
Bandwidth with HP filter	Linear: 0.005 – 5000 Hz With -3dB: 0.005 – 11000 Hz
Galvanic isolation	Yes, by insulation amplifier
Output saturation level	±10 V (insulation amplifier)
Scale factor tolerance	<1%
Linearity (analogue)	<1%
Sensitivity (analogue)	< 0.9 nV/√Hz
White noise 1/f_c	f_c = 0.1 Hz, see table
Temperature drift	1.5 µV/°C
Temperature range	Operational: -5 to +70°C Storage: -40 to +85°C
Power Supply (exclusive external output drive power)	±15 V, 1.1 or 1.4 W +15 V 52 mA -15 V 35 mA 80 dB -15 V 50 mA 60 dB
Output type (analogue)	Voltage drive, capability > 4 km cable
Lightning protection	Via internal gas discharge tubes
Size (HxDxL)	37x24x136 mm
Weight	65 g

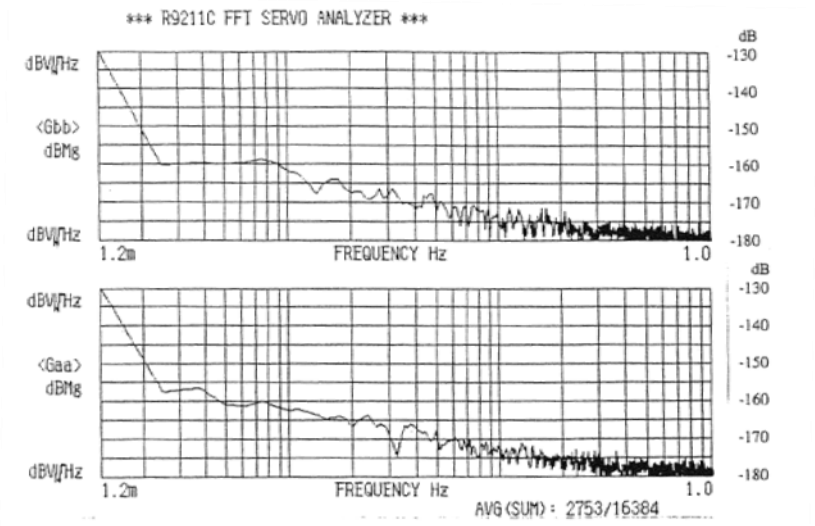
1 nV Differential amplifier specifications



- JP1 – sensor input, one sensor per pole.
- JP1 – sensor type switch. Remove jumper for electrodes like AgAgCL
- JP2 – always enabled
- JP3 – Signal to HPF and +20 dB amplifier
- JP4 – Preamplifier direct output DC – 14 kHz, JP3 disabled.
- JP5 – Signal selector to insulation amplifier, with +2.5 dB
- JP6/JP7 – Bypassing the Line amplifier, box Gain 6 dB compensation of the line driver gives 60/80 dB amplification
- Gain set from +20 dB to 0 dB by grounding to zero

Signal output characteristic
The output is using a line amplifier that can drive a 10 V rms signal into 600 Ω and will remain stable despite cable capacitances of up to 0.16 µF in either balanced or single-ended configurations.
It is intended to send the amplified analogue signal several kilometers and to be matched with a mating line amplifier on the receiving side.

The output can also be used directly into a differential input ADC mounted near the amplifier.
The +6 dB can be compensated to 0 dB by adding a jumper on JP8.
The output can also be directed by jumpers from the insulation amplifier directly to the output, thus omitting the balanced line amplifier. The – output (2,7) becomes zero and + output (3, 8) supply the ± signal voltage.



Both noise plots are measured by Swedish Defence Research Institute FOI with 10 Ohm on input with simulation of 2700 m sea cable using the balanced line driver of PA3004 on both ends.
Above 1 Hz the noise levels are -180 dB from 1 to 10 kHz

The Carbon Fibre Sensor

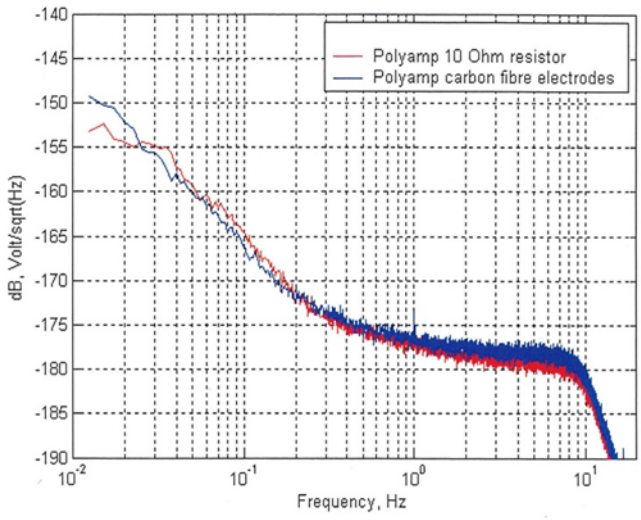
The Carbon fibre sensor is very sensitive and its noise is lower than the PA3004 amplifier (see diagram below). In differential mode low Ohm measurements, the characteristic of the sensor is Capacitive, which means a virtual DC voltage will occur. For that reason the amplifier is equipped with a High Pass filter (5 mHz) to provide stable zero level. This filter also protects from amplifier saturation, due to DC noise that is the most common cause of saturation on this type of highly sensitive amplifier. Therefore this HP filter is also especially relevant for AgAgCl systems.

PA3001C sensor shape, with up to 1 m cable and ILM1M connector.

PA3001D sensor shape, with up to 1 m cable and ILM1M connector.

Model	PA3001	PA3001B
Height	125 ±5 mm	58 mm
Diameter	Ø 50 mm	Ø 55 mm
Weight in air	150 g	130 g
Weight in water	10 g	10 g
Standard cable	100 cm	100 cm
O-ring sealing (Optional)	no	Ø 55 mm Ø 3 mm
Model	**PA3001C**	**PA3001D**
ILM1M connector cable	Customized < 1m	Customized < 1m

Sensor Environmental Specification	
Depth, standard	300 m
Depth, optional	3000 m
Operating temperature	-5 to +55°C
Storage temperature Wet Dry	+1 to +55°C -40 to +55°C
Stream protection	PP Felt
Growth / weed protection	PP Felt
General Sensor Specification	
Type of electrode	Carbon fibre
Pairing of Sensors	Not needed
Salinity	Independent
Salt bridge	Not required
Maintenance	None required
Design life	>10 years
Repeated deployment	No degradation
Deployment precautions	None

The Carbon Fibre Sensor noise

The plot to the right shows noise performance of the amplifier inputs with a 10 Ohm resistor (Red) and connected to carbon fibre sensors (Blue) in the frequency range 0.01 Hz to 10 Hz.
This concludes that the Carbon fibre sensors operate within the noise limit of the amplifier.
(Measurement made by Norwegian Geotechnical Institute NGI, with our PA3002 amplifier with LP filter at 10 Hz.)