



## Acoustic Emission Sensors

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# 1 AE - Sensor Overview

## 1.1 Standard Models

Sensor Model	Freq. Range/ kHz	Case	Temp. Range/°C	Capacity in pF	Comments
VS30-V	25-80	V	-5 to +85	140	Flat response
VS30-SI-40dB	25-80	SI	-5 to +85		Integral preamp. 40dB
VS30-SIC-34/40/46dB	25-80	SI	-5 to +85		Integral preamp. 34/40/46dB
VS45-H	20-450	H	-20 to +100	270	Multi purpose
VS75-V	30-120	V	-5 to +85	140	Resonance at 75kHz
VS75-SI-40dB	30-120	SI	-5 to +85		Integral preamp. 40dB
VS75-SIC-34/40/46dB	30-120	SI	-5 to +85		Integral preamp. 34/40/46dB
VS150-M	100-450	M	-50 to +100	350	Resonance at 150kHz
VS150-L	100-450	L	-50 to +100	350	Full metal case Contact face not isolated
VS150-RI	100-450	R	-40 to +85		Integral preamp. 40dB
VS150-RIC	100-450	R	-40 to +85		Integral preamp. 34dB
VS160-NS	100-450	NS	-50 to +180	350	High temperature
VS375-M	250-700	M	-50 to +100	390	Resonance at 375kHz
VS375-RIC	250-700	R	-40 to +85		Integral preamp. 34dB
VS600-Z1	550-730	Z1	-10 to +110	250*	1m integral cable
VS650-P	300-850	P	-50 to +100	85	Resonance at 650kHz
VS700-D	60-800	D	-20 to +70	163*	35cm integral cable, magnet integrated in sensor
VS900-M	100-900	M	-50 to +100	540	Multiple peaks
VS900-RIC	100-900	R	-40 to +85		Integral preamp. 34dB
VS1000-H	10-400	H	-20 to +100	50	Flat from 30 to 270kHz
VS2M-P	350-2000	P	-50 to +100	340	Resonance at 320, 790 kHz
AE1045S	100-1500	S	-20 to +80	89	Very flat response
AE2045S	200-2500	S	-20 to +80	140	Very flat response
AE104A	100-400	A	-20 to +80	40	
AE105A	450-1150	A	-20 to +80	60	
AE144A	100-500	A	-20 to +80	30	
AE204A	180-700	A	-20 to +80	46	
M31	300-800	M31	-20 to +80	89*	0.5m integral cable
M58	700	M58	-20 to +80	260*	1m integral cable
HT114-S1	80-370	S1	-50 to +500	70	Differential preamplifier required, 1m integral high-temp cable (300pF/m) plus 1m fix connected softcable (90pF/m), other lengths on request

\* capacity of sensors with integral cable

## 1.2 Special Models

Sensor Model	Freq. Range/ kHz	Case	Temp. Range/°C	Capacity in pF	Comments
VS150-RTIC	100-450	R	-40 to +85		Integral preamp. 34dB
VS150-RTI	100-450	R	-40 to +85		Integral preamp. 40dB
VS30-VTB	25-80	VTB	-5 to +85	140	Flat response
VS75-T	30-120	T	-5 to +85	140	Response like VS75-V
VS45-T	20-450	T	-20 to +100	270	Response like VS45-H

## 1.3 Sensor Cases : Dimensions and Materials

Case	Size DxH (mm)	Weight	Case Material	Connector	Wear Plate	
A	8 x 18	5g	Stainless steel	Microdot	Ceramics	 <p>all cases except T-case</p> <p>T-case</p>
D	6.3 x 10	1.5g <sup>++</sup>	E-Copper, tinned	SMA/BNC <sup>+</sup>	Neodyne	
H	20.3 x 22	21g	Aluminum	Microdot	Ceramics	
L	20.3 x 14.3	13g	Aluminum <sup>x</sup>	SMC	Aluminum	
M	20.3 x 14.3	12g	Aluminum <sup>x</sup>	Microdot	Ceramics	
M31	3 x 3	0,2g <sup>++</sup>	Stainless steel	μdot/BNC <sup>**</sup>	Ceramics	
M58	5 x 3	0,4g <sup>++</sup>	Stainless steel	BNC <sup>**</sup>	Ceramics	
NS	20.3 x 14.3	12g	Aluminum <sup>x</sup>	SMC	Ceramics	
P	12.7 x 13.8	8g	Stainless steel	Microdot	Ceramics	
R	28.6 x 31.5	50g	Aluminum <sup>x</sup>	BNC	Ceramics	
RT	28.6 x 38	65g	Aluminum	Top BNC	Ceramics	
S	20 x 20	31g	Stainless steel	Microdot	Ceramics	
SI	28.6 x 51.8	93g	Aluminum <sup>x</sup>	BNC	Ceramics	
S1	20 x 20.5	30g <sup>++</sup>	X5CrNi13	BNO	X5CrNi13	
T	20.3 x 27	32g	Aluminum	Top Microdot	Ceramics	
V	20.3 x 37	44g	Aluminum	Microdot	Ceramics	
VTB	20.3 x 45	52g	Aluminum	Top BNC	Ceramics	
Z1	4.75 x 5.8	0,8g <sup>++</sup>	Stainless steel	SMA/BNC <sup>+</sup>	Ceramics	

<sup>x</sup> case material stainless steel on request

<sup>+</sup> SMA-BNC adapter included

<sup>++</sup> Weight without integral cable

<sup>\*\*</sup> microdot-BNC adapter included

The ceramics wear plate provides electrical isolation of the sensor's metallic case from the structure under test.

**Note: the lower the sensor's capacity the worse the influence of cable length**

### Warranty:

Warranty period for sensors: 3 months, provided the sensors have been correctly handled. Defects caused by mechanical shock are not covered by the warranty. Except of the replacement of defective sensors, we disclaim all other warranties. We shall not be liable for any direct, indirect or consequential damage arising out of the use of or inability to use delivered sensors.

Specifications are subject to change as product developments are made.

## 2 Frequency Response Measurement

### 2.1 AE Sensor Frequency Response Curves

AE sensors come with a test certificate. The test certificate shows the frequency response of a specific AE sensor to a reproducible excitation. When re-checked with same setup, a comparison of the new test certificate with the original one lets one determine whether the sensor has changed or not. Some aspects of sensor response are not addressed:

- The type of wave (pulse or continuous) may affect the sensor output, especially with resonant sensors. The frequency response diagrams in this document were created with continuous sine wave driving a directly (face to face) coupled emitter.
- The surface displacement caused by a wave is three dimensional, the electrical AE signal is one dimensional. How an AE sensor performs with respect to each displacement direction is not found in a frequency response curve.
- The sensor's response will be affected by the structure on which it is mounted. Even when the same setup is used, care must be taken to align the sensor properly to maintain relative reproducibility.

### 2.2 Pressure Excitation

With this testing method the exciting displacement is uniform over the whole crystal face. This is realised by coupling the sensor under test face-to-face with a wideband ultrasonic emitter. The emitter is then stimulated with a continuous sine wave which frequency is swept over the range of interest. The RMS signal level of the sensor under test is plotted in dB versus frequency, whereby 0 dB refers to a sensor output of 1V at an excitation of 1  $\mu$ bar.

This testing method is fast, easy to reproduce (e.g. by the Vallen Sensor Tester, VST) and most standard test certificates are made by this method.

This document shows pressure excitation results.

Customers having the Vallen Sensor Tester (VST) can reproduce the frequency response curves with the following settings:

	Pressure Excitation:
Output Voltage	0,1V <sub>RMS</sub> (0,05V <sub>RMS</sub> if preamplifier gain > 40dB)
Offset	-114dB – external gain (+ 6dB if preamplifier gain >40dB)
Cable length used	RG178m 1,2m, if no other length is mentioned below

As emitter a Panametrics V103 (ultrasonic wideband sensor), coupled directly face to face to the sensor under test with a suited couplant (e.g. light machine oil) is used.

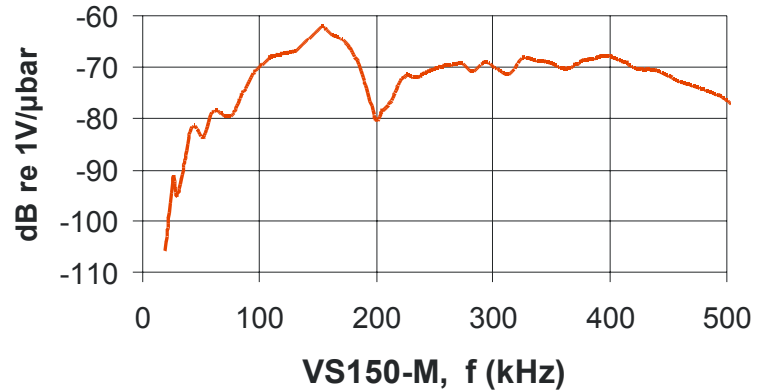
For the VS30-V and VS75-V a Panametrics V101 is used instead of the V103. The other settings can be seen from the legends in the frequency curves.

### 3 Frequency Response Curves

#### 3.1 M-Series

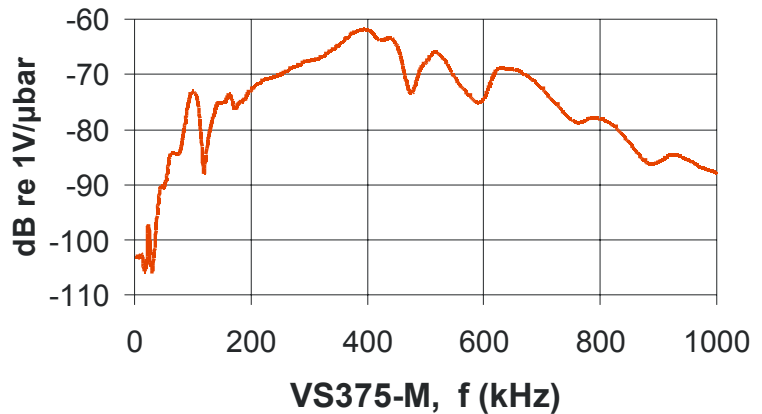
##### VS150-M

The VS150-M sensor has proved very popular over many years for a variety of field and laboratory applications. Due to its very high sensitivity it is used by many AE specialists.



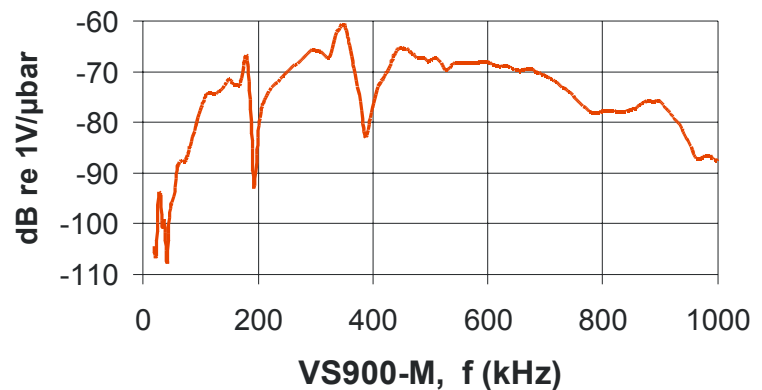
##### VS375-M

The VS375-M is the optimum selection, when the 150kHz signal is contaminated by noise. It is ideally suited to detect crack-growth signals in noisy environments.



##### VS900-M

The VS900-M covers a wide frequency range at an economic price.



### 3.2 V-Series

#### VS30-V

High sensitivity low-frequency AE-sensor optimized for testing tank floors and other civil structures as well as for leak detection.

Cable used: RG 178/ 0.3m

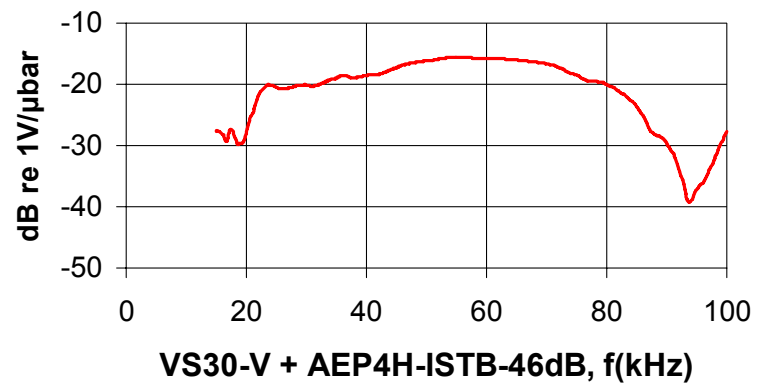
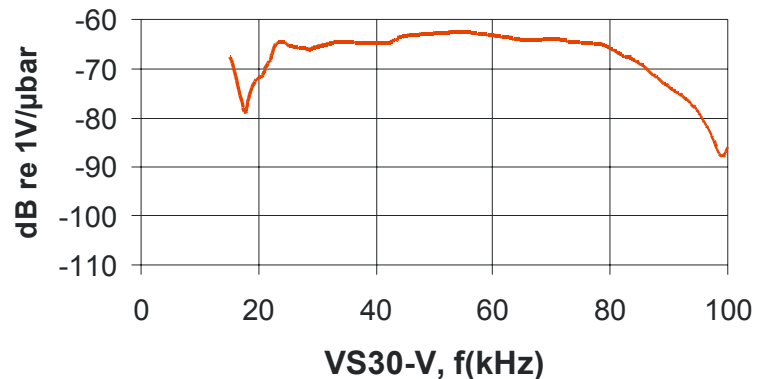
#### VS30-VTB

Like VS30-V, but with BNC top connector.

#### VS30-V + AEP4H-ISTB-46dB

High sensitivity low-frequency AE-sensor optimized for testing tank floors and other civil structures as well as for leak detection.

Sensor is mounted to a preamplifier (AEP4H-ISTB) with 46dB gain.



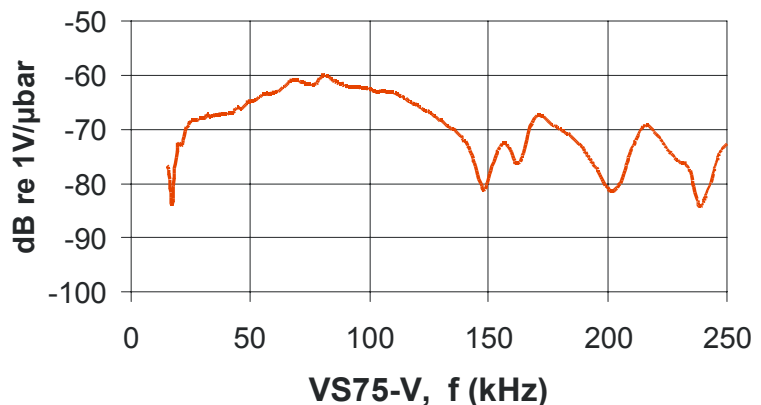
#### VS75-V

Low frequency sensor with resonance at 75kHz.

Cable used: RG 178/ 0.3m

#### VS75-T

Like VS75-V, but with Microdot top connector.



Note :

VS30-V/-VTB and VS75-T have 6dB less sensitivity if used with 1.2m long cable

### 3.3 T-Series

#### VS45-T

For frequency response see **VS45-H** , page 10

#### VS75-T

For frequency response see VS75-V (above)

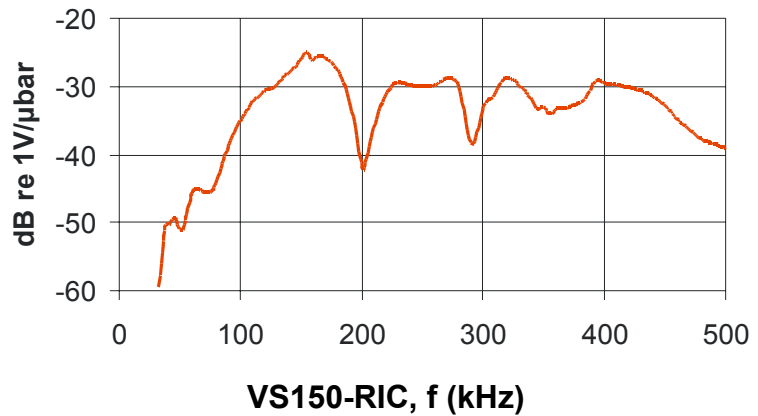
### 3.4 R-Series

#### VS150-RIC

##### VS150-RI

High sensitivity AE-sensor with integral preamplifier. RIC version comes with calibration bypass. Same characteristic as VS150-M. Optimized for performing field tests on pressure vessels, piping systems, and other structures. Able to drive long cables.

Gain VS150-RIC: 34dB  
Gain VS150-RI: 40dB



#### VS150-RTIC

##### VS150-RTI

With top BNC-connector instead of side BNC-connector.

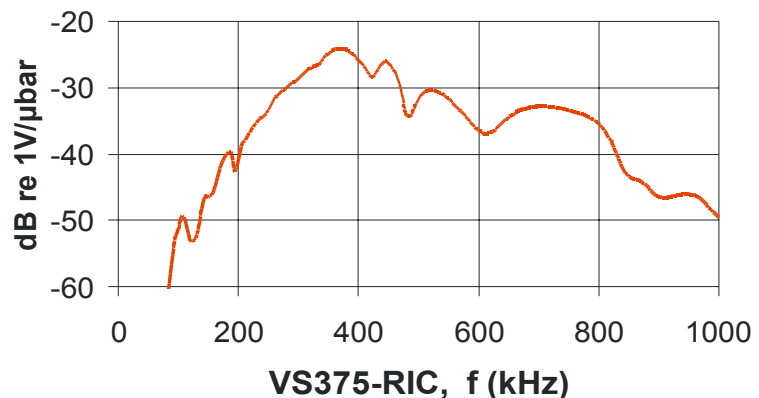
Gain VS150-RTIC: 34dB  
Gain VS150-RTI: 40dB

frequency behaviour identical to VS150-RIC

#### VS375-RIC

High sensitivity AE-sensor with integral preamplifier (34dB) and calibration bypass.

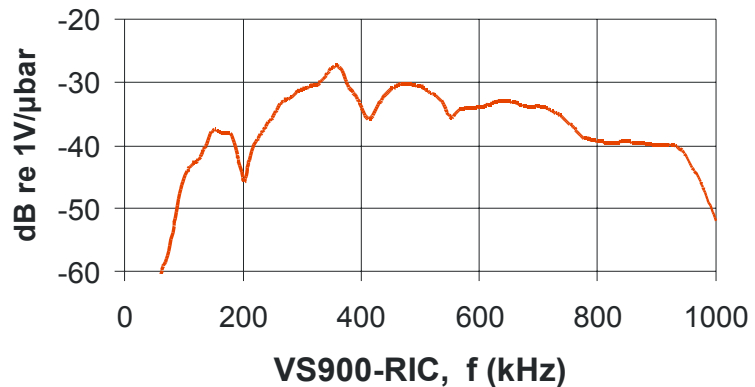
Same characteristic as VS375-M. Optimized for performing field tests on pressure vessels, piping systems, and other structures when low frequency noise is present. Able to drive long cables.



#### VS900-RIC

High sensitivity AE-sensor (wide band) with integral preamplifier (34dB) and calibration bypass.

Same characteristic as VS900-M. Optimized for applications requiring sensitivity from 100-900kHz. Able to drive long cables.



### 3.5 SIC/SI-Series

#### VS30-SIC-34/40/46dB

#### VS30-SI-40dB

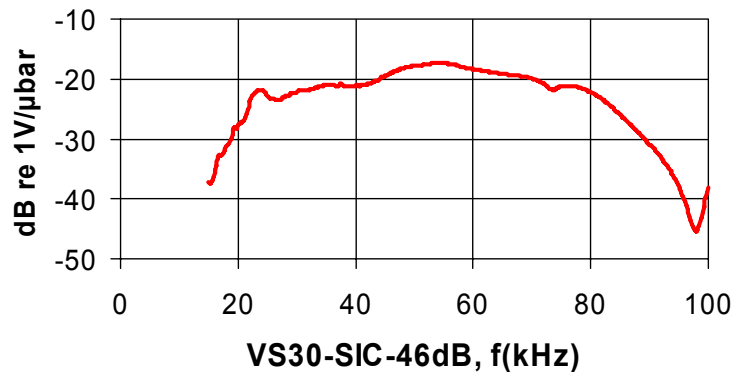
SIC: with calibration bypass  
 SI: without calibration bypass

Low frequency sensor with integral preamplifier and BNC connector.

Gain:

-SIC: select one of 34, 40, or 46 dB.

-SI: 40dB available (only)



To obtain the frequency response of

- VS30-SIC/SI-40dB: subtract 6dB from the curve above
- VS30-SIC-34dB: subtract 12dB from the curve above

#### VS75-SIC-34/40/46dB

#### VS75-SI-40dB

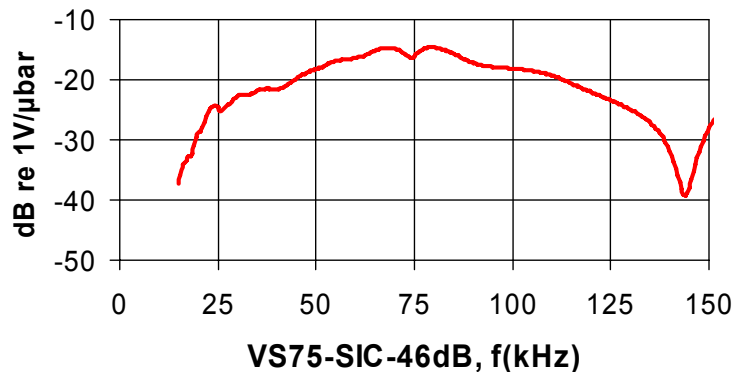
SIC: with calibration bypass  
 SI: without calibration bypass

Low frequency sensor with integral preamplifier.

Gain:

-SIC: select one of 34, 40, or 46 dB.

-SI: 40dB available (only)



To obtain the frequency response of

- VS75-SIC/SI-40dB: subtract 6dB from the curve above
- VS75-SIC-34dB: subtract 12dB from the curve above

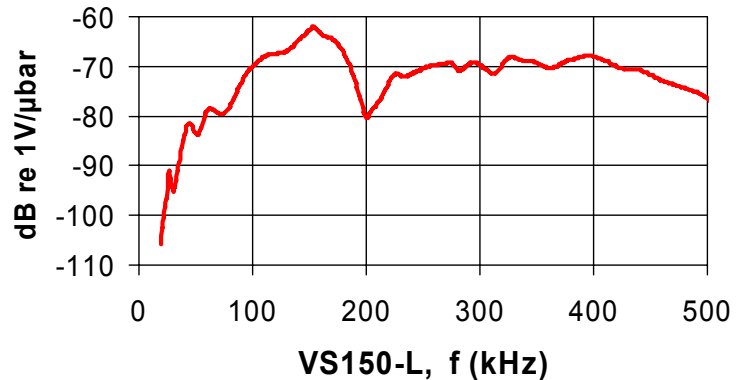
### 3.6 L-Series

#### VS150-L

Rugged full metal case sensor, designed for use on non-conducting composite materials.

The full metal case design allows convenient and fast sensor mounting using a hot glue gun or other adhesives.

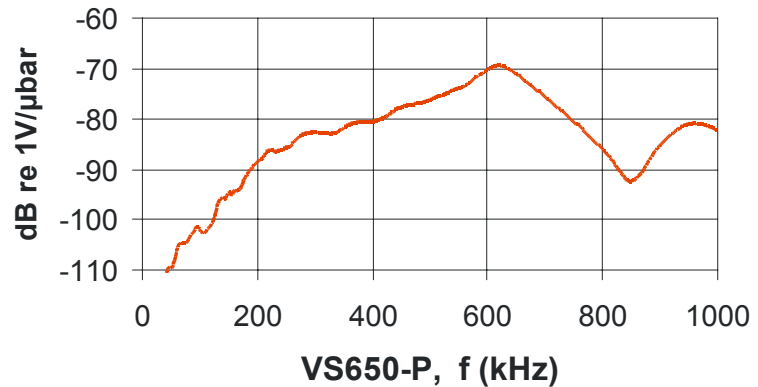
Not recommended on electrically conducting materials.



### 3.7 P-Series

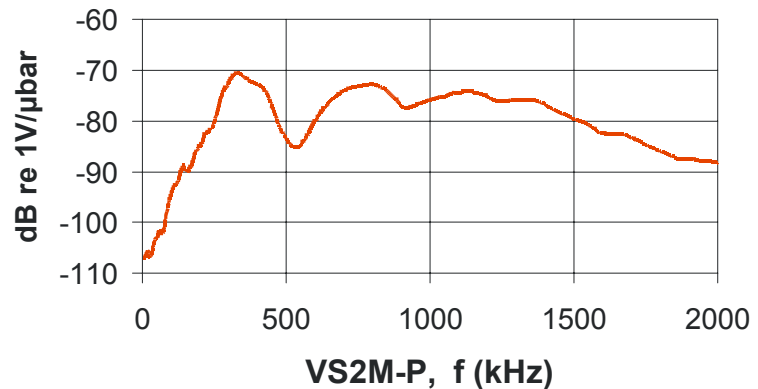
#### VS650-P

Compact, low-cost high-frequency sensor with small (3.2mm) aperture.



#### VS2M-P

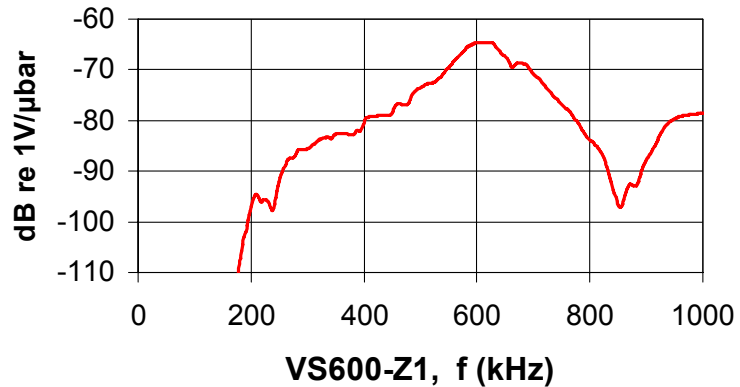
Compact low-cost broadband sensor with high sensitivity up to 1.5MHz. Aperture about 6mm.



### 3.8 Z1-Series

#### VS600-Z1

The VS600-Z1 is a very small AE - sensor designed for use on small specimens or for disk media burnish and glide tests and head -disk interference (HDI) studies. Supplied with 1m integral cable, SMA connector plus SMA-to-BNC adapter.



Response measured with 1m integral cable

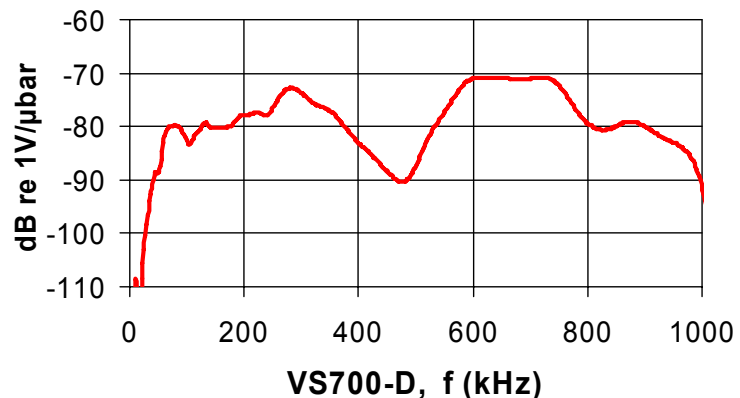
### 3.9 D-Series

#### VS700-D

VS700-D is a miniature AE sensor with small (3mm) aperture.

By design the VS700-D is very well suited for wave pick-up from weakest specimens, even from thin paper. Its design features are:

- very low weight (1.5 grams without cable)
- integral magnetic clamp
- integral thin and flexible cable (35 cm long)

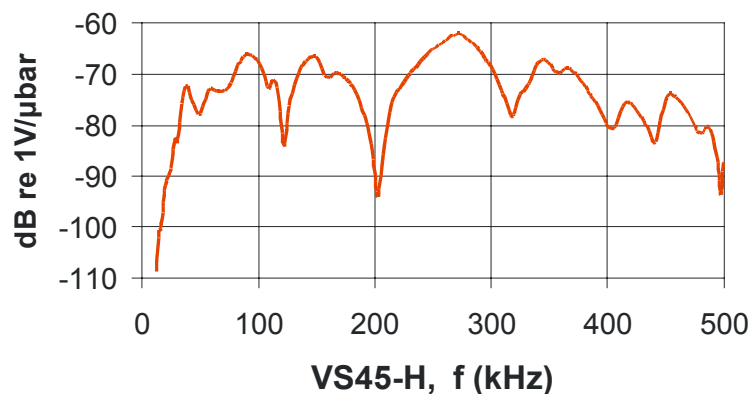


Response measured with 35 cm integral cable (33pF).

### 3.10 H-Series

#### VS45-H

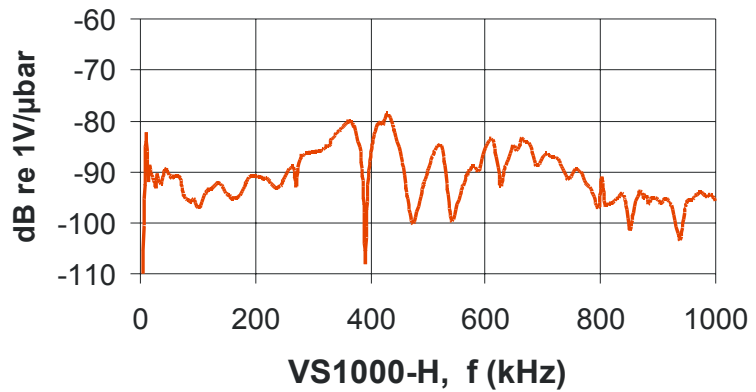
Mass-loaded AE-sensor that behaves as a displacement sensor below 45kHz (leak detection) and as a velocity sensor at 70kHz and above (crack detection).



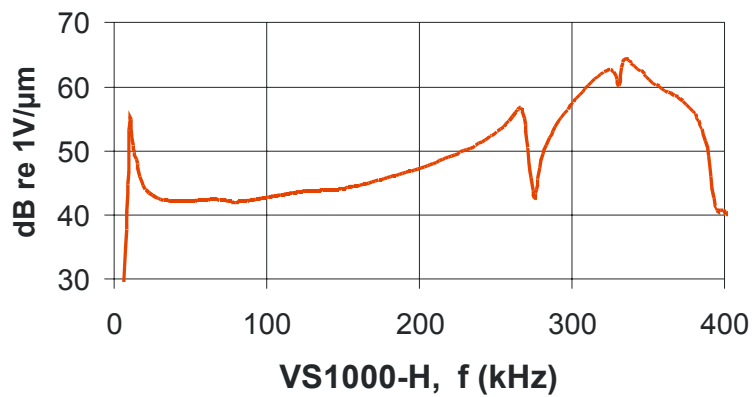
**VS1000-H**

The VS1000-H is a flat response displacement sensor with small aperture (1.5 mm). The pressure excitation curve is only shown for rough sensitivity comparison to other models.

Upper curve:  
Pressure excitation



Lower curve:  
Displacement excitation by using a VS1000-H as exciter instead of a V103.



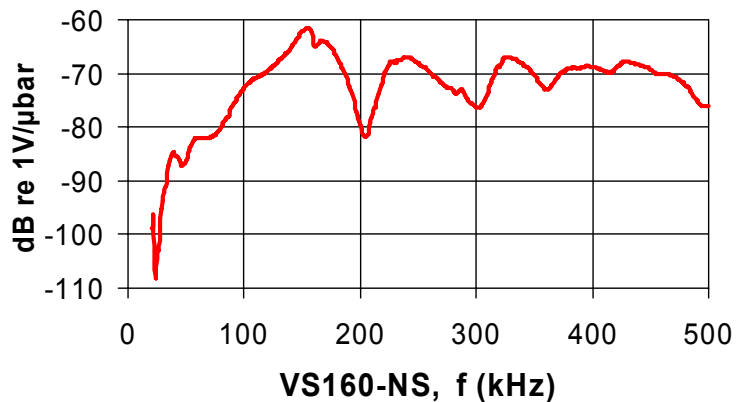
**3.11 NS-Series**

**VS160-NS**

High temperature sensor for up to 180°C (e.g. for structures showing brittle failure behaviour at lower temperatures).

SMC connector.

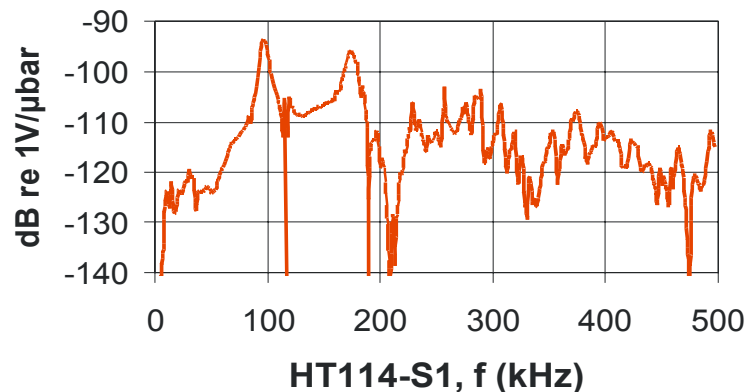
For this sensor the high temperature magnet holder MAG4NS was developed.



### 3.12 HT-Series

#### HT114-S1

The HT114-S1 is a high-temp LiN-sensor for up to 500°C. It has an integral high-temp Inconel cabel (length to be specified) with transition to a soft-cable (up to 100°C, length to be specified). The HT114-S1 has to be pressed with a force of 80N to the sample to ensure good coupling.

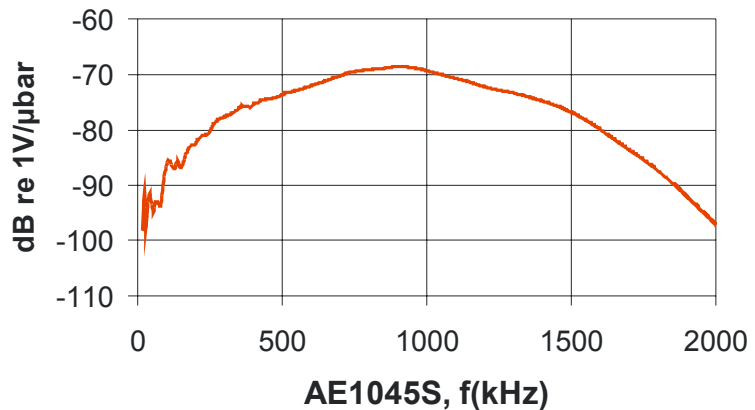


### 3.13 S-Series

#### AE1045S

The AE1045S is a wideband AE - sensor. The frequency characteristic on the right is dominated by the excitation and only shown for sensitivity comparison to the other models.

Comes with a calibration sheet from absolute reciprocal velocity calibration showing a very flat frequency response from 0,1 to 1.3MHz

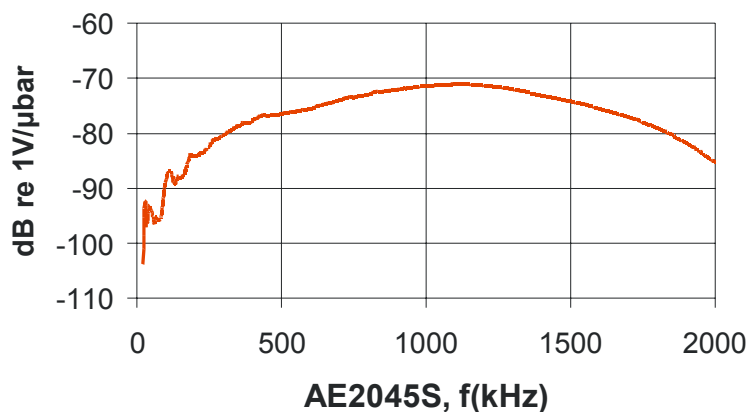


Response measured with 1 m cable (90pF). 4 dB higher sensitivity with 10cm cable due to the low internal capacity (90pF).

#### AE2045S

The AE2045S is a wideband AE - sensor. The frequency characteristic on the right is dominated by the excitation and only shown for sensitivity comparison to the other models.

Comes with a calibration sheet from absolute reciprocal velocity calibration showing a very flat frequency response from 0,2 to 2MHz.



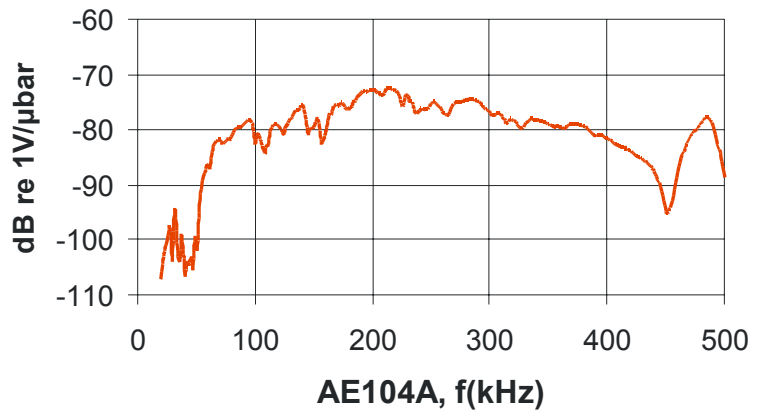
Response measured with 1 m cable (90pF). 3 dB higher sensitivity with 10cm cable due to the low internal capacity (140pF).

### 3.14 A-Series

#### AE104A

The AE104A comes with a calibration sheet from absolute reciprocal velocity calibration, peak sensitivity at about 100kHz. Use the curve (right) only for rough sensitivity comparison with other models. Measured with 1 m cable (90pF). 6dB sensitivity increase with 10cm cable.

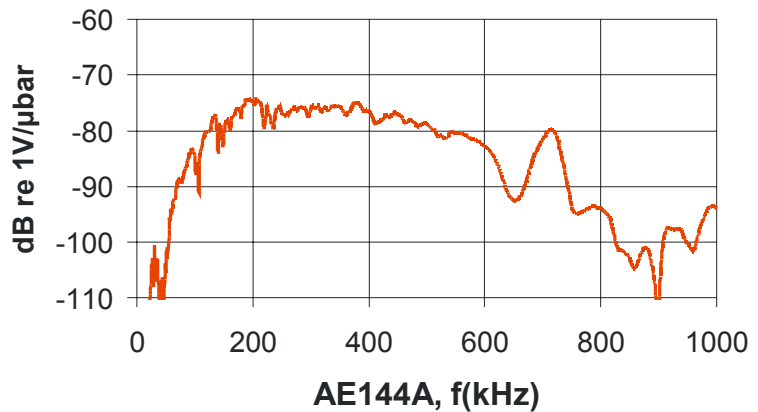
Internal capacity: 40pF



#### AE144A

The AE144A comes with a calibration sheet from absolute reciprocal velocity calibration, peak sensitivity at about 140kHz. Use the curve (right) only for rough sensitivity comparison with other models. Measured with 1 m cable (90pF). 7dB sensitivity increase with 10cm cable.

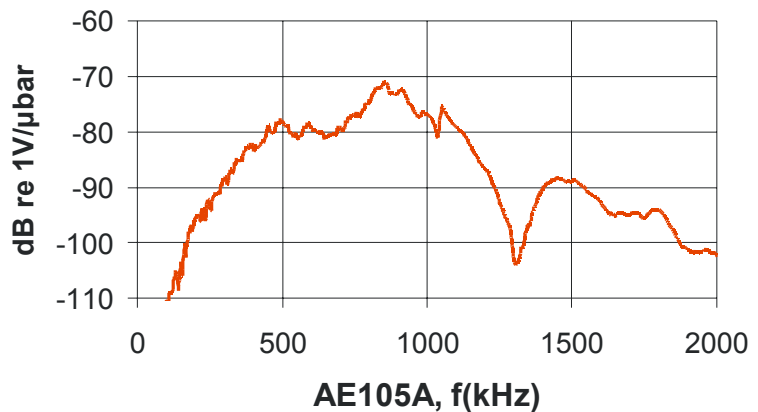
Internal capacity: 33pF



#### AE105A

The AE105A comes with a calibration sheet from absolute reciprocal velocity calibration, peak sensitivity at 0,5 and 1MHz. Use the curve (right) only for rough sensitivity comparison with other models. Measured with 1 m cable. (90pF). 5dB sensitivity increase with 10cm cable.

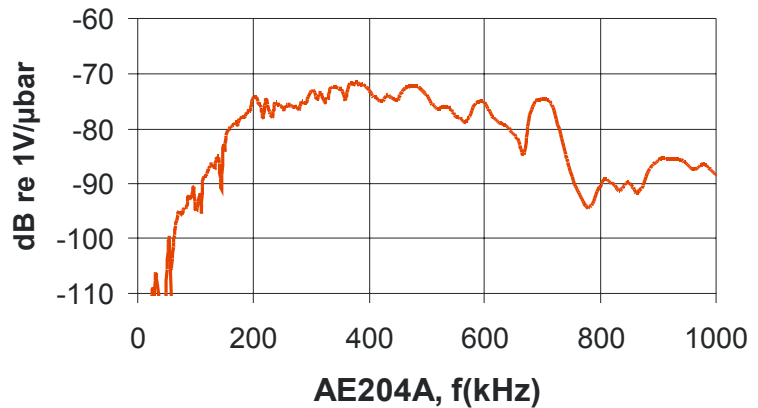
Internal capacity: 60pF



**AE204A**

The AE204A comes with a calibration sheet from absolute reciprocal velocity calibration, peak sensitivity at about 200kHz. Use the curve (right) only for rough sensitivity comparison with other models. Measured with 1 m cable. (90pF). 6dB sensitivity increase with 10cm cable.

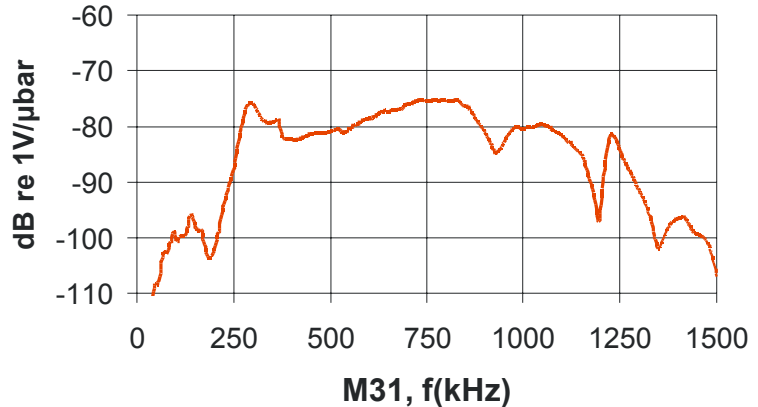
Internal capacity: 46pF



**3.15 Micro-Series**

**M31**

The M31 comes with a calibration sheet from absolute reciprocal velocity calibration, peak sensitivity at about 350kHz. Use the curve (right) only for rough sensitivity comparison with other models. Measured with 0.5 m integral cable. Capacity: 89pF (including 0.5m cable).



**M58**

The M58 comes with a calibration sheet from absolute reciprocal velocity calibration, peak sensitivity at about 750kHz. Use the curve (right) only for rough sensitivity comparison with other models. Measured with 1 m integral cable. Capacity: 260pF (including 1m cable).

