

# Calibration Results

## Calibration Method

The Müller-Platte Needle probe will be delivered shock wave calibrated. The calibration takes place in a water basin relative to a Needle probe calibrated in a water shock tube by the Shock Wave Laboratory of the University Aachen. The shock wave is generated in this basin by a high voltage spark and the pressure amplitudes  $P_2$  in a save distance reaches max. 20 bar. The calibration takes place relative to the incident shock wave. That means, if the shock has a e.g. pressure  $P_2$  of 20 bar we also measure 20 bar.

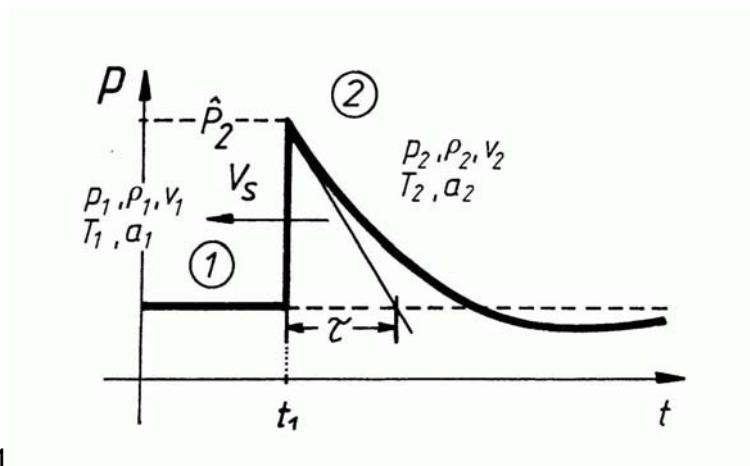


Fig. 1

All other sensors are calibrated under stationary conditions. In case of such an incident wave like in fig. 1, which hits the sensor perpendicular to its axis the other sensors show a signal relative to 40 bar.

The reason is that the incident wave is reflected at the sensor (see fig. 2). And this reflected shock pressure  $P_5$  is nearly double as high in case of water shock waves. So these sensors (like our M60 series as well) measure a pressure of 40 bar.

The Needle probe with its half spherical head is difficult to calculate. That's why we have decided to calibrate on the incident wave directly.

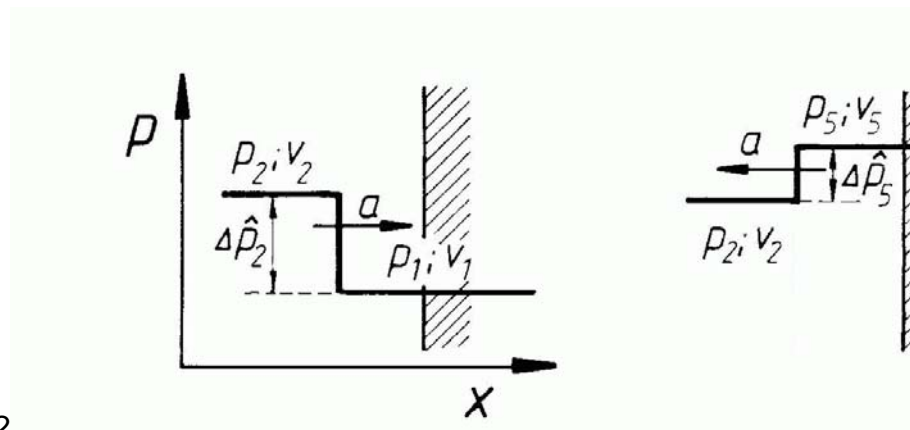
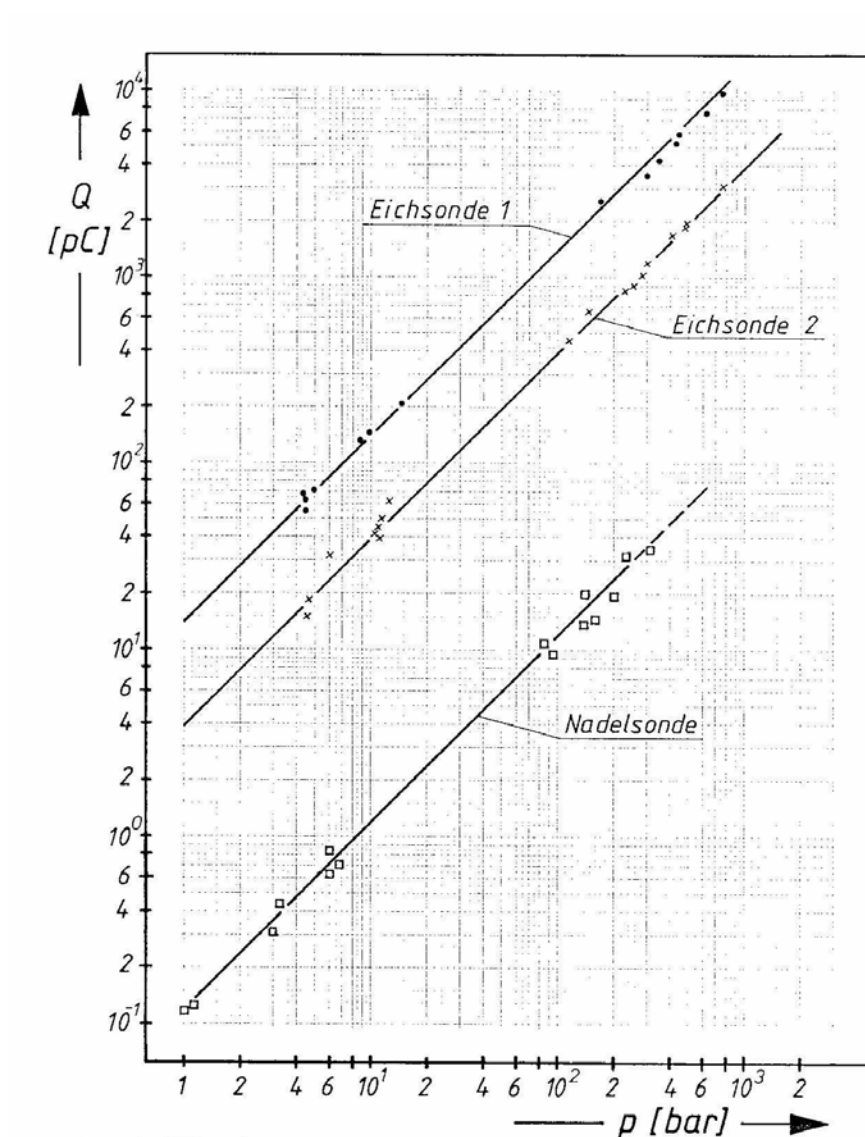


Fig. 2

## Linearity

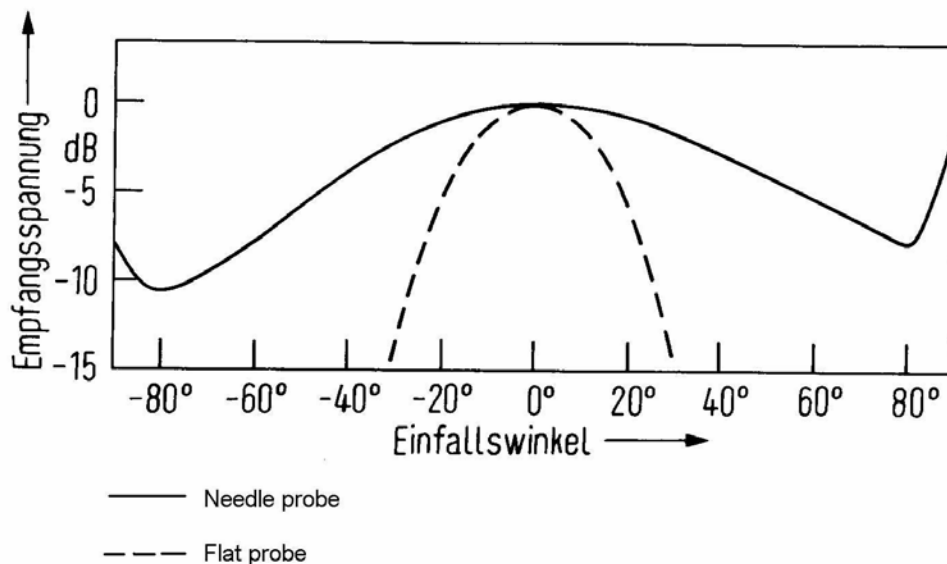
The Sensor was tested in a water shock tube relative to the sensor 603B from Kistler (Eichsonde).

The Needle Probe (Nadelsonde) is linear up to the maximal pressure of 320 bar. Other studies show a linearity of pvdf up to 800 bar.



### Sensitivity versus Angle of Incidence

In comparison to a flat sensor the Needle probe is quite less sensitive to the angle of incidence. Within a angle range of  $\pm 20^\circ$  there is nearly a constant sensitivity, measured at 10 MHz. In case of 1 MHz pulses the sensitivity is nearly constant within a range of  $\pm 90^\circ$ .



Measured at 10 MHz

## Bandwidth

The Needle Probe has a constant sensitivity ( $\pm 3$  dB) within a range of 0.3 to 11 MHz.

### Hydrophone Calibration Chart

Hydrophone description: Mueller\_Platte\_100\_100\_1\_S/N\_300/25/332\_HighGain

Preamplifier: AH\_2020\_25\_S/N\_1024

Active element diameter: no data

Hydrophone capacitance: no data

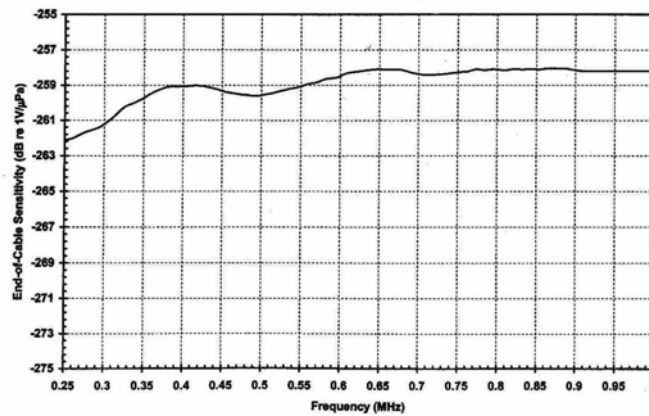
Electrical loading: 50 Ohms

Water temperature: 17.0 deg C

Date: 03.28.06

Calibrated by: Peter A. Lewin/  
*add edo Mar 30*  
*and April 2-06*  
*PAW*

Calibration uncertainty:  $f < 1$  MHz:  $\pm 1.5$  dB;  $f \in (1-15)$  MHz:  $\pm 1$  dB;  $f \in (15-25)$  MHz:  $\pm 1.2$  dB;  
 $f \in (25-30)$  MHz:  $\pm 1.5$  dB;  $f \in (30-40)$  MHz:  $\pm 2$  dB



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