Three Axis Magnetic Field Transducer
x-H3x-xx_E3D-2.5kHz-0.1-2T

Test results

Version 1.0 S.D.

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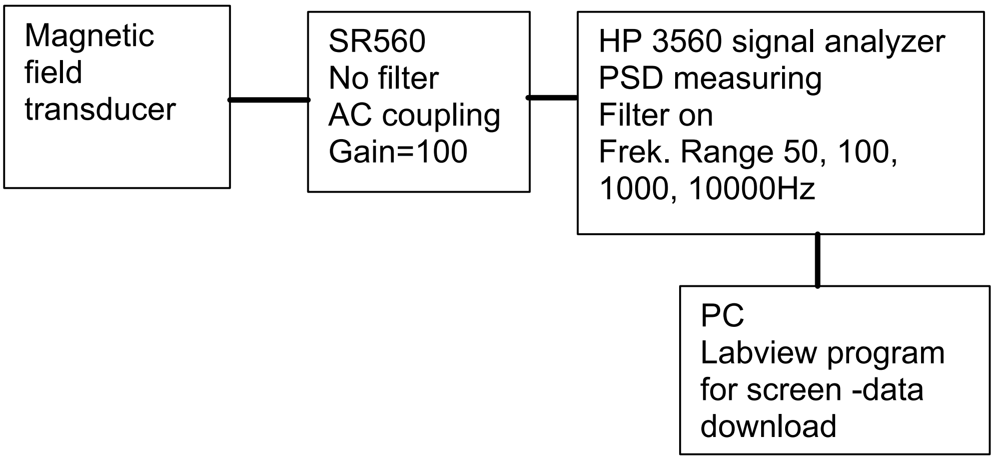
2. Noise power spectral density

Output noise-transducer specification:

Noise spectral density at f=1Hz NSD_1 ˜ 35µV/$\sqrt{Hz}$ Region of 1/f noise
Corner frequency f_c ˜ 10Hz Where 1/f noise = white noise
Noise spectral density at f > 100Hz NSD_w ˜ 10µV/$\sqrt{Hz}$ Region of white noise



The measurement was done in 4 frequency range and the results are overlapped

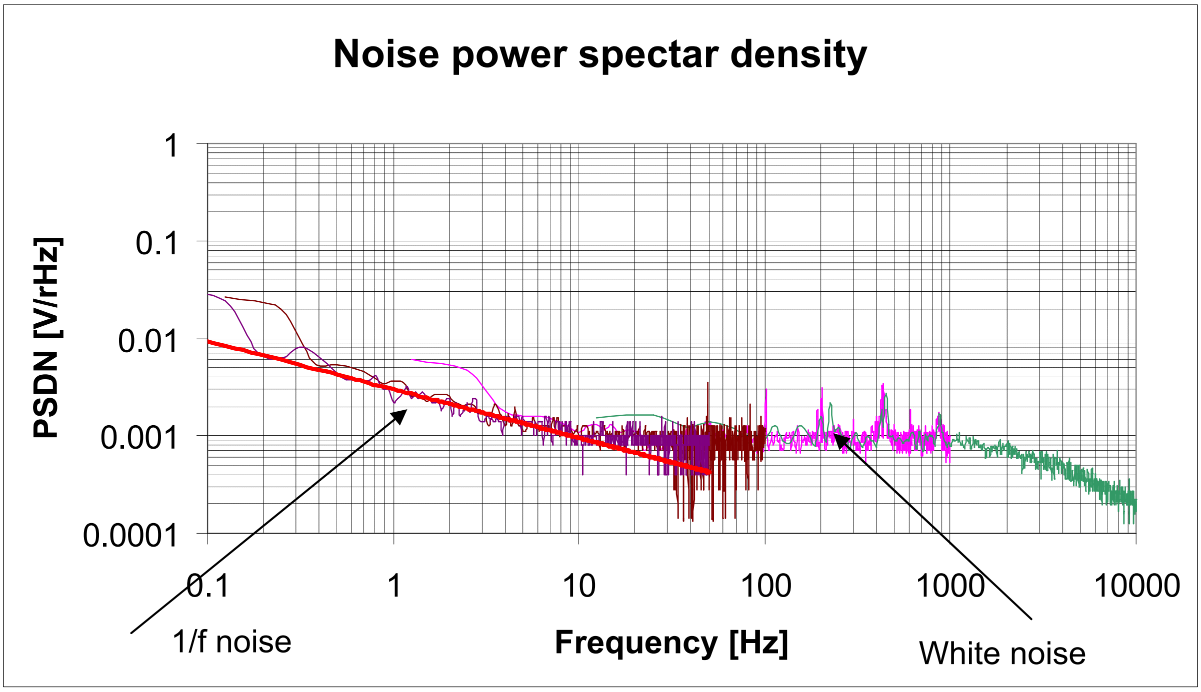


Figure 1: PSDN vs Frequency

The resolution of a measurement can be increased by limiting the corresponding frequency bandwidth. This can be done by passing the transducer output signal trough a band-pass filter or by averaging the measured values. (Caution: filtering produces a phase shift, and averaging a time delay!) The RMS noise voltage of the transducer in a frequency band from f_L to f_H can be estimated as follows:

$$V_{rmsB} = [\ (NSD_1^2 - NSD_w^2) \text{ x } 1\text{Hz x } \ln(f_H / f_L) + NSD_w^2(f_H - f_L)\ ]^{1/2}$$

Here NSD_1 is the RMS noise voltage spectral density at f=1Hz, NSD_w is the RMS white noise voltage spectral density (well above the corner frequency f_c), f_L is the lower, and f_H is the higher frequency limit of the bandwidth of interest. The corresponding peak-to-peak noise voltage can be calculated according to the 6-sigma rule, i. e $V_{nP\text{-}PB} = 6 \text{ x } V_{rmsB}$.

Example calculation:

Let calculate rms noise for bandwith 0.1-100Hz:

Using previous equation we have

$$V_{rmsB} = [\ ((35uV)^2 - (10uV)^2) \text{ x } 1\text{Hz x } \ln(100 / 0.1_L) + (10uV)^2(100 - 0.1)\ ]^{1/2} \quad \text{or}$$

$$V_{rmsB} = [\ (1125\ uV^2) \text{ x } 6.9 + 10000\ uV^2\ ]^{1/2} = 133\ uV$$

This value is little lower then measured which is 0.15mV

The full-band resolution of the transducer (in the bandwidth from 0.01Hz to f_T) can be estimated as follows:

Full-band RMS noise ˜ [(1/6 Offset fluctuation & drift)^2 + (Broad-band AC noise 10Hz to f_T)^2]$^{1/2}$ (4)

3. Offset fluctuation and drift

Transducer specification:
Offset fluctuation & drift (?*t* = 0.05s, *t* = 100s) < 0.5 mV_{p-p} ($0.1mT_{p-p}$)

The DC resolution is the smallest detectable slow (quasi-DC) incremental change of the magnetic flux density that can be detected in the output signal. Arbitrarily, “a slow change” is here defined as a change with a time constant between 0.1s and 100s. Then the DC resolution is limited by the offset fluctuation and drift in the frequency bandwidth from 0.01Hz to 10Hz. The offset fluctuation and drift is here characterized as follows. The probe was kept in a zero-gaus chamber, and over a time period of 100s, 2000 samples of the transducer output voltage were recorded. Thereby each sample was averaged over the sampling time period of 0.05s. This sampling scheme corresponds to the above frequency bandwidth. The standard deviation (sigma) of the voltage samples equals the root-mean-square (RMS) fluctuation of the offset voltage. The specification “Offset fluctuation & drift” gives the 6-sigma peak-to-peak span of these fluctuations. The corresponding RMS fluctuation equals 1/6 of “Offset fluctuation & drift

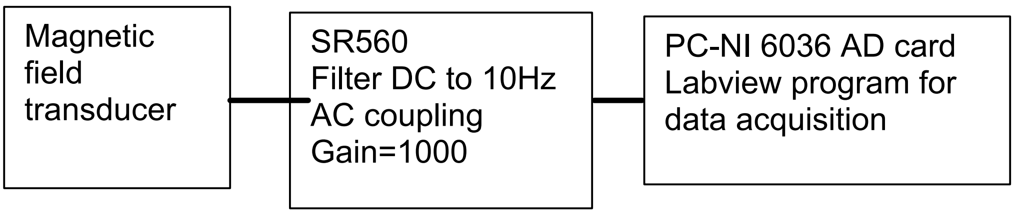


Figure 2: Block diagram of measurement setup

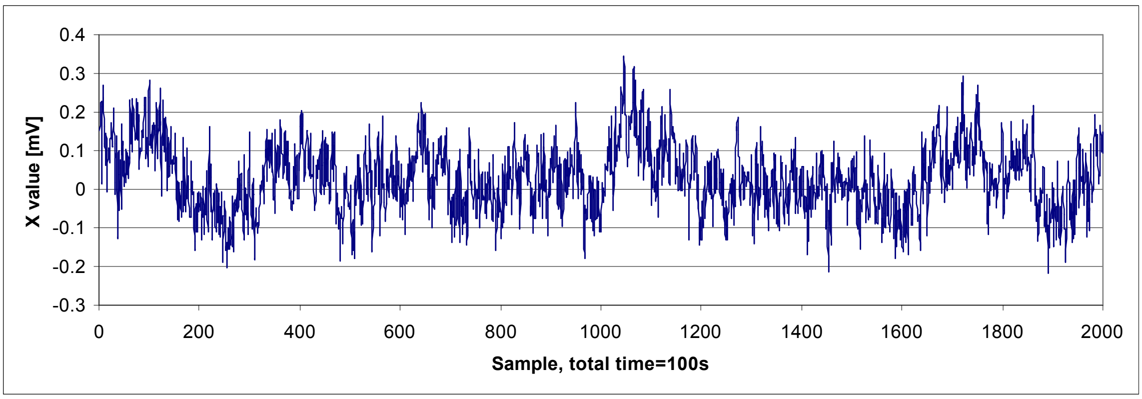


Figure 3: Time domain, 20samples/sec

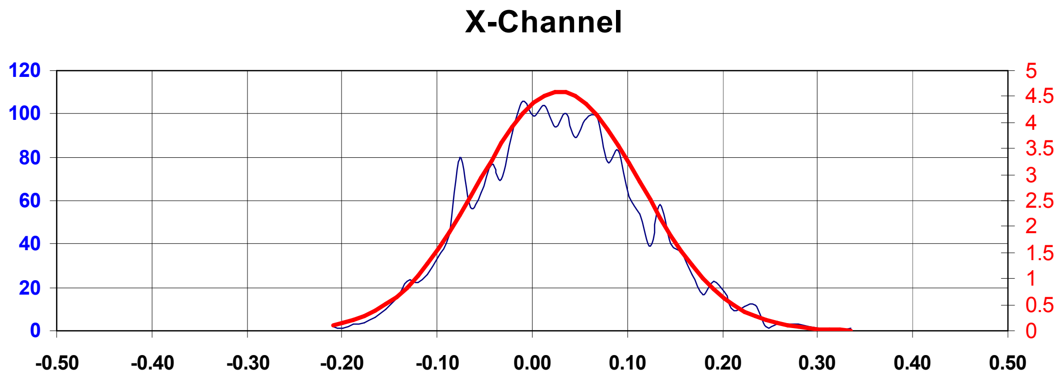


Figure 4: Histogram

The measured values are imported to Excel and it calculated standard deviation as

Stdev = 0.086792 mV
Peak to Peak=6 x Stdev = 0.520749116

4. AC resolution

Transducer specification:
Broad-band noise (10Hz to f_T) V_{nRMS} < 0.6 mV (0.12mT) RMS noise

The broad-band AC resolution is the smallest detectable fast incremental change of the magnetic flux density that can be detected in the output signal. Arbitrarily, “a fast change” is here defined as a change with a time constant between 0.1s and $1/f_T$, f_T being the bandwidth of the instrument. The AC resolution is limited by the noise of the instrument. The noise of the transducer is here specified by the RMS output noise voltage in the 10Hz to f_T frequency band. The corresponding peak-to-peak noise is about 6 times the RMS noise
Since bandwith of transducer is defined as 2.5kHz we limited our signal with external filter of 3kHz

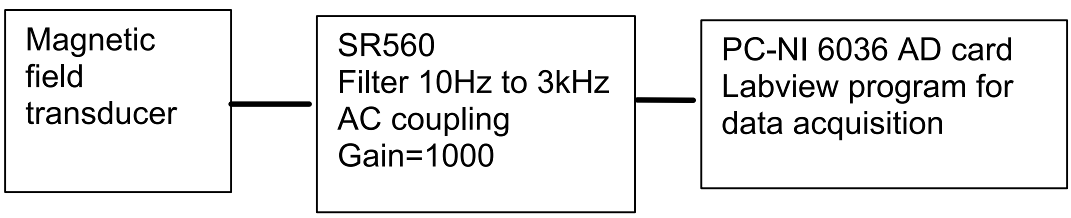


Figure 5: Block diagram of measurement setup

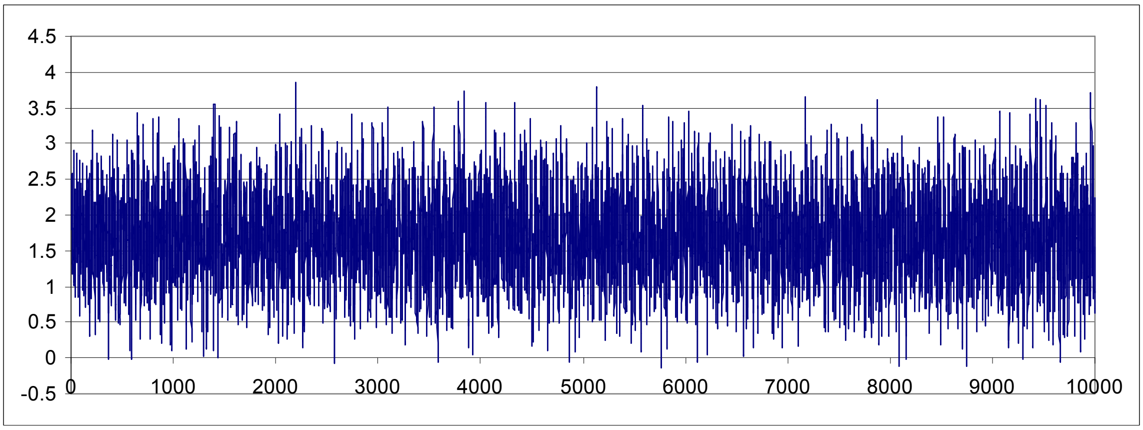


Figure 6: Time domain ,10000 samples per second

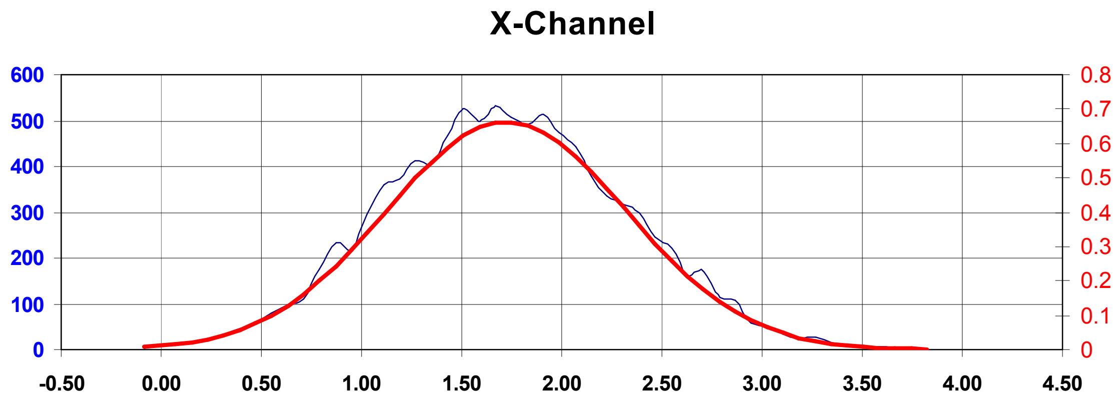


Figure 7: Histogram

The measured values are imported to Excel and it calculated standard deviation as

Stdev = 0.601725 mV

5. Frequency response of the transducer

Transducer specification:

Typical frequency response:	0.1% error	> 110 Hz	Test: *B* ˜ 150mT sin(2p *f*)
	1% error	> 350 Hz	
	Bandwidth f_T	2.5 kHz	Sensitivity decrease -3dB

We built a coil, made from tubes for water cooling, which we use for magnetic field creation.
We supply this coil with DC current and modulated AC current up to 300 Hz.

Figure 8: Coil for producing magnetic field

AC current of about 180A rms (500 Apk-pk) produce in center of coil magnetic field of about 50mT rms (140 mTpk-pk).

Current is measured using Danfyzik current transducer ULTRASTAB 860R and voltmeter Agilent HP34401A.

Transducer output, Y channel, was measured by voltmeter Agilent HP34401A
Frequency range was from 5Hz to 400Hz.

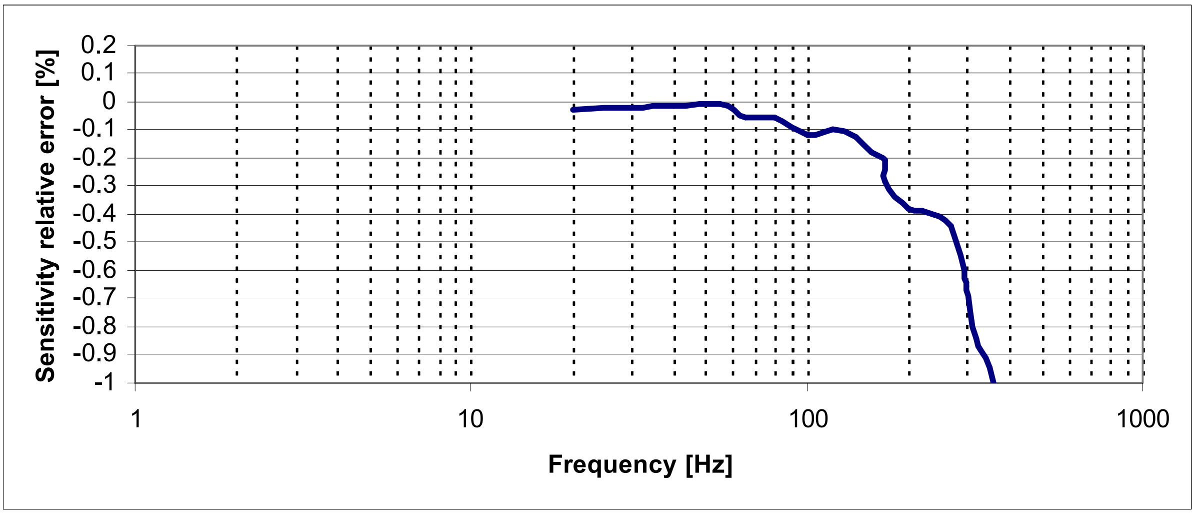


Figure 9: Frequency response