

<b>Title</b>	<b>Plotting seismograph response (BODE-diagram)</b>
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<b>Version</b>	May 2001; DOI: <a href="https://doi.org/10.2312/GFZ.NMSOP-2_EX_5.1">10.2312/GFZ.NMSOP-2_EX_5.1</a>

## 1 Aim

The exercise aims at making you familiar with the easy way of construction of a BODE-diagram which displays the transfer function of a given device as a plot of logarithmic amplitude  $A$  and of linear phase shift  $\phi$  versus logarithmic frequency  $f$  (or period  $1/f$ ). Its advantage is that response curves are approximated by straight lines (see IS 5.2). The main features are:

- any Pole in the transfer function generates an amplitude decay proportional to frequency  $f$  (20 dB per decade or 6 dB per octave) and a phase shift  $\phi$  of  $-90^\circ$ ;
- any Zero causes a slope of 1:1 too and a phase shift of  $+90^\circ$ ;
- corner frequencies (e.g., of filters) correspond to the point of intersection of two straight lines.

All stages of a signal-transfer chain can thus be constructed component-wise, one after the other. It is recommended to decompose all functions into parts of 1<sup>st</sup> or 2<sup>nd</sup> order. One gets the complete transfer function by multiplying these individual functions. In both the logarithmic amplitude scale and the linear phase scale this means adding the related individual curves.

## 2 Tasks

**Task 1:** Plot the BODE-diagrams (amplitude only) of the following seismograph components:

### Seismometer

Transducer Constant  $G_S = 15.915$  Vs/m

Natural Period  $T_S = 5$  s

Attenuation  $D_S = 0.707$

### HIGH Pass HP1 (1<sup>st</sup> order)

Magnification  $A_{H1} = 3$

Corner Frequency  $f_{H1} = 0.01$  Hz

### LOW Pass LP1 (1<sup>st</sup> order)

Magnification  $A_{L1} = 5$

Corner Frequency  $f_{L1} = 0.2$  Hz

### LOW Pass LP2 (2<sup>nd</sup> order)

Magnification  $A_{L2} = 2$

Corner Frequency  $f_{L2} = 10$  Hz

Attenuation  $D_{L2} = 0.707$

**Task 2:** Plot the overall amplitude response of the system approximated by straight lines on double logarithmic paper (see Figure 1).

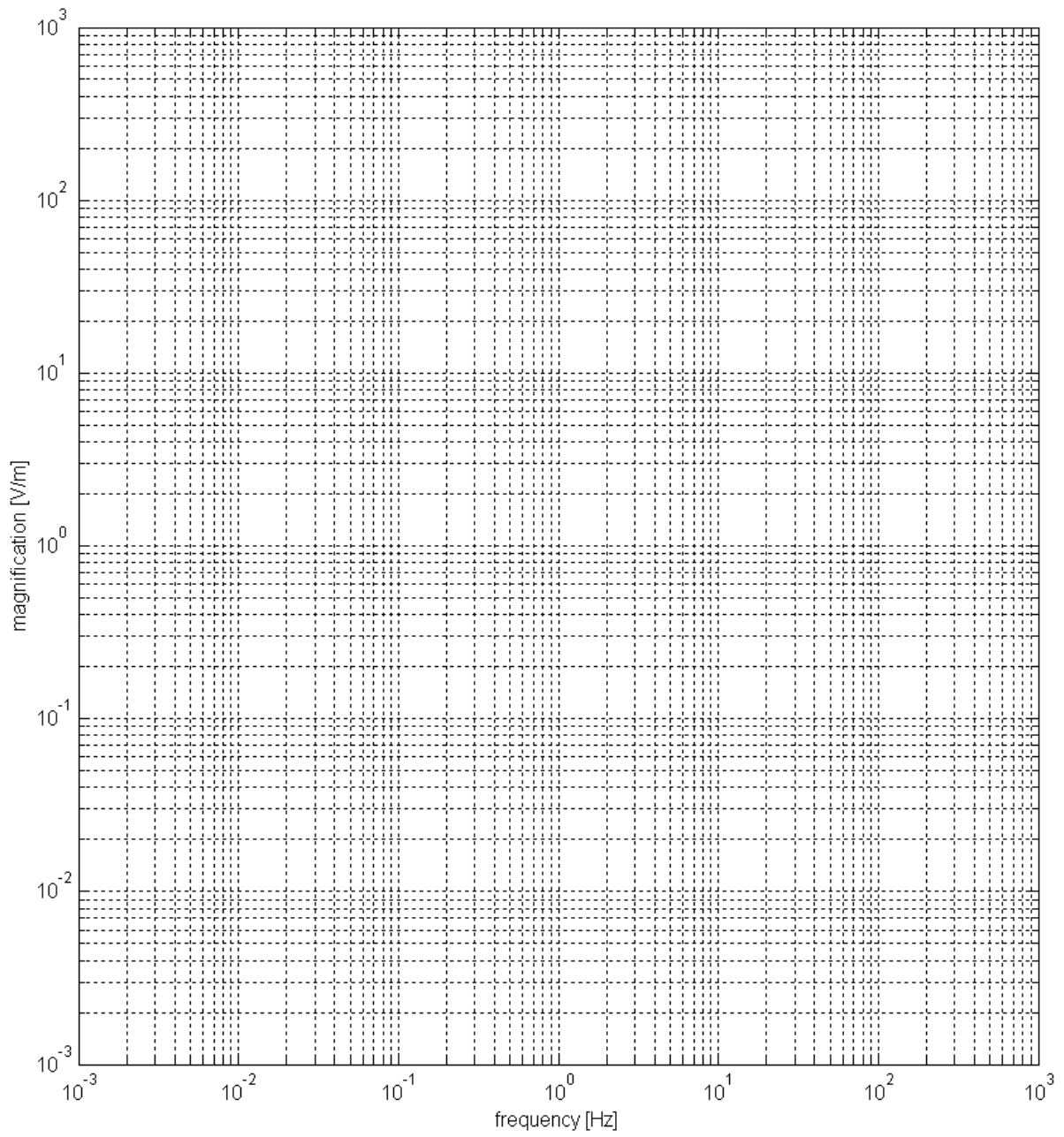
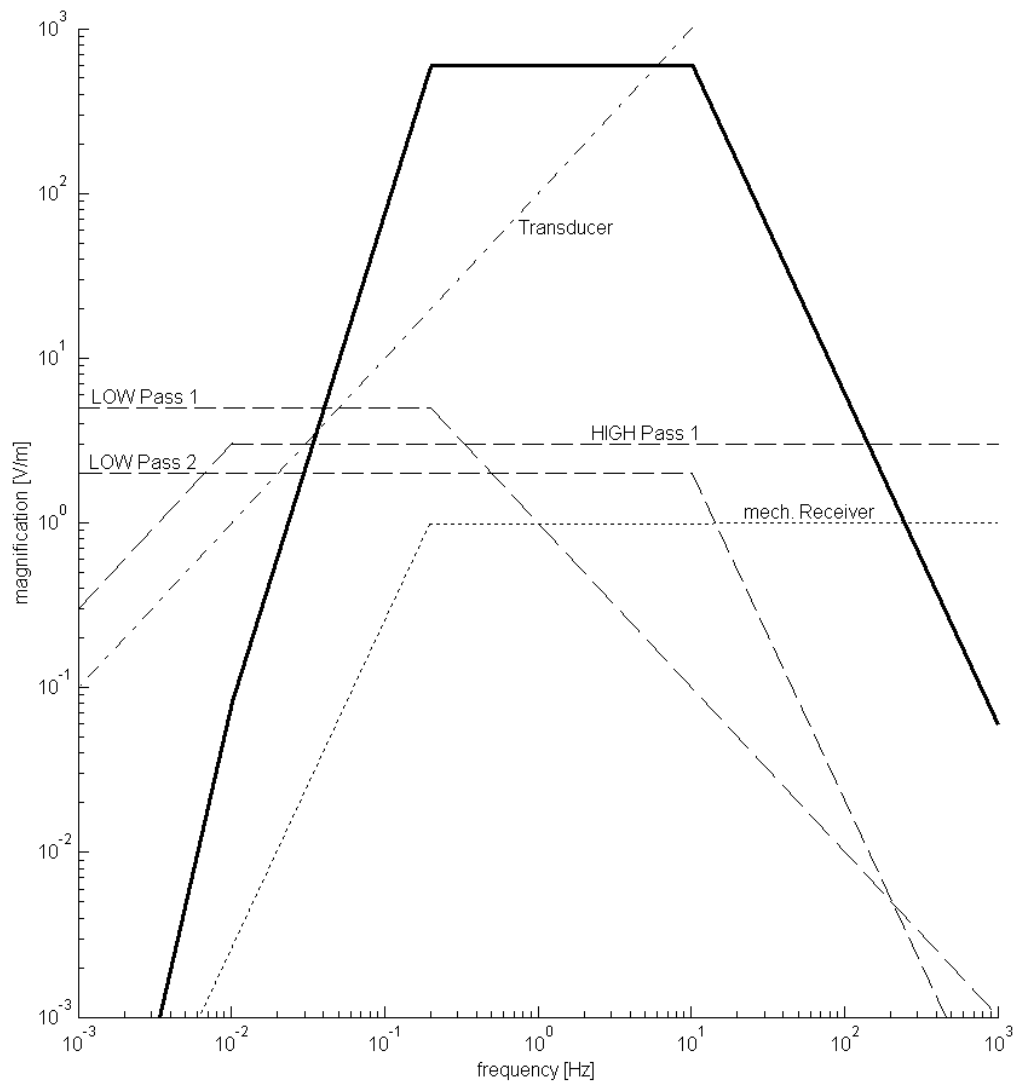


Figure 1

### 3 Solution

The solution to this exercise is given in Figure 2 below.



**Figure 2** Overall BODE-diagram (solid curve) for the seismograph amplitude response. It results from the logarithmic addition of the BODE-diagrams of all individual components given in Task 1.