

1 Hydrophone decoupling

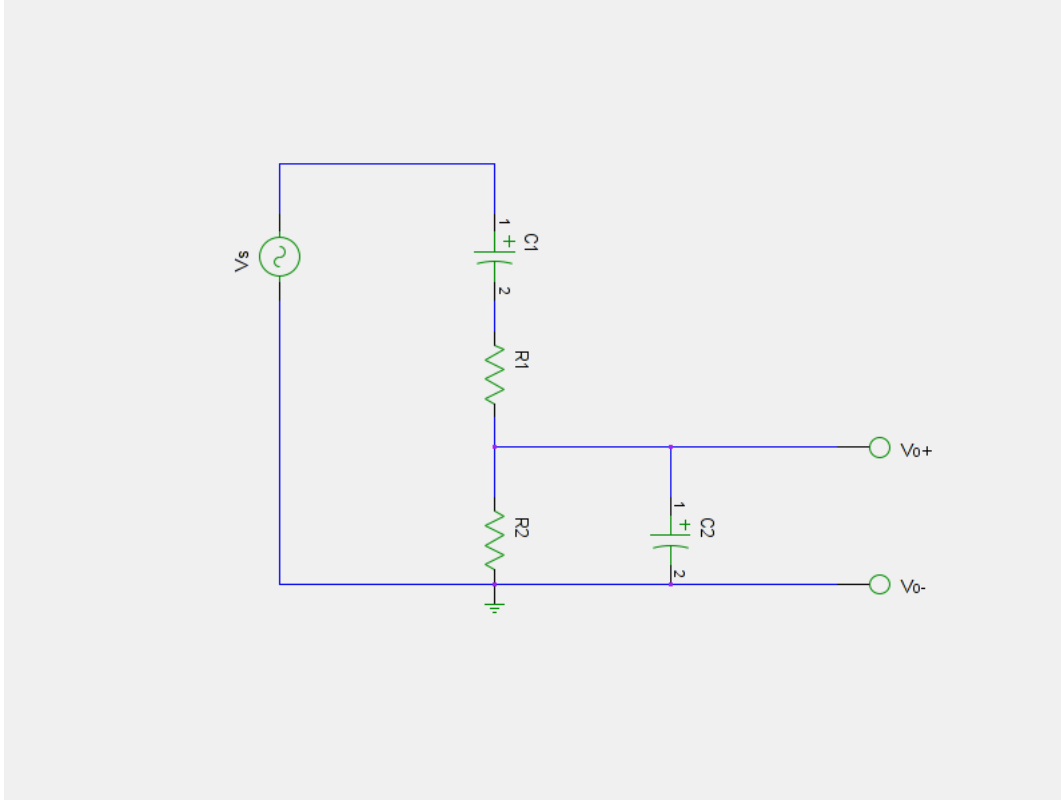


Figure 1: Hydrophone decoupling circuit

The figure above (1) shows an equivalent circuit of the deployed input decoupling to the hydrophone.

The circuit was based on the suggested decoupling in figure 2 seen below, it was designed to have the same properties, but also low-pass the signal at cutoff frequency f_{LP} . The original design already decouples, and high-passes, the signal at frequency f_{HP} .

SUGGESTED PRE AMPLIFIER DECOUPLING
AND WIRING FOR AQ-11, AQ-12, AQ-17, AQ-18.

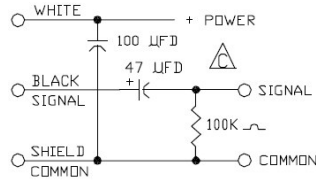


Figure 2: AQ-18 suggested decoupling and wiring [1].

2 Derivation of transfer function

i_1 and i_2 signify the current loops passing through respectively left and right loop. Using Kirchoff's equation:

$$V_s = i_1(Z_{C_1} + Z_{R_1}) + (i_1 - i_2) \cdot Z_{R_2} \quad (1)$$

$$0 = (i_2 - i_1) \cdot Z_{R_2} + i_2 \cdot Z_{C_2} \quad (2)$$

V_s is the signal source, the hydrophone. See separate data sheet for hydrophone frequency response. V_o , output, is measured at the terminals T_+ and T_- .

$$V_o = i_2 \cdot Z_{C_2} \quad (3)$$

$$H(s) = \frac{V_o}{V_s}, s = i\omega \quad (4)$$

Solving for $H(s)$ gives:

$$H(s) = \frac{8.218 \cdot 10^{60} \times s^2}{1.822 \cdot 10^{56} \times s^3 + 1.972 \cdot 10^{61} \times s^2 + 4.196 \cdot 10^{60} \times s} \quad (5)$$

A bode plot of the transfer function (instrument response) is shown in figure 3 below.

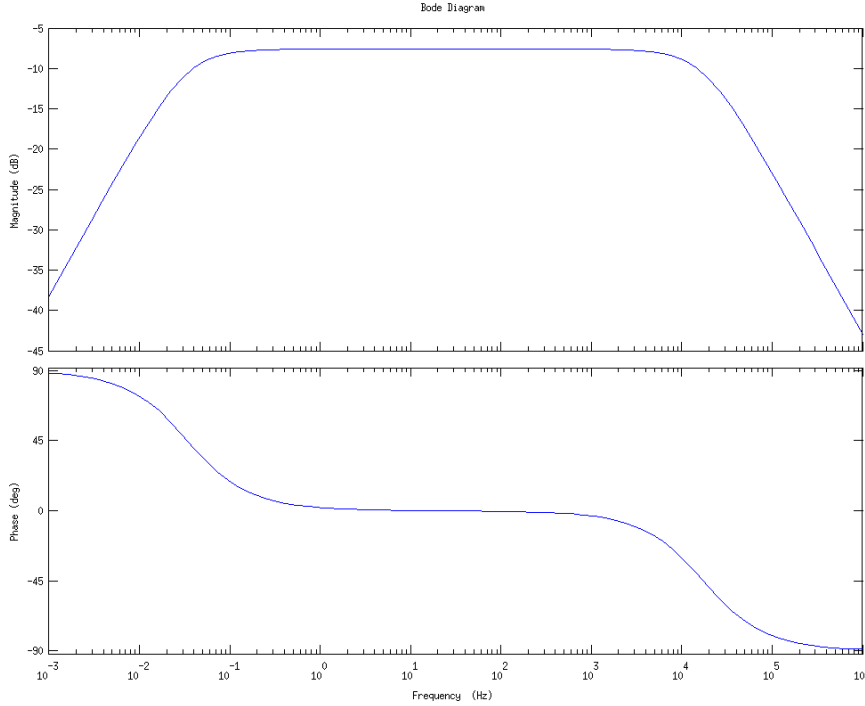


Figure 3: Bode plot of transfer function

Equation 5 can be solved by using the MATLAB script response.m (listing 1), the Bode plot in figure 3 was created with the same script.

2.1 Analysis

The transfer function is a bandpass filter with the suggested decoupling creating a high-pass filter with corner frequency at $f_{LP} = 0.0339$ Hz or a period of 29.4985 s. The higher corner frequency is at $f_{HP} = 17.189$ kHz. The corner frequency is well above the band of interest (< 1 kHz), but should provide sufficient damping at the Nyquist frequency of the digitizer which has a modulator speed of ca $f_{clk}/4 = 4 \text{ MHz}/4 = 1 \text{ MHz}$ [2].

3 Attachments

3.1 response.m

Listing 1: response.m, MATLAB code for calculating instrument response

```
1 % Calculates instrument response
2 r1 = 58.33e3;
3 r2 = 41.67e3;
4
5 c1 = 47e-6;
6 c2 = 380e-12;
7
8 syms s i1 i2 vs;
9 zc1 = 1/(s*c1);
10 zr1 = r1;
11 zc2 = 1/(s*c2);
12 zr2 = r2;
13
14 [i1, i2] = solve ('vs = i1*(zc1 + zr1) + (i1 - i2)*zr2', ...
15                 '0 = (i2 - i1)*zr2 + i2*zc2', 'i1', 'i2');
16
17 vo = i2*sym('zc2');
18 H = vo/vs;
19 pretty (simplify(H))
20 H = subs (H);
21
22 pretty(H);
23
24 [n, d] = numden (H);
25
26 Tn = sym2poly(n);
27 Td = sym2poly(d);
28 T = tf(Tn, Td)
29
30
31 P = bodeoptions;
32 P.FreqUnits = 'Hz';
33
34 bodeplot (T, P);
```

References

- [1] Benthos. *AQ-18 suggested decoupling*.
- [2] Texas Instrument. *ADS1282 (Datasheet)*. rev b. Texas Instruments.