Frequency Range

$f_c = 40\ kHz$.

$f_d = \frac{2V_r}{\lambda}$

with $\lambda = \frac{343\ m/s}{40000} = 8.575 \times 10^{-3} m$ $\therefore f_d = ?$

Take max V_r as fastest recorded ball (golf shot) = 91 m/s
≈ 95 m/s

$\therefore f_d = \frac{2(95)}{8.575 \times 10^{-3}} = 22,1574\ kHz$.

$\therefore f_L = 17.843\ kHz$ AND $f_H = 62.157\ kHz$.

Passband with $f_{c_{centre}} = 40\ kHz$

2 stage BPF? (Rx)

- 1st stage cutoffs:

  $f_{c1,H} = 8\ kHz$ $\quad f_{c1,L} = 120\ kHz$

- 2nd stage cutoffs:

  $f_{c2,H} = 12 kHz$ $\quad f_{c2,H} = 100\ kHz$ (prevent rolloff at 62 kHz).

Calculations: $f_c = \frac{1}{2\pi RC}$ and $G = -\frac{R_f}{R_i}$

① • $8000\ Hz = \frac{1}{2\pi RC}$

$\therefore C = 1,65786\ nF$

• $120000 = \frac{1}{2\pi RC}$

$C = 110,52\ pF$

② • Gain $= 20dB = 10\frac{V}{V} = \frac{R_f}{R_i}$

Choose $R_i = 12k\Omega$ (get many 12kΩ)

$\therefore R_f = 120k\Omega$

• $|G| = 1 = -\frac{R_f}{R_i}$, choose $R_f = 12k\Omega$ $\therefore R_i = 12k\Omega$

• $12000 = \frac{1}{2\pi(12 \times 10^3)(C)}$

$\therefore C = 1,105\ nF$

• $100\,000 = \frac{1}{2\pi(120 \times 10^3)(C)}$

$\therefore C = 13.263\ pF$

Simulations:

f_{centre} @ 35 kHz. @ 18.44dB
f_H (62 kHz) @ 17.269 dB.
f_L (17.84 kHz) @ 17.356dB.

42 kHz @ 18.279 dB
40 kHz @ 18.34 dB.
38 kHz @ 18.39 dB

-3dB pts:

$f_{c_1} = 12.24\ kHz$ & $f_c = 87.284\ kHz$.
BW = 75.044 kHz

Slew Rate = $2\pi f V_{pp} \times 10^{-6}$ V/μs

$= 2\pi (62.157 \times 10^{3})(24) \times 10^{-6}$ V/μs

$= 9,373$ V/μs

GBWP = $10 A_{cl} B$

$= 10\left(\frac{24}{3.3}\right)(44.31 \text{ kHz})$

$= 3,222836$ MHz.

Stage 1 : Frequency range :
17.8426 kHz ⟷ 62.157 kHz.
centred on
40kHz.

1st stage : No gain

30 kHz
12kΩ
= 442.97 pF
= 330 pF + 100pF

60 kHz.
12kΩ
2.65-26 pF.
= 220pF + 47pF

2nd stage 20 dB gain

34 kHz.
12 kΩ
≈ 390 pF.
≈ 330pF + 68pF

48 kHz.
120kΩ.
≈ ~~2200~~ 27,6pF
≈ 22pF + 3,3pF.
or
≈ 10p + 10p + 3,3p + 3,3pF

3dB
32kHz ⟷ 74.41 kHz
centre : 40kHz.

38 kHz.
12 k
349.02 pF
330 + 22

42 kHz :
120 k
31,58pF
33pF

Similar results.