## Experiment: TIA Z5 ZL

### Filter 1

Invalid filter
$Z(s)$: $(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ R_L)$

### Filter 2

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ \frac{1}{C_L s}\right)$

### Filter 3

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ \frac{R_L}{C_L R_L s+1}\right)$

### Filter 4

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ R_L+\frac{1}{C_L s}\right)$

### Filter 5

**Filter Type:** BS
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ L_L s+\frac{1}{C_L s}\right)$
$H(s)$: $\frac{(R_4 g_m-1)(C_L L_L s^2+1)}{2C_L L_L g_m s^2+C_L R_4 g_m s+C_L s+2g_m}$
**Q:** $\frac{2L_L g_m \sqrt{\frac{1}{C_L L_L}}}{R_4 g_m+1}$
$\omega_0$: $\sqrt{\frac{1}{C_L L_L}}$
**Bandwidth:** $\frac{R_4 g_m+1}{2L_L g_m}$

### Filter 6

**Filter Type:** BP
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ \frac{L_L s}{C_L L_L s^2+1}\right)$
$H(s)$: $\frac{L_L s(R_4 g_m-1)}{C_L L_L R_4 g_m s^2+2C_L L_L R_L g_m s^2+C_L L_L s^2+2L_L g_m s+R_4 g_m+1}$
**Q:** $\frac{C_L \sqrt{\frac{1}{C_L L_L}}(R_4 g_m+1)}{2g_m}$
$\omega_0$: $\sqrt{\frac{1}{C_L L_L}}$
**Bandwidth:** $\frac{2g_m}{C_L(R_4 g_m+1)}$

### Filter 7

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ L_L s+R_L+\frac{1}{C_L s}\right)$
$H(s)$: $\frac{(R_4 g_m-1)(C_L L_L s^2+C_L R_L s+1)}{2C_L L_L g_m s^2+C_L R_4 g_m s+2C_L R_L g_m s+C_L s+2g_m}$
**Q:** $\frac{2L_L g_m \sqrt{\frac{1}{C_L L_L}}}{R_4 g_m+2R_L g_m+1}$
$\omega_0$: $\sqrt{\frac{1}{C_L L_L}}$
**Bandwidth:** $\frac{R_4 g_m+2R_L g_m+1}{2L_L g_m}$
**Qz:** $\frac{L_L \sqrt{\frac{1}{C_L L_L}}}{R_L}$

### Filter 8

**Filter Type:** BP
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ \frac{1}{C_L s+\frac{1}{R_L}+\frac{1}{L_L s}}\right)$
$H(s)$: $\frac{L_L R_L s(R_4 g_m-1)}{C_L L_L R_L R_4 L_L g_m s^2+C_L L_L R_L s^2+L_L R_4 g_m s+2L_L R_L g_m s+L_L s+R_4 R_L g_m+R_L}$
**Q:** $\frac{C_L R_L \sqrt{\frac{1}{C_L L_L}}(R_4 g_m+1)}{R_4 g_m+2R_L g_m+1}$
$\omega_0$: $\sqrt{\frac{1}{C_L L_L}}$
**Bandwidth:** $\frac{R_4 g_m+2R_L g_m+1}{C_L R_L(R_4 g_m+1)}$

### Filter 9

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ \frac{L_L s}{C_L L_L s^2+1}+R_L\right)$
$H(s)$: $\frac{(R_4 g_m-1)(C_L L_L R_L s^2+L_L s+R_L)}{C_L L_L R_4 g_m s^2+2C_L L_L R_L g_m s^2+C_L L_L s^2+2L_L g_m s+R_4 g_m+2R_L g_m+1}$
**Q:** $\frac{C_L \sqrt{\frac{1}{C_L L_L}}(R_4 g_m+2R_L g_m+1)}{2g_m}$
$\omega_0$: $\sqrt{\frac{1}{C_L L_L}}$
**Bandwidth:** $\frac{2g_m}{C_L(R_4 g_m+2R_L g_m+1)}$
**Qz:** $C_L R_L \sqrt{\frac{1}{C_L L_L}}$

### Filter 10

**Filter Type:** BS
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4,\ \frac{R_L\left(L_L s+\frac{1}{C_L s}\right)}{L_L s+R_L+\frac{1}{C_L s}}\right)$
$H(s)$: $\frac{R_L(R_4 g_m-1)(C_L L_L s^2+1)}{C_L L_L R_4 g_m s^2+2C_L L_L R_L g_m s^2+C_L L_L s^2+C_L R_4 R_L g_m s+C_L R_L s+R_4 g_m+2R_L g_m+1}$
**Q:** $\frac{L_L \sqrt{\frac{1}{C_L L_L}}(R_4 g_m+2R_L g_m+1)}{R_L(R_4 g_m+1)}$
$\omega_0$: $\sqrt{\frac{1}{C_L L_L}}$
**Bandwidth:** $\frac{R_L(R_4 g_m+1)}{L_L(R_4 g_m+2R_L g_m+1)}$

### Filter 11

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ R_L\right)$

### Filter 12

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ \frac{1}{C_L s}\right)$

### Filter 13

**Filter Type:** Invalid011
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ \frac{R_L}{C_L R_L s+1}\right)$
$H(s)$: $\frac{R_L(-C_4 s+g_m)}{C_4 C_L R_L s^2+2C_L R_L g_m s+C_4 s+C_L R_L g_m s+g_m}$
**Q:** $\frac{C_4 C_L R_L \sqrt{\frac{g_m}{C_4 C_L R_L}}}{2C_L R_L g_m+C_4+C_L R_L g_m}$
$\omega_0$: $\sqrt{\frac{g_m}{C_4 C_L R_L}}$
**Bandwidth:** $\frac{2C_4 R_L g_m+C_4+C_L R_L g_m}{C_4 C_L R_L}$

### Filter 14

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ R_L+\frac{1}{C_L s}\right)$

### Filter 15

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ L_L s+\frac{1}{C_L s}\right)$

### Filter 16

**Filter Type:** Invalid110
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ \frac{L_L s}{C_L L_L s^2+1}\right)$
$H(s)$: $\frac{L_L s(-C_4 s+g_m)}{C_4 C_L L_L s^3+2C_4 L_L g_m s^2+C_4 s+C_L L_L g_m s^2+g_m}$
**Q:** $\frac{L_L g_m \sqrt{\frac{1}{L_L(2C_4+C_L)}}(2C_4+C_L)}{C_4}$
$\omega_0$: $\sqrt{\frac{1}{L_L(2C_4+C_L)}}$
**Bandwidth:** $\frac{C_4}{L_L g_m(2C_4+C_L)}$

### Filter 17

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ L_L s+R_L+\frac{1}{C_L s}\right)$

### Filter 18

**Filter Type:** Invalid110
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ \frac{1}{C_L s+\frac{1}{R_L}+\frac{1}{L_L s}}\right)$
$H(s)$: $\frac{L_L R_L s(-C_4 s+g_m)}{C_4 C_L L_L R_L s^3+2C_4 L_L R_L g_m s^2+C_4 L_L s^2+C_4 R_L s+C_L L_L R_L g_m s^2+L_L g_m s+R_L g_m}$
**Q:** $\frac{L_L \sqrt{\frac{R_L g_m+1}{L_L(2C_4 R_L g_m+C_4+C_L R_L g_m)}}(2C_4 R_L g_m+C_4+C_L R_L g_m)}{C_4 R_L+L_L g_m}$
$\omega_0$: $\sqrt{\frac{R_L g_m+1}{L_L(2C_4 R_L g_m+C_4+C_L R_L g_m)}}$
**Bandwidth:** $\frac{C_4 R_L+L_L g_m}{L_L(2C_4 R_L g_m+C_4+C_L R_L g_m)}$

### Filter 19

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ \frac{L_L s}{C_L L_L s^2+1}+R_L\right)$

### Filter 20

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s},\ \frac{R_L\left(L_L s+\frac{1}{C_L s}\right)}{L_L s+R_L+\frac{1}{C_L s}}\right)$

### Filter 21

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ R_L\right)$

### Filter 22

**Filter Type:** Invalid011
$Z(s)$: $\left(\infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ \frac{1}{C_L s},\ \frac{1}{C_L s}\right)$
$H(s)$: $\frac{-C_4 R_4 s+R_4 g_m-1}{C_4 C_L R_4 L_L s^2+2C_4 L_L g_m s+C_4 R_4 s+C_L R_4 L_L g_m s^2+2C_L L_L g_m s+C_L s+2g_m}$
**Q:** $\frac{\sqrt{2}C_4 C_L R_4 \sqrt{\frac{g_m}{C_4 C_L R_4}}}{2C_4 R_4 g_m+C_L R_4 g_m+C_L}$
$\omega_0$: $\sqrt{2}\sqrt{\frac{g_m}{C_4 C_L R_4}}$
**Bandwidth:** $\frac{2C_4 R_4 g_m+C_L R_4 g_m+C_L}{C_4 C_L R_4}$

### Filter 23

**Filter Type:** Invalid011
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ \frac{R_L}{C_L R_L s+1}\right)$
$H(s)$: $\frac{R_L(-C_4 R_4 s+R_4 g_m-1)}{C_4 C_L R_4 R_L s^2+2C_4 R_4 R_L g_m s+C_4 R_4 s+C_4 R_4 R_L g_m s+C_L R_4 R_L g_m s^2+C_L R_L s+R_4 g_m+2R_L g_m+1}$
**Q:** $\frac{C_4 C_L R_4 R_L \sqrt{\frac{R_4 g_m+2R_L g_m+1}{C_4 C_L R_4 R_L}}}{2C_4 R_4 R_L g_m+C_4 R_4+C_L R_4 R_L g_m+C_L R_L}$
$\omega_0$: $\sqrt{\frac{R_4 g_m+2R_L g_m+1}{C_4 C_L R_4 R_L}}$
**Bandwidth:** $\frac{2C_4 R_4 R_L g_m+C_4 R_4+C_L R_4 R_L g_m+C_L R_L}{C_4 C_L R_4 R_L}$

### Filter 24

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ R_L+\frac{1}{C_L s}\right)$

### Filter 25

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ L_L s+\frac{1}{C_L s}\right)$

### Filter 26

**Filter Type:** Invalid110
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ \frac{L_L s}{C_L L_L s^2+1}\right)$
$H(s)$: $\frac{L_L s(-C_4 R_4 s+R_4 g_m-1)}{C_4 C_L L_L R_4 s^3+2C_4 L_L R_4 g_m s^2+C_4 R_4 s+C_L L_L R_4 g_m s^2+C_L L_L s^2+2L_L g_m s+R_4 g_m+1}$
**Q:** $\frac{L_L \sqrt{\frac{R_4 g_m+1}{L_L(2C_4 R_4 g_m+C_L R_4 g_m+C_L)}}(2C_4 R_4 g_m+C_L R_4 g_m+C_L)}{C_4 R_4+2L_L g_m}$
$\omega_0$: $\sqrt{\frac{R_4 g_m+1}{L_L(2C_4 R_4 g_m+C_L R_4 g_m+C_L)}}$
**Bandwidth:** $\frac{C_4 R_4+2L_L g_m}{L_L(2C_4 R_4 g_m+C_L R_4 g_m+C_L)}$

### Filter 27

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ L_L s+R_L+\frac{1}{C_L s}\right)$

### Filter 28

**Filter Type:** Invalid110
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4 R_4 s+1},\ \frac{1}{C_L s+\frac{1}{R_L}+\frac{1}{L_L s}}\right)$
$H(s)$: $\frac{L_L R_L s(-C_4 R_4 s+R_4 g_m-1)}{C_4 C_L L_L R_4 R_L s^3+2C_4 L_L R_4 R_L g_m s^2+C_4 L_L R_4 s^2+C_4 R_4 R_L s+C_L L_L R_4 R_L g_m s^2+C_L L_L R_L s^2+L_L R_4 g_m s+2L_L R_L g_m s+L_L s+R_4 R_L g_m+R_L}$
**Q:** $\frac{L_L \sqrt{\frac{R_L(R_4 g_m+1)}{L_L(2C_4 R_4 R_L g_m+C_4 R_4+C_L R_4 R_L g_m+C_L R_L)}}(2C_4 R_4 R_L g_m+C_4 R_4+C_L R_4 R_L g_m+C_L R_L)}{C_4 R_4 R_L+L_L R_4 g_m+2L_L R_L g_m+L_L}$
$\omega_0$: $\sqrt{\frac{R_L(R_4 g_m+1)}{L_L(2C_4 R_4 R_L g_m+C_4 R_4+C_L R_4 R_L g_m+C_L R_L)}}$
**Bandwidth:** $\frac{C_4 R_4 R_L+L_L R_4 g_m+2L_L R_L g_m+L_L}{L_L(2C_4 R_4 R_L g_m+C_4 R_4+C_L R_4 R_L g_m+C_L R_L)}$

### Filter 29

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4R_4s+1},\ \frac{L_Ls}{C_LL_Ls^2+1}+R_L\right)$

### Filter 30

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4}{C_4R_4s+1},\ \frac{R_L\left(L_Ls+\frac{1}{C_Ls}\right)}{L_Ls+R_L+\frac{1}{C_Ls}}\right)$

### Filter 31

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ R_L\right)$

### Filter 32

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ \frac{1}{C_Ls}\right)$

### Filter 33

**Filter Type:** Invalid011
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ \frac{R_s}{C_TR_Ls+1}\right)$
$H(s)$: $\frac{R_L(C_4R_4g_ms+C_4s+g_m)}{C_4C_TR_4R_Lg_ms^2+C_4C_TR_Ls^2+C_4R_4g_ms+2C_4R_Lg_ms+C_4s+C_TR_Lg_ms+g_m}$
**Q:** $\frac{C_4C_TR_L\sqrt{\frac{g_m}{C_4C_TR_L(R_4g_m+1)}}(R_4g_m+1)}{C_4R_4g_m+2C_4R_Lg_m+C_4+C_TR_Lg_m}$
$\omega_0$: $\sqrt{\frac{g_m}{C_4C_TR_L(R_4g_m+1)}}$
**Bandwidth:** $\frac{C_4R_4g_m+2C_4R_Lg_m+C_4+C_TR_Lg_m}{C_4C_TR_L(R_4g_m+1)}$

### Filter 34

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ R_L+\frac{1}{C_Ls}\right)$

### Filter 35

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ L_Ls+\frac{1}{C_Ls}\right)$

### Filter 36

**Filter Type:** Invalid110
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ \frac{L_Ls}{C_TL_Ls^2+1}\right)$
$H(s)$: $\frac{L_Ls(C_4R_4g_ms-C_4s+g_m)}{C_4C_TL_TR_4g_ms^3+C_4C_TL_Ls^3+2C_4L_Lg_ms^2+C_4R_4g_ms-C_4s+C_TL_Lg_ms^2+g_m}$
**Q:** $\frac{L_Lg_m\sqrt{\frac{1}{L_L(2C_4+C_L)}}(2C_4+C_L)}{C_4(R_4g_m+1)}$
$\omega_0$: $\sqrt{\frac{1}{L_L(2C_4+C_L)}}$
**Bandwidth:** $\frac{C_4(R_4g_m+1)}{L_Lg_m(2C_4+C_L)}$

### Filter 37

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ L_Ls+R_L+\frac{1}{C_Ls}\right)$

### Filter 38

**Filter Type:** Invalid110
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ \frac{1}{C_Ls+\frac{1}{R_L+\frac{1}{L_Ls}}}\right)$
$H(s)$: $\frac{L_Ls(C_4R_4g_ms-C_4s+g_m)}{C_4C_TL_TR_4R_Lg_ms^3+C_4C_TL_TR_Ls^3+C_4L_TR_4g_ms^2+2C_4L_TR_Lg_ms^2+C_4L_Ls^2+C_4R_4R_Lg_ms+C_4R_Ls+C_TL_TR_Lg_ms^2+L_Lg_ms+R_Lg_m}$
**Q:** $\frac{L_L\sqrt{\frac{R_Lg_m}{L_L(C_4R_4g_m+2C_4R_Lg_m+C_4+C_TR_Lg_m)}}(C_4R_4g_m+2C_4R_Lg_m+C_4+C_TR_Lg_m)}{C_4R_4R_Lg_m+C_4R_L+L_Lg_m}$
$\omega_0$: $\sqrt{\frac{R_Lg_m}{L_L(C_4R_4g_m+2C_4R_Lg_m+C_4+C_TR_Lg_m)}}$
**Bandwidth:** $\frac{C_4R_4R_Lg_m+C_4R_L+L_Lg_m}{L_L(C_4R_4g_m+2C_4R_Lg_m+C_4+C_TR_Lg_m)}$

### Filter 39

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ \frac{L_Ls}{C_TL_Ls^2+1}+R_L\right)$

### Filter 40

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ R_4+\frac{1}{C_4s},\ \frac{R_L\left(L_Ls+\frac{1}{C_Ls}\right)}{L_Ls+R_L+\frac{1}{C_Ls}}\right)$

### Filter 41

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4s+\frac{1}{C_4s},\ R_L\right)$
$H(s)$: $\frac{R_L(C_4L_4g_ms^2-C_4s+g_m)}{C_4L_4g_ms^2+2C_4R_Lg_ms+C_4s+g_m}$
**Q:** $\frac{L_4g_m\sqrt{\frac{1}{C_4L_4}}}{2R_Lg_m+1}$
$\omega_0$: $\sqrt{\frac{1}{C_4L_4}}$
**Bandwidth:** $\frac{2R_Lg_m+1}{L_4g_m}$
**Qz:** $-L_4g_m\sqrt{\frac{1}{C_4L_4}}$

### Filter 42

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4s+\frac{1}{C_4s},\ \frac{1}{C_Ls}\right)$

### Filter 43

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4s+\frac{1}{C_4s},\ \frac{R_L}{C_LR_Ls+1}\right)$

### Filter 44

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4s+\frac{1}{C_4s},\ R_L+\frac{1}{C_Ls}\right)$

### Filter 45

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4s+\frac{1}{C_4s},\ L_Ls+\frac{1}{C_Ls}\right)$

### Filter 46

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + \frac{1}{C_4 s},\ \frac{L_L s}{C_L L_L s^2+1}\right)$

### Filter 47

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + \frac{1}{C_4 s},\ L_L s + R_L + \frac{1}{C_L s}\right)$

### Filter 48

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + \frac{1}{C_4 s},\ \frac{1}{C_L s + \frac{1}{R_L} + \frac{1}{L_L s}}\right)$

### Filter 49

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + \frac{1}{C_4 s},\ \frac{L_L s}{C_L L_L s^2+1} + R_L\right)$

### Filter 50

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + \frac{1}{C_4 s},\ \frac{R_L\left(L_L s + \frac{1}{C_L s}\right)}{L_L s + R_L + \frac{1}{C_L s}}\right)$

### Filter 51

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ R_L\right)$
$H(s)$: $\frac{R_L\left(-C_4 L_4 s^2 + L_4 g_m s - 1\right)}{2C_4 L_4 R_L g_m s^2 + C_4 L_4 s^2 + L_4 g_m s + 2R_L g_m + 1}$
**Q:** $\frac{C_4\sqrt{\frac{1}{C_4 L_4}}\left(2R_L g_m + 1\right)}{g_m}$
$\omega_0$: $\sqrt{\frac{1}{C_4 L_4}}$
**Bandwidth:** $\frac{g_m}{C_4(2R_L g_m + 1)}$
**Qz:** $-\frac{C_4\sqrt{\frac{1}{C_4 L_4}}}{g_m}$

### Filter 52

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ \frac{1}{C_L s}\right)$

### Filter 53

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ \frac{R_L}{C_L R_L s+1}\right)$

### Filter 54

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ R_L + \frac{1}{C_L s}\right)$

### Filter 55

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ L_L s + \frac{1}{C_L s}\right)$

### Filter 56

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ \frac{L_L s}{C_L L_L s^2+1}\right)$

### Filter 57

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ L_L s + R_L + \frac{1}{C_L s}\right)$

### Filter 58

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ \frac{1}{C_L s + \frac{1}{R_L} + \frac{1}{L_L s}}\right)$

### Filter 59

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ \frac{L_L s}{C_L L_L s^2+1} + R_L\right)$

### Filter 60

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1},\ \frac{R_L\left(L_L s + \frac{1}{C_L s}\right)}{L_L s + R_L + \frac{1}{C_L s}}\right)$

### Filter 61

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ R_L\right)$
$H(s)$: $\frac{R_L\left(C_4 L_4 g_m s^2 + C_4 R_4 g_m s - C_4 s + g_m\right)}{C_4 L_4 g_m s^2 + C_4 R_4 g_m s + 2C_4 R_L g_m s + C_4 s + g_m}$
**Q:** $\frac{L_4 g_m\sqrt{\frac{1}{C_4 L_4}}}{R_4 g_m + 2R_L g_m + 1}$
$\omega_0$: $\sqrt{\frac{1}{C_4 L_4}}$
**Bandwidth:** $\frac{R_4 g_m + 2R_L g_m + 1}{L_4 g_m}$
**Qz:** $\frac{L_4 g_m\sqrt{\frac{1}{C_4 L_4}}}{R_4 g_m - 1}$

### Filter 62

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ \frac{1}{C_L s}\right)$

### Filter 63

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ \frac{R_L}{C_L R_L s+1}\right)$

### Filter 64

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ R_L + \frac{1}{C_L s}\right)$

### Filter 65

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ L_L s + \frac{1}{C_L s}\right)$

### Filter 66

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ \frac{L_L s}{C_L L_L s^2+1}\right)$

### Filter 67

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ L_L s + R_L + \frac{1}{C_L s}\right)$

### Filter 68

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ \frac{1}{C_L s + \frac{1}{R_L + \frac{1}{L_L s}}}\right)$

### Filter 69

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ \frac{L_L s}{C_L L_L s^2+1} + R_L\right)$

### Filter 70

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ L_4 s + R_4 + \frac{1}{C_4 s},\ \frac{R_L\left(L_L s + \frac{1}{C_L s}\right)}{L_L s + R_L + \frac{1}{C_L s}}\right)$

### Filter 71

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ R_L\right)$
$H(s)$: $\frac{R_L\left(-C_4 L_4 R_4 s^2 + L_4 R_4 g_m s - L_4 s - R_4\right)}{2C_4 L_4 R_4 R_L g_m s^2 + C_4 L_4 R_4 s^2 + L_4 R_4 g_m s + 2L_4 R_L g_m s + L_4 s + 2R_4 R_L g_m + R_4}$
**Q:** $\frac{C_4 R_4 \sqrt{\frac{1}{C_4 L_4}}\left(2R_L g_m + 1\right)}{R_4 g_m + 2R_L g_m + 1}$
$\omega_0$: $\sqrt{\frac{1}{C_4 L_4}}$
**Bandwidth:** $\frac{R_4 g_m + 2R_L g_m + 1}{C_4 R_4 (2R_L g_m + 1)}$
**Qz:** $-\frac{C_4 R_4 \sqrt{\frac{1}{C_4 L_4}}}{R_4 g_m - 1}$

### Filter 72

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ \frac{1}{C_L s}\right)$

### Filter 73

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ \frac{R_L}{C_L R_L s + 1}\right)$

### Filter 74

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ R_L + \frac{1}{C_L s}\right)$

### Filter 75

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ L_L s + \frac{1}{C_L s}\right)$

### Filter 76

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ \frac{L_L s}{C_L L_L s^2+1}\right)$

### Filter 77

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ L_L s + R_L + \frac{1}{C_L s}\right)$

### Filter 78

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ \frac{1}{C_L s + \frac{1}{R_L + \frac{1}{L_L s}}}\right)$

### Filter 79

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ \frac{L_L s}{C_L L_L s^2+1} + R_L\right)$

### Filter 80

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{1}{C_4 s + \frac{1}{R_4 + \frac{1}{L_4 s}}},\ \frac{R_L\left(L_L s + \frac{1}{C_L s}\right)}{L_L s + R_L + \frac{1}{C_L s}}\right)$

### Filter 81

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ R_L\right)$
$H(s)$: $\frac{R_L\left(C_4 L_4 R_4 g_m s^2 - C_4 L_4 s^2 + L_4 g_m s + R_4 g_m - 1\right)}{C_4 L_4 R_4 g_m s^2 + 2C_4 L_4 R_L g_m s^2 + C_4 L_4 s^2 + L_4 g_m s + R_4 g_m + 2R_L g_m + 1}$
**Q:** $\frac{C_4 \sqrt{\frac{1}{C_4 L_4}}\left(R_4 g_m + 2R_L g_m + 1\right)}{g_m}$
$\omega_0$: $\sqrt{\frac{1}{C_4 L_4}}$
**Bandwidth:** $\frac{g_m}{C_4 (R_4 g_m + 2R_L g_m + 1)}$
**Qz:** $\frac{C_4 \sqrt{\frac{1}{C_4 L_4}}\left(R_4 g_m - 1\right)}{g_m}$

### Filter 82

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ \frac{1}{C_L s}\right)$

### Filter 83

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ \frac{R_L}{C_L R_L s+1}\right)$

### Filter 84

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ R_L + \frac{1}{C_L s}\right)$

### Filter 85

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ L_L s + \frac{1}{C_L s}\right)$

### Filter 86

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ \frac{L_L s}{C_L L_L s^2+1}\right)$

### Filter 87

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ L_L s + R_L + \frac{1}{C_L s}\right)$

### Filter 88

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ \frac{1}{C_L s + \frac{1}{R_L} + \frac{1}{L_L s}}\right)$

### Filter 89

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ \frac{L_L s}{C_L L_L s^2+1} + R_L\right)$

### Filter 90

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{L_4 s}{C_4 L_4 s^2+1} + R_4,\ \frac{R_L\left(L_L s + \frac{1}{C_L s}\right)}{L_L s + R_L + \frac{1}{C_L s}}\right)$

### Filter 91

**Filter Type:** GE
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ R_L\right)$
$H(s)$: $\frac{R_L\left(C_4 L_4 R_4 g_m s^2 - C_4 L_4 s^2 - C_4 R_4 s + R_4 g_m - 1\right)}{C_4 L_4 R_4 g_m s^2 + 2C_4 L_4 R_L g_m s^2 + C_4 L_4 s^2 + 2C_4 R_4 R_L g_m s + C_4 R_4 s + R_4 g_m + 2R_L g_m + 1}$
**Q:** $\frac{L_4\sqrt{\frac{1}{C_4 L_4}}\left(R_4 g_m + 2R_L g_m + 1\right)}{R_4(2R_L g_m + 1)}$
$\omega_0$: $\sqrt{\frac{1}{C_4 L_4}}$
**Bandwidth:** $\frac{R_4(2R_L g_m + 1)}{L_4(R_4 g_m + 2R_L g_m + 1)}$
**Qz:** $\frac{L_4\sqrt{\frac{1}{C_4 L_4}}\left(-R_4 g_m + 1\right)}{R_4}$

### Filter 92

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ \frac{1}{C_L s}\right)$

### Filter 93

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ \frac{R_L}{C_L R_L s+1}\right)$

### Filter 94

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ R_L + \frac{1}{C_L s}\right)$

### Filter 95

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ L_L 8 + \frac{1}{C_L s}\right)$

### Filter 96

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ \frac{L_L s}{C_L L_L s^2+1}\right)$

### Filter 97

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ L_L 8 + R_L + \frac{1}{C_L s}\right)$

### Filter 98

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ \frac{1}{C_L s + \frac{1}{R_L} + \frac{1}{L_L s}}\right)$

### Filter 99

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ \frac{L_L s}{C_L L_L s^2+1} + R_L\right)$

### Filter 100

Invalid filter
$Z(s)$: $\left(\infty,\ \infty,\ \infty,\ \infty,\ \frac{R_4\left(L_4 s + \frac{1}{C_4 s}\right)}{L_4 s + R_4 + \frac{1}{C_4 s}},\ \frac{R_L\left(L_L s + \frac{1}{C_L s}\right)}{L_L s + R_L + \frac{1}{L_L s}}\right)$