

# Filter Summary Report: TIA,simple,Z1,Z5

Generated by MacAnalog-Symbolix

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<b>11 PolynomialError</b>	<b>21</b>
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1    Examined  $H(z)$  for TIA simple Z1 Z5:  $\frac{Z_1(Z_5g_m-1)}{2Z_1g_m+1}$

$$H(z) = \frac{Z_1 (Z_5g_m - 1)}{2Z_1g_m + 1}$$

2    HP

3    BP

3.1    BP-1  $Z(s) = \left( \frac{L_1s}{C_1L_1s^2+1}, \infty, \infty, \infty, R_5, \infty \right)$

$$H(s) = \frac{s (L_1R_5g_m - L_1)}{C_1L_1s^2 + 2L_1g_ms + 1}$$

Parameters:

Q:  $\frac{C_1\sqrt{\frac{1}{C_1L_1}}}{2g_m}$   
wo:  $\sqrt{\frac{1}{C_1L_1}}$   
bandwidth:  $\frac{2g_m}{C_1}$   
K-LP: 0  
K-HP: 0  
K-BP:  $\frac{R_5g_m-1}{2g_m}$   
Qz: 0  
Wz: None

3.2    BP-2  $Z(s) = \left( \frac{L_1R_1s}{C_1L_1R_1s^2+L_1s+R_1}, \infty, \infty, \infty, R_5, \infty \right)$

$$H(s) = \frac{s (L_1R_1R_5g_m - L_1R_1)}{C_1L_1R_1s^2 + R_1 + s (2L_1R_1g_m + L_1)}$$

Parameters:

Q:  $\frac{C_1R_1\sqrt{\frac{1}{C_1L_1}}}{2R_1g_m+1}$   
wo:  $\sqrt{\frac{1}{C_1L_1}}$   
bandwidth:  $\frac{2R_1g_m+1}{C_1R_1}$   
K-LP: 0  
K-HP: 0  
K-BP:  $\frac{R_1(R_5g_m-1)}{2R_1g_m+1}$   
Qz: 0  
Wz: None

4    LP

5    BS

**5.1 BS-1**  $Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \infty, \infty, \infty, R_5, \infty \right)$

**Parameters:**

$$\begin{aligned} \text{Q: } & 2L_1 g_m \sqrt{\frac{1}{C_1 L_1}} \\ \text{wo: } & \sqrt{\frac{1}{C_1 L_1}} \\ \text{bandwidth: } & \frac{1}{2L_1 g_m} \\ \text{K-LP: } & \frac{R_5 g_m - 1}{2g_m} \\ \text{K-HP: } & \frac{R_5 g_m - 1}{2g_m} \\ \text{K-BP: } & 0 \\ \text{Qz: } & \text{None} \\ \text{Wz: } & \sqrt{\frac{1}{C_1 L_1}} \end{aligned}$$

**5.2 BS-2**  $Z(s) = \left( \frac{R_1(C_1 L_1 s^2 + 1)}{C_1 L_1 s^2 + C_1 R_1 s + 1}, \infty, \infty, \infty, R_5, \infty \right)$

**Parameters:**

$$\begin{aligned} \text{Q: } & \frac{L_1 \sqrt{\frac{1}{C_1 L_1}} (2R_1 g_m + 1)}{R_1} \\ \text{wo: } & \sqrt{\frac{1}{C_1 L_1}} \\ \text{bandwidth: } & \frac{R_1}{L_1 (2R_1 g_m + 1)} \\ \text{K-LP: } & \frac{R_1 (R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{K-HP: } & \frac{R_1 (R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{K-BP: } & 0 \\ \text{Qz: } & \text{None} \\ \text{Wz: } & \sqrt{\frac{1}{C_1 L_1}} \end{aligned}$$

## 6 GE

**6.1 GE-1**  $Z(s) = \left( R_1, \infty, \infty, \infty, \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \infty \right)$

**Parameters:**

$$\begin{aligned} \text{Q: } & C_5 R_5 \sqrt{\frac{1}{C_5 L_5}} \\ \text{wo: } & \sqrt{\frac{1}{C_5 L_5}} \\ \text{bandwidth: } & \frac{1}{C_5 R_5} \\ \text{K-LP: } & -\frac{R_1}{2R_1 g_m + 1} \\ \text{K-HP: } & -\frac{R_1}{2R_1 g_m + 1} \\ \text{K-BP: } & \frac{R_1 (R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{Qz: } & -\frac{C_5 R_5 \sqrt{\frac{1}{C_5 L_5}}}{R_5 g_m - 1} \\ \text{Wz: } & \sqrt{\frac{1}{C_5 L_5}} \end{aligned}$$

$$H(s) = \frac{R_5 g_m + s^2 (C_1 L_1 R_5 g_m - C_1 L_1) - 1}{2C_1 L_1 g_m s^2 + C_1 s + 2g_m}$$

$$H(s) = \frac{R_1 R_5 g_m - R_1 + s^2 (C_1 L_1 R_1 R_5 g_m - C_1 L_1 R_1)}{C_1 R_1 s + 2R_1 g_m + s^2 (2C_1 L_1 R_1 g_m + C_1 L_1) + 1}$$

$$H(s) = \frac{-C_5 L_5 R_1 R_5 s^2 - R_1 R_5 + s (L_5 R_1 R_5 g_m - L_5 R_1)}{2R_1 R_5 g_m + R_5 + s^2 (2C_5 L_5 R_1 R_5 g_m + C_5 L_5 R_5) + s (2L_5 R_1 g_m + L_5)}$$

$$\mathbf{6.2 \quad GE-2} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad \frac{R_5(C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \quad \infty \right)$$

**Parameters:**

$$\begin{aligned} \text{Q:} & \frac{L_5 \sqrt{\frac{1}{C_5 L_5}}}{R_5} \\ \text{wo:} & \sqrt{\frac{1}{C_5 L_5}} \\ \text{bandwidth:} & \frac{R_5}{L_5} \\ \text{K-LP:} & \frac{R_1(R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{K-HP:} & \frac{R_1(R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{K-BP:} & -\frac{R_1}{2R_1 g_m + 1} \\ \text{Qz:} & \frac{L_5 \sqrt{\frac{1}{C_5 L_5}}(-R_5 g_m + 1)}{R_5} \\ \text{Wz:} & \sqrt{\frac{1}{C_5 L_5}} \end{aligned}$$

$$\mathbf{6.3 \quad GE-3} \quad Z(s) = \left( L_1 s + R_1 + \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad R_5, \quad \infty \right)$$

**Parameters:**

$$\begin{aligned} \text{Q:} & \frac{2L_1 g_m \sqrt{\frac{1}{C_1 L_1}}}{2R_1 g_m + 1} \\ \text{wo:} & \sqrt{\frac{1}{C_1 L_1}} \\ \text{bandwidth:} & \frac{2R_1 g_m + 1}{2L_1 g_m} \\ \text{K-LP:} & \frac{R_5 g_m - 1}{2g_m} \\ \text{K-HP:} & \frac{R_5 g_m - 1}{2g_m} \\ \text{K-BP:} & \frac{R_1(R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{Qz:} & \frac{L_1 \sqrt{\frac{1}{C_1 L_1}}}{R_1} \\ \text{Wz:} & \sqrt{\frac{1}{C_1 L_1}} \end{aligned}$$

$$\mathbf{6.4 \quad GE-4} \quad Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \quad \infty, \quad \infty, \quad \infty, \quad R_5, \quad \infty \right)$$

**Parameters:**

$$\begin{aligned} \text{Q:} & \frac{C_1 \sqrt{\frac{1}{C_1 L_1}}(2R_1 g_m + 1)}{2g_m} \\ \text{wo:} & \sqrt{\frac{1}{C_1 L_1}} \\ \text{bandwidth:} & \frac{2g_m}{C_1(2R_1 g_m + 1)} \\ \text{K-LP:} & \frac{R_1(R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{K-HP:} & \frac{R_1(R_5 g_m - 1)}{2R_1 g_m + 1} \\ \text{K-BP:} & \frac{R_5 g_m - 1}{2g_m} \\ \text{Qz:} & C_1 R_1 \sqrt{\frac{1}{C_1 L_1}} \\ \text{Wz:} & \sqrt{\frac{1}{C_1 L_1}} \end{aligned}$$

$$H(s) = \frac{-C_5 R_1 R_5 s + R_1 R_5 g_m - R_1 + s^2 (C_5 L_5 R_1 R_5 g_m - C_5 L_5 R_1)}{2R_1 g_m + s^2 (2C_5 L_5 R_1 g_m + C_5 L_5) + s (2C_5 R_1 R_5 g_m + C_5 R_5) + 1}$$

$$H(s) = \frac{R_5 g_m + s^2 (C_1 L_1 R_5 g_m - C_1 L_1) + s (C_1 R_1 R_5 g_m - C_1 R_1) - 1}{2C_1 L_1 g_m s^2 + 2g_m + s (2C_1 R_1 g_m + C_1)}$$

$$H(s) = \frac{R_1 R_5 g_m - R_1 + s^2 (C_1 L_1 R_1 R_5 g_m - C_1 L_1 R_1) + s (L_1 R_5 g_m - L_1)}{2L_1 g_m s + 2R_1 g_m + s^2 (2C_1 L_1 R_1 g_m + C_1 L_1) + 1}$$

## 7 AP

## 8 INVALID-NUMER

### 8.1 INVALID-NUMER-1 $Z(s) = \left( L_1 s, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_5 L_1 R_5 s^2 + s (L_1 R_5 g_m - L_1)}{2 C_5 L_1 R_5 g_m s^2 + s (C_5 R_5 + 2 L_1 g_m) + 1}$$

**Parameters:**

$$\begin{aligned} \text{Q: } & \frac{\sqrt{2} C_5 L_1 R_5 g_m \sqrt{\frac{1}{C_5 L_1 R_5 g_m}}}{C_5 R_5 + 2 L_1 g_m} \\ \text{wo: } & \frac{\sqrt{2} \sqrt{\frac{1}{C_5 L_1 R_5 g_m}}}{2} \\ \text{bandwidth: } & \frac{C_5 R_5 + 2 L_1 g_m}{2 C_5 L_1 R_5 g_m} \\ \text{K-LP: } & 0 \\ \text{K-HP: } & -\frac{1}{2 g_m} \\ \text{K-BP: } & \frac{L_1 (R_5 g_m - 1)}{C_5 R_5 + 2 L_1 g_m} \\ \text{QZ: } & -\frac{\sqrt{2} C_5 R_5 \sqrt{\frac{1}{C_5 L_1 R_5 g_m}}}{2 R_5 g_m - 2} \\ \text{Wz: } & \text{None} \end{aligned}$$

### 8.2 INVALID-NUMER-2 $Z(s) = \left( \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_5 R_5 s + R_5 g_m - 1}{C_1 C_5 R_5 s^2 + 2 g_m + s (C_1 + 2 C_5 R_5 g_m)}$$

**Parameters:**

$$\begin{aligned} \text{Q: } & \frac{\sqrt{2} C_1 C_5 R_5 \sqrt{\frac{g_m}{C_1 C_5 R_5}}}{C_1 + 2 C_5 R_5 g_m} \\ \text{wo: } & \sqrt{2} \sqrt{\frac{g_m}{C_1 C_5 R_5}} \\ \text{bandwidth: } & \frac{C_1 + 2 C_5 R_5 g_m}{C_1 C_5 R_5} \\ \text{K-LP: } & \frac{R_5 g_m - 1}{2 g_m} \\ \text{K-HP: } & 0 \\ \text{K-BP: } & -\frac{C_5 R_5}{C_1 + 2 C_5 R_5 g_m} \\ \text{QZ: } & 0 \\ \text{Wz: } & \text{None} \end{aligned}$$

### 8.3 INVALID-NUMER-3 $Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_5 R_1 R_5 s + R_1 R_5 g_m - R_1}{C_1 C_5 R_1 R_5 s^2 + 2 R_1 g_m + s (C_1 R_1 + 2 C_5 R_1 R_5 g_m + C_5 R_5) + 1}$$

**Parameters:**

$$\begin{aligned} \text{Q: } & \frac{C_1 C_5 R_1 R_5 \sqrt{\frac{2 R_1 g_m + 1}{C_1 C_5 R_1 R_5}}}{C_1 R_1 + 2 C_5 R_1 R_5 g_m + C_5 R_5} \\ \text{wo: } & \sqrt{\frac{2 R_1 g_m + 1}{C_1 C_5 R_1 R_5}} \\ \text{bandwidth: } & \frac{C_1 R_1 + 2 C_5 R_1 R_5 g_m + C_5 R_5}{C_1 C_5 R_1 R_5} \\ \text{K-LP: } & \frac{R_1 (R_5 g_m - 1)}{2 R_1 g_m + 1} \\ \text{K-HP: } & 0 \\ \text{K-BP: } & -\frac{C_5 R_1 R_5}{C_1 R_1 + 2 C_5 R_1 R_5 g_m + C_5 R_5} \\ \text{QZ: } & 0 \\ \text{Wz: } & \text{None} \end{aligned}$$



**8.4 INVALID-NUMER-4**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$

**Parameters:**

Q:  $\frac{C_1 \sqrt{\frac{1}{C_1 L_1}}}{2g_m}$   
 wo:  $\sqrt{\frac{1}{C_1 L_1}}$   
 bandwidth:  $\frac{2g_m}{C_1}$   
 K-LP:  $\frac{L_1 g_m}{C_5}$   
 K-HP: 0  
 K-BP:  $-\frac{1}{2g_m}$   
 Qz: 0  
 Wz: None

$$H(s) = \frac{-C_5 L_1 s + L_1 g_m}{C_1 C_5 L_1 s^2 + 2C_5 L_1 g_m s + C_5}$$

**8.5 INVALID-NUMER-5**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$

**Parameters:**

Q:  $\frac{C_1 \sqrt{\frac{1}{C_1 L_1}}}{2g_m}$   
 wo:  $\sqrt{\frac{1}{C_1 L_1}}$   
 bandwidth:  $\frac{2g_m}{C_1}$   
 K-LP:  $\frac{L_1 g_m}{C_5}$   
 K-HP: 0  
 K-BP:  $\frac{R_5 g_m - 1}{2g_m}$   
 Qz: 0  
 Wz: None

$$H(s) = \frac{L_1 g_m + s (C_5 L_1 R_5 g_m - C_5 L_1)}{C_1 C_5 L_1 s^2 + 2C_5 L_1 g_m s + C_5}$$

**8.6 INVALID-NUMER-6**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$

**Parameters:**

Q:  $\frac{C_1 R_1 \sqrt{\frac{1}{C_1 L_1}}}{2R_1 g_m + 1}$   
 wo:  $\sqrt{\frac{1}{C_1 L_1}}$   
 bandwidth:  $\frac{2R_1 g_m + 1}{C_1 R_1}$   
 K-LP:  $\frac{L_1 g_m}{C_5}$   
 K-HP: 0  
 K-BP:  $-\frac{R_1}{2R_1 g_m + 1}$   
 Qz: 0  
 Wz: None

$$H(s) = \frac{-C_5 L_1 R_1 s + L_1 R_1 g_m}{C_1 C_5 L_1 R_1 s^2 + C_5 R_1 + s (2C_5 L_1 R_1 g_m + C_5 L_1)}$$

**8.7 INVALID-NUMER-7**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$

**Parameters:**

Q:  $\frac{C_1 R_1 \sqrt{\frac{1}{C_1 L_1}}}{2R_1 g_m + 1}$

$$H(s) = \frac{L_1 R_1 g_m + s (C_5 L_1 R_1 R_5 g_m - C_5 L_1 R_1)}{C_1 C_5 L_1 R_1 s^2 + C_5 R_1 + s (2C_5 L_1 R_1 g_m + C_5 L_1)}$$

wo:  $\sqrt{\frac{1}{C_1 L_1}}$   
 bandwidth:  $\frac{2R_1 g_m + 1}{C_1 R_1}$   
 K-LP:  $\frac{L_1 g_m}{C_5}$   
 K-HP: 0  
 K-BP:  $\frac{R_1(R_5 g_m - 1)}{2R_1 g_m + 1}$   
 Qz: 0  
 Wz: None

## 9 INVALID-WZ

**9.1 INVALID-WZ-1**  $Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 R_1 R_5 s^2 + R_5 g_m + s(C_1 R_1 R_5 g_m - C_1 R_1 - C_5 R_5) - 1}{2g_m + s^2(2C_1 C_5 R_1 R_5 g_m + C_1 C_5 R_5) + s(2C_1 R_1 g_m + C_1 + 2C_5 R_5 g_m)}$$

**Parameters:**

Q:  $\frac{\sqrt{2}C_1 C_5 R_5 \sqrt{\frac{g_m}{C_1 C_5 R_5 (2R_1 g_m + 1)}} (2R_1 g_m + 1)}{2C_1 R_1 g_m + C_1 + 2C_5 R_5 g_m}$   
 wo:  $\sqrt{2} \sqrt{\frac{g_m}{C_1 C_5 R_5 (2R_1 g_m + 1)}}$   
 bandwidth:  $\frac{2C_1 R_1 g_m + C_1 + 2C_5 R_5 g_m}{C_1 C_5 R_5 (2R_1 g_m + 1)}$   
 K-LP:  $\frac{R_5 g_m - 1}{2g_m}$   
 K-HP:  $-\frac{R_1}{2R_1 g_m + 1}$   
 K-BP:  $\frac{C_1 R_1 R_5 g_m - C_1 R_1 - C_5 R_5}{2C_1 R_1 g_m + C_1 + 2C_5 R_5 g_m}$   
 Qz:  $\frac{\sqrt{2}C_1 C_5 R_1 R_5 \sqrt{\frac{g_m}{C_1 C_5 R_5 (2R_1 g_m + 1)}}}{-C_1 R_1 R_5 g_m + C_1 R_1 + C_5 R_5}$   
 Wz:  $\sqrt{\frac{-R_5 g_m + 1}{C_1 C_5 R_1 R_5}}$

**9.2 INVALID-WZ-2**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \infty, \infty, \infty, L_5 s + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_5 L_1 L_5 g_m s^2 - C_5 L_1 s + L_1 g_m}{C_1 C_5 L_1 s^2 + 2C_5 L_1 g_m s + C_5}$$

**Parameters:**

Q:  $\frac{C_1 \sqrt{\frac{1}{C_1 L_1}}}{2g_m}$   
 wo:  $\sqrt{\frac{1}{C_1 L_1}}$   
 bandwidth:  $\frac{2g_m}{C_1}$   
 K-LP:  $\frac{L_1 g_m}{C_5}$   
 K-HP:  $\frac{L_5 g_m}{C_1}$   
 K-BP:  $-\frac{1}{2g_m}$   
 Qz:  $-L_5 g_m \sqrt{\frac{1}{C_1 L_1}}$   
 Wz:  $\sqrt{\frac{1}{C_5 L_5}}$

**9.3 INVALID-WZ-3**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \infty, \infty, \infty, L_5 s + R_5 + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_5 L_1 L_5 g_m s^2 + L_1 g_m + s(C_5 L_1 R_5 g_m - C_5 L_1)}{C_1 C_5 L_1 s^2 + 2C_5 L_1 g_m s + C_5}$$

**Parameters:**

Q:  $\frac{C_1 \sqrt{\frac{1}{C_1 L_1}}}{2g_m}$   
 wo:  $\sqrt{\frac{1}{C_1 L_1}}$

$$\begin{aligned}
&\text{bandwidth: } \frac{2g_m}{C_1} \\
&\text{K-LP: } \frac{L_1 g_m}{C_5} \\
&\text{K-HP: } \frac{L_5 g_m}{C_1} \\
&\text{K-BP: } \frac{R_5 g_m - 1}{2g_m} \\
&\text{QZ: } \frac{L_5 g_m \sqrt{\frac{1}{C_1 L_1}}}{R_5 g_m - 1} \\
&\text{WZ: } \sqrt{\frac{1}{C_5 L_5}}
\end{aligned}$$

$$\mathbf{9.4 \quad INVALID-WZ-4} \quad Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_1 L_5 R_1 g_m s^2 - C_5 L_1 R_1 s + L_1 R_1 g_m}{C_1 C_5 L_1 R_1 s^2 + C_5 R_1 + s (2C_5 L_1 R_1 g_m + C_5 L_1)}$$

**Parameters:**

$$\begin{aligned}
&\text{Q: } \frac{C_1 R_1 \sqrt{\frac{1}{C_1 L_1}}}{2R_1 g_m + 1} \\
&\text{wo: } \sqrt{\frac{1}{C_1 L_1}} \\
&\text{bandwidth: } \frac{2R_1 g_m + 1}{C_1 R_1} \\
&\text{K-LP: } \frac{L_1 g_m}{C_5} \\
&\text{K-HP: } \frac{L_5 g_m}{C_1} \\
&\text{K-BP: } -\frac{R_1}{2R_1 g_m + 1} \\
&\text{QZ: } -L_5 g_m \sqrt{\frac{1}{C_1 L_1}} \\
&\text{WZ: } \sqrt{\frac{1}{C_5 L_5}}
\end{aligned}$$

$$\mathbf{9.5 \quad INVALID-WZ-5} \quad Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_1 L_5 R_1 g_m s^2 + L_1 R_1 g_m + s (C_5 L_1 R_1 R_5 g_m - C_5 L_1 R_1)}{C_1 C_5 L_1 R_1 s^2 + C_5 R_1 + s (2C_5 L_1 R_1 g_m + C_5 L_1)}$$

**Parameters:**

$$\begin{aligned}
&\text{Q: } \frac{C_1 R_1 \sqrt{\frac{1}{C_1 L_1}}}{2R_1 g_m + 1} \\
&\text{wo: } \sqrt{\frac{1}{C_1 L_1}} \\
&\text{bandwidth: } \frac{2R_1 g_m + 1}{C_1 R_1} \\
&\text{K-LP: } \frac{L_1 g_m}{C_5} \\
&\text{K-HP: } \frac{L_5 g_m}{C_1} \\
&\text{K-BP: } \frac{R_1 (R_5 g_m - 1)}{2R_1 g_m + 1} \\
&\text{QZ: } \frac{L_5 g_m \sqrt{\frac{1}{C_1 L_1}}}{R_5 g_m - 1} \\
&\text{WZ: } \sqrt{\frac{1}{C_5 L_5}}
\end{aligned}$$

## 10 INVALID-ORDER

$$\mathbf{10.1 \quad INVALID-ORDER-1} \quad Z(s) = (R_1, \quad \infty, \quad \infty, \quad \infty, \quad R_5, \quad \infty)$$

$$H(s) = \frac{R_1 R_5 g_m - R_1}{2R_1 g_m + 1}$$

$$10.2 \quad \text{INVALID-ORDER-2} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 R_1 s + R_1 g_m}{s (2C_5 R_1 g_m + C_5)}$$

$$10.3 \quad \text{INVALID-ORDER-3} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad \frac{R_5}{C_5 R_5 s + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 R_1 R_5 s + R_1 R_5 g_m - R_1}{2R_1 g_m + s (2C_5 R_1 R_5 g_m + C_5 R_5) + 1}$$

$$10.4 \quad \text{INVALID-ORDER-4} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{R_1 g_m + s (C_5 R_1 R_5 g_m - C_5 R_1)}{s (2C_5 R_1 g_m + C_5)}$$

$$10.5 \quad \text{INVALID-ORDER-5} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_5 R_1 g_m s^2 - C_5 R_1 s + R_1 g_m}{s (2C_5 R_1 g_m + C_5)}$$

$$10.6 \quad \text{INVALID-ORDER-6} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_5 R_1 s^2 + L_5 R_1 g_m s - R_1}{2R_1 g_m + s^2 (2C_5 L_5 R_1 g_m + C_5 L_5) + 1}$$

$$10.7 \quad \text{INVALID-ORDER-7} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_5 R_1 g_m s^2 + R_1 g_m + s (C_5 R_1 R_5 g_m - C_5 R_1)}{s (2C_5 R_1 g_m + C_5)}$$

$$10.8 \quad \text{INVALID-ORDER-8} \quad Z(s) = \left( R_1, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \quad \infty \right)$$

$$H(s) = \frac{L_5 R_1 g_m s + R_1 R_5 g_m - R_1 + s^2 (C_5 L_5 R_1 R_5 g_m - C_5 L_5 R_1)}{2R_1 g_m + s^2 (2C_5 L_5 R_1 g_m + C_5 L_5) + 1}$$

$$10.9 \quad \text{INVALID-ORDER-9} \quad Z(s) = (L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad R_5, \quad \infty)$$

$$H(s) = \frac{s (L_1 R_5 g_m - L_1)}{2L_1 g_m s + 1}$$

$$10.10 \quad \text{INVALID-ORDER-10} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 s + L_1 g_m}{2C_5 L_1 g_m s + C_5}$$

$$10.11 \quad \text{INVALID-ORDER-11} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{L_1 g_m + s (C_5 L_1 R_5 g_m - C_5 L_1)}{2C_5 L_1 g_m s + C_5}$$

$$10.12 \quad \text{INVALID-ORDER-12} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_1 L_5 g_m s^2 - C_5 L_1 s + L_1 g_m}{2 C_5 L_1 g_m s + C_5}$$

$$10.13 \quad \text{INVALID-ORDER-13} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 L_5 s^3 + L_1 L_5 g_m s^2 - L_1 s}{2 C_5 L_1 L_5 g_m s^3 + C_5 L_5 s^2 + 2 L_1 g_m s + 1}$$

$$10.14 \quad \text{INVALID-ORDER-14} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_1 L_5 g_m s^2 + L_1 g_m + s (C_5 L_1 R_5 g_m - C_5 L_1)}{2 C_5 L_1 g_m s + C_5}$$

$$10.15 \quad \text{INVALID-ORDER-15} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 L_5 R_5 s^3 - L_1 R_5 s + s^2 (L_1 L_5 R_5 g_m - L_1 L_5)}{2 C_5 L_1 L_5 R_5 g_m s^3 + R_5 + s^2 (C_5 L_5 R_5 + 2 L_1 L_5 g_m) + s (2 L_1 R_5 g_m + L_5)}$$

$$10.16 \quad \text{INVALID-ORDER-16} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \quad \infty \right)$$

$$H(s) = \frac{L_1 L_5 g_m s^2 + s^3 (C_5 L_1 L_5 R_5 g_m - C_5 L_1 L_5) + s (L_1 R_5 g_m - L_1)}{2 C_5 L_1 L_5 g_m s^3 + C_5 L_5 s^2 + 2 L_1 g_m s + 1}$$

$$10.17 \quad \text{INVALID-ORDER-17} \quad Z(s) = \left( L_1 s, \quad \infty, \quad \infty, \quad \infty, \quad \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 R_5 s^2 + s^3 (C_5 L_1 L_5 R_5 g_m - C_5 L_1 L_5) + s (L_1 R_5 g_m - L_1)}{2 C_5 L_1 L_5 g_m s^3 + s^2 (2 C_5 L_1 R_5 g_m + C_5 L_5) + s (C_5 R_5 + 2 L_1 g_m) + 1}$$

$$10.18 \quad \text{INVALID-ORDER-18} \quad Z(s) = \left( \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad R_5, \quad \infty \right)$$

$$H(s) = \frac{R_5 g_m - 1}{C_1 s + 2 g_m}$$

$$10.19 \quad \text{INVALID-ORDER-19} \quad Z(s) = \left( \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 s + g_m}{C_1 C_5 s^2 + 2 C_5 g_m s}$$

$$10.20 \quad \text{INVALID-ORDER-20} \quad Z(s) = \left( \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{g_m + s (C_5 R_5 g_m - C_5)}{C_1 C_5 s^2 + 2 C_5 g_m s}$$

$$10.21 \quad \text{INVALID-ORDER-21} \quad Z(s) = \left( \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_5 L_5 g_m s^2 - C_5 s + g_m}{C_1 C_5 s^2 + 2 C_5 g_m s}$$

$$10.22 \quad \text{INVALID-ORDER-22} \quad Z(s) = \left( \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1}, \infty \right)$$

$$H(s) = \frac{-C_5 L_5 s^2 + L_5 g_m s - 1}{C_1 C_5 L_5 s^3 + C_1 s + 2C_5 L_5 g_m s^2 + 2g_m}$$

$$10.23 \quad \text{INVALID-ORDER-23} \quad Z(s) = \left( \frac{1}{C_1 s}, \infty, \infty, \infty, L_5 s + R_5 + \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{C_5 L_5 g_m s^2 + g_m + s(C_5 R_5 g_m - C_5)}{C_1 C_5 s^2 + 2C_5 g_m s}$$

$$10.24 \quad \text{INVALID-ORDER-24} \quad Z(s) = \left( \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \infty \right)$$

$$H(s) = \frac{-C_5 L_5 R_5 s^2 - R_5 + s(L_5 R_5 g_m - L_5)}{C_1 C_5 L_5 R_5 s^3 + 2R_5 g_m + s^2(C_1 L_5 + 2C_5 L_5 R_5 g_m) + s(C_1 R_5 + 2L_5 g_m)}$$

$$10.25 \quad \text{INVALID-ORDER-25} \quad Z(s) = \left( \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \infty \right)$$

$$H(s) = \frac{L_5 g_m s + R_5 g_m + s^2(C_5 L_5 R_5 g_m - C_5 L_5) - 1}{C_1 C_5 L_5 s^3 + C_1 s + 2C_5 L_5 g_m s^2 + 2g_m}$$

$$10.26 \quad \text{INVALID-ORDER-26} \quad Z(s) = \left( \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{R_5(C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \infty \right)$$

$$H(s) = \frac{-C_5 R_5 s + R_5 g_m + s^2(C_5 L_5 R_5 g_m - C_5 L_5) - 1}{C_1 C_5 L_5 s^3 + 2g_m + s^2(C_1 C_5 R_5 + 2C_5 L_5 g_m) + s(C_1 + 2C_5 R_5 g_m)}$$

$$10.27 \quad \text{INVALID-ORDER-27} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, R_5, \infty \right)$$

$$H(s) = \frac{R_1 R_5 g_m - R_1}{C_1 R_1 s + 2R_1 g_m + 1}$$

$$10.28 \quad \text{INVALID-ORDER-28} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{-C_5 R_1 s + R_1 g_m}{C_1 C_5 R_1 s^2 + s(2C_5 R_1 g_m + C_5)}$$

$$10.29 \quad \text{INVALID-ORDER-29} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{R_1 g_m + s(C_5 R_1 R_5 g_m - C_5 R_1)}{C_1 C_5 R_1 s^2 + s(2C_5 R_1 g_m + C_5)}$$

$$10.30 \quad \text{INVALID-ORDER-30} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, L_5 s + \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{C_5 L_5 R_1 g_m s^2 - C_5 R_1 s + R_1 g_m}{C_1 C_5 R_1 s^2 + s(2C_5 R_1 g_m + C_5)}$$

$$10.31 \quad \text{INVALID-ORDER-31} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1}, \infty \right)$$

$$H(s) = \frac{-C_5 L_5 R_1 s^2 + L_5 R_1 g_m s - R_1}{C_1 C_5 L_5 R_1 s^3 + C_1 R_1 s + 2R_1 g_m + s^2(2C_5 L_5 R_1 g_m + C_5 L_5) + 1}$$

$$10.32 \quad \text{INVALID-ORDER-32} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, L_5 s + R_5 + \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{C_5 L_5 R_1 g_m s^2 + R_1 g_m + s (C_5 R_1 R_5 g_m - C_5 R_1)}{C_1 C_5 R_1 s^2 + s (2 C_5 R_1 g_m + C_5)}$$

$$10.33 \quad \text{INVALID-ORDER-33} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \infty \right)$$

$$H(s) = \frac{-C_5 L_5 R_1 R_5 s^2 - R_1 R_5 + s (L_5 R_1 R_5 g_m - L_5 R_1)}{C_1 C_5 L_5 R_1 R_5 s^3 + 2 R_1 R_5 g_m + R_5 + s^2 (C_1 L_5 R_1 + 2 C_5 L_5 R_1 R_5 g_m + C_5 L_5 R_5) + s (C_1 R_1 R_5 + 2 L_5 R_1 g_m + L_5)}$$

$$10.34 \quad \text{INVALID-ORDER-34} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \infty \right)$$

$$H(s) = \frac{L_5 R_1 g_m s + R_1 R_5 g_m - R_1 + s^2 (C_5 L_5 R_1 R_5 g_m - C_5 L_5 R_1)}{C_1 C_5 L_5 R_1 s^3 + C_1 R_1 s + 2 R_1 g_m + s^2 (2 C_5 L_5 R_1 g_m + C_5 L_5) + 1}$$

$$10.35 \quad \text{INVALID-ORDER-35} \quad Z(s) = \left( \frac{R_1}{C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \infty \right)$$

$$H(s) = \frac{-C_5 R_1 R_5 s + R_1 R_5 g_m - R_1 + s^2 (C_5 L_5 R_1 R_5 g_m - C_5 L_5 R_1)}{C_1 C_5 L_5 R_1 s^3 + 2 R_1 g_m + s^2 (C_1 C_5 R_1 R_5 + 2 C_5 L_5 R_1 g_m + C_5 L_5) + s (C_1 R_1 + 2 C_5 R_1 R_5 g_m + C_5 R_5) + 1}$$

$$10.36 \quad \text{INVALID-ORDER-36} \quad Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, R_5, \infty \right)$$

$$H(s) = \frac{R_5 g_m + s (C_1 R_1 R_5 g_m - C_1 R_1) - 1}{2 g_m + s (2 C_1 R_1 g_m + C_1)}$$

$$10.37 \quad \text{INVALID-ORDER-37} \quad Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{-C_1 C_5 R_1 s^2 + g_m + s (C_1 R_1 g_m - C_5)}{2 C_5 g_m s + s^2 (2 C_1 C_5 R_1 g_m + C_1 C_5)}$$

$$10.38 \quad \text{INVALID-ORDER-38} \quad Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{g_m + s^2 (C_1 C_5 R_1 R_5 g_m - C_1 C_5 R_1) + s (C_1 R_1 g_m + C_5 R_5 g_m - C_5)}{2 C_5 g_m s + s^2 (2 C_1 C_5 R_1 g_m + C_1 C_5)}$$

$$10.39 \quad \text{INVALID-ORDER-39} \quad Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, L_5 s + \frac{1}{C_5 s}, \infty \right)$$

$$H(s) = \frac{C_1 C_5 L_5 R_1 g_m s^3 + g_m + s^2 (-C_1 C_5 R_1 + C_5 L_5 g_m) + s (C_1 R_1 g_m - C_5)}{2 C_5 g_m s + s^2 (2 C_1 C_5 R_1 g_m + C_1 C_5)}$$

$$10.40 \quad \text{INVALID-ORDER-40} \quad Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1}, \infty \right)$$

$$H(s) = \frac{-C_1 C_5 L_5 R_1 s^3 + s^2 (C_1 L_5 R_1 g_m - C_5 L_5) + s (-C_1 R_1 + L_5 g_m) - 1}{2 C_5 L_5 g_m s^2 + 2 g_m + s^3 (2 C_1 C_5 L_5 R_1 g_m + C_1 C_5 L_5) + s (2 C_1 R_1 g_m + C_1)}$$

**10.41 INVALID-ORDER-41**  $Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, L_5 s + R_5 + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 C_5 L_5 R_1 g_m s^3 + g_m + s^2 (C_1 C_5 R_1 R_5 g_m - C_1 C_5 R_1 + C_5 L_5 g_m) + s (C_1 R_1 g_m + C_5 R_5 g_m - C_5)}{2 C_5 g_m s + s^2 (2 C_1 C_5 R_1 g_m + C_1 C_5)}$$

**10.42 INVALID-ORDER-42**  $Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_5 R_1 R_5 s^3 - R_5 + s^2 (C_1 L_5 R_1 R_5 g_m - C_1 L_5 R_1 - C_5 L_5 R_5) + s (-C_1 R_1 R_5 + L_5 R_5 g_m - L_5)}{2 R_5 g_m + s^3 (2 C_1 C_5 L_5 R_1 R_5 g_m + C_1 C_5 L_5 R_5) + s^2 (2 C_1 L_5 R_1 g_m + C_1 L_5 + 2 C_5 L_5 R_5 g_m) + s (2 C_1 R_1 R_5 g_m + C_1 R_5 + 2 L_5 g_m)}$$

**10.43 INVALID-ORDER-43**  $Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \infty \right)$

$$H(s) = \frac{R_5 g_m + s^3 (C_1 C_5 L_5 R_1 R_5 g_m - C_1 C_5 L_5 R_1) + s^2 (C_1 L_5 R_1 g_m + C_5 L_5 R_5 g_m - C_5 L_5) + s (C_1 R_1 R_5 g_m - C_1 R_1 + L_5 g_m) - 1}{2 C_5 L_5 g_m s^2 + 2 g_m + s^3 (2 C_1 C_5 L_5 R_1 g_m + C_1 C_5 L_5) + s (2 C_1 R_1 g_m + C_1)}$$

**10.44 INVALID-ORDER-44**  $Z(s) = \left( R_1 + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{R_5 g_m + s^3 (C_1 C_5 L_5 R_1 R_5 g_m - C_1 C_5 L_5 R_1) + s^2 (-C_1 C_5 R_1 R_5 + C_5 L_5 R_5 g_m - C_5 L_5) + s (C_1 R_1 R_5 g_m - C_1 R_1 - C_5 R_5) - 1}{2 g_m + s^3 (2 C_1 C_5 L_5 R_1 g_m + C_1 C_5 L_5) + s^2 (2 C_1 C_5 R_1 R_5 g_m + C_1 C_5 R_5 + 2 C_5 L_5 g_m) + s (2 C_1 R_1 g_m + C_1 + 2 C_5 R_5 g_m)}$$

**10.45 INVALID-ORDER-45**  $Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 s^3 + C_1 L_1 g_m s^2 - C_5 s + g_m}{2 C_1 C_5 L_1 g_m s^3 + C_1 C_5 s^2 + 2 C_5 g_m s}$$

**10.46 INVALID-ORDER-46**  $Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 R_5 s^3 - C_5 R_5 s + R_5 g_m + s^2 (C_1 L_1 R_5 g_m - C_1 L_1) - 1}{2 C_1 C_5 L_1 R_5 g_m s^3 + 2 g_m + s^2 (C_1 C_5 R_5 + 2 C_1 L_1 g_m) + s (C_1 + 2 C_5 R_5 g_m)}$$

**10.47 INVALID-ORDER-47**  $Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 L_1 g_m s^2 + g_m + s^3 (C_1 C_5 L_1 R_5 g_m - C_1 C_5 L_1) + s (C_5 R_5 g_m - C_5)}{2 C_1 C_5 L_1 g_m s^3 + C_1 C_5 s^2 + 2 C_5 g_m s}$$

**10.48 INVALID-ORDER-48**  $Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \infty, \infty, \infty, L_5 s + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 C_5 L_1 L_5 g_m s^4 - C_1 C_5 L_1 s^3 - C_5 s + g_m + s^2 (C_1 L_1 g_m + C_5 L_5 g_m)}{2 C_1 C_5 L_1 g_m s^3 + C_1 C_5 s^2 + 2 C_5 g_m s}$$

**10.49 INVALID-ORDER-49**  $Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 L_5 s^4 + C_1 L_1 L_5 g_m s^3 + L_5 g_m s + s^2 (-C_1 L_1 - C_5 L_5) - 1}{2 C_1 C_5 L_1 L_5 g_m s^4 + C_1 C_5 L_5 s^3 + C_1 s + 2 g_m + s^2 (2 C_1 L_1 g_m + 2 C_5 L_5 g_m)}$$



$$10.50 \quad \text{INVALID-ORDER-50} \quad Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad L_5 s + R_5 + \frac{1}{C_5 s}, \quad \infty \right)$$

$$H(s) = \frac{C_1 C_5 L_1 L_5 g_m s^4 + g_m + s^3 (C_1 C_5 L_1 R_5 g_m - C_1 C_5 L_1) + s^2 (C_1 L_1 g_m + C_5 L_5 g_m) + s (C_5 R_5 g_m - C_5)}{2 C_1 C_5 L_1 g_m s^3 + C_1 C_5 s^2 + 2 C_5 g_m s}$$

$$10.51 \quad \text{INVALID-ORDER-51} \quad Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \quad \infty \right)$$

$$H(s) = \frac{-C_1 C_5 L_1 L_5 R_5 s^4 - R_5 + s^3 (C_1 L_1 L_5 R_5 g_m - C_1 L_1 L_5) + s^2 (-C_1 L_1 R_5 - C_5 L_5 R_5) + s (L_5 R_5 g_m - L_5)}{2 C_1 C_5 L_1 L_5 R_5 g_m s^4 + 2 R_5 g_m + s^3 (C_1 C_5 L_5 R_5 + 2 C_1 L_1 L_5 g_m) + s^2 (2 C_1 L_1 R_5 g_m + C_1 L_5 + 2 C_5 L_5 R_5 g_m) + s (C_1 R_5 + 2 L_5 g_m)}$$

$$10.52 \quad \text{INVALID-ORDER-52} \quad Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \quad \infty \right)$$

$$H(s) = \frac{C_1 L_1 L_5 g_m s^3 + L_5 g_m s + R_5 g_m + s^4 (C_1 C_5 L_1 L_5 R_5 g_m - C_1 C_5 L_1 L_5) + s^2 (C_1 L_1 R_5 g_m - C_1 L_1 + C_5 L_5 R_5 g_m - C_5 L_5) - 1}{2 C_1 C_5 L_1 L_5 g_m s^4 + C_1 C_5 L_5 s^3 + C_1 s + 2 g_m + s^2 (2 C_1 L_1 g_m + 2 C_5 L_5 g_m)}$$

$$10.53 \quad \text{INVALID-ORDER-53} \quad Z(s) = \left( L_1 s + \frac{1}{C_1 s}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_1 C_5 L_1 R_5 s^3 - C_5 R_5 s + R_5 g_m + s^4 (C_1 C_5 L_1 L_5 R_5 g_m - C_1 C_5 L_1 L_5) + s^2 (C_1 L_1 R_5 g_m - C_1 L_1 + C_5 L_5 R_5 g_m - C_5 L_5) - 1}{2 C_1 C_5 L_1 L_5 g_m s^4 + 2 g_m + s^3 (2 C_1 C_5 L_1 R_5 g_m + C_1 C_5 L_5) + s^2 (C_1 C_5 R_5 + 2 C_1 L_1 g_m + 2 C_5 L_5 g_m) + s (C_1 + 2 C_5 R_5 g_m)}$$

$$10.54 \quad \text{INVALID-ORDER-54} \quad Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{R_5}{C_5 R_5 s + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 R_5 s^2 + s (L_1 R_5 g_m - L_1)}{C_1 C_5 L_1 R_5 s^3 + s^2 (C_1 L_1 + 2 C_5 L_1 R_5 g_m) + s (C_5 R_5 + 2 L_1 g_m) + 1}$$

$$10.55 \quad \text{INVALID-ORDER-55} \quad Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 L_5 s^3 + L_1 L_5 g_m s^2 - L_1 s}{C_1 C_5 L_1 L_5 s^4 + 2 C_5 L_1 L_5 g_m s^3 + 2 L_1 g_m s + s^2 (C_1 L_1 + C_5 L_5) + 1}$$

$$10.56 \quad \text{INVALID-ORDER-56} \quad Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 L_5 R_5 s^3 - L_1 R_5 s + s^2 (L_1 L_5 R_5 g_m - L_1 L_5)}{C_1 C_5 L_1 L_5 R_5 s^4 + R_5 + s^3 (C_1 L_1 L_5 + 2 C_5 L_1 L_5 R_5 g_m) + s^2 (C_1 L_1 R_5 + C_5 L_5 R_5 + 2 L_1 L_5 g_m) + s (2 L_1 R_5 g_m + L_5)}$$

$$10.57 \quad \text{INVALID-ORDER-57} \quad Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \quad \infty \right)$$

$$H(s) = \frac{L_1 L_5 g_m s^2 + s^3 (C_5 L_1 L_5 R_5 g_m - C_5 L_1 L_5) + s (L_1 R_5 g_m - L_1)}{C_1 C_5 L_1 L_5 s^4 + 2 C_5 L_1 L_5 g_m s^3 + 2 L_1 g_m s + s^2 (C_1 L_1 + C_5 L_5) + 1}$$

$$10.58 \quad \text{INVALID-ORDER-58} \quad Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1}, \quad \infty, \quad \infty, \quad \infty, \quad \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \quad \infty \right)$$

$$H(s) = \frac{-C_5 L_1 R_5 s^2 + s^3 (C_5 L_1 L_5 R_5 g_m - C_5 L_1 L_5) + s (L_1 R_5 g_m - L_1)}{C_1 C_5 L_1 L_5 s^4 + s^3 (C_1 C_5 L_1 R_5 + 2 C_5 L_1 L_5 g_m) + s^2 (C_1 L_1 + 2 C_5 L_1 R_5 g_m + C_5 L_5) + s (C_5 R_5 + 2 L_1 g_m) + 1}$$

**10.59 INVALID-ORDER-59**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, \frac{1}{C_5s}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1s^3 + g_m + s^2(-C_1C_5R_1 + C_1L_1g_m) + s(C_1R_1g_m - C_5)}{2C_1C_5L_1g_ms^3 + 2C_5g_ms + s^2(2C_1C_5R_1g_m + C_1C_5)}$$

**10.60 INVALID-ORDER-60**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, \frac{R_5}{C_5R_5s+1}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1R_5s^3 + R_5g_m + s^2(-C_1C_5R_1R_5 + C_1L_1R_5g_m - C_1L_1) + s(C_1R_1R_5g_m - C_1R_1 - C_5R_5) - 1}{2C_1C_5L_1R_5g_ms^3 + 2g_m + s^2(2C_1C_5R_1R_5g_m + C_1C_5R_5 + 2C_1L_1g_m) + s(2C_1R_1g_m + C_1 + 2C_5R_5g_m)}$$

**10.61 INVALID-ORDER-61**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, R_5 + \frac{1}{C_5s}, \infty \right)$

$$H(s) = \frac{g_m + s^3(C_1C_5L_1R_5g_m - C_1C_5L_1) + s^2(C_1C_5R_1R_5g_m - C_1C_5R_1 + C_1L_1g_m) + s(C_1R_1g_m + C_5R_5g_m - C_5)}{2C_1C_5L_1g_ms^3 + 2C_5g_ms + s^2(2C_1C_5R_1g_m + C_1C_5)}$$

**10.62 INVALID-ORDER-62**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, L_5s + \frac{1}{C_5s}, \infty \right)$

$$H(s) = \frac{C_1C_5L_1L_5g_ms^4 + g_m + s^3(-C_1C_5L_1 + C_1C_5L_5R_1g_m) + s^2(-C_1C_5R_1 + C_1L_1g_m + C_5L_5g_m) + s(C_1R_1g_m - C_5)}{2C_1C_5L_1g_ms^3 + 2C_5g_ms + s^2(2C_1C_5R_1g_m + C_1C_5)}$$

**10.63 INVALID-ORDER-63**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, \frac{L_5s}{C_5L_5s^2+1}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1L_5s^4 + s^3(-C_1C_5L_5R_1 + C_1L_1L_5g_m) + s^2(-C_1L_1 + C_1L_5R_1g_m - C_5L_5) + s(-C_1R_1 + L_5g_m) - 1}{2C_1C_5L_1L_5g_ms^4 + 2g_m + s^3(2C_1C_5L_5R_1g_m + C_1C_5L_5) + s^2(2C_1L_1g_m + 2C_5L_5g_m) + s(2C_1R_1g_m + C_1)}$$

**10.64 INVALID-ORDER-64**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, L_5s + R_5 + \frac{1}{C_5s}, \infty \right)$

$$H(s) = \frac{C_1C_5L_1L_5g_ms^4 + g_m + s^3(C_1C_5L_1R_5g_m - C_1C_5L_1 + C_1C_5L_5R_1g_m) + s^2(C_1C_5R_1R_5g_m - C_1C_5R_1 + C_1L_1g_m + C_5L_5g_m) + s(C_1R_1g_m + C_5R_5g_m - C_5)}{2C_1C_5L_1g_ms^3 + 2C_5g_ms + s^2(2C_1C_5R_1g_m + C_1C_5)}$$

**10.65 INVALID-ORDER-65**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, \frac{L_5R_5s}{C_5L_5R_5s^2+L_5s+R_5}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1L_5R_5s^4 - R_5 + s^3(-C_1C_5L_5R_1R_5 + C_1L_1L_5R_5g_m - C_1L_1L_5) + s^2(-C_1L_1R_5 + C_1L_5R_1R_5g_m - C_1L_5R_1 - C_5L_5R_5) + s(-C_1R_1R_5 + L_5R_5g_m - L_5)}{2C_1C_5L_1L_5R_5g_ms^4 + 2R_5g_m + s^3(2C_1C_5L_5R_1R_5g_m + C_1C_5L_5R_5 + 2C_1L_1L_5g_m) + s^2(2C_1L_1R_5g_m + 2C_1L_5R_1g_m + C_1L_5 + 2C_5L_5R_5g_m) + s(2C_1R_1R_5g_m + C_1R_5 + 2L_5g_m)}$$

**10.66 INVALID-ORDER-66**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, \frac{L_5s}{C_5L_5s^2+1} + R_5, \infty \right)$

$$H(s) = \frac{R_5g_m + s^4(C_1C_5L_1L_5R_5g_m - C_1C_5L_1L_5) + s^3(C_1C_5L_5R_1R_5g_m - C_1C_5L_5R_1 + C_1L_1L_5g_m) + s^2(C_1L_1R_5g_m - C_1L_1 + C_1L_5R_1g_m + C_5L_5R_5g_m - C_5L_5) + s(C_1R_1R_5g_m - C_1R_1 + L_5g_m) - 1}{2C_1C_5L_1L_5g_ms^4 + 2g_m + s^3(2C_1C_5L_5R_1g_m + C_1C_5L_5) + s^2(2C_1L_1g_m + 2C_5L_5g_m) + s(2C_1R_1g_m + C_1)}$$

**10.67 INVALID-ORDER-67**  $Z(s) = \left( L_1s + R_1 + \frac{1}{C_1s}, \infty, \infty, \infty, \frac{R_5(C_5L_5s^2+1)}{C_5L_5s^2+C_5R_5s+1}, \infty \right)$

$$H(s) = \frac{R_5g_m + s^4(C_1C_5L_1L_5R_5g_m - C_1C_5L_1L_5) + s^3(-C_1C_5L_1R_5 + C_1C_5L_5R_1R_5g_m - C_1C_5L_5R_1) + s^2(-C_1C_5R_1R_5 + C_1L_1R_5g_m - C_1L_1 + C_5L_5R_5g_m - C_5L_5) + s(C_1R_1R_5g_m - C_1R_1 - C_5R_5) - 1}{2C_1C_5L_1L_5g_ms^4 + 2g_m + s^3(2C_1C_5L_1R_5g_m + 2C_1C_5L_5R_1g_m + C_1C_5L_5) + s^2(2C_1C_5R_1R_5g_m + C_1C_5R_5 + 2C_1L_1g_m + 2C_5L_5g_m) + s(2C_1R_1g_m + C_1 + 2C_5R_5g_m)}$$

**10.68 INVALID-ORDER-68**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_5 L_1 R_1 R_5 s^2 + s (L_1 R_1 R_5 g_m - L_1 R_1)}{C_1 C_5 L_1 R_1 R_5 s^3 + R_1 + s^2 (C_1 L_1 R_1 + 2C_5 L_1 R_1 R_5 g_m + C_5 L_1 R_5) + s (C_5 R_1 R_5 + 2L_1 R_1 g_m + L_1)}$$

**10.69 INVALID-ORDER-69**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1}, \infty \right)$

$$H(s) = \frac{-C_5 L_1 L_5 R_1 s^3 + L_1 L_5 R_1 g_m s^2 - L_1 R_1 s}{C_1 C_5 L_1 L_5 R_1 s^4 + R_1 + s^3 (2C_5 L_1 L_5 R_1 g_m + C_5 L_1 L_5) + s^2 (C_1 L_1 R_1 + C_5 L_5 R_1) + s (2L_1 R_1 g_m + L_1)}$$

**10.70 INVALID-ORDER-70**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \infty \right)$

$$H(s) = \frac{-C_5 L_1 L_5 R_1 R_5 s^3 - L_1 R_1 R_5 s + s^2 (L_1 L_5 R_1 R_5 g_m - L_1 L_5 R_1)}{C_1 C_5 L_1 L_5 R_1 R_5 s^4 + R_1 R_5 + s^3 (C_1 L_1 L_5 R_1 + 2C_5 L_1 L_5 R_1 R_5 g_m + C_5 L_1 L_5 R_5) + s^2 (C_1 L_1 R_1 R_5 + C_5 L_5 R_1 R_5 + 2L_1 L_5 R_1 g_m + L_1 L_5) + s (2L_1 R_1 R_5 g_m + L_1 R_5 + L_5 R_1)}$$

**10.71 INVALID-ORDER-71**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \infty \right)$

$$H(s) = \frac{L_1 L_5 R_1 g_m s^2 + s^3 (C_5 L_1 L_5 R_1 R_5 g_m - C_5 L_1 L_5 R_1) + s (L_1 R_1 R_5 g_m - L_1 R_1)}{C_1 C_5 L_1 L_5 R_1 s^4 + R_1 + s^3 (2C_5 L_1 L_5 R_1 g_m + C_5 L_1 L_5) + s^2 (C_1 L_1 R_1 + C_5 L_5 R_1) + s (2L_1 R_1 g_m + L_1)}$$

**10.72 INVALID-ORDER-72**  $Z(s) = \left( \frac{L_1 R_1 s}{C_1 L_1 R_1 s^2 + L_1 s + R_1}, \infty, \infty, \infty, \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_5 L_1 R_1 R_5 s^2 + s^3 (C_5 L_1 L_5 R_1 R_5 g_m - C_5 L_1 L_5 R_1) + s (L_1 R_1 R_5 g_m - L_1 R_1)}{C_1 C_5 L_1 L_5 R_1 s^4 + R_1 + s^3 (C_1 C_5 L_1 R_1 R_5 + 2C_5 L_1 L_5 R_1 g_m + C_5 L_1 L_5) + s^2 (C_1 L_1 R_1 + 2C_5 L_1 R_1 R_5 g_m + C_5 L_1 R_5 + C_5 L_5 R_1) + s (C_5 R_1 R_5 + 2L_1 R_1 g_m + L_1)}$$

**10.73 INVALID-ORDER-73**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 R_1 s^3 + R_1 g_m + s^2 (C_1 L_1 R_1 g_m - C_5 L_1) + s (-C_5 R_1 + L_1 g_m)}{2C_5 L_1 g_m s^2 + s^3 (2C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2C_5 R_1 g_m + C_5)}$$

**10.74 INVALID-ORDER-74**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 R_1 R_5 s^3 + R_1 R_5 g_m - R_1 + s^2 (C_1 L_1 R_1 R_5 g_m - C_1 L_1 R_1 - C_5 L_1 R_5) + s (-C_5 R_1 R_5 + L_1 R_5 g_m - L_1)}{2R_1 g_m + s^3 (2C_1 C_5 L_1 R_1 R_5 g_m + C_1 C_5 L_1 R_5) + s^2 (2C_1 L_1 R_1 g_m + C_1 L_1 + 2C_5 L_1 R_5 g_m) + s (2C_5 R_1 R_5 g_m + C_5 R_5 + 2L_1 g_m) + 1}$$

**10.75 INVALID-ORDER-75**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{R_1 g_m + s^3 (C_1 C_5 L_1 R_1 R_5 g_m - C_1 C_5 L_1 R_1) + s^2 (C_1 L_1 R_1 g_m + C_5 L_1 R_5 g_m - C_5 L_1) + s (C_5 R_1 R_5 g_m - C_5 R_1 + L_1 g_m)}{2C_5 L_1 g_m s^2 + s^3 (2C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2C_5 R_1 g_m + C_5)}$$

**10.76 INVALID-ORDER-76**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, L_5 s + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 C_5 L_1 L_5 R_1 g_m s^4 + R_1 g_m + s^3 (-C_1 C_5 L_1 R_1 + C_5 L_1 L_5 g_m) + s^2 (C_1 L_1 R_1 g_m - C_5 L_1 + C_5 L_5 R_1 g_m) + s (-C_5 R_1 + L_1 g_m)}{2C_5 L_1 g_m s^2 + s^3 (2C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2C_5 R_1 g_m + C_5)}$$

**10.77 INVALID-ORDER-77**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 L_5 R_1 s^4 - R_1 + s^3 (C_1 L_1 L_5 R_1 g_m - C_5 L_1 L_5) + s^2 (-C_1 L_1 R_1 - C_5 L_5 R_1 + L_1 L_5 g_m) + s (-L_1 + L_5 R_1 g_m)}{2 C_5 L_1 L_5 g_m s^3 + 2 L_1 g_m s + 2 R_1 g_m + s^4 (2 C_1 C_5 L_1 L_5 R_1 g_m + C_1 C_5 L_1 L_5) + s^2 (2 C_1 L_1 R_1 g_m + C_1 L_1 + 2 C_5 L_5 R_1 g_m + C_5 L_5) + 1}$$

**10.78 INVALID-ORDER-78**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, L_5 s + R_5 + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 C_5 L_1 L_5 R_1 g_m s^4 + R_1 g_m + s^3 (C_1 C_5 L_1 R_1 R_5 g_m - C_1 C_5 L_1 R_1 + C_5 L_1 L_5 g_m) + s^2 (C_1 L_1 R_1 g_m + C_5 L_1 R_5 g_m - C_5 L_1 + C_5 L_5 R_1 g_m) + s (C_5 R_1 R_5 g_m - C_5 R_1 + L_1 g_m)}{2 C_5 L_1 g_m s^2 + s^3 (2 C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2 C_5 R_1 g_m + C_5)}$$

**10.79 INVALID-ORDER-79**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, \frac{L_5 R_5 s}{C_5 L_5 R_5 s^2 + L_5 s + R_5}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 L_5 R_1 R_5 s^4 - R_1 R_5 + s^3 (C_1 L_1 L_5 R_1 R_5 g_m - C_1 L_1 L_5 R_1 - C_5 L_1 L_5 R_5) + s^2 (-C_1 L_1 R_1 R_5 - C_5 L_5 R_1 R_5 + L_1 L_5 R_5 g_m - L_1 L_5) + s (-L_1 R_5 + L_5 R_1 R_5 g_m - L_5 R_1)}{2 R_1 R_5 g_m + R_5 + s^4 (2 C_1 C_5 L_1 L_5 R_1 R_5 g_m + C_1 C_5 L_1 L_5 R_5) + s^3 (2 C_1 L_1 L_5 R_1 g_m + C_1 L_1 L_5 + 2 C_5 L_1 L_5 R_5 g_m) + s^2 (2 C_1 L_1 R_1 R_5 g_m + C_1 L_1 R_5 + 2 C_5 L_5 R_1 R_5 g_m + C_5 L_5 R_5 + 2 L_1 L_5 g_m) + s (2 L_1 R_5 g_m + 2 L_5 R_1 g_m + L_5)}$$

**10.80 INVALID-ORDER-80**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, \frac{L_5 s}{C_5 L_5 s^2 + 1} + R_5, \infty \right)$

$$H(s) = \frac{R_1 R_5 g_m - R_1 + s^4 (C_1 C_5 L_1 L_5 R_1 R_5 g_m - C_1 C_5 L_1 L_5 R_1) + s^3 (C_1 L_1 L_5 R_1 g_m + C_5 L_1 L_5 R_5 g_m - C_5 L_1 L_5) + s^2 (C_1 L_1 R_1 R_5 g_m - C_1 L_1 R_1 + C_5 L_5 R_1 R_5 g_m - C_5 L_5 R_1 + L_1 L_5 g_m) + s (L_1 R_5 g_m - L_1 + L_5 R_1 g_m)}{2 C_5 L_1 L_5 g_m s^3 + 2 L_1 g_m s + 2 R_1 g_m + s^4 (2 C_1 C_5 L_1 L_5 R_1 g_m + C_1 C_5 L_1 L_5) + s^2 (2 C_1 L_1 R_1 g_m + C_1 L_1 + 2 C_5 L_5 R_1 g_m + C_5 L_5) + 1}$$

**10.81 INVALID-ORDER-81**  $Z(s) = \left( \frac{L_1 s}{C_1 L_1 s^2 + 1} + R_1, \infty, \infty, \infty, \frac{R_5 (C_5 L_5 s^2 + 1)}{C_5 L_5 s^2 + C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{R_1 R_5 g_m - R_1 + s^4 (C_1 C_5 L_1 L_5 R_1 R_5 g_m - C_1 C_5 L_1 L_5 R_1) + s^3 (-C_1 C_5 L_1 R_1 R_5 + C_5 L_1 L_5 R_5 g_m - C_5 L_1 L_5) + s^2 (C_1 L_1 R_1 R_5 g_m - C_1 L_1 R_1 - C_5 L_1 R_5 + C_5 L_5 R_1 R_5 g_m - C_5 L_5 R_1) + s (-C_5 R_1 R_5 + L_1 R_5 g_m - L_1)}{2 R_1 g_m + s^4 (2 C_1 C_5 L_1 L_5 R_1 g_m + C_1 C_5 L_1 L_5) + s^3 (2 C_1 C_5 L_1 R_1 R_5 g_m + C_1 C_5 L_1 R_5 + 2 C_5 L_1 L_5 g_m) + s^2 (2 C_1 L_1 R_1 g_m + C_1 L_1 + 2 C_5 L_1 R_5 g_m + 2 C_5 L_5 R_1 g_m + C_5 L_5) + s (2 C_5 R_1 R_5 g_m + C_5 R_5 + 2 L_1 g_m) + 1}$$

**10.82 INVALID-ORDER-82**  $Z(s) = \left( \frac{R_1 (C_1 L_1 s^2 + 1)}{C_1 L_1 s^2 + C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 R_1 s^3 + C_1 L_1 R_1 g_m s^2 - C_5 R_1 s + R_1 g_m}{C_1 C_5 R_1 s^2 + s^3 (2 C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2 C_5 R_1 g_m + C_5)}$$

**10.83 INVALID-ORDER-83**  $Z(s) = \left( \frac{R_1 (C_1 L_1 s^2 + 1)}{C_1 L_1 s^2 + C_1 R_1 s + 1}, \infty, \infty, \infty, \frac{R_5}{C_5 R_5 s + 1}, \infty \right)$

$$H(s) = \frac{-C_1 C_5 L_1 R_1 R_5 s^3 - C_5 R_1 R_5 s + R_1 R_5 g_m - R_1 + s^2 (C_1 L_1 R_1 R_5 g_m - C_1 L_1 R_1)}{2 R_1 g_m + s^3 (2 C_1 C_5 L_1 R_1 R_5 g_m + C_1 C_5 L_1 R_5) + s^2 (C_1 C_5 R_1 R_5 + 2 C_1 L_1 R_1 g_m + C_1 L_1) + s (C_1 R_1 + 2 C_5 R_1 R_5 g_m + C_5 R_5) + 1}$$

**10.84 INVALID-ORDER-84**  $Z(s) = \left( \frac{R_1 (C_1 L_1 s^2 + 1)}{C_1 L_1 s^2 + C_1 R_1 s + 1}, \infty, \infty, \infty, R_5 + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 L_1 R_1 g_m s^2 + R_1 g_m + s^3 (C_1 C_5 L_1 R_1 R_5 g_m - C_1 C_5 L_1 R_1) + s (C_5 R_1 R_5 g_m - C_5 R_1)}{C_1 C_5 R_1 s^2 + s^3 (2 C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2 C_5 R_1 g_m + C_5)}$$

**10.85 INVALID-ORDER-85**  $Z(s) = \left( \frac{R_1 (C_1 L_1 s^2 + 1)}{C_1 L_1 s^2 + C_1 R_1 s + 1}, \infty, \infty, \infty, L_5 s + \frac{1}{C_5 s}, \infty \right)$

$$H(s) = \frac{C_1 C_5 L_1 L_5 R_1 g_m s^4 - C_1 C_5 L_1 R_1 s^3 - C_5 R_1 s + R_1 g_m + s^2 (C_1 L_1 R_1 g_m + C_5 L_5 R_1 g_m)}{C_1 C_5 R_1 s^2 + s^3 (2 C_1 C_5 L_1 R_1 g_m + C_1 C_5 L_1) + s (2 C_5 R_1 g_m + C_5)}$$

**10.86 INVALID-ORDER-86**  $Z(s) = \left( \frac{R_1(C_1L_1s^2+1)}{C_1L_1s^2+C_1R_1s+1}, \infty, \infty, \infty, \frac{L_5s}{C_5L_5s^2+1}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1L_5R_1s^4 + C_1L_1L_5R_1g_ms^3 + L_5R_1g_ms - R_1 + s^2(-C_1L_1R_1 - C_5L_5R_1)}{C_1C_5L_5R_1s^3 + C_1R_1s + 2R_1g_m + s^4(2C_1C_5L_1L_5R_1g_m + C_1C_5L_1L_5) + s^2(2C_1L_1R_1g_m + C_1L_1 + 2C_5L_5R_1g_m + C_5L_5) + 1}$$

**10.87 INVALID-ORDER-87**  $Z(s) = \left( \frac{R_1(C_1L_1s^2+1)}{C_1L_1s^2+C_1R_1s+1}, \infty, \infty, \infty, L_5s + R_5 + \frac{1}{C_5s}, \infty \right)$

$$H(s) = \frac{C_1C_5L_1L_5R_1g_ms^4 + R_1g_m + s^3(C_1C_5L_1R_1R_5g_m - C_1C_5L_1R_1) + s^2(C_1L_1R_1g_m + C_5L_5R_1g_m) + s(C_5R_1R_5g_m - C_5R_1)}{C_1C_5R_1s^2 + s^3(2C_1C_5L_1R_1g_m + C_1C_5L_1) + s(2C_5R_1g_m + C_5)}$$

**10.88 INVALID-ORDER-88**  $Z(s) = \left( \frac{R_1(C_1L_1s^2+1)}{C_1L_1s^2+C_1R_1s+1}, \infty, \infty, \infty, \frac{L_5R_5s}{C_5L_5R_5s^2+L_5s+R_5}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1L_5R_1R_5s^4 - R_1R_5 + s^3(C_1L_1L_5R_1R_5g_m - C_1L_1L_5R_1) + s^2(-C_1L_1R_1R_5 - C_5L_5R_1R_5) + s(L_5R_1R_5g_m - L_5R_1)}{2R_1R_5g_m + R_5 + s^4(2C_1C_5L_1L_5R_1R_5g_m + C_1C_5L_1L_5R_5) + s^3(C_1C_5L_5R_1R_5 + 2C_1L_1L_5R_1g_m + C_1L_1L_5) + s^2(2C_1L_1R_1R_5g_m + C_1L_1R_5 + C_1L_5R_1 + 2C_5L_5R_1R_5g_m + C_5L_5R_5) + s(C_1R_1R_5 + 2L_5R_1g_m + L_5)}$$

**10.89 INVALID-ORDER-89**  $Z(s) = \left( \frac{R_1(C_1L_1s^2+1)}{C_1L_1s^2+C_1R_1s+1}, \infty, \infty, \infty, \frac{L_5s}{C_5L_5s^2+1} + R_5, \infty \right)$

$$H(s) = \frac{C_1L_1L_5R_1g_ms^3 + L_5R_1g_ms + R_1R_5g_m - R_1 + s^4(C_1C_5L_1L_5R_1R_5g_m - C_1C_5L_1L_5R_1) + s^2(C_1L_1R_1R_5g_m - C_1L_1R_1 + C_5L_5R_1R_5g_m - C_5L_5R_1)}{C_1C_5L_5R_1s^3 + C_1R_1s + 2R_1g_m + s^4(2C_1C_5L_1L_5R_1g_m + C_1C_5L_1L_5) + s^2(2C_1L_1R_1g_m + C_1L_1 + 2C_5L_5R_1g_m + C_5L_5) + 1}$$

**10.90 INVALID-ORDER-90**  $Z(s) = \left( \frac{R_1(C_1L_1s^2+1)}{C_1L_1s^2+C_1R_1s+1}, \infty, \infty, \infty, \frac{R_5(C_5L_5s^2+1)}{C_5L_5s^2+C_5R_5s+1}, \infty \right)$

$$H(s) = \frac{-C_1C_5L_1R_1R_5s^3 - C_5R_1R_5s + R_1R_5g_m - R_1 + s^4(C_1C_5L_1L_5R_1R_5g_m - C_1C_5L_1L_5R_1) + s^2(C_1L_1R_1R_5g_m - C_1L_1R_1 + C_5L_5R_1R_5g_m - C_5L_5R_1)}{2R_1g_m + s^4(2C_1C_5L_1L_5R_1g_m + C_1C_5L_1L_5) + s^3(2C_1C_5L_1R_1R_5g_m + C_1C_5L_1R_5 + C_1C_5L_5R_1) + s^2(C_1C_5R_1R_5 + 2C_1L_1R_1g_m + C_1L_1 + 2C_5L_5R_1g_m + C_5L_5) + s(C_1R_1 + 2C_5R_1R_5g_m + C_5R_5) + 1}$$

## 11 PolynomialError