The following are circuit diagrams of operational amplifiers and their use of standard resistor networks. These diagrams are supplied to illustrate typical resistor network applications using Vishay Thin Film’s standard precision, low noise, stable resistor networks.

**CIRCUIT DIAGRAMS**

**Inverting Amplifier with $I_{OFF}$ Compensation**

- $A = \frac{V_o}{V_{in}} = \frac{R_2}{R_1}$  
  - For A = 1  Use VTF1087
  - For A = 2  Use VTF1088
  - For A = 5  Use VTF1089
  - For A = 10 Use VTF1090

**Inverting Amplifier**

- $A = \frac{V_o}{V_{in}} = \frac{R_1}{R_2}$  
  - For A = 1  Use VTF209 thru 218
  - For A = 10 Use VTF282 thru 283

**Power Supply Voltage Splitter**

- $R_1 = R_2$
- $R_1 = 50K$  Use VTF214
- $= 100K$  Use VTF215
- $= 200K$  Use VTF216
- $= 500K$  Use VTF217
- $= 1M$  Use VTF218

**Non Inverting Amplifier**

- $A = \frac{V_o}{V_{in}} = \frac{R_1 + R_2}{R_2}$  
  - For A = 10  Use VTF193, 280 and 281
  - For A = 2  Use VTF209 thru 218
  - For A = 11 Use VTF282 or 283

**Differential Input Amplifier**

- $A = \frac{V_o}{V_{in}} = \frac{R_1}{R_2}$  
  - For A = 20  Use VTF1073
    - For A = 10  Use VTF1074
    - For A = 10  Use VTF328
    - For A = 10  Use VTF284
    - For A = 5  Use VTF285
    - For A = 5  Use VTF1007
    - For A = 10  Use VTF1008
    - For A = 2  Use VTF1009
    - For A = 2  Use VTF1010
    - For A = 10  Use VTF225
    - For A = 10  Use VTF286
    - For A = 10  Use VTF219
    - For A = 10  Use VTF287

**Two Operational Instrumentation Amplifier**

- $GAIN at 1 + \frac{R_1}{R_2} = 10$
- $R_1 + R_2 = 10K$  Use VTF280
- $= 100K$  Use VTF193
- $= 1M$  Use VTF281
Applications
Vishay Thin Film Typical Resistor Network Applications

CIRCUIT DIAGRAMS

Current Driver

\[ I_{out} = \frac{V_{in}(R_1 + R_2)}{R_5} \]

For \( R_3 + R_4 + R_5 \) at \( R_1 + R_2 \)

\[ I_{out} = \frac{V_{in}}{R_5} \]

Max \( I_{out} = \frac{V_{0 \text{ MAX}}}{R_2 + R_1} \)

For \( R_1 = R_2 = R_3 = R_4 = R \)

\[ I_{out} = \frac{V_{in}(1 + 1)}{2R} \]

If \( R \) is large then, \( I_{out} \) at \( \frac{V_{in}}{R_5} \)

Instrumentation Amplifier with Guard Driver

\[ A = R_4 \left( \frac{1 + R_1}{R_2} \right) = 100 \]

Use VTF272

Note

- OP-AMP references AD713, LTC1058, RMAX479

High Common Mode Voltage Rejection Unity Gain Differential Amplifier

\[ R_1 = \text{CMV Rejection Ratio} = \text{CMVRR} \]

\[ R_1 = R_3 = 1 \text{ M\Omega} \]

Optional External CMVRR Trim

\[ R_T = 2R_6 \]

CMVRR = 250 Use VTF442

= 100 Use VTF443

= 50 Use VTF444

\[ R_6 = 1\text{ M} \]

= 1M Use VTF442

= 1M Use VTF443

= 1M Use VTF444

Note

- With optional adjustment (RT) over 120 dB, common mode voltage rejection is possible.

Adder - Subtractor

If \( R_1 \) thru \( R_6 \) and \( R_7 = R_8 = R_1 \) then

\[ V_0 = \frac{R_1}{R} \times (V_1 + V_2 + V_3 - V_4 - V_5 - V_6) \]

\[ R_1 \] thru \( R_4 = 10K \) Use VTF366

\[ R_1 \] thru \( R_4 = 100K \) Use VTF367

Notes

(1) Unused source inputs must be grounded

(2) Circuit assumes the source impedance of all voltage sources are buffered or low (impedance adds to input resistors)
CIRCUIT DIAGRAMS

Non Inverting Two Input Adder

\[
\frac{V_1 + V_2 + V_3 - V_0}{R_1 + R_2 + R_3 - R_4} = 0
\]

If \( R_1 = R_2 = R_3 \) then

\[V_1 + V_2 + V_3 = R_4 \times V_0\]

A GAIN = \( \frac{R_4}{R} \)

\( R_1 \) thru \( R_4 = 10K \) Use VTF366

\( R_1 \) thru \( R_4 = 100K \) Use VTF367

Note

• Potential at two inputs of OP-AMP are always equal. \( e_x = e_y \)

Three Adder Buffer Input Non Inverting

For \( R_1 \) and \( R_2 \) use VTF212, 213 or 215

For \( R_3, R_4, R_5 \) and \( R_6 \) use VTF366 or 367 where

\( R_3 = R_4 = R_5 = R_6 \)

Note

• Capacitor values should be determined for desired cut off frequency and \( R_2C_1 = \frac{1}{4} R_3C_2 \).

For amplifier use AD713, LT1058 or RMAX479 these contain all four OP-AMP in one package.

For best results all unused inputs should be grounded.

These diagrams are supplied to illustrate typical resistor network applications. Vishay assumes no responsibility for specific use of performance.

Two Input Adder

Always two inputs of OP-AMP at same potential \( e_x = e_y \)

\[V_1 - e_y + V_2 - e_y = 0\]

\[e_x = \frac{V_0 R_1}{R_1 + R_2} = e_y\]

If \( R_3 = R_2 \) the \( V_1 + V_2 = 2e_y = \frac{2V_0 R_1}{R_1 + R_2}\)

If we make \( R_1 = R_2 \) then \( V_1 + V_2 = \frac{V_0}{5} \) VTF193 or 281

Notes

(1) Circuit assumes the source impedance is very low or incorporated in \( R_1 \) and \( R_2 \)

(2) Unused inputs should be grounded otherwise equations will not hold true

(3) \( C_1 \) and \( C_2 \) should be chosen \( R_2C_1 = \frac{R_3R_2}{R_3 + R_4} C_2\)

Four Input Adder

\[V_1 - e_x + V_2 - e_x + V_3 - e_x + V_4 - e_x = 0\]

If \( R_3 = R_4 = R_5 = R_6 \) then

\[V_1 + V_2 + V_3 + V_4 = 4e_x = \frac{4V_0 R_1}{R_1 + R_2}\]

If we use VTF280 for \( R_1 + R_2 \) and VTF367 for \( R_3, R_4, R_5 \) and \( R_6 \) then

\[V_1 + V_2 + V_3 + V_4 = 4 \frac{1}{2} \frac{V_0}{2.5} = V_0 \]

or for \( R_1, R_2 \) use VTF212

\[V_1 + V_2 + V_3 + V_4 = \frac{2V_0}{2} = 2V_0 \]

Notes

(1) Unused source inputs must be grounded

(2) Circuit assumes the source impedance of all voltage sources are buffered or low (impedance adds to input resistors)