Op Amp Circuit Collection

SECTION 1—BASIC CIRCUITS

Inverting Amplifier

\[ V_{OUT} = \frac{R_2}{R_1} V_{IN} \]
\[ R_{IN} = R_1 \]

Non-Inverting Amplifier

\[ V_{OUT} = \frac{R_1 + R_2}{R_1} V_{IN} \]

Difference Amplifier

\[ V_{OUT} = \left( \frac{R_1 + R_2}{R_3 + R_4} \right) V_1 \]
\[ V_{OUT} = \frac{R_2}{R_1} (V_2 - V_1) \]
\[ R_1 / R_2 = R_3 / R_4 \]

Inverting Summing Amplifier

\[ V_{OUT} = -\left( \frac{R_1}{R_2} \right) V_1 \]
\[ V_{OUT} = \left( \frac{R_3}{R_4} \right) V_2 \]
\[ R_5 = R_1 / R_2 / R_3 / R_4 \]

For minimum offset error due to input bias current

Non-Inverting Summing Amplifier

\[ V_{OUT} = \frac{R_1}{R_2} \]

For 1% accuracy

Fast Inverting Amplifier with High Input Impedance

\[ R_{IN} < 100 \text{k} \]

gives less than 1% gain error.

Non-Inverting AC Amplifier

\[ V_{OUT} = \frac{R_1 + R_2}{R_1} V_{IN} \]
\[ R_{IN} = R_3 \]
\[ R_3 = R_1 / R_2 \]
Practical Differentiator

\[ V_{OUT} = \frac{1}{2\pi R_2 C_1} \int V_{IN} \, dt \]

For minimum offset error due to input bias current

Fast Integrator

Current to Voltage Converter

For minimum error due to bias current \( R_2 = R_1 \)

Circuit for Operating the LM101 without a Negative Supply

Circuit for Generating the Second Positive Voltage

For minimum offset error due to input bias current

\[ t_c = \frac{1}{2\pi R_2 C_1} \]

\[ t_h = \frac{1}{2\pi R_1 C_1} \]

\[ t_c < t_h < \text{unity gain} \]
Neutralizing Input Capacitance to Optimize Response Time

Integrator with Bias Current Compensation

Voltage Comparator for Driving DTL or TTL Integrated Circuits

Threshold Detector for Photodiodes

Double-Ended Limit Detector

Multiple Aperture Window Discriminator

Adjust for zero integrator drift. Current drift typically 0.1, nA/C over –55°C to 125°C temperature range.
Offset Voltage Adjustment for Inverting Amplifiers Using Any Type of Feedback Element

\[ \text{RANGE} = \pm V \left( \frac{R_2}{R_1} \right) \]

Offset Voltage Adjustment for Non-Inverting Amplifiers Using Any Type of Feedback Element

\[ \text{RANGE} = \pm V \left( \frac{R_2}{R_1} \right) \]

\[ \text{GAIN} = 1 + \frac{R_5}{R_4 + R_2} \]

Offset Voltage Adjustment for Voltage Followers

\[ \text{RANGE} = \pm V \left( \frac{R_3}{R_1} \right) \]

Offset Voltage Adjustment for Differential Amplifiers

\[ \text{RANGE} = \pm V \left( \frac{R_5}{R_4} \right) \left( \frac{R_1}{R_1 + R_3} \right) \]

\[ \text{GAIN} = \frac{R_2}{R_1} \]

Offset Voltage Adjustment for Inverting Amplifiers Using 10 kΩ Source Resistance or Less

\[ R_1 = 2000 \frac{R_3}{R_4} \]

\[ R_4/R_3 \leq 10 \text{kΩ} \]

\[ \text{RANGE} = \pm V \left( \frac{R_3}{R_4} \right) \left( \frac{R_3}{R_4} \right) \]

TL/H/7057–21

TL/H/7057–22

TL/H/7057–23

TL/H/7057–24

TL/H/7057–25
SECTION 2 — SIGNAL GENERATION

Low Frequency Sine Wave Generator with Quadrature Output

High Frequency Sine Wave Generator with Quadrature Output
Free-Running Multivibrator

Wein Bridge Sine Wave Oscillator

*Chosen for oscillation at 100 Hz

TL/H/7057–28

Function Generator

Pulse Width Modulator

TL/H/7057–29

TL/H/7057–30

TL/H/7057–31
SECTION 3 — SIGNAL PROCESSING

Negative Voltage Reference

Precision Current Sink

Precision Current Source

Differential-Input Instrumentation Amplifier
Variable Gain, Differential-Input Instrumentation Amplifier

Instrumentation Amplifier with ±100 Volt Common Mode Range

Matching determines common mode rejection.
Instrumentation Amplifier with ±10 Volt Common Mode Range

Matching Determines CMRR

High Input Impedance Instrumentation Amplifier

Bridge Amplifier with Low Noise Compensation

*May be deleted to maximize bandwidth

*Matching determines CMRR

*Reduces feed through of power supply noise by 20 dB and makes supply bypassing unnecessary.

Trim for best common mode rejection

Gain adjust
TL/H/7057–48
Bridge Amplifier

TL/H/7057–49
Precision Diode

TL/H/7057–50
Precision Clamp

TL/H/7057–51
Fast Half Wave Rectifier

TL/H/7057–52
Precision AC to DC Converter

TL/H/7057–53
Low Drift Peak Detector

* EREF must have a source impedance of less than 200 Ω if D2 is used.

* Feedforward compensation can be used to make a fast full wave rectifier without a filter.
Absolute Value Amplifier with Polarity Detector

\[ V_{OUT} = -|V_{IN}| \times \frac{R_2}{R_1} \]

\[ \frac{R_2}{R_1} = \frac{R_4 + R_3}{R_3} \]

Sample and Hold

*Polycarbonate-dielectric capacitor

Sample and Hold

*Worst case drift less than 2.5 mV/sec
*Teflon, Polyethylene or Polycarbonate Dielectric Capacitor
Low Drift Integrator

Q1 and Q3 should not have internal gate-protection diodes. Worst case drift less than 500 mV/sec over −55°C to +125°C.

Fast Summing Amplifier with Low Input Current

* In addition to increasing speed, the LM101A raises high and low frequency gain, increases output drive capability and eliminates thermal feedback.

† Power Bandwidth: 250 kHz
Small Signal Bandwidth: 3.5 MHz
Slew Rate: 10V/j.s

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Fast Integrator with Low Input Current

Adjustable Q Notch Filter

\[ f_0 = \frac{1}{2\pi R1 C1} \]

- \( f_0 = 60 \text{ Hz} \)
- \( R1 = R2 = R3 \)
- \( C1 = C2 = C3 \)
Easily Tuned Notch Filter

\[ f_0 = \frac{1}{2 \pi R_4 C_1 C_2} \]

Tuned Circuit

\[ f_0 = \frac{1}{2 \pi R_2 C_3} \]

Two-Stage Tuned Circuit

\[ f_0 = \frac{1}{2 \pi R_1 C_1 C_2} \]
High Pass Active Filter

Values are for 100 Hz cutoff. Use metalized polycarbonate capacitors for good temperature stability.

Low Pass Active Filter

Values are for 10 kHz cutoff. Use silvered mica capacitors for good temperature stability.

Nonlinear Operational Amplifier with Temperature Compensated Breakpoints

Values are for 10 kHz cutoff. Use silvered mica capacitors for good temperature stability.
Analog Multiplier

\[ V_{OUT} = \frac{V_1 V_2}{10} \]

Long Interval Timer

*Low leakage — 0.017 \( \mu F \) per second delay

Fast Zero Crossing Detector

Propagation delay approximately 200 ns

Amplifier for Piezoelectric Transducer

Low frequency cutoff = \( R_1 C_1 \)

Temperature Probe

*Set for 0V at 0°C

\( \text{TL/H/7057–77} \)

\( \text{TL/H/7057–78} \)

\( \text{TL/H/7057–79} \)

\( \text{TL/H/7057–80} \)

\( \text{TL/H/7057–81} \)

\( \text{TL/H/7057–80} \)
Operating photodiode with less than 3 mV across it eliminates leakage currents.

Temperature Compensated Logarithmic Converter

Available from Vishay Ultronix, Grand Junction, CO, Q81 Series.

Determines current for zero crossing on output: 10 μA as shown.

10 nA < I<sub>IN</sub> < 1 mA
Sensitivity is 1V per decade
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