

# Analog Integrated Circuits

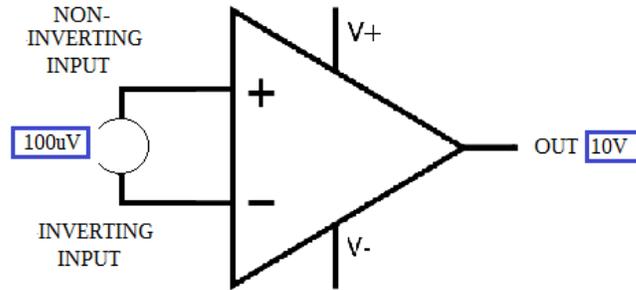
## Operational Amplifiers (Opamps):

Open Loop (no feedback network)

Example for Open loop Gain of 100dB or 100,000

A = Gain

Open Loop (no feedback) opamp



$$A_{vol} = \text{Open Loop Voltage Gain}; \frac{V_{out}}{(V+ - V-)} = \frac{10V}{100\mu V} = 100,000$$

### OPAMP Key parameters

Supply Voltage Range; Minimum and Maximum Supply Voltage

Input Common Mode Range; Relative to power supply pins. for normal operation

Offset Voltage;  $(V+ - V-)$  with  $V_{out} = 0$  Typical 10mV (legacy parts) to  $> 10\mu V$  or lower

Gain Bandwidth; Frequency where open loop gain = 1 10KHz to 100MHz

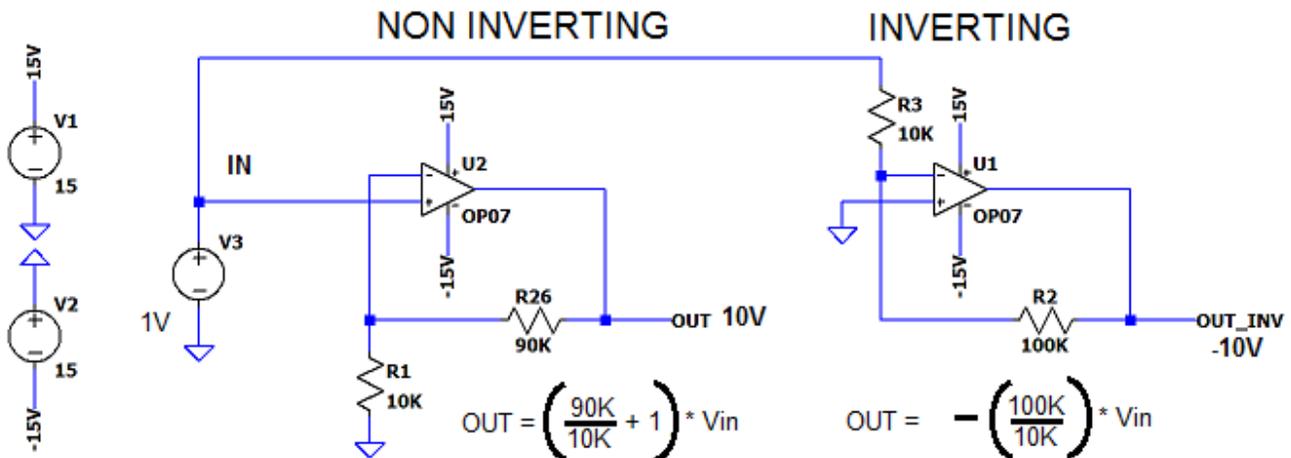
Output Range; output voltage Relative to power supply pins.

Open Loop Voltage Gain;  $V_{out} / (V+ - V-)$  typical 100dB = 100,000 or higher

Input Bias Current; current on input pins nano A to  $>$  pico A

Slew rate; Volts in  $\mu S$ .

Minimum Stable Gain.



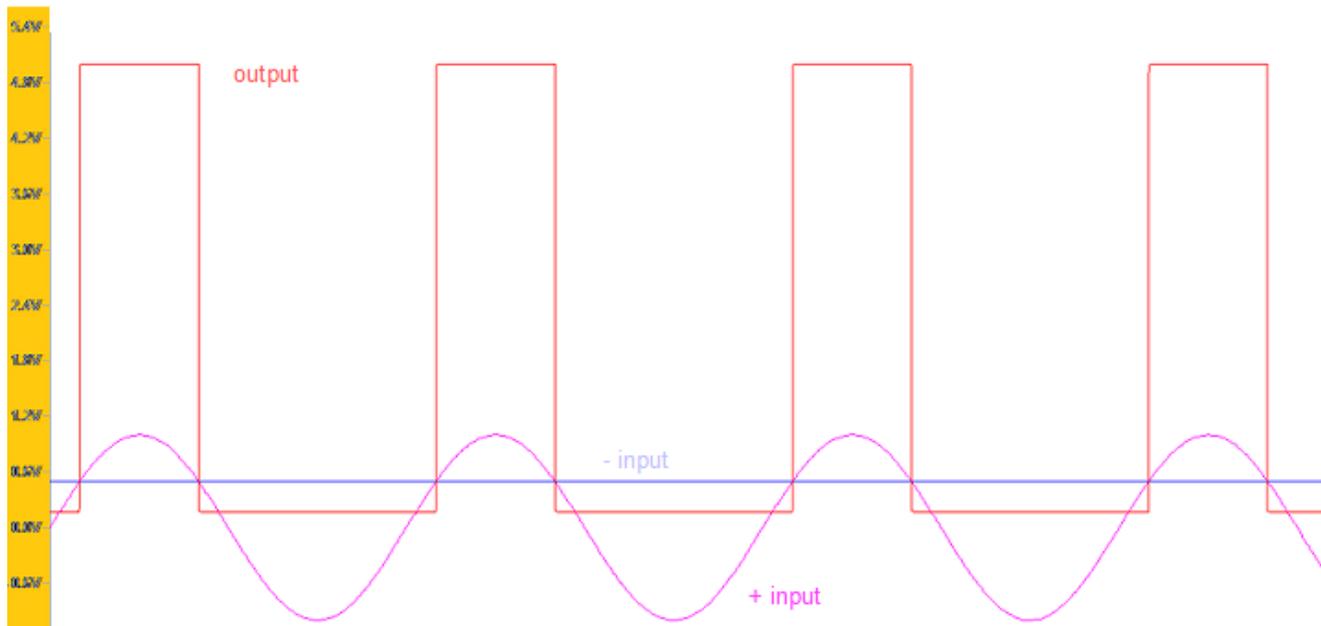
Because of the open loop gain of the opamp, the voltage between the input pins is effectively 0v  
Negative feedback is used to set the gain of the opamp circuit. The output divided by the feedback network forces the inverting input to match the non-inverting input.

Common Opamps. +/-15V

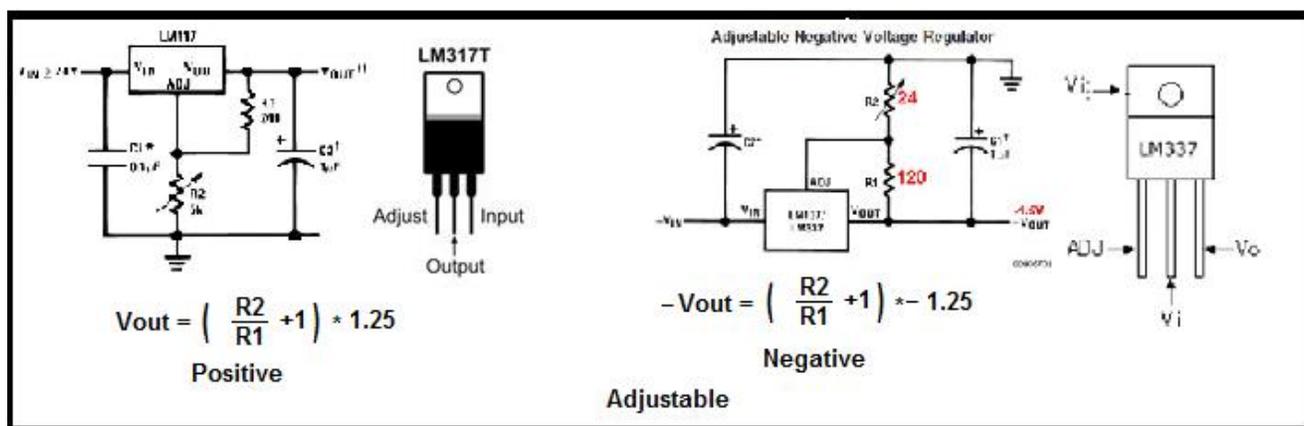
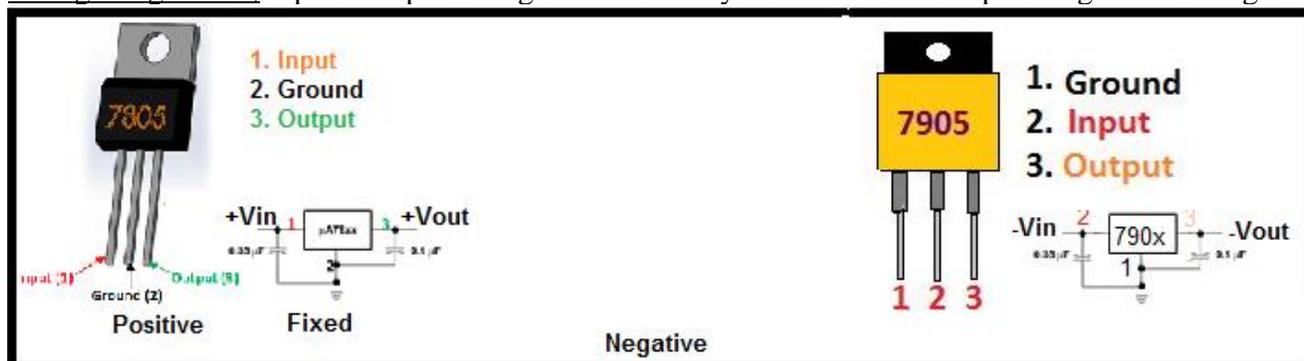
	Channels	Vos	GBW
741	Single	10mV(lame)	1MHz
1458	Dual	10mV	1MHz dual 741
OP07	Single	75uV	0.6MHz
OPA388	Single	25uA	10MHz

Other opamps, Rail to Rail single supply, Jfet input, Zero input offset, High current. High Frequency, high voltage. The above are 4 of over 8000 different opamps.

**Comparators:** Similar to opamp except used to compare two analog levels and output a digital result. Symbol for a comparator is the same as an opamp. Symbol may have a ground terminal for the output. The output may be open collector or “totem poll” pull up and pull down output.



**Voltage Regulators:** Input an input voltage from a battery or rectifier and output a regulated voltage.



**Power Dissipation:**  $P = (V_{in} - V_{out}) * I_{out}$  if this is over a watt Heat sink needed.

**Voltage References:** Same as above except low output current and accurate output voltage. Some of the latest parts are 0.01% accurate. Typical Voltages are 2.048 , 2.5, 4.096, 5 and 10Volts.

Balanced Mixer: two frequencies are mix resulting in an output of the sum and difference of the input frequencies but not the original frequencies. In example if 1 KHz and 500 KHz are on the inputs the output is 499 KHz and 501KHz. Figure 2. This is how Single Side Band is generated. Example part is the MC1496 also marketed under other part numbers by other manufacturers.

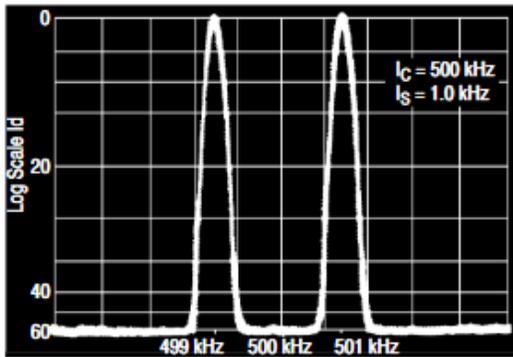


Figure 2. Suppressed Carrier Spectrum

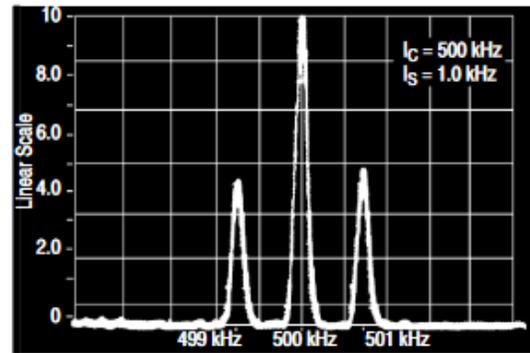


Figure 4. Amplitude-Modulation Spectrum

Instrumentation Amplifiers: input and gain up a differential voltage to the output.

Isolation Amplifiers: provide a galvanically isolated signal path. Up to Kilovolts of isolation.

Timer Circuits: use an RC circuit to set a time or frequency.

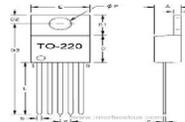
General IC Specifications:

- Absolute Maximum Ratings: Exceeding these specifications will damage the part.
- General specifications. Min and Max, the part's parameter are tested to be with these limits.
- Note: temperatures are specified.
- Typical spec; means untested in production test, user is on their own with this (non) spec.

Packages

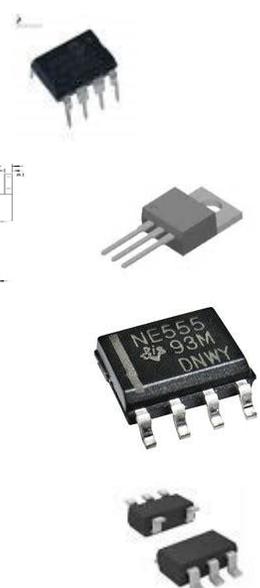
C dip and P dip (dual inline package) though hole.

TO-220



SO-8 / SOIC -8 surface mount

SOT 23-5 surface mount



leadless surface mount exposed paddle

