OPERATIONAL AMPLIFIERS

- **The integrated circuit or IC is a Miniature, low cost electronic circuit consisting of active and passive components that are joined together on a single crystal chip of silicon**

- **It is a versatile device that can be used to amplify DC as well as AC input signals and was originally designed for computing such mathematical functions as Addition,Subtraction,Multiplication and Integration**

APPLICATIONS OF AN INTEGRATED CIRCUIT

- **Communication**
- **Control**
- **Instrumentation**
- **Computer**
- **Electronics**

ADVANTAGES

- Small size
- Low cost
- Less weight
- Low supply voltages
- Low power consumption
- High reliable
- Matched devices
- Fast speed

DISADVANTAGES

- **Most Op-amp are designed for low power operation.**

- **For high output the Op-Amp should be designed specifically.**

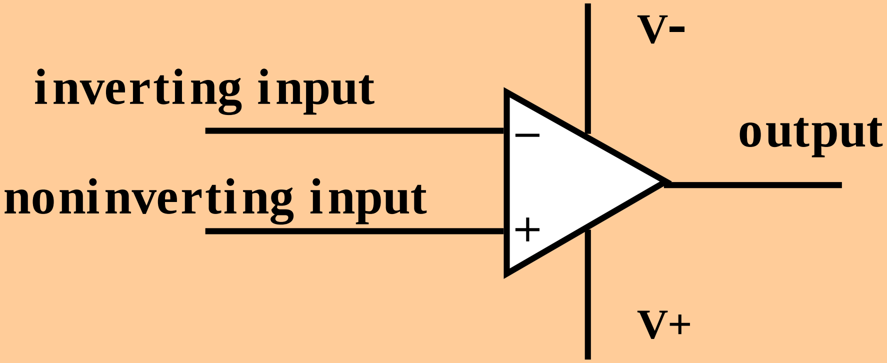
- **Commercial Op-Amp shuts off when the load resistance is below the specific level**

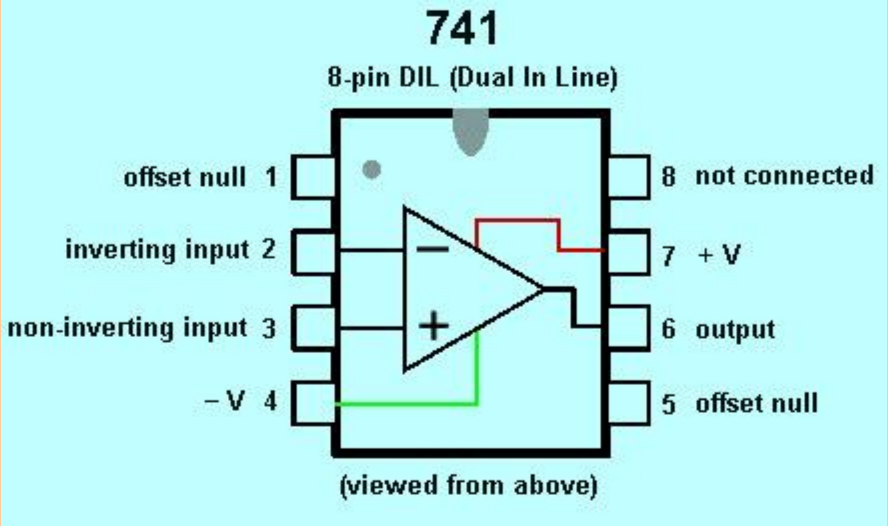
CLASIFICATION OF IC 'S

- **Digital IC's**
- **Linear IC's**

- **Integrated circuits**
  - i) Monolithic circuits
    - a) Bipolar
      - i)PN junction isolation
      - ii) Dielectric isolation
    - ` b) Unipolar
      - i) MOSFET
      - II) JFET
  - ii) Thick and Thin Film
  - iii) Hybrid circuits

SYMBOL OF OP-AMP





7- Terminals, 4- Input, 1-Output =IC 741

IDEAL CHARACTERISTICS OF OP-AMP

- Infinite input impedance
- Infinite open-loop gain
- Zero output impedance
- Infinite bandwidth
- Zero noise.
- It has positive and negative inputs which allow circuits that use feedback to achieve a wide range of functions.

PERFORMANCE PARAMETERS OF OP-AMP

- Input Offset voltage
- Input Offset current
- Input bias current
- Differential Input resistance
- Open loop Voltage gain
- CMRR
- Output resistance
- Input voltage range
- Power supply rejection ratio
- Power consumption
- Slew rate
- Gain
- Output offset voltage

INPUT OFFSET VOLTAGE

- It is defined as the **voltage** that must be applied between the two **input** terminals of an **OPAMP** to null or zero the output.

- The input offset voltage of IC741 Op-Amp is 6mv

INPUT OFFSET CURRENT

- The algebraic difference between the currents flowing into the two input terminals of the Op-Amp.

- The input offset current of IC741 Op-Amp is 200nA

INPUT BIAS CURRENT

- **The average value of the two currents flowing into the Op-Amp input terminals.**

- **The input bias current of IC741 Op-Amp is 500nA**

DIFFERENTIAL INPUT RESISTANCE

- **It is the equivalent resistance measured at either the Inverting or Non-Inverting Input terminal with the other Input terminal grounded.**

- **The Differential Input Resistance of IC741 Op-Amp is 2MΩ**

OPEN LOOP VOLTAGE GAIN

- **It is the ratio of output voltage to the differential input voltage.**

- **It is denoted by AOL = Vo/Vd**

- **The Open loop Voltage gain of IC741 Op-Amp is typically 200,000**

CMRR

- **It is the ratio of differential voltage gain Ad to the Common mode voltage gain Ac.**

- **It is denoted by CMRR = Ad/Ac**

- **The CMRR of IC741 Op-Amp is 90db**

OUTPUT RESISTANCE

- It is the equivalent resistance measured between the output terminal of the Op-Amp and Ground.

- It is denoted by Ro.

- The Output Resistance of IC741 Op-Amp is 75 Ω

INPUT VOLTAGE RANGE

- It is the range of a common mode input signal for which a differential amplifier remains linear.

- The Input Voltage Range of IC741 Op-Amp is ± 13V

POWER SUPPLY REJECTION RATIO

- **It is defined as the ratio of the change in supply voltage to the equivalent (differential) output voltage it produces.**

- **The Power Supply Rejection Ratio of IC741 Op-Amp is 30 μV/V**

POWER CONSUMPTION

- **It is the amount of quiescent power to be consumed by Op-Amp with zero input voltage, for its proper functioning.**

- **The Power Consumption of IC741 Op-Amp is 85mW.**

SLEW RATE

- It is defined as the maximum rate of change of output voltage with time.

GAIN

- It is the bandwidth of an Op-Amp when voltage gain is unity.

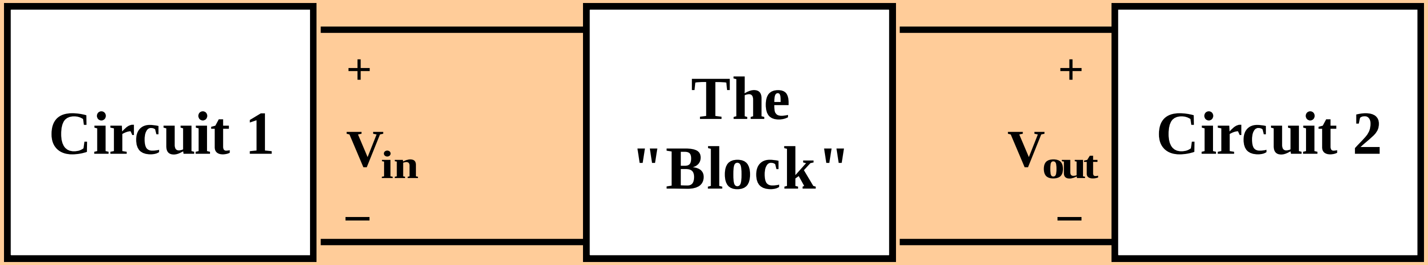
- The Gain of IC741 Op-Amp is 1MHz

OUTPUT OFFSET VOLTAGE

- It is the DC voltage present at the Output terminals when both the input terminals are grounded

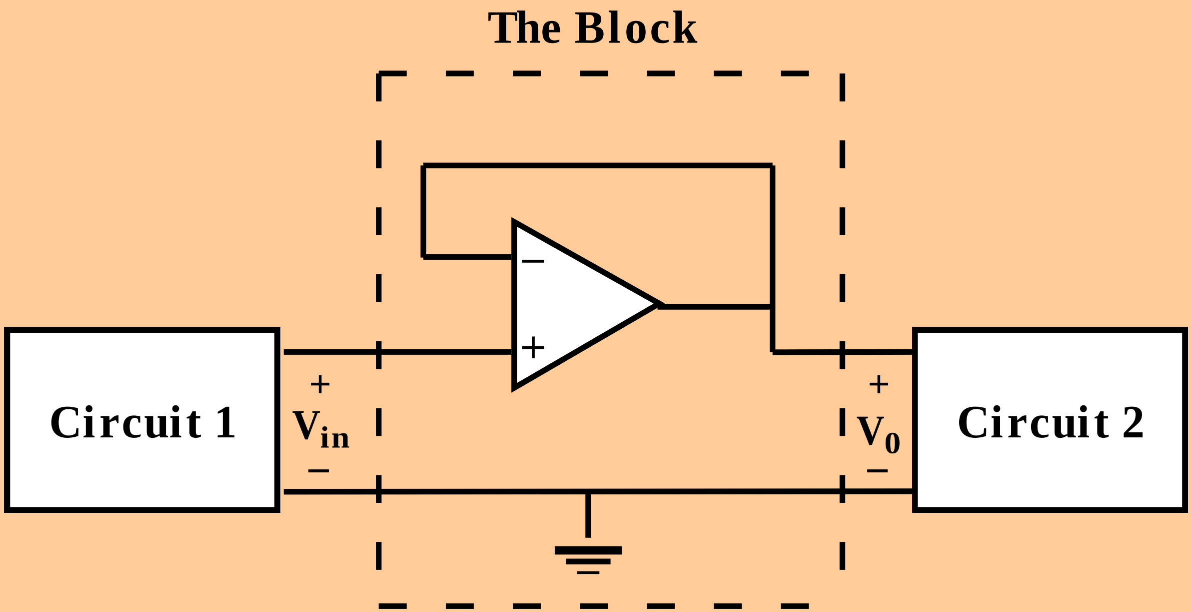
ISOLATION OR VOLTAGE FOLLOWER.

➢Applications arise in which we wish to connect one circuit to another without the first circuit loading the second. This requires that we connect to a “block” that has infinite input impedance and zero output impedance. An operational amplifier does a good job of approximating this. Consider the following:



Illustrating Isolation.

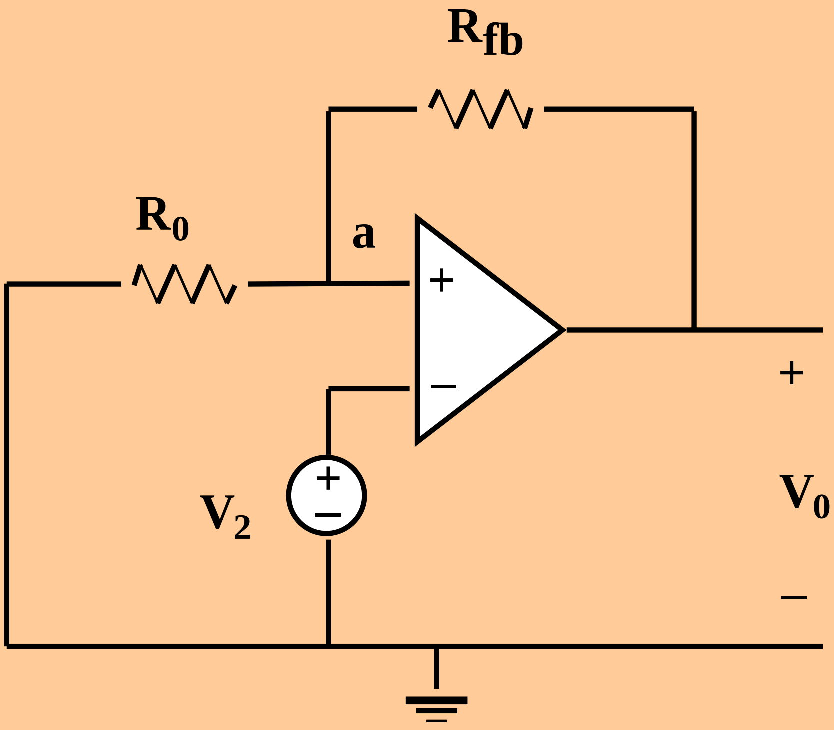
ISOLATION OR VOLTAGE FOLLOWER….



Circuit isolation with an op amp.

It is easy to see that: $V_0 = V_{in}$

NONINVERTING OP AMP



Non-inverting op amp configuration.

NON- INVERTING OP AMP…

Writing a node equation at “a” gives;

$$\frac{V_2}{R_0} + \frac{(V_2 - V_0)}{R_{fb}} = 0$$

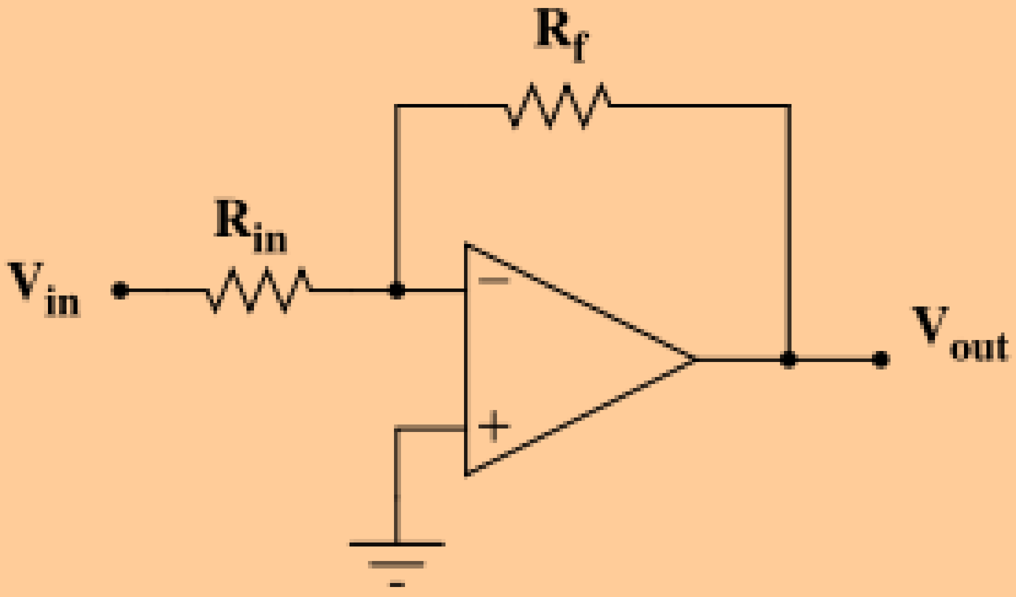
so

$$\frac{V_0}{R_{fb}} = V_2\left[\frac{1}{R_0} + \frac{1}{R_{fb}}\right]$$

which gives,

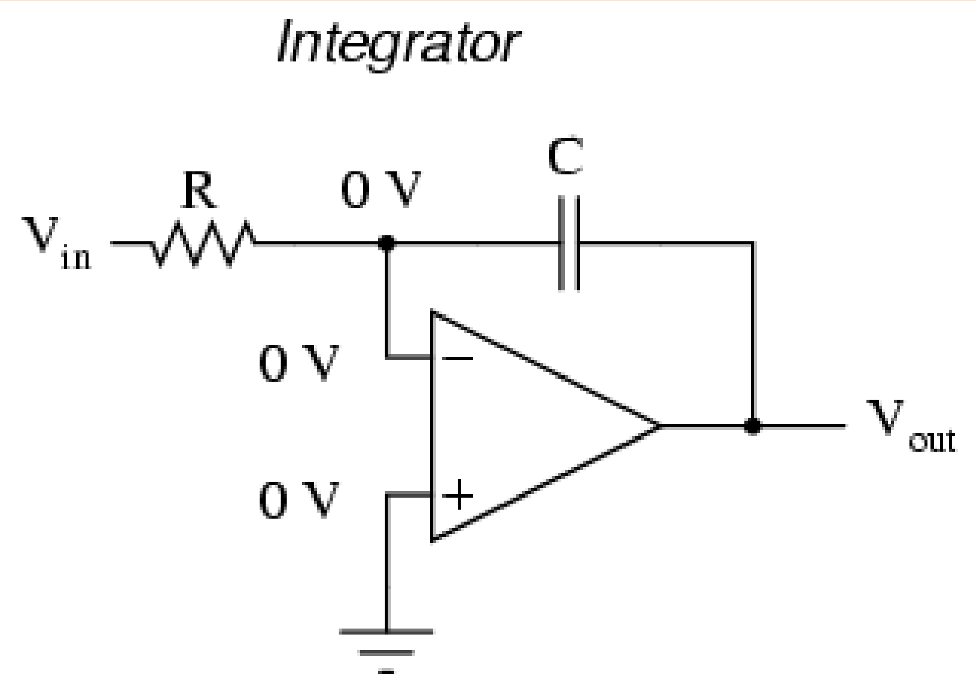
$$V_0 = \left(1 + \frac{R_{fb}}{R_0}\right)V_2$$

INVERTING OP AMP



$$V_{\mathrm{out}} = -V_{\mathrm{in}}(R_{\mathrm{f}}/R_{\mathrm{in}})$$

INTEGRATOR



$$\frac{dv_{out}}{dt} = -\frac{V_{in}}{RC}$$

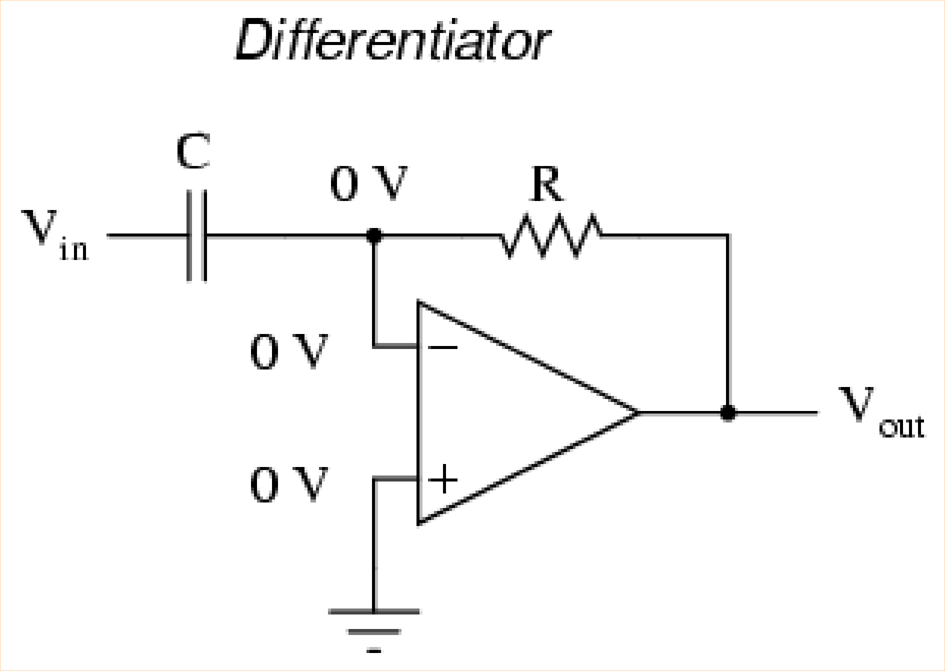
or

$$V_{out} = \int_0^t -\frac{V_{in}}{RC}\, dt + c$$

Where,

c = Output voltage at start time (t=0)

DIFFERENTIATOR



$$V_{out} = -RC \frac{dv_{in}}{dt}$$