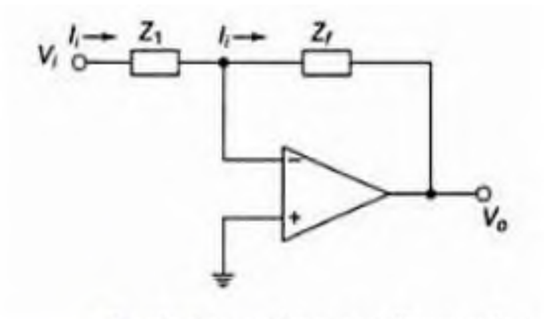
Sign Changer (Phase Inverter)



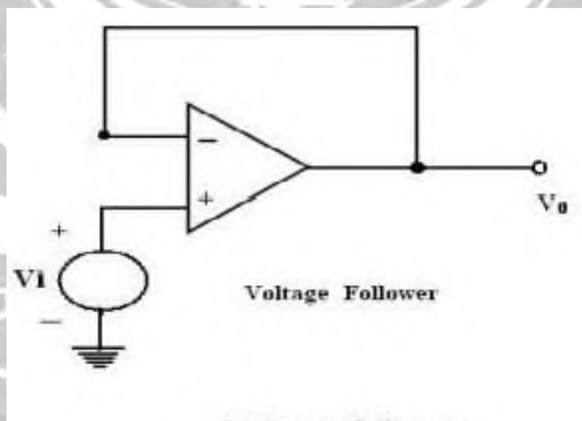
Basic inverting configuration

The basic inverting amplifier configuration using an op-amp with input impedance Z1 and feedback impedance Zf . If the impedance Z1 and Z f are equal in magnitude° and phase, then the closed loop voltage gain is -1, and the input signal will undergo a 180 phase shift at the output. Hence, such circuit is also called phase inverter. If two such amplifiers are connected in cascade, then the output from the second stage is the same as the input signal without any change of sign. Hence, the outputs from the two stages are equal in magnitude but opposite in phase and such a system is an excellent paraphase amplifier.

Scale Changer:

Referring the above diagram, if the ratio $Z_f / Z_1 = k$, a real constant, then the closed loop gain is – k, and the input voltage is multiplied by a factor –k and the scaled output is available at the output. Usually, in such applications, Z_f and Z_1 are selected as precision resistors for obtaining precise and scaled value of input voltage.

Voltage follower



Voltage follower

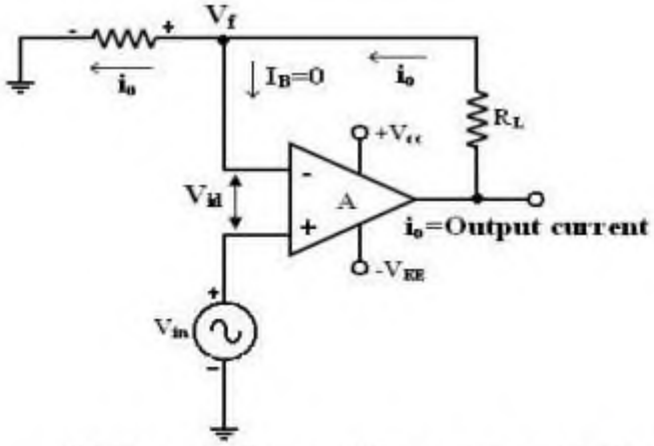
If $R_1=\infty$ and $R_f=0$ in the non inverting amplifier configuration. The amplifier act as a unity-gain amplifier or voltage follower.

The circuit consists of an op -amp and a wire connecting the output voltage to the input, i.e. the output voltage is equal to the input voltage, both in magnitude and phase. $V_0=V_i$.Since the output voltage of the circuit follows the input voltage, the circuit is called voltage follower. It offers very high input impedance of the order of MΩ and very low output impedance.

Therefore, this circuit draws negligible current from the source. Thus, the voltage follower can be used as a buffer between a high impedance source and a low impedance load for impedance matching applications.

Voltage to Current Converter with floating loads (V/I):

Voltage to current converter in which load resistor R_L is floating (not connected to ground). V_{in} is applied to the non- inverting input terminal, and the feedback voltage across R_1 devices the inverting input terminal. This circuit is also called as a current – series negative feedback amplifier. Because the feedback voltage across R_1 (applied Non-inverting terminal) depends on the output current i_0 and is in series with the input difference voltage V_{id}.



Voltage to Current Converter with floating loads (V/I):

Writing KVL for the input loop,

Voltage V_{id}=V_f and I_B = 0 , vi=$R_L i_0$ = where = i_0=v_i/R_L

From the fig input voltage Vin is converted into output current of V_{in}/R_L [V_{in} -> i_0]. In other words, input volt appears across R_1. If R_L is a precision resistor, the output current

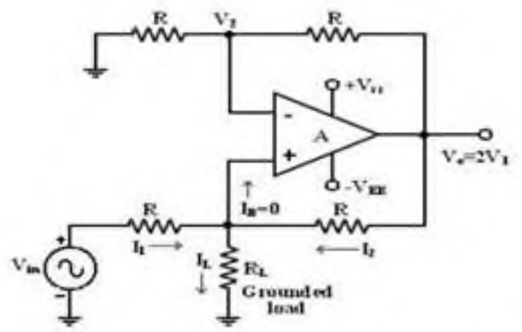
(i_0 = V_{in}/R_1) will be precisely fixed

Applications:

1. Low voltage ac and dc voltmeters
2. Diode match finders
3. LED and Zener diode testers.

Voltage – to current converter with Grounded load:

This is the other type V – I converter, in which one terminal of the load is connected to ground.



V – I converter with grounded load

Analysis of the circuit:

The analysis of the circuit can be done by following 2 steps.

1. To determine the voltage V_1 at the non-inverting (+) terminals and

2. To establish relationship between V_1 and the load current I_L. Applying KCL at node a,

$R= R_f$

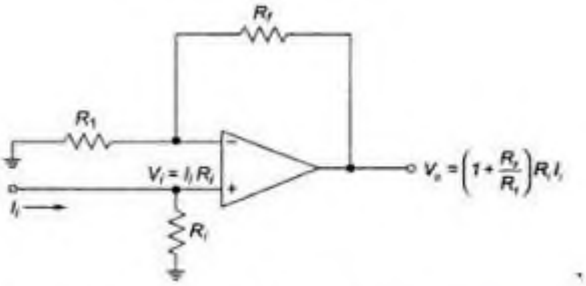
$I_1 + I_2 = I_L$

$(V_i + V_a)/R + (V_0 - V_a)/R = I_L$

$V_o = (V_i + V_o - I_L R)/2$ and gain $=1+ R/R= 2$.

$\therefore V_i = I_L R$; $I_L = V_i/R$

Current to Voltage Converter (I –V):



Non inverting current to voltage convertor

Open – loop gain A of the op-amp is very large. Input impedance of the op amp is very high.

Sensitivity of the I – V converter:

1. The output voltage $V_0 = -R_F$ Iin.
2. Hence the gain of this converter is equal to -RF. The magnitude of the gain (i.e.) is called as sensitivity of I to V converter.
3. The amount of change in output volt ΔV0 for a given change in the input current ΔIin is decide by the sensitivity of I-V converter.
4. By keeping RF variable, it is possible to vary the sensitivity as per the requirements.

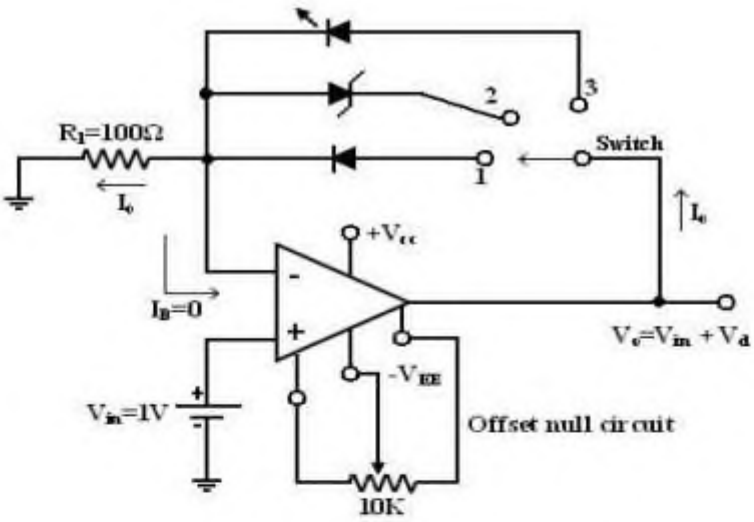
Applications of V-I converter with Floating Load:

1. Diode Match finder:

In some applications, it is necessary to have matched diodes with equal voltage drops at a particular value of diode current. The circuit can be used in finding matched diodes and is obtained from fig (V-I converter with floating load) by replacing RL with a diode.

When the switch is in position 1: (Diode Match Finder) Rectifier diode (IN 4001) is placed in the f/b loop, the current through this loop is set by input voltage V_{in} and Resistor R_1. For $V_{in} = 1V$ and $R_1 = 100\Omega$, the current through this $I0 = V_{in}/R_1 = 1/100 = 10mA$. As long as V_0 and R_1 constant, I_0 will be constant. The Voltage drop across the diode can be found either by measuring the volt across it or o/p voltage.

The output voltage is equal to $(V_{in} + V_D)$ $V_0 = V_{in} + V_D$.



Diode Match finder:

To avoid an error in output voltage the op-amp should be initially nulled. Thus the matched diodes can be found by connecting diodes one after another in the feedback path and measuring voltage across them.

2. Zener diode Tester:

(When the switch position 2) when the switch is in position 2, the circuit becomes a Zener diode tester. The circuit can be used to find the breakdown voltage of Zener diodes. The Zener current is set at a constant value by Vin and R1. If this current is larger than the knee current (I_{ZK}) of the Zener, the Zener blocks (Vz) volts. For Ex: I_{ZK} = 1mA , V_Z = 6.2V, Vin = 1V, R_1 = 100Ω Since the current through the Zener is , I0 = Vin/R_1 = 1/100 =10mA > I_{ZK} the voltage across the Zener will be approximately equal to 6.2V.

3. When the switch is in position 3: (LED)

The circuit becomes a LED when the switch is in position 3. LED current is set at a constant value by V_{in} and R_1. LEDs can be tested for brightness one after another at this current.

Matched LEDs with equal brightness at a specific value of current are useful as indicates and display devices in digital applications.

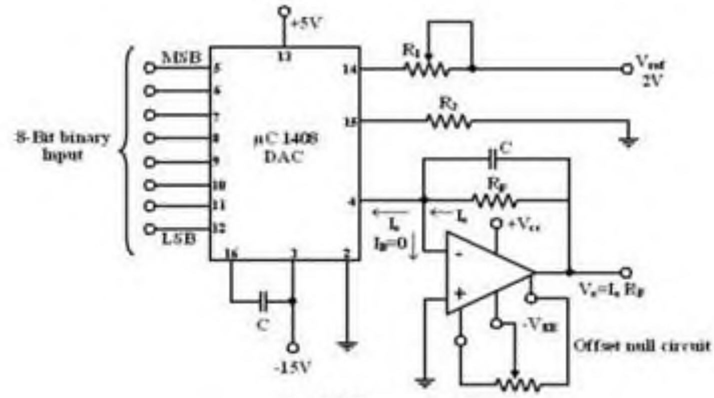
Applications of I – V Converter:

One of the most common uses of the current to voltage converter is

1. Digital to analog Converter (DAC)
2. Sensing current through Photo detector. Such as photo cell, photo diodes and photovoltaic cells.

Photoconductive devices produce a current that is proportional to an incident energy or light (i.e).

It can be used to detect the light.



I – V Converter DAC

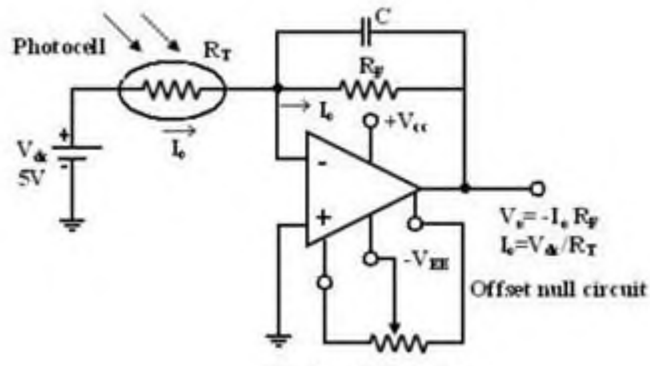


Photo cell detector

Photocells, photodiodes, photovoltaic cells give an output current that depends on the intensity of light and independent of the load. The current through these devices can be converted to voltage by I – V converter and it can be used as a measure of the amount of light. In this fig photocell is connected to the I – V Converter. Photocell is a passive transducer it requires an external dc voltage (V_{dc}). The dc voltage can be eliminated if a photovoltaic cell is used instead of a photocell. The Photovoltaic Cell is a semiconductor device that converts the radiant energy to electrical power. It is a self- generating circuit because it does not require dc voltage externally. Ex of Photovoltaic Cell: used in space applications and watches.