FEEDBACK AMPLIFIER

Introduction of Feedback Amplifiers:

The phenomenon of feeding a portion of the output signal back to the input circuit is known as feedback. The effect results in a dependence between the output and the input and an effective control can be obtained in the working of the circuit. Feedback is of two types.

- Positive Feedback
- Negative Feedback

Positive or regenerate feedback:

- In positive feedback, the feedback energy (voltage or currents), is in phase with the input signal and thus aids it. Positive feedback increases gain of the amplifier also increases distortion, noise and instability.
- Because of these disadvantages, positive feedback is seldom employed in amplifiers. But the positive feedback is used in oscillators.

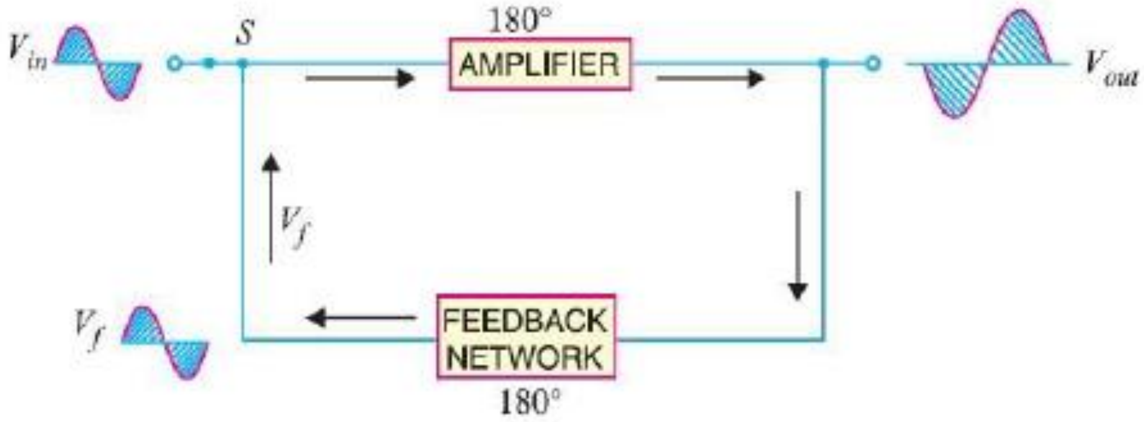
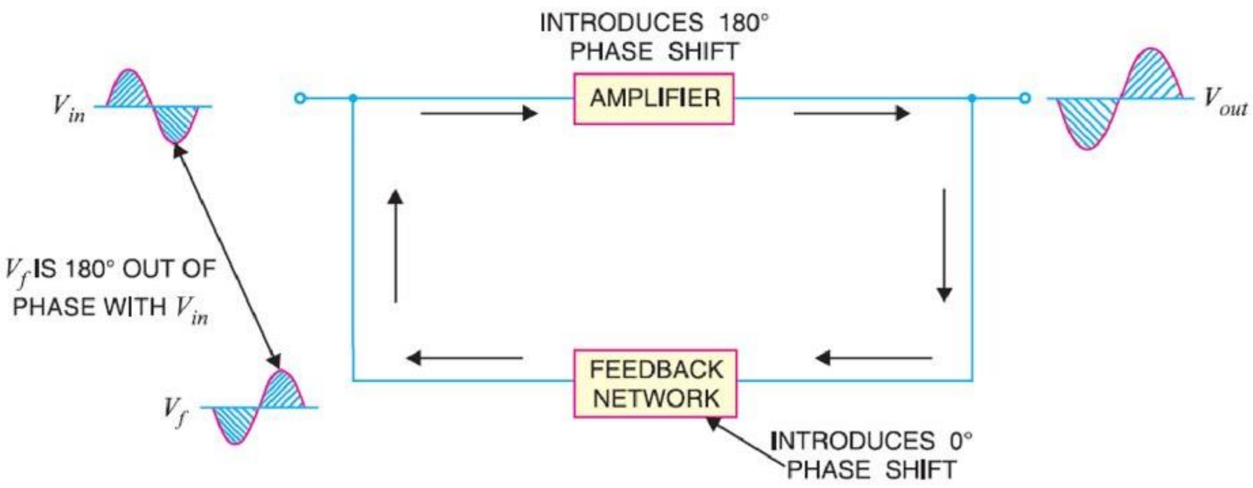


Fig 6.5

Negative or Degenerate feedback:

- In negative feedback, the feedback energy (voltage or current), is out of phase with the input signal and thus opposes it.
- Negative feedback reduces gain of the amplifier. It also reduce distortion, noise and instability.
- This feedback increases bandwidth and improves input and output impedances.
- Due to these advantages, the negative feedback is frequently used in amplifiers.

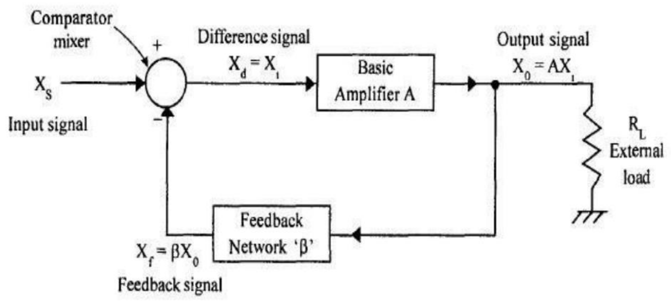


Comparison Between Positive and Negative Feed Back:

S.No.	Negative Feedback	Positive Feedback
1.	Feedback energy is out phase with their input signal	Feedback energy is in phase with the input signal.
2.	Gain of the amplifier decreases	Gain of the amplifier increases
3.	Gain stability increases	Gain stability decreases
4.	Noise and distortion decreases.	Noise and distribution increases.
5.	Increase the band width	Decreases bandwidth
6.	Used in amplifiers	Used in Oscillators

Principle of Feedback Amplifier:

A feedback amplifier generally consists of two parts. They are the **amplifier** and the **feedback circuit**. The feedback circuit usually consists of resistors. The concept of feedback amplifier can be understood from the following figure.



Generalized feedback amplifier

In the above figure, the gain of the amplifier is represented as A. The gain of the amplifier is the ratio of output voltage V_o to the input voltage V_i. The feedback network extracts a voltage $V_f = \beta\ V_o$ from the output V_o of the amplifier.

This voltage is subtracted for negative feedback, from the signal voltage V_s. Now,

$$Vi=Vs-Vf=Vs-\beta Vo$$

The quantity $\beta = V_f/V_o$ is called as feedback ratio or feedback fraction.

The output V_o must be equal to the input voltage (V_s - βV_o) multiplied by the gain A of the amplifier.

Hence,

$$(Vs-\beta Vo)A=Vo$$

$$AVs-A\beta Vo=Vo$$

$$AVs=Vo(1+A\beta)$$

$$Vo/Vs=A/(1+A\beta)$$

Therefore, the gain of the amplifier with feedback is given by

$$A_f=A/(1+A\beta)$$

Effect of negative feedback on amplifier performance:

The effect of negative feedback on an amplifier is considered in relation to gain, gain stability, distortion, noise, input/output impedance and bandwidth and gain-bandwidth product.

Gain:

The gain of the amplifier with feedback is given by

$$\mathbf{A_f = A/(1+A\beta)}$$

Hence, gain decreases with feedback.

Gain Stability:

An important advantage of negative voltage feedback is that the resultant gain of the amplifier can be made independent of transistor parameters or the supply voltage variations,

$$A_f = A/(1+A\beta)$$

$$A_f = A/(1+A\beta) = 1/\beta$$

It may be seen that the gain now depends only upon feedback fraction, **β**, i.e., on the characteristics of feedback circuit. As feedback circuit is usually a voltage divider (a resistive network), therefore, it is unaffected by changes in temperature, variations in transistor parameters and frequency. Hence, the gain of the amplifier is extremely stable.

Feedback in Emitter Follower Amplifier:

Operation:

For the emitter follower, the input voltage is applied at base and the resulting a.c. emitter current produces an output voltage ($I_e R_E$) across the emitter resistance. This voltage opposes the input voltage, thus providing negative feedback (Voltage series). It is called emitter follower because the output voltage follows the input voltage.

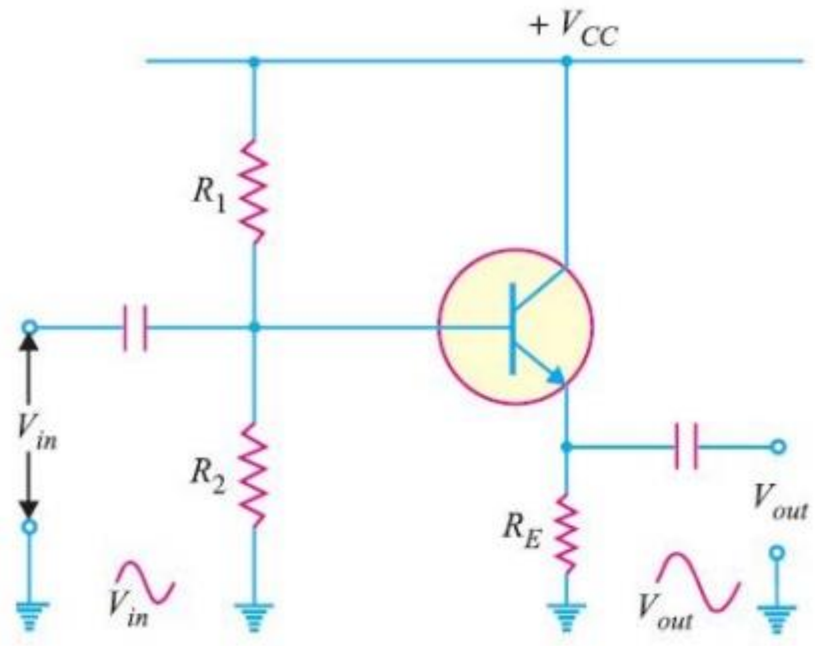
The major characteristics of the emitter follower are:

The voltage gain of an emitter follower is close to 1.

Relatively high current gain and power gain.

High input impedance and low output impedance.

Input and output ac voltages are in phase.



Classification of Feedback Amplifiers:

There are four types of feedback,

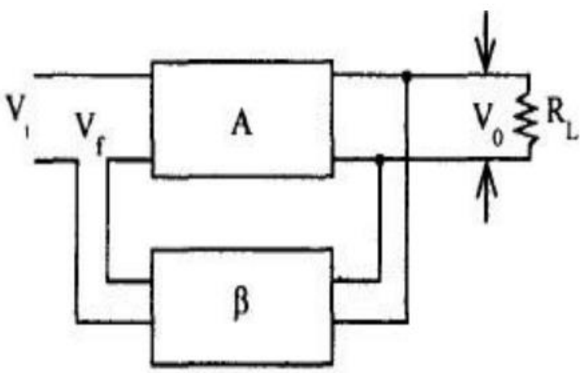
- Voltage series feedback.
- Voltage shunt feedback.
- Current shunt feedback.
- Current series feedback

The alternative nomenclature used is as follows:

1. Voltage-series or series-shunt feedback
2. Current-series or series-series feedback
3. Current-shunt or shunt-series feedback
4. Voltage-shunt or shunt-shunt feedback

$R_{if} = R_i\,(1+A\beta)$

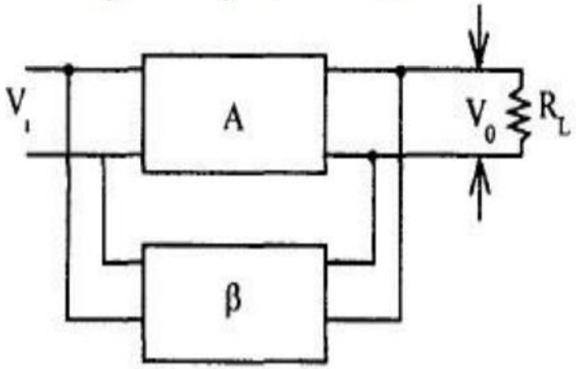
$R_{of} = R_o\,/\,(1+A\beta)$



Voltage series feedback.

$R_{if} = R_i\,/\,(1+A\beta)$

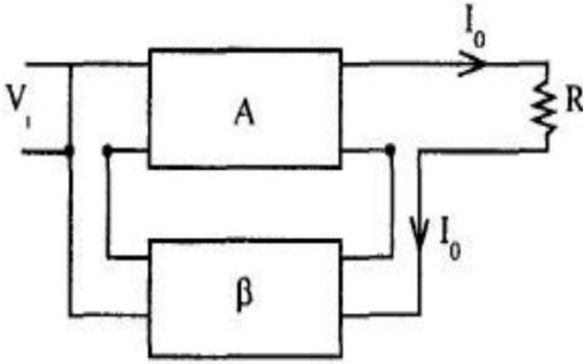
$R_{of} = R_o\,/\,(1+A\beta)$



Voltage shunt Feedback

$R_{if} = R_i\,/\,(1+A\beta)$

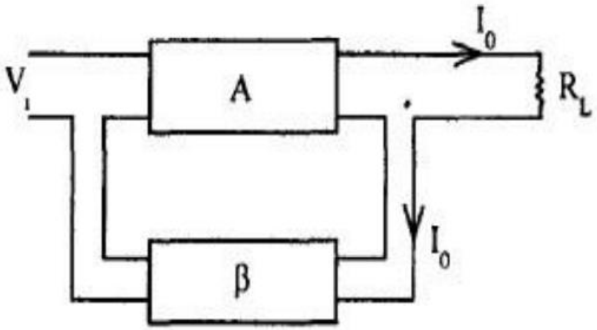
$R_{of} = R_o\,(1+A\beta)$



Current Shunt Feedback

$R_{if} = R_i\,(1+A\beta)$

$R_{of} = R_o\,(1+A\beta)$



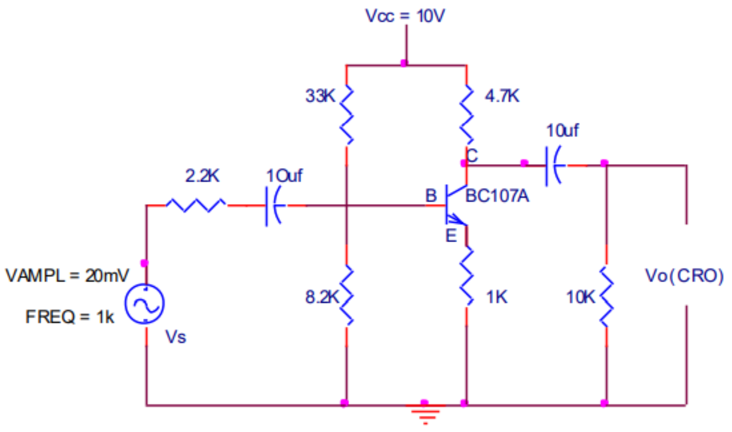
Current Series Feedback

Summary:

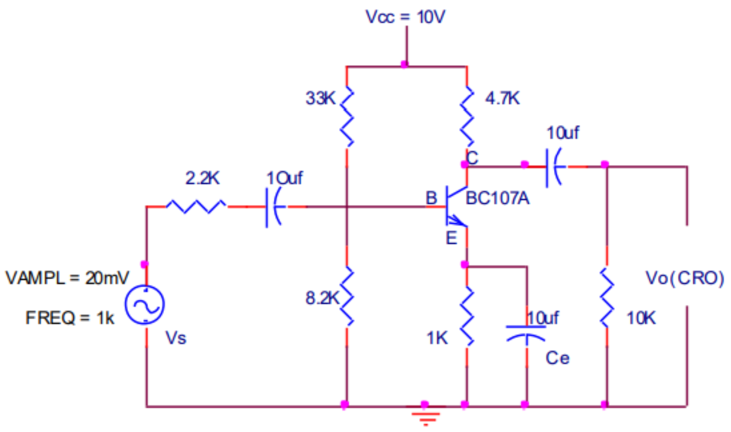
Sl. No.	Type	Rif	Rof
1	Voltage Shunt Feedback Amplifier	$R_{if} = R_i / (1+A\beta)$	$R_{of} = R_o / (1+A\beta)$
2	Current Shunt Feedback Amplifier	$R_{if} = R_i / (1+A\beta)$	$R_{of} = R_o (1+A\beta)$
3	Voltage Series Feedback Amplifier	$R_{if} = R_i (1+A\beta)$	$R_{of} = R_o / (1+A\beta)$
4	Current Series Feedback Amplifier	$R_{if} = R_i (1+A\beta)$	$R_{of} = R_o (1+A\beta)$

CURRENT SERIES FEEDBACK AMPLIFIER

AIM: To obtain the frequency response characteristics of a Current Series amplifier with and without feedback and Obtain the bandwidth.

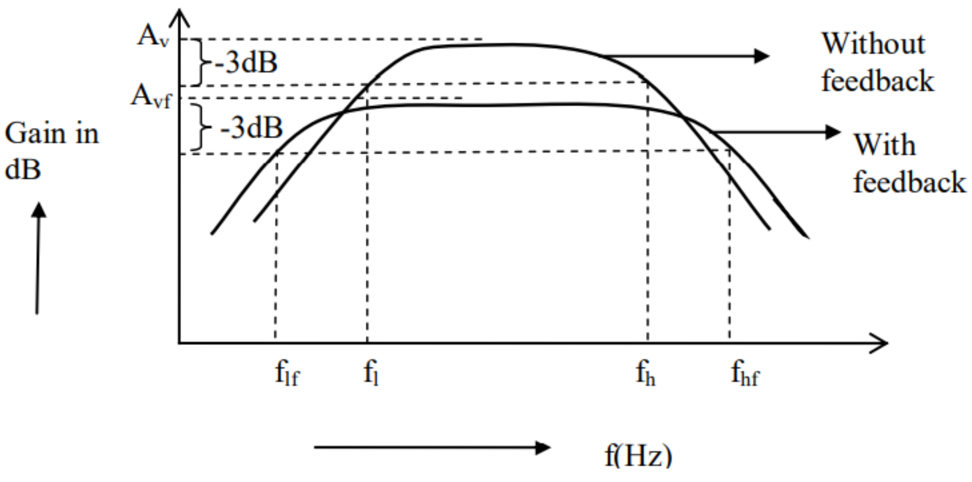


CURRENT SERIES AMPLIFIER WITH FEEDBACK



CURRENT SERIES AMPLIFIER WITHOUT FEEDBACK

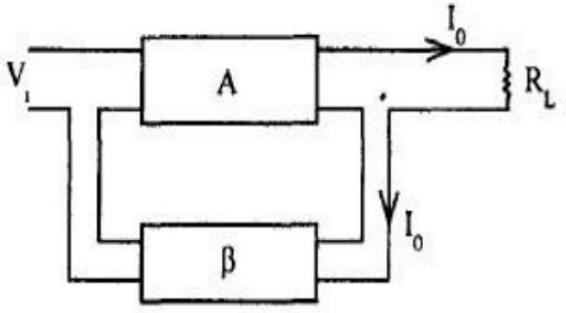
Gain = 20 log Vo / Vi (dB)



Bandwidth= f_l-f_h

$R_{if} = R_i\,(1+A\beta)$

$R_{of} = R_o\,(1+A\beta)$



Current Series Feedback

Advantages:

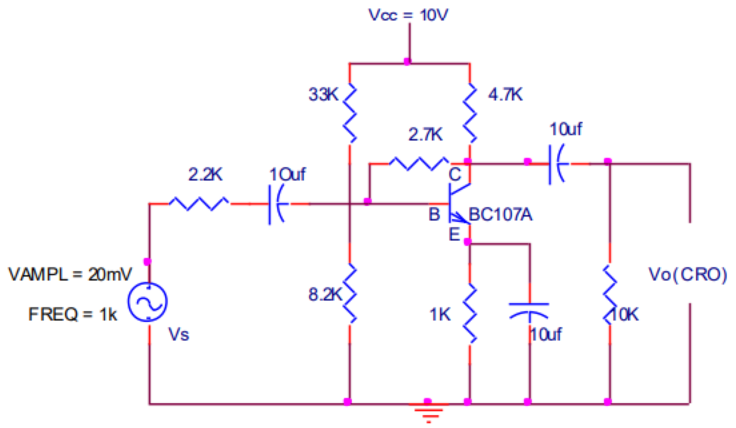
- High BW
- less noise
- less distortion
- gain stability

$$A_f = A/(1+A\beta)$$

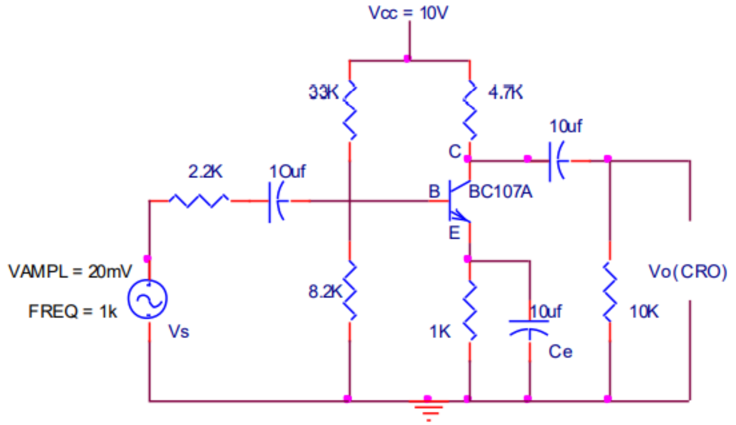
$$A_f = I_o/V_s$$

VOLTAGE SHUNT FEEDBACK AMPLIFIER

AIM: To obtain the frequency response characteristics of a Current Series amplifier with and without feedback and Obtain the bandwidth.

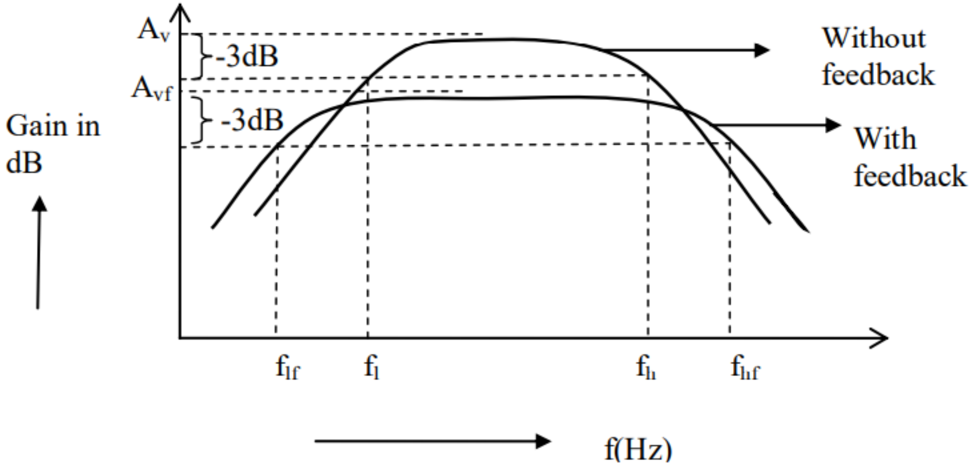


VOLTAGE SHUNT AMPLIFIER WITH FEEDBACK



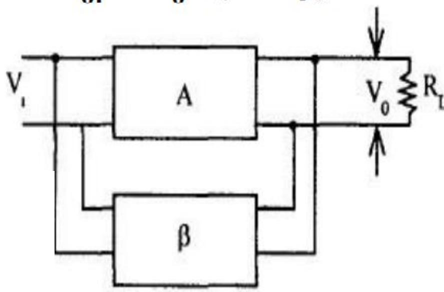
VOLTAGE SHUNT AMPLIFIER WITHOUT FEEDBACK

Gain = 20 log Vo / Vi (dB)



$R_{if} = R_i / (1+A\beta)$

$R_{of} = R_o / (1+A\beta)$



Voltage shunt Feedback

Advantages:

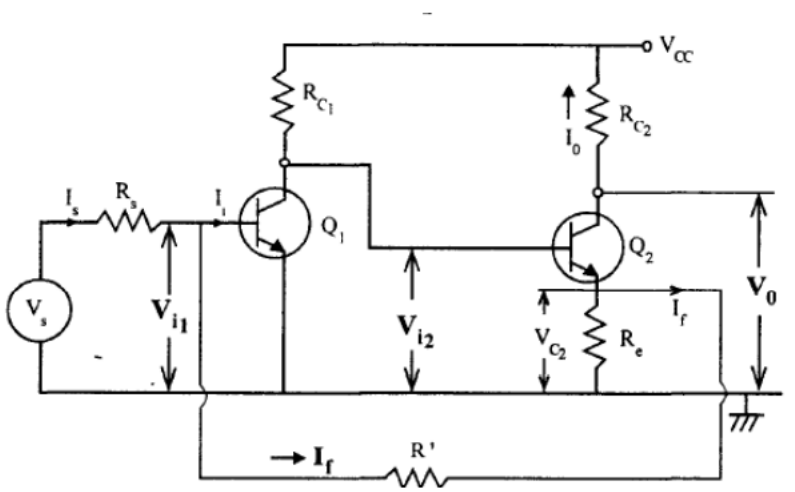
- High BW
- less noise
- less distortion
- gain stability

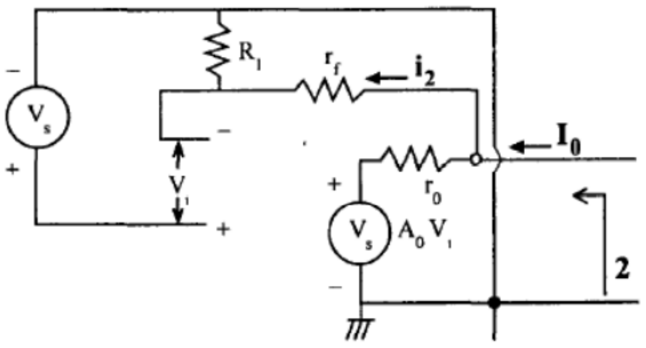
$$A_f = A/(1+A\beta)$$

$$A_f = V_o/I_s$$

Configuration	Output Connection	Input Connection	Output Resistance	Input resistance
Voltage Series	Shunt	Series	Decrease	Increase
Voltage Shunt	Shunt	Shunt	Decrease	Decrease
Current Series	Series	Series	Increase	Increase
Current Shunt	Series	Shunt	Increase	Decrease

Current shunt feedback.





Equivalent circuit.