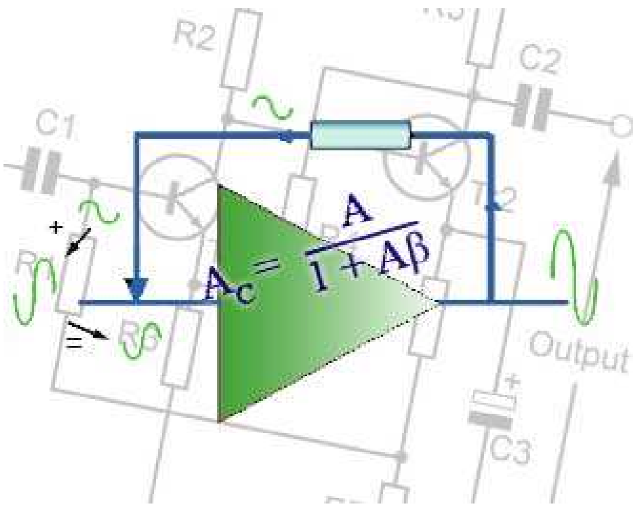
Negative Feedback

Introduction to Negative Feedback

What you'll learn in Module 3.



Negative Feedback

Negative feedback is the technique of sampling some of the output of a device or system and applying it back to the input. This makes the input partly dependent on the output, and in doing so makes it possible to exert very fine control over whatever process is being carried out by the system.

NFB With Everything!

Negative feedback is almost as old as machines, and is used in just about every possible process where some control over the output is necessary. Cans of beans may be weighed as they come off a production line and if there is any difference between the weight measured and the ideal weight, the number of beans per can will be automatically adjusted further back in the process to maintain a constant weight.

Manufacturers launching a new product will test public reaction to a small sample of their product by asking prospective buyers for their opinions, and adjust the product design as a result of the feedback. Anything from a builder repeatedly checking that the layers of bricks are level as he builds the wall, to an aircraft landing safely at the correct point on the airport runway is an example of feedback in action.

Positive and Negative Feedback

There are two types of feedback commonly used in electronic circuits, positive (regenerative) feedback and negative (degenerative) feedback. Positive feedback is primarily used in electronic oscillators, it increases gain (and distortion if not properly controlled) and narrows bandwidth to such a degree that it can be the primary reason for oscillators to work at a single frequency, rather than a band of frequencies.

This module describes the application of negative feedback in amplifiers, where its use provides a number of very useful attributes that improve the performance of the amplifier.

Module 3.1

Negative Feedback and Gain

What you'll learn in Module 3.1.

After studying this section, you should be able to:

Understand the basic principles of NFB as applied to amplifiers.

- Open loop gain.
- Closed loop gain.
- The relationship between β and gain.
- Reasons for using Negative Feedback.

Why NFB is needed in amplifiers

Transistors cannot be manufactured to have a closely controlled value of current gain h_{fe} therefore it should not be possible to build a number of examples of the same amplifier circuit, all having the same gain. In addition the gain of a transistor varies with temperature, and even has different gain at different frequencies. All of these factors would make transistor amplifiers totally unreliable and impossible to make in large numbers. The main reason that this situation does not exist, and transistor amplifiers have become the mainstay of the electronics industry is the introduction, very early in the transistor's history, of negative feedback.

Principle of NFB

The principle of negative feedback is that a portion of the output signal is fed back to the input and combined with the input signal in such a way as to reduce it. This reduces the overall gain of the amplifier but also introduces a number of benefits, such as reducing distortion and noise, and widening the amplifier's bandwidth.

Problems with NFB

Introducing feedback within a system can also introduce the possibility of instability; in amplifiers the signal will normally undergo a phase reversal of 180 degrees between input and output but reactive components such as capacitors and inductors, whether actual components or 'stray' capacitance and inductance, can introduce unwanted phase changes at particular (usually high) frequencies. If these additional changes add up to a further 180 degrees at any frequency where the transistor has a gain of more than 1, the application of negative feedback may become positive feedback. Instead of reducing gain this will increase it to the point where the amplifier will become an oscillator and produce unwanted signals. Negative feedback must therefore be designed to maximise the benefits mentioned above, without creating unwanted problems.

The Amplifier in Open Loop Mode

Fig. 3.1.1 shows a phase reversing voltag feedback, which can be called A_o (**Ampl** 1mV is applied, then the output will be a $A_o = A_o$(mV).

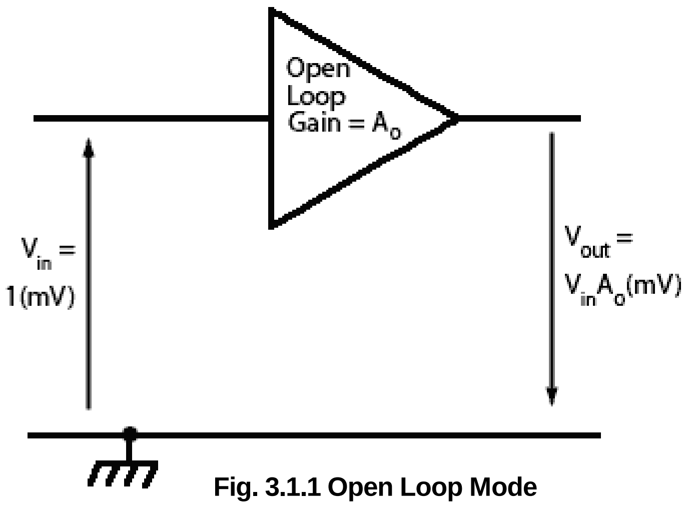


Fig. 3.1.1 Open Loop Mode

The Negative Feedback Amplifier in Closed Loop Mode

A basic negative feedback arrangement is shown in Fig. 3.1.2 where the phase reversing amplifier has a fraction of its output (V_{out}) fed back and added to the input (V_{in}) so as to reduce the amplitude of the input signal. The arrows show the relative polarity of the signals and it can be seen that the output and the feedback signals are in anti-phase to the input signal. The fraction of the output signal to be fed back is controlled by the potential divider (β) and this fraction is added to the input signal in anti-phase so that it is, in effect, subtracted from the input signal (V_{in}) to give a combined signal (V_c) that is reduced in amplitude before being fed to the actual input of the amplifier.

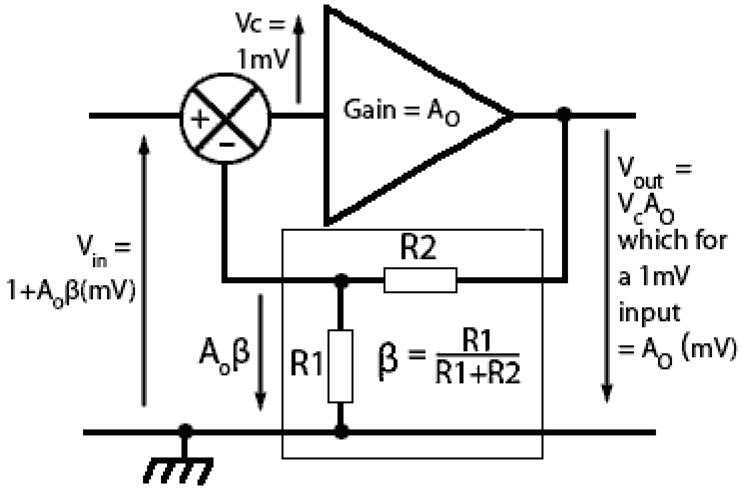


Fig. 3.1.2 Closed Loop Mode

The gain of the amplifier, excluding any feedback, is A_o so that, for example, every 1mV applied across the circuit's input terminals, the amplifier will produce a phase-reversed signal of A_o x 1mV across the output terminals.

The feedback circuit comprising R1 and R2 will feed back a fraction (β) of output V_{out} which = A_o, so that A_o x βmV (Aβ) will be added in anti-phase to the 1mV signal to produce a reduced input signal of V_c.

The signal source V_{in} driving the amplifier must therefore deliver not 1mV but **1+AβmV** to produce the same amplitude of output. Therefore the overall gain of the amplifier with negative feedback is reduced now called the closed loop gain (A_c).

Negative Feedback Formula

The voltage gain of any amplifier can be described by the formula:

$$A_V = \frac{V_{out}}{V_{in}}$$

Because, in the closed loop negative feedback amplifier (Fig. 3.1.2):

$$\mathbf{V_{out} = A_o}$$

and

$$\mathbf{V_{in} = 1 + A_o\beta}$$

the closed loop gain (A_c) can also be described by the standard NFB formula:

$$\text{Closed Loop Gain } A_C = \frac{A_o}{1 + A_o\beta}$$

Negative feedback amplifiers are designed so that the open loop gain A_o (without feedback applied) of the amplifier is much greater than 1, and so the 1 in the formula becomes insignificant. The closed loop gain (A_c) can therefore be approximated to:

$$\frac{A_o}{A_o\beta} \quad \text{or} \quad \frac{1}{\beta}$$

The effect of NFB on amplifier Gain

This is of great significance because it means that, once negative feedback is applied, the closed loop gain A_c depends almost exclusively on β, which in turn depends on the ratio of the potential divider R1, R2.

Example:

The amplifier in Fig 3.1.2 uses the following feedback resistors:

R1 = 1kΩ

R2 = 10kΩ

Therefore:

$$\beta = R1 / (R1+R2) = 0.0909 = 1 / 11$$

and as the closed loop gain $A_c = 1/\beta$ then,

$$\mathbf{A_c\ 1 / 0.0909 = 11}$$

Testing this approximate result against the full formula for the closed loop gain:

Assuming an open loop gain of 1000 and β = 1 / 11 The closed loop gain A_c should be 11

Compare this result with the full formula for closed loop gain by entering the following data into your calculator:

$$\mathbf{1000 / (1+ 1000 * 11^{-1}) = 10.88}$$

So the closed loop gain of the amplifier is actually 10.88, but a gain of 11 is close enough to this figure for any practical purposes.

How would a change in the **open loop gain** of the amplifier affect the **closed loop gain** with the same negative feedback applied?

To see the effect of large changes in open loop gain, try the same calculation but this time make the open loop gain A_o = 5000

Enter this data into your calculator: **5000 / (1+ 5000*** $\mathbf{11^{-1}}$**) = 10.97**

So for a 400% increase in the open loop gain, the closed loop gain has changed by only 0.8%

This means that the gain no longer relies on the variable, temperature dependent and non-linear gain characteristics of the transistor, but on a minimal two resistor network that has a linear temperature coefficient and an easily predicted β value.

Module 3.2

Negative Feedback & Impedance

What you'll learn in Module 3.2

After studying this section, you should be able to:

Give reasons for using DC and AC negative feedback in amplifiers.

Describe the effects of implementing Negative Feedback (NFB) on the input and output impedance of amplifiers:

- Voltage Derived, Series Fed.
- Current Derived, Series Fed.
- Voltage Derived, Parallel Fed.
- Current Derived, Parallel Fed.

Understand how DC and AC negative feedback may be applied in amplifiers.

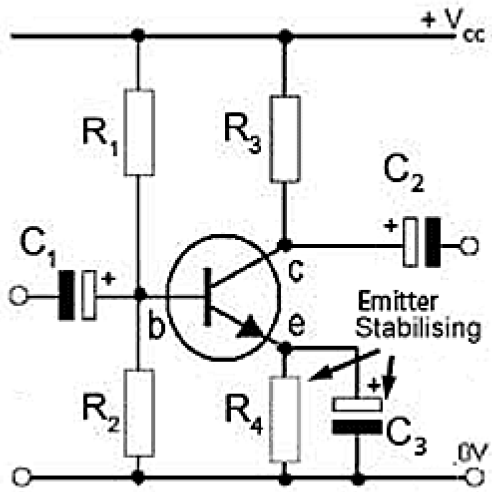


Fig 3.2.1 Emitter Stabilising Components.

DC Negative Feedback

DC negative feedback, is used in stabilising the biasing of amplifiers against drift due to thermal effects etc. Because negative feedback amplifiers often use direct coupling and may have several stages of amplification, stable bias conditions are essential. Very small changes in bias in an early stage can become major problems as the error is amplified in following stages.

AC Negative Feedback

As described in Amplifiers Module 3.1 AC negative feedback (NFB) in amplifiers feeds back a fraction of the output signal to the input in such a way that it subtracts from the input signal, reducing overall gain.

In its simplest form NFB can be applied to a single stage amplifier by changing the arrangement of emitter stabilising components shown in Fig. 3.2.1 as explained in Amplifiers Module 2.4

Using multi stage amplifiers overall gain can be greatly increased, as the overall gain is the product of the individual amplifier stages. Amplifiers Module 3.1 explained how it is possible to design an amplifier with NFB that has an exact amount of gain and can be simply set by the choice of two resistor values.

Controlling Input & Output Impedance with NFB

The way that negative feedback is derived from the output of the amplifier and applied to the input can be used to modify the amplifier's input and output impedances so that impedance matching is maximised. For example an ideal voltage amplifier would have a very high input impedance and a very low output impedance; this would ensure that the maximum voltage waveform is passed from the previous circuit and transferred to the next circuit. By contrast, a current amplifier would need a very low output impedance to ensure the maximum current is passed to the following circuit or output device.

The diagrams below show four basic methods of implementing NFB and how in each case, the feedback is derived from the output and is applied to the input.

Fig. 3.2.2 Voltage Derived, Series Fed NFB

In Fig. 3.2.2 the feedback is derived from the collector voltage, which effectively reduces the output impedance of the amplifier. Applying the feedback to the emitter circuit of the input stage, which is in phase with the base signal, the feedback waveform on the emitter reduces the current into the base, so effectively increasing the input impedance.

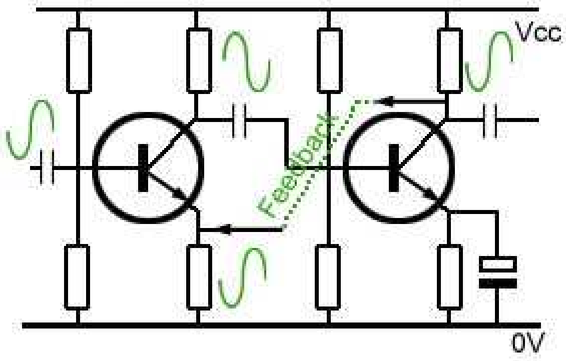


Fig. 3.2.3 Current Derived, Series Fed NFB

Fig. 3.2.3 shows the feedback applied in series again, increasing the input impedance of the amplifier as in Fig.3.2.2. In this circuit the feedback is derived from a resistor (R_f) connected in series with the amplifier load current in order to maintain the correct phase relationship with the emitter signal of the input transistor; the extra resistance here will effectively increase the output impedance.

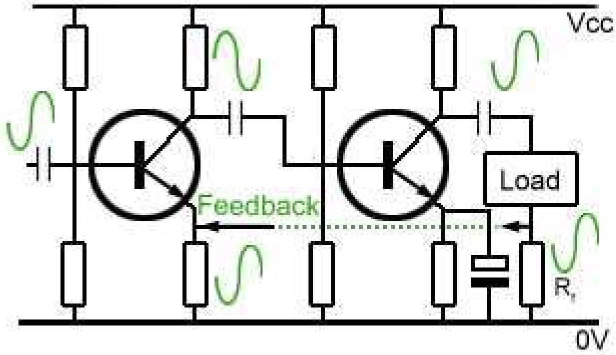


Fig. 3.2.4 Voltage Derived, Parallel Fed NFB

With voltage derived parallel fed NFB both input and output impedances are reduced. In Fig.3.2.4 an intermediate stage has been included maintaining the correct 180° phase relationship between the output collector voltage and the input voltage waveform.

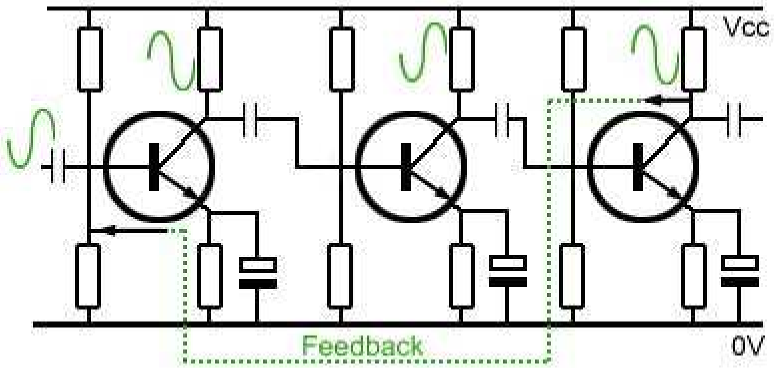
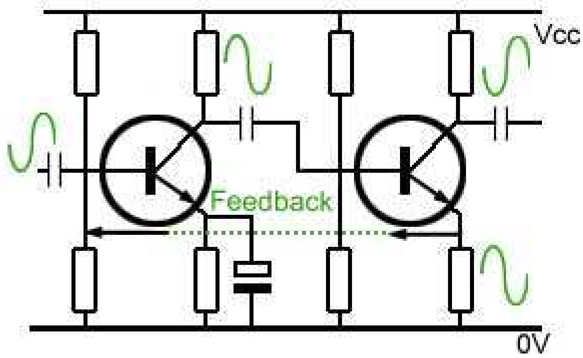


Fig. 3.2.5 Current Derived, Parallel Fed NFB

When this configuration is used, the input impedance is reduced and the output impedance increased.



The choice of which of these four feedback connections is used depends on a number of factors, including the required effect on input and output impedance, and the phase relationship between the feedback source and the point of application.

Problems with negative feedback.

Designing a multi stage amplifier using negative feedback has the advantages of being able to closely control the gain, independent of individual stage gains, and in addition being able to control the input and output impedances of the amplifier. There is however a practical limit to the amount of NFB applied in any particular circuit.

There will inevitably be phase shifts generated within the feedback loop, especially where capacitors are used in conjunction with resistors, as is the case with the coupling capacitors and bias resistors in each of the examples in Figures 3.2.2 to 3.2.5. Such combinations will form filter networks that produce phase shifts at some particular frequency. If these unwanted phase shifts add up to 180° at any frequency where the amplifier has a gain of more then 1, then the circuit becomes unstable and acts as an oscillator.

It is therefore usual for amplifier designs to avoid the use of coupling and decoupling capacitors where possible to avoid the problems of instability at low and medium frequencies. Where such a problem may still exist at high frequencies it may be necessary to include extra reactive components (capacitors and/or inductors) to prevent oscillation.

DC coupled amplifier with NFB.

Negative feedback can create stability problems when the circuit contains capacitors in the signal or feedback paths. The problem can be reduced by using direct, instead of capacitive coupling. however, DC coupling normally requires extra feedback to maintain stable bias conditions.

The circuit in Fig. 3.2.6 shows a two stage directly coupled class A amplifier using voltage derived, series fed negative feedback and is an example of how the above problems may be overcome in a practical amplifier design.

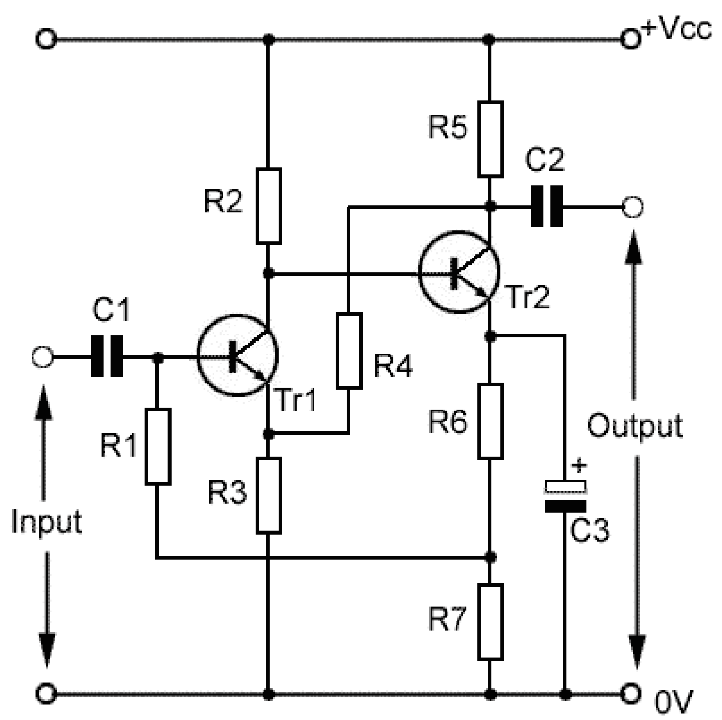


Fig. 3.2.6 DC coupled amplifier with negative feedback.

The output signal at Tr2 collector is fed back to the emitter of Tr1 via the feedback network R4 R3. A portion β of the output signal equal to the ratio R3/(R4+R3) appears across the emitter, and assuming that R4 is 10KΩ and R3 is 1KΩ, β will be 1/11 and the closed loop amplification will be 1/β = 11.

Because the amplifier is DC coupled, the bias system also uses DC negative feedback with Tr1 base bias being derived from the emitter of Tr2. If the base voltage (V_B) on Tr1 starts to increase for any reason, Tr1 collector voltage (V_C) will fall and so will the directly coupled base of Tr2. This in turn will make the collector emitter current of Tr2 fall and so the voltage at the junction of R6 and R7 will also reduce. Since this point in the circuit is the supply point (via R1) for Tr1 base bias, the base voltage on Tr1 will also tend to fall, counteracting the original rise in base voltage and restoring the bias to the correct value. Any fall in Tr1 base voltage causing variations in the opposite sense to those described above will be counteracted in a similar manner.

Module 3.3

Negative Feedback & Noise

What you'll learn in Module 3.3

After studying this section, you should be able to:

Describe common types of noise in electronic circuits.

- From external sources.
- From internal sources.

Describe steps that may be taken to minimise noise in amplifiers.

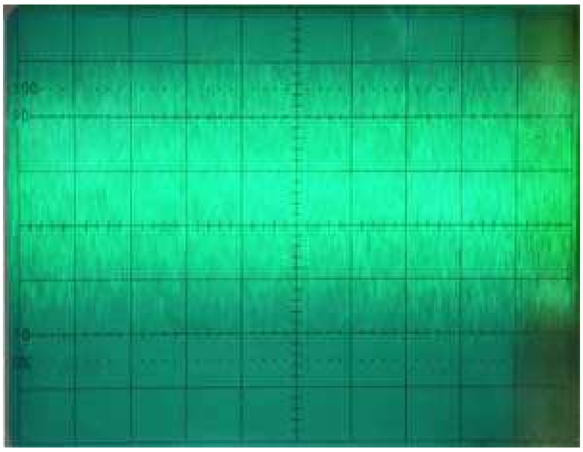


Fig. 3.3.1 CRO Displaying HF Noise

Noise

Noise is any random unwanted signal that is added to the signal being amplified, it is also known as 'White Noise' as it typically occurs across the whole bandwidth or frequency spectrum of an amplifier just as white light contains all of the frequencies across the visible light spectrum. Applying negative feedback has the useful effect of reducing noise in amplifiers. However the important word in that sentence is IN, negative feedback does not greatly affect noise introduced before the amplifier input.

Externally Generated Noise and Interference

Externally generated interference (non random noise) includes mains (line) born sources such as spikes of interference caused by arcing contacts when heavy currents are switched. Thyristor and Triac control of mains power can also generate mains born interference as well as interference transmitted by electromagnetic radiation. While most of this type of interference is low frequency, around 50Hz to 120Hz, the widespread use of switch mode power supplies that switch high voltages on and off at high frequency, adds to the spectrum of frequencies where noise may be generated.

Noise may also come from entirely natural sources such 'static' noise in the form of hissing and crackling that is continually radiated from space, and atmospheric noise generated by lightning discharges in thunderclouds. Radio frequency amplifiers may also be subject to interference from transmissions broadcasting at similar frequencies to the required signal.

Minimising External Noise

All of this noise or interference can be present at the amplifier input and/or the power supply input in mains/line powered equipment. Because noise and interference occurs over a very wide frequency range, any amplifier (audio, RF VHF etc.) may be affected. As Negative feedback will not eliminate noise from external sources, other steps will be taken in well designed systems to minimise external noise, rather than relying solely on NFB. External noise reduction will use methods such as:

- Efficient screening to minimise electromagnetic and electrostatic interference.

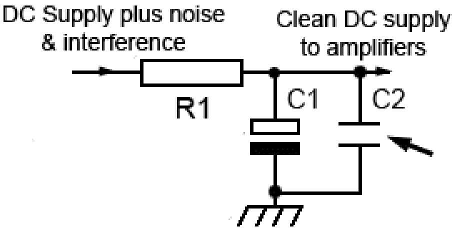
• Good low resistance connections to ground within the amplifier circuit to minimise electromagnetic pickup into circuit wiring.

• Careful placement and electromagnetic shielding of components that may be a cause of noise, such as power transformers and supplies.

• Efficient decoupling and interference suppression of DC power supplies to the circuit to limit mains/line noise and interference.

Extra HF decoupling for amplifier power supplies.

The decoupling circuit in Fig. 3.3.2 is designed to remove any noise present on the power supply lines of a circuit and examples can typically be found wherever supply lines feed circuits that are particularly susceptible to noise, such as amplifiers. Low and medium frequency noise will be removed by the electrolytic capacitor (C1), which has a much lower impedance at these frequencies than the series resistance (R). At higher frequencies, although capacitive reactance (X_C) reduces, in electrolytic capacitors at high frequencies X_C tends to increase once more, so for efficient high frequency decoupling a polyester capacitor, with typically a medium to high value, is added.



Electrolytic capacitor C1 decouples low frequencies & polyester capacitor C2 gives extra decoupling at HF

Fig. 3.3.2 Extra HF decoupling

Internally Generated Noise

When all steps have been taken to minimise externally generated noise, there is still the problem of noise generated within the components that make up the amplifier. Transistors, especially bipolar types, will generate noise from a variety of causes including Thermal noise due to molecular agitation of the semiconductor material caused by heat, and ‘Shot noise’, which is caused by charge carriers (electrons and holes) randomly diffusing across the semiconductor junctions. All these types of noise combine to produce a typical background hiss that can be heard from an audio amplifier in the absence of much louder signals.

The presence of internally generated noise is most noticeable when it is generated in the earliest stages of the amplifier, noise produced in the first stage of a series of amplifiers will receive the greatest amplification as it passes through the most stages. For this reason, in many amplifiers, the input stage will use a FET, which produces less junction noise because the current path through the transistor does not cross any PN junctions.

The Role of Negative Feedback

Noise at frequencies above and below the required bandwidth of the amplifier can be reduced by the use of high and low pass filters, but negative feedback can play a part in improving the signal to noise ratio within the bandwidth of an amplifier. The feedback signal from the amplifier output contains both an anti phase portion of output signal and an anti phase sample of any noise generated in the amplifier. When this anti-phase noise is added to the input signal, it subtracts from the noise generated within the closed loop, reducing it by a factor of $1+A\beta$ compared to what it would be without NFB.

Using NFB to reduce noise will not, entirely eliminate, but will reduce noise generated within the amplifier; it will improve a well-designed amplifier but will not eliminate problems on one that is poorly designed.

Module 3.4

Negative Feedback & Distortion

What you'll learn in Module 3.4

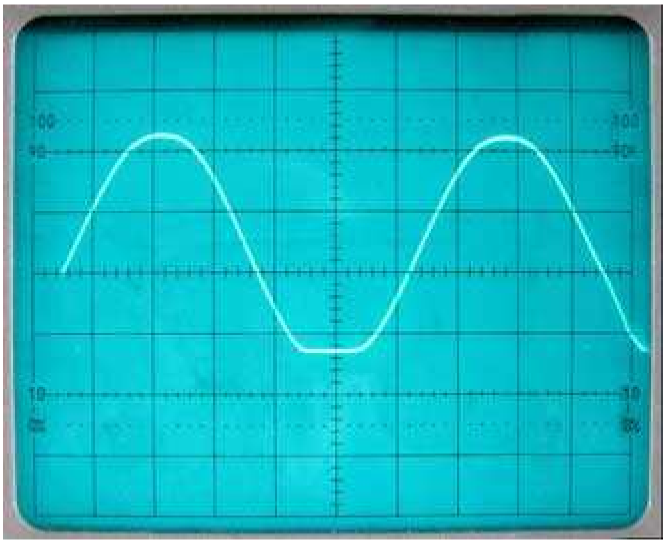
After studying this section, you should be able to:

Understand the causes of distortion in common emitter amplifiers.

- Amplitude distortion.
- Frequency distortion.
- Phase distortion.

Understand methods of reducing distortion.

- Biasing.
- Negative feedback.



Distorted Sine Wave

Causes of Distortion

In any amplifier the output waveform is a less than perfect reproduction of the input waveform, because the process of amplification introduces some distortion. The changes introduced can be due to one or more of the following effects.

a.) Amplitude Distortion.

b.) Frequency Distortion.

c.) Phase Distortion.

Amplitude Distortion

Amplitude distortion, also called Non-Linear distortion, is caused by the effect of the non-linear characteristics of transistors reducing the amplification applied to the positive and negative tips of the waveform as shown in Fig. 3.4.1. Although the sections of the wave either side of the waveform's centre are unaffected, the overall amplitude of the waveform is reduced. The reduction in amplitude in audio signals is however, much less noticeable to the ear than the associated change in shape of the waveform tips.

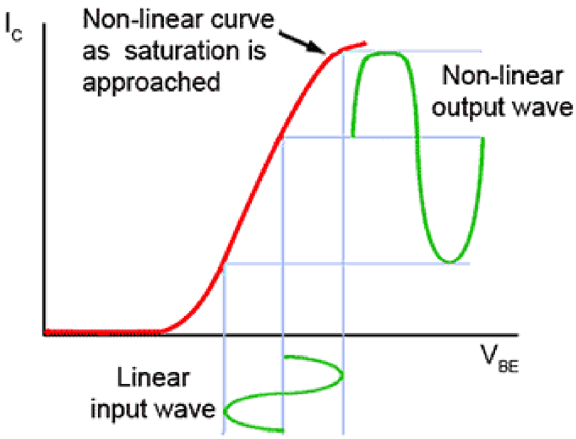


Fig. 3.4.1 Amplitude Distortion caused by poor DC biasing.

When the peaks of a sine wave become flattened, due to the non linearity of the amplifier's characteristics, as shown in Fig. 3.4.1, odd harmonics of the original (fundamental) wave are created. Fig. 3.4.2 shows what happens when odd harmonics (the 3rd to 15th) are added to the fundamental; the result is a squaring effect of the wave.

In a practical situation, when the tips of a sine wave become flattened, and the wave consequently becomes more square, many more odd number harmonics will be added, as shown in Fig.3.4.2. Each of these extra sine waves, caused by the flattening of the waveform peaks, will have a frequency that is an odd multiple of the fundamental, and these frequencies will in turn, add and subtract from other frequencies present in the wave shape to produce many more waves at yet more frequencies. Some of these new frequencies will be outside the bandwidth of the amplifier, but some will be within the bandwidth and be audible. The result of this 'odd harmonic distortion' on the ear will be a note having a harsher sound than the original.

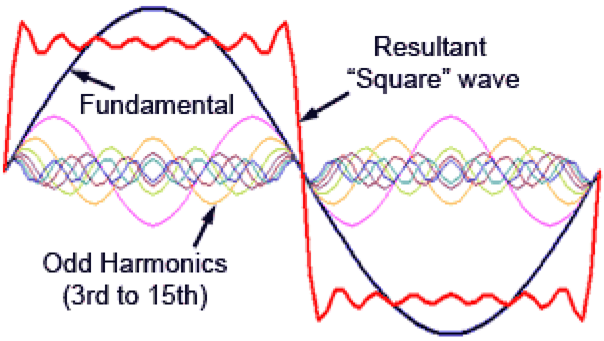


Fig. 3.4.2 Adding odd harmonics to a sine wave.

Correct biasing prevents one peak of the waveform distorting before the other, as shown in Fig. 3.4.1 where the positive going peak of the input wave is driving the transistor into saturation and causing the collector current waveform to be 'clipped'.

Using negative feedback to control the gain of the amplifier stages can also reduce amplitude distortion by ensuring that a signal level is not reached where the output waveform of one stage may drive a following stage into its saturation and/or cut off regions.

Frequency Distortion

Frequency distortion describes the condition where different frequencies within the amplifier's bandwidth are amplified by different amounts. The gain over the bandwidth is no longer flat. Under these conditions the various frequency components of complex waves are amplified by different amounts and the wave becomes distorted.

Frequency distortion can be caused by the frequency dependent effects of reactive components (capacitances and inductances) in the circuit. Figs. 3.4.3 and 3.4.4 illustrate the effects of frequency distortion on the response curve of an amplifier.

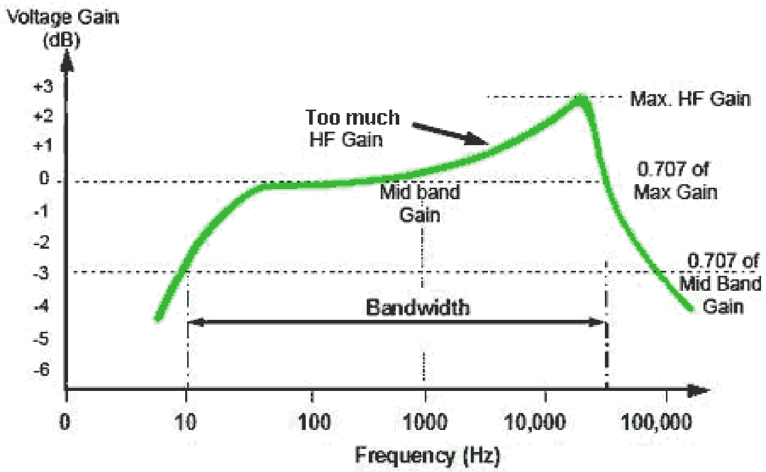


Fig. 3.4.3 Too much HF gain.

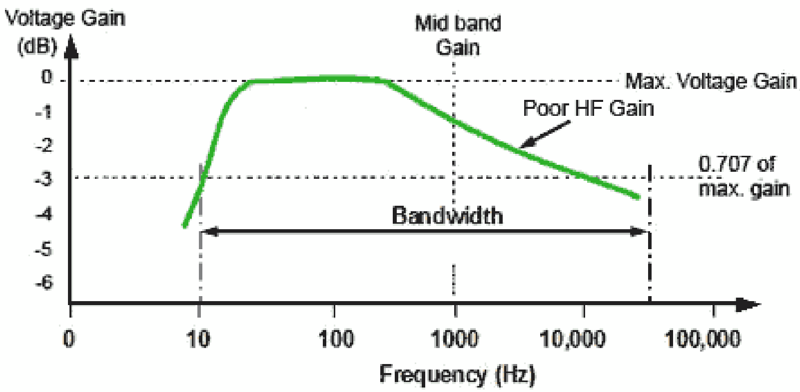


Fig. 3.4.4 Insufficient HF gain.

Testing for Frequency Distortion

Frequency distortion can be detected when present, by using a square wave as the amplifier input signal and monitoring the output waveforms. Fig. 3.4.5 shows how frequency distortion can affect the transient response of a square wave (waveform a.).

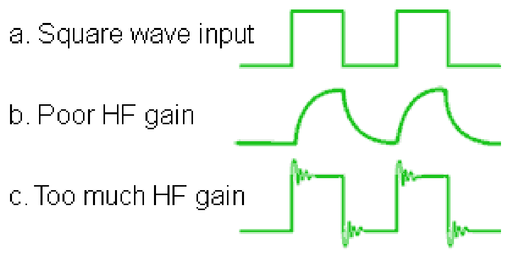


Fig. 3.4.5 Frequency distortion

Waveform b.) shows the effect poor (insufficient) LF gain on the reproduction of a square wave. The amplifier is unable to respond to the fast rising and falling edges of the input wave, the delaying effect this causes is also likely to produce unwanted phase changes.

Waveform c.) shows the effect of excessive HF response amplifying the higher harmonics preset in a square wave to such a degree that the fast transients (the rising and falling edges of the wave) are overshooting and even beginning to oscillate, causing a 'ringing' effect on the waveform.

Negative feedback has an important role in helping prevent frequency distortion. As the worked example in Module 3.1 illustrates, applying NFB keeps the closed loop gain at a constant level for even large changes in open loop gain. This effect of NFB helps produce a flat response curve.

Phase Distortion

A signal passing through the various stages of an amplifier usually comprises of a complex wave made up of many different frequencies and amplitudes. The electrical components of the amplifier circuit may well contain some reactive components such as capacitors and/or inductors as well as resistors; where these combinations of components exist they may form LC, LR, CR and/or LCR filter networks and change the amplitudes of individual waves at different frequencies.

A further property of filters is that they also change the phase of waves at different frequencies. An individual frequency component of the complex wave having it's phase is shifted by 180° would convert a negative feedback amplifier into a positive feedback amplifier at particular frequencies and cause severe instability. Even if the phase change effect is less than this, shifting the phase of some of the component waves or harmonics of the complex signal can have the effect of changing the shape of the signal wave and so cause distortion.

Figs. 3.4.6 and 3.4.7 show what can happen when the phase relationship between the fundamental sine wave component of a complex wave (shown in black) and its harmonics is changed. Fig. 3.4.6 shows a sine wave (the fundamental) together with its 3rd and 5th harmonics. Adding these harmonics to the fundamental produces a resultant wave (shown in red) that is beginning to look like a square wave, in fact adding an infinite number of odd harmonics in this way would produce a perfect square wave. Notice also that in this case the harmonics all have the same phase, i.e. they all start by going positive at the same time as the fundamental, and end the cycle by returning to zero at the same time as the fundamental.

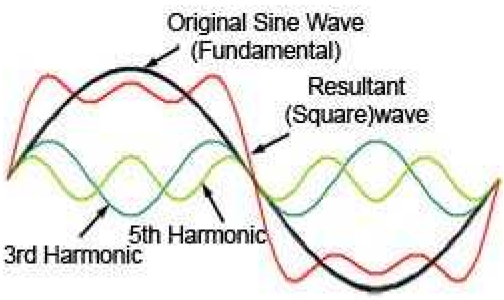


Fig. 3.4.6 The Effect of Adding In-phase Odd Harmonics

Fig. 3.4.7 shows the same fundamental wave, again with the same two odd harmonics, but this time the third harmonic has its phase shifted by 180 degrees; now the resultant complex wave looks more like a triangular wave.

Although this is an extreme case of phase distortion, it demonstrates that phase shifts in only a few harmonics (i.e. phase changes taking place at just a few critical frequencies) can significantly change the shape of signal waves.

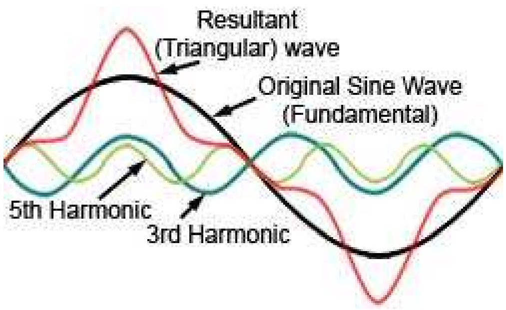


Fig. 3.4.7 The Effect on Fig.3.4.6 of inverting the 3rd Harmonic

Phase distortion in audio signals is less noticeable to the human ear than amplitude or frequency distortion, but it is critical to avoid phase distortion in video signals, where the distortion becomes visible. Phase distortion can be limited by avoiding the use of reactive components such as capacitors and inductors in both the amplifier and any feedback loops where possible. For this reason direct (DC) inter-stage coupling is the preferred method in many amplifiers.

Negative Feedback Module 3.5

Negative Feedback Quiz 3

Try our quiz, based on the information you can find in Negative Feedback Module 3. You can check your answers by going to:

http://www.learnabout-electronics.org/Amplifiers/amplifiers35.php

1.

Which of the following correctly lists the benefits of using NFB in an amplifier system?

a) More gain, wider bandwidth and reduced noise.

b) Wider bandwidth, better stability and less distortion.

c) Less noise, less distortion and predictable gain.

d) Predictable gain, better reliability and wider bandwidth.

2.

If a voltage amplifier has an open loop gain (A_O) of 150 and a feedback factor (β) of 1/20, what will be the approximate gain with negative feedback applied?

a) 18 b) 55 c) 36 d) 70

3.

What is the NFB method being used in Fig. 3.5.1?

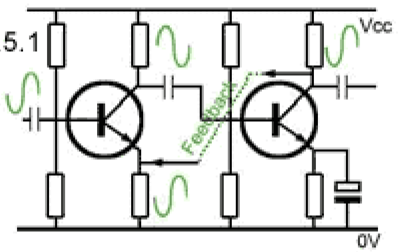
a) Voltage derived, parallel fed.

b) Voltage derived, series fed.

c) Current derived, parallel fed.

d) Current derived, series fed.

Fig. 3.5.1



4.

What is the main advantage of using direct coupling in multi stage NFB amplifiers?

a) It is more efficient than indirect coupling.

b) It increases the input impedance of the amplifier.

c) It reduces phase shifts.

d) It allows more stages to be used.

5.

Refer to Fig. 3.5.2: Which of the following statements most accurately describes the type of inter stage coupling and method of feedback used?

a) Direct coupling with DC negative feedback.

b) Resistive coupling with AC negative feedback.

c) Capacitive coupling with AC and DC negative feedback.

d) DC coupling with AC and DC negative feedback.

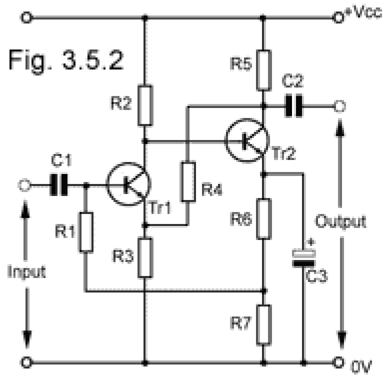


Fig. 3.5.2

6.

Refer to Fig. 3.5.2: Assuming that the input signal is normal, what would be the probable effect on the circuit if R4 became open circuit?

a) No output signal.

b) Normal output signal.

c) Large and distorted output signal.

d) Small and distorted output signal.

7.

To increase the input impedance, and reduce the output impedance of a multi stage amplifier, which of the following NFB methods should be used?

a) Voltage derived, parallel fed.

b) Current derived, parallel fed.

c) Voltage derived, series fed.

d) Current derived, series fed.

8.

In an audio amplifier using NFB which of the following methods would be most effective in reducing electro-magnetically induced noise from the power supply?

a) Using a low pass filter in the negative feedback system.

b) Decoupling the DC power lines using both electrolytic and polyester capacitors.

c) Using a high pass filter in the negative feedback system.

d) Using electromagnetic screening on the power supply components.

9.

Negative feedback loops avoid the use of reactive components where possible to minimise which of the following effects?

a) Amplitude distortion.

b) Phase distortion.

c) Frequency distortion.

d) External noise.

10.

The audio amplifier response curve illustrated in Fig. 3.5.3 shows which of the following problems?

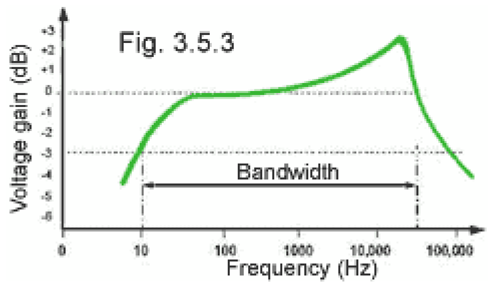


Fig. 3.5.3

a) Frequency distortion.

b) Phase distortion.

c) Bandwidth distortion.

d) Amplitude Distortion.