Module

2

Amplifiers

Class A Amplifier Design

Introduction to Amplifier Design

What you'll learn in Module 2.

Section 2.0 Introduction to Amplifier Design.

Section 2.1 DC Conditions.

- Design a BJT class A common emitter audio amplifier.

Section 2.2 AC Conditions.

- Calculate suitable values for AC components.
- Build a prototype amplifier on Breadboard.

Section 2.3 Testing the Amplifier.

- Test the amplifier for Gain, Bandwidth, Input and Output Impedance.

Section 2.4 Improving the Amplifier.

- Carry out tests and modifications, and apply Negative Feedback to achieve specified performance criteria.

Section 2.5 Multi-stage Amplifiers.

- Describe methods for inter-stage coupling in multi-stage amplifiers:

Section 2.6 Amplifier Design Quiz.

- Test your knowledge & understanding of basic amplifier design.

Basic design process.

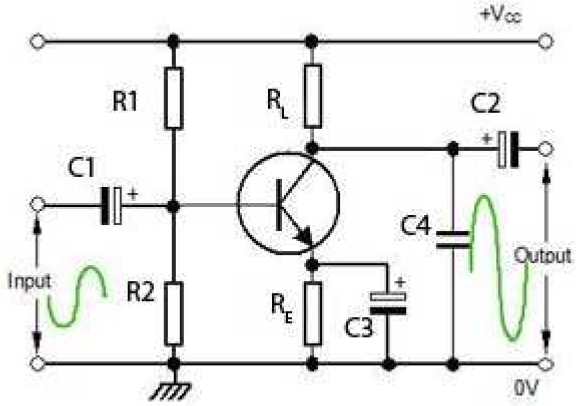


Fig. 2.0.1. Common Emitter Amplifier

Fig. 2.0.1 shows a class A common emitter amplifier, but without its component values. This module shows how to simply calculate the values needed to make a working amplifier that has correct class A bias as described in Amplifier Module 1.2 and so produce an undistorted and amplified output. Building and testing an amplifier is a good way learn how and why an amplifier works.

How will you know that your calculations are correct? The best way is to build your design and test it. Follow the guidelines in this section and download the accompanying pdf documents, so you can design, build and test a working amplifier.

Although amplifier design can be a complex process, this simple exercise takes some short cuts, because it is more concerned with learning about how an amplifier works, rather than designing a complete new hi-fi system.

Amplifier Design Project

Sections 2.1 to 2.4 of this module are a practical project to design a single stage class A common emitter amplifier. Use information from other sections modules in learnabout-electronics (just click the links where needed) to help you calculate the component values needed for a working amplifier. The only maths involved will be some Ohms law and some capacitive reactance calculations.

The Amplifier Design Record

Download and print out the Amplifier Design Record, which can be used in conjunction with sections 2.1 to 2.4 of this module so you will have a complete record of how to design, build and test an amplifier. It contains all the formulae needed to calculate the correct DC and AC conditions for the amplifier, and once the Amplifier Design is complete, the prototype circuit can be easily built on breadboard (Proto board). The project also shows you how to test an amplifier for performance using a multi meter and oscilloscope.

The project is split into four sections so that it can be checked for errors as the design progresses. By splitting the design task in this way, there is far less chance of going wrong.

Carefully follow the design sequence instructions on line in sections 2.1 to 2.4 of this module, and record the results of your calculations and tests on the Amplifier Design Record sheets to design and build a working class A common emitter amplifier. This is a great way to understanding how an amplifier works.

Module 2.1

Class A Amplifier Design

What you'll learn in Module 2.1.

After studying this section, you should be able to:

Design a basic class a Common emitter audio amplifier.

- Understand appropriate design and component requirements for a class A amplifier.
- Calculate resistance values for DC bias conditions.
- Assemble a prototype amplifier on Breadboard.
- Use a multimeter to carry out appropriate tests to confirm operation.

Part 1. Designing the DC Conditions.

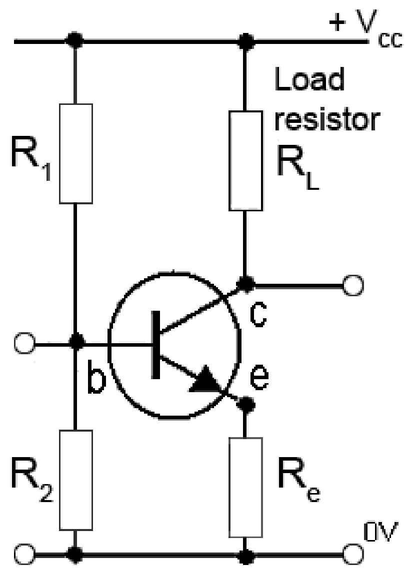


Fig. 2.1.1 Amplifier DC components

As you work through the design process, record your results of your calculations and design decisions on the Amplifier Design Record sheets that you can also download from www.learnabout-electronics.org by clicking any of the links to **Amplifier Design Record sheets**. You will need these results when building the amplifier.

Calculate the component values and record your results in Part 1 of the Amplifier Design Record sheets.

1. Decide on the DC supply voltage V_{CC}

This should be less than the maximum V_{CEO} voltage for the transistor you intend to use and will also depend on the available supply; this may be a bench power supply or a battery. Values of 6 to 12 volts are common for a common emitter voltage amplifier.

2. Choose a transistor

The prototype amplifier for this exercise used a NPN small signal transistor such as the 2N3904, but other similar transistors should work equally well. A datasheet for the 2N3904 can be downloaded from www.datasheetcatalog.com or you could choose a different general purpose NPN small signal transistor and download its datasheet.

3. Decide on a suitable quiescent collector current Iq

I_q is the Collector current when no signal is applied. The maximum value must be less than the maximum V_{CEO} figure for the transistor. However using a high value of current will waste power as the circuit is supposed to be a VOLTAGE amplifier so current should be kept quite low, but the lower the current you choose, the higher the value of R_L will be. This increases the output impedance of the amplifier (which will be approximately the value of the load resistor) and ideally this should be low. A compromise figure of around 10 to 20% of the transistor's Ic_{MAX} figure shown on the data sheet should be adequate for I_q and a commonly selected current of around 1mA would be typical.

4. Calculating a value for the load resistor RL

Once the supply voltage and collector current are decided, the value of the collector resistor can be calculated. The transistor quiescent collector voltage needs to be about half of V_{CC} so that the output signal can swing by equal amounts above and below this value without driving the transistor into saturation (0V and maximum collector current) or cut off (zero current and V_C equal to the supply voltage). R_L will therefore be half of V_{CC} divided by I_q.

Note that whenever a component value has been calculated, it is unlikely that the result of the calculation will match any of the available preferred values of real resistors. Therefore you will need to choose the nearest preferred value.

5. Calculating the value of RE

To provide efficient bias stabilisation, the emitter voltage V_E should be about 10% to 15% of V_{CC}. So choosing a value of 12% of V_{CC} for V_E and assuming that I_E is the same as I_C (It is only different by the small amount of the base current), a value for the resistor R_E can be calculated by dividing the emitter voltage V_E by the emitter current I_E then choosing the nearest preferred value.

6. Estimate a value for base current IB

This can be found by dividing the collector current I_C by the transistor's current gain h_{fe} obtained from the data sheet. Because the h_{fe} varies from one transistor to another, even of the same type, it may be quoted as a typical value or as a range between minimum and maximum values, h_{fe} also varies with collector current so whatever figure you choose for h_{fe}, the result of calculating I_B will be an approximation so the base voltage will probably not be accurate. However this can be 'fine tuned' when the amplifier is being constructed.

7. Calculating VB

The base voltage should be about 0.7V (700mV) higher than V_E to ensure that the input signal is biased on the linear part of the transistor input characteristic.

8. Calculating the DC bias network current.

To ensure adequate bias stability, the current flowing through R1 and R2 should be about 10 times greater than the base current I_B so the current flowing through R1 and R2 will be simply I_B x 10.

9. Calculating the resistance for R1

The value of this resistor will be the difference between V_{CC} and V_B divided by the bias network current through R1 and R2.

10. Calculating the resistance for R2

The value of R2 will be the base voltage V_B divided by the bias network current through R1 and R2.

11. Start constructing the amplifier

Fit the transistor and the four resistors in place on the breadboard together with any necessary wire links (Do NOT fit any capacitors yet). Then after a thorough visual check that everything is correctly connected, connect the power supply, switch on and use a multimeter to check the voltages on collector, base and emitter of the transistor.

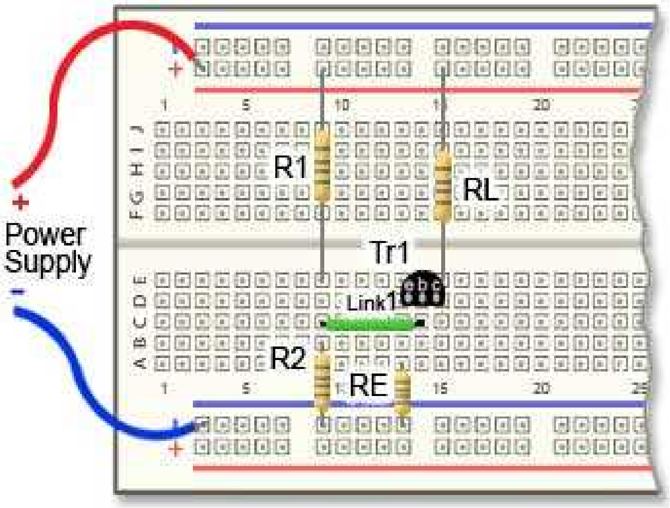


Fig. 2.1.2 Fitting the DC components.

If the voltages are correct you have successfully designed the DC conditions. If there are any drastically wrong voltages, (e.g. more than 30% high or low) check that all the connections on the amplifier are correct, and that you have read the resistor colour codes correctly. Any smaller differences may need the value of one or more of the resistors changing.

Try to make collector voltage V_C exactly half of the supply voltage V_{CC}. If it already is, well done! If not (which is most likely) the first thing to check is that you have correctly calculated the values of R_L and R_E and fitted the nearest preferred value of resistor in both positions. If these resistors are OK, the base voltage probably needs correcting, as mentioned in "Estimate a value for base current" above. If the collector voltage is high, the base voltage will need increasing slightly (try changing R2 to the next higher preferred value). If the collector voltage is low, decrease the value of R2.

It is not unusual to have to ´tweak´ the values slightly in this way, as it is only possible to use preferred values of resistor rather than the exact calculated values. Make sure to note the effect of any changes you make, if you change a resistor value to increase a voltage, did it increase as expected? If not try to work out why. Remember the purpose of this exercise is to help you understand the effects of each of the components in the amplifier circuit − experiment and learn!

Module 2.2

Class A Amplifier Design

What you'll learn in Module 2.2.

After studying this section, you should be able to:

Design a basic class A common emitter audio amplifier.

• Calculate capacitor values for coupling and decoupling components.

• Assemble a prototype amplifier on Breadboard

Part 2. Adding the AC Components.

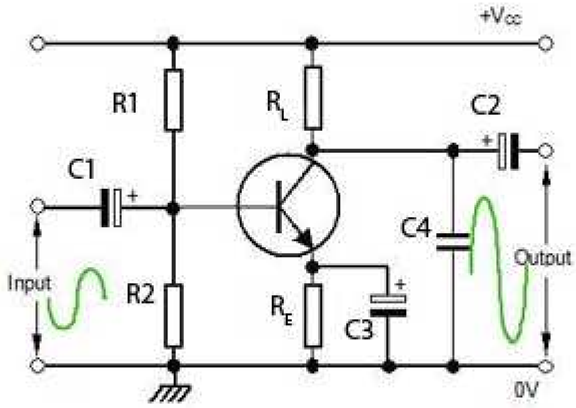


Fig. 2.2.1. Common Emitter Amplifier

Calculate the component values and record your results in Part 2 of the Amplifier Design Record sheets.

Choosing a value for C1 and C2

The primary function of C1 and C2 is to act as coupling capacitors, allowing AC signals to pass whilst blocking DC at the input and output so that voltages present on preceding or later circuits will not upset the bias condition for this amplifier.

The main consideration in choosing these capacitor values is to ensure that their capacitive reactance is low enough, compared with the input impedance of the amplifier, or any load connected to the output, to allow signals at all the required frequencies to pass.

The reactance of a capacitor is greatest at low frequencies, therefore the choice of coupling capacitor values must allow for a low reactance at the lowest frequencies the amplifier is designed to amplify. A generally accepted value for coupling capacitors in an audio amplifier would be between 1µF and 10µF, (this can be changed later when the design is finalised).

Choosing a value for C3

The purpose of C3 is to prevent any AC signal voltage appearing across the emitter resistor R_E. Any AC appearing on the emitter of the transistor would be in phase with the signal at the base, therefore the base and emitter voltages would rise and fall together, and the difference between base and emitter voltages would be reduced. This would effectively reduce the input signal and so reduce the amplifier's gain.

C3 must therefore remove as much of the AC from across R_E as possible, and so must have a low reactance at all audio frequencies. As the lowest frequency is going to be around 20Hz, C3 must have a reactance (X_C) that is small compared to the value of R_E at all frequencies above 20Hz.

The value of C4

The purpose of C4 is to give an appropriate reduction in amplification at the high frequency end of the amplifier's bandwidth. The choice of its value will be covered after initial testing of the amplifier. At this stage it is not necessary to fit C4.

After switching off the power to the circuit, capacitors C1, C2 and C3 can now be added to the circuit on the ´Bread board´ for testing.

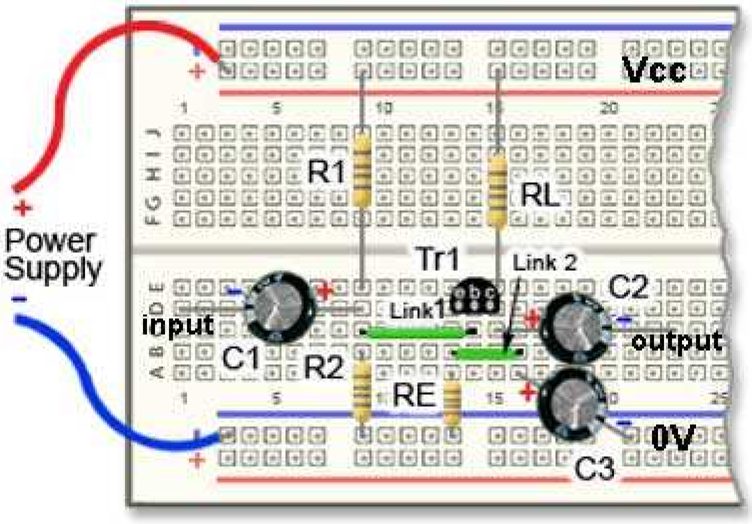


Fig. 2.2.2 Fitting the AC components.

WARNING: Be extra careful when connecting electrolytic capacitors to ensure they are connected with the correct polarity, see Fig. 2.2.3 showing negative lead marking on a capacitor, but note that the convention in circuit schematic diagrams (Fig. 2.2.1) is to mark the **positive** plate of an electrolytic capacitor with a + symbol. Fig. 2.2.3 also shows the safe working voltage of the capacitor, which must be high enough to withstand any likely voltage the capacitor will be subject to in the circuit.

Connecting electrolytic capacitors the wrong way round, or exceeding their working voltage can cause them to EXPLODE!

Fig. 2.2.3

Carry out the initial checks in Part 3 before re-connecting the power.

Module 2.3

Testing the Amplifier

> **What you'll learn in Module 2.3**
>
> **After studying this section, you should be able to:**
>
> Test the amplifier operation using a multimeter, signal generator and oscilloscope for:
>
> • Gain, Bandwidth, Input and Output Impedance.
>
> Understand the importance of individual component values relating to:
>
> • Gain, Bandwidth, and Distortion.

Part 3. Testing the amplifier under signal conditions.

Record your results in Part 3 of the Amplifier Design Record sheets.

1. Initial check.

Visually double check the circuit, especially the capacitor connections (see warning in Part 2). Switch on and re-check the transistor voltages to make sure the circuit is operating as predicted.

2. Gain (Voltage Amplification Av).

Gain can be measured using the set up shown in Fig 2.3.1. The generator is set to a mid-band frequency of 1kHz and a small amplitude sine wave signal applied to the amplifier input. With the oscilloscope attached to the output terminals, the input signal is adjusted to give a large amplitude output signal that still has an undistorted waveform. The peak-to-peak amplitude of the output signal is measured and then the oscilloscope probes are transferred to measure the input. The two values are compared, and the Small Signal Voltage Amplification (Av) is calculated using the formula on the Amplifier Design Record sheets.

A_v is simply the ratio of output to input, so does not have any units.

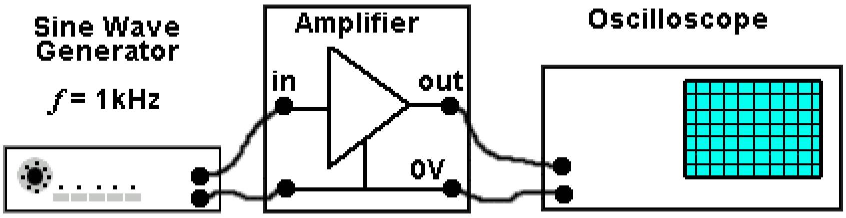


Fig. 2.3.1 Measuring the Amplifier Gain

Input Impedance.

Since the input of the amplifier will be mainly resistive at frequencies around or below 1kHz the input impedance Zin can be represented in the diagram of the amplifier (Fig. 2.3.2) as a resistor across the input terminals. To find the value of Z_{in} (at 1kHz) a variable resistor of about 10K ohms (a larger value than the amplifier input impedance is expected to be), or a decade resistance box can be connected between the generator and the amplifier input as shown in Fig. 2.3.2.

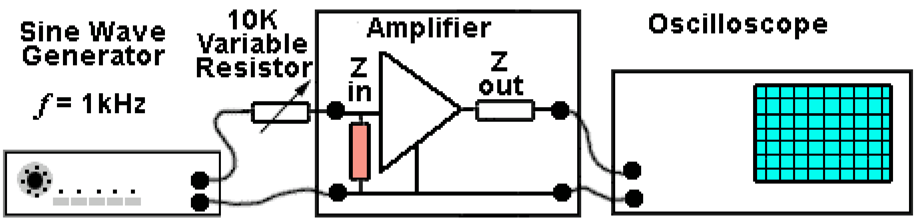


Fig. 2.3.2 Measuring the Input Impedance Z_{in}

Initially the variable resistor is set to zero ohms and the generator is adjusted to give a large undistorted display on the oscilloscope. The amplitude of the display on the oscilloscope should be adjusted to fit exactly between an even number of the horizontal graticule markings.

The variable resistor is now adjusted until the peak-to-peak of the output wave is exactly half its original value. Disconnect the variable resistor taking care not to disturb the slider position, and measure its resistance value with the multi-meter. As the variable resistor and the input impedance must both be the same value to give 50% of the amplitude across each, the resistance value of the variable resistor is therefore the same value as Z_{in}.

Output Impedance Z_{out}

The output of the amplifier is developed across the load resistor R_L so this resistor is effectively the output resistance (and approximately the output impedance Z_{out} at 1kHz) of the amplifier. The output coupling capacitor C2 (see Fig. 2.2.1 in section 2.2) will not have a significant effect on Z_{out} as it will have a very low reactance at 1kHz.

C4 (when fitted later), will effectively be in parallel with R_L but as it will have a very high reactance over most of the amplifier's bandwidth, it will not greatly affect the output impedance Z_{out} at 1kHz.

Bandwidth.

Checking the bandwidth of the amplifier requires the same equipment set up as in Fig. 2.3.1 but this time the frequency of the input will be varied.

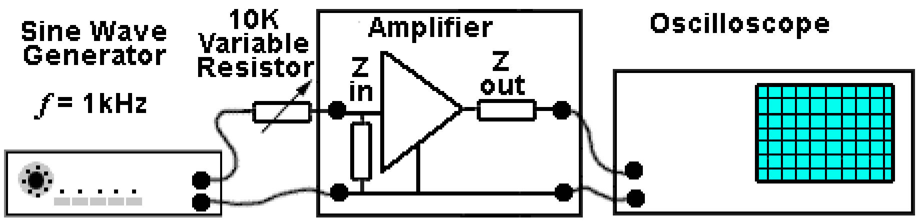


Fig. 2.3.3 Measuring the Amplifier Bandwidth

a.) Initially set the generator frequency to 1kHz and adjust the generator amplitude and the oscilloscope controls to view a large, undistorted waveform, adjust the amplitude of the waveform to fit exactly between an even number of horizontal graticule lines on the oscilloscope display.

b.) Calculate the −3dB level by multiplying the V_{pp} value observed in a.) by 0.707.

c.) Without altering the generator amplitude, reduce the frequency of the input wave and observe its V_{PP} amplitude on the oscilloscope. Keep reducing the frequency until the amplitude of the output wave falls to 0.707 of that observed at 1kHz. This is the low frequency −3dB limit of the bandwidth.

d.) Increase the frequency past 1kHz until the output V_{PP} again falls to 0.707 of the 1kHz value (this may be up to 100kHz or even be higher). This frequency is the high frequency −3dB limit of the bandwidth.

It is quite probable that the tests will show that the amplifier bandwidth will not conform to a nice 20Hz to 20kHz specification, or that there may be variations in maximum gain over the frequency range. This is not the ideal situation for a good audio amplifier, so the design may need improving as described in Amplifiers module 2.4.

Module 2.4

Class A Amplifier Design

What you'll learn in Module 2.4.

After studying this section, you should be able to:

- Carry out tests and modifications, and apply Negative Feedback to achieve specified performance criteria.

Part 4. Improving The Design.

Once the circuit has been through the initial stages of design, improvements can be made to get the design to match specific criteria. This design represents a basic audio amplifier, and therefore it should at least conform to the following very basic requirements. The gain (at the mid band frequency of 1kHz) should be of a specific value, this requirement would depend on the overall system design, of which this is only a single stage, but for this exercise:

Required Gain = 50

Bandwidth = 20Hz to 20kHz

Max. Undistorted Output Vpp > 70% of V_{CC}

Achieving these criteria will require repeating the above design calculations and tests several times, because as you change one component in the design, some if not all of the test results previously obtained will change! Refining the design in this way is a normal part of any design process and learning how the different components change the operation of the whole circuit is a great learning exercise - enjoy!

Introducing some negative feedback.

In the DC only conditions introduced in Amplifiers Module 2.1, the gain of the amplifier was dependent on the ratio of R_L to R_E but when the emitter is decoupled by C3 in part 2, the AC voltage across R_E is reduced to virtually zero by the low reactance of C3. This makes the ratio R_L to R_E just about infinite and the gain then becomes dependent on the h_{fe} of the transistor. The h_{fe} of small signal transistor is quite high, but also it can be seen from transistor data sheets to have a wide variation, 100 to 300 in the case of the 2N3904.

Changing the transistor would therefore, very probably change the gain, also it would not be possible to make multiple versions of this design and expect the gain to be identical on each example. One way around these problems would be to use negative feedback. This will reduce the gain but make it much more dependent on fixed component values rather than the variable value of h_{fe}.

Negative feedback also helps reduce distortion, and any background noise (hiss) generated within the circuit. It also helps to even out the gain over the amplifier's bandwidth. If the gain is not constant, some frequencies will receive more or less amplification than others and 'frequency distortion' will occur. Slight differences in gain, of 1dB or less would not generally be noticeable, but using negative feedback can reduce larger differences.

Amplifiers Module 2.2 described how C3 is used to prevent negative feedback, but if some gain is sacrificed by allowing a controlled amount of negative feedback, this will flatten the response of the amplifier and increase the bandwidth, and although an increase in bandwidth may not be needed at this point, having achieved the advantages above, the bandwidth can be adjusted later.

There are two ways to reduce the decoupling effect of C3 as shown in Fig. 2.4.1 Both involve introducing an additional resistor R_{NFB} into the emitter circuit.

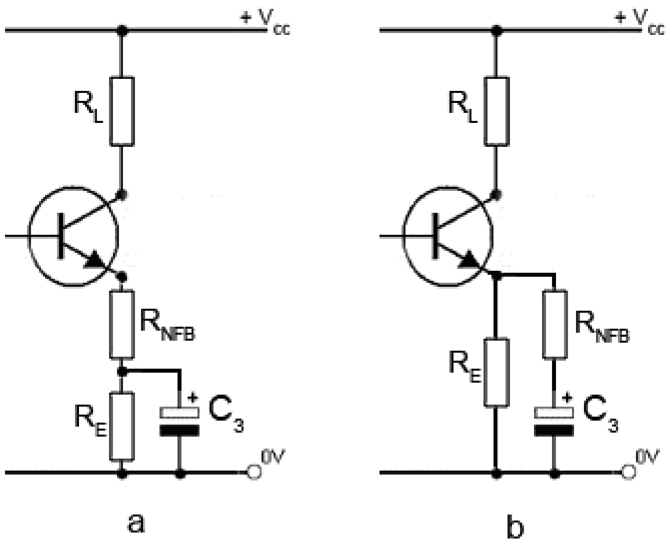


Fig. 2.4.1 Two methods of applying NFB

In Fig. 2.4.1a R_{NFB} is not decoupled.

In Fig. 2.4.1b R_{NFB} reduces the decoupling effect of C3.

Adding R_{NFB} reduces the decoupling effect of C3, making the (reduced) gain independent of h_{fe} and sets it to the ratio of R_L / R_{NFB}. Once the value of R_{NFB} has been calculated to give a gain A_V of 50, the value of R_E should also be re calculated and changed so that the original value of R_E is shared between R_E and R_{NFB}. This will keep the DC conditions of the amplifier at about the same values as you set earlier.

Once these values have been calculated record the results in the Amplifier Design Record sheet, Part 4.1.

Because of the negative feedback, the effective input signal to the amplifier is reduced. This reduces I_{in} and because input current has input reduced, input impedance Z_{in} (measured in Amplifiers Module 2.3) increase. The change in Z_{in} will also affect calculations for the value of C1, so it would be good to re- check both the gain at 1kHz and the input impedance before carrying out the next operations. Record the new figure for Z_{in} in the Amplifier Design Record sheet Part 4.1.

Refining the Bandwidth

The specification for this exercise asks for the bandwidth of the amplifier to be as close to the range 20Hz to 20kHz as possible, this part of the design exercise will adjust the high and low frequency limits of the bandwidth.

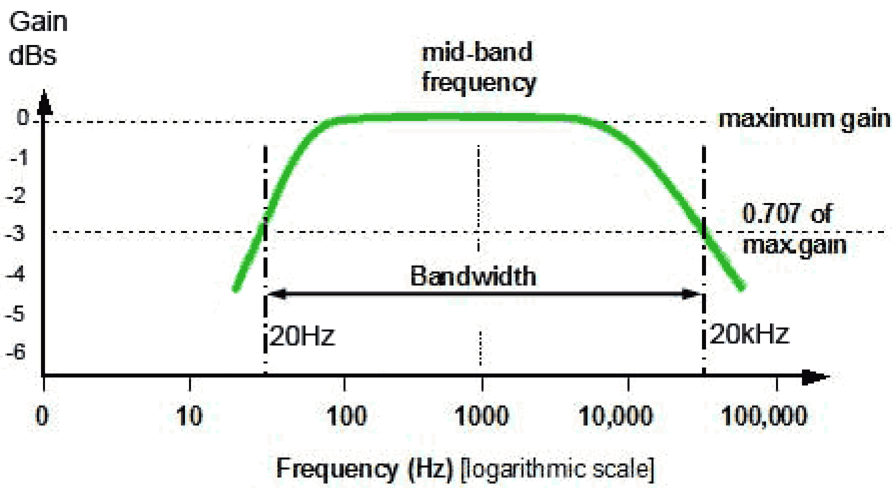


Fig. 2.4.2 Ideal Audio Response

Setting the low frequency limit of the bandwidth.

The low end of the bandwidth can be controlled by C1 and choosing an appropriate value allows the low frequency end of the bandwidth curve to be tailored to approximately (within the limits imposed by component preferred values) the frequency required e.g. −3dB at 20Hz.

C1 together with the input impedance (Z_{in}) of the amplifier forms a high pass filter, which will shape the bandwidth at low frequencies. To get an accurate frequency for the -3dB point may require some experimentation with different preferred values of capacitor close to the calculated value, and repeated checks on the low end (20Hz) frequency of the bandwidth as described in Part 3 (5c). A suitable value for C1 can be found by re-arranging the standard formula for a filter corner frequency to give:

$$C = \frac{1}{2\pi f Z_{in}}$$

Calculate the value for C1 and the nearest preferred value and enter them in Part 4.2 of the Amplifier Design Record sheet.

The value of C2

The primary function of C2 is to provide DC isolation between this amplifier stage and any following circuitry, whilst coupling the AC signal. As such it needs to have a reactance that is low enough to pass all audio frequencies, a value of between 1µF and 10µF should be suitable. A more accurate value would only need to be considered if it would form any filter arrangement with any circuit connected to the output.

The value of C4

Now that the mid band gain and the low frequency limit of the bandwidth are set, C4 can be added to the circuit. The purpose of this capacitor is to form a low pass filter together with R_L. This filter will control the high frequency limit of the amplifier reducing high frequency noise and instability. Too much gain at high frequencies can also lead to instability and positive feedback problems if not rejected. The value of C4 can be calculated in a similar way to the value for C1, however for C4, the resistive part of the filter is R_L and the corner frequency of the filter (where the gain will drop by −3dB) will, for this exercise be 20kHz.

In a practical amplifier designed to accommodate all frequencies within the audio spectrum plus some higher frequencies to allow for the amplification of the audio harmonics the cut of frequency would be considerably higher, some commercial audio amplifiers will have a cut of frequency of around 100 to 150kHz.

The process of making C4 and R_L act as a low pass filter is the same for any chosen frequency, only the corner frequency of the filter (your chosen cut off frequency) will be different, and so this will change the calculated value of C4. The main point is that you are able calculate the value of C4 to produce the cut off frequency of your choice. If you choose 20kHz you will loose some of the harmonics and the amplifier will not perform well at amplifying complex waves, such as square waves. If you choose a much higher value (or leave out C4 altogether, you run the risk of excessive HF noise and possibly some instability.

Calculate the value for C4 and the nearest preferred value and enter them in Part 4.2 of the Amplifier Design Record sheet.

Maximum undistorted waveform

Apply a 1kHz sine wave to the amplifier input and connect an oscilloscope to the amplifier output to monitor the output waveform.

Adjust the amplitude of the input signal until the output wave observed on the oscilloscope just begins to show distortion.

Record the peak to peak value of the wave to ensure that V_{PP} is greater than 70% of the value of V_{CC}.

Module 2.5

Multi-Stage Amplifiers

What you'll learn in Module 2.5.

After studying this section, you should be able to:

Describe methods for inter-stage coupling in multi-stage amplifiers:

- Direct Coupling
- Capacitor coupling.
- Transformer Coupling

Inter-Stage Coupling

For many amplification purposes, a single transistor does not provide enough gain, so multiple circuits, or ´stages of amplification´ are needed. When an amplifier contains multiple stages the total gain is the product of the individual stage gains:

$$\text{Gain } G = G_1 \times G_2 \times G_3 \text{ etc.}$$

Or, when the gain is expressed in deciBels, the sum of the individual stage gains:

$$\text{Total gain in dBs} = dB_1 + dB_2 + dB_3 \text{ etc.}$$

The way in which the individual stages are coupled together is important. The design of the coupling circuitry must fulfil several requirements, including:

a.) Impedance Matching.

When coupling amplifier stages together impedance matching is important so that as much signal as possible is transferred from the output of one stage to the input of the next, keeping inter stage losses to a minimum.

b.) Correct Frequency Response.

Ensuring that the correct bandwidth is maintained throughout all stages of amplification.

c.) DC Isolation.

It may be required that where the output of one stage is at a different DC potential to the input of the next, the two stages are electrically isolated from each other.

Direct (DC) coupling

In some amplifiers, it is important that DC, as well as AC is coupled between stages. In direct coupling, illustrated in Fig. 2.5.1, the output of one stage (e.g. the collector) is connected directly, or via a component such as a resistor, which does not block DC, to the input (e.g. the base) of the next stage. This method allows the amplification of very low frequencies as well as DC (0Hz).

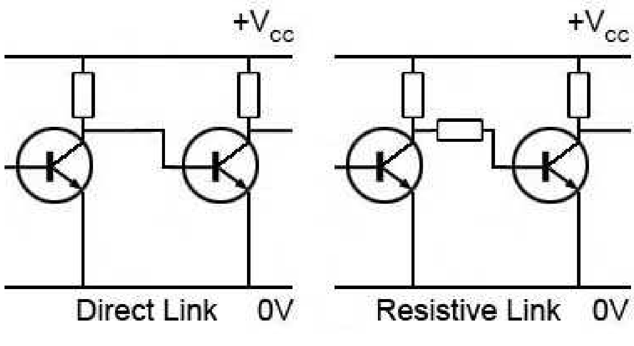


Fig. 2.5.1 Direct

DC coupling may also be used in wideband amplifiers to eliminate the use of capacitors where there may be a possibility of high frequency instability caused by capacitors and resistors combining to form filter or phase shift circuits; if this happens the gain may have variations at some frequencies due to filter action and may become unstable and begin to oscillate if unwanted phase shifts occur.

Amplifiers using direct coupling must be very stable in their operation, especially with regard to variations in temperature, as even a very small change in the bias conditions at the base of a transistor caused by fluctuating temperature, will cause a large change in the DC conditions at the collector, creating an error voltage (the difference between the predicted collector voltage and the actual voltage present). Any such error will be magnified at each subsequent stage, and so efficient bias stabilisation is vital, also some additional error correcting feedback is normally required.

Capacitor Coupling.

Capacitor coupling (Fig. 2.5.2) provides electrical isolation (DC Blocking) between the coupled stages, whilst allowing AC signals to pass. This allows for different collector and base voltages on the coupled stages, and reduces DC stability problems. With this type of coupling, the reactance of the capacitor must be low enough at the lowest signal frequencies so as not to unduly reduce signal between stages. However, using capacitors in this way can introduce unwanted high and low pass filter effects, as described in DC Coupling above.

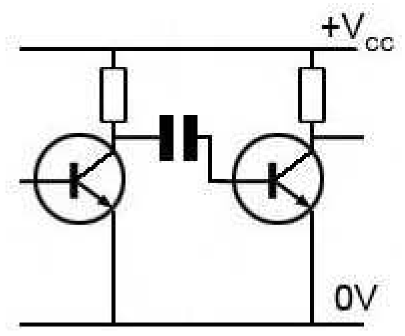


Fig. 2.5.2 Capacitor Coupling

Transformer Coupling.

In transformer coupling (Fig. 2.5.3), the signal current flowing in the collector circuit of one stage flows through the primary winding of a transformer, which induces a signal voltage into a secondary winding connected in the input of the next stage. This signal is added to the DC bias at the base of the next stage.

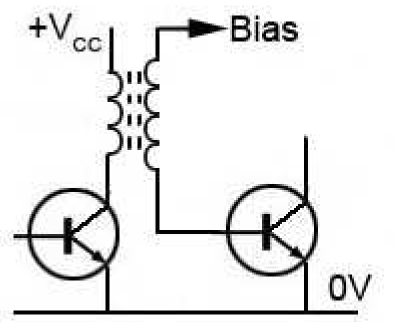


Fig. 2.5.3 Transformer Coupling

Only AC signals are coupled, DC is blocked and the transformer turns ratios can also be used to provide impedance matching between stages. Transformer coupling is more ideally suited to radio frequency (RF) amplifiers because the size of transformers at these frequencies can be kept reasonably small. The much larger audio transformers are used for matching power output amplifiers to loudspeakers and microphones to amplifier inputs, but even so, tend to be too large and heavy for applications such as inter-stage coupling between multiple stages.

Amplifiers Module 2.6

Amplifiers Quiz 2

Amplifiers Quiz

Try our quiz, based on the information you can find in Amplifiers Module 1. Submit your answers and see how many you get right. If you get any answers wrong. Just follow the hints to find the right answer and learn about Amplifiers as you go.

1.

What would be the approximate transistor collector voltage when operating correctly in class A with no signal input?

a) Vcc b) 0V c) 0.5Vcc d) 0.707Vcc

2.

Which of the following statements regarding the biasing of a class A amplifier is correct?

a) The base current should be 10% higher than the emitter current.

b) The base voltage should be 0.6V to 0.7V higher that the emitter voltage.

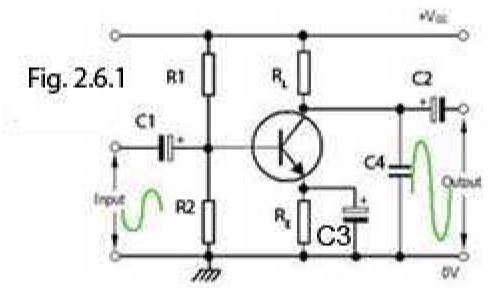
c) The emitter voltage should be 10% higher than the base voltage.

d) The emitter voltage should be 0.6V to 0.7V higher that the base voltage.

3.

Which of the following values would be most suitable for C1 and C2 in the audio amplifier illustrated in Fig 2.6.1?

a) 10µF b) 22nF c) 220nF d) 470µF



4.

Which of the following statements would best describe for C3 in the audio amplifier illustrated in Fig 2.6.1?

a) C3 should have a high value of Z at 1 kHz.

b) C3 should have a maximum working voltage of about 4 to 5 times Vcc.

c) C3 should have a value of Xc that is small compared to the resistance of R4 at low frequencies.

d) C3 should have a tolerance of 5% or less.

5.

Which combination of test equipment would be most suitable for measuring the gain of an audio amplifier?

a) AC voltmeter and decade resistor box.

b) AF signal generator and AC voltmeter.

c) AC voltmeter and CRO.

d) AF signal generator and CRO .

6.

Which combination of test equipment would be most suitable for measuring the input impedance of an audio amplifier?

a) An AF signal generator, a decade resistance box and a CRO.

b) An AF signal generator, a decade resistance box and an ohmmeter.

c) An AC voltmeter, an AF signal generator and a variable resistor.

d) An AF signal generator, a CRO and an ohmmeter.

7.

Refer to Fig 2.6.2. What is the purpose of R4?

a) To increase low frequency gain

b) To improve decoupling.

c) To increase gain and decrease bandwidth.

d) To decrease gain and increase bandwidth.

8.

For what reason is it not desirable to have the amplifier gain reliant on the h_{fe} of the transistor?

a) The h_{fe} gives too much gain.

b) The value of h_{fe} is too variable.

c) Relying on the h_{fe} makes the amplifier unstable.

d) Relying on the h_{fe} makes the bandwidth to narrow.

9.

Which of the following is an advantage of direct coupling between stages of a multi stage amplifier?

a) There is no voltage drop between the collector of one stage and the following base.

b) It increases gain.

c) It increases the input impedance of the amplifier.

d) It reduces the likelihood of phase changes.

10.

What will be overall gain of a two stage amplifier where the gain of the individual stages is 6dB and 12dB.

a) 18dB

b) 2dB

c) 72dB

d) 6dB

Check your answers at http://www.learnabout-electronics.org/Amplifiers/amplifiers26.php

