

The Wayback Machine - <http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/transistor-biasing.html>

[Home](#) (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/>) » Amplifier

(<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/category/amplifier>) » Transistor Biasing

Search

Transistor Biasing

Transistor Biasing

Transistor Biasing is the process of setting a transistors DC operating voltage or current conditions to the correct level so that any AC input signal can be amplified correctly by the transistor. A transistors steady state of operation depends a great deal on its base current, collector voltage, and collector current and therefore, if a transistor is to operate as a linear amplifier, it must be properly biased to have a suitable operating point.

Establishing the correct operating point requires the proper selection of bias resistors and load resistors to provide the appropriate input current and collector voltage conditions. The correct biasing point for a Bipolar Transistor

(<http://web.archive.org/web/20140715213650/http://www.amazon.co.uk/gp/aws/cart/add.html?ASIN.1=0962852570&Quantity.1=1&AWSAccessKeyId=AKIAIQ6ODJLR27IKQI7Q&AssociateTag=basicelecttut-21>), either NPN or PNP, generally lies somewhere between the two extremes of operation with respect to it being either "fully-ON" or "fully-OFF" along its load line. This central operating point is called the "Quiescent Operating Point", or **Q-point** for short.

When a bipolar transistor is biased so that the Q-point is near the middle of its operating range, that is approximately halfway between cut-off and saturation, it is said to be operating as a Class-A amplifier. This mode of operation allows the output current to increase and decrease around the amplifiers Q-point without distortion as the input signal swings through a complete cycle. In other words, the output current flows for the full 360° of the input cycle.

So how do we set this Q-point biasing of a transistor? – The correct biasing of the transistor is achieved using a process know commonly as **Base Bias**.

The function of the "DC Bias level" or "no input signal level" is to correctly set the transistors Q-point by setting its Collector current (I_C) to a constant and steady state value without an input signal applied to the transistors Base.

This steady-state or DC operating point is set by the values of the circuits DC supply voltage (V_{CC}) and the value of the biasing resistors connected the transistors Base terminal.

Since the transistors Base bias currents are steady-state DC currents, the appropriate use of coupling and bypass capacitors will help block bias current setup for one transistor stage affecting the bias conditions of the next. Base bias networks can be used for Common-base (CB), common-collector (CC) or common-emitter (CE) transistor configurations. In this simple transistor biasing tutorial we will look at the different biasing arrangements available for a Common Emitter Amplifier.

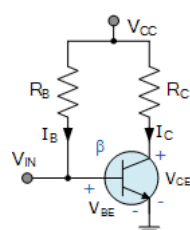
Base Biasing a Common Emitter Amplifier

One of the most frequently used biasing circuits for a transistor circuit is with the self-bias of the emitter-bias circuit where one or more biasing resistors are used to set up the initial DC values of transistor currents, (I_B), (I_C) and (I_E).

The two most common forms of transistor biasing are: *Beta Dependent* and *Beta Independent*. Transistor bias voltages are largely dependent on transistor beta, (β) so the biasing set up for one transistor may not necessarily be the same for another transistor. Transistor biasing can be achieved either by using a single feed back resistor or by using a simple voltage divider network to provide the required biasing voltage.

The following are five examples of transistor Base bias configurations from a single supply (V_{CC}).

Current Biasing a Transistor



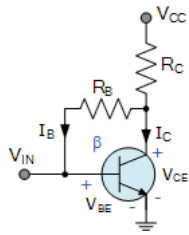
The circuit shown is called as a "fixed current bias circuit", because the transistors base current, I_B remains constant for given values of V_{CC} , and therefore the transistors operating point must also remain fixed. This two resistor biasing network is used to establish the initial operating region of the transistor using a fixed current bias.

This type of transistor biasing arrangement is also beta dependent biasing as the steady-state condition of operation is a function of the transistors beta β value, so the biasing point will vary over a wide range for transistors of the same type as the characteristics of the transistors will not be exactly the same.

The emitter diode of the transistor is forward biased by applying the required positive base bias voltage via the current limiting resistor R_B . Assuming a standard bipolar transistor, the forward base-emitter voltage drop will be 0.7V. Then the value of R_B is simply: $(V_{CC} - V_{BE})/I_B$ where I_B is defined as I_C/β .

With this single resistor type of biasing method the biasing voltages and currents do not remain stable during transistor operation and can vary enormously as temperature also adversely effects the operating point.

Feedback Biasing a Transistor



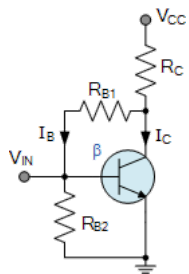
This self biasing configuration is another beta dependent biasing method that requires only two resistors to bias the transistor. The collector to base feedback configuration ensures that the transistor is always biased in the active region regardless of the value of Beta (β) as the base bias is derived from the collector voltage.

In this circuit, the base bias resistor, R_B is connected to the transistors collector C, instead of to the supply voltage rail, V_{CC} . Now if the collector current increases, the collector voltage drops, reducing the base drive and thereby automatically reducing the collector current. Then this method of biasing produces negative feedback.

The biasing voltage is derived from the voltage drop across the load resistor, R_L . So if the load current increases there will be a larger voltage drop across R_L , and a corresponding reduced collector voltage, V_C which will cause a corresponding drop in the base current, I_B which in turn, brings I_C back to normal.

The opposite reaction will also occur when transistors collector current becomes less. Then this method of biasing is called self-biasing with the transistors stability using this type of feedback bias network being generally good for most amplifier designs.

Dual Feedback Transistor Biasing

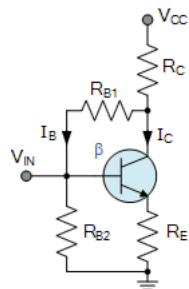


Adding an additional resistor to the base bias network of the previous configuration improves stability even more with respect to variations in Beta, (β) by increasing the current flowing through the base bias resistors.

The current flowing through R_{B1} is generally set at a value equal to about 10% of collector current, I_C . Obviously it must also be greater than the base current required for the minimum value of Beta, β .

One of the advantages of this type of self biasing configuration is that the resistors provide both automatic biasing and Rf feedback at the same time.

Transistor Biasing with Emitter Feedback



This type of transistor biasing configuration, often called self-emitter biasing, uses both emitter and collector-base feedback to stabilize the collector current but the output has reduced gain because of the base resistor connection.

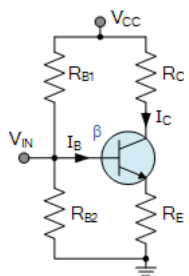
The current flowing from the emitter causes a voltage drop across R_E in such a direction, that it forward biases the emitter-base junction.

So if the emitter current increases, voltage drop $I R_E$ also increases. Since the polarity of this voltage reverse biases the emitter-base junction, I_B automatically decrease. Therefore the emitter current increase less than it would have done had there been no self biasing resistor.

Resistor values are generally set so that the voltage drop across emitter resistor R_E is approximately 10% of V_{CC} and the current flowing through resistor R_{B1} is 10% of the collector current I_C .

This type of transistor biasing configuration works best at relatively low power supply voltages.

Voltage Divider Transistor Biasing



The common emitter transistor is biased using a voltage divider network. The name of this biasing configuration comes from the fact that the two resistors R_{B1} and R_{B2} are connected to the transistors base terminal across the supply.

This voltage divider configuration is the most widely used transistor biasing method, as the emitter diode of the transistor is forward biased by the voltage dropped across resistor R_{B2} . Also, voltage divider network biasing makes the transistor circuit independent of changes in beta as the voltages at the transistors base, emitter, and collector are dependant on external circuit values.

To calculate the voltage developed across resistor R_{B2} and therefore the voltage applied to the base terminal we simply use the voltage divider formula for **resistors in series** (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/resistor/res_3.html). The current flowing through resistor R_{B2} is generally set at 10 times the value of the required base current I_B so that it has no effect on the voltage divider current or changes in Beta.

The goal of **Transistor Biasing** is to establish a known Q-point in order for the transistor to work efficiently and produce an undistorted output signal. Correct biasing of the transistor also establishes its initial AC operating region with practical biasing circuits using either a two or four-resistor bias network.

In bipolar transistor circuits, the Q-point is represented by (V_{CE} , I_C) for the NPN transistors or (V_{EC} , I_C) for PNP transistors. The stability of the base bias network and therefore the Q-point is generally assessed by considering the collector current as a function of both Beta (β) and temperature.

Here we have looked briefly at five different configurations for "biasing a transistor" using resistive networks. But we can also bias a transistor using either silicon diodes, zener diodes or active networks all connected to the base terminal of the transistor or by biasing the transistor from a dual power supply.



(http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/resistor/res_3.html)
ASIN.1=0750619996&Quantity.1=1&AWSAccessKey

21)
Principles of Transistor
Circuits: Introduction to the
Design of Amplifiers,
Receivers and Digital
Circuits

(http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/resistor/res_3.html)
ASIN.1=0750619996&Quantity.1=1&AWSAccessKey
21)

« Amplifier Classes (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amplifier-classes.html>) | Amplifiers Summary (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_8.html) »

Other Good Tutorials in this Category

Amplifier Classes (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amplifier-classes.html>)

Amplifier Distortion (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_4.html)

Amplifiers Summary (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_8.html)

Class A Amplifier (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_5.html)

Class B Amplifier (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_6.html)

Common Emitter Amplifier (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_2.html)

Common Source JFET Amplifier (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_3.html)

Crossover Distortion in Amplifiers (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_7.html)

Emitter Resistance (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/emitter-resistance.html>)

Input Impedance of an Amplifier (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/input-impedance-of-an-amplifier.html>)

Introduction to the Amplifier (http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/amp_1.html)

Transistor Biasing (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/transistor-biasing.html>)

List Price: £43.99

(<http://web.archive.org/web/20140715213650/http://www.amazon.co.uk/dp/B000060111>)

Current Price: £39.50

(<http://web.archive.org/web/20140715213650/http://www.amazon.co.uk/dp/B000060111>)



(<http://web.archive.org/web/20140715213650/http://www.amazon.co.uk/dp/B000060111>)

Price Disclaimer

Tags:

Transistor

(<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/tag/transistors>)

Transistor Amplifier (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/tag/transistor-amplifier>)

2 Responses to "Transistor Biasing"



sami

Thanks for the great helping. i was really stuck in electronic paper. But may be now this this i will must pass this paper. i never used this notes for the paper. so i think therefore i failed ..

June 11th, 2014 (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/transistor-biasing.html?replytocom=1043#comment-1043>)



fabrice

very interesting

June 29th, 2014 (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/amplifier/transistor-biasing.html?replytocom=1233#comment-1233>)

Leave a Reply

Your email address will not be published. Required fields are marked *

Name *

Email *

Website

What's the Sum *

five + 6 =

Comment

You may use these [HTML \(HyperText Markup Language\)](#) tags and attributes: `<a href="" title="">` `<abbr title="">` `<acronym title="">` `<b>` `<blockquote cite="">` `<cite>` `<code>` `<del datetime="">` `<em>` `<i>` `<q cite="">` `<strike>` `<strong>`

Post Comment

(<http://web.archive.org/web/20140715213650/https://www.electronics-tutorials.ws/amplifier/transistor-biasing.html#>)

(<http://web.archive.org/web/20140715213650/https://www.electronics-tutorials.ws/amplifier/transistor-biasing.html#>)

(http://web.archive.org/web/20140715213650/https://www.addthis.com/bookmark.php?v=300&winname=addthis&pub=ra-4dabe1c24a1ae8c8&source=tbx32-300&lng=en-US&s=google_plusone_share&url=http%3A%2F%2Fwww.electronics-tutorials.ws%2Famplifier%2Ftransistor-biasing.html&title=Transistor%20Biasing%20and%20the%20Biasing%20of%20Transistors&ate=AT-ra-4dabe1c24a1ae8c8/-/53c59efd097e597a/2&frommenu=1&uid=53c59efd29e76b1b&ct=1&tt=0&captcha_provider=nuc)

(http://web.archive.org/web/20140715213650/https://www.addthis.com/bookmark.php?v=300&winname=addthis&pub=ra-4dabe1c24a1ae8c8&source=tbx32-300&lng=en-US&s=stumbleupon&url=http%3A%2F%2Fwww.electronics-tutorials.ws%2Famplifier%2Ftransistor-biasing.html&title=Transistor%20Biasing%20and%20the%20Biasing%20of%20Transistors&ate=AT-ra-4dabe1c24a1ae8c8/-/53c59efd097e597a/3&frommenu=1&uid=53c59efdaaff8224&ct=1&tt=0&captcha_provider=nuc)

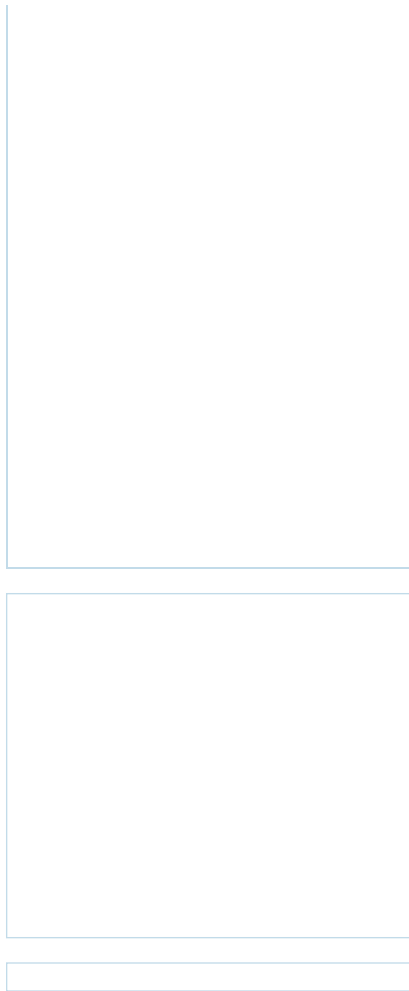
(<http://web.archive.org/web/20140715213650/https://www.electronics-tutorials.ws/amplifier/transistor-biasing.html#>)

?

(<http://web.archive.org/web/20140715213650/https://www.electronics-tutorials.ws/amplifier/transistor-biasing.html#>)



(<http://web.archive.org/web/20140715213650/http://schematics.com/>)



Basic Electronics Tutorials Site by Wayne Storr. Last updated 15th July 2014,
Copyright © 1999 – 2014, All Rights Reserved - Basic Electronics Tutorials.
| RSS (<http://web.archive.org/web/20140715213650/http://feeds.feedburner.com/electronics-tutorials>) |
Privacy Policy (<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/privacypolicy>) | Terms of Use
(<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/terms>) | Site Map
(<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/sitemap>) | Contact Us
(<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/contact>) | Find us on
Google+ (<http://web.archive.org/web/20140715213650/https://plus.google.com/+Electronics-tutorialsWs/posts>) | Electronics Tutorials
(<http://web.archive.org/web/20140715213650/http://www.electronics-tutorials.ws/>) |