

Q POINT

To learn about Q-point, first we will learn about DC load line.

How is DC load line plotted?

The fig. shown below is of a bipolar junction transistor connected in common emitter configuration. Consider the output loop of the transistor and applying Kirchhoff's voltage law to output circuit.

$$V_{cc} - V_{CE} - I_c R_c = 0$$

Rearranging the terms,

$$I_c = \{-1/R_c\} V_{CE} + V_{cc}/R_c$$

Comparing the above equation with $y = mx + c$ (general equation of straight line),

we get $y = I_c$, $m = -1/R_c$, $x = V_{CE}$ and $C = V_{cc}/R_c$

With these values of y , m , x & c , a straight line is plotted and this line is called DC load line. The DC load line is always plotted on the output characteristics of transistor.

Q-point

The Q stands for quiescent which means still, quiet or stable.

The Q-point is on the DC load line and represents the current flowing in output circuit and voltage across it. In our case, they are I_c and V_{ce} . The value of current and voltage at Q-point are written as (V_{ceQ}, I_{cQ}) .

The position of Q-point is selected according to the application of transistor.

- ♣ If transistor is to be used as switch, Q-point is in cut-off region for open switch and in saturation region for closed switch.
- ♣ If transistor is to be operated as amplifier, Q-point is placed exactly in the middle of the DC load line. It is preferred at midpoint of DC load line so that it does not enter in other regions due change in temperature, \hat{I}_{dc}^2 etc.

Q-point in different regions:

The distortion or output waveform depends on the position of Q-point. The Q-point can be in three operating regions of transistors namely “cut-off, saturation and active region.

Q-point in active region

When transistor is used as amplifier, the Q-point is placed in active region and most preferably at the centre of DC load line. It is placed at midpoint so that output waveform is not distorted and makes sure it remains in active region even if there is little variation in temperature or \hat{I}_{dc}^2 .

Q-point in cut-off and saturation region

When transistor is used as switch, the Q-point is placed in either cut-off region or saturation region. It is in cut-off region if it acts like open switch or in saturation region. The output waveform of V_{CEQ} & I_{CQ} are distorted when Q-point is in either cut-off or saturation region. If Q-point is in cut-off region, negative half cycle of I_{CQ} and positive half cycle of V_{CEQ} are distorted and vice versa for saturation region.

Source: <http://www.knowelectronics.org/q-point/>