Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Department of Medical Physics

Analog Electronics

Lecture 5

Common Collector Circuit

By

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2021 A.D **1443 A.H**

Common Collector Circuit

The Common Collector Amplifier is another type of bipolar junction transistor, (BJT) configuration where the input signal is applied to the base terminal and the output signal taken from the emitter terminal. Thus the collector terminal is common to both the input and output circuits. This type of configuration is called Common Collector, (CC) because the collector terminal is effectively “grounded” or “earthed” through the power supply. In many ways the common collector (CC) configuration is the opposite of the common emitter (CE) configuration, as the connected load resistor is moved from the usual collector terminal, labelled RC, to the emitter terminal where it is labelled R_E.

The common collector or grounded collector configuration is generally used where a high impedance input source needs to be connected to a low impedance output load requiring a high current gain.

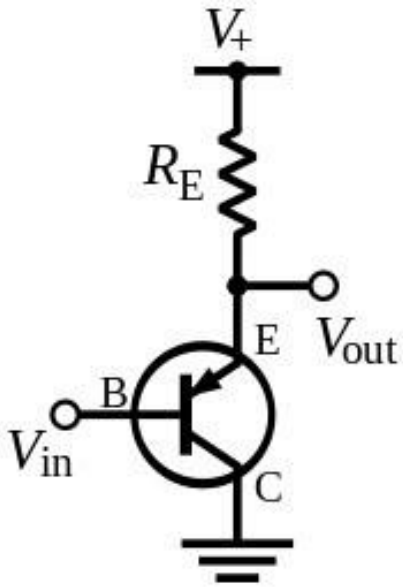

Figure (30) Common Collector Circuit Symbol.

CC Amplifier using an NPN Transistor

The amplifier is an electronic circuit that is used for amplifying a voltage or current signal. The input for the transistor will be a voltage or current and the output will be an amplified form of that input signal. An amplifier circuit is generally designed with one or more transistors is called a transistor amplifier. The transistor (BJT, FET) is a major component in an amplifier system. Resistors R_1 and R_2 form a simple voltage divider network used to bias the NPN transistor into conduction. Since this voltage divider lightly loads the transistor, the base voltage, V_B can be easily calculated by using the simple voltage divider formula. With the collector terminal of the transistor connected directly to V_{CC} and no collector resistance, (R_C = 0) any collector current will generate a voltage drop across the emitter resistor R_E. However, in the common collector amplifier circuit, the same voltage drop V_E also represents the output voltage V_{OUT}.

As the base-emitter pn-junction is forward biased, base current flows through the junction to the emitter encouraging transistor action causing a much larger collector current, I_C to flow. Thus the emitter current is a combination of base current and collector current as: $I_E = I_B + I_C$. However, as the base current is extremely small compared to the collector current, the emitter current is therefore approximately equal to the collector current. Thus $I_E \approx I_C$.

- If a high impedance source is connected to low impedance amplifier then most of the signal is dropped across the internal impedance of the source.
- To avoid this problem common collector amplifier is used in between source and CE amplifier.
- It increases the input impedance of the CE amplifier without significant change in input voltage.

- Since there is no resistance in collector circuit, therefore collector is ac grounded.
- It is also called grounded collector amplifier.
- When input source drives the base, output appears across emitter resistor.
- A CC amplifier is like a heavily swamped CE amplifier with a collector resistor shorted and output taken across emitter resistor.

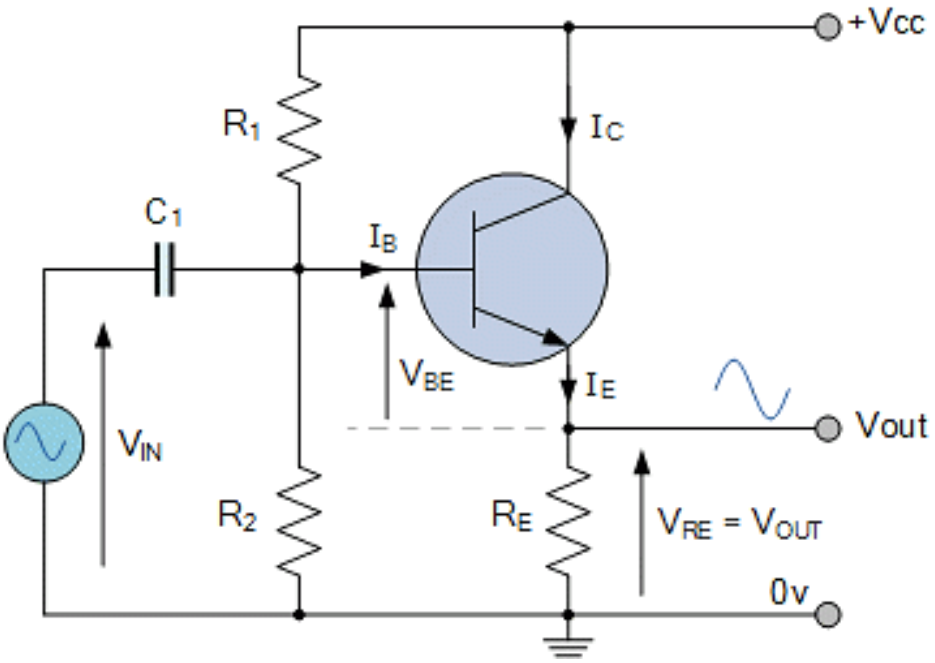

Figure (31) Common Collector Amplifiers.

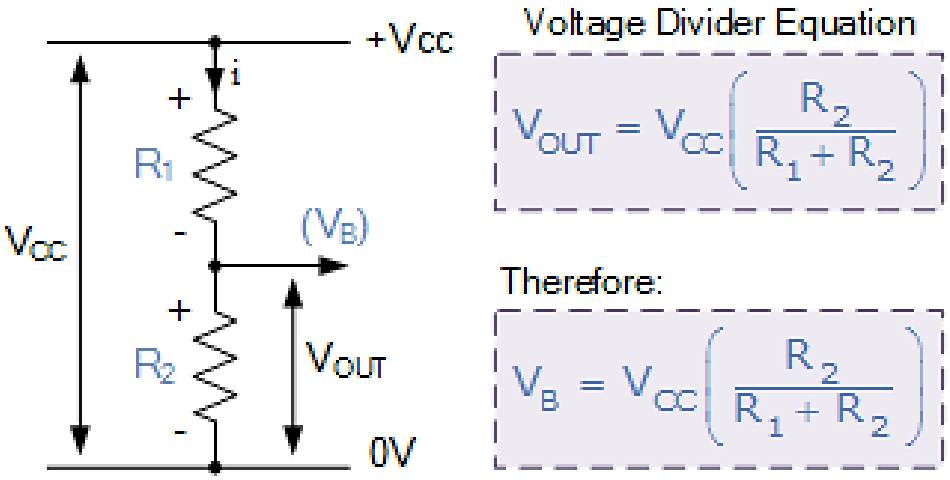

Figure (32) Voltage Divider Network.

Characteristics of Common Collector Amplifier

The load resistor in the common collector amplifier being placed in series with the emitter circuit receives both the base current and collector currents. Since the emitter of a transistor is the sum of the base and collector currents, since the base and collector currents always add together to form the emitter current, it would be reasonable to assume that this amplifier will have a very large current gain. The common collector amplifier has quite a large current gain, larger than any other transistor amplifier configuration.

Parameters	Characteristics
Voltage gain	Zero
Current gain	High
Power gain	Medium
Input or output phase relationship	Zero degree
Input resistance	High
Output resistance	Low

Input Characteristics

The common collector characteristics are quite different from the common base and common emitter characteristics. This is because the input voltage V_{bc} is largely determined by the output voltage V_{ec}. As V_{bc} increases with V_{ec} constant V_{eb} decreases hence I_b decreases.

Output Characteristics

Here as V_{cc} increases I_e also increases. Just as in common emitter output characteristics I_c increases with increasing I_b, so

I_e also increases here with the increase in I_b. Hence, for constant V_{ec}, I_e increases with I_b.

Advantages of CC amplifier

- It has current gain but maintain voltage gain unchanged
- It has the lowest output impedance compare to other type amplifier
- It can be used for impedance matching between an amplifier stage with a high output impedance and an amplifier stage with a low input impedance.
- When used like this it is sometimes called a buffer amp or isolation amp.
- When placed between the two stages it prevents the stage with the low input impedance from overloading the stage with the high output impedance.
- The Voltage gain of a common collector amp is at best slightly less than 1.

Applications

- This amplifier is used as an impedance matching circuit.
- It is used as a switching circuit.
- The high current gain combined with near-unity voltage gain makes this circuit a great voltage buffer.
- It is also used for circuit isolation.

I-V Characteristic Curves

The I-V Characteristic Curves, which is short for Current-Voltage Characteristic Curves or simply I-V curves of an electrical device or component, are a set of graphical curves which are used to define its operation within an electrical circuit. As its name suggests, I-V characteristic curves show the relationship between the current flowing through an electronic device and the applied voltage across its terminals. I-V characteristic curves are generally used as a tool to determine and understand the basic parameters of a component or device and which can also be used to mathematically model its behavior within an electronic circuit. But as with most electronic devices, there are an infinite number of I-V characteristic curves representing the various inputs or parameters and as such we can display a family or group of curves on the same graph to represent the various values.

I-V Characteristic Curves of an Ideal Resistor

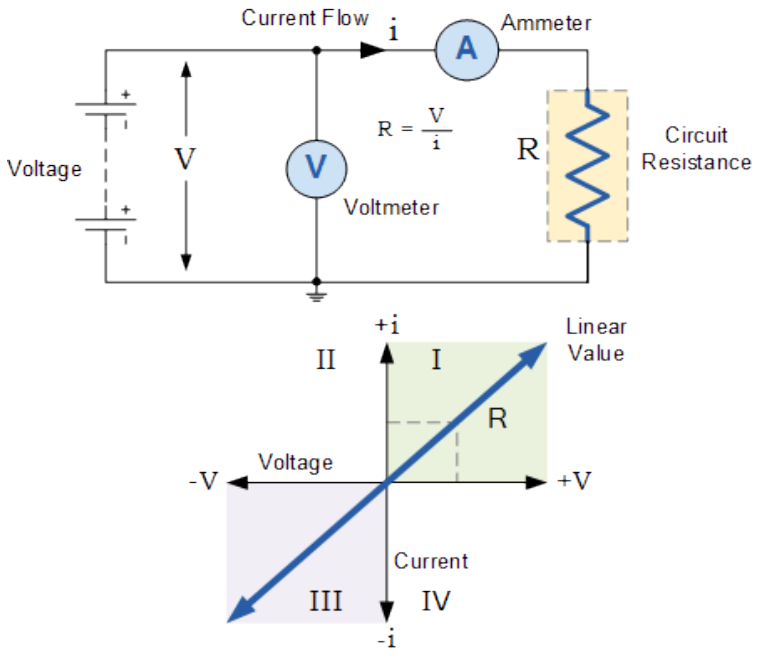

Figure (33) Ideal Resistor Circuit.

I-V Characteristic Curve of a Diode

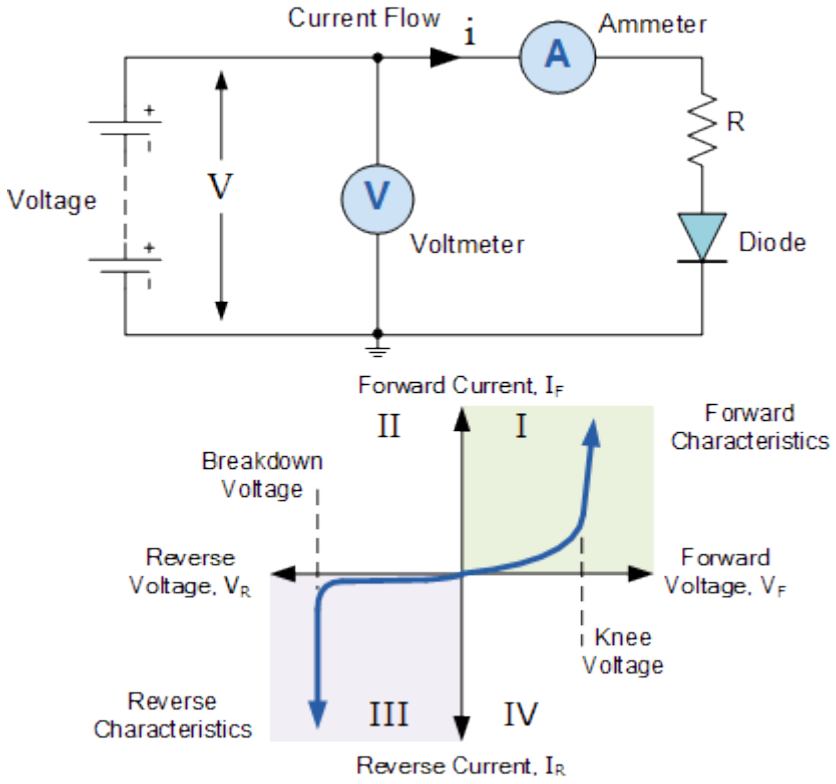

Figure (34) Diode Circuit.

CC Amplifier Circuit with Load Line

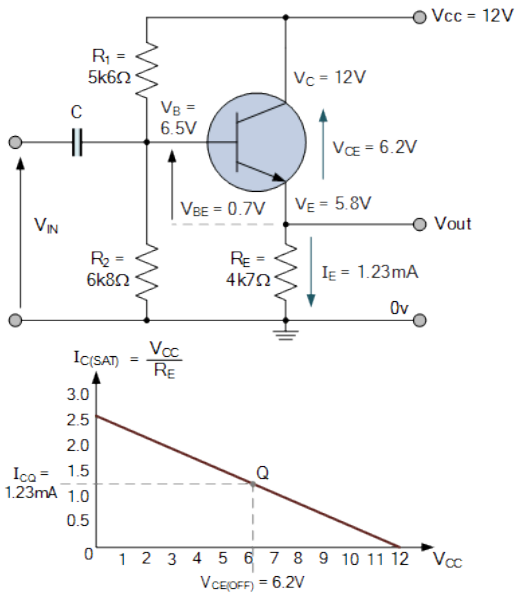

Figure (35) CC Amplifier Circuit.