

Bootstrap Amplifier Circuit using Transistors

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Amplifiers are integral part of Electronics which are used to amplify low amplitude signals. Amplifier plays a very important role to boost the signal, specially in Audio and power electronics. Amplifier circuit can be defined as, a circuit which is used to amplify a signal. The input of the amplifier is a voltage otherwise current, where the output will be an amplifier input signal. An amplifier circuit which uses a transistor otherwise transistors is known as a transistor amplifier. The applications of transistor amplifier circuits mainly involve in audio, radio, optical fiber communication, etc.

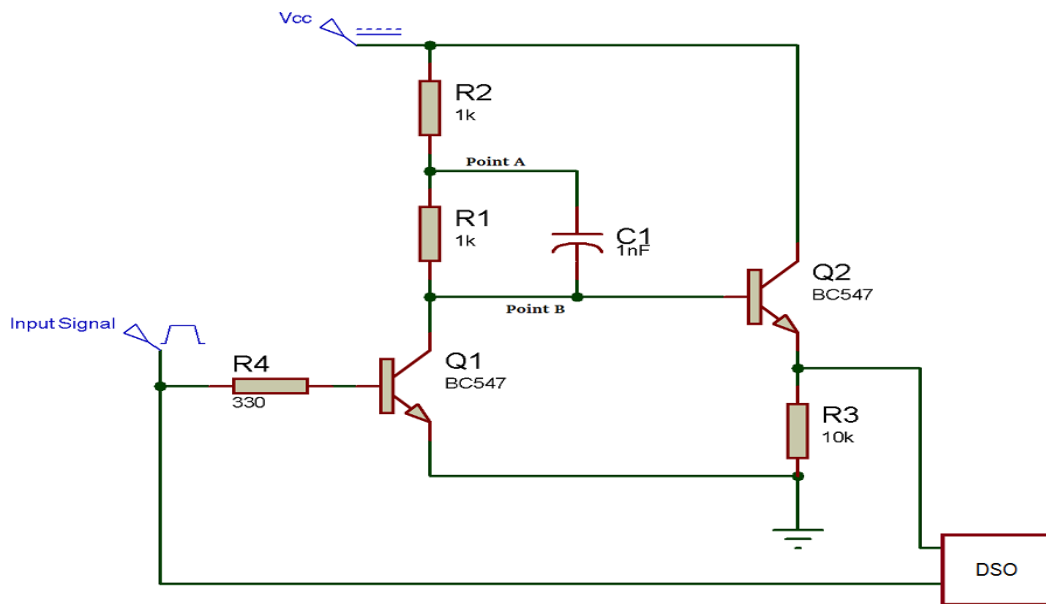
Bootstrapping is technique where some part of output is used at the startup. In Bootstrap amplifier, bootstrapping is used to increase the input impedance. Due to which the loading effect on the input source also decreases. The design looks similar to the Darlington pair, having a bootstrap capacitor. Bootstrap capacitor is used to provide AC signal's positive feedback to the base of the transistor. This positive feedback help in improving the effective value of the base resistance. This increment in the base resistance also determined by the voltage gain of the amplifier circuit.

A bipolar junction transistor (BJT) has an inherently low input impedance of typically 1 Ω to 50 k Ω , and this reduces further after the addition of biasing transistors such as a potential divider network connected to the base junction of a transistor. Whilst it improves dc stability, these resistors have the effect of shunting the input thereby reducing the input resistance. These types of circuits usually pose a problem where high input impedance is required, and therefore bootstrapping is a technique that helps increase the input impedance.

High input impedance improves the amplification of the input signal and thus required in various amplifier applications. If we have low input impedance we will get low amplification. Generally, BJT (Bipolar Junction Transistor) have low input impedance (typically 1 ohm to 50 kilo ohm). So for this, bootstrapping technique is used to increase the input impedance. The voltage across the input impedance is calculated by using the below formula:

$$V = \{(V_{in}.Z_{in}) / (V_{in} + Z.V_{in})\}$$

Hence, according to the above formula, the input impedance is proportional to the voltage across it. If the input impedance is increased the voltage across it will also increase and vice versa.



Components Required

- NPN Transistor – BC547
- Resistor – 1k, 10k
- Capacitor – 33pf
- AC or Pulse Input Signal
- DC supply – 9V or 12V
- Breadboard
- Connecting wires

For the input pulse signal, we have used an AC signal (using transformer), you can also use PWM input. And, for the Vcc input, we are using the RPS (Regulated positive supply) in the circuit.

Working of Bootstrap Amplifier

After connecting the circuit as per the circuit diagram, the circuit looks similar to the Darlington pair. Here, we have used bootstrapping technique to increase the input impedance of this amplifier circuit. When the base of the transistor Q1 is high and point B is low. Therefore, the capacitor charges upto the value of voltage across R2. When Q1 goes low and voltage start increasing at the base of Q2, the capacitor discharges slowly. And to maintain the charge, point A is also pushed up. So the voltage at point B increases and the voltage at point A also keeps rising until it goes more than the Vcc. The charge into the bootstrap capacitor C1 is drained by the resistor R1 and R2. The technique is called as bootstrapping because rising the voltage at one end of the capacitor will increase the voltage at the other end of the capacitor.