# In The Circuit Shown In Fig 7.54 The Transistor Has A Beta Of 200. What Is The Dc Voltage At The Collector?

**In The Circuit Shown In Fig 7.54 The Transistor Has A Beta Of 200. What Is The Dc Voltage At The Collector?**

Understanding the operation of bipolar junction transistors (BJTs) is fundamental in analyzing electronic circuits. When examining a specific circuit configuration, such as the one depicted in Fig 7.54, determining the DC collector voltage is essential for assessing transistor functionality and overall circuit performance. Given that the transistor has a current gain (Beta) of 200, this article guides you through a detailed, step-by-step approach to calculate the collector voltage, integrating key concepts, formulas, and practical considerations.

---

## Overview of the Circuit in Fig 7.54

Before diving into calculations, it is crucial to understand the typical configuration of the circuit described in Fig 7.54. Although the diagram is not provided here, standard transistor biasing circuits often follow certain patterns.

Common features of such circuits include:

- A voltage source (Vcc) supplying power.
- A collector resistor (Rc) connected between Vcc and the collector terminal.
- An emitter resistor (Re), if present, connected between the emitter and ground.
- A base biasing network, typically involving a resistor connected from Vcc or ground to the base.
- The transistor itself, with collector, base, and emitter terminals.

Assumptions for this analysis:

- The transistor is operating in the forward-active region.
- The circuit has known resistor values (which will be specified or assumed).
- The supply voltage Vcc is known.
- The base bias voltage or base resistor value is known.
- The transistor's current gain (Beta) is 200.

---

## Key Concepts and Parameters

Understanding the core parameters involved is essential:

- Beta (β): The current gain of the transistor, representing the ratio of collector current (Ic) to base current (Ib).

$$
\beta = \frac{I_C}{I_B}
$$

- Base-Emitter Voltage (Vbe): Typically about 0.6V to 0.7V for silicon BJTs when forward-biased.

- Collector Voltage (Vc): The voltage at the collector terminal relative to ground; the quantity we aim to find.

- Collector Current (Ic): The current flowing through the collector, influenced by the biasing circuit and transistor parameters.

- Resistor Values (Rc, Rb, Re): Resistors in the circuit affecting biasing and collector voltage.

- Power Supply Voltage (Vcc): The voltage source powering the circuit.

---

## Step-by-Step Calculation of Collector Voltage

Calculating the collector voltage involves multiple steps, encompassing determining the collector current and then applying Ohm's law.

Step 1: Determine Base Current (Ib)

The base current depends on the biasing resistor network and the base-emitter voltage.

For example, if the base is biased via a resistor Rb connected from Vcc, and the base voltage (Vb) is known or can be calculated, then:

$$
I_B = \frac{V_{bias} - V_{BE}}{R_B}
$$

where:

- $V_{bias}$ is the voltage at the base, which could be from a voltage divider or biasing network.
- $V_{BE}$ is approximately 0.7V for silicon transistors.

Step 2: Calculate Collector Current (Ic)

Using the current gain:

$$
I_C = \beta \times I_B
$$

Since $\beta = 200$:

$$
I_C = 200 \times I_B
$$

Step 3: Determine Collector Voltage (Vc)

The collector voltage is influenced by the collector resistor (Rc) and the collector current:

$$
V_C = V_{CC} - I_C \times R_C
$$

This is derived from Kirchhoff's Voltage Law (KVL) around the collector loop.

---

# Practical Example with Assumed Values

To illustrate, let's assume some typical values:

- Power supply voltage, $V_{CC} = 12\,V$
- Collector resistor, $R_C = 2\,k\Omega$
- Base bias resistor, $R_B = 100\,k\Omega$
- Voltage at base, $V_{B} = 2.5\,V$

Calculating base current:

$$
I_B = \frac{V_B - V_{BE}}{R_B} = \frac{2.5\,V - 0.7\,V}{100\,k\Omega} = \frac{1.8\,V}{100\,k\Omega} = 0.018\,mA
$$

Calculating collector current:

$$
I_C = 200 \times 0.018\,mA = 3.6\,mA
$$

Calculating collector voltage:

$$
V_C = V_{CC} - I_C \times R_C = 12\,V - (3.6\,mA \times 2\,k\Omega) = 12\,V - (3.6 \times 10^{-3} \times 2000) V
$$

$$
V_C = 12\,V - 7.2\,V = 4.8\,V
$$

Thus, the collector voltage in this example is approximately 4.8V.

---

# Factors Affecting the Collector Voltage

Multiple factors can influence the actual collector voltage in practice:

- Biasing accuracy: Variations in resistor values or supply voltage can affect $I_B$ and $I_C$.

- Transistor beta variation: Although given as 200, actual beta can vary between devices and with temperature.

- Saturation conditions: If the transistor enters saturation, the collector voltage drops close to $V_{CE(sat)}$, typically around 0.2V.

- Emitter resistor (Re): Adds negative feedback and stabilizes bias point, affecting collector voltage.

- Temperature effects: Higher temperatures can reduce $V_{BE}$ and alter transistor currents.

---

# Design Considerations for Achieving Desired Collector Voltage

When designing a transistor circuit to achieve a specific collector voltage, consider the following:

- Select appropriate resistor values for biasing and collector load to set desired operating points.

- Ensure the transistor remains in the forward-active region, not saturating or cutoff.

- Use voltage divider biasing for better stability against beta variations.

- Account for temperature stability by incorporating bias stabilization techniques.

---

# Summary of Key Formulas

To summarize the core calculations:

- Base current:

$$
I_B = \frac{V_{bias} - V_{BE}}{R_B}
$$

- Collector current:

$$
I_C = \beta \times I_B
$$

- Collector voltage:

$$
V_C = V_{CC} - I_C \times R_C
$$

---

# Conclusion: Calculating the Collector Voltage in Fig 7.54

Determining the DC voltage at the collector in the circuit shown in Fig 7.54 involves understanding the biasing network, transistor parameters, and resistor values. By calculating the base current using the biasing resistors and known voltages, then applying the transistor's current gain to find the collector current, and finally applying Ohm's law to determine the voltage drop across the collector resistor, you can accurately estimate the collector voltage.

In the example provided, with assumed values, the collector voltage was approximately 4.8V. However, in real-world applications, precise measurements and component tolerances should be considered. Proper biasing ensures the transistor operates in the desired region, providing predictable collector voltages essential for circuit functionality.

Remember: Always verify your assumptions with actual circuit measurements and consider temperature effects and component tolerances for accurate analysis.

---

Keywords: transistor biasing, collector voltage, Beta current gain, DC analysis, circuit analysis, Ohm’s law, bipolar junction transistor, biasing resistors, circuit design

# Frequently Asked Questions

## In the circuit shown in Fig 7.54, with a transistor beta of 200, how do you determine the collector current (Ic)?

You calculate the collector current (Ic) by first determining the base current (Ib) from the base resistor and input voltage, then multiply Ib by the beta (200): $Ic = \beta \times Ib$.

## What is the significance of the transistor's beta value in calculating the collector voltage?

The beta value indicates the current gain, which helps determine the collector current, and subsequently, the collector voltage, since $Vc = Vcc - Ic \times Rc$.

## How do you find the collector voltage (Vc) once you know the collector current in the circuit shown in Fig 7.54?

Calculate Ic based on base current and beta, then use $V_c = V_{cc} - I_c \times R_c$, where Vcc is the supply voltage and Rc is the collector resistor.

## If the collector resistor (Rc) and supply voltage (Vcc) are given, how does changing the beta of the transistor affect the collector voltage?

Changing beta affects Ic; a higher beta results in a higher Ic for the same base current, which lowers Vc; conversely, a lower beta increases Vc.

## What assumptions are typically made when calculating the collector voltage in such a transistor circuit?

Assumptions include that the transistor is in active region, the base-emitter junction voltage (Vbe) is approximately 0.7V for silicon transistors, and the transistor's beta is constant at 200.

## How does the transistor's beta of 200 influence the biasing and operation point in the circuit shown in Fig 7.54?

A beta of 200 means the transistor provides significant current amplification, which influences the biasing point, ensuring the transistor remains in active mode for proper operation.

## What are the typical steps to compute the collector voltage in a transistor circuit with known parameters?

Identify base current from input voltages and resistors, calculate collector current using $I_c = \beta \times I_b$, then determine collector voltage using $V_c = V_{cc} - I_c \times R_c$.

## If the collector voltage is found to be too low, what circuit adjustments can be made to correct this in the scenario shown in Fig 7.54?

Reduce the collector resistor (Rc), increase the supply voltage (Vcc), or adjust the base bias to decrease collector current and raise the collector voltage to desired levels.

# Additional Resources

Transistor Circuit Analysis

Understanding the behavior and operation of transistors within electronic circuits is fundamental for engineers, students, and enthusiasts alike. In the scenario presented—analyzing the collector voltage in a specific circuit where the transistor has a current gain (beta) of 200—it's essential to approach the problem systematically. This article provides an in-depth exploration of how to determine the DC voltage at the collector, considering all relevant circuit parameters, and elucidates the underlying principles that govern transistor operation.

---

# Introduction to the Circuit and Key Concepts

Before delving into calculations, it’s important to clarify the context and fundamental concepts. Although the exact schematic (Fig 7.54) isn't provided here, typical basic transistor amplifier circuits serve as a basis for analysis. These often include a bipolar junction transistor (BJT), biasing resistors, power supply, and load components.

Key Concepts:

- Bipolar Junction Transistor (BJT): A three-terminal device with base (B), collector (C), and emitter (E). It operates as a current-controlled switch or amplifier.
- Current Gain (Beta, β): The ratio of collector current (Ic) to base current (Ib). A beta of 200 indicates that the collector current is 200 times the base current.
- DC Operating Point (Q-Point): The steady-state voltages and currents when the circuit is powered without input AC signals.
- Biasing: The process of setting the transistor's operating point within its active region to ensure linear amplification and prevent distortion.

---

# Understanding the Circuit Parameters and Their Significance

To analyze the collector voltage, one must identify and interpret the circuit parameters, which typically include:

- Supply voltage (Vcc): The power source driving the collector circuit.
- Biasing resistors (e.g., RB, RC): Resistors connected to the base and collector to establish the operating point.
- Base current (Ib): The current injected into the base terminal, setting the collector current.
- Collector resistor (Rc): The resistor connected to the collector, influencing the voltage drop and collector voltage.
- Emitter resistor (Re): Sometimes present to stabilize the operating point via negative feedback.

Assumption: Let's consider a typical circuit with the following parameters (or similar, as an example):

- Vcc = 12V
- RB = 100kΩ (Base bias resistor)

- RC = 2kΩ (Collector resistor)
- Re = 0Ω or omitted for simplicity
- Base voltage (Vb) set by a biasing network
- The base-emitter voltage (Vbe) ≈ 0.7V for silicon BJTs

---

# Step-by-Step Approach to Find Collector Voltage

The goal is to determine the DC collector voltage (Vc), which depends on the collector current (Ic) and the collector resistor (Rc).

Step 1: Determine Base Current (Ib)

The base current is the starting point. If the base is biased via a resistor from Vcc (or a voltage divider), the base bias voltage (Vb) can be established. For simplicity, assume that the base is biased with a voltage source or a network that provides a known base voltage.

If a base bias resistor is connected from Vcc to the base, then:

$$ I_b = \frac{V_{bias} - V_{be}}{R_B} $$

where:

- $V_{bias}$ is the voltage at the base (from biasing network)
- $V_{be}$ ≈ 0.7V for silicon BJTs

Step 2: Calculate Collector Current (Ic)

Using the current gain:

$$ I_c = \beta \times I_b $$

Given:

$$ \beta = 200 $$

Thus,

$$ I_c = 200 \times I_b $$

Step 3: Determine Collector Voltage (Vc)

The collector voltage is affected by the voltage drop across Rc due to Ic:

$$ V_{Rc} = I_c \times R_c $$

The collector voltage is then:

$$ V_c = V_{cc} - V_{Rc} $$

which shows how the collector voltage drops from the supply voltage depending on the collector current.

---

## Applying Numerical Values for a Concrete Example

Let's assume specific values to illustrate the calculation:

- Vcc = 12V
- Rb (bias resistor) = 100kΩ
- Vb (bias voltage) = 1.5V (from a voltage divider or biasing network)
- Rc = 2kΩ
- Vbe ≈ 0.7V

Calculating Ib:

$$ I_b = \frac{V_{bias} - V_{be}}{R_B} = \frac{1.5V - 0.7V}{100k\Omega} = \frac{0.8V}{100,000\Omega} = 8 \times 10^{-6} \text{A} \ (8 \mu A) $$

Calculating Ic:

$$ I_c = \beta \times I_b = 200 \times 8 \times 10^{-6}A = 1.6 \times 10^{-3}A = 1.6mA $$

Calculating voltage drop across Rc:

$$ V_{Rc} = I_c \times R_c = 1.6mA \times 2k\Omega = 1.6 \times 10^{-3}A \times 2000\Omega = 3.2V $$

Determining collector voltage:

$$ V_c = V_{cc} - V_{Rc} = 12V - 3.2V = 8.8V $$

This indicates that, under these assumptions, the collector voltage stabilizes around 8.8V in the DC operating point.

---

## Impact of Beta on Collector Voltage

The transistor's current gain (beta) significantly influences the collector current and thus the collector voltage:

- Higher Beta: More collector current for a given base current, leading to a larger voltage drop across Rc, and consequently a lower collector voltage.
- Lower Beta: Less collector current, less voltage drop, higher collector voltage, assuming all other parameters remain constant.

Given Beta = 200, the collector current is directly proportional to the base current. If beta were to change, the collector voltage would adjust correspondingly, assuming biasing conditions are fixed.

---

## Additional Factors Affecting the Collector Voltage

While the calculations above consider an ideal case, real circuits are affected by:

- Temperature Variations: Affect Vbe and beta, altering current levels.
- Biasing Network Stability: Proper biasing ensures the Q-point remains stable under variations.
- Emitter Resistance (Re): Can stabilize the operating point and influence collector voltage.
- Saturation and Cutoff Conditions: If the transistor approaches saturation (collector near ground) or cutoff (collector near Vcc), the voltage levels shift dramatically.

---

## Conclusion and Practical Implications

Determining the DC collector voltage in a transistor circuit hinges on understanding the interrelation between biasing, current gain, and load resistances. With a beta of 200, the collector current scales proportionally with the base current, which is set by the biasing network. The collector voltage then follows from the voltage drop across the collector resistor.

Key takeaways:

- Accurate biasing is vital for predictable operation.
- The collector voltage can be tailored by selecting appropriate resistor values.
- Changes in beta impact the collector current and voltage, but the biasing network can be designed for stability across beta variations.
- The methodology demonstrated—calculating base current, then collector current, and finally collector voltage—is fundamental in transistor circuit analysis.

This comprehensive approach ensures that engineers and students can confidently analyze similar circuits, ensuring reliable performance in practical electronic applications.

## [In The Circuit Shown In Fig 7 54 The Transistor Has A Beta Of 200 What Is The Dc Voltage At The Collector]

In The Circuit Shown In Fig 7 54 The Transistor Has A Beta Of 200 What Is The Dc Voltage At The Collector

## Related Articles


- If The Government Levies A $10 Tax Per Designer Handbag, Then The Price Paid By Buyers Of

Designer Handbags

- Suppose We Observe That The Outcome Of The Game Is One In Which Each Company Earns A Profit Of $10 Million.
- How Does Bradbury Describe The Physical Appearance Of Peter And Wendy When They Return Home In The Evening?

Back to Home