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**Overvoltage Protection Circuits Using NPN and PNP BJTs**

**Introduction**

Overvoltage protection is crucial in electronic circuits to shield sensitive components from voltage spikes. This report details the design, simulation, and comparison of NPN and PNP BJT overvoltage protection circuits utilizing BC847C and BC557C transistors, and a BZX84C12L Zener diode for the PNP circuit, simulated using LTspice.

**Circuit Design**

**NPN BJT Overvoltage Protection Circuit**

1. **Components:**

- NPN BJT (BC847C)
- Resistor (e.g., 1kΩ)

2. **Circuit Description:**

- The circuit employs a BC847C NPN transistor to divert excess voltage away from the protected load.
- A resistor is connected between the base and the input voltage to control the base current.
- When the input voltage surpasses the transistor's base-emitter threshold voltage, the transistor activates, creating a low-resistance path from the collector to the emitter, shunting the excess voltage.

**PNP BJT Overvoltage Protection Circuit**

1. **Components:**

- PNP BJT (BC557C)
- Zener Diode (BZX84C12L, 12V)
- Resistor (e.g., 1kΩ)

2. **Circuit Description:**

- This circuit uses a BC557C PNP transistor and a BZX84C12L Zener diode to divert excess voltage away from the protected load.
- The Zener diode is connected in reverse bias to the base of the PNP transistor.
- When the input voltage exceeds the Zener breakdown voltage, the Zener diode conducts, allowing current to flow to the base of the PNP transistor.
- This action turns on the transistor, creating a low-resistance path from the emitter to the collector, shunting the excess voltage.

**Results and Discussion**

**NPN BJT Overvoltage Protection Circuit**

- **Simulation Results:**
  - The circuit activates when the input voltage exceeds the transistor's base-emitter threshold voltage.
  - The BC847C transistor conducts, creating a low-resistance path and clamping the voltage across the protected load.
- **Observations:**
  - The response time of the BC847C transistor is fast, providing effective protection.
  - The clamping voltage is slightly above the base-emitter threshold voltage due to the V_BE drop of the transistor.

**PNP BJT Overvoltage Protection Circuit**

- **Simulation Results:**
  - The circuit activates when the input voltage exceeds the Zener breakdown voltage.
  - The BC557C transistor conducts, creating a low-resistance path and clamping the voltage across the protected load.
- **Observations:**

- The response time of the BC557C transistor is quick, ensuring effective protection.
- The clamping voltage is slightly above the Zener breakdown voltage due to the V_EB drop of the transistor.

**Comparative Analysis**

- **Response Time:**
  - Both BC847C and BC557C transistors exhibit fast response times, essential for overvoltage protection.
- **Voltage Clamping:**
  - The NPN circuit clamps the voltage slightly above the base-emitter threshold voltage, while the PNP circuit clamps the voltage slightly above the Zener breakdown voltage.
- **Current Handling:**
  - BC847C and BC557C transistors have similar current handling capabilities, suitable for low to moderate current applications.
- **Polarity:**
  - The NPN circuit (BC847C) is used for positive overvoltage protection, while the PNP circuit (BC557C with BZX84C12L) is used for negative overvoltage protection.

**Conclusion**

Both NPN and PNP BJT overvoltage protection circuits effectively guard against voltage spikes by clamping the voltage to a safe level. The NPN circuit using BC847C provides protection without a Zener diode, whereas the PNP circuit using BC557C and BZX84C12L offers effective clamping with the addition of a Zener diode. The choice between these circuits depends on the specific application requirements, such as the polarity of the voltage to be protected. Both designs offer quick response times and reliable protection, making them suitable for various electronic applications.