

7. Process Variables Which Affect Germanium Transistor Reliability

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Investigations by the Bell Telephone Laboratories into the reliability characterization of PNP germanium alloy transistors produced by the Western Electric Company have resulted in dramatic improvement in the stability of their electrical properties. These studies have extended over about five million device hours of life testing, including about 600 transistors, some tests extending over two years.

Early investigations were aimed at characterizing the stability of the emitter and collector junctions as well as the direct current gain of the transistor when subjected to various conditions of temperature, current, voltage and power. From these studies evolved a simple method for the early detection of instability which would eventually lead to failure. A need for improving the stability of this transistor was also established.

With the aid of this background, a statistically designed process experiment was carried out aimed at establishing the cause of instability in the manufacturing process. The experiment involved a one-fourth replicate of five process variables at two levels each. About 500 transistors were fabricated. Analysis of initial electrical characteristics, as well as life studies beyond 2000 hours, indicate the main sources of instability were in the final encapsulation process. According to certain criteria of survival, transistors from the various processes ranged from 50% to 100% survival at 2000 hours of life test under power at 55°C ambient. Reliability of production units is running near the latter figure.