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# NASA TECH BRIEF



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## Diffusion Technique Stabilizes Resistor Values

### The problem:

To stabilize the values, over a broad temperature range, of resistors used in linear integrated circuits. When several resistors are to be used together in a linear circuit, it is important that they remain as close as possible to their absolute values or that their values vary with temperature in such a manner that the same electrical relationship is maintained. If one resistance of a voltage divider, for example, is in the 10–100 ohm range while the other is several thousand ohms, their proportional variation with temperature or temperature tracking, can be expected to be very poor.

### The solution:

Reduce the contact resistance of resistors by P+ diffusion under the alloyed aluminum contacts.

### How it's done:

Impurities are introduced into the resistor by P+ diffusion. These impurities offer high conductivity to the region under the aluminum contacts of the resistor, thus reducing contact resistance. The effectiveness of this technique is checked by measuring the reverse breakdown of a base-emitter junction to compare the resistance of a resistor to its geometry after P+ diffusion. A metallographic cross section stained with acid to delineate the junctions shows whether the reduction in contact resistance may be attributed to the P+ diffusion.

### Notes:

1. The effectiveness of this innovation has been verified by experiment; it is being used for all small-value resistors in the linear circuits of the Lunar Excursion Module TV camera.
2. Absolute value tolerances of resistors are reduced from  $\pm 20\%$  to better than  $\pm 10\%$ . A linear amplifier whose voltage gain depends on the linearity and temperature tracking of a 1K ohm:50 ohm resistance ratio was improved from 25% to 3% variation in voltage gain over the temperature range  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . In general, linearity with voltage polarity change is also improved.
3. Inquiries concerning this innovation may be directed to:

Technology Utilization Officer  
Manned Spacecraft Center  
Houston, Texas, 77001  
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### Patent status:

No patent action is contemplated by NASA.

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Category 01