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# NASA TECH BRIEF



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## Conceptual Techniques for Reducing Parasitic Current Gain of Lateral PNP Transistors

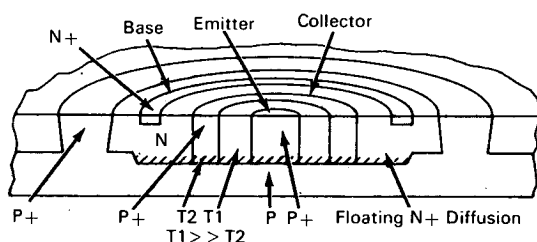
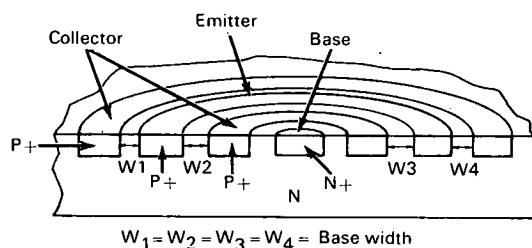


Fig. 1. Isolation Diffused Lateral PNP Structure



$$W_1 = W_2 = W_3 = W_4 = \text{Base width}$$

Fig. 2. Annular Ring PNP Structure

Two proposed techniques are presented as possible means of reducing parasitic Beta in lateral PNP transistors. These methods may be applicable and of interest to persons and organizations involved in the fabrication, design, and development of semiconductor components and integrated circuits.

### The problem:

Lateral PNP bipolar transistors require isolation of the "active" regions of the device structure from the substrate and peripheral boundaries in order to reduce parasitic Beta. Conventional fabrication process techniques require additional photoresist and diffusion steps to accomplish this.

### The solution:

Two methods have been conceptually proposed to provide the isolation.

Method (1) uses a degenerate substrate and a high concentration P<sup>+</sup> guard-ring diffusion.

Method (2) places the base contact at the center of an annular ring structure to improve lateral PNP transistor action and reduce parasitic Beta.

### How it's done:

Method (1). The diffusion used for the isolation of

the epitaxy region is also used to form the emitter and collector regions. A cross-sectional view of the device shown in Figure 1 demonstrates the stopping action of the floating N<sup>+</sup> diffusion located beneath the emitter and collector. The lifetime,  $\tau_2$ , of the N<sup>+</sup> region is much lower than  $\tau_1$  of the epitaxy base. The isolation diffusion guard-ring has a surface concentration between  $5.0 \times 10^{19} - 5.0 \times 10^{20}$  which is sufficient to maintain the injection efficiency.

Method (2). The base contact on a lateral PNP device is normally located on the outside of the collector region. If the base contact is located within the emitter, the emitter will assume a donut shape rather than a circular shape. Since the emitter injects from both sides, the collector should completely encircle the emitter. The annular ring structure shown in Figure 2 accomplishes this and also maximizes the emitter injection efficiency for a given area. This structure gives a base contact that is symmetrical to the structure rather than a non-symmetric location outside the collector and provides for collection of minority carriers injected towards the center as well as those which are injected radially.

(continued overleaf)

**Notes:**

1. No further documentation is available.
2. Inquiries may be directed to:  
Technology Utilization Officer  
Manned Spacecraft Center  
Houston, Texas 77058  
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**Patent status:**

No patent action is contemplated by NASA.

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