

# NASA TECH BRIEF

## Marshall Space Flight Center



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### Overlap Diffusion for Increasing Phototransistor Dynamic Range

#### The problem:

The present phototransistors operating in the charge-storage mode have very limited dynamic ranges. There are severe limitations on both the maximum voltage at which these devices may be operated and the maximum base-collector capacitance which can be obtained from them.

#### The solution:

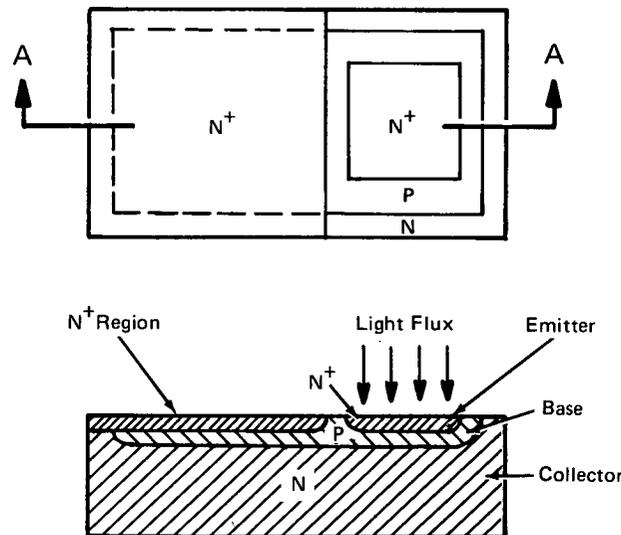
The base-collector capacitance in phototransistors is increased by a factor of five by use of one of the two methods of  $n^+$  diffusion.

#### How it's done:

As shown in the Figure 1, one configuration of the improved phototransistor is constructed of a silicon or germanium semiconductor wafer. The lower portion forms the collector region to provide an n-type con-

ductivity for n-p-n type phototransistors (p-type conductivity for p-n-p type). Above the collector region is a base region which is formed by diffusion of impurities into the substrate exhibiting p-type conductivity for an n-p-n device (n-type for a p-n-p device). A third distinct emitter region is formed by diffusion of  $n^+$  impurities into the base region ( $p^+$  impurities for p-n-p device) to create a second junction. This stage completes the formation of conventional phototransistor. To depart from the conventional device, a second base-collector junction is formed by an  $n^+$  ( $p^+$  for p-n-p) conductivity layer, as in the case of an emitter region. This layer is out of the emitter-collector path and does not contribute to the base-collector junction breakdown. At the same time, this layer increases the base-collector capacitance.

A second type of construction that increases the base-collector capacitance is shown in Figure 2. This photo-



SECTION A-A

Figure 1.

(continued overleaf)

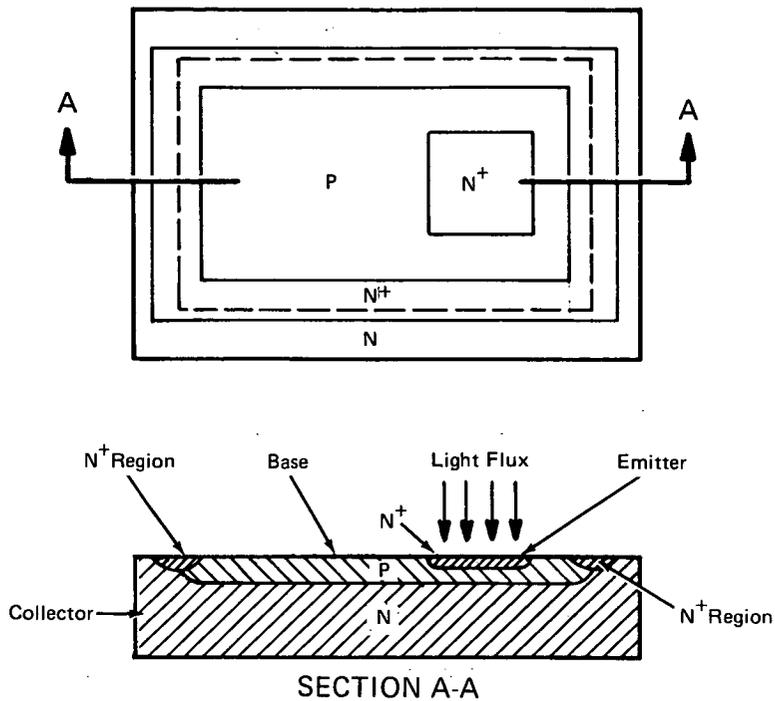


Figure 2.

transistor includes an additional base-collector junction which is provided by diffusion of  $n^+$  region into the base periphery ( $p^+$  for p-n-p). This additional region connects to the collector region by a common peripheral boundary. Again, being out of the emitter-collector path, this region provides additional base-collector capacitance without a decrease in the maximum base-collector operating voltage.

**Note:**

Requests for further information may be directed to:  
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**Patent status:**

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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