

Epitaxial phototransistor with feedback has fast response

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A high-gain negative-feedback loop will reduce the response time of an epitaxial phototransistor to 100 nanoseconds—a significant improvement over several schemes previously suggested.^{1,2,3} Because of its construction, the epitaxial device all but eliminates the diffusion of carriers into its depletion region from the bulk collector region, which slows a conventional non-epitaxial phototransistor's operating speed. And added feedback reduces the input-signal swing across the collector-base junction to 1% of what it is normally, further reducing the input-capacitance charge and discharge times.

The MRD 300 phototransistor shown in the circuit has a typical rise time of 2.5 microseconds and a fall

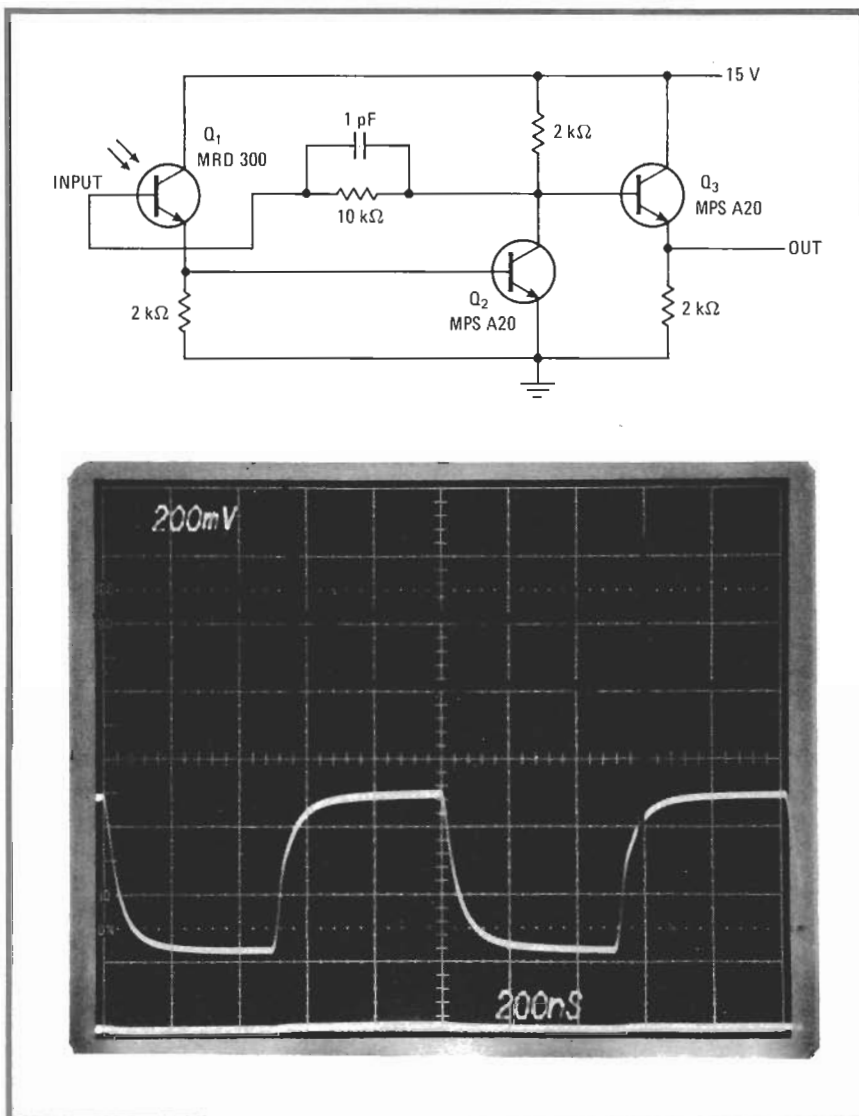
time of 4 μ s if operated in the conventional emitter-follower configuration. In this modified circuit Q_2 serves as the feedback amplifier that keeps the base of the phototransistor at an almost constant voltage for changes in input-signal level. Thus the effective input capacitance that must be charged and discharged is reduced. Q_3 serves as a buffer. Note that using feedback that is negative enables the switching times to be maximally reduced without fear of creating instability (that is, oscillations can be generated with circuits using positive feedback).

With this circuit, both the rise time and the fall time of the phototransistor are reduced to 100 ns. The output voltage is equal to the product of feedback resistance (10 kilohms) and the collector-base photocurrent. The photograph shows a typical output waveform.

As for the phototransistor itself, it can be hard to determine from data sheets if one is epitaxial or not. The best way to find out is to consult the manufacturer. □

References

1. "Why not a cascode optocoupler?", *Electronics*, March 2, 1978, p. 132.
2. "Why not a cascode optocoupler? Here's why not", *Electronics*, April 27, 1978, p. 154.
3. "Bootstrapping a phototransistor improves its pulse response", *Electronics*, Aug. 17, 1978, p. 105.



Speedy. Collector-to-base capacitance of phototransistor Q_1 is reduced by employing epitaxial device (MRD 300) and high-gain negative feedback (Q_2), so that operating speed can be increased. Emitter-follower Q_3 provides low-impedance output. Photograph shows typical output response.