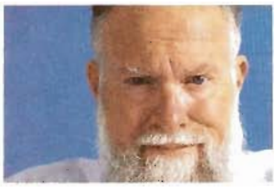

What's All This PNP Stuff, Anyhow?

Back in the 1960s, I worked with Joe, a good technician who was very analytical. He told me he had put in many months of study to figure out how to bet on horse races. He analyzed all the handicaps, the horses' records and times, the jockeys' records, and so on, just as bettors have done for years.

After all those months, though, he decided he couldn't compute how he should bet on horses. His system was never really good enough to actually predict which horse would win and make him money. So, he gave up.

Then Joe tried to invent a way to get around the poor PNP transistors of the day. If he could do that, he would be a hero. Even now, many PNPs aren't as good as NPNs. Joe told me that he had put in many hours, over several months, to try to use two good NPNs to replace a mediocre PNP. And, he finally admitted, he couldn't do it. Instead, he was going to try to use three NPNs to replace a PNP.

I thought about his idea. I finally told him that he should go back to playing the horses. It would be a better investment of his time.

HERE'S ONE SOLUTION

But there is a good way to replace a PNP Darlington *(Fig. 1a)* or a composite PNP/NPN *(Fig. 1b)* with a trick circuit using one PNP and one NPN (plus a couple of auxiliary 1-mA current sources). We figured it out when we were trying to build some very fast digital-to-analog converters (DACs).

We had a bunch of PNP current sources that were turned on and off. They were working well and fast. The output currents were added together. Yet when all the PNP collectors were bussed together, the output capacitance was getting quite big.

Could we avoid having the response delayed by the poor total capacitance? Maybe we could put in a PNP cascode. But obviously, the cascode's alpha would get poor, quite fast. And, a PNP Darlington would have inferior response. We couldn't get it to settle in the required 80 ns. What's a mother to do?

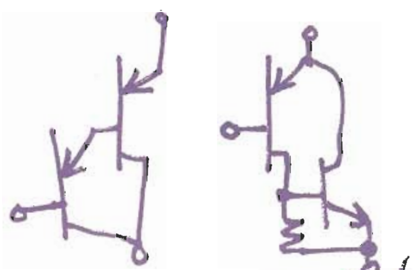

Fig 1a. Fig 1 b.

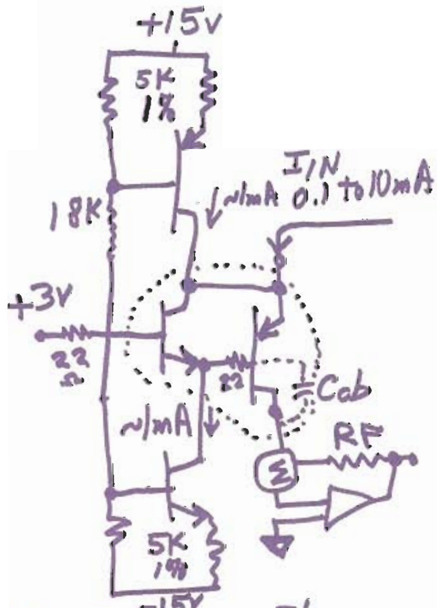

Fig. 2 Fancy-Shmancy compound PNP

It turns out that this trick circuit has some advantages *(Fig. 2)*. It not only has better alpha than the best single PNP, it also has lower output capacitance and faster F-alpha. These days, PNPs are often good enough so you don't always get in trouble with them. But sometimes, this circuit's advantages are still useful.

ON THE BENCH

The current flowing in Ccb does still flow, but at moderate speeds (slower than 250 V/µs), this current can be ignored! Any current that flows at the collector end is dumped into the base, through the NPN's emitter, and is subtracted from the PNP's emitter current. So, the effective Ccb is decreased by a factor of the NPN's beta.

Likewise, if you dump current into the PNP's emitter and its C_{TE} causes a lot of that current to flow into its base, that current gets cancelled, and the current gain at high frequency is improved, just as the dc alpha is improved. I must admit this sounds much too good to be true, but it does work, and it does tend to settle quickly in the time domain, too.

This improvement applies to the ratty old 2N1131s and 2N1132s (with Cob = 30 pF and beta = 7 to 40) and provides surprisingly good, quick performance. It also applies to faster PNPs such as 2N2907s and 2N3906s, if you need a little boost in performance. I don't recall if I have ever seen this circuit in print. Joe never figured it out, because he wasn't looking for this approach. But it can be useful, even in the era of modern PNPs and fast ICs. It can even help an NPN! ED

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