ALTERNATOR REGULATOR

Having designed a regulator similar to that of Mr Watkinson (August issue), I have discovered that stabilising the regulator is not as straightforward as he suggests.

I found that with a circuit very similar to his, including stabilising capacitor C_1, I was getting gross instability to the extend that at night a 2Hz flicker was apparent in the headlight beams. The battery potential was varying by about 0.5 volts, indicating that the regulator was switching the alternator fully on or fully off. After some thought I realised, as Mr Watkinson states, that the transfer function of the alternator has poor bandwidth. Because of the inductance of the field winding, a sizeable lag is introduced into the feedback loop.

The instability this causes may be eliminated by lowering the loop again, i.e. decreasing the gain of the regulator. However, this then has the effect of widening the error band of the loop, so that for light loads the battery voltage is high, leading to overcharging during daylight in the summer, and conversely low battery voltage for heavy loads such as rear screen heaters and lights — not a desirable phenomenon.

The alternative that I chose was to accept that the feedback loop will be unstable, and to ensure that the regulator switches at a few hundred hertz. This has the advantage that the output transistor dissipates very little power. (An analogy is the switched mode power supply compared with the linear regulating type.) Loop gain can be very high, giving constant battery voltage whatever the load.

This is achieved by connecting C_1 between the base of Tr_1 and the positive rail instead of earth, in Mr Watkinson's Fig. 1. In fact, my circuit as shown is very similar to his Fig. C, differing mainly in that my alternator field winding is earthed at one end. I therefore inverted the connections to the op-amp, and used a p-n-p Darlington transistor between the positive supply rail and the field winding. Using a 741 op-amp with its low output slew-rate helps avoid fast switching transients coupling through the alternator.

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