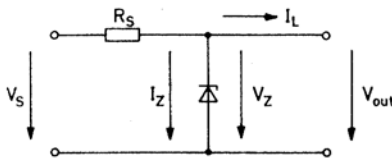


Temperature-Compensated Stabilizing Circuits

Two Zener diode parameters in particular affect the stabilizer performance - the voltage temperature coefficient α_{VZ} and the differential resistance r_{zj} . These parameters are determined by the physical properties of the conventional Zener diodes and their effect on stabilization performance will be better appreciated if the simple stabilizer circuit shown in the figure below, consisting of a resistor in series with a Zener diode, is considered.



In this circuit the output voltage V_{out} (which in this case is the same as the Zener voltage V_Z) is related to the supply voltage V_S , the load current I_L and the ambient temperature T_{amb} by the expression

$$\Delta V_{out} = \frac{r_z}{R_S} \cdot \Delta V_S + r_z \cdot \Delta I_L + \alpha_{VZ} \cdot V_Z \cdot \Delta T_{amb} \quad (18)$$

As far as the differential resistance r_z is concerned a distinction should be made between the inherent differential resistance r_{zj} and the static differential resistance r_{zu} . The following equation applies:

$$r_{zu} = r_{zj} + \alpha_{VZ} \cdot V_Z^2 \cdot R_{th} = r_{zj} + r_{zth}, \quad (19)$$

where R_{th} is the thermal resistance and r_{zth} the thermal differential resistance of the diode.

The second term in this expression takes into account the change in dissipation $V_Z \cdot \Delta I_L$ due to the current variation ΔI_L , which, for a thermal resistance R_{th} , produces a crystal temperature change of

$$\Delta T_j = V_Z \cdot R_{th} \cdot \Delta I_L \quad (20)$$

and consequently an output change of

$$\Delta V_Z = \alpha_{VZ} \cdot V_Z \cdot \Delta T_j = \alpha_{VZ} \cdot V_Z^2 \cdot R_{th} \cdot \Delta I_L \quad (21)$$

Let us, by way of an example, calculate the performance of a stabilizer circuit which incorporates a Zener diode type ZPD 22 from ITT Semiconductors and operates from a high supply voltage and with low load current. For this type the following data are published for $I_Z = 5 \text{ mA}$:

$$V_Z = 22 \text{ V}$$

$$r_{zu} = r_{zj} + r_{zth} = 25 \Omega + 100 \Omega = 125 \Omega$$

$$\alpha_{VZ} = 9 \cdot 10^{-4} / \text{K}$$

For a supply voltage of $V_S = 220 \text{ V}$, a load current of $I_L = 5 \text{ mA}$ and a diode Zener current of $I_Z = 5 \text{ mA}$ the value of the series resistor works out to

$$R_S = \frac{220 \text{ V} - 22 \text{ V}}{5 \text{ mA} + 5 \text{ mA}} = 19,8 \approx 20 \text{ k}\Omega.$$

Let us also assume that the supply voltage varies by $\pm 10\%$, i.e. $\Delta V_S \approx 40 \text{ V}$, the load current by $\Delta I_L = 2 \text{ mA}$ and the ambient temperature by $\Delta T_{amb} = 20 \text{ K}$, then, according to equation (18), the output varies by

$$\begin{aligned} \Delta V_{out} &= \frac{125 \Omega \cdot 40 \text{ V}}{20 \text{ k}\Omega} + 125 \Omega \cdot 2 \text{ mA} + 9 \cdot 10^{-4} / \text{K} \cdot 22 \text{ V} \cdot 20 \text{ K} \\ &= 250 \text{ mV} + 250 \text{ mV} + 396 \text{ mV} \end{aligned}$$

This example shows that ambient temperature variations exercise a larger effect on the output than supply voltage or load current variations.

Silicon Schottky Barrier Diodes

Schottky diode current flow is due to majority carrier conduction. It is not affected by reverse recovery transients as are conventional PN diodes due to stored charge and minority carrier injection.

The low forward voltage drop and fast switching make the diodes ideal for protection of MOS devices, steering, biasing and coupling for fast switching and low logic level applications.