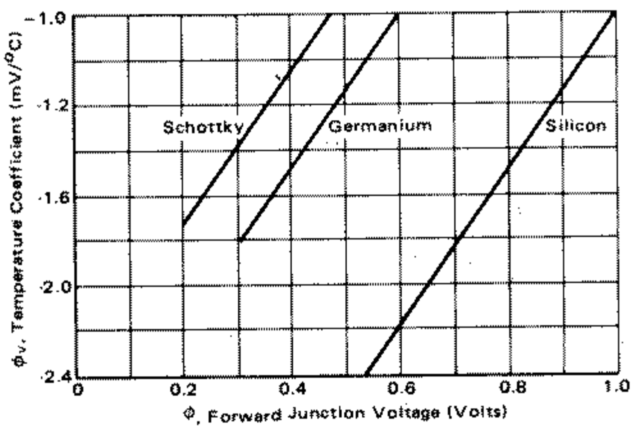
Although not apparent from Equation 1, temperature exerts a considerable influence upon the ideal diode characteristic. The diffusion current (I_R) roughly doubles for every 10°C increase in junction temperature, due to thermal agitation of the semiconductor molecules. Since Equation 1 is valid at all temperatures, V_F decreases (I_F being held constant) when I_R increases. The general "rule of thumb" used for the temperature coefficient of V_F is -2.0 mV/°C; the exact value depends upon the forward drop of the junction[2] which is dependent upon the forward current and the diode area, resistivity, and material. Figure 4 shows temperature coefficient behavior.



Data applies only at T_J = 25°C, but the effect of temperature is small. Valid only when $\epsilon^{q\phi/KT} >> 1$.

Figure 4 — Temperature Coefficient of The Ideal Diode.

REAL DIODE BEHAVIOR

There are a number of reasons why real diodes do not follow the ideal equations. Rather than complicate the equations, some effects are generally shown graphically while others can often be depicted by constructing a model or equivalent circuit for the diode.

Leakage Current — Whenever a semiconductor p-n junction is reverse biased, a reverse or leakage current (I_R) follows through the junction. The reverse current is the sum of three currents: I_D, due to diffusion, I_G, due to charge generation and I_S, due to surface leakage. Therefore,

$$I_R = I_D + I_G + I_S. \qquad (2)$$

The behavior of each of these components of reverse current will be considered separately. The "ideal diode" equation assumes I_G and I_S are negligible.

The diffusion current (I_D) is caused by minority carriers in the high resistivity region, which come under the influence of the high field across the depletion layer and are pulled across the junction. The diffusion current is strongly dependent upon temperature and is constant with voltage only in