

MEASURING DIODE CHARACTERISTICS

n and I_s

K. KUHN

9-20-97

DIODE EQUATION

$$I = I_s \left(e^{V/nV_T} - 1 \right)$$

I = DIODE CURRENT IN AMPERES

I_s = REVERSE SATURATION CURRENT IN AMPERES

V = VOLTAGE ACROSS JUNCTION IN VOLTS

V_T = THERMAL VOLTAGE

$$V_T = \frac{kT}{q}$$

T = TEMPERATURE IN °K

k = BOLTZMANN'S CONSTANT

$$= 1.38 \times 10^{-23} \text{ J/°K}$$

q = MAGNITUDE OF ELECTRONIC CHARGE

$$= 1.6 \times 10^{-19} \text{ C}$$

$$V_T = \frac{1.38 \times 10^{-23} \text{ (J/°K)} * T}{1.6 \times 10^{-19} \text{ C}} = \underline{86.25 \mu\text{V/°K}}$$

NOTE J/C = V

n = JUNCTION CONSTANT TYPICALLY BETWEEN 1 AND 2

WE WILL APPROXIMATE THE DIODE EQUATION

AS
$$I = I_s e^{V/nV_T}$$

MAKE 2 MEASUREMENTS

$$I_1, V_1$$

$$I_2, V_2$$

I IS DIODE CURRENT

V IS DIODE VOLTAGE

FOR SMALL SIGNAL DIODES, GOOD VALUES TO USE ARE:

SET I_1 TO 1 mA AND READ V_1

SET I_2 TO 100 μ A AND READ V_2

$$\frac{I}{I_s} = e^{V/nVT}$$

$$\ln\left(\frac{I}{I_s}\right) = \frac{V}{nVT}$$

$$nVT \ln\left(\frac{I}{I_s}\right) = V$$

$$nVT [\ln I_1 - \ln I_s] = V_1$$

$$nVT [\ln I_2 - \ln I_s] = V_2$$

$$nVT [\ln I_1 - \ln I_2] = V_1 - V_2$$

$$n = \frac{V_1 - V_2}{VT \ln\left(\frac{I_1}{I_2}\right)}$$

MUST KNOW AMBIENT TEMPERATURE IN $^{\circ}$ K

$$I_s = I_1 e^{\frac{-V_1}{nVT}}$$