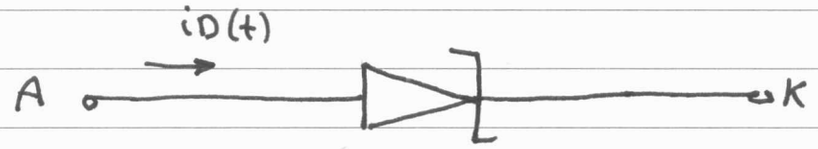
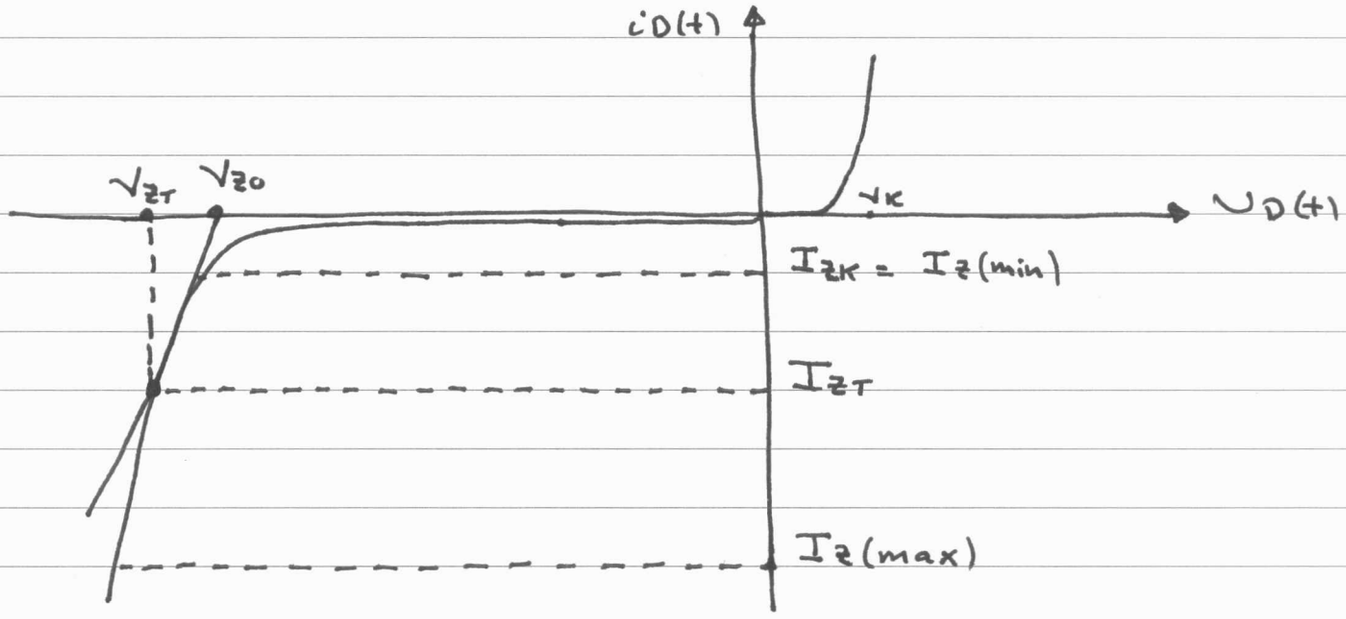
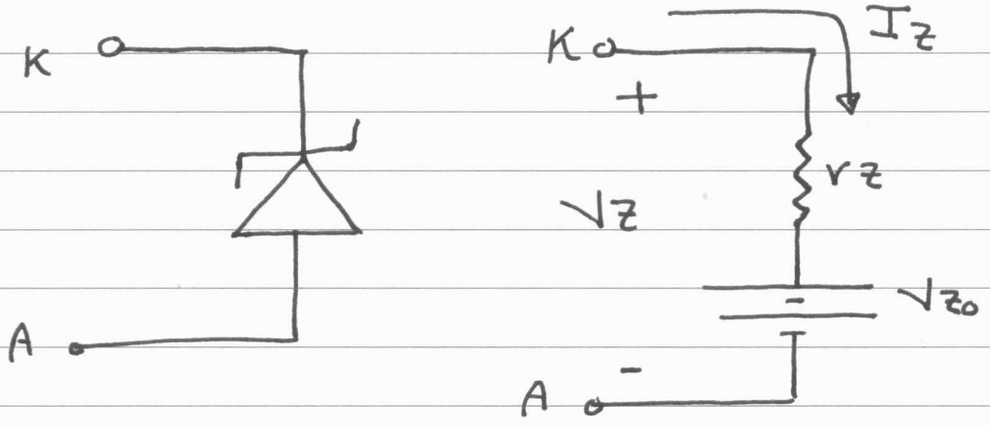
Zener Diode



\+ $v_D(t)$ −



The Model of the Zener diode in the breakdown



$$r_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

Example

A 1N4736 Zener diode has $r_z = 3.5\,\Omega$

The data sheet gives $V_{ZT} = 6.8\,V$ @ $I_{ZT} = 37\,mA$

and $I_{ZK} = 1\,mA$.

a) Find V_z when $I_z = 50\,mA$
b) Find V_z when $I_z = 25\,mA$

$$V_z = r_z I_z + V_{z0}$$

$$V_{ZT} = r_z I_{ZT} + V_{z0}$$

$$6.8\,V = (3.5)(37\,mA) + V_{z0}$$

$$\therefore V_{z0} = 6.6705\,V$$

a) when $I_z = 50\,mA$

$$V_z = (3.5)(50\,mA) + 6.6705$$

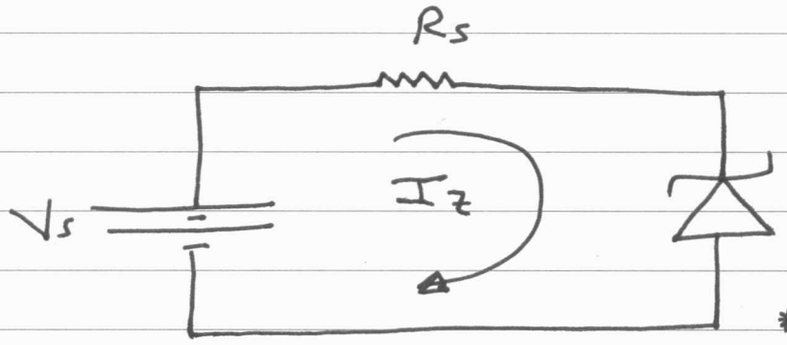
$$V_z = 6.8455\,V$$

b) when $I_z = 25\,mA$

$$V_z = 6.6705 + (3.5)(25\,mA)$$

$$V_z = 6.756\,V$$

Circuits Containing Zener diode



* Zener diode is reversed-bias

If $V_s > V_{z0}$, the zener diode is in the breakdown region

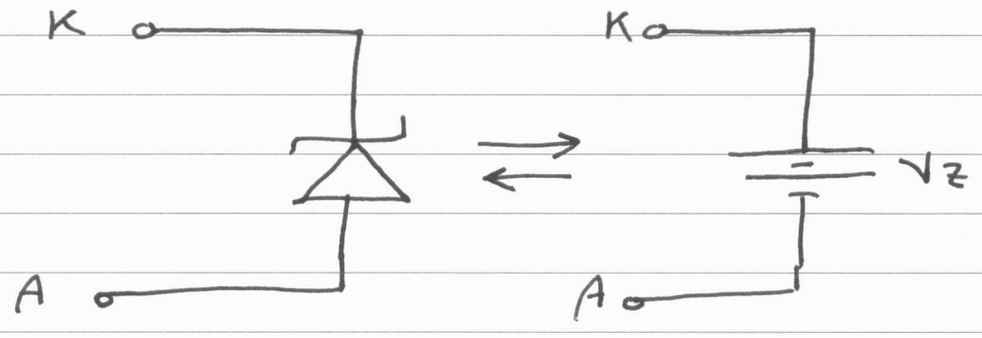
If $V_s < V_{z0}$, the zener diode is open circuit

also we must make sure that

$I_{z(max)} > I_z > I_{z(min)}$

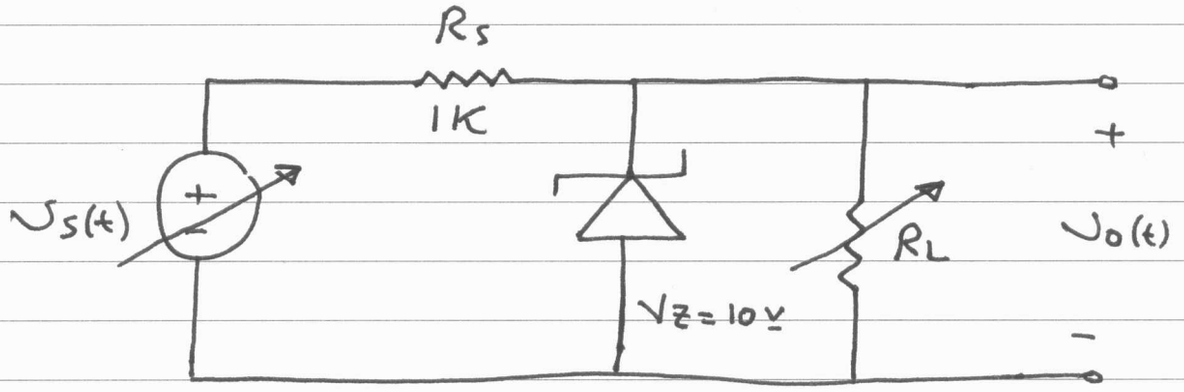
for the zener diode to operate safely in the breakdown region

Ideal model of zener diode in the breakdown region

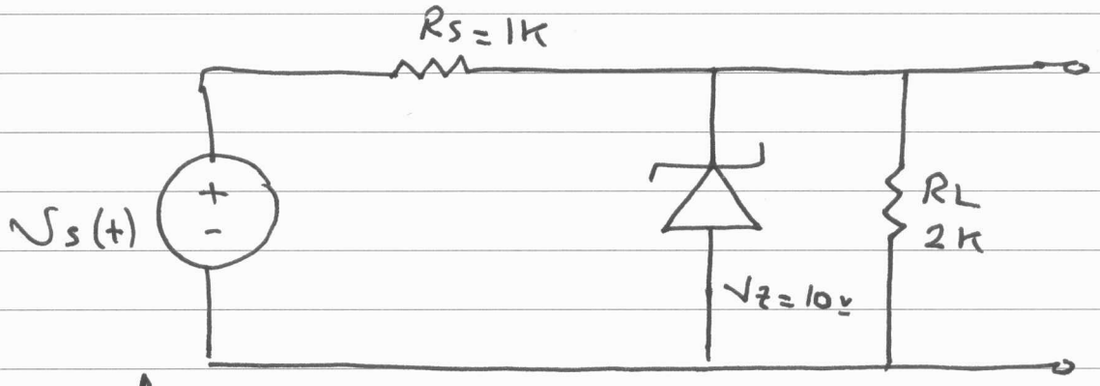


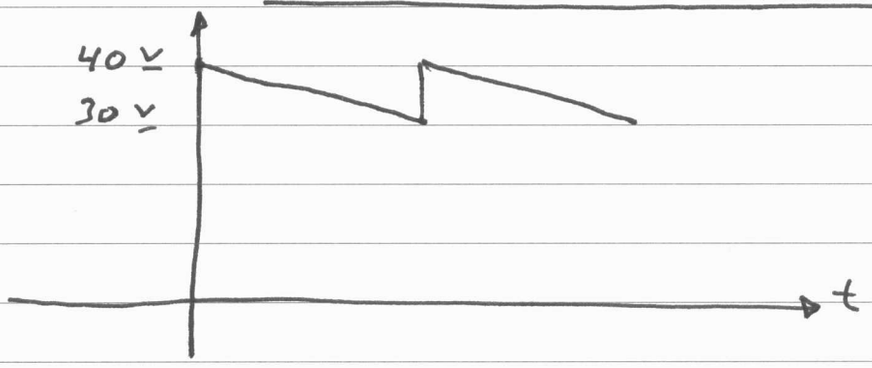
Regulator : used to maintain a constant dc output voltage under variation in the Load current from the dc power supply and under variation in the ac line voltage

Simple voltage regulator

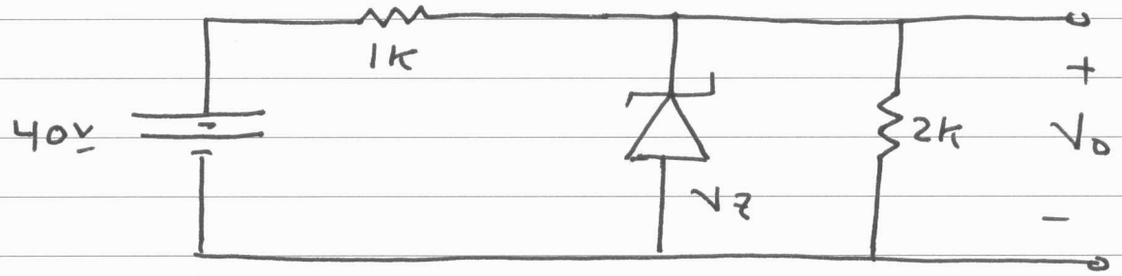


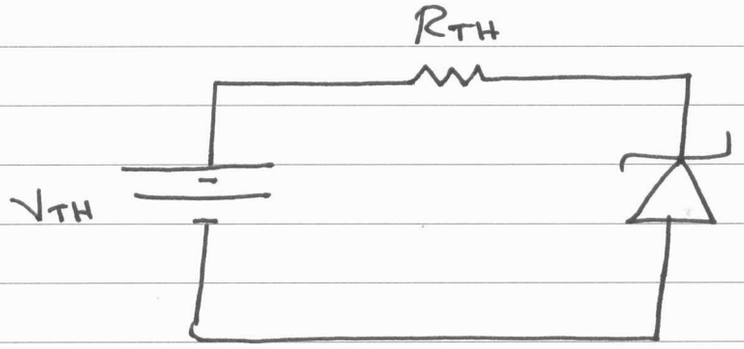
1) Voltage regulation with input variation





a) let $V_S(t) = 40V$

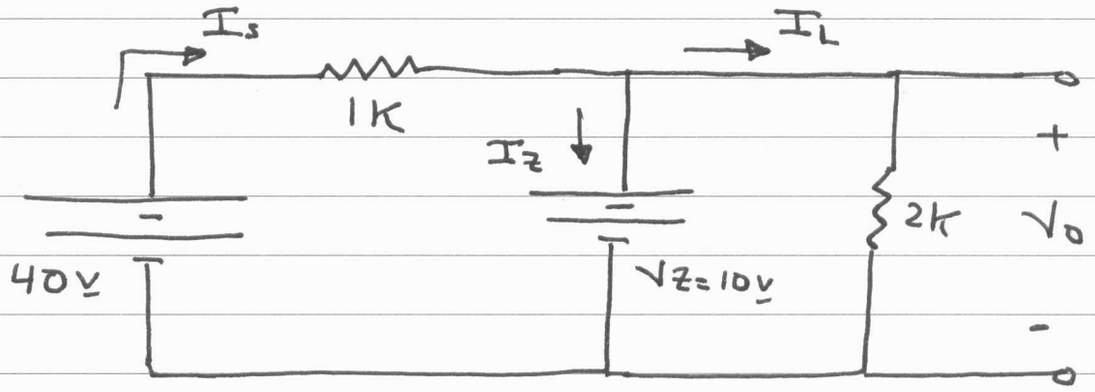




$R_{TH} = 1K \| 2K = 0.67K$

$V_{TH} = \frac{2K}{2K+1K} \cdot 40 = 26.7V$

Since $V_{TH} > V_z$; the Zener diode is in the breakdown region



$\therefore V_o = V_z = 10\ V$

$$I_s = \frac{40-10}{1K} = 30\ mA$$

$$I_L = \frac{V_o}{R_L} = 5\ mA$$

$$I_z = I_s - I_L = 25\ mA$$

b) Let $V_s(t) = 30V$

following the same steps as before

$R_{TH} = 0.67K$

$V_{TH} = 20V$

Since $V_{TH} > V_z$; The Zener in the breakdown

$\therefore V_o = V_z = 10$

$I_s = 20mA$

$I_L = 5mA$

$\therefore I_z = 15mA$