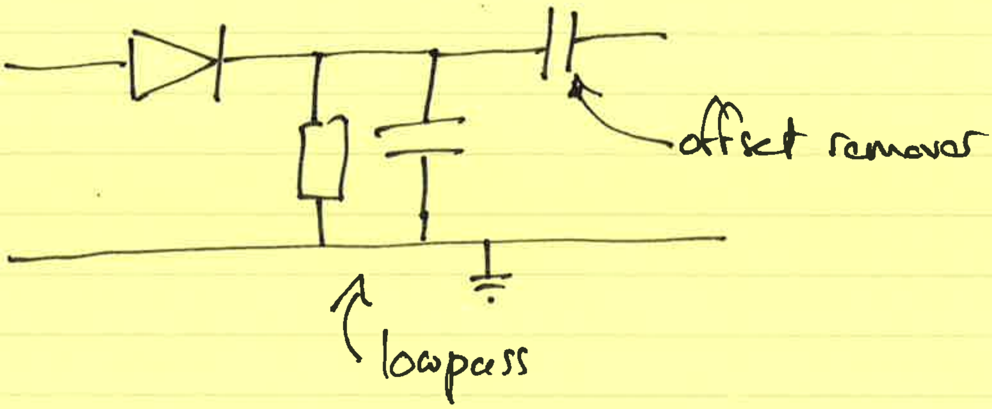
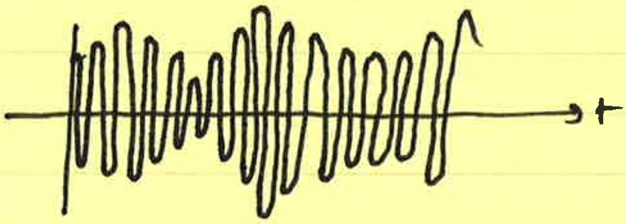
Passive AM receiver (IEP)

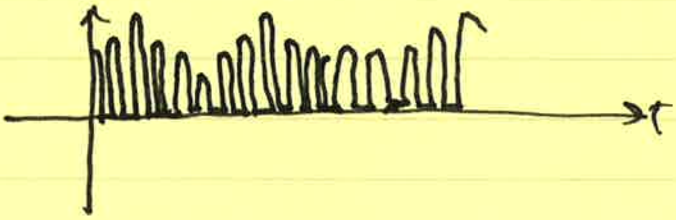


What does the diode do?

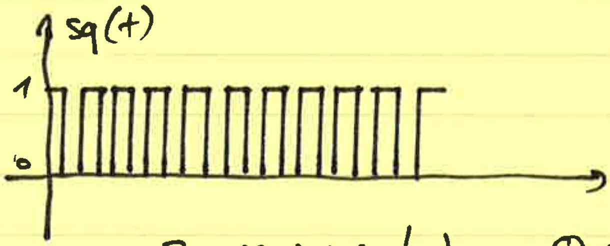
AM signal



after diode



equivalent to multiplication of AM signal with



square wave between 0 and 1

Mathematics data book : $\tilde{sq}(t) = \frac{4}{\pi}\sum_{m=1}^{\infty} \frac{\sin(2m-1)\omega_c t}{2m-1}$

(square wave between -1 and 1).

$$\Rightarrow sq(t) = \frac{1}{2} + \frac{1}{2}\cdot\frac{4}{\pi}\sum_{m=1}^{\infty}\frac{\sin(2m-1)\omega_c t}{2m-1}$$

if $s(t) = (a_0 + x(t))\cos\omega_c t$

then the output of the diode is

$$\hat{s}(t) = (a_0 + x(t))\cdot\cos\omega_c t \cdot sq(t)$$

$$= (a_0 + x(t))\cos\omega_c t\left(\frac{1}{2} + \frac{1}{2}\frac{4}{\pi}\sum_{m=1}^{\infty}\frac{\cos(2m-1)\omega_c t}{2m-1}\right)$$

(note use of cos instead of sin which merely corresponds to a phase shift of the square wave).

Recovered signal:

$$\hat{x}(t) = \text{Lowpass}\left[(a_0 + x(t))\cos\omega_c t\left(\frac{1}{2} + \frac{1}{2}\frac{4}{\pi}\sum_{m=1}^{\infty}\frac{\cos(2m-1)\omega_c t}{2m-1}\right)\right] - \text{offset}$$

$$= \text{Lowpass}\left[(a_0 + x(t))\left(\underbrace{\frac{1}{2}\cos\omega_c t}_{0 \text{ after low pass}} + \frac{2}{\pi}\sum_{m=1}^{\infty}\frac{\cos\omega_c t\cos(2m-1)\omega_c t}{2m-1}\right)\right] - \text{offset}$$

$$= \text{Lowpass}\left[(a_0 + x(t))\left(\frac{2}{\pi}\cos^2\omega_c t + \frac{2}{3\pi}\cos\omega_c t\cos 3\omega_c t + \frac{2}{5\pi}\cos\omega_c t\cos 5\omega_c t + \dots\right)\right] - \text{offset}$$

$$= \text{lowpass}\left[(a_0 + x(t))\left(\frac{2}{\pi}\cdot\left(\frac{1}{2} + \underbrace{\frac{1}{2}\cos 2\omega_c t}_{0}\right) + \frac{2}{3\pi}\left(\underbrace{\frac{1}{2}\cos 4\omega_c t}_{0} + \underbrace{\frac{1}{2}\cos 2\omega_c t}_{0}\right) + \dots\right]\right] - \text{offset}$$

after lowpass

$$= \frac{1}{\pi}(a_0 + x(t)) - \text{offset} = \frac{1}{\pi}x(t).$$