

Principles of Communications

ECS 332

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4. Amplitude Modulation



Office Hours:

BKD, 6th floor of Sirindhralai building

Wednesday **14:00-15:30**

Friday **14:00-15:30**

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4.1 DSB-SC



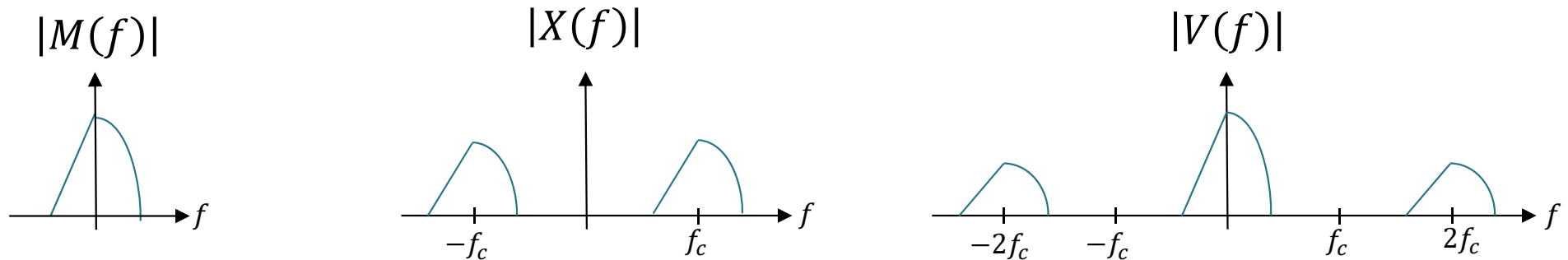
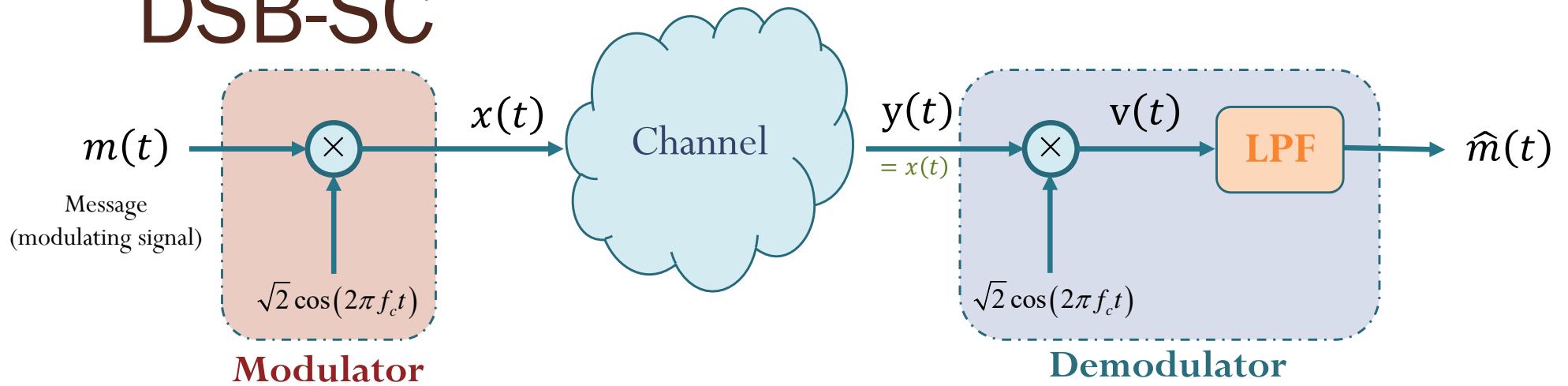
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DSB-SC



Key equation:

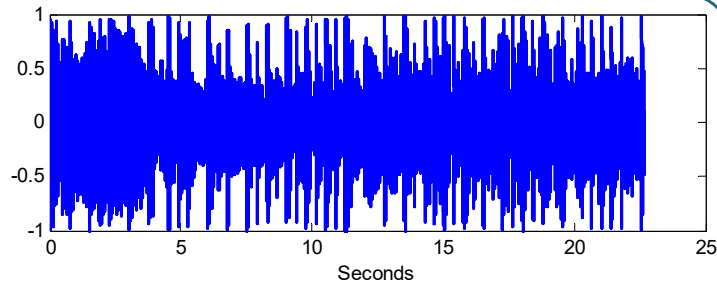
$$\text{LPF} \left\{ \underbrace{\left(m(t) \times \sqrt{2} \cos(2\pi f_c t) \right)}_{x(t)} \times \underbrace{\left(\sqrt{2} \cos(2\pi f_c t) \right)}_{v(t)} \right\} = m(t)$$



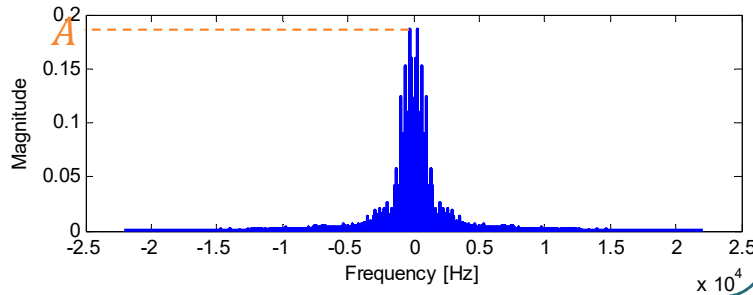


DSB-SC

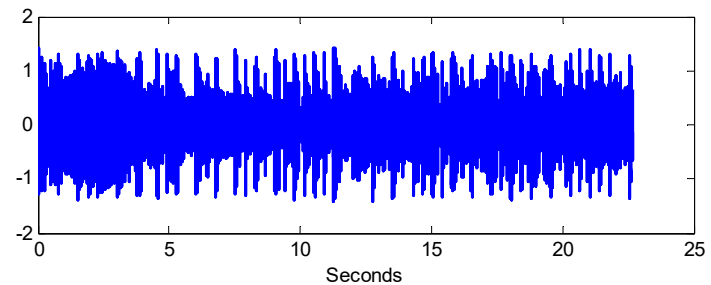
$m(t)$



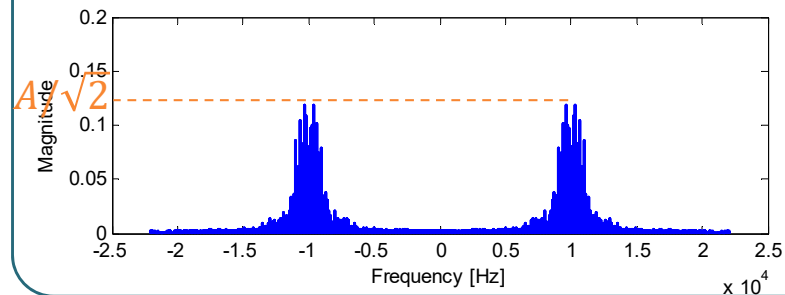
$|M(f)|$



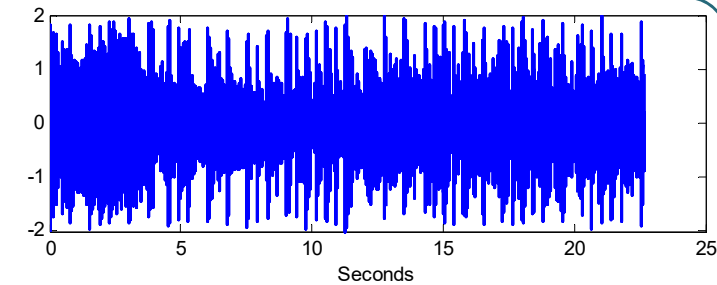
$x(t)$



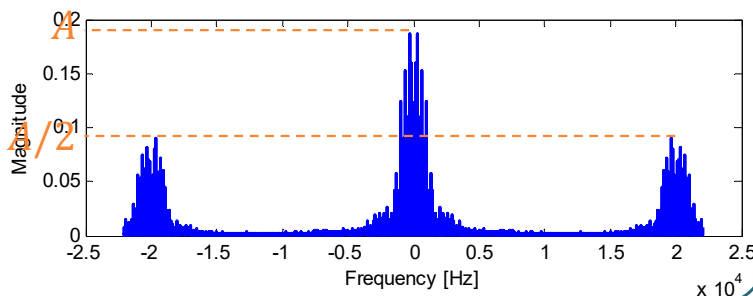
$|X(f)|$



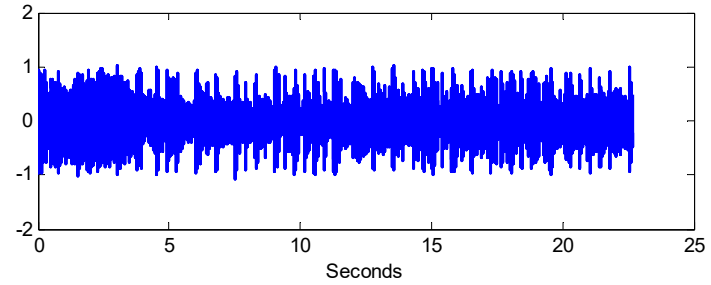
$v(t)$



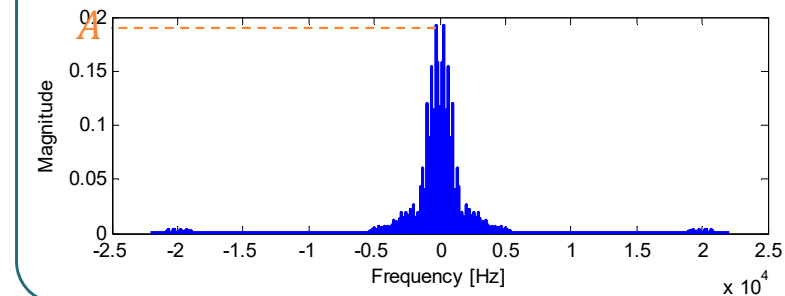
$|V(f)|$



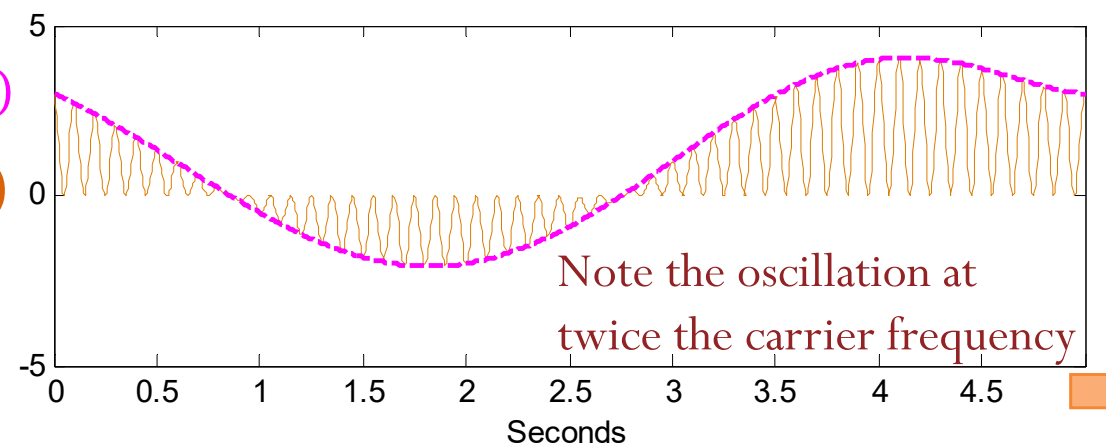
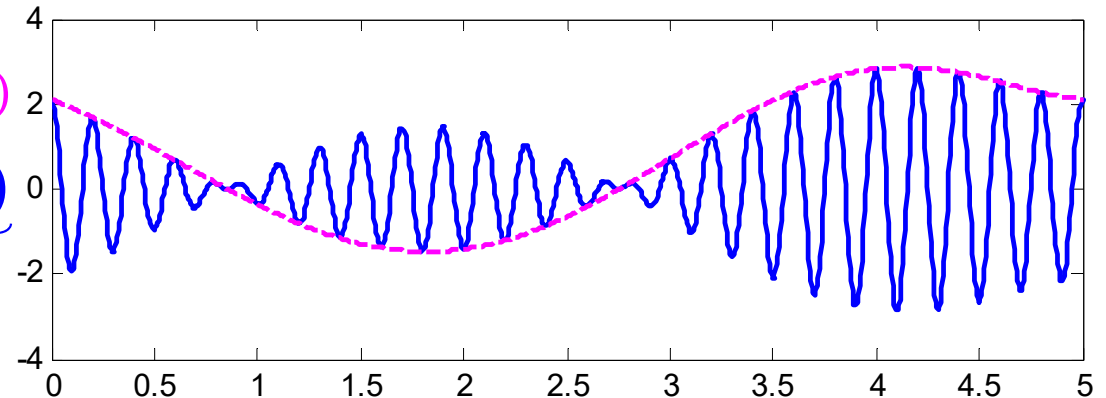
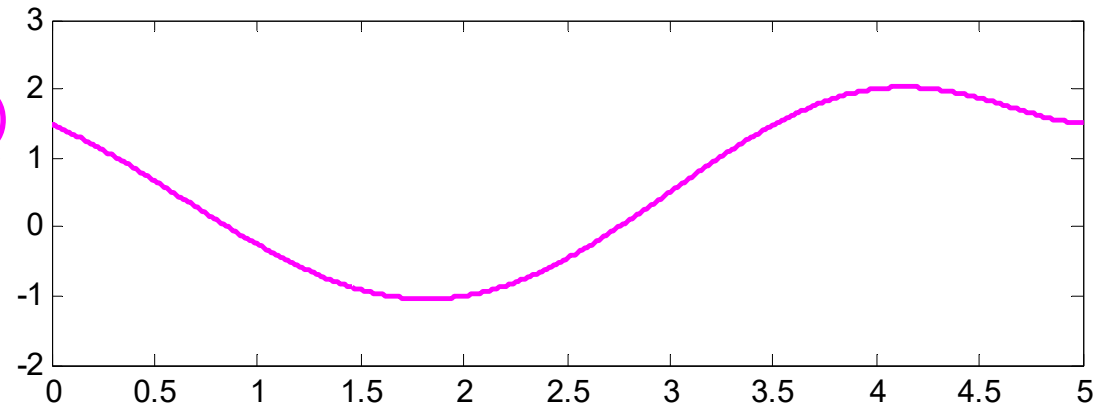
$\hat{m}(t)$



$|\hat{M}(f)|$



In the time domain...



$m(t)$

$$m(t) \times \sqrt{2} \cos(2\pi f_c t) = x(t)$$

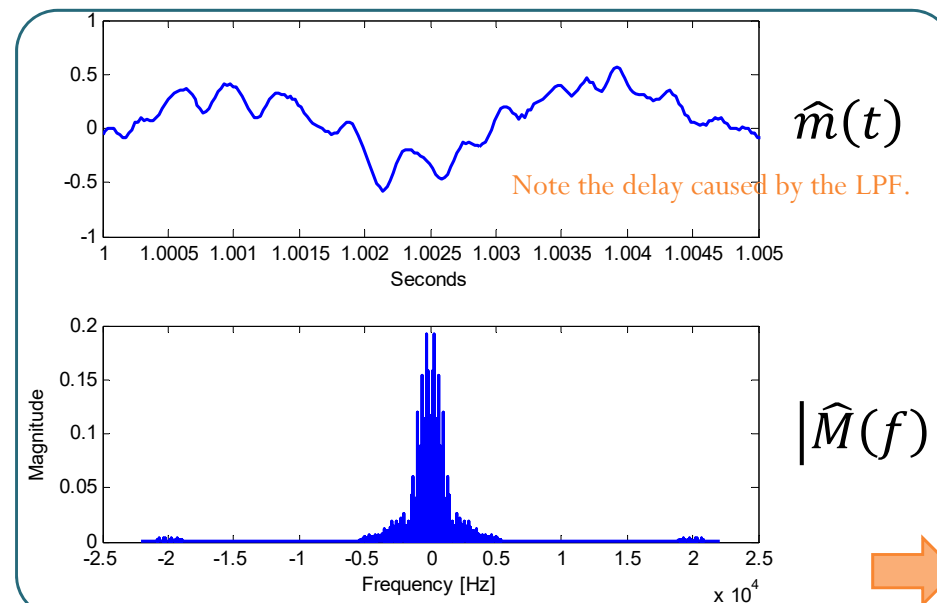
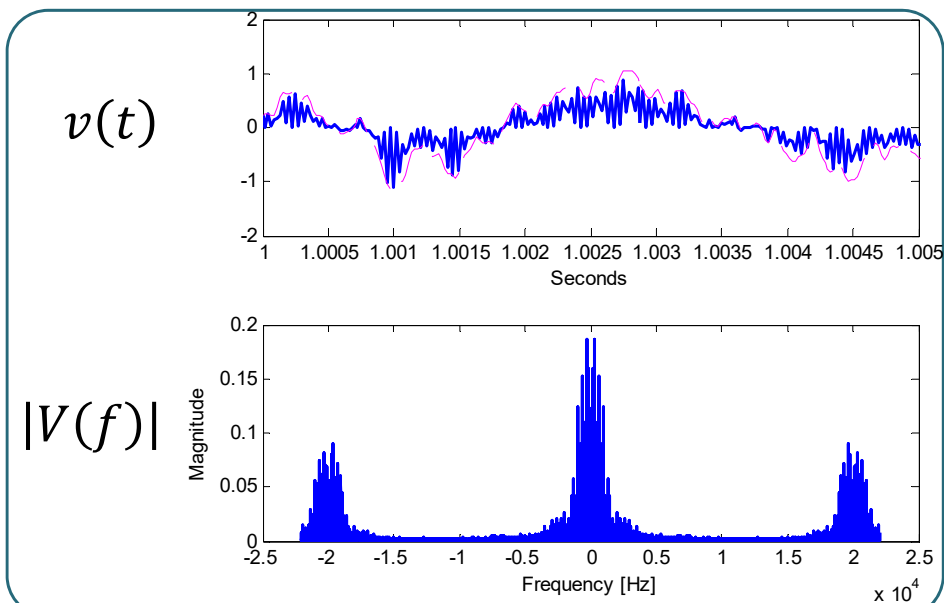
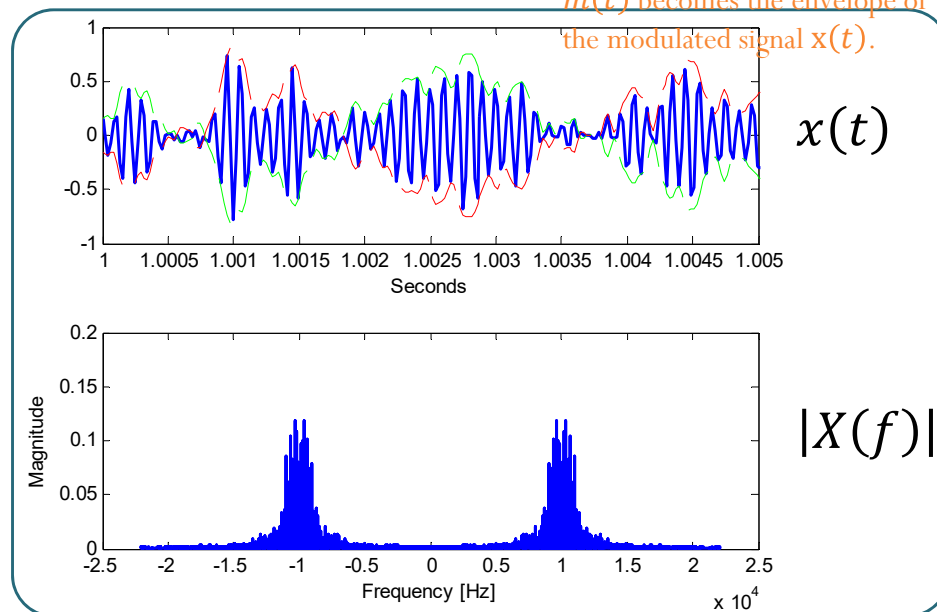
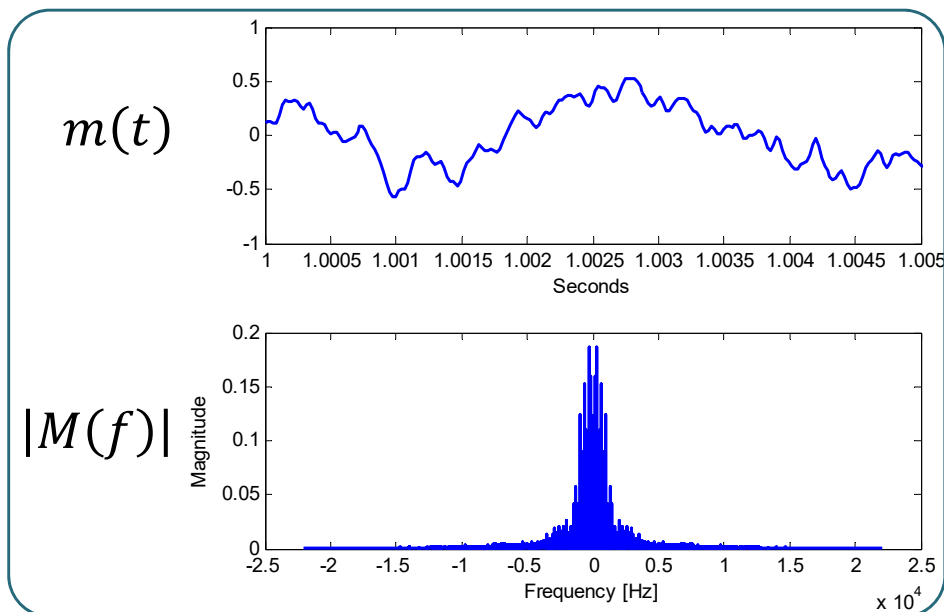
$\sqrt{2}m(t)$

$$x(t) \times \sqrt{2} \cos(2\pi f_c t) = v(t)$$

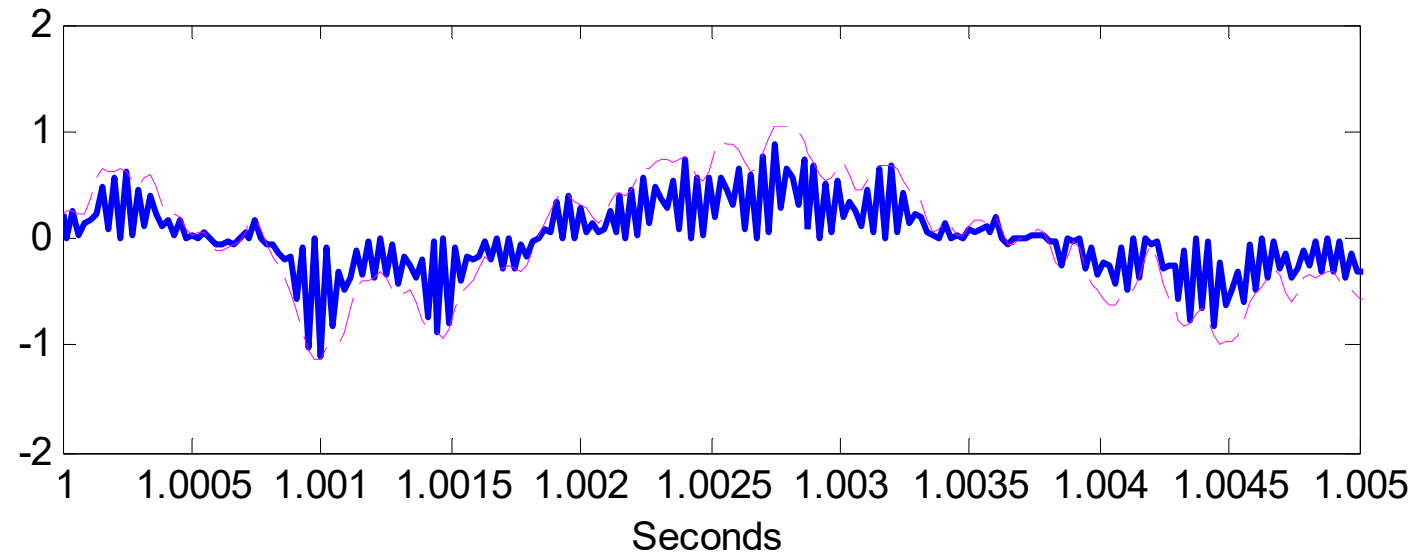
$2m(t)$

DSB-SC (Zoomed in time)

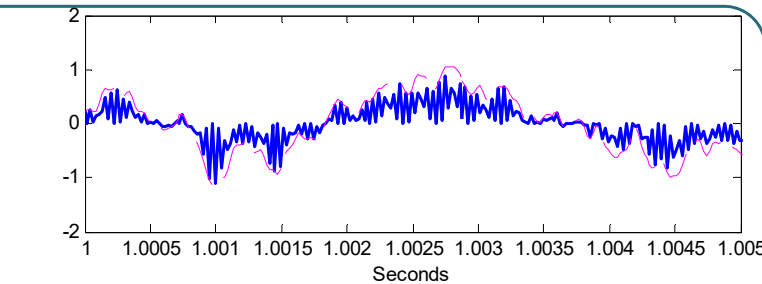
Note how the baseband signal $m(t)$ becomes the envelope of the modulated signal $x(t)$.



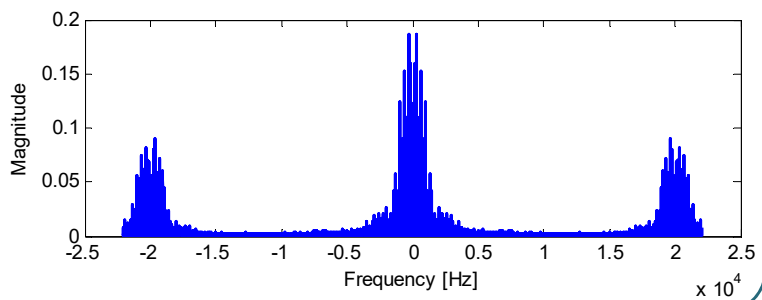
$v(t)$ (Zoomed in time)



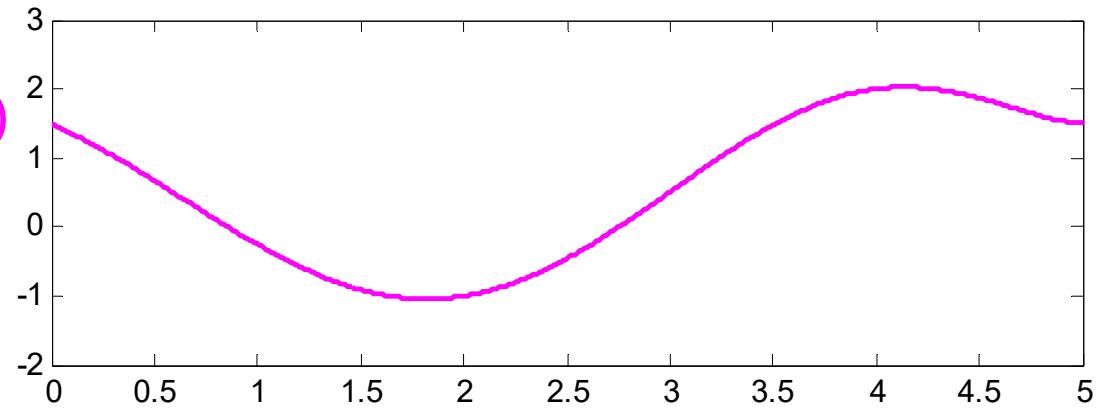
$v(t)$



$|V(f)|$

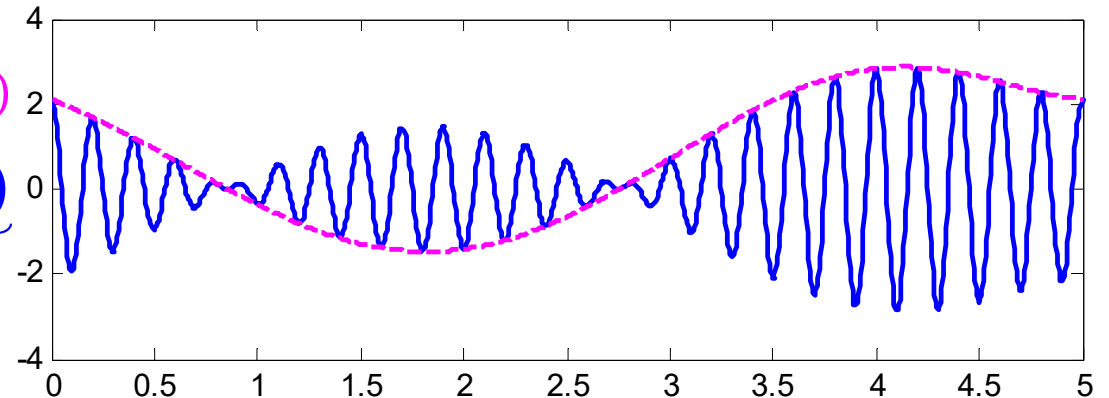


In the time domain... we expect



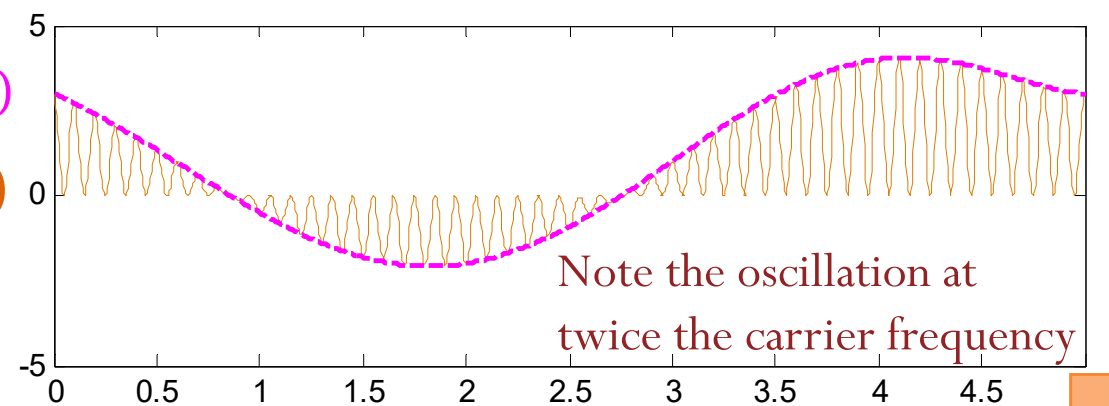
$m(t)$

$$\underbrace{m(t)} \times \sqrt{2} \cos(2\pi f_c t) = \underbrace{x(t)}$$



$\sqrt{2}m(t)$

$$\underbrace{x(t)} \times \sqrt{2} \cos(2\pi f_c t) = \underbrace{v(t)}$$



$2m(t)$

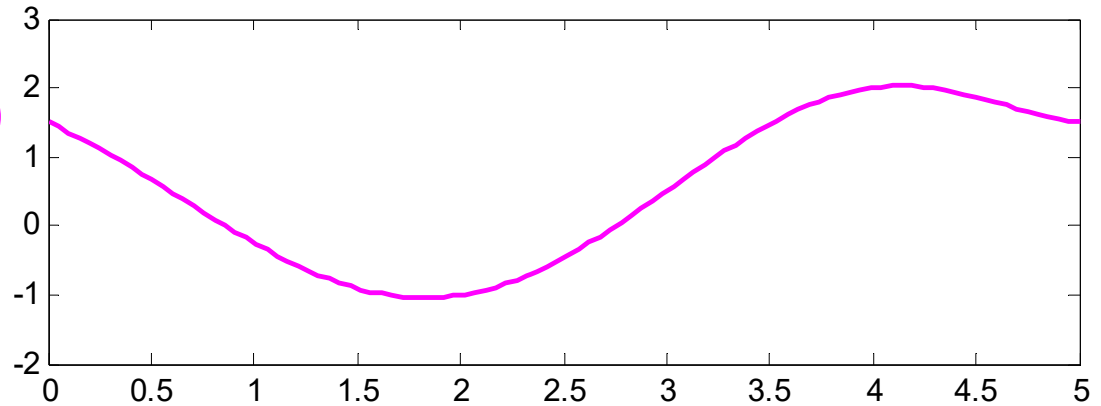
Note the oscillation at twice the carrier frequency



In the time domain...

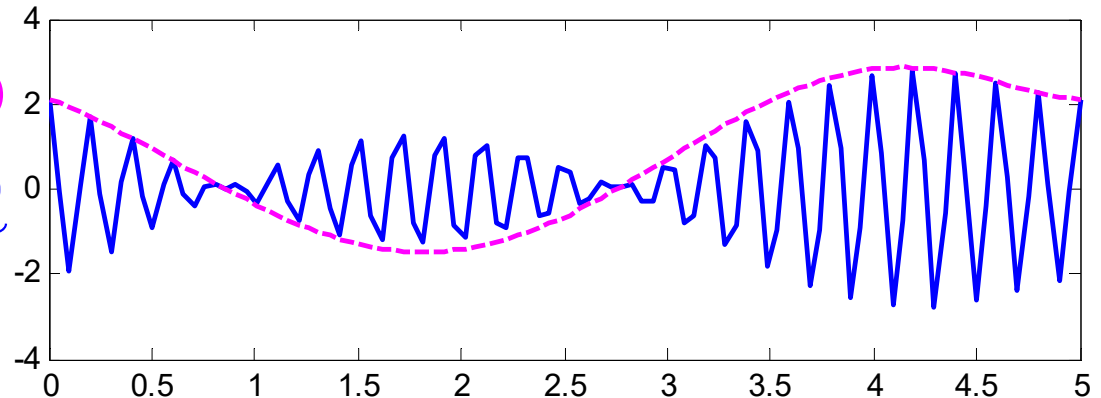
When the sampling rate is not fast enough,...

$m(t)$



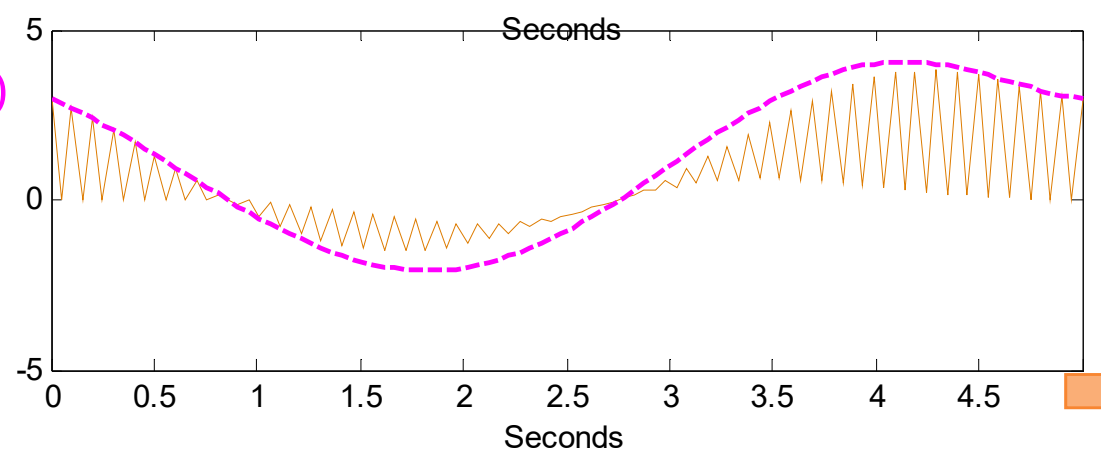
$$m(t) \times \sqrt{2} \cos(2\pi f_c t) = x(t)$$

$\sqrt{2}m(t)$



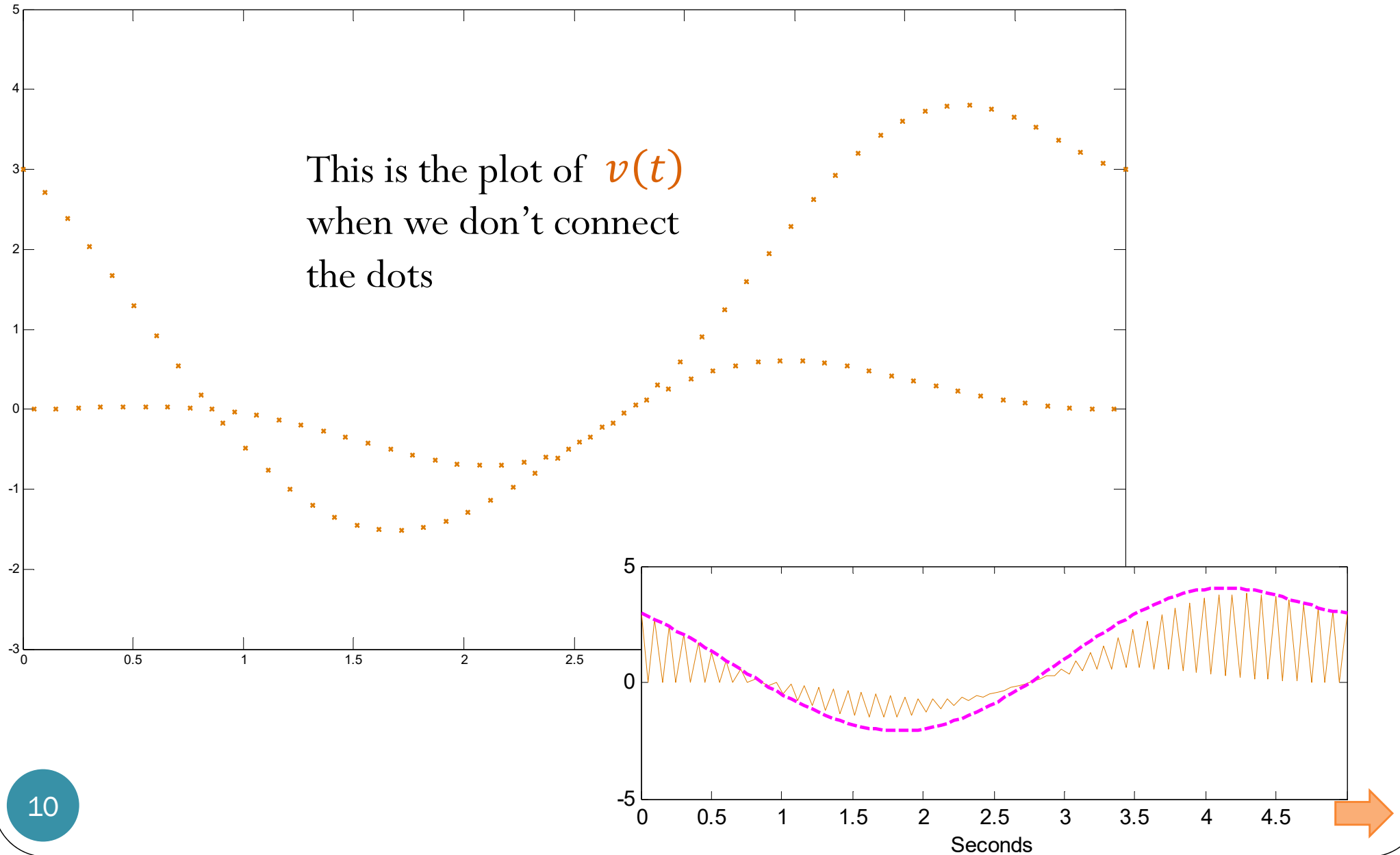
$$x(t) \times \sqrt{2} \cos(2\pi f_c t) = v(t)$$

$2m(t)$



The problem with sampling rate

This is the plot of $v(t)$
when we don't connect
the dots



The problem with sampling rate

