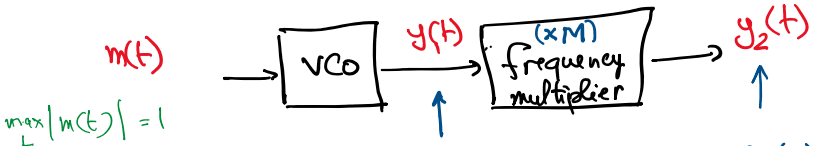
Online Lecture # 02 - Example for Wideband FM Implementation

Friday, March 20, 2020 9:01 AM

Wideband FM:



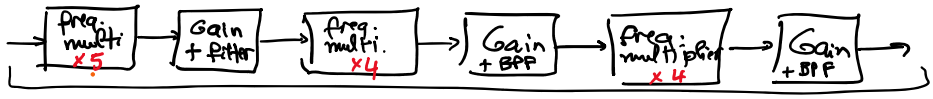
$f_{i_1}(t) = f_1 + \Delta f \cdot m(t)$ $\quad f_{i_2}(t) = M \cdot f_1 + M \cdot \Delta f\, m(t)$

$\beta_1 = \frac{\Delta f}{f_m} \ll 1$ $\quad \beta_2 = \frac{M \cdot \Delta f}{f_m} = M \cdot \beta_1 > 1$ from narrowband to wideband

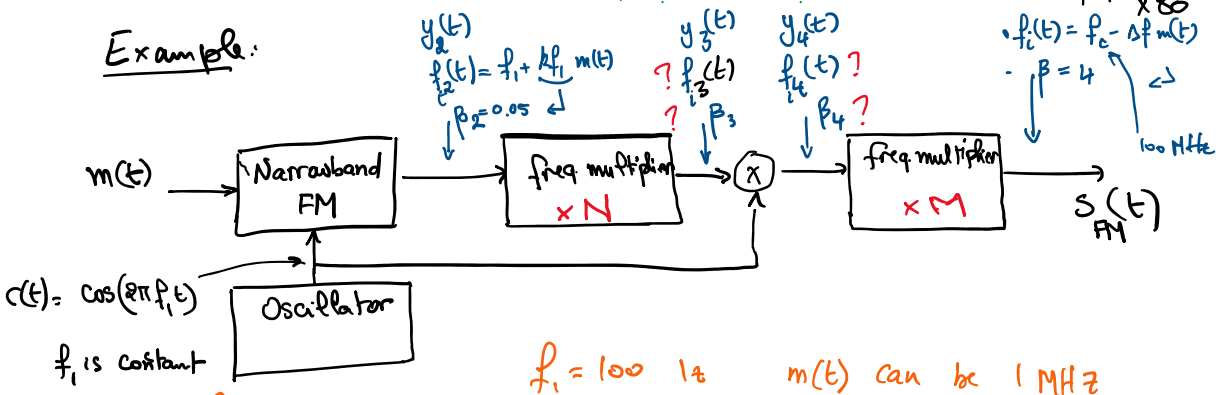
foreramples: $\beta = 0.1$

$f_{i_2}(t) = M \cdot f_{i_1}(t)$ $\quad \beta_2 = 4$ $\quad M = \beta_2 / \beta_1 = 40$

In practice, we implement high order multiplier, by cascading low-order freq. multipliers: For eramplo (80x) freq. multiplier can be implemented as:



Example:



$f_1 = 100$ Hz $\quad m(t)$ can be 1 MHz

Using the above block diagram, we would like to generate a wideband FM signal with carrier frequency $f_c = 100$ MHz and modulation index $\beta = 4$.

the frequency of the oscillator is $f_1 = 1$ MHz and the modulation index of the narrowband FM modulator is $\beta_1 = 0.05$.

What should be the value of and N?

$f_{i_3}(t) = N f_1 + N k_{f_1} \cdot m(t)$

$\beta_3 = N \cdot \beta_2 = 0.05 \times N$

the varying part of $f_i(t)$ is the same $\rightarrow \beta_3 = \beta_4$

$f_{i_4}(t) = f_{i_3}(t) + f_1 = (N+1) f_1 + N k_{f_1} m(t)$

$$f_{i_4}(t) = f_{i_3}(t) + f_1 = (N+1) f_1 + N k_{f_1} m(t)$$

$$\beta_4 = \beta_3 = 0.05 \times N$$

$$f_i(t) = M \cdot f_{i_4}(t) = M(N+1) \cdot f_1 + N \times M \cdot k_{f_1} m(t)$$

$$\beta = M \cdot \beta_4 = M \times N \times 0.05 = 4$$

$$M(N+1) \cdot f_1 = f_c \longrightarrow M(N+1) = 100$$

$$M \times N \times 0.05 = 4 \longrightarrow M \cdot N = 80 \rightarrow N = \frac{80}{N}$$

$$\frac{80}{N}(N+1) = 100 \rightarrow 80N + 80 = 100N$$

$$20N = 80$$

$$N = 4$$

$$M = \frac{80}{N} = 20$$