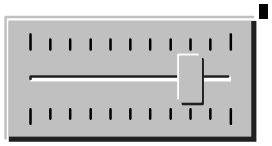
filename:
fmsidebands.mcd
avo 03/02/2013
last edit date:

Modulation
Index

$A_c := 1$

$\beta := .6$



FM/PM modulation index: set to π/2 for peak phase dev of π/2
set to Δf/fm for frequency modulation.
spectrum is the same for sinewave modulation.

$f_c := 12 \cdot 10^6$

$Fm := 10^3$ Modulating frequency- single

$\beta := \frac{x}{10}$

$n := \text{round}(\beta + 1)$ 2 * n is the number of significant sidebands per Carsons rule

$n = 2$

$Bandwidth := 2 \cdot n \cdot Fm$

$\beta = 0.6$

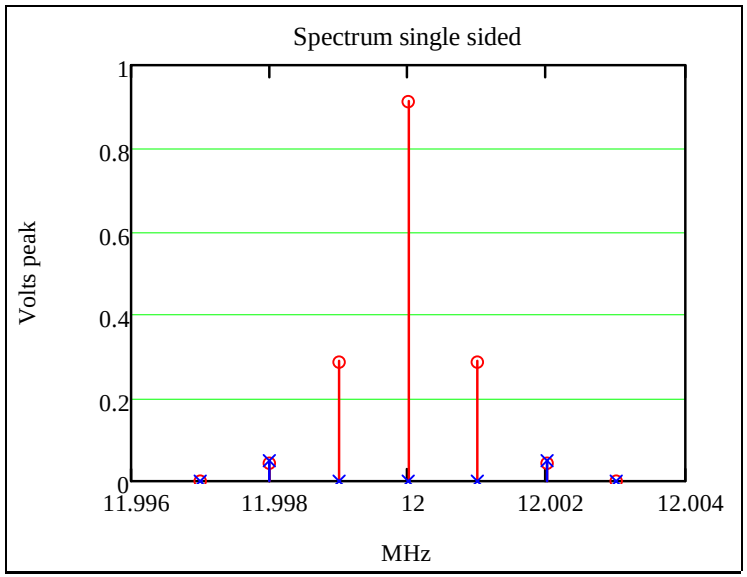
$$Si(f) := A_c \cdot \left[(J0(\beta)) \cdot \delta(f, f_c) + \sum_{k=1}^{n} \left[Jn(k,\beta) \cdot \delta\left[f, (f_c + k \cdot Fm)\right] + (-1)^k \cdot Jn(k,\beta) \cdot \delta\left[f, (f_c - k \cdot Fm)\right] \right] \right]$$

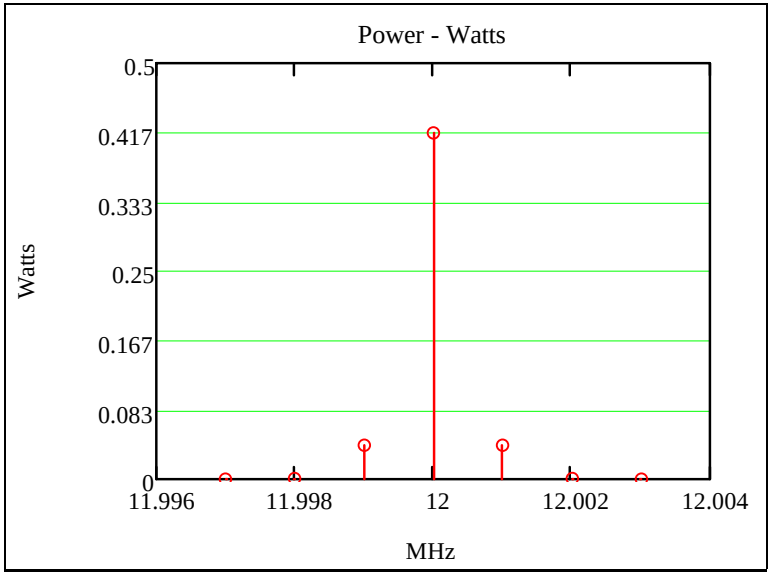
$B(f) := \delta\left[f, f_c + (n+0) \cdot Fm\right] + \delta(f, f_c - n \cdot Fm)$ $\quad f := f_c - (n+1) \cdot Fm, (f_c - n \cdot Fm) .. \left[f_c + (n+1) \cdot Fm\right]$

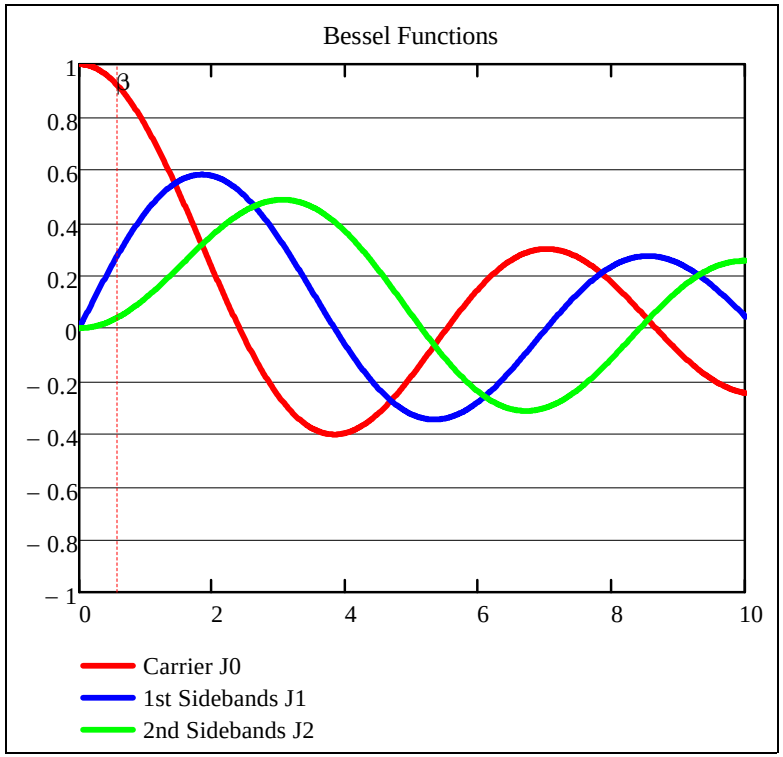
$Bandwidth = 4 \times 10^3$

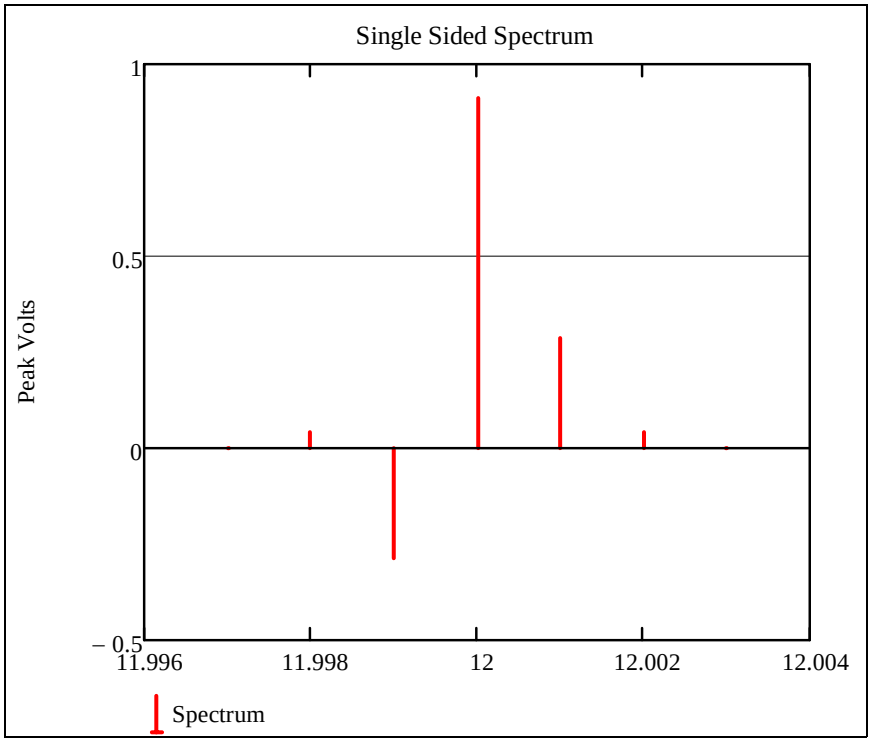
$\beta = 0.6$

$n = 2$ number of significant sideband pairs


Spectrum single sided
Volts peak
1
0.8
0.6
0.4
0.2
0
11.996
11.998
12
12.002
12.004
MHz


Power - Watts
Watts
0.5
0.417
0.333
0.25
0.167
0.083
0
11.996
11.998
12
12.002
12.004
MHz


Bessel Functions
3
1
0.8
0.6
0.4
0.2
0
– 0.2
– 0.4
– 0.6
– 0.8
– 1
0
2
4
6
8
10
Carrier J0
1st Sidebands J1
2nd Sidebands J2

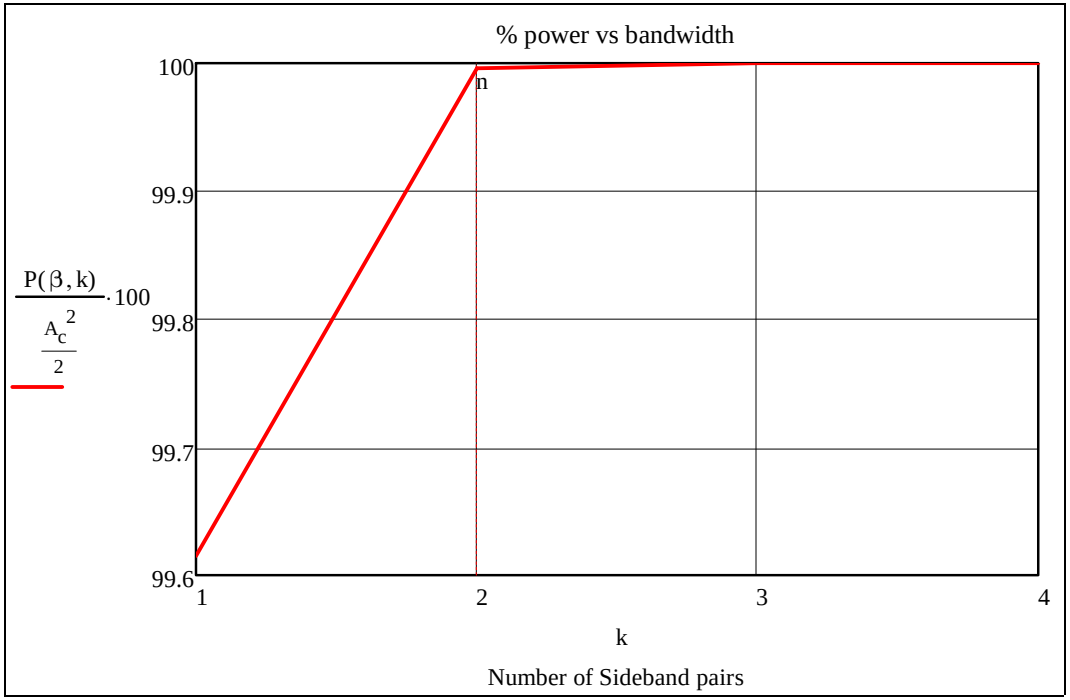

Single Sided Spectrum
Peak Volts
1
0.5
0
– 0.5
11.996
11.998
12
12.002
12.004
Spectrum

$k := 1 .. 2 \cdot n$

$\beta = 0.6$

$$P(M, n) := \left(\frac{J0(M)^2}{2} + \sum_{k=1}^{n} Jn(k, M)^2 \right)$$

second term includes power in +Jn and power in -Jn, i.e the upper and lower sideband pairs



$Fm = 1 \times 10^3$ Hz

Bandwidth = $4 \cdot (Hz)^3$

$$\frac{P(\beta, n)}{\frac{A_c^2}{2}} \cdot 100 = 99.996$$

$m := 0 .. n + 1$

$\beta = 0.6$

Bessel Function Magnitudes:

$Jn(m, \beta) =$

0.912
0.287
0.044
4.4·10-3