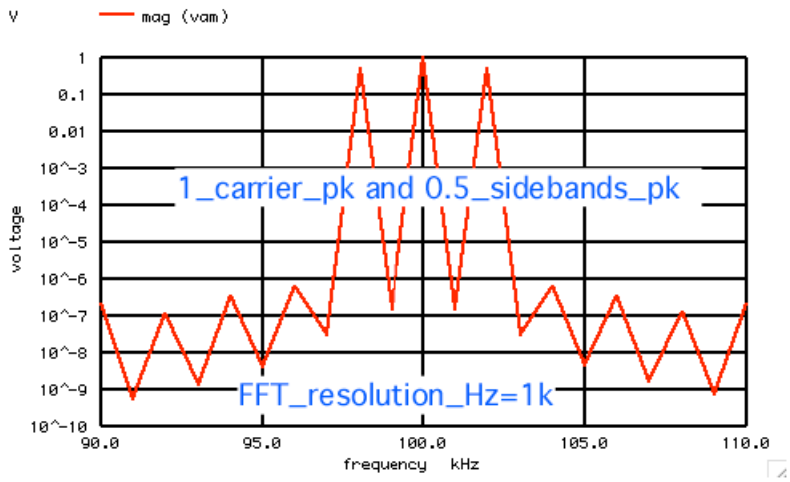
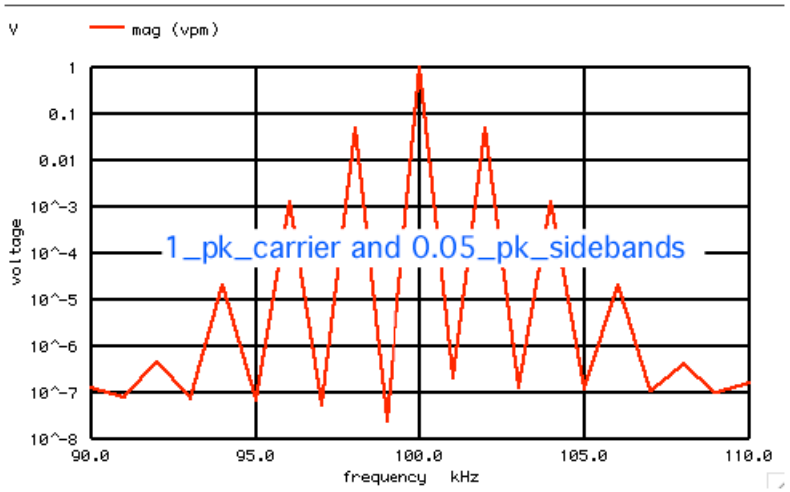
=====PM LOOKS LIKE AM AT LOW MODULATION=====



Simple 100% AM is 100% carrier with two 50% side bands
Simple 10% AM is 100% carrier with two 5% side bands

The two side bands are synchronous.
100% AM increases the power by sqrt(2).



Simple 10% radian PM is basically 100% carrier with two 5% side bands.
The two side bands are synchronous just like AM.
They just have 90deg phase shift.

Note that 10% refers to a magnitude.

====================MacSpiceCode====================================

SIMPLE_AM_WAVEFORM_GENERATION

```
*=========Create_Signal=================
VTime      VTime  0       DC      0     PWL(    0       0     1       1)
Vfreq1     Vfreq1 0       DC      2
BMOD       VMOD   0       V       = cos(6.2831853*2000*V(VTime))
BAM        VAM    0       V       = (1-V(VMOD))*cos(6.2831853*100k*V(VTime))
BCOS       VCOS   0       V       = 1*cos(6.2831853*100k*V(VTime))

.control
*TRAN              TSTEP   TSTOP   TSTART TMAX    ?UIC?
tran               .1u     1m      0       .1u
set                pensize = 2
```

```
plot             vam vcos
echo             "=======================Find_Ave_RmsCOS======================================="
let averVal =    mean(vcos)
let noisAC =     vcos - averVal
let RmsVal =     sqrt(mean(noisAC* noisAC))
echo             "RMS_level_Expect       .707   RMS_level_Cos  $&RmsVal  "
unlet averVal
unlet RmsVal
echo             "=======================Find_Ave_RmsAM========================================"
let averVal =    mean(VAM)
let noisAC =     VAM - averVal
let RmsVal =     sqrt(mean(noisAC* noisAC))
echo             "RMS_level_Expect       .866   RMS_level_RM  $&RmsVal  "
unlet averVal
unlet RmsVal

echo             "=======================FFT_and_Plot_AM======================================="
linearize
let              FFT_BandWidth_Hz =      500k
let              FFT_resolution_Hz =     1k
echo             "FFT_BandWidth_Hz=      $&FFT_BandWidth_Hz"
echo             "FFT_resolution_Hz=     $&FFT_resolution_Hz"
set              specwindow=   "rectangular"
spec             $&FFT_resolution_Hz  $&FFT_BandWidth_Hz   $&FFT_resolution_Hz     v(vam)
plot             mag (vam) ylog xlimit 90k 110k
plot             mag (vam) ylog xlimit 95k 105k ylimit .1 1

let fund =       mag(vam[99])
let upsb =       mag(vam[101])
let lpsb =       mag(vam[97])
echo             "Fundamental+sideband   $&fund + $&upsb + $&lpsb "
let totalrms =   sqrt( fund*fund +upsb*upsb+ lpsb*lpsb)
echo             "Total_RMS      $&totalrms "


echo             "=======================FFT_and_Plot_Vcos====================================="
destroy
let              FFT_BandWidth_Hz =      500k
let              FFT_resolution_Hz =     1k
echo             "FFT_BandWidth_Hz=      $&FFT_BandWidth_Hz"
echo             "FFT_resolution_Hz=     $&FFT_resolution_Hz"
set              specwindow=   "rectangular"
spec             $&FFT_resolution_Hz  $&FFT_BandWidth_Hz   $&FFT_resolution_Hz     v(vcos)
plot             mag (vcos) ylog xlimit 90k 110k
plot             mag (vcos) ylog xlimit 95k 105k ylimit .1 1

let fund =       mag(vcos[99])
let upsb =       mag(vcos[101])
let lpsb =       mag(vcos[97])
echo             "Fundamental+sideband   $&fund + $&upsb + $&lpsb "
let totalrms =   sqrt( fund*fund +upsb*upsb+ lpsb*lpsb)
echo             "Total_RMS      $&totalrms "

.endc
.end
```

SIMPLE_PM_WAVEFORM_GENERATION

```
*=========Create_Signal==================
VTime     VTime  0      DC     0    PWL(    0      0    1      1)
Vfreq1    Vfreq1 0      DC     2
BMOD      VMOD   0      V      = cos(6.2831853*2000*V(VTime))
BPM       VPM    0      V      = 1*cos(6.2831853*100k*V(VTime)+1*V(VMOD))
BCOS      VCOS   0      V      = 1*cos(6.2831853*100k*V(VTime))

.control
*TRAN            TSTEP  TSTOP  TSTART TMAX   ?UIC?
tran             .1u    1m     0       .1u
set              pensize = 2
plot             vpm vcos
echo             "=======================Find_Ave_RmsCOS======================================="
let averVal =    mean(vcos)
let noisAC =     vcos - averVal
let RmsVal =     sqrt(mean(noisAC* noisAC))
echo             "RMS_level_Expect       .707   RMS_level_Cos  $&RmsVal  "
unlet averVal
unlet RmsVal
echo             "=======================Find_Ave_RmsPM========================================"
let averVal =    mean(VPM)
let noisAC =     VPM - averVal
let RmsVal =     sqrt(mean(noisAC* noisAC))
echo             "RMS_level_Expect       .707   RMS_level_RM  $&RmsVal  "
unlet averVal
unlet RmsVal
```

```
echo            "======================FFT_and_Plot_PM===================================="
linearize
let             FFT_BandWidth_Hz =      500k
let             FFT_resolution_Hz =     1k
echo            "FFT_BandWidth_Hz=      $&FFT_BandWidth_Hz"
echo            "FFT_resolution_Hz=     $&FFT_resolution_Hz"
set             specwindow=   "rectangular"
spec            $&FFT_resolution_Hz  $&FFT_BandWidth_Hz   $&FFT_resolution_Hz     v(vpm)
plot            mag (vpm) ylog xlimit 90k 110k
plot            mag (vpm) ylog xlimit 95k 105k ylimit .1 1

let fund =      mag(vpm[99])
let upsb =      mag(vpm[101])
let lpsb =      mag(vpm[97])
echo            "Fundamental+sideband   $&fund + $&upsb + $&lpsb "
let totalrms =  sqrt( fund*fund +upsb*upsb+ lpsb*lpsb)
echo            "Total_RMS      $&totalrms "


echo            "======================FFT_and_Plot_Vcos=================================="
destroy
let             FFT_BandWidth_Hz =      500k
let             FFT_resolution_Hz =     1k
echo            "FFT_BandWidth_Hz=      $&FFT_BandWidth_Hz"
echo            "FFT_resolution_Hz=     $&FFT_resolution_Hz"
set             specwindow=   "rectangular"
spec            $&FFT_resolution_Hz  $&FFT_BandWidth_Hz   $&FFT_resolution_Hz     v(vcos)
plot            mag (vcos) ylog xlimit 90k 110k
plot            mag (vcos) ylog xlimit 95k 105k ylimit .1 1

let fund =      mag(vcos[99])
let upsb =      mag(vcos[101])
let lpsb =      mag(vcos[97])
echo            "Fundamental+sideband   $&fund + $&upsb + $&lpsb "
let totalrms =  sqrt( fund*fund +upsb*upsb+ lpsb*lpsb)
echo            "Total_RMS      $&totalrms "

.endc
.end


4.18.11_1.14PM
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```