filename:pulsewaveform.mcd
avo Last edit date: 1/21/14

************************************ Definitions **

$\delta(f,R) \equiv \text{if}(f = R, 1, 0)$ $\quad$ $\text{sinc}(x) \equiv \text{if}\left(x = 0, 1, \frac{\sin(\pi \cdot x)}{\pi \cdot x}\right)$

$\Lambda(t,T) \equiv \text{if}\left(|t| \le \frac{T}{2}, 1 - \left|\frac{2t}{T}\right|, 0\right)$ $\quad$ $\text{rect}(t,T) \equiv \text{if}\left[\left(|t| \le \frac{T}{2}\right), 1, 0\right]$

*************************************** set up waveform ******************************

$T := 400 \times 10^{-6} s$ period $\quad$ $D := 0.5$ duty cycle $\quad$ $\tau := D \cdot T$ $\quad$ $\tau = 2 \times 10^{-4} s$ pulse width

$A := 2 \cdot V$ $\quad$ $\frac{1}{T} = 2.5 \times 10^{3} \frac{1}{s}$ pps $\quad$ $\frac{1}{\tau} = 5 \times 10^{3} \cdot Hz$ First null

****************************** Set up Sweep Parameters ******************

$N := 1000$ $\quad$ $i := 0..N$ $\quad$ $f_{min} := 0Hz$ $\quad$ $f_{max} := \frac{6}{T \cdot D}$

$\Delta f := \frac{f_{max} - f_{min}}{N}$ $\quad$ $f_i := -f_{max} + i \cdot 2 \cdot \Delta f$ $\quad$ $w_i := 2 \cdot \pi \cdot f_i$

Pulse shape Pt Definition ******************************

Assume a rectangular pulse shape with an amplitude of 1

$X_\tau(f) := A \cdot \tau \cdot \text{sinc}(f \cdot \tau)$ $\quad$ Single Pulse Fourier Transform, "double sided"

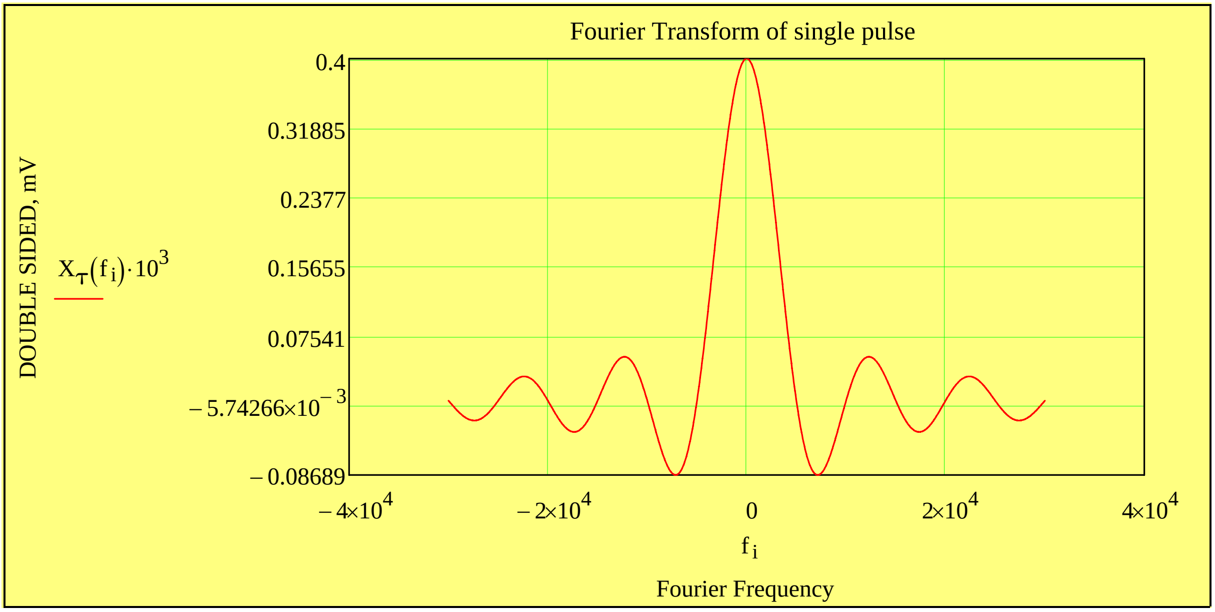
$n := -25, -24..25$

$c(n) := \frac{A \cdot \tau}{T} \cdot \text{sinc}\left(\frac{n \cdot \tau}{T}\right)$ $\quad$ Fourier Series for repeatative pulse "double sided spectrum"

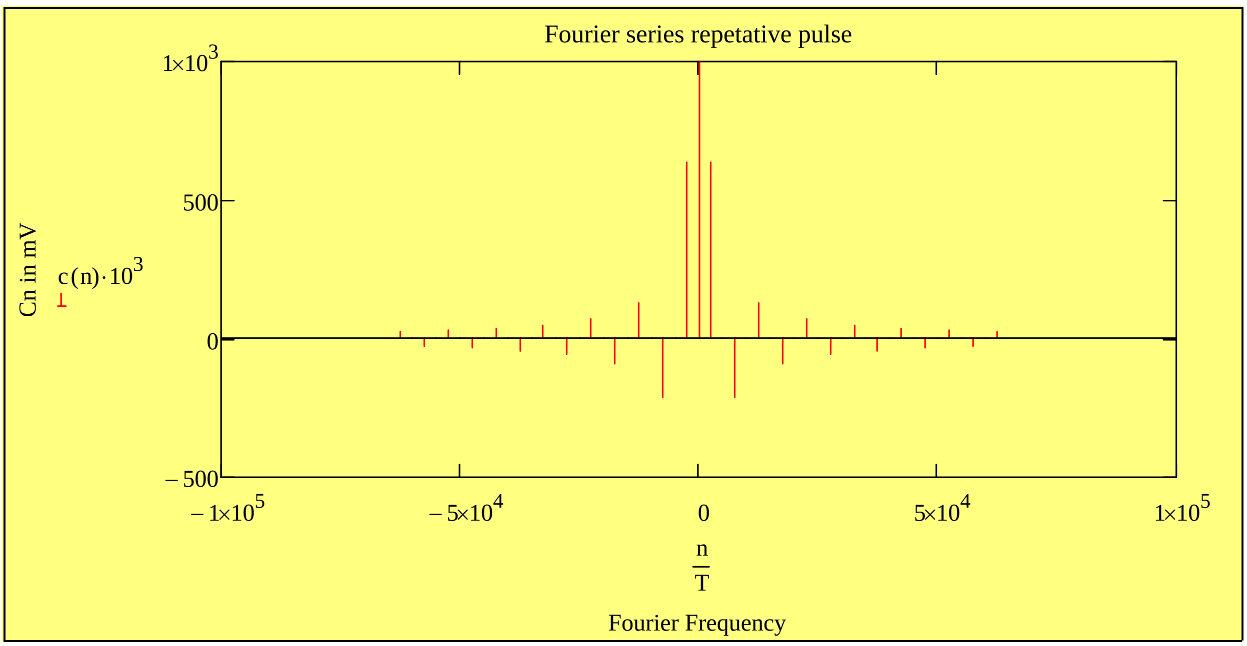
$c(0) = 1V$ $\quad$ DC value

Pulse width: $\tau = 0.2 \cdot ms$

Null bandwidth: $\frac{1}{\tau} = 5 \times 10^{3} \cdot Hz$

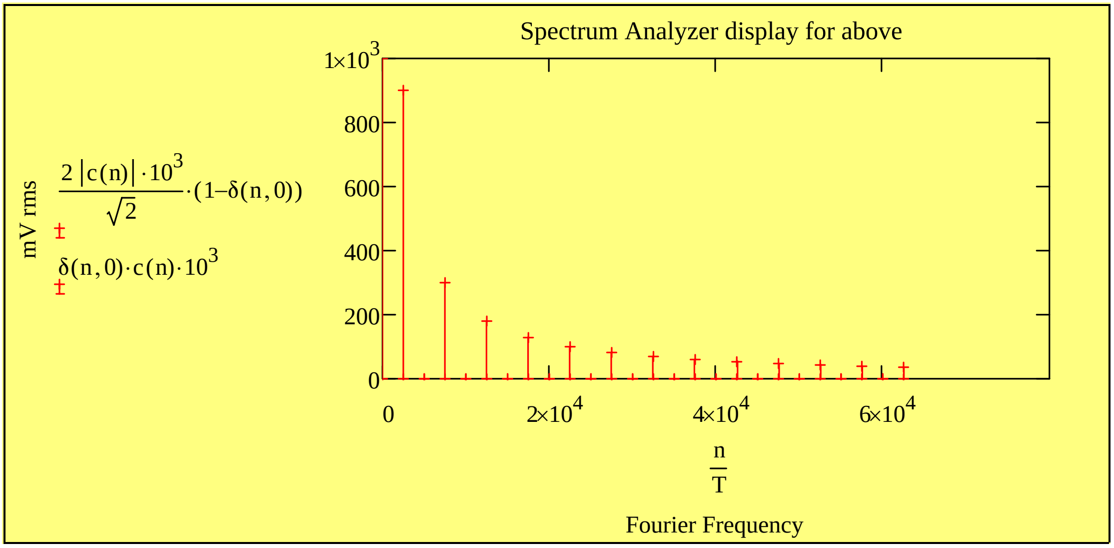


********************************* Spectrum Plot of Repetative pulse *****************************



Amplitude of fundamental as seen by scope FFT: $\frac{2\,|c(1)|}{\sqrt{2}} = 0.9\,V$

$n := 0 .. 25$



*********************** Spectrum analyser Voltage levels rms ***********************************

$k := 1 .. 10$ $\quad P_{0,k} := k \quad P_{1,k} := \frac{2\,|c(k)|}{\sqrt{2}\,V} \quad P_{2,k} := 20\cdot\log\left(\frac{2\,|c(k)|}{\sqrt{2}\,V}\right) \quad P_{3,k} := 10\cdot\log\left[\frac{(P_{1,k})^2}{50}\cdot 10^3\right]$

$P_{1,0} := \frac{c(0)}{V} \quad P_{2,0} := 20\cdot\log\left(\frac{c(0)}{V}\right) \quad P_{3,0} := 10\cdot\log\left[\frac{(P_{1,0})^2}{50}\cdot 10^3\right]$

P =

	0	1	2	3	4	5	6	7	8	9	10	
0	0	1	2	3	4	5	6	7	8	9	10	Harmonic
1	1	0.9	.513·10-17	0.3	.513·10-17	0.18	.513·10-17	0.129	.513·10-17	0.1	.647·10-16	Vrms
2	0	-0.912	-325.173	-10.455	-325.173	-14.891	-325.173	-17.814	-325.173	-19.997	-311.544	dBV
3	13.01	12.098	-312.162	2.556	-312.162	-1.881	-312.162	-4.804	-312.162	-6.987	-298.534	dBm

$L := 2$

Power to L[th] harmonic: $\sum_{k=0}^{L} (P_{1,k})^2 = 1.811$ Watts

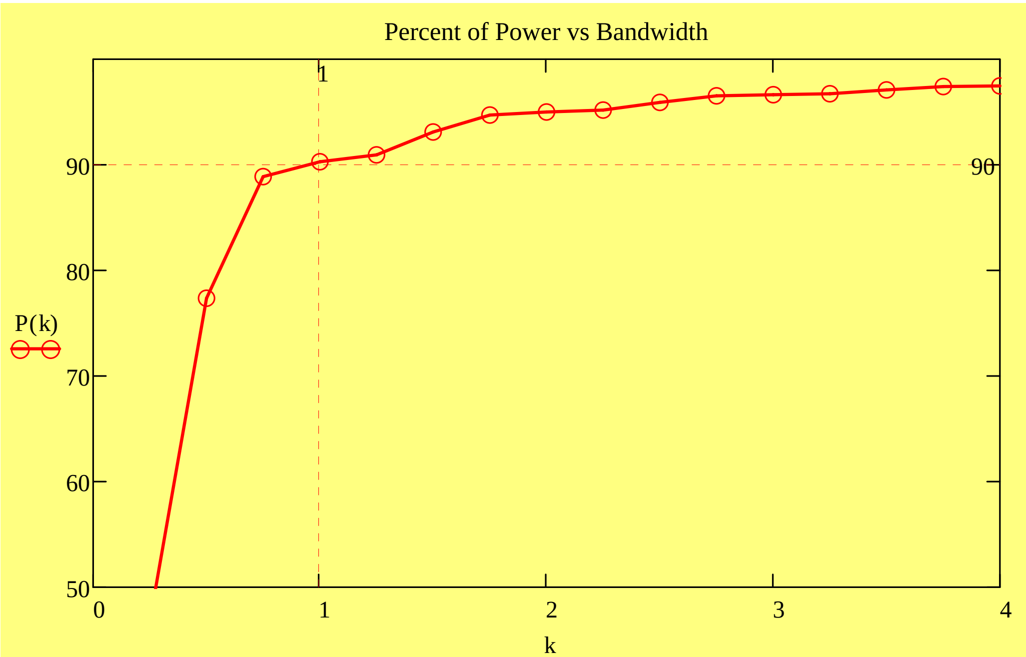
Percent of power to L[th] Harmonic: $\frac{\sum_{k=0}^{L} (P_{1,k})^2}{\left(\frac{A}{V}\right)^2\cdot D} = 90.528\cdot\%$

************************************** Percent of power in first Lobe ****************************

Percent of total power in the null bandwidth: $2\int_0^1 \mathrm{sinc}(x)^2\,dx = 90.282\cdot\%$

Percent of total power vs bandwidth: $P(x) := 2\left(\int_0^x \mathrm{sinc}(x)^2\,dx\right)\cdot 100$

$k := 0, .25 .. 4$



Note: k=1 is the null bandwidth of the spectrum.