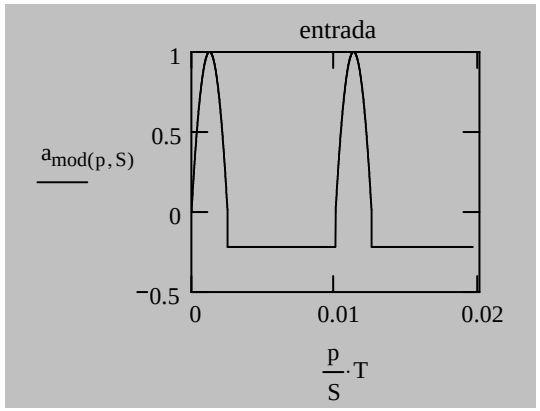
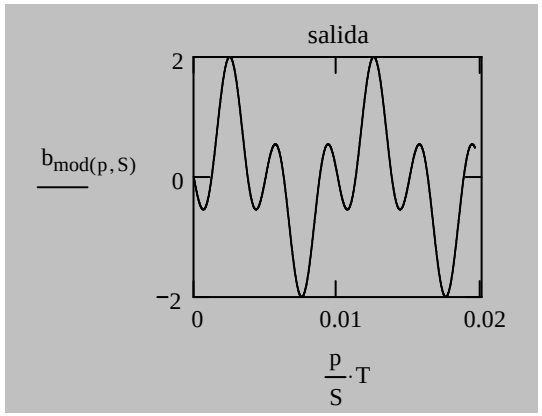
Proyecto Generico 2011

$$(S\ \ i\ \ p\ \ wo\ \ T\ \ k) := \left(1024\ \ 0..S-1\ \ 0..2000\ \ \frac{2\cdot\pi}{S}\ \ \frac{1}{100}\ \ 0..\frac{S}{2}\right)$$

$$a_i := 16\cdot i\cdot\frac{S-4\cdot i}{S^2}\cdot(4\cdot i \geq 0)\cdot(4\cdot i < S) - \frac{14}{64}\cdot\left(i \geq S\cdot\frac{1}{4}\right)\cdot(i < S) \quad b_i := \sin(wo\cdot i) - \sin(3\cdot wo\cdot i)$$

$c_i := a_i$ $c_S := 0$ $tx_i := T\cdot\frac{i}{S}$ $tx_S := T$

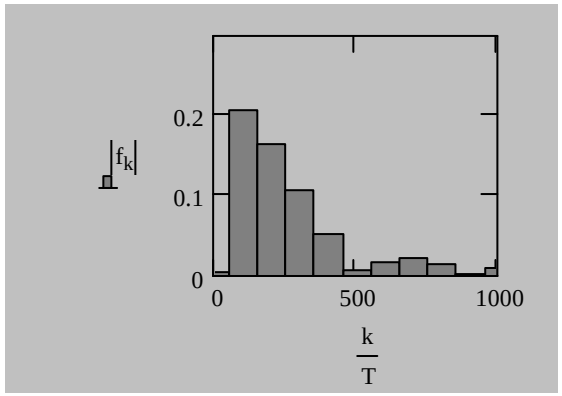




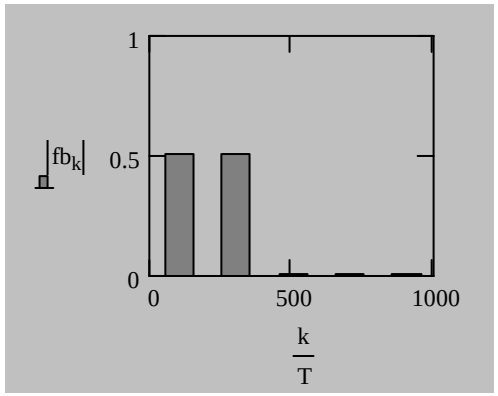
sig

augment(tx, c)

f := FFT(a)



fb := FFT(b)

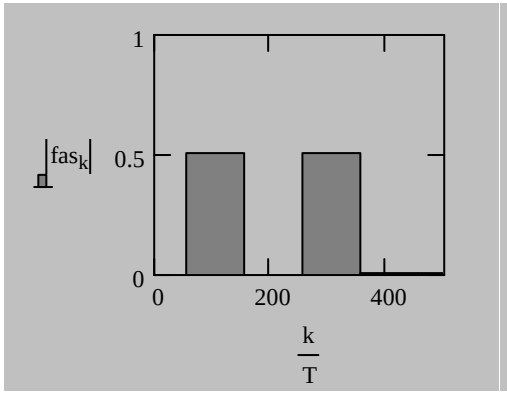


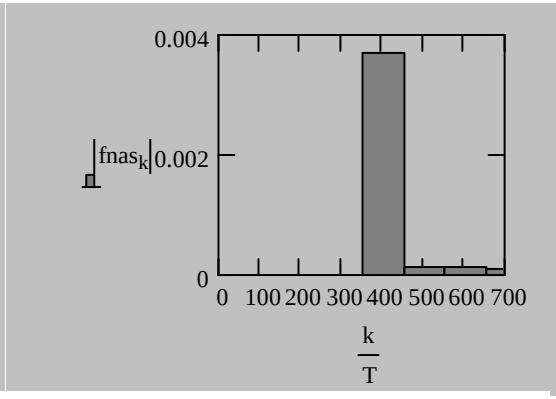
$$(A\ \ w1\ \ Q1\ \ w2\ \ Q2\ \ w3\ \ fas) := \left(8105\ \ 2\cdot\pi\cdot100\ \ 7\ \ 2\cdot\pi\cdot300\ \ \frac{128}{10}\ \ 2\cdot\pi\cdot200\ \ 2\cdot\pi\cdot180\right)$$

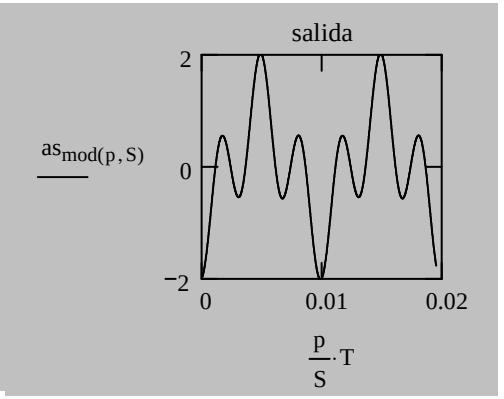
$$H(s) := A\cdot\left(\frac{\frac{s\cdot w1}{Q1}}{s^2 + \frac{s\cdot w1}{Q1} + w1^2}\right)^2\cdot\left(\frac{\frac{s\cdot w2}{Q2}}{s^2 + \frac{s\cdot w2}{Q2} + w2^2}\right)^2\cdot\frac{s^2 + w3^2}{\left[s + \left(2-\sqrt{3}\right)\cdot w3\right]\cdot\left[s + \left(2+\sqrt{3}\right)\cdot w3\right]}\cdot\frac{s - fas}{s + fas}$$

$fas_k := H(2i\cdot\pi\cdot 100\cdot k)\cdot f_k$ $fnas_k := fas_k\cdot(k \neq 1)\cdot(k \neq 3)$ $as := IFFT(fas)$ $nas := IFFT(fnas)$

ruido $stdev(nas) = 5.214\times 10^{-3}$ <debe ser .007 $\frac{2}{max(as)} = 1$ <debe ser 1







Para armar el filtro usare 2 pasabandas en 100 y 300 Hertz de Q 7 y 12.8 y ganancia $\sqrt[4]{A} = 9.488$

Luego de un poceso de calculo no mostrado de "**algunas horas**" decido hacer prueba de lo calculado

$C1a := 47\times 10^{-9}$ $C2a := 56\times 10^{-9}$ $\begin{pmatrix} R1a \\ R2a \\ R3a \end{pmatrix} := \begin{pmatrix} 25500 \\ 453000 \\ 2320 \end{pmatrix}$ $Ha(s) := \frac{\frac{-s}{C1a\cdot R1a}}{s^2 + \left(\frac{1}{C2a} + \frac{1}{C1a}\right)\cdot\frac{1}{R2a}\cdot s + \frac{1}{C1a\cdot C2a\cdot R2a}\cdot\left(\frac{1}{R1a} + \frac{1}{R3a}\right)}$

$C1b := 27\times 10^{-9}$ $C2b := 22\times 10^{-9}$ $\begin{pmatrix} R1b \\ R2b \\ R3b \end{pmatrix} := \begin{pmatrix} 26700 \\ 562000 \\ 866 \end{pmatrix}$ $Hb(s) := \frac{\frac{-s}{C1b\cdot R1b}}{s^2 + \left(\frac{1}{C2b} + \frac{1}{C1b}\right)\cdot\frac{1}{R2b}\cdot s + \frac{1}{C1b\cdot C2b\cdot R2b}\cdot\left(\frac{1}{R1b} + \frac{1}{R3b}\right)}$

Phaser $Cf := 22\times 10^{-9}$ $Rf := 34800$ Twint $Ct := 15\times 10^{-9}$ $Rt := 53600$

$$Hp(s) := \frac{s - \frac{1}{Cf \cdot Rf}}{s + \frac{1}{Cf \cdot Rf}} \qquad Ht(s) := \frac{s^2 + \left(\frac{1}{Ct \cdot Rt}\right)^2}{\left[s + \left(2 - \sqrt{3}\right) \cdot \left(\frac{1}{Ct \cdot Rt}\right)\right] \cdot \left[s + \left(2 + \sqrt{3}\right) \cdot \left(\frac{1}{Ct \cdot Rt}\right)\right]}$$

Transferencia normalizada $Hn(s) := Ha(s)^2 \cdot Hb(s)^2 \cdot Ht(s) \cdot Hp(s)$

comparacion trasferencia ideal versus normalizada

$$H(s)\ \text{float}, 3 \rightarrow 1.41 \cdot 10^{12} \cdot \frac{s^4}{\left(s^2 + 89.8 \cdot s + 3.94 \cdot 10^5\right)^2 \cdot \left(s^2 + 147. \cdot s + 3.55 \cdot 10^6\right)^2} \cdot \frac{s^2 + 1.58 \cdot 10^6}{(s + 339.) \cdot \left(s + 4.68 \cdot 10^3\right)} \cdot \frac{s - 1.13 \cdot 10^3}{s + 1.13 \cdot 10^3}$$

$$Hn(s)\ \text{float}, 3 \rightarrow 1.34 \cdot 10^{12} \cdot \frac{s^4}{\left(s^2 + 86.4 \cdot s + 3.94 \cdot 10^5\right)^2 \cdot \left(s^2 + 147. \cdot s + 3.57 \cdot 10^6\right)^2} \cdot \frac{s^2 + 1.55 \cdot 10^6}{\left(s + 3.4 \cdot 10^2\right) \cdot \left(s + 4.64 \cdot 10^3\right)} \cdot \frac{s - 1.31 \cdot 10^3}{s + 1.31 \cdot 10^3}$$

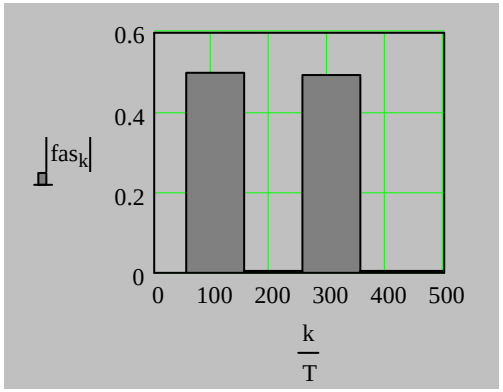
Confirmacion

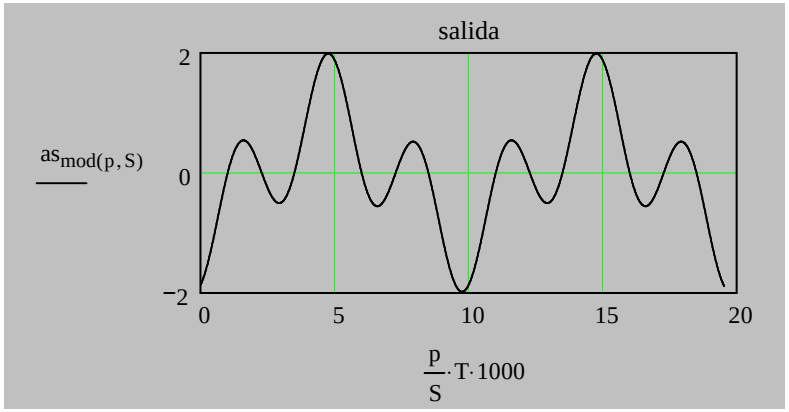
$$Hn(s) \rightarrow \frac{400000000000000000000000000}{298597466880729} \cdot \frac{s^4}{\left(s^2 + \frac{12875000}{149037} \cdot s + \frac{86937500000000}{220425723}\right)^2 \cdot \left(s^2 + \frac{12250000}{83457} \cdot s + \frac{3132500000000000}{877140657}\right)^2} \cdot \frac{s^2 + \frac{62500000000}{40401}}{\left(s + \frac{500000}{201} - \frac{250000}{201} \cdot 3^{\frac{1}{2}}\right) \cdot \left(s + \frac{500000}{201} + \frac{25000}{201}\right.}$$

Recalculando aplitud y ruido con filtro normalizado

$fas_k := Hn\left(2i \cdot \pi \cdot 100 \cdot k\right) \cdot f_k$ $\quad fnas_k := fas_k \cdot (k \neq 1) \cdot (k \neq 3)$ $\quad as := IFFT(fas)$ $\quad nas := IFFT(fnas)$

$stdev(nas) = 5.12 \times 10^{-3}$





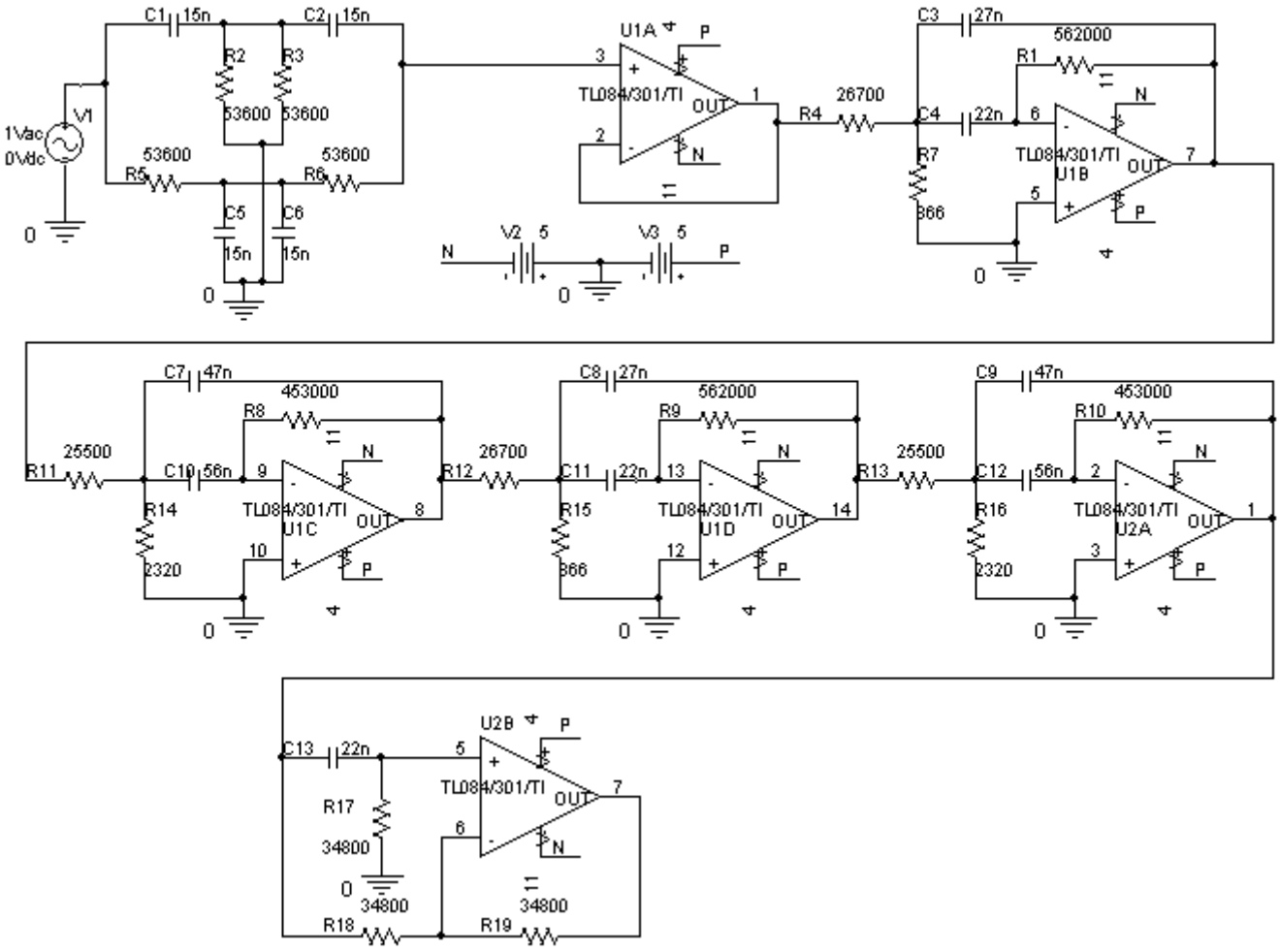
$$\frac{\left|fas_1\right| - \frac{1}{2}}{\frac{1}{2}} \cdot 100 = -0.092$$

$$\frac{\left|fas_3\right| - \frac{1}{2}}{\frac{1}{2}} \cdot 100 = -1.452$$

error de amplitudes menor 1.5%
ruido menor que 7 mv rms
con exigencias de circuito moderadas

Como todo salio de acuerdo a lo planeado correponde implementar el circuito en Pspice >>>>>>>>>>>>>

Circuito

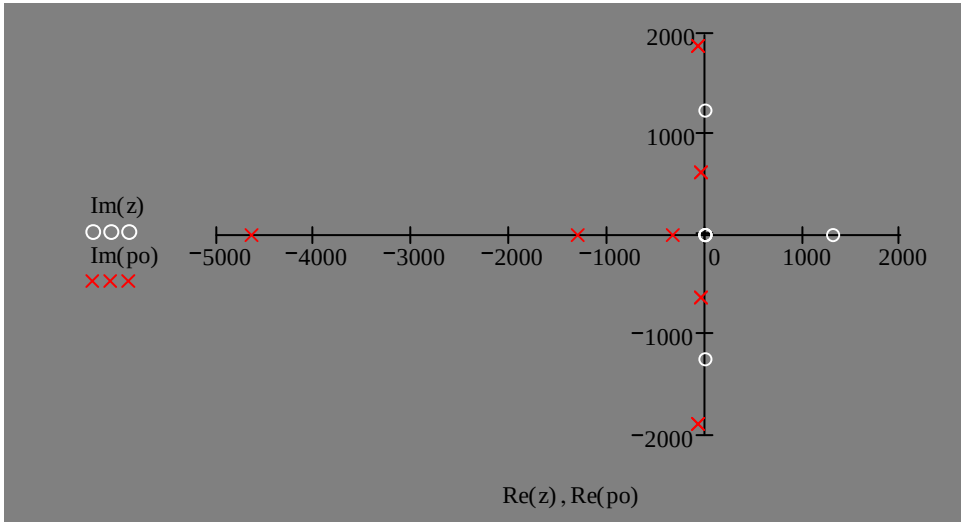

C1 15n
C2 15n
R2
R3
53600
53600
V1
1Vac
0Vdc
53600
R5
53600
R6
C5
C6
15n
15n
0
U1A
TL084/301/TI
OUT
R4
26700
C3 27n
562000
R1
C4 22n
R7
366
U1B
TL084/301/TI
OUT
V2 5
V3 5
N
P
C7 47n
453000
R8
R11
25500
C10 56n
R14
2320
U1C
TL084/301/TI
OUT
R12
26700
C8 27n
562000
R9
C11 22n
R15
366
U1D
TL084/301/TI
OUT
R13
25500
C9 47n
453000
R10
C12 56n
R16
2320
U2A
TL084/301/TI
OUT
C13 22n
R17
34800
U2B
TL084/301/TI
OUT
34800
R18
34800
R19

"sch.gif"

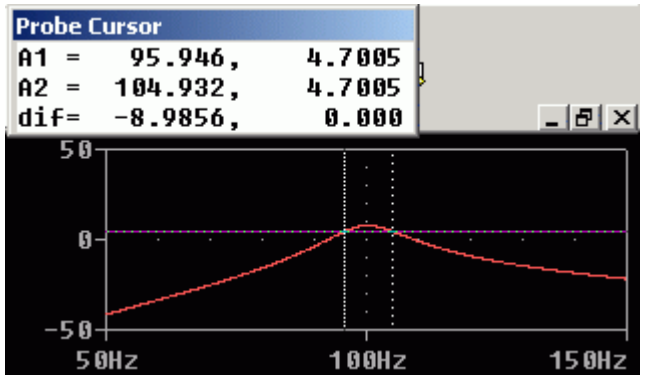
Diagrama de polos y ceros

$$z := Hn(u)\ \left|\begin{array}{l}\text{solve},u\\ \text{float},5\end{array}\right.\rightarrow \begin{pmatrix}0\\0\\0\\0\\1243.8\cdot i\\-1243.8\cdot i\\1306.2\end{pmatrix}$$

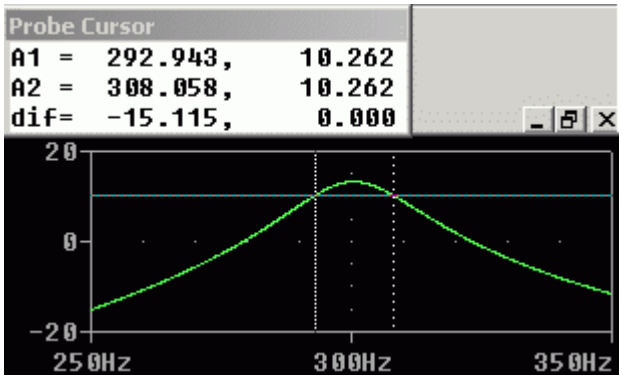
$$po := \frac{1}{Hn(u)}\ \left|\begin{array}{l}\text{solve},u\\ \text{float},5\end{array}\right.\rightarrow \begin{pmatrix}-43.194+626.53\cdot i\\-43.194-626.53\cdot i\\-43.194+626.53\cdot i\\-43.194-626.53\cdot i\\-73.391+1888.3\cdot i\\-73.391-1888.3\cdot i\\-73.391+1888.3\cdot i\\-73.391-1888.3\cdot i\\-333.2\\-4642.0\\-1306.2\end{pmatrix}$$



Puntos de 3dB [maximos]



"3db1.gif"



"3db2.gif"

Diagrama de bode de amplitud

$db(x) := 20 \cdot \log(|x|)$

$$Hn(s)\ \text{float},4 \rightarrow 1.340 \cdot 10^{12} \cdot \frac{s^4}{\left(s^2 + 86.39 \cdot s + 3.944 \cdot 10^5\right)^2 \cdot \left(s^2 + 146.8 \cdot s + 3.571 \cdot 10^6\right)^2} \cdot \frac{s^2 + 1.547 \cdot 10^6}{(s + 333.) \cdot (s + 4643.)} \cdot \frac{s - 1306.}{s + 1306.}$$

$w1 := \sqrt{3.944 \cdot 10^5}$ $w2 := \sqrt{3.571 \cdot 10^6}$ $w3a := 333.$ $w3b := 4643.$ $w3c := \sqrt{1.547 \cdot 10^6}$

$$ko := \lim_{x \to 0} \frac{-Hn(x)}{x^4}\ \text{float},6 \rightarrow 6.75210 \cdot 10^{-13} \qquad w_k := 2 \cdot \pi \cdot 10 \cdot (300)^{\frac{k \cdot 2}{S}}$$

$$Hdb(x) := 20 \cdot \log\left(ko \cdot x^4\right) - 4 \cdot db\left(\frac{x}{w1}\right) \cdot (x > w1) - \left[4 \cdot db\left(\frac{x}{w2}\right) \cdot (x > w2)\right] - db\left(\frac{x}{w3a}\right) \cdot (x > w3a) - db\left(\frac{x}{w3b}\right) \cdot (x > w3b) + 2 \cdot db\left(\frac{x}{w3c}\right) \cdot (x > w3c)$$

ps :=

	0	1
0	10	-99.5396
1	10.0231	-99.4595
2	10.0462	-99.3794
3	10.0693	-99.2993
4	10.0925	-99.2192
5	10.1158	-99.1391
6	10.1391	-99.059

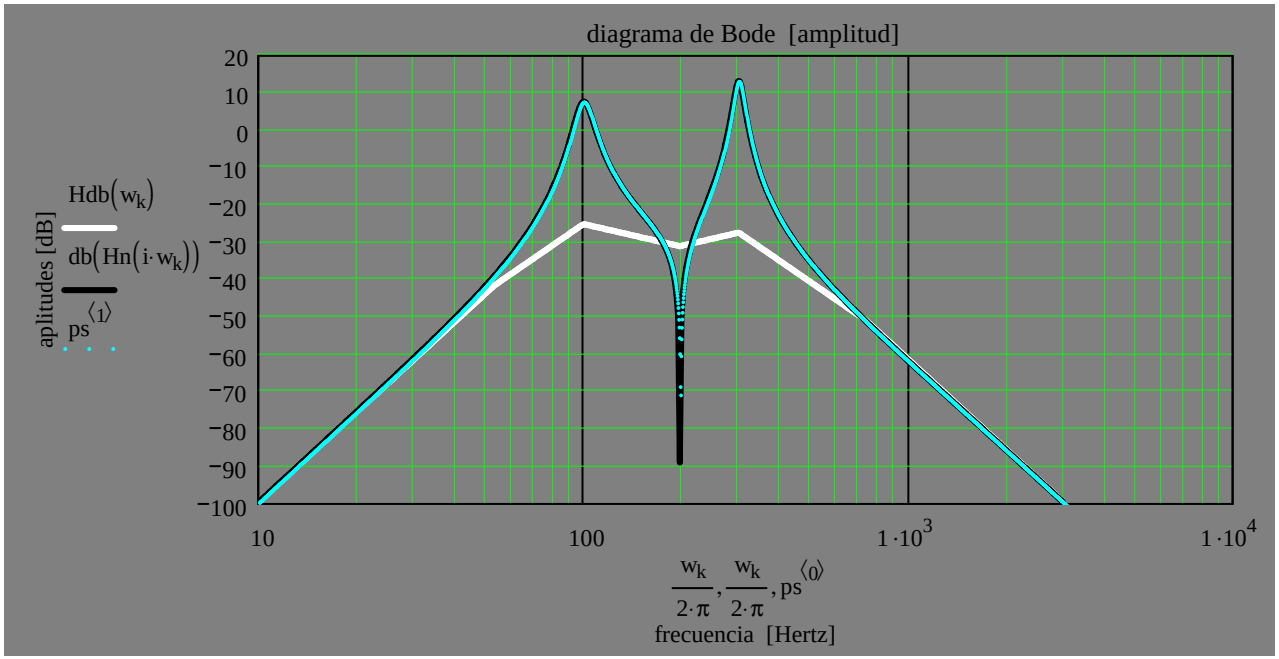


Diagrama de Bode [fase]

$$b(x, xo) := \text{if}\left(x < \frac{xo}{10}, 0, \text{if}\left(x > 10 \cdot xo, -90, -45 - 45 \cdot \log\left(\frac{x}{xo}\right)\right)\right)$$

$$Hc(s) := \frac{s^2 + 1.547 \cdot 10^6}{(s + 333.) \cdot (s + 4643.)}$$

$$Hd(s) := \frac{s - 1306.}{s + 1306.}$$

$$Ha(s) := \frac{s}{s^2 + 86.39 \cdot s + 3.944 \cdot 10^5}$$

$$Hb(s) := \frac{s}{s^2 + 146.8 \cdot s + 3.571 \cdot 10^6}$$

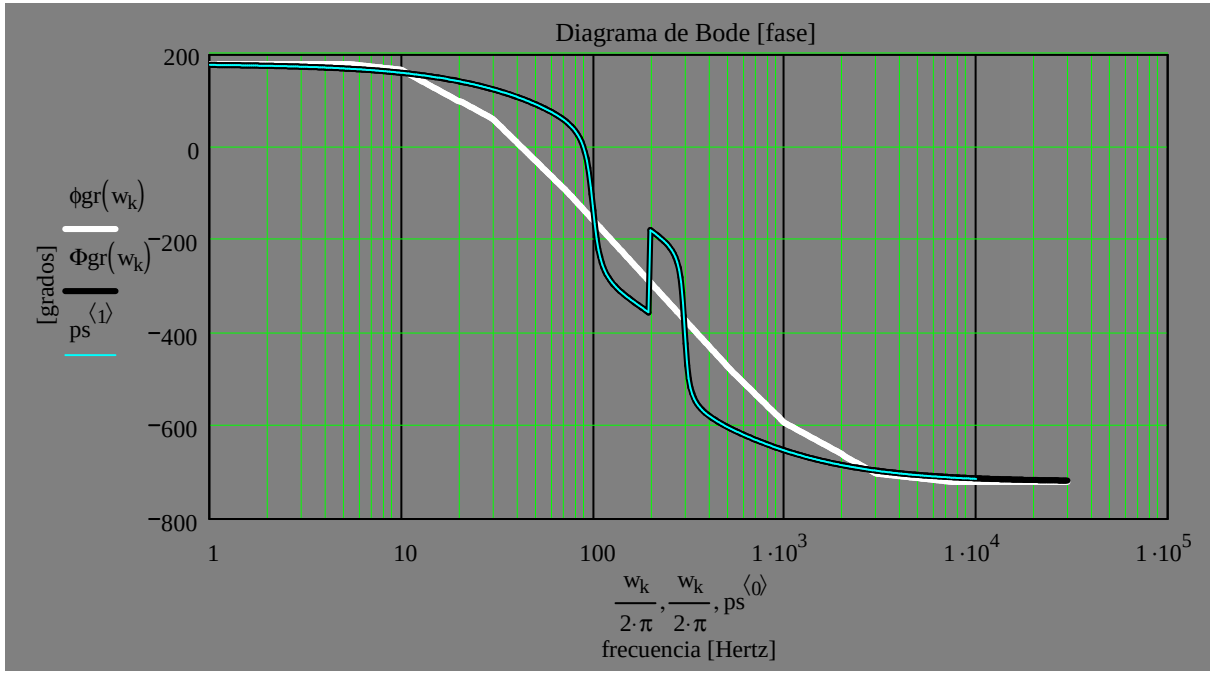
$$w_k := 2 \cdot \pi \cdot 1 \cdot (30000)^{\frac{k \cdot 2}{S}}$$

$$\phi gr(x) := 180 + 4\cdot b\left(x,\sqrt{3.944\cdot 10^5}\right) + 4\cdot b\left(x,\sqrt{3.571\cdot 10^6}\right) - 2\cdot b\left(x,\sqrt{1.547\cdot 10^6}\right) + b(x,333.) + b(x,4643.) + 2\cdot b(x,1306)$$

$$\Phi gr(x) := \left[2\cdot\left(\arg(Ha(i\cdot x)) - \frac{\pi}{2}\right) + 2\cdot\left(\arg(Hb(i\cdot x)) - \frac{\pi}{2}\right) + (\arg(Hc(i\cdot x))) + \arg(Hd(i\cdot x))\right]\cdot\frac{180}{\pi}$$

ps :=

	0	1
0	1	178.1036
1	1.0233	178.0594
2	1.0471	178.0142
3	1.0715	177.968
4	1.0965	177.9207



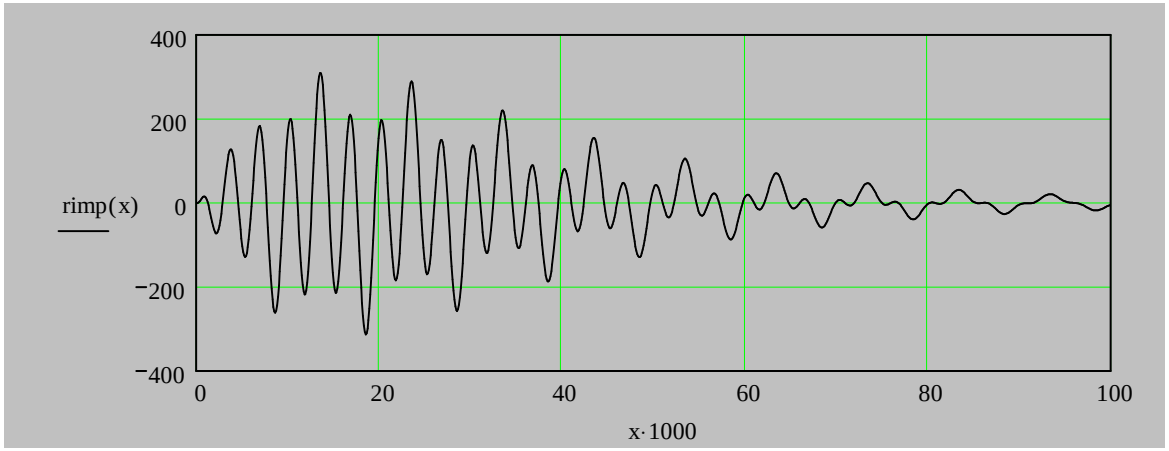
Respuesta a exitaciones

Respuesta al impulso

$$\text{rimp}(t) := \text{Hn}(s)\ \text{invlaplace}, s \rightarrow \frac{-8543327668848626268475054622436925173698982830596063380418275366001060539668460602852422777495924594147771195416494080000046371081344308596154328415164103846586783068252288708503822450592592557456147833290571049260740298354308769051999706873730}$$

$$\text{rimp}(t) \left| \begin{matrix} \text{float}, 2 \\ \text{collect}, \cos, \sin, \exp \end{matrix} \right. \rightarrow \left(-3.8 \cdot 10^3 \cdot t - 18.\right) \cdot \exp(-43. \cdot t) \cdot \cos\left(6.2 \cdot 10^2 \cdot t\right) + \left(4.9 \cdot 10^4 \cdot t - 56.\right) \cdot \exp(-73. \cdot t) \cdot \cos\left(2.0 \cdot 10^3 \cdot t\right) + \left(-36. + 9.1 \cdot 10^3 \cdot t\right) \cdot \exp(-43. \cdot t) \cdot \sin\left(6.2 \cdot 10^2 \cdot t\right) + \left(1.4 + 2.1 \cdot 10\right.$$

$$x := 0, \frac{1}{10000} .. \frac{1}{10}$$



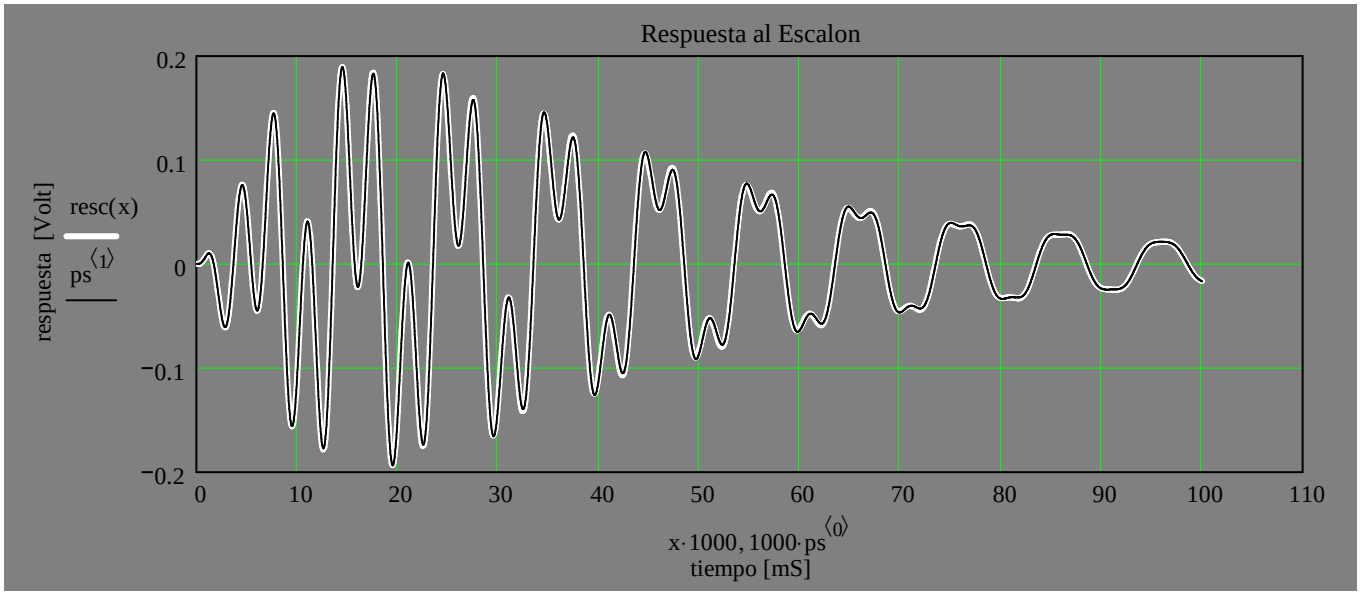
Respuesta al escalon

$$\text{resc}(t) := \frac{\text{Hn}(s)}{s}\ \text{invlaplace}, s \rightarrow \frac{7338971033876538390045068464848230534100427930781371350479521955662735520589758233934455682850400729437802342610406563840 0}{1545702711476953205144280505470128219559435608409623616794081686419751915204927776352368308691343278476958968399990229124 35}$$

$$\text{resc}(t)\ \left|\begin{array}{l}\text{float}, 3\\ \text{collect}, \sin, \cos, \exp\end{array}\right. \rightarrow \left(-3.27\cdot 10^{-3} - 7.10\cdot t\right)\cdot\exp(-43.2\cdot t)\cdot\sin(625.\cdot t) + \left(-2.30\cdot 10^{-2} + 25.4\cdot t\right)\cdot\exp(-73.4\cdot t)\cdot\sin\left(1.88\cdot 10^{3}\cdot t\right) + \left(-14.3\cdot t + 4.75\cdot 10^{-2}\right)\cdot\exp(-43.2\cdot t)\cdot\cos(625.\cdot t) + \left(-1\right.$$

ps :=

	0	1
0	$2\cdot 10^{-7}$	$2.3386\cdot 10^{-5}$
1	$2.0317\cdot 10^{-7}$	$2.375\cdot 10^{-5}$



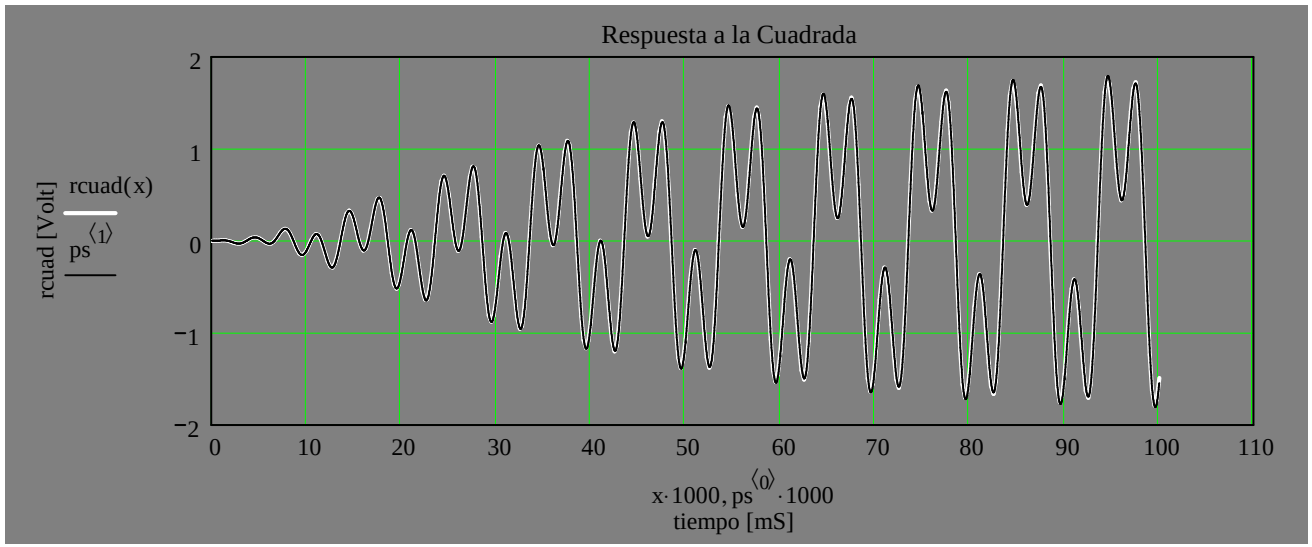
Respuesta a la Onda Cuadrada

$$x := 0, \left(\frac{1}{4000}\right) .. \frac{100}{1000}$$

ps :=

	0	1
0	$1 \cdot 10^{-7}$	$1.721 \cdot 10^{-5}$
1	$1.0177 \cdot 10^{-7}$	$1.7514 \cdot 10^{-5}$

$$rcuad(t) := \sum_{j=0}^{20} \frac{(-1)^{j}}{s \cdot [1 + (j = 0) + (j = 20)]} \cdot \exp\left(-s \cdot j \cdot \frac{T}{2}\right) \cdot Hn(s)\ \text{invlaplace}, s \rightarrow$$

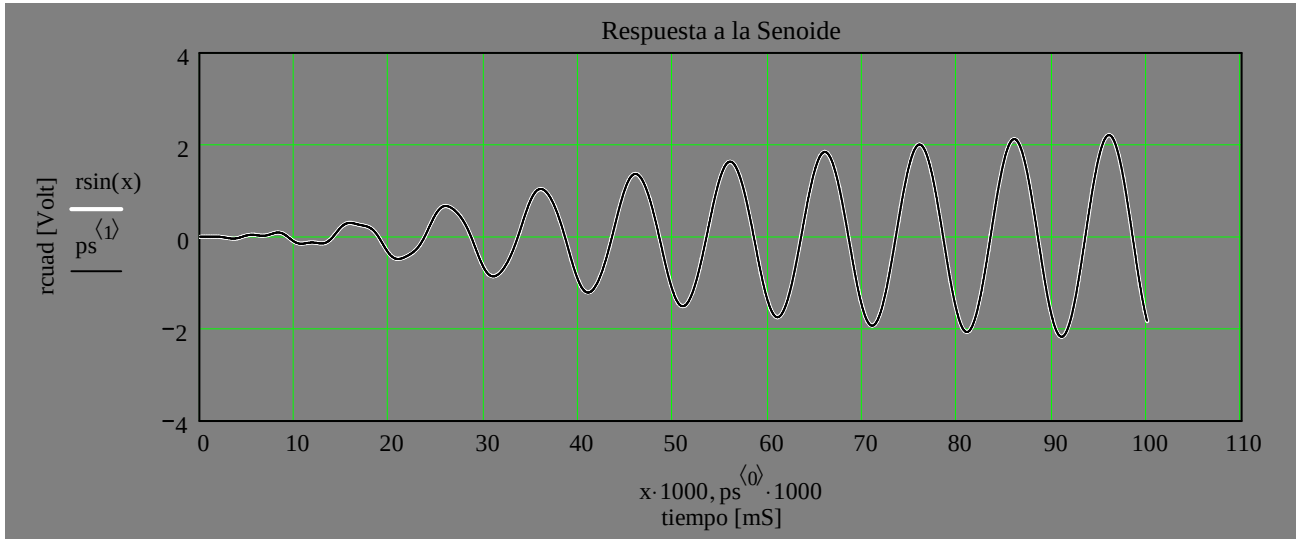


Respuesta a la senoide

ps :=

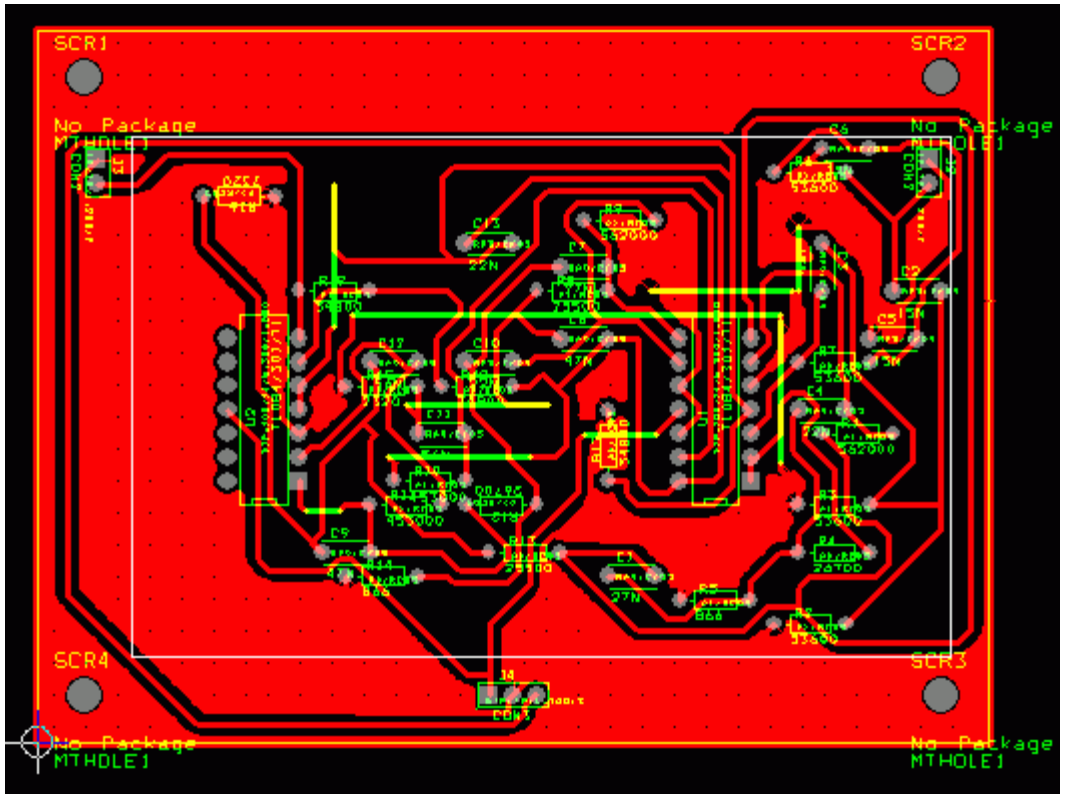
	0	1
0	$1 \cdot 10^{-7}$	$1.721 \cdot 10^{-5}$
1	$1.7969 \cdot 10^{-7}$	$2.5726 \cdot 10^{-5}$

$$rsin(t) := \frac{\frac{2 \cdot \pi}{T}}{s^2 + \left(\frac{2 \cdot \pi}{T}\right)^2} \cdot Hn(s)\ \text{invlaplace}, s \rightarrow$$



Implementacion opcional

se desarrolla un circuito Impreso con Layout cuyo detalle se ve en las 2 fotos que siguen



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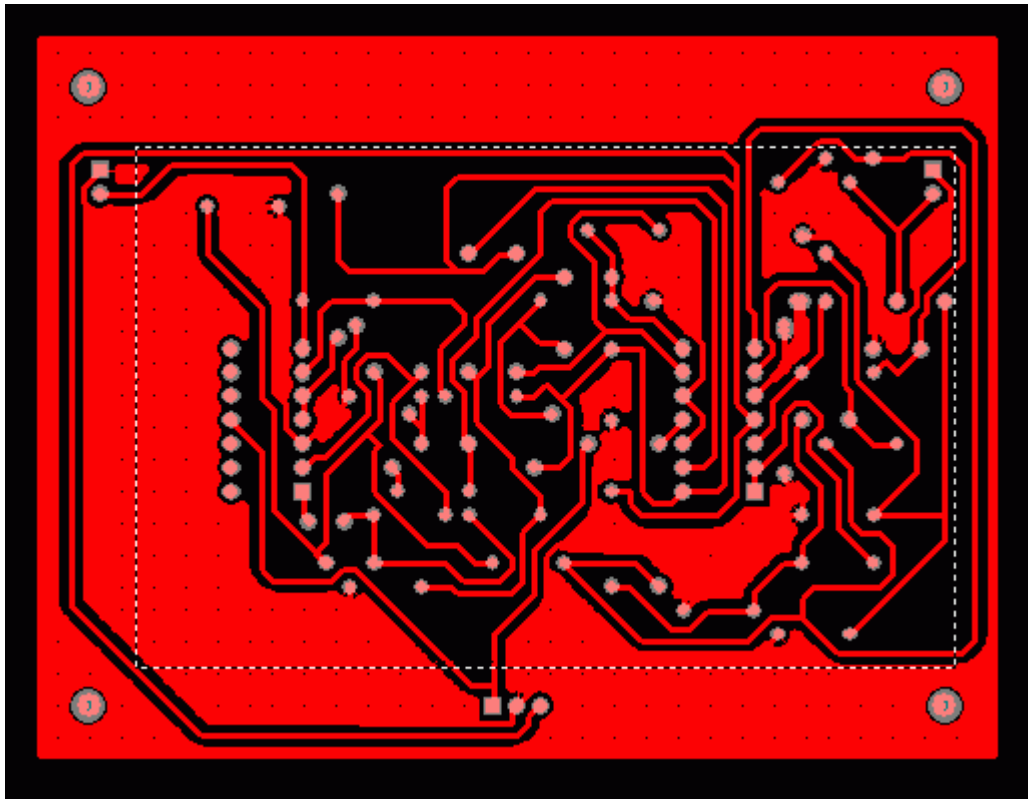

"cupper.GIF"