Exercício 8.22 Daniel Hart CC CA PWM

Escolher a tensão de entrada CC para THD seja menor que 10%

$V_{out} := 220 \quad (rms)$ $\quad R := 30$ $\quad L := 0,025$ $\quad F := 60$ $\quad w_o := 2 \cdot \pi \cdot F = 376,9911$ $\quad \%THD := \frac{10}{100} = 0,1$

Taxa modulação da amplitude

$V_1 := V_{out} \cdot \sqrt{2} = 311,127$

$M_a := \frac{V_1}{V_{in}} = 0,7778$

Escolha de Tensão de Entrada

$V_{in} := 400 \quad (CC)$ $\quad V_{portadora} := 5$

$V_{referencia} := M_a \cdot V_{portadora} = 3,8891$

Amplitude de corrente 60Hz

$Z_1 := \sqrt{R^2 + \left(w_o \cdot L\right)^2} = 31,4456$

$I_1 := \frac{V_1}{Z_1} = 9,8941$

Corrente da harmônica na frequecia da portadora

$I_{mf} := \%THD \cdot I_1 = 0,9894$

A amplitude Vmf

A amplitude Vmf

Table 8-3 Normalized Fourier Coefficients V_n/V_{dc} for Bipolar PWM

	m_a=1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
n=1	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10
$n=m_f$	0.60	0.71	0.82	0.92	1.01	1.08	1.15	1.20	1.24	1.27
$n=mf\pm2$	0.32	0.27	0.22	0.17	0.13	0.09	0.06	0.03	0.02	0.00

Para ma=0,94, mf=0,75

$V_{mf} := 0,75 \cdot V_{in} = 300$

$Z_{mf} := \frac{V_{mf}}{I_{mf}} = 303,2101$

Para a impedância de carga (Zmf) ser maior que 250,
Mf deverá ser maior que:

$M_f := \frac{Z_{mf}}{w_o \cdot L} = 32,1716$

$M_f := 29$

Definindo a Portadora

$F_{por} := M_f \cdot F = 1740$

Calculando as Harmônicas Saída

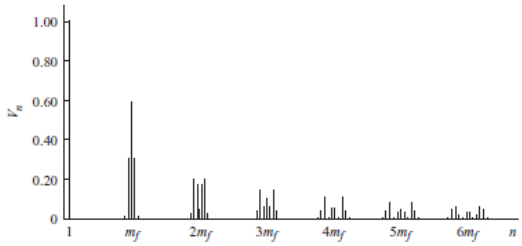


Figure 8-21 Frequency spectrum for bipolar PWM with $m_a = 1$.

Conforme gráfico 8-21 as harmônicas estarão em torno da frequência de chaveamento e seus multiplos.

Utilizando a tabela 8-23 calcula-se as harmônicas, com Mf=27, calcula-se as V25, V27 e 29

$n := 1$

$V_1 := M_a \cdot V_{in} = 311,127$

$I_1 := \frac{V_1}{Z_1} = 9,8941$

$Z_1 := \sqrt{R^2 + \left(n \cdot w_o \cdot L\right)^2} = 31,4456$

$P_1 := \left(\frac{I_1}{\sqrt{2}}\right)^2 \cdot R = 1468,4073$

$n := 27$

$V_{27} := 0,74 \cdot V_{in} = 296$

$I_{27} := \frac{V_{27}}{Z_{27}} = 1,1552$

$Z_{27} := \sqrt{R^2 + \left(n \cdot w_o \cdot L\right)^2} = 256,2313$

$P_{27} := \left(\frac{I_{27}}{\sqrt{2}}\right)^2 \cdot R = 20,0175$

$n := 27$

$V_{27} := 0,74 \cdot V_{in} = 296$

$I_{27} := \frac{V_{27}}{Z_{27}} = 1,1552$

$Z_{27} := \sqrt{R^2 + \left(n \cdot w_o \cdot L\right)^2} = 256,2313$

$P_{27} := \left(\frac{I_{27}}{\sqrt{2}}\right)^2 \cdot R = 20,0175$

$n := 25$

$V_{25} := 0,29 \cdot V_{in} = 116$

$I_{25} := \frac{V_{25}}{Z_{25}} = 0,4884$

$Z_{25} := \sqrt{R^2 + \left(n \cdot w_o \cdot L\right)^2} = 237,5216$

$P_{25} := \left(\frac{I_{25}}{\sqrt{2}}\right)^2 \cdot R = 3,5777$

$n := 29$

$V_{29} := V_{25} = 116$

$I_{29} := \frac{V_{29}}{Z_{29}} = 0,4219$

$Z_{29} := \sqrt{R^2 + \left(n \cdot w_o \cdot L\right)^2} = 274,9601$

$P_{29} := \left(\frac{I_{29}}{\sqrt{2}}\right)^2 \cdot R = 2,6697$

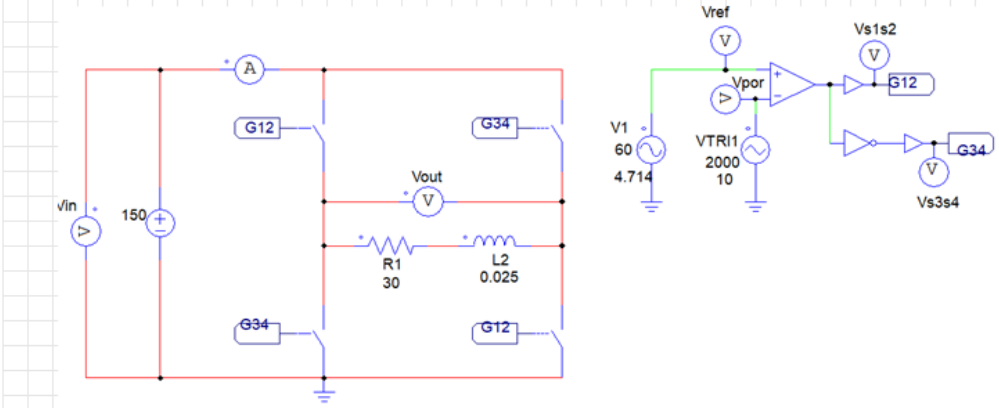
$P := P_1 + P_{25} + P_{27} + P_{29} = 1494,6723$

$I_{out\_rms} := \sqrt{\left(\frac{I_1}{\sqrt{2}}\right)^2 + \left(\frac{I_{25}}{\sqrt{2}}\right)^2 + \left(\frac{I_{27}}{\sqrt{2}}\right)^2 + \left(\frac{I_{29}}{\sqrt{2}}\right)^2} = 7,0585$

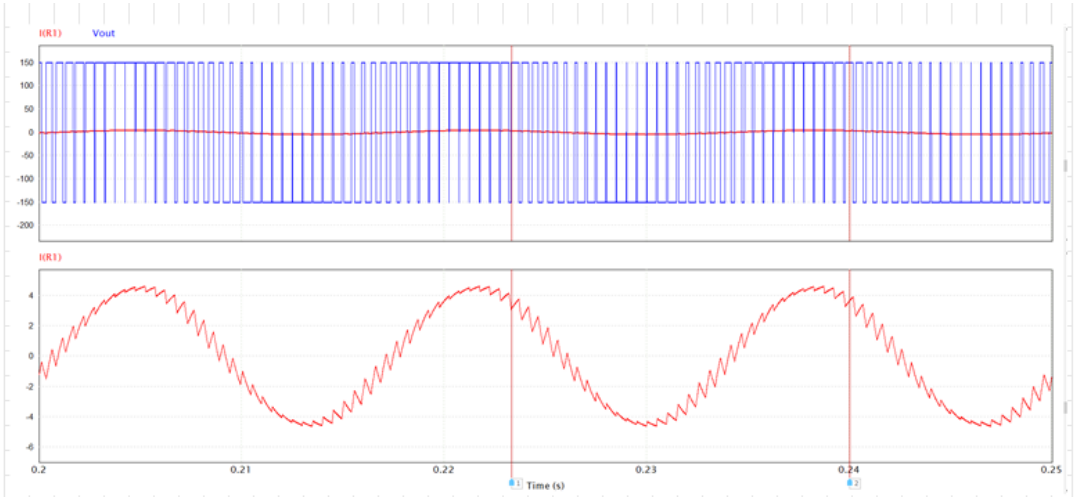
$S := V_{in} \cdot I_{out\_rms} = 2823,3996$

$$DHT_I := \frac{\sqrt{\left(\frac{I_{25}}{\sqrt{2}}\right)^2 + \left(\frac{I_{27}}{\sqrt{2}}\right)^2 + \left(\frac{I_{29}}{\sqrt{2}}\right)^2}}{\frac{I_1}{\sqrt{2}}} = 0,1337$$

$$Fp := \frac{P}{S} = 0,5294$$



Tensão e Corrente Saída



	X1	X2	Δ	Average	Average |X|	RMS	P	S	PF	THD
Time	2.23335e-001	2.40002e-001	1.66667e-002							freq=60
I(R1)	3.15658e+000	3.66269e+000	5.06111e-001	9.69375e-004	2.87311e+000	3.19059e+000	3.07993e+002	4.78588e+002	6.43546e-001	8.64834e-002
Vout	1.50000e+002	1.50000e+002	-1.06283e-005	7.19424e-001	1.47032e+002	1.50000e+002				1.10774e+000
I(R1)	3.15658e+000	3.66269e+000	5.06111e-001	9.69375e-004	2.87311e+000	3.19059e+000	Only 2 curves m...	Only 2 curves m...	Only 2 curves m...	8.64834e-002

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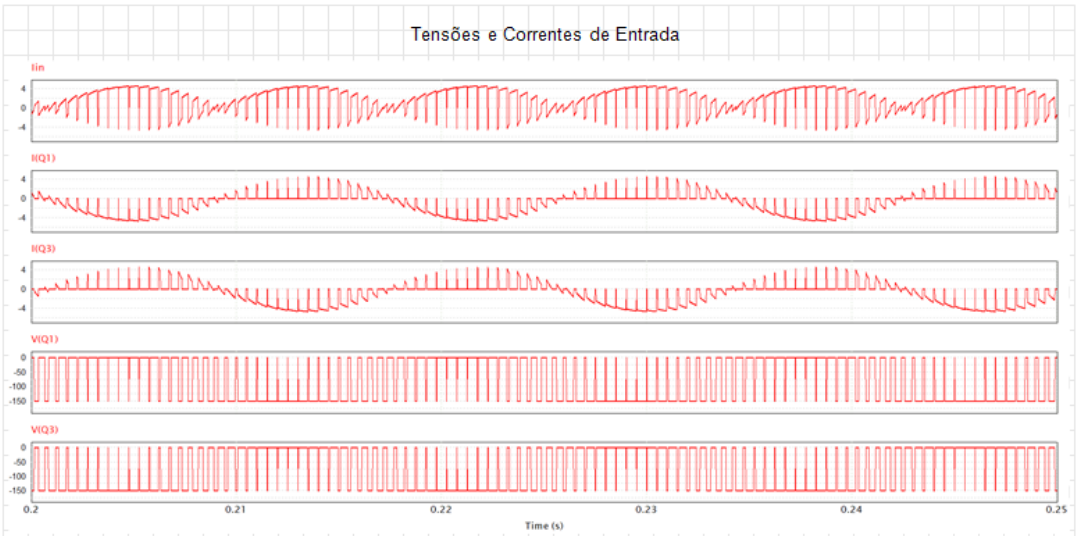
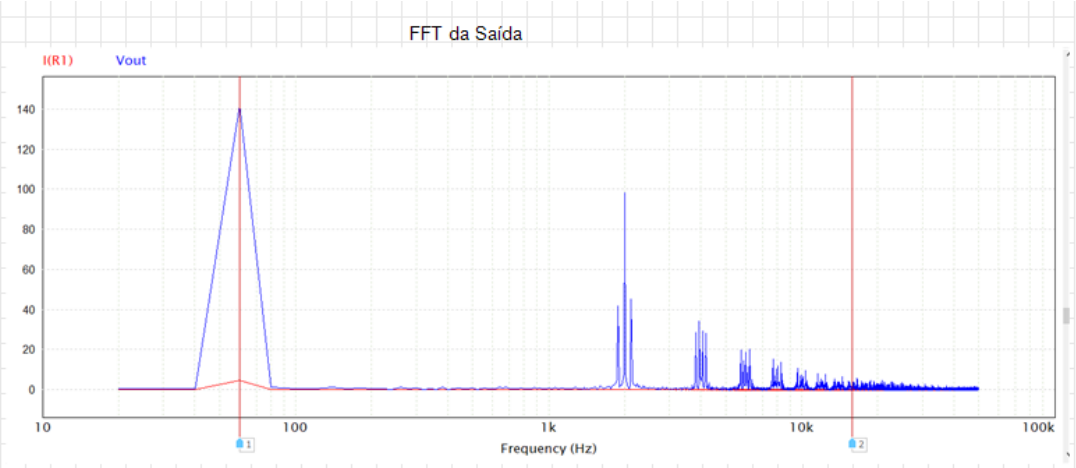


	X1	X2	Δ	Average	Average |X|	RMS	P	S	PF	THD
Time	2.23335e-001	2.40002e-001	1.66667e-002							freq=60
Iin	3.15658e+000	3.66269e+000	5.06111e-001	2.05245e+000	2.81628e+000	3.19059e+000	Only 2 curves m...	Only 2 curves m...	Only 2 curves m...	1.10984e+002
I(Q1)	-3.15658e+000	-3.66269e+000	-5.06111e-001	-1.02671e+000	1.44671e+000	2.26317e+000	Only 2 curves m...	Only 2 curves m...	Only 2 curves m...	9.99913e-001
I(Q3)	0.00000e+000	0.00000e+000	0.00000e+000	-1.02574e+000	1.42641e+000	2.24898e+000	Only 2 curves m...	Only 2 curves m...	Only 2 curves m...	1.01498e+000
V(Q1)	-3.15658e-005	-3.66269e-005	-5.06111e-006	-7.46403e+001	7.46403e+001	1.05811e+002	Only 2 curves m...	Only 2 curves m...	Only 2 curves m...	1.85279e+000
V(Q3)	-1.50000e+002	-1.50000e+002	5.56722e-006	-7.53597e+001	7.53597e+001	1.06320e+002	Only 2 curves m...	Only 2 curves m...	Only 2 curves m...	1.86428e+000



	X1	X2	Δ	Average	Average |X|	RMS	P	S	PF	THD
Frequency	6.00120e+001	1.58489e+004	1.57889e+004							freq=60
I(R1)	4.49947e+000	6.30105e-004	-4.49884e+000							
Vout	1.41871e+002	1.42685e+000	-1.40444e+002							

Tabela Valores Calculados X Simulados

	Calculado	Medido	%
Corrente Saída eficaz	3,19	3,19	0%
Tensão de Saída eficaz	100,00	150,00	50%
Potencia Ativa	307,08	307,90	0%
Potencia Aparente	479,90	478,58	0%
Fator Potência	0,63	0,64	2%
THD Saída Corrente	0,11	0,08	27%
Hamônica Fundamental Tensão	141,42	141,87	0%
Hamônica Fundamental Corrente	4,49	4,49	0%
Corrente Chave Rms		2,26	
Corrente Chave Pico		4,59	
Tensão Máxima Chaves	150,00	150,00	0%