

Actuators

Report for

Lab#6 AC drive PWM converters

Student name: Xu Miao

HDU Student ID: 19322103

HDU-ITMO Joint Institute
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- ✓ LAB#6 is aimed at study Sine PWM and Delta PWM
- ✓ LAB#6 is performed in MATLAB / Simulink

Task 1. Perform simulation with sine wave PWM. Compare ideal and converter power sources

1.1 Provide speed-torque transients

1.2 Analyze the harmonic spectrum

Draw conclusions

Task 2. Perform simulation with Delta PWM. Compare ideal and converter power sources

2.1 Provide speed-torque transients

2.2 Analyze the harmonic spectrum

Draw conclusions

Task 1. Perform simulation with sine wave PWM. Compare ideal and converter power sources

1.1 Provide speed-torque transients

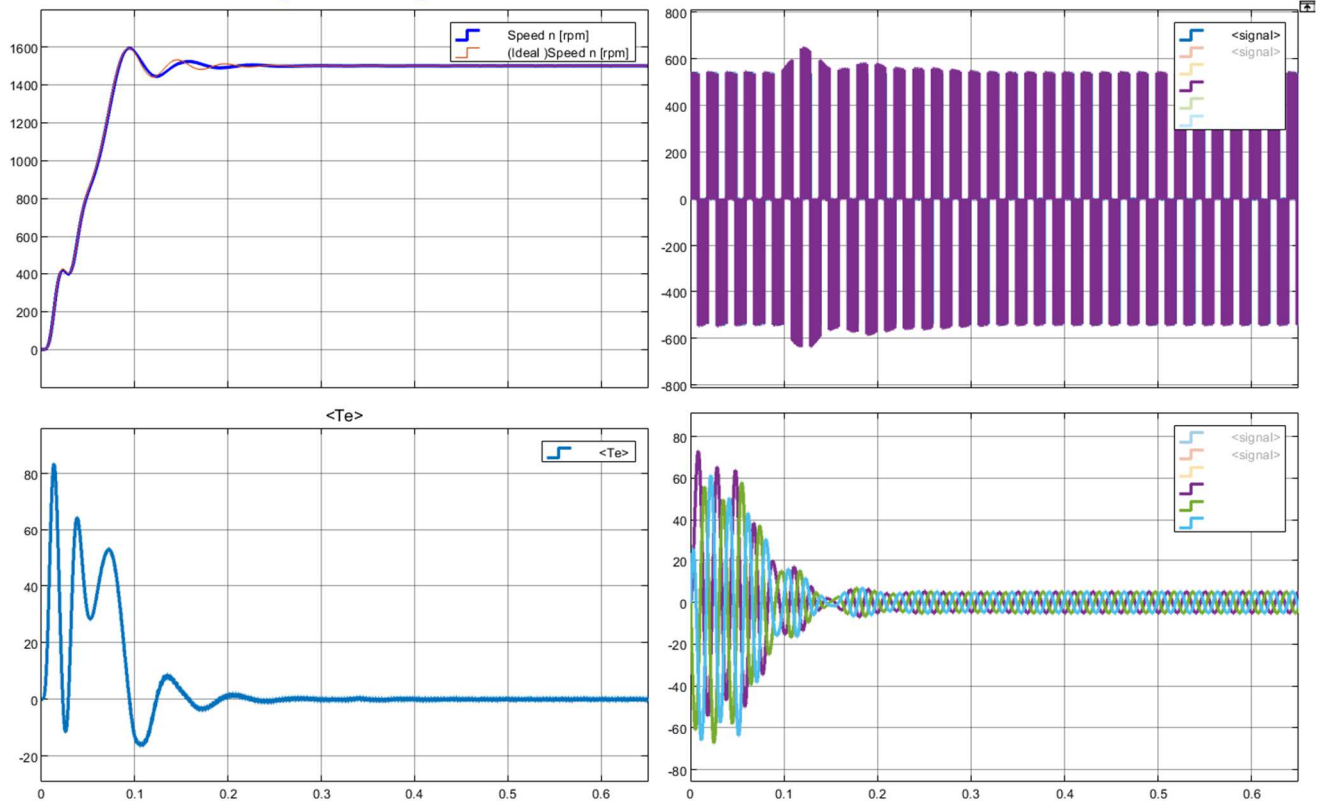


Figure 1 : Ideal and Converter speed and torque transients (sine wave PWM)

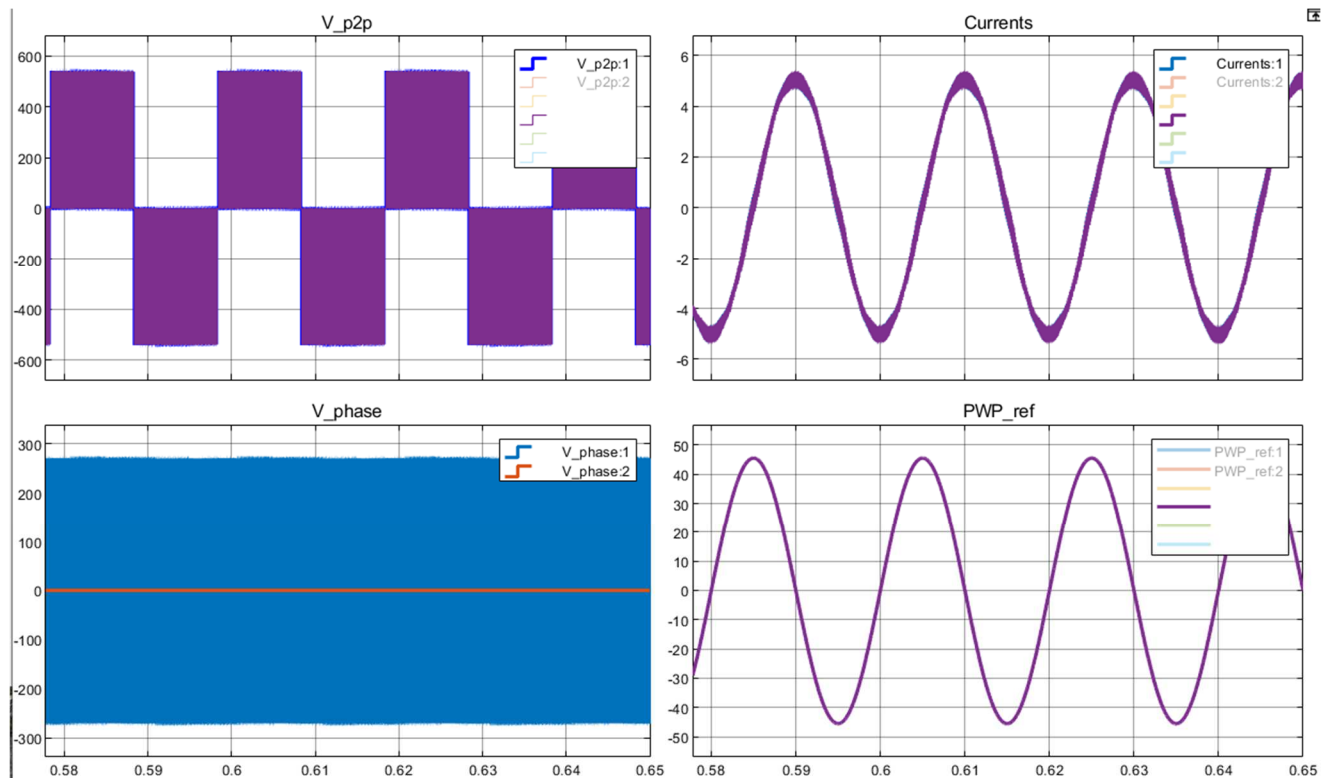


Figure 2 : Ideal and Converter Current and Voltage transients (sine wave PWM)

1.2 Analyze the harmonic spectrum

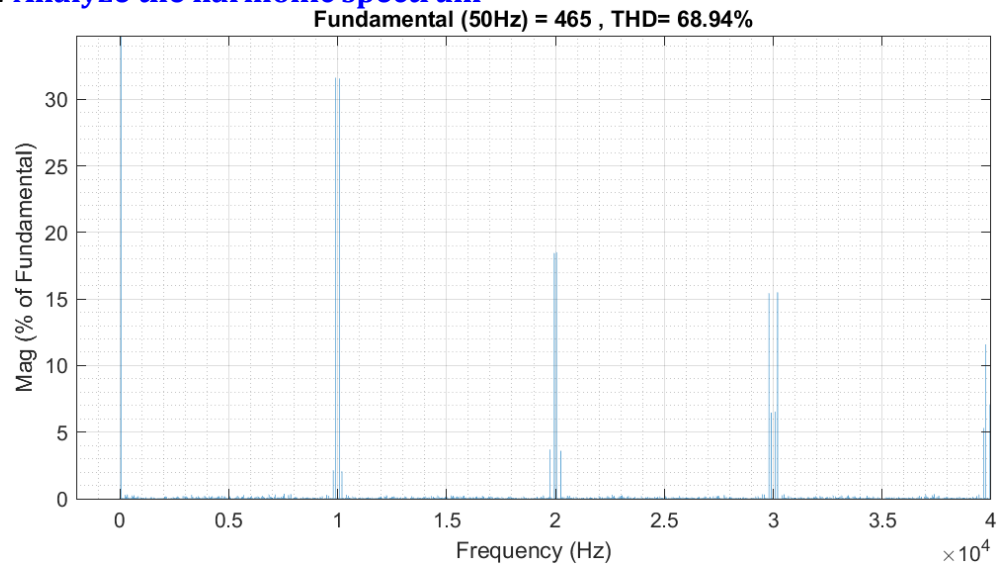


Figure 8 : FFT analysis (V_{p2p}) (Delta PWM)

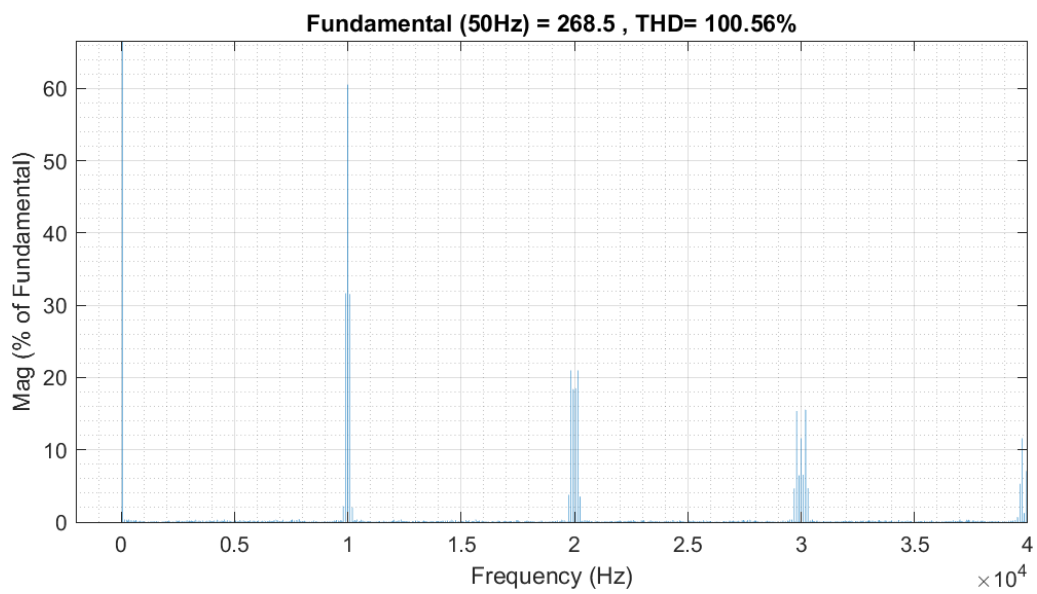


Figure 9 : FFT analysis (V_{phase}) (Delta PWM)

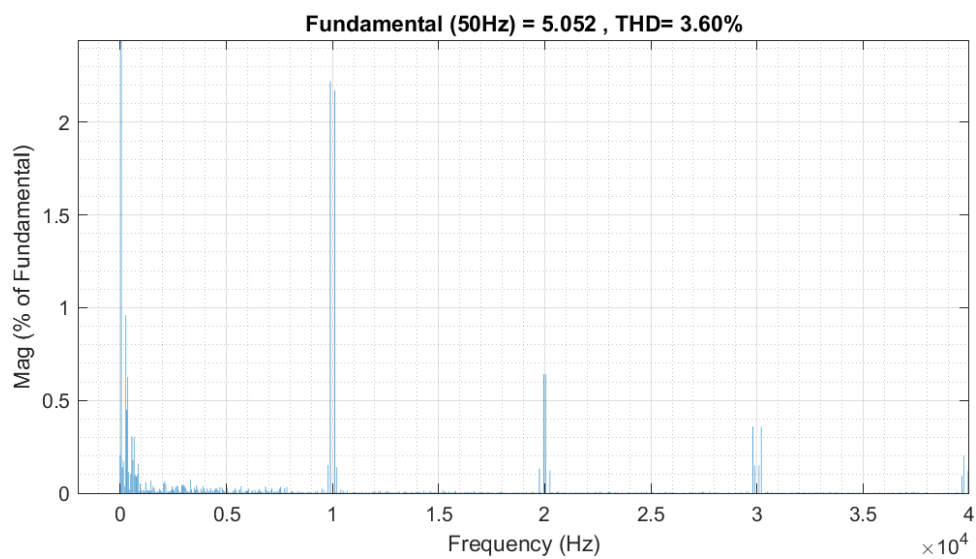


Figure 10 : FFT analysis (Currents) (Delta PWM)

Task 2. Perform simulation with Delta PWM. Compare ideal and converter power sources

2.1 Provide speed-torque transients

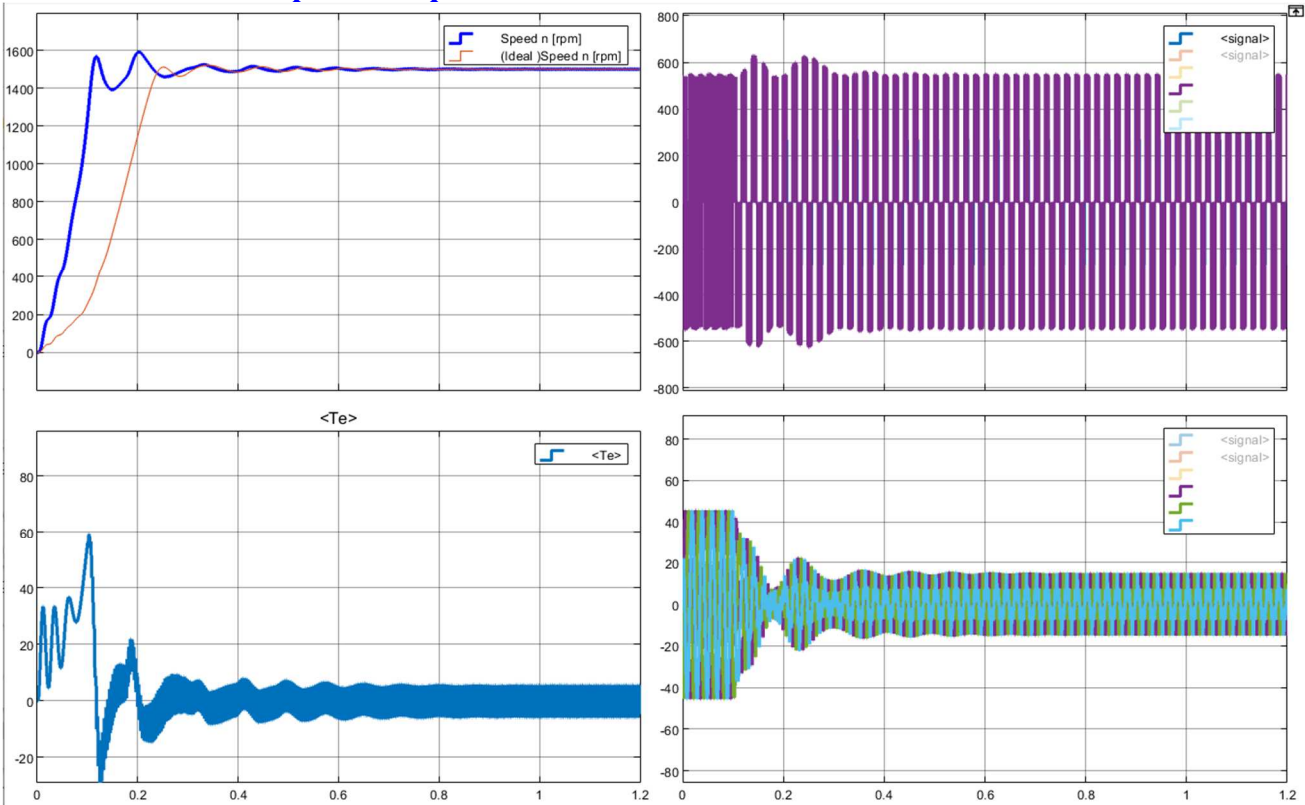


Figure 6 : Ideal and Converter speed and torque transients (Delta PWM)

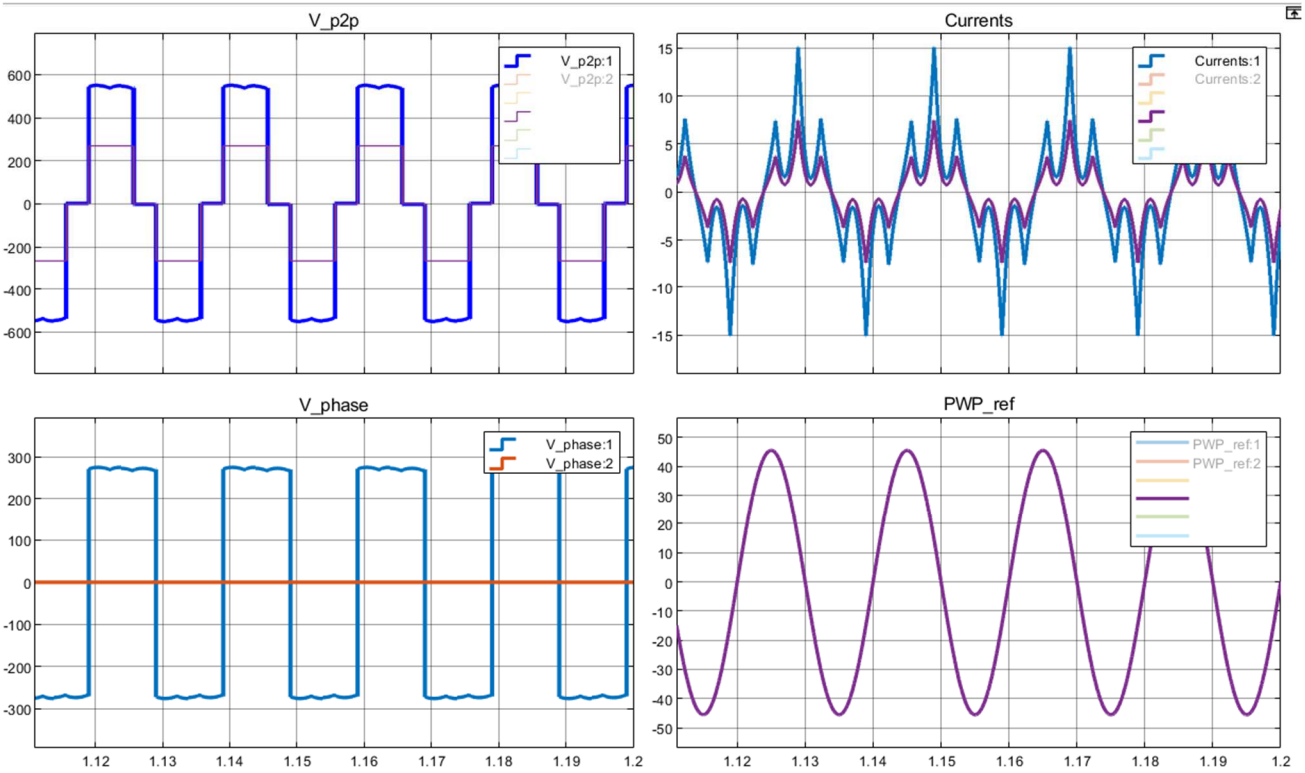


Figure 7 : Ideal and Converter Current and Voltage transients (Delta PWM)

2.2 Analyze the harmonic spectrum

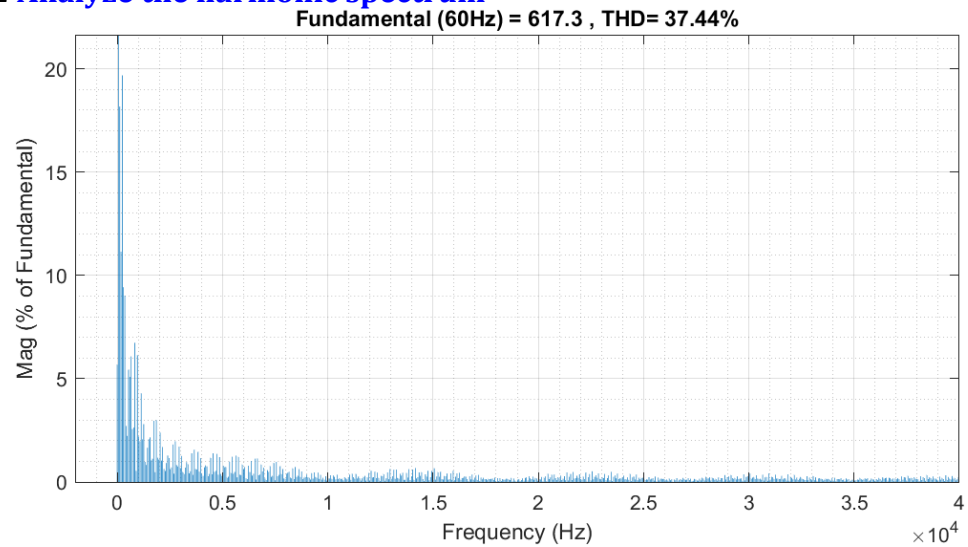


Figure 8 : FFT analysis (V_p2p) (Delta PWM)

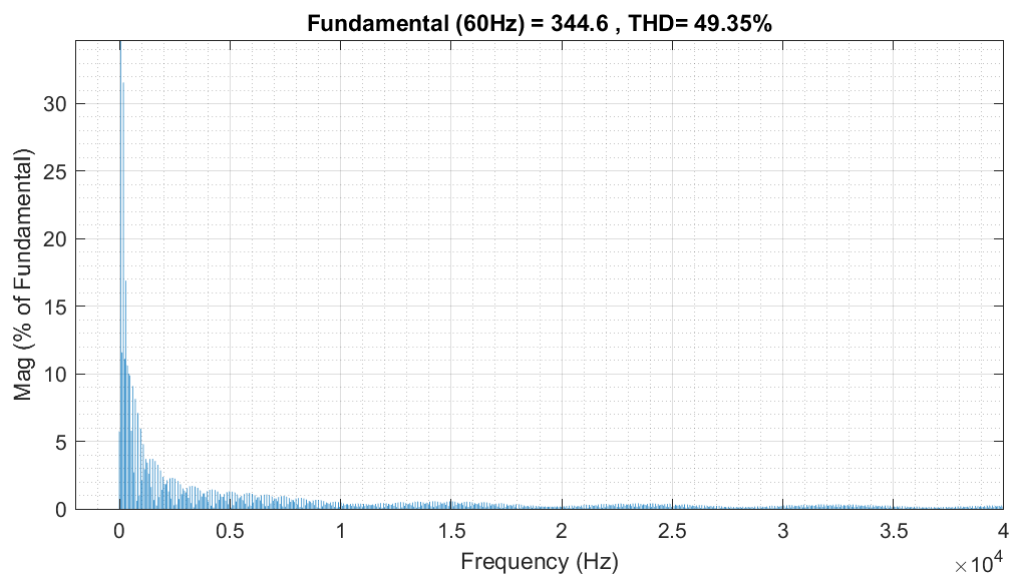


Figure 9 : FFT analysis (V_phase) (Delta PWM)

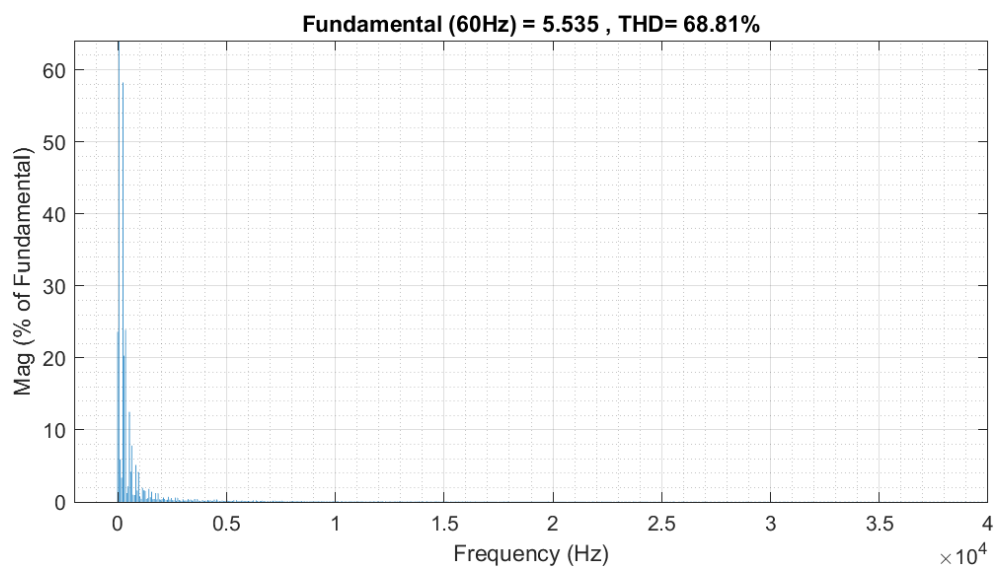


Figure 10 : FFT analysis (Currents) (Delta PWM)

Task 3. Draw conclusions

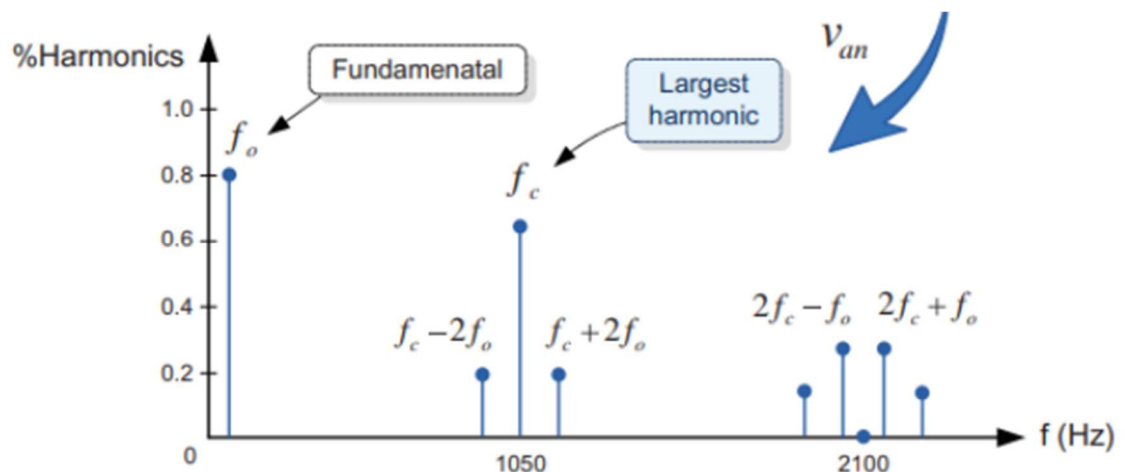
1. Under the same parameters, the **time** to reach **steady state** :

sine wave PWM < Delta PWM

2. Under the same parameters, the output torque and speed of the motor:

Oscillation of delta PWM > sine wave PWM

3. The difference between the output results (speed, current) of the power supply of the Delta PWM converter and the ideal converter is large, and the difference between the sine wave PWM is small.
4. The FFT result of sine wave PWM, the harmonic frequency image is distributed according to the law of $(f_o), (f_c - 2f_o, f_c, f_c + 2f_o), (2f_c - f_o, 2f_c + f_o), \dots$, As shown below:



5. The FFT result of Delta PWM, the harmonic frequency image is distributed according to the law of "increasing from the fundamental frequency, the proportion is less"

The data for the fifth motor I used in this report is shown in the table below:

		a ₃
f _e	nominal frequency , Hz	50
I _n	nominal current, A	11.1
L _m	mutual inductance, H	.164
L _s	stator inductance, H	.169
L _r	rotor inductance, H	.1715
R _s	stator resistance, Ohm	1.32
R _r	rotor resistance, Ohm	.922
J	moment of inertia , kg*m ²	.0202
P _n	rated power, W	5500
s _n	nominal slip	0.035
z _p	pairs of poles	2
i _{lim}	ratio of max current	4.5
m _f		200

Data of IM

Block Parameters: AC Machine

Asynchronous Machine (mask) (link)

Implements a three-phase asynchronous machine (wound rotor, squirrel cage or double squirrel cage) modeled in a selectable dq reference frame (rotor, stator, or synchronous). Stator and rotor windings are connected in wye to an internal neutral point.

Configuration
Parameters
Advanced
Load Flow

Nominal power, voltage (line-line), and frequency [Pn(VA), Vn(Vrms), fn(Hz)]:

Stator resistance and inductance [Rs(ohm) Lls(H)]:

Rotor resistance and inductance [Rr'(ohm) Llr'(H)]:

Mutual inductance Lm (H):

Inertia, friction factor, pole pairs [J(kg.m^2) F(N.m.s) p()]:

Initial conditions

[slip, th(deg), ia, ib, ic(A), pha, phb, phc(deg)]:

☐ Simulate saturation

Plot

[i(Arms) ; v(VLL rms)]:

OK
Cancel
Help
Apply

```

clc, clear
Pn = 5500 % - rated power, [W]
f_e=50; % - nominal (rated) frequency , [Hz]

Rs = 1.32 % - stator resistance, [Ohm]
Ls = 0.169 % - stator inductance, [H]

Lr = 0.1715 % - rotor inductance, [H]
Rr = 0.922 % - rotor resistance, [Ohm]

Lm = 0.164 % - mutual inductance, [H]

J = 0.0202 % - moment of inertia , [kg*m2]
zp = 2 % - pairs of poles
L1s = Ls - Lm;
L2s = Lr - Lm;
s_n = 0.035 % - nominal slip
I_n = 11.1; % - nominal (rated) current, [A]
I_rated = 11.1;
T_e_rated = Pn*zp/((1-s_n)*2*pi*f_e) % - nominal (rated) torque, [N*m]
i_lim = 4.5; % - ratio of max current

w_rated=2*pi*f_e*(1-s_n); % - rated speed [rad/s]
n_rated = w_rated/2/pi*60; % - rated speed [rpm]
w_idle_1=2*pi*f_e/zp; % - idle speed [rad/s]

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