PW AVANCED POWER ELECTRONIC

PW N^{r}4
Elimination of Harmonics

Objective :

In practical work related to harmonic elimination, several key objectives are pursued:

1. **Reduction of Total Harmonics Distortion (THD) :** The primary goal is to minimize THD, which is a measure of how much the voltage or current waveform deviates from a perfect sine wave. Lower THD values indicate better power quality and reduced energy losses13.
2. **Selective Harmonic Elimination (SHE):** This involves eliminating specific harmonic frequencies, such as the third and fifth harmonics, by optimizing switching angles in multilevel inverters. SHE is crucial for achieving high-quality output voltage waveforms13.
3. **Improvement of System Efficiency:** By reducing harmonic distortion, the efficiency of electrical systems can be improved, leading to reduced energy consumption and lower operating costs2.
4. **Enhancement of Power Quality:** Harmonic elimination helps in maintaining stable and reliable power supply, which is essential for sensitive electronic equipment and industrial processes4.
5. **Flexibility and Adaptability :** Developing methods that can be applied to various types of inverters and systems, including those with unequal DC voltages, is another important objective2.
6. **Optimization of switching Patterns:** Using advanced algorithms and techniques to optimize switching patterns and angles, ensuring that the desired harmonic elimination is achieved efficientlyThe objective of this practical work is to remind the student of the interest in improving the power factor, which is related to reactive energy compensation, analyzing its impact and seeing how to size the compensation capacitors using MATLAB/SIMULINK.

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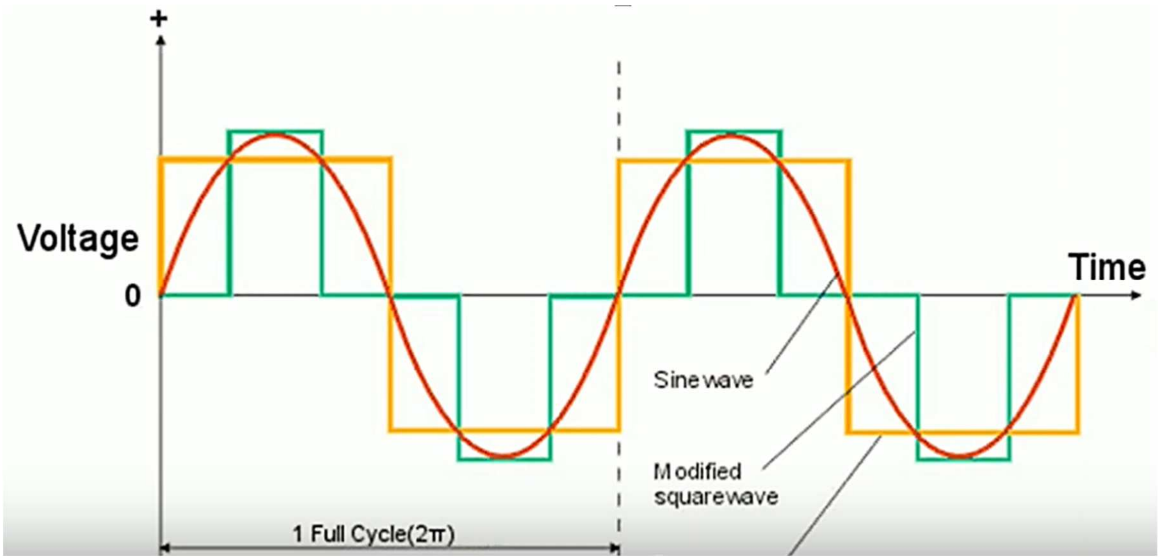
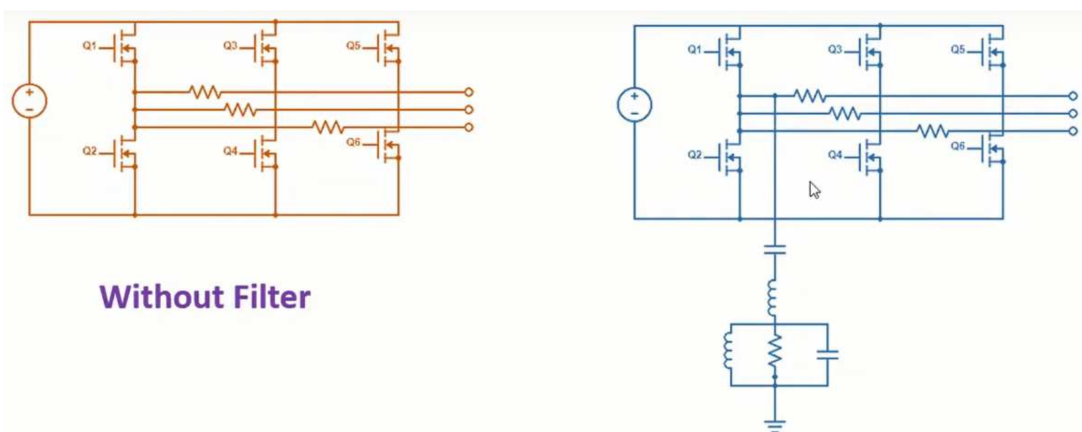


2- Handling:

Two types of passive filters are generally used, the resonant filter and the damped filter. This device, which allows the selective attenuation of harmonic currents, is illustrated in figures below as follow:



1- Resonant filter:

This filter is designed to eliminate lower order harmonic currents h5 and h7 . The tuning rank n_a corresponds to the multiple, integer or not, of the nominal frequency of the network for which the impedance of the LC filter is minimal such that:

$$Z = \frac{1 + j\left(\frac{R}{L\omega}\right)\frac{\omega^2}{\omega_a^2} - \left(\frac{\omega^2}{\omega_a^2}\right)}{jC\omega} \quad \text{with} \quad \omega_a = \frac{1}{\sqrt{LC}}$$

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To eliminate harmonics h5 then h7, we respectively insert the filter resonant with the network.

2- Damped Filter:

To attenuate an entire harmonic band such as h11, h13, h17 and h19, a second-order high-pass filter called a damped filter is generally used. The impedance of a damped filter is given by the following formula:

$$Z(\omega) = \frac{R + jL\omega + j^2 RLC\omega^2}{(R + jL\omega)jC\omega}$$ with $$n_a = \frac{1}{\omega_1 \sqrt{LC}}$$

Knowing that: na is the tuning rank; ω1: Network pulsation

3- Simulation:

- **Simulation parameters:**

e_s (t) = 400*sin ωs*t ; ωs=100*π; fs=50Hz; Es = 230 V; Rs = 1Ω; Ls = 1mH.

Harmonic 5: L = 1.6 mH; C = 255µ;

Harmonic 7: L = 0.96 mH; C = 215µF

Harmonic band (h11, h13, h17 and h19): L = 0.19 mH; C = 358 µF.

Coupling impedance: Rc=2 Ω, Lc=20 mH.

- **Work requested:**
  - Implement the model in figure 02 on Simulink, then visualize the current absorbed by the rectifier bridge and its harmonic distortion rate (Before inserting the resonant and damped filter). What do you notice, give your comments.
  - Insert the resonant filter alone in parallel with the network, then illustrate the shape of the current absorbed by the rectifier bridge and its harmonic distortion rate. Record your comments.
  - Add the damped filter in parallel with the resonant filter, then visualize the current absorbed by the rectifier bridge and its harmonic distortion rate. Give your findings.
  - Disconnect the resonant filter and keep the damped filter in parallel with the network, then visualize the current absorbed by the rectifier bridge and its harmonic distortion rate. Give your comments.
  - If we change the network frequency to a value of 100Hz, keeping the same parameters indicated above. What do you notice, give your comments.