2022 8th International Conference
on Energy Efficiency and Agricultural Engineering
EE&AE 2022

30th June - 2nd July 2022, Ruse, Bulgaria

A multidimensional comparative analysis of inverters used in wireless power transfer

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GOAL OF THE STUDY

This paper presents a comparative study of inverters used in the wireless transmission of electricity: full-bridge, half-bridge, half-bridge with mid-voltage point capacitors, class E. The paper's purpose is to achieve a multidimensional comparative analysis of each type of inverter used in high-frequency voltages coils supplying for wireless power transmission, determining the advantages and disadvantages for each type o load.

METHODOLOGY OF THE INVESTIGATION

The inverter simulation was performed in Matlab Simulink using resistive and reactive loads (LC, RLC). In order to realize a comparative study of these four inverters, they were supplied from the same voltage source, 15Vd.c., the half-bridge inverters requires a medium point voltage source, therefore two 7.5Vd.c. series voltage sources were used, summing 15Vd.c. in first configuration and a mid-voltage point capacitors with 15Vd.c. voltage source in second configuration.

MAIN RESULTS FROM THE STUDY

The inverters output voltage frequency can be varied by changing the control frequency of the switching elements. Following the simulations, it will be determined the values (RMS-root mean square) of voltages and currents, but also the values of THD (Total Harmonic Distortion).

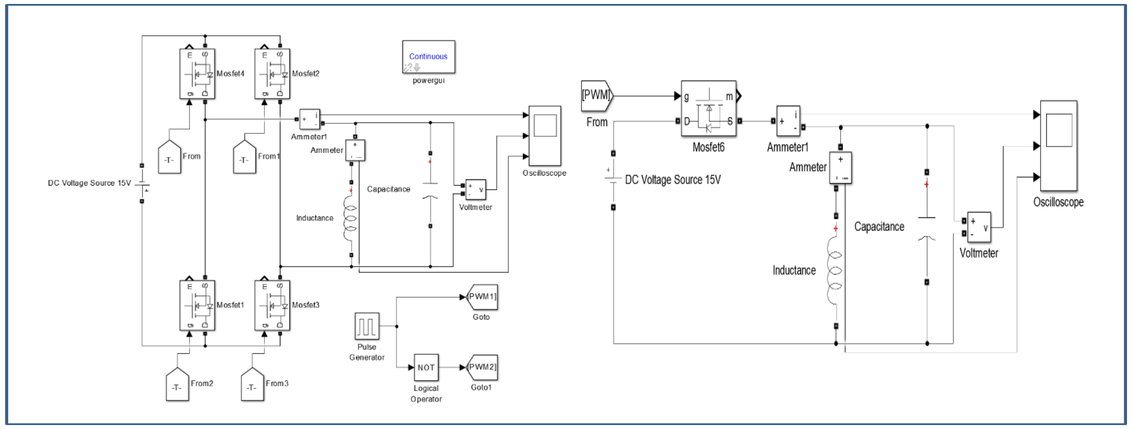

Fig. 1. Full-bridge and class E inverter

Following the previous simulations, all recorded data were registred into the graphs exposed in below figure for easier results interpretation.

Table 1. Table caption

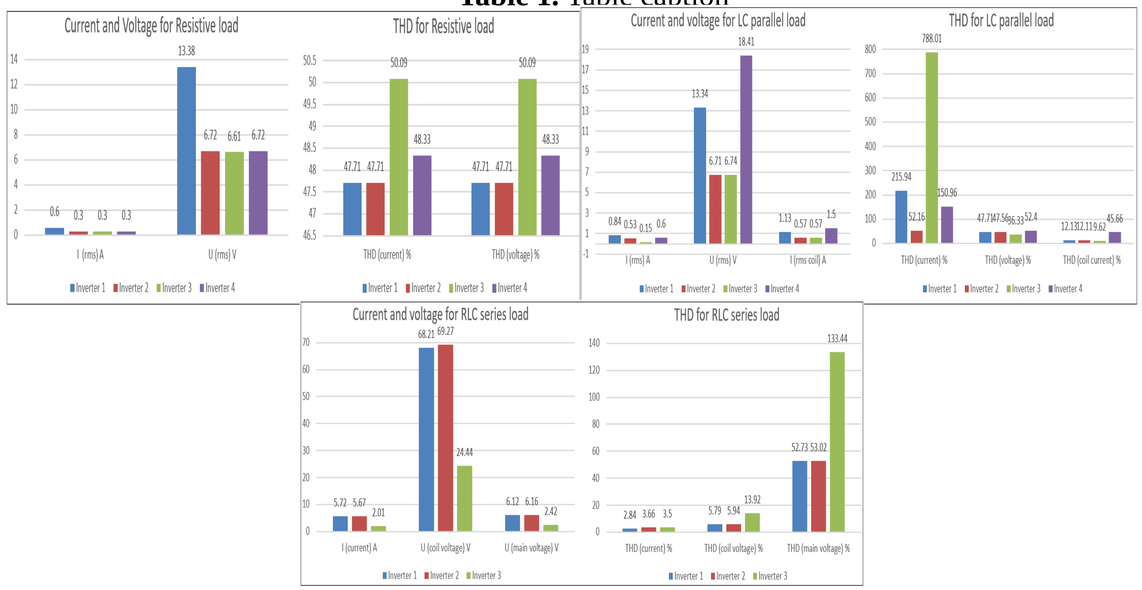

Fig. 2. Simulations graphs inverters: 1 (full-bridge inverter), 2 (half-bridge inverter), 3 (half-bridge inverter (mid-voltage point capacitors)), 4 (Class E inverter)

CONCLUSIONS

The inverters simulations results exposed was analysed, concluding the following:

- Resistive load
  - the full-bridge inverter (using all source energy) obtained twice as high values of voltage and current compared to the other three inverters, thus full-bridge inverter is recommended in resistive loads.
- Parallel LC load
  - the class E inverter amplifies the voltage applied to the coil, therefore the current through the coil is higher than the other inverters, being recommended for powering the LC parallel loads.
- RLC series load
  - the class E inverter can not be operated in this configuration; in the case of full-bridge and half-bridge inverter, there is an coil voltage increasing and therefore a much higher current flows through the coil, the coil current and voltage values are higher than all experiments, which recommend full-bridge and half-bridge inverter for powering RLC series oscillating loads.

About the inverters loads power-factor, influenced by the current THD factor, concluding:

- Resistive loads, the four inverters have an approximately equal THD factor.
- Parallel LC load, the half-bridge inverter has the lowest main current THD, which determines the lowest influence of the current THD on the reactive energy.
- Series RLC load, the half-bridge inverter has a higher main current THD than the full-bridge inverter and half-bridge inverter (mid-voltage point capacitors), which determines a greater influence on half-bridge inverter reactive energy.

From the point of view of electromagnetic waves propagation, the current THD passing through the emission coil, influences the waves propagation (depending on the harmonic orders amplitude).