EMC COMPATIBILITY OF POWER SEMICONDUCTOR CONVERTERS AND INVERTERS

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SUMMARY

This papers deals with the computer analysis of the electromagnetic compatibility (EMC) problems focused to the area of power electronics and performed by numerical computer simulation, which can also disclose the startling facts concerning.

Keywords: *electromagnetic compatibility, power electronics, converters, inverters*

1. INTRODUCTION

Development of power semiconductor parts caused vehement evolution of the power electronics branch in the last ten years. For the converter functionality investigation was necessary first theoretically analyze and then practically verify the assumed activity of converter. Now we can eliminate laborious theoretical analysis by numerical computer simulation, which can also disclose the startling facts concerning the electromagnetic compatibility (EMC) problems.

2. IMPULSE CONVERTERS

Regulation of speed rotation of DC motors usually utilizes the connection of four quadrant impulse converter, the scheme of which is shown in Fig. 1. As consequence of the fact that this circuit

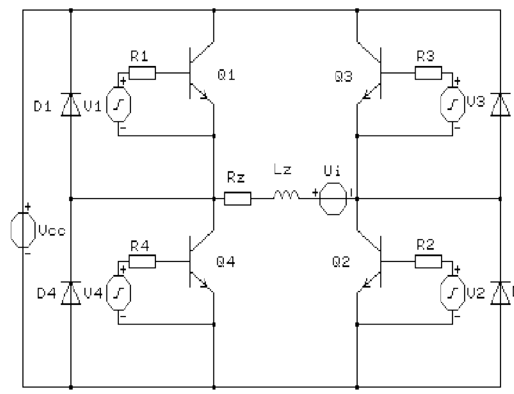

Fig. 1 Four quadrant impulse converter

is also containing non-linear power semiconductor parts, the theoretical analysis will be very difficult. In this case we can do it with very easily by utilizing PSPICE program simulation. Obtained results are showing the transistor and load currents and voltages in Fig. 2. From the curves one can see that during the certain part of the switching period is switch on the first diagonal of transistors and during the rest

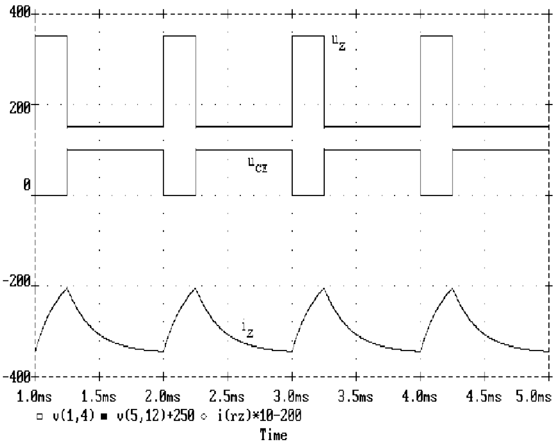

Fig. 2 Converter voltage and current waveforms

time of period is switch on the second diagonal. The dead time during diagonal switching is required because we must secure that two transistors in one-branch can not be switch on at the same time, because it can to lead to the destruction of the transistors. Obviously the dead time is not visible in figure waveforms due to existence of load inductance, which is causing that the current is flowing through backward connected diodes and this fact exactly defines all circuit potentials. If we change the ratio of the switch on times of the both

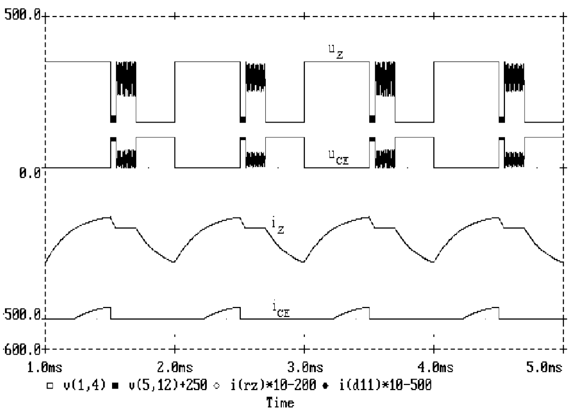

Fig. 3 Interrupted load current

diagonals, we will change output voltage average value and so the turns of DC motor, too. From the Fig. 3 it is evident that load current has the zero value in certain part of the period. It is leading to the mistake conclusion that by Ohm's Law also the load voltage must have zero value in this time. However, from picture we can see that above mentioned voltage is not zero and once more it is also very undulating. That fact has very unfavorable effect to the used power semiconductor parts and deteriorate EMC of the converter. Exact explanation of this fact is very difficult to perform by classical method, but the investigation of such circuit we can do easy by PSPICE program simulation. By such a way we are able to find that during the part of period when all converter parts are in non-conducting state the parasitic transistor capacities, parasitic circuit inductances and load inductance defines all circuit potentials. All above-mentioned elements create the resonance circuit, which is easily inclined to the oscillation. The oscillation frequency mainly depends on the values of converter capacities and inductances. If the converter construction is utilizing the modern field effect transistors with small parasitic capacities then the higher oscillation frequencies and the worse EMC could be.

3. PARASITIC INDUCTANCES

The basic electrical equivalent scheme representing the converter and motor interconnection is shown in Fig. 4.

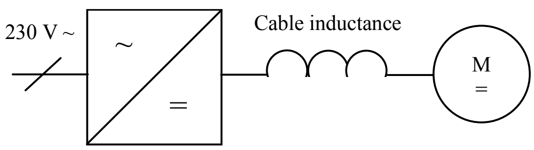

Fig. 4 Motor and converter interconnection

The inductance connected between converter and motor is representing the real parasitic inductance of wire used for interconnection of both above-mentioned equipments, the value of which is depending on the length of wire. It has important secondary effect on working conditions of feeding converter. Typical situation is illustrated in Fig. 5.

4. FILTERING

The most frequent principle of connection of safeguard circuit, which is securing the limitation of *du/dt* value is shown in Fig. 6.

Three-phase principle of filtering which is utilized for filtering AC waveforms is shown in Fig. 7. This type of filtering circuit is the so called sinusoidal filter, because such a filter is very important for reducing the content of the higher harmonics in AC output waveforms.

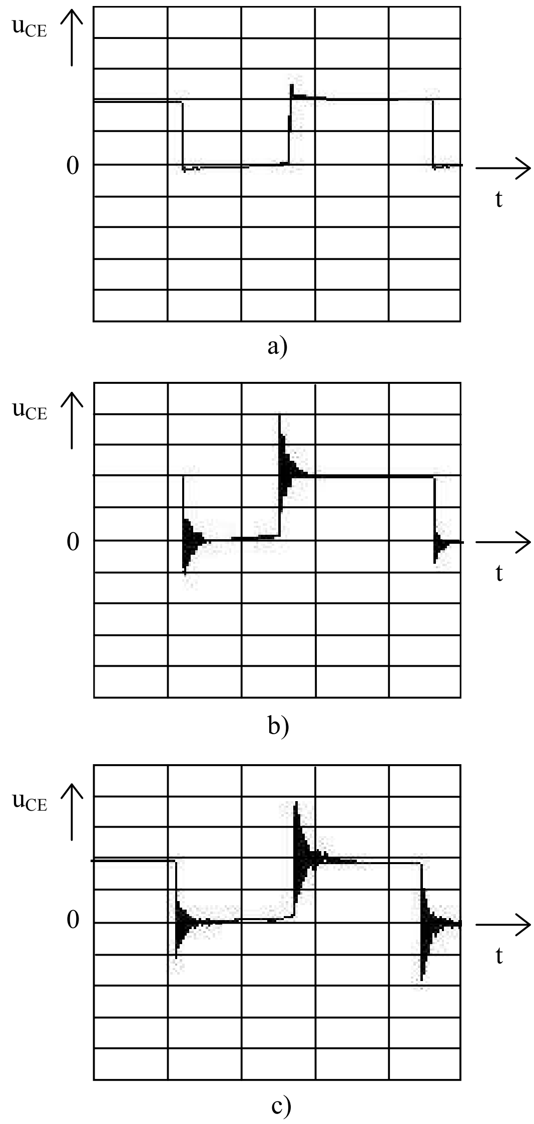

Fig. 5 Collector over voltages of converter transistors in depends on the interconnecting wire length; a) length is equal to 3m, b) length is equal to 30m, c) length is equal to 60m

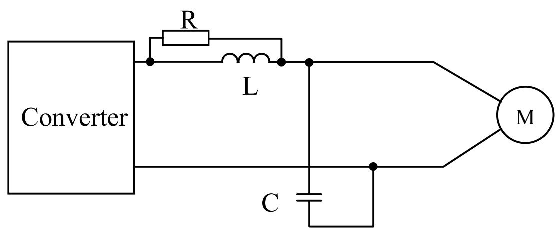

Fig. 6 Filtering circuit for limitation of *du/dt* values

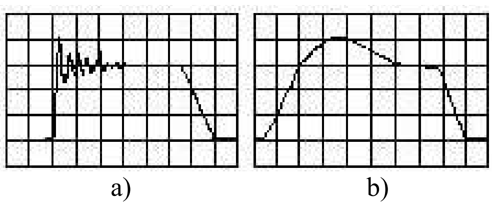

Fig. 7 Output converter voltages
a) without filtering circuit b) with filtering circuit

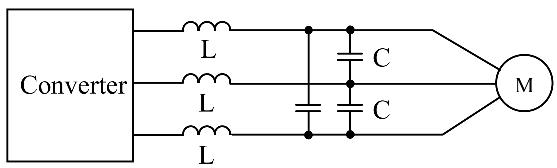

Fig. 8 Sinusoidal filter

5. CONCLUSION

Performed analyzes indicates that besides the main influence on the converter's EMC, which is represented by large current switching, also the switch off state with small parasitic resonant load current is very important.

We can see that the converter is operating as transmitter with 100 MHz frequency range.

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BIOGRAPHIES

Irena Kováčová - She finished her studies in 1982 at the Technical University of Košice, Department of Electrical Drives, direction - Power electronics with excellent evaluation. From this time she has worked at the Department of Electrical Drives, first as assistant lecturer and now as associate professor. In 1988 she has got her doctoral diploma. In 1991 she has got the Award of Minister of Education for Development of Science and Technology. Her working interest is mainly focused to the field of power electronics, especially to the construction of converters and inverters with new perspective elements and computer simulation of new power semiconductor parts and devices.

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