



A SIMPLE CONTROL STRATEGY FOR REJECTING HIGHER HARMONICS IN A SINGLE PHASE INVERTER CIRCUIT

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Abstract: *Inverters today are realised with well known converter circuits, as the push-pull, half bridge, bridge, as well as with the complex stepped and interval variable circuit. These switched mode circuits generate voltage/current shapes which generate the required first, but also the higher, parasitic, harmonics which can influence the ac loads. One of the main designing problem of the inverter circuits is the higher harmonics rejection which can be obtained by output filters, pwm control strategy or by the combination of both. The paper deals with the simple control strategy for the rejection of the higher harmonics which is based on the injection of the control pulses at the strictly defined angles and with proper amplitude. The main feature of this method is that it ensures simple and very satisfactory higher harmonics rejection with only a few injected pulses per period. The harmonic analysis of the several examples is presented, as well as the proposed solutions for the realisation of the inverter circuit.*

Key Words: *Control Strategy, Higher Harmonics Rejection, Injection of Control Pulses, Single Phase Inverte*

1. INTRODUCTION

Inverters today are realised by applying well known converter circuits as the push-pull, half bridge, bridge, or by applying the complex stepped and interval variable circuit as well. These switched mode circuits generate voltage/current shapes which generate the required first, but also the higher, parasitic, harmonics which can influence the ac loads. One of the main designing problems of the inverter circuits is the higher harmonics rejection, which can be obtained by output filters, pwm control strategy or by the combination of both. Many of the pulse-width, frequency or hybrid modulations are developed for this purpose. The motor drives inverters have some specific preferences, according to the other ac loads; they are based on motor current self-filtering characteristic. Further, the single-phase motor drives have special requirements and design criteria. They are used at low power, up to a few kW, and because of that

the price of the devices has to be as low as it is possible which leads to the solutions which have very simple and well known converter circuit, as well as of the simple control strategy to simplified control circuits and applied software.

The paper deals with the simple control strategy for the rejection of the higher harmonics, which is based on the injection of the control pulses at the strictly defined angles, and with proper amplitude. The main feature of this method is that it ensures simple and very satisfactory higher harmonics rejection with only a few injected pulses per period. The harmonic analysis of the several examples is presented, as well as the proposed solutions for the realisation of the inverter circuit.

2. THE ANALYSIS OF THE HARMONIC CONTENTS OF THE PULSE PERIODIC FUNCTION

The adequate choice of the distribution angle and adequate amplitudes of the pulses of some periodic function can achieve the efficient rejection of the higher harmonics. It is well known that the odd periodic function has only the odd harmonic in their Fourier's harmonic extrapolation. The paper considers only the class of the mathematical functions, which have all pulses of the same duration, but their amplitudes can be different. The pulses can have monotonous or symmetric distributions during operating half period /or period. The number of the pulses can be odd or even. The particular characteristics of the above possibilities are considered.

2.1. Monotonously function

In this case the pulses are monotonously distributed during the half-period for the angle difference of β and with the pulse duration of 2α . The edge pulses have the distance of 2β . Figure 1 shows the odd and even distribution of the function. The odd and even number of pulse were analysed, and some examples and mathematic conditions for the maximum rejection of the first higher harmonics are discussed. Example is given in figure 2.

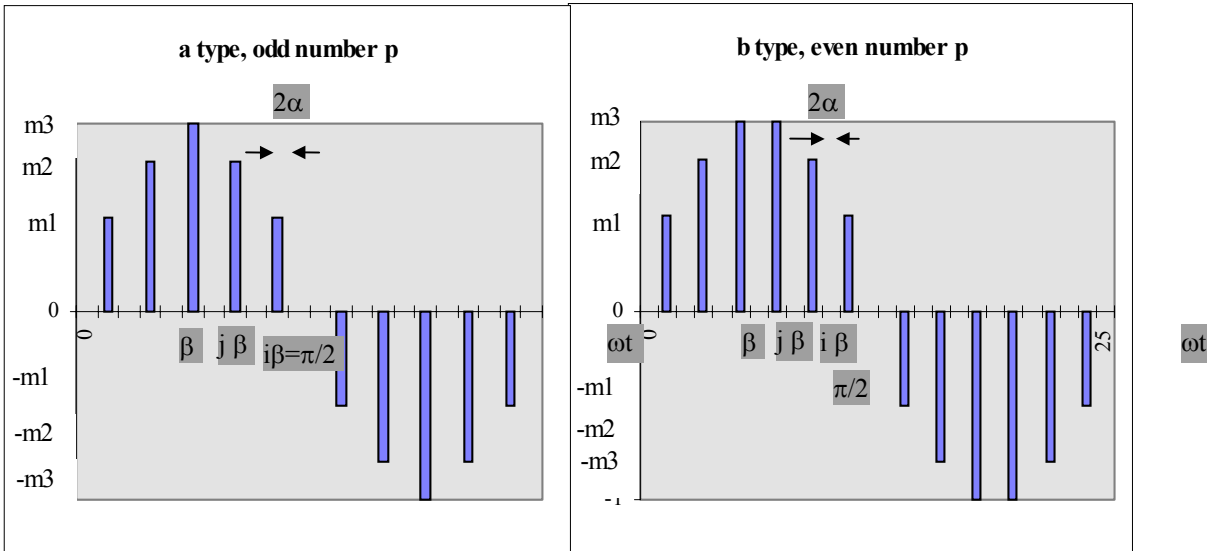


Fig.1. The odd a), and even b) functions of the monotonously distribution type.

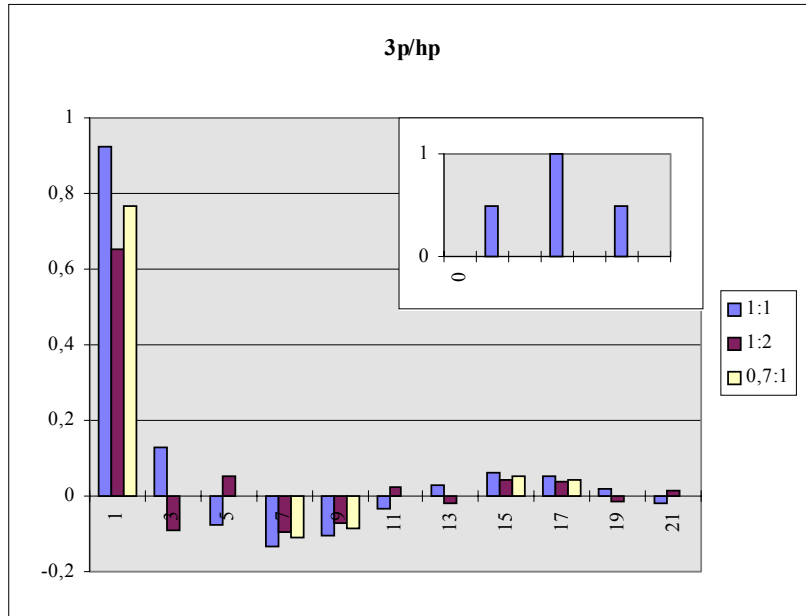


Fig.2. Example 1. 3 pulses per half-period

2.2. Symmetrical distribution of the pulses in half-period

In this case the pulses are symmetrically distributed during the half-period for the angle difference of β and with the pulse duration of the 2α . The point of symmetry is π . The edge pulses have the distance of β . Figure 3 shows two possible cases, the odd and even distribution of the function.

Some examples are also examined, and figure 4 shows typical example.

From the presented calculations it is obvious that rejection of the higher harmonics can be very simply achieved by *defining injection angle* of the pulses and with the choice of *the proper amplitude* of the pulses.

The basic idea of the work was to find the simplest way of rejection of higher harmonics and the simplest inverter circuit. The results of the analysis show that injection of only a few pulses is enough to reject third and higher harmonics satisfactorily. Figure 5 shows a few proposed circuits for the realisation of the inverter circuit, which enable almost ideal rejection of the higher harmonics, and so-called applying of the "classical" circuit types.

An example of monotonous type, three pulses per period, amplitude ratio 1:2:1 were simulated, (figure 6).

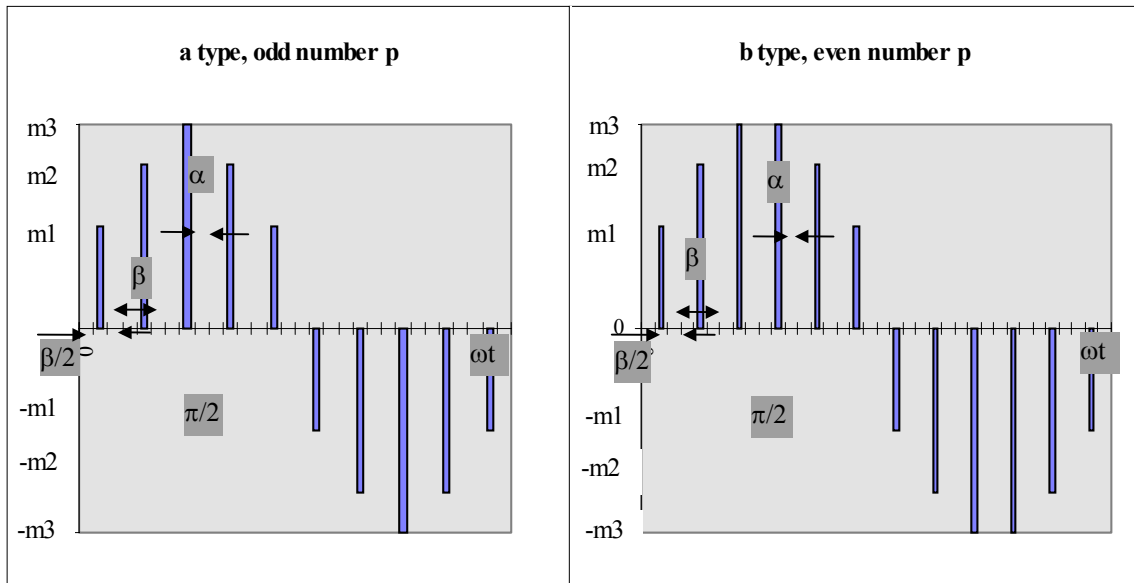


Fig.3. The odd a), and even b) examples of the symmetrically distributed function.

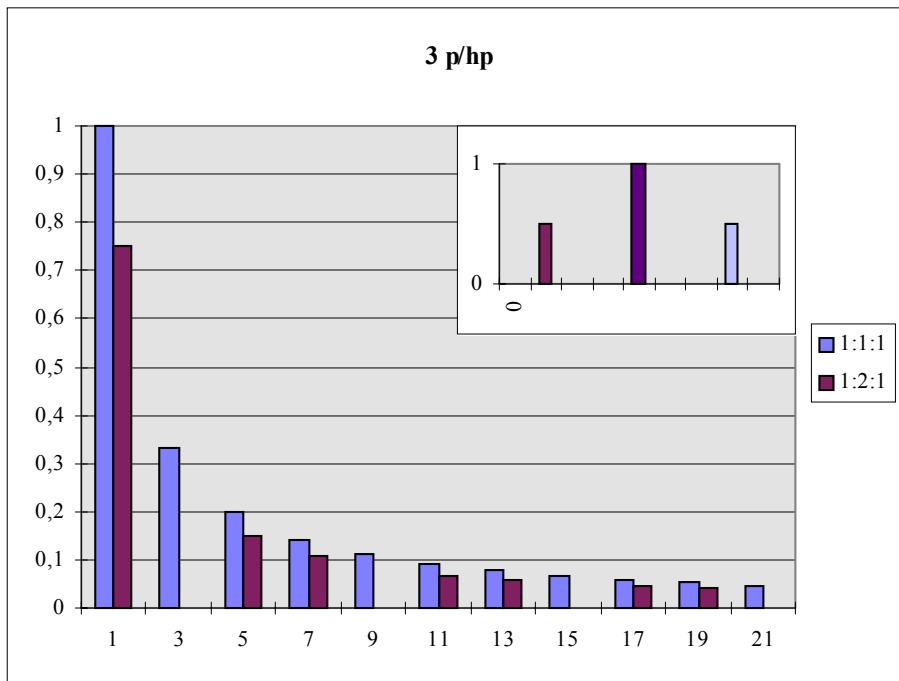


Fig. 4. Example 5. Three pulses per half-period

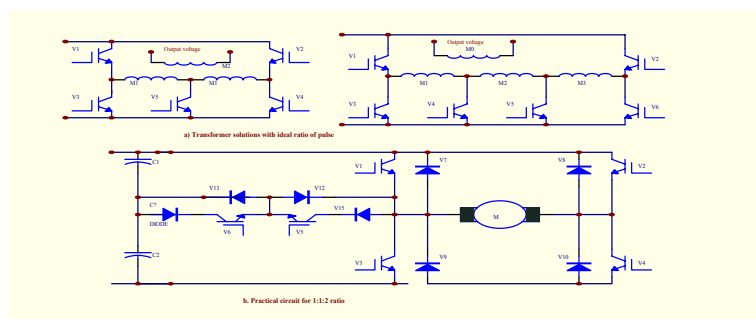


Fig. 5. Converter circuits for the realization of the analysed functions.

3. CONCLUSION

A method of rejection of higher harmonics based on injection of the pulses at defined trigger angle was

presented. Two types of functions, monotonous and symmetrical are examined. Examples analysed in paper show that it is possible to inject pulses at proper angle and with defined amplitude and cancel third, and in some

cases higher harmonics as well. Practical ratio of pulses amplitudes of 1:1:2 is also considered, and they that in some cases results are very close to the mentioned ideal situation. It leads to practical converter circuit solution, combination of bridge and half bridge circuits. Simplest case of the injection function, as an example for a single

motor drive, gave satisfactory distortion of the motor current. Considered method gives simple and cheap solution which can be used for following applications; single ac motor drives with frequency regulation, controlling the pumps in thermal heating systems, driving of the pumps in solar powered systems, ups etc.

Simulation 3p/hp

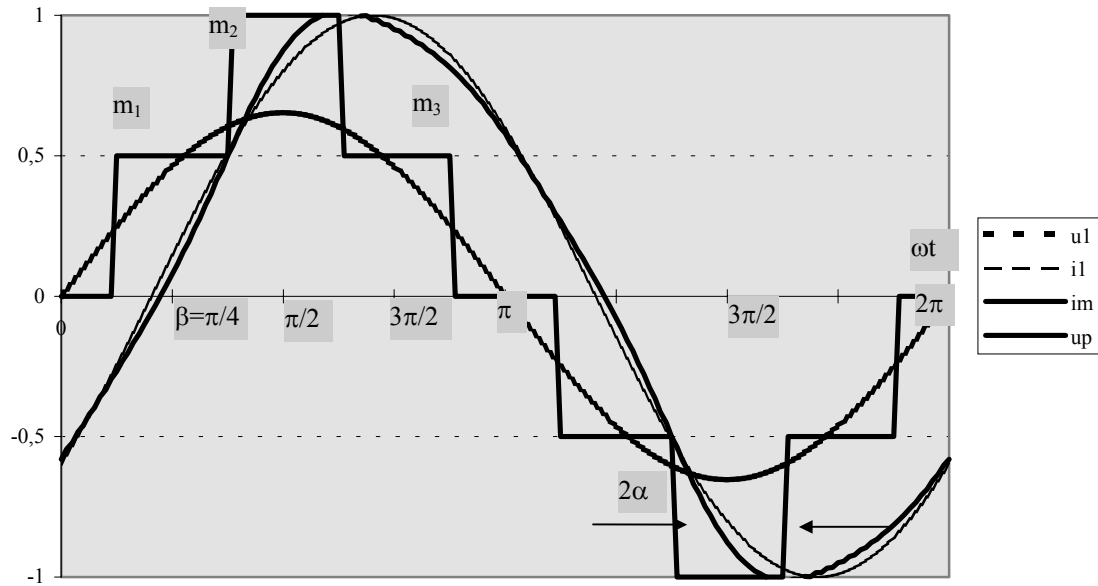


Fig 6. Simulation example results of the motor current.

4. REFERENCES

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