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***Journal of Scientific and Engineering Research*, 2021, 8(4):186-194**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

DC–AC Converter: Analysis, Design, Experimentation and Realization

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Abstract Specific objective: stabilized a voltage of 220v at the output on a socket for an input of 12v continuous but also to view for different frequency values 50HZ, 100HZ and 200HZ of the signals on the oscilloscope.

Keywords DC–AC Converter, inverter, thyristors, cycloconverters

1.1. Introduction

Thanks to the technological progress made in recent years in the field of power electronics, static converters are progressively widening their field of applications. Some of these new applications, such as active filtering and depollution of electrical networks, or the supply of alternating current machines for particular applications, are very demanding in terms of dynamic performance.

The applications of electronics were for a long time limited to the technique of high frequencies. The possibilities of application were limited by the unreliability of the electronic elements then available. This reliability was insufficient to meet the high requirements required by new applications in the industrial field.

It was only as a result of the development of special electronic components of higher reliability higher and more restricted tolerance, than the new techniques can be envisaged, thus is born a new branch of electronics called power electronics.

At the base of the power electronics are the power elements, which can be subdivided into non-controllable rectifier elements (diodes) and controllable rectifier elements (thyristors, triacs, transistors ...).

The power elements, associated with appropriate auxiliary devices (trigger control, dissipation radiators, RC protection circuit), make up standard modules allowing power conversion, such as rectifiers, inverters, cycloconverters, etc.

1.2. Definition of the inverter

An inverter is a static converter that converts electrical energy from continuous form (DC) to alternative form (AC). In fact, this energy conversion is satisfied by means of a control device (semiconductors). It makes it possible to obtain at the receiver terminals an alternating voltage adjustable in frequency and in rms value, thus using an adequate sequence of control.

1.3. Types of inverters

1.3.1. Standalone inverter

An inverter is said to be autonomous if it uses the energy of an auxiliary circuit of its own for switching thyristors or the other semiconductor in this case we control the frequency the waveform of the output voltage. There are two types of autonomous inverters [1, 4]:

- Voltage inverters supplied by a DC voltage source.
- Current inverters supplied by a direct current source.

1.3.2. Non-autonomous inverter

This is the name given to the rectifier assembly all thyristors (Graëtz bridge) which, in natural switching assisted by the network to which it is connected, allows operation in inverter (for example by energy recovery during braking periods in electric motor drives). On the basis of the development of static variable speed drives for direct and alternating current motors, cycloconverters, current inverters for synchronous and asynchronous machines, up to powers of several MW, this type of assembly is gradually supplanted, in favor of IGBT or GTO converters, [1, 4].

1.4. General operating principle

Schema and mathematical equation

1.5. Inverter applications

Among the numerous fields of use of stand-alone inverters, there are mainly fixed frequency inverters with forced switching: Most often supplied by an accumulator battery, they usually play the role of safety power supply, they constitute As such, the principle loops current autonomous inverters [1, 4].
network by means of a rectifier assembly, they deliver a voltage of frequency and rms value necessary to run an AC motor at variable speed.

Applications

Adjustment of the speed of a synchronous motor
The speed of a synchronous motor is fixed by the pulsation of static currents. To change speed it is therefore necessary to change the frequency of the supply voltages. It is therefore necessary to rectify the network voltage and then to undulate it at the desired frequency.

Emergency power

In the event of a power outage, an inverter ensures that the machines continue to be supplied from batteries. In professional IT, an inverter is essential to avoid the loss of information in the event of a power failure [3].

Voltage inverter

A voltage inverter is called an inverter which is supplied by a DC voltage source. We present the principle of voltage inverters in the case where the output is single-phase and use the bridge inverter with four switches: K1, K2, K1 'and K2'.
Figure 1.1 shows the power circuit of such an inverter (single-phase bridge) and the
Figure 1.2 represents the control signals and the waveforms of the voltages:

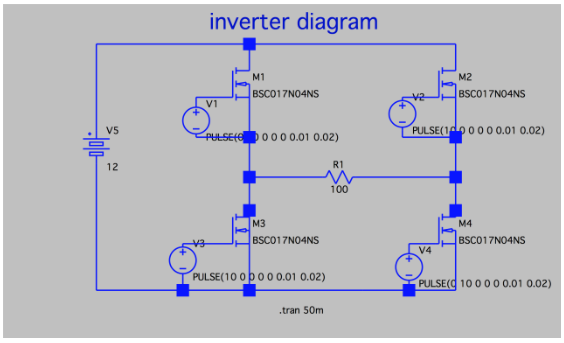

Figure 1.1: Bridge voltage inverter

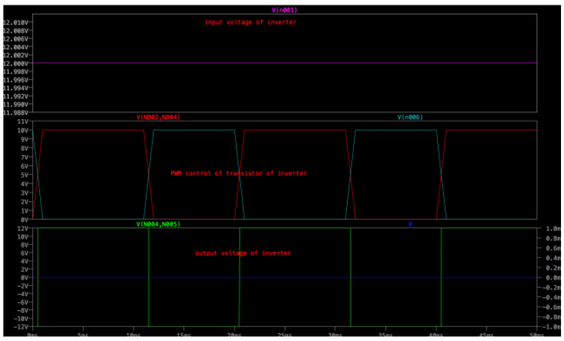

Figure 1.2: Control signals Single phase and waveform of the output voltages

The states of the controlled switches allow us to give the expression of Ud (t) as follows: If the input voltage of the inverter is constant and equal to U, whatever I is:

For 0 <t <T / 2: the switches, K1, K2’ are closed, and K2, K1’ are open.

D’où$u_{out} = V_{in}$ (1.1)

- For T / 2 <t <T: the switches, K2, K1 ’are closed, and K1, K2’ are open.

$u_{aout} = -u$ (1.2)

RMS value and average value of the output voltage

$$\langle U_{out} \rangle = \frac{1}{T}\int_0^T u_{out}\ t\ dt$$

$$=\frac{1}{T}[V_{in} - V_{in}] * T = 0$$

$$U_{rms} = \sqrt{\left(\frac{1}{T}\int_0^T {u_{out}}^2 dt\right)}$$

$$=U_{rms} = \sqrt{\frac{1}{T}}(Vin^2 + Vin^2) * T = U$$

finally

$$\langle U_{out} \rangle = 0$$
$$U_{rms} = U$$

The current of the output is therefore the current I at the input, it depends on the load placed on the AC side.

Noting that the Ki switches of the inverter; Figure1 are formed by the parallel connection of a semiconductor Ti controlled on opening and closing and a diode Di. The latter ensures the continuity of current thus allowing the conduction of a negative current in the case where the current is out of phase with respect to the output voltage [2], [3].

1.6. Current invert

A current inverter, which is supplied by a direct current source, is called a current inverter. As an example, we take the assembly of the figure below illustrating the model of a single-phase current inverter, which consists of four powers

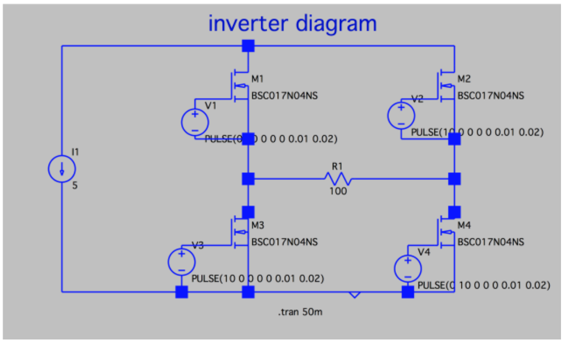

Figure 1.3: Single-phase bridge current inverter

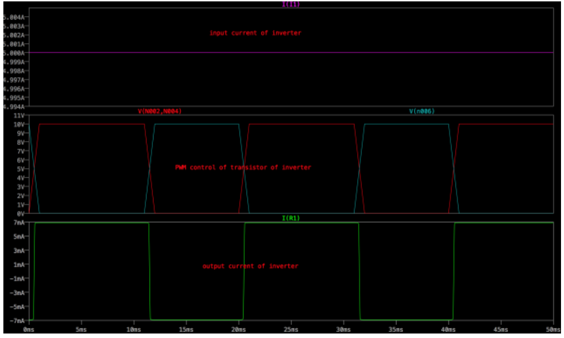

Figure 1.4: Control signals and single-phase bridge waveform of currents

Similarly, for the current inverter, the states of the controlled switches allow us to give the expression of id (t). If the input current of the inverter is constant and equal to I, whatever U is:

- For 0 <t <T / 2: the switches, K1, K2 ’are closed, and K2, K1’ are open:

Id= +I (1.3)

For T / 2 <t <T: the switches, K2, K1 ’are closed, and K1, K2’ are open:

Id= -I (1.4)

The voltage Ud (t) of the output is therefore the voltage U at the input, it depends on the load placed on the AC side. In that case; the switch is formed by a semiconductor controlled for opening and closing, it does not have to be reversible in current, so there is no need for a diode placed in parallel, [2], [3].

Among the voltage or current inverters, there are also resonance inverters:

1.7. Resonance inverter

These inverters allow to impose the current or the voltage and the frequency. Then, for the particular case where the load consists of a slightly damped oscillating circuit, the switches can be controlled at a frequency very close to the resonance frequency of the load. If the load varies, the command frequency varies. This means that the frequency of the inverter depends on the load, it is no longer non-autonomous. There are two resonance models [2-4].

1.7.1. Parallel resonance inverter

The latter flows on a poorly damped parallel resonant RLC circuit as illustrated in

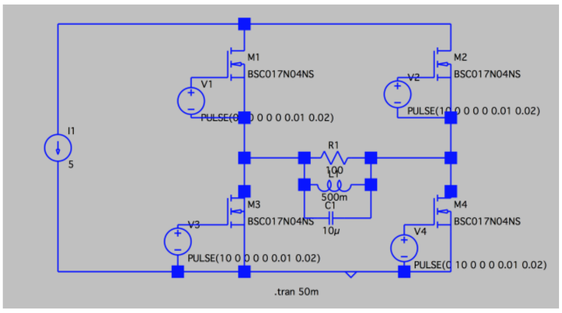

Figure 1.5: Parallel resonance inverter (single phase)

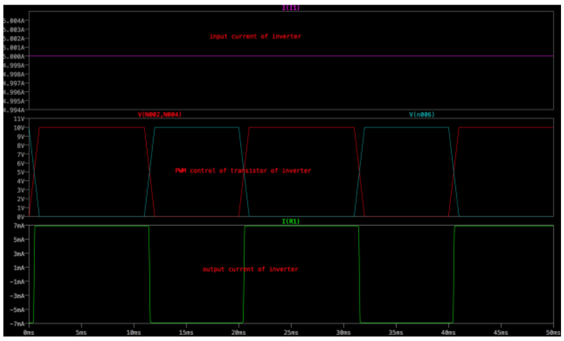

Figure 1.6: Control signals and current waveform

For this, there is a capacity connected between the terminals of the output, to oppose the sudden variation of the voltage; therefore the inverter must be powered by a direct current source. It therefore represents a particular case of the current inverter, whose Figure 16 gives the control signals and the waveforms of the currents [2-4].

1.7.2. Series resonance inverter

This flows on a series resonant RLC circuit with little damping. a source of tension. It therefore represents a particular case of the voltage inverter. Figure 1.8 shows the control signals and the waveforms of the voltages:

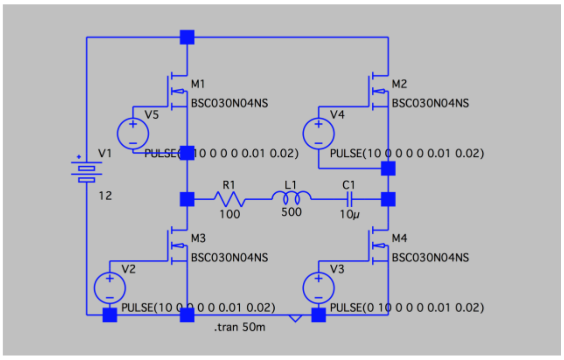

Figure 1.7: single-phase series resonance inverter

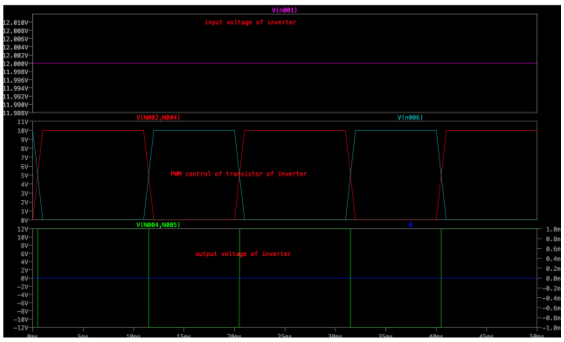

Figure 1.8: control signals and voltage waveform

1.8 Conversion from Square Voltage to Sinusoidal Voltage (highpass filter)

We notice that the form off the output signal obtained is a square signal while our main goal is to obtain a sinusoidal signal, therefore we have to use a lowpass filter.

Fourier series are powerful mathematical tools that allow us to decompose any signal into a sum of continuous signal, fundamental and harmonics.

$$\frac{a_0}{2}+\sum_{n=1}^{\infty}[a_n\cos(nx)+b_n\sin(nx)]$$

$$avec\ a_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\cos(nx)dx$$

$$b_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\sin(nx)\,dx$$

$$a_0 = \frac{1}{2\pi}\int_0^{2\pi} f(x)dx$$

for square signal the DC component is zero, therefore it still only the fundamental and harmonics.

With lowpass filter we will be able to extract only the fundamental (sinusoidal) wave on the the square wave of the output voltage of inverter.

In our case weused an LC serial as lowpassfilter.

The cutofffrequencyis$\frac{1}{2\pi\sqrt{LC}}$

The fundamentalfrequencyis 1Mhz sowechoose$1\mu F\ as\ capacitor\ value\ then\ we\ find\ inductor\ value$ $is\ 0.0025\mu H$

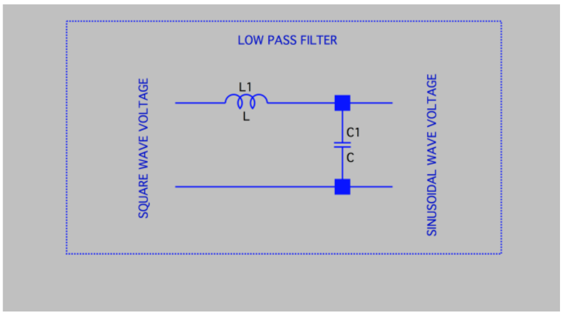

Figure 1.9: low pass filter diagram

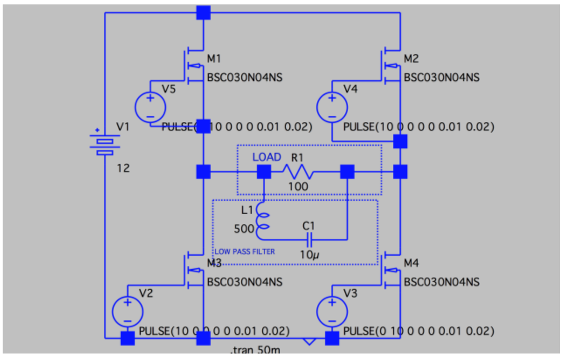

Figure 1.10: full dc/ac converter diagram

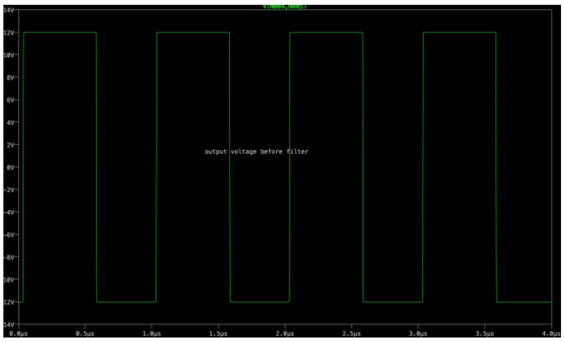

Figure 1.11: output voltage wave of inverter without filter

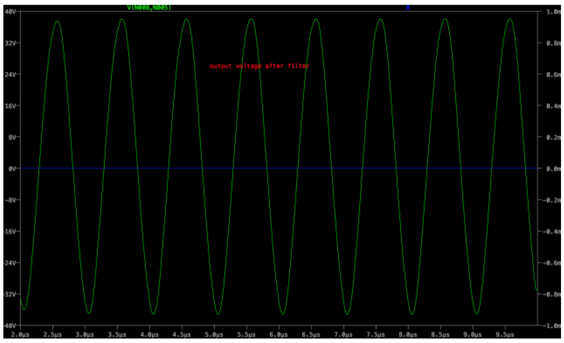

Figure 1.12: output voltage wave of inverter with low pass filter

1 .9 REALIZATION

Figure 1.13:Interface of the ups realize

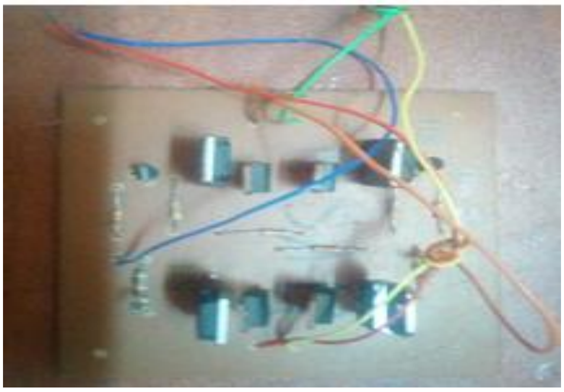

Figure 1.14: Card power circuit realize

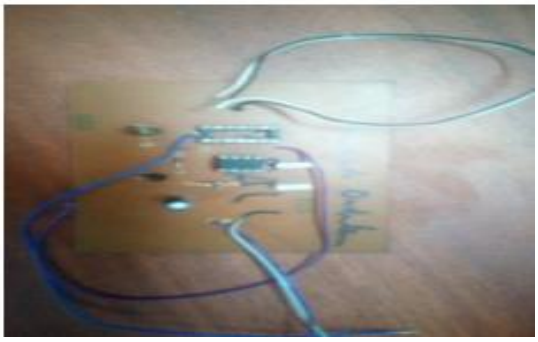

Figure 1.15: Control circuit of the card

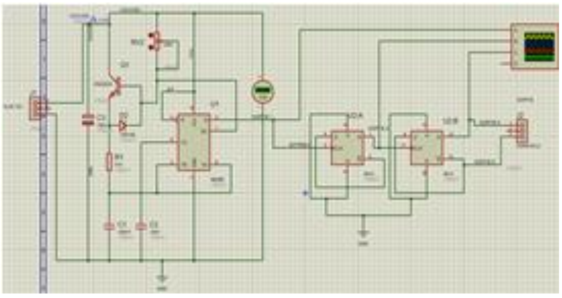

Figure 1.16: Schema to realize on poteus

Figure 1.17:3D view of electronic components

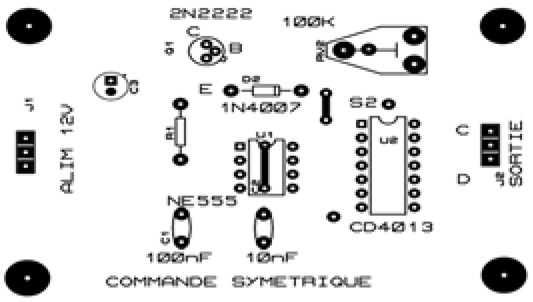

Figure 1.18: **Layout diagram of electronic components**

Conclusion

The development of electronics and electronic components allowed us to realize the device of the DC / AC converter called inverter. The output voltage of the inverter is a square signal whereas the final objective was to make it purely sinusoidal without harmonics. The high pass filter was a big help in going from square to sinusoidal signals. Fourier series was also a powerful tool in decomposing the square wave signal in sum of Sinusoids (continuous, harmonic, fundamental).

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