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Demonstration of Effective Analysis of Power Electronic Circuit Performance Using Pspice Simulator

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Abstract: *In this work two basic switching devices of power electronic are discussed and employed to demonstrate the simulation performance of Pspice software. It analyses the operational effectiveness of the devices when used in electric circuit to drive a load. The individual assessment of the devices divides the work into two sections. Thyristor on its part is functionally examined under a range of some specified values of gate pulses for driving a resistive load of 250 ohms. Graphs are generated which characteristically explain the relationship that exists between the specified gate pulses and the supply voltage at the anode of the thyristor. On the other part, bipolar junction transistor (BJT) is included as the major active component that drives a pulse width modulation (PWM) inverter. The inverter incorporates a dc pulse generator that produces a control signal with which the output is moderated. The half bridge inverter was drawn in Pspice environment using a schematic editor. It powers a 10W load at output frequency of 1kHZ and inductance of 2.5mH. The inverter runs at output voltage waveform of a period of 1 millisecond. The voltage waveform as plotted against time is shown graphically.*

Keywords: *Pspice Simulator, Analysis, Power Electronic Circuit*

1.0 Introduction:

Transistors and thyristors are among the common vital switching components in power electronics. They are both products of semiconductor materials that are structurally composed of P-N junctions. The P and N layers of the devices are the doped regions of the semiconductor product designated with P-type and N-type notation based on the ionic composition of the atoms with which the regions are doped. The two switching devices are three terminal equipments .For thyristor switches, the anode terminals are fundamentally used as points of connection to the power line either through a provided interface or on direct connection with the line. The gate terminal is used for switching when a signal is applied as a driving input pulse to the gate . It is good to note at this point that operating SCR devices through the gate pulse driving is the most convenient mechanism and safety oriented means of switching the components: This is due to the fact that the angles at which voltage and current propagate the network can be determined and targeted using the gate pulse in order to allow a certain amount of power to flow through the device. This is the basis of phase control concept as applied in single and multiphase electric power control.

As soon as the thyristor is fired and it is conducting in the forward direction (anode positive), the gate signal will have no control over it due to the regenerative latching operational effect of the two internal transistors. If any gate signal or pulse is applied after regeneration is obtained, it will have no essence at all because of the fact that the thyristor is already in operation.

Contrary to the transistors' characteristics, most of the SCRs do not get biased and remain within some active region along a load line between its blocking and saturation states. The magnitude and duration of the gate turn-on and pulse are of a very little implication on the functional effectiveness of the device as long as conduction control is an internal issue. As a result, applying a momentary gate pulse to the device is enough to enable its conduction which remains continuously as long as latching current is reached.

Keywords: Pspice Simulator, Analysis, Power Electronic Circuit

Work Format:

This work is categorically divided into three sections. Section 1.0 is the introduction of the article which as a preamble supplies the details of the information within the body of the work. It provides to the readers a good insight that should govern their mind ready to the true picture of the work. The two key components , thyristor and transistor that form the bedrock of our discussion are actually mirrored here with a brief tale that borders on their respective mode of operations. A deeper thought of reading on this segment of work

will perceive some sounds of operational characteristics evaluation that may exhume much to the readers which among other features may include similarities and dissimilarities of the two power / electronic devices etc. Section 1.1 is graphically illustrative to thorough understanding of the work. The operational habit of thyristor and its usual operational principle that looks on the switching mechanism are graphed .We never left behind the structural composition as it relates to functional characteristics of the device in this section. Section 1.3 made a great impart on the true aim of this work. It looks into the simulation work of this article using single phase PWM inverter, thyristor device as the power electronic components etc which are the main instruments of the test for confirmation of the effectiveness of PSPICE simulator for generating the expected simulation result. The graphs that are produce serves a great testimony of acceptability and authenticity of the result. We rounded off the work in Section 1.3 to raise a conclusion surrounding the main observation from the experimental details that are so far gathered in the work

1.1 Voltage-Current Characteristics of Thyristors:

The diagrams below show the graphical illustration of voltage-current characteristics of thyristor component with the symbol and the four structural layers comprising of P-N-P-N regions. Transistors are among the major switching devices used in power control. They are usually dc powered devices which may include bipolar junction transistors (BJTs) , metal oxide field effect transistors (MOSFET) etc.

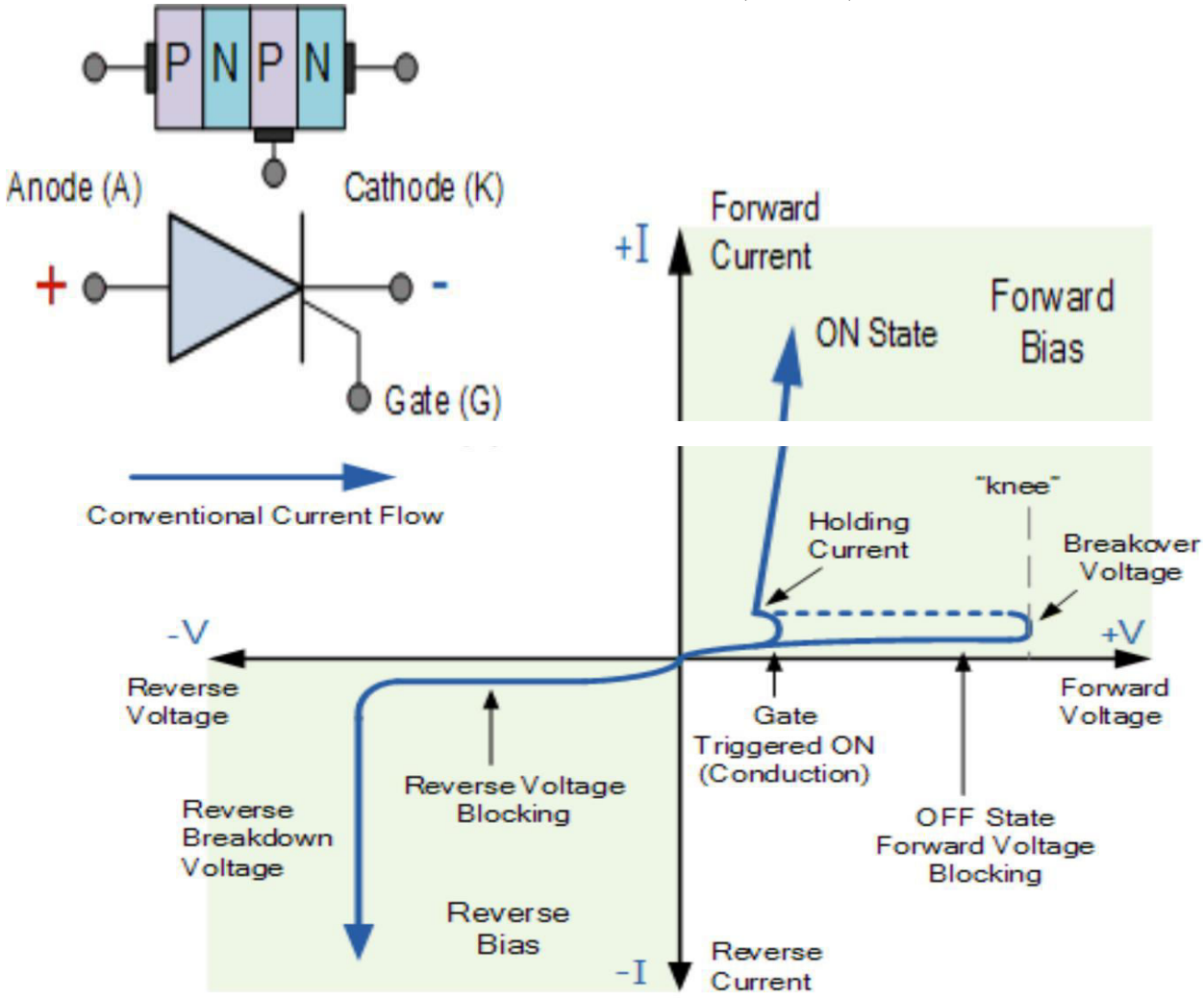

Diagram showing the switchin characteristics and structural composition of a thyristor device

fig. 1.0

Transistors are the chief components that are mostly used in electronic circuit designs; as a result, they are commonly found as current drivers in such devices as chopper circuits, inverter

circuits, and many others. They are three terminal devices that are structurally built with p and n type semiconductor material that form the internal joints of the components popularly known as the p-n junctions. When the collector terminal is positive compared with the base, the device can be powered using a pulse signal at the base. At this point, the base must be positive in polarity with respect to emitter; and must be constant at the base as far as the current must continue flowing through the collector

1.2 Single-Phase PWM Inverter/Thyristor Test Circuit:

The circuit below is a schematic diagram of a single – phase pulse width modulation inverter that comprises of two n-p-n transistors, two diodes, an inductor etc. It adopts a unique method of generating a control signal and applies a direct current (dc) pulse sources to generate triangular or square waves. The load driven at the output is only 10W,and this is connected in series with a 2.5mH inductor. The inverter runs at output frequency of 1kHZ in a period of 1ms

The control section maintains pulse rate of 10 units every one cycle; thus ,making a switching frequency of 10kHZ with a period of 100ms. It has a carrier voltage of a triangular wave which is dc powered at 50% duty cycle.

The thyristor circuit on the other hand is composed of 100V dc source in series with the load of250 ohm at the anode of the equipment. The gate voltages are at the range: Vg = 5.894V , 5.898V and 5.91V gated through a resistor, Rg =100 ohm

The inverter and the thyristor circuits are simulated in Pspice environment to demonstrate the ability of the simulator in effective analysis of circuit performance more especially in a steady or transient state situation. The simulation results are illustrated on the graph.

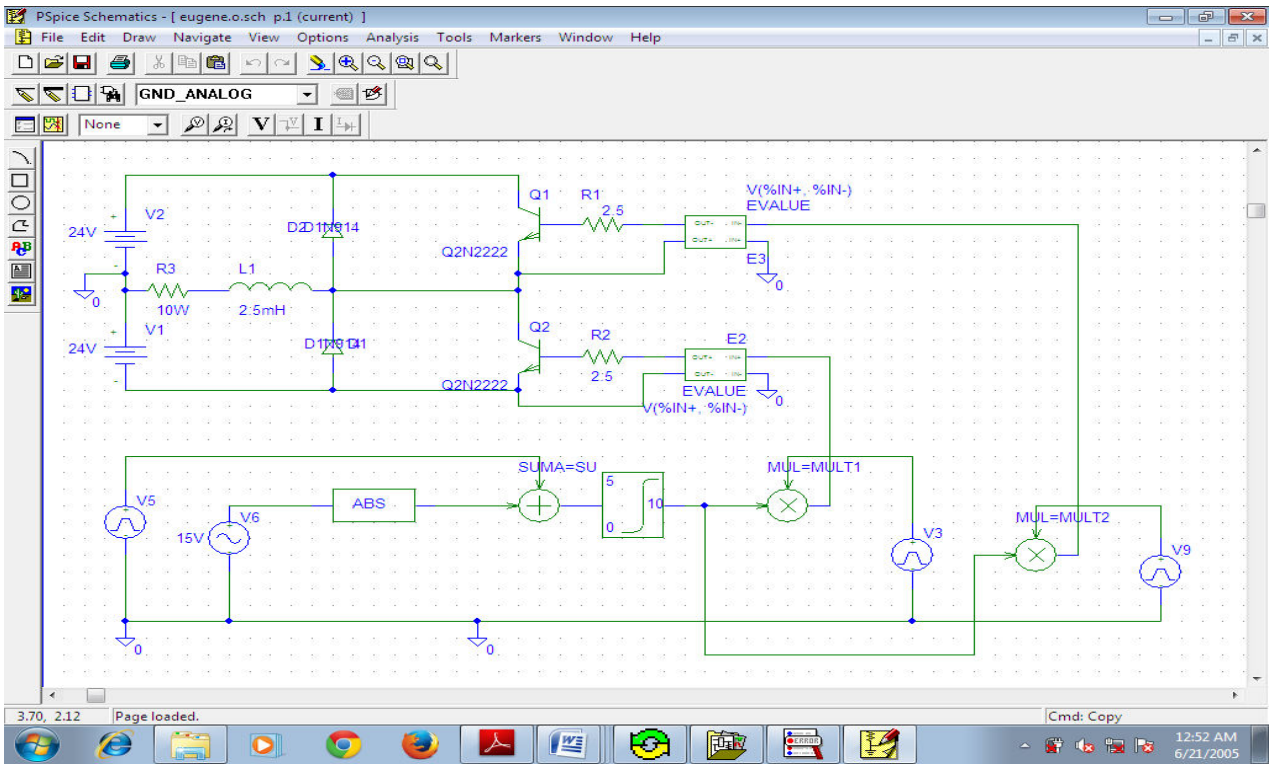

Diagram showing the schematic diagram of the pulse width modulation inverter
Fig.1.1

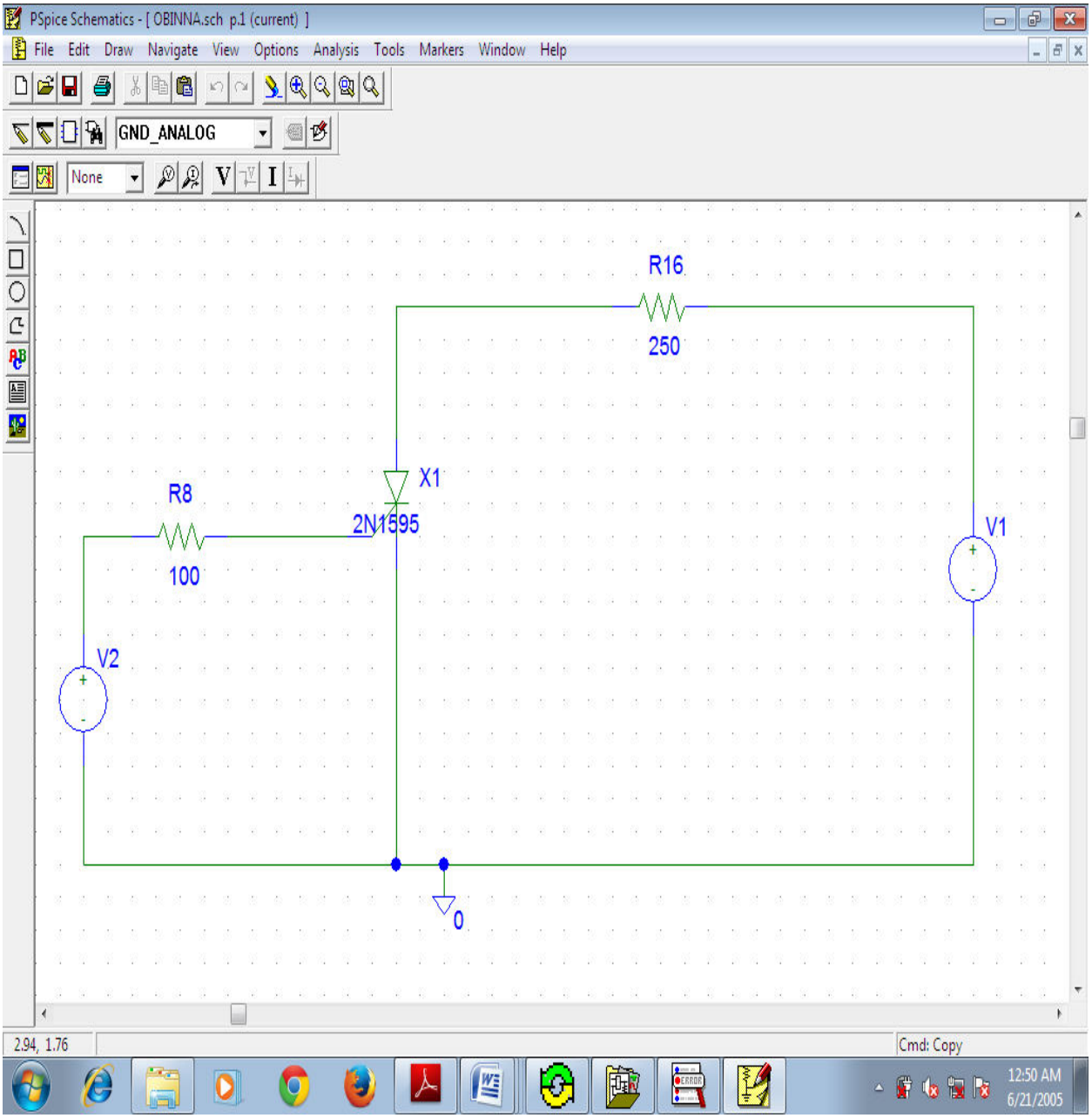

Diagram showing the schematic diagram of the thyristor test circuit
Fig.1.2

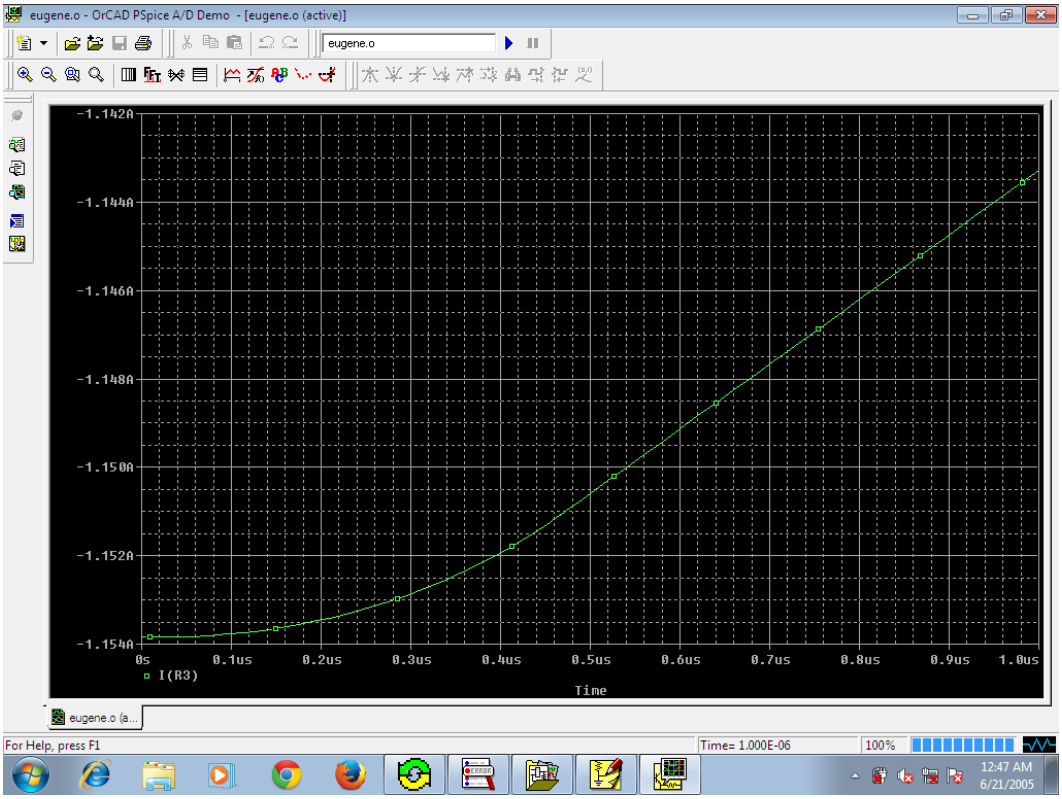

Diagram showing the output waveform of the pulse width modulation inverter
Fig.1.3

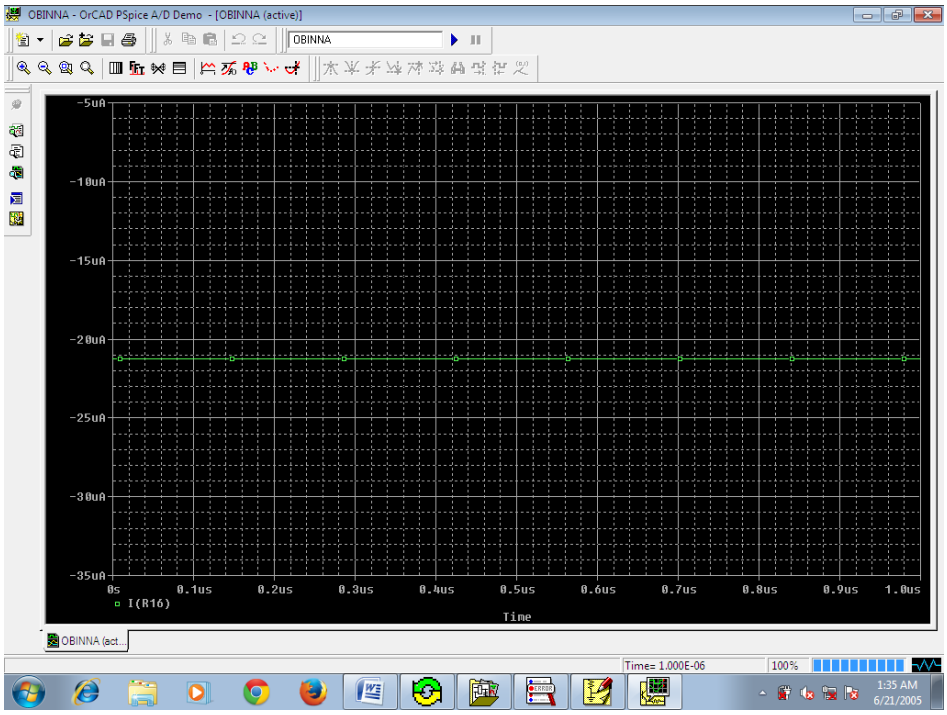

Diagram showing the output waveform of the current across the thyristor's 250ohm resistive load
Fig.1.4

1.3 Conclusion:

Following the waveforms that give the actual output simulation results of the two power electronic circuits, PWM inverter and thyristor test circuit, it can be obviously affirmed that Pspice simulator can be used to analyze the operational effectiveness of electronic systems. The accuracy of the simulation results can stand the fact that Pspice simulator can be a good substitute for an oscilloscope in a situation where the later is unavailable for urgent practical work.

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