

Digital Control of Single Phase H Bridge Converter Using Matlab/Dspace

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Abstract- The main objective of this paper is to generate the digital pwm pulse using matlab/dspace to control the motor through H-bridge converter which will be used for robotics and other applications. An H Bridge converter is an electronic circuit which is built with four switches that enables a voltage to be applied across a load in either direction with current flow in positive direction. These circuits are often used in robotics and other control applications to allow DC motors to run forward and backward. A PWM signal is generated using matlab/dspace and this signal is used to control the switching signal of the MOSFET gates. This pwm pulse is fed to the prototype model of h-bridge circuit through the D-SPACE hard ware kit. By varying the duty cycles the output voltage is controlled .The D-SPACE kit and the power circuit (H-bridge circuit) are connected as well as isolated using driver circuit. The power to the driver circuit is fed through 240/12 V transformers. In this paper, the digital pwm pulse generation using matlab/dspace, the design of h-bridge circuit and output results are discussed.

Index terms: D-SPACE, MOSFET, PWM etc

I. INTRODUCTION

An H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. The term *H Bridge* is derived from the typical graphical representation of such a circuit. An H bridge is built with four switches (solid-state switch). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the load resistor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the same. Using the nomenclature above, the switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source. The same applies to the switches S3 and S4. This condition is known as shoot-through.

II. HARDWARE IMPLEMENTATION OF H BRIDGE INVERTER

The overall block diagram of the hard ware consists of the PC with MATLAB/Simulink, D-SPACE ACE kit, a driver circuit and combination of four MOSFET. Switches and a DC power source which is shown in fig.2.

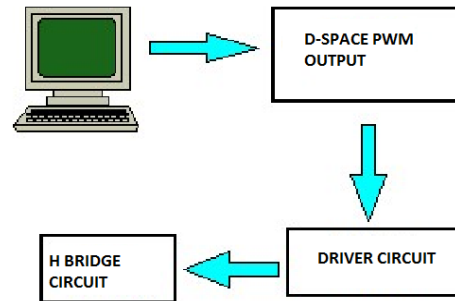


Fig2: block diagram showing the overall implementation of H bridge inverter with D space

A. Slave I/O PWM Connector

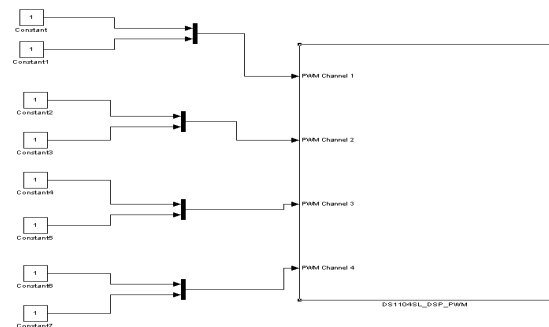
The slave I/O PWM connector (CP18) is a 37-pin, female Sub-D connector located on the front of the connector panel.

B. Single Phase PWM Pulse

The slave DSP provides four output channels for 1-phase PWM signal generation.

Related RTI Block	Channel (RTI)	Connecting pin	Pin on
DS1104SL_DSP_PWM	Ch1	P1 23	CP18 5
	Ch2	P1 31	CP18 10
	Ch3	P1 29	CP18 29
	Ch4	P1 27	CP18 11

C. SIMULINK MODEL OF PWM GENERATION



The above model has four PWM channels through which we would be able to generate the PWM pulses. From this model we would be able to vary the duty cycles as per the requirement.

C. DRIVER CIRCUIT

The switching signal for a MOSFET is usually generated by a logic circuit or a microcontroller. In this paper the switching signal is generated through D-SPACE, which provides an output signal that typically is limited to a few milliamperes of current. Consequently, a MOSFET which is directly driven by such a signal would switch very slowly, with correspondingly high power loss. During switching, the gate capacitor of the MOSFET may draw current so quickly that it causes a current overdraw in the logic circuit or microcontroller, causing overheating which leads to permanent damage or even complete destruction of the chip. To prevent this from happening, a gate driver is provided between the microcontroller output signal and the MOSFET.



Fig 4: MOSFET Driver Circuit

III. IMPLEMENTED CIRCUIT OF H BRIDGE INVERTER

The implemented circuit of H Bridge Inverter consists of 4 MOSFETs with a resistive load of 1kohm in the breadboard which is shown below:

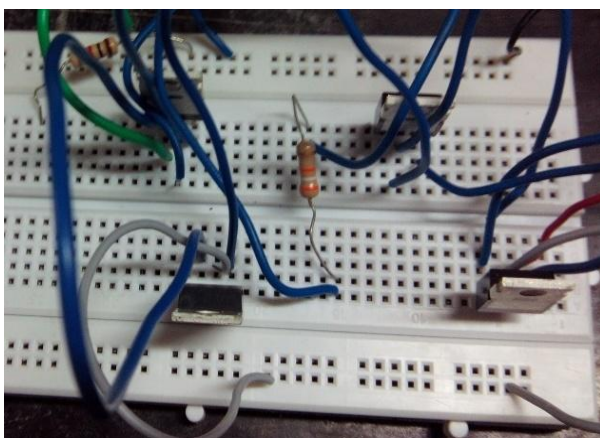


Fig 5: H-Bridge Circuit with resistive load

In this we have applied PWM pulse to the gate terminal of the MOSFET. The drain terminals of the opposite MOSFET switches have been short circuited and feed by +12V DC supply. The source terminals of the MOSFET switches has been short circuited and fed to ground. The output of the circuit is achieved through the load resistor R connected across the MOSFETs forming the bridge of the circuit. Overall set up of H bridge inverter with driver circuits and transformer is shown in Fig 6. The transformer is used in order to redefine the voltage to the required level required voltage to the driver circuit for excitation overall set up of H bridge inverter with driver circuits and transformer is shown in Fig 6. The transformer is used in order to redefine the voltage to the required level so that we would be able to feed the required voltage to the driver circuit for excitation. The generated PWM pulse through the D Space is fed to the driver circuit and then the output of driver circuit is provided to the four switches of the H Bridge Inverter.

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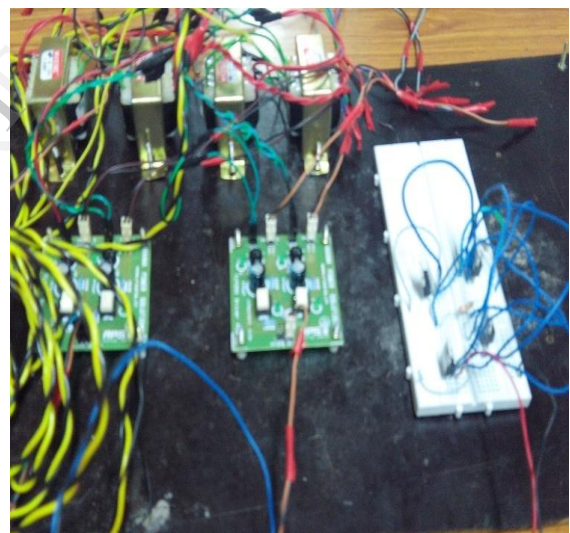


Fig 6: Experimental set up of H-Bridge Inverter

IV. RESULTS AND OUTPUT WAVE FORMS

The algorithm which is used to generate the gating signal is as follows:

1. Generate the triangular waveform of period T as the reference signal v_r and a dc carrier signal v_{cr} .
2. Compare these signals by a comparator to generate the difference $v_c - v_{cr}$ and then a hard limiter to obtain a square wave gate pulse of width kT , which must be applied to the switching device through an isolating circuit.
3. Any variation on V_{cr} varies linearly with the duty cycle K . Where $K = V_{cr} / V_r$

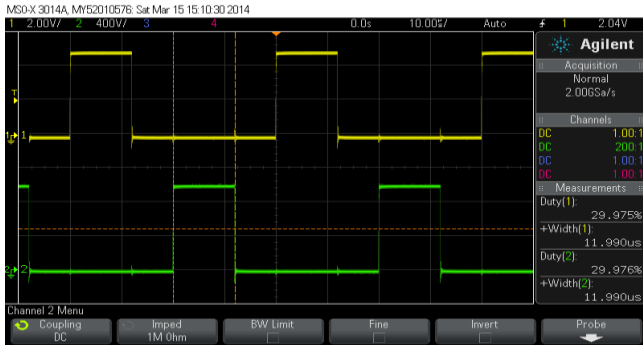


Fig 7: PWM waveform generation using D-SPACE for two channels.

V. OUTPUT ACROSS LOAD IN H BRIDGE

The unfiltered output across resistive load of 1kΩ is as shown below with different variation of the duty cycle.

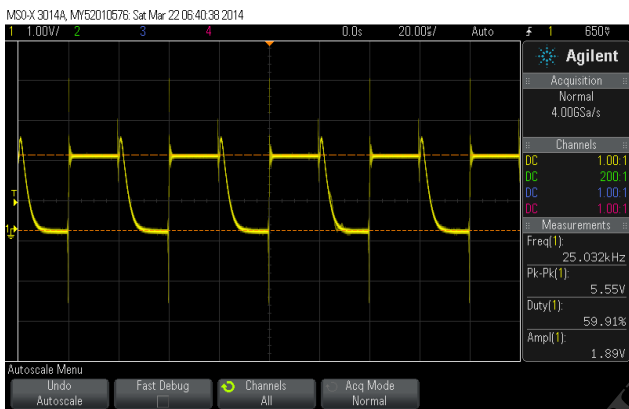


Fig 8: output with 0.6 duty cycle.

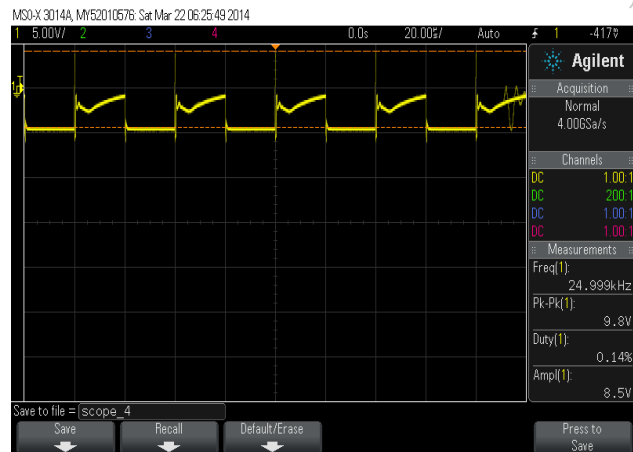


Fig 9: Output with 0.14 duty cycle.

A 9V DC motor as a load was used across the H-Bridge of the circuit. The practical output proves that as the duty cycle of the PWM wave form is decreased the corresponding voltage and speed of the motor increases. The result of the simulation is shown in figure 10 and figure 11.

Sl.No	Duty Cycle	Voltage (in Volts)	Speed (in RPM)
1	0.1	1.3	792.4
2	0.4	1.01	90.3
3	0.5	0.92	80.4
4	0.6	0.8	68.1
5	0.7	0.7	34.9

Fig 10: response of speed and voltage across various duty cycles.

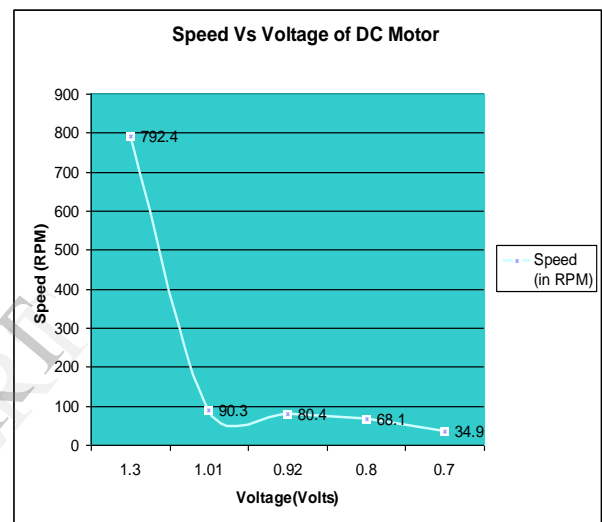


Figure 11: graph showing speed and voltage of DC motor.

VI. CONCLUSION

In this paper H BRIDGE Inverter has been studied and the simulation is been carried out using MATLAB software and the results are obtained for different time periods. Using the PWM waveform generated through D-SPACE, the switching pattern is developed and we were able to achieve the output through the digital control. We were able to find that digital control is more reliable and easy to vary the outputs by varying the duty cycles in contrast to the conventional method of PWM generation. We would like to also extend our work to implement the four quadrant operation of DC Motor by digital control in future.

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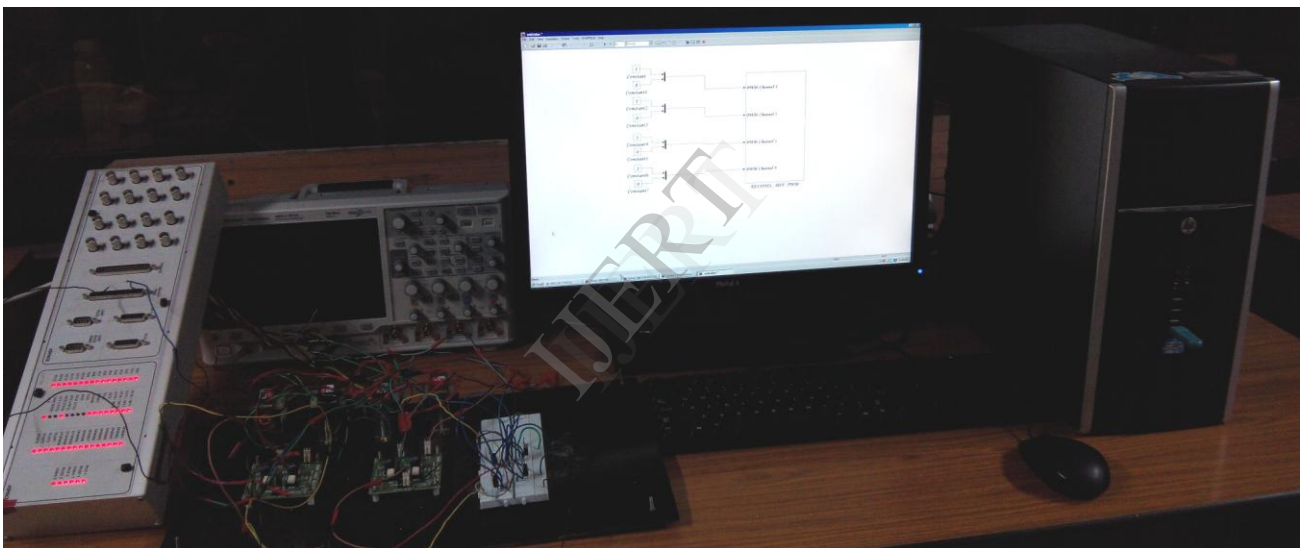


Fig 12: Over all set up of digital control of single phase H Bridge converter using MATLAB/Dspace.