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Hardware Implementation of Single Phase Inverter Using Microlab Box

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ABSTRACT

The aim of developing this project is to monitor the real time response of machines, robots and artificial intelligences by using the Microlabbox. Without connecting the any load, the predetermination of the machine or electronic devices can be observed. Here, we have varied the pulse width modulation of single phase inverter with time response output voltage, current and gate pulses. The D-space is involved in this project by using the Simulink model of MATLAB 2017. The time response is varied by D-space software. This project is practical prototypic model and highly feasible in point of observation and has the advantages of speed of output response. It is reliable, Accurate and efficient way of observation.
Keywords – Microlabbox, D-space, MATLAB

I. I. INTRODUCTION

This project consist of Microlabbox pc with D-space and single phase inverter hardware kit we are controlling the voltage to the gate terminal of IGBT by using the Microlabbox. This project deals with analysis and observation of any output variable of single phase inverter. The Microlabbox is a digital processor which can implement any other application in real time model. Electric motor controls play an important role in various application fields such as automotive industry, robotics, medical engineering, and many more, e.g., to comply with new, strict emission regulations or to build up more precise machines in industrial environments. Often, the control algorithm for an electric motor is a key point in fulfilling customers' requirements. But the effort of developing, implementing, and validating the required control algorithms in traditional tool chains can be very high, and these tool chains often lack flexibility. The MicroLabbox in combination with the RTI Electric Motor Control Block set is the ideal system to reduce this effort.

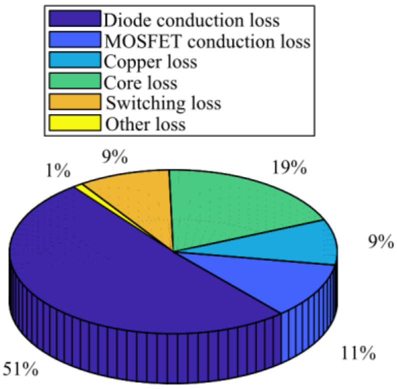

Fig.1.1. Power loss breakdown of LLC converter in [11]

II. BLOCK DIAGRAM OF SINGLE PHASE INVETER USING MICROLAB BOX

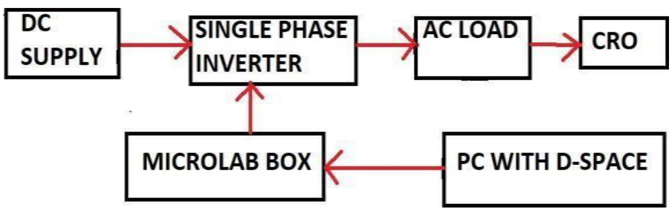

Fig.2.1. Block diagram of single phase inverter using Microlab box

2.1 BLOCK DIAGRAM AND OPERATION:

The block diagram of single phase inverter is consist of Single phase inverter hardware kit, PC with D-space software, Matlab with 2017 version software and Microlab box. The operation of block diagram is the designed Matlab simulation is built in the pc with D space and it is converted as SDF (Spatial database format), then the hardware kit is interfaced with Microlab box.

The Microlab box will generate the PWM signal to the IGBT gate terminal. The DC supply is taken from rectifier supply or inbuilt rectifier circuit with single phase inverter kit. The output simulation is interfaced with hardware kit with help of the Microlabbox and it is given to the hardware kit with patch cards. Now the output waveform is seen in CRO or DSO.

2.2 CIRCUIT DIAGRAM OF SINGLE PHASE INVERTER:

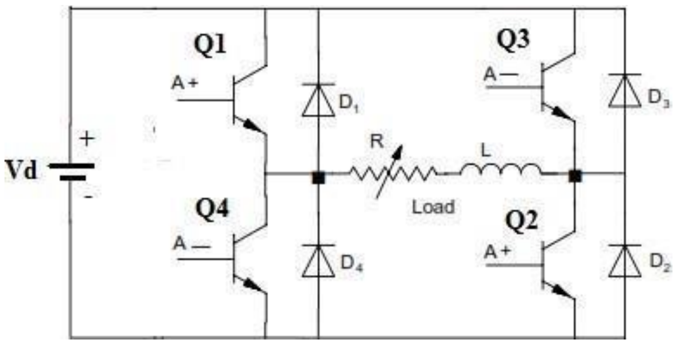

Fig 2.2 Block diagram of single-phase inverter

III. HARDWARE DESCRIPTION

3.1 INVERTER

An inverter is used to provide uninterrupted 220v AC supply to the load connected to its output socket. It provides constant AC supply at its output, even when the AC main supply is not available. It is a combination of inverter circuit; charge circuit keeps the battery when the main supply fails. The inverter takes dc power in the battery and converts its into 220/50 HZ.

The use of semiconductor power devices such as transistor, thyristor for voltage amplification particularly IGBT as power switch, makes inverter a better additional power supply.

The inverter is less noise, provides complete automatic switch over function, possess less bulky expensive to maintain.

3.2 SINGLE PHASE INVERTER:

In a full-bridge topology 4 switches are needed, since the alternating output voltage obtained by the difference between two branches of switching cells. The output voltage is obtained by intelligently switching the transistors on and off at particular time instants. There are four different states depending upon which switches are closed. The tae summarizes the states and output voltage based on whiich switches are closed.

3.3 IGBT:

The Insulated Gate Bipolar Transistor (IGBT) is like a MOSFET with of junction. This allows voltage- based control, like a MOSFET, but with output characteristics a BJT regarding high loads and low saturation voltage.

Four main regions can be observed on its static behavior.

- Avalanche Region
- Saturation Region
- Cut Area
- Active Region

The avalanche region is the area when a voltage below breakdown voltage is applied, resulting in the destruction of the IGBT. The cut area includes values from breakdown voltage up to threshold voltage, where in the IGBT doesn’t conduct. In the saturation region, the IGBT behaves as a dependent voltage source and a series resistance. With low variations of voltage, high amplification of current can be achieved. This area is the most desirable for operation. If the voltage is augmented, the IGBT enters the active region, and current remains constant. There is a maximum voltage applied for the IGBT to ensure it won't enter the avalanche region. This is one of the most used semiconductors in power electronics, since it can support a wide range of voltages from a few volts to KV and power between KW and MW.

3.4 PULSE WIDTH MODULATION:

The Pulse Width Modulation (PWM) Block is a useful block that can be used for a wide range of applications. The DCMP/PWM Block can be configured as a PWM Block. The PWM block can be sourced through FSM0 and FSM1. PWM IN+ pin is connected to FSM0 whereas IN- pin is connected to FSM1. Both FSM0 and FSM1 provide 8-bit data to PWM Block. PWM time period is defined by the time period of FSM1.

The duty cycle for the PWM block is controlled by the FSM0.

$Output\ Duty\ Cycle = IN+\ 256$

There are two options for the duty cycle configuration:

- 0-99.6%: DC ranges from 0% to 99.6% and is determined as IN+/256.
- 0.39-100%: DC ranges from 0.39% to 100% and isdetermined as (IN+ + 1)/256.

3.5 RL LOAD

A resistor inductor circuit (RL circuit), or RL filter or RL filter or network, is an electric circuit composed of resistors and inductors driven by a voltage or current source. A first - orderRL circuit is composed of one resistor and one inductor and is the simplest type of RL circuit. These circuits exhibit important types of behavior that are fundamental to analogue electronics. In particular, they are able to act as passive filters

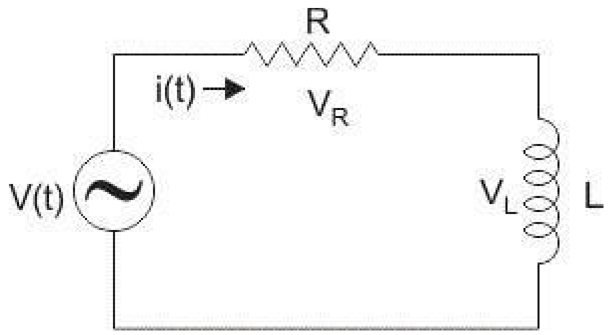

Fig 3.1: RL Load

3.6 WAVEFORM OF SINGLE PHASE INVERTER:

The Q1 and Q2 are triggered simultaneously and so are Q3 and Q4 each device to conduct for half time of the output cycle, the load voltage waveform with the transistor base current. with resistive – inductive load, the current i0 lags the square waveoutput voltage v0. Triggering Q1 and Q2 connects the load to vd. for steady load condition, i0 grows exponentially through D1 D2 and then through Q1 Q2 fromIn to Ip according to (vd=Ri+L di/dt). Negative half starts by triggering Q3 and Q3 at t1=t/2 and Q1 Q2 goes off when ib1=ib2=0 (base current blocking). Load voltage reverses to - vd and i0 will flow through D3D4 and then through Q3 Q4 according to the equation (-vd = Ri + L di/dt).

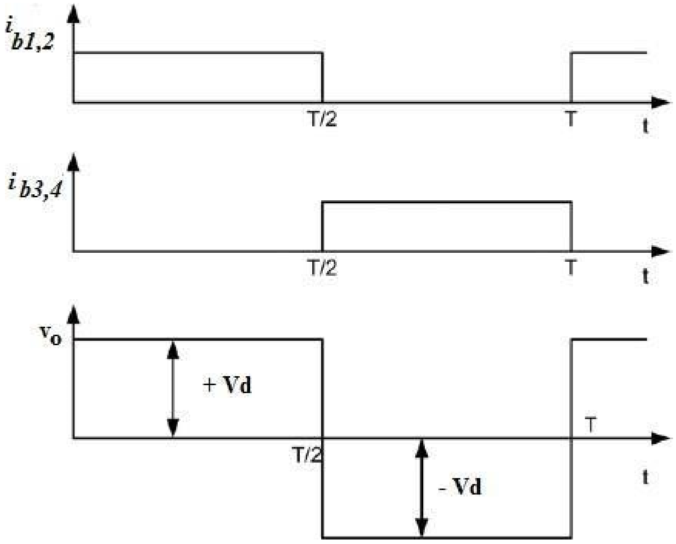

Fig 3.2: Waveform of single phase inverter

3.7 MICROLAB BOX:

- Compact all-in-one development system for the laboratory.
- More than 100 high-performance I/O channels with easy access.
- Comprehensive support for electric motor control. Three connector panel variants available.

3.8 DESCRIPTION

Microlabbox is available in three connector panel variants(p.3-4), offering different types and/or positions of the I/O connectors. The front panel variant provides Sub-D connectors at the front to access the connectors of the Microlabbox when it is included in a stack of laboratory equipment or easily switch between wire harnesses. The top panel variants available with two different connector types and is ideal for desk use. Equipped with BNC and Sub-D connectors, the top panel Microlabbox allows easy access to the analog I/O channels via probes that are typically used in laboratories to offer high analog signal quality. Additionally, a top panel variant with spring-cage terminal blocks, which are often used in industrial automation, is available. This means, signal by means of a common push-in and release mechanism of the clamp with a standard screwdriver. To make wiring and signal tracing as user- friendly as possible, all panel variants show the pinout information on the unit itself. The pinout information is also displayed in the I/O blocks ofthe implementation software Real-Time Interface (RTI).

3.9 FUNCTION:

Microlabbox is available in three connector panel variants offering different types and/or positions of the I/O connectors. The front panel variant provides Sub-D connectors at the front to access the connectors of the Microlabbox when it is included in a stack of laboratory equipment or easily switch between wire harnesses. The top panel variant is available with two different connector types and is ideal for desk use. Equipped with BNC and Sub-D connectors, the top panel Microlabbox allows easy access to the analog I/O channels via probes that are typically used in laboratories to offer high analog signal quality. Additionally, a top panel variant with spring-cage terminal blocks, which are often used in industrial automation, is available. This means, signal connections can be changed very fast and conveniently by means of a common push-in and release mechanism of the clamp with a standard screwdriver. To make wiring and signal tracing as user-friendly as possible, all panel variants show the pinout information on the unit itself. The pinout information is also displayed in the I/O blocks of the implementation software Real-Time Interface (RTI).

3.10 INTERIOR PARTS OF MICROLABBOX:

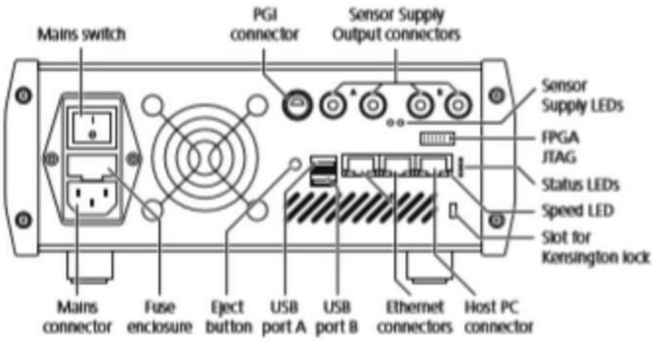

Fig 3.3: Interior Parts of The Microlabbox

Interior parts of Microlab box are

- Ethernet patch cable (HSL PATCH) for host connection
- Power supply cable
- Set of sub-d plugs
- Case for storage and transportation
- Adapter cable 50-pin sub-d to WAGO terminal panel
- RapidPro SC unit
- RapidPro power unit

3.11 D -SPACE:

3.11.1 DS1202:

This is the base board of Microlabbox, which is based on the Freescale Power Architecture technology. It provides the communication and computation features. The Ethernet interface, including the switch configuration for host communication and I/O access & The USB interface for data recording and booting an application via a USB mass storage device & Flash management for booting Microlabbox and loading real-time applications from the flash memory & Communication and data exchange with the DS1302 I/O Board & DS1302. This is the I/O board of Microlabbox. It provides the board's standard I/O features.

3.12 REAL TIME INTERFACE:

To connect the simulation model to the physical world, you need to introduce I/O interfaces into the model. These allow you to replace parts of your simulated model with real hardware. dSPACE's RTI(Real-Time Interface) blocks provide I/O interfaces for accessing dSPACE hardware.

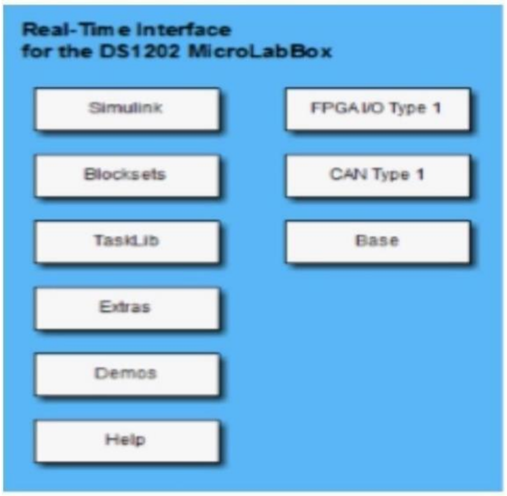

Fig 3.4: Real Time Interface

The numerous interfaces make Microlabbox ideal for many kinds of robotics applications. In this example, Microlabbox replaces the robot's position controller and receives the robot's incremental encoder signals for determining the current position of the robot. Then, the real-time processor calculate the control algorithm and sends the controller output with position and velocity data back to the robot. Thus, you can implement and test different control algorithms very quickly.

IV. SOFTWARE IMPLEMENTATION OF SINGLE-PHASE INVERTER

A description of the processor boards belonging to a multiprocessor system and their interconnections via Gigalinks. The topology also contains information on which Gigalinks port of each processor board is connected to the Gigalink ports of other processor boards in the multiprocessor system. Topology information is contained in the real-time application (PPC/x86/RTA) files of the multiprocessor system's processor boards. TRC file A variable description file with information on the variables available in an environment model running on a d-SPACE platform Trigger.

4.1 MATLAB:

The tutorials are independent of the erst document the primarily objective is to help you learn quickly the first steps. The emphasis here is “ learning by doing”. Therefore, the best way to learn is by trying it yourself. Working through the examples will give you a feel for the way that MATLAB operates in this introduction we will describe how MATLAB handles simple numerical expressions and mathematical formulas. The name MATLAB stands for MATRIX LABORATORY. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (eigen system package) projects. MATLAB [1] is a high – performance language for technical computing. It integrates computation visualization, and programming environment.

4.2 SIMULINK MODEL:

Simulink is a MATLAB- based graphical programming environment for modeling, simulating and analyzing multi domain dynamical systems. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries.

4.3 SIMULINK MODEL OF SINGLE PHASE INVERTER:

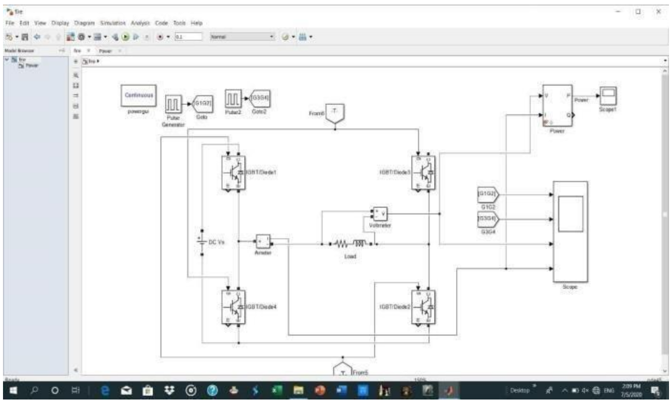

Fig 4.1: Simulink Model of single phase inverter

4.4 OUTPUT WAVEFORM:

RC circuits can produce useful output waveforms such as square, triangular and saw tooth, when a periodic waveform is applied to its input. In the previous RC charging and discharging tutorials, we saw how an IGBT has the ability to both charge and discharge itself through a series connected resistor.

4.5 OUTPUT WAVEFORM OF SIMULINK:

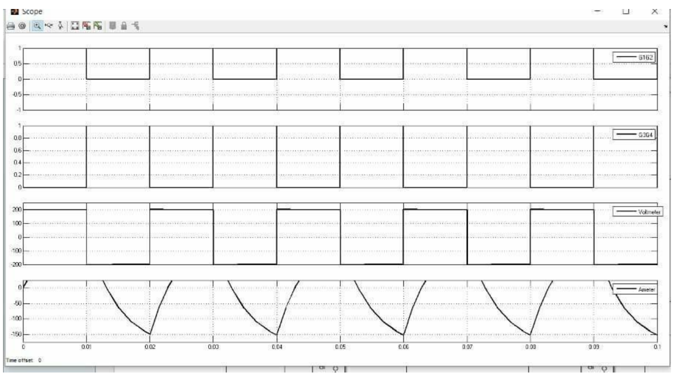

Fig 4.2 : Output Waveform of simulink

4.6 INTERFACING:

Interfacing to connect it with various peripherals to perform various operation to a obtain a desired output memory interfacing is used when the need to access memory frequently for readingand writing data stored in the memory.

4.7 METHOD OF INTERFACE:

4.7.1 MEMORY INTERFACING:

Memory is an integral part of a microprocessor system, and in this section, we will discuss how to interface a memory device with the microprocessor. The memory interfacing in used to access memory quite frequently to read instruction codes and data stored. This read/write operation are monitored by control signals. The microprocessor activates these signals when it wants to read from and write into memory. In the last section we have already seen the memory read and memory write machine cycles, and status of the RD, WR and IO/M status signals for read/write operation. In the following section were memory structure and its requirement, concepts in memory interfacing and interfacing examples

4.7.2 INPUT OUTPUT INTERFACING:

The most of the microprocessors support isolated I/O system. It partitions memory from I/O, via software, by having instruction that specifically access (address) memory, and others that specifically access I/O. when these instruction aredecoded by the microprocessor, an appropriate control signalis generated to activate either memory or I/O operation. In signal is used for this purpose. The outputs a logic ‘1’ on the IO/M line for an I/O operation and a logic ‘0’ for memory operation. It is possible to connect 64 Kbyte memory and 256 I/O ports in the system since send 16bit address for memory and 8bit address for I/O. I/O devices can be input or output.

V. HARDWARE IMPLEMENTATION OF SINGLE PHASE VI.ADVANTAGES AND CONCLUSION INVERTER

5.1 HARDWARE SETUP OF SINGLE-PHASE INVERTER 6.1 ADVANTAGES:
USING MICROLAB BOX

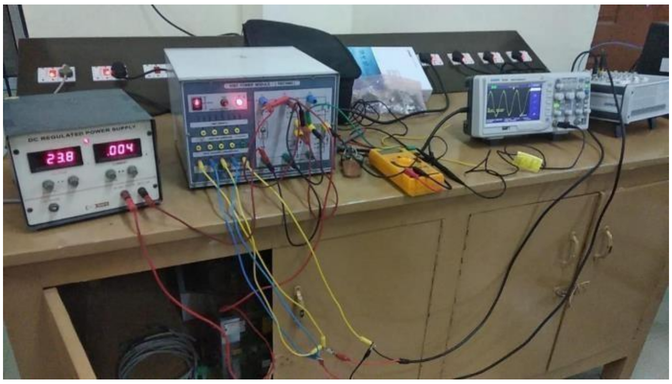

Fig 5.1: Hardware Setup Of Single Phase Inverter Using Microlab Box

5.2 SINGLE PHASE INVERTER OUTPUT VOLTAGE WAVEFORM IN DSO

Fig 5.2: Single Phase Inverter Output Voltage Waveform In DSO.

5.3 PWM OUTPUT IN CONTROL DESK:

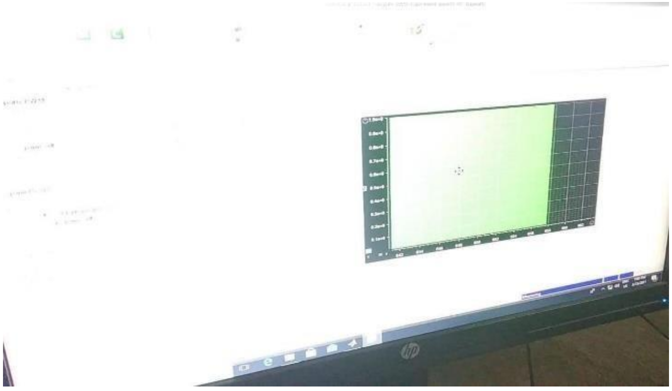

Fig 5.3: PWM Output In Control Desk

V. ADVANTAGES

- Microlab box is a compact development system for the laboratory that combines compact size and cost- effectiveness with high performanceand versatility.
- Microlab box lets you set up your control, test or measurement applications quickly and easily, and helps you turn your new control concepts into reality.
- More than 100 I/O channels of different types make Microlabbox a versatile system that can be used in mechatronic research and development areas.
- As robotics, medical engineering, electric drives control, renewable energy, vehicle engineering, or aerospace.

VI. CONCLUSION

Safety and reliability play a crucial role in thedevelopment of medical devices. New functions must have an optimal design and undergo extensive testing. In many cases, capturing and pre- processing signals is an integral part of function development. With Microlab box, you can outsource extensive and computation- intensive signal pre-processing tasks, such as filtering or signal analysis, to an integrated FPGA. Connecting BNC cables directly to Microlab box for processing analog signals minimizes the influence of external errors on the signal and makes it possible to achieve a high signal quality. During or after the development of the medical device, Microlab box can also be used as a testing system. With it, you can reproducibly simulate many different environment conditions, e.g., based on test algorithms or existing measurement data. This increases the medical device's maturity, saves time, reduces costs, and minimizes the risks compared to tests on a living organism.

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