Optoelectronics Interfaces for Power Converters

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Abstract *– The most important issue interface is galvanic separation between the signal part and the power board. Standards in the field have increased continuously electro-security requirements on the rigidity of the dielectric and insulation resistance. Recommendations for classical solutions require the use of galvanic separation optoelectronics devices. Interfacing with a PC or DSP - controller is a target of interposition optical signals via the power hardware commands.*

Keywords: **Integrated Circuit, Optoelectronic, Interface,** ***Power Drive, Phototransistor.***

I. INTRODUCTION

Digital or analog interfaces operating at low voltage. In general inputs/outputs will be on digital TTL levels. For better immunity to electromagnetic disturbance, it is preferred higher logical levels, mainly for installations in industrial environments. A dedicated integrated circuit for such an interface IR3101 (International Rectifier) are acceptable supply voltage between 10V and 20V, and the input logic levels will be strictly dependent on supply voltage.

There are digital integrated circuits to command the electronic converters. They will be provided with internal galvanic separation orders for grids at high voltage. There is separate galvanic isolation from digital circuits for power devices, but the ground will be at high voltage. Integrated circuits are created just for such power commands. They are in the reliability parameters and electro-security domain.

II. INTERFACE FOR SINGLE-PHASE CONVERTERS

Optoelectronics devices can handle a long line of justifications for integrated circuits. Basically a diode LED (Light emitting diode) emits an infrared signal to a phototransistor. Evolution is continuous for optoelectronic devices. Structure of optoelectronic devices will involve maximum frequency at which these devices can switch. If the command signals are specific for industrial electronics allowed frequencies are up to 200KHz. In other applications this frequency is too low. In the example of Fig.1., are used optoelectronics devices HCPL2531; operating at a switching frequency of up to 3MHz.

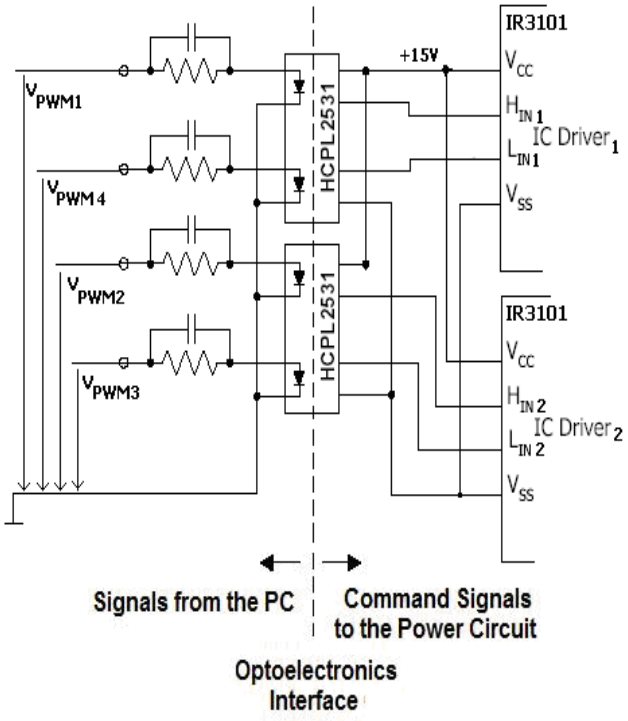

Fig.1. Galvanic separation with optoelectronics devices for a single-phase converter.

Integrated circuit HCPL2531 has used two independent optoelectronics devices. PWM voltage pulses are transformed into optical pulses in the corresponding inputs offered by the two integrated HCPL2531 (Fig.1.). Optical commands, from phototransistor, will generate commands voltage on each channel for the command of power devices. New PWM voltage signals are necessary for inputs of integrated circuits IR3101.

IR3101 driver circuit for a single side of the single-phase bridge inverter has two transistors with field effect MOSFET (Metal Oxide Semiconductor Field Effect Transistor) power integrated (Fig.2.), in the same chip. In this way the whole structure of the the single-phase bridge inverter will be made by two such integrated circuits. Load RL will be attached to bridge between the output pins A and B of the two integrated drivers.

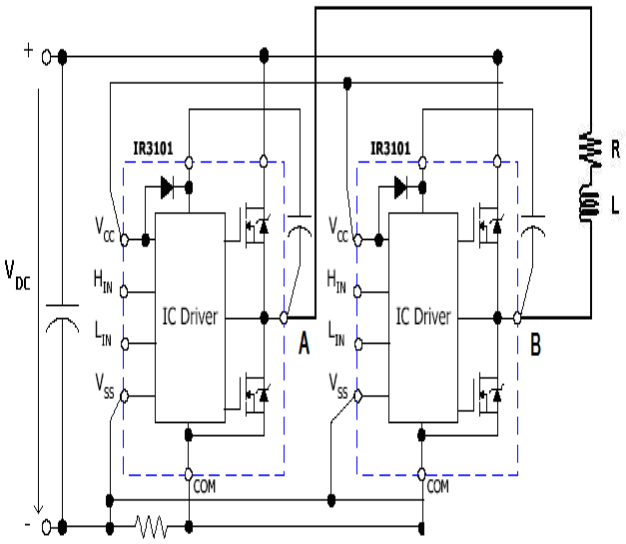

Fig.2. Power drive of a single-phase inverter.

Applications are multiple. Supply voltage is up to 450V. The power dissipated per chip does not exceed 5.8W, and power output is limited to 1.6 A.

III. INTERFACE FOR THREE-PHASE CONVERTERS

Interface for three-phase bridge converters adds an additional integrated circuit HCPL2531 relative to the single-phase bridge converters.

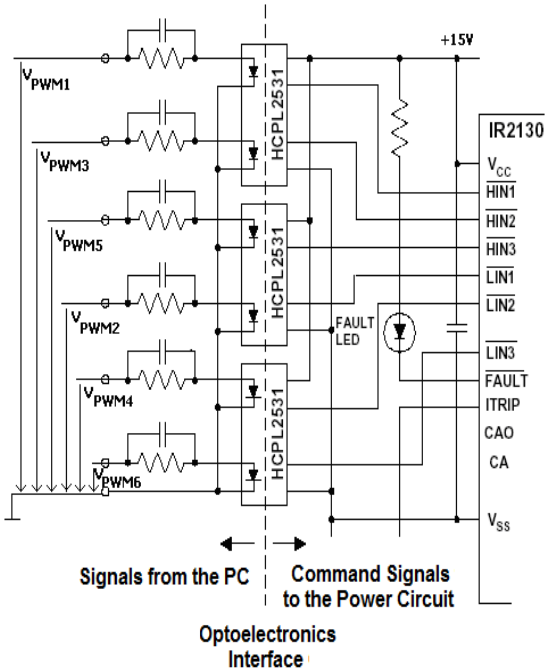

Fig.3. Galvanic separation with optoelectronics devices for a three-phase converter.

Configurations derived from those presented can be easily achieved to develop low power applications with an additional digital ports PC. It can increase the power load in the circuit using power electronic devices with proper electric values. Integrated circuits for digital commands can be chosen corresponding applications. For example, for a single-phase converters power circuit can be used IR2130, IR2132 or IR2137. Integrated circuits ensure internal adjustment controls of the input voltage so that it can be made directly control power devices. This option provides sizing of power switches for high values of voltage and current. Three-phase bridge inverter with a MOSFET or IGBT transistors can work well for low power and relatively high power. IGBT transistors in this application are IRGB20M. Interface presented in Fig.3. provide galvanic isolation. Command signals to command the power will be active with "0" logic level.

IR2130 integrated circuit and provides other useful functions for monitoring can be found a defect or you can measure the load current. Integrated circuits are created in a wide variety is very flexible in designing various interfaces. An electronic interface is used (Fig.4.) for adapted the PWM outputs signals with the all six gates of IGBT's power devices of the inverter bridge.

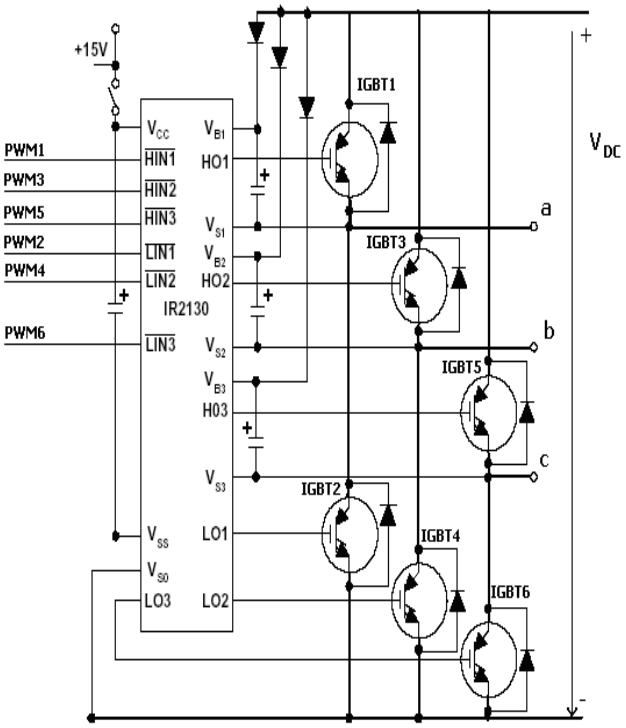

Fig.4. Circuit structure of power three-phase bridge inverter with IGBT transistors.

In this way are commuted the all six devices of three-phase bridge with IGBT's. Six pulses are generated for a 3-arm bridge. Pulses PWM1, PWM 3, and PWM 5 fire the upper devices of the first, second, and third arm. Pulses PWM 2, PWM 4, and PWM 6 fire the lower devices.

There are a large number of specialized drivers for integrated power converters. The scheme with three IR3101 integrated circuits achieved the structure of a three-phase inverter without external electronic switches.

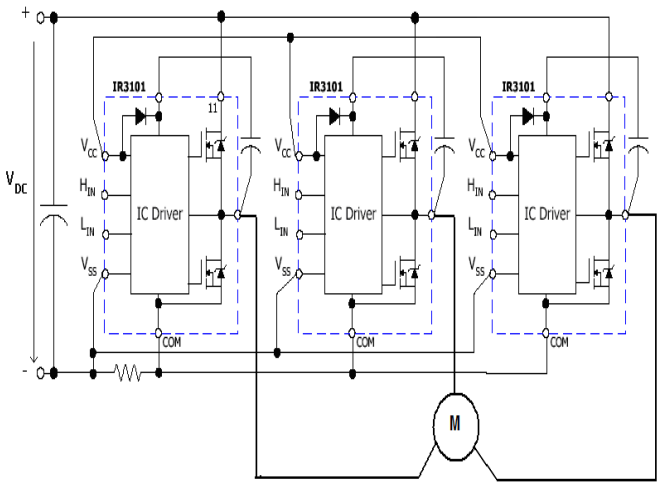

Fig.5. Power structure of the three-phase bridge inverter built with integrated drivers and power switches included in the electronic chip.

There are required only PWM control signals. They may be isolated optoelectronic through an interface similar to that shown in Fig.3.

IV. SIMULATION WITH INTERACTIVE BLOCS

It is possible to use digital signal controllers which have digital ports for Input/Output interfaces (Motorola, National Instruments,…). For these application is used National Instruments PCIe-6259 board.

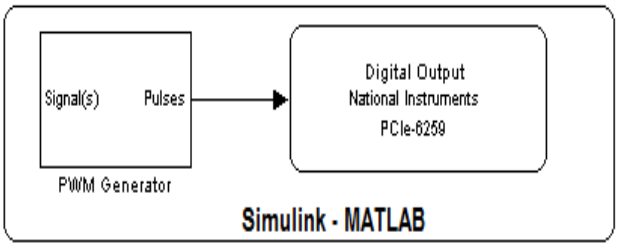

Fig.6. PWM generator for board interface.

Software for interface command is realised in an simulink schema, like in Fig.6., in which are generated binary data from "PWM Generator" bloc.

Sinusoidal generators or pulse generators are usually. There is in Simulink - developed program – a functional bloc predefined for generating PWM signals. A "PWM generator" is used in simulink schema presented in Fig.1., and the signals coming from PWM generator are showed in Fig.4.. Using Simulink-Matlab, a PWM generator can be possible to define, which is setup for commands of single phase or three phase bridge inverters. In this focus setup are fixed: f_c=10KHz – carrier frequency, m=0.8 – modulation index (0<m<1) and f_{out}=50Hz – frequency of output voltage. (shown in Fig.3). The magnitude of out PWM signals are per unit values. In these circumstances, the compatibility with driver software of electronics boards for commands is satisfied.

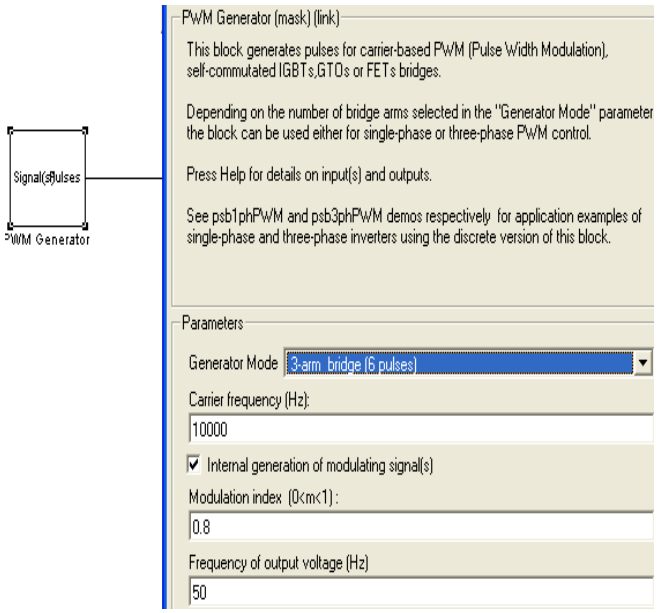

Fig.7. Simulink bloc for parameters defines of PWM pulses.

Simulation design showed in Fig.1., is concept for obtaining proper signals commands for a tree phase bridge inverter. In this way, 6 PWM signals for IGBT's electronics switches are presented in self run for 0.03 seconds.

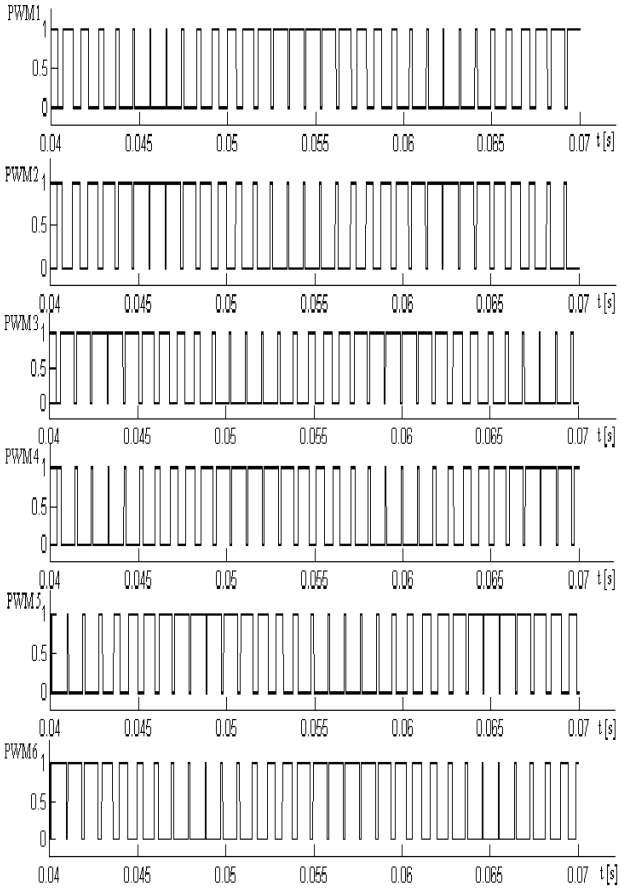

Fig.8. PWM waveforms for three phase bridge inverter commands.

The generating of the signals is realized with the simulink schema showed in Fig.1. and it continues for a obviously much longer time. Matlab facilities offer possibilities to realized a different program for signals, like those presented in Fig.8.

For generating PWM signals to the outside of the computer, with digital ports can be used. Very large offers of electronics manufacturing companies have for these way solutions. The supplementary cost are present, but there are compensated with some technically advantages. Main boards of computers have many sockets for PCI (Peripheral Component Interconnect bus) interfaces, resulting the possibility of using simultaneous many boards. In direct simulink run these dates are used in one cyclically evolution obtaining a time for functioned needful of application.

In this paper example, the controller consists in one National Instruments board for PCIe interface. For usual hardware electronics, this one which is defined with real-time Matlab-Simulink, offers a particular executable soft without all software tools. All the classical files (*.c ; *.pas; *.h) for other compilers are offered. The direct link between software simulation on PC and the extern hardware is important for defining and optimizing applications.

V. CONCLUSIONS

Optoelectronic interfaces provide galvanic isolation required in modern electronic applications converters. Electro standards require generalization of such solutions. Examples are implemented evidence optoelectronic interfaces operating at higher frequencies, covering a wide range of applications of power electronic converters.

One good electronic application is made with several specialized devices and one controller. In this paper example, the controller consists in one National Instruments board for PCIe interface. PWM modulation is used. The direct link between software simulation on PC and the extern hardware is important for defining and optimizing applications.

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