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COMPACT AC DRIVE COMPRISING HVIC INTEGRATED CIRCUIT AND A NEW GENERATION, 150 MIPS DSP

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Abstract: *DSP controllers have advanced over the past decade in such way that they are available with the performance of 150 MIPS at a cost of 1-2 USD, compatible with low cost drives economic parameters, and even AC drives in household appliances. At the same time, HVIC (high voltage integrated circuit) technology offers a low cost integration of the IGBT drivers, auxiliary floating power supply, IGBT components and protection logic in one chip. This paper propose a way to create a setup for drive control development using IRADK10, board with power module, and eZDSP, board with TMS320F2812. Interface board is presented with explanations of all signals and PCB design is explained.*
Key Words: ***setup for drive control, DSP F2812, IRADK10***

1. INTRODUCTION

This paper will present a simple way to upgrade performance of existing power converter using new generation DSP.

Power electronics has greatly advanced in last decade. Performance of electronic elements became better and the amount of lost energy on heat dissipation was decreased [3]. Implying new materials, manufactures were capable to integrate corresponding drivers, flouting power supply, protect circuits and IGBT modules, all in one chip. All of this result with small dimensions of power converters, reduced number of components and overall simpler design of PCB boards. Development of integrated power electronics have influenced in a great deal the coast of manufacturing household appliances and there maintenances. In this paper one power converter with integrated IGBT inverter is used.

In the other hand it is not a rare case that, due to the faster progress in information technology, after few years of usage, power converters are upgraded with a faster microcontroller. In this way, we retain power electronics witch often satisfies performance demands and upgrade controller subsystems. Overall cost is greatly lowered and performance of power converter is enhanced. Nowadays, developers have broad specter of microcontrollers. Demands that must be satisfied by microcontroller are numerous. From basic PWM generation and ADC conversion through communications needs, microcontroller must have a capability to compute fast, many different peripherals, low price etc. For products in household, reliability and price are parameters that maters the most. Digital Signal Processor, (DSP) as a microcontroller that is adjusted to handle digital numbers and process them with grate speed, is often a best solution for most applications. Recently, DSP become the way to utilize two most important characteristics for microcontrollers, processor speed and coast. Today, with series that exceed tenths of million units, developers have chance to use vary powerful microcontrollers at vary low coast. For the purpose of this article one new generation DSP is used, TMS320F2812.

In order to use microcontroller such as TMS320F2812, design of PCB board that supports this particular DSP must be obtain first. Advance knowledge about performing, as well as internal architecture of DSP is essential to achieve that. Due to the complexity of that task, in this paper development board for that microcontroller was used. Such boards exist on markets manly for this purpose. Description of board and main features will be presented as portion of this paper. As a consequence for using a development board, and power electronic from IRDAK 10.0, interface board must be created. This board adjusts signals from power electronics board to DSP board, and vice verse. Detailed description of this board will be presented in paper.

2. POWER CONVERTER

Three phase inverter is a power converter that has for output three phase average value of voltage. This type of converter is used for supply AC motors in applications where frequency and value of applied voltage is variable. Such inverter can be found in IRDAK 10.0 power converter. IRDAK 10.0, product of International Rectifier, represents compact, small power, three phase inverter. Inverter contain six IGBT, corresponding drivers, flouting power supply all integrated in one chip, IRAMS10UP60X. Beside inverter, IRDAK 10.0 have one phase 230V AC input, 300V DC link, +5V and +15V supply, over current and over and under voltage protect circuit, opto isolated RS232. As a microcontroller

it was used 8 bit PIC16F873 with his modest 5 MIPS [2]. All of this puts IRDAK 10.0 on a market as compact, small power inverter with low price.

2.1 Description of power electronic

Input for IRDAK is standard 50 Hz one phase 230V line, customary in Europe, with a fuse for 4 A. After EMI filter and power ON/OFF switch there is an integrated diode rectifier for 4 A. In DC link IRDAK 10.0 contains selector switch for selection either 110V or 220V as voltage of DC link. This means that IRDAK 10.0 can operates with two different powers, lower and higher, depending from needs. For purpose of this paper 220V is used as DC link voltage. Also before rectifier there is a NTC resistor for limiting inrush current of DC link capacitors, as well as varistor (VDR) for protection against excessive transient voltage. This portion of power electronic can be seen on Fig. 1.

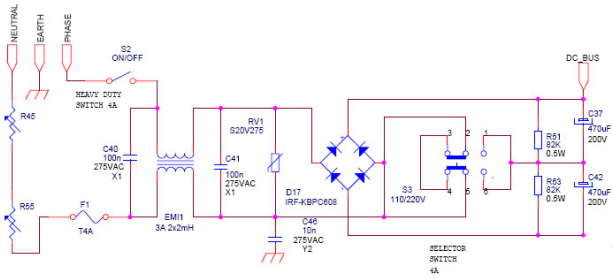

Fig. 1. *AC to DC converter with DC link on IRDAK 10.0*

Inverter on IRDAK 10.0 is integrated in chip IRAMS10UP60X. Scheme of internal connections is showed on Fig. 2. As it can be seen, chip IRAMS10UP60X represent 3 phase inverter with 10A and 450V (DC voltage) for maximum current and voltage.

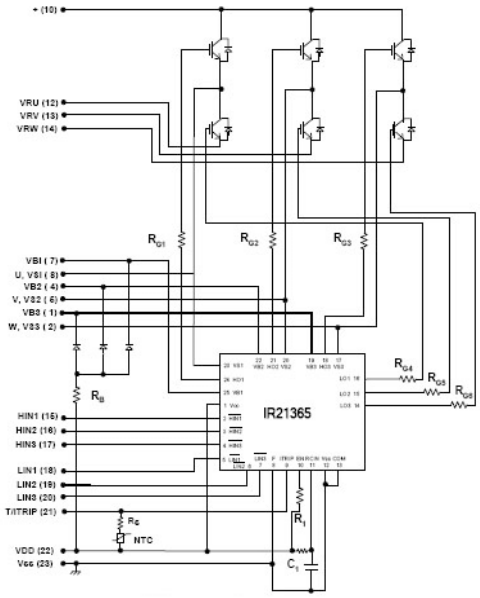

Fig. 2. *Internal architecture of IRAMS10UP60X*

Maximum switching frequency for IGBT inside this module is 20 KHz what is more than enough in most applications. Chip has internal protection from overheating realized with NTC resistor. When temperature riches critical value (+100 °C) the outputs are shutting down and inverter stop working.

2.2 Protection circuits

IRDAK 10.0 has over current and protection from to low and to high voltage. Current in DC link is measured by shunt. Voltage signal from shunt is proceed to microcontroller. It is reverse proportional to DC current. Voltage of DC link is measured with resistor divider and also proceeds to microcontroller. This circuit can be seen on Fig.3.

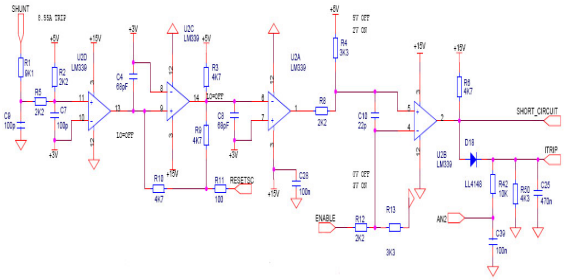

Fig. 3. *Protect circuit on IRDAK 10.0*

2.3 Microcontroller signals

PIC16F873 is a microcontroller on IRDAK 10.0. List of his signals and nature of them is presented in Table.1. All signals are in scope from 0 to +5 V.

Table.1. *Signals of IRDAK microcontrollers*

Name of Sig.	Nature of Sig.	Short Description
MCLR	Digital	Reset
AN0	Analog	Sig. of DC current
AN1	Analog	Sig. of DC voltage
AN2	Analog	Sig. of IRAMS temperature
AN3	Analog	ADC reference
RA4	Digital	LED1
AN4	Analog	Standby analog input
GND		
OSC1/2		
RC0	Digital	LED2
RC1	Digital	LED3
RC2	Digital	Spare input
RC3	Digital	Spare input
RC4	Digital	Short circuit
RC5	Digital	Reset short circuit
RC6	Digital	TxD
RC7	Digital	RxD
VCC		+5V
RB0	Digital	
RB1	Digital	
RB2/3/ 4/5/6/7	Digital	PWM signals

3. DSP DEVELOPMENT BOARD (EZDSPF2812)

The eZdspF2812 is product of Spectrum Digital. It represents an evaluation module for Texas Instruments fix point, 32 bit DSP TMS320F2812. The eZdspF2812 is stand-alone card-allowing evaluators to examine the TMS320F2812 digital signal processor (DSP) to determine if it meets their application requirements. The eZdspF2812 is shipped with a TMS320F2812 DSP. The eZdspF2812 allows full speed verification of F2812 code. Two expansion connectors are provided for any necessary valuation circuitry not provided on the as shipped configuration. To simplify code development and shorten debugging time, a C2000 Tools Code Composer driver is provided. In addition, an onboard JTAG connector provides interface to emulators, operating with other debuggers to provide assembly language and 'C' high level language debug. [1] The eZdspF2812 has the following features [1]:

- TMS320F2812 Digital Signal Processor
- 150 MIPS operating speed
- 18K words on-chip RAM
- 128K words on-chip Flash memory
- 64K words off-chip SRAM memory
- 30 MHz clock
- 2 Expansion Connectors (analog, I/O)
- Onboard IEEE 1149.1 JTAG Controller
- 5-volt only operation with supplied AC adapter
- TI F28xx Code Composer Studio tools driver
- On board IEEE 1149.1 JTAG emulation connector.

5. INTERFACE BOARD

Some adjustments need to be done in order to integrate DSP as IRDAK's microcontroller. DSP operates on 3.3V level and his pins are NOT 5V tolerant. All signals, digital and analog, must be adequately converted from 5V level to 3V. At this occasion it is convenient to plan features that are missing on IRDAK 10.0. Phase current and voltage is to be measured. Schematic of this board is drowned in ORCAD 10 and is presented on Fig.3.

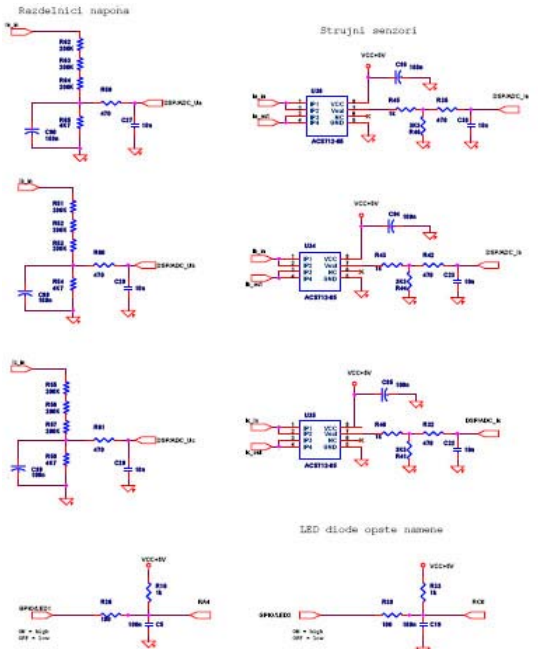

Fig. 3.a. *Interface board schematics. Voltages and currents measurements.*

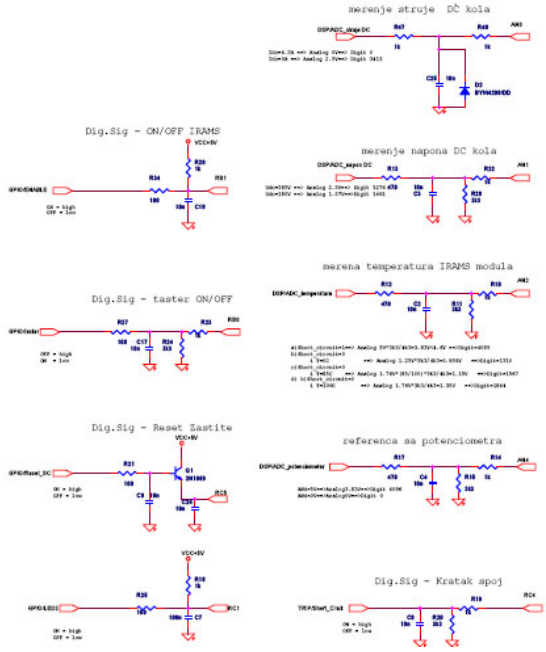

Fig. 3.b.*Interface board schematics. Signals adjusting circuits.*

The boards routing was done in OrCad 10.5 Layout editor. It is two sides printing with 'SMD' and 'trough hole' elements. Routing is presented on Fig.4.

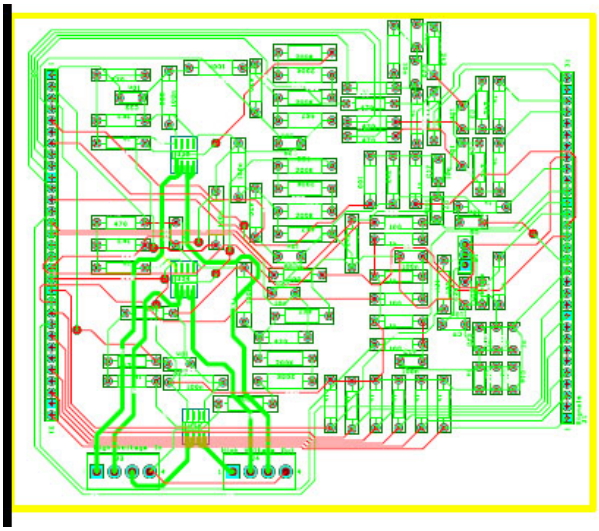

Fig. 4. *Interface board lines.*

6. REFERENCE

[1] *EZDSP TM F2812* Technical Reference.

[2] *IRADK 10.0 Motor Drive Reference* Design Kit Technical Reference.

[3] Slobodan N. Vukosavić, „*Digitalno upravljanje električnim pogonima*", Beograd 2003 (in Serbian)