WORKPLACE FOR CONTROL ELECTRICAL MOTORS

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ABSTRACT

This paper describes design of new workplace for validation of electrical drives and power inverters control algorithms. This workplace is based on processor DSP56F803 from Motorola, which is interfaced with hybrid power module, and induction motor and communication unit towards connection of personal computer.

1 INTRODUCTION

Break 80th an 90th years can be characterized as dynamic expansion of AC drives at field of electrical drives. Even greater complexity of control and inverter power parts in comparison with DC drives, AC drives and motors have the same priority as DC motor on market. Development in microelectronics and research in power transistors contributed with this situation. IGBT with Backward voltages 600 V to 3000 V and current-carrying capacity 10 A to 3000 A is matter of course. These parameters allow directly processing six-pulsate rectifiering distribution network 3 x 380 V and therefore can be made transistor three-phase chopper with DC-link voltage 600 V. Then can be easy implement AC induction motor drive with power up-to 100kVA.

To validate new algorithms of AC drives control in research and for teaching of electrical drives microprocessor control a school workplace was designed.

The school workplace consists of three main parts:

- Supply unit - contains voltage sources for feeding of electronics of power interface and EMI filter for power input rectifier.
- Power interface unit - serves for interconnection DSP module to driving and measuring ports. It contains power transistors drivers described bellow and current and voltage transducers and their electronics.
- IGBT module - contains transistor module with DC-link capacitors and break resistors.

2 DSP 56F803

Processor DSP 56F803 by firm Motorola is a member of the DSP 56800 core-based family of Digital Signal Processors (DSPs). It combines, on a single chip, the processing power of a DSP and the functionality of a micro controller with a flexible set of peripherals to create an extremely cost-effective solution. The DSP56F803 includes many peripherals that are especially useful for applications such as motion control, smart appliances, steppers, encoders, tachometers, limit switches, power supply and control, automotive control, engine management, noise suppression, remote utility metering, and industrial control for power, lighting, and automation.

The DSP 56F803 includes these peripheral circuits:

- Pulse Width Modulator module (PWM) with six PWM outputs, three Current Sense inputs, and three Fault inputs, fault tolerant design with dead time insertion, supports both center- and edge-aligned modes, support Motorola patented dead time distortion correction;
- Two 12-bit Analog-to-Digital Converters (ADCs), which support two simultaneous conversions; ADC and PWM modules can be synchronized;
- Quadrature Decoder with four inputs (shares pins with Quad Timer);
- Four General Purpose Quad Timers: Timer A (sharing pins with Quad Dec0), Timers B & C without external pins and Timer D with two pins;
- CAN 2.0 B module with 2-pin ports for transmit and receive;
- Serial Communication Interface (SCI) with two pins (or two additional GPIO lines);
- Serial Peripheral Interface (SPI) with configurable 4-pin port (or four additional GPIO lines);
- Computer Operating Properly (COP) Watchdog timer
- Two dedicated external interrupt pins;
- Sixteen multiplexed General Purpose I/O (GPIO) pins;
- External reset input pin for hardware reset;
- JTAG/On-Chip Emulation for unobtrusive, processor speed-independent debugging;
- Software-programmable, Phase Lock Loop-based frequency synthesizer for the DSP core clock.

More detailed description is in [2].

Control module has these dimensions, width is 79 mm and height is 56 mm. Parts are planted double-sided. This module can you see on the figure 2. On left is top layer and on right is bottom layer.

Inner layers are used for supply both analogue and digital part. Digital and analogue grounds are connected nearby processor for prevention to difference voltage rise on the chip. Next module includes two voltages stabilizer for positive analogue and digital supply voltage.

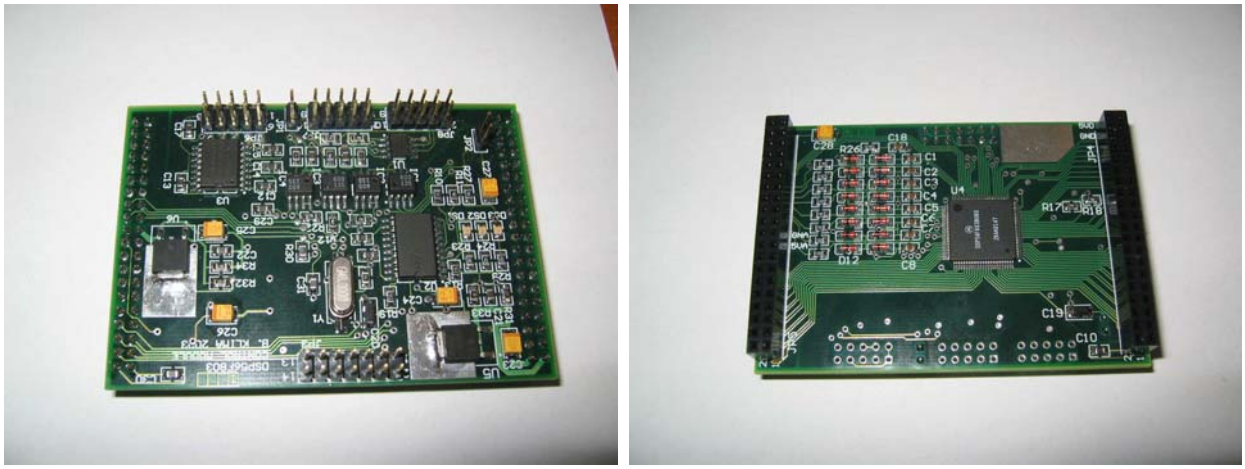

Fig. 1: *Module with DSP 56F803 (on the left is top layer, on the right is bottom layer)*

On the inputs are connected RC filters and protective diodes. Breakdown frequency this filter is set around 80 kHz. Input of reference voltage is also connected through RC filter and it is connected to external pin. Serial interfaces CAN and RS232 are connected to connector through optical interface.

This module designed Ing. Bohumil Klima,Ph.D and Ing. Radek Stupka. More detailed description is in [3].

3 POWER DRIVER

Power Driver supports regular switching of IGBT transistor, further it is responsible for report of the fault. Power driver is composed with supply transformer, two logic gate optocouplers 6N137, and gate driver MC33153 and output stage. Power drive is shown in fig. 2.

Optocoupler 6N137 is single-channel optocoupler, that consists of a 850 nm AlGaAS LED, optically coupled to very high speed integrated photodetector logic gate with strobable output.

The MC33153 is designed as an IGBT driver for high power applications. Although designed for driving discrete and module IGBTs, this device offers a cost effective solution for driving power MOSFETs and Bipolar Transistors. Device protection features include the choice of desaturation or overcurrent sensing and undervoltage detection. In our sample is select protection via desaturation. The best method for detection desaturation is the use of a high voltage clamp diode and a comparator. The MC33153 has a Fault Blanking/Desaturation Comparator which senses the collector voltage and provides an output indicating when the device is not fully saturated. To this pin is connected high voltage diode with a rated voltage comparable to the power device. When the IGBT is “on” and saturated, diode will pull down the voltage on the Fault Blanking/ Desaturation Input.

When the IGBT pulls out of saturation or is “off”, the current source will pull up the input and trip the comparator. The comparator threshold is 6.5 V, allowing a maximum

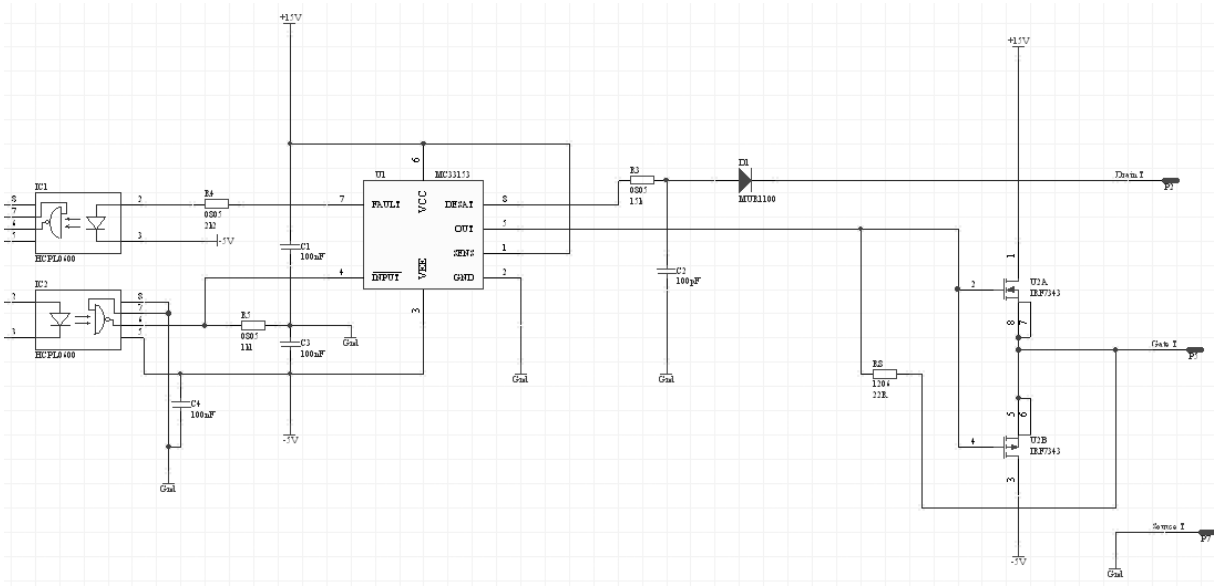

Fig. 2: *Power Driver*

on-voltage of about 5.8 V

A fault exists when gate input is high and V_{CE} is greater then maximum allowable $V_{CE(SAT)}$. The output of the Desaturation Comparator is ANDed with the gate input signal and fed into Short Circuit and Overcurrent Latches. The Overcurrent Latch will turn-off the IGBT for the remainder of the cycle when a fault is detected. When input goes high, both latches are reset.

4 HYBRID POWER MODULE

This module integrates a 3-phase rectifier, bus control IGBT, and temperature sense in a single convenient package. It is designed for general-purpose 3-phase induction motor drive application. The inverter incorporates advanced insulated gate bipolar transistors (IGBT) with integrated ESD protection Gate-Emitter zener diodes and fast soft freewheeling diodes to give optimum performance. The solderable top connector pins are designed for easy interfacing to the user’s control board. IGBT allows flow current 10 A and it Reverse Voltage is 600 V.

5 CONCLUSION

Described workplace is designed for new algorithms development for control of electric drives and power inverters. It allows validation of research works in this field and in teaching students can obtain greater practice. At time of writing this article, the workplace was not yet finished and therefore weren't provided more practical results.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Motorola Semiconductor Product Sector: Preliminary Data Sheet, DSP56F803 16-bit Digital Signal Processor, online: www.motorola.com/semiconductor/

[2] Klíma, B., Stupka, R.: Řídicí modul s mikrokontrolérem DSP56F803 pro výzkumné účely v elektrických pohonech a výkonové elektronice, conference proceeding EPVE 2003

[3] Motorola Semiconductor Technical Data: Preliminary Data Sheet, Power Hybrid Module PHPM7D1E60DC3, online: www.motorola.com/semiconductor/

[4] On Semiconductor: Single IGBT gate driver MC33153, online: www.onsemi.com