RESEARCH ARTICLE OPEN ACCESS

Study Driver Module For IGBT's

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ABSTRACT
The functional schematic of the driver module for IGBT's is described in this paper, how it works and what the particularities of its design are. The version of the driver and timing diagrams are also presented here.
Keywords: driver , module, IGBT.

I. INTRODUCTION

There are well known integrated circuits from different companies for control of the MOSFET and IGBT's, some of them with internal protection (limits) mechanism [1-5]. They are described in the company's data sheets, but also there are a few specialized publications in the scientific journals [6]. Quite limited full solutions including power and control circuitry are presented. In [7] DC/DC converter is proposed to produce the power supply voltages for the secondary part of the integrated circuitry. The signal transmission via a pulse transformer is described in [8].

This paper gives an entire solution for the driver module for IGBT's, including the functional schematic, the control part and the power supply unit.

II. FUNCTIOANAL SCHEMATIC

The full functional schematic of the driver module is shown on Fig.1. It is based on HCPL3120 component [9], which power supply voltages are produced by DC/DC converter as a part of this module. The converter is a "flyback" type, based on the integrated circuit LM2587T-ADJ [10]. There is an indirect stabilization of the output voltage on the capacitors C4 and C5, which is possible by using D3, C3, R2, R3 components and the additional coil 1 - 2 of the pulse transformer. The diodes D1, D2 are using as a protection for the LM2587T-ADJ transistor. The nominal values of the voltages over the C4 and C5 are 8V and 18V respectively. When the driver's input voltage is changing in the range of 4 - 6V, those voltages are also changing in the certain limits. Therefore an additional stabilization via integrated circuits U1 and U2 guarantees the parameters of the switching impulse for IGBT. The diodes D8 and D9 are for a protection of HCPL3120 and is selected according to the transistor type. The logical 0 on the $\overline{ENABLE}$ input - enable the driver and the IGBT is switched ON and OFF depend of the logical level of the $INPUT$. The logical 1 on the $\overline{ENABLE}$ input drives the U3 outputs in a tristate and the IGBT is permanently OFF.

III. DESIGN PARTICULARITIES

In the following part are described some of the design particularities of the driver, related to its components. When the outputs of 74HC126 are connected in parallel, the current via the LED of HCPL3120 $I_{F(ON)}$ is equal to the sum of the outputs buffers currents, i.e. $4.I_{OH}$. It is necessary that $I_{F(ON)} > I_{Fmin} = 7mA$ and $I_{OH} \leq 4mA$ [11]. The voltage when the LEDs is on is $V_F = 1.5V$ [9] and the output voltage of the buffers when logical 1 and current $I_{OH} \leq 4mA$ is $V_{OH} = 4.5V$, therefore:

$$R_4 = \frac{V_{OH} - V_F}{4.I_{OH}} = \frac{4.5 - 1.5}{4.4.10^{-3}} \approx 180\Omega \quad (1)$$

There are different methods for R_{gate} value calculation, for example [12, 13]. Typical resistor values or methods for its value calculation are given from IGBT producers in the transistor data sheet [14]. In the current example for the MII100-12A3 transistors used, the value of the resistor $R_{gate} = 10\Omega$.

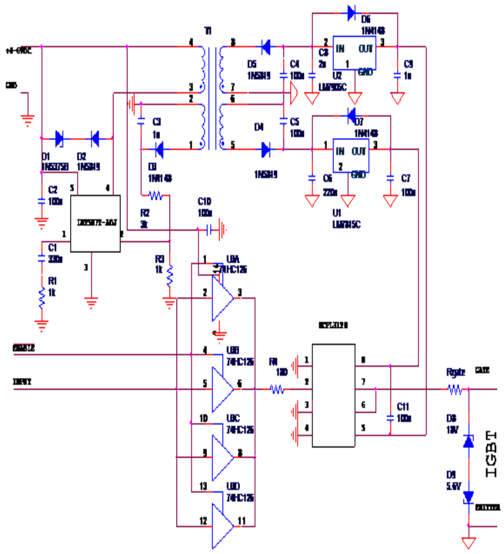

Fig.1. Functional schematic of the driver module

The DC/DC converter design and the pulse transformer calculations were done using the methods described in [15]. In our example is used the integrated circuit LM2587T-ADJ and the resistors R_2 and R_3 values are calculated as follow[10]: for the selected voltage U_{OUT} the value of R_3 need to fulfil the conditions $1K \leq R_3 \leq 5K$, i.e. for $U_{OUT} = 5V$:

$$(2) \qquad R_3 = R_2 \cdot \left(\frac{U_{OUT}}{1.23} - 1 \right) = 1K \cdot \left(\frac{5}{1.23} - 1 \right) \approx 3K$$

IV. REALIZATION AND EXPERIMENTAL RESULTS

The photo of the driver module connected to IGBT is shown on Fig.2. The transistor module MII100-12A3 from IXYS is used for the experimental measurements. The input capacitance of the transistor is $C_{ies} = 5.5\ nF$ [16].

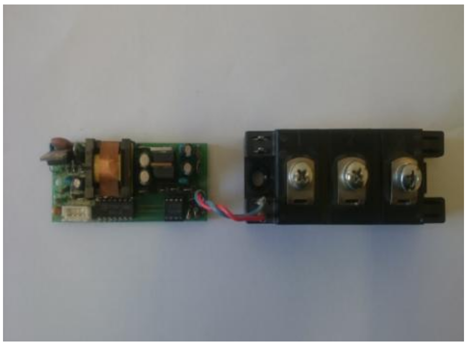

Fig.2 Photo of the driver module connected to IGBT

The timing diagrams of the control pulses in different horizontal sweeps are shown on the Fig.3 and Fig.4. for understanding the most important parameters.

V. CONCLUSION

The described in this paper driver module can be used for control of different types IGBT's with similar parameters as of the used here transistor. Depending of the transistor type the necessary change of the R_{gate} value is needed. The integrated circuits HCPL3120 can be replaced by a similar one of the same type. Improvement of the functional schematic can be done in order to be used for other drivers with a transistor protection and communication signals $\overline{FAULT}$ and $\overline{RESET}$, see for example [17].

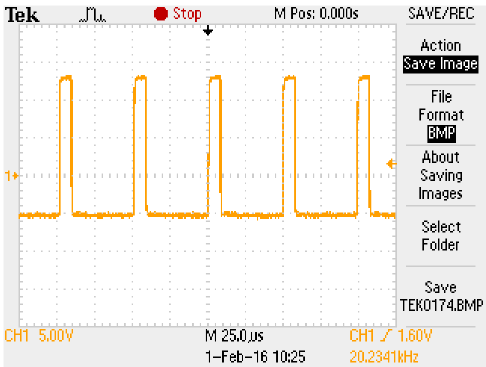

Fig. 3. The control pulses timing diagram

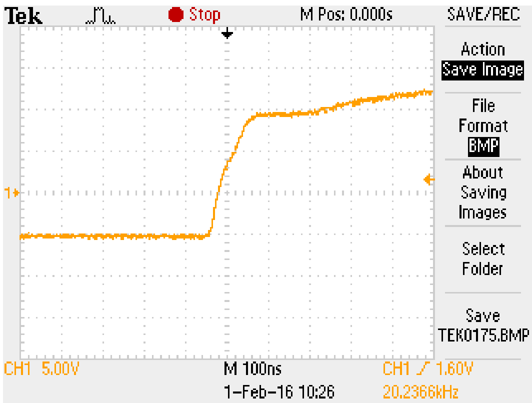

Fig. 4. Timing diagram of the control pulses rising edge

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