80C196MC Microcontroller-based Inverter Motor Control And IR2130 Six-output IGBT Driver

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Abstract –This paper describes how to apply the IR2130 to an inverter motor control and presents an overview of an 8xC196MC controller-based IGBT inverter motor control design. The IR2130 six-channel gate drivers perform all the requirements for interfacing logic level control circuits to high power IGBT devices.

I. INTRODUCTION

Over the last few years the number and variety of inverter motor control applications has increased tremendously. An inverter converts DC power to AC power at a desired output voltage or current and frequency. The two general types are voltage-fed inverters and current-fed inverters. The former has essentially a constant DC input voltage. The latter has a constant supply current. Fig.1 shows the basic structure of a voltage-fed inverters based on IR2130 and 80C196MC. The 80C196MC microcontroller on the inverter produce a variable frequency AC, which can drive an induction motor at varying speeds. Slow starting speed reduces strain on mechanical system and reduces starting current.

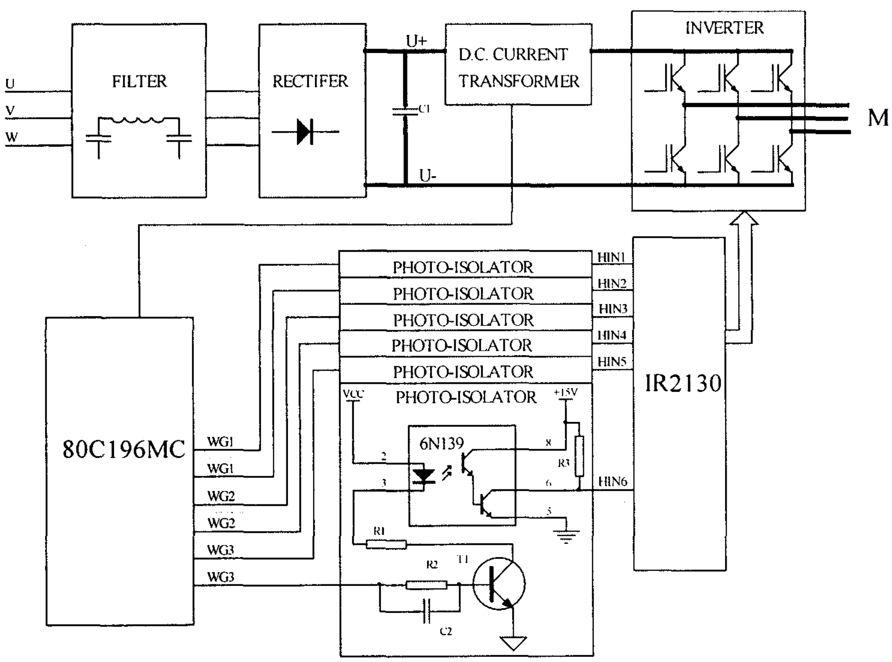

FIGURE 1. BASIC STRUCTURE OF AN INVERTER

II. IGBT GATE DRIVE REQUIREMENTS

IGBT commonly used in the inverter operating at DC bus voltages up to 600V DC require voltage drive in order to achieve a saturated "ON" state condition. The drive signal must have the following characteristics:

1) An amplitude of 10V to 15V.

2) A low source resistance for rapid charge and discharge of the gate capacitance.

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3) A floating output so that high side switches can be driven.

In addition to the above requirements the actual driver should be capable of driving combinations of devices in both low-side and high-side switch configurations. With this in mind the driver should also provide the following:

1) Low internal power loss at high switching frequency and maximum offset voltage.

2) Accept ground referenced logic level input signals.

3) Protect the power switch from damage by clamping the gate signal to the low state in the event of gate under-voltage or over-voltage or if the load current exceeds a predetermined peak value.

4) Protect the power switch by clamping the signal to the low state if the signal inputs are disconnected.

Traditionally the functions described above have required discrete circuits of some complexity but International Rectifier's IR2130 six-channel gate drivers perform all the requirements for interfacing logic level control circuits to high power IGBT devices in high-side/ low-side switch configurations using up to six devices.

III. IR2130 DRIVER

As shown in Figure 2 the IR2130 consists of six output drivers which receive their inputs from the three input signal generator blocks each providing two outputs. The three low-side output drivers are driven directly from the signal generators L1, L2 and L3 but the high-side drive signals H1, H2 and H3 must be level shifted before being applied to the high-side output drivers.

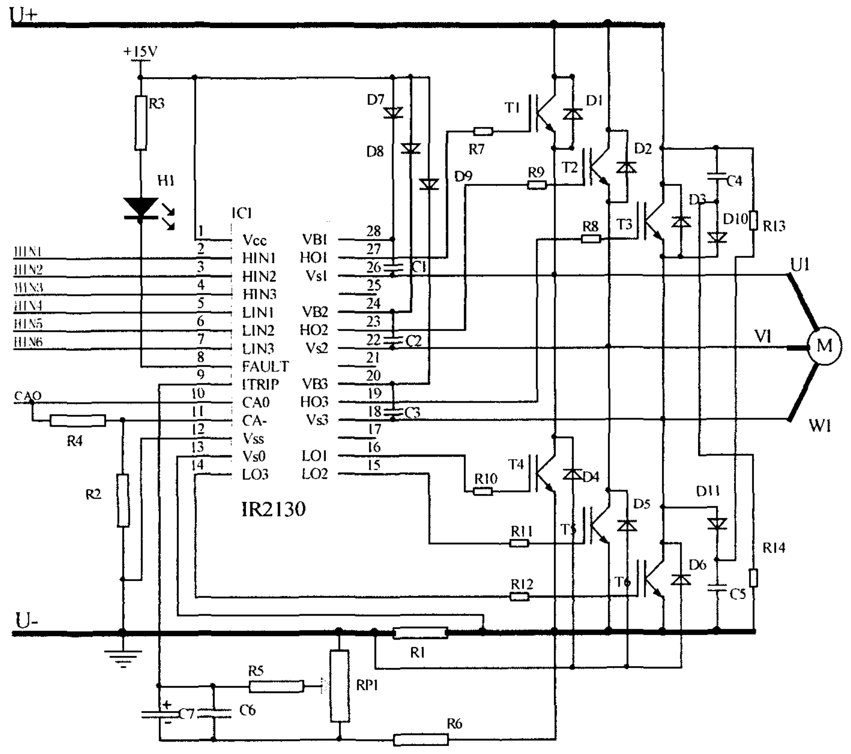

Figure 2. IGBT INVERTER BASED IR2130

A. Bootstrap Capacitors

Three bootstrap capacitors C1, C2 and C3 are required to supply power for the floating outputs of the driver, the values of which are a function of the gate charge requirements of the power switch and the maximum power switch "ON" times. The internal floating driver current also must be supplied from the bootstrap capacitors. After all these energy requirements have been met there must still be enough charge remaining on 8.3V nominal to avoid shutdown. The diode D7, D8 and D9 must be super-fast.

B. Protection Circuits and Fault Logic

An under-voltage detector circuit monitoring the VCC level provides an input to inhibit the six outputs of the signal generator circuits. In addition, there are individual under-voltage lockout circuits for the high-side outputs should any of the floating bias supplies fall below a predetermined level.

The ITRIP signal, which can be derived from a current sensor R1 in the main power circuit of the motor, is compared with a 0.5volt reference to inhibit the six signal generator outputs. A fault logic circuit set by ITRIP inputs provides an open drain TTL output for system indication or diagnostics.

C. 3-Phase Motor IGBTs Drive

Figure 2 shows a typical 3-phase motor IGBT drive in which the IR2130 supplies all the gate drive signals for the high-side and low-side IGBTs. The IR2130 is operated from a 15-volt dc supply and its input signals supplied by an 80C196MC. The DC bus for the inverter is supplied by rectifying the 110-volt AC input and filtering it with a capacitor.

There is an internal current amplifier in the IR2130 that provides an analog signal proportional to the voltage difference between VSS and VS0. Thus, a viewing resistor in the main power circuit can provide a positive voltage at VS0, and the current amplifier can be scaled to generate 0-5Vdc as a function of actual load current by suitable feedback resistors.

IV. INVERTER BASED 80C196MC

An inverter is used to control the speed of the AC motor by varying the supply frequency. In the inverter motor control scheme, the voltage/frequency ratio is typically held constant. The speed of an AC motor is proportional to the supply frequency. As the motor speeds up (higher frequency) the motor consumes more power (higher voltage input), thus producing a greater amount of torque.

To control the supply frequency, a microcontroller is required to produce the three-phase complementary PWM signals required for the IGBTs switching. These waveforms must be generated using the sinusoidal PWM technique with three reference sinusoidal waveforms, each 120° apart in phase.

The 80C196MC microcontroller is used to produce the PWM signal and enable or disable the IGBT. The switching points of the PWM signal are determined by the intersection of the fixed-frequency triangular carrier wave and the reference modulation sine wave. The output frequency is at the sine-wave frequency and the output voltage is proportional to the magnitude of the sine wave. When the frequency increases, the pulse width increases and the modulation depth also increases. The pulses change more rapidly and a larger change is observed. The opposite happens when the frequency decreases.

The on-chip waveform generator (WFG) of 80C196MC can produce three independent pairs of complementary PWM outputs that share a common carrier period, dead time and operating mode. The waveform generator has three main parts: a time-base generator, phase driver channels and control circuitry. The time base generator establishes the carrier period, the phase driver channels determine the duty cycle and the control circuitry determines the operating mode and controls interrupt generation.

The 80C196MC controller has the sine table to perform the sinusoidal wave PWM and V/F pattern in the internal memory. When the controller receives the frequency command, the controller knows the output voltage of the inverter from V/F pattern and creates the equivalent PWM pulse in sinusoidal wave using the sine table. The PWM pulses are output from the 80C196MC controller six Waveform Generate outputs pins.

V. CONCLUSION

The IGBT high requirements for driver have required discrete circuits of some complexity but International Rectifier's IR2130 six-channel gate drivers perform all the requirements for interfacing logic level control circuits to high power IGBT devices in high-side/ low-side switch configurations using up to six devices. This paper describes how to apply the IR2130 to an inverter motor control and presents an overview of an 8xC196MC controller-based IGBT inverter motor control design.

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