APPLICATION NOTE

L6350A SMART DRIVER IN IGBTs AND MOSFETs SWITCHING APPLICATIONS

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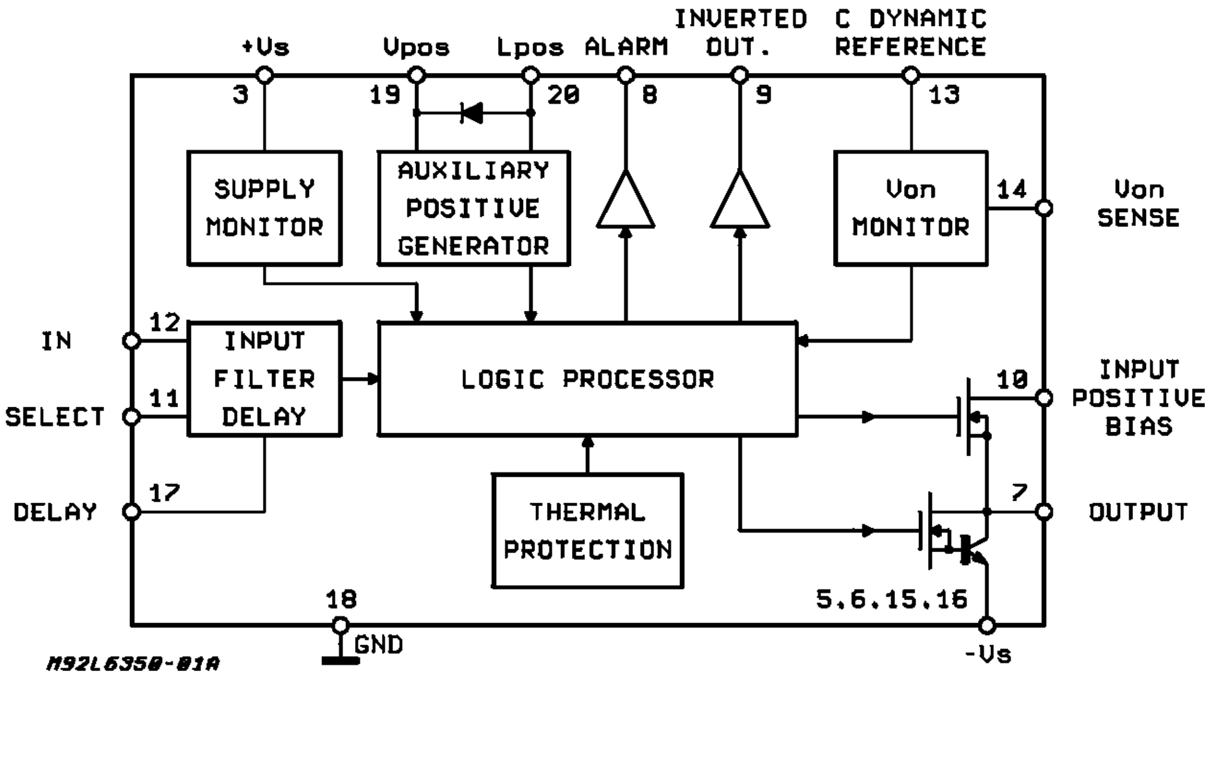
This paper describes the use of the L6350 smart driver in MOSFETs and IGBTs power applications. There are presented two easy and low-cost applicative schematics, suitable for insulated-gate devices, that can be implemented with very few additional external components.

1. INTRODUCTION.

Two kinds of insulated-gate power devices, now available on the market, are becoming more and more widely used: the MOSFET and the more recently developed IGBT.
Their ruggedness, their capability to operate both at high voltage and high current and, most of all, their easy and economic driving method explain their growing use in many applications such as UPSs, SMPSs, motion control and so on.
The energy needed during switchings and the way in which it is supplied are the main differences between MOSFETs and IGBTs driving method and BJTs one. The designer of a driving circuit has to take especial care of this difference.

BLOCK DIAGRAM



2. THE L6350A SMART DRIVER USED AS AN INSULATED-GATE DEVICES DRIVER.

The L6350A smart driver has been designed and dimensioned to be used as high power NPN bipolar transistors and darlington driver, so it is known also as ”Base Driver”.

However, it can be effectively used to drive insulated-gate power devices, like MOSFETs and IGBTs, with easy and low-cost external circuitry. To understand how it is possible, we will examine which are the requirements needed to drive such devices and the L6350A's features which can be used to fulfill these requisites. MOSFETs and IGBTs requires that their gate is supplied with a voltage at least 10V higher than the voltage of source/emitter (typically, 10V for MOSFETs, 15V for IGBTs), in order to turn them fully on. If the driving voltage drops below 10V the on-voltage increases, leading to higher power consumption. Besides, it is recommendable for the gate voltage not to exceed 16-17V to avoid ageing problems of the power device's gate. The L6350A's supply is guaranteed in the 5.5 to 15V range and an internal comparator allows the circuit start-up as the supply voltage rises up to 7.5V and above; if the supply voltage drops below 5.5V, the comparator stops the device (undervoltage shutdown).

These parameters has been designed for BJTs and are not suitable for MOSFETs and IGBTs. However, the L6350A generates a boosted voltage on an external capacitor at least 10V higher than the supply voltage (needed to drive the internal output buffer).

Using this auxiliary voltage generator, and considering that the DC current capability is above 10 mA, we can get a sufficient driving voltage value with a threshold supply voltage shifted of 10V. Now we have to pay attention only to limit this value in order to avoid the above mentioned ageing problems. A power device driver must also provide a protection against short-circuits in the power section. L6350A has a built-in protection circuit that needs only one diode and its biasing resistor as external components.

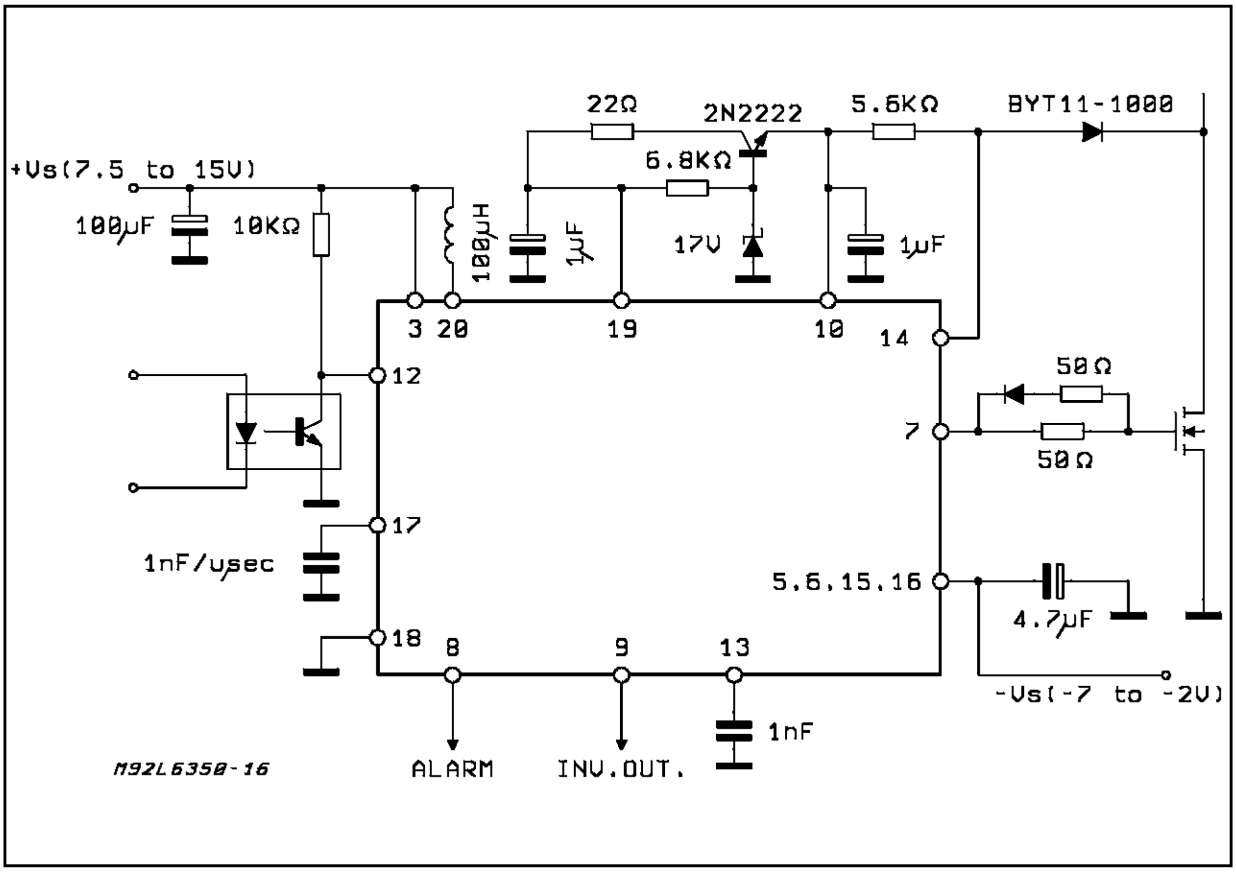
This protection, which is adequate not only for BJTs but also for MOSFETs, could be ineffective for most of the IGBTs for which a particular solution is required.

3. APPLICATIVE CIRCUITS.

Two typical applicative circuits, one for MOSFETs and one for IGBTs driving, are here proposed.

By the above-mentioned requirements, an insulated-gate device driver is also requested to shape purposely the charge and discharge speeds of the gate capacitance to better control

Figure 1: Optocontrolled High Power MOSFET Applications



the switching characteristics, aiming at a compromise among switching speed, power losses and noise problems.
A simple and low-cost solution, with fair performances, is the coupling network shown in fig. 1, where the overall driving circuit is depicted. The coupling network parametrs can be adjusted according to the speed needs and the MOSFET's input capacitance.
The L6350A limits the maximum operating frequency to about 100 Khz, but it's better to keep in mind that its power consumption increases with frequency, (due to the increasing of the current flowing through the gate capacitance) and this could lower the frequency limit when using very big MOSFET modules.
The circuit in fig.1 is specific for MOSFETs driving but, with few additions (see below), it's well suited for IGBTs too.

4. SHORT CIRCUIT PROTECTION OF IGBTs.

The basic circuit for IGBT driving is the same of MOSFET but it is necessary to provide additional external circuitry in order to well protect the power device versus short circuits.
The IGBT, unlike the BJT and the MOSFET, is a very high density current device and its transconductance usually decreases only when the collector current value is many times the maximum rated current.
This can lead the device to work out of the extreme safe operating area if a "load short circuit" occurs. The IGBT can be destroyed if it is forced out of the "extreme operating area", apart from the duration.
This means that the smart driver's built-in protection cannot guarantee the safety of the device. The only way to reduce the short-circuit current to a safe value (usually up to three or four times the maximum rated current), is a two step driving: first, a lower gate voltage (8 to 10V, typically) turns the IGBT on as well as ensures the short-circuit current to be limited; than, as the IGBT is sensed on (by mean of the Von.sense function), the gate voltage is increased, ensuring a low power dissipation in on state.
According to the previous remarks, the proposed schematic is shown in fig. 2. In comparison with the driving circuit for MOSFETs we can notice the addition of the protection circuit and the reduction of the value of the Von.sense resistor in order to well saturate the protection transistor. This increases the power consumption but it is not a big problem because IGBTs usually do not work at a too high frequency.

5. CONCLUSIONS

One MOSFETs driving circuit using L6350A Base Driver has been shown; the same circuit, with the addition of a short circuit protection network, can be adopted to drive IGBTs.
The cost and the complexity of the proposed circuits are comparable to that of he BJT driving circuit. Besides, the use of L6350A considerably simplify the implementation of a driving circuit dedicated to insulated-gate power devices, putting at designer's disposal all "Base Driver's" smart functions.

Figure 2: Optocontrolled High Power IGBT Applications