DN1153

Bootstrap Capacitor Considerations

DGD2101 is a popular high voltage gate driver IC intended for motor drive applications. This design note discusses how to use the DGD2101 in certain circuits with special requirements.

Standard MOSFET and IGBT gate drivers are designed to operate at a nominal driving voltage range of 10-15V. Thus most of these gate drivers have an under-voltage-lock-out (UVLO) feature around 8-9V incorporated in both the high and low sides.

DGD2101 is one of the few gate drivers that does not have UVLO on the high-side. As a result, the IC could theoretically be operational from the set V_{BS} voltage down to 0V. However, this is not possible as all devices internal to the IC have operational threshold voltages (Vth). For DGD2101, its internal MOSFET has the Vth of ~2.5V; thus once the V_{BS} supply falls below this value, incoming input signals are no longer controlled and could leave HO in an undefined state as seen in Figure 1. If the external driven MOSFET gate is not fully discharged at this point it might end in improper operation and cause shoot-through in the same leg during the next cycle forcing LO and HO to be on simultaneously.

A simple and inexpensive solution is to increase the value of the bootstrap capacitor. This will ensure the supply voltage does not fall below the Vth until the external MOSFET gate is fully discharged as seen in Figure 2. Ideally the bootstrap capacitor should be large enough such that V_{BS} voltage is much higher than the 2.5V during periods where to HIN is actively being driven. Selection of the bootstrap capacitor will depend on the maximum required high-side duty cycle, external MOSFET gate charge to be dissipated, external gate resistance used, package and space constraints. Typical bootstrap capacitor values vary from 0.47µF to 10µF. It is a good idea to have two in parallel, if possible, with a smaller cap in parallel for fast response. An example selection would be 2.2µF in parallel with a 0.1µF. In conclusion; care should be exercised in maintaining a V_{BS} voltage higher than 2.5V when high-side input signal (HIN) is actively driven by an external signal.

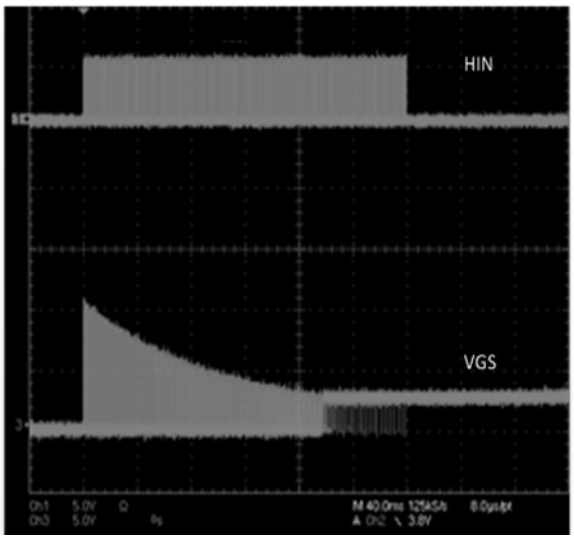

Figure 1: Once V_{BS} drops to ~2.5V, the external MOSFET V_{GS} stays high; V_{GS} @ 5V/div

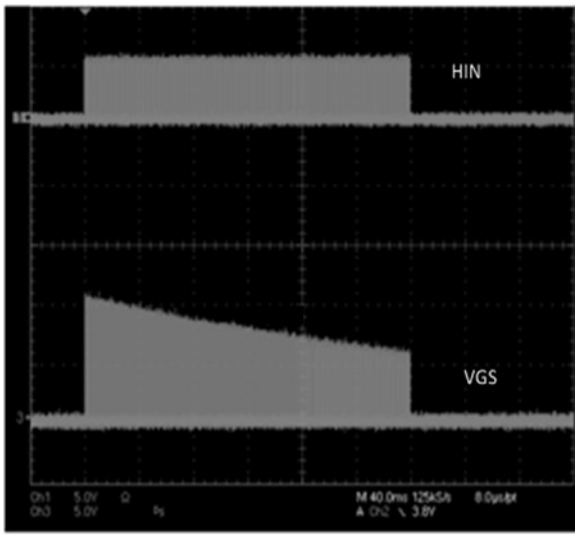

Figure 2: With increased bootstrap capacitance, V_{BS} is maintained above 2.5V for each cycle, and the outputs are completed. The external MOSFET V_{GS} switches low and high as intended. V_{GS} @ 5V/div

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.
Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or

2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

www.diodes.com