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 ($V_{th}$). For DGD2101, its internal MOSFET has the $V_{th}$ 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 $V_{th}$ 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](image1)

![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](image2)
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