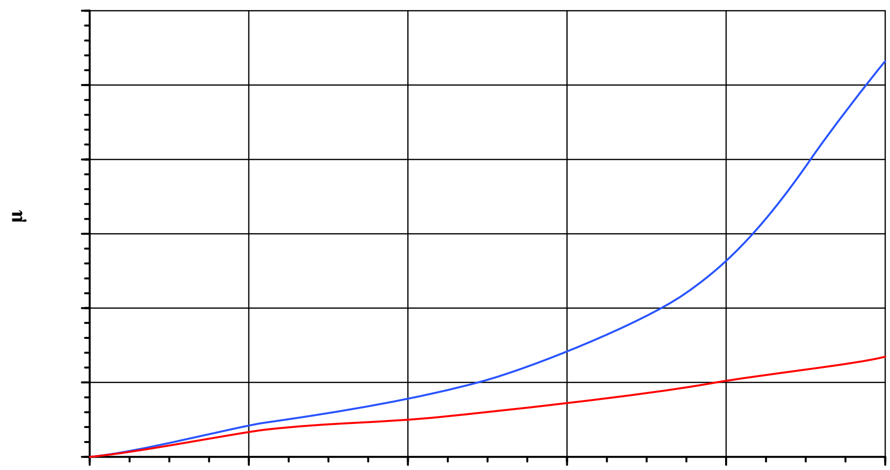
2. Gate charge considerations – In order to fully turn-on the device in high voltage application, both MOSFET and the IGBT drivers must supply voltage beyond the plateau voltage that is needed to overcome the equivalent of the Miller effect in the device (providing the Q_{GD} and Q_{GC} charge at a constant voltage to the MOSFET and IGBT, respectively). The plateau voltage is shown in Figure 2. As shown here, the typical IGBT has a higher plateau voltage (near 10 V) than a typical MOSFET (near 5 V). There is also a higher variability in the IGBT plateau voltage as a function of collector current. As a result, it makes sense to set the IGBT V_{GE} value higher than the typical FET V_{GS} value. However, in both cases, increasing the gate voltage beyond the plateau voltage increases the value of total gate charge that has to be delivered every switching cycle. If we partition the gate-voltage vs. Q chart in three regions as shown in the figure, the first section is the Q_{GE} – from origin to the point the plateau region is reached. The next one is the Q_{GC} – which represents the plateau region and finally, the charge in the 3rd region is proportional to the actual value of V_{GE}. In this instance, every 2 V increase in V_{GE} value beyond the plateau voltage, leads to increase of about 10 nC in Q_G value. This increase leads to higher dissipation in the device as well as in the drive circuit due to the additional gate charge, but will also result in a lower V_{CE}. In that sense, it is advisable to keep the V_{GE} value always above the plateau voltage, but not too much higher than it.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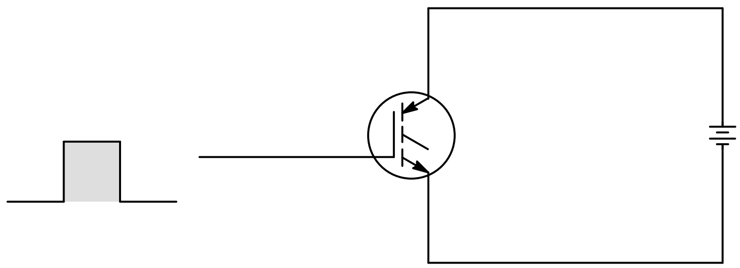
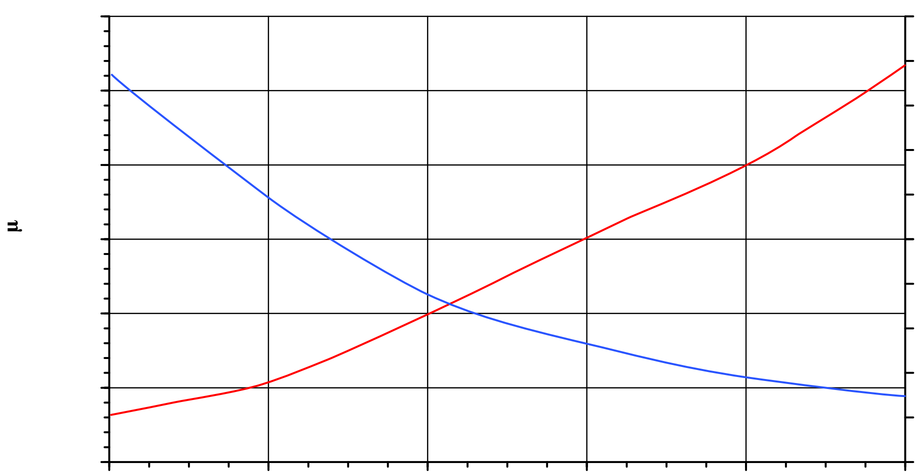


Since an IGBT is less sensitive to second breakdown due to hot spot formulation compared to a BJT, it can survive a short circuit condition if the energy delivered to the device is maintained below some value that is tolerable to the device. An IGBT is typically specified with a guaranteed short circuit withstand time under given conditions (a typical value is 10 μs). It is expected that this withstand time allows an external circuitry to be activated and intervene to rectify the condition.

There are many different ways to protect the device from the short circuit condition for some duration. The most effective way to provide the short circuit survivability would be to inherently build current sensing capability into the device – however, that is not an option in most cases. Another method of increasing the short circuit survivability is to decrease the gate voltage when the short circuit across the device is observed. Figure 6 data shows the relationship between the gate voltage, short circuit current, and the short circuit survival time period. As shown in Figure 6, it is clear that the smaller gate voltage limits the current at lower value and increases the short circuit time duration. Thus, if more rugged performance and longer short circuit survivability is needed, it may make sense to trade-off some of the switching loss gain and reduce the V_{GE} voltage in the application.



IGBTs are high current and high voltage devices that offer certain benefits compared to the MOSFETs. Because of their use in high power applications, both lifetime considerations (ruggedness) and efficiency (low losses) are important. As discussed in this section, the magnitude of the gate-emitter voltage can be optimized in order to reduce the turn-on loss of the device. But on the other hand, the designer needs to understand that the high gate-emitter voltage reduces the short circuit survivability of the device. Using these two relationships and taking into consideration specific application requirements, the designer can choose the best voltage value (and the best IGBT) which will meet the design requirements.