Gate drivers are often confused as continuous current sources because of the $I_{\text{OH}}$ and $I_{\text{OL}}$ specifications in the datasheet. For example, designers looking at the UCC5320SC might read the parameters 4.3-A source and 4.4-A sink and mistakenly believe these devices are capable of providing these currents continuously. Gate drivers do not need to provide constant current because they only have to source/sink current when switching the gate of the MOSFET or IGBT. Refer to Figure 1 for the turn-on waveforms.

In order to understand the $I_{\text{OH}}$ and $I_{\text{OL}}$ specifications, we need to look at the pull-up and pull-down structures inside the device. The output stage of a gate driver typically comes in some variation of Figure 2. UCC5320SC is offered in a split output pinout that gives designers more control of the rise and fall times without adding extra components like schottky diodes.

Under a no load condition, $I_{\text{OH}}$ is determined by $V_{\text{CC2}}$ and the parallel combination of $R_{\text{NMOS}}$ and $R_{\text{OH}}$ while $I_{\text{OL}}$ is set by $V_{\text{CC2}}$ and $R_{\text{OL}}$. $R_{\text{NMOS}}$ helps the pull-up structure deliver the peak current with a brief boost in peak-sourcing current during the Miller plateau region shown as interval 3 in Figure 1. This is done by turning on the N-channel MOSFET during a narrow instant when the output is changing states from low to high. When driving MOSFETs and IGBTs high, the external gate resistor $R_{\text{ON}}$ and the transistor's internal gate resistance $R_{\text{GFET\_Int}}$, reduce the peak output current as shown in Equation 1.

\[
I_{\text{OH}} = \min \left( 4.3 \ \text{A}, \frac{V_{\text{CC2}}}{R_{\text{NMOS}} \parallel R_{\text{OH}} + R_{\text{ON}} + R_{\text{GFET\_Int}}} \right) \tag{1}
\]

Likewise, the peak sink current is limited by the external gate resistor $R_{\text{OFF}}$ in series with $R_{\text{OL}}$ and $R_{\text{GFET\_Int}}$ and is determined by Equation 2.

\[
I_{\text{OL}} = \min \left( 4.4 \ \text{A}, \frac{V_{\text{CC2}}}{R_{\text{OL}} + R_{\text{OFF}} + R_{\text{GFET\_Int}}} \right) \tag{2}
\]
This TI TechNote will use the isolated single-channel gate driver, UCC5320SC and a 100-nF capacitive load to demonstrate different techniques to determine the peak drive current. The first method calculates the expected peak currents based on Equation 1 and Equation 2. Use these equations to estimate the peak drive current when selecting a gate driver for your system.

In order to simulate driving a MOSFET or IGBT before installing it onto the PCB, select a load capacitor that is equivalent to the switch's input capacitance, $C_{ISS}$. Determine the input capacitance by looking up the required gate charge from the MOSFET or IGBT's datasheet at the drive voltage condition.

A second technique uses this $C_{ISS}$ value and the dV/dt of the switching waveform to determine the source or sink current. Figure 3 measures the dV/dt using cursors set to a fixed 35-ns interval and swept across the rising edge in order to find the peak dV/dt. As a guideline, set the oscilloscope's cursors to a time interval, $\Delta t$ of approximately 10% of the rise time to determine the current through the load capacitor.

Use the measured peak dV/dt and load capacitor value along with Equation 3 to calculate the peak current.

$$I_C = C \frac{dV}{dt} \tag{3}$$

A third method inserts a 0.1-Ω sense resistor between the capacitor and ground to calculate $I_{OH}$ or $I_{OL}$. Figure 4 shows the voltage waveform across the sense resistor, $V_{SENSE}$ and its measurement coincides with the highest dV/dt value of the $V_{cap}$ waveform.

The results of the three presented techniques are shown in Table 1. Even with the 0.1-Ω sense resistor in series with the capacitor, Equation 1 predicts 4.30-A sourcing current. Equation 3 uses the largest measured dV/dt value in the linear region of the gate drive waveform which gives an estimated 4.53-A. In this same linear region, the voltage across the sense resistor is measured in Figure 4 and Ohm's law is used to determine peak $I_{OH}$ at 4.29-A.

To reiterate, $I_{OH}$ and $I_{OL}$ are not continuous DC values. The peak current charges or discharges $C_{ISS}$ in an instant and then reduces in value as the switch begins to turn on.

**Table 1. Measurement Comparison**

<table>
<thead>
<tr>
<th>Method</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical</td>
<td>$I_{OH} = \text{min}[4.30A, 4.44A]$</td>
</tr>
<tr>
<td>Calculated from Measurement</td>
<td>Equation 3: $I_C = 102nF(44.4MV/s)$</td>
</tr>
<tr>
<td>Calculated from Measurement</td>
<td>Ohm's Law: $I_{OH} \approx 438mV/102m\Omega$</td>
</tr>
</tbody>
</table>
### Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<table>
<thead>
<tr>
<th>Changes from Original (June 2018) to A Revision</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Added additional Gate Driver detail.</td>
<td>1</td>
</tr>
</tbody>
</table>

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