Introduction – What is an isolated gate driver?
TIPL 501
TI Precision Labs – Isolated Gate Drivers

Presented and Prepared by Derek Payne
WHAT IS A GATE DRIVER?
Gate drivers and switching power supplies

- 12x Transistor with:
  - > 5 V threshold voltage
  - > 10 nF capacitive load
  - > 40 kHz switching
  - Not all ground referenced
**Gate drivers and power transistors**

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### Table 1: Key Performance Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_DS @ T_{j,max}</td>
<td>700</td>
<td>V</td>
</tr>
<tr>
<td>R_DS(on),max</td>
<td>45</td>
<td>mΩ</td>
</tr>
<tr>
<td>Q_g.typ</td>
<td>93</td>
<td>nC</td>
</tr>
<tr>
<td>I_D,pulse</td>
<td>212</td>
<td>A</td>
</tr>
</tbody>
</table>

*Note: (9.3nF @ 10V)*

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**Power MOSFET**

**Small Signal MOSFET**

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- \( E_C = \frac{1}{2} \times C \times V^2 \)
- \( P_{SW} = C_G \times V_{DD}^2 \times F_{SW} \)

**Example:**
- \( C_G = 15\text{nF} \)
- \( F_{SW} = 200\text{kHz} \)
- \( V_{DD} = 12\text{V} \)

- \( P_{SW} = 15 \times 10^{-9} \text{ F} \times (12 \text{ V})^2 \times 2 \times 10^5 \text{ Hz} \)

- \( P_{SW} = 0.48\text{W} \)
Switching losses
What is a gate driver?

- **w/ weak Driver**
  - $V_{GS}$
  - $V_{DS}$
  - $I_D$
  - $t_0$, $t_1$, $t_2$, $t_3$, $t_4$

- **w/ Strong Driver**
  - $V_{GS}$
  - $V_{DS}$
  - $I_D$
  - $t_0$, $t_1$, $t_2$, $t_3$
NON-ISOLATED AND ISOLATED GATE DRIVERS
Non-isolated gate drivers

Bootstrap Supply

Half-Bridge

I_Q < 10 µA
Non-isolated gate drivers – Limitations

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted), all voltages are with respect to COM (unless otherwise noted), currents are positive into and negative out of the specified terminal.\(^{(1)(2)}\)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HI, LI(^{(3)})</td>
<td>-5</td>
<td>22</td>
<td>V</td>
</tr>
<tr>
<td>VDD supply voltage</td>
<td>-0.3</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>HB</td>
<td>-0.3</td>
<td>700</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DYNAMIC CHARACTERISTICS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_{PD_{LH}} )</td>
<td>Turn-on propagation delay (without deadtime)</td>
</tr>
<tr>
<td>Li to LO, HI to HO, HS = COM = 0 V</td>
<td>100</td>
</tr>
<tr>
<td>( t_{PD_{HL}} )</td>
<td>Turn-off propagation delay</td>
</tr>
<tr>
<td>Li to LO, HI to HO, HS = COM = 0 V</td>
<td>100</td>
</tr>
</tbody>
</table>
Isolated gate drivers

\[ \text{\( I_Q = 0 \, \text{A} \)} \]

\[ \pm 1.5\text{kV} \]

\[ \pm 5\text{kV} \]
Why use isolation in gate drivers?
Example Topologies

Traction Inverter

Solar String Inverter

Motor Drive

3ϕ PFC
Thanks for your time!
Please try the quiz.