IGBT losses in hard switching

Energy Saving Products BU
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The IGBT Selector calculates the losses

IGBTs are ranked by junction temperature

Switching and conduction losses

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>IRGB4056DPBF</td>
<td>105.6</td>
<td>13.41</td>
<td>4.76</td>
<td>8.65</td>
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<tr>
<td>IRGB4064DPbF</td>
<td>111.6</td>
<td>13.51</td>
<td>3.83</td>
<td>9.68</td>
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<td>IRGB4060DPbF</td>
<td>116.8</td>
<td>14.69</td>
<td>4.17</td>
<td>10.52</td>
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<tr>
<td>IRGB10B60KDPBF</td>
<td>116.2</td>
<td>17.48</td>
<td>7.12</td>
<td>10.36</td>
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<tr>
<td>IRGB4045DPbF</td>
<td>142.4</td>
<td>18.84</td>
<td>5.06</td>
<td>13.78</td>
</tr>
</tbody>
</table>

For detailed conditions, see next page
1. Buck (or Boost) converter operating at 50% duty cycle, single switch
2. Losses are calculated for the operating temperature indicated in the results
3. Hard switching. IGBT turn-on losses due to diode reverse recovery are included in the switching losses.

Diode losses are not calculated
Conduction losses scale with duty cycle, switching losses do not change.
Switching losses are calculated at:
- this voltage
- this current
- this frequency

Conduction losses are calculated at this current

Ambient temperature

Thermal resistances
All losses are calculated at the temperature indicated in the results.

What if you don’t know the thermal resistance of the sink? (see later)
Topologies with variable current and duty cycle

**PFC, continuous current**

Enter boost voltage

Use the rms value of the line current

PFCs operate at a duty cycle that is less than 50%. Scale the conduction losses from 50% to the average duty cycle.

Some PFCs operate in discontinuous mode with triangular waveforms. Losses cannot be calculated with this tool.
Motor drives

Use the rms value of the motor current

“per IGBT”: heatsink for 6 IGBTs would be 1.3

Results are not accurate because diode losses are not included. They provide a good indication of what they are likely to be and they are very useful to compare alternative IGBTs. Tools dedicated to motor drives are available. Some are already on the web (follow link below).

What if you don’t know the heatsink size?

Select “Fixed case temperature”

Enter a reasonable operating temperature for the stated conditions. A lower temperature requires a bigger heatsink. For SM applications remember that FR4 is limited to 110-125°C.

The losses in the table can be used to calculate a first approximation for the heatsink thermal resistance:

\[ R_{th} = \frac{(T_{jmax} - \text{Derating from } T_{jmax}) - \text{Tambient}}{\text{Total } Pd} \]

Now you can enter the thermal resistance of the heatsink and do a finer selection with a second (and third) iteration.