General Description

- Latest AlphaIGBT (αIGBT) technology
- 650V breakdown voltage
- Very fast and soft recovery freewheeling diode
- High efficient turn-on di/dt controllability
- Low $V_{CE(sat)}$ enables high efficiencies
- Low turn-off switching loss and softness
- Very good EMI behavior
- High short-circuit ruggedness

Applications

- Motor drives
- Sewing machines
- Home appliances
- Fan, pump, vacuum cleaner
- Other hard switching applications

Product Summary

- $V_{CE}$: 650V
- $I_C$ ($T_C=100\degree C$): 10A
- $V_{CE(sat)}$ ($T_J=25\degree C$): 1.6V

Orderable Part Number | Package Type | Form | Minimum Order Quantity |
------------------------|--------------|------|------------------------|
AOT10B65MQ2            | TO220        | Tube | 1000                   |

Absolute Maximum Ratings $T_A=25\degree C$ unless otherwise noted

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>AOT10B65MQ2</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector-Emitter Voltage</td>
<td>$V_{CE}$</td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>Gate-Emitter Voltage</td>
<td>$V_{GE}$</td>
<td>±30</td>
<td>V</td>
</tr>
<tr>
<td>Continuous Collector Current</td>
<td>$I_{C}$</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>$T_C=25\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_C=100\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulsed Collector Current, Limited by $T_{J(max)}$</td>
<td>$I_{CM}$</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>$T_C=25\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_C=100\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-Off SOA, $V_{CE}\leq 650V$, Limited by $T_{J(max)}$</td>
<td>$I_{LM}$</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>$T_C=25\degree C$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$T_C=100\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Diode Forward Current</td>
<td>$I_{F}$</td>
<td>20</td>
<td>A</td>
</tr>
<tr>
<td>$T_C=25\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_C=100\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode Pulsed Current, Limited by $T_{J(max)}$</td>
<td>$I_{FM}$</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>$T_C=25\degree C$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$T_C=100\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Circuit Withstanding Time</td>
<td>$t_{SC}$</td>
<td>5</td>
<td>$\mu S$</td>
</tr>
<tr>
<td>$V_{GE}=15V$, $V_{CC}\leq 400V$, $T_J\leq 175\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>$P_D$</td>
<td>150</td>
<td>W</td>
</tr>
<tr>
<td>$T_C=25\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_C=100\degree C$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction and Storage Temperature Range</td>
<td>$T_J$, $T_{STG}$</td>
<td>-55 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Lead Temperature for Soldering Purpose, 1/8” from case for 5 seconds</td>
<td>$T_L$</td>
<td>300</td>
<td>°C</td>
</tr>
</tbody>
</table>

Thermal Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>AOT10B65MQ2</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Junction-to-Ambient</td>
<td>$R_{JA}$</td>
<td>65</td>
<td>°C/W</td>
</tr>
<tr>
<td>Maximum IGBT Junction-to-Case</td>
<td>$R_{JC}$</td>
<td>1</td>
<td>°C/W</td>
</tr>
<tr>
<td>Maximum Diode Junction-to-Case</td>
<td>$R_{JUC}$</td>
<td>3.5</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

(1) Allowed number of short circuits: <1000; time between short circuits: >1s.
**Symbol** | **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Units**
---|---|---|---|---|---|
\(BV_{GES}\) | Collector-Emitter Breakdown Voltage | \(I_c=1\text{mA}, V_{GE}=0\text{V}, T_J=25\text{°C}\) | 650 | - | - | V
\(V_{CE(sat)}\) | Collector-Emitter Saturation Voltage | \(V_{GE}=15\text{V}, I_C=10\text{A}\) | | 1.6 | 2 | V
\(V_F\) | Diode Forward Voltage | \(V_{GE}=0\text{V}, I_F=10\text{A}\) | | 1.65 | 2.1 | V
\(V_{GE(th)}\) | Gate-Emitter Threshold Voltage | \(V_{CE}=5\text{V}, I_c=1\text{mA}\) | | 5.1 | - | V
\(I_{CES}\) | Zero Gate Voltage Collector Current | \(V_{CE}=650\text{V}, V_{GE}=0\text{V}\) | | - | 10 | \(\mu\text{A}\)
\(I_{GES}\) | Gate-Emitter Leakage Current | \(V_{CE}=0\text{V}, V_{GE}=\pm3\text{0V}\) | | - | ±100 | nA
\(g_{FS}\) | Forward Transconductance | \(V_{CE}=20\text{V}, I_c=10\text{A}\) | | 9 | - | S

**DYNAMIC PARAMETERS**

\(C_{iss}\) | Input Capacitance | \(V_{GE}=0\text{V}, V_{CC}=25\text{V}, f=1\text{MHz}\) | - | 655 | - | pF
\(C_{oss}\) | Output Capacitance | \(V_{GE}=0\text{V}, V_{CC}=25\text{V}, f=1\text{MHz}\) | - | 55 | - | pF
\(C_{rss}\) | Reverse Transfer Capacitance | | - | 25 | - | pF
\(Q_g\) | Total Gate Charge | \(V_{GE}=15\text{V}, V_{CC}=520\text{V}, I_c=10\text{A}\) | - | 24 | - | nC
\(Q_{ge}\) | Gate to Emitter Charge | \(V_{GE}=15\text{V}, V_{CC}=520\text{V}, I_c=10\text{A}\) | - | 5.5 | - | nC
\(Q_{gc}\) | Gate to Collector Charge | | - | 12 | - | nC
\(I_{(SCC)}\) | Short Circuit Collector Current | \(V_{GE}=15\text{V}, V_{CC}=400\text{V}, I_{SC}=5\text{sA}, T_J\leq175\text{°C}\) | - | 70 | - | A
\(R_g\) | Gate Resistance | \(V_{GE}=0\text{V}, V_{CC}=0\text{V}, f=1\text{MHz}\) | - | 5.8 | - | \(\Omega\)

**SWITCHING PARAMETERS, (Load Inductive, \(T_J=25\text{°C}\))**

\(t_{(on)}\) | Turn-On Delay Time | | - | 12 | - | ns
\(t_{r}\) | Turn-On Rise Time | \(T_J=25\text{°C}\) | - | 16 | - | ns
\(t_{(off)}\) | Turn-Off Delay Time | \(T_J=25\text{°C}\) | - | 91 | - | ns
\(t_{f}\) | Turn-Off Fall Time | \(V_{GE}=15\text{V}, V_{CC}=400\text{V}, I_c=10\text{A}, R_{Q}=30\Omega\) | - | 14 | - | ns
\(E_{on}\) | Turn-On Energy | \(R_{Q}=30\Omega\) | - | 0.18 | - | mJ
\(E_{off}\) | Turn-Off Energy | - | 0.13 | - | mJ
\(E_{total}\) | Total Switching Energy | - | 0.31 | - | mJ
\(I_{DR}\) | Diode Reverse Recovery Time | \(T_J=25\text{°C}\) | - | 106 | - | ns
\(Q_{DR}\) | Diode Reverse Recovery Charge | \(I_f=10\text{A}, di/dt=200\text{A}/\mu\text{s}, V_{CC}=400\text{V}\) | - | 0.24 | - | \(\mu\text{C}\)
\(I_{ms}\) | Diode Peak Reverse Recovery Current | - | 3.7 | - | A

**SWITCHING PARAMETERS, (Load Inductive, \(T_J=175\text{°C}\))**

\(t_{(on)}\) | Turn-On Delay Time | | - | 10 | - | ns
\(t_{r}\) | Turn-On Rise Time | \(T_J=175\text{°C}\) | - | 17 | - | ns
\(t_{(off)}\) | Turn-Off Delay Time | \(T_J=175\text{°C}\) | - | 111 | - | ns
\(t_{f}\) | Turn-Off Fall Time | \(V_{GE}=15\text{V}, V_{CC}=400\text{V}, I_c=10\text{A}, R_{Q}=30\Omega\) | - | 26 | - | ns
\(E_{on}\) | Turn-On Energy | \(R_{Q}=30\Omega\) | - | 0.2 | - | mJ
\(E_{off}\) | Turn-Off Energy | - | 0.23 | - | mJ
\(E_{total}\) | Total Switching Energy | - | 0.43 | - | mJ
\(I_{DR}\) | Diode Reverse Recovery Time | \(T_J=175\text{°C}\) | - | 168 | - | ns
\(Q_{DR}\) | Diode Reverse Recovery Charge | \(I_f=10\text{A}, di/dt=200\text{A}/\mu\text{s}, V_{CC}=400\text{V}\) | - | 0.51 | - | \(\mu\text{C}\)
\(I_{ms}\) | Diode Peak Reverse Recovery Current | - | 5 | - | A

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TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

Figure 1: Output Characteristic
(Tj=25°C)

Figure 2: Output Characteristic
(Tj=175°C)

Figure 3: Transfer Characteristic

Figure 4: Diode Characteristic

Figure 5: Collector-Emitter Saturation Voltage vs. Junction Temperature

Figure 6: Diode Forward voltage vs. Junction Temperature
TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

Figure 7: Gate-Charge Characteristics

Figure 8: Capacitance Characteristic

Figure 9: Forward Bias Safe Operating Area

Figure 10: Power Dissipation as a Function of Case

Figure 11: Current De-rating

Figure 12: Diode Reverse Leakage Current vs. Junction Temperature
TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

- Figure 13: Switching Time vs. I_C
  \( (T_j=175^\circ C, \ V_{GE}=15V, \ V_{CE}=400V, \ R_g=30\Omega) \)

- Figure 14: Switching Time vs. R_g
  \( (T_j=175^\circ C, \ V_{GE}=15V, \ V_{CE}=400V, \ I_C=10A) \)

- Figure 15: Switching Time vs. T_j
  \( (V_{GE}=15V, \ V_{CE}=400V, \ I_C=10A, \ R_g=30\Omega) \)

- Figure 16: V_{GE(th)} vs. T_j

- Figure 17: Switching Loss vs. I_C
  \( (T_j=175^\circ C, \ V_{GE}=15V, \ V_{CE}=400V, \ R_g=30\Omega) \)

- Figure 18: Switching Loss vs. R_g
  \( (T_j=175^\circ C, \ V_{GE}=15V, \ V_{CE}=400V, \ I_C=10A) \)
TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS

Figure 19: Switching Loss vs. $T_J$ ($V_{GE}=15V, V_{CE}=400V, I_F=10A, R_g=30\Omega$)

Figure 20: Switching Loss vs. $V_{CE}$ ($T_J=175^\circ C, V_{GE}=15V, I_F=10A, R_g=30\Omega$)

Figure 21: Diode Reverse Recovery Charge and Peak Current vs. Conduction Current ($V_{GE}=15V, V_{CE}=400V, \text{di/dt}=200A/\mu s$)

Figure 22: Diode Reverse Recovery Time and Softness Factor vs. Conduction Current ($V_{GE}=15V, V_{CE}=400V, \text{di/dt}=200A/\mu s$)

Figure 23: Diode Reverse Recovery Charge and Peak Current vs. di/dt ($V_{GE}=15V, V_{CE}=400V, I_F=10A$)

Figure 24: Diode Reverse Recovery Time and Softness Factor vs. di/dt ($V_{GE}=15V, V_{CE}=400V, I_F=10A$)
**TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS**

![Graph](image)

**Figure 25:** Normalized Maximum Transient Thermal Impedance for IGBT

![Graph](image)

**Figure 26:** Normalized Maximum Transient Thermal Impedance for Diode

\[ D = T_{on}/T \]

\[ T_{J,PK} = T_{C} + P_{DM} \cdot Z_{JC} \cdot R_{JC} \]

\[ R_{JC} = 1 ^\circ C/W \]

In descending order:

- \( D = 0.5, 0.3, 0.1, 0.05, 0.02, 0.01 \), single pulse

**Normalized Transient Thermal Resistance**

Pulse Width (s)
Figure A: Gate Charge Test Circuit & Waveforms

Figure B: Inductive Switching Test Circuit & Waveforms

Figure C: Diode Recovery Test Circuit & Waveforms