INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features
- Low V_{CE\,(ON)} Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5 μs short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current (I_{LM})
- Positive V_{CE\,(ON)} Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package

Benefits
- High Efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to Low V_{CE\,(ON)} and Low Switching losses
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{CES} Collector-to-Emitter Voltage</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>I_{C} @ T_{C} = 25°C Continuous Collector Current</td>
<td>96</td>
<td>A</td>
</tr>
<tr>
<td>I_{C} @ T_{C} = 100°C Continuous Collector Current</td>
<td>48</td>
<td>A</td>
</tr>
<tr>
<td>I_{CM} Pulse Collector Current</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td>I_{LM} Clamped Inductive Load Current (^{(1)})</td>
<td>192</td>
<td>A</td>
</tr>
<tr>
<td>I_{F} @ T_{C} = 25°C Diode Continuous Forward Current</td>
<td>96</td>
<td>A</td>
</tr>
<tr>
<td>I_{FM} Diode Maximum Forward Current (^{(1)})</td>
<td>192</td>
<td>A</td>
</tr>
<tr>
<td>V_{GE} Continuous Gate-to-Emitter Voltage</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>T_{J} Operating Junction and Storage Temperature Range</td>
<td>-55 to +175</td>
<td>°C</td>
</tr>
<tr>
<td>P_{D} @ T_{C} = 25°C Maximum Power Dissipation</td>
<td>330</td>
<td>W</td>
</tr>
<tr>
<td>P_{D} @ T_{C} = 100°C Maximum Power Dissipation</td>
<td>170</td>
<td>W</td>
</tr>
</tbody>
</table>

Soldering Temperature, for 10 sec. 300 (0.063 in. (1.6mm) from case) 10 lbf-in (1.1 N.m)

Thermal Resistance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{JUC} (IGBT) Thermal Resistance Junction-to-Case-(each IGBT)</td>
<td>——</td>
<td>——</td>
<td>0.45</td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{JUC} (Diode) Thermal Resistance Junction-to-Case-(each Diode)</td>
<td>——</td>
<td>——</td>
<td>0.92</td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{RCS} Thermal Resistance, Case-to-Sink (flat, greased surface)</td>
<td>——</td>
<td>0.24</td>
<td>——</td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{RJA} Thermal Resistance, Junction-to-Ambient (typical socket mount)</td>
<td>——</td>
<td>——</td>
<td>40</td>
<td>°C/W</td>
</tr>
</tbody>
</table>
### Electrical Characteristics @ $T_J = 25^\circ C$ (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{BR(CES)}$  Collector-to-Emitter Breakdown Voltage</td>
<td>600</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>$V_{GE} = 0V, I_C = 150\mu A$</td>
</tr>
<tr>
<td>$\Delta V_{BR(CES)/ATJ}$ Temperature Coeff. of Breakdown Voltage</td>
<td>—</td>
<td>0.30</td>
<td>—</td>
<td>V/°C</td>
<td>$V_{GE} = 0V, I_C = 1mA$ (25°C-175°C)</td>
</tr>
<tr>
<td>$V_{CE(sat)}$  Collector-to-Emitter Saturation Voltage</td>
<td>—</td>
<td>1.65</td>
<td>2.14</td>
<td>V</td>
<td>$I_C = 48A, V_{GE} = 15V, T_J = 25^\circ C$</td>
</tr>
<tr>
<td>$V_{GE(th)}$  Gate Threshold Voltage</td>
<td>4.0</td>
<td>—</td>
<td>6.5</td>
<td>V</td>
<td>$V_{CE} = 0V, I_C = 1.4mA$</td>
</tr>
<tr>
<td>$\Delta V_{GE(th)/ATJ}$ Threshold Voltage temp. coefficient</td>
<td>—</td>
<td>-21</td>
<td>—</td>
<td>mV/°C</td>
<td>$V_{CE} = V_{GE}, I_C = 1.0mA$ (25°C - 175°C)</td>
</tr>
<tr>
<td>$g_{fe}$  Forward Transconductance</td>
<td>—</td>
<td>32</td>
<td>—</td>
<td>S</td>
<td>$V_{GE} = 50V, I_C = 48A, PW = 80\mu s$</td>
</tr>
<tr>
<td>$I_{CES}$  Collector-to-Emitter Leakage Current</td>
<td>—</td>
<td>1.0</td>
<td>150</td>
<td>µA</td>
<td>$V_{GE} = 0V, V_{CE} = 600V$</td>
</tr>
<tr>
<td>$V_{FM}$  Diode Forward Voltage Drop</td>
<td>—</td>
<td>1.85</td>
<td>2.91</td>
<td>V</td>
<td>$I_F = 48A$</td>
</tr>
<tr>
<td>$I_{GES}$  Gate-to-Emitter Leakage Current</td>
<td>—</td>
<td>1.45</td>
<td>—</td>
<td>nA</td>
<td>$I_F = 48A, T_J = 175^\circ C$</td>
</tr>
</tbody>
</table>

### Switching Characteristics @ $T_J = 25^\circ C$ (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_g$  Total Gate Charge (turn-on)</td>
<td>95</td>
<td>140</td>
<td>—</td>
<td>nC</td>
<td>$I_C = 48A$</td>
</tr>
<tr>
<td>$Q_{ge}$  Gate-to-Emitter Charge (turn-on)</td>
<td>28</td>
<td>42</td>
<td>—</td>
<td>nC</td>
<td>$V_{GE} = 15V, V_{CC} = 400V$</td>
</tr>
<tr>
<td>$Q_{gc}$  Gate-to-Collector Charge (turn-on)</td>
<td>35</td>
<td>53</td>
<td>—</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>$E_{on}$  Turn-On Switching Loss</td>
<td>625</td>
<td>1141</td>
<td>—</td>
<td>µJ</td>
<td>$I_C = 48A, V_{CC} = 400V, V_{GE} = 15V$</td>
</tr>
<tr>
<td>$E_{off}$  Turn-Off Switching Loss</td>
<td>1275</td>
<td>1481</td>
<td>—</td>
<td>µJ</td>
<td>$R_{G} = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ C$</td>
</tr>
<tr>
<td>$E_{total}$  Total Switching Loss</td>
<td>1900</td>
<td>2622</td>
<td>—</td>
<td>µJ</td>
<td>Energy losses include tail &amp; diode reverse recovery</td>
</tr>
<tr>
<td>$t_{on}$  Turn-On delay time</td>
<td>60</td>
<td>78</td>
<td>—</td>
<td>ns</td>
<td>$I_C = 48A, V_{CC} = 400V, V_{GE} = 15V$</td>
</tr>
<tr>
<td>$t_r$  Rise time</td>
<td>40</td>
<td>56</td>
<td>—</td>
<td>ns</td>
<td>$R_{G} = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 25^\circ C$</td>
</tr>
<tr>
<td>$t_{off}$  Turn-Off delay time</td>
<td>145</td>
<td>176</td>
<td>—</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_f$  Fall time</td>
<td>35</td>
<td>46</td>
<td>—</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$E_{on}$  Turn-On Switching Loss</td>
<td>1625</td>
<td>—</td>
<td>—</td>
<td>µJ</td>
<td>$I_C = 48A, V_{CC} = 400V, V_{GE} = 15V$</td>
</tr>
<tr>
<td>$E_{off}$  Turn-Off Switching Loss</td>
<td>1585</td>
<td>—</td>
<td>—</td>
<td>µJ</td>
<td>$R_{G} = 10\Omega, L = 200\mu H, L_S = 150nH, T_J = 175^\circ C$</td>
</tr>
<tr>
<td>$E_{total}$  Total Switching Loss</td>
<td>3210</td>
<td>—</td>
<td>—</td>
<td>µJ</td>
<td>Energy losses include tail &amp; diode reverse recovery</td>
</tr>
<tr>
<td>$C_{ies}$  Input Capacitance</td>
<td>3025</td>
<td>—</td>
<td>—</td>
<td>pF</td>
<td>$V_{GE} = 0V$</td>
</tr>
<tr>
<td>$C_{oes}$  Output Capacitance</td>
<td>245</td>
<td>—</td>
<td>—</td>
<td>pF</td>
<td>$V_{CC} = 30V$</td>
</tr>
<tr>
<td>$C_{res}$  Reverse Transfer Capacitance</td>
<td>90</td>
<td>—</td>
<td>—</td>
<td>pF</td>
<td>$f = 1.0\text{MHz}$</td>
</tr>
</tbody>
</table>

### Notes:
1. $V_{CC} = 80\% (V_{CES}), V_{CE} = 20V, L = 200\mu H, R_G = 10\Omega$.
2. This is only applied to TO-247AC package.
3. Pulse width limited by max. junction temperature.
4. Refer to AN-1086 for guidelines for measuring $V_{BR(CES)}$ safely.

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Fig. 1 - Maximum DC Collector Current vs. Case Temperature

Fig. 2 - Power Dissipation vs. Case Temperature

Fig. 3 - Forward SOA
- $T_C = 25°C$, $T_J \leq 175°C$; $V_{GE} = 15V$

Fig. 4 - Reverse Bias SOA
- $T_J = 175°C$; $V_{GE} = 15V$

Fig. 5 - Typ. IGBT Output Characteristics
- $T_J = -40°C$; $tp = 80\mu s$

Fig. 6 - Typ. IGBT Output Characteristics
- $T_J = 25°C$; $tp = 80\mu s$
Fig. 7 - Typ. IGBT Output Characteristics  
$T_J = 175^\circ C$; $t_p = 80\mu s$

Fig. 8 - Typ. Diode Forward Characteristics  
$t_p = 80\mu s$

Fig. 9 - Typical $V_{CE}$ vs. $V_{GE}$  
$T_J = -40^\circ C$

Fig. 10 - Typical $V_{CE}$ vs. $V_{GE}$  
$T_J = 25^\circ C$

Fig. 11 - Typical $V_{CE}$ vs. $V_{GE}$  
$T_J = 175^\circ C$

Fig. 12 - Typ. Transfer Characteristics  
$V_{CE} = 50V$; $t_p = 10\mu s$
Fig. 13 - Typ. Energy Loss vs. $I_C$
$t_{f\text{OFF}}$ vs. $I_C$
$t_{f\text{ON}}$ vs. $I_C$
$E_{OFF}$ vs. $I_C$
$E_{ON}$ vs. $I_C$
$T_J = 175°C; L = 200\mu H; V_{CE} = 400V, R_G = 10\Omega; V_{GE} = 15V$

Fig. 14 - Typ. Switching Time vs. $I_C$
$t_{d\text{OFF}}$ vs. $I_C$
$t_{d\text{ON}}$ vs. $I_C$
$t_{r\text{R}}$ vs. $I_C$
$t_{r\text{F}}$ vs. $I_C$
$T_J = 175°C; L = 200\mu H; V_{CE} = 400V, R_G = 10\Omega; V_{GE} = 15V$

Fig. 15 - Typ. Energy Loss vs. $R_G$
$t_{f\text{OFF}}$ vs. $R_G$
$t_{f\text{ON}}$ vs. $R_G$
$E_{OFF}$ vs. $R_G$
$E_{ON}$ vs. $R_G$
$T_J = 175°C; L = 200\mu H; V_{CE} = 400V, I_{CE} = 48A; V_{GE} = 15V$

Fig. 16 - Typ. Switching Time vs. $R_G$
$t_{d\text{OFF}}$ vs. $R_G$
$t_{d\text{ON}}$ vs. $R_G$
$t_{r\text{R}}$ vs. $R_G$
$t_{r\text{F}}$ vs. $R_G$
$T_J = 175°C; L = 200\mu H; V_{CE} = 400V, I_{CE} = 48A; V_{GE} = 15V$

Fig. 17 - Typ. Diode $I_{RR}$ vs. $I_F$
$T_J = 175°C$

Fig. 18 - Typ. Diode $I_{RR}$ vs. $R_G$
$T_J = 175°C$
Fig. 19 - Typ. Diode $I_{RR}$ vs. $dI_F/dt$
$V_{CC} = 400V; V_{GE} = 15V; I_F = 48A; T_J = 175°C$

Fig. 20 - Typ. Diode $Q_{RR}$ vs. $dI_F/dt$
$V_{CC} = 400V; V_{GE} = 15V; T_J = 175°C$

Fig. 21 - Typ. Diode $E_{RR}$ vs. $I_F$
$T_J = 175°C$

Fig. 22 - $V_{GE}$ vs. Short Circuit Time
$V_{CC} = 400V; T_C = 25°C$

Fig. 23 - Typ. Capacitance vs. $V_{CE}$
$V_{CE} = 0V; f = 1MHz$

Fig. 24 - Typical Gate Charge vs. $V_{GE}$
$V_{GE} = 48A; L = 600μH$
Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)
Fig.C.T.1 - Gate Charge Circuit (turn-off)

Fig.C.T.2 - RBSOA Circuit

Fig.C.T.3 - S.C. SOA Circuit

Fig.C.T.4 - Switching Loss Circuit

Fig.C.T.5 - Resistive Load Circuit

Fig.C.T.6 - BVCES Filter Circuit
Fig. WF1 - Typ. Turn-off Loss Waveform
@ T<sub>J</sub> = 175°C using Fig. CT.4

Fig. WF2 - Typ. Turn-on Loss Waveform
@ T<sub>J</sub> = 175°C using Fig. CT.4

Fig. WF3 - Typ. Diode Recovery Waveform
@ T<sub>J</sub> = 175°C using Fig. CT.4

Fig. WF4 - Typ. S.C. Waveform
@ T<sub>J</sub> = 25°C using Fig. CT.3
TO-247AC Package Outline
Dimensions are shown in millimeters (inches)

TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30 WITH ASSEMBLY LOT CODE 5657 ASSEMBLED ON WW 35, 2001 IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position indicates "Lead-Free"

TO-247AC package is not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at http://www.irf.com/package/
TO-247AD Package Outline
Dimensions are shown in millimeters (inches)

TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRGP30B120KD-E WITH ASSEMBLY LOT CODE 5657 ASSEMBLED ON WW 35, 2000 IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position indicates "Lead-Free"

TO-247AD package is not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

Data and specifications subject to change without notice.
This product has been designed and qualified for Industrial market.
Qualification Standards can be found on IR's Web site.