Utilizing the latest Field Stop and Trench Gate technologies, these IGBT's have ultra low \( V_{CE(on)} \) and are ideal for low frequency applications that require absolute minimum conduction loss. Easy paralleling is a result of very tight parameter distribution and a slightly positive \( V_{CE(on)} \) temperature coefficient. A built-in gate resistor ensures extremely reliable operation, even in the event of a short circuit fault. Low gate charge simplifies gate drive design and minimizes losses.

- 600V Field Stop
- Trench Gate: Low \( V_{CE(on)} \)
- Easy Paralleling
- 6\( \mu \)s Short Circuit Capability
- Integrated Gate Resistor: Low EMI, High Reliability

Applications: Welding, Inductive Heating, Solar Inverters, SMPS, Motor drives, UPS

### MAXIMUM RATINGS

All Ratings: \( T_C = 25^\circ C \) unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>APT75GN60LDQ3(G)</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CES} )</td>
<td>Collector-Emitter Voltage</td>
<td>600</td>
<td>Volts</td>
</tr>
<tr>
<td>( V_{GE} )</td>
<td>Gate-Emitter Voltage</td>
<td>±30</td>
<td></td>
</tr>
<tr>
<td>( I_{C1} )</td>
<td>Continuous Collector Current ( @ T_C = 25^\circ C )</td>
<td>155</td>
<td>Amps</td>
</tr>
<tr>
<td>( I_{C2} )</td>
<td>Continuous Collector Current ( @ T_C = 110^\circ C )</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>( I_{CM} )</td>
<td>Pulsed Collector Current ( 1 )</td>
<td>225</td>
<td></td>
</tr>
<tr>
<td>SSOA</td>
<td>Switching Safe Operating Area ( @ T_J = 175^\circ C )</td>
<td>225A @ 600V</td>
<td></td>
</tr>
<tr>
<td>( P_D )</td>
<td>Total Power Dissipation</td>
<td>536</td>
<td>Watts</td>
</tr>
<tr>
<td>( T_J,T_{STG} )</td>
<td>Operating and Storage Junction Temperature Range</td>
<td>-55 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>( T_L )</td>
<td>Max. Lead Temp. for Soldering: 0.063&quot; from Case for 10 Sec.</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

### STATIC ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic / Test Conditions</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{BR(CES)} )</td>
<td>Collector-Emitter Breakdown Voltage ( (V_{GE} = 0V, I_C = 4mA) )</td>
<td>600</td>
<td></td>
<td></td>
<td>Volts</td>
</tr>
<tr>
<td>( V_{GE(TH)} )</td>
<td>Gate Threshold Voltage ( (V_{CE} = V_{GE}, I_C = 1mA, T_J = 25^\circ C) )</td>
<td>5.0</td>
<td>5.8</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>( V_{CE(ON)} )</td>
<td>Collector-Emitter On Voltage ( (V_{GE} = 15V, I_C = 75A, T_J = 25^\circ C) )</td>
<td>1.05</td>
<td>1.45</td>
<td>1.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collector-Emitter On Voltage ( (V_{GE} = 15V, I_C = 75A, T_J = 125^\circ C) )</td>
<td>1.87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{CES} )</td>
<td>Collector Cut-off Current ( (V_{CE} = 600V, V_{GE} = 0V, T_J = 25^\circ C) ) ( 2 )</td>
<td>50</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>Collector Cut-off Current ( (V_{CE} = 600V, V_{GE} = 0V, T_J = 125^\circ C) ) ( 2 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{GES} )</td>
<td>Gate-Emitter Leakage Current ( (V_{GE} = \pm 20V) )</td>
<td>600</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>( R_{G(int)} )</td>
<td>Integrated Gate Resistor</td>
<td>4</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
</tbody>
</table>

\( \text{CAUTION: These Devices are Sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.} \)
### THERMAL AND MECHANICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_{juc}</td>
<td>Junction to Case (IGBT)</td>
<td>.28</td>
<td></td>
<td></td>
<td>°C/W</td>
</tr>
<tr>
<td>R_{juc}</td>
<td>Junction to Case (DIODE)</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W_T</td>
<td>Package Weight</td>
<td>5.9</td>
<td></td>
<td></td>
<td>gm</td>
</tr>
</tbody>
</table>

1. Repetitive Rating: Pulse width limited by maximum junction temperature.
2. For Combi devices, I_{ces} includes both IGBT and FRED leakages.
4. E_{on1} is the clamped inductive turn-on energy of the IGBT only, without the effect of a commutating diode reverse recovery current adding to the IGBT turn-on loss. Tested in inductive switching test circuit shown in figure 21, but with a Silicon Carbide diode.
5. E_{on2} is the clamped inductive turn-on energy that includes a commutating diode reverse recovery current in the IGBT turn-on switching loss. (See Figures 21, 22.)
6. E_{off} is the clamped inductive turn-off energy measured in accordance with JEDEC standard JESD24-1. (See Figures 21, 23.)
7. R_g is external gate resistance, not including R_{g(int)} nor gate driver impedance. (MIC4452)
8. Continuous current limited by package lead temperature to 100A.

APT Reserves the right to change, without notice, the specifications and information contained herein.
APT75GN60LDQ3(G) TYPICAL PERFORMANCE CURVES

VGS(TH), THRESHOLD VOLTAGE
VCE, COLLECTOR-TO-EMITTER VOLTAGE (V)
IC, COLLECTOR CURRENT (A)

FIGURE 1, Output Characteristics (TJ = 25°C)

FIGURE 2, Output Characteristics (TJ = 125°C)

FIGURE 3, Transfer Characteristics

FIGURE 4, Gate Charge

FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

FIGURE 6, On State Voltage vs Junction Temperature

FIGURE 7, Threshold Voltage vs. Junction Temperature

FIGURE 8, DC Collector Current vs Case Temperature
FIGURE 9, Turn-On Delay Time vs Collector Current

FIGURE 10, Turn-Off Delay Time vs Collector Current

FIGURE 11, Current Rise Time vs Collector Current

FIGURE 12, Current Fall Time vs Collector Current

FIGURE 13, Turn-On Energy Loss vs Collector Current

FIGURE 14, Turn-Off Energy Loss vs Collector Current

FIGURE 15, Switching Energy Losses vs. Gate Resistance

FIGURE 16, Switching Energy Losses vs Junction Temperature
**APT75GN60LDQ3(G)**

**TYPICAL PERFORMANCE CURVES**

Figure 17, Capacitance vs Collector-To-Emitter Voltage

Figure 18, Minimum Switching Safe Operating Area

Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

Figure 19b, Transient Thermal Impedance Model

Figure 20, Operating Frequency vs Collector Current

Note:

\[
\theta_{JC} = \frac{P_{Diss} - P_{cond}}{E_{on} + E_{off}}
\]

\[
F_{max} = \min \left( f_{max1}, f_{max2} \right)
\]

\[
f_{max1} = \frac{P_{Diss} - P_{cond}}{E_{on} + E_{off}}
\]

\[
f_{max2} = \frac{P_{Diss} - P_{cond}}{E_{on} + E_{off}}
\]

\[
T_{J} = 125°C
\]

\[
I_{D} = 75°C
\]

\[
V_{CE} = 50%
\]

\[
V_{CE} = 400V
\]

\[
I_{D} = 1.00
\]

Power (watts)

Case temperature (°C)

Junction temp. (°C)

RC Model

0.0998

0.00438

0.181

0.153

10 30 50 70 90 110 130

F_{max} (kHz)

I_{C}, COLLECTOR CURRENT (A)

10 20 30 40 50 60 70

100

50

20

10

5

1
Figure 21, Inductive Switching Test Circuit

Figure 22, Turn-on Switching Waveforms and Definitions

Figure 23, Turn-off Switching Waveforms and Definitions
ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic / Test Conditions</th>
<th>APT75GN60LDQ3(G)</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{I}_{\text{F(AV)}}$</td>
<td>Maximum Average Forward Current ($T_C = 108°C$, Duty Cycle = 0.5)</td>
<td>75</td>
<td>Amps</td>
</tr>
<tr>
<td>$\text{I}_{\text{F(RMS)}}$</td>
<td>RMS Forward Current (Square wave, 50% duty)</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>$\text{I}_{\text{FSM}}$</td>
<td>Non-Repetitive Forward Surge Current ($T_J = 45°C$, 8.3ms)</td>
<td>600</td>
<td></td>
</tr>
</tbody>
</table>

STATIC ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic / Test Conditions</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_F$</td>
<td>Forward Voltage</td>
<td></td>
<td></td>
<td></td>
<td>Volts</td>
</tr>
<tr>
<td></td>
<td>$I_F = 75A$</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_F = 150A$</td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_F = 75A, T_J = 125°C$</td>
<td>1.7</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

DYNAMIC CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic</th>
<th>Test Conditions</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{rr}$</td>
<td>Reverse Recovery Time</td>
<td>$I_F = 1A$, $\text{di}_F/\text{dt} = -100A/\mu s$, $V_R = 30V$, $T_J = 25°C$</td>
<td>-</td>
<td>29</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse Recovery Time</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -200A/\mu s$</td>
<td>-</td>
<td>31</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse Recovery Charge</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -200A/\mu s$, $V_R = 400V$, $T_C = 25°C$</td>
<td>-</td>
<td>55</td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$I_{RRM}$</td>
<td>Maximum Reverse Recovery Current</td>
<td>$V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>Amps</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse Recovery Time</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -200A/\mu s$, $V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>140</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse Recovery Charge</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -100A/\mu s$, $V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>650</td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$I_{RRM}$</td>
<td>Maximum Reverse Recovery Current</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -1000A/\mu s$, $V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>9</td>
<td>-</td>
<td>Amps</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse Recovery Time</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -1000A/\mu s$, $V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>90</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse Recovery Charge</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -1000A/\mu s$, $V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>1300</td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>$I_{RRM}$</td>
<td>Maximum Reverse Recovery Current</td>
<td>$I_F = 75A$, $\text{di}_F/\text{dt} = -1000A/\mu s$, $V_R = 400V$, $T_C = 125°C$</td>
<td>-</td>
<td>27</td>
<td></td>
<td>Amps</td>
</tr>
</tbody>
</table>

FIGURE 24a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION

FIGURE 24b. TRANSIENT THERMAL IMPEDANCE MODEL
APT75GN60LDQ3(G)  

Duty cycle = 0.5

TJ  = 175°C

VR = 400V

Figure 25. Forward Current vs. Forward Voltage

Figure 26. Reverse Recovery Time vs. Current Rate of Change

Figure 27. Reverse Recovery Charge vs. Current Rate of Change

Figure 28. Reverse Recovery Current vs. Current Rate of Change

Figure 29. Dynamic Parameters vs. Junction Temperature

Figure 30. Maximum Average Forward Current vs. Case Temperature

Figure 31. Junction Capacitance vs. Reverse Voltage
APT75GN60LDQ3(G)

TYPICAL PERFORMANCE CURVES

Figure 32. Diode Test Circuit

1. $I_F$ - Forward Conduction Current
2. $\frac{di_F}{dt}$ - Rate of Diode Current Change Through Zero Crossing.
3. $I_{RRM}$ - Maximum Reverse Recovery Current.
4. $t_{rr}$ - Reverse Recovery Time, measured from zero crossing where diode current goes from positive to negative, to the point at which the straight line through $I_{RRM}$ and $0.25\cdot I_{RRM}$ passes through zero.
5. $Q_{rr}$ - Area Under the Curve Defined by $I_{RRM}$ and $t_{rr}$.

Figure 33. Diode Reverse Recovery Waveform and Definitions

TO-264(L) Package Outline

SAC: Tin, Silver, Copper

Dimensions in Millimeters and (Inches)