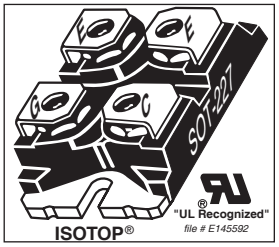
**1200V**

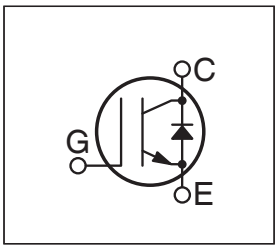
**APT50GT120JRDQ2**

# Thunderbolt IGBT®




The Thunderblot IGBT® is a new generation of high voltage power IGBTs. Using Non- Punch Through Technology, the Thunderblot IGBT® offers superior ruggedness and ultrafast switching speed.

- **Low Forward Voltage Drop**
- **High Freq. Switching to 50KHz**
- **Low Tail Current**
- **Ultra Low Leakage Current**
- **RBSOA and SCSOA Rated**
- **Intergrated Gate Resistor: Low EMI, High Reliability**




## MAXIMUM RATINGS

All Ratings: $T_C$ = 25°C unless otherwise specified.

| Symbol | Parameter | APT50GT120JRDQ2 | UNIT |
|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | 1200 | Volts |
| $V_{GE}$ | Gate-Emitter Voltage | ±30 | |
| $I_{C1}$ | Continuous Collector Current @ $T_C$ = 25°C | 72 | Amps |
| $I_{C2}$ | Continuous Collector Current @ $T_C$ = 110°C | 32 | |
| $I_{CM}$ | Pulsed Collector Current ① | 150 | |
| SSOA | Switching Safe Operating Area @ $T_J$ = 150°C | 150A @ 1200V | |
| $P_D$ | Total Power Dissipation | 379 | Watts |
| $T_J$,$T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to 150 | °C |
| $T_L$ | Max. Lead Temp. for Soldering: 0.063" from Case for 10 Sec. | 300 | |

## STATIC ELECTRICAL CHARACTERISTICS

| Symbol | Characteristic / Test Conditions | MIN | TYP | MAX | Units |
|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-Emitter Breakdown Voltage ($V_{GE}$ = 0V, $I_C$ = 3mA) | 1200 | | | Volts |
| $V_{GE(TH)}$ | Gate Threshold Voltage ($V_{CE}$ = $V_{GE}$, $I_C$ = 2mA, $T_j$ = 25°C) | 4.5 | 5.5 | 6.5 | |
| $V_{CE(ON)}$ | Collector-Emitter On Voltage ($V_{GE}$ = 15V, $I_C$ = 50A, $T_j$ = 25°C) | 2.7 | 3.2 | 3.7 | |
| | Collector-Emitter On Voltage ($V_{GE}$ = 15V, $I_C$ = 50A, $T_j$ = 125°C) | | 4.0 | | |
| $I_{CES}$ | Collector Cut-off Current ($V_{CE}$ = 1200V, $V_{GE}$ = 0V, $T_j$ = 25°C) ② | | | 400 | µA |
| | Collector Cut-off Current ($V_{CE}$ = 1200V, $V_{GE}$ = 0V, $T_j$ = 125°C) ② | | | TBD | |
| $I_{GES}$ | Gate-Emitter Leakage Current ($V_{GE}$ = ±20V) | | | 300 | nA |
| $R_{G(int)}$ | Intergrated Gate Resistor | | 5 | | Ω |

**CAUTION:** These Devices are Sensitive to Electrostatic Discharge. Proper Handling Procedures Should Be Followed.

## DYNAMIC CHARACTERISTICS

**APT50GT120JRDQ2**

| Symbol | Characteristic | Test Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input Capacitance | **Capacitance** | | 2500 | | pF |
| $C_{oes}$ | Output Capacitance | $V_{GE}$ = 0V, $V_{CE}$ = 25V | | 250 | | |
| $C_{res}$ | Reverse Transfer Capacitance | f = 1 MHz | | 155 | | |
| $V_{GEP}$ | Gate-to-Emitter Plateau Voltage | Gate Charge | | 7.5 | | V |
| $Q_g$ | Total Gate Charge ③ | $V_{GE}$ = 15V | | 240 | | nC |
| $Q_{ge}$ | Gate-Emitter Charge | $V_{CE}$ = 600V | | 20 | | |
| $Q_{gc}$ | Gate-Collector ("Miller") Charge | $I_C$ = 50A | | 110 | | |
| SSOA | Switching Safe Operating Area | $T_J$ = 150°C, $R_G$ = 1.0Ω⑦, $V_{GE}$ = 15V, L = 100µH, $V_{CE}$ = 1200V | 150 | | | A |
| $t_{d(on)}$ | Turn-on Delay Time | **Inductive Switching (25°C)** | | 23 | | ns |
| $t_r$ | Current Rise Time | $V_{CC}$ = 800V | | 50 | | |
| $t_{d(off)}$ | Turn-off Delay Time | $V_{GE}$ = 15V | | 215 | | |
| $t_f$ | Current Fall Time | $I_C$ = 50A | | 26 | | |
| $E_{on1}$ | Turn-on Switching Energy ④ | $R_G$ = 1.0Ω⑦ | | 3585 | | µJ |
| $E_{on2}$ | Turn-on Switching Energy (Diode) ⑤ | $T_J$ = +25°C | | 4835 | | |
| $E_{off}$ | Turn-off Switching Energy ⑥ | | | 1910 | | |
| $t_{d(on)}$ | Turn-on Delay Time | **Inductive Switching (125°C)** | | 23 | | ns |
| $t_r$ | Current Rise Time | $V_{CC}$ = 800V | | 50 | | |
| $t_{d(off)}$ | Turn-off Delay Time | $V_{GE}$ = 15V | | 255 | | |
| $t_f$ | Current Fall Time | $I_C$ = 50A | | 50 | | |
| $E_{on1}$ | Turn-on Switching Energy ④ | $R_G$ = 1.0Ω⑦ | | 3580 | | µJ |
| $E_{on2}$ | Turn-on Switching Energy (Diode) ⑤ | $T_J$ = +125°C | | 6970 | | |
| $E_{off}$ | Turn-off Switching Energy ⑥ | | | 2750 | | |

## THERMAL AND MECHANICAL CHARACTERISTICS

| Symbol | Characteristic | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction to Case **(IGBT)** | | | .33 | °C/W |
| $R_{\theta JC}$ | Junction to Case **(DIODE)** | | | 1.1 | |
| $W_T$ | Package Weight | | 29.2 | | gm |
| $V_{Isolation}$ | RMS Voltage (50-60hHz Sinusoidal Wavefomr Ffrom Terminals to Mounting Base for 1 Min.) | 2500 | | | Volts |

① Repetitive Rating: Pulse width limited by maximum junction temperature.

② For Combi devices, $I_{ces}$ includes both IGBT and FRED leakages

③ See MIL-STD-750 Method 3471.

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.

**APT Reserves the right to change, without notice, the specifications and information contained herein.**

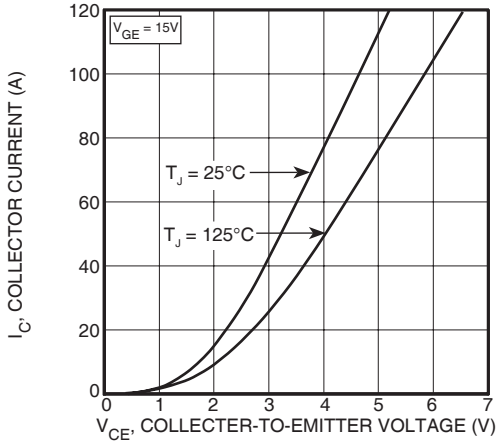



**FIGURE 1, Output Characteristics($T_J$ = 25°C)**

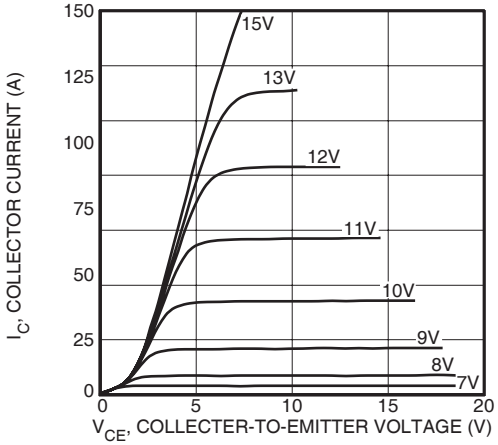



**FIGURE 2, Output Characteristics ($T_J$ = 125°C)**

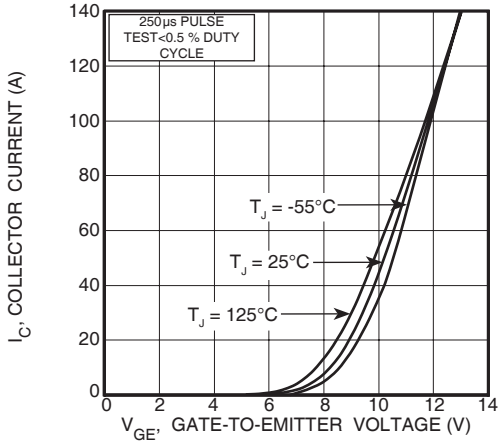



**FIGURE 3, Transfer Characteristics**

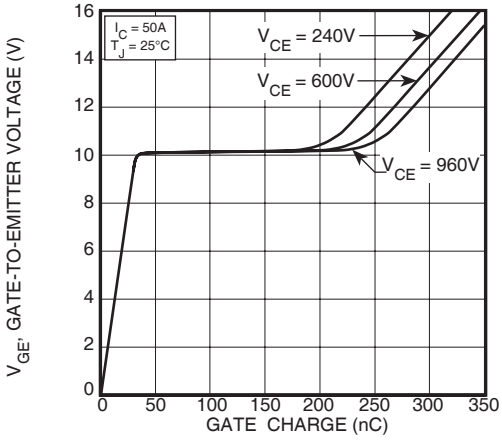



**FIGURE 4, Gate Charge**

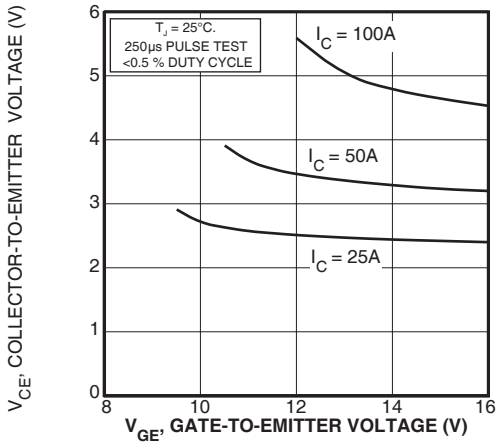



**FIGURE 5, On State Voltage vs Gate-to- Emitter Voltage**

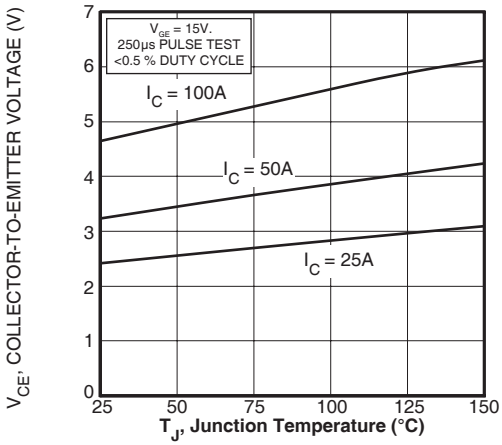



**FIGURE 6, On State Voltage vs Junction Temperature**

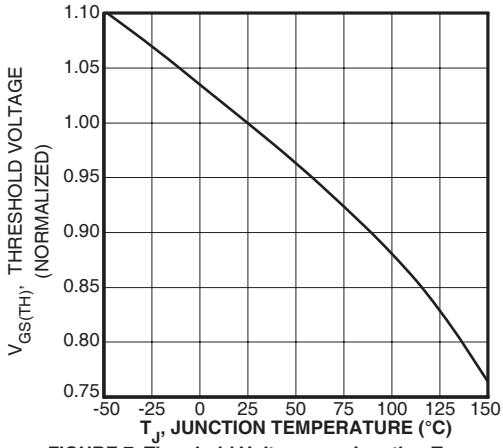



**FIGURE 7, Threshold Voltage vs. Junction Temperature**

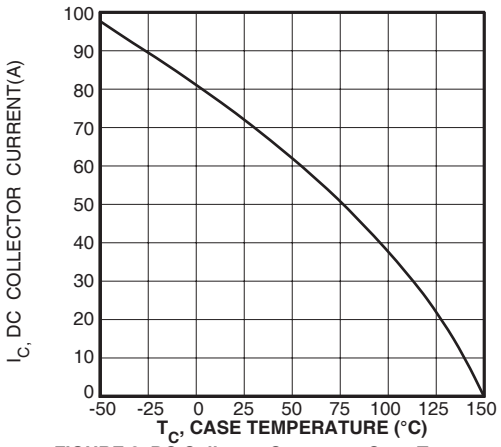



**FIGURE 8, DC Collector Current vs Case Temperature**

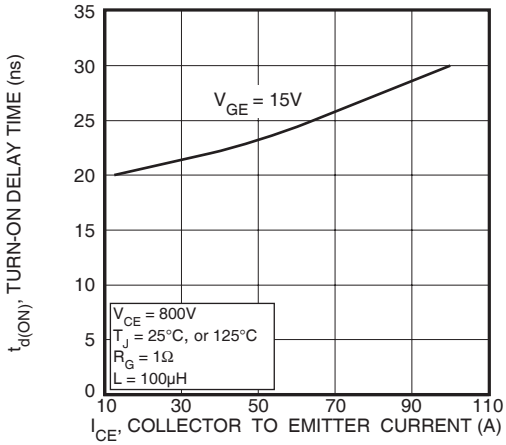



**FIGURE 9, Turn-On Delay Time vs Collector Current**

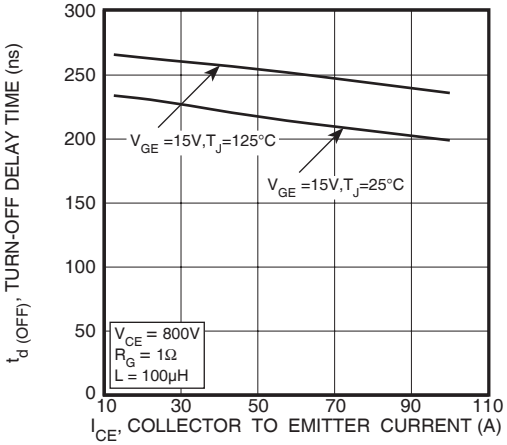



**FIGURE 10, Turn-Off Delay Time vs Collector Current**

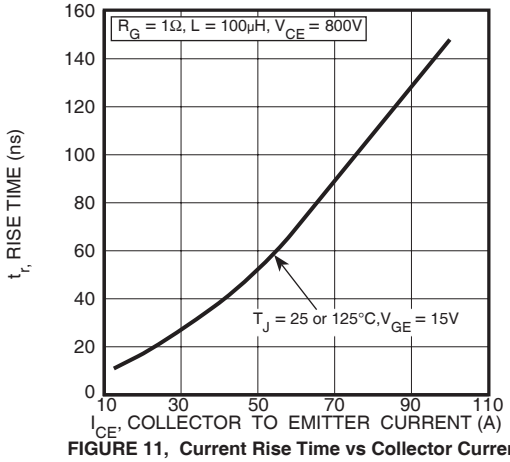



**FIGURE 11, Current Rise Time vs Collector Current**

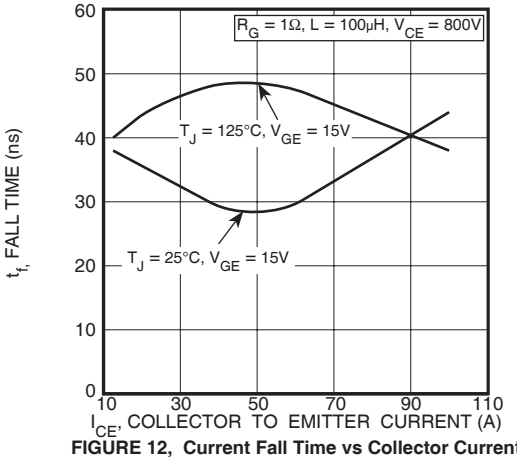



**FIGURE 12, Current Fall Time vs Collector Current**

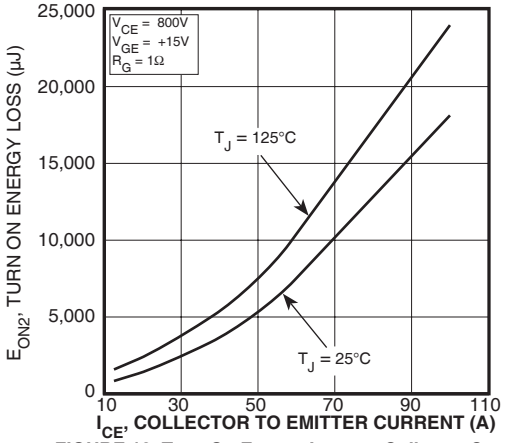



**FIGURE 13, Turn-On Energy Loss vs Collector Current**

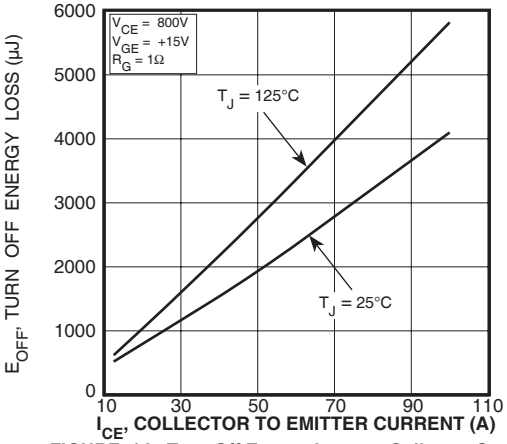



**FIGURE 14, Turn Off Energy Loss vs Collector Current**

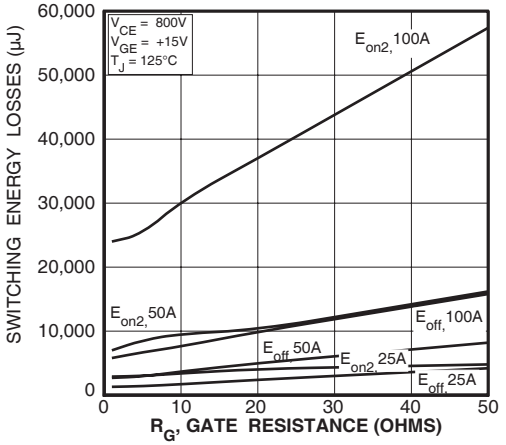



**FIGURE 15, Switching Energy Losses vs. Gate Resistance**

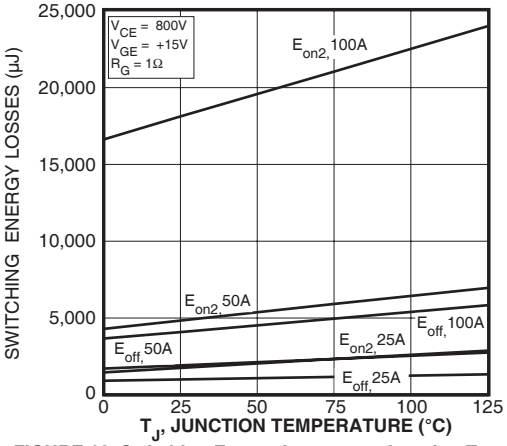



**FIGURE 16, Switching Energy Losses vs Junction Temperature**

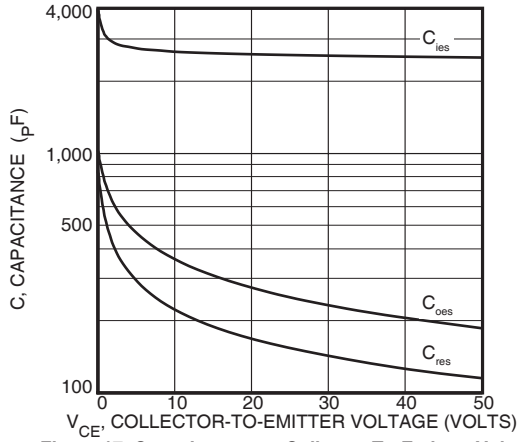



**Figure 17, Capacitance vs Collector-To-Emitter Voltage**

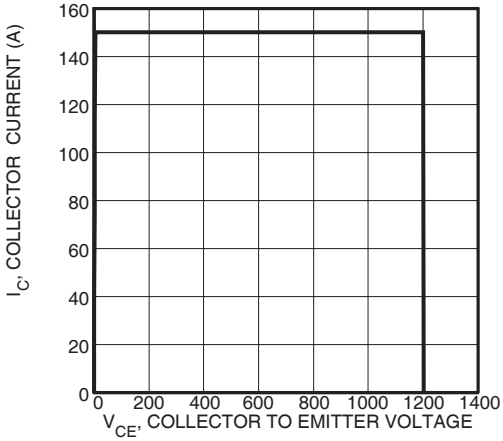



**Figure 18,Minimim Switching Safe Operating Area**

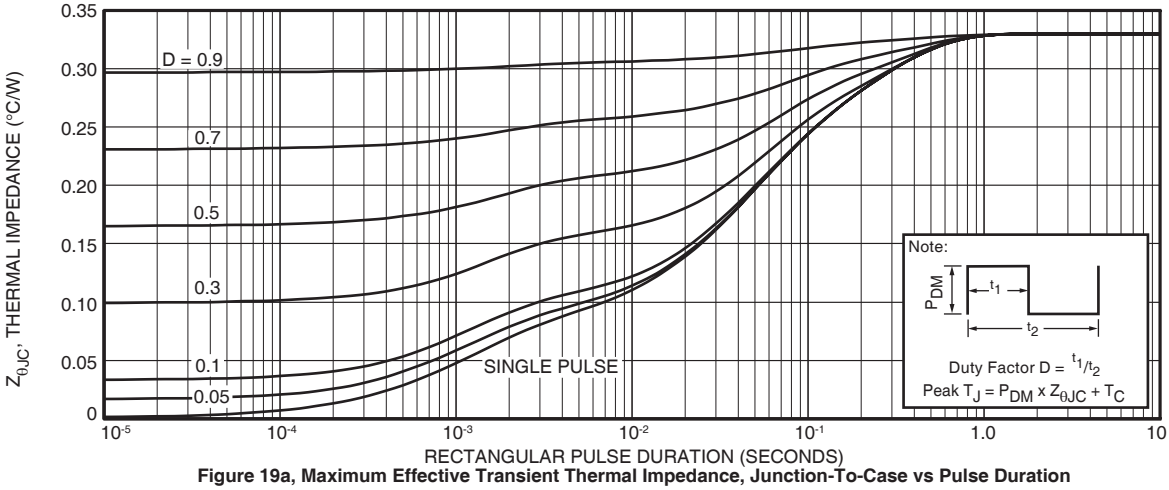



**Figure 19a, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration**

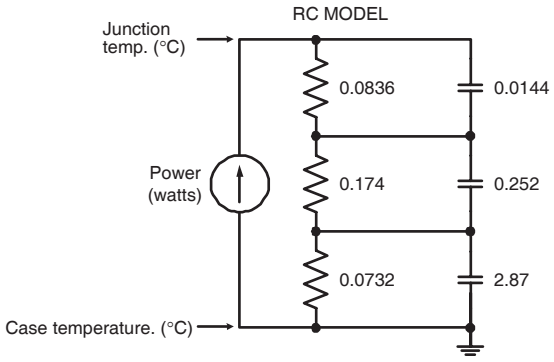



**FIGURE 19b, TRANSIENT THERMAL IMPEDANCE MODEL**

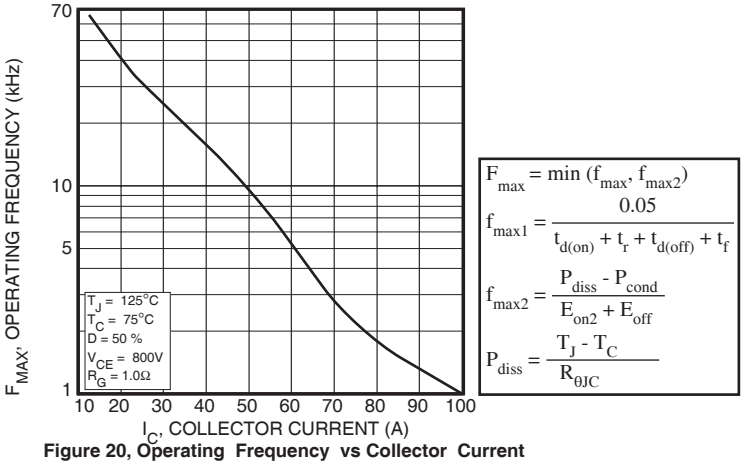



**Figure 20, Operating Frequency vs Collector Current**

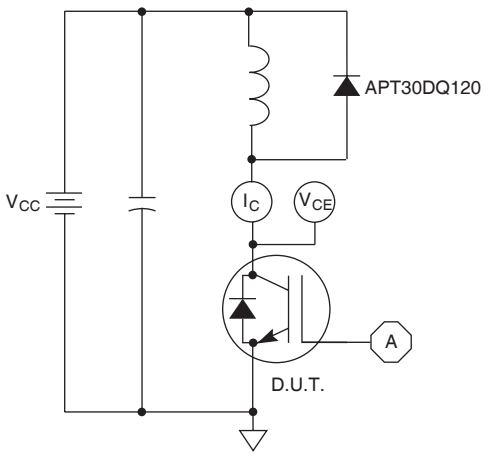



**Figure 21, Inductive Switching Test Circuit**

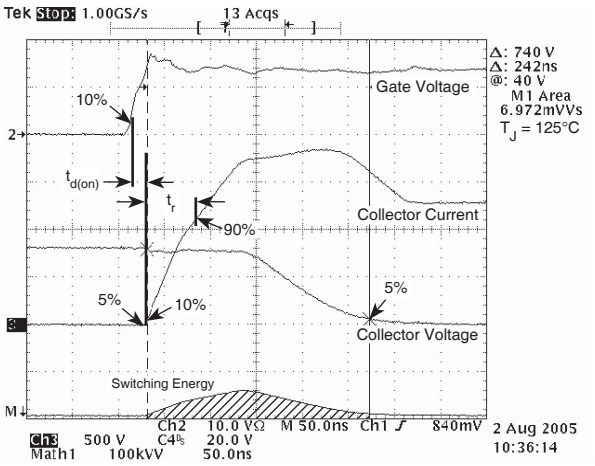



**Figure 22, Turn-on Switching Waveforms and Definitions**

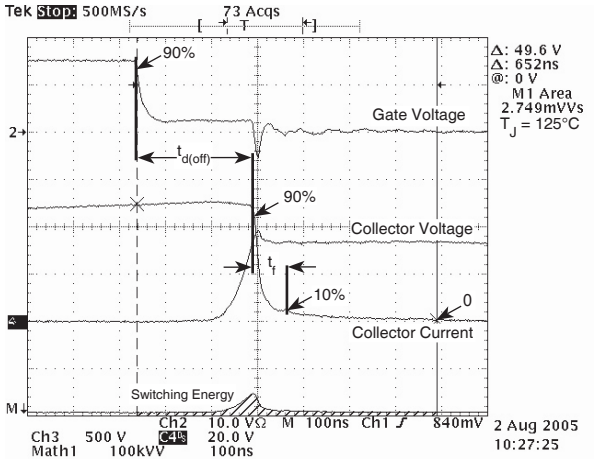



**Figure 23, Turn-off Switching Waveforms and Definitions**

# ULTRAFAST SOFT RECOVERY ANTI-PARALLEL DIODE

## MAXIMUM RATINGS

All Ratings: $T_C$ = 25°C unless otherwise specified.

| Symbol | Characteristic / Test Conditions | APT50GT120JRDQ2 | | | UNIT |
|---|---|---|---|---|---|
| $I_F(AV)$ | Maximum Average Forward Current ($T_C$ = 89°C, Duty Cycle = 0.5) | | 30 | | Amps |
| $I_F(RMS)$ | RMS Forward Current (Square wave, 50% duty) | | 39 | | |
| $I_{FSM}$ | Non-Repetitive Forward Surge Current ($T_J$ = 45°C, 8.3ms) | | 210 | | |

## STATIC ELECTRICAL CHARACTERISTICS

| Symbol | Characteristic / Test Conditions | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_F$ | Forward Voltage | $I_F$ = 50A | | 2.98 | | Volts |
| | | $I_F$ = 100A | | 3.67 | | |
| | | $I_F$ = 50A, $T_J$ = 125°C | | 2.36 | | |

## DYNAMIC CHARACTERISTICS

| Symbol | Characteristic | Test Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{rr}$ | Reverse Recovery Time | $I_F$ = 1A, $di_F/dt$ = -100A/µs, $V_R$ = 30V, $T_J$ = 25°C | - | 25 | | ns |
| $t_{rr}$ | Reverse Recovery Time | $I_F$ = 30A, $di_F/dt$ = -200A/µs, $V_R$ = 800V, $T_C$ = 25°C | - | 300 | | |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 360 | | nC |
| $I_{RRM}$ | Maximum Reverse Recovery Current | | - | 4 | - | Amps |
| $t_{rr}$ | Reverse Recovery Time | $I_F$ = 30A, $di_F/dt$ = -200A/µs, $V_R$ = 800V, $T_C$ = 125°C | - | 380 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 1700 | | nC |
| $I_{RRM}$ | Maximum Reverse Recovery Current | | - | 8 | - | Amps |
| $t_{rr}$ | Reverse Recovery Time | $I_F$ = 30A, $di_F/dt$ = -1000A/µs, $V_R$ = 800V, $T_C$ = 125°C | - | 160 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 2550 | | nC |
| $I_{RRM}$ | Maximum Reverse Recovery Current | | - | 28 | | Amps |

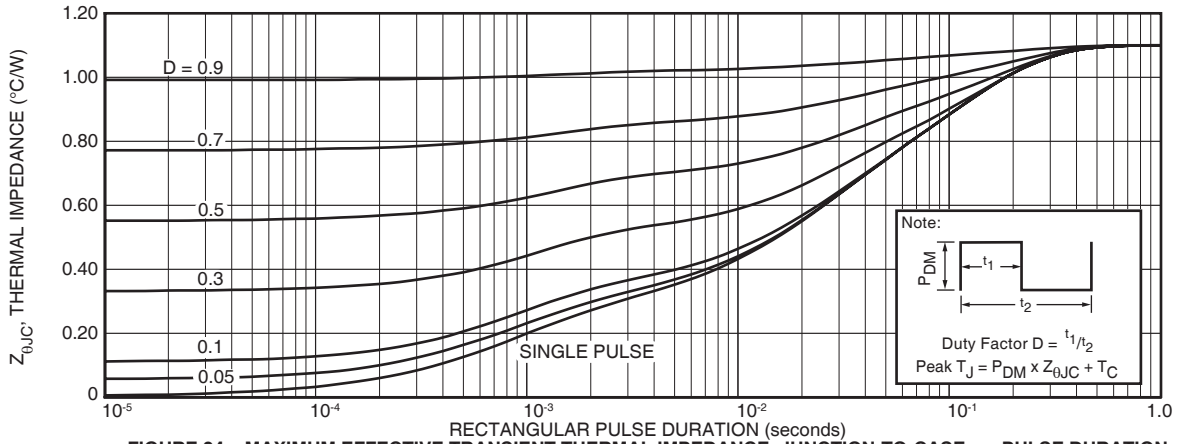



**FIGURE 24a. MAXIMUM EFFECTIVE TRANSIENT THERMAL IMPEDANCE, JUNCTION-TO-CASE vs. PULSE DURATION**

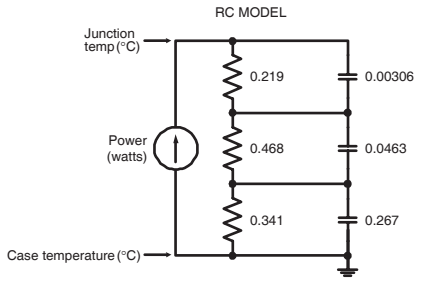



**FIGURE 24b, TRANSIENT THERMAL IMPEDANCE MODEL**

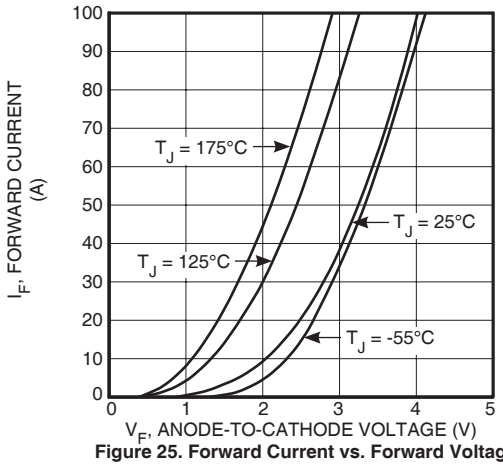



**Figure 25. Forward Current vs. Forward Voltage**

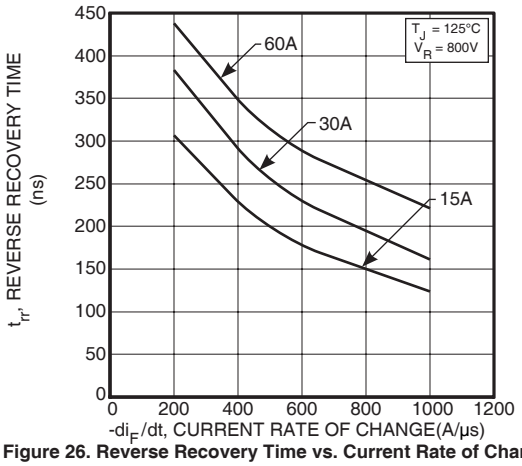



**Figure 26. Reverse Recovery Time vs. Current Rate of Change**

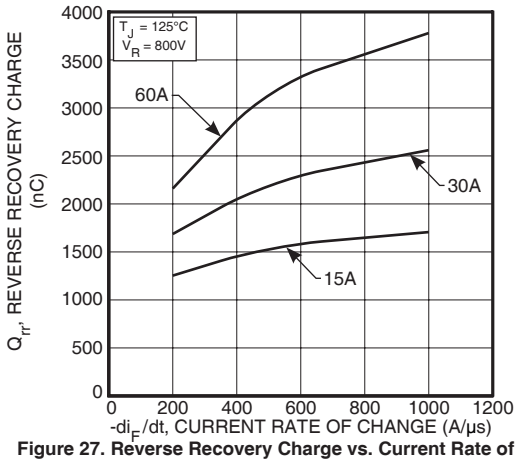



**Figure 27. Reverse Recovery Charge vs. Current Rate of Change**

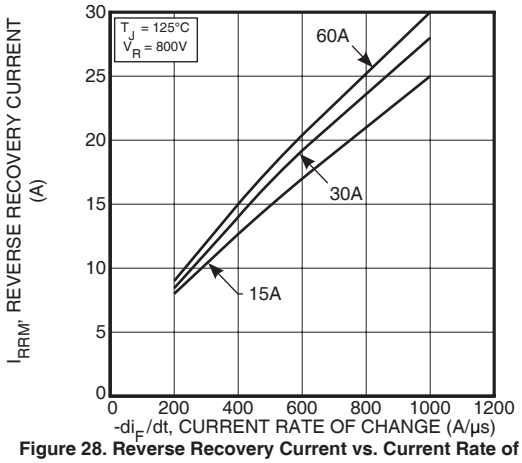



**Figure 28. Reverse Recovery Current vs. Current Rate of Change**

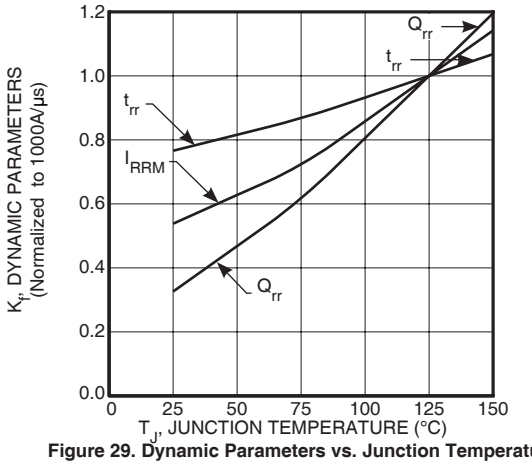



**Figure 29. Dynamic Parameters vs. Junction Temperature**

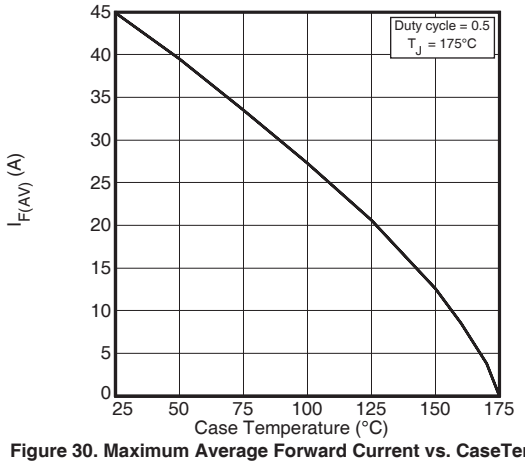



**Figure 30. Maximum Average Forward Current vs. CaseTemperature**

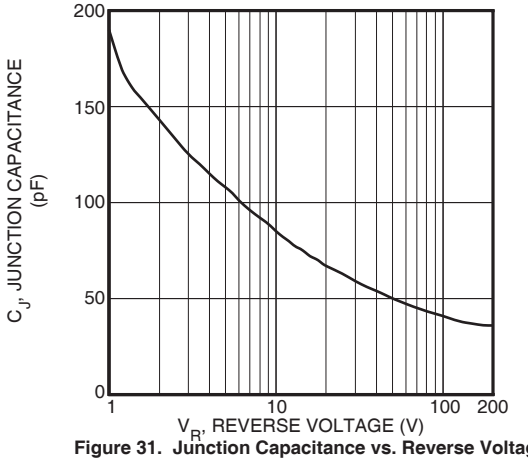



**Figure 31. Junction Capacitance vs. Reverse Voltage**

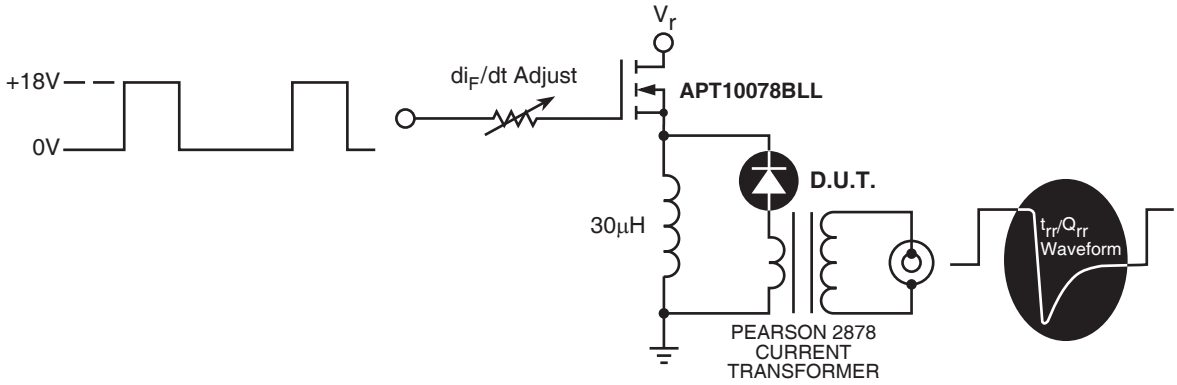
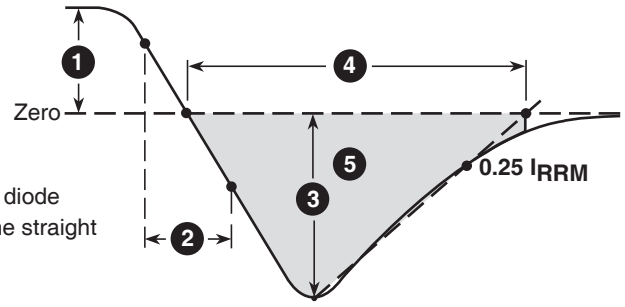


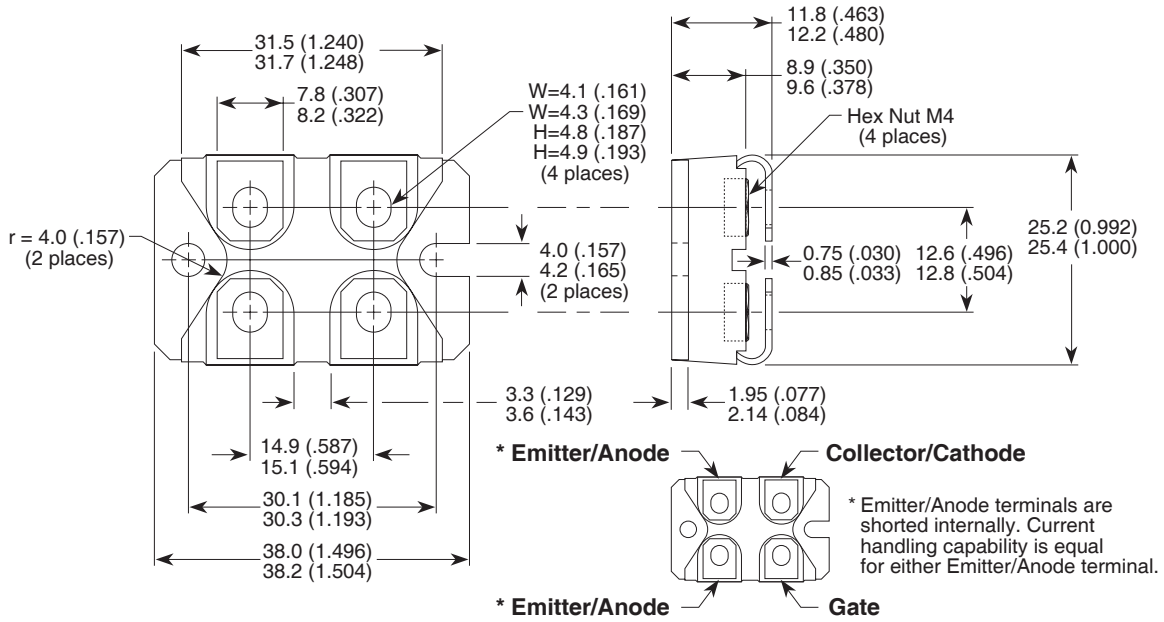

**Figure 32. Diode Test Circuit**




1. $I_F$ - Forward Conduction Current
2. $di_F/dt$ - 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 $0.25 \bullet I_{RRM}$ 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**

## SOT-227 (ISOTOP®) Package Outline




Dimensions in Millimeters and (Inches)

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