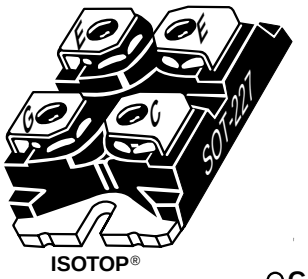
# APT40GF120JRD

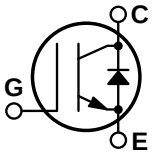
**1200V 60A**

## Fast IGBT




The Fast IGBT is a new generation of high voltage power IGBTs. Using Non-Punch Through Technology the Fast IGBT offers superior ruggedness, fast switching speed and low Collector-Emitter On voltage.

- **Low Tail Current**
- **Low Forward Voltage Drop**
- **High Freq. Switching to 20KHz**
- **Ultra Low Leakage Current**
- **RBSOA and SCSOA Rated**




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

| Symbol | Parameter | APT40GF120JRD | UNIT |
|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | 1200 | Volts |
| $V_{CGR}$ | Collector-Gate Voltage ($R_{GE}$ = 20KΩ) | 1200 | |
| $V_{GE}$ | Gate-Emitter Voltage | ±20 | |
| $I_{C1}$ | Continuous Collector Current @ $T_C$ = 25°C | 60 | Amps |
| $I_{C2}$ | Continuous Collector Current @ $T_C$ = 60°C | 40 | |
| $I_{CM}$ | Pulsed Collector Current ① @ $T_C$ = 25°C | 150 | |
| $I_{LM}$ | RBSOA Clamped Inductive Load Current @ $R_g$ = 11Ω $T_C$ = 90°C | 100 | |
| $P_D$ | Total Power Dissipation | 390 | 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 | UNIT |
|---|---|---|---|---|---|
| $V_{GE}$(TH) | Gate Threshold Voltage ($V_{CE}$ = $V_{GE}$, $I_C$ = 700µA, $T_j$ = 25°C) | 4.5 | 5.5 | 6.5 | Volts |
| $V_{CE}$(ON) | Collector-Emitter On Voltage ($V_{GE}$ = 15V, $I_C$ = 50A, $T_j$ = 25°C) | | 2.9 | 3.4 | |
| | Collector-Emitter On Voltage ($V_{GE}$ = 15V, $I_C$ = 50A, $T_j$ = 125°C) | | 3.5 | 4.1 | |
| $I_{CES}$ | Collector Cut-off Current ($V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V, $T_j$ = 25°C) | | | 0.5 | mA |
| | Collector Cut-off Current ($V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V, $T_j$ = 125°C) | | | 5.0 | |
| $I_{GES}$ | Gate-Emitter Leakage Current ($V_{GE}$ = ±20V, $V_{CE}$ = 0V) | | | ±100 | nA |

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

## DYNAMIC CHARACTERISTICS

| Symbol | Characteristic | Test Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input Capacitance | **Capacitance** $V_{GE}$ = 0V, $V_{CE}$ = 25V, f = 1 MHz | | 3450 | 4200 | pF |
| $C_{oes}$ | Output Capacitance | | | 330 | 470 | |
| $C_{res}$ | Reverse Transfer Capacitance | | | 230 | 350 | |
| $Q_g$ | Total Gate Charge ③ | **Gate Charge** $V_{GE}$ = 15V, $V_{CC}$ = 0.5$V_{CES}$, $I_C$ = $I_{C2}$ | | 325 | 490 | nC |
| $Q_{ge}$ | Gate-Emitter Charge | | | 35 | 40 | |
| $Q_{gc}$ | Gate-Collector ("Miller") Charge | | | 195 | 300 | |
| $t_d(on)$ | Turn-on Delay Time | **Resistive Switching (25°C)** $V_{GE}$ = 15V, $V_{CC}$ = 0.5$V_{CES}$, $I_C$ = $I_{C2}$, $R_G$ = 10Ω | | 47 | 94 | ns |
| $t_r$ | Rise Time | | | 178 | 360 | |
| $t_d(off)$ | Turn-off Delay Time | | | 320 | 480 | |
| $t_f$ | Fall Time | | | 190 | 380 | |
| $t_d(on)$ | Turn-on Delay Time | **Inductive Switching (150°C)** $V_{CLAMP}$(Peak) = 0.66$V_{CES}$, $V_{GE}$ = 15V, $I_C$ = $I_{C2}$, $R_G$ = 10Ω, $T_J$ = +150°C | | 45 | 90 | ns |
| $t_r$ | Rise Time | | | 102 | 210 | |
| $t_d(off)$ | Turn-off Delay Time | | | 440 | 880 | |
| $t_f$ | Fall Time | | | 102 | 210 | |
| $E_{on}$ | Turn-on Switching Energy | | | 6.4 | 13 | mJ |
| $E_{off}$ | Turn-off Switching Energy | | | 5.6 | 12 | |
| $E_{ts}$ | Total Switching Losses | | | 12.0 | 25 | |
| $t_d(on)$ | Turn-on Delay Time | **Inductive Switching (25°C)** $V_{CLAMP}$(Peak) = 0.66$V_{CES}$, $V_{GE}$ = 15V, $I_C$ = $I_{C2}$, $R_G$ = 10Ω, $T_J$ = +25°C | | 46 | 100 | ns |
| $t_r$ | Rise Time | | | 115 | 230 | |
| $t_d(off)$ | Turn-off Delay Time | | | 390 | 790 | |
| $t_f$ | Fall Time | | | 100 | 210 | |
| $E_{ts}$ | Total Switching Losses | | | 10.8 | 22 | mJ |
| gfe | Forward Transconductance | $V_{CE}$ = 20V, $I_C$ = $I_{C2}$ | 8 | | | S |

## THERMAL AND MECHANICAL CHARACTERISTICS

| Symbol | Characteristic | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $R_{\Theta JC}$ | Junction to Case (IGBT) | | | 0.32 | °C/W |
| | Junction to Case (FRED) | | | 0.66 | |
| $R_{\Theta JA}$ | Junction to Ambient | | | 40 | |
| $W_T$ | Package Weight | | 1.03 | | oz |
| | | | 29.2 | | gm |
| Torque | Mounting Torque (Mounting = 8-32 or 4mm Machine and Terminals = 4mm Machine) | | | 10 | lb•in |
| | | | | 1.1 | N•m |

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

② $I_C$ = $I_{C2}$, $R_{GE}$ = 25Ω, L = 68µH, $T_j$ = 25°C

③ See MIL-STD-750 Method 3471

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

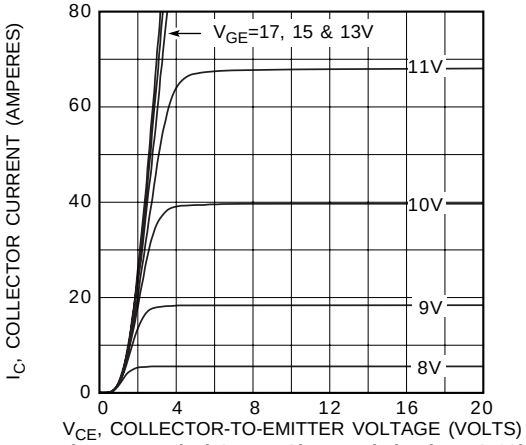



**Figure 1, Typical Output Characteristics ($T_J$ = 25°C)**

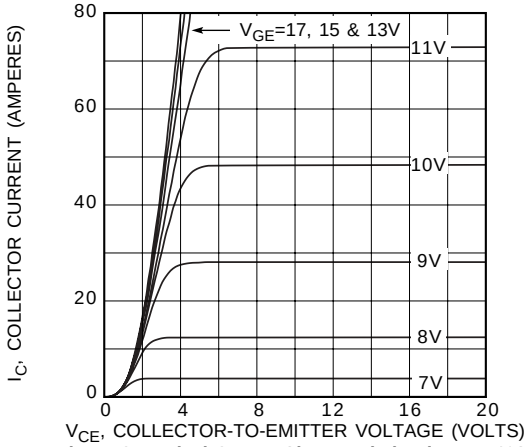



**Figure 2, Typical Output Characteristics ($T_J$ = 150°C)**

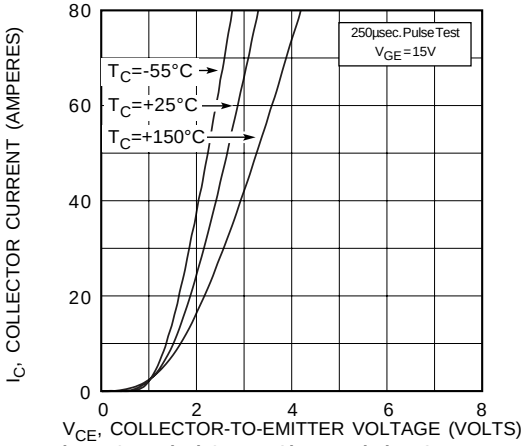



**Figure 3, Typical Output Characteristics @ $V_{GE}$ = 15V**

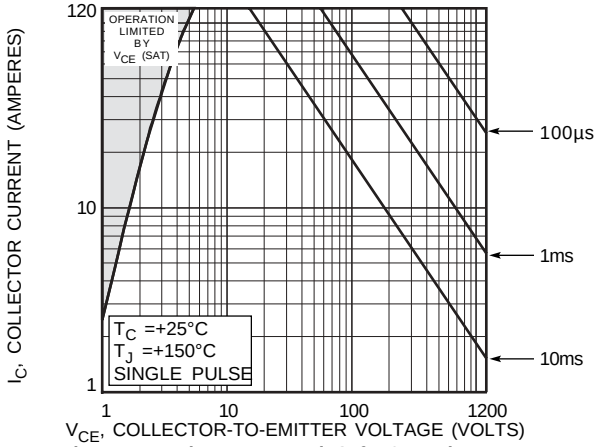



**Figure 4, Maximum Forward Safe Operating Area**

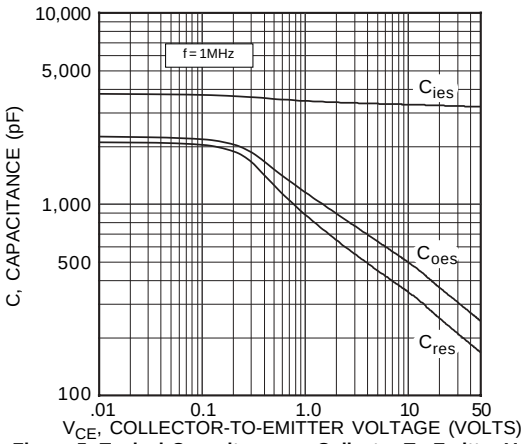



**Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage**

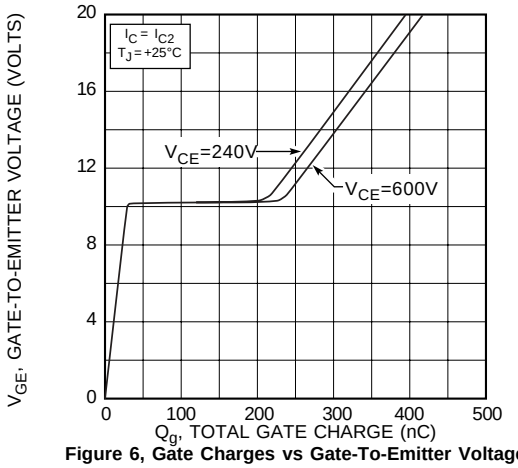



**Figure 6, Gate Charges vs Gate-To-Emitter Voltage**

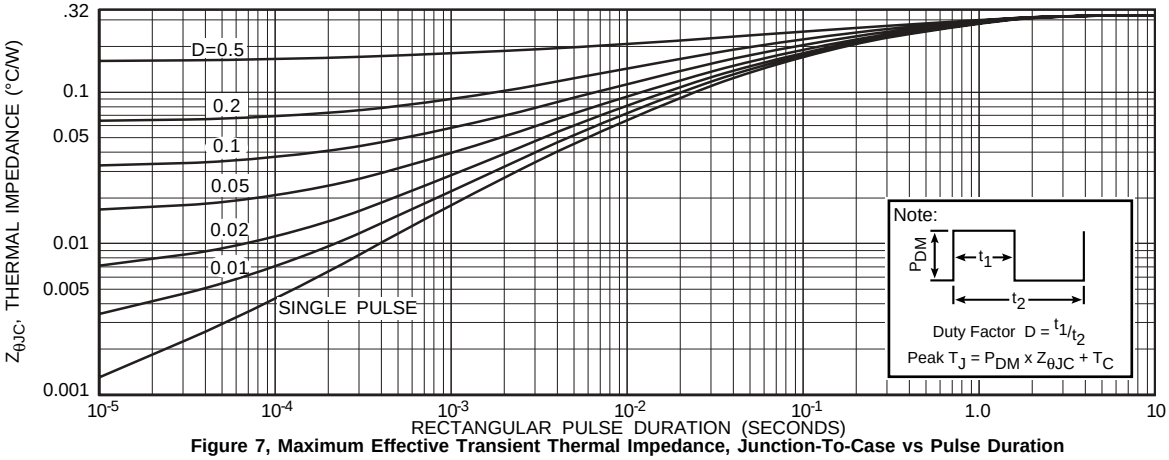



**Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration**

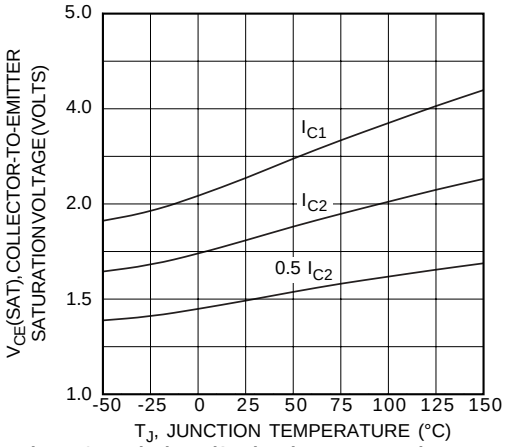



**Figure 8, Typical $V_{CE}$(SAT) Voltage vs Junction Temperature**

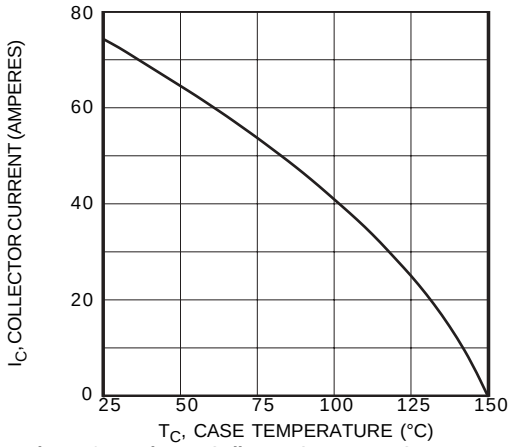



**Figure 9, Maximum Collector Current vs Case Temperature**

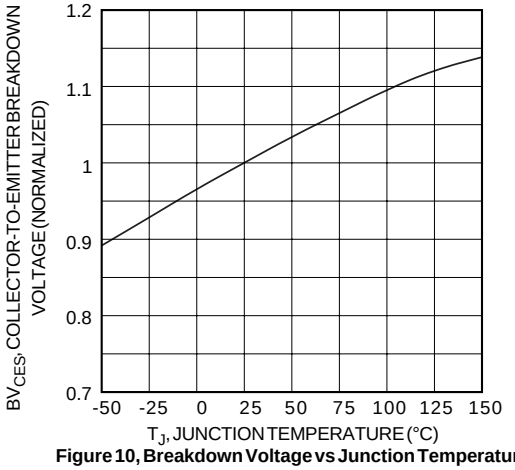



**Figure 10, Breakdown Voltage vs Junction Temperature**

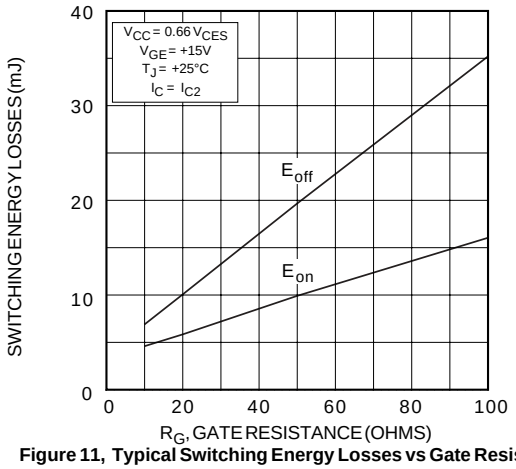



**Figure 11, Typical Switching Energy Losses vs Gate Resistance**

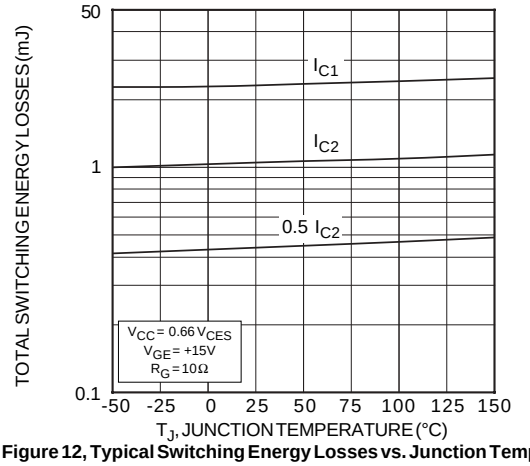



**Figure 12, Typical Switching Energy Losses vs. Junction Temperature**

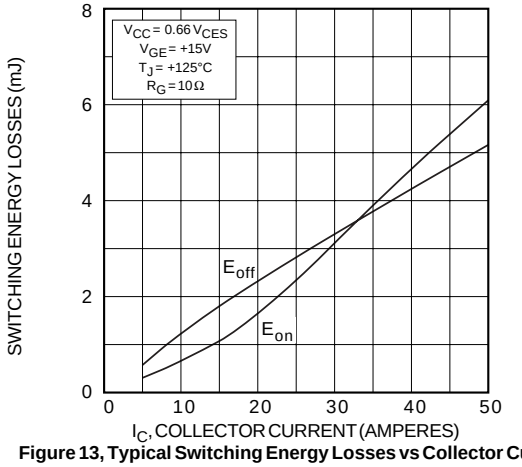



**Figure 13, Typical Switching Energy Losses vs Collector Current**

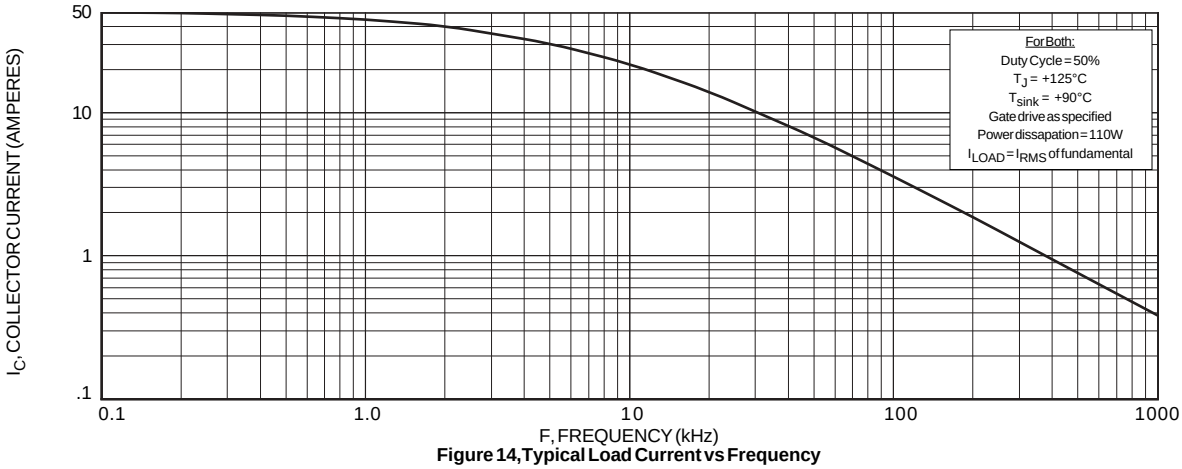



**Figure 14, Typical Load Current vs Frequency**

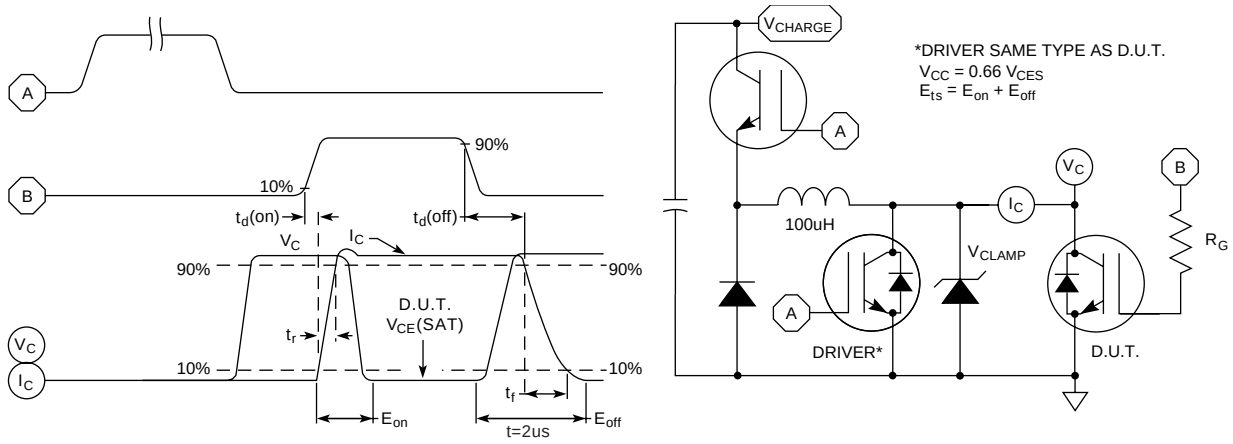



**Figure 15, Switching Loss Test Circuit and Waveforms**

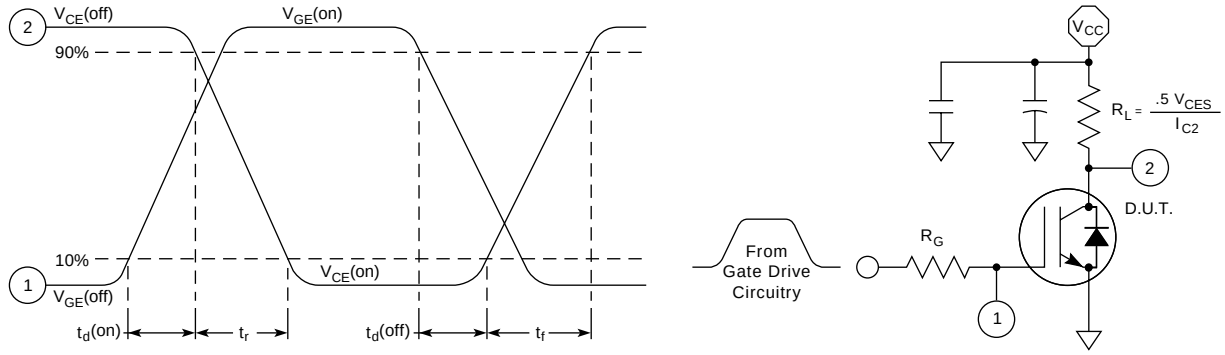



**Figure 16, Resistive Switching Time Test Circuit and Waveforms**

## MAXIMUM RATINGS (FRED)

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

| Symbol | Characteristic | APT40GF120JRD | UNIT |
|---|---|---|---|
| $IF_{AV}$ | Maximum Average Forward Current ($T_C$ = 100°C, Duty Cycle = 0.5) | 60 | Amps |
| $IF_{RMS}$ | RMS Forward Current | 115 | |
| $I_{FSM}$ | Non-Repetive Forward Surge Current ($T_J$ = 45°C, 8.3 ms) | 540 | |

## STATIC ELECTRICAL CHARACTERISTICS (FRED)

| Symbol | Characteristic / Test Conditions | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_F$ | Maximum Forward Voltage | $I_F$ = 60A | | | 2.5 | Volts |
| | | $I_F$ = 120A | | 2.7 | | |
| | | $I_F$ = 60A, $T_J$ = 150°C | | | 2.0 | |

## DYNAMIC CHARACTERISTICS (FRED)

| Symbol | Characteristic | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{rr1}$ | Reverse Recovery Time, $I_F$ = 1.0A, $di_F/dt$ = -15A/µs, $V_R$ = 30V, $T_J$ = 25°C | | | 70 | 85 | ns |
| $t_{rr2}$ | Reverse Recovery Time | $T_J$ = 25°C | | 70 | | |
| $t_{rr3}$ | $I_F$ = 60A, $di_F/dt$ = -480A/µs, $V_R$ = 650V | $T_J$ = 100°C | | 130 | | |
| $t_{fr1}$ | Forward Recovery Time | $T_J$ = 25°C | | 170 | | |
| $t_{fr2}$ | $I_F$ = 60A, $di_F/dt$ = 480A/µs, $V_R$ = 650V | $T_J$ = 100°C | | 170 | | |
| $I_{RRM1}$ | Reverse Recovery Current | $T_J$ = 25°C | | 18 | 30 | Amps |
| $I_{RRM2}$ | $I_F$ = 60A, $di_F/dt$ = -480A/µs, $V_R$ = 650V | $T_J$ = 100°C | | 29 | 40 | |
| $Q_{rr1}$ | Recovery Charge | $T_J$ = 25°C | | 630 | | nC |
| $Q_{rr2}$ | $I_F$ = 60A, $di_F/dt$ = -480A/µs, $V_R$ = 650V | $T_J$ = 100°C | | 1820 | | |
| $V_{fr1}$ | Forward Recovery Voltage | $T_J$ = 25°C | | 12 | | Volts |
| $V_{fr2}$ | $I_F$ = 60A, $di_F/dt$ = 480A/µs, $V_R$ = 650V | $T_J$ = 100°C | | 12 | | |
| dIM/dt | Rate of Fall of Recovery Current | $T_J$ = 25°C | | 900 | | A/µs |
| | $I_F$ = 60A, $di_F/dt$ = -480A/µs, $V_R$ =650V | $T_J$ = 100°C | | 600 | | |

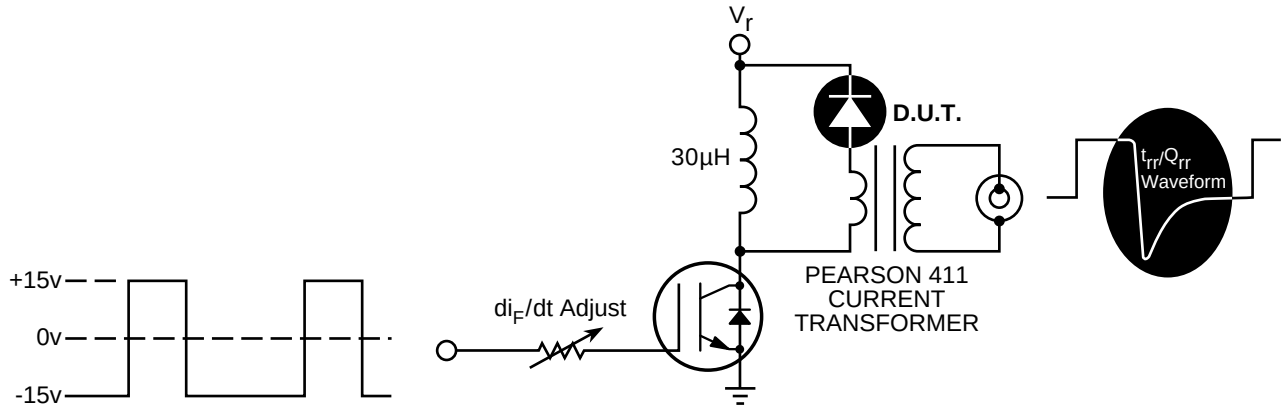



**Figure 17, Diode Reverse Recovery Test Circuit and Waveforms**

1. $I_F$ - Forward Conduction Current
2. $di_F/dt$ - Current Slew Rate, Rate of Forward Current Change Through Zero Crossing.
3. $I_{RRM}$ - Peak Reverse Recovery Current.
4. $t_{rr}$ - Reverse Recovery Time Measured from Point of $I_F$ Current Falling Through Zero to a Tangent Line {6 diM/dt} Extrapolated Through Zero Defined by 0.75 and 0.50 $I_{RRM}$.
5. $Q_{rr}$ - Area Under the Curve Defined by $I_{RRM}$ and $t_{rr}$.
6. diM/dt - Maximum Rate of Current Change During the Trailing Portion of $t_{rr}$.

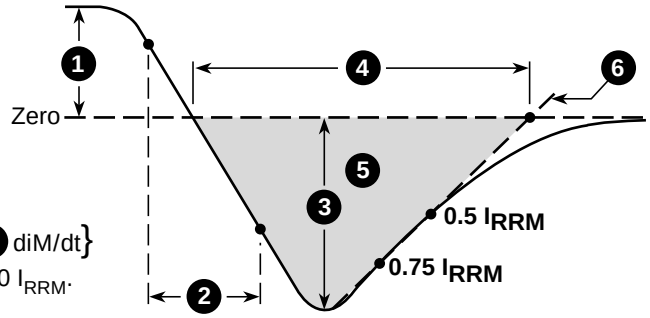



**Figure 18, Diode Reverse Recovery Waveform and Definitions**

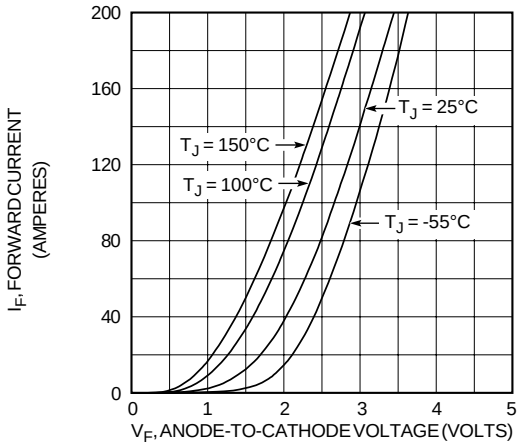



**Figure 2, Forward Voltage Drop vs Forward Current**

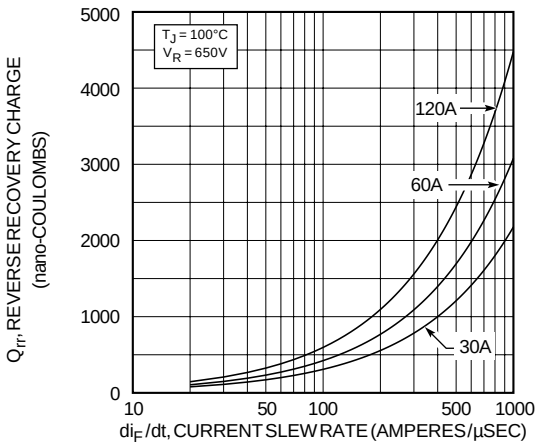



**Figure 3, Reverse Recovery Charge vs Current Slew Rate**

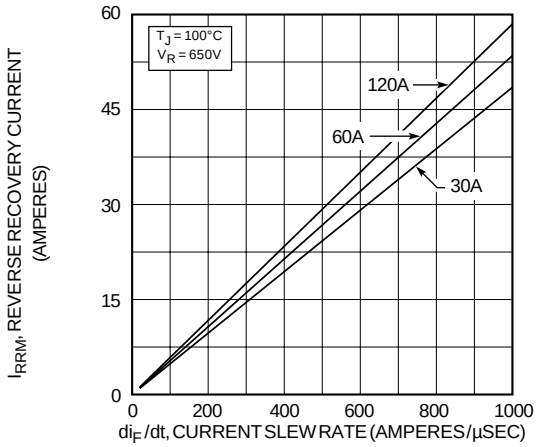



**Figure 4, Reverse Recovery Current vs Current Slew Rate**

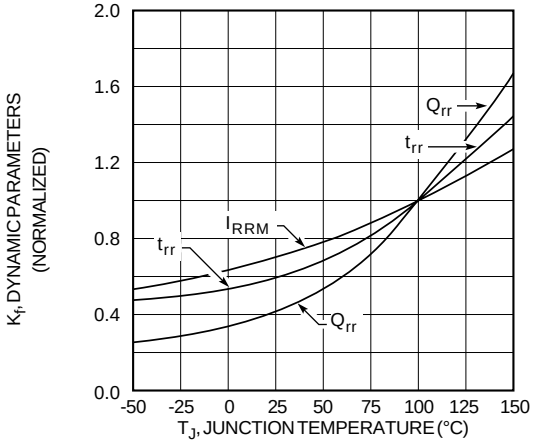



**Figure 5, Dynamic Parameters vs Junction Temperature**

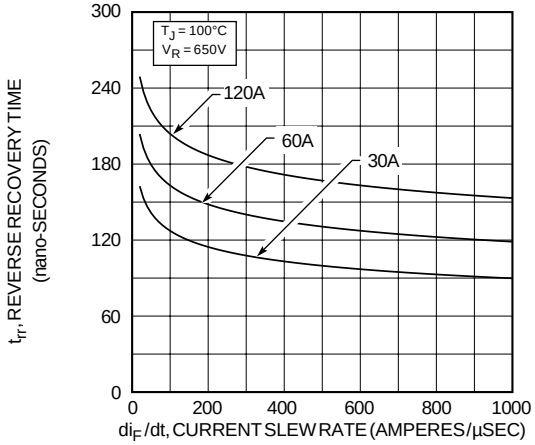



**Figure 6, Reverse Recovery Time vs Current Slew Rate**

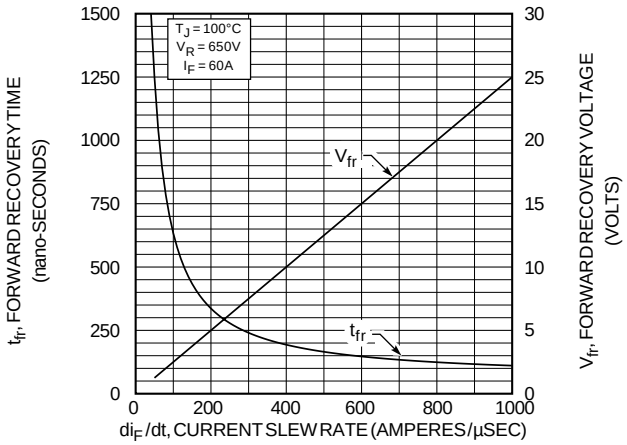



**Figure 7, Forward Recovery Voltage/Time vs Current Slew Rate**

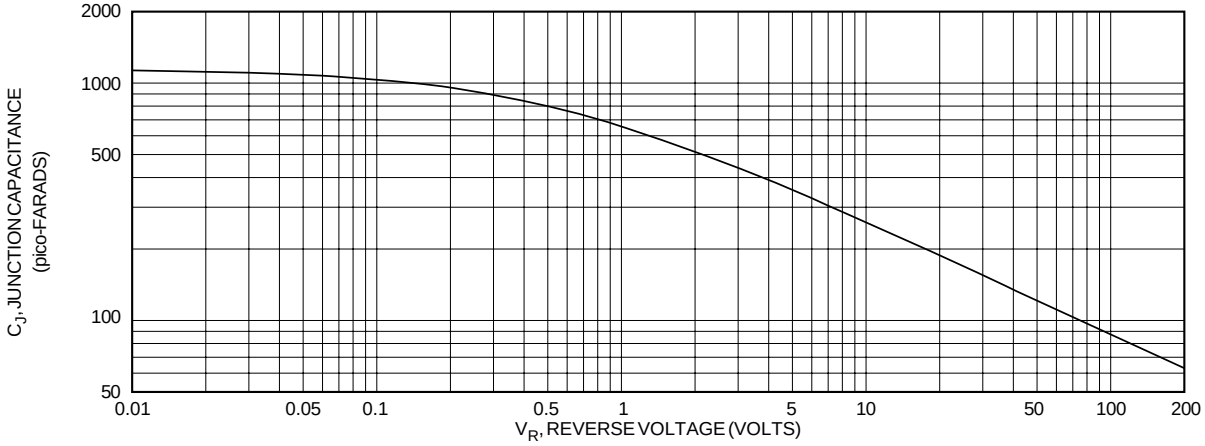
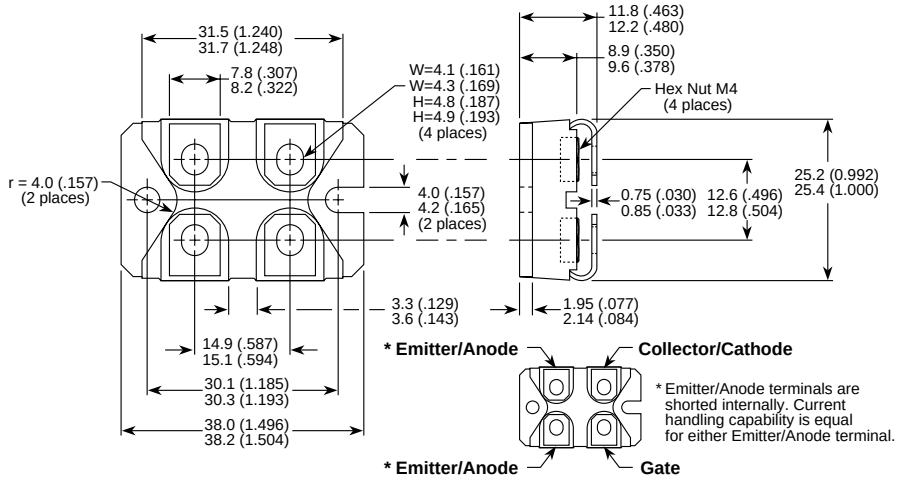



**Figure 8, Junction Capacitance vs Reverse Voltage**

## SOT-227 (ISOTOP®) Package Outline




Dimensions in Millimeters and (Inches)

APT's devices are covered by one or more of the following U.S.patents: 4,895,810 5,045,903 5,089,434 5,182,234 5,019,522 5,262,336 5,256,583 4,748,103 5,283,202 5,231,474 5,434,095 5,528,058

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