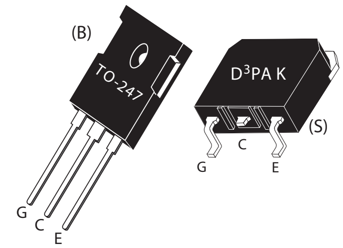
POWER PRODUCTS GROUP

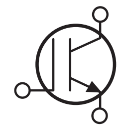
# APT60GT60BRG
# APT60GT60SRG
# 600V

## Thunderbolt IGBT®




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

- **Low Forward Voltage Drop**
- **Low Tail Current**
- **Avalanche Rated**
- **RoHS Compliant**
- **High Freq. Switching to 150KHz**
- **Ultra Low Leakage Current**
- **RBSOA and SCSOA Rated**



### MAXMUM RATINGS

| Symbol | Parameter | APT60GT60BR_SRG | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | 600 | Volts |
| $V_{GE}$ | Gate Emitter Voltage | ±20 | |
| $I_{C1}$ | Continuous Collector Current @ $T_C$ = 25°C [4]± | 100 | Amps |
| $I_{C2}$ | Continuous Collector Current @ $T_C$ = 105°C | 60 | |
| $I_{CM}$ | Pulsed Collector Current [1] @ $T_C$ = 25°C | 360 | |
| $I_{LM}$ | RBSOA Clamped Inductive Load Current $R_G$ = 11Ω, $T_C$ = 25°C | 360 | |
| $E_{AS}$ | Single Pulse Avalanche Energy [2] | 65 | mJ |
| $P_D$ | Total Power Dissipation | 500 | 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 |
|---|---|---|---|---|---|
| $BV_{CES}$ | Collector-Emitter Breakdown Voltage ($V_{GE}$ = 0V, $I_C$ = 0.5mA) | 600 | | | Volts |
| $V_{GE}(TH)$ | Gate Threshold Voltage ($V_{CE}$ = $V_{GE}$, $I_C$ = 500μA, $T_j$ = 25°C) | 3 | 4 | 5 | |
| $V_{CE}(ON)$ | Collector-Emitter On Voltage ($V_{GE}$ = 15V, $I_C$ = $I_{C2}$, $T_j$ = 25°C) | 1.6 | 2.2 | 2.5 | |
| | Collector-Emitter On Voltage ($V_{GE}$ = 15V, $I_C$ = $I_{C2}$, $T_j$ = 125°C) | | | 2.8 | |
| $I_{CES}$ | Collector Cut-off Current ($V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V, $T_j$ = 25°C) | | | 80 | μA |
| | Collector Cut-off Current ($V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V, $T_j$ = 125°C) | | | 2000 | |
| $I_{GES}$ | 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 | | 3125 | 3590 | pF |
| $C_{oes}$ | Output Capacitance | | | 310 | 450 | |
| $C_{res}$ | Reverse Transfer Capacitance | | | 180 | 310 | |
| $Q_g$ | Total Gate Charge [3] | **Gate Charge** $V_{GE}$ = 15V $V_{CC}$ = 0.5$V_{CES}$ $I_C$ = $I_{C2}$ | | 275 | 410 | nC |
| $Q_{ge}$ | Gate-Emitter Charge | | | 19 | 30 | |
| $Q_{gc}$ | Gate-Collector ("Miller") Charge | | | 120 | 180 | |
| $t_d$(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 | | 20 | 40 | ns |
| $t_r$ | Rise Time | | | 95 | 190 | |
| $t_d$(off) | Turn-off Delay Time | | | 315 | 470 | |
| $t_f$ | Fall Time | | | 245 | 490 | |
| $t_d$(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 | | 25 | 50 | ns |
| $t_r$ | Rise Time | | | 59 | 120 | |
| $t_d$(off) | Turn-off Delay Time | | | 430 | 650 | |
| $t_f$ | Fall Time | | | 65 | 130 | |
| $E_{on}$ | Turn-on Switching Energy | | | 1.6 | 3.2 | mJ |
| $E_{off}$ | Turn-off Switching Energy | | | 2.4 | 4.8 | |
| $E_{ts}$ | Total Switching Losses | | | 4.0 | 8.0 | |
| $t_d$(on) | Turn-on Delay Time | **Inductive Switching (25°C)** $V_{CLAMP}$(Peak) = 0.66$V_{CES}$ $V_{GE}$ = 15V $I_C$ = $I_{C2}$ $R_G$ = 5Ω $T_J$ = +25°C | | 26 | 50 | ns |
| $t_r$ | Rise Time | | | 63 | 125 | |
| $t_d$(off) | Turn-off Delay Time | | | 395 | 590 | |
| $t_f$ | Fall Time | | | 68 | 140 | |
| $E_{ts}$ | Total Switching Losses | | | 3.4 | 7.0 | mJ |
| gfe | Forward Transconductance | $V_{CE}$ = 20V, $I_C$ = $I_{C2}$ | 4 | | | S |

## THERMAL AND MECHANICAL CHARACTERISTICS

| Symbol | Characteristic | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction to Case | | | 0.25 | °C/W |
| $R_{\theta JA}$ | Junction to Ambient | | | 40 | |
| $W_T$ | Package Weight | | 0.22 | | oz |
| | | | 6.1 | | gm |
| Torque | Mounting Torque (using a 6-32 or 3mm Binding Head Machine Screw) | | | 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 = 36μH, $T_j$ = 25°C

③ See MIL-STD-750 Method 3471

④ The maximum current is limited by lead temperature.

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

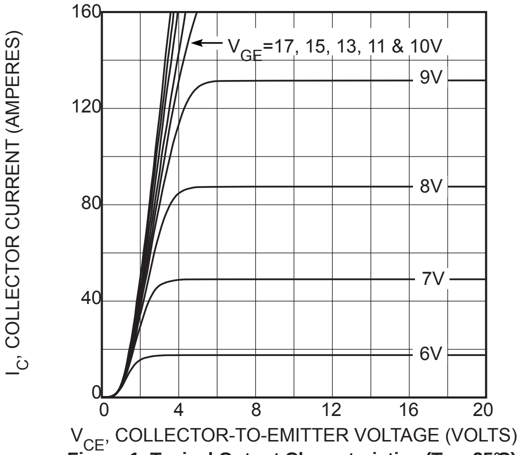



Figure 1, Typical Output Characteristics ($T_J$ = 25°C)

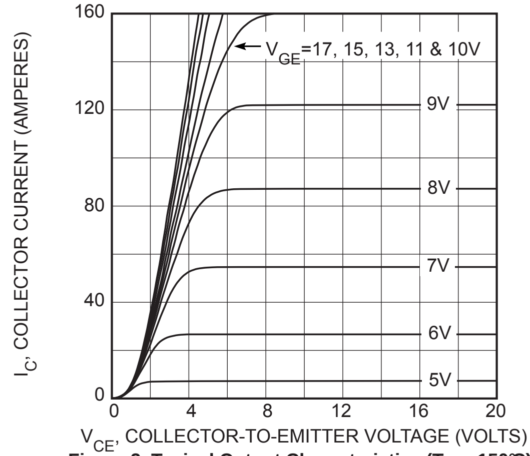



Figure 2, Typical Output Characteristics ($T_J$ = 150°C)

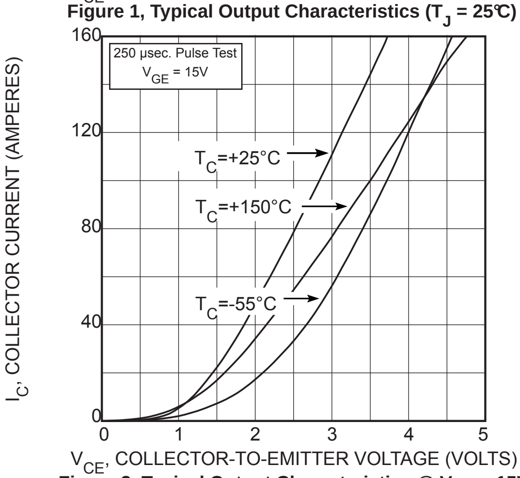



Figure 3, Typical Output Characteristics @ $V_{GE}$ = 15V

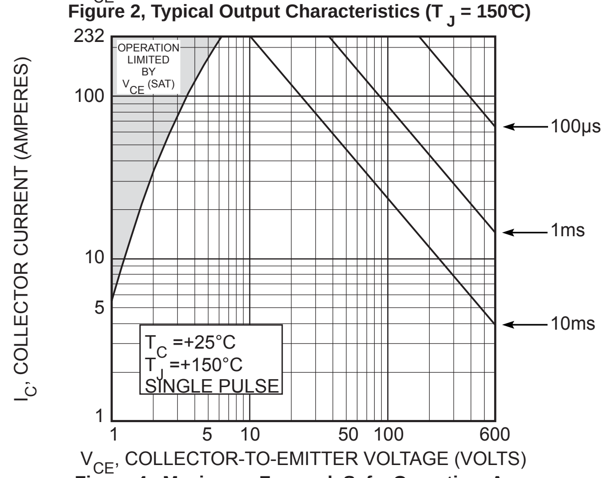



Figure 4, Maximum Forward Safe Operating Area

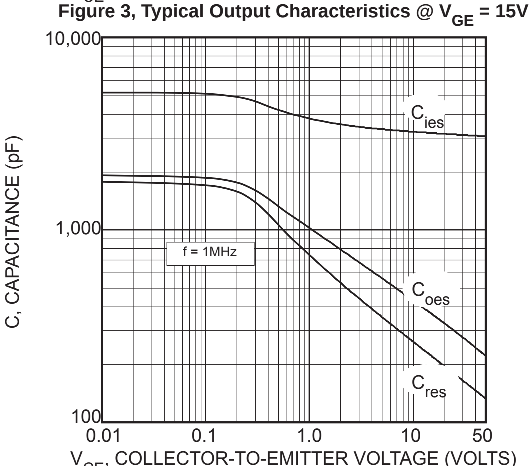



Figure 5, Typical Capacitance vs Collector-To-Emitter Voltage

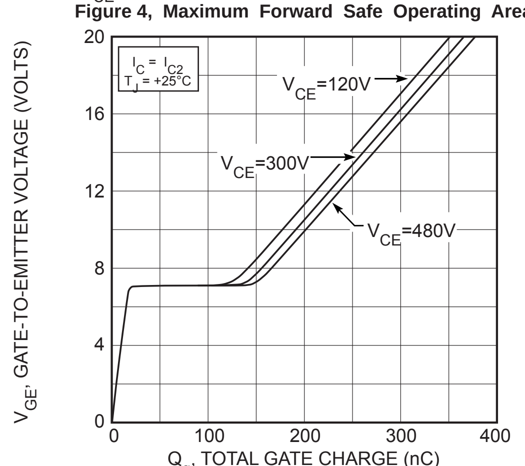



Figure 6, Gate Charges vs Gate-To-Emitter Voltage

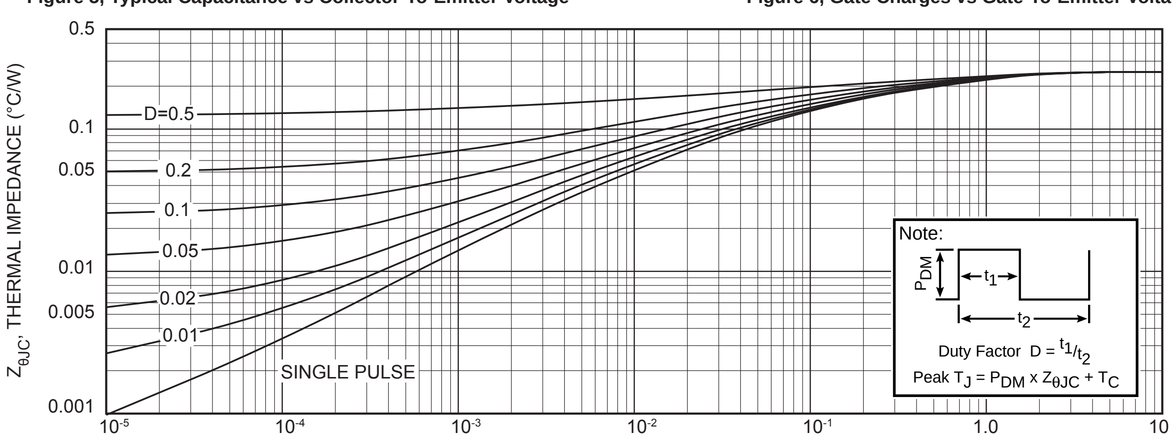



Figure 7, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

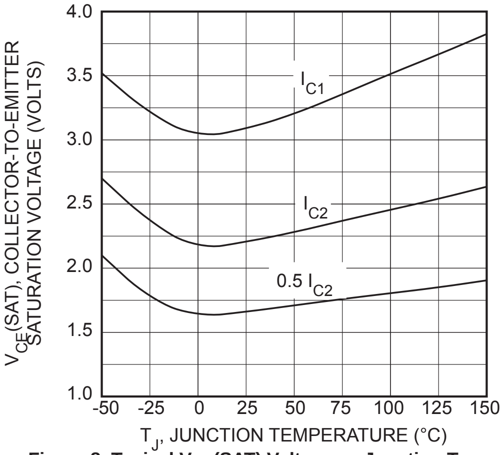



**Figure 8, Typical $V_{CE}$(SAT) Voltage vs Junction Temperature**

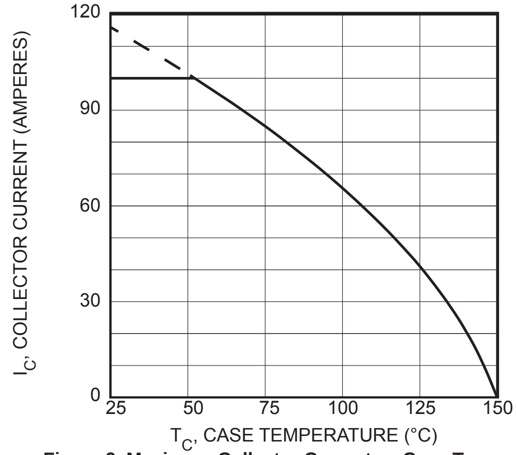



**Figure 9, Maximum Collector Current vs Case Temperature**

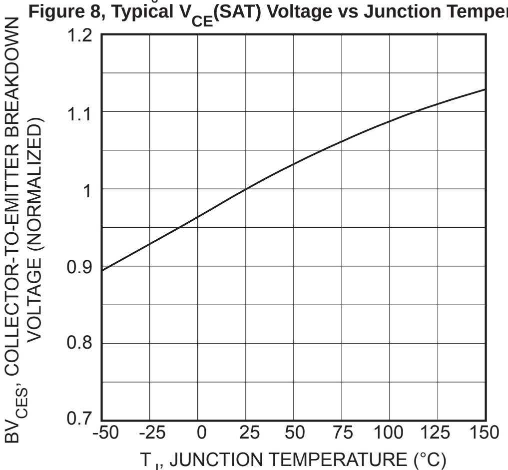



**Figure 10, Breakdown Voltage vs Junction Temperature**

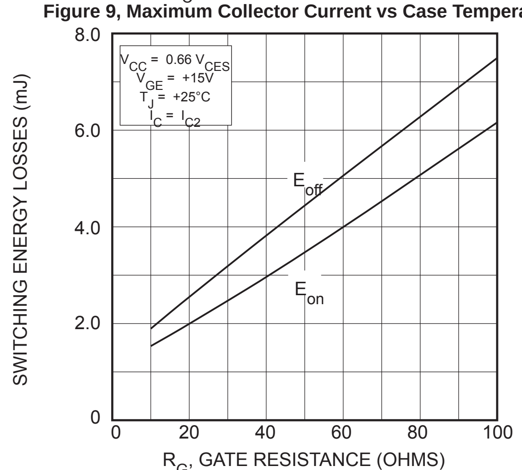



**Figure 11, Typical Switching Energy Losses vs Gate Resistance**

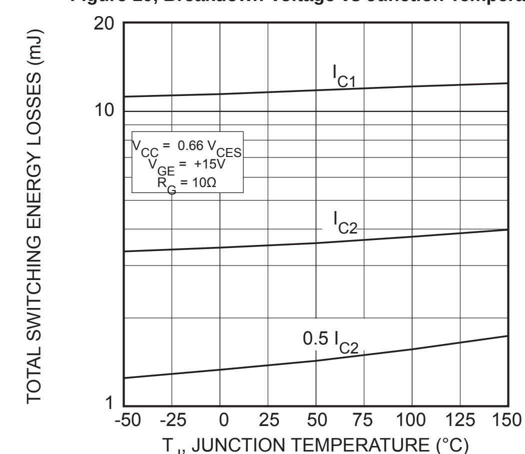



**Figure 12, Typical Switching Energy Losses vs. Junction Temperature**

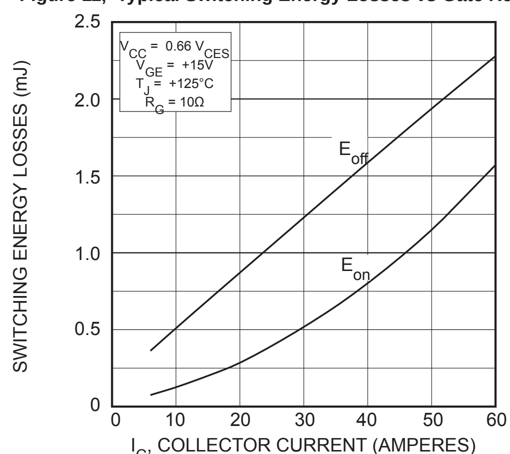



**Figure 13, Typical Switching Energy Losses vs Collector Current**

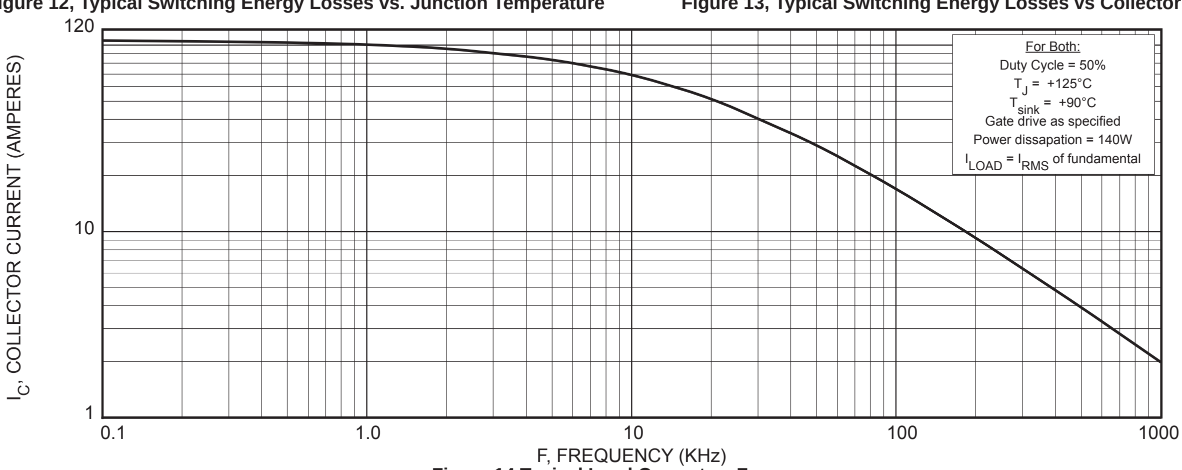



**Figure 14,Typical Load Current vs Frequency**

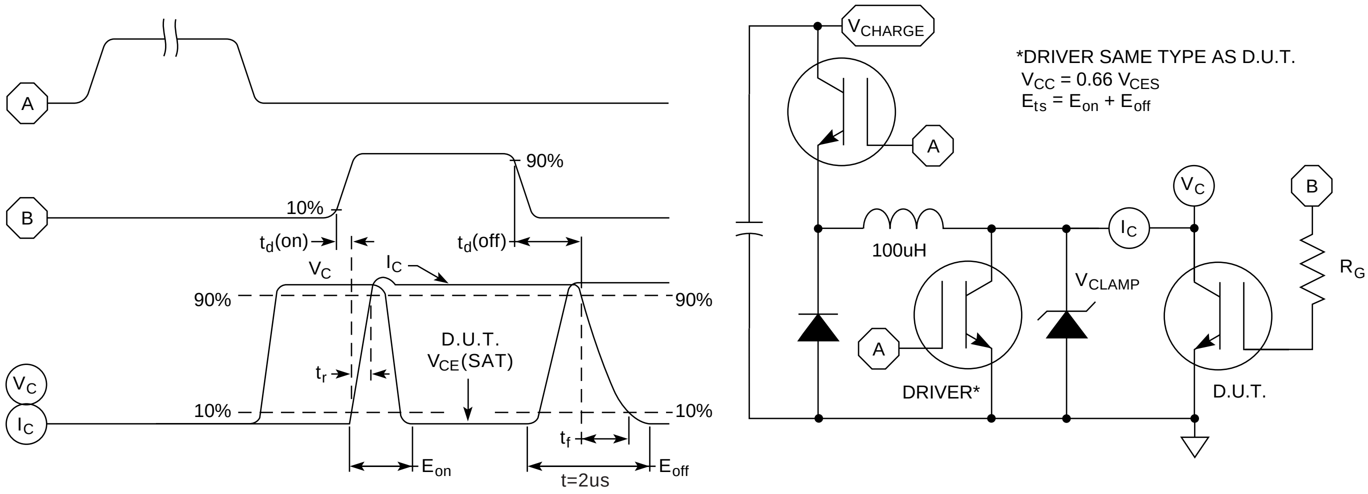



**Figure 15, Switching Loss Test Circuit and Waveforms**

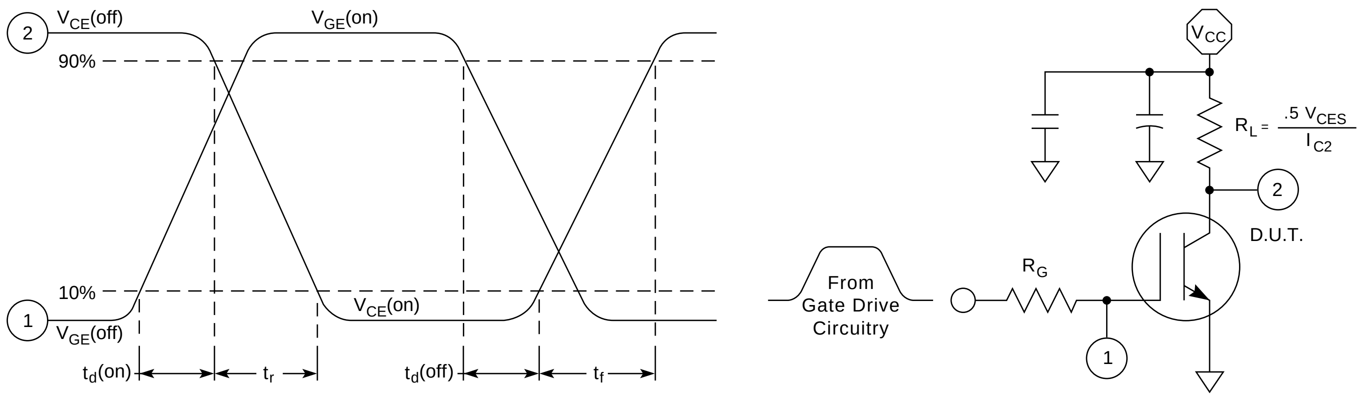
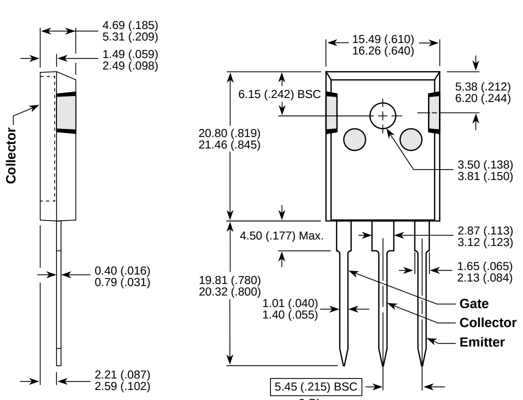



**Figure 16, Resistive Switching Time Test Circuit and Waveforms**

## TO-247 Package Outline

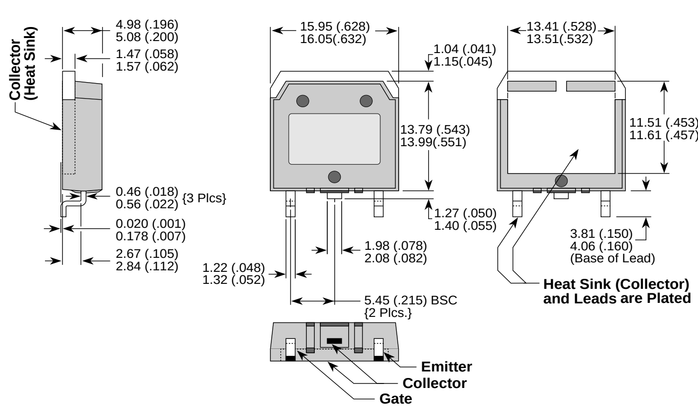
e1 SAC: Tin, Silver, Copper




Dimensions in Millimeters and (Inches)

## D3PAK Package Outline

e3 SAC: Tin, Silver, Copper




Dimensions in Millimeters (Inches)