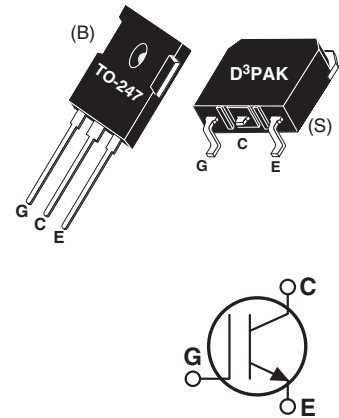


Utilizing the latest Field Stop and Trench Gate technologies, these IGBT's have ultra low  $V_{CE(ON)}$  and are ideal for low frequency applications that require absolute minimum conduction loss. Easy paralleling is a result of very tight parameter distribution and a slightly positive  $V_{CE(ON)}$  temperature coefficient. 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
- 175°C Rated



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

## MAXIMUM RATINGS

All Ratings:  $T_C = 25^\circ\text{C}$  unless otherwise specified.

| Symbol         | Parameter                                                         | APT20GN60B_S(G) | UNIT             |
|----------------|-------------------------------------------------------------------|-----------------|------------------|
| $V_{CES}$      | Collector-Emitter Voltage                                         | 600             | Volts            |
| $V_{GE}$       | Gate-Emitter Voltage                                              | $\pm 30$        |                  |
| $I_{C1}$       | Continuous Collector Current @ $T_C = 25^\circ\text{C}$           | 40              | Amps             |
| $I_{C2}$       | Continuous Collector Current @ $T_C = 110^\circ\text{C}$          | 24              |                  |
| $I_{CM}$       | Pulsed Collector Current <sup>①</sup> @ $T_C = 175^\circ\text{C}$ | 60              |                  |
| SSOA           | Switching Safe Operating Area @ $T_J = 175^\circ\text{C}$         | 60A @ 600V      |                  |
| $P_D$          | Total Power Dissipation                                           | 136             | Watts            |
| $T_J, T_{STG}$ | Operating and Storage Junction Temperature Range                  | -55 to 175      | $^\circ\text{C}$ |
| $T_L$          | 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 ( $V_{GE} = 0V, I_C = 2mA$ )                                 | 600 |     |     | Volts    |
| $V_{GE(TH)}$  | Gate Threshold Voltage ( $V_{CE} = V_{GE}, I_C = 290\mu A, T_J = 25^\circ\text{C}$ )             | 5.0 | 5.8 | 6.5 |          |
| $V_{CE(ON)}$  | Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = 20A, T_J = 25^\circ\text{C}$ )               | 1.1 | 1.5 | 1.9 |          |
|               | Collector-Emitter On Voltage ( $V_{GE} = 15V, I_C = 20A, T_J = 125^\circ\text{C}$ )              |     | 1.7 |     |          |
| $I_{CES}$     | Collector Cut-off Current ( $V_{CE} = 600V, V_{GE} = 0V, T_J = 25^\circ\text{C}$ ) <sup>②</sup>  |     |     | 25  | $\mu A$  |
|               | Collector Cut-off Current ( $V_{CE} = 600V, V_{GE} = 0V, T_J = 125^\circ\text{C}$ ) <sup>②</sup> |     |     | TBD |          |
| $I_{GES}$     | Gate-Emitter Leakage Current ( $V_{GE} = \pm 20V$ )                                              |     |     | 300 | nA       |
| $R_{G(int)}$  | Integrated Gate Resistor                                                                         |     | N/A |     | $\Omega$ |



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

# DYNAMIC CHARACTERISTICS

APT20GN60B\_S(G)

| Symbol       | Characteristic                                | Test Conditions                                                                                                                                   | MIN | TYP  | MAX | UNIT          |
|--------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|---------------|
| $C_{ies}$    | Input Capacitance                             | <b>Capacitance</b><br>$V_{GE} = 0V, V_{CE} = 25V$<br>$f = 1 \text{ MHz}$                                                                          |     | 1110 |     | pF            |
| $C_{oes}$    | Output Capacitance                            |                                                                                                                                                   |     | 50   |     |               |
| $C_{res}$    | Reverse Transfer Capacitance                  |                                                                                                                                                   |     | 35   |     |               |
| $V_{GEP}$    | Gate-to-Emitter Plateau Voltage               | <b>Gate Charge</b><br>$V_{GE} = 15V$<br>$V_{CE} = 300V$<br>$I_C = 20A$                                                                            |     | 9.5  |     | V             |
| $Q_g$        | Total Gate Charge <sup>③</sup>                |                                                                                                                                                   |     | 120  |     | nC            |
| $Q_{ge}$     | Gate-Emitter Charge                           |                                                                                                                                                   |     | 10   |     |               |
| $Q_{gc}$     | Gate-Collector ("Miller") Charge              |                                                                                                                                                   |     | 70   |     |               |
| SSOA         | Switching Safe Operating Area                 | $T_J = 175^\circ\text{C}, R_G = 4.3\Omega^{⑦}, V_{GE} = 15V, L = 100\mu\text{H}, V_{CE} = 600V$                                                   | 60  |      |     | A             |
| SCSOA        | Short Circuit Safe Operating Area             | $V_{CC} = 360V, V_{GE} = 15V, T_J = 150^\circ\text{C}, R_G = 4.3\Omega^{⑦}$                                                                       | 6   |      |     | $\mu\text{s}$ |
| $t_{d(on)}$  | Turn-on Delay Time                            | <b>Inductive Switching (25°C)</b><br><br>$V_{CC} = 400V$<br>$V_{GE} = 15V$<br>$I_C = 20A$<br>$R_G = 4.3\Omega^{⑦}$<br>$T_J = +25^\circ\text{C}$   |     | 9    |     | ns            |
| $t_r$        | Current Rise Time                             |                                                                                                                                                   |     | 10   |     |               |
| $t_{d(off)}$ | Turn-off Delay Time                           |                                                                                                                                                   |     | 140  |     |               |
| $t_f$        | Current Fall Time                             |                                                                                                                                                   |     | 95   |     |               |
| $E_{on1}$    | Turn-on Switching Energy <sup>④</sup>         |                                                                                                                                                   |     | 230  |     | $\mu\text{J}$ |
| $E_{on2}$    | Turn-on Switching Energy (Diode) <sup>⑤</sup> |                                                                                                                                                   |     | 260  |     |               |
| $E_{off}$    | Turn-off Switching Energy <sup>⑥</sup>        |                                                                                                                                                   |     | 580  |     |               |
| $t_{d(on)}$  | Turn-on Delay Time                            | <b>Inductive Switching (125°C)</b><br><br>$V_{CC} = 400V$<br>$V_{GE} = 15V$<br>$I_C = 20A$<br>$R_G = 4.3\Omega^{⑦}$<br>$T_J = +125^\circ\text{C}$ |     | 9    |     | ns            |
| $t_r$        | Current Rise Time                             |                                                                                                                                                   |     | 10   |     |               |
| $t_{d(off)}$ | Turn-off Delay Time                           |                                                                                                                                                   |     | 160  |     |               |
| $t_f$        | Current Fall Time                             |                                                                                                                                                   |     | 130  |     |               |
| $E_{on1}$    | Turn-on Switching Energy <sup>④</sup>         |                                                                                                                                                   |     | 250  |     | $\mu\text{J}$ |
| $E_{on2}$    | Turn-on Switching Energy (Diode) <sup>⑤</sup> |                                                                                                                                                   |     | 450  |     |               |
| $E_{off}$    | Turn-off Switching Energy <sup>⑥</sup>        |                                                                                                                                                   |     | 750  |     |               |

# THERMAL AND MECHANICAL CHARACTERISTICS

| Symbol          | Characteristic                    | MIN | TYP | MAX | UNIT               |
|-----------------|-----------------------------------|-----|-----|-----|--------------------|
| $R_{\theta JC}$ | Junction to Case ( <b>IGBT</b> )  |     |     | 1.1 | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Junction to Case ( <b>DIODE</b> ) |     |     | N/A |                    |
| $W_T$           | Package Weight                    |     | 5.9 |     | gm                 |

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. (MIC4452)

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

# TYPICAL PERFORMANCE CURVES

APT20GN60B\_S(G)

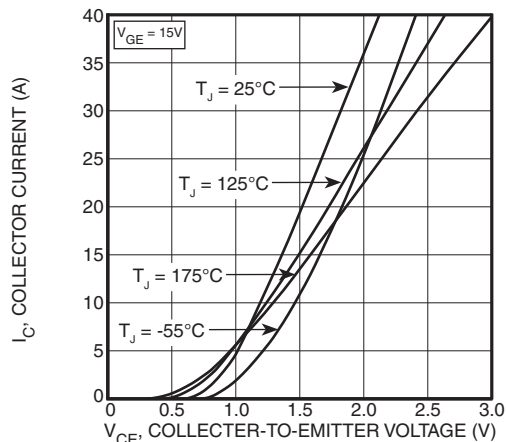


FIGURE 1, Output Characteristics( $T_J = 25^{\circ}\text{C}$ )

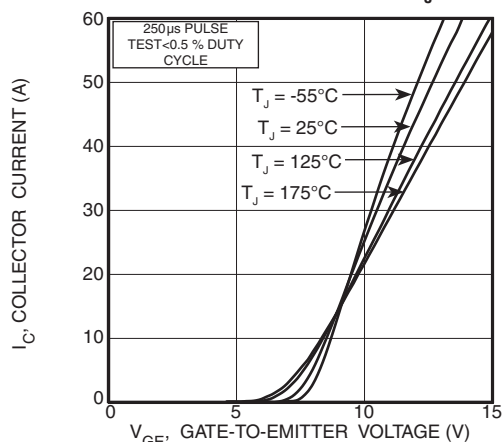


FIGURE 3, Transfer Characteristics

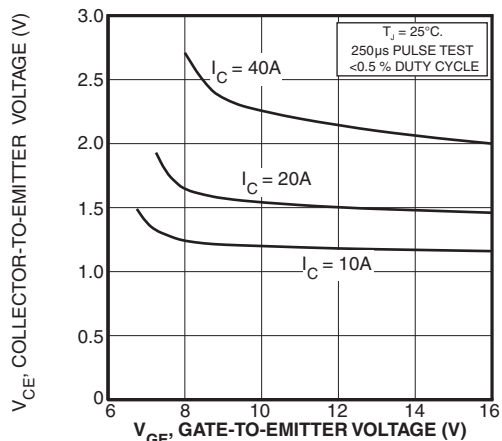


FIGURE 5, On State Voltage vs Gate-to-Emitter Voltage

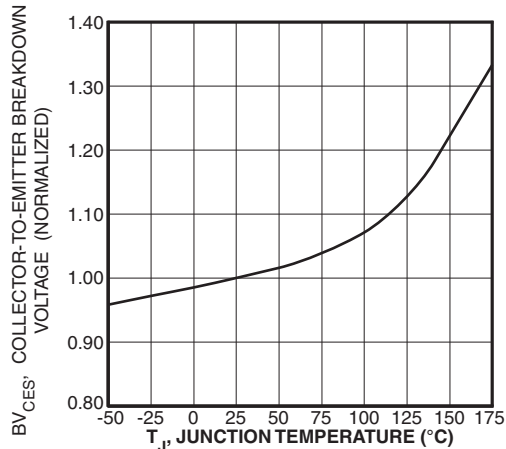


FIGURE 7, Breakdown Voltage vs. Junction Temperature

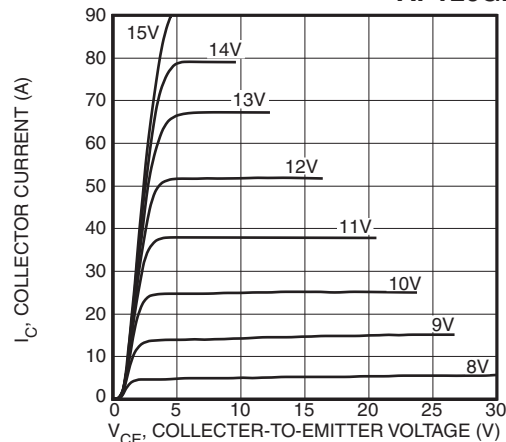


FIGURE 2, Output Characteristics ( $T_J = 125^{\circ}\text{C}$ )

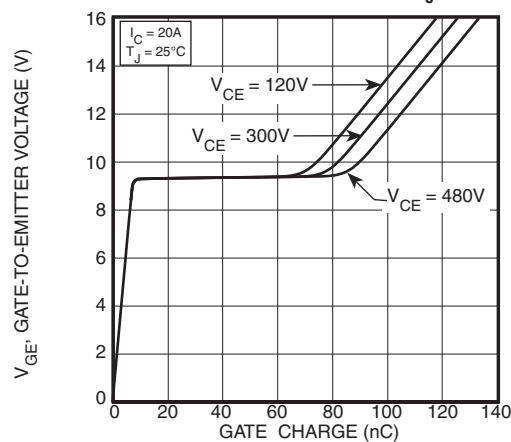


FIGURE 4, Gate Charge

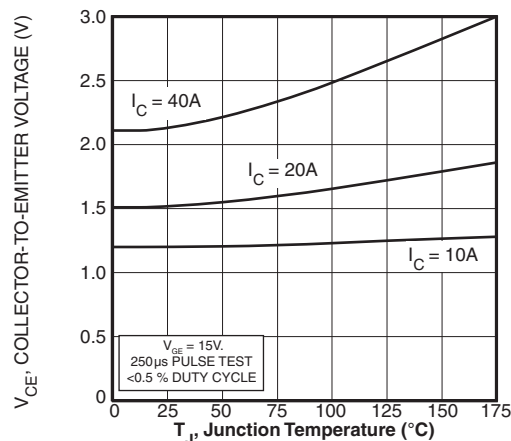


FIGURE 6, On State Voltage vs Junction Temperature

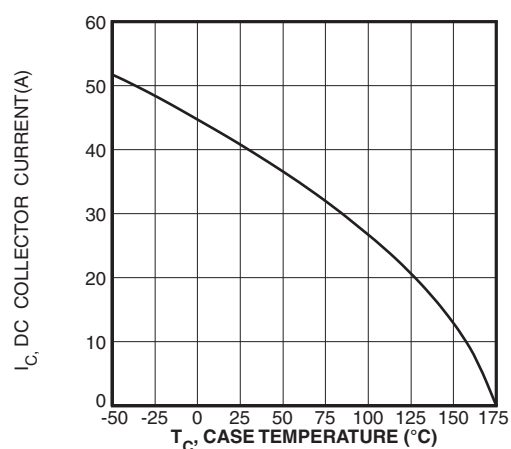


FIGURE 8, DC Collector Current vs Case Temperature

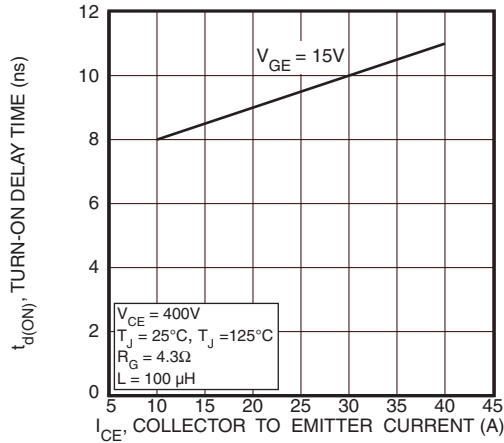


FIGURE 9, Turn-On Delay Time vs Collector Current

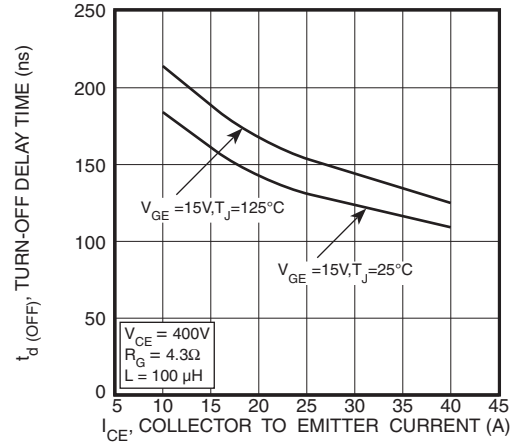


FIGURE 10, Turn-Off Delay Time vs Collector Current

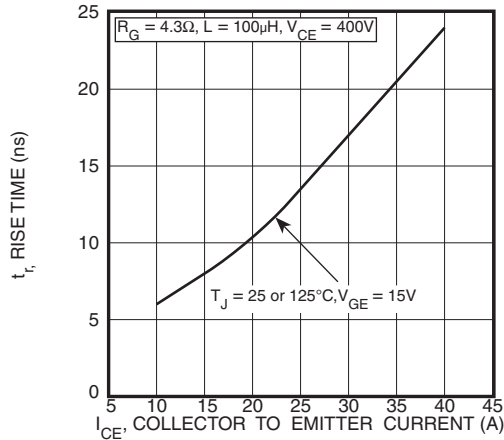


FIGURE 11, Current Rise Time vs Collector Current

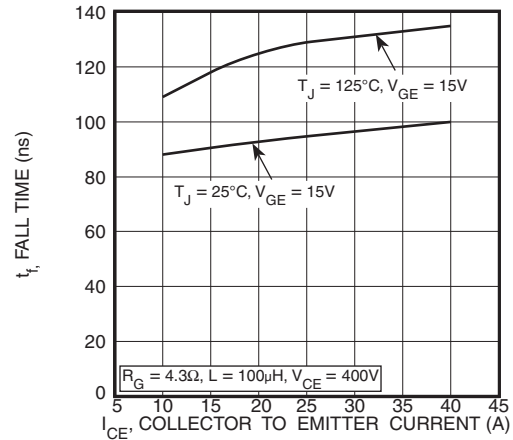


FIGURE 12, Current Fall Time vs Collector Current

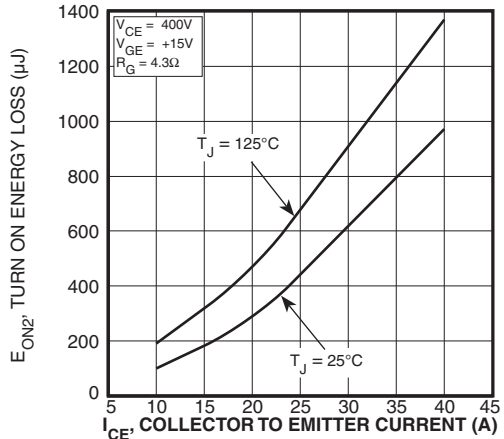


FIGURE 13, Turn-On Energy Loss vs Collector Current

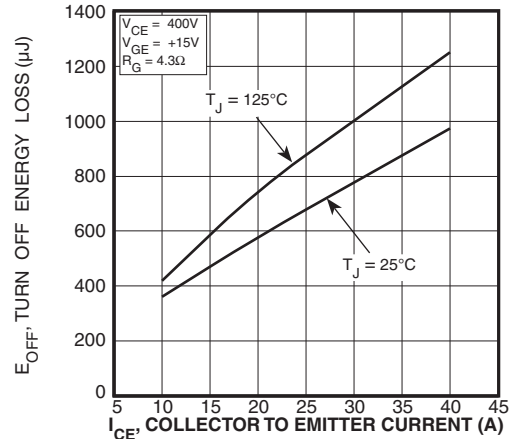


FIGURE 14, Turn Off Energy Loss vs Collector Current

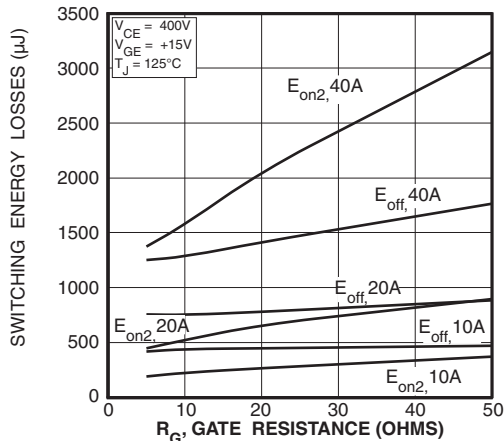


FIGURE 15, Switching Energy Losses vs. Gate Resistance

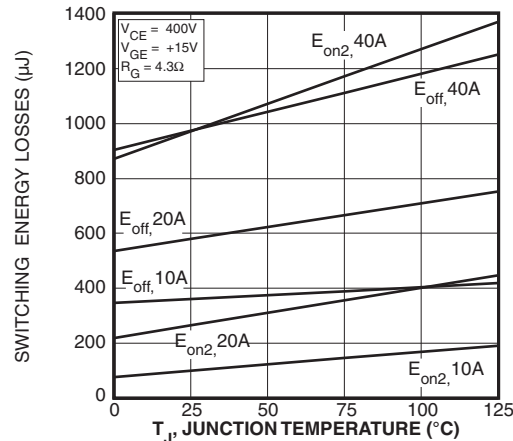


FIGURE 16, Switching Energy Losses vs Junction Temperature

## TYPICAL PERFORMANCE CURVES

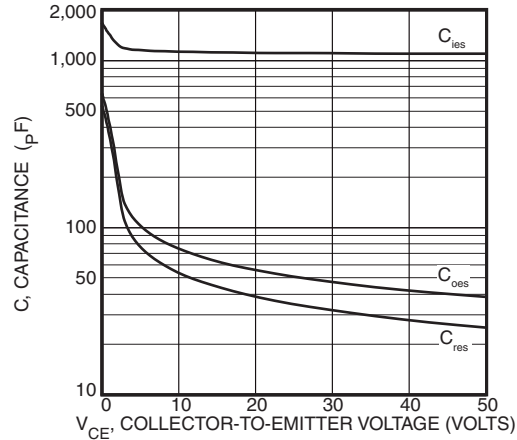


Figure 17, Capacitance vs Collector-To-Emitter Voltage

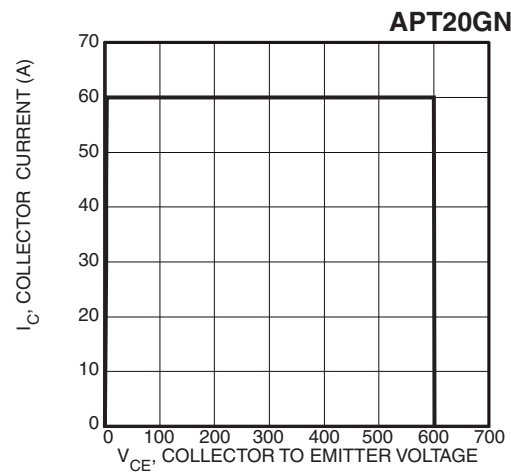


Figure 18, Minimum Switching Safe Operating Area

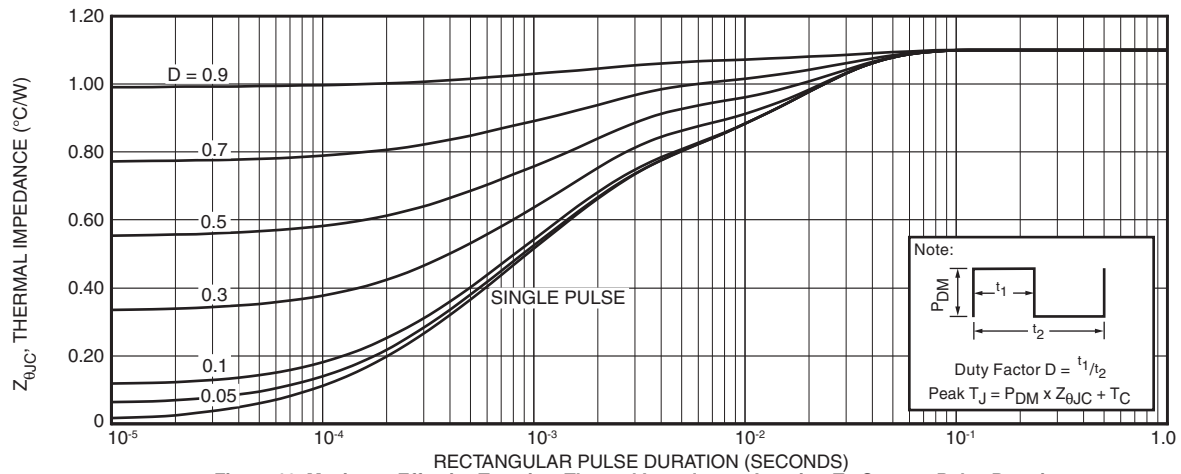


Figure 19, Maximum Effective Transient Thermal Impedance, Junction-To-Case vs Pulse Duration

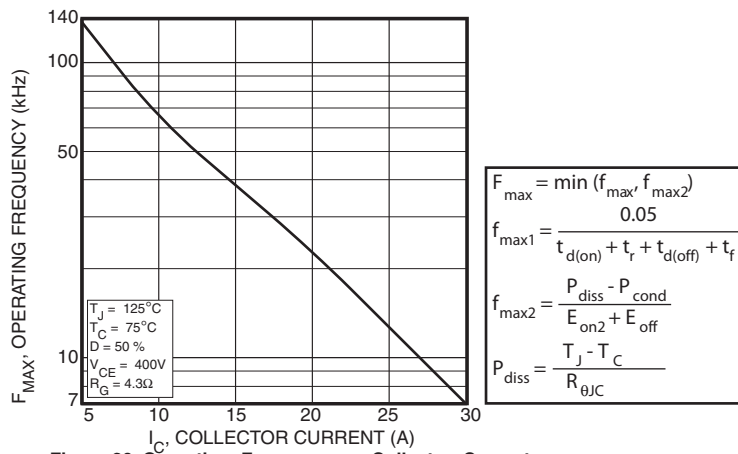


Figure 20, Operating Frequency vs Collector Current

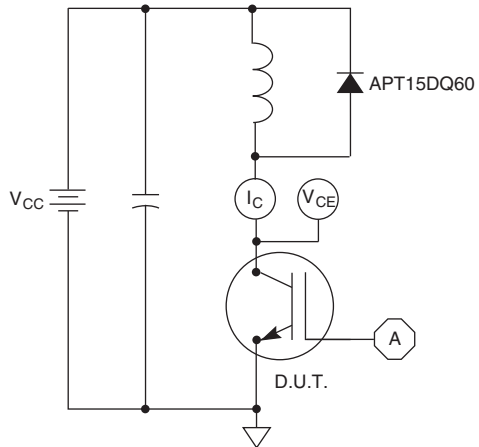


Figure 21, Inductive Switching Test Circuit

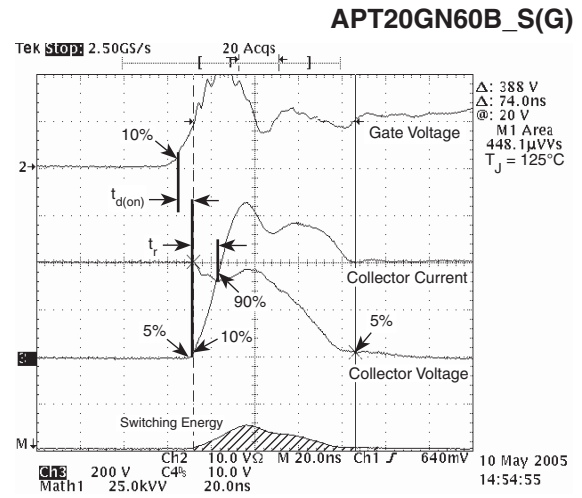


Figure 22, Turn-on Switching Waveforms and Definitions

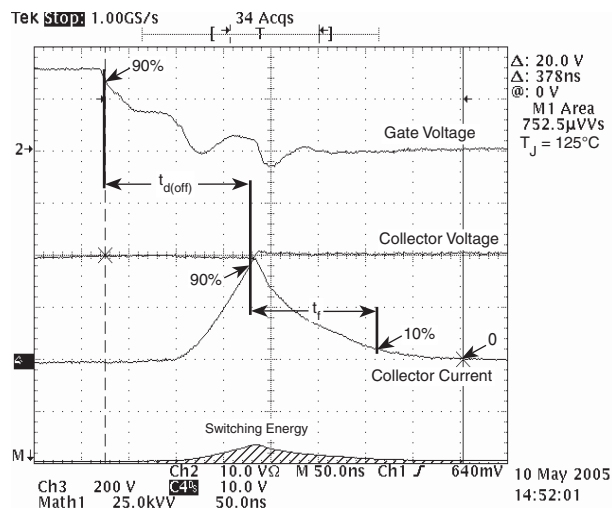
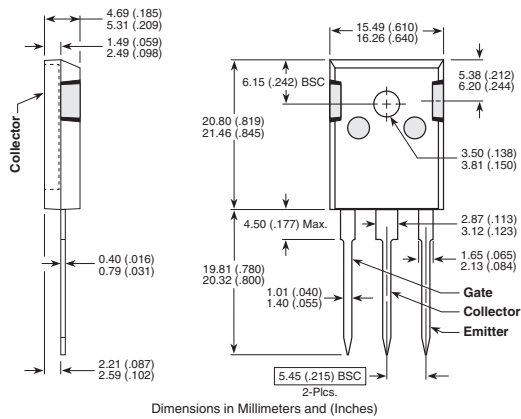


Figure 23, Turn-off Switching Waveforms and Definitions

## TO-247 Package Outline

e1 SAC: Tin, Silver, Copper



## D<sup>3</sup>PAK Package Outline

e3 SAC: Tin, Silver, Copper

