

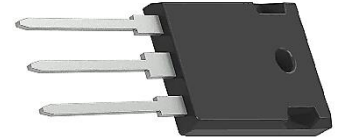
# Insulated Gate Bipolar Transistor 1200V 80A 357W TO-247

MIG120N80T247

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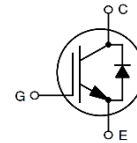
## FEATURE

- Trench Gate and Field Stop Processes IGBT
- Low  $V_{CE(sat)}$  and High Switching Speed
- Positive  $V_{CE(sat)}$  Temperature Coefficient
- Soft and Fast Recovery Freewheeling Diode
- Application: Uninterruptible Power Supplies, Solar Converters, Welding Machine, and Motor Drives, etc.



## MECHANICAL DATA

- Case: TO-247 Package
- Terminals: Solderable per MIL-STD-750, Method 2026



## MAXIMUM RATINGS

| Parameter                              |                                                                          | Symbol           | Value      | Unit |
|----------------------------------------|--------------------------------------------------------------------------|------------------|------------|------|
| Collector-to-Emitter Breakdown Voltage |                                                                          | V <sub>CES</sub> | 1200       | V    |
| Gate-to-Emitter Voltage                |                                                                          | V <sub>GES</sub> | ±20        | V    |
| Gate-to-Emitter Transient Voltage      |                                                                          |                  | ±30        |      |
| Collector Current – Continuous         | T <sub>C</sub> =25°C                                                     | I <sub>C</sub>   | 80         | A    |
|                                        | T <sub>C</sub> =100°C                                                    |                  | 40         |      |
| Collector Current – Pulsed             | tp limited by T <sub>jmax</sub>                                          | I <sub>CM</sub>  | 160        | A    |
| Diode Forward Current – Continuous     | T <sub>C</sub> =25°C                                                     | I <sub>F</sub>   | 80         | A    |
|                                        | T <sub>C</sub> =100°C                                                    |                  | 40         |      |
| Diode Forward Current – Pulsed         | limited by T <sub>jmax</sub>                                             | I <sub>FM</sub>  | 160        | A    |
| Turn-off Latching Current              | V <sub>CC</sub> =600V, V <sub>GE</sub> =15V,<br>T <sub>jmax</sub> =150°C | I <sub>LM</sub>  | 160        | A    |
| Short Circuit Current                  |                                                                          | I <sub>SC</sub>  | 260        | A    |
| Short Circuit Withstanding Time        |                                                                          | t <sub>sc</sub>  | 5          | µs   |
| Power Dissipation                      | T <sub>C</sub> =25°C                                                     | P <sub>D</sub>   | 357        | W    |
|                                        | T <sub>C</sub> =100°C                                                    |                  | 178        |      |
| Thermal Resistance Junction to Ambient |                                                                          | R <sub>θJA</sub> | 40         | °C/W |
| Thermal Resistance Junction to Case    | For IGBT                                                                 | R <sub>θJC</sub> | 0.42       | °C/W |
|                                        | For Diode                                                                |                  | 1.2        |      |
| Operating Junction Temperature Range   |                                                                          | T <sub>J</sub>   | -40 to 175 | °C   |
| Storage Temperature Range              |                                                                          | T <sub>STG</sub> | -55 to 150 | °C   |
| Maximum Soldering Temperature          |                                                                          | T <sub>L</sub>   | 260        | °C   |

# Insulated Gate Bipolar Transistor

## 1200V 80A 357W TO-247

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### ELECTRICAL CHARACTERISTICS

| Static Characteristics               | Conditions                                                                                | Symbol        | Min  | Typ.  | Max       | Unit     |
|--------------------------------------|-------------------------------------------------------------------------------------------|---------------|------|-------|-----------|----------|
| Collector-Emitter Breakdown Voltage  | $V_{GE}=0V, I_{CE}=1mA$                                                                   | $BV_{CES}$    | 1200 | --    | --        | V        |
| Zero Gate Voltage Collector Current  | $V_{CE}=1200V, V_{GE}=0V$                                                                 | $I_{CES}$     | --   | --    | 1         | mA       |
| Gate-Emitter Leakage Current         | $V_{GE}=\pm 20V$                                                                          | $I_{GES}$     | --   | --    | $\pm 250$ | nA       |
|                                      | $V_{GE}=\pm 30V$                                                                          |               | --   | --    | $\pm 500$ | nA       |
| Collector-Emitter Saturation Voltage | $V_{GE}=15V, I_C=40A, T_J=25^\circ C$                                                     | $V_{CE(SAT)}$ | --   | 1.7   | --        | V        |
|                                      | $V_{GE}=15V, I_C=40A, T_J=125^\circ C$                                                    |               | --   | 2.0   | --        |          |
|                                      | $V_{GE}=15V, I_C=40A, T_J=150^\circ C$                                                    |               | --   | 2.1   | --        |          |
| Gate-Emitter Threshold Voltage       | $V_{CE}=V_{GE}, I_C=250\mu A$                                                             | $V_{GE(th)}$  | 4.5  | --    | 7.5       | V        |
| Diode Forward Voltage                | $I_F=40A, T_J=25^\circ C$                                                                 | $V_F$         | --   | 2.7   | --        | V        |
|                                      | $I_F=40A, T_J=125^\circ C$                                                                |               | --   | 2.0   | --        |          |
|                                      | $I_F=40A, T_J=150^\circ C$                                                                |               | --   | 1.9   | --        |          |
| Dynamic Characteristics              | Conditions                                                                                | Symbol        | Min  | Typ.  | Max       | Unit     |
| Total Gate Charge                    | $V_{CE}=960V, V_{GE}=15V, I_C=40A$                                                        | $Q_g$         | --   | 172.6 | --        | nC       |
| Gate-Emitter Charge                  |                                                                                           | $Q_{ge}$      | --   | 43.3  | --        |          |
| Gate-Collector Charge                |                                                                                           | $Q_{gc}$      | --   | 95.6  | --        |          |
| Input Capacitance                    | $V_{CE}=30V, V_{GE}=0V, F=1MHz$                                                           | $C_{ies}$     | --   | 4225  | --        | pF       |
| Output Capacitance                   |                                                                                           | $C_{oes}$     | --   | 125   | --        |          |
| Reverse Transfer Capacitance         |                                                                                           | $C_{res}$     | --   | 27.5  | --        |          |
| Gate Resistance                      | $V_{CC}=0V, V_{GE}=0V, F=1MHz$                                                            | $R_g$         | --   | 1.0   | --        | $\Omega$ |
| Switching Characteristics            | Conditions                                                                                | Symbol        | Min  | Typ.  | Max       | Unit     |
| Turn-On Delay Time                   | $V_{CE}=600V, V_{GE}=15V, R_G=10\Omega$<br>$I_C=40A, T_J=25^\circ C$ ,<br>Inductive Load  | $T_{d(on)}$   | --   | 41    | --        | ns       |
| Rise Time                            |                                                                                           | $T_r$         | --   | 93    | --        |          |
| Turn-Off Delay Time                  |                                                                                           | $T_{d(off)}$  | --   | 171   | --        |          |
| Fall Time                            |                                                                                           | $T_f$         | --   | 66    | --        |          |
| Turn-On Switching Energy             |                                                                                           | $E_{on}$      | --   | 3     | --        | mJ       |
| Turn-Off Switching Energy            | $V_{CE}=600V, V_{GE}=15V, R_G=10\Omega$<br>$I_C=40A, T_J=125^\circ C$ ,<br>Inductive Load | $E_{off}$     | --   | 1.4   | --        |          |
| Total Switching Energy               |                                                                                           | $E_{ts}$      | --   | 4.4   | --        |          |
| Turn-On Delay Time                   |                                                                                           | $T_{d(on)}$   | --   | 32    | --        | ns       |
| Rise Time                            |                                                                                           | $T_r$         | --   | 85    | --        |          |
| Turn-Off Delay Time                  |                                                                                           | $T_{d(off)}$  | --   | 201   | --        |          |
| Fall Time                            |                                                                                           | $T_f$         | --   | 102   | --        |          |
| Turn-On Switching Energy             | $V_R=600V, I_F=40A$ ,<br>$di_F/dt=100A/\mu s$                                             | $E_{on}$      | --   | 2.9   | --        | mJ       |
| Turn-Off Switching Energy            |                                                                                           | $E_{off}$     | --   | 1.9   | --        |          |
| Total Switching Energy               |                                                                                           | $E_{ts}$      | --   | 4.8   | --        |          |
| Reverse Recovery Time                | $V_R=600V, I_F=40A$ ,<br>$di_F/dt=100A/\mu s$                                             | $t_{rr}$      | --   | 69.5  | --        | ns       |
| Reverse Recovery Charge              |                                                                                           | $Q_{rr}$      | --   | 149.6 | --        | nC       |
| Peak Reverse Recovery Current        |                                                                                           | $I_{rr}$      | --   | 3.73  | --        | A        |

Note:

1. Allowed number of short circuits: < 1000; time between short circuits: > 1s
2. During overload conditions, allow operation at the maximum junction temperature,  $T_J = 175^\circ C$ , with a maximum duty cycle of 20% (60s at most)
3. Including the reverse recovery of the diode

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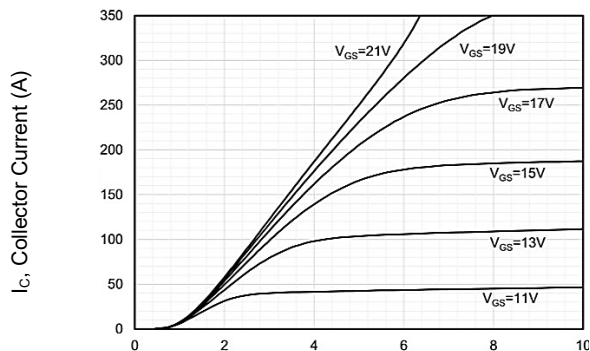
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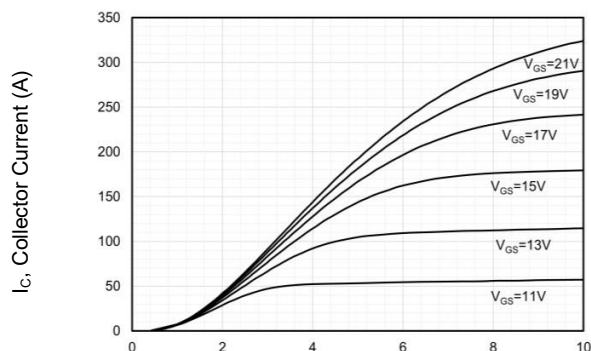
### CHARACTERISTIC CURVES

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



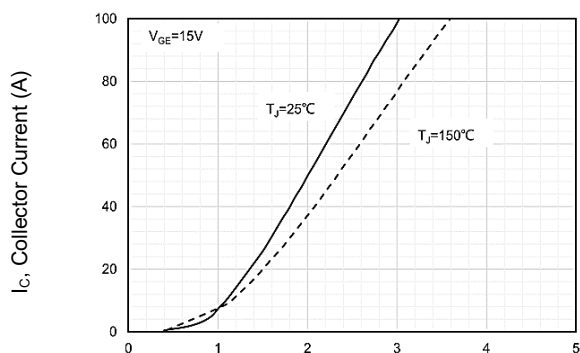
$V_{CE}$ , Collector-to-Emitter Voltage (V)

Output Characteristics ( $T_J = 150^\circ\text{C}$ )



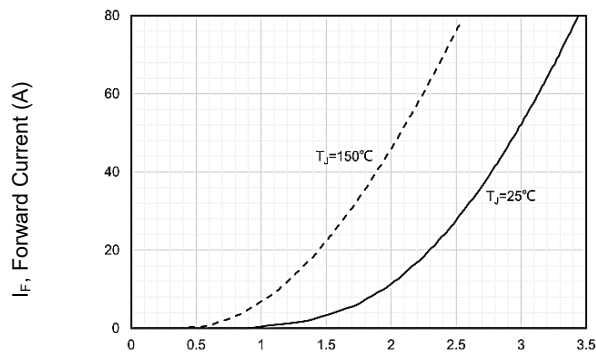
$V_{CE}$ , Collector-to-Emitter Voltage (V)

Collector-Emitter Saturation Voltage



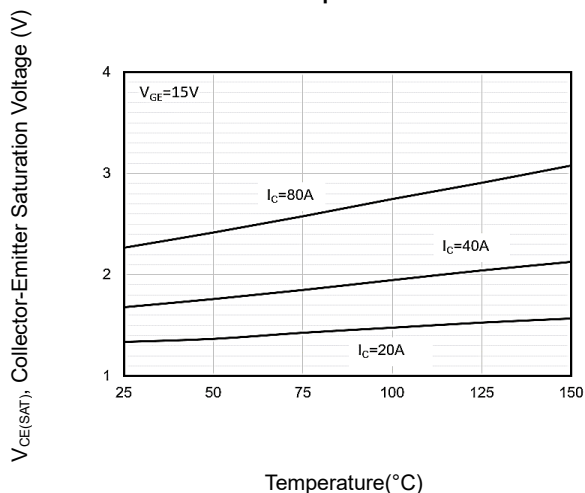
$V_{CE}$ , Collector-Emitter Voltage (V)

Diode Characteristic

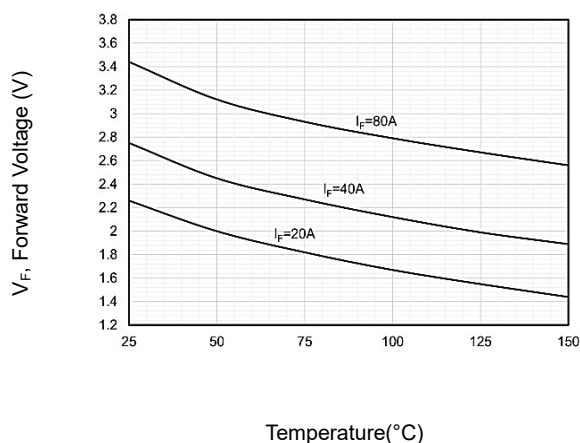


$V_F$ , Forward Voltage (V)

Collector-Emitter Saturation Voltage vs Junction Temperature



Diode Forward Voltage vs Junction Temperature



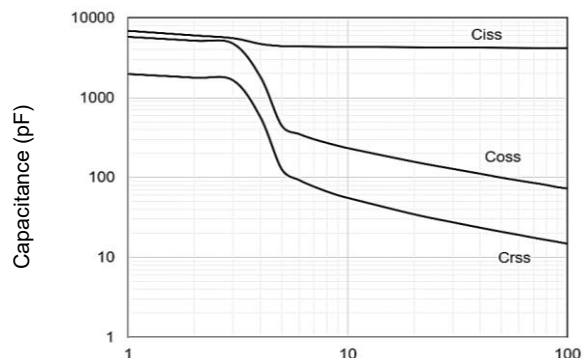
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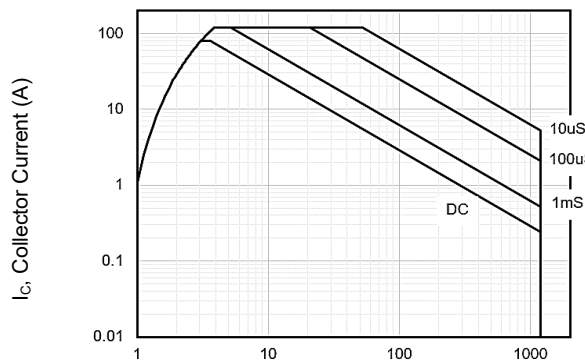
## CHARACTERISTIC CURVES

Capacitance Characteristics



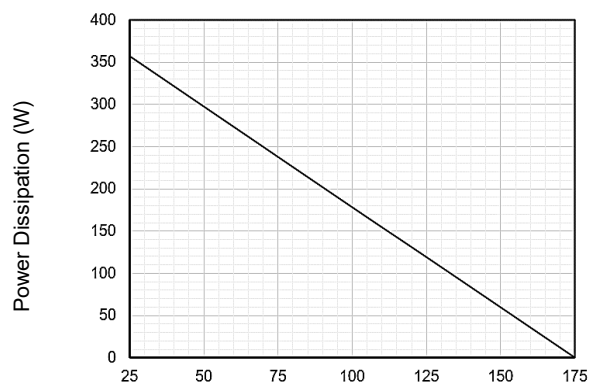
$V_{CE}$ , Collector-to-Emitter Voltage (V)

Forward Bias Safe Operating Area ( $T_C=25^\circ\text{C}$ ,  $V_{GE}=15\text{V}$ )



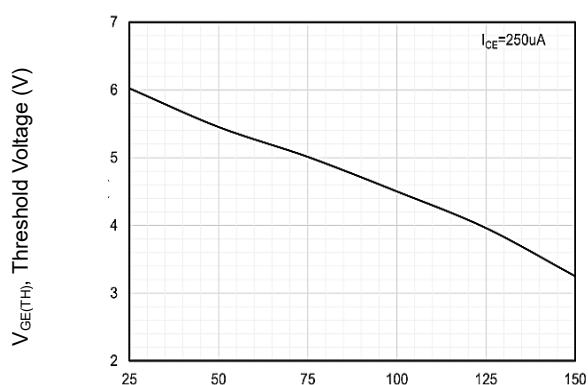
$V_{CE}$ , Collector-to-Emitter Voltage (V)

Power Dissipation as a Function of Case Temperature



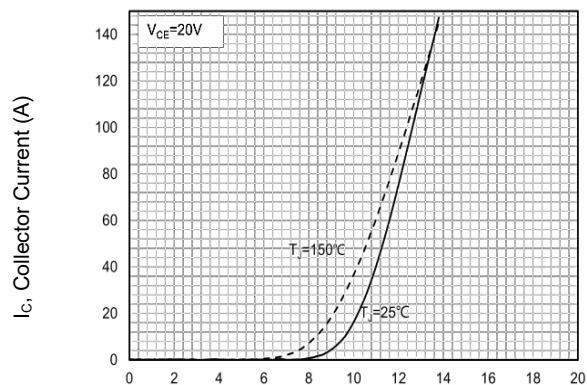
Case Temperature ( $^\circ\text{C}$ )

Threshold Voltage vs Junction Temperature



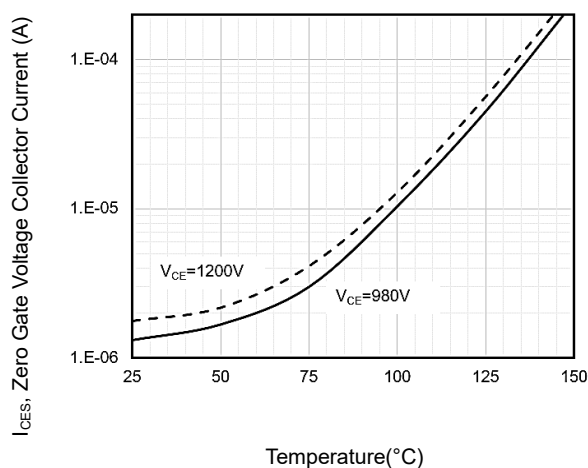
Temperature ( $^\circ\text{C}$ )

Transfer Characteristic



$V_{GE}$ , Gate-to-Emitter Voltage (V)

Reverse Leakage Current vs Junction Temperature



Temperature ( $^\circ\text{C}$ )

# Insulated Gate Bipolar Transistor

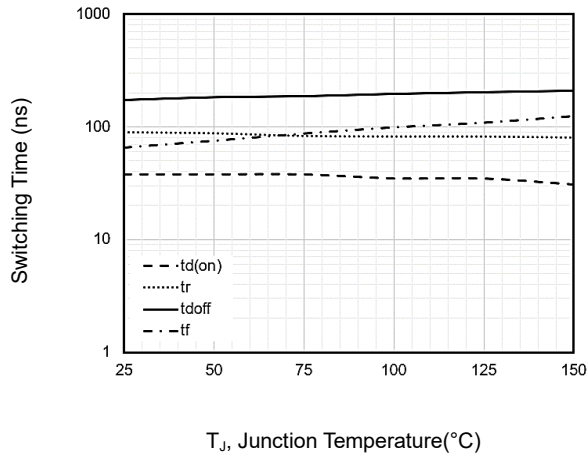
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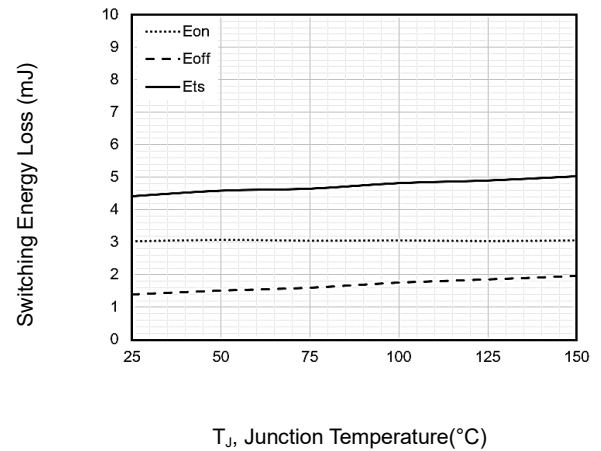
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### CHARACTERISTIC CURVES

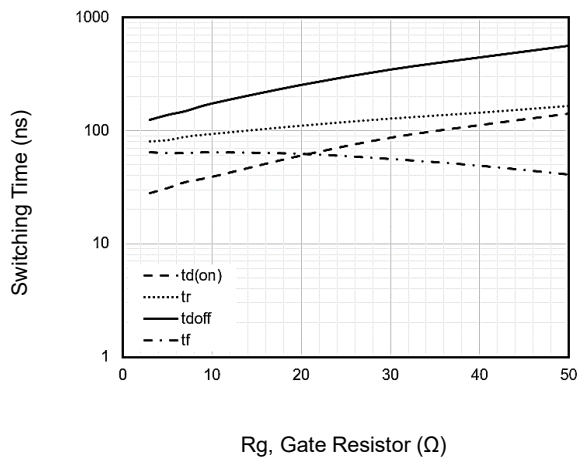
Typical Switching Time vs Junction Temperature



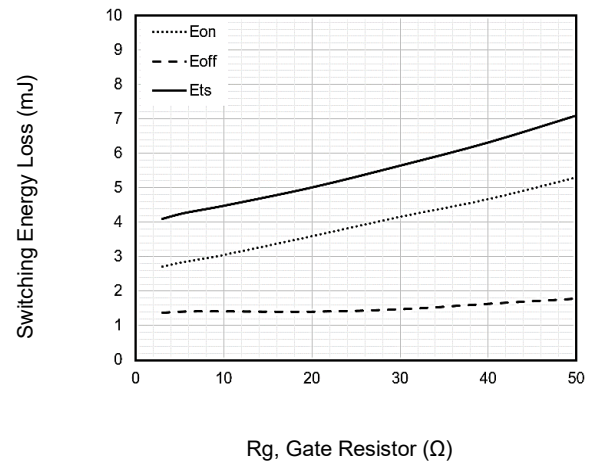
Typical Switching Energy Loss vs Junction Temperature



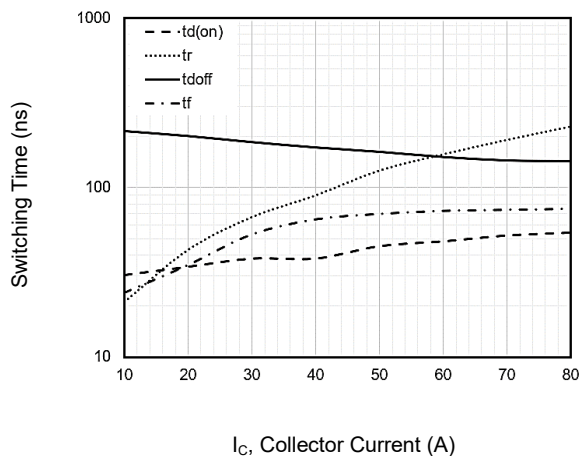
Typical Switching Time vs Gate Resistor



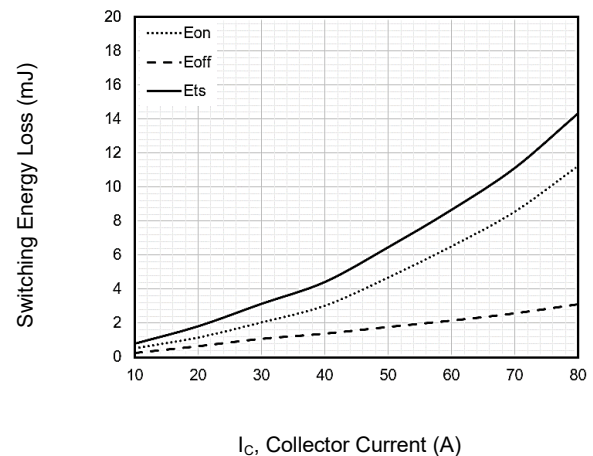
Typical Switching Energy Loss vs Gate Resistor



Typical Switching Time vs Collector Current



Typical Switching Energy Loss vs Collector Current



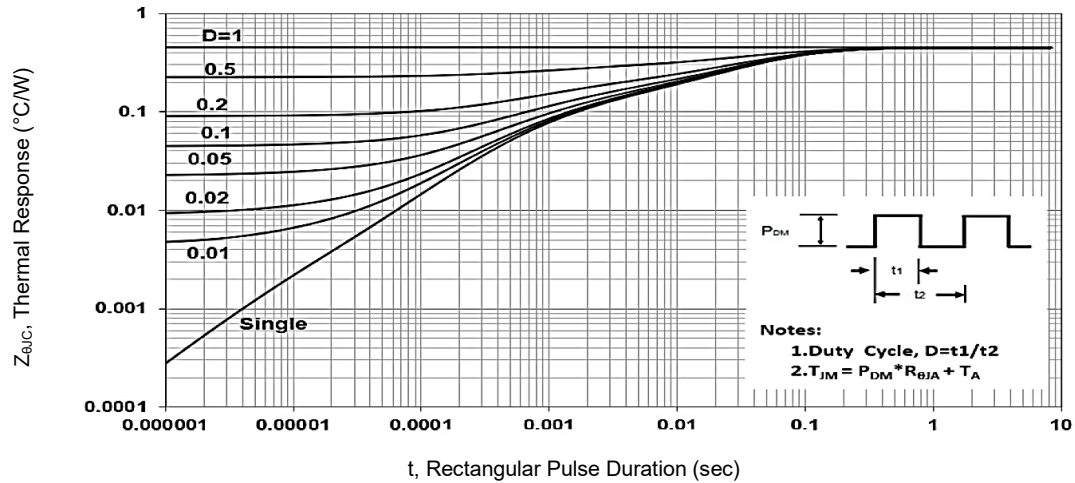
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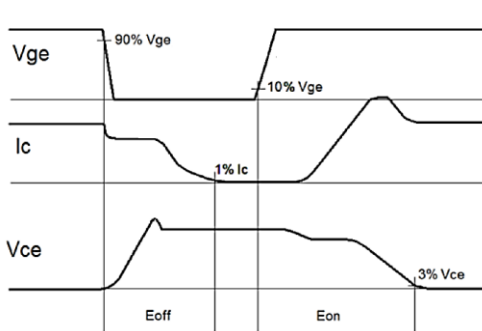
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## CHARACTERISTIC CURVES

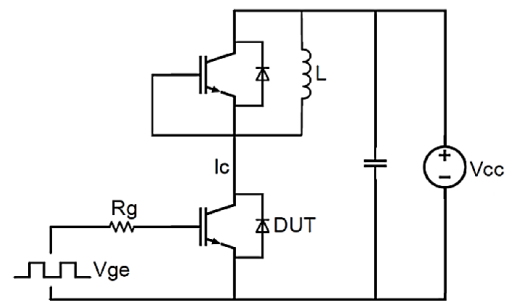
Normalized Transient Thermal Impedance for IGBT



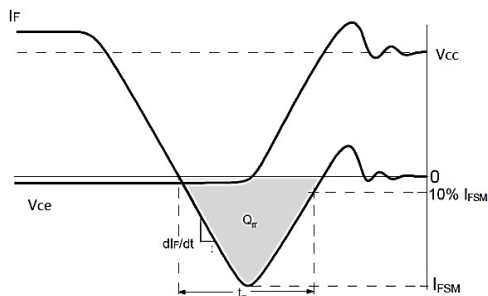
Switching Time Waveform



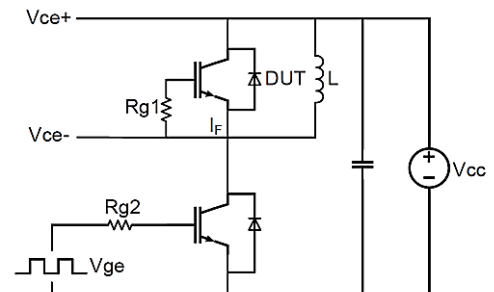
Switching Test Circuit



Switching Time Waveform



Switching Test Circuit



# Insulated Gate Bipolar Transistor

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### DIMENSIONS

| TO-247 | Min   | Max   |
|--------|-------|-------|
| A      | 4.90  | 5.10  |
| A1     | 2.31  | 2.51  |
| A2     | 1.90  | 2.10  |
| b      | 1.15  | 1.25  |
| b1     | 2.95  | 3.25  |
| b2     | 1.95  | 2.25  |
| c      | 0.55  | 0.65  |
| D      | 20.90 | 21.10 |
| D1     | 16.35 | 16.75 |
| e      | 5.40  | 5.48  |
| e1     | 5.40  | 5.48  |
| E      | 15.70 | 15.90 |
| E1     | 13.10 | 13.40 |
| E2     | 4.85  | 5.10  |
| L      | 19.80 | 20.15 |
| L1     | --    | 4.30  |
| p      | 3.40  | 3.60  |
| p1     | 6.90  | 7.30  |
| Q      | 5.60  | 6.00  |
| S      | 6.05  | 6.25  |

Note: 1: Gate(G), 2: Collector(C), 3: Emitter (E).

