

## Features

- Low switching losses
- Maximum junction temperature 175 °C
- Positive temperature coefficient
- High ruggedness, temperature stable
- High short circuit capability(5us)
- Halogen Free. "Green" Device (Note 1)
- Epoxy Meets UL 94 V-0 Flammability Rating
- Lead Free Finish/RoHS Compliant ("P" Suffix Designates RoHS Compliant. See Ordering Information)

## Applications

- AC and DC servo drive amplifier
- Uninterruptible power supply
- Motion/servo control

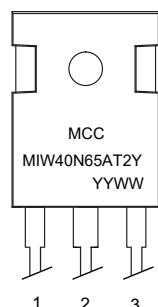
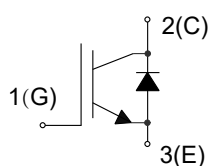
## Maximum Ratings

| Parameter                                                                    | Symbol       | Rating | Unit |
|------------------------------------------------------------------------------|--------------|--------|------|
| Collector-Emitter Voltage                                                    | $V_{CE}$     | 650    | V    |
| DC Collector Current <sup>(2)</sup>                                          | $I_C$        | 80     | A    |
|                                                                              |              | 40     |      |
| Pulsed Collector Current <sup>(3)</sup> $V_{GE}=15V$                         | $I_{CM}$     | 120    | A    |
| Diode Forward Current <sup>(2)</sup>                                         | $I_F$        | 80     | A    |
|                                                                              |              | 40     |      |
| Diode Pulsed Current <sup>(3)</sup>                                          | $I_{F,puls}$ | 120    | A    |
| Gate-Emitter Voltage                                                         | $V_{GE}$     | ±20    | V    |
| Transient Gate-Emitter Voltage <sup>(4)</sup>                                |              | ±30    |      |
| Short Circuit Withstand Time<br>$V_{GE}=15V, V_{CC}=400V, V_{CEM} \leq 650V$ | $t_{SC}$     | 5      | µs   |
| Turn off Safe Operating Area<br>$V_{CE} \leq 650V, T_J = 150^\circ C$        |              | 120    | A    |
| Power Dissipation, $T_J = 175^\circ C, T_C = 25^\circ C$                     | $P_D$        | 187    | W    |

Note:

1. Halogen free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
2. Limited by  $T_{Jmax}$ .
3.  $t_p$  limited by  $T_{Jmax}$ .
4.  $t_p \leq 10\mu s, D \leq 0.01$

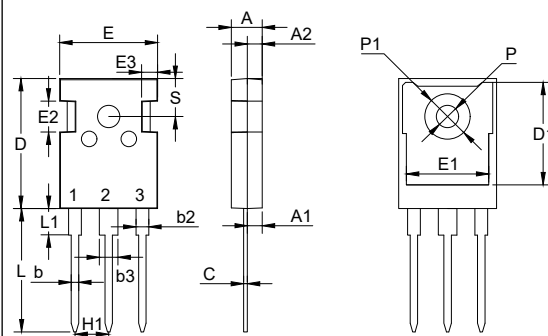
## Internal Structure



Device Code: MIW40N65AT2Y  
Date Code: YYWW (Year & Week)

# Trench and Field Stop IGBT 650V 40A

## TO-247AB



### DIMENSIONS

| DIM | INCHES |       | MM    |       | NOTE |
|-----|--------|-------|-------|-------|------|
|     | MIN    | MAX   | MIN   | MAX   |      |
| A   | 0.189  | 0.205 | 4.80  | 5.20  |      |
| A1  | 0.087  | 0.103 | 2.21  | 2.61  |      |
| A2  | 0.073  | 0.085 | 1.85  | 2.15  |      |
| b   | 0.039  | 0.055 | 1.00  | 1.40  |      |
| b2  | 0.075  | 0.087 | 1.91  | 2.21  |      |
| C   | 0.020  | 0.028 | 0.50  | 0.70  |      |
| D   | 0.815  | 0.839 | 20.70 | 21.30 |      |
| D1  | 0.640  | 0.663 | 16.25 | 16.85 |      |
| E   | 0.610  | 0.634 | 15.50 | 16.10 |      |
| E1  | 0.512  | 0.535 | 13.00 | 13.60 |      |
| E2  | 0.189  | 0.205 | 4.80  | 5.20  |      |
| E3  | 0.091  | 0.106 | 2.30  | 2.70  |      |
| L   | 0.772  | 0.796 | 19.62 | 20.22 |      |
| L1  | -      | 0.169 | -     | 4.30  |      |
| P   | 0.134  | 0.150 | 3.40  | 3.80  | Φ    |
| P1  |        | 0.287 | -     | 7.30  | Φ    |
| S   | 0.242  |       | 6.15  |       | TYP  |
| H1  | 0.214  |       | 5.44  |       | TYP  |
| b3  | 0.110  | 0.126 | 2.80  | 3.20  |      |

**Electrical Characteristics @ 25°C (Unless Otherwise Specified)**

| Parameter                             | Symbol        | Test Conditions                                                                         | Min | Typ  | Max  | Unit    |
|---------------------------------------|---------------|-----------------------------------------------------------------------------------------|-----|------|------|---------|
| <b>Static Characteristics</b>         |               |                                                                                         |     |      |      |         |
| Collector-Emitter Breakdown Voltage   | $V_{(BR)CES}$ | $V_{GE}=0V, I_C=250\mu A$                                                               | 650 |      |      | V       |
| Collector-Emitter Saturation Voltage  | $V_{CE(sat)}$ | $V_{GE}=15V, I_C=40A, T_J=25^\circ C$                                                   |     | 1.60 | 1.90 | V       |
|                                       |               | $V_{GE}=15V, I_C=40A, T_J=125^\circ C$                                                  |     | 1.85 |      |         |
|                                       |               | $V_{GE}=15V, I_C=40A, T_J=150^\circ C$                                                  |     | 2.00 |      |         |
| G-E Threshold Voltage                 | $V_{GE(th)}$  | $I_C=1mA, V_{GE}=V_{CE}$                                                                | 4.1 | 5.1  | 6.1  | V       |
| C-E Leakage Current                   | $I_{CES}$     | $V_{CE}=650V, V_{GE}=0V, T_J=25^\circ C$                                                |     |      | 0.25 | mA      |
|                                       |               | $V_{CE}=650V, V_{GE}=0V, T_J=150^\circ C$                                               |     |      | 4.0  |         |
| G-E Leakage Current                   | $I_{GES}$     | $V_{CE}=0V, V_{GE}=\pm 20V$                                                             |     |      | 100  | nA      |
| <b>Dynamic Characteristics</b>        |               |                                                                                         |     |      |      |         |
| Input Capacitance                     | $C_{ies}$     | $V_{CE}=25V, V_{GE}=0V, f=1MHz$                                                         |     | 2.03 |      | nF      |
| Reverse Transfer Capacitance          | $C_{res}$     |                                                                                         |     | 0.02 |      |         |
| Gate Charge                           | $Q_g$         | $V_{CC}=400V, I_C=40A, V_{GE}=15V$                                                      |     | 0.14 |      | $\mu C$ |
| Short Circuit Collector Current       | $I_{sc}$      | $V_{GE}=15V, t_{sc}\leq 5\mu s, V_{CC}=400V$                                            |     | 185  |      | A       |
| <b>IGBT Switching Characteristics</b> |               |                                                                                         |     |      |      |         |
| Turn-On Delay Time                    | $t_{d(on)}$   | $V_{CC}=400V, I_C=40A, V_{GE}=-5\sim 15V, R_G=20\Omega, T_J=25^\circ C$                 |     | 55   |      | ns      |
| Rise Time                             | $t_r$         |                                                                                         |     | 72   |      |         |
| Turn-Off Delay Time                   | $t_{d(off)}$  |                                                                                         |     | 129  |      |         |
| Fall Time                             | $t_f$         |                                                                                         |     | 116  |      |         |
| Turn-On Energy                        | $E_{on}$      |                                                                                         |     | 1.34 |      | mJ      |
| Turn-Off Energy                       | $E_{off}$     |                                                                                         |     | 0.91 |      |         |
| Turn-On Delay Time                    | $t_{d(on)}$   | $V_{CC}=400V, I_C=40A, V_{GE}=-5\sim 15V, R_G=20\Omega, T_J=125^\circ C$                |     | 52   |      | ns      |
| Rise Time                             | $t_r$         |                                                                                         |     | 74   |      |         |
| Turn-Off Delay Time                   | $t_{d(off)}$  |                                                                                         |     | 140  |      |         |
| Fall Time                             | $t_f$         |                                                                                         |     | 159  |      |         |
| Turn-On Energy                        | $E_{on}$      |                                                                                         |     | 1.47 |      | mJ      |
| Turn-Off Energy                       | $E_{off}$     |                                                                                         |     | 1.14 |      |         |
| Turn-On Delay Time                    | $t_{d(on)}$   | $V_{CC}=400V, I_C=40A, V_{GE}=-5\sim 15V, R_G=20\Omega, T_J=150^\circ C$ Inductive Load |     | 50   |      | ns      |
| Rise Time                             | $t_r$         |                                                                                         |     | 75   |      |         |
| Turn-Off Delay Time                   | $t_{d(off)}$  |                                                                                         |     | 144  |      |         |
| Fall Time                             | $t_f$         |                                                                                         |     | 178  |      |         |
| Turn-On Energy                        | $E_{on}$      |                                                                                         |     | 1.53 |      | mJ      |
| Turn-Off Energy                       | $E_{off}$     |                                                                                         |     | 1.24 |      |         |

# Electrical Characteristics @ 25°C (Unless Otherwise Specified)

| Parameter                     | Symbol           | Test Conditions                                                                                  | Min | Typ  | Max  | Unit |
|-------------------------------|------------------|--------------------------------------------------------------------------------------------------|-----|------|------|------|
| Diode Static Characteristics  |                  |                                                                                                  |     |      |      |      |
| Diode Forward Voltage         | V <sub>F</sub>   | I <sub>F</sub> =40A, T <sub>J</sub> =25℃                                                         |     | 1.60 | 2.10 | V    |
|                               |                  | I <sub>F</sub> =40A, T <sub>J</sub> =125℃                                                        |     | 1.40 |      |      |
|                               |                  | I <sub>F</sub> =40A, T <sub>J</sub> =150℃                                                        |     | 1.45 |      |      |
| Diode Dynamic Characteristics |                  |                                                                                                  |     |      |      |      |
| Reverse Recovery Current      | I <sub>rr</sub>  | V <sub>R</sub> =400V, I <sub>F</sub> =40A,<br>-di <sub>F</sub> /dt=470A/μs, T <sub>J</sub> =25℃  |     | 14   |      | A    |
| Reverse Recovery Charge       | Q <sub>rr</sub>  |                                                                                                  |     | 0.60 |      | uC   |
| Diode reverse recovery time   | t <sub>rr</sub>  |                                                                                                  |     | 79   |      | ns   |
| Reverse Recovery Energy       | E <sub>rec</sub> |                                                                                                  |     | 0.10 |      | mJ   |
| Reverse Recovery Current      | I <sub>rr</sub>  | V <sub>R</sub> =400V, I <sub>F</sub> =40A,<br>-di <sub>F</sub> /dt=470A/μs, T <sub>J</sub> =125℃ |     | 20   |      | A    |
| Reverse Recovery Charge       | Q <sub>rr</sub>  |                                                                                                  |     | 1.31 |      | μC   |
| Diode reverse recovery time   | t <sub>rr</sub>  |                                                                                                  |     | 125  |      | ns   |
| Reverse Recovery Energy       | E <sub>rec</sub> |                                                                                                  |     | 0.25 |      | mJ   |
| Reverse Recovery Current      | I <sub>rr</sub>  | V <sub>R</sub> =400V, I <sub>F</sub> =40A,<br>-di <sub>F</sub> /dt=470A/μs, T <sub>J</sub> =150℃ |     | 22   |      | A    |
| Reverse Recovery Charge       | Q <sub>rr</sub>  |                                                                                                  |     | 1.62 |      | μC   |
| Diode reverse recovery time   | t <sub>rr</sub>  |                                                                                                  |     | 144  |      | ns   |
| Reverse Recovery Energy       | E <sub>rec</sub> |                                                                                                  |     | 0.32 |      | mJ   |

## Thermal characteristics

| Parameter                                        | Symbol         | Min | Typ | Max  | Units         |
|--------------------------------------------------|----------------|-----|-----|------|---------------|
| Operating Junction Temperature Range             | $T_J$          | -40 |     | 175  | $^{\circ}C$   |
| Storage Temperature Range                        | $T_{stg}$      | -55 |     | 150  | $^{\circ}C$   |
| Thermal Resistance from Junction to Case (IGBT)  | $R_{th_{J-C}}$ |     |     | 0.8  | $^{\circ}C/W$ |
| Thermal Resistance from Junction to Case (Diode) | $R_{th_{J-C}}$ |     |     | 1.05 | $^{\circ}C/W$ |
| Thermal Resistance from Junction to Ambient      | $R_{th_{J-A}}$ |     |     | 40   | $^{\circ}C/W$ |

## Curve Characteristics

Fig. 1 - Typical Output Characteristic ( $T_j = 25^\circ\text{C}$ )

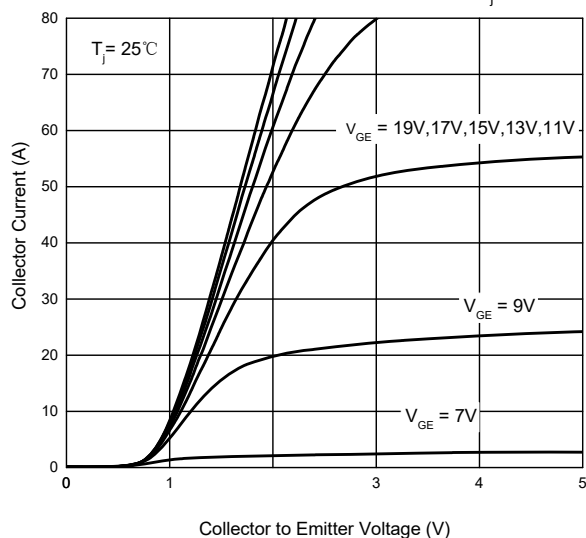


Fig. 2 - Typical Output Characteristic ( $T_j = 150^\circ\text{C}$ )

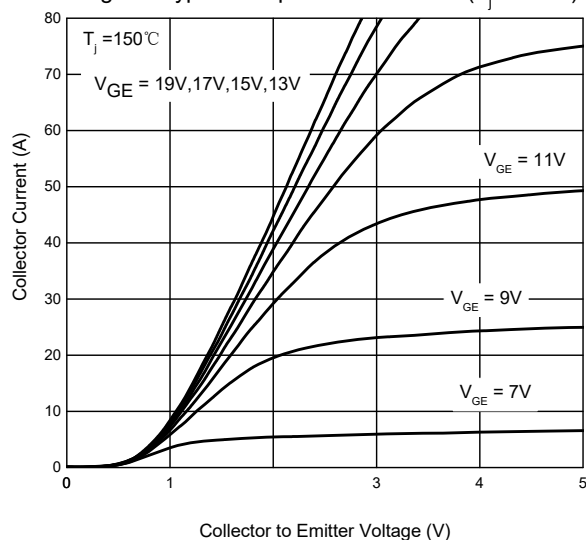


Fig. 3 - Typical Transfer Characteristic

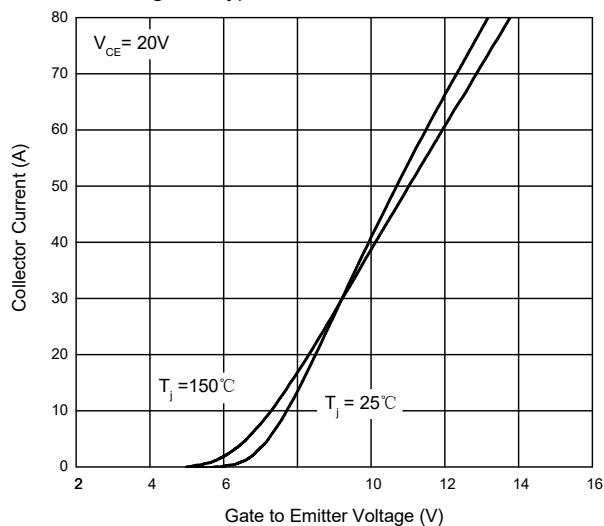


Fig. 4 - Diode Forward Current vs. Forward Voltage

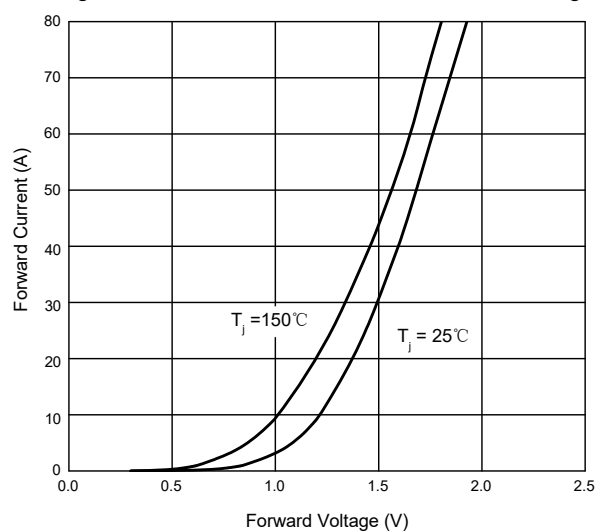


Fig. 5 - Capacitance Characteristics

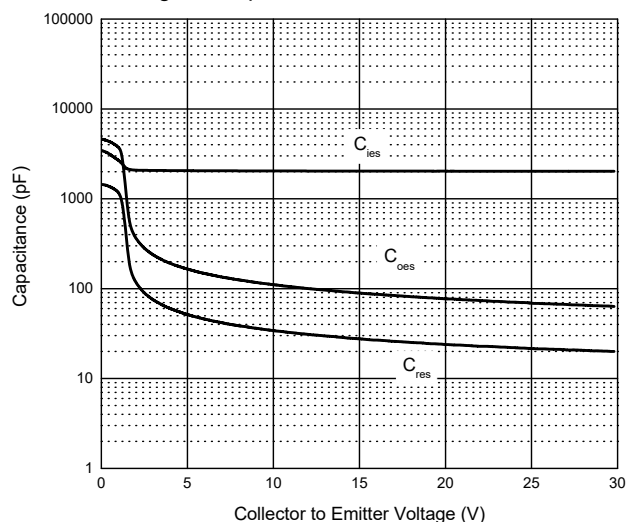
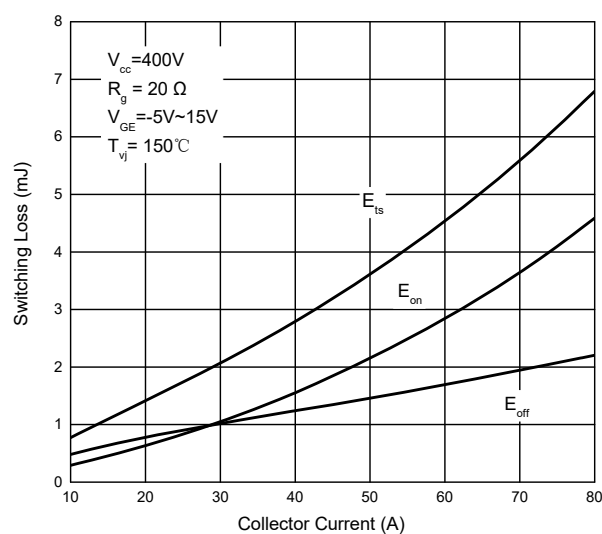


Fig. 6 - IGBT Switching Loss vs. IC



## Curve Characteristics

Fig. 7 - IGBT Switching Loss vs. Junction Temperature

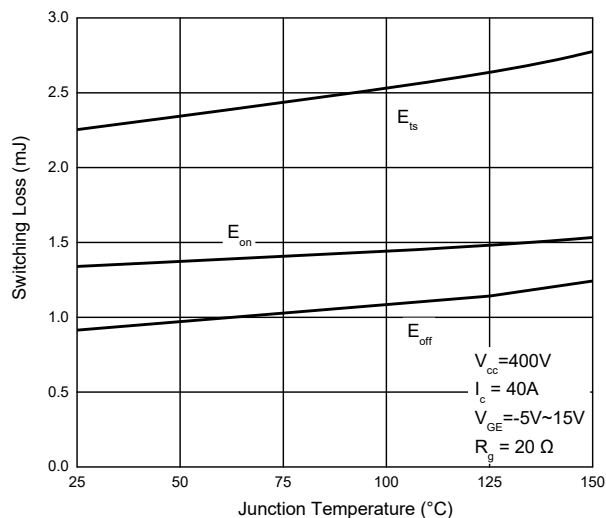


Fig. 8 - Switching Loss vs.  $V_{CE}$

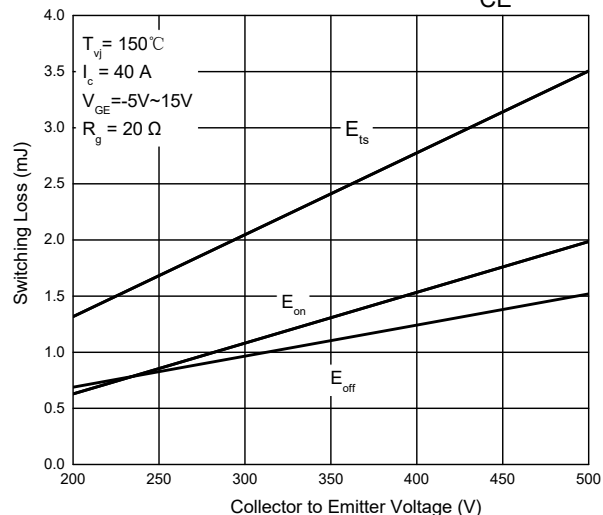


Fig. 9 -  $V_{GE(th)}$  vs. Junction Temperature

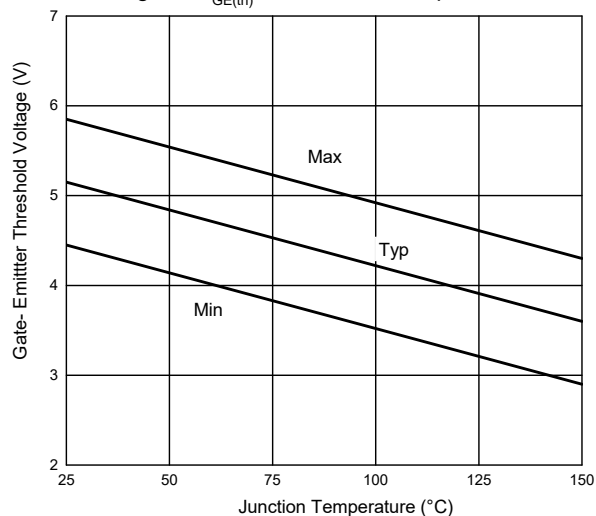


Fig. 10 - Switching Time vs. Collect Current

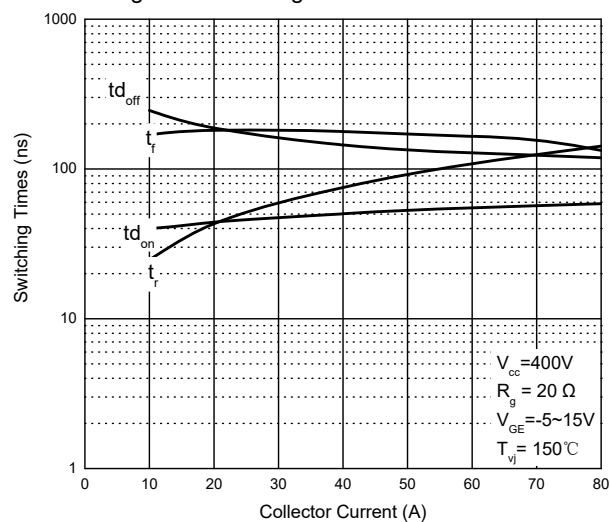


Fig. 11 - IGBT Transient Thermal Impedance

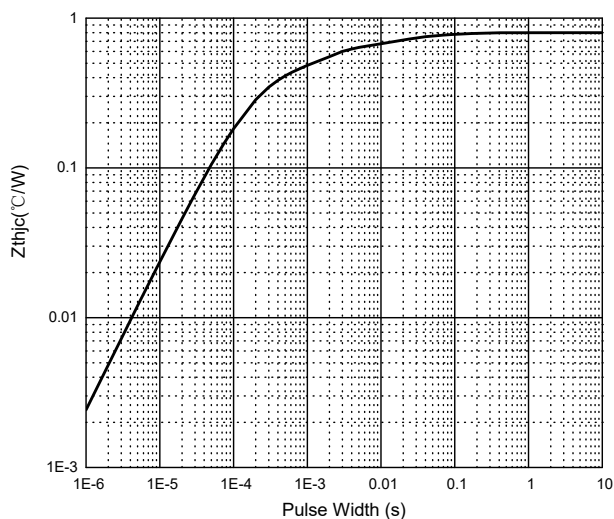
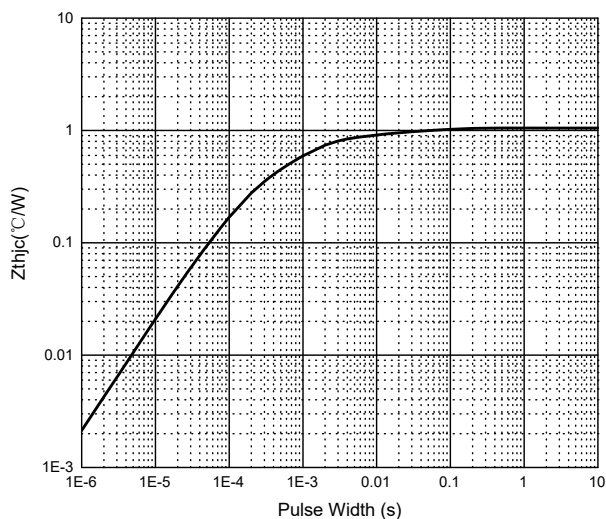


Fig. 12 - Diode Transient Thermal Impedance



## Curve Characteristics

Fig. 13 - Collector Current vs. Case Temperature

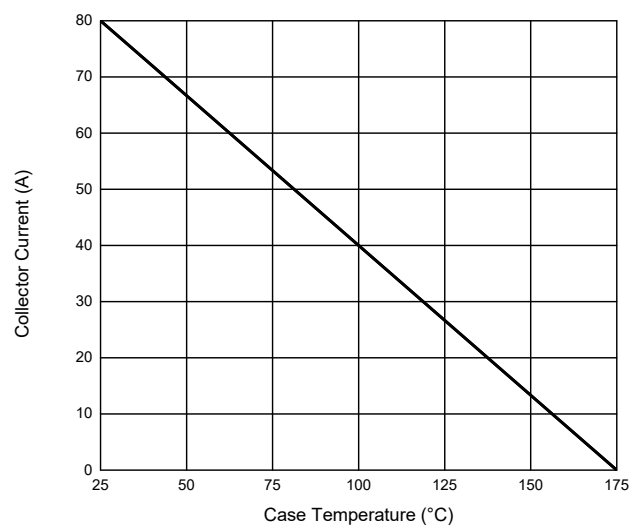
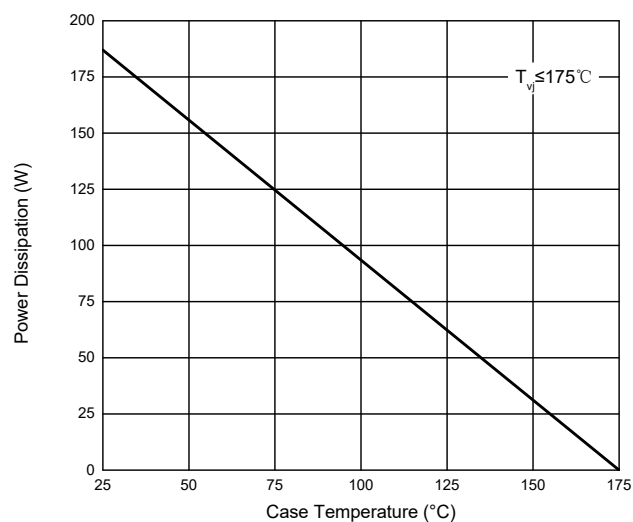


Fig. 14 - Power Derating



## Ordering Information

| Device         | Packing                       |
|----------------|-------------------------------|
| Part Number-BP | Tube: 30pcs/Tube, 1800pcs/Ctn |

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