



# TT060U065FB

## 主要参数 MAIN CHARACTERISTICS

|                        |      |
|------------------------|------|
| I <sub>c</sub>         | 60A  |
| V <sub>CE</sub>        | 650V |
| V <sub>CEsat-typ</sub> | 1.9V |

### 用途

- PFC
- 储能

### APPLICATIONS

- Power factor corrector (PFC)
- Energy Storage

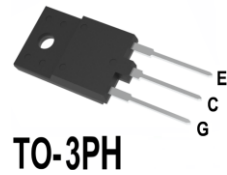
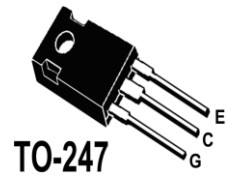
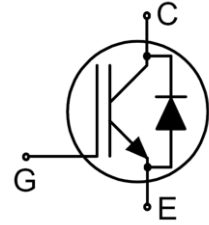
### 产品特性

- 低栅极电荷
- Trench FS 技术
- RoHS 产品
- 快开关速度
- 低开关损耗
- V<sub>CE(sat)</sub> 正温度系数

### FEATURES

- Low gate charge
- Trench FS Technology
- RoHS product
- Fast switching speed
- Low switching losses
- V<sub>CE(sat)</sub> with positive temperature coefficient

## 封装 Package



## 订货信息 ORDER MESSAGE

| 订货型号 Order codes        | 印记 Marking  | 封装 Package |
|-------------------------|-------------|------------|
| 无卤-条管 Halogen-Free-Tube |             |            |
| TT060U065FB-GE-BR       | TT060U065FB | TO-247     |
| TT060U065FB-GA-BR       | TT060U065FB | TO-3PH     |

绝对最大额定值 ABSOLUTE RATINGS ( $T_C=25^{\circ}\text{C}$ )

| 项 目<br>Parameter  | 符 号<br>Symbol   | 数 值 Value                        | 单 位<br>Unit        |
|---|---|----------------------------------|--------------------|
| 最高集电极—发射极直流电压<br>Collector-emitter voltage  | $V_{CE}$  | 650                              | V                  |
| *连续集电极电流<br>Collector current-continuous  | $I_C$   | 120( $T_C=25^{\circ}\text{C}$ )  | A                  |
|   |   | 60( $T_C=100^{\circ}\text{C}$ )  | A                  |
| 最大脉冲集电极极电流 (注1)<br>Collector current – pulse (note 1)   | $I_{CM}$  | 240                              | A                  |
| *二极管正向测试电流<br>Diode RMS forward current   | $I_F$   | 80 ( $T_C=25^{\circ}\text{C}$ )  | A                  |
|   |   | 40 ( $T_C=100^{\circ}\text{C}$ ) | A                  |
| 二极管正向不重复峰值电流 (浪涌电流)<br>Surge non repetitive forward current $t_p=10\text{ ms}$<br>sinusoidal                      | $I_{FSM}$   | 160                              | A                  |
| 最高栅极发射极电压<br>Gate-emitter voltage   | $V_{GE}$  | $\pm 20$                         | V                  |
| 瞬态栅极发射极电压<br>Transient gate-emitter voltage<br>( $t_p \leq 10\mu\text{s}$ , $D < 0.010$ )                         | $V_{GE}$  | $\pm 30$                         | V                  |
| 安全工作区<br>Turn-off safe area<br>$V_{CE} \leq 650\text{V}$ , $T_{vj} \leq 175^{\circ}\text{C}$ , $t_p=1\mu\text{s}$ | -   | 240                              | A                  |
| 耗散功率(TO-247)<br>Power dissipation   | $P_D$ $T_C=25^{\circ}\text{C}$<br>$P_D$ $T_C=100^{\circ}\text{C}$ | 375                              | W                  |
|   |   | 187                              |                    |
| 耗散功率(TO-3PH)<br>Power dissipation   | $P_D$ $T_C=25^{\circ}\text{C}$<br>$P_D$ $T_C=100^{\circ}\text{C}$ | 90                               | W                  |
|   |   | 45                               |                    |
| 工作结温 (注2)<br>Operating junction temperature range   | $T_{vj}$  | $-40 \sim +175$                  | $^{\circ}\text{C}$ |
| 存储温度<br>Storage temperature   | $T_{STG}$   | $-55 \sim +150$                  | $^{\circ}\text{C}$ |
| 引线最高焊接温度<br>Maximum lead temperature for soldering<br>purposes  | $T_L$   | 260                              | $^{\circ}\text{C}$ |

\*连续集电极电流由最高结温限制。

\*Collector current limited by maximum junction temperature.

For optimum lifetime and reliability, JSMC recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet

注释:

1: 脉冲宽度由最高结温限制。

2: 过载工况时, 允许在最高结温  $T_{vjop}=175^{\circ}\text{C}$  下运行, 最大占空比  $< 20\%$  (最多持续 60s)

Notes:

1: Pulse width limited by maximum junction temperature.

2: Under overload condition, it is allowed to operate at the maximum junction temperature  $T_{vjop}=175^{\circ}\text{C}$ , and the maximum duty ratio is less than 20% (lasting for 60 s at most)





## 电特性 ELECTRICAL CHARACTERISTICS

| 项 目<br>Parameter                                  | 符 号<br>Symbol | 测试条件<br>Tests conditions   | 最小<br>Min | 典型<br>Typ  | 最大<br>Max | 单位<br>Units |
|---|---------------|--|-----------|------------|-----------|-------------|
| <b>关态特性 Off –Characteristics</b>                  |               |  |           |            |           |             |
| 集电极-发射极击穿电压<br>Collector-emitter voltage          | $BV_{CES}$    | $I_C=250\mu A, V_{GE}=0V$  | 650       | -          | -         | V           |
| 零栅压下集电极漏电流<br>Zero gate voltage collector current | $I_{CES}$     | $V_{CE}=650V, V_{GE}=0V, T_{vj}=25^\circ C$                          | -         | -          | 80        | $\mu A$     |
| 正向栅极体漏电流<br>Gate-body leakage current, forward    | $I_{GESF}$    | $V_{CE}=0V, V_{GE}=20V, T_{vj}=25^\circ C$                           | -         | -          | 200       | nA          |
| 反向栅极体漏电流<br>Gate-body leakage current, reverse    | $I_{GESR}$    | $V_{CE}=0V, V_{GE}=-20V, T_{vj}=25^\circ C$                          | -         | -          | -200      | nA          |
| <b>通态特性 On-Characteristics</b>                    |               |  |           |            |           |             |
| 阈值电压<br>Gate threshold voltage                    | $V_{GE(th)}$  | $V_{CE} = V_{GE}, I_C=0.6mA$   | 3.5       | 4.5        | 5.5       | V           |
| 饱和压降<br>Collector-emitter saturation voltage      | $V_{CESAT}$   | $V_{GE}=15V, I_C=60A$<br>$T_{vj}=25^\circ C$<br>$T_{vj}=150^\circ C$ | -<br>-    | 1.9<br>2.3 | 2.3<br>-  | V           |
| <b>动态特性 Dynamic Characteristics</b>               |               |  |           |            |           |             |
| 输入电容<br>Input capacitance                         | $C_{ies}$     | $V_{CE}=25V$<br>$V_{GE}=0V$<br>$f=1.0MHz$                            | -         | 3280       | -         | pF          |
| 输出电容<br>Output capacitance                        | $C_{oes}$     |  | -         | 213        | -         | pF          |
| 反向传输电容<br>Reverse transfer capacitance            | $C_{res}$     |  | -         | 36         | -         | pF          |
| 栅极电荷总量 Total gate charge                          | $Q_g$         | $V_{CC}=480V, I_C=60A, V_{GE}=15V$                                   | -         | 128        | -         | nC          |
| 栅极-发射极 Gate to emitter charge                     | $Q_{ge}$      |  | -         | 21         | -         |             |
| 栅极-集电极 Gate to collector charge                   | $Q_{gc}$      |  | -         | 71         | -         |             |



## 电特性 ELECTRICAL CHARACTERISTICS

## 开关特性 Switching Characteristics

| 项 目<br>Parameter             | 符 号<br>Symbol | 测试条件<br>Tests conditions  | 最小<br>Min | 典型<br>Typ | 最大<br>Max | 单位<br>Units |
|------------------------------|---------------|---|-----------|-----------|-----------|-------------|
| 开启延迟时间 Turn-on delay time    | $t_{d(on)}$   | $V_{CC}=400V, I_c=60A, R_G=5\Omega$<br>$V_{GE}=15V$<br>$T_{vj}=25^\circ C$  | -         | 12        | -         | ns          |
| 上升时间 Turn-on rise time       | $t_r$         |   | -         | 80        | -         | ns          |
| 关断延迟时间 Turn-off delay time   | $t_{d(off)}$  |   | -         | 98        | -         | ns          |
| 下降时间 Turn-off fall time      | $t_f$         |   | -         | 82        | -         | ns          |
| 开通损耗 Turn-on energy          | Eon           |   | -         | 1.46      | -         | mJ          |
| 关断损耗 Turn-off energy         | Eoff          |   | -         | 1.34      | -         | mJ          |
| 总开关损耗 Total switching energy | Etot          |   | -         | 2.80      | -         | mJ          |
| 开启延迟时间 Turn-on delay time    | $t_{d(on)}$   | $V_{CC}=400V, I_c=60A, R_G=5\Omega$<br>$V_{GE}=15V$<br>$T_{vj}=150^\circ C$ | -         | 14        | -         | ns          |
| 上升时间 Turn-on rise time       | $t_r$         |   | -         | 80        | -         | ns          |
| 关断延迟时间 Turn-off delay time   | $t_{d(off)}$  |   | -         | 122       | -         | ns          |
| 下降时间 Turn-off fall time      | $t_f$         |   | -         | 112       | -         | ns          |
| 开通损耗 Turn-on energy          | Eon           |   | -         | 1.60      | -         | mJ          |
| 关断损耗 Turn-off energy         | Eoff          |   | -         | 1.84      | -         | mJ          |
| 总开关损耗 Total switching energy | Etot          |   | -         | 3.44      | -         | mJ          |

## 反并联二极管特性及最大额定值 Anti-Parallel Diode Characteristics and Maximum Ratings

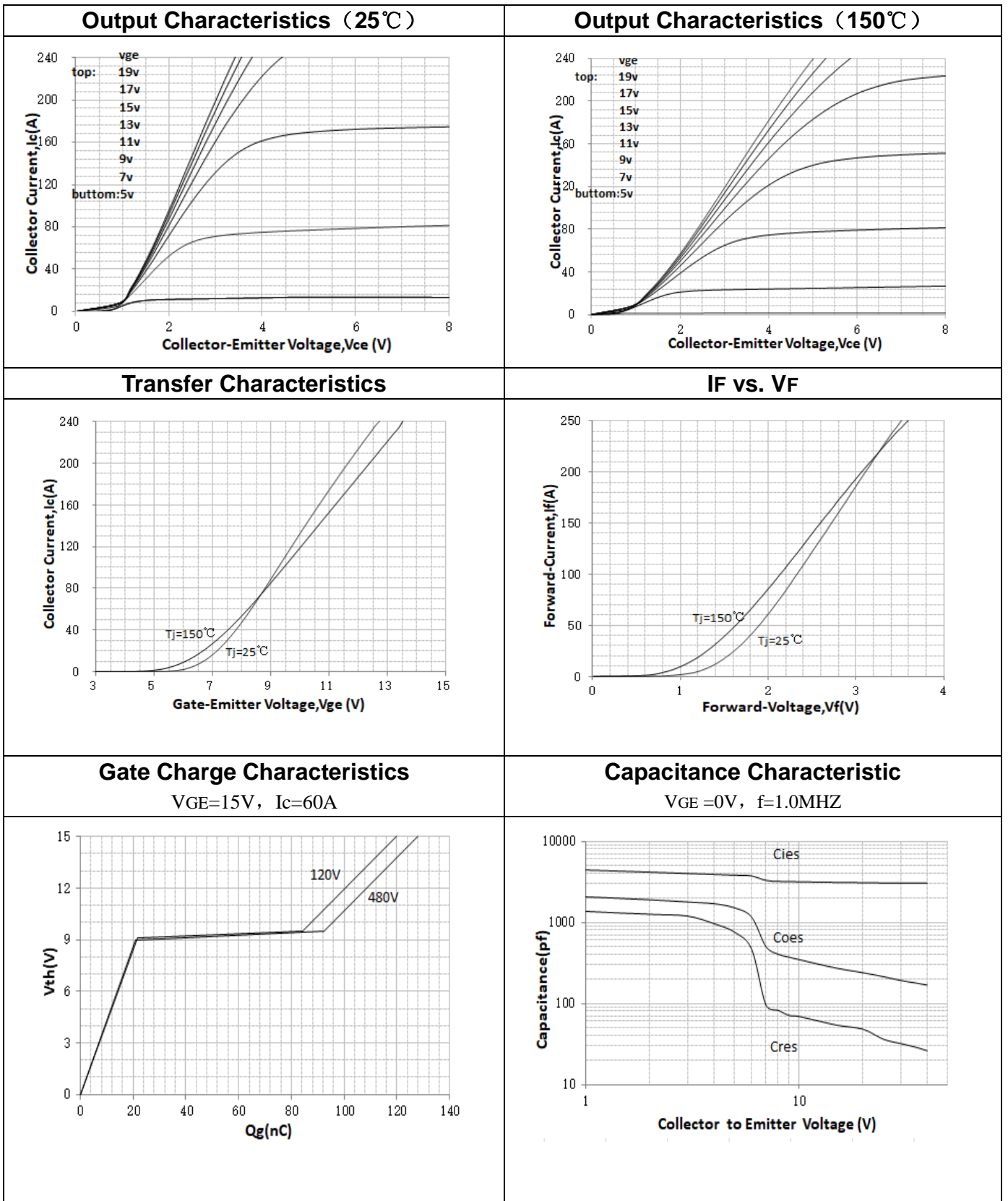
|  |           |   |   |      |     |    |
|--|-----------|---|---|------|-----|----|
| 正向压降 Diode forward voltage               | $V_F$     | $I_F=30A, T_{vj}=25^\circ C$  | - | 1.7  | 2.1 | V  |
| 反向恢复时间<br>Diode reverse recovery time    | $t_{rr}$  | $V_R=400V, I_F=30A$<br>$dI_F/dt=200A/\mu s$<br>$T_{vj}=25^\circ C$  | - | 156  | -   | ns |
| 反向恢复电荷<br>Diode reverse recovery charge  | $Q_{rr}$  |   | - | 418  | -   | nC |
| 反向恢复电流<br>Diode reverse recovery current | $I_{rrm}$ |   | - | 4.3  | -   | A  |
| 反向恢复时间<br>Diode reverse recovery time    | $t_{rr}$  | $V_R=400V, I_F=30A$<br>$dI_F/dt=200A/\mu s$<br>$T_{vj}=150^\circ C$ | - | 223  | -   | ns |
| 反向恢复电荷<br>Diode reverse recovery charge  | $Q_{rr}$  |   | - | 1586 | -   | nC |
| 反向恢复电流<br>Diode reverse recovery current | $I_{rrm}$ |   | - | 11.9 | -   | A  |

| 项 目 Parameter                  | 符 号 Symbol    | MAX    |        | 单 位 Unit     |
|--------------------------------|---------------|--------|--------|--------------|
|                                |               | TO-247 | TO-3PH |              |
| 结到管壳的热阻 Junction to case IGBT  | $R_{th(j-c)}$ | 0.4    | 1.65   | $^\circ C/W$ |
| 结到管壳的热阻 Junction to case Diode | $R_{th(j-c)}$ | 1.0    | 2.5    | $^\circ C/W$ |
| 结到环境的热阻 Junction to ambient    | $R_{th(j-a)}$ | 40     | 40     | $^\circ C/W$ |





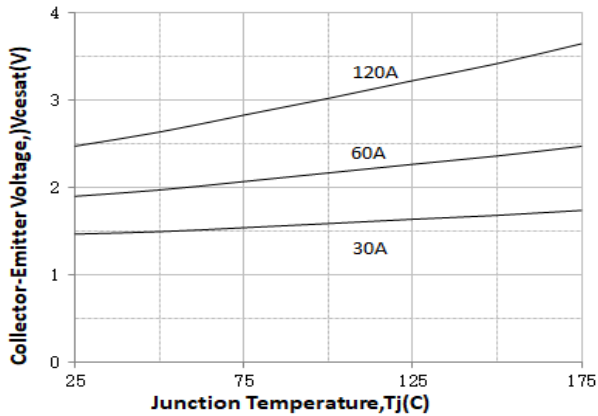
特征曲线 ELECTRICAL CHARACTERISTICS (curves)





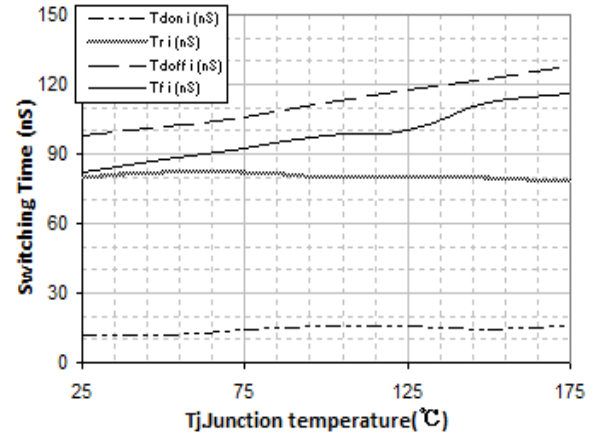
**V<sub>CESAT</sub> vs. T<sub>j</sub>**

V<sub>GE</sub>=15V, I<sub>c</sub>=30A, 60A, 120A



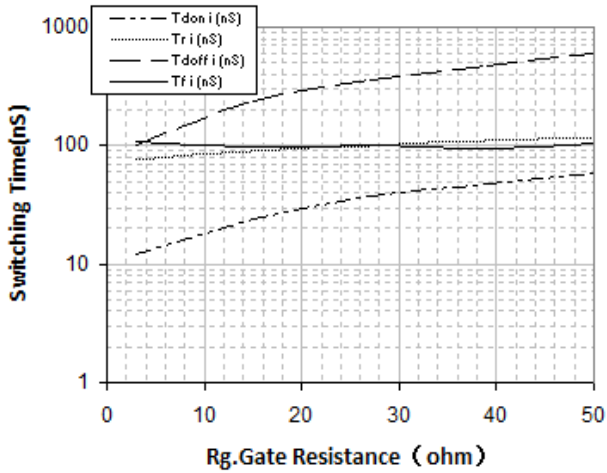
**Switching Time vs. T<sub>j</sub>**

V<sub>GE</sub>=15V, V<sub>CE</sub>=400V, I<sub>c</sub>=60A, R<sub>G</sub>=5Ω



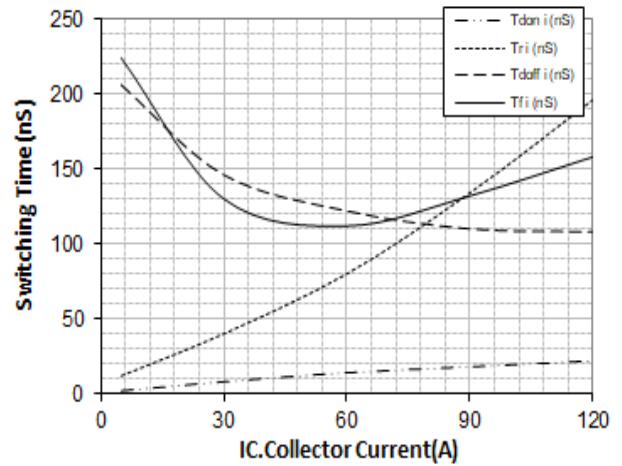
**Switching Time vs. R<sub>G</sub>(150°C)**

V<sub>GE</sub>=15V, V<sub>CE</sub>=400V, I<sub>c</sub>=60A



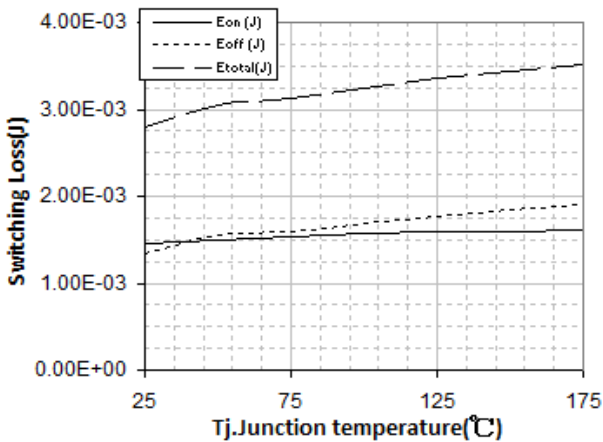
**Switching Time vs. I<sub>c</sub>(150°C)**

V<sub>CE</sub>=400V, V<sub>GE</sub>=15V, R<sub>G</sub>=5Ω



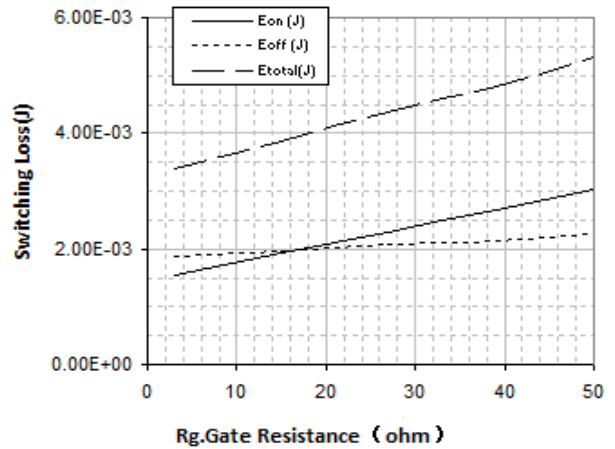
**Switching Loss vs. T<sub>j</sub>**

V<sub>GE</sub>=15V, V<sub>CE</sub>=400V, I<sub>c</sub>=60A, R<sub>G</sub>=5Ω



**Switching Loss vs. R<sub>G</sub>(150°C)**

V<sub>GE</sub>=15V, V<sub>CE</sub>=400V, I<sub>c</sub>=60A

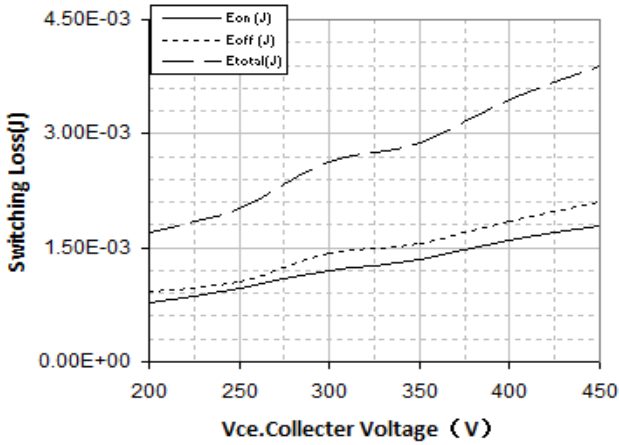




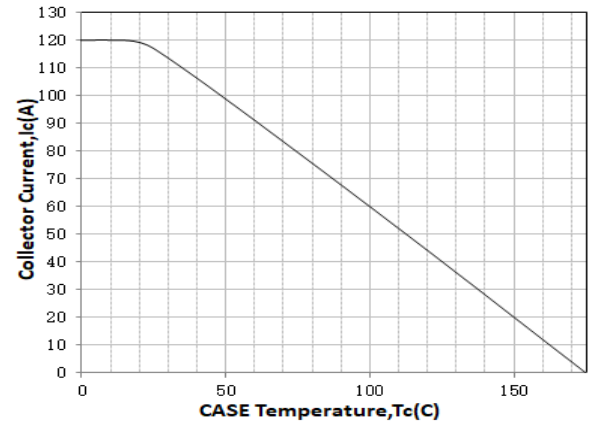


### Switching Loss vs. VCE(150°C)

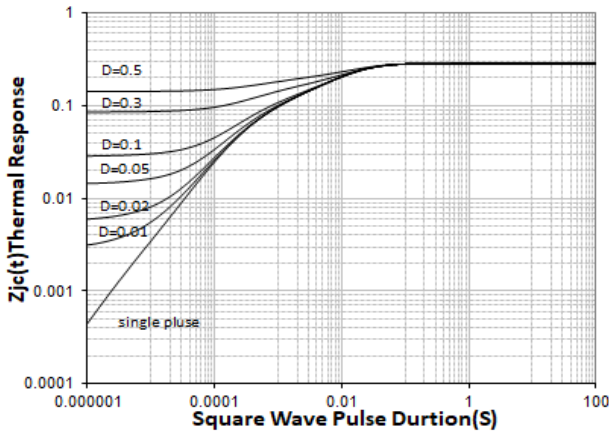
VGE=15V, Ic=60A, RG=5Ω



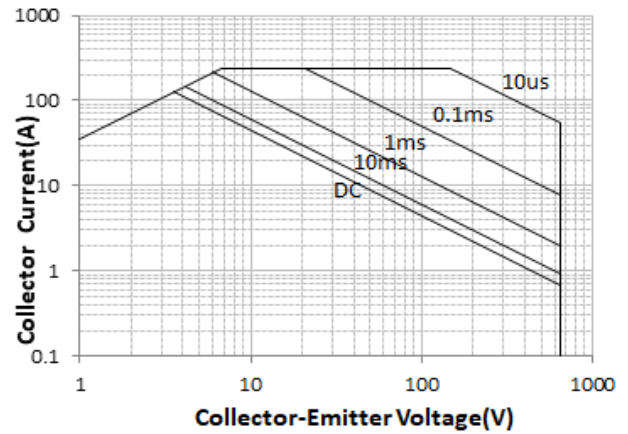
### Collector Current vs. Case temperature



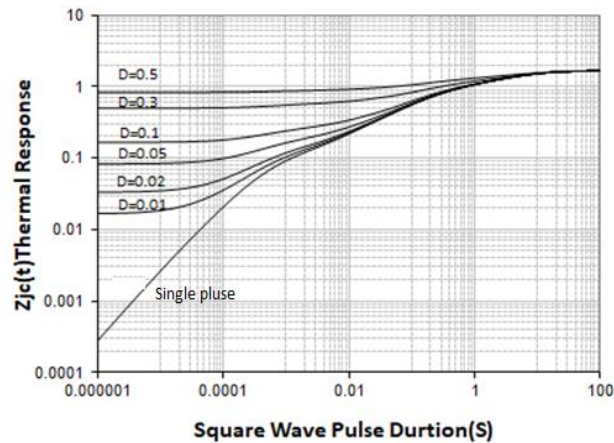
### Transient Thermal Impedance for IGBT TO-247



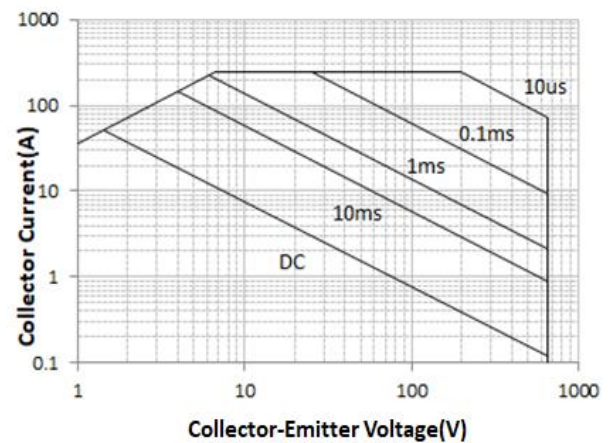
### Forward Bias Safe Operating Area TO-247



### Transient Thermal Impedance for IGBT TO-3PH



### Forward Bias Safe Operating Area TO-3PH

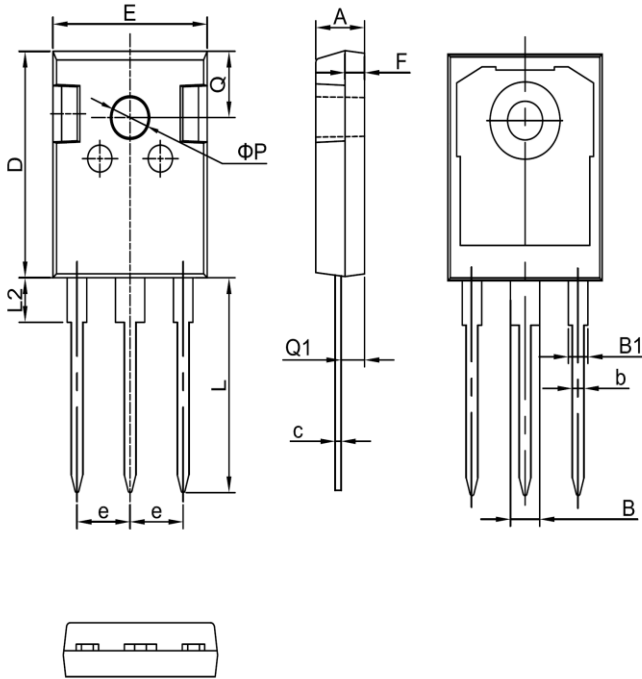




## 外形尺寸 PACKAGE MECHANICAL DATA

TO-247

单位 Unit: mm



| 符号<br>symbol | MIN   | MAX   |
|--------------|-------|-------|
| A            | 4.90  | 5.10  |
| B            | 2.95  | 3.35  |
| B1           | 1.95  | 2.35  |
| b            | 1.15  | 1.35  |
| c            | 0.50  | 0.70  |
| D            | 20.90 | 21.10 |
| E            | 15.70 | 15.90 |
| e            | 5.34  | 5.54  |
| F            | 1.90  | 2.10  |
| L            | 19.40 | 20.40 |
| L2           | 4.03  | 4.23  |
| Q            | 6.00  | 6.40  |
| Q1           | 2.30  | 2.50  |
| P            | 3.50  | 3.70  |



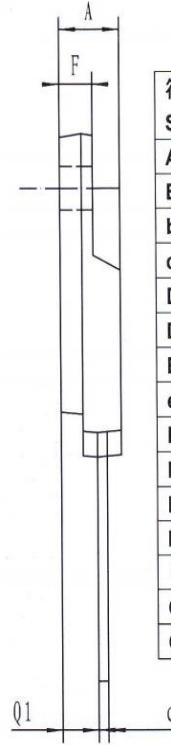
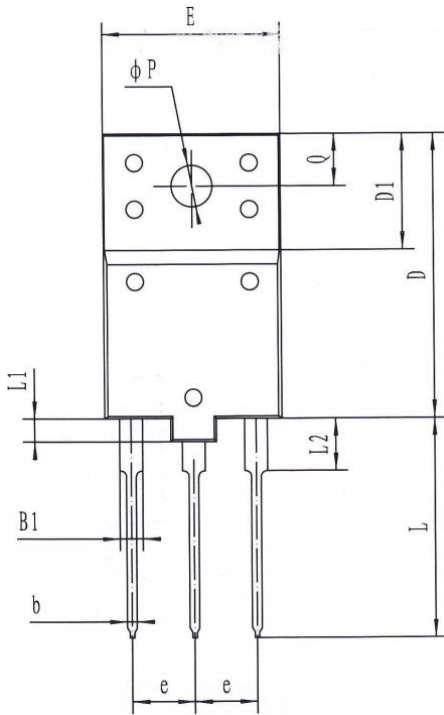




## 外形尺寸 PACKAGE MECHANICAL DATA

TO-3PH

单位 Unit: mm



| 符号<br>Symbol | Min        | Max  |
|--------------|------------|------|
| A            | 5.2        | 5.8  |
| B1           | 1.8        | 2.2  |
| b            | 0.75       | 1.05 |
| c            | 0.8        | 1.1  |
| D            | 24.0       | 25.0 |
| D1           | 9.8        | 10.2 |
| E            | 15.0       | 16.0 |
| e            | 5.45 (typ) |      |
| F            | 2.7        | 3.3  |
| L            | 18.5       | 19.5 |
| L1           | 1.8        | 2.2  |
| L2           | 4.3        | 4.7  |
| φP           | 3.4        | 3.8  |
| Q            | 4.3        | 4.7  |
| Q1           | 3.1        | 3.5  |





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