

### General Description

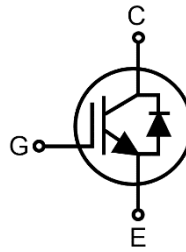
This IGBT is produced using advanced Magnachip's Field Stop Trench IGBT Technology, which provides low  $V_{CE(sat)}$ , high ruggedness performance and excellent quality.

### Applications

- Automotive PTC Heater
- General Inverter

### Features

- High ruggedness
- $V_{CE(sat)} = 1.61V @ I_C = 40A$
- Ultra-Soft, fast recovery anti-parallel diode
- Ultra-narrowed  $V_F$  distribution control
- Positive Temperature coefficient for easy paralleling
- AEC-Q101 qualified



Package outline and symbol

- G : Gate
- C : Collector
- E : Emitter

### Absolute Maximum Ratings

| Characteristics   |                   | Symbol      | Rating  | Unit |
|---|-------------------|-------------|---------|------|
| Collector-emitter voltage   |                   | $V_{CES}$   | 650     | V    |
| Gate-emitter voltage  |                   | $V_{GE}$    | ±25     | V    |
| DC collector current <sup>1)</sup>  | $T_C=25^\circ C$  | $I_C$       | 80      | A    |
|   | $T_C=100^\circ C$ |             | 40      | A    |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$                              |                   | $I_{Cpuls}$ | 120     | A    |
| Diode forward current <sup>1)</sup>   | $T_C=25^\circ C$  | $I_F$       | 80      | A    |
|   | $T_C=100^\circ C$ |             | 40      | A    |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$                                  |                   | $I_{Fpuls}$ | 120     | A    |
| Total power dissipation   | $T_C=25^\circ C$  | $P_{total}$ | 307     | W    |
|   | $T_C=100^\circ C$ |             | 153     | W    |
| Short circuit withstand time<br>$V_{CE} = 400V, V_{GE} = 15V, T_{vj} = 175^\circ C$ |                   | $t_{SC}$    | 10      | µs   |
| Operating Junction temperature range  |                   | $T_{vj}$    | -40~175 | °C   |
| Storage temperature range   |                   | $T_{stg}$   | -55~175 | °C   |

Note 1) Current is limited by junction temperature.

### Thermal Characteristics

| Characteristics                               | Symbol        | Rating | Unit |
|---|---------------|--------|------|
| Thermal resistance junction-to-ambient        | $R_{th(j-a)}$ | 40     | °C/W |
| Thermal resistance junction-to-case for IGBT  | $R_{th(j-c)}$ | 0.49   |      |
| Thermal resistance junction-to-case for Diode | $R_{th(j-c)}$ | 0.9    |      |

**Ordering Information**

| Part Number    | Marking  | Temp. Range | Package | Packing | RoHS Status |
|----------------|----------|-------------|---------|---------|-------------|
| AMBQ40T65PHRTH | 40T65PHR | -55~175°C   | TO-247  | Tube    | Compliant   |

**Electrical Characteristics ( $T_{vj} = 25^\circ\text{C}$  unless otherwise specified)**

| Parameter                            | Symbol        | Conditions                                 | Min                          | Typ | Max  | Unit |   |
|--------------------------------------|---------------|--|------------------------------|-----|------|------|---|
| <b>Static Characteristics</b>        |               |  |                              |     |      |      |   |
| Collector-emitter breakdown voltage  | $BV_{CES}$    | $I_C = 2\text{mA}, V_{GE} = 0\text{V}$     | 650                          | -   | -    | V    |   |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $I_C = 40\text{A}, V_{GE} = 15\text{V}$    | $T_{vj} = 25^\circ\text{C}$  | -   | 1.61 | 2.1  | V |
|                                      |               |  | $T_{vj} = 175^\circ\text{C}$ | -   | 2.06 | -    |   |
| Diode forward voltage                | $V_F$         | $V_{GE} = 0\text{V}, I_F = 40\text{A}$     | $T_{vj} = 25^\circ\text{C}$  | -   | 1.51 | 2.1  | V |
|                                      |               |  | $T_{vj} = 175^\circ\text{C}$ | -   | 2.05 | -    |   |
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $V_{CE} = V_{GE}, I_C = 2\text{mA}$        | 4.3                          | 5.3 | 6.3  | V    |   |
| Zero gate voltage collector current  | $I_{CES}$     | $V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$ | -                            | -   | 1    | mA   |   |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{GE} = 25\text{V}, V_{CE} = 0\text{V}$  | -                            | -   | ±300 | nA   |   |

**Dynamic Characteristics**

|                              |           |   |   |      |   |    |
|------------------------------|-----------|---|---|------|---|----|
| Total gate charge            | $Q_G$     | $V_{CE} = 520\text{V}, I_C = 40\text{A}, V_{GE} = 15\text{V}$ | - | 167  | - | nC |
| Gate-emitter charge          | $Q_{GE}$  |   | - | 30   | - |    |
| Gate-collector charge        | $Q_{GC}$  |   | - | 78   | - |    |
| Input capacitance            | $C_{ies}$ | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$    | - | 3897 | - | pF |
| Output capacitance           | $C_{oes}$ |   | - | 147  | - |    |
| Reverse transfer capacitance | $C_{res}$ |   | - | 81   | - |    |

**Switching Characteristics**

|                           |              |   |      |      |   |               |    |
|---------------------------|--------------|---|------|------|---|---------------|----|
| Turn-on delay time        | $t_{d(on)}$  | $V_{GE} = 15\text{V}, V_{CC} = 400\text{V}, I_C = 40\text{A}, R_G = 10\Omega,$<br>Inductive Load,<br>$T_{vj} = 25^\circ\text{C}$  | -    | 27   | - | ns            |    |
| Rise time                 | $t_r$        |   | -    | 156  | - |               |    |
| Turn-off delay time       | $t_{d(off)}$ |   | -    | 102  | - |               |    |
| Fall time                 | $t_f$        |   | -    | 115  | - |               |    |
| Turn-on switching energy  | $E_{on}$     |   | -    | 2.56 | - |               | mJ |
| Turn-off switching energy | $E_{off}$    |   | -    | 0.83 | - |               |    |
| Total switching energy    | $E_{ts}$     | -   | 3.39 | -    |   |               |    |
| Turn-on delay time        | $t_{d(on)}$  | $V_{GE} = 15\text{V}, V_{CC} = 400\text{V}, I_C = 40\text{A}, R_G = 10\Omega,$<br>Inductive Load,<br>$T_{vj} = 175^\circ\text{C}$ | -    | 29   | - | ns            |    |
| Rise time                 | $t_r$        |   | -    | 161  | - |               |    |
| Turn-off delay time       | $t_{d(off)}$ |   | -    | 111  | - |               |    |
| Fall time                 | $t_f$        |   | -    | 202  | - |               |    |
| Turn-on switching energy  | $E_{on}$     |   | -    | 3.35 | - |               | mJ |
| Turn-off switching energy | $E_{off}$    |   | -    | 1.18 | - |               |    |
| Total switching energy    | $E_{ts}$     | -   | 4.53 | -    |   |               |    |
| Reverse recovery time     | $t_{rr}$     | $I_F = 40\text{A}, di_F/dt = 200\text{A}/\mu\text{s}, T_{vj} = 25^\circ\text{C}$  | -    | 304  | - | ns            |    |
| Reverse recovery current  | $I_{rr}$     |   | -    | 11   | - | A             |    |
| Reverse recovery charge   | $Q_{rr}$     |   | -    | 1.42 | - | $\mu\text{C}$ |    |
| Reverse recovery time     | $t_{rr}$     | $I_F = 40\text{A}, di_F/dt = 200\text{A}/\mu\text{s}, T_{vj} = 175^\circ\text{C}$   | -    | 387  | - | ns            |    |
| Reverse recovery current  | $I_{rr}$     |   | -    | 15   | - | A             |    |
| Reverse recovery charge   | $Q_{rr}$     |   | -    | 3.23 | - | $\mu\text{C}$ |    |

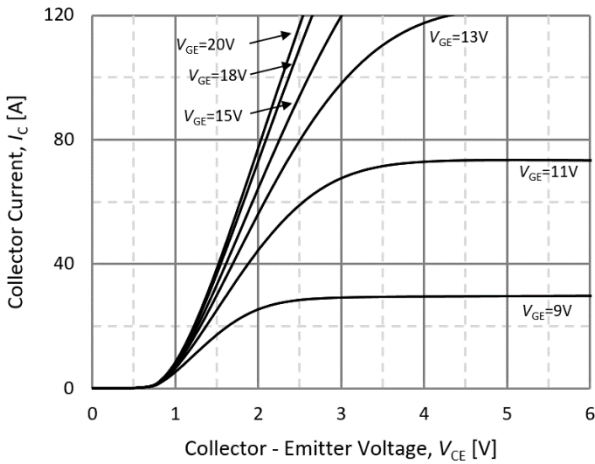


Fig.1. Typical output characteristics ( $T_{vj}=25^{\circ}\text{C}$ )

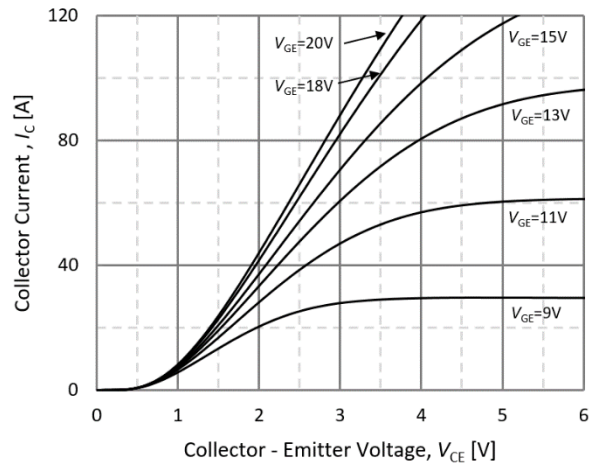


Fig.2. Typical output characteristics ( $T_{vj}=175^{\circ}\text{C}$ )

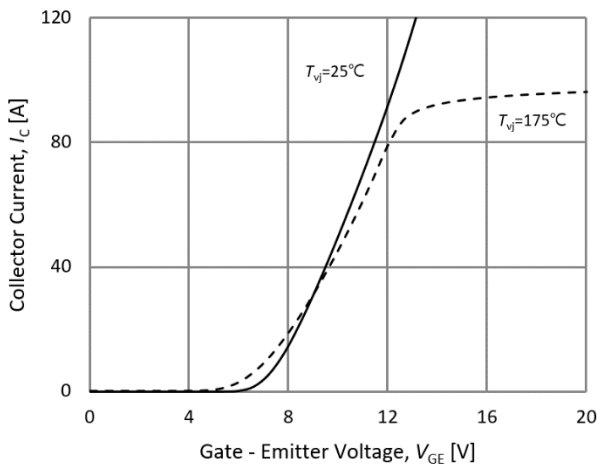


Fig.3. Typical transfer characteristics

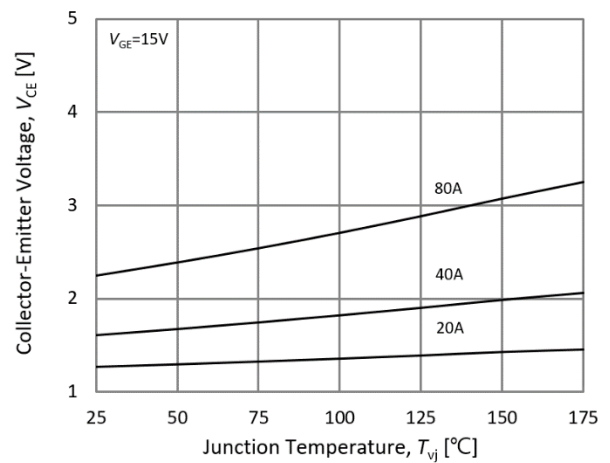


Fig.4. Typical collector-emitter saturation voltage-junction temperature

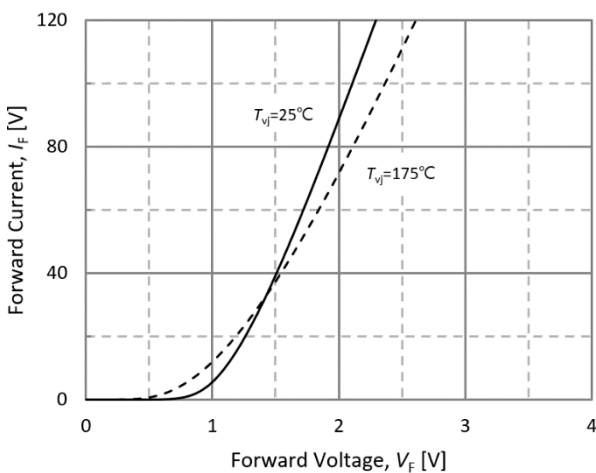


Fig.5. Diode forward characteristics

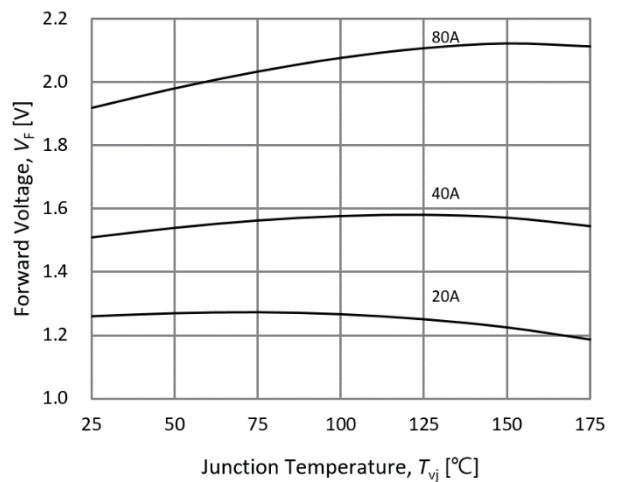


Fig.6. Diode forward-junction temperature

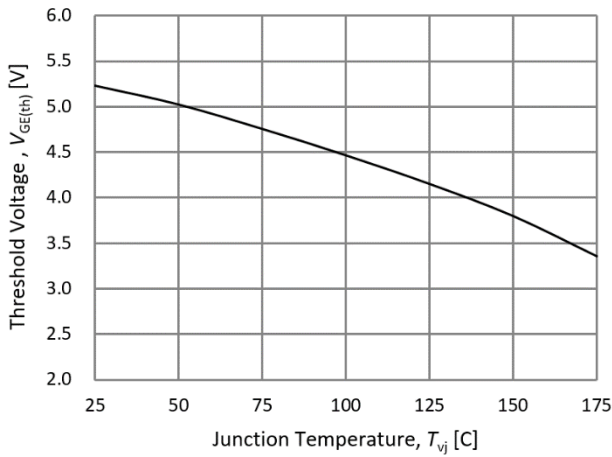


Fig.7. Threshold voltage-junction temperature

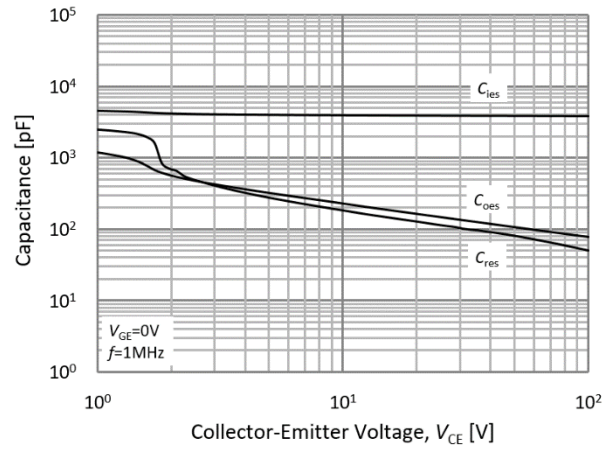


Fig.8. Typical capacitance

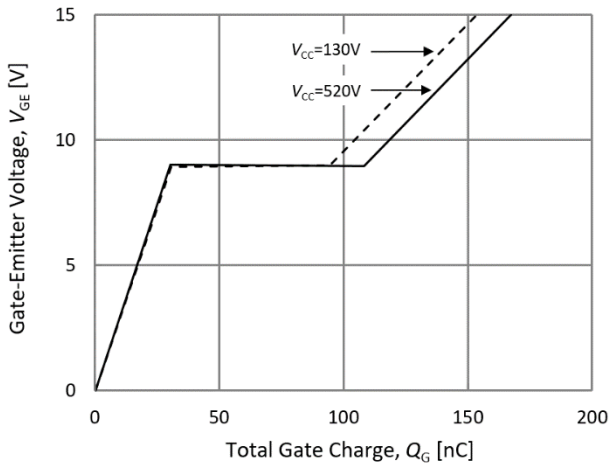


Fig.9. Typical gate charge

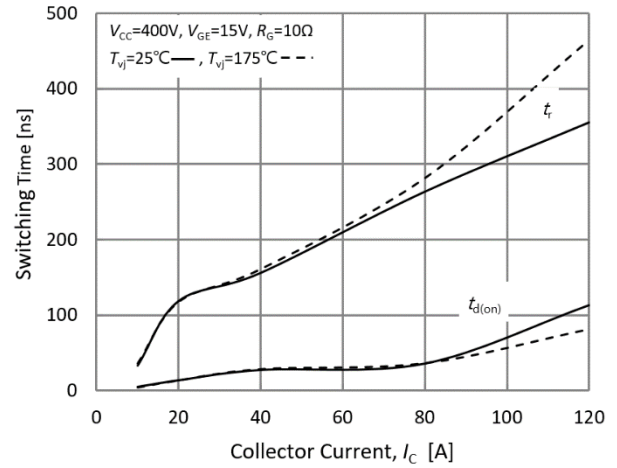


Fig.10. Typical turn on-collector current

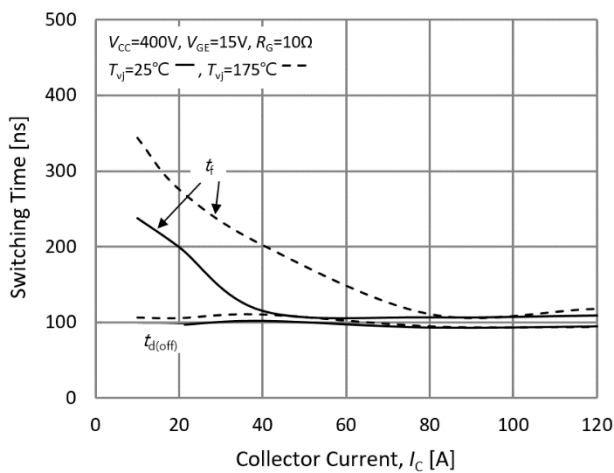


Fig.11. Typical turn off-collector current

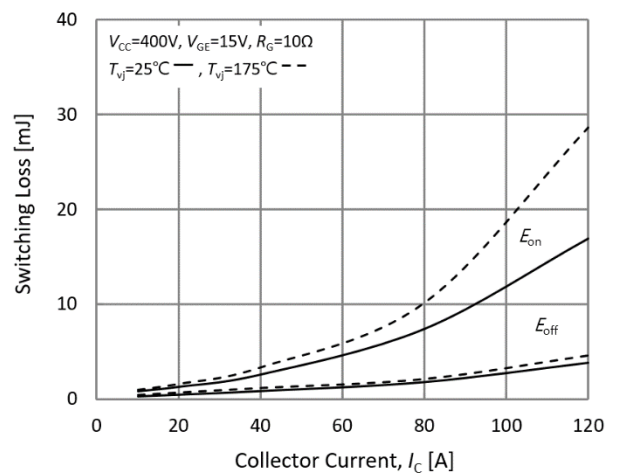


Fig.12. Switching loss-collector current

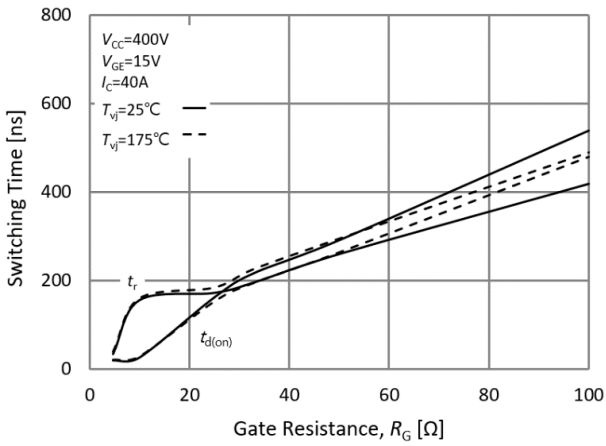


Fig.13. Turn on characteristics-gate resistance

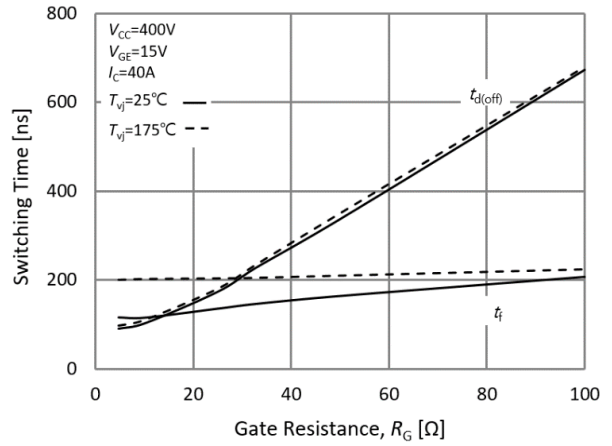


Fig.14. Turn off characteristics-gate resistance

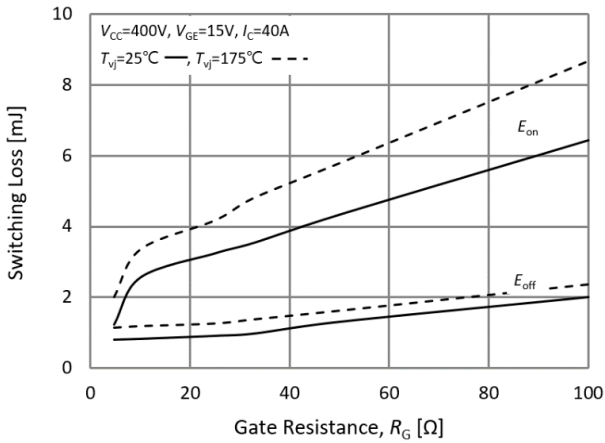


Fig.15. Switching loss-gate resistance

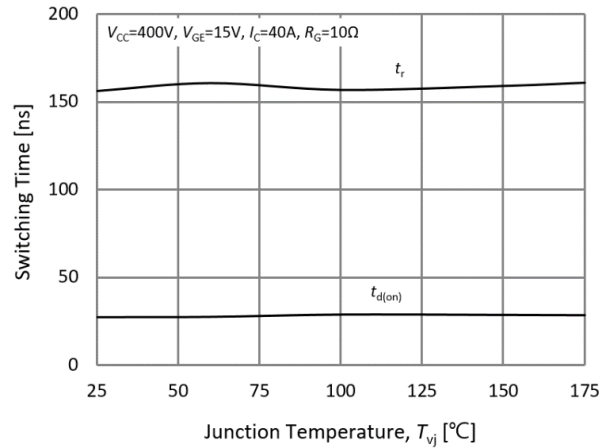


Fig.16. Turn on characteristics-junction temperature

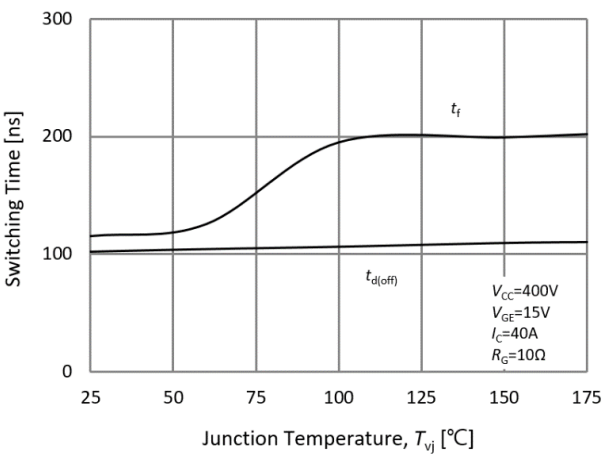


Fig.17. Turn off characteristics-junction temperature

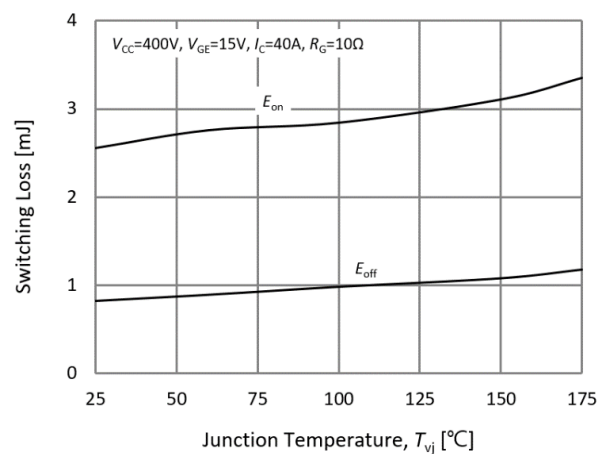
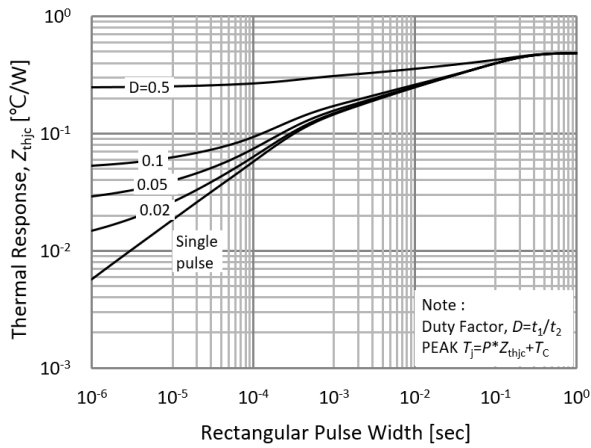
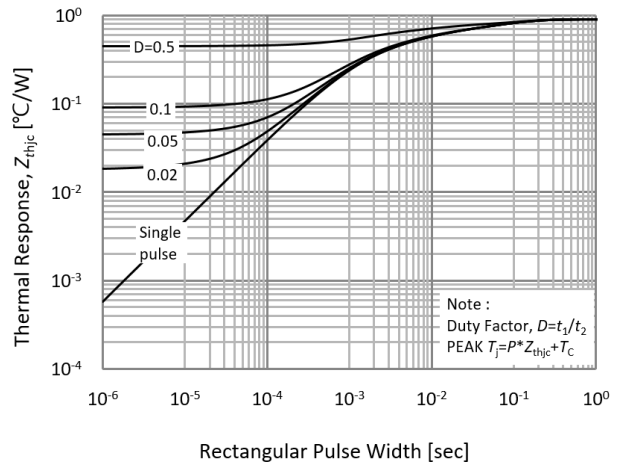


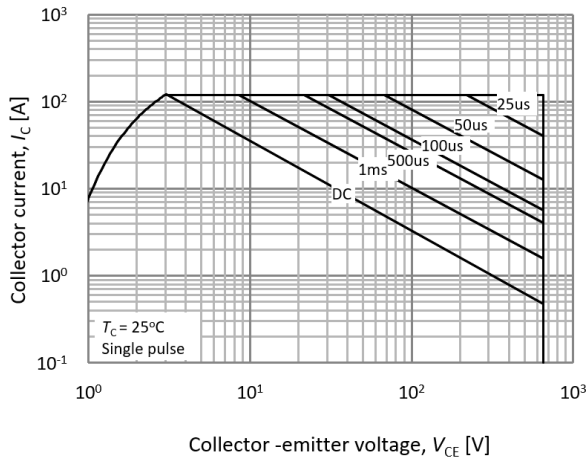
Fig.18. Switching loss-junction temperature



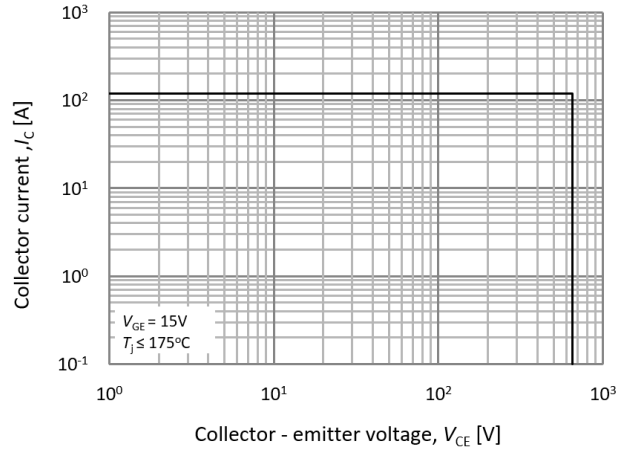
**Fig.19 IGBT Transient Thermal Impedance**



**Fig.20 FRD Transient Thermal Impedance**



**Fig.21 FBSOA**

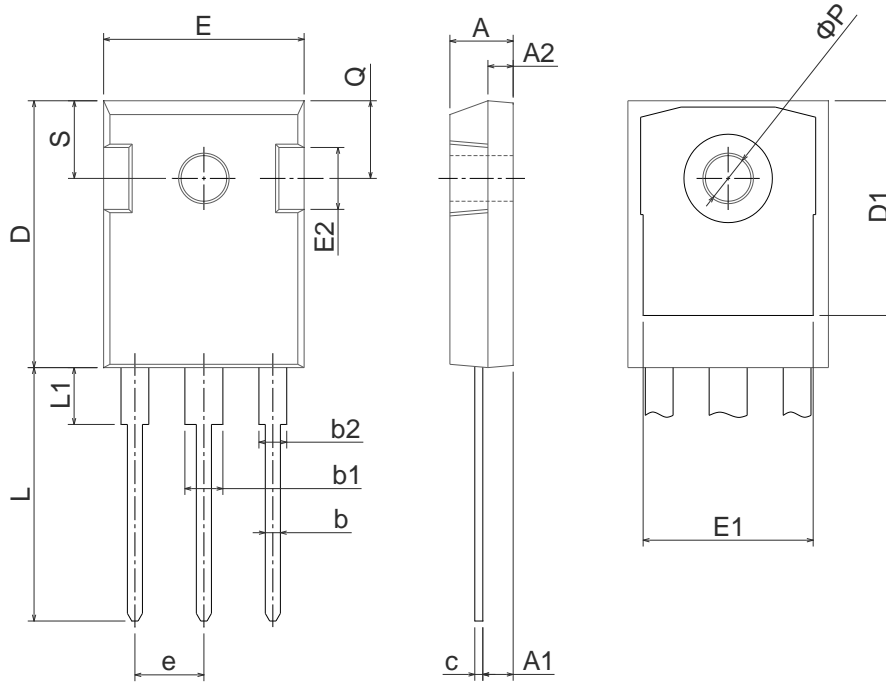


**Fig.22 RBSOA**

## Physical Dimension

### TO-247

Dimensions are in millimeters, unless otherwise specified




| Dimension | Min(mm) | Max(mm) |
|-----------|---------|---------|
| A         | 4.70    | 5.31    |
| A1        | 2.20    | 2.60    |
| A2        | 1.50    | 2.49    |
| b         | 0.99    | 1.40    |
| b1        | 2.59    | 3.43    |
| b2        | 1.65    | 2.39    |
| c         | 0.38    | 0.89    |
| D         | 20.30   | 21.46   |
| D1        | 13.08   | -       |
| E         | 15.45   | 16.26   |
| E1        | 13.06   | 14.02   |
| E2        | 4.32    | 5.49    |
| e         | 5.45BSC |         |
| L         | 19.81   | 20.57   |
| L1        | -       | 4.50    |
| ΦP        | 3.50    | 3.70    |
| Q         | 5.38    | 6.20    |
| S         | 6.15BSC |         |

Note: Package body size, length and width do not include mold flash, protrusions and gate burrs.



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