

### General Description

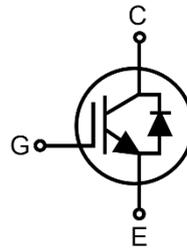
This IGBT is produced using advanced Magnachip's Field Stop Trench IGBT Technology, which provides low  $V_{CE(sat)}$ , low switching loss performance and excellent quality.

### Applications

- UPS
- Welder
- General inverter
- E-Compressor

### Features

- High ruggedness
- $V_{CE(sat)}$  positive temperature coefficient
- Very soft, fast recovery anti-parallel diode
- Maximum junction temperature 175°C
- 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  |                   | $V_{GE}$    | ±30     | V    |
| DC collector current, $t_p$ limited by $T_{vjmax}$                                  | $T_C=25^\circ C$  | $I_C$       | 76.0    | A    |
|   | $T_C=100^\circ C$ |             | 50.5    | A    |
| Pulsed collector current, $t_p$ limited by $T_{vjmax}$                              |                   | $I_{Cpuls}$ | 150     | A    |
| Diode forward current, $t_p$ limited by $T_{vjmax}$                                 | $T_C=25^\circ C$  | $I_F$       | 62.8    | A    |
|   | $T_C=100^\circ C$ |             | 38.7    | A    |
| Diode pulsed current, $t_p$ limited by $T_{vjmax}$                                  |                   | $I_{Fpuls}$ | 150     | A    |
| Total power dissipation   | $T_C=25^\circ C$  | $P_{tot}$   | 273     | W    |
|   | $T_C=100^\circ C$ |             | 136     | W    |
| Short circuit withstand time<br>$V_{CC} \leq 400V, V_{GE} = 15V, T_C = 150^\circ C$ |                   | $t_{sc}$    | 5       | µs   |
| Operating Junction temperature range  |                   | $T_{vj}$    | -40~175 | °C   |
| Storage temperature range   |                   | $T_{stg}$   | -55~150 | °C   |

### 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  | $R_{th(j-c)}$ | 0.55   |      |
| Thermal resistance junction-to-case for Diode | $R_{th(j-c)}$ | 0.9    |      |

**Ordering Information**

| Part Number    | Marking  | Temp. Range | Package | Packing | RoHS Status |
|----------------|----------|-------------|---------|---------|-------------|
| AMBQ50T65RFRTH | 50T65RFR | -55~150°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  | $BV_{CES}$    | $I_C = 5\text{mA}, V_{GE} = 0\text{V}$     | 650                          | -   | -         | V             |   |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $I_C = 50\text{A}, V_{GE} = 15\text{V}$    | $T_{vj} = 25^\circ\text{C}$  | -   | 1.85      | 2.40          | V |
|                                      |               |  | $T_{vj} = 175^\circ\text{C}$ | -   | 2.60      | -             |   |
| Diode forward voltage                | $V_F$         | $V_{GE} = 0\text{V}, I_F = 50\text{A}$     | $T_{vj} = 25^\circ\text{C}$  | -   | 2.20      | 2.70          | V |
|                                      |               |  | $T_{vj} = 175^\circ\text{C}$ | -   | 2.27      | -             |   |
| Gate-emitter threshold voltage       | $V_{GE(th)}$  | $V_{CE} = V_{GE}, I_C = 0.5\text{mA}$      | 3.8                          | 5.0 | 6.2       | V             |   |
| Zero gate voltage collector current  | $I_{CES}$     | $V_{CE} = 650\text{V}, V_{GE} = 0\text{V}$ | -                            | -   | 40        | $\mu\text{A}$ |   |
| Gate-emitter leakage current         | $I_{GES}$     | $V_{GE} = 30\text{V}, V_{CE} = 0\text{V}$  | -                            | -   | $\pm 100$ | nA            |   |

**Dynamic Characteristics**

|                              |           |   |   |      |   |    |
|------------------------------|-----------|---|---|------|---|----|
| Total gate charge            | $Q_G$     | $V_{CE} = 520\text{V}, I_C = 50\text{A}, V_{GE} = 15\text{V}$ | - | 86   | - | nC |
| Gate-emitter charge          | $Q_{GE}$  |   | - | 20   | - |    |
| Gate-collector charge        | $Q_{GC}$  |   | - | 37   | - |    |
| Input capacitance            | $C_{ies}$ | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$    | - | 2461 | - | pF |
| Output capacitance           | $C_{oes}$ |   | - | 150  | - |    |
| Reverse transfer capacitance | $C_{res}$ |   | - | 38   | - |    |

**Switching Characteristics**

|                           |              |  |   |   |      |      |    |               |
|---------------------------|--------------|--|---|---|------|------|----|---------------|
| Turn-on delay time        | $t_{d(on)}$  | $V_{GE} = -10/15\text{V}, V_{CC} = 400\text{V}, I_C = 50\text{A}, R_G = 10\Omega,$<br>Inductive Load,<br>$T_{vj} = 25^\circ\text{C}$ | -   | 45  | -    | ns   |    |               |
| Rise time                 | $t_r$        |  | -   | 51  | -    |      |    |               |
| Turn-off delay time       | $t_{d(off)}$ |  | -   | 53  | -    |      |    |               |
| Fall time                 | $t_f$        |  | -   | 22  | -    |      |    |               |
| Turn-on switching energy  | $E_{on}$     |  | $V_{GE} = -10/15\text{V}, V_{CC} = 400\text{V}, I_C = 50\text{A}, R_G = 10\Omega,$<br>Inductive Load,<br>$T_{vj} = 175^\circ\text{C}$ | -   | 1.36 | -    | mJ |               |
| Turn-off switching energy | $E_{off}$    |  |   | -   | 0.49 | -    |    |               |
| Total switching energy    | $E_{ts}$     |  |   | -   | 1.85 | -    |    |               |
| Turn-on delay time        | $t_{d(on)}$  |  |   | $V_{GE} = -10/15\text{V}, V_{CC} = 400\text{V}, I_C = 50\text{A}, R_G = 10\Omega,$<br>Inductive Load,<br>$T_{vj} = 175^\circ\text{C}$ | -    | 46   | -  | ns            |
| Rise time                 | $t_r$        |  |   |   | -    | 51   | -  |               |
| Turn-off delay time       | $t_{d(off)}$ |  |   |   | -    | 55   | -  |               |
| Fall time                 | $t_f$        | -  |   |   | 24   | -    |    |               |
| Turn-on switching energy  | $E_{on}$     | $I_F = 50\text{A}, di_F/dt = 1000\text{A}/\mu\text{s}, T_{vj} = 25^\circ\text{C}$  |   |   | -    | 1.67 | -  | mJ            |
| Turn-off switching energy | $E_{off}$    |  |   |   | -    | 0.56 | -  |               |
| Total switching energy    | $E_{ts}$     |  |   |   | -    | 2.22 | -  |               |
| Reverse recovery time     | $t_{rr}$     |  | $I_F = 50\text{A}, di_F/dt = 1000\text{A}/\mu\text{s}, T_{vj} = 175^\circ\text{C}$  |   | -    | 135  | -  | ns            |
| Reverse recovery current  | $I_{rr}$     |  |   |   | -    | 22   | -  |               |
| Reverse recovery charge   | $Q_{rr}$     |  |   |   | -    | 1.55 | -  | $\mu\text{C}$ |
| Reverse recovery time     | $t_{rr}$     |  |   | $I_F = 50\text{A}, di_F/dt = 1000\text{A}/\mu\text{s}, T_{vj} = 175^\circ\text{C}$  | -    | 197  | -  | ns            |
| Reverse recovery current  | $I_{rr}$     |  |   |   | -    | 24   | -  |               |
| Reverse recovery charge   | $Q_{rr}$     |  |   |   | -    | 2.53 | -  | $\mu\text{C}$ |

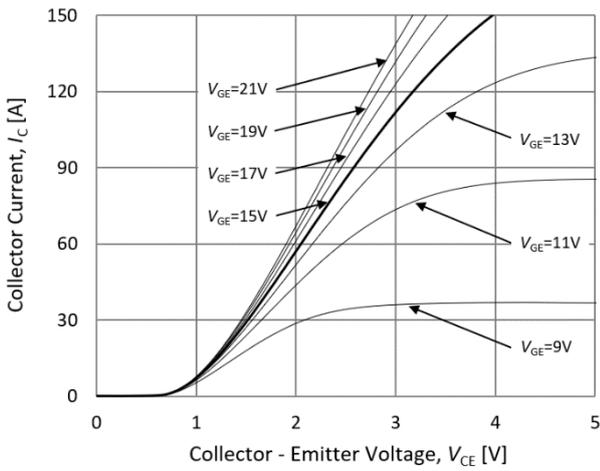


Fig.1. Typical output characteristics ( $T_{vj}=25^{\circ}\text{C}$ )

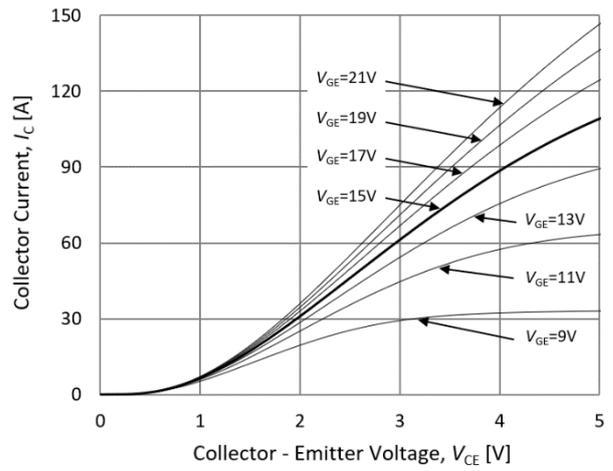


Fig.2. Typical output characteristics ( $T_{vj}=175^{\circ}\text{C}$ )

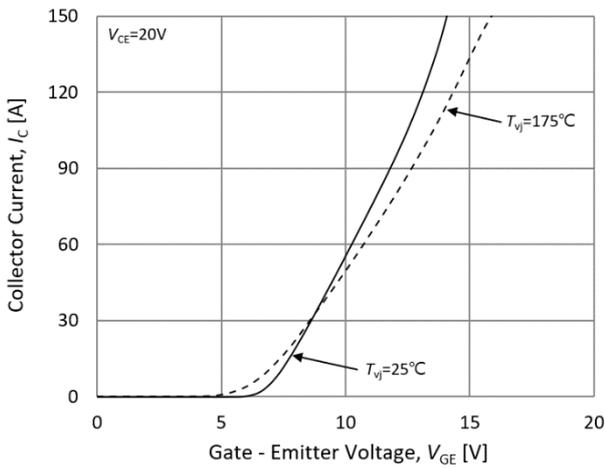


Fig.3. Typical transfer characteristics

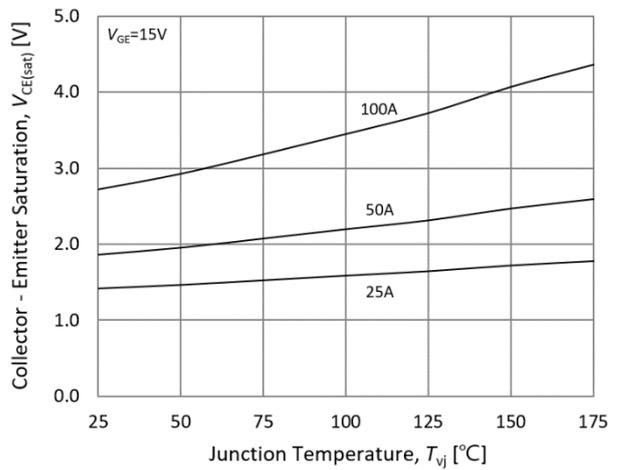


Fig.4. Typical collector-emitter saturation voltage-junction temperature

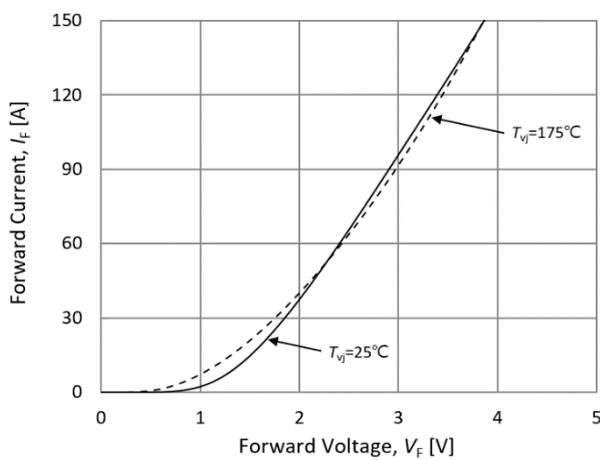


Fig.5. Diode forward characteristics

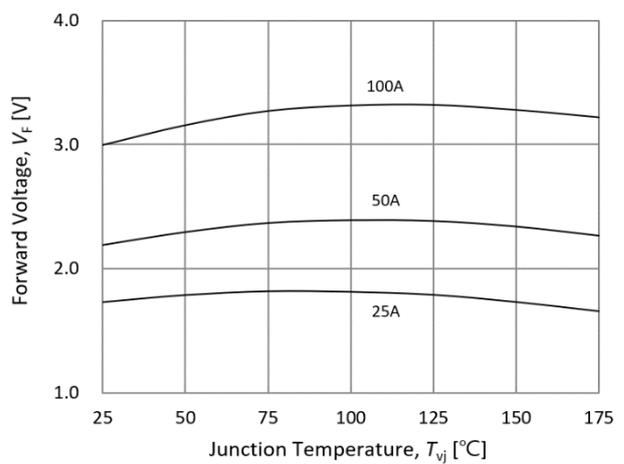


Fig.6. Diode forward voltage-junction temperature

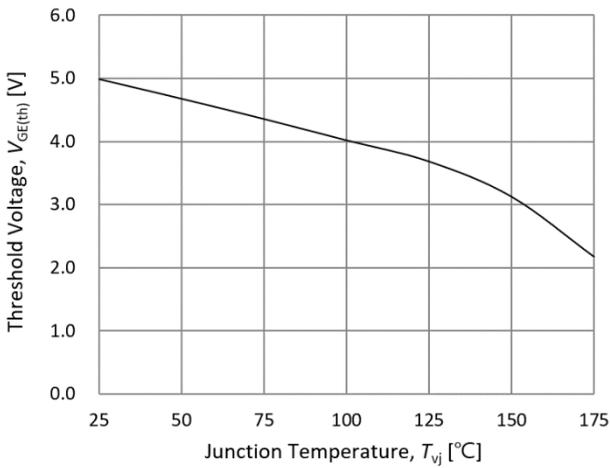


Fig.7. Threshold voltage-junction temperature

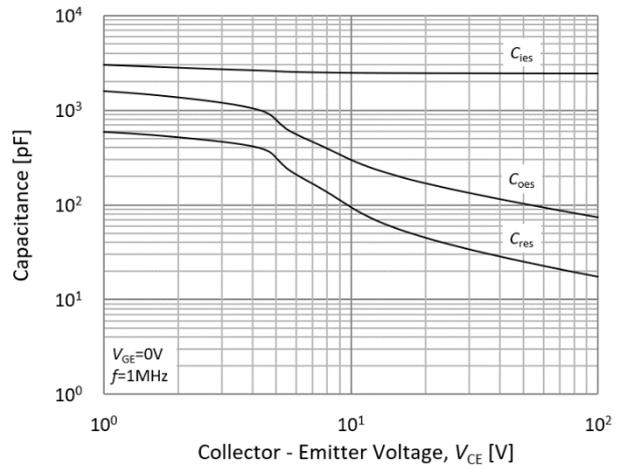


Fig.8. Typical capacitance

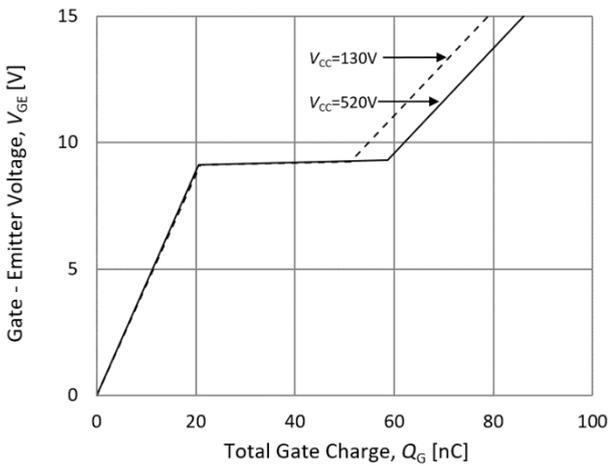


Fig.9. Typical gate charge

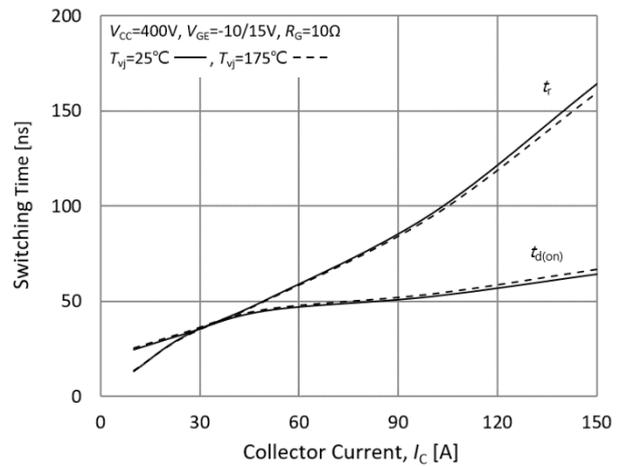


Fig.10. Typical turn on times-collector current

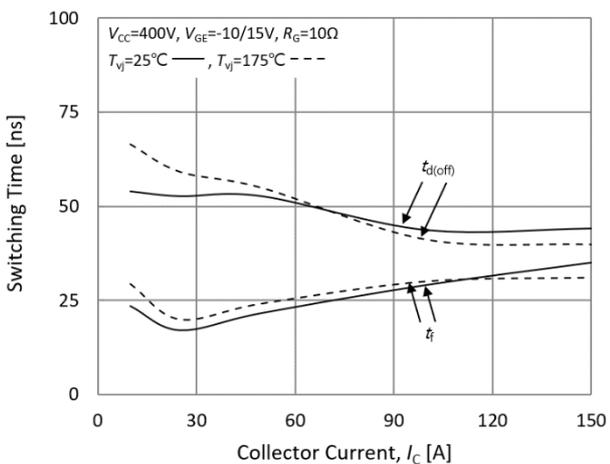


Fig.11. Typical turn off times-collector current

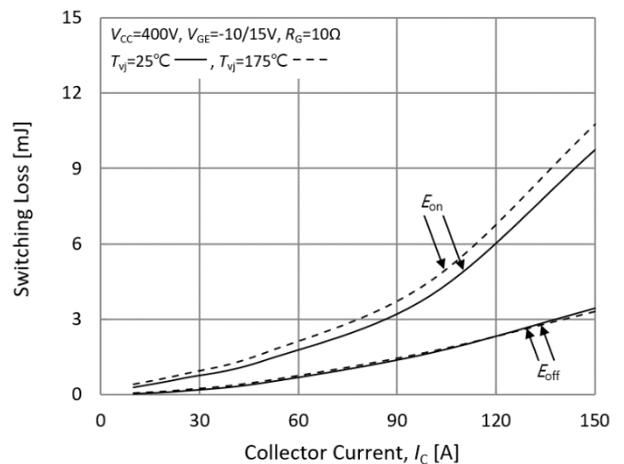


Fig.12. Switching losses-collector current

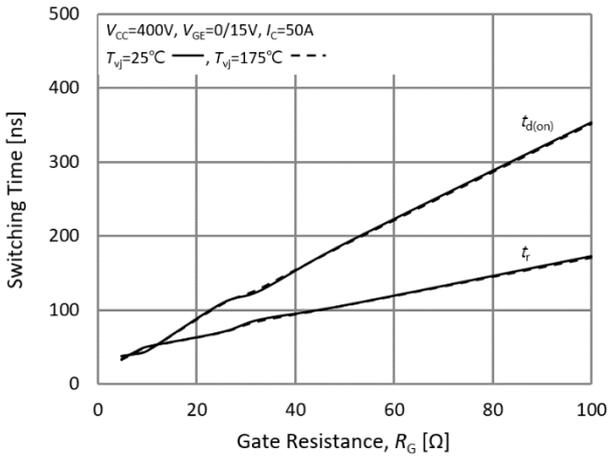


Fig.13. Typical turn on times-gate resistance

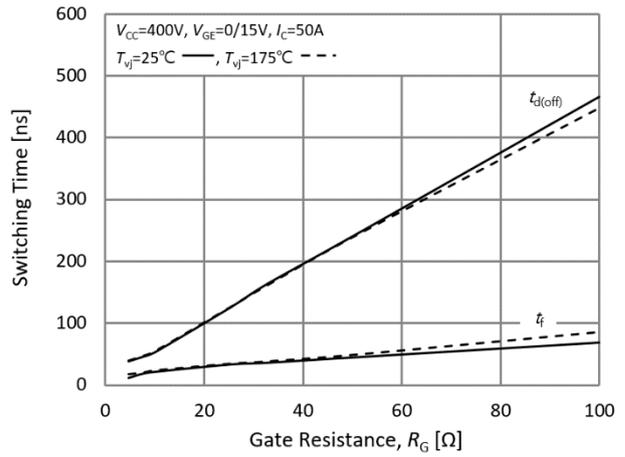


Fig.14. Typical turn off times-gate resistance

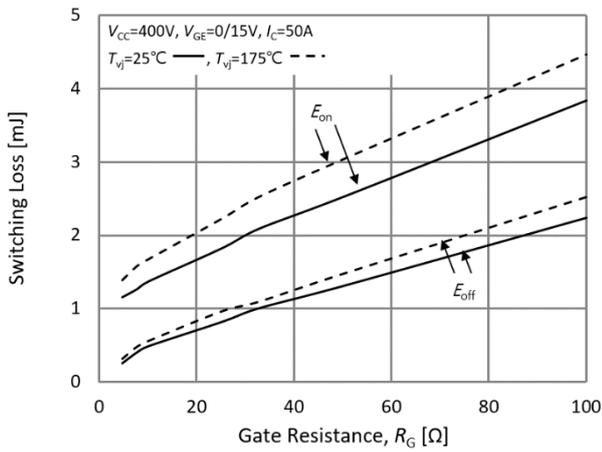


Fig.15. Switching losses-gate resistance

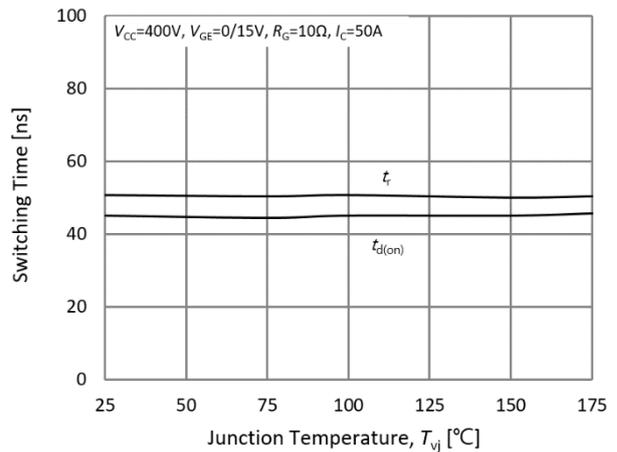


Fig.16. Typical turn on times-junction temperature

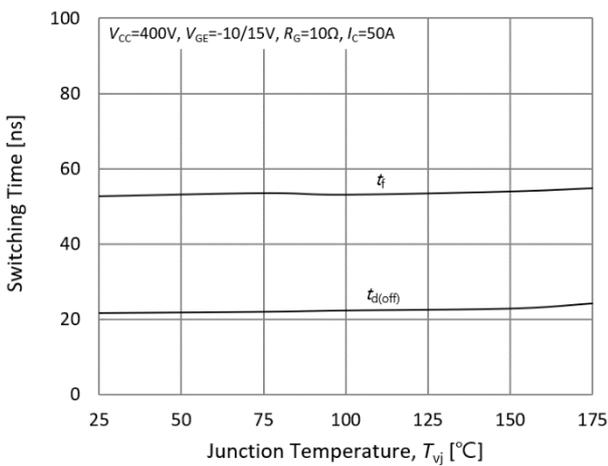


Fig.17. Typical turn off times-junction temperature

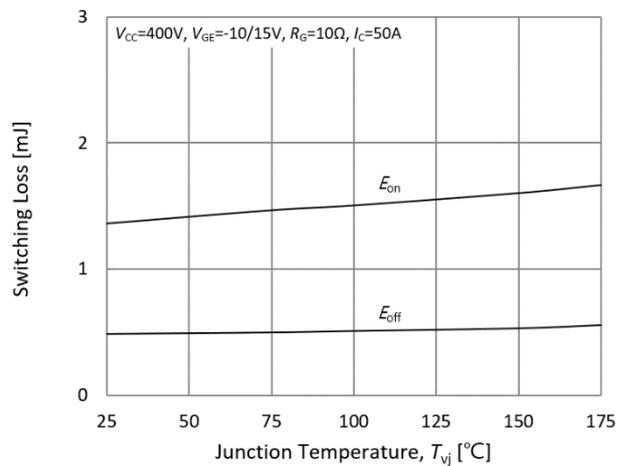


Fig.18. Switching losses-junction temperature

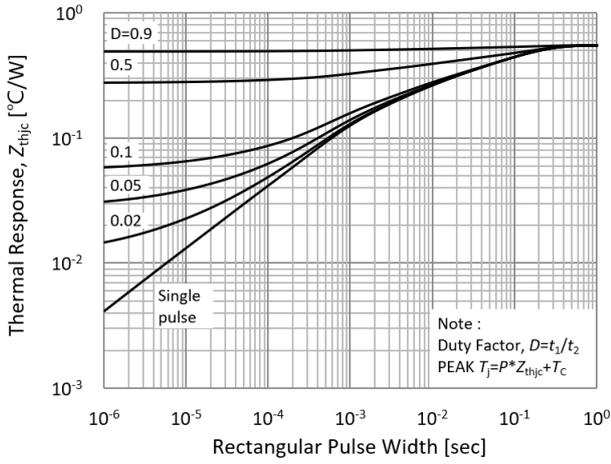


Fig.19. IGBT transient thermal impedance

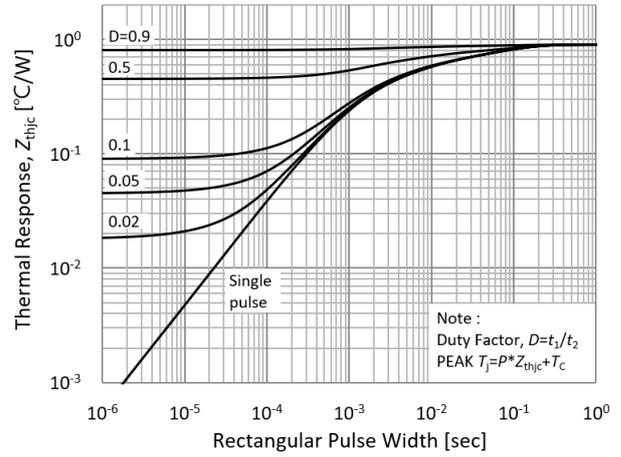


Fig.20. FRD transient thermal impedance

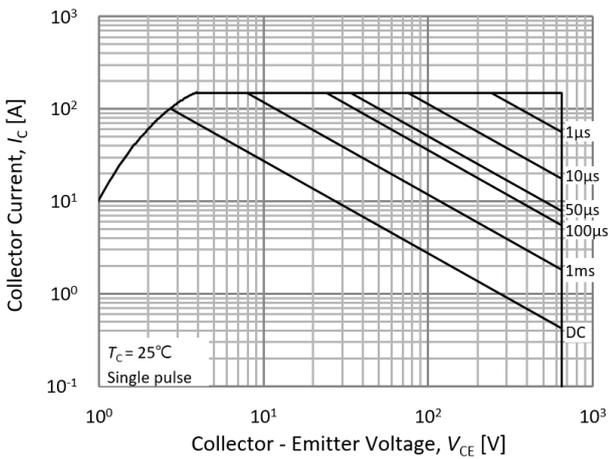


Fig.21. FBSOA

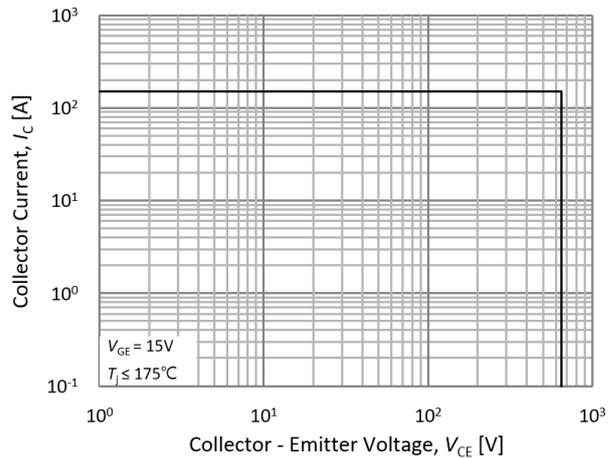
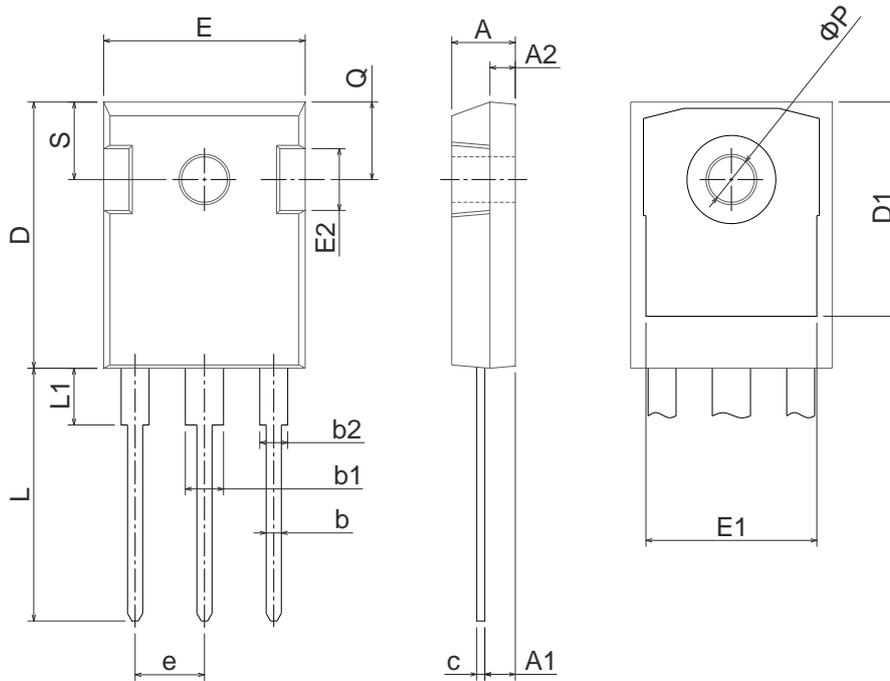


Fig.22. RBSOA

## 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   | 14.15   |
| 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.



**DISCLAIMER:**

The Products are not designed for use in hostile environments, including, without limitation, aircraft, nuclear power generation, medical appliances, and devices or systems in which malfunction of any Product can reasonably be expected to result in a personal injury. Seller's customers using or selling Seller's products for use in such applications do so at their own risk and agree to fully defend and indemnify Seller.

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