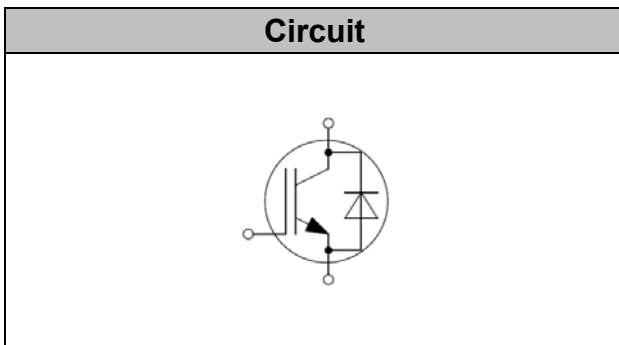




## IGBT Discrete

|                       |      |   |
|-----------------------|------|---|
| $V_{CE}$              | 650  | V |
| $I_C$                 | 15   | A |
| $V_{CE(SAT)} I_C=15A$ | 1.65 | V |



## Applications

- Soft switching applications
- Airconditioning
- Motor drive inverter

## Features

- High speed smooth switching device for hard & soft switching
- Maximum junction temperature 175°C
- Positive temperature coefficient
- High ruggedness, temperature stable
- Pb-free lead plating; RoHS compliant

## Maximum Ratings

| Parameter                                                                                                      | Symbol      | Value    | Unit    |
|----------------------------------------------------------------------------------------------------------------|-------------|----------|---------|
| Collector-Emitter Breakdown Voltage                                                                            | $V_{CE}$    | 650      | V       |
| DC Collector Current, limited by $T_{jmax}$<br>$T_C=25^\circ C$ value limited by bondwire<br>$T_C=100^\circ C$ | $I_C$       | 30<br>15 | A       |
| Diode Forward Current, limited by $T_{jmax}$<br>$T_C=25^\circ C$<br>$T_C=100^\circ C$                          | $I_F$       | 30<br>15 | A       |
| Continuous Gate-Emitter Voltage                                                                                | $V_{GE}$    | $\pm 20$ | V       |
| Transient Gate-Emitter Voltage                                                                                 | $V_{GE}$    | $\pm 30$ | V       |
| Turn off Safe Operating Area $V_{CE} \leq 650V$ ,<br>$T_j \leq 150^\circ C$                                    |             | 60       | A       |
| Pulsed Collector Current, $V_{GE}=15V$ ,<br>$t_p$ limited by $T_{jmax}$                                        | $I_{CM}$    | 60       | A       |
| Short Circuit Withstand Time, $V_{GE}=15V$ ,<br>$V_{CE} \leq 400V$                                             | $T_{sc}$    | 5        | $\mu s$ |
| Diode Pulsed Current, $t_p$ limited by $T_{jmax}$                                                              | $I_{Fpuls}$ | 60       | A       |
| Power Dissipation, $T_j=175^\circ C, T_c=25^\circ C$                                                           | $P_{tot}$   | 130      | W       |



|                                                                          |       |            |    |
|--------------------------------------------------------------------------|-------|------------|----|
| Operating Junction Temperature                                           | $T_j$ | -40...+175 | °C |
| Storage Temperature                                                      | $T_s$ | -55...+150 | °C |
| Soldering Temperature, wave soldering 1.6mm (0.063in.) from case for 10s |       | 260        | °C |

### Electrical Characteristics of the IGBT ( $T_j = 25^\circ\text{C}$ unless otherwise specified):

| Parameter                            | Symbol        | Conditions                                                                                              | Min. | Typ.                 | Max.      | Unit |
|--------------------------------------|---------------|---------------------------------------------------------------------------------------------------------|------|----------------------|-----------|------|
| <b>Static</b>                        |               |                                                                                                         |      |                      |           |      |
| Collector-Emitter Breakdown Voltage  | $BV_{CES}$    | $V_{GE}=0V, I_C=250\mu A$                                                                               | 650  |                      | -         | V    |
| Gate Threshold Voltage               | $V_{GE(th)}$  | $V_{GE}=V_{CE}, I_C=250\mu A$                                                                           | 4.1  | 5.0                  | 5.7       | V    |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_{GE}=15V, I_C=15A$<br>$T_j=25^\circ\text{C}$ ,<br>$T_j=125^\circ\text{C}$<br>$T_j=150^\circ\text{C}$ |      | 1.65<br>1.95<br>2.05 | 1.95      | V    |
| Zero Gate Voltage Collector Current  | $I_{CES}$     | $V_{CE}=650V, V_{GE}=0V$<br>$T_j=25^\circ\text{C}$ ,<br>$T_j=150^\circ\text{C}$                         |      |                      | 0.25      | mA   |
| Gate-Emitter Leakage Current         | $I_{GES}$     | $V_{CE}=0V, V_{GE}=\pm 20V$                                                                             |      |                      | $\pm 200$ | nA   |
| Transconductance                     | $g_{fs}$      | $V_{CE}=20V, I_C=15A$                                                                                   |      | 10                   |           | S    |

| Parameter                       | Symbol      | Conditions                                                                                  | Min. | Typ.  | Max. | Unit          |
|---------------------------------|-------------|---------------------------------------------------------------------------------------------|------|-------|------|---------------|
| <b>Dynamic</b>                  |             |                                                                                             |      |       |      |               |
| Input Capacitance               | $C_{ies}$   | $V_{CE}=25V, V_{GE}=0V,$<br>$f=1\text{MHz}$                                                 | -    | 0.99  | -    | nF            |
| Output capacitance              | $C_{oes}$   |                                                                                             |      | 0.056 |      |               |
| Reverse Transfer Capacitance    | $C_{res}$   |                                                                                             | -    | 0.03  | -    |               |
| Gate Charge                     | $Q_G$       | $V_{CC}=480V, I_C=15A,$<br>$V_{GE}=15V$                                                     | -    | 0.052 | -    | $\mu\text{C}$ |
| Short circuit collector current | $I_{C(SC)}$ | $V_{GE}=15V, t_{SC} \leq 5\mu\text{s}$<br>$V_{CC}=400V,$<br>$T_{j, start}=25^\circ\text{C}$ | -    | 98    | -    | A             |



## Electrical Characteristics of the Diode (T<sub>j</sub>= 25°C unless otherwise specified):

| Parameter             | Symbol         | Conditions                                                                                         | Min. | Typ.                 | Max. | Unit |
|-----------------------|----------------|----------------------------------------------------------------------------------------------------|------|----------------------|------|------|
| <b>Static</b>         |                |                                                                                                    |      |                      |      |      |
| Diode Forward Voltage | V <sub>F</sub> | I <sub>F</sub> = 15A<br>T <sub>j</sub> = 25°C,<br>T <sub>j</sub> = 125°C<br>T <sub>j</sub> = 150°C |      | 1.70<br>1.65<br>1.65 |      | V    |

## Switching Characteristic, Inductive Load

| Parameter                                | Symbol              | Conditions                                                                                                                 | Min. | Typ. | Max. | Unit |
|------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| <b>Dynamic , at T<sub>j</sub>= 25°C</b>  |                     |                                                                                                                            |      |      |      |      |
| Turn-on Delay Time                       | t <sub>d(on)</sub>  | T <sub>j</sub> =25°C<br>V <sub>CC</sub> = 400V,<br>I <sub>C</sub> =15A,<br>V <sub>GE</sub> =0/15V,<br>R <sub>g</sub> =12 Ω | -    | 15   | -    | ns   |
| Rise Time                                | t <sub>r</sub>      |                                                                                                                            | -    | 25   | -    | ns   |
| Turn-on Energy                           | E <sub>on</sub>     |                                                                                                                            | -    | 0.75 | -    | mJ   |
| Turn-off Delay Time                      | t <sub>d(off)</sub> |                                                                                                                            | -    | 60   | -    | ns   |
| Fall Time                                | t <sub>f</sub>      |                                                                                                                            | -    | 46   | -    | ns   |
| Turn-off Energy                          | E <sub>off</sub>    |                                                                                                                            | -    | 0.1  | -    | mJ   |
| <b>Dynamic , at T<sub>j</sub>= 125°C</b> |                     |                                                                                                                            |      |      |      |      |
| Turn-on Delay Time                       | t <sub>d(on)</sub>  | T <sub>j</sub> =25°C<br>V <sub>CC</sub> = 400V,<br>I <sub>C</sub> =15A,<br>V <sub>GE</sub> =0/15V,<br>R <sub>g</sub> =12 Ω | -    | 24   | -    | ns   |
| Rise Time                                | t <sub>r</sub>      |                                                                                                                            | -    | 30   | -    | ns   |
| Turn-on Energy                           | E <sub>on</sub>     |                                                                                                                            | -    | 1.10 | -    | mJ   |
| Turn-off Delay Time                      | t <sub>d(off)</sub> |                                                                                                                            | -    | 90   | -    | ns   |
| Fall Time                                | t <sub>f</sub>      |                                                                                                                            | -    | 54   | -    | ns   |
| Turn-off Energy                          | E <sub>off</sub>    |                                                                                                                            | -    | 0.15 | -    | mJ   |
| <b>Dynamic , at T<sub>j</sub>= 150°C</b> |                     |                                                                                                                            |      |      |      |      |
| Turn-on Delay Time                       | t <sub>d(on)</sub>  | T <sub>j</sub> =25°C<br>V <sub>CC</sub> = 400V,<br>I <sub>C</sub> =15A,<br>V <sub>GE</sub> =0/15V,<br>R <sub>g</sub> =12 Ω | -    | 26   | -    | ns   |
| Rise Time                                | t <sub>r</sub>      |                                                                                                                            | -    | 32   | -    | ns   |
| Turn-on Energy                           | E <sub>on</sub>     |                                                                                                                            | -    | 1.25 | -    | mJ   |
| Turn-off Delay Time                      | t <sub>d(off)</sub> |                                                                                                                            | -    | 95   | -    | ns   |
| Fall Time                                | t <sub>f</sub>      |                                                                                                                            | -    | 58   | -    | ns   |
| Turn-off Energy                          | E <sub>off</sub>    |                                                                                                                            | -    | 0.18 | -    | mJ   |



## Electrical Characteristics of the DIODE

| Parameter                                | Symbol           | Conditions                                                        | Min. | Typ. | Max. | Unit |
|------------------------------------------|------------------|-------------------------------------------------------------------|------|------|------|------|
| <b>Dynamic , at T<sub>j</sub>= 25°C</b>  |                  |                                                                   |      |      |      |      |
| Reverse Recovery Current                 | I <sub>rr</sub>  | I <sub>F</sub> =15A,<br>V <sub>R</sub> =300V,<br>-di/dt= 200A/μs, | -    | 12   | -    | A    |
| Reverse Recovery Charge                  | Q <sub>rr</sub>  |                                                                   | -    | 0.5  | -    | uC   |
| Reverse Recovery Energy                  | E <sub>rec</sub> |                                                                   | -    | 0.06 |      | mJ   |
| <b>Dynamic , at T<sub>j</sub>= 125°C</b> |                  |                                                                   |      |      |      |      |
| Reverse Recovery Current                 | I <sub>rr</sub>  | I <sub>F</sub> =15A,<br>V <sub>R</sub> =300V,<br>-di/dt= 200A/μs, | -    | 15   | -    | A    |
| Reverse Recovery Charge                  | Q <sub>rr</sub>  |                                                                   | -    | 0.9  | -    | uC   |
| Reverse Recovery Energy                  | E <sub>rec</sub> |                                                                   | -    | 0.12 |      | mJ   |
| <b>Dynamic , at T<sub>j</sub>= 150°C</b> |                  |                                                                   |      |      |      |      |
| Reverse Recovery Current                 | I <sub>rr</sub>  | I <sub>F</sub> =15A,<br>V <sub>R</sub> =300V,<br>-di/dt= 200A/μs, | -    | 16   | -    | A    |
| Reverse Recovery Charge                  | Q <sub>rr</sub>  |                                                                   | -    | 1.2  | -    | uC   |
| Reverse Recovery Energy                  | E <sub>rec</sub> |                                                                   | -    | 0.15 |      | mJ   |

## Thermal Resistance

| Parameter                                 | Symbol               | Max. Value | Unit |
|-------------------------------------------|----------------------|------------|------|
| IGBT Thermal Resistance, Junction - Case  | R <sub>th(j-c)</sub> | 1.15       | K/W  |
| Diode Thermal Resistance, Junction - Case | R <sub>th(j-c)</sub> | 1.9        | K/W  |
| Thermal Resistance, Junction - Ambient    | R <sub>th(j-a)</sub> | 60         | K/W  |



Fig. 1 FBSOA characteristics

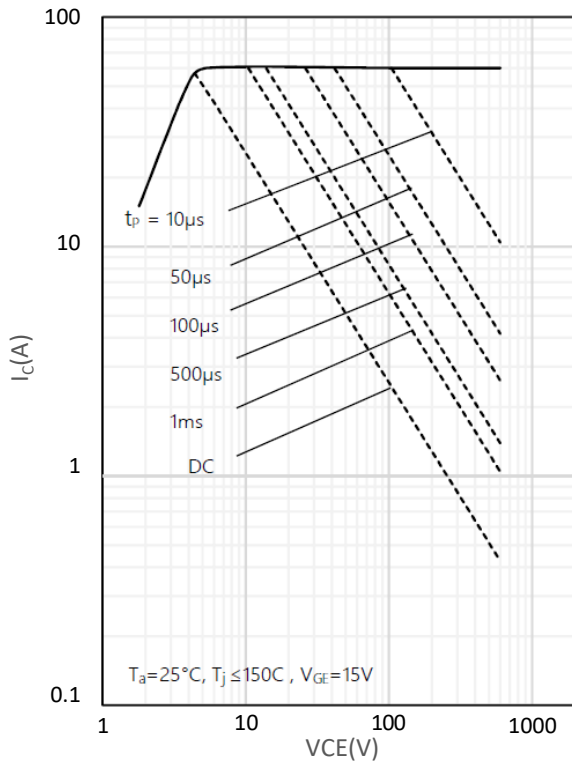


Fig. 2 Load Current vs. Frequency

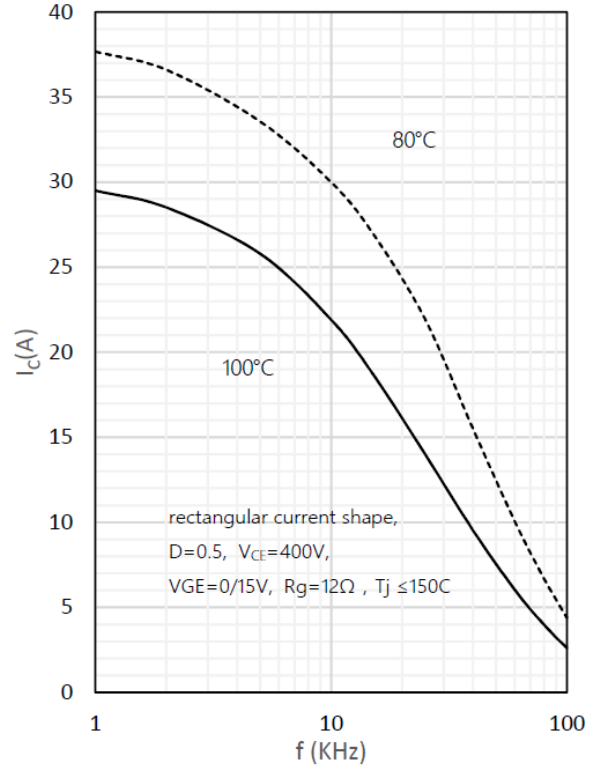


Fig. 3 Output characteristics

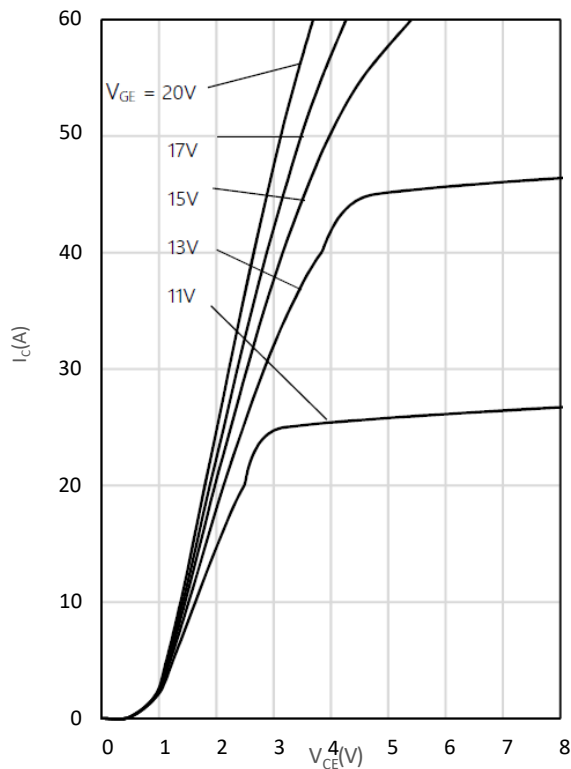
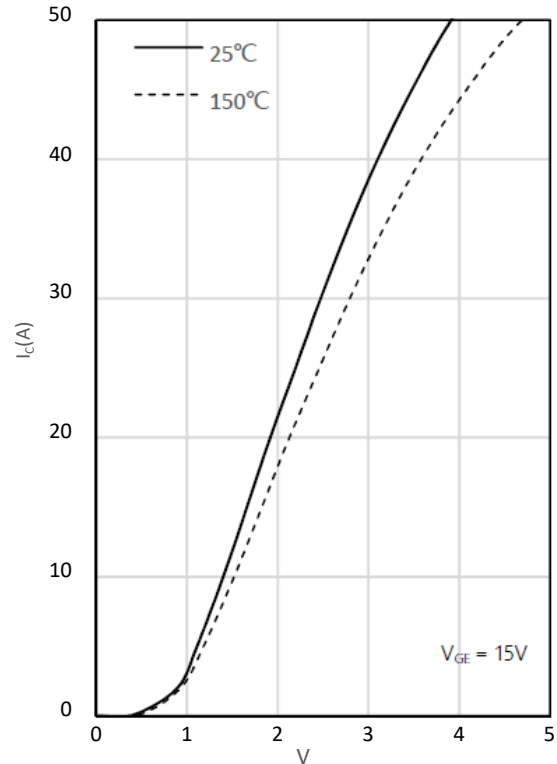


Fig. 4 Saturation voltage characteristics





ce(V)

Fig. 5 Switching times vs. gate resistor

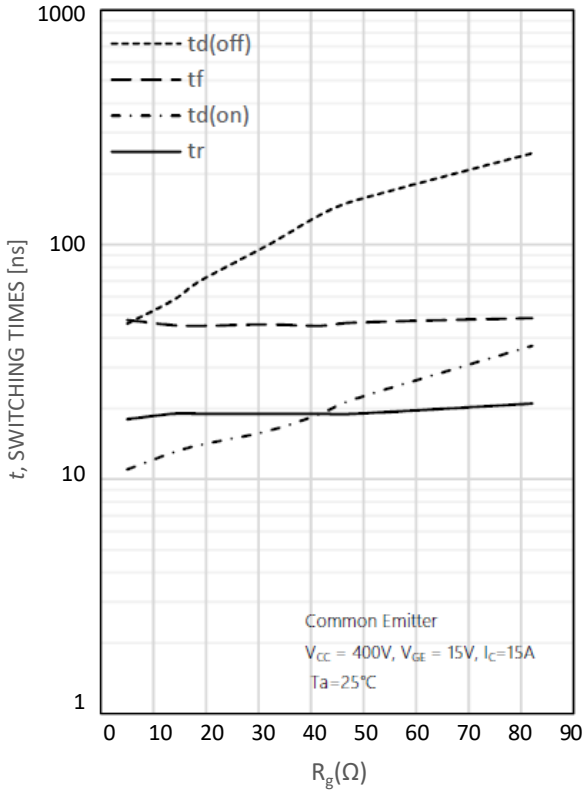


Fig. 6 Switching times vs. collector current

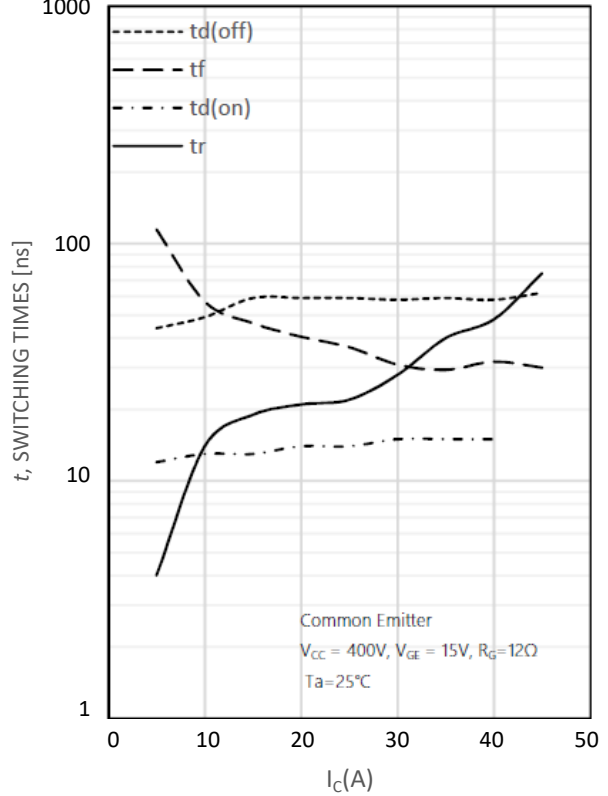


Fig. 7 Switching loss vs. gate resistor

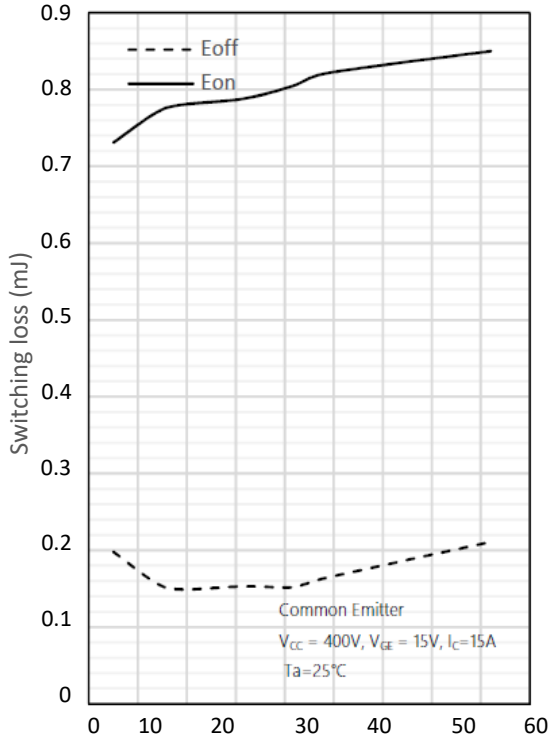
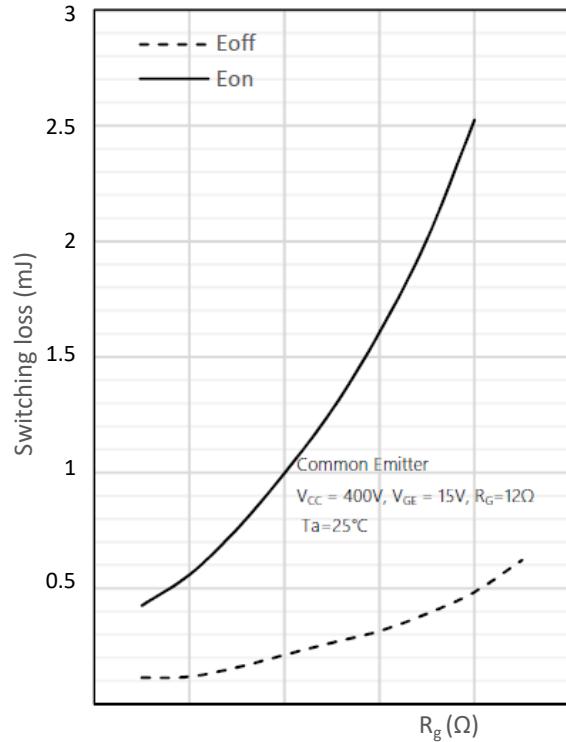


Fig. 8 Switching loss vs. collector current





0 10 20 30 40 50  $I_c$  (A)

Fig. 9 Gate charge characteristics

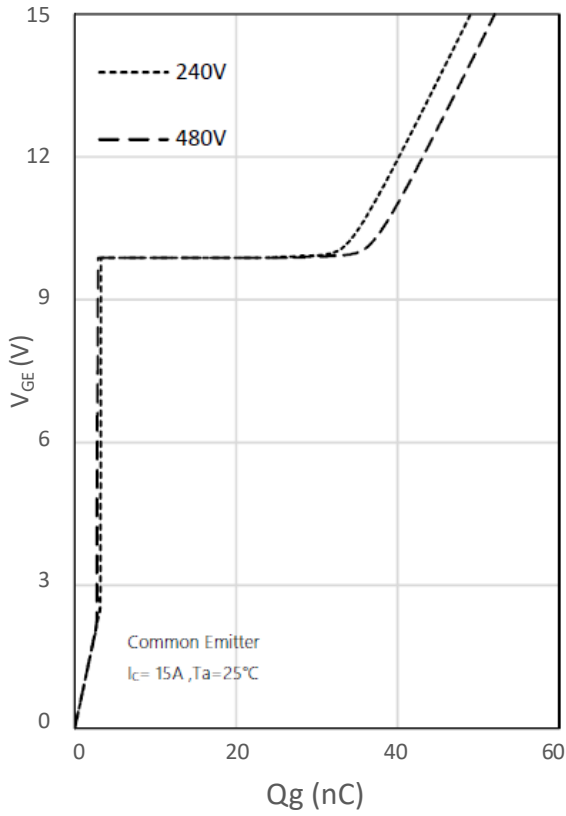
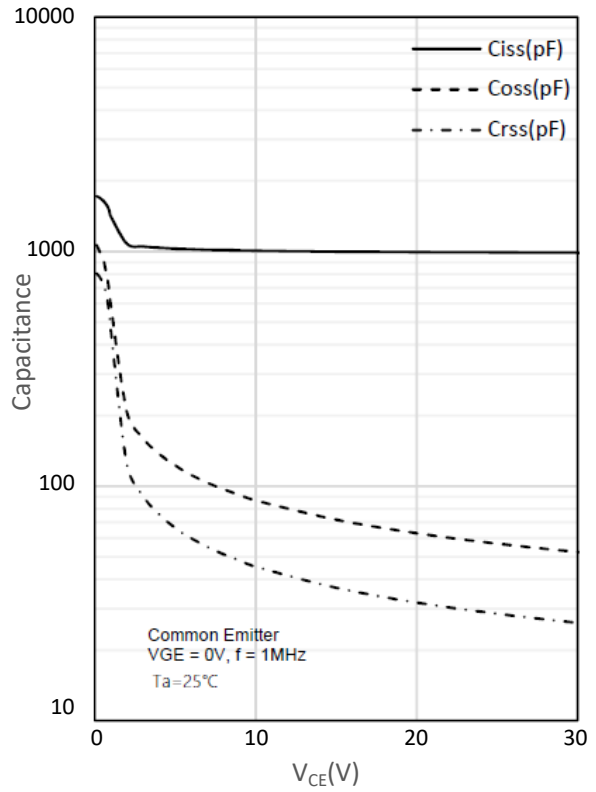
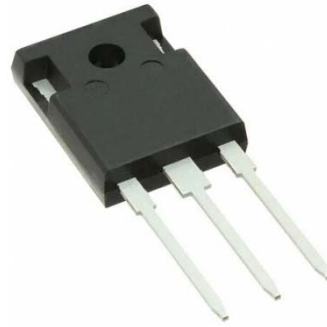
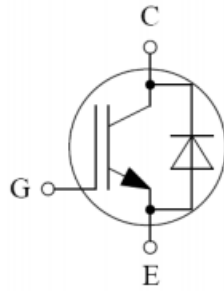


Fig. 10 Capacitance characteristics

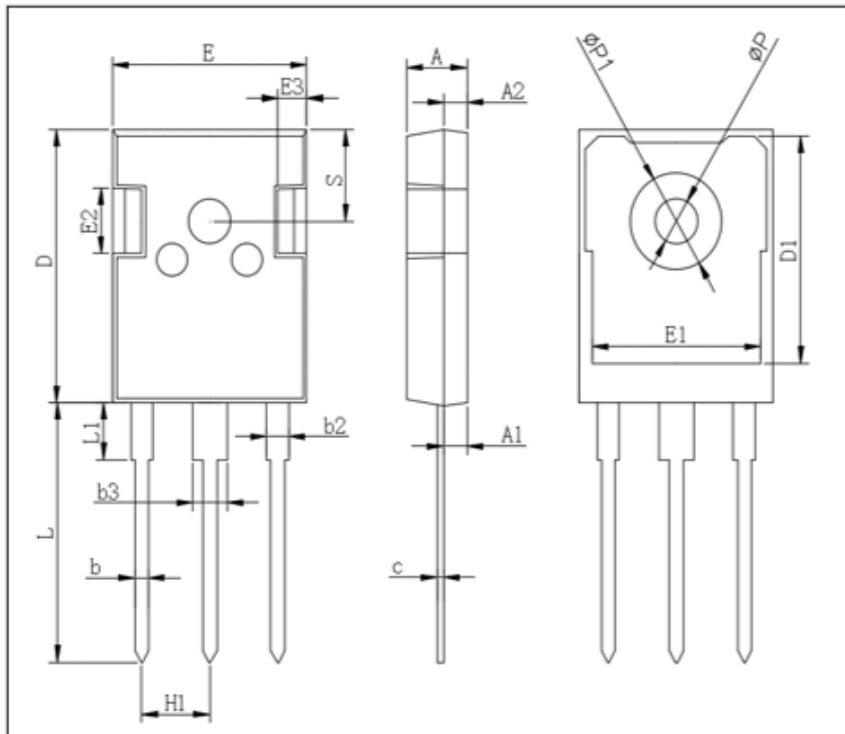


● Circuit Diagram



● Package Outline Information

CASE: TO 247



| TO-247AB <sup>⊃</sup>  |                      |                    |
|------------------------|----------------------|--------------------|
| Dim <sup>⊃</sup>       | Min <sup>⊃</sup>     | Max <sup>⊃</sup>   |
| A <sup>⊃</sup>         | 4.80 <sup>⊃</sup>    | 5.20 <sup>⊃</sup>  |
| A1 <sup>⊃</sup>        | 2.21 <sup>⊃</sup>    | 2.61 <sup>⊃</sup>  |
| A2 <sup>⊃</sup>        | 1.85 <sup>⊃</sup>    | 2.15 <sup>⊃</sup>  |
| b <sup>⊃</sup>         | 1.0 <sup>⊃</sup>     | 1.4 <sup>⊃</sup>   |
| b2 <sup>⊃</sup>        | 1.91 <sup>⊃</sup>    | 2.21 <sup>⊃</sup>  |
| C <sup>⊃</sup>         | 0.5 <sup>⊃</sup>     | 0.7 <sup>⊃</sup>   |
| D <sup>⊃</sup>         | 20.70 <sup>⊃</sup>   | 21.30 <sup>⊃</sup> |
| D1 <sup>⊃</sup>        | 16.25 <sup>⊃</sup>   | 16.85 <sup>⊃</sup> |
| E <sup>⊃</sup>         | 15.50 <sup>⊃</sup>   | 16.10 <sup>⊃</sup> |
| E1 <sup>⊃</sup>        | 13.0 <sup>⊃</sup>    | 13.6 <sup>⊃</sup>  |
| E2 <sup>⊃</sup>        | 4.80 <sup>⊃</sup>    | 5.20 <sup>⊃</sup>  |
| E3 <sup>⊃</sup>        | 2.30 <sup>⊃</sup>    | 2.70 <sup>⊃</sup>  |
| L <sup>⊃</sup>         | 19.62 <sup>⊃</sup>   | 20.22 <sup>⊃</sup> |
| L1 <sup>⊃</sup>        | - <sup>⊃</sup>       | 4.30 <sup>⊃</sup>  |
| $\phi P$ <sup>⊃</sup>  | 3.40 <sup>⊃</sup>    | 3.80 <sup>⊃</sup>  |
| $\phi P1$ <sup>⊃</sup> | - <sup>⊃</sup>       | 7.30 <sup>⊃</sup>  |
| S <sup>⊃</sup>         | 6.15TYP <sup>⊃</sup> |                    |
| H1 <sup>⊃</sup>        | 5.44TYP <sup>⊃</sup> |                    |
| b3 <sup>⊃</sup>        | 2.80 <sup>⊃</sup>    | 3.20 <sup>⊃</sup>  |