



## Insulated Gate Bi-Polar Transistor Type T2960BB45E

### Absolute Maximum Ratings

|                | VOLTAGE RATINGS                                | MAXIMUM LIMITS | UNITS |
|----------------|------------------------------------------------|----------------|-------|
| $V_{CES}$      | Collector – emitter voltage                    | 4500           | V     |
| $V_{DC\ link}$ | Permanent DC voltage for 100 FIT failure rate. | 2800           | V     |
| $V_{GES}$      | Peak gate – emitter voltage                    | $\pm 20$       | V     |

|             | RATINGS                                                        | MAXIMUM LIMITS | UNITS       |
|-------------|----------------------------------------------------------------|----------------|-------------|
| $I_C$       | Continuous DC collector current, IGBT                          | 3000           | A           |
| $I_{CRM}$   | Repetitive peak collector current, $t_p=1ms$ , IGBT            | 6000           | A           |
| $I_{ECO}$   | Maximum reverse emitter current, $t_p=100\mu s$ , (note 2 & 3) | 3000           | A           |
| $P_{MAX}$   | Maximum power dissipation, IGBT (note 2)                       | 23.8           | kW          |
| $T_{j\ op}$ | Operating temperature range                                    | -40 to +125    | $^{\circ}C$ |
| $T_{stg}$   | Storage temperature range                                      | -40 to +125    | $^{\circ}C$ |

#### Notes: -

- 1) Unless otherwise indicated  $T_j = 125^{\circ}C$ .
- 2)  $T_{sink} = 25^{\circ}C$ , double side cooled.
- 3) Maximum commutation loop inductance 200nH.
- 4) Half-sinewave,  $125^{\circ}C$   $T_j$  initial.

## Characteristics

### IGBT Characteristics

|               | PARAMETER                              | MIN | TYP  | MAX      | TEST CONDITIONS                                                                                                                                                                                                                          | UNITS      |
|---------------|----------------------------------------|-----|------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| $V_{CE(sat)}$ | Collector – emitter saturation voltage | -   | 2.75 | 3.15     | $I_C = 3000A, V_{GE} = 15V, T_J = 25^\circ C$                                                                                                                                                                                            | V          |
|               |                                        | -   | 3.6  | 4.0      | $I_C = 3000A, V_{GE} = 15V$                                                                                                                                                                                                              | V          |
| $V_{T0}$      | Threshold voltage                      | -   | -    | 1.84     | Current range: 1000A – 3000A                                                                                                                                                                                                             | V          |
| $r_T$         | Slope resistance                       | -   | -    | 0.73     |                                                                                                                                                                                                                                          | m $\Omega$ |
| $V_{GE(TH)}$  | Gate threshold voltage                 | -   | 5.1  | -        | $V_{CE} = V_{GE}, I_C = 300mA$                                                                                                                                                                                                           | V          |
| $I_{CES}$     | Collector – emitter cut-off current    | -   | 55   | 85       | $V_{CE} = V_{CES}, V_{GE} = 0V$                                                                                                                                                                                                          | mA         |
| $I_{GES}$     | Gate leakage current                   | -   | -    | $\pm 35$ | $V_{GE} = \pm 20V$                                                                                                                                                                                                                       | $\mu A$    |
| $C_{ies}$     | Input capacitance                      | -   | 495  | -        | $V_{CE} = 25V, V_{GE} = 0V, f = 1MHz$                                                                                                                                                                                                    | nF         |
| $t_{d(on)}$   | Turn-on delay time                     | -   | 1.1  | -        | $I_C = 3000A, V_{CE} = 2800V, di/dt = 5000A/\mu s$<br>$V_{GE} = \pm 15V, L_s = 200nH$<br>$R_{g(ON)} = 1.3\Omega, R_{g(OFF)} = 6.8\Omega, C_{GE} = 330nF$<br>Freewheel diode type E2400TC45C at $T_J = 125^\circ C$ .<br>(Notes 3, 4 & 5) | $\mu s$    |
| $t_r(V)$      | Rise time                              | -   | 2.2  | -        |                                                                                                                                                                                                                                          | $\mu s$    |
| $Q_{g(on)}$   | Turn-on gate charge                    | -   | 21   | -        |                                                                                                                                                                                                                                          | $\mu C$    |
| $E_{on}$      | Turn-on energy                         | -   | 11.5 | -        |                                                                                                                                                                                                                                          | J          |
| $t_{d(off)}$  | Turn-off delay time                    | -   | 5.3  | -        |                                                                                                                                                                                                                                          | $\mu s$    |
| $t_f(I)$      | Fall time                              | -   | 2.5  | -        |                                                                                                                                                                                                                                          | $\mu s$    |
| $Q_{g(off)}$  | Turn-off gate charge                   | -   | 18   | -        |                                                                                                                                                                                                                                          | $\mu C$    |
| $E_{off}$     | Turn-off energy                        | -   | 17.5 | -        |                                                                                                                                                                                                                                          | J          |
| $I_{SC}$      | Short circuit current                  | -   | 10.9 | -        | $V_{GE} = +15V, V_{CC} = 2800V, V_{CEmax} \leq V_{CES}, t_p \leq 10\mu s$                                                                                                                                                                | kA         |

### Thermal Characteristics

|            | PARAMETER                                 | MIN | TYP | MAX  | TEST CONDITIONS       | UNITS |
|------------|-------------------------------------------|-----|-----|------|-----------------------|-------|
| $R_{thJK}$ | Thermal resistance junction to sink, IGBT | -   | -   | 4.2  | Double side cooled    | K/kW  |
|            |                                           | -   | -   | 6.87 | Collector side cooled | K/kW  |
|            |                                           | -   | -   | 10.9 | Emitter side cooled   | K/kW  |
| F          | Mounting force                            | 75  | -   | 85   | Note 2                | kN    |
| $W_t$      | Weight                                    | -   | 2.8 | -    |                       | kg    |

#### Notes:-

- 1) Unless otherwise indicated  $T_J = 125^\circ C$ .
- 2) Consult application note 2008AN01 for detailed mounting requirements.
- 3)  $C_{GE}$  is additional gate - emitter capacitance added to output of gate drive circuit.
- 4)  $E_{on}$  integration time 15 $\mu s$  from 10% rising  $I_C$ .
- 5)  $E_{off}$  integration time 15 $\mu s$  from 90% falling  $V_{GE}$ .

## Curves

Figure 1 – Typical collector-emitter saturation voltage characteristics

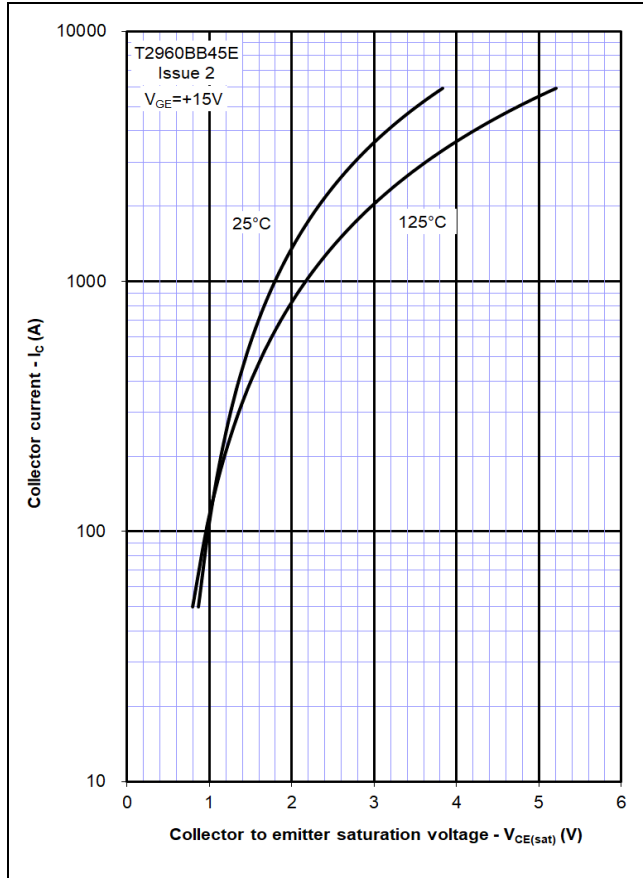


Figure 2 – Typical output characteristic

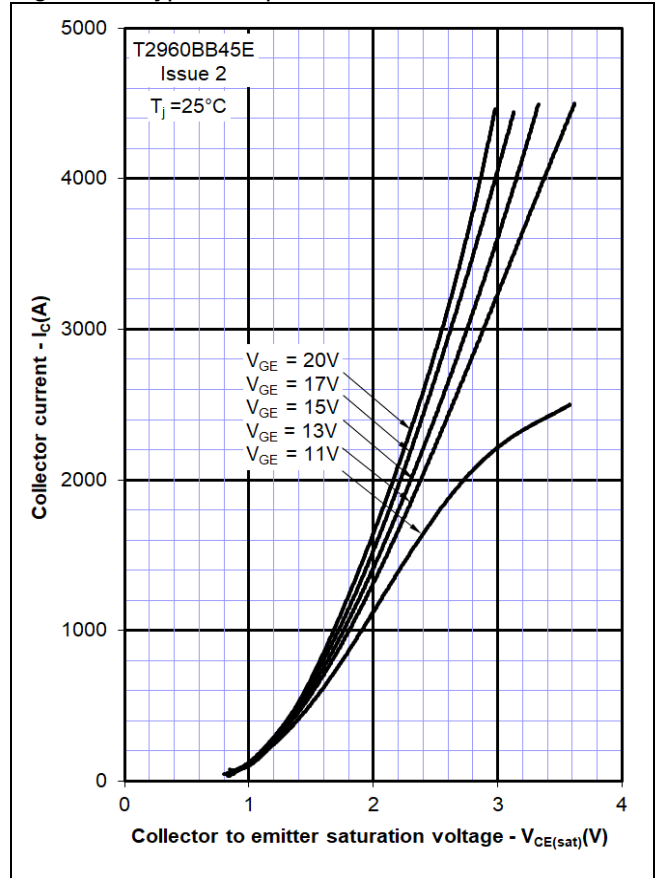


Figure 3 – Typical output characteristic

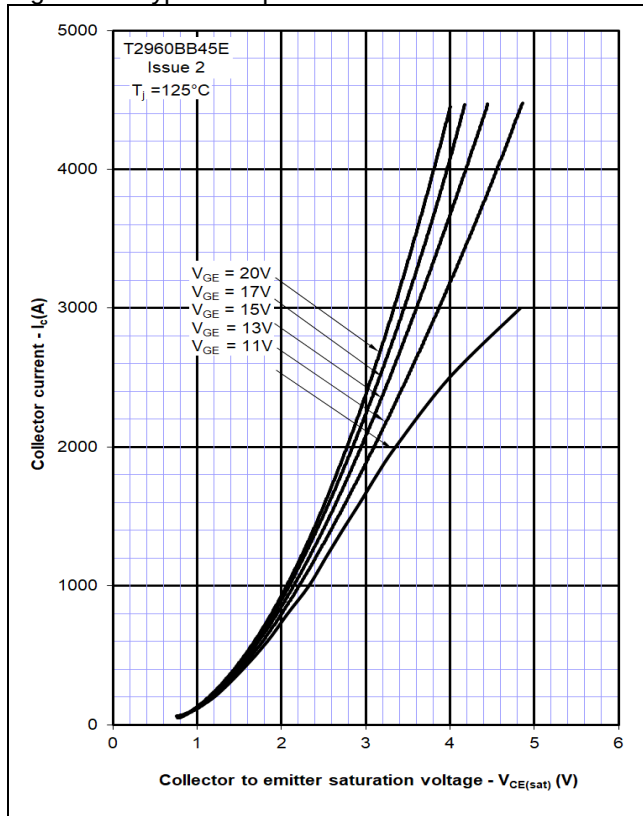


Figure 4 – Typical turn-on delay time vs gate resistance

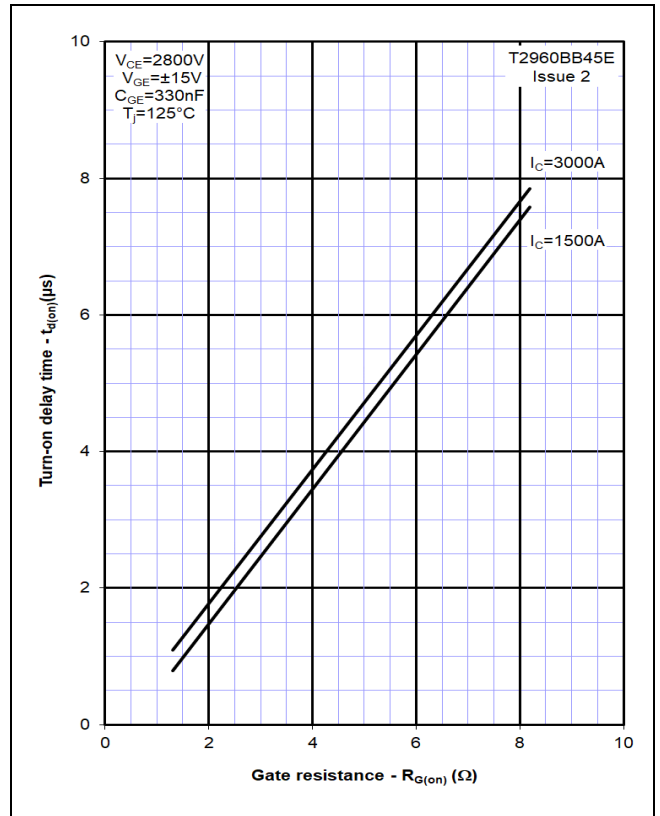


Figure 5 – Typical turn-off delay time vs. gate resistance

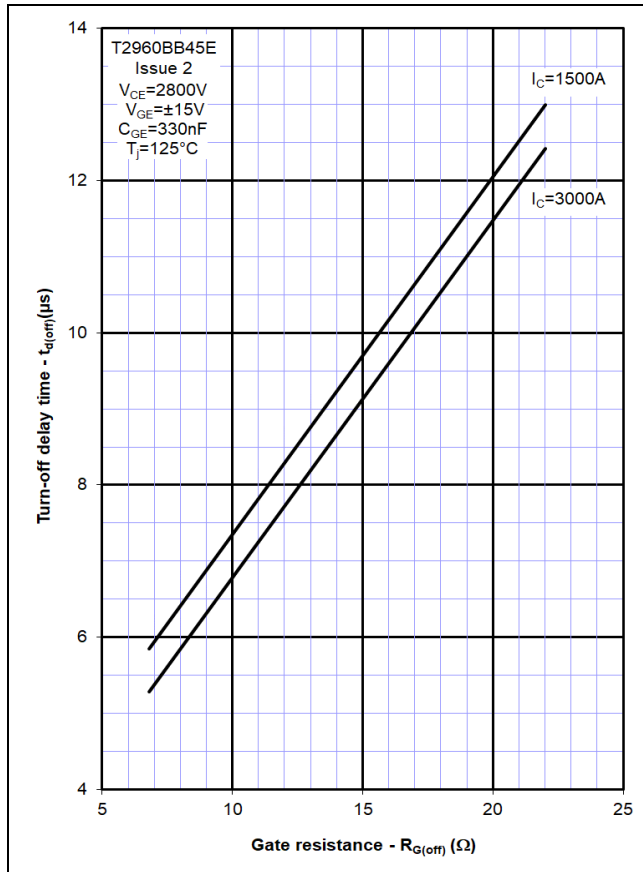


Figure 6 – Typical turn-on energy vs. collector current

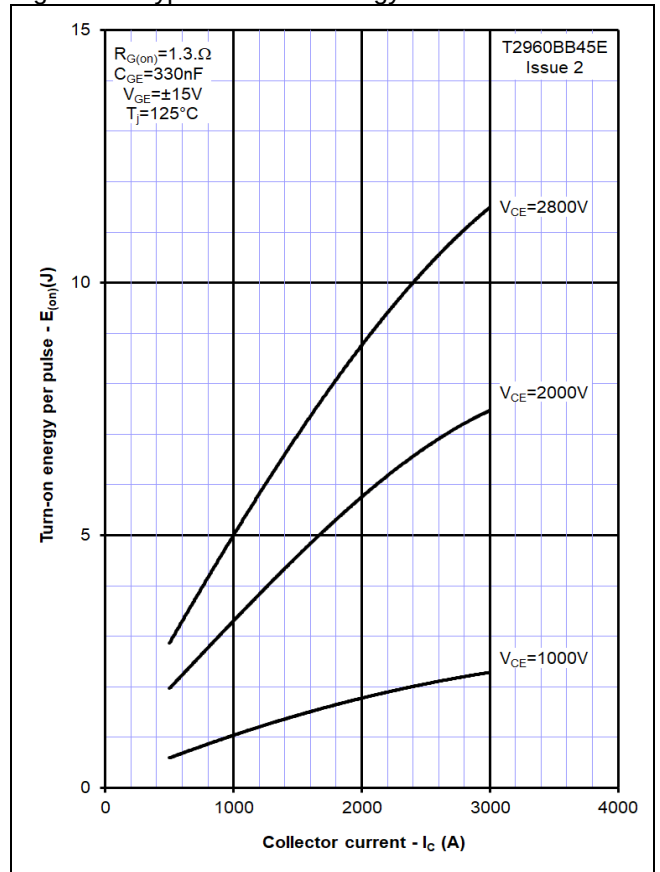


Figure 7 – Typical turn-on energy vs. di/dt

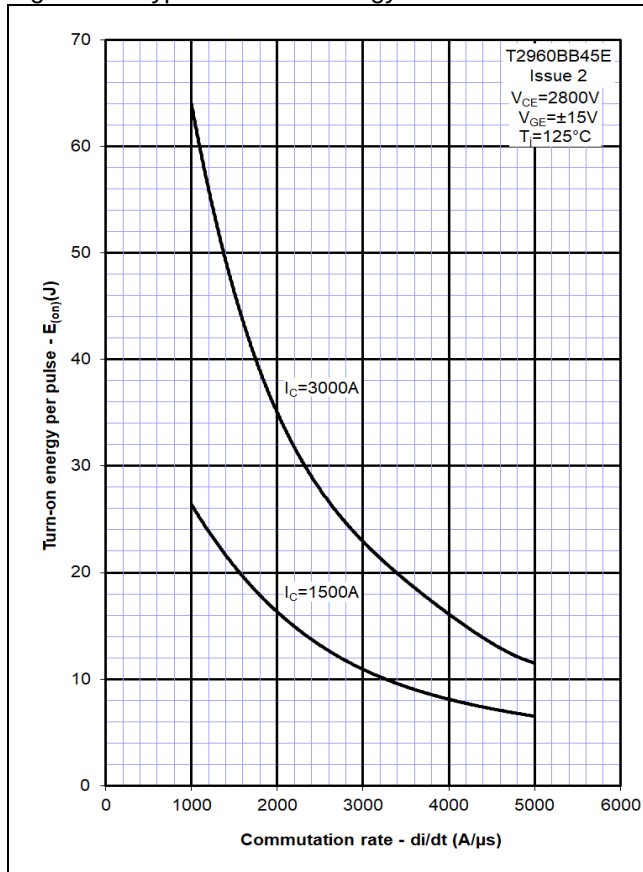


Figure 8 – Typical turn-off energy vs. collector current

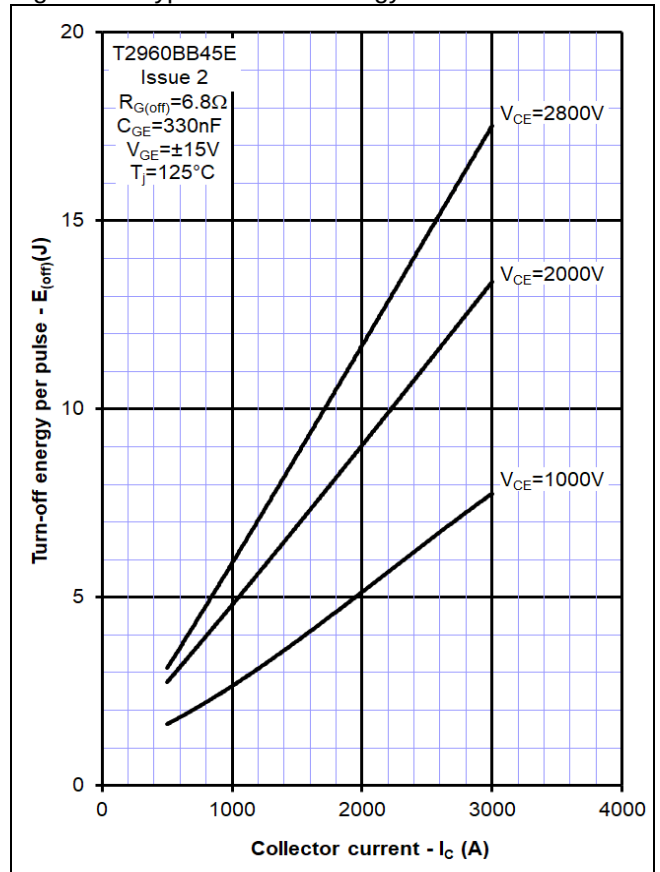


Figure 9 – Turn-off energy vs voltage

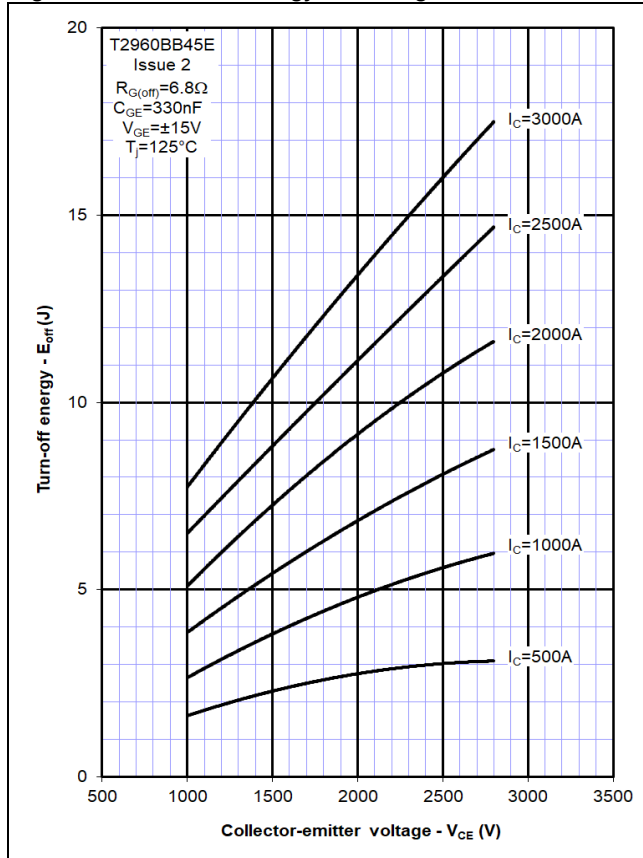


Figure 10 – Safe operating area

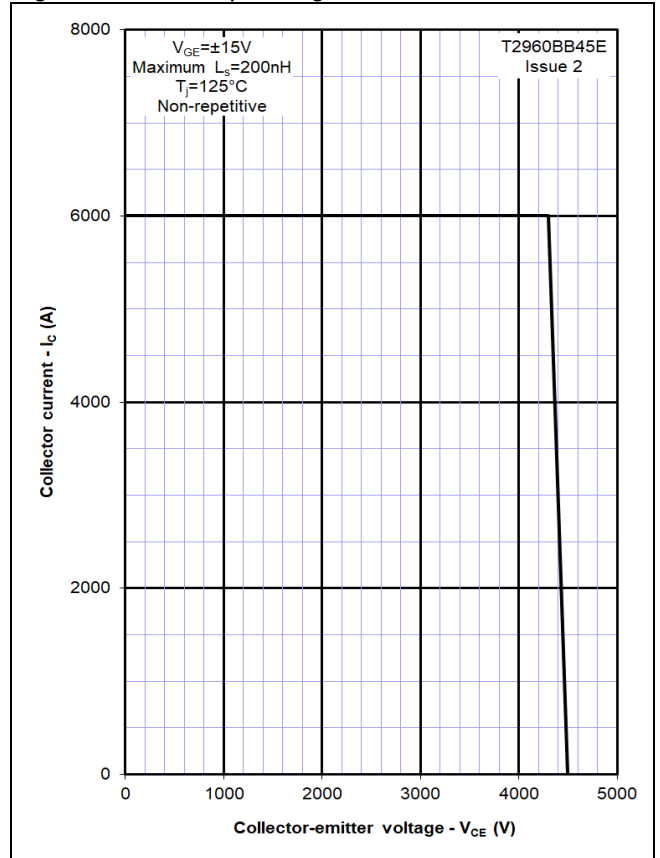
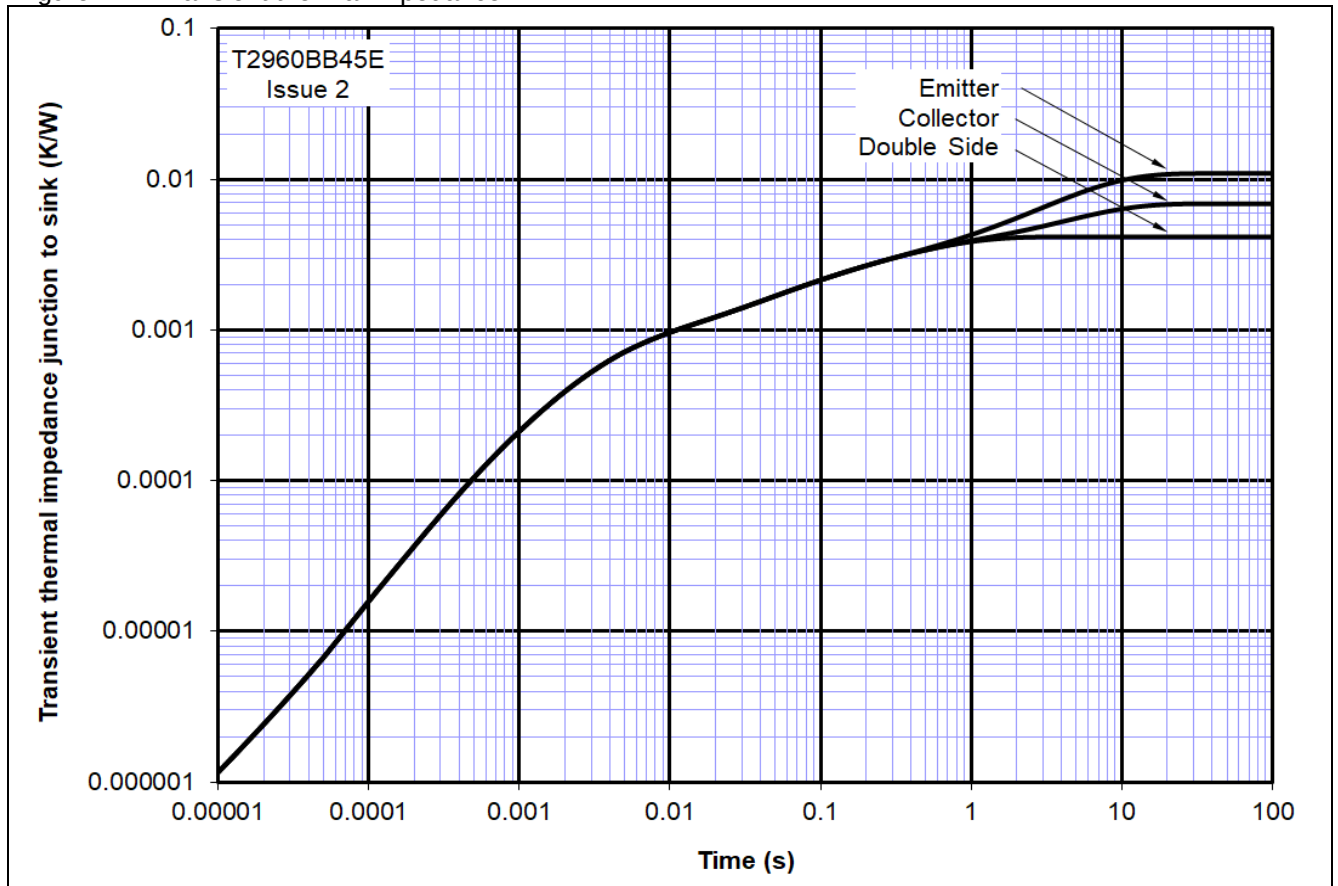
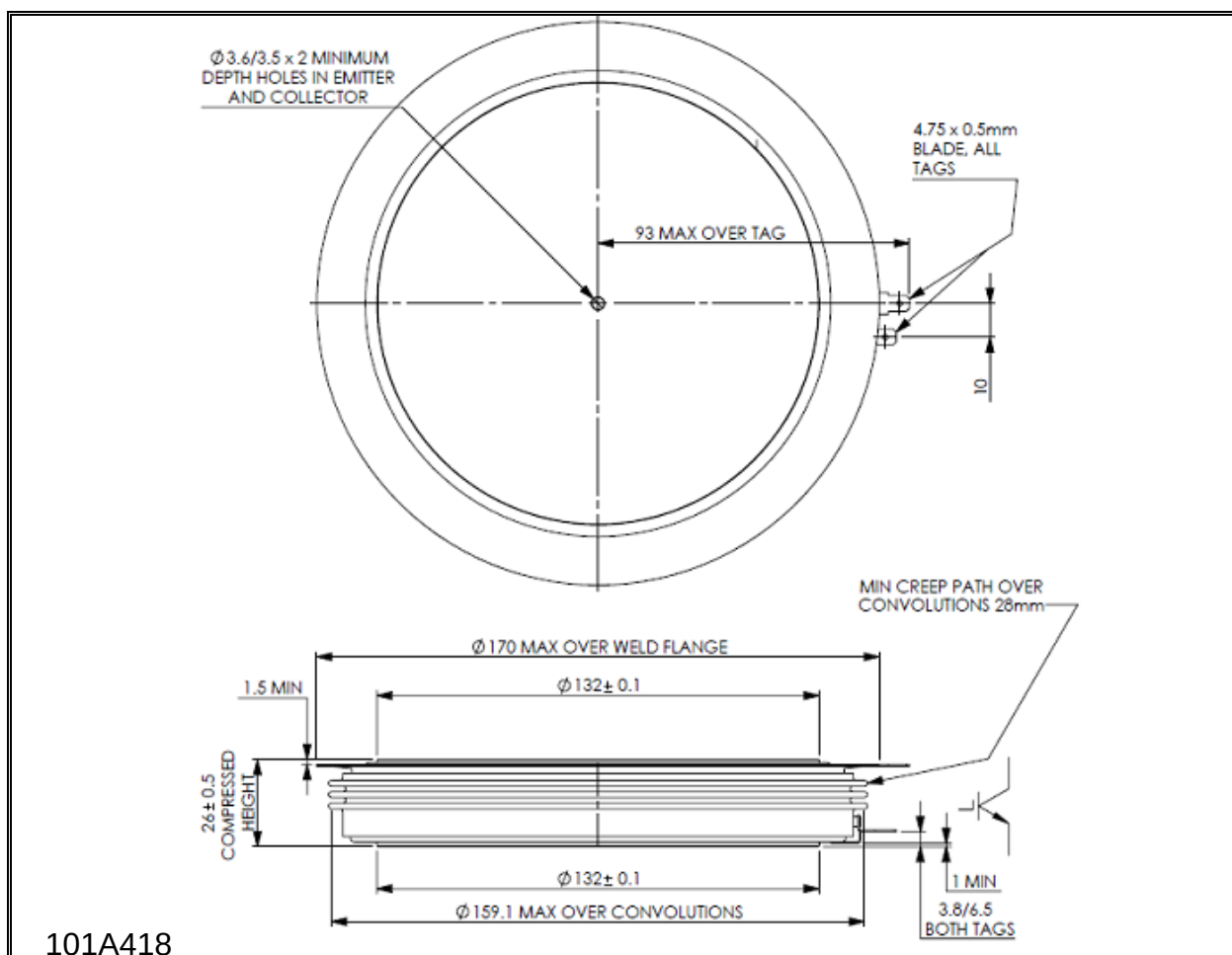


Figure 11 – Transient thermal impedance



## Outline Drawing & Ordering Information



### ORDERING INFORMATION

(Please quote 10 digit code as below)

| <b>T2960</b>    | <b>BB</b>          | <b>45</b>                            | <b>E</b>          |
|-----------------|--------------------|--------------------------------------|-------------------|
| Fixed type Code | Fixed Outline Code | Voltage Grade<br>$V_{CES}/100$<br>45 | Fixed format code |

 Typical order code: T2960BB45E ( $V_{CES} = 4500V$ )

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