

# MG250V2YMS3

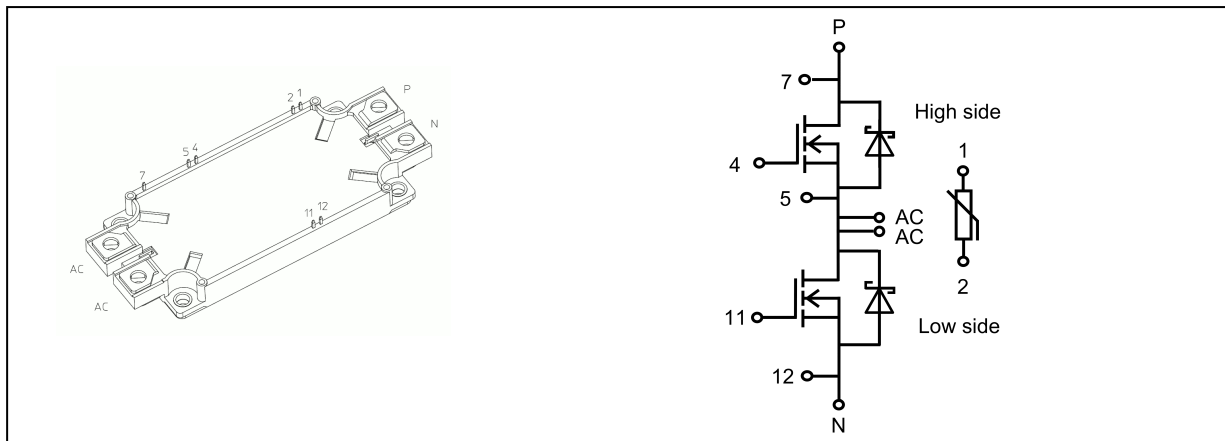
## 1. Applications

- High-Power Switching
- Motor Controllers (including rail traction)

## 2. Features

- (1)  $V_{DS} = 1700\text{ V}$ ,  $I_D = 250\text{ A}$  All SiC MOSFET Module (Low loss & High speed switching)
- (2) Low stray inductance, low thermal resistance, maximum  $T_{ch} = 150\text{ }^{\circ}\text{C}$ , built in thermistor.
- (3) Enhancement mode.
- (4) Electrodes are isolated from metal base plate.
- (5) UL-recognized: UL 1557, File No.E552353

## 3. Packaging and Internal Circuit (Note)



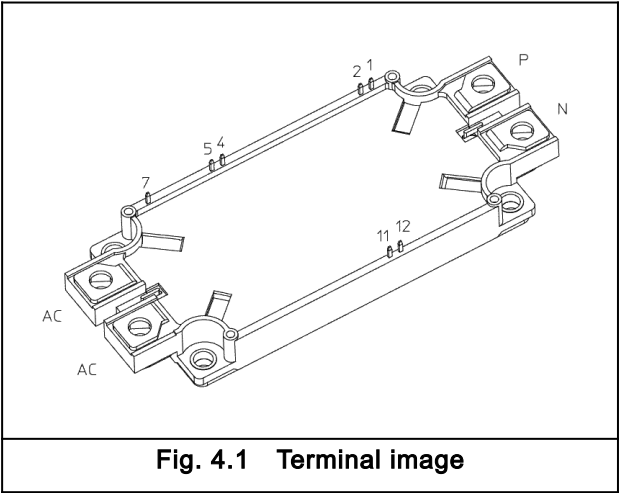
Note: P and N terminal should use one screw to fasten in each and AC terminal should use two screws to fasten. When the thermistor is not used, pin 1 and pin 2 should be electrically connected to pin 12.

Start of commercial production

2024-03

## 4. Terminal

| Symbol & No. | Terminal name                                 |
|--------------|-----------------------------------------------|
| P            | P(main terminal)                              |
| N            | N(main terminal)                              |
| AC           | AC(main terminals)                            |
| 1            | Thermistor                                    |
| 2            | Thermistor                                    |
| 4            | High side gate                                |
| 5            | High side source sense / Low side drain sense |
| 7            | High side drain sense                         |
| 11           | Low side gate                                 |
| 12           | Low side source sense                         |



## 5. Absolute Maximum Ratings(Note)( $T_c = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

| Characteristics                                         | Symbol            | Note     | Test Condition    | Rating      | Unit               |
|---------------------------------------------------------|-------------------|----------|-------------------|-------------|--------------------|
| Drain-source voltage                                    | $V_{DSS}$         |          |                   | 1700        | V                  |
| Gate-source voltage                                     | $V_{GSS}$         |          |                   | + 25 / - 10 | V                  |
| Drain current (DC)                                      | $I_D$             | (Note 1) |                   | 250         | A                  |
| Drain current (pulsed)                                  | $I_{DP}$          | (Note 1) | 1 ms              | 500         | A                  |
| Drain power dissipation                                 | $P_D$             | (Note 1) |                   | 1350        | W                  |
| Source current (DC)                                     | $I_S$             | (Note 1) |                   | 250         | A                  |
| Source current (pulsed)                                 | $I_{SP}$          | (Note 1) | 1 ms              | 500         | A                  |
| Channel temperature                                     | $T_{ch}$          |          |                   | 150         | $^{\circ}\text{C}$ |
| Storage temperature                                     | $T_{stg}$         |          |                   | - 40 to 150 | $^{\circ}\text{C}$ |
| Isolation voltage                                       | $V_{isol}$        |          | AC , 60 s         | 4000        | Vrms               |
| Isolation voltage (thermistor terminal-other terminals) | $V_{isol(therm)}$ |          | AC , 60 s         | 4000        | Vrms               |
| Mounting torque                                         | TOR               | (Note 2) | Main terminal: M6 | 4.5         | N · m              |
|                                                         |                   | (Note 3) | Mountng: M5       | 3.5         | N · m              |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note: Refer to the application notes.

Note 1: Ensure that the channel temperature does not exceed  $150\text{ }^{\circ}\text{C}$ .

Note 2: The recommended tightening torque for the main terminal (M6) is  $4.0\text{ N} \cdot \text{m}$ .

Note 3: The recommended tightening torque for mounting (M5) is  $3.0\text{ N} \cdot \text{m}$ .

## 6. Thermal-resistance

| Characteristics                      | Symbol         | Note     | Min | Typ.  | Max   | Unit |
|--------------------------------------|----------------|----------|-----|-------|-------|------|
| Thermal resistance (channel-to-case) | $R_{th(ch-c)}$ | (Note 1) | —   | —     | 0.090 | K/W  |
| Thermal resistance (case-to-fin)     | $R_{th(c-f)}$  | (Note 2) | —   | 0.020 | —     | K/W  |

Note 1: The value per half a module.

Note 2: The value per module.

Apply  $50\text{ }\mu\text{m}$  of  $3\text{ W}/(\text{m} \cdot \text{K})$  grease between the case and fin while taking care not to create a void, and tighten to the recommended torque before use.

7. Electrical Characteristics ( $T_C = 25\text{ }^\circ\text{C}$  unless otherwise specified)

| Characteristics                      | Symbol                    | Note     | Test Condition                                                                                                                                                                                                                                  | Min | Typ. | Max       | Unit          | Fig.       |
|--------------------------------------|---------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----------|---------------|------------|
| Gate-source leakage current          | $I_{GSS}$                 |          | $V_{GS} = +25\text{ V} / -10\text{ V}, V_{DS} = 0\text{ V}$                                                                                                                                                                                     | —   | —    | $\pm 100$ | nA            | —          |
| Drain-source cut-off current         | $I_{DSS}$                 |          | $V_{DS} = 1700\text{ V}, V_{GS} = 0\text{ V}$                                                                                                                                                                                                   | —   | —    | 250       | $\mu\text{A}$ | —          |
| Gate threshold voltage               | $V_{th}$                  | (Note 4) | $I_D = 250\text{ mA}, V_{DS} = 10\text{ V}$                                                                                                                                                                                                     | 3.5 | 4.5  | 5.5       | V             | —          |
| Drain-source on-voltage (sense)      | $V_{DS(on)}$<br>sense     | (Note 3) | $I_D = 250\text{ A}, V_{GS} = +20\text{ V}, T_{ch} = 25\text{ }^\circ\text{C}$                                                                                                                                                                  | —   | 0.8  | —         | V             | —          |
|                                      |                           |          | $I_D = 250\text{ A}, V_{GS} = +20\text{ V}, T_{ch} = 150\text{ }^\circ\text{C}$                                                                                                                                                                 | —   | 1.5  | 2.4       | V             | —          |
| Drain-source on-voltage (terminal)   | $V_{DS(on)}$<br>terminal  | (Note 2) | $I_D = 250\text{ A}, V_{GS} = +20\text{ V}, T_{ch} = 25\text{ }^\circ\text{C}$                                                                                                                                                                  | —   | 1.0  | —         | V             | —          |
| Input capacitance                    | $C_{iss}$                 |          | $V_{DS} = 900\text{ V}, V_{GS} = 0\text{ V}, f = 10\text{ kHz}$                                                                                                                                                                                 | —   | 36   | —         | nF            | —          |
| Internal gate resistance             | $r_{ig}$                  |          | $V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$                                                                                                                                                                                   | —   | 5.3  | —         | $\Omega$      | —          |
| Switching time (turn-on delay time)  | $t_{d(on)}$               | (Note 1) | Inductive load,<br>$V_{DD} = 900\text{ V}, I_D = 250\text{ A},$<br>$V_{GS} = +20\text{ V} / -6\text{ V},$<br>$R_{G(on)} = 3.0\text{ }\Omega, R_{G(off)} = 3.9\text{ }\Omega,$<br>$T_{ch} = 150\text{ }^\circ\text{C}, L_S \approx 45\text{ nH}$ | —   | 0.18 | —         | $\mu\text{s}$ | 7.1        |
| Switching time (rise time)           | $t_r$                     |          |                                                                                                                                                                                                                                                 | —   | 0.07 | —         | $\mu\text{s}$ | 7.2        |
| Switching time (turn-on time)        | $t_{on}$                  |          |                                                                                                                                                                                                                                                 | —   | 0.25 | —         | $\mu\text{s}$ | 7.3        |
| Switching time (turn-off delay time) | $t_{d(off)}$              |          |                                                                                                                                                                                                                                                 | —   | 0.43 | —         | $\mu\text{s}$ | —          |
| Switching time (fall time)           | $t_f$                     |          |                                                                                                                                                                                                                                                 | —   | 0.07 | —         | $\mu\text{s}$ | —          |
| Switching time (turn-off time)       | $t_{off}$                 |          |                                                                                                                                                                                                                                                 | —   | 0.50 | —         | $\mu\text{s}$ | —          |
| Turn-on switching loss               | $E_{on}$                  |          |                                                                                                                                                                                                                                                 | —   | 18   | 37        | mJ            | —          |
| Turn-off switching loss              | $E_{off}$                 |          |                                                                                                                                                                                                                                                 | —   | 11   | 16        | mJ            | —          |
| Source-drain on-voltage (sense)      | $V_{SD(on)}$<br>sense     | (Note 3) | $I_S = 250\text{ A}, V_{GS} = +20\text{ V}, T_{ch} = 25\text{ }^\circ\text{C}$                                                                                                                                                                  | —   | 0.8  | —         | V             | —          |
|                                      |                           |          | $I_S = 250\text{ A}, V_{GS} = +20\text{ V}, T_{ch} = 150\text{ }^\circ\text{C}$                                                                                                                                                                 | —   | 1.5  | 2.2       | V             | —          |
| Source-drain on-voltage (terminal)   | $V_{SD(on)}$<br>terminal  | (Note 2) | $I_S = 250\text{ A}, V_{GS} = +20\text{ V}, T_{ch} = 25\text{ }^\circ\text{C}$                                                                                                                                                                  | —   | 1.0  | —         | V             | —          |
| Source-drain off-voltage (sense)     | $V_{SD(off)}$<br>sense    | (Note 3) | $I_S = 250\text{ A}, V_{GS} = -6\text{ V}, T_{ch} = 25\text{ }^\circ\text{C}$                                                                                                                                                                   | —   | 1.6  | —         | V             | —          |
|                                      |                           |          | $I_S = 250\text{ A}, V_{GS} = -6\text{ V}, T_{ch} = 150\text{ }^\circ\text{C}$                                                                                                                                                                  | —   | 2.4  | 3.5       | V             | —          |
| Source-drain off-voltage (terminal)  | $V_{SD(off)}$<br>terminal | (Note 2) | $I_S = 250\text{ A}, V_{GS} = -6\text{ V}, T_{ch} = 25\text{ }^\circ\text{C}$                                                                                                                                                                   | —   | 1.8  | —         | V             | —          |
| Reverse recovery time                | $t_{rr}$                  | (Note 1) | Inductive load,<br>$V_{DD} = 900\text{ V}, I_S = 250\text{ A},$<br>$V_{GS} = -6\text{ V},$<br>Drive side $R_{G(on)} = 3.0\text{ }\Omega,$<br>$T_{ch} = 150\text{ }^\circ\text{C}, L_S \approx 45\text{ nH}$                                     | —   | 40   | —         | ns            | 7.4        |
| Reverse recovery loss                | $E_{rr}$                  |          |                                                                                                                                                                                                                                                 | —   | 0.3  | —         | mJ            | 7.5<br>7.6 |
| Stray inductance                     | $L_{SPN}$                 |          | P terminal-N terminal                                                                                                                                                                                                                           | —   | 12   | —         | nH            | —          |
| Rated NTC resistance                 | R                         |          | $T_C = 25\text{ }^\circ\text{C}$                                                                                                                                                                                                                | 3.5 | 5.0  | 6.5       | k $\Omega$    | —          |
|                                      |                           |          | $T_C = 150\text{ }^\circ\text{C}$                                                                                                                                                                                                               | 125 | 165  | 205       | $\Omega$      | —          |
| NTC B value                          | B                         |          | $T_{NTC} = 25\text{ to }150\text{ }^\circ\text{C}$                                                                                                                                                                                              | —   | 3375 | —         | K             | —          |

Note 1:  $L_S$  is a sum of the stray inductance between the P and N terminals ( $L_{SPN}$ ) and the stray inductance of external circuitry ( $L_{ext}$ ). ( $L_{ext}$  is shown in Fig. 7.1, 7.2, 7.4, 7.5)

Note 2: The value shown are when two AC terminals are connected.

Note 3: The values are measured between drain sense and source sense.

Note 4: Gate-source voltage (-10V) is applied 5ms before measurement.

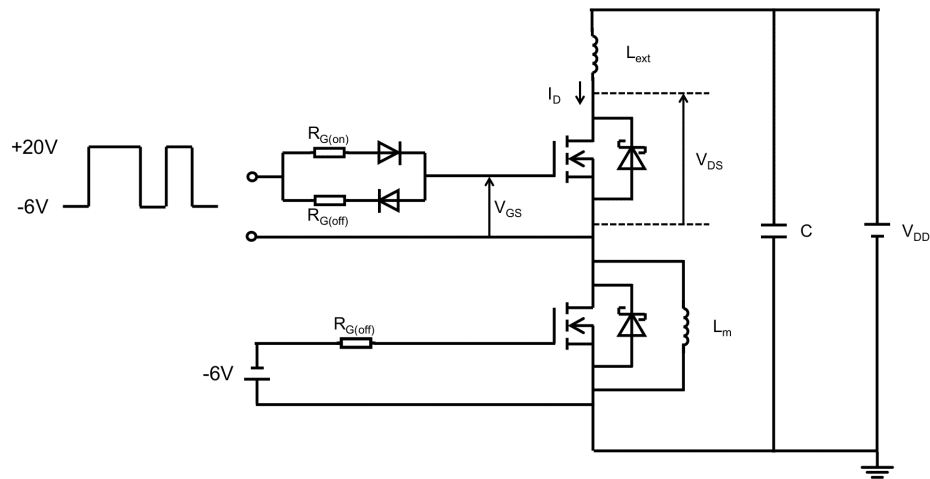


Fig. 7.1 Inductive Load Switching Test Circuit(High side Switching)

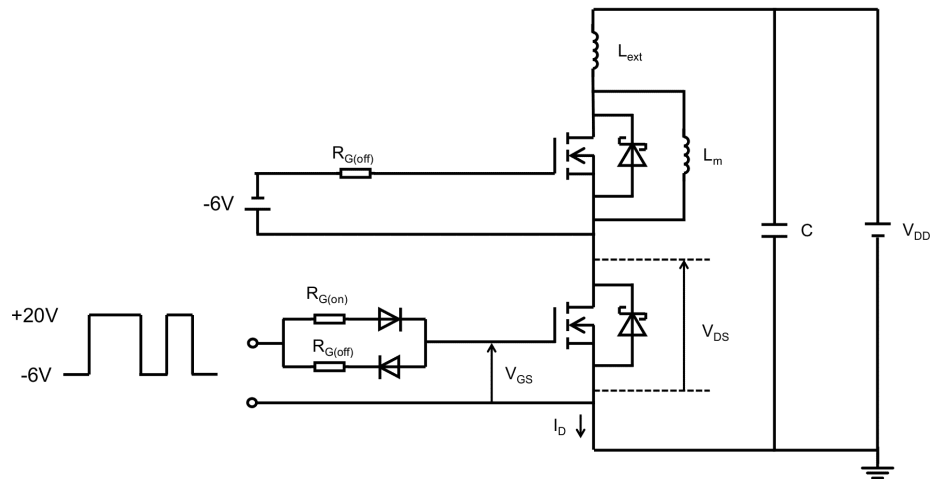


Fig. 7.2 Inductive Load Switching Test Circuit(Low side Switching)

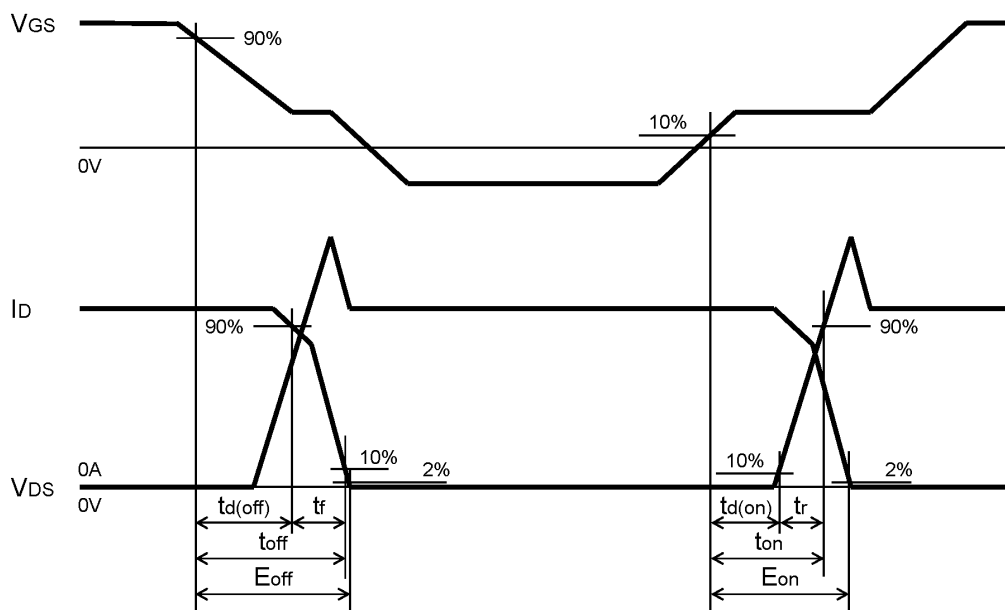


Fig. 7.3 Timing Chart(MOSFET part)



### 8. Characteristics Curves (Note)

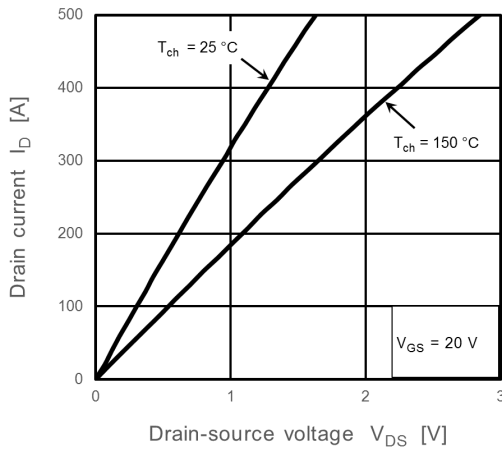


Fig. 8.1  $I_D - V_{DS}$ (Note 1)

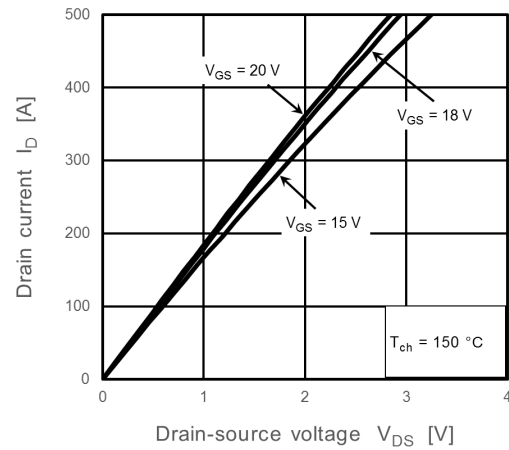


Fig. 8.2  $I_D - V_{DS}$ (Note 1)

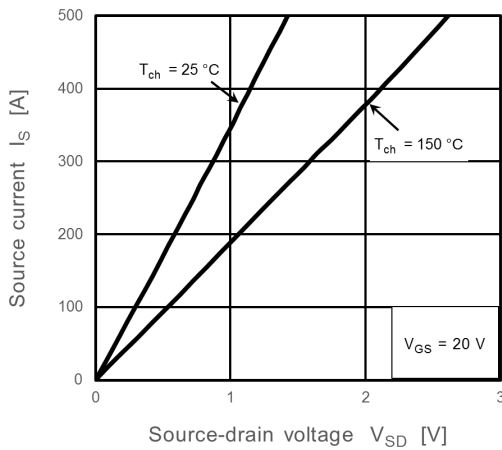


Fig. 8.3  $I_S - V_{SD}$ (Note 1)

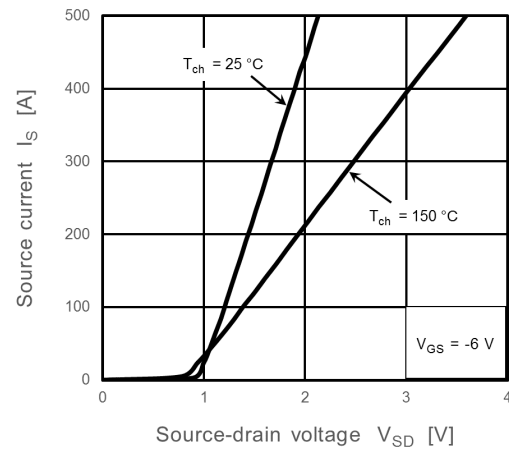


Fig. 8.4  $I_S - V_{SD}$ (Note 1)

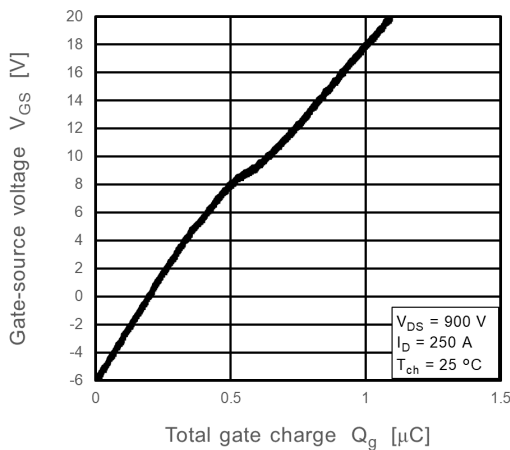


Fig. 8.5  $V_{GS} - Q_g$

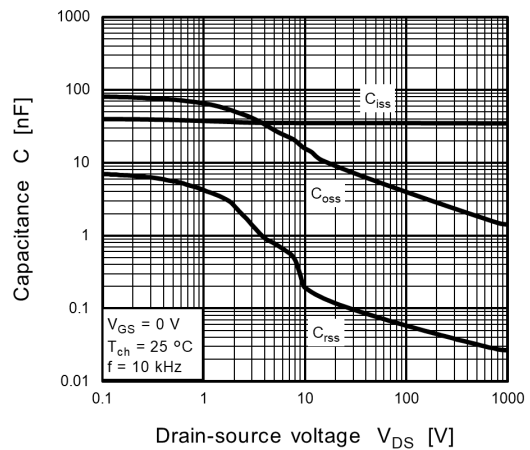


Fig. 8.6  $C_{iss}, C_{oss}, C_{rss} - V_{DS}$

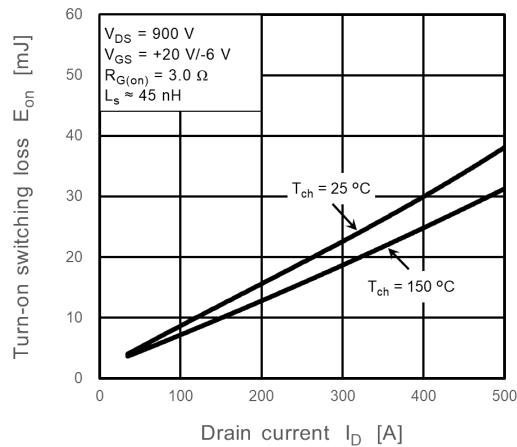


Fig. 8.7  $E_{on} - I_D$

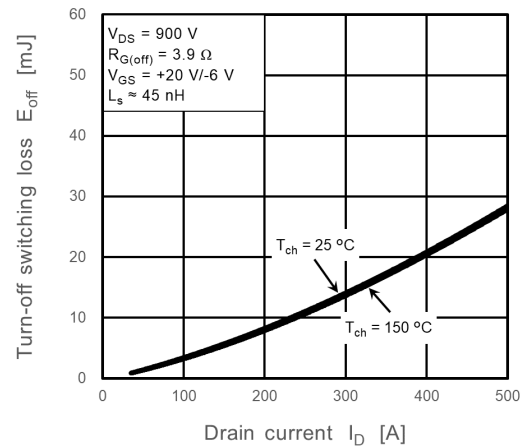


Fig. 8.8  $E_{off} - I_D$

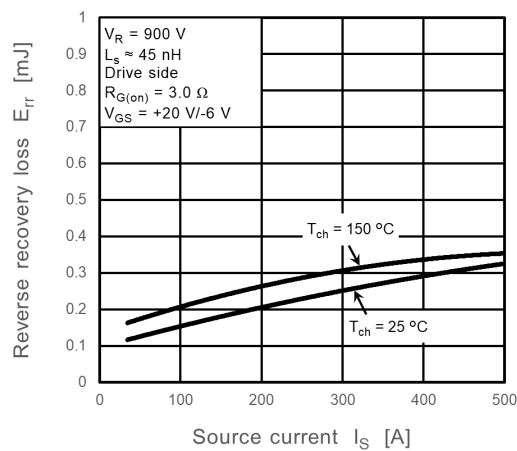


Fig. 8.9  $E_{rr} - I_S$

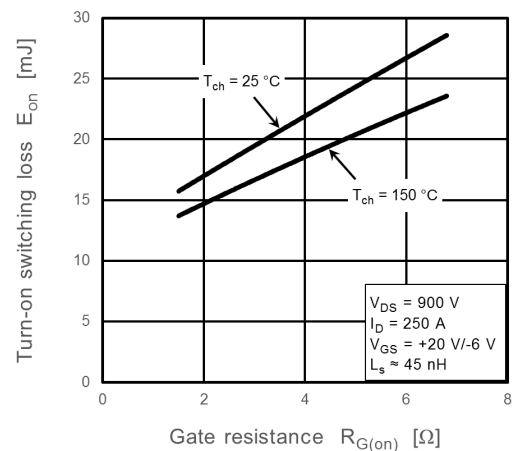


Fig. 8.10  $E_{on} - R_{G(on)}$

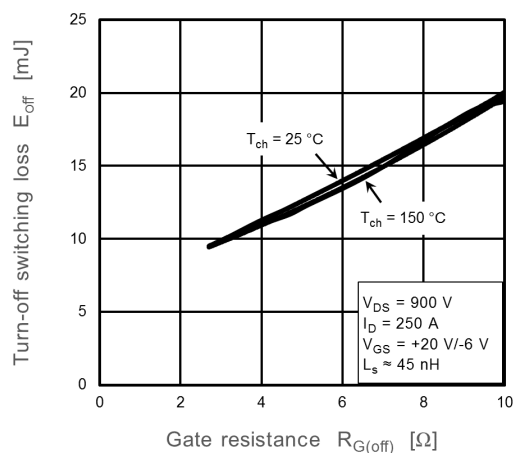


Fig. 8.11  $E_{off} - R_{G(off)}$

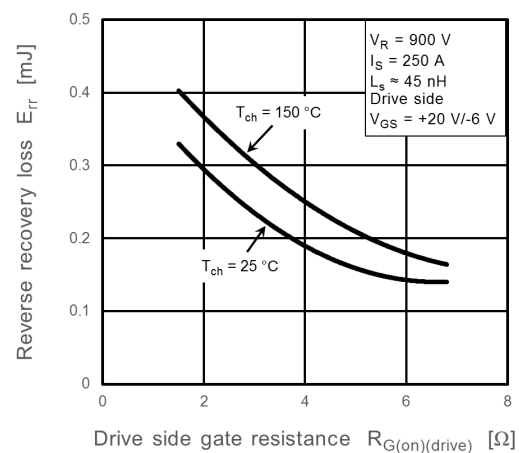


Fig. 8.12  $E_{rr} - R_{G(on)}$

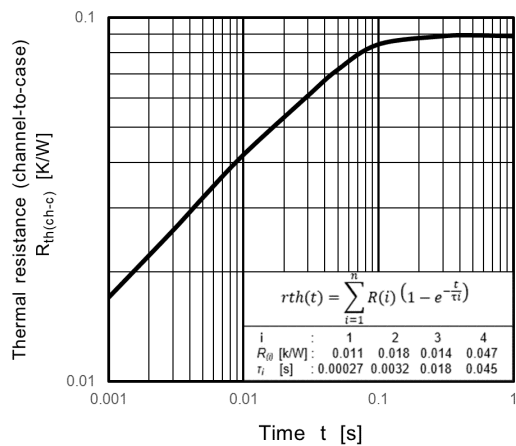


Fig. 8.13  $R_{th(ch-c)} - t$   
(Guaranteed Maximum)

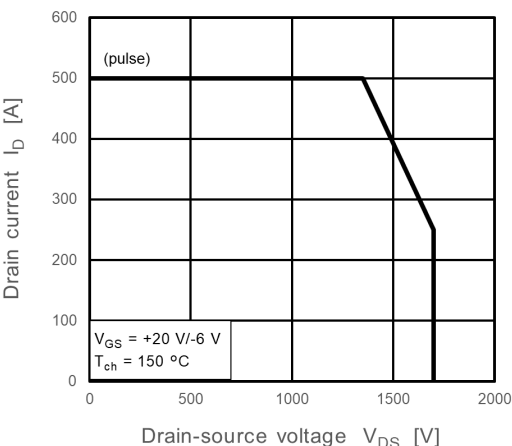


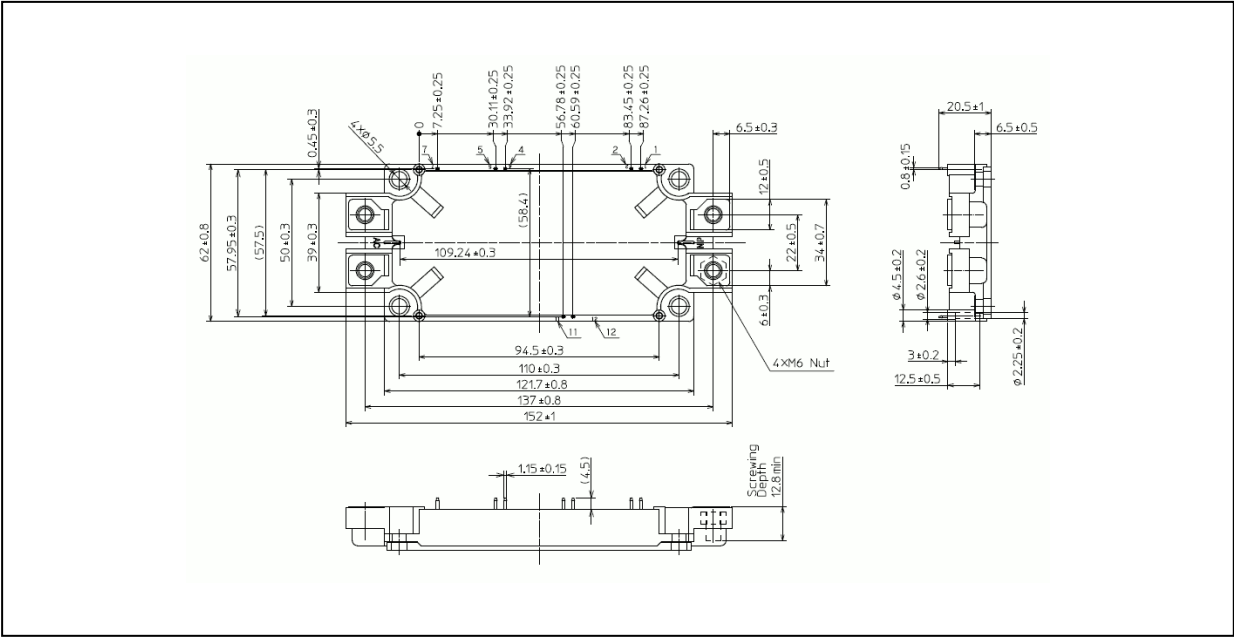
Fig. 8.14 Reverse bias safe operating area  
(RBSOA)  
(Guaranteed Maximum)

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Note 1: Source - drain voltage and Drain - source voltage are measured at sense terminals.

Package Dimensions

Unit: mm



Weight: 350 g (typ.)

| Package Name(s)   |
|-------------------|
| TOSHIBA: 2-153A1A |

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