

MOSFETs Silicon Carbide N-Channel MOS

# TW015N120C

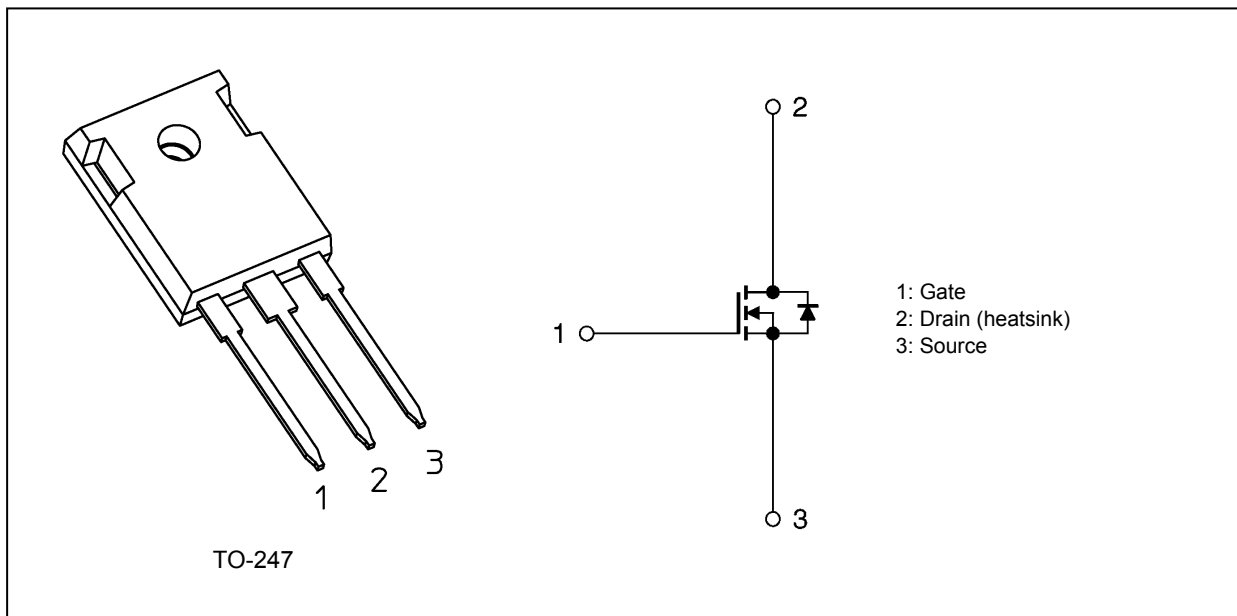
## 1. Applications

- Switching Voltage Regulators

## 2. Features

- (1) Chip design of 3rd generation (Built-in SiC schottky barrier diode)
- (2) Low diode forward voltage:  $V_{DSF} = -1.35 \text{ V}$  (typ.)
- (3) High voltage:  $V_{DSS} = 1200 \text{ V}$
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 15 \text{ m}\Omega$  (typ.)
- (5) Less susceptible to malfunction due to high threshold voltage:  $V_{th} = 3.0 \text{ to } 5.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 11.7 \text{ mA}$ )
- (6) Enhancement mode.

## 3. Packaging and Internal Circuit



Start of commercial production

2022-07

## 4. Absolute Maximum Ratings (Note) ( $T_a = 25\text{ °C}$ unless otherwise specified)

| Characteristics                                  | Symbol    | Rating     | Unit  |
|--|-----------|------------|-------|
| Drain-source voltage                             | $V_{DSS}$ | 1200       | V     |
| Gate-source voltage                              | $V_{GSS}$ | +25/-10    |       |
| Drain current (DC) ( $T_c = 25\text{ °C}$ )      | $I_D$     | 100        | A     |
| Drain current (DC) ( $T_c = 100\text{ °C}$ )     | $I_D$     | 81         |       |
| Drain current (pulsed) ( $T_c = 25\text{ °C}$ )  | $I_{DP}$  | 336        |       |
| Drain current (pulsed) ( $T_c = 100\text{ °C}$ ) | $I_{DP}$  | 235        |       |
| Power dissipation ( $T_c = 25\text{ °C}$ )       | $P_D$     | 431        | W     |
| Channel temperature                              | $T_{ch}$  | 175        | °C    |
| Storage temperature                              | $T_{stg}$ | -55 to 175 |       |
| Mounting torque                                  | TOR       | 0.8        | 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).

## 5. Thermal Characteristics

| Characteristics                       | Symbol         | Max   | Unit |
|---------------------------------------|----------------|-------|------|
| Channel-to-case thermal resistance    | $R_{th(ch-c)}$ | 0.348 | °C/W |
| Channel-to-ambient thermal resistance | $R_{th(ch-a)}$ | 50    |      |

Note 1: Ensure that the channel temperature does not exceed 175 °C.

Note: This transistor is sensitive to electrostatic discharge and should be handled with care. It should be used for switching applications.

## 6. Electrical Characteristics

### 6.1. Static Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics                 | Symbol        | Test Condition  | Min  | Typ. | Max       | Unit             |
|---------------------------------|---------------|---|------|------|-----------|------------------|
| Gate leakage current            | $I_{GSS}$     | $V_{GS} = +25/-10\text{ V}, V_{DS} = 0\text{ V}$                                    | —    | —    | $\pm 0.1$ | $\mu\text{A}$    |
| Drain cut-off current           | $I_{DSS}$     | $V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$                                       | —    | 3    | 38        |                  |
|                                 |               | $T_a = 150\text{ }^\circ\text{C},$<br>$V_{DS} = 1200\text{ V}, V_{GS} = 0\text{ V}$ | —    | 17   | —         |                  |
| Drain-source breakdown voltage  | $V_{(BR)DSS}$ | $I_D = 4\text{ mA}, V_{GS} = 0\text{ V}$  | 1200 | —    | —         | V                |
| Gate threshold voltage (Note 2) | $V_{th}$      | $V_{DS} = 10\text{ V}, I_D = 11.7\text{ mA}$  | 3.0  | —    | 5.0       |                  |
| Drain-source on-resistance      | $R_{DS(ON)}$  | $V_{GS} = 18\text{ V}, I_D = 50\text{ A}$   | —    | 15   | 20        | $\text{m}\Omega$ |
|                                 |               | $T_a = 150\text{ }^\circ\text{C},$<br>$V_{GS} = 18\text{ V}, I_D = 50\text{ A}$     | —    | 24   | —         |                  |

Note 2: Please be sure to apply  $I_{GSS}$  ( $V_{GS} = 25\text{ V}$ ) before the  $V_{th}$  test.

### 6.2. Dynamic Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics                | Symbol    | Test Condition  | Min | Typ. | Max | Unit        |               |
|--------------------------------|-----------|---|-----|------|-----|-------------|---------------|
| Input capacitance              | $C_{ISS}$ | $V_{DS} = 800\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 100\text{ kHz}$ | —   | 6000 | —   | $\text{pF}$ |               |
| Reverse transfer capacitance   | $C_{RSS}$ |   | —   | 7    | —   |             |               |
| Output capacitance             | $C_{OSS}$ |   | —   | 289  | —   |             |               |
| Output charge                  | $Q_{OSS}$ |   | —   | 397  | —   |             | $\text{nC}$   |
| $C_{OSS}$ stored energy        | $E_{OSS}$ |   | —   | 106  | —   |             | $\mu\text{J}$ |
| Gate resistance                | $r_g$     | $V_{DS} = \text{OPEN}, f = 1\text{ MHz}$                              | —   | 1.1  | —   | $\Omega$    |               |
| Switching time (rise time)     | $t_r$     | See Figure 6.2.1  | —   | 80   | —   | $\text{ns}$ |               |
| Switching time (turn-on time)  | $t_{on}$  |   | —   | 121  | —   |             |               |
| Switching time (fall time)     | $t_f$     |   | —   | 75   | —   |             |               |
| Switching time (turn-off time) | $t_{off}$ |   | —   | 139  | —   |             |               |

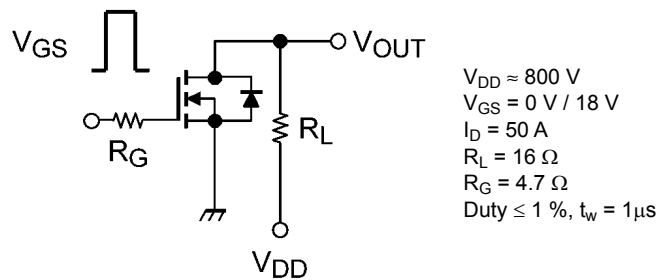


Fig. 6.2.1 Switching Time Test Circuit

### 6.3. Gate Charge Characteristics ( $T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

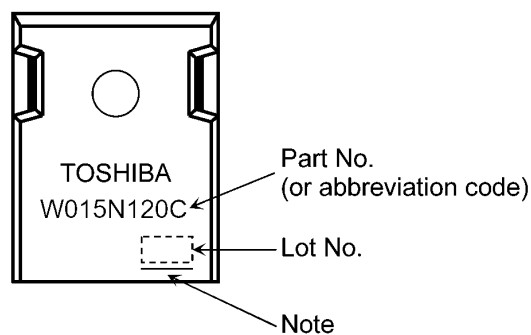
| Characteristics                                 | Symbol    | Test Condition  | Min | Typ. | Max | Unit        |
|---|-----------|---|-----|------|-----|-------------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$     | $V_{DD} \approx 800\text{ V}, V_{GS} = 18\text{ V},$<br>$I_D = 50\text{ A}$ | —   | 158  | —   | $\text{nC}$ |
| Gate-source charge 1                            | $Q_{gs1}$ |   | —   | 56   | —   |             |
| Gate-drain charge                               | $Q_{gd}$  |   | —   | 23   | —   |             |

## 6.4. Source · Drain Characteristics ( $T_a = 25\text{ °C}$ unless otherwise specified)

| Characteristics                         | Symbol    | Test Condition  | Min | Typ.  | Max   | Unit |
|---|-----------|---|-----|-------|-------|------|
| Reverse drain current (DC) (Note 3)     | $I_{DR}$  | $T_c = 25\text{ °C}, V_{GS} = -5\text{ V}$  | —   | —     | 92    | A    |
|   |           | $T_c = 100\text{ °C}, V_{GS} = -5\text{ V}$   | —   | —     | 62    |      |
|   |           | $T_c = 25\text{ °C}, V_{GS} = 18\text{ V}$  | —   | —     | 100   |      |
|   |           | $T_c = 100\text{ °C}, V_{GS} = 18\text{ V}$   | —   | —     | 81    |      |
| Reverse drain current (pulsed) (Note 3) | $I_{DRP}$ | $T_c = 25\text{ °C}, V_{GS} = -5\text{ V}$  | —   | —     | 336   |      |
|   |           | $T_c = 100\text{ °C}, V_{GS} = -5\text{ V}$   | —   | —     | 115   |      |
|   |           | $T_c = 25\text{ °C}, V_{GS} = 18\text{ V}$  | —   | —     | 336   |      |
|   |           | $T_c = 100\text{ °C}, V_{GS} = 18\text{ V}$   | —   | —     | 235   |      |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = 31\text{ A}, V_{GS} = -5\text{ V}$  | —   | -1.35 | -1.80 | V    |
|   |           | $T_a = 150\text{ °C}, I_{DR} = 31\text{ A}, V_{GS} = -5\text{ V}$   | —   | -1.80 | —     |      |
| Reverse recovery time                   | $t_{rr}$  | $I_{DR} = 33\text{ A}, V_{GS} = 0\text{ V}, V_{DD} = 800\text{ V}, -dI_{DR}/dt = 1000\text{ A}/\mu\text{s}$ | —   | 66    | —     | ns   |
| Reverse recovery charge                 | $Q_{rr}$  |   | —   | 594   | —     | nC   |
| Peak reverse recovery current           | $I_{rr}$  |   | —   | 18    | —     | A    |

Note 3: Ensure that the channel temperature does not exceed 175 °C.

## 7. Marking (Note)



**Fig. 7.1 Marking**

Note: A line under a Lot No. identifies the indication of product Labels.

Not underlined: [[Pb]]/INCLUDES > MCV

Underlined: [[G]]/RoHS COMPATIBLE or [[G]]/RoHS [[Pb]]

Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

## 8. Characteristics Curves (Note)

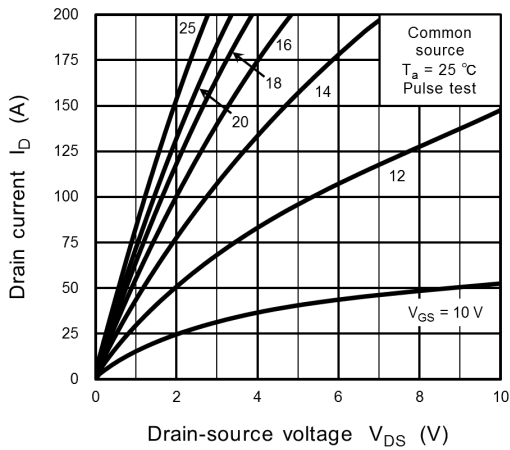


Fig. 8.1  $I_D - V_{DS}$

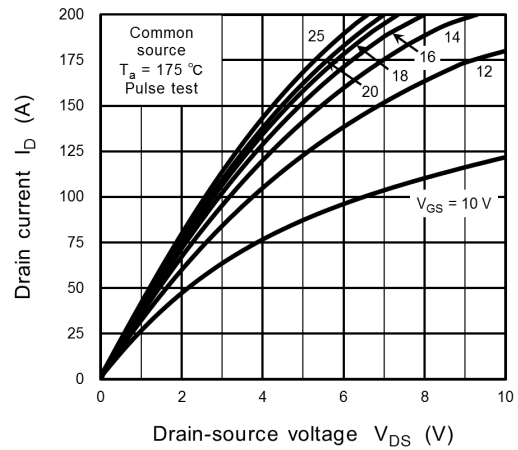


Fig. 8.2  $I_D - V_{DS}$

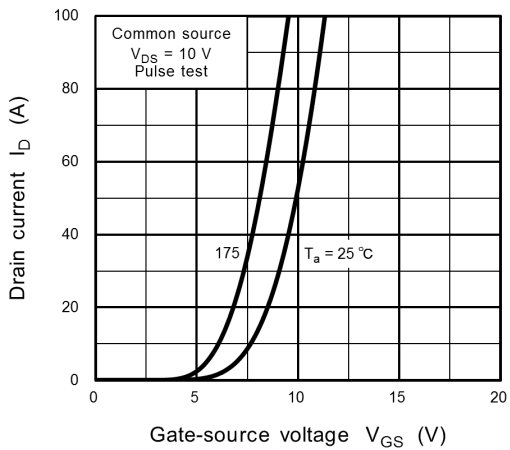


Fig. 8.3  $I_D - V_{GS}$

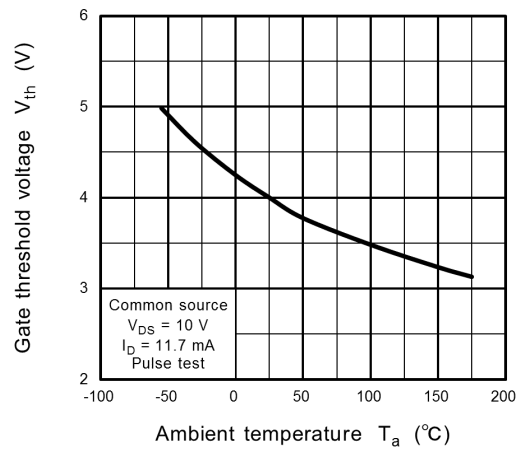


Fig. 8.4  $V_{th} - T_a$

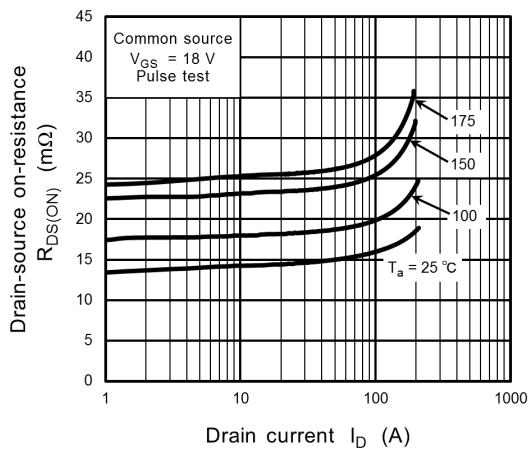


Fig. 8.5  $R_{DS(ON)} - I_D$

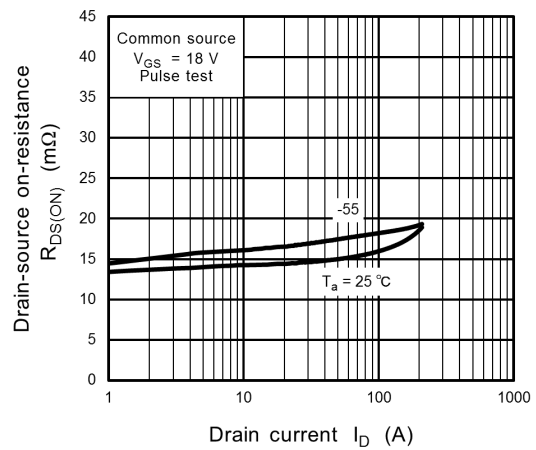
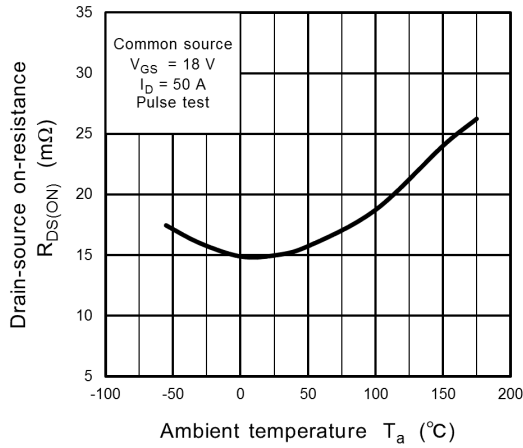
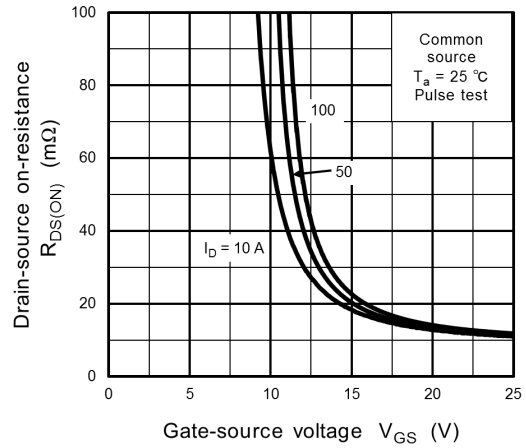


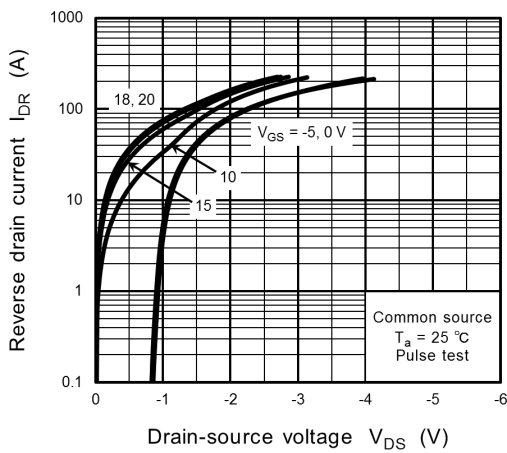
Fig. 8.6  $R_{DS(ON)} - I_D$



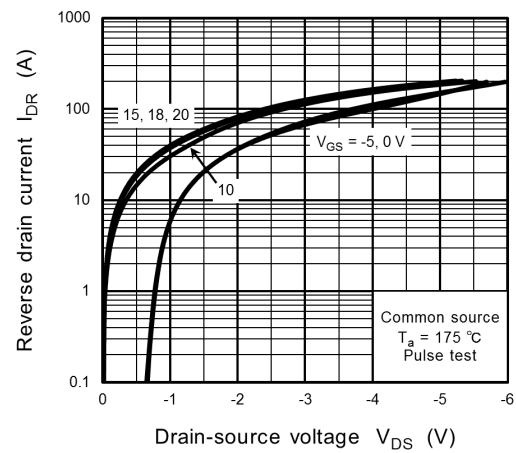
**Fig. 8.7  $R_{DS(ON)} - T_a$**



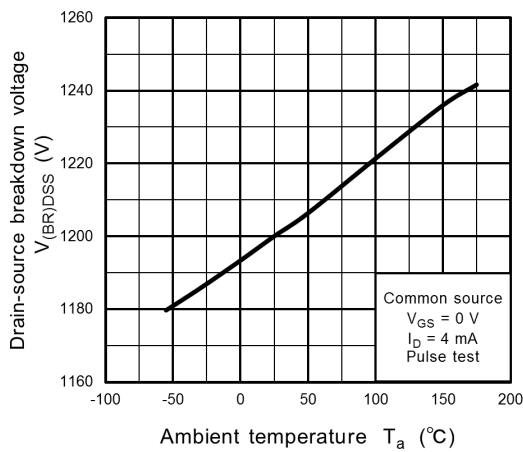
**Fig. 8.8  $R_{DS(ON)} - V_{GS}$**



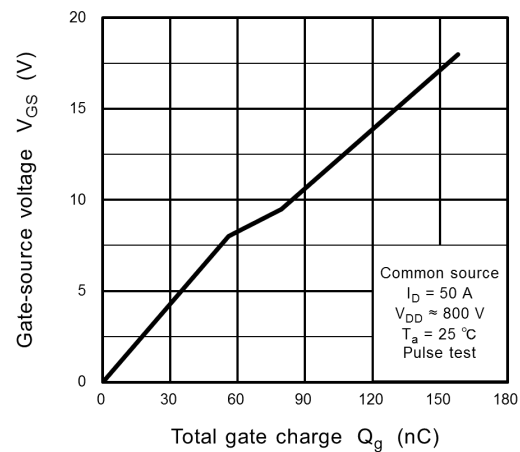
**Fig. 8.9  $I_{DR} - V_{DS}$**



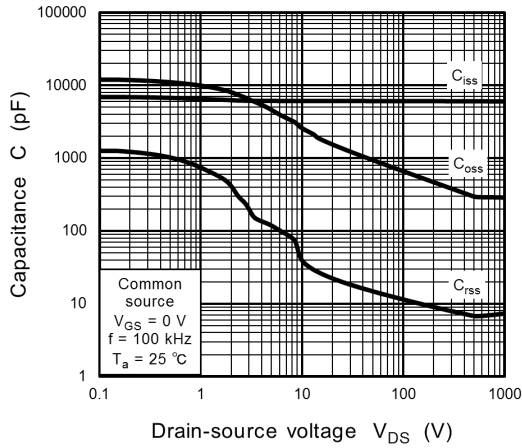
**Fig. 8.10  $I_{DR} - V_{DS}$**



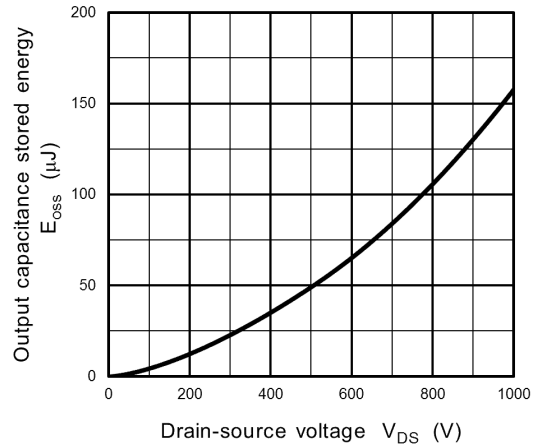
**Fig. 8.11  $V_{DSS} - T_a$**



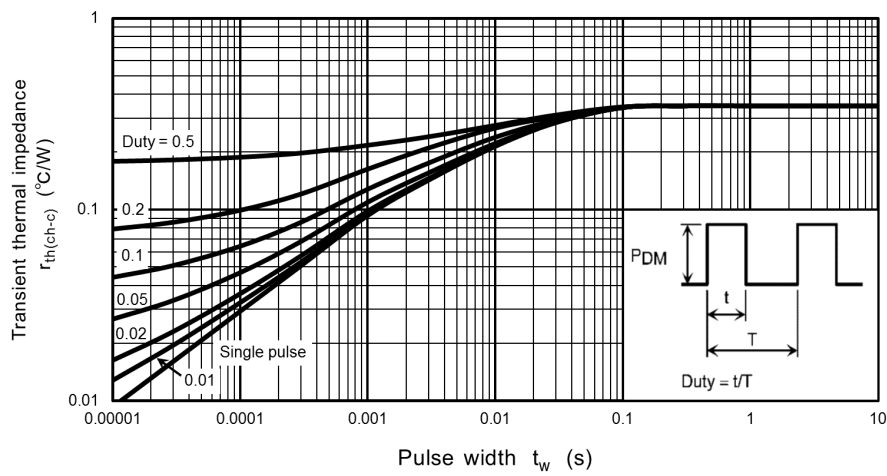
**Fig. 8.12 Dynamic Input Characteristics**



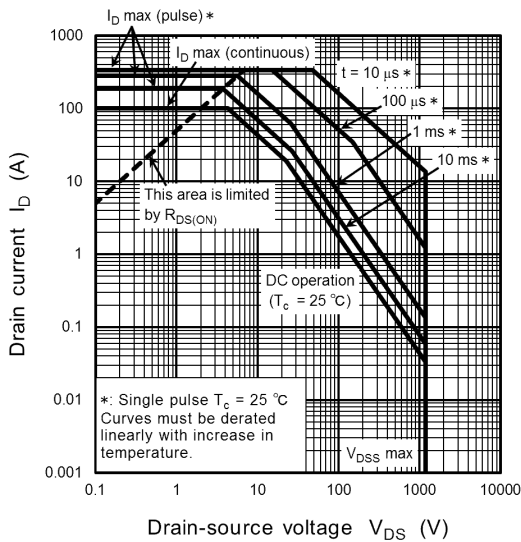
**Fig. 8.13 C -  $V_{DS}$**



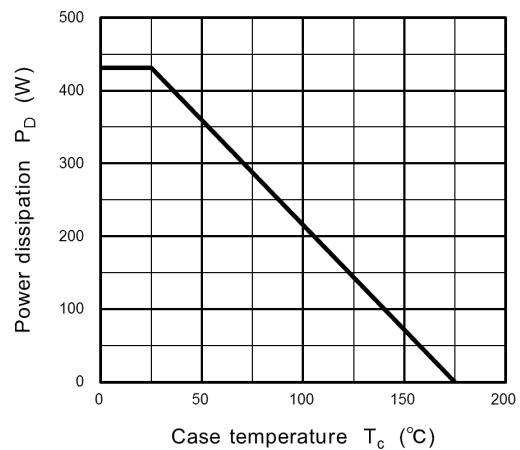
**Fig. 8.14  $E_{oss}$  -  $V_{DS}$**



**Fig. 8.15  $r_{th}$  -  $t_w$   
(Guaranteed Maximum)**



**Fig. 8.16 Safe Operating Area  
(Guaranteed Maximum)**



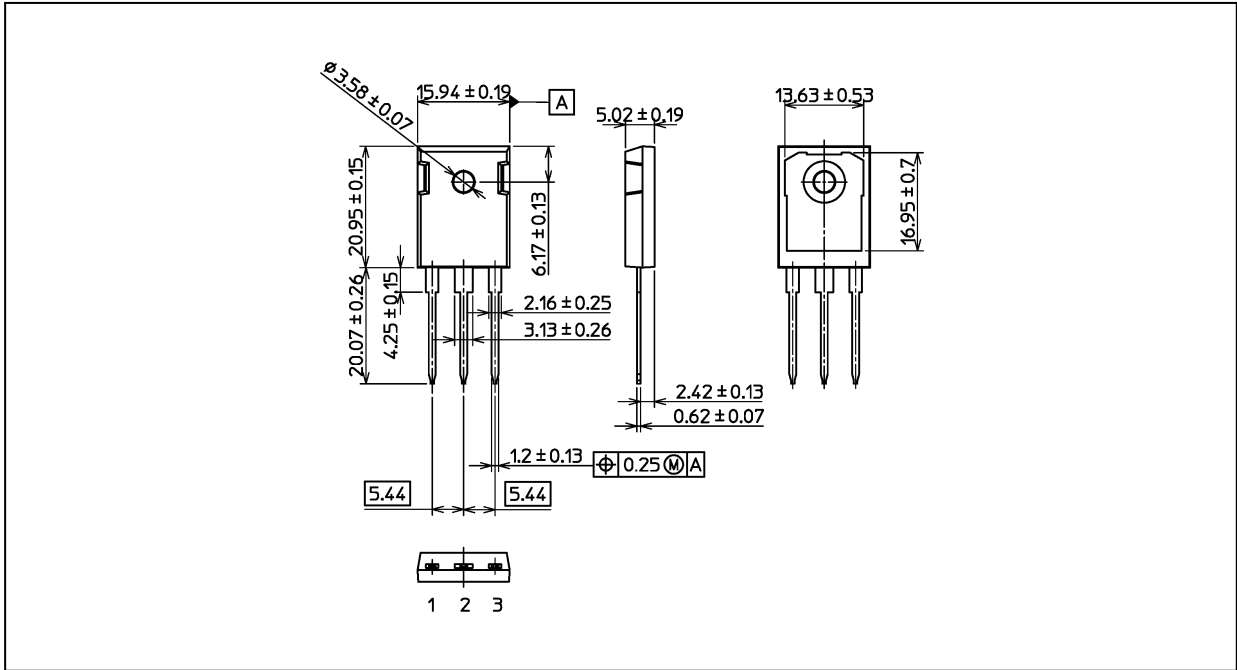
**Fig. 8.17  $P_D$  -  $T_c$   
(Guaranteed Maximum)**

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



## Package Dimensions

Unit: mm



Weight: 6.15 g (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 2-16L1A |
| Nickname: TO-247 |

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