MOSFETs Silicon Carbide N-Channel MOS

# TW027N65C

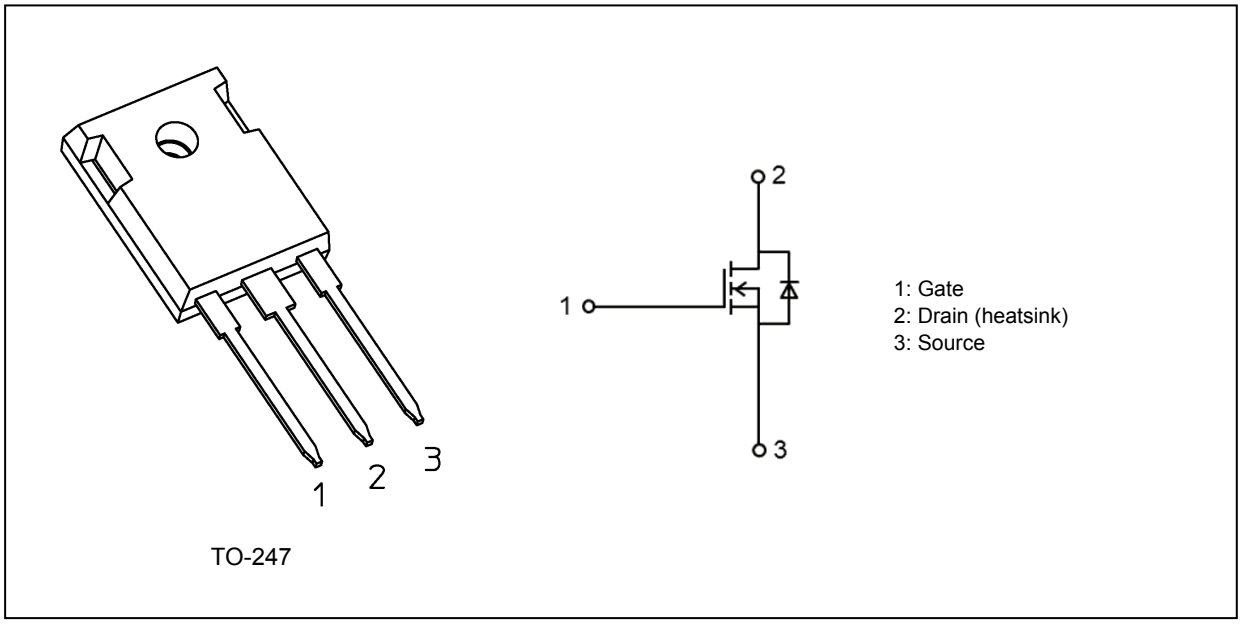
## 1. Applications

- 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 V (typ.)
(3) High voltage: $V_{DSS}$ = 650 V
(4) Low drain-source on-resistance: $R_{DS(ON)}$ = 27 mΩ (typ.)
(5) Less susceptible to malfunction due to high threshold voltage: $V_{th}$ = 3.0 to 5.0 V ($V_{DS}$ = 10 V, $I_D$ = 3 mA)
(6) Recommended gate - source drive voltage: $V_{GS_on}$ = 18 V, $V_{GS_off}$ = 0 V
(7) Enhancement mode.

## 3. Packaging and Internal Circuit




Start of commercial production
2022-07

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

| Characteristics | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-source voltage | | $V_{DSS}$ | 650 | V |
| Gate-source voltage | | $V_{GSS}$ | +25/-10 | |
| Drain current (DC) | ( $T_c$ = 25 °C ) | $I_D$ | 58 | A |
| Drain current (DC) | ( $T_c$ = 100°C ) | $I_D$ | 42 | |
| Drain current (pulsed) | ( $T_c$ = 25 °C ) | $I_{DP}$ | 170 | |
| Drain current (pulsed) | ( $T_c$ = 100°C ) | $I_{DP}$ | 128 | |
| Power dissipation | ( $T_c$ = 25°C ) | $P_D$ | 156 | 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 | $R_{th(ch-c)}$ | 0.961 | °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.

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# 6. Electrical Characteristics

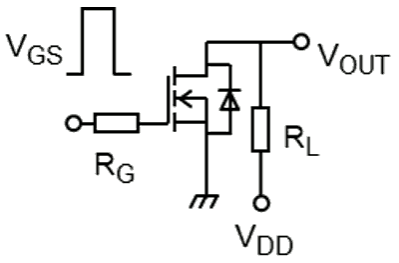
## 6.1. Static Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Gate leakage current | $I_{GSS}$ | $V_{GS}$ = +25/-10 V, $V_{DS}$ = 0 V | — | — | ±0.1 | μA |
| Drain cut-off current | $I_{DSS}$ | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | — | 7 | 100 | |
| | | $T_a$ = 150 °C, $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | — | 37 | — | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D$ = 4 mA, $V_{GS}$ = 0 V | 650 | — | — | V |
| Gate threshold voltage (Note 2) | $V_{th}$ | $V_{DS}$ = 10 V, $I_D$ = 3 mA | 3.0 | — | 5.0 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS}$ = 18 V, $I_D$ = 29 A | — | 27 | 37 | mΩ |
| | | $T_a$ = 150 °C, $V_{GS}$ = 18 V, $I_D$ = 29 A | — | 31 | — | |

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

## 6.2. Dynamic Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, f = 100 kHz | — | 2288 | — | pF |
| Reverse transfer capacitance | $C_{rss}$ | | — | 6.6 | — | |
| Output capacitance | $C_{oss}$ | | — | 249 | — | |
| Effective output capacitance (energy related) | $C_{o(er)}$ | | — | 288 | — | |
| Effective output capacitance (time related) | $C_{o(tr)}$ | | — | 413 | — | |
| Output charge | $Q_{oss}$ | | — | 165 | — | nC |
| $C_{oss}$ stored energy | $E_{oss}$ | | — | 23 | — | μJ |
| Gate resistance | $r_g$ | $V_{DS}$ = OPEN, f = 1 MHz | — | 2.1 | — | Ω |
| Switching time (rise time) | $t_r$ | See Fig. 6.2.1 | — | 50 | — | ns |
| Switching time (turn-on time) | $t_{on}$ | | — | 80 | — | |
| Switching time (fall time) | $t_f$ | | — | 40 | — | |
| Switching time (turn-off time) | $t_{off}$ | | — | 83 | — | ns |




$V_{DD}$ ≈ 400 V
$V_{GS}$ = 0 V / 18 V
$I_D$ = 29 A
$R_L$ = 14 Ω
$R_G$ = 4.7 Ω
Duty ≤ 1 %, $t_w$ = 1 μs

**Fig. 6.2.1 Switching Time Test Circuit**

## 6.3. Gate Charge Characteristics ($T_a$ = 25 °C unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Total gate charge (gate-source plus gate-drain) | $Q_g$ | $V_{DD}$ ≈ 400 V, $V_{GS}$ = 18 V, $I_D$ = 29 A | — | 65 | — | nC |
| Gate-source charge 1 | $Q_{gs1}$ | | — | 26 | — | |
| Gate-drain charge | $Q_{gd}$ | | — | 10 | — | |

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

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Reverse drain current (DC) (Note 3) | $I_{DR}$ | $T_c$ = 25 °C, $V_{GS}$ = -5 V | — | — | 44 | A |
| | | $T_c$ = 100 °C, $V_{GS}$ = -5 V | — | — | 29 | |
| | | $T_c$ = 25 °C, $V_{GS}$ = 18 V | — | — | 58 | |
| | | $T_c$ = 100 °C, $V_{GS}$ = 18 V | — | — | 42 | |
| Reverse drain current (pulsed) (Note 3) | $I_{DRP}$ | $T_c$ = 25 °C, $V_{GS}$ = -5 V | — | — | 163 | |
| | | $T_c$ = 100 °C, $V_{GS}$ = -5 V | — | — | 75 | |
| | | $T_c$ = 25 °C, $V_{GS}$ = 18 V | — | — | 170 | |
| | | $T_c$ = 100 °C, $V_{GS}$ = 18 V | — | — | 128 | |
| Diode forward voltage | $V_{DSF}$ | $I_{DR}$ = 21 A, $V_{GS}$ = -5 V | — | -1.35 | -1.80 | V |
| | | $T_a$ = 150 °C, $I_{DR}$ = 21 A, $V_{GS}$ = -5 V | — | -1.57 | — | |
| Reverse recovery time | $t_{rr}$ | $I_{DR}$ = 19 A, $V_{GS}$ = 0 V, $V_{DD}$ = 400 V, -$dI_{DR}$/dt = 1000 A/μs | — | 55 | — | ns |
| Reverse recovery charge | $Q_{rr}$ | | — | 358 | — | nC |
| Peak reverse recovery current | $I_{rr}$ | | — | 13 | — | A |

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

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## 7. Marking (Note)

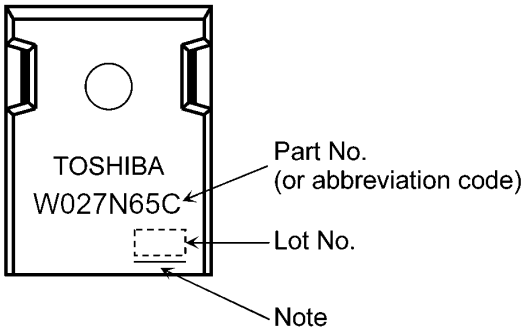



**Fig. 7.1 Marking**

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.

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## 8. Characteristics Curves (Note)

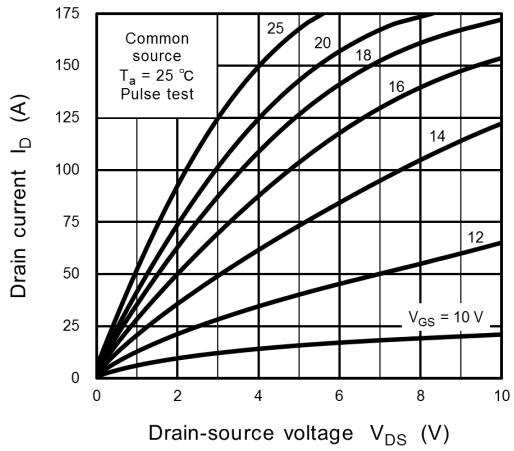



Fig. 8.1 $I_D$ - $V_{DS}$

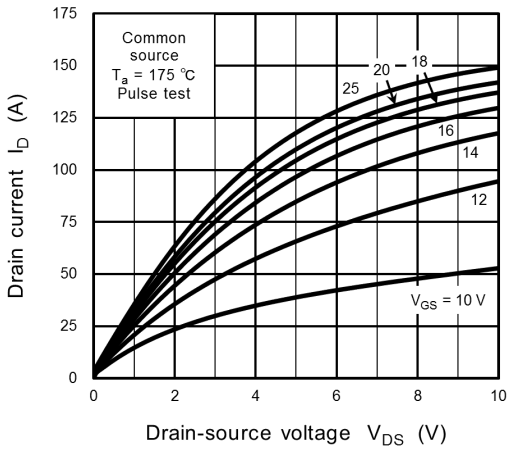



Fig. 8.2 $I_D$ - $V_{DS}$

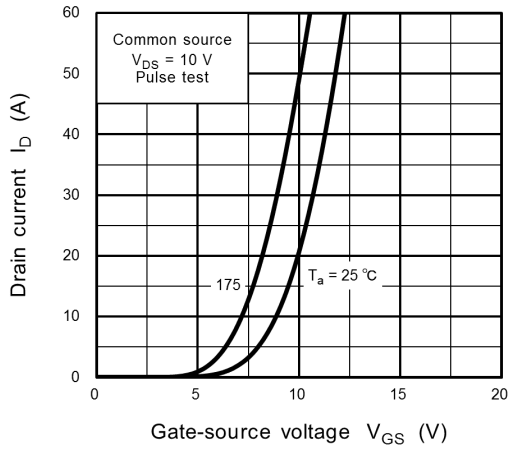



Fig. 8.3 $I_D$ - $V_{GS}$

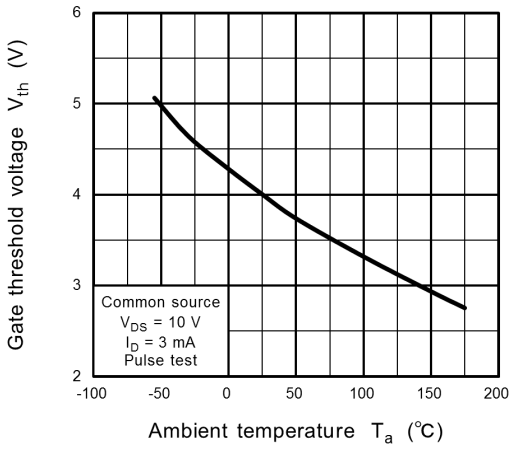



Fig. 8.4 $V_{th}$ - $T_a$

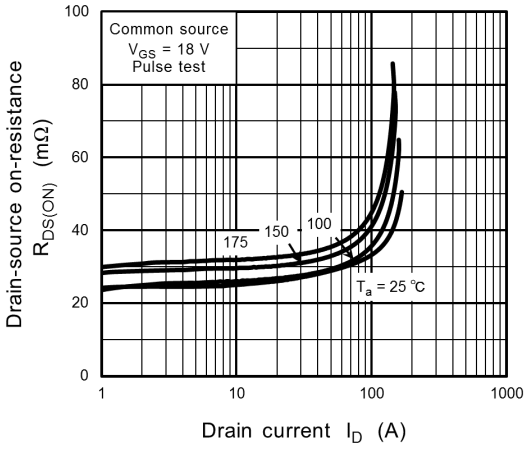



Fig. 8.5 $R_{DS(ON)}$ - $I_D$

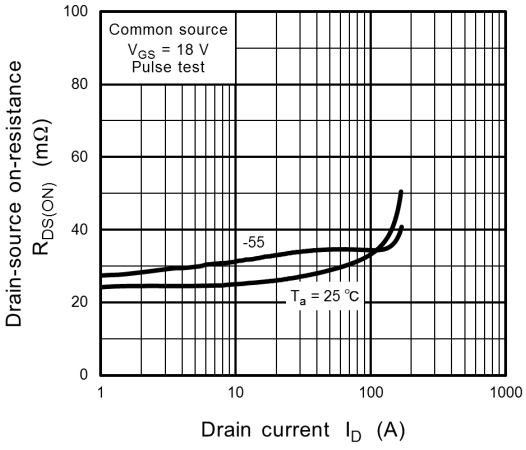



Fig. 8.6 $R_{DS(ON)}$ - $I_D$

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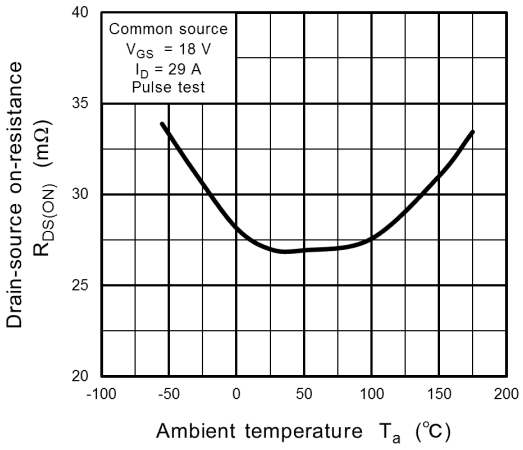



Fig. 8.7 $R_{DS(ON)}$ - $T_a$

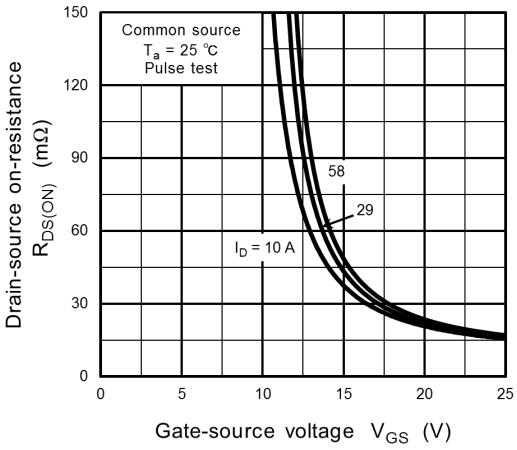



Fig. 8.8 $R_{DS(ON)}$ - $V_{GS}$

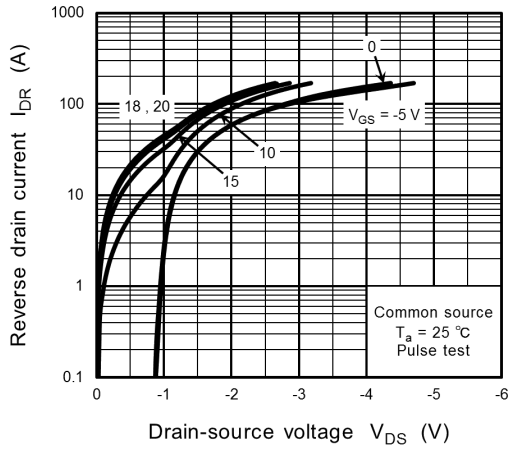



Fig. 8.9 $I_{DR}$ - $V_{DS}$

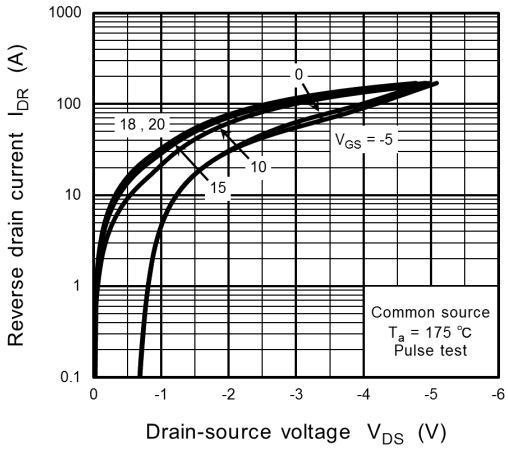



Fig. 8.10 $I_{DR}$ - $V_{DS}$

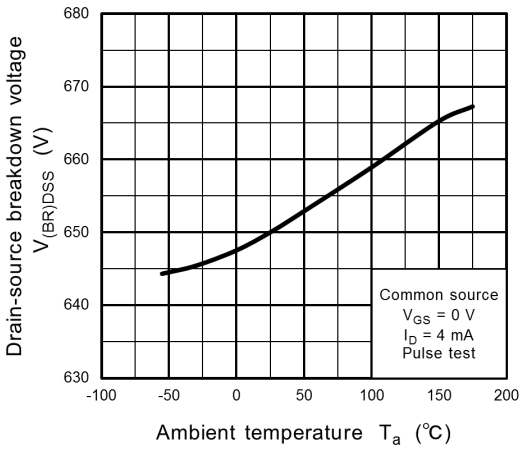



Fig. 8.11 $V_{DSS}$ - $T_a$

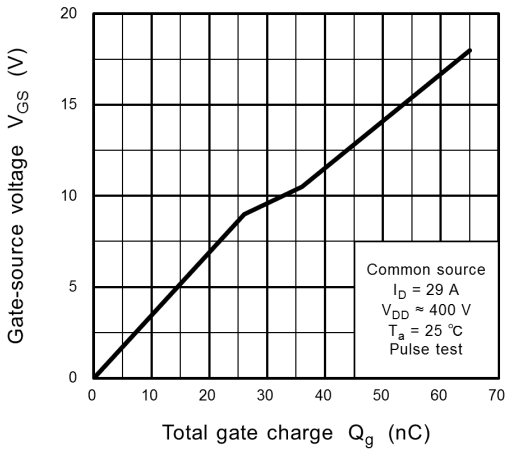



Fig. 8.12 Dynamic Input Characteristics

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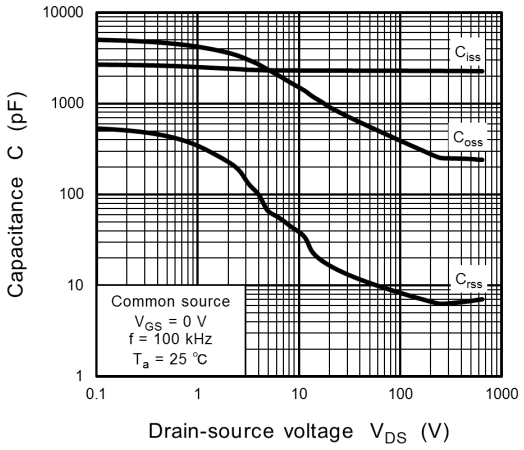



**Fig. 8.13 C - $V_{DS}$**

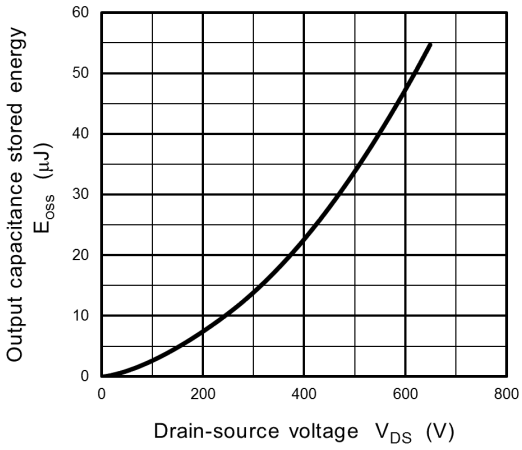



**Fig. 8.14 $E_{oss}$ - $V_{DS}$**

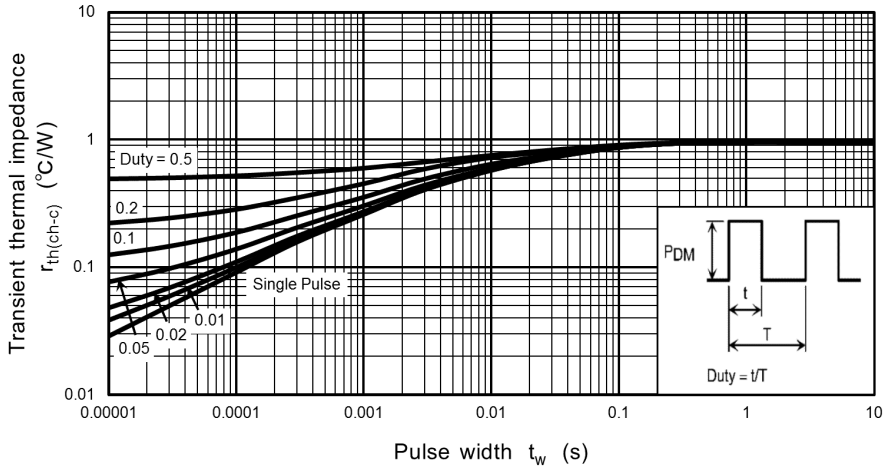



**Fig. 8.15 $r_{th(ch-c)}$ - $t_w$ (Guaranteed Maximum)**

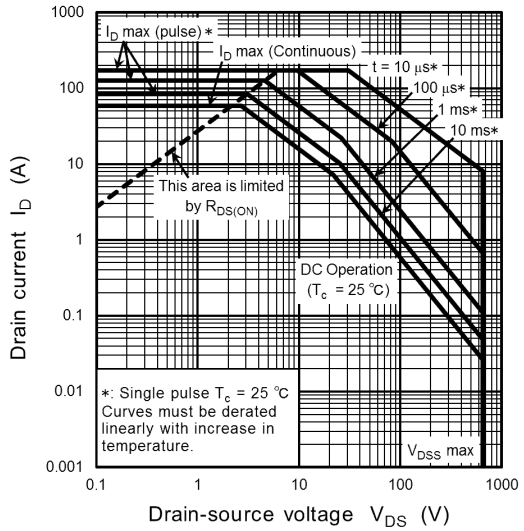



**Fig. 8.16 Safe Operating Area (Guaranteed Maximum)**

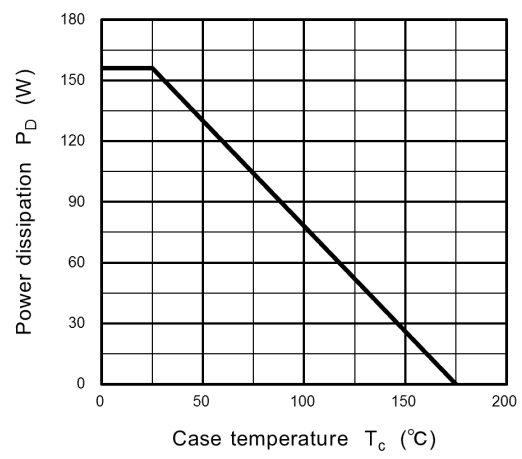


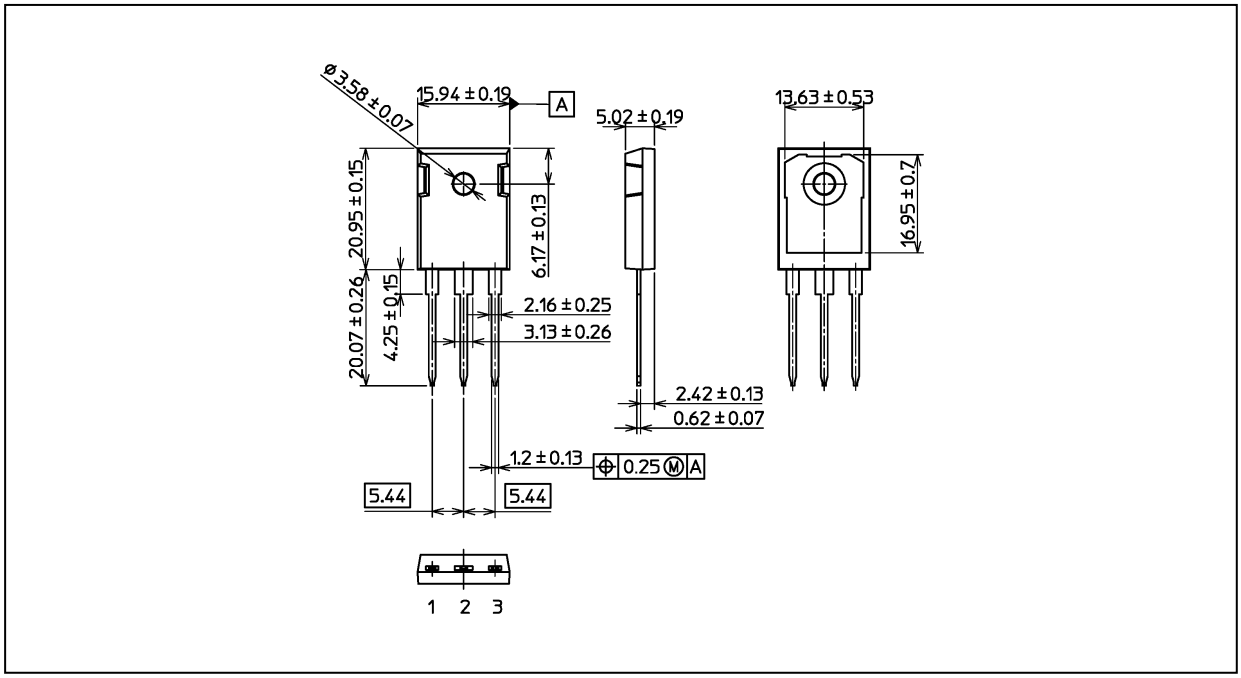

**Fig. 8.17 $P_D$ - $T_c$ (Guaranteed Maximum)**

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

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## Package Dimensions

Unit: mm




Weight: 6.15 g (typ.)

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

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