

MOSFETs Silicon Carbide N-Channel MOS

TW048N65C

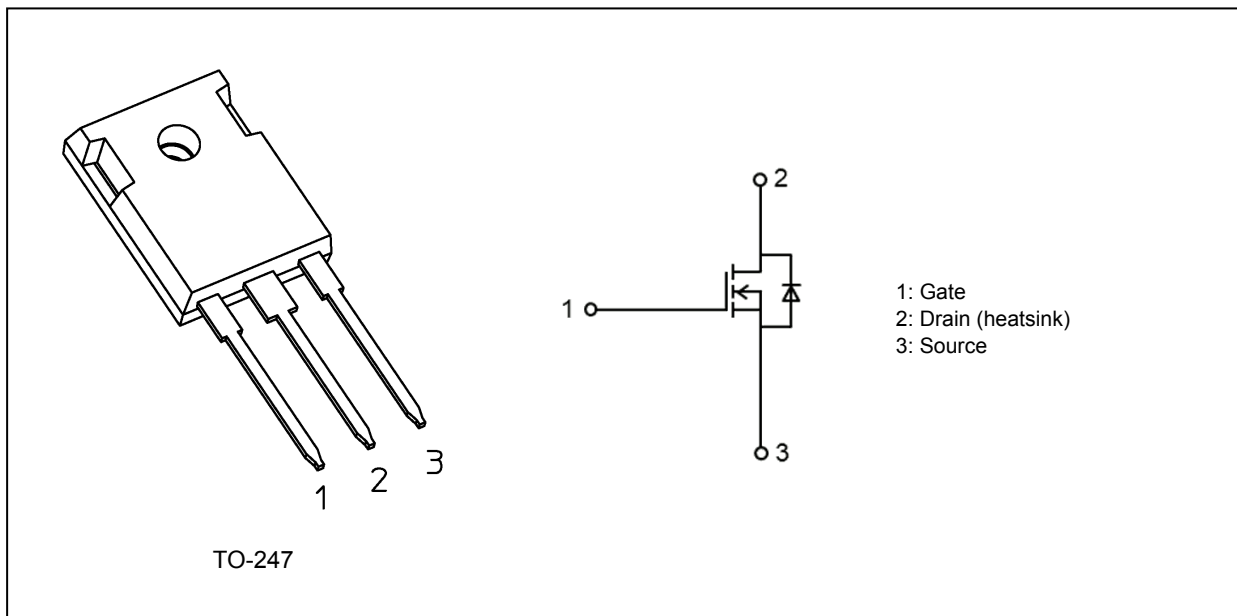
1. Applications

- 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: $V_{DSS} = 650 \text{ V}$
- (4) Low drain-source on-resistance: $R_{DS(ON)} = 48 \text{ m}\Omega$ (typ.)
- (5) Less susceptible to malfunction due to high threshold voltage: $V_{th} = 3.0 \text{ to } 5.0 \text{ V}$ ($V_{DS} = 10 \text{ V}$, $I_D = 1.6 \text{ mA}$)
- (6) Recommended gate - source drive voltage: $V_{GS_{on}} = 18 \text{ V}$, $V_{GS_{off}} = 0 \text{ V}$
- (7) 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} | 650 | V |
| Gate-source voltage | V_{GSS} | +25/-10 | |
| Drain current (DC) ($T_c = 25\text{ °C}$) | I_D | 40 | A |
| Drain current (DC) ($T_c = 100\text{ °C}$) | I_D | 28 | |
| Drain current (pulsed) ($T_c = 25\text{ °C}$) | I_{DP} | 103 | |
| Drain current (pulsed) ($T_c = 100\text{ °C}$) | I_{DP} | 80 | |
| Power dissipation ($T_c = 25\text{ °C}$) | P_D | 132 | 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 | $R_{th(ch-c)}$ | 1.133 | °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} | $V_{GS} = +25/-10\text{ V}, V_{DS} = 0\text{ V}$ | — | — | ± 0.1 | μA |
| Drain cut-off current | I_{DSS} | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$ | — | 3 | 58 | |
| | | $T_a = 150\text{ }^\circ\text{C},$ $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$ | — | 17 | — | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 4\text{ mA}, V_{GS} = 0\text{ V}$ | 650 | — | — | V |
| Gate threshold voltage (Note 2) | V_{th} | $V_{DS} = 10\text{ V}, I_D = 1.6\text{ mA}$ | 3.0 | — | 5.0 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS} = 18\text{ V}, I_D = 20\text{ A}$ | — | 48 | 65 | $\text{m}\Omega$ |
| | | $T_a = 150\text{ }^\circ\text{C},$ $V_{GS} = 18\text{ V}, I_D = 20\text{ A}$ | — | 53 | — | |

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} | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V},$ $f = 100\text{ kHz}$ | — | 1362 | — | pF |
| Reverse transfer capacitance | C_{riss} | | — | 4.4 | — | |
| Output capacitance | C_{oss} | | — | 156 | — | |
| Effective output capacitance (energy related) | $C_{o(er)}$ | | — | 175 | — | |
| Effective output capacitance (time related) | $C_{o(tr)}$ | | — | 258 | — | |
| Output charge | Q_{oss} | | — | 103 | — | |
| C_{oss} stored energy | E_{oss} | — | 14 | — | μJ | |
| Gate resistance | r_g | $V_{DS} = \text{OPEN}, f = 1\text{ MHz}$ | — | 3.6 | — | Ω |
| Switching time (rise time) | t_r | See Fig. 6.2.1 | — | 43 | — | ns |
| Switching time (turn-on time) | t_{on} | | — | 69 | — | |
| Switching time (fall time) | t_f | | — | 32 | — | |
| Switching time (turn-off time) | t_{off} | | — | 68 | — | |
| | | | — | 68 | — | |

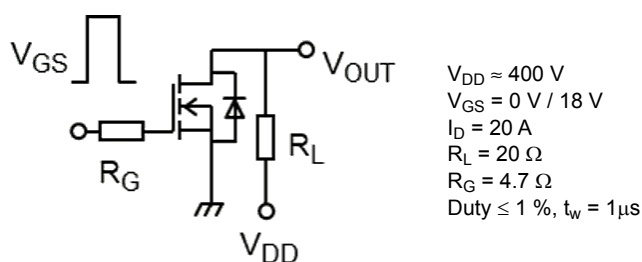


Fig. 6.2.1 Switching Time Test Circuit

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 | $V_{DD} \approx 400\text{ V}, V_{GS} = 18\text{ V},$ $I_D = 20\text{ A}$ | — | 41 | — | nC |
| Gate-source charge 1 | Q_{gs1} | | — | 17 | — | |
| Gate-drain charge | Q_{gd} | | — | 6.2 | — | |

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} | $T_c = 25\text{ °C}, V_{GS} = -5\text{ V}$ | — | — | 35 | A |
| | | $T_c = 100\text{ °C}, V_{GS} = -5\text{ V}$ | — | — | 23 | |
| | | $T_c = 25\text{ °C}, V_{GS} = 18\text{ V}$ | — | — | 40 | |
| | | $T_c = 100\text{ °C}, V_{GS} = 18\text{ V}$ | — | — | 28 | |
| Reverse drain current (pulsed) (Note 3) | I_{DRP} | $T_c = 25\text{ °C}, V_{GS} = -5\text{ V}$ | — | — | 103 | |
| | | $T_c = 100\text{ °C}, V_{GS} = -5\text{ V}$ | — | — | 41 | |
| | | $T_c = 25\text{ °C}, V_{GS} = 18\text{ V}$ | — | — | 103 | |
| | | $T_c = 100\text{ °C}, V_{GS} = 18\text{ V}$ | — | — | 80 | |
| Diode forward voltage | V_{DSF} | $I_{DR} = 12\text{ A}, V_{GS} = -5\text{ V}$ | — | -1.35 | -1.80 | V |
| | | $T_a = 150\text{ °C}, I_{DR} = 12\text{ A}, V_{GS} = -5\text{ V}$ | — | -1.60 | — | |
| Reverse recovery time | t_{rr} | $I_{DR} = 13\text{ A}, V_{GS} = 0\text{ V}, V_{DD} = 400\text{ V}, -dI_{DR}/dt = 1000\text{ A}/\mu\text{s}$ | — | 50 | — | ns |
| Reverse recovery charge | Q_{rr} | | — | 250 | — | nC |
| Peak reverse recovery current | I_{rr} | | — | 10 | — | A |

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

7. Marking (Note)

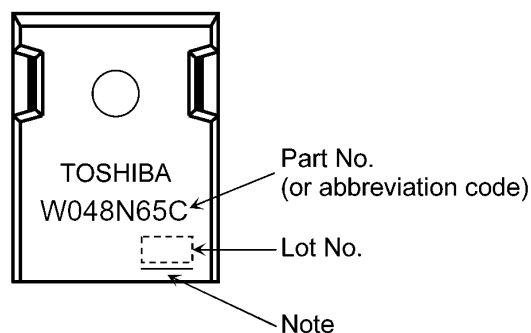


Fig. 7.1 Marking

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)

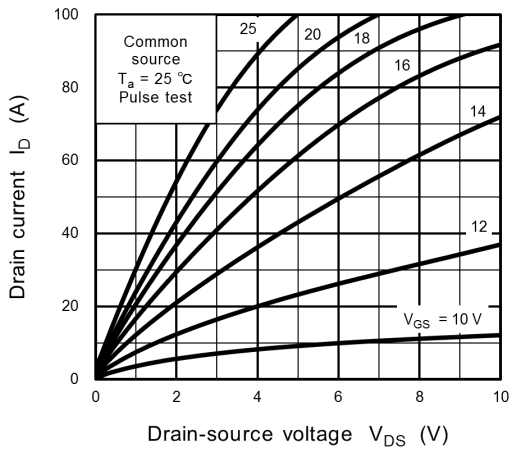


Fig. 8.1 $I_D - V_{DS}$

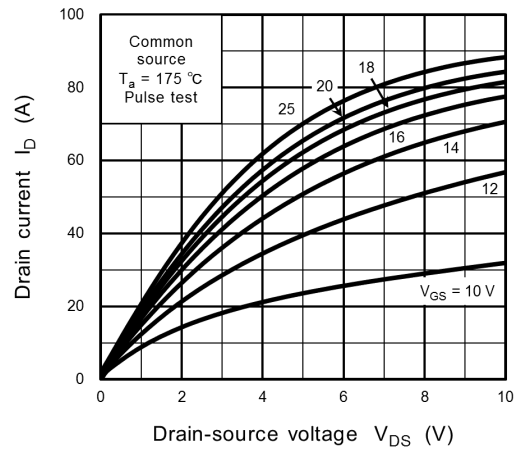


Fig. 8.2 $I_D - V_{DS}$

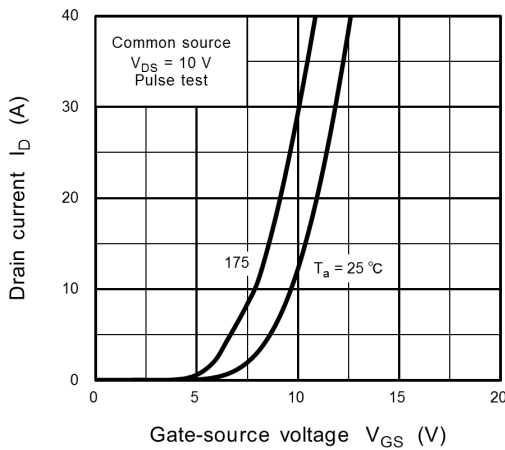


Fig. 8.3 $I_D - V_{GS}$

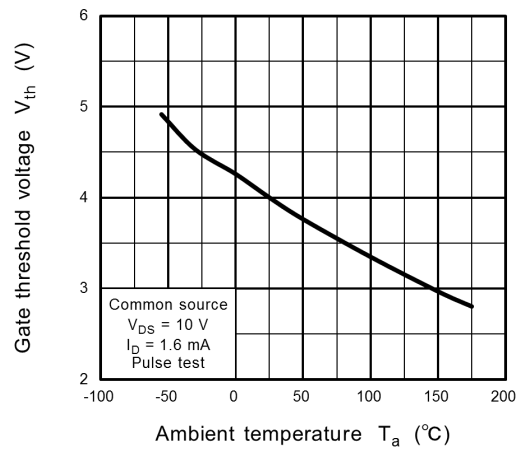


Fig. 8.4 $V_{th} - T_a$

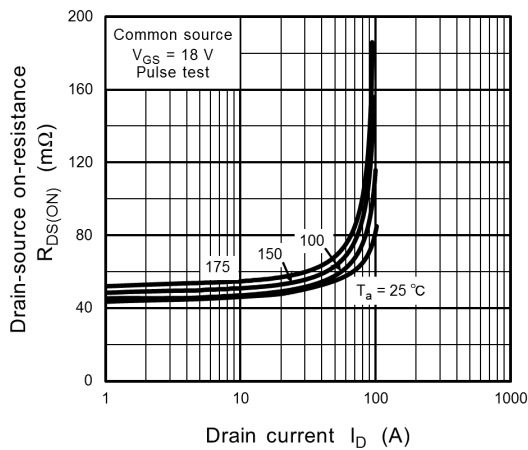


Fig. 8.5 $R_{DS(ON)} - I_D$

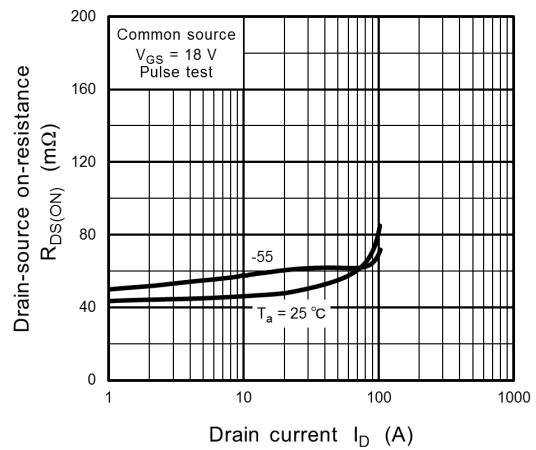


Fig. 8.6 $R_{DS(ON)} - I_D$

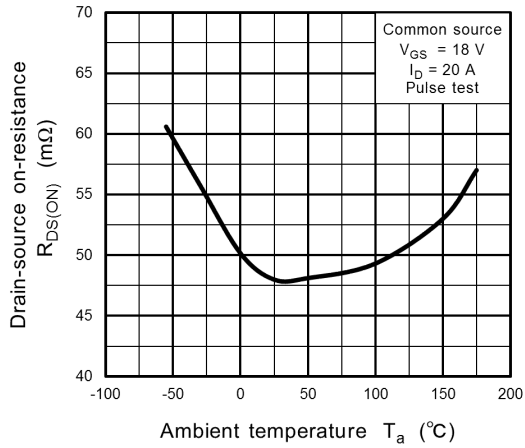


Fig. 8.7 $R_{DS(ON)} - T_a$

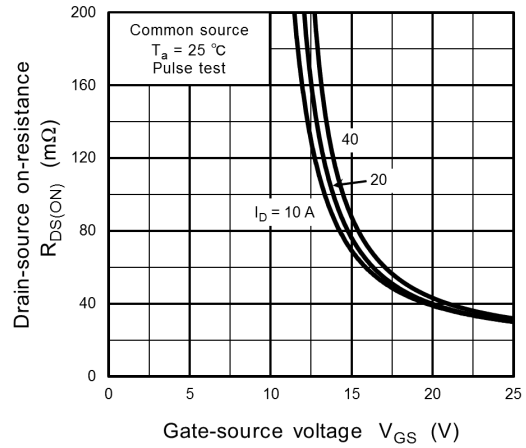


Fig. 8.8 $R_{DS(ON)} - V_{GS}$

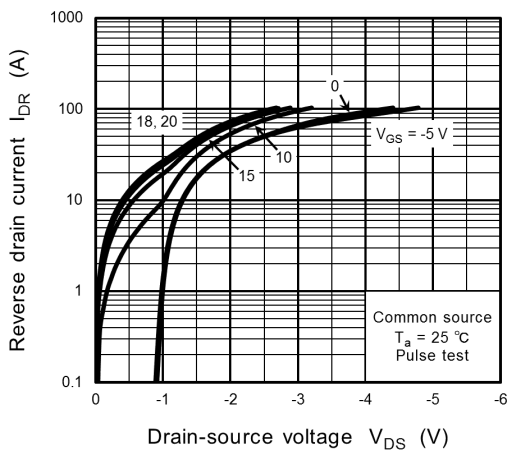


Fig. 8.9 $I_{DR} - V_{DS}$

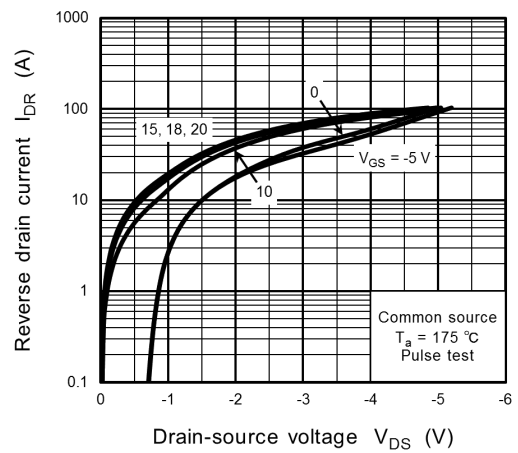


Fig. 8.10 $I_{DR} - V_{DS}$

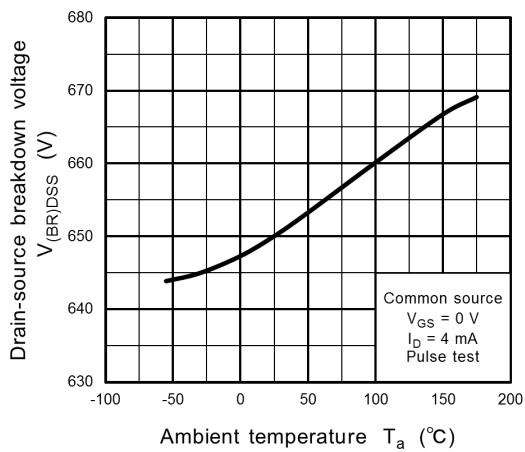


Fig. 8.11 $V_{DSS} - T_a$

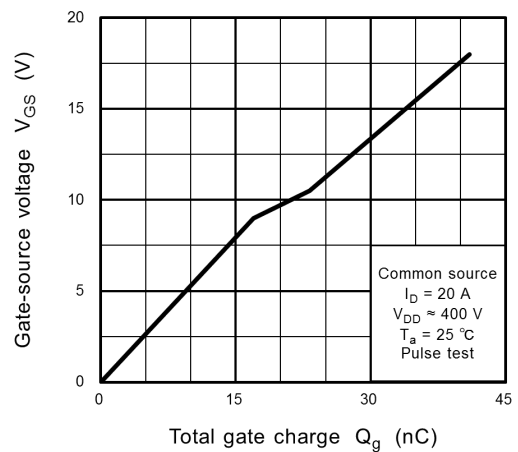


Fig. 8.12 Dynamic Input Characteristics

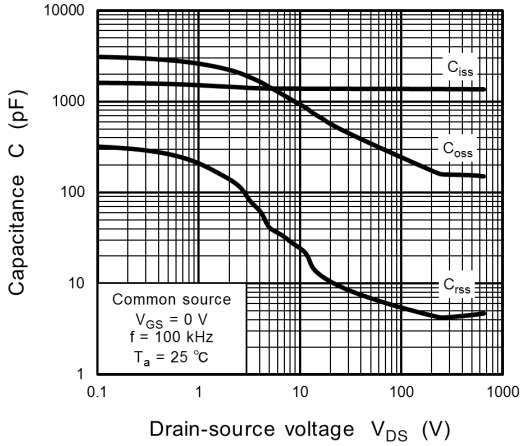


Fig. 8.13 C - V_{DS}

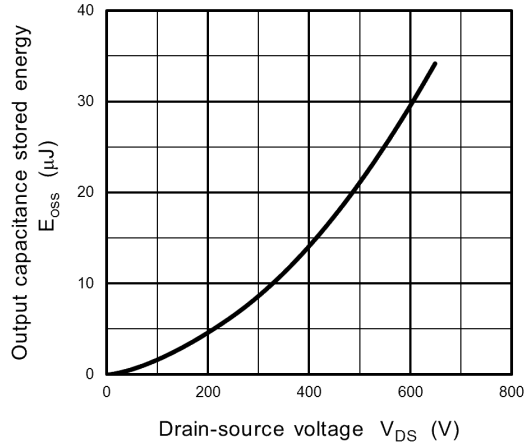
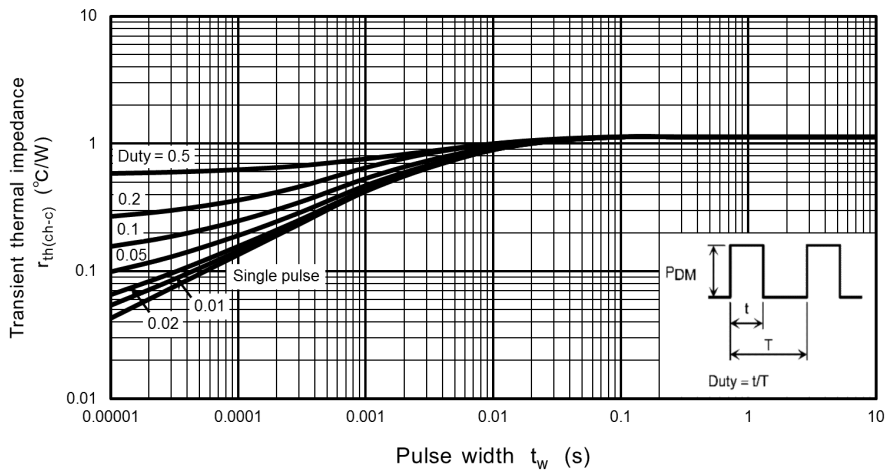
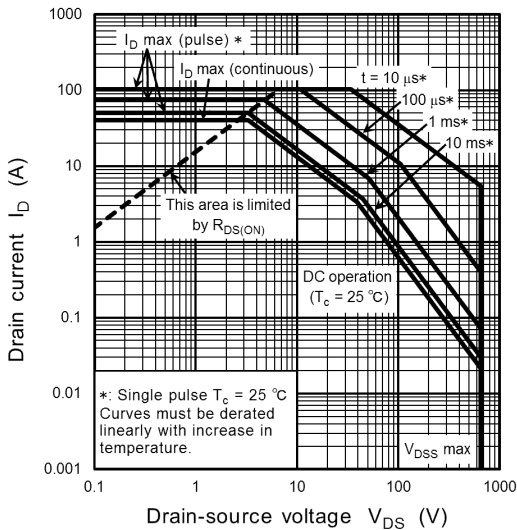


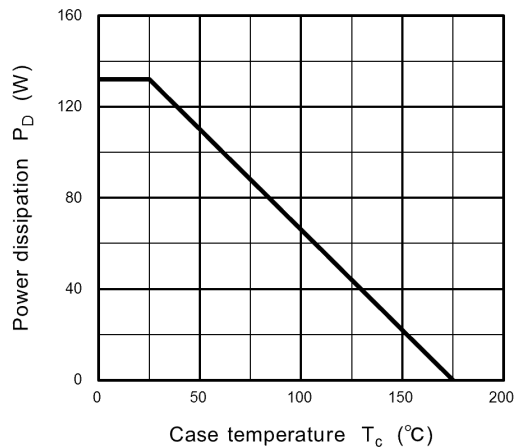
Fig. 8.14 E_{oss} - V_{DS}



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



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

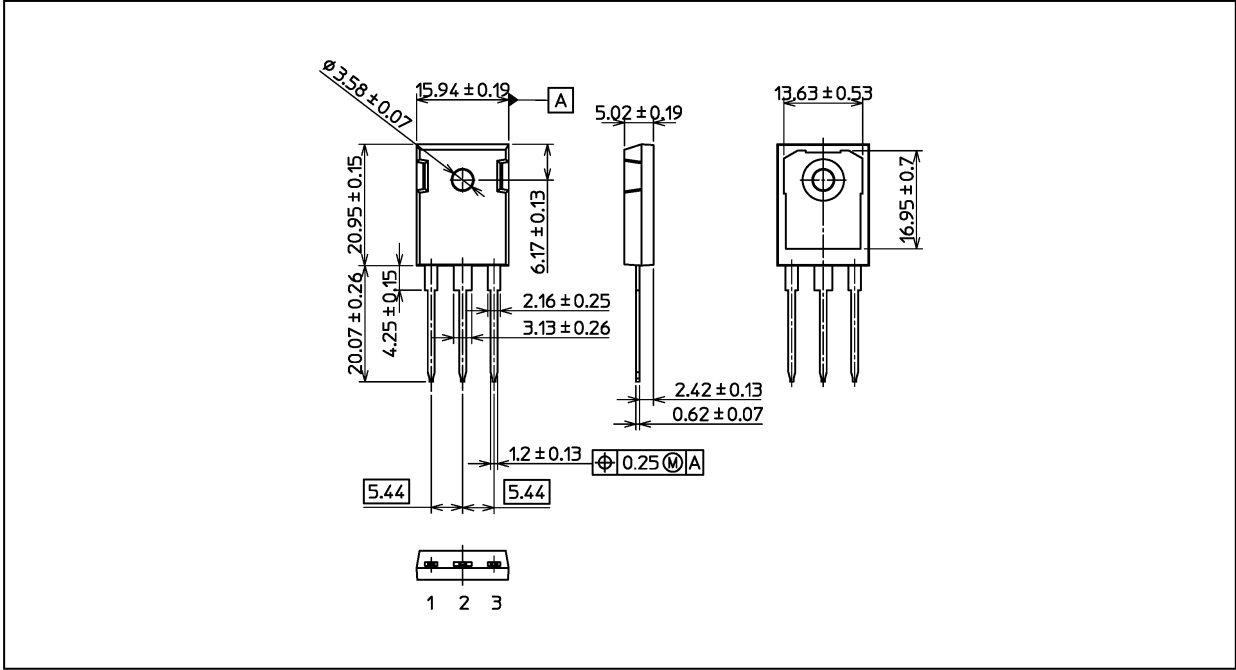


**Fig. 8.17 P_D - T_c
(Guaranteed Maximum)**

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

Package Dimensions

Unit: mm



Weight: 6.15 g (typ.)

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

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