

MOSFETs Silicon N-Channel MOS (DTMOSVI)

TK040N60Z1

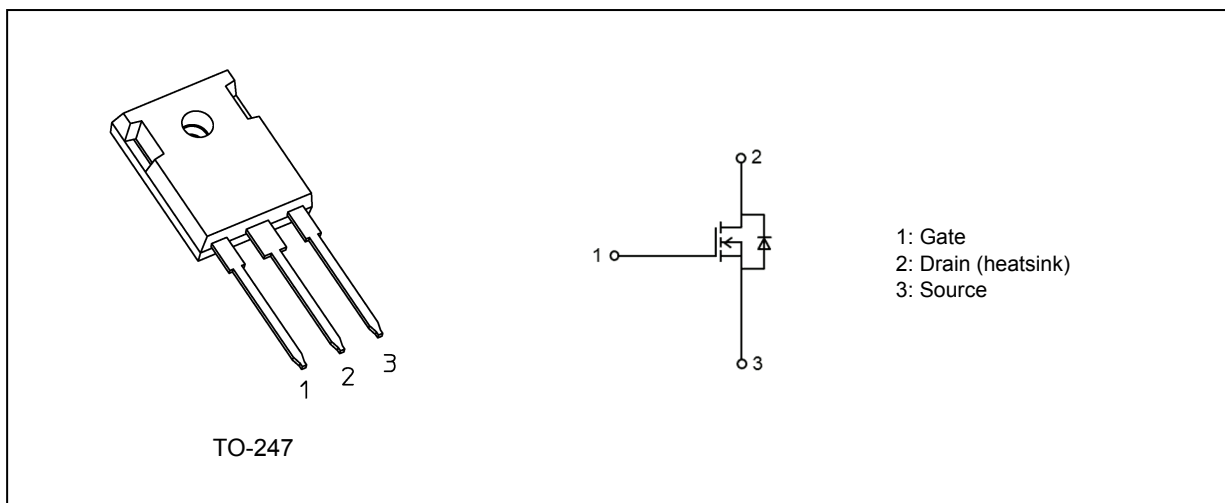
1. Applications

- Switching Power Supplies

2. Features

- (1) Low drain-source on-resistance: $R_{DS(ON)} = 0.033 \Omega$ (typ.)
- (2) High-speed switching properties with lower capacitance.
- (3) Enhancement mode: $V_{th} = 3$ to 4 V ($V_{DS} = 10$ V, $I_D = 2.4$ mA)

3. Packaging and Internal Circuit



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

| Characteristics | Symbol | Rating | Unit |
|---|-----------|------------|------------------|
| Drain-source voltage | V_{DSS} | 600 | V |
| Gate-source voltage | V_{GSS} | ± 30 | |
| Drain current (DC) (Note 1) | I_D | 52 | A |
| Drain current (pulsed) (Note 1) | I_{DP} | 208 | |
| Power dissipation ($T_c = 25 \text{ }^\circ\text{C}$) | P_D | 297 | W |
| Single-pulse avalanche energy (Note 2) | E_{AS} | 1049 | mJ |
| Single-pulse avalanche current | I_{AS} | 8.0 | A |
| Reverse drain current (DC) (Note 1) | I_{DR} | 52 | |
| Reverse drain current (pulsed) (Note 1) | I_{DRP} | 208 | |
| Channel temperature | T_{ch} | 150 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | -55 to 150 | |
| 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).

Start of commercial production
2024-06

5. Thermal Characteristics

| Characteristics | Symbol | Max | Unit |
|---------------------------------------|----------------|-------|------|
| Channel-to-case thermal resistance | $R_{th(ch-c)}$ | 0.420 | °C/W |
| Channel-to-ambient thermal resistance | $R_{th(ch-a)}$ | 50 | |

Note 1: Ensure that the channel temperature does not exceed 150 °C.

Note 2: $V_{DD} = 90\text{ V}$, $T_{ch} = 25\text{ °C}$ (initial), $L = 29\text{ mH}$, $I_{AS} = 8.0\text{ A}$

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

6. Electrical Characteristics

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

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------|---------------|--|-----|-------|---------|---------------|
| Gate leakage current | I_{GSS} | $V_{GS} = \pm 30\text{ V}$, $V_{DS} = 0\text{ V}$ | — | — | ± 1 | μA |
| Drain cut-off current | I_{DSS} | $V_{DS} = 600\text{ V}$, $V_{GS} = 0\text{ V}$ | — | — | 2 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}$, $V_{GS} = 0\text{ V}$ | 600 | — | — | V |
| Gate threshold voltage | V_{th} | $V_{DS} = 10\text{ V}$, $I_D = 2.4\text{ mA}$ | 3 | — | 4 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS} = 10\text{ V}$, $I_D = 21.2\text{ A}$ | — | 0.033 | 0.040 | Ω |

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

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--|-------------|--|-----|------|-----|---------------|
| Input capacitance | C_{iss} | $V_{DS} = 300\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 100\text{ kHz}$ | — | 5200 | — | μF |
| Reverse transfer capacitance | C_{rss} | | — | 4.0 | — | |
| Output capacitance | C_{oss} | | — | 120 | — | |
| Effective output capacitance (energy related) (Note 3) | $C_{o(er)}$ | $V_{DS} = 0\text{ to }400\text{ V}$, $V_{GS} = 0\text{ V}$ | — | 200 | — | V |
| Effective output capacitance (time related) (Note 4) | $C_{o(tr)}$ | $V_{DS} = 0\text{ to }400\text{ V}$, $V_{GS} = 0\text{ V}$ | — | 1450 | — | |
| Gate resistance | r_g | $V_{DS} = \text{OPEN}$, $f = 1\text{ MHz}$ | — | 2.4 | — | Ω |
| Switching time (rise time) | t_r | See Fig.6.2.1 | — | 75 | — | ns |
| Switching time (turn-on time) | t_{on} | | — | 120 | — | |
| Switching time (fall time) | t_f | | — | 5 | — | |
| Switching time (turn-off time) | t_{off} | | — | 150 | — | |
| MOSFET dv/dt ruggedness | dv/dt | $V_{DS} \leq V_{DSS}$, $I_D \leq 26\text{ A}$ | 120 | — | — | V/ns |

Note 3: $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{OSS} while V_{DS} is rising from 0 V to 400 V.

Note 4: $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{OSS} while V_{DS} is rising from 0 V to 400 V.

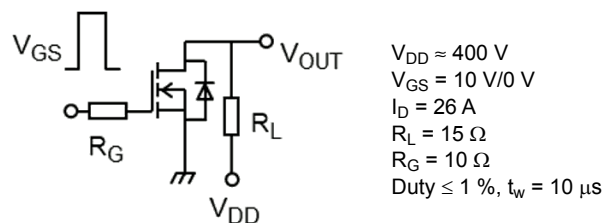


Fig. 6.2.1 Switching Time Test Circuit

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 | $V_{DD} \approx 400\text{ V}, V_{GS} = 10\text{ V}, I_D = 52\text{ A}$ | — | 85 | — | nC |
| Gate-source charge 1 | Q_{gs1} | | — | 29 | — | |
| Gate-drain charge | Q_{gd} | | — | 22 | — | |

6.4. Source-Drain Characteristics ($T_a = 25\text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|-------------------------------|-----------|---|-----|------|------|---------------|
| Diode forward voltage | V_{DSF} | $I_{DR} = 52\text{ A}, V_{GS} = 0\text{ V}$ | — | — | -1.7 | V |
| Reverse recovery time | t_{rr} | $V_{DD} = 400\text{ V},$ $I_{DR} = 26\text{ A}, V_{GS} = 0\text{ V}$ $-dI_{DR}/dt = 100\text{ A}/\mu\text{s}$ | — | 380 | — | ns |
| Reverse recovery charge | Q_{rr} | | — | 6.7 | — | μC |
| Peak reverse recovery current | I_{rr} | | — | 35 | — | A |
| Diode dv/dt ruggedness | dv/dt | $V_{DD} \leq 400\text{ V}, I_{DR} \leq 26\text{ A}, V_{GS} = 0\text{ V}$ | 50 | — | — | V/ns |

7. Marking (Note)

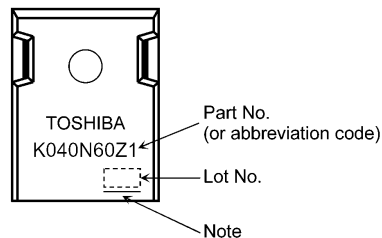


Fig. 7.1 Marking

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)

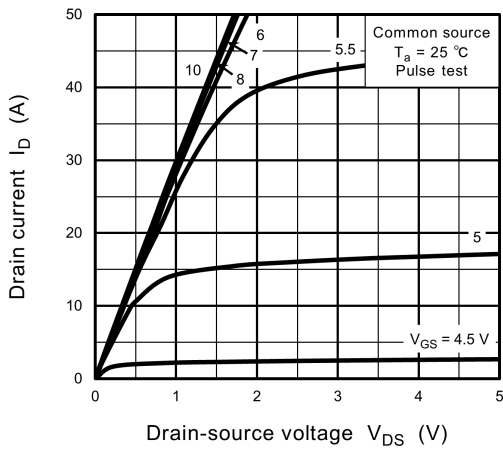


Fig. 8.1 $I_D - V_{DS}$

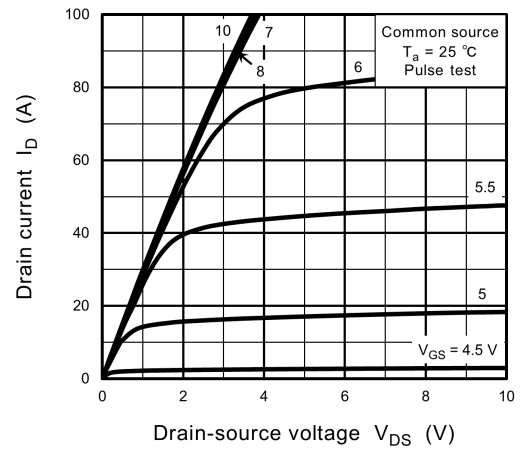


Fig. 8.2 $I_D - V_{DS}$

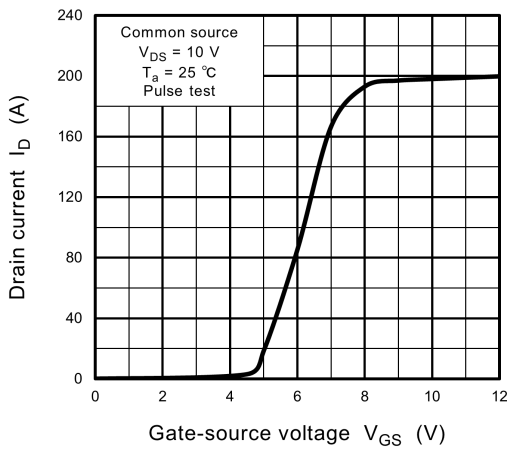


Fig. 8.3 $I_D - V_{GS}$

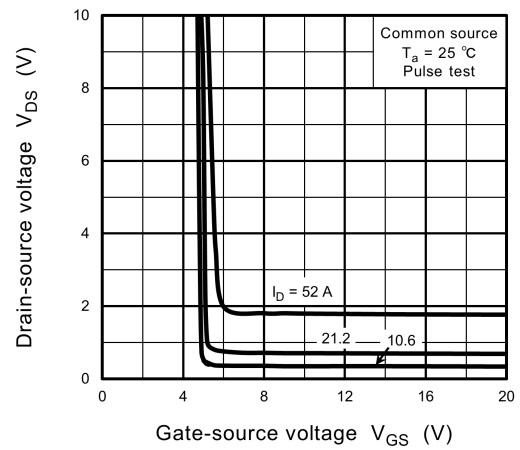


Fig. 8.4 $V_{DS} - V_{GS}$

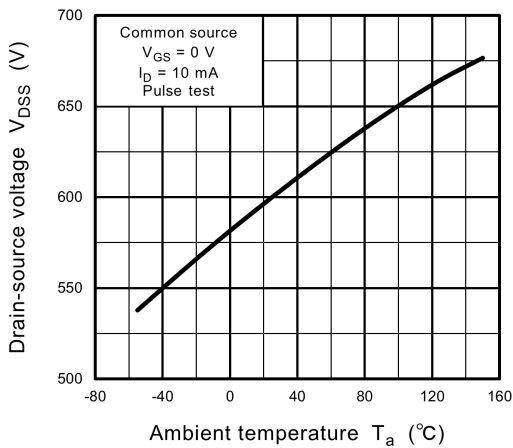


Fig. 8.5 $V_{DSS} - T_a$

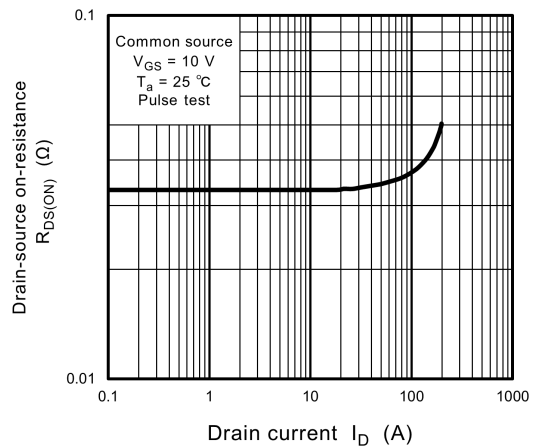


Fig. 8.6 $R_{DS(ON)} - I_D$

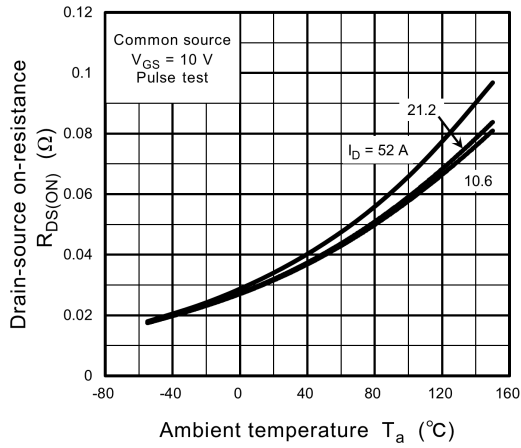


Fig. 8.7 $R_{DS(ON)} - T_a$

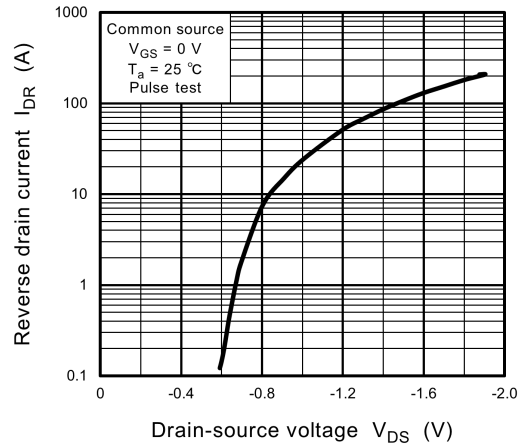


Fig. 8.8 $I_{DR} - V_{DS}$

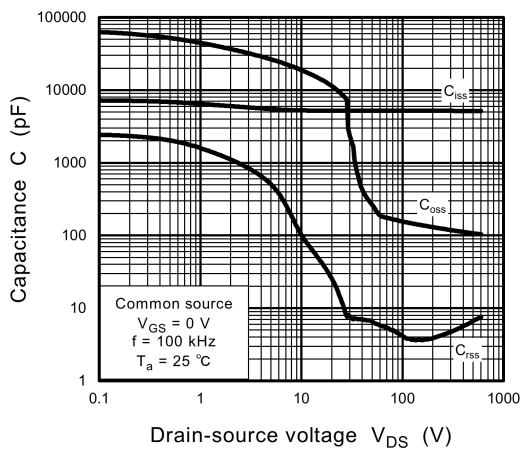


Fig. 8.9 $C - V_{DS}$

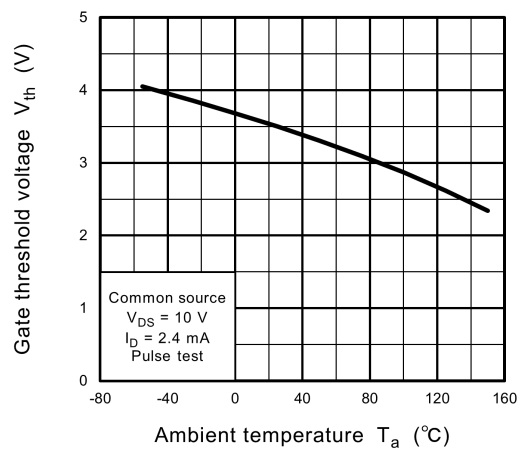


Fig. 8.10 $V_{th} - T_a$

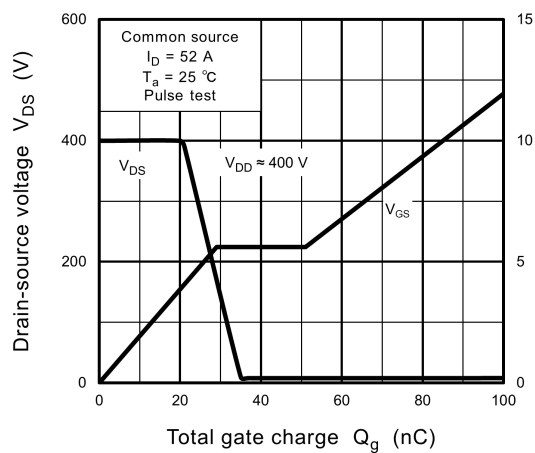


Fig. 8.11 Dynamic Input/Output Characteristics

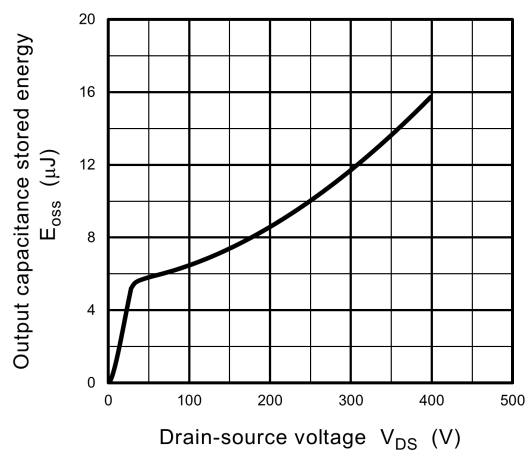


Fig. 8.12 $E_{oss} - V_{DS}$

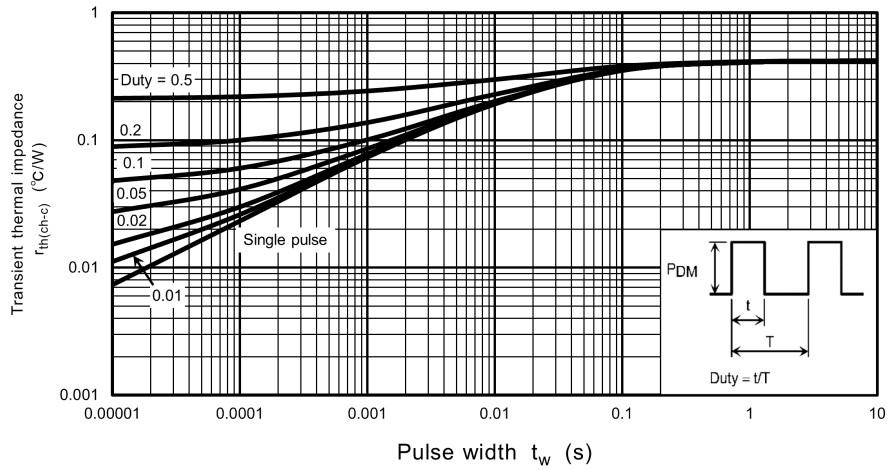


Fig. 8.13 $r_{th} - t_w$
(Guaranteed Maximum)

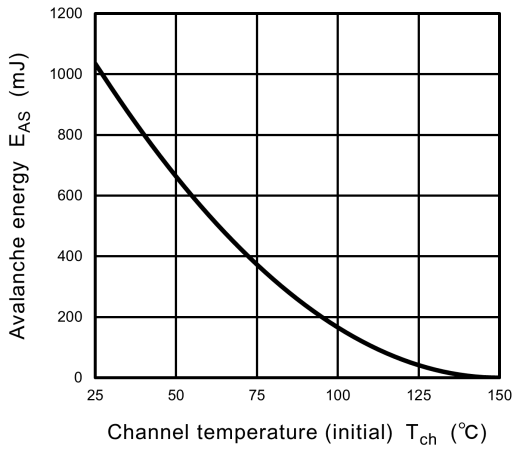


Fig. 8.14 $E_{AS} - T_{ch}$
(Guaranteed Maximum)

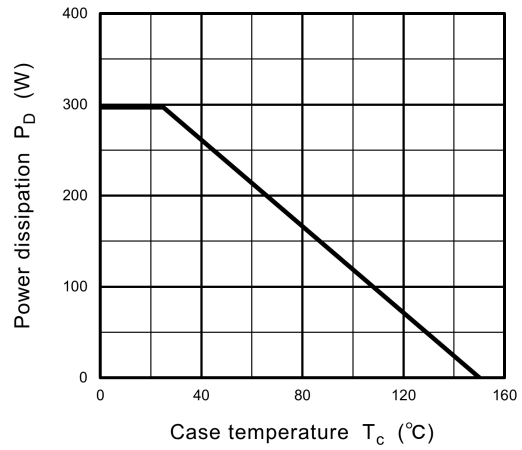


Fig. 8.15 $P_D - T_c$
(Guaranteed Maximum)

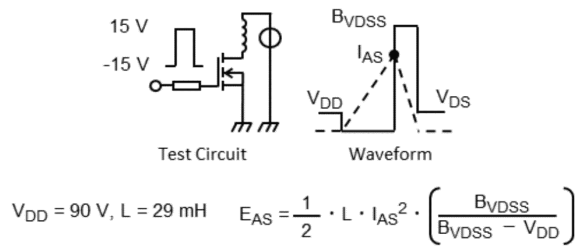


Fig. 8.16 Test Circuit/Waveform

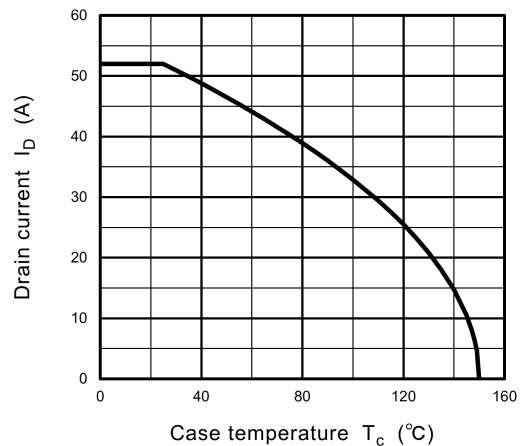


Fig. 8.17 $I_D - T_c$
(Guaranteed Maximum)

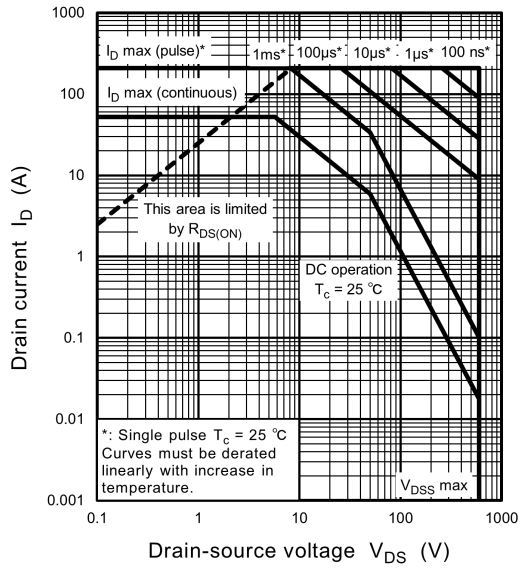
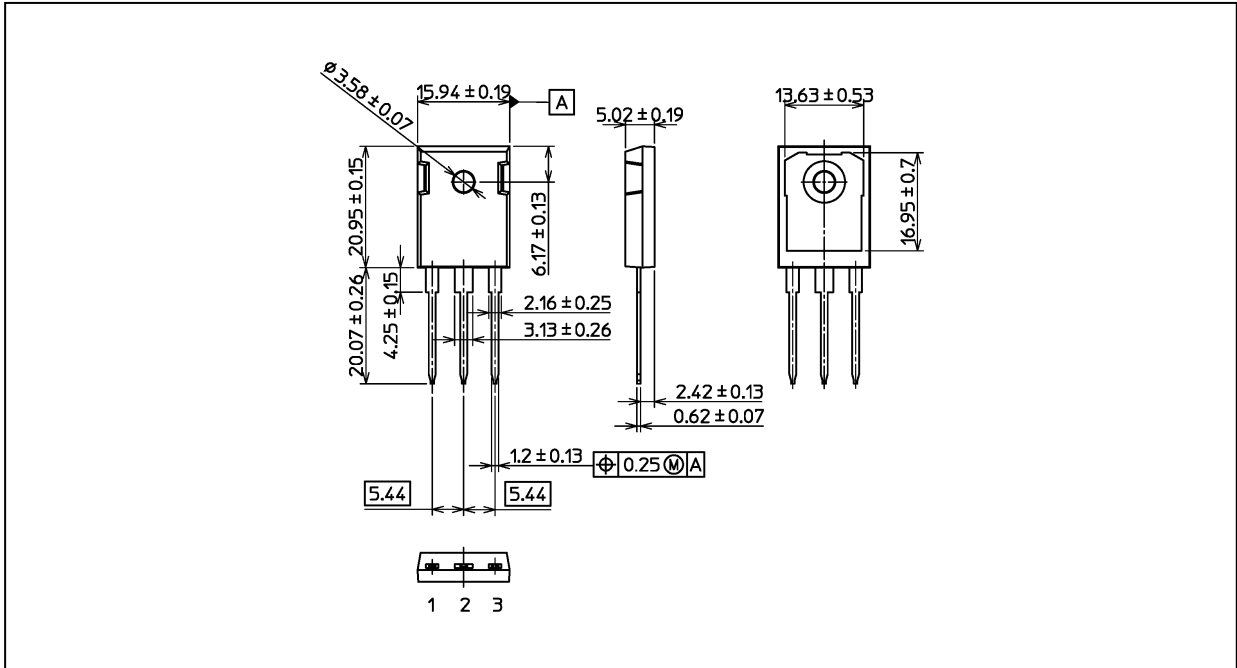


Fig. 8.18 Safe Operating Area (Guaranteed Maximum)

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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