

TK165U65Z5

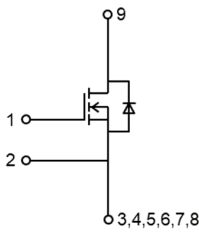
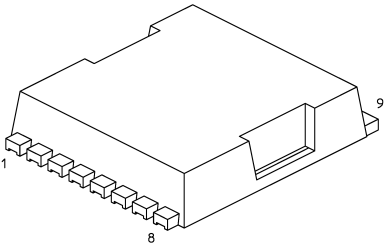
1. Applications

- Switching Voltage Regulators

2. Features

- (1) Fast reverse recovery time:  $t_{rr} = 100 \text{ ns}$  (typ.)
- (2) Low drain-source on-resistance:  $R_{DS(ON)} = 0.127 \Omega$  (typ.)
- (3) High-speed switching properties with the lower capacitance.
- (4) Enhancement mode:  $V_{th} = 3.5 \text{ to } 4.5 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.73 \text{ mA}$ )

3. Packaging and Internal Circuit



1: Gate  
2: Source 2  
3, 4, 5, 6, 7, 8: Source 1  
9: Drain (heatsink)

Notice: Only use source 2 pin for gate input signal return. Please make sure that the main current flows into the source 1 pins.

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

| Characteristics                | Symbol    | Rating     | Unit             |
|--------------------------------|-----------|------------|------------------|
| Drain-source voltage           | $V_{DSS}$ | 650        | V                |
| Gate-source voltage            | $V_{GSS}$ | $\pm 30$   |                  |
| Drain current (DC)             | $I_D$     | 18         | A                |
| Drain current (pulsed)         | $I_{DP}$  | 72         |                  |
| Power dissipation              | $P_D$     | 150        | W                |
| Single-pulse avalanche energy  | $E_{AS}$  | 282        | mJ               |
| Single-pulse avalanche current | $I_{AS}$  | 3.6        | A                |
| Reverse drain current (DC)     | $I_{DR}$  | 18         |                  |
| Reverse drain current (pulsed) | $I_{DRP}$ | 72         |                  |
| Channel temperature            | $T_{ch}$  | 150        | $^\circ\text{C}$ |
| Storage temperature            | $T_{stg}$ | -55 to 150 |                  |

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  
2025-02

5. Thermal Characteristics

| Characteristics                    | Symbol         | Max   | Unit |
|------------------------------------|----------------|-------|------|
| Channel-to-case thermal resistance | $R_{th(ch-c)}$ | 0.833 | °C/W |

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),  $L = 38.5\text{ mH}$ ,  $I_{AS} = 3.6\text{ A}$

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

## 6. Electrical Characteristics

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

| Characteristics                | Symbol        | Test Condition                                     | Min | Typ.  | Max     | Unit          |
|--------------------------------|---------------|----------------------------------------------------|-----|-------|---------|---------------|
| Gate leakage current           | $I_{GSS}$     | $V_{GS} = \pm 30\text{ V}$ , $V_{DS} = 0\text{ V}$ | —   | —     | $\pm 1$ | $\mu\text{A}$ |
| Drain cut-off current          | $I_{DSS}$     | $V_{DS} = 650\text{ V}$ , $V_{GS} = 0\text{ V}$    | —   | —     | 100     |               |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}$ , $V_{GS} = 0\text{ V}$       | 650 | —     | —       | V             |
| Gate threshold voltage         | $V_{th}$      | $V_{DS} = 10\text{ V}$ , $I_D = 0.73\text{ mA}$    | 3.5 | —     | 4.5     |               |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 10\text{ V}$ , $I_D = 9\text{ A}$        | —   | 0.127 | 0.165   | $\Omega$      |

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

| Characteristics                                           | Symbol      | Test Condition                                                         | Min | Typ. | Max | Unit        |
|-----------------------------------------------------------|-------------|------------------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance                                         | $C_{iss}$   | $V_{DS} = 300\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 100\text{ kHz}$ | —   | 1660 | —   | $\text{pF}$ |
| Reverse transfer capacitance                              | $C_{rss}$   |                                                                        | —   | 1.6  | —   |             |
| Output capacitance                                        | $C_{oss}$   |                                                                        | —   | 45   | —   |             |
| Effective output capacitance (Note 3)<br>(energy related) | $C_{O(er)}$ | $V_{DS} = 0\text{ to }400\text{ V}$ , $V_{GS} = 0\text{ V}$            | —   | 70   | —   |             |
| Effective output capacitance (Note 4)<br>(time related)   | $C_{O(tr)}$ |                                                                        | —   | 435  | —   |             |
| Gate resistance                                           | $r_g$       | $V_{DS} = \text{OPEN}$ , $f = 1\text{ MHz}$                            | —   | 2.8  | —   | $\Omega$    |
| Switching time (rise time)                                | $t_r$       | See Fig. 6.2.1                                                         | —   | 12   | —   | ns          |
| Switching time (turn-on time)                             | $t_{on}$    |                                                                        | —   | 38   | —   |             |
| Switching time (fall time)                                | $t_f$       |                                                                        | —   | 3.8  | —   |             |
| Switching time (turn-off time)                            | $t_{off}$   |                                                                        | —   | 65   | —   |             |
| MOSFET dv/dt ruggedness                                   | dv/dt       | $V_{DS} \leq V_{DSS}$ , $I_D \leq 9\text{ A}$                          | 90  | —    | —   | 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.

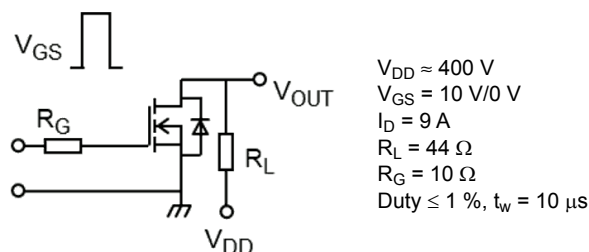


Fig. 6.2.1 Switching Time Test Circuit

### 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) | $Q_g$     | $V_{DD} \approx 400\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 18\text{ A}$ | —   | 30   | —   | nC   |
| Gate-source charge 1                            | $Q_{gs1}$ |                                                                              | —   | 10   | —   |      |
| Gate-drain charge                               | $Q_{gd}$  |                                                                              | —   | 10   | —   |      |

## 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          | $V_{DSF}$ | $I_{DR} = 18\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                         | —   | —    | -1.7 | V             |
| Reverse recovery time (Note 5) | $t_{rr}$  | $V_{DD} = 400\text{ V}$ ,<br>$I_{DR} = 9\text{ A}$ , $V_{GS} = 0\text{ V}$<br>$-dI_{DR}/dt = 100\text{ A}/\mu\text{s}$ | —   | 100  | 160  | ns            |
| Reverse recovery charge        | $Q_{rr}$  |                                                                                                                        | —   | 0.45 | —    | $\mu\text{C}$ |
| Peak reverse recovery current  | $I_{rr}$  |                                                                                                                        | —   | 9    | —    | A             |
| Diode dv/dt ruggedness         | dv/dt     | $V_{DD} \leq 400\text{ V}$ , $I_{DR} \leq 9\text{ A}$ , $V_{GS} = 0\text{ V}$                                          | 70  | —    | —    | V/ns          |

Note 5: Defined by design.

## 7. Marking (Note)

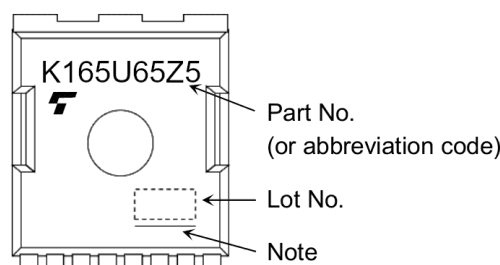


Fig. 7.1 Marking

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)

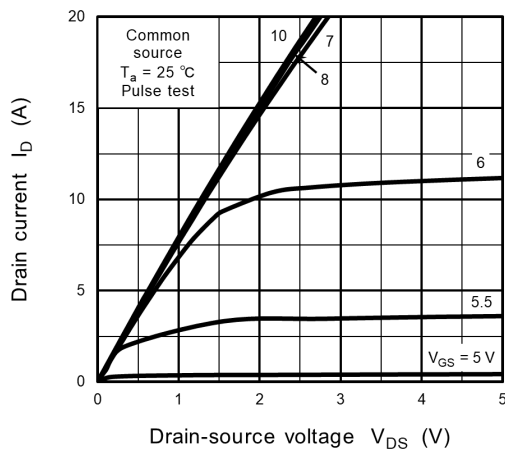


Fig. 8.1  $I_D - V_{DS}$

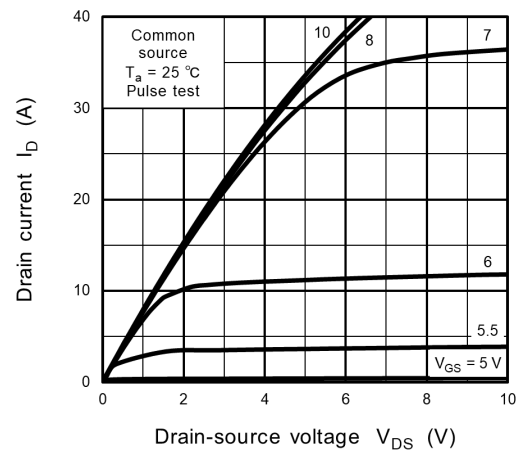


Fig. 8.2  $I_D - V_{DS}$

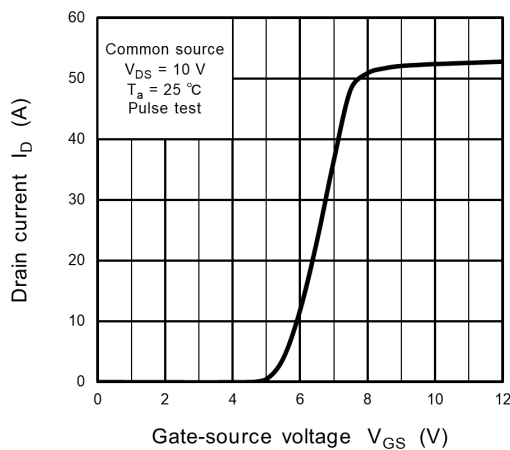


Fig. 8.3  $I_D - V_{GS}$

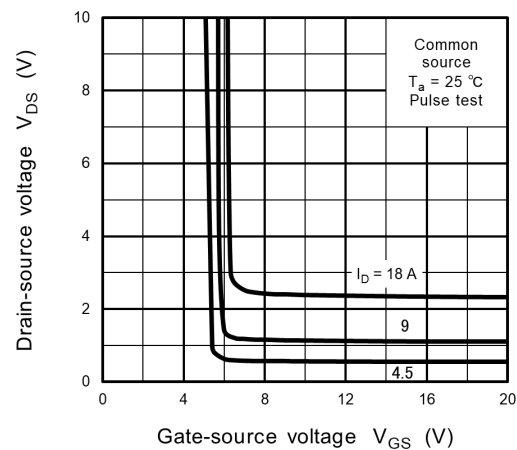


Fig. 8.4  $V_{DS} - V_{GS}$

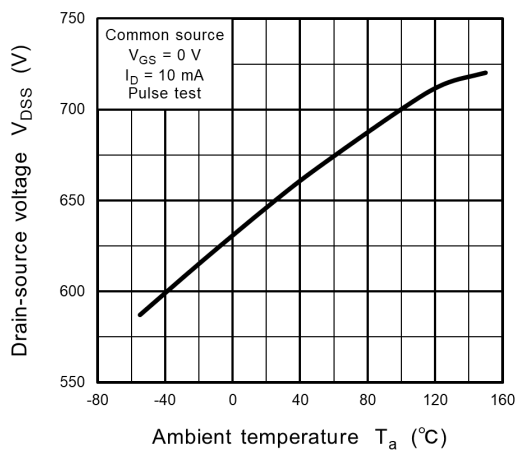


Fig. 8.5  $V_{DS} - T_a$

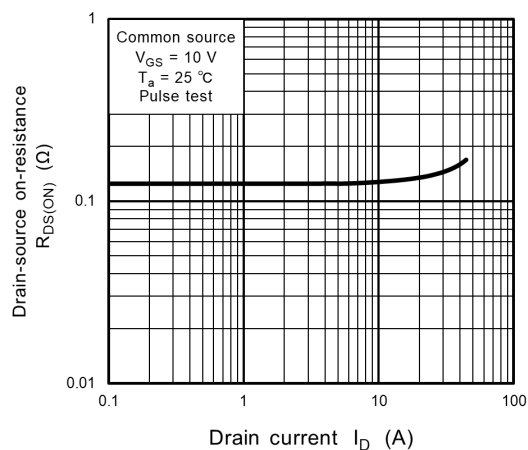


Fig. 8.6  $R_{DS(ON)} - I_D$

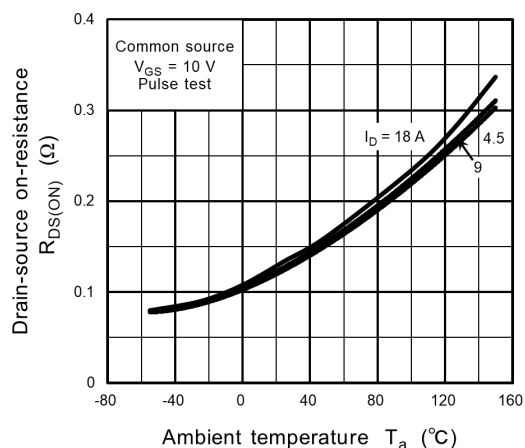


Fig. 8.7  $R_{DS(ON)} - T_a$

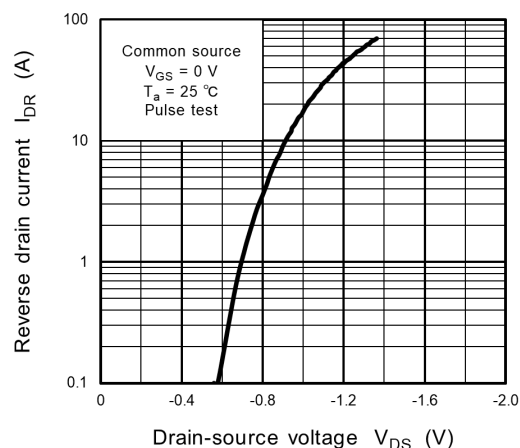


Fig. 8.8  $I_{DR} - V_{DS}$

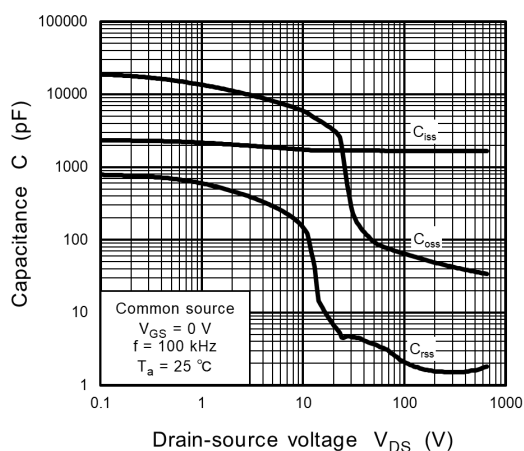


Fig. 8.9  $C - V_{DS}$

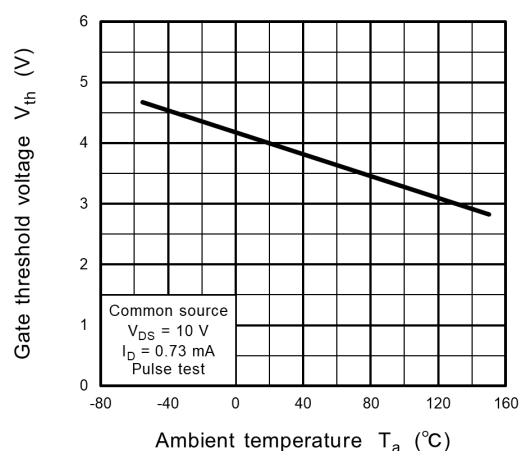


Fig. 8.10  $V_{th} - T_a$

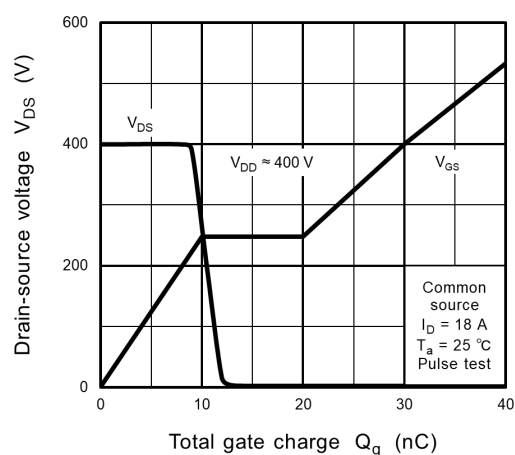


Fig. 8.11 Dynamic Input/Output Characteristics

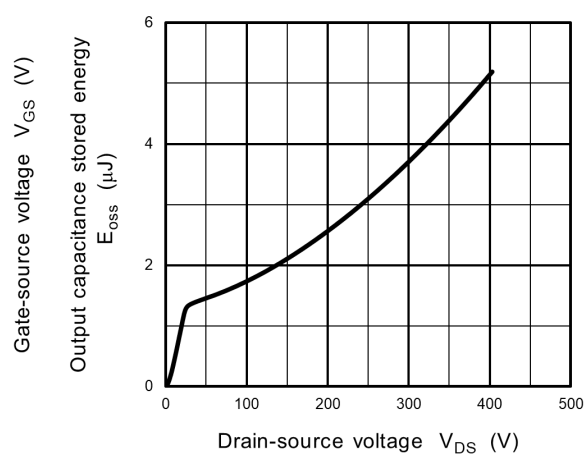


Fig. 8.12  $E_{oss} - V_{DS}$

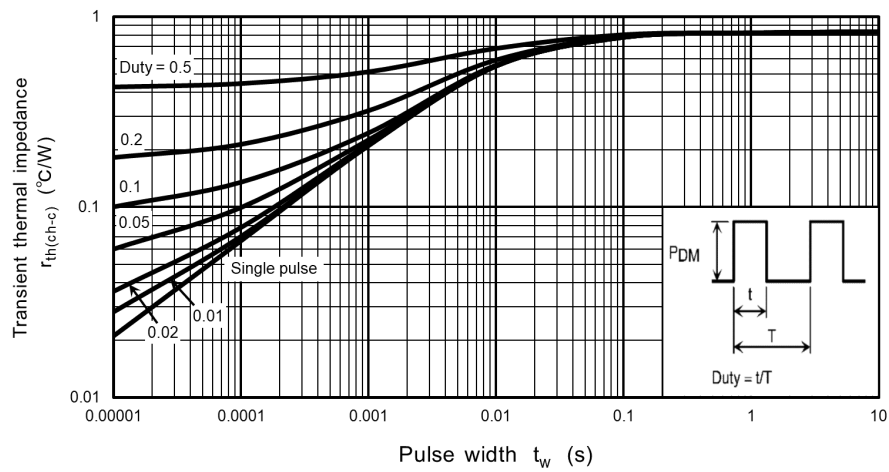


Fig. 8.13  $r_{th} - t_w$   
(Guaranteed Maximum)

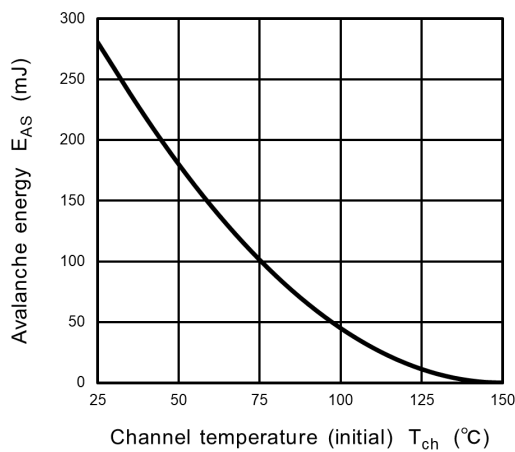


Fig. 8.14  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)

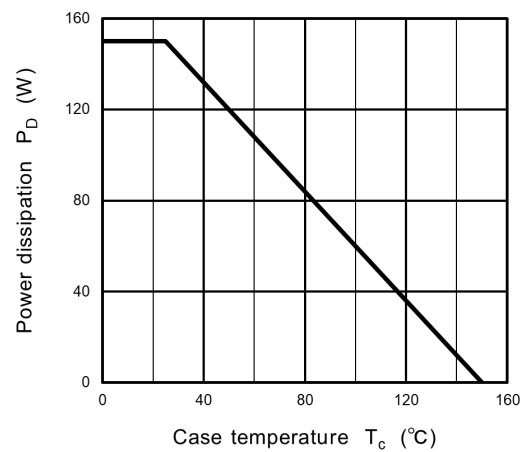


Fig. 8.15  $P_D - T_c$   
(Guaranteed Maximum)

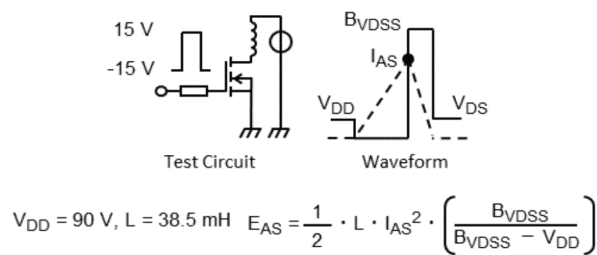


Fig. 8.16 Test Circuit/Waveform

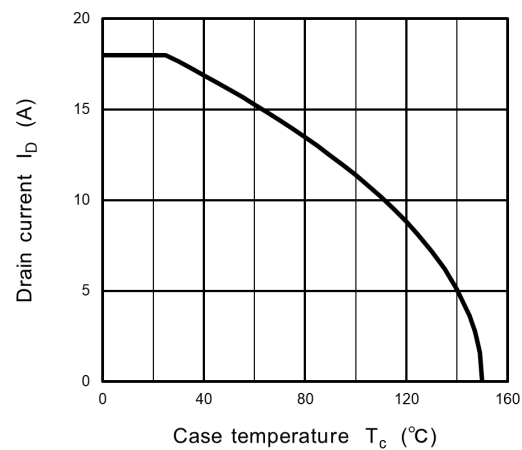
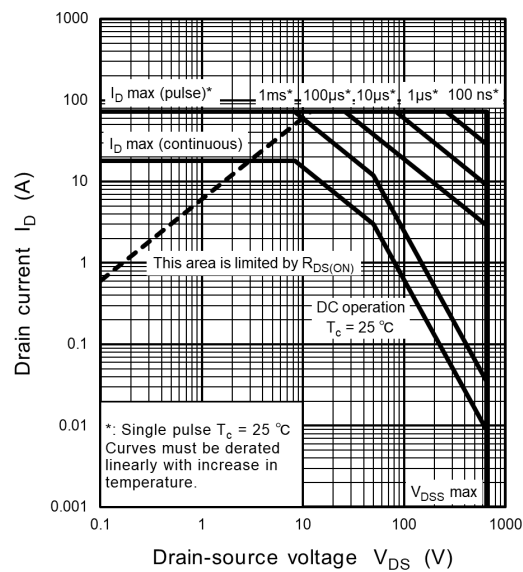


Fig. 8.17  $I_D - T_c$   
(Guaranteed Maximum)

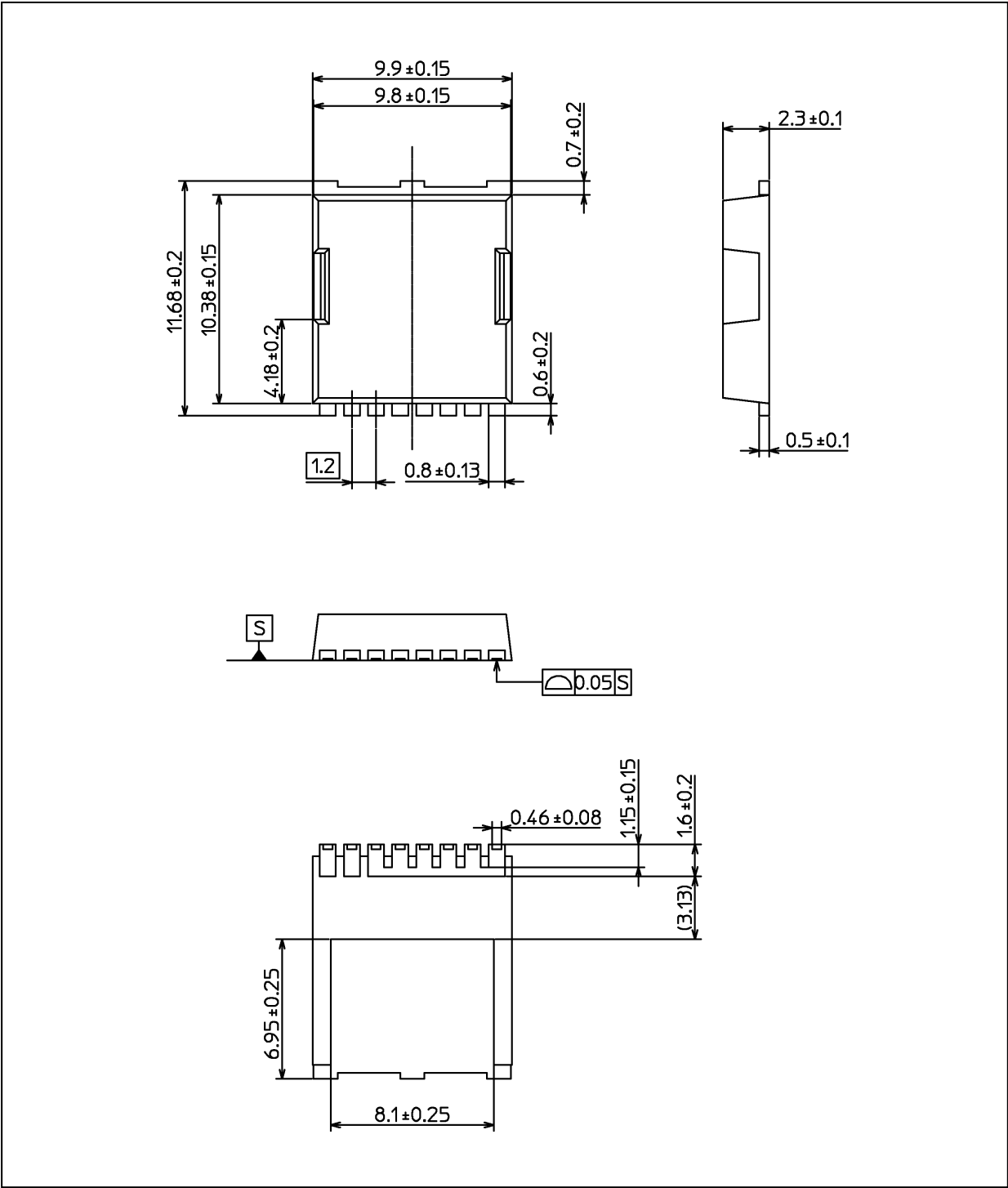


**Fig. 8.18 Safe Operating Area  
(Guaranteed Maximum)**

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

Package Dimensions

Unit: mm



Weight: 0.75 g (typ.)

| Package Name(s)   |
|-------------------|
| TOSHIBA: 2-10AF1A |
| Nickname: TOLL    |

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