

# TK115Z65Z5

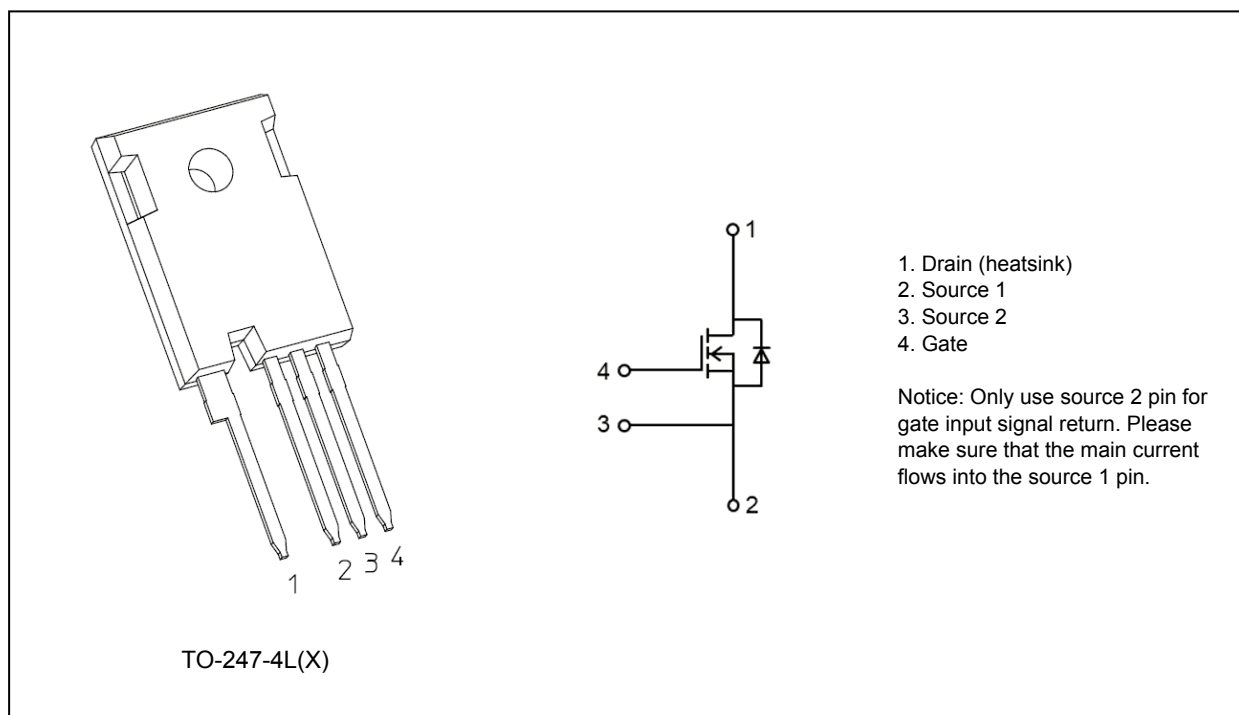
## 1. Applications

- Switching Voltage Regulators

## 2. Features

- (1) Fast reverse recovery time:  $t_{rr} = 110 \text{ ns}$  (typ.)
- (2) Low drain-source on-resistance:  $R_{DS(ON)} = 0.088 \Omega$  (typ.)
- (3) High-speed switching properties with the lower capacitance.
- (4) Enhancement mode:  $V_{th} = 3.5 \text{ to } 4.5 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1.02 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2025-10

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

| Characteristics                                          | Symbol    | Rating     | Unit               |
|----------------------------------------------------------|-----------|------------|--------------------|
| Drain-source voltage                                     | $V_{DS}$  | 650        | V                  |
| Gate-source voltage                                      | $V_{GS}$  | $\pm 30$   |                    |
| Drain current (DC) (Note 1)                              | $I_D$     | 24         | A                  |
| Drain current (pulsed) (Note 1)                          | $I_{DP}$  | 96         |                    |
| Power dissipation ( $T_c = 25\text{ }^{\circ}\text{C}$ ) | $P_D$     | 190        | W                  |
| Single-pulse avalanche energy (Note 2)                   | $E_{AS}$  | 325        | mJ                 |
| Single-pulse avalanche current                           | $I_{AS}$  | 4.8        | A                  |
| Reverse drain current (DC) (Note 1)                      | $I_{DR}$  | 24         |                    |
| Reverse drain current (pulsed) (Note 1)                  | $I_{DRP}$ | 96         |                    |
| 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.).

#### 5. Thermal Characteristics

| Characteristics                       | Symbol         | Max   | Unit                        |
|---------------------------------------|----------------|-------|-----------------------------|
| Channel-to-case thermal resistance    | $R_{th(ch-c)}$ | 0.657 | $^{\circ}\text{C}/\text{W}$ |
| Channel-to-ambient thermal resistance | $R_{th(ch-a)}$ | 50    |                             |

Note 1: Ensure that the channel temperature does not exceed  $150\text{ }^{\circ}\text{C}$ .

Note 2:  $V_{DD} = 90\text{ V}$ ,  $T_{ch} = 25\text{ }^{\circ}\text{C}$  (initial),  $L = 25.0\text{ mH}$ ,  $I_{AS} = 4.8\text{ A}$

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         | $V_{th}$      | $V_{DS} = 10\text{ V}$ , $I_D = 1.02\text{ mA}$    | 3.5 | —     | 4.5     |               |
| Drain-source on-resistance     | $R_{DS(ON)}$  | $V_{GS} = 10\text{ V}$ , $I_D = 12\text{ A}$       | —   | 0.088 | 0.115   | $\Omega$      |

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

| Characteristics                                           | Symbol      | Test Condition                                                   | Min | Typ. | Max | Unit     |
|-----------------------------------------------------------|-------------|------------------------------------------------------------------|-----|------|-----|----------|
| Input capacitance                                         | $C_{iss}$   | $V_{DS} = 300\text{ V}, V_{GS} = 0\text{ V}, f = 100\text{ kHz}$ | —   | 2280 | —   | pF       |
| Reverse transfer capacitance                              | $C_{rss}$   |                                                                  | —   | 2.6  | —   |          |
| Output capacitance                                        | $C_{oss}$   |                                                                  | —   | 55   | —   |          |
| Effective output capacitance (Note 3)<br>(energy related) | $C_{o(er)}$ | $V_{DS} = 0\text{ to }400\text{ V}, V_{GS} = 0\text{ V}$         | —   | 90   | —   | pF       |
| Effective output capacitance (Note 4)<br>(time related)   | $C_{o(tr)}$ |                                                                  | —   | 600  | —   |          |
| Gate resistance                                           | $r_g$       | $V_{DS} = \text{OPEN}, f = 1\text{ MHz}$                         | —   | 3.2  | —   | $\Omega$ |
| Switching time (rise time)                                | $t_r$       | See Fig. 6.2.1                                                   | —   | 14   | —   | ns       |
| Switching time (turn-on time)                             | $t_{on}$    |                                                                  | —   | 45   | —   |          |
| Switching time (fall time)                                | $t_f$       |                                                                  | —   | 3.7  | —   |          |
| Switching time (turn-off time)                            | $t_{off}$   |                                                                  | —   | 83   | —   |          |
| MOSFET dv/dt ruggedness                                   | dv/dt       | $V_{DS} \leq V_{DSS}, I_D \leq 12\text{ A}$                      | 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.

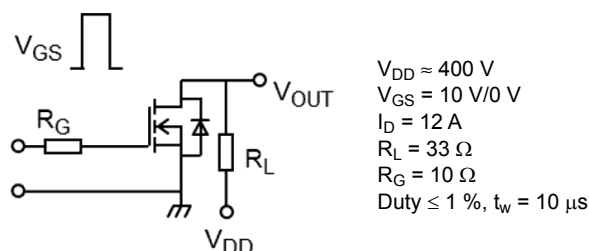


Fig. 6.2.1 Switching Time Test Circuit

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

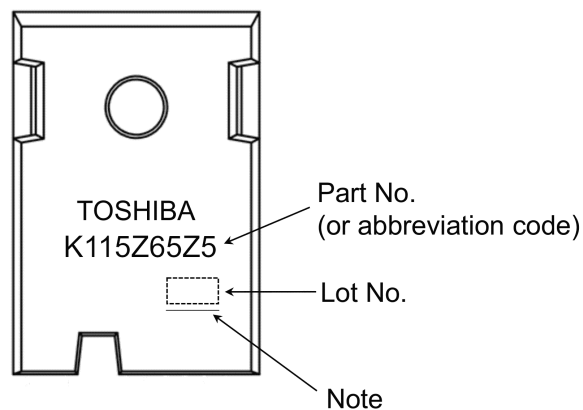
| Characteristics                                 | Symbol    | Test Condition                                                         | Min | Typ. | Max | Unit |
|-------------------------------------------------|-----------|------------------------------------------------------------------------|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$     | $V_{DD} \approx 400\text{ V}, V_{GS} = 10\text{ V}, I_D = 24\text{ A}$ | —   | 42   | —   | nC   |
| Gate-source charge 1                            | $Q_{gs1}$ |                                                                        | —   | 14   | —   |      |
| Gate-drain charge                               | $Q_{gd}$  |                                                                        | —   | 14   | —   |      |

## 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          | $V_{DSF}$ | $I_{DR} = 24\text{ A}, V_{GS} = 0\text{ V}$                                                                         | —   | —    | -1.7 | V             |
| Reverse recovery time (Note 5) | $t_{rr}$  | $V_{DD} = 400\text{ V},$<br>$I_{DR} = 12\text{ A}, V_{GS} = 0\text{ V}$<br>$-dI_{DR}/dt = 100\text{ A}/\mu\text{s}$ | —   | 110  | 176  | ns            |
| Reverse recovery charge        | $Q_{rr}$  |                                                                                                                     | —   | 0.52 | —    | $\mu\text{C}$ |
| Peak reverse recovery current  | $I_{rr}$  |                                                                                                                     | —   | 9.5  | —    | A             |
| Diode dv/dt ruggedness         | dv/dt     | $V_{DD} \leq 400\text{ V}, I_{DR} \leq 12\text{ A}, V_{GS} = 0\text{ V}$                                            | 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)

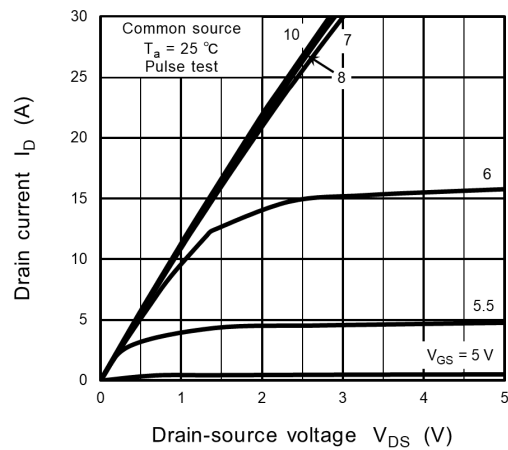


Fig. 8.1  $I_D - V_{DS}$

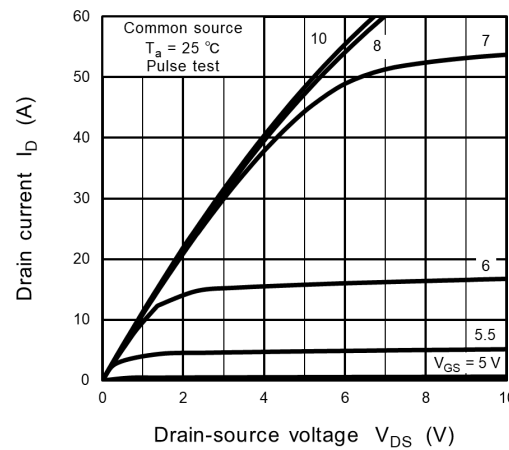


Fig. 8.2  $I_D - V_{DS}$

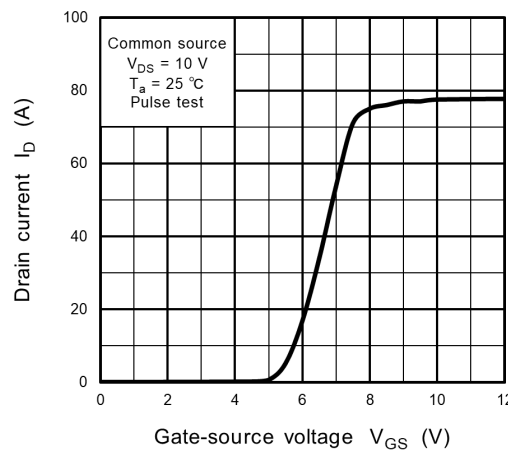


Fig. 8.3  $I_D - V_{GS}$

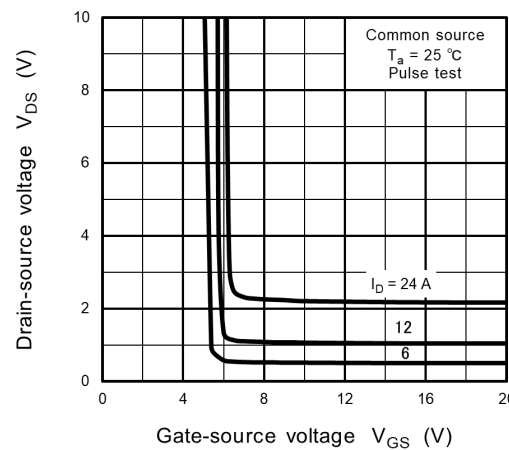


Fig. 8.4  $V_{DS} - V_{GS}$

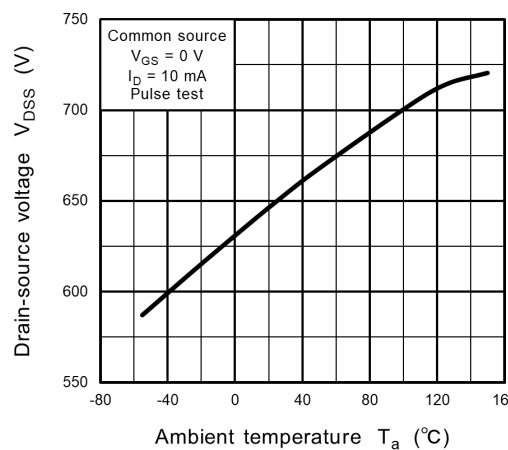


Fig. 8.5  $V_{DS} - T_a$

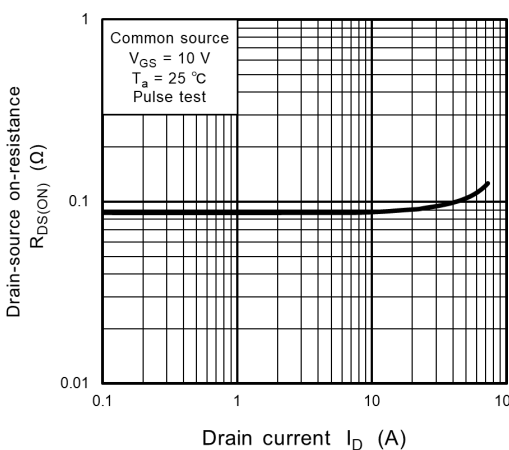


Fig. 8.6  $R_{DS(ON)} - I_D$

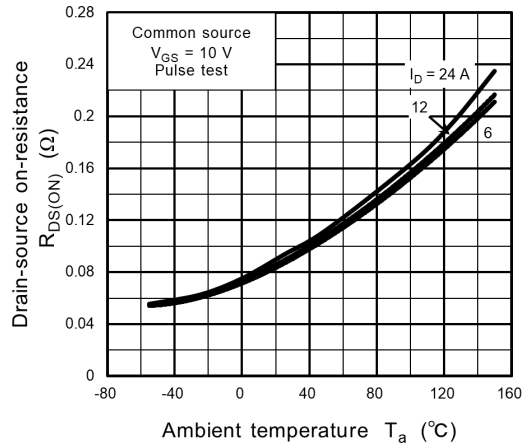


Fig. 8.7  $R_{DS(ON)} - T_a$

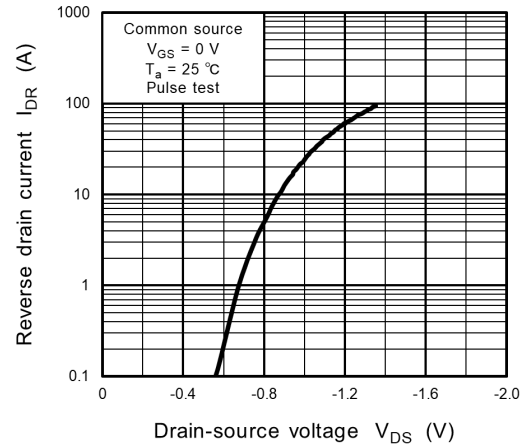


Fig. 8.8  $I_{DR} - V_{DS}$

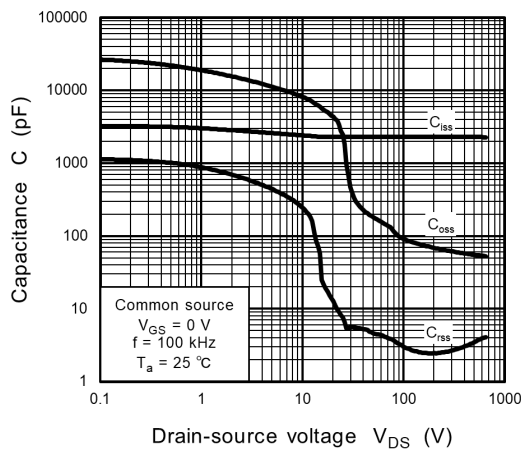


Fig. 8.9  $C - V_{DS}$

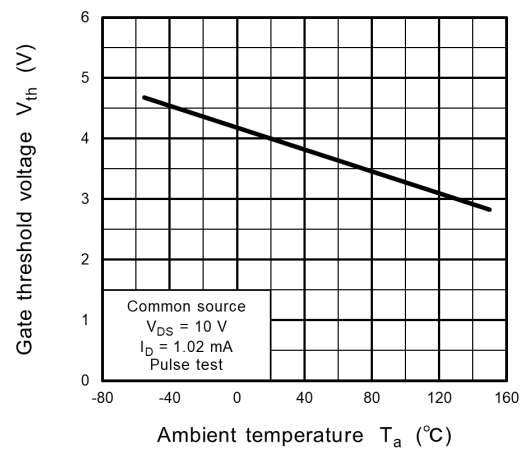


Fig. 8.10  $V_{th} - T_a$

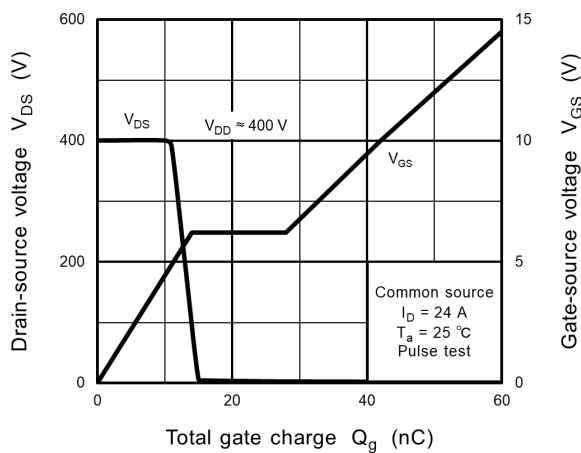


Fig. 8.11 Dynamic Input/Output Characteristics

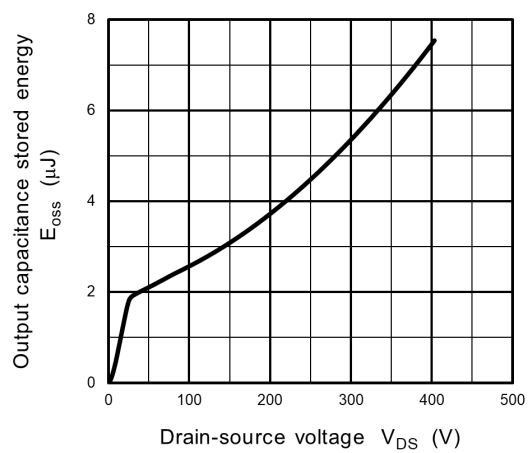


Fig. 8.12  $E_{oss} - V_{DS}$

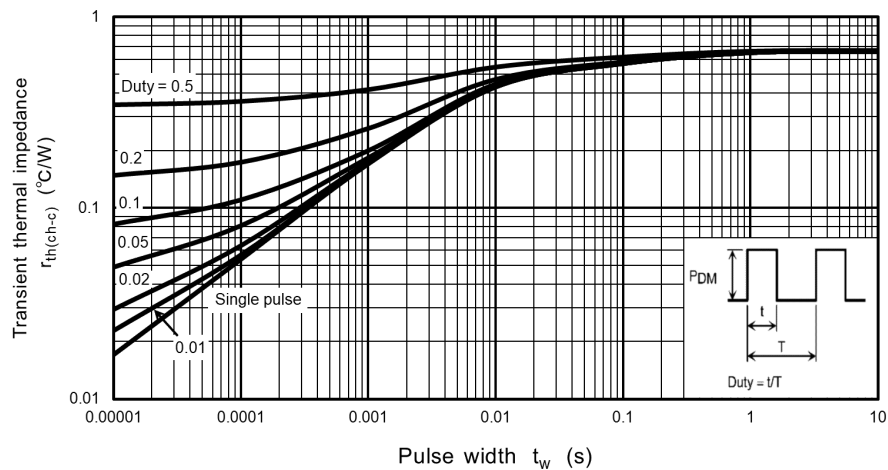


Fig. 8.13  $r_{th} - t_w$   
(Guaranteed Maximum)

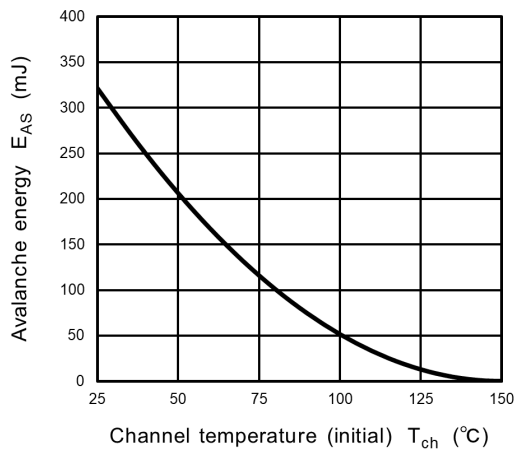


Fig. 8.14  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)

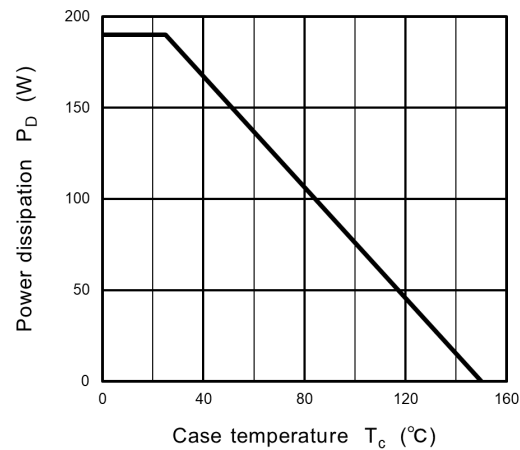


Fig. 8.15  $P_D - T_c$   
(Guaranteed Maximum)

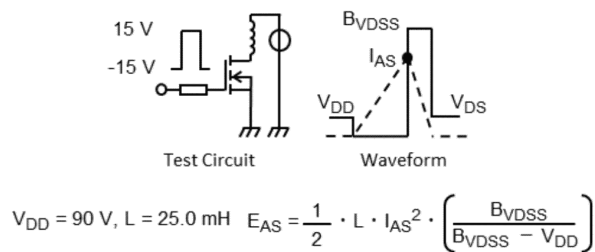


Fig. 8.16 Test Circuit/Waveform

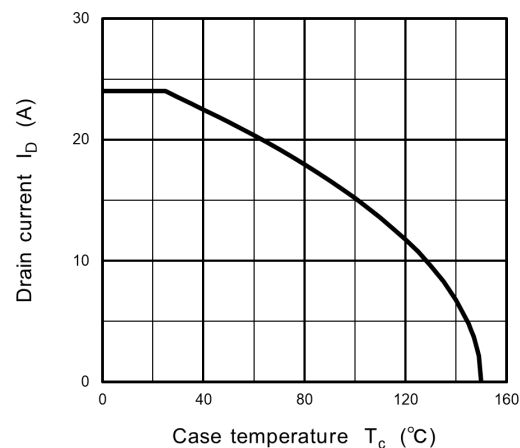
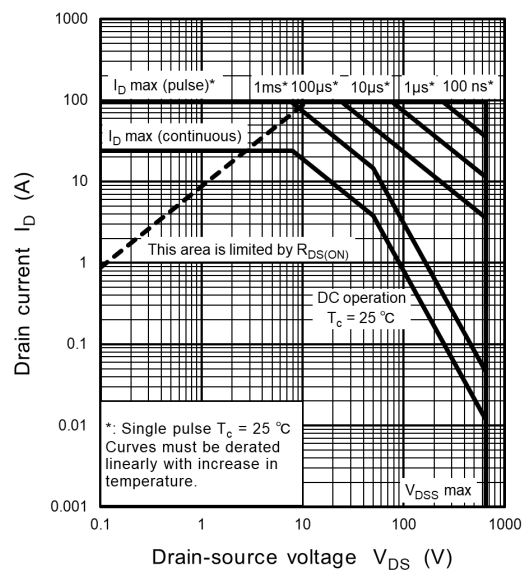


Fig. 8.17  $I_D - T_c$   
(Guaranteed Maximum)

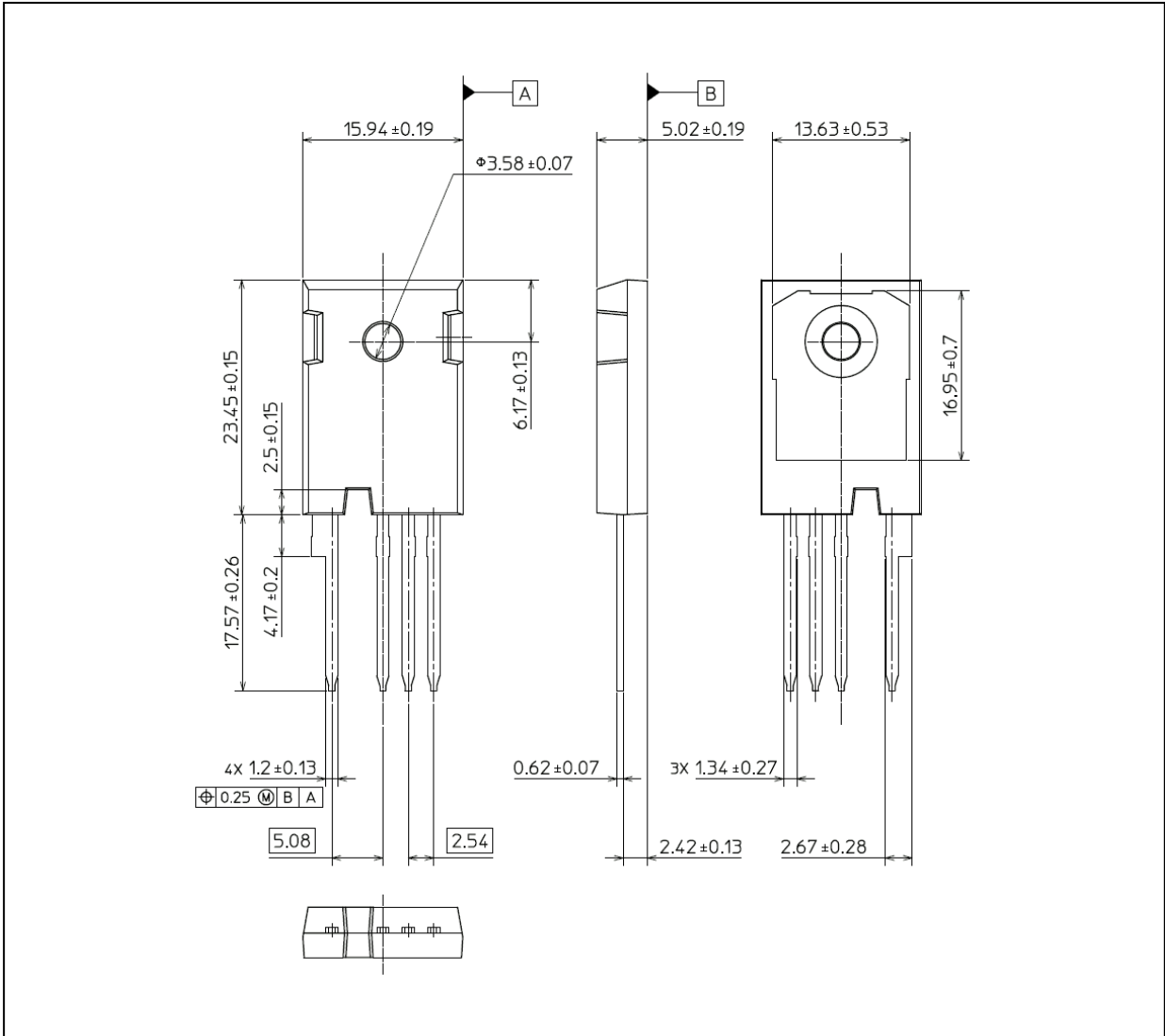


**Fig. 8.18 Safe Operating Area  
(Guaranteed Maximum)**

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

Package Dimensions

Unit: mm



Weight: 6.55 g (typ.)

| Package Name(s)        |
|------------------------|
| TOSHIBA: 2-16M3A       |
| Nickname: TO-247-4L(X) |

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