

# TJ40S04M3L

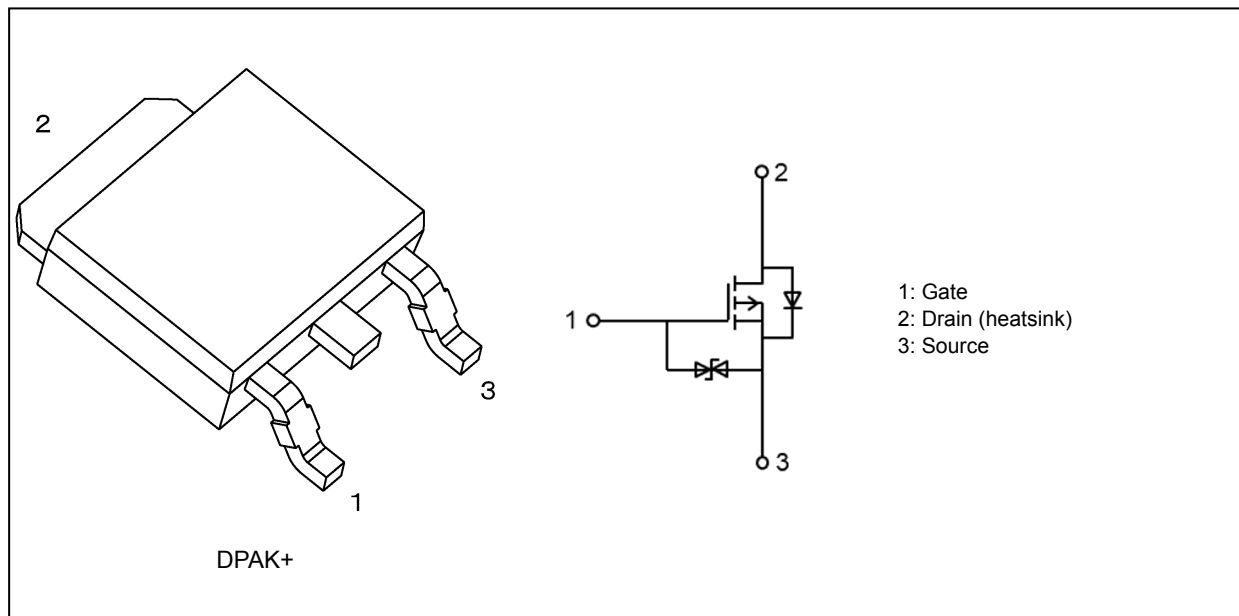
## 1. Applications

- Automotive
- Motor Drivers
- DC-DC Converters
- Switching Voltage Regulators

## 2. Features

- (1) AEC-Q101 qualified
- (2) Low drain-source on-resistance:  $R_{DS(ON)} = 7.0 \text{ m}\Omega$  (typ.) ( $V_{GS} = -10 \text{ V}$ )
- (3) Low leakage current:  $I_{DSS} = -10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = -40 \text{ V}$ )
- (4) Enhancement mode:  $V_{th} = -2.0$  to  $-3.0 \text{ V}$  ( $V_{DS} = -10 \text{ V}$ ,  $I_D = -1 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production

2011-03

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

| Characteristics                                | Symbol           | Rating     | Unit             |
|------------------------------------------------|------------------|------------|------------------|
| Drain-source voltage                           | $V_{\text{DSS}}$ | -40        | V                |
| Gate-source voltage                            | $V_{\text{GSS}}$ | -20/+10    |                  |
| Drain current (DC) (Note 1)                    | $I_{\text{D}}$   | -40        | A                |
| Drain current (pulsed) (Note 1)                | $I_{\text{DP}}$  | -80        |                  |
| Power dissipation ( $T_c = 25^\circ\text{C}$ ) | $P_{\text{D}}$   | 68         | W                |
| Single-pulse avalanche energy (Note 2)         | $E_{\text{AS}}$  | 72         | mJ               |
| Avalanche current                              | $I_{\text{AR}}$  | -40        | A                |
| Channel temperature (Note 3)                   | $T_{\text{ch}}$  | 175        | $^\circ\text{C}$ |
| Storage temperature (Note 3)                   | $T_{\text{stg}}$ | -55 to 175 |                  |

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 | $R_{\text{th(ch-c)}}$ | 2.2 | $^\circ\text{C/W}$ |

Note 1: Ensure that the channel temperature does not exceed  $175^\circ\text{C}$ .

Note 2:  $V_{\text{DD}} = -25\text{ V}$ ,  $T_{\text{ch}} = 25^\circ\text{C}$  (initial),  $L = 47\text{ }\mu\text{H}$ ,  $R_{\text{G}} = 25\text{ }\Omega$ ,  $I_{\text{AR}} = -40\text{ A}$

Note 3: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

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

## 6. Electrical Characteristics

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

| Characteristics                         | Symbol        | Test Condition                                      | Min  | Typ. | Max      | Unit             |
|-----------------------------------------|---------------|-----------------------------------------------------|------|------|----------|------------------|
| Gate leakage current                    | $I_{GSS}$     | $V_{GS} = -16/+10\text{ V}$ , $V_{DS} = 0\text{ V}$ | —    | —    | $\pm 10$ | $\mu\text{A}$    |
| Drain cut-off current                   | $I_{DSS}$     | $V_{DS} = -40\text{ V}$ , $V_{GS} = 0\text{ V}$     | —    | —    | -10      |                  |
| Drain-source breakdown voltage          | $V_{(BR)DSS}$ | $I_D = -10\text{ mA}$ , $V_{GS} = 0\text{ V}$       | -40  | —    | —        | V                |
| Drain-source breakdown voltage (Note 4) | $V_{(BR)DSX}$ | $I_D = -10\text{ mA}$ , $V_{GS} = 10\text{ V}$      | -30  | —    | —        |                  |
| Gate threshold voltage                  | $V_{th}$      | $V_{DS} = -10\text{ V}$ , $I_D = -1\text{ mA}$      | -2.0 | —    | -3.0     |                  |
| Drain-source on-resistance              | $R_{DS(ON)}$  | $V_{GS} = -6\text{ V}$ , $I_D = -20\text{ A}$       | —    | 8.7  | 13       | $\text{m}\Omega$ |
|                                         |               | $V_{GS} = -10\text{ V}$ , $I_D = -20\text{ A}$      | —    | 7.0  | 9.1      |                  |

Note 4: If a forward bias is applied between gate and source, this device enters  $V_{(BR)DSX}$  mode. Note that the drain-source breakdown voltage is lowered in this mode.

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

| Characteristics                | Symbol    | Test Condition                                                       | Min | Typ. | Max | Unit        |
|--------------------------------|-----------|----------------------------------------------------------------------|-----|------|-----|-------------|
| Input capacitance              | $C_{iss}$ | $V_{DS} = -10\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$ | —   | 4140 | —   | $\text{pF}$ |
| Reverse transfer capacitance   | $C_{rss}$ |                                                                      | —   | 410  | —   |             |
| Output capacitance             | $C_{oss}$ |                                                                      | —   | 510  | —   |             |
| Switching time (rise time)     | $t_r$     | See Figure 6.2.1.                                                    | —   | 46   | —   | ns          |
| Switching time (turn-on time)  | $t_{on}$  |                                                                      | —   | 63   | —   |             |
| Switching time (fall time)     | $t_f$     |                                                                      | —   | 150  | —   |             |
| Switching time (turn-off time) | $t_{off}$ |                                                                      | —   | 465  | —   |             |

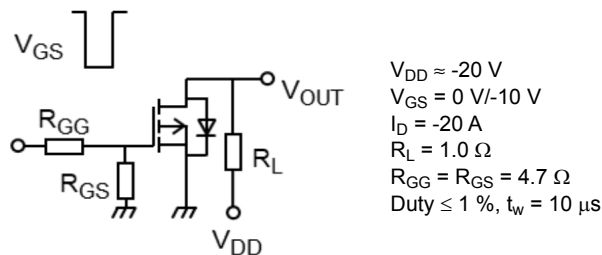


Fig. 6.2.1 Switching Time Test Circuit

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

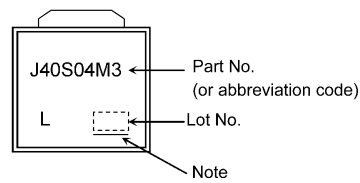
| Characteristics                                 | Symbol   | Test Condition                                                                 | Min | Typ. | Max | Unit |
|-------------------------------------------------|----------|--------------------------------------------------------------------------------|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | $Q_g$    | $V_{DD} \approx -32\text{ V}$ , $V_{GS} = -10\text{ V}$ , $I_D = -40\text{ A}$ | —   | 83   | —   | nC   |
| Gate-source charge                              | $Q_{gs}$ |                                                                                | —   | 55   | —   |      |
| Gate-drain charge                               | $Q_{gd}$ |                                                                                | —   | 28   | —   |      |

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

| Characteristics                         | Symbol    | Test Condition                                                                            | Min | Typ. | Max | Unit |
|-----------------------------------------|-----------|-------------------------------------------------------------------------------------------|-----|------|-----|------|
| Reverse drain current (DC) (Note 5)     | $I_{DR}$  | —                                                                                         | —   | —    | -40 | A    |
| Reverse drain current (pulsed) (Note 5) | $I_{DRP}$ | —                                                                                         | —   | —    | -80 |      |
| Diode forward voltage                   | $V_{DSF}$ | $I_{DR} = -40\text{ A}$ , $V_{GS} = 0\text{ V}$                                           | —   | —    | 1.2 | V    |
| Reverse recovery time                   | $t_{rr}$  | $I_{DR} = -40\text{ A}$ , $V_{GS} = 0\text{ V}$<br>$dI_{DR}/dt = 50\text{ A}/\mu\text{s}$ | —   | 39   | —   | ns   |
| Reverse recovery charge                 | $Q_{rr}$  |                                                                                           | —   | 22   | —   | nC   |

Note 5: Ensure that the channel temperature does not exceed  $175^\circ\text{C}$ .

## 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)

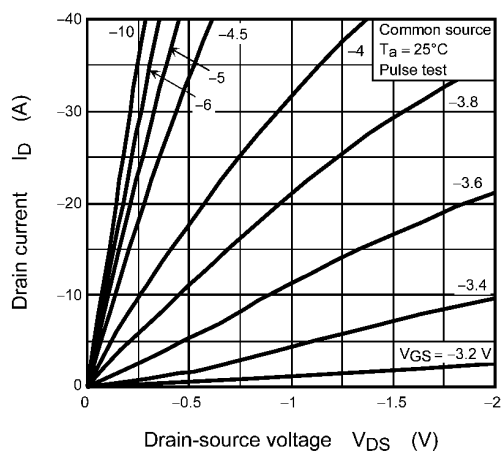


Fig. 8.1  $I_D - V_{DS}$

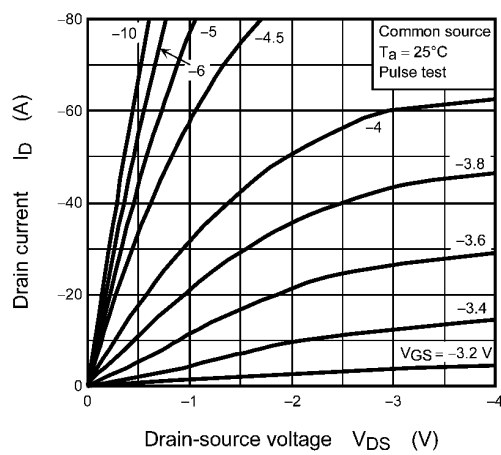


Fig. 8.2  $I_D - V_{DS}$

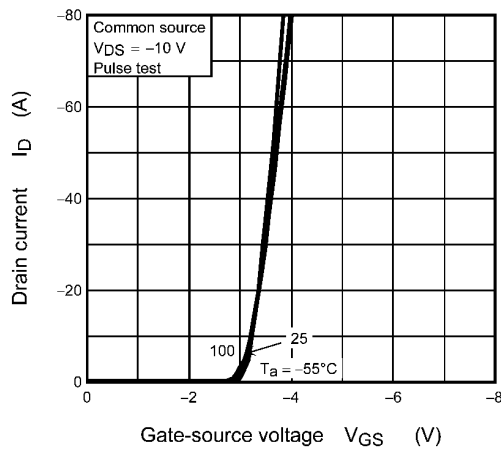


Fig. 8.3  $I_D - V_{GS}$

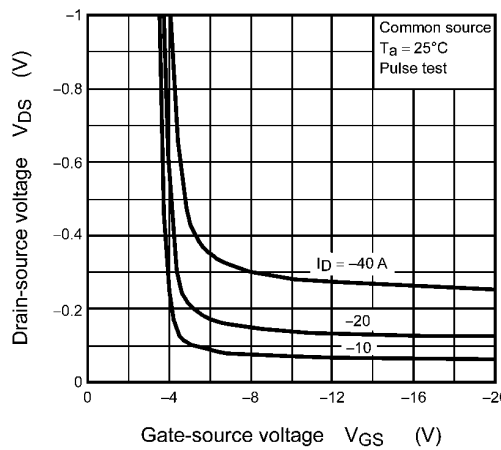


Fig. 8.4  $V_{DS} - V_{GS}$

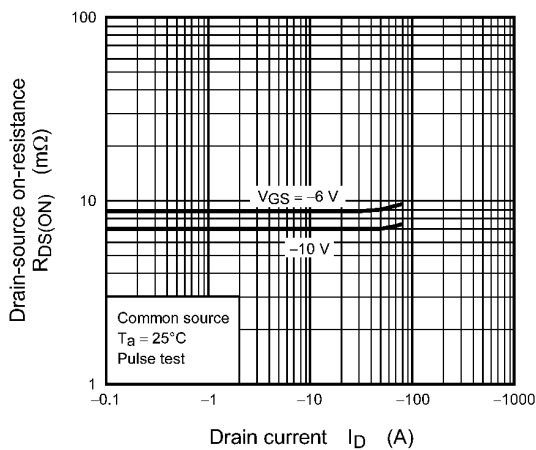


Fig. 8.5  $R_{DS(ON)} - I_D$

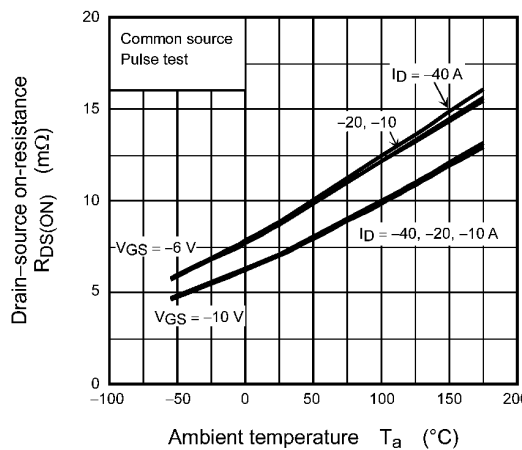


Fig. 8.6  $R_{DS(ON)} - T_a$

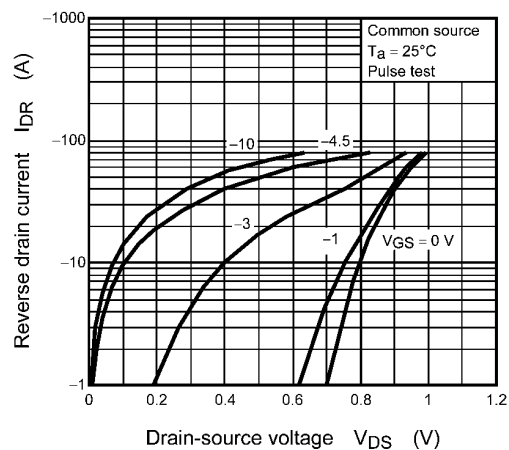


Fig. 8.7  $I_{DR} - V_{DS}$

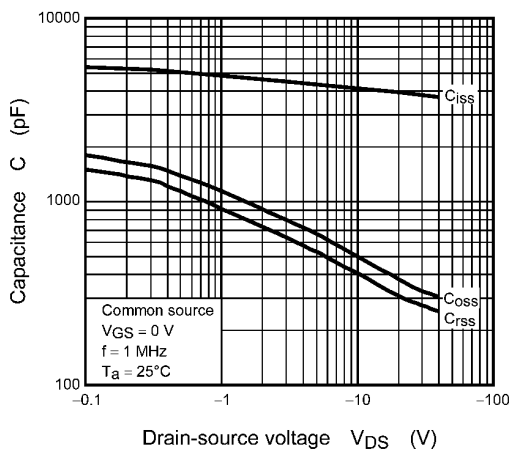


Fig. 8.8 Capacitance -  $V_{DS}$

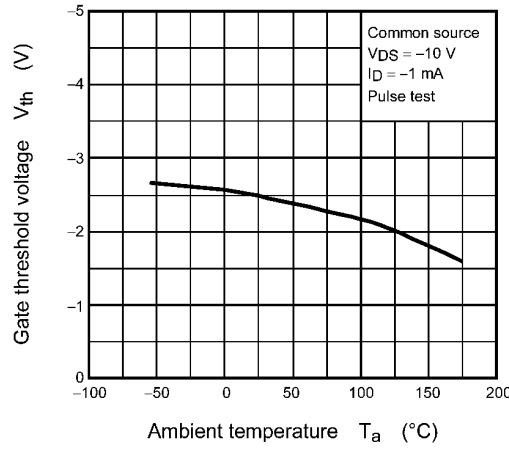


Fig. 8.9  $V_{th} - T_a$

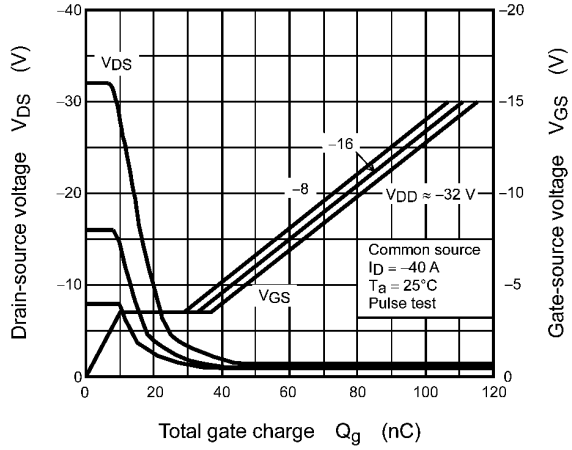


Fig. 8.10 Dynamic Input/Output Characteristics

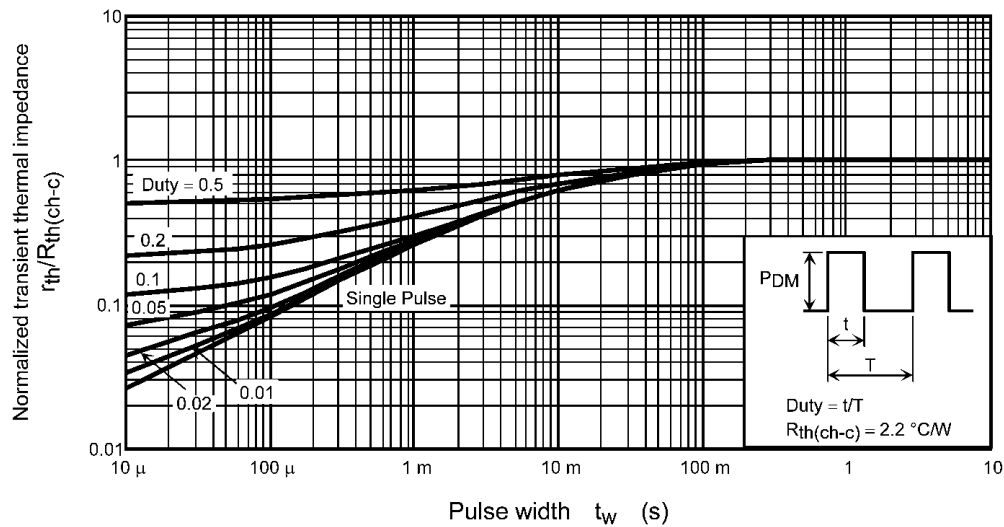


Fig. 8.11  $r_{th}/R_{th(ch-c)} - t_w$   
(Guaranteed Maximum)

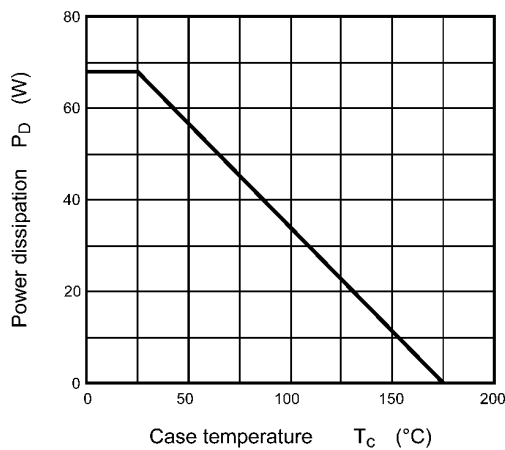


Fig. 8.12  $P_D - T_c$   
(Guaranteed Maximum)

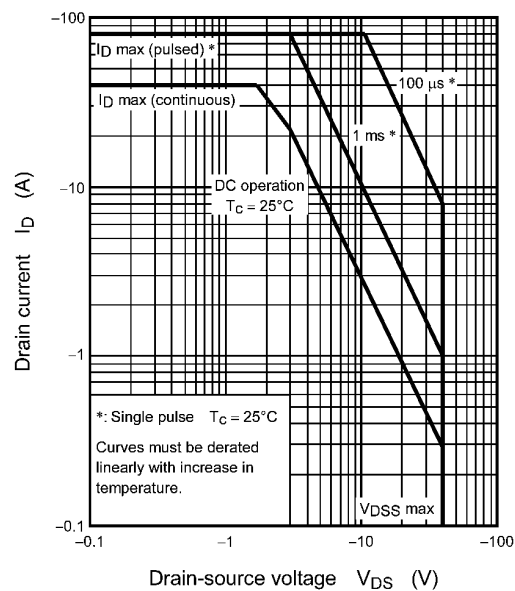
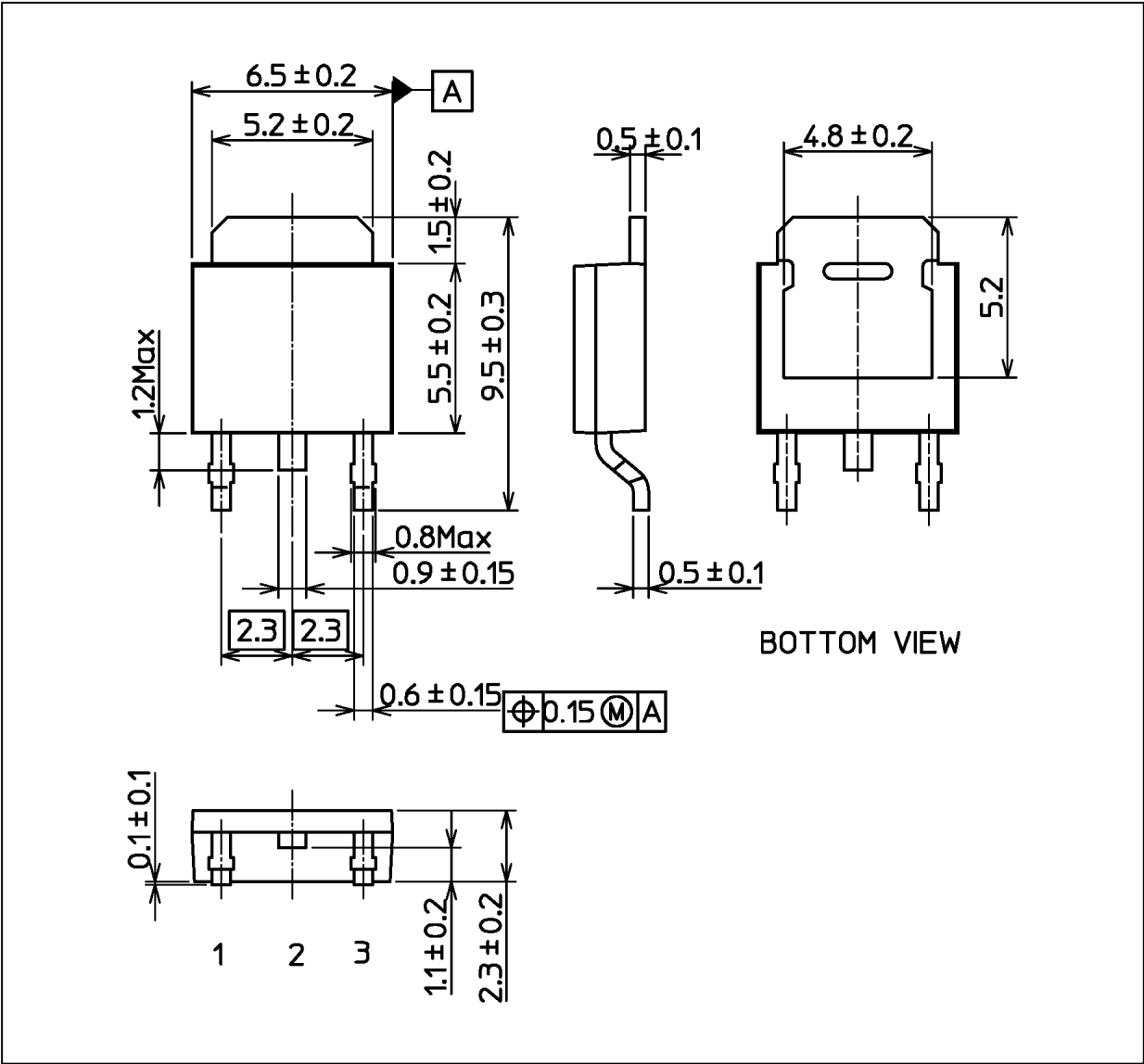


Fig. 8.13 Safe Operating Area  
(Guaranteed Maximum)

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

Package Dimensions

Unit: mm



Weight: 0.36 g (typ.)

| Package Name(s) |
|-----------------|
| TOSHIBA: 2-7M1A |
| Nickname: DPAK+ |



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