

MOSFETs Silicon N-Channel MOS (π -MOSIX)

TK650A60F

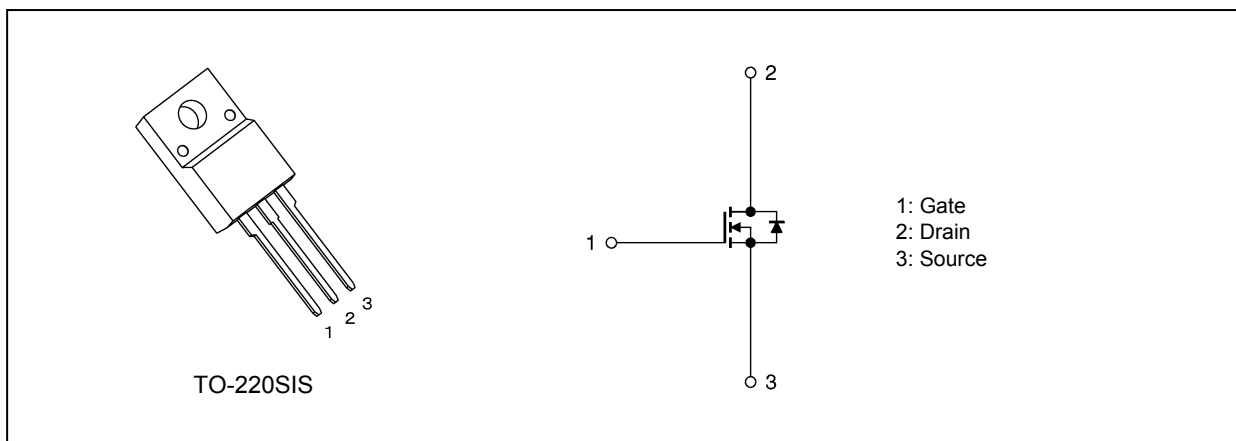
1. Applications

- Switching Power Supplies

2. Features

- (1) Easy to control Gate switching
- (2) Low drain-source on-resistance: $R_{DS(ON)} = 0.54 \Omega$ (typ.)
- (3) Enhancement mode: $V_{th} = 2.0$ to 4.0 V ($V_{DS} = 10$ V, $I_D = 1.16$ mA)

3. Packaging and Internal Circuit



4. Absolute Maximum Ratings (Note) ($T_a = 25$ °C unless otherwise specified)

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DSS}	600	V
Gate-source voltage	V_{GSS}	± 30	
Drain current (DC)	I_D (Note 1)	11	A
Drain current (pulsed)	I_{DP} (Note 1)	44	
Power dissipation ($T_c = 25$ °C)	P_D	45	W
Single-pulse avalanche energy	E_{AS} (Note 2)	224	mJ
Single-pulse avalanche current	I_{AS}	11	A
Reverse drain current (DC)	I_{DR} (Note 1)	11	
Reverse drain current (pulsed)	I_{DRP} (Note 1)	44	
Channel temperature	T_{ch}	150	°C
Storage temperature	T_{stg}	-55 to 150	
Isolation voltage (RMS)	$V_{ISO(RMS)}$ ($t = 1.0$ s)	2000	V
Mounting torque	TOR	0.6	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

2018-02

5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance	$R_{th(ch-c)}$	2.77	°C/W
Channel-to-ambient thermal resistance	$R_{th(ch-a)}$	62.5	

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), $L = 3.25\text{ mH}$, $I_{AS} = 11\text{ A}$

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}	$V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$	—	—	± 1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	600	—	—	V
Gate threshold voltage	V_{th}	$V_{DS} = 10\text{ V}, I_D = 1.16\text{ mA}$	2.0	—	4.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}$	—	0.54	0.65	Ω

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}	$V_{DS} = 300\text{ V}, V_{GS} = 0\text{ V}, f = 100\text{ kHz}$	—	1320	—	μF
Reverse transfer capacitance	C_{rss}		—	10	—	
Output capacitance	C_{oss}		—	47	—	
Gate resistance	r_g	$V_{DS} = \text{OPEN}, f = 1\text{ MHz}$	—	6.2	—	Ω
Switching time (rise time)	t_r	See Figure 6.2.1	—	25	—	ns
Switching time (turn-on time)	t_{on}		—	55	—	
Switching time (fall time)	t_f		—	22	—	
Switching time (turn-off time)	t_{off}		—	85	—	
MOSFET dv/dt ruggedness	dv/dt	$V_{DS} \leq V_{(BR)DSS}, I_D \leq 5.5\text{ A}$	15	—	—	V/ns

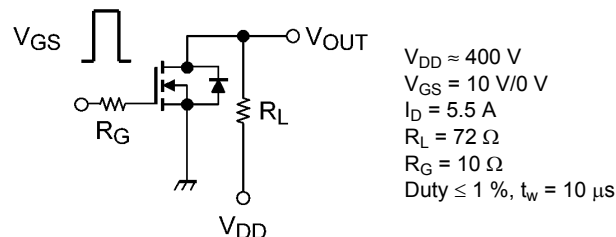


Fig. 6.2.1 Switching Time Test Circuit

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	$V_{DD} \approx 400\text{ V}, V_{GS} = 10\text{ V}, I_D = 11\text{ A}$	—	34	—	nC
Gate-source charge 1	Q_{gs1}		—	9.5	—	
Gate-drain charge	Q_{gd}		—	15.5	—	

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}	$I_{DR} = 11\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.7	V
Reverse recovery time	t_{rr}	$V_{DD} = 400\text{ V}, I_{DR} = 11\text{ A}, V_{GS} = 0\text{ V}, -dI_{DR}/dt = 100\text{ A}/\mu\text{s}$	—	600	—	ns
Reverse recovery charge	Q_{rr}		—	3.8	—	
Peak reverse recovery current	I_{rr}		—	12.5	—	
Diode dv/dt ruggedness	dv/dt	$V_{DD} \leq 400\text{ V}, I_{DR} \leq 11\text{ A}, V_{GS} = 0\text{ V}$	5	—	—	V/ns

7. Marking (Note)

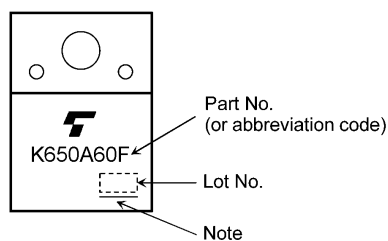


Fig. 7.1 Marking

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)

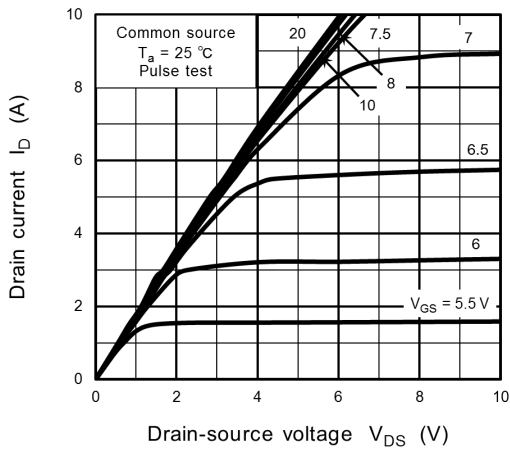


Fig. 8.1 $I_D - V_{DS}$

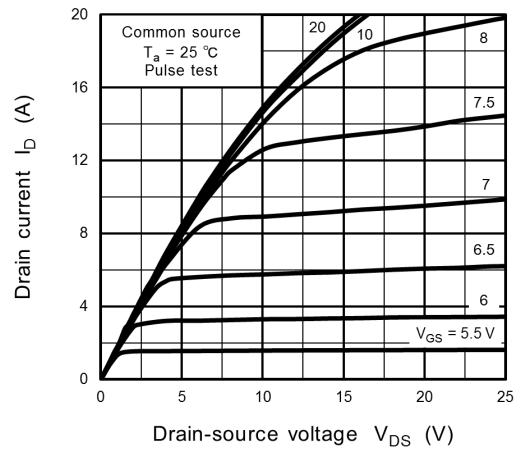


Fig. 8.2 $I_D - V_{DS}$

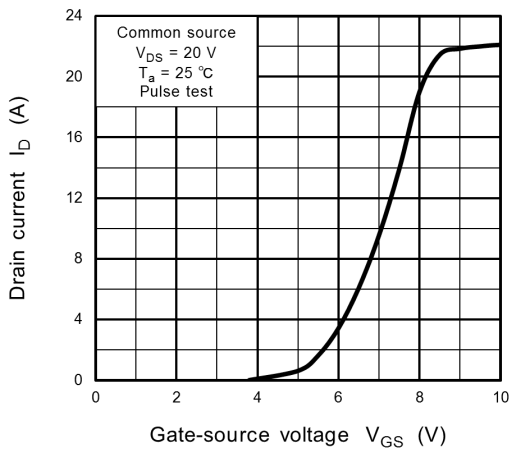


Fig. 8.3 $I_D - V_{GS}$

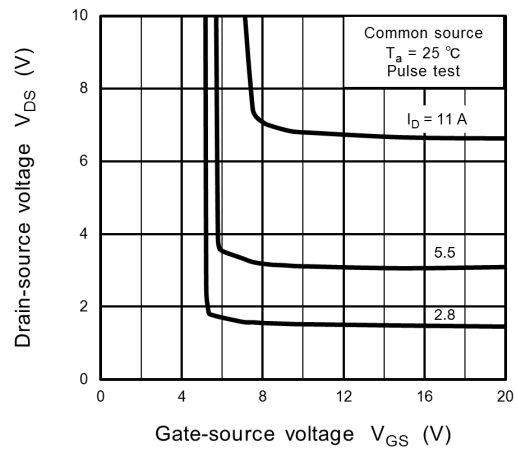


Fig. 8.4 $V_{DS} - V_{GS}$

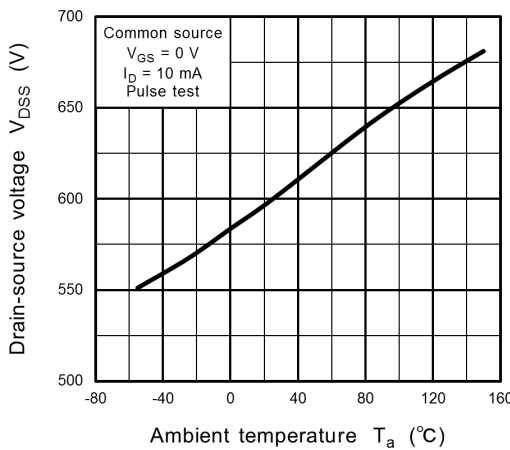


Fig. 8.5 $V_{DSS} - T_a$

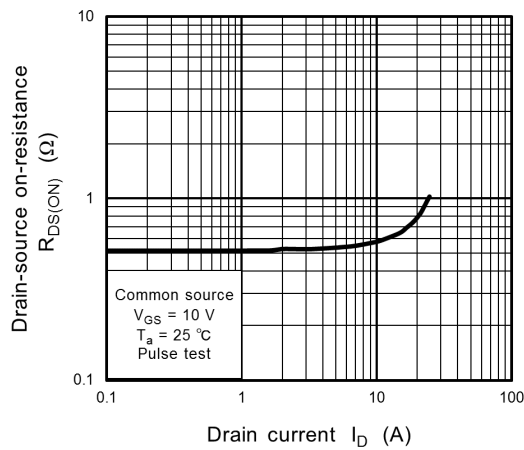


Fig. 8.6 $R_{DS(ON)} - I_D$

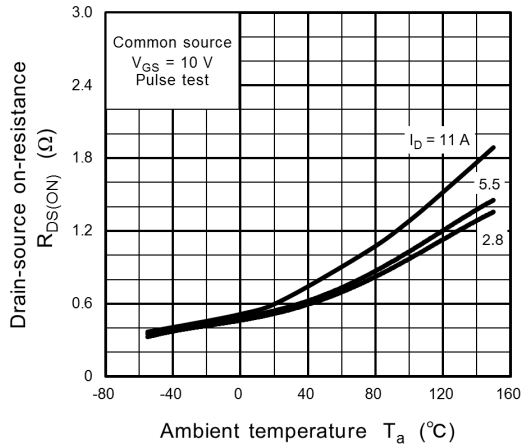


Fig. 8.7 $R_{DS(ON)} - T_a$

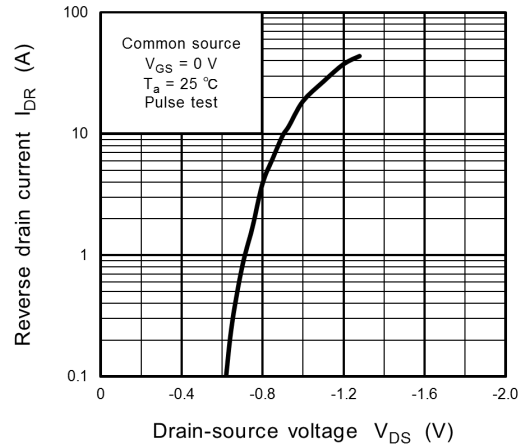


Fig. 8.8 $I_{DR} - V_{DS}$

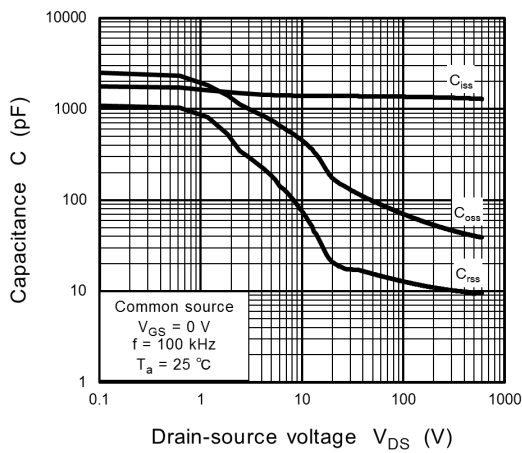


Fig. 8.9 $C - V_{DS}$

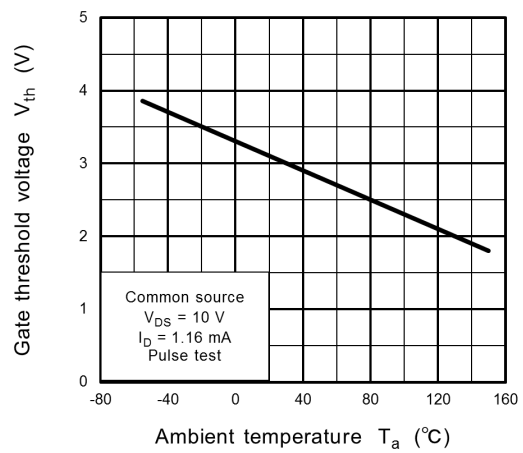


Fig. 8.10 $V_{th} - T_a$

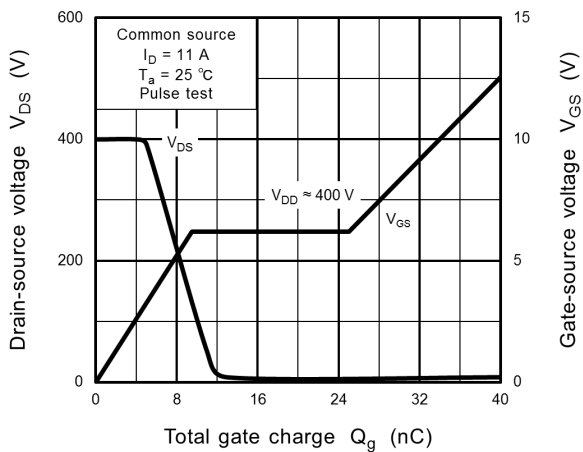


Fig. 8.11 Dynamic Input/Output Characteristics

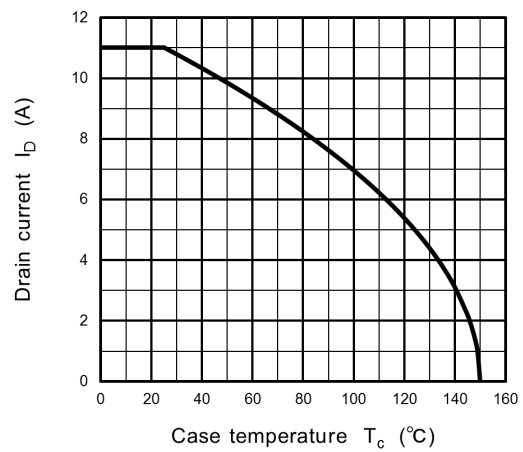


Fig. 8.12 $I_D - T_c$
(Guaranteed Maximum)

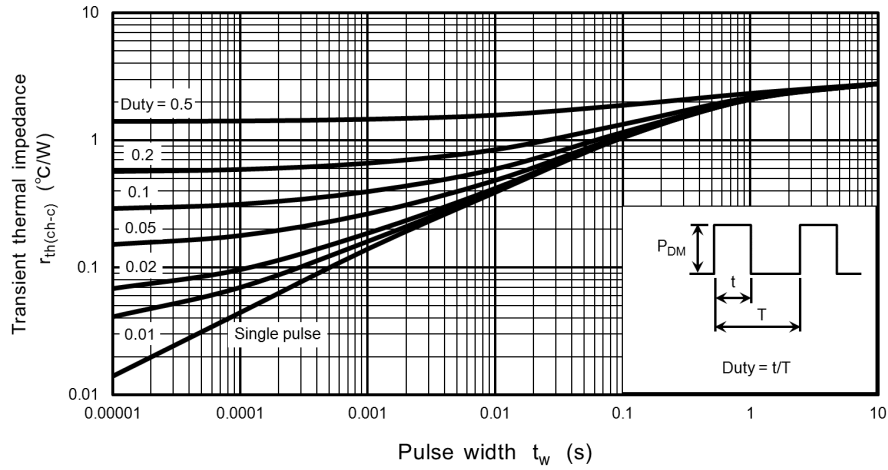


Fig. 8.13 $r_{th} - t_w$
(Guaranteed Maximum)

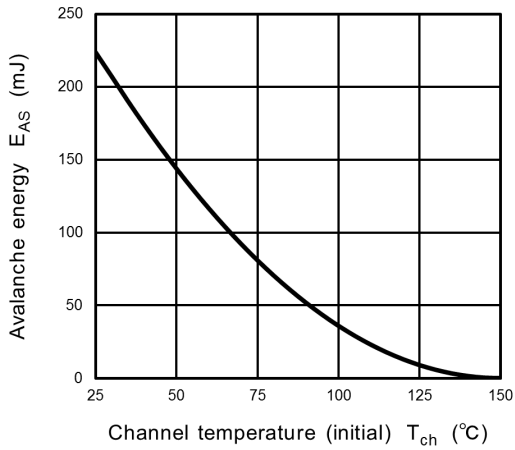


Fig. 8.14 $E_{AS} - T_{ch}$
(Guaranteed Maximum)

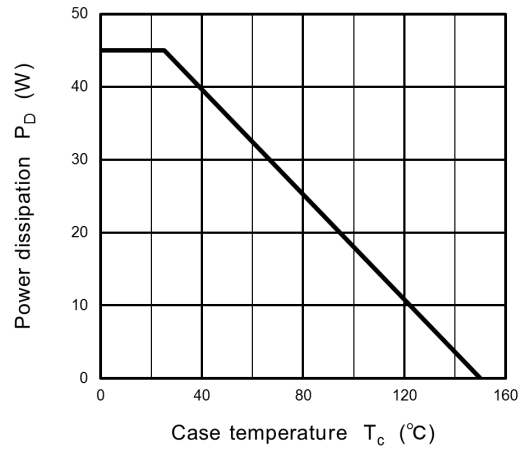
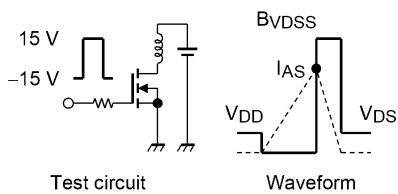
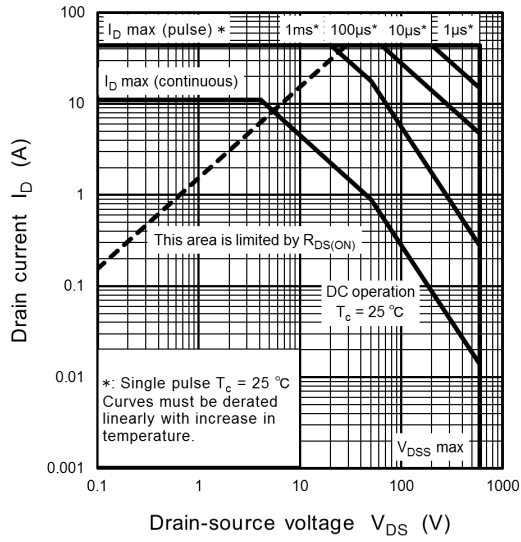


Fig. 8.15 $P_D - T_c$
(Guaranteed Maximum)



$$V_{DD} = 90 \text{ V}, L = 3.25 \text{ mH} \quad E_{AS} = \frac{1}{2} \cdot L \cdot I_{AS}^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

Fig. 8.16 Test Circuit/Waveform

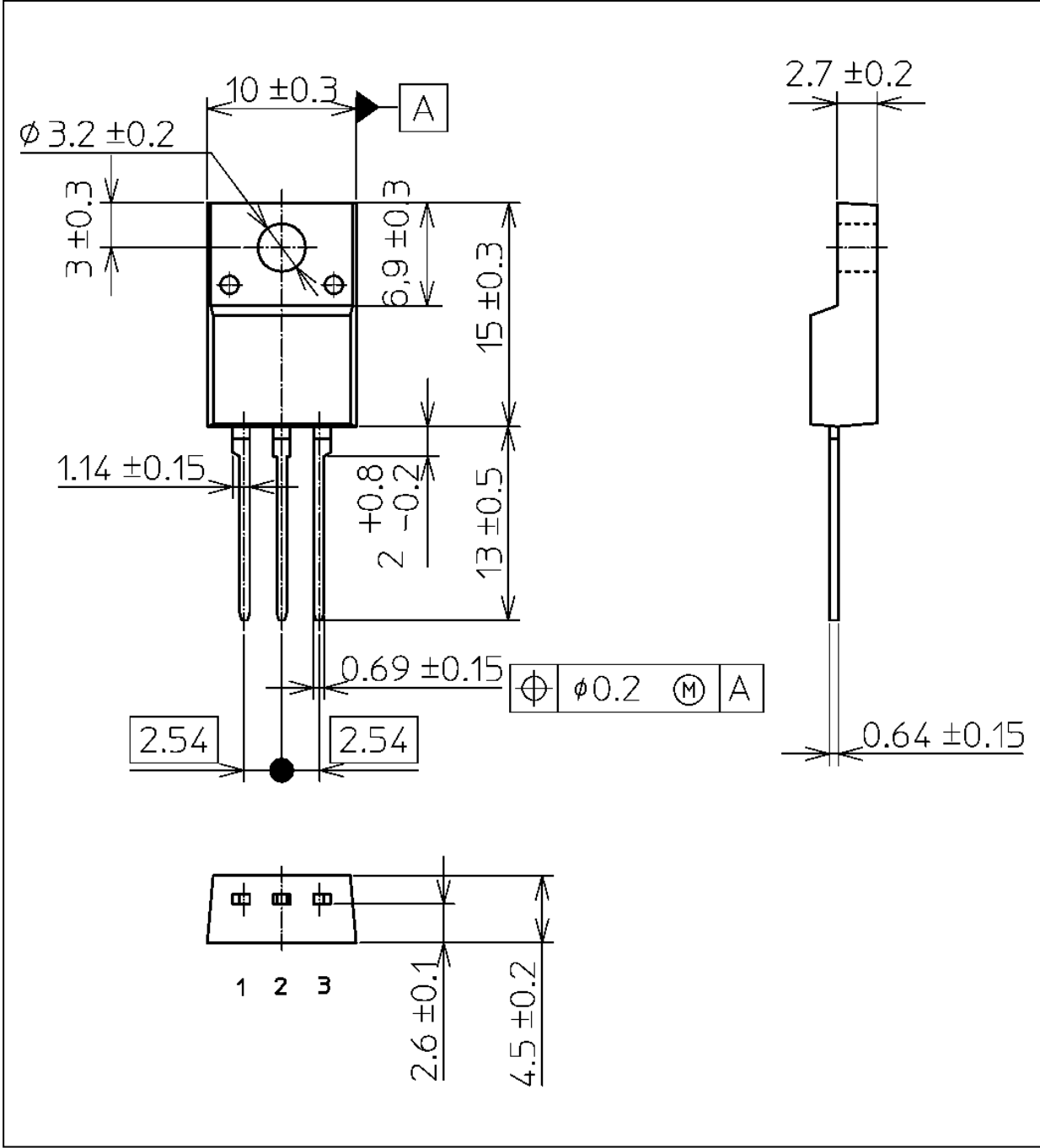


**Fig. 8.17 Safe Operating Area
(Guaranteed Maximum)**

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

Package Dimensions

Unit: mm



Weight: 1.7 g (typ.)

Package Name(s)
JEITA: SC-67
TOSHIBA: 2-10U1S
Nickname: TO-220SIS

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