MOSFETs Silicon N-channel MOS (U-MOSⅨ-H)

TK4R3A06PL

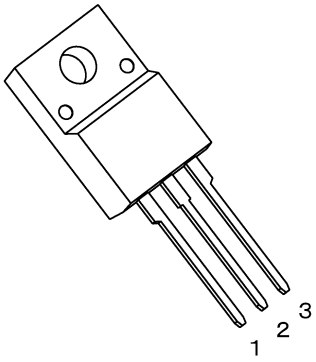
1. Applications

- High-Efficiency DC-DC Converters
- Switching Voltage Regulators
- Motor Drivers

2. Features

(1) High-speed switching
(2) Small gate charge: Q_{SW} = 15.1 nC (typ.)
(3) Small output charge: Q_{oss} = 39 nC (typ.)
(4) Low drain-source on-resistance: $R_{DS(ON)}$ = 3.3 mΩ (typ.) (V_{GS} = 10 V)
(5) Low leakage current: I_{DSS} = 10 μA (max) (V_{DS} = 60 V)
(6) Enhancement mode: V_{th} = 1.5 to 2.5 V (V_{DS} = 10 V, I_D = 0.5 mA)

3. Packaging and Internal Circuit



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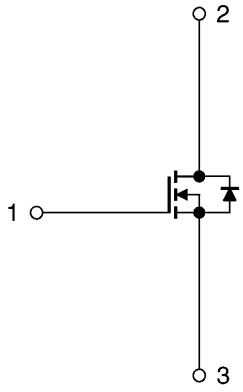

1: Gate
2: Drain
3: Source

Start of commercial production
2016-10

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

Characteristics			Symbol	Rating	Unit
Drain-source voltage			V_{DSS}	60	V
Gate-source voltage			V_{GSS}	±20	
Drain current (DC)	(T_c = 25 °C)	(Note 1)	I_D	68	A
Drain current (pulsed)	(t = 100 μs)	(Note 1)	I_{DP}	350	A
Power dissipation	(T_c = 25 °C)		P_D	36	W
Single-pulse avalanche energy		(Note 2)	E_{AS}	34	mJ
Single-pulse avalanche current		(Note 2)	I_{AS}	68	A
Channel temperature			T_{ch}	175	°C
Storage temperature			T_{stg}	-55 to 175	°C
Isolation voltage (RMS)	(t = 1.0 s)		$V_{ISO(RMS)}$	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).

5. Thermal Characteristics

Characteristics		Symbol	Max	Unit
Channel-to-case thermal resistance	(T_c = 25 °C)	$R_{th(ch-c)}$	4.16	°C/W
Channel-to-ambient thermal resistance	(T_a = 25 °C)	$R_{th(ch-a)}$	62.5	

Note 1: Ensure that the channel temperature does not exceed 175 °C.
Note 2: V_{DD} = 48 V, T_{ch} = 25 °C (initial), L = 5.7 μH, I_{AS} = 68 A

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

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6. Electrical Characteristics

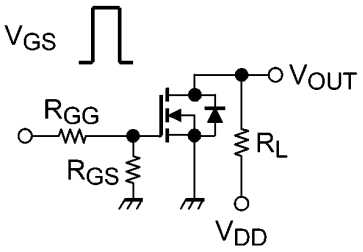
6.1. Static Characteristics (T_a = 25 °C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	V_{GS} = ±20 V, V_{DS} = 0 V	—	—	±0.1	μA
Drain cut-off current	I_{DSS}	V_{DS} = 60 V, V_{GS} = 0 V	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = 10 mA, V_{GS} = 0 V	60	—	—	V
Drain-source breakdown voltage (Note 3)	$V_{(BR)DSX}$	I_D = 10 mA, V_{GS} = -20 V	45	—	—	
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 0.5 mA	1.5	—	2.5	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = 4.5 V, I_D = 15 A	—	5.2	7.2	mΩ
		V_{GS} = 10 V, I_D = 34 A	—	3.3	4.3	

Note 3: If a reverse 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 °C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = 30 V, V_{GS} = 0 V, f = 1 MHz	—	3280	—	pF
Reverse transfer capacitance	C_{rss}		—	60	—	
Output capacitance	C_{oss}		—	600	—	
Gate resistance	r_g	—	—	1.7	—	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1	—	10	—	ns
Switching time (turn-on time)	t_{on}		—	24	—	
Switching time (fall time)	t_f		—	18	—	
Switching time (turn-off time)	t_{off}		—	55	—	



V_{DD} ≈ 30 V
V_{GS} = 0 V/ 10 V
I_D = 34 A
R_L = 0.88 Ω
R_{GG} = 4.7 Ω
R_{GS} = 4.7 Ω
Duty ≤ 1 %, t_w = 10 μs

Fig. 6.2.1 Switching Time Test Circuit

6.3. Gate Charge Characteristics (T_a = 25 °C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	V_{DD} ≈ 30 V, V_{GS} = 10 V, I_D = 34 A	—	48.2	—	nC
		V_{DD} ≈ 30 V, V_{GS} = 4.5 V, I_D = 34 A	—	23.9	—	
Gate-source charge 1	Q_{gs1}	V_{DD} ≈ 30 V, V_{GS} = 10 V, I_D = 34 A	—	13.1	—	
Gate-drain charge	Q_{gd}		—	8.6	—	
Gate switch charge	Q_{SW}		—	15.1	—	
Output charge	Q_{oss}	V_{DS} = 30 V, V_{GS} = 0 V, f = 1 MHz	—	39	—	

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6.4. Source-Drain Characteristics (T_a = 25 °C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (pulsed) (Note 4)	I_{DRP} (t = 100 μs)	—	—	—	350	A
Diode forward voltage	V_{DSF}	I_{DR} = 68 A, V_{GS} = 0 V	—	—	-1.5	V
Reverse recovery time	t_{rr}	I_{DR} = 17 A, V_{GS} = 0 V, $-dI_{DR}/dt$ = 100 A/μs	—	47	—	ns
Reverse recovery charge	Q_{rr}		—	57	—	nC

Note 4: Ensure that the channel temperature does not exceed 175 °C.

7. Marking (Note)

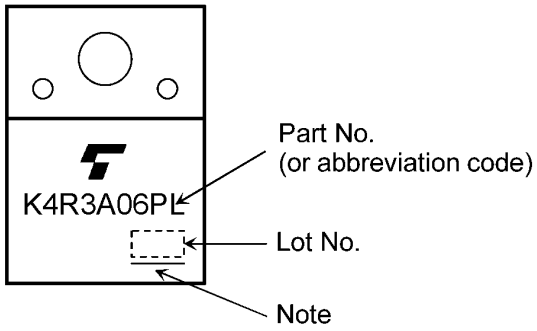

Fig. 7.1 Marking

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.

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8. Characteristics Curves (Note)

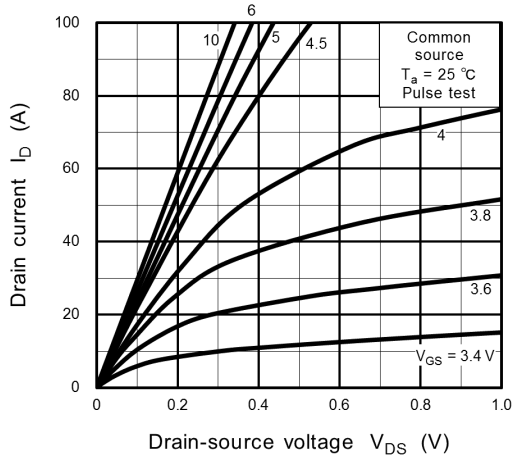

Fig. 8.1 I_D - V_{DS}

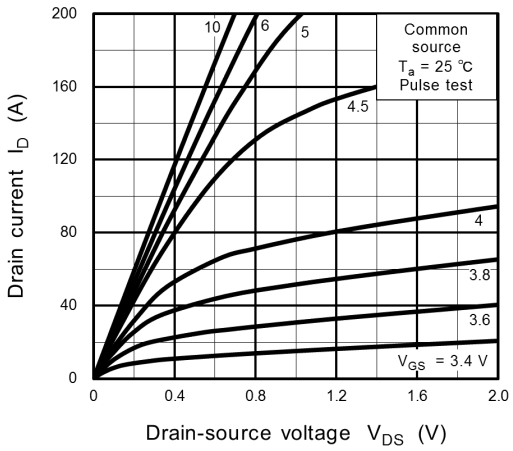

Fig. 8.2 I_D - V_{DS}

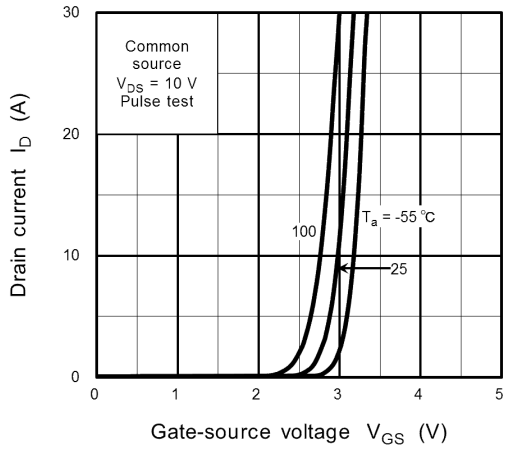

Fig. 8.3 I_D - V_{GS}

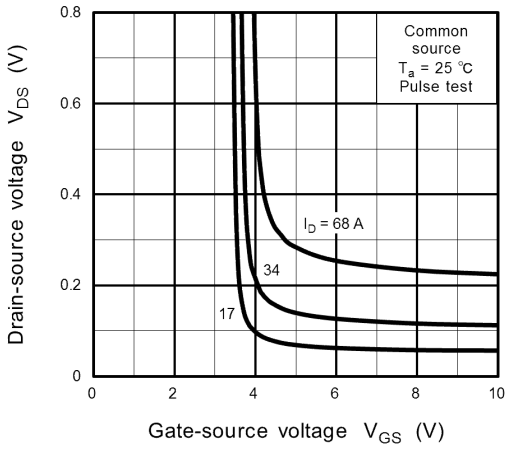

Fig. 8.4 V_{DS} - V_{GS}

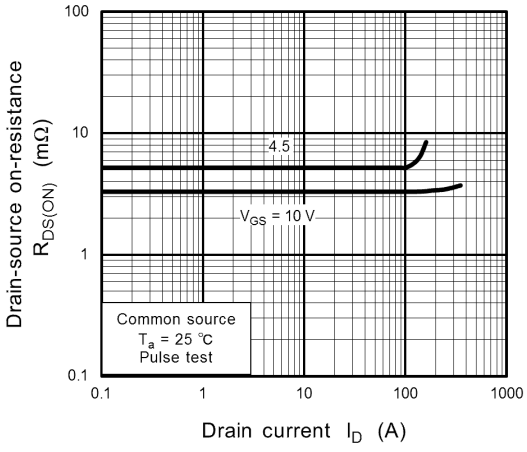

Fig. 8.5 $R_{DS(ON)}$ - I_D

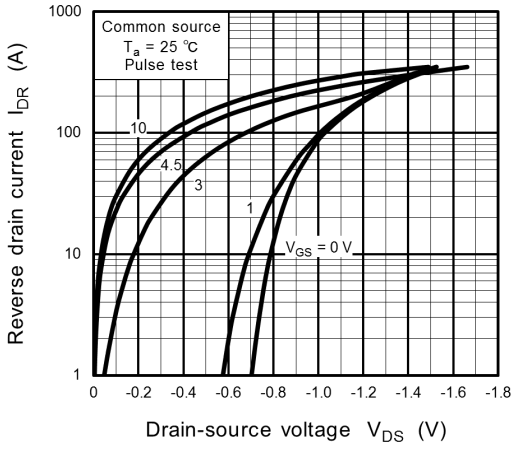

Fig. 8.6 I_{DR} - V_{DS}

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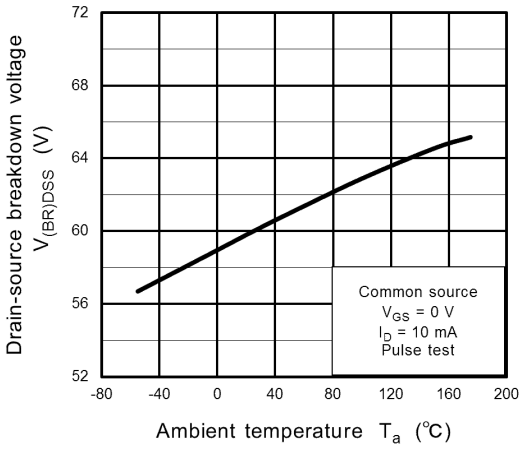

Fig. 8.7 $V_{(BR)DSS}$ - T_a

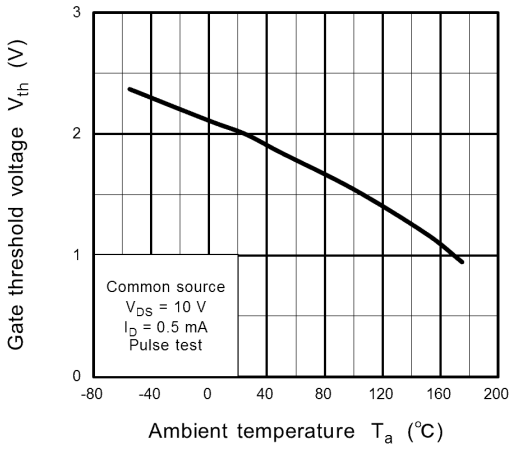

Fig. 8.8 V_{th} - T_a

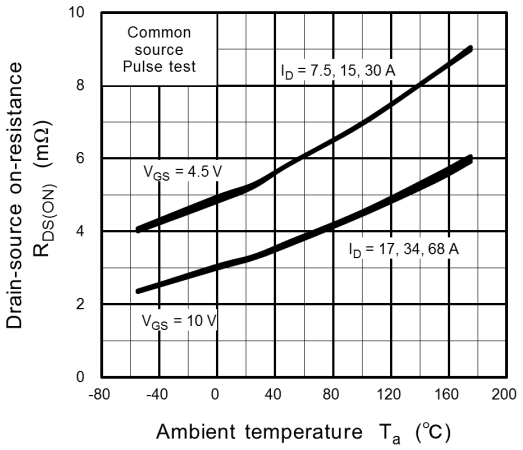

Fig. 8.9 $R_{DS(ON)}$ - T_a

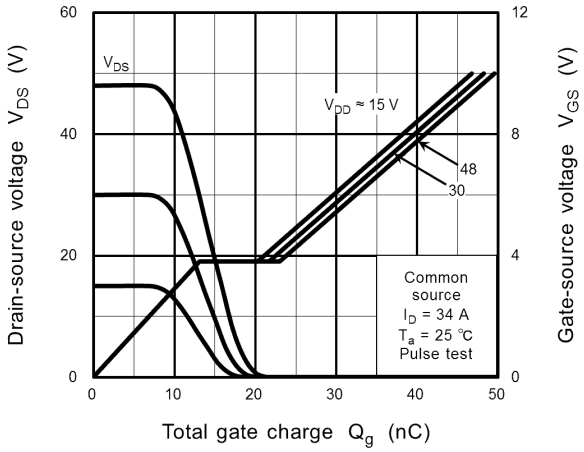

Fig. 8.10 Dynamic Input/Output Characteristics

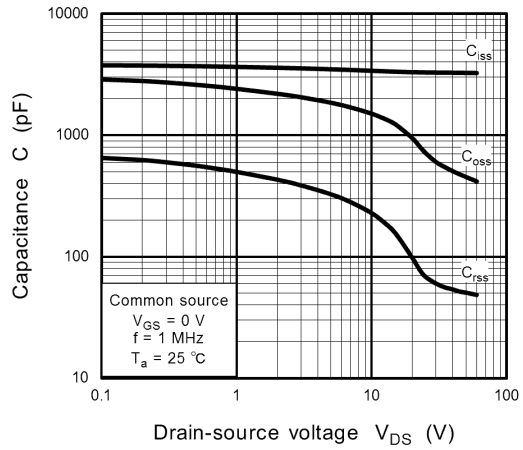

Fig. 8.11 Capacitance - V_{DS}

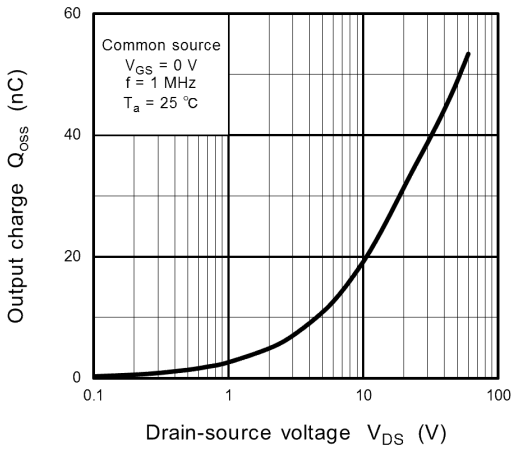

Fig. 8.12 Q_{oss} - V_{DS}

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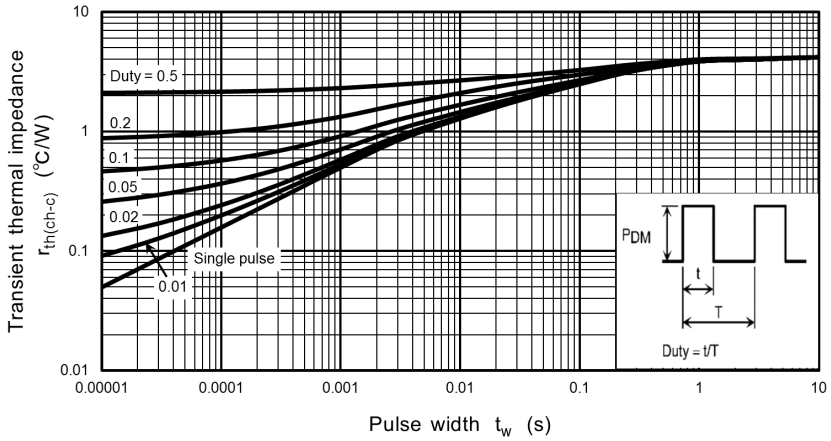


Fig. 8.13 r_{th} - t_w
(Guaranteed Maximum)

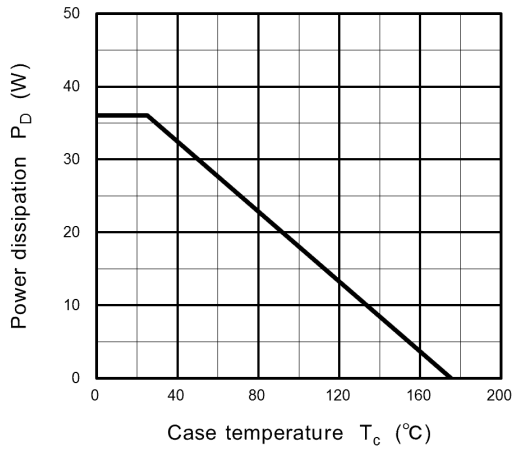


Fig. 8.14 P_D - T_c
(Guaranteed Maximum)

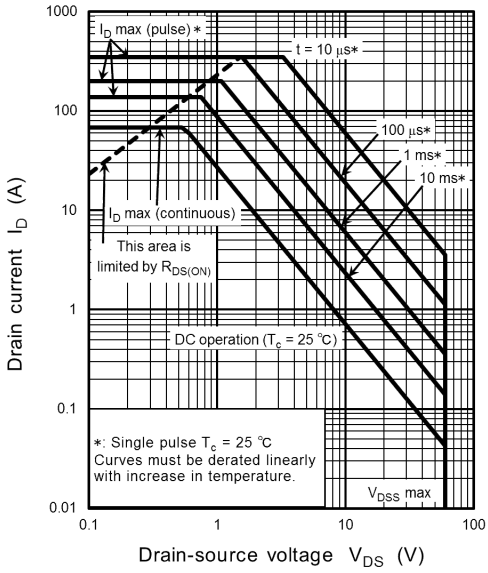
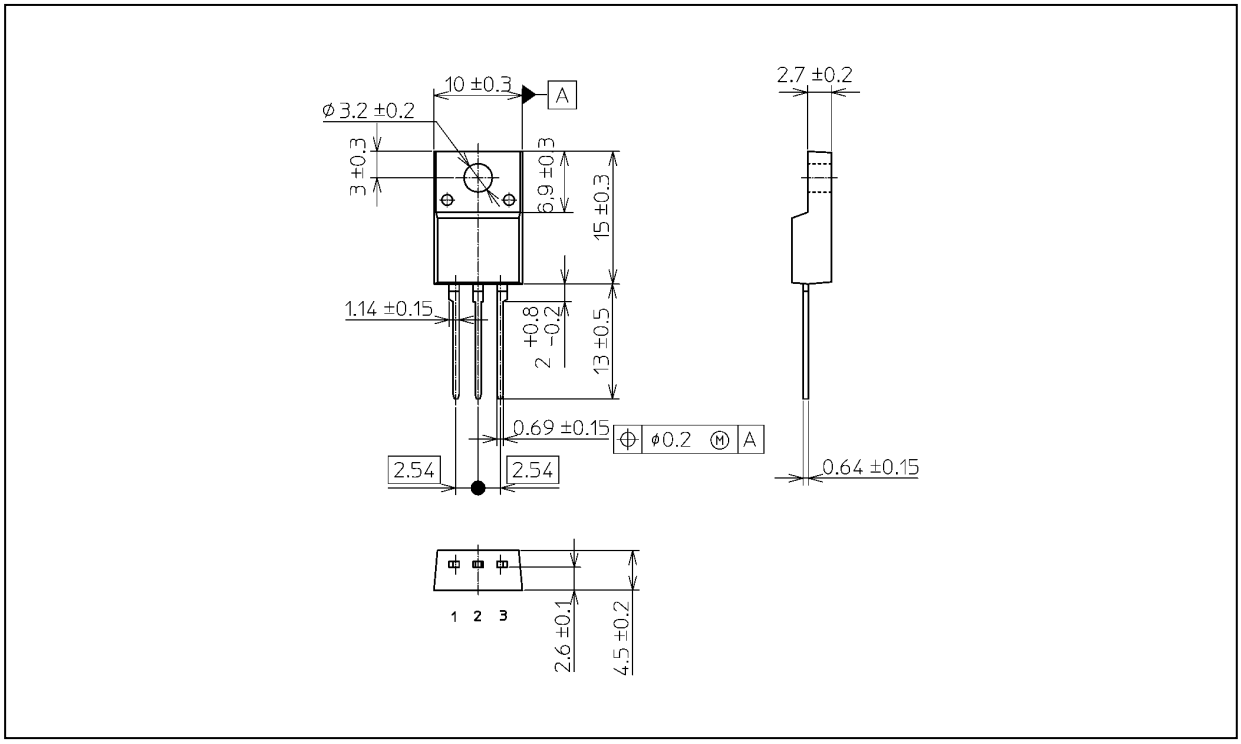


Fig. 8.15 Safe Operating Area
(Guaranteed Maximum)

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

Package Dimensions

Unit: mm



Weight: 1.56 g (typ.)

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

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