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

TK3R1A04PL

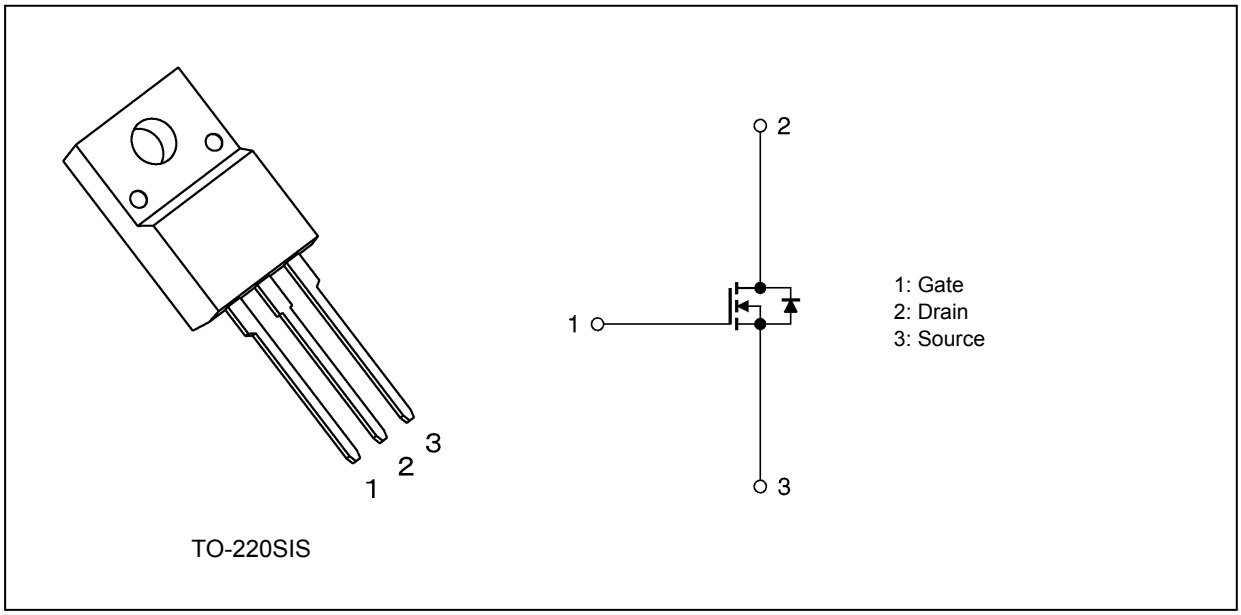
1. Applications

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

2. Features

(1) High-speed switching
(2) Small gate charge: Q_{SW} = 17.5 nC (typ.)
(3) Small output charge: Q_{oss} = 42 nC (typ.)
(4) Low drain-source on-resistance: $R_{DS(ON)}$ = 2.5 mΩ (typ.) (V_{GS} = 10 V)
(5) Low leakage current: I_{DSS} = 10 μA (max) (V_{DS} = 40 V)
(6) Enhancement mode: V_{th} = 1.4 to 2.4 V (V_{DS} = 10 V, I_D = 0.5 mA)

3. Packaging and Internal Circuit



TO-220SIS

Start of commercial production
2016-07

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

Characteristics			Symbol	Rating	Unit
Drain-source voltage			V_{DSS}	40	V
Gate-source voltage			V_{GSS}	±20	
Drain current (DC)	(T_c = 25 °C)	(Note 1)	I_D	82	A
Drain current (pulsed)	(t = 100 μs)	(Note 1)	I_{DP}	400	A
Power dissipation	(T_c = 25 °C)		P_D	36	W
Single-pulse avalanche energy		(Note 2)	E_{AS}	43	mJ
Single-pulse avalanche current		(Note 2)	I_{AS}	82	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} = 32 V, T_{ch} = 25 °C (initial), L = 4.9 μH, I_{AS} = 82 A

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

6. Electrical Characteristics

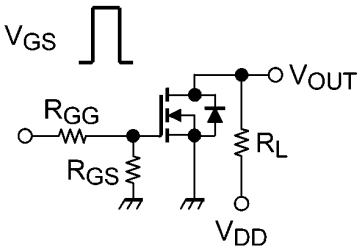
6.1. Static Characteristics (T_a = 25 °C unless otherwise specified)

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} = 40 V, V_{GS} = 0 V	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = 10 mA, V_{GS} = 0 V	40	—	—	V
Drain-source breakdown voltage (Note 3)	$V_{(BR)DSX}$	I_D = 10 mA, V_{GS} = -20 V	25	—	—	
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 0.5 mA	1.4	—	2.4	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = 4.5 V, I_D = 30 A	—	3.0	3.8	mΩ
		V_{GS} = 10 V, I_D = 41 A	—	2.5	3.1	

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} = 20 V, V_{GS} = 0 V, f = 1 MHz	—	4670	—	pF
Reverse transfer capacitance	C_{rss}		—	70	—	
Output capacitance	C_{oss}		—	1000	—	
Gate resistance	r_g	—	—	2.2	—	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1	—	12	—	ns
Switching time (turn-on time)	t_{on}		—	28	—	
Switching time (fall time)	t_f		—	27	—	
Switching time (turn-off time)	t_{off}		—	83	—	



V_{DD} ≈ 20 V
V_{GS} = 0 V/ 10 V
I_D = 41 A
R_L = 0.49 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} ≈ 20 V, V_{GS} = 10 V, I_D = 41 A	—	63.4	—	nC
		V_{DD} ≈ 20 V, V_{GS} = 4.5 V, I_D = 41 A	—	29.7	—	
Gate-source charge 1	Q_{gs1}	V_{DD} ≈ 20 V, V_{GS} = 10 V, I_D = 41 A	—	16.8	—	
Gate-drain charge	Q_{gd}		—	8.9	—	
Gate switch charge	Q_{SW}		—	17.5	—	
Output charge	Q_{oss}	V_{DS} = 20 V, V_{GS} = 0 V, f = 1 MHz	—	42	—	

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)	—	—	—	400	A
Diode forward voltage	V_{DSF}	I_{DR} = 82 A, V_{GS} = 0 V	—	—	-1.5	V
Reverse recovery time	t_{rr}	I_{DR} = 21 A, V_{GS} = 0 V, $-dI_{DR}/dt$ = 100 A/μs	—	50	—	ns
Reverse recovery charge	Q_{rr}		—	50	—	nC

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

7. Marking (Note)

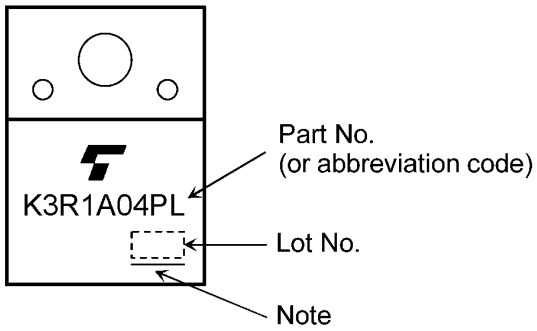


Fig. 7.1 Marking

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.

8. Characteristics Curves (Note)

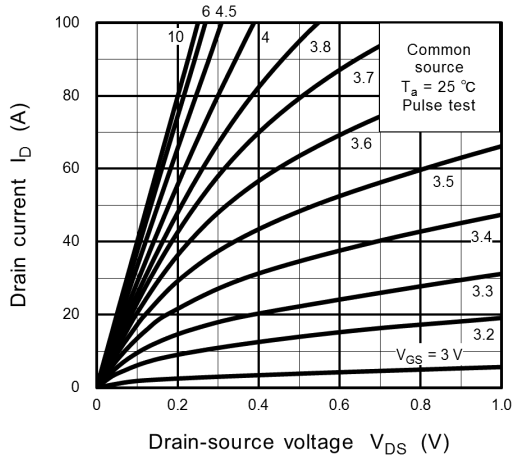


Fig. 8.1 I_D - V_{DS}

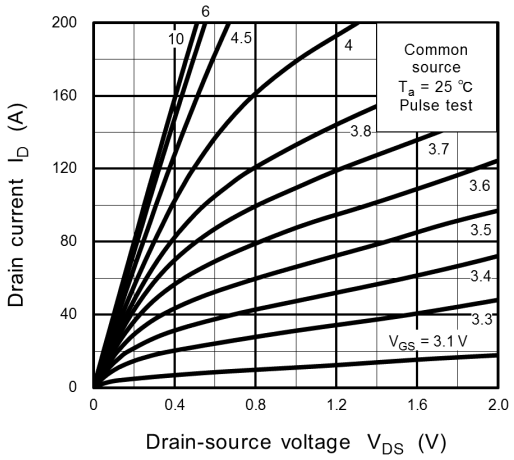


Fig. 8.2 I_D - V_{DS}

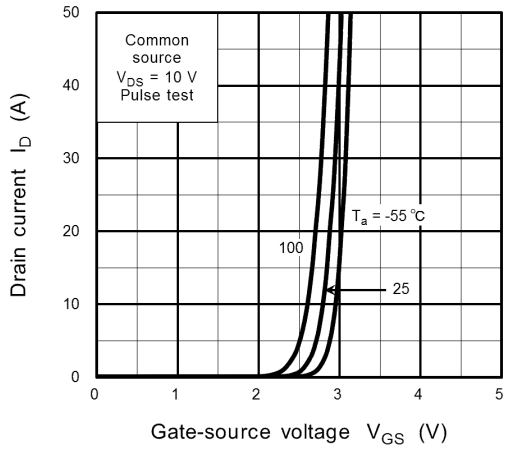


Fig. 8.3 I_D - V_{GS}

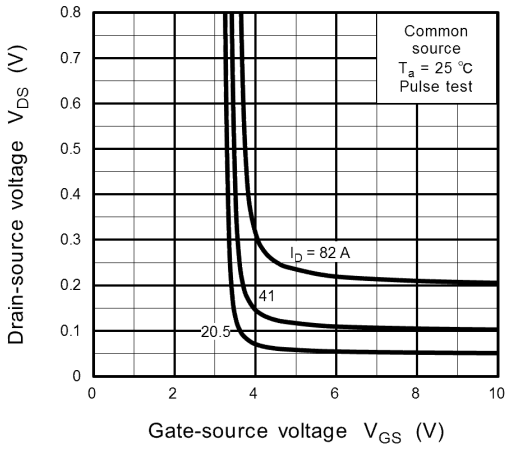


Fig. 8.4 V_{DS} - V_{GS}

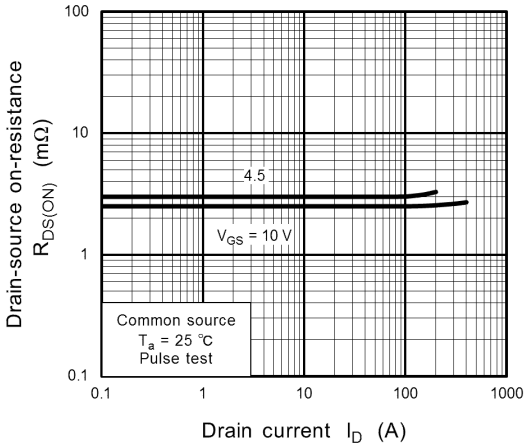


Fig. 8.5 $R_{DS(ON)}$ - I_D

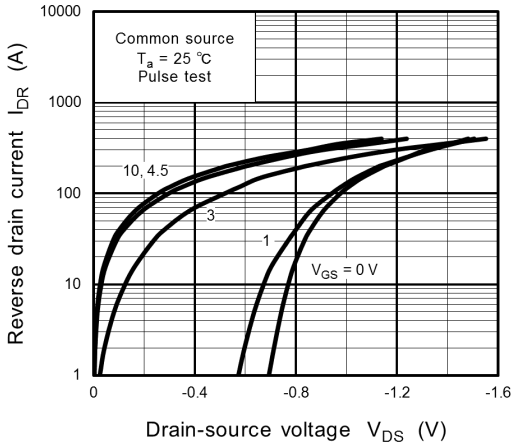


Fig. 8.6 I_{DR} - V_{DS}

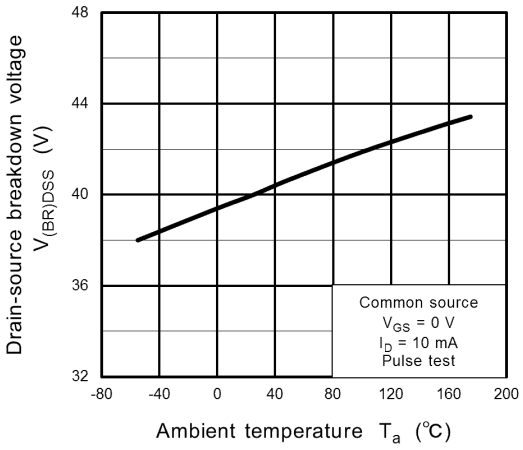


Fig. 8.7 $V_{(BR)DSS}$ - T_a

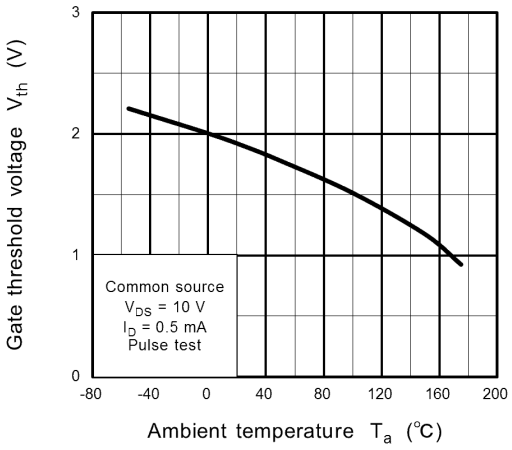


Fig. 8.8 V_{th} - T_a

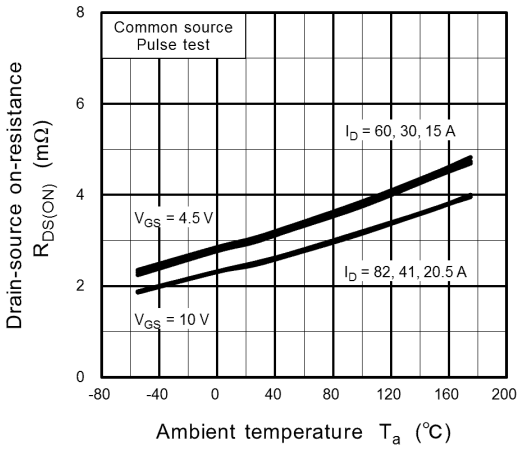


Fig. 8.9 $R_{DS(ON)}$ - T_a

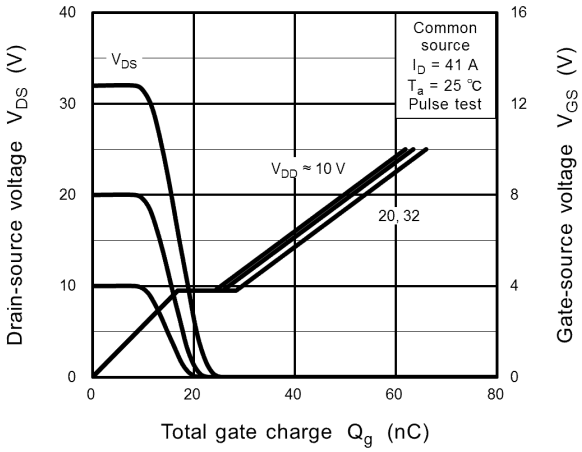


Fig. 8.10 Dynamic Input/Output Characteristics

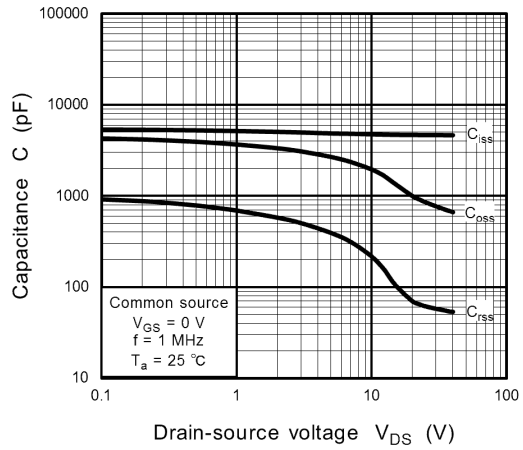


Fig. 8.11 Capacitance - V_{DS}

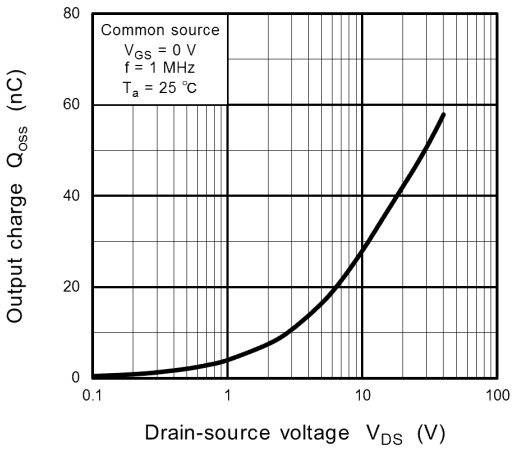


Fig. 8.12 Q_{oss} - V_{DS}

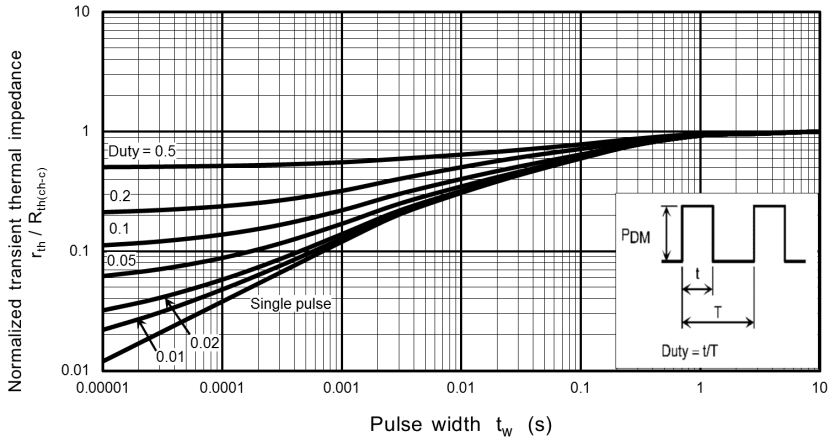


Fig. 8.13 $r_{th}/R_{th(ch-c)}$ - t_w (Guaranteed Maximum)

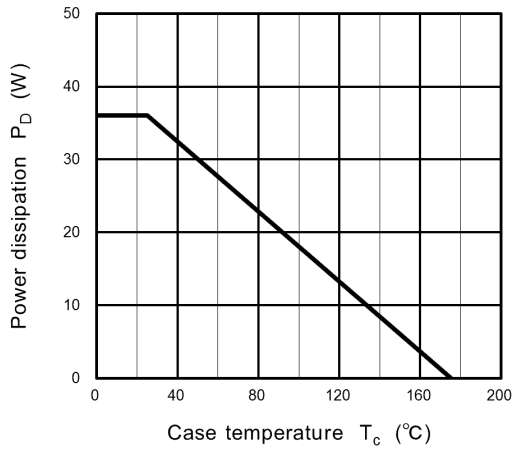


Fig. 8.14 P_D - T_c (Guaranteed Maximum)

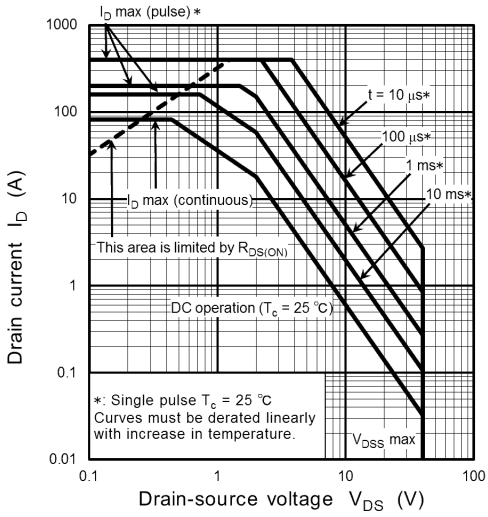
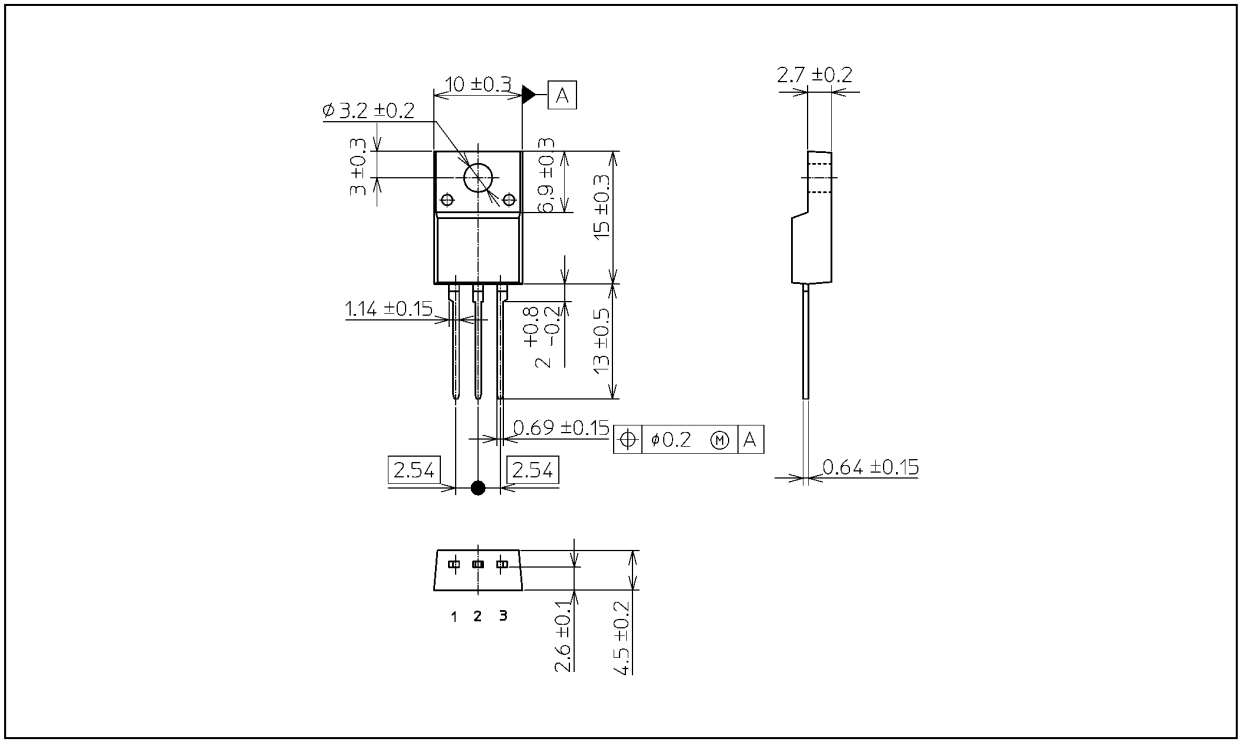


Fig. 8.15 Safe Operating Area (Guaranteed Maximum)

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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