MOSFETs Silicon N-Channel MOS (π-MOSIX)

TK1K9A60F

1. Applications

- Switching Power Supplies

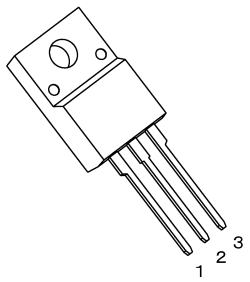
2. Features

(1) Easy to control Gate switching

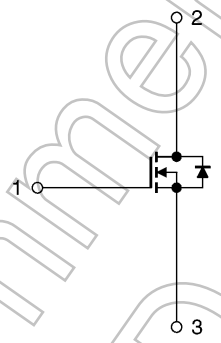
(2) Low drain-source on-resistance: $R_{DS(ON)}$ = 1.6 Ω (typ.)

(3) Enhancement mode: V_{th} = 2 to 4 V (V_{DS} = 10 V, I_D = 0.4 mA)

3. Packaging and Internal Circuit



TO-220SIS



1: Gate
2: Drain
3: Source

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)	(Note 1)	I_D	3.7	A
Drain current (pulsed)	(Note 1)	I_{DP}	14.8	
Power dissipation	(T_c = 25 °C)	P_D	30	W
Single-pulse avalanche energy	(Note 2)	E_{AS}	101	mJ
Single-pulse avalanche current		I_{AS}	3.7	A
Reverse drain current (DC)	(Note 1)	I_{DR}	3.7	
Reverse drain current (pulsed)	(Note 1)	I_{DRP}	14.8	
Channel temperature		T_{ch}	150	°C
Storage temperature		T_{stg}	-55 to 150	
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).

Start of commercial production
2017-12

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5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance	$R_{th(ch-c)}$	4.16	°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 V, T_{ch} = 25 °C (initial), L = 12.9 mH, I_{AS} = 3.7 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} = ±30 V, V_{DS} = 0 V	—	—	±1	μA
Drain cut-off current	I_{DSS}	V_{DS} = 600 V, V_{GS} = 0 V	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = 10 mA, V_{GS} = 0 V	600	—	—	V
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 0.4 mA	2	—	4	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = 10 V, I_D = 1.9 A	—	1.6	1.9	Ω

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} = 300 V, V_{GS} = 0 V, f = 100 kHz	—	490	—	pF
Reverse transfer capacitance	C_{rss}		—	5.2	—	
Output capacitance	C_{oss}		—	20	—	
Gate resistance	r_g	V_{DS} = OPEN , f = 1 MHz	—	7	—	Ω
Switching time (rise time)	t_r	See Figure 6.2.1	—	15	—	ns
Switching time (turn-on time)	t_{on}		—	32	—	
Switching time (fall time)	t_f		—	15	—	
Switching time (turn-off time)	t_{off}		—	50	—	
MOSFET dv/dt ruggedness	dv/dt	$V_{DS} \leq V_{(BR)DSS}$, $I_D \leq$ 1.9 A	12	—	—	V/ns

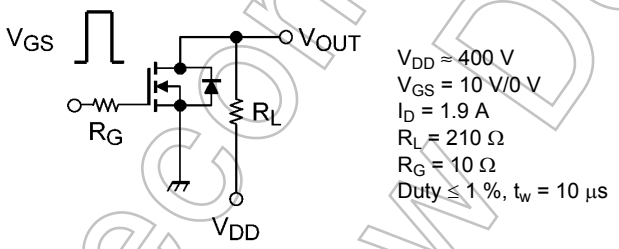

Fig. 6.2.1 Switching Time Test Circuit

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} ≈ 400 V, V_{GS} = 10 V, I_D = 3.7 A	—	14	—	nC
Gate-source charge 1	Q_{gs1}		—	3	—	
Gate-drain charge	Q_{gd}		—	5.9	—	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Diode forward voltage	V_{DSF}	I_{DR} = 3.7 A, V_{GS} = 0 V	—	—	-1.7	V
Reverse recovery time	t_{rr}	V_{DD} ≈ 400 V, I_{DR} = 3.7 A, V_{GS} = 0 V, $-dI_{DR}/dt$ = 100 A/μs	—	600	—	ns
Reverse recovery charge	Q_{rr}		—	3.0	—	μC
Peak reverse recovery current	I_{rr}		—	10	—	A
Diode dv/dt ruggedness	dv/dt	$V_{DD} \leq$ 400 V, $I_{DR} \leq$ 3.7 A, V_{GS} = 0 V	5	—	—	V/ns

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7. Marking (Note)

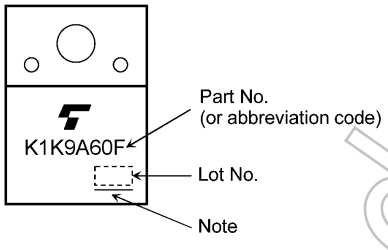

Fig. 7.1 Marking

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)

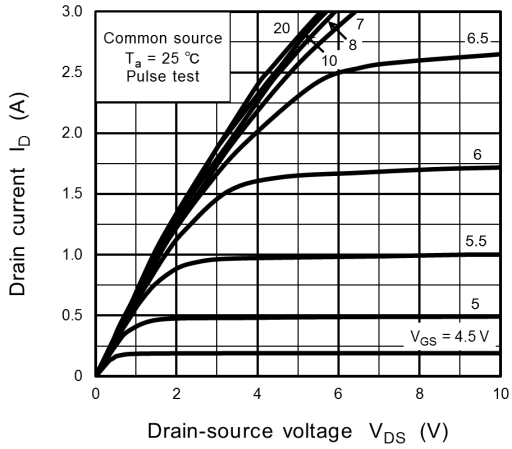

Fig. 8.1 I_D - V_{DS}

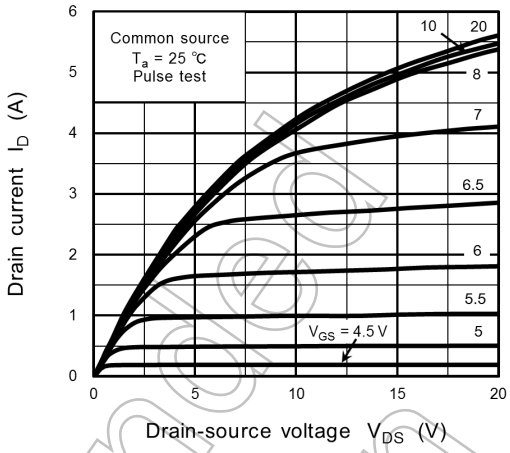

Fig. 8.2 I_D - V_{DS}

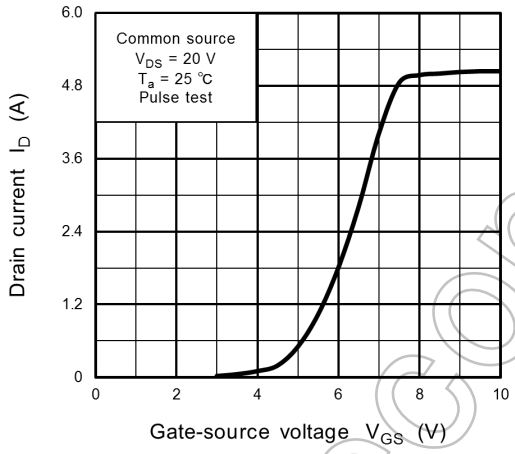

Fig. 8.3 I_D - V_{GS}

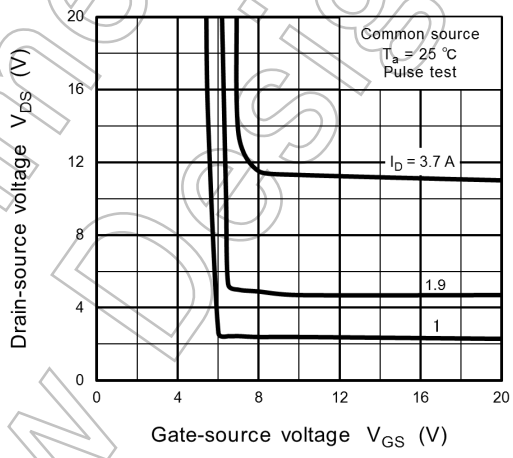

Fig. 8.4 V_{DS} - V_{GS}

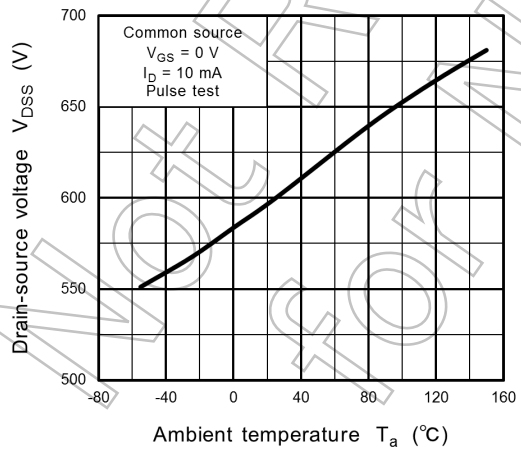

Fig. 8.5 V_{DSS} - T_a

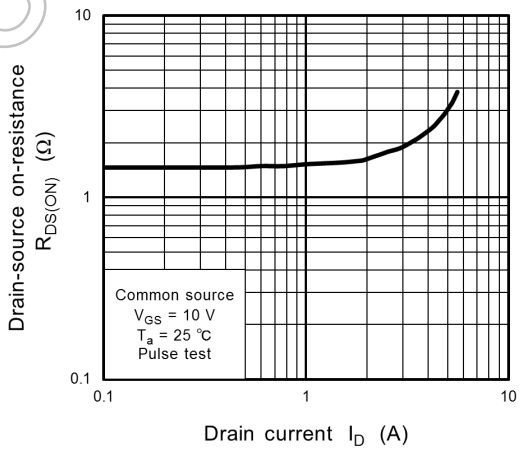

Fig. 8.6 $R_{DS(ON)}$ - I_D

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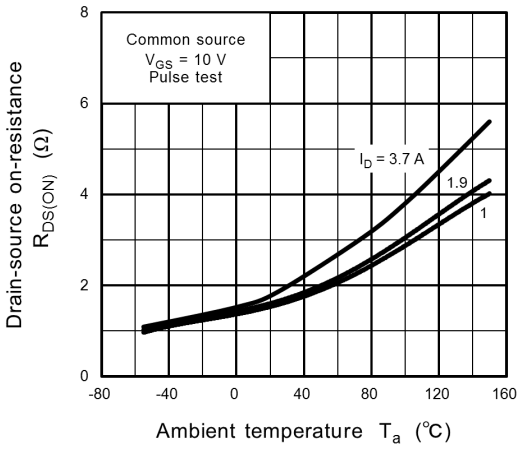

Fig. 8.7 $R_{DS(ON)}$ - T_a

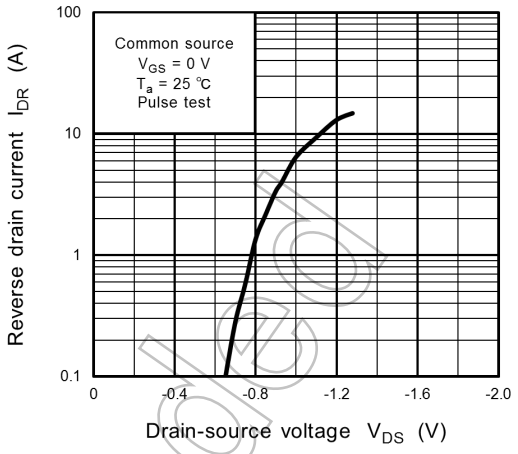

Fig. 8.8 I_{DR} - V_{DS}

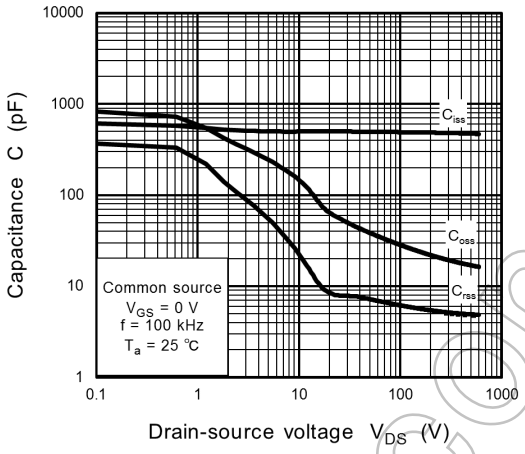

Fig. 8.9 C - V_{DS}

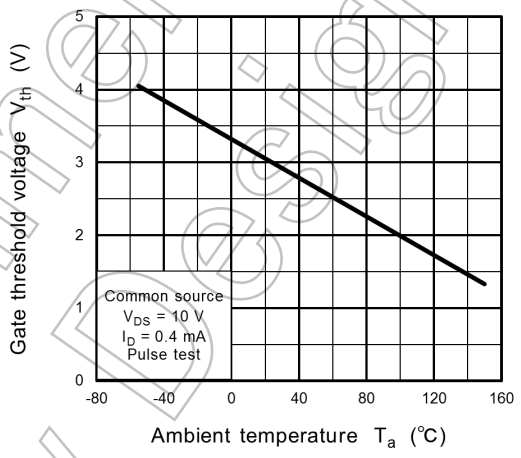

Fig. 8.10 V_{th} - T_a

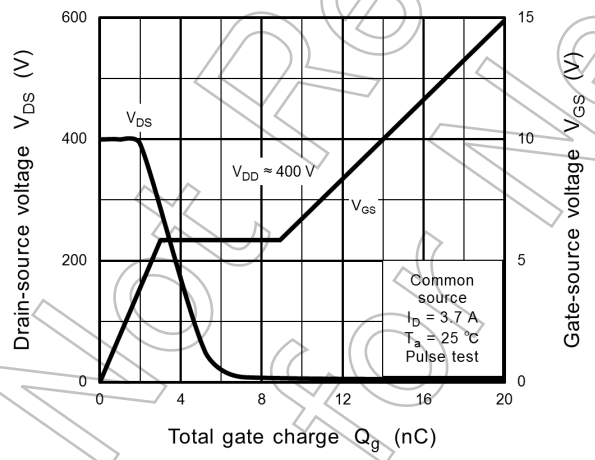

Fig. 8.11 Dynamic Input/Output Characteristics

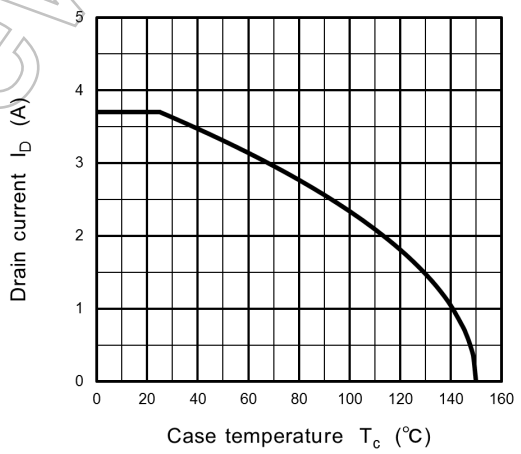

Fig. 8.12 I_D - T_c (Guaranteed Maximum)

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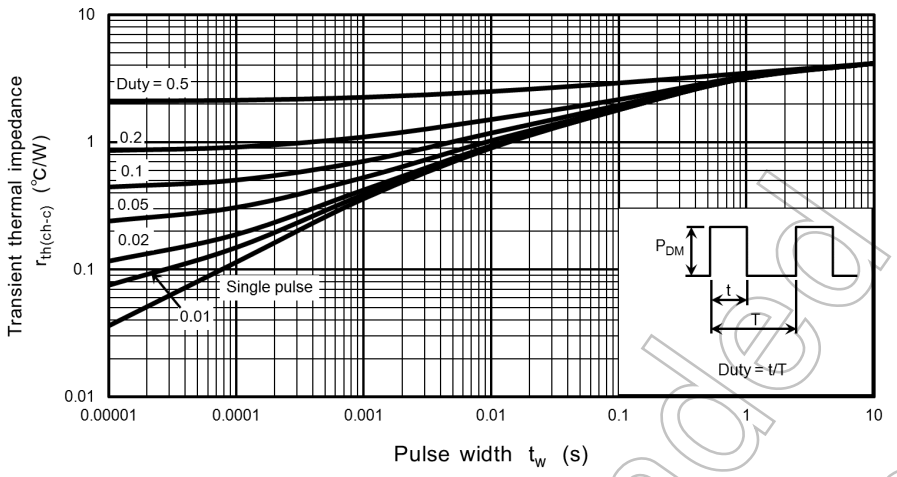


Fig. 8.13 r_{th} - t_w (Guaranteed Maximum)

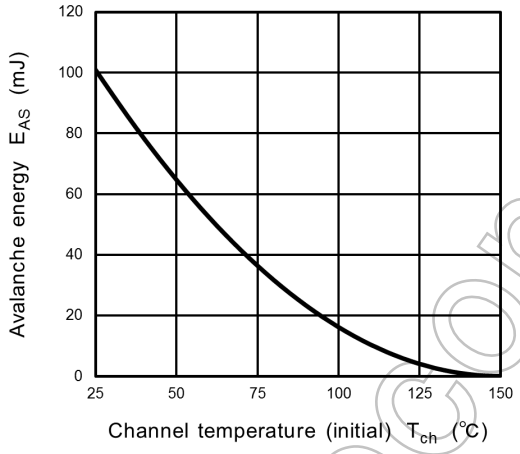


Fig. 8.14 E_{AS} - T_{ch} (Guaranteed Maximum)

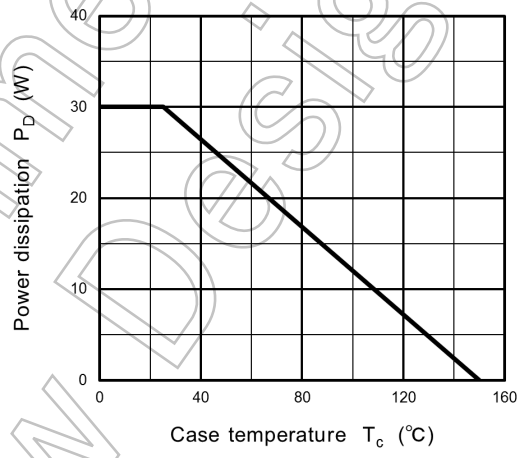
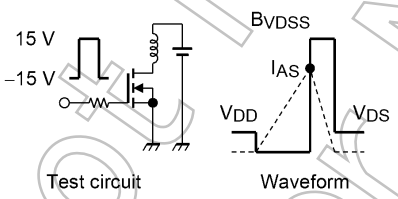


Fig. 8.15 P_D - T_c (Guaranteed Maximum)



V_{DD} = 90 V, L = 12.9 mH

$$E_{AS} = \frac{1}{2} \cdot L \cdot I_{AS}^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

Fig. 8.16 Test Circuit/Waveform

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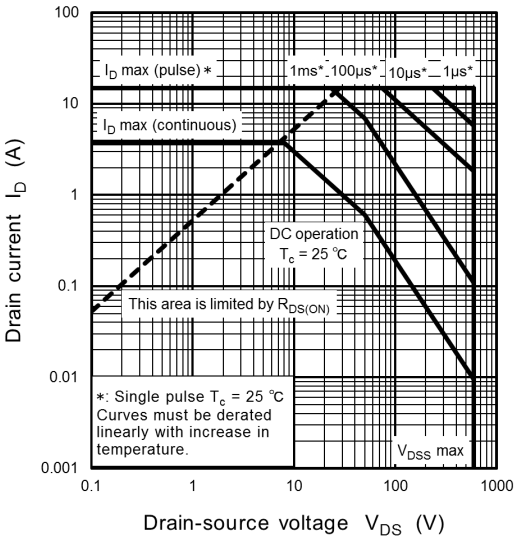

Fig. 8.17 Safe Operating Area (Guaranteed Maximum)

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

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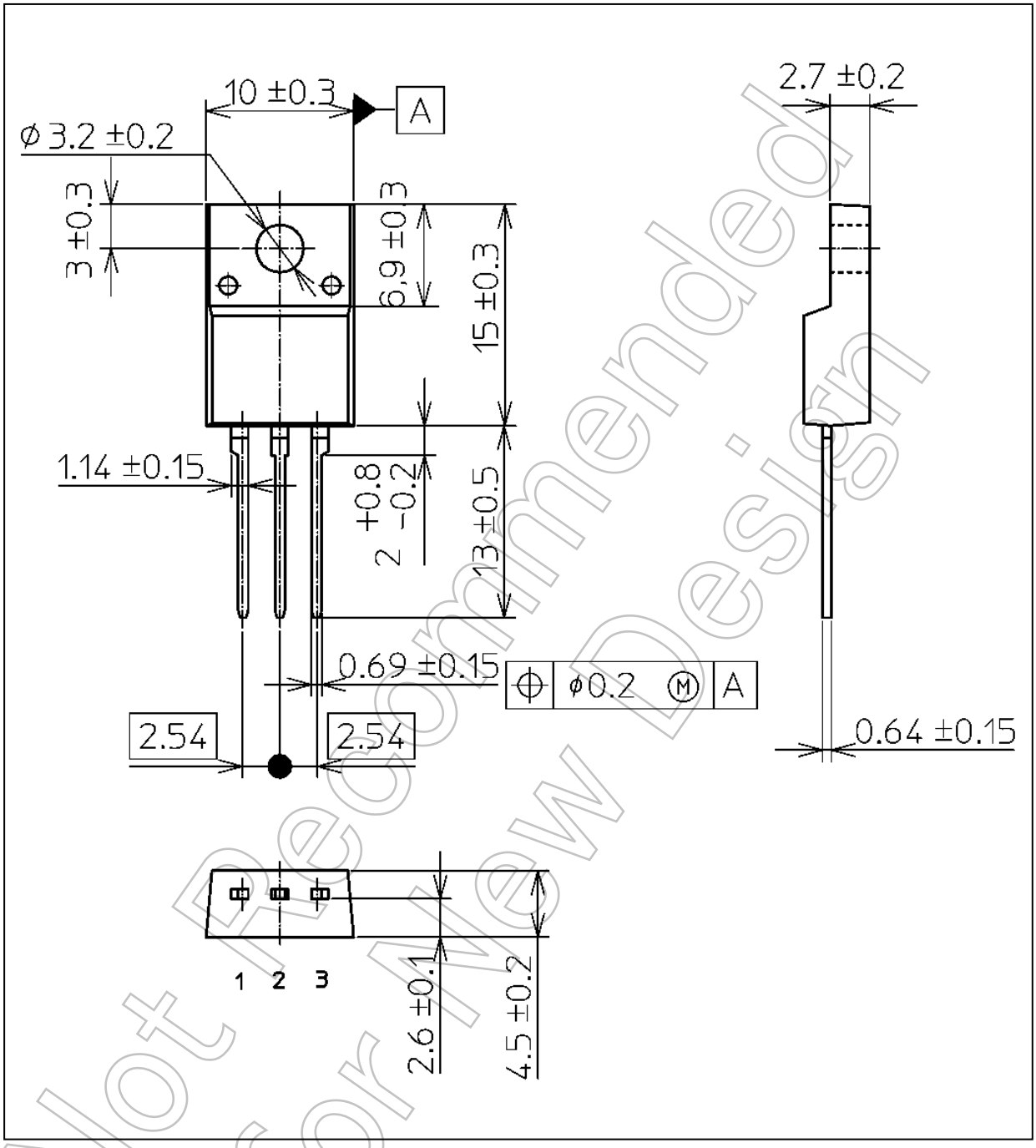
Package Dimensions

Unit: mm



Weight: 1.7 g (typ.)

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

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