

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

# TK5R3A06PL

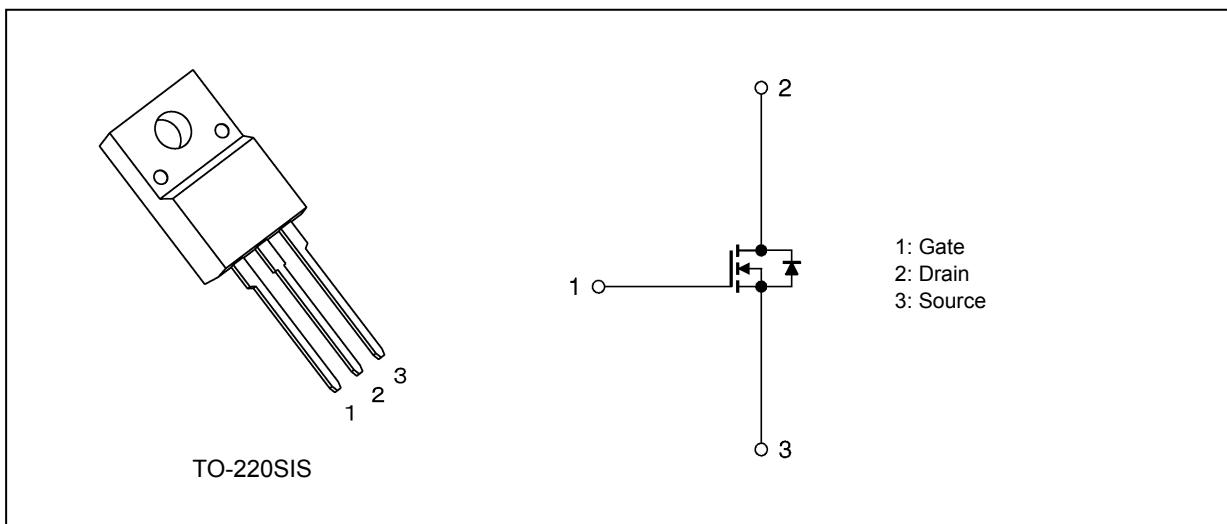
## 1. Applications

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

## 2. Features

- (1) High-speed switching
- (2) Small gate charge:  $Q_{SW} = 11 \text{ nC}$  (typ.)
- (3) Small output charge:  $Q_{oss} = 32 \text{ nC}$  (typ.)
- (4) Low drain-source on-resistance:  $R_{DS(ON)} = 4.1 \text{ m}\Omega$  (typ.) ( $V_{GS} = 10 \text{ V}$ )
- (5) Low leakage current:  $I_{DSS} = 10 \mu\text{A}$  (max) ( $V_{DS} = 60 \text{ V}$ )
- (6) Enhancement mode:  $V_{th} = 1.5$  to  $2.5 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 0.3 \text{ mA}$ )

## 3. Packaging and Internal Circuit



Start of commercial production  
2017-06

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	60	V
Gate-source voltage	$V_{GSS}$	$\pm 20$	
Drain current (DC) ( $T_c = 25^\circ\text{C}$ ) (Note 1)	$I_D$	56	A
Drain current (DC) (Silicon limit) (Note 1), (Note 2)	$I_D$	62	A
Drain current (pulsed) ( $t = 100\ \mu\text{s}$ ) (Note 1)	$I_{DP}$	280	A
Power dissipation ( $T_c = 25^\circ\text{C}$ )	$P_D$	36	W
Single-pulse avalanche energy (Note 3)	$E_{AS}$	29	mJ
Single-pulse avalanche current (Note 3)	$I_{AS}$	56	A
Channel temperature	$T_{ch}$	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 175	$^\circ\text{C}$
Isolation voltage (RMS) ( $t = 1.0\ \text{s}$ )	$V_{ISO(\text{RMS})}$	2000	V
Mounting torque	TOR	0.6	$\text{N} \cdot \text{m}$

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 ( $T_c = 25^\circ\text{C}$ )	$R_{th(ch-c)}$	4.16	$^\circ\text{C}/\text{W}$
Channel-to-ambient thermal resistance ( $T_a = 25^\circ\text{C}$ )	$R_{th(ch-a)}$	62.5	

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

Note 2: Limited by silicon chip capability.

Note 3:  $V_{DD} = 48\ \text{V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 7.3\ \mu\text{H}$ ,  $I_{AS} = 56\ \text{A}$

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

## 6. Electrical Characteristics

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$ , $V_{DS} = 0\text{ V}$	—	—	$\pm 0.1$	$\mu\text{A}$
Drain cut-off current	$I_{DSS}$	$V_{DS} = 60\text{ V}$ , $V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}$ , $V_{GS} = 0\text{ V}$	60	—	—	
Drain-source breakdown voltage (Note 4)	$V_{(BR)DSX}$	$I_D = 10\text{ mA}$ , $V_{GS} = -20\text{ V}$	45	—	—	
Gate threshold voltage	$V_{th}$	$V_{DS} = 10\text{ V}$ , $I_D = 0.3\text{ mA}$	1.5	—	2.5	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 4.5\text{ V}$ , $I_D = 14\text{ A}$	—	6.2	9.3	
		$V_{GS} = 10\text{ V}$ , $I_D = 28\text{ A}$	—	4.1	5.3	$\text{m}\Omega$

Note 4: 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 ( $T_a = 25^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	$C_{iss}$	$V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	—	2380	—	$\text{pF}$
Reverse transfer capacitance	$C_{rss}$		—	50	—	
Output capacitance	$C_{oss}$		—	470	—	
Gate resistance	$r_g$	See Fig. 6.2.1	—	1.4	—	$\Omega$
Switching time (rise time)	$t_r$		—	6	—	$\text{ns}$
Switching time (turn-on time)	$t_{on}$		—	19	—	
Switching time (fall time)	$t_f$		—	7	—	
Switching time (turn-off time)	$t_{off}$		—	35	—	

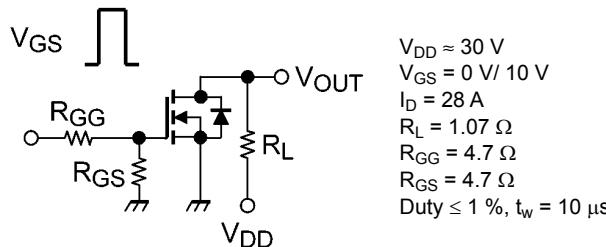


Fig. 6.2.1 Switching Time Test Circuit

### 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)	$Q_g$	$V_{DD} \approx 30\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 28\text{ A}$	—	36	—	$\text{nC}$
		$V_{DD} \approx 30\text{ V}$ , $V_{GS} = 4.5\text{ V}$ , $I_D = 28\text{ A}$	—	18	—	
Gate-source charge 1	$Q_{gs1}$	$V_{DD} \approx 30\text{ V}$ , $V_{GS} = 10\text{ V}$ , $I_D = 28\text{ A}$	—	9.0	—	
Gate-drain charge	$Q_{gd}$		—	6.5	—	
Gate switch charge	$Q_{SW}$		—	11	—	
Output charge	$Q_{oss}$	$V_{DS} = 30\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$	—	32	—	

#### 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 (pulsed) (Note 5)	$I_{DRP}$ ( $t = 100 \mu\text{s}$ )	—	—	—	280	A
Diode forward voltage	$V_{DSF}$	$I_{DR} = 56 \text{ A}, V_{GS} = 0 \text{ V}$	—	—	-1.5	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 14 \text{ A}, V_{GS} = 0 \text{ V},$ $-dI_{DR}/dt = 100 \text{ A}/\mu\text{s}$	—	40	—	ns
Reverse recovery charge	$Q_{rr}$		—	38	—	nC

Note 5: Ensure that the channel temperature does not exceed 175 °C.

#### 7. Marking (Note)

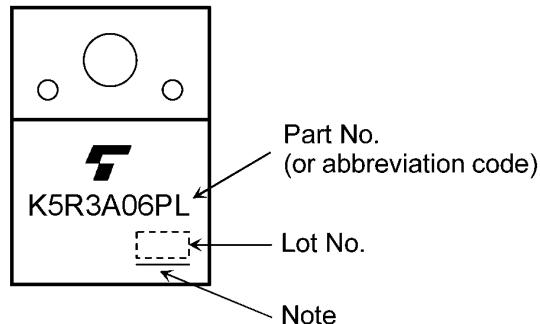


Fig. 7.1 Marking

Note: A line under a Lot No. identifies the indication of product Labels.

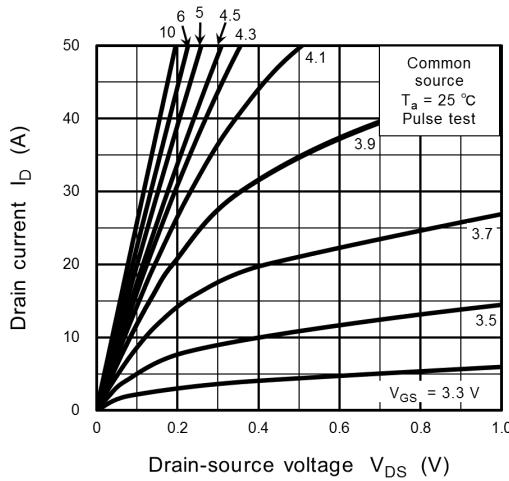
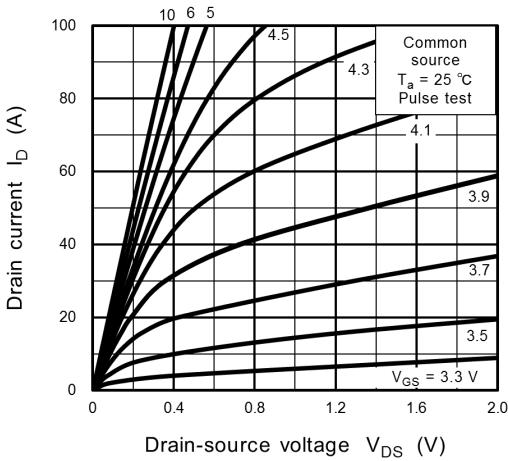
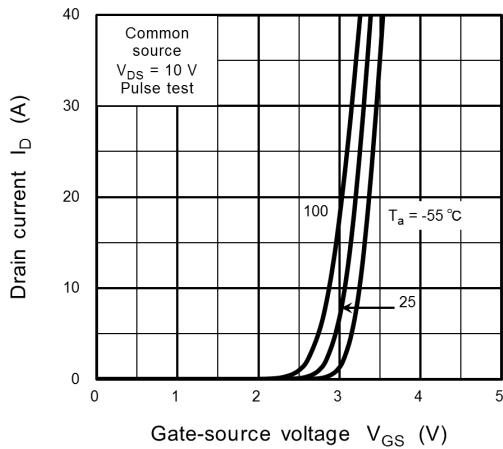
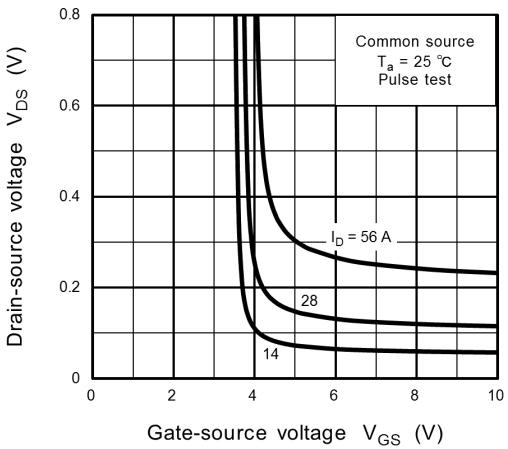
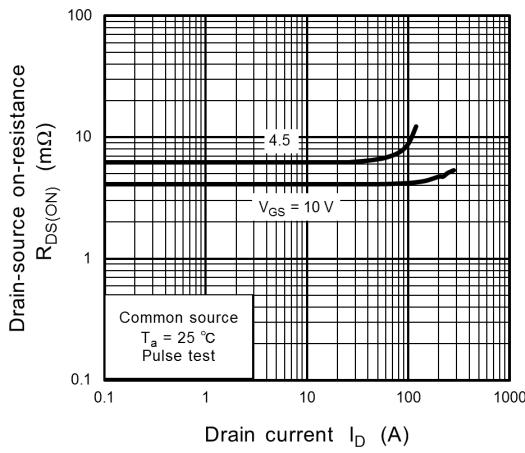
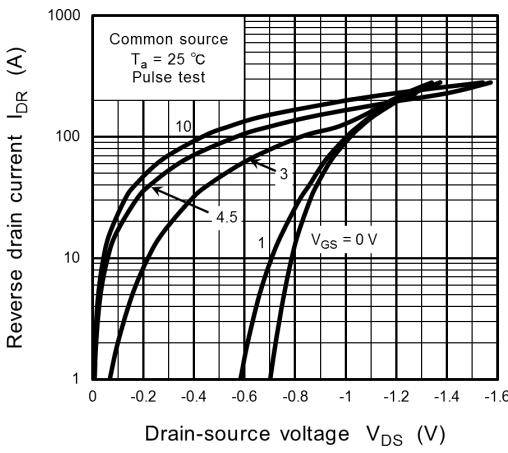
Not underlined: [[Pb]]/INCLUDES > MCV

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  $I_{DR}$  -  $V_{DS}$

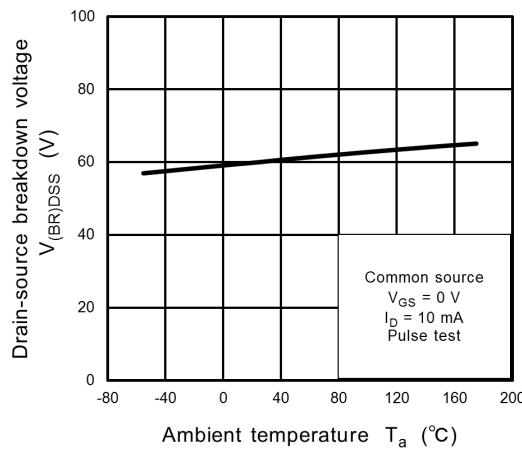


Fig. 8.7  $V_{(BR)DSS}$  -  $T_a$

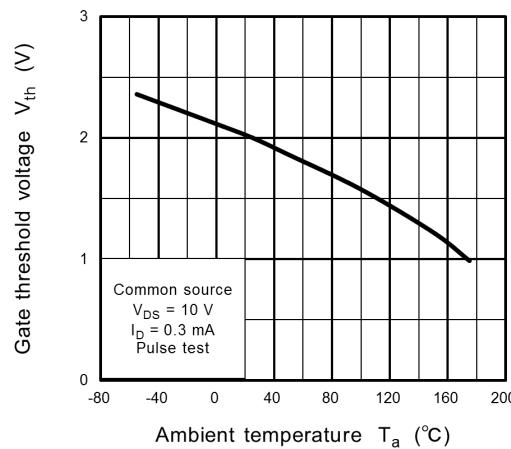


Fig. 8.8  $V_{th}$  -  $T_a$

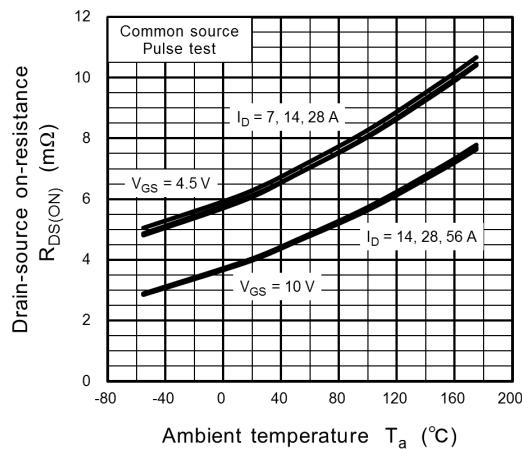


Fig. 8.9  $R_{DS(ON)}$  -  $T_a$

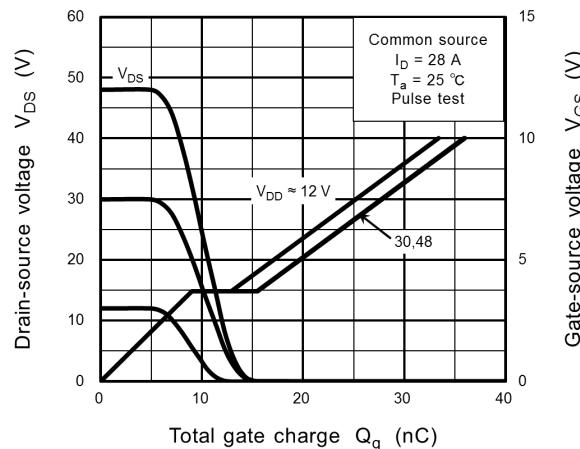


Fig. 8.10 Dynamic Input/Output Characteristics

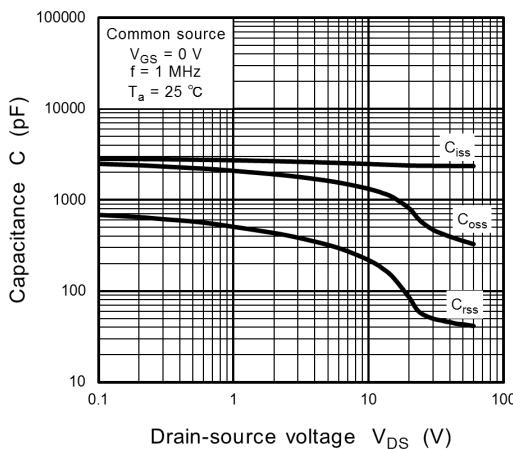


Fig. 8.11 Capacitance -  $V_{DS}$

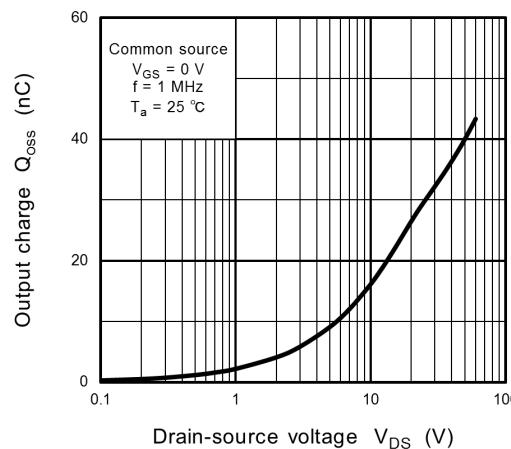
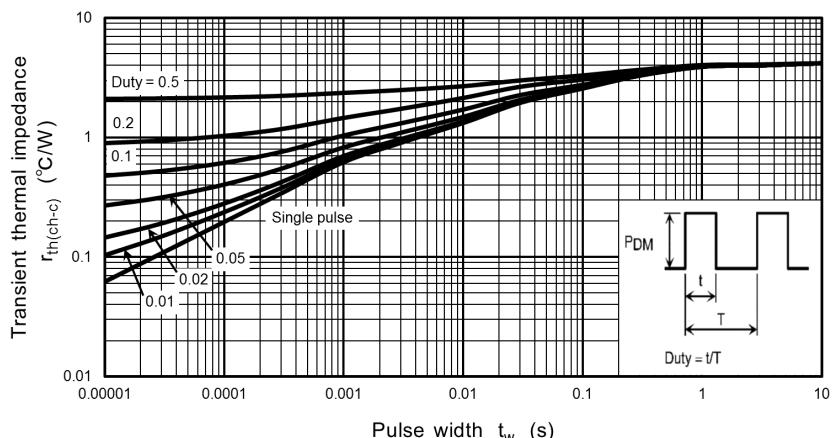
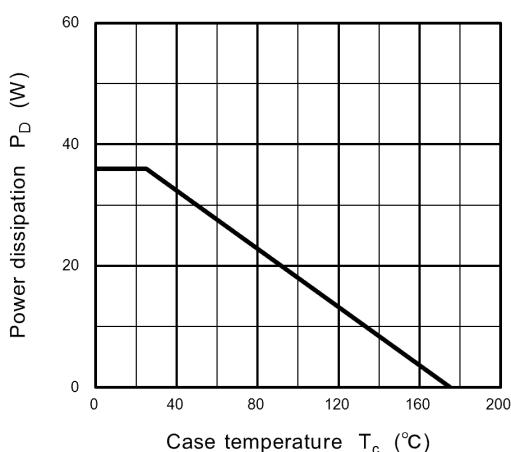


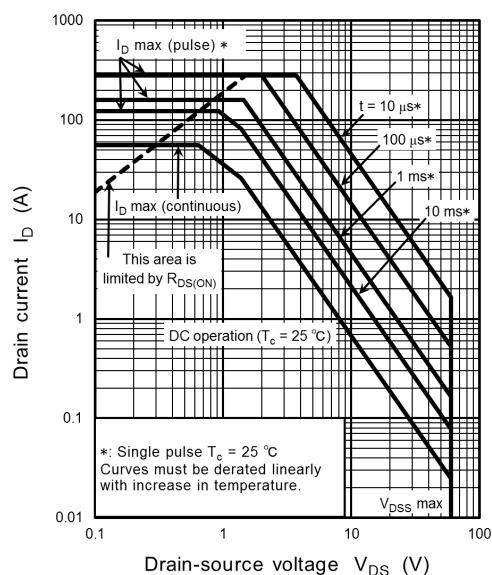
Fig. 8.12  $Q_{oss}$  -  $V_{DS}$



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



**Fig. 8.14  $P_D - T_c$   
(Guaranteed Maximum)**

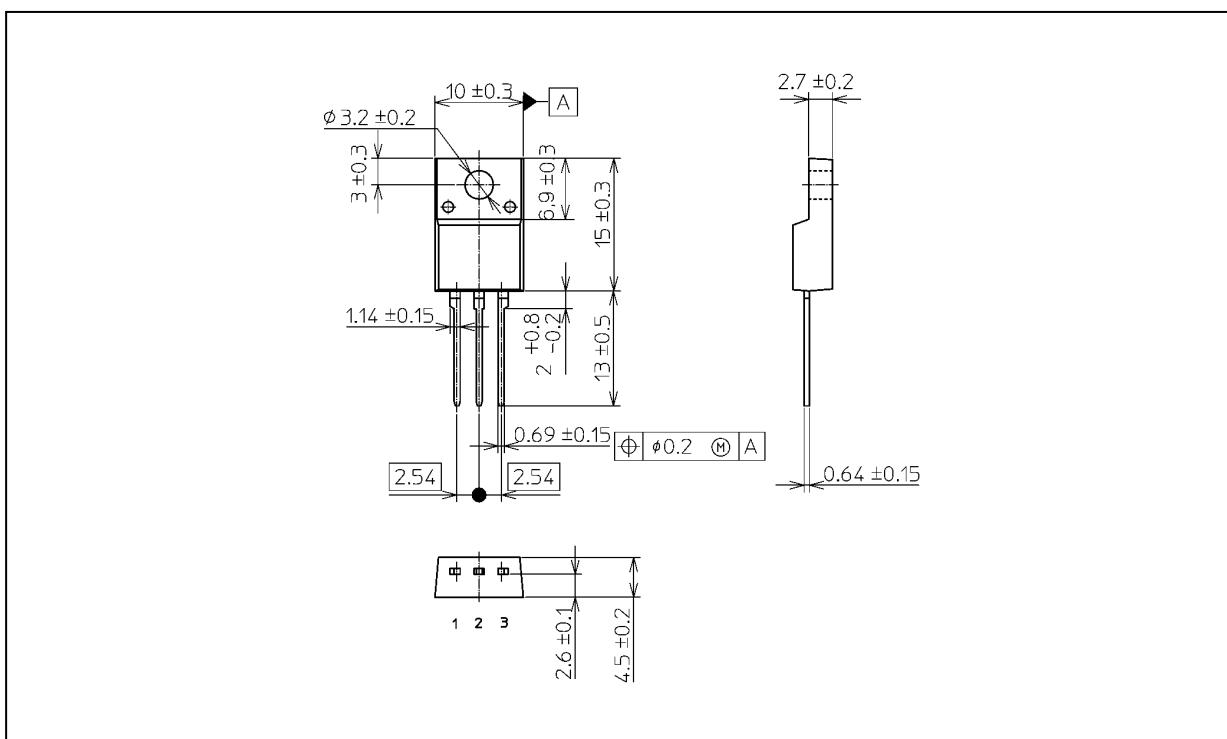


**Fig. 8.15 Safe Operating Area  
(Guaranteed Maximum)**

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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