

# TK150F04K3L

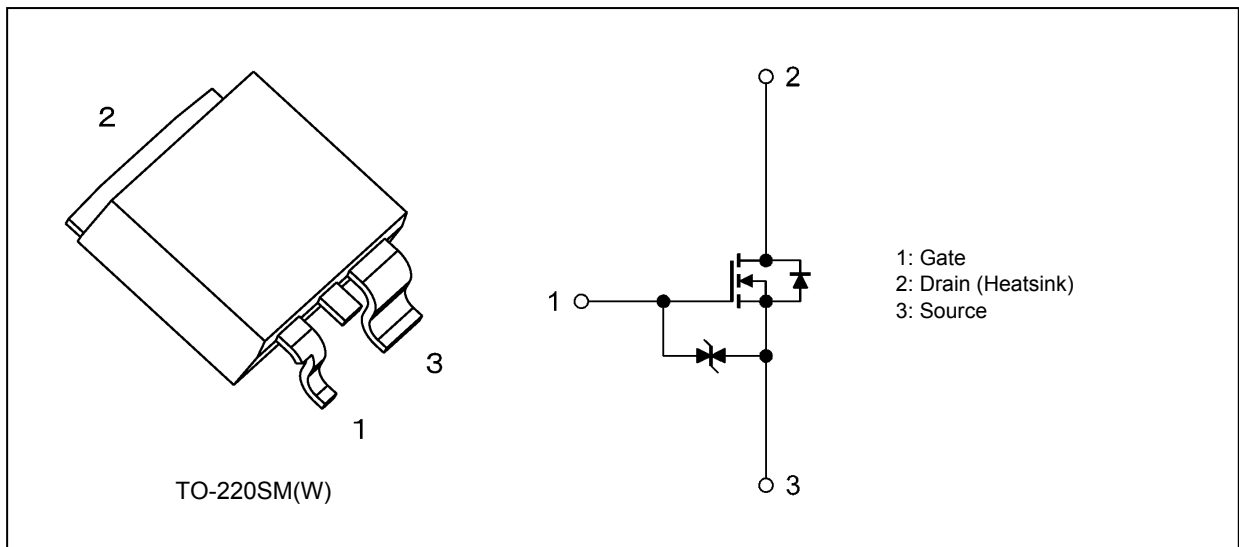
## 1. Applications

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

## 2. Features

- (1) Low drain-source on-resistance:  $R_{DS(ON)} = 1.7 \text{ m}\Omega$  (typ.) ( $V_{GS} = 10 \text{ V}$ )
- (2) Low leakage current:  $I_{DSS} = 10 \text{ }\mu\text{A}$  (max) ( $V_{DS} = 40 \text{ V}$ )
- (3) Enhancement mode:  $V_{th} = 2.0$  to  $3.0 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1 \text{ mA}$ )

## 3. Packaging and Internal Circuit



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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	$V_{DSS}$	40	V
Gate-source voltage	$V_{GSS}$	$\pm 20$	
Drain current (DC)	$I_D$	150	A
Drain current (pulsed)	$I_{DP}$	450	
Power dissipation	$P_D$	300	W
Single-pulse avalanche energy	$E_{AS}$	238	mJ
Avalanche current	$I_{AR}$	150	A
Channel temperature	$T_{ch}$	175	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 175	

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

2009-10

**5. Thermal Characteristics**

Characteristics	Symbol	Max	Unit
Channel-to-case thermal resistance	$R_{th(ch-c)}$	0.5	°C/W

Note 1: Ensure that the channel temperature does not exceed 175°C.

Note 2:  $V_{DD} = 25\text{ V}$ ,  $T_{ch} = 25^\circ\text{C}$  (initial),  $L = 11\ \mu\text{H}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = 150\text{ A}$

Note 3: The definitions of the absolute maximum channel and storage temperatures are based on AEC-Q101.

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

**6. Electrical Characteristics**

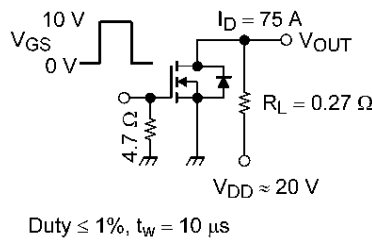
**6.1. Static Characteristics ( $T_a = 25^\circ\text{C}$  unless otherwise specified)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 16\text{ V}, V_{DS} = 0\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Drain cut-off current	$I_{DSS}$	$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}, V_{GS} = 0\text{ V}$	40	—	—	V
Drain-source breakdown voltage (Note 4)	$V_{(BR)DSX}$	$I_D = 10\text{ mA}, V_{GS} = -20\text{ V}$	20	—	—	
Gate threshold voltage	$V_{th}$	$V_{DS} = 10\text{ V}, I_D = 1\text{ mA}$	2.0	—	3.0	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 6\text{ V}, I_D = 75\text{ A}$	—	2.1	3.2	m $\Omega$
		$V_{GS} = 10\text{ V}, I_D = 75\text{ A}$	—	1.7	2.1	

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	$C_{iss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	—	9400	—	pF
Reverse transfer capacitance	$C_{rss}$		—	1200	—	
Output capacitance	$C_{oss}$		—	1900	—	
Switching time (rise time)	$t_r$	See Fig. 6.2.1	—	20	—	ns
Switching time (turn-on time)	$t_{on}$		—	42	—	
Switching time (fall time)	$t_f$		—	43	—	
Switching time (turn-off time)	$t_{off}$		—	158	—	



Duty  $\leq 1\%$ ,  $t_w = 10\ \mu\text{s}$

**Fig. 6.2.1 Switching Time Test Circuit**

**6.3. Gate Charge Characteristics ( $T_a = 25^\circ\text{C}$  unless otherwise specified)**

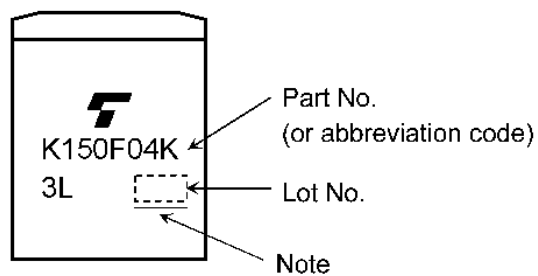
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g$	$V_{DD} \approx 32\text{ V}, V_{GS} = 10\text{ V}, I_D = 150\text{ A}$	—	190	—	nC
Gate-source charge	$Q_{gs}$		—	127	—	
Gate-drain charge	$Q_{gd}$		—	63	—	

**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 (DC) (Note 5)	$I_{DR}$	—	—	—	150	A
Reverse drain current (pulsed) (Note 5)	$I_{DRP}$	—	—	—	450	
Diode forward voltage	$V_{DSF}$	$I_{DR} = 150\text{ A}, V_{GS} = 0\text{ V}$	—	—	-1.2	V
Reverse recovery time	$t_{rr}$	$I_{DR} = 150\text{ A}, V_{GS} = 0\text{ V}$ $-di_{DR}/dt = 50\text{ A}/\mu\text{s}$	—	80	—	ns
Reverse recovery charge	$Q_{rr}$		—	80	—	nC

Note 5: Ensure that the channel temperature does not exceed  $175^\circ\text{C}$ .

**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. Moisture-Proof Packing

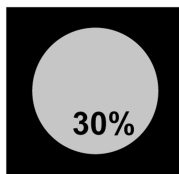
This device is packed in a moisture-proof laminated aluminum bag.

### 8.1. Precautions for Transportation and Storage (Note)

- (1) Avoid excessive vibration during transportation.
- (2) Do not toss or drop the packed devices to avoid ripping of the bag.
- (3) After opening the moisture-proof bag, the devices should be assembled within two weeks in an environment of 5°C to 30°C and RH70% or below. Perform reflow at most twice.
- (4) The moisture-proof bag may be stored unopened for up to 24 months at 5°C to 30°C and RH90% or below.
- (5) If, upon opening the bag, the moisture indicator card shows humidity of 30% or above (the color of the 30% dot has changed from blue to pink) or the expiration date has passed, the devices should be baked as follows:

Baking conditions: 125°C for 48 hours.

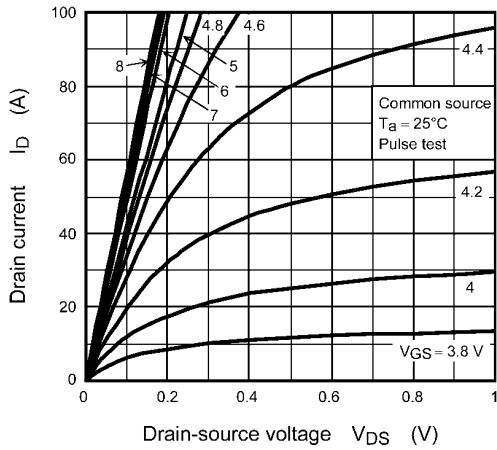
Note: Since the tape materials are not heat-proof, devices should be placed on either heat-proof trays or aluminum magazines when baking.



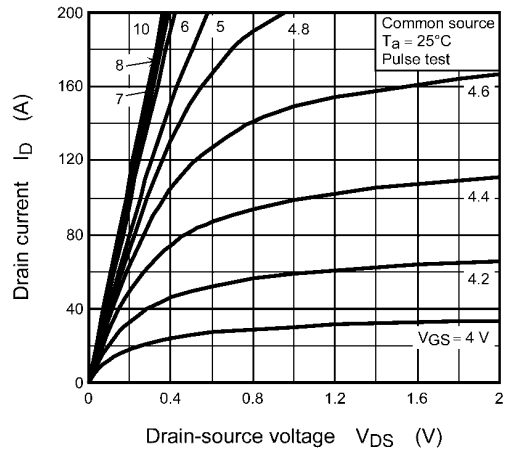
The humidity indicator shows an approximate ambient humidity at 25°C. If the ambient humidity is below 30%, the color of all the indicator dots is blue. If, upon opening the bag, the color of the 30% dot has changed from blue to pink, the devices should be baked before assembly.

Fig. 8.1.1 Humidity Indicator

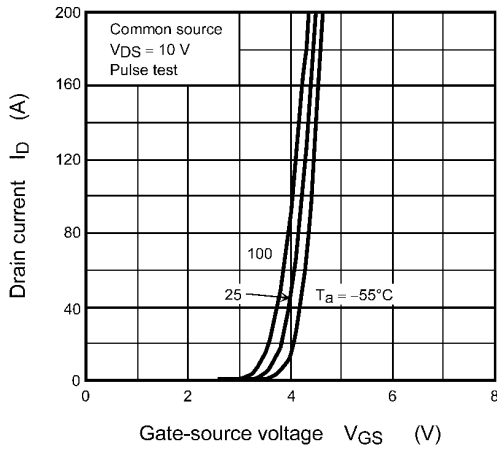
**9. Characteristics Curves (Note)**



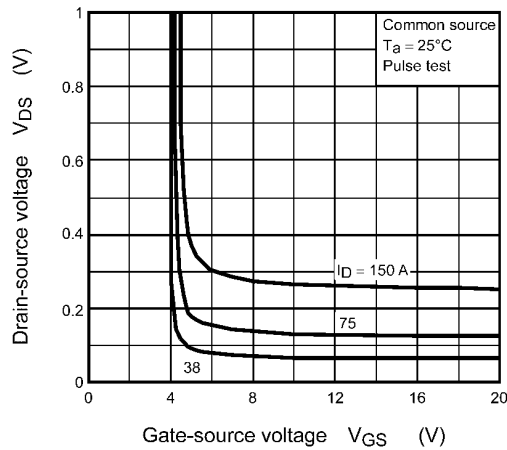
**Fig. 9.1  $I_D - V_{DS}$**



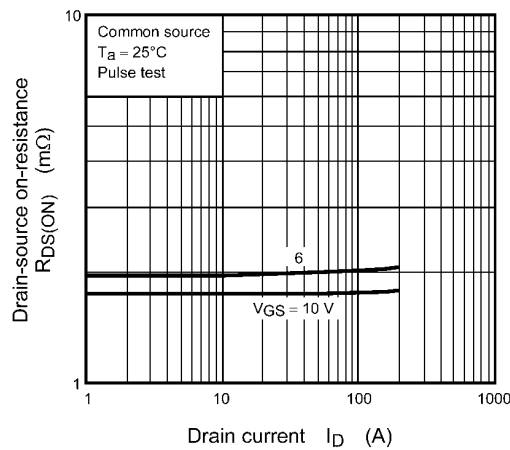
**Fig. 9.2  $I_D - V_{DS}$**



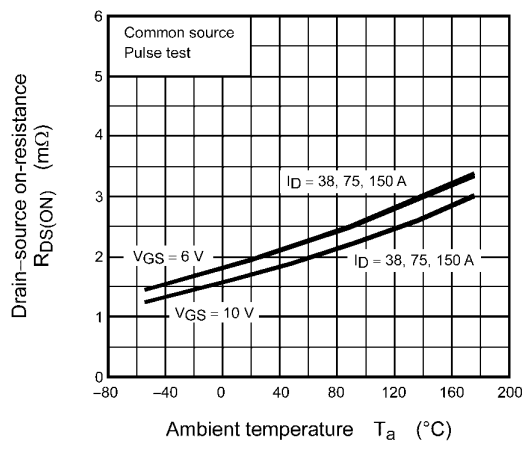
**Fig. 9.3  $I_D - V_{GS}$**



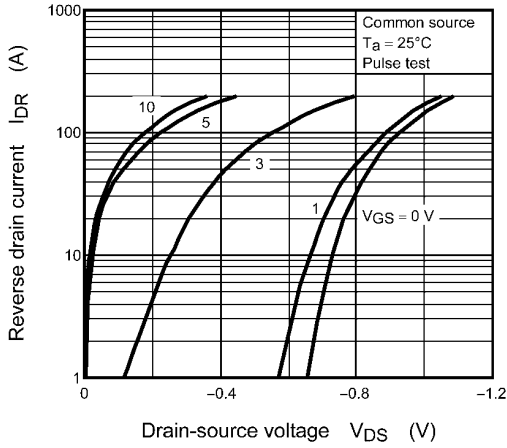
**Fig. 9.4  $V_{DS} - V_{GS}$**



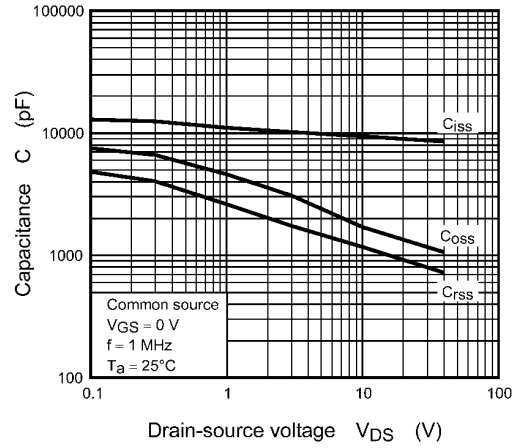
**Fig. 9.5  $R_{DS(ON)} - I_D$**



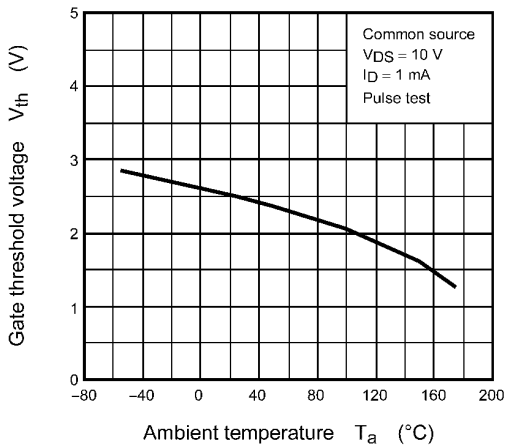
**Fig. 9.6  $R_{DS(ON)} - T_a$**



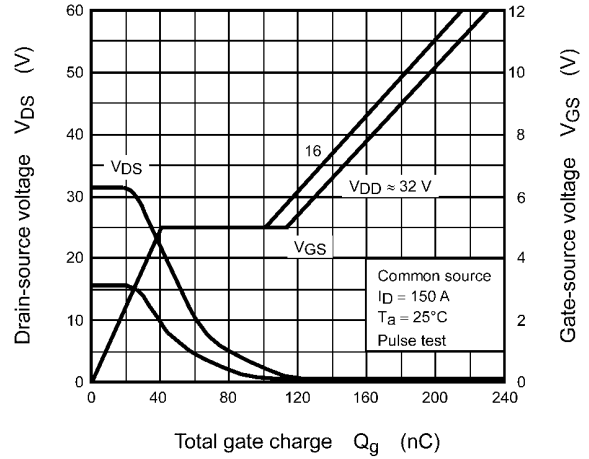
**Fig. 9.7  $I_{DR} - V_{DS}$**



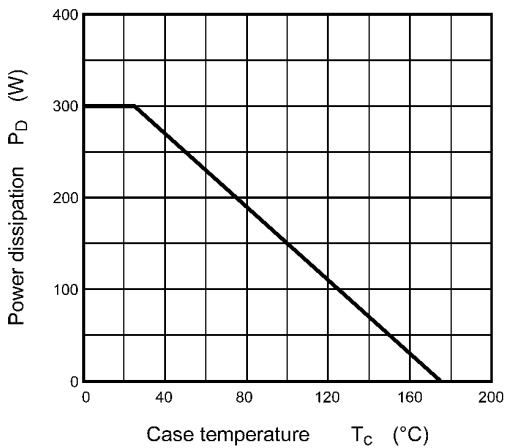
**Fig. 9.8 Capacitance -  $V_{DS}$**



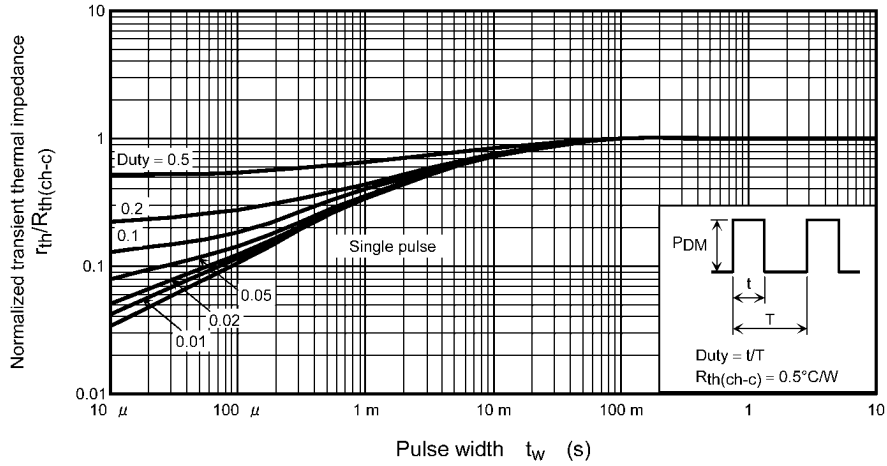
**Fig. 9.9  $V_{th} - T_a$**



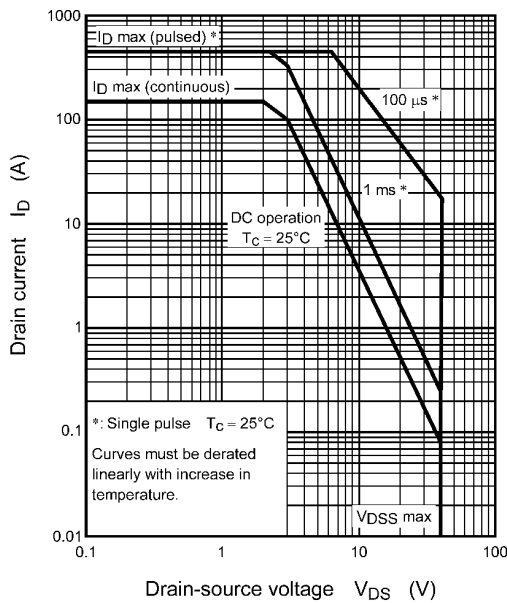
**Fig. 9.10 Dynamic Input/Output Characteristics**



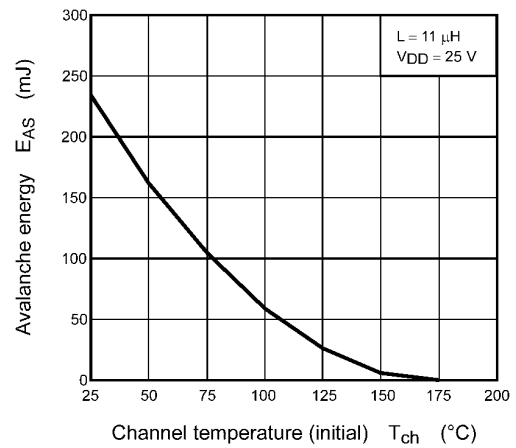
**Fig. 9.11  $P_D - T_c$   
 (Guaranteed Maximum)**



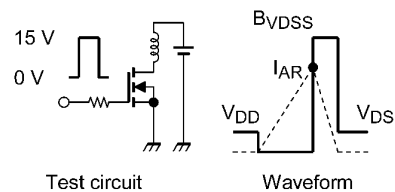
**Fig. 9.12**  $r_{th}/R_{th(ch-c)} - t_w$   
(Guaranteed Maximum)



**Fig. 9.13** Safe Operating Area  
(Guaranteed Maximum)



**Fig. 9.14**  $E_{AS} - T_{ch}$   
(Guaranteed Maximum)



$R_G = 25 \Omega$   
 $V_{DD} = 25 \text{ V}, L = 11 \mu\text{H}$

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

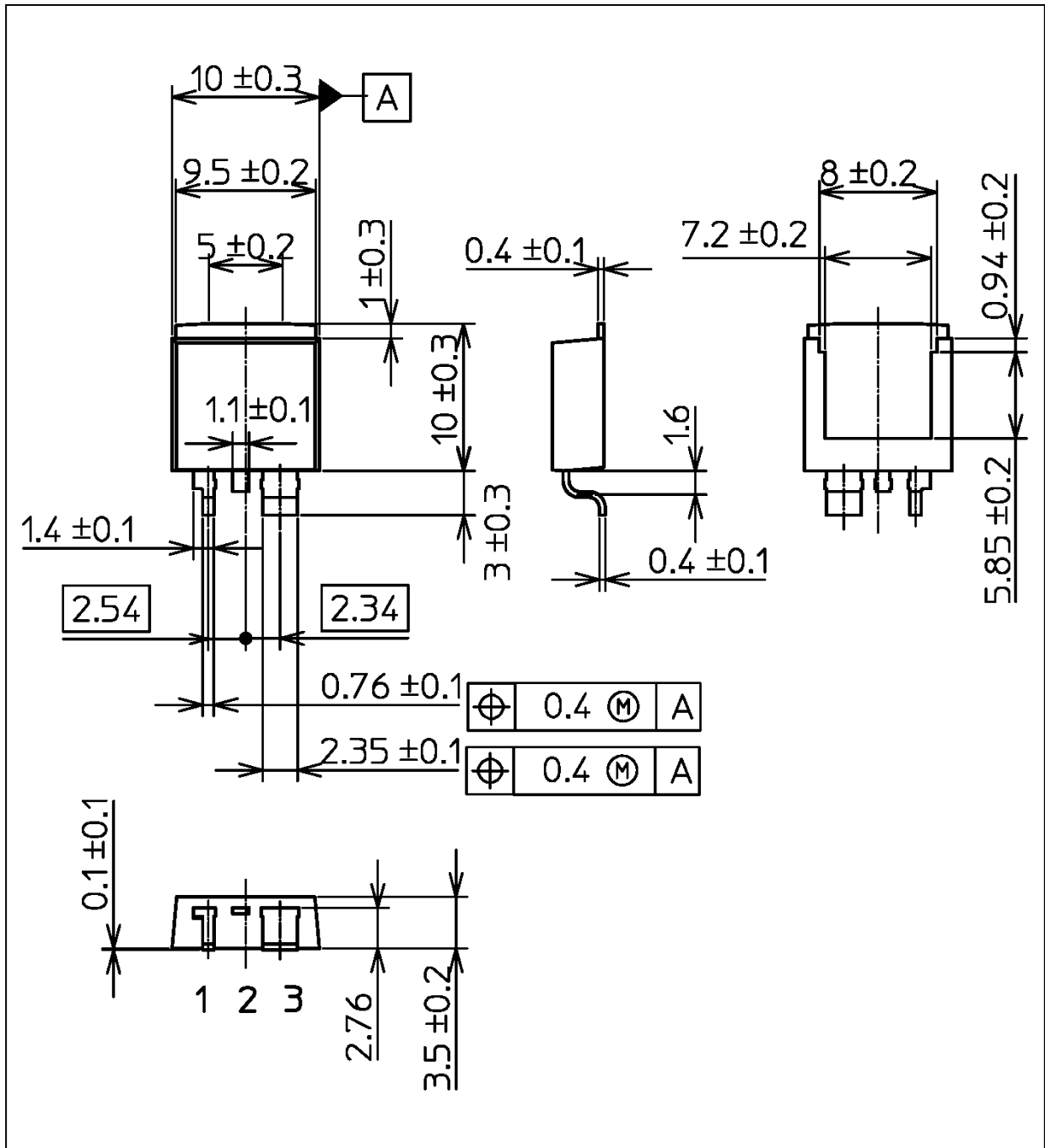
**Fig. 9.15** Test Circuit/Waveform

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



Package Dimensions

Unit: mm



Weight: 1.07 g (typ.)

Package Name(s)
TOSHIBA: 2-10W1S
Nickname: TO-220SM(W)

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