

TK6R4E10PL

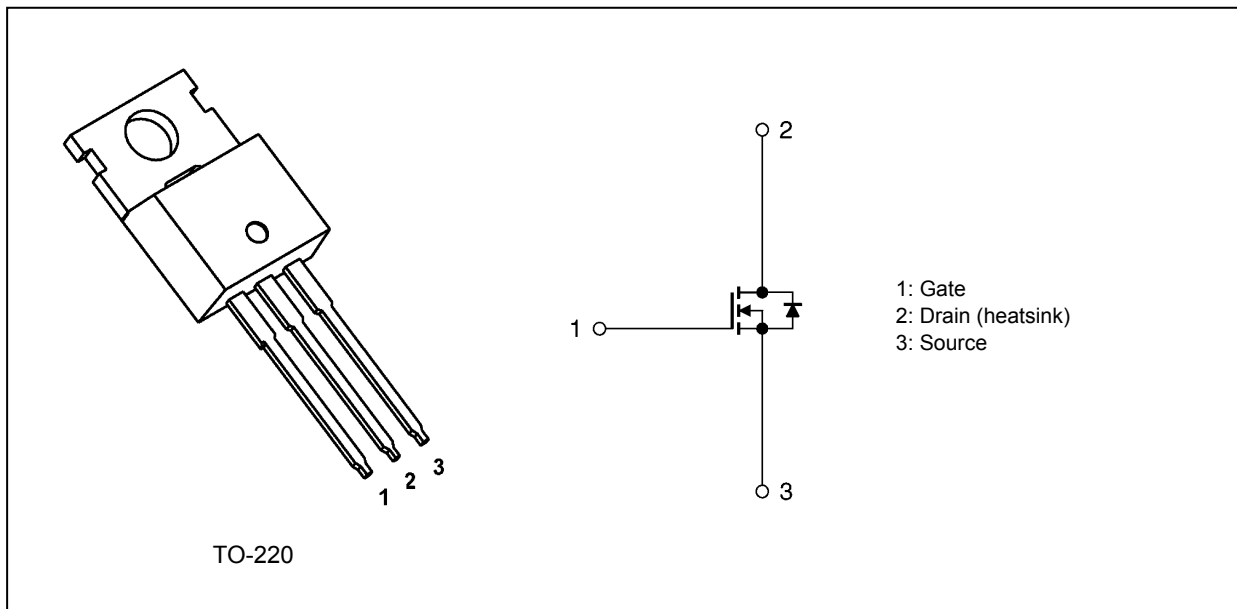
1. Applications

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

2. Features

- (1) High-speed switching
- (2) Small gate charge: $Q_{SW} = 17 \text{ nC (typ.)}$
- (3) Small output charge: $Q_{OSS} = 58 \text{ nC (typ.)}$
- (4) Low drain-source on-resistance: $R_{DS(ON)} = 5.5 \text{ m}\Omega \text{ (typ.) (} V_{GS} = 10 \text{ V)}$
- (5) Low leakage current: $I_{DSS} = 10 \text{ }\mu\text{A (max) (} V_{DS} = 100 \text{ V)}$
- (6) Enhancement mode: $V_{th} = 1.5 \text{ to } 2.5 \text{ V (} V_{DS} = 10 \text{ V, } I_D = 0.5 \text{ mA)}$

3. Packaging and Internal Circuit



Start of commercial production

2018-01

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

Characteristics	Symbol	Rating	Unit
Drain-source voltage	V_{DS}	100	V
Gate-source voltage	V_{GS}	± 20	
Drain current (DC) ($T_c = 25\text{ }^{\circ}\text{C}$) (Note 1)	I_D	70	A
Drain current (DC) (Silicon limit) (Note 1), (Note 2)	I_D	112	
Drain current (pulsed) ($t = 100\text{ }\mu\text{s}$) (Note 1)	I_{DP}	310	
Power dissipation ($T_c = 25\text{ }^{\circ}\text{C}$)	P_D	152	W
Single-pulse avalanche energy (Note 3)	E_{AS}	47	mJ
Single-pulse avalanche current (Note 3)	I_{AS}	70	A
Channel temperature	T_{ch}	175	$^{\circ}\text{C}$
Storage temperature	T_{stg}	-55 to 175	$^{\circ}\text{C}$
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 ($T_c = 25\text{ }^{\circ}\text{C}$)	$R_{th(ch-c)}$	0.99	$^{\circ}\text{C/W}$
Channel-to-ambient thermal resistance ($T_a = 25\text{ }^{\circ}\text{C}$)	$R_{th(ch-a)}$	83.3	

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

Note 2: Limited by silicon chip capability.

Note 3: $V_{DD} = 80\text{ V}$, $T_{ch} = 25\text{ }^{\circ}\text{C}$ (initial), $L = 7.5\text{ }\mu\text{H}$, $I_{AS} = 70\text{ A}$

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

6. Electrical Characteristics

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	$V_{GS} = \pm 20\text{ V}$, $V_{DS} = 0\text{ V}$	—	—	± 0.1	μA
Drain cut-off current	I_{DSS}	$V_{DS} = 100\text{ V}$, $V_{GS} = 0\text{ V}$	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 10\text{ mA}$, $V_{GS} = 0\text{ V}$	100	—	—	V
Drain-source breakdown voltage (Note 4)	$V_{(BR)DSX}$	$I_D = 10\text{ mA}$, $V_{GS} = -20\text{ V}$	65	—	—	
Gate threshold voltage	V_{th}	$V_{DS} = 10\text{ V}$, $I_D = 0.5\text{ mA}$	1.5	—	2.5	
Drain-source on-resistance	$R_{DS(ON)}$	$V_{GS} = 4.5\text{ V}$, $I_D = 16\text{ A}$	—	6.9	9.7	$\text{m}\Omega$
		$V_{GS} = 10\text{ V}$, $I_D = 35\text{ A}$	—	5.5	6.4	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	$V_{DS} = 50\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$	—	3455	—	pF
Reverse transfer capacitance	C_{rss}		—	30	—	
Output capacitance	C_{oss}		—	520	—	
Gate resistance	r_g	—	—	2.4	—	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1	—	12	—	ns
Switching time (turn-on time)	t_{on}		—	29	—	
Switching time (fall time)	t_f		—	14	—	
Switching time (turn-off time)	t_{off}		—	67	—	

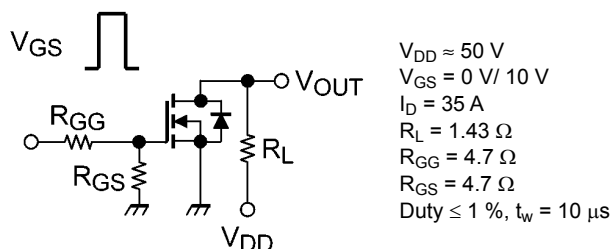


Fig. 6.2.1 Switching Time Test Circuit

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	Q_g	$V_{DD} \approx 50\text{ V}$, $V_{GS} = 10\text{ V}$, $I_D = 35\text{ A}$	—	58	—	nC
		$V_{DD} \approx 50\text{ V}$, $V_{GS} = 4.5\text{ V}$, $I_D = 35\text{ A}$	—	30	—	
Gate-source charge 1	Q_{gs1}	$V_{DD} \approx 50\text{ V}$, $V_{GS} = 10\text{ V}$, $I_D = 35\text{ A}$	—	12	—	
Gate-drain charge	Q_{gd}		—	12	—	
Gate switch charge	Q_{SW}		—	17	—	
Output charge	Q_{oss}	$V_{DS} = 50\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$	—	58	—	

6.4. Source-Drain Characteristics ($T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (pulsed) (Note 5)	I_{DRP}	$t = 100\text{ }\mu\text{s}$	—	—	310	A
Diode forward voltage	V_{DSF}	$I_{DR} = 70\text{ A}$, $V_{GS} = 0\text{ V}$	—	—	-1.5	V
Reverse recovery time	t_{rr}	$I_{DR} = 17.5\text{ A}$, $V_{GS} = 0\text{ V}$, $-dI_{DR}/dt = 100\text{ A}/\mu\text{s}$	—	52	—	ns
Reverse recovery charge	Q_{rr}		—	80	—	nC

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

7. Marking

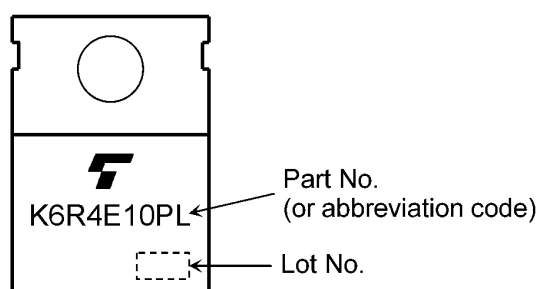


Fig. 7.1 Marking

8. Characteristics Curves (Note)

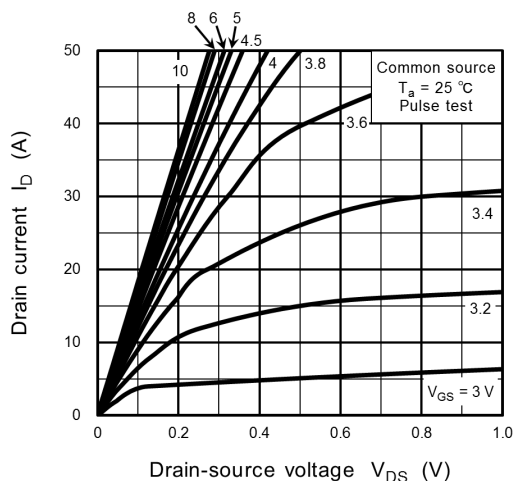


Fig. 8.1 $I_D - V_{DS}$

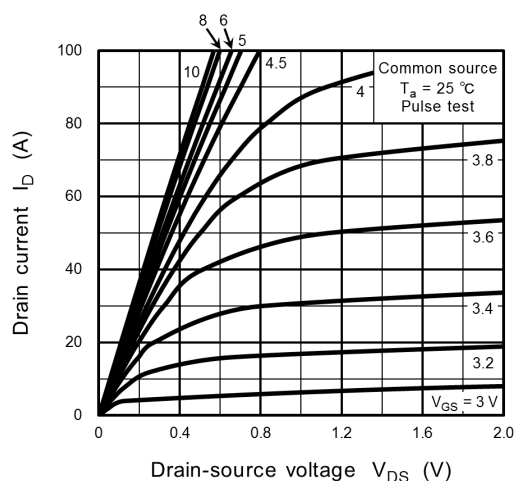


Fig. 8.2 $I_D - V_{DS}$

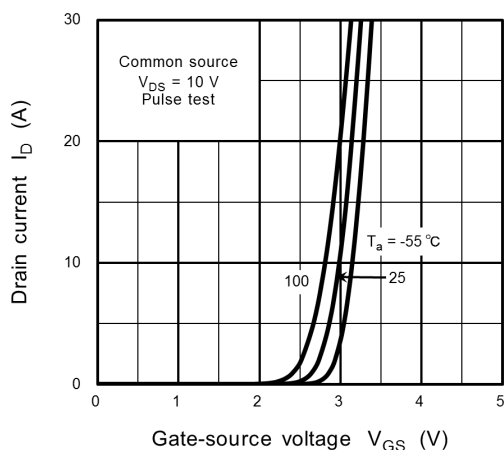


Fig. 8.3 $I_D - V_{GS}$

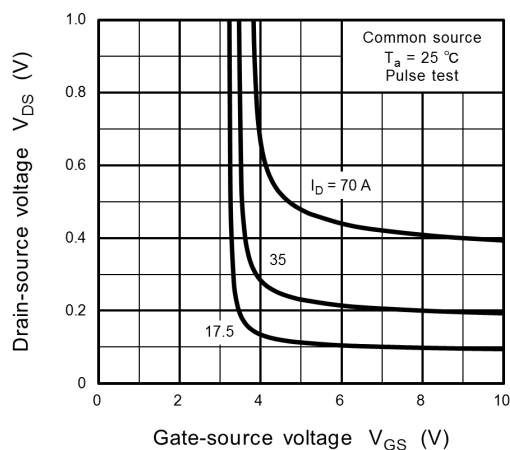


Fig. 8.4 $V_{DS} - V_{GS}$

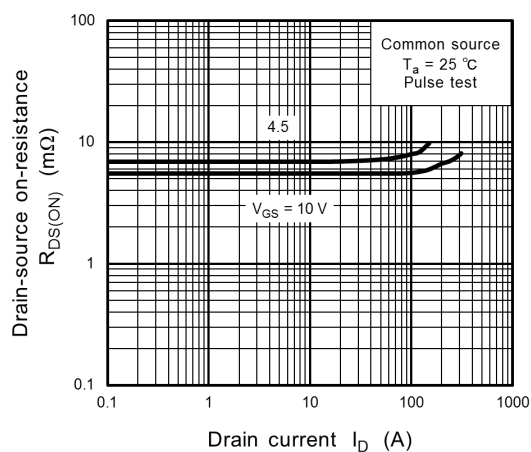


Fig. 8.5 $R_{DS(ON)} - I_D$

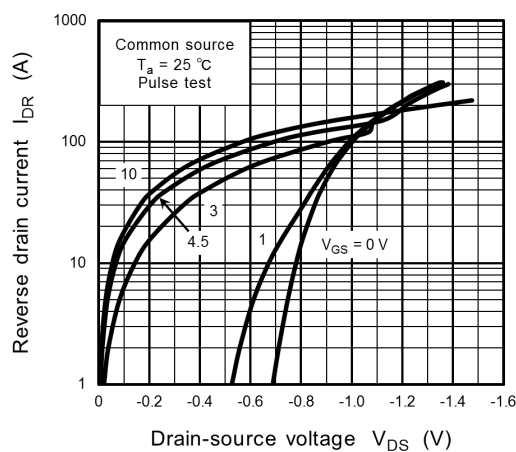


Fig. 8.6 $I_{DR} - V_{DS}$

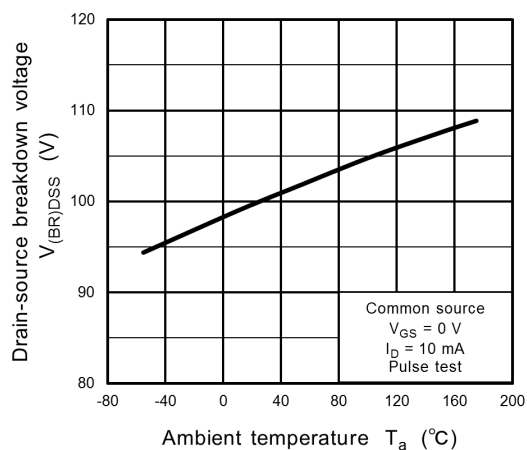


Fig. 8.7 $V_{(BR)DSS} - T_a$

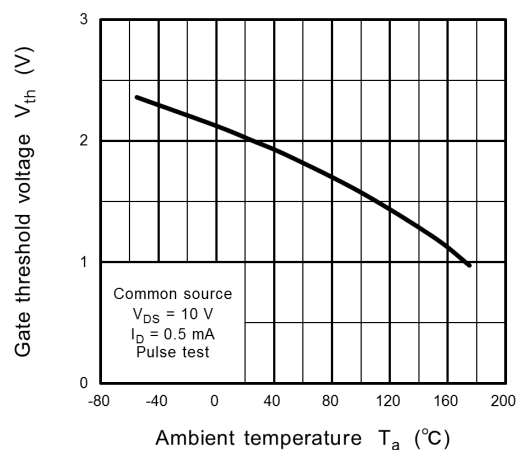


Fig. 8.8 $V_{th} - T_a$

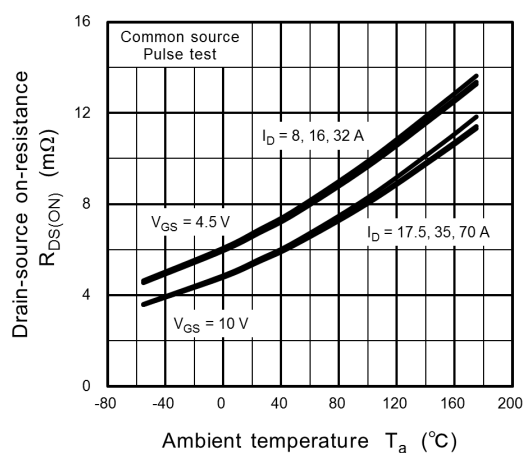


Fig. 8.9 $R_{DS(ON)} - T_a$

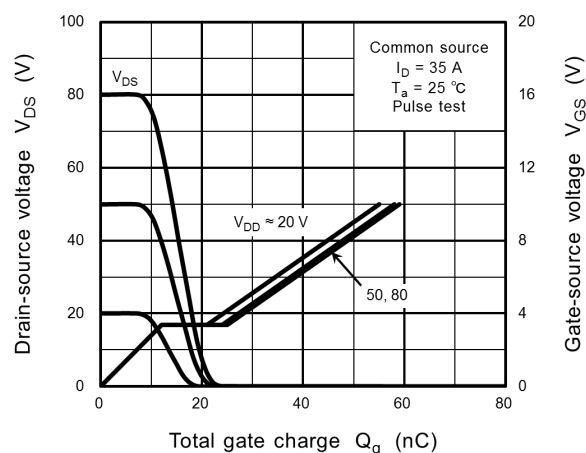


Fig. 8.10 Dynamic Input/Output Characteristics

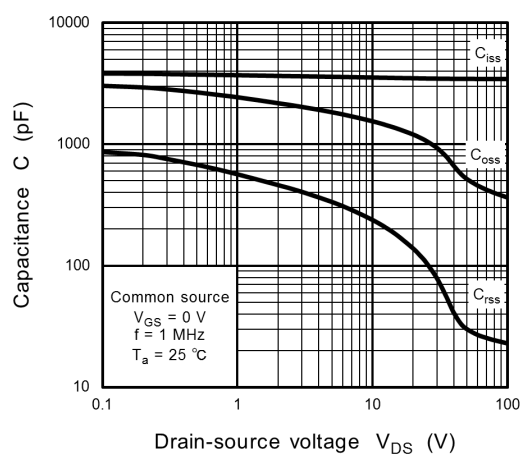


Fig. 8.11 Capacitance - V_{DS}

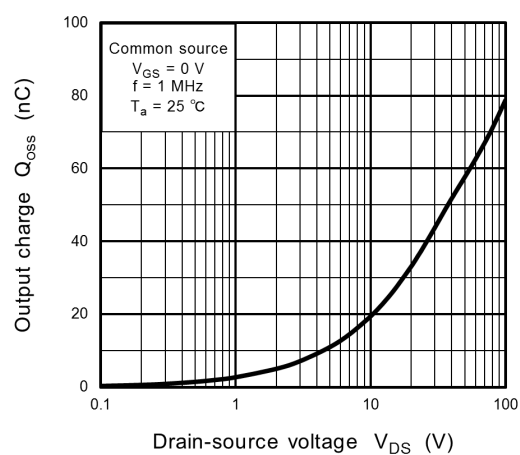


Fig. 8.12 $Q_{oss} - V_{DS}$

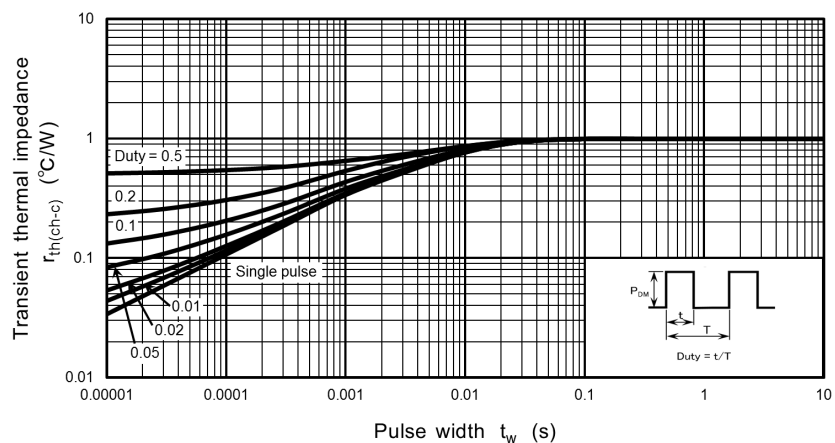


Fig. 8.13 $r_{th} - t_w$
(Guaranteed Maximum)

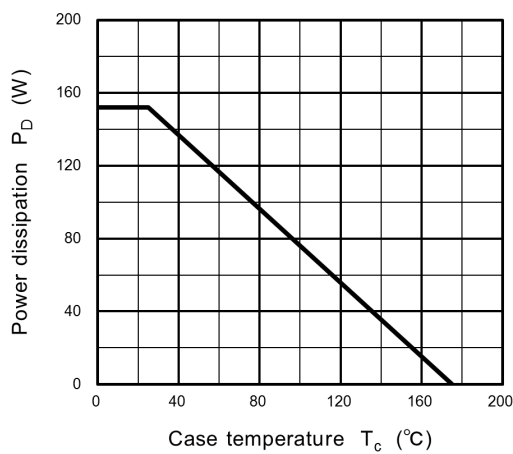


Fig. 8.14 $P_D - T_c$
(Guaranteed Maximum)

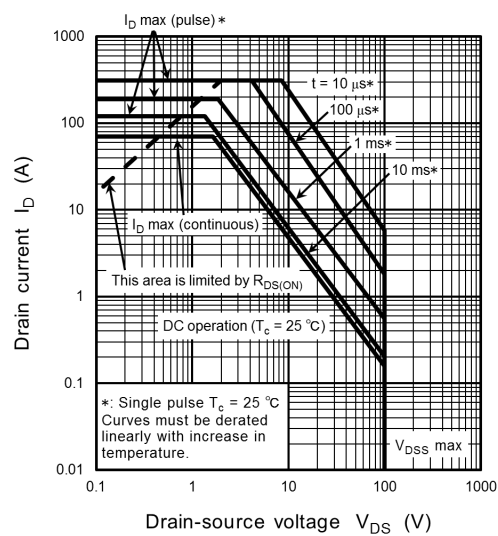
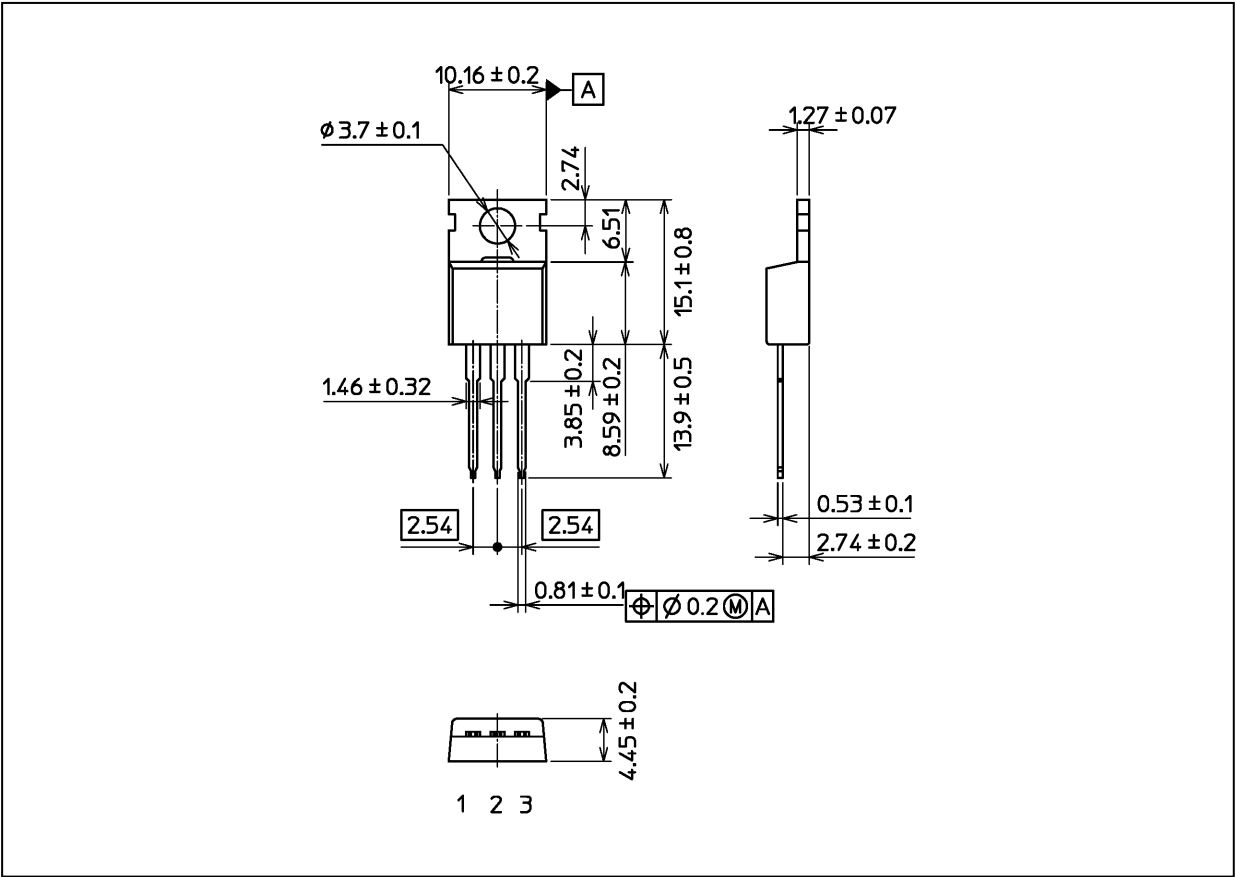


Fig. 8.15 Safe Operating Area
(Guaranteed Maximum)

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

Package Dimensions

Unit: mm



Weight: 1.96 g (typ.)

Package Name(s)
TOSHIBA: 2-10X1A
Nickname: TO-220

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