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

XK1R9F10QB

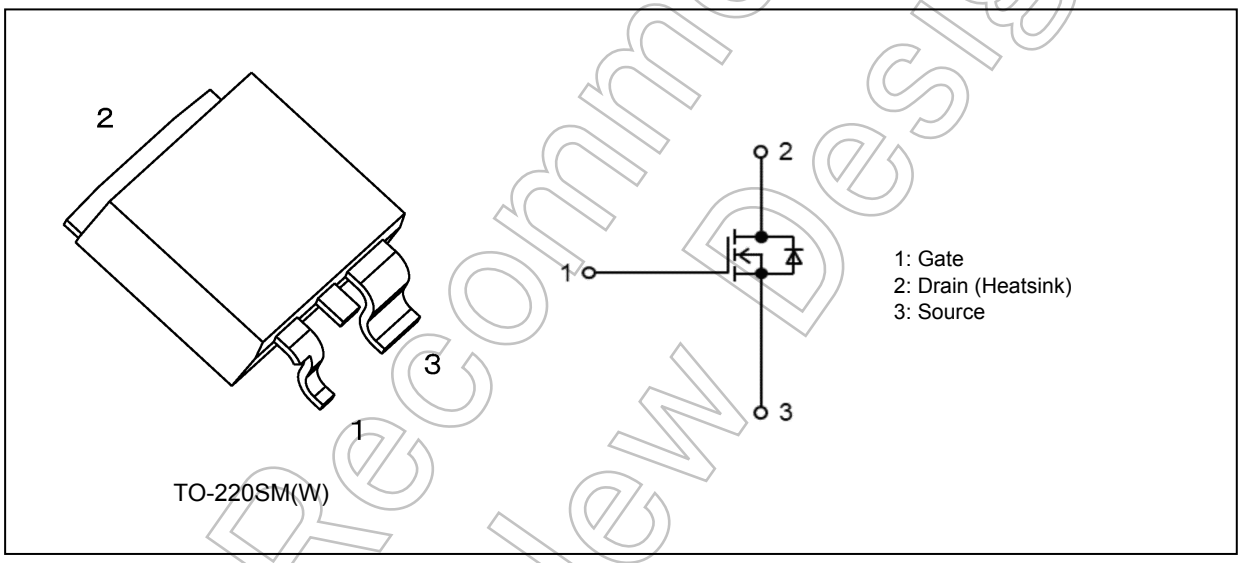
1. Applications

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

2. Features

(1) AEC-Q101 qualified
(2) Low drain-source on-resistance: $R_{DS(ON)}$ = 1.6 mΩ (typ.) (V_{GS} = 10 V)
(3) Low leakage current: I_{DSS} = 10 μA (max) (V_{DS} = 100 V)
(4) Enhancement mode: V_{th} = 2.5 to 3.5 V (V_{DS} = 10 V, I_D = 1 mA)

3. Packaging and Internal Circuit



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Start of commercial production
2020-01

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

Characteristics		Symbol	Rating	Unit
Drain-source voltage		V_{DSS}	100	V
Gate-source voltage		V_{GSS}	±20	
Drain current (DC)	(Note 1)	I_D	160	A
Drain current (pulsed)	(Note 1)	I_{DP}	480	
Power dissipation	(T_c = 25 °C)	P_D	375	W
Single-pulse avalanche energy	(Note 2)	E_{AS}	566	mJ
Single-pulse avalanche current		I_{AS}	160	A
Channel temperature	(Note 3)	T_{ch}	175	°C
Storage temperature	(Note 3)	T_{stg}	-55 to 175	°C

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).

Note: When the body or a connecting part of a semiconductor product is subjected to vibration, impact or stress in actual equipment, bonding fault or device destruction may result.
Therefore, be sure to keep this in mind at the time of structural design.
If a semiconductor product is subject to especially strong vibration, impact or stress, the package or chip may crack. If stress is applied to a semiconductor chip through the package, changes in the resistance of the chip may result due to piezoelectric effects, resulting in fluctuation in element characteristics.
Furthermore, if a stress that does not instantly result in damage is applied continually for a long period of time, product deformation may result, causing defects such as disconnection or element failure.
Thus, at the time of structural design, carefully consider vibration, impact and stress.

Note: In this product, radiation resistance and cosmic ray resistance are not designed, and these natural environmental factors may affect reliability. In addition, radiation from the constituent materials of the product are also part of natural environmental factors which may affect reliability.

5. Thermal Characteristics

Characteristics	Symbol	Max	Unit
Channel-to-case thermal impedance	$z_{th(ch-c)}$	0.4	°C/W

Note 1: Ensure that the channel temperature does not exceed 175 °C.
Note 2: V_{DD} = 80 V, T_{ch} = 25 °C (initial), L = 17 μH, R_G = 25 Ω, I_{AS} = 160 A
Note 3: The definitions of the absolute maximum channel and storage temperatures are qualified per AEC-Q101.

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

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6. Electrical Characteristics

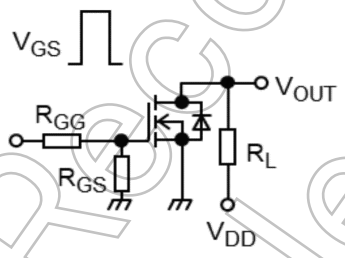
6.1. Static Characteristics (T_a = 25 °C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current	I_{GSS}	V_{GS} = ±20 V, V_{DS} = 0 V	—	—	±1	μA
Drain cut-off current	I_{DSS}	V_{DS} = 100 V, V_{GS} = 0 V	—	—	10	
Drain-source breakdown voltage	$V_{(BR)DSS}$	I_D = 10 mA, V_{GS} = 0 V	100	—	—	V
Drain-source breakdown voltage (Note 4)	$V_{(BR)DSX}$	I_D = 10 mA, V_{GS} = -20 V	80	—	—	
Gate threshold voltage	V_{th}	V_{DS} = 10 V, I_D = 1 mA	2.5	—	3.5	
Drain-source on-resistance	$R_{DS(ON)}$	V_{GS} = 6 V, I_D = 80 A	—	2.0	3.31	mΩ
		V_{GS} = 10 V, I_D = 80 A	—	1.6	1.92	

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 °C unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input capacitance	C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 300 kHz	—	11500	—	pF
Reverse transfer capacitance	C_{rss}		—	730	—	
Output capacitance	C_{oss}		—	4400	—	
Gate resistance	r_g		—	2.4	4.8	Ω
Switching time (rise time)	t_r	See Fig. 6.2.1.	—	58	—	ns
Switching time (turn-on time)	t_{on}		—	112	—	
Switching time (fall time)	t_f		—	60	—	
Switching time (turn-off time)	t_{off}		—	214	—	



V_{DD} ≈ 50 V
V_{GS} = 0 V/10 V
I_D = 80 A
R_L = 0.63 Ω
R_{GG} = 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} ≈ 80 V, V_{GS} = 10 V, I_D = 160 A	—	184	—	nC
Gate-source charge 1	Q_{gs1}		—	50	—	
Gate-drain charge	Q_{gd}		—	52	—	

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Reverse drain current (DC) (Note 5)	I_{DR}	—	—	—	160	A
Reverse drain current (pulsed) (Note 5)	I_{DRP}		—	—	480	
Diode forward voltage	V_{DSF}	I_{DR} = 160 A, V_{GS} = 0 V	—	—	-1.2	V
Reverse recovery time	t_{rr}	I_{DR} = 160 A, V_{GS} = 0 V $-dI_{DR}/dt$ = 50 A/μs	—	115	—	ns
Reverse recovery charge	Q_{rr}		—	138	—	nC

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

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7. Marking (Note)

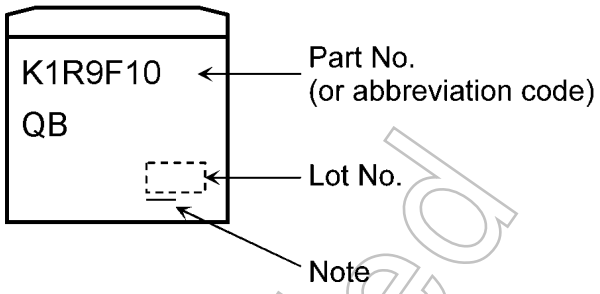


Fig. 7.1 Marking

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. 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 ℃ to 30 ℃ 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 ℃ to 30 ℃ 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 ℃ 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 ℃.
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

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9. Characteristics Curves (Note)

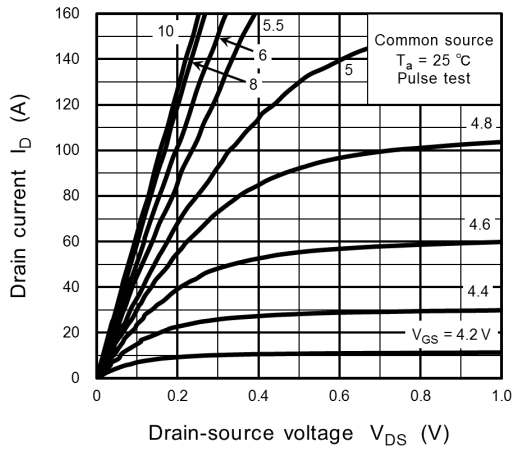


Fig. 9.1 I_D - V_{DS}

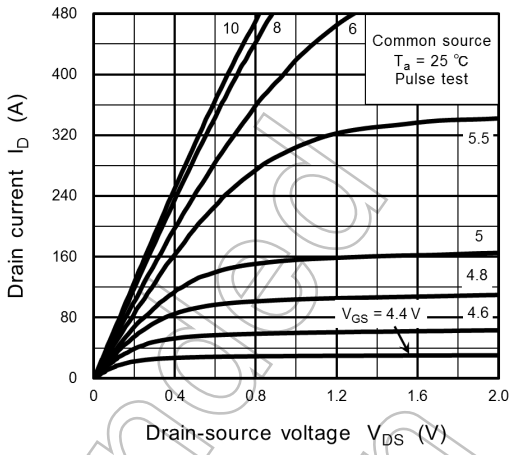


Fig. 9.2 I_D - V_{DS}

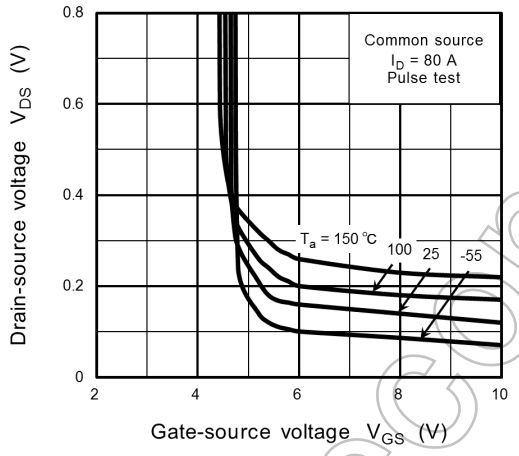


Fig. 9.3 V_{DS} - V_{GS}

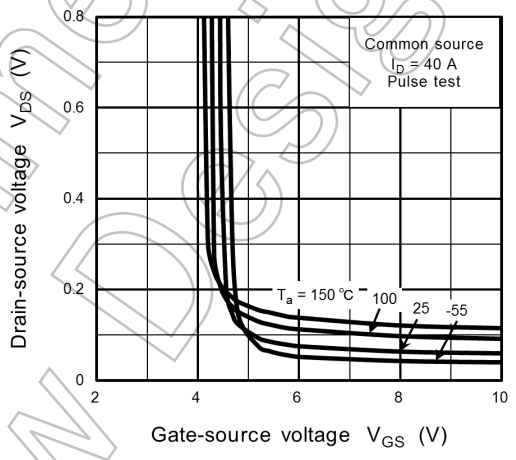


Fig. 9.4 V_{DS} - V_{GS}

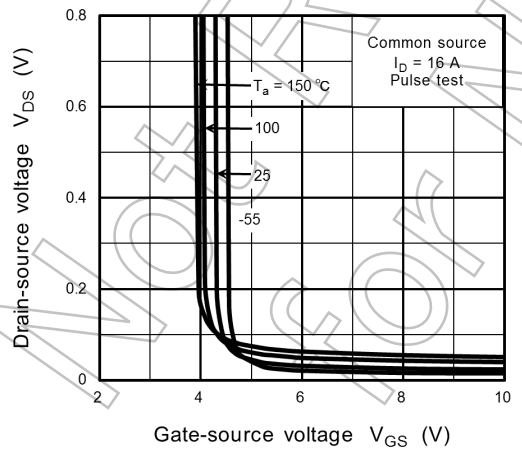


Fig. 9.5 V_{DS} - V_{GS}

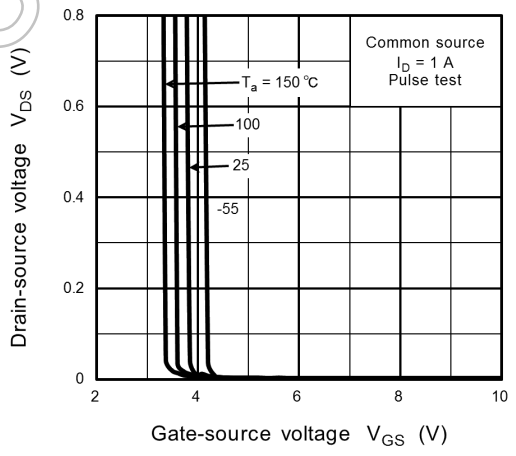


Fig. 9.6 V_{DS} - V_{GS}

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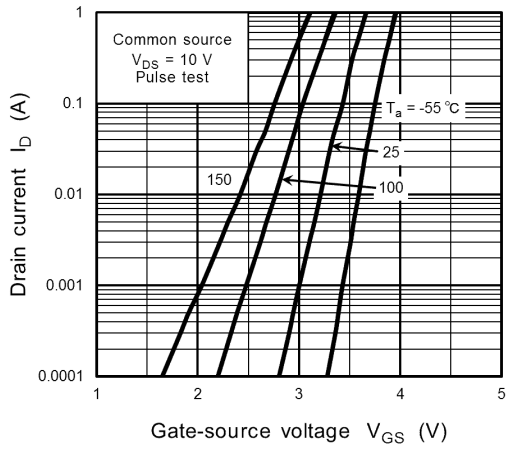


Fig. 9.7 I_D - V_{GS}

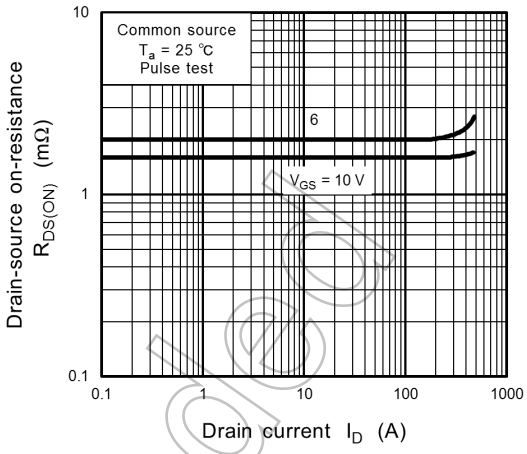


Fig. 9.8 $R_{DS(ON)}$ - I_D

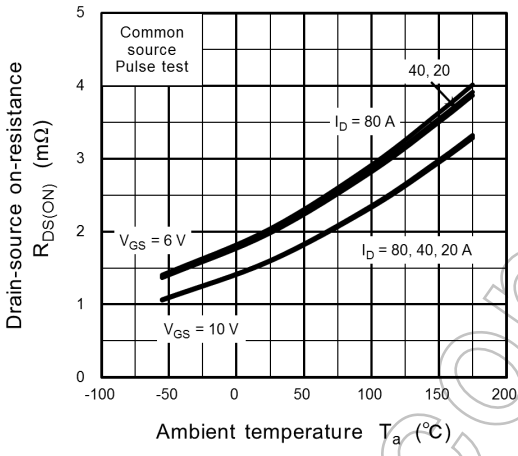


Fig. 9.9 $R_{DS(ON)}$ - T_a

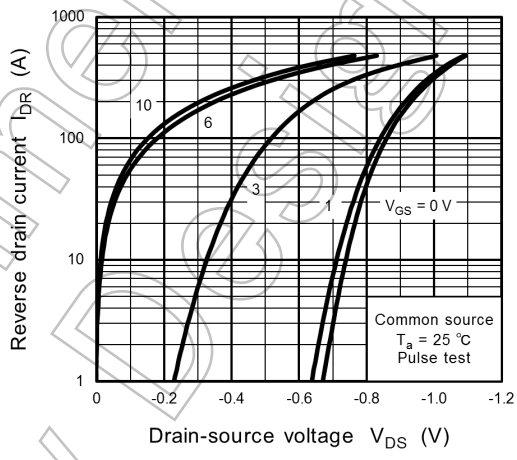


Fig. 9.10 I_{DR} - V_{DS}

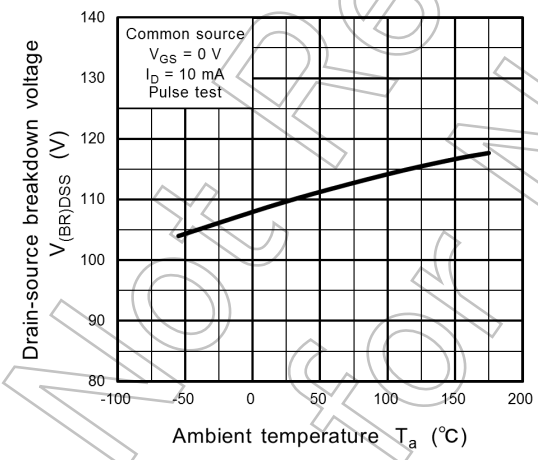


Fig. 9.11 $V_{(BR)DSS}$ - T_a

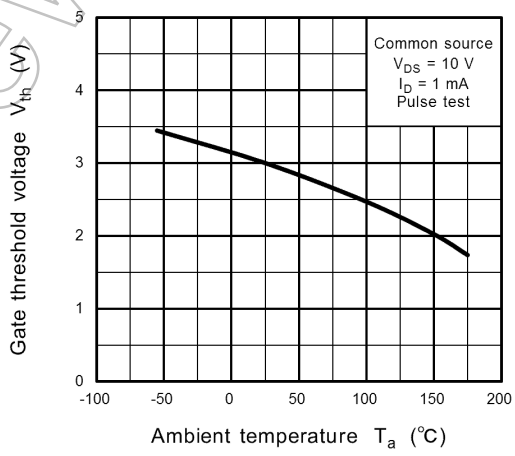


Fig. 9.12 V_{th} - T_a

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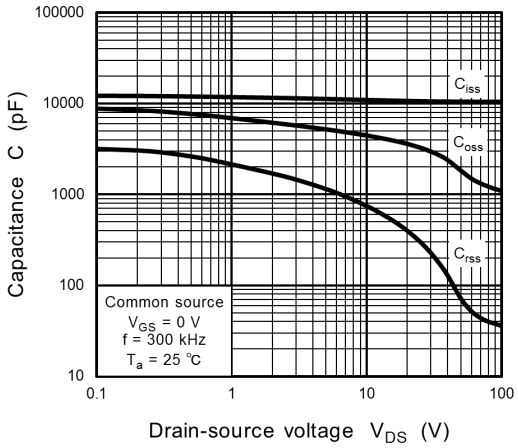


Fig. 9.13 Capacitance - V_{DS}

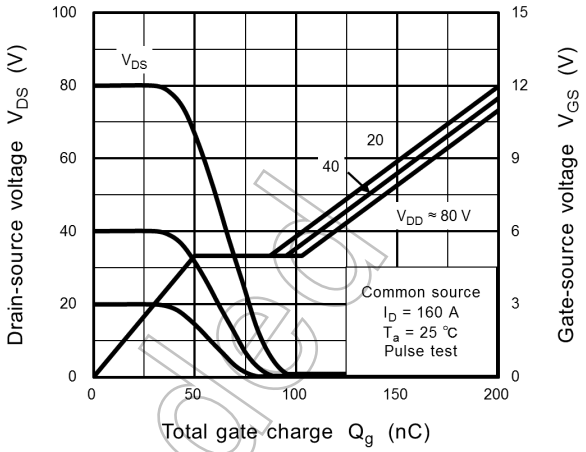


Fig. 9.14 Dynamic Input/Output Characteristics

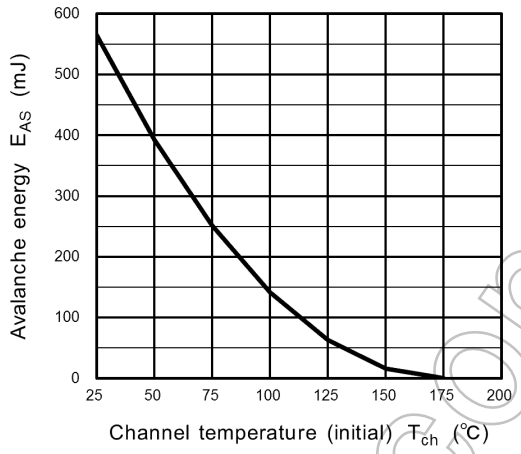


Fig. 9.15 E_{AS} - T_{ch}
(Guaranteed Maximum)

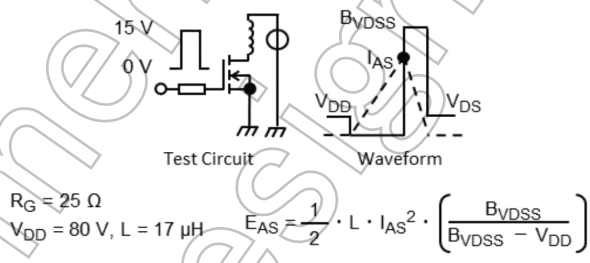


Fig. 9.16 Test Circuit/Waveform

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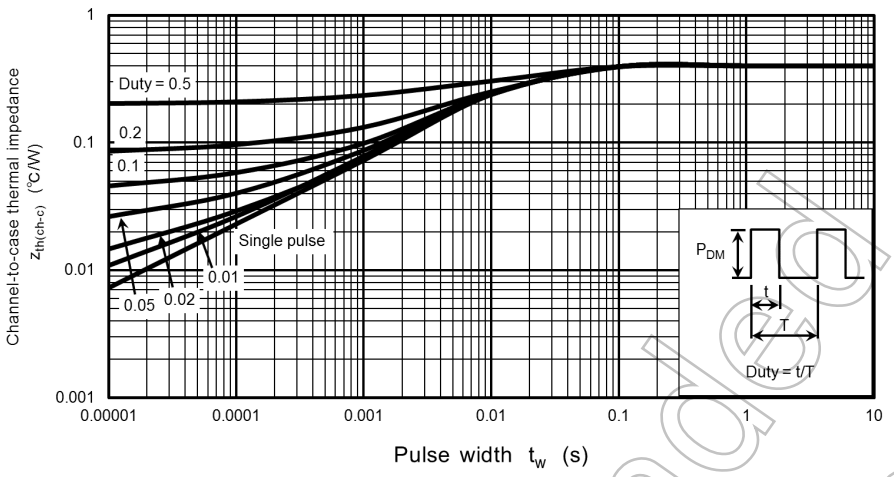


Fig. 9.17 $z_{th(ch-c)}$ - t_w (Guaranteed Maximum)

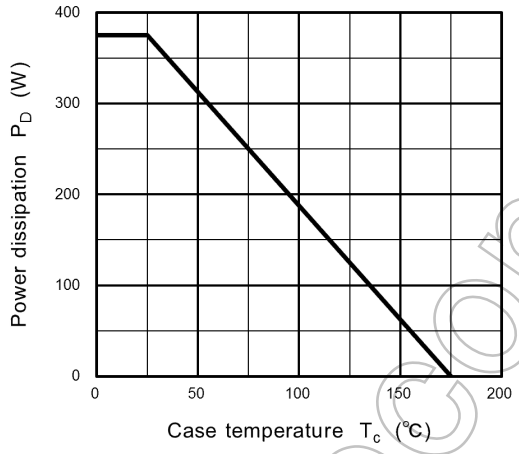


Fig. 9.18 P_D - T_c (Guaranteed Maximum)

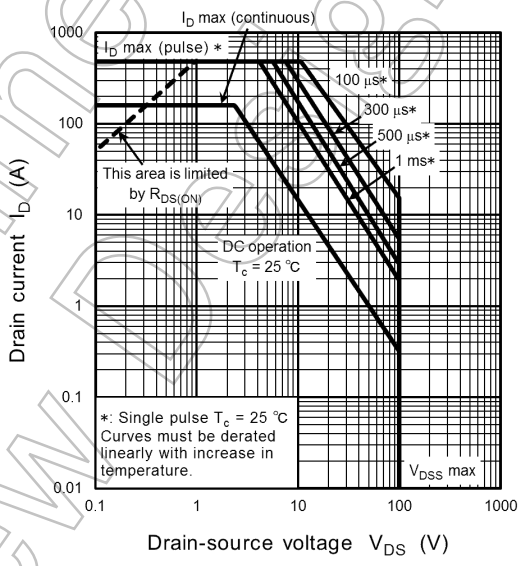


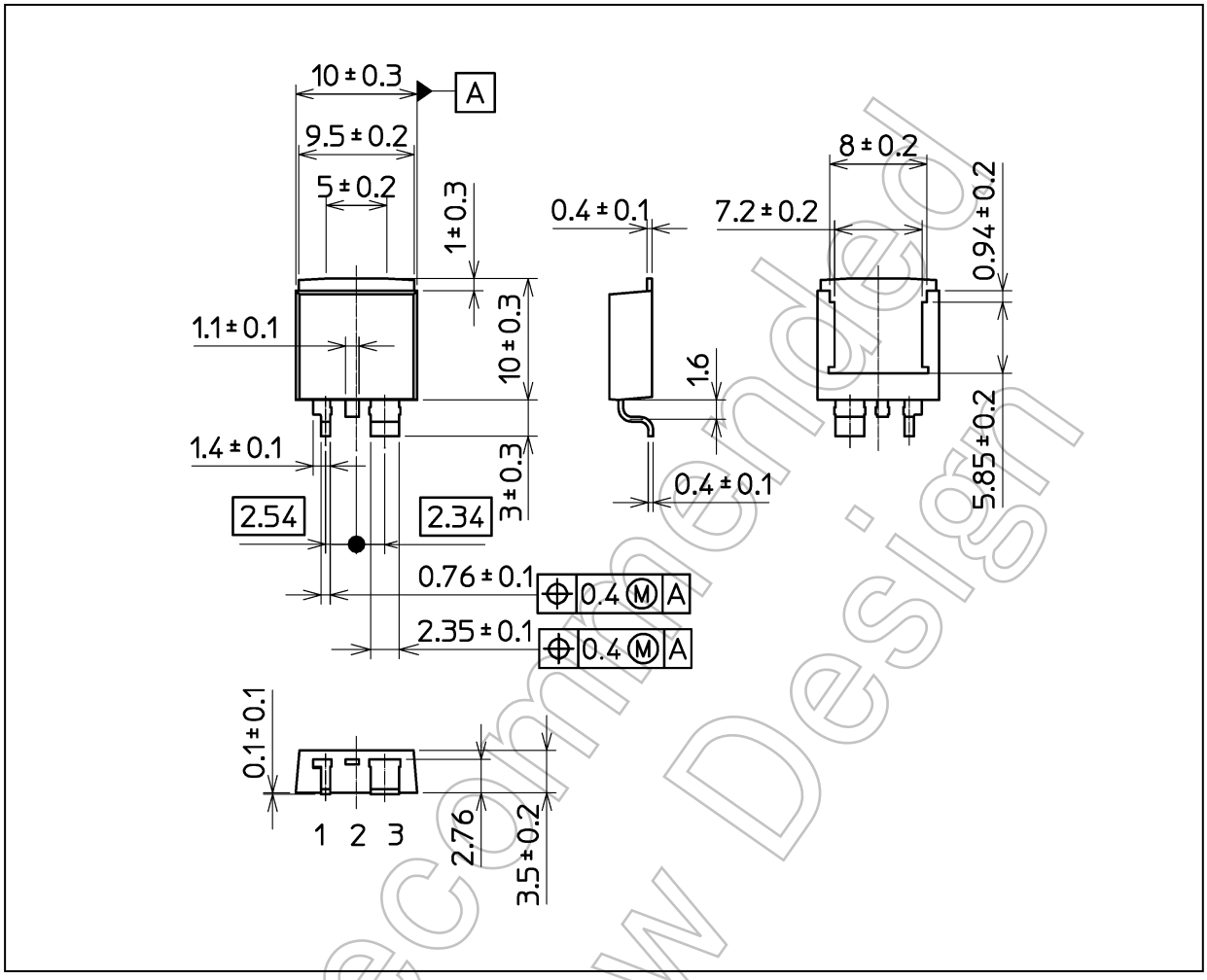
Fig. 9.19 Safe Operating Area (Guaranteed Maximum)

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: 1.07 g (typ.)

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

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