

V_{DSS}	600V
$R_{DS(on)}(Max.)$	0.98Ω
I_D	±2.4A
P_D	9.1W

●Features

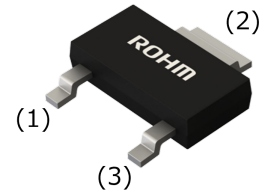
- 1) Low on-resistance
- 2) Low radiation noise
- 3) Fast switching
- 4) Parallel use is easy
- 5) Pb-free plating ; RoHS compliant

●Application

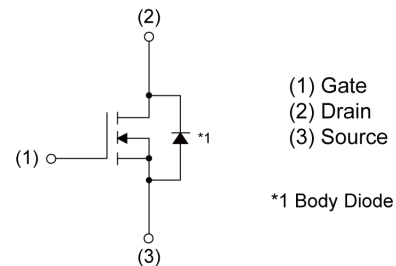
Switching applications

●Outline

SOT-223-3



●Inner circuit



●Packaging specifications

Packing	Embossed Tape
Packing code	TL1
Marking	R6004END4
Quantity (pcs)	4000

●Absolute maximum ratings ($T_a = 25^\circ\text{C}$,unless otherwise specified)

Parameter		Symbol	Value	Unit
Drain - Source voltage		V_{DSS}	600	V
Continuous drain current ($T_c = 25^\circ\text{C}$)		I_D^{*1}	±2.4	A
Pulsed drain current		I_{DP}^{*2}	±8.0	A
Gate - Source voltage	Static	V_{GSS}	±20	V
	AC($f > 1\text{Hz}$)		±30	V
Avalanche current, single pulse		I_{AS}^{*3}	0.8	A
Avalanche energy, single pulse		E_{AS}^{*3}	46	mJ
Power dissipation ($T_c = 25^\circ\text{C}$)		P_D	9.1	W
Junction temperature		T_j	150	°C
Operating junction and storage temperature range		T_{stg}	-55 to +150	°C

● Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - solder point	R_{thJS}^{*4}	-	-	13.7	°C/W
Thermal resistance, junction - ambient	R_{thJA}^{*5}	-	-	160	°C/W
Soldering temperature, wavesoldering for 10s	T_{sold}	-	-	265	°C

● Electrical characteristics ($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 1mA$	600	-	-	V
Zero gate voltage drain current	I_{DSS}	$V_{DS} = 600V, V_{GS} = 0V$ $T_j = 25^\circ\text{C}$	-	-	100	μA
		$T_j = 125^\circ\text{C}$	-	-	1000	
Gate - Source leakage current	I_{GSS}	$V_{GS} = \pm 20V, V_{DS} = 0V$	-	-	± 100	nA
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = 10V, I_D = 1mA$	2	-	4	V
Static drain - source on - state resistance	$R_{DS(on)}^{*6}$	$V_{GS} = 10V, I_D = 1.5A$ $T_j = 25^\circ\text{C}$	-	0.9	0.98	Ω
		$T_j = 125^\circ\text{C}$	-	1.36	-	
Gate resistance	R_G	$f = 1MHz, \text{open drain}$	-	17.5	-	Ω

●Electrical characteristics ($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Forward Transfer Admittance	$ Y_{fs} ^{*6}$	$V_{DS} = 10\text{V}, I_D = 2\text{A}$	1.5	3.0	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$	-	250	-	pF
Output capacitance	C_{oss}	$V_{DS} = 25\text{V}$	-	250	-	
Reverse transfer capacitance	C_{rss}	$f = 1\text{MHz}$	-	30	-	
Turn - on delay time	$t_{d(on)}^{*6}$	$V_{DD} \approx 300\text{V}, V_{GS} = 10\text{V}$	-	22	-	ns
Rise time	t_r^{*6}	$I_D = 2\text{A}$	-	22	-	
Turn - off delay time	$t_{d(off)}^{*6}$	$R_L \approx 150\Omega$	-	55	-	
Fall time	t_f^{*6}	$R_G = 10\Omega$	-	40	-	

●Gate charge characteristics ($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	Q_g^{*6}	$V_{DD} \approx 300\text{V}$	-	15	-	nC
Gate - Source charge	Q_{gs}^{*6}	$I_D = 4\text{A}$	-	2.5	-	
Gate - Drain charge	Q_{gd}^{*6}	$V_{GS} = 10\text{V}$	-	10	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 300\text{V}, I_D = 4\text{A}$	-	6.5	-	V

*1 Limited only by maximum channel temperature allowed.

*2 $P_w \leq 10\mu\text{s}$, Duty cycle $\leq 1\%$

*3 $L \approx 100\text{mH}$, $V_{DD} = 50\text{V}$, $R_G = 25\Omega$, starting $T_j = 25^\circ\text{C}$

*4 $T_s = 25^\circ\text{C}$

*5 Mounted on an epoxy PCB FR4 (20mm x 20mm x 0.8mm)

*6 Pulsed

●Body diode electrical characteristics (Source-Drain) ($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Source current	I_S^{*1}	$T_C = 25^\circ\text{C}$	-	-	2.4	A
Pulsed source current	I_{SP}^{*2}		-	-	8.0	A
Source-Drain voltage	V_{SD}^{*6}	$V_{GS} = 0\text{V}, I_S = 4.0\text{A}$	-	-	1.5	V
Reverse recovery time	t_{rr}^{*6}	$I_S = 4.0\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	320	-	ns
Reverse recovery charge	Q_{rr}^{*6}		-	2.4	-	μC
Peak reverse recovery current	I_{rr}^{*6}		-	15	-	A

●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

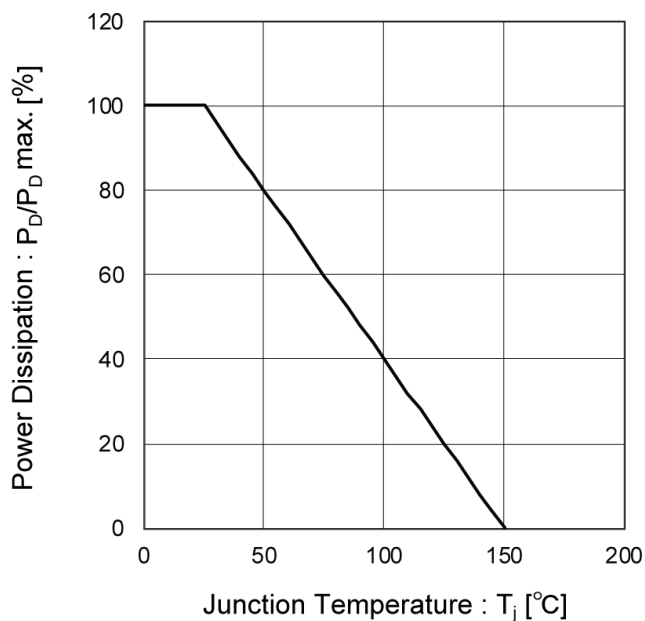


Fig.2 Drain Current Derating Curve

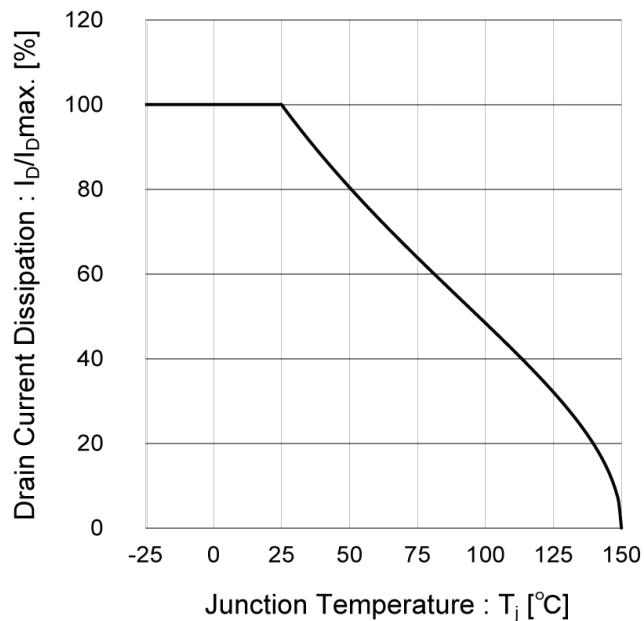


Fig.3 Transient Thermal Resistance vs. Pulse Width

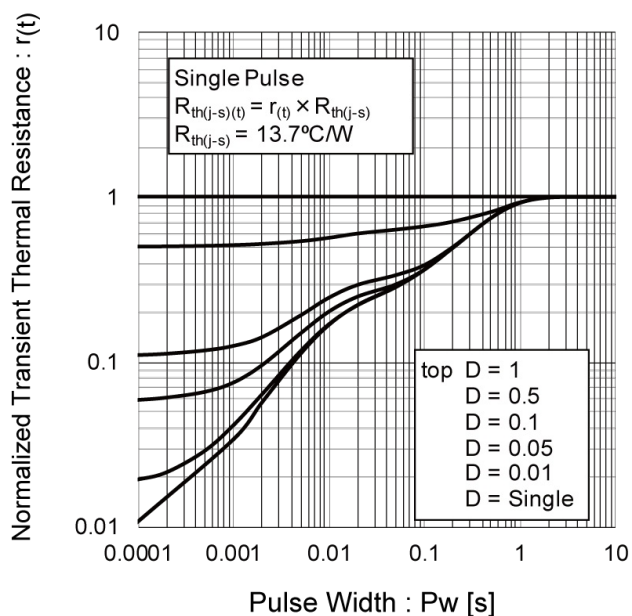
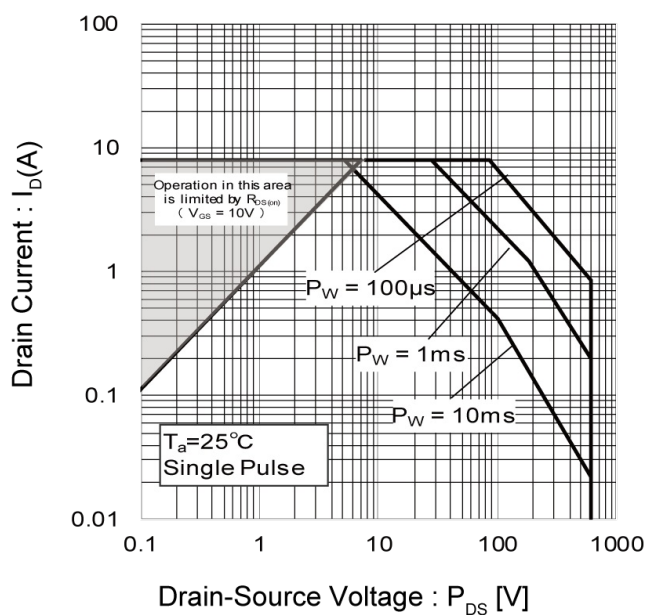


Fig.4 Maximum Safe Operating Area



●Electrical characteristic curves

Fig.5 Avalanche Energy Derating Curve

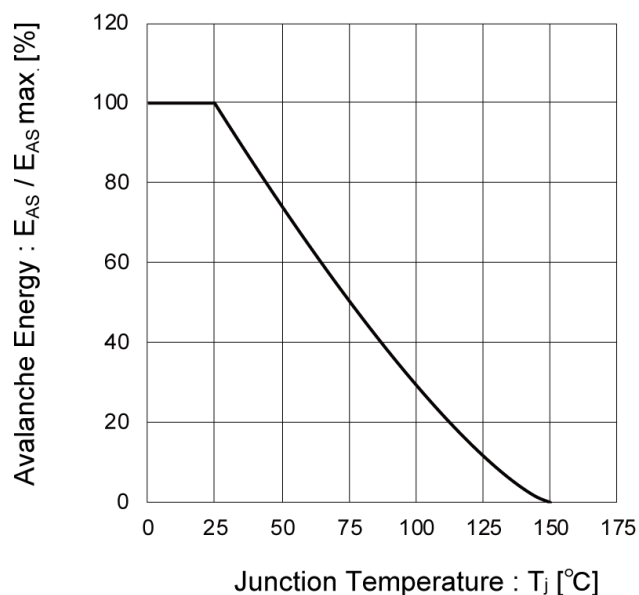


Fig.6 Breakdown Voltage vs. Junction Temperature

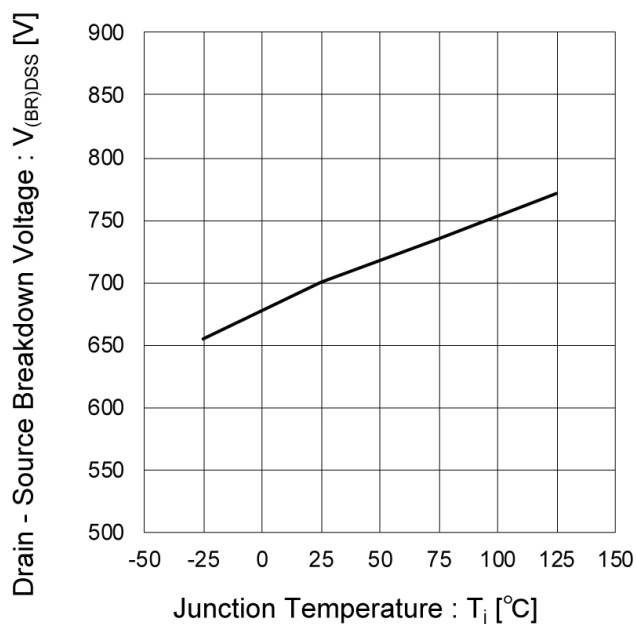


Fig.7 Typical Output Characteristics(I)

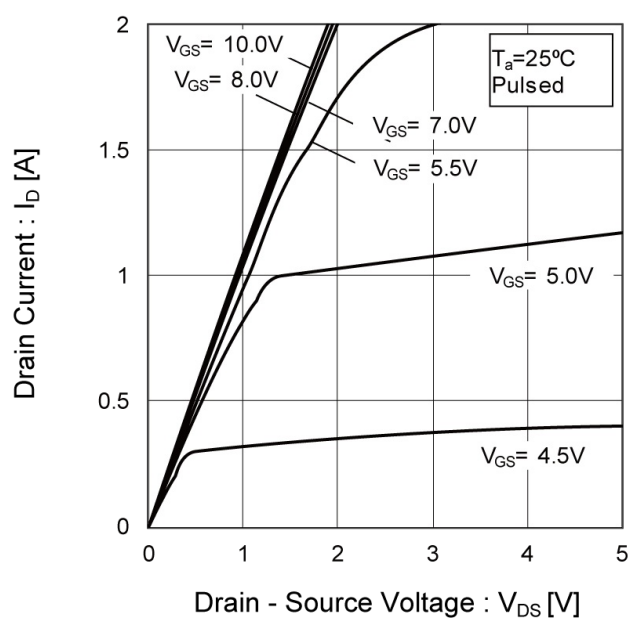
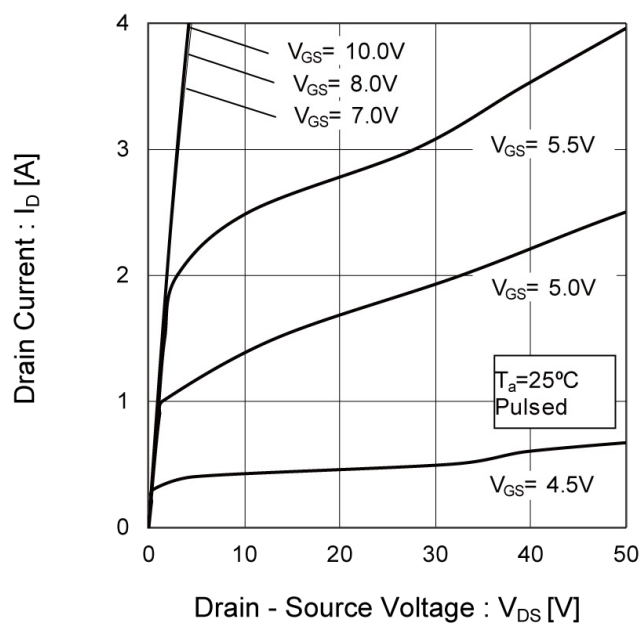


Fig.8 Typical Output Characteristics(II)



●Electrical characteristic curves

Fig.9 Gate Threshold Voltage
vs. Drain Current

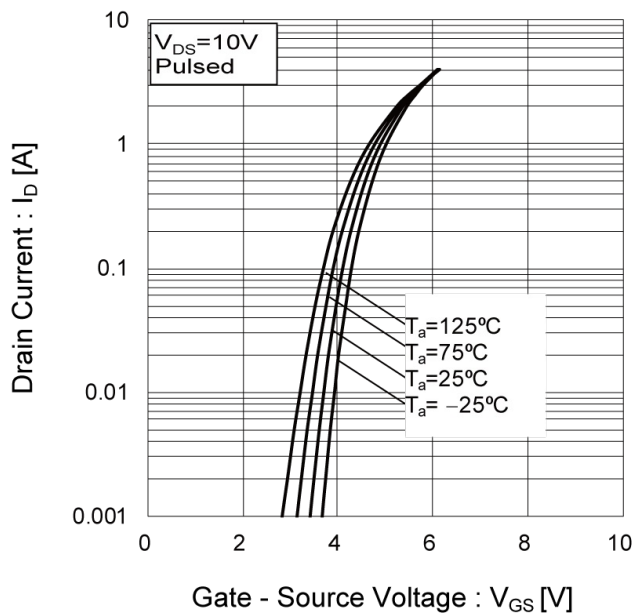


Fig.10 Gate Threshold Voltage
vs. Junction Temperature

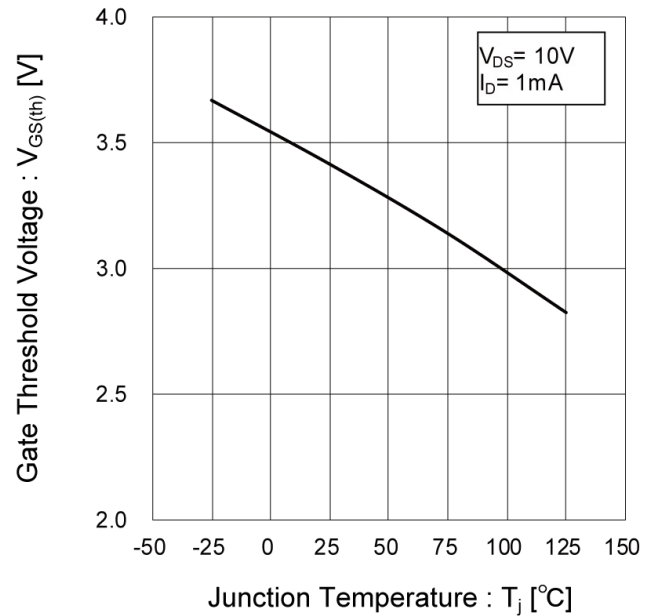
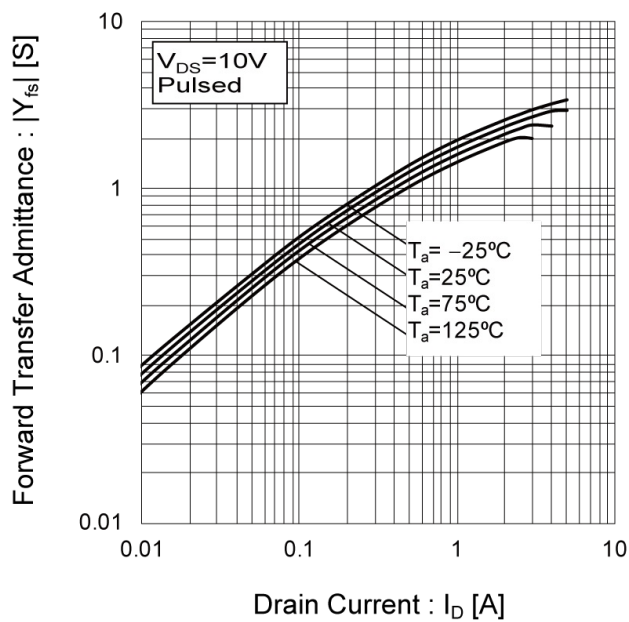


Fig.11 Forward Transfer Admittance
vs. Drain Current



●Electrical characteristic curves

Fig.12 Static Drain - Source On - State Resistance vs. Drain Current

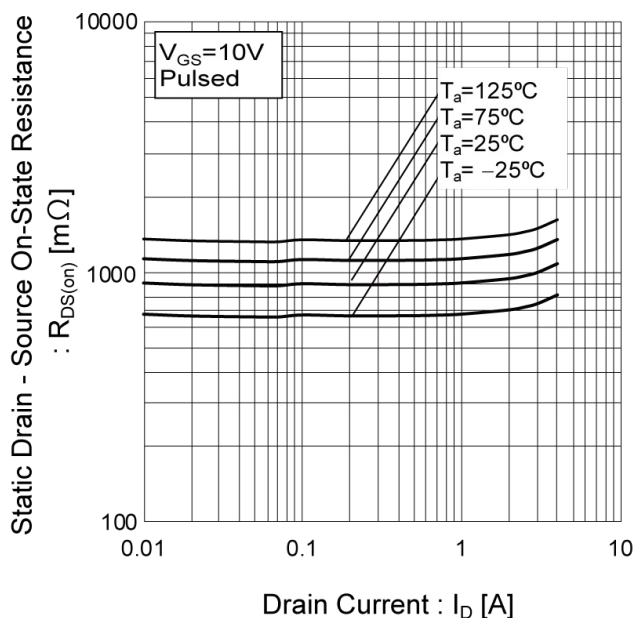


Fig.13 Static Drain - Source On - State Resistance vs. Gate Source Voltage

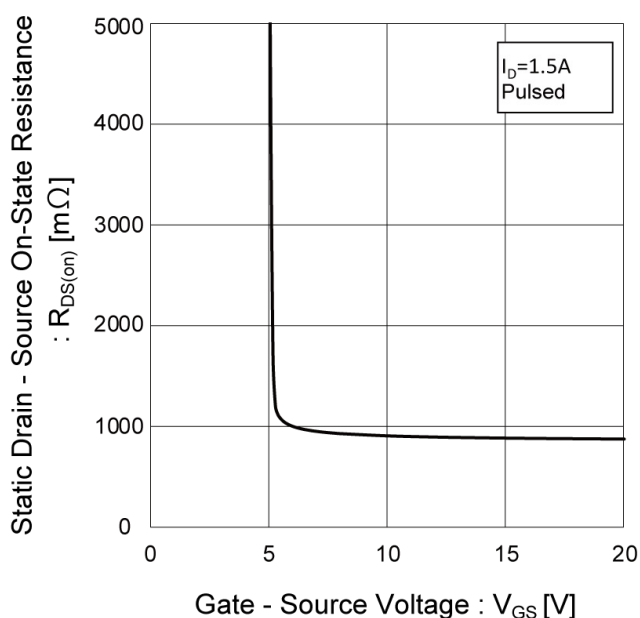
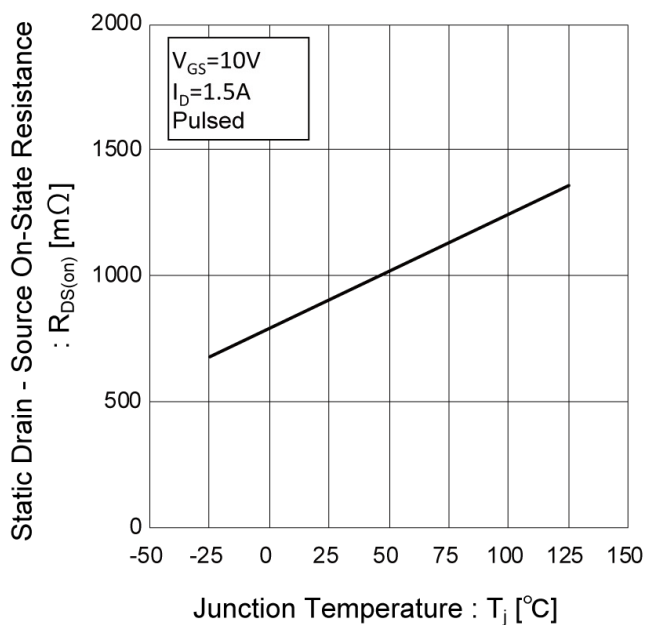


Fig.14 Static Drain - Source On - State Resistance vs. Junction Temperature



●Electrical characteristic curves

Fig.15 Typical Capacitance
vs. Drain - Source Voltage

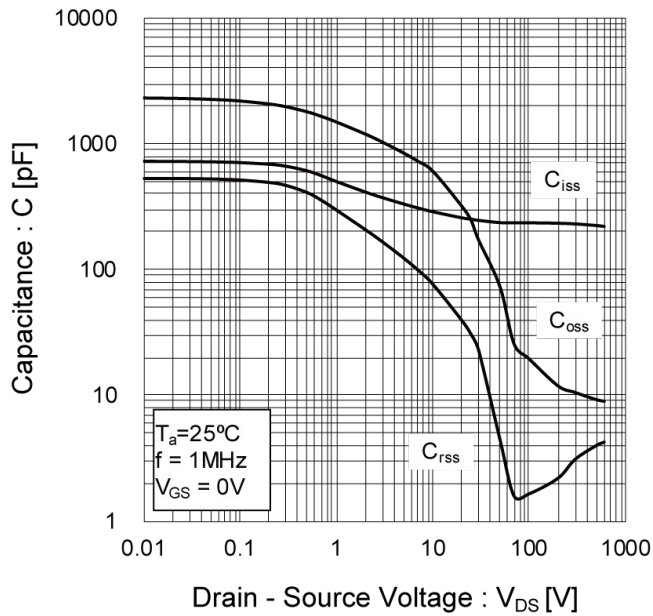


Fig.16 Switching Characteristics

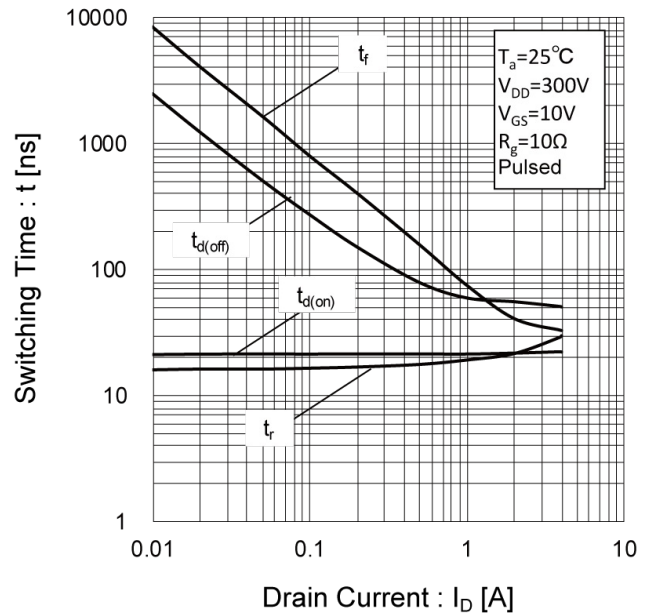
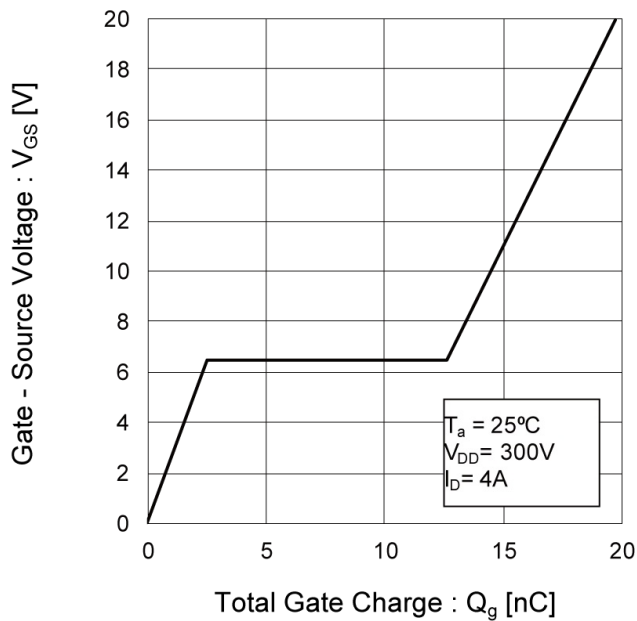


Fig.17 Typical Gate Charge



●Electrical characteristic curves

Fig.18 Source Current
vs. Source - Drain Voltage

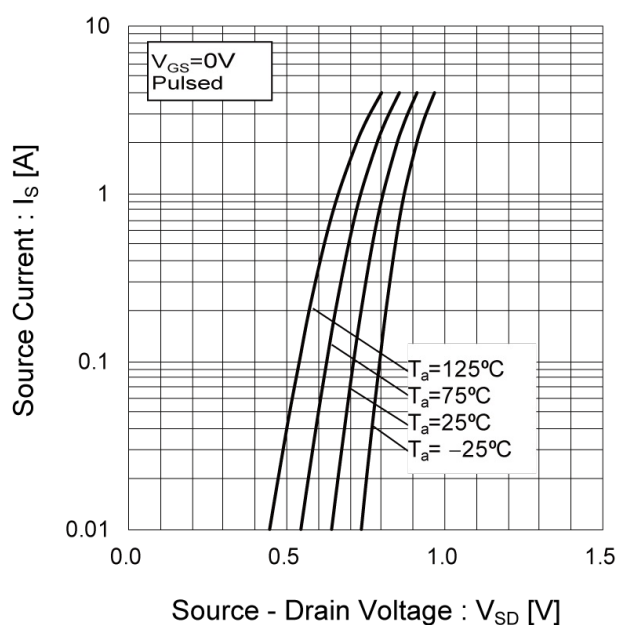
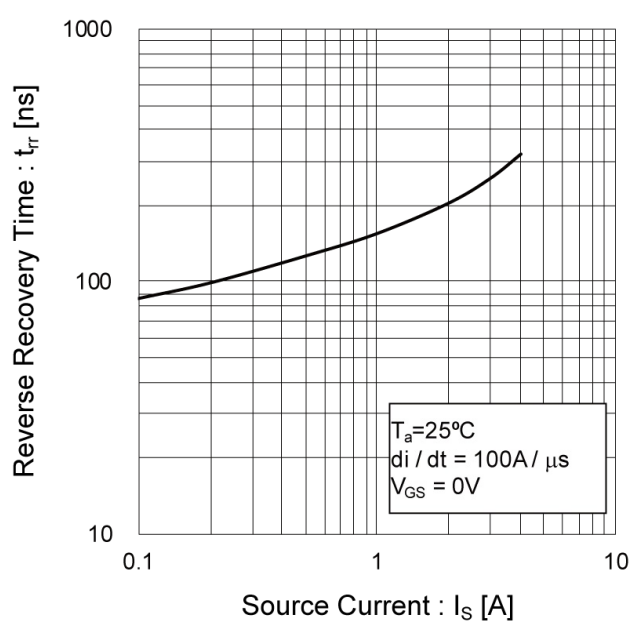


Fig.19 Reverse Recovery Time
vs. Source Current



● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

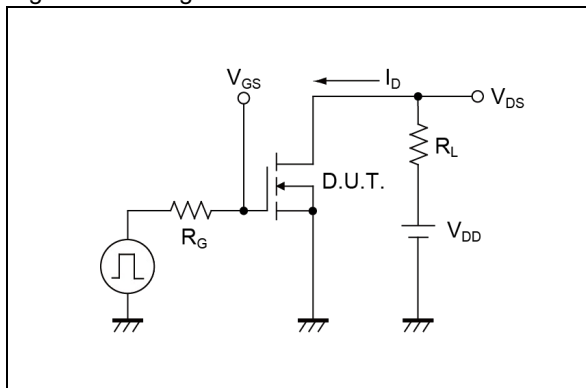


Fig.1-2 Switching Waveforms

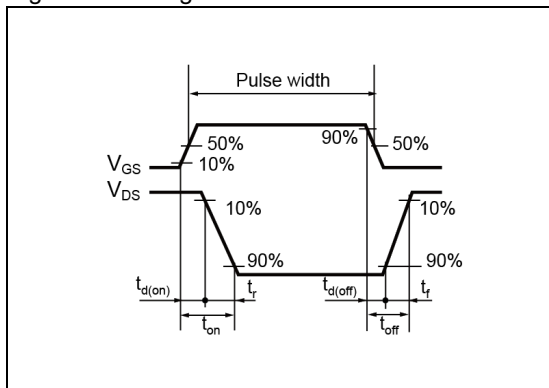


Fig.2-1 Gate Charge Measurement Circuit

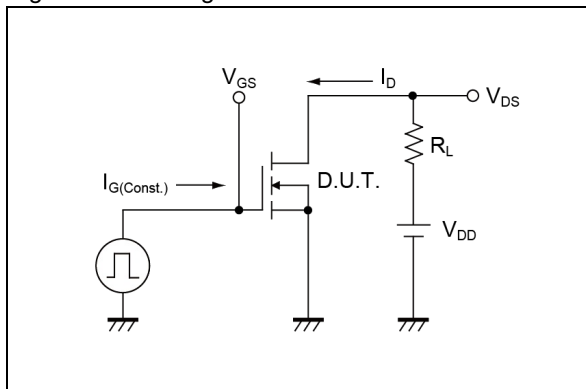


Fig.2-2 Gate Charge Waveform

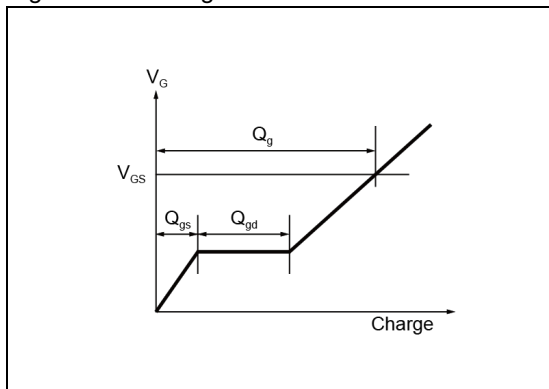


Fig.3-1 Avalanche Measurement Circuit

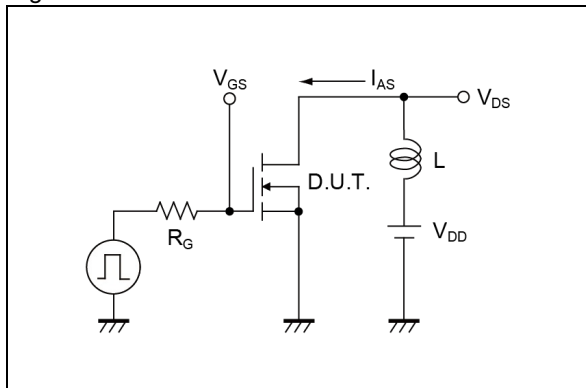


Fig.3-2 Avalanche Waveform

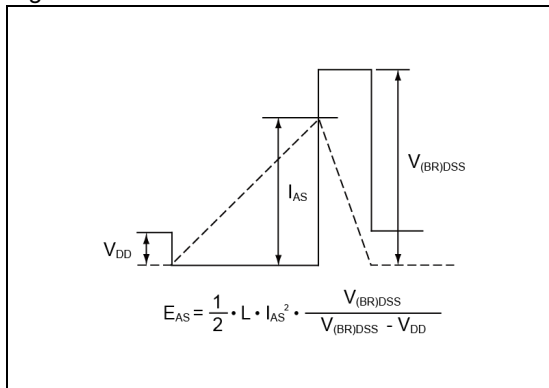


Fig.4-1 trr Measurement Circuit

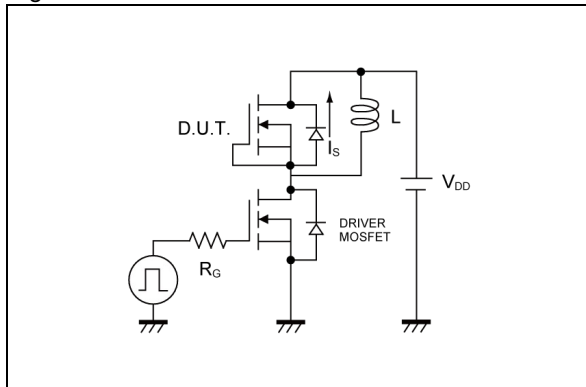
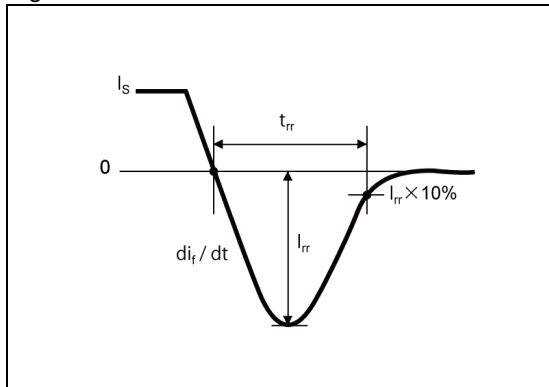
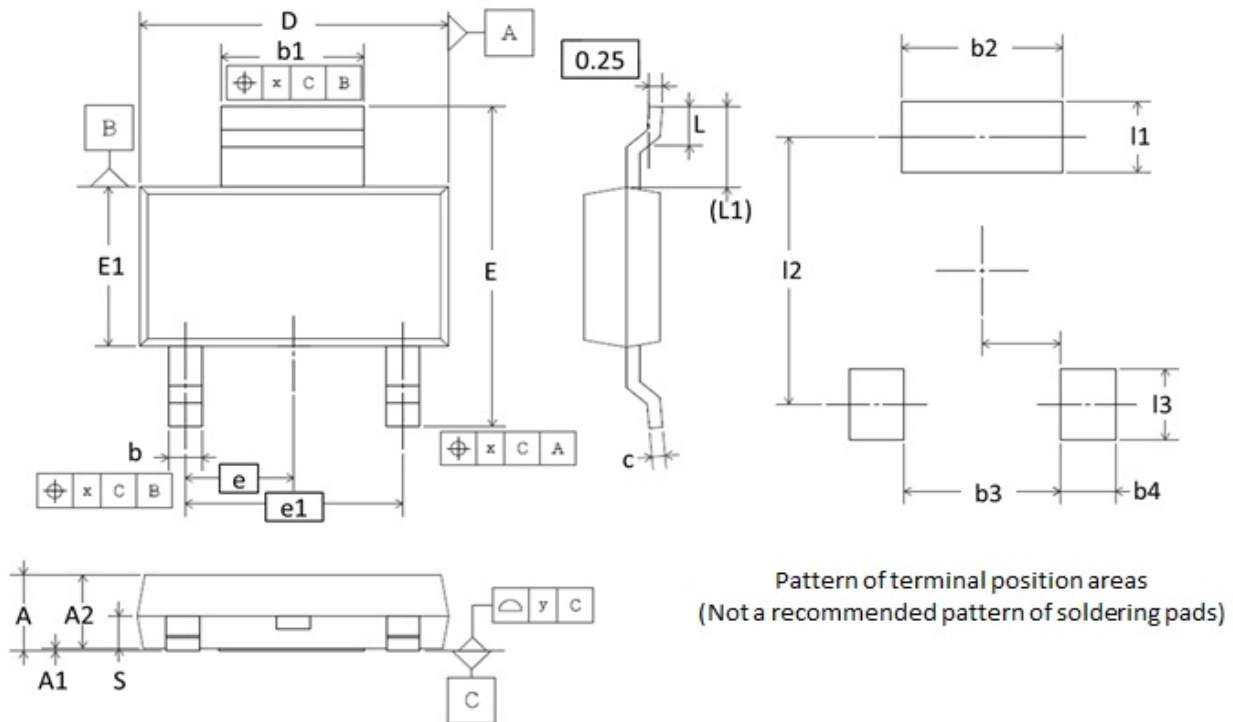


Fig.4-2 trr Waveform



●Dimensions

SOT-223



DIM	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.52	1.80	0.060	0.071
A1	0.02	0.10	0.001	0.004
A2	1.50	1.70	0.059	0.067
b	0.60	0.80	0.024	0.031
b1	2.95	3.10	0.116	0.122
c	0.24	0.32	0.009	0.013
D	6.30	6.70	0.248	0.264
E	6.70	7.30	0.264	0.287
E1	3.30	3.70	0.130	0.146
e	2.30		0.091	
e1	4.60		0.181	
L	0.85	1.15	0.033	0.045
L1	1.75		0.069	
S	0.70		0.028	
x	-	0.10	-	0.004
y	-	0.08	-	0.003

DIM	Millimeters		Inches	
	Min.	Max.	Min.	Max.
b2	-	3.50	-	0.138
b3	-	3.40	-	0.134
b4	-	1.20	-	0.047
l1	-	1.60	-	0.063
l2	-	6.00	-	0.236
l3	-	1.60	-	0.063

Dimension in mm / inches

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

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 - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
 - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
 - Sealing or coating our Products with resin or other coating materials
 - Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
 - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
 - [a] the Products are exposed to sea winds or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [b] the temperature or humidity exceeds those recommended by ROHM
 - [c] the Products are exposed to direct sunshine or condensation
 - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

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