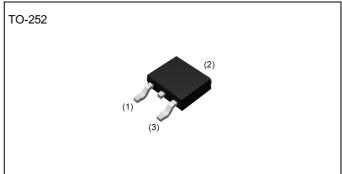


# R6509KND3

# Nch 650V 9A Power MOSFET

V <sub>DSS</sub>	650V
R <sub>DS(on)</sub> (Max.)	0.585Ω
I <sub>D</sub>	±9A
P <sub>D</sub>	94W

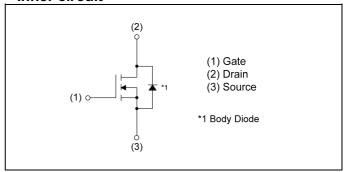
# Outline TO-252



## Features

- 1) Low on-resistance
- 2) Ultra fast switching speed
- 3) Parallel use is easy
- 4) Pb-free plating; RoHS compliant

# •Inner circuit



# Application

Switching

Packaging specifications

Packing	Embossed Tape
Packing code	TL1
Marking	R6509K
Quantity (pcs)	2500

# ● **Absolute maximum ratings** (T<sub>a</sub> = 25°C ,unless otherwise specified)

Parameter	Symbol	Value	Unit	
Drain - Source voltage		V <sub>DSS</sub>	650	V
Continuous drain current (T <sub>c</sub> = 25°C)		I <sub>D</sub> *1	±9	Α
Pulsed drain current	I <sub>DP</sub> *2	±27	Α	
static		\/	±20	V
Gate - Source voltage	AC(f>1Hz)	$V_{GSS}$	±30	V
Avalanche current, single pulse		I <sub>AS</sub>	1.4	А
Avalanche energy, single pulse		E <sub>AS</sub> *3	158	mJ
Power dissipation (T <sub>c</sub> = 25°C)	P <sub>D</sub>	94	W	
Junction temperature	T <sub>j</sub>	150	°C	
Operating junction and storage tempera	ature range	T <sub>stg</sub>	-55 to +150	°C

# ●Thermal resistance

Downwortow	Cymah al	Values			1.124
Parameter	Symbol	Min.	Тур.	Max.	Unit
Thermal resistance, junction - case	R <sub>thJC</sub> *4	-	-	1.3	°C/W
Thermal resistance, junction - ambient	R <sub>thJA</sub> *5	-	-	147	°C/W
Soldering temperature, wavesoldering for 10s	T <sub>sold</sub>	-	-	265	°C

# ● Electrical characteristics (T<sub>a</sub> = 25°C)

Darameter	Cumbal	Conditions	Values			- Unit	
Parameter	Symbol	Symbol Conditions –		Тур.	Max.	Offic	
Drain - Source breakdown voltage	$V_{(BR)DSS}$ $V_{GS} = 0V, I_D = 1mA$		650	-	-	V	
		V <sub>DS</sub> = 650V, V <sub>GS</sub> = 0V					
Zero gate voltage drain current	I <sub>DSS</sub>	$T_j = 25^{\circ}C$	-	-	100	μΑ	
aram canoni		$T_j = 125^{\circ}C$	-	-	1000		
Gate - Source leakage current	I <sub>GSS</sub>	V <sub>GS</sub> = ±20V, V <sub>DS</sub> = 0V	-	-	±100	nA	
Gate threshold voltage	V <sub>GS(th)</sub>	$V_{DS} = V_{GS}, I_{D} = 230 \mu A$	3	-	5	V	
		V <sub>GS</sub> = 10V, I <sub>D</sub> = 2.8A					
Static drain - source on - state resistance	R <sub>DS(on)</sub> *6	$T_j = 25^{\circ}C$	-	0.530	0.585	Ω	
		$T_j = 125^{\circ}C$	-	1.10	-		
Gate resistance	$R_{G}$	f = 1MHz, open drain	-	3.1	-	Ω	

# ● Electrical characteristics (T<sub>a</sub> = 25°C)

Downwater	Cymah al	Conditions		Unit		
Parameter	Symbol	Symbol Conditions -		Тур.	Max.	Unit
Input capacitance	C <sub>iss</sub>	V <sub>GS</sub> = 0V	-	540	-	
Output capacitance	C <sub>oss</sub>	V <sub>DS</sub> = 25V	-	550	-	pF
Reverse transfer capacitance	C <sub>rss</sub>	f = 1MHz	-	25	-	
Turn - on delay time	t <sub>d(on)</sub> *6	$V_{DD} \simeq 300V$ , $V_{GS} = 10V$	-	20	-	
Rise time	t <sub>r</sub> *6	I <sub>D</sub> = 4.5A	-	20	-	
Turn - off delay time	t <sub>d(off)</sub> *6	$R_L \simeq 66.7\Omega$	-	38	-	ns
Fall time	t <sub>f</sub> *6	$R_G = 10\Omega$	-	20	-	

# ● Gate charge characteristics (T<sub>a</sub> = 25°C)

Daramatar	Cymah al	Conditions	Values			Unit	
Parameter	Symbol	Conditions	Min.	Тур.	Max.	Offic	
Total gate charge	$Q_g^{*6}$	V <sub>DD</sub> ≈ 300V	-	16.5	-		
Gate - Source charge	Q <sub>gs</sub> *6	I <sub>D</sub> = 9.0A	-	4.5	-	nC	
Gate - Drain charge	Q <sub>gd</sub> *6	V <sub>GS</sub> = 10V	-	7.6	-		
Gate plateau voltage	V <sub>(plateau)</sub>	V <sub>DD</sub> ≈ 300V, I <sub>D</sub> = 9A	-	6.9	-	V	

<sup>\*1</sup> Limited only by maximum channel temperature allowed.

<sup>\*2</sup> Pw ≤ 10µs, Duty cycle ≤ 1%

<sup>\*3</sup> L $\doteqdot$ 100mH, V<sub>DD</sub>=50V, R<sub>G</sub>=25 $\Omega$ , STARTING T<sub>i</sub>=25 $^{\circ}$ C

<sup>\*4</sup> T<sub>C</sub>=25°C

<sup>\*5</sup> Mounted on an epoxy PCB FR4 (20mm x 20mm x 0.8mm)

<sup>\*6</sup> Pulsed

# ● Body diode electrical characteristics (Source-Drain) (T<sub>a</sub> = 25°C)

Parameter	Cymbol	Conditions	Values			Unit	
Parameter	Symbol Conditions —		Min.	Тур.	Max.	UTIIL	
Source current	I <sub>S</sub> *1	T <sub>C</sub> = 25°C	1	-	9	Α	
Pulsed source current	I <sub>SP</sub> *2	1C - 23 C	1	-	27	Α	
Source-Drain voltage	V <sub>SD</sub> *6	$V_{GS} = 0V, I_{S} = 9.0A$	-	-	1.5	٧	
Reverse recovery time	t <sub>rr</sub> *6		-	360	-	ns	
Reverse recovery charge	Q <sub>rr</sub> *6	I <sub>S</sub> = 9A di/dt = 100A/μs	-	3.6	-	μC	
Peak reverse recovery current	I <sub>rr</sub> *6		-	20	-	Α	

Fig.1 Power Dissipation Derating Curve

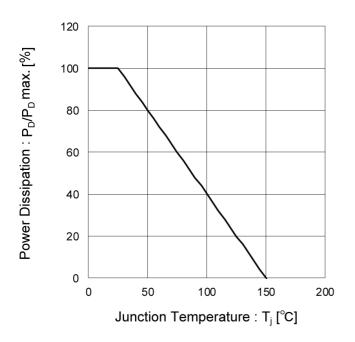


Fig.2 Drain Current Derating Curve

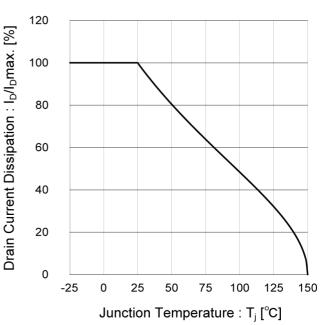


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

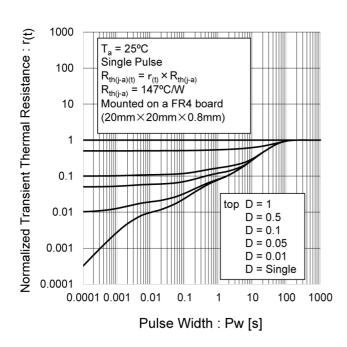
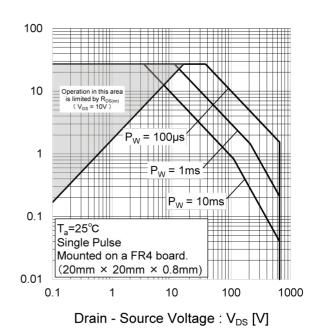


Fig.4 Maximum Safe Operating Area



Drain Current : I<sub>D</sub> [A]

Fig.5 Avalanche Energy Derating
Curve vs. Junction Temperature

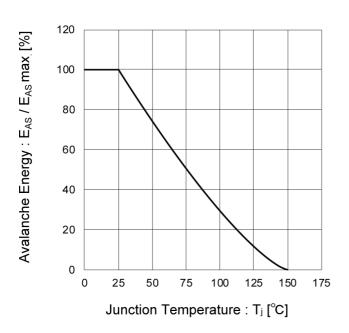


Fig.6 Normalized Breakdown Voltage vs. Junction Temperature

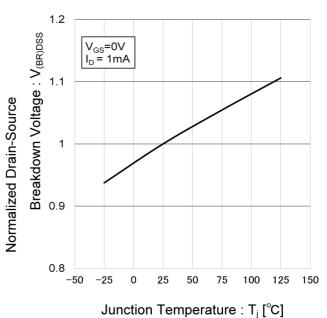


Fig.7 Typical Output Characteristics(I)

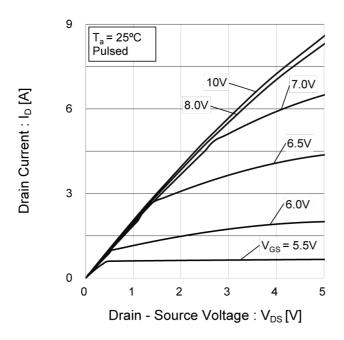
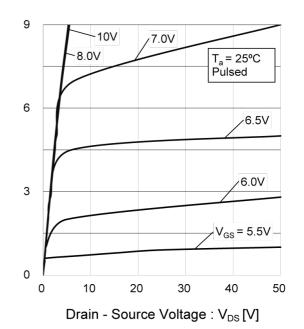


Fig.8 Typical Output Characteristics(II)



Drain Current : I<sub>D</sub> [A]

Fig.9 Typical Transfer Characteristics

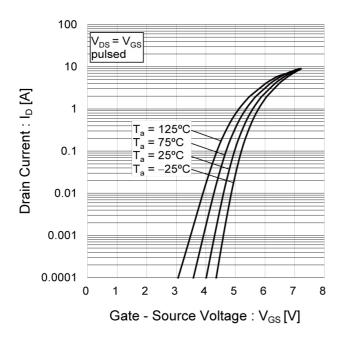


Fig.10 Normalized Gate Threshold

Voltage vs. Junction Temperature

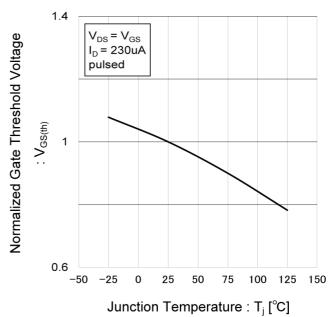


Fig.11 Static Drain - Source On - State Resistance vs. Drain Current

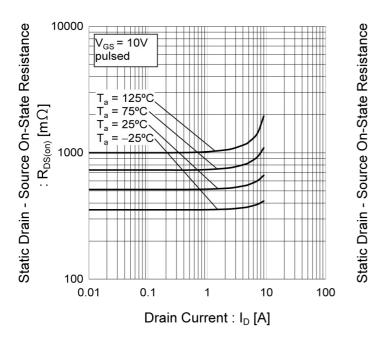


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

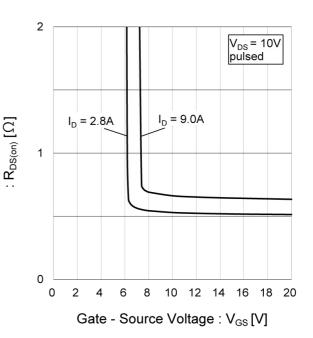


Fig.13 Normalized Static Drain - Source On - State Resistance vs. Junction Temperature

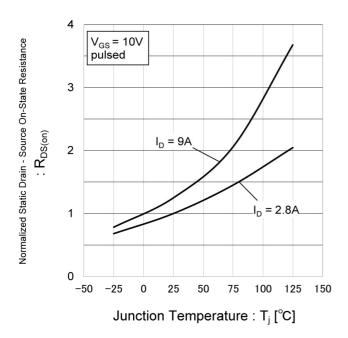


Fig.14 Typical Capacitance vs.

Drain - Source Voltage

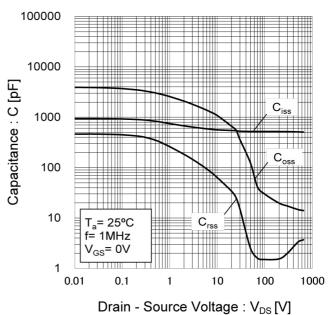


Fig.15 Switching Characteristics

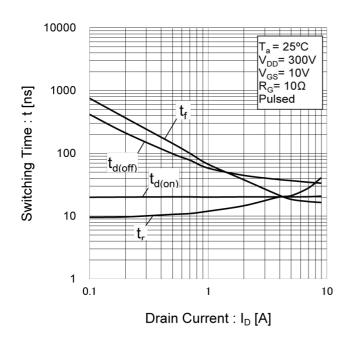
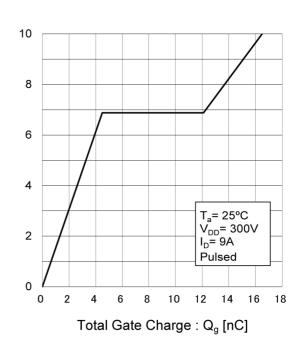
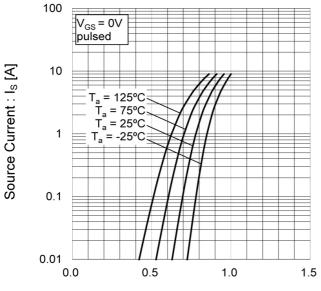


Fig.16 Typical Gate Charge



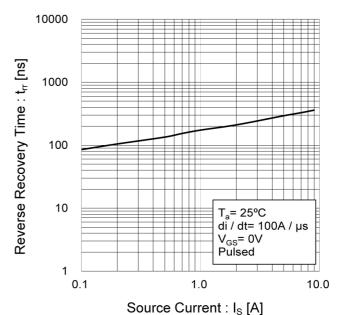
Gate - Source Voltage : V<sub>GS</sub> [V]

Fig.17 Source Current vs. Source - Drain Voltage



Source - Drain Voltage : V<sub>SD</sub> [V]

Fig.18 Reverse Recovery Time vs. Source Current



## Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

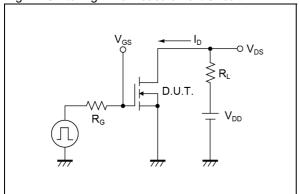


Fig.2-1 Gate Charge Measurement Circuit

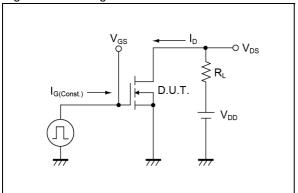


Fig.3-1 Avalanche Measurement Circuit

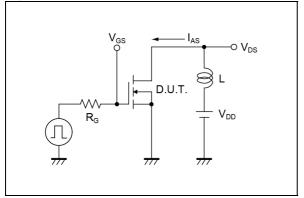


Fig.4-1 trr Measurement Circuit

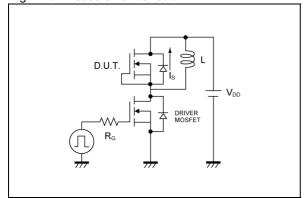


Fig.1-2 Switching Waveforms

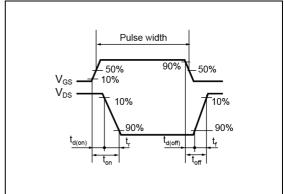


Fig.2-2 Gate Charge Waveform

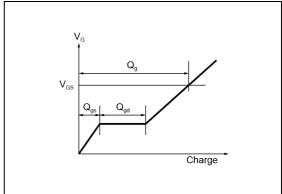


Fig.3-2 Avalanche Waveform

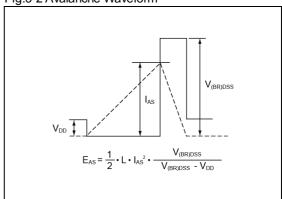
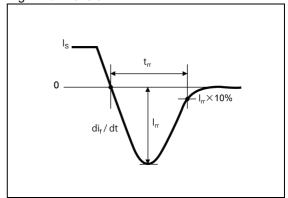
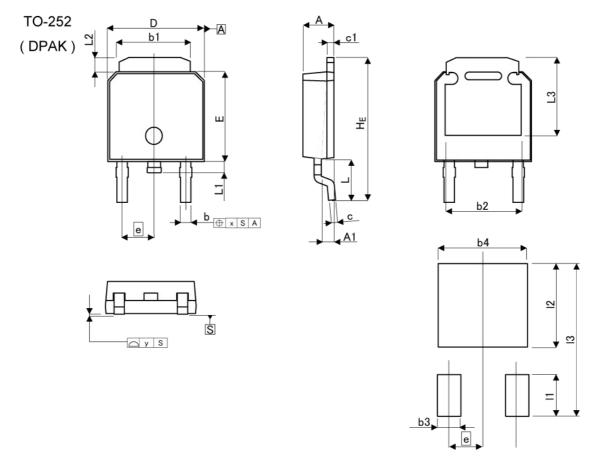


Fig.4-2 trr Waveform



# Dimensions



Pattern of terminal position areas [Not a recommended pattern of soldering pads]

DIM	MILIME	TERS	INCI	HES	
DIIVI	MIN	MAX	MIN	MAX	
Α	2.20	2.40	0.087	0.094	
A1	0.70	1.10	0.028	0.043	
b	0.60	0.90	0.024	0.035	
b1	5.20	5.50	0.205	0.217	
b2	5.	35	0.2	211	
С	0.40	0.60	0.016	0.024	
c1	0.40	0.60	0.016	0.024	
D	6.40	6.80	0.252	0.268	
е	2.	30	0.0	91	
E	6.00	6.40	0.236	0.252	
HE	9.40	10.40	0.370	0.409	
L	2.70		0.1	06	
L1	0.60	1.00	0.024	0.039	
L2	0.70	1.30	0.028	0.051	
L3	5.	30	0.2	209	
Х	1	0.25	-	0.010	
У	-	0.10	-	0.004	

DIM	MILIME	ETERS	INC	HES
DIIVI	MIN	MAX	MIN	MAX
b3	127	1.15	51	0.045
b4	(=)(	5.55	-	0.219
I1		2.77	2	0.109
12	180	5.50	-	0.217
13	-	10.40		0.409

11/11

Dimension in mm/inches



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1. Our Products are designed and manufactured for application in ordinary electronic equipment (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, 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 any ROHM's Products for Specific Applications.

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JÁPAN	USA	EU	CHINA
CLASSⅢ	CL ACCIII	CLASS II b	CL ACCIII
CLASSIV	CLASSⅢ	CLASSⅢ	CLASSⅢ

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  - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] 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
  - [h] Use of the Products in places subject to dew condensation
- 4. The Products are not subject to radiation-proof design.
- 5. Please verify and confirm characteristics of the final or mounted products in using the Products.
- 6. 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.
- 7. 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.
- 8. 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

- 1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- 2. 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

### **Precautions Regarding Application Examples and External Circuits**

- 1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
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#### **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 lonizer, 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 Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [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
- 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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