

COMMON PARTS/MATERIALS, SPACE USE,
APPLICATION DATA SHEET FOR

Part Description	POWER MOSFET, N-CHANNEL, RADIATION HARDENED, HIGH RELIABILITY, SPACE USE
Part Number and Type	JAXA R 2SK1A01
Applicable Specification	JAXA-QTS-2030 JAXA-QTS-2030/105

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Prepared and Established by Fuji Electric Co., Ltd.

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This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official Japanese version.

The release date of the English version of this specification: March 15, 2022.

Revision Log

Rev.	Date	Description
-----	29 March 2012	Original
A	18 March 2020	▪ Cover: Changed the corporate name. ▪ Paragraph 10 Others: Changed the contact information.

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**COMMON PARTS/MATERIALS,
SPACE USE,
APPLICATION DATA SHEET FOR**

1. GENERAL

1.1 Scope

This Application Data Sheet provides additional detailed information necessary for designing or selecting products not contained in JAXA QML. Relevant information not covered in this document shall also be considered. Users are responsible for all aspects pertaining to selection and use of the product(s) specified in this document.

1.2 Applicable Documents

The latest versions of the following documents are applicable to the device mentioned in this data sheet.

- | | |
|----------------------|--|
| a) JAXA-QTS-2030 | Semiconductor Device, High Reliability, Space Use,
General Specification for |
| b) JAXA-QTS-2030/105 | POWER MOSFET, N-CHANNEL, RADIATION HARDENED,
HIGH RELIABILITY, SPACE USE, DETAIL SPECIFICATION
FOR |
| c) MIL-STD-750 | TEST METHOD STANDARD, TEST METHODS FOR
SEMICONDUCTOR DEVICES |

2. SUMMARY OF PRODUCT

2.1 Externals and Dimensions

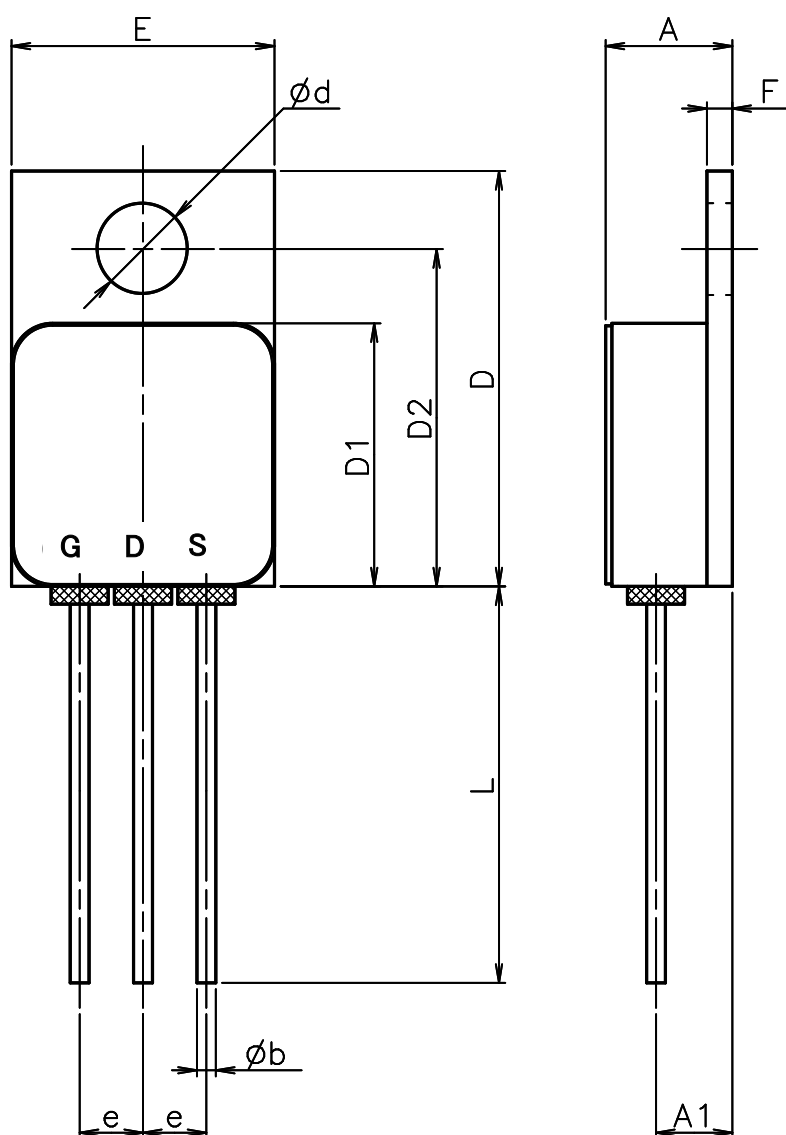
The case outline and dimensions of the device are shown in Figure 1. The internal structure is shown in Figure 2 and the marking of the device is illustrated in Figure 3.

2.2 Net Weight

4.3g (typ.)

2.3 Devices Structure

The device consists of one N-channel enhancement planar type MOSFET chip and a seam-welded hermetic seal package. The internal structure and the cross-section of the device are drawn in Figure 2.

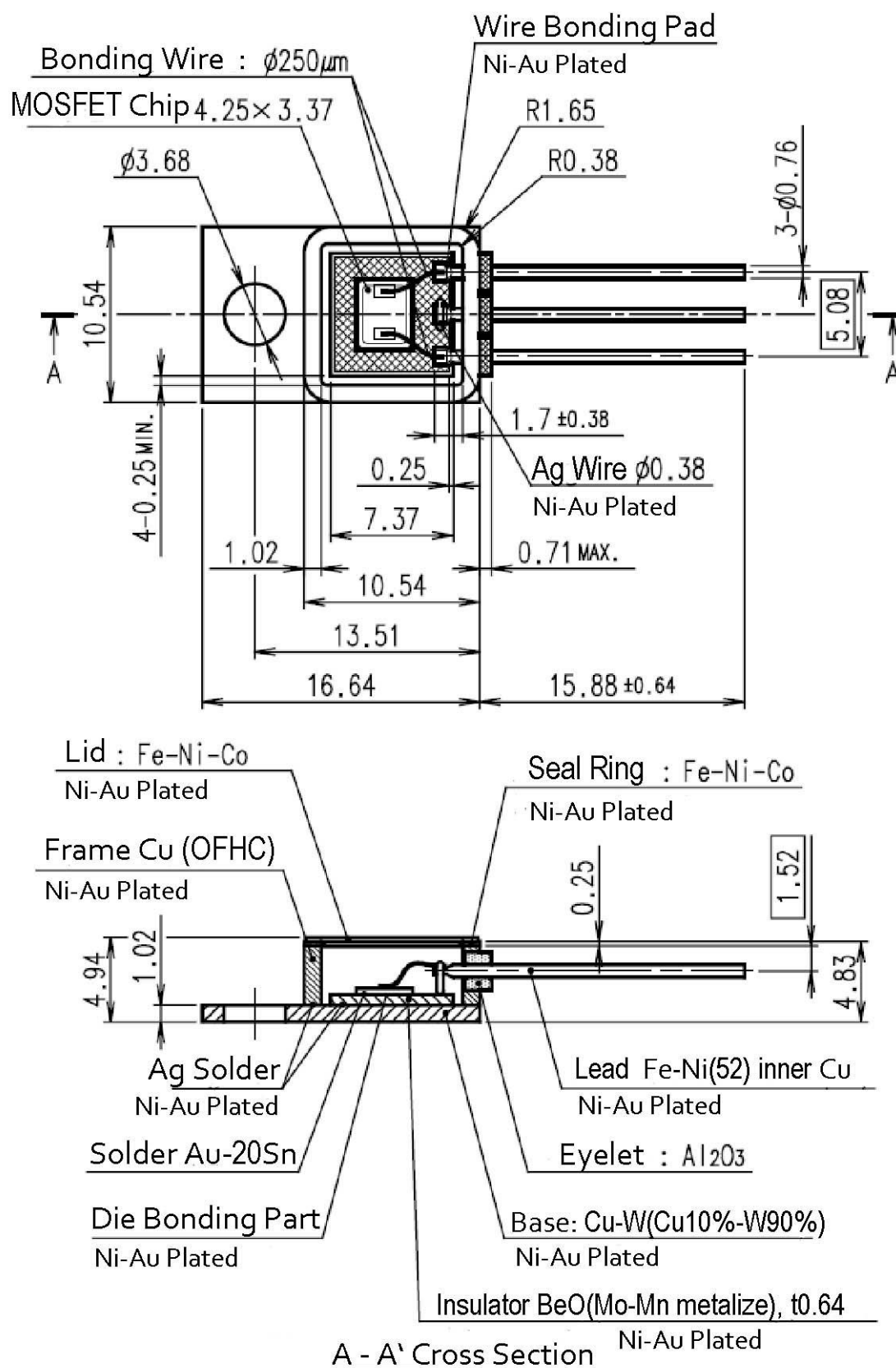


Symbol	Dimension (mm)	
	Min	Max
A	4.76	5.11
A1	2.92	3.18
ϕb	0.64	0.89
D	16.51	16.76
D1	10.41	10.67
D2	13.39	13.64

Symbol	Dimension (mm)	
	Min	Max
ϕd	3.56	3.81
E	10.41	10.67
e	2.48	2.60
F	0.89	1.14
L	15.24	16.51

Note: All leads are isolated from the case.

Figure 1. Outline and Dimensions of TO-257



Unit: mm

Figure 2. Inner Structure and Cross-Section of TO-257

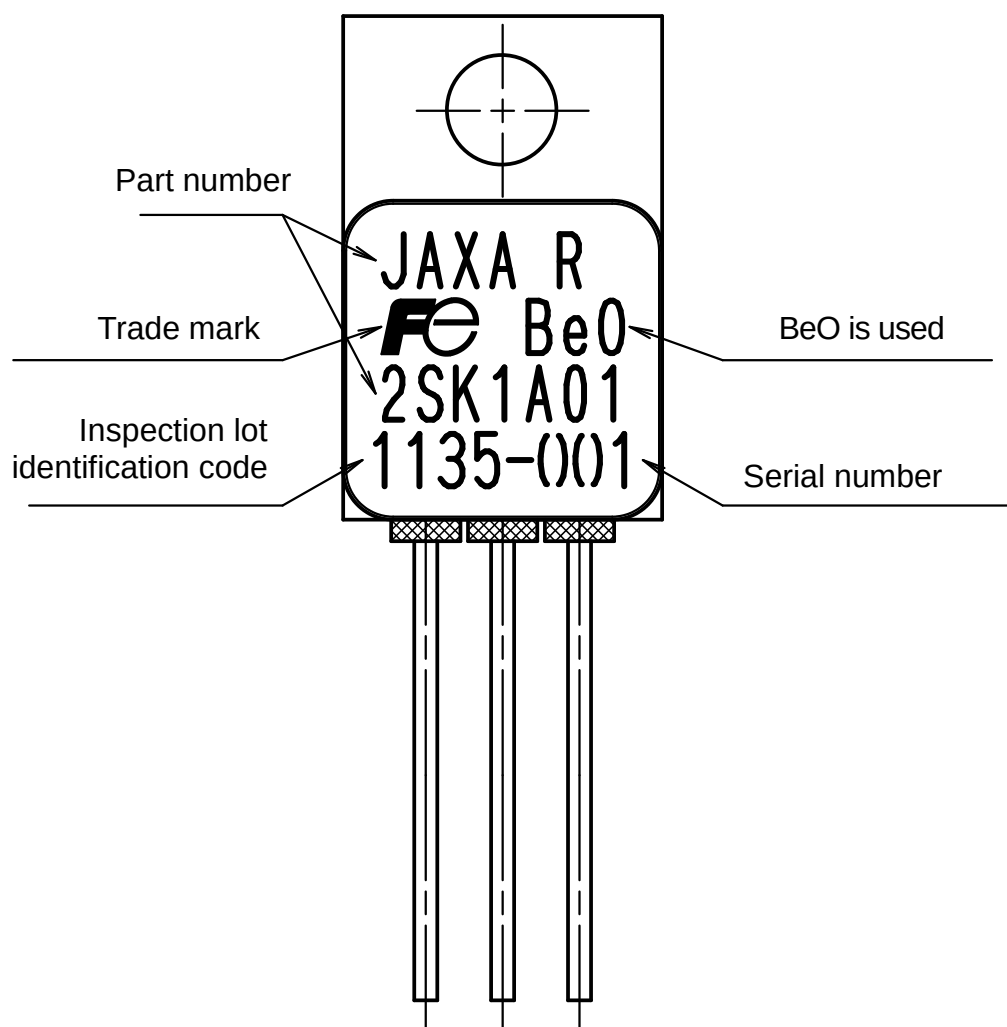


Figure 3. Marking

3. USAGE

The circuit must be designed to have sufficient margins for the absolute maximum ratings as shown in Table 1. It is desirable that the device is operated under the recommended operating conditions as shown in Table 2.

3.1 Absolute Maximum Ratings

Table 1. Absolute Maximum Ratings

Part No.	V _{DS} (V)	I _D (A)	I _{D(pulse)} (A)	V _{GS} (V)	P _D T _C =25°C (W)	P _D T _A =25°C (W)	T _{ch} ⁽¹⁾ (°C)	T _{stg} (°C)	R _{th(ch-c)} (°C/W)	R _{th(ch-a)} (°C/W)
JAXA R 2SK1A01	600	3.9	15.6	±20	70	2.55	150	-55 to 150	1.67	49.0

Note⁽¹⁾ Channel temperature T_{ch} is given by the following equations:

$$T_{ch} = T_C + R_{th(ch-c)} \times P_D$$

$$T_{ch} = T_A + R_{th(ch-a)} \times P_D$$

Where T_C: Case temperature (°C)

T_A: Ambient temperature (°C)

R_{th(ch-c)}: Thermal resistance between channel and case (°C/W)

R_{th(ch-a)}: Thermal resistance between channel and ambient (°C/W)

P_D: Power dissipation (W)

3.2 Recommended Operating Conditions

Table 2. Recommended Operating Conditions

Items	Recommended Values
$V_{DS}(DC)$	450V (75% of rated)
$I_D(DC)$	2.73A (70% of rated)
V_{GS}	-7.5 to +15V
T_{ch}	-55 to 125°C

3.3 Torque

The recommended torque when mounting the device on a heat sink shall be shown in the following table. Excess torque applied to the mounting screw will cause damage to the device, and smaller torque will depress the heat dissipation and may cause to destroy by thermal runaway.

Package	Screw	Tightening torques
TO-257	M3	40-60Ncm

Note: Flatness of heat sink: $< \pm 30\mu m$
Roughness: $< 10\mu m$
Plane off the edges: $C < 1.0mm$

3.4 Lead Bending

- The bending shall be performed at the point of 2.0 mm as a minimum apart from the lead egress.
- The minimum inside radius when the lead is bent shall be 1.5mm.
- The egress of the lead shall be held securely when bending to avoid adding stress on the ceramic.

4. CHARACTERISTICS IN NORMAL CONDITIONS

4.1 Electrical Characteristics

The electrical characteristics are shown in Tables 3a, 3b, 3c and 3d.

4.2 Mechanical and Thermal Characteristics

The mechanical and thermal characteristics (environmental resistance) assured in detail specification are shown in Table 4.

Table 3a. Electrical Characteristics (T_A=+25°C unless otherwise specified)

Part No.	V _{(BR)DSS} (V)		I _{DSS} (μA)		I _{GSS} (nA)		V _{GS(th)} (V)		R _{DS(on)} ⁽¹⁾ (Ω)		gfs ⁽¹⁾ (S)	
	I _D =1mA V _{GS} =0V		V _{DS} =480V V _{GS} =0V		V _{GS} =±20V V _{DS} =0V		I _D =1mA V _{DS} =V _{GS}		I _D =1.95A V _{GS} =12V		I _D =1.95A V _{DS} =25V	
	Min.	Typ.	Max.	Typ.	Max.	Typ.	Min.-Max.	Typ.	Max.	Typ.	Min.	Typ.
JAXA R 2SK1A01	600	660	10	40n	±100	+1 -1	2.5-4.5	3.5	1.9	1.4	2.5	3.4

Note⁽¹⁾ Pulse test: Pulse width≤1ms, Duty cycle≤2%**Table 3b. Electrical Characteristics (T_A=+25°C unless otherwise specified)**

Part No.	Q _{GS} (nC)		Q _{GD} (nC)		Q _G (nC)		t _{d(on)} (ns)		t _r (ns)		t _{d(off)} (ns)		t _f (ns)	
	V _{DS} =300V, I _D = 3.9A, V _{GS} =12V						V _{DS} =300V, I _D = 3.9A, V _{GS} =12V, R _G =10Ω							
	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ
JAXA R 2SK1A01	14	9	14	7	48	33	55	36	10	6.5	100	66	15	8

Table 3c. Electrical Characteristics (T_A=+25°C unless otherwise specified)

Electrical Characteristics (TA=+25°C unless otherwise specified)						
Part No.	Ciss (pF)		Coss (pF)		Crss (pF)	
	VDS=75V, VGS=0V f=1MHz					
	Max	Typ	Max	Typ	Max	Typ
JAXA R 2SK1A01	1350	900	85	55	10	5

**Table 3d. Electrical Characteristics (Body Diode Characteristics)
(T_A=+25°C unless otherwise specified)**

Part No. JAXA R	V _{SD} ⁽¹⁾ (V)		t _{rr} (ns)	Q _{rr} (μC)
	I _F = 3.9A V _{GS} =0V		I _F = 3.9A, V _{GS} =0V, -di/dt=100A/μs, T _{ch} =+25°C	
	Max.	Typ.	Typ.	Typ.
JAXA R 2SK1A01	1.6	1.2	800	11

Note⁽¹⁾ Pulse test: Pulse width≤1ms, Duty cycle≤2%

Table 4. Mechanical and Thermal Characteristics

Test Items		Limits and Conditions
Temperature	Temperature Cycling	-55 to 150°C, 500cycles
	Thermal Shock	0 to 100°C, 25cycles
	Resistance to Soldering heat	250°C, 10s
Moisture Resistance		80 to 98%, 25 to 65°C, 10cycles
Salt Atmosphere		35°C, 24hr, Rate of salt deposit=10 to 50g/m ² /24hr
Mechanical Environment	Vibration	196.1m/s ² (20G), 100 to 2000Hz, 4minutes X-Y-Z each orientation, 4 times
	Shock	14700m/s ² (1500G), 0.5ms X ₁ -Y ₁ -Y ₂ -Z ₁ each orientation, 5 times
	Constant Acceleration	98100 m/s ² (10000G) X ₁ -Y ₁ -Y ₂ -Z ₁ each orientation, 1 time
	Lead Strength	1.5kgf, Z ₁ orientation, 30s
Electrostatic Discharge (ESD)		C=100pF, R=1.5kΩ V _{GS} =±500V

5. CHARACTERISTIC CURVES IN VARIOUS OPERATING CONDITIONS

The characteristic curves are shown in Figures 4 through 6:

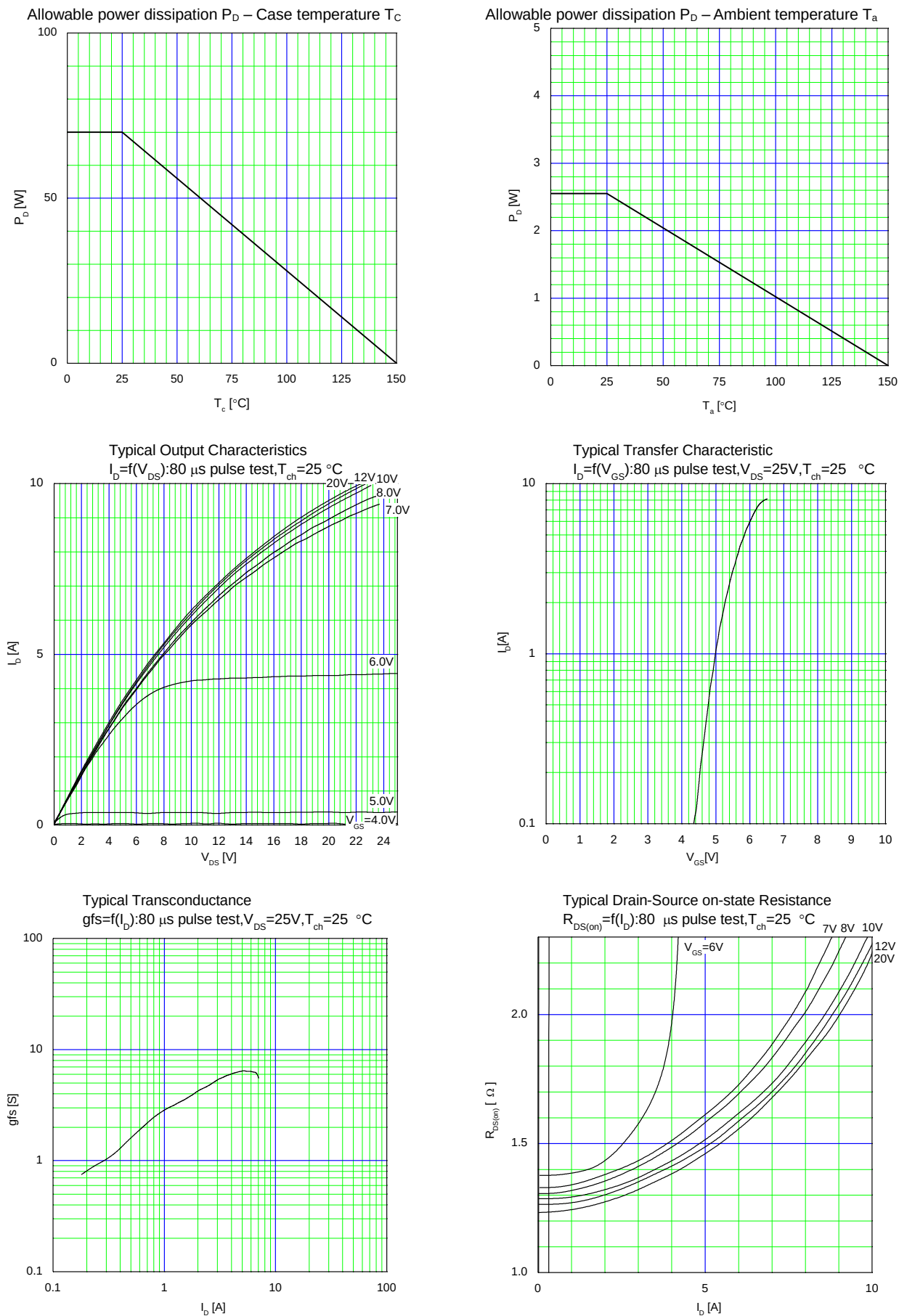


Figure 4. Characteristic Curves of JAXA R 2SK1A01 (1/3)

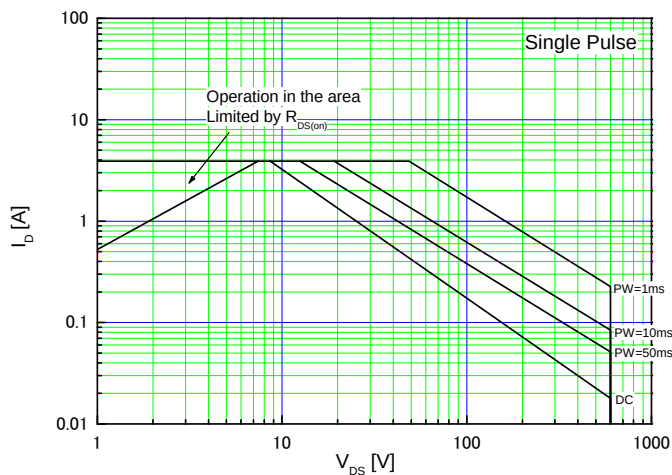
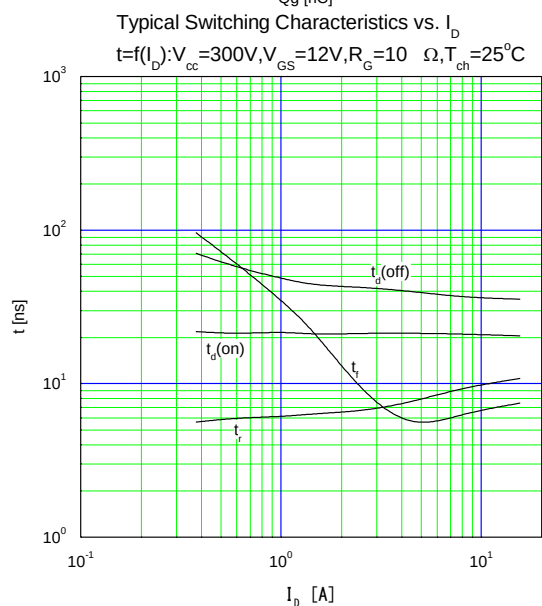
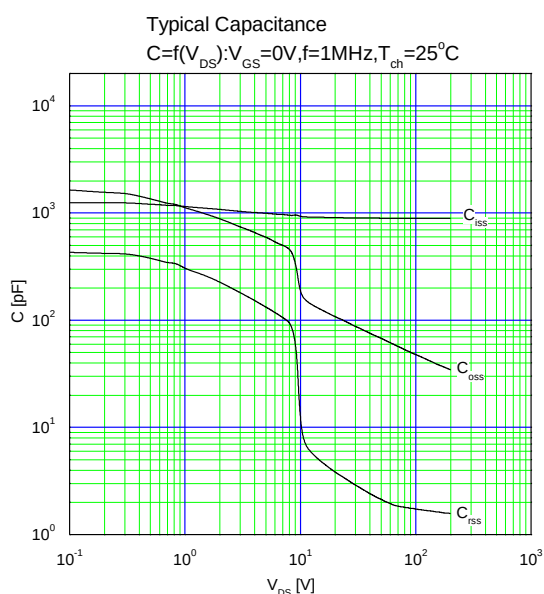
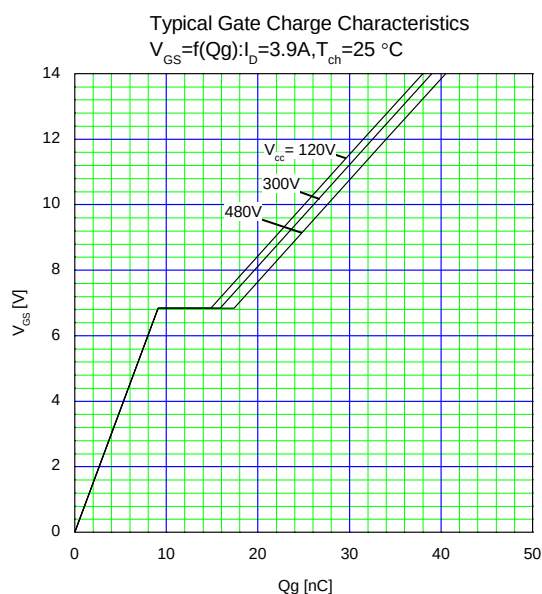
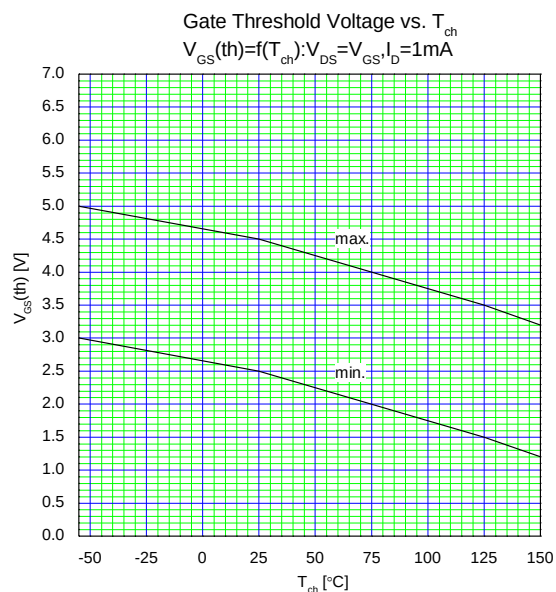
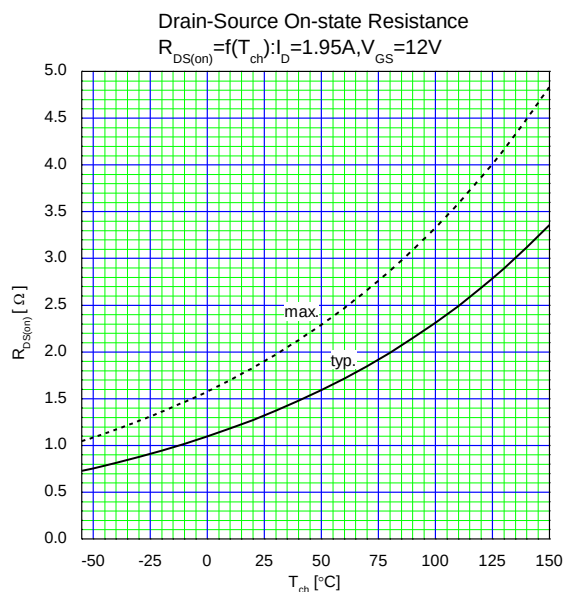


Figure 5. Characteristic Curves of JAXA R 2SK1A01 (2/3)

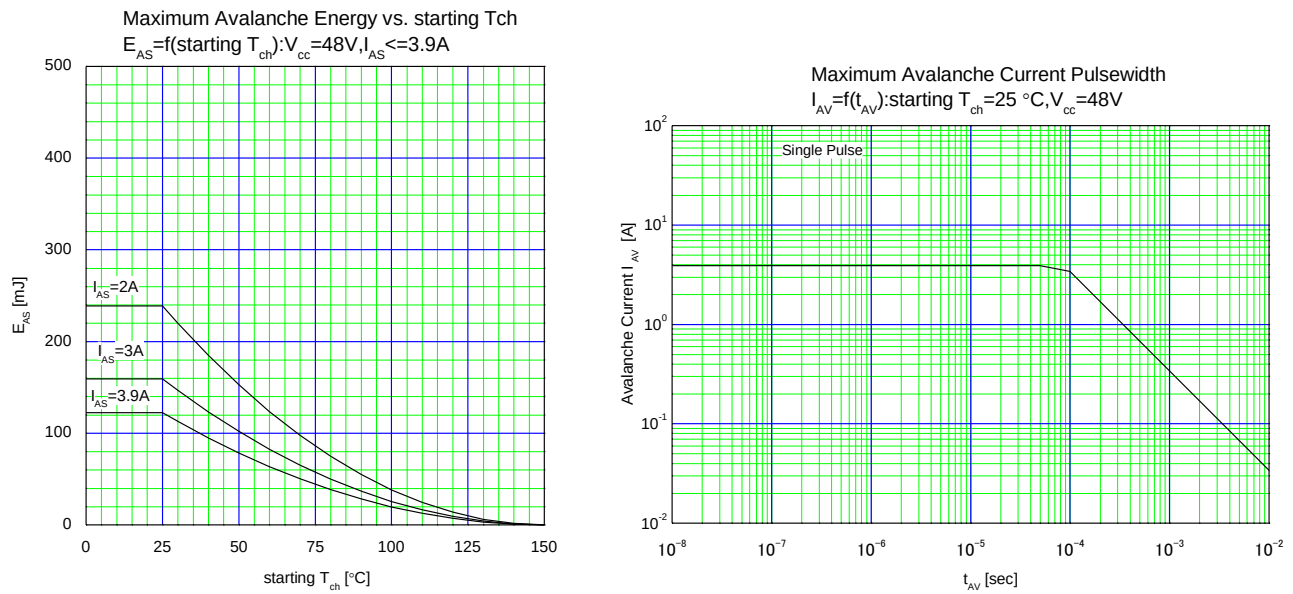


Figure 6. Characteristic Curves of JAXA R 2SK1A01 (3/3)

6. ENVIRONMENTAL LIMITS

The environmental test results are shown in Tables 5 through 10.

6.1 Mechanical Vibration

Table 5. Mechanical Vibration Test Result

Test Items	Test Conditions	Failure/Samples
Vibration, Variable Frequency	20G (peak) or Maximum vibration amplitude 1.52mm, whichever is smaller, 100 to 2000Hz, Total sweep time: 4 minutes X, Y, Z each orientation: 4 times	0/22 pieces

6.2 Mechanical Shock

Table 6. Mechanical Shock Test Result

Test Items	Test Conditions	Failure/Samples
Shock	1500G (14700m/s ²): Pulse width 0.5msec X ₁ , Y ₁ , Y ₂ , Z ₁ each orientation : 5 times	0/22 pieces

6.3 Constant Acceleration

Table 7. Constant Acceleration Test Result

Test Items	Test Conditions	Failure/Samples
Constant Acceleration	10000G (98100m/s ²): 1 minute X ₁ , Y ₁ , Y ₂ , Z ₁ each orientation	0/22 pieces

6.4 Thermal Shock

Table 8. Thermal Shock Test Result

Test Items	Test Conditions	Failure/Samples
Thermal Shock	-55°C to 25°C to 150°C (30min) (5min) (30min.) 500cycles	0/45 pieces

6.5 Electrostatic Discharge Sensitivity Classification

Table 9. Electrostatic Discharge Sensitivity Classification

Test Items	Test Conditions Method 1020 of MIL-STD-750	Test result
Electrostatic Discharge	V _{GS} =±500V	Class 1

6.6 Radiation Hardness

Table 10a. Radiation Hardness Test Results

Total Dose Irradiation (TID)	Test Conditions
	Source: Co ⁶⁰ gamma-ray TID: 1000Gy(360Gy/hr)
	Bias Conditions (During and after irradiation) (a) $V_{DS}=0V$, $V_{GS}=20V$ (b) $V_{DS}=0V$, $V_{GS}=-20V$ (c) $V_{DS}=480V$, $V_{GS}=0V$
	Test Results
	For each bias condition: 0/4 pieces (1×10^3 Gy) BV_{DSS} TID dependence: Fig. 7, $V_{GS(th)}$ TID dependence : Fig. 8

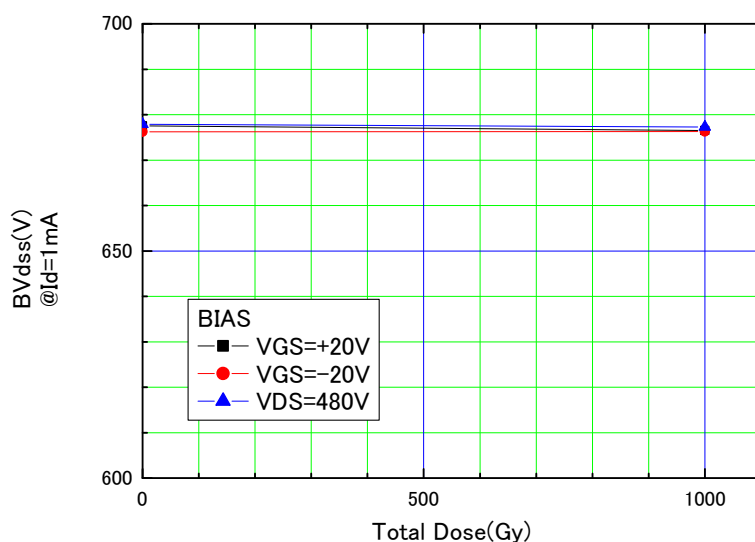


Figure 7. Total Dose Dependence of BV_{DSS}

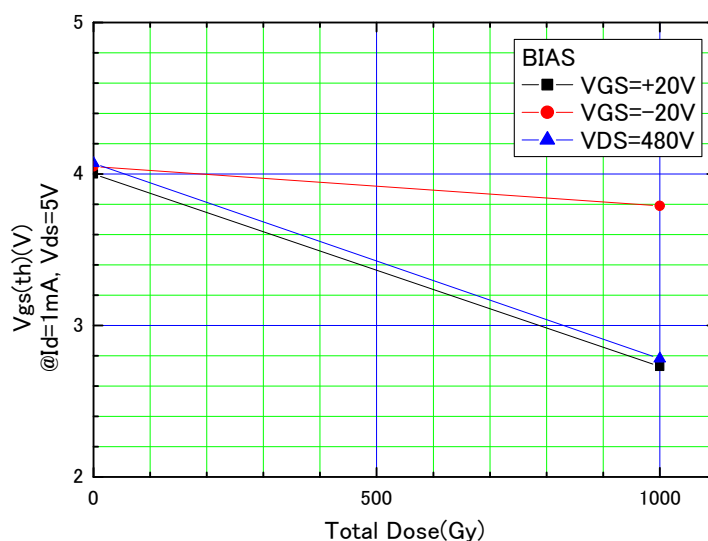
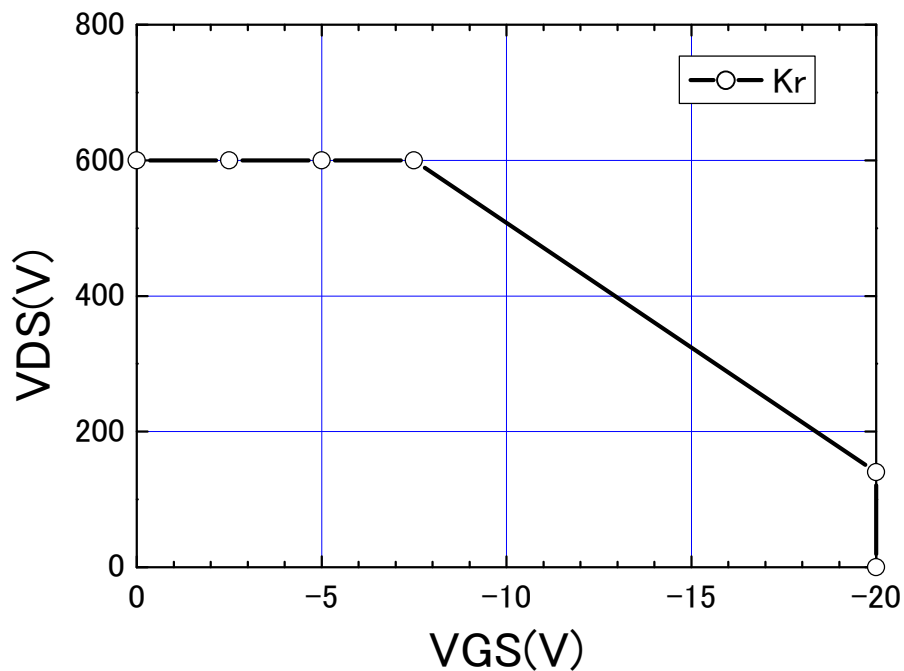


Figure 8. Total Dose Dependence of $V_{GS(th)}$

Table 10b. Radiation Hardness Test Results

Part Number JAXA R	600V Class	
	2SK1A01	
Single Event Tolerance (SEB/SEGR) Single Event Burnout/ Single Event Gate Rupture	Test Conditions	Test Results
	Ion:Kr, Energy: 768 MeV LET: 38.2 MeV (mg/cm ²) ⁽¹⁾ Range: 94μm, T _A =25+/-5°C Fluence: 3E5+/- 5% ions/cm ² Irradiation angle: Perpendicular to die surface Limits: I _{GSS} ≤10μA and it shall not be destroyed.	V _{DS} =600V and V _{GS} =-7.5V 0/3 pieces V _{DS} =140V and V _{GS} =-20.0V 0/3 pieces (SEE-SOA: Fig. 9)

Note⁽¹⁾: Average LET in the device.**Figure 9. SEE-SOA**

7. RELIABILITY

7.1 Accelerated Test Results

The accelerated test results are shown in Table 11.

Table 11. Accelerated Test Results

Test Items	Test Conditions	Failure/Samples
Steady-state operating life test (High Temperature, voltage applied for gate to source)	Method 1042 of MIL-STD-750, Condition A $T_A=150^{\circ}\text{C}$, 1000hr $V_{GS}=16\text{V}$	0/45 pieces
Steady-state operating life test (High Temperature, voltage applied for drain to source)	Method 1042 of MIL-STD-750, Condition B $T_A=150^{\circ}\text{C}$, 1000hr $V_{DS}=480\text{V}$	0/45 pieces
Thermal shock test (Temperature Cycling)	-55 to 150°C , 500cycles	0/45 pieces
Intermittent operating life test (Power Cycling)	$\Delta T_C=100\text{deg}$, 6000cycles	0/22 pieces

7.2 Possible Failure Mode

Table 12. Possible Failure Mode

Failure mode	Rate (%)
Short	70
Increase of Leakage Current	20
Thermal Resistance Increase	3
Degradation of $V_{GS(th)}$	3
Open	3
Others	1

8. STORAGE

- (1) The devices are necessary to be stored under the appropriate temperature and humidity ranges. The recommended ambient temperature range is 10 to 30°C. The recommended relative humidity range is 40 to 60%.
- (2) The devices shall be stored in an environment free of corrosive gases and minimum dusts.
- (3) Countermeasures such as conductive bags and aluminum films shall be utilized to avoid the electrostatic discharge occurring between gate and source, and gate and drain terminals.

9. NOTES

The following precautions shall be taken when handling this device.

- (1) The soldering of leads shall be performed at the temperature of 250°C or below and at the point of 1mm as a minimum apart from the lead egress within a time frame of 5 seconds. The solder pot and the soldering iron shall be properly grounded.
- (2) In handling the product, ground human body, work area and measuring instruments.
- (3) BERYLLIA WARNING: The products contain beryllium oxide (BeO). Disintegration or chemical processing of the products that may produce dusts or fumes shall be prohibited. Disposition of the products shall be performed in accordance with applicable regulations.

10. OTHERS

The contact information on this data sheet is as follows:

Supplier: Fuji Electric Co., Ltd.

Address: Gate City Ohsaki, East Tower

11-2, Osaki 1-chome, Shinagawa-ku, Tokyo 141-0032, Japan

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