

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

Part Description	POWER MOSFET, P-CHANNEL, RADIATION HARDENED, HIGH RELIABILITY, SPACE USE
Part Number and Type	JAXA R 2SJ1A01 JAXA R 2SJ1A02 JAXA R 2SJ1A03 JAXA R 2SJ1A04 JAXA R 2SJ1A05 JAXA R 2SJ1A06 JAXA R 2SJ1A07 JAXA R 2SJ1A08 JAXA R 2SJ1A09 JAXA R 2SJ1A10 JAXA R 2SJ1A11 JAXA R 2SJ1A12
Applicable Specification	JAXA-QTS-2030 JAXA-QTS-2030/104

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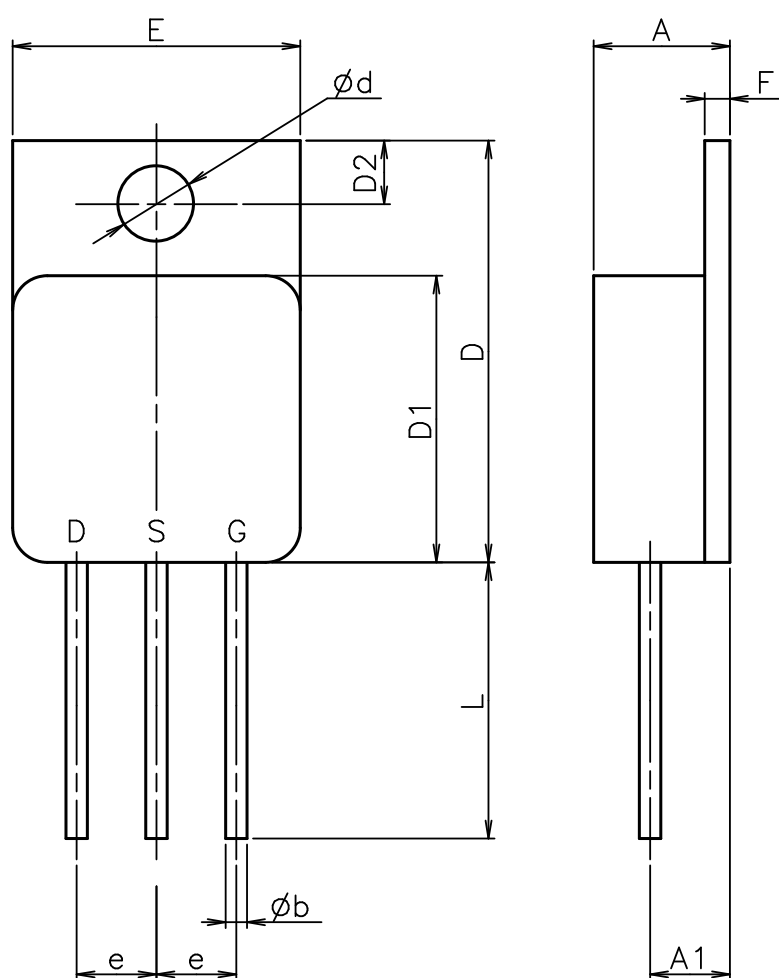
This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official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

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

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Revision Log			
Rev.	Date	Description	
-----	21 June 2011	Original	
A	18 March 2020	▪ Cover: Changed the corporate name. ▪ Figures 2, 3, 5 and 6: Corrected bonding wire diameter from Al $\Phi 350\mu\text{m}$ to Al $\Phi 500\mu\text{m}$. ▪ Added the following Paragraphs, tables and figure. · Paragraph 3.5 Recommended Surface Mounting Method (for SMD Packages) · Paragraph 3.5.1 Recommended Mounting Board · Paragraph 3.5.2 Recommended Reflow Conditions · Table A. Recommended Reflow Temperature Profile · Figure A. Recommended Reflow Temperature Profile · Paragraph 3.5.3 Thermal Stress Evaluation Test for Cargo Flight On-Board Devices · Table B. Results of Environmental Tests after Thermal Stresses ▪ 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 selecting products or designing system not contained in JAXA QTS. 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 sheet.			
JAXA-QTS-2030	Semiconductor Device, High Reliability, Space Use, General Specification for		
JAXA-QTS-2030/104	Power MOSFET, P-Channel, Radiation Hardened, High Reliability, Space Use, Detail Specification For		
MIL-STD-750	TEST METHOD STANDARD, TEST METHODS FOR SEMICONDUCTOR DEVICES		
JERG-0-043	STANDARD FOR SURFACE MOUNT SOLDERING PROCESS		
2. SUMMARY OF PRODUCT			
2.1 Externals and Dimensions			
The case outline and dimensions of the device are shown in Figures 1a, 1b, 1c and 1d. The marking of the device is illustrated in Figures 8a, 8b, 8c and 8d.			
2.2 Net Weight			
TO-254 package type (JAXA R 2SJ1A01, J1A02, J1A03, 2SJ1A07, J1A08, J1A09):		9.3g	(typ.)
SMD-2 package type (JAXA R 2SJ1A04, J1A10) :		3.3g	(typ.)
SMD-1 package type (JAXA R 2SJ1A05, J1A11) :		2.6g	(typ.)
SMD-0.5 package type (JAXA R 2SJ1A06, J1A12) :		1.0g	(typ.)
2.3 Devices Structure			
The device consists of one P-channel enhancement planar structured MOSFET chip and a seam-welded hermetic seal package shown in Figures 1a, 1b, 1c and 1d. The internal structure and the cross-section of the device are drawn in Figures 2 through 7.			

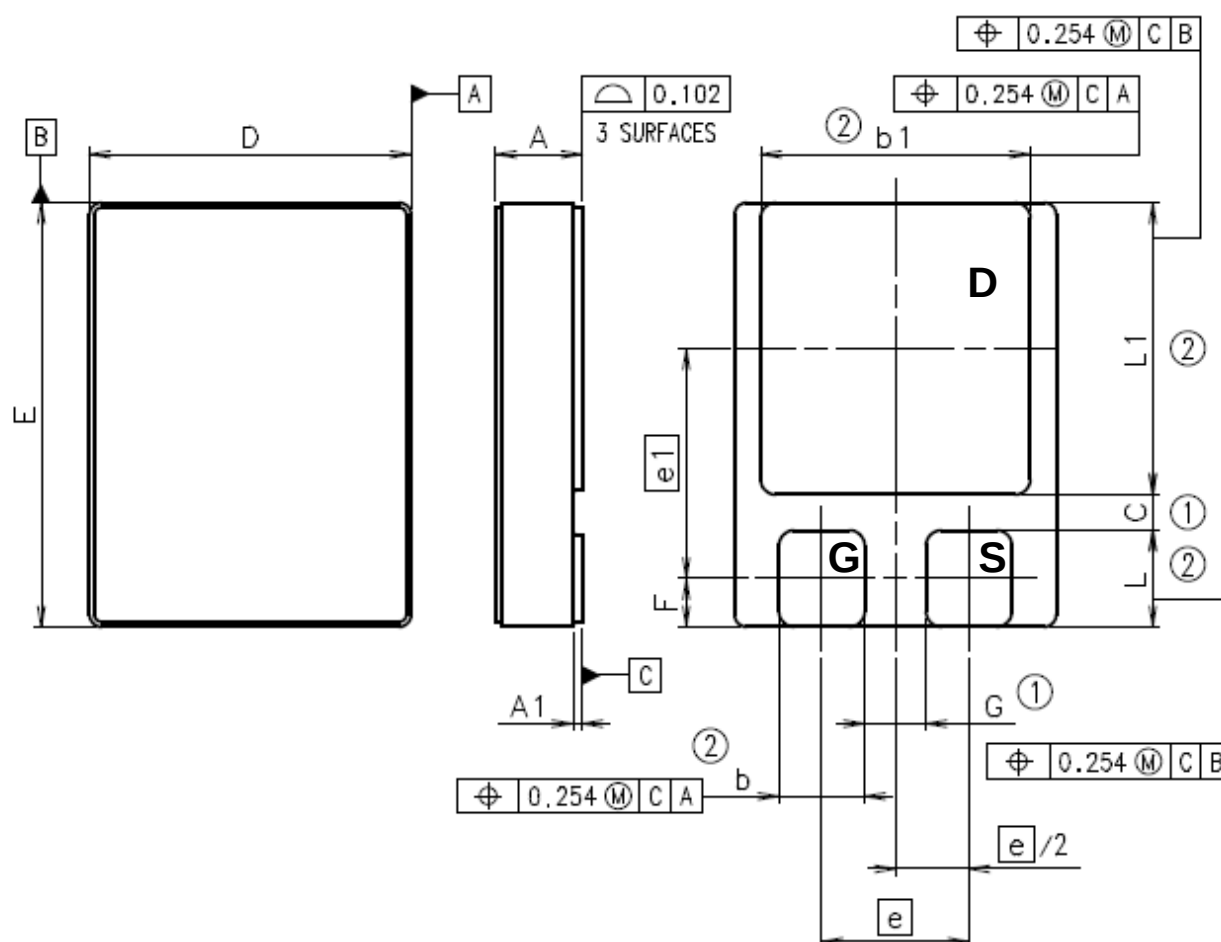


Symbol	Dimension (mm)	
	Min	Max
A	6.35	6.65
A1	3.61	4.01
ϕb	0.90	1.14
D	20.07	20.31
D1	13.59	13.85
D2	2.93	3.17

Symbol	Dimension (mm)	
	Min	Max
ϕd	3.56	3.80
E	13.60	13.84
e	3.51	4.11
F	1.10	1.30
L	12.84	13.60

Note: All leads are isolated from the case.

Figure 1a. Outline and Dimensions of TO-254
(JAXA R 2SJ1A01, 2SJ1A02, 2SJ1A03, 2SJ1A07, 2SJ1A08 and 2SJ1A09)



Symbol	Dimension (mm)		
	Min	Typ	Max
A	—	—	3.58
A1	0.254	0.381	0.508
b	3.43	3.555	3.68
b1	11.05	11.175	11.30
C	0.89	—	—
D	13.21	13.335	13.46
E	17.40	17.525	17.65

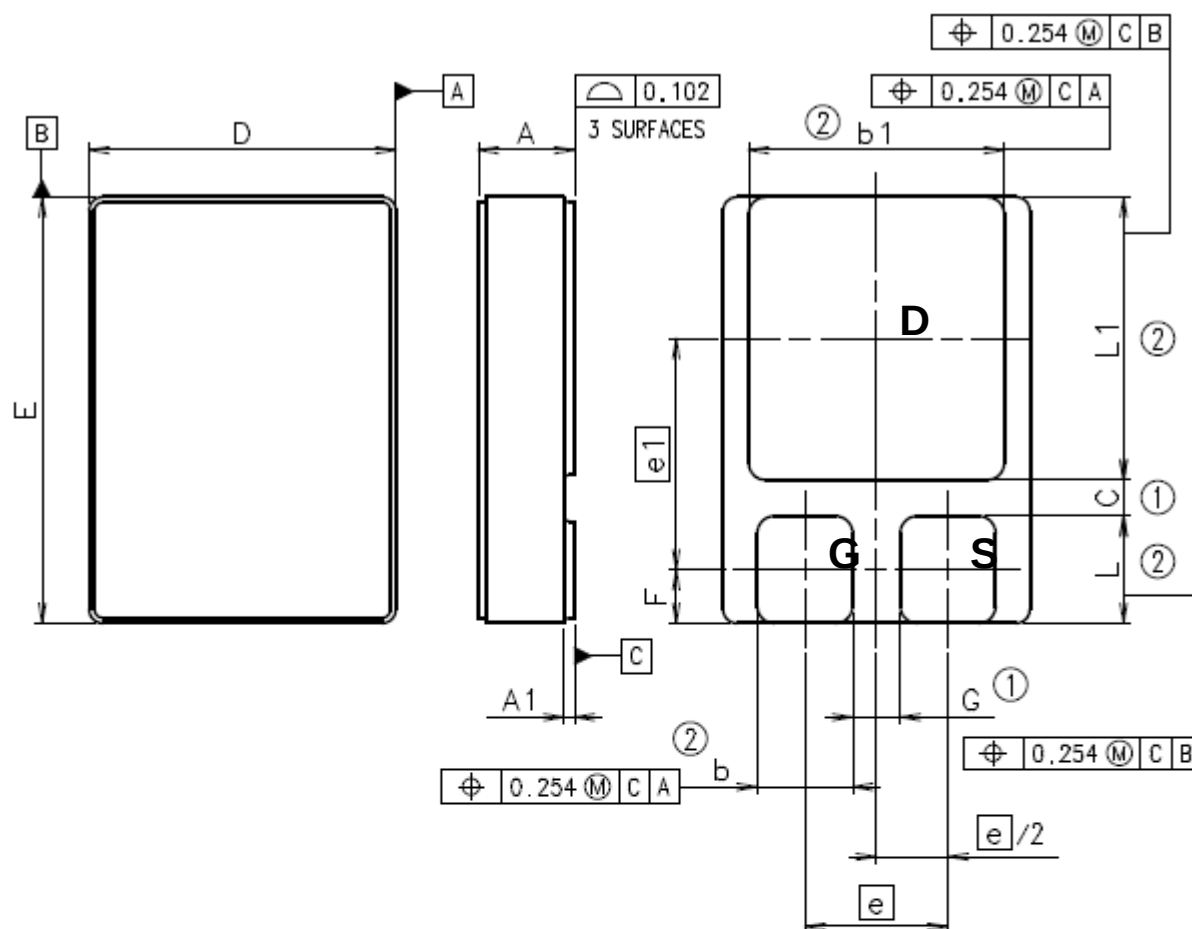
Symbol	Dimension (mm)		
	Min	Typ	Max
$e/2$	—	3.05	—
e	—	6.10	—
$e1$	—	9.50	—
F	—	1.99	—
G	1.27	—	—
L	3.87	3.99	4.11
L1	11.94	12.065	12.19

Notes: ① Dimension includes metallization flash.

② Dimension does not include metallization flash.

Note: All terminals are isolated from the case.

Figure 1b. Outline and Dimensions of SMD-2
(JAXA R 2SJ1A04 and 2SJ1A10)



Symbol	Dimension (mm)		
	Min	Typ	Max
A	—	—	3.58
A1	0.254	0.381	0.508
b	3.43	3.555	3.68
b1	9.40	9.525	9.65
C	0.76	—	—
D	11.31	11.43	11.55
E	15.75	15.875	16.00

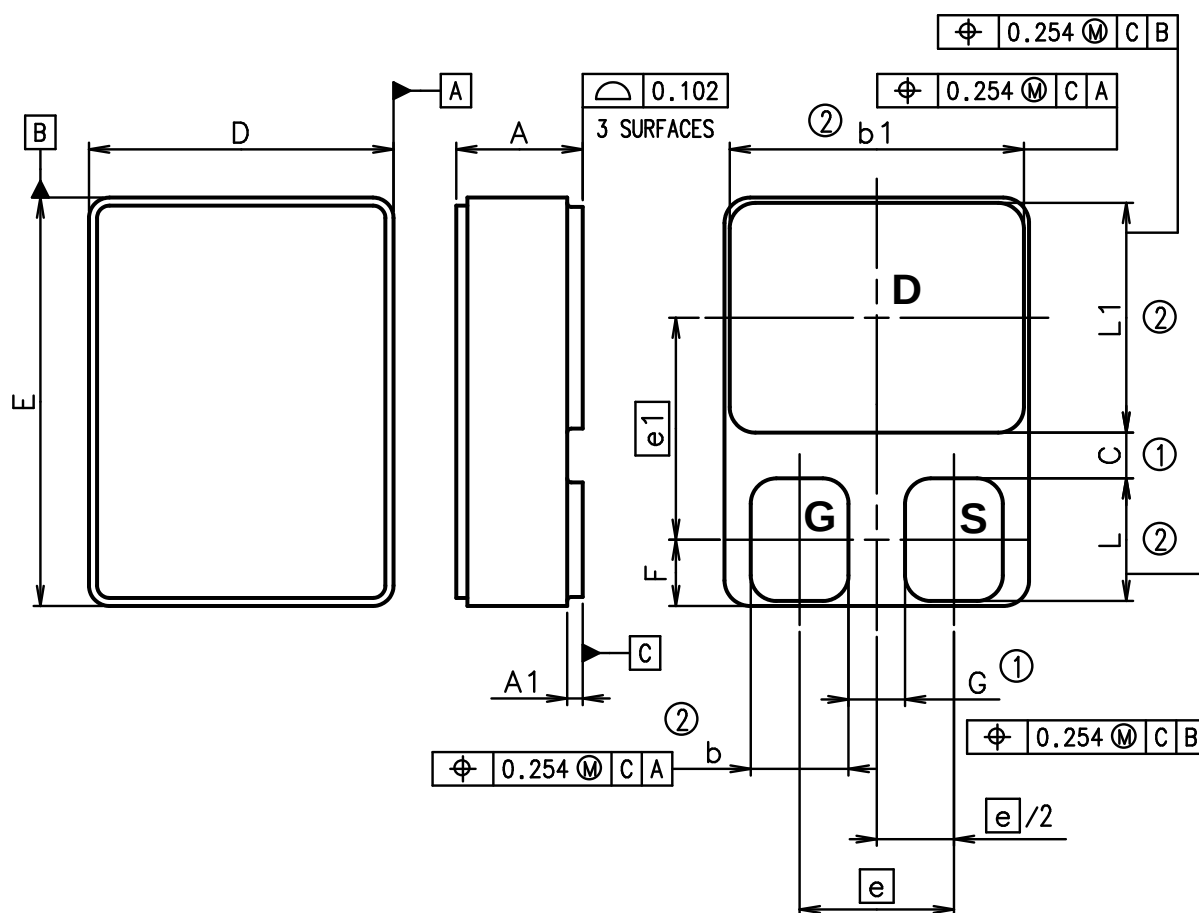
Symbol	Dimension (mm)		
	Min	Typ	Max
$e/2$	—	2.67	—
e	—	5.33	—
$e1$	—	8.61	—
F	—	1.99	—
G	0.89	—	—
L	3.87	3.99	4.11
L1	10.42	10.54	10.66

Notes: ① Dimension includes metallization flash.

② Dimension does not include metallization flash.

Note: All terminals are isolated from the case.

Figure 1c. Outline and Dimensions of SMD-1
(JAXA R 2SJ1A05 and 2SJ1A11)



Symbol	Dimension (mm)		
	Min	Typ	Max
A	—	—	3.12
A1	0.254	0.381	0.508
b	2.29	2.415	2.54
b1	7.14	7.265	7.39
C	0.76	—	—
D	7.40	7.52	7.64
E	10.04	10.16	10.28

Symbol	Dimension (mm)		
	Min	Typ	Max
$e/2$	—	1.905	—
e	—	3.81	—
$e1$	—	5.52	—
F	—	1.65	—
G	0.762	—	—
L	2.93	3.05	3.17
L1	5.59	5.715	5.84

- Notes: ① Dimension includes metallization flash.
② Dimension does not include metallization flash.

Note: All terminals are isolated from the case.

Figure 1d. Outline and Dimensions of SMD-0.5
(JAXA R 2SJ1A06 and 2SJ1A12)

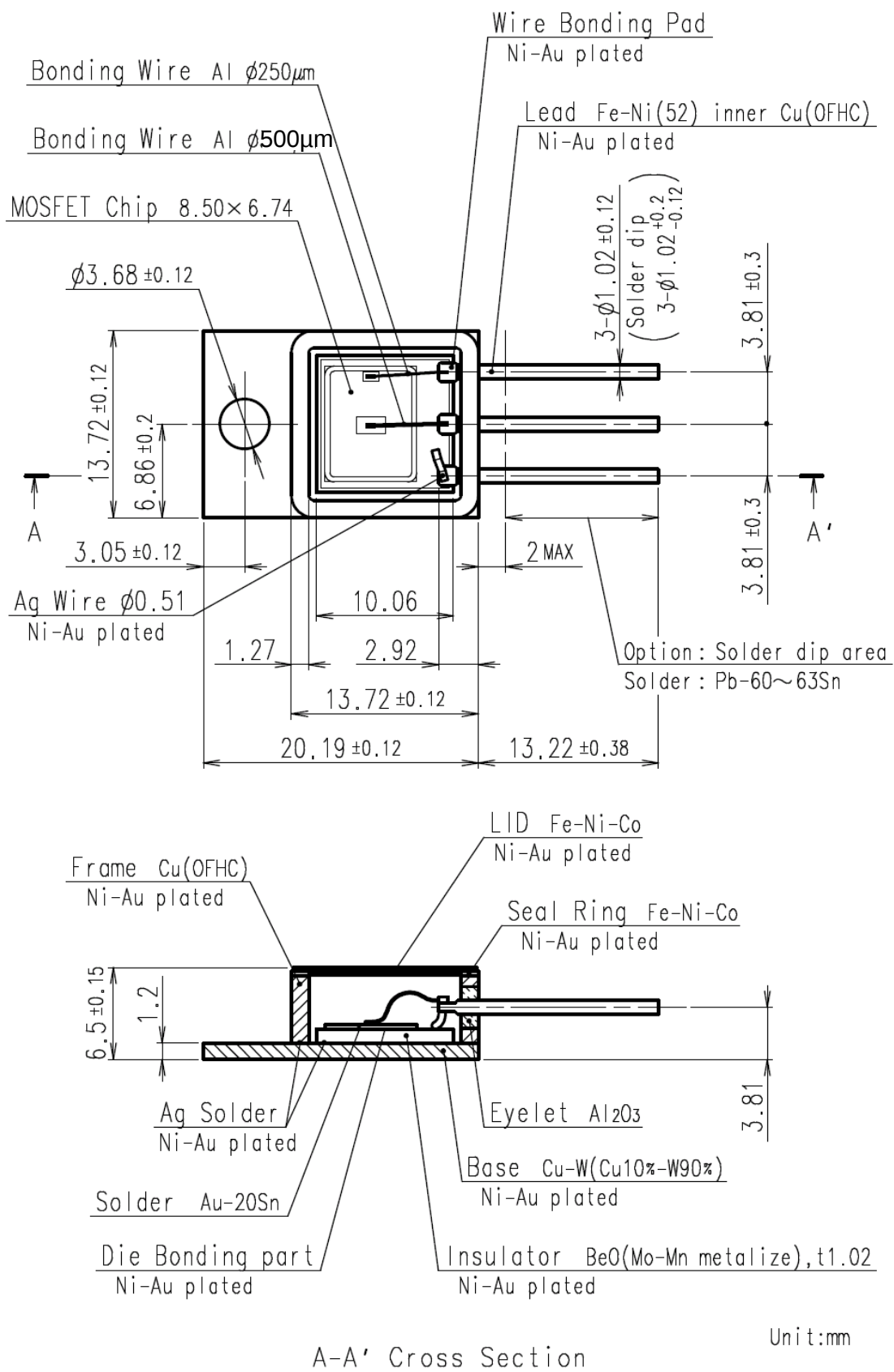
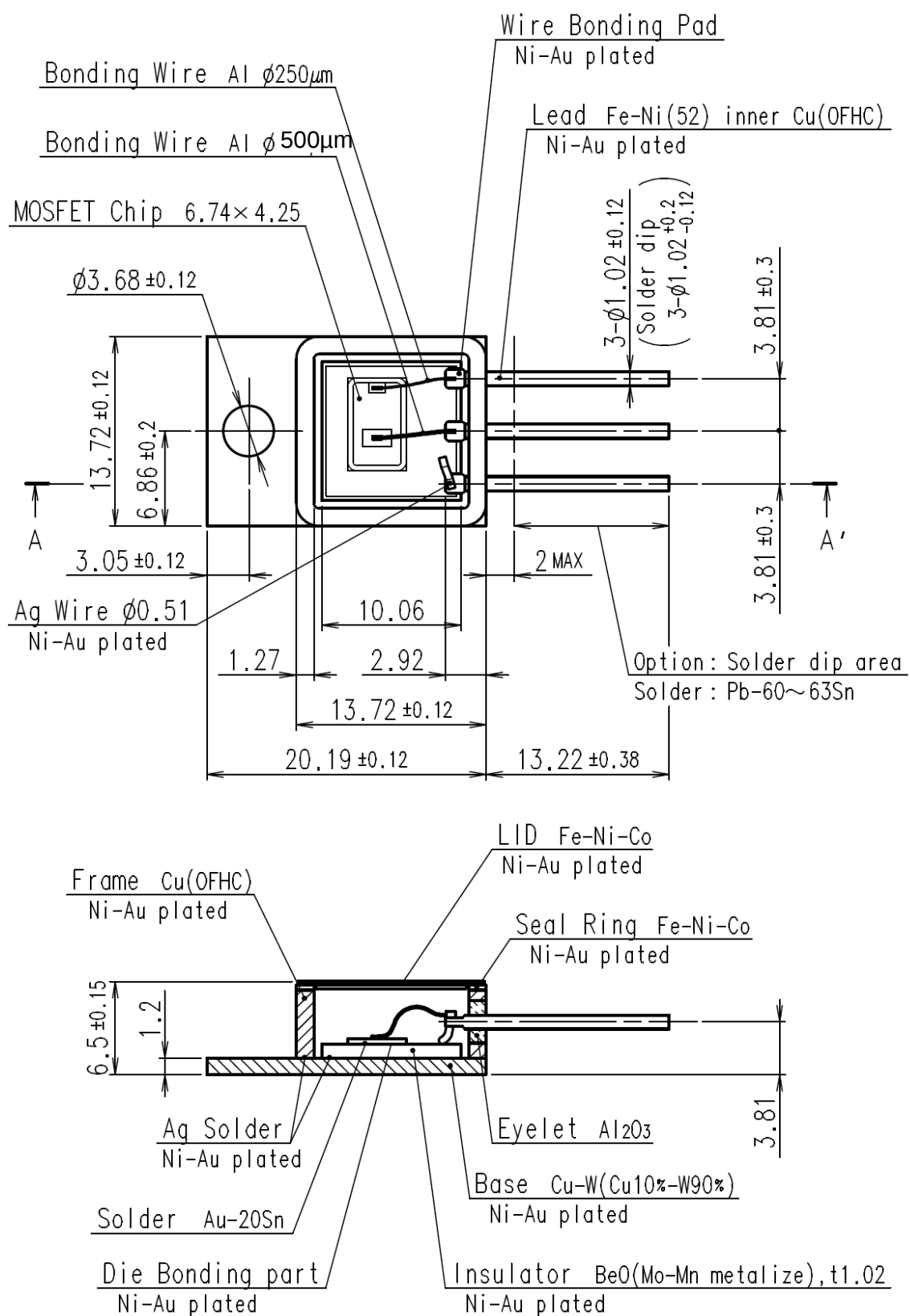


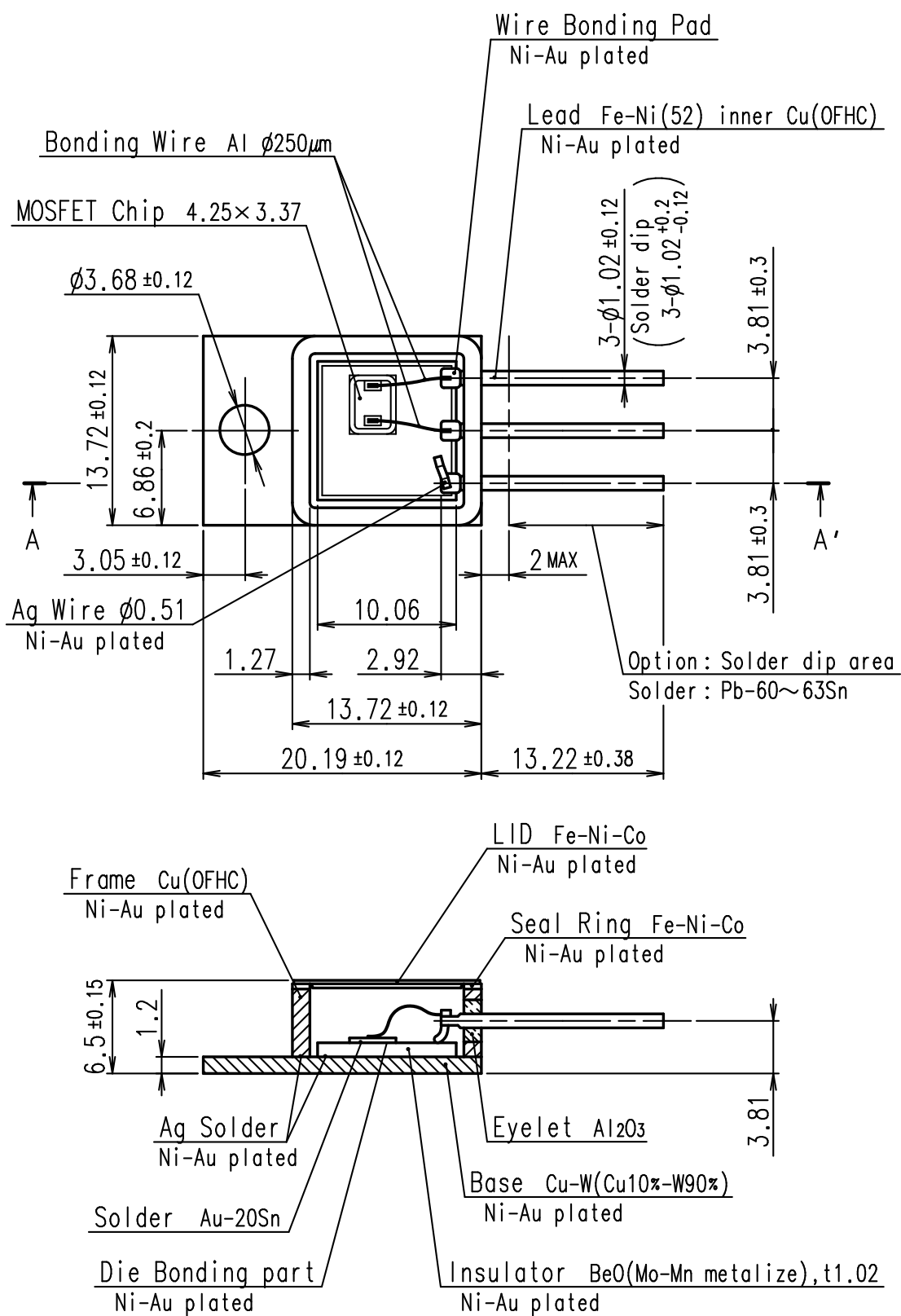
Figure 2. Inner Structure and Cross-section (JAXA R 2SJ1A01 and 2SJ1A07)



Unit:mm

A-A' Cross Section

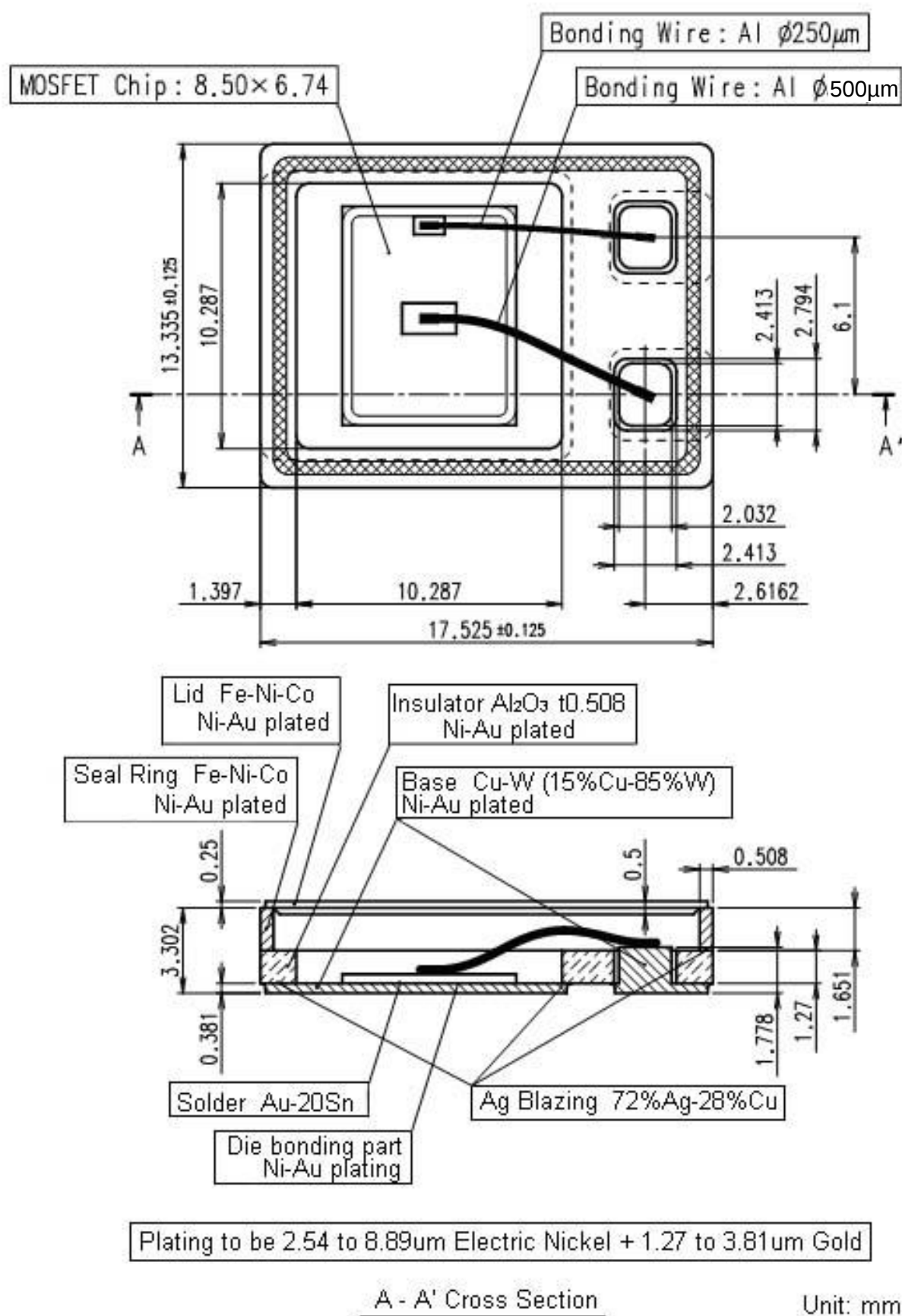
Figure 3. Inner Structure and Cross-section (JAXA R 2SJ1A02 and 2SJ1A08)



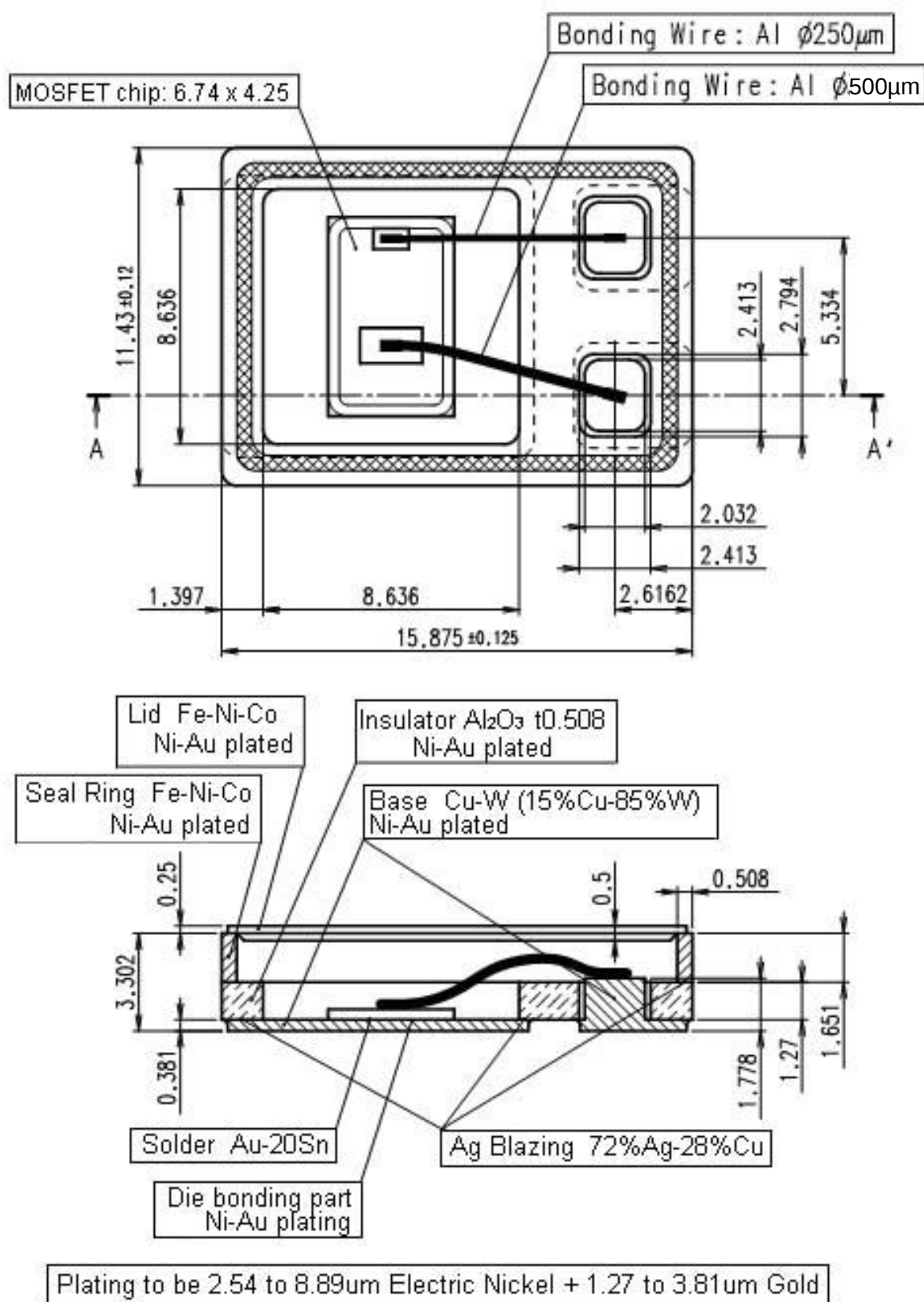
Unit:mm

A-A' Cross Section

Figure 4. Inner Structure and Cross-section (JAXA R 2SJ1A03 and 2SJ1A09)



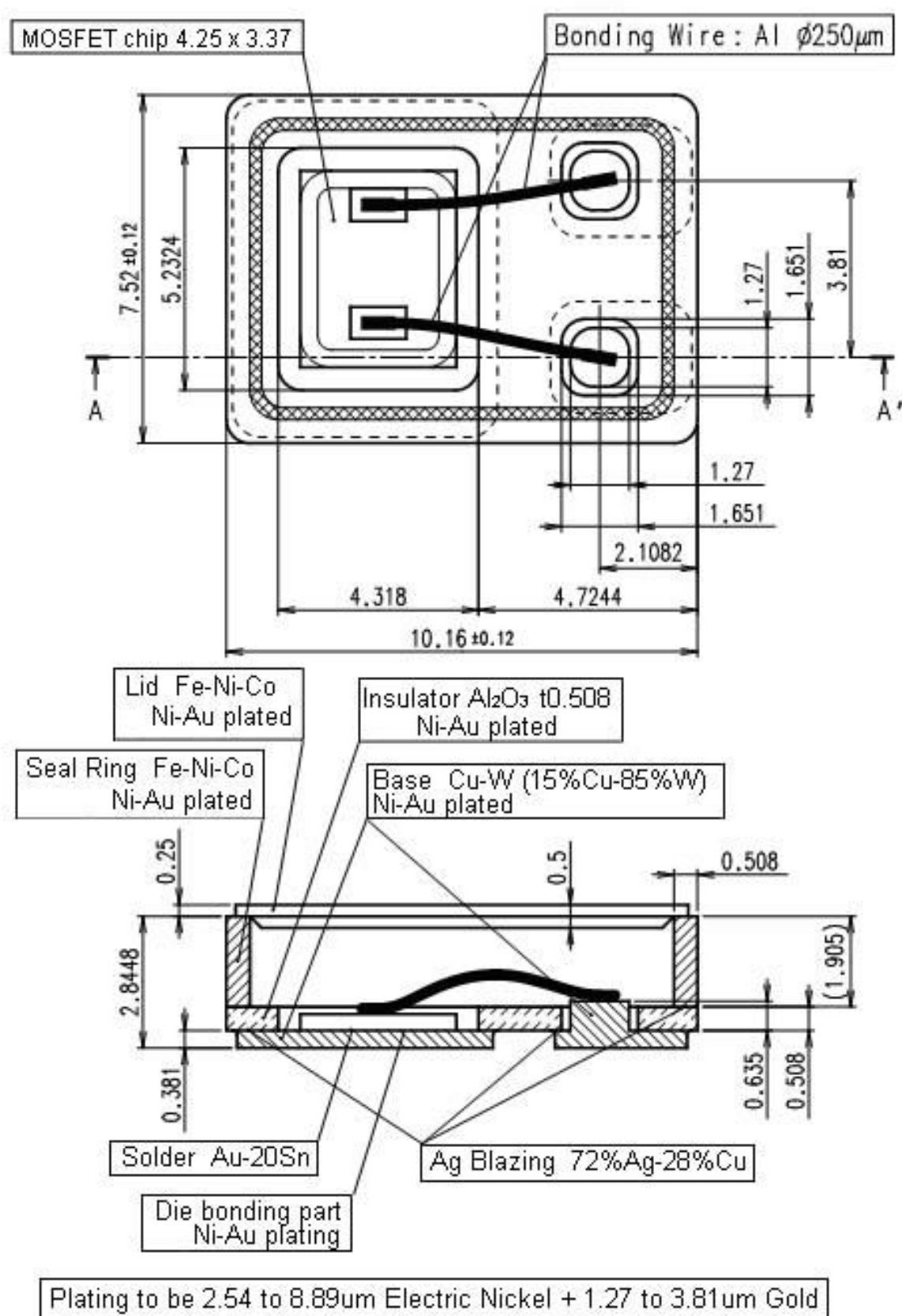
**Figure 5. Inner Structure and Cross-section
(JAXA R 2SJ1A04 and 2SJ1A10)**



A - A' Cross Section

Unit: mm

Figure 6. Inner Structure and Cross-section
(JAXA R 2SJ1A05 and 2SJ1A11)



A - A' Cross Section

Unit: mm

Figure 7. Inner Structure and Cross-section
(JAXA R 2SJ1A06 and 2SJ1A12)

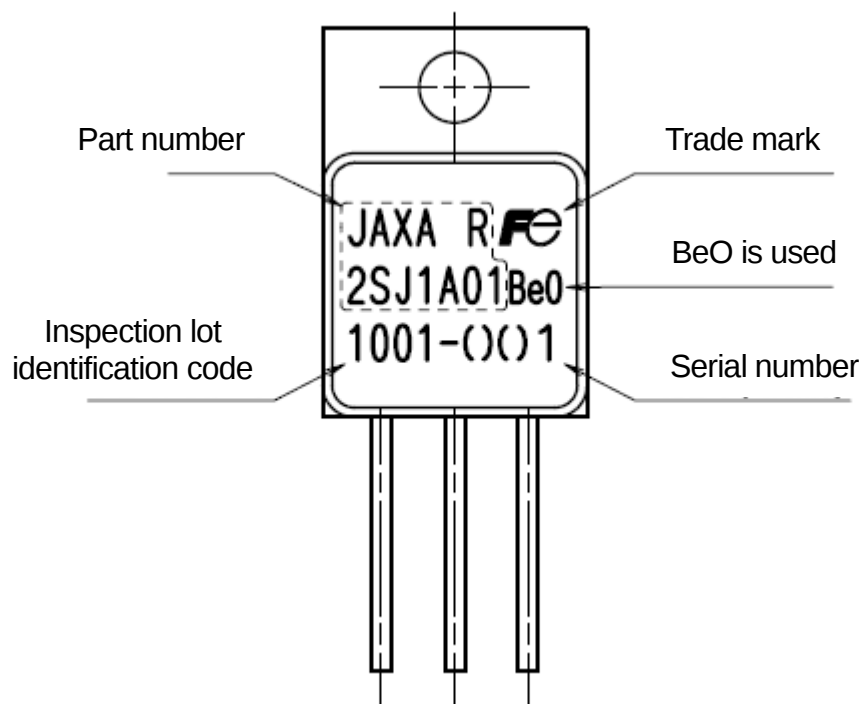


Figure 8a Markings of TO-254
(JAXA R 2SJ1A01, 2SJ1A02, 2SJ1A03, 2SJ1A07, 2SJ1A08 and 2SJ1A09)

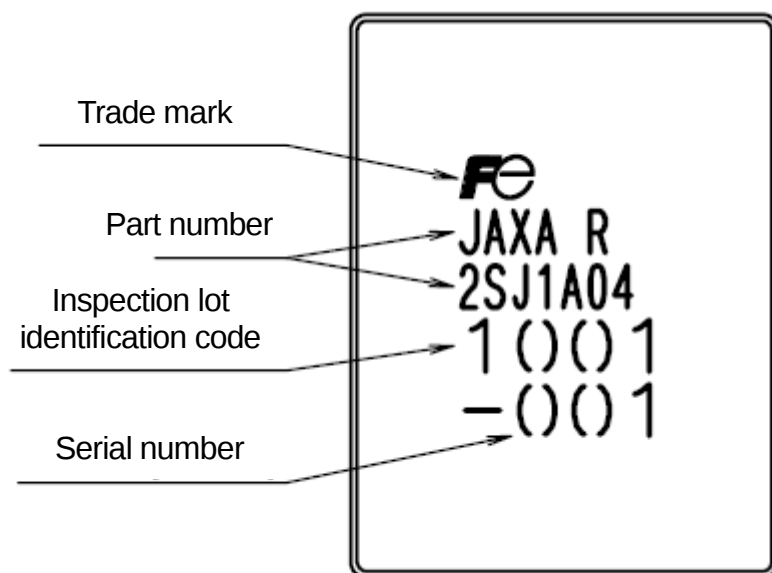


Figure 8b. Marking of SMD-2
(JAXA R 2SJ1A04 and 2SJ1A10)

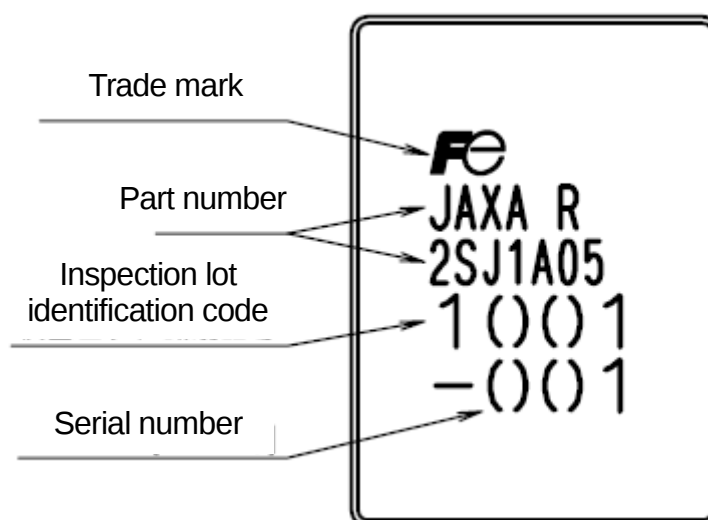


Figure 8c. Marking of SMD-1
(JAXA R 2SJ1A05 and 2SJ1A11)

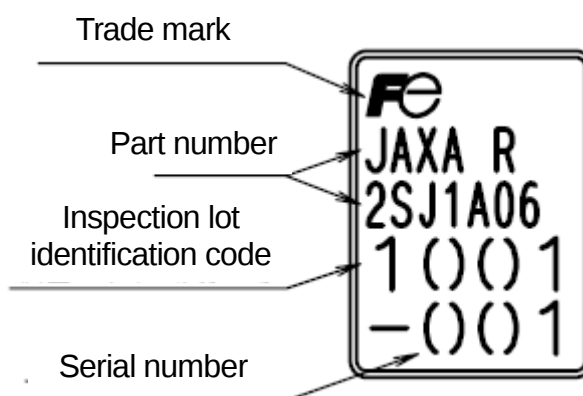


Figure 8d. Marking of SMD-0.5
(JAXA R 2SJ1A06 and 2SJ1A12)

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 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 2SJ1A01	-100	-42	-168	±20	250	2.60	150	-55 to 150	0.5	48.0
JAXA R 2SJ1A02		-25	-100		125	2.58			1.0	48.5
JAXA R 2SJ1A03		-11	-44		62.5	2.55			2.0	49.0
JAXA R 2SJ1A04		-42	-168		250	---			0.5	---
JAXA R 2SJ1A05		-29	-116		150	---			0.83	---
JAXA R 2SJ1A06		-13	-52		70	---			1.67	---
JAXA R 2SJ1A07	-200	-35	-140	±20	250	2.60	150	-55 to 150	0.5	48.0
JAXA R 2SJ1A08		-16	-64		125	2.58			1.0	48.5
JAXA R 2SJ1A09		-7.5	-30		62.5	2.55			2.0	49.0
JAXA R 2SJ1A10		-37	-148		250	---			0.5	---
JAXA R 2SJ1A11		-18	-72		150	---			0.83	---
JAXA R 2SJ1A12		-8.5	-34		70	---			1.67	---

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

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

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

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 ambience (°C/W)

P_D: Power dissipation (W)

3.2 Recommended Operating Conditions

Table 2. Recommended Operating Conditions

Items	Recommended Values
$V_{DS}(DC)$	75% of rated
$I_D(DC)$	70% of rated
V_{GS}	+5.0 to -15V
T_{ch}	-55 to 125°C

3.3 Torque (for TO-254 package)

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 insufficient torque will depress the heat dissipation and may result in the destruction by thermal runaway.

Package	Screw	Tightening torques
TO-254	M3	40 to 60Ncm

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

3.4 Lead Bending (for TO-254 package)

- 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.

3.5 Recommended Surface Mounting Method (for SMD Packages)

3.5.1 Recommended Mounting Board

Unintentional cracks may occur on the solder joints and ceramic due to the heat stress on the parts, substrate, or solder materials during and after the device is mounted. Therefore, the mounting boards shall be either CIC, metal core boards, or the boards with thermal expansion coefficient similar to that of ceramics, and post-mount evaluation is recommended.

3.5.2 Recommended Reflow Conditions

The reflow soldering of terminals shall be performed in accordance with JERG-0-043 Standards for Surface Mount Soldering Process.

Recommended reflow temperature profile shall be shown in table A and figure A.

Table A. Recommended Reflow Temperature Profile

	Zone	Temperature / Time
I	Ramp to pre-heat	2.0 to 5.0°C/sec. for 30 to 60 sec.
II	Pre-heat	150±10°C for 60±30 sec.
III	Ramp to peak	2.0 to 5.0°C/sec. for 20 to 40 sec.
IV	Reflow	200°C or higher for 30 to 60 sec. with peak temperature of 240°C max.
V	Cooling	Cool continuously

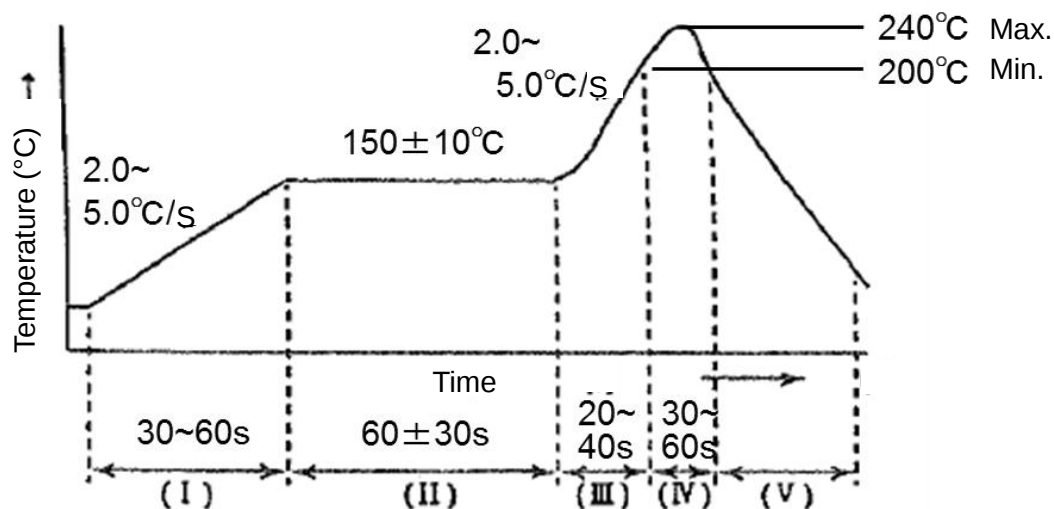


Figure A. Recommended Reflow Temperature Profile

3.5.3 Thermal Stress Evaluation Test for Cargo Flight On-Board Devices

The evaluation test was performed simulating that space-use stand-alone power devices without being mounted on PWB etc. were subjected to thermal stress of reflow soldering process to assure static characteristics, hermeticity, and bond strength of the devices.

Note: As environmental tests after 6 times of above thermal processes, temperature cycling tests were performed on the assumption that the device was on board the cargo flight. The results of the evaluation tests were shown in Table B.

Table B. Results of Environmental Tests after Thermal Stresses

Order	MIL-STD-750		JAXA R	Typical evaluation sample	Evaluation result Defect /sample size
	Test item	Method		2SJ1A04(-100V, SMD2)	
1	Reflow soldering (Assuming Au plating is removed and reflow is re-performed.		Sample size	22p	---
		---	Condition	Reflow temperature profile: see table A and figure A 6 times	
2	Temperature Cycling (Air to Air) (Assuming on-board flight environmental stress)		Sample size	22p	---
		1051	Condition	-55 ⁺⁰ _{-.5} °C↔25 ⁺¹⁰ _{-.5} °C↔150 ⁺⁵ _{-.0} °C 30 cycles	
3-1	Visual Inspection		Sample size	22p	0/22
		1051 1021	Condition	---	
3-2 Static characteristics (T _A =25°C)			Sample size	22p	0/22
-2a	Breakdown Voltage Drain to Source V _{DSS}	3407	Condition	Bias condition C, I _D =-1mA , V _{GS} =0V	
			Limits	min -100V DC	
-2b	Gate to Source Leakage Current I _{GSS}	3411	Condition	Bias condition C, V _{GS} =±20V, V _{DS} =0V	
			Limits	max ±100nA DC	
-2c	Drain Current I _{DSS}	3413	Condition	Bias condition C, V _{DS} =-80V, V _{GS} =0V	
			Limits	max -10μA DC	
-2d	Gate to Source Voltage (Threshold) V _{GS(th)}	3404	Condition	Bias condition C, V _{GS} =V _{DS} , I _D =-1mA	
			Limits	-2.5 ~ - 4.5V DC	
-2e	Static Drain to Source On-State Resistance R _{DS(on)}	3421	Condition	Pulse test ⁽¹⁾ , V _{GS} =-12V, I _D =-21A	
			Limits	max 38mΩ	
-2f	Forward Transconductance g _{fs}	3475	Condition	Pulse test ⁽¹⁾ , V _{DS} = -25V, I _D =-21A	
			Limits	min 8S	
-2g	Forward Voltage V _{SD}	---	Condition	Pulse test ⁽¹⁾ , V _{GS} =0V, I _D =-42A	
			Limits	max -2.0V DC	
3-3	Hermetic Seal (1) Fine Leak (2) Gross Leak	1071	Condition	Condition H	0/22
			Limits	max 1×10 ⁻³ Pa·cm³/s	
		1071	Condition	Condition C	
3-4	Ultrasonic test	---	Condition	No cracks between chip-solder-frame.	0/22
3-5	Internal visual and Mechanical inspection	2075 2071	Condition	---	0/22
3-6	Bond strength		Sample size	22p	0/22
		2037	Condition Limits	Condition D G-Wire >90gf S-Wire >300gf	

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

4. CHARACTERISTICS IN NORMAL CONDITIONS

4.1 Electrical Characteristics

Electrical characteristics are shown in Tables 3a, 3b and 3c.

4.2 Mechanical and Thermal Characteristics

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⁾ (mΩ)		gfs ⁽¹⁾ (S)	
	I _D =-1mA V _{GS} =0V		V _{DS} =80% of rated V _{DS} V _{GS} =0V		V _{GS} =±20V V _{DS} =0V		I _D =-1mA V _{DS} =V _{GS}		I _D =50% of rated I _D V _{GS} =-12V		I _D =50% of rated I _D V _{DS} =-25V	
	Min.	Typ.	Max.	Typ.	Max.	Typ.	Min.-Max.	Typ.	Max.	Typ.	Min.	Typ.
JAXA R 2SJ1A01	-100	-110	-10	200n	±100	+5 -3	-2.5 to -4.5	-3.0	45	38	8	22
JAXA R 2SJ1A02				50n		+1 -5			97	81	8	13
JAXA R 2SJ1A03				30n		+1 -1			226	188	4	5
JAXA R 2SJ1A04				200n		+5 -3			38	32	8	22
JAXA R 2SJ1A05				50n		+1 -5			90	75	8	13
JAXA R 2SJ1A06				30n		+1 -1			219	183	4	5
JAXA R 2SJ1A07	-200	-215		200n		+5 -3			91	76	8	20
JAXA R 2SJ1A08				50n		+1 -5			210	175	8	10
JAXA R 2SJ1A09				30n		+1 -1			487	405	3.5	4.5
JAXA R 2SJ1A10				200n		+5 -3			84	70	8	20
JAXA R 2SJ1A11				50n		+1 -5			203	170	8	10
JAXA R 2SJ1A12				30n		+1 -1			480	400	3.5	4.5

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

Table 3b. Electrical Characteristics ($T_A=+25^{\circ}\text{C}$ 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} =50% of rated V _{DS} , I _D = rated I _D , V _{GS} =-12V						V _{DD} =50% of rated V _{DS} , I _D = rated I _D , V _{GS} =-12V, R _G =10Ω							
	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ	Max	Typ
JAXA R 2SJ1A01	75	50	50	33	230	150	70	45	60	50	225	150	150	100
JAXA R 2SJ1A02	30	20	20	13	95	63	50	33	25	17	115	77	45	30
JAXA R 2SJ1A03	15	10	10	7	40	26	25	17	20	13	75	50	25	17
JAXA R 2SJ1A04	75	50	50	33	230	150	70	45	60	50	225	150	150	100
JAXA R 2SJ1A05	30	20	20	13	95	63	50	33	25	17	115	77	45	30
JAXA R 2SJ1A06	15	10	10	7	40	26	25	17	20	13	75	50	25	17
JAXA R 2SJ1A07	75	50	50	33	230	150	70	45	60	50	225	150	150	100
JAXA R 2SJ1A08	30	20	20	13	95	63	50	33	25	17	115	77	45	30
JAXA R 2SJ1A09	15	10	10	7	40	26	25	17	20	13	75	50	25	17
JAXA R 2SJ1A10	75	50	50	33	230	150	70	45	60	50	225	150	150	100
JAXA R 2SJ1A11	30	20	20	13	95	63	50	33	25	17	115	77	45	30
JAXA R 2SJ1A12	15	10	10	7	40	26	25	17	20	13	75	50	25	17

Table 3c. Electrical Characteristics (Body Diode Characteristics)
($T_A=+25^{\circ}\text{C}$ unless otherwise specified)^o

Part No. JAXA R	V _{SD} ⁽¹⁾ (V)		t _{rr} (ns)		Q _{rr} (μC)	
	I _F = rated I _D V _{GS} =0V		I _F = rated I _D , V _{GS} =0V, -di/dt=100A/μs, T _{ch} =25°C			
	Max.	Typ.	Max.	Typ.	Max.	Typ.
2SJ1A01	-2.0	-1.4	260	175	2.0	1.3
2SJ1A02			255	170	2.0	1.3
2SJ1A03			215	145	1.5	1.0
2SJ1A04			260	175	2.0	1.3
2SJ1A05			255	170	2.0	1.3
2SJ1A06			215	145	1.5	1.0
2SJ1A07			375	250	4.5	3.0
2SJ1A08			315	201	3.0	2.0
2SJ1A09			280	185	2.5	1.7
2SJ1A10			375	250	4.5	3.0
2SJ1A11			315	201	3.0	2.0
2SJ1A12			280	185	2.5	1.7

Note⁽¹⁾ Pulse test: Pulse width $\leq 1\text{ms}$, Duty cycle $\leq 2\%$

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	TO-254: 250°C, 10s, SMD : 240°C, 10s		
Moisture Resistance		80 to 98%, 25 to 65°C, 10 cycles		
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, 4 minutes X-Y-Z each orientation, 4 times		
	Shock	14710m/s ² (1500G), 0.5ms X ₁ -Y ₁ -Z ₁ each orientation, 5 times		
	Constant Acceleration	98066.5 m/s ² (10000G) X ₁ -Y ₁ -Z ₁ each orientation, 1 time		
	Terminal strength	TO-254: 1.5kgf, Z ₁ orientation, 30s		
Electrostatic Discharge (ESD)		JAXA R 2SJ1A01 JAXA R 2SJ1A04 JAXA R 2SJ1A07 JAXA R 2SJ1A10	JAXA R 2SJ1A02 JAXA R 2SJ1A05 JAXA R 2SJ1A08 JAXA R 2SJ1A11	JAXA R 2SJ1A03 JAXA R 2SJ1A06 JAXA R 2SJ1A09 JAXA R 2SJ1A12
		C=100pF, R=1.5kΩ		
		V _{GS} =±2750V	V _{GS} =±1000V	V _{GS} =±500V

5. CHARACTERISTIC CURVES

Characteristic curves for each operating condition are shown in Figures 9 through 44:

Figures 9 though 11 : Characteristic curves of JAXA R 2SJ1A01

Figures 12 though 14 : Characteristic curves of JAXA R 2SJ1A02

Figures 15 though 17 : Characteristic curves of JAXA R 2SJ1A03

Figures 18 though 20 : Characteristic curves of JAXA R 2SJ1A04

Figures 21 though 23 : Characteristic curves of JAXA R 2SJ1A05

Figures 24 though 26 : Characteristic curves of JAXA R 2SJ1A06

Figures 27 though 29 : Characteristic curves of JAXA R 2SJ1A07

Figures 30 though 32 : Characteristic curves of JAXA R 2SJ1A08

Figures 33 though 35 : Characteristic curves of JAXA R 2SJ1A09

Figures 36 though 38 : Characteristic curves of JAXA R 2SJ1A10

Figures 39 though 41 : Characteristic curves of JAXA R 2SJ1A11

Figures 42 though 44 : Characteristic curves of JAXA R 2SJ1A12

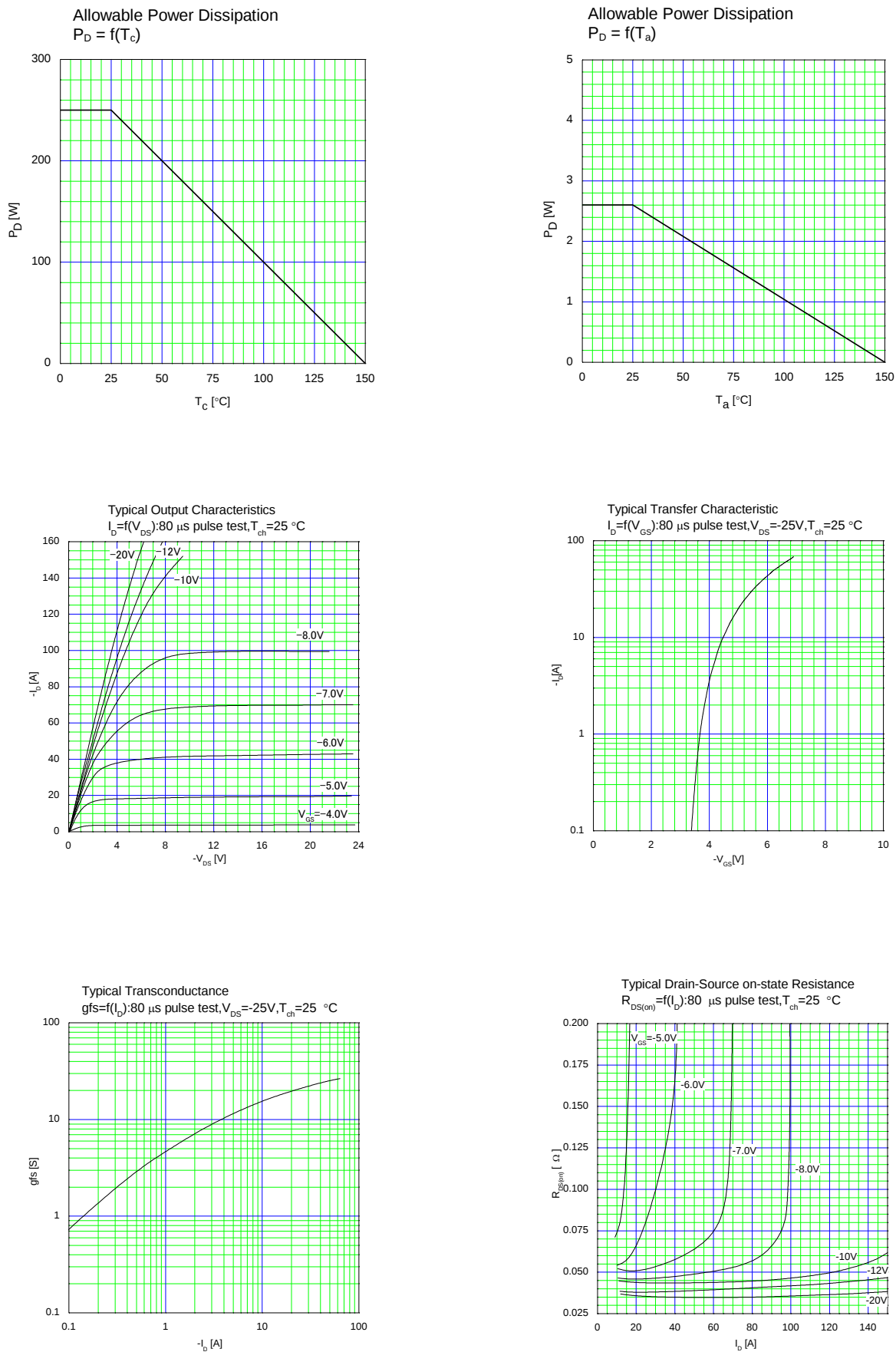


Figure 9. Characteristic Curves of JAXA R 2SJ1A01 (1/3)

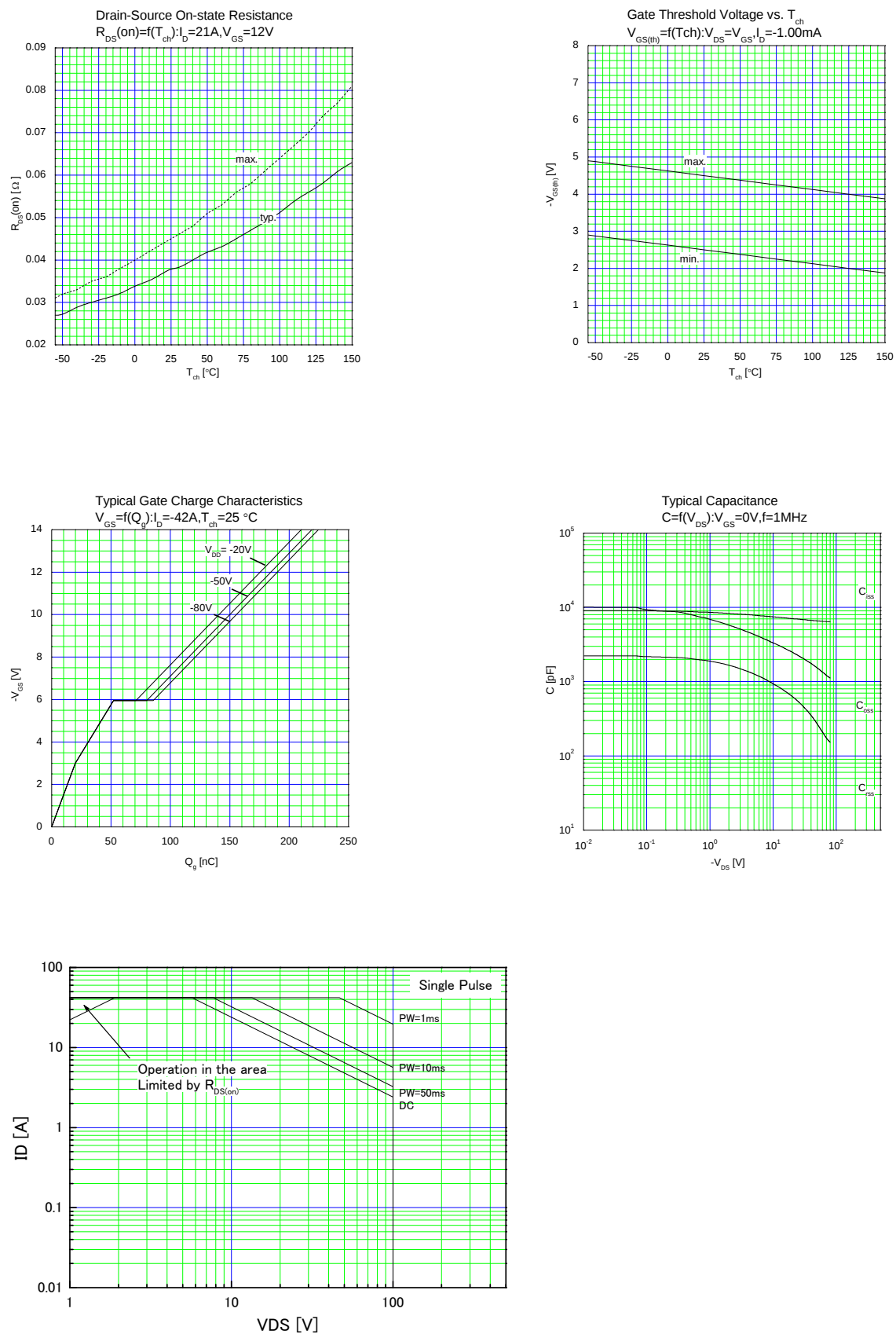


Figure 10. Characteristic Curves of JAXA R 2SJ1A01 (2/3)

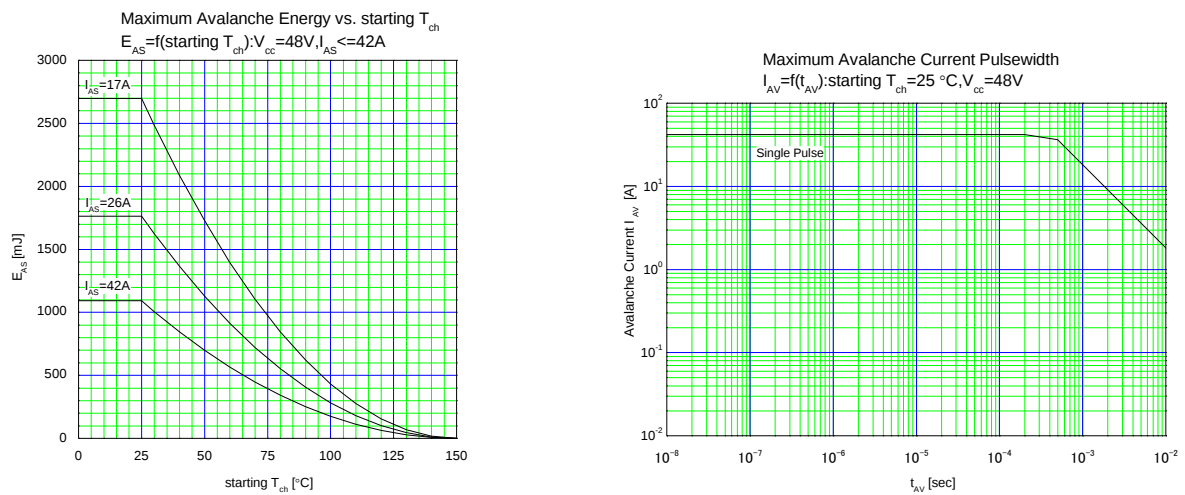


Figure 11. Characteristic Curves of JAXA R 2SJ1A01 (3/3)

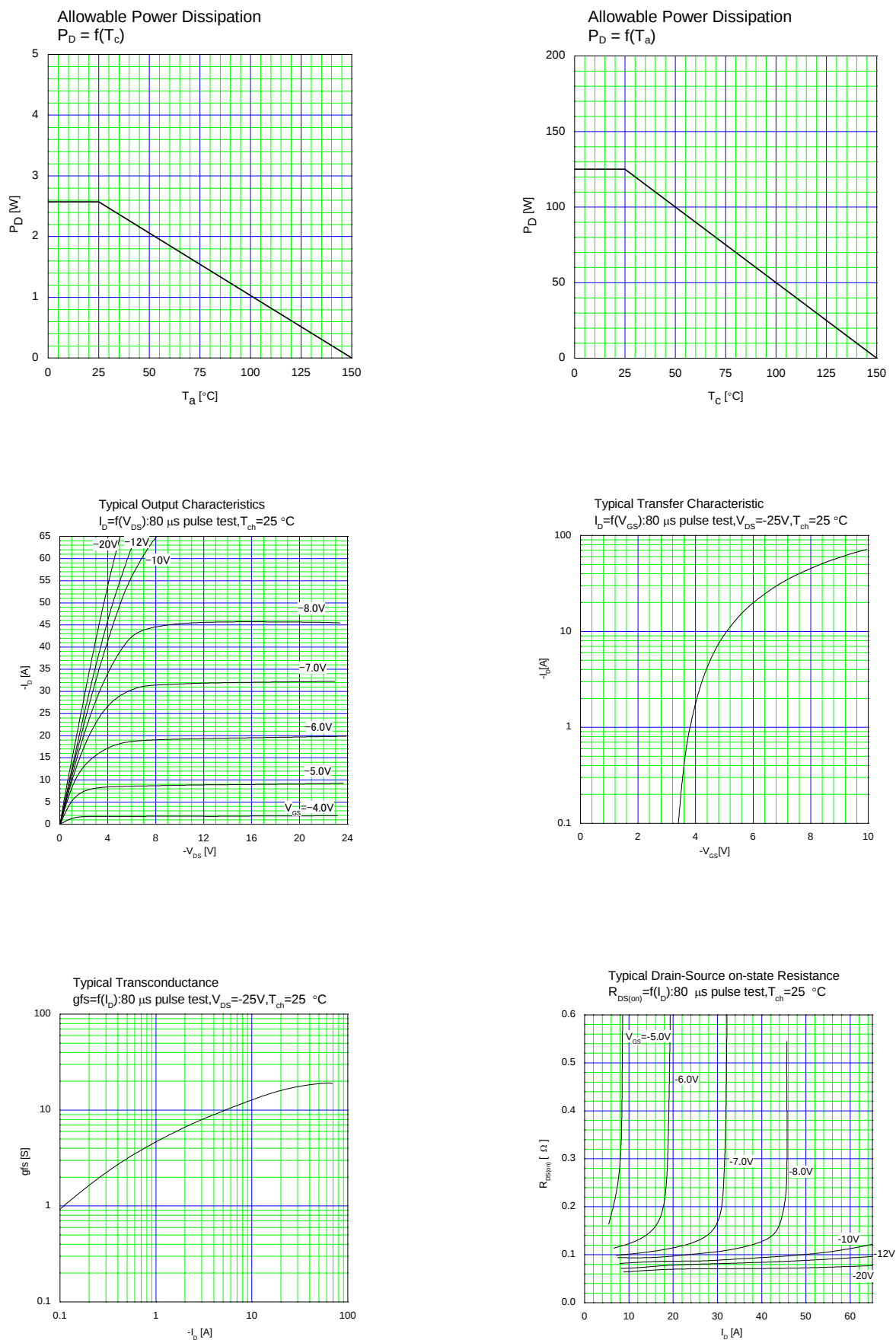


Figure 12. Characteristic Curves of JAXA R 2SJ1A02 (1/3)

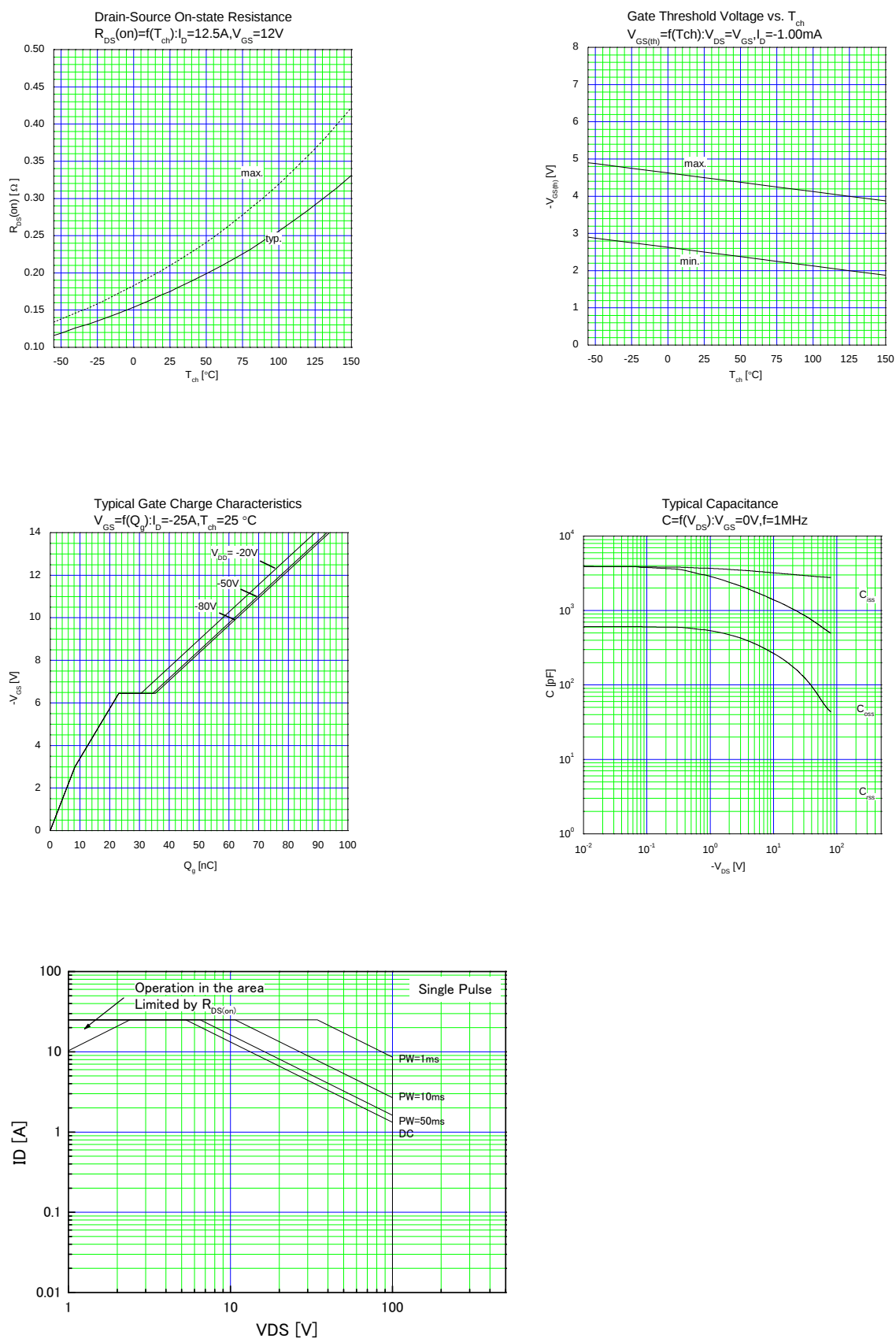


Figure 13. Characteristic Curves of JAXA R 2SJ1A02 (2/3)

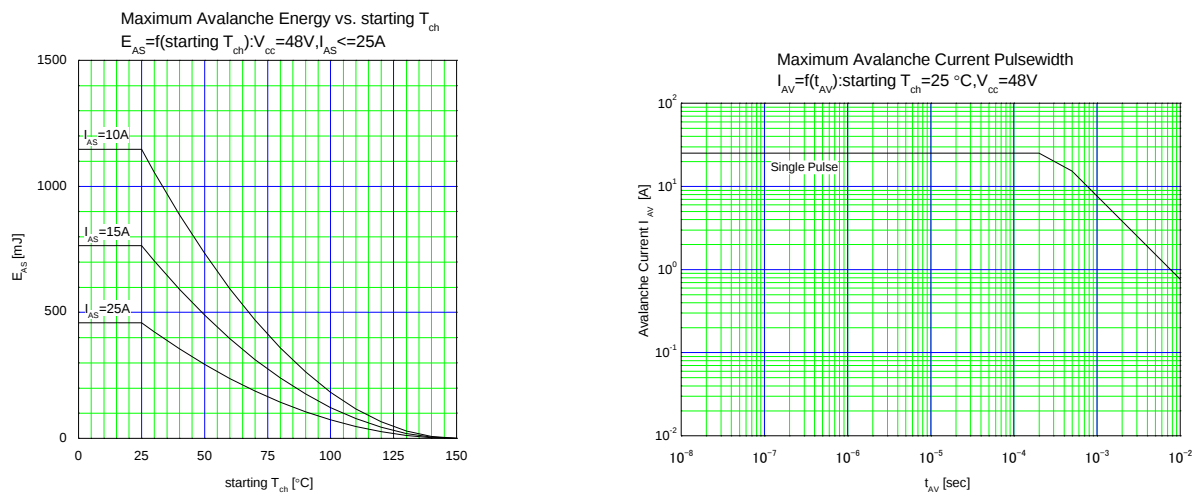


Figure 14. Characteristic Curves of JAXA R 2SJ1A02 (3/3)

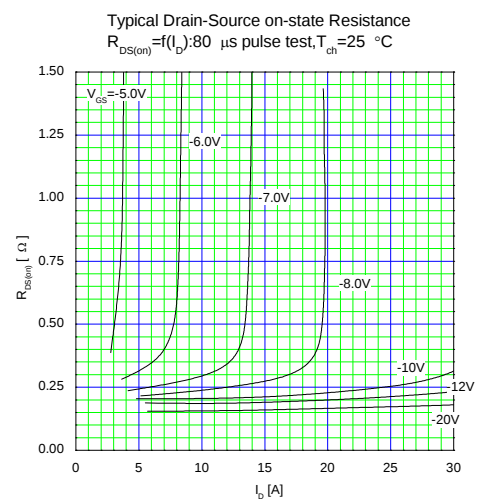
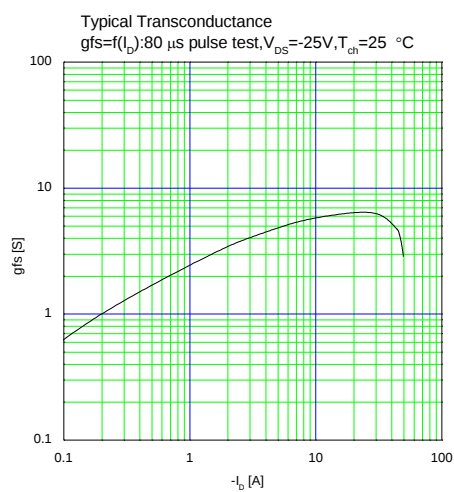
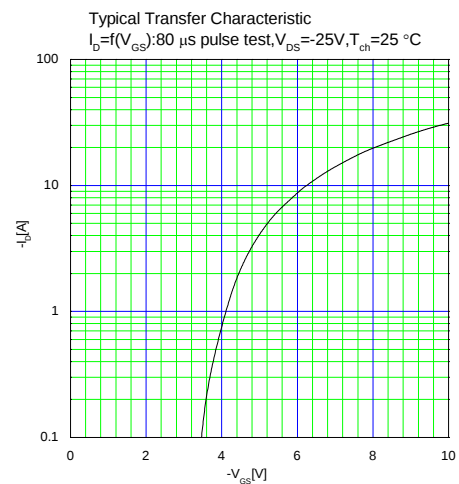
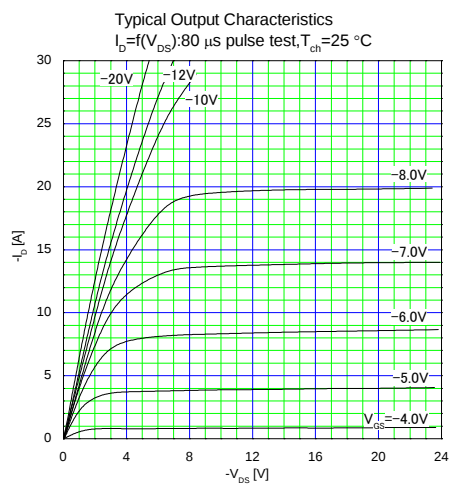
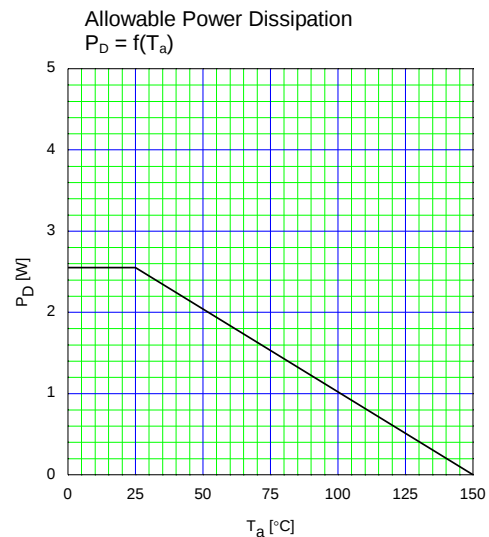
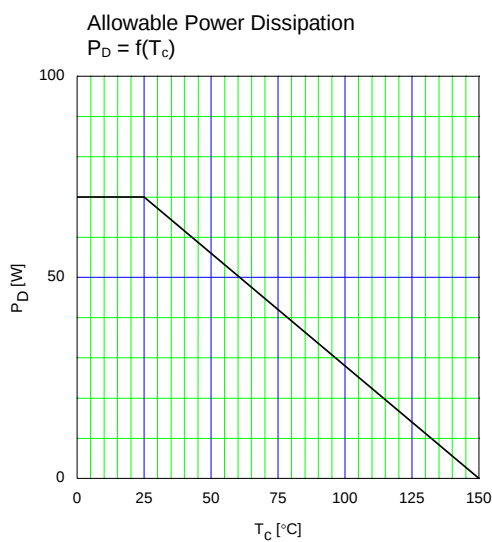


Figure 15. Characteristic Curves of JAXA R 2SJ1A03 (1/3)

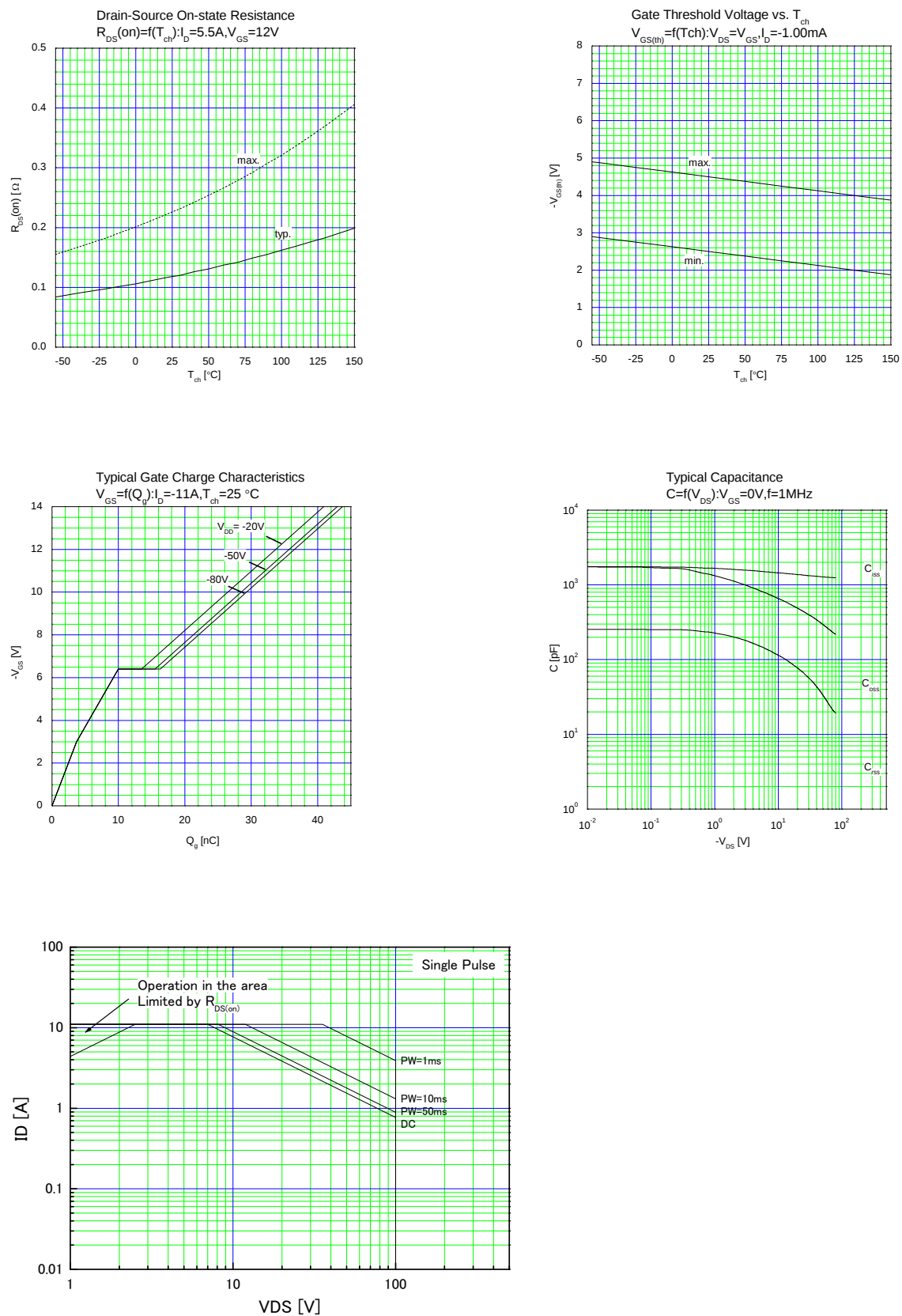


Figure 16. Characteristic Curves of JAXA R 2SJ1A03 (2/3)

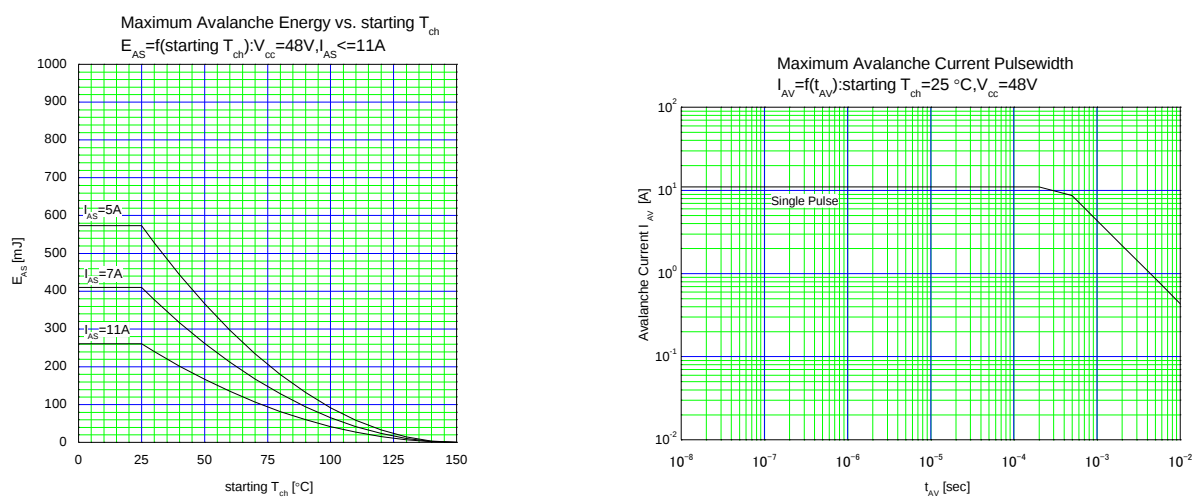


Figure 17. Characteristic Curves of JAXA R 2SJ1A03 (3/3)

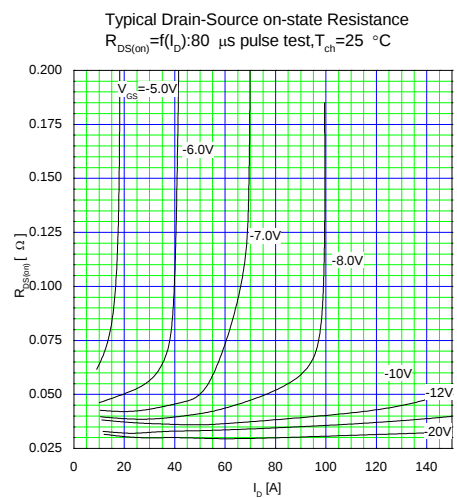
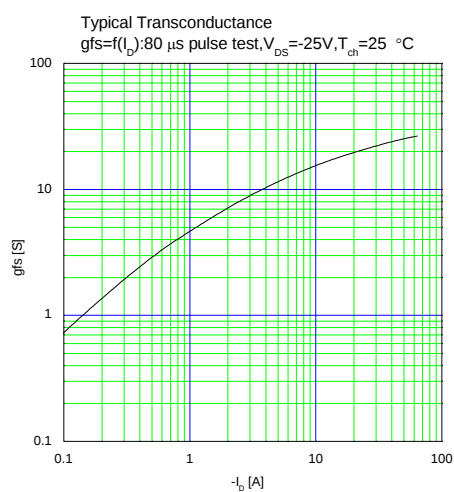
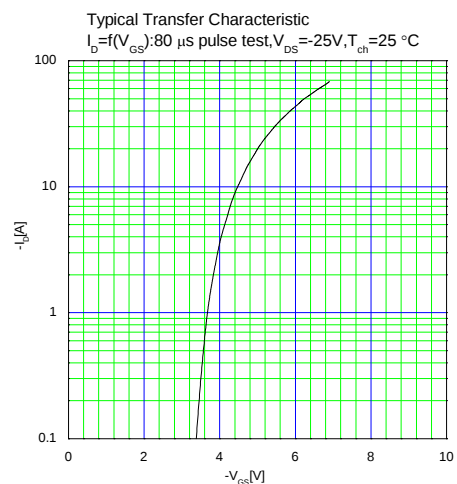
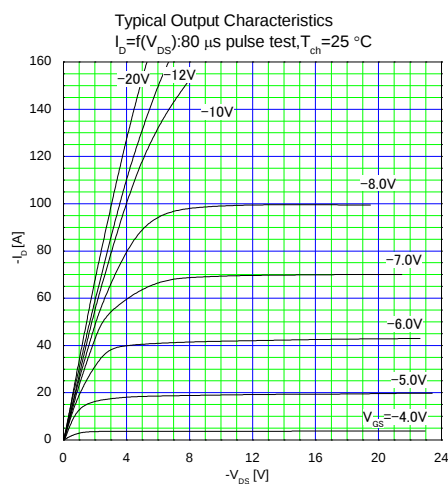
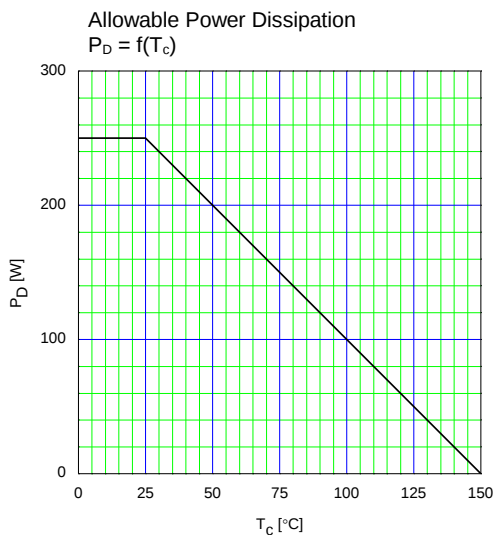


Figure 18. Characteristic Curves of JAXA R 2SJ1A04 (1/3)

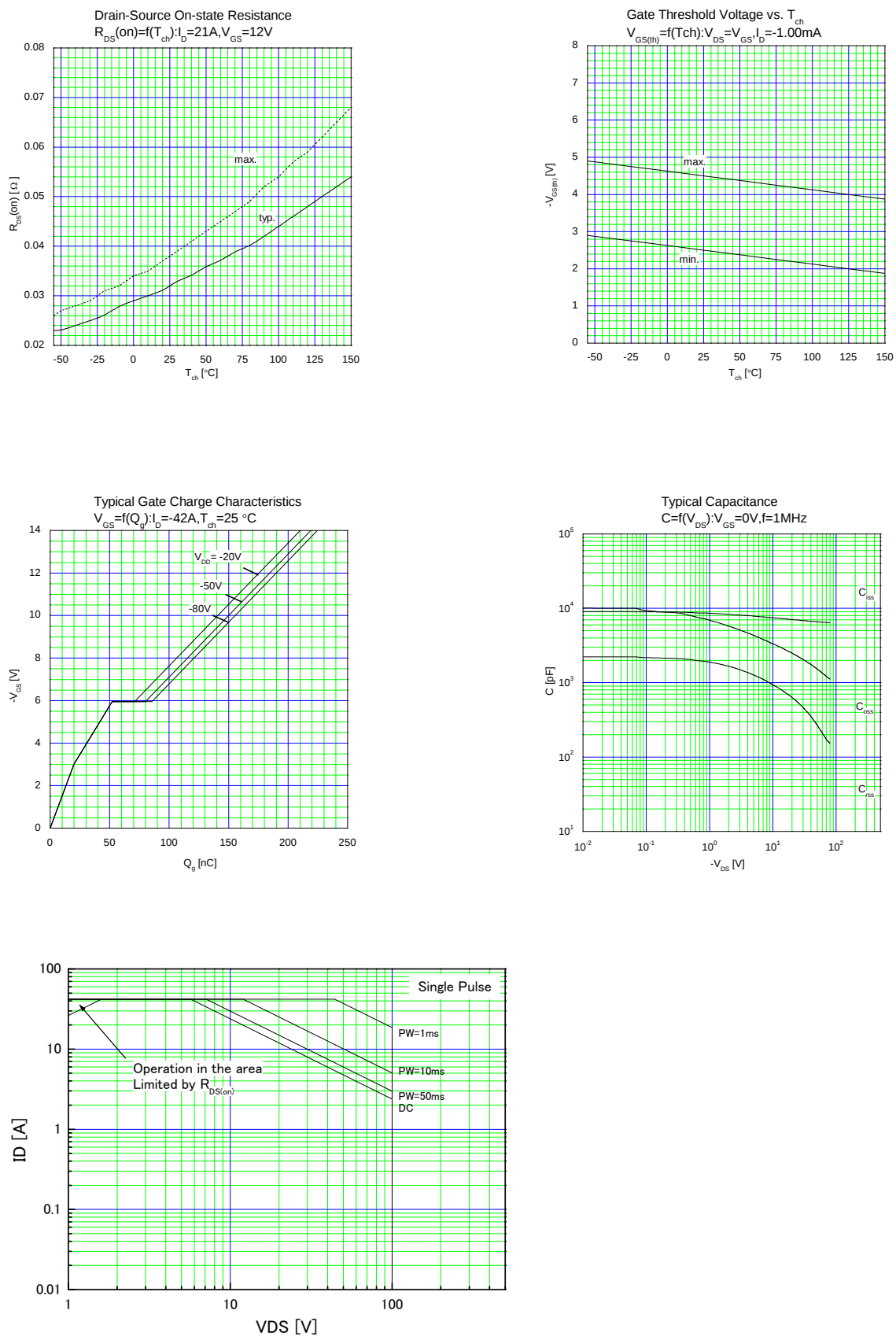


Figure 19. Characteristic Curves of JAXA R 2SJ1A04 (2/3)

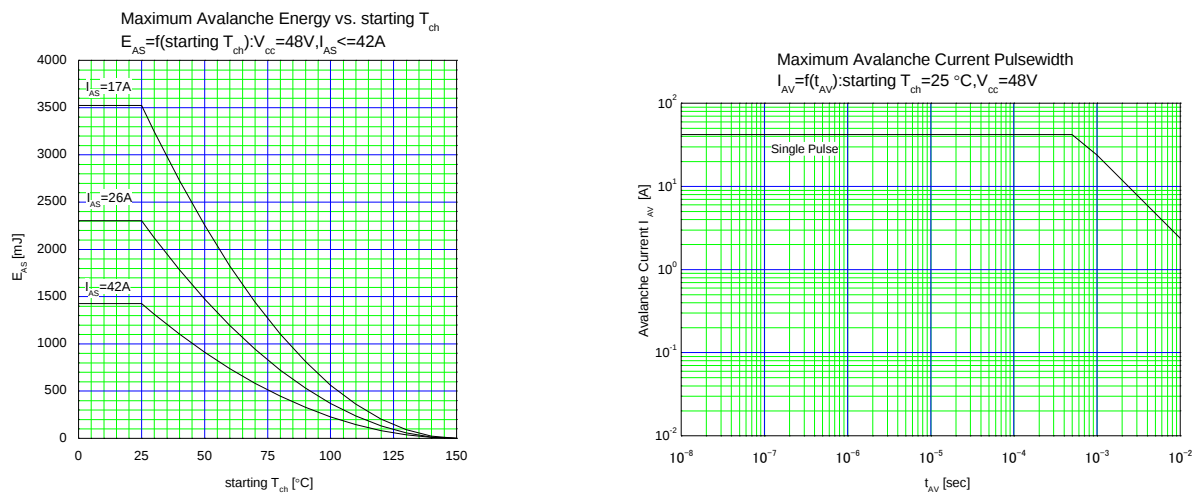


Figure 20. Characteristic Curves of JAXA R 2SJ1A04 (3/3)

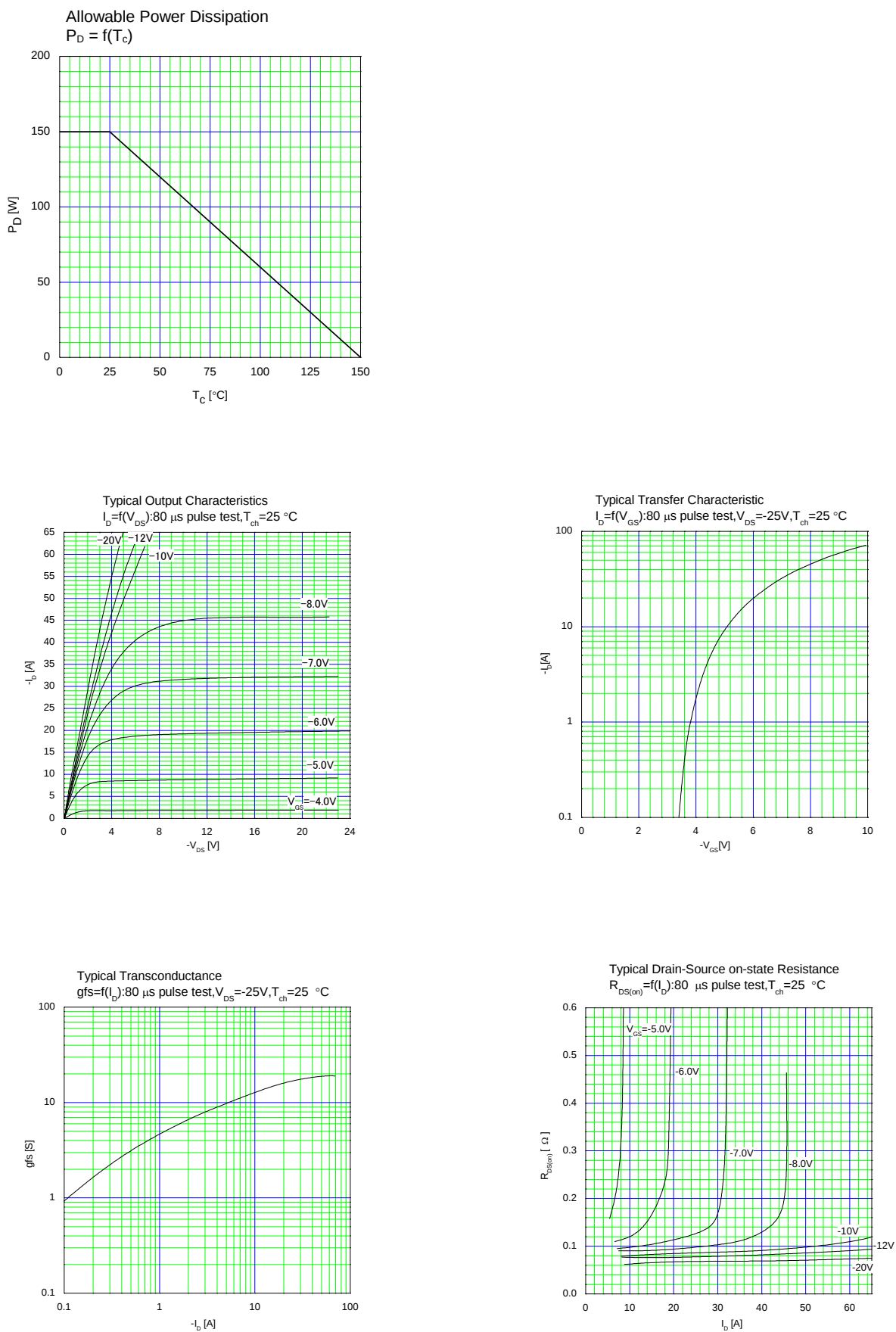


Figure 21. Characteristic Curves of JAXA R 2SJ1A05 (1/3)

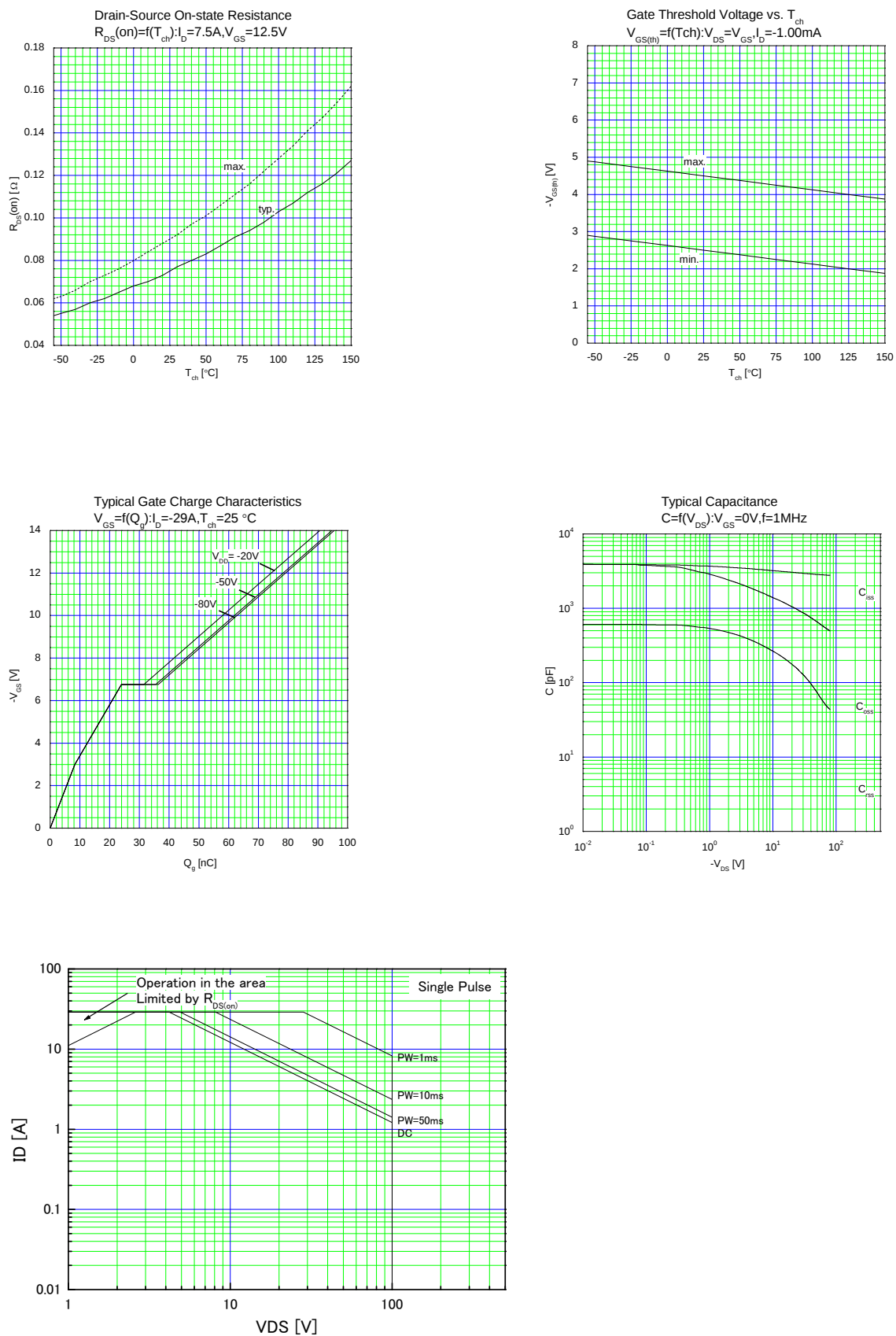


Figure 22. Characteristic Curves of JAXA R 2SJ1A05 (2/3)

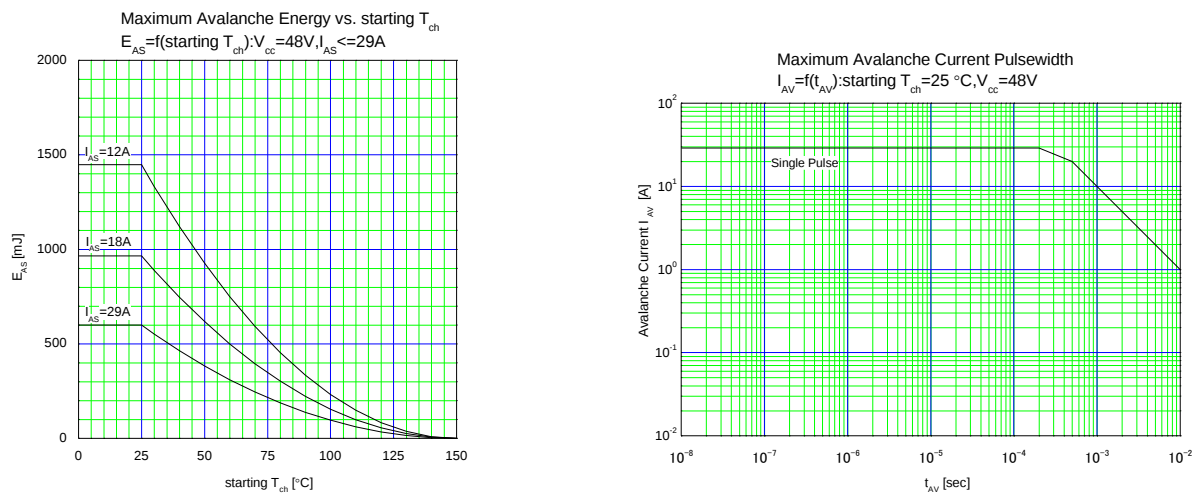


Figure 23. Characteristic Curves of JAXA R 2SJ1A05 (3/3)

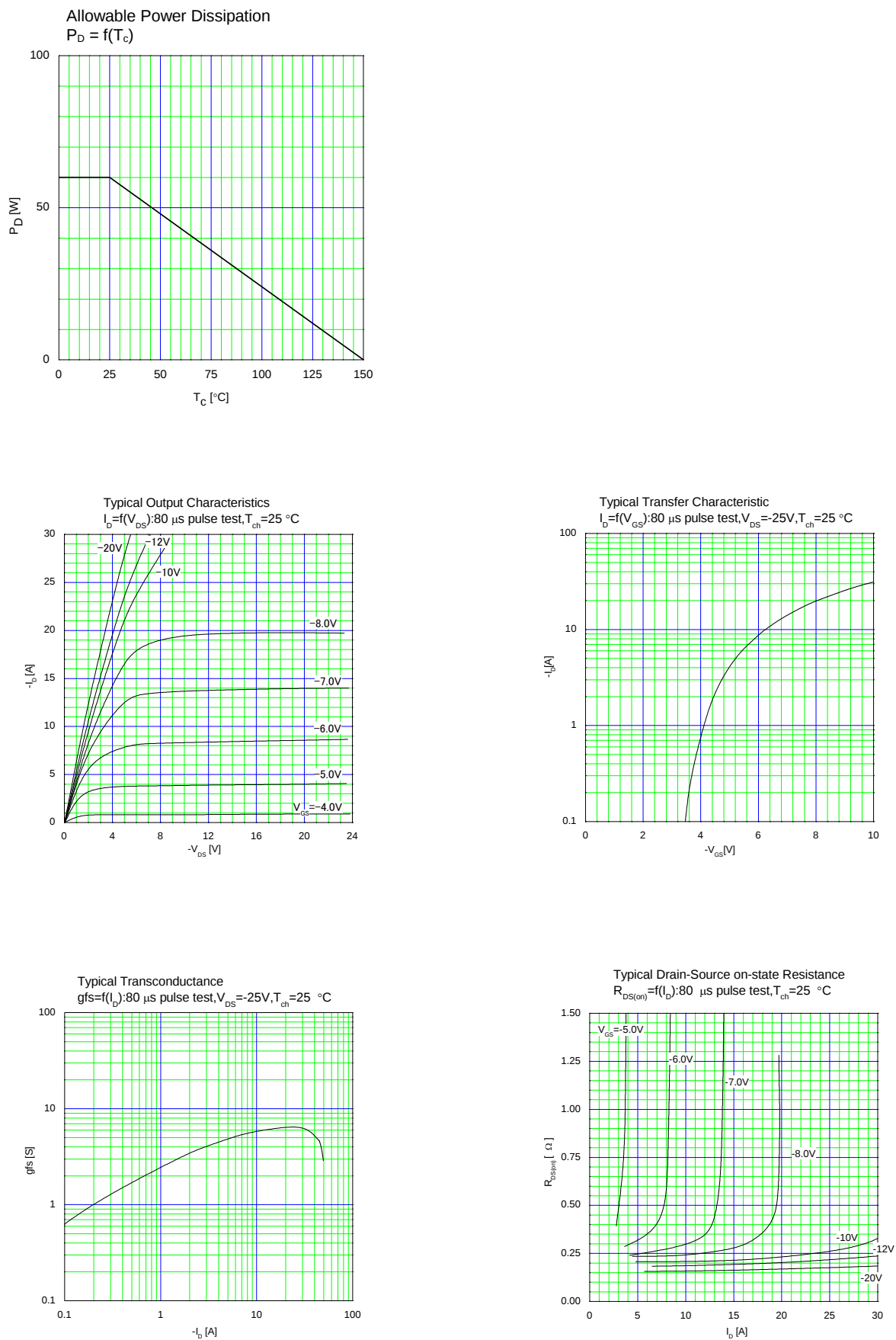


Figure 24. Characteristic Curves of JAXA R 2SJ1A06 (1/3)

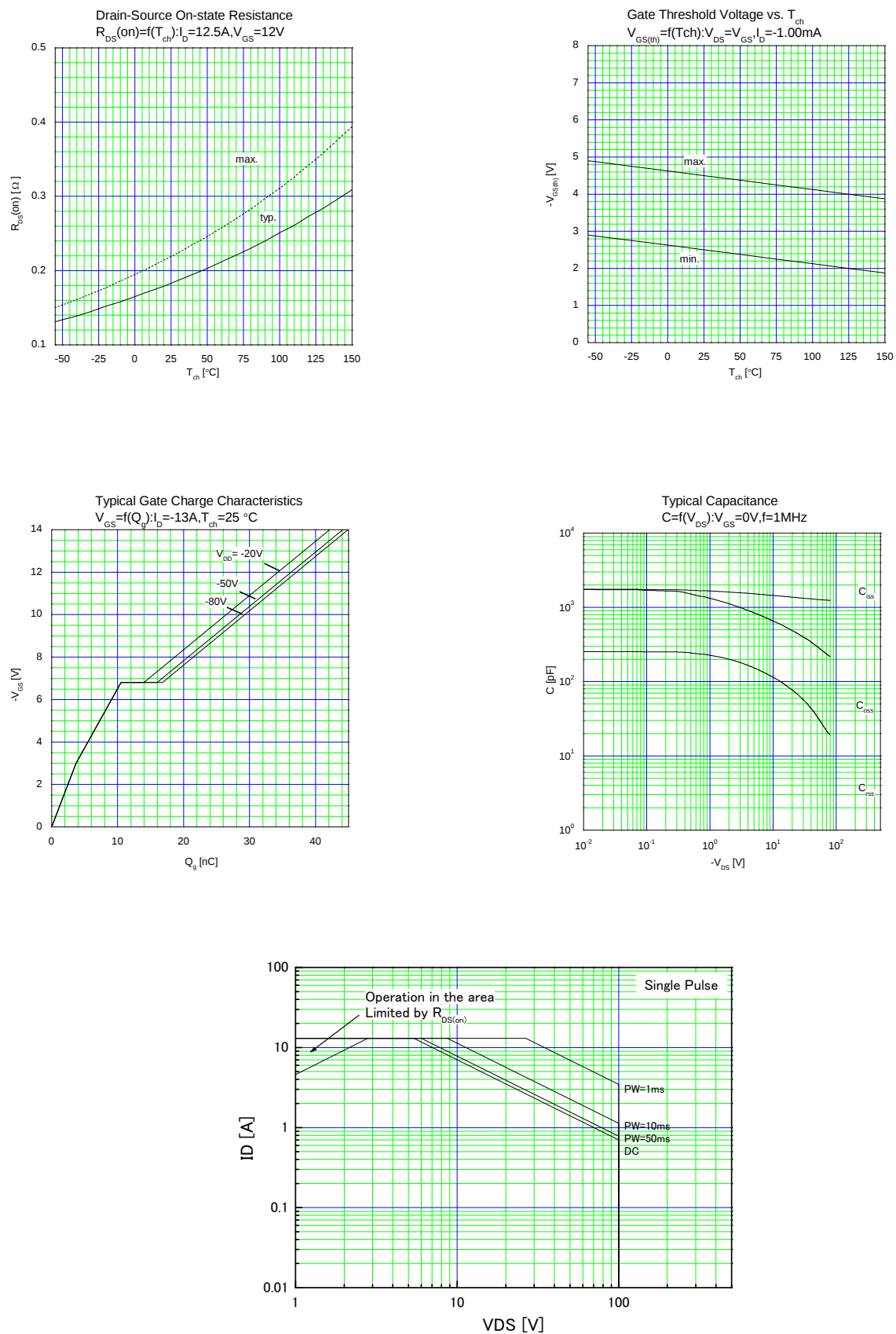


Figure 25. Characteristic Curves of JAXA R 2SJ1A06 (2/3)

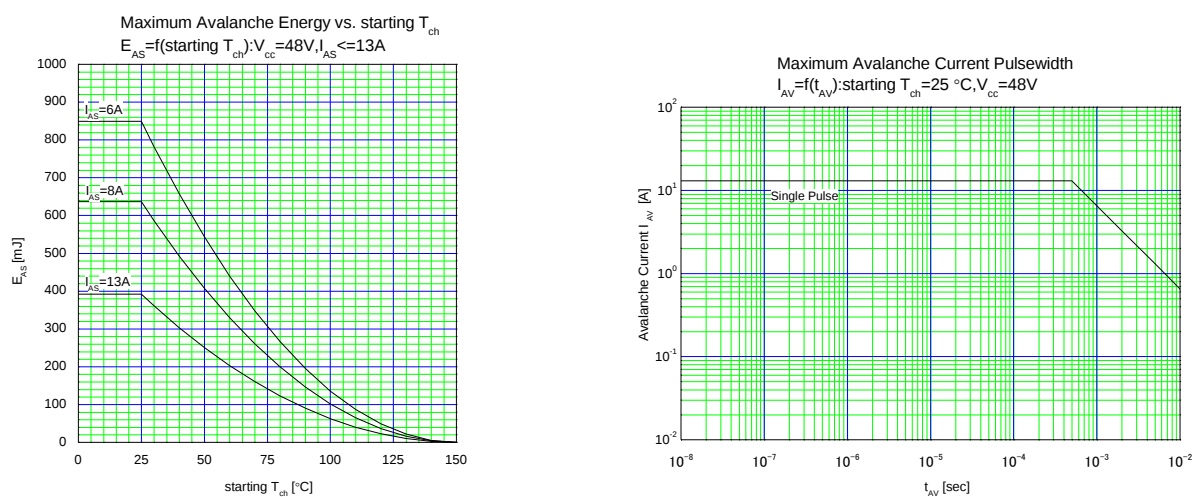


Figure 26. Characteristic Curves of JAXA R 2SJ1A06 (3/3)

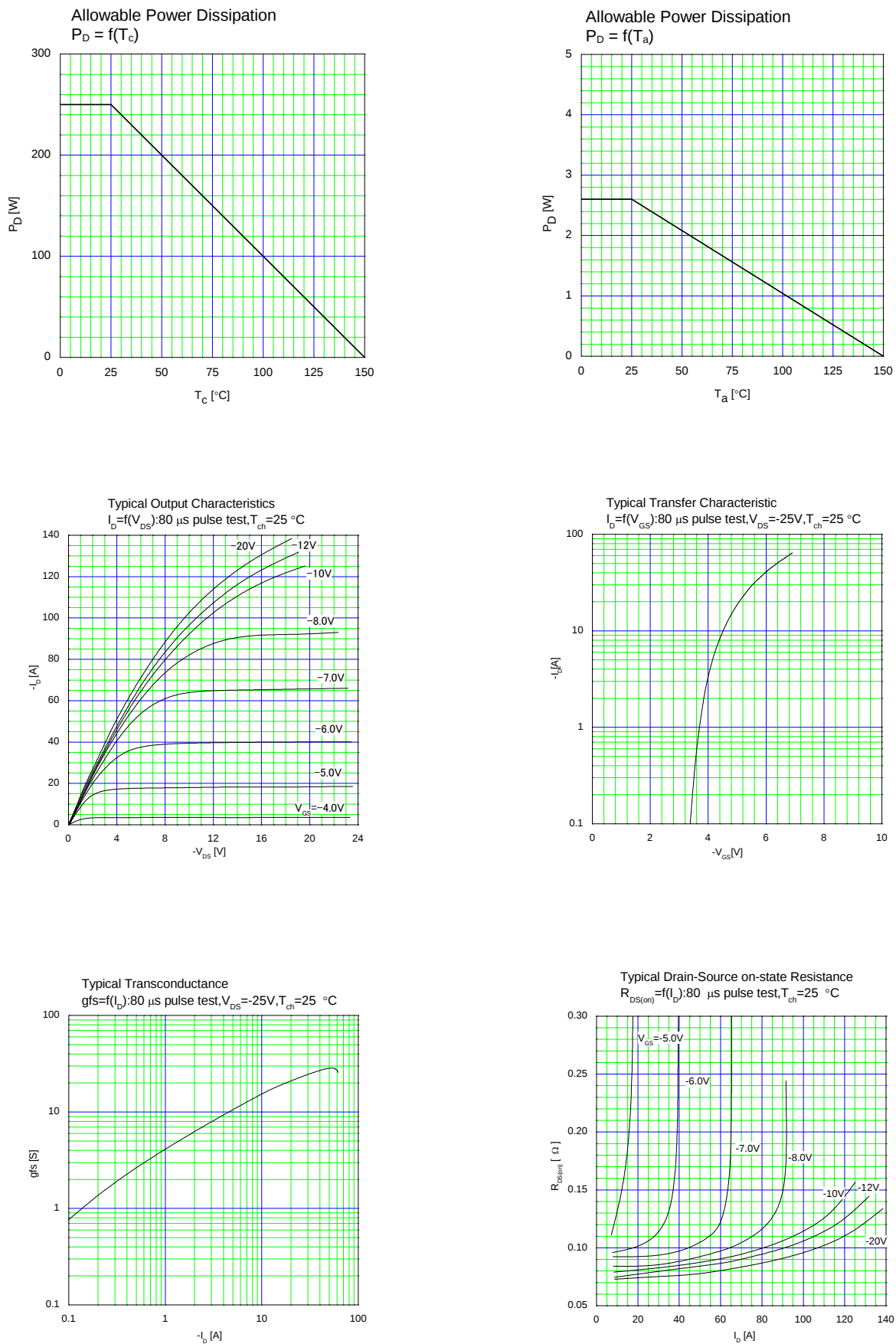


Figure 27. Characteristic Curves of JAXA R 2SJ1A07 (1/3)

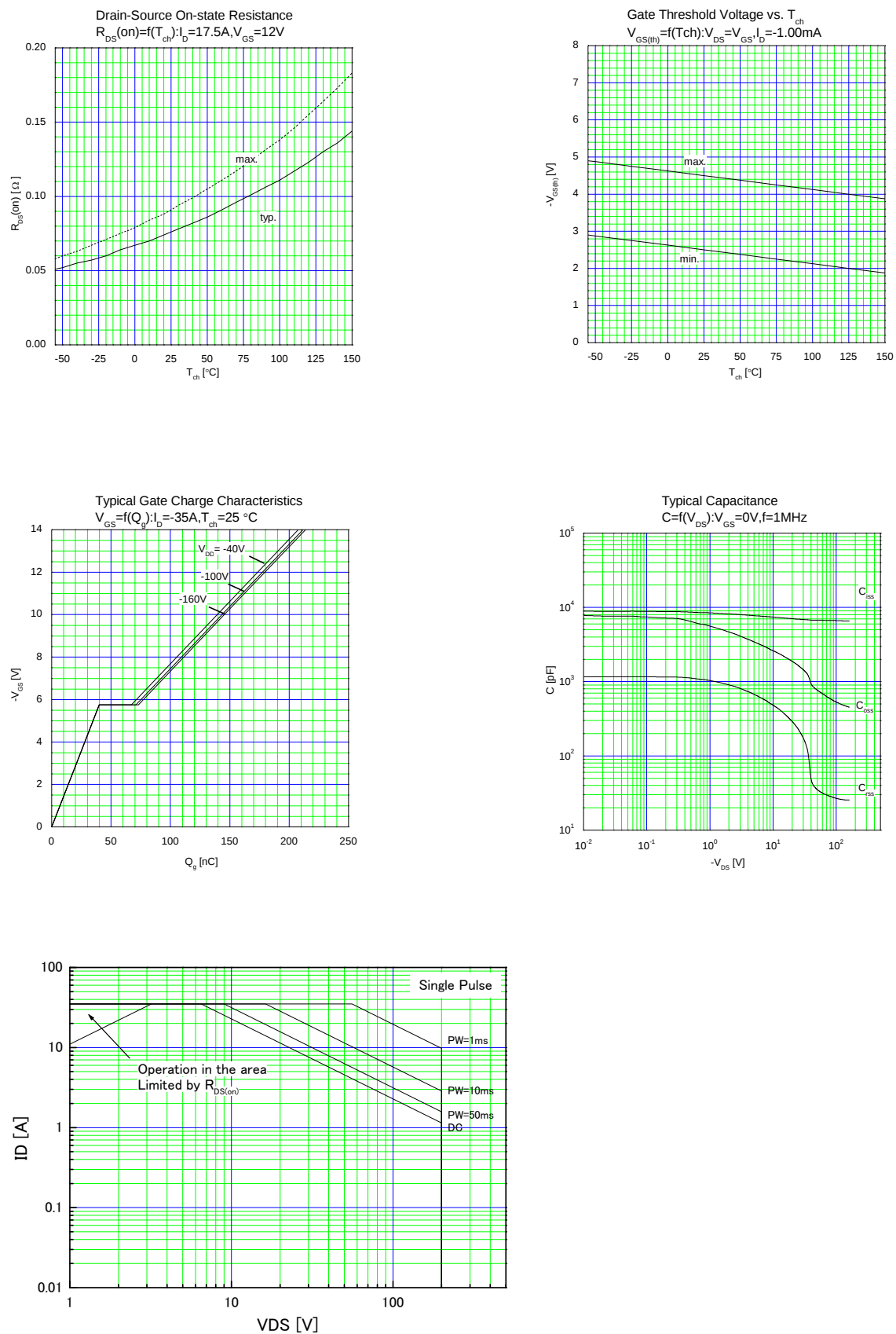


Figure 28. Characteristic Curves of JAXA R 2SJ1A07 (2/3)

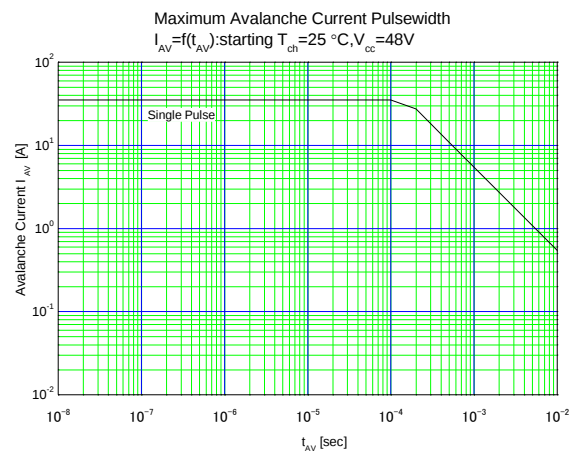
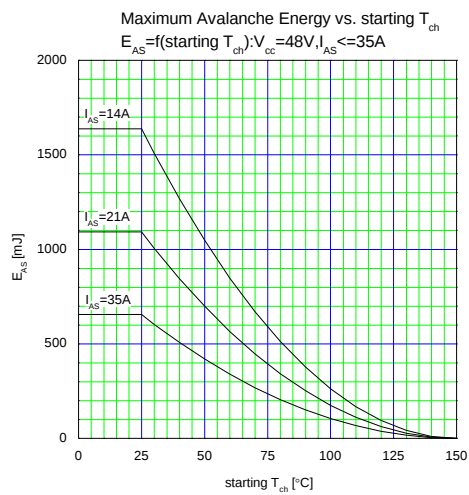


Figure 29. Characteristic Curves of JAXA R 2SJ1A07 (3/3)

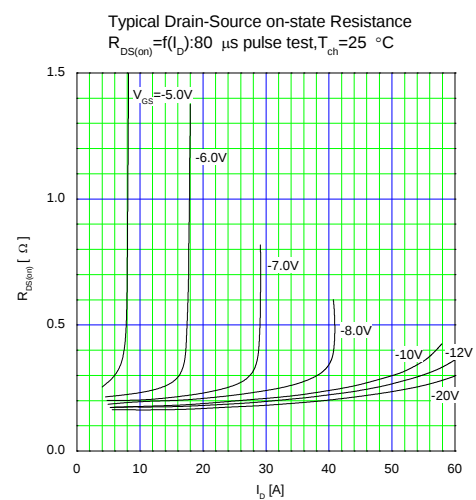
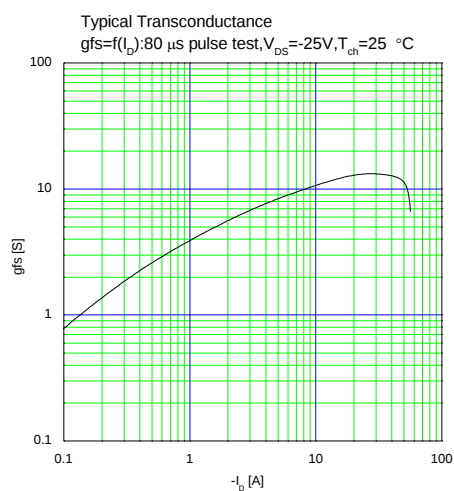
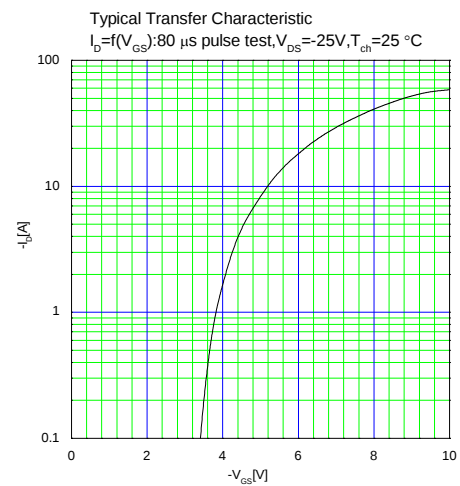
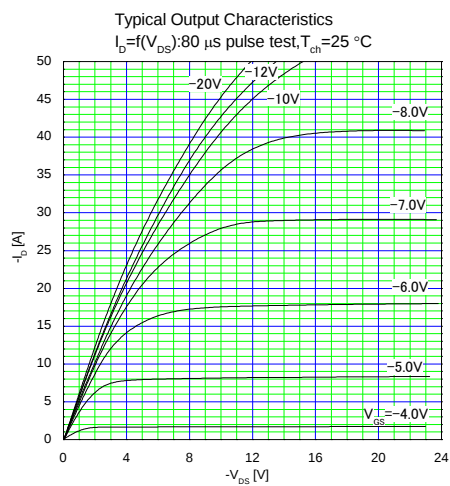
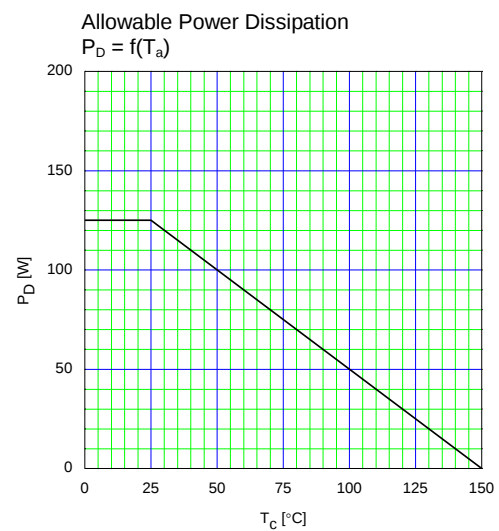
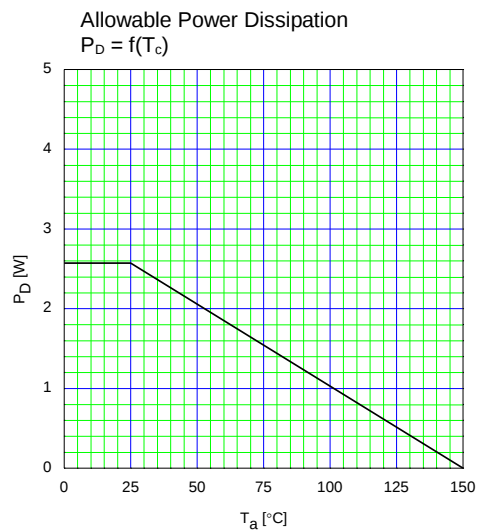


Figure 30. Characteristic Curves of JAXA R 2SJ1A08 (1/3)

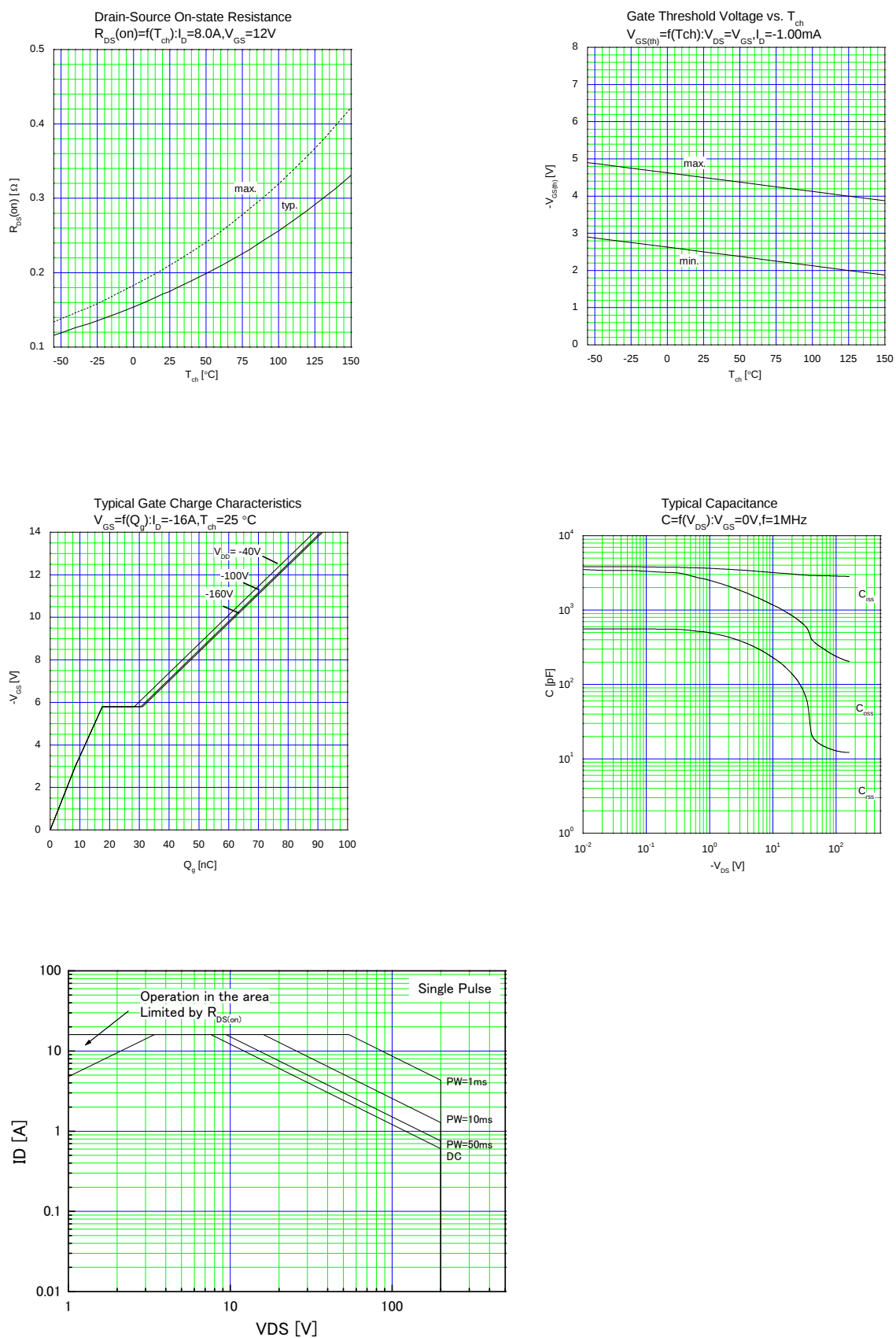


Figure 31. Characteristic Curves of JAXA R 2SJ1A08 (2/3)

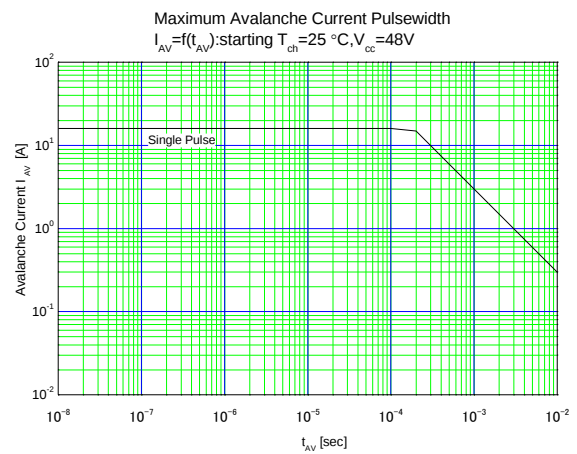
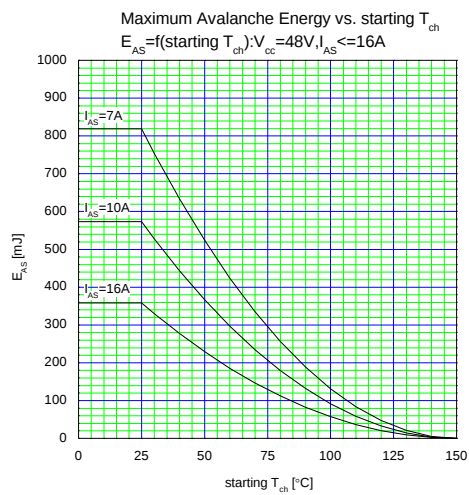


Figure 32. Characteristic Curves of JAXA R 2SJ1A08 (3/3)

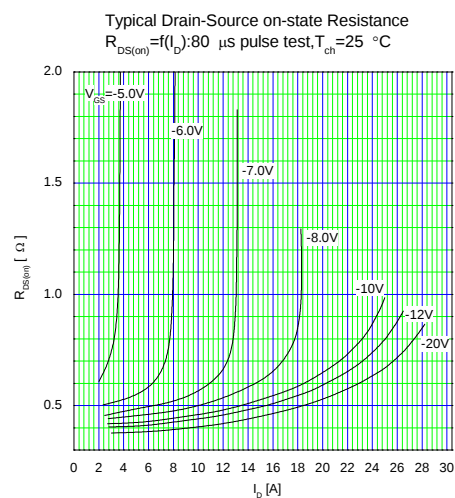
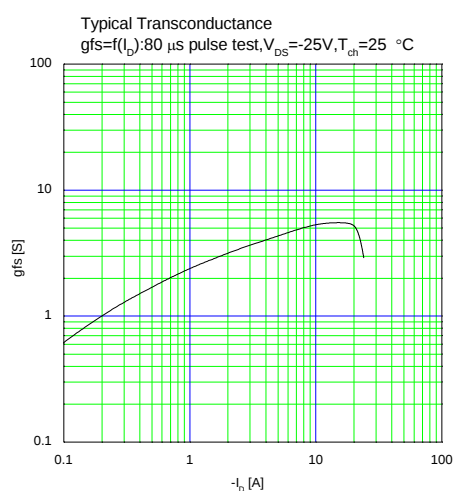
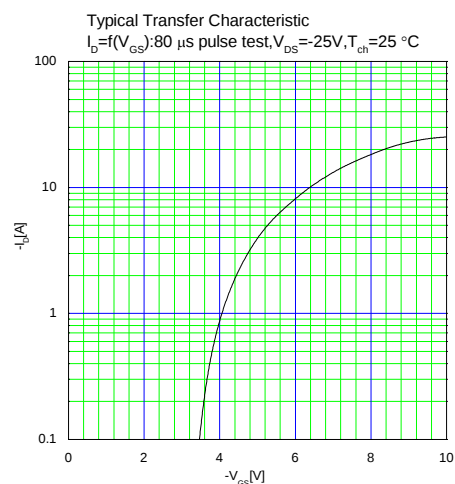
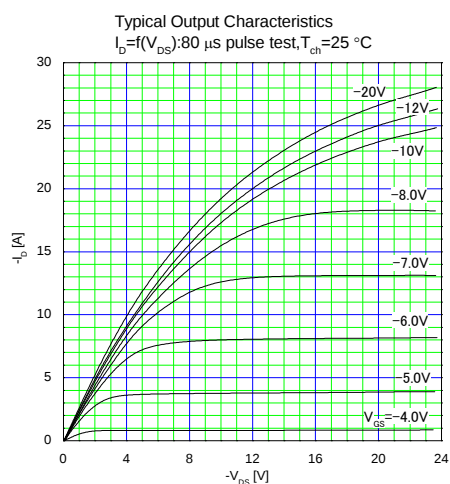
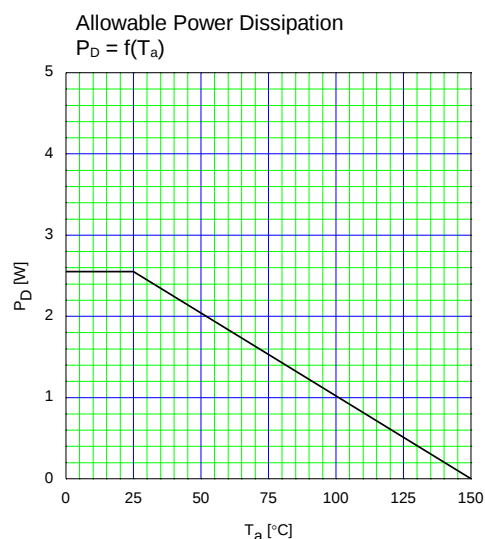
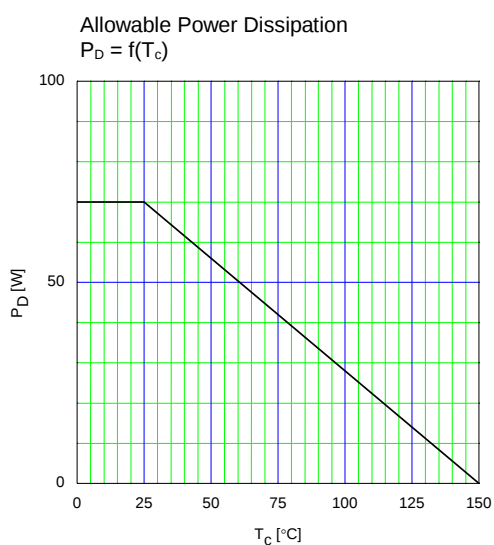


Figure 33. Characteristic Curves of JAXA R 2SJ1A09 (1/3)

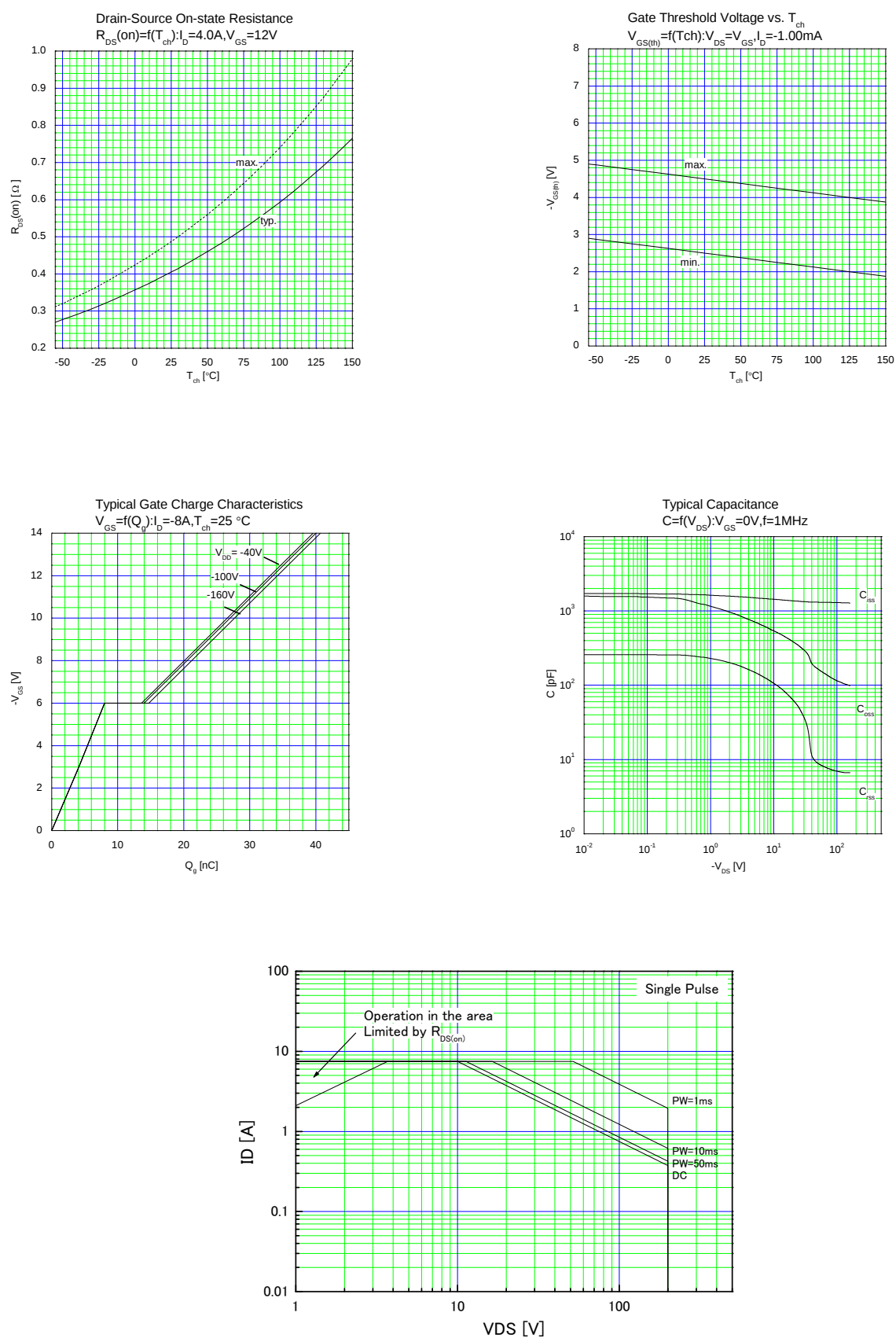


Figure 34. Characteristic Curves of JAXA R 2SJ1A09 (2/3)

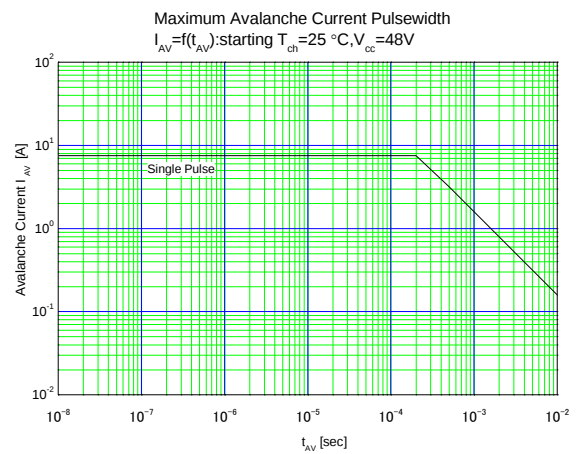
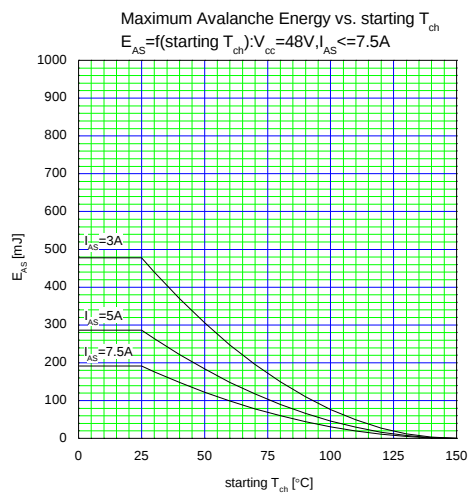


Figure 35. Characteristic Curves of JAXA R 2SJ1A09 (3/3)

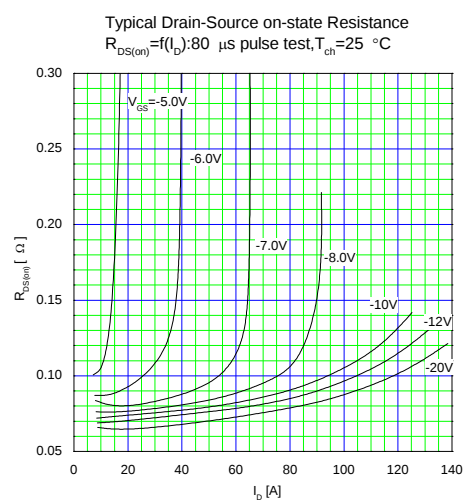
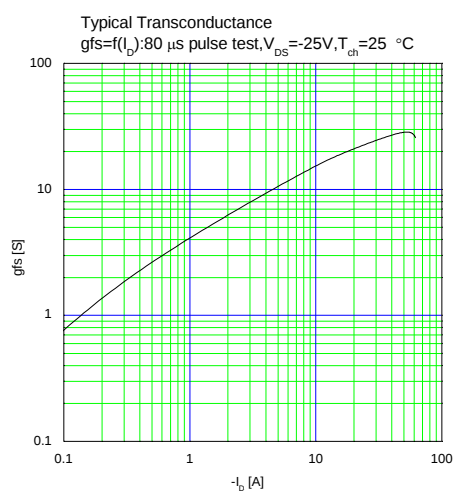
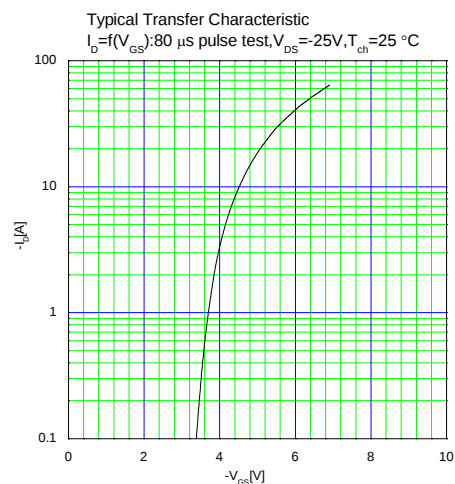
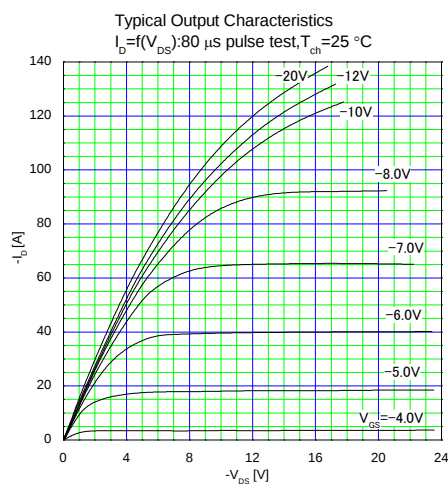
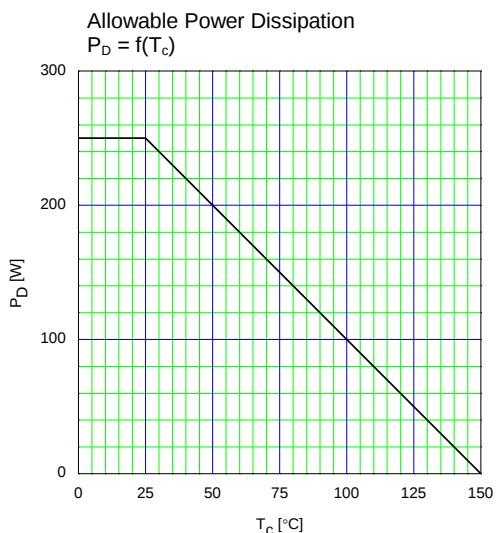


Figure 36. Characteristic Curves of JAXA R 2SJ1A10 (1/3)

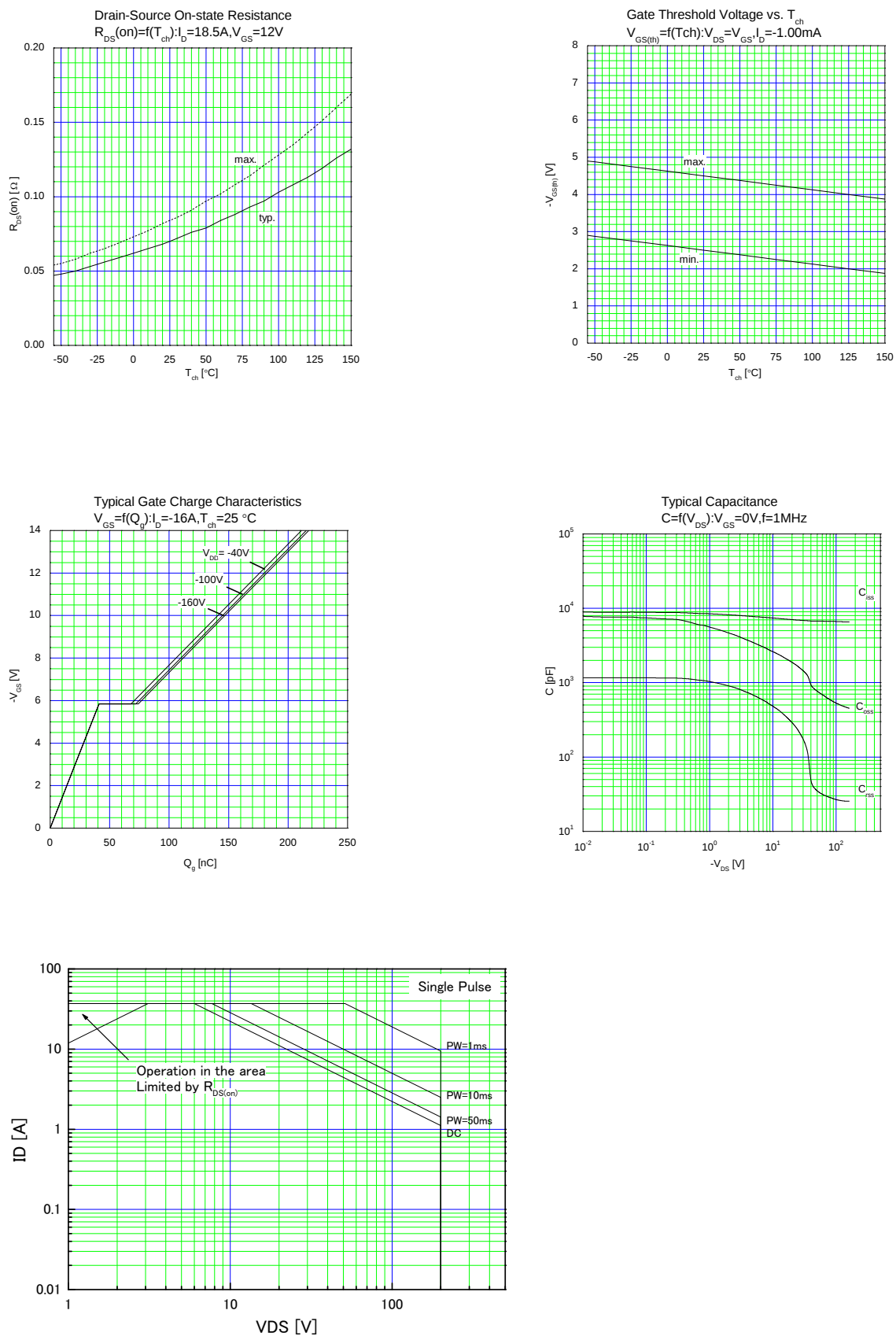


Figure 37. Characteristic Curves of JAXA R 2SJ1A10 (2/3)

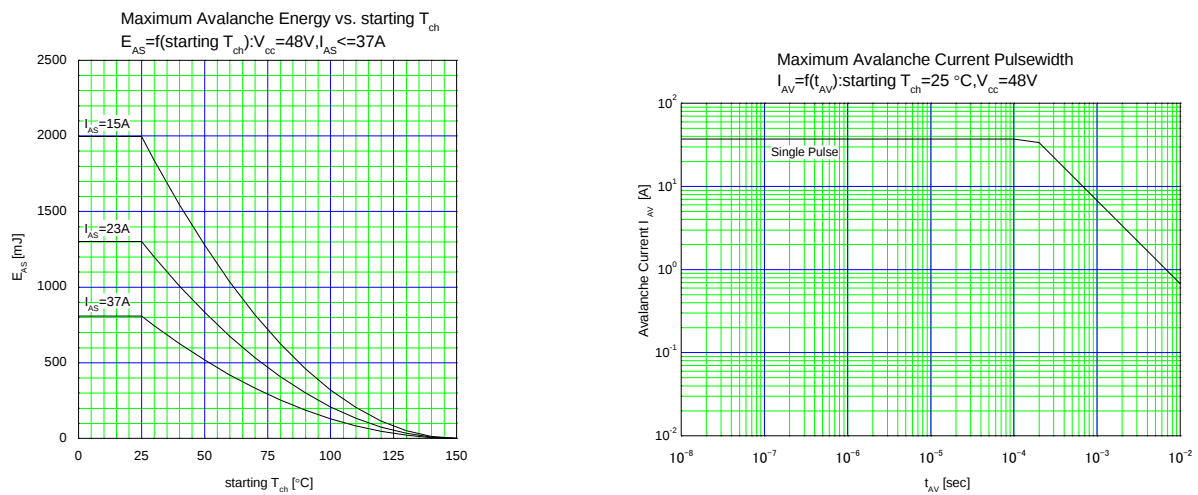


Figure 38. Characteristic Curves of JAXA R 2SJ1A10 (3/3)

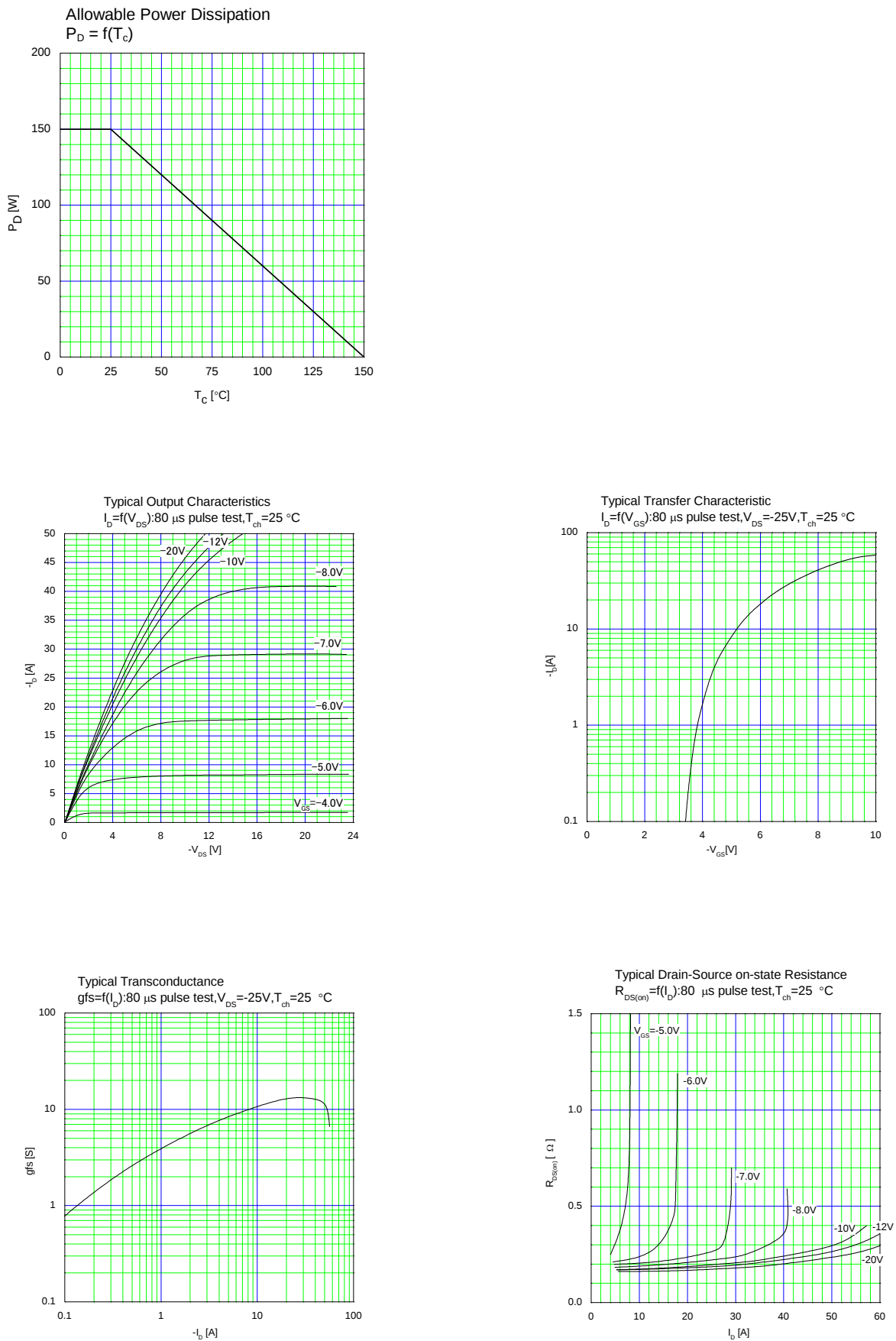


Figure 39. Characteristic Curves of JAXA R 2SJ1A11 (1/3)

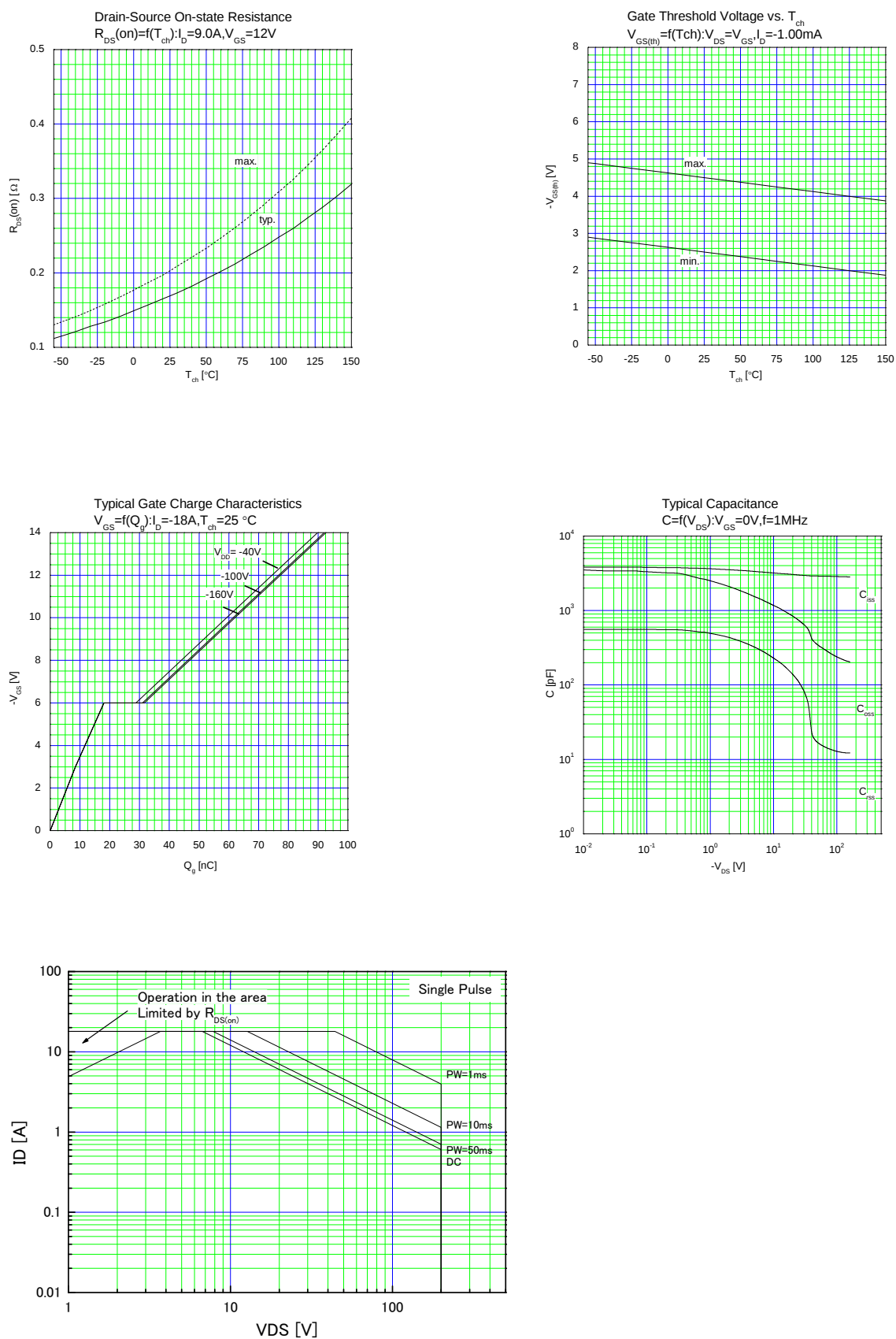


Figure 40. Characteristic Curves of JAXA R 2SJ1A11 (2/3)

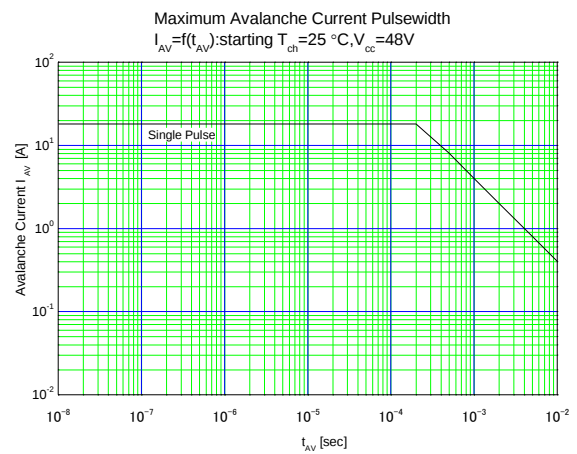
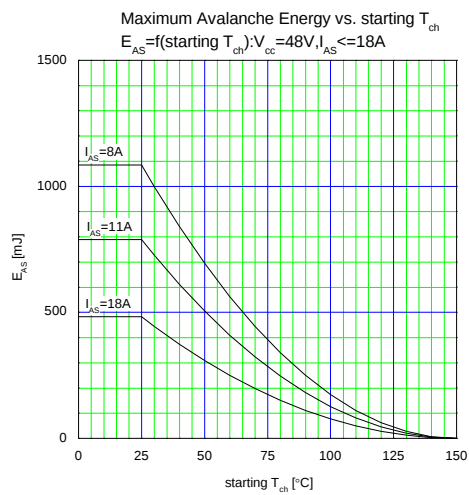


Figure 41. Characteristic Curves of JAXA R 2SJ1A11 (3/3)

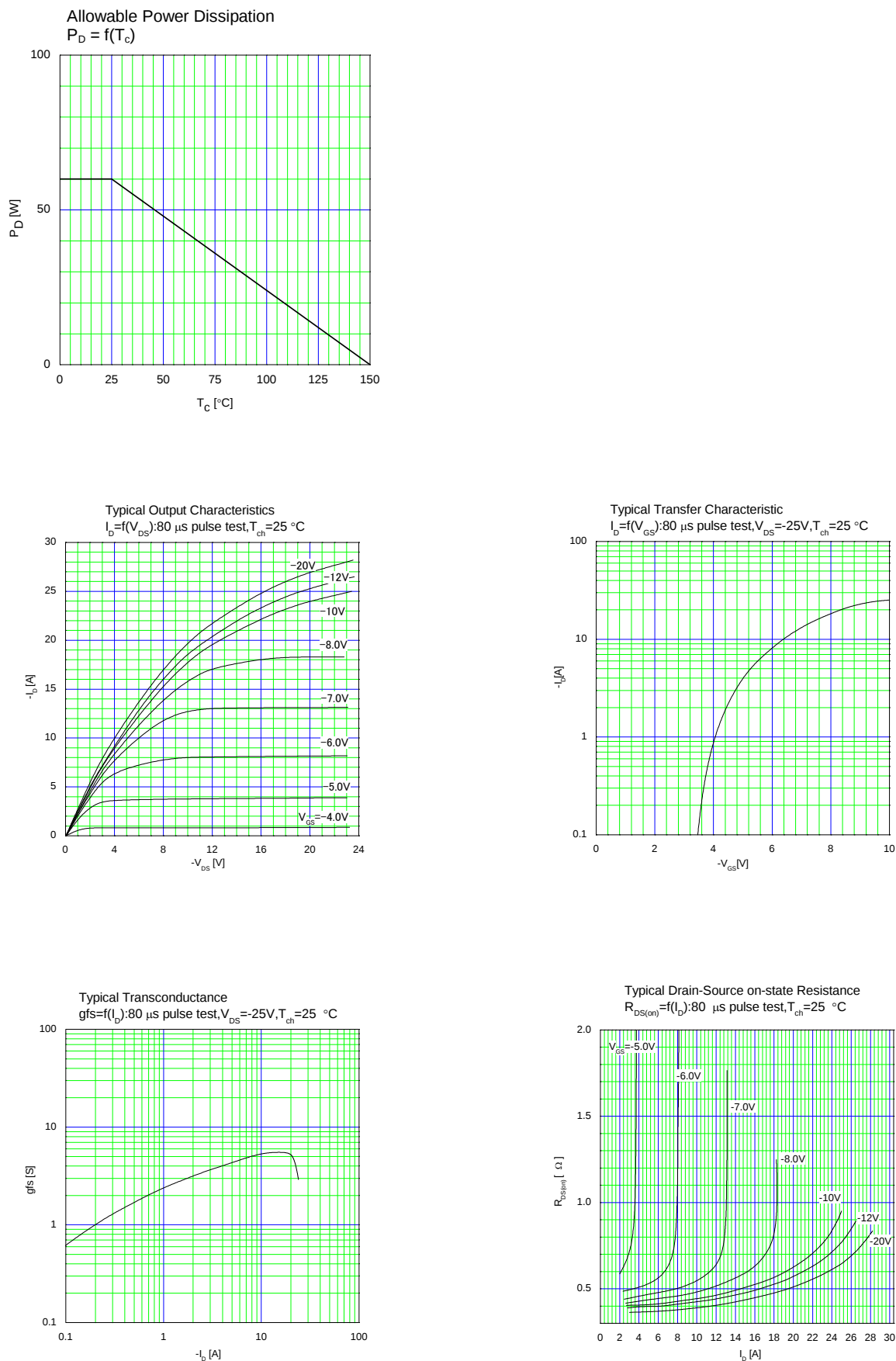


Figure 42. Characteristic Curves of JAXA R 2SJ1A12 (1/3)

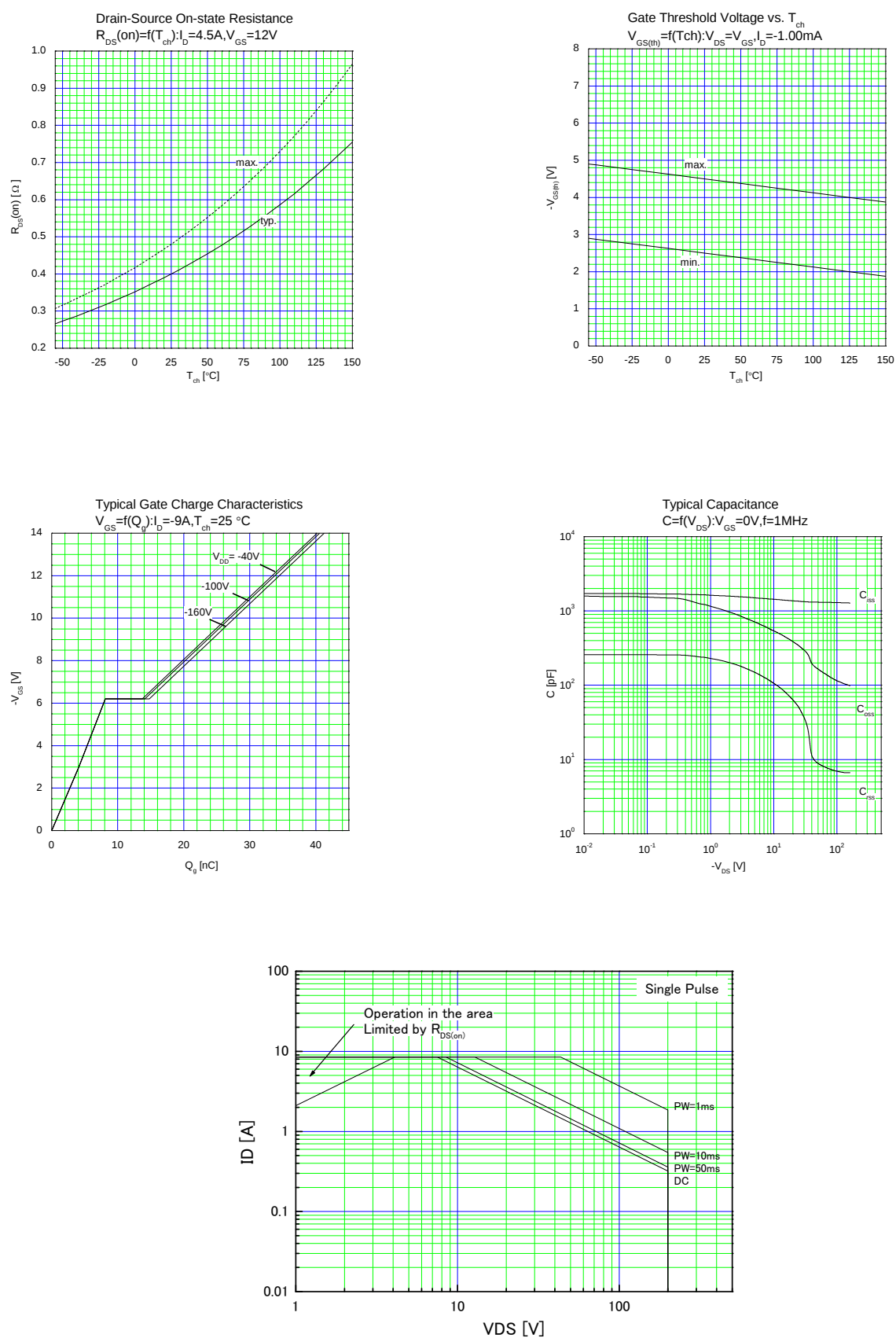


Figure 43. Characteristic Curves of JAXA R 2SJ1A12 (2/3)

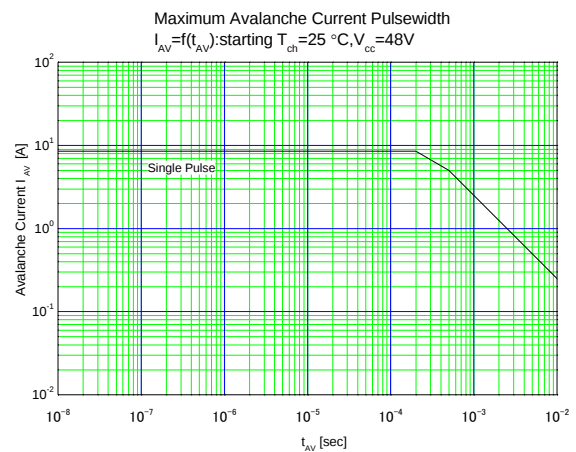
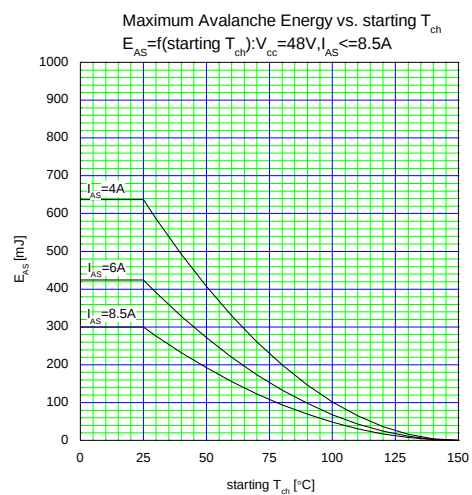


Figure 44. Characteristic Curves of JAXA R 2SJ1A12 (3/3)

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
Variable Frequency Vibration	20G (peak) or Maximum vibration amplitude 1.52mm, whichever the smaller. 100 to 2000Hz, Total sweep time: 4 minutes X, Y, Z each orientation: 4 times	0/22 pieces (SMD2) JAXA R 2SJ1A10 /22pcs 0/22 pieces (TO-254) JAXA R 2SK4185 ⁽¹⁾ /22pcs 0/66 pieces (SMD) JAXA R 2SK4152 ⁽¹⁾ /22pcs JAXA R 2SK4153 ⁽¹⁾ /22pcs JAXA R 2SK4154 ⁽¹⁾ /22pcs

6.2 Mechanical Shock

Table 6. Mechanical Shock Test Result

Test Items	Test Conditions	Failure/Samples
Shock	1500G (14710m/s ²) Pulse width: 0.5msec X ₁ , Y ₁ , Y ₂ , Z ₁ each orientation: 5 times	0/22 pieces (SMD2) JAXA R 2SJ1A10 /22pcs 0/22 pieces (TO-254) JAXA R 2SK4185 ⁽¹⁾ /22pcs 0/66 pieces (SMD) JAXA R 2SK4152 ⁽¹⁾ /22pcs JAXA R 2SK4153 ⁽¹⁾ /22pcs JAXA R 2SK4154 ⁽¹⁾ /22pcs

6.3 Constant Acceleration

Table 7. Constant Acceleration Test Result

Test Items	Test Conditions	Failure/Samples
Constant Acceleration	10,000G (98066.5m/s ²): 1 minute for X ₁ , Y ₁ , Y ₂ , Z ₁ each orientation	0/22 pieces (SMD2) JAXA R 2SJ1A10 /22pcs 0/22 pieces (TO-254) JAXA R 2SK4185 ⁽¹⁾ /22pcs 0/66 pieces (SMD) JAXA R 2SK4152 ⁽¹⁾ /22pcs JAXA R 2SK4153 ⁽¹⁾ /22pcs JAXA R 2SK4154 ⁽¹⁾ /22pcs

Note⁽¹⁾: This test is substituted with the device having the same chip size and the package passed in this test.

See JAXA-QTS-2030/102 and JAXA-QTS-2030/103.

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) 500 cycles	0/45 pieces (TO-254) JAXA R 2SJ1A07 /45pcs 0/45 pieces (SMD2) JAXA R 2SJ1A10 /45pcs 0/45 pieces (SMD1) JAXA R 2SJ1A11 /45pcs 0/45 pieces (SMD0.5) JAXA R 2SJ1A12 /45pcs

6.5 Electrostatic Discharge Sensitivity Classification

Table 9. Electrostatic Discharge Sensitivity Classification

Test Items	Test Conditions MIL-STD-750 method 1020		Test result
Electrostatic Discharge	JAXA R 2SJ1A01, JAXA R 2SJ1A04 JAXA R 2SJ1A07, JAXA R 2SJ1A10	$V_{GS}=\pm 2750V$	Class 2
	JAXA R 2SJ1A02, JAXA R 2SJ1A05 JAXA R 2SJ1A08, JAXA R 2SJ1A11	$V_{GS}=\pm 1000V$	Class 1
	JAXA R 2SJ1A03, JAXA R 2SJ1A06 JAXA R 2SJ1A09, JAXA R 2SJ1A12	$V_{GS}=\pm 500V$	Class 1

6.6 Radiation Hardness

Table 10a. Radiation Hardness Test Results

Part number	-100V class	-200V class
JAXA R	2SJ1A01	2SJ1A10
Total Dose Irradiation (TID)	Test Conditions	
	Source: Co-60 gamma-ray 1×10^3 Gy (42Gy/hr)	
	Bias Conditions (During and after irradiation) (a) $V_{DS}=0V$, $V_{GS}=-20 V$ (b) $V_{DS}=-80V$, $V_{GS}=0 V$	Bias Conditions (During and after irradiation) (a) $V_{DS}=0V$, $V_{GS}=-20 V$ (b) $V_{DS}=-160V$, $V_{GS}=0 V$
	Test Results	
	For each bias condition: 0/4 pieces (1×10^3 Gy) BV_{DSS} TID dependence: Fig. 45, $V_{GS(th)}$ TID effect : Fig. 46	For each bias condition: 0/4 pieces (1×10^3 Gy) BV_{DSS} TID dependence: Fig. 47, $V_{GS(th)}$ TID effect : Fig. 48

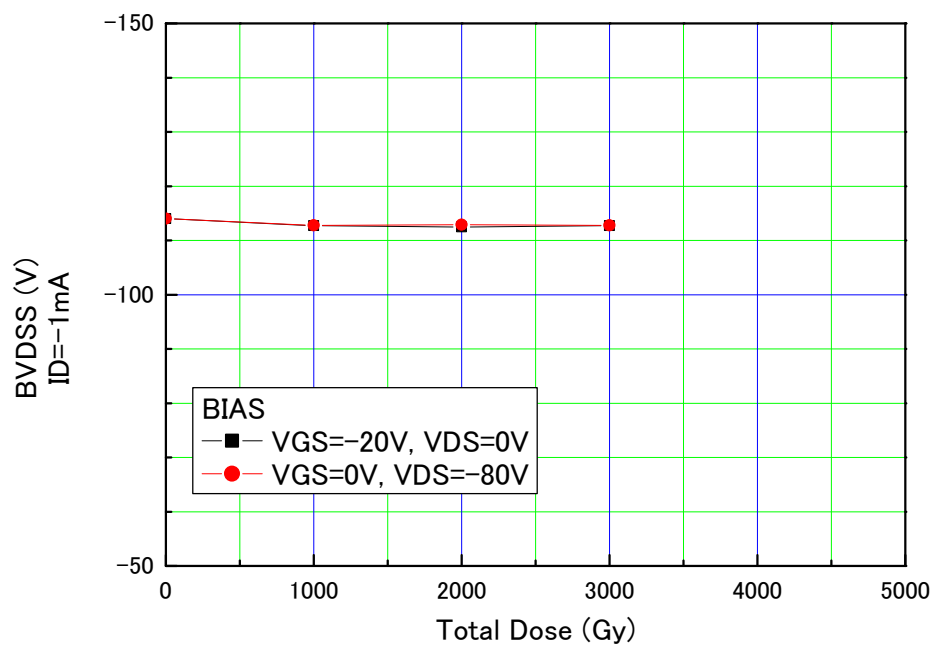


Figure 45. Total Dose Dependence of BV_{DSS} (-100V Class) (JAXA R 2SJ1A01)

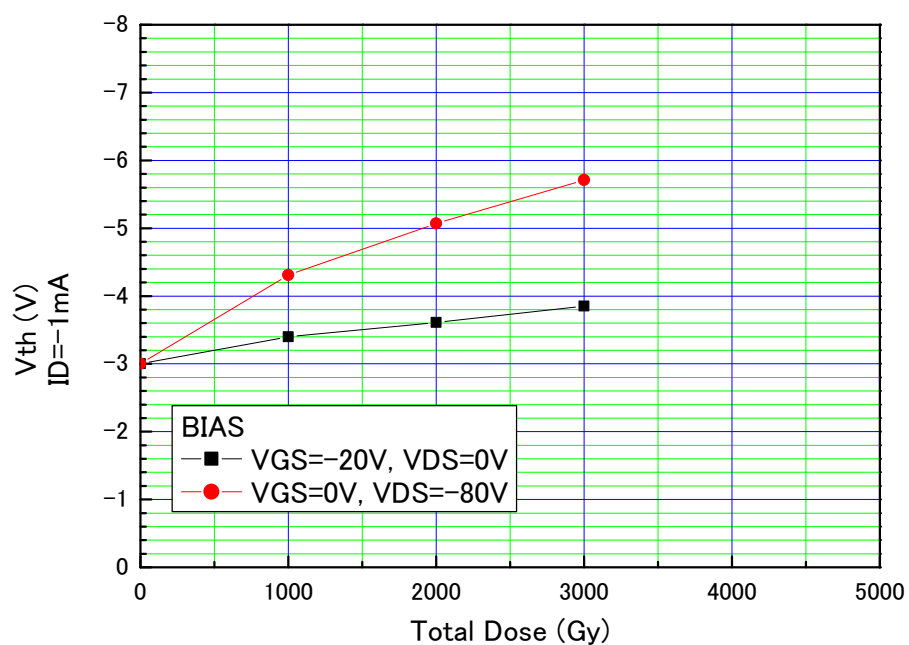


Figure 46. Total Dose Dependence of V_{GS(th)} (-100V Class) (JAXA R 2SJ1A01)

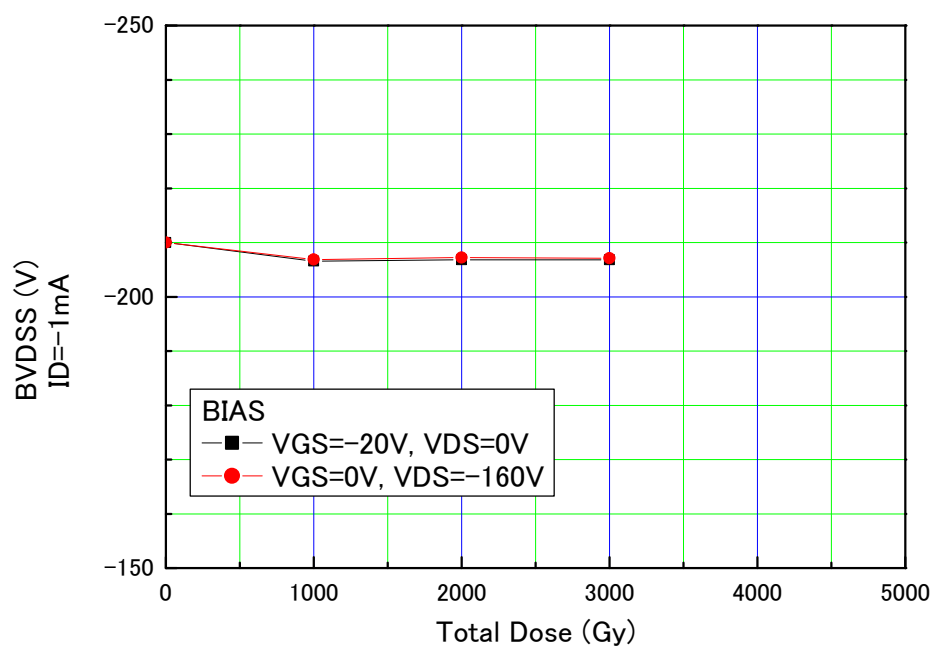


Figure 47. Total Dose Dependence of BV_{DSS} (-200V Class) (JAXA R 2SJ1A10)

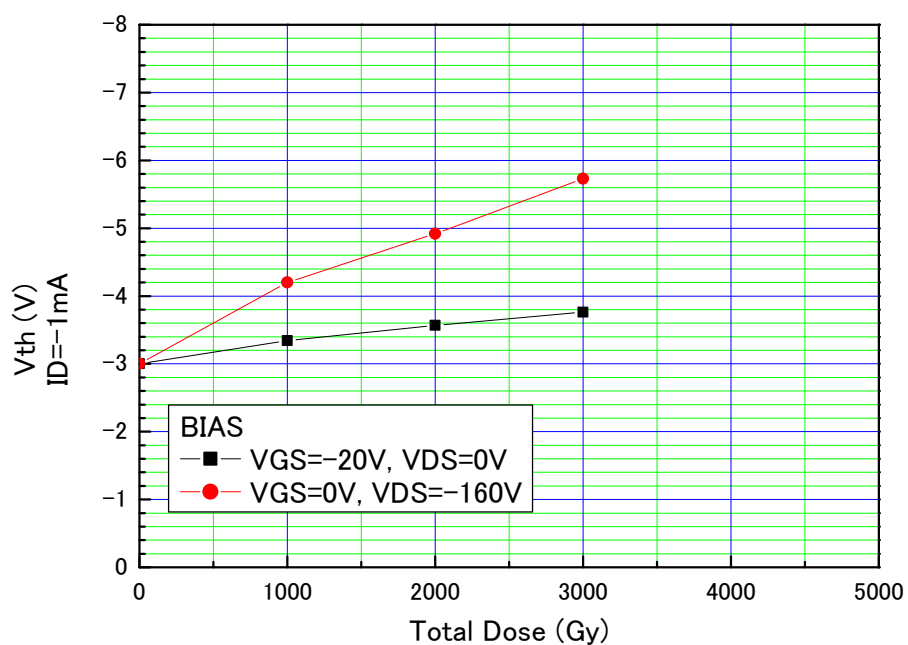


Figure 48. Total Dose Dependence of V_{GS(th)} (-200V Class) (JAXA R 2SJ1A10)

Table 10b. Radiation Hardness Results

Part Number JAXA R	100V Class						200V Class					
	2SJ 1A01	2SJ 1A02	2SJ 1A03	2SJ 1A04	2SJ 1A05	2SJ 1A06	2SJ 1A07	2SJ 1A08	2SJ 1A09	2SJ 1A10	2SJ 1A11	2SJ 1A12
Single Event Tolerance (SEB/SEGR) Single Event Burnout/ Single Event Gate Rupture	Test Conditions											
	LET 39MeV/(mg/cm ²)(¹)						LET 40MeV/(mg/cm ²)(¹)					
	Ion: Kr, Energy: 520 MeV Range: 63.1μm, 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.											
	Test Results											
	V _{DS} =-100V and V _{GS} =+5.0V 0/3 pieces V _{DS} = -20V and V _{GS} =+20V 0/3 pieces (SEE-SOA: Figure 49)						V _{DS} =-200V and V _{GS} =+5.0V 0/3 pieces V _{DS} =30V and V _{GS} =+20V 0/3 pieces (SEE-SOA: Figure 50)					

Note(¹): Average LET in the device

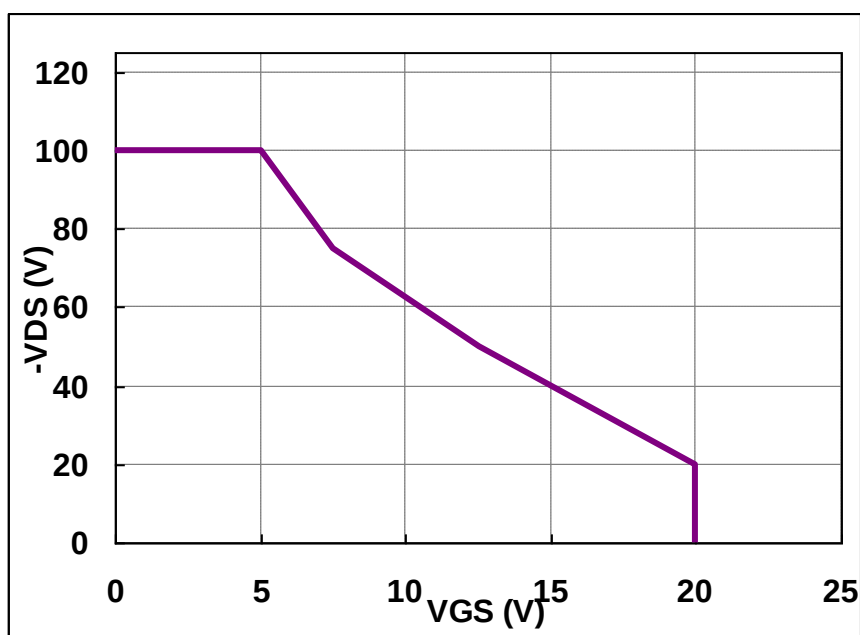


Figure 49. SEE-SOA (JAXA R 2SJ1A01, 2SJ1A02, 2SJ1A03, 2SJ1A04, 2SJ1A05, 2SJ1A06)

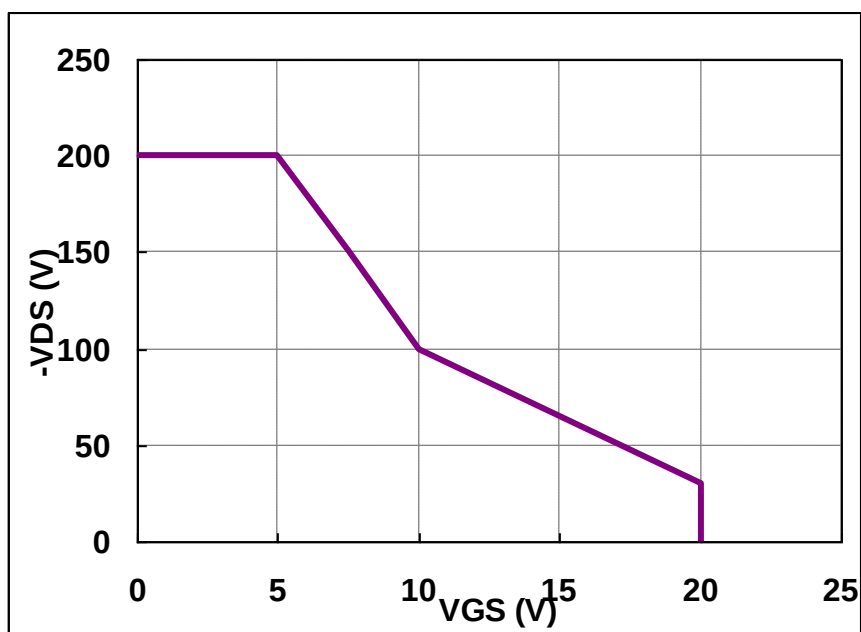


Figure 50. SEE-SOA (JAXA R 2SJ1A07, 2SJ1A08, 2SJ1A09, 2SJ1A10, 2SJ1A11, 2SJ1A12)

7. RELIABILITY

7.1 Accelerated Test Results

The accelerated life test results shall be shown in Table 11.

Table 11. Acceleration 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 JAXA R 2SJ1A10 /45 pcs
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 $V_{DS}=-160\text{V}$	0/45 pieces JAXA R 2SJ1A10 /45 pcs
Thermal shock test (Temperature cycling)	-55 to 150°C , 500cycles	0/180 pieces JAXA R 2SJ1A07 /45 pcs JAXA R 2SJ1A10 /45 pcs JAXA R 2SJ1A11 /45 pcs JAXA R 2SJ1A12 /45 pcs
Intermittent operating life test (Power cycling)	$\Delta T_C=100\text{deg}$, 6000cycles	0/88 pieces JAXA R 2SJ1A07 /22 pcs JAXA R 2SJ1A10 /22 pcs JAXA R 2SJ1A11 /22 pcs JAXA R 2SJ1A12 /22 pcs

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 lead terminals for TO-254 package 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) The soldering of the terminals for SMD package shall be performed at 200°C or more for 30 to 60 seconds of pre-heat temperature and at 240°C or below for 10sec of peak temperature in accordance with JERG-0-043, STANDARDS FOR SURFACE MOUNT SOLDERING PROCESS.
- (3) In handling the product, ground human body, work area and measuring instruments.
- (4) BERYLLIA WARNING for TO-254 package: .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

Phone: +81-3-5453-7018