

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

Part Description	POWER MOSFET, N-CHANNEL, RADIATION HARDENED
Part Number and Type	JAXA R 2SK4048 JAXA R 2SK4049 JAXA R 2SK4050 JAXA R 2SK4051 JAXA R 2SK4052 JAXA R 2SK4053 JAXA R 2SK4054 JAXA R 2SK4055 JAXA R 2SK4056 JAXA R 2SK4214 JAXA R 2SK4215 JAXA R 2SK4216
Applicable Specification	JAXA-QTS-2030 JAXA-QTS-2030/101

March 2020

Prepared and Established by Fuji Electric Co., Ltd.

Issued by Japan Aerospace Exploration Agency

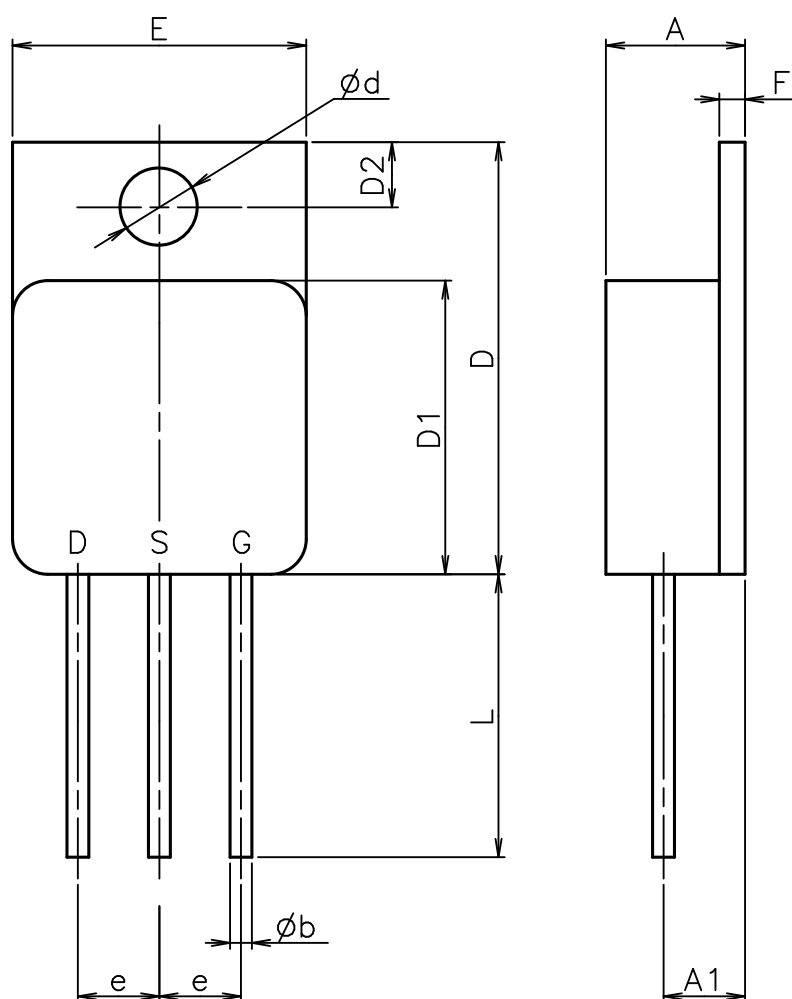
This document is the English version of JAXA QTS/ADS which was originally written and authorized in Japanese and carefully translated into English for international users. If any question arises as to the context or detailed description, it is strongly recommended to verify against the latest official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

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

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Revision Log			
Rev.	Date	Description	
-----	20 Dec. 2006	Original	
A	29 Feb. 2008	Added the family type part number. ▪ Part No.: 2SK4214, 2SK4215, 2SK4216 (V_{DS} 130V Class) Revised to reflect the changes made to JAXA-QTS-2030C. ▪ Revised screening test in compliance with JAXA-QTS-2030C. ▪ Revised qualification test and quality conformance inspection in compliance with JAXA-QTS-2030C.	
B	12 Nov. 2012	▪ Table 4: Reviewed the number of significant figures in the test conditions of Vibration, Shock, and Constant acceleration test. ▪ Table 6: Reviewed the number of significant figures in the test conditions of shock test. ▪ Table 7: Reviewed the number of significant figures in the test conditions of Constant acceleration test. ▪ Added the maximum safe operating area of DC to figures.	
C	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 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 data sheet.			
JAXA-QTS-2030		Semiconductor Device, High Reliability, Space Use, General Specification for	
JAXA-QTS-2030/101		POWER MOSFET, N-CHANNEL, RADIATION HARDENED, HIGH RELIABILITY, SPACE USE, DETAIL SPECIFICATION FOR	
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 marking of the device is illustrated in Figure 5.			
2.2 Net Weight			
9.3g (typ.)			
2.3 Devices Structure			
The device consists of one N-channel enhancement MOSFET chip with planar structure and a seam-welded hermetic seal package as shown in Figure 1. The internal structure and the cross-section of the device are drawn in Figures 2 through 4.			

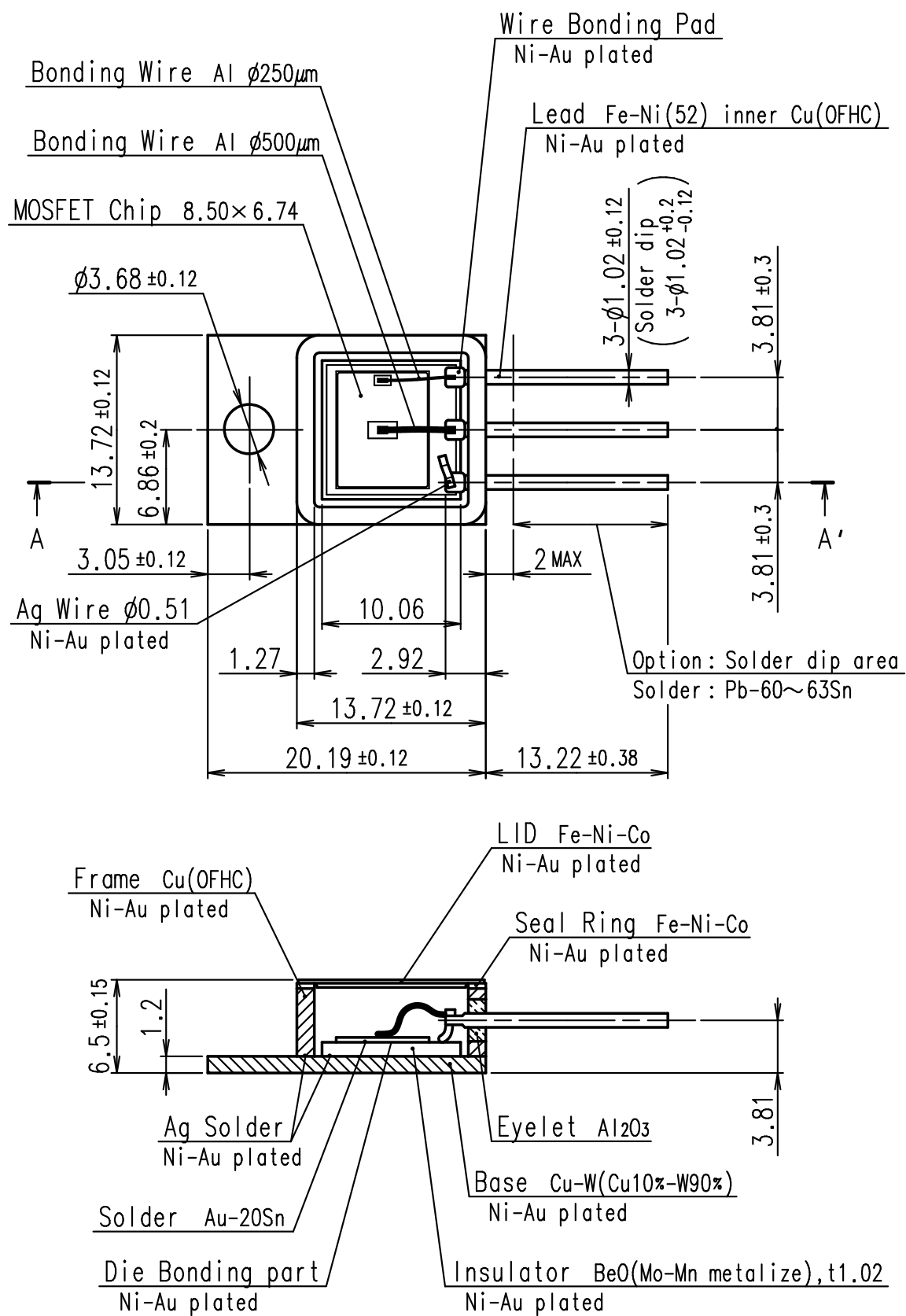


Symbol	Dimension (mm)	
	Min	Max
A	6.35	6.65
A1	3.61	4.01
ϕb	0.90	1.14
D	20.07	20.31
D1	13.59	13.85
D2	2.93	3.17

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.

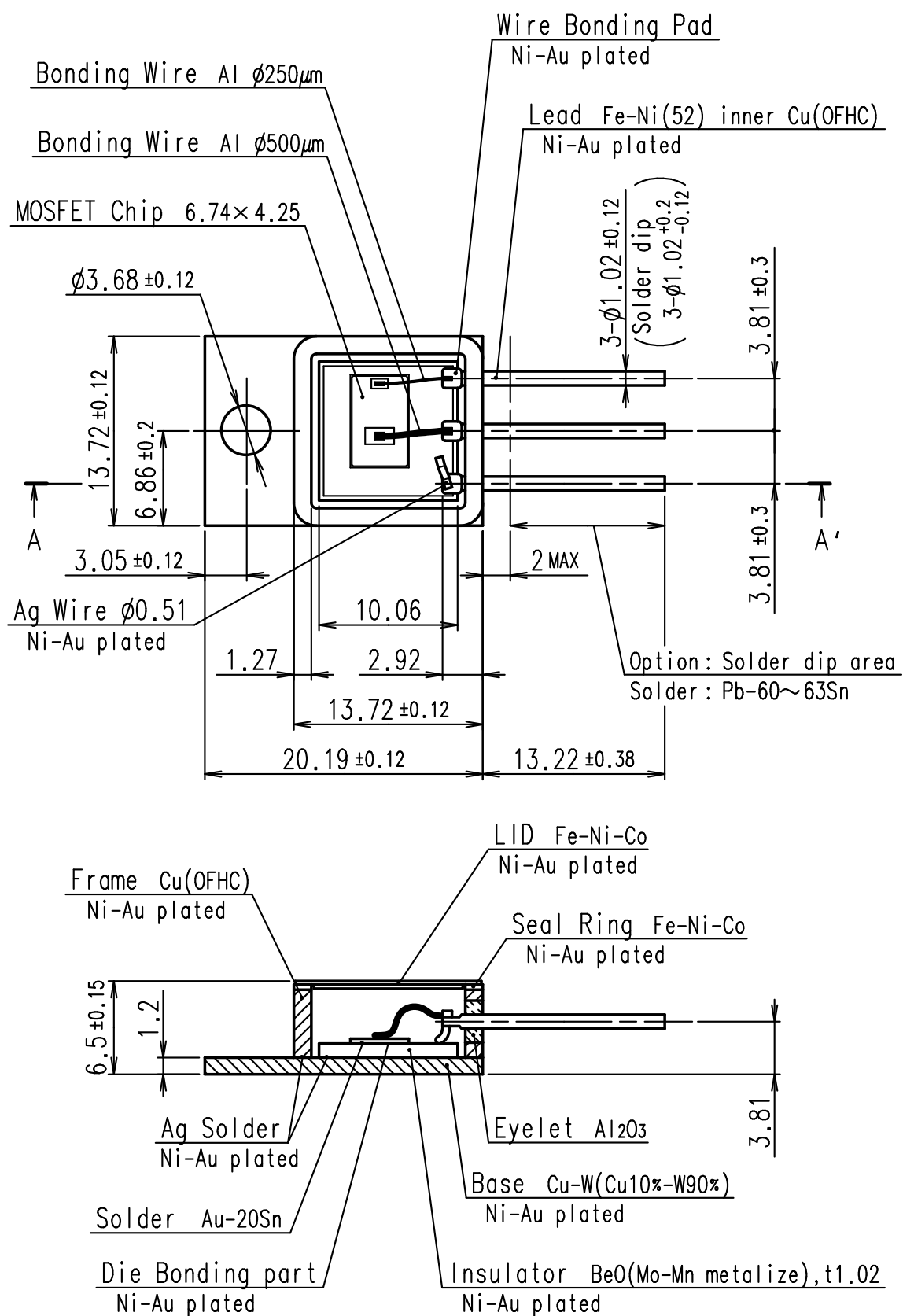
Figure 1. Outline and Dimensions of TO-254



Unit:mm

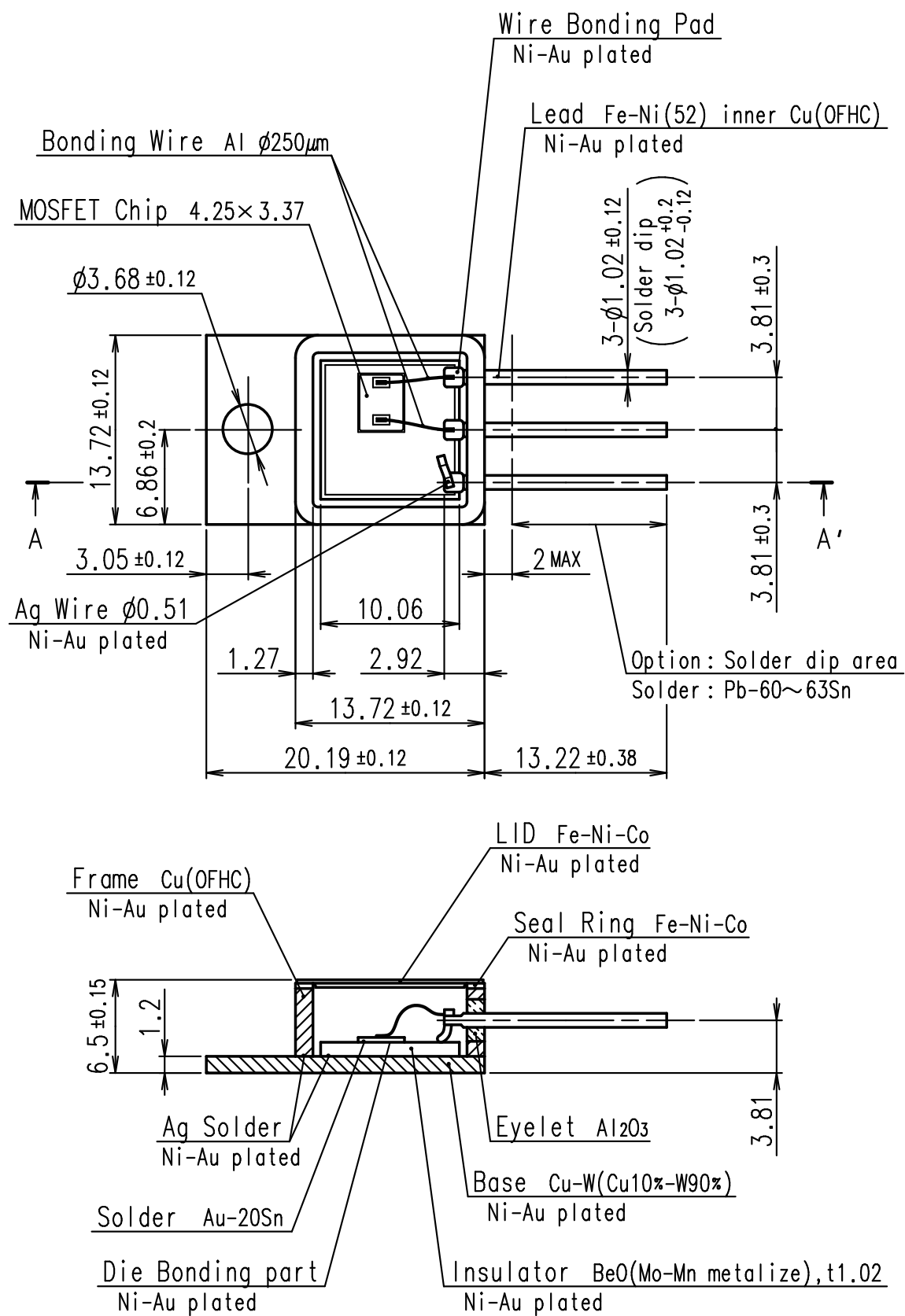
A-A' Cross Section

**Figure 2. Inner structure and cross-section
(JAXA R 2SK4048, 4051, 4054, 4214)**



Unit:mm

A-A' Cross Section
Figure 3. Inner structure and cross-section
(JAXA R 2SK4049, 4052, 4055, 4215)



Unit:mm

A-A' Cross Section

**Figure 4. Inner structure and cross-section
(JAXA R 2SK4050, 4053, 4056, 4216)**

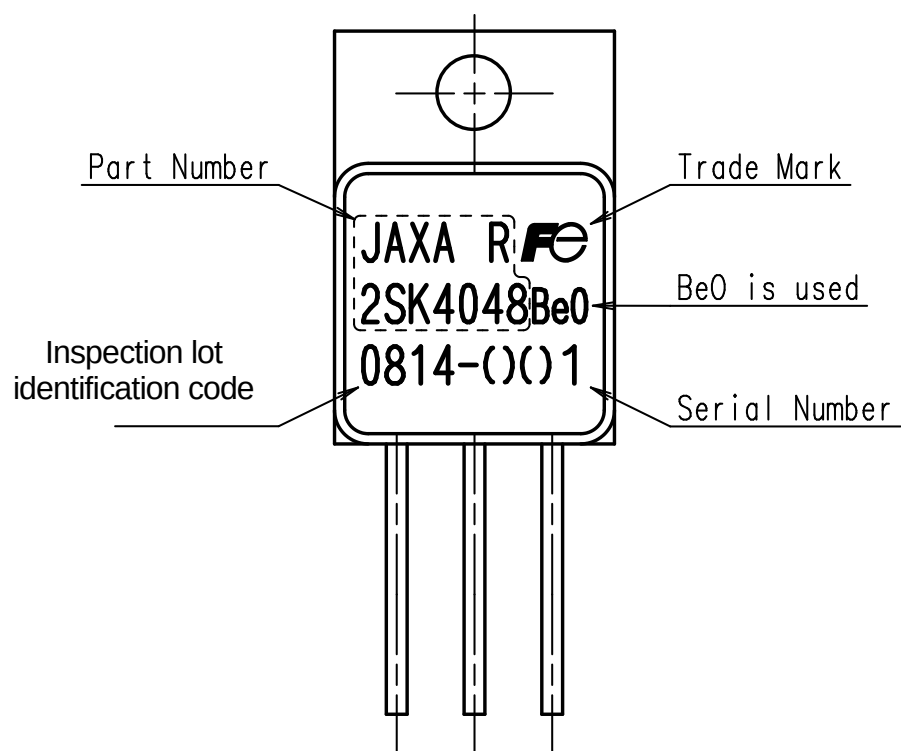


Figure 5. Marking

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 2SK4048	100	42	168	±20	250	2.60	150	-55 to 150	0.5	48.0
JAXA R 2SK4049	100	42	168		125	2.58			1	48.5
JAXA R 2SK4050	100	15	60		62.5	2.55			2	49.0
JAXA R 2SK4051	200	42	168		250	2.60			0.5	48.0
JAXA R 2SK4052	200	33	132		125	2.58			1	48.5
JAXA R 2SK4053	200	14	56		62.5	2.55			2	49.0
JAXA R 2SK4054	250	42	168		250	2.60			0.5	48.0
JAXA R 2SK4055	250	27	108		125	2.58			1	48.5
JAXA R 2SK4056	250	12	48		62.5	2.55			2	49.0
JAXA R 2SK4214	130	42	168		250	2.60			0.5	48.0
JAXA R 2SK4215	130	35	140		125	2.58			1.0	48.5
JAXA R 2SK4216	130	15	60		62.5	2.55			2.0	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
$V_{DS}(DC)$	75% of rated
$I_D(DC)$	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-254	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 terminal is bent shall be 1.5mm.
- The egress of the terminal 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⁾ (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 2SK4048	100	110	10	40n	±100	+9 -12	2.5-4.5	3.5	18	16.8	8	12
JAXA R 2SK4049	100	110		30n		+8 -8			33	30	8	12
JAXA R 2SK4050	100	110		25n		+1 -1			69	62	4	6
JAXA R 2SK4051	200	220		130n		+7 -15			33	29	8	12
JAXA R 2SK4052	200	220		70n		+5 -10			69	61	8	12
JAXA R 2SK4053	200	220		40n		+5 -2			155	138	4	6
JAXA R 2SK4054	250	275		140n		+8 -16			45	39	8	12
JAXA R 2SK4055	250	275		120n		+15 -10			98	89	8	12
JAXA R 2SK4056	250	275		50n		+6 -1			230	195	4	6
JAXA R 2SK4214	130	143		60n		+9 -12			24	21	8	12
JAXA R 2SK4215	130	143		40n		+8 -8			46	40	8	12
JAXA R 2SK4216	130	143		30n		+1 -1			96	83	4	6

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 2SK4048	60	40	70	47	220	147	65	43	30	20	190	127	65	43
JAXA R 2SK4049	30	20	30	20	100	67	40	27	20	13	100	67	30	20
JAXA R 2SK4050	13	9	10	7	50	33	30	20	20	13	65	43	15	10
JAXA R 2SK4051	60	40	70	47	220	147	65	43	30	20	190	127	35	23
JAXA R 2SK4052	30	20	30	20	100	67	40	27	20	13	100	67	20	13
JAXA R 2SK4053	13	9	10	7	50	33	30	20	20	13	65	43	15	10
JAXA R 2SK4054	60	40	70	47	220	147	65	43	30	20	190	127	30	20
JAXA R 2SK4055	30	20	30	20	100	67	40	27	20	13	100	67	15	10
JAXA R 2SK4056	13	9	10	7	50	33	30	20	20	13	65	43	10	7
JAXA R 2SK4214	60	40	70	47	220	147	65	43	30	20	190	127	65	43
JAXA R 2SK4215	30	20	30	20	100	67	40	27	20	13	100	67	30	20
JAXA R 2SK4216	13	9	10	7	50	33	30	20	20	13	65	43	15	10

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

Part No.	C _{iss} (pF)		C _{oss} (pF)		C _{rss} (pF)	
	V _{DS} =75V, V _{GS} =0V f=1MHz					
	Max	Typ	Max	Typ	Max	Typ
JAXA R 2SK4048	8000	5200	1500	1000	90	55
JAXA R 2SK4049	3300	2100	650	460	30	20
JAXA R 2SK4050	1500	1000	350	220	20	11
JAXA R 2SK4051	8000	5250	900	580	65	40
JAXA R 2SK4052	3300	2200	350	280	30	15
JAXA R 2SK4053	1500	1000	200	130	20	10
JAXA R 2SK4054	8000	5300	750	500	65	40
JAXA R 2SK4055	3300	2200	350	240	20	15
JAXA R 2SK4056	1500	1000	150	110	10	8
JAXA R 2SK4214	8000	5200	1300	870	80	53
JAXA R 2SK4215	3300	2100	550	370	30	20
JAXA R 2SK4216	1500	1000	300	200	20	13

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

Part No.	$V_{SD}^{(1)}$ (V)		t_{rr} (ns)	Q_{rr} (μC)
	$I_F = \text{rated } I_D$ $V_{GS}=0\text{V}$		$I_F = \text{rated } I_D, V_{GS}=0\text{V},$ $-di/dt=100\text{A}/\mu\text{s},$ $T_{ch}=25^{\circ}\text{C}$	
	Max.	Typ.	Typ.	Typ.
2SK4048	1.6	1.2	450	7.0
2SK4049			500	6.5
2SK4050			350	3.5
2SK4051			690	13.5
2SK4052			800	12.0
2SK4053			620	6.0
2SK4054			1000	19.0
2SK4055			900	12.0
2SK4056			640	6.5
2SK4214			520	11.0
2SK4215			540	9.0
2SK4216			390	5.0

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, 500 cycles		
	Thermal Shock	0 to 100°C, 25 cycles		
	Resistance to Soldering heat	250°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	196m/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 -Z ₁ each orientation, 5 times		
	Constant Acceleration	98100m/s ² (10000G) X ₁ -Y ₁ -Z ₁ each orientation, 1 time		
	Terminal Strength	1.5kgf, Z ₁ orientation, 30s		
Electrostatic Discharge (ESD)		2SK4048 2SK4051 2SK4054 2SK4214	2SK4049 2SK4052 2SK4055 2SK4215	2SK4050 2SK4053 2SK4056 2SK4216
		C=100pF, R=1.5kΩ V _{GS} =±2750V V _{GS} =±1000V V _{GS} =±500V		

5. CHARACTERISTIC CURVES IN VARIOUS OPERATING CONDITIONS

The characteristic curves are shown in Figures 6 through 41:

Figs. 6 - 8 : Characteristic curves of JAXA R 2SK4048

Figs. 9 - 11 : Characteristic curves of JAXA R 2SK4049

Figs. 12-14 : Characteristic curves of JAXA R 2SK4050

Figs. 15-17 : Characteristic curves of JAXA R 2SK4051

Figs. 18-20 : Characteristic curves of JAXA R 2SK4052

Figs. 21-23 : Characteristic curves of JAXA R 2SK4053

Figs. 24-26 : Characteristic curves of JAXA R 2SK4054

Figs. 27-29 : Characteristic curves of JAXA R 2SK4055

Figs. 30-32 : Characteristic curves of JAXA R 2SK4056

Figs. 33-35 : Characteristic curves of JAXA R 2SK4214

Figs. 36-38 : Characteristic curves of JAXA R 2SK4215

Figs. 39-41 : Characteristic curves of JAXA R 2SK4216

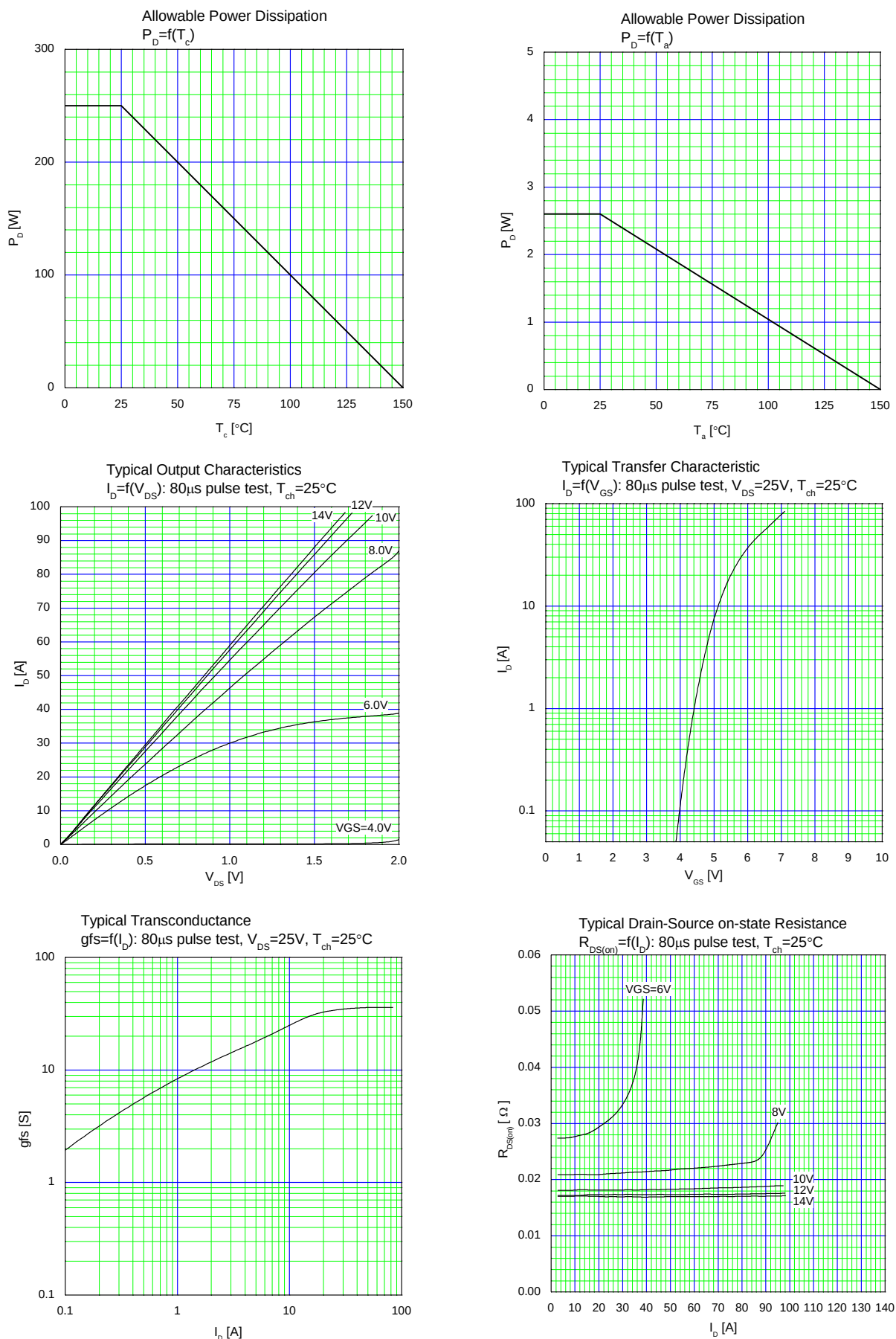


Figure 6. Characteristic curves of JAXA R 2SK4048 (1/3)

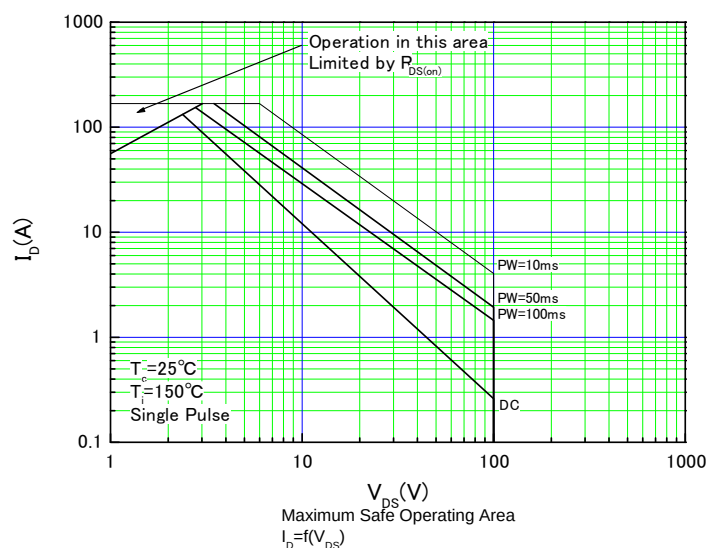
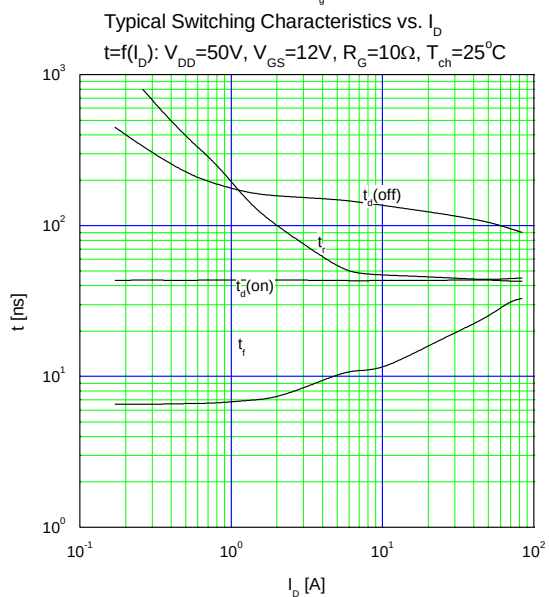
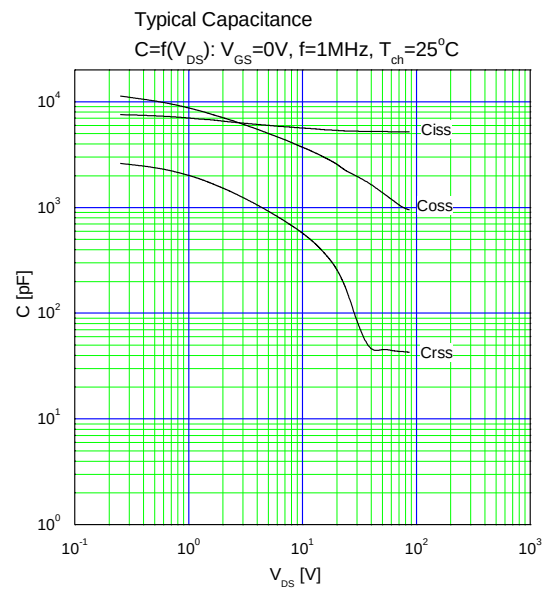
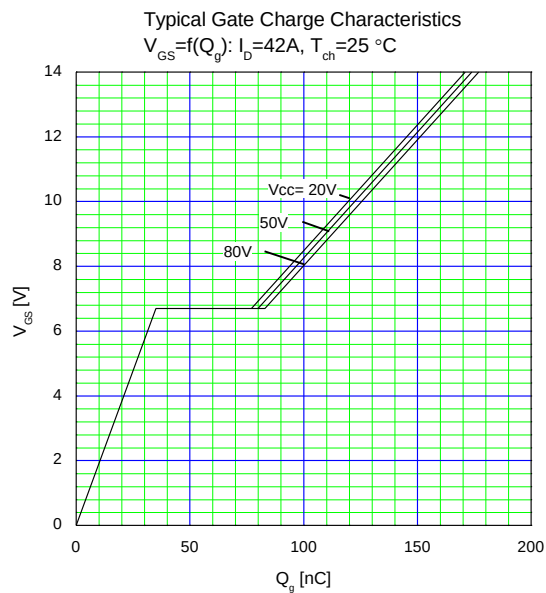
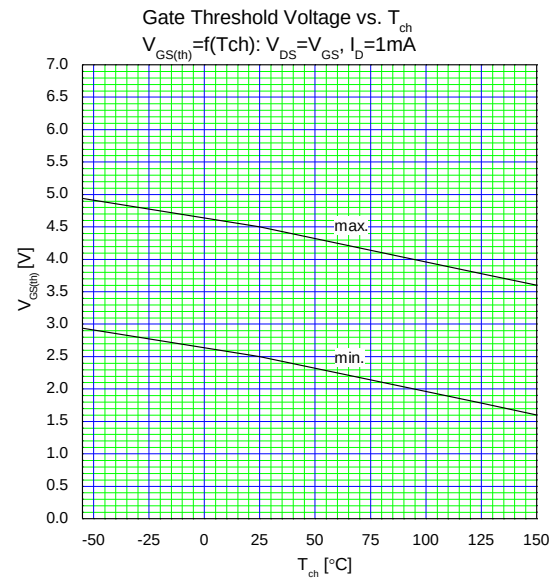
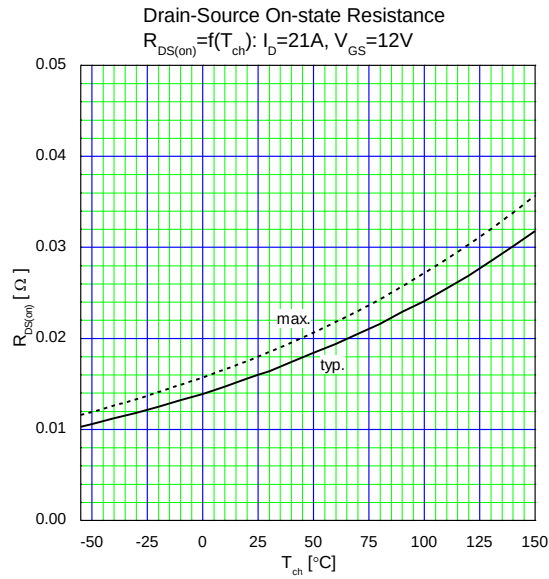


Figure 7. Characteristic curves of JAXA R 2SK4048 (2/3)

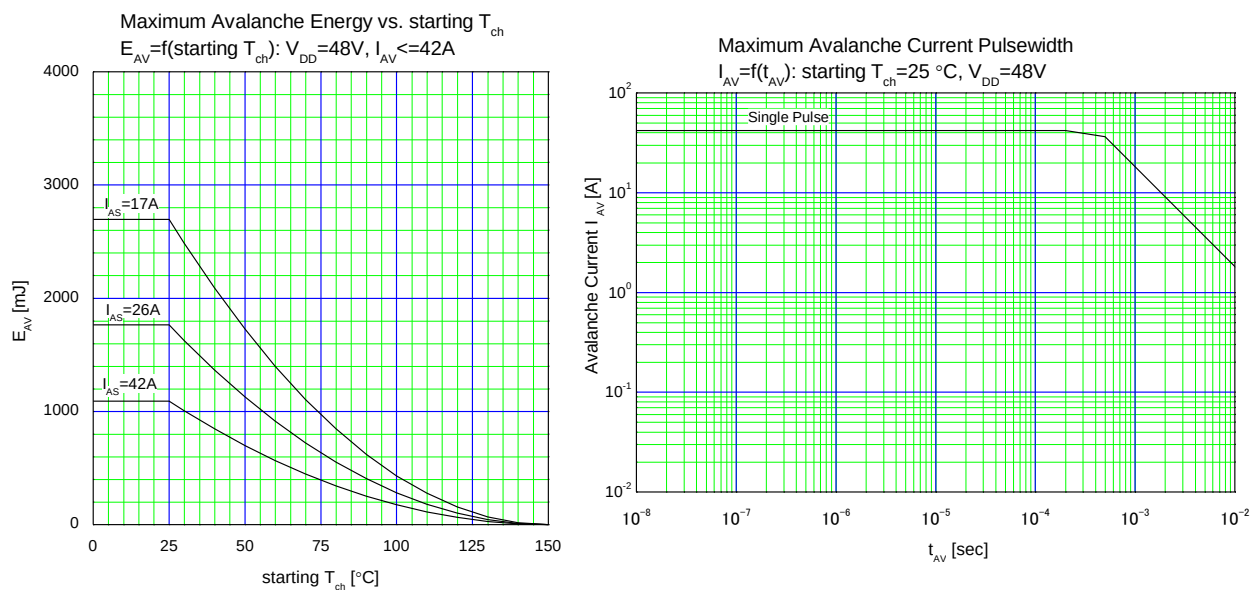


Figure 8. Characteristic curves of JAXA R 2SK4048 (3/3)

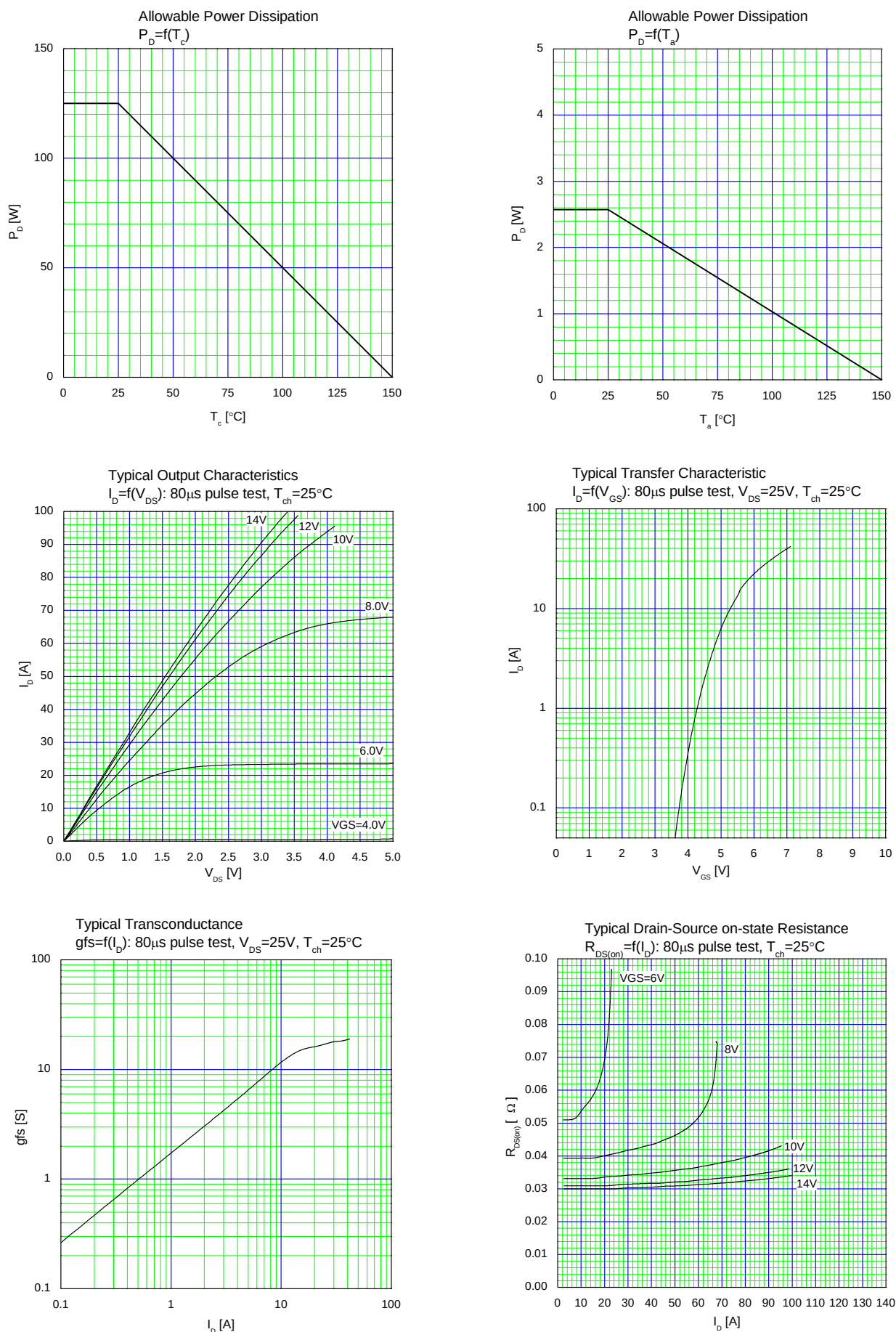


Figure 9. Characteristic curves of JAXA R 2SK4049 (1/3)

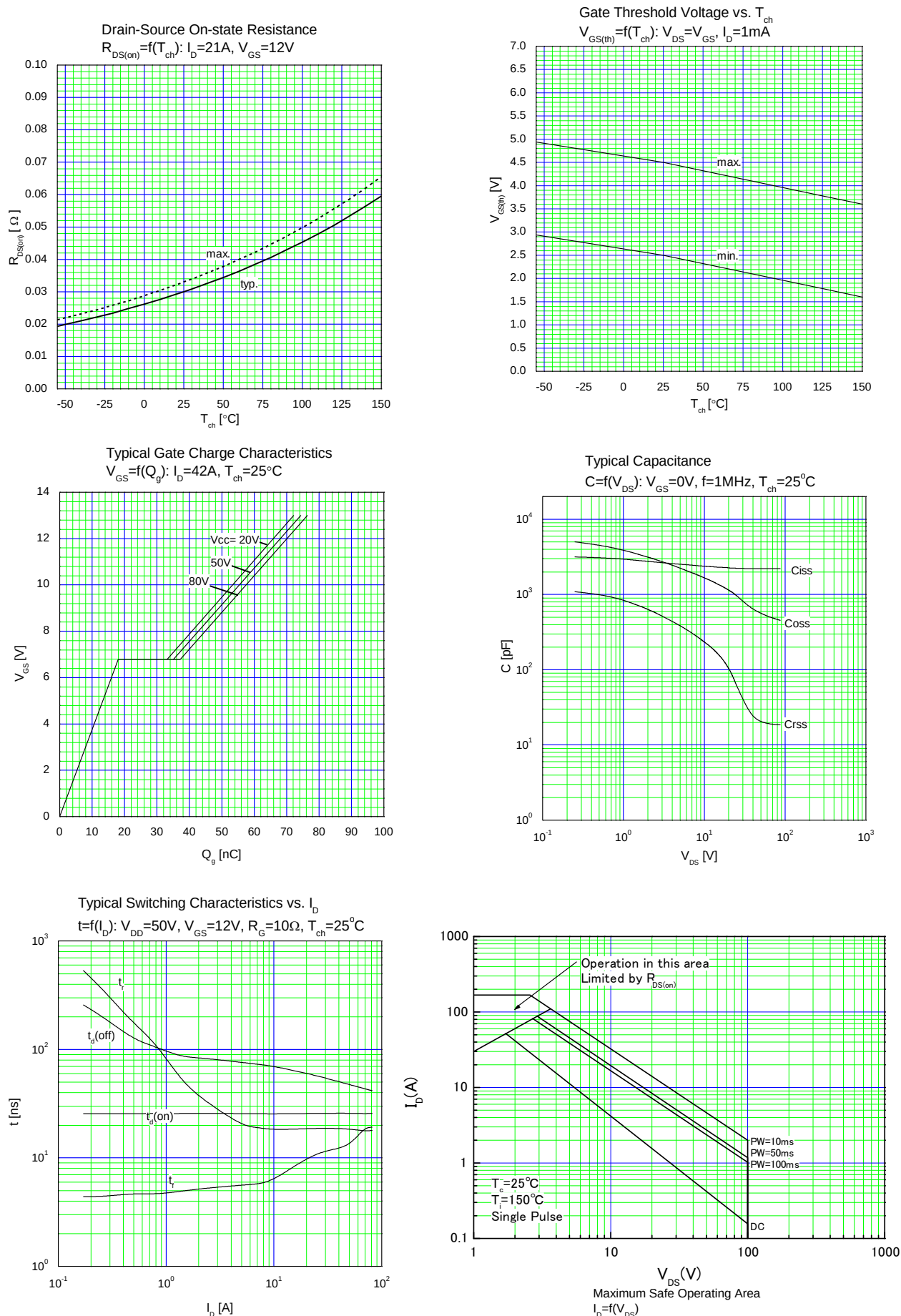


Figure 10. Characteristic curves of JAXA R 2SK4049 (2/3)

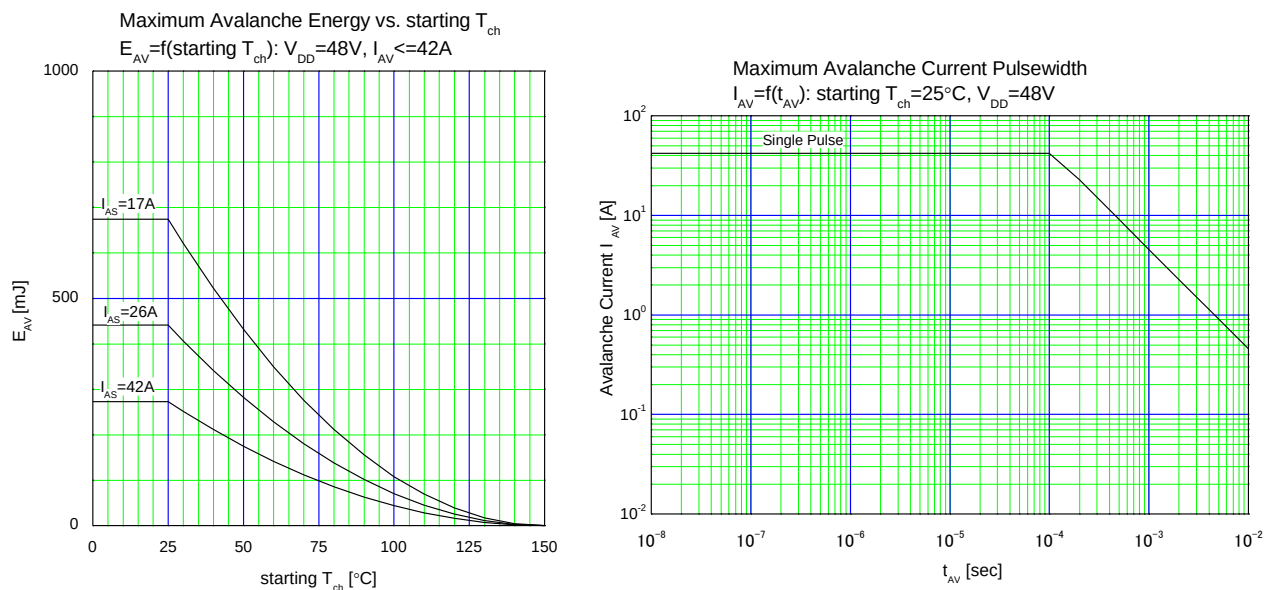


Figure 11. Characteristic curves of JAXA R 2SK4049 (3/3)

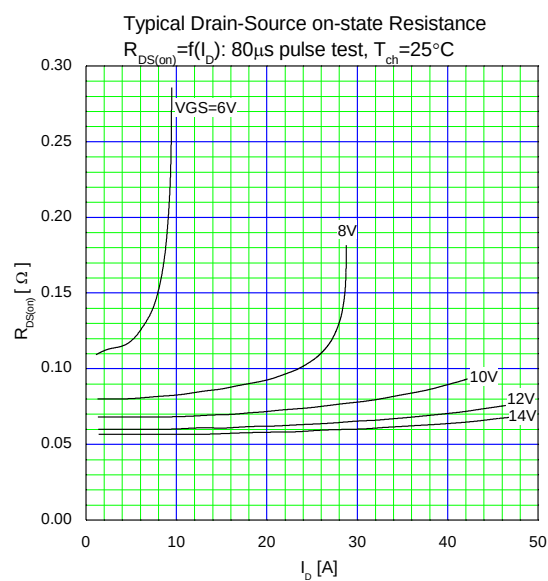
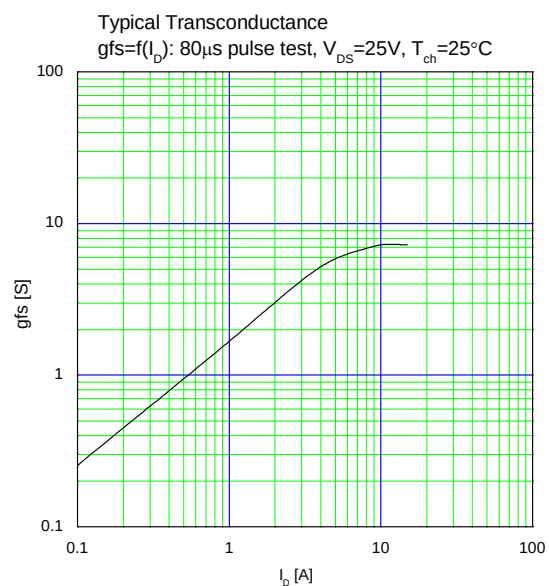
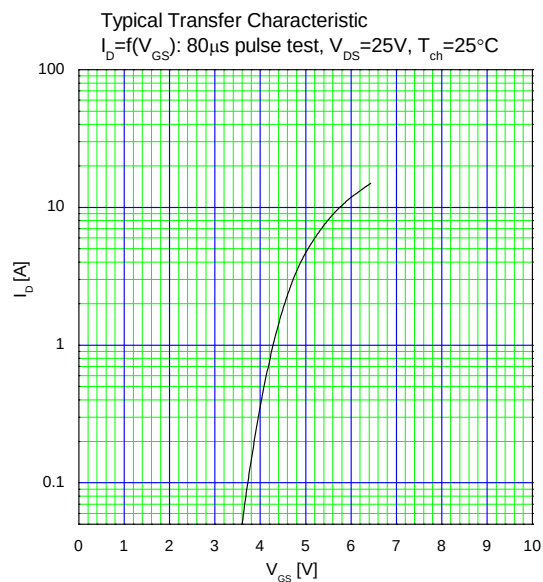
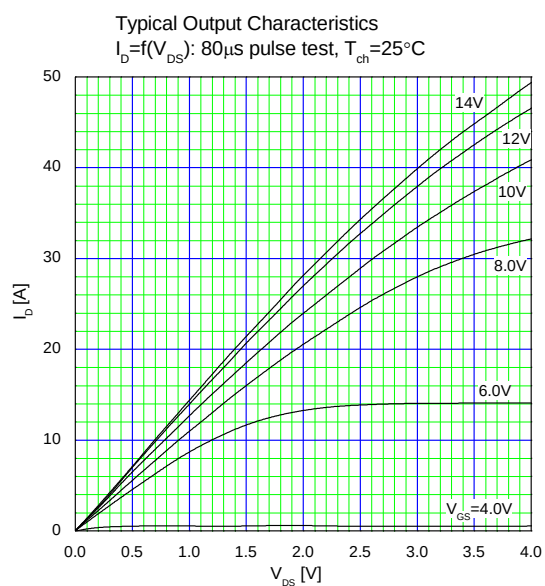
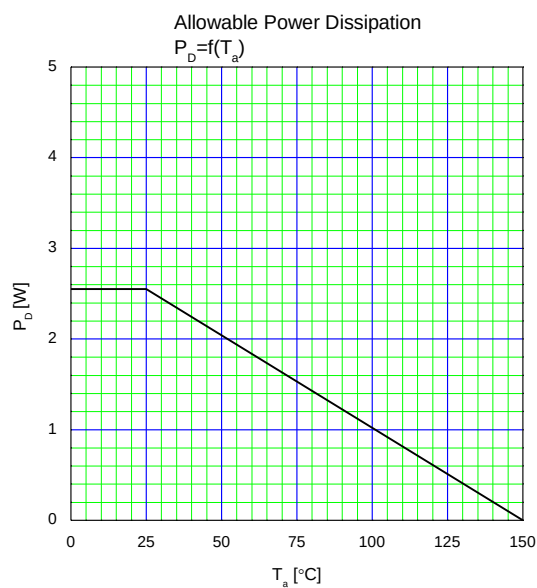
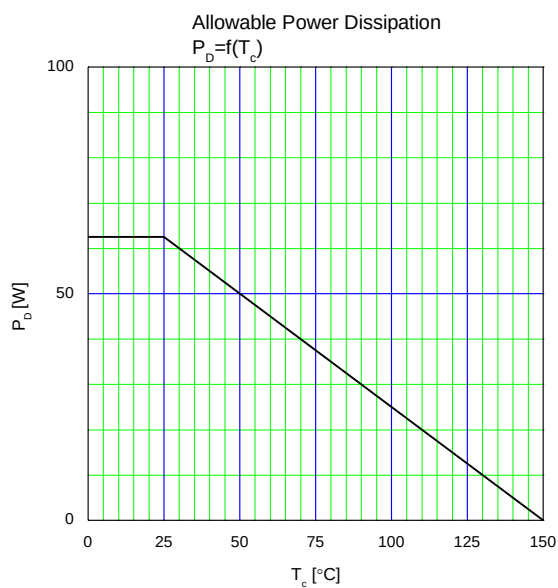


Figure 12. Characteristic curves of JAXA R 2SK4050 (1/3)

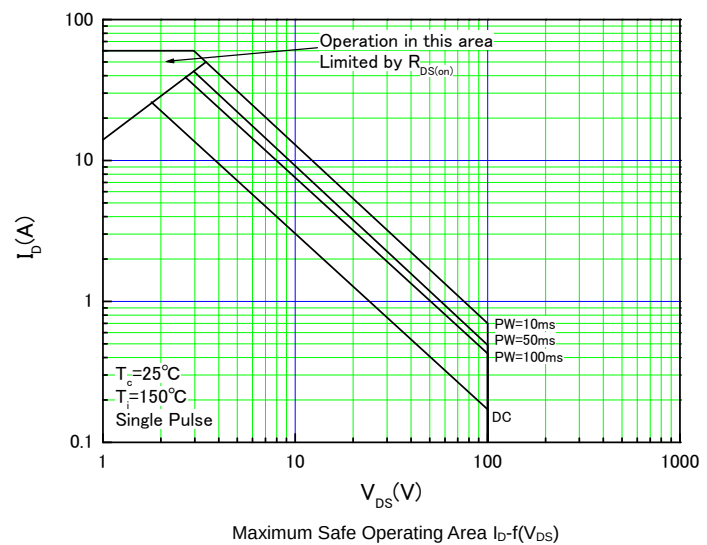
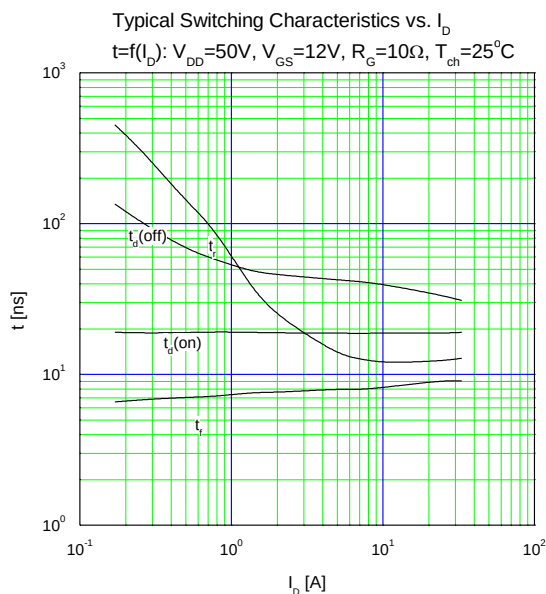
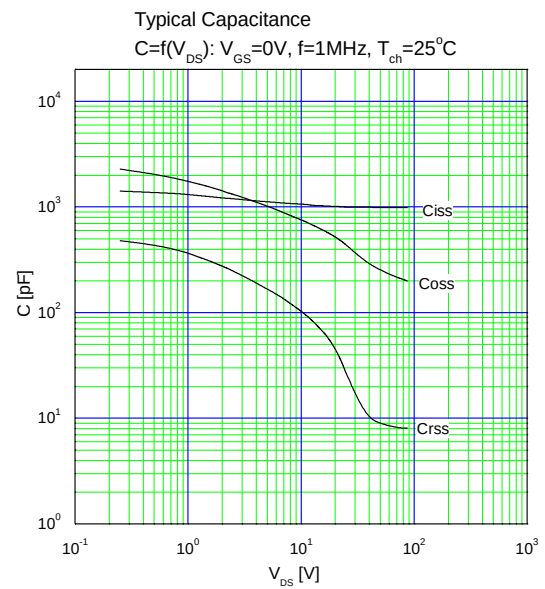
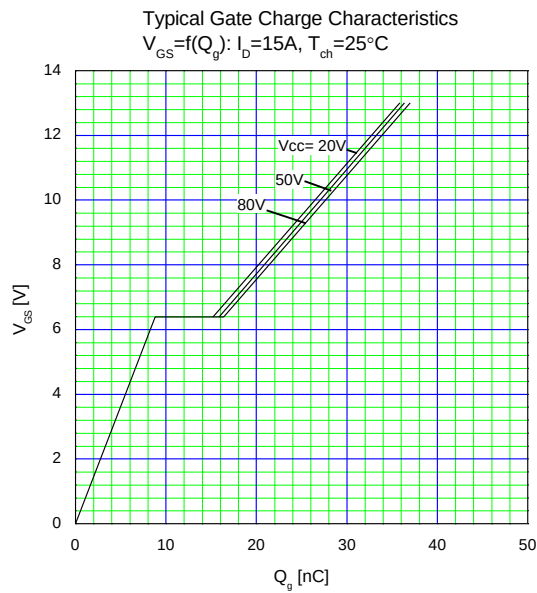
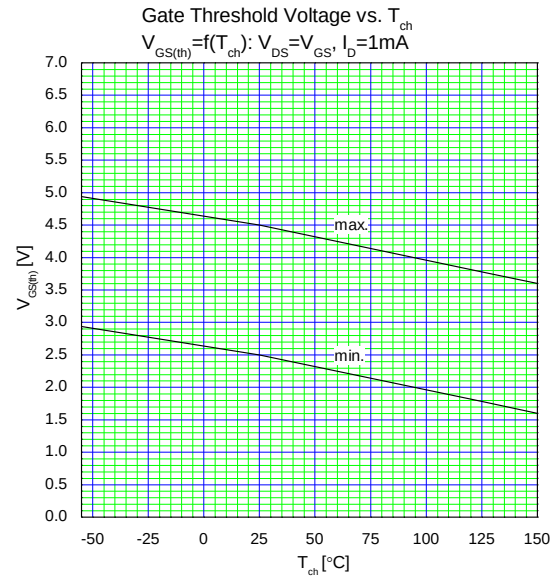
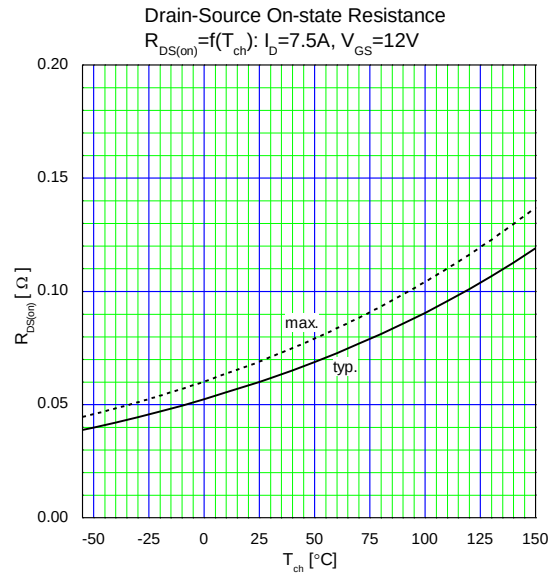


Figure 13. Characteristic curves of JAXA R 2SK4050 (2/3)

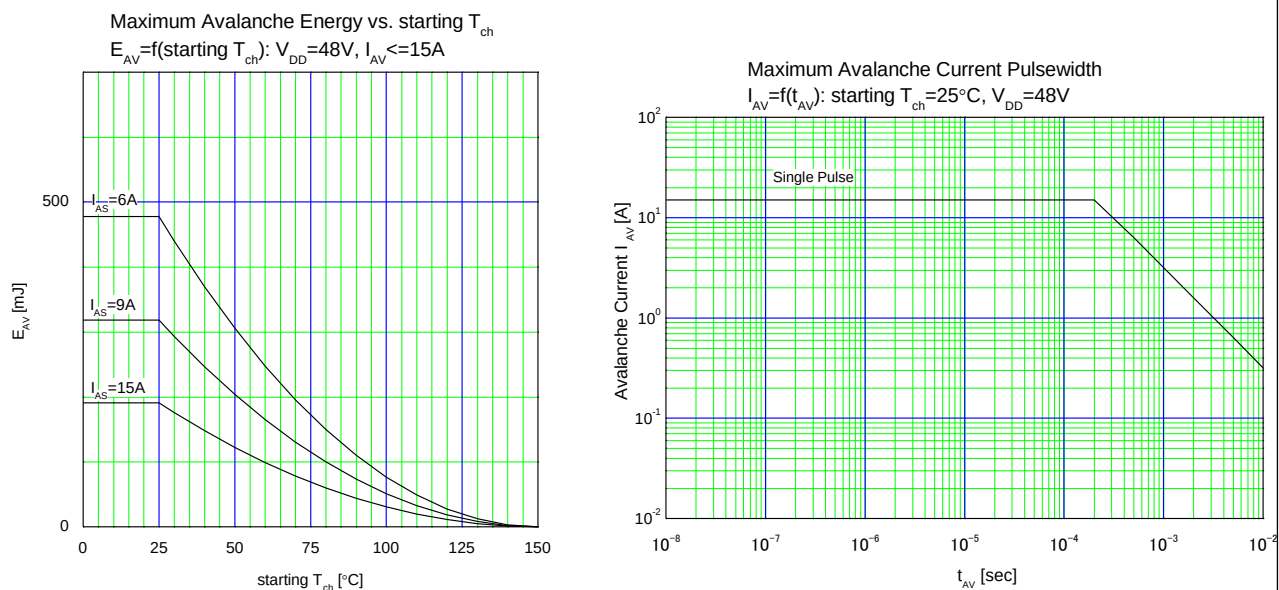


Figure 14. Characteristic curves of JAXA R 2SK4050 (3/3)

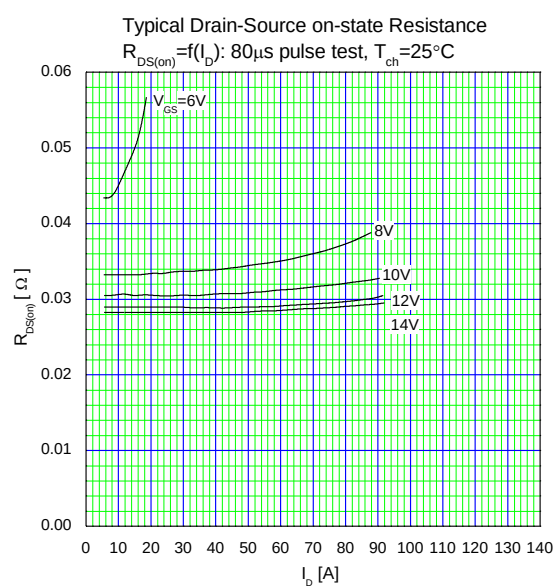
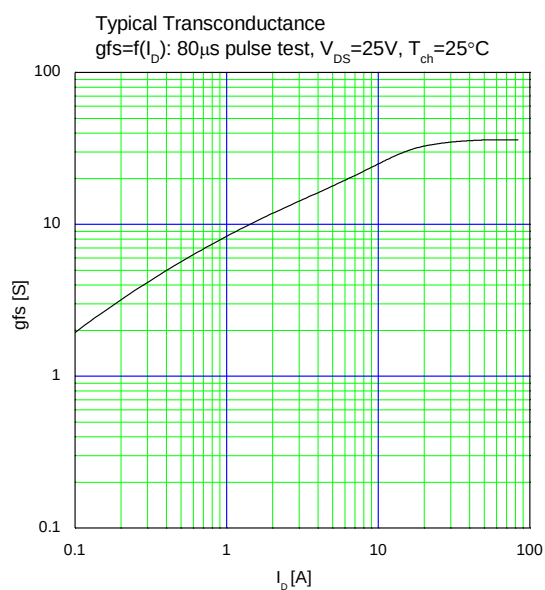
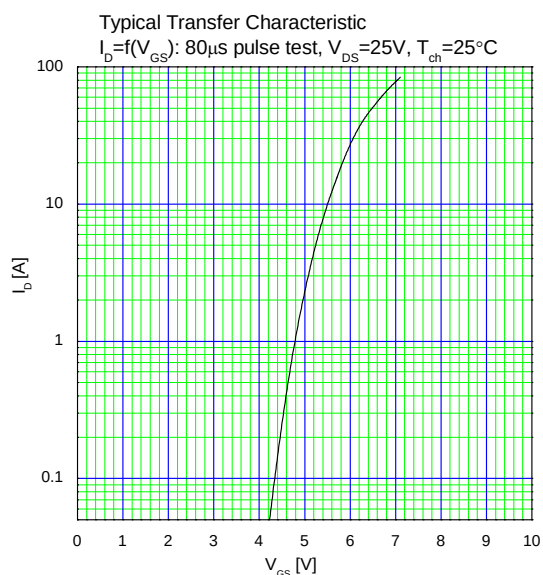
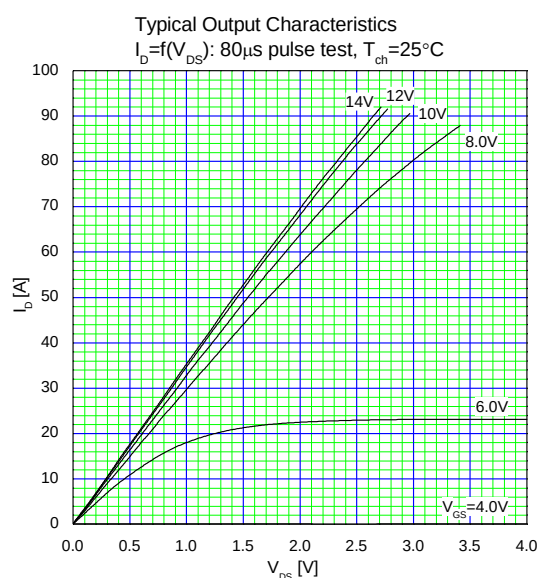
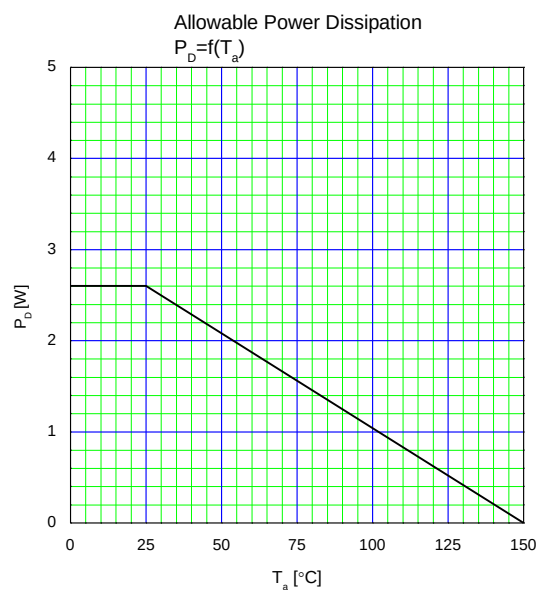
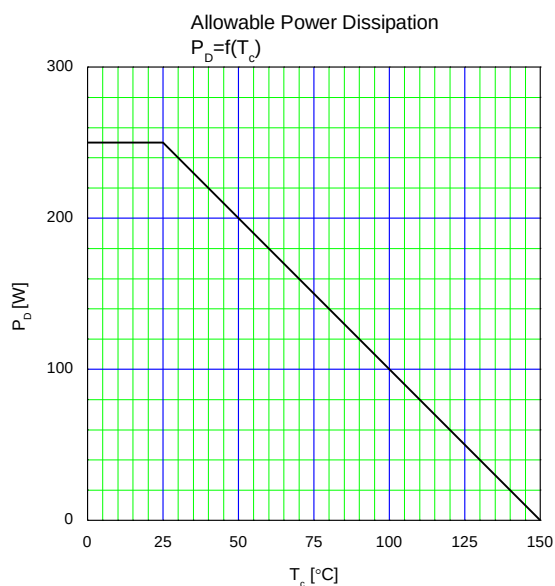


Figure 15. Characteristic curves of JAXA R 2SK4051 (1/3)

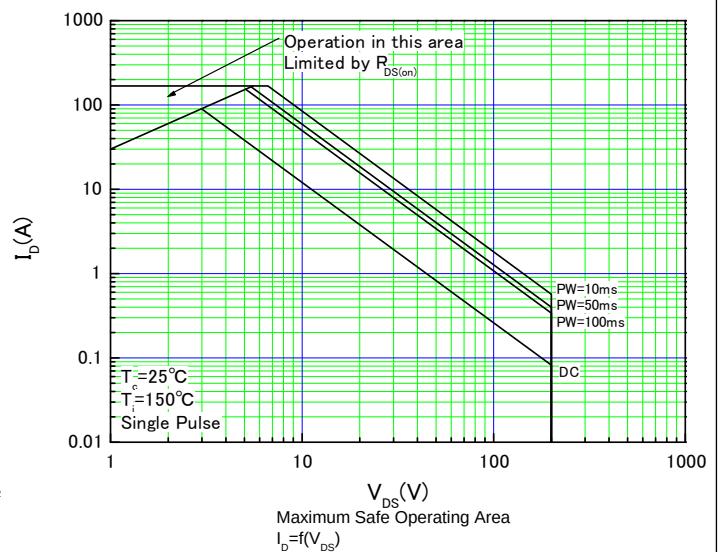
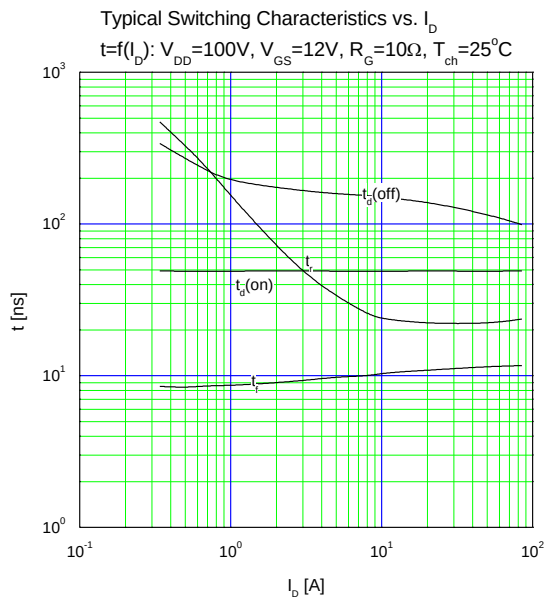
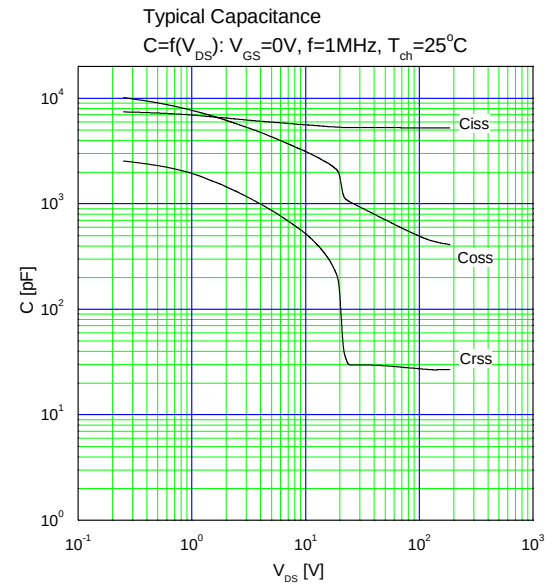
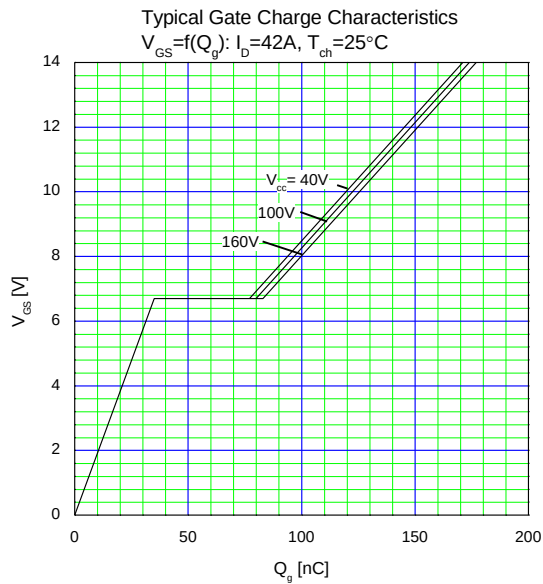
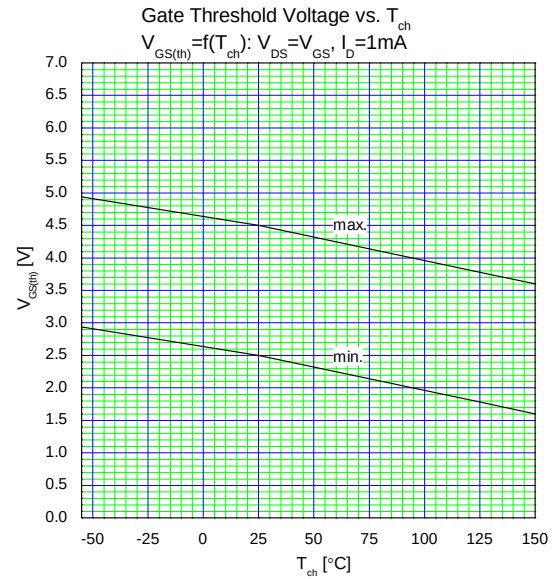
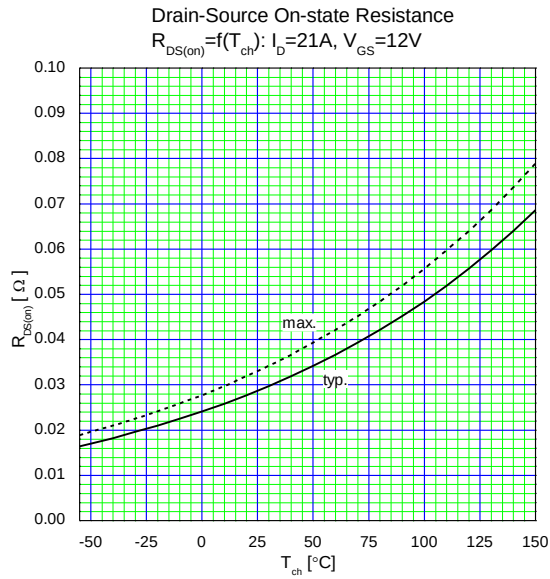


Figure 16. Characteristic curves of JAXA R 2SK4051 (2/3)

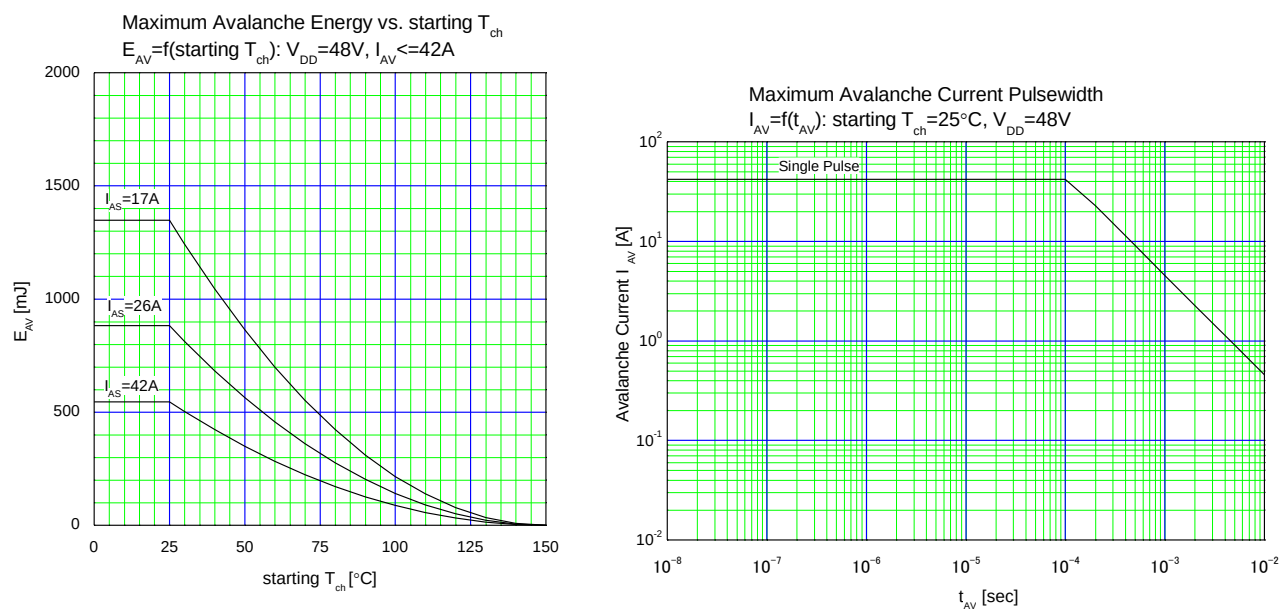


Figure 17. Characteristic curves of JAXA R 2SK4051 (3/3)

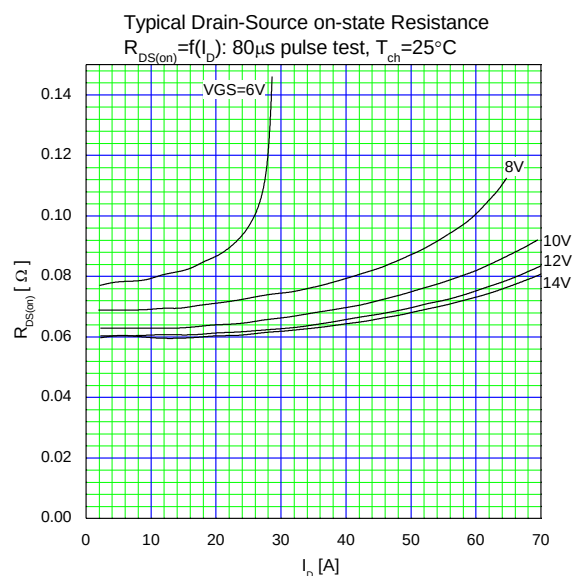
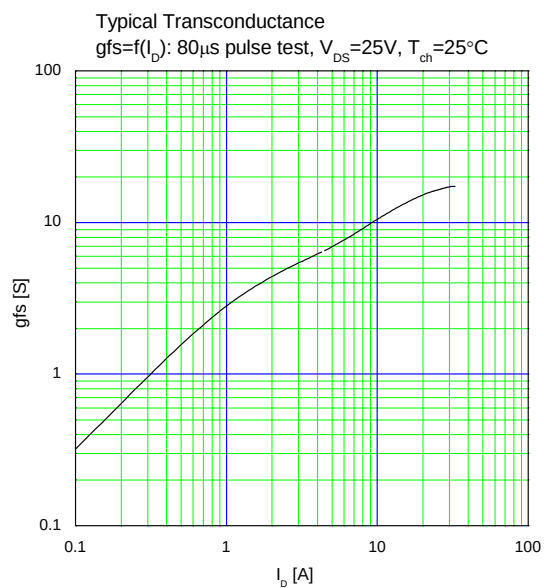
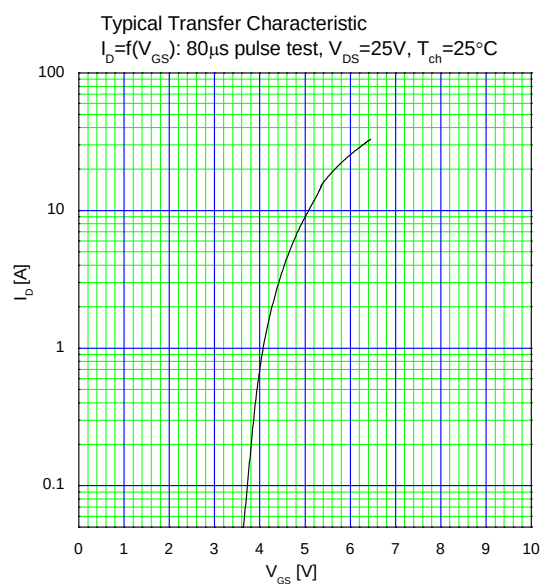
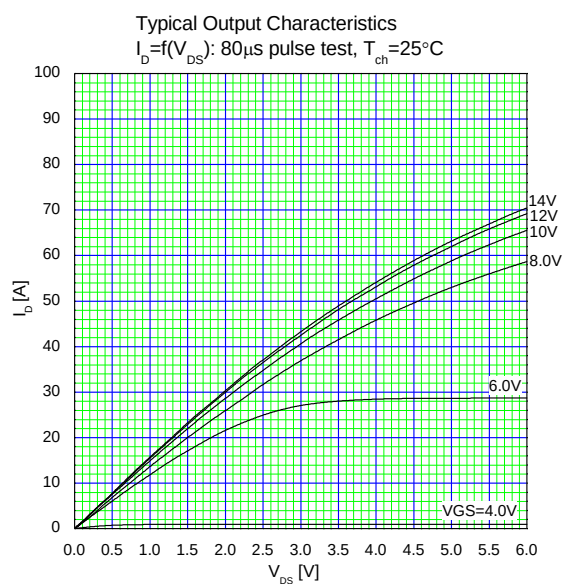
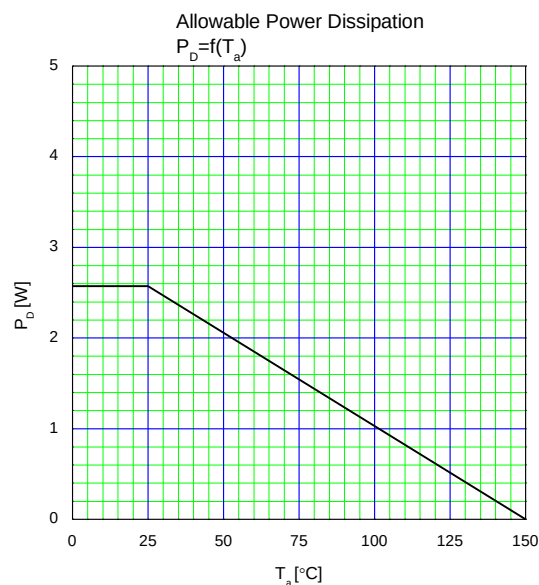
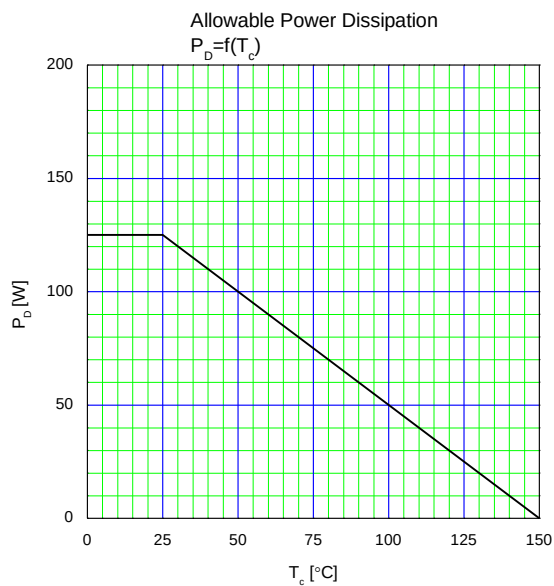


Figure 18. Characteristic curves of JAXA R 2SK4052 (1/3)

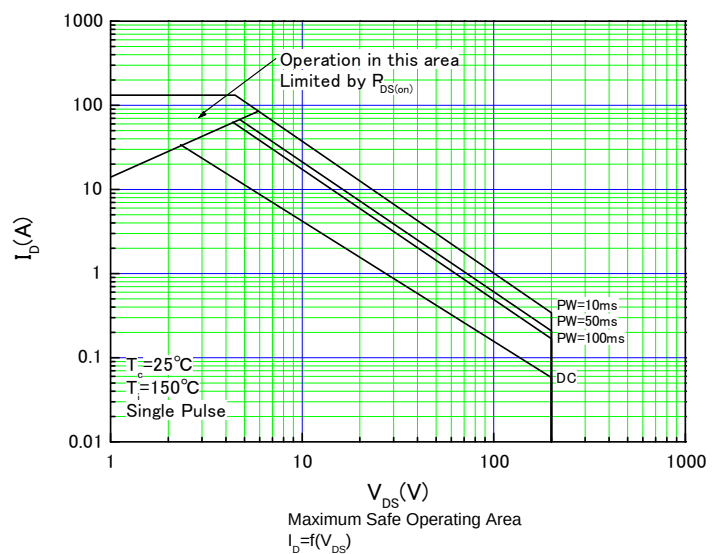
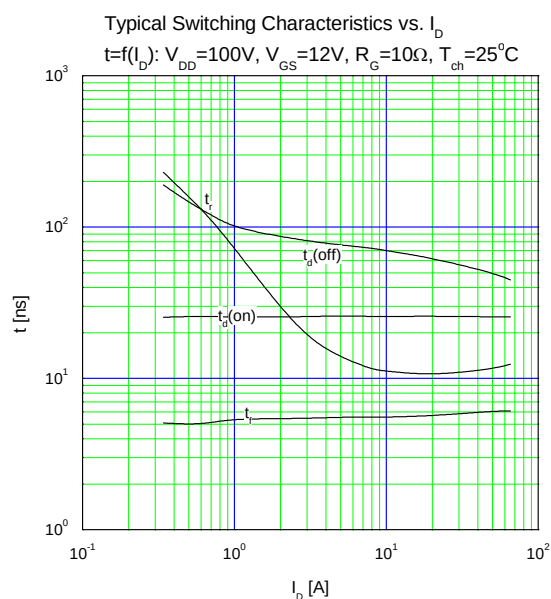
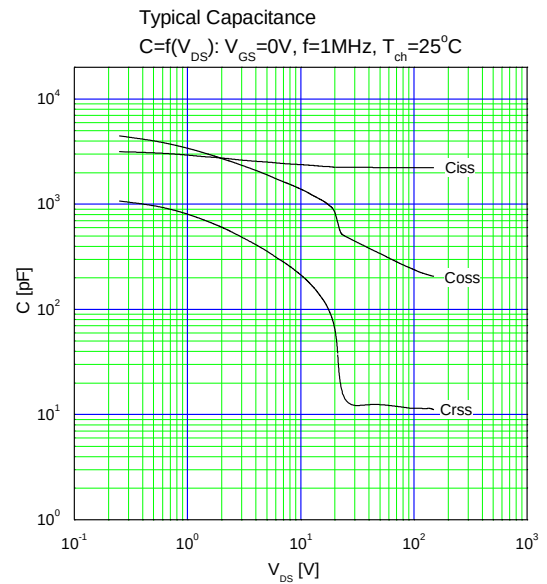
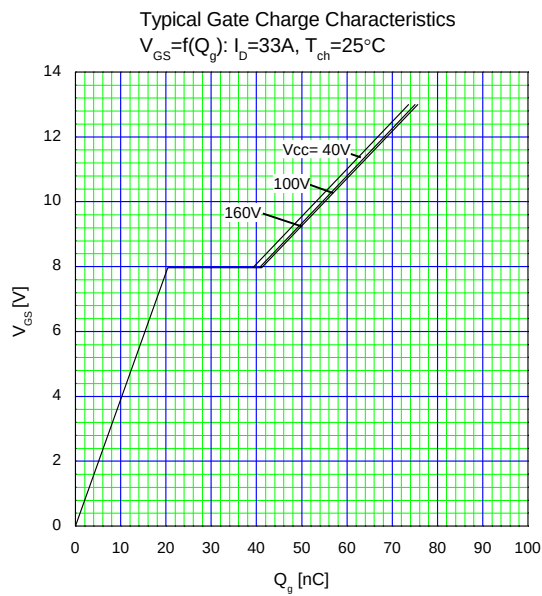
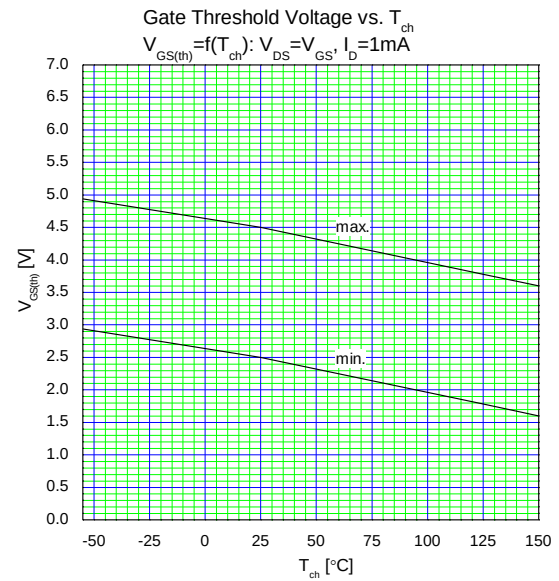
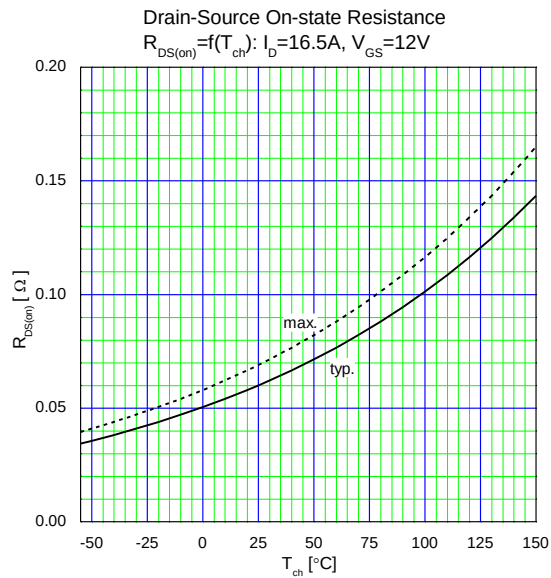


Figure 19. Characteristic curves of JAXA R 2SK4052 (2/3)

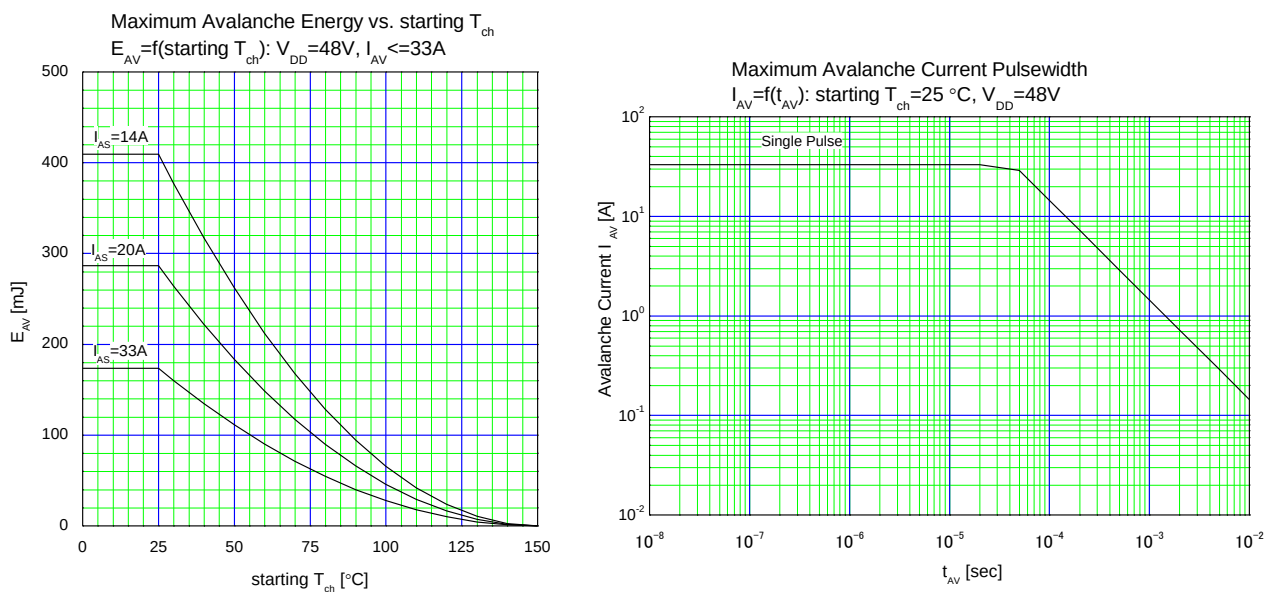


Figure 20. Characteristic curves of JAXA R 2SK4052 (3/3)

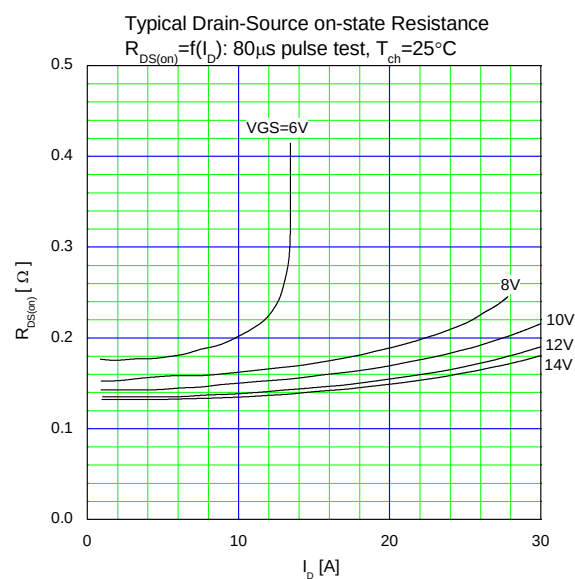
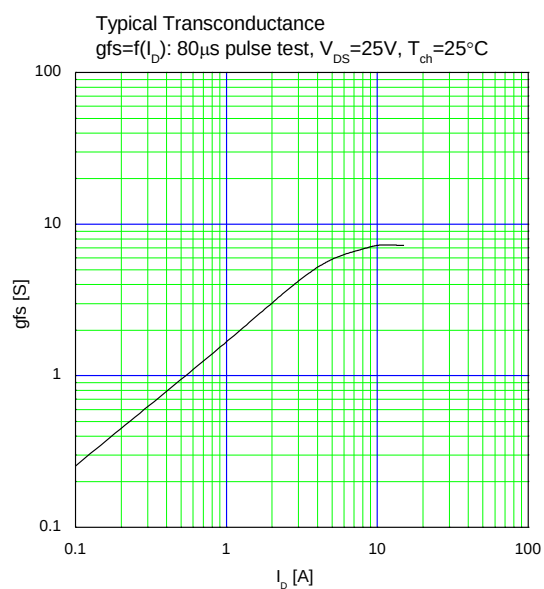
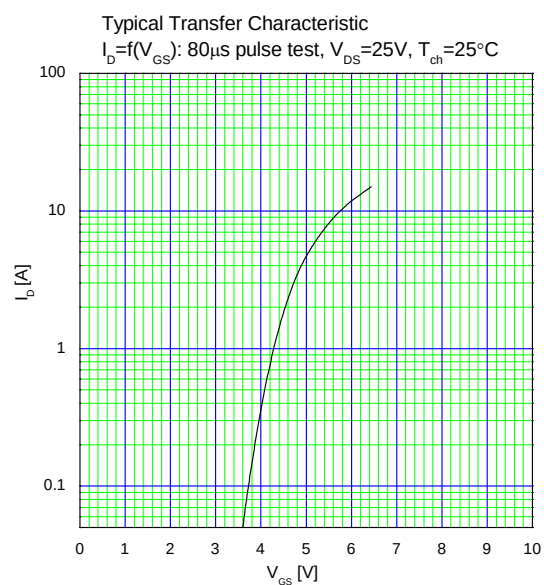
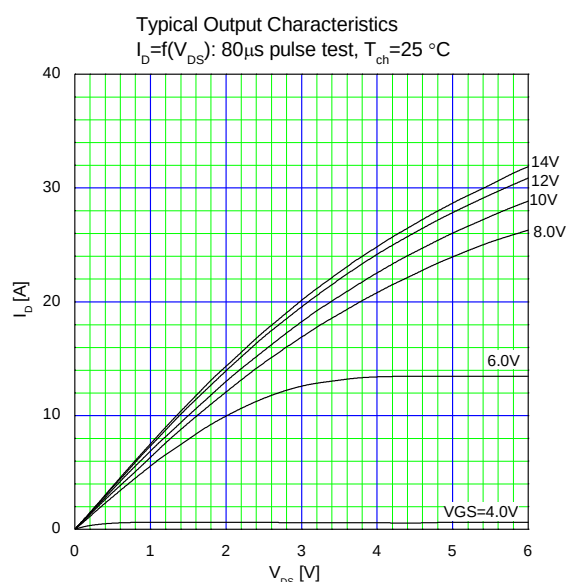
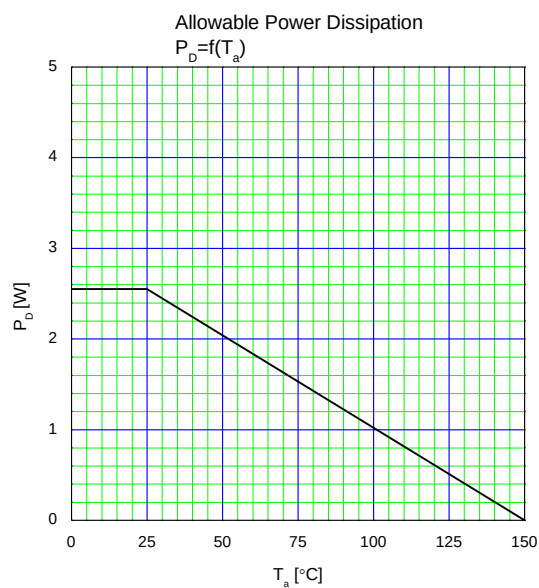
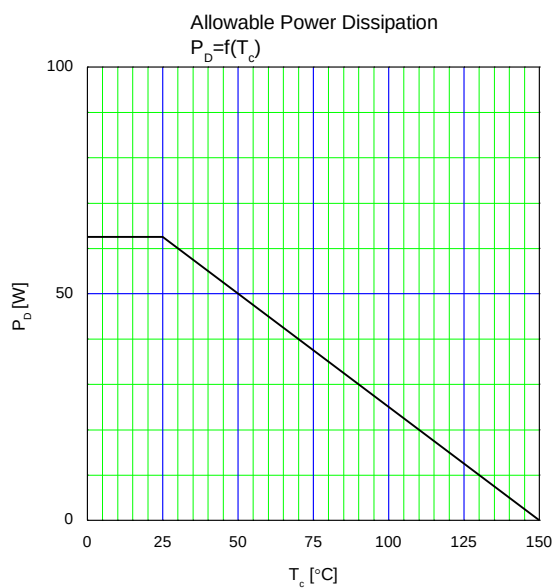


Figure 21. Characteristic curves of JAXA R 2SK4053 (1/3)

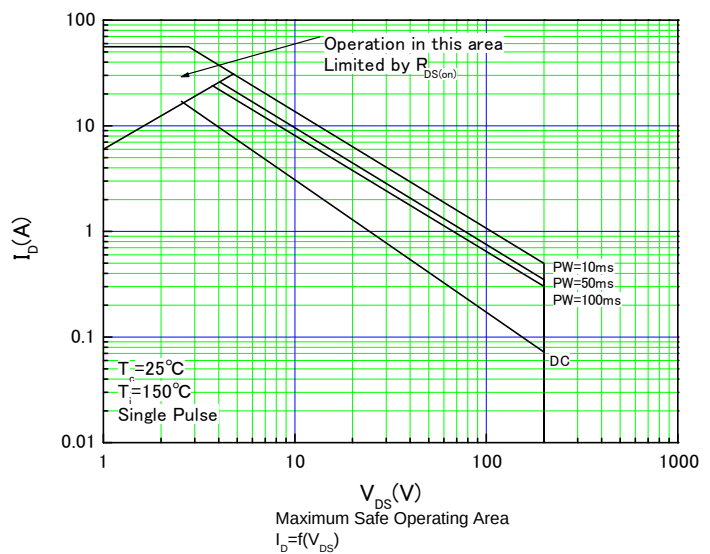
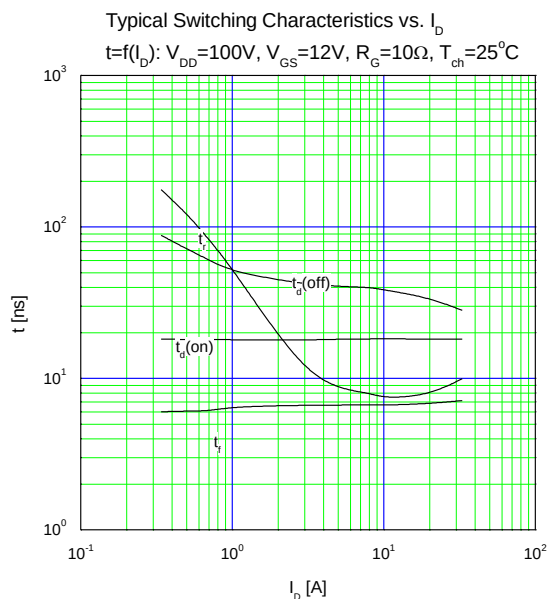
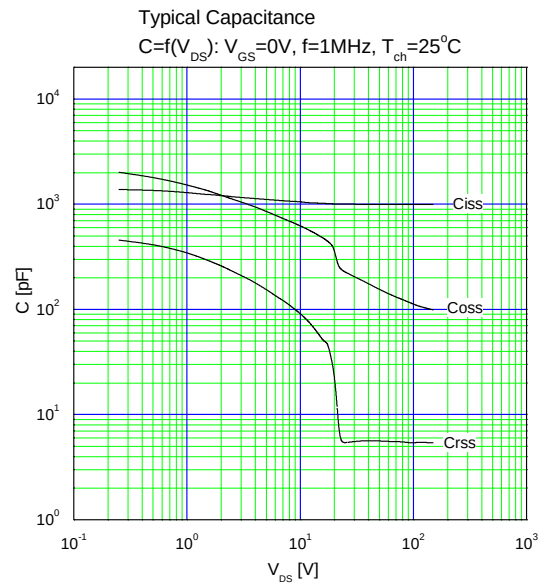
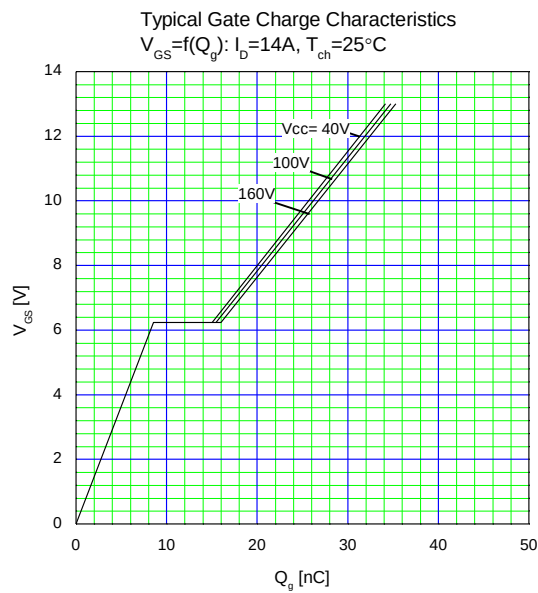
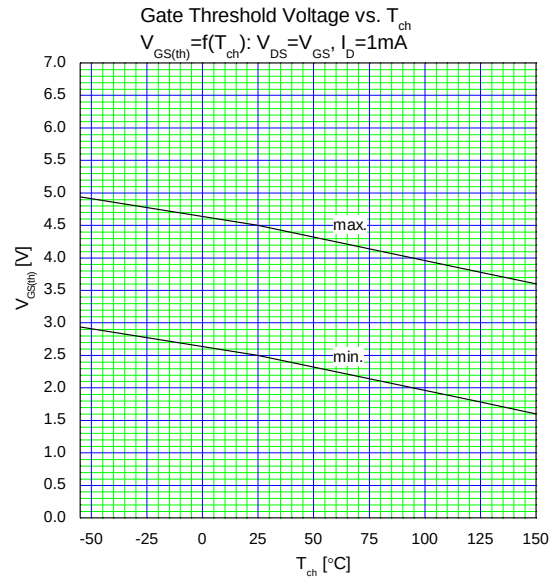
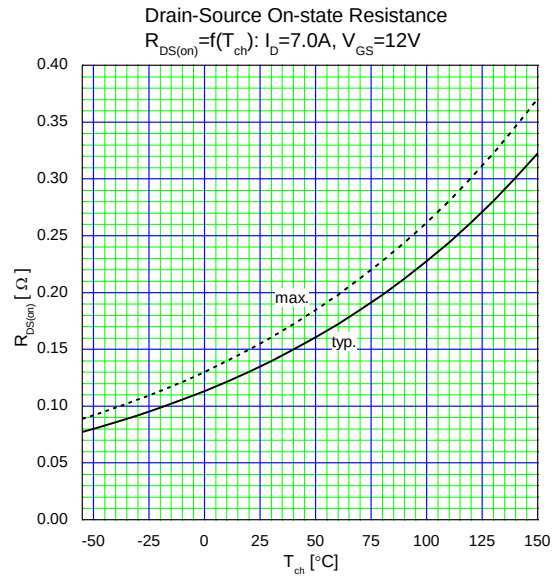


Figure 22. Characteristic curves of JAXA R 2SK4053 (2/3)

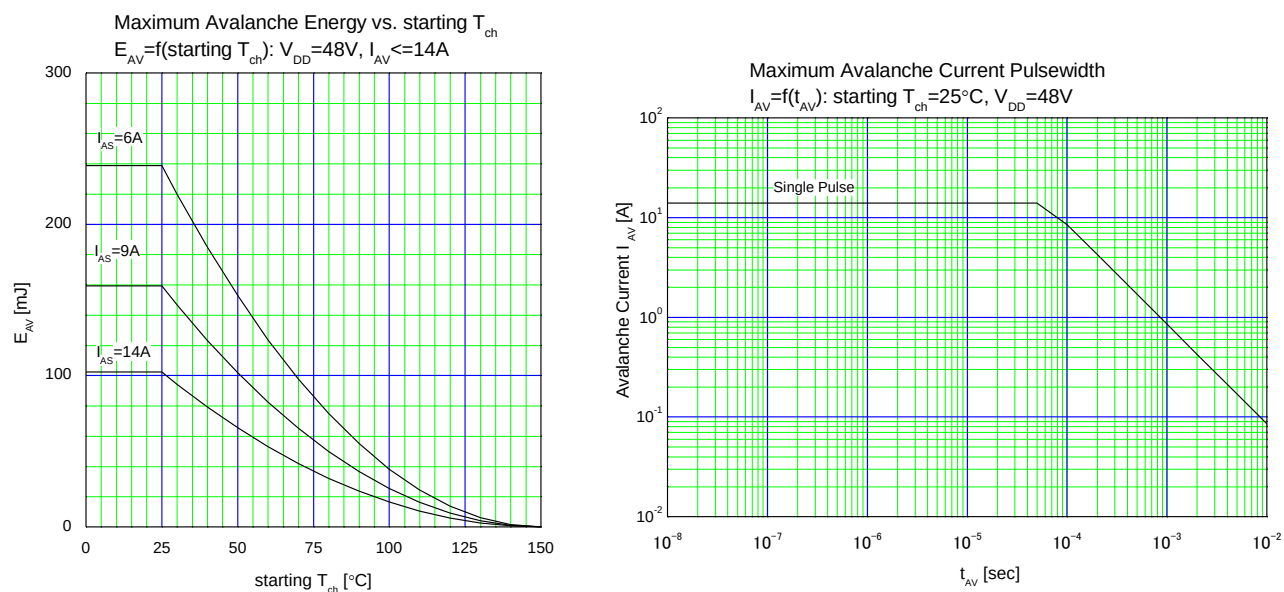


Figure 23. Characteristic curves of JAXA R 2SK4053 (3/3)

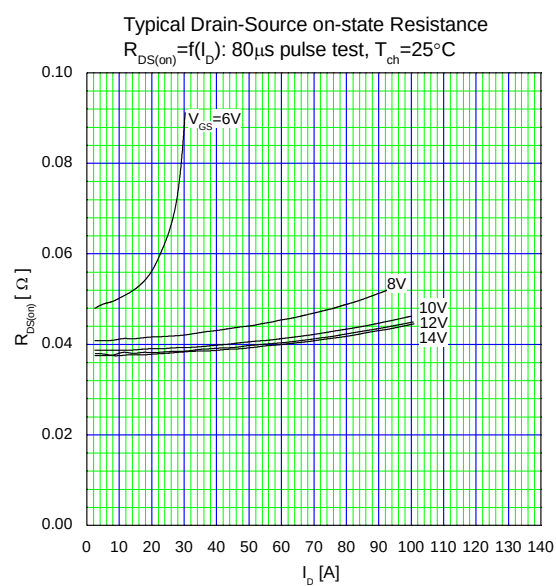
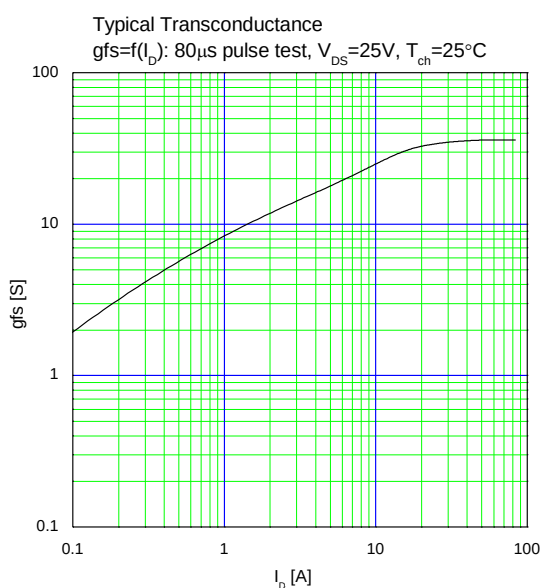
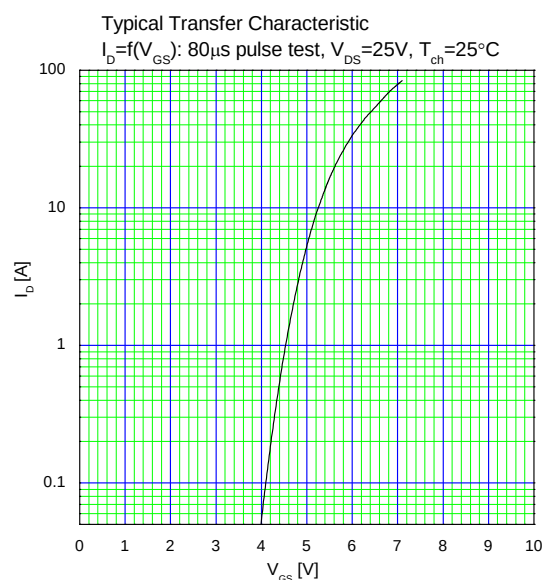
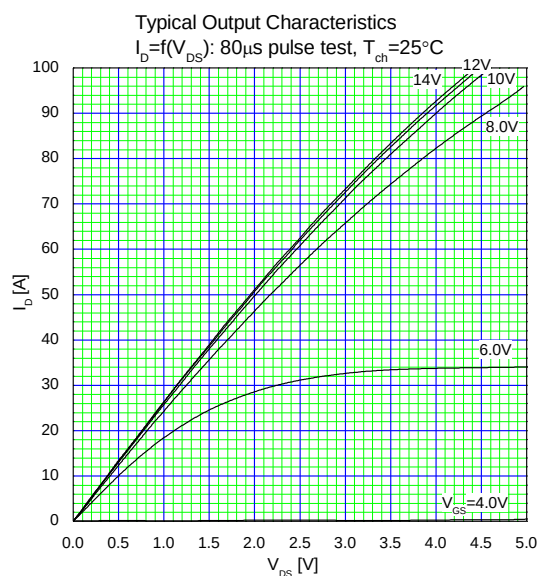
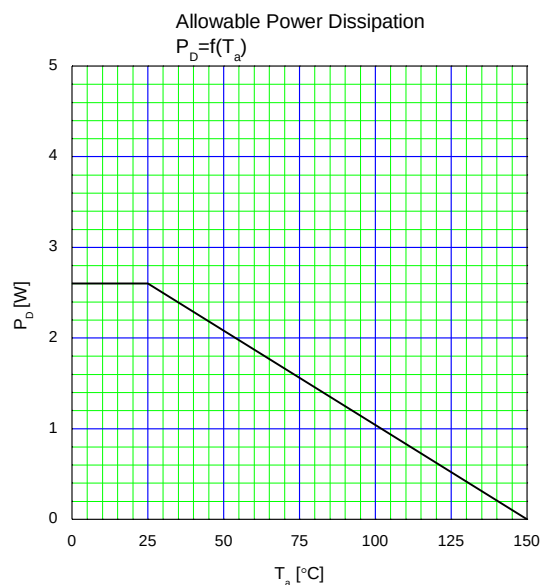
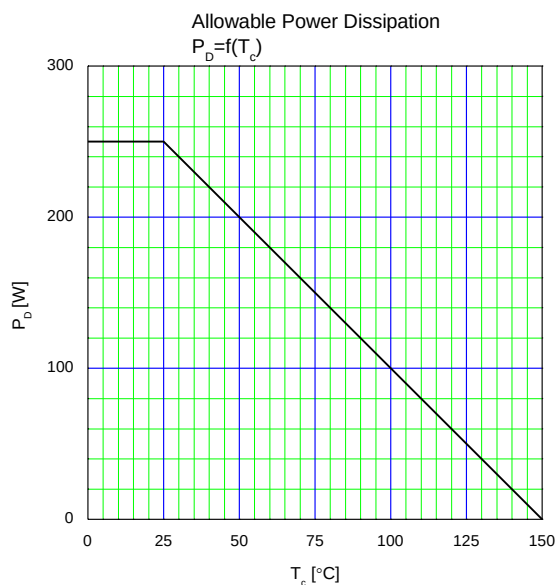


Figure 24. Characteristic curves of JAXA R 2SK4054 (1/3)

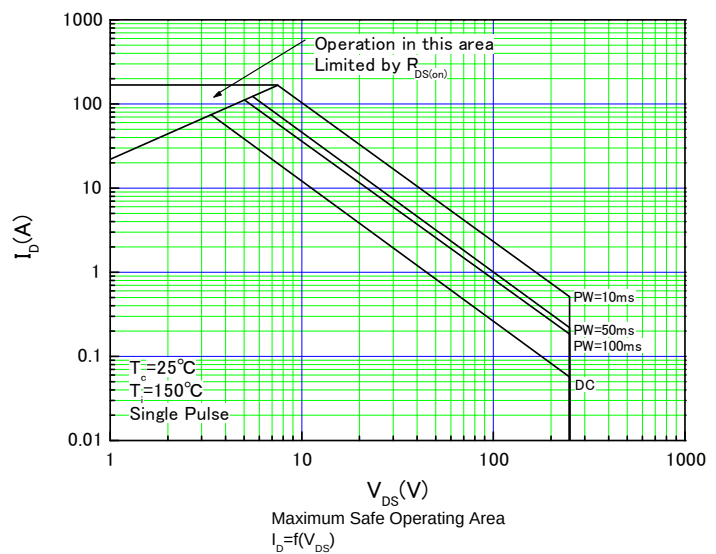
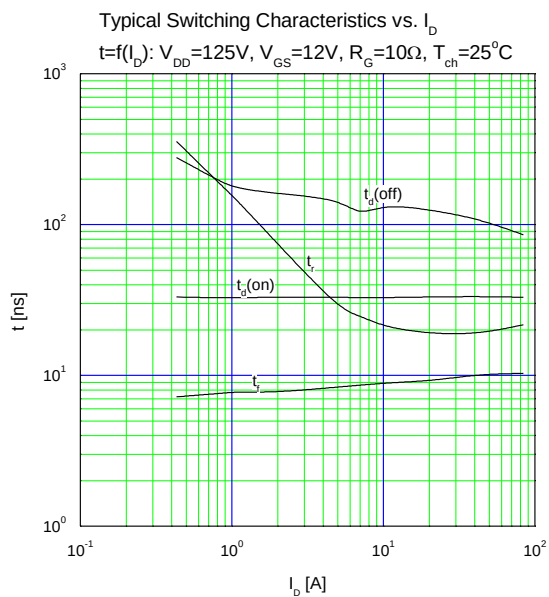
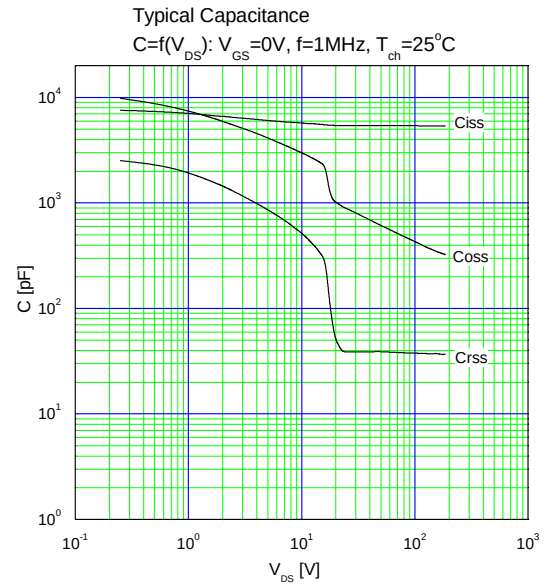
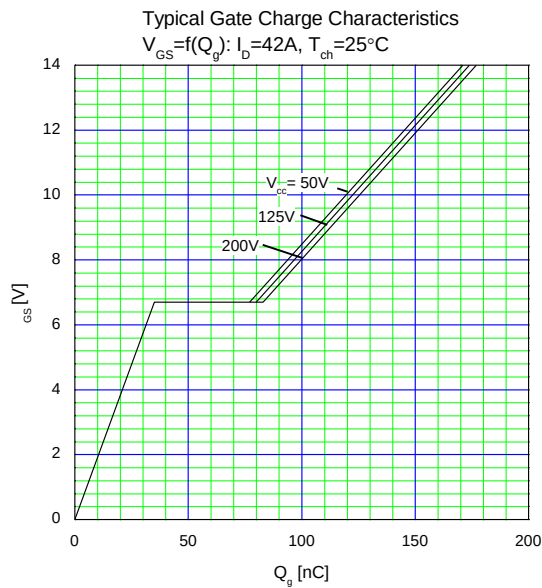
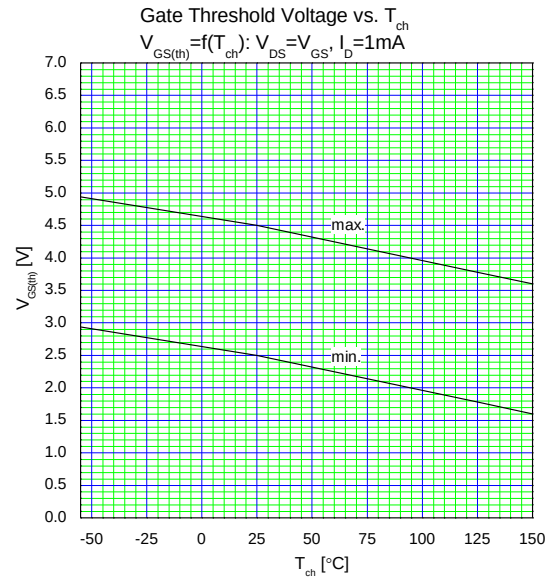
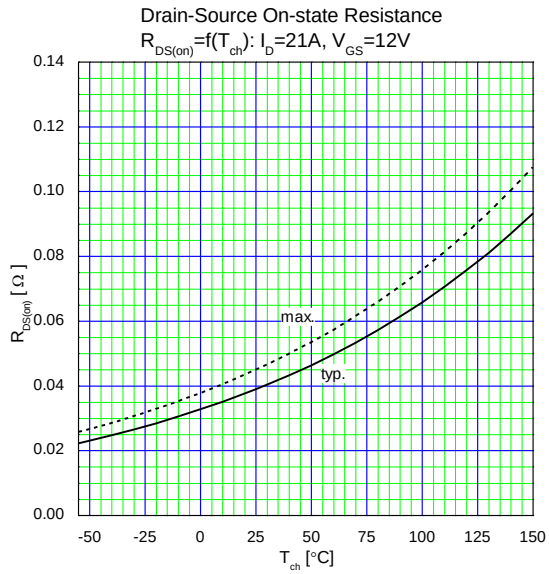


Figure 25. Characteristic curves of JAXA R 2SK4054 (2/3)

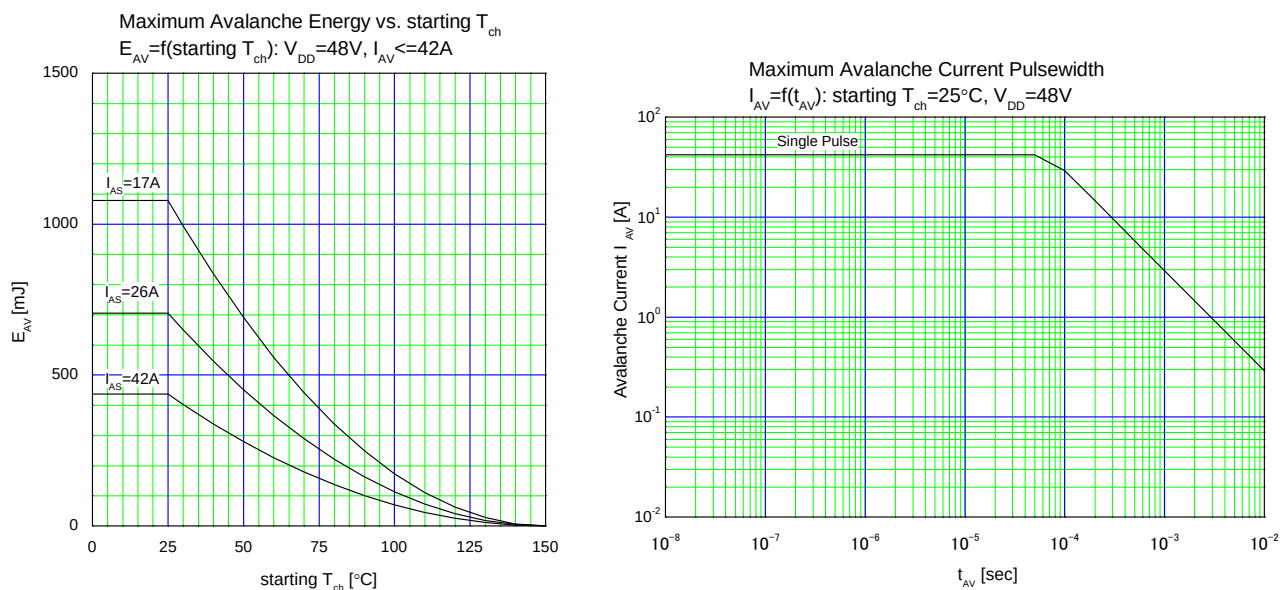


Figure 26. Characteristic curves of JAXA R 2SK4054 (3/3)

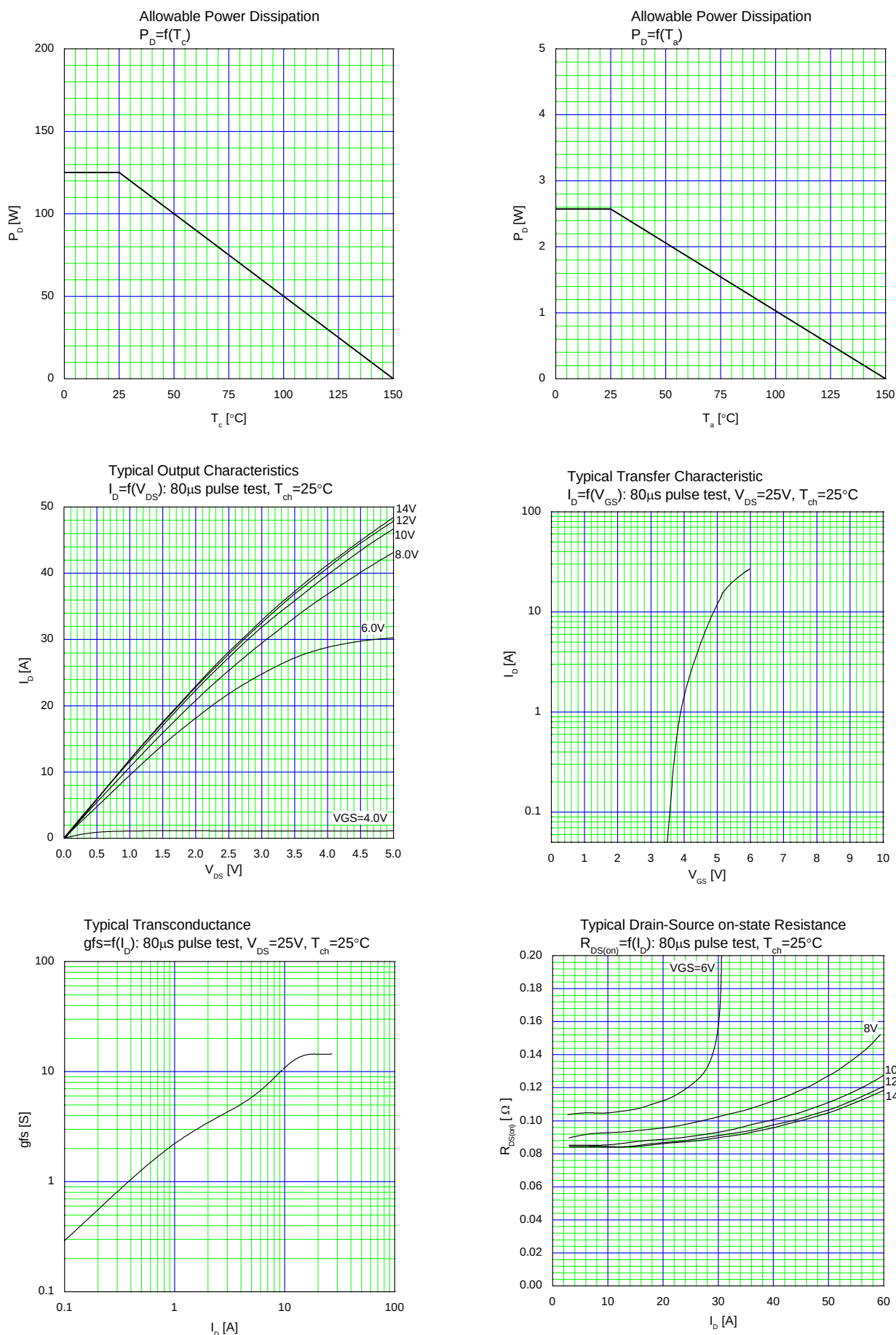


Figure 27. Characteristic curves of JAXA R 2SK4055 (1/3)

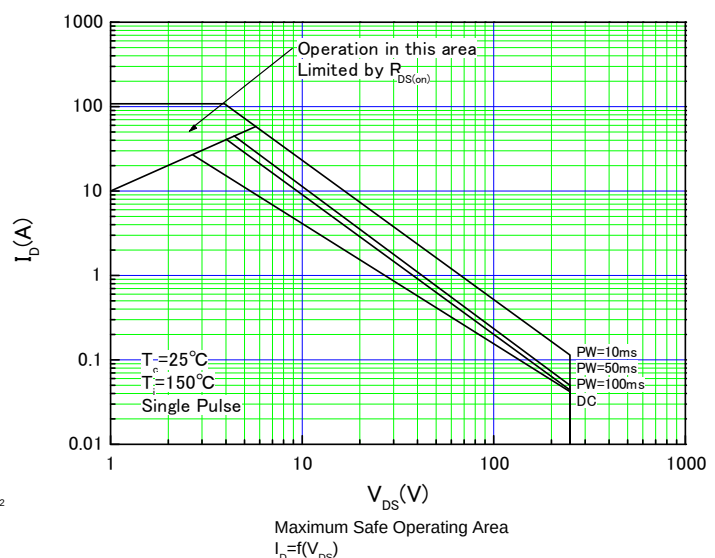
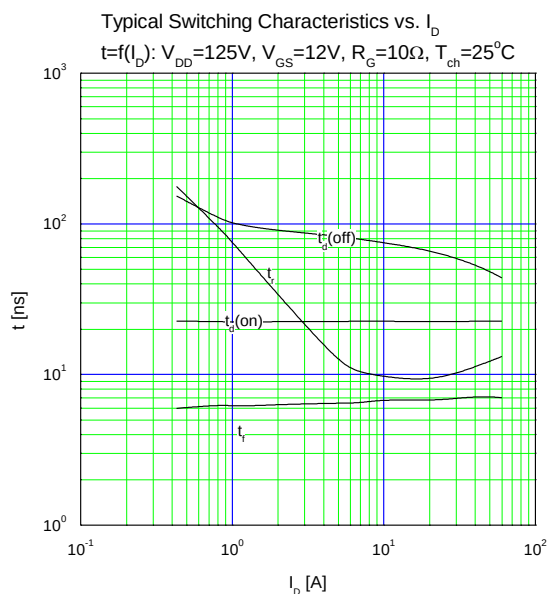
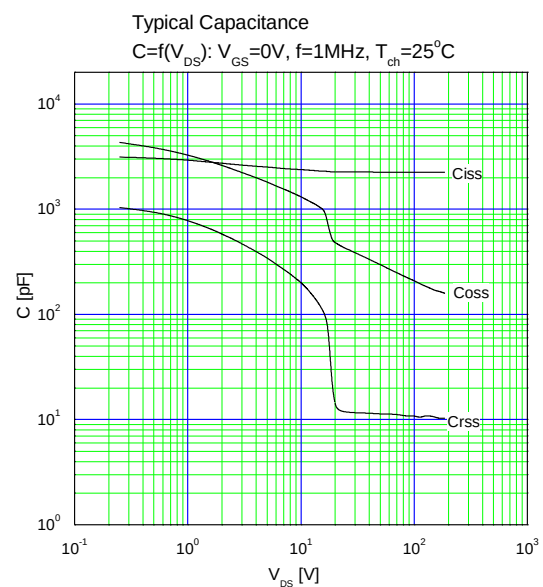
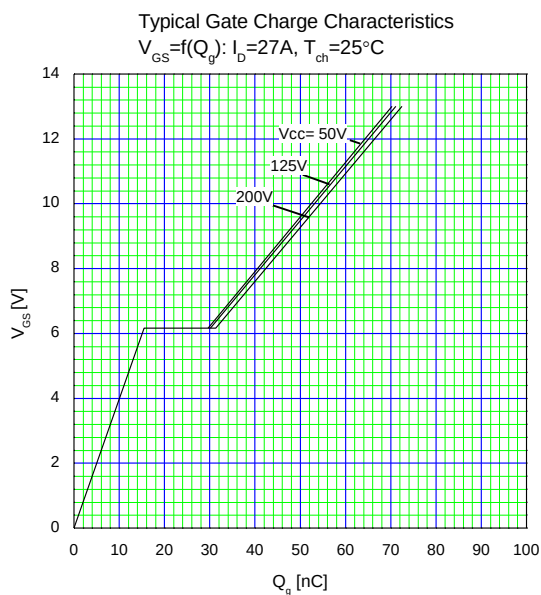
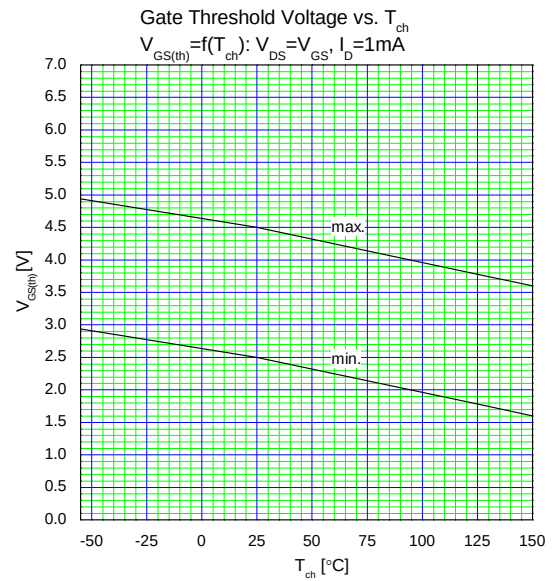
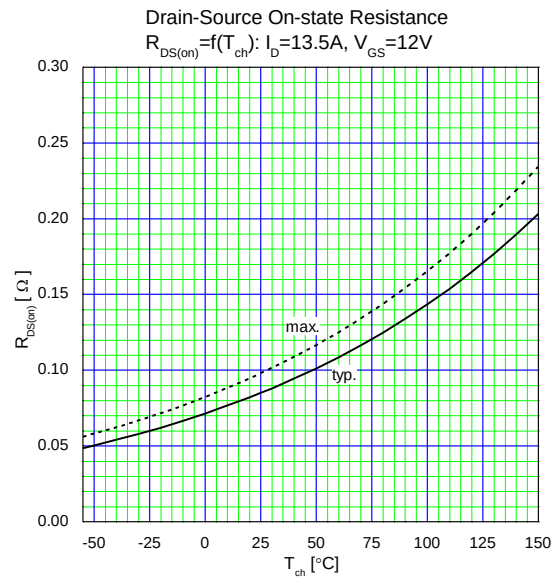


Figure 28. Characteristic curves of JAXA R 2SK4055 (2/3)

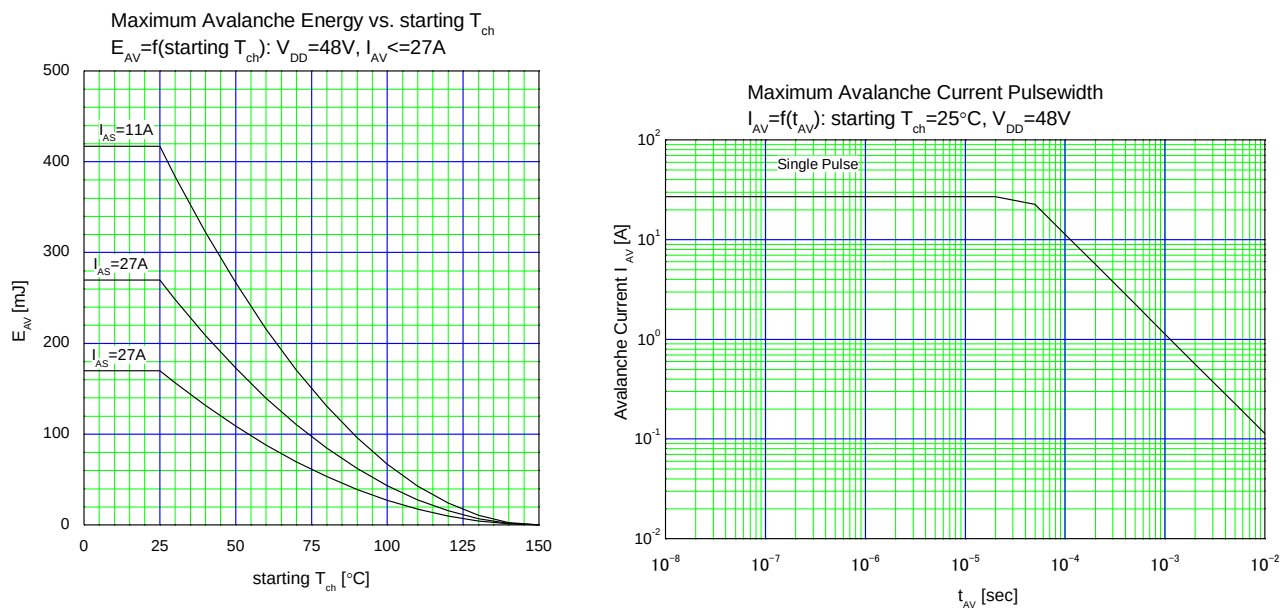


Figure 29. Characteristic curves of JAXA R 2SK4055 (3/3)

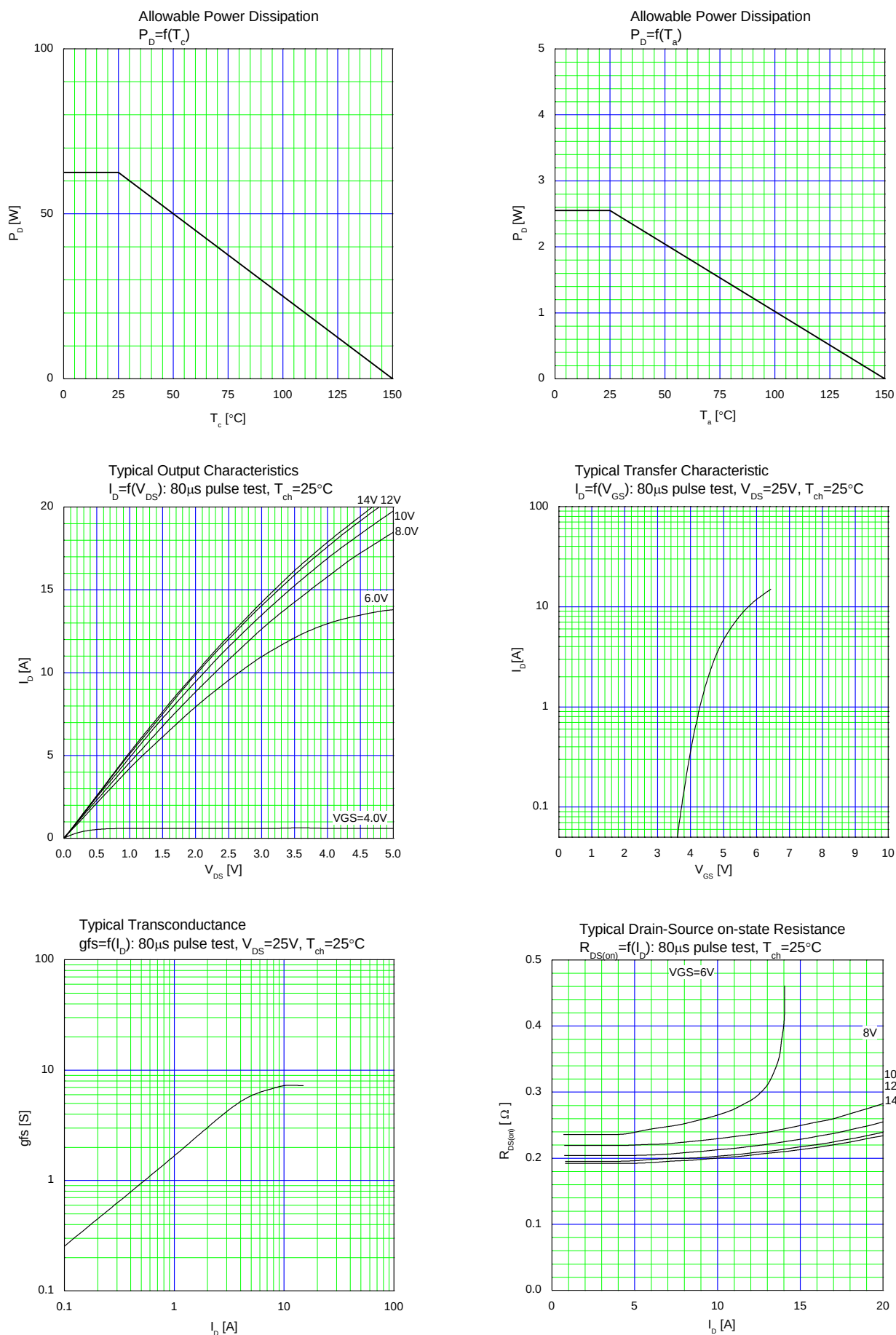


Figure 30. Characteristic curves of JAXA R 2SK4056 (1/3)

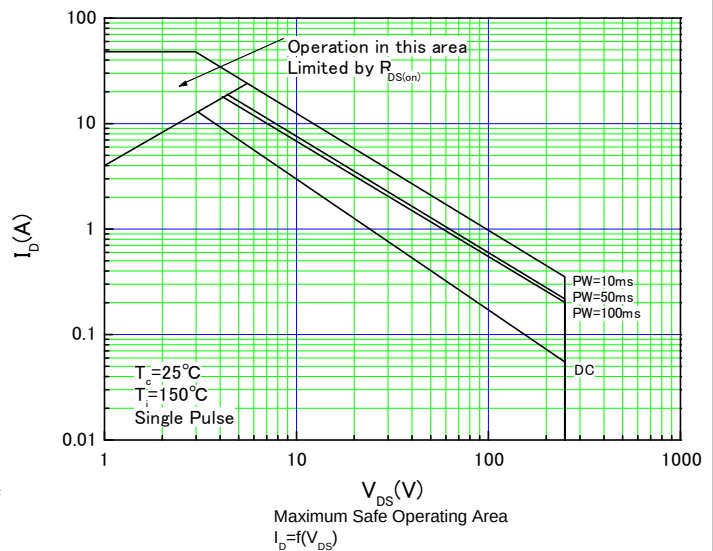
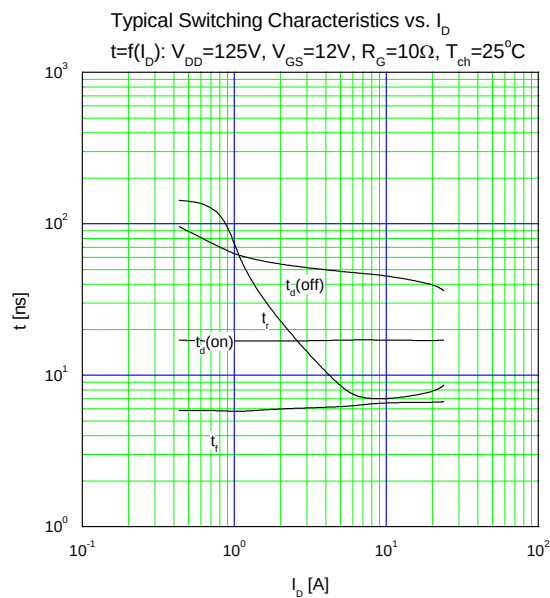
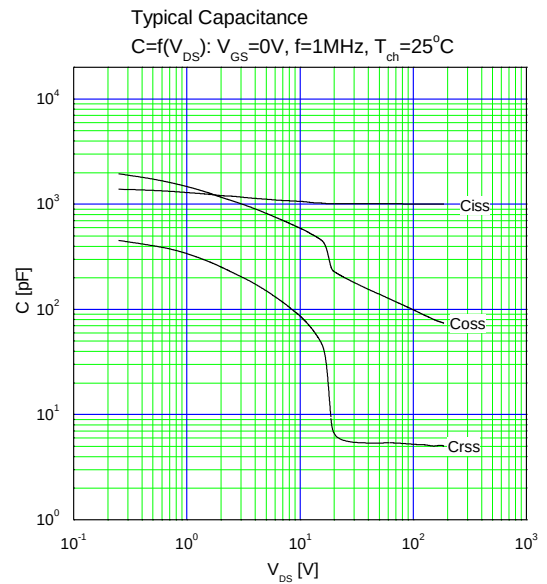
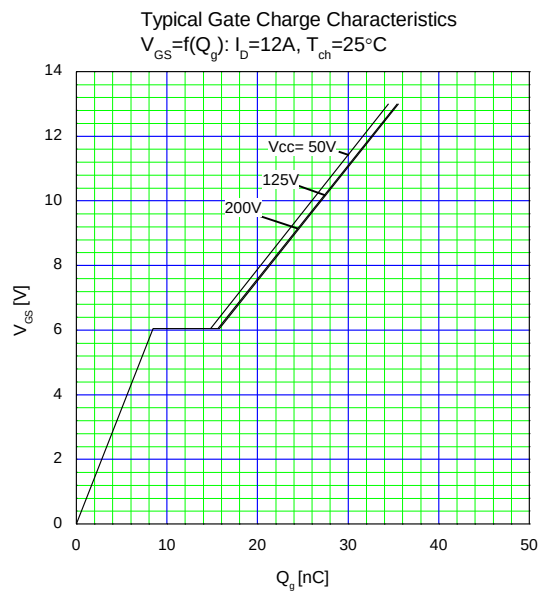
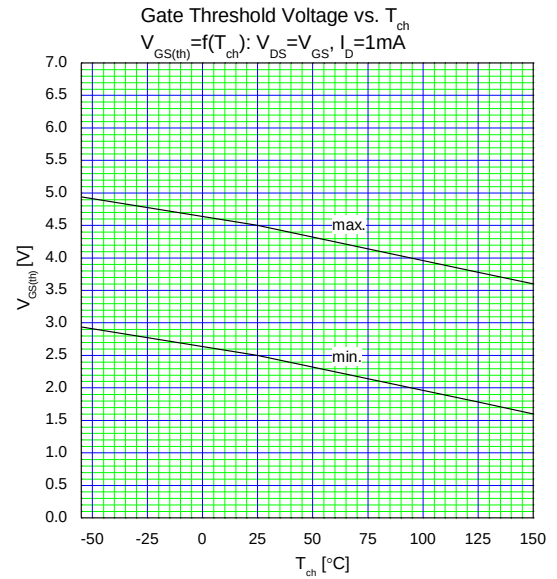
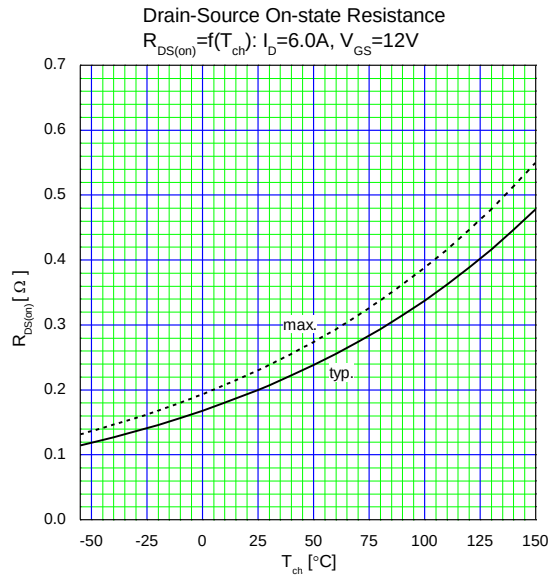


Figure 31. Characteristic curves of JAXA R 2SK4056 (2/3)

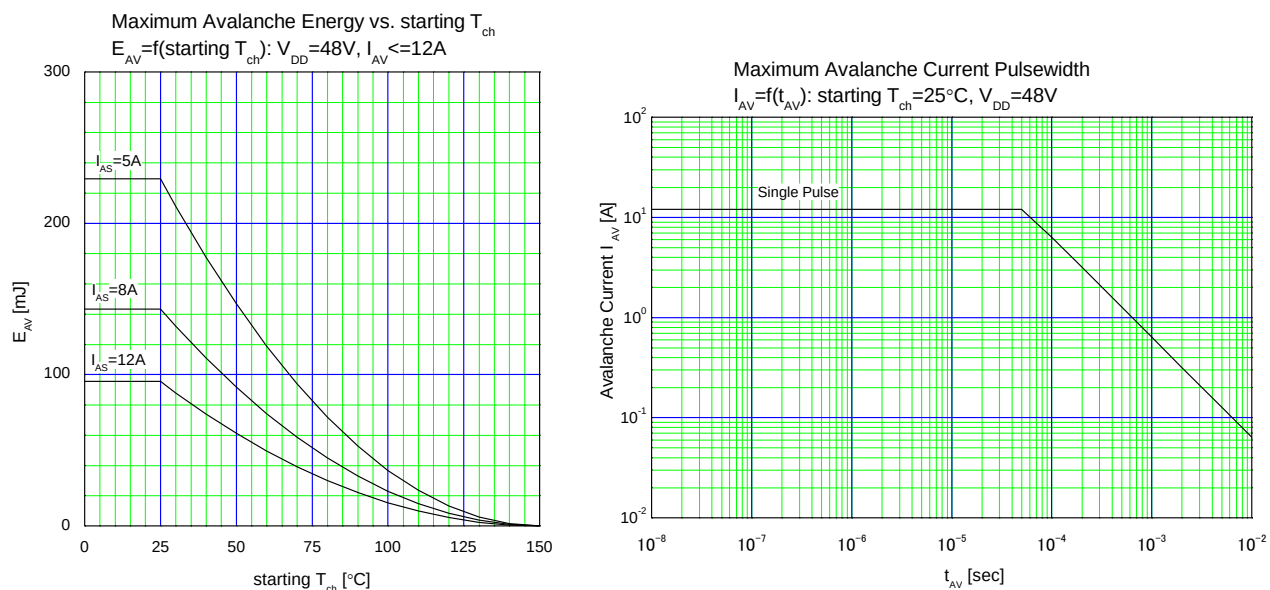


Figure 32. Characteristic curves of JAXA R 2SK4056 (3/3)

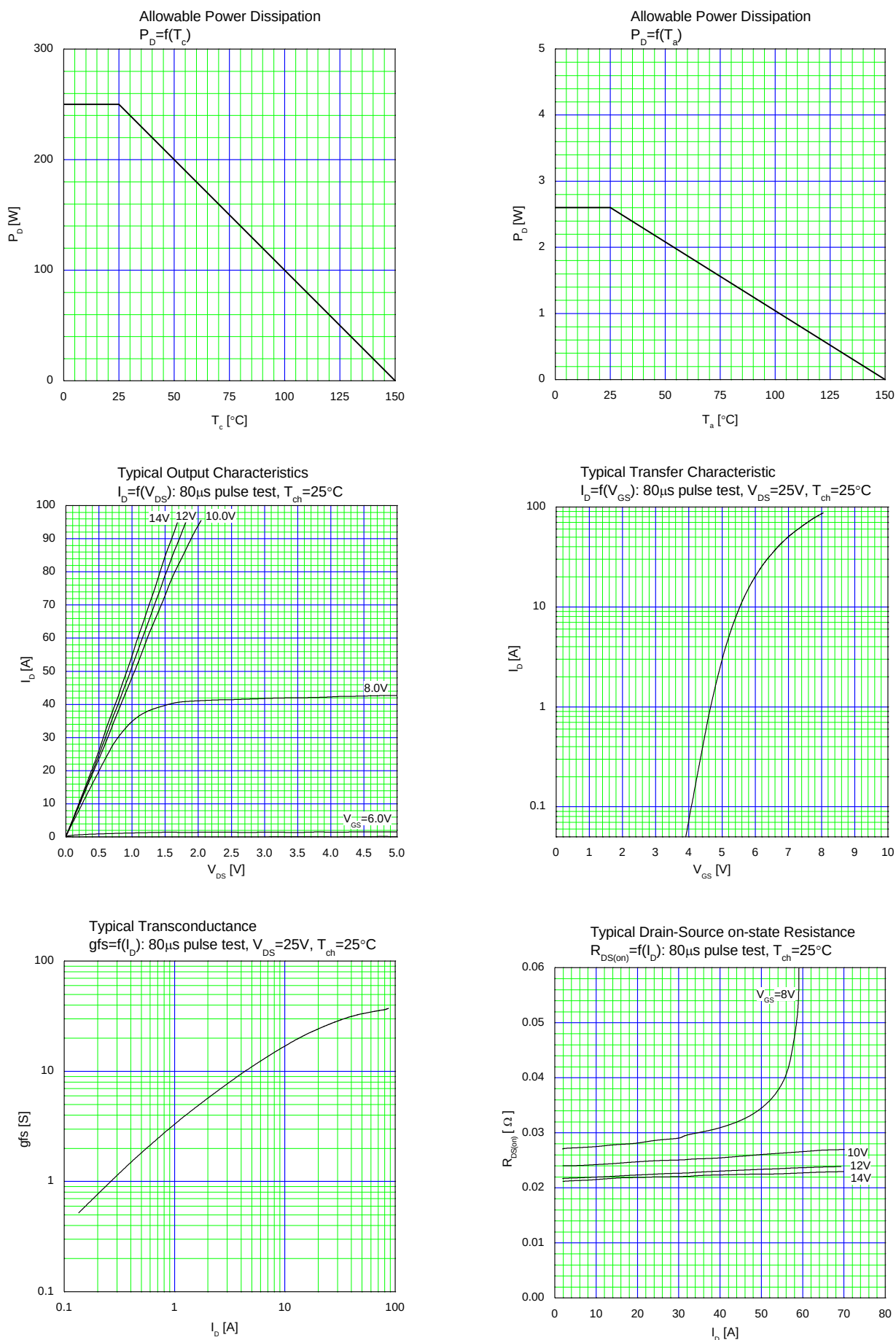


Figure 33. Characteristic curves of JAXA R 2SK4214 (1/3)

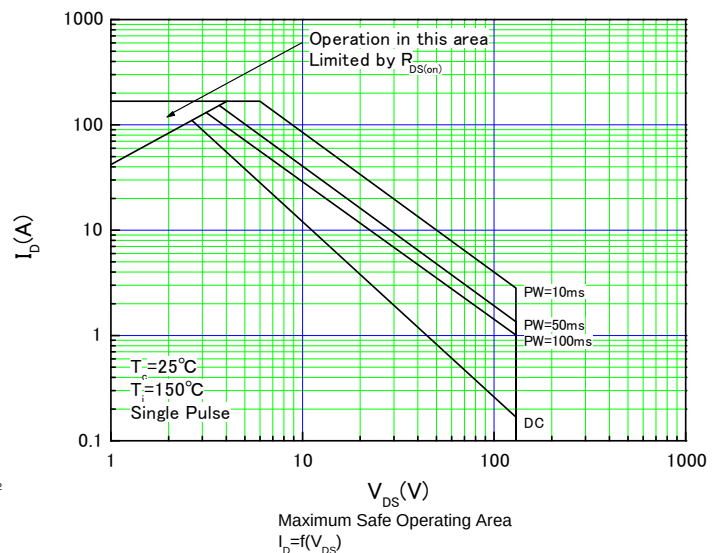
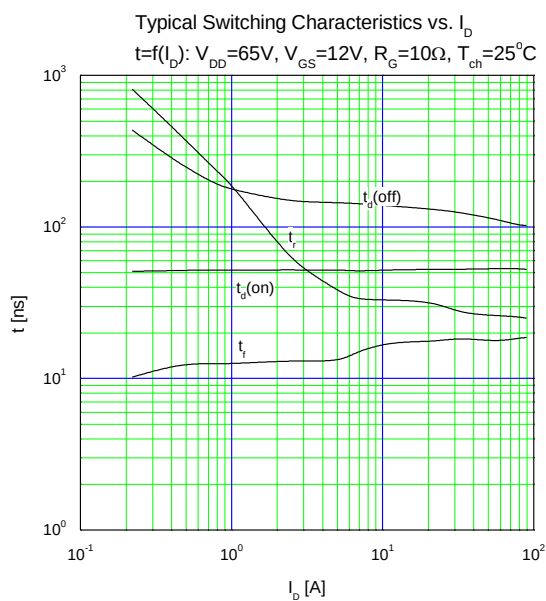
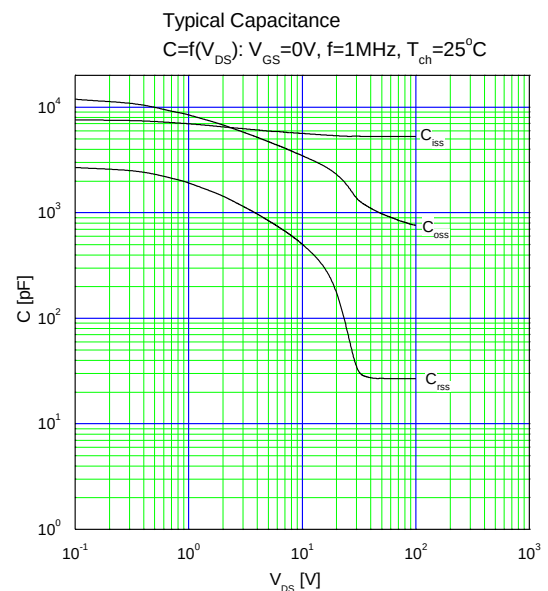
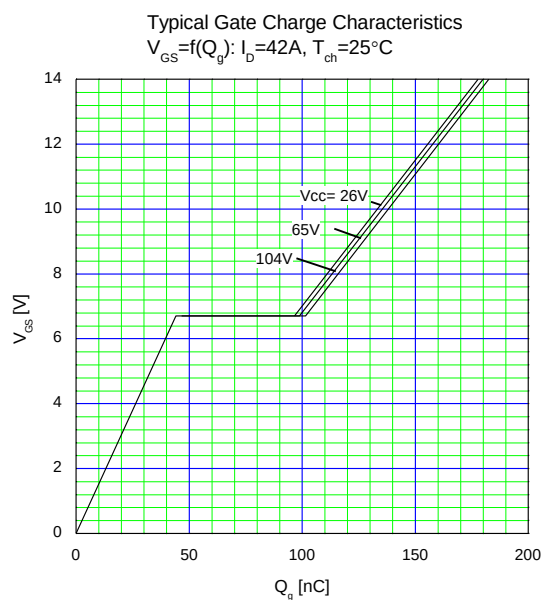
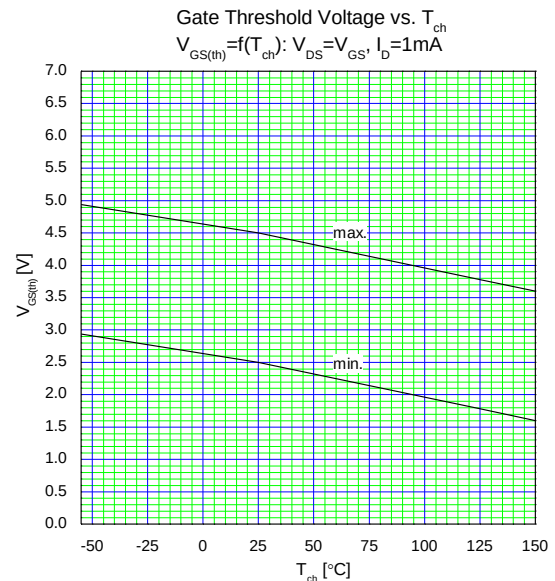
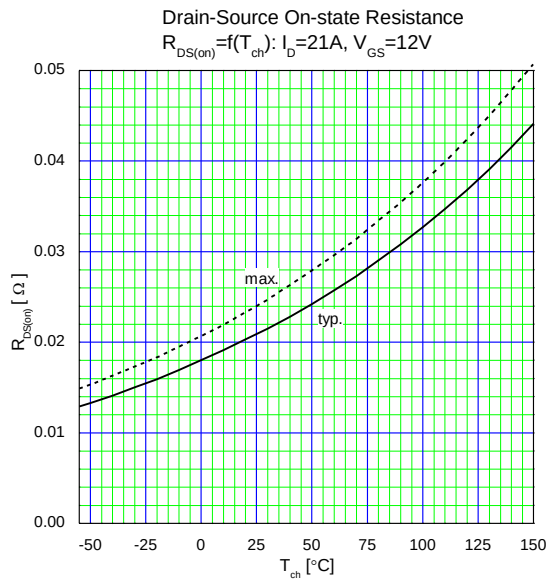


Figure 34. Characteristic curves of JAXA R 2SK4214 (2/3)

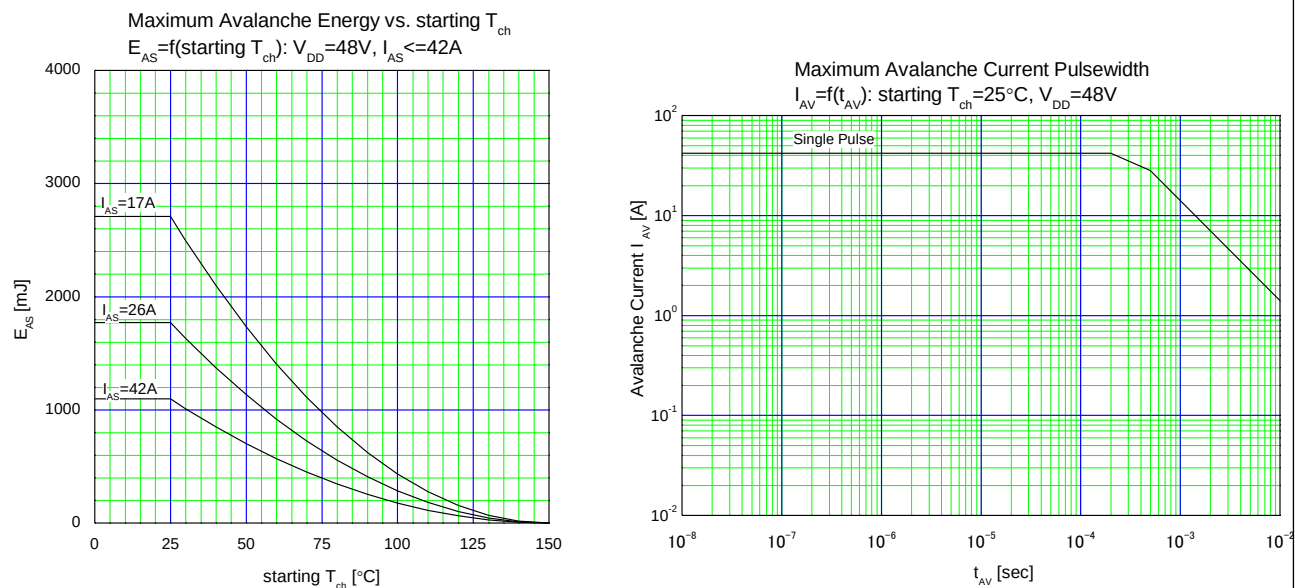


Figure 35. Characteristic curves of JAXA R 2SK4214 (3/3)

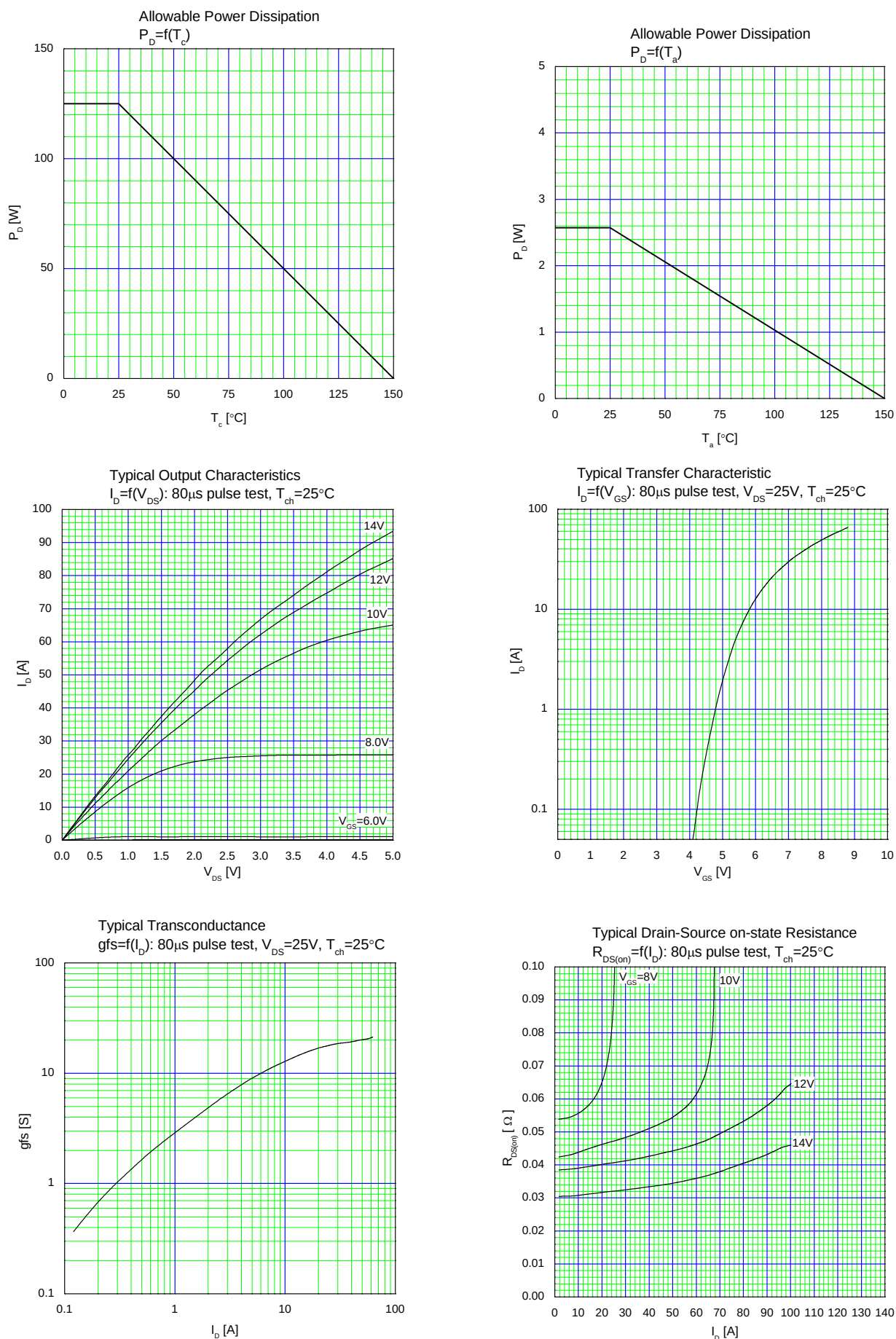


Figure 36. Characteristic curves of JAXA R 2SK4215 (1/3)

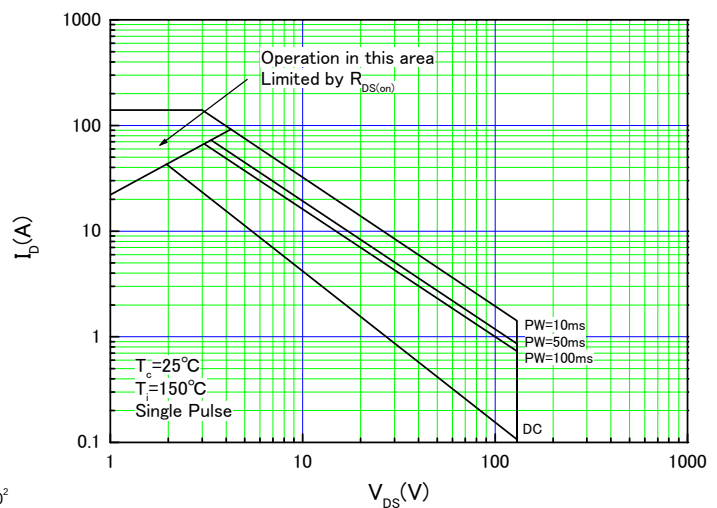
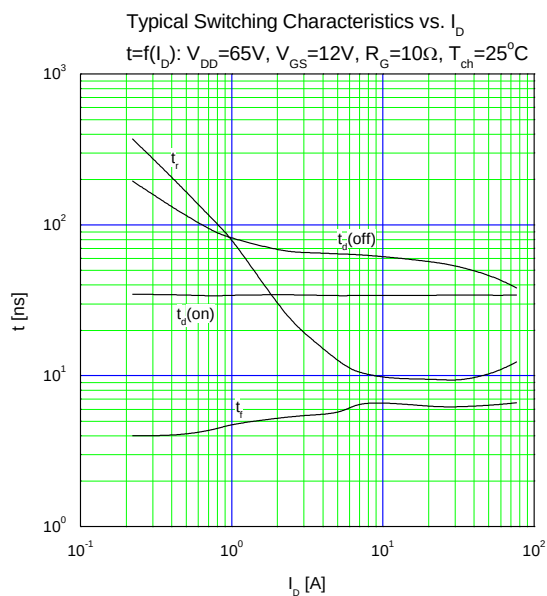
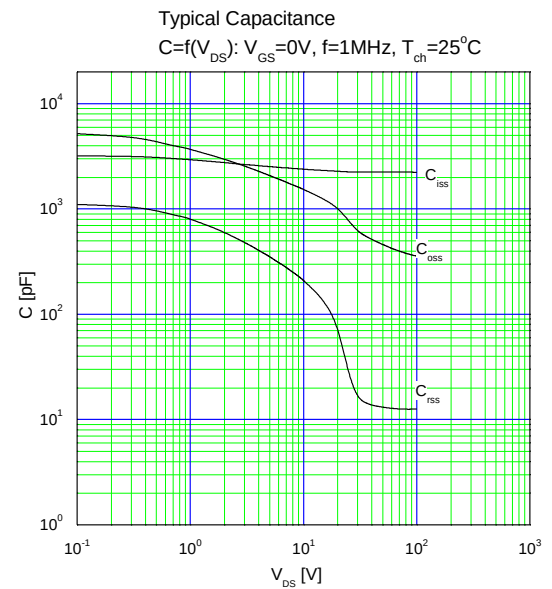
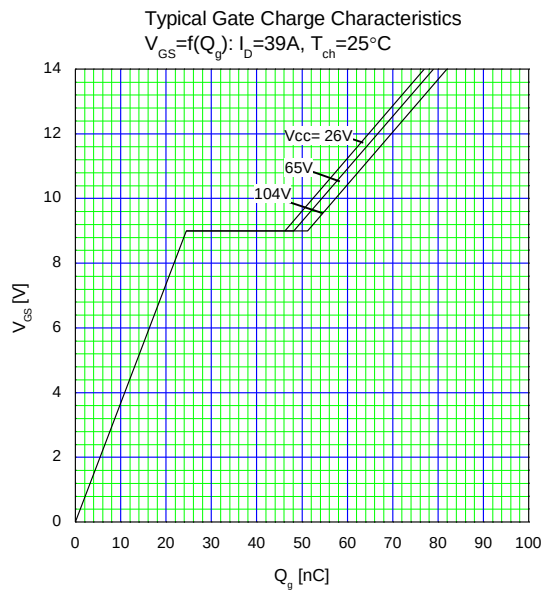
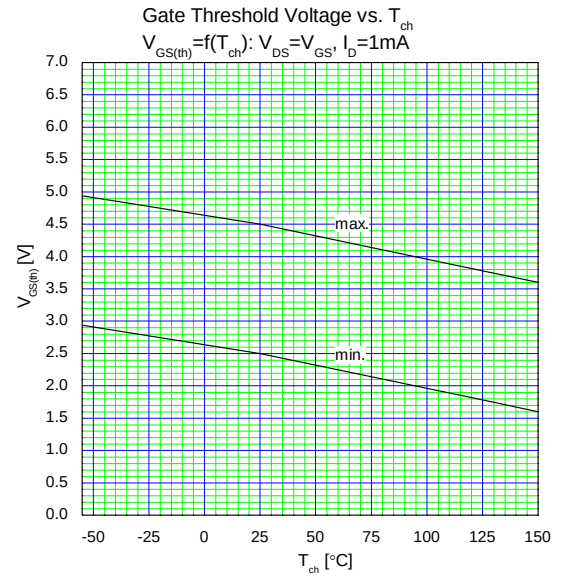
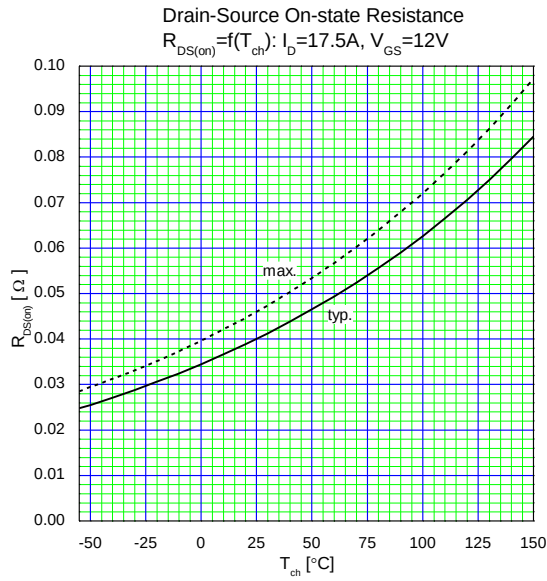


Figure 37. Characteristic curves of JAXA R 2SK4215 (2/3)

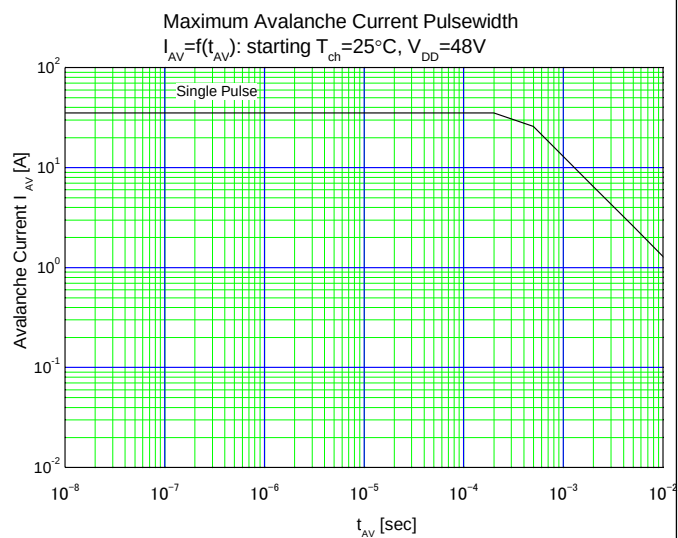
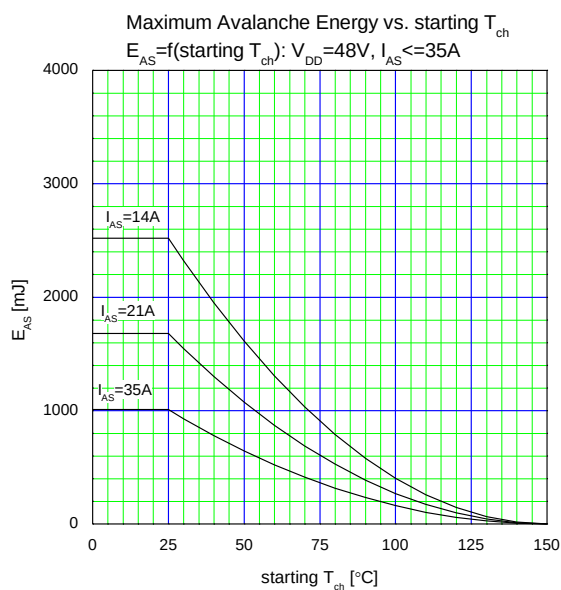


Figure 38. Characteristic curves of JAXA R 2SK4215 (3/3)

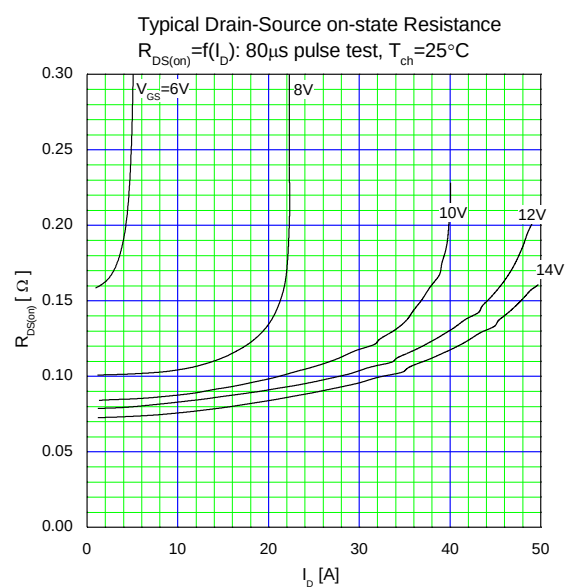
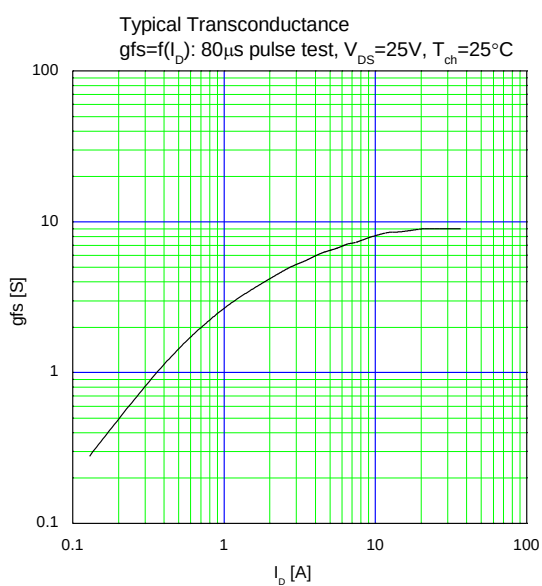
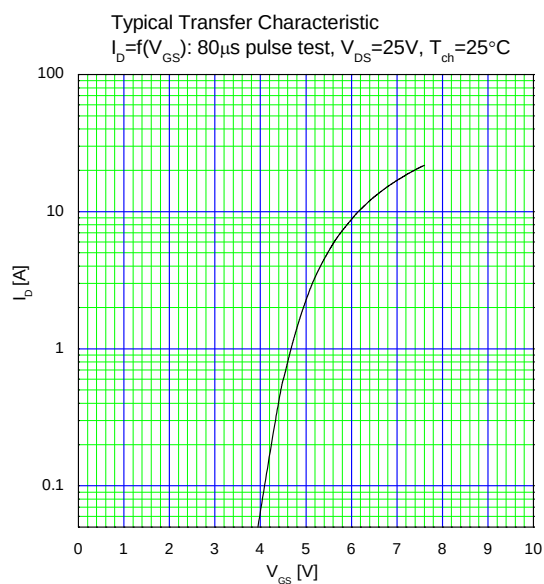
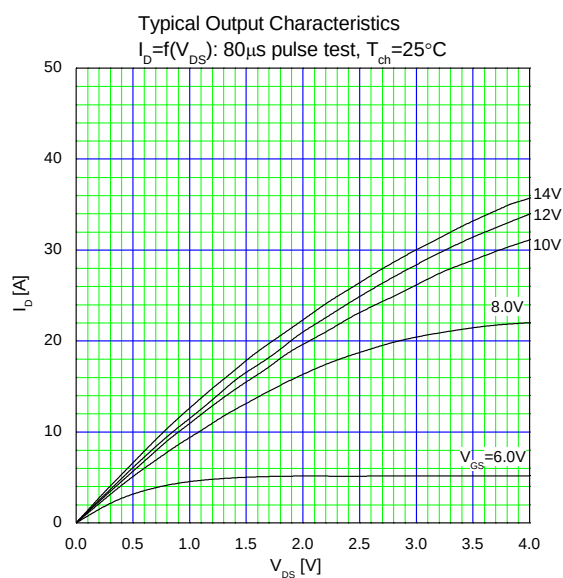
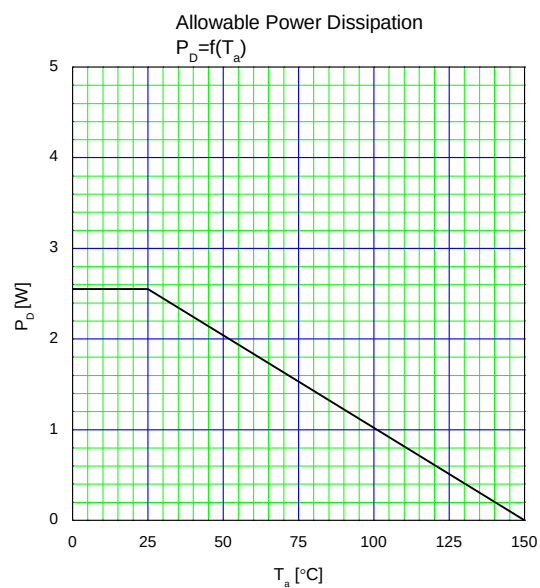
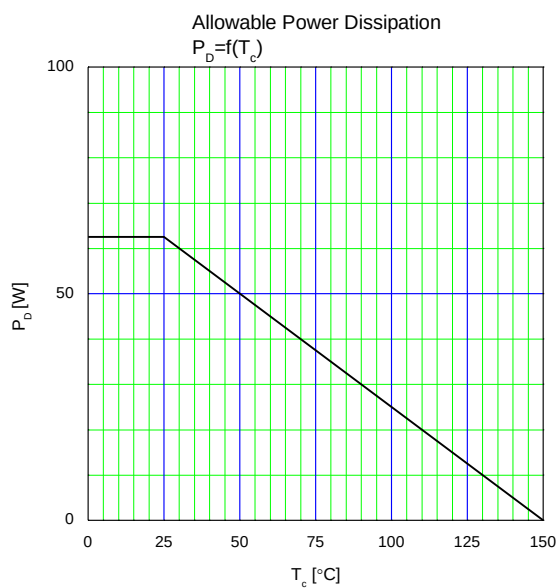


Figure 39. Characteristic curves of JAXA R 2SK4216 (1/3)

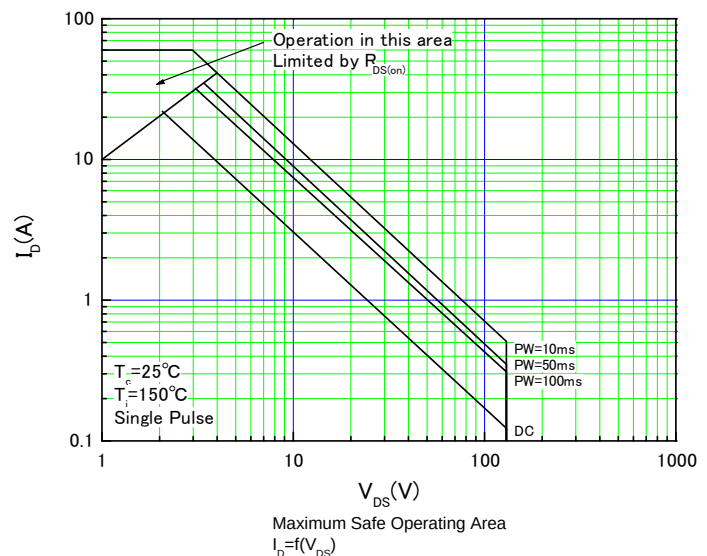
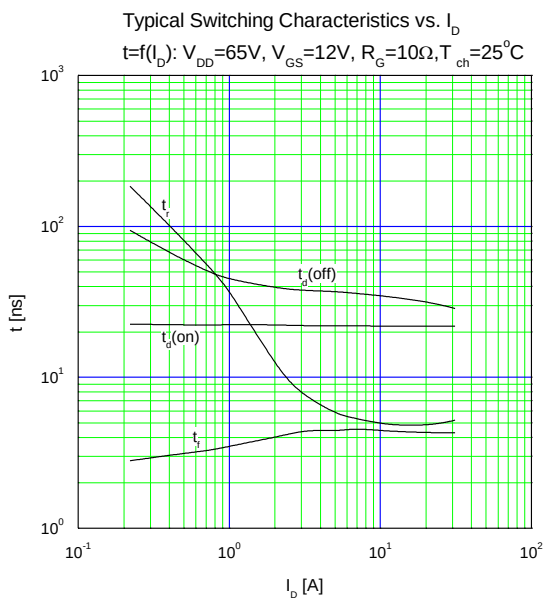
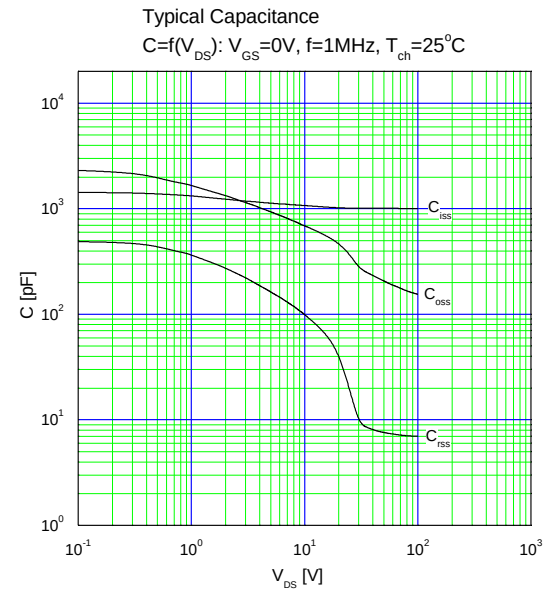
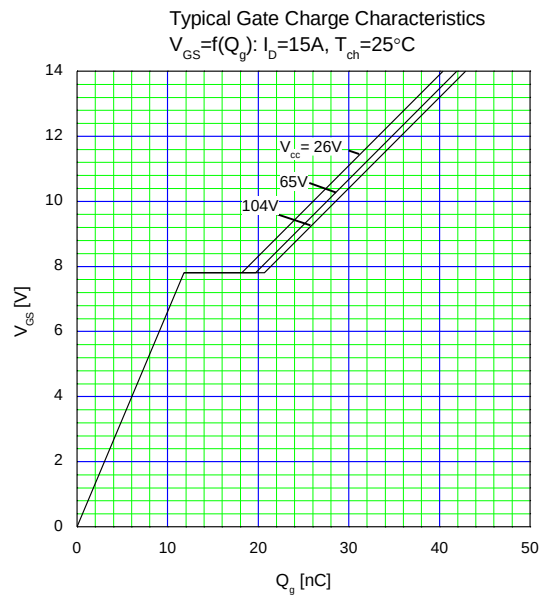
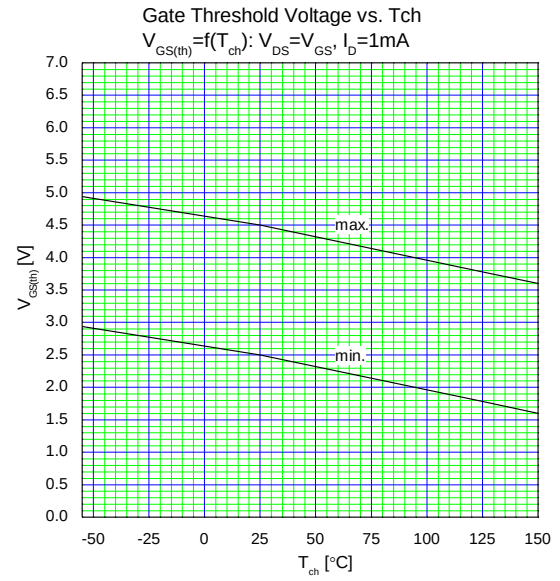
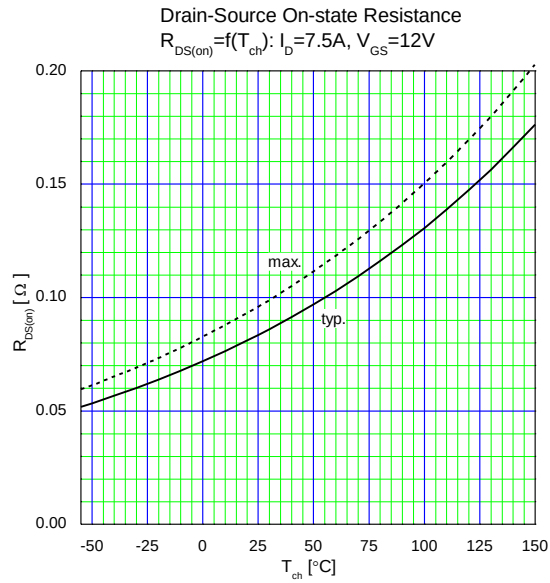


Figure 40. Characteristic curves of JAXA R 2SK4216 (2/3)

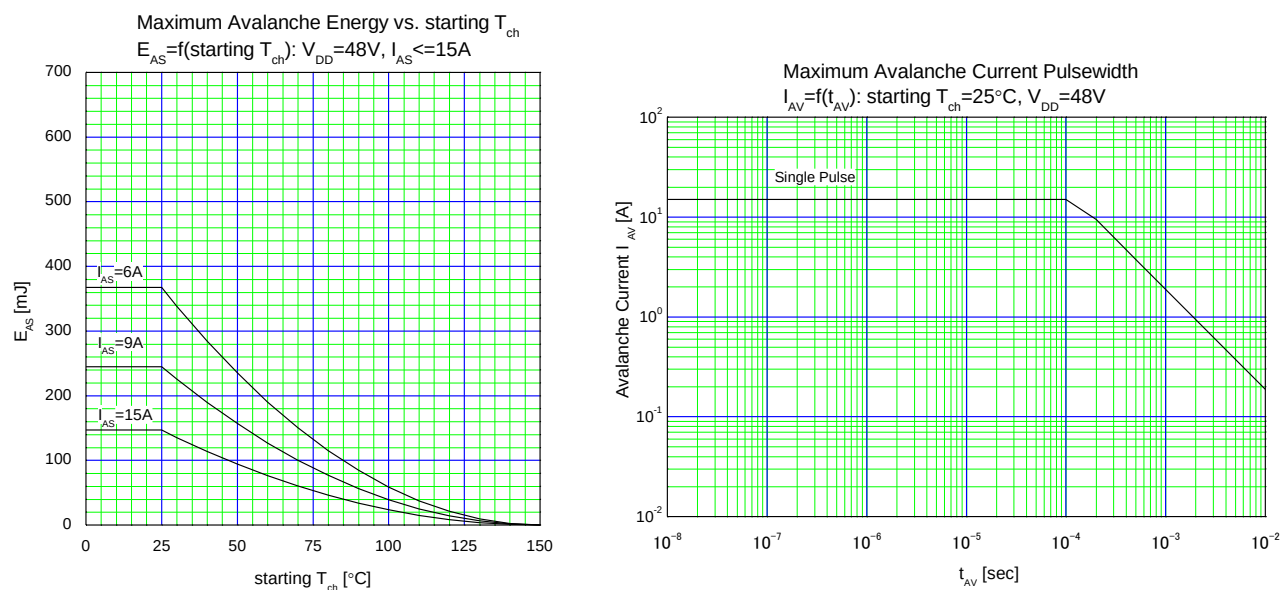


Figure 41. Characteristic curves of JAXA R 2SK4216 (3/3)

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 JAXA R 2SK4185 ⁽¹⁾ /22pcs

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 JAXA R 2SK4185 ⁽¹⁾ /22pcs

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 JAXA R 2SK4185 ⁽¹⁾ /22pcs

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 JAXA R 2SK4185 ⁽¹⁾ /45pcs

Note⁽¹⁾ This test is substituted with the device having same package passed in this test.
See the detail specification, JAXA-QTS-2030/103.

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 2SK4048 JAXA R 2SK4051 JAXA R 2SK4054 JAXA R 2SK4214	$V_{GS}=\pm 2750V$	Class 2
	JAXA R 2SK4049 JAXA R 2SK4052 JAXA R 2SK4055 JAXA R 2SK4215	$V_{GS}=\pm 1000V$	Class 1
	JAXA R 2SK4050 JAXA R 2SK4053 JAXA R 2SK4056 JAXA R 2SK4216	$V_{GS}=\pm 500V$	Class 1

6.6 Radiation Hardness

Table 10a. Radiation hardness test results

Total Dose Irradiation (TID)	Test Conditions
	Source: Co ⁶⁰ gamma-ray Dose: 1000 Gy(1000Gy/hr), 3000 Gy(3000Gy/hr), 6000 Gy(3000Gy/hr)
	Bias Conditions (During and after irradiation) (a) $V_{DS}=0V$, $V_{GS}=20 V$ (b) $V_{DS}=0V$, $V_{GS}=-20 V$ (c) $V_{DS}=200V$, $V_{GS}=0V$
	Representative Sample: JAXA R 2SK4158 ⁽¹⁾
	Test Results
	For each bias condition: 0/4 pieces (1×10^3 Gy, JAXA R 2SK4158 ⁽¹⁾) BV _{DSS} TID dependence: Fig. 42, $V_{GS(th)}$ TID dependence : Fig. 43

Note⁽¹⁾ This test is substituted with the same test result in JAXA-QTS-2030/102.

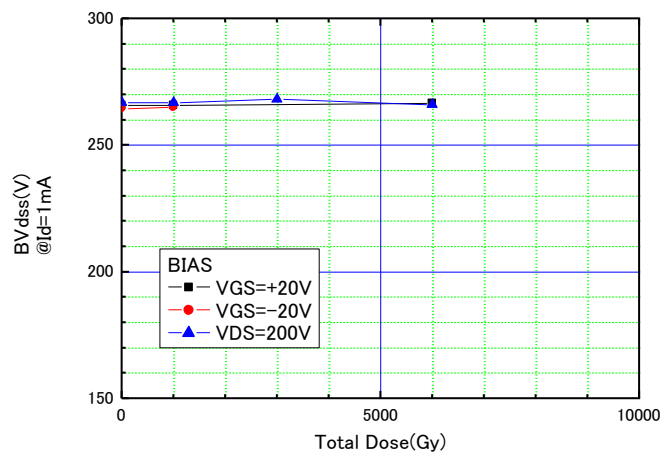


Figure 42. Total dose dependence of BV_{DSS} (JAXA R 2SK4158)

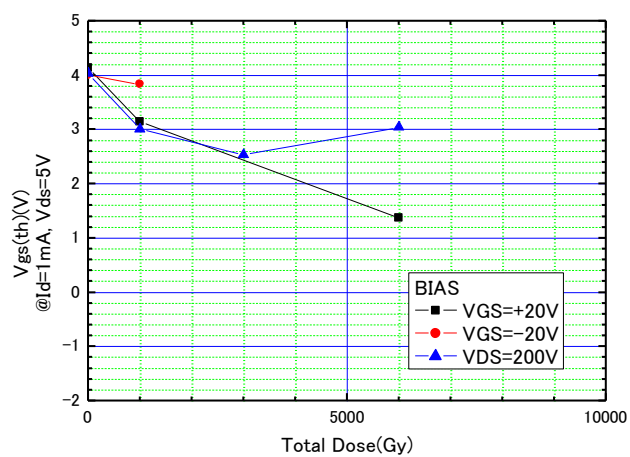


Figure 43. Total dose dependence of $V_{GS(th)}$ (JAXA R 2SK4158)

Table 10b. Radiation hardness test results

Part Number JAXA R	100V Class			130V Class			200V Class			250V Class		
	2SK 4048	2SK 4049	2SK 4050	2SK 4214	2SK 4215	2SK 4216	2SK 4051	2SK 4052	2SK 4053	2SK 4054	2SK 4055	2SK 4056
Single Event Tolerance (SEB/SEGR) Single Event Burnout/ Single Event Gate Rupture	Test Conditions											
	LET 37.9MeV/(mg/cm ²)(¹)			LET 38.4MeV/(mg/cm ²)(¹)			LET 39.3MeV/(mg/cm ²)(¹)			LET 40.1MeV/(mg/cm ²)(¹)		
	Ion: ⁸⁹ Y, Energy: 928 MeV Range: 102μm, 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} =-7.5V 0/3 pieces V _{DS} = 20V and V _{GS} =-20V 0/1 pieces (SEE-SOA: Fig. 44)			V _{DS} =130V and V _{GS} =-7.5V 0/3 pieces (SEE-SOA: Fig. 45)			V _{DS} =200V and V _{GS} =-7.5V 0/3 pieces V _{DS} =30V and V _{GS} =-20V 0/1 pieces (SEE-SOA: Fig. 46)			V _{DS} =250V and V _{GS} =-7.5V 0/3 pieces V _{DS} =30V and V _{GS} =-20V 0/1 pieces (SEE-SOA: Fig. 47)		

Note(¹): Average LET in the device.

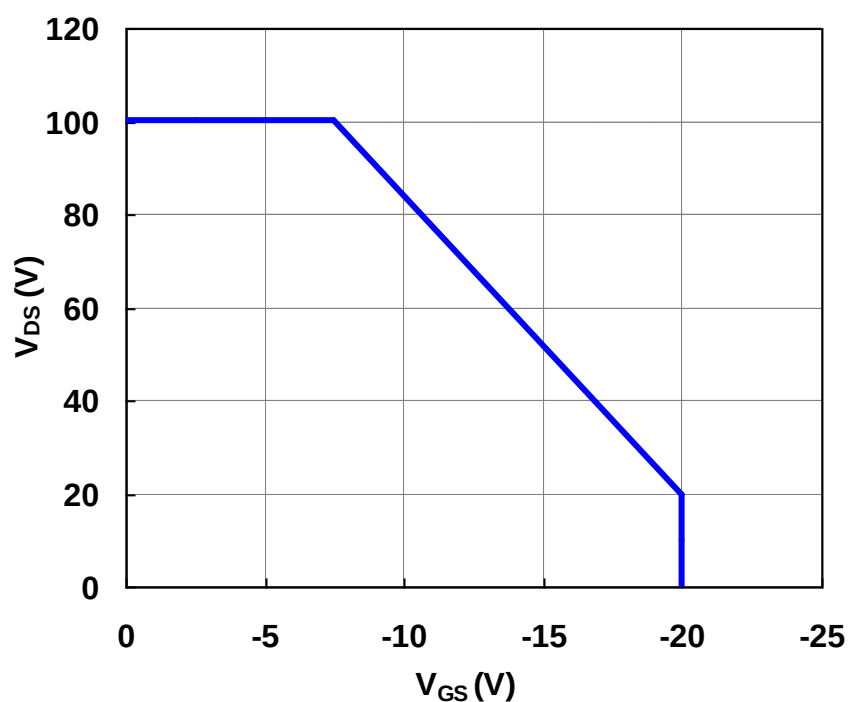


Figure 44. SEE-SOA (JAXA R 2SK4048, 2SK4049, 2SK4050)

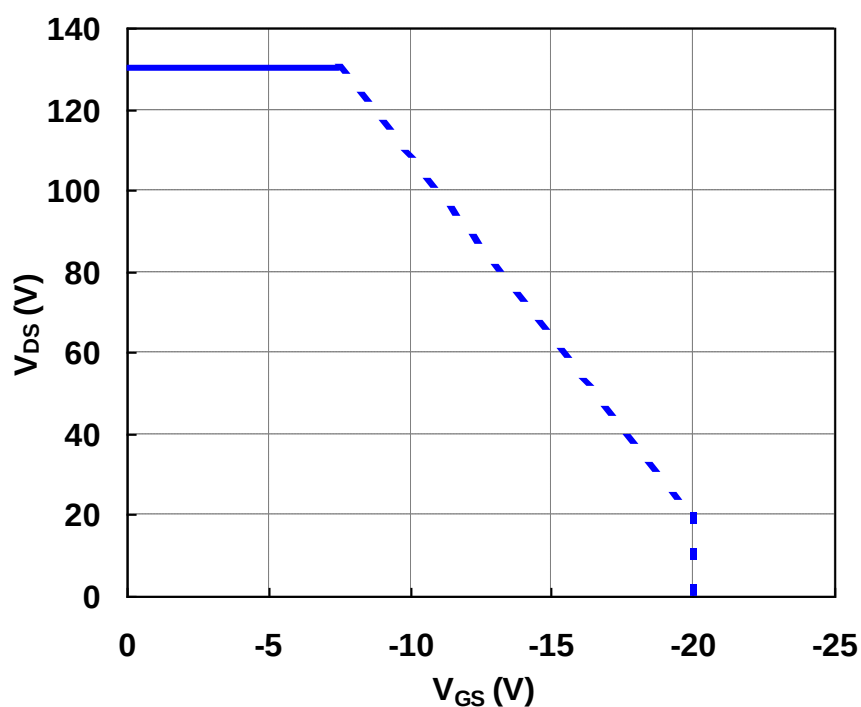


Figure 45. SEE-SOA (JAXA R 2SK4214, 2SK4215, 2SK4216)

Note: The dotted line in this figure is estimated from the results of the radiation hardness test in the 100V-class devices.

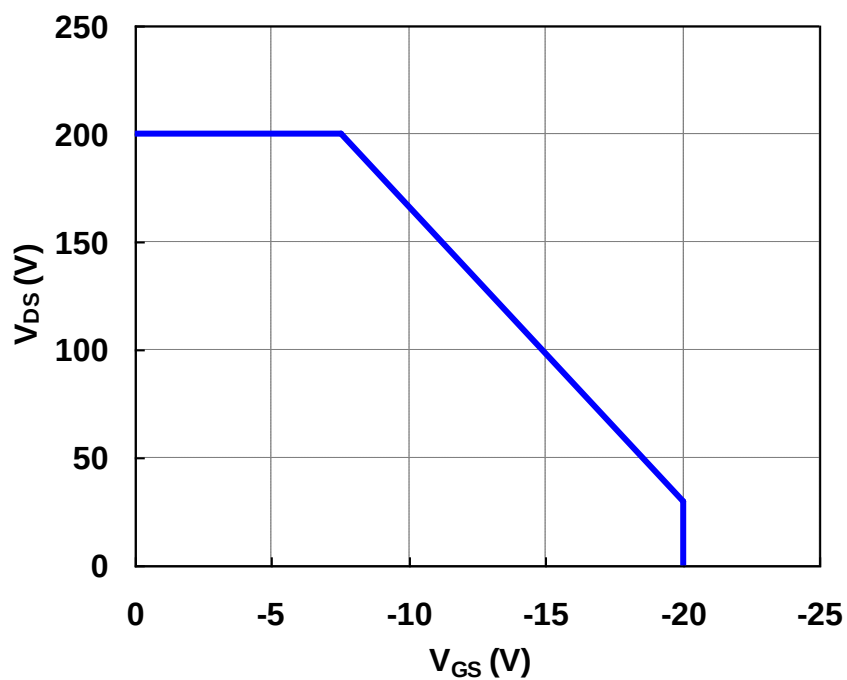


Figure 46. SEE-SOA (JAXA R 2SK4051, 2SK4052, 2SK4053)

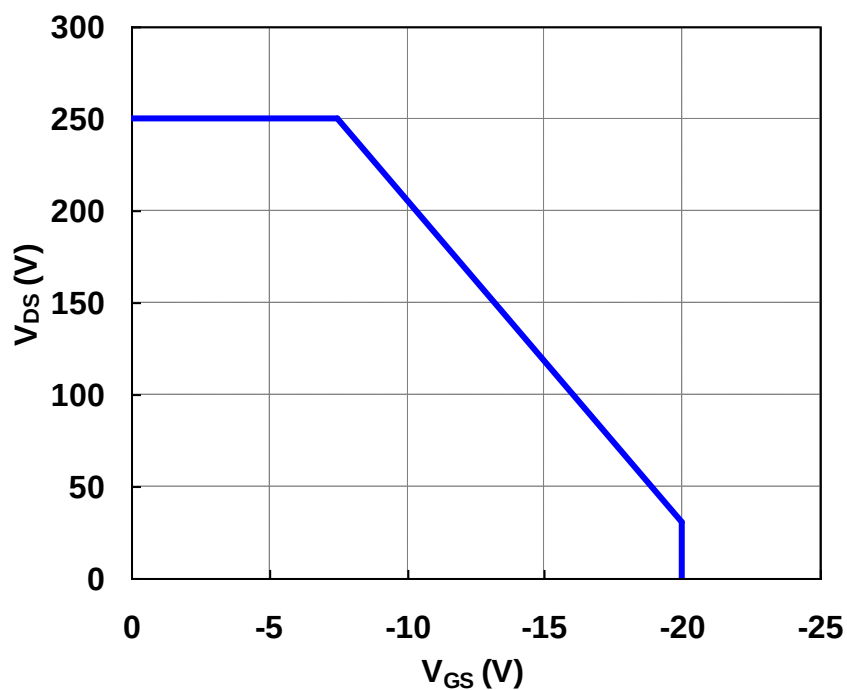


Figure 47. SEE-SOA (JAXA R 2SK4054, 2SK4055, 2SK4056)

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 $V_{GS}=16\text{V}$	0/135 pieces (JAXA R 2SK4152/15 pcs JAXA R 2SK4153/15 pcs JAXA R 2SK4154/15 pcs JAXA R 2SK4155/15 pcs JAXA R 2SK4156/15 pcs JAXA R 2SK4157/15 pcs JAXA R 2SK4158/15 pcs JAXA R 2SK4159/15 pcs JAXA R 2SK4160/15 pcs (¹))
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 2SK4152, K4153, K4154: $V_{DS}=104\text{V}$ 2SK4155, K4156, K4157: $V_{DS}=160\text{V}$ 2SK4158, K4159, K4160: $V_{DS}=200\text{V}$	0/135 pieces (JAXA R 2SK4152/15 pcs JAXA R 2SK4153/15 pcs JAXA R 2SK4154/15 pcs JAXA R 2SK4155/15 pcs JAXA R 2SK4156/15 pcs JAXA R 2SK4157/15 pcs JAXA R 2SK4158/15 pcs JAXA R 2SK4159/15 pcs JAXA R 2SK4160/15 pcs (¹))
Thermal shock test (Temperature Cycling)	-55 to 150°C , 500cycles	0/45 pieces JAXA R 2SK4185 /45pcs (²)
Intermittent operating life test (Power Cycling)	$\Delta T_C=70\text{deg}$, 6000cycles	0/72 pieces (JAXA R 2SK4152/8 pcs JAXA R 2SK4153/8 pcs JAXA R 2SK4154/8 pcs JAXA R 2SK4155/8 pcs JAXA R 2SK4156/8 pcs JAXA R 2SK4157/8 pcs JAXA R 2SK4158/8 pcs JAXA R 2SK4159/8 pcs JAXA R 2SK4160/8 pcs (¹))

Notes(¹) This test is substituted with the device having same die passed in this test.

See the detail specification, JAXA-QTS-2030/102.

(²) This test is substituted with the device having same package passed in this test.

See the detail specification, JAXA-QTS-2030/103.

7.2 Possible Failure Mode

Table 12. Possible failure mode

Failure mode	Rate (%)
Short	70
Increase of Leakage Current	20
Increase of Thermal Impedance	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 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

Phone: +81-3-5435-7151