MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, FIELD EFFECT TRANSISTORS, N-CHANNEL, SILICON
TYPES 2N6966, 2N6967, 2N6968, AND 2N6969
JANTX, JANTXV, AND JANS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for an N-Channel, enhancement-mode, MOSFET, power transistor intended for use in high density power switching applications. Three levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1. TO-213AA. (formerly TO66)

1.3 Maximum ratings.

Type	P_T 1/ T_C = +25°C	P_T T_A = 25°C	V_{DS}	V_{DG}	V_{GS}	I_{D1} 2/ T_C = 25°C	I_{D2} T_C = 100°C	I_S 2/	I_{DM}	T_{OP} and T_{stg}	V_{DS} + V_{DG} 100,000 altitude
	W	W	V dc	V dc	V dc	mA dc	A dc	A dc	A(pk)	°C	
	70	5			±20						
2N6966			100	100		15	13	-15	±60	-55 to	
2N6967			200	200		13	8	-13	±50	+150	
2N6968			400	400		7.5	5	-7.5	±30		400
2N6969			500	500		6.0	4	-6.0	±24		500

1/ Derate linearly .56 W/°C for T_C >25°C.
2/ Derate above T_C = 25°C according to the formula $I_D = \sqrt{\frac{P(rated)}{K}}$, where

$P(rated) = \left[150 - (T_C - 25)(.56)\right]$ watts; K = max $r_{DS(on)}$ at T_J = 150°C.

1.4 Primary electrical characteristics at T_C = 25°C.

Type	Min $V_{(BR)DSS}$ V_{GS} = 0 V I_D = 1.0 mA dc	$V_{GS(th)1}$ $V_{DS} \geq V_{GS}$ I_D = .25 mA		Max I_{DSS1} V_{GS} = 0 V V_{DS} = 80% of rated V_{DS}	Max $r_{DS(on)}$ 1/ V_{GS} = 10 V dc T_J = 25°C at I_{D1}	T_J = 150°C at I_{D2}	$R_{\theta JC}$ Max
	V dc	V dc Min	V dc Max	µA dc	Ohm	Ohm	°C/W
		2.0	4.0	25			1.8
2N6966	100				0.085	0.13	
2N6967	200				0.18	0.27	
2N6968	400				0.55	1.04	
2N6969	500				0.85	1.62	

1/ Pulsed (see 4.5.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Space and Naval Warfare Systems, ATTN: Code 8111, Washington Dc 20363, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification and standard. The following specification and standard form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards and supplement thereto, cited in the solicitation.

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of the specification and standard required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

$V_{(BR)DSS}$ - - - - - - - - - - - - - Drain to source breakdown voltage, all other terminals short-circuited to source (junction-drain).

I_S - - - - - - - - - - - - - - - - Source current through drain diodes (forward biased V_{DS}).

C - - - - - - - - - - - - - - - - - Coulomb

g_{FS} - - - - - - - - - - - - - - - DC forward transconductance.

$I_{(ISO)}$ - - - - - - - - - - - - - - Source pin to case isolation current.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, and figure 1 herein.

3.3.1 Lead material and finish. Lead material shall be Kovar, Alloy 52 or steel; a copper core is permitted. Lead finish shall be gold, tin, or solder dip. Where a choice of lead material or finish is desired, it shall be specified in the contract or purchase order (see 6.3).

3.3.2 Internal construction. Multiple chip construction shall not be permitted.

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic protection (see 6.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

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Screen (see table II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
3	Test condition F, except T_{low} = -55°C, 20 cycles	Test condition F, except T_{low} = -55°C, 20 cycles
1/ 2/	Method 3470 (see 4.5.4)	Method 3470 (see 4.5.4)
1/	Method 3161 (see 4.5.3)	Method 3161 (see 4.5.3)
9	I_{GSS1}, I_{DSS1}. gate stress test (see 4.5.5) Subgroup 2 of table I herein	Gate stress test (see 4.5.5) Subgroup 2 of table I herein
10	Method 1042, test condition B	Method 1042, test condition B
11	Subgroup 2 of table I herein I_{GSS1}, I_{DSS1}, $r_{DS(on)1}$, $V_{GS(th)1}$ ΔI_{GSS1} = ±20 nA dc or ±100% of initial value, whichever is greater ΔI_{DSS1} = ±25 µA dc or ±100% of initial value, whichever is greater	Subgroup 2 of table I herein I_{GSS1}, I_{DSS1}, $r_{DS(on)1}$, $V_{GS(th)1}$
12	Method 1042, test conditions A and C (see 4.3.1)	Method 1042, test condition A
13	Subgroups 2 and 3 of table I herein; ΔI_{GSS1} = ±20 nA dc or ±100% of initial value, whichever is greater. ΔI_{DSS1} = ±25 µA dc or ±100% of initial value, whichever is greater. $\Delta r_{DS(on)1}$ = ±20% of initial value $\Delta V_{GS(th)1}$ = ±20% of initial value	Subgroup 2 of table I herein; ΔI_{GSS1} = ±20 nA dc or ±100% of initial value, whichever is greater. ΔI_{DSS1} = ±25 µA dc or ±100% of initial value, whichever is greater. $\Delta r_{DS(on)1}$ = ±20% initial value $\Delta V_{GS(th)1}$ = ±20% initial value

1/ Shall be performed anytime before screen 9.
2/ This test method in no way implies a repetitive avalanche energy rating. This is a stress test designed to ensure a rugged product.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500. Alternate flow is allowed for qualification inspection in accordance with figure 2 of MIL-S-19500.

4.3 Screening (JANX, JANTX, and JANTXV levels only). Screening shall be in accordance with MIL-S-19500 (table II), and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

4.3.1 Power burn-in. Power burn-in conditions are as follows: T_A = +25°C, -5°C +10°C; $V_{DS} \geq 10$ V minimum. I_D is adjusted to meet a junction temperature of 140°C -0°C +10°C. By controlling V_{GS} voltage, one can obtain the specific I_D current required to apply an appropriate power for the device under stress. Power condition and T_J requirements can be established by the ΔV_{SD} measurement technique described in MIL-STD-750, method 3161. For condition C, t = 240 hours.

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4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500. Alternate flow is allowed for quality conformance inspection in accordance with figure 2 of MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein. (Endpoint electrical measurements shall be in accordance with the applicable steps of table IV herein.)

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVa (JANS) and table IVb (JANTX, and JANTXV) of MIL-S-19500, and tables IIa and IIb herein. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table IV herein.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and table III herein. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table IV herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows:

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Thermal impedance. Thermal impedance measurements shall be performed in accordance with method 3161 of MIL-STD-750. $R_{\theta JC(max)}$ = 1.8°C/W.

a. I_M measuring current- - - - - - - - - 10 mA
b. I_H drain heating current- - - - - - - 2 A
c. t_H heating time - - - - - - - - - - - - steady state (see MIL-STD-750 method 3161 for definition)
d. V_H drain-source heating voltage - - - 23 V
e. t_{MD} measurement time delay- - - - - - 10 to 80 µs
f. t_{SW} sample window time- - - - - - - - 10 (max) µs

4.5.3 Thermal response (ΔV_{SD} measurements). The delta V_{SD} measurements shall be performed in accordance with method 3161 of MIL-STD-750. The delta V_{SD} conditions (I_H and V_H) and maximum limit shall be derived by each vendor from the thermal response curves (see figure 2) and shall be specified in the certificate of conformance prior to qualification. The following parameter measurements shall apply:

a. I_M measuring current- - - - - - - - - 10 mA
b. I_H drain heating current- - - - - - - 2 (min) A
c. t_H heating time - - - - - - - - - - - - 100 ms
d. V_H drain-source heating voltage - - - 23 (min) V
e. t_{MD} measurement time delay- - - - - - 10 to 80 µs
f. t_{SW} sample window time- - - - - - - - 10 (max) µs

4.5.4 Unclamped inductive switching.

a. Peak current, I_D- - - - - - - - - - - -3.1 A
b. Peak gate voltage, V_{GS}- - - - - - - - 10 V
c. Gate to source resistor, R_{GS}- - - - -
d. Initial case temperature- - - - - - - 25°C +10 -5°C
e. Inductance, L - - - - - - - - - - - - - 100 µH ±10%
f. Number of pulses to be applied- - - - 1 pulse
g. Pulse repetition rate - - - - - - - - none

4.5.5 Gate stress test.

a. V_{GS} = 30 V min
b. t = 250 µs min

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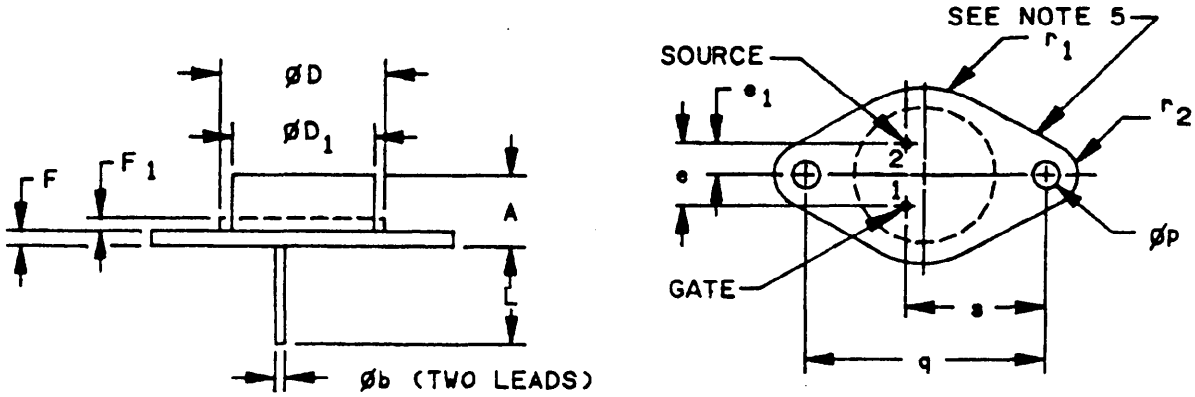

Symbol	Inches Min.	Inches Max.	Millimeters Min.	Millimeters Max.	Note
A	.250	.340	6.35	8.63	
$Ø_b$	.028	.034	.712	.863	
ØD	-	.620	-	15.74	1
$ØD_1$	.470	.500	11.94	12.70	
e	.190	.210	4.83	5.33	
e_1	.093	.107	2.37	2.71	
F	.050	.075	1.27	1.90	2
F_1	-	.050	-	1.27	1
L	.360	-	9.15	-	
Øp	.142	.161	3.61	4.08	
q	.950	.970	24.13	24.63	
r_1		.350		8.89	
r_2	-	.145	-	3.68	
s	.570	.590	14.48	14.98	

NOTES:
1. Package contour optional within dimensions specified.
2. Dimension does not include sealing flanges.
3. Controlling dimensions: Inch.
4. Mounting holes shall be deburred on the seating plane side.
5. Drain is electrically connected to the case.

FIGURE 1. Physical dimensions for TO-213AA.

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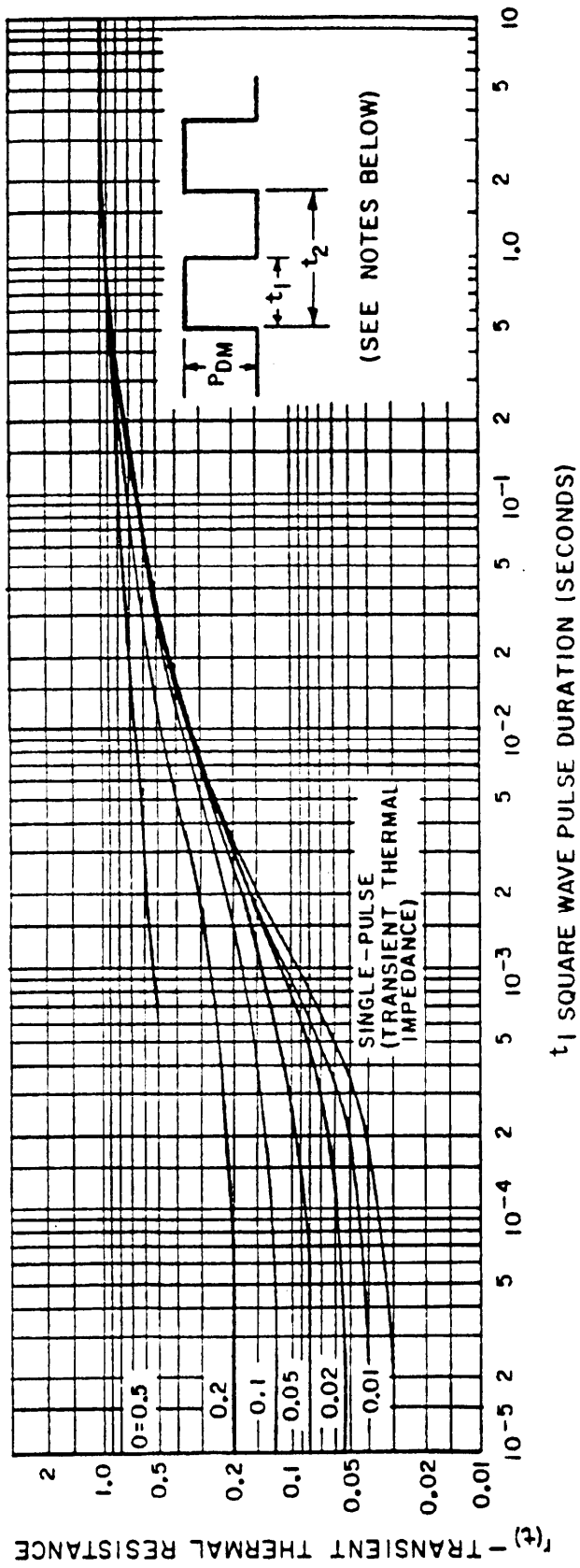

NOTES:
1. Duty factor, $D = \frac{t_1}{t_2}$.
2. Per unit base = $R_{\theta JC}$ = 1.8° C/W.
3. $T_{JM} - T_C = P_{DM} Z_{\theta JC}(t)$.

FIGURE 2. Thermal response curves.

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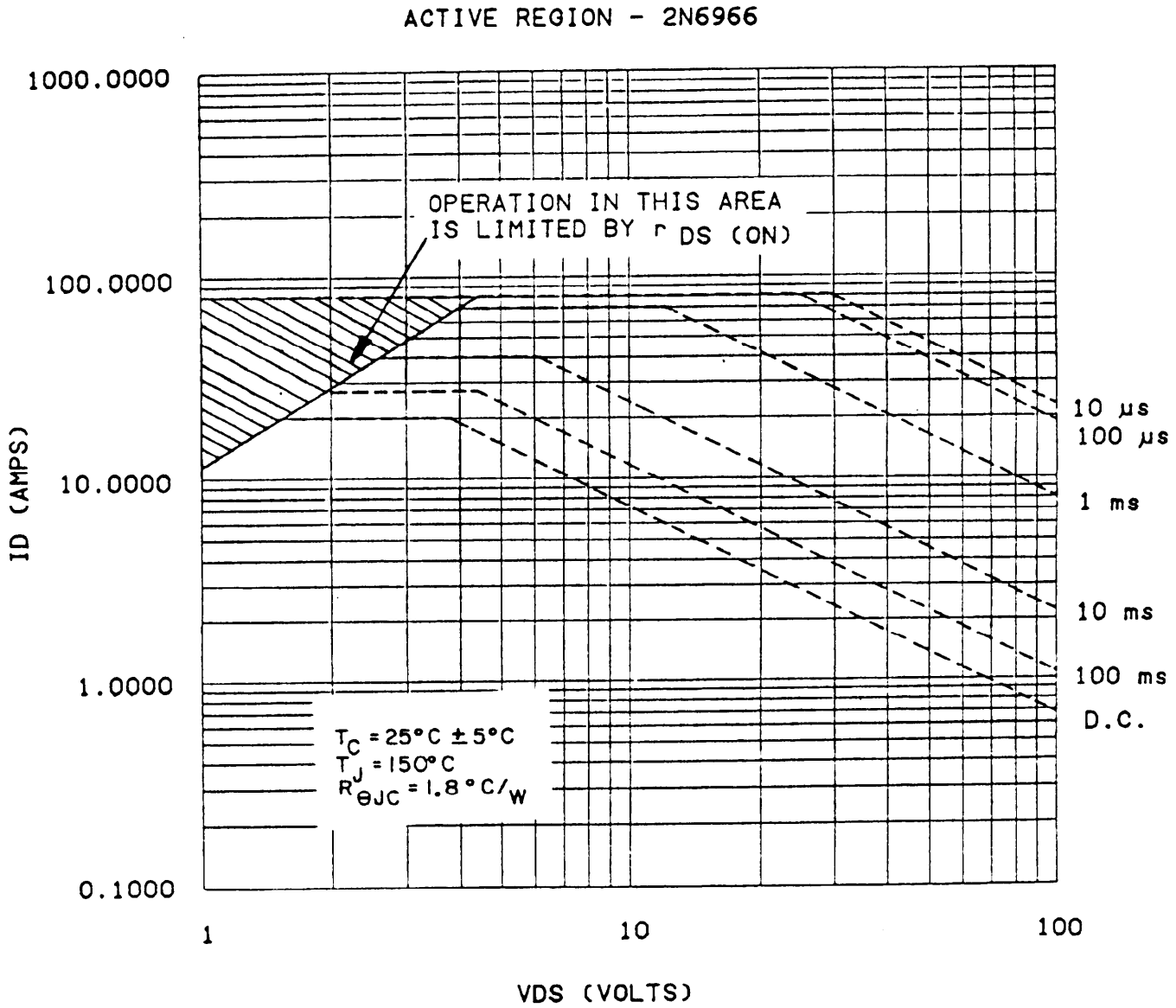

FIGURE 3. Maximum safe operating area.

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ACTIVE REGION - 2N6967

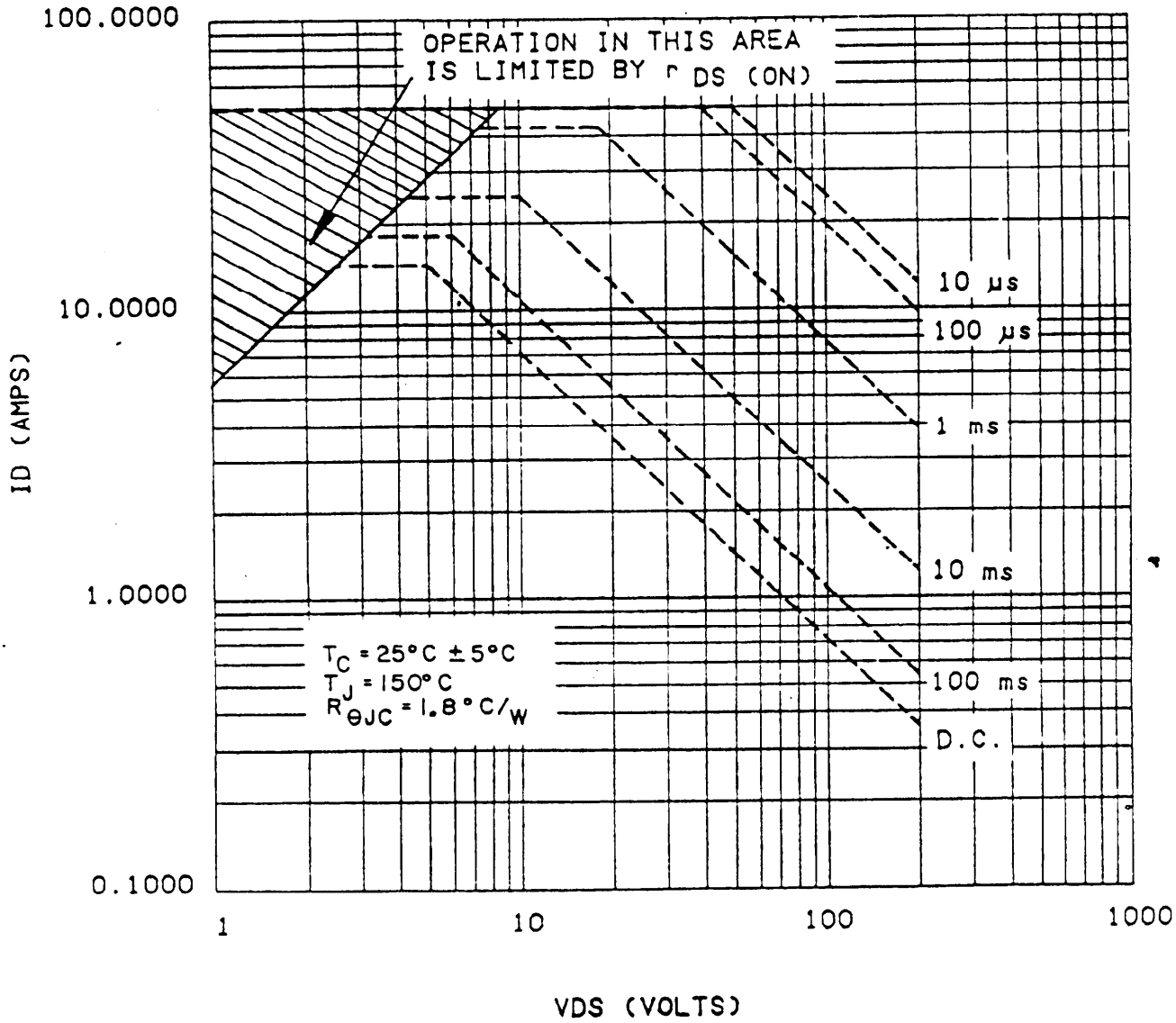

FIGURE 3. Maximum safe operating area - Continued.

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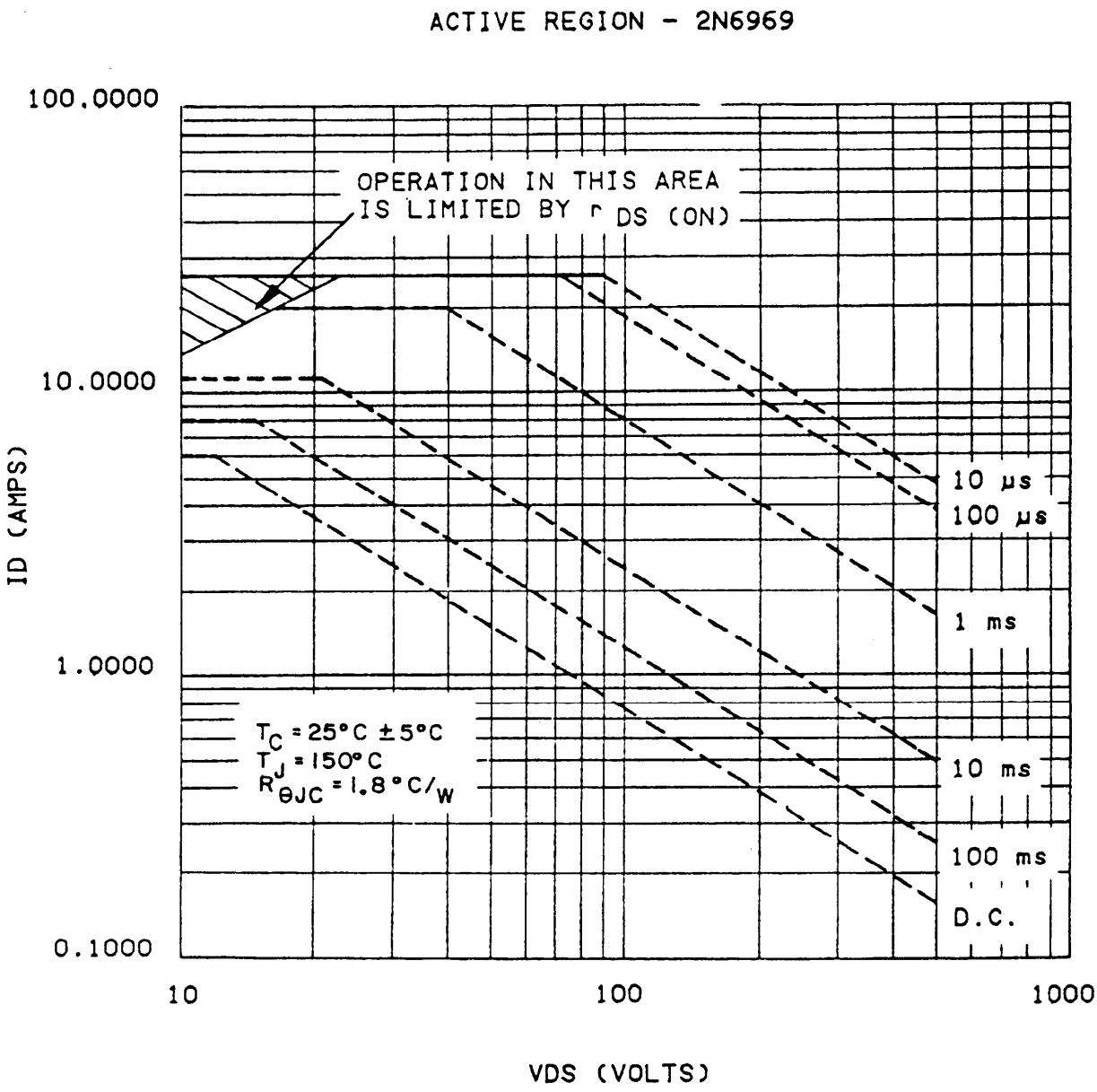

FIGURE 3. Maximum safe operating area - Continued.

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ACTIVE REGION - 2N6968

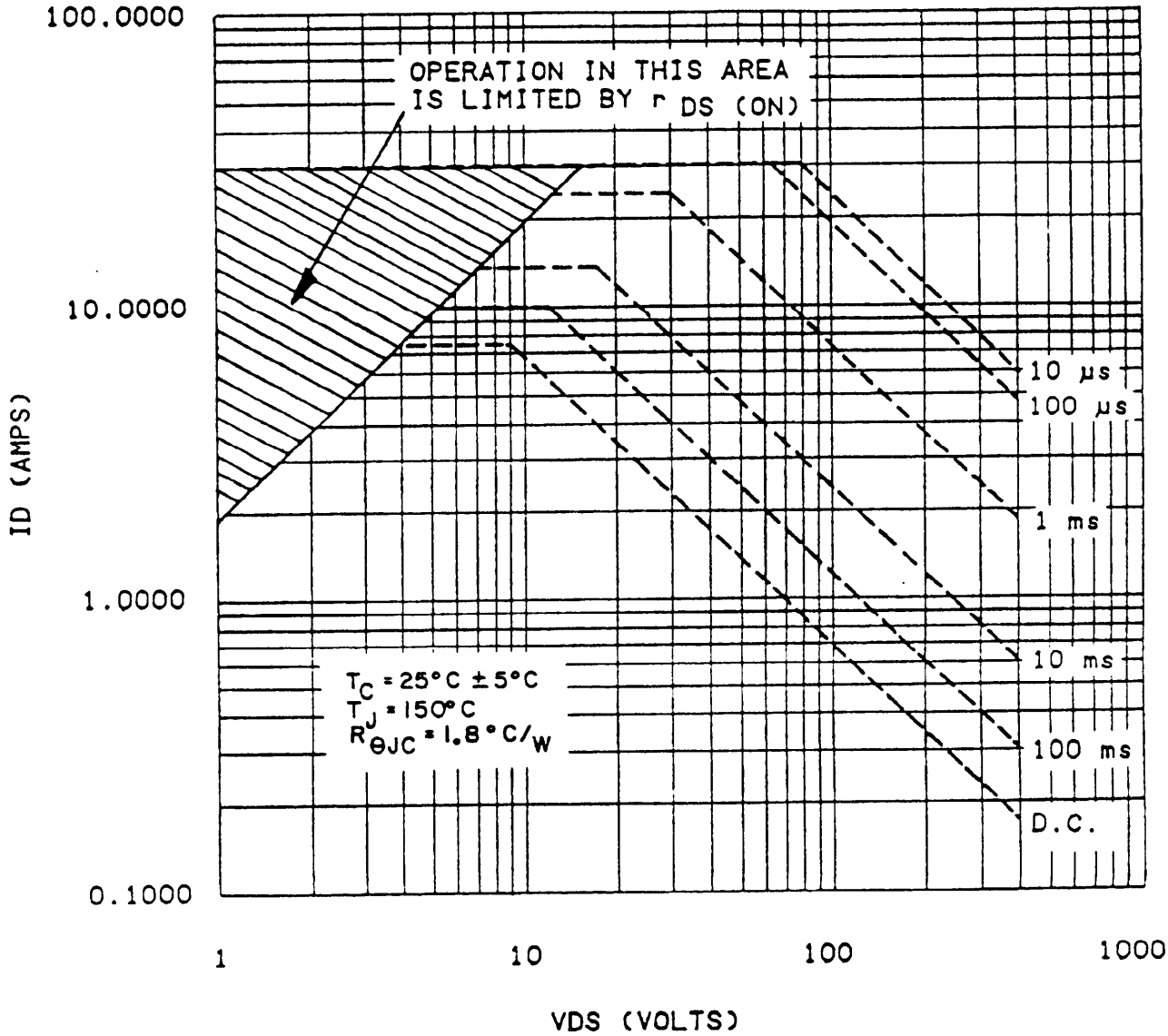

FIGURE 3. Maximum safe operating area - Continued.

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TABLE I. Group A inspection.

Inspection	MIL-STD-750		LTPD 1/		Symbol	Limits		Unit
	Method	Conditions	JANS	JANTX, JANTXV		Min	Max	
Subgroup 1								
Visual and mechanical inspection	2071							
Subgroup 2								
Breakdown voltage, drain to source	3407	I_D = 1.0 mA dc, Bias condition C, V_{GS} = 0 V dc			$V_{(BR)DSS}$			
2N6966						100	---	V dc
2N6967						200	---	V dc
2N6968						400	---	V dc
2N6969						500	---	V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, I_D = .25 mA			$V_{GS(th)1}$	2.0	4.0	V dc
Gate current	3411	V_{GS} = ±20 V dc, Bias condition C, V_{DS} = 0			I_{GSS1}	---	±100	nA dc
Drain current	3413	V_{DS} = 80% of rated V_{DS} Bias condition C, V_{GS} = 0			I_{DSS1}	---	25	µA dc
Static drain to source "on" -state resistance	3421	V_{GS} = 10 V dc, condition A, pulsed (see 4.5.1)			$r_{DS(on)1}$			
2N6966		I_D = 10 A dc				---	0.085	ohm
2N6967		I_D = 7 A dc				---	0.18	ohm
2N6968		I_D = 6.2 A dc				---	0.55	ohm
2N6969		I_D = 3.3 A dc				---	0.85	ohm
Drain to source "on" - state voltage	3405	V_{GS} = 10 V dc, condition A, pulsed (see 4.5.1)			$V_{DS(on)}$			
2N6966		I_D = 15 A dc				---	1.70	V
2N6967		I_D = 13 A dc				---	2.40	V
2N6968		I_D = 7.5 A dc				---	4.13	V
2N6969		I_D = 6 A dc				---	5.10	V
Forward voltage (source drain diode)	4011	Pulsed method (see 4.5.1)			V_{SD}			
2N6966		I_S = 15 A dc				.85	2.5	V
2N6967		I_S = 13 A dc				.8	2.0	V
2N6968		I_S = 7.5 A dc				.8	2.0	V
2N6969		I_S = 6 A dc				.8	2.0	V

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		LTPD 1/		Symbol	Limits		Unit
	Method	Conditions	JANS	JANTX, JANTXV		Min	Max	
Subgroup 2 - Continued								
Forward transconductance	3475	Pulsed (see 4.5.1)			g_{FS}			
2N6966						6	18	S
2N6967						6	18	S
2N6968						4	12	S
2N6969						4	12	S
Subgroup 3								
High temperature operation		$T_C = T_J = +125°C$						
Gate current	3411	$V_{GS} = \pm 20$ V dc, Bias condition C, $V_{DS} = 0$			I_{GSS2}	---	±200	nA dc
Drain current	3413	V_{DS} = 80% rated V_{DS}, $V_{GS} = 0$ Bias condition C			I_{DSS2}	---	.25	mA dc
2N6966								
2N6967								
2N6968								
2N6969								
Static drain to source on-state resistance	3421	V_{GS} = 10 V dc, pulsed (see 4.5.1)			$r_{DS(on)2}$			
2N6966						---	0.13	ohm
2N6967						---	0.27	ohm
2N6968						---	1.04	ohm
2N6969						---	1.62	ohm
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$; $I_D = 0.25$ mA dc			$V_{GS(th)2}$	1.0	---	V dc
Low temperature operation:		$T_C = T_J = -55°C$						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 0.25$ mA dc			$V_{GS(th)3}$	---	5.0	V dc
Subgroup 4								
Switching time test	3472	I_D = half rated I_{D1}, $R_{Gen} = 15\Omega$, $R_{GS} = 15\Omega$, V_{DD} = 50% of rated V_{DS}, $V_{GS} = 10$ V dc						

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		LTPD 1/		Symbol	Limits		Unit
	Method	Conditions	JANS	JANTX, JANTXV		Min	Max	
Subgroup 4 - continued								
Turn-on delay time					$t_{d(on)}$			
2N6966						---	30	ns
2N6967						---	30	ns
2N6968						---	35	ns
2N6969						---	35	ns
Rise time					t_r			
2N6966						---	60	ns
2N6967						---	60	ns
2N6968						---	30	ns
2N6969						---	30	ns
Turn-off delay time					$t_{d(off)}$			
2N6966						---	80	ns
2N6967						---	80	ns
2N6968						---	90	ns
2N6969						---	90	ns
Fall time					t_f			
2N6966						---	60	ns
2N6967						---	60	ns
2N6968						---	35	ns
2N6969						---	30	ns
Subgroup 5								
Safe operating test area	3474	See figure 3						
High voltage test		V_{DS} = 80% of rated V_{DS}						
2N6966								
2N6967								
2N6968								
2N6969								
Electrical measurements		See table IV, steps 1,2,3,4,5,6, and 7						
Subgroup 6								
Not applicable								

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		LTPD 1/		Symbol	Limits		Unit
	Method	Conditions	JANS	JANTX, JANTXV		Min	Max	
Subgroup 7								
Gate charge	3471	Condition A and B						
Test no. 1								
Minimum off-state gate charge					$Q_{g(th)}$			nC
2N6966						2.7	8.0	
2N6967						2.7	8.0	
2N6968						2.7	8.0	
2N6969						2.7	8.0	
Test no. 2								
On-state gate charge					$Q_{g(on)}$			nC
2N6966						30	77	
2N6967						30	77	
2N6968						30	77	
2N6969						30	77	
Test no. 3								
Maximum on-state gate charge					$Q_{gm(on)}$			nC
2N6966						51	130	
2N6967						51	130	
2N6968						51	130	
2N6969						51	130	
Test no. 4								
Gate plateau voltage					V_{GP}	4	8	V dc
2N6966								
2N6967								
2N6968								
2N6969								
Test no. 5								
Gate to source charge					Q_{gs}			nC
2N6966						4.6	13	
2N6967						4.6	13	
2N6968						4.6	13	
2N6969						4.6	13	
Test no. 6								
Gate to drain charge					Q_{gd}			nC
2N6966						13	35	
2N6967						13	35	
2N6968						13	35	
2N6969						13	35	

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		LTPD 1/		Symbol	Limits		Unit
	Method	Conditions	JANS	JANTX, JANTXV		Min	Max	
Subgroup 7 - continued								
Reverse recovery time	3473	$V_{DD} \leq 30$ V $di/dt \geq 100$ A/µs			t_{rr}			ns
2N6966		$I_F = -15$ A $V_{GS} = 0$					400	
2N6967		$I_F = -13$ A $V_{GS} = 0$					650	
2N6968		$I_F = -7.5$ A $V_{GS} = 0$					800	
2N6969		$I_F = -6$ A $V_{GS} = 0$					1000	

1/ LTPD numbers are to be taken from MIL-S-19500.

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TABLE IIa. Group B inspection for JANS devices.

Inspection	MIL-STD-750		Qualification and large lot quality conformance 1/ inspection LTPD	Small lot quality conformance inspection n/c 1/
	Method	Conditions		
Subgroup 1				
Physical dimensions	2066	See figure 1		
Subgroup 2				
Solderability	2026			
Resistance to solvents	1022			
Subgroup 3				
Thermal shock (temperature cycling)	1051	Test condition F3, except T_{low} = -55°C		
Hermetic seal	1071			
a. Fine b. Gross				
Electrical measurements		See table IV, steps 1,2,3,4, 5,6, and 7		
Decap-internal visual (design verification)	2075	See 3.3.2		
SEM	2077			
Bond strength	2037	Test condition A; all internal wires for each device shall be pulled separately		
Die Shear	2017			
Subgroup 4				
Intermittent operation life	1037	Condition D, see 4.3.1 power on time shall be 3 minutes minimum 2,000 cycles. No heat sink nor forced-air cooling on the device shall be permitted, during the on cycle.		
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8		
Subgroup 5				
Accelerated steady state operation life	1042	120 hours; See 4.3.1, T_J = 200°C. Marking legibility requirements shall not apply.		

See footnote at end of table.

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TABLE IIa. Group B inspection for JANS devices - Continued.

Inspection	MIL-STD-750		Qualification and large lot quality conformance 1/ inspection LTPD	Small lot quality conformance inspection n/c 1/
	Method	Conditions		
Subgroup 5 - continued				
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, and 7		
Bond strength (Al-Au die interconnects only)	2037	Test condition A		
Subgroup 6				
Thermal impedance	3161	See 4.5.2		

1/ For LTPD numbers see MIL-S-19500.

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TABLE IIb. Group B inspection for JANTX and JANTXV devices.

Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD 1/
Subgroup 1			
Solderability	2026	Appendix A	
Resistance to solvents	1022		
Subgroup 2			
Thermal shock (temperature cycling)	1051	Test condition F1, except T_{low} = -55°C, 25 cycles	
Hermetic seal	1071		
a. Fine leak b. Gross leak			
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, and 7	
Subgroup 3			
Intermittent operation life (LTPD)	1042	Test condition D, 2,000 cycles A cycle shall be 1 minute minimum	
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8	
Subgroup 4			
Decap internal visual (design verification)	2075	See 3.3.2	
Bond strength	2037	Test condition A; all internal bond wires for each device shall be pulled separately.	
Subgroup 5			
Qualification only			
Thermal impedance	3161	See 4.5.2	
Subgroup 6			
High-temperature (nonoperating) life (LTPD)	1032	T_A = +150°C	
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, and 7	

1/ LTPD numbers are to be taken from MIL-S-19500.

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TABLE III. Group C inspection.

Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD 1/	Symbol	Limits Min	Limits Max	Unit
Subgroup 1							
Physical dimensions	2066	See figure 1					
Subgroup 2							
Thermal shock (glass strain)	1056						
Terminal strength (lead torque)	2036	Test condition D_1, t = 15 s, torque = 6 in-oz					
Terminal strength (tension)	2036	Test condition A, weight = 10 lbs; t = 15 s					
Hermetic seal	1071						
a. Fine leak							
b. Gross leak							
Moisture resistance	1021						
Visual and mechanical evaluation	2071						
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, and 7					
Subgroup 3							
Shock	2016						
Vibration, variable frequency	2056						
Constant acceleration	2006						
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, and 7					
Subgroup 4							
Salt atmosphere (corrosion)	1041						
Subgroup 5							
Barometer pressure test (not required for 2N6966 and 2N6967)	1001	Test condition C		$I_{(ISO)}$		.25	mA dc
2N6968		V_{DS} = 400 V dc			---		
2N6969		V_{DS} = 500 V dc			---		

See footnote at end of table.

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TABLE III. Group C inspection - Continued.

Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD 1/	Symbol	Limits Min	Limits Max	Unit
Subgroup 6			3				
Intermittent operation life (LTPD)	1042	Test condition D; 6,000 cycles see 4.5.3. A cycle shall be minutes minimum.					
Hermetic seal a. Fine leak b. Gross leak	1071						
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8					
Subgroup 7			3				
Qualification only							
Thermal shock temperature cycling destructive	1051	-55°C to 150°C, 200 cycles					
Hermetic seal a. Fine leak b. Gross leak	1071						
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8					
Subgroup 8			10				
Qualification only							
Steady state reverse bias	1042	Test condition A, 1,000 hours					
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6 and 7					
Subgroup 9			10				
Qualification only							
Steady state gate bias	1042	Test condition B, 1,000 hours V_{GS} = rated voltage					
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6 and 7					

1/ LTPD numbers are to be taken from MIL-S-19500.

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TABLE IV. Group A, B, and C electrical measurements.

Step	Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	Symbol	Limits Min	Limits Max	Unit
1.	Breakdown voltage, drain to source	3407	V_{GS} = 0 V I_D = 1.0 mA dc, Bias condition C	$V_{(BR)DSS}$			
	2N6966				100	---	V dc
	2N6967				200	---	V dc
	2N6968				400	---	V dc
	2N6969				500	---	V dc
2.	Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, I_D = 0.25 mA dc	$V_{GS(th)1}$	2.0	4.0	V dc
3.	Gate current	3411	V_{GS} = ±20 V dc, V_{DS} = 0 V, Bias condition C	I_{GSS1}	---	±100	nA dc
4.	Drain current	3413	V_{GS} = 0 V dc; Bias condition C V_{DS} = 80% of rated V_{DS}	I_{DSS1}		25	µA dc
5.	Static drain to source on-state resistance	3421	V_{GS} = 10 V dc, condition A, pulsed (see 4.5.1)	$r_{DS(on)1}$	---		
	2N6966		I_D = 10 A dc		---	0.085	ohm
	2N6967		I_D = 7 A dc		---	0.18	ohm
	2N6968		I_D = 6.2 A dc		---	0.55	ohm
	2N6969		I_D = 3.3 A dc		---	0.85	ohm
6.	Drain to source on-state voltage	3405	V_{GS} = 10 V dc, condition A, pulsed (see 4.5.1)	$V_{DS(on)}$	---		
	2N6966		I_D = 15 A dc		---	0.085	V
	2N6967		I_D = 13 A dc		---	1.26	V
	2N6968		I_D = 7.5 A dc		---	3.41	V
	2N6969		I_D = 6 A dc		---	2.81	V
7.	Forward voltage (source drain voltage)	4011	Pulsed method, (see 4.5.1)	V_{SD}			
	2N6966		I_S = 15 A dc		.85	2.5	V
	2N6967		I_S = 13 A dc		.8	2.0	V
	2N6968		I_S = 7.5 A dc		.8	2.0	V
	2N6969		I_S = 6 A dc		.8	2.0	V
8.	Thermal response	3161	See 4.5.3	ΔV_{SD}	1/		

1/ 10% degradation in group B is permitted.
2/ 30% degradation in group C is permitted.

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5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Handling. MOS devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended (see 3.5).

a. Devices should be handled on benches with conductive and grounded surfaces.
b. Ground test equipment, tools, and personnel handling devices.
c. Do not handle devices by the leads.
d. Store devices in conductive foam or carriers.
e. Avoid use of plastic, rubber, or silk in MOS areas.
f. Maintain relative humidity above 50 percent if practical.
g. Care should be exercised, during test and troubleshooting, to apply not more than maximum rated voltage to any lead.
h. Gate must be terminated to source, R $\leq$ 100 K, whenever bias voltage is to be applied drain to source.

6.3 Cross reference compliment list. Parts from this specification may be used to replace the following commercial similar part numbers.

Preferred types	Commercial types
2N6966	IRFJ140
2N6967	IRFJ240
2N6968	IRFJ340
2N6969	IRFJ440

6.4 Ordering data. Acquisition documents may specify the material and finish (see 3.3.1).

6.5 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Navy - TD
Air Force - 11, 70, 80
NASA - EG02

User activities:
Air Force - 19

Preparing activity:
Navy - EC

Agent:
DLA - ES

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER
MIL-S-19500/569

2. DOCUMENT TITLE SEMICONDUCTOR DEVICE, FIELD EFFECT TRANSISTORS, N-CHANNEL, SILICON TYPES 2N6966, 2N6967,68,69 JANTX, JANTXV,JAN

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION *(Mark one)*

- [ ] VENDOR
- [ ] USER
- [ ] MANUFACTURER
- [ ] OTHER *(Specify)*: _____

b. ADDRESS *(Street, City, State, ZIP Code)*

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional

8. DATE OF SUBMISSION *(YYMMDD)*

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