The documentation and process conversion measures necessary to comply with this revision shall be completed by 21 September 1996

IINCH-POUND

MIL-PRF-19500/592C
21 June 1996
SUPERSEDING
MIL-S-19500/592B
31 January 1991

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, REPETITIVE AVALANCHE, FIELD EFFECT TRANSISTOR, N-CHANNEL, SILICON, TYPES 2N7224, 2N7225, 2N7227, 2N7228, 2N7224U, 2N7225U, 2N7227U, AND 2N7228U JANTX, JANTXV, JANS, JANHC AND JANKC

This specification supersedes DESC drawing 89026 (see 6.3.1).

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 performance 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 encapsulated device type as specified in MIL-PRF-19500, and two levels of product assurance for each unencapsulated device type die, with avalanche energy ratings (E_{AS} and E_{AR}) and maximum avalanche current (I_{AR}).

1.2 Physical dimensions. See figure 1 (TO-254AA), figure 2 for surface mount devices, and figure 3 for JANHC and JANKC (die) dimensions.

1.3 Maximum ratings (T_A = +25°C, unless otherwise specified).

Type 1/	P_T 2/ T_C = +25°C	P_T 2/ T_C = +25°C	V_{GS}	I_{D1} 3/ T_C = +25°C	I_{D2} 3/ T_C = +100°C	I_S	I_{DM} 4/	T_{op} and T_{STG}	V_{ISO} at 70,000 foot	$R_{\Theta JC}$ max
	W	W	V dc	A dc	A dc	A dc	A(pk)	°C		°C/W
2N7224	150	4.0	±20	34.0	21	34.0	136	-55		0.83
2N7225	150	4.0	±20	27.4	17	27.4	110	50		0.83
2N7226	150	4.0	±20	14.0	9	14.0	56	+150	400	0.83
2N7227	150	4.0	±20	12.0	8	12.0	48		500	0.83

See footnotes on next page.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ELDT, 1507 Wilmington Pike, Dayton, OH 45444-5765, by using the addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

Type 1/	I_{AR} 2/	E_{AS}	E_{AR}	$r_{DS(on)}$ max 2/ 5/ V_{GS} = 10 Vdc $I_D = I_{D2}$	
				T_J = +25° C	T_J = +150° C
	A	mj	mj	Ω	Ω
2N7224	34.0	150	15.0	0.070	0.133
2N7225	27.4	500	15.0	0.100	0.200
2N7227	14.0	700	15.0	0.315	0.693
2N7228	12.0	750	15.0	0.415	0.913

1/ Electrical chracteristics for "U" suffix devices are identical to the corresponding non-"U" suffix devices unless otherwise noted.

2/ Derate linearly 1.2 W/° C for T_C > +25° C; $P_T = \frac{T_{J(max)} - T_C}{R_{\theta JX}}$

3/ $I_D = \sqrt{\frac{T_{J(max)} - T_C}{(R_{\theta JX}) \times (R_{DS(on)} \text{ at } T_{J(max)})}}$

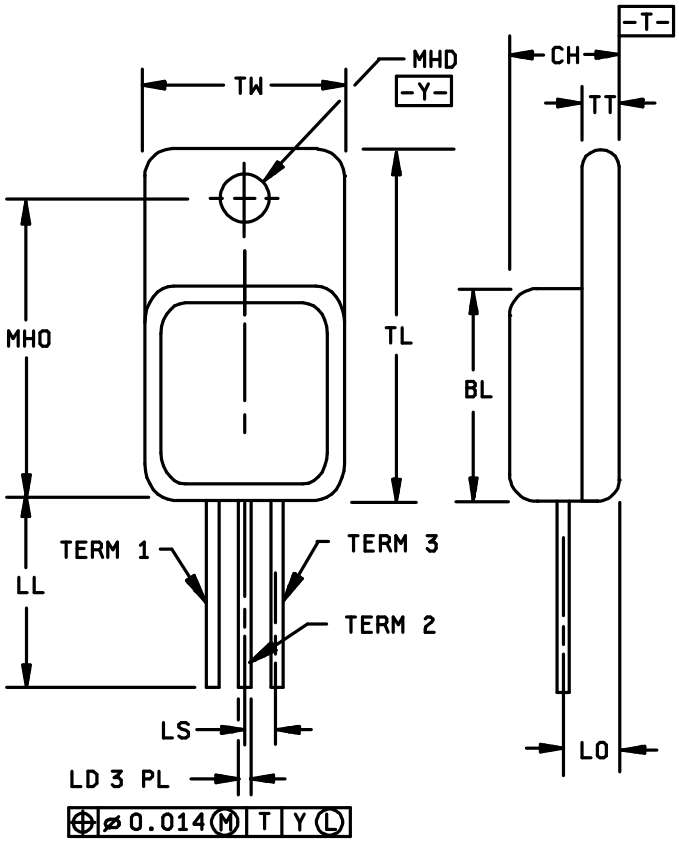
4/ $I_{DM} = 4I_{D1}$; I_{D1} as calculated in footnote 3/.

5/ Pulsed (see 4.5.1).

1.4 Primary electrical characteristics at T_C = +25° C (unless otherwise specified).

Type 1/	Min $V_{(BR)DSS}$ V_{GS} = 0 I_D = 1.0 mA dc	$V_{GS(th)1}$ $V_{DS} \geq V_{GS}$ I_D = 0.25 mA		Max I_{DSS1} V_{GS} = 0 V_{DS} = 80 percent of rated V_{DS}	Max $r_{DS(on)}$ 2/ V_{GS} = 10 V dc $I_D = I_{D2}$ T_J = +25° C
	V dc	V dc		μA dc	Ohms
		Min	Max		
2N7224	100	2.0	4.0	25	0.070
2N7225	200	2.0	4.0	25	0.100
2N7227	400	2.0	4.0	25	0.315
2N7228	500	2.0	4.0	25	0.415

1/ Unless otherwise specified, electrical characteristics for "U" suffix devices are identical to the corresponding non "U" devices.
2/ Pulsed (see 4.5.1).

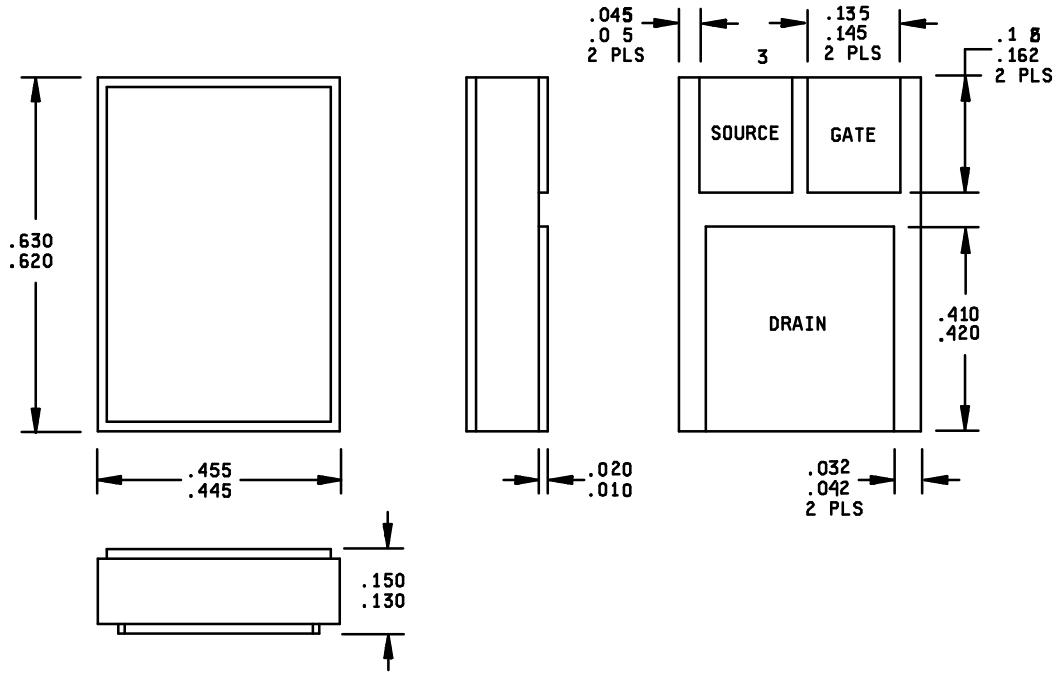


NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Glass meniscus included in dimension D and E.
4. All terminals are isolated from the case.

FIGURE 1. Physical dimensions for TO-254AA.

Ltr	Dimension				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BL	.535	.545	13.59	13.84	
CH	.249	.260	6.32	6.60	
LD	.035	.045	0.89	1.14	
LL	.510	.570	12.95	14.48	
LO	.150 BSC		3.81 BSC		
LS	.150 BSC		3.81 BSC		
MHD	.139	.149	3.53	3.78	
MHO	.665	.685	16.89	17.40	
TL	.790	.800	20.07	20.32	3, 4
TT	.040	.050	1.02	1.27	
TW	.5353	.545	13.59	13.84	3, 4
Term 1	Drain				
Term 2	Source				
Term 3	Gate				

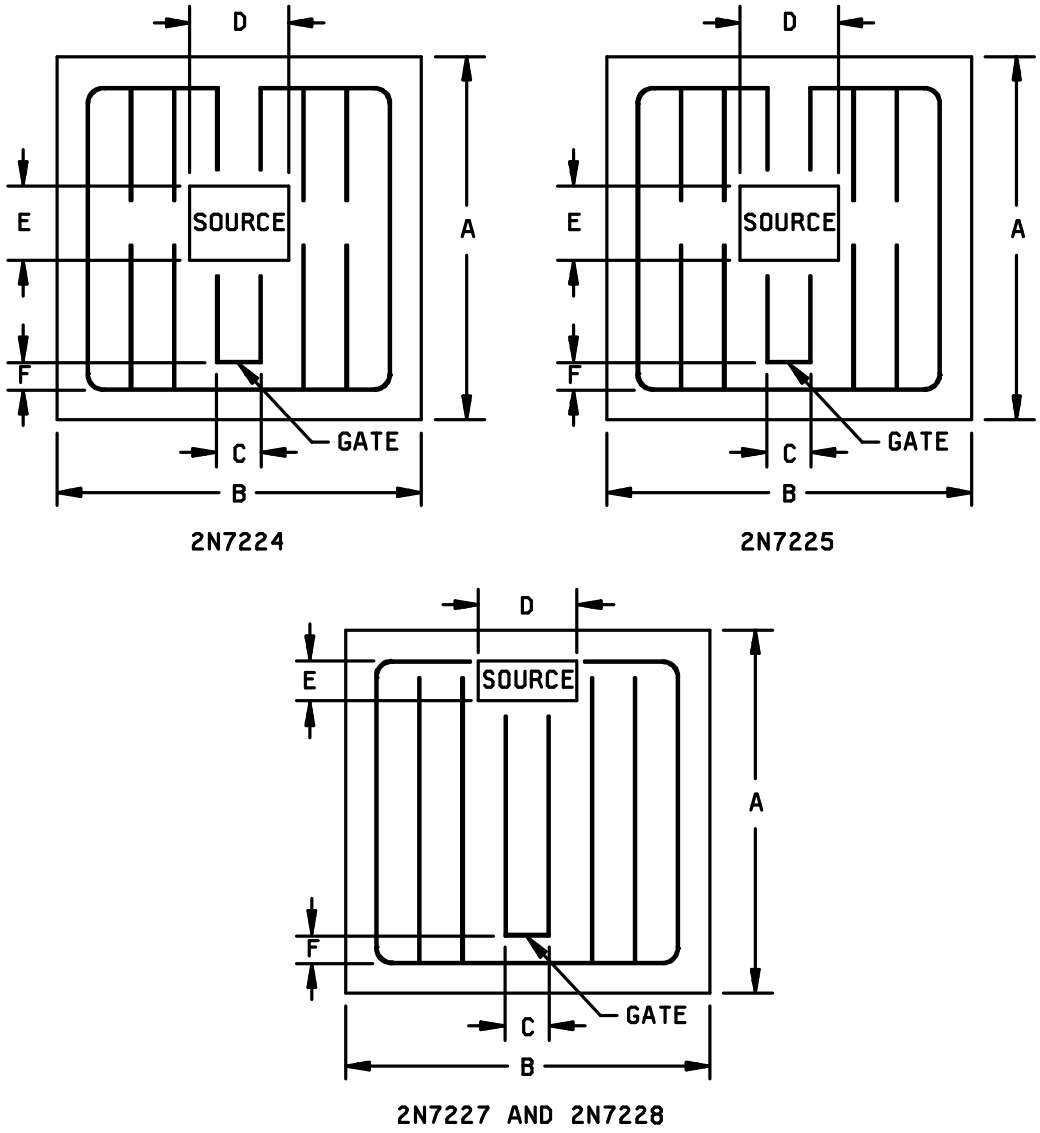
FIGURE 1. Physical dimensions for TO-254AA - Continued.



Inches	mm	Inches	mm
.010	0.25	.150	3.81
.020	0.51	.152	3.86
.032	0.81	.162	4.11
.042	1.07	.410	10.41
.045	1.14	.420	10.67
.055	1.40	.445	11.30
.130	3.30	.455	11.56
.135	3.43	.620	15.75
.145	3.68	.630	16.00

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for information only.

FIGURE 2. Dimensions and configuration of surface mount package outline.



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Unless otherwise specified, tolerance is ±0.005 inches (0.13 mm).
4. Physical characteristics of the die thickness = .0187 inch (0.47 mm).
5. Back metal: Cr - Ni - Ag.
6. Top metal: Al.
7. Back contact: Drain.

FIGURE 3. Physical dimensions JANHC and JANKC.

A version

Ltr	Dimensions - 2N7224				Dimensions - 2N7225				Dimensions - 2N7227 and 2N7228			
	Inches		Millimeters		Inches		Millimeters		Inches		Millimeters	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
A	.252	.262	6.40	6.65	.252	.262	6.40	6.65	.252	.262	6.40	6.65
B	.252	.262	6.40	6.65	.252	.262	6.40	6.65	.252	.262	6.40	6.65
C	.027	.037	0.69	0.94	.027	.037	0.69	0.94	.025	.035	0.64	0.89
D	.066	.076	1.68	1.93	.066	.076	1.68	1.93	.043	.053	1.09	1.35
E	.047	.057	1.19	1.45	.047	.057	1.19	1.45	.032	.042	0.81	1.07
F	.013	.023	0.33	0.58	.013	.023	0.33	0.58	.015	.025	0.38	0.64

FIGURE 3. JANHC and JANKC die dimensions - Continued.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARD

MILITARY

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500 and as specified herein.

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

JANH - - - - - - - - - - - - High reliability product assurance level for unencapsulated devices.
JANK - - - - - - - - - - - - Space reliability product assurance level for unencapsulated devices.

3.3 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and on figures 1, 2, and 3 herein. Methods used for electrical isolation of the terminal feed through shall employ materials that contain a minimum of 90 percent AL_20_3 (ceramic). Examples of such construction techniques are metallized ceramic eyelets or ceramic walled packages.

3.3.1 Lead formation material and finish. Lead material shall be Kovar or Alloy 52; a copper core or plated core is permitted. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead formation material or finish is desired, it shall be specified in the acquisition document (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14 of Table II of MIL-PRF-19500 and 100 percent DC testing in accordance with group A, subgroup 2 herein.

3.3.2 Internal construction. Multiple chip construction shall not be permitted to meet the requirements of this specification.

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

3.4.1 Marking of JANHC and JANKC die. For JANHC and JANKC die container, the following marking shall be used (example):

JAN HC A M 2N7224
↑ ↑ ↑ ↑
| | | |___RHA level (see MIL-PRF-19500).
| | |____Source of manufacturer (see figure 3).
| |____Unencapsulated.
|____ Product assurance level 1/.

1/ Two levels of product assurance levels are provided for unencapsulated devices, H and K (see MIL-PRF-19500.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic protection.

3.5.1 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 surface.

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.

3.6 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.2).

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in MIL-PRF-19500, and figures 1, 2, and 3 herein.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3 herein.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3).

c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500. Alternate flow is allowed for qualification inspection in accordance with figure 4, Appendix E of MIL-PRF-19500.

4.2.1 JANHC and JANKC devices. Qualification shall be in accordance with appendix H of MIL-PRF-19500.

4.3 Screening (JANTX, JANTXV, and JANS levels only). Screening shall be in accordance with table IV of MIL-PRF-19500, 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.

Screen (see table IV, of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
1/	Gate stress (see 4.5.5)	Gate stress test (see 4.5.5)
1/	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 1/	I_{GSS1}, I_{DSS1} Subgroup 2 of table herein	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 percent of initial value, whichever is greater. ΔI_{DSS1} = ±25 µA dc or ±100 percent 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	MIL-STD-750, method 1042, condition A	MIL-STD-750, method 1042, condition A
13	Subgroups 2 and 3 of table I herein; ΔI_{GSS1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{DSS1} = ±25 µA dc or ±100 percent of initial value, whichever is greater. $\Delta r_{DS(on)1}$ = ±20 percent of initial value, $\Delta V_{GS(th)1}$ = ±20 percent of initial value.	Subgroup 2 of table I herein; ΔI_{GSS1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{DSS1} = ±25 µA dc or ±100 percent of initial value, whichever is greater. $\Delta r_{DS(on)1}$ = ±20 percent of initial value, $\Delta V_{GS(th)1}$ = ±20 percent of initial value.

1/ Shall be performed anytime before screen 10.

4.3.1 Screening (JANHC and JANKC). Screening of die shall be in accordance with MIL-PRF-19500, (appendix H), as a minimum die shall be 100 percent probed in accordance with group A, subgroup 2, except test current shall not exceed 20 A.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500. Alternate flow is allowed for quality conformance inspection in accordance with figure 4, Appendix E of MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. (End-point electrical measurements shall be in accordance with the applicable steps of table I, subgroup 2 herein.)

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIa (JANS) and table VIb (JANTX and JANTXV) of MIL-PRF-19500 and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table I, subgroup 2 herein.

4.4.2.1 Group B inspection, table VIa (JANS) of MIL-PRF-19500.

Subgroup	Method	Conditions
B3	1051	Test condition G.
B3	2037	Test condition A. All internal wires for each device shall be pulled separately. If group B3 is to be continued to C6, strength test may be performed after C6.
B4	1042	Test condition D, 2,000 cycles. The heating cycle shall be 1 minute minimum. No heat sink nor forced air cooling on the device shall be permitted during the "on" cycle.
B5	1042	A separate sample may be pulled for each test. Accelerated steady-state reverse bias; test condition A, V_{DS} = rated, T_A = +175°C, t = 120 hours, read and record $V_{BR(DSS)}$ (pre and post) at I_D = 1 mA. Read and record I_{DSS} (pre and post) in accordance with table I, subgroup 2 herein. $V_{BR(DSS)}$ delta cannot exceed 10 percent.
B5	1042	Accelerated steady-state gate stress; test condition B, V_{GS} = rated, T_A = +175°C, t = 24 hours.
B6		See 4.5.2.

4.4.2.2 Group B inspection, table VIb (JANTX and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Conditions
B2	1051	Test condition G.
B3	1042	Test condition D, 2,000 cycles. The heating cycle shall be 1 minute minimum. No heat sink nor forced air cooling on the device shall be permitted during the "on" cycle.
B3	2037	Test condition A. All internal wires for each device shall be pulled separately. If group B3 is to be continued to C6, bond strength test may be performed after C6.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table I, subgroup 2 herein.

Subgroup	Method	Conditions
C2	2036	Test condition A; weight = 10 pounds, t = 15 s (not applicable for surface mount devices).
C6	1042	Test condition D, 6,000 cycles. The heating cycle shall be 1 minute minimum. No heat sink nor forced air cooling on the device shall be permitted during the "on" cycle.

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 resistance. Thermal resistance measurements shall be performed in accordance with method 3161 of MIL-STD-750. $R_{\Theta JC(max)}$ = .83° C/W for TO-254AA case style devices and surface mount devices. The following parameter measurements shall apply:

a. I_M measuring current ..... 10 mA.

b. I_H drain heating current..... 3 A.

c. t_H heating time ..... Steady state (see MIL-STD-750, method 3161).

d. V_H drain-source heating voltage..... 25 V.

e. t_{MD} measurement time delay..... 30 to 60 µs.

f. t_{SW} sample window time..... 10 µs maximum.

4.5.3 Thermal impedance ($Z_{\Theta JC}$ measurements). The $Z_{\Theta JC}$ measurements shall be performed in accordance with method 3161 of MIL-STD-750. The maximum limit (not to exceed the group A, subgroup 2 limit or figure 4 thermal impedance curve) for $Z_{\Theta JC}$ in screening (table IV of MIL-S-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable X, R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for Engineering evaluation and disposition. This procedure may be used in lieu of an in line monitor. The following parameter measurements shall apply:

a. I_M measuring current ..... 10 mA.

b. I_H drain heating current ..... 3 A minimum.

c. t_H heating time ..... 100 ms.

d. V_H drain-source heating voltage ..... 25 V minimum.

e. t_{MD} measurement time delay..... 30 to 60 µs.

f. t_{SW} sample window time..... 10 µs maximum.

4.5.4 Single pulsed unclamped inductive switching.

a. Peak current, I_D ..... I_{AR}(max)

b. Peak gate voltage, V_{GS} ..... 10 V.

c. Gate to source resistor, R_{GS}..... $25 \leq R_g \leq 200$ ohms.

d. Initial case temperature ..... +25° C, +10° C, -5° C.

e. Inductance, L ..... $\left[\frac{2E_{AS}}{(I_{D1})^2}\right]\left[\frac{(V_{BR}-V_{DD})}{V_{BR}}\right]$ mH minimum.

f. Number of pulses to be applied..... 1 pulse minimum.

g. Supply voltage (V_{DD})..... 50 V, (25 V for devices with minimum $V_{(BR)DSS}$ of 100 V).

4.5.5 Gate stress test..... V_{GS} = ±30 V minimum; t = 250 µs minimum.

TABLE I. Group A inspection.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2			$Z_{\Theta JC}$		.65	°C/W
Thermal impedance 3/	3101					
Breakdown voltage, drain to source	3407	I_D = 1.0 mA dc, bias condition C, V_{GS} = 0 V dc	$V_{(BR)DSS}$			
2N7224				100		V dc
2N7225				200		V dc
2N7227				400		V dc
2N7228				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 reverse current	3411	V_{GS} = +20 V dc and -20 V dc, bias condition C, V_{DS} = 0	I_{GSS1}		±100	nA dc
Drain current	3413	V_{DS} = 80 percent 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), I_D = rated I_{D2} (see 1.3)	$r_{DS(on)1}$			
2N7224					0.070	Ohm
2N7225					0.100	Ohm
2N7227					0.315	Ohm
2N7228					0.415	Ohm
Static drain to source "on"-state resistance	3421	V_{GS} = 10 V dc, pulsed (see 4.5.1), condition A, I_D = rated I_{D1} (see 1.3)	$r_{DS(on)2}$			
2N7224					0.081	Ohm
2N7225					0.105	Ohm
2N7227					0.415	Ohm
2N7228					0.515	Ohm

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Forward voltage (source drain diode)	4011	Pulsed (see 4.5.1), $I_D = I_{D1}$ (see 1.3)	V_{SD}			
2N7224					1.8	V
2N7725					1.9	V
2N7227					1.7	V
2N7228					1.7	V
Subgroup 3						
High temperature operation:		$T_C = T_J = +125°C$				
Gate reverse current	3411	V_{GS} = +20 V dc and -20 V dc, bias condition C, $V_{DS} = 0$	I_{GSS2}		±200	nA dc
Drain current	3413	Bias condition C, V_{GS} = 0 V dc				
		V_{DS} = 80 percent rated	I_{DSS2}		0.25	mA dc
Static drain to source "on"-state resistance	3421	V_{GS} = 10 V dc, pulsed (see 4.5.1) I_D = rated I_{D2} (see 1.3)	$\lvert r_{DS(on)3} \rvert$			
2N7224					0.11	Ohm
2N7225					0.17	Ohm
2N7227					0.68	Ohm
2N7228					0.90	Ohm
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ I_D = .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 = .25 mA dc	$V_{GS(th)3}$		5.0	V dc

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
Switching time test	3472	I_D = Rated I_{D2} (see 1.3), V_{GS} = 10 V dc, Gate drive impedance = 2.35 ohms; V_{DD} = 0.5 $V_{BR(DSS)}$				
Turn-on delay time			$t_{d(on)}$		35	ns
Rise time			t_r		190	ns
Turn-off delay time			$t_{d(off)}$		170	ns
Fall time			t_f		130	ns
Subgroup 5						
Safe operating area test	3474	See figure 5; V_{DS} = 80 percent of rated V_{DS} V_{DS} = 200 V maximum, t_p = 10 ms				
Electrical measurements		See table I, subgroup 2				
Subgroup 6						
Not applicable						
Subgroup 7						
Gate charge	3471	Condition B				
On-state gate charge			$Q_{g(on)}$			nC
2N72224					125	
2N7225					115	
2N7227					110	
2N7228					120	
Charge gate to source			Q_{gs}			nC
2N7224					22	
2N7225					22	
2N7227					18	
2N7228					19	

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 7 - Continued						
Charge gate to drain			Q_{gd}			nC
2N7224					65	
2N7225					60	
2N7227					65	
2N7228					70	
Reverse recovery time	3473	$V_{DD} \leq 30$ V, $di/dt \leq 100$ A/µs $I_D = I_{D1}$	t_{rr}			ns
2N7224					500	
2N7225					950	
2N7227					1,200	
2N7228					1,600	

1/ For sampling plan, see MIL-PRF-19500.
2/ Inspections, conditions, and limits for "U" suffix devices are identical to corresponding non-suffix devices unless otherwise indicated.
3/ This test is required for the following endpoint measurement only (not intended for screen 13): JANS, group B, subgroups 3 and 4; JANTX and JANTXV, group B, subgroups 2 and 3; group C, subgroup 6, and group E, subgroup 1.

TABLE II. Group E inspection (all quality levels except JANC) for qualification only.

Inspection 1/	MIL-STD-750		Sampling plan
	Method	Conditions	
Subgroup 1			22 devices c = 0
Temperature cycling	1051	500 cycles, test condition G	
Electrical measurements		See table I, group A, subgroup 2	
Subgroup 2 2/			45 devices c = 0
Steady-state reverse bias	1042	Condition A, 1,000 hours	
Electrical measurements		See table I, group A, subgroup 2	
Steady-state gate bias	1042	Condition B, 1,000 hours	
Electrical measurements		See table I, group A, subgroup 2	
Subgroup 3			
Not applicable			
Subgroup 4			5 devices c = 0
Thermal resistance	3161	$R_{\Theta JC}$ = see 4.5.2	
Subgroup 5			
Not applicable			
Subgroup 6			5 devices c = 0
Repetitive avalanche energy	3469	Peak current $I_{AR} = I_D$; Peak gate voltage V_{GS} = 10 V; Gate to source resistor, R_{GS} 2.5 $\leq R_{GS} \leq$ 200 ohms Temperature = T_J = 150° C +0, -10° C Inductance = $\left[\frac{2E_{AR}}{(I_{D1})^2}\right]\left[\frac{V_{BR}-V_{DD}}{V_{BR}}\right] mH \min$ Number of pulses to be applied = 3.6 X 10^8; supply voltage (V_{DD}) = 50 V; time in avalanche = 2 µs minimum, 20 µs minimum; f = 500 Hz minimum	

1/ JANHC and JANKC device are qualified with appendix H of MIL-PRF-19500.
2/ A separate sample for each test may be pulled.

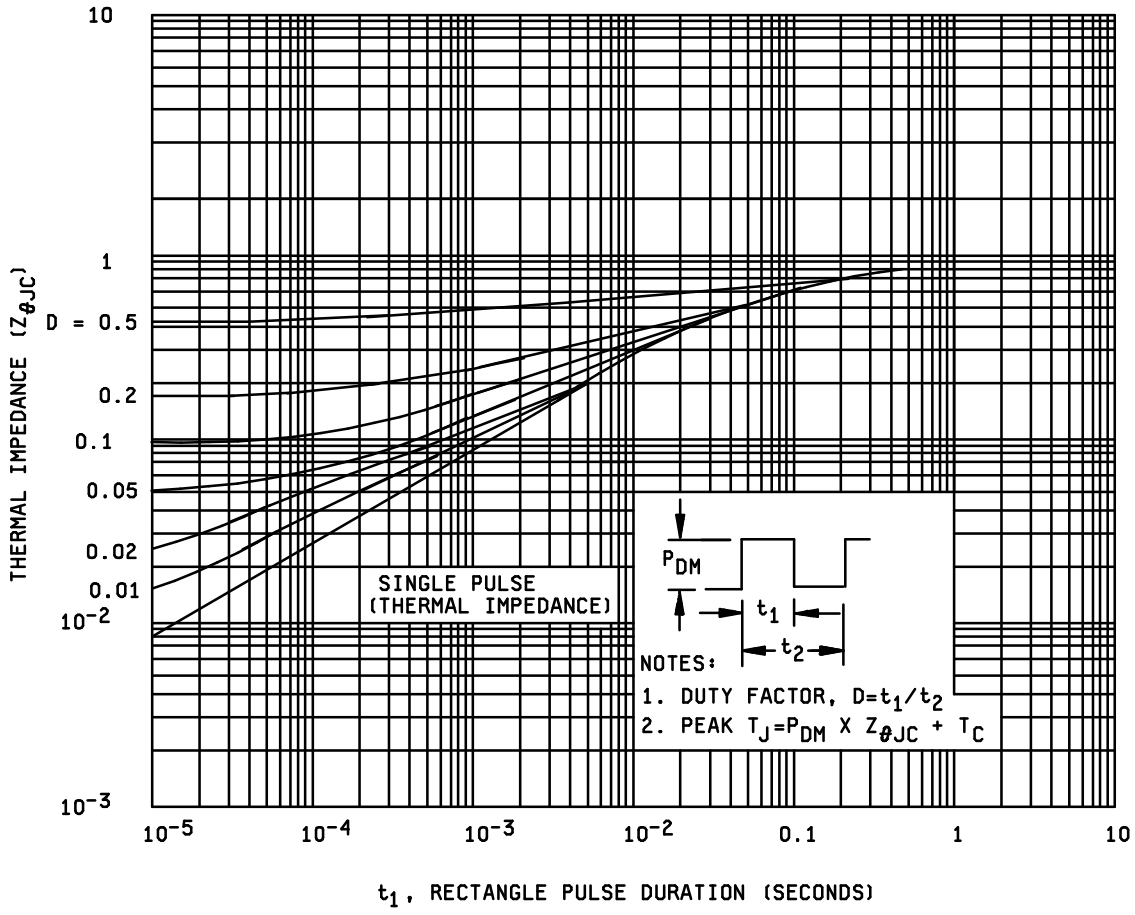
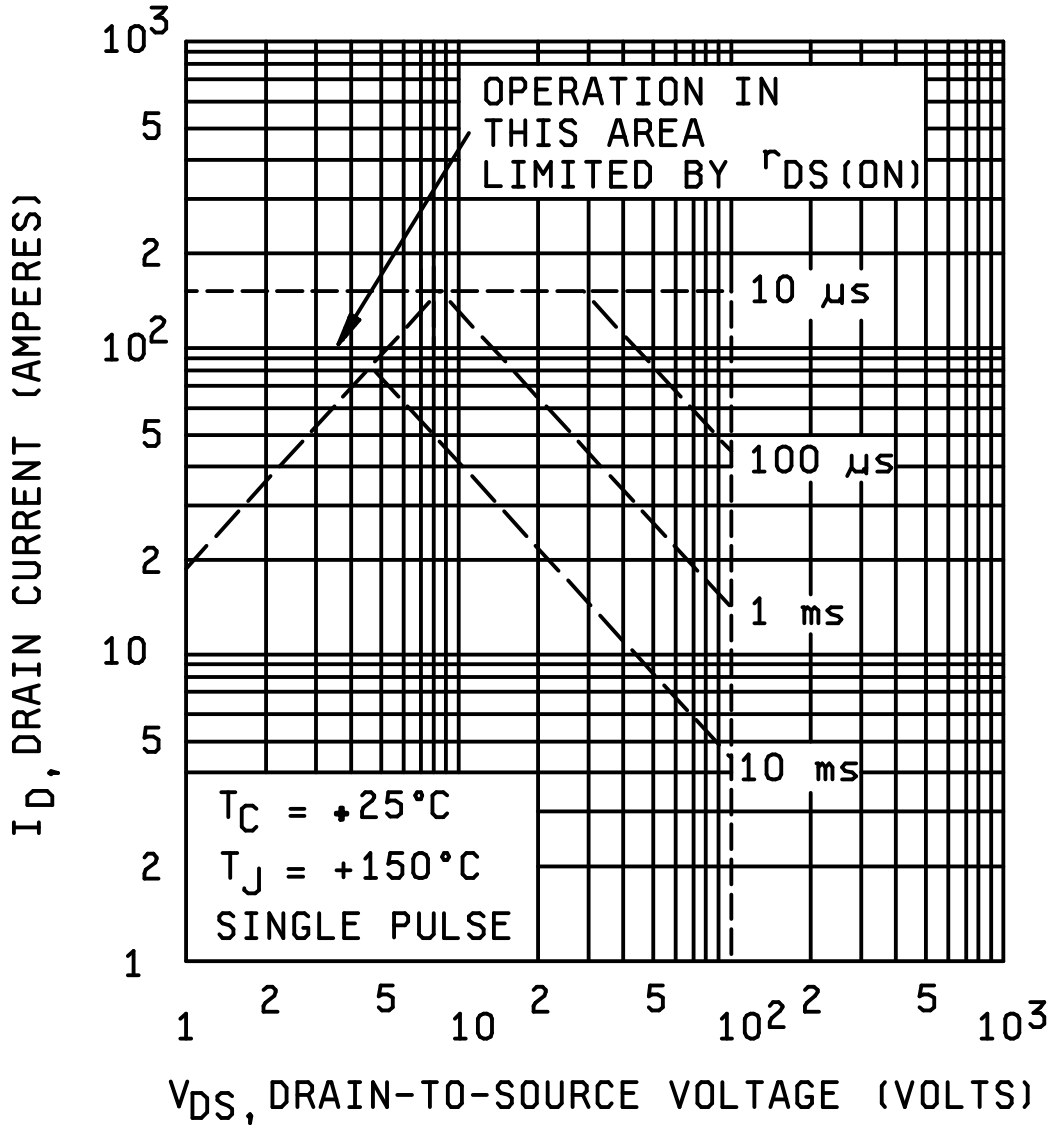
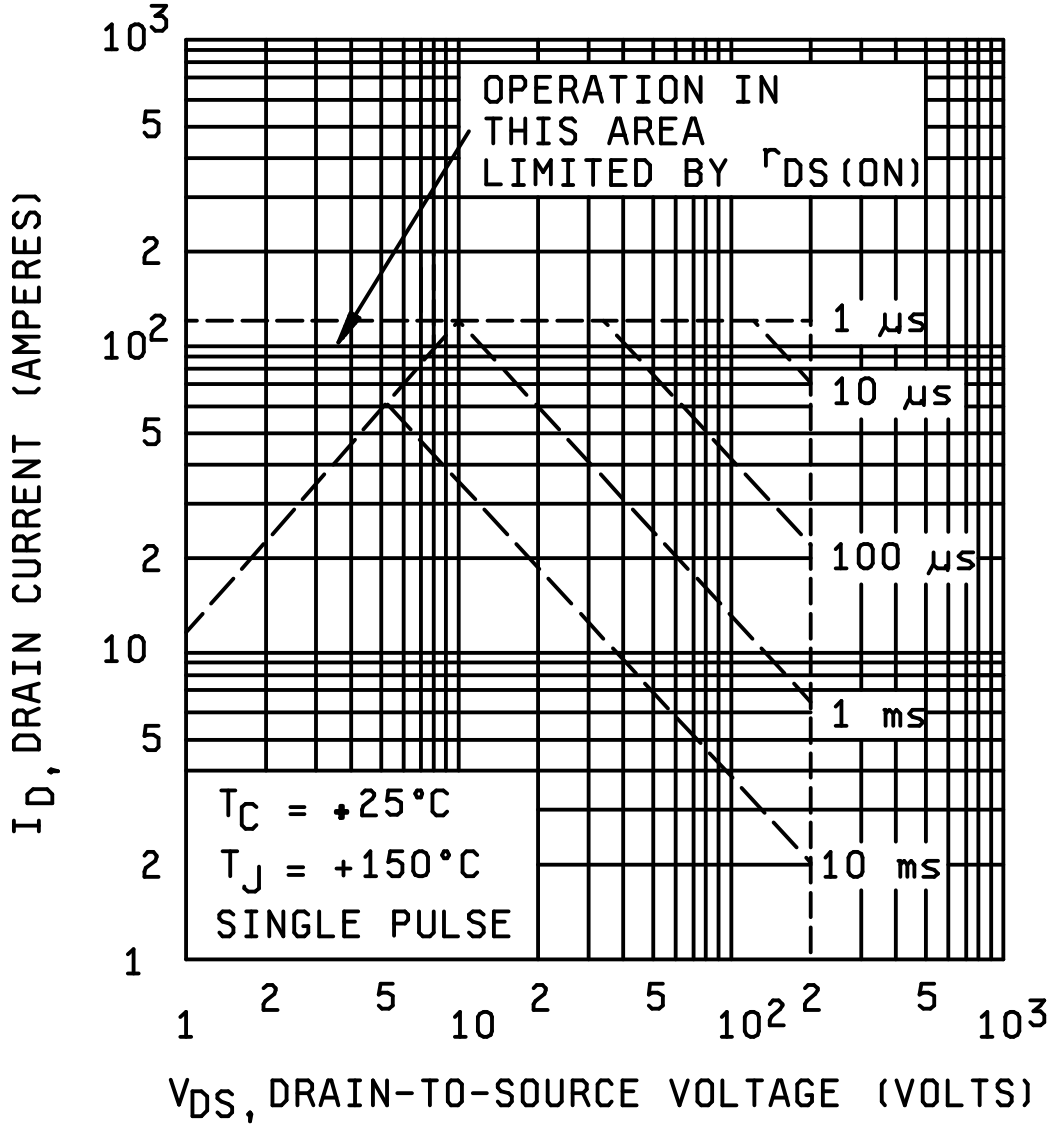


FIGURE 4. Thermal impedance curves.



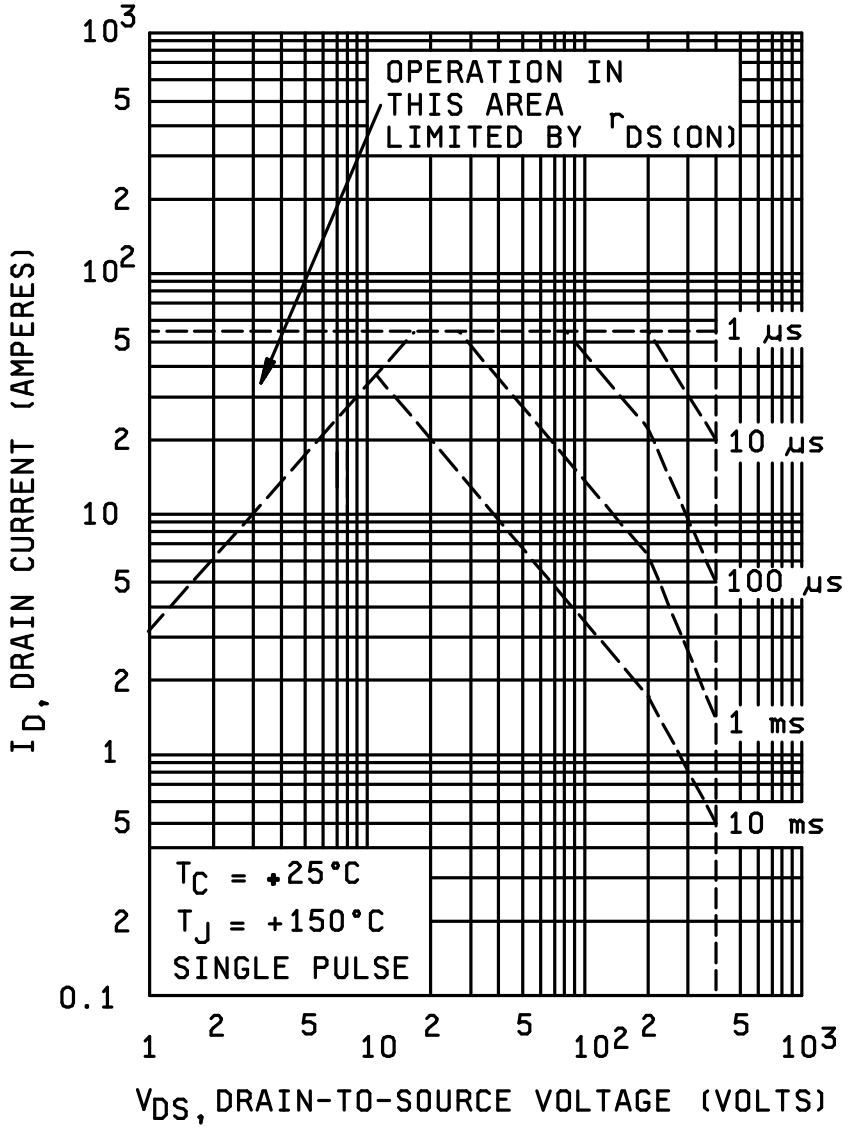
2N7224

FIGURE 5. Safe operating area graph.



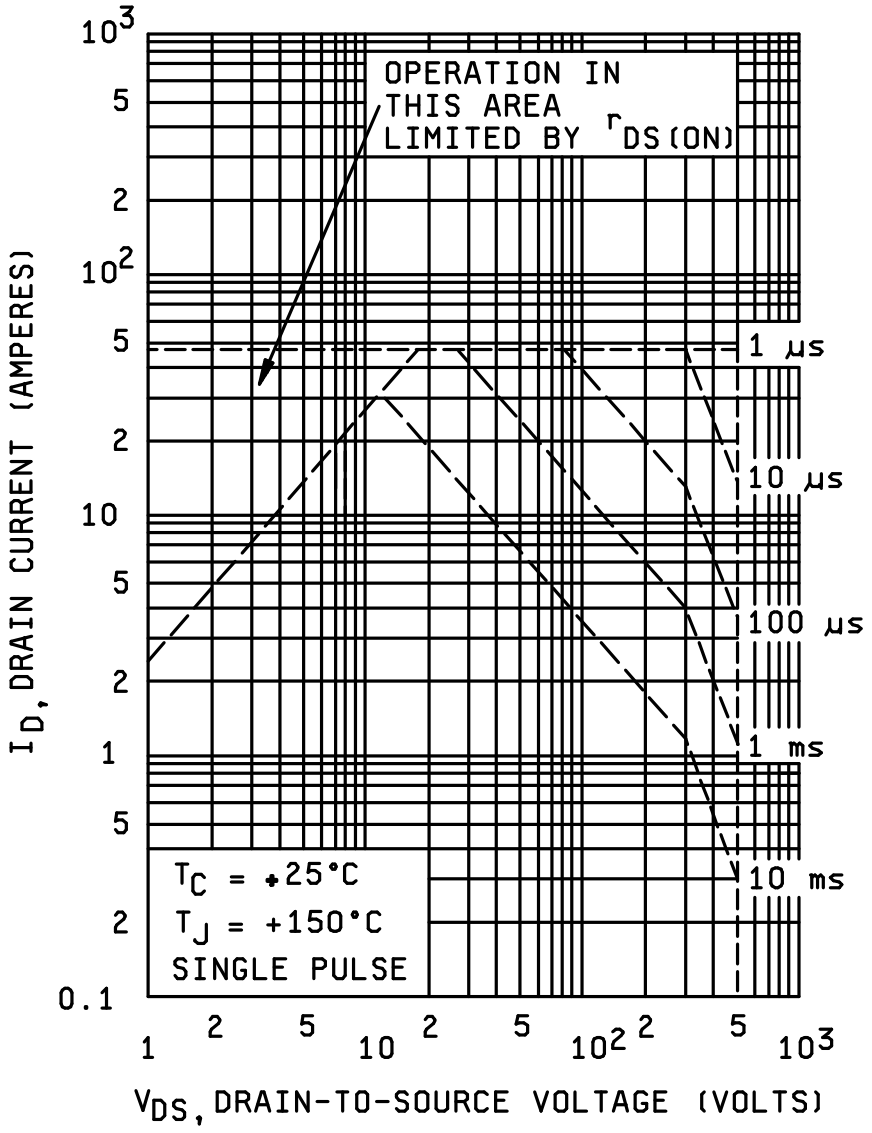
2N7225

FIGURE 5. Safe operating area graph - Continued.



2N7227

FIGURE 5. Safe operating area graph - Continued.



2N7228

FIGURE 5. Safe operating area graph - Continued.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Marking. Unless otherwise specified (see 6.2), marking shall be in accordance with MIL-STD-129.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish and formation as specified (see 3.3.1).

c. Type designation, product assurance level and for die acquisition, the manufacturer's letter identification should be specified.

6.3 Substitution information. Devices covered by this specification are oneway substitutable for the following manufacturer's Part or Identifying Number (PIN) listed below. This information in no way implies that manufacturers's part numbers are suitable for the military Part or Identifying Number (PIN).

Military PIN	Manufacturer's CAGE code	Manufacturer's and User's PIN
2N7224	59993	IRFM150
2N7225	59993	IRFM250
2N7227	59993	IRFM350
2N7228	59993	IRFM450
2N7224U	59993	IRFN150
2N7225U	59993	IRFN250
2N7227U	59993	IRFN350
2N2778U	59993	IRFN450

6.3.1 Substitution of DESC drawing. This specification supersedes DESC drawing 89026, dated 19 December 1989.

6.4 Suppliers of die. The qualified die suppliers will be identified on the QPL (example JANHCA7224).

JANC ordering information		
Military PIN	Manufacturer	
	59993	59993
2N7224 2N7225 2N7227 2N2778	JANHCA2N7224 JANHCA2N7225 JANHCA2N7227 JANHCA2N7228	JANKCA2N7224 JANKCA2N7225 JANKCA2N7227 JANKCA2N7228

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

6.6 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Electronics Supply Center, DESC-ELS, Dayton, OH 45444.

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

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

Review activities:
Navy - TD
Air Force - 70, 80

Preparing activity:
DLA - ES

(Project 5961-1838)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-PRF-19500/592C	**2. DOCUMENT DATE (YYMMDD)** 96/06/21

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, REPETITIVE AVALANCHE, FIELD EFFECT TRANSISTOR, N-CHANNEL, SILICON, TYPES 2N7224, 2N7225, 2N7227, 2N7228, 2N7224U, 2N7225U, 2N7227U, AND 2N7228U JANTX, JANTXV, JANS, JANHC AND JANKC

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Alan Barone	b. TELEPHONE (Include Area Code) (1) Commercial 513-296-6048 (2) AUTOVON 986-6048
c. ADDRESS (Include Zip Code) Defense Electronics Supply Center ATTN: DESC-ELDT Dayton, OH 45444-5765	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340