

The documentation and process conversion measures necessary to comply with this revision shall be completed by 5 Sep 95.

INCH-POUND

MIL-S-19500/597B
5 April 1995
SUPERSEDING
MIL-S-19500/597A
14 September 1994

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, QUAD, FIELD EFFECT TRANSISTORS,
N-CHANNEL, SILICON TYPE 2N7334
JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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 quad N-channel, enhancement-mode, MOSFET, transistor intended for use in high density power switching applications. Four levels of product assurance are provided for each device type as specified in MIL-S-19500, with avalanche energy ratings (E_{AS} and E_{AR}) and maximum avalanche current (I_{AR}). Two levels of product assurance for die.

1.2 Physical dimensions. See figure 1 (MO-036AB, dual-inline package), figure 2, and 6.3 for JANHC and JANKC die dimensions.

1.3 Unless otherwise specified, maximum ratings ($T_A = +25^\circ\text{C}$).

Type	P_T 1/ $T_C = +25^\circ\text{C}$ (free air)	V_{GS}	I_{D1} 2/ $T_C = +25^\circ\text{C}$	I_{D2} 2/ $T_C = +100^\circ\text{C}$	I_S
	W	V dc	A dc	A dc	A dc
2N7334	1.4	± 20	1.0	0.6	1.0

E_{AS}	E_{AR}	I_{AR} 2/	I_{DM} 3/	T_{op} and T_{STG}	Max $r_{DS(on)}$ 1/ $V_{GS} = 10$ V dc, $I_D = I_{D2}$	$R_{\theta JA1}$ maximum (1 die)	$R_{\theta JA2}$ Max (4 die)
Mj	Mj	A	A (pk)	$^\circ\text{C}$	ohm	ohm	$^\circ\text{C/W}$
75	.14	1.0	4.0	-55 to +150	0.70	1.4	90

1/ Derate linearly, 11 mW/ $^\circ\text{C}$ for $T_C > +25^\circ\text{C}$. $P_T = \frac{T_J \text{ max} - T_C}{R_{\theta JA}}$

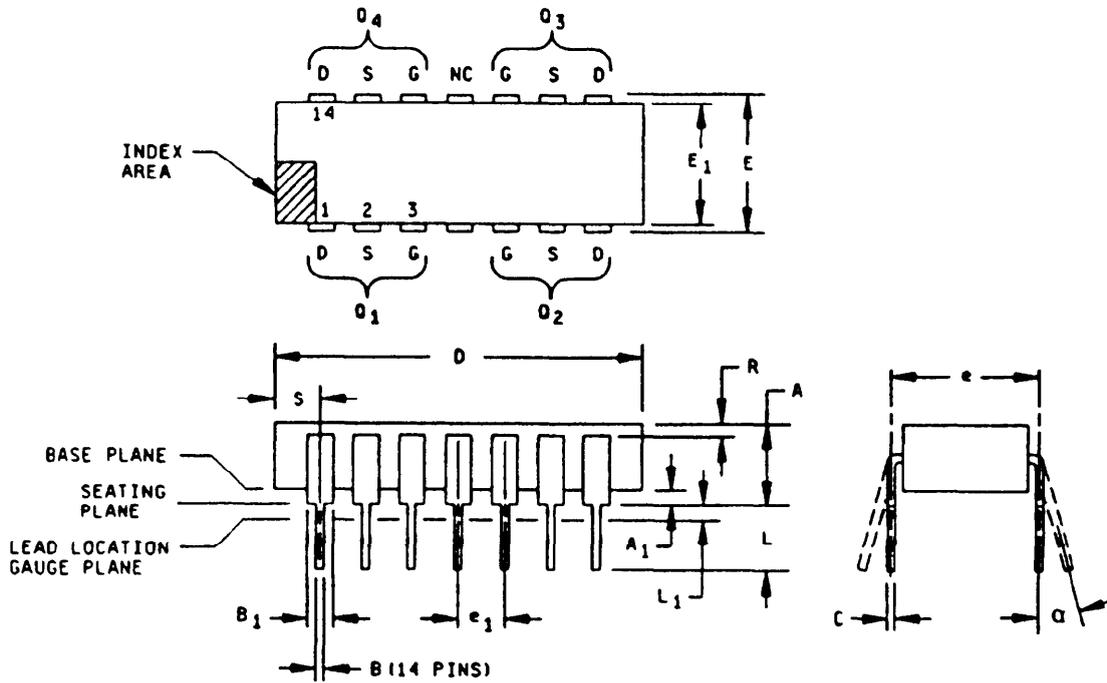
2/ $I_D = \sqrt{\frac{T_J \text{ max} - T_C}{(R_{\theta JA}) \times (R_{DS(on)} \text{ at } T_J \text{ max})}}$

3/ $I_{DM} = 4 I_{D1}$; I_{D1} as calculated in footnote 2.

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, using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A
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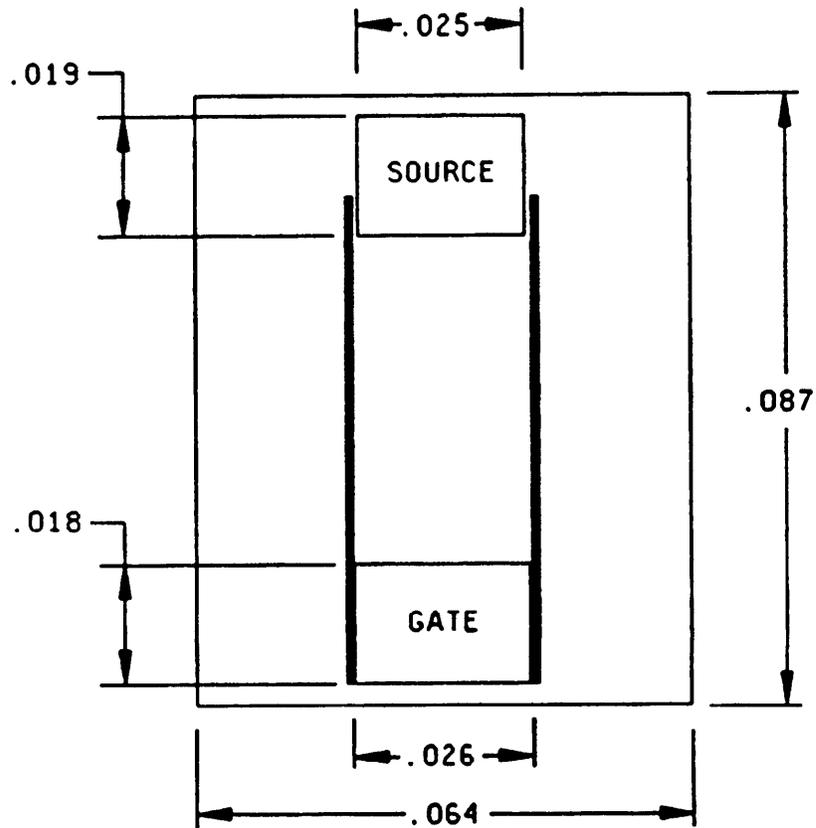
Symbol	AB				Notes
	Dimensions				
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.105	.175	2.67	4.45	11
A ₁	.025	.055	0.64	1.40	11
B	.015	.021	0.381	0.533	
B ₁	.038	.060	0.97	1.52	
C	.008	.012	0.203	0.305	
D	.690	.770	17.53	19.56	
E	.290	.325	7.37	8.26	
E ₁	.280	.310	7.11	7.87	10
e ₁	.100 TP		2.54 TP		5, 6
e	.300 TP		7.62 TP		5, 6
L	.125	.175	3.18	4.45	11
L ₁	.000	.030	0.00	0.76	
α	0°	15°	0°	15°	7
N	14		14		8
R	.010		0.25		
S	.030	.095	0.76	2.41	

FIGURE 1. Dimensions and configuration (MO-036AB).

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are for general information only.
3. Refer to applicable symbol list.
4. Dimensioning and tolerancing in accordance with ANSI Y14.5-1973.
5. Leads within .005 inch (0.13 mm) radius of true position (TP) at gauge plane with maximum material condition and unit installed.
6. e_1 and e applies in zone L_1 when unit installed.
7. α applies to spread leads prior to installation.
8. N is the number of terminal positions.
9. Outlines on which the seating plane is coincident with the base plane ($A_1 = 0$), terminals lead standoffs are not required, and B_1 may equal B along any part of the lead above the seating/base plane.
10. E_1 does not include particles of package materials.
11. This dimension shall be measured with the device seated in the seating plane gauge JEDEC outline No. GS-3.

FIGURE 1. Dimensions and configuration (MO-036AB) - Continued.



Inches	mm
.018	0.46
.019	0.48
.025	0.64
.026	0.66
.064	1.63
.087	2.21

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ± 0.005 inch (0.13 mm).
4. The physical characteristics of the die thickness are .0187 inch (0.475 mm). The back metal is gold (Au). The top metal is aluminum and the back contact is the drain.

FIGURE 2. JANHCA and JANKCA die dimensions.

1.4 Primary electrical characteristics at $T_C = +25^\circ\text{C}$.

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0 \text{ V dc}$ $I_D = 1 \text{ mA dc}$	$V_{GS(th)1}$ $V_{DS} \geq V_{GS}$ $I_D = 0.25 \text{ mA}$		$\text{Max } I_{DSS1}$ $V_{GS} = 0 \text{ V dc}$	$\text{Max } r_{DS(on)1} \text{ } 1/$ $V_{GS} = 10 \text{ V dc}$ $I_D = I_{D2}$
				$V_{DS} = 80 \text{ percent}$ of rated V_{DS}	$T_J = +25^\circ\text{C}$
	<u>V dc</u>	<u>V dc</u>		<u>$\mu\text{A dc}$</u>	<u>ohms</u>
	<u>Min</u> <u>Max</u>				
ZN7334	100	2.0	4.0	25	0.70

1/ Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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

MILITARY

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

STANDARD

MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, 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 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.

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

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-S-19500.

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.

3.5.1 Handling. MOS devices must be handled with certain precautions to avoid damage due to the accumulation of electrostatic charge. The following handling practices shall be followed:

- a. Devices shall be handled on benches with conductive handling devices.
- 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 shall be exercised, during test and troubleshooting, to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source, $R \leq 100 \text{ k}$, whenever bias voltage is to be applied drain to source.

4. QUALITY ASSURANCE PROVISIONS

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

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

4.2.1 Group E inspection. Group E inspection shall be conducted in accordance with MIL-S-19500 and 4.4.4 herein.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-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 II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
1/ 2/	Gate stress test, (see 4.5.5)	Gate stress test, (see 4.5.5)
1/	Method 3161, (see 4.5.3)	Method 3161, (see 4.5.3)
9 1/	I_{GSS1} , I_{DSS1} , subgroup 2 of table I herein	Subgroup 2 of table I herein
10	Method 1042, test condition B	Method 1042, test condition B
11	I_{GSS1} , I_{DSS1} , $r_{DS(on)1}$, $V_{GS(th)1}$ Subgroup 2 of table I herein; $\Delta I_{GSS1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater	I_{GSS1} , I_{DSS1} , $r_{DS(on)1}$, $V_{GS(th)1}$, subgroup 2 of table I herein
12	Method 1042, test condition A, $t = 240$ hours	Method 1042, test condition A
13	Subgroups 2 and 3 of table I herein; $\Delta I_{GSS1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater $\Delta r_{DS(on)1} = \pm 20$ percent of initial value $\Delta V_{GS(th)1} = \pm 20$ percent of initial value	Subgroup 2 of table I herein; $\Delta I_{GSS1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater $\Delta r_{DS(on)1} = \pm 20$ percent of initial value $\Delta V_{GS(th)1} = \pm 20$ percent of initial value

1/ Shall be performed anytime before screen 10.

2/ This is a stress test designed to insure a rugged product.

4.3.1 Screening (JANC). Screening shall be in accordance with MIL-S-19500 (see appendix H). As a minimum, die shall be 100 percent probed in accordance with group A.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500 and as specified herein. 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. Electrical measurements shall be in accordance with the table I, subgroup 2, group A 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 (JAN, JANTX, and JANTXV) of MIL-S-19500 and as follows. Electrical measurements shall be in accordance with the table I, subgroup 2, group A herein.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Condition
B3	1051	Condition G.
B4		Not applicable.
B5	1042	Condition A, $V_{DS} = 80$ percent of rated, $T_A = +175^\circ\text{C}$, $t = 120$ 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 V. Electrical measurements in accordance with table I, subgroup 2 herein. No more than 15 percent of the sample shall be permitted to have a $\Delta V_{BR(DSS)}$ shift of more than 10 percent and ΔI_{DSS} greater than $50 \mu\text{A}$.
B5	1042	Condition B, $V_{GS} = 80$ percent of rated, gate stress $T_A = +175^\circ\text{C}$, $t = 24$ hours.
B6	3161	See 4.5.2.

4.4.2.2 Group B inspection, table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B2	1051	Condition G.
B3	1042	Condition A, $V_{DS} = 80$ percent of rated, $T_A = +150^\circ\text{C}$, $t = 160$ hours.
B3	1042	Condition B, $V_{DS} = 80$ percent of rated, $T_A = +150^\circ\text{C}$, $t = 24$ hours.
B5 and B6		Not applicable.

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 as follows. Electrical measurements shall be in accordance with the table I, subgroup 2, group A herein.

Subgroup	Method	Condition
C2	2036	Test condition E: The sampling plan applies to the number of leads tested. A minimum of three devices shall be tested.
C6	1042	Condition A, $V_{DS} = 80$ percent of rated $T_A = +150^\circ\text{C}$, $t = 340$ hours. Electrical measurements in accordance with table I, subgroup 2 herein.
C6	1042	Condition B, $V_{DS} = 80$ percent of rated, $T_A = +150^\circ\text{C}$, $t = 24$ hours.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-S-19500. Electrical measurements shall be in accordance with the table I, subgroup 2, group A herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>	<u>Sampling plan</u>
E1	1051		22 devices, $c = 0$
E2	1042	Test condition A, 1,000 hours; Electrical measurements, table I, subgroup 2 herein.	22 devices, $c = 0$
E2	1042	Test condition B, 1,000 hours	22 devices, $c = 0$
E3		Not applicable.	
E4	3161	$R_{\theta JA}$ = 90°C/W maximum, see 4.5.2.	5 devices, $c = 0$
E5		Not applicable.	

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. $R_{\theta JA}$ maximum = 90°C/W, for each die.

- | | |
|---|---|
| a. I_M measuring current | 10 mA. |
| b. I_H drain heating current | 0.15 A (minimum). |
| c. t_H heating time | Steady-state (see method 3161 of MIL-STD-750 for definition). |
| d. V_H drain-source heating voltage | 15 V. |
| e. t_{MD} measurement time delay | 30 to 60 μ s. |
| f. t_{SW} sample window time | 10 μ s maximum. |

4.5.3 Thermal impedance ($Z_{\theta JC}$ measurements). The $Z_{\theta JC}$ measurements shall be performed in accordance with MIL-STD-750, method 3161. The maximum limit for $Z_{\theta JC}$ in screening (see table II 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 process monitor.

- | | |
|---|-----------------------|
| a. Measuring current (I_M) | 10 mA. |
| b. Drain heating current (I_H) | .15 A minimum. |
| c. Heating time (t_H) | 100 ms. |
| d. Drain-source heating voltage (V_H) | 15 V minimum. |
| e. Measurement time delay (t_{MD}) | 30 to 60 μ s. |
| f. t_{SW} sample window time | 10 μ s (maximum). |

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Breakdown voltage, drain to source	3407	$V_{GS} = 0$ V dc, $I_D = 1$ mA dc, Condition C	$V_{(BR)DSS}$	100		V dc
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
Gate 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	$V_{GS} = 0$ V dc, $V_{DS} = 80$ percent of rated V_{DS} , Bias condition C	I_{DSS1}		25	μ A dc
Static drain to source on-state resistance	3421	$V_{GS} = 10$ V dc, Pulsed (see 4.5.1), condition A, $I_D =$ rated I_{D2} (see 1.3), $I_D = I_{D1}$ (see 1.3)	$r_{DS(on)1}$		0.70	Ω
			$r_{DS(on)2}$		0.80	Ω
Forward voltage (source drain diode)	4011	Pulsed (see 4.5.1), $V_{GS} = 0$ V dc, $I_D = I_{D1}$	V_{SD}		1.5	V
<u>Subgroup 3</u>						
High temperature operation: $T_C = T_J = +125^\circ\text{C}$						
Gate current	3411	Bias condition C, $V_{GS} = +20$ V dc and -20 V dc, $V_{DS} = 0$ V dc	I_{GSS2}		± 200	nA dc
Drain current	3413	Bias condition C, $V_{GS} = 0$ V dc, $V_{DS} = 80$ percent of rated V_{DS}	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}	$r_{DS(on)3}$		1.4	Ω

See footnote at end table.

TABLE 1. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u> - Continued						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 0.25 \text{ mA dc}$	$V_{GS(th)2}$	1.0		V dc
Low temperature operation:		$T_C = T_J = -55^\circ\text{C}$				
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 0.25 \text{ mA dc}$	$V_{GS(th)3}$		5.0	V dc
<u>Subgroup 4</u>						
Switching time test	3472	$I_D = \text{rated } I_{D1}$, $V_{GS} = 10 \text{ V dc}$, $R_g = 24 \Omega$, $V_{DD} = 0.5 V_{BR(DSS)}$				
Turn-on delay time			$t_{d(on)}$		20	ns
Rise time			t_r		25	ns
Turn-off delay time			$t_{d(off)}$		40	ns
Fall time			t_f		40	ns
<u>Subgroup 5</u>						
Single pulse avalanche energy	3470	See 4.5.4	EAS			
Electrical measurements		Group A, subgroup 2 herein				
Safe operating area test	3474	$V_{DS} = 80 \text{ percent of rated } V_{BR(DSS)}$, $t_p = 10 \text{ ms}$, $I_D = .25 \text{ A}$				
Electrical measurements		Group A, subgroup 2 herein				
<u>Subgroup 6</u>						
Not applicable						

1/ For sampling plan, see MIL-S-19500.

4.5.4 Single pulse avalanche energy E_{AS} .

- a. Peak current (I_{AS}) I_{D1} .
- b. Peak gate voltage (V_{GS}) 10 V dc.
- c. Gate to source resistor (R_{GS}) $25 \leq R_{GS} \leq 200 \Omega$.
- d. Initial case temperature $+25^\circ\text{C}$, $+10^\circ\text{C}$, -5°C .
- e. Inductance $2E_{AS}/(I_{D1})^2 \frac{(V_{BR} - V_{DD})}{V_{BR}}$ mH minimum
- f. Number of pulses to be applied 1 pulse minimum.
- g. Supply voltage (V_{DD}) 25 V dc minimum.

4.5.5 Gate stress test.

- a. $V_{GS} = \pm 30$ V minimum.
- b. $t = 250 \mu\text{s}$ minimum.

5. PACKAGING

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

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-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of the specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
- c. Lead material and finish may be specified (see 3.3.1).

6.3 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC die suppliers with the applicable letter version (example, JANHCA2N7334) will be identified on the QPL.

JANHC and JANKC ordering information	
PIN	Manufacture CAGE
	59993
2N7334 2N7334	JANHCA2N7334 JANKCA2N7334

6.4 Substitution information. Devices covered by this specification are substitutable for the manufacturers' and users' Part or Identifying Number (PIN). This information in no way implies that manufacturers' PIN's are suitable as a substitute for the military PIN's.

Military PIN	Manufacturers' CAGE code	Manufacturers' and users' PIN
2N7334	59993	IRFG110

CONCLUDING MATERIAL

Custodians:

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

Preparing activity:
 DLA - ES

(Project 5961-1768)

Review activities:

Army - SH, AR, MI
 Navy - AS, CG, MC,
 Air Force - 13, 19, 85, 99

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-S-19500/597B

2. DOCUMENT DATE (YYMMDD)
95/04/05

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, QUAD, FIELD EFFECT TRANSISTORS, N-CHANNEL, SILICON TYPE 2N7334, JAN, 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)

7. DATE SUBMITTED
(YYMMDD)

(1) Commercial
(2) AUTOVON
(if applicable)

8. PREPARING ACTIVITY

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Dayton, Ohio 45444-5765

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