

The documentation and process conversion measures necessary to comply with this revision shall be completed by 5 February 2003.

INCH-POUND

MIL-PRF-19500/664A  
5 November 2003  
SUPERSEDING  
MIL-PRF-19500/664  
12 June 1998

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED  
(TOTAL DOSE ONLY) TRANSISTORS, N-CHANNEL, SILICON  
TYPES 2N7431U, 2N7432U and 2N7433U  
JANTXVR, F, G and H; and JANSR, F, G and H

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, radiation hardened (total dose only), power transistor. Two levels of product assurance are provided for each device type specified in MIL-PRF-19500, with avalanche energy maximum rating (E<sub>AS</sub>) and maximum avalanche current (I<sub>AS</sub>).

1.2 Physical dimensions. See figure 1, SMD-2 (surface mount).

\* 1.3 Maximum ratings. Unless otherwise specified, T<sub>C</sub> = +25°C.

Type	P <sub>T</sub> (1)	P <sub>T</sub> T <sub>A</sub> = +25°C (1)	V <sub>DS</sub>	V <sub>DG</sub>	V <sub>GS</sub>	I <sub>D1</sub> (2) (3)	I <sub>D2</sub> T <sub>C</sub> = +100°C (2)	I <sub>S</sub>	I <sub>DM</sub> (4)	T <sub>J</sub> and T <sub>STG</sub>
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A(pk)</u>	<u>°C</u>
2N7431U	300	2.5	60	60	±20	75.0	56.0	75.0	356	-55
2N7432U	300	2.5	100	100	±20	51.0	32.5	51.0	204	to
2N7433U	300	2.5	200	200	±20	43.0	27.0	43.0	172	+150

(1) Derate linearly by 2.4 W/°C for T<sub>C</sub> > +25°C.

(2) The following formula derives the maximum theoretical I<sub>D</sub> limit. I<sub>D</sub> is limited by package and internal wires and may be limited by pin diameter:

$$I_D = \sqrt{\frac{T_{JM} - T_C}{(R_{\theta IC}) \times (R_{DS(on)} \text{ at } T_{JM})}}$$

(3) See figure 2, maximum drain current graph.

(4) I<sub>DM</sub> = 4 X I<sub>D1</sub> as calculated in note (2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAC, Post Office Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0$ $I_D = 1.0$ mA dc	$V_{GS(TH)1}$ $V_{DS} \geq V_{GS}$ $I_D = 1.0$ mA dc	Max $I_{DSS1}$ $V_{GS} = 0$ $V_{DS} = 80$ percent of rated $V_{DS}$	Max $r_{DS(ON)}$ (1) $V_{GS} = 12$ V dc		$R_{\theta JC}$ max	$E_{AS}$ at $I_{D1}$	$I_{AS}$	
				$T_J = +25^\circ\text{C}$ at $I_{D2}$	$T_J = +150^\circ\text{C}$ at $I_{D2}$				
	<u>V dc</u>	<u>V dc</u>		<u><math>\mu\text{A dc}</math></u>	<u>ohm</u>	<u>ohm</u>	<u><math>^\circ\text{C/W}</math></u>	<u>mJ</u>	<u>A</u>
		Min	Max						
2N7431U	60	2.0	4.0	25	0.015	0.036	0.42	500	75.0
2N7432U	100	2.0	4.0	25	0.040	0.100	0.42	500	51.0
2N7433U	200	2.0	4.0	25	0.070	0.175	0.42	500	43.0

(1) Pulsed (see 4.5.1).

## 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

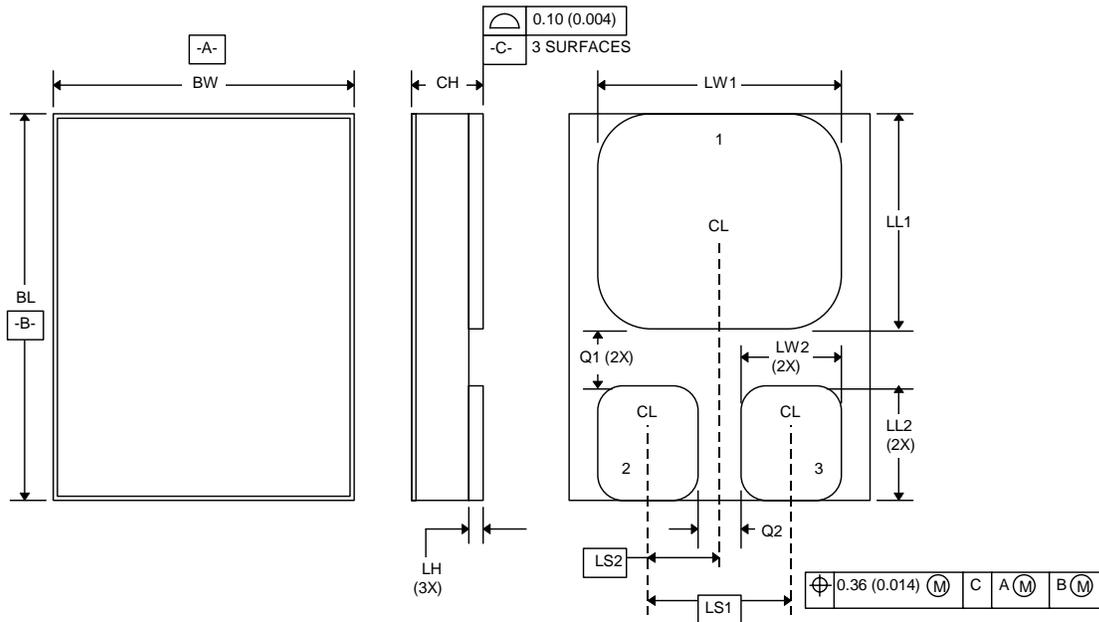
## DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robbins Avenue, 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, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.684	.696	17.38	17.67
BW	.519	.531	13.19	13.48
CH		.142		3.60
LH	.010	.020	0.26	0.50
LW1	.434	.446	11.03	11.32
LW2	.134	.146	3.41	3.70
LL1	.469	.481	11.92	12.21
LL2	.151	.163	3.84	4.14
LS1	.240 BSC		6.10 BSC	
LS2	.120 BSC		3.05 BSC	
Q1	.035		0.89	
Q2	.050		1.27	
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

Notes:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. The lid shall be electrically isolated from the drain, gate and source.
4. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi$ x symbology.

\* FIGURE 1. Physical dimensions for SMD-2 (Surface mount package).

3. REQUIREMENTS

\* 3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

\* 3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

\* 3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and as follows:

$I_{AS}$  .....Rated avalanche current, nonrepetitive  
nC .....nano Coulomb.

\* 3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 herein. Methods used for electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent  $Al_2O_3$  (ceramic).

\* 3.4.1 Terminal material and finish. Terminal material shall be copper-tungsten. Terminal finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of terminal finish is desired, it shall be specified in the acquisition document (see 6.2).

\* 3.4.2 Internal construction. Multiple chip construction is not be permitted to meet the requirements of this specification.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in paragraph 1.3, 1.4 and table I.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in paragraphs 4.4.2 and 4.4.3.

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

3.7.1 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.

- a. Devices should 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 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,  $R \leq 100 \text{ k}\Omega$ , whenever bias voltage is to be applied drain to source.

\* 3.8 Marking. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking of the country of origin may be omitted from the body of the transistor but shall be retained on the initial container.

\* 3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

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.

\* 4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification that did not request the performance of table III tests, the tests specified in table III herein shall be performed by the first inspection lot of this revision to maintain qualification.

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\* 4.3 Screening (JANS and JANTXV 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) (1) (2)	Measurement	
	JANS level	JANTXV levels
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, E <sub>AS</sub> test (see 4.3.2)	Method 3470 of MIL-STD-750, E <sub>AS</sub> test (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)
9	Subgroup 2 of table I herein. I <sub>DSS1</sub> , I <sub>GSSF1</sub> , I <sub>GSSR1</sub> ,	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub> , r <sub>DS(on)</sub> , V <sub>GS(TH)</sub> Subgroup 2 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 10$ $\mu$ A dc or $\pm 100$ percent of initial value, whichever is greater.	I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub> , r <sub>DS(on)</sub> , V <sub>GS(TH)</sub> Subgroup 2 of table I herein
12	MIL-STD-750, method 1042, test condition A	MIL-STD-750, method 1042, test condition A
13	Subgroups 2 and 3 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 10$ $\mu$ A dc or $\pm 100$ 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	Subgroups 2 and 3 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 10$ $\mu$ A dc or $\pm 100$ 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) At the end of the test program, I<sub>GSSF1</sub>, I<sub>GSSR1</sub>, and I<sub>DSS1</sub> are measured.
- (2) An out-of-family program to characterize I<sub>GSSF1</sub>, I<sub>GSSR1</sub>, I<sub>DSS1</sub> and V<sub>GS(th)1</sub> shall be invoked.
- (3) Shall be performed anytime before screen 9.

\* 4.3.1 Gate stress test. Apply  $V_{GS} = 30\text{ V}$  minimum for  $t = 250\ \mu\text{s}$  minimum.

\* 4.3.2 Single pulse avalanche energy  $E_{AS}$ .

- a. Peak current ( $I_{AS}$ ) .....  $I_{AS} = I_{D1}$ .
- b. Peak gate voltage ( $V_{GS}$ ) .....  $12\text{ V}$ .
- c. Gate to source resistor ( $R_{GS}$ ).....  $25\ \Omega \leq R_{GS} \leq 200\ \Omega$ .
- d. Initial case temperature ( $T_C$ ) .....  $+25^\circ\text{C} +10^\circ\text{C}, -5^\circ\text{C}$ .
- e. Inductance .....  $\left[ \frac{2E_{AS}}{(I_{D1})^2} \right] \left[ \frac{V_{BR} - V_{DD}}{V_{BR}} \right]$  *mH minimum*
- f. Number of pulses to be applied .....  $1\text{ pulse minimum}$ .
- g. Supply voltage ( $V_{DD}$ ) .....  $25\text{ V}$  ( $50\text{ V}$  for 2N7433).

\* 4.3.3 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 (not to exceed figure 3, thermal impedance curves and the table I, subgroup 2 limits) for  $Z_{\theta JC}$  in screening (table VI of MIL-PRF-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 bar 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.

- a. Measuring current ( $I_M$ ) .....  $10\text{ mA}$ .
- b. Drain heating current ( $I_H$ ) .....  $10\text{ A minimum}$ .
- c. Heating time ( $t_H$ ) .....  $30\text{ ms}$ .
- d. Drain-source heating voltage ( $V_H$ ).....  $20\text{ V}$ .
- e. Measurement time delay ( $t_{MD}$ ) .....  $30\text{ to }60\ \mu\text{s}$ .
- f. Sample window time ( $t_{SW}$ ).....  $10\ \mu\text{s maximum}$ .

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein. Alternate flow is allowed for quality conformance inspection in accordance with MIL-PRF-19500.

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

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition G, 100 cycles.
B3	2075	See 3.4.2.
B3	2077	SEM qualification may be performed anytime prior to lot formation.
B4	1042	Intermittent operation life, condition D, 2000 cycles . No heat sink or forced air cooling on the device shall be permitted during the on cycle; $t_{on} = 30$ seconds minimum.
B5	1042	Accelerated steady-state gate bias, condition B, $V_{GS} = \text{rated}$ , $T_A = +175^{\circ}\text{C}$ , $t = 24$ hours minimum.
B5	1042	Accelerated steady-state reverse bias, condition A, $V_{DS} = \text{rated}$ , $T_A = +175^{\circ}\text{C}$ , $t = 120$ hours minimum.
B5	2037	Bond strength; test condition A.
B6	3161	Thermal resistance, see 4.5.2.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	1051	Test condition G, 25 cycles.
B3	1042	Intermittent operation life, condition D, 2000 cycles . No heat sink or forced air cooling on the device shall be permitted during the on cycle; $t_{on} = 30$ seconds minimum.
B3	2037	Test condition A.
B5	3161	Thermal resistance, see 4.5.2.

\* 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 tests of table I, subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Not applicable.
C5	3161	Thermal resistance, see 4.5.2.
C6	1042	Intermittent operation life, condition D, 6000 cycles . No heat sink or forced air cooling on the device shall be permitted during the on cycle; ton = 30 seconds minimum.

4.4.4 Group D Inspection. Group D inspection shall be conducted in accordance with table VIII of MIL-PRF-19500 and table II herein.

\* 4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 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 resistance. Thermal resistance measurements shall be performed in accordance with method 3161 of MIL-STD-750. The maximum limit of  $R_{\theta JC(max)} = 0.42^{\circ}C/W$ . The following parameter measurements shall apply:

- a. Measuring current ( $I_M$ ) ..... 10 mA.
- b. Drain heating current ( $I_H$ ) ..... 10 A minimum.
- c. Heating time ( $t_H$ ) ..... Steady-state (see MIL-STD-750, method 3161 for definition).
- d. Drain-source heating voltage ( $V_H$ )..... 20 V.
- e. Measurement time delay ( $t_{MD}$ ) ..... 30 to 60  $\mu s$ .
- f. Sample window time ( $t_{SW}$ ) ..... 10  $\mu s$  maximum.

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\* TABLE I. Group A inspection.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Thermal impedance <u>2</u> /	3161	See 4.3.3	$Z_{\theta JC}$		0.32	$^{\circ}C/W$
Breakdown voltage, drain to source	3407	$V_{GS} = 0 V$ ; $I_D = 1 mA$ dc bias condition C	$V_{(BR)DSS}$			
2N7431U				60		V dc
2N7432U				100		V dc
2N7433U				200		V dc
Gate to source voltage threshold	3403	$V_{DS} \geq V_{GS}$ $I_D = 1 mA$ dc	$V_{GS(TH)1}$	2.0	4.0	V dc
Gate current	3411	$V_{GS} = +20 V$ dc $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{GSSF1}$		+ 100	nA dc
Gate current	3411	$V_{GS} = -20 V$ dc $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{GSSR1}$		-100	nA dc
Drain current	3413	$V_{GS} = 0 V$ dc, Bias condition C $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{DSS1}$		25	$\mu A$ dc
Static drain to source On-state resistance	3421	$V_{GS} = 12 V$ dc, condition A pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(on)1}$			
2N7431U					0.015	ohm
2N7432U					0.040	ohm
2N7433U					0.070	ohm
Static drain to source On-state resistance	3421	$V_{GS} = 12 V$ dc, condition A pulsed (see 4.5.1), $I_D = I_{D1}$	$r_{DS(on)2}$			
2N7431U					0.018	ohm
2N7432U					0.045	ohm
2N7433U					0.077	ohm
Forward voltage	4011	Pulsed (see 4.5.1), $I_D = I_{D1}$ $V_{GS} = 0 V$ dc	$V_{SD}$			
2N7431U					1.5	V dc
2N7432U					1.8	V dc
2N7433U					1.8	V dc

See footnotes at end of table.

\* TABLE I. Group A inspection - Continued.

Inspection 1/  <u>Subgroup 3</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
High temperature operation:		$T_C = T_J = +125^\circ\text{C}$				
Gate current	3411	$V_{GS} = +20$ and $-20$ V dc bias condition C, $V_{DS} = 0$	$I_{GSS2}$		$\pm 200$	nA dc
Drain current	3413	$V_{GS} = 0$ V; bias condition C $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{DSS2}$		0.25	mA dc
Static drain to source On-state resistance	3421	$V_{GS} = 12$ V dc pulsed (see 4.51), $I_D = I_{D2}$	$r_{DS(on)3}$		0.030 0.085 0.140	ohm ohm ohm
2N7431U 2N7432U 2N7433U						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ , $I_D = 1$ 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	$V_{DS} \geq V_{GS}$ , $I_D = 1$ mA dc	$V_{GS(TH)3}$		5.0	V dc
<u>Subgroup 4</u>						
Forward transconductance	3475	$I_D = \text{rated } I_{D2}$ , $V_{DD} = 15$ V (see 4.5.1)	$g_{FS}$			
2N7431U 2N7432U 2N7433U				18.0 16.0 9.0		S S S
Switching time test	3472	$I_D = I_{D1}$ , $V_{GS} = 12$ V dc $R_G = 2.35\Omega$ , $V_{DD} = 50$ percent of rated $V_{DS}$				
Turn-on delay time			$t_{d(on)}$		27 35 50	ns ns ns
2N7431U 2N7432U 2N7433U						
Rise time			$t_r$		120 150 200	ns ns ns
2N7431U 2N7432U 2N7433U						
Turn-off delay time			$t_{d(off)}$		120 150 200	ns ns ns
2N7431U 2N7432U 2N7433U						

See footnotes at end of table.

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\* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - Continued						
Fall time 2N7431U 2N7432U 2N7433U			$t_f$		100 130 130	ns ns ns
<u>Subgroup 5</u>	3474					
Safe operating area test (high voltage)		See figures 4, 5, and 6 $t_p = 10$ ms minimum $V_{DS} = 80$ percent of maximum rated $V_{DS}$ , ( $V_{DS} \leq 200$ )				
Electrical measurements		See table I, subgroup 2				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition B				
On-state gate charge 2N7431U 2N7432U 2N7433U			$Q_{g(on)}$		270 310 290	nC nC nC
Gate to source charge 2N7431U 2N7432U 2N7433U			$Q_{gs}$		60 53 42	nC nC nC
Gate to drain charge 2N7431U 2N7432U 2N7433U			$Q_{gd}$		110 110 120	nC nC nC
Reverse recovery time 2N7431U 2N7432U 2N7433U	3473	$di/dt \leq 100$ A/ $\mu$ s, $V_{DD} \leq 50$ V, $I_D = I_{D1}$	$t_{rr}$		360 520 820	ns ns ns

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

2/ This test is required for the following end-point measurement only (not intended for screen 9, 11, or 13): JANS, table VIa of MIL-PRF-19500, group B, subgroups 3 and 4; JANTEX, table VIb of MIL-PRF-19500, group B, subgroups 2 and 3; and table VII of MIL-PRF-19500, group C, subgroup 6, and table IX of MIL-PRF-19500, group E, subgroup 1.

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\* TABLE II. Group D inspection.

Inspection 1/ 2/	MIL-STD-750		Symbol	Preirradiation limits				Postirradiation limits				Unit
	Method	Conditions		R		3/ F, G and H		R		3/ F, G and H		
				Min	Max	Min	Max	Min	Max	Min	Max	
<u>Subgroup 1</u>												
Not applicable												
<u>Subgroup 2</u>		TC = +25°C										
Steady-state total dose irradiation (VGS bias) 4/	1019	VGS = 12V VDS = 0										
Steady-state total dose irradiation (VDS bias) 4/	1019	VDS = 80% of rated VDS (pre-irradiation) VGS = 0										
Pre & Post electricals												
Breakdown voltage, drain to source	3407	VGS = 0 ID = 1 mA Bias Cond. C	VBRDSS									
2N7431U				60		60		60		60		V dc
2N7432U				100		100		100		100		V dc
2N7433U				200		200		200		200		V dc
Gate to source voltage (threshold)	3403	VDS ≥ VGS	VGSth1									
2N7431U				2.0	4.0	2.0	4.0	2.0	4.0	1.25	4.5	V dc
2N7432U				2.0	4.0	2.0	4.0	2.0	4.0	1.25	4.5	V dc
2N7433U				2.0	4.0	2.0	4.0	2.0	4.0	1.25	4.5	V dc
Gate current	3411	VGS = 20 V VDS = 0 Bias Cond. C	IGSSF1		100		100		100		100	nA dc
Gate current	3411	VGS = -20 V VDS = 0 Bias Cond. C	IGSSR1		-100		-100		-100		-100	nA dc
Drain current	3413	VGS = 0 Bias Cond. C VDS = 80% of rated VDS (pre-irradiation)	IDSS1		25		25		25		50	µA dc

See footnotes at end of table

\* TABLE II. Group D inspection - Continued.

Inspection <u>1/ 2/</u>	MIL-STD-750		Symbol	Preirradiation limits				Postirradiation limits				Unit
	Method	Conditions		R		<u>3/</u> F, G and H		R		<u>3/</u> F, G and H		
				Min	Max	Min	Max	Min	Max	Min	Max	
Static drain to source on-state voltage  2N7431U 2N7432U 2N7433U	3405	V <sub>GS</sub> = 12 V Cond. A pulsed (see 4.5.1)  I <sub>D</sub> = I <sub>D2</sub>	V <sub>DSon1</sub>									
					0.840		0.840		0.840		1.400	V dc
					1.300		1.300		1.300		1.852	V dc
				1.890		1.890		1.890		2.970	Vdc	
Forward voltage source to drain diode  2N7431U 2N7432U 2N7433U	4011	V <sub>GS</sub> = 0  I <sub>D</sub> = I <sub>D1</sub>	V <sub>SD</sub>									
					1.5		1.5		1.5		1.5	V dc
					1.8		1.8		1.8		1.8	V dc
					1.8		1.8		1.8		1.8	V dc

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

2/ Group D qualification may be performed anytime prior to lot formation. Wafers qualified to these group D, QCI requirements may be used for any other specification utilizing the same die design.

3/ The F designation represent devices which pass end-points at 100k and 300k Rads (Si). The G designation represents devices which pass 100k, 300k and 600k Rads (Si) end-points. H must meet end-points for 100k, 300k, 600k and 1000k Rads (Si).

4/ Separate samples shall be pulled for each bias.

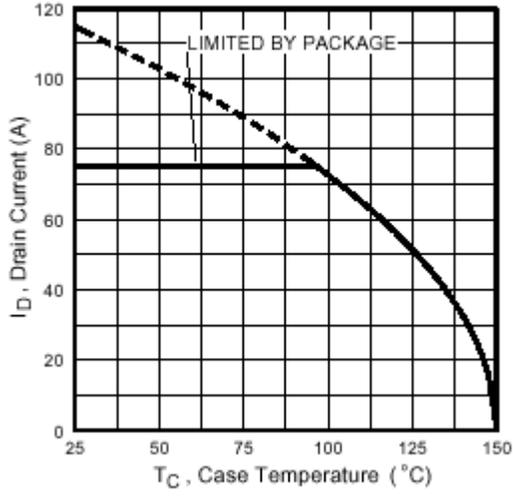
5/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in it's qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

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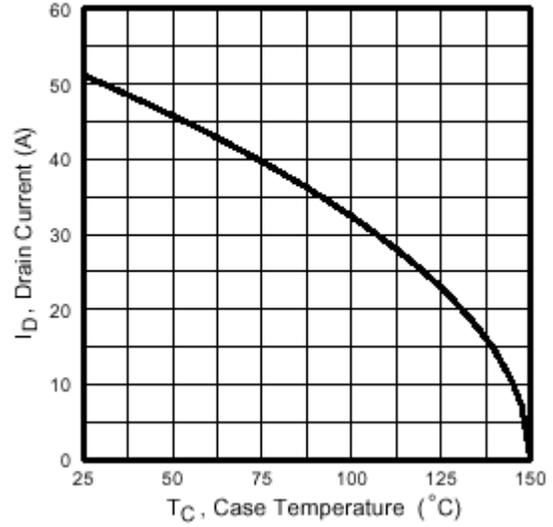
\* TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
<u>Subgroup 1</u>			12 devices c = 0
Temperature cycling	1051	Test condition G, 500 cycles	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2.	
<u>Subgroup 2 1/</u>			12 devices c = 0
Steady-state reverse bias	1042	Condition A, 1,000 hours.	
Electrical measurements		See table I, subgroup 2.	
Steady-state gate bias	1042	Condition B, 1,000 hours.	
Electrical measurements		See table I, subgroup 2.	
<u>Subgroup 3</u>			3 devices, c = 0
DPA	2102		
<u>Subgroup 4</u>			sample size N/A
Thermal impedance curves		Each supplier shall submit their (typical) design thermal impedance curves. In addition, test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 6</u>			3 devices
ESD	1020	Not required for devices classified as ESD class 1.	
<u>Subgroup 7</u>			
Commutating diode for safe operating area test procedure for measuring dv/dt during reverse recovery of power MOSFET transistors or insulated gate bipolar transistors	3476		22 devices c = 0

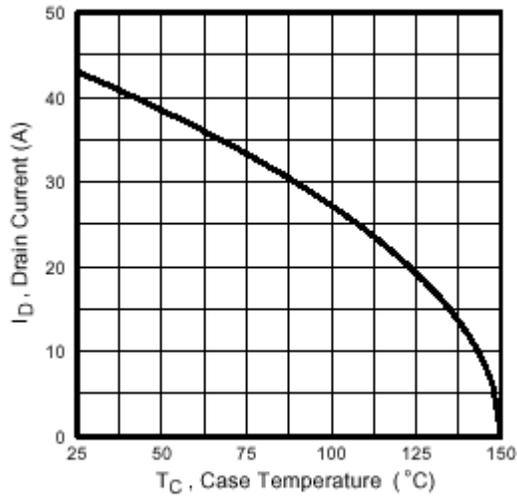
1/ A separate sample may be pulled for each test condition.



2N7431U

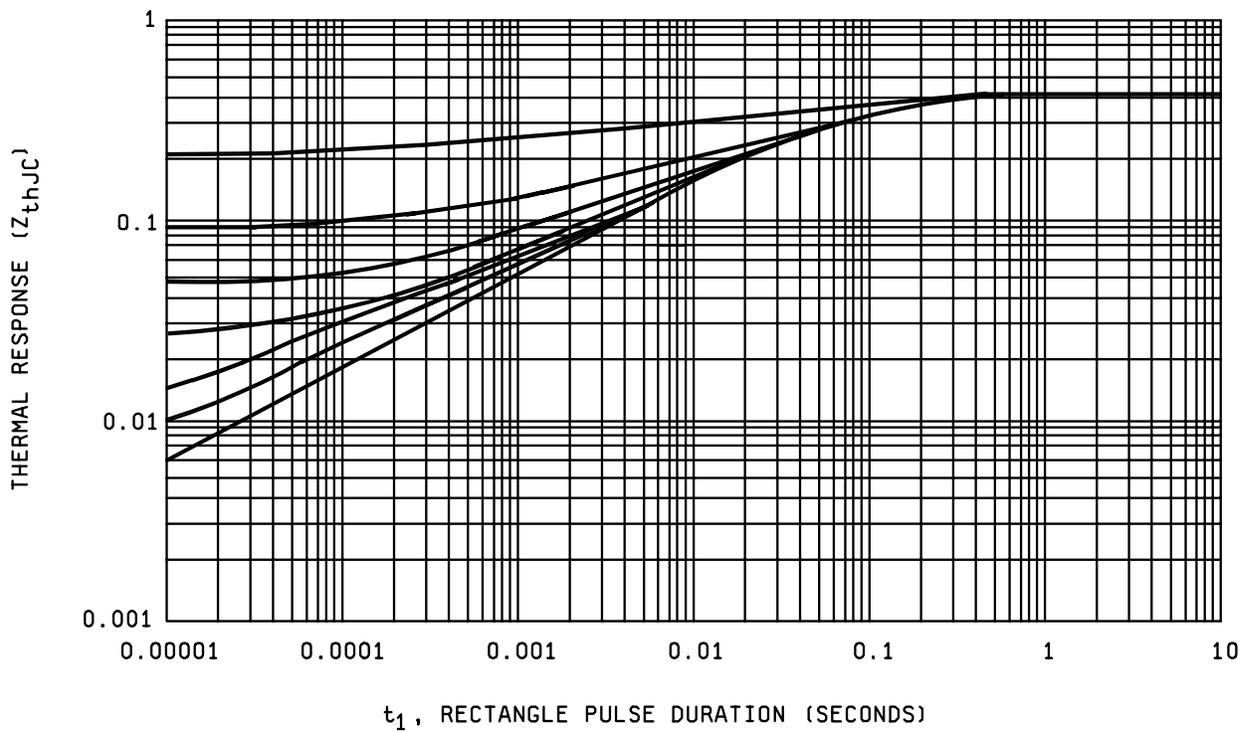


2N7432U



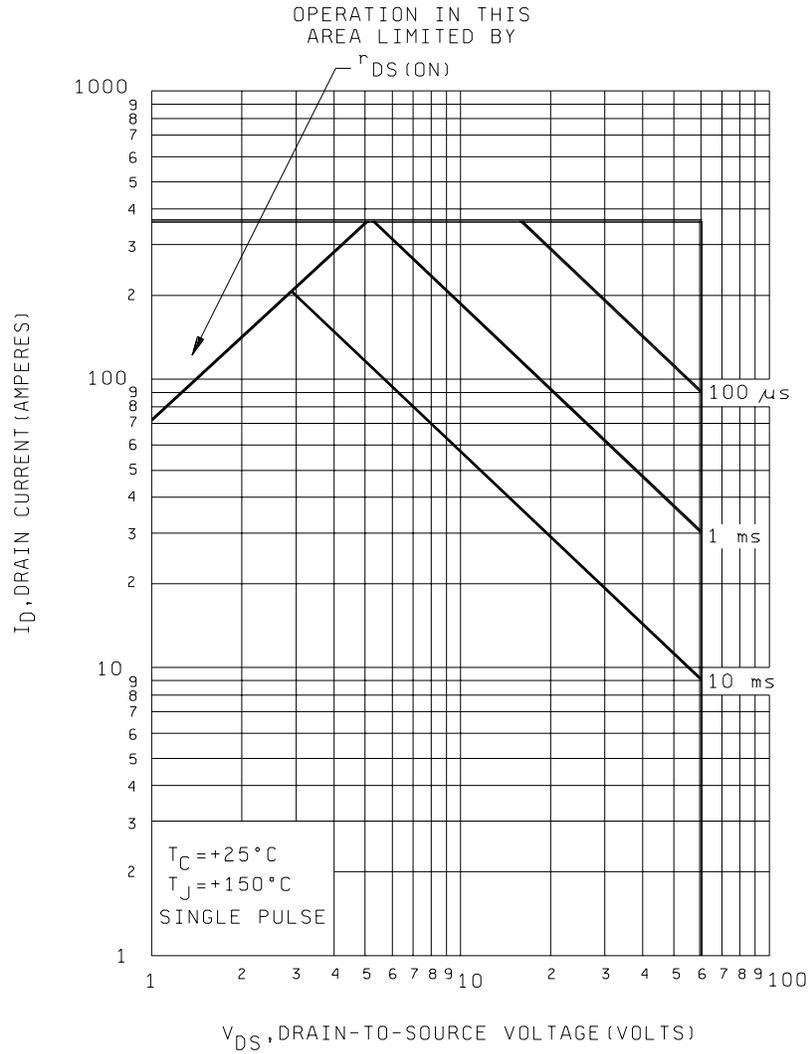
2N7433U

\* FIGURE 2. Maximum drain current vs case temperature graphs.



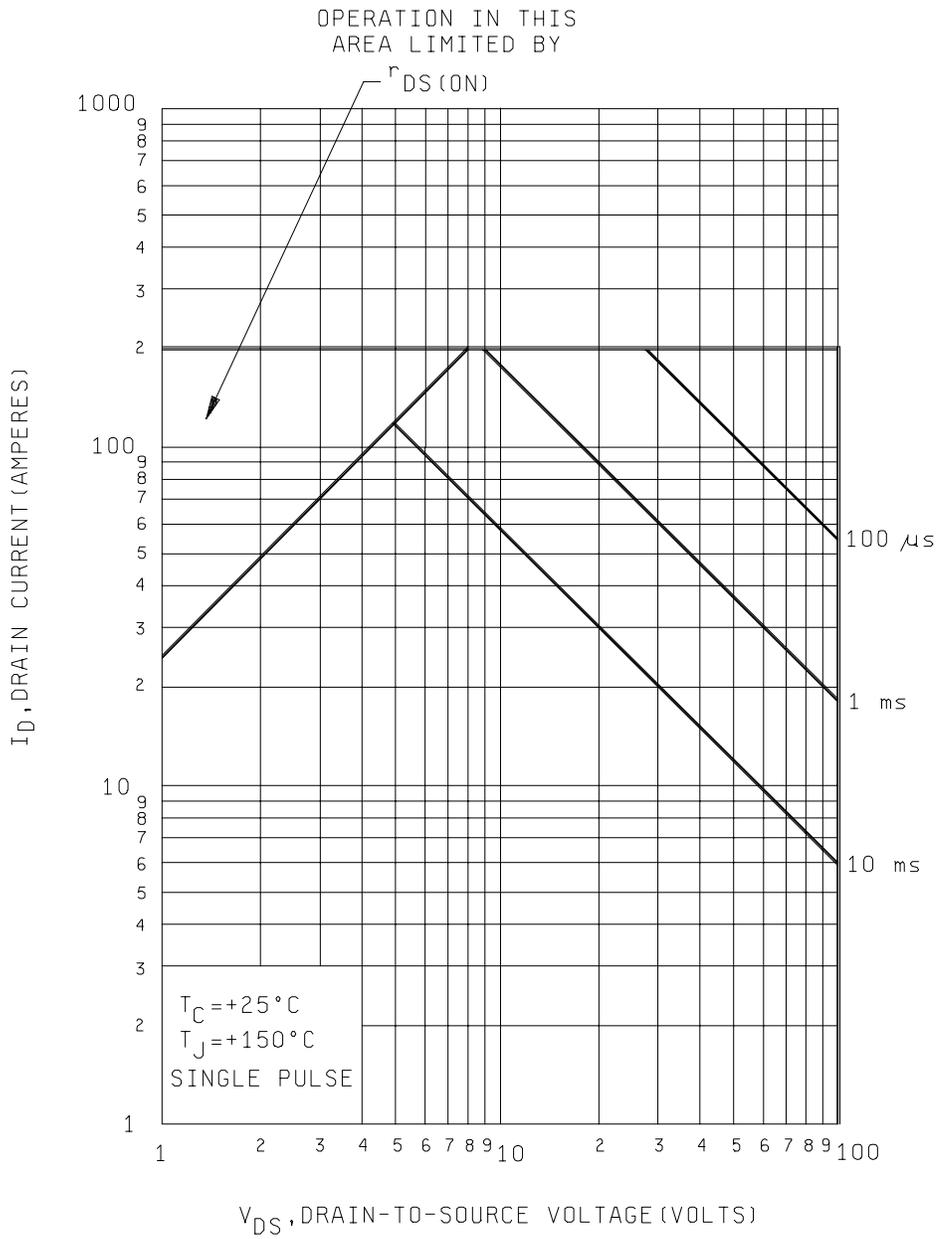
\* FIGURE 3. Thermal response curve.

2N7431U

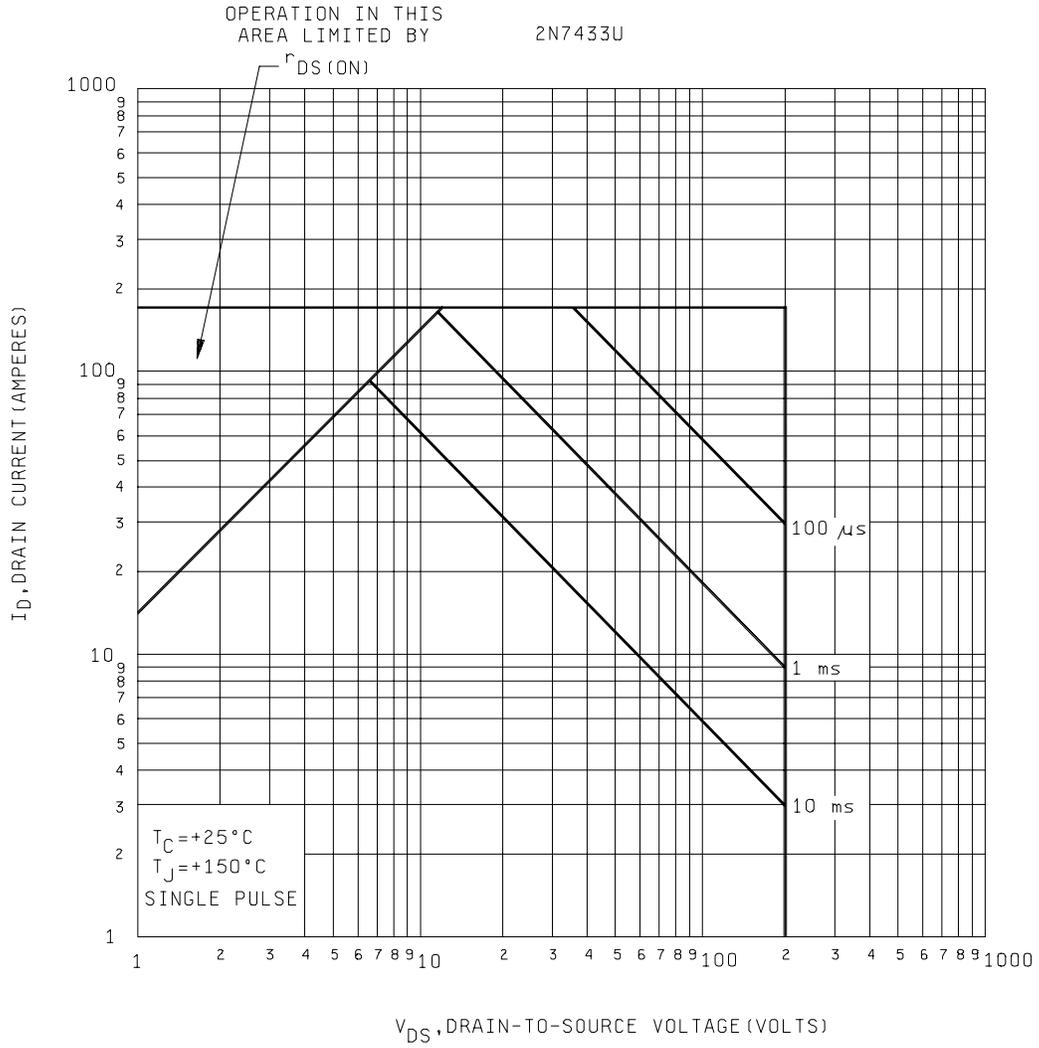


\* FIGURE 4. Safe operating area graph for 2N7431U.

2N7432U



\* FIGURE 5. Safe operating area graph for 2N7432U.



\* FIGURE 6. Safe operating area graph for 2N7433U.

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 materiel 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 Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

\* 6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

\* 6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation and if required, the specific issue of individual documents referenced (see 2.2.1).
- c. Packaging requirements (see 5.1).
- d. Lead finish (see 3.4.1).
- e. Type designation and quality assurance level.

\* 6.3 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 Manufacturers' List (QML) 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000.

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

Preferred types Military PIN	Commercial PIN (1)
2N7431U 2N7432U 2N7433U	IRHNA_064 IRHNA_160 IRHNA_260

- (1) IRHNA7: 100k RAD (Si)
- IRHNA3: 300k RAD (Si)
- IRHNA4: 600k RAD (Si)
- IRHNA8: 1000k RAD (Si)

\* 6.5 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:  
Army - CR  
Navy - EC  
Air Force - 11  
NASA - NA  
DLA - CC

Preparing activity:  
DLA - CC  
  
(Project 5961-2833)

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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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.

<b>I RECOMMEND A CHANGE:</b>	1. DOCUMENT NUMBER MIL-PRF-19500/664A	2. DOCUMENT DATE 5 November 2003
3. <b>DOCUMENT TITLE</b> SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED (TOTAL DOSE ONLY) TRANSISTORS, N-CHANNEL, SILICON TYPES 2N7431U, 2N7432U and 2N7433U JANTXVR, F, G and H; and JANSR, F, G and H		
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) COMMERCIAL DSN FAX EMAIL	7. DATE SUBMITTED
8. PREPARING ACTIVITY		
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c. ADDRESS Defense Supply Center Columbus ATTN: DSCC-VAC P.O. Box 3990 Columbus, OH 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533 Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888      DSN 427-6888	