The documentation and process conversion measures necessary to comply with this revision shall be completed by 27 January 2004.

INCH-POUND

MIL-PRF-19500/661A
27 October 2003
SUPERSEDING
MIL-PRF-19500/661
18 August 1998

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED
(TOTAL DOSE AND SINGLE EVENT EFFECTS) TRANSISTORS, N-CHANNEL, SILICON,
TYPES 2N7444, 2N7434, 2N7391, AND 2N7392,
JANTXVR, AND JANSR

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 and single event effects), power transistor intended for use in high density power switching applications. Two levels of product assurance are provided for each device type specified in MIL-PRF-19500, with avalanche energy maximum rating (E_{AS}) and maximum avalanche current (I_{AS}).

1.2 Physical dimensions. See figure 1, TO-254AA.

* 1.3 Maximum ratings. Unless otherwise specified, T_C = +25°C.

Type	P_T (1)	P_T T_A = +25°C	V_{DS}	V_{DG}	V_{GS}	I_{D1} (2) (3)	I_{D2} T_C = +100°C	I_S (2)	I_{DM} (4)	Top and T_{STG}	V_{ISO} 100,000 ft altitude
	W	W	V dc	V dc	V dc	A dc	A dc	A dc	A(pk)	°C	V dc
2N7444	250	3.0	200	200	±20	35.0	25.0	35.0	140	-55	NA
2N7434	250	3.0	250	250	±20	31.0	19.0	31.0	124	to	NA
2N7391	250	3.0	400	400	±20	22.0	14.0	22.0	88	+150	400
2N7392	250	3.0	500	500	±20	18.0	11.7	18.0	72		500

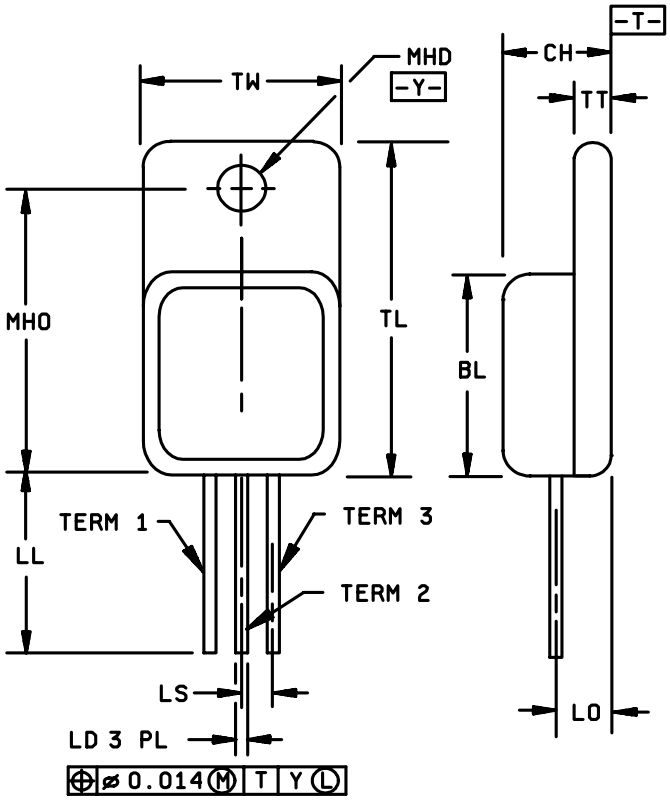
(1) Derate linearly 2.0 W/°C for T_C > +25°C.
(2) The following formula derives the maximum theoretical I_D limit. I_D is limited by package and internal wires and may be limited by pin diameter:

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

(3) See figure 2, maximum drain current graphs.
(4) I_{DM} = 4 x I_{D1} 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.

Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.535	.545	13.59	13.89
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	1.53	3.78
MHO	.665	.685	16.89	17.40
TL	.790	.800	20.07	20.32
TT	.040	.050	1.02	1.27
TW	.535	.545	13.59	13.89
Term 1	Drain			
Term 2	Source			
Term 3	Gate			



NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Refer to applicable symbol list.
4. Dimensioning and tolerating are in accordance with ASME Y14.5M.
5. All terminals are isolated from case.

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

1.4 Primary electrical characteristics at T_C = +25°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°C at I_{D2}	T_J = +150°C at I_{D2}			
	V dc	V dc		µA dc	ohm	ohm	°C/W	mJ	A
		Min	Max						
2N7444	200	2.5	4.5	50	0.070	0.150	0.50	500	35.0
2N7434	250	2.5	4.5	50	0.110	0.250	0.50	500	31.0
2N7391	400	2.5	4.5	50	0.200	0.450	0.50	500	22.0
2N7392	500	2.5	4.5	50	0.320	0.700	0.50	500	18.0

(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.

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 physical dimensions. The Interface and physical dimensions shall be as specified in MIL-PRF-19500, and herein. Methods used for electrical isolation of the terminal feedthroughs shall employ materials that contain a minimum of 90 percent AL_2O_3 (ceramic). Examples of such construction techniques are metallized ceramic eyelets.

* 3.4.1 Lead 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 and herein. Where a choice of lead material or 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 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

* 3.6.1 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 3.6).

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, $R \leq 100$ k, whenever bias voltage is to be applied drain to source.

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

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

* 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 and tables I, II, and III).

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 associated 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.

* 4.2.1.1 Single event effects (SEE). Design capability shall be tested on the initial qualification and thereafter whenever a major die design or process change is introduced. Figure 3 illustrates the design safe operation area. End-point electrical measurements shall be in accordance with table III.

* 4.3 Screening (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) (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 (see 4.3.2), optional	Method 3470 of MIL-STD-750 (see 4.3.2), optional
(3) 3c	Method 3161 of MIL-STD-750 (see 4.3.3)	Method 3161 of MIL-STD-750 (see 4.3.3)
9	Subgroup 2 of table I herein. I_{GSS}, I_{DSS1}	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	I_{GSSF1}, I_{GSSR1} I_{DSS1}, $r_{DS(on)}$, $V_{GS(TH)}$ Subgroup 2 of table I herein. ΔI_{GSSF1} = ± 20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI_{GSSR1} = ± 20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI_{DSS1} = ± 10 µA dc or ± 100 percent of initial value, whichever is greater.	I_{GSSF1}, I_{GSSR1} I_{DSS1}, $r_{DS(on)}$, $V_{GS(TH)}$ Subgroup 2 of table I herein.
12	Method 1042 of MIL-STD-750, test condition A	Method 1042 of MIL-STD-750, test condition A
13	Subgroups 2 and 3 of table I herein. ΔI_{GSSF1} = ± 20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI_{GSSR1} = ± 20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI_{DSS1} = ± 10 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_{GSSF1} = ± 20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI_{GSSR1} = ± 20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI_{DSS1} = ± 10 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) At the end of the test program, I_{GSSF1}, I_{GSSR1}, and I_{DSS1} are measured.
(2) An out-of-family program to characterize I_{GSSF1}, I_{GSSR1}, I_{DSS1}, and $V_{GS(th)1}$ shall be invoked.
(3) Shall be performed anytime before screen 9.

* 4.3.1 Gate stress test. Apply V_{GS} = 30 V minimum for t = 250 µs minimum.

* 4.3.2 Single pulse avalanche energy E_{AS}.

a. Peak current (I_{AS}) ..... I_{AS}(max)·

b. Peak gate voltage (V_{GS}) ..... 12 V.

c. Gate to source resistor (R_{GS}) ..... $25\Omega \leq R_{GS} \leq 200\Omega$.

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

e. Inductance (L) ..... $L = \left[\frac{2\ E_{AR}}{(I_{DI})^2}\right]\left[\frac{V_{BR} - V_{DD}}{V_{BR}}\right]$ *nH minimum*

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

g. Supply voltage (V_{DD}) ..... 50 V .

* 4.3.3 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 figure 4, 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 mA.

b. Drain heating current (I_H) ..... 8 A minimum.

c. Heating time (t_H) ..... 100 ms.

d. Drain-source heating voltage (V_H) ..... 25 V.

e. Measurement time delay (t_{MD}) ..... 30 to 60 µs.

f. Sample window time (t_{SW})..... 10 µs 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 of 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.

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

Subgroup	Method	Condition
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	Test condition D. The heating cycle shall be 30 seconds minimum.
B5	1042	Accelerated steady-state gate bias, condition B, V_{GS} = rated, T_A = +175°C, t = 24 hours minimum; or, T_A = +150°C, t = 48 hours minimum.
B5	1042	Accelerated steady-state reverse bias, condition A, V_{DS} = rated, T_A = +175°C, t = 120 hours minimum; or, T_A = +150°C, t = 240 hours minimum.
B5	2037	Bond strength; test condition A.
B6	3161	See 4.5.2.

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

Subgroup	Method	Condition
B2	1051	Test condition G, 25 cycles.
B3	1042	Test condition D. The heating cycle shall be 30 seconds minimum.
B3	2037	Test condition A. All internal bond wires for each device shall be pulled separately.
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 VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable of table I, subgroup 2 herein.

Subgroup	Method	Condition
C2	2036	Test condition A; weight = 10 pounds; t = 15 s.
C5	3161	See 4.5.2.
C6	1042	Test condition D. The heating cycle shall be 30 seconds minimum.

4.4.4 Group D Inspection. Group D inspection shall be conducted in accordance with table VII 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 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 $R_{\theta JC(max)}$ = 0.50°C/W. The following parameter measurements shall apply:

a. Measuring current (I_M) ..... 10 mA.

b. Drain heating current (I_H) ..... 8 A minimum.

c. Heating time (t_H) ..... Steady-state (see method 3161 of MIL-STD-750 for definition).

d. Drain-source heating voltage (V_H) ..... 25 V.

e. Measurement time delay (t_{MD}) ..... 30 to 60 µs.

f. Sample window time (t_{SW}) ..... 10 µs maximum.

* TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Thermal impedance 2/	3161	See 4.3.3	$Z_{\theta JC}$		0.39	°C/W
Breakdown voltage, drain to source	3407	V_{GS} = 0 V; I_D = 1 mA dc, bias condition C	$V_{(BR)DSS}$			
2N7444				200		V dc
2N7434				250		V dc
2N7391				400		V dc
2N7392				500		V dc
Gate to source voltage threshold	3403	$V_{DS} \geq V_{GS}$, I_D = 1 mA dc	$V_{GS(TH)1}$	2.5	4.5	V dc
Gate current	3411	V_{GS} = +20 and -20 V dc, V_{DS} = 80 percent of rated V_{DS}	I_{GSS1}		± 100	nA dc
Drain current	3413	V_{GS} = 0 V dc, bias condition C, V_{DS} = 80 percent of rated V_{DS}	I_{DSS1}		50	µA dc
Static drain to source on-state resistance	3421	V_{GS} = 12 V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(on)1}$			
2N7444					0.070	ohm
2N7434					0.110	ohm
2N7391					0.200	ohm
2N7392					0.320	ohm
Static drain to source on-state resistance	3421	V_{GS} = 12 V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	$r_{DS(on)2}$			
2N7444					0.075	ohm
2N7434					0.123	ohm
2N7391					0.210	ohm
2N7392					0.360	ohm
Forward voltage	4011	Pulsed (see 4.5.1), $I_D = I_{D1}$, V_{GS} = 0 V dc	V_{SD}			
2N7444					1.4	V dc
2N7434					1.4	V dc
2N7391					1.4	V dc
2N7392					1.8	V dc

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High temperature operation:		$T_C = T_J = +125°C$				
Gate current	3411	V_{GS} = +20 and -20 V dc, bias condition C, V_{DS} = 0	I_{GSS2}		± 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 4.5.1), $I_D = I_{D2}$	$r_{DS(on)3}$			
2N7444					0.140	ohm
2N7434					0.220	ohm
2N7391					0.390	ohm
2N7392					0.590	ohm
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, I_D = 1 mA dc	$V_{GS(TH)2}$	1.5		V dc
Low temperature operation:		$T_C = T_J = -55°C$				
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, I_D = 1 mA dc	$V_{GS(TH)3}$		5.5	V dc
Subgroup 4						
Forward transconductance	3475	I_D = rated I_{D2}, V_{DD} = 15 V, (see 4.5.1)	g_{FS}			
2N7444				12		S
2N7434				10		S
2N7391				6		S
2N7392				6		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			$t_{d(on)}$			
2N7444					35	ns
2N7434					30	ns
2N7391					28	ns
2N7392					29	ns

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued						
Rise time			t_r			
2N7444					200	ns
2N7434					130	ns
2N7391					97	ns
2N7392					93	ns
Turn-off delay time			$t_{d(off)}$			
2N7444					150	ns
2N7434					100	ns
2N7391					120	ns
2N7392					90	ns
Fall time			t_f			
2N7444					150	ns
2N7434					90	ns
2N7391					72	ns
2N7392					59	ns
Subgroup 5	3474					
Safe operating area test (high voltage)		See figure 3, 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				
Subgroup 6						
Not applicable						
Subgroup 7						
Gate charge	3471	Condition B				
On-state gate charge			$Q_{g(on)}$			
2N7444					260	nC
2N7434					210	nC
2N7391					185	nC
2N7392					180	nC

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 7 - Continued						
Gate to source charge			Q_{gs}			
2N7444					80	nC
2N7434					50	nC
2N7391					35	nC
2N7392					30	nC
Gate to drain charge			Q_{gd}			
2N7444					150	nC
2N7434					110	nC
2N7391					100	nC
2N7392					95	nC
Reverse recovery time	3473	$di/dt \leq 100$ A/µs, $V_{DD} \leq 50$ V, $I_D = I_{D1}$	t_{rr}			
2N7444					650	ns
2N7434					700	ns
2N7391					720	ns
2N7392					800	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; JANTXV, 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.

* TABLE II. Group D inspection.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Preirradiation limits		Postirradiation limits		Unit
	Method	Conditions		R		R		
				Min	Max	Min	Max	
Subgroup 1								
Not applicable								
Subgroup 2		T_C = +25°C						
Steady-state total dose irradiation (V_{GS} bias) 4/	1019	V_{GS} = 12V, V_{DS} = 0						
Steady-state total dose irradiation (V_{DS} bias) 4/	1019	V_{GS} = 0, V_{DS} = 80 percent of rated V_{DS} (pre-irradiation)						
End-point electricals								
Breakdown voltage, drain to source	3407	Bias condition C, V_{GS} = 0, I_D = 1 mA	V_{BRDSS}					
2N7444				200		200		V dc
2N7434				250		250		V dc
2N7391				400		400		V dc
2N7392				500		500		V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$	V_{GSth1}					
2N7444				2.5	4.5	2.0	4.5	V dc
2N7434				2.5	4.5	2.0	4.5	V dc
2N7391				2.5	4.5	2.0	4.5	V dc
2N7392				2.5	4.5	2.0	4.5	V dc
Gate current	3411	Bias condition C, V_{GS} = 20 V, V_{DS} = 0	I_{GSSF1}		100		100	nA dc
Gate current	3411	Bias condition C, V_{GS} = -20 V, V_{DS} = 0	I_{GSSR1}		-100		-100	nA dc
Drain current	3413	Bias condition C, V_{GS} = 0, V_{DS} = 80 percent of rated V_{DS} (pre-irradiation)	I_{DSS1}		50		50	µA dc

See footnotes at end of table.

* TABLE II. Group D inspection - Continued.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Preirradiation limits		Postirradiation limits		Unit
	Method	Conditions		R		R		
				Min	Max	Min	Max	
Subgroup 2 - Continued.								
Static drain to source on-state voltage	3405	V_{GS} = 12 V, bias condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	V_{DSon1}					
2N7444					1.75		1.75	V dc
2N7434					2.09		2.09	V dc
2N7391					2.80		2.80	V dc
2N7392					3.744		3.744	Vdc
Forward voltage source to drain diode	4011	V_{GS} = 0, $I_D = I_{D1}$	V_{SD}					
2N7444					1.4		1.4	V dc
2N7434					1.4		1.4	V dc
2N7391					1.4		1.4	V dc
2N7392					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/ 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.
4/ Separate samples shall be pulled for each bias.

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

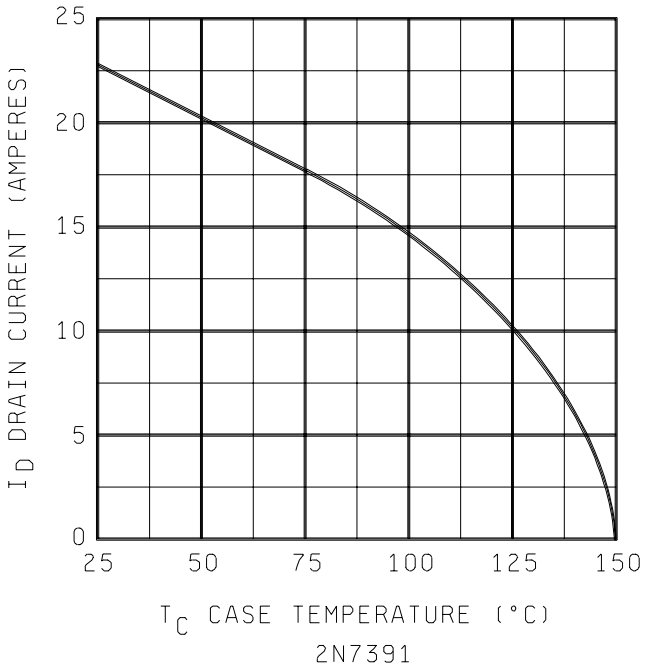
Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
Subgroup 1			12 devices c = 0
Thermal shock (temperature cycling)	1051	Test condition G.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2.	
Subgroup 2 1/			12 devices c = 0
Steady-state gate bias	1042	Condition B, 1,000 hours.	
Electrical measurements		See table I, subgroup 2.	
Steady-state reverse bias	1042	Condition A, 1,000 hours.	
Electrical measurements		See table I, subgroup 2.	
Subgroup 3			3 devices c = 0
DPA	2102		
Subgroup 4			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.	
Subgroup 5			12 devices c = 0
Barometric pressure	1001	V_{DS} = rated; $I_{(ISO)}$ < 0.25 mA, not required for 2N7444 and 2N7434	
Subgroup 6			3 devices
ESD	1020		
Electrical measurements		See table I, subgroup 2.	
Subgroup 7			45 devices c = 0
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		

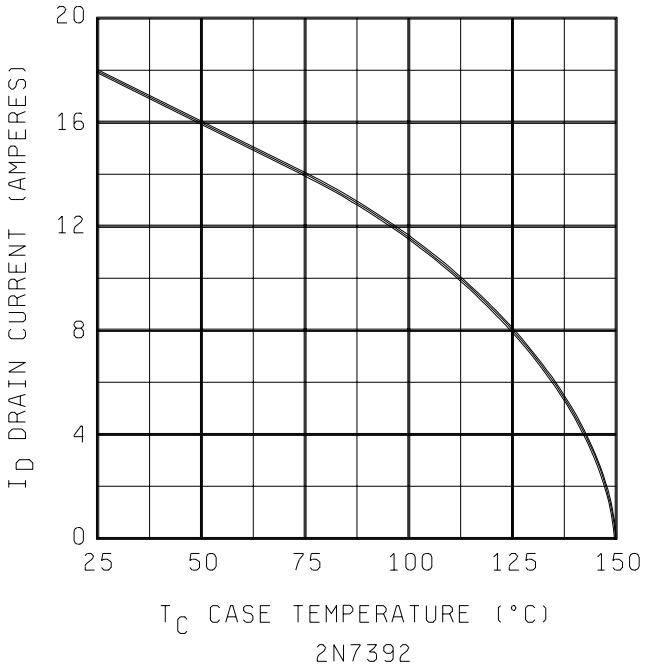
See footnotes at end of table.

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

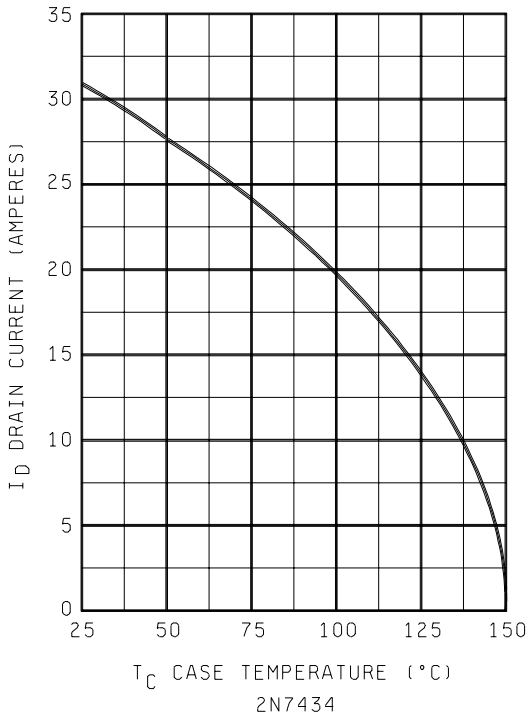
Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
Subgroup 8			3 devices c = 0
Electrical measurements 2/		I_{GSS1} and I_{DSS1} in accordance with table I, subgroup 2.	
Single event effects (SEE) 3/ 4/ 5/	1080		
SEE irradiation		Fluence = 3E5 ± 20% ions/cm^2 Flux = 2E3 to 2E4 ions/cm^2/sec, temperature = 25 ± 5 °C	
2N7444		LET = 28 MeV-cm^2/mg, range = 43 microns Energy = 285 MeV Insitu bias conditions: V_{DS} = 200 V & V_{GS} = -20 V LET = 37 MeV-cm^2/mg, range = 39 microns Energy = 305 MeV Insitu bias conditions: V_{DS} = 200 V & V_{GS} = -10 V V_{DS} = 180 V & V_{GS} = -15 V V_{DS} = 140 V & V_{GS} = -20 V	
2N7434		LET = 28 MeV-cm^2/mg, range = 43 microns Energy = 285 MeV Insitu bias conditions: V_{DS} = 250 V & V_{GS} = -20 V LET = 37 MeV-cm^2/mg, range = 39 microns Energy = 305 MeV Insitu bias conditions: V_{DS} = 250 V & V_{GS} = -10 V V_{DS} = 225 V & V_{GS} = -15 V V_{DS} = 210 V & V_{GS} = -20 V	
2N7391		LET = 28 MeV-cm^2/mg, range = 43 microns Energy = 285 MeV Insitu bias conditions: V_{DS} = 325 V & V_{GS} = -15 V LET = 37 MeV-cm^2/mg, range = 39 microns Energy = 305 MeV Insitu bias conditions: V_{DS} = 325 V & V_{GS} = -10 V V_{DS} = 275 V & V_{GS} = -15 V	
2N7392		LET = 28 MeV-cm^2/mg, range = 43 microns Energy = 285 MeV Insitu bias conditions: V_{DS} = 375 V & V_{GS} = -20 V LET = 37 MeV-cm^2/mg, range = 39 microns Energy = 305 MeV Insitu bias conditions: V_{DS} = 350 V & V_{GS} = -10 V V_{DS} = 325 V & V_{GS} = -15 V V_{DS} = 300 V & V_{GS} = -20 V	
Electrical measurements 2/		I_{GSS1} and I_{DSS1} in accordance with table I, subgroup 2.	

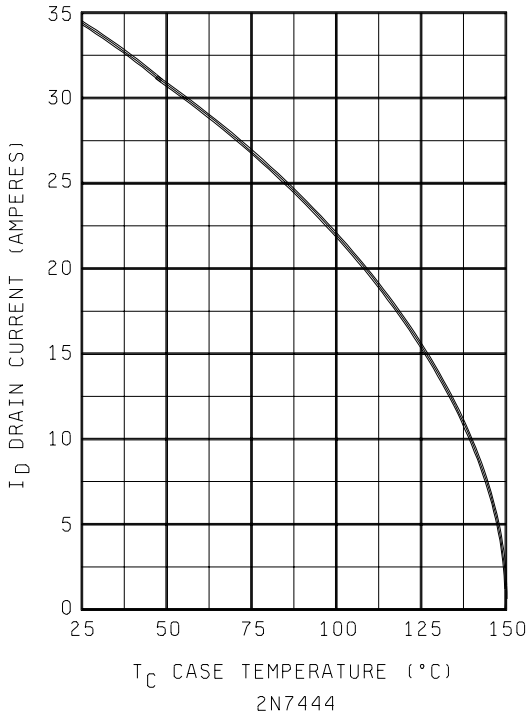
1/ A separate sample may be pulled for each test condition.
2/ Examine I_{GSS1} and I_{DSS1} before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with table I, subgroup 2, may be performed at the manufacturer's option.
3/ Group E qualification of SEE testing may be performed prior to lot formation. Qualification may be extended to other performance specifications utilizing the same structurally identical die design.
4/ Device qualification to a higher level LET is sufficient to qualify all lower level LET's.
5/ The sampling plan applies to each bias condition.



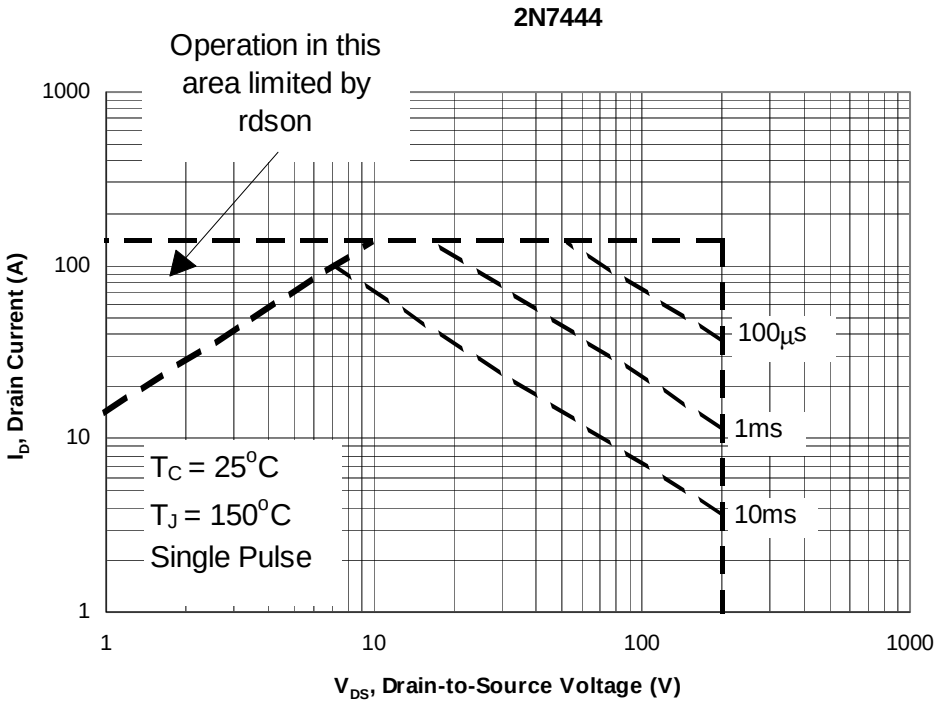


* FIGURE 2. Maximum drain current vs case temperature graphs.

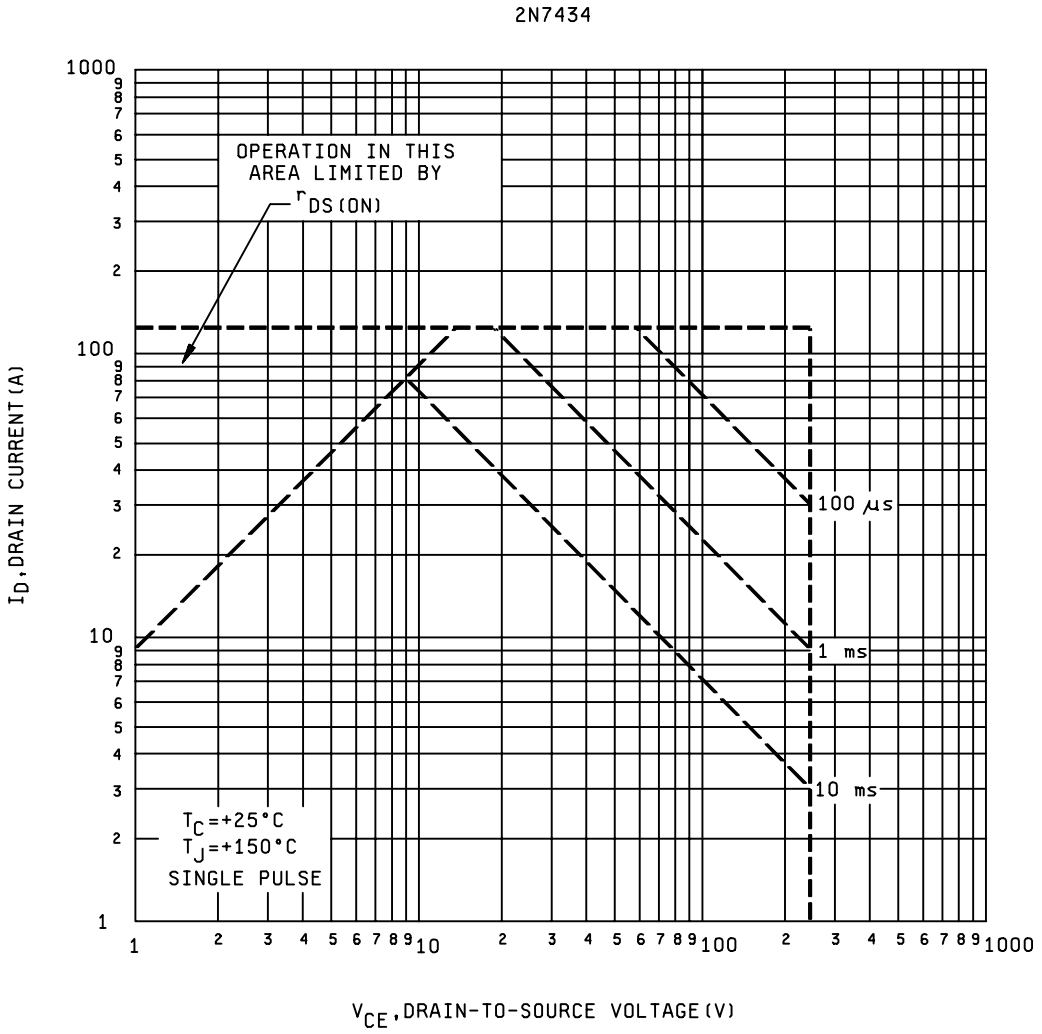




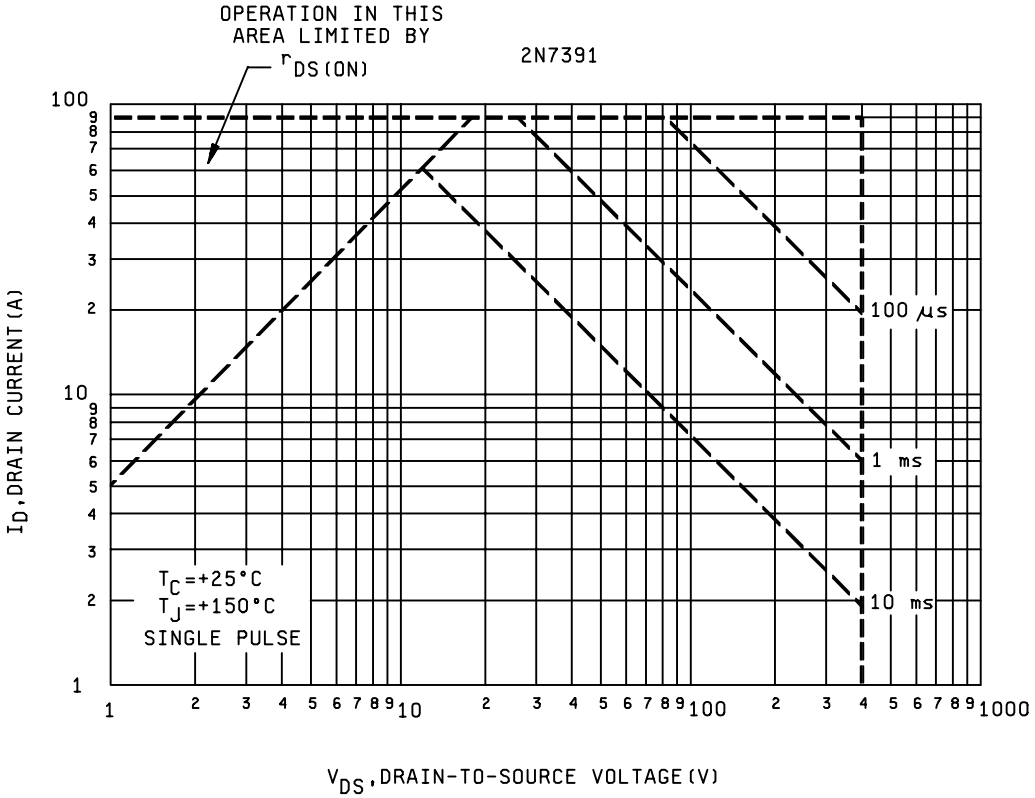
* FIGURE 2. Maximum drain current vs case temperature graphs - Continued.



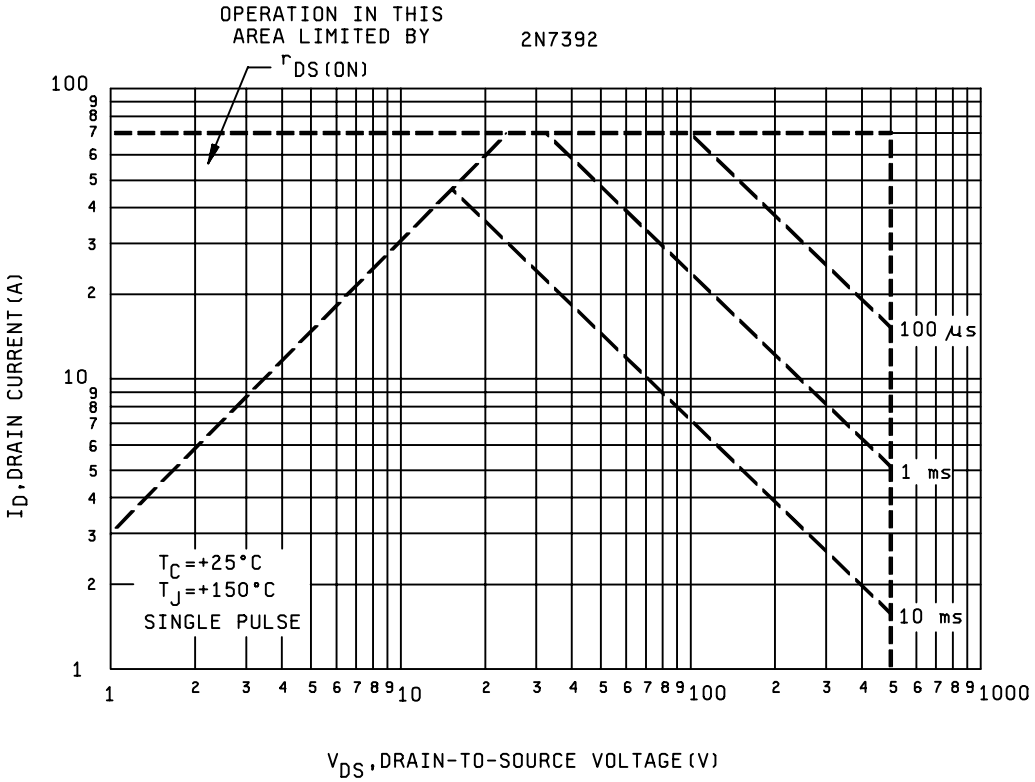
* FIGURE 3. Safe operating area graph.



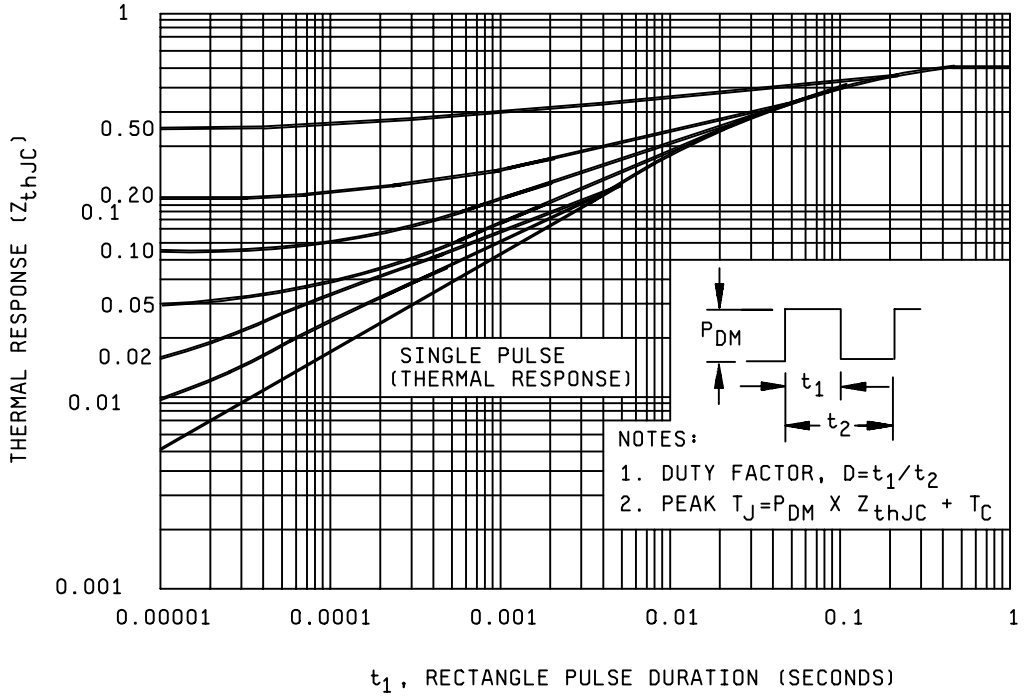
* FIGURE 3. Safe operating area graph - Continued.



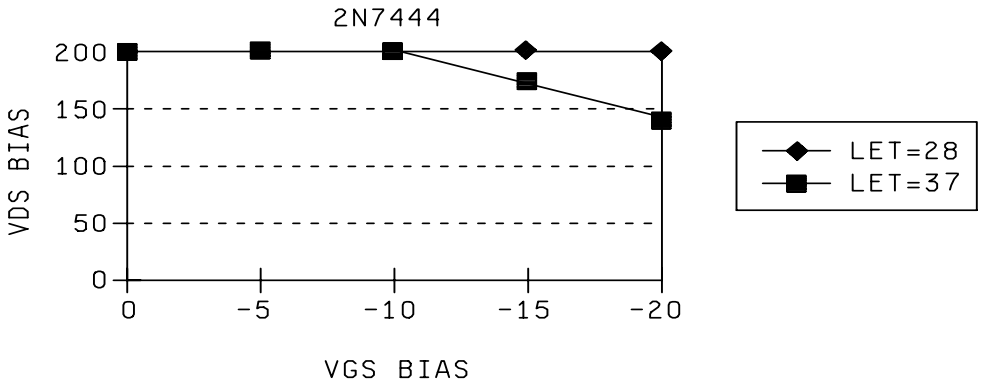
* FIGURE 3. Safe operating area graph - Continued.

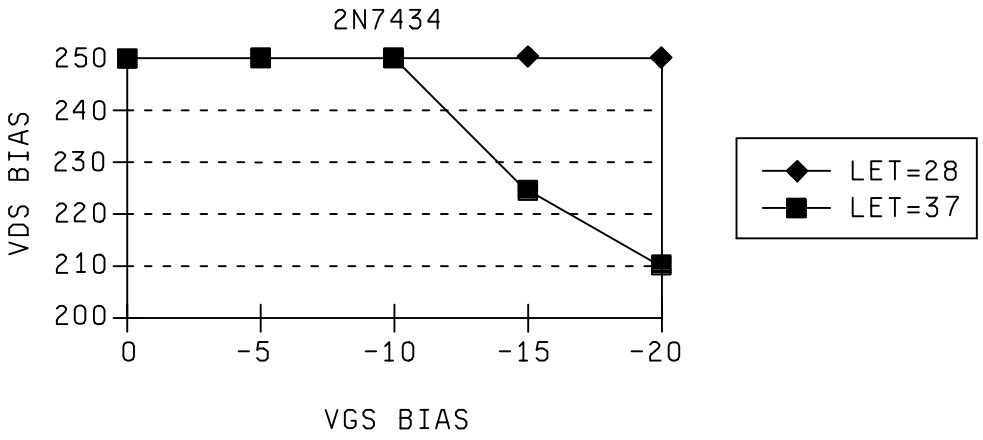


* FIGURE 3. Safe operating area graph - Continued.

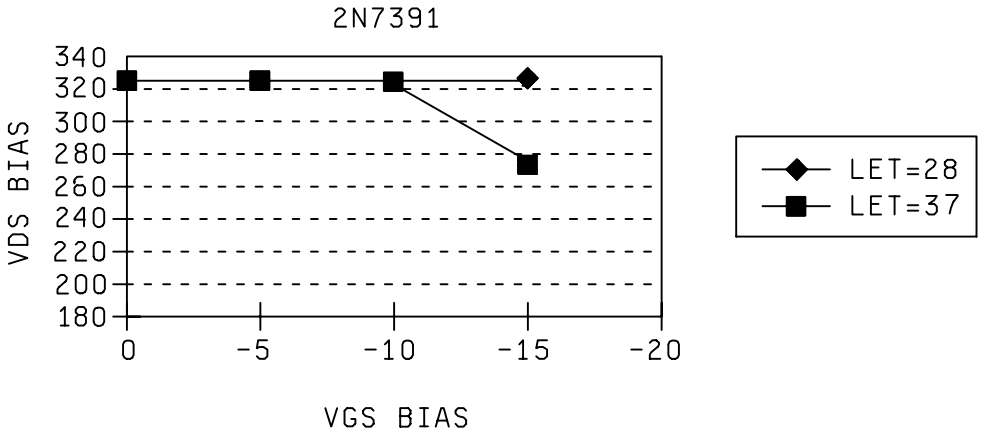


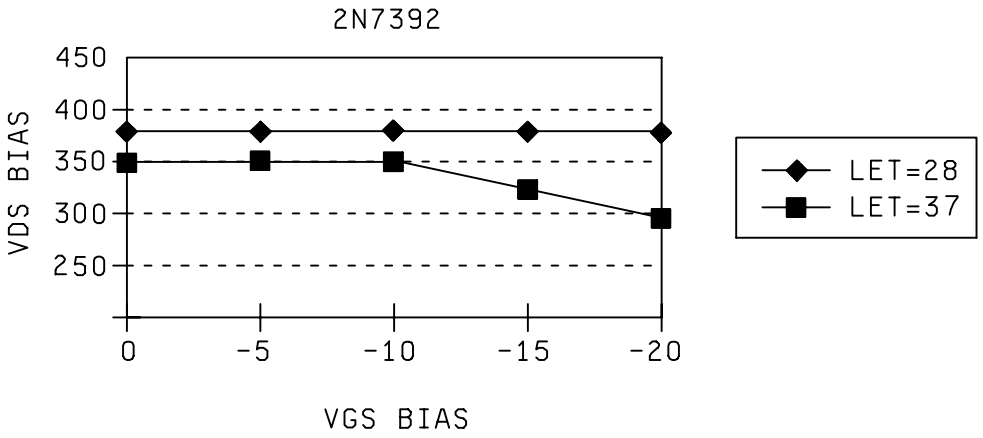
* FIGURE 4. Thermal response curve.





* FIGURE 5. Single event effects safe operation area.





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* FIGURE 5. Single event effects safe operation area - 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 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 material and 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
	TO-254AA
2N7444	IRHM7260SE
2N7434	IRHM7264SE
2N7391	IRHM7360SE
2N7392	IRHM7460SE

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 5961-2773)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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

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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-19500/661A	2. DOCUMENT DATE 27 October 2003

3. **DOCUMENT TITLE** SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED (TOTAL DOSE AND SINGLE EVENT EFFECTS) TRANSISTORS, N-CHANNEL, SILICON, TYPES 2N7444, 2N7434, 2N7391, AND 2N7392, JANTXVR AND JANSR

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

a. Point of Contact Alan Barone	b. TELEPHONE Commercial 614-692-0510	DSN 850-0510	FAX 614-692-6939	EMAIL alan.barone@.dla.mil
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			