

The documentations and process conversion measures necessary to comply with this revision shall be completed by 2 August 2014.

INCH-POUND

MIL-PRF-19500/632C
 2 May 2014
 SUPERSEDING
 MIL-PRF-19500/632B
 16 March 2004

PERFORMANCE SPECIFICATION SHEET

* SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED TRANSISTORS, N-CHANNEL SILICON, TYPES 2N7399, 2N7400, 2N7401, AND 2N7402, JANSJ AND R

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

The requirements for acquiring the product described herein shall consist of this specification sheet and MIL-PRF-19500.

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 characterization), power transistor. One level of product assurance is provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1, (similar to TO-257).

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

Type	P _T (1) T _C =+25°C	P _T T _A =+25°C	V _{DS}	V _{DG}	V _{GS}	I _{D1} (2) (3) T _C =+25°C	I _{D2} T _C = +100°C	I _S	I _{DM}	T _J and T _{STG}	V _{ISO} 70,000 ft. altitude
	<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>	<u>V dc</u>
2N7399	50	20	100	100	±20	11.0	7.0	11.0	33		N/A
2N7400			200	200		8.0	5.0	8.0	24	-55	N/A
2N7401			250	250		6.0	4.0	6.0	18	to	250
2N7402			500	500		3.0	2.0	3.0	9	+150	500

- (1) Derate linearly 0.4 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}; I_{D1} as calculated in note (3).

* Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

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

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0$ $I_D = 1.0 \text{ mA dc}$	$V_{GS(TH)1}$ $V_{DS} \geq V_{GS}$ $I_D = 1.0 \text{ mA dc}$	Max I_{DSS1} $V_{GS} = 0$ $V_{GS} = 80\%$ of rated V_{DS}	Max $r_{DS(on)}$ (1) $V_{GS} = 12\text{V}$		$R_{\theta JC}$ Max	$I_{AS} = I_{DM}$
				$T_J = +25^\circ\text{C}$ at I_{D2}	$T_J = +125^\circ\text{C}$ at I_{D2}		
	<u>V dc</u>	<u>V dc</u> Min Max	<u>$\mu\text{A dc}$</u>	<u>Ω</u>	<u>Ω</u>	<u>$^\circ\text{C/W}$</u>	<u>A (pk)</u>
2N7399	100	1.5 4.0	25	0.21	0.351	2.50	33
2N7400	200			0.44	0.744		24
2N7401	250			0.60	1.08		18
2N7402	500			2.70	5.37		9

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3 or 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 of documents cited in sections 3 or 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 cited in the solicitation or contract.

* DEPARTMENT OF DEFENSE SPECIFICATIONS

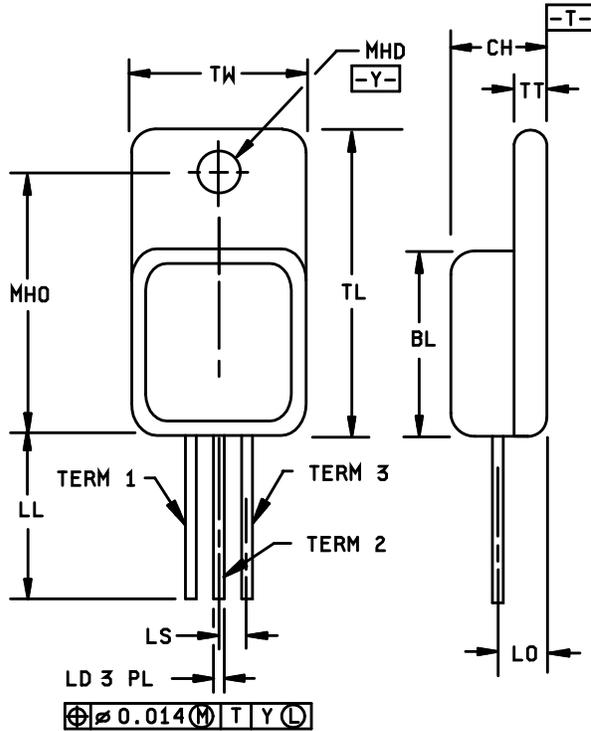
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

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

* (Copies of these documents are available online at <http://quicksearch.dla.mil>.)

* 2.3 Order of precedence. Unless otherwise noted herein or in the contract, 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.



Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.405	.425	10.29	10.80
CH	.190	.200	4.83	5.08
LD	.025	.035	0.64	0.89
LL	.600	.650	15.24	16.51
LO	.120 BSC		3.05 BSC	
LS	.100 TYP		2.54 TYP	
MHD	.140	.150	3.56	3.81
MHO	.522	.542	13.26	13.77
TL	.645	.665	16.38	16.89
TT	.035	.045	0.89	1.14
TW	.410	.420	10.41	10.67
Term 1	Gate			
Term 2	Drain			
Term 3	Source			

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. All terminals are isolated from case.
4. Die to base is BeO isolated, terminals to case ceramic (AL₂O₃) isolated.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 1. Physical dimensions (similar to TO-257).

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 manufacturers list 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.

nCnano coulomb.
I_{AS}Rated avalanche current, non-repetitive.

3.4 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500, and figure 1.

* 3.4.1 Lead material and finish. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

* 3.4.2 Internal construction. Multiple construction is not permitted.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge 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 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, $R \leq$ or 100 k Ω , whenever bias voltage is applied drain to source.

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

3.7 Electrical test requirements. The electrical test requirements shall be as specified in table I.

* 3.8 Marking. Marking shall be in accordance with MIL-PRF-19500.

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 and as specified herein.

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 sheet that did not request the performance of [table III](#) tests, the tests specified in [table III](#) herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

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* 4.3 Screening (JANS only). Screening shall be in accordance with table E-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 E-IV of MIL-PRF-19500) (1) (2)	Measurement
	JANS
(3)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, (see 4.3.3)
7	Optional.
9	I_{GSSF1} , I_{GSSR1} , I_{DSS1} , subgroup 2 of table I herein.
10	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. $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ 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.
12	Method 1042 of MIL-STD-750, test condition A
13	Subgroups 2 and 3 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ 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.
14	Required.
17	For TO-257 packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein

- (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 $t = 250$ μ s minimum.

4.3.2 Single pulse avalanche energy (E_{AS}).

- a. $I_{AS} = I_{DM}$.
- b. $L = 0.1$ mH .
- c. $E_{AS} = 1/2 LI_{AS}^2$.
- d. $V_{DD} = 50$ V to 150 V dc.
- e. Initial junction temperature = +25°C, -5°C, +10°C.

4.3.3 Thermal impedance (ΔV_{SD} measurement). The ΔV_{SD} measurement shall be performed in accordance with method 3161 of MIL-STD-750. The ΔV_{SD} conditions (I_H and V_H) and maximum limit shall be derived by each vendor from the thermal response curves (see [figure 3](#)) and shall be specified in the certificate of conformance prior to qualification. The following parameter measurements shall apply:

- a. Measuring current (I_M).....10 mA.
- b. Heating time (t_H).....100 ms.
- c. Measurement time delay (t_{MD})30 - 60 μ s.
- d. Sample window time (t_{SW}).....10 μ s maximum.

* 4.3.4 Dielectric withstanding voltage.

- a. Magnitude of test voltage.....800 V dc.
- b. Duration of application of test voltage.....15 seconds (min).
- c. Points of application of test voltage.....All leads to case (bunch connection).
- d. Method of connection.....Mechanical.
- e. Kilovolt-ampere rating of high voltage source.....1,200 V/1.0 mA (min).
- f. Maximum leakage current.....1.0 mA.
- g. Voltage ramp up time.....500 V/second

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of MIL-PRF-19500 and [table I](#) herein.

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* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIa (JANS) of MIL-PRF-19500, and as follows. End-point electrical measurements shall be in accordance with the applicable steps of [table IV](#) herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition G, 100 cycles
B3	2077	SEM
* B4	1042	Intermittent operation life, condition D. No heat sink nor or forced-air cooling on the device shall be permitted during the on cycle. $t_{ON} = 30$ seconds 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	1042	Accelerated steady-state gate bias, condition B, $V_{GS} = \text{rated}$; $T_A = +175^{\circ}\text{C}$; $t = 24$ hours.
* B5	2037	Bond strength, test condition D.
B6	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 E-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 IV](#) herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Terminal strength, test condition A, weight = 10 pounds., $t = 15$ seconds.
C5	3161	See 4.5.2 .
C6	1042	Test condition D; 1 cycle = 30 seconds minimum.

4.4.4 Group D inspection. Group D inspection shall be conducted in accordance with table E-VIII of MIL-PRF-19500 and [table II](#) herein.

4.4.4.1 Design parameters. Not tested on a per lot basis. Design shall be such that the devices shall be capable of meeting the requirements herein.

* 4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in [table III](#) herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of [table IV](#) herein.

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

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

4.5.2 Thermal resistance. Thermal resistance measurements shall be performed in accordance with method 3161 of MIL-STD-750. The maximum limit of $R_{\theta JC} = 2.5 \text{ }^{\circ}\text{C/W}$. The following parameters shall apply:

- a. Measuring current (I_M) 10 mA.
- b. Drain heating current (I_H) 1 A.
- c. Heating time (t_H) Steady-state (see method 3161 of MIL-STD-750).
- 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.

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* TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Breakdown voltage, drain to source 2N7399 2N7400 2N7401 2N7402	3407	Bias condition C $V_{GS} = 0 \text{ V}$, $I_D = 1.0 \text{ mA dc}$	$V_{(BR)DSS}$	100 200 250 500		V dc V dc V dc V dc
Gate to source voltage (threshold)	3403	$V_{DG} \geq V_{GS}$	$V_{GS(th)1}$	1.5	4.0	V dc
Gate current	3411	Bias condition C, $V_{GS} = +20 \text{ V dc}$, $V_{DS} = 0$	I_{GSSF1}		+100	nA dc
Gate current	3411	Bias condition C, $V_{GS} = -20 \text{ V dc}$, $V_{DS} = 0$	I_{GSSR1}		-100	nA dc
Drain current	3413	Bias condition C, $V_{GS} = 0 \text{ V dc}$, $V_{DS} = 80 \text{ percent of rated } V_{DS}$	I_{DSS1}		25	$\mu\text{A dc}$
Static drain to source on-state resistance 2N7399 2N7400 2N7401 2N7402	3421	Bias condition A, $V_{GS} = 12 \text{ V dc}$, $I_D = I_{D1}$, pulsed (see 4.5.1)	$r_{DS(ON)1}$		0.21 0.44 0.60 2.70	Ω Ω Ω Ω
Static drain to source on-state voltage 2N7399 2N7400 2N7401 2N7402	3405	Bias condition A, $V_{GS} = 0 \text{ V dc}$, $I_D = I_{D1}$, pulsed (see 4.5.1)	$V_{DS(ON)1}$		2.43 3.70 3.78 8.51	V dc V dc V dc V dc
Forward voltage	4011	Pulsed (see 4.5.1), $I_D = I_{D1}$ $V_{GS} = 0 \text{ V dc}$	V_{SD}		1.8	V dc

See footnote at end of table.

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* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 3</u>						
High temperature operation:						
Gate current	3411	$T_C = T_J = +125^\circ\text{C}$ Bias condition C, $V_{GS} = \pm 20\text{ V dc}$, $V_{DS} = 0\text{ V dc}$,	I_{GSS2}		± 200	nA dc
Drain current	3413	Bias condition C, $V_{GS} = 0\text{ V dc}$, $V_{DS} = 80$ percent of rated V_{DS}	I_{DSS2}		0.25	mA dc
* Static drain to source on-state resistance	3421	Bias condition A, $V_{GS} = -10\text{ V dc}$, pulsed (see 4.5.1), $I_D = \text{rated } I_{D2}$	$r_{DS(on)2}$			
2N7399					0.351	Ω
2N7400					0.744	Ω
2N7401					1.08	Ω
2N7402					5.37	Ω
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 1\text{ mA}$	$V_{GS(th)2}$	0.5		V dc
Low temperature operation:						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 1\text{ mA}$	$V_{GS(th)3}$		5.0	V dc
<u>Subgroup 4</u>						
Switching time test	3472	$I_D = \text{rated } I_{D1}$; $V_{GS} = 12\text{ V dc}$; $R_G = 7.5\ \Omega$; $V_{DD} = 50$ percent of rated V_{DS} ($V_{DS} \leq 200\text{V}$)				
Turn-on delay time			$t_{d(on)}$			
2N7399					65	ns
2N7400					65	ns
2N7401					70	ns
2N7402					85	ns
Rise time			t_r			
2N7399					200	ns
2N7400					160	ns
2N7401					140	ns
2N7402					120	ns

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 4</u> - Continued						
Turn-off delay time			$t_{d(off)}$			
2N7399					130	ns
2N7400					120	ns
2N7401					120	ns
2N7402				150	ns	
Fall time			t_f			
2N7399					90	ns
2N7400					90	ns
2N7401					95	ns
2N7402				85	ns	
<u>Subgroup 5</u>						
Safe operating area test (high voltage)	3474	See figure 4 , $t_p = 10$ ms, $V_{DS} = 80$ percent of rated V_{DS} , $V_{DS} \leq 200$ V dc max.				
Electrical measurements		See table IV , steps 1, 2, 3, 4, 5, 6, and 7				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition B				
On-state gate charge			$Q_{g(on)}$			
2N7399					42	nC
2N7400					42	nC
2N7401					41	nC
2N7402				36	nC	
Gate to source charge			Q_{gs}			
2N7399					11	nC
2N7400					12	nC
2N7401					11	nC
2N7402				8.4	nC	

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 7</u> - Continued						
Gate to drain charge			Q _{gd}			
2N7399					23	nC
2N7400					22	nC
2N7401					21	nC
2N7402				15	nC	
Reverse recovery time	3473	Condition A, di/dt ≤ 100 A/μs, V _{DD} ≤ 30 V, I _D = I _{D1}	t _{rr}			
2N7399					280	ns
2N7400					340	ns
2N7401					420	ns
2N7402					400	ns

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

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TABLE II. Group D inspection.

Inspection <u>1/</u> <u>2/</u> <u>3/</u> <u>4/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post irradiation limits		Units
	Method	Conditions		Min	Max	Min	Max	
<u>Subgroup 1</u>								
Not applicable								
<u>Subgroup 2</u>		$T_C = +25^\circ\text{C}$						
Steady state total dose irradiation (V_{GS} bias) <u>4/</u>	1019	$V_{GS} = 12\text{ V}, V_{DS} = 0\text{ V}$						
Steady state total dose irradiation (V_{DS} bias)	1019	$V_{GS} = 0\text{ V}, V_{DS} = 80\text{ percent of rated } V_{DS}$						
Breakdown voltage drain to source 2N7399 2N7400 2N7401 2N7402	3407	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA dc},$ Bias condition C	$V_{(BR)DSS}$	100 200 250 500		100 200 250 500		V dc V dc V dc V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}, I_D = 1\text{ mA dc}$	$V_{GS(TH)1}$	1.5	4.0	1.5	4.0	V dc
Gate current	3411	$V_{GS} = \pm 20\text{ V dc}, V_{DS} = 0\text{ V},$ Bias condition C	I_{GSS1}		± 100		± 100	nA dc
Drain current	3413	$V_{GS} = 0\text{ V}, V_{DS} = 80\text{ percent of}$ rated V_{DS} , Bias condition C	I_{DSS1}		25		25	$\mu\text{A dc}$
Static drain to source on-state resistance 2N7399 2N7400 2N7401 2N7402	3421	$V_{GS} = 12\text{ V dc},$ condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$		0.21 0.44 0.60 2.70		0.21 0.44 0.60 2.70	Ω Ω Ω Ω
Static drain to source on-state voltage 2N7399 2N7400 2N7401 2N7402	3405	$V_{GS} = 12\text{ V dc},$ condition A, Pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{DS(ON)}$		2.43 3.70 3.78 8.51		2.43 3.70 3.78 8.51	V dc V dc V dc V dc

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

2/ Electrical specifications are for 'D' and 'R' rad levels.

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

4/ At the manufacturer's option, group D samples need not be subjected to all the screening tests, but shall be assembled in its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

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

Inspection 1/ 2/ 3/ 4/ 5/	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycle	1051	Condition G, 500 cycles	
Hermetic seal Fine leak Gross leak	1071		
Electrical measurements		See table IV , steps 1, 2, 3, 4, 5, 6, 7, and 8	
<u>Subgroup 2 1/</u>			45 devices c = 0
Steady-state reverse bias	1042	Condition A, 1,000 hours	
Electrical measurements		See table IV , steps 1, 2, 3, 4, 5, 6, and 7	
Steady-state gate bias	1042	Condition B, 1,000 hours	
Electrical measurements		See table IV , steps 1, 2, 3, 4, 5, 6, and 7	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500	
<u>Subgroup 5</u>			5 devices c = 0
Barometric pressure test (not required for $V_{BR(DSS)} \leq 200$ V) 2N7401 2N7402	1001	$V_{DS} = 250$ V; $I_{(ISO)} < 0.25$ mA $V_{DS} = 500$ V; $I_{(ISO)} < 0.25$ mA	
<u>Subgroup 8</u>			22 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		

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

2/ As a minimum, gate to source leakages and drain to source leakage are to be examined to verify the electrical performance of the DUT prior to and after test. At the manufacturer's option, the remaining static tests in [table IV](#), with the exception of step 8, may be performed.

3/ This sampling plan applies to each bias condition specified.

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

Step	Inspection <u>1/</u> <u>2/</u> <u>3/</u>	MIL-STD-750		Symbol	Limits		Units
		Method	Conditions		Min	Max	
1.	Breakdown voltage drain to source 2N7399 2N7400 2N7401 2N7402	3407	$V_{GS} = 0 \text{ V}$, $I_D = 1 \text{ mA dc}$, bias condition C	$V_{(BR)DSS}$	100 200 250 500		V dc V dc V dc V dc
2.	Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 1 \text{ mA dc}$	$V_{GS(TH)1}$	1.5	4.0	V dc
3.	Gate current	3411	$V_{GS} = +20 \text{ V}$ and -20 V dc bias condition C, $V_{DS} = 0 \text{ V}$	I_{GSS1}		± 100	na dc
4.	Drain current	3413	$V_{GS} = 0 \text{ V dc}$, bias condition C, $V_{DS} = 80$ percent of rated V_{DS}	I_{DSS1}		25	$\mu\text{A dc}$
5.	Static drain to source on-state resistance 2N7399 2N7400 2N7401 2N7402	3421	$V_{GS} = 12 \text{ V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$		0.21 0.44 0.60 2.70	Ω Ω Ω Ω
6.	Static drain to source on-state voltage 2N7399 2N7400 2N7401 2N7402	3405	$V_{GS} = 12 \text{ V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{DS(ON)}$		2.434 3.70 3.78 8.51	V dc V dc V dc V dc
7.	Forward voltage	4011	$V_{GS} = 0 \text{ V dc}$, condition A, pulsed (see 4.5.1; $I_D = I_{D1}$)	V_{SD}		1.8	V dc
8.	Thermal impedance	3161	See 4.3.3	ΔV_{SD}		90	mV

1/ The electrical measurements for table E-VIa (JANS) of MIL-PRF-19500 are as follows:

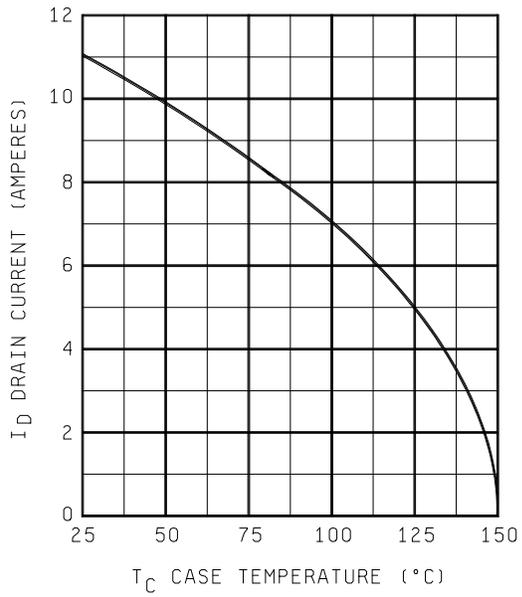
- a. Subgroup 3, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.
- b. Subgroup 4, see table IV herein, steps 1, 2, 3, 4, 5, 6, 7, and 8.
- c. Subgroup 5, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.

2/ The electrical measurements for table E-VII of MIL-PRF-19500 are as follows:

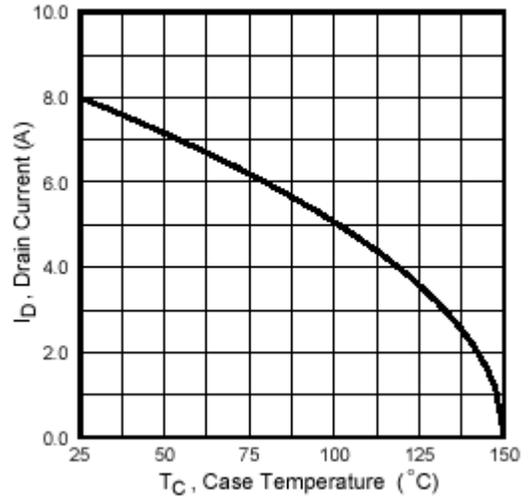
- a. Subgroup 2 and 3, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.
- b. Subgroup 6, see table IV herein, steps 1, 2, 3, 4, 5, 6, 7, and 8.

3/ The electrical measurements for table E-IX of MIL-PRF-19500 are as follows:

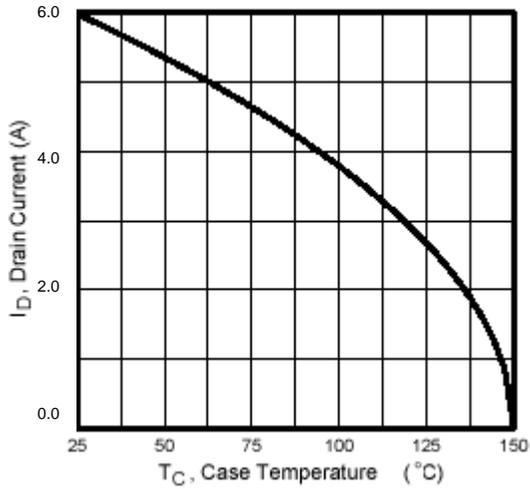
- a. Subgroups 1, see table IV herein, steps 1, 2, 3, 4, 5, 6, 7, and 8.
- b. Subgroups 2, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.
- c. Subgroup 8, see table IV herein, steps 3 and 4.



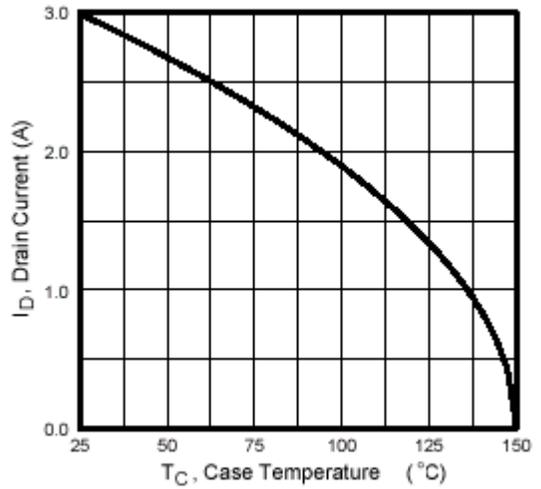
2N7399



2N7400



2N7401



2N7402

FIGURE 2. Maximum drain current vs case temperature graphs.

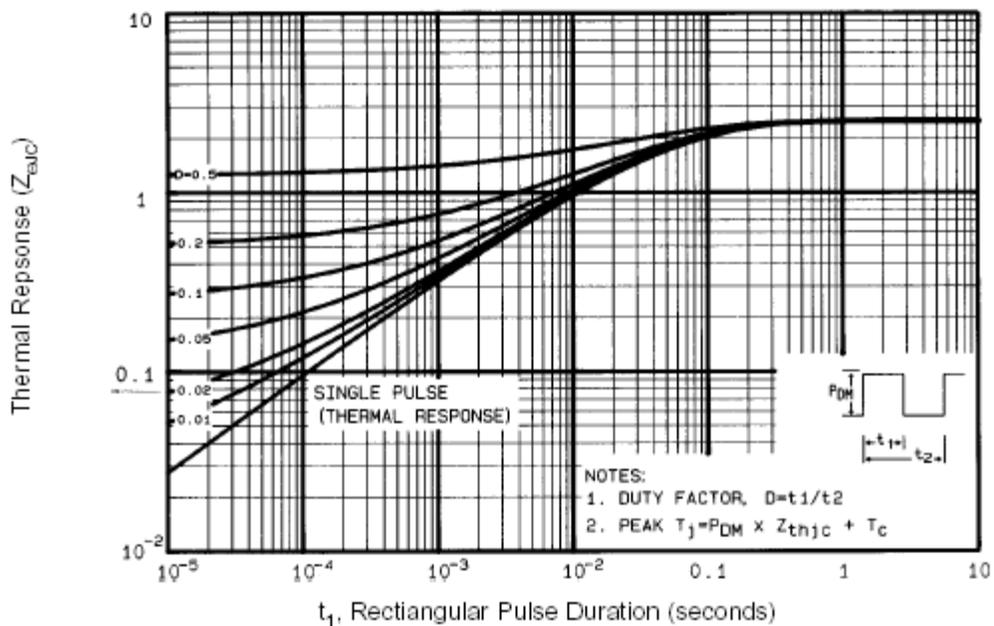


FIGURE 3. Thermal response curves

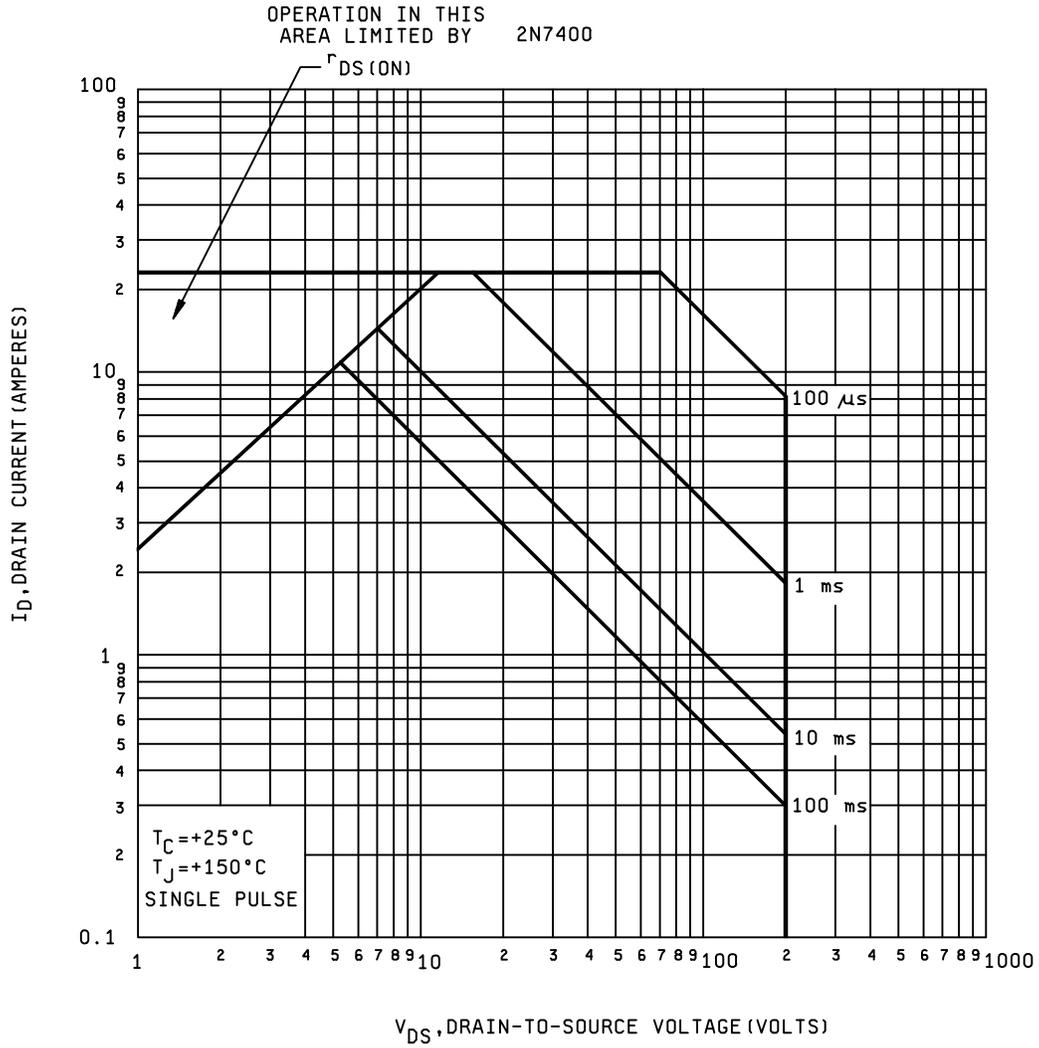


FIGURE 4. Safe operating area graphs - Continued.

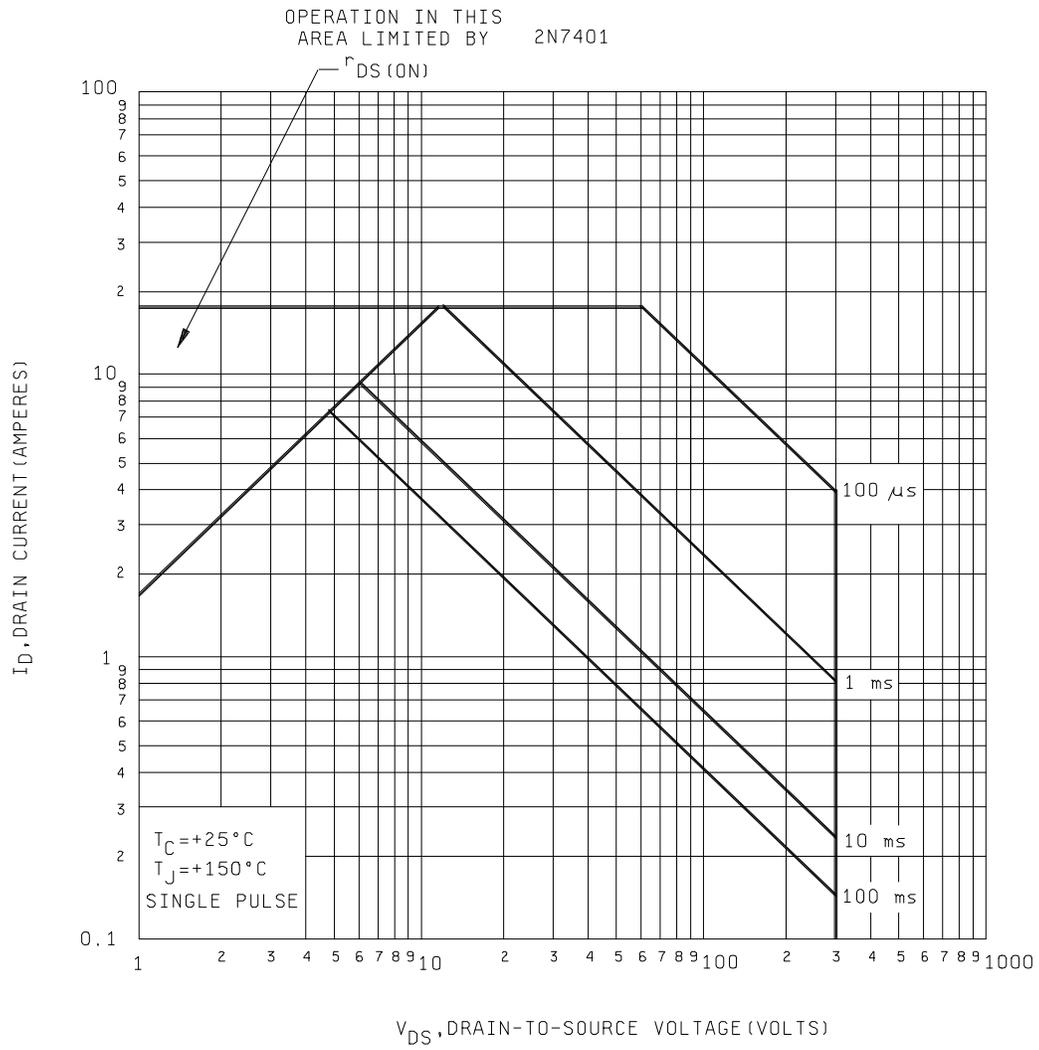


FIGURE 4. Safe operating area graphs - Continued.

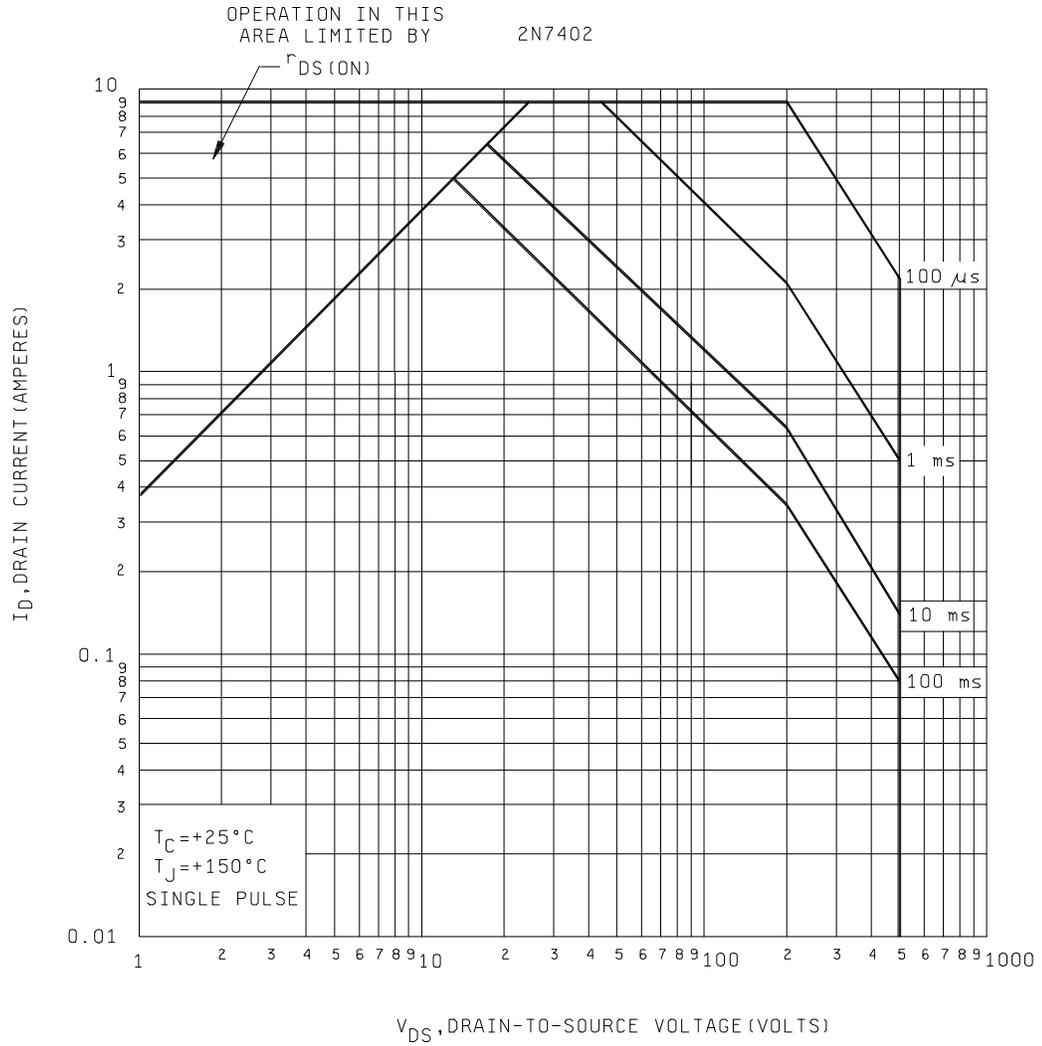


FIGURE 4. Safe operating area graphs - Continued.

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 or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. 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. The notes specified in MIL-PRF-19500 are applicable to this specification.)

* 6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

* 6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead material and finish may be specified (see 3.4.1).
- d. The complete Part or Identifying Number (PIN), see title and section 1.
- e. For acquisition of RHA designated devices, [table II](#), subgroup 1 testing of group D herein is optional. If subgroup 1 is desired, it should be specified in the contract.
- f. If specific SEE characterization conditions are desired (see section 6.5 and [table IV](#)), manufacturer's cage code should be specified in the contract or order.
- g. If SEE testing data is desired, it should be specified in the contract or order.

* 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 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, Columbus, ATTN: VQE, P.O. Box 3990, Columbus, OH 43216-5000 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

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 PINs are substitutable for the military PIN.

Generic P/N	Military P/N
SS130	2N7399
SS230	2N7400
SS234	2N7401
SS430	2N7402

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 previous issue.

Custodians:
 Army - CR
 Navy - EC
 Air Force - 85
 NASA - NA
 DLA - CC

Preparing activity:
 DLA - CC
 (Project 5961-2014-071)

Review activities:
 Army - AV, MI

* NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.