

The documentation and process conversion measures necessary to comply with this revision shall be completed by 31 August 2023.

INCH-POUND

MIL-PRF-19500/755A
w/AMENDMENT 5
31 May 2023
SUPERSEDING
MIL-PRF-19500/755A
w/AMENDMENT 4
17 August 2022

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, FIELD EFFECT, N-CHANNEL, RADIATION HARDENED,
SILICON, ENCAPSULATED (THROUGH HOLE PACKAGE),
TYPES 2N7588, 2N7590, 2N7592, AND 2N7594, JANTXVR AND F AND JANSR, F, AND G

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 effects (SEE)), power transistor. Two levels of product assurance (JANTXV and JANS) are provided for each encapsulated device, with avalanche energy maximum rating (E_{AS}) and maximum avalanche current (I_{AS}). Provisions for radiation hardness assurance (RHA) to three radiation levels ("R", "F", and "G") are provided for JANTXV and JANS product assurance levels.

1.2 Package outlines. The device package outlines are as follows: TO-257AA in accordance with [figure 1](#) for all encapsulated device types.

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

Type	P _T (1) T _C = +25°C	P _T T _A = +25°C	R _{θJC} (2)	V _{DS}	V _{DG}	V _{GS}	I _{D1} (3) (4) T _C =+25°C	I _{D2} T _C = +100°C	I _S	I _{DM} (5)	T _J and T _{STG}	V _{ISO} 70,000 ft. altitude
	<u>W</u>	<u>W</u>	<u>°C/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>
2N7588T3	75	1.56	1.67	100	100	±20	20	19	20	80	-55 to +150	250
2N7590T3	75	1.56	1.67	150	150	±20	19	12	19	76		
2N7592T3	75	1.56	1.67	200	200	±20	16	10	16	64		
2N7594T3	75	1.56	1.67	250	250	±20	12	7.6	12	48		

(1) Derate linearly by 0.6 W/°C for T_C > +25°C.

(2) See [figure 2](#), thermal impedance curves.

(3) 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:

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

(4) See [figure 3](#), maximum drain current graph.

(5) I_{DM} = 4 X I_{D1}; I_{D1} as calculated by footnote (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/>.

AMSC N/A

DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited.

FSC 5961



MIL-PRF-19500/755A
w/AMENDMENT 5

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} $V_{GS} = 0$ $V_{DS} = 80\%$ of rated V_{DS}	Max $r_{DS(on)} (1)$ $V_{GS} = 12\text{V},$ $I_D = I_{D2}$	Max $r_{DS(on)} (1)$ $V_{GS} = 12\text{V},$ $I_D = I_{D2}$	E_{AS}
					$T_J = +25^\circ\text{C}$	$T_J = +150^\circ\text{C}$	
	<u>V dc</u>	<u>V dc</u> Min Max		<u>$\mu\text{A dc}$</u>	<u>Ω</u>	<u>Ω</u>	<u>mJ</u>
2N7588T3	100	2.0	4.0	10	0.042	0.084	107
2N7590T3	150	2.0	4.0	10	0.090	0.207	67
2N7592T3	200	2.0	4.0	10	0.130	0.300	83
2N7594T3	250	2.0	4.0	10	0.220	0.517	80

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example and 6.5 for a list of available PINs.

1.5.1 JAN certification mark and quality level for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JANTXV" and "JANS".

1.5.2 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest are as follows: "R", "F", and "G".

1.5.3 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

1.5.3.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

1.5.3.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "7588", "7590", "7592", and "7594".

1.5.3.3 Suffix letters. The suffix letters "T3" are used on devices that are packaged in the TO-257A package of figure 1.

1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QPDSIS-19500.

MIL-PRF-19500/755A
w/AMENDMENT 5

1.6 Radiation features:

Maximum total ionizing dose (TID) available (Dose rate = 50-300 rad(Si)/s):

For device type 2N7588T3, 2N7590T3, 2N7592T3: 300 krads(Si) 1/

For device type, 2N7594T3:..... 500 krads(Si) 1/

Heavy Ion Single Event Effect (SEE) SEB and SEGR test:

For device type 2N7588T3:

No SEB and SEGR were observed at surface LET (see table IV) $\leq 90 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 100 \text{ V}$ and $V_{GS} = -5 \text{ V}$)

For device type 2N7590T3:

No SEB and SEGR were observed at surface LET (see table IV) $\leq 90 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 50 \text{ V}$ and $V_{GS} = -5 \text{ V}$)
(In-situ Bias $V_{DS} = 30 \text{ V}$ and $V_{GS} = -10 \text{ V}$)

For device type 2N7592T3:

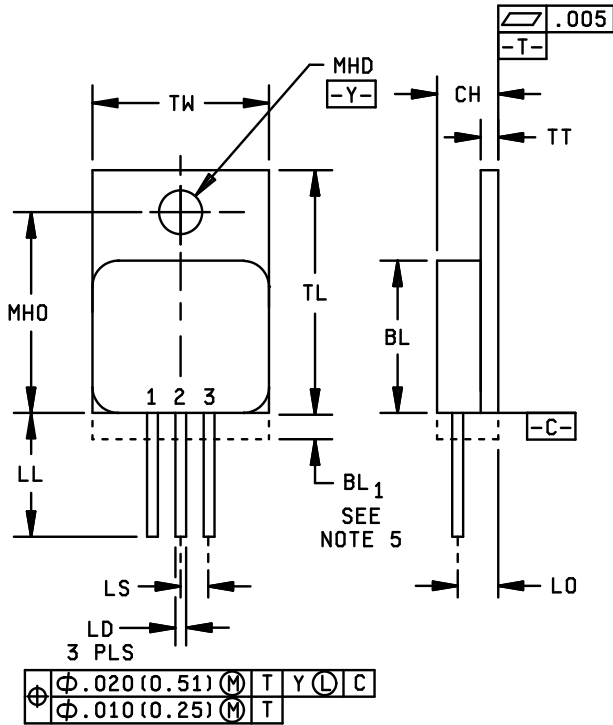
No SEB and SEGR were observed at surface LET (see table IV) $\leq 90 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 150 \text{ V}$ and $V_{GS} = -4 \text{ V}$)
(In-situ Bias $V_{DS} = 110 \text{ V}$ and $V_{GS} = -5 \text{ V}$)

For device type 2N7594T3:

No SEB and SEGR were observed at surface LET (see table IV) $\leq 90 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 75 \text{ V}$ and $V_{GS} = -5 \text{ V}$)

-
- 1/ Manufacturer supplying device types 2N7588T3, 2N7590T3, 2N7592T3, and 2N7594T3 have performed characterization testing in accordance with MIL-STD-750, method 1019, condition A (dose rate = 50 - 300 rad(Si)/s). The radiation end point limits are guaranteed only for the conditions as specified in MIL-STD-750, method 1019, condition A to a maximum total ionizing dose level of 300 and 500 krads(Si).
- 2/ Manufacturer also performed heavy ion SEB and SEGR test at TAMU Radiation Effects Facility for the MOSFET technology devices in accordance with TM1080 of MIL-STD-750. Limits are characterized at initial qualification and after any design or process changes which may affect the SEE (SEB/SEGR) characteristics. For more information on SEE (SEB/SEGR) test results, customers are requested to contact the manufacturer.

MIL-PRF-19500/755A
w/AMENDMENT 5



Ltr	Inches	Inches	mm	mm
	Min	Max	Min	Max
BL	.410	.430	10.41	10.92
BL1		.028		0.71
CH	.190	.200	4.83	5.08
LD	.025	.035	0.64	0.89
LL	.500	.650	12.70	15.88
LO	.120 BSC		3.05 BSC	
LS	.100 BSC		2.54 BSC	
MHD	.140	.150	3.56	3.81
MHO	.527	.537	13.39	13.64
TL	.645	.665	16.38	16.89
TT	.035	.045	0.89	1.14
TW	.410	.420	10.41	10.67
Term 1	Drain			
Term 2	Source			
Term 3	Gate			

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. All terminals are isolated from case.
4. This area is for the lead feed-thru eyelets (configuration is optional, but will not extend beyond this zone).

FIGURE 1. Dimensions and configuration (TO-257AA).

MIL-PRF-19500/755A
w/AMENDMENT 5

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 of 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 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.

[MIL-STD-883](#) - Test Method Standard Microcircuits.

(Copies of these documents are available online at <https://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.

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](#).

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in [MIL-PRF-19500](#), and on [figure 1](#) (TO-257) herein.

3.4.1 Lead 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 Multiple chip construction. Multiple chip construction is not permitted to meet the requirements of this specification.

3.4.3 Silicone die coat. The use of a silicone die coat requires a successful completion of [MIL-STD-883](#), [method 5011](#) on each silicone lot for its intended applications, and as part of the full [MIL-PRF-19500](#) qualification process.

MIL-PRF-19500/755A
w/AMENDMENT 5

3.5 Electrostatic discharge sensitive (ESDS). The devices covered by this specification sheet have been classified as ESDS. The devices shall be handled in accordance with the ESD program established to comply with the requirements of [MIL-PRF-19500](#) to avoid damage due to the accumulation of static charge. The following handling practices shall be followed:

- a. Devices shall be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care 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 [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 and II).

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 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.

4.2.1.1 Single Event Effects (SEE). SEE (SEB/SEGR) shall be performed in accordance with TM1080 of MIL-STD-750 at initial qualification and after process or design changes which may affect radiation hardness (see [table III](#) and [table IV](#)). Upon qualification, manufacturers shall provide the verification test conditions from section 5 of method 1080 of [MIL-STD-750](#) that were used to qualify the device for inclusion into section 6 of the slash sheet. End-point measurements shall be in accordance with [table II](#). SEE (SEB/SEGR) characterization data shall be made available upon request of the qualifying or acquiring activity.

MIL-PRF-19500/755A
w/AMENDMENT 5

4.3 Screening (JANS and JANTXV). 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 (1) (2)	Measurements for JANS	Measurements for JANTXV
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, E _{AS} (see 4.3.2)	Method 3470 of MIL-STD-750, E _{AS} (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)
5	Method 2052 of MIL-STD-750, PIND (see MIL-PRF-19500 and 4.3.4)	Not applicable
9	Subgroup 2 of table I herein	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	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. $\Delta I_{DSS1} = \pm 10$ μ A dc or ± 100 percent of initial value, whichever is greater.	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 $\Delta I_{GSSF1} = \pm 20$ 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. $\Delta I_{DSS1} = \pm 10$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(ON)1} = \pm 20$ percent of initial value. $\Delta V_{GS(TH)1} = \pm 20$ percent of initial value.	Subgroup 2 of table I herein $\Delta I_{GSSF1} = \pm 20$ 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. $\Delta I_{DSS1} = \pm 10$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(ON)1} = \pm 20$ percent of initial value. $\Delta V_{GS(TH)1} = \pm 20$ percent of initial value.

- (1) 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} , $V_{GS(TH)1}$, and $r_{DS(ON)1}$ shall be invoked.
- (3) Shall be performed anytime after temperature cycling, screen 3a; JANTXV level does not need to be repeated in screening requirements.

MIL-PRF-19500/755A
w/AMENDMENT 5

4.3.1 Gate stress test. Apply $V_{GS} = 24$ V minimum for $t = 250$ μ s minimum.

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

a. Peak current $I_{AS} = I_{D1}$.

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

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

d. Supply voltage (V_{DD}) $V_{DD} = 25$ V dc, except $V_{DD} = 50$ V dc (2N7594T3), up to rated V_{DS} .

e. Peak gate voltage (V_{GS}) 12 V, up to maximum rated V_{GS} .

f. Initial case temperature $T_C = +25^\circ\text{C} + 10^\circ\text{C}, -5^\circ\text{C}$.

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

4.3.3 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of [MIL-STD-750](#) using the guidelines in that method for determining I_M , I_H , t_H , t_{sw} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 30 - 60 μ s max. See [table III](#), group E, subgroup 4 herein.

4.3.4 PIND. Not applicable in screening when devices are processed using alternative method and flow requirements approved by the qualifying activity, that includes incorporating the use of certified clean processing and silicone die coat. Instead, the PIND test performance shall be performed in group B3 and group C3, on a lot sample basis. PIND failures detected in group B or C will represent lot jeopardy and be evaluated for root cause and lot integrity.

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.

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) and table E-VIB (JANTXV) of [MIL-PRF-19500](#), and as follows.

4.4.2.1 Quality level JANS, table E-VIA of [MIL-PRF-19500](#).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition G, 100 cycles.
B3	2077	Scanning electron microscope (SEM).
B3	2052	PIND, required if not performed in screening. (22 devices, c = 0 for large lots, 12 devices, c = 0 for small lots).
B4	1042	Intermittent operation life, condition D, $t_{on} = 30$ seconds minimum.
B5	1042	Accelerated steady-state gate bias, condition B, $V_{GS} =$ rated; $T_A = +175^\circ\text{C}$, $t = 24$ hours minimum; or $T_A = +150^\circ\text{C}$, $t = 48$ hours minimum.
B5	1042	Accelerated steady-state reverse bias, condition A, $V_{DS} =$ rated; $T_A = +175^\circ\text{C}$, $t = 120$ hours minimum; or $T_A = +150^\circ\text{C}$, $t = 240$ hours minimum.

MIL-PRF-19500/755A
w/AMENDMENT 5

4.4.2.2 Quality level JANTXV, table E-VIB 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, $t_{on} = 30$ seconds minimum.

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.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition A.
C3	2052	PIND, required if not performed in screening. (22 devices, $c = 0$ for large lots, 12 devices, $c = 0$ for small lots).
C5	3161	See 4.3.3, $R_{\theta JC} = 1.67$ °C/W.
C6	1042	Intermittent operation life, condition D, $t_{on} = 30$ 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.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with MIL-PRF-19500, and table III 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.

MIL-PRF-19500/755A
w/AMENDMENT 5

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>						
Thermal impedance <u>2/</u>	3161	See 4.3.3	$Z_{\theta JC}$			°C/W
Breakdown voltage drain to source	3407	Bias condition C, $V_{GS} = 0$ V, $I_D = 1$ mA dc	$V_{(BR)DSS}$			
2N7588T3				100		V dc
2N7590T3				150		V dc
2N7592T3				200		V dc
2N7594T3				250		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, bias condition C, $V_{DS} = 0$ V	I_{GSSF1}		+100	nA dc
Gate current	3411	$V_{GS} = -20$ V dc, bias condition C, $V_{DS} = 0$ V	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}		10	μA dc
Static drain to source on-state resistance	3421	$V_{GS} = 12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$			
2N7588T3					0.042	Ω
2N7590T3					0.090	Ω
2N7592T3					0.130	Ω
2N7594T3					0.220	Ω
Forward voltage	4011	$V_{GS} = 0$ V dc, condition A, $I_D = I_{D1}$	V_{SD}		1.2	V dc

See footnotes at end of table.

MIL-PRF-19500/755A
w/AMENDMENT 5

TABLE I. Group A inspection - Continued.

Inspection 1/ <u>Subgroup 3</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
High temperature operation		$T_C = T_J = +125^\circ\text{C}$				
Gate current	3411	$V_{GS} = \pm 20\text{ V dc}$, bias condition C, $V_{DS} = 0\text{ V}$	I_{GSS2}		± 200	nA dc
Drain current	3413	$V_{GS} = 0\text{ V dc}$, bias condition C, $V_{DS} = 80\text{ percent of rated } V_{DS}$	I_{DSS2}		25	$\mu\text{A dc}$
Static drain to source on-state resistance	3421	$V_{GS} = 12\text{ V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)3}$			
2N7588T3					0.080	Ω
2N7590T3					0.180	Ω
2N7592T3					0.260	Ω
2N7594T3					0.510	Ω
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)2}$	1.0		V dc
Low temperature operation		$T_C = T_J = -55^\circ\text{C}$				
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS(TH)3}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)3}$		5.0	V dc
<u>Subgroup 4</u>						
Forward transconductance	3475	$I_D = I_{D2}$, $V_{DD} = 15\text{ V dc}$ (see 4.5.1)	g_{FS}			
2N7588T3				14		S
2N7590T3				13		S
2N7592T3				11		S
2N7594T3				8.6		S
Switching time test	3472	$I_D = I_{D1}$, $V_{GS} = 12\text{ V dc}$, $R_G = 7.5\ \Omega$, $V_{DD} = 50\text{ percent of rated } V_{DS}$				
Turn-on delay time			$t_{D(on)}$			
2N7588T3					20	ns
2N7590T3					20	ns
2N7592T3					15	ns
2N7594T3					19	ns

See footnotes at end of table.

MIL-PRF-19500/755A
w/AMENDMENT 5

TABLE I. Group A inspection - Continued.

Inspection <u>1</u> /	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 4</u> - Continued						
Rise time			t_r			
2N7588T3					50	ns
2N7590T3					30	ns
2N7592T3					40	ns
2N7594T3					27	ns
Turn-off delay time			$t_{D(off)}$			
2N7588T3					35	ns
2N7590T3					35	ns
2N7592T3					35	ns
2N7594T3					36	ns
Fall time			t_f			
2N7588T3					15	ns
2N7590T3					25	ns
2N7592T3					15	ns
2N7594T3					20	ns
<u>Subgroup 5</u>						
Safe operating area test	3474	See figure 4 , $t_p = 10$ ms min., $V_{DS} = 80$ percent of max. rated V_{DS}				
Electrical measurements		See table I , subgroup 2				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition B, $I_D = I_{D1}$, $V_{GS} = 12$ V dc $V_{DD} = 50$ percent of rated V_{DS}				
On-state gate charge / turn-off gate charge			$Q_{G(ON)}$			
2N7588T3					50	nC
2N7590T3					50	nC
2N7592T3					42	nC
2N7594T3					40	nC
Gate to source charge (turn-on and turn-off)			Q_{GS}			
2N7588T3					15	nC
2N7590T3					15	nC
2N7592T3					10	nC
2N7594T3					12	nC

See footnotes at end of table.

MIL-PRF-19500/755A
w/AMENDMENT 5

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 (turn-on and turn-off)			Q_{GD}			
2N7588T3					12	nC
2N7590T3					18	nC
2N7592T3					20	nC
2N7594T3					17	nC
Reverse recovery time	3473	Condition A, $di/dt = -100 \text{ A}/\mu\text{s}$, $V_{DD} \leq 50 \text{ V}$, $I_D = I_{D1}$	t_{rr}			
2N7588T3					250	ns
2N7590T3					300	ns
2N7592T3					300	ns
2N7594T3					450	ns

1/ For sampling plan, see [MIL-PRF-19500](#).

2/ For end-point measurements, this test is required for the following subgroups:

Group B, subgroups 2 and 3 (JANTXV).

Group B, subgroups 3 and 4 (JANS).

Group C, subgroup 2 and 6.

Group E, subgroup 1.

MIL-PRF-19500/755A
w/AMENDMENT 5

TABLE II. Group D inspection.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits		Unit
				R, F, & G		R, F, & G		
	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) 4/	1019	Condition A, $V_{GS} = 12\text{ V};$ $V_{DS} = 0$						
Steady-state total dose irradiation (V_{DS} bias) 4/	1019	Condition A, $V_{GS} = 0;$ $V_{DS} = 80$ percent of rated $V_{DS}(\text{preirradiation})$						
End-point electricals:								
Breakdown voltage, drain to source	3407	Bias condition C, $V_{GS} = 0; I_D = 1\text{ mA}$	$V_{(BR)DSS}$					
2N7588T3				100		100		V dc
2N7590T3				150		150		V dc
2N7592T3				200		200		V dc
2N7594T3				250		250		V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ $I_D = 1\text{ mA}$	$V_{GS(th)1}$	2.0	4.0	2.0	4.0	V dc
Gate current	3411	Bias condition C, $V_{GS} = +20\text{ V};$ $V_{DS} = 0$	I_{GSSF1}		100		100	nA dc
Gate current	3411	Bias condition C, $V_{GS} = -20\text{ V}; V_{DS} = 0$	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_{DSS}		10		10	μA dc
Static drain to source on-state voltage	3405	$V_{GS} = 12\text{ V}; I_D = I_{D2}$ condition A, pulsed (see 4.5.1)	$V_{DS(on)}$					
2N7588T3					0.855		0.855	V dc
2N7590T3					1.104		1.104	V dc
2N7592T3					1.340		1.340	V dc
2N7594T3					1.824		1.824	V dc
Forward voltage source drain diode	4011	Bias condition A, $V_{GS} = 0; I_D = I_{D1}$	V_{SD}		1.2		1.2	V dc

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

2/ 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 sheets 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.

MIL-PRF-19500/755A
w/AMENDMENT 5

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>			45 devices c = 0
Temperature cycling	1051	-55°C to +150°C, 500 cycles	
Hermetic seal Fine leak Gross leak	1071	As applicable	
Electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 2 1/</u>			45 devices c = 0
Steady-state gate bias	1042	Condition B, 1,000 hours.	
Electrical measurements		See table I , subgroup 2 herein.	
Steady-state reverse bias	1042	Condition A, 1,000 hours.	
Electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 5</u>			3 devices c = 0
Barometric pressure 2N7594T3 only	1001	To 70,000 feet	
<u>Subgroup 10</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	Test conditions shall be derived by the manufacturer	
<u>Subgroup 11</u>			3 devices
SEE 2/ 3/	1080	See method 1080 of MIL-STD-750 .	

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

2/ Group E qualification of SEE testing may be performed prior to lot formation. Qualification may be extended to other specification sheets utilizing the same structurally identical die design.

3/ The sampling plan applies to each bias condition.

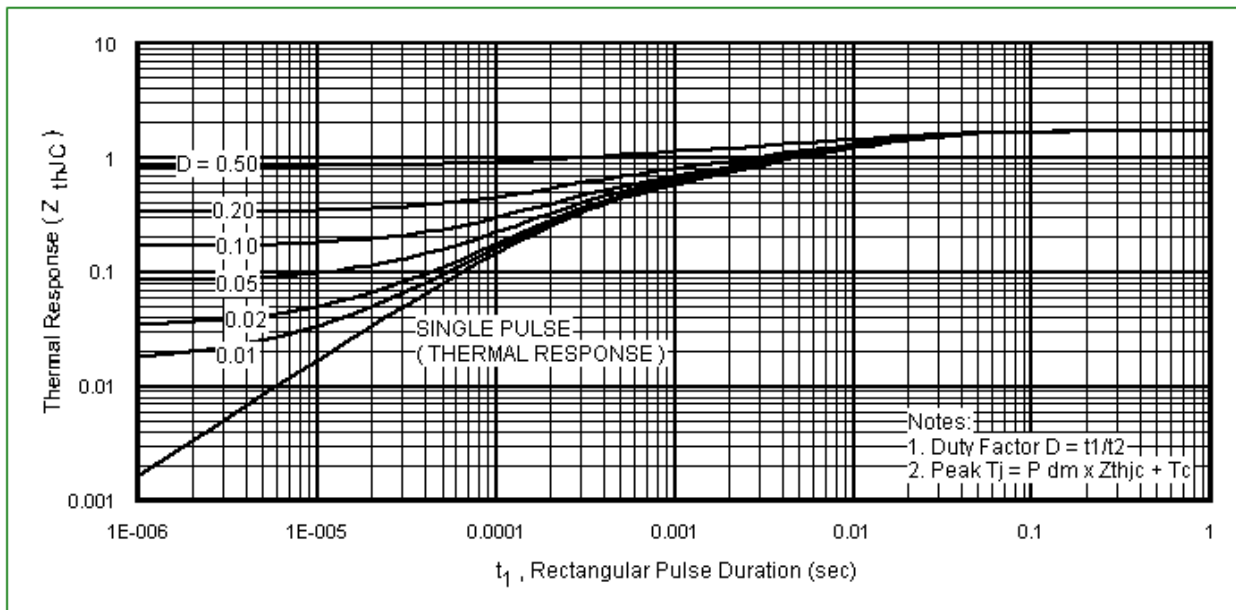


FIGURE 2. Thermal response curve.

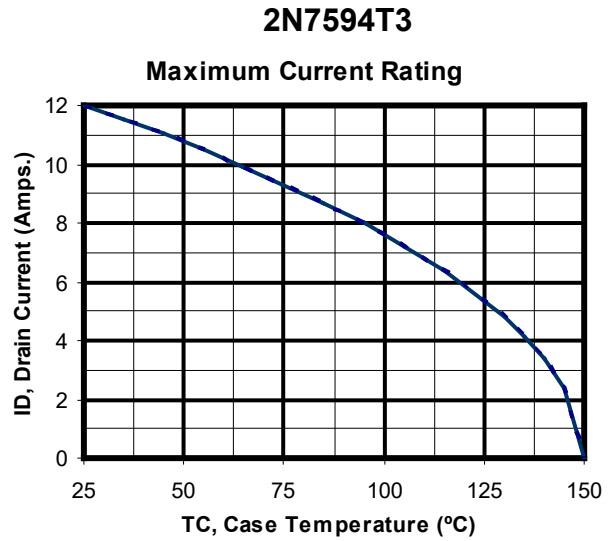
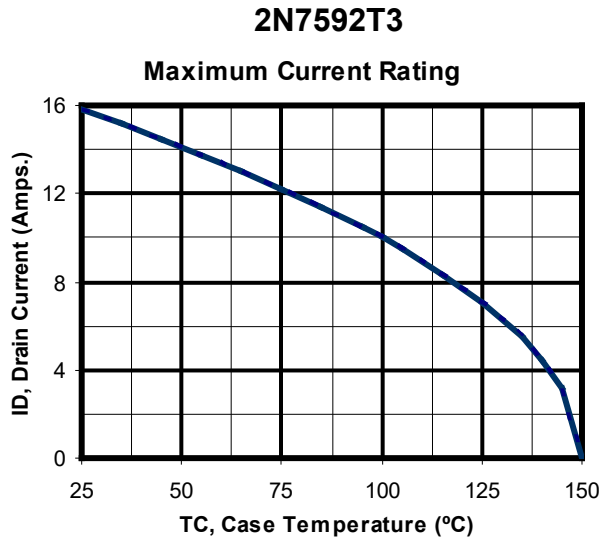
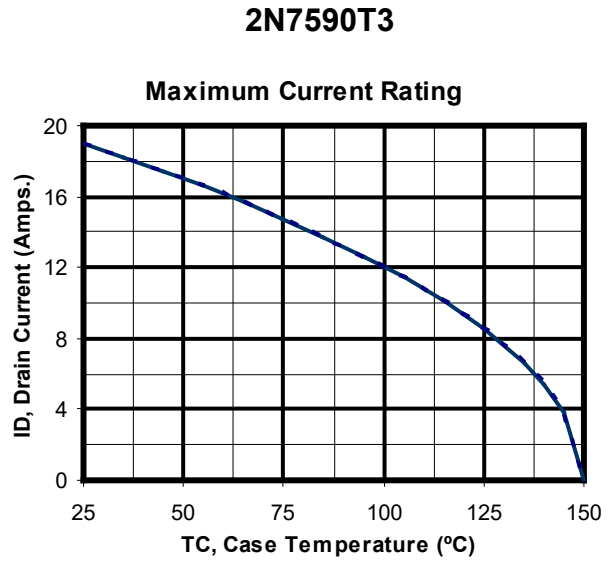
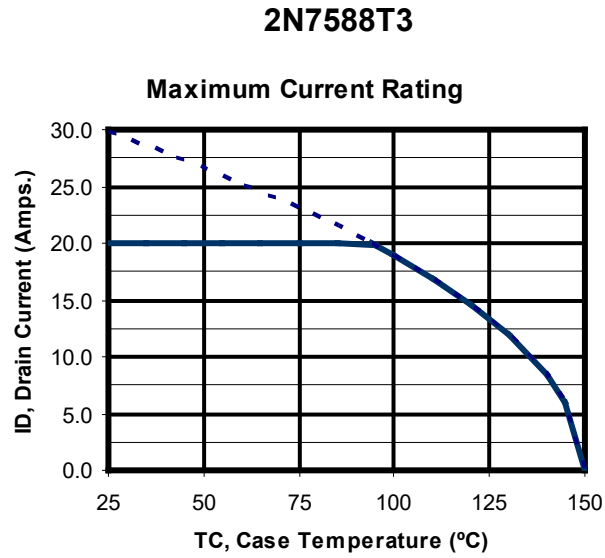
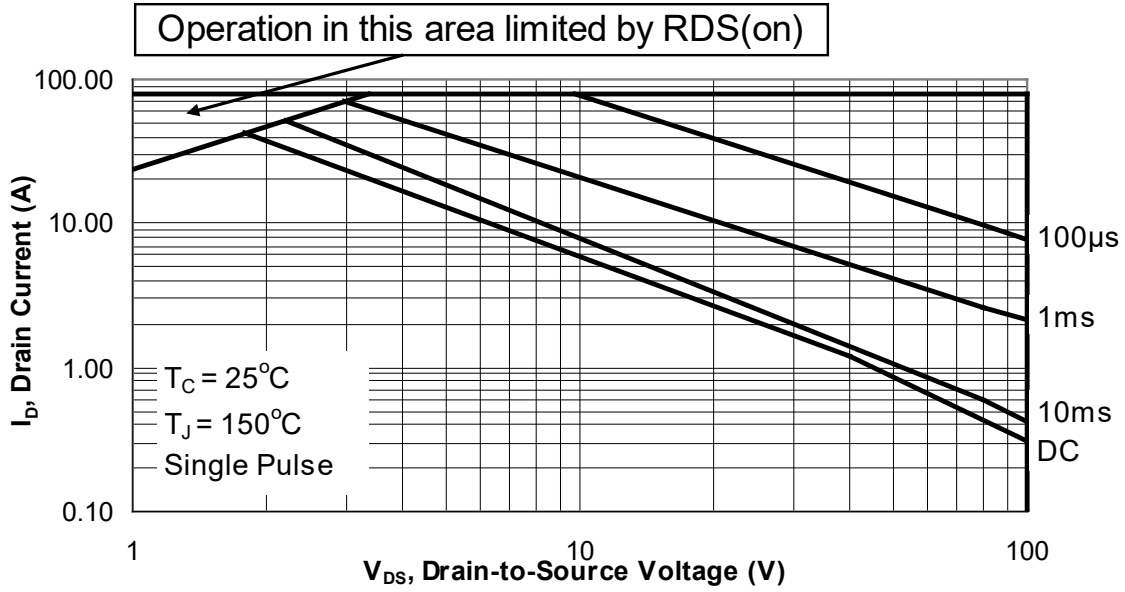


FIGURE 3. Maximum drain current versus case temperature graphs.

2N7588T3



2N7590T3

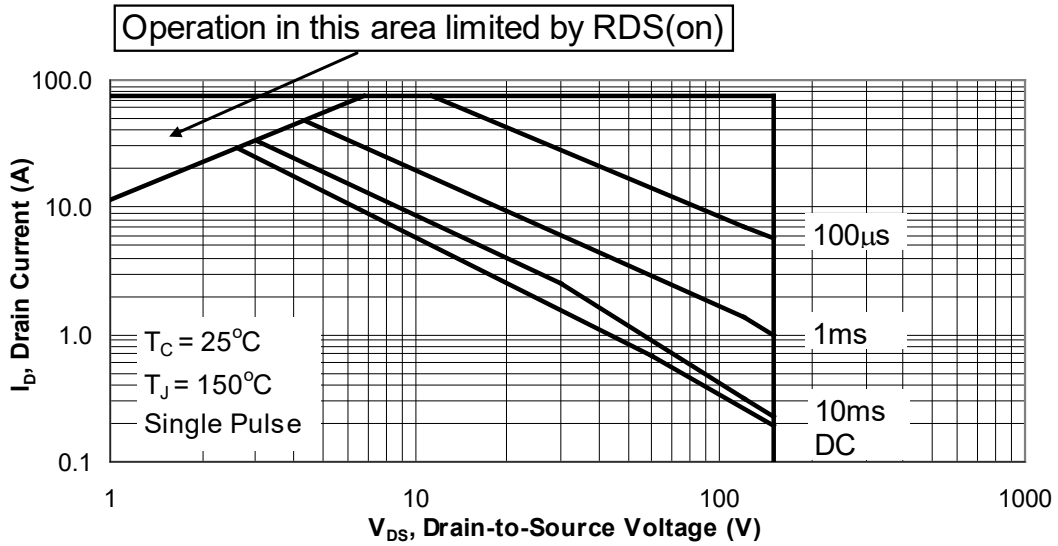
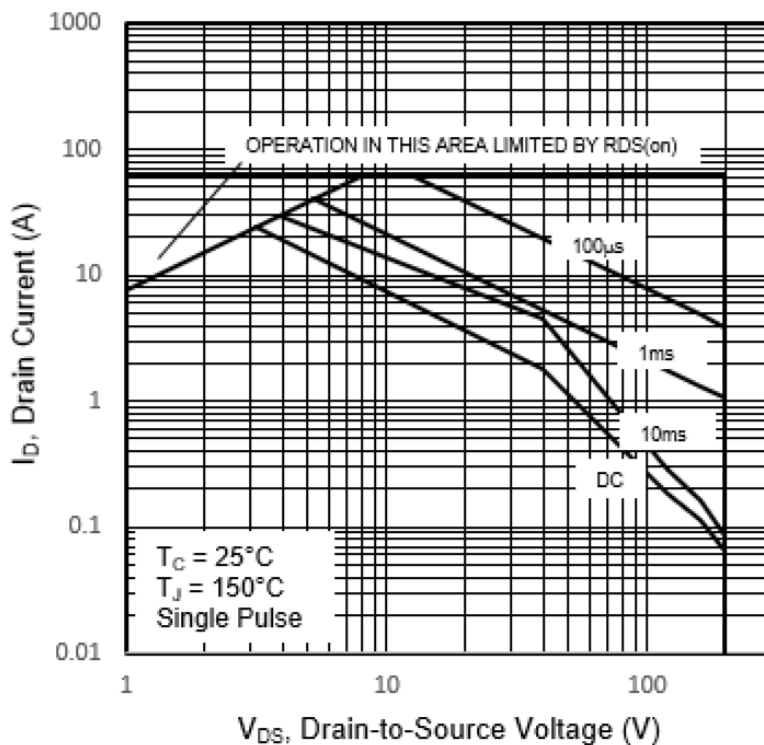


FIGURE 4. Safe operating area graph.

2N7592T3



2N7594T3

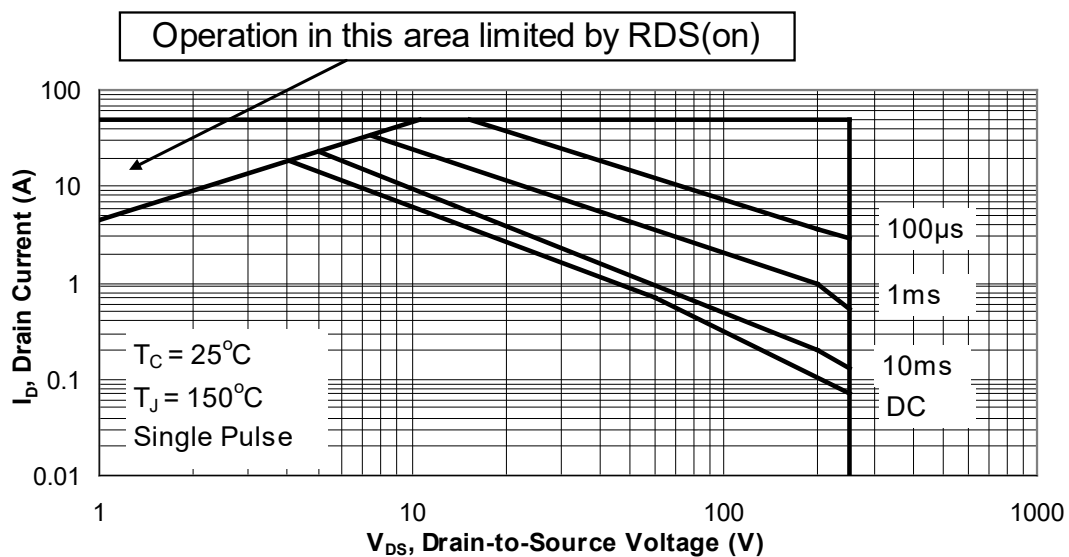


FIGURE 4. Safe operating area graph - Continued.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When 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.

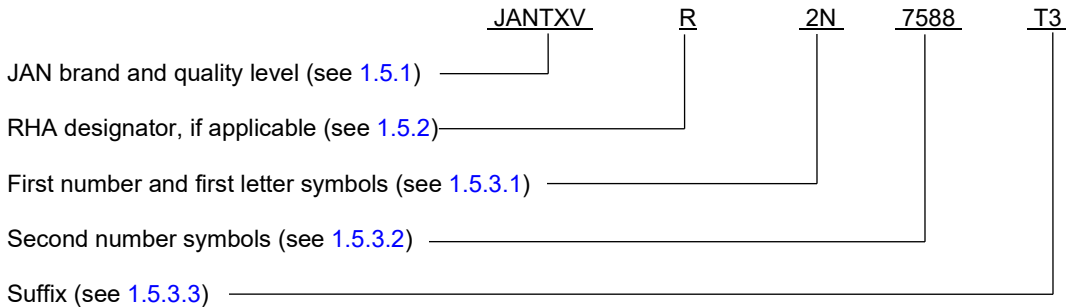
6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. The complete PIN, see 1.5 and 6.5.
- 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 or order.
- f. If SEE testing data is desired, it should be specified in the contract or order.
- g. If specific SEE characterization conditions are desired (see section 6.7 and [table IV](#)), manufacturer's cage code 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 ([QPDSIS-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, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 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/>.

MIL-PRF-19500/755A
w/AMENDMENT 5

6.4 PIN construction example. The PINs for encapsulated devices are construction using the following form.



6.5 List of PINs. The following is a list of possible PINs available on this specification sheet.

PINs for devices of the "TXV" quality level	PINs for devices of the "TXV" quality level with RHA (1)	PINs for devices of the "S" quality level	PINs for devices of the "S" quality level with RHA (1)
JANTXV2N7588T3	JANTXV#2N7588T3	JANS2N7588T3	JANS#2N7588T3
JANTXV2N7590T3	JANTXV#2N7590T3	JANS2N7590T3	JANS#2N7590T3
JANTXV2N7592T3	JANTXV#2N7592T3	JANS2N7592T3	JANS#2N7592T3
JANTXV2N7594T3	JANTXV#2N7594T3	JANS2N7594T3	JANS#2N7594T3

1/ The number sign (#) represents one of three RHA designators available on this specification sheet ("R", "F", or "G").

2/ DLA Land and Maritime maintains an online database of all current sources of supply at https://landandmaritimeapps.dla.mil/Downloads/QPLQML/19500/QPDSIS_19500.pdf/

6.6 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN) (without JAN and RHA prefix). This information in no way implies that manufacturer's PINs are substitutable for the military PIN.

Preferred types military PIN	Commercial PIN
2N7588T3	IRHYS67130CM
2N7590T3	IRHYS67134CM
2N7592T3	IRHYS67230CM
2N7594T3	IRHYS67234CM

6.7 Application data.

6.7.1 Manufacturer specific irradiation data. Each manufacturer qualified to this slash sheet has characterized its devices to the requirements of MIL-STD-750 method 1080 and as specified herein. Since each manufacturer's characterization conditions can be different and can vary by the version of method 1080 qualified to, the MIL-STD-750 method 1080 revision version date and conditions used by each manufacturer for characterization have been listed here (see table IV) for information only. SEE conditions and figures listed in section 6 are current as of the date of this specification sheet, please contact the manufacturer for the most recent conditions.

MIL-PRF-19500/755A
w/AMENDMENT 5

TABLE IV. Manufacturers characterization conditions.

Manufactures cage	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
69210 (Data is based on a test report date of July 2018, date code of 1734)	SEE 1/	1080	See MIL-STD-750E method 1080.0 dated 20 November 2006. See figure 5	3 devices
	Electrical measurements		I_{GSSF1} , I_{GSSR1} , and I_{DSS1} in accordance with table I, subgroup 2	
	SEE irradiation:		Fluence = $3E5 \pm 20$ percent ions/cm ² Flux = $2E3$ to $2E4$ ions/cm ² /sec, temperature = $25^\circ \pm 5^\circ C$	
	2N7588T3		Surface LET = 39 MeV-cm ² /mg, range = 40 μm , Kr ion energy = 315 MeV. In situ bias conditions: $V_{DS} = 100 V$ and $V_{GS} = -19 V$, $V_{DS} = 40 V$ and $V_{GS} = -20 V$, (typical 3.80 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7590T3		Surface LET = 39 MeV-cm ² /mg, range = 50 μm , Kr ion energy = 410 MeV. In situ bias conditions: $V_{DS} = 150 V$ and $V_{GS} = -20 V$, (typical 4.90 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7592T3		Surface LET = 61 MeV-cm ² /mg, range = 66 μm , Xe ion energy = 825 MeV. In situ bias conditions: $V_{DS} = 200 V$ and $V_{GS} = -10 V$, In situ bias conditions: $V_{DS} = 190 V$ and $V_{GS} = -15 V$, (typical 19.01 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7594T3		Surface LET = 44 MeV-cm ² /mg, range = 125 μm , Ag ion energy = 1350 MeV. In situ bias conditions: $V_{DS} = 250 V$ and $V_{GS} = -15 V$, In situ bias conditions: $V_{DS} = 40 V$ and $V_{GS} = -20 V$, (typical 12.40 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7588T3		Surface LET = 61 MeV-cm ² /mg $\pm 5\%$, range = 32 μm , Xe ion energy = 345 MeV. In situ bias conditions: $V_{DS} = 100 V$ and $V_{GS} = -10 V$, $V_{DS} = 30 V$ and $V_{GS} = -15 V$, (typical 2.70 MeV/Nucleon at Texas A & M Cyclotron).	
2N7590T3	Surface LET = 61 MeV-cm ² /mg, range = 66 μm , Xe ion energy = 825 MeV. In situ bias conditions: $V_{DS} = 150 V$ and $V_{GS} = -10 V$, $V_{DS} = 40 V$ and $V_{GS} = -15 V$, (typical 6.40 MeV/Nucleon at Texas A & M Cyclotron).			

See footnotes at end of table.

MIL-PRF-19500/755A
w/AMENDMENT 5

TABLE IV. Manufacturers characterization conditions – Continued.

Manufactures cage	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
69210 (Data is based on a test report date of July 2018, date code of 1734)	SEE <u>1/</u>	1080	See MIL-STD-750E method 1080.0 dated 20 November 2006. See figure 5	
	2N7592T3		Surface LET = 42 MeV-cm ² /mg, range = 205 μm, Xe ion energy = 2450 MeV. In situ bias conditions: V _{DS} = 200 V and V _{GS} = -10 V, In situ bias conditions: V _{DS} = 190 V and V _{GS} = -15 V, (typical 6.41 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7594T3		Surface LET = 61 MeV-cm ² /mg, range = 66 μm, Xe ion energy = 825 MeV. In situ bias conditions: V _{DS} = 250 V and V _{GS} = -10 V, In situ bias conditions: V _{DS} = 50 V and V _{GS} = -15 V, (typical 6.41 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7588T3		Surface LET = 90 MeV-cm ² /mg, range = 29 μm, Au ion energy = 375 MeV. In situ bias conditions: V _{DS} = 100 V and V _{GS} = -5 V, (typical 1.88 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7590T3		Surface LET = 90 MeV-cm ² /mg, range = 80 μm, Au ion energy = 1470 MeV. In situ bias conditions: V _{DS} = 50 V and V _{GS} = -5 V, In situ bias conditions: V _{DS} = 30 V and V _{GS} = -10 V, (typical 7.46 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7592T3		Surface LET = 90 MeV-cm ² /mg, range = 80 μm, Au ion energy = 1470 MeV. In situ bias conditions: V _{DS} = 150 V and V _{GS} = -4 V, In situ bias conditions: V _{DS} = 110 V and V _{GS} = -5 V, (typical 7.46 MeV/Nucleon at Texas A & M Cyclotron).	
	2N7594T3		Surface LET = 90 MeV-cm ² /mg, range = 80 μm, Au ion energy = 1470 MeV. In situ bias conditions: V _{DS} = 75 V and V _{GS} = -5 V, (typical 7.46 MeV/Nucleon at Texas A & M Cyclotron).	
	Electrical measurements		I _{GSSF1} , I _{GSSR1} , and I _{DSS1} in accordance with table I , subgroup 2	
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;"> <p>Upon qualification, all manufacturers should provide the verification test conditions to be added to this table.</p> </div>				

- 1/ I_{GSSF1}, I_{GSSR1}, and I_{DSS1} was examined before and following SEE(SEB/SEGR) 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.
- 2/ Manufacturer performed heavy ion SEE(SEB/SEGR) test at TAMU Radiation Effects Facility for the MOSFET technology devices in accordance with TM1080 of MIL-STD-750. No single event burnout (SEB) and Single event gate rupture(SEGR) were observed to surface LET as stated above table IV and safe operating area (see [figure 5](#)). Limits are characterized at initial qualification and after any design or process changes which may affect the SEE(SEB/SEGR) characteristics. For more information on SEE (SEB/SEGR) test results, customers are requested to contact the manufacturer.

MIL-PRF-19500/755A
w/AMENDMENT 5

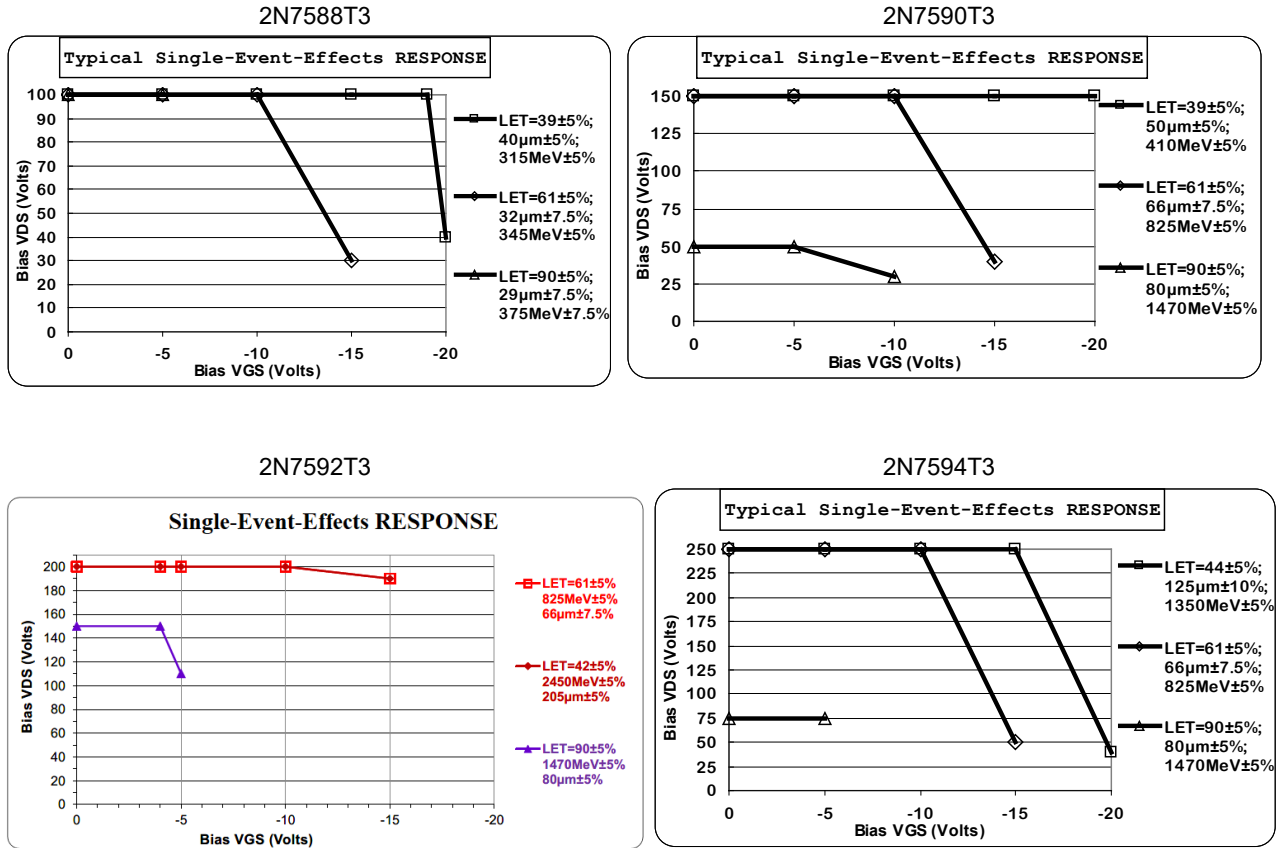


FIGURE 5. Typical SEE safe operating area graphs.

MIL-PRF-19500/755A
w/AMENDMENT 5

6.8 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at Semiconductor@dla.mil or by facsimile (614) 692-6939 or DSN 850-6939.

6.9 Amendment notations. The margins of this specification are marked with asterisks to indicate modifications generated by this amendment. 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.

Custodians:

Army - CR
Navy - SH
Air Force - 85
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2023-058)

Review activity:
Air Force - 19

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/>.