The documentation and process conversion measures necessary to comply with this revision shall be completed by 3 February 2023.

INCH-POUND

MIL-PRF-19500/705E
w/AMENDMENT 2
3 November 2022
SUPERSEDING
MIL-PRF-19500/705E
w/AMENDMENT 1
17 July 2019

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, FIELD EFFECT RADIATION HARDENED, N-CHANNEL, SILICON
DEVICE TYPES 2N7488T3, 2N7489T3, 2N7490T3, AND 2N7556T3 JANTXVR AND JANSR

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 a N-Channel, enhancement-mode, MOSFET, radiation hardened (total dose and single event effects (SEE), power transistor Two levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500 with avalanche energy maximum rating (E_{AS}) and maximum avalanche current (I_{AS}) for use in particular power-switching applications.

1.2 Package outlines. The device package outlines are as follows: TO-257AA in accordance with figure 1 for all packaged device types. The dimensions and topography for JANHC and JANKC unencapsulated die are as listed in slash sheet MIL-PRF-19500/741.

* 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	$R_{\theta JC}$ (2)	V_{DS}	V_{DG}	V_{GS}	I_{D1} (3) (4) T_C = +25°C	I_{D2} (3) (4) T_C = +100°C	I_S	I_{DM} (5)	T_J and T_{STG}	V_{ISO} 70,000 ft. altitude
	W	W	°C/W	V dc	V dc	V dc	A dc	A dc	A dc	A (pk)	°C	V dc
2N7488T3	75	1.56	1.67	130	130	±20	18	12	18	72	-55	N/A
2N7489T3	75	1.56	1.67	200	200	±20	12	7.6	12	48	to	N/A
2N7490T3	75	1.56	1.67	250	250	±20	9.6	6.0	9.6	38.4	+150	250
2N7556T3	75	1.56	1.67	250	250	±20	9.6	6.0	9.6	38.4		250

(1) Derate linearly 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 specs. I_D is limited to 18 A by package and device construction.

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

(4) See figure 3, maximum drain current graphs.
(5) 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.

AMSC N/A FSC 5961

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

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} = 12V, $I_D = I_{D2}$ T_J = +25°C	Max $r_{DS(on)}$ (1) V_{GS} = 12V, $I_D = I_{D2}$ T_J = +150°C	E_{AS}
	V dc	V dc Min	V dc Max	µA dc	Ω	Ω	mJ
2N7488T3	130	2.5	4.5	10	0.090	0.207	80
2N7489T3	200	2.5	4.5	10	0.230	0.522	60
2N7490T3	250	2.5	4.5	10	0.410	0.820	59
2N7556T3	250	2.5	4.5	10	0.410	0.820	59

(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 6.5 for PIN construction example and 6.6 for a list of available PINs.

1.5.1 JAN certification mark and quality level. 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 JAN brand and quality level designators for unencapsulated devices (die). See 6.7 for unencapsulated devices.

1.5.3 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest for JANTXV and JANS quality levels are as follows: "M", "D", "P", "L", and "R".

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

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

1.5.4.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "7488", "7489", "7490" and "7556".

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

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

* 1.6 Radiation features. The following radiation features are applicable for RHA devices supplied to this specification sheet.

* 1.6.1 Maximum total ionizing dose (TID). The maximum TID that RHA devices were tested to in accordance with condition A (dose rate = 50 to 300 rad(Si)/s) of method 1019 of MIL-STD-750 are as follows:

For device type 2N7488T3, 2N7489T3, 2N7490T3, and 2N7556T3:..... 100 krads(Si) 1/

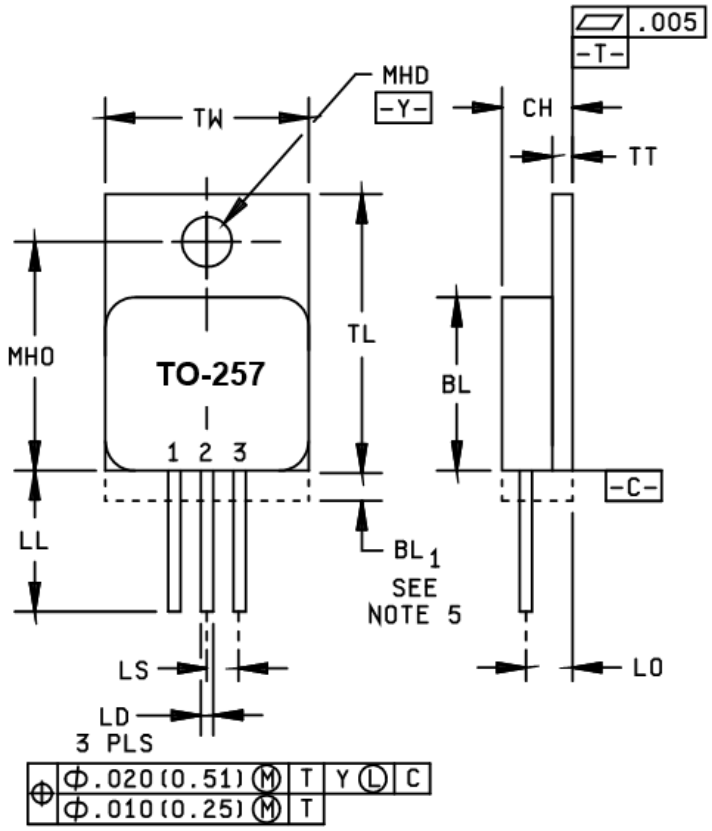
* 1.6.2 Heavy ion irradiation SEE. SEE testing includes Single-Event Burnout (SEB) and Single-Event Gate Rupture (SEGR) tests at the specified linear energy transfer (LET) units. See 6.8 for the specific RHA SEE characterization testing details. The following characterization conditions were used for the testing to the requirements herein:

For device type 2N7488T3:
No SEB and SEGR were observed at surface LET (see table IV) ..... ≤ 84 MeV·cm^2/mg 2/
(In-situ Bias V_{DS} = 130 V and V_{GS} = -0 V)
(In-situ Bias V_{DS} = 120 V and V_{GS} = -5 V)
(In-situ Bias V_{DS} = 30 V and V_{GS} = -10 V)

For device type 2N7489T3:
No SEB and SEGR were observed at surface LET (see table IV) ..... ≤ 84 MeV·cm^2/mg 2/
(In-situ Bias V_{DS} = 200 V and V_{GS} = -5 V)
(In-situ Bias V_{DS} = 150 V and V_{GS} = -10 V)
(In-situ Bias V_{DS} = 50 V and V_{GS} = -15 V)
(In-situ Bias V_{DS} = 25 V and V_{GS} = -20 V)

For device type 2N7490T3 and 2N7556T3:
No SEB and SEGR were observed at surface LET (see table IV) ..... ≤ 84 MeV·cm^2/mg 2/
(In-situ Bias V_{DS} = 250 V and V_{GS} = -5 V)
(In-situ Bias V_{DS} = 225 V and V_{GS} = -10 V)
(In-situ Bias V_{DS} = 175 V and V_{GS} = -15 V)
(In-situ Bias V_{DS} = 50 V and V_{GS} = -20 V)

* 1/ The manufacturers supplying these device types have performed characterization testing in accordance with condition A (dose rate = 50 to 300 rad(Si)/s) of method 1019 of MIL-STD-750. The radiation end point limits are guaranteed only to a maximum TID level of 100 krads(Si).
* 2/ The manufacturers have performed SEE tests at Texas A&M University (TAMU) Radiation Effects Facility and Brookhaven National Lab in accordance with method1080 of MIL-STD-750. For more information on SEE testing and results, customers should contact the qualified manufacturer.



Ltr	Inches	Inches	mm	mm
	Min	Max	Min	Max
BL	.410	.430	10.41	10.92
BL_1		.033		0.84
CH	.190	.200	4.83	5.08
LD	.025	.035	0.64	0.89
LL	.500	.650	12.70	16.51
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. The lid shall be electrically isolated from the drain, gate and source.
4. This area is for the lead feed-thru eyelets (configuration is optional, but will not extend beyond this zone).

* FIGURE 1. Physical dimensions for TO-257AA.

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 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.

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

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (TO-257AA). Methods used for electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent Al_2O_3 (ceramic).

3.4.1 Lead formation and finish. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-PRF-19500 and herein. Where a choice of finish is desired, it shall be specified in the acquisition document (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14 of MIL-PRF-19500 and 100 percent dc testing in accordance with table I, subgroup 2 herein.

3.4.2 Internal construction. Multiple chip construction shall not be 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.

3.5 Electrostatic discharge sensitive (ESDS). The devices covered by this specification sheet have been classified as ESDS. The Metal oxide semiconductor (MOS) 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. However, the following handling practices are recommended.

a. Devices should be handled on benches with conductive handling devices.

b. Ground test equipment, tools, and personnel handling devices.

c. Do not handle devices by the leads.

d. Store devices in conductive foam or carriers.

e. Avoid use of plastic, rubber, or silk in MOS areas.

f. Maintain relative humidity above 50 percent if practical.

g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.

h. Gate must be terminated to source, R $\leq$ or 100 kΩ, 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 table I and II).

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.

4.2.1.1 Single event effects SEE. SEE shall be performed 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 characterization data shall be made available upon request of the qualifying or acquiring activity.

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} test (see 4.3.2)	Method 3470 of MIL-STD-750, E_{AS} test (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)
5	Method 2052 of MIL-STD-750, PIND (see MIL-PRF-19500 and 4.3.5	Not applicable
9	Subgroup 2 of table I herein I_{DSS1}, I_{GSSF1}, I_{GSSR1}, as a minimum	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}, $r_{DS(ON)1}$, $V_{GS(TH)1}$ 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}, $r_{DS(ON)1}$, $V_{GS(TH)1}$ 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.
17	For TO-257AA packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein	For TO-257AA 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 after temperature cycling, screen 3a. JANTXV level does not need to be repeated in screening requirements.

4.3.1 Gate stress test. Apply V_{GS} = 24 V, minimum for t = 250 μS, 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 Ω ≤ R_{GS} ≤ 200 Ω.

d. Supply voltage ..... V_{DD} = 25 V dc, except V_{DD} = 50 V dc
..... for 2N7490T3 and 2N7556T3.

e. Initial case temperature..... T_C = +25° C, -5° C, +10° C.

f. Gate voltage ..... V_{GS} = 12 V dc.

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}) = 70 μs maximum. See table III, group E, subgroup 4 herein.

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.

4.3.5 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 shall 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 Group B inspection, table E-VIA (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
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. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. t_{on} = 30 seconds minimum.
B5	1042	Accelerated steady-state gate bias, condition B, V_{GS} = 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 D.

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

Subgroup	Method	Condition
B2	1051	Test condition G, 25 cycles.
B3	1042	Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. t_{on} = 30 seconds minimum.
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 E-VII of MIL-PRF-19500 and as follows.

Subgroup	Method	Condition
C2	2036	Test condition A; weight = 10 pounds; t = 10 s.
C3	2052	PIND, required if not performed in screening. (JANS only, 22 devices, c = 0 for large lots, 12 devices, c = 0 for small lots).
C5	3161	Thermal resistance, see 4.5.2.
C6	1042	Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. 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 the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in 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.

4.5.2 Thermal resistance. The thermal resistance 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}) = 70 µs maximum. See table E-IX of MIL-PRF-19500, group E, subgroup 4.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Condition		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Thermal impedance 2/	3161	See 4.3.3	$Z_{\theta JC}$			°C/W
Breakdown voltage drain to source	3407	V_{GS} = 0, I_D = 1 mA dc, bias condition C	$V_{(BR)DSS}$			
2N7488T3				130		V dc
2N7489T3				200		V dc
2N7490T3				250		V dc
2N7556T3				250		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 V dc, bias condition C, V_{DS} = 0	I_{GSSF1}		+100	nA dc
Gate current	3411	V_{GS} = −20 V dc, bias condition C, V_{DS} = 0	I_{GSSR1}		-100	nA dc
Drain current	3413	V_{GS} = 0, 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}	$r_{DS(ON)1}$			
2N7488T3					0.090	Ω
2N7489T3					0.230	Ω
2N7490T3					0.410	Ω
2N7556T3					0.410	Ω
Forward voltage	4011	V_{GS} = 0, condition A, I_D = I_{D1}	V_{SD}		1.2	V dc

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Condition		Min	Max	
Subgroup 3						
High temperature operation		$T_C = T_J = +125°C$				
Gate current	3411	$V_{GS} = \pm 20$ V dc, bias condition C, $V_{DS} = 0$	I_{GSS2}		±200	nA dc
Drain current	3413	$V_{GS} = 0$, bias condition C, V_{DS} = 80 percent of rated V_{DS}	I_{DSS2}		25	µA dc
Static drain to source on-state resistance	3421	V_{GS} = 12 V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)3}$			
2N7488T3					0.180	Ω
2N7489T3					0.483	Ω
2N7490T3, 2N7556T3					0.780	Ω
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	$V_{DS} \geq V_{GS(TH)3}$, I_D = 1 mA dc	$V_{GS(TH)3}$		5.5	V dc
Subgroup 4						
Forward transconductance	3475	$I_D = I_{D2}$, V_{DD} = 15 V dc (see 4.5.1)	g_{FS}			
* 2N7488T3				5		S
2N7489T3				6		S
2N7490T3				6		S
2N7556T3				4		S
Switching time test	3472	$I_D = I_{D1}$, V_{GS} = 12 V dc, R_G = 7.5 Ω, V_{DD} = 50 percent of rated V_{DS}				
Turn-on delay time			$t_{D(on)}$			
2N7488T3					20	ns
2N7489T3					25	ns
2N7490T3, 2N7556T3					25	ns
Rise time			t_r			
2N7488T3					70	ns
2N7489T3					100	ns
2N7490T3, 2N7556T3					100	ns
Turn-off delay time			$t_{D(off)}$			
2N7488T3					25	ns
2N7489T3					35	ns
2N7490T3, 2N7556T3					35	ns
Fall time			t_f			
2N7488T3					35	ns
2N7489T3					30	ns
2N7490T3, 2N7556T3					30	ns

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Condition		Min	Max	
Subgroup 5						
Safe operating area test (high voltage)	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				
Subgroup 6						
Not applicable						
Subgroup 7						
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			$Q_{G(ON)}$			
2N7488T3					48	nC
2N7489T3					35	nC
2N7490T3					28	nC
2N7556T3					32	nC
Gate to source charge			Q_{GS}			
2N7488T3					16	nC
2N7489T3					9	nC
2N7490T3					7.4	nC
2N7556T3					11	nC
Gate to drain charge			Q_{GD}			
2N7488T3					18	nC
2N7489T3					15	nC
2N7490T3					12	nC
2N7556T3					16	nC
Reverse recovery time	3473	Condition A, di/dt = -100 A/µs, $V_{DD} \leq 50$ V, $I_D = I_{D1}$	t_{rr}			
2N7488T3					200	ns
2N7489T3					300	ns
2N7490T3, 2N7556T3					300	ns

1/ For sampling plan, see MIL-PRF-19500.
2/ For end-point measurements, this test is required for the following subgroups (not intended for 4.3, screen 9 or 11):
Group B, subgroups 2 and 3 (JANTXV).
Group B, subgroups 3 and 4 (JANS).
Group C, subgroups 2 and 6.
Group E, subgroup 1.

TABLE II. Group D inspection.

	Inspection 1/ 2/ 3/	Method	MIL-STD-750 Conditions	Symbol	Pre-irradiation limits R Min	Pre-irradiation limits R Max	Post-irradiation limits R Min	Post-irradiation limits R Max	Unit
	Subgroup 1								
	Not applicable								
	Subgroup 2		T_C = + 25°C						
*	Steady-state total dose irradiation (V_{GS} bias) 4/	1019	Condition A, V_{GS} = 12 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} (preirradiation)						
	End-point electricals:								
	Breakdown voltage, drain to source	3407	V_{GS} = 0; I_D = 1 mA; bias condition C	$V_{(BR)DSS}$					
	2N7488T3				130		130		V dc
	2N7489T3				200		200		V dc
	2N7490T3, 2N7556T3				250		250		V dc
	Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ I_D = 1 mA	$V_{GS(th)1}$	2.5	4.5	2.0	4.5	V dc
	Gate current	3411	V_{GS} = +20 V; V_{DS} = 0; bias condition C	I_{GSSF1}		100		100	nA dc
	Gate current	3411	V_{GS} = -20 V; V_{DS} = 0; bias condition C	I_{GSSR1}		-100		-100	nA dc
	Drain current	3413	V_{GS} = 0, V_{DS} = 80 percent of rated V_{DS} (preirradiation); bias condition C	I_{DSS}		10		10	µA dc
	Static drain to source on-state voltage 5/	3405	V_{GS} = 12 V; I_D = I_{D2} condition A, pulsed (see 4.5.1)	$V_{DS(on)}$					
	2N7488T3					1.080		1.080	V dc
*	2N7489T3					1.748		1.748	V dc
*	2N7490T3, 2N7556T3					2.460		2.460	V dc
	Forward voltage source drain diode	4011	V_{GS} = 0; I_D = I_{D1}, bias condition A	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.
*5/ Group D samples are built and tested in TO-3 packages. The equivalent pre-radiation and post radiation limit for $V_{DS(on)}$ in the TO-3 package is 1.080 Vdc for the 2N7488T3 device, 1.763 Vdc for the 2N7489T3 device, and 2.484 Vdc for the 2N7490T3 and 2N7556T3 devices.

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			45 devices c = 0
Temperature cycling	1051	Test condition G, 500 cycles	
Hermetic seal Fine leak Gross leak	1071	As applicable.	
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 2 1/			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.	
Subgroup 4			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500.	
Subgroup 5			15 devices c = 0
Barometric pressure (2N7490T3 and 2N7556T3 only)	1001	Test condition C, V_{DS} = 250 V; $I_{(ISO)}$ < 0.25 mA.	
Subgroup 10			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	
Subgroup 11			
SEE 2/ 3/	1080	See method 1080 of MIL-STD-750.	3 devices

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/ Device qualification to a higher level LET is sufficient to qualify all lower level LETs.

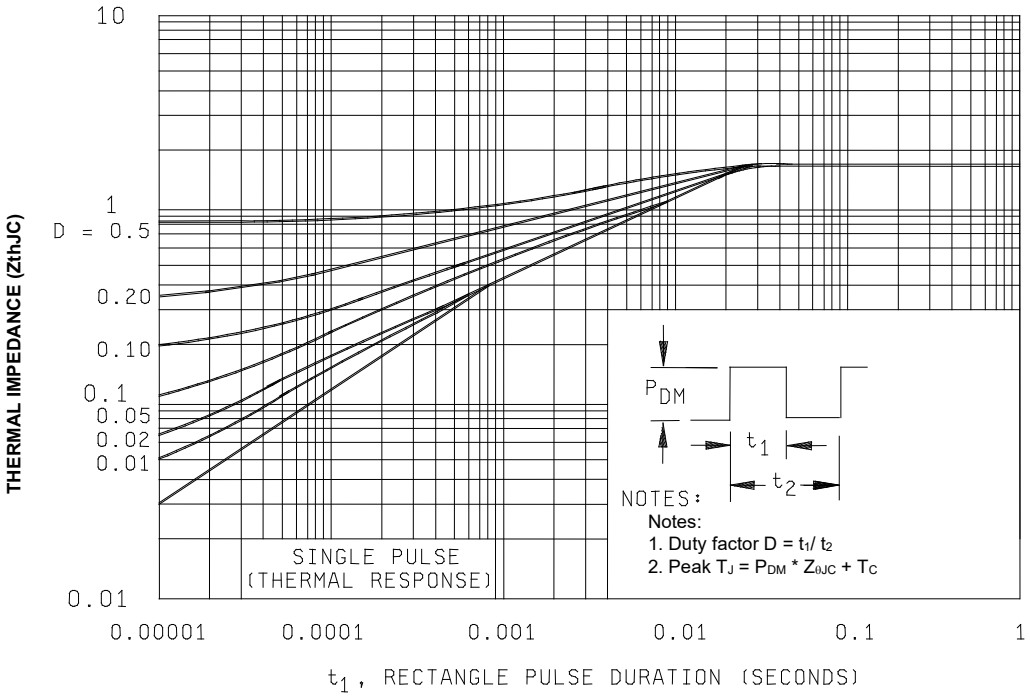
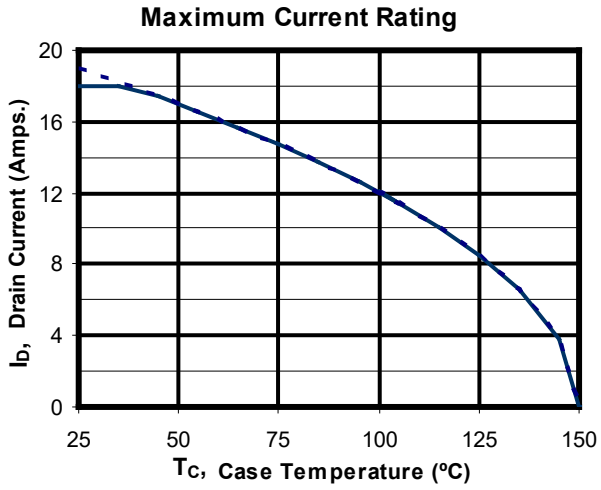
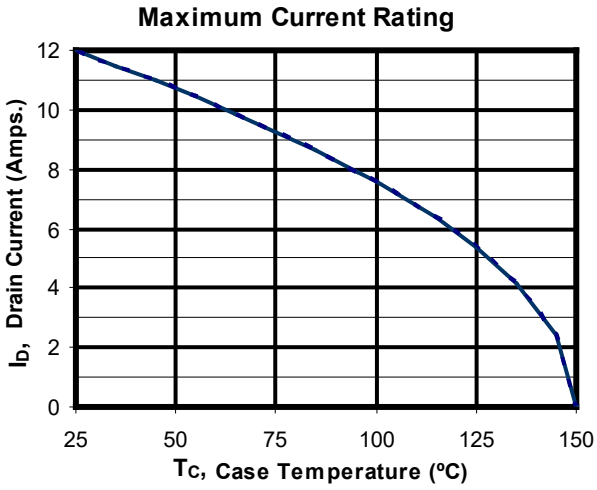


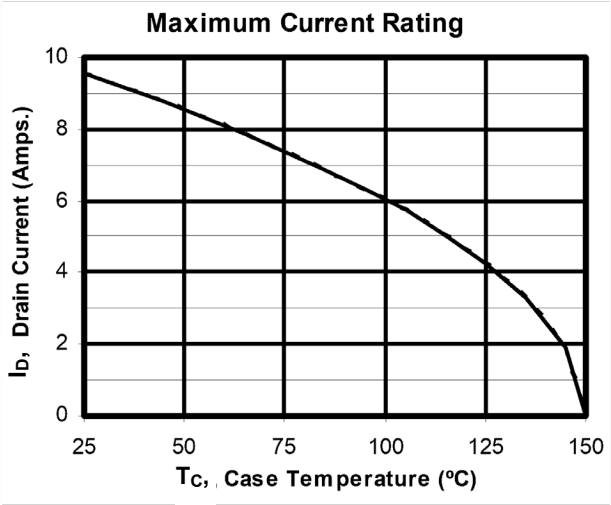
FIGURE 2. Thermal impedance curve.



2N7488T3

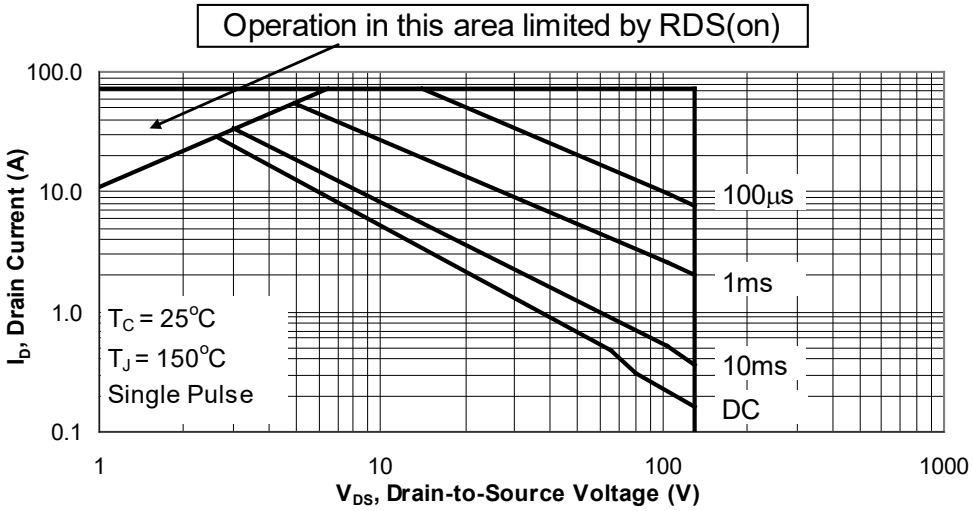


2N7489T3

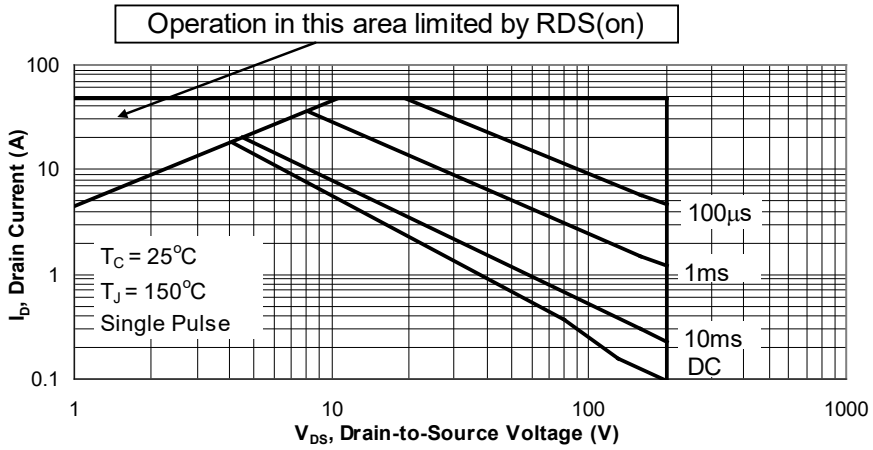


2N7490T3, 2N7556T3

FIGURE 3. Maximum drain current vs case temperature graphs.

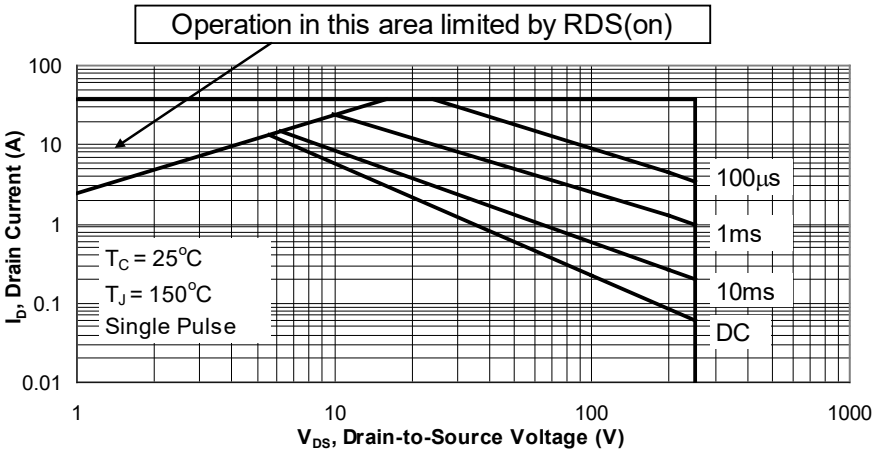


2N7488T3

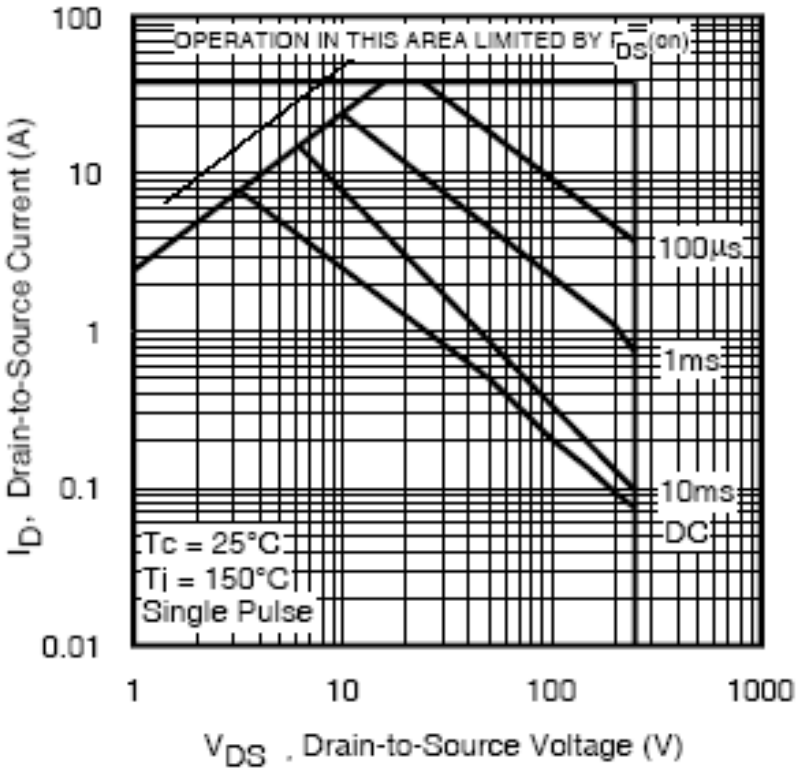


2N7489T3

FIGURE 4. Safe operating area graphs.



2N7490T3



2N7556T3

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 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 formation and 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.

f. If SEE testing data is desired, it should be specified in the contract or order.

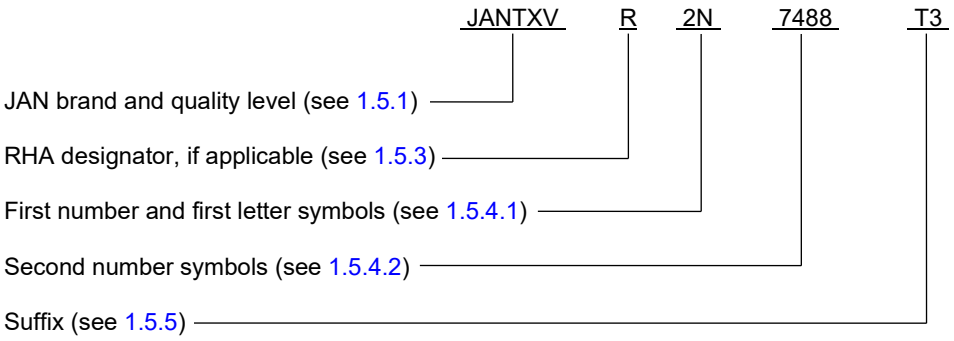
g. If specific SEE characterization conditions are desired (see section 6.8 and table IV), manufacturer's CAGE code should be specified in the contract or order.

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 (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, 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://qpldocs.dla.mil.

6.4 Cross-reference list. The following table shows the generic P/N and its associated military P/N (without JANTX and RHA prefix).

Generic P/N	Military P/N
IRHY57133CMSE	2N7488T3
IRHY57230CMSE	2N7489T3
	2N7490T3
IRHY57234CMSE	2N7556T3

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



6.6 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)
JANTXV2N7488T3	JANTXV#2N7488T3	JANS2N7488T3	JANS#2N7488T3
JANTXV2N7489T3	JANTXV#2N7489T3	JANS2N7489T3	JANS#2N7489T3
JANTXV2N7490T3	JANTXV#2N7490T3	JANS2N7490T3	JANS#2N7490T3
JANTXV2N7556T3	JANTXV#2N7556T3	JANS2N7556T3	JANS#2N7556T3

(1) The number sign (#) represent one of five RHA designators available (M, D, P, L, or R).

6.7 JANC die versions. The JANHC and JANKC die versions of these devices are covered under specification sheet MIL-PRF-19500/741.

6.8 Application data.

6.8.1 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.

* TABLE IV. Manufacturers characterization conditions.

Manufactures CAGE	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
69210 (Applicable to devices with a date code of 16 June 1998 and older)	SEE 1/	1080	See MIL-STD-750 method 1080.0 dated 20 November 2006. See figure 5	
	Electrical measurements		I_{GSSF1}, I_{GSSR1}, and I_{DSS1} in accordance with table I, subgroup 2	3 devices
	SEE irradiation:		Fluence = 3E5 ±20 percent ions/cm^2 Flux = 2E3 to 2E4 ions/cm^2/sec, temperature = 25 ±5°C	
*	2N7488T3		Surface LET = 38 MeV-cm2/mg ±5% Range = 38 µm ±7.5%, Kr ion Energy = 300 MeV ±7.5%	
*			In-situ bias conditions: V_{DS} = 130 V and V_{GS} = -20 V (typical 3.58 MeV/nucleon at Texas A & M Cyclotron)	
*	2N7489T3		Surface LET = 38 MeV-cm2/mg ±5% Range = 38 µm ±7.5%, Br ion Energy = 300 MeV ±7.5%	
*			In-situ bias conditions: V_{DS} = 200 V and V_{GS} = -20 V (nominal 3.80 MeV/nucleon at Brookhaven National Lab Accelerator)	
*	2N7490T3, 2N7556T3		Surface LET = 38 MeV-cm2/mg ±5% Range = 38 µm ±7.5%, Br ion Energy = 300 MeV ±7.5%	
*			In-situ bias conditions: V_{DS} = 250 V and V_{GS} = -20 V (nominal 3.80 MeV/nucleon at Brookhaven National Lab Accelerator)	
*	2N7488T3		Surface LET = 61 MeV-cm2/mg ±5% Range = 31 µm ±10%, Xe ion Energy = 330 MeV ±7.5%	
*			In-situ bias conditions: V_{DS} = 130 V and V_{GS} = -10 V V_{DS} = 100 V and V_{GS} = -15 V V_{DS} = 50 V and V_{GS} = -20 V (typical 2.56 MeV/nucleon at Texas A & M Cyclotron)	
*	2N7489T3		Surface LET = 61 MeV-cm2/mg ±5% Range = 31 µm ±10%, I ion Energy = 330 MeV ±7.5%	
*			In-situ bias conditions: V_{DS} = 200 V and V_{GS} = -10 V V_{DS} = 185 V and V_{GS} = -15 V V_{DS} = 120 V and V_{GS} = -20 V (nominal 2.60 MeV/nucleon at Brookhaven National Lab Accelerator)	
*	2N7490T3, 2N7556T3		Surface LET = 61 MeV-cm2/mg ±5% Range = 31 µm ±10%, I ion Energy = 330 MeV ±7.5%	
*			In-situ bias conditions: V_{DS} = 250 V and V_{GS} = -15 V V_{DS} = 240 V and V_{GS} = -20 V (nominal 2.60 MeV/nucleon at Brookhaven National Lab Accelerator)	

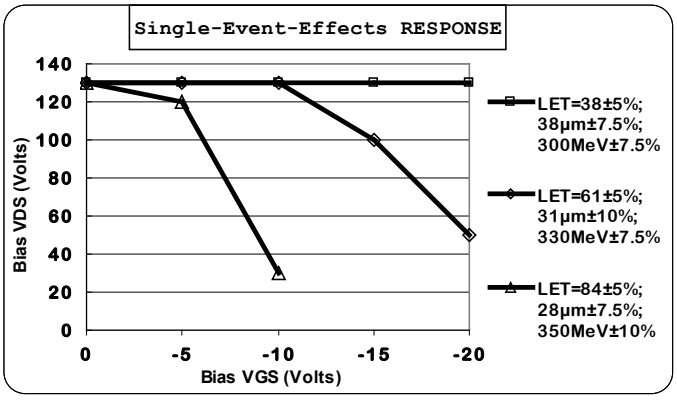
See footnotes at end of table.

* TABLE IV. Manufacturers characterization conditions - Continued.

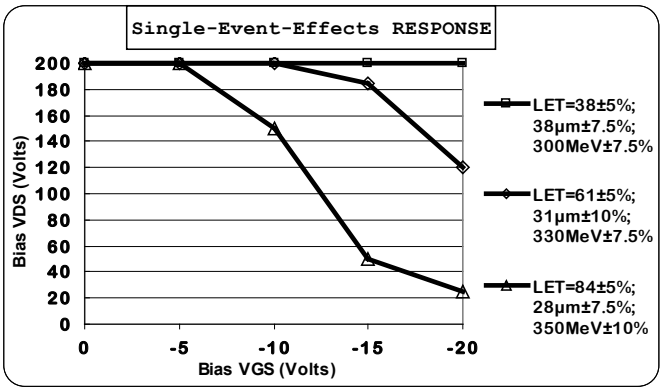
Manufactures CAGE	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
*			Surface LET = 84 MeV-cm2/mg ±5% Range = 28 µm ±7.5%, Au ion Energy = 350 MeV ±10%	3 devices
*	2N7488T3		In-situ bias conditions: V_{DS} = 130 V and V_{GS} = 0 V V_{DS} = 120 V and V_{GS} = -5 V V_{DS} = 30 V and V_{GS} = - 10 V (typical 1.78 MeV/nucleon at Texas A & M Cyclotron)	
*	2N7489T3		In-situ bias conditions: V_{DS} = 200 V and V_{GS} = -5V V_{DS} = 150 V and V_{GS} = -10 V V_{DS} = 50 V and V_{GS} = -15 V V_{DS} = 25 V and V_{GS} = -20 V (nominal 1.78 MeV/nucleon at Brookhaven National Lab Accelerator)	
*	2N7490T3, 2N7556T3		In-situ bias conditions: V_{DS} = 250 V and V_{GS} = -5 V V_{DS} = 225 V and V_{GS} = -10 V V_{DS} = 175 V and V_{GS} = -15 V V_{DS} = 50 V and V_{GS} = -20 V (nominal 1.78 MeV/nucleon at Brookhaven National Lab Accelerator)	
	Electrical measurements		I_{GSSF1}, I_{GSSR1}, and I_{DSS1} in accordance with table I, subgroup 2	

1/ I_{GSSF1}, I_{GSSR1}, and I_{DSS1} was examined 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.

2N7488T3



2N7489T3



2N7490T3, 2N7556T3

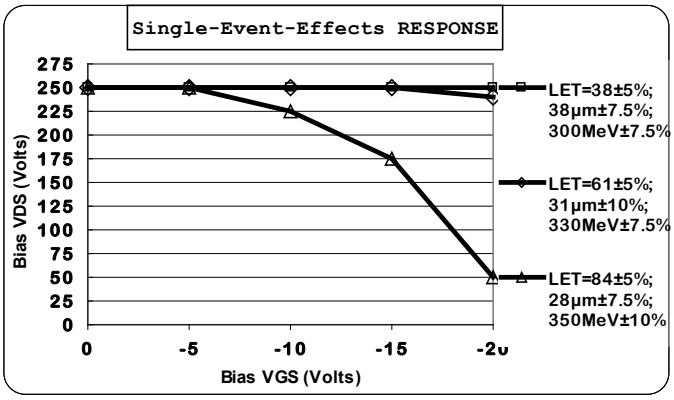


FIGURE 5. Typical SEE safe operating area graphs.

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 and relationship to the last previous issue.

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

Review activity:
Army - AV, MI
Air Force - 19

Preparing activity:
DLA - CC

(Project 5961-2022-089)

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.