

The documentation and process conversion measures necessary to comply with this revision shall be completed by 21 March 2005.

INCH-POUND

MIL-PRF-19500/698A  
 21 December 2004  
 SUPERSEDING  
 MIL-PRF-19500/698  
 16 August 2001

\* PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED (TOTAL DOSE AND SINGLE EVENT EFFECTS) TRANSISTOR, N-CHANNEL, SILICON TYPES 2N7470T1 AND 2N7471T1, JANTXVR, F, G, AND H AND JANSR, F, G, AND H

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

\* 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 device type as specified in MIL-PRF-19500, with avalanche energy maximum rating ( $E_{AS}$ ) and maximum avalanche current ( $I_{AS}$ ).

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

\* 1.3 Maximum ratings.  $T_A = +25^\circ\text{C}$ , unless otherwise specified.

Type	$P_T$ (1) $T_C = +25^\circ\text{C}$	$P_T$ $T_A = +25^\circ\text{C}$	$R_{\theta JC}$	$V_{DS}$	$V_{DG}$	$V_{GS}$	$I_{D1}$ (2) (3) $T_C = +25^\circ\text{C}$	$I_{D2}$ (2) (3) $T_C = +100^\circ\text{C}$	$I_s$	$I_{DM}$ (4)	$T_J$ and $T_{STG}$
	W	W	$^\circ\text{C/W}$	V dc	V dc	V dc	A dc	A dc	A dc	A (pk)	$^\circ\text{C}$ -55 to +150
2N7470T1	208	3.0	0.6	60	60	$\pm 20$	45	45	45	180	
2N7471T1				100	100		45	45	45	180	

(1) Derate linearly 1.67 W/ $^\circ\text{C}$  for  $T_C > +25^\circ\text{C}$ .

(2) The following formula derives the maximum theoretical  $I_D$  limit.  $I_D$  is limited by package and device construction to 45 A.

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

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

(4)  $I_{DM} = 4 \times I_{D1}$ ;  $I_{D1}$  as calculated by footnote (2).

\* Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to [Semiconductor@dsc.dla.mil](mailto:Semiconductor@dsc.dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.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 $I_{DSS1}$ $V_{GS} = 0$ $V_{DS} = 80$ percent of rated $V_{DS}$	Max $r_{DS(on)}$ (1) $V_{GS} = 12\text{ V}, I_D = I_{D2}$		EAS	
				$T_J = +25^\circ\text{C}$	$T_J = +150^\circ\text{C}$		
	<u>V dc</u>	<u>V dc</u>		<u><math>\mu\text{A dc}</math></u>	<u><math>\Omega</math></u>	<u><math>\Omega</math></u>	<u>mJ</u>
		Min	Max				
2N7470T1	60	2.0	4.0	10	0.0066	0.013	824
2N7471T1	100				0.013	0.026	493

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

\* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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, 4, or 5 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

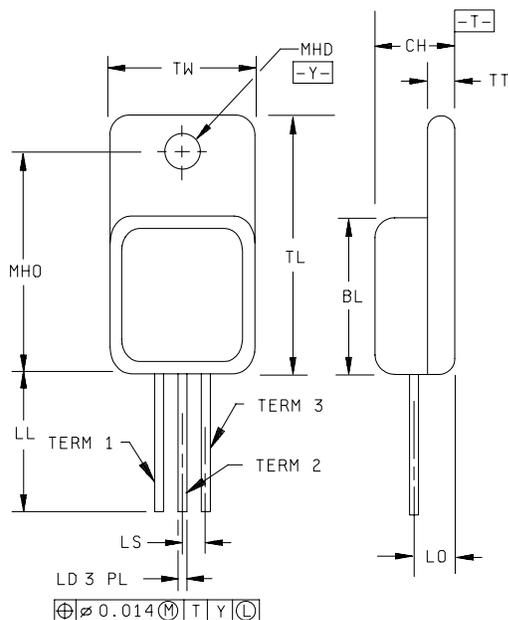
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

\* DEPARTMENT OF DEFENSE STANDARDS

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

\* (Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BL	.535	.545	13.59	13.84	
CH	.249	.260	6.32	6.60	
LD	.035	.045	0.89	1.14	
LL	.665	.685	16.89	17.40	3
LO	.150 BSC		3.81 BSC		
LS	.150 BSC		3.81 BSC		
MHD	.139	.149	3.53	3.78	
MHO	.665	.685	16.89	17.40	
TL	.790	.800	20.07	20.32	4
TT	.040	.050	1.02	1.27	
TW	.535	.545	13.59	13.84	4
Term 1	Drain				
Term 2	Source				
Term 3	Gate				

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
- \* 3. Protrusion thickness of ceramic eyelets included in dimension LL.
4. All terminals are isolated from case.
- \* 5. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi x$  symbology.

\* FIGURE 1. Physical dimensions for TO-254AA (2N7470T1 and 2N7471T1).

### 3. REQUIREMENTS

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

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

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

$I_{AS}$  - Rated avalanche current, nonrepetitive

nC - nano Coulomb

\* 3.4 Interface and physical dimensions. The Interface and physical dimensions shall be as specified in MIL-PRF-19500, figure 1 (TO-254AA) herein. Methods used for electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent  $Al_2O_3$  (ceramic).

\* 3.4.1 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.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection (see 3.5.1).

3.5.1 Handling. MOS devices must be handled with the following precautions to avoid damage due to the accumulation of static charge.

- a. Devices should be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber, or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source,  $R \leq 100 \text{ k}\Omega$ , whenever bias voltage is 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 herein.

\* 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 and as specified herein. Alternate flow is allowed for qualification inspection in accordance with figure 4 of 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 SEE. Design capability shall be tested on the initial qualification and thereafter whenever a major die design or process change is introduced. See the design safe operation area figure. End-point measurements shall be in accordance with table III.

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\* 4.3 Screening (JANS and JANTXV levels only). Screening shall be in accordance with table IV of MIL-PRF-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500) (1) (2)	Measurement	
	JANS level	JANTXV levels
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, E <sub>AS</sub> (see 4.3.2)	Method 3470 of MIL-STD-750, E <sub>AS</sub> (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)
7	Optional.	Optional.
9	Subgroup 2 of table I herein, I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub>	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub> , r <sub>DS(on)1</sub> , V <sub>GS(TH)1</sub> Subgroup 2 of table I herein ΔI <sub>GSSF1</sub> = ±20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI <sub>GSSR1</sub> = ±20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI <sub>DSS1</sub> = ±10 μA dc or ± 100 percent of initial value, whichever is greater.	I <sub>GSSF1</sub> , I <sub>GSSR1</sub> , I <sub>DSS1</sub> , r <sub>DS(on)1</sub> , V <sub>GS(TH)1</sub> Subgroup 2 of table I herein
12	MIL-STD-750, method 1042, test condition A	MIL-STD-750, method 1042, test condition A
13	Subgroups 2 and 3 of table I herein ΔI <sub>GSSF1</sub> = ±20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI <sub>GSSR1</sub> = ±20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI <sub>DSS1</sub> = ±10 μA dc or ± 100 percent of initial value, whichever is greater. Δr <sub>DS(on)1</sub> = ± 20 percent of initial value ΔV <sub>GS(TH)1</sub> = ± 20 percent of initial value	Subgroup 2 and 3 of table I herein ΔI <sub>GSSF1</sub> = ±20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI <sub>GSSR1</sub> = ±20 nA dc or ± 100 percent of initial value, whichever is greater. ΔI <sub>DSS1</sub> = ±10 μA dc or ± 100 percent of initial value, whichever is greater. Δr <sub>DS(on)1</sub> = ± 20 percent of initial value ΔV <sub>GS(TH)1</sub> = ± 20 percent of initial value
14	Required.	Required.

- (1) At the end of the test program, I<sub>GSSF1</sub>, I<sub>GSSR1</sub>, and I<sub>DSS1</sub> are measured.
- (2) An out-of-family program to characterize I<sub>GSSF1</sub>, I<sub>GSSR1</sub>, I<sub>DSS1</sub>, and V<sub>GS(th)1</sub> shall be invoked.
- (3) Shall be performed anytime before screen 9.

\* 4.3.1 Gate stress test. Apply  $V_{GS} = 24 \text{ V}$ , minimum for  $t = 250 \text{ } \mu\text{S}$ , minimum.

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

- a. Peak current .....  $I_{AS} = I_{D1}$ .
- b. Inductance .....  $L = \left[ \frac{2E_{AS}}{(I_{D1})^2} \right] \left[ \frac{V_{BR} - V_{DD}}{V_{BR}} \right] \text{ mH minimum.}$
- c. Gate to source resistor  $R_{GS}$  .....  $25 \text{ } \Omega \leq R_{GS} \leq 200 \text{ } \Omega$ .
- d. Supply voltage .....  $V_{DD} = 25 \text{ V dc}$ , except  $V_{DD} = 50 \text{ V dc}$  for 2N7471T1.
- e. Initial case temperature .....  $T_C = +25^\circ \text{ C}$ ,  $-5^\circ \text{ C}$ ,  $+10^\circ \text{ C}$ .
- f. Gate voltage .....  $V_{GS} = 12 \text{ V dc}$ .
- g. Number of pulses to be applied ..... 1 pulse minimum.

\* 4.3.3 Thermal impedance. The thermal impedance measurement shall be performed in accordance with method 3161 of MIL-STD-750. The maximum limit (not to exceed figure 3, thermal impedance curves and the table I, subgroup 2 limits) for thermal impedance in screening (table IV of MIL-PRF-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot, to be plotted on the applicable X bar R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for engineering evaluation and disposition. This procedure may be used in lieu of an in line process monitor.

- a. Measuring current ( $I_M$ ) ..... 10 mA.
- b. Drain heating current ( $I_H$ ) ..... 11.11 A.
- c. Heating time ( $t_H$ ) ..... 100 ms.
- d. Drain-source heating voltage ( $V_H$ ) ..... 12 V.
- e. Measurement time delay ( $t_{MD}$ ) ..... 30 - 60  $\mu\text{s}$ .
- f. Sample window time ( $t_{SW}$ ) ..... 10  $\mu\text{s}$  maximum.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. Alternate flow is allowed for conformance inspection in accordance with figure 4 of MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table V of MIL-PRF-19500 and table I herein.

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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 VIa (JANS) and table VIb (JANTXV) of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition G, 100 cycles.
B3	2077	SEM (scanning electron microscope).
B4	1042	Intermittent operation life, condition D, 2,000 cycles. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. $t_{on} = 30$ seconds minimum.
B5	1042	Accelerated steady-state gate bias, condition B, $V_{GS} = \text{rated}$ ; $T_A = +175^\circ\text{C}$ , $t = 24$ hours minimum; or $T_A = +150^\circ\text{C}$ , $t = 48$ hours minimum.
B5	1042	Accelerated steady-state reverse bias, condition A, $V_{DS} = \text{rated}$ ; $T_A = +175^\circ\text{C}$ , $t = 120$ hours minimum; or $T_A = +150^\circ\text{C}$ , $t = 240$ hours minimum.
B5	2037	Bond strength (Al-Au die interconnects only), test condition A.
B6	3161	Thermal resistance, see 4.5.2.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	1051	Test condition G, 25 cycles.
B3	1042	Intermittent operation life, condition D, 2,000 cycles. 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 VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
* C2	2036	Test condition A; weight = 10 pounds; $t = 15$ s.
* C5	3161	See 4.5.2.
* C6	1042	Intermittent operation life, condition D, 6,000 cycles. 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 VIII of MIL-PRF-19500 and table II herein.

\* 4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

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

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

\* 4.5.2 Thermal resistance. Thermal resistance measurement shall be performed in accordance with method 3161 of MIL-STD-750. Read and record data and information shall be included in the qualification report. Forced moving air or draft shall not be permitted across the devices during the test. The maximum limit under these test conditions shall be  $R_{\theta JC} = 0.60 \text{ }^\circ\text{C/W}$ . The following parameters shall apply:

- a. Drain heating current ( $I_H$ )..... 11.11 A.
- b. Heating time ( $t_H$ )..... Steady-state (see method 3161 of MIL-STD-750).
- c. Drain-source heating voltage ( $V_H$ )..... 12 V.
- d. Measuring current( $I_M$ )..... 10 mA.
- e. Measurement time delay ( $t_{MD}$ )..... 30 to 60  $\mu\text{s}$ .
- f. Sample window time ( $t_{SW}$ )..... 10  $\mu\text{s}$  maximum.

\* 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	$Z_{\theta JC}$		0.582	°C/W
Breakdown voltage drain to source 2N7470T1 2N7471T1	3407	$V_{GS} = 0$ , $I_D = 1$ mA dc, bias condition C	$V_{(BR)DSS}$	60 100		V dc 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, $V_{DS} = 0$	$I_{GSSF1}$		+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 2N7470T1 2N7471T1	3421	$V_{GS} = 12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$		0.006 0.013	Ω Ω
Forward voltage 2N7470T1 2N7471T1	4011	$V_{GS} = 0$ , condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{SD}$		1.2 1.2	V dc V dc

See footnotes at end of table.

\* 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 $T_C = T_J = +125^\circ\text{C}$						
Gate current	3411	$V_{GS} = \pm 20$ V dc, bias condition C, $V_{DS} = 0$	$I_{GSS2}$		$\pm 200$	nA dc
Drain current	3413	$V_{GS} = 0$ , bias condition C, $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{DSS2}$		25	$\mu\text{A}$ dc
* Static drain to source on-state resistance 2N7470T1 2N7471T1	3421	$V_{GS} = 12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)2}$		0.010 0.022	$\Omega$ $\Omega$
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ , $I_D = 1$ mA dc	$V_{GS(TH)2}$	1.0		V dc
Low temperature operation $T_C = T_J = -55^\circ\text{C}$						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS(TH)3}$ , $I_D = 1$ mA dc	$V_{GS(TH)3}$		5.0	V dc
<u>Subgroup 4</u>						
Forward transconductance 2N7470T1 2N7471T1	3475	$I_D = I_{D2}$ , $V_{DD} = 15$ V dc (see 4.5.1)	$g_{FS}$	42 42		S S
* Switching time test	3472	$I_D = I_{D1}$ , $V_{GS} = 12$ V dc; $R_G = 2.35 \Omega$ , $V_{DD} = 50$ percent of rated $V_{DS}$				
Turn-on delay time 2N7470T1 2N7471T1			$t_{D(on)}$		35 35	ns ns
Rise time 2N7470T1 2N7471T1			$t_r$		125 125	ns ns
Turn-off delay time 2N7470T1 2N7471T1			$t_{D(off)}$		60 75	ns ns
Fall time 2N7470T1 2N7471T1			$t_f$		50 50	ns ns

See footnotes at end of table.

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\* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 5</u>						
* 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				
<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 2N7470T1 2N7471T1			$Q_{G(ON)}$		150 160	nC nC
* Gate to source charge 2N7470T1 2N7471T1			$Q_{GS}$		75 55	nC nC
* Gate to drain charge 2N7470T1 2N7471T1			$Q_{GD}$		50 65	nC nC
* Reverse recovery time  2N7470T1 2N7471T1	3473	$di/dt = -100$ A/ $\mu$ s, $V_{DD} \leq 50$ V, $I_D = I_{D1}$	$t_{rr}$			
					170 270	ns ns

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

2/ This test required for the following end-point measurements only (not intended for screen 9, 11, or 13):

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  <u>1/ 2/ 3/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits				Unit
	Method	Conditions		R, F, G and H		R, F and G		H <u>4/</u>		
				Min	Max	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>5/</u>	1019	$V_{GS} = 12 \text{ V};$ $V_{DS} = 0$								
Steady-state total dose irradiation ( $V_{DS}$ bias) <u>5/</u>	1019	$V_{GS} = 0; V_{DS} = 80$ percent of rated $V_{DS}$ (preirradiation)								
End-point electricals										
Breakdown voltage, drain to source 2N7470T1 2N7471T1	3407	$V_{GS} = 0; I_D = 1 \text{ mA};$ bias condition C	$V_{(BR)DSS}$	60 100		60 100		60 100		V dc V dc
Gate to source voltage (threshold) 2N7470T1 2N7471T1	3403	$V_{DS} \geq V_{GS}$ $I_D = 1 \text{ mA}$	$V_{GS(th)1}$	2.0 2.0	4.0 4.0	2.0 2.0	4.0 4.0	1.5 1.5	4.0 4.0	V dc V dc
Gate current	3411	$V_{GS} = +20 \text{ V dc};$ $V_{DS} = 0$ bias condition C	$I_{GSSF1}$		100		100		100	nA dc
Gate current	3411	$V_{GS} = -20 \text{ V dc}$ $V_{DS} = 0$ bias condition C	$I_{GSSR1}$		-100		-100		-100	nA dc

See footnotes at end of table.

\* TABLE II. Group D inspection - Continued.

Inspection  <u>1/ 2/ 3/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits				Unit
	Method	Conditions		R, F, G and H		R, F and G		H <u>4/</u>		
				Min	Max	Min	Max	Min	Max	
<u>Subgroup 2</u> - Continued										
* Drain current	3413	$V_{GS} = 0$ $V_{DS} = 80$ percent of rated $V_{DS}$ (preirradiation) bias condition C	$I_{DSS}$		10		10		25	$\mu A$ dc
* Static drain to source on- state voltage 2N7470T1 2N7471T1	3405	$V_{GS} = 12$ V; $I_D = I_{D2}$ condition A, pulsed (see 4.5.1)	$V_{DS(on)}$		0.275 0.585		0.275 0.585		0.320 0.630	V dc V dc
Forward voltage source drain diode 2N7470T1 2N7471T1	4011	$V_{GS} = 0$ ; $I_D = I_{D2}$ bias condition C	$V_{SD}$		1.2 1.2		1.2 1.2		1.2 1.2	V dc V dc

## NOTES

- 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 its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.
- 4/ The H designation represents devices which pass end-points at all 100K, 300K and 600K rads (Si).
- 5/ Separate samples shall be pulled for each bias.

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

Inspection	MIL-STD-750		Qualification inspection
	Method	Conditions	
<u>Subgroup 1</u>			12 devices c = 0
Temperature cycling	1051	Test condition G, 500 cycles	
Hermetic seal Fine leak Gross leak	1071	Test conditions G or H Test conditions C or D	
Electrical measurements		See table I, subgroup 2	
<u>Subgroup 2 1/</u>			12 devices c = 0
Steady-state gate bias	1042	Test condition B; 1,000 hours	
Electrical measurements		See table I, subgroup 2	
Steady state reverse bias	1042	Test condition A; 1,000 hours	
Electrical measurements		See table I, subgroup 2	
<u>Subgroup 4</u>			Sample size N/A
* Thermal impedance curves		Each supplier shall submit their qual-lot average and design maximum thermal impedance curves to the qualifying activity. In addition, the optimal test conditions and thermal impedance limit shall be provided to the qualifying activity in the qualification report.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 6</u>			3 devices c = 0
* ESD	1020	Not required for devices classified as ESD class 1.	
<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	Test conditions shall be derived by the manufacturer	

See footnotes at end of table.

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

Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
* <u>Subgroup 9</u>			3 devices
SEE <u>2/ 3/ 4/</u>	1080	See figure 5	
Electrical measurements <u>5/</u>		$I_{GSSF1}$ , $I_{GSSR1}$ , and $I_{DSS1}$ in accordance with table I, subgroup 2	
SEE irradiation		Fluence = $3E5 \pm 20$ percent ions/cm <sup>2</sup> Flux = $2E3$ to $2E4$ ions/cm <sup>2</sup> /sec, temperature = $25 \pm 5$ °C	
2N7470T1		LET = 37 MeV-cm <sup>2</sup> /mg, range = 37 microns, Energy = 285 MeV Insitu bias conditions: $V_{DS} = 60$ V & $V_{GS} = -15$ V $V_{DS} = 40$ V & $V_{GS} = -20$ V	
2N7471T1		LET = 37 MeV-cm <sup>2</sup> /mg, range = 39 microns, Energy = 305 MeV Insitu bias conditions: $V_{DS} = 100$ V & $V_{GS} = -20$ V	
2N7470T1		LET = 63 MeV-cm <sup>2</sup> /mg, range = 29 microns, Energy = 300 MeV Insitu bias conditions: $V_{DS} = 46$ V & $V_{GS} = -5$ V $V_{DS} = 35$ V & $V_{GS} = -10$ V $V_{DS} = 25$ V & $V_{GS} = -15$ V $V_{DS} = 15$ V & $V_{GS} = -20$ V	
2N7471T1		LET = 60 MeV-cm <sup>2</sup> /mg, range = 32 microns, Energy = 340 MeV Insitu bias conditions: $V_{DS} = 100$ V & $V_{GS} = -10$ V $V_{DS} = 35$ V & $V_{GS} = -15$ V $V_{DS} = 25$ V & $V_{GS} = -20$ V	
2N7470T1		LET = 87 MeV-cm <sup>2</sup> /mg, range = 106 microns, Energy = 2068 MeV Insitu bias conditions: $V_{DS} = 35$ V & $V_{GS} = -5$ V $V_{DS} = 27$ V & $V_{GS} = -10$ V $V_{DS} = 20$ V & $V_{GS} = -15$ V $V_{DS} = 14$ V & $V_{GS} = -20$ V	
2N7471T1		LET = 82 MeV-cm <sup>2</sup> /mg, range = 28 microns, Energy = 350 MeV Insitu bias conditions: $V_{DS} = 100$ V & $V_{GS} = -8$ V $V_{DS} = 80$ V & $V_{GS} = -10$ V $V_{DS} = 25$ V & $V_{GS} = -15$ V	
Electrical measurements <u>5/</u>		$I_{GSSF1}$ , $I_{GSSR1}$ , and $I_{DSS1}$ in accordance with table I, subgroup 2	

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.

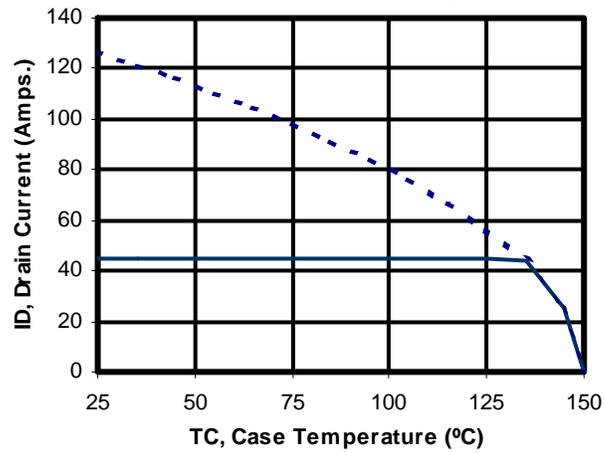
3/ Device qualification to a higher level LET is sufficient to qualify all lower level LETs.

4/ The sampling plan applies to each bias condition.

5/ Examine  $I_{GSS1}$  and  $I_{DSS1}$  before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with table I, subgroup 2, may be performed at the manufacturer's option.

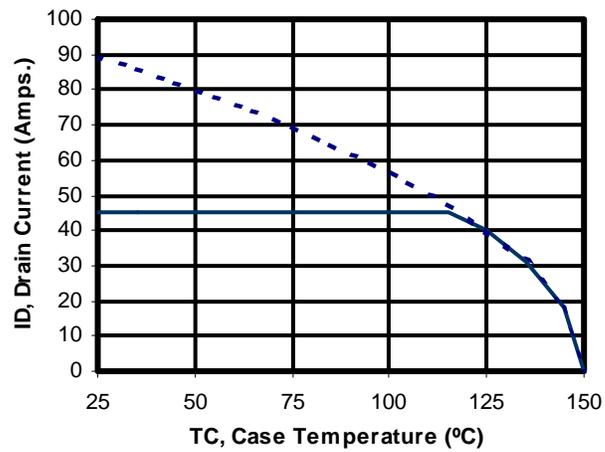
2N7470T1

Maximum Current Rating

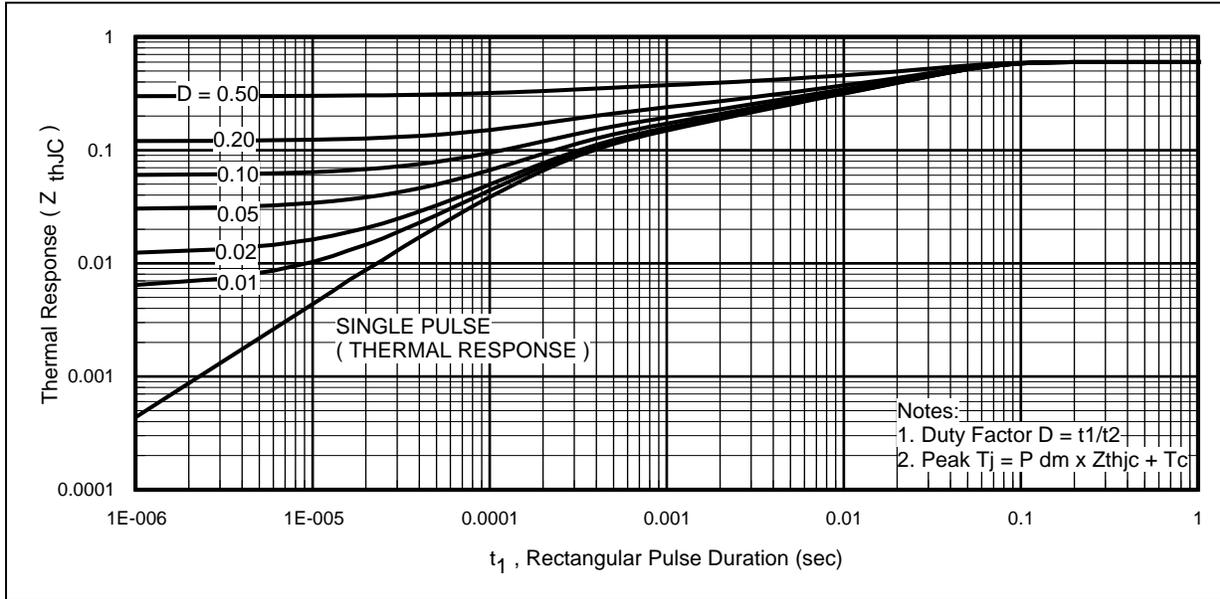


2N7471T1

Maximum Current Rating

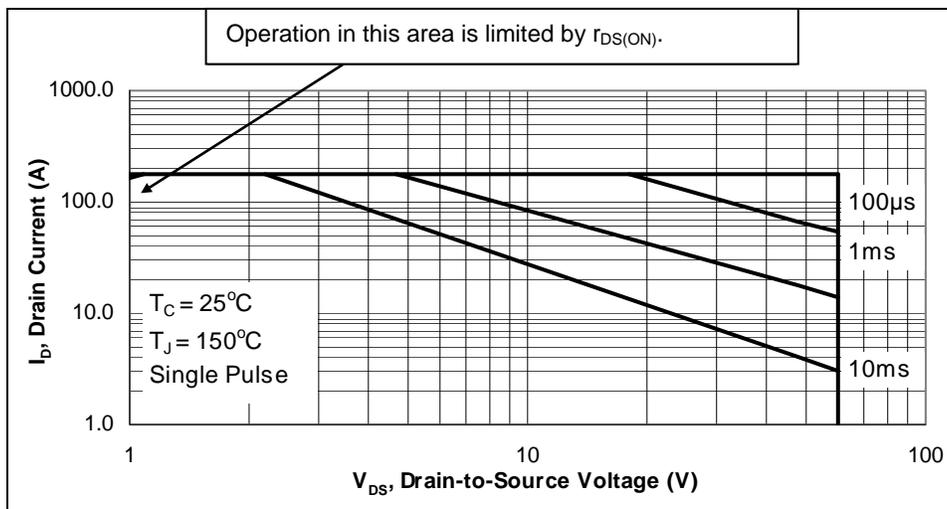


\* FIGURE 2. Maximum drain current vs case temperature graphs.

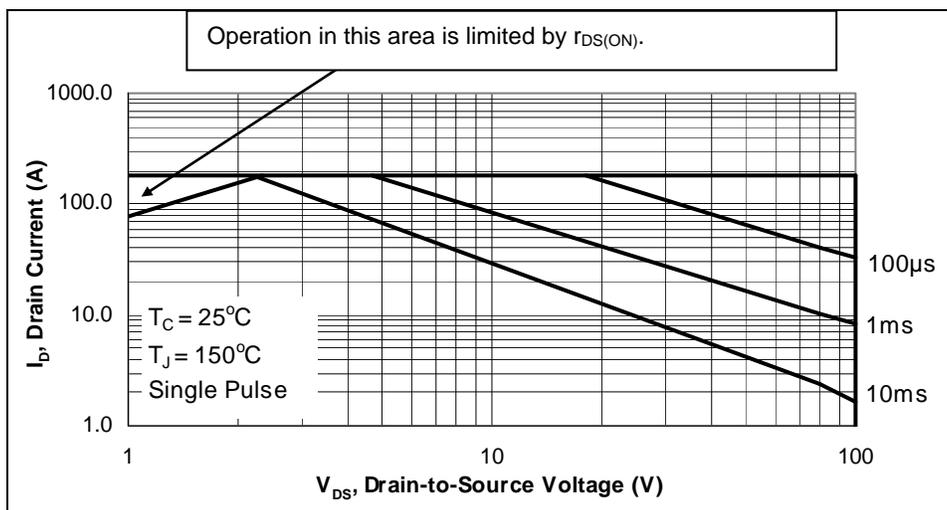


\* FIGURE 3. Thermal response curve.

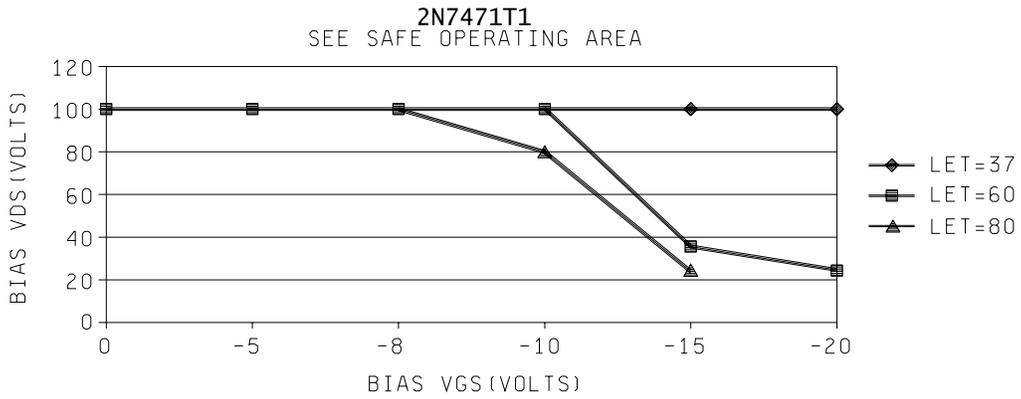
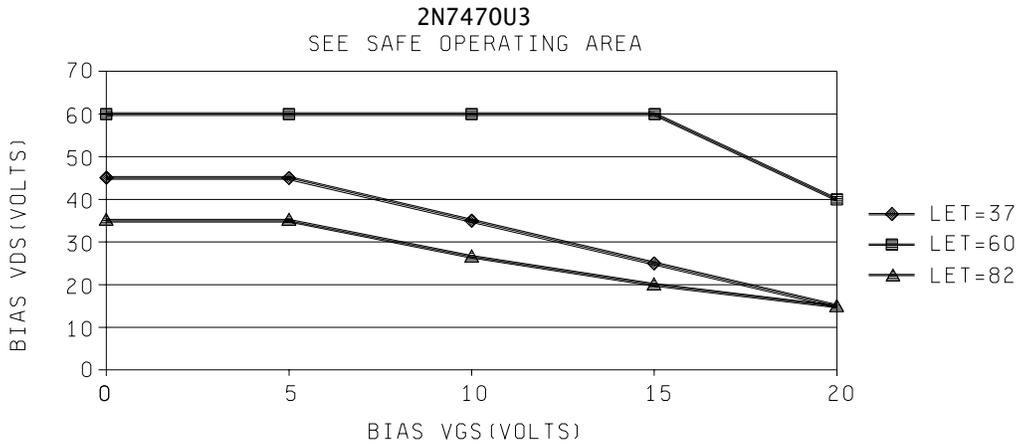
2N7470T1



2N7471T1



\* FIGURE 4. Safe operating area graphs.



\* FIGURE 5. SEE safe operating area graph.

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.)

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

\* 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. Product assurance level and type designator.

\* 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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail [vqe.chief@dla.mil](mailto:vqe.chief@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
IRHMS57064	2N7470T1
IRHMS57160	2N7471T1

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

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

Preparing activity:  
DLA - CC  
  
(Project 5961-2932)

Review activity:  
Army - AV, MI  
Air Force - 71

\* 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 <http://assist.daps.dla.mil/> .