

The documentation and process conversion measures necessary to comply with this revision shall be completed by 7 February 2004.

INCH-POUND

MIL-PRF-19500/630C
7 November 2003
SUPERSEDING
MIL-PRF-19500/630B
22 December 1997

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, FIELD EFFECT, RADIATION HARDENED TRANSISTOR, P-CHANNEL, SILICON, TYPES 2N7389, 2N7390, 2N7389U, AND 2N7390U, JANTXV, R, AND F AND JANS, R, AND F

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

1. SCOPE

1.1 Scope. This specification covers the performance requirements for a P-channel, radiation hardened, enhancement mode, MOSFET, power transistor. Two levels of product assurance are provided for each device type as specified in MIL-PRF-19500, with avalanche energy ratings (E_{AS}) and maximum avalanche current (I_{AS}).

1.2 Physical dimensions. See figure 1 (TO-205AF) and figure 2 (LCC).

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

| Type (1) | Min V _{(BR)DSS} V _{GS} = 0 V I _D = -1 mA dc | P _T (2) T _C = +25°C | P _T T _A = +25°C (free air) | V _{GS} | I _{D1} (3) (4) T _C = +25°C | I _{D2} (3) T _C = +100°C | T _J and T _{STG} |
|----------|--|--|--|-----------------|---|--|-------------------------------------|
| | <u>V dc</u> | <u>W</u> | <u>W</u> | <u>V dc</u> | <u>A dc</u> | <u>A dc</u> | <u>V dc</u> |
| 2N7389 | -100 | 25 | 0.8 | ± 20 | -6.5 | -4.1 | -55 to +150 |
| 2N7390 | -200 | 25 | 0.8 | ± 20 | -4.0 | -2.4 | -55 to +150 |

| Type (1) | I _S | I _{DM} (5) | E _{AS} | Max r _{DS(on)} (1) V _{GS} = -12 V dc, I _D = I _{D2} | | R _{θJC} max | I _{AS} |
|----------|----------------|------------------------|-----------------|---|-------------------------|-------------------------|-----------------|
| | | | | T _J = +25°C | T _J = +150°C | | |
| | <u>A dc</u> | <u>A (pk)</u> | <u>mJ</u> | <u>ohms</u> | <u>ohms</u> | <u>°C/W</u> | <u>A dc</u> |
| 2N7389 | -6.5 | -26 | 165 | 0.30 | 0.60 | 5 | -6.5 |
| 2N7390 | -4.0 | -16 | 171 | 0.80 | 1.68 | 5 | -4.0 |

- (1) Electrical characteristics, ratings, and conditions for "U" suffix devices are identical to the corresponding non "U" suffix devices, unless otherwise specified.
- (2) Derate linearly 0.2 W/°C for T_C > +25°C.
- (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} as calculated in note 3.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAC, Post Office Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.4 Primary electrical characteristics. Unless otherwise specified, $T_C = +25^\circ\text{C}$.

| Type | Min $V_{(BR)DSS}$ $V_{GS} = 0\text{ V}$ $I_D = -1\text{ mA dc}$ | $V_{GS(th)1}$ $V_{DS} \geq V_{GS}$ $I_D = -1\text{ mA}$ | Max I_{DSS1} $V_{GS} = 0\text{ V}$ | Max $r_{DS(on)1}$ (1) $V_{GS} = -12\text{ V dc}$ $I_D = I_{D2}$ |
|-----------------|---|---|---|---|
| | | | $V_{DS} = 80$ percent of rated V_{DS} | $T_J = +25^\circ\text{C}$ |
| | <u>V dc</u> | <u>V dc</u> | | <u>ohms</u> |
| | | <u>Min</u> | <u>Max</u> | |
| 2N7389, 2N7289U | -100 | -2.0 | -4.0 | 0.30 |
| 2N7390, 2N7390U | -200 | -2.0 | -4.0 | 0.80 |
| | | | <u>$\mu\text{A dc}$</u> | |
| | | | -25 | |
| | | | -25 | |

(1) Pulsed, (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

* 2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARD

DEPARTMENT OF DEFENSE

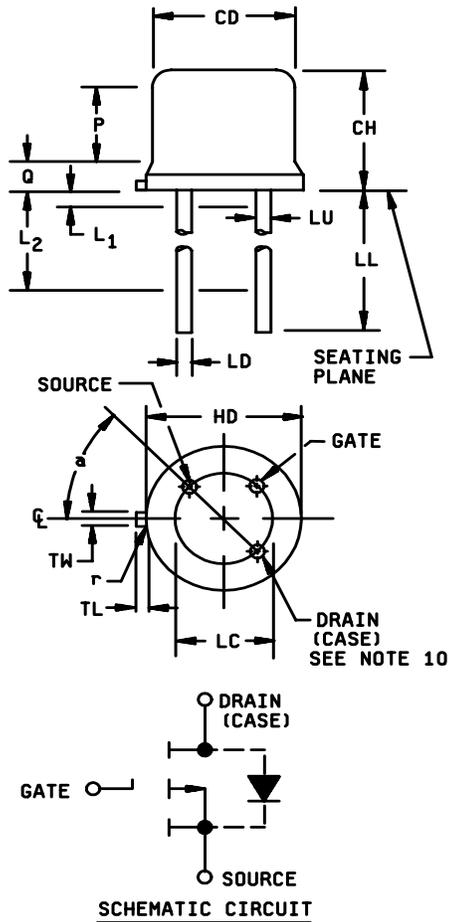
MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

3. REQUIREMENTS

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



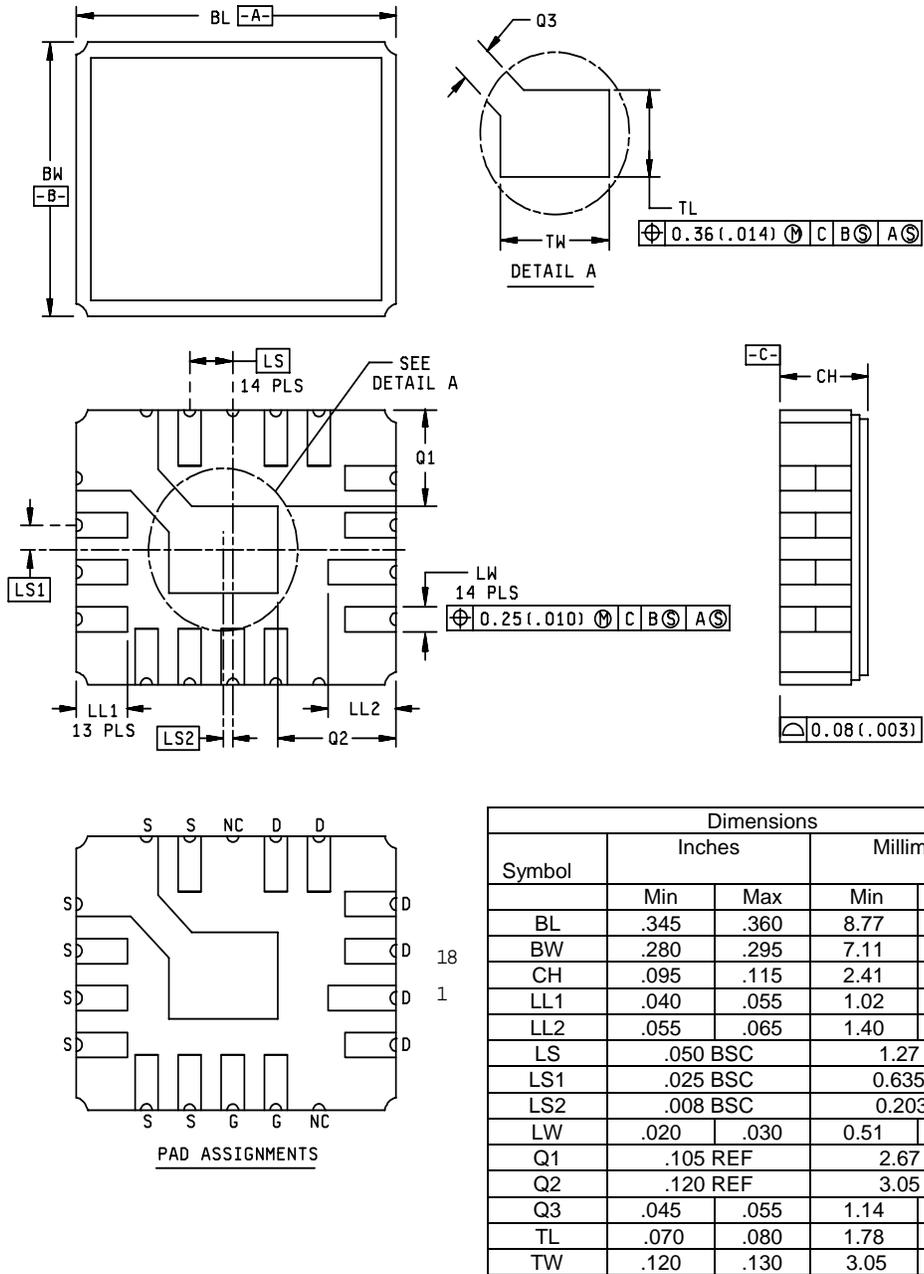
| Ltr | Dimensions | | | | Notes |
|----------|------------|------|-------------|-------|-------|
| | Inches | | Millimeters | | |
| | Min | Max | Min | Max | |
| CD | .305 | .335 | 7.75 | 8.51 | |
| CH | .160 | .180 | 4.07 | 4.57 | |
| HD | .335 | .370 | 8.51 | 9.39 | |
| LC | .200 TP | | 5.08 TP | | 6 |
| LD | .016 | .021 | 0.41 | 0.53 | 7, 8 |
| LL | .500 | .750 | 12.7 | 19.05 | 7, 8 |
| LU | .016 | .019 | 0.41 | 0.48 | 7, 8 |
| L1 | | .050 | | 1.27 | 7, 8 |
| L2 | .250 | | 6.35 | | 7, 8 |
| P | .100 | | 2.54 | | 5 |
| Q | | .050 | | 1.27 | 4 |
| r | | .010 | | 0.25 | 9 |
| TL | .029 | .045 | 0.74 | 1.14 | 3 |
| TW | .028 | .034 | 0.72 | 0.86 | 2 |
| α | 45° TP | | 45° TP | | 6 |

NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Beyond radius (r) maximum, TW shall be held for a minimum length of .011 (0.028 mm).
3. Dimension TL measured from maximum HD.
4. Outline in this zone is not controlled.
5. Dimension CD shall not vary more than .010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane .054 +.001, -.000 (1.37 +0.03, -0.00 mm) below seating plane shall be within .007 (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC.
7. LU applies between L1 and L2. LD applies between L2 and LL minimum. Diameter is uncontrolled in L1 and beyond LL minimum.
8. All three leads.
9. Radius (r) applies to both inside corners of tab.
10. Drain is electrically connected to the case.
11. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 1. Physical dimensions for TO-205AF (2N7389, 2N7390).

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NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. In accordance with ASME Y14.5M, diameters are equivalent to $\varnothing x$ symbology.

* FIGURE 2. Physical dimensions for LCC (2N7389U, 2N7390U).

* 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 defined 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, and on figures 1 and 2 herein.

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

* 3.4.2 Internal construction. Multiple chip construction shall not be permitted.

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

3.5.1 Handling. MOS devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. The following handling procedures 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 shall 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 to be applied drain to source.

* 3.6 Marking. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking of country of origin may be omitted from the body of the transistor, but shall be retained on the initial container.

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

* 3.8 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I.

* 3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4, and tables I, II, and III).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

* 4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the associated specification that did not request the performance of table III tests, the tests specified in table III herein shall be performed by the first inspection lot of this revision to maintain qualification.

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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 MIL-PRF-19500, table IV) (1) (2) | Measurement | |
|--|--|---|
| | JANS level | JANTXV levels |
| (3) | Gate stress test (see 4.3.1) | Gate stress test (see 4.3.1). |
| (3) | Method 3470 of MIL-STD-750 (see 4.3.2), optional | Method 3470 of MIL-STD-750 (see 4.3.2), optional |
| (3) 3c | Method 3161 of MIL-STD-750 (see 4.3.3) | Method 3161 of MIL-STD-750 (see 4.3.3) |
| 9 | I_{GSSF1} , I_{GSSR1} , I_{DSS1} | Not applicable |
| 10 | Method 1042 of MIL-STD-750, test condition B | Method 1042 of MIL-STD-750, test condition B |
| 11 | I_{GSSF1} , I_{GSSR1} , I_{DSS1} , $r_{DS(on)1}$, $V_{GS(th)1}$ subgroup 2 of table I herein: $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater. | 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, t = 240 hours | Method 1042 of MIL-STD-750, test condition A |
| 13 | Subgroups 2 and 3 of table I herein; $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(on)1} = \pm 20$ percent of initial value. $\Delta V_{GS(th)1} = \pm 20$ percent of initial value. | Subgroup 2 of table I herein; $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(on)1} = \pm 20$ 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} and $V_{GS(th)1}$ shall be invoked.
- (3) Shall be performed anytime before screen 9.

* 4.3.1 Gate stress test. Apply $V_{GS} = -24$ 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. Peak gate voltage (V_{GS}): -12 V.
- c. Gate to source resistor (R_{GS}) $25 \Omega \leq R_{GS} \leq 200 \Omega$.
- d. Initial case temperature +25°C +10°C, -5°C.
- e. Inductance $(2 E_{AS}/(I_{AS})^2)((V_{BR} - V_{DD})/V_{BR})$ mH minimum.
- f. Number of pulses to be applied 1 pulse minimum.
- g. Supply voltage $V_{DD} = -50$ V, or -25 V for 100 V devices.

* 4.3.3 Thermal impedance ($Z_{\theta JC}$ measurements). The $Z_{\theta JC}$ measurements shall be performed in accordance with method 3161 of MIL-STD-750. The maximum limit (not to exceed figure 4, thermal impedance curves and the table I, subgroup 2 limits) for $Z_{\theta JC}$ in screening (table 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 screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable X bar R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for engineering evaluation and disposition. This procedure may be used in lieu of an in-line process monitor.

- a. Measuring current (I_M) 10 mA.
- b. Drain heating current (I_H) 1.0 A minimum for TO-205AF devices, 1.3 A minimum for LCC devices.
- c. Heating time (t_H) 10 ms.
- d. Drain-source heating voltage (V_H) ... 25 V minimum for TO-205AF devices, 15 V minimum for LCC devices.
- e. Measurement time delay (t_{MD}) 30 to 60 μ s maximum.
- f. Sample window time (t_{SW}) 10 μ s maximum.

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 MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with the inspections of table I, subgroup 2 herein.

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIa (JANS) and table VIb (JANTXV) of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, subgroup 2 herein.

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

| | | |
|----|------|---|
| B3 | 1051 | Condition G, 100 cycles. |
| B4 | 1042 | The heating cycle shall be 30 seconds minimum. |
| B5 | 1042 | Condition B; $V_{GS} = 100$ percent of rated; $T_A = +175^\circ\text{C}$; $t = 24$ hours, or $T_A = +150^\circ\text{C}$; $t = 48$ hours (manufacturers option). |
| B5 | 1042 | Condition A; $V_{DS} = 100$ percent of rated; $T_A = +175^\circ\text{C}$, $t = 120$ hours, or $T_A = +150^\circ\text{C}$, $t = 240$ hours (manufacturers option). |
| B5 | 2037 | Bond strength; 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.Subgroup Method Condition

| | | |
|----|------|--|
| B2 | 1051 | Test condition G, 25 cycles. |
| B3 | 1042 | The heating cycle shall be 30 seconds minimum. |
| B3 | 2037 | Test condition A. |
| B4 | 2075 | See 3.4.2. |
| B5 | 3161 | Thermal resistance, see 4.5.2. |

* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, subgroup 2 herein.

Subgroup Method Condition

| | | |
|----|------|---|
| C2 | 2036 | Test condition E (applicable to TO-205AF only). |
| C5 | 3161 | See 4.5.2. |
| C6 | 1042 | The heating cycle shall be 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 appropriate tables and as follows.

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

* 4.5.2 Thermal resistance. Thermal resistance measurements shall be performed in accordance with method 3161 of MIL-STD-750. The maximum limit of $R_{\theta JC}(\max)$ shall be 5.0°C/W . The following parameter measurements shall apply:

- a. Measuring current (I_M) 10 mA.
- b. Drain heating current (I_H) 1.0 A minimum for TO-205AF devices, 1.3 A minimum for LCC devices.
- c. Heating time (t_H) Steady-state (see method 3161 of MIL-STD-750 for definition).
- d. Drain-source heating voltage (V_H) ... 25 V minimum for TO-205AF devices, 15 V minimum for LCC devices.
- e. Measurement time delay (t_{MD}) 30 to 60 μs maximum.
- f. Sample window time (t_{SW}) 10 μs maximum.

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* TABLE I. Group A inspection.

| Inspection 1/ | 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 2/ | 3161 | See 4.3.3 | $Z_{\theta JC}$ | | 1.6 | °C/W |
| Breakdown voltage, drain to source 2N7389, 2N7389U 2N7390, 2N7390U | 3407 | Bias condition C, $V_{GS} = 0V$, $I_D = -1$ mA dc | $V_{(BR)DSS}$ | -100 -200 | | V dc V dc |
| Gate to source voltage (threshold) | 3403 | $V_{DS} \geq V_{GS}$, $I_D = -1$ mA | $V_{GS(th)1}$ | -2.0 | -4.0 | V dc |
| Gate current | 3411 | Bias condition C, $V_{GS} = +20$ V dc $V_{DS} = 0$ V dc | I_{GSSF1} | | ±100 | nA dc |
| Gate current | 3411 | Bias condition C, $V_{GS} = -20$ V dc $V_{DS} = 0$ V dc | I_{GSSR1} | | ±100 | nA dc |
| Drain current | 3413 | Bias condition C, $V_{GS} = 0$ V dc, $V_{DS} = 80$ percent of rated V_{DS} | I_{DSS1} | | -25 | µA dc |
| Static drain to source on-state resistance 2N7389, 2N7389U 2N7390, 2N7390U | 3421 | $V_{GS} = -12$ V dc, condition A, pulsed (see 4.5.1), $I_D = \text{rated } I_{D2}$ (see 1.3) | $r_{DS(on)1}$ | | 0.30 0.80 | Ω Ω |
| Static drain to source on-state resistance 2N7389, 2N7389U 2N7390, 2N7390U | 3421 | $V_{GS} = -12$ V dc, condition A, pulsed (see 4.5.1), $I_D = \text{rated } I_{D1}$, (see 1.3) | $r_{DS(on)2}$ | | 0.35 0.92 | Ω Ω |
| Forward voltage 2N7389, 2N7389U 2N7390, 2N7390U | 4011 | $V_{GS} = 0$ V dc, $I_D = \text{rated } I_{D1}$, pulsed (see 4.5.1) | V_{SD} | | -3.0 -5.0 | V V |

See footnote 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 3</u> | | | | | | |
| High temperature operation: | | $T_C = T_J = +125^\circ\text{C}$ | | | | |
| Gate current | 3411 | Bias condition C, $V_{GS} = \pm 20\text{ V dc}$, $V_{DS} = 0\text{ V dc}$, | I_{GSS2} | | ± 200 | nA dc |
| Drain current | 3413 | Bias condition C, $V_{GS} = 0\text{ V dc}$, $V_{DS} = 80\text{ percent of rated } V_{DS}$ | I_{DSS2} | | -0.25 | mA dc |
| Static drain to source on-state resistance 2N7389, 2N7389U 2N7390, 2N7390U | 3421 | $V_{GS} = -12\text{ V dc}$, pulsed (see 4.5.1), $I_D = \text{rated } I_{D2}$ | $r_{DS(on)3}$ | | 0.54 1.60 | Ω Ω |
| Gate to source voltage (threshold) | 3403 | $V_{DS} \geq V_{GS}$, $I_D = -1\text{ mA}$ | $V_{GS(th)2}$ | -1.0 | | V dc |
| Low temperature operation: | | $T_C = T_J = -55^\circ\text{C}$ | | | | |
| Gate to source voltage (threshold) | 3403 | $V_{DS} \geq V_{GS}$, $I_D = -1\text{ mA}$ | $V_{GS(th)3}$ | | -5.0 | V dc |
| <u>Subgroup 4</u> | | | | | | |
| Switching time test | 3472 | $I_D = \text{rated } I_{D1}$; $V_{GS} = -12\text{ V dc}$; Gate drive impedance = $7.5\ \Omega$; $V_{DD} = 50\text{ percent of } V_{(BR)DSS}$ | | | | |
| Turn-on delay time | | | $t_{d(on)}$ | | 30 | ns |
| Rise time 2N7389, 2N7389U 2N7390, 2N7390U | | | t_r | | 50 30 | ns ns |
| Turn-off delay time 2N7389, 2N7389U 2N7390, 2N7390U | | | $t_{d(off)}$ | | 70 75 | ns ns |
| Fall time 2N7389, 2N7389U 2N7390, 2N7390U | | | t_f | | 70 65 | ns ns |

See footnotes at end of table.

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* TABLE I. Group A inspection - Continued.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|--|-------------|--|-------------|------------|------------|----------|
| | Method | Condition | | Min | Max | |
| <u>Subgroup 4</u> - Continued | | | | | | |
| Forward transconductance 2N7389, 2N7389U 2N7390, 2N7390U | 3475 | $I_D = I_{D2}$; $V_{DD} = -15$ V dc, pulsed (see 4.5.1) | g_{fs} | 2.5 2.5 | | S S |
| <u>Subgroup 5</u> | | | | | | |
| Safe operating area test (high voltage) | 3474 | See figures 5 and 6 $t_p = 10$ ms, $V_{DS} = 80$ percent of rated $V_{(BR)DSS}$ | | | | |
| Electrical measurements | | See table I, subgroup 2 | | | | |
| <u>Subgroup 6</u> | | | | | | |
| Not applicable | | | | | | |
| <u>Subgroup 7</u> | | | | | | |
| Gate charge | 3471 | Condition B | | | | |
| On-state gate charge 2N7389, 2N7389U 2N7390, 2N7390U | | | $Q_{g(on)}$ | | 45 45 | nC nC |
| Gate to source charge 2N7389, 2N7389U 2N7390, 2N7390U | | | Q_{gs} | | 10 10 | nC nC |
| Gate to drain charge 2N7389, 2N7389U 2N7390, 2N7390U | | | Q_{gd} | | 25 25 | nC nC |
| Reverse recovery time 2N7389, 2N7389U 2N7390, 2N7390U | 3473 | $d_i/d_t \leq -100$ A/ μ s, $V_{DD} \leq -50$ V, $I_D = I_{D1}$, (see 1.3) | t_{rr} | | 250 400 | ns ns |

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

2/ This test is required for the following end-point measurement only (not intended for screen 9, 11, and 13): JANS, table VIa of MIL-PRF-19500, group B, subgroups 3 and 4; JANTXV, table VIb of MIL-PRF-19500, group B, subgroups 2 and 3; and table VII of MIL-PRF-19500, group C, subgroup 6, and table IX of MIL-PRF-19500, group E, subgroup 1.

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* TABLE II. Group D inspection.

| Inspection 1/ 2/ 3/ | MIL-STD-750 | | Symbol | Pre-irradiation limits | | Post-irradiation limits | | Post-irradiation limits 4/ | | Units |
|---|-------------|---|----------------------|------------------------|--------------|-------------------------|--------------|----------------------------|--------------|--------------|
| | Method | Conditions | | M,D,R, and F | | M,D, and R | | F | | |
| | | | | 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) 5/ | 1019 | V _{GS} = -12 V; V _{DS} = 0 V | | | | | | | | |
| Steady-state total dose irradiation (V _{DS} bias) 5/ | 1019 | V _{GS} = 0 V; V _{DS} = 80 percent of rated V _{DS} (pre-irradiation) | | | | | | | | |
| End-point electricals | | See table I, subgroup 2 | | | | | | | | |
| Breakdown voltage, drain to source 2N7389, 2N7389U 2N7390, 2N7390U | 3407 | V _{GS} = 0 V; I _D = -1 mA; bias condition C | V _{(BR)DSS} | -100 -200 | | -100 -200 | | -100 -200 | | V dc V dc |
| Gate to source voltage (threshold) 5/ 2N7389, 2N7389U 2N7390, 2N7390U | 3403 | V _{DS} ≥ V _{GS} ; I _D = -1 mA | V _{GS(th)} | -2.0 -2.0 | -4.0 -4.0 | -2.0 -2.0 | -4.0 -4.0 | -2.0 -2.0 | -5.0 -5.0 | V dc V dc |
| Gate current | 3411 | Bias condition C V _{GS} = -20 V; V _{DS} = 0 V; | I _{GSSF1} | | -100 | | -100 | | -100 | nA dc |
| Gate current | 3411 | Bias condition C V _{GS} = +20 V; V _{DS} = 0 V; | I _{GSSR1} | | 100 | | 100 | | 100 | nA dc |
| Drain current | 3413 | Bias condition C V _{GS} = 0 V; V _{DS} = 80 percent of rated V _{DS} (pre-irradiation) | I _{DSS} | | -25 | | -25 | | -25 | μA dc |

See footnotes at end of table.

* TABLE II. Group D inspection - Continued.

| Inspection 1/ 2/ | MIL-STD-750 | | Symbol | Pre-irradiation limits | | Post-irradiation limits | | Post-irradiation limits 4/ | | Units |
|---|-------------|---|--------------------|------------------------|--------------|-------------------------|--------------|----------------------------|-----|-------|
| | Method | Conditions | | M,D,R, and F | | M,D, and R | | F | | |
| | | | | Min | Max | Min | Max | Min | Max | |
| | | | | | | | | | | |
| <u>Subgroup 2</u> - Continued | | | | | | | | | | |
| Static drain to source on-state voltage | 3405 | V _{GS} = -12 V, condition A pulsed (see 4.5.1) I _D = I _{D2} | V _{DSon1} | | | | | | | |
| 2N7389, 2N7389U 2N7390, 2N7390U | | | | | 1.23 1.92 | 1.23 1.92 | 1.23 1.92 | V dc V dc | | |
| Forward voltage source drain diode | 4011 | V _{GS} = 0 V, condition A I _D = I _{D1} | V _{SD} | | | | | | | |
| 2N7389, 2N7389U 2N7390, 2N7390U | | | | | -3.0 -5.0 | -3.0 -5.0 | -3.0 -5.0 | V V | | |

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

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

3/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in it's qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

4/ The F designation represent devices which pass end-points at both 100K and 300K rad (Si).

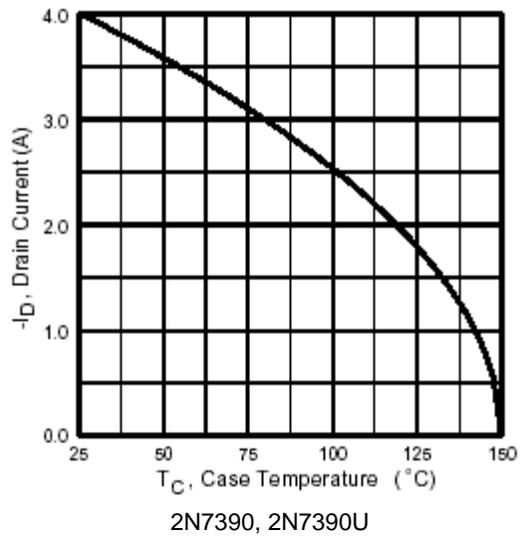
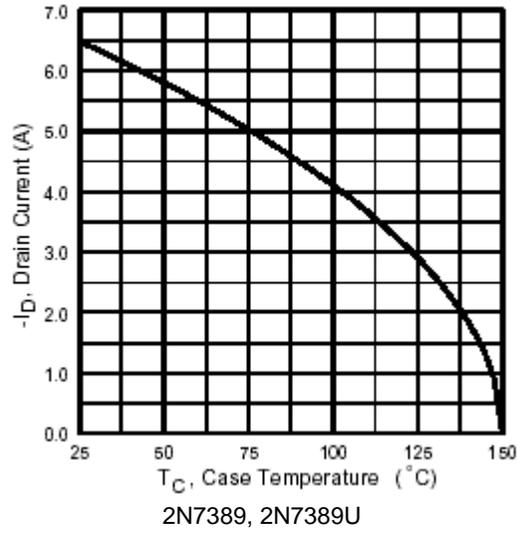
5/ Separate samples shall be pulled for each bias.

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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 cycle | 1051 | Condition G, 500 cycles | |
| Hermetic seal | 1071 | | |
| Fine leak | | | |
| Gross leak | | | |
| Electrical measurements | | See table I, subgroup 2 | |
| <u>Subgroup 2 1/</u> | | | 45 devices c = 0 |
| Steady-state reverse bias | 1042 | Condition A, 1,000 hours | |
| Electrical measurements | | See table I, subgroup 2 | |
| Steady-state gate bias | 1042 | Condition B, 1,000 hours | |
| Electrical measurements | | See table I, subgroup 2 | |
| <u>Subgroup 3</u> | | | 3 devices, c = 0 |
| DPA | 2102 | | |
| <u>Subgroup 4</u> | | | sample size N/A |
| Thermal impedance curves | | Each supplier shall submit their (typical) design thermal impedance curves. In addition, test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report | |
| <u>Subgroup 5</u> | | | |
| Not applicable | | | |
| <u>Subgroup 6</u> | | | 3 devices |
| ESD | 1020 | Not required for devices classified as ESD class 1. | |
| <u>Subgroup 7</u> | | | |
| 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 | | 22 devices c = 0 |

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



* FIGURE 3. Maximum drain current vs case temperature graphs.

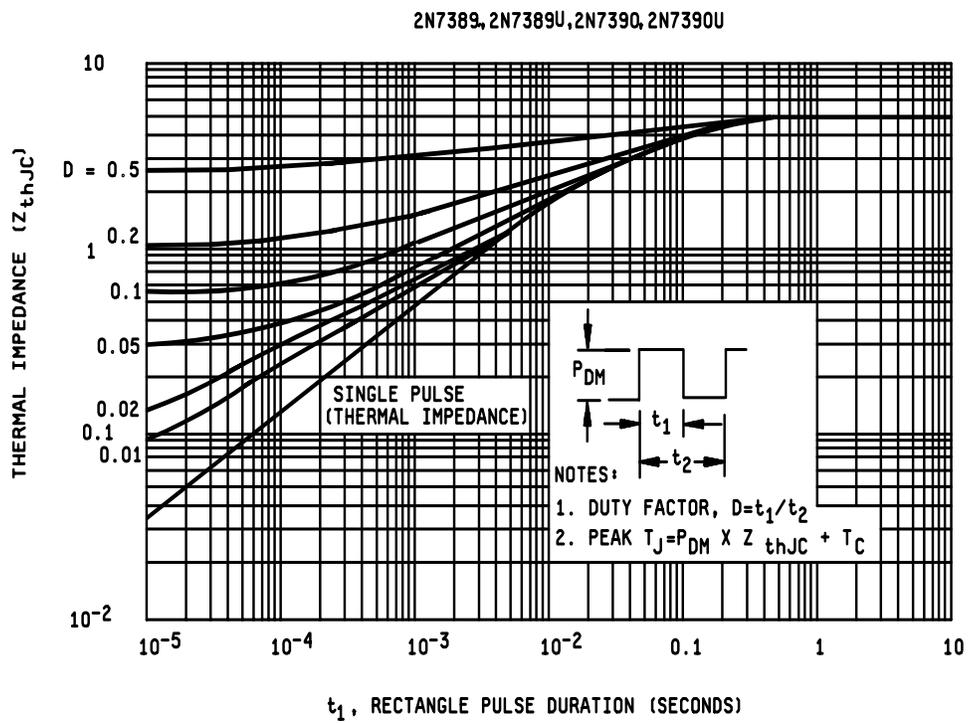


FIGURE 4. Thermal response curves.

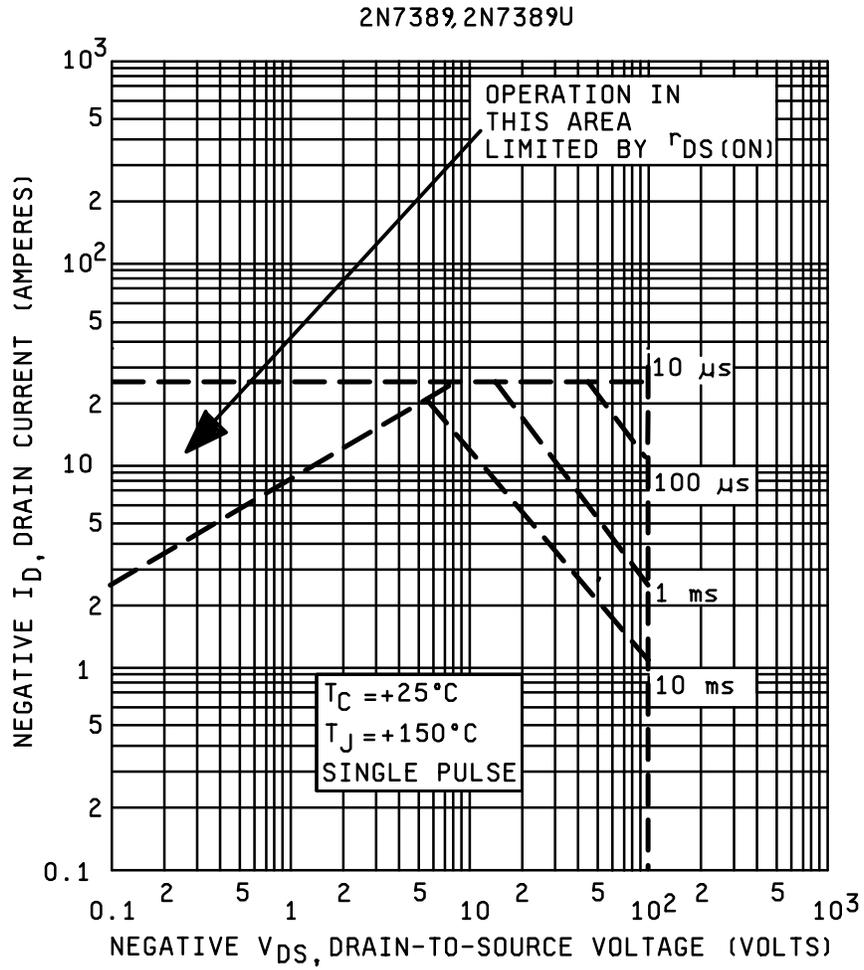


FIGURE 5. Safe operating area graphs.

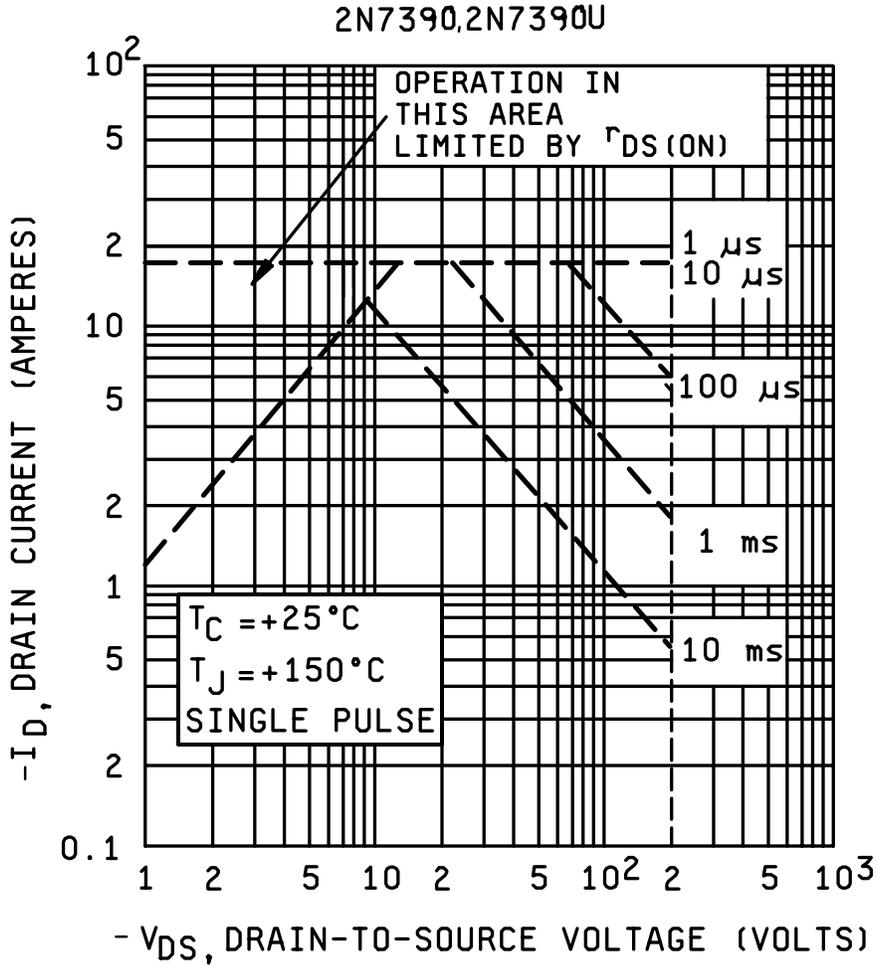


FIGURE 6. Safe operating area graphs.

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 material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' 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. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1).
- c. Lead finish (see 3.4.1).
- d. Type designation and product assurance level.
- e. Packaging requirements (see 5.1).

* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers' List (QML) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000.

* 6.4 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.

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Air Force - 11
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(Project 5961-2772)

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| 4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.) | | |
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