

The documentation and process conversion measures necessary to comply with this document shall be completed by 6 January 2021.

INCH-POUND

MIL-PRF-19500/569B  
6 October 2020  
SUPERSEDING  
MIL-PRF-19500/569A  
19 August 2015

## PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, FIELD EFFECT, N-CHANNEL, SILICON,  
CASE MOUNT THROUGH-HOLE MOUNT PACKAGE,  
TYPES 2N6966, 2N6967, 2N6968, 2N6969,  
QUALITY LEVELS JAN, JANTX, JANTXV, AND JANS

Inactive for new design after 7 June 1999.

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 N-channel, enhancement-mode, MOSFET, power transistor intended for use in high density power switching applications. Four levels of product assurance (JAN, JANTX, JANTXV, and JANS) are provided for each encapsulated device type.

1.2 Package outlines. The device package outline is a diamond base, flange mount TO-204AE (modified TO-3) in accordance with [figure 1](#).

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

| Type   | $P_T$ (1)<br>$T_C = +25^\circ\text{C}$ | $P_T$<br>$T_A = +25^\circ\text{C}$ | $R_{\theta JC}$<br>(2)               | $V_{DS}$    | $V_{DG}$    | $V_{GS}$    | $I_{D1}$ (3) (4)<br>$T_C = +25^\circ\text{C}$ | $I_{D2}$ (3)<br>$T_C = +100^\circ\text{C}$ | $I_S$       | $I_{DM}$     | $T_J$ and<br>$T_{STG}$             |
|--------|----------------------------------------|------------------------------------|--------------------------------------|-------------|-------------|-------------|-----------------------------------------------|--------------------------------------------|-------------|--------------|------------------------------------|
|        | <u>W</u>                               | <u>W</u>                           | <u><math>^\circ\text{C/W}</math></u> | <u>V dc</u> | <u>V dc</u> | <u>V dc</u> | <u>A dc</u>                                   | <u>A dc</u>                                | <u>A dc</u> | <u>A(pk)</u> | <u><math>^\circ\text{C}</math></u> |
| 2N6966 | 70                                     | 5                                  | 1.8                                  | 100         | 100         | $\pm 20$    | 15                                            | 13                                         | 15          | $\pm 60$     | -55 to<br>+150                     |
| 2N6967 | 70                                     | 5                                  | 1.8                                  | 200         | 200         | $\pm 20$    | 13                                            | 8                                          | 13          | $\pm 50$     |                                    |
| 2N6968 | 70                                     | 5                                  | 1.8                                  | 400         | 400         | $\pm 20$    | 7.5                                           | 5                                          | 7.5         | $\pm 30$     |                                    |
| 2N6969 | 70                                     | 5                                  | 1.8                                  | 500         | 500         | $\pm 20$    | 6                                             | 4                                          | 6.0         | $\pm 24$     |                                    |

(1) Derate linearly 0.56 W/ $^\circ\text{C}$  for  $T_C > +25^\circ\text{C}$ .

(2) See [figure 2](#) for thermal impedance curve.

(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)  $I_D = 4 \times I_{D1}$  as calculated in note 2.

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

| Type   | Min $V_{(BR)DSS}$<br>$V_{GS} = 0\text{ V}$<br>$I_D = 1\text{ mA dc}$ | $V_{GS(th)1}$<br>$V_{DS} \geq V_{GS}$<br>$I_D = 0.25\text{ mA}$ | Max $I_{DSS1}$<br>$V_{GS} = 0\text{ V}$           | Max $r_{DS(on)1}$ (1)<br>$V_{GS} = 10\text{ V dc}$ , $I_D = I_{D2}$ |                                                  |
|--------|----------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------|
|        |                                                                      |                                                                 | $V_{DS} = 80\text{ percent}$<br>of rated $V_{DS}$ | $T_J = +25\text{ }^{\circ}\text{C}$ at $I_{D1}$                     | $T_J = +150\text{ }^{\circ}\text{C}$ at $I_{D2}$ |
|        | <u>V dc</u>                                                          | <u>V dc</u><br><u>Min</u> <u>Max</u>                            | <u><math>\mu\text{A dc}</math></u>                | <u>ohms</u>                                                         | <u>ohms</u>                                      |
| 2N6966 | 100                                                                  | 2.0   4.0                                                       | 25                                                | 0.085                                                               | 0.13                                             |
| 2N6967 | 200                                                                  | 2.0   4.0                                                       | 25                                                | 0.18                                                                | 0.27                                             |
| 2N6968 | 400                                                                  | 2.0   4.0                                                       | 25                                                | 1.0                                                                 | 1.04                                             |
| 2N6969 | 500                                                                  | 2.0   4.0                                                       | 25                                                | 1.5                                                                 | 1.62                                             |

(1) Pulsed (see 4.5.1).

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

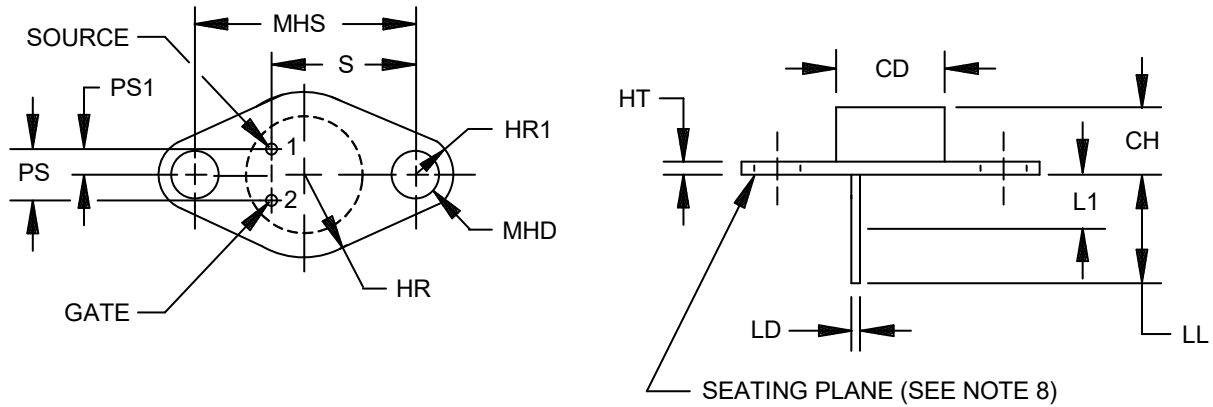
1.5.1 JAN certification mark and quality level for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JAN", "JANTX", "JANTXV" and "JANS".

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

1.5.2.1 First number and first letter symbols. The transistors of this specification sheet are identified by the first number and letter symbols "2N".

1.5.2.2 Second number symbols. The second number symbols for the transistor covered by this specification sheet are as follows: "6966", "6967", "6968", and "6969".

1.5.3 Lead finish. The lead finishes applicable to this specification sheet are listed on [QPDSIS-19500](#).



| Symbol | Dimensions |      |             |       | Notes | Symbol | Dimensions |       |             |       | Notes |
|--------|------------|------|-------------|-------|-------|--------|------------|-------|-------------|-------|-------|
|        | Inches     |      | Millimeters |       |       |        | Inches     |       | Millimeters |       |       |
|        | Min        | Max  | Min         | Max   |       |        | Min        | Max   | Min         | Max   |       |
| CD     |            | .875 |             | 22.22 | 3     | LL     | .440       | .500  | 11.18       | 12.70 | 6     |
| CH     | .250       | .450 | 6.35        | 11.43 |       | L1     |            | .050  |             | 1.27  | 6     |
| HR     | .495       | .525 | 12.58       | 13.33 |       | MHD    | .151       | .165  | 3.84        | 4.19  | 4     |
| HR1    | .131       | .188 | 3.33        | 4.77  | 4     | MHS    | 1.177      | 1.197 | 29.90       | 30.40 |       |
| HT     | .050       | .075 | 1.27        | 1.91  | 5     | PS     | .420       | .440  | 10.67       | 11.18 | 7     |
| LD     | .057       | .063 | 0.97        | 1.60  | 4, 6  | PS1    | .205       | .225  | 5.21        | 5.72  | 7     |
|        |            |      |             |       |       | S      | .655       | .675  | 16.64       | 17.15 |       |

## NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Pin 1 is the Source, pin 2 is the Gate. The Drain shall be electrically connected to the case.
3. Body contour is optional within zone defined by dimension CD.
4. Two places.
5. Dimension HT does not include sealing flanges.
6. Dimension LD applies between dimensions L1 and LL. Lead diameter shall not exceed twice dimension LD within dimension L1.
7. These dimensions should be measured at points .050 inch (1.27 mm) +.005 inch (0.13 mm) to -.000 inch (0.00 mm) below seating plane. When gauge is not used, measurement will be made at the seating plane.
8. The seating plane of the header shall be flat within .001 inch (0.03 mm) concave to .004 inch (0.10 mm) convex inside a .930 inch (23.62 mm) diameter circle on the center of the header and flat within .001 inch (0.03 mm) concave to .006 inch (0.15 mm) convex overall.
9. In accordance with ASME Y14.5M, diameters are equivalent to Øx symbology.

FIGURE 1. Physical dimensions for diamond base, flange mount TO-204AE package.

## 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.

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

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

## 3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as modified herein.

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

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#) and as follows:

|                 |                                          |
|-----------------|------------------------------------------|
| nC              | nano coulomb.                            |
| I <sub>AS</sub> | Rated avalanche current, non-repetitive. |

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in [MIL-PRF-19500](#), and on [figure 1](#) (similar to TO-204AE).

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

3.4.2 Internal construction. Multiple chip construction is not permitted to meet the requirements of this specification.

3.5 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).

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 the subgroups specified in 4.4.2 and 4.4.3 herein.

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

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

3.9 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).

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

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

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

| Screen<br>(1) (2) | Measurement                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | JANS level                                                                                                                                                                                                                                                                                                                                                                                                                                                               | JANTX and JANTXV levels                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| (3)               | Gate stress test (see 4.3.1)                                                                                                                                                                                                                                                                                                                                                                                                                                             | Gate stress test (see 4.3.1)                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| (3)               | Unclamped inductive switching (see 4.3.2) optional                                                                                                                                                                                                                                                                                                                                                                                                                       | Unclamped inductive switching (see 4.3.2) optional                                                                                                                                                                                                                                                                                                                                                                                                                |
| (3) 3c            | Thermal impedance (see 4.3.3)                                                                                                                                                                                                                                                                                                                                                                                                                                            | Thermal impedance (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:<br><br>$\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta I_{DSS1} = \pm 25$ $\mu$ A dc or $\pm 100$ 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; or $t = 48$ hours minimum at $+175$ °C min                                                                                                                                                                                                                                                                                                                                                                          |
| 13                | Subgroups 2 and 3 of table I herein;<br><br>$\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta I_{DSS1} = \pm 25$ $\mu$ A dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta r_{DS(on)1} = \pm 20$ percent of initial value.<br>$\Delta V_{GS(th)1} = \pm 20$ percent of initial value. | Subgroup 2 of table I herein;<br><br>$\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta I_{DSS1} = \pm 25$ $\mu$ A dc or $\pm 100$ percent of initial value, whichever is greater.<br>$\Delta r_{DS(on)1} = \pm 20$ percent of initial value.<br>$\Delta V_{GS(th)1} = \pm 20$ 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 after temperature cycling, screen 3a. Quality levels JANTX and JANTXV levels do not need to be repeated in screening requirements.

4.3.1 Gate stress test. Apply  $V_{GS} = 30$  V minimum for  $t = 250$   $\mu$ s minimum.

4.3.2 Single pulse unclamped inductive switching. The test for single pulse unclamped inductive switching shall be performed in accordance with method 3470 of [MIL-STD-750](#). The following details shall apply:

- a. Peak current,  $I_D$ .....Rated  $I_{D1}$ .
- b. Peak gate voltage,  $V_{GS}$ .....10 V.
- c. Gate to source resistor,  $R_{GS}$ ..... $25\ \Omega \leq R_{GS} \leq 200\ \Omega$ .
- d. Initial case temperature  $T_C$ .....+25 °C +10 °C, -5 °C.
- e. Inductance.....100  $\mu$ H minimum.
- f. Supply voltage  $V_{DD}$ .....50 V.
- 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  $I_M$ ,  $I_H$ ,  $t_H$ ,  $t_{SW}$ ,  $t_{MD}$  (and  $V_H$  where appropriate). (See [figure 2](#) herein.) See [table II](#), group E, subgroup 4 herein.

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#), and as specified herein.

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. 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 E-VIA (for quality level JANS) and table E-VIB (for quality levels JAN, JANTX, and JANTXV) of [MIL-PRF-19500](#), and as follows.

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

| <u>Subgroup</u> | <u>Method</u> | <u>Conditions</u>                                                                                                                                                                                                                                                                    |
|-----------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B3              | 1051          | Test condition G.                                                                                                                                                                                                                                                                    |
| B4              | 1042          | Test condition D. The heating cycle shall be 1 minute minimum.                                                                                                                                                                                                                       |
| B5              | 1042          | Test condition A, $V_{DS}$ = rated $T_A$ = +175 °C, $t$ = 120 hours minimum. Read and record $V_{(BR)DSS}$ (pre and post at 1 mA = $I_D$ . Read and record $I_{DSS}$ (pre and post). Deltas for $V_{(BR)DSS}$ shall not exceed 10 percent and $I_{DSS}$ shall not exceed 25 $\mu$ A. |
| B5              | 1042          | Test condition B, $V_{GS}$ = rated, $T_A$ = +175 °C, $t$ = 24 hours.                                                                                                                                                                                                                 |
| B5              | 2037          | Test condition D.                                                                                                                                                                                                                                                                    |

4.4.2.2 Quality level JAN, JANTX and JANTXV (table E-VIB of [MIL-PRF-19500](#)).

| <u>Subgroup</u> | <u>Method</u> | <u>Conditions</u>                                                                     |
|-----------------|---------------|---------------------------------------------------------------------------------------|
| B2              | 1051          | Test condition G.                                                                     |
| B3              | 1042          | Test condition D. The heating cycle shall be 1 minute minimum.                        |
| B3              | 2037          | Test condition D. All internal bond wires for each device shall be pulled separately. |
| B4              | 2075          | See <a href="#">3.4.2</a> .                                                           |

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-VII of [MIL-PRF-19500](#).

| <u>Subgroup</u> | <u>Method</u> | <u>Conditions</u>                                              |
|-----------------|---------------|----------------------------------------------------------------|
| C2              | 1056          | Test condition A.                                              |
| C2              | 2036          | Test condition A; weight = 10 lbs. (4.54 kg), t = 15 s.        |
| C5              | 3161          | See <a href="#">4.3.3</a> .                                    |
| C6              | 1042          | Test condition D. The heating cycle shall be 1 minute minimum. |

4.4.4 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 II](#) 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 measurements shall be as specified in section 4 of [MIL-STD-750](#).

TABLE I. Group A inspection.

| Inspection <a href="#">1/</a>              | MIL-STD-750 |                                                                                                                               | Symbol          | Limits |       | Unit  |
|--------------------------------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------|--------|-------|-------|
|                                            | Method      | Conditions                                                                                                                    |                 | Min    | Max   |       |
| <u>Subgroup 1</u>                          |             |                                                                                                                               |                 |        |       |       |
| Visual and mechanical examination          | 2071        |                                                                                                                               |                 |        |       |       |
| <u>Subgroup 2</u>                          |             |                                                                                                                               |                 |        |       |       |
| Thermal response <a href="#">2/</a>        | 3161        | See <a href="#">4.3.3</a>                                                                                                     | $Z_{\theta JC}$ |        |       | °C/W  |
| Breakdown voltage, drain to source         | 3407        | Condition C, $V_{GS} = 0$ V dc, $I_D = 1$ mA dc,                                                                              | $V_{(BR)DSS}$   |        |       | V dc  |
| 2N6966                                     |             |                                                                                                                               |                 | 100    |       |       |
| 2N6967                                     |             |                                                                                                                               |                 | 200    |       |       |
| 2N6968                                     |             |                                                                                                                               |                 | 400    |       |       |
| 2N6969                                     |             |                                                                                                                               |                 | 500    |       |       |
| Gate to source voltage (threshold)         | 3403        | $V_{DS} \geq V_{GS}$ , $I_D = 0.25$ mA dc                                                                                     | $V_{GS(th)1}$   | 2.0    | 4.0   | V dc  |
| Gate current                               | 3411        | Bias condition C; $V_{DS} = 0$ , $V_{GS} = +20$ V dc                                                                          | $I_{GSSF1}$     |        | ±100  | nA dc |
| Gate current                               | 3411        | Bias condition C; $V_{DS} = 0$ , $V_{GS} = -20$ V dc                                                                          | $I_{GSSR1}$     |        | ±100  | nA dc |
| Drain current                              | 3413        | Bias condition C; $V_{GS} = 0$ V dc $V_{DS} = 80$ percent of rated $V_{DS}$ ; bias condition C                                | $I_{DSS1}$      |        | 25    | μA dc |
| Static drain to source on-state resistance | 3421        | Condition A, $V_{GS} = 10$ V dc, pulsed (see <a href="#">4.5.1</a> ), $I_D = \text{rated } I_{D2}$ (see <a href="#">1.3</a> ) | $r_{DS(on)1}$   |        |       | ohms  |
| 2N6966                                     |             |                                                                                                                               |                 |        | 0.085 |       |
| 2N6967                                     |             |                                                                                                                               |                 |        | 0.18  |       |
| 2N6968                                     |             |                                                                                                                               |                 |        | 0.55  |       |
| 2N6969                                     |             |                                                                                                                               |                 |        | 0.85  |       |
| Static drain to source on-state resistance | 3421        | Condition A, $V_{GS} = 10$ V dc, pulsed (see <a href="#">4.5.1</a> ); $I_D = \text{rated } I_{D1}$ (see <a href="#">1.3</a> ) | $V_{DS(on)}$    |        |       | V     |
| 2N6966                                     |             |                                                                                                                               |                 |        | 1.70  |       |
| 2N6967                                     |             |                                                                                                                               |                 |        | 2.40  |       |
| 2N6968                                     |             |                                                                                                                               |                 |        | 4.13  |       |
| 2N6969                                     |             |                                                                                                                               |                 |        | 5.10  |       |

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

| Inspection <u>1/</u>                                                                  | MIL-STD-750 |                                                                                     | Symbol        | Limits                |                              | Unit  |
|---------------------------------------------------------------------------------------|-------------|-------------------------------------------------------------------------------------|---------------|-----------------------|------------------------------|-------|
|                                                                                       | Method      | Conditions                                                                          |               | Min                   | Max                          |       |
| Subgroup 2 – Continued                                                                |             |                                                                                     |               |                       |                              |       |
| Forward voltage<br>(source drain diode)<br>2N6966<br>2N6967<br>2N6968<br>2N6969       | 4011        | Condition C, $I_D = I_{D1}$ ,<br>$V_{GS} = 0$ V                                     | $V_{SD}$      | .85<br>.8<br>.8<br>.8 | 2.5<br>2.0<br>2.0<br>2.0     | V     |
| Forward<br>transconductance<br>2N6966<br>2N6967<br>2N6968<br>2N6969                   | 3475        | Pulsed (see 4.5.1)                                                                  | $g_{FS}$      | 6<br>6<br>4<br>4      | 18<br>18<br>12<br>12         | S     |
| <u>Subgroup 3</u>                                                                     |             |                                                                                     |               |                       |                              |       |
| High temperature<br>operation:                                                        |             | $T_C = T_J = +125$ °C                                                               |               |                       |                              |       |
| Gate current                                                                          | 3411        | Bias condition C,<br>$V_{GS} = \pm 20$ V dc,<br>$V_{DS} = 0$ V dc                   | $I_{GSS2}$    |                       | $\pm 200$                    | nA dc |
| Drain current<br><br>2N6966<br>2N6967<br>2N6968<br>2N6969                             | 3413        | Bias condition C, $V_{DS} = 80$<br>percent of rated $V_{DS}$ ,<br>$V_{GS} = 0$ V dc | $I_{DSS2}$    |                       | 0.25                         | mA dc |
| Static drain to source<br>on-state resistance<br>2N6966<br>2N6967<br>2N6968<br>2N6969 | 3421        | $V_{GS} = 10$ V dc pulsed<br>(see 4.5.1); $I_D = \text{rated } I_{D2}$              | $r_{DS(on)2}$ |                       | 0.13<br>0.27<br>1.04<br>1.62 | ohms  |
| Gate to source<br>voltage (threshold)                                                 | 3403        | $V_{DS} \geq V_{GS}$<br>$I_D = 0.25$ mA dc                                          | $V_{GS(th)2}$ | 1.0                   |                              | V dc  |

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

| Inspection <a href="#">1/</a>          | MIL-STD-750 |                                                                                                                                       | Symbol        | Limits |     | Unit |
|----------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------|---------------|--------|-----|------|
|                                        | Method      | Conditions                                                                                                                            |               | Min    | Max |      |
| <a href="#">Subgroup 3</a> – Continued |             |                                                                                                                                       |               |        |     |      |
| Low temperature operation:             |             | $T_C = T_J = -55\text{ }^{\circ}\text{C}$                                                                                             |               |        |     |      |
| Gate to source voltage threshold       | 3403        | $V_{DS} \geq V_{GS}$ , $I_D = 0.25\text{ mA dc}$                                                                                      | $V_{GS(th)3}$ |        | 5.0 | V dc |
| <a href="#">Subgroup 4</a>             |             |                                                                                                                                       |               |        |     |      |
| Switching time test                    | 3472        | $I_D = \text{rated } I_{D2}$ (see <a href="#">1.3</a> );<br>$V_{GS} = 10\text{ V dc}$ ,<br>Gate drive impedance = $7.5\text{ }\Omega$ |               |        |     |      |
| Turn-on delay time<br>2N6966           |             | $V_{DD} = 34\text{ V dc}$                                                                                                             | $t_{d(on)}$   |        | 30  | ns   |
| 2N6967                                 |             | $V_{DD} = 75\text{ V dc}$                                                                                                             |               |        | 30  |      |
| 2N6968                                 |             | $V_{DD} = 175\text{ V dc}$                                                                                                            |               |        | 35  |      |
| 2N6969                                 |             | $V_{DD} = 200\text{ V dc}$                                                                                                            |               |        | 35  |      |
| Rise time<br>2N6966                    |             | $V_{DD} = 34\text{ V dc}$                                                                                                             | $t_r$         |        | 60  | ns   |
| 2N6967                                 |             | $V_{DD} = 75\text{ V dc}$                                                                                                             |               |        | 60  |      |
| 2N6968                                 |             | $V_{DD} = 175\text{ V dc}$                                                                                                            |               |        | 30  |      |
| 2N6969                                 |             | $V_{DD} = 200\text{ V dc}$                                                                                                            |               |        | 30  |      |
| Turn-off delay time<br>2N6966          |             | $V_{DD} = 34\text{ V dc}$                                                                                                             | $t_{d(off)}$  |        | 80  | ns   |
| 2N6967                                 |             | $V_{DD} = 75\text{ V dc}$                                                                                                             |               |        | 80  |      |
| 2N6968                                 |             | $V_{DD} = 175\text{ V dc}$                                                                                                            |               |        | 90  |      |
| 2N6969                                 |             | $V_{DD} = 200\text{ V dc}$                                                                                                            |               |        | 90  |      |
| Fall time<br>2N6966                    |             | $V_{DD} = 34\text{ V dc}$                                                                                                             | $t_f$         |        | 30  | ns   |
| 2N6967                                 |             | $V_{DD} = 75\text{ V dc}$                                                                                                             |               |        | 60  |      |
| 2N6968                                 |             | $V_{DD} = 175\text{ V dc}$                                                                                                            |               |        | 35  |      |
| 2N6969                                 |             | $V_{DD} = 200\text{ V dc}$                                                                                                            |               |        | 30  |      |
| <a href="#">Subgroup 5</a>             |             |                                                                                                                                       |               |        |     |      |
| Safe operating area test               | 3474        | See figure 3; $V_{DS} = 80$ percent of rated $V_{DS}$ ; $t_p = 10\text{ ms}$                                                          |               |        |     |      |
| Electrical measurements                |             | See <a href="#">table I</a> , subgroup 2                                                                                              |               |        |     |      |

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

| Inspection <u>1/</u>                    | MIL-STD-750 |                                                                                      | Symbol       | Limits |      | Unit |
|-----------------------------------------|-------------|--------------------------------------------------------------------------------------|--------------|--------|------|------|
|                                         | Method      | Conditions                                                                           |              | Min    | Max  |      |
| <u>Subgroup 6</u>                       |             |                                                                                      |              |        |      |      |
| Not applicable                          |             |                                                                                      |              |        |      |      |
| <u>Subgroup 7</u>                       |             |                                                                                      |              |        |      |      |
| Gate charge                             | 3471        | Condition A and B                                                                    |              |        |      |      |
| Test 1<br>Minimum off-state gate charge |             |                                                                                      | $Q_{g(th)}$  | 2.7    | 8.0  | nC   |
| Test 2<br>On-state gate charge          |             |                                                                                      | $Q_{g(on)}$  | 30     | 77   | nC   |
| Test 3<br>Maximum on-state gate charge  |             |                                                                                      | $Q_{gm(on)}$ | 51     | 130  | nC   |
| Test 4<br>Gate plateau voltage charge   |             |                                                                                      | $V_{GP}$     | 4      | 8    | V dc |
| Test 5<br>Gate to source charge         |             |                                                                                      | $Q_{gs}$     | 4.6    | 13   | nC   |
| Test 6<br>Gate to drain charge          |             |                                                                                      | $Q_{gd}$     | 13     | 40   | nC   |
| Reverse recovery time                   | 3473        | $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} \leq 30 \text{ V}$ ,<br>$I_D = I_{D1}$ | $t_{rr}$     |        |      | ns   |
| 2N6966                                  |             |                                                                                      |              |        | 400  |      |
| 2N6967                                  |             |                                                                                      |              |        | 650  |      |
| 2N6968                                  |             |                                                                                      |              |        | 800  |      |
| 2N6969                                  |             |                                                                                      |              |        | 1000 |      |

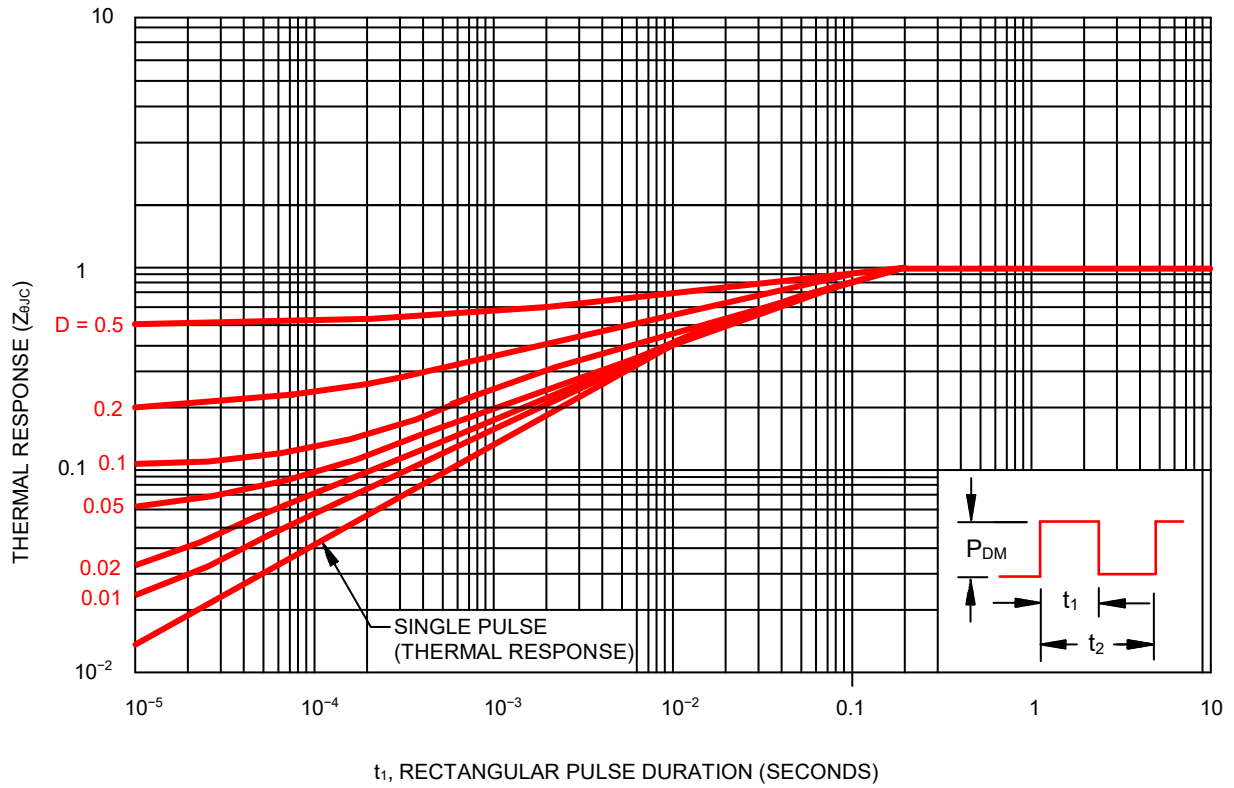
1/ For sampling plan, see [MIL-PRF-19500](#).

2/ This test required for the following end-point measurements only:  
 Group B, subgroups 2 and 3 (JAN, JANTX, and JANTXV).  
 Group B, subgroups 3 and 4 (JANS).  
 Group C, subgroup 6.  
 Group E, subgroup 1.

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

| Inspection                                                                                                                                                                               | MIL-STD-750 |                                                                                   | Sample plan       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------|-------------------|
|                                                                                                                                                                                          | Method      | Conditions                                                                        |                   |
| <u>Subgroup 1</u>                                                                                                                                                                        |             |                                                                                   | 45 devices, c = 0 |
| Temperature cycle                                                                                                                                                                        | 1051        | Condition G, 500 cycles.                                                          |                   |
| Hermetic seal                                                                                                                                                                            | 1071        | Fine and gross leak.                                                              |                   |
| Electrical measurements                                                                                                                                                                  |             | See <a href="#">table I</a> , subgroup 2.                                         |                   |
| <u>Subgroup 2</u> <sup>1/</sup>                                                                                                                                                          |             |                                                                                   | 45 devices, c = 0 |
| Steady-state reverse bias                                                                                                                                                                | 1042        | Condition A, 1,000 hours.                                                         |                   |
| Electrical measurements                                                                                                                                                                  |             | See <a href="#">table I</a> , subgroup 2.                                         |                   |
| Steady-state gate bias                                                                                                                                                                   | 1042        | Condition B, 1,000 hours.                                                         |                   |
| Electrical measurements                                                                                                                                                                  |             | See <a href="#">table I</a> , subgroup 2.                                         |                   |
| <u>Subgroup 4</u>                                                                                                                                                                        |             |                                                                                   | sample size, N/A  |
| Thermal impedance curves                                                                                                                                                                 |             | See <a href="#">MIL-PRF-19500</a> .                                               |                   |
| <u>Subgroup 5</u>                                                                                                                                                                        |             |                                                                                   | 3 devices, c = 0  |
| Barometric pressure (reduced)<br>(2N6968 and 2N6969 only)                                                                                                                                | 1001        | Test condition C, $I_{(ISO)} = 0.25 \text{ mA (maximum)}$ ,<br>$V_{ISO} = V_{DS}$ |                   |
| <u>Subgroup 10</u>                                                                                                                                                                       |             |                                                                                   |                   |
| Commutating diode for safe<br>operating area test procedure<br>for measuring dv/dt during<br>reverse recovery of power<br>MOSFET transistors or<br>insulated gate bipolar<br>transistors | 3476        | Test conditions shall be derived by the<br>manufacturer.                          | 22 devices, c = 0 |

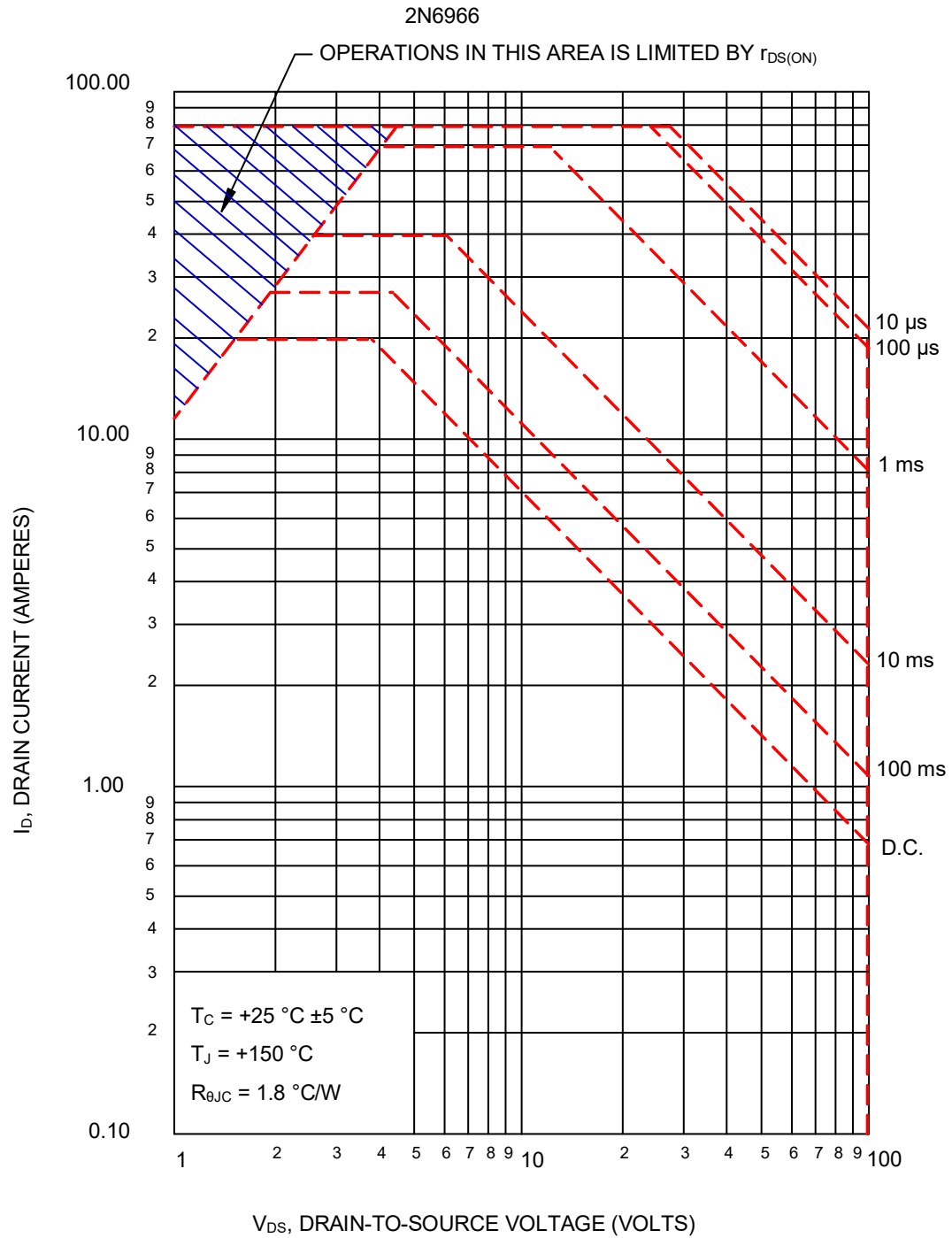
<sup>1/</sup> A separate sample for each test may be pulled.



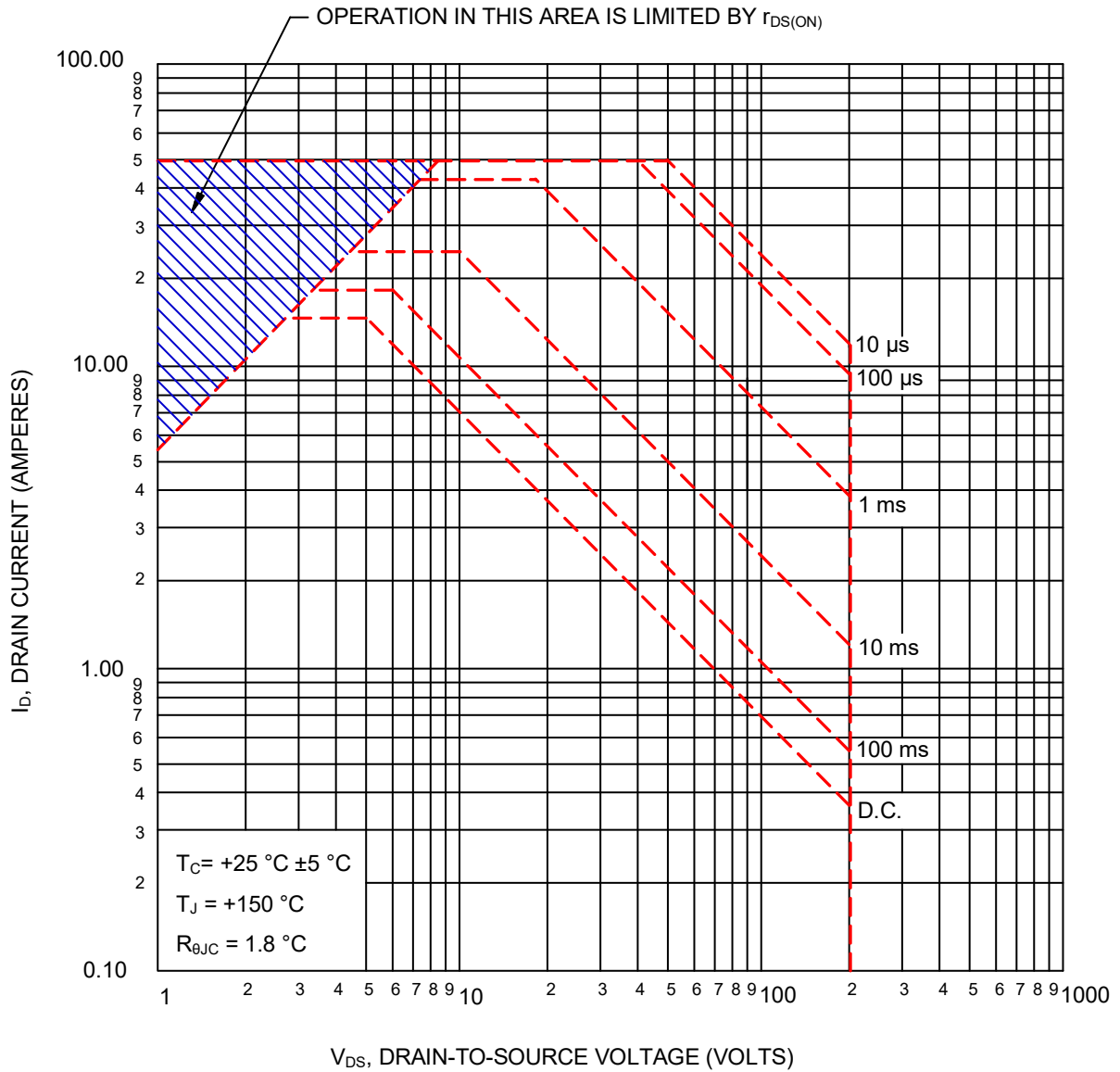
## NOTES:

1. Duty factor  $D = t_1 / t_2$
2. Per unit base  $R_{\theta JC} = 1.8 \text{ } ^\circ\text{C/W}$
3.  $T_{JM} = P_T * R_{\theta JC} * r(t) + T_C$

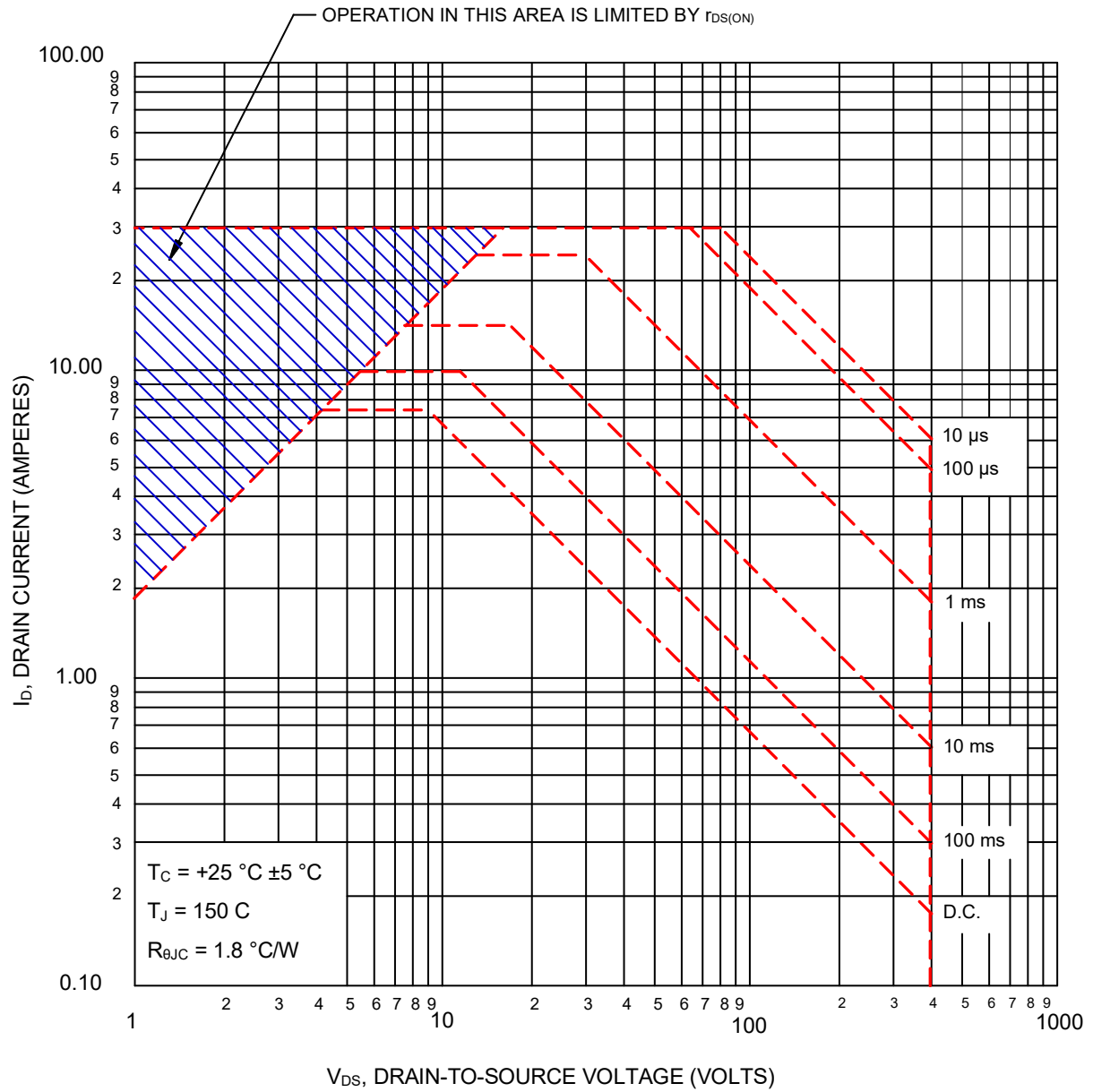
FIGURE 2. Thermal response curves.

FIGURE 3. Safe operating area.

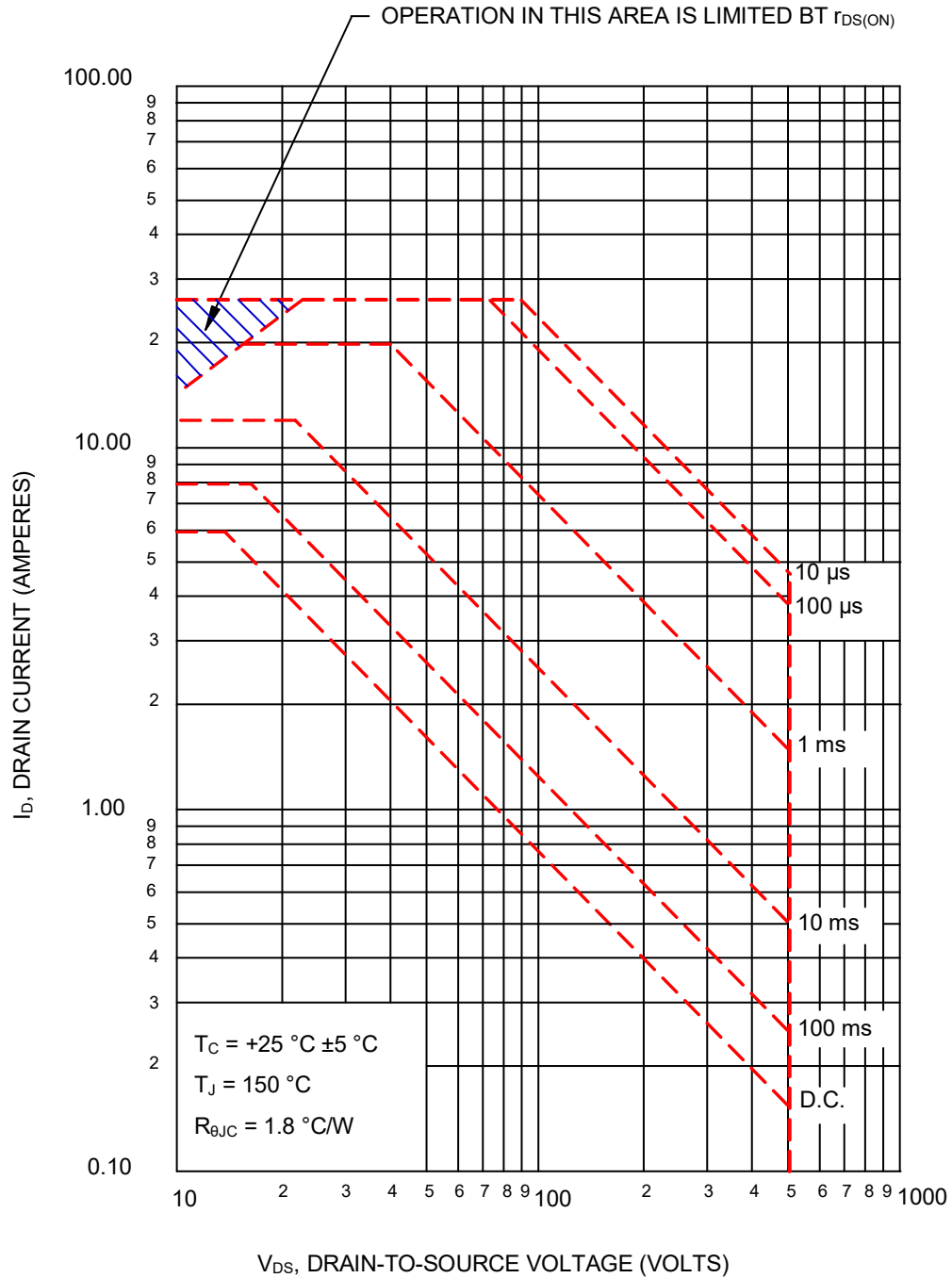
2N6967

FIGURE 3. Safe operating area - Continued.

2N6968

FIGURE 3. Safe operating area - Continued.

2N6969

FIGURE 3. Safe operating area - Continued.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in MIL-PRF-19500 are applicable to this specification.)

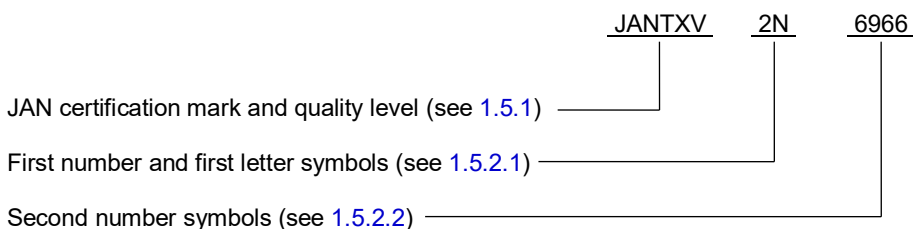
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. The complete PIN, see 1.5 and 6.5.

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](mailto: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 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



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

| PINs for devices of the base quality level | PINs for devices of the "TX" quality level | PINs for devices of the "TXV" quality level | PINs for devices of the "S" quality level |
|--------------------------------------------|--------------------------------------------|---------------------------------------------|-------------------------------------------|
| JAN2N6966                                  | JANTX2N6966                                | JANTXV2N6966                                | JANS2N6966                                |
| JAN2N6967                                  | JANTX2N6967                                | JANTXV2N6967                                | JANS2N6967                                |
| JAN2N6968                                  | JANTX2N6968                                | JANTXV2N6968                                | JANS2N6968                                |
| JAN2N6969                                  | JANTX2N6969                                | JANTXV2N6969                                | JANS2N6969                                |

6.6 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's PIN. This information in no way implies that manufacturers' PIN's are suitable as a substitute for the military PIN.

| PIN    | Commercial types |
|--------|------------------|
| 2N6966 | IRFJ140          |
| 2N6967 | IRFJ240          |
| 2N6968 | IRFJ340          |
| 2N6969 | IRFJ440          |

6.7 Changes from previous issue. The margins of this specification are not marked with asterisks due to the extent of the changes.

Custodians:

Army – CR  
Navy – EC  
Air Force – 85  
NASA – NA  
DLA – CC

Preparing activity:  
DLA – CC

(Project 5961–2020–081)

Review activities:

Army – AR, SM  
Navy – AS, CG, MC, OS, SH  
Air Force – 19, 70, 170

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>.