

MIL-S-19500/280A(EC)  
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 SUPERSEDING  
 MIL-S-19500/280 (NAVY)  
 2 October 1964

# MILITARY SPECIFICATION

SEMICONDUCTOR DEVICES, THYRISTOR (CONTROLLED RECTIFIER), SILICON  
 TYPES 2N3091, 2N3093, 2N3095, 2N3097,  
 2N3098, 2N3099, 2N3101, 2N3103,  
 2N3105, AND 2N3106

This specification is approved for use by Naval Electronic Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the detail requirements for silicon thyristors, types 2N3091, 2N3093, 2N3095, 2N3097, 2N3098, 2N3099, 2N3101, 2N3103, 2N3105, and 2N3106 and is in accordance with MIL-S-19500, except as otherwise specified herein.

1.2 Physical dimensions. See figure 1.

1.3 Characteristics. The following devices have characteristics at 25° ±3°C, unless otherwise specified herein.

| Characteristic   | Conditions                                                                      | Symbol   | Min  | Max | Units      |
|------------------|---------------------------------------------------------------------------------|----------|------|-----|------------|
| On state voltage | $I_{TM} = 220 \text{ A(pk)}$                                                    | $V_{TM}$ | ---  | 1.7 | $V_{(pk)}$ |
| Holding current  |                                                                                 | $I_H$    | ---  | 40  | mAdc       |
| Trigger voltage  | $V_{AA} = 6.0 \text{ Vdc}$<br>$T_A = -40^\circ \text{ to } +125^\circ\text{C.}$ | $V_{GT}$ | 0.25 | 3.0 | Vdc        |
| Trigger current  | $V_{AA} = 6.0 \text{ Vdc}$<br>$V_{GT} = 3.0 \text{ Vdc max}$                    | $I_{GT}$ | 5    | 70  | mAdc       |
| Turn-off time    | ---                                                                             | $t_q$    | ---  | 47  | us         |

## 1.4 Maximum ratings.

| $I_{O \frac{1}{}}$ | $I_{TSM \frac{2}{}}$ | $V_{GM}$ | $V_{DM}$ | $P_{GM}$ | $P_{G(AV)}$ | $T_{STG}$   | $T_J$       | Stud torque | Maximum operating altitude |
|--------------------|----------------------|----------|----------|----------|-------------|-------------|-------------|-------------|----------------------------|
| A                  | A(1 cycle)           | V        | V        | W        | W           | °C          | °C          | lb-in       | mmHg                       |
| 50                 | 1000                 | 5        | 10       | 5        | 0.5         | -40 to +125 | -40 to +125 | 150         | 15                         |

1/ This average on-state current is for a maximum allowable case temperature of 93°C and 180 electrical degrees of half sine wave conduction. For other maximum operating conditions, see figure 2.

2/ Surge rating is nonrecurrent and applies only with device in conducting state.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Electronic Systems Command, ATTN: ELEX 5043, Department of the Navy, Washington DC 20360, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

| Type   | $V_{T(RMS)}$ | $V_{RRM} \frac{1/}{}$ | $V_{DRM} \frac{1/}{}$ | $V_{(BR)R} \frac{2/}{}$ | $V_{(BR)R} \frac{2/}{}$ | Units |
|--------|--------------|-----------------------|-----------------------|-------------------------|-------------------------|-------|
|        |              |                       |                       | <u>min</u>              | <u>max</u>              |       |
| 2N3091 | 420          | 600                   | 600                   | 700                     | ---                     | V     |
| 2N3093 | 560          | 800                   | 800                   | 900                     | ---                     | V     |
| 2N3095 | 700          | 1000                  | 1000                  | 1100                    | ---                     | V     |
| 2N3097 | 840          | 1200                  | 1200                  | 1300                    | ---                     | V     |
| 2N3098 | 910          | 1300                  | 1300                  | 1400                    | ---                     | V     |
| 2N3099 | 420          | 600                   | 600                   | 700                     | 900                     | V     |
| 2N3101 | 560          | 800                   | 800                   | 900                     | 1100                    | V     |
| 2N3103 | 700          | 1000                  | 1000                  | 1100                    | 1300                    | V     |
| 2N3105 | 840          | 1200                  | 1200                  | 1300                    | 1500                    | V     |
| 2N3106 | 910          | 1300                  | 1300                  | 1400                    | 1600                    | V     |

1/ Values apply for zero or negative gate voltage ( $-V_G$ ).

2/ Reverse breakdown voltage.

## 2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

### SPECIFICATIONS

#### MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification For.

### STANDARD

#### MILITARY

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

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

#### National Bureau of Standards

Handbook H28 - Screw-Thread Standards for Federal Services.

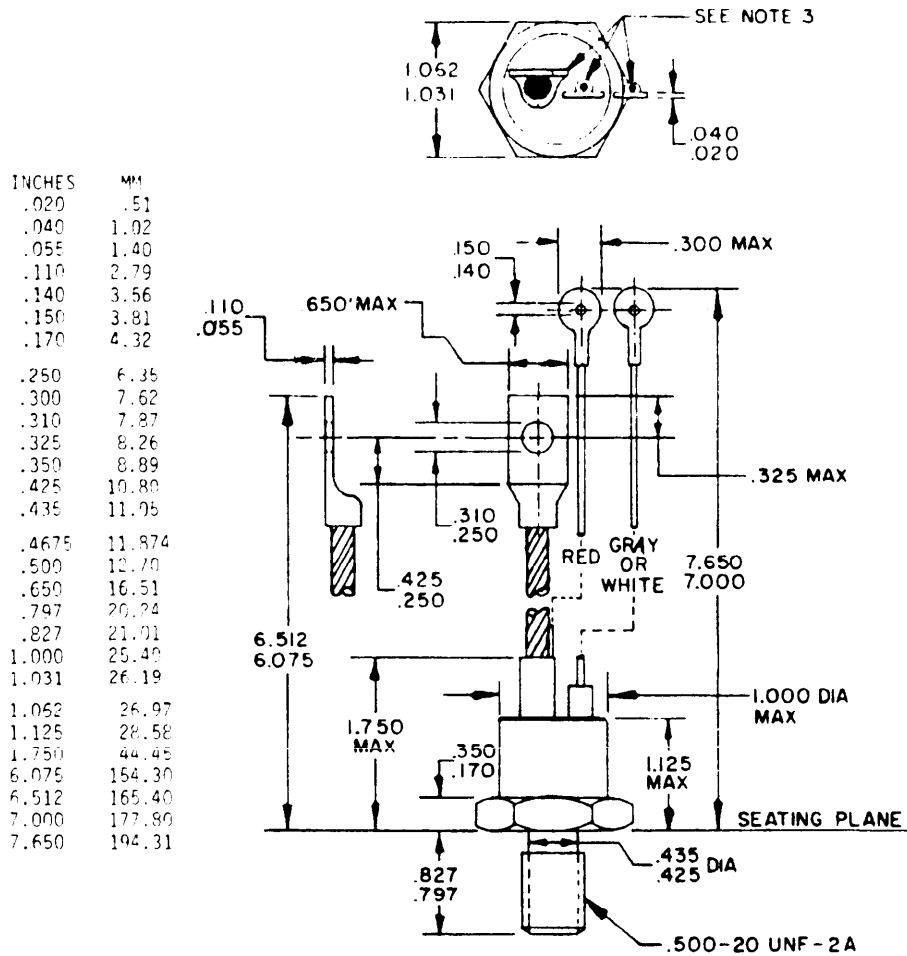
(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

## 3. REQUIREMENTS

3.1 General. The devices shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500.

3.3 Symbol. The symbol for thyristors shall be as shown on figure 3.



## NOTES:

1. Complete threads to extend within 2.50 threads of seating plane.
2. Maximum pitch diameter of plated threads shall be basic pitch diameter .4675 (11.874 mm) Ref. (Screw Thread Standards for Federal Services 1969) Handbook H28, Pl.
3. Angular orientation of these terminals is undefined. Square or radius on end of terminal is optional.
4. A chamfer or undercut on one or both ends of hex portions is optional.
5. Dimensions are in inches.
6. Metric equivalents are given for general information only and are based upon 1.00 inch = 25.4 mm.

FIGURE 1. Dimensions of thyristors, types 2N3091, 2N3093, 2N3095, 2N3097, 2N3098, 2N3099, 2N3101, 2N3103, 2N3105 and 2N3106 - Continued.

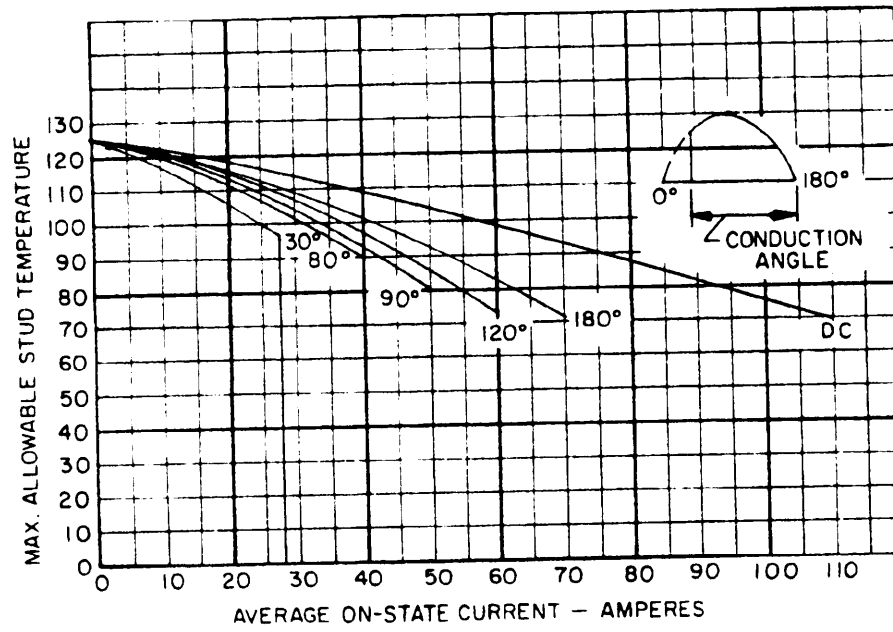


FIGURE 2. Maximum allowable case temperature.

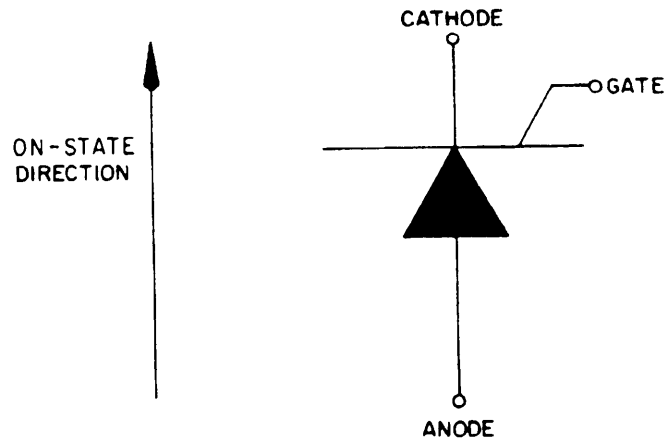


FIGURE 3. Symbol for thyristors.

3.4 Design, construction, and physical dimensions. Thyristors shall be of the design, construction, and physical dimensions shown on figure 1.

3.5 Performance characteristics. The performance characteristics of thyristors shall be as specified in 4.3.1, 4.3.2, and 4.3.3.

3.6 Marking. The following marking specified in MIL-S-19500 may be omitted from the devices:

- a. Manufacturer's identification.
- b. Country of origin.

3.6.1 Polarity marking on thyristors. The polarity shall be indicated by marking the body with the graphical symbol for thyristors so oriented that the arrow points in the direction of easy flow of the conventional current (on-state direction).

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500 and as specified herein.

4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.

4.2.1 Qualification testing. Qualification testing shall consist of the following:

- a. All structurally identical device types that specify a maximum reverse breakdown voltage may be used to qualify device types that do not specify a maximum reverse breakdown voltage.
- b. Subgroups 1 and 4 of group B inspection and subgroup 4 of group C inspection may be performed on any type to qualify that type and all lower voltage types or shall be performed on a "lot" basis.
- c. Subgroup 2 of group B inspection shall be performed on a "sublot" basis.
- d. Subgroup 3 of group B inspection and subgroups 1 and 2 of group C inspection may be performed on any type to qualify all types under this specification.
- e. Subgroup 3 of group C inspection may be performed on any type to qualify that type and all lower voltage types.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of group A, B, and C inspections.

4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I.

4.3.2 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table II.

4.3.3 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table III.

4.4 Methods of examination and test. Methods of examination and test shall be as specified in table I, II, and III and as follows:

4.4.1 Intermittent life. The thyristors shall be operated in a single phase circuit as shown on figure 4 with  $165 \pm 15$  degree conduction angle. Device case temperature shall be maintained at  $80^\circ \pm 5^\circ\text{C}$  as measured with a thermocouple rigidly attached to the case hex. Peak input voltage from a 60 hertz (Hz) sinusoidal blocking voltage power supply shall be equal to rated blocking voltage. Average forward current shall be 50 amperes per device from the 60 Hz sinusoidal forward current supply. The blocking voltage supply shall be phase delayed 90 electrical degrees with respect to the forward current supply in order to impose both off-state and reverse blocking duty on the devices under test. The on-state current supply consists of a low voltage transformer with a means of adjusting the secondary voltage. The blocking voltage supply consists of a high voltage transformer with a synchronous switch connected in series with one of the secondary transformer leads. The synchronous switch is set to conduct for  $165 \pm 15$  electrical degrees during the interval when terminal A is negative with respect to terminal C. A minimum of two and a maximum of five electrical degrees off-time shall be allowed after on-state current conduction before blocking voltage is applied by the synchronous switch. The gate trigger pulses shall be delivered from a trigger circuit having an open circuit voltage of  $7.0 \pm 3.0$  volts and a short circuit current of  $1.2 \pm 0.8$  amperes. The gate pulse average power input shall not exceed 0.5 watts. The gate trigger supply shall be in phase with the device forward current supply.

4.4.2 Hermetic seal tests. All devices shall be subjected to hermetic seal tests (fine-leak followed by gross-leak) with test conditions as specified in 4.4.2.1 and 4.4.2.2. Failed devices from either test shall be removed from the lot.

4.4.2.1 Hermetic seal (fine-leak) test. All devices shall be fine leak tested in accordance with MIL-STD-750, method 1071, test condition C or H. The leak-rate rejection criterion shall be  $5 \times 10^{-7}$  cubic centimeters of helium per second when measured at a differential pressure of one atmosphere.

4.4.2.2 Hermetic seal (gross-leak) test. All devices shall be tested for gross-leaks in accordance with MIL-STD-750, method 1071, test conditions A, C, D, or F.

4.4.3 Blocking life. The specified peak voltage shall be applied from anode to cathode with the gate terminal open circuited. The voltage shall be a 60 Hz sine wave. The device case temperature shall be maintained at the specified value throughout the specified test time. A resistor of 50 ohms shall be connected in series with the voltage power supply to limit current in the event of device voltage breakdown. The basic circuit shown on figure 5 may be used.

4.4.4 Breakover voltage. This test shall be performed by applying a full wave rectified 60 Hz sine wave of voltage that exceeds the breakover voltage of the device and will turn it on. The on-state current shall then be adjusted to 100 milliamperes (pk), minimum. The duration of this test shall be no less than 5 seconds. This test shall be performed with the gate terminal open circuited. The circuit shown on figure 6 may be used for this test.

4.4.5 Reverse breakdown voltage. This test shall be performed by applying a full wave rectified 60 Hz sine wave of voltage that exceeds the reverse breakdown voltage of the device and will drive it into the reverse breakdown mode. The peak power dissipation shall be 20 watts peak minimum. This test shall be performed with the gate terminal open circuited. The circuit shown on figure 6 may be used for this test.

TABLE 1. Group A inspection.

| Examination or test                      | MIL-STD-750 |                                                                        | LTPD | Symbol      | Limits |      | Unit   |
|------------------------------------------|-------------|------------------------------------------------------------------------|------|-------------|--------|------|--------|
|                                          | Method      | Details                                                                |      |             | Min    | Max  |        |
| <u>Subgroup 1</u>                        |             |                                                                        | 5    |             |        |      |        |
| Visual and mechanical examination        | 2071        |                                                                        |      |             |        |      |        |
| <u>Subgroup 2</u>                        |             |                                                                        | 5    |             |        |      |        |
| Breakover voltage<br>(See 4.4.4)         |             | 60 Hz full wave rectified<br>ac, 100 mA peak, 5 s minimum<br>duration  |      | $V_{(BO)}$  |        |      |        |
| 2N3091                                   |             |                                                                        |      |             | 600    | ---  | V(pk)  |
| 2N3093                                   |             |                                                                        |      |             | 800    | ---  | V(pk)  |
| 2N3095                                   |             |                                                                        |      |             | 1000   | ---  | V(pk)  |
| 2N3097                                   |             |                                                                        |      |             | 1200   | ---  | V(pk)  |
| 2N3098                                   |             |                                                                        |      |             | 1300   | ---  | V(pk)  |
| 2N3099                                   |             |                                                                        |      |             | 600    | ---  | V(pk)  |
| 2N3101                                   |             |                                                                        |      |             | 800    | ---  | V(pk)  |
| 2N3103                                   |             |                                                                        |      |             | 1000   | ---  | V(pk)  |
| 2N3105                                   |             |                                                                        |      |             | 1200   | ---  | V(pk)  |
| 2N3106                                   |             |                                                                        |      |             | 1300   | ---  | V(pk)  |
| Forward blocking current                 | 4206        | AC method, bias condition D<br>$f = 60$ Hz                             |      | $I_{DRM}$   |        |      |        |
| 2N3091                                   |             | $V_{DRM} = 600$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3093                                   |             | $V_{DRM} = 800$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3095                                   |             | $V_{DRM} = 1000$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3097                                   |             | $V_{DRM} = 1200$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3098                                   |             | $V_{DRM} = 1300$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3099                                   |             | $V_{DRM} = 600$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3101                                   |             | $V_{DRM} = 800$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3103                                   |             | $V_{DRM} = 1000$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3105                                   |             | $V_{DRM} = 1200$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3106                                   |             | $V_{DRM} = 1300$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| Reverse breakdown voltage<br>(See 4.4.5) | ---         | 60 Hz full wave rectified<br>ac, 20 watt peak, 5 s minimum<br>duration |      | $V_{(BR)R}$ |        |      |        |
| 2N3091                                   |             |                                                                        |      |             | 700    | ---  | V(pk)  |
| 2N3093                                   |             |                                                                        |      |             | 900    | ---  | V(pk)  |
| 2N3095                                   |             |                                                                        |      |             | 1100   | ---  | V(pk)  |
| 2N3097                                   |             |                                                                        |      |             | 1300   | ---  | V(pk)  |
| 2N3098                                   |             |                                                                        |      |             | 1400   | ---  | V(pk)  |
| 2N3099                                   |             |                                                                        |      |             | 700    | 900  | V(pk)  |
| 2N3101                                   |             |                                                                        |      |             | 900    | 1100 | V(pk)  |
| 2N3103                                   |             |                                                                        |      |             | 1100   | 1300 | V(pk)  |
| 2N3105                                   |             |                                                                        |      |             | 1300   | 1500 | V(pk)  |
| 2N3106                                   |             |                                                                        |      |             | 1400   | 1600 | V(pk)  |
| Reverse blocking current                 | 4211        | AC method, bias condition D<br>$f = 60$ Hz                             |      | $I_{RRM}$   |        |      |        |
| 2N3091                                   |             | $V_{RRM} = 600$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3093                                   |             | $V_{RRM} = 800$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3095                                   |             | $V_{RRM} = 1000$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3097                                   |             | $V_{RRM} = 1200$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3098                                   |             | $V_{RRM} = 1300$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3099                                   |             | $V_{RRM} = 600$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3101                                   |             | $V_{RRM} = 800$ V(pk)                                                  |      |             | ---    | 2    | mA(pk) |
| 2N3103                                   |             | $V_{RRM} = 1000$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3105                                   |             | $V_{RRM} = 1200$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |
| 2N3106                                   |             | $V_{RRM} = 1300$ V(pk)                                                 |      |             | ---    | 2    | mA(pk) |

TABLE I. Group A inspection - Continued

| Examination or test                                                                                     | MIL-STD-750 |                                                                                                    | LTPD | Symbol                             | Limits |           | Unit        |
|---------------------------------------------------------------------------------------------------------|-------------|----------------------------------------------------------------------------------------------------|------|------------------------------------|--------|-----------|-------------|
|                                                                                                         | Method      | Details                                                                                            |      |                                    | Min    | Max       |             |
| Subgroup 2 (cont'd)                                                                                     |             |                                                                                                    |      |                                    |        |           |             |
| High temperature forward blocking current                                                               | 4206        | AC method, bias condition D<br>$T_C = 125^{\circ}\text{C}$ , $f = 60\text{ Hz}$                    |      | $I_{\text{DRM}}$                   |        |           |             |
| 2N3091                                                                                                  |             | $V_{\text{DRM}} = 600\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3093                                                                                                  |             | $V_{\text{DRM}} = 800\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3095                                                                                                  |             | $V_{\text{DRM}} = 1000\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3097                                                                                                  |             | $V_{\text{DRM}} = 1200\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3098                                                                                                  |             | $V_{\text{DRM}} = 1300\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3099                                                                                                  |             | $V_{\text{DRM}} = 600\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3101                                                                                                  |             | $V_{\text{DRM}} = 800\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3103                                                                                                  |             | $V_{\text{DRM}} = 1000\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3105                                                                                                  |             | $V_{\text{DRM}} = 1200\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3106                                                                                                  |             | $V_{\text{DRM}} = 1300\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| High temperature reverse blocking current                                                               | 4211        | AC method, bias condition D<br>$T_C = 125^{\circ}\text{C}$ , $f = 60\text{ Hz}$                    |      | $I_{\text{RRM}}$                   |        |           |             |
| 2N3091                                                                                                  |             | $V_{\text{RRM}} = 600\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3093                                                                                                  |             | $V_{\text{RRM}} = 800\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3095                                                                                                  |             | $V_{\text{RRM}} = 1000\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3097                                                                                                  |             | $V_{\text{RRM}} = 1200\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3098                                                                                                  |             | $V_{\text{RRM}} = 1300\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3099                                                                                                  |             | $V_{\text{RRM}} = 600\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3101                                                                                                  |             | $V_{\text{RRM}} = 800\text{ V(pk)}$                                                                |      |                                    | ---    | 15        | mA(pk)      |
| 2N3103                                                                                                  |             | $V_{\text{RRM}} = 1000\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3105                                                                                                  |             | $V_{\text{RRM}} = 1200\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| 2N3106                                                                                                  |             | $V_{\text{RRM}} = 1300\text{ V(pk)}$                                                               |      |                                    | ---    | 15        | mA(pk)      |
| Exponential rate of voltage rise                                                                        | 4231        | $T_C = 125^{\circ}\text{C}$ , bias condition D<br>$\frac{dv}{dt} = 200\text{ V}/\mu\text{s}$       |      | $V_D$                              |        |           |             |
| 2N3091                                                                                                  |             | $V_{\text{AA}} = 600\text{ Vdc}$                                                                   |      |                                    | 570    | ---       | Vdc         |
| 2N3093                                                                                                  |             | $V_{\text{AA}} = 800\text{ Vdc}$                                                                   |      |                                    | 760    | ---       | Vdc         |
| 2N3095                                                                                                  |             | $V_{\text{AA}} = 1000\text{ Vdc}$                                                                  |      |                                    | 950    | ---       | Vdc         |
| 2N3097                                                                                                  |             | $V_{\text{AA}} = 1200\text{ Vdc}$                                                                  |      |                                    | 1140   | ---       | Vdc         |
| 2N3098                                                                                                  |             | $V_{\text{AA}} = 1300\text{ Vdc}$                                                                  |      |                                    | 1235   | ---       | Vdc         |
| 2N3099                                                                                                  |             | $V_{\text{AA}} = 600\text{ Vdc}$                                                                   |      |                                    | 570    | ---       | Vdc         |
| 2N3101                                                                                                  |             | $V_{\text{AA}} = 800\text{ Vdc}$                                                                   |      |                                    | 760    | ---       | Vdc         |
| 2N3103                                                                                                  |             | $V_{\text{AA}} = 1000\text{ Vdc}$                                                                  |      |                                    | 950    | ---       | Vdc         |
| 2N3105                                                                                                  |             | $V_{\text{AA}} = 1200\text{ Vdc}$                                                                  |      |                                    | 1140   | ---       | Vdc         |
| 2N3106                                                                                                  |             | $V_{\text{AA}} = 1300\text{ Vdc}$                                                                  |      |                                    | 1235   | ---       | Vdc         |
| $C = 1\text{ }\mu\text{F}$ , $R_L = 50\text{ ohms}$<br>Repetition rate = 60 pps<br>Test duration = 15 s |             |                                                                                                    |      |                                    |        |           |             |
| Subgroup 3                                                                                              |             |                                                                                                    |      |                                    |        |           |             |
| Gate trigger voltage and gate trigger current                                                           | 4221        | $V_2 = 6.0\text{ Vdc}$<br>$R_L = 10\text{ ohms}$ ; $R_E = 20\text{ ohms}$                          | 5    | $V_{\text{GT}}$<br>$I_{\text{GT}}$ | ---    | 3.0<br>70 | Vdc<br>mAdc |
| On-state voltage                                                                                        | 4226        | $I_{\text{TM}} = 220\text{ A(pk)}$ , pulse<br>$P_W = 8.5\text{ ms (max)}$<br>duty cycle = 2% (max) |      | $V_{\text{TM}}$                    | ---    | 1.7       | V(pk)       |

TABLE I. Group A inspection - Continued

| Examination or test        | MIL-STD-750 |                                                                                                                                                                                                                                                                                                                                                        | LTPD | Symbol          | Limits |     | Unit          |
|----------------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------|--------|-----|---------------|
|                            | Method      | Details                                                                                                                                                                                                                                                                                                                                                |      |                 | Min    | Max |               |
| <u>Subgroup 3 (cont'd)</u> |             |                                                                                                                                                                                                                                                                                                                                                        |      |                 |        |     |               |
| Gate trigger voltage       | 4221        | $T_C = 125^{\circ}\text{C}$ , $R_e = 200$ max<br>$V_2 = V_{\text{DRM}}$ (see 1.4),<br>$R_2 = 1$ k $\Omega$                                                                                                                                                                                                                                             |      | $V_{\text{GT}}$ | 0.25   |     | Vdc           |
| Holding current            | 4201        | $V_{\text{AA}} = 22.5$ Vdc<br>Gate trigger source<br>voltage = 6.0 Vdc<br>$I_{\text{F1}} = 10$ Adc<br>$I_{\text{F2}} = 500$ mAdc<br>$R_2 = 50$ ohms<br>condition D                                                                                                                                                                                     |      | $I_{\text{H}}$  | ---    | 40  | mAdc          |
| Turn-off time              | 4224        | $I_{\text{TM}} = 50$ Apk,<br>$t_{\text{on}} = 100 \pm 50$ $\mu\text{s}$ max,<br>$V_{\text{RM}} = V_{\text{RRM}}$ , $T_C = 125^{\circ}\text{C}$<br>$\frac{dv}{dt} = 20$ V/ $\mu\text{s}$ ,<br>$V_{\text{DM}} = V_{\text{DRM}}$ (see 1.4)<br>repetition rate = 60 pps<br>max, gate source voltage =<br>0 volts, gate source<br>resistance = 100 $\Omega$ |      | $t_{\text{q}}$  |        | 47  | $\mu\text{s}$ |

TABLE II. Group B inspection

| Examination or test      | MIL-STD-750 |                                                                                                                                   | LTPD | Symbol    | Limits |     | Unit   |
|--------------------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------|------|-----------|--------|-----|--------|
|                          | Method      | Details                                                                                                                           |      |           | Min    | Max |        |
| <u>Subgroup 1</u>        |             |                                                                                                                                   |      |           |        |     |        |
| Reverse gate current     | 4219        | $V_G = -5.0$ Vdc                                                                                                                  | 10   | $-I_G$    | ---    | 300 | mAdc   |
| Surge current            | 4066        | $I_{TSM} = 1,000$ Adc<br>10 surges total<br>1 surge per minute<br>1/120 s duration<br>$T_C = 125^\circ\text{C}$ , rated $V_{RRM}$ |      |           |        |     |        |
| End points:              |             |                                                                                                                                   |      |           |        |     |        |
| Reverse blocking current | 4211        | AC method, bias condition D<br>$f = 60$ Hz                                                                                        |      | $I_{RRM}$ |        |     |        |
| 2N3091                   |             | $V_{RRM} = 600$ V(pk)                                                                                                             |      |           | ---    | 4   | mA(pk) |
| 2N3093                   |             | $V_{RRM} = 800$ V(pk)                                                                                                             |      |           | ---    | 4   | mA(pk) |
| 2N3095                   |             | $V_{RRM} = 1000$ V(pk)                                                                                                            |      |           | ---    | 4   | mA(pk) |
| 2N3097                   |             | $V_{RRM} = 1200$ V(pk)                                                                                                            |      |           | ---    | 4   | mA(pk) |
| 2N3098                   |             | $V_{RRM} = 1300$ V(pk)                                                                                                            |      |           | ---    | 4   | mA(pk) |
| 2N3099                   |             | $V_{RRM} = 600$ V(pk)                                                                                                             |      |           | ---    | 4   | mA(pk) |
| 2N3101                   |             | $V_{RRM} = 800$ V(pk)                                                                                                             |      |           | ---    | 4   | mA(pk) |
| 2N3103                   |             | $V_{RRM} = 1000$ V(pk)                                                                                                            |      |           | ---    | 4   | mA(pk) |
| 2N3105                   |             | $V_{RRM} = 1200$ V(pk)                                                                                                            |      |           | ---    | 4   | mA(pk) |
| 2N3106                   |             | $V_{RRM} = 1300$ V(pk)                                                                                                            |      |           | ---    | 4   | mA(pk) |

TABLE II. Group B inspection - Continued

| Examination or test                                           | MIL-STD-750 |                                                                                                                    | LTPD | Symbol                             | Limits |            | Unit        |
|---------------------------------------------------------------|-------------|--------------------------------------------------------------------------------------------------------------------|------|------------------------------------|--------|------------|-------------|
|                                                               | Method      | Details                                                                                                            |      |                                    | Min    | Max        |             |
| <u>Subgroup 1 (cont'd)</u>                                    |             |                                                                                                                    |      |                                    |        |            |             |
| End points: (cont'd)                                          |             |                                                                                                                    |      |                                    |        |            |             |
| Forward blocking current                                      | 4206        | AC method, bias condition D<br>f = 60 Hz                                                                           |      | I <sub>DRM</sub>                   |        |            |             |
| 2N3091                                                        |             | V <sub>DRM</sub> = 600 V(pk)                                                                                       |      |                                    | ---    | 4          | mA(pk)      |
| 2N3093                                                        |             | V <sub>DRM</sub> = 800 V(pk)                                                                                       |      |                                    | ---    | 4          | mA(pk)      |
| 2N3095                                                        |             | V <sub>DRM</sub> = 1000 V(pk)                                                                                      |      |                                    | ---    | 4          | mA(pk)      |
| 2N3097                                                        |             | V <sub>DRM</sub> = 1200 V(pk)                                                                                      |      |                                    | ---    | 4          | mA(pk)      |
| 2N3098                                                        |             | V <sub>DRM</sub> = 1300 V(pk)                                                                                      |      |                                    | ---    | 4          | mA(pk)      |
| 2N3099                                                        |             | V <sub>DRM</sub> = 600 V(pk)                                                                                       |      |                                    | ---    | 4          | mA(pk)      |
| 2N3101                                                        |             | V <sub>DRM</sub> = 800 V(pk)                                                                                       |      |                                    | ---    | 4          | mA(pk)      |
| 2N3103                                                        |             | V <sub>DRM</sub> = 1000 V(pk)                                                                                      |      |                                    | ---    | 4          | mA(pk)      |
| 2N3105                                                        |             | V <sub>DRM</sub> = 1200 V(pk)                                                                                      |      |                                    | ---    | 4          | mA(pk)      |
| 2N3106                                                        |             | V <sub>DRM</sub> = 1300 V(pk)                                                                                      |      |                                    | ---    | 4          | mA(pk)      |
| <u>Subgroup 2</u>                                             |             |                                                                                                                    |      |                                    |        |            |             |
| Low temperature reverse blocking current                      | 4211        | T <sub>C</sub> = -40° ±3°C.<br>AC method, bias condition D<br>f = 60 Hz                                            | 10   | I <sub>RRM</sub>                   |        |            |             |
| 2N3091                                                        |             | V <sub>RRM</sub> = 600 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3093                                                        |             | V <sub>RRM</sub> = 800 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3095                                                        |             | V <sub>RRM</sub> = 1000 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3097                                                        |             | V <sub>RRM</sub> = 1200 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3098                                                        |             | V <sub>RRM</sub> = 1300 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3099                                                        |             | V <sub>RRM</sub> = 600 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3101                                                        |             | V <sub>RRM</sub> = 800 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3103                                                        |             | V <sub>RRM</sub> = 1000 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3105                                                        |             | V <sub>RRM</sub> = 1200 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3106                                                        |             | V <sub>RRM</sub> = 1300 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| Low temperature forward blocking current                      | 4206        | T <sub>C</sub> = -40° ±3°C<br>AC method, bias condition D<br>f = 60 Hz                                             |      | I <sub>DRM</sub>                   |        |            |             |
| 2N3091                                                        |             | V <sub>DRM</sub> = 600 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3093                                                        |             | V <sub>DRM</sub> = 800 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3095                                                        |             | V <sub>DRM</sub> = 1000 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3097                                                        |             | V <sub>DRM</sub> = 1200 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3098                                                        |             | V <sub>DRM</sub> = 1300 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3099                                                        |             | V <sub>DRM</sub> = 600 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3101                                                        |             | V <sub>DRM</sub> = 800 V(pk)                                                                                       |      |                                    | ---    | 2          | mA(pk)      |
| 2N3103                                                        |             | V <sub>DRM</sub> = 1000 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3105                                                        |             | V <sub>DRM</sub> = 1200 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| 2N3106                                                        |             | V <sub>DRM</sub> = 1300 V(pk)                                                                                      |      |                                    | ---    | 2          | mA(pk)      |
| Low temperature gate trigger voltage and gate trigger current | 4221        | R <sub>L</sub> = 10 ohms max<br>R <sub>E</sub> = 20 ohms<br>V <sub>2</sub> = 6.0 Vdc<br>T <sub>C</sub> = -40° ±3°C |      | V <sub>GT</sub><br>I <sub>GT</sub> | ---    | 3.0<br>130 | Vdc<br>mAdc |
| End points (Same as subgroup 1)                               |             |                                                                                                                    |      |                                    |        |            |             |

TABLE II. Group B Inspection - Continued

| Examination or test                           | MIL-STD-750 |                                                                                                  | LTPD | Symbol               | Limits |             | Unit        |
|-----------------------------------------------|-------------|--------------------------------------------------------------------------------------------------|------|----------------------|--------|-------------|-------------|
|                                               | Method      | Details                                                                                          |      |                      | Min    | Max         |             |
| <u>Subgroup 3</u>                             |             |                                                                                                  | 20   |                      |        |             |             |
| Thermal shock (temperature cycling)           | 1051        | Test condition B, except<br>$T_{min} = -40^{\circ}\text{C}$                                      |      |                      |        |             |             |
| Thermal shock (glass strain)                  | 1056        | Test condition A                                                                                 |      |                      |        |             |             |
| Hermetic seal                                 | 1071        | Test condition G or H for fine leaks<br>Test condition A, C, D, or E for gross leaks (see 4.4.2) |      |                      |        |             |             |
| End points (Same as subgroup 1)               |             |                                                                                                  | 10   |                      |        |             |             |
| <u>Subgroup 4</u>                             |             |                                                                                                  |      |                      |        |             |             |
| Biasing life (see 4.4.3)                      | ---         | $V_{DPM} = V_{DRM}$<br>$T_C = 123^{\circ} \pm 1.5^{\circ}\text{C}$<br>$t = 500$ hours            |      |                      |        |             |             |
| Gate trigger voltage and gate trigger current | 4221        | $V_G = 6.0\text{ Vdc}$<br>$R_G = 10\text{ ohms}$<br>$R_E = 20\text{ ohms}$                       |      | $V_{GT}$<br>$I_{GT}$ | ---    | 3.0<br>70.0 | Vdc<br>mAdc |
| On state voltage                              | 4226        | $I_{TM} = 220\text{ Adc}$<br>pulse width = 8.5 ms<br>duty cycle = 2% max                         |      | $V_{TM}$             |        | 1.7         | V(pk)       |
| End points (Same as subgroup 1)               |             |                                                                                                  |      |                      |        |             |             |

TABLE III. Group C Inspection.

| Examination or test                        | MIL-STD-750 |                                                               | LTPD | Symbol | Limits |     | Unit |
|--------------------------------------------|-------------|---------------------------------------------------------------|------|--------|--------|-----|------|
|                                            | Method      | Details                                                       |      |        | Min    | Max |      |
| <u>Subgroup 1</u>                          |             |                                                               | 20   |        |        |     |      |
| Physical dimensions                        | 2066        |                                                               |      |        |        |     |      |
| End points (Same as subgroup 1 of group A) |             |                                                               |      |        |        |     |      |
| <u>Subgroup 2</u>                          |             |                                                               | 20   |        |        |     |      |
| Shock                                      | 2016        | Nonoperating, 5 blows each<br>$Y_1, Y_2, Z_1$<br>500 g 1.0 ms |      |        |        |     |      |
| Vibration fatigue                          | 2046        | Nonoperating, 5 g (Leads secured or removed)                  |      |        |        |     |      |
| Vibration, variable frequency              | 2056        | 5 g, 100 to 1000 Hz (Leads secured or removed)                |      |        |        |     |      |
| Constant acceleration                      | 2006        | 2500 g<br>$Y_1, Y_2, Z_1$ (Leads secured or removed)          |      |        |        |     |      |
| End points (Same as subgroup 1 of group B) |             |                                                               |      |        |        |     |      |
| <u>Subgroup 3</u>                          |             |                                                               | 20   |        |        |     |      |
| Barometric pressure (reduced)              | 1001        | 15 mmHg<br>$V_{RRW}$ (see 1.4), 60 seconds                    |      |        |        |     |      |
| Salt spray (corrosion)                     | 1046        | Test condition A                                              |      |        |        |     |      |
| Terminal strength (Stud torque)            | 2036        | 150 lb-in<br>15 seconds<br>Test condition D2                  |      |        |        |     |      |
| End points (Same as subgroup 1 of group C) |             |                                                               |      |        |        |     |      |
| <u>Subgroup 4</u>                          |             |                                                               | 120  |        |        |     |      |
| Intermittent life                          | ---         | 50 min on, 10 min off (See 4.4.1)                             |      |        |        |     |      |
| End points (Same as subgroup 1 of group B) |             |                                                               |      |        |        |     |      |

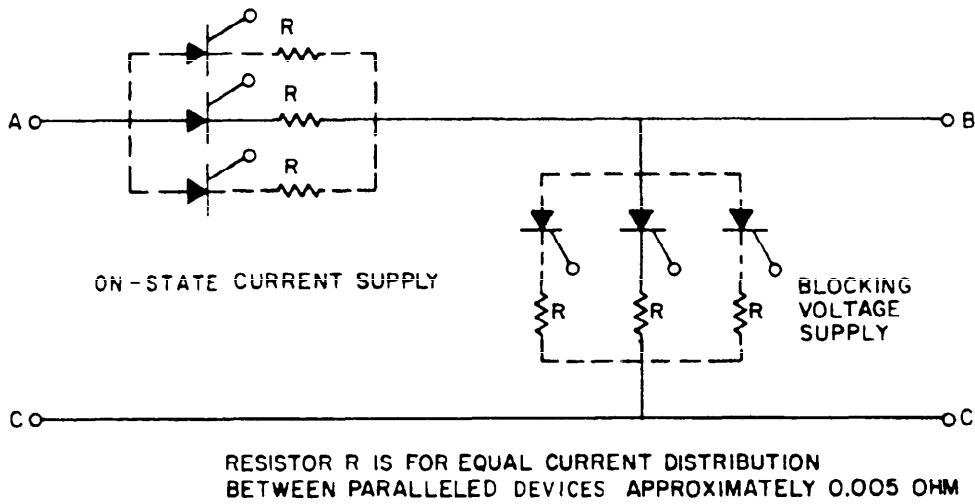
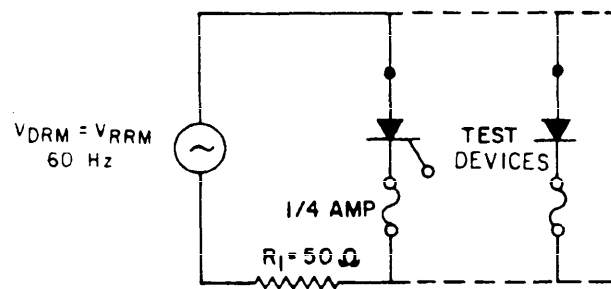


FIGURE 4. Basic test circuit for intermittent life test.



NOTE: A .25 amp fuse shall also be connected in series with each device to serve as an indicator of device voltage breakdown. Failure shall be indicated by either a blown fuse or failure to meet the specified end point test limits. The equipment shall be designed to limit peak transient voltage values to the device voltage rating ( $V_{DRM} = V_{RRM}$ ).

FIGURE 5. Basic circuit for blocking life test.

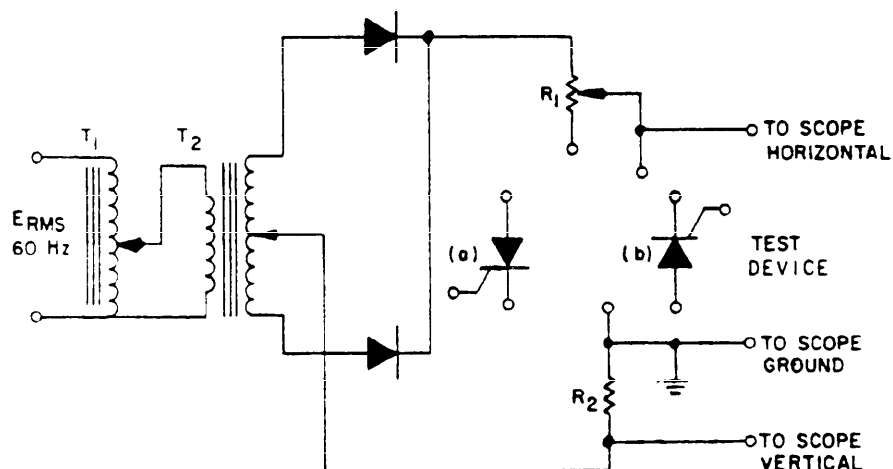


FIGURE 6. Breakover (a) and reverse breakdown (b) tester.

4.4.6 Ambient temperature. Where tests are specified at ambient temperature, sufficient time shall be allowed for the device case temperature to stabilize at the specified ambient temperature before measurements are taken.

## 5. PACKAGING

5.1 Packaging requirements The requirements for packaging shall be in accordance with MIL-S-19500.

## 6. NOTES

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodian:  
Navy - EC

User activities:  
Navy - AS, OS, MC, CG, SH

Preparing activity:  
Navy - EC

Agent:  
DLA - ES

(Project 5961-0649)

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