

The documentation and process conversion measures necessary to comply with this revision shall be completed by 19 October 2002.

INCH-POUND

MIL-PRF-19500/287F
 19 July 2002
 SUPERSEDING
 MIL-PRF-19500/287E
 27 June 1999

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN SILICON, SWITCHING
 TYPE 2N3013
 JAN AND JANTX

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

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon switching transistors. Two levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (similar to T0- 52).

1.3 Maximum ratings.

Types	P_T (1) $T_A = +25^\circ\text{C}$	P_T (2) $T_C = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	I_C	I_C	T_{STG} and T_{OP}
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C</u>
2N3013	0.36	1.2	40	20	5.0	300	-65 to +200

- (1) Derate linearly, 2.10 mW/°C for $T_A = 25^\circ\text{C}$.
 (2) Derate linearly, 6.86 mW/°C for $T_A = 25^\circ\text{C}$.

1.4 Primary electrical characteristics at $T_A = +25^\circ\text{C}$.

Limit	h_{FE1} (1) $V_{CE} = 0.4 \text{ V dc}$ $I_C = 30 \text{ mA dc}$	$V_{CE(sat)1}$ (1) $I_C = 30 \text{ mA dc}$ $I_B = 3.0 \text{ mA dc}$	$V_{BE(sat)2}$ (1) $I_C = 30 \text{ mA dc}$ $I_B = 3.0 \text{ mA dc}$	t_{on} $I_C = 300 \text{ mA dc}$ $I_{B1} = 30 \text{ mA dc}$ $V_{CC} = 15 \text{ V dc}$	t_{off} $I_C = 300 \text{ mA dc}$ $I_{B1} = 30 \text{ mA dc}$ $I_{B2} = 30 \text{ mA dc}$	$ h_{fe} $ $V_{CE} = 10 \text{ V dc}$ $I_C = 30 \text{ mA dc}$ $f = 100 \text{ MHz}$
		<u>V dc</u>	<u>V dc</u>	<u>ns</u>	<u>ns</u>	
Minimum	35	0.18	0.75	15	25	35
Maximum	120		0.95			12

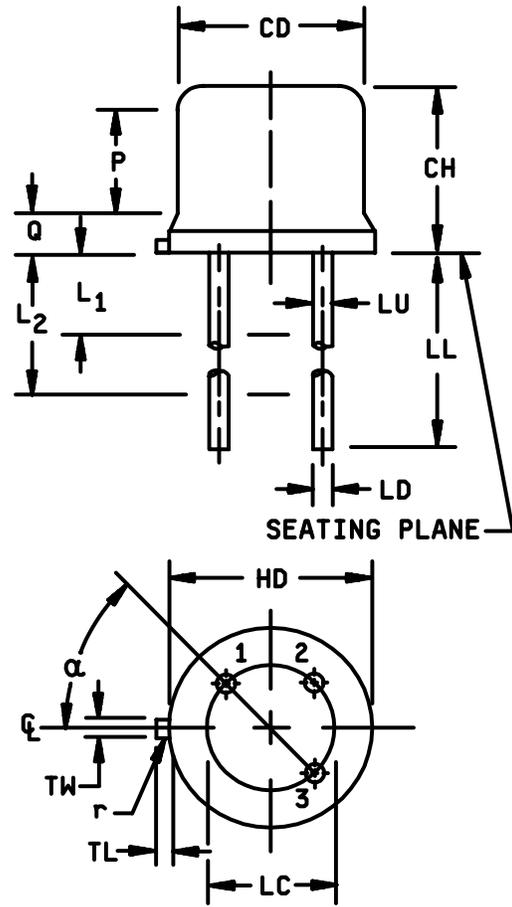
(1) Pulsed (see 4.5.1).

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

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FSC 5961

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7,8
LL	.500	.750	12.7	19.05	7,8,13
LU	.016	.019	0.41	0.48	7,8
L1		.050		1.27	7,8
L2	.250		6.35		7,8
P	.100		2.54		
Q		.030		0.76	5
TL	.028	.048	0.71	1.22	3,4
TW	.036	.046	0.91	1.17	3
r		.010		0.25	10
α	45° TP		45° TP		6



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, TL shall be held for a minimum length of .011 inch (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC.
7. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
8. All three leads.
9. The collector shall be electrically connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕ x symbology.
12. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

* FIGURE 1. Physical dimensions (similar to TO-52).

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARD

DEPARTMENT OF DEFENSE

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

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

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

3. REQUIREMENTS

* 3.1 General. The requirements for acquiring the product described herein shall consist of this document and MIL-PRF-19500.

* 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.

* 3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1.

* 3.4.1 Lead finish. Lead finish shall be solderable as defined in 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).

* 3.5 Marking. Devices shall be marked in accordance with MIL-PRF-19500. At the option of the manufacturer, the marking of the country of origin may be omitted from the body of the transistor.

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

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

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

4. VERIFICATION

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

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

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

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

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

Screen (see table IV of MIL-PRF-19500)	Measurement
	JANTX levels
3	Thermal impedance, method 3131 of MIL-STD-750
9	Not applicable
11	I_{CES1} and h_{FE1}
12	See 4.3.1
13	Subgroup 2 of table I herein, $\Delta I_{CES1} = 100$ percent of initial value or 50 nA dc, whichever is greater. $\Delta h_{FE1} = \pm 20$ percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: 2N3013 $V_{CB} \geq 10$ V dc, $P_T = 360$ mW at $T_A = +25^\circ \pm 3^\circ\text{C}$. NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. Group A inspection shall be performed on each subplot.

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

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified in 4.4.2.1 for JAN and JANTX group B testing. Electrical measurements (end-points) and delta requirements for JAN and JANTX shall be after each step in 4.4.2.1 and shall be in accordance with group A, subgroup 2 and table II herein.

* 4.4.2.1 Group B inspection, JAN and JANTX. Separate samples may be used for each step. In the event of a group B failure, the manufacturer may pull a new sample at double size from either the failed assembly lot or from another assembly lot from the same wafer lot. If the new "assembly lot" option is exercised, the failed assembly lot shall be scrapped.

<u>Step</u>	<u>Method</u>	<u>Condition</u>
1	1039	Steady-state life: Test condition B, 340 hours minimum, $V_{CB} = 10 - 30$ V dc, power shall be applied to achieve $T_J = +150^\circ\text{C}$ minimum using a minimum of $P_D = 75$ percent of maximum rated P_T as defined in 1.3. $n = 45$ devices, $c = 0$.
2	1039	The steady-state life test of step 1 shall be extended to 1,000 hours for each die design. Samples shall be selected from a wafer lot every twelve months of wafer production. Group B, step 2 shall not be required more than once for any single wafer lot. $n = 45$, $c = 0$.
3	1032	High-temperature life (non-operating), $t = 340$ hours, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$.

* 4.4.2.2 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

- For JAN and JANTX, samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. See MIL-PRF-19500.
- Must be chosen from an inspection lot that has been submitted to and passed group A, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (group B for JAN and JANTX) may be pulled prior to the application of final lead finish.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	1056	Thermal shock, test condition A.
C2	2036	Terminal strength, test condition E.

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

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

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

5. PACKAGING

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

MIL-PRF-19500/287F

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown to voltage, collector to base	3001	Bias condition D, $I_C = 100 \mu\text{A dc}$	$V_{(BR)CBO}$	40		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D, $I_C = 10 \text{ mA dc}$ pulsed (see 4.5.1)	$V_{(BR)CEO}$	20		V dc
Breakdown voltage, collector to emitter	3011	Bias condition C, $I_C = 100 \mu\text{A dc}$	$V_{(BR)CES}$	40		V dc
Breakdown voltage emitter to base	3026	Bias condition D, $I_E = 100 \mu\text{A dc}$	$V_{(BR)EBO}$	5		V dc
Collector to emitter cutoff current	3041	Bias condition C, $V_{CE} = 20 \text{ V dc}$ $V_{BE} = 0$	I_{CES1}		300	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 0.4 \text{ V dc}$; $I_C = 30 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE1}	35	120	
Forward-current transfer ratio	3076	$V_{CE} = 0.5 \text{ V dc}$; $I_C = 100 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE2}	30		
Forward-current transfer ratio	3076	$V_{CE} = 1.0 \text{ V dc}$; $I_C = 300 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE3}	15		
Collector to emitter voltage (saturated)	3071	$I_C = 30 \text{ mA dc}$; $I_B = 3.0 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.18	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 100 \text{ mA dc}$; $I_B = 10 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.28	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 300 \text{ mA dc}$; $I_B = 30 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(sat)3}$		0.50	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 30 \text{ mA dc}$; $I_B = 10 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)1}$	0.75	0.95	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 100 \text{ mA dc}$; $I_B = 10 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)2}$		1.20	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 300 \text{ mA dc}$; $I_B = 30 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)3}$		1.70	V dc

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 3</u>						
High-temperature operation:		$T_A = +125^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition D, $V_{CB} = 20\text{ V dc}$ $V_{BE} = 0$	I_{CES2}		40	$\mu\text{A dc}$
Collector to emitter voltage (saturated)	3071	$I_C = 30\text{ mA dc}$; $I_B = 3.0\text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(sat)4}$		0.25	V dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 0.4\text{ V dc}$; $I_C = 30\text{ mA dc}$ pulsed (see 4.5.1)	h_{FE4}	15		
<u>Subgroup 4</u>						
Open circuit output capacitance	3236	$V_{CB} = 5\text{ V dc}$; $I_E = 0$; $f = 140\text{ kHz}$	C_{obo}		5	pF
Input capacitance (output open-circuited)	3240	$V_{EB} = 0.5\text{ V dc}$; $I_C = 0$; $f = 140\text{ kHz}$	C_{ibo}		8	pF
Magnitude of common emitter, small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 10\text{ V dc}$; $I_C = 30\text{ mA dc}$; $f = 100\text{ MHz}$	$ h_{FE} $	3.5	12	
Saturated turn-on time	3251	$I_C = 300\text{ mA dc}$; $I_B = 30\text{ mA dc}$; $V_{CC} = 15\text{ V dc}$; (see figure 2); Test condition A	t_{on}		15	ns
Saturated turn-off time	3251	$I_C = 300\text{ mA dc}$; $I_{B1} = I_{B2} = 30\text{ mA dc}$; $V_{CC} = 15\text{ V dc}$; (see figure 2); Test condition A	t_{off}		25	ns
Storage time	3251	Test condition A; $I_C = 10\text{ mA dc}$; $I_{B1} = I_{B2} = -10\text{ mA dc}$ (see figure 3)	t_s		18	ns
<u>Subgroups 5, 6, and 7</u>						
Not applicable						

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

* TABLE II. Groups B and C delta measurements.

Step	Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	$V_{CE} = 0.4 \text{ V dc};$ $I_C = 30 \text{ mA dc}$ pulsed (see 4.5.1)	Δh_{FE1}	±25 percent change from initial value.		

1/ The delta measurements for 4.4.2 herein (JAN and JANTX) are as follows: Subgroups 3 and 6, see table II herein.

2/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, see table II herein.

MIL-PRF-19500/287F

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

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles	
Hermetic seal	1071		
Fine leak			
Gross leak			
Electrical measurements		See group A, subgroup 2 and table II herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	V _{CB} = 10 V dc, 6000 cycles	
Electrical measurements		See group A, subgroup 2 and table II herein.	
<u>Subgroups 3, 4, 5, 6, and 7</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V, condition B for devices < 400 V.	

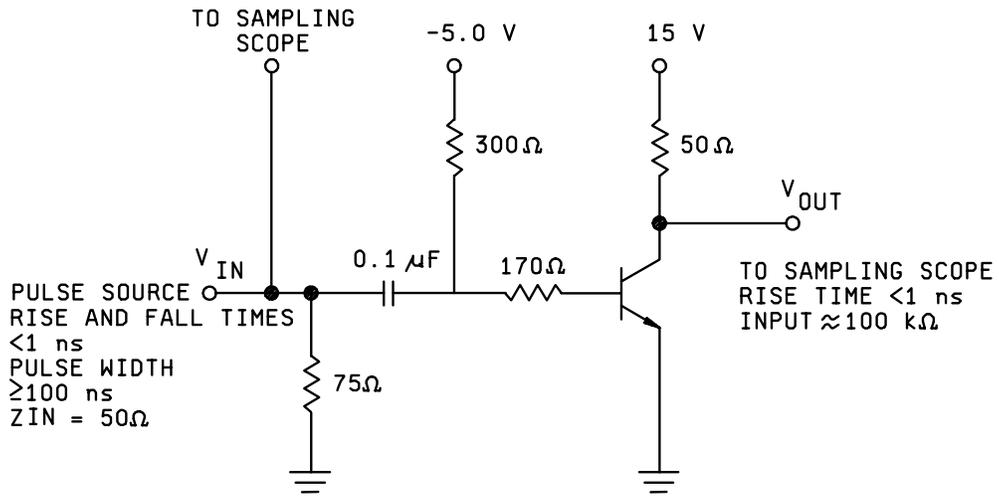


FIGURE 2. T_{on} and T_{off} test circuit.

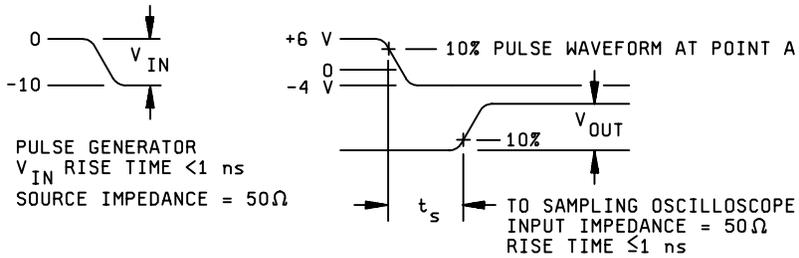
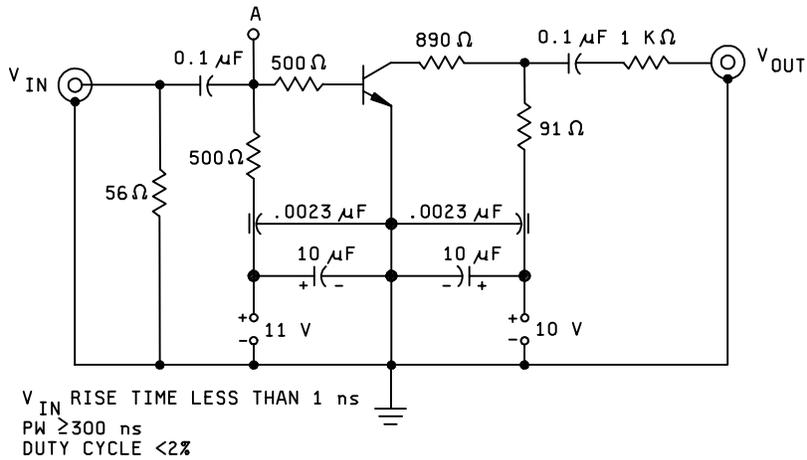


FIGURE 3. Charge storage time test circuit.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

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

* 6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2).
- c. Packaging requirements (see 5.1).
- d. Lead formation and finish may be specified (see 3.4.1).
- e. Type designation and product assurance level.

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

6.4 Supersession information. Devices covered by this specification supersedes the manufacturers' and users' Part or Identifying Number (PIN). This information in no way implies that manufacturers' PIN's are suitable as a substitute for the military PIN.

Military PIN	Manufacturers' CAGE code	Manufacturers' and users' PIN
2N3013	04713	SS5623H ST1334H SUN0520H1 SUN1015H SUN1051H1

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

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

Preparing activity:
DLA - CC

(Project 5961-2622)

Review activities:
Army - MI, SM
Navy - AS, MC, OS, SH
Air Force - 13, 19, 70, 71, 99

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE
	MIL-PRF-19500/287F	19 July 2002

3. **DOCUMENT TITLE** SEMICONDUCTOR DEVICE, TRANSISTOR, NPN SILICON, SWITCHING TYPE 2N3013 JAN AND JANTX

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

5. **REASON FOR RECOMMENDATION**

6. **SUBMITTER**

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) COMMERCIAL DSN FAX EMAIL	7. DATE SUBMITTED

8. **PREPARING ACTIVITY**

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c. ADDRESS Defense Supply Center Columbus ATTN: DSCC-VAC P.O. Box 3990 Columbus, OH 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533 Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888