The documentation and process conversion measures necessary to comply with this document shall be completed by 8 August 2008.

INCH-POUND

MIL-PRF-19500/287G
8 May 2008
SUPERSEDING
MIL-PRF-19500/287F
19 July 2002

PERFORMANCE SPECIFICATION SHEET

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.

* 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 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 TO-52).

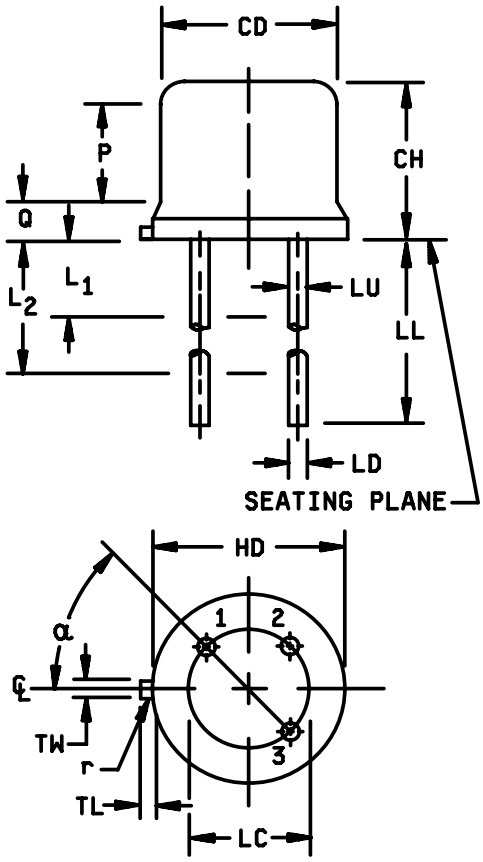
* 1.3 Maximum ratings. Unless otherwise specified, T_A = +25°C.

Types	P_T (1) T_A = +25°C	P_T (2) T_C = +25°C	V_{CBO}	V_{CEO}	I_C	I_C	$R_{\theta JA}$	$R_{\theta JC}$	T_{STG} and T_{OP}
	W	W	V dc	V dc	V dc	mA dc	°C/W	°C/W	°C
2N3013	0.36	1.2	40	20	5.0	300	476	146	-65 to +200

(1) Derate linearly, 2.10 mW/°C for T_A = 25°C.
(2) Derate linearly, 6.86 mW/°C for T_C = 25°C.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil .

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
L_1		.050		1.27	7,8
L_2	.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. Millimeters 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 L_1 and L_2. Dimension LD applies between L_2 and LL minimum. Diameter is uncontrolled in L_1 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 ASME Y14.5M, diameters are equivalent to ϕx symbology.
12. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

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

1.4 Primary electrical characteristics at T_A = +25°C.

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

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

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

DEPARTMENT OF DEFENSE STANDARDS

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

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

2.3 Order of precedence. 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 manufacturers list 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. The interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 herein.

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).

3.5 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 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 (see table E-IV of MIL-PRF-19500)	Measurement JANTX levels
(1) 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, ΔI_{CES1} = 100 percent of initial value or 50 nA dc, whichever is greater. Δh_{FE1} = ±20 percent of initial value.

(1) Shall be performed anytime after temperature cycling, screen 3a; and does not need to be repeated in screening requirements.

* 4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: V_{CB} = 10 - 30 V dc. Power shall be applied to achieve T_J = +135°C minimum using a minimum P_D = 75 percent of P_T maximum rated as defined in 1.3. With approval of the qualifying activity and preparing activity, alternate burn-in criteria (hours, bias conditions, T_J, and mounting conditions) may be used for JANTX quality levels. A justification demonstrating equivalence is required. In addition, the manufacturing site's burn-in data and performance history will be essential criteria for burn-in modification approval.

* 4.3.2 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining I_M, I_H, t_H, t_{SW} (V_C and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μs max. See table III, group E, subgroup 4 herein.

* 4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. If alternate screening is being performed in accordance with MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of subgroup 1 and 2, of table I herein, inspection only (table E-VIb, group B, subgroup 1 is not required to be performed since solderability and resistance to solvents testing is performed in table I herein.

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 table I, 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 lot failure, the resubmission requirements of MIL-PRF-19500 shall apply. In addition, all catastrophic failures during conformance inspection shall be analyzed to the extent possible to identify root cause and corrective action. Whenever a failure is identified as wafer lot and wafer processing related, the entire wafer lot and related devices assembled from the wafer lot shall be rejected unless an appropriate determined corrective action to eliminate the failure~~s~~ mode has been implemented and the devices from the wafer lot are screened to eliminate the failure mode.

Step	Method	Condition
1	1026	Steady-state life: 1,000 hours minimum, V_{CB} = 10 dc, power and ambient shall be applied to achieve T_J = +150°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. The sample size may be increased and the test time decreased as long as the devices are stressed for a total of 45,000 device hours minimum, and the actual time of test is at least 340 hours.
2	1048	Blocking life, T_A = +150°C, V_{CB} = 80 percent of rated voltage, 48 hours minimum. n = 45 devices, c = 0.
3	1032	High-temperature life (non-operating), t = 340 hours, T_A = +200°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:

a. 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.

b. Shall 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 E-VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

Subgroup	Method	Condition
C2	1056	Thermal shock, test condition A.
C2	2036	Terminal strength, test condition E.
C5	3131	$R_{\theta JA}$ and $R_{\theta JC}$ only (see 1.3).
C6		Not applicable.

* 4.4.3.1 Group C sample selection. Samples for steps in group C shall be chosen at random from any inspection lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes table I tests for conformance inspection. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

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.

* TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1 2/						
Visual and mechanical inspection 3/	2071	n = 45 devices, c = 0				
Solderability 3/ 4/	2026	n = 15 leads, c = 0				
Resistance to solvents 3/ 4/ 5/	1022	n = 15 devices, c = 0				
Temp cycling 3/ 4/	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal 4/ 6/ Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements 4/		Table I, subgroup 2				
Bond strength 3/ 4/	2037	Precondition T_A = +250°C at t = 24 hours or T_A = +300°C at t = 2 hours n = 11 wires, c = 0				
Decap internal visual (design verification) 4/	2075	n = 4 devices, c = 0				
Subgroup 2						
Breakdown to voltage, collector to base	3001	Bias condition D, I_C = 100 µA dc	$V_{(BR)CBO}$	40		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D, I_C = 10 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 µA dc	$V_{(BR)CES}$	40		V dc
Breakdown voltage emitter to base	3026	Bias condition D, I_E = 100 µA dc	$V_{(BR)EBO}$	5		V dc
Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 20 V dc V_{BE} = 0	I_{CES1}		300	nA dc
Forward-current transfer ratio	3076	V_{CE} = 0.4 V dc; I_C = 30 mA dc; pulsed (see 4.5.1)	h_{FE1}	35	120	
Forward-current transfer ratio	3076	V_{CE} = 0.5 V dc; I_C = 100 mA dc; pulsed (see 4.5.1)	h_{FE2}	30		
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 300 mA dc; pulsed (see 4.5.1)	h_{FE3}	15		
Collector to emitter voltage (saturated)	3071	I_C = 30 mA dc; I_B = 3.0 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.18	V dc

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Collector to emitter voltage (saturated)	3071	I_C = 100 mA dc; I_B = 10 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.28	V dc
Collector to emitter voltage (saturated)	3071	I_C = 300 mA dc; I_B = 30 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 mA dc; I_B = 10 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 mA dc; I_B = 10 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 mA dc; I_B = 30 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)3}$		1.70	V dc
Subgroup 3						
High-temperature operation:		T_A = +125°C				
Collector to emitter cutoff current	3041	Bias condition D, V_{CB} = 20 V dc V_{BE} = 0	I_{CES2}		40	µA dc
Collector to emitter voltage (saturated)	3071	I_C = 30 mA dc; I_B = 3.0 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)4}$		0.25	V dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 0.4 V dc; I_C = 30 mA dc pulsed (see 4.5.1)	h_{FE4}	15		
Subgroup 4						
Open circuit output capacitance	3236	V_{CB} = 5 V dc; I_E = 0; f = 140 kHz	C_{obo}		5	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; f = 140 kHz	C_{ibo}		8	pF
Magnitude of common emitter, small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 30 mA dc; f = 100 MHz	$\|h_{FE}\|$	3.5	12	
Saturated turn-on time	3251	I_C = 300 mA dc; I_B = 30 mA dc; V_{CC} = 15 V dc; (see figure 2); test condition A	t_{on}		15	ns

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued						
Saturated turn-off time	3251	I_C = 300 mA dc; I_{B1} = I_{B2} = 30 mA dc; V_{CC} = 15 V dc; (see figure 2); test condition A	t_{off}		25	ns
Storage time	3251	Test condition A; I_C = 10 mA dc; I_{B1} = I_{B2} = -10 mA dc (see figure 3)	t_s		18	ns
Subgroups 5, 6, and 7						
Not applicable						

1/ For sampling plan see MIL-PRF-19500.
2/ For resubmission of failed test subgroup of table I, double the sample size of the failed test or sequence of tests. A failure in table I, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.
3/ Separate samples may be used.
4/ Not required for JANS devices.
5/ Not required for laser marked devices.
6/ This hermetic seal test is an end-point to temp-cycling in addition to electrical measurements.

TABLE II. Groups B and C delta measurements.

Step	Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	V_{CE} = 0.4 V dc; I_C = 30 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 E-VII of MIL-PRF-19500 are as follows: Subgroup 6, see table II herein.

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

Inspection	MIL-STD-750		Qualification
	Method	Condition	
Subgroup 1			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 table I, subgroup 2 and table II herein.	
Subgroup 2			45 devices c = 0
Intermittent life	1037	V_{CB} = 10 V dc, 6,000 cycles. Adjust device current, or power to achieve a minimum ΔT_J of 100°C.	
Electrical measurements		See group A, subgroup 2 and table II herein.	
Subgroups 3			
Not applicable			
Subgroup 4			
Thermal impedance curves		See MIL-PRF-19500, table E-IX, group E, subgroup 4.	
Subgroup 5, 6, and 7			
Not applicable			
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition B.	

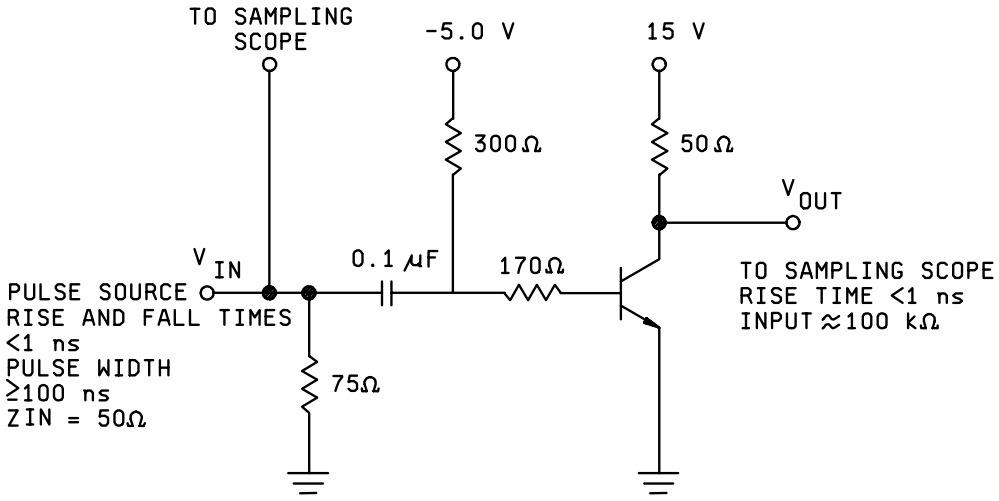


FIGURE 2. T_{on} and T_{off} test circuit.

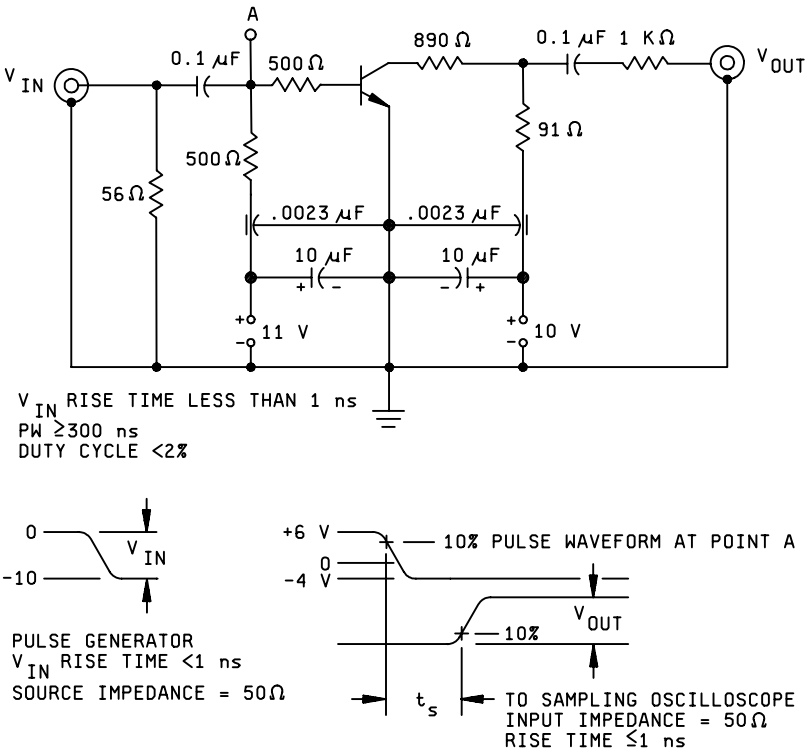


FIGURE 3. Charge storage time test circuit.

* 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. Product assurance level and type designator.

* 6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at http://assist.daps.dla.mil .

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

Review activities:
Army - MI, SM
Navy - AS, OS, SH

Preparing activity:
DLA - CC

(Project 5961-2008-036)

* NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil/ .