The documentation and process conversion measures necessary to comply with this revision shall be completed by 20 May 2001.

INCH-POUND

MIL-PRF-19500/312D
20 February 2001
SUPERSEDING
MIL-S-19500/312C
1 August 1992

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING
TYPE 2N708, JAN, JANTX, AND JANHC

Inactive for new design after 7 June 1999.

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 detail requirements for NPN silicon switching transistors. Two levels of product assurance are provided for the device type as specified in MIL-PRF-19500. One level of product assurance is provided for die.

1.2 Physical dimensions. See figure 1 (T0-18) and figure 2 (die).

1.3 Maximum ratings.

P_T (1) T_A = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	V_{CER} $R_{BE} \leq 10$ ohms	T_{op} and T_{STG}
W	V dc	V dc	V dc	V dc	°C
0.5	40	15	5.0	20	-65 to +200

(1) Derate linearly 3.08 mW/°C above T_A = +37.5°C.

1.4 Primary electrical characteristics.

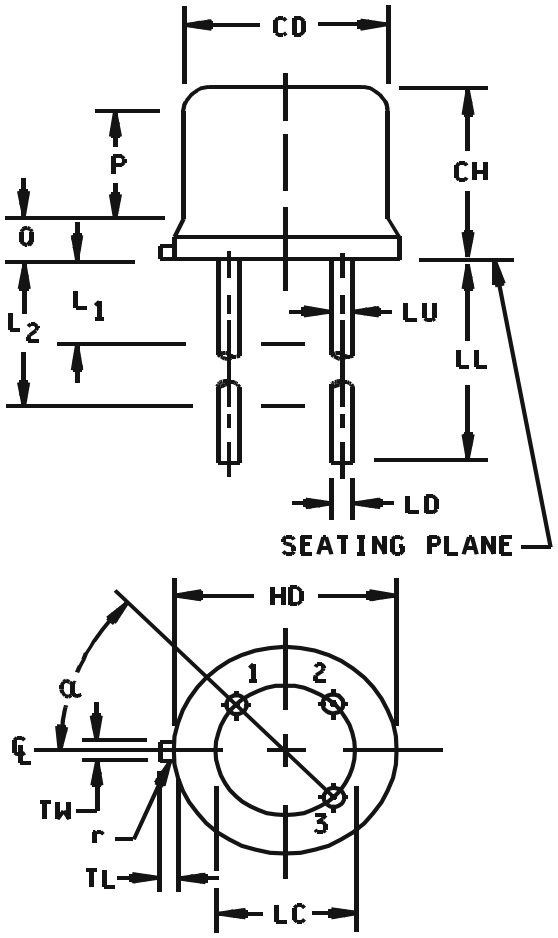
Limits	h_{FE2} (1)	$V_{CE(SAT)1}$	$V_{BE(SAT)1}$	t_{on}	t_{off}	$\|h_{fe}\|$
	V_{CE} = 1.0 V dc I_C = 10 mA dc	I_C = 10 mA dc I_B = 1.0 mA dc	I_C = 10 mA dc I_B = 1.0 mA dc	$I_C \approx$ 10 mA dc $I_{B1} \approx$ 3 mA dc $V_{BE} \approx$ 2 V dc	$I_C \approx$ 10 mA dc $I_{B1} \approx$ 3 mA dc $I_{B2} \approx$ 1 mA dc	V_{CE} = 10 V dc I_C = 10 mA dc f = 100 MHz
		V dc	V dc	ns	ns	
Min	40		0.72			3.0
Max	120	0.4	0.80	40	75	9.0

(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, Post Office Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

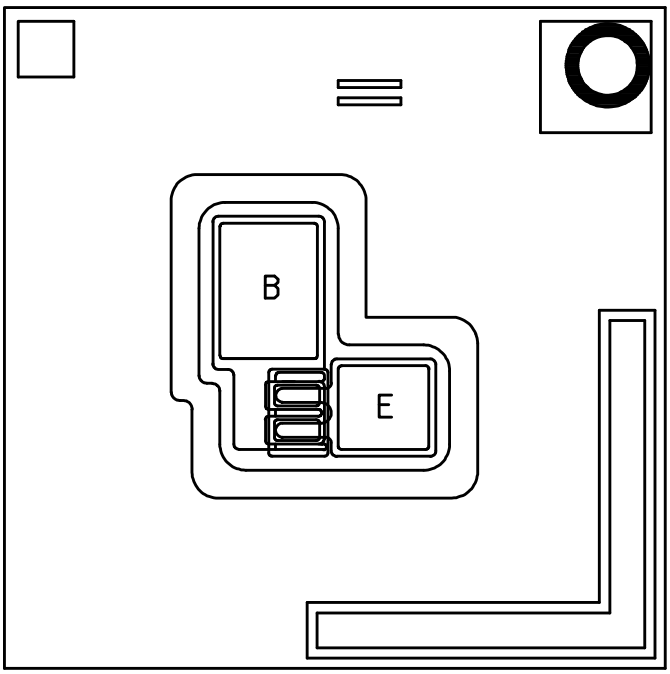
AMSC N/A FSC 5961
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Ltr	Dimensions				Notes
	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		5
LD	---	.021	---	0.53	3, 8
LL	.500	---	12.70	---	8, 9
LU	.016	.019	0.41	0.48	3, 8, 9
L1	---	.050	---	1.27	9
L2	.250	---		---	9
Q	---	.040	---	0.86	4
TL	.028	.048	0.71	1.22	7
TW	.036	.046	0.91	1.17	
r	45° TP		45° TP		



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 inch (6.35 mm) from the seating plane.
4. Details of outline in this zone are optional.
5. When measured in a gauging plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 inch (0.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance.
6. The collector shall be internally connected to the case.
7. Measured from the maximum diameter of the actual device.
8. All 3 leads.
9. Symbol LU applies between L1 and L2. Dimension LD applies between L2 and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L1 and beyond LL minimum.
10. Lead 1 = emitter, lead 2 = base, lead 3 = collector.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions.



NOTES:

1. Chip size: 20 x 20 mils, ± 2 mils.
2. Chip thickness: 10 mils, ± 1.5 mils nominal.
3. Top metal: Aluminum 10,000 Å min, 12,000 Å nominal.
4. Back metal:
   a. Al/Ti/Ni/Ag 12 kÅ/ 3 kÅ/ 7 kÅ/ 7 kÅ min., 15 kÅ/ 5 kÅ/ 10 kÅ/ 10 kÅ.
   b. Gold 2,500 Å minimum, 3,000 Å nominal.
   c. Eutectic mount - no gold.
5. Backside: Collector.
6. Chip size: B = 4 X 4.5 mils, E = 4.5 X 5 mils.

FIGURE 2. JANHC (A-version) die dimensions.

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 (T0-18) and figure 2 (die).

3.4.1 Lead finish. Unless otherwise specified, 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. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking of the country of origin may be omitted from the body of the transistor, but shall be retained on the initial container.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3.

3.7 Electrical test requirements. The electrical test requirements shall be group A as specified herein.

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

a. Qualification inspection (see 4.2).

b. Screening (see 4.3).

c. Conformance inspection (see 4.4).

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

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

Screen (see table IV of MIL-PRF-19500)	Measurement JANTX level
11	I_{CBO1} and h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein; I_{CBO1} = 100 percent of initial value or 10 nA dc, whichever is greater; h_{FE1} = ±15 percent of initial value.

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 and a minimum power dissipation = 75 percent of maximum rated P_T (see 1.3). NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.3.2 Screening (JANHC). Screening of JANHC die shall be in accordance with MIL-PRF-19500. As a minimum, die shall be 100-percent probed to insure compliance with group A, subgroup 2.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

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

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIb (JAN and JANTX) of MIL-PRF-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2.1 Group B inspection, table VIb (JAN and JANTX) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	1027	V_{CB} = 12 V dc; T_A = room ambient as defined in the general requirements of MIL-STD-750. Power shall be applied to achieve T_J = +150°C minimum and a minimum power dissipation P_D = 75 percent of P_T maximum rated as defined in 1.3 herein. No heat sink or forced-air cooling on the devices shall be permitted.

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) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.3.1 Group C inspection (table VII of MIL-PRF-19500).

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1027	V_{CB} = 12 V dc; T_A = room ambient as defined in the general requirements of MIL-STD-750. Power shall be applied to achieve T_J = +150°C minimum and a minimum power dissipation P_D = 75 percent of P_T maximum rated as defined in 1.3 herein. No heat sink or forced-air cooling on devices shall be permitted.

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.

4.5.2 Real part of small-signal short-circuit input impedance. Test shall be conducted in accordance with method 3266 of MIL-STD-750 except that capacitor "c" as shown in the test circuit shall be removed and connected directly across the collector-emitter output.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage collector to base	3001	Bias condition D; I_C = 1.0 μA dc	$V_{(BR)CEO}$	40		V dc
Breakdown to voltage emitter to base	3026	Bias condition D; I_E = 10 μA dc	$V_{(BR)EBO}$	5.0		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D; I_C = 10 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	15		V dc
Breakdown voltage, collector to emitter	3011	Bias condition B; I_C = 10 mA dc; $R_{BE} \leq$ 10 ohms; pulsed (see 4.5.1)	$V_{(BR)CER}$	20		V dc
Collector to base cutoff current	3036	Bias condition D; V_{CB} = 20 V dc	I_{CBO1}		25	nA dc
Emitter to base cutoff current	3061	Bias condition D; V_{EB} = 4 V dc	I_{EBO}		80	nA dc
Forward-current transfer ratio	3076	V_{CE} = 1 V dc; I_C = 0.5 mA dc	h_{FE1}	15		
Forward-current transfer ratio	3076	V_{CE} = 1 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE2}	40	120	
Saturation voltage (collector to emitter)	3071	I_C = 10 mA dc; I_B = 1 mA dc	$V_{CE(SAT)1}$		40	V dc
Base emitter voltage (saturated)	3066	Test condition A; I_C = 10 mA dc; I_B = 1 mA dc	$V_{BE(SAT)1}$	.72	.80	V dc
Base emitter voltage (saturated)	3066	Test condition A; I_C = 1 mA dc; I_B = 0.1 mA dc	$V_{BE(SAT)2}$		.72	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

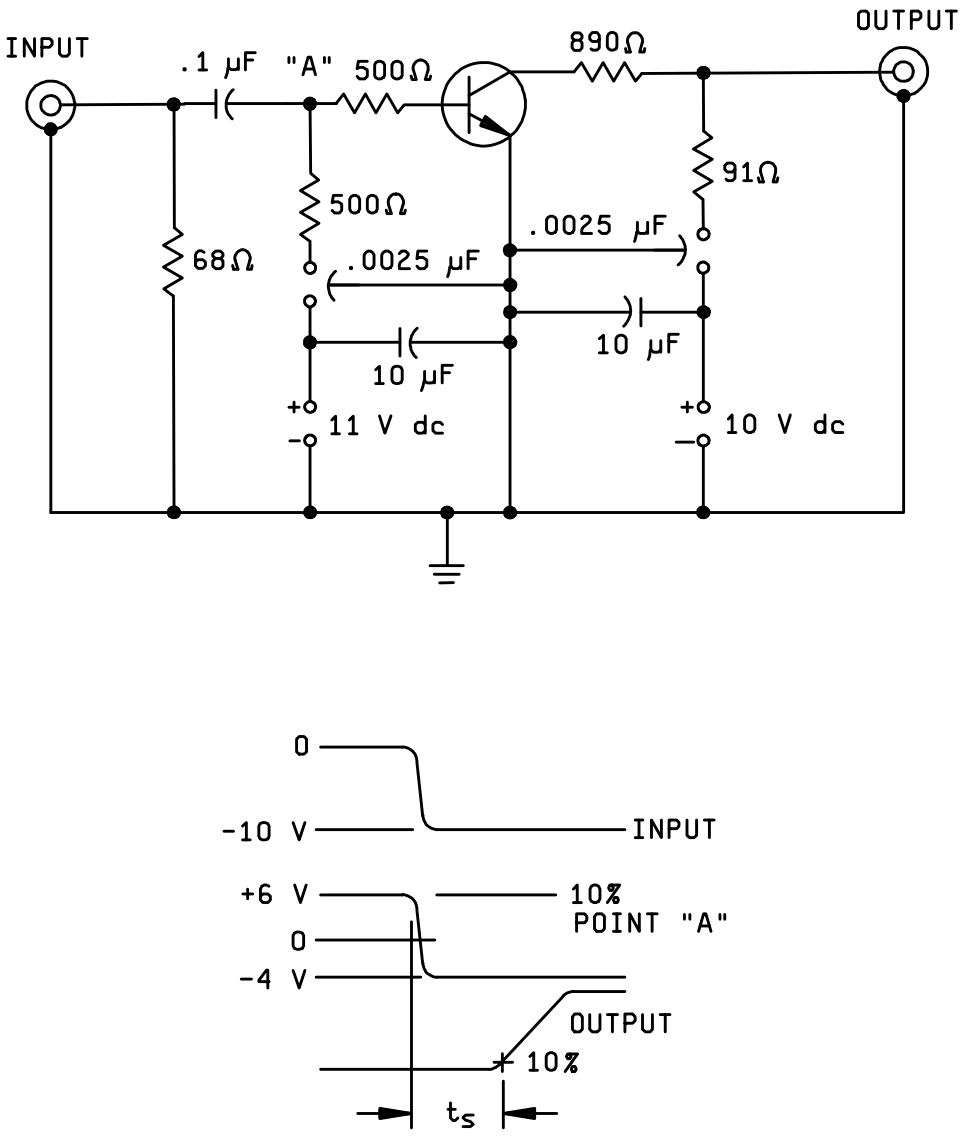
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D; V_{CB} = 20 V dc; T_A = +125°C	I_{CBO2}		15	µA dc
Collector to emitter cutoff current	3041	Bias condition A; V_{CE} = 20 V dc; V_{BE} = 0.25 V dc	I_{CEX}		10	µA dc
Saturation voltage (collector to emitter)	3071	I_C = 7 mA dc; I_B = 0.7 mA dc	$V_{CE(SAT)2}$		.40	V dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	2076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE2}	15		
Base emitter voltage (saturated)	3066	Test condition A; I_C = 7 mA dc; I_B = 0.7 mA dc	$V_{BE(SAT)3}$		.90	V dc
Subgroup 4						
Common emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 100 MHz	$\|h_{fe}\|$	3.0	9.0	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; f = 1 MHz	C_{obo}		6.0	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; f = 1 MHz	C_{ibo}		9.0	pF
Real part small-signal short-circuit input impedance	3266	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 300 MHz (see 4.5.2)	RE_{hie}		50	Ω
Charge storage time		$I_C = I_{B1} = -I_{B21}$ = 10 mA dc (see figure 3)	t_s		25	ns
Turn-on time		$I_C \approx$ 10 mA dc; $I_{B1} \approx$ 3 mA dc; $V_{BE}(0) \approx$ -2.0 V dc (see figure 4)	t_{on}		40	ns
Turn-off time		$I_C \approx$ 10 mA dc; $I_{B1} \approx$ 3 mA dc; $I_{B2} \approx$ -1 mA dc; (see figure 4)	t_{off}		75	ns
Subgroups 5, 6, and 7						
Not applicable						

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

TABLE II. Groups A, B, and C delta measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	Δh_{FE}	±25 percent change from initial value		

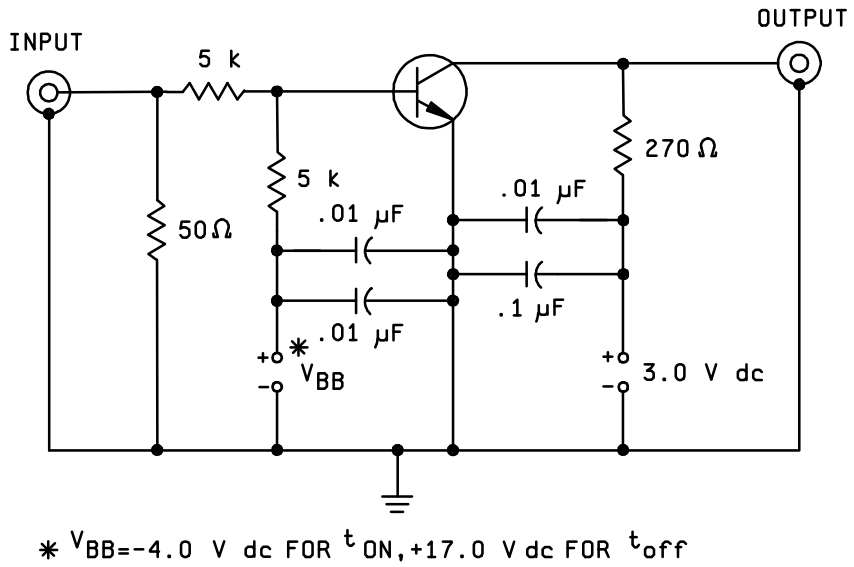
1/ The delta measurements for table VIb (JAN, JANTX) of MIL-PRF-19500 are as follows: Subgroups 3 and 6, step 1.
2/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, step 1.



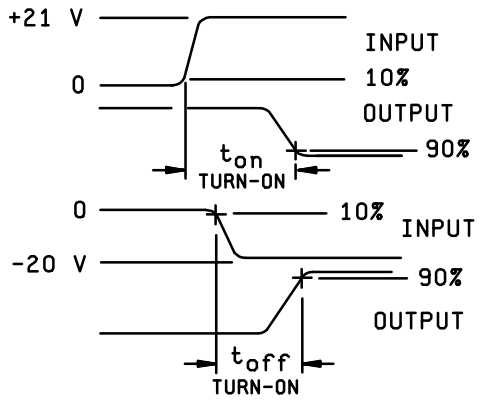
NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: Z_{out} = 50Ω, $t_r \leq 1$ ns, PW ≥ 300 ns, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on a sampling oscilloscope with the following characteristics: $Z_{in} \geq 100$ kΩ, $t_r \leq 1$ ns.

FIGURE 3. Charge storage time.



* V_{BB}=-4.0 V dc FOR t_{ON}, +17.0 V dc FOR t_{off}



VOLTAGE WAVEFORMS

NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: Z_{out} = 50Ω, $t_r \leq 1$ ns, PW ≥ 300 ns, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on a sampling oscilloscope with the following characteristics: $Z_{in} \geq 100$ kΩ, $t_r \leq 1$ ns.

FIGURE 4. Turn-on and turn-off 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 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 Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's 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.

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 herein (see 2.1).

c. Solder dip lead finish, if required (see 3.4.1).

d. Type designation and quality product assurance level.

e. Packaging requirements (see 5.1).

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

6.4 Suppliers of JANHC die. The qualified JANHC suppliers with the applicable letter version (example, JANHCA2N708) will be identified on the QML.

JANC ordering information	
PIN	Manufacturer
	43611
2N708	JANHCA2N708

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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

Review activities:
Army - AR, AV, MI, SM
Navy - AS, CG, MC, OS, SH
Air Force - 13, 19, 80

Preparing activity:
DLA - CC

(Project 5961-2338)

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.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/312D	2. DOCUMENT DATE 20 February 2001

3. **DOCUMENT TITLE**
SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING TYPE 2N708, JAN, JANTX, AND JANHC

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

a. Point of Contact Alan Barone	b. TELEPHONE Commercial DSN FAX EMAIL 614-692-0510 850-0510 614-692-6939 alan_barone@dscc.dla.mil
c. ADDRESS Defense Supply Center Columbus ATTN: DSCC-VAC Post Office 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