The documentation and process conversion measures necessary to comply with this revision shall be completed by 7 February 2004.

INCH-POUND

MIL-PRF-19500/622B
7 November 2003
SUPERSEDING
MIL-PRF-19500/622A
22 October 1997

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, HIGH-POWER
TYPE 2N7368 JAN, JANTX, JANTXV, AND JANS

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, high-power transistor. Four levels of product assurance are provided as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO - 254).

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

Type	P_T (1) T_C = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_J and T_{STG}	$R_{\theta JC}$ (2)
	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W
2N7368	115	80	80	7.0	4.0	10	-65 to +200	1.5

(1) See figure 2 for temperature-power derating curve.
(2) See figure 3, transient thermal impedance graph.

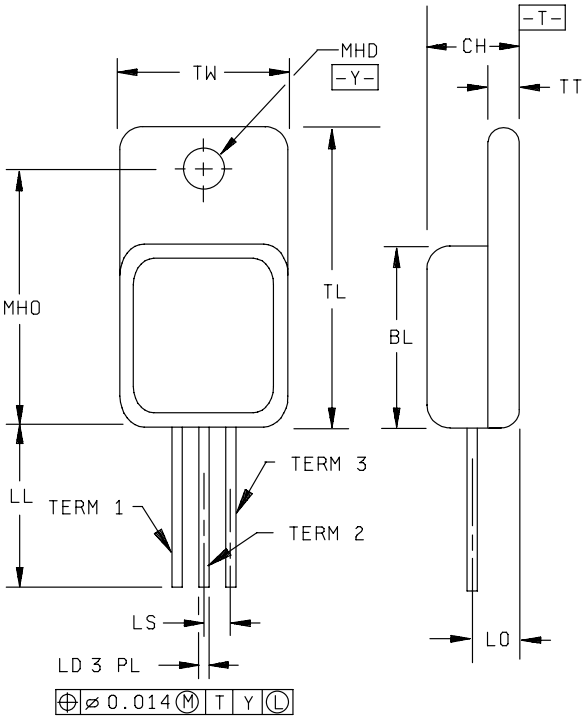
* 1.4 Primary electrical characteristics.

Limit	h_{FE2} (1)	$V_{BE(SAT)1}$ (1)	$V_{CE(SAT)1}$ (1)	C_{obo}	$\|h_{fe}\|$
	V_{CE} = 2.0 V dc I_C = 3.0 A dc	I_C = 5.0 A dc I_B = 0.5 A dc	I_C = 5.0 A dc I_B = 0.5 A dc	V_{CB} = 10 V dc I_E = 0 f = 100 kHz to 1 MHz	V_{CE} = 10 V dc I_C = 0.5 A dc f = 1 MHz
		V dc	V dc	pF	
Min	30				4.0
Max	140	1.5	1.0	500	20

(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



Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.535	.545	13.59	13.84
CH	.249	.260	6.32	6.60
LD	.035	.045	0.89	1.14
LL	.530	.550	13.46	13.97
LO	.150 BSC		3.81 BSC	
LS	.150 BSC		3.81 BSC	
MHD	.139	.149	3.53	3.78
MHO	.665	.685	16.89	17.40
TL	.790	.800	20.07	20.32
TT	.040	.050	1.02	1.27
TW	.535	.545	13.59	13.84
Term 1	Base			
Term 2	Collector			
Term 3	Emitter			

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. All terminals are isolated from case.
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 1. Dimensions and configuration (TO-254AA).

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 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 authorized by the qualifying activity for listing on the applicable qualified products 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 requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 herein. Methods used for electrical isolation of the terminal feedthroughs shall employ materials that contain a minimum of 90 percent AL_2O_3 (ceramic). Examples of such construction techniques are metallized ceramic eyelets or ceramic walled packages.

* 3.4.1 Lead formation and finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish or formation is desired, it shall be specified in the acquisition requirements (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14, of MIL-PRF-19500.

* 3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

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

* 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 II tests, the tests specified in table II herein shall be performed by the first inspection lot of this revision to maintain qualification.

* 4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with MIL-PRF-19500 (Appendix E, table IV), and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of

Screen (see appendix E, table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal impedance (see 4.3.2)	Thermal impedance (see 4.3.2)
9	I_{CES1} and h_{FE2}	Not applicable
11	Subgroup 2 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 10 μA dc, whichever is greater. Δh_{FE2} = ± 20 percent of initial value.	I_{CES1} and h_{FE2}
12	See 4.3.1	See 4.3.1
13	Subgroup 2 and 3 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 10 μA dc, whichever is greater. Δh_{FE2} = ± 20 percent of initial value.	Subgroup 2 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 10 μA dc, whichever is greater. Δh_{FE2} = ± 20 percent of initial value.

(1) May be performed anytime before screen 9.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

T_J = +175°C min, V_{CE} = 10-30 V dc, T_A = +30 ± 5°C.

* 4.3.2 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ 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_{MD} (and V_C where appropriate). The $Z_{\theta JX}$ limit used in screen 3c shall comply with the thermal impedance graph on figure 3 (less than or equal to the curve value at the same t_H time) and/or shall be less than the process determined statistical maximum limit as outlined in method 3131.

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 appendix E, table V of 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 appendix E, tables VIa and VIb of MIL-PRF-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

* 4.4.2.1 Group B inspection, appendix E, table VIa (JANS) of MIL-PRF-19500.

Subgroup	Method	Conditions
B4	1037	$V_{CB} \geq 10$ V dc, 2,000 cycles.
B5	2037	Bond strength, test condition A.
B6	3131	See 4.5.2.

* 4.4.2.2 Group B inspection, appendix E, table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Conditions
B3	1037	$V_{CB} \geq 10$ V dc, 2,000 cycles.
B5	3131	See 4.5.2.
B6	1032	$T_A = +200^{\circ}C$.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VII of MIL-PRF-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

Subgroup	Method	Conditions
C2	1056	Test condition B.
C2	2036	Test condition A, weight = 4.5 kg, t = 10 seconds.
C6	1037	$V_{CB} \geq 10$ V dc, 6,000 cycles.

* 4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IX of MIL-PRF-19500 and as specified in table II herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

4.5 Method 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 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with test method 3131 of MIL-STD-750. The following details shall apply:

a. Collector current magnitude during power application shall be 1.0 A dc.

b. Collector to emitter voltage magnitude shall be $\geq$ 10 V dc.

c. Reference temperature measuring point shall be the case.

d. Reference point temperature shall be $+25^{\circ}C \leq T_R \leq +75^{\circ}C$ and recorded before the test is started.

e. Mounting arrangement shall be with heat sink to header.

f. Maximum limit of $R_{\theta JC}$ shall be $1.5^{\circ}C/W$.

* 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						
Thermal impedance	3131	See 4.3.2	$Z_{\theta JC}$			°C/W
Collector - emitter breakdown voltage	3011	Bias condition D; I_C = 0.2 A dc; pulsed (see 4.5.1)	$V_{CEO(sus)}$	80		V dc
Emitter - base cutoff current	3061	Bias condition D; V_{EB} = 7 V dc	I_{EBO}		1.0	mA dc
Collector - emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc; V_{CE} = 80 V dc	I_{CEX1}		1.0	mA dc
Collector - emitter cutoff current	3041	Bias condition C; V_{CE} = 70 V dc	I_{CES1}		1.0	mA dc
Base - emitter saturated voltage	3066	Test condition A; I_C = 5 A dc; I_B = 0.5 A dc; pulsed (see 4.5.1)	$V_{BE(sat)1}$		1.5	V dc
Collector - emitter saturated voltage	3071	I_C = 5 A dc; I_B = 0.5 A dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		1.0	V dc
Forward - current transfer ratio	3076	V_{CE} = 2.0 V dc; I_C = 1.0 A dc; pulsed (see 4.5.1)	h_{FE1}	50	175	
Forward - current transfer ratio	3076	V_{CE} = 2.0 V dc; I_C = 3.0 A dc; pulsed (see 4.5.1)	h_{FE2}	30	140	
Subgroup 3						
High - temperature operation:		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition C; V_{CE} = 70 V dc	I_{CES2}		5.0	mA dc
Low - temperature operation:		T_A = -55°C				
Forward - current transfer ratio	3076	V_{CE} = 2.0 V dc; I_C = 3.0 A dc; pulsed (see 4.5.1)	h_{FE3}	12		

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 4						
Switching parameters						
Pulse delay time		See figure 4	t_d		0.2	µs
Pulse rise time		See figure 4	t_r		1.3	µs
Pulse storage time		See figure 4	t_s		1.4	µs
Pulse fall time		See figure 4	t_f		1.2	µs
Magnitude of small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 0.5 A dc; f = 1 MHz	$\|h_{fe}\|$	4.0	20	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; f = 100 kHz to 1 MHz	C_{obo}		500	pF
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = +25°C; t ≥ 1 s; 1 cycle; (see figure 5)				
Test 1		V_{CE} = 11.5 V dc; I_C = 10 A dc				
Test 2		V_{CE} = 45 V dc; I_C = 2.5 A dc				
Test 3		V_{CE} = 60 V dc; I_C = 0.9 A dc				
Safe operating area (clamped inductive)	3053	T_A = +25°C; I_C = 10 A dc; V_{CC} = 11.5 V dc; (See figures 6 and 7) Clamp voltage = 80 V dc				
Electrical measurements		See table III, steps 1 and 2				
Subgroups 6 and 7						
Not applicable						

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

* TABLE II. Group E inspection (all quality levels) for qualification or requalification only.

Inspection	MIL-STD-750		Qualification conformance inspection
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	500 cycles	
Hermetic seal	1071		
Electrical measurements		See table III, all steps	
Subgroup 2			45 devices c = 0
High temperature reverse bias	1039	Condition A; 1,000 hours	
Electrical measurements		See table III, all steps	
Subgroup 3			3 devices c = 0
DPA			
Subgroup 4			
Thermal impedance curves		Each supplier shall submit their (typical) design thermal impedance curves. In addition, test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report	sample size N/A
Subgroups 5 and 6			
Not applicable			
Subgroup 7			45 devices c = 0
Reverse stability	1033	Condition A for devices $\geq$ 400 V, condition B for devices < 400 V.	

* TABLE III. Group B, C, and E electrical measurements. 1/ 2/ 3/ 4/

Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector - emitter cutoff current	3041	Bias condition C; V_{CE} = 70 V dc	I_{CES1}		1.0	mA dc
2.	Forward - current transfer ratio	3076	V_{CE} = 2.0 V dc; I_C = 3.0 A dc; pulsed (see 4.5.1)	h_{FE2}	30	140	
3.	Collector - emitter cutoff current	3041	Bias condition C; V_{CE} = 70 V dc	ΔI_{CES1} 5/	100 percent of initial value or 10 μA dc; whichever is greater		
4.	Forward - current transfer ratio	3076	V_{CE} = 2.0 V dc; I_C = 3.0 A dc; pulsed (see 4.5.1)	Δh_{FE2} 5/	±25 percent change from initial value		

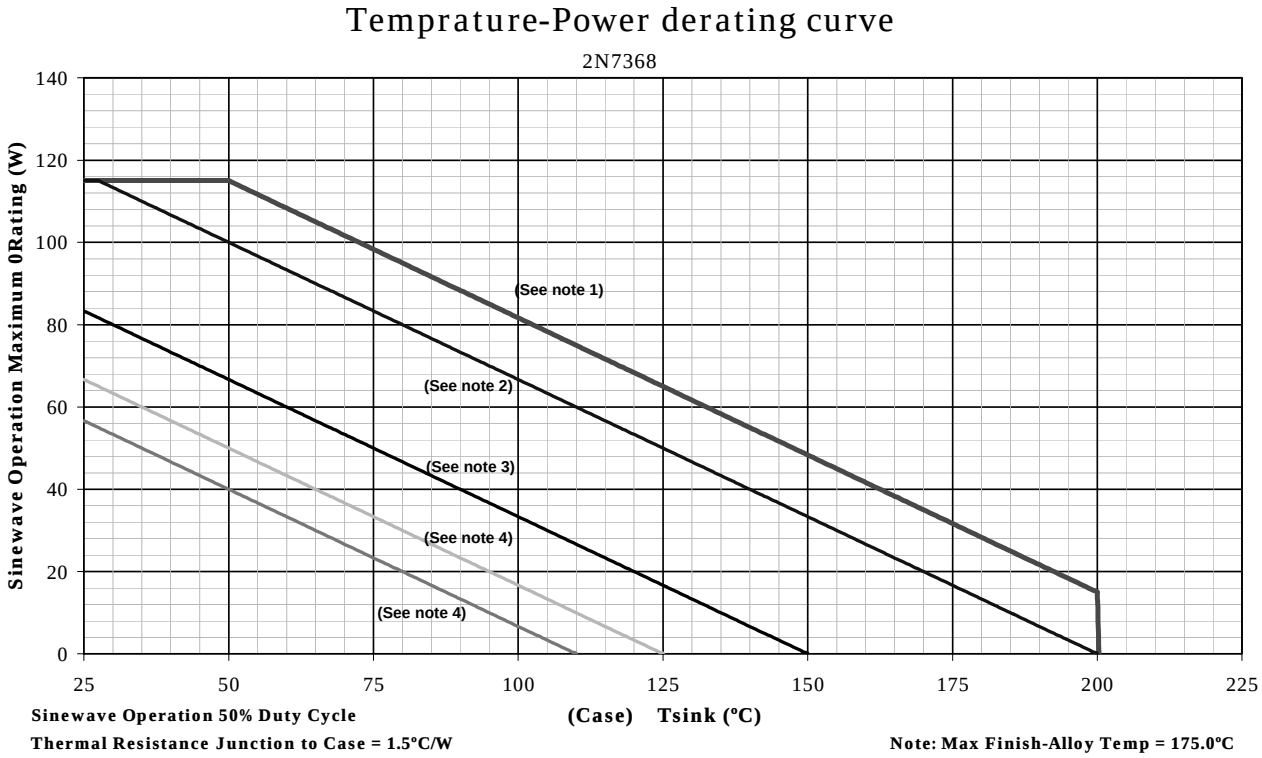
1/ The electrical measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:
   a. Subgroup 3, see table III herein, steps 1 and 2.
   b. Subgroup 4 and 5, see table III herein, steps 3 and 4.

2/ The electrical measurements for table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are as follows: Subgroups 2, 3, and 6, see table III herein, steps 1 and 2.

3/ The electrical measurements for table VII of MIL-PRF-19500 are as follows: Subgroups 2, 3, and 6, see table III herein, steps 1 and 2.

4/ The electrical measurements for appendix E; table IX of MIL-PRF-19500 are as follows: Subgroups 1 and 2, see table III herein, all steps.

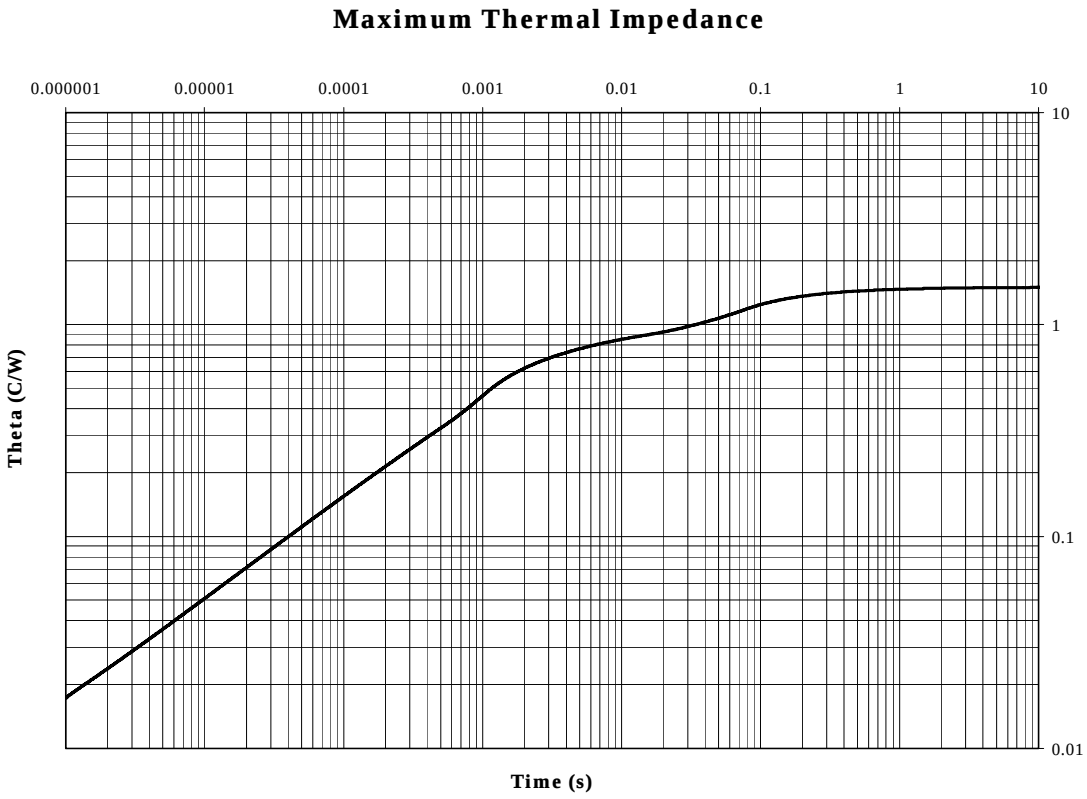
5/ Devices which exceed the group A limits for this test shall not be shippable but are not considered failures for the test.



NOTES:

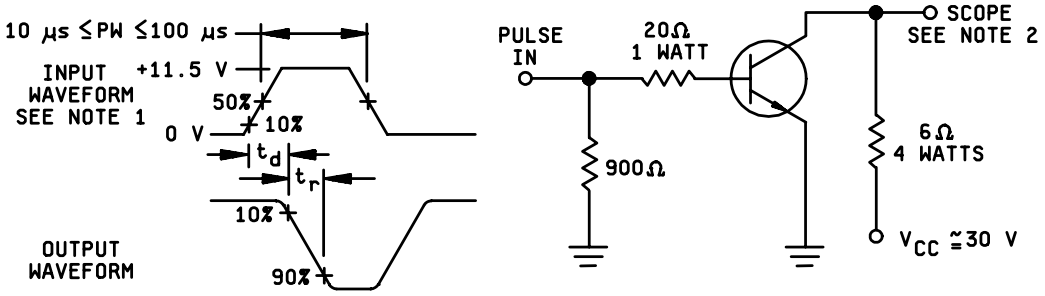
1. Maximum theoretical derate design curve. This is the true inverse of the worst case thermal resistance value. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperatures and power rating specified. (See 1.3.)
3. Derate design curve chosen at $T_J \leq +150^{\circ}C$, where the maximum temperature of electrical test is performed.
4. Derate design curve chosen at $T_J \leq +125^{\circ}C$, and $+110^{\circ}C$ to show power rating where most users want to limit T_J in their application.

* FIGURE 2. Temperature-power derating graph.

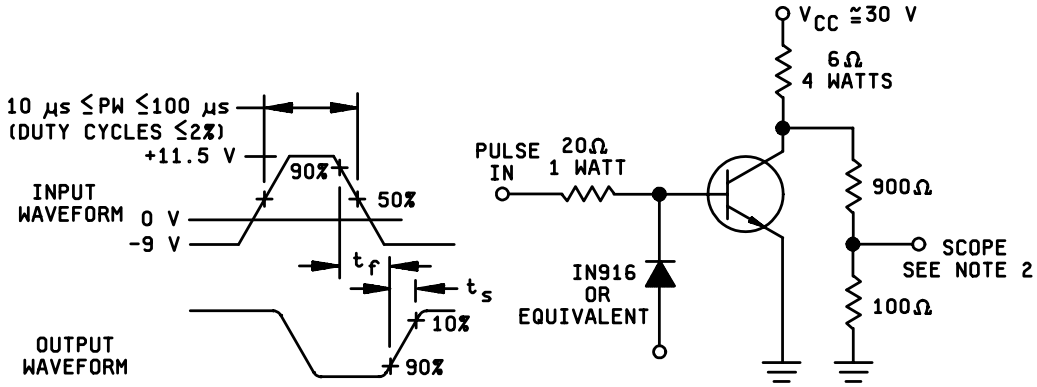


T_C = +25◦C. Thermal resistance = 1.5◦C/W.

* FIGURE 3. Transient thermal impedance graph.



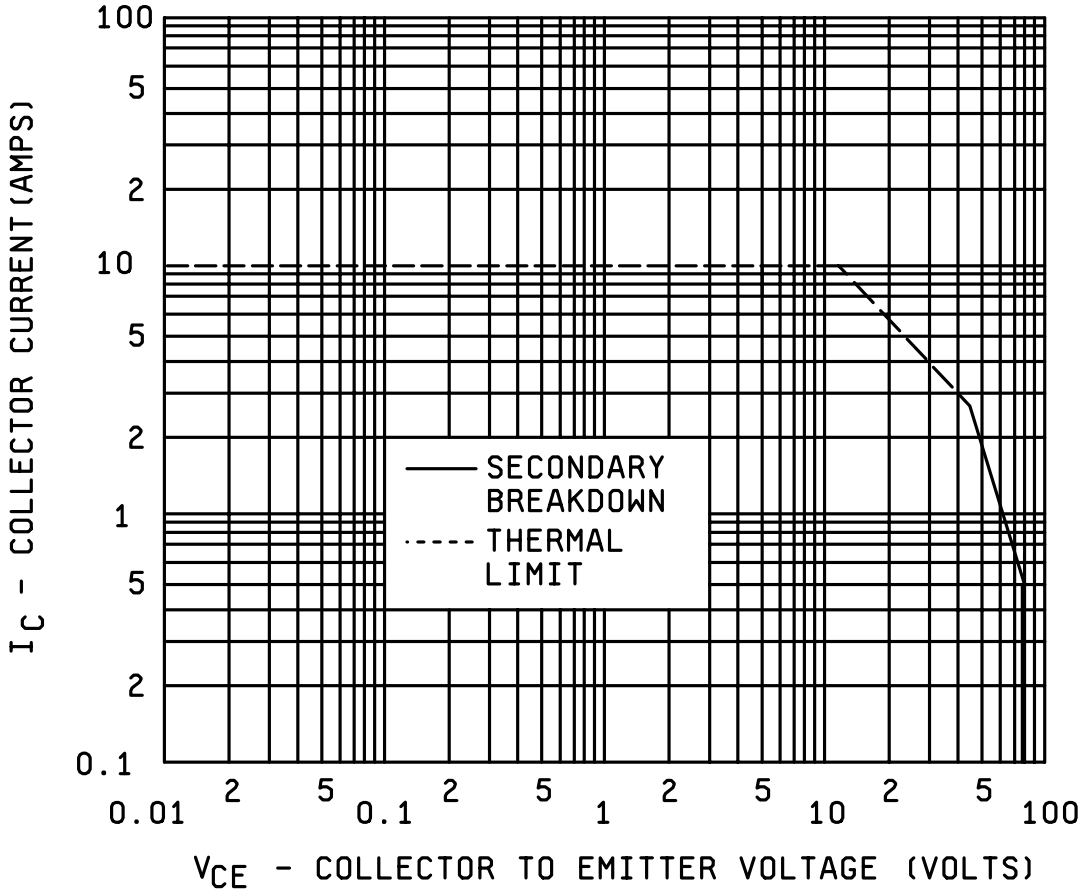
TEST CIRCUIT A



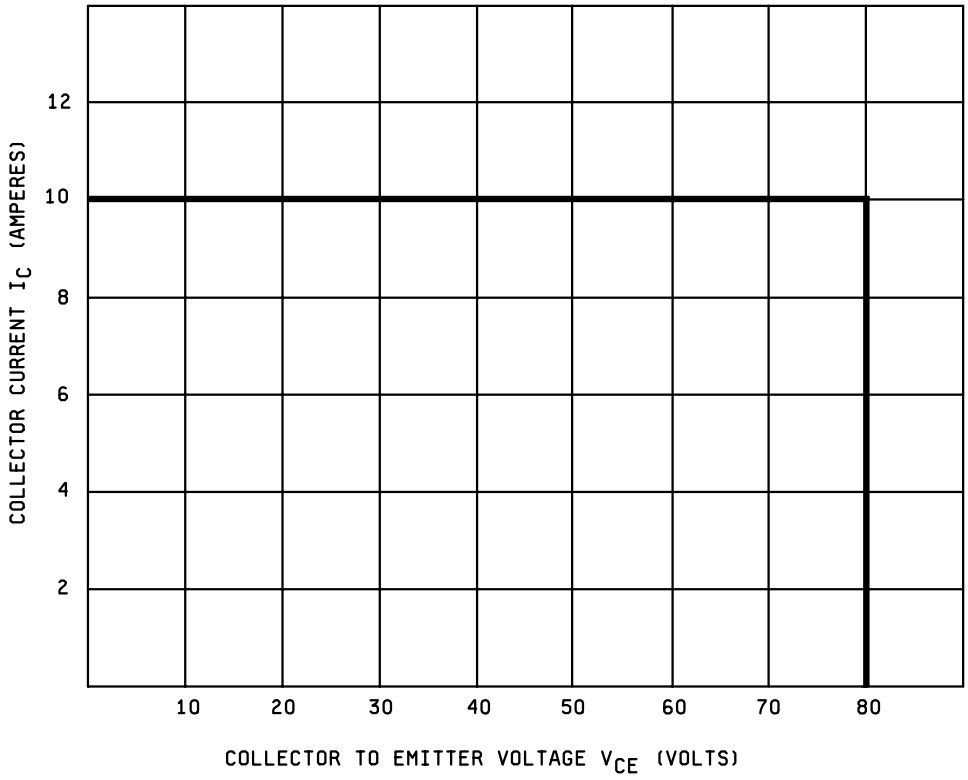
TEST CIRCUIT B

NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 20.0$ ns, $t_f \leq 1$ µs, 10 µs ≤ PW ≤ 100 µs, $Z_{OUT} = 50\Omega$, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 5$ ns, $Z_{IN} \geq 100$ kS, $C_{IN} \leq 12$ pF.
3. Test circuit A for t_d and t_r; test circuit B for t_s and t_f.

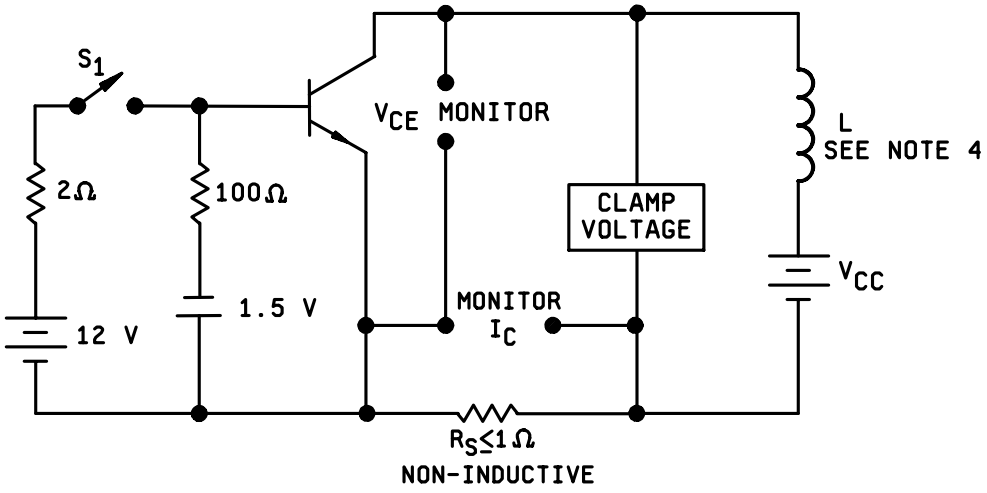
* FIGURE 4. Pulse response test circuits.



* FIGURE 5. Safe operating area.



* FIGURE 6. Safe operating area for switching between saturation and cutoff (clamped inductive load).



L = 4 mH, .05Ω, 20 A
Q ≥ 100 at 1 kHz
(Stanford Miller CK-20 or equivalent

Procedures:

1. With switch S_1 closed, set the specified test conditions.
2. Open S_1. Device fails, if clamp voltage is not reached.
3. Perform specified end-point tests.

* FIGURE 7. Clamped inductive sweep 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 (see 2.2.1).

c. Packaging requirements (see 5.1).

d. Lead finish (see 3.4.1).

e. Type designation and quality 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 Interchangeability information. MIL-PRF-19500/622 is a TO-254 package version of MIL-PRF-19500/408, which is a TO-3 package version. The military 2N7368 contains the same die as the military 2N3716. The MIL-PRF-19500/622 is preferred over the MIL-PRF-19500/408 whenever interchangeability is not a problem. For new design use 2N7368. The 2N3716 is inactive for new design.

* 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
NASA - NA
DLA - CC

Review activities:
Army - AR, MI, SM
Navy - AS, MC
Air Force - 19, 99

Preparing activity:
DLA - CC

(Project 5961-2801)

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-19500/622B	2. DOCUMENT DATE 7 November 2003

3. **DOCUMENT TITLE** SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, HIGH-POWER, TYPE 2N7368 JAN, JANTX, JANTXV, AND JANS

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 614-692-0510	DSN 850-0510	FAX 614-692-6939	EMAIL alan.barone@.dla.mil
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			