The documentation and process conversion measures necessary to comply with this revision shall be completed by 15 March 2004.

INCH-POUND

MIL-PRF-19500/623B
15 December 2003
SUPERSEDING
MIL-PRF-19500/623A
20 November 1997

* PERFORMANCE SPECIFICATION SHEET

* SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, HIGH-POWER
TYPE 2N7371 JAN, JANTX, JANTXV, AND JANS

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

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

* 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
2N7371	100	100	100	5.0	0.2	12	-65 to +200	1.5

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

* 1.4 Primary electrical characteristics.

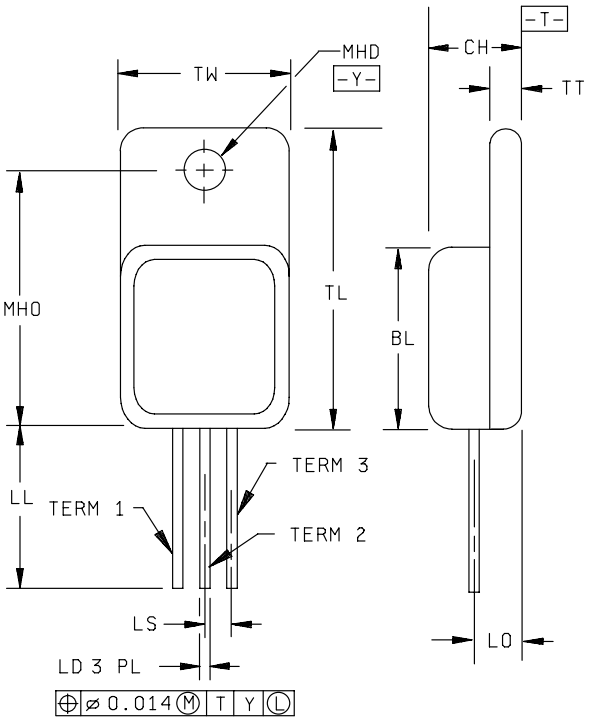
	h_{FE1} (1) V_{CE} = 3.0 V dc I_C = 6.0 A dc	$V_{BE(SAT)1}$ (1) I_C = 12.0 A dc I_B = 120 mA dc	$V_{CE(SAT)1}$ (1) I_C = 12.0 A dc I_B = 120 mA dc	$\|h_{fe}\|$ V_{CE} = 3.0 V dc I_C = 5.0 A dc f = 1 MHz
7Limit		V dc	V dc	
Min	1,000			10
Max	18,000	4.0	3.0	250

(1) Pulsed (see 4.5.1).

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, Post Office Box 3990, Columbus, OH 43216-5000,mailing address) or emailed to Alan.Barone@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

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 (T0-254AA).

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 www.dodssp.dap.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, 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 and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1. Methods used for electrical isolation of the terminal feedthroughs shall employ materials that contain a minimum of 90 percent ceramic AL_2O_3 or equivalent. Examples of such construction techniques are metallized ceramic eyelets or ceramic walled packages.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-PRF-19500, 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 appendix E, table IV, 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, 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 as 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.

* 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 specification sheet 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 (JANS, JANTX and JANTXV levels 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	
	JANS level	JANTX and JANTXV levels
(1) 3c	Thermal impedance (see 4.3.2)	Thermal impedance (see 4.3.2)
9	I_{CEX1} and h_{FE1}	Not applicable
11	Subgroup 2 of table I herein; I_{CEX1} and h_{FE1}; ΔI_{CEX1} = 100 percent of initial value or 100 µA dc, whichever is greater. Δh_{FE1} = ± 40 percent of initial value.	I_{CEX1} and h_{FE1}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; I_{CEX1} and h_{FE1}; ΔI_{CEX1} = 100 percent of initial value or 100 µA dc, whichever is greater. Δh_{FE1} = ± 40 percent of initial value.	Subgroup 2 of table I herein; I_{CEX1} and h_{FE1}; ΔI_{CEX1} = 100 percent of initial value or 100 µA dc, whichever is greater. Δh_{FE1} = ± 40 percent of initial value.

(1) Thermal impedance limits ($Z_{\theta JC}$) shall not exceed the thermal impedance curve on figure 3.

* 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, and 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, table VIa (JANS) and table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500, and herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable steps of table II 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	$T_A = +200°C$.

* 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) shall be in accordance with table I, subgroup 2 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 III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable steps of table II 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 ≥ 10 V dc.

c. Reference temperature measuring point shall be the case.

d. Reference point temperature shall be +25°C ≤ T_R ≤ +75°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°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	$Z_{\theta JC}$			
Collector - emitter breakdown voltage	3011	Bias condition D; I_C = 100 mA dc pulsed (see 4.5.1)	$V_{CEO(sus)}$	100		V dc
Collector - emitter cutoff current	3036	Bias condition D; V_{CE} = 50 V dc	I_{CEO}		1.0	mA dc
Emitter - base cutoff current	3061	Bias condition D; V_{EB} = 5 V dc	I_{EBO}		2.0	mA dc
Collector = emitter cutoff current	3041	Bias condition A; V_{BE} = 1.5 V dc; V_{CE} = 100 V dc	I_{CEX1}		0.5	mA dc
Base - emitter saturated voltage	3066	Test condition A; I_C = 12 A dc; I_B = 120 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		4.0	V dc
Collector - emitter saturated voltage	3071	I_C = 12 A dc; I_B = 120 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)}$		3.0	V dc
Forward - current transfer ratio	3076	V_{CE} = 3.0 V dc; I_C = 6.0 A dc pulsed (see 4.5.1)	h_{FE1}	1000	18,000	
Forward - current transfer ratio	3076	V_{CE} = 3.0 V dc; I_C = 12 A dc pulsed (see 4.5.1)	h_{FE2}	150		
Subgroup 3						
High - temperature operation:		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition C; V_{CE} = 100 V dc; V_{BE} = 1.5 V dc	I_{CEX2}		5.0	mA dc
Low - temperature operation:		T_A = -55°C				
Forward - current transfer ratio	3076	V_{CE} = 3.0 V dc I_C = 6.0 A dc pulsed (see 4.5.1)	h_{FE3}	300		

See footnote at end of table.

7

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
Switching parameters		See figure 4	t_{on}		2.0	µs
Turn-on Turn-off		See figure 4	t_{off}		10	µs
Magnitude of small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 3.0 V dc; I_C = 5.0 A dc; f = 1 MHz	$\|h_{fe}\|$	10	250	
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = 25°C; t ≥ 1 s; 1 cycle; (see figure 5)				
Test 1		V_{CE} = 8.3 V dc; I_C = 12.0 A dc				
Test 2		V_{CE} = 30 V dc; I_C = 3.3 A dc				
Test 3		V_{CE} = 90 V dc; I_C = 150 mA dc				
Safe operating area (clamped inductive)	3053	Load condition B (clamped inductive load); T_A = +25°C; $t_r + t_f \leq 1.0$ µs; duty cycle ≤ 2 percent; t_p = 1 ms; (vary to obtain I_C); R_s = 0.10 ohms; R_{BB1} = 80 ohms; V_{BB1} =16 V dc; R_{BB2} = 100 ohms; V_{BB2} = 1.5 V dc; I_C = 12 A dc; V_{CC} = 20 V dc; $R_L \leq 2$ ohms; L = 10 mH; (Stancor C-2688 or equivalent) clamp voltage = 100 +0, -5 V dc; Device fails if clamp voltage not reached.				
Electrical measurements		See table II, steps 1 and 2.				
Subgroups 6 and 7						
Not applicable						

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

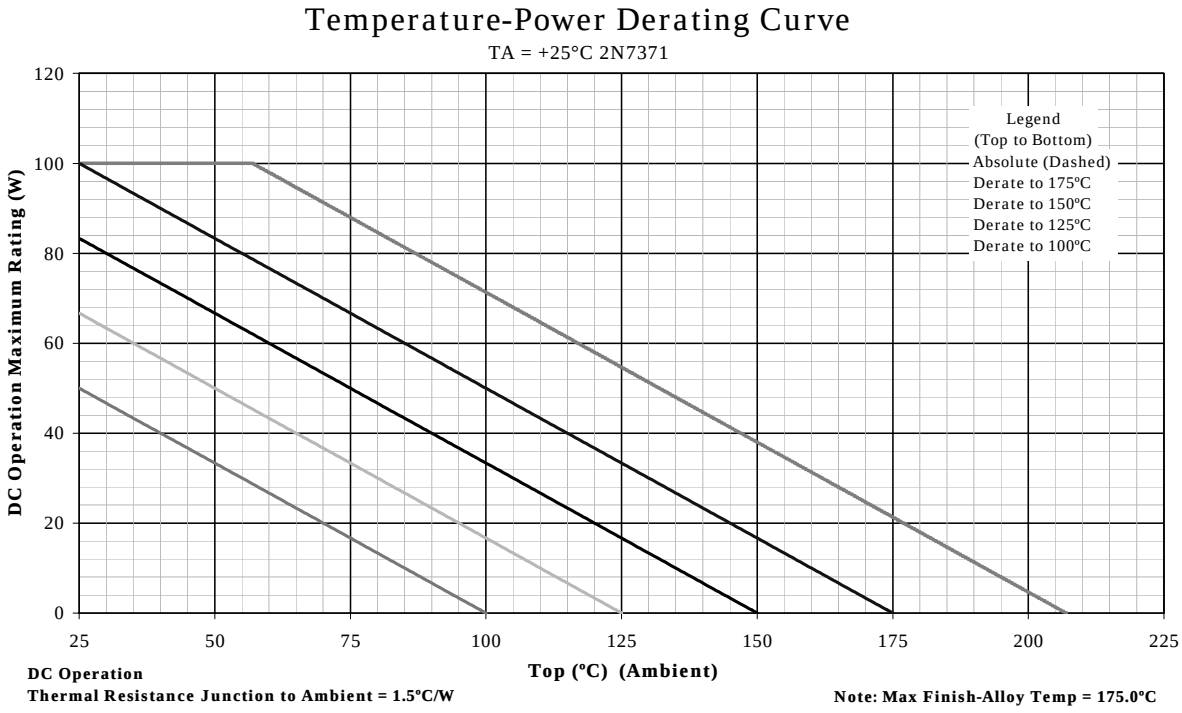
* TABLE II. Group B, C, and E electrical measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector - emitter cutoff current	3041	Bias condition C; V_{CE} = 100 V dc V_{BE} = 1.5 V dc	ΔI_{CEX1} 3/	100 percent of initial value or 100 µA dc; whichever is greater.		
2.	Forward - current transfer ratio	3076	V_{CE} = 3.0 V dc; I_C = 6.0 A dc; pulsed (see 4.5.1)	Δh_{FE1} 3/	± 40 percent change from initial value.		

1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are subgroup 4 and 5, see table II herein, steps 1 and 2.
2/ The delta measurements for table IX of MIL-PRF-19500 are subgroups 1 and 2, see table II herein, all steps.
3/ Devices which exceed the group A limits for this test shall not be shippable but are not considered failures for the test.

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

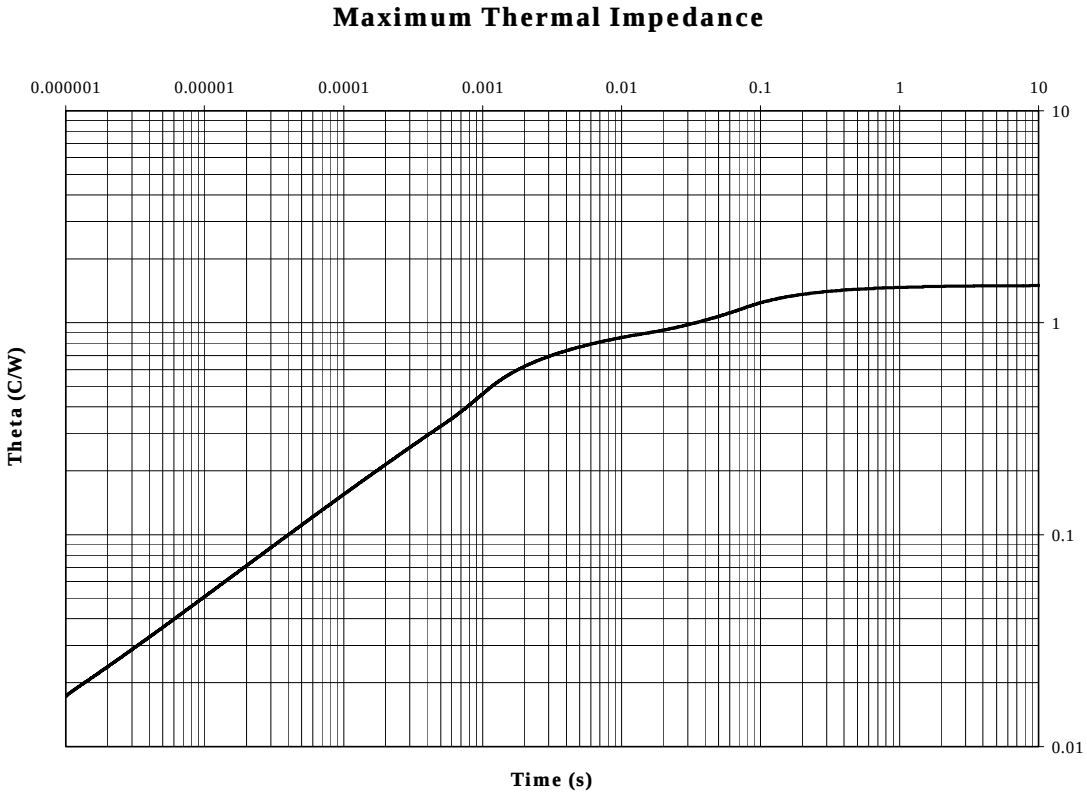
Inspection	MIL-STD-750		Qualification
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	500 cycles	
Hermetic seal	1071		
Fine leak Gross leak		Test conditions G or H Test conditions C or D	
Electrical measurements		See table I, subgroup 2 and table II, all steps.	
Subgroup 2			45 devices c = 0
High temperature reverse bias	1039	Condition A; 1,000 hrs	
Electrical measurements		See table I, subgroup 2 and table II, all steps.	
Subgroup 3			3 devices c = 0
DPA	2102		
Subgroup 4			Sample size N/A
Thermal impedance curves		Each supplier shall submit their (typical) design maximum thermal impedance curves. In addition, the optimal test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report	
Subgroup 5			
Not applicable			
Subgroup 6			3 devices c = 0
ESD	2102		
Subgroup 7			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V, condition B for devices < 400 V.	



NOTES:

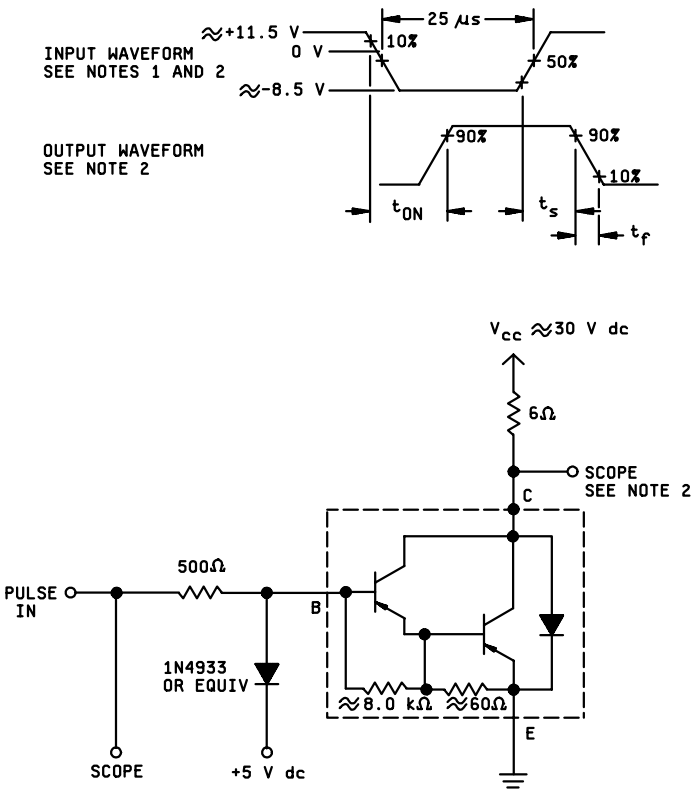
1. Maximum theoretical derate design curve. This is the true inverse of the worst case thermal resistance value. All devices are capable of operating at ≤ T_J specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design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

* FIGURE 2. Temperature-power derating graph.



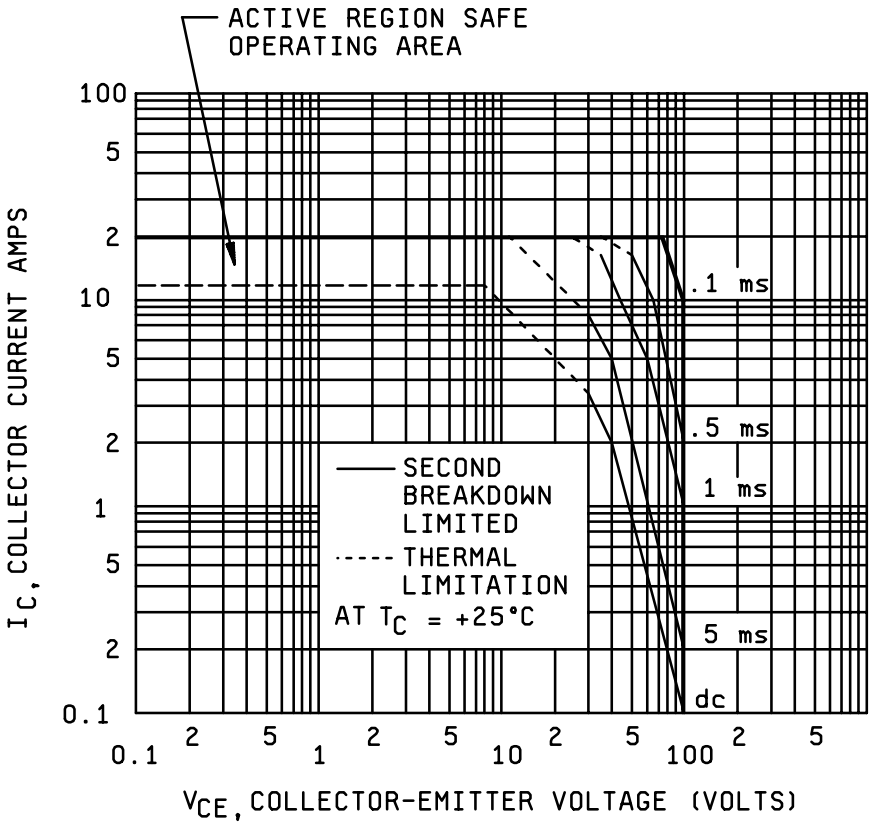
T_C = +25°C. Thermal resistance = 1.5°C/W.

* FIGURE 3. Transient thermal impedance graph.



NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 20$ ns, $t_f \leq 20$ ns, $Z_{OUT} = 50\ \Omega$, PW = 25 µs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 20$ ns, $Z_{IN} \geq 20\ k\Omega$, $C_{IN} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional by-passing in order to minimize ringing.

* FIGURE 4. Pulse response test circuit.



* FIGURE 5. Safe operating area.

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 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.)

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

* 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 No. 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 43216-5000 or e-mail vqe.chief@dla.mil.

6.4 Interchangeability information. MIL-PRF-19500/623 is a TO-254 package version of MIL-PRF-19500/501, which is a TO-3 package version. The military 2N7371 contains the same die as the military 2N6052. The MIL-PRF-19500/623 is preferred over the MIL-PRF-19500/501 whenever interchangeability is not a problem. For new design use 2N7371. The 2N6052 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
Air Force - 19, 99

Preparing activity:
DLA - CC

(Project 5961-2803)

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