INCH–POUND

The documentation and process conversion measures necessary to comply with this revision shall be completed by 24 February 2013.

MIL–PRF–19500/624E
w/AMENDMENT 1
24 November 2013
SUPERSEDING
MIL–PRF–19500/624D
31 December 2012
(See 6.4)

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER DARLINGTON
TYPE 2N7370, 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 NPN silicon, high power Darlington transistors. Four levels of product assurance are provided for each device type as specified in MIL–PRF–19500.

1.2 Physical dimensions. The device package style is TO–254AA in accordance with figure 1.

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

Type	P_T (1) T_C = +25°C	$R_{\theta JC}$ (2)	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_J and T_{STG}
	W	°C/W	V dc	V dc	V dc	A dc	A dc	°C
2N7370	100	1.5	100	100	5.0	0.2	12	–65 to +200

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

Comments, suggestions, or questions on this document should be addressed DLA Land and Maritime ATTN: VAC, P.O. Box 3990, Columbus, OH 43218–3990, or emailed to semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

1.4 Primary electrical characteristics. Unless otherwise specified, T_A = +25°C.

Limit	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
		V dc	V dc	
Minimum	1,000			10
Maximum	18,000	4.0	3.0	250

(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

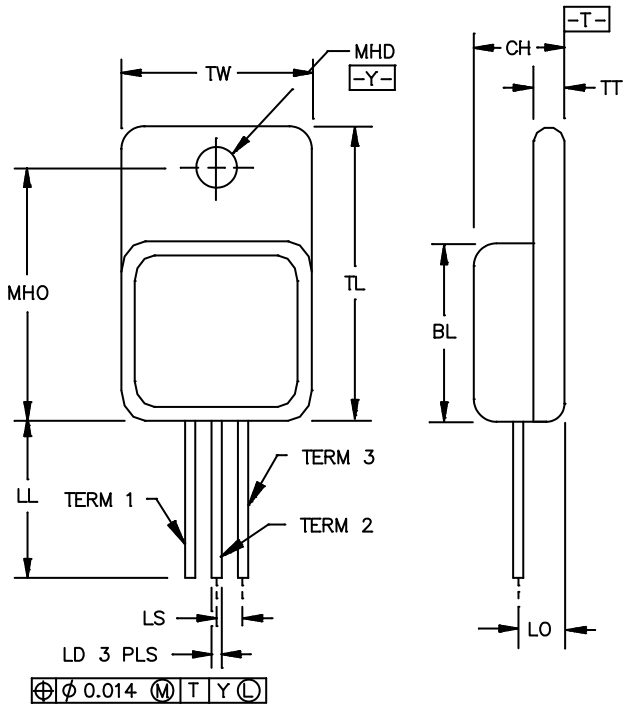
MIL–PRF–19500 – Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

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

(Copies of these documents are available online at http://quicksearch.dla.mil or https://assist.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.



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	.510	.570	12.95	14.48
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. Millimeters are given for general information only.
2. All terminals are isolated from case
3. Protrusion of ceramic eyelets included in dimension LL.
4. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.

FIGURE 1. Physical dimensions (TO–254AA).

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 manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein shall be as specified in MIL–PRF–19500 and as follows:

I_H – The collector current applied to the device under test during the heating period.
I_M – The measurement current applied to forward bias the junction for measurement of V_{BE}.
t_H – The duration of the applied heating power pulse.
t_{SW} – Sample window time during which final V_{BE} measurement is made.

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. The 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).

3.4.2 Lead formation. Where a choice of lead formation is desired, it shall be specified in the acquisition document (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform hermetic seal in accordance with screen 14 of table E–IV of MIL–PRF–19500 and 100 percent dc testing in accordance with subgroup 2 of table I herein on all devices that had its leads altered.

3.4.3 Lead isolation. Methods used for electrical isolation of the terminal feedthroughs shall employ material that contain a minimum of 90 percent ceramic AL_2O_3 or equivalent. Examples of such construction techniques are metalized eyelets or ceramic walled packages.

3.4.4 Polarity. The polarity of the device shall be as shown on figure 1.

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

3.6 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.7 Marking. Marking shall be in accordance with MIL–PRF–19500.

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 and II).

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 specification sheet that did not request the performance of table II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening (JANTX, JANTXV and JANS levels only). 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	
	JANS	JANTX and JANTXV
3c (1)	Thermal impedance (see 4.3.1)	Thermal impedance (see 4.3.1)
9	I_{CEX1} and h_{FE2}	Not applicable
11	Subgroup 2 of table I herein; I_{CEX1} and h_{FE2}; ΔI_{CEX1} = 100 percent of initial value or 2 μA dc, whichever is greater. Δh_{FE2} = ± 40 percent of initial value	I_{CEX1} and h_{FE2}
12	See 4.3.2	See 4.3.2
13	Subgroups 2 and 3 of table I herein. I_{CEX1} and h_{FE2}; ΔI_{CEX1} = 100 percent of initial value or 2 μA dc, whichever is greater. Δh_{FE2} = ±40 percent of initial value	Subgroup 2 of table I herein. I_{CEX1} and h_{FE2}; ΔI_{CEX1} = 100 percent of initial value or 2 μA dc, whichever is greater. Δh_{FE2} = ±40 percent of initial value

(1) Thermal impedance shall be performed anytime after temperature cycling (screen 3a); JANTX and JANTXV levels do not need to be repeated in screening requirements.

4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with test method 3131 of MIL–STD–750 using the guidelines in that method for determining I_H, I_M, t_H, t_{SW}, V_H, and t_{MD}, (and V_C where appropriate). Measurement delay time (t_{MD}) = 70 μs maximum. The thermal impedance limit used in screen 3c of 4.3 and table I, subgroup 2 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 test method 3131 of MIL–STD–750. See table II, subgroup 4 (group E) herein.

4.3.2 Power burn-in conditions. Power burn-in conditions shall be as follows: T_J = +175°C minimum, V_{CE} = 10 to 30 V dc, T_A = +30 ±5°C.

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 table E–V of MIL–PRF–19500, and table I herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E–VIA (JANS) or table E–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 step of 4.6 herein.

4.4.2.1 Quality level JANS (table E–VIA of MIL–PRF–19500).

Subgroup	Method	Conditions
B4	1037	V_{CB} ≥ 10 V dc, adjust device current, or power, to achieve a minimum ΔT_J of +100°C.
B5	2037	Test condition A.

4.4.2.2 Quality levels JAN, JANTX, and JANTXV (table E–VIB of MIL–PRF–19500).

Subgroup	Method	Conditions
B3	1037	V_{CB} ≥ 10 V dc, adjust device current, or power, to achieve a minimum ΔT_J of +100°C.
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 table E–VII of MIL–PRF–19500 and as follows herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable step of 4.6 herein.

Subgroup	Method	Conditions
C2	1056	Test condition B.
C2	2036	Test condition A (tension), weight = 10 pounds (4.5 kg), t = 10 seconds.
C5	3131	See 4.3.1.
C6	1037	V_{CB} ≥ 10 V dc, adjust device current, or power, to achieve a minimum ΔT_J of +100°C.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E–IX of MIL–PRF–19500 and as specified in table II herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable step of 4.6 herein.

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

4.5.1 Pulse response measurements. The conditions for pulse response measurement shall be as specified in section 4 of MIL–STD–750.

4.6 Delta requirements (JANS). The requirements for delta measurements for groups B, C, and E shall be as specified below. (1) (2) (3)

Step	Inspection	MIL–STD–750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	V_{CE} = 3.0 V dc; I_C = 6.0 A dc; pulsed (see 4.5.1)	Δh_{FE1} (4)	±40 percent change from initial value.		

(1) The delta electrical measurements for group B, product assurance level JANS, shall be as follows:
   a. In addition to the measurements specified for subgroup 4 of table E–VIA of MIL–PRF–19500, the measurements of step 1 shall also be taken.
   b. In addition to the measurements specified for subgroup 5 of table E–VIA of MIL–PRF–19500, the measurements of step 1 shall also be taken.

(2) The delta electrical measurements for group C, product assurance level JANS, shall be as follows:
   a. In addition to the measurements specified for subgroup 2 of table E–VII of MIL–PRF–19500, the measurements of step 1 shall also be taken.
   b. In addition to the measurements specified for subgroup 3 of table E–VII of MIL–PRF–19500, the measurements of step 1 shall also be taken.
   c. In addition to the measurements specified for subgroup 6 of table E–VII of MIL–PRF–19500, the measurements of step 1 shall also be taken.

(3) The delta measurements for group E, product assurance level JANS, shall be as follows: In addition to the measurements specified for subgroups 1 and 2 of table E–IX of MIL–PRF–19500, the measurements of step 1 shall also be taken.

(4) Devices which exceed the group A limits for this test shall not be supplied as complaint parts but are not considered failures for the test.

TABLE I. Group A inspection.

Inspection 1/	MIL–STD–750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Thermal impedance 2/	3131	See 4.3.1	$Z_{\theta JX}$			°C/W
Breakdown voltage collector to emitter	3011	Bias condition D, I_C = 100 mA dc; pulsed (see 4.5.1)	$V_{CEO(sus)}$	100		V dc
Collector to emitter cutoff current	3041	Bias condition D; V_{CE} = 50 V dc	I_{CEO}		1.0	mA
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 5 V dc	I_{EBO}		2.0	mA
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = 1.5 V dc V_{CE} = 100 V dc	I_{CEX1}		0.01	mA dc
Base to 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
Saturation voltage; collector to emitter	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}	1,000	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 A, V_{BE} = 1.5 V dc V_{CE} = 100 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 footnotes at end of table.

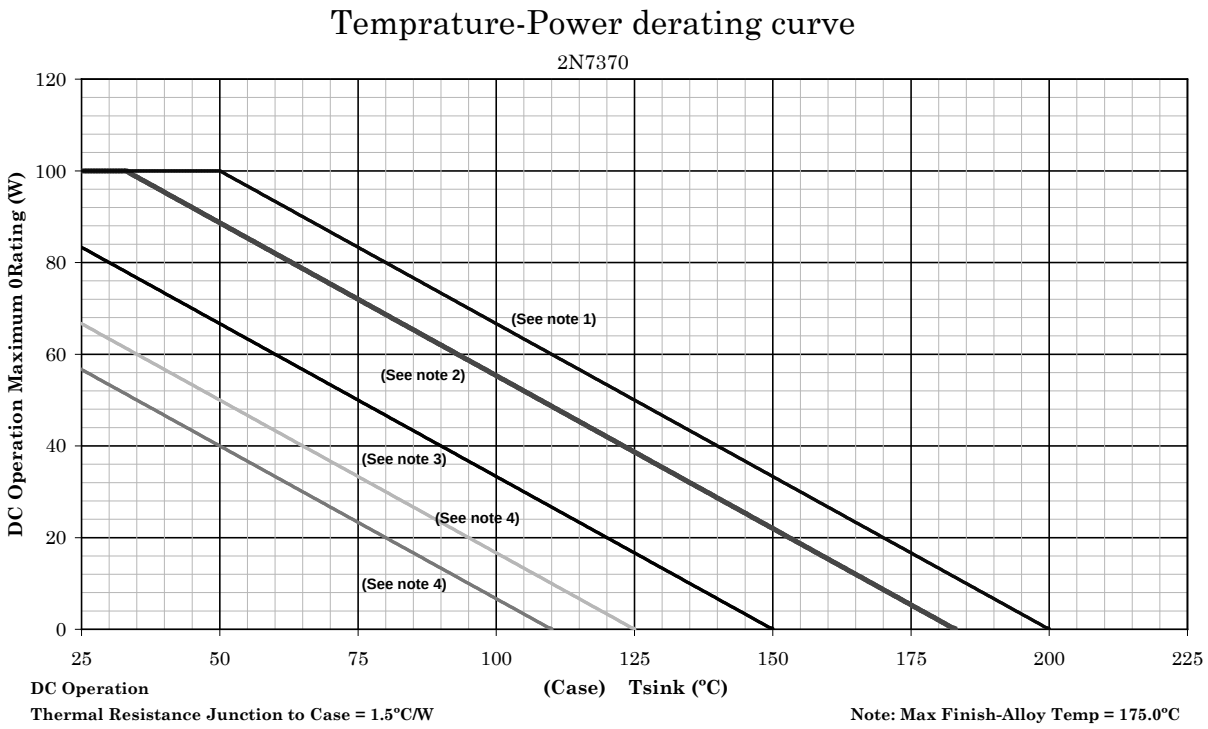
TABLE I. Group A inspection – Continued.

Inspection 1/	MIL–STD–750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
Pulse response						
Turn-on time		See figure 4	t_{on}		2.0	µs
Turn-off time		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 (switching, 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 Ω; R_{BB1} = 80 Ω; V_{BB1} =16 V dc; R_{BB2} = 100 Ω; V_{BB2} = 1.5 V dc; I_C =12 A dc; V_{CC} = 20 V dc; $R_L \leq 2$ Ω; 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 subgroup 2 of this table				
Subgroups 6 and 7						
Not applicable						

1/ For sampling plan see MIL–PRF–19500.
2/ This test required for the following end-point measurements only:
Group B, subgroups 3, 4, and 5 (JANS).
Group B, subgroups 2 and 3 (JAN, JANTX, and JANTXV).
Group C, subgroup 2 and 6.
Group E, subgroup 1.

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

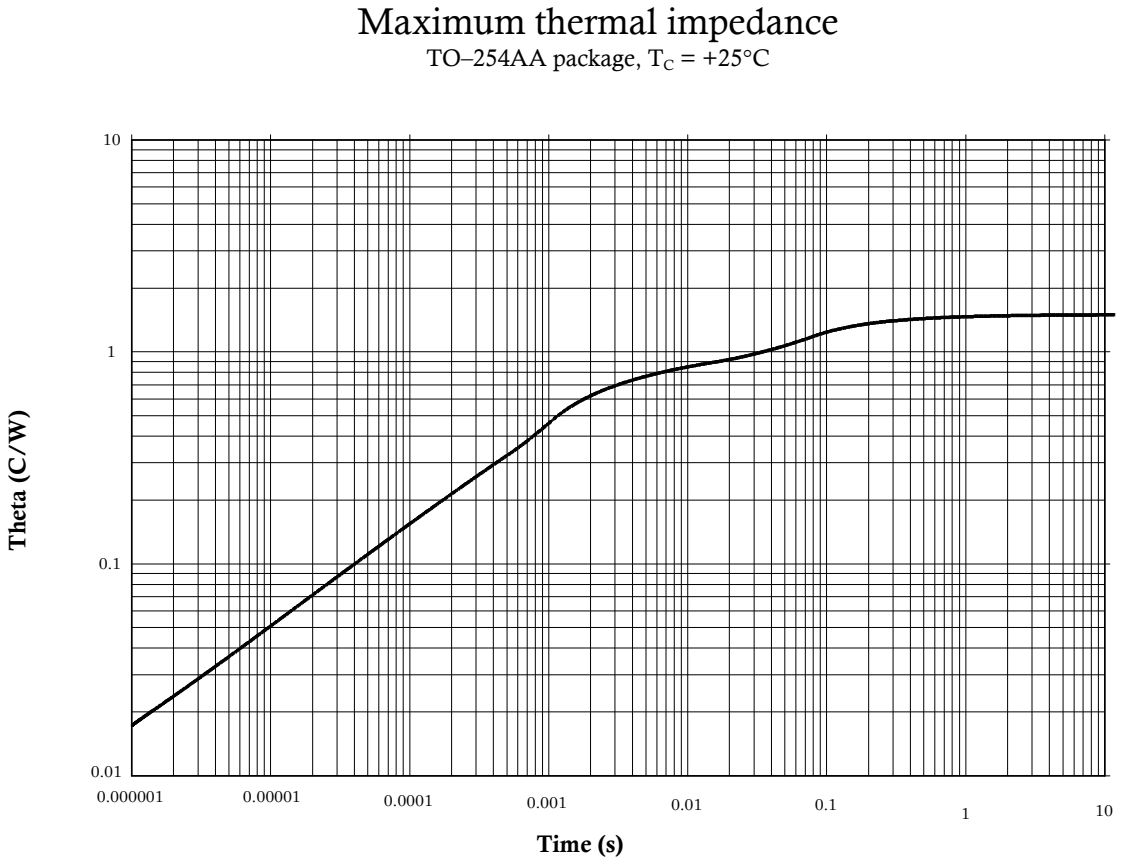
Inspection	MIL–STD–750		Qualification sample plan
	Method	Conditions	
Subgroup 1			45 devices; c = 0
Temperature cycling (air to air)	1051	500 cycles.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 2			45 devices; c = 0
High temperature reverse bias	1039	Condition A; 1,000 hours.	
Electrical measurements		See table I, subgroup 2 herein.	
Subgroup 4			Sample size N/A
Thermal impedance curves		See MIL–PRF–19500.	
Subgroup 5			
Not applicable			
Subgroup 8			45 devices; c = 0
Reverse voltage leakage stability	1033	Condition B.	



NOTES:

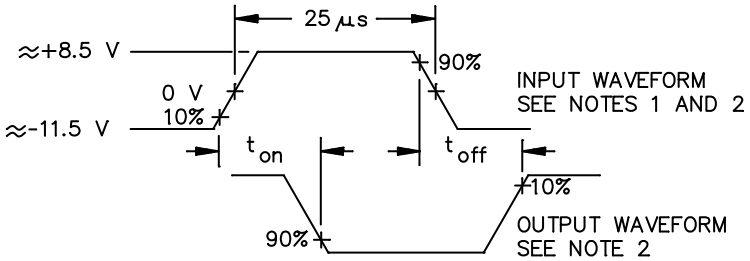
1. All devices are capable of operating at ≤ T_J specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature (T_J ≤ +200°C) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at T_J ≤ +150°C, where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at T_J ≤ +125°C, and +110°C to show power rating where most users want to limit T_J in their application.

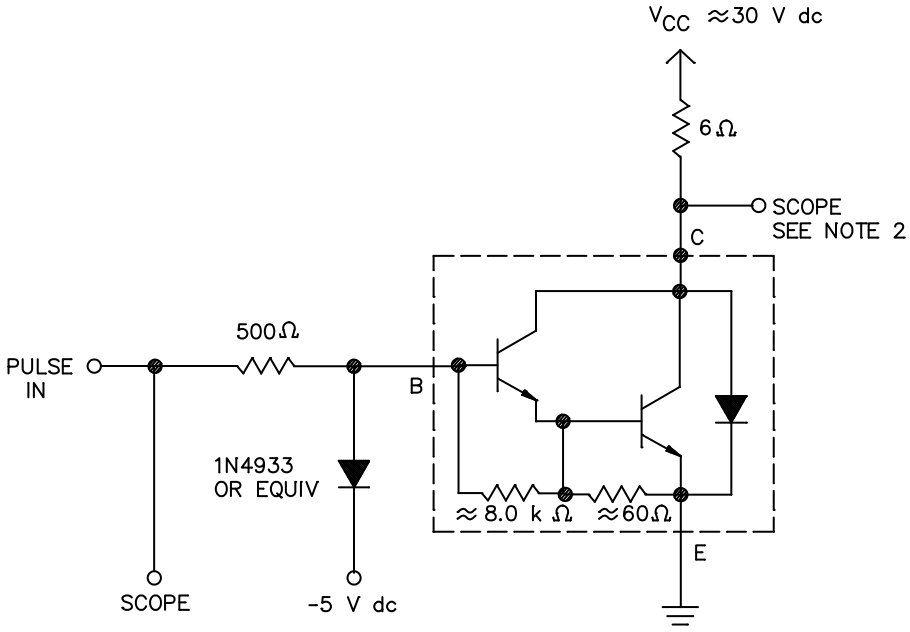
FIGURE 2. Temperature-power derating graph for device type 2N7370.



Thermal impedance $R_{\theta JC}$ = 1.5°C/W maximum.

FIGURE 3. Transient thermal impedance graph.





NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: t_r ≤ 20 ns, t_f ≤ 20 ns, Z_{OUT} = 50 Ω, PW = 25 μs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: t_r ≤ 20 ns, Z_{IN} ≥ 20 kΩ, C_{IN} ≤ 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.

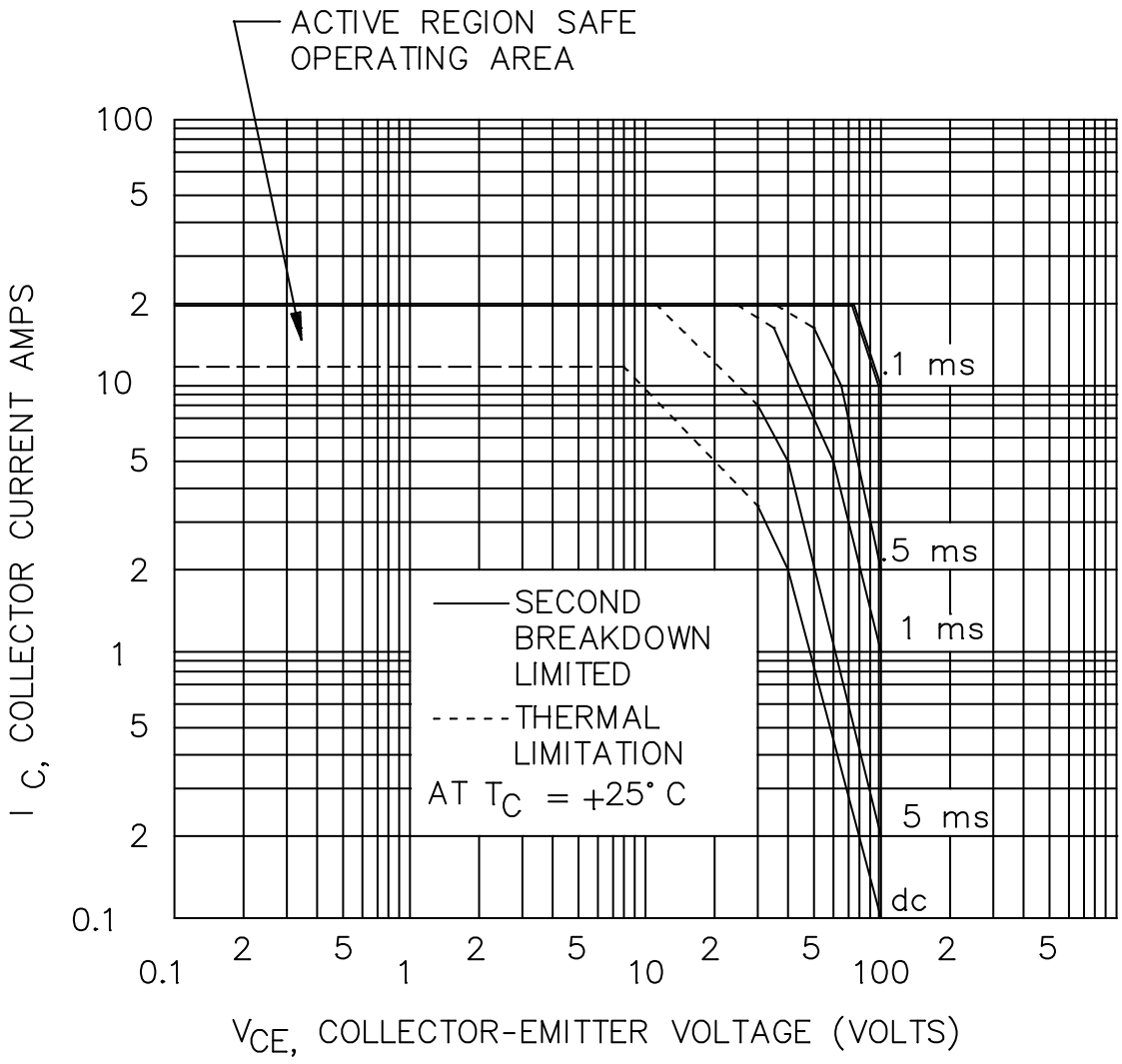


FIGURE 5. Safe operating area graph.

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) and if applicable, any needed lead formation (see 3.4.2).

d. The complete Part or Identifying Number (PIN), see section 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 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 DLA Land and Maritime, ATTN: 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 https://assist.dla.mil.

6.4 Interchangeability information. The die of the device type 2N7370 covered by this specification sheet is the same die as the device type 2N6059 covered by MIL–PRF–19500/502. However, the package style of this specification sheet is a TO–254AA package whereas the package style of MIL–PRF–19500/502 is a TO–204AA package. The devices from MIL–PRF–19500/624 are preferred over the devices of MIL–PRF–19500/502 whenever interchangeability is not a problem.

6.5 Changes from previous issue. The margins of this specification are marked with vertical lines 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 – 85
NASA – NA
DLA – CC

Review activities:
Army – AV, MI
Air Force – 99

Preparing activity:
DLA – CC

(Project 5961–2013–044)

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