The documentation and process conversion measures necessary to comply with this revision shall be completed by 24 March 2014.

INCH-POUND

MIL-PRF-19500/621D
24 January 2014
SUPERSEDING
MIL-PRF-19500/621C
11 December 2008

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, HIGH-POWER,
TYPE 2N7369, 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 PNP 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_A = +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
2N7369	115	-80	-80	-7.0	-4.0	-10	-65 to +200	1.5

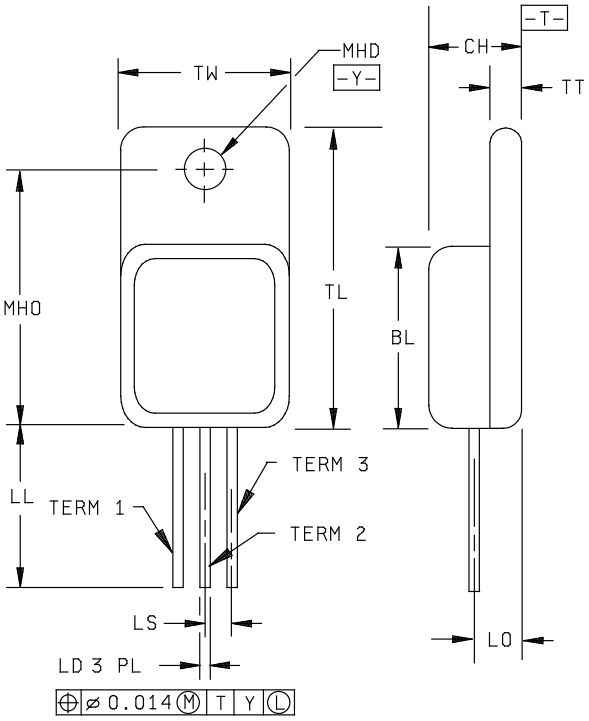
(1) See figure 2 for temperature-power derating curves.
(2) See figure 3, transient thermal impedance graph.

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

Type	h_{FE2} (1) V_{CE} = -2.0 V dc I_C = -3.0 A dc	$V_{BE(SAT)1}$ (1) I_C = -5.0 A dc I_B = -0.5 A dc	$V_{CE(SAT)1}$ (1) I_C = -5.0 A dc I_B = -0.5 A dc	C_{obo} V_{CB} = -10 V dc I_E = 0 f = 100 kHz to 1 MHz	$\|h_{fe}\|$ V_{CE} = -10 V dc V_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).

* 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@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.



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.
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, 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.

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 (TO-254AA). Methods used for electrical isolation of the terminal feed-throughs 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 table E-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 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 4.4.2 and 4.4.3.

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.

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, 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 level	JANTX and JANTXV levels
3c (1)	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 herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 2 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	Subgroups 2 and 3 of table I herein; I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 2 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 2 μA dc, whichever is greater. Δh_{FE2} = ±20 percent of initial value.
* 17	For TO-254 packages: Method 1081 of MIL-STD-750 (see 4.3.3), Endpoints: Subgroup 2 of table I herein.	For TO-254 packages: Method 1081 of MIL-STD-750 (see 4.3.3), Endpoints: Subgroup 2 of table I herein.

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

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

T_J = +175°C minimum, V_{CE} = -10 to -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.

* 4.3.3 Dielectric withstanding voltage.

a. Magnitude of test voltage……..900 V dc.

b. Duration of application of test voltage……..15 seconds (min).

c. Points of application of test voltage……...All leads to case (bunch connection).

d. Method of connection……...Mechanical.

e. Kilovolt-ampere rating of high voltage source…….1,200 V/1.0 mA (min).

f. Maximum leakage current……...1.0 mA.

g. Voltage ramp up time.....500 V/second.

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

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

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

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

	Subgroup	Method	Conditions
*	B3	1037	$V_{CB} \geq$ -10 V dc.
	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 table E-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.

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.

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°C $\leq T_R \leq$ 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	$Z_{\theta JC}$			°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}		-5.0	mA dc
Collector - emitter cutoff current	3041	Bias condition A; V_{BE} = -1.5 V dc; V_{CE} = -80 V dc	I_{CEX1}		-20	µA dc
Collector - emitter cutoff current	3041	Bias condition C; V_{CE} = -70 V dc	I_{CES1}		-20	µA 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.

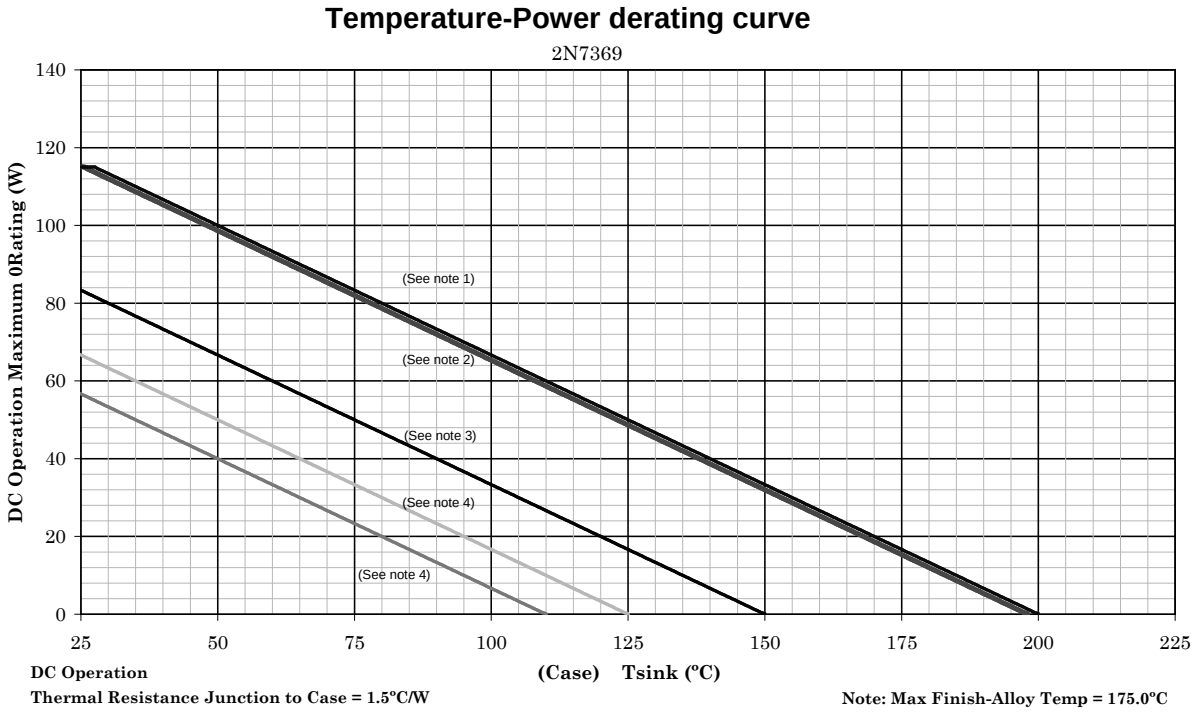
TABLE I. Group A inspection - Continued.

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 s1 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 I, subgroup 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.

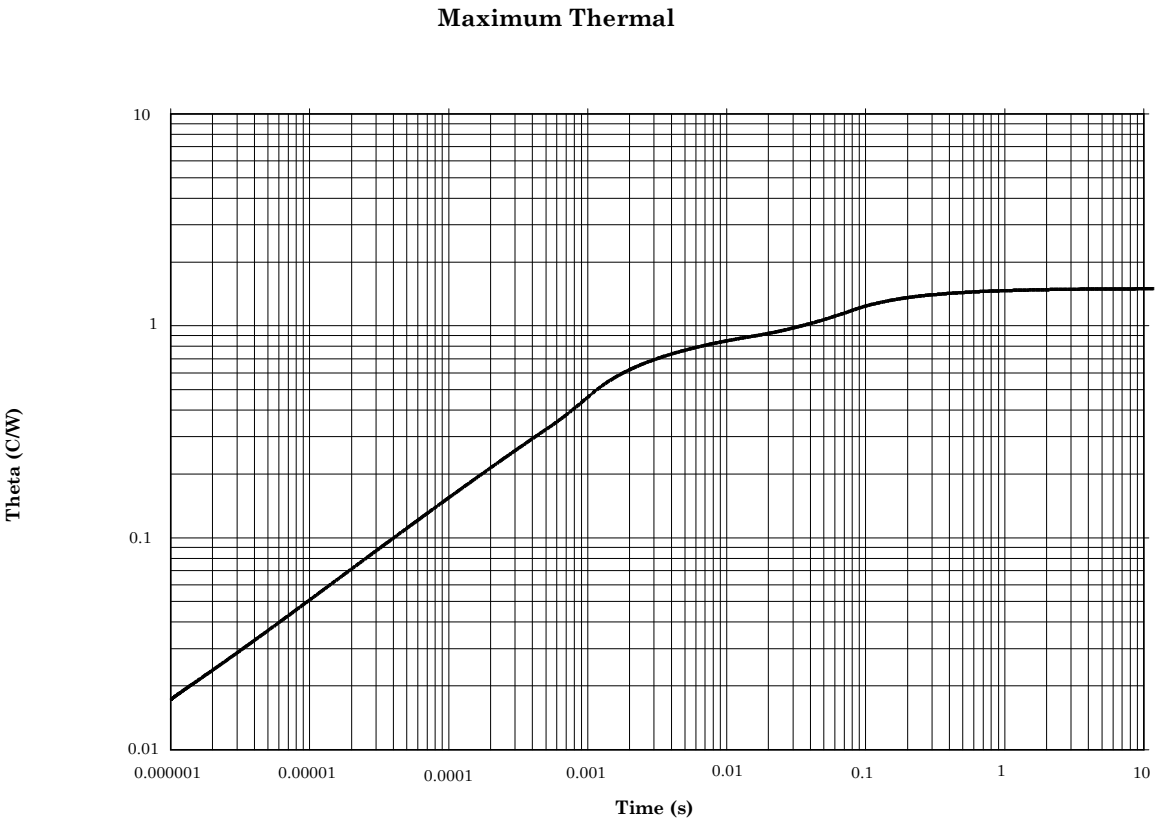
Inspection	MIL-STD-750		Qualification conformance inspection
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	500 cycles	
Hermetic seal	1071		
Electrical measurements		See table I, subgroup 2	
Subgroup 2			45 devices c = 0
High temperature reverse bias	1039	Condition A, 1,000 hours	
Electrical measurements		See table I, subgroup 2	
* Subgroup 4			
Thermal impedance curves		See MIL-PRF-19500.	sample size N/A
Subgroups 5 and 6			
Not applicable			
* Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V, condition B for devices < 400 V.	



NOTES:

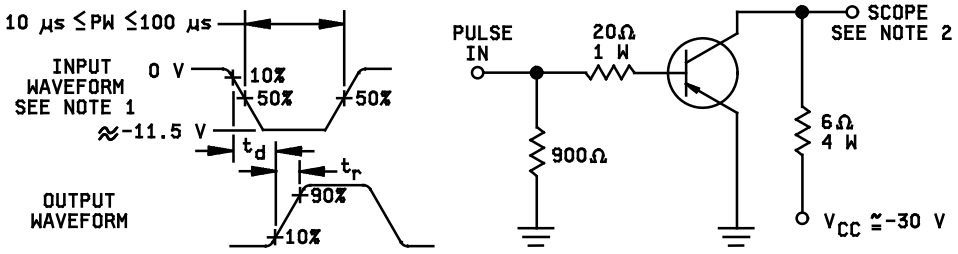
1. Maximum theoretical derate design curve. This is the true inverse of the worst case thermal resistance value. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate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

FIGURE 2. Temperature-power derating graph.

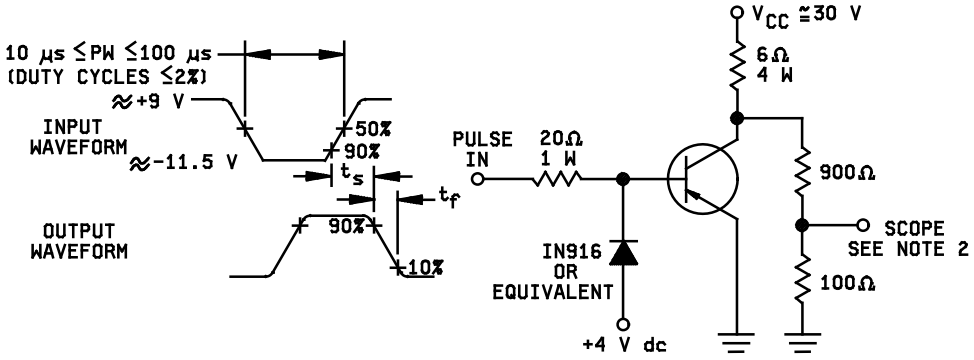


T_C = +25°C. Thermal resistance = 1.5°C/W.

FIGURE 3. Transient thermal impedance graph.



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, $t_f \leq 1\mu s$, 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, $Z_{IN} \geq 100$ kΩ, $C_{IN} \leq 12$ 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.

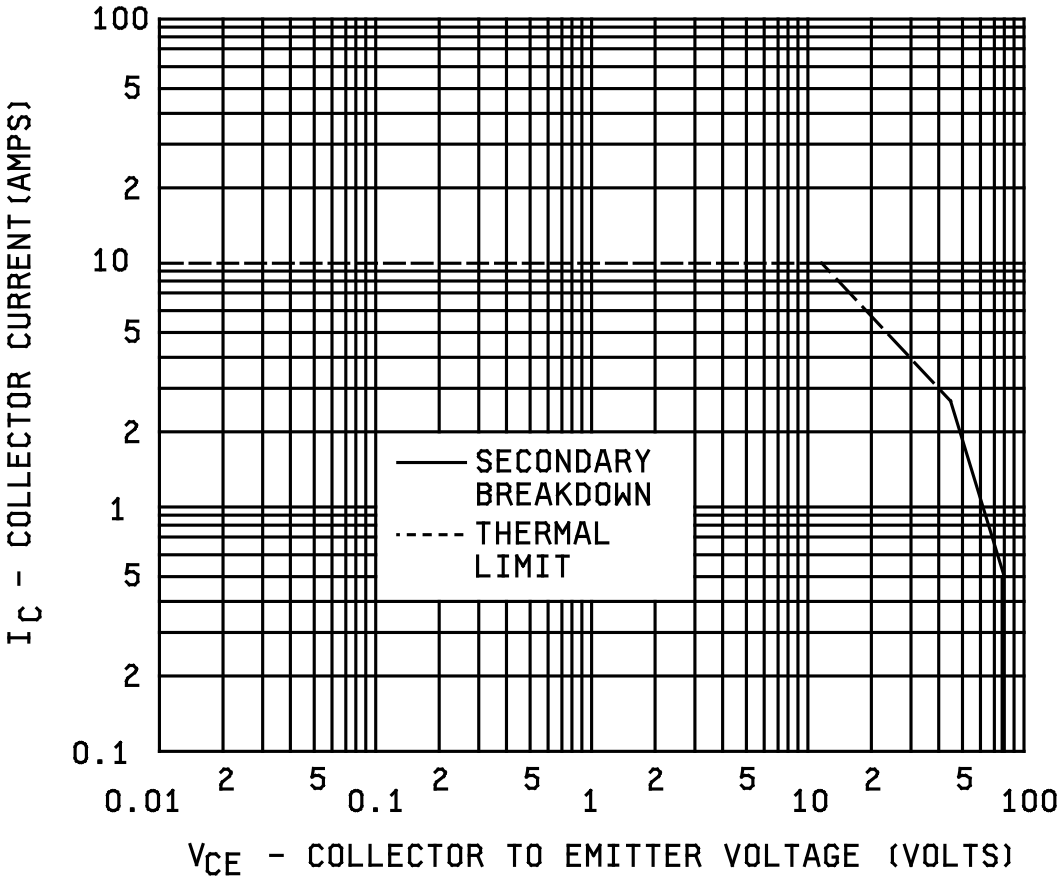


FIGURE 5. Safe operating area.

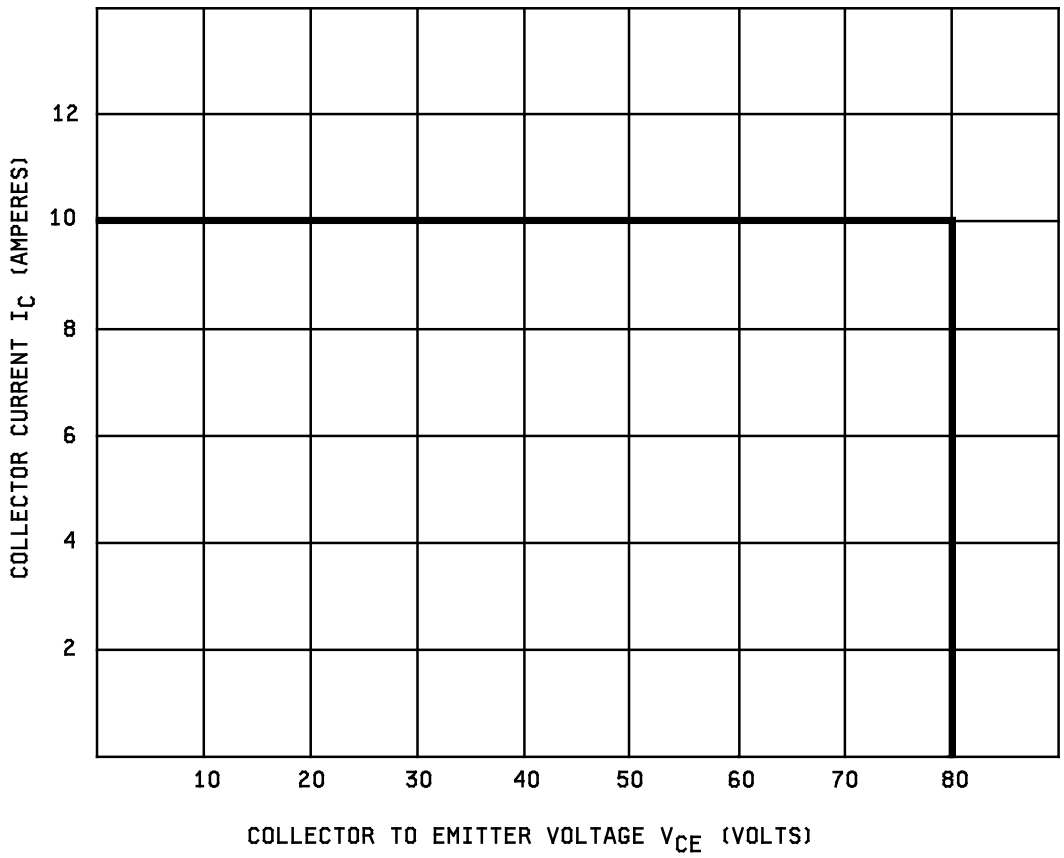
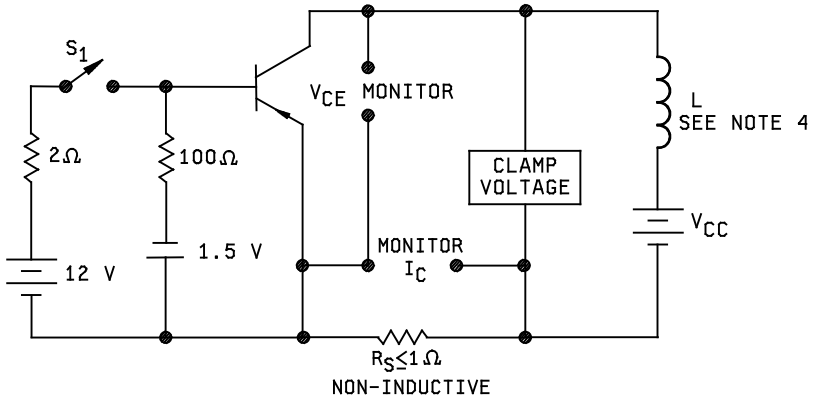


FIGURE 6. Safe operating area for switching between saturation and cutoff (clamped inductive load).



NOTE:

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 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. 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 must 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 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. MIL-PRF-19500/621 is a T0-254 package version of MIL-PRF-19500/379, which is a TO-3 package version. The military 2N7369 contains the same die as the military 2N3792. The MIL-PRF-19500/621 is preferred over the MIL-PRF-19500/379 whenever interchangeability is not a problem. For new design use 2N7369. The 2N2792 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 - 85
NASA - NA
DLA - CC

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

Preparing activity:
DLA - CC

(Project 5961-2014-032)

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