The documentation and process conversion measures necessary to comply with this revision shall be completed by 19 September 2007.

INCH-POUND

MIL-PRF-19500/407E
19 June 2007
SUPERSEDING
MIL-PRF-19500/407D
20 January 2004

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER,
TYPE 2N3055, JAN, JANTX, AND JANTXV

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, power, transistor. Three levels of product assurance is provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1.

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

Type	P_T		V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_{STG} and T_J	$R_{\theta JC}$
	T_A = +25°C (1) (2)	T_C = +25°C (3)							(4)
	W	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W
2N3055	6	117	100	70	7	15	7	-65°C to +200°C	1.5

(1) T_A = room ambient as defined in the general requirements of 4.5 of MIL-STD-750.
(2) Derate linearly 34.2 mW/°C for T_A > +25°C.
(3) See figure 2 for temperature-power derating curves.
(4) See figure 3 for transient thermal impedance graph.

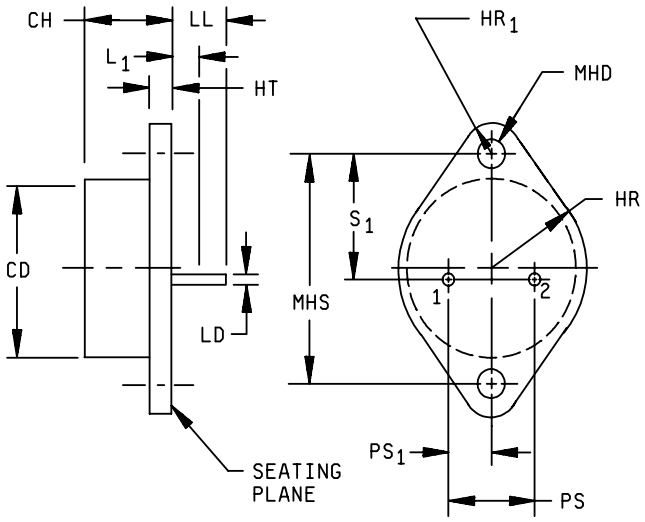
1.4 Primary electrical characteristics.

	h_{FE2} I_C = 4 A dc V_{CE} = 4 V dc (1)	C_{obo} I_E = 0, V_{CB} = 10 V dc 100 kHz ≤ f ≤ 1 MHz	$\lvert h_{fe} \rvert$ I_C = 1 A dc V_{CE} = 4 V dc f = 100 kHz	$V_{CE(sat)}$ I_C = 4 A dc I_B = 0.4 A dc (1)	Pulse response	
					t_{on}	t_{off}
		pF		V dc	µs	µs
Min	20		8			
Max	60	700	40	0.75	6	12

(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@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil .

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD		.875		22.22	
CH	.270	.380	6.86	9.65	
* HT	.060	.135	1.52	3.43	
HR	.495	.525	12.57	13.3	
HR_1	.131	.188	3.33	4.78	
LD	.038	.043	0.97	1.09	7
LL	.312	.500	7.92	12.70	
L_1		.050		1.27	
MHD	.151	.165	3.84	4.19	
MHS	1.177	1.197	29.90	30.40	
PS	.420	.440	10.67	11.18	4
PS_1	.205	.225	.521	5.72	4
s_1	.655	.675	16.64	17.15	



NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Terminal 1, emitter, terminal 2,base, case, collector.
4. These dimensions should be measured at points .050-.055 inch (1.27-1.40 mm) below seating plane. When gauge is not used, measurement will be made at the seating plane.
5. The seating plane of the header shall be flat within .004 inch (0.10 mm) concave to .004 inch (0.10 mm) convex inside a .930 inch (23.62 mm) diameter circle on the center of the header and flat within .006 inch (0.15 mm) concave to .006 inch (0.15 mm) convex overall.
6. Collector shall be electrically connected to the case.
7. LD applies between L_1 and LL. Diameter is uncontrolled in L_1.
8. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 1. Physical dimensions of transistor types 2N3055 (TO-3).

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 http://assist.daps.dla.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 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.

3.4.1 Lead finish. 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 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

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

3.7 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 III tests, the tests specified in table III 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 and JANTXV 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
	JANTX, JANTXV levels only
(1) 3c	Thermal impedance (transient), method 3131 of MIL-STD-750, see 4.3.2
9	Not applicable
11	I_{CEX1}, h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein. ΔI_{CEX1} = 100 percent or 100 μA dc whichever is greater, Δh_{FE2} = ±25 percent of initial value.

(1) Shall be performed anytime after temperature cycling, screen 3a, and 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 = +187.5°C ±12.5°C, V_{CB} = 10 - 30 V dc. NOTE: No heat sink or forced air cooling on the devices shall be permitted.

* 4.3.2 Thermal impedance measurements). The thermal impedance 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). Measurement delay time (t_{MD}) = 70 μs max. See table III, group E, subgroup 4 herein.

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. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2.

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2. Delta requirements shall be in accordance with the applicable steps of table II herein.

Subgroup	Method	Conditions
B3	1027	T_J = +187.5°C ±12.5°C, V_{CB} = 10 - 30 V dc.
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. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2. Delta requirements shall be in accordance with the applicable steps of table II herein.

Subgroup	Method	Conditions
C2	1056	Test condition B.
C2	2036	Test condition A, weight = 10 lbs, application time = 15 seconds.
* C5	3131	See 4.3.2, $R_{\theta JC}$ = 1.5 °C/W.
C6	1026	V_{CB} = 10 - 30 V dc, T_J = +187.5°C ±12.5°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 III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2. Delta requirements shall be in accordance with the applicable steps of table II herein.

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 Coil selection for safe operating area (SOA) tests. In selecting coils for use in the clamped and unclamped inductive SOA tests, prime consideration should be given to the recommended commercially available coil. However, due to the extreme critical nature of the coil in these circuits and the wide tolerance of some commercially available coils (+100 percent, -50 percent), it shall be the semiconductor manufacturer's responsibility to prove upon request, compliance or equivalency of any coil used (commercial or in plant designed) to be within (+20 percent, -10 percent) of the specified inductance at the rated current and dc resistance.

* 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
Breakdown voltage collector to emitter	3011	Bias condition D, I_C = 200 mA dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$	70		V dc
Breakdown voltage collector to emitter	3011	Bias condition B, I_C = 200 mA dc, pulsed (see 4.5.1), R_{BE} = 100 ohms	$V_{(BR)CER}$	80		V dc
Breakdown voltage collector to emitter	3011	Bias condition D, I_C = 200 mA dc, pulsed (see 4.5.1), V_{BE} = -1.5 V dc	$V_{(BR)CEX}$	90		V dc
Collector-emitter cutoff current	3041	Bias condition D, V_{CE} = 60 V dc	I_{CEO}		1	mA dc
Collector-emitter cutoff current	3041	Bias condition A, V_{CE} = 100 V dc, V_{BE} = -1.5 V dc	I_{CEX1}		1	mA dc
Emitter-base cutoff current	3061	Base condition D, V_{EB} = 7 V dc	I_{EBO}		1	mA dc
Forward-current transfer ratio	3076	V_{CE} = 4 V dc, I_C = 0.5 A dc	h_{FE1}	40		
Forward-current transfer ratio	3076	V_{CE} = 4 V dc, I_C = 4 A dc, pulsed (see 4.5.1)	h_{FE2}	20	60	
Forward-current transfer ratio	3076	V_{CE} = 4 V dc, I_C = 10 A dc, pulsed (see 4.5.1)	h_{FE3}	5		
Collector-emitter saturated voltage	3071	I_C = 4 A dc, I_B = 0.4 A dc, pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.75	V dc
Base-emitter saturated voltage	3066	Test condition B, V_{CE} = 4 V dc, I_C = 4 A dc, pulsed (see 4.5.1)	V_{BE}		1.4	V dc
Collector-emitter saturated voltage	3071	I_C = 10 A dc, I_B = 3.3 A dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		2	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 emitter cutoff current	3041	Bias condition A, V_{CE} = 100 V dc, V_{BE} = -1.5 V dc	I_{CEX2}		10	mA dc
* Low temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 4 V dc, I_C = 4 A dc, pulsed (see 4.5.1)	h_{FE4}	15		
Subgroup 4						
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 4 V dc, I_C = 1 A dc, f = 100 kHz	$\lvert h_{fe} \rvert$	8	40	
Open circuit output capacitance	3236	V_{CB} = 10 V dc, I_C = 0, 100 kHz ≤ f ≤ 1 MHz	C_{obo}		700	pF
Subgroup 5						
Pulse response	3251	Test condition A				
Turn-on time		V_{CC} = 30 V dc, I_C = 4 A dc, I_{B1} = 0.4 A dc, see figure 4	t_{on}		6	µs
Turn-off time		V_{CC} = 30 V dc, I_C = 4 A dc I_{B1} = $-I_{B2}$ = 0.4 A dc, see figure 4	t_{off}		12	µs
Subgroup 6						
Safe operating area (continuous dc)	3051	T_C = +25°C, 1 cycle, t = 1 s, (see figure 5)				
Test 1		V_{CE} = 7.8 V dc, I_C = 15 A dc				
Test 2		V_{CE} = 70 V dc, I_C = 1.67 A dc				
Electrical measurements		See table I, subgroup 2				

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 6 - Continued						
Safe operating area (switching)	3053	Load condition C, (unclamped inductive load) (see figure 6), T_A = +25°C, duty cycle ≤ 10 percent, R ≤ 0.1 ohms				
Test 1		t_p = 5 ms (vary to obtain I_C), R_{BB1} = 2 ohms, $V_{BB1} \geq$ 10 V dc, R_{BB2} = 100 ohms, $V_{CC} \geq$ 10 V dc, V_{BB2} = 1.5 V dc, I_C = 15 A dc, the coil used shall provide a minimum inductance of 2 mH at 15 A dc with a maximum dc resistance of 0.1 ohms (for reference only: Signal Transformer Co. CH-50, or equivalent) (see 4.5.2).				
* Test 2		t_p = 20 ms (vary to obtain I_C), R_{BB1} = 30 ohms, $V_{BB1} \geq$ 10 V dc, R_{BB2} = 100 ohms, $V_{CC} \geq$ 10 V dc, V_{BB2} = 0 V dc, I_C = 4.2 A dc, the coil used shall provide a minimum inductance of 40 mH at 3.8 A dc with a maximum dc resistance of 0.5 ohms (for reference only: Signal Transformer Co. CH-8, or equivalent) (see 4.5.2).				
Electrical measurements		See table I, subgroup 2				
Subgroup 7						
Safe operating area (switching)	3053	T_A = +25°C, duty cycle ≤ 10 percent, t_p = 10ms (vary to obtain I_C), $R_S \leq$ 0.1 ohms, $V_{CC} \geq$ 10 V dc, I_C = 15 A dc, clamp voltages = 90 V dc (see figure 7)				
Electrical measurements		See table I, subgroup 2				

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

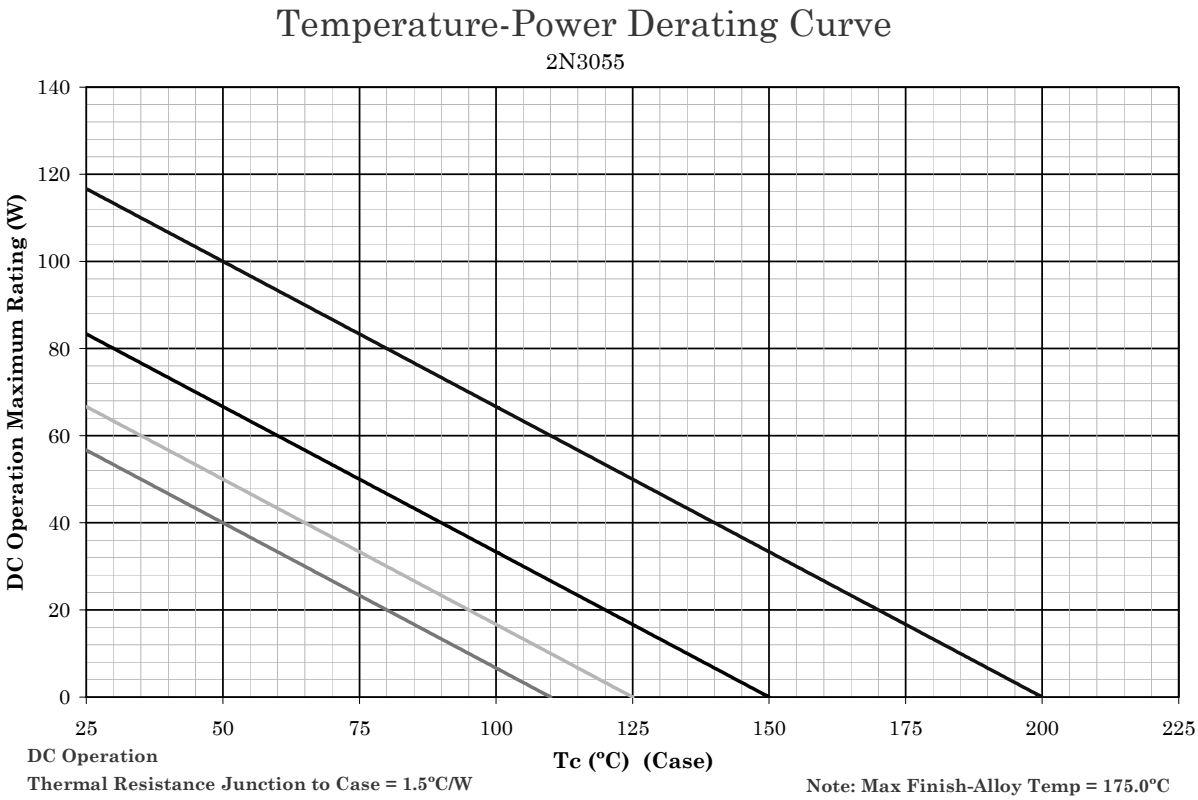
TABLE II. Groups A, B, C, and E delta measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = -1.5 V dc, V_{CE} = 100 V dc	ΔI_{CEX1}	±100 percent of initial value or 100 μA dc, which ever is greater		
2.	Forward-current transfer ratio	3076	V_{CE} = 4 V dc, I_C = 4 A dc, pulsed (see 4.5.1)	Δh_{FE2}	±25 percent change in initial recorded value		

1/ The delta measurements for table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are: Subgroups 3 and 6, see table II herein, steps 1 and 2.
2/ The delta measurements for table E-VII of MIL-PRF-19500 are: Subgroup 6, see table II herein, steps 1 and 2.
3/ The delta measurements for table E-IX of MIL-PRF-19500 are: Subgroups 1 and 2, see table II herein, all steps.

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

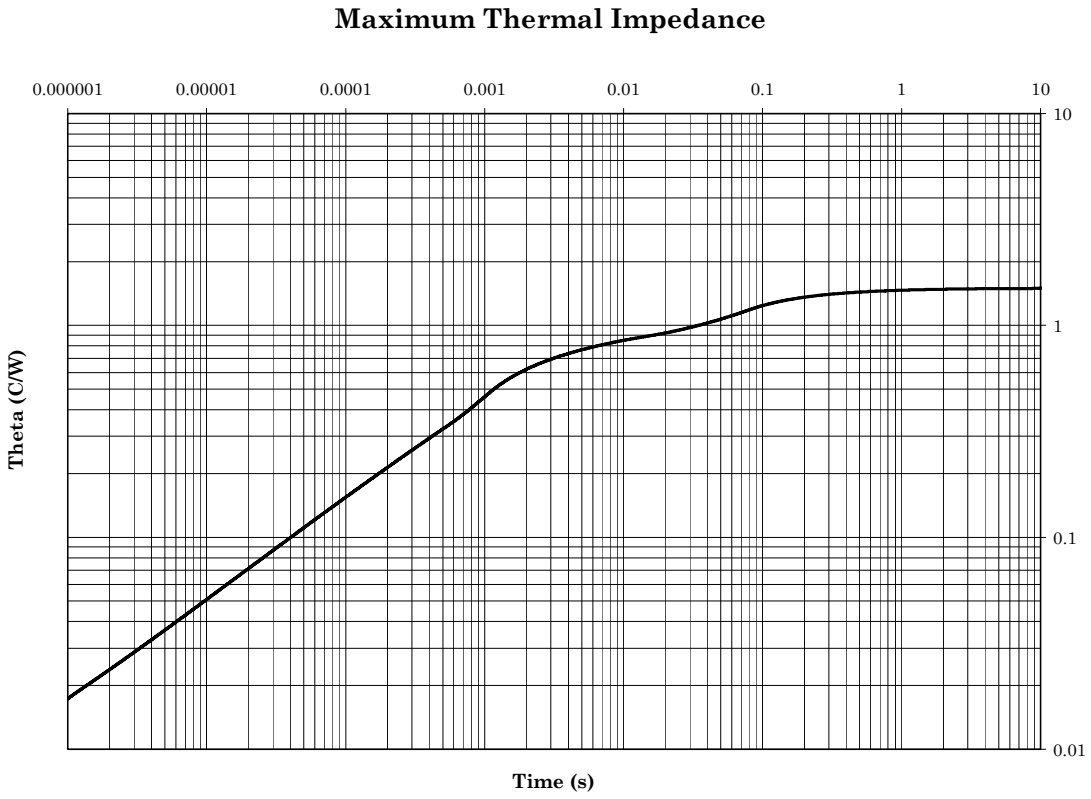
Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	500 cycles minimum	
Hermetic seal	1071		
Fine leak		Test conditions G or H	
Gross leak		Test conditions C or D	
Electrical measurements		Table I, subgroup 2 and table II herein.	
Subgroup 2			45 devices c = 0
Blocking life	1048	Test temperature = +125°C, V_{CB} = 80 percent of rated, T = 1,000 hours.	
Electrical measurements		Table I, subgroup 2 and table II herein.	
Subgroup 4			sample size N/A
Thermal impedance curves		See MIL-PRF-19500.	
Subgroup 6			3 devices
ESD	1020	Testing not required for class 3 listing. Testing is required for nonsensitive listing to prove capability.	
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition B	



NOTES:

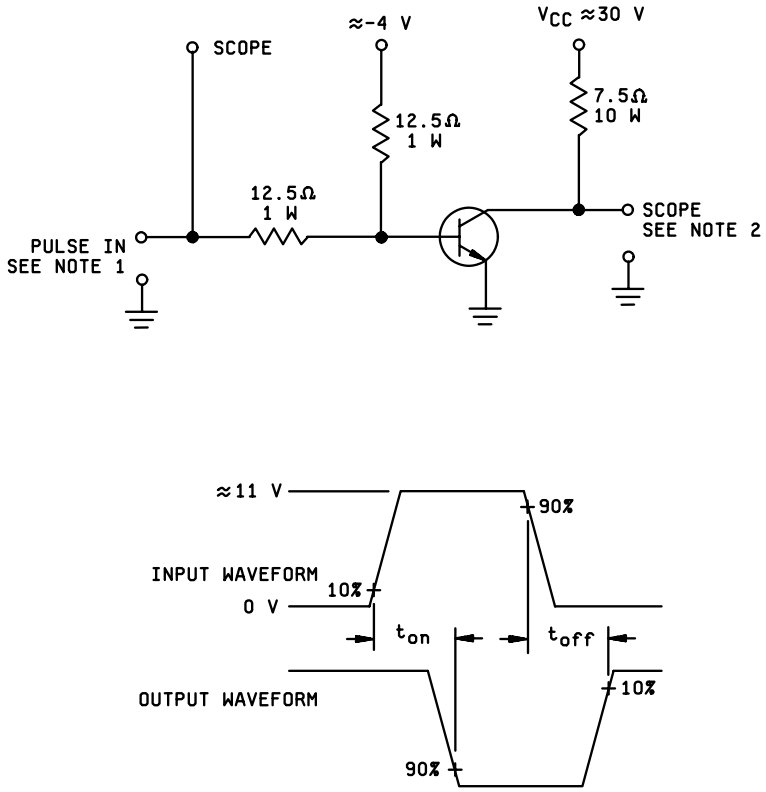
1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq +200°C$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq +150°C$ where the maximum temperature of electrical test is performed.
4. Derate design curves 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 (TO-3).



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

FIGURE 3. Transient thermal impedance graph.



NOTES:

1. The rise time (t_r) and fall time (t_f) of applied pulse shall be each ≤ 20 ns, duty cycle ≤ 2 percent, generator source impedance shall be 50Ω, pulse width = 20 μs.
2. Output sampling oscilloscope: Z_{in} ≥ 100 kΩ, C_{in} ≤ 50 pF, rise time ≤ 2 ns.

FIGURE 4. Pulse response test circuit.

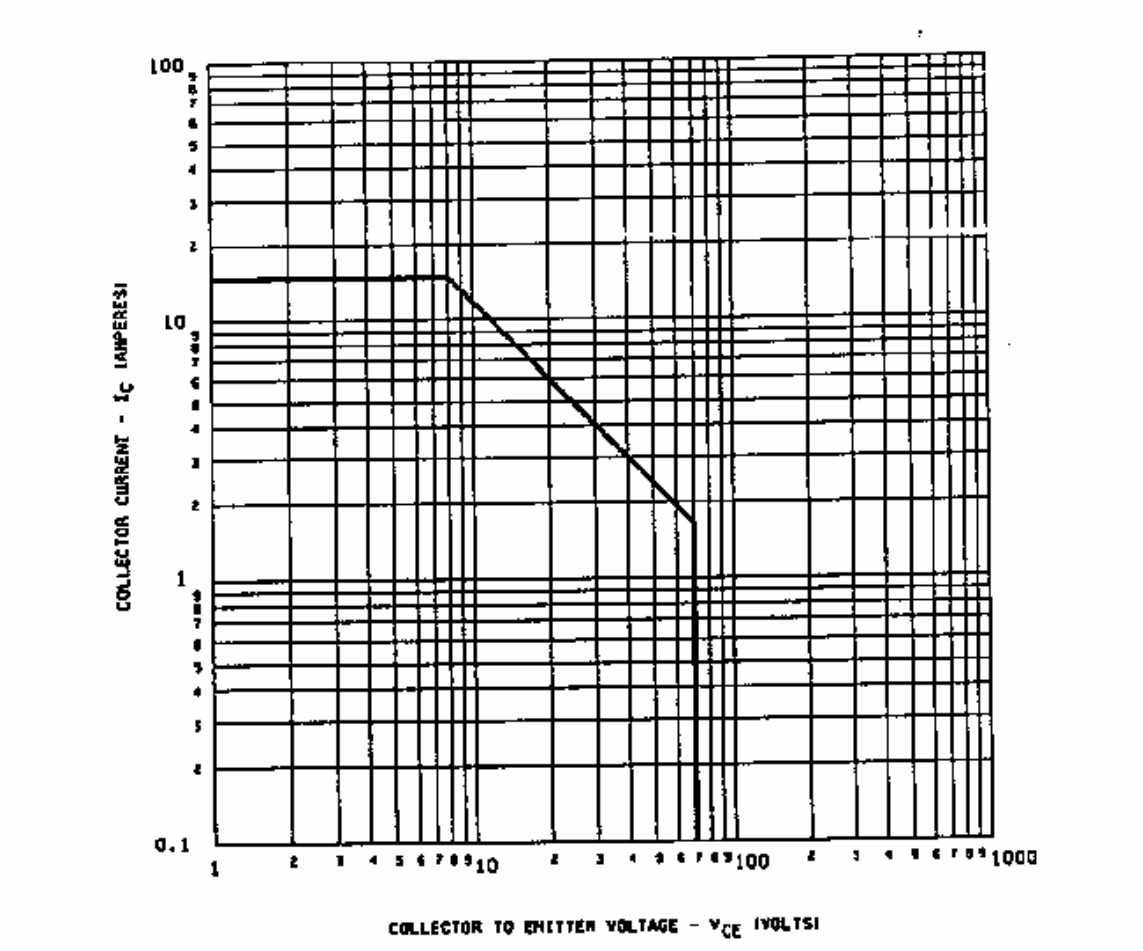


FIGURE 5. Maximum safe operating area graph (continuous dc).

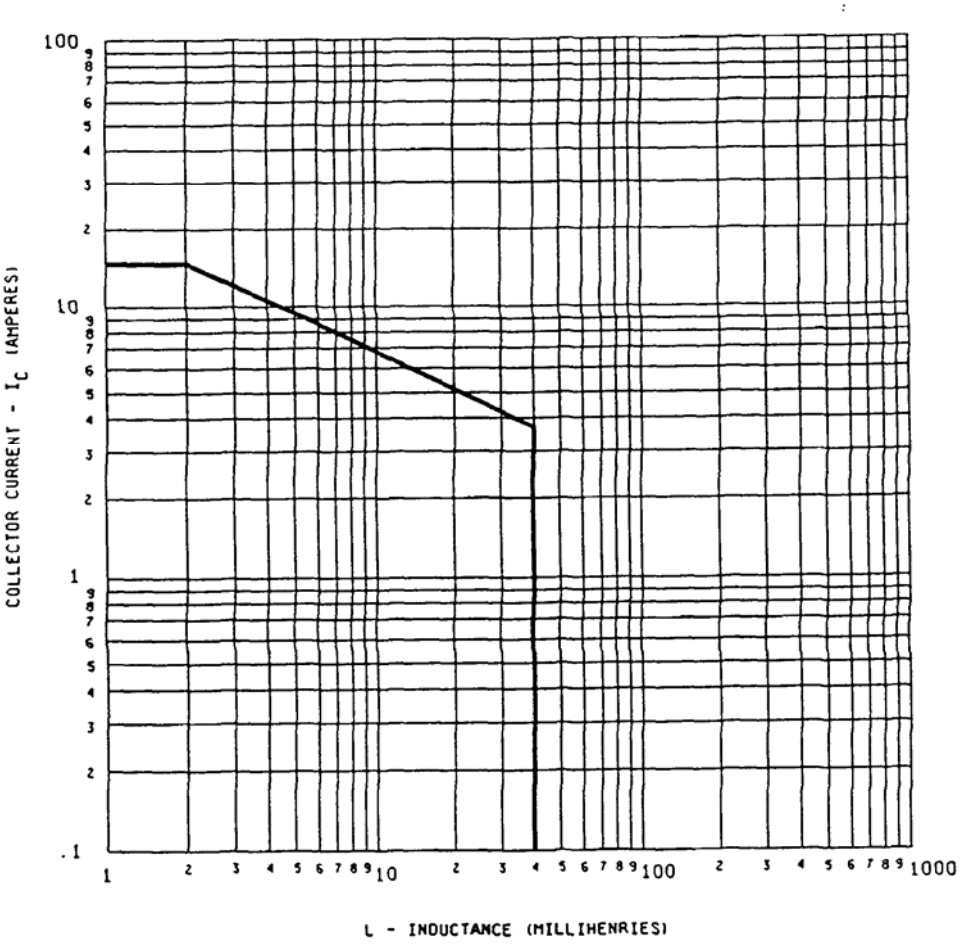
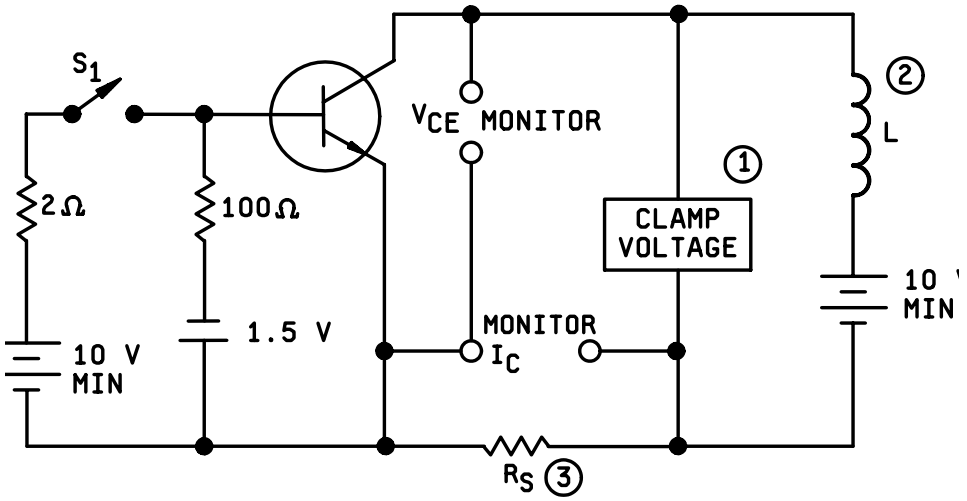


FIGURE 6. Safe operating area for switching between saturation and cutoff (unclamped inductive load).



NOTES:

1. Either a clamping circuit or clamping diode may be used.
2. The coil used shall provide a minimum inductance of 5 mH at 15 A dc with a maximum dc resistance of 0.1 ohm. (For reference only: Signal Transformer Co., CH-20, or equivalent). (See 4.5.2.)
3. $R_S \leq 0.1$ ohm, 12 W, 1 percent tolerance maximum (non-inductive).

Procedure:

1. With switch S_1 closed, set the specified test conditions.
2. Open S_1. Device fails if clamp voltage not reached and maintained until the current returns to zero.
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 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).

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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil.

6.4 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, AV, MI, SM
Navy - AS, MC
Air Force - 19, 99

Preparing activity:
DLA - CC

(Project 5961-2007-011)

* NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil/ .