This documentation process conversion measures necessary to comply with this revision shall be completed by 30 October 1999.

INCH-POUND

MIL-PRF-19500/402C
30 August 1999
SUPERSEDING
MIL-S-19500/402B
8 April 1993

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
TYPE 2N3739
JAN, JANTX AND JANTXV

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

1.2 Physical dimensions. See figure 1 (similar to TO-66)

1.3 Maximum ratings.

Types	P_T 1/ T_C = +25°C	P_T 2/ T_C = +100°C	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_{STG} and T_J	$R_{\Theta JC}$
	W	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W
2N3739	20	10	325	300	6.0	0.5	1.0	-55 to +200	7.5

1/ Derate linearly, 0.114 W/°C for $T_C \geq +25°C$.
2/ Derate linearly, 0.100 W/°C for $T_C \geq +100°C$.

1.4 Primary electrical characteristics at T_A = 25°C.

Limit	h_{FE1} 1/	h_{FE3} 1/	V_{BE}	$V_{CE(SAT)}$	C_{obo}	$\|h_{fe}\|$	Switching	
	V_{CE} = 10 V dc I_C = 10 mA dc	V_{CE} = 10 V dc I_C = 100 mA dc	V_{CE} = 10 V dc I_C = 100 mA dc	I_C = 250 mA dc I_B = 25 mA dc	V_{CB} = 100 V dc I_E = 0 mA dc 100 kHz≤f≤1 MHz	V_{CE} = 10 V dc I_C = 100 mA dc f = 10 MHz	t_{on}	t_{off}
			V dc	V dc	pF		µs	µs
Min	30	40				1		
Max		200	1	2.5	20	6	1.5	3.5

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: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, 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

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 - Performance Specification Semiconductor Devices, General Specification for.

STANDARD

MILITARY

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Sevice, 700 Robbins Avenue, Building 4D (DPM-DODSSP), 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 (except for related associated specifications or specification sheets), 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 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2 and 6.4).

3.2 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

3.2.1 Lead finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein.

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

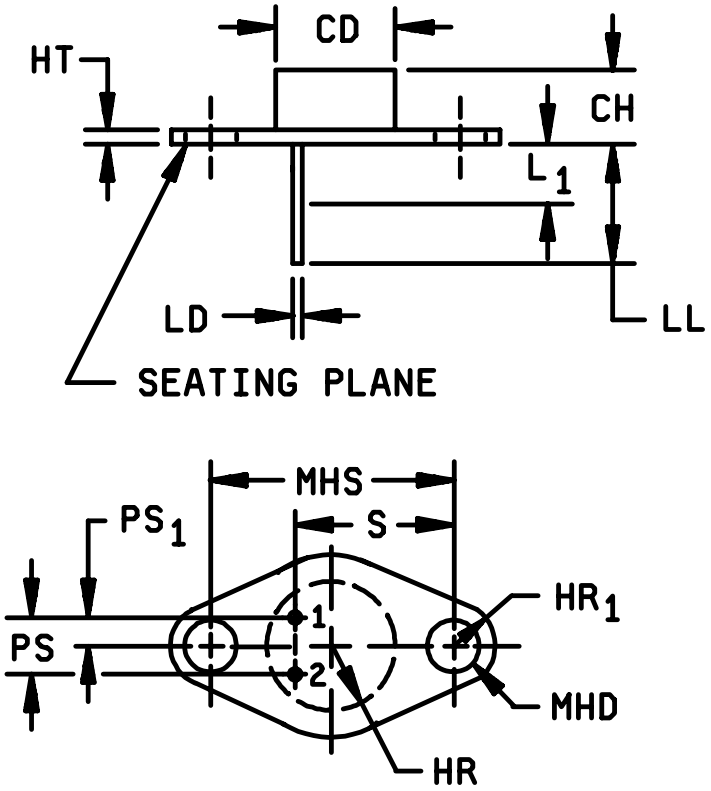
3.4 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

3.4 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-PRF-19500.

3.5 Interface requirements and physical dimensions. The Interface requirements, and physical dimensions shall be as specified in MIL-PRF-19500, and figure 1 herein.

3.6 Marking. Devices shall be marked in accordance with MIL-PRF-19500.

Symbol	T-5A		Note
	Min	Max	
CD		.620	
CH	.250	.340	
HR		.350	
HT	.050	.075	
HR_1	.115	.145	4
LD	.028	.034	4, 6
LL	.360	.500	
L_1		.050	6
MHD	.142	.152	4
MHS	.958	.962	
PS	.190	.210	3
PS1	.093	.107	3
S	.570	.590	
Notes	1, 2, 5, 7		



Inches	mm	Inches	mm
.028	0.71	.250	6.35
.034	0.86	.340	8.64
.050	1.27	.350	8.89
.075	1.91	.360	9.14
.093	2.36	.470	11.94
.107	2.72	.50	12.70
.115	2.92	.570	14.48
.142	3.61	.590	14.99
.145	3.68	.620	15.75
.152	3.86	.958	24.33
.190	4.83	.962	24.43
.210	5.33		

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. These dimensions should be measured at points .050 inch (1.27 mm) +.005 inch (0.13 mm) -.000 inch (0.00 mm) below seating plane. When gauge is not used, measurement will be made at the seating plane.
4. Two places.
5. The seating plane of the header shall be flat within .001 inch (0.03 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 .001 inch (0.03 mm) concave to .006 inch (0.15 mm) convex overall.
6. Lead diameter shall not exceed twice LD within L_1.
7. Lead designation, depending on device type, shall be as follows:

Lead number	Bipolar transistor
1	Emitter
2	Base
Case	Collector

FIGURE 1. Physical dimensions. (Similar to TO-66).

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).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening (JANTX AND JANTXV levels only). Screening shall be in accordance with MIL-PRF-19500 (table IV), 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
	JANTX and JANTXV levels only
9	Not applicable
11	h_{FE2} and I_{CBO1}
12	See 4.3.1
13	Subgroup 2 of table I herein, ΔI_{CBO1} = 100% of initial value or 10 μA dc, whichever is greater Δh_{FE2} = ±20% of initial value

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

2N3739 - - - - $V_{CB} \geq 50$ V dc, $T_J = +162.5°C \pm 12.5°C$

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. Group A inspection shall be performed on each sublot.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with 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 table 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 and delta requirements shall be in accordance with 4.5.2 herein.

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

Subgroup	Method	Conditions
B3	1037 1026	For solder die attach: $V_{CB} \geq 10$ V dc, 2,000 cycles. $T_A \leq 35°C$ For eutectic die attach: $V_{CB} \geq 10$ V dc, $T_A \leq 35°C$ adjust P_T to achieve $T_J = 150°C$ min.
B4		Bond pull condition (see figure 6)
B6		Not applicable

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 and as follows. Electrical measurements (end points) shall be in accordance with table I, subgroup 2 and delta requirements shall be in accordance with 4.5.2, herein.

4.4.3.1 Group C inspection, appendix E, table VII of MIL-PRF-19500.

Subgroup	Method	Conditions
C6	1037 1026	For solder die attach: $V_{CB} \geq 10$ V dc, 6,000 cycles. $T_A \leq 35°C$ For eutectic die attach: $V_{CB} \geq 10$ V dc, $T_A \leq 35°C$ adjust P_T to achieve $T_J = 150°C$ min.

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 Delta requirements. Delta requirements shall be as specified below:

Step	Inspection	MIL-STD-750		Symbol	Limit 1/ 2/	Unit
		Method	Conditions			
1	Collector to base cutoff current	3036	Bias condition D; V_{CB} = 325 V dc	ΔI_{CBO}	100 percent or 10 μA dc, whichever is greater	
2	Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 100 mA dc pulsed (see 4.5.1)	Δh_{FE1}	±25 percent change from initial recorded value.	

1/ The electrical measurements for table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500 are as follows:

a. Subgroups 3 and 6, 4.5.2 herein, steps 1 and 2.

2/ The electrical measurements for table VII of MIL-PRF-19500 are as follows:

a. Subgroup 6, see 4.5.2 herein, steps 1 and 2.

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						
Breakdown voltage, collector to emitter	3011	Bias condition D, I_C = 5.0 mA dc	$V_{(BR)CEO}$	300		V dc
Collector to base cutoff current	3036	Bias condition D, V_{CB} = 325 V dc	I_{CBO1}		0.1	mA dc
Collector to emitter cutoff current	3041	Bias condition A, V_{CE} = 300 V dc, V_{BE} = 1.5 V dc	I_{CEX}		0.5	mA dc
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 6.0 V dc	I_{EBO}		0.1	mA dc
Base to emitter, non-saturated voltage	3066	Test condition B, V_{CE} = 10 V dc, I_C = 100 mA dc; pulsed (see 4.5.1)	V_{BE}		1	V dc
Collector to emitter voltage (saturated)	3071	I_C = 100 mA dc; I_B = 10 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.75	V dc
Collector to emitter voltage (saturated)	3071	I_C = 250 mA dc; I_B = 25 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		2.5	V dc
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE1}	30		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 50 mA dc; pulsed (see 4.5.1)	h_{FE2}	30		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 100 mA dc; pulsed (see 4.5.1)	h_{FE3}	40	200	
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 250 mA dc; pulsed (see 4.5.1)	h_{FE4}	25		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 500 mA dc; pulsed (see 4.5.1)	h_{FE5}	10		

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

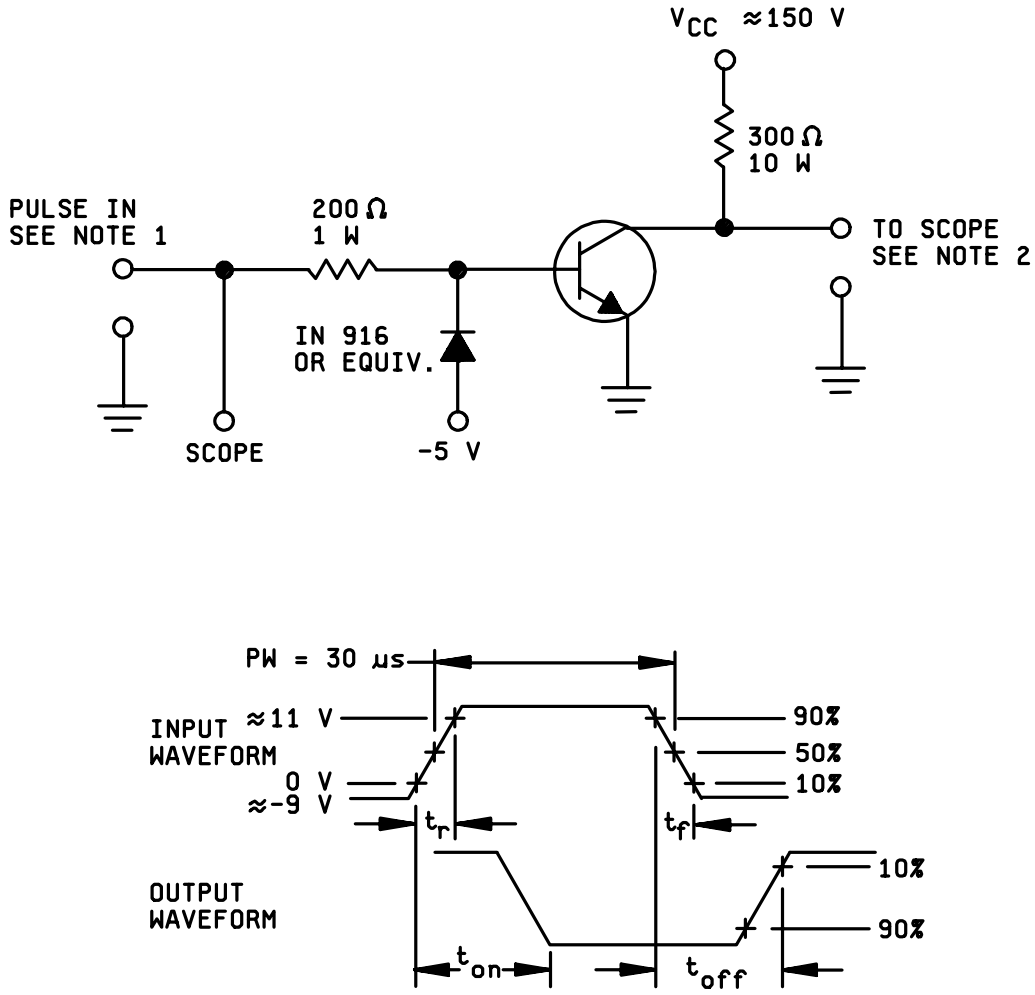
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D, V_{CB} = 325 V dc	I_{CBO2}		1.0	mA dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 100 mA dc; pulsed (see 4.5.1)	h_{FE6}	15		
Subgroup 4						
Pulse response:						
Turn-on time		V_{CC} = 150 V dc; I_C = 500 mA dc; I_B = 50 mA dc (see figure 2)	t_{on}		1.5	µs
Turn-off time		V_{CC} = 150 V dc; I_C = 500 mA dc; $I_{B1} = I_{B2}$ = 50 mA dc (see figure 2)	t_{off}		3.5	µs
Magnitude of common emitter, small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 100 mA dc; f = 10 MHz	$\|h_{FE}\|$	1.0	6	
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 20 V dc; I_C = 100 mA dc	h_{fe}	35	300	
Open circuit output capacitance	3236	V_{CB} = 100 V dc; I_E = 0 mA dc; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		20	pF
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = +25°C; t = 1 s; 1 cycle; (see figure 3)				
Test 1		V_{CE} = 80 V dc; I_C = 250 mA dc				
Test 2		V_{CE} = 290 V dc; I_C = 6 mA dc				

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued						
Safe operating area (switching)	3053	Load condition C (unclamped inductive load) (see figure 4) T_A = +25°C; duty cycle ≤ 10%; R_s = 1Ω; t_r = t_f ≤ 500 ns				
Test 1		t_p approx 8 ms (Vary to obtain I_C); R_{BB1} = 100Ω; V_{BB1} ≥ 10 V dc; R_{BB2} = ∞; V_{BB2} = 0 V dc; V_{CC} ≥ 100 V dc; I_C = 500 mA dc; The coil used shall provide a minimum inductance of 3.5 mH at 500 mA with max. dc resistance of 0.5 ohm (For reference only: Acme T58220, or equivalent)				
Test 2		t_p approx 8 ms (Vary to obtain I_C); R_{BB1} = 100Ω; V_{BB1} ≥ 10 V dc; R_{BB2} = ∞; V_{BB2} = 0 V dc; V_{CC} ≥ 100 V dc; I_C = 100 mA dc; The coil used shall provide a minimum inductance of 25 mH at 100 mA with max. dc resistance of 1.0 ohm (For reference only: Triad C-48u, centertapped, or equivalent.)				
Safe operating area (switching)		T_A = +25°C; duty cycle ≤ 10%; t_p approx 8 ms (Vary to obtain I_C) V_{CC} ≥ 100 V dc; I_C = 1 A dc; R_s = 1Ω; clamp voltage = 300 V dc				
Electrical measurements		See table I, subgroup 2				

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



NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be each ≤ 20 ns; duty cycle ≤ 1 percent; generator source impedance shall be 50 ohms.
2. Output sampling oscilloscope: $Z_{in} \geq 100$ kΩ; $C_{in} \leq 50$ pF; rise time ≤ 2.0 ns.

FIGURE 2. Pulse response test circuit.

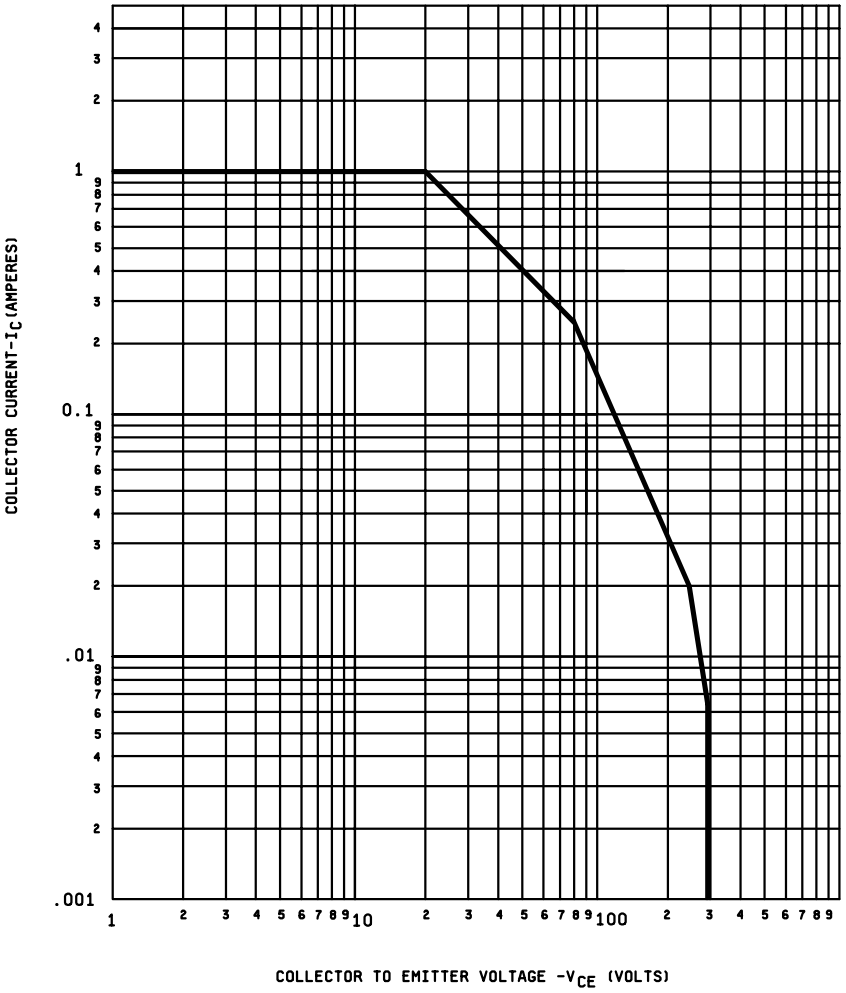


FIGURE 3. Maximum safe operating area graph (continuous dc).

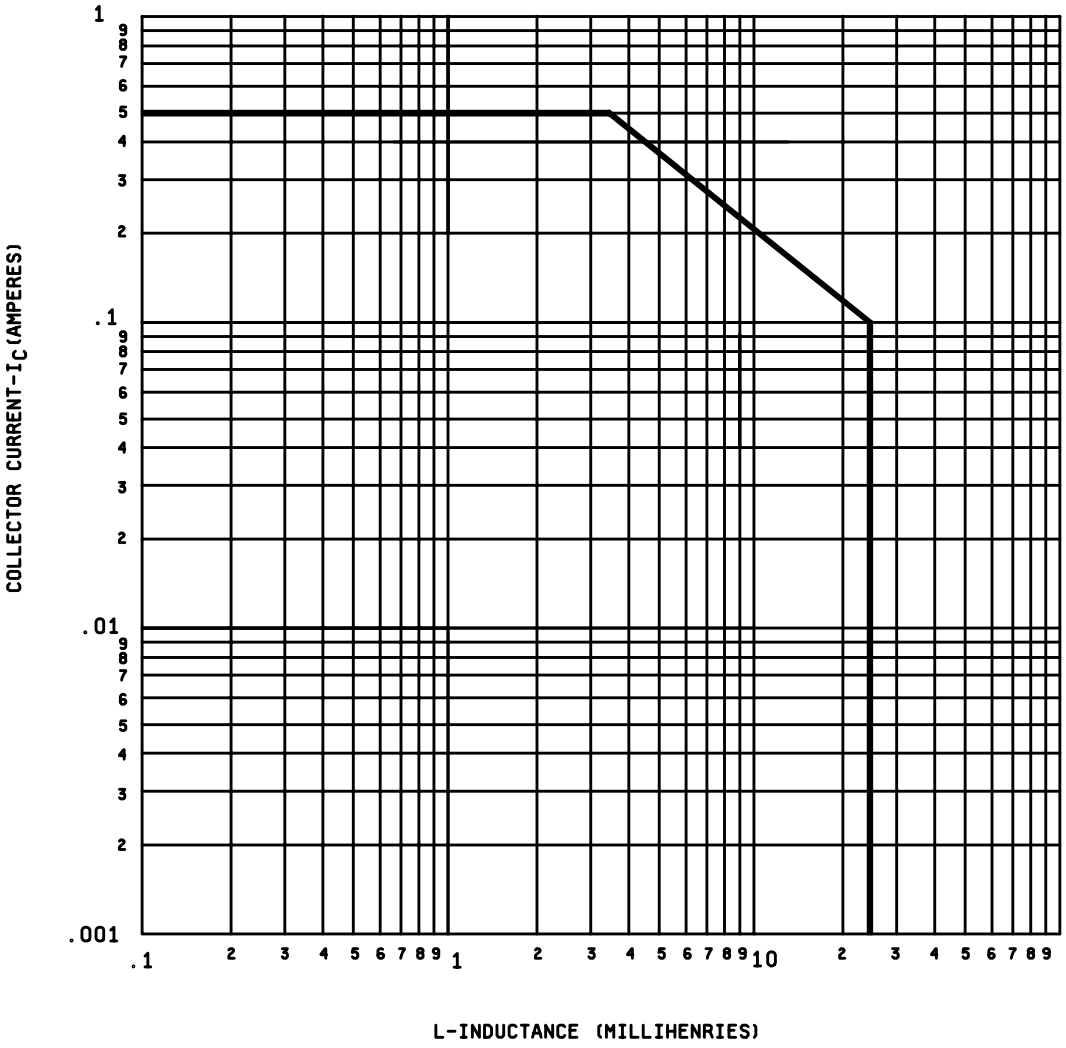
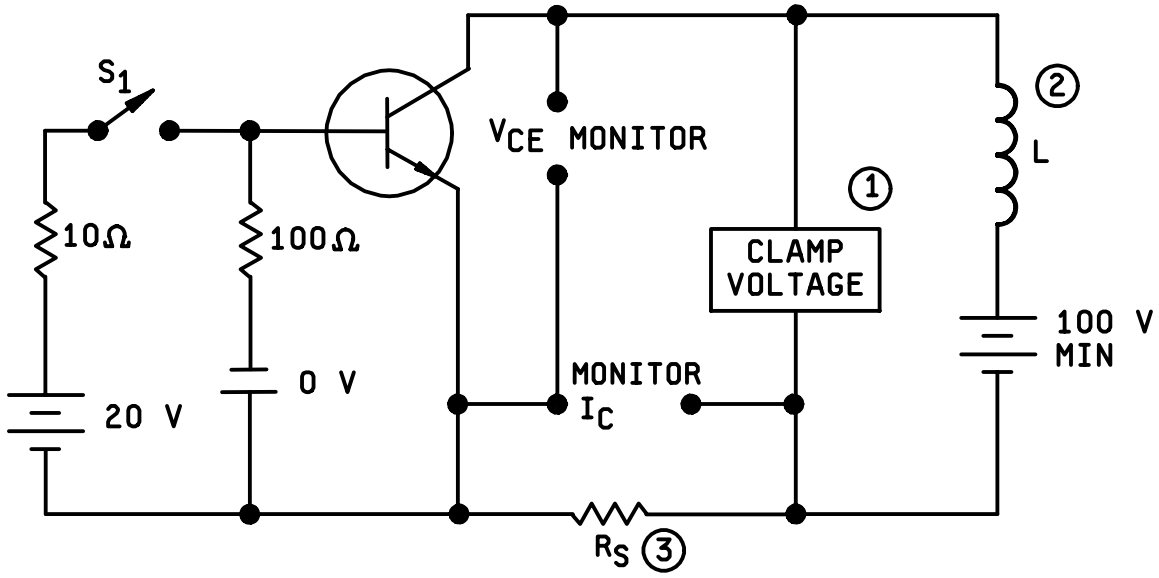


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).



NOTES:
1. Either a clamping circuit or clamping diode may be used.
2. The coil used shall provide a minimum inductance of 25 mH at 1 A with a maximum dc resistance of 1 ohm. For reference only: Triad C-48u (center-tapped), or equivalent (see 4.4.5)
3. $R_S \leq 1$ ohm, 12 W, 1% tolerance max., (noninductive).

Procedure:

1. With switch S_I 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 endpoint tests.

FIGURE 5. Clamped inductive sweep test circuit.

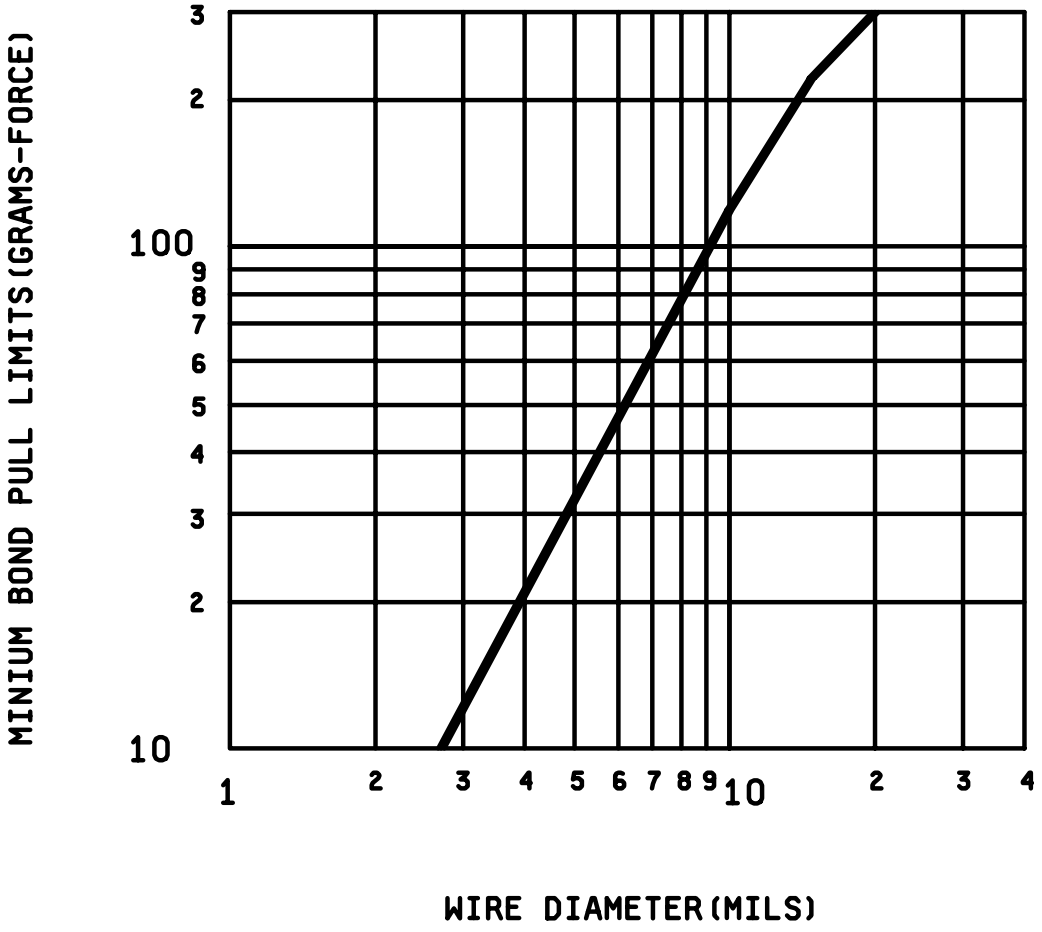


FIGURE 6. Minimum destructive bond-pull breaking-force vs. wire diameter for aluminum wire bonds.

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 material 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 Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' 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 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2.1).

b. Lead finish as specified (see 3.2.1).

c. Type designation and product assurance level.

d. Packing requirements (see 5.1)

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

6.4 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 purchase 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, 3990 East Broad Street, Columbus, OH 43216-5000.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - EC
Air Force - 11
NASA - NA
DLA - CC

Review activities:
Army - AR, AV, MI, SM
Navy - AS, CG, MC, SH
Air Force - 13, 19

Preparing activity:
DLA - CC

(Project 5961-2153)

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-19500/402C	**2. DOCUMENT DATE**

3. DOCUMENT TITLE Semiconductor Device, Transistor, NPN, Silicon, Power Types 2N3739, JAN, JANTX and JANTXV

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 Al Barone	d. TELEPHONE (Include Area Code) Commercial DSN 850-0510 FAX (614) 692-6939 EMAIL alan_barone@dscc.dla.mil
c. ADDRESS Defense Supply Center Columbus ATTN: DSCC-VAC 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 Road, Suite 2533, Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888

DD Form 1426, FEB 1999 (EG) **Previous editions are obsolete**