

The documentation and process conversion measures necessary to comply with this revision shall be completed by 27 September 1999.

INCH-POUND

MIL-PRF-19500/287E
27 June 1999
SUPERSEDING
MIL-S-19500/287D
5 February 1993

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN SILICON, SWITCHING
TYPE 2N3013
JAN AND JANTX

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 switching transistors. Two 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 T0- 52).

1.3 Maximum ratings.

Types	P _T 1/	P _T 2/	V _{CB0}	V _{CEO}	I _C	I _C	T _{STG} and T _{OP}
	T _A = +25°C	T _C = +25°C					
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C</u>
2N3013	0.36	1.2	40	20	5.0	300	-65 to +200

1/ Derate linearly, 2.10 mW/°C for T_A = 25°C.

2/ Derate linearly, 6.86 mW/°C for T_A = 25°C.

1.4 Primary electrical characteristics at T_A = +25°C.

Limit	h _{FE1} 1/ V _{CE} = 0.4 V dc I _C = 30 mA dc	V _{CE(sat)1} 1/ I _C = 30 mA dc I _B = 3.0 mA dc	V _{BE(sat)2} 1/ I _C = 30 mA dc I _B = 3.0 mA dc	t _{on}	t _{off}	h _{FE} V _{CE} = 10 V dc I _C = 30 mA dc f = 100 MHz
				I _C = 300 mA dc I _{B1} = 30 mA dc V _{CC} + 15 V dc	I _C = 300 mA dc I _{B1} = 30 mA dc I _{B2} = 30 mA dc	
Minimum	35	<u>V dc</u>	<u>V dc</u>	<u>ns</u>	<u>ns</u>	35
Maximum	120	0.18	0.75 0.95	15	25	12

1/ Pulsed (see 4.5.1)

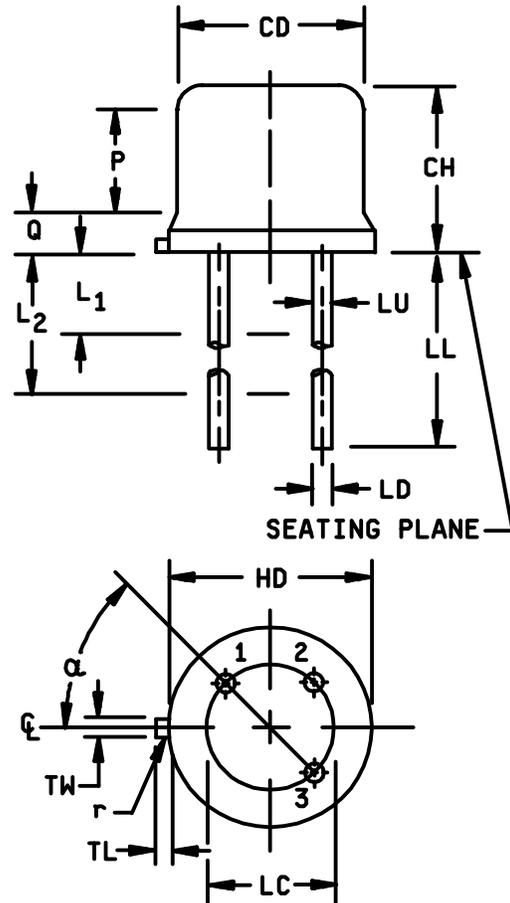
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad St., Columbus, OH 43216-5000, by using the addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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FSC 5961

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7,8
LL	.500	.750	12.70	19.05	7,8,13
LU	.016	.019	0.41	0.48	7,8
L1	---	.050	---	1.27	7,8
L2	.250	---	6.35	---	7,8
Q	---	.030	---	0.76	5
TL	.028	.048	0.71	1.22	3,4
TW	.036	.046	0.91	1.17	3
r	---	.010	---	0.25	10
α	45° TP		45° TP		6



NOTES:

1. Dimension are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, TL shall be held for a minimum length of .011 (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by the gauge and gauging procedure shown in figure 2.
7. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
8. All three leads.
9. The collector shall be electrically connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕ x symbology.
12. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 1. Physical dimensions (similar to TO-52).

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

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

3.3 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500, MIL-HDBK-6100, and herein.

3.3.1 Lead finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the contract or purchase order (see 6.2).

3.4 Marking. Devices shall be marked in accordance with MIL-PRF-19500. At the option of the manufacturer, the marking of the country of origin may be omitted from the body of the transistor.

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 the subgroups specified in table I.

3.7 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 6.4).

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 and as specified herein.

4.3 Screening. 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 levels
9	Not applicable
11	I_{CES1} and h_{FE1}
12	See 4.3.1
13	Subgroup 2 of table I herein, $\Delta I_{CES1} = 100$ percent of initial value or 50 nA dc, whichever is greater. $\Delta h_{FE1} = \pm 20$ percent of initial value.

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

2N3013 - - - - $V_{CB} \geq 10$ V dc, $P_T = 360$ mW at $T_A = +25^\circ \pm 3^\circ\text{C}$.

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

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 subplot.

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 tables VIa (JANS) and VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and paragraphs 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

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

Subgroup	Method	Condition
B3	1027	$V_{CB} \geq 10$ V dc, $T_J = 150^\circ\text{C}$ min, $T_A = +25^\circ\text{C} \pm 5^\circ\text{C}$. No heat sink or forced air cooling on the devices shall be permitted.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

Subgroup	Method	Condition
C2	1056	Thermal shock, test condition A.
C2	2036	Terminal strength, test condition E.
C6	1026	1,000 hours at $V_{CB} \geq 10$ V dc; $T_J = 150^\circ\text{C}$ min, $T_A = +25^\circ\text{C} \pm 5^\circ\text{C}$. No heat sink or forced air cooling on the devices shall be permitted.

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.

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 Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Marking. Unless otherwise specified (see 6.2), marking shall be in accordance with MIL-STD-129.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown to voltage, collector to base	3001	Bias condition D, $I_C = 100 \mu\text{A}$ dc	$V_{(BR)CBO}$	40		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D, $I_C = 10 \text{ mA}$ dc pulsed (see 4.5.1)	$V_{(BR)CEO0}$	20		V dc
Breakdown voltage, collector to emitter	3011	Bias condition C, $I_C = 100 \mu\text{A}$ dc	$V_{(BR)CES}$	40		V dc
Breakdown voltage emitter to base	3026	Bias condition D, $I_E = 100 \mu\text{A}$ dc	$V_{(BR)EBO}$	5		V dc
Collector to emitter cutoff current	3041	Bias condition C, $V_{CE} = 20 \text{ V}$ dc $V_{BE} = 0$	I_{CES1}		300	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 0.4 \text{ V}$ dc; $I_C = 30 \text{ mA}$ dc; pulsed (see 4.5.1)	h_{FE1}	35	120	
Forward-current transfer ratio	3076	$V_{CE} = 0.5 \text{ V}$ dc; $I_C = 100 \text{ mA}$ dc; pulsed (see 4.5.1)	h_{FE2}	30		
Forward-current transfer ratio	3076	$V_{CE} = 1.0 \text{ V}$ dc; $I_C = 300 \text{ mA}$ dc; pulsed (see 4.5.1)	h_{FE3}	15		
Collector to emitter voltage (saturated)	3071	$I_C = 30 \text{ mA}$ dc; $I_B = 3.0 \text{ mA}$ dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.18	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 100 \text{ mA}$ dc; $I_B = 10 \text{ mA}$ dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.28	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 300 \text{ mA}$ dc; $I_B = 30 \text{ mA}$ dc; pulsed (see 4.5.1)	$V_{CE(sat)3}$		0.50	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 30 \text{ mA}$ dc; $I_B = 10 \text{ mA}$ dc; pulsed (see 4.5.1)	$V_{BE(sat)1}$	0.75	0.95	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 100 \text{ mA}$ dc; $I_B = 10 \text{ mA}$ dc; pulsed (see 4.5.1)	$V_{BE(sat)2}$		1.20	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 300 \text{ mA}$ dc; $I_B = 30 \text{ mA}$ dc; pulsed (see 4.5.1)	$V_{BE(sat)3}$		1.70	V 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	
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +125^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition D, $V_{CB} = 20\text{ V dc}$ $V_{BE} = 0$	I_{CES2}		40	$\mu\text{A dc}$
Collector to emitter voltage (saturated)(3071	$I_C = 30\text{ mA dc}$; $I_B = 3.0\text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(sat)4}$		0.25	V dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 0.4\text{ V dc}$; $I_C = 30\text{ mA dc}$ pulsed (see 4.5.1)	h_{FE4}	15		
<u>Subgroup 4</u>						
Open circuit output capacitance	3236	$V_{CB} = 5\text{ V dc}$; $I_E = 0$; $f = 140\text{ kHz}$	C_{obo}		5	pF
Input capacitance (output open-circuited)	3240	$V_{EB} = 0.5\text{ V dc}$; $I_C = 0$; $f = 140\text{ kHz}$	C_{ibo}		8	pF
Magnitude of common emitter, small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 10\text{ V dc}$; $I_C = 30\text{ mA dc}$; $f = 100\text{ MHz}$	$ h_{FE} $	3.5	12	
Storage time	3251	Test condition A; $I_C = 10\text{ mA dc}$; $I_{B1} = I_{B2} = -10\text{ mA dc}$ (see figure 3)	t_s		18	ns
Saturated turn-on time	3251	$I_C = 300\text{ mA dc}$; $I_B = 30\text{ mA dc}$; $V_{CC} = 15\text{ V dc}$; (see figure 2); Test condition A	t_{on}		15	ns
Saturated turn-off time	3251	$I_C = 300\text{ mA dc}$; $I_{B1} = I_{B2} = 30\text{ mA dc}$; $V_{CC} = 15\text{ V dc}$; (see figure 2); Test condition A	t_{off}		25	ns
<u>Subgroups 5, 6, and 7</u>						
Not applicable						

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

TABLE II. Groups B and C delta measurements.

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	$V_{CE} = 0.4 \text{ V dc};$ $I_C = 30 \text{ mA dc}$ pulsed (see 4.5.1)	Δh_{FE1}	±25 percent change from initial value.		

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

- a. Subgroups 3 and 6, see table II herein.

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

- a. Subgroup 6, see table II herein.

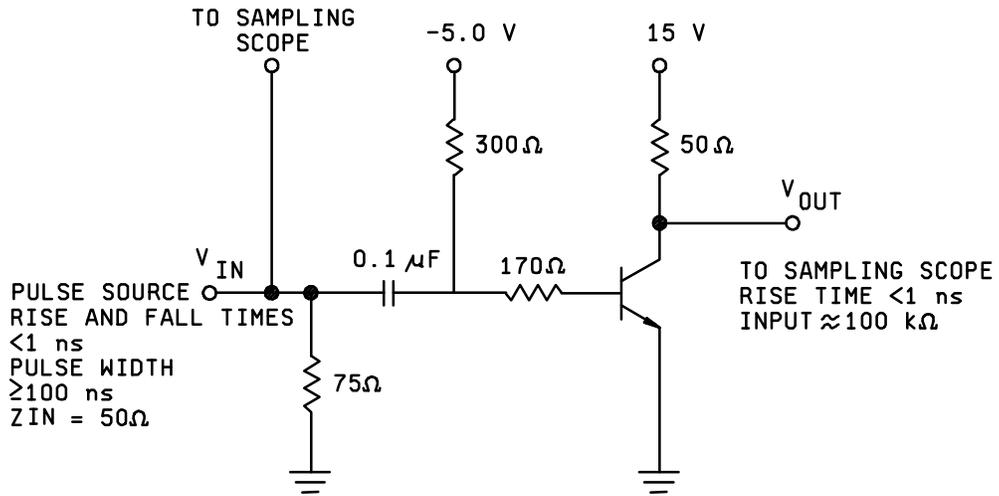


FIGURE 2. T_{on} and T_{off} test circuit.

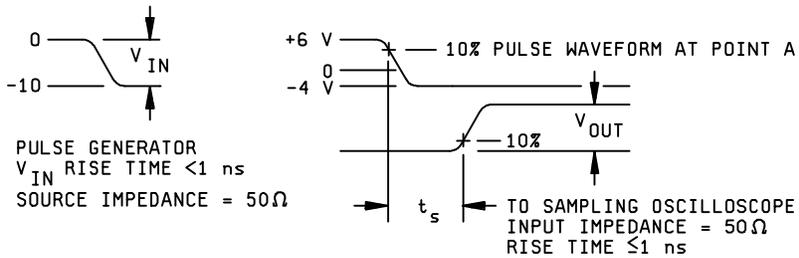
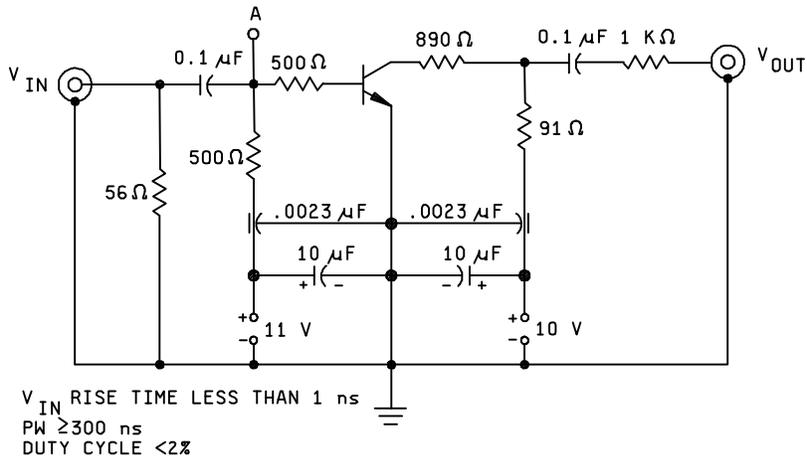


FIGURE 3. Charge storage time test circuit.

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 (see 3.3.1).
- c. Type designation and product assurance level.
- d. Packaging 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 extent 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, DSCC-VQE, Columbus, OH 43216.

6.5 Supersession information. Devices covered by this specification supersedes the manufacturers' and users' Part or Identifying Number (PIN). This information in no way implies that manufacturers' PIN's are suitable as a substitute for the military PIN.

Military PIN	Manufacturers' CAGE code	Manufacturers' and users' PIN
2N3013	04713	SS5623H ST1334H SUN0520H1 SUN1015H SUN1051H1

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

Preparing activity:
DLA - CC
(Project 5961-2169)RP

Review activities:
Army - MI, SM
Navy - AS, CG, MC, OS, SH
Air Force - 13, 19, 70, 80, 99

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL		
<u>INSTRUCTIONS</u>		
<p>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.</p> <p>2. The submitter of this form must complete blocks 4, 5, 6, and 7.</p> <p>3. The preparing activity must provide a reply within 30 days from receipt of the form.</p> <p>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.</p>		
I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/287E	2. DOCUMENT DATE 99/06/27
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN SILICON, SWITCHING TYPE 2N3013 JAN AND JANTX		
4. NATURE OF CHANGE <i>(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)</i>		
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 Alan Barone	b. TELEPHONE Commercial DSN FAX EMAIL 614-692-0510 850-0510 614-692-6939 alan_barone@dscclia.mil	
c. ADDRESS Defense Supply Center Columbus ATTN: DSCC-VAT 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	