

The documentation and process conversion measures necessary to comply with this revision shall be completed by 20 March 2003.

INCH-POUND

MIL-PRF-19500/448C
 20 December 2002
 SUPERSEDING
 MIL-PRF-19500/448B
 3 February 1999

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW-POWER
 TYPE 2N4405
 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 PNP, silicon, low-power 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 TO-39).

1.3 Maximum ratings.

Types	P _T (1) T _C = +25°C	P _T (2) T _A = +25°C	V _{CB0}	V _{CEO}	V _{EBO}	I _C	T _{STG} and T _{OP}
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>°C</u>
2N4405	5.0	1.0	80	80	5	0.5	-65 to +200

(1) Derate linearly, 28.6 mW/°C for T_C ≥ +25°C.

(2) Derate linearly, 5.72 mW/°C for T_A ≥ +25°C.

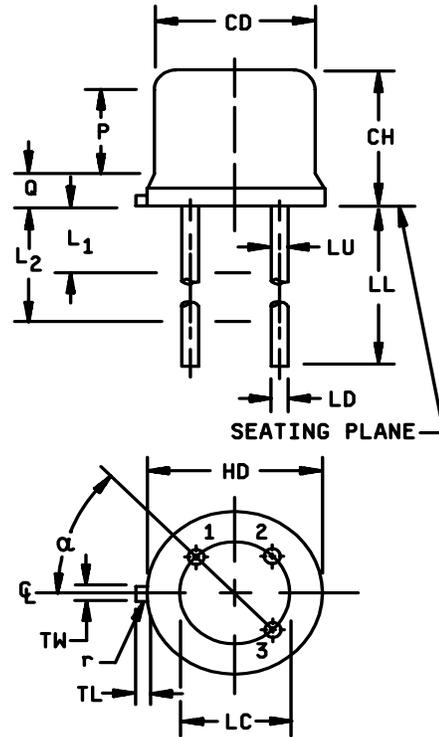
1.4 Primary electrical characteristics at T_A = 25°C.

Limit	h _{FE1} (1)	h _{FE3} (1)	V _{BE(SAT)2} (1)	V _{CE(SAT)3} (1)	C _{obo}	h _{re}
	V _{CE} = 5 V dc I _C = 100 μA dc	V _{CE} = 5 V dc I _C = 150 mA dc	I _C = 500 mA dc I _B = 50 mA dc	I _C = 500 mA dc I _B = 50 mA dc	V _{CB} = 10 V dc I _E = 0 mA dc 100 kHz ≤ f ≤ 1 MHz	V _{CE} = 20 V dc I _C = 50 mA dc f = 100 MHz
Min	75	100	<u>V dc</u> 0.85	<u>V dc</u> 0.5	<u>pF</u> 20	2.0
Max		300	1.20			6.0

(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: Defense Supply Center Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min.	Max.	Min.	Max.	
CD	.305	.335	7.75	8.51	
CH	.24	.26	6.1	6.6	
HD	.335	.37	8.51	9.4	
LC	.200 TP		5.08 TP		4
LD	.016	.021	.41	.53	2, 5
LL	.500	.750	12.70	19.05	5
LU	.016	.019	.41	.48	3, 5
L1		.050		1.27	
L2	.250		6.35		
P	.100		2.54		
Q		.040		1.02	
r		.007		.18	
TL	.029	.045	.74	1.14	
TW	.028	.034	.71	.86	
α	45° TP		45° TP		



NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Measured in the zone beyond .250 (6.35) from the seating plane.
4. Measured in the zone .050 (1.27 mm) and .250 (6.35) from the seating plane.
5. Measured from the maximum diameter of the actual case.
6. All three leads.
- *7. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
8. Lead 1 is the emitter, lead 2 is the base, and lead 3 is the collector, which is electrically connected to the case.

FIGURE 1. Physical dimensions (similar to T0-39).

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

DEPARTMENT OF DEFENSE

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

*(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robins Avenue, 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 (similar to TO-39) herein.

*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).

*3.5 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 group A as specified in 4.4.1 and 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).

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 qualification shall be performed herein for qualification or requalification 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 to this revision to maintain qualification.

*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 level only
3c	Method 3131 of MIL-STD-750, thermal impedance
9	Not applicable
11	h_{FE2} and I_{CBO2}
12	See 4.3.1
13	Subgroup 2 of table I herein, $\Delta I_{CBO2} = 100$ percent of initial value or 10 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 20$ percent of initial value.

*4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: 2N4405 - - - - $V_{CB} \geq 30$ V dc; $T_A =$ room ambient as defined in the general requirements of 4.5 of MIL-STD-750; apply P_D to achieve $T_J = +135^\circ C$. Apply a minimum $P_D = 75$ percent of maximum rated P_T .

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 tests and conditions specified in 4.4.2.1 for JAN and JANTX group B testing. Electrical measurements (end-points) and delta requirements for JAN and JANTX shall be after each step in 4.4.2.1 and shall be in accordance with table I, group A, subgroup 2. Delta measurements shall be in accordance with table III herein as specified in the notes for table III.

*4.4.2.1 Group B inspection, (JAN and JANTX). Separate samples may be used for each step. In the event of a group B failure, the manufacturer may pull a new sample at double size from either the failed assembly lot or from another assembly lot from the same wafer lot. If the new "assembly lot" option is exercised, the failed assembly lot shall be scrapped.

<u>Step</u>	<u>Method</u>	<u>Condition</u>
1	1039	Steady-state life: Test condition B, 340 hours minimum, $V_{CB} = 10 - 30$ V dc, power shall be applied to achieve $T_J = +150^\circ\text{C}$ minimum using a minimum of $P_D = 75$ percent of maximum rated P_T as defined in 1.3. $n = 45$ devices, $c = 0$.
2	1039	The steady-state life test of step 1 shall be extended to 1,000 hrs for each die design. Samples shall be selected from a wafer lot every twelve months of wafer production. Group B step 2 shall not be required more than once for any single wafer lot. $n = 45$, $c = 0$.
3	1032	High-temperature life (non-operating), $t = 340$ hours, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$.

*4.4.2.2 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

- a. For JAN and JANTX, samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. See MIL-PRF-19500.
- b. Must be chosen from an inspection lot that has been submitted to and passed table I, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (group B for JAN and JANTX) may be pulled prior to the application of final lead finish.

*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. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E.
C6		Not applicable.

*4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table IX of MIL-PRF-19500 and as specified herein. Electrical measurements (end-points) and delta measurements shall be in accordance with the applicable steps of table III and table I, subgroup 2 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.

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TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
* <u>Subgroup 1 2/</u>						
Visual and mechanical examination	2071					
Solderability <u>3/ 4/</u>	2026	n = 15 leads, c = 0				
Resistance to solvents <u>3/ 4/ 5/</u>	1022	n = 15 devices, c = 0				
Temp cycling <u>3/ 4/</u>	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal <u>4/</u> Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements <u>4/</u>		Group A, subgroup 2				
Bond strength <u>3/ 4/</u>	2037	Precondition T _A = +250°C at t = 24 hrs or T _A = +300°C at t = 2 hrs n = 11 wires, c = 0				
Decap internal visual (design verification) <u>4/</u>	2075	n = 4 devices, c = 0				
<u>Subgroup 2</u>						
Breakdown voltage, collector to emitter	3011	Bias condition D, I _C = 10 mA dc pulsed (see 4.5.1)	V _{(BR)CEO}	80		V dc
Collector to base cutoff current	3036	Bias condition D, V _{CB} = 80 V dc	I _{CBO1}		10	μA dc
Collector to base cutoff current	3036	Bias condition D, V _{CB} = 60 V dc	I _{CBO2}		25	nA dc
Emitter to base breakdown voltage	3061	Bias condition D, V _{EB} = 5.0 V dc	I _{EBO1}		10	μA dc
Emitter to base cutoff current	3061	Bias condition D, V _{EB} = 3.0 V dc	I _{EBO2}		25	nA dc
Forward-current transfer ratio	3076	V _{CE} = 5 V dc; I _C = 0.1 mA dc; pulsed (see 4.5.1)	h _{FE1}	75		
Forward-current transfer ratio	3076	V _{CE} = 5 V dc; I _C = 10 mA dc; pulsed (see 4.5.1)	h _{FE2}	100		
Forward-current transfer ratio	3076	V _{CE} = 5 V dc; I _C = 150 mA dc, pulsed (see 4.5.1)	h _{FE3}	100	300	
Forward-current transfer ratio	3076	V _{CE} = 5 V dc; I _C = 500 mA dc; pulsed (see 4.5.1)	h _{FE4}	50		
Collector-emitter saturated voltage	3071	I _C = 10 mA dc; I _B = 1.0 mA dc; pulsed (see 4.5.1)	V _{CE(SAT)1}		0.15	V dc

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> Continued						
Collector-emitter saturated voltage	3071	$I_C = 150 \text{ mA dc}; I_B = 15 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(SAT)2}$		0.20	V dc
Collector-emitter saturated voltage	3071	$I_C = 500 \text{ mA dc}; I_B = 50 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{CE(SAT)3}$		0.50	V dc
Base-emitter non-saturated	3066	Test condition B; $V_{CE} = 5 \text{ V dc};$ $I_C = 150 \text{ mA dc};$ pulsed (see 4.5.1)	V_{BE}		0.90	V dc
Base-emitter saturated voltage	3066	Test condition A; $I_C = 10 \text{ mA dc};$ $I_B = 1 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{BE(SAT)1}$		0.80	V dc
Base-emitter saturated voltage	3066	Test condition A; $I_C = 500 \text{ mA dc};$ $I_B = 50 \text{ mA dc};$ pulsed (see 4.5.1)	$V_{BE(SAT)2}$	0.85	1.20	V dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ\text{C}$				
Collector to base cutoff current	3036	Bias condition D, $V_{CB} = 60 \text{ V dc}$ $T_A = -55^\circ\text{C}$	I_{CBO3}		25	$\mu\text{A dc}$
Low-temperature operation						
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}; I_C = 150 \text{ mA dc}$ pulsed (see 4.5.1)	h_{FE5}	40		
<u>Subgroup 4</u>						
Delay time		$V_{CC} = 31.9 \text{ V dc}; V_{BE(OFF)} = 0.8 \text{ V dc}; I_C =$ $500 \text{ mA dc}; I_{B1} = 50 \text{ mA dc};$ (see figure 2)	t_d		15	ns
Rise time		$V_{CC} = 31.9 \text{ V dc}; V_{BE(OFF)} = 0.8 \text{ V dc};$ $I_C = 500 \text{ mA dc}; I_{B1} = 50 \text{ mA dc};$ (see figure 2)	t_r		25	ns
Storage time		$V_{CC} = 31.9 \text{ V dc}; I_C = 500 \text{ mA dc};$ $I_{B1} = I_{B2} = 50 \text{ mA dc};$ (see figure 2)	t_s		175	ns
Fall time		$V_{CC} = 31.9 \text{ V dc}; I_C = 500 \text{ mA dc};$ $I_{B1} = I_{B2} = 50 \text{ mA dc};$ (see figure 2)	t_f		50	ns
Magnitude of common emitter, small-signal short-circuit forward current transfer ratio	3306	$V_{CE} = 20 \text{ V dc}; I_C = 50 \text{ mA dc};$ $f = 100 \text{ MHz}$	$ h_{FE} $	2.0	6	
Noise figure	3246	$V_{CE} = 10 \text{ V dc}; I_C = 1 \text{ mA dc};$ $f = 1 \text{ kHz}; R_s = 100 \text{ ohms}$	NF		3.5	dB
Open circuit output capacitance	3236	$V_{CB} = 10 \text{ V dc}; I_E = 0 \text{ mA dc}$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		20	pF
<u>Subgroup 5</u>						
Safe operating area (continuous dc)	3051	$T_C = +25^\circ\text{C}; V_{CE} = 10 \text{ V dc};$ $I_C = 0.5 \text{ A dc}; t = 1 \text{ s}; 1 \text{ cycle}$				
Electrical measurements		See table I, subgroup 2				

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

- 1/ For sampling plan, see MIL-PRF-19500.
- 2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in table I, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.
- 3/ Separate samples may be used.
- 4/ Not required for laser marked devices.

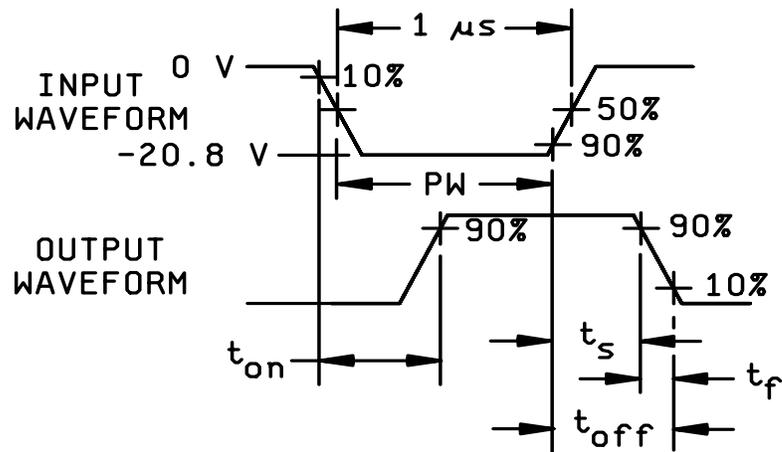
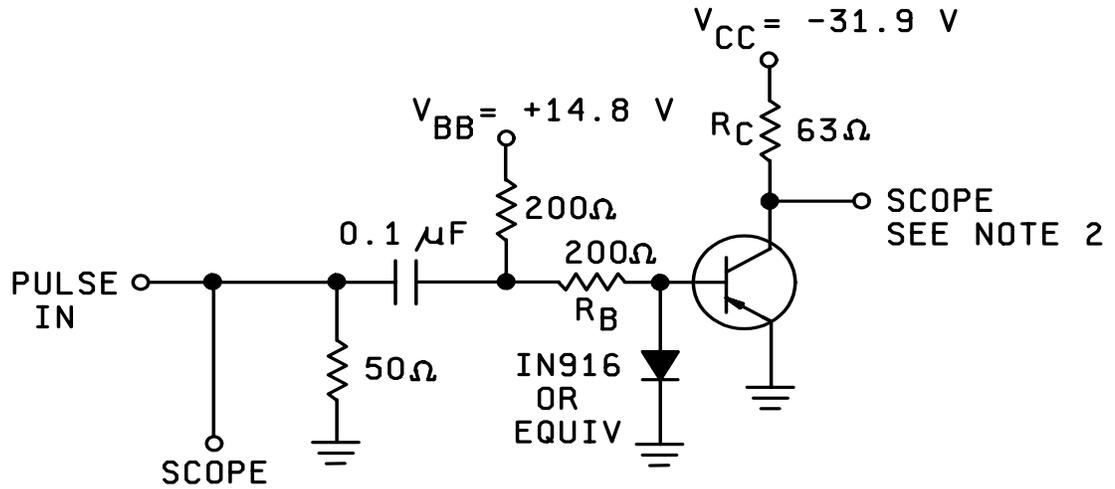
* TABLE II. Group E inspection (all quality levels) – for qualification only.

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles	
Hermetic seal	1071		
Fine leak			
Gross leak			
Electrical measurements		See table 1, subgroup 2 .	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	V _{CB} = 10 V dc, 6000 cycles	
Electrical measurements		See table 1, subgroup 2.	
<u>Subgroup 3, 4, 5, 6, and 7</u>			
Not applicable			
<u>Subgroup 8</u>			
Reverse stability	1033	Condition A ≥ 400v Condition B < 400v	45 devices c = 0

* TABLE III. Delta measurements. 1/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1	Forward-current transfer ratio	3076	V _{CE} = 5.0 V dc; I _C = 10 mA dc; pulsed (see 4.5.1)	Δh _{FE2}	±20 percent change		

1/ The delta measurements for 4.4.2.1 are as follows: Table III, step 1, to be performed after each step in group B.



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 2.0 ns; duty cycle ≤ 2 percent; generator source impedance shall be 50 ohms.
2. Output sampling oscilloscope: $Z_{in} \geq 100$ k Ω ; $C_{in} \leq 12$ pF; rise time ≤ 0.2 ns.
3. To obtain data for curves, voltage levels are approximately as shown, R_B and R_C are varied.

FIGURE 2. Pulse response 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 actual 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.)

*6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

*6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2)
- c. Packaging requirements (see 5.1).
- d. Lead finish (see 3.4.1).
- e. Type designation and quality assurance level.

*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 QML 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, DSCC-VQE, P.O. Box 3990, Columbus, OH 43216-5000.

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:
Air Force - 11
Army - CR
DLA - CC

Preparing activity:
DLA - CC

Review activities:
Air Force - 19, 99
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(Project 5961-2650)

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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-19500/448C	2. DOCUMENT DATE 20 December 2002
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, LOW – POWER TYPE 2N4405 JAN AND JANTX		
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
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