The documentation and process conversion measures necessary to comply with this revision shall be completed by 28 September 2001.

INCH-POUND

MIL-PRF-19500/366H
28 June 2001
SUPERSEDING
MIL-PRF-19500/366G
22 July 2000

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, AMPLIFIER TYPES 2N3498, 2N3498L, 2N3499, 2N3499L, 2N3500, 2N3500L, 2N3501, 2N3501L, AND 2N3501UB JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

Device types 2N3498, 2N3499, 2N3500 and their corresponding L suffix versions are inactive for new design after 14 April 1995.

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, low-power amplifier and switching transistors. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for die.

1.2 Physical dimensions. See figure 1 (similar to TO- 5, 39), figure 2 (surface mount, 2N3501UB), and figures 3 and 4 (die).

1.3 Maximum ratings.

Types (1)	P_T T_A = +25°C (2)	V_{CBO}	V_{CEO}	V_{EBO}	I_C	$R_{\theta JA}$	T_{STG} and T_{OP}
	W	V dc	V dc	V dc	mA dc	°C /W	°C
2N3498	1	100	100	6	500	175	-65 to +200
2N3499	1	100	100	6	500	175	-65 to +200
2N3500	1	150	150	6	300	175	-65 to +200
2N3501	1	150	150	6	300	175	-65 to +200
2N3501UB	0.5 (3)	150	150	6	300	325	-65 to +200

(1) Electrical characteristics for "L" suffix devices are identical to their corresponding "non L" suffix devices.
(2) Derate linearly 5.71 mW/°C for T_A > +25°C.
(3) Derate linearly 3.07 mW/°C for T_A > +25°C, 2N3501UB.

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, Post Office 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.

AMSC N/A FSC 5961

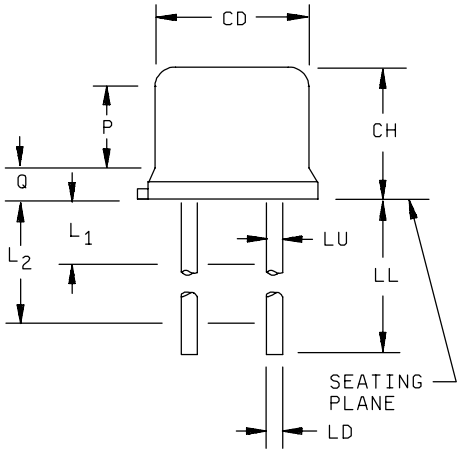
1.4 Primary electrical characteristics at T_A = +25°C.

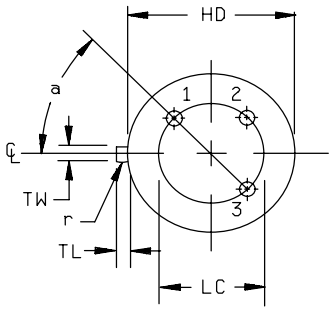
Type (1)	h_{FE} at V_{CE} = 10 V dc				$\|h_{fe}\|$ V_{CE} = 20 V dc I_C = 20 mA dc f = 100 MHz	C_{obo} V_{CB} = 10 V dc I_E = 0 100 kHz ≤f ≤ 1 MHz
	h_{FE1} (2) I_C = 0.1 mA dc	h_{FE4} (2) I_C = 150 mA dc	h_{FE5} (2) I_C = 300 mA dc	h_{FE6} (2) I_C = 500 mA dc		
	Min Max	Min Max	Min Max	Min Max	Min Max	Min Max
2N3498	20	40 120		15	1.5 8	10
2N3499	35	100 300		20	1.5 8	10
2N3500	20	40 120	15		1.5 8	8
2N3501	35	100 300	20		1.5 8	8

(1) Electrical characteristics for the "L" and "UB" suffix devices are identical to the corresponding "non L" and "non-UB" suffix devices unless otherwise noted.
(2) Pulsed (see 4.5.1)

Types (1)	$V_{CE(sat)}$ (2)		$V_{BE(sat)}$ (2)		t_{on}	t_{off}
	I_C = 150 mA dc I_B = 15 mA dc	I_C = 300 mA dc I_B = 30 mA dc	I_C = 150 mA dc I_B = 15 mA dc	I_C = 300 mA dc I_B = 30 mA dc	I_C = 150 mA dc I_{B1} = 15 mA dc V_{EB} = 2 V dc	I_C = 150 mA dc I_{B1} = -I_{B2} = 15 mA dc
	Min Max	Min Max	Min Max	Min Max	Max ns	Max ns
2N3498		0.6		1.4	115	1,150
2N3499		0.6		1.4	115	1,150
2N3500	0.4		1.2		115	1,150
2N3501	0.4		1.2		115	1,150

(1) Electrical characteristics for the "L" and "UB" suffix devices are identical to the corresponding "non L" and "non-UB" suffix devices unless otherwise noted.
(2) Pulsed see 4.5.1.



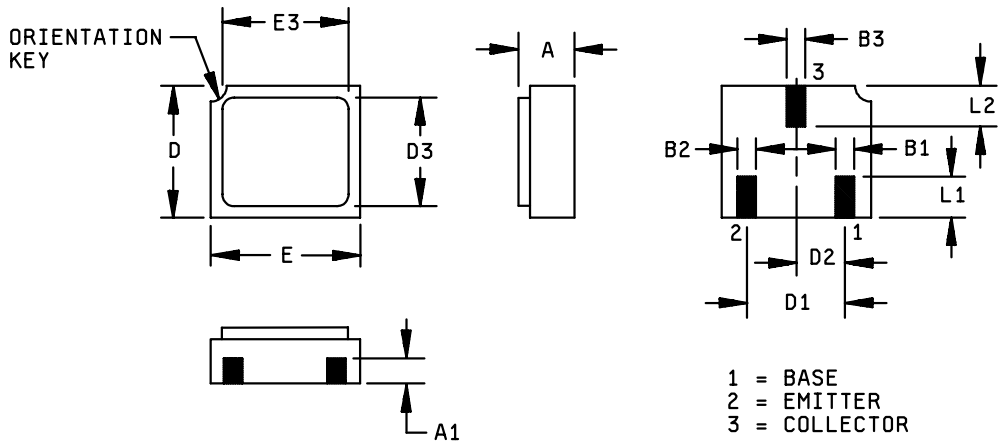


Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.021	0.41	0.53	7
LL	See notes 7, 12, and 13				
LU	.016	.019	0.41	0.48	7, 13
L_1		.050		1.27	13
L_2	.250		6.35		13
TL	.029	.045	0.74	1.14	3
TW	.028	.034	0.71	0.86	10, 11
P	.100		2.54		5
Q		.050		1.27	4
r		.010		.250	11
α	45° TP		45° TP		6

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Symbol CD shall not vary more than .010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LD applies between L_1 and L_2. Dimension LD applies between L_2 and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L_1 and beyond LL minimum.
8. Lead designation, shall be as follows: 1 - emitter, 2 - base, 3 - collector.
9. Lead number three is electrically connected to case.
10. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
11. Symbol r applied to both inside corners of tab.
12. For transistor types 2N3498, 2N3499, 2N3500, and 2N3501, LL = .50 inch (12.70 mm) minimum and .750 inch (19.05 mm) maximum. For transistor types 2N3498L, 2N3499L, 2N3500L, and 2N3501L, LL = 1.50 inch (38.10 mm) minimum and 1.750 inch (44.45 mm) maximum.
13. All three leads.

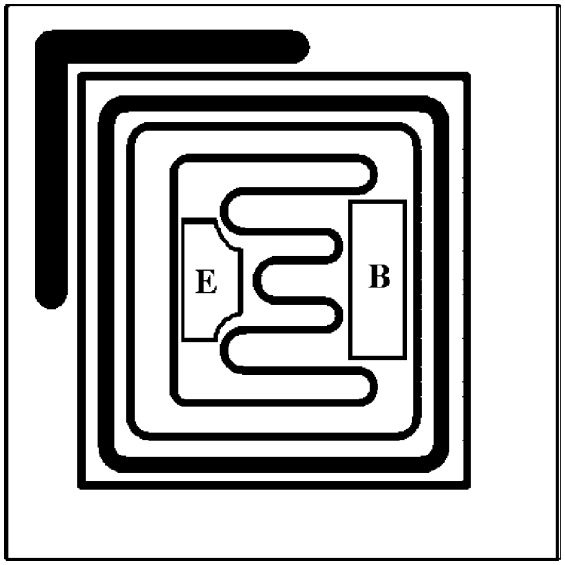
FIGURE 1. Physical dimensions (similar to TO - 5, 39).



Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.046	.056	0.97	1.42	
A1	.017	.035	0.43	0.89	
B1	.016	.024	0.41	0.61	
B2	.016	.024	0.41	0.61	
B3	.016	.024	0.41	0.61	
D	.085	.108	2.41	2.74	
D1	.071	.079	1.81	2.01	
D2	.035	.039	0.89	0.99	
D3	.085	.108	2.41	2.74	
E	.115	.128	2.82	3.25	
E3		.128		3.25	
L1	.022	.038	0.56	0.96	
L2	.022	.038	0.56	0.96	

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

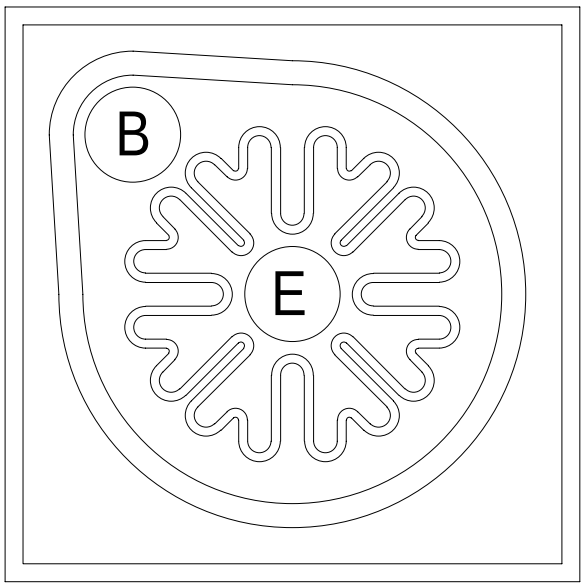
FIGURE 2. Physical dimensions, surface mount (2N3501UB version).



A - Version

1. Chip size ..... 40 x 40 mils ± 1 mil.
2. Chip thickness..... 10 ± 1.5 mil .
3. Top metal ..... Aluminum 15,000 nÅ minimum, 18,000Å nominal.
4. Back metal ..... Al/Ti/Ni/Ag 12kÅ/3kÅ/7kÅ/7kÅ min., 15kÅ/5kÅ/10kÅ/10kÅ nom.
   Gold 2,500Å minimum, 3,000Å nominal.
   Eutectic Mount – No Gold.
5. Backside ..... Collector.
6. Bonding pad..... B = 6 x 8 mils, E = 6 x 4 mils.

FIGURE 3. Physical dimensions, JANHCA and JANKCA die.



B - Version

Die size ----------0.030 (0.762 mm) x 0.030 inch.
Die thickness-------0.008 (2032 mm) ± 0.0016 inch (0.041 mm).
Base pad ----------0.005 inch (0.127 mm) diameter.
Emitter pad ---------0.005 inch diameter
Back metal----------Gold, 6500 ± 1950 Å
Top metal ----------Aluminum, 22500 ± 2500 Å
Back side----------Collector
Glassivation --------SiO_2, 7500 ± 1500 Å

FIGURE 4. Physical dimensions, JANHCB and JANKCB die.

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 Robbins 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 requirements for acquiring the product described herein shall consist of this document and MIL-PRF-19500.

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- 5, 39), figure 2 (surface mount, 2N3501UB), and figures 3 and 4 (die).

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 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 group A as specified herein.

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.

4.3 Screening (JANS, JANTXV, and JANTX levels only). Screening shall be in accordance with table 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 IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
3c	Thermal impedance (see 4.3.3) (1)	Thermal impedance (see 4.3.3) (1)
9	I_{CBO2} and h_{FE4}	Not applicable
11	I_{CBO2} and h_{FE4}; ΔI_{CB02} 100 percent of initial value or 5 nA dc, whichever is greater; $\Delta h_{FE4} = \pm$ 15 percent of initial value.	I_{CBO2} and h_{FE4}
12	See 4.3.2 240 hours minimum	See 4.3.2 80 hours minimum
13	Subgroups 2 and 3 of table I herein; ΔI_{CBO2} = 100 percent of initial value or 5 na dc, whichever is greater; $\Delta h_{FE4} = \pm$ 15 percent of initial value. (1)	Subgroups 2 of table I herein; ΔI_{CBO2} = 100 percent of initial value or 5 na dc, whichever is greater; $\Delta h_{FE4} = \pm$ 15 percent of initial value. (1)

(1) Thermal impedance need not be performed if previously done in step 3.

4.3.1 Screening (JANHC and JANKC). Screening of JANHC and JANKC die shall be in accordance with MIL-PRF-19500. Burn-in duration for the JANKC level follows JANS requirements; the JANHC follows JANTX requirements.

4.3.2 Power burn-in conditions. Power burn-in conditions are as follows: V_{CB} = 10-30 V dc; power shall be applied to achieve T_J = +135°C minimum using a minimum power dissipation = 75 percent of maximum rated P_T (see 1.3). NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.3.3 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ measurements shall be performed in accordance with method 3131 of MIL-STD-750.

a. I_M measurement current ---------- 5 mA.

b. I_H forward heating current ---------- 100 mA (min).

c. t_H heating time ---------- 10 - 20 ms.

d. t_{md} measurement delay time ------- 100 µs max.

e. V_{CE} collector-emitter voltage ------- 10 V dc minimum.

The maximum limit for $Z_{\theta JX}$ under these test conditions are $Z_{\theta JX}$ (max) = 30°C/W (2N3501UB); 25°C/W (all others).

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein. If alternate screening is being performed in accordance with MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of group A1 and A2 inspection only (table VIb, group B, subgroup 1 is not required to be performed again if group B has already been satisfied in accordance with 4.4.2).

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 for subgroup testing in table VIa (JANS) of MIL-PRF-19500 and 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta measurements shall be in accordance with table II herein. See 4.4.2.2 for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) for JAN, JANTX, and JANTXV shall be after each step in 4.4.2.2 herein and shall be in accordance with group A, subgroup 2 herein. Delta measurements shall be after each step in 4.4.2.2 herein and shall be in accordance with table II herein.

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

Subgroup	Method	Condition
B4	1037	V_{CB} = 10 V dc.
B5	1027	V_{CB} = 10 V dc; $P_D \geq$ 75 percent of maximum rated P_T (see 1.3). Option 1: 96 hours min, sample size in accordance with MIL-PRF-19500 table VIa, adjust T_A to achieve T_J = +275°C minimum. Option 2: 216 hrs min., sample size = 45, c = 0; adjust T_A to achieve T_J = +225°C minimum.
B6	3131	See 4.5.2.

4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV). 1/

Step	Method	Condition
1	1039	Steady-state life: Test condition B, 340 hours, V_{CB} = 10 - 30 V dc, T_J = +150°C min. External heating of the device under test to achieve T_J = +150°C minimum is allowed provided that a minimum of 75 percent of rated power is dissipated. No heat sink or forced-air cooling on the devices shall be permitted; n = 45 devices, c = 0.
2	1039	The steady-state life test of step 1 shall be extended to 1,000 hours 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°C; n = 22, c = 0.

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

a. For JAN, JANTX, and JANTXV, samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. For JANS, samples shall be selected from each inspection lot. See MIL-PRF-19500.

b. Must be chosen from an inspection lot that has been submitted to and passed group A, 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 (subgroups B4 and B5 for JANS, and group B for JAN, JANTX, and JANTXV) may be pulled prior to the application of final lead finish.

1/ 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.

4.4.3 Group C inspection, Group C inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table VII of MIL-PRF-19500, and in 4.4.3.1 (JANS).and 4.4.3.2 (JAN, JANTX, and JANTXV) herein for group C testing. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta measurements shall be in accordance with table II herein.

4.4.3.1 Group C inspection, table VII (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1026	1,000 hours at V_{CB} = 10 V dc; T_J = +150°C min. External heating of the device under test to achieve T_J = +150°C minimum is allowed provided that a minimum of 75 percent of rated power is dissipated. No heat sink or forced-air cooling on device shall be permitted.

4.4.3.2 Group C inspection, table VII (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E.
C5	3131	See 4.5.2 herein; n = 22, c = 0.
C6		Not applicable.

4.4.3.3 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any inspection lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes group A tests for conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for C6 life test may be pulled prior to the application of final lead finish. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

4.4.4 Group E inspection. 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 III tests, the tests specified in table III herein must be performed to maintain qualification.

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 performed in accordance with method 3131 of MIL-STD-750. The following conditions shall apply:

a. Collector current magnitude or emitter current magnitude during heating shall be 50 mA dc.

b. Collector-emitter voltage or collector-base voltage magnitude shall be 12 V dc.

c. Reference temperature measuring point shall be case ambient air.

d. Reference point temperature shall be +25°C.

e. Mounting arrangement shall be case to ambient air.

f. Maximum limit shall be $R_{\theta JA}$ = 175°C/W.

TABLE I. Group A inspection .

Inspection 1/ 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1 3/						
Visual and mechanical 4/ examination	2071	n = 45 devices, c = 0				
Solderability 4/ 5/	2026	n = 15 leads, c = 0				
Resistance to solvents 4/ 5/ 6/	1022	n = 15 devices, c = 0				
Temp cycling 4/ 5/	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic seal 5/ Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements 5/		Group A, subgroup 2				
Bond strength 4/ 5/	2037	Precondition T_A = +250°C at t = 24 hrs or T_A = +300°C at t = 2 hrs; n = 11 wires, c = 0				
Subgroup 2						
Collector to base, cutoff current	3036	Bias condition D;	I_{CBO1}		10	µA dc
2N3498, 2N3499 2N3500, 2N3501, 2N3501UB		V_{CB} = 100 V dc V_{CB} = 150 V dc				
Collector to emitter cutoff current 2N3498, 2N3499 2N3500, 2N3501, 2N3501UB	3041	Bias condition D; pulsed (see 4.5.1) V_{CE} = 80 V dc V_{CE} = 120 V dc	I_{CEO}		1	µA dc
Breakdown voltage, collector to emitter 2N3498, 2N3499 2N3500, 2N3501, 2N3501UB	3011	Bias condition D; I_C = 10 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	 100 150		 V dc V dc
Emitter to base, cutoff current	3061	Bias condition D; V_{EB} = 6 V dc	I_{EBO1}		10	µA dc
Collector to base cutoff current 2N3498, 2N3499 2N3500, 2N3501, 2N3501UB	3036	Bias condition D; V_{CB} = 50 V dc V_{CB} = 75 V dc	I_{CBO2}		 50 50	 nA dc nA dc
Emitter to base cutoff current	3061	Bias condition D;V_{EB} = 4 V dc	I_{EBO2}		25	nA dc
Collector to emitter saturation voltage	3071	I_C = 10 mA dc; I_B = 1 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$ 7/		0.2	V dc
Collector to emitter saturation voltage 2N3500, 2N3501, 2N3501UB only	3071	I_C = 150 mA dc; I_B = 15 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$ 7/		0.4	V dc

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Collector to emitter saturation voltage 2N3498, 2N3499 only	3071	I_C = 300 mA dc; I_B = 30 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)3}$ 7/		0.6	V dc
Base emitter saturation voltage	3066	Test condition A; I_C = 10 mA dc; I_B = 1 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)1}$ 7/		0.8	V dc
Base emitter saturation voltage (2N3500, 2N3501, 2N3501UB only)	3066	Test condition A; I_C = 150 mA dc; I_B = 15 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)2}$ 7/		1.2	V dc
Base emitter saturation voltage (2N3498, 2N3499 only)	3066	Test condition A; I_C = 300 mA dc; I_B = 30 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)3}$ 7/		1.4	V dc
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 0.1 mA dc; pulsed (see 4.5.1)	h_{FE1}			
2N3498, 2N3500				20		
2N3499, 2N3501, 2N3501UB				35		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 1.0 mA dc; pulsed (see 4.5.1)	h_{FE2}			
2N3498, 2N3500				25		
2N3499, 2N3501, 2N3501UB				50		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE3}			
2N3498, 2N3500				35		
2N3499, 2N3501, 2N3501UB				75		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 150 mA dc; pulsed (see 4.5.1)	h_{FE4}			
2N3498, 2N3500				40	120	
2N3499, 2N3501, 2N3501UB				100	300	

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 300 mA dc; pulsed (see 4.5.1)	h_{FE5}			
2N3500				15		
2N3501, 2N3501UB				20		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 500 mA dc; pulsed (see 4.5.1)	h_{FE6}			
2N3498				15		
2N3499				20		
High temperature operation		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D	I_{CBO3}		50	µA dc
2N3498, 2N3499		V_{CB} = 50 V dc				
2N3500, 2N3501, 2N3501UB		V_{CB} = 75 V dc				
Low temperature operation		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 150 mA dc	h_{FE7}			
2N3498, 2N3500				22		
2N3499, 2N3501, 2N3501UB				45		
Subgroup 4						
Magnitude of small-signal short- circuit forward current transfer ratio	3306	V_{CE} = 20 V dc; I_C = 20 mA dc; f = 100 MHz	$\lvert h_{fe} \rvert$	1.5	8	
Small-signal short-circuit forward current transfer ratio	3206	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 1 kHz	h_{fe}			
2N3498, 2N3500				35	300	
2N3499, 2N3501, 2N3501UB				75	375	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}			
2N3498, 2N3499					10	pF
2N3500, 2N3501, 2N3501UB					8	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; 100 kHz ≤ f ≤ 1 MHz	C_{ibo}		80	pF
Noise figure (Test 1)	3246	V_{CE} = 10 V dc; I_C = 0.5 mA dc; R_g = 1 kΩ; f = 1 kHz	NF		16	dB

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Noise figure (Test 2)	3246	V_{CE} = 10 V dc; I_C = 0.5 mA dc; R_g = 1 kΩ; f = 10 kHz	NF		6	dB
Turn-on time		V_{EB} = 5 V dc; I_C = 150 mA dc; I_{B1} = 15 mA dc; (see figure 5)	t_{on}		115	ns
Turn-off time		I_C = 150 mA dc, I_{B1} = I_{B2} = 15 mA dc; (see figure 5)	t_{off}		1150	ns
Safe operating area (continuous dc)	3051	T_C = 25°C; $t_r \geq$ 10 ns; 1 cycle; (see figure 6); t = 1 s				
Test 1						
2N3498, 3N3499 2N3500, 3N3501 3N3501UB		V_{CE} = 10 V dc; I_C = 500 mA dc V_{CE} = 16.67 V dc; I_C = 300 mA dc V_{CE} = 10 V dc; I_C = 113 mA dc				
Test 2						
2N3498, 2N3499, 2N3500, 2N3501 2N3501UB		V_{CE} = 50 V dc; I_C = 100 mA dc V_{CE} = 50 V dc; I_C = 23 mA dc				
Test 3						
2N3498, 2N3499, 2N3500, 2N3501 2N3501UB		V_{CE} = 80 V dc; I_C = 40 mA dc V_{CE} = 80 V dc; I_C = 14 mA dc				
Safe operating area (clamped switching) 2N3498, 2N3499 2N3500, 2N3501, 2N3501UB	3053	T_A = +25°C; (see figure 7); device fails if clamp voltage is not reached I_B = 85 mA dc; I_C = 500 mA dc I_B = 50 mA dc; I_C = 300 mA dc				
Electrical measurements		See table I, group A, subgroup 2 herein.				
Subgroup 6						
Not required						
Subgroup 7 6/						
Decap internal visual (design verification)	2075	n = 1 device, c = 0				

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

1/ For sampling plan see MIL-PRF-19500, unless otherwise specified.
2/ Electrical characteristics for "L" suffix devices are identical to the corresponding "non L" suffix devices.
3/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.
4/ Separate samples may be used.
5/ Not required for JANS devices.
6/ Not required for laser marked devices.
7/ Maximum limit for this test characterized at ≤ .125 inch (3.18 mm) from the case.

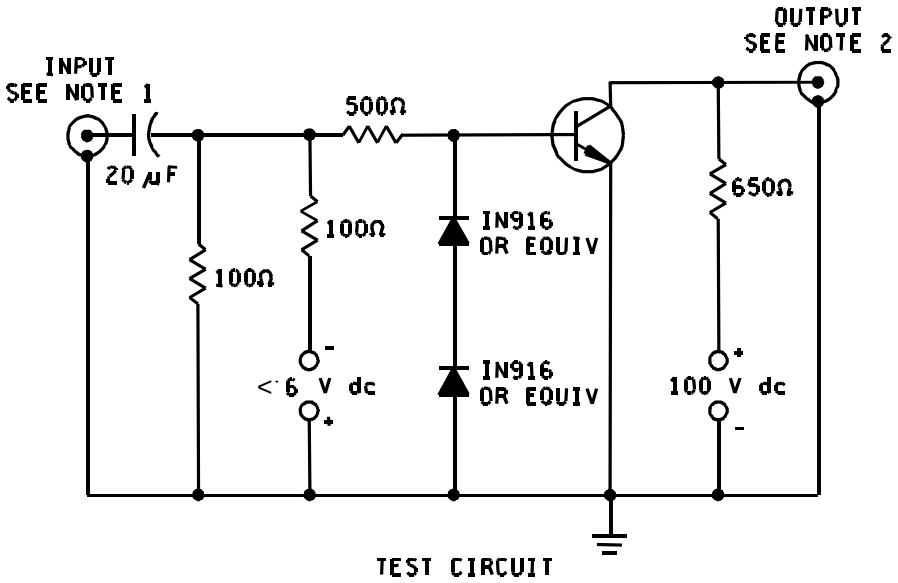
TABLE II. Groups B and C delta measurements. 1/ 2/ 3/

Step	Inspection 4/	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector to base cutoff current 2N3498, 2N3499 2N3500, 2N3501	3036	Bias condition D; V_{CB} = 50 V dc V_{CB} = 75 V dc	ΔI_{CBO2} 5/	± 100 percent of initial value or 10 nA dc, whichever is greater.		
2.	Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 10 mA dc pulsed (see 4.5.1)	Δh_{FE3} 5/ 6/	± 25 percent change from initial reading		
3.	Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 150 mA dc pulsed (see 4.5.1)	Δh_{FE4} 5/	± 25 percent change from initial reading		
4.	Collector to emitter voltage (saturated)	3071	I_C = 10 mA dc; I_B = 1.0 mA dc pulsed (see 4.5.1)	$\Delta V_{CE(sat)1}$ 5/ 6/ 7/	± 50 mV dc change from previous measured value		

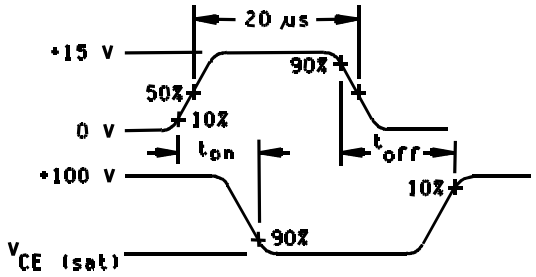
1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:
a. Subgroup 4, see table II herein, steps 3 and 4.
b. Subgroup 5, see table II herein, steps 1 and 2.
2/ The delta measurements for group B, (see 4.4.2.2 herein, JAN, JANTX, and JANTXV) are as follows: After each step in 4.4.2.2, see table II herein, steps 1 and 3.
3/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, see table II herein, step 1 (for JANS only).
4/ Electrical characteristics for "L" and "UB" suffix devices are identical to their corresponding "non L" and "non-UB" suffix devices unless otherwise noted.
5/ Devices which exceed the group A limits shall not be returned to the lot, but will not be considered failures.
6/ JANS only.
7/ Maximum limit for this test characterized at ≤ .125 inch (3.18 mm) from the case.

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

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
Subgroup 1			12 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See group A, subgroup 2 herein.	
Subgroup 2			45 devices c = 0
Intermittent life	1037	Intermittent operation life: V_{CB} = 10 V dc , 6,000 cycles.	
Electrical measurements		See group A, subgroup 2 herein.	
Subgroup 3			
Not applicable			
Subgroup 4			
Not applicable			
Subgroup 5			
Not applicable			



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: pulse width = 20 µs, pulse repetition rate = 1 kHz, rise time (t_r) and fall time (t_f) ≤ 10 ns, duty cycle ≤ 2 percent.
2. The output waveform is monitored on a sampling oscilloscope with Z_{in} ≥ 1 ms and t_r ≤ 1 ns.

FIGURE 5. Turn-on turn-off switching time test circuit.

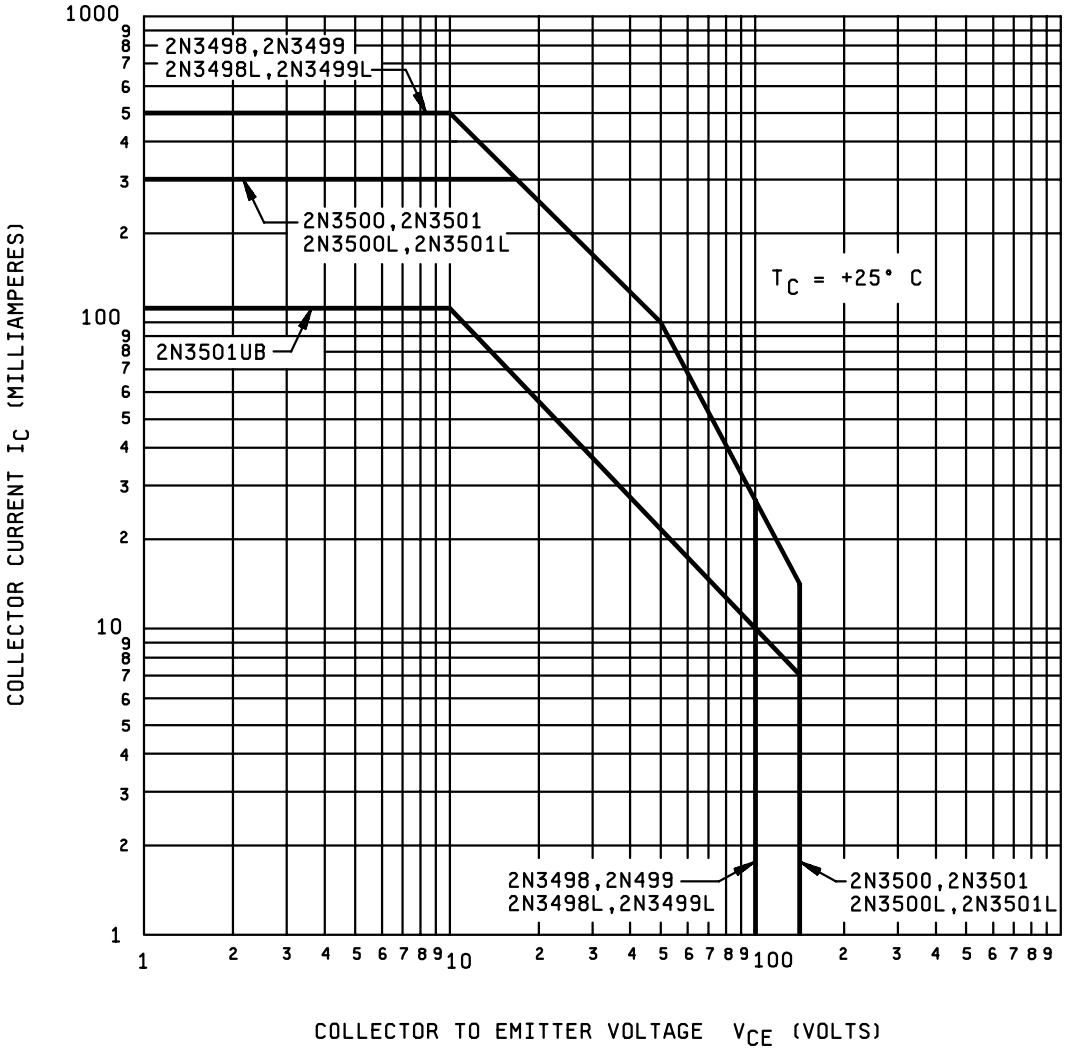
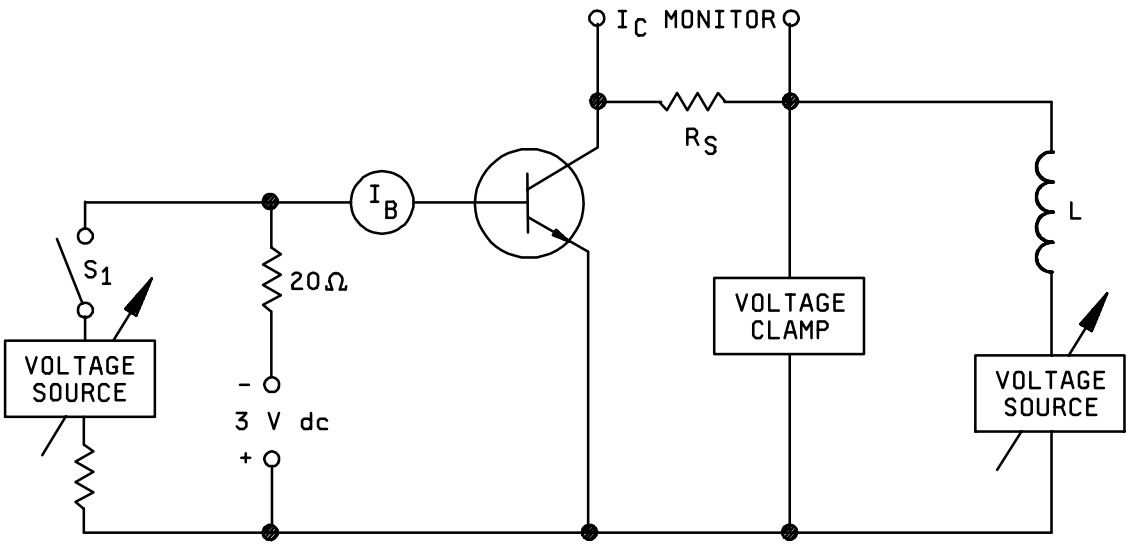


FIGURE 6. Maximum safe operating area.



Voltage clamp:

2N3498, 2N3498L, 2N3499, 2N3499L = 100 V dc
2N3500, 2N3500L, 2N3501, 2N3501L, 2N3501UB = 150 V dc

$R_S \leq 1.0$ ohm (noninductive)
L = (STANCOR C-2688, 0.425 ohm, or equivalent)

Procedure:
1. With switch S_1 closed, set the specified test conditions.
2. Open S_1.
3. Perform specified end-point tests.

FIGURE 7. Clamped inductive sweep test circuit diagram.

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. The acquisition requirements are as specified in MIL-PRF-19500.

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) 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 43216-5000.

6.4 Substitutability. The 2N3498, 2N3499 and 2N3500 devices (including "L" suffix versions) are now inactive for new design. The 2N3501 is the preferred item and is a direct substitute for the 2N3499, however, due to the higher gain of the 2N3501, it should be evaluated on a case by case basis before it is substituted for the 2N3498 and 2N3500.

6.5 Suppliers of JANHC die. The qualified JANC suppliers with the applicable letter version (example JANHCA2N3500) will be identified on the QML.

JANC ordering information		
PIN	Manufacturer	
	43611	34156
2N3498	JANHCA2N3498 JANKCA2N3498	JANHCB2N3498 JANKCB2N3498
2N3499	JANHCA2N3499 JANKCA2N3499	JANHCB2N3499 JANKCB2N3499
2N3500	JANHCA2N3500 JANKCA2N3500	JANHCB2N3500 JANKCB2N3500
2N3501	JANHCA2N3501 JANKCA2N3501	JANHCB2N3501 JANKCB2N3501

6.6 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.

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

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

Preparing activity:
DLA - CC

(Project 5961-2400)

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-19500/366H	2. DOCUMENT DATE 28 June 2001

3. **DOCUMENT TITLE**
SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, AMPLIFIER TYPES 2N3498, 2N3498L, 2N3499, 2N3499L, 2N3500, 2N3500L, 2N3501, 2N3501L, 2N3501UB, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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 Alan Barone	b. TELEPHONE Commercial: 614-692-0510 DSN: 850-0510 FAX: 614-692-6939 EMAIL: alan.barone@dscc.dla.mil
c. ADDRESS Defense Supply Center Columbus, ATTN: DSCC-VAC, P.O. Box 3990, 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, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888

DD Form 1426, Feb 1999 (EG) Previous editions are obsolete WHS/DIOR, Feb 99