

The documentation and process conversion measures necessary to comply with this revision shall be completed by 14 August 1999.

INCH-POUND

MIL-PRF-19500/366F
 14 May 1999
 SUPERSEDING
 MIL-PRF-19500/366E
 12 March 1998

PERFORMANCE SPECIFICATION SHEET

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

Device types 2N3498, 2N3499, 2N3500 and their corresponding L suffix versions are inactive for new design as of 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.

1.2 Physical dimensions. See figure 1 (similar to TO- 5, 39).

1.3 Maximum ratings.

Types 1/	P _T 2/ T _A = +25°C	P _T 3/ T _C = +25°C	V _{CBO}	V _{CEO}	V _{EBO}	I _C	R _{θJA}	R _{θJC}	T _{STG} and T _{OP}
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C /W</u>	<u>°C/W</u>	<u>°C</u>
2N3498	1	5	100	100	6	500	175	35	-55 to +200
2N3499	1	5	100	100	6	500	175	35	-55 to +200
2N3500	1	5	150	150	6	300	175	35	-55 to +200
2N3501	1	5	150	150	6	300	175	35	-55 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 28.6 mW/°C for T_C > +25°C.

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 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

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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} $V_{CE} = 10$ V dc $I_E = 0$ 100 kHz $\leq f \leq 1$ 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				
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" suffix devices are identical to the corresponding "non L" suffix devices.

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" suffix devices are identical to the corresponding "non L" suffix devices.

2/ Pulsed see 4.5.1.

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 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. Abbreviations, symbols, and definitions used herein shall be as specified 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.

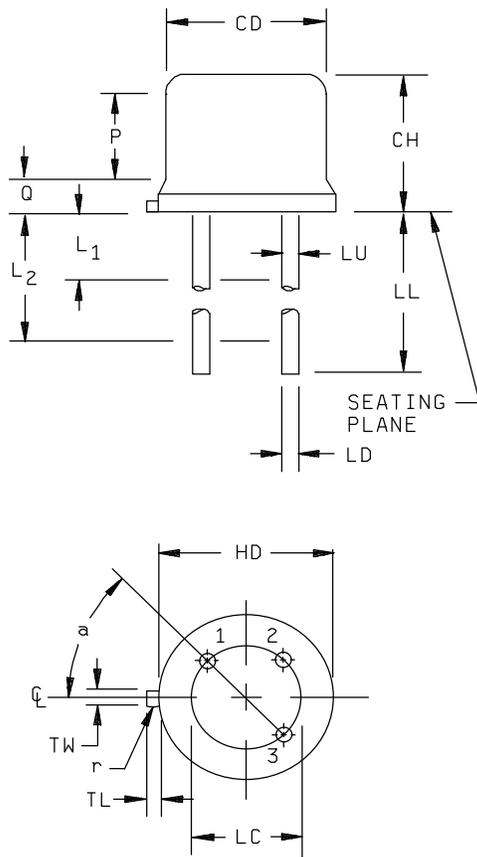
3.3.1 Lead material and finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3 herein.

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 6.3).



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
L1	---	.050	---	1.27	13
L2	.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) $+0.001$ inch (0.03 mm) -0.000 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).

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 (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 4.3.2) <u>1/</u>	Thermal impedance (see 4.3.2) <u>1/</u>
9	I_{CB02} and h_{FE4}	Not applicable
11	I_{CB02} 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_{CB02} and h_{FE4}
12	See 4.3.1 240 hours minimum	See 4.3.1 80 hours minimum
13	Subgroups 2 and 3 of table I herein; $\Delta I_{CB02} = 100$ percent of initial value or 5 na dc, whichever is greater; $\Delta h_{FE4} = \pm 15$ percent of initial value. <u>1/</u>	Subgroup 2 of table I herein; $\Delta I_{CB02} = 100$ percent of initial value or 5 na dc, whichever is greater; $\Delta h_{FE4} = \pm 15$ percent of initial value. <u>1/</u>

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

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = Room ambient as defined in the general requirements of MIL-STD-750 (see 4.5):

JANS (all device types)..... $V_{CB} = 10 - 30$ V dc, $P_T = 1.0$ W .

JANTX, and JANTXV levels:
 2N3498, 2N3499 $V_{CB} = 10 - 30$ V dc, $P_T = 1.0$ W.

2N3500, 2N3501 $V_{CB} = 10 - 30$ V dc, $P_T = 1.0$ W.

NOTE: No heat sink or forced air cooling on the devices shall be permitted. Electrical characteristics for the "L" suffix devices are identical to the corresponding non "L" suffix devices.

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

- a. I_M measurement current5 mA.
- b. I_H forward heating current100 mA (min).
- c. t_H heating time10 - 20 ms.
- d. t_{md} measurement delay time10 μ s max.
- e. V_{CE} collector-emitter voltage10 V dc minimum

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

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein. If alternate screening is being performed per 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 per 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 conditions specified for subgroup testing in table VIa (JANS) of MIL-PRF-19500 and 4.4.2.1. Electrical measurements (end-points) and delta requirements shall be in accordance with group A, subgroup 2 and 4.5.3 herein, excluding thermal impedance. See 4.4.2.2 for JAN, JANTX, and JANTXV group B testing. Electrical measurements (end-points) and delta requirements for JAN, JANTX, and JANTXV shall be after each step in 4.4.2.2 and shall be in accordance with group A, subgroup 2 and 4.5.3 herein, excluding thermal impedance.

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

Subgroup	Method	Condition
B4	1037	$V_{CB} = 10$ V dc; $T_J = 150^\circ\text{C}$, $t_{on} = t_{off} = 3$ minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	$V_{CB} = 10$ V dc; $T_A = +125^\circ\text{C} \pm 25^\circ\text{C}$ for 96 hours with P_T adjusted according to the chosen T_A to give an average $T_J = +275^\circ\text{C}$.
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, $T_J = 150^\circ\text{C}$ min. 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 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, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$

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.

4.4.2.3 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.

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 in 4.4.3.1 (JANS) and 4.4.3.2 (JAN, JANTX, and JANTXV) herein for group C testing. Electrical measurements (end points) and delta requirements shall be in accordance with group A, subgroup 2 and 4.5.3 herein, excluding thermal impedance.

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; $T_J = 150^\circ\text{C}$ min. 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; $n = 22$, $c = 0$
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. 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 D inspection. Conformance inspection for hardness assured JANS and JANTXV types shall include the group D tests specified in table II herein. These tests shall be performed as required in accordance with MIL-PRF-19500 and MIL-STD-750, method 1019 for total ionizing dose or method 1017 for neutron fluence as applicable.

4.4.5 Group E Inspection. Group E inspection shall be performed for qualification or re-qualification only. The tests specified in table II 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 conducted 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 $R_{\theta JA} = 175^\circ\text{C/W}$.

4.5.3 Delta Requirements. Delta requirements shall be as specified below:

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

1/ Electrical characteristics for "L" suffix devices are identical to their corresponding "non L" suffix devices.

2/ Devices which exceed the group A limits shall not be returned to the lot, but will not be considered failures.

3/ Maximum limit for this test characterized at $\leq .125$ inch (3.18 mm) from the case.

4/ JANS only.

TABLE I. Group A inspection.

Inspection <u>1/</u> , <u>2/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u> <u>3/</u>						
Visual and mechanical <u>4/</u> examination	2071	n = 45 devices, c = 0				
Solderability <u>4/</u> , <u>6/</u>	2026	n = 15 leads, c = 0				
Resistance to solvents <u>4/</u> , <u>5/</u> , <u>6/</u>	1022	n = 15 devices, c = 0				
Temp Cycling <u>4/</u> , <u>6/</u>	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic Seal <u>6/</u> Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements <u>6/</u>		Group A, subgroup 2				
Bond strength <u>4/</u> , <u>6/</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				
<u>Subgroup 2</u>						
Thermal impedance	3131	See 4.3.2	Z _{θJX}		25	°C/W
Collector to base, cutoff current 2N3498, 2N3499 2N3500, 2N3501	3036	Bias condition D; V _{CB} = 100 V dc V _{CB} = 150 V dc	I _{CBO1}		10	μA dc
Breakdown voltage, collector to emitter 2N3498, 2N3499 2N3500, 2N3501	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	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} <u>Z/</u>		0.2	V dc
Collector to emitter saturation voltage 2N3500, 2N3501 only	3071	I _C = 150 mA dc; I _B = 15 mA dc; pulsed (see 4.5.1)	V _{CE(sat)2} <u>Z/</u>		0.4	V dc

See footnotes at end of table.

TABLE I. Group A inspection - continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Collector to emitter saturation voltage 2N3498, 2N3499 only	3071	$I_C = 300 \text{ mA dc}$; $I_B = 30 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(sat)3}$ <u>7/</u>		0.6	V dc
Base emitter saturation voltage	3066	Test condition A; $I_C = 10 \text{ mA dc}$; $I_B = 1 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)1}$ <u>7/</u>		0.8	V dc
Base emitter saturation voltage (2N3500, 2N3501 only)	3066	Test condition A; $I_C = 150 \text{ mA dc}$; $I_B = 15 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)2}$ <u>7/</u>		1.2	V dc
Base emitter saturation voltage (2N3498, 2N3499 only)	3066	Test condition A; $I_C = 300 \text{ mA dc}$; $I_B = 30 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)3}$ <u>7/</u>		1.4	V dc
Forward-current transfer ratio 2N3498, 2N3500 2N3499, 2N3501	3076	$V_{CE} = 10 \text{ V dc}$; $I_C = 0.1 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE1}	20 35		
Forward-current transfer ratio 2N3498, 2N3500 2N3499, 2N3501	3076	$V_{CE} = 10 \text{ V dc}$; $I_C = 1.0 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE2}	25 50		
Forward-current transfer ratio 2N3498, 2N3500 2N3499, 2N3501	3076	$V_{CE} = 10 \text{ V dc}$; $I_C = 10 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE3}	35 75		
Forward-current transfer ratio 2N3498, 2N3500 2N3499, 2N3501	3076	$V_{CE} = 10 \text{ V dc}$; $I_C = 150 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE4}	40 100	120 300	
Forward-current transfer ratio 2N3500 2N3501	3076	$V_{CE} = 10 \text{ V dc}$; $I_C = 300 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE5}	15 20		
Forward-current transfer ratio 2N3498 2N3499	3076	$V_{CE} = 10 \text{ V dc}$; $I_C = 500 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE6}	15 20		

See footnotes at end of table.

TABLE I. Group A inspection - continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ\text{C}$				
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 50\text{ V dc}$ $V_{CB} = 75\text{ V dc}$	I_{CBO3}		50	$\mu\text{A dc}$
2N3498, 2N3500 2N3499, 2N3501						
Low temperature operation		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 10\text{ V dc}; I_C = 150\text{ mA dc}$	h_{FE7}			
2N3498, 2N3500 2N3499, 2N3501				22 45		
<u>Subgroup 4</u>						
Magnitude of small-signal short-circuit forward current transfer ratio	3306	$V_{CE} = 20\text{ V dc}; I_C = 20\text{ mA dc};$ $f = 100\text{ MHz}$	$ h_{fe} $	1.5	8	
Small-signal short-circuit forward current transfer ratio	3206	$V_{CE} = 10\text{ V dc}; I_C = 10\text{ mA dc};$ $f = 1\text{ kHz}$	h_{fe}			
2N3498, 2N3500 2N3499, 2N3501				35 75	300 375	
Open circuit Output capacitance	3236	$V_{CB} = 10\text{ V dc}; I_E = 0;$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	C_{obo}			
2N3498, 2N3500 2N3499, 2N3501					10 8	pF pF
Input capacitance (output open-circuited)	3240	$V_{EB} = 0.5\text{ V dc}; I_C = 0;$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	C_{ibo}		80	pF
Noise figure (Test 1)	3246	$V_{CE} = 10\text{ V dc}; I_C = 0.5\text{ mA dc};$ $R_g = 1\text{ k}\Omega; f = 1\text{ kHz}$	NF		16	dB
Noise figure (Test 2)	3246	$V_{CE} = 10\text{ V dc}; I_C = 0.5\text{ mA dc};$ $R_g = 1\text{ k}\Omega; f = 10\text{ kHz}$	NF		6	dB
Turn-on time		$V_{EB} = 5\text{ V dc}; I_C = 150\text{ mA dc};$ $I_{B1} = 15\text{ mA dc};$ (see figure 2)	t_{on}		115	ns
Turn-off time		$I_C = 150\text{ mA dc}; I_{B1} = I_{B2} = -15\text{ mA dc};$ (see figure 2)	t_{off}		1150	ns

See footnotes at end of table.

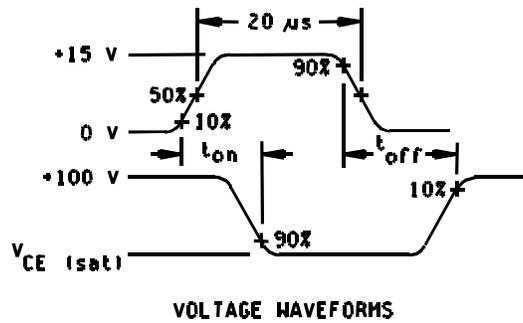
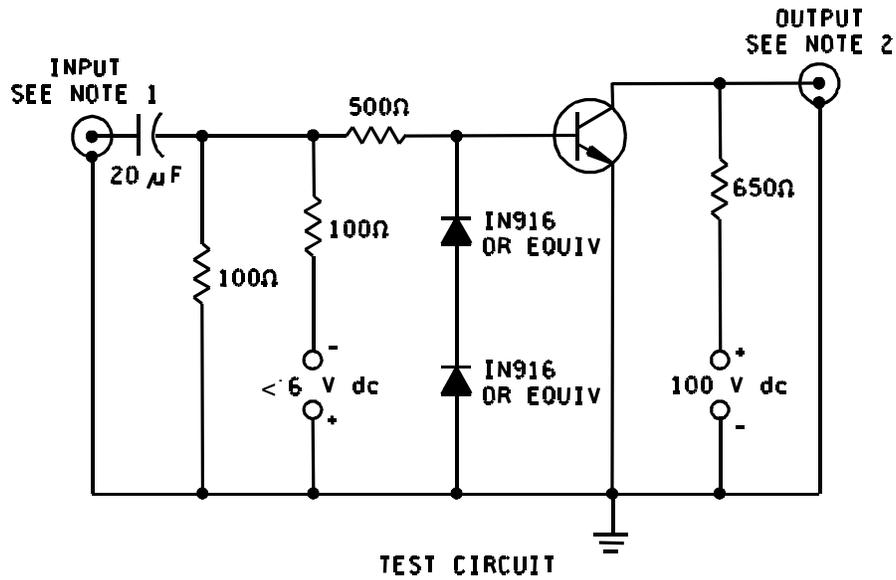
TABLE I. Group A inspection - continued.

Inspection ^{1/}	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u>						
Safe operating area (continuous dc)	3051	$T_C = 25^\circ\text{C}$; $t_r \geq 10 \text{ ns}$; 1 cycle; (see figure 3); $t = 1 \text{ s}$				
<u>Test 1</u>						
2N3498, 3N3499		$V_{CE} = 10 \text{ V dc}$; $I_C = 500 \text{ mA dc}$				
2N3500, 3N3501		$V_{CE} = 16.67 \text{ V dc}$; $I_C = 300 \text{ mA dc}$				
<u>Test 2</u>		$V_{CE} = 50 \text{ V dc}$; $I_C = 100 \text{ mA dc}$				
<u>Test 3</u>		$V_{CE} = 80 \text{ V dc}$; $I_C = 40 \text{ mA dc}$				
Safe operating area (clamped switching)	3053	$T_A = 25^\circ\text{C}$; (see figure 4); device fails if clamp voltage is not reached				
2N3498, 2N3499		$I_B = 85 \text{ mA dc}$; $I_C = 500 \text{ mA dc}$				
2N3500, 2N3501		$I_B = 50 \text{ mA dc}$; $I_C = 300 \text{ mA dc}$				
Electrical measurements		See 4.5.3, steps 1 and 3				
<u>Subgroup 6</u>						
Not required						
<u>Subgroup 7</u> ^{6/}						
Decap internal visual (design verification)	2075	$n = 1 \text{ device}$, $c = 0$				

^{1/} For sampling plan see MIL-PRF-19500.^{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 laser marked devices.^{6/} Not required for JANS devices.^{7/} Maximum limit for this test characterized at $\leq .125 \text{ inch}$ (3.18 mm) from the case.

TABLE II. Group E inspection (all quality levels) - For qualification only

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			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 and 4.5.3 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	Intermittent operation life: $V_{CB} = 10 \text{ V dc}$, 6,000 cycles, $\Delta T_J \geq +100^\circ\text{C}$; $T_J > +150^\circ\text{C}$, forced air cooling allowed on cooling cycle only.	
Electrical measurements		See group A, subgroup 2 and 4.5.3 herein.	
<u>Subgroup 3</u>			
Not applicable			
<u>Subgroup 4</u>			
Not applicable			
<u>Subgroup 5</u>			
Not applicable			



NOTES:

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

FIGURE 2. Turn-on turn-off switching time test circuit.

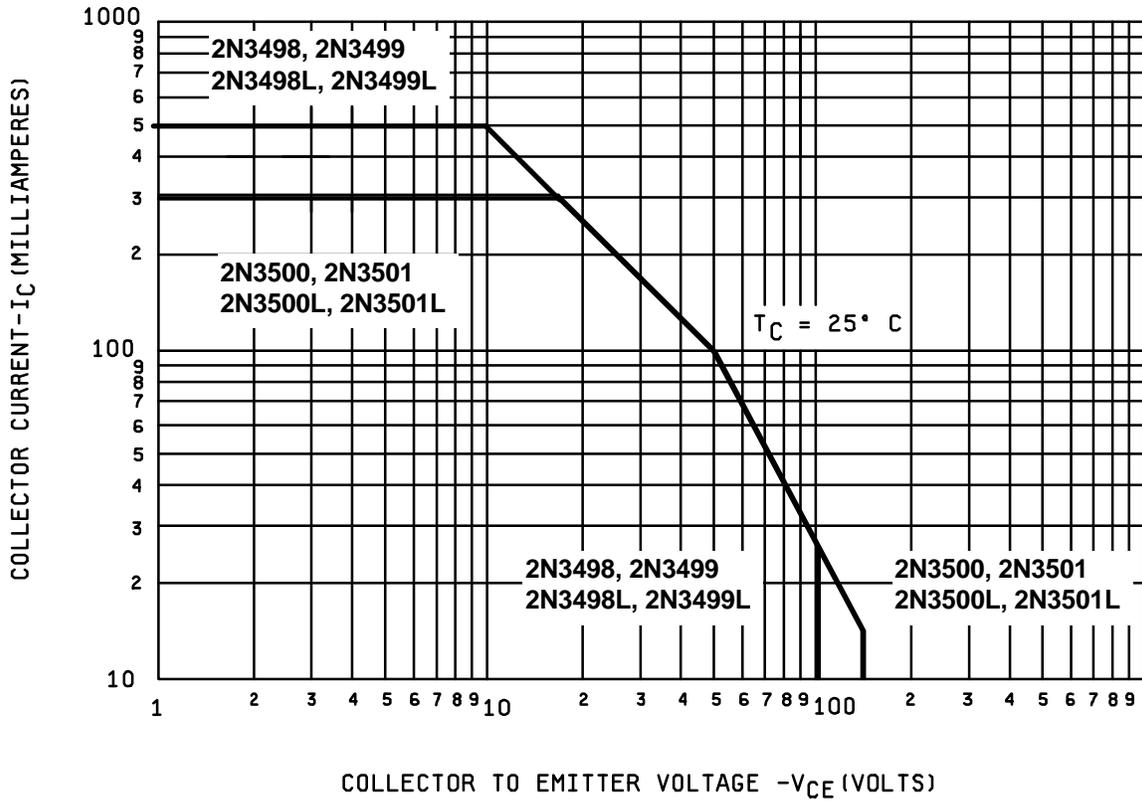
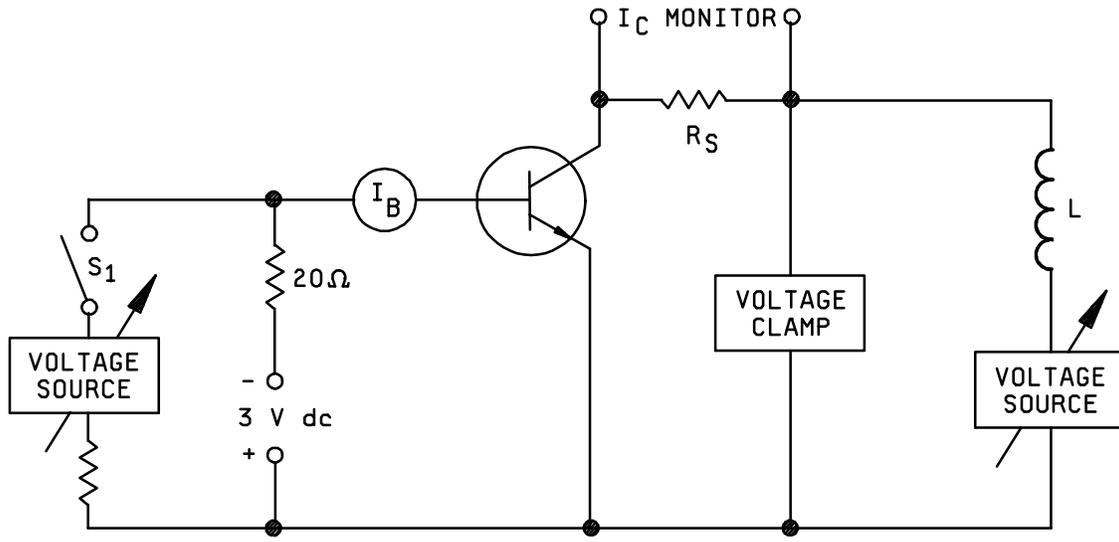


FIGURE 3. Maximum safe operating area.



Voltage clamp:

2N3498, 2N3498L, 2N3499, 2N3499L = 100 V dc
 2N3500, 2N3500L, 2N3501, 2N3501L = 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 4. Clamped inductive sweep test circuit diagram.

5. PACKAGING

5.1 Packaging. Packaging shall prevent mechanical damage of the devices during shipping and handling and shall not be detrimental to the device. 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.

5.2 Marking. Unless otherwise specified (see 6.2), marking shall be in accordance with MIL-PRF-19500.

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. See 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 No.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.

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 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.

CONCLUDING MATERIAL

Custodians:

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

Preparing activity:

DLA - CC

(Project 5961-2062)

Review activities:

Army - AR, MI, SM
Navy - AS, CG, MC
Air Force - 19, 85

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-19500/366F	2. DOCUMENT DATE 14 May 1999
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, AMPLIFIER TYPES 2N3498, 2N3498L, 2N3499, 2N3499L, 2N3500, 2N3500L, 2N3501 AND 2N3501L JAN, JANTX, JANTXV, AND JANS			
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@dsccl.dla.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	