

The documentation and process conversion measures necessary to comply with this revision shall be completed by 9 November 1993

INCH-POUND

MIL-S-19500/376C
9 August 1993
SUPERSEDING
MIL-S-19500/376B
2 September 1980

MILITARY SPECIFICATION
SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, LOW-POWER
TYPES 2N2484 JANTX, JANTXV, AND JANS

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 detail requirements for NPN, silicon, low-power transistors. Three levels of product assurance is provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See 3.3.

1.3 Maximum ratings.

P _T		V _{CB0}	V _{EB0}	V _{CE0}	I _C	T _J and T _{STG}
T _A = +25°C 1/	T _C = +25°C 2/					
mW	W	V dc	V dc	V dc	mA dc	°C
360	1.2	60	6	60	50	-65 to +200

1/ Derate linearly at 2.06 mW/°C above T_A = +25°C.
2/ Derate linearly at 6.85 mW/°C above T_C = +25°C.

1.4 Primary electrical characteristics.

LIMITS	h _{fe}	C _{ob0}	h _{fe} ₂	V _{CE(sat)} 1/	R _{θJC}
	V _{CE} = 5 V dc I _C = 1 mA dc f = 1 kHz	I _E = 0 V _{CB} = 5 V dc 100 kHz ≤ f ≤ 1 MHz	I _C = 500 μA dc V _{CE} = 5 V dc f = 30 MHz	I _C = 1.0 mA dc I _B = 0.1 mA dc	°C/W
Min	250	pF	2.0	V dc	
Max	900	5.0	7.0	0.3	146

1/ Pulsed (see 4.5.1).

	F I _C = 10 μA dc, V _{CE} = 5 V dc R _g = 10 kΩ			h _{FE2}	h _{FE5}
	f = 100 Hz	f = 1000 Hz	f = 10 kHz	V _{CE} = 5 V dc I _C = 10 μA dc	V _{CE} = 5 V dc I _C = 1 mA dc
Min	dB	dB	dB	200	250
Max	7.5	3	2	500	800

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: NASA/Parts Projects Office (NPPPO), NASA Goddard Space Flight Center, Code 310.A, Greenbelt, MD 20771 by using the 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

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 1911-5094.)

2.2 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 shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

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

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, appendix F, and figure 9, T-2A.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-S-19500.

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

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

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

4.3 Screening. Screening shall be in accordance with MIL-S-19500 (table II), 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 II of MIL-S-19500)	Measurement	
	JANS level	JAN, JANTX, and JANTXV levels
9	I _{CB01} and hFE2	Not applicable
11	I _{CB01} ; hFE2; ΔI_{CB01} = 100% of initial value or 2 nA dc, whichever is greater; $\Delta hFE2$ = $\pm 15\%$ of initial value.	I _{CB01} and hFE4
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CB01} = 100% of initial value or 2 nA dc, whichever is greater; $\Delta hFE2$ = $\pm 15\%$ of initial value.	Subgroup 2 of table I herein; ΔI_{CB01} = 100% of initial value or 2 nA dc whichever is greater; $\Delta hFE4$ = $\pm 25\%$ of initial value;

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 paragraph 4.5 of MIL-STD-750;

JANS level - - - V_{CB} = 10 V dc; P_T = 360 mW.

JAN, JANTX & JANTXV levels - - - V_{CB} = 30 V dc; P_T = 360 mW.

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

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-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 IVa (JANS) and table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500 and as follows. Electrical measurements (end-points) shall be in accordance with the applicable steps and footnotes of table II herein.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Condition
B3	2037	Condition A
B4	1037	V_{CB} = 10 V dc; P_T = 360 mW; T_A = $30^\circ \pm 5^\circ\text{C}$; t_{on} = t_{off} = 3 minutes minimum for 2000 cycles. No heat sink or forced-air cooling on the devices shall be permitted.
B5	1027	V_{CB} = 10 V dc; T_A = $125^\circ \pm 25^\circ\text{C}$ for 96 hours; P_T = 360 mW at 100°C , or adjusted as required by the chosen T_A to give an average lot T_J = 275°C . No heat sink or forced-air cooling on the devices shall be permitted.

4.4.2.2 Group B inspection, table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B3	1027	$V_{CB} = 30 \text{ V dc}$; $P_T = 360 \text{ mW}$ at $T_A = 30^\circ \pm 5^\circ\text{C}$. No heat sink or forced-air cooling on the devices shall be permitted.
B3	2037	Test condition A.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and as follows. Electrical measurements (end points) shall be in accordance with the applicable steps and footnotes of table II herein.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1026	$V_{CB} = 30 \text{ V dc}$; $P_T = 360 \text{ mW}$ at $T_A = 30^\circ\text{C} \pm 5^\circ\text{C}$. No heat sink or forced-air cooling on device shall be permitted.

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.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Collector to emitter breakdown voltage	3011	Bias condition D; $I_C = 10 \text{ mA dc}$ pulsed (see 4.5.1)	$V_{(BR)CEO}$	60		V dc
Collector to base breakdown voltage	3001	Bias condition D; $I_C = 10 \mu\text{A dc}$	$V_{(BR)CBO}$	60		V dc
Emitter to base breakdown voltage	3026	Bias condition B; $I_E = 10 \mu\text{A dc}$	$V_{(BR)EBO}$	6		V dc
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 45 \text{ V dc}$	I_{CBO1}		5	nA dc
Collector to emitter cutoff current	3041	Bias condition D; $V_{CE} = 5 \text{ V dc}$	I_{CEO}		2	nA dc
Emitter to base cutoff current	3061	Bias condition D; $V_{EB} = 5 \text{ V dc}$	I_{EBO}		2	nA dc
Collector to emitter cutoff current	3041	Bias condition C; $V_{CE} = 45 \text{ V dc}$	I_{CES}		5	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 1 \mu\text{A dc}$	h_{FE1}	45		
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 10 \mu\text{A dc}$	h_{FE2}	200	500	
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 100 \mu\text{A dc}$;	h_{FE3}	225	675	
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 500 \mu\text{A dc}$;	h_{FE4}	250	800	
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 1 \text{ mA dc}$;	h_{FE5}	250	800	
Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 10 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE6}	225	800	
Collector to emitter voltage (saturated)	3071	$I_C = 1.0 \text{ mA dc}$; $I_B = 100 \mu\text{A dc}$	$V_{CE(sat)}$		0.3	V dc

See footnote at end of table.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued.						
Base emitter voltage (nonsaturated)	3066	Test condition B; VCE = 5 V dc; IC = 100 μ A dc	VBE	0.5	0.7	V dc
<u>Subgroup 3</u>						
High-temperature operation		TA = +150°C				
Collector to base cutoff current	3041	Bias condition D; VCB = 45 V dc	ICBO2		10	μ A dc
Low-temperature operation		TA = -55°C				
Forward-current transfer ratio	3076	VCE = 5 V dc; IC = 10 μ A dc	hFE7	35		
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	VCE = 5 V dc; IC = 50 μ A dc; f = 5 MHz	hfe 1	3.0		
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	VCE = 5 V dc; IC = 500 μ A dc; f = 30 MHz	hfe 2	2.0	7.0	
Small-signal open-circuit output admittance	3216	VCE = 5 V dc; IC = 1.0 mA dc; f = 1 kHz	hoe		40	μ mhos
Small-signal open-circuit reverse-voltage transfer ratio	3211	VCE = 5 V dc; IC = 1.0 mA dc; f = 1 kHz	hre		8.0 $\times 10^{-4}$	
Small-signal short-circuit input impedance	3201	VCE = 5 V dc; IC = 1 mA dc; f = 1 kHz	hie	3.5	24	k Ω
Small-signal short-circuit forward current transfer ratio	3206	VCE = 5 V dc; IC = 1 mA dc; f = 1 kHz	hfe	250	900	
Open circuit output capacitance	3236	VCB = 5 V dc; IE = 0; 100 kHz \leq f \leq 1 MHz	Cobo		5.0	pf

See footnote at end of table.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u>						
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}		6.0	pF
Noise figure	3246	$f = 100 \text{ Hz};$ $V_{CE} = 5 \text{ V dc};$ $I_C = 10 \mu\text{A dc};$ $R_g = 10 \text{ k}\Omega;$	F1		7.5	dB
Noise figure	3246	$f = 1 \text{ kHz};$ $V_{CE} = 5 \text{ V dc};$ $I_C = 10 \mu\text{A dc};$ $R_g = 10 \text{ k}\Omega;$	F2		3	dB
Noise figure	3246	$f = 10 \text{ kHz};$ $V_{CE} = 5 \text{ V dc};$ $I_C = 10 \mu\text{A dc};$ $R_g = 10 \text{ k}\Omega;$	F3		2	dB
Noise figure (wideband)	3246	Noise bandwidth = 10 Hz to 15.7 kHz; $V_{CE} = 5 \text{ V dc};$ $I_C = 10 \mu\text{A dc};$ $R_g = 10 \text{ k}\Omega;$	F4		3	dB
<u>Subgroups 5, 6, and 7</u>						
Not applicable						

For sampling plan, see MIL-S-19500.

TABLE II. Groups B and C electrical measurements.

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Bias condition C; VCE = 45 V dc	ICES		5	nA dc
2.	Collector to emitter cutoff current	3041	Bias condition C; VCE = 45 V dc	ICES		10	nA dc
3.	Emitter to base cutoff current	3061	Bias condition D; VEB = 5 V dc	IEBO		2	nA dc
4.	Forward-current transfer ratio	3076	VCE = 5 V dc; IC = 10 μ A dc	hFE2	200	500	
5.	Forward-current transfer ratio	3076	VCE = 5 V dc; IC = 10 mA dc; pulsed (see 4.5.1)	hFE6	225	800	
6.	Forward-current transfer ratio	3076	VCE = 5 V dc; IC = 500 μ A dc;	Δ hFE4 1/	±25% change from initial recorded reading.		
7.	Collector to emitter voltage (saturated)	3071	IC = 1.0 mA dc; IB = 100 μ A dc	VCE(sat)		0.3	V dc
8.	Base emitter voltage (saturated)	3066	Test condition B; VCE = 5 V dc; IC = 100 μ A dc	VBE	0.5	0.7	V dc
9.	Collector to emitter voltage (saturated)	3071	IC = 1.0 mA dc; IB = 100 μ A dc	Δ VCE(sat) 1/	±50 mV dc change from previously measured value.		
10.	Collector to emitter voltage (saturated)	3041	Bias condition C; VCB = 45 V dc	Δ ICES 1/	100% of initial value or 2 nA dc, whichever is greater.		

1/ Devices which exceed the Group A limits for this shall not be acceptable.

2/ The electrical measurements for table IVa (JANS) of MIL-S-19500 are as follows:

- a. Subgroup 3, see table II herein, steps 1, 3, 4, 5, 7, and 8.
- b. Subgroup 4, see table II herein, steps 1, 3, 4, 5, 7, 8, and 9.
- c. Subgroup 5, see table II herein, steps 1, 3, 4, 5, 6, 7, 8, and 10.

3/ The electrical measurements for table IVb (JAN, JANTX, and JANTXV) of MIL-S-19500 are as follows:

- a. Subgroup 2, see table II herein, steps 1 and 4.
- b. Subgroups 3 and 6, see table II herein, steps 2 and 6.

4/ The electrical measurements for table V of MIL-S-19500 are as follows:

- a. Subgroups 2 and 3, see table II herein, steps 1, 3, 4, 5, 7, and 8 for JANS; steps 1 and 4 for JAN, JANTX, and JANTXV.
- b. Subgroup 6, see table II herein, steps 1, 3, 4, 5, 6, 7, 8, and 10 for JANS; steps 2 and 6 for JAN, JANTX, and JANTXV.

6. NOTES

6.1 Notes. The notes specified in MIL-S-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 2.1).
- b. Lead formation and finish may be specified (see 3.3.1).
- c. Type designation and product assurance level.

6.3 Changes from previous issue. Asterisks 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 - ER
Navy - EC
Air Force - 17

Review activities:

Army - SM
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DLA - ES

User activities:

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Preparing activity:
NASA - NA

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The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-S-19500/376C

2. DOCUMENT DATE (YYMMDD)

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, LOW-POWER, TYPES 2N2484 JAN, JANTX, JANTXV, AND JANS

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)

7. DATE SUBMITTED (YYMMDD)

- (1) Commercial
(2) AUTOVON (if applicable)

8. PREPARING ACTIVITY

a. NAME

b. TELEPHONE (Include Area Code)

- (1) Commercial (2) AUTOVON

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