The documentation and process conversion measures necessary to comply with this revision shall be completed by 29 Oct 92

INCH-POUND

MIL-S-19500/283D
29 July 1992
SUPERSEDING
MIL-S-19500/283C
15 November 1983

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING
TYPES 2N869A AND 2N4453
JANTX AND JANTXV

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 a PNP, silicon, high-speed switching transistor. Two levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1 and 3.3.

1.3 Maximum ratings.

Types	P_T T_A = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{STG} and T_J
	mW	V dc	V dc	V dc	mA dc	°C
2N869A	0.36 1/	25	5.0	18	200	-55 to +200
2N4453	0.30 2/	25	5.0	18	200	-55 to +200

1/ Derate linearly, 2.10 mW/°C for T_A > +25°C.
2/ Derate linearly, 1.71 mW/°C for T_A > +25°C.

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

Limit	h_{FE2} 1/ V_{CE} = 5.0 V dc I_C = 10 mA dc	h_{FE3} 1/ V_{CE} = 0.5 V dc I_C = 20 mA dc	$V_{CE(sat)1}$ I_C = 10 mA dc I_B = 1.0 mA dc	$V_{BE(sat)2}$ I_C = 10 mA dc I_B = 1.0 mA dc	Pulse response t_{on}	Pulse response t_{off}	$\|h_{FE2}\|$ V_{CE} = 15 V dc I_C = 10 mA dc f = 100 Mhz
			V dc	V dc	ns	ns	
Minimum	40	40	----	0.70	--	--	4.0
Maximum	120	120	0.15	0.98	50	80	10.0

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: Commander, Defense Electronics Supply Center, ATTN: DESC-ECT, 1507 Wilmington Pike, Dayton, OH 45444-5280 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

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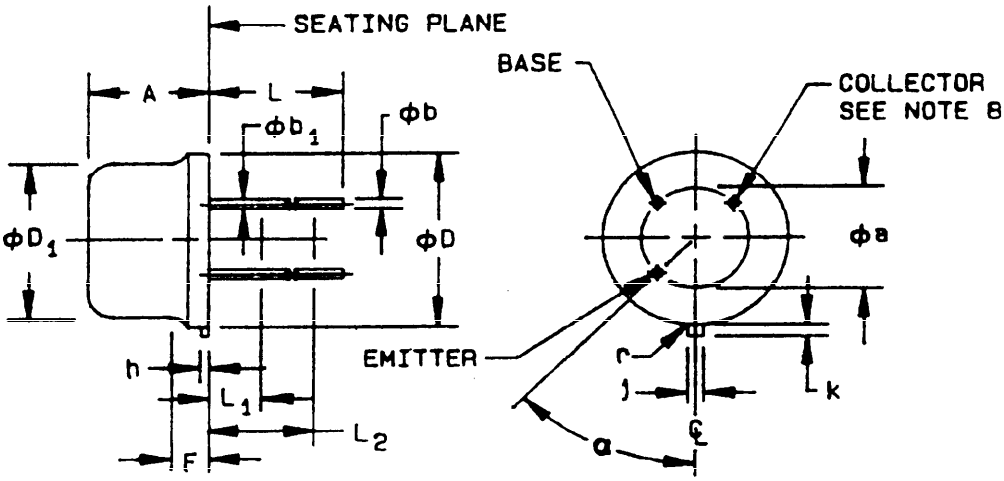


FIGURE 1. Physical dimensions.

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
ϕa	.100 TP		2.54 TP		6
A	See notes 10 and 11				
ϕb	.016	.021	0.41	0.53	7,8
ϕb_1	.016	.019	0.41	0.48	7,8
ϕD	.209	.230	5.31	5.84	
ϕD_1	.178	.195	4.52	4.95	
F	----	.041	----	1.04	5
h	----	.020	----	0.51	
j	.036	.046	0.91	1.17	3
k	.028	.048	0.71	1.22	3,4
L	.500	.750	12.70	19.05	7,8
L_1	----	.050	----	1.27	7,8
L_2	.250	----	6.35	----	7,8
r	----	.010	----	0.25	10
α	45° TP		45°TP		6

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, j shall be held for a minimum length of .011 inch (0.28 mm).
4. Symbol k measured from maximum ϕD.
5. Body contour optional within zone defined by ϕD, ϕD_1, and F.
6. Leads at gauge plane .054 - .055 inch (1.37 - 1.40 mm) below seating plane shall be within .007 inch (.18 mm) radius of true position (TP) at a maximum material condition (MMC) relative to the tab at MMC. The device may be measured by direct methods or by the gauge and gauging procedure described on gauge drawing GS-1.
7. Symbol ϕb_1 applies between L_1 and L_2. ϕb applies between L_2 and L minimum. Diameter is uncontrolled in L_1 and beyond minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Symbol r (radius) applies to both inside corners of tab.
11. For transistor types 2N869A, A is .170 inches (4.32 mm) minimum, and .210 inches (5.34 mm) maximum. (TO-18)
12. For transistor types 2N4453, A is .065 inch (1.65 mm) minimum, and .085 inch (2.16 mm) maximum. (TO-46)

FIGURE 1. Physical dimensions - Continued.

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).

SPECIFICATIONS

MILITARY

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

STANDARDS

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 19111-5094.)

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 takes 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. The 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, figure 9.

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

3.4 Marking. Marking shall be in accordance with MIL-S-19500. At the option of the manufacturer, marking of the country of origin may be omitted from the body of the transistor, but shall be retained on the initial container.

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 (JANTX and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-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 II of MIL-S-19500)	Measurement
	JANTX and JANTXV levels
9	Not applicable
11	I_{CES1} and h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein, ΔI_{CES1} = 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE2} = ±15 percent of initial value.

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

2N869A - - - - V_{CB} = 12 V dc, P_T = 360 mW at T_A = +25°C ±3°C.
2N4453 - - - - V_{CB} = 12 V dc, P_T = 300 mW at T_A = +25°C ±3°C.

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

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500. Group A inspection shall be performed on each sublot.

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 IVb (JANTX and JANTXV) of MIL-S-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2.1 Group B inspection, table IVb (JANTX and JANTXV of MIL-S-19500. Condition for steady-state operation life, (see 4.3.1). No heat sink or forced air cooling on the devices shall be permitted.

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

4.4.3.1 Group C inspection, table V of MIL-S-19500. Condition for steady-state operation life, (see 4.3.1). No heat sink or forced air cooling on the devices shall be permitted.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-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-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish as specified (see 3.3.1).

c. Product assurance level and type designation.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage, collector to base	3001	Bias condition A, I_C = 10 µA dc	$V_{(BR)CBO}$	25		V dc
Breakdown voltage, collector to emitter	3011	Bias condition A, I_C = 10 mA dc pulsed (see 4.5.1)	$V_{(BR)CEO}$	18		V dc
Breakdown voltage, collector to emitter	3011	Bias condition C, I_C = 10 mA dc	$V_{(BR)CES}$	25		V dc
Breakdown voltage, emitter to base	3026	Bias condition A, I_E = 10 µA dc	$V_{(BR)EBO}$	5		V dc
Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 15 V dc V_{BE} = 0	I_{CES1}		10	nA dc
Emitter to base cutoff current	3061	Bias condition A, V_{EB} = 3.5 V dc	I_{EBO}		10	nA dc
Forward-current transfer ratio	3076	V_{CE} = 0.3 V dc; I_C = 10 mA dc	h_{FE1}	30		
Forward-current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 10 mA dc	h_{FE2}	40	120	
Forward-current transfer ratio	3076	V_{CE} = 0.5 V dc; I_C = 30 mA dc	h_{FE3}	40	120	
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 100 mA dc; pulsed (see 4.5.1)	h_{FE4}	25		
Collector to emitter voltage (saturated)	3071	I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{CE(sat)1}$		0.15	V dc
Collector to emitter voltage (saturated)	3071	I_C = 100 mA dc; I_B = 10 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$		0.50	V dc
Base emitter voltage (saturated)	3066	Test condition A I_C = 10 mA dc; I_B = 1.0 mA dc	$V_{BE(sat)1}$	0.70	0.98	V dc
Base emitter voltage (saturated)	3066	Test condition A; I_C = 100 mA dc; I_B = 10 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)2}$	-----	1.7	V dc

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High temperature operation:		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition C, V_{CE} = 15 V dc V_{BE} = 0	I_{CES2}		10	µA dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 0.5 V dc; I_C = 30 mA dc	h_{FE5}	17		
Subgroup 4						
Open circuit output capacitance	3236	V_{CB} = 5 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}		6	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; 100 kHz ≤ f ≤ 1 MHz	C_{ibo}		6	pF
Common emitter, small-signal short-circuit forward current transfer ratio	3306	V_{CE} = 15 V dc; I_C = 10 mA dc; f = 100 MHz	$\|h_{FE}\|$	4	10	
Small-signal short-circuit forward current transfer ratio	3206	V_{CE} = 5 V dc; I_C = 1 mA dc	h_{fe1}	30		
Small-signal short-circuit forward current transfer ratio	3206	V_{CE} = 5 V dc; I_C = 5 mA dc	h_{fe2}	30		
Pulse response, saturated turn-on time	3251	I_C = 30 mA dc; I_B = 1.5 mA dc (see figure 2)	t_{on}		50	ns
Pulse response, saturated turn-off time	3251	I_C = 30 mA dc; I_{B1} = I_{B2}; I_{B2} = 1.5 mA dc (see figure 2)	t_{off}		80	ns
Noise figure	3246	V_{CE} = 5 V dc; I_C = 0.5 mA dc; Rg = 1 kΩ; f = 1 MHz; BW ≤ 200 kHz	N_F		6.0	db
Subgroup 5, 6, and 7						
Not applicable						

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

TABLE II. Groups B and C electrical measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1	Collector to emitter cutoff current	3041	Bias condition C; V_{CE} = 10 V dc	I_{CES1}		10	nA dc
2	Collector to emitter cutoff current	3041	Bias condition C; V_{CE} = 15 V dc	I_{CES2}		20	nA dc
3	Collector to emitter saturation voltage and resistance	3071	I_C = 100 mA dc; I_B = 10 mA dc, pulsed (see 4.5.1)	$V_{CE(SAT)2}$		0.5	V dc
4	Base to emitter saturation voltage	3066	Test condition A; I_C = 100 mA dc, I_B = 10 mA dc, pulsed (see 4.5.1)	$V_{BE(SAT)2}$		1.7	V dc
5	Forward-current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 10 mA dc	h_{FE2}	40	120	
6	Forward-current transfer ratio	3076	V_{CE} = 5 V dc; I_C = 10 mA dc, pulsed (see 4.5.1)	Δh_{FE2} 3/	±25 percent change from initial value		

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

a. Subgroup 2, see table II herein, steps 1, 3, and 5.

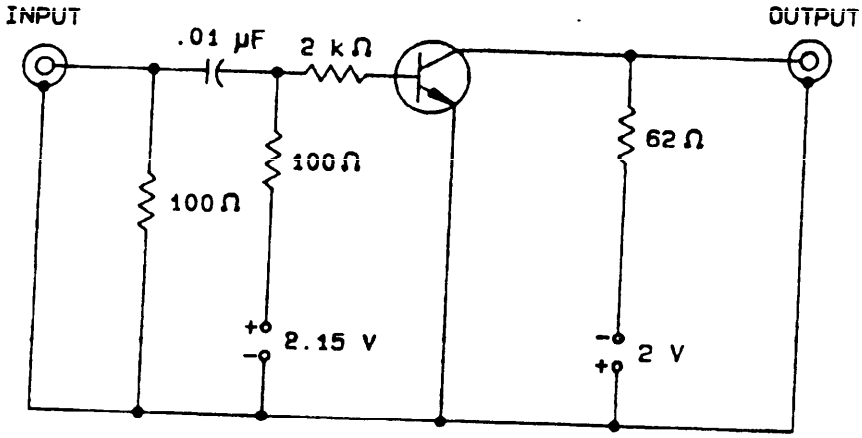
b. Subgroup 3 and 6, see table II herein, steps 2, 3, 4, and 6.

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

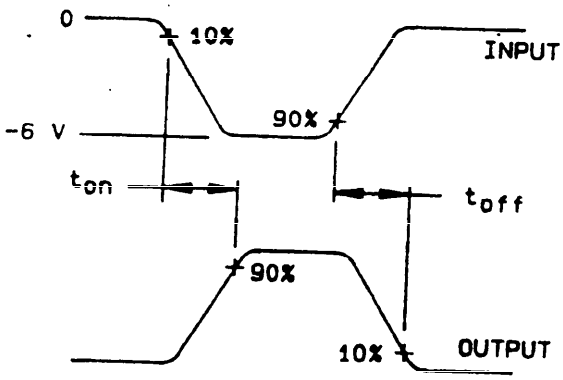
a. Subgroup 2 and 3, see table II herein, steps 1, 3, and 5 for all levels.

b. Subgroup 6, see table II herein, steps 2, 3, 4, and 6 for all levels.

3/ Devices which exceed the group A limits for this test shall not be accepted.



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

1. The input waveform shall be supplied by a pulsed generator with the following characteristics: $Z_{OUT} = 50\Omega$; $t_r \leq 1$ ns, $t_f \leq 1$ ns; PW ≥ 200 ns; duty cycle ≤ 2 percent.
2. The output waveform shall be monitored on an oscilloscope with the following characteristics: $Z_{IN} \geq 100k\ \Omega$; $C_{in} \leq 12$ pF; $t_r \leq 1$ ns.

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

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Army - AR, MI
Air Force - 19, 80, 85, 99
DLA - ES
NASA - LRC, MSF

User activities:
Army - AV, SM
Navy - AS, CG, MC, OS, SH
Air Force - 13, 15

Preparing activity:
Navy - EC

Agent:
DLA - ES

(Project 5961-1386)