

The documentation and process conversion measures necessary to comply with this revision shall be completed by 10 November 1998.

INCH-POUND

MIL-PRF-19500/423D
10 August 1998
SUPERSEDING
MIL-PRF-19500/423C
29 August 1997

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING TYPES 2N5581 AND 2N5582, JAN, JANTX, AND JANTXV

This specification is approved for use by the Department of the Air Force and is available 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 switching transistors. Three levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See 3.3 (similar to TO-46).

1.3 Maximum ratings.

P_T $T_A = +25^\circ\text{C}$	P_T $T_C = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	I_C	T_{OP}
<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C</u>
0.5 <u>1/</u>	2.0 <u>2/</u>	75	50	800	-55 to +200

1/ Derate linearly 2.86 mW/°C above $T_A = +25^\circ\text{C}$.

2/ Derate linearly 11.43 mW/°C above $T_C = +25^\circ\text{C}$.

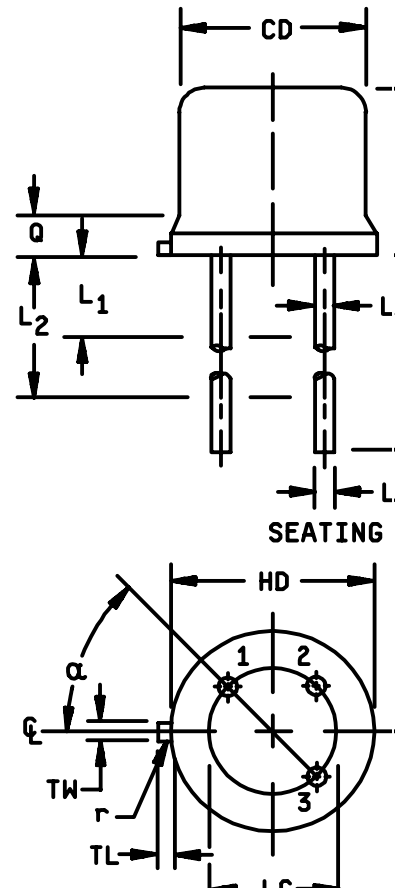
1.4 Primary electrical characteristics.

7. Static electrical characteristics										
		h_{FE2}		h_{FE4}		$ h_{fe} $ $V_{CE} = 20\text{ V dc}$ $I_C = 20\text{ mA dc}$ $f = 100\text{ MHz}$	Cobo $V_{CB} = 10\text{ V dc}$ $I_E = 0$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	Switching		
		$V_{CE} = 10\text{ V dc}$ $I_C = 1.0\text{ mA dc}$		$V_{CE} = 10\text{ V dc}$ $I_C = 150\text{ mA dc}$ <u>1/</u>				t_{on}	t_{off}	$t_{on} + t_{off}$
		2N5581	2N5582	2N5581	2N5582		<u>pF</u>	<u>ns</u>	<u>ns</u>	<u>ns</u>
Min		35	75	40	100	2.5				
Max				120	300	5.0	8	35	300	18

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 Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad St., Columbus, OH 43216-5000, by using the addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

Symbol	Dimensions				Note
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.065	.085	1.65	2.16	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7
LL	.500	.750	12.70	19.05	7
LU	.016	.019	0.41	0.48	7
L1	---	.050	---	1.27	7
L2	.250	---	6.35	---	7
Q	---	.040	---	1.02	4
TL	.028	.048	0.71	1.22	4
TW	.036	.046	0.91	1.17	3
r	---	.007	---	0.18	10, 11
α	45° TP		45° TP		6



NOTES:

1. Dimension are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC.
7. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕ x symbology.
12. Lead 1 = emitter, lead 2 = base, lead 3 = collector.

FIGURE 1. Physical dimensions.

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 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 paragraph 1.3, 1.4, and table I.

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

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 6.4).

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 (JANTX and JANTXV 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)	Measurements
	JANTX and JANTXV levels
3c	Thermal impedance (see 4.3.2)
9	Not applicable
10	48 hours minimum
11	I_{CBO2} , h_{FE4}
12	See 4.3.1 80 hours minimum
13	Subgroup 2 of table I herein; $\Delta I_{CBO2} = 100\%$ of initial value or 5 nA dc, whichever is greater; $\Delta h_{FE4} = \pm 15\%$

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

$$V_{CB} = 10 - 30 \text{ V dc}; P_T = 400 \text{ mW}.$$

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

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 current ----- 5 mA.
- b. I_H forward heating current ----- 200 mA (min).
- c. t_H heating time ----- 25 - 30 ms.
- d. t_{md} measurement delay time ----- 60 μ s max.
- e. V_{CE} collector-emitter voltage ----- 10 V dc minimum

The maximum limit for $Z_{\theta JX}$ under these test conditions are $Z_{\theta JX} \text{ (max)} = 72^\circ\text{C/W}$.

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 as follows for JAN, JANTX, and JANTXV group B testing herein. Electrical measurements (end-points) and delta requirements for JAN, JANTX, and JANTXV shall be after each following step and shall be in accordance with group A, subgroup 2 and 4.5.2 herein.

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), $t = 340$ hrs, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$

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.

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

- 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.
- 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 (group B herein 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 as follows. Electrical measurements (end points) and delta requirements shall be in accordance with group A, subgroup 2 and 4.5.2 herein.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6		Not Applicable

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

Step	Inspection	MIL-STD-750		Symbol	Limit	Unit
		Method	Conditions			
1	Collector-base cutoff current	3036	Bias condition D, $V_{CB} = 60$ V dc	ΔI_{CB02} <u>1/</u>	100% of initial value or 8 nA dc, whichever is greater.	
2	Forward current transfer ratio	3076	$V_{CE} = 10$ V dc; $I_C = 150$ mA dc; pulsed see 4.5.2	Δh_{FE4} <u>1/</u>	$\pm 25\%$ change from initial reading.	

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

TABLE I. Group A inspection

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1 2/</u>						
Visual and mechanical <u>3/</u> examination	2071	n = 45 devices, c = 0				
Solderability <u>3/</u>	2026	n = 15 leads, c = 0				
Resistance to solvents <u>3/</u> , <u>4/</u>	1022	n = 15 devices, c = 0				
Temp Cycling <u>3/</u>	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Hermetic Seal Fine leak Gross leak	1071	n = 22 devices, c = 0				
Electrical measurements Bond strength <u>3/</u>	2037	Group A, subgroup 2 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>						
Collector to base cutoff current	3036	Bias condition D, V _{CB} = 75 V dc	I _{CBO1}		10	μA dc
Emitter to base cutoff current	3061	Bias condition D, V _{EB} = 6 V dc	I _{EBO1}		10	μA dc
Breakdown voltage, collector to emitter	3011	Bias condition D; I _C = 10 mA dc; pulsed (see 4.5.1)	V _{(BR)CEO}	50		V dc
Collector to base cutoff Current	3036	Bias condition D; V _{CB} = 60 V dc	I _{CBO2}		10	nA dc
Emitter to base cutoff current	3061	Bias condition D; V _{EB} = 4 V dc	I _{EBO2}		10	nA dc
Forward-current transfer ratio 2N5581 2N5582	3076	V _{CE} = 10 V dc; I _C = 0.1 mA dc	h _{FE1}		30 50	
Forward-current transfer ratio 2N5581 2N5582	3076	V _{CE} = 10 V dc; I _C = 1.0 mA dc	h _{FE2}		35 75	
Forward-current transfer ratio 2N5581 2N5582	3076	V _{CE} = 10 V dc; I _C = 10 mA dc	h _{FE3}		40 100	

See footnotes at end of table.

TABLE I. Group A inspection

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Forward-current transfer ratio 2N5581 2N5582	3076	V _{CE} = 10 V dc; I _C = 150 mA dc; pulsed(see 4.5.1)	h _{FE4}	40 100	120 300	
Forward-current transfer ratio 2N5581 2N5582	3076	V _{CE} = 10 V dc; I _C = 500 mA dc; pulsed see 4.5.1	h _{FE5}	20 30		
Collector-emitter saturation voltage	3071	I _C = 150 mA dc; I _B = 15 mA dc pulsed (see 4.5.1)	V _{CE(sat)1}		0.3	V dc
Collector-emitter saturation voltage	3071	I _C = 500 mA dc; I _B = 50 mA dc; pulsed (see 4.5.1)	V _{CE(sat)2}		1.0	V dc
Base-emitter saturation voltage	3066	Test condition A; I _C = 150 mA dc; I _B = 15 mA dc; pulsed (see 4.5.1)	V _{BE(sat)1}	0.6	1.2	V dc
Base-emitter saturation voltage	3066	Test condition A; I _C = 500 mA dc; I _B = 50 mA dc; pulsed (see 4.5.1)	V _{BE(sat)2}		2.0	V dc
<u>Subgroup 3</u>						
High temperature operation		T _A = +150°C				
Collector to base cutoff current	3036	Bias condition D;V _{CB} = 60 V dc	I _{CBO3}		10	µA dc
Low temperature operation		T _A = -55°C				
Forward-current transfer ratio 2N5581 2N5582	3076	V _{CE} = 10 V dc; I _C = 10 mA dc	h _{FE6}	15 35		
<u>Subgroup 4</u>						
Small-signal short- circuit forward current transfer ratio 2N5581 2N5582	3206	V _{CE} = 10 V dc; I _C = 1 mA dc; f = 1 kHz	h _{fe}	30 50		
Magnitude of small-signal short- circuit forward current transfer ratio	3306	V _{CE} = 20 V dc; I _C = 50 mA dc; f = 100 MHz	/h _{fe} /	2.5		
Open circuit Output capacitance	3236	V _{CB} = 10 V dc; I _E = 0; 100 kHz ≤ f ≤ 1 MHz	C _{obo}		8	pF

See footnotes at end of table.

TABLE I. Group A inspection - continued

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - Continued	3240	$V_{EB} = 0.5 \text{ V dc}; I_C = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$ (See figure 2) (See figure 3) (See figure 4)	C_{ibo} t_{on} t_{off} $t_{on} + t_{off}$		25 35 300 18	pF ns ns ns
Input capacitance (output open- circuited)						
turn-on time						
turn-off time						
Pulse response						
<u>Subgroups 5 and 6</u>	2075	n = 1 device, c = 0				
Not required						
<u>Subgroup 7</u>						
Decap internal visual (design verification)						

1/ For sampling plan see MIL-PRF-19500.

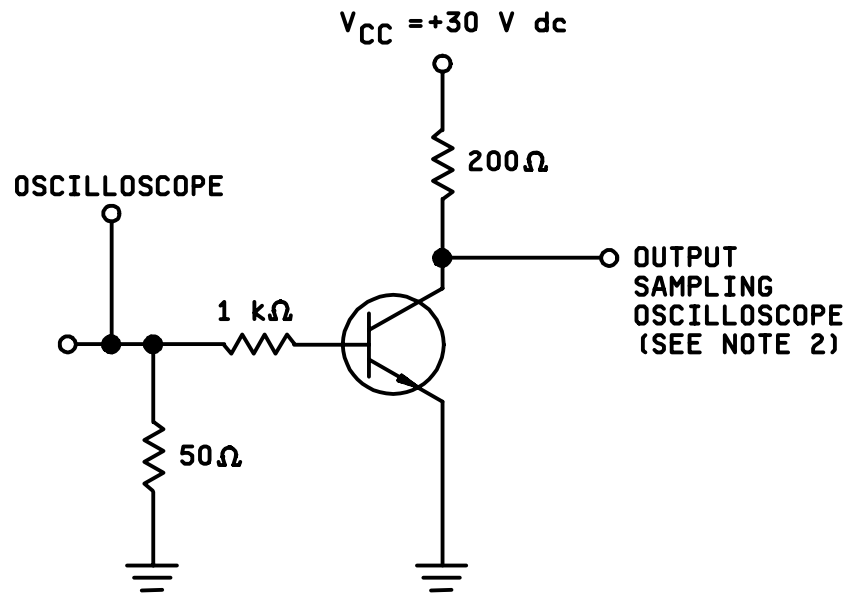
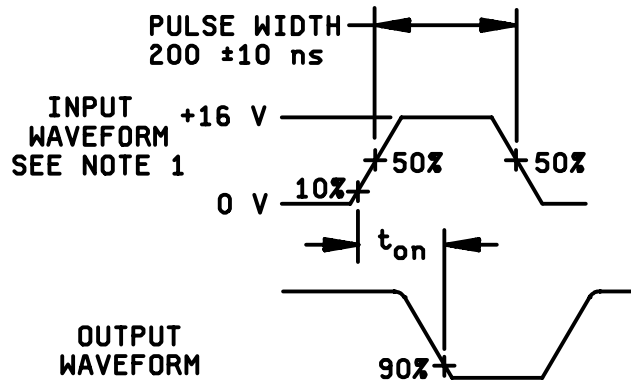
2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.

3/ Separate samples may be used.

4/ Not required for laser marked devices.

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

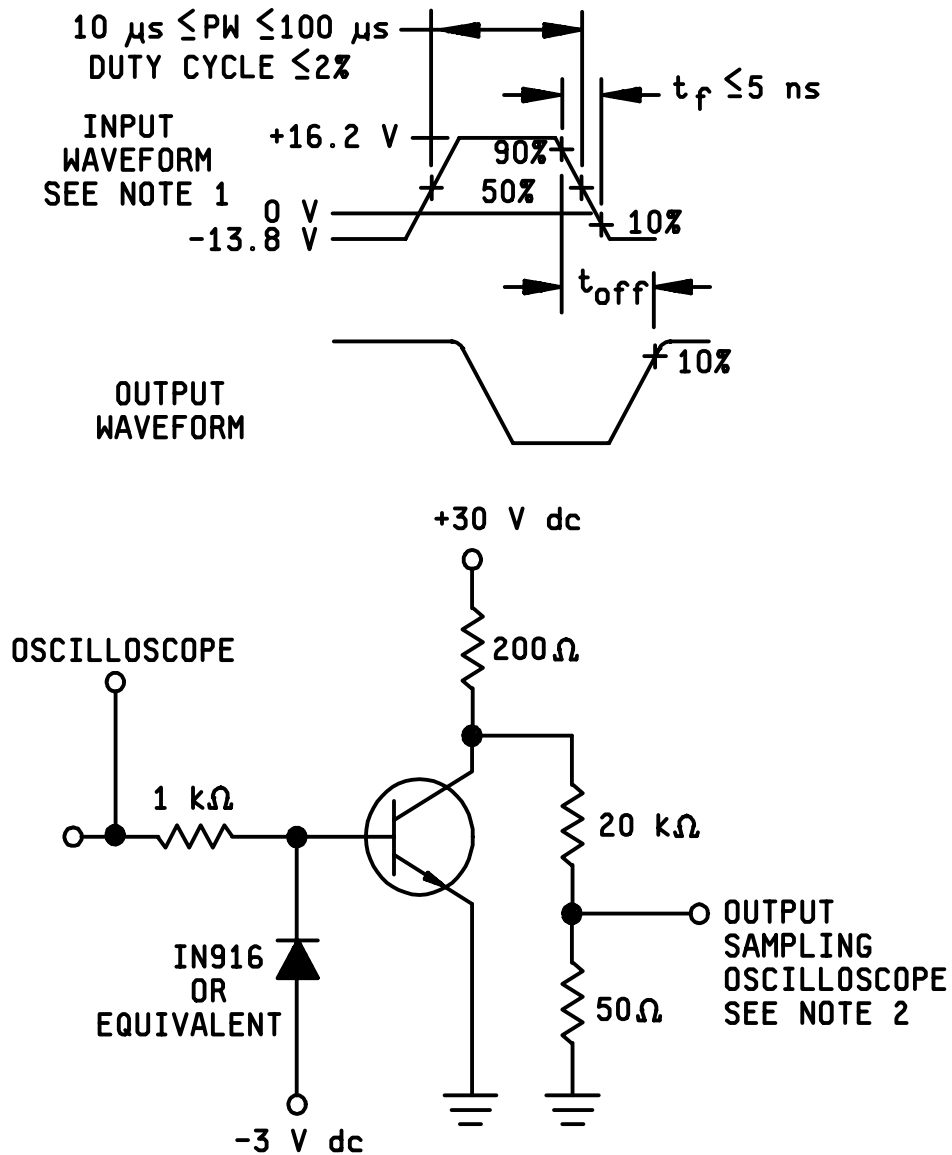
Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			12 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See group A, subgroup 2 and 4.5.3 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	Intermittent operation life: $V_{CB} = 10 \text{ V dc}$, 6,000 cycles, $\Delta T_J \geq +100^\circ\text{C}$; forced air cooling allowed on cooling cycle only.	
Electrical measurements		See group A, subgroup 2 and 4.5.2 herein.	
<u>Subgroup 3</u>			
Not applicable			
<u>Subgroup 4</u>			
Not applicable			
<u>Subgroup 5</u>			
Not applicable			



NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be ≤ 2.0 ns;
duty cycle ≤ 2 percent; generator source impedance shall be 50 ohms.
2. Output sampling oscilloscope: $Z_{in} \geq 100$ k Ω ; $C_{in} \leq 12$ pF; rise time ≤ 5.0 ns.

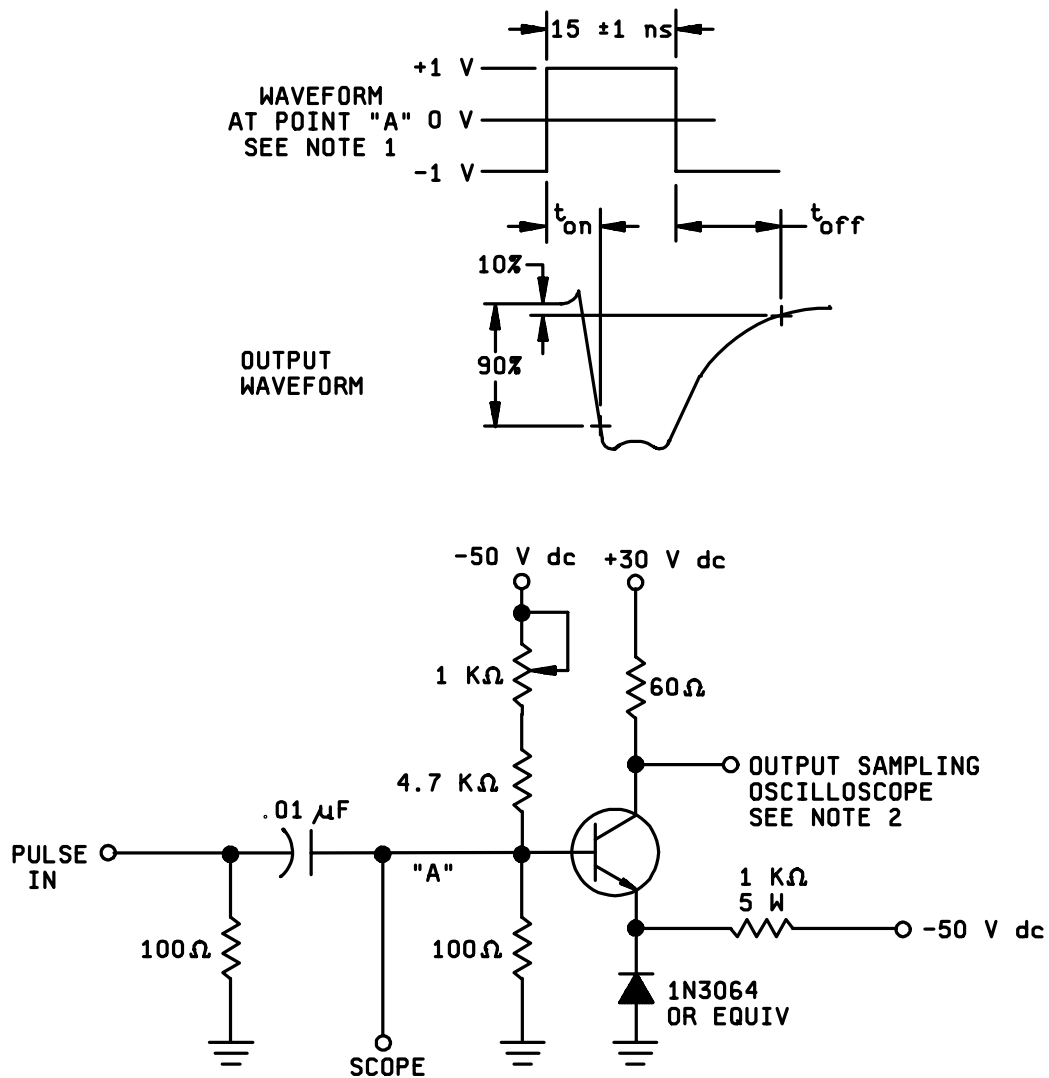
FIGURE 2. Saturated turn-on switching time test circuit.



NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be $\leq 2.0\ \text{ns}$; duty cycle ≤ 2 percent; generator source impedance shall be $50\ \text{ohms}$.
2. Output sampling oscilloscope: $Z_{\text{in}} \geq 100\ \text{k}\Omega$; $C_{\text{in}} \leq 12\ \text{pF}$; rise time $\leq 0.2\ \text{ns}$.

FIGURE 3. Saturated turn-off switching time test circuit.



NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be ≤ 2.0 ns; duty cycle ≤ 2 percent; generator source impedance shall be 50 ohms.
2. Output sampling oscilloscope: $Z_{in} \geq 100$ k Ω ; $C_{in} \leq 12$ pF; rise time ≤ 0.2 ns.

FIGURE 4. Nonsaturated turn-on switching time test circuit.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of 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-STD-129.

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. Acquisition documents should specify the following:

- a. Lead finish (see 3.3.1).
- b. Type designation and product assurance level.

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.

6.4 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 Products List QPL-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, DSCC-VQE, Columbus, OH 43216.

Custodian:
Army - CR
Navy - EC
Air Force - 17

Preparing activity:
DLA - CC

(Project 5961-2048-03)

Review activities:
Air Force - 13, 19, 85, 90

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I RECOMMEND A CHANGE :	1. DOCUMENT NUMBER MIL-PRF-19500/423D	2. DOCUMENT DATE 10 August 1998
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING TYPES 2N5581 AND 2N5582, JAN, JANTX, AND JANTXV		
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)		
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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@dscclia.mil	
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