

The documentation and process conversion measures necessary to comply with this revision shall be completed by 31 April 1998

INCH-POUND

MIL-PRF-19500/512C
 31 January 1998
 SUPERSEDING
 MIL-S-19500/512B
 26 August 1994

PERFORMANCE SPECIFICATION SHEET
 SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING
 TYPES 2N4029, 2N4033, JAN, 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 performance requirements for PNP silicon transistors designed for use in high speed switching and driver applications. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figures 1 (TO-18) and 2 (TO-39) herein.

1.3 Maximum ratings.

P_T 1/ $T_A = +25^\circ\text{C}$	P_T 2/ $T_A = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{OP} and T_{STG}	$R_{\theta JC}$
2N4029	2N4033						
<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>°C</u>	<u>°C/W</u>
0.5	0.8	80	80	5.0	1.0	-55 to +200	17.5

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

2/ Derate linearly 4.56 mW/°C above $T_A = +25^\circ\text{C}$.

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

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

FSC 5961

1.4 Primary electrical characteristics at $T_A = +25^\circ\text{C}$.

Limits	h_{FE1} $V_{CE} = 5.0 \text{ V dc}$ $I_C = 100 \mu\text{A dc}$	h_{FE2} $V_{CE} = 5.0 \text{ V dc}$ $I_C = 100 \text{ mA dc}$	h_{FE3} $V_{CE} = 5.0 \text{ V dc}$ $I_C = 500 \text{ mA dc}$	h_{FE4} $V_{CE} = 5.0 \text{ V dc}$ $I_C = 1.0 \text{ A dc}$	$ h_{fe} $ $f = 100 \text{ MHz}$ $V_{CE} = 10 \text{ V dc}$ $I_C = 50 \text{ mA dc}$
Min Max	50	100 300	70	25	1.5 6.0

Limits	$V_{CE(SAT)2}$ $I_C = 500 \text{ mA dc}$ $I_B = 50 \text{ mA dc}$	C_{obo} $V_{CB} = 10 \text{ V dc}$ $I_E = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	t_d	t_r	t_s	t_f
Min Max	<u>V dc</u> 0.5	<u>pF</u> 20	<u>ns</u> 15	<u>ns</u> 25	<u>ns</u> 175	<u>ns</u> 35

1/ 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 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

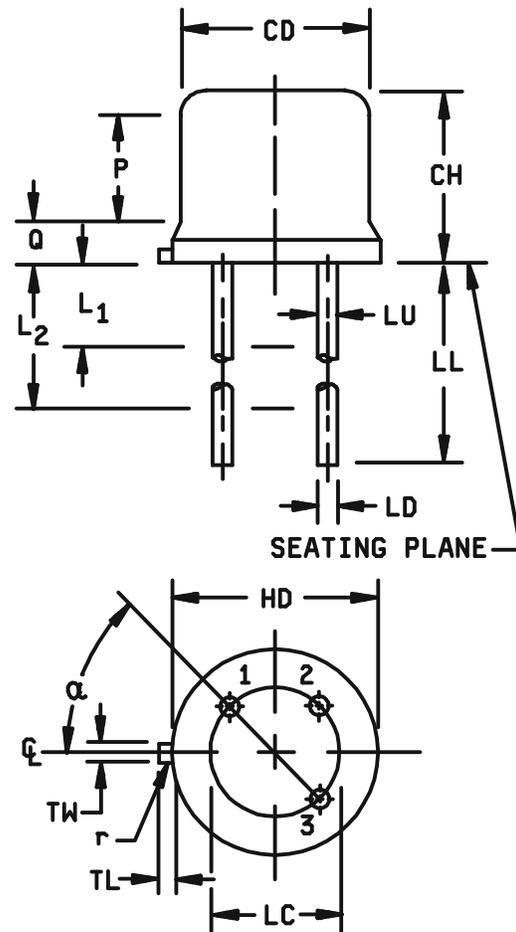
MILITARY

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.

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.34	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		6
LD	.016	.021	0.41	0.53	7, 8
LL	.500	.750	12.70	19.05	7, 8, 12
LU	.016	.019	0.41	0.48	7, 8
L ₁	---	.050	---	1.27	7, 8
L ₂	.250	---	6.35	---	7, 8
Q	---	.040	---	1.02	5
TL	.028	.048	0.71	1.22	3, 4
TW	.036	.046	0.91	1.17	3
r	---	.010	---	0.18	10
α	45°TP		45°TP		6

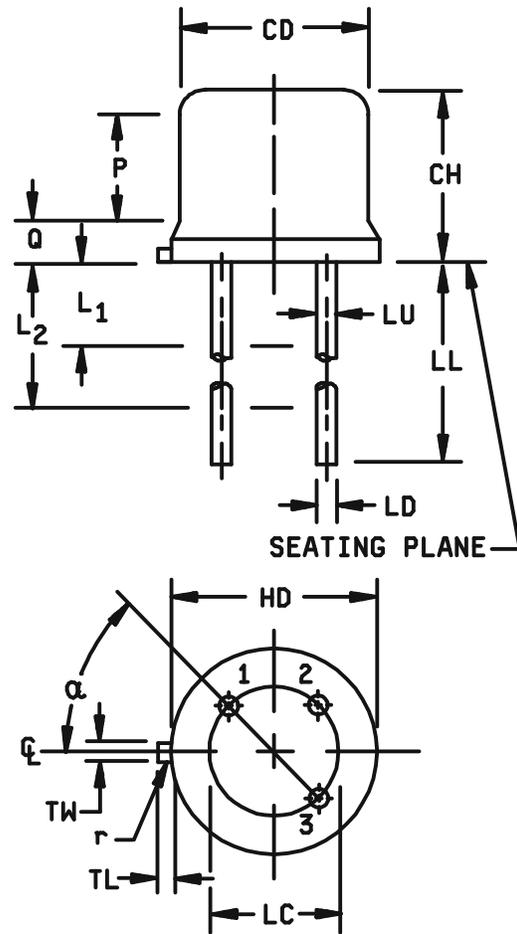


NOTES:

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. The device may be measured by direct methods.
7. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and 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 Nx symbology.
12. For "L" suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (19.05 mm) maximum.

FIGURE 1. Physical dimensions (type 2N4029) (TO - 18).

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, 8
LL	.500	.750	12.70	19.05	7, 8, 12
LU	.016	.019	0.41	0.48	7, 8
L ₁	---	.050	--	1.27	7, 8
L ₂	.250	---	6.35	---	7, 8
Q	---	.050	---	1.27	5
TL	.029	.045	0.74	1.14	3, 4
TW	.028	.034	0.71	0.86	3
r	---	.010	---	0.18	10
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. The device may be measured by direct methods.
7. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and 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 Nx symbology.
12. For "L" suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (19.05 mm) maximum.

FIGURE 2. Physical dimensions (type 2N4033) (TO - 39).

3. REQUIREMENTS

3.1 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).

3.2 Associated specification. The individual item performance requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

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

3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and on figures 1 and 2 herein.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500. 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 the subgroups specified in 4.4.2 and 4.4.3 herein.

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, JANTX and JANTXV levels only). Screening shall be in accordance with MIL-PRF-19500 (Appendix E, table IV), 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 appendix E, table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	h_{FE2} , I_{CBO2}	Not applicable
11	I_{CBO2} ; h_{FE2} ; ΔI_{CBO2} = 100 percent of initial value or 2 nA dc, whichever is greater; Δh_{FE2} = 15 percent change from initial value.	I_{CBO2} and h_{FE2}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CBO2} = 100 percent of initial value or 2 nA dc, whichever is greater; Δh_{FE2} = 15 percent change from initial value.	Subgroup 2 of table I herein; ΔI_{CBO2} = 100 percent of initial value or 2 nA dc, whichever is greater; Δh_{FE2} = 15 percent change from initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = Room ambient as defined in 4.5 of MIL-STD-750; JANS --- V_{CB} = 10 V dc; JANTX and JANTXV --- V_{CB} = 40 V dc; 2N4029 ---- P_T = 0.5 W. 2N4033 ---- P_T = 0.8 W.

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

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with appendix E, table V of 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 appendix E, table VIa (JANS) and table VIb (JANTX and JANTXV) of MIL-PRF-19500. Electrical measurements (end points) shall be in accordance with table I, group A, subgroup 2 herein.

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

Subgroup	Method	Conditions
B4	1037	V_{CB} = 40 V dc; 2N4029 P_T = 0.5 W 2N4033 P_T = 0.8 W at T_A = Room ambient as defined in the requirements of MIL-STD-750; $t_{on} = t_{off}$ = 3 minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	V_{CB} = 40 V dc; T_A = +125°C ± 25°C for 96 hours, 2N4029 P_T = 0.5 W, 2N4033 P_T = 0.8 W or adjusted as required according to the chosen T_A to give an average T_J = +275°C.
B5	2037	Test condition A (Au)die interconnects only).
B6	3131	See 4.5.2.

4.4.2.2 Group B inspection, appendix E, table VIb (JANTX and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Conditions
B3	1027	$V_{CB} = 40 \text{ V dc}$; 2N4029 $P_T = 0.5 \text{ W}$ 2N4033 $P_T = 0.8 \text{ W}$ at $T_A = \text{room ambient}$ as defined in the general requirements of MIL-STD-750. No heat sink or forced-air cooling on the devices shall be permitted.
B5	3131	See 4.5.2.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VII of MIL-PRF-19500 Electrical measurements (end points) shall be in accordance with table I, group A, subgroup 2 herein.

4.4.3.1 Group C inspection, appendix E, table VII of MIL-PRF-19500.

Subgroup	Method	Conditions
C2	2036	Test condition E.
C6	1026	$V_{CB} = 40 \text{ V dc}$, 2N4029 $P_T = 0.5 \text{ W}$ 2N4033 $P_T = 0.8 \text{ W}$ at $T_A = \text{room ambient}$ as defined in the general requirements of MIL-STD-750. 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.

4.5.2 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with test method 3131 of MIL-STD-750. The following details shall apply:

- a. Collector current magnitude during power applications shall be 0.15 A dc.
- b. Collector to emitter voltage magnitude shall be 20 V dc.
- c. Reference temperature measuring point shall be the case.
- d. Reference point temperature shall be $+25^\circ\text{C} \leq T_R \leq +35^\circ\text{C}$. The chosen reference temperature shall be recorded before the test is started.
- e. Mounting arrangements shall be with heat sink to case.
- f. Maximum $R_{\theta JC}$ limit shall be 17.5°C/W .

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 80$ V dc pulsed (see 4.5.1)	I_{CBO1}		10	μ A dc
Breakdown voltage collector - base	3001	Bias condition D; $I_C = 10$ μ A dc	$V_{(BR)CBO}$	80		V dc
Emitter to base current cutoff	3061	Bias condition D; $V_{CB} = 5$ V dc	I_{EBO1}	5	10	μ A dc
Collector - base cutoff current	3306	Bias condition D; $V_{CB} = 60$ V dc	I_{CBO2}		10	nA dc
Collector - emitter cutoff current	3041	Bias condition A; $V_{BE} = 2.0$ V dc; $V_{CE} = 60$ V dc	I_{CEX1}		25	nA dc
Base emitter cutoff current	3061	Bias condition D; $V_{BE} = 3.0$ V dc	I_{EBO2}		25	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 100$ μ A dc	h_{FE1}	50		
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 100$ μ A dc	h_{FE2}	100	300	
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 100$ μ A dc, pulsed (see 4.5.1)	h_{FE3}	70		
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 1.0$ A dc; pulsed (see 4.5.1)	h_{FE4}	25		
Collector - emitter saturated voltage	3071	$I_C = 150$ mA dc; $I_B = 15$ mA dc pulsed (see 4.5.1)	$V_{CE(SAT)1}$		0.15	V dc
Collector - emitter saturated voltage	3071	$I_C = 500$ mA dc; $I_B = 50$ mA dc; pulsed (see 4.5.1)	$V_{CE(SAT)2}$		0.50	V dc
Collector - emitter saturated voltage	3071	$I_C = 1.0$ A dc; $I_B = 100$ mA dc; pulsed (see 4.5.1)	$V_{CE(SAT)3}$		1.0	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

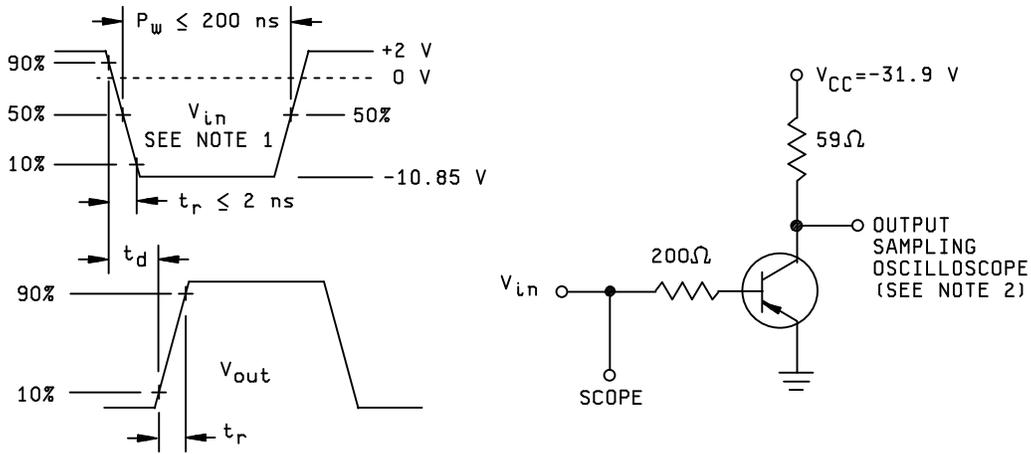
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Base - emitter saturated voltage	3066	Test condition A; $I_C = 150$ mA dc; $I_B = 15$ mA dc pulsed (see 4.5.1)	$V_{BE(SAT)1}$		0.9	V dc
Base - emitter saturated voltage	3066	Test condition A; $I_C = 500$ mA dc; $I_B = 50$ mA dc; pulsed (see 4.5.1)	$V_{BE(SAT)2}$		1.2	V dc
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector -base cutoff current	3041	Bias condition D; $V_{CE} = 60$ V dc	I_{CBO3}		25	$\mu\text{A dc}$
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 5.0$ V dc; $I_C = 500$ mA dc pulsed (see 4.5.1)	h_{FE5}	30		
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 10$ V dc; $I_C = 50$ mA dc; $f = 100$ MHz	$ h_{fe} $	1.5	6.0	
Open circuit output capacitance	3236	$V_{CB} = 10$ V dc; $I_E = 0$ 100 kHz $\leq f \leq 1$ MHz	C_{obo}		20	pF
Input capacitance (output open-circuited)	3240	$V_{EB} = 0.5$ V dc; $I_C = 0$; 100 kHz $\leq f \leq 1$ MHz	C_{ibo}		80	pF
Pulse response						
On-time	3251	Test condition A; $I_C = 500$ mA dc; $I_{B1} = 50$ mA dc; (see figure 3)	t_d		15	ns
Rise time	3251	Test condition A; $I_C = 500$ mA dc; $I_{B1} = 50$ mA dc; (see figure 3)	t_r		25	ns

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - Continued						
Storage time	3251	Test condition A; $I_C = 500 \text{ mA dc}$; $I_{B1} = 50 \text{ mA dc}$; (see figure 4)	t_s		175	ns
Fall time	3251	Test condition A; $I_C = 500 \text{ mA dc}$; $I_{B1} = 50 \text{ mA dc}$; (see figure 4)	t_f		35	ns
<u>Subgroups 5, 6, and 7</u>						
Not applicable						

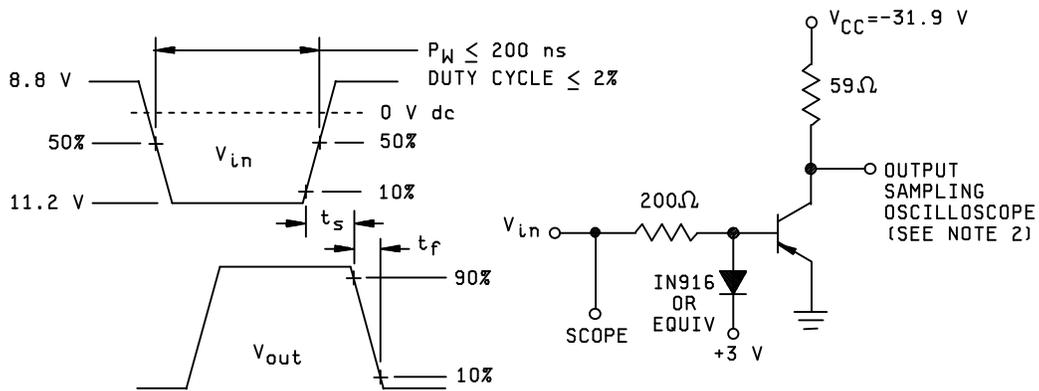
1/ For sampling plan, see MIL-PRF-19500.



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 2.0 ns, duty cycle ≤ 2 percent, and the generator source Z shall be 50Ω .
2. Sampling oscilloscope: $Z_{IN} \geq 100 \text{ k}\Omega$; $C_{in} \leq 12 \text{ pF}$, rise time(t_r) ≤ 5 ns.

FIGURE 3. Delay and rise time, test circuit.



NOTES:

1. The rise time (t_r) of the applied pulse shall be ≤ 20 ns, duty cycle ≤ 2 percent, and the generator source impedance shall be 50Ω .
2. Sampling oscilloscope: $Z_{IN} \geq 100 \text{ k}\Omega$; $C_{in} \leq 12 \text{ pF}$, rise time(t_r) ≤ 5 ns.

FIGURE 3. Storage and fall time, test circuit.

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-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. 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 Products List QPL 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 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 - EC
Air Force - 17

Preparing activity:
DLA - CC
(Project 5961-1915)

Review activities:
Army - AV
Air Force - 19, 80, 85, 99

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-19500/512C

 2. DOCUMENT DATE (YYMMDD)
980131

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, SWITCHING TYPES 2N4029, 2N4033, 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)
Commercial
DSN
FAX
EMAIL

 7. DATE SUBMITTED
(YYMMDD)

8. PREPARING ACTIVITY

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5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466
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