

The documentation and process conversion measures necessary to comply with this revision shall be completed by 16 August 2014.

INCH-POUND

MIL-PRF-19500/347B
 16 May 2014
 SUPERSEDING
 MIL-S-19500/347A
 w/AMENDMENT 1
 11 January 2007

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
 TYPES: 2N3253, 2N3253S, 2N3444, 2N3444S, JAN AND JANTX

Inactive for new design after 7 June 1999.

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and [MIL-PRF-19500](#).

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN silicon power transistors. Two levels of product assurance are provided for the device type as specified in [MIL-PRF-19500](#).

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

1.3 Maximum ratings.

Type	P_T		V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{STG} and T_{op}
	$T_A = +25^\circ C$ (1)	$T_C = +25^\circ C$ (2)					
2N3253,S	$\frac{W}{1.0}$	$\frac{W}{5.0}$	$\frac{V\ dc}{75}$	$\frac{V\ dc}{40}$	$\frac{V\ dc}{5}$	$\frac{A\ dc}{1}$	$^\circ C$ -65 to +200
2N3444,S	1.0	5.0	80	50	5	1	-65 to +200

(1) Derate linearly at 28.6 mW/°C above $T_A > +25^\circ C$.

(2) Derate linearly at 5.71 mW/°C above $T_C > +25^\circ C$.

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil/>.

1.4 Primary electrical characteristics.

	h_{FE2}		h_{FE3}		C_{obo}		$ h_{fe} $		$V_{BE(sat)2}$		$V_{CE(sat)2}$	
	$I_C = 500 \text{ mA dc}$ $V_{CE} = 1 \text{ V dc}$ (1)		$I_C = 1 \text{ A dc}$ $V_{CE} = 5 \text{ V dc}$ (1)		$V_{CB} = 10 \text{ V dc}$ $f = 100 \text{ kHz}$		$I_C = 50 \text{ mA dc}$ $V_{CE} = 10 \text{ V dc}$ $f = 5 \text{ MHz}$		$I_C = 500 \text{ mA dc}$ $I_B = 50 \text{ mA dc}$ (1)		$I_C = 500 \text{ mA dc}$ $I_B = 50 \text{ mA dc}$ (1)	
					pF				V dc		V dc	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2N3253,S	25	75	20		12		17	50	0.7	1.3		0.6
2N3444,S	20	60	15		12		17	50	0.7	1.3		0.6

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 or 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 of documents cited in sections 3 or 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-19500](#) - Semiconductor Devices, General Specification for.

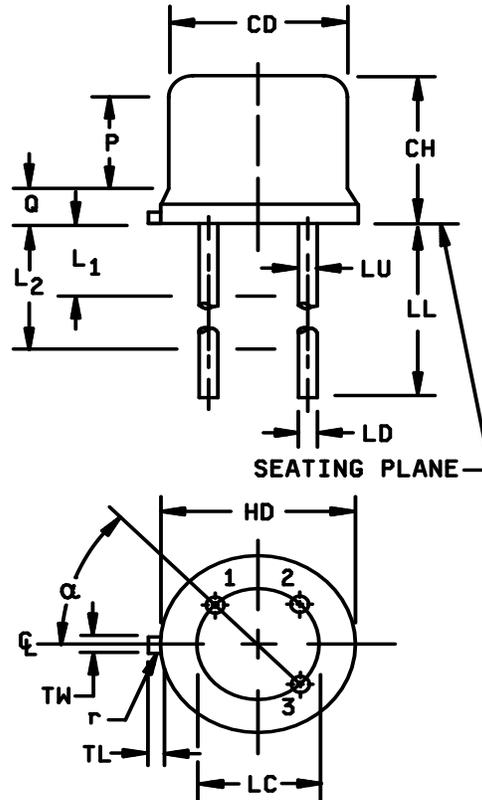
DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-750](#) - Test Methods for Semiconductor Devices.

(Copies of these documents are available online at <http://quicksearch.dla.mil/>).

2.3 Order of precedence. Unless otherwise noted herein or in the contract, 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.

Symbol	Dimensions				Note
	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		7
LD	.016	.019	0.41	0.48	8,9
LL	See note 14				
LU	.016	.019	0.41	0.48	8,9
L ₁		.050		1.27	8,9
L ₂	.250		6.35		8,9
P	.100		2.54		7
Q		.030		0.76	5
TL	.029	.045	0.74	1.14	3,4
TW	.028	.034	0.71	0.86	3
r		.010		0.25	10
α	45° TP		45° TP		7



NOTES:

1. Dimensions are in inches.
2. Millimeters 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. CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
7. 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.
8. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum.
9. All three leads.
10. The collector shall be internally connected to the case.
11. Dimension r (radius) applies to both inside corners of tab.
12. In accordance with ASME Y14.5M, diameters are equivalent to φx symbology.
13. Lead 1 = emitter, lead 2 = base, lead 3 = collector.
14. For transistor types 2N3253 and 2N3444, dimension LL = 1.5 inches (38.10 mm) min. and 1.75 inches (44.45 mm) max. For transistor types 2N3253S and 2N3444S, dimension LL = .5 inch (12.70 mm) min. and .750 inch (19.05 mm) max.

FIGURE 1. Physical dimensions (similar to TO-39, TO-5).

3. REQUIREMENTS

- * 3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as modified herein.
- * 3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list ([QML](#)) before contract award (see [4.2](#) and [6.3](#)).
- 3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#).
 - a. Total control charge. Q_T when a transistor is held in a conductive state by a current, I_B , a charge Q_S is stored in the device when operating in the active region. A charge Q_T may be stored on an external capacitor C to neutralize the effect of the internal charge, Q_S when the transistor is turned off (see [4.5.2](#)).
 - b. Base leakage current. (I_{BL}) is defined as base leakage current with both junctions reverse biased. I_C is always $\leq I_{BL}$ for $V_{BE} \geq V_T$. (V_{BE} is off condition base bias; V_T is base voltage at threshold of conduction).
- * 3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in [MIL-PRF-19500](#), and on **Error! Reference source not found.**. The suffix "S" is used on devices which have 0.5 inch minimum to 0.75 inch maximum lead length.
 - * 3.4.1 Lead finish. Lead finish shall be solderable in accordance with [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 **Error! Reference source not found.**).
 - 3.4.2 Terminal-lead length. Terminal lead length(s) other than that specified in [figure 1](#) may be furnished when so stipulated in the contract or order. Where other lead lengths are required and provided, it shall not be construed as adversely affecting the qualified-product status of the device, or applicable JAN marking (see [6.2](#)).
 - 3.4 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).
 - 3.4.1 'S' suffix marking. The 'S' suffix shall be used on devices meeting the 0.5 inch minimum to 0.75 inch maximum lead length requirement.
- * 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 as specified in [table I](#).
- * 3.7 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

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 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500. Either "S" suffix devices or non-suffix devices may be used for qualification.

* 4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III tests, the tests specified in table III herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.3 Screening (JANTX level only). Screening shall be in accordance with table E-IV of MIL-PRF-19500 (table E-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 table E-IV) of MIL-PRF-19500	Measurement
	JANTX level
(1) 3c	Thermal impedance (see 4.3.2)
9	Not applicable
11	I_{CBO1} and h_{FE2}
12	See 4.3.1
13	ΔI_{CBO1} = 100 percent of initial value or .05 μ A dc, whichever is greater; Δh_{FE2} = 15 percent of initial value; subgroup 2 of table I herein.

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, paragraph 4.5.

2N3444 = V_{CB} = 40 V dc,

2N3253 = V_{CB} = 32 V dc, P_T = 1.0 W.

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

4.3.2 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , t_{SW} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μ s max. See table III, group E, subgroup 4 herein.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

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 E-VIB (JAN and JANTX) of MIL-PRF-19500, and as follows. End-point electrical measurements shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable test of table II herein.

4.4.2.1 Group B inspection, table E-VIB of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$T_A = 25^\circ$; $V_{CB} = 10$ V dc; $P_T = 1.0$ W.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows. End-point electrical measurements shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable test of table II herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E.
C6	1026	$T_A = 25^\circ$; $V_{CB} = 10$ V dc; $P_T = 1.0$ W.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable test of table II herein.

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 Total control charge. The capacitor C, is adjusted to the minimum value which will produce a turn off waveform similar to the one shown in figure 2, where $C = C_{\text{optimum}}$. The optimum capacitance is obtained when the "bumps" just disappear. The charge, on the capacitor which will be called Q_T is: $Q_T = C_{\text{optimum}} V_{\text{in}}$.

4.5.3 Input capacitance. This test shall be conducted in accordance with method 3240 of MIL-STD-750, except the output capacitor shall be omitted.

TABLE I. Group A inspection.

Inspection 1/ <u>Subgroup 1</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance	3131	See 4.3.2	$Z_{\theta JX}$			$^{\circ}\text{C/W}$
Collector to emitter breakdown voltage 2N3253, S 2N3444, S	3011	Bias condition D, $I_C = 10 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{(BR)CEO}$	40 50		V dc V dc
Collector to base cutoff current 2N3253, S 2N3444, S	3036	Bias condition D; $V_{CB} = 75 \text{ V dc}$ $V_{CB} = 80 \text{ V dc}$	I_{CBO1}		10	$\mu\text{A dc}$
Emitter to base voltage cutoff current	3061	Bias condition D; $V_{EB} = 5 \text{ V dc}$	I_{EBO}		10	$\mu\text{A dc}$
Collector to emitter cutoff current	3041	Bias condition A; $V_{BE} = 4 \text{ V dc}$; $V_{CE} = 60 \text{ V dc}$	I_{CEX}		0.5	$\mu\text{A dc}$
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 60 \text{ V dc}$	I_{CBO2}		0.5	$\mu\text{A dc}$
Forward-current transfer ratio 2N3253, S 2N3444, S	3076	$V_{CE} = 1.0 \text{ V dc}$; $I_C = 150 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE1}	25 20		
Forward-current transfer ratio 2N3253, S 2N3444, S	3076	$V_{CE} = 1.0 \text{ V dc}$; $I_C = 500 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE2}	25 20	75 60	
Forward-current transfer ratio 2N3253, S 2N3444, S	3076	$V_{CE} = 5 \text{ V dc}$; $I_C = 1 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE3}	20 15		
Collector-emitter saturated voltage	3071	$I_C = 150 \text{ mA dc}$; $I_B = 15 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(SAT)1}$		0.35	V dc
Collector-emitter saturated voltage	3071	$I_C = 500 \text{ mA dc}$; $I_B = 50 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(SAT)2}$		0.60	V dc
Collector-emitter saturated voltage	3071	$I_C = 1.0 \text{ A dc}$; $I_B = 100 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{CE(SAT)3}$		1.2	V dc

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ <u>Subgroup 2</u> - Continued	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Base-emitter saturated voltage	3066	Test condition A; $I_C = 150$ mA dc; $I_B = 15$ mA dc; pulsed (see 4.5.1)	$V_{BE(SAT)1}$		1.0	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)	$V_{BE(SAT)2}$	0.7	1.3	V dc
Base-emitter voltage saturated	3066	Test condition A; $I_C = 1.0$ A dc; $I_B = 100$ mA dc; pulsed (see 4.5.1)	$V_{BE(SAT)3}$		1.8	V dc
<u>Subgroup 3</u>						
High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 60$ V dc	I_{CBO2}		75	μA dc
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc; $I_C = 150$ mA dc; pulsed (see 4.5.1)	h_{FE4}			
2N3253, S 2N3444, S				12 10		
<u>Subgroup 4</u>						
Pulse response:	3251	Test condition A				
Delay time		$V_{CC} = 30$ V dc; $V_{EB} = 2$ V dc; $I_C = 500$ mA dc; $I_{B1} = 50$ mA dc (see figure 2 and 3)	t_d		15	ns
Rise time		$V_{CC} = 30$ V dc; $V_{EB} = 2$ V dc; $I_C = 500$ mA dc; $I_{B1} = 50$ mA dc (see figure 2 and 3)	t_r		35	ns
Storage time		$V_{CC} = 30$ V dc; $I_{B1} = 500$ mA dc; $I_{B2} = 50$ mA dc (see figure 2 and 3)	t_s		40	ns
Fall time		$V_{CC} = 30$ V dc; $I_{B1} = 500$ mA dc; $I_{B2} = 50$ mA dc (see figure 2 and 3)	t_f		30	ns

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 4</u> - Continued						
Base leakage current		$V_{CC} = 60 \text{ V dc}; V_{EB} = 4 \text{ V dc};$ (see 4.5.2)	I_{BL}		0.5	$\mu\text{A dc}$
Extrapolated unity gain frequency	3306	$V_{CE} = 10 \text{ V dc}; I_C = 50 \text{ mA dc};$ $f = 100 \text{ MHz}$	$ h_{fe} $	17	60	
Open circuit output capacitance	3236	$V_{CB} = 10 \text{ V dc}; f = 1 \text{ MHz}$	C_{obo}		12	pf
Input capacitance	3240	$V_{EB} = 0.5 \text{ V dc}; f = 1 \text{ MHz}$ (see 4.5.3)	C_{ibo}		80	pf
Total control charge		$V_{CC} = 30 \text{ V dc}; I_C = 500 \text{ mA dc};$ $I_{B1} = 50 \text{ mA dc}$ (see figure 4)	Q_T		5	n Coulombs
<u>Subgroup 5</u>						
Not applicable						

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

TABLE II. Groups B and C delta measurement. ^{1/}

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	$V_{CE} = 1.0 \text{ V dc};$ $I_C = 500 \text{ mA dc};$ Pulsed (see 4.5.1)	Δh_{FE2}		± 25 percent change from initial recorded value.	

^{1/} The delta measurements for-group B, table E-VIB (JAN, JANTX), group C table E-VII, and group E, table E-IX subgroup 2 of MIL-PRF-19500 are step 1, subgroup 6.

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TABLE III. Group E inspection (all quality levels) - for qualification or re-qualification only.

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	V _{CB} = 10 V dc, 6,000 cycles, forced air cooling allowed on cooling cycle only. Adjust device current, or power, to achieve a minimum ΔT_J of +100°C.	
Electrical measurements		Table I , subgroup 2 and table II herein.	
<u>Subgroup 4</u>			
Thermal impedance curves		See MIL-PRF-19500, table E-IX, group E, subgroup 4.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

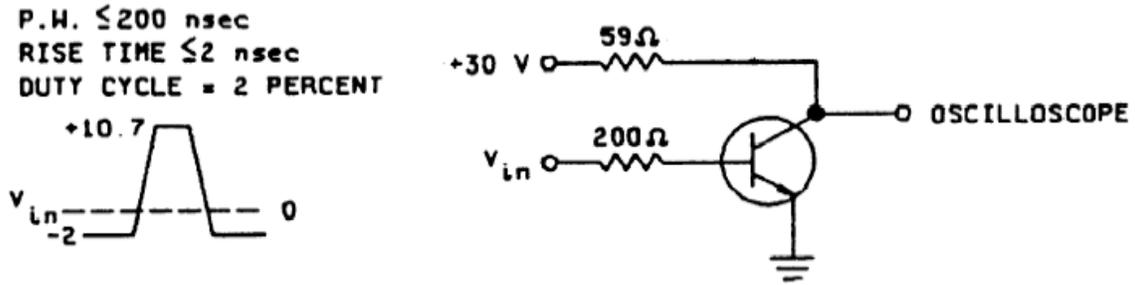


FIGURE 2. Equivalent circuit for measuring delay and rise times.

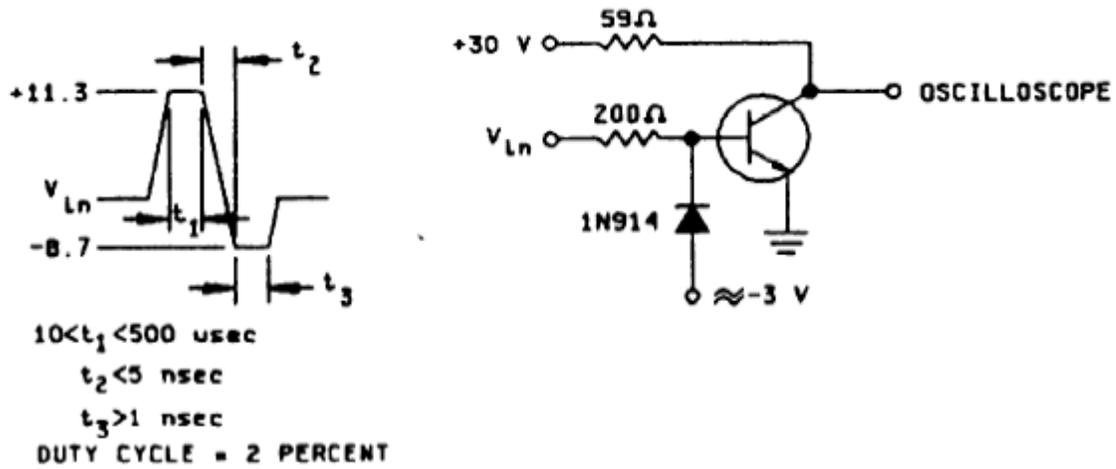


FIGURE 3. Equivalent circuit for measuring storage and fall times.

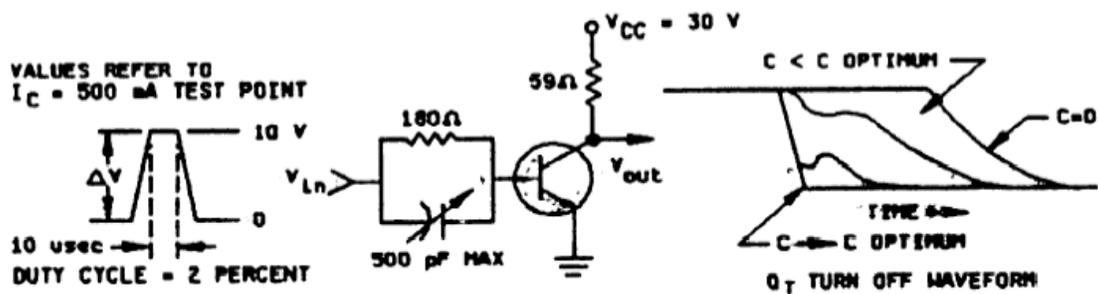


FIGURE 4. Q_T test circuit.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in [MIL-PRF-19500](#) are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1) and terminal-lead length (see 3.4.2).
- d. The complete Part or Identifying Number (PIN), see title and section 1.

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 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://assist.dla.mil>.

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 extent of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2014-090)

Review activities:
Navy - AS, MC, SH
Air Force - 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil/>.