

The documentation and process conversion measures necessary to comply with this document shall be completed by 17 April 2024.

INCH-POUND

MIL-PRF-19500/302D
17 January 2024
SUPERSEDING
MIL-PRF-19500/302C
1 August 1999

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, LOW-POWER, TYPE 2N2708, JAN

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, VHF-UHF amplifier transistor. One level of product assurance (JAN) is provided for each device type as specified in [MIL-PRF-19500](#).

* 1.2 Package outlines. The device package outline for this specification sheet is in accordance with [figure 1](#) (similar to TO-72) for all encapsulated device types.

* 1.3 Maximum ratings. Unless otherwise specified, $T_A = +25^\circ\text{C}$.

P_T 1/ $T_A = +25^\circ\text{C}$	P_T 2/ $T_C = +25^\circ\text{C}$	I_C	V_{CBO}	V_{CEO}	V_{EBO}	T_J and T_{STG}
mW	mW	mA dc	V dc	V dc	V dc	$^\circ\text{C}$
300	200	50	35	20	3	-65 to +200

- * (1) Derate linearly 1.71 mW/ $^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.
(2) Derate linearly 1.14 mW/ $^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.

1.4 Primary electrical characteristics. Unless otherwise specified, $T_A = +25^\circ\text{C}$.

Limits	h_{FE}	$ h_{fe} $	$r_b'C_c$	C_{cb}	NF	G_{pe}
	$I_C = 2\text{ mA dc}$ $V_{CE} = 2\text{ V dc}$	$I_C = 2\text{ mA dc}$ $V_{CE} = 2\text{ V dc}$ $f = 100\text{ MHz}$	$I_C = 2\text{ mA dc}$ $V_{CE} = 2\text{ V dc}$ $f = 31.8\text{ MHz}$	$V_{CB} = 2\text{ V dc}$ $I_E = 0$ $100\text{ kHz} \leq f \leq 1\text{ MHz}$	$V_{CE} = 15\text{ V dc}$ $I_C = 2\text{ mA dc}$ $f = 200\text{ MHz}$	$V_{CE} = 15\text{ V dc}$ $I_C = 2\text{ mA dc}$ $f = 200\text{ MHz}$
Min	30	7	<u>psec</u>	<u>pF</u>	<u>db</u>	<u>db</u>
Max	180	12	33	1.0	7.5	22

* 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>.



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- * 1.5 Part or Identifying Number (PIN). The PIN is in accordance with [MIL-PRF-19500](#), and as specified herein. See [6.4](#) for PIN construction example, [6.5](#) for a list of available PINs.
- * 1.5.1 JAN certification mark and quality level.
- * 1.5.1.1 Quality level designators for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: The base quality level "JAN".
- * 1.5.2.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".
- * 1.5.2.2 Second number symbols. The second number symbols for the transistors covered by this specification sheet are as follows: "2708".
- * 1.5.3 Suffix symbols. Suffix symbols are not applicable for this specification sheet.
- * 1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on [QML-19500](#).

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 of 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 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 <https://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.

3. REQUIREMENTS

* 3.1 General Associated specification. The individual item requirements shall be as specified in accordance **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 manufacturers list (**QML-19500**) 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**.

* 3.4 Interface requirements and physical dimensions. Interface and physical dimensions shall be as specified in **MIL-PRF-19500**, and on [figure 1](#) (similar to TO-72).

* 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 6.2).

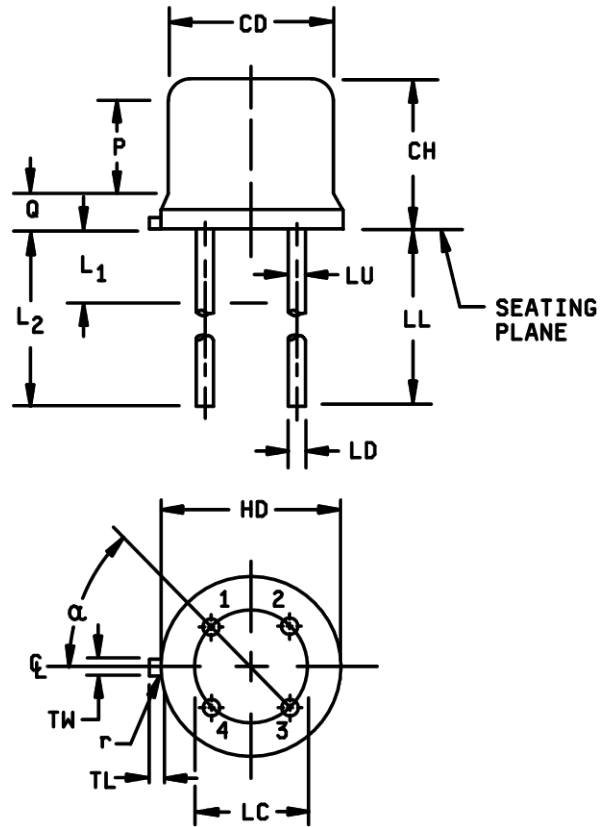
* 3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and [table I](#) herein.

3.6 Electrical test requirements. The electrical test requirements shall be as specified in ([table I](#))

* 3.7 Marking. Marking shall be in accordance with **MIL-PRF-19500**.

* 3.8 Workmanship. 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.

LTR	in	in	mm	Mm	Note
	Min	Max	Min	Max	
CD	0.178	0.195	4.52	4.95	
CH	0.170	0.210	4.32	5.33	
HD	0.209	0.230	5.31	5.84	
LC	0.100	TP	2.54	TP	6
LD	0.016	0.021	0.41	0.53	7
LL	0.500	0.750	12.70	19.05	7
LU	0.016	0.019	0.41	0.48	7
L1		0.050		1.27	7
L2	0.250		6.35		7
TL	0.028	0.048	0.71	1.22	3
TW	0.036	0.046	0.91	1.17	
P	0.100		2.54		
Q		0.040		1.02	4
r		0.007		0.18	
α	45° TP				6



NOTES

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Symbol CD shall not vary more than 0.010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane 0.054 inch (1.37 mm) +0.001 inch (0.03 mm) -0.000 inch (0.00 mm) below seating plane shall be within 0.007 inch (0.18 mm) radius of TP relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Lead diameter shall not exceed 0.042 inch (1.07 mm) within L₁ and beyond LL minimum.
8. Lead designation, depending on device type, shall be as follows: 1 - emitter, 2 - base, 3 - collector, 4 - case.

* FIGURE 1. Physical dimensions (similar to TO-72).

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.3 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.3.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein.

4.3.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in VIb (JAN) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1026	$V_{CB} \geq 10 \text{ V dc}$; adjust P_T to achieve $T_J = +150^\circ\text{C}$ minimum; $T_A \leq +35^\circ\text{C}$.
B5		Not applicable.

* 4.3.3 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. Electrical measurements (end points) shall be in accordance with table I, subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E.
C6	1026	$V_{CB} \geq 10 \text{ V dc}$; adjust P_T to achieve $T_J = +150^\circ\text{C}$ minimum; $T_A \leq +35^\circ\text{C}$.

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

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

4.4.2 Collector-base feedback capacitance. This test shall be conducted in accordance with method 3236 of MIL-STD-750, except that the case and emitter leads shall be connected to the guard terminal of the measuring equipment.

4.4.3 Noise figure test. Noise figure shall be measured using a HP 342A voltmeter and 343A noise source in conjunction with the small signal power gain test circuit or equivalent.

4.4.4 Disposition of "CASE" lead. Except for the following tests, the "CASE" lead shall be "floating" during all electrical tests and measurements: noise figure; small-signal power gain; collector-base time constant; and magnitude of $|h_{fe}|$. These tests shall be conducted with the "CASE" lead connected to a common rf chassis ground.

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TABLE I. Group A inspection.

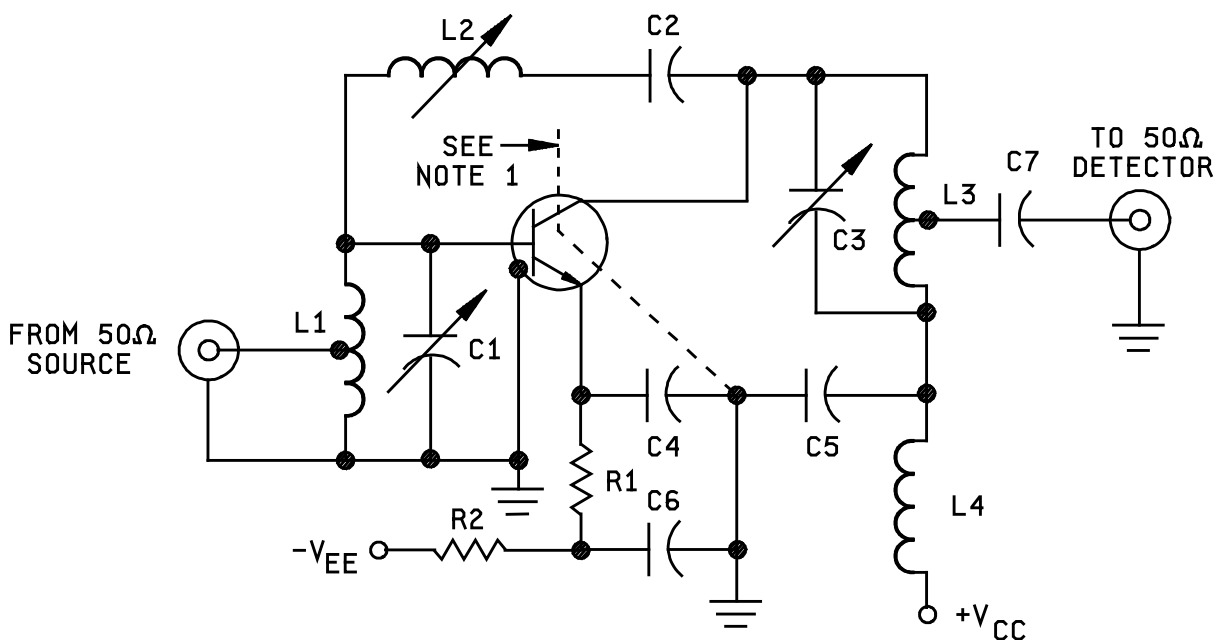
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown voltage, collector to base	3001	Bias condition D, $I_C = 1.0 \mu A$ dc	$V_{(BR)CBO}$	35		V dc
Breakdown voltage, emitter to base	3026	Bias condition D, $I_C = 10 \mu A$ dc	$V_{(BR)EBO}$	3		V dc
* Breakdown voltage, collector to emitter	3011	Bias condition D, $I_C = 10 mA$ dc; Pules (see 4.4.1)	$V_{(BR)CEO}$	20		V dc
Collector to base cutoff Current	3036	Bias condition D; $V_{CB} = 15 V$ dc	I_{CBO}		10	nA dc
Forward-current transfer ratio	3076	$V_{CE} = 2 V$ dc; $I_C = 2 mA$ dc	h_{FE}	30	180	
Collector-emitter saturation voltage	3071	$I_C = 10 mA$ dc; $I_B = 1 mA$ dc	$V_{CE(sat)}$		0.4	V dc
Base-emitter saturation voltage	3066	Test condition A; $I_C = 10 mA$ dc; $I_B = 1 mA$ dc	$V_{BE(sat)}$		1.0	V dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ C$				
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 15 V$ dc	I_{CBO}		1.0	μA dc
Low temperature operation		$T_A = -55^\circ C$				
Forward-current transfer ratio	3076	$V_{CE} = 2.0 V$ dc; $I_C = 2.0 mA$ dc	h_{FE}	15		
* <u>Subgroup 4</u>						
Small-signal short-circuit forward current transfer ratio	3206	$V_{CE} = 2 V$ dc; $I_C = 2 mA$ dc	h_{fe}	30	180	
* Magnitude of small-signal short-circuit forward current transfer ratio	3306	$V_{CE} = 2 V$ dc; $I_C = 1 mA$ dc; $f = 100 MHz$	$ h_{fe} $	7	12	

See footnotes 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 Continued</u>						
Collector-base feedback capacitance (see 4.4.2)	3236	$V_{CB} = 15 \text{ V dc}; I_E = 0;$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{cb}		1	pF
<u>Subgroup 5</u> Small-signal power gain circuted)		$V_{CE} = 15 \text{ V dc}; I_C = 2 \text{ mA dc},$ $f = 200 \text{ MHz}$ (see 4.4.4 and figure 2)	G_{pe}	15	22	dB
Collector-base time constant		$V_{CB} = 2 \text{ V dc}, I_C = 2 \text{ mA dc},$ $f = 31.8 \text{ MHz}$ (see 4.4.4 and figure 3)	$r_b'C_c$	9	33	ps
Noise figure	3246	$V_{CE} = 15 \text{ V dc}, I_C = 2 \text{ mA dc},$ $f = 200 \text{ MHz}$ $R_g = 50 \Omega$ (see 4.4.3 and 4.4.4)	NF		7.5	dB
<u>Subgroups 6 and 7</u>						
Not required						

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



NOTE 1: External interlead shield to isolate the collector from the emitter and base leads.

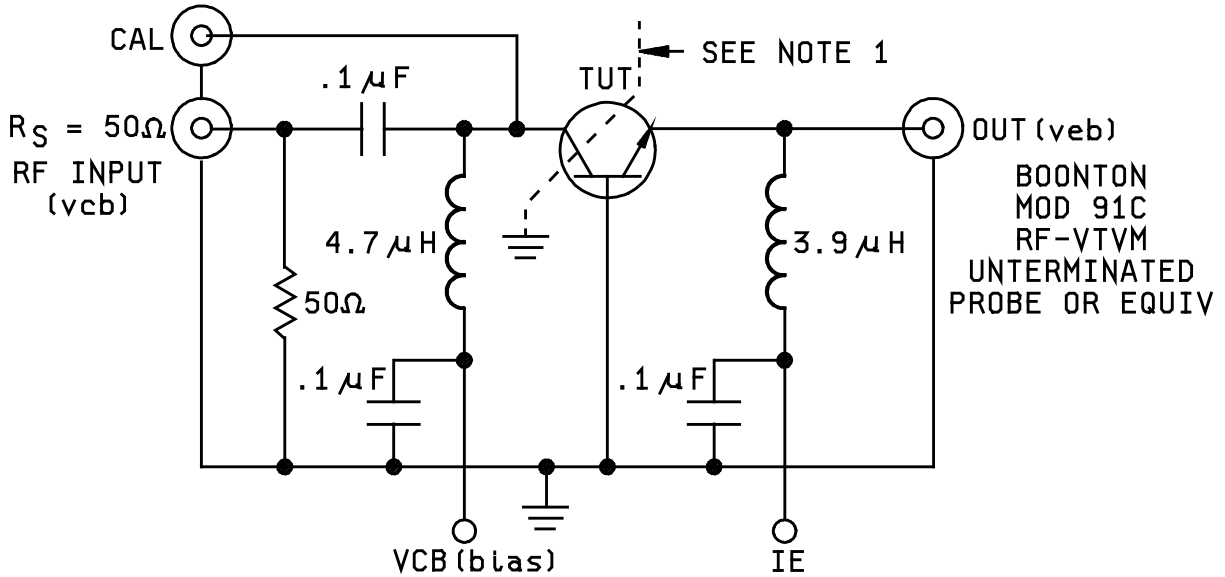
NEUTRALIZATION PROCEDURE:

1. Connect a 200 MHz signal generator (with a 50 ohm output impedance) to the input terminals of the amplifier, and connect a 50 ohm rf voltmeter to the output terminals of the amplifier.
2. Apply V_{EE} and V_{CC} to obtain the specified conditions.
3. Adjust the output of the signal generator to approximately 10 millivolts and tune C_1 and C_3 for maximum output.
4. Interchange the connections to the signal generator and rf voltmeter and with sufficient signal applied at the output terminals, tune L_2 for a minimum indication on the rf voltmeter.
5. Repeat this sequence until optimum settings are obtained for all variables.

Circuit-component information:

C_1	3 - 12 pF.
C_2 and C_7	1000 pF.
C_3	1.5 - 7.5 pF.
C_4 and C_5	0.01 μ F.
C_6	0.05 μ F.
L_1	3.5 T No. 16 AWG 0.312 inch ID, 0.438 inch length, Turns ratio $\approx$ 2 to 1.
L_2	0.4 - 0.65 μ H, Miller No. 4303 or equal.
L_3	8 T No. 16 AWG, 0.125 inch ID, 0.875 inch length, Turns ratio $\approx$ 8 to 1.
L_4	200 MHz RFC.
R_1	100 Ω .
R_2	1 k Ω .

FIGURE 2. Small-signal power gain.



NOTE 1: External interlead shield to isolate the collector from the emitter and base leads.

PROCEDURE:

1. Connect 31.8 MHz source to input connect on test jig.
2. Connect RF voltmeter to "CAL" connector on test jig.
3. Adjust 31.8 MHz signal level so that 0.5 volts is read on RF voltmeter.
4. Remove the RF voltmeter from "CAL" connector and connect to "OUT" connector.
5. Insert TUT into socket and adjust bias.
6. Read output on RF voltmeter and compute $r_b'C_c$ from the following relationship:

$$r_b'C_c:(\text{psec}) = 10 \times V_{eb} \text{ (millivolts)}$$

Derivation of $r_b'C_c$ readout:

h_{rb} set-up:

Set input (V_{cb}) at 1.0 Volt; then $h_{rb} = \frac{V_{eb}}{V_{cb}} = \frac{V_{eb}}{1} = \text{meter reading.}$

$$r_b'C_c = \frac{h_{rb}}{2\pi f}; \text{ therefore, } h_{rb} = (2Xf)(r_b'C_c), \text{ also } h_{rb} = \frac{V_{eb}}{V_{cb}}.$$

Sample: at 31.8 MHz

Make $h_{rb} = .2$; $h_{rb} = \frac{V_{eb}}{V_{cb}} = \frac{.1}{.5} = .2$ then

$$r_b'C_c = \frac{h_{rb}}{2Xf} = \frac{.2}{200 \times 10^6} = 1 \times 10^{-9} \times 1,000 \text{ psec.}$$

(Other frequencies are treated in the same manner).

FIGURE 3. Collector-base time constant test circuit (an equivalent circuit may be used).

For information purposesInput levels (V_{cb}):

4.0 MHz = 400 mV	46.0 MHz = 346 mV
10.7 MHz = 471 mV	50.0 MHz = 318.4 mV
31.8 MHz = 500 mV	63.6 MHz = 250 mV
40.0 MHz = 400 mV	79.8 MHz = 200 mV

INTERPRETATION OF READINGS:

Meter range full scale	$r_b'C_c$ range (psec)		
	31.8, 40.0, 46.0, 50.0 63.6, 79.8 MHz	4.0 MHz	10.7 MHz
0.001 volt	10 psec	100 psec	31.6
0.003 volt	30 psec	300 psec	100.0
0.01 volt	100 psec	1000 psec	316.0
0.03 volt	300 psec		1000.0
0.1 volt	1000 psec		

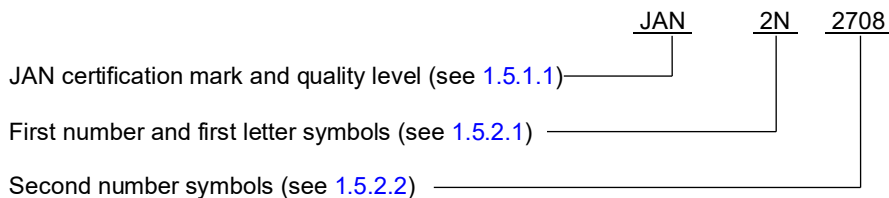
FIGURE 3. Collector-base time constant test circuit (an equivalent circuit may be used). - Continued.

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 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. 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).
 - * d. The complete PIN, see 1.5 and 6.4.
- * 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://qpldocs.dla.mil>.
- * 6.4 PIN construction example.
- * 6.4.1 Encapsulated devices The PINs for encapsulated devices are constructed using the following form.



6.5 List of PINs.

6.5.1 PINs for encapsulated devices. There is currently only one possible PIN available on this specification sheet. It is JAN2N2708.

* 6.6 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

- Army - CR
- * Navy - SH
- * Air Force - 85
- DLA - CC

Preparing activity:

DLA - CC

(Project 5961-2024-015)

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