

The documentation and process conversion measures necessary to comply with this revision shall be completed by 11 September 2015.

INCH-POUND

MIL-PRF-19500/120D
12 June 2015
SUPERSEDING
MIL-S-19500/120C
15 April 1970

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, SWITCHING, LOW-POWER,
THROUGH-HOLE MOUNT, TYPE 2N706, QUALITY LEVEL JAN

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, switching, medium power transistors. One level of product assurance (JAN) is provided for encapsulated devices.

1.2 Package outlines. The device package outline is a modified TO-206AA (formerly TO-18) in accordance with [figure 1](#) for all encapsulated device types.

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

P_T (1) $T_A = +25^\circ\text{C}$	V_{CBO}	V_{EBO}	V_{CEO}	V_{CER}	$R_{\theta JA}$	T_{STG}
<u>mW</u> 300	<u>V dc</u> 25	<u>V dc</u> 5.0	<u>V dc</u> 15	<u>V dc</u> 20	<u>$^\circ\text{C}/\text{W}$</u> 500	<u>$^\circ\text{C}$</u> -65 to +200

(1) Derate linearly 2.0 mW/ $^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.

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

Limits	h_{FE1} $V_{CE} = 1.0 \text{ V dc}$ $I_C = 10 \text{ mA dc}$	$ h_{FE} $ $V_{CE} = 10 \text{ V dc}$ $I_C = 10 \text{ mA dc}$ $f = 100 \text{ MHz}$	$V_{CE(sat)}$ $I_C = 10 \text{ mA dc}$ $I_B = 1.0 \text{ mA dc}$	$V_{BE(sat)}$ $I_C = 10 \text{ mA dc}$ $I_B = 1.0 \text{ mA dc}$	Switching		
					t_s	t_{on}	t_{off}
Min	30	2.0	<u>V dc</u> ---	<u>V dc</u> 0.7	<u>nsec</u> 5.0	<u>nsec</u> ---	<u>nsec</u> ---
Max	120	7.0	0.5	0.9	35	40	75

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>.



1.5 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, and [6.6](#) for supersession information.

1.5.1 JAN certification mark and quality level. The only quality level designator for encapsulated devices that is applicable for this specification sheet is the base quality level "JAN" that uses no modifiers.

1.5.2 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

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 only second number symbol for the transistors covered by this specification sheet is "706".

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 [QPDSIS-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.

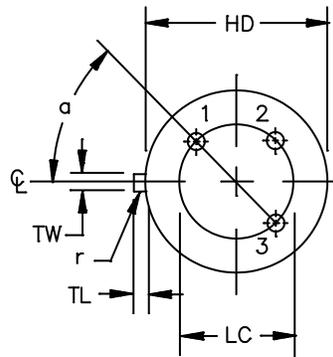
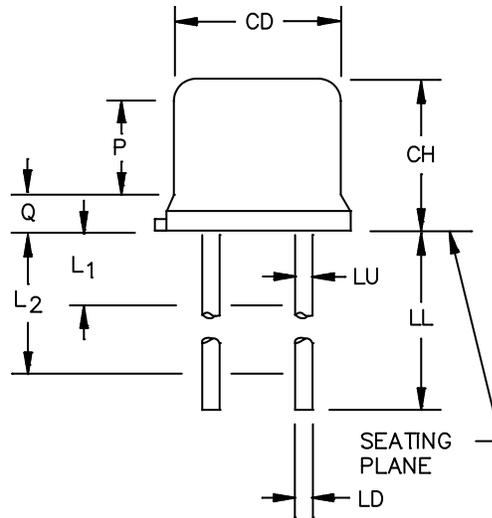
DEPARTMENT OF DEFENSE STANDARDS

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

(Copies of these documents are available online at <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	.178	.195	4.52	4.95	3
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	3
LC	.100 TP		2.54 TP		4
LD	.016	.021	0.41	0.53	5
LL	.5	.75	12.7	19	5
LU	.016	.019	0.41	0.48	5
L ₁		.050		1.27	5
L ₂	.250		6.35		5
P	.100		2.54		
Q		.030		0.76	3
TL	.028	.048	0.71	1.22	6, 7
TW	.036	.046	0.91	1.17	
r		.010		0.25	8
α	45° TP		45° TP		4



NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Lead 1 = emitter, lead 2 = base, lead 3 = collector. The collector shall be internally connected to the case.
3. Body contour optional within zone defined by HD, CD, and Q.
4. 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 or by gauging procedure.
5. Dimension LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Diameter is uncontrolled in L₁ and beyond LL minimum. Applies to all three leads.
6. Dimension TL measured from maximum HD.
7. Beyond r (radius) maximum, TL shall be held for a minimum length of $.011$ (0.28 mm).
8. Dimension r (radius) applies to both inside corners of tab.
9. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.

FIGURE 1. Physical dimensions and configuration of modified TO-206AA (formerly TO-18 package).

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as specified 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. The 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 herein. The device package style is a modified TO-206AA in accordance with [figure 1](#) for all device types.

3.4.1 Lead finish. Unless otherwise specified, lead finish shall be solderable in accordance with [MIL-STD-750](#), [MIL-PRF-19500](#), and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see [6.2](#)).

3.4.2 Pin-out. The pin-out of the device shall be as shown on [figure 1](#). Terminal 1 is the emitter, terminal 2 is the base, and terminal 3 is the collector. The collector shall be electrically connected to the case.

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

3.6 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).

3.7 Workmanship. The devices covered by this specification sheet 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](#), and as specified herein.

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 II](#) tests, the tests specified in [table II](#) 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. Screening is not applicable for devices compliant to this specification sheet.

4.4 Conformance inspection. 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. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VIB of MIL-PRF-19500 and herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B3	1027	$T_A = +25^\circ\text{C}$, $P_T = 300\text{mW}$, $V_{CB} = 15\text{V dc}$, $t = 340$ hours.

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 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C1	1051	Test cond. C; 25 cycles exposure time at temperature extremes = 15 minutes (min); test to be completed within 72 hours.
C2	2036	Test condition E.
C6	1026	$T_A = 25^\circ\text{C}$; $P_T = 300$ mW; $V_{CB} = 15$ V d.

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 II herein.

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

4.5.1 Thermal impedance (ΔV_{BE} measurements). The ΔV_{BE} measurements shall be performed in accordance with method 3131 of MIL-STD-750 using the guidelines in that method for determining V_H , V_{CE} , I_M , I_H , t_H , t_{SW} , and t_{MD} . The ΔV_{BE} limit used in table I, subgroup 2 shall be set statistically by the supplier submitted to the qualifying activity for approval. See table II, subgroup 4 and figure 5 herein.

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance <u>2/</u>	3131	See 4.5.1.	ΔV_{BE}			mV
Collector to base, breakdown to voltage	3001	Bias condition D, $I_C = 100 \mu A$ dc.	$V_{(BR)CBO}$	25		V dc
Collector to emitter breakdown voltage	3011	Bias condition D, $I_C = 10$ mA dc.	$V_{(BR)CEO}$	15		V dc
Emitter to base, breakdown to voltage	3026	Bias condition D, $I_E = 100 \mu A$ dc	$V_{(BR)EBO}$	5.0		V dc
Collector to emitter breakdown voltage	3011	Bias condition B, $I_C = 50$ mA dc, $R_{BE} = 10$ ohms, $t_p = 167 \mu sec$, duty cycle 1 percent.	$V_{(BR)CER}$	20		V dc
Collector to base, cutoff current	3036	Bias condition D, $V_{CB} = 15$ V dc.	I_{CBO1}		0.1	μA dc
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 10$ mA dc;	h_{FE1}	30	120	
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 0.1$ mA dc;	h_{FE2}	10		
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 1.0$ mA dc;	h_{FE3}	20		
Collector to emitter voltage (saturated)	3071	$I_C = 10$ mA dc, $I_B = 1.0$ mA dc	$V_{CE(sat)}$	---	0.5	V dc
Base emitter voltage (saturated or nonsaturated)	3066	Test condition A; $I_C = 10$ mA dc; $I_B = 1.0$ mA dc	$V_{BE(sat)}$	0.7	0.9	V dc
Magnitude of common emitter small-signal, short-circuit forward-current transfer ratio	3306	$V_{CE} = 10$ V dc, $I_C = 10$ mA dc; $f = 100$ MHz	$ h_{FE} $	2.0	7.0	
Open circuit output capacitance	3236	$V_{CB} = 10$ V dc, $I_E = 0$; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{obo}		6.0	pf

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

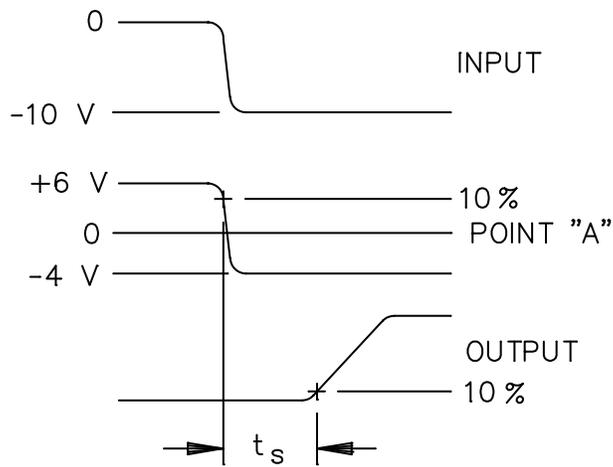
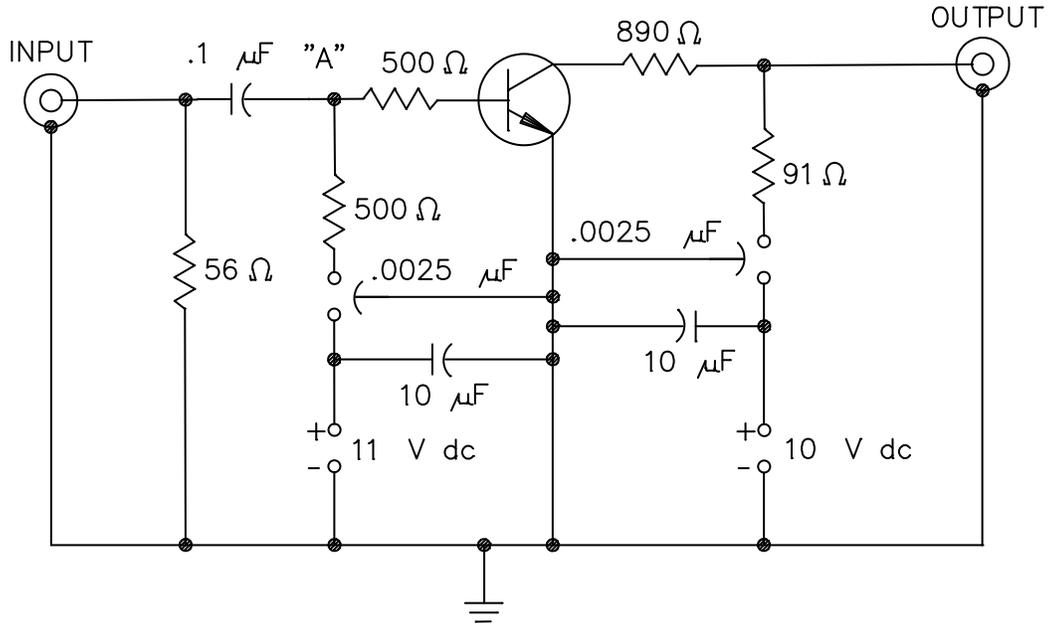
Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2 - continued</u>						
Input capacitance (output open-circuit)	3240	$V_{EB} = 0.5 \text{ V dc}$, $I_C = 0$; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{ibo}		9.0	pf
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ\text{C}$				
Collector to base cut-off current	3036	Bias condition D; $V_{CB} = 15 \text{ V dc}$	I_{CBO2}		20	$\mu\text{A dc}$
Low temperature operation		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 10 \text{ V dc}$, $I_C = 10 \text{ mA dc}$;	h_{FE}	12		
<u>Subgroup 4</u>						
Charge-storage time		See figure 3	t_s		35	nsec
Turn-on time		See figure 4	t_{on}	---	40	nsec
Turn-off time		See figure 4	t_{off}	---	75	nsec
<u>Subgroups 5 and 6</u>						
Not applicable						

1/ For sampling plan, see [MIL-PRF-19500](#).

2/ This test required for the following end-point measurements only:
 Group B, subgroups 3, 4 and 5 (JANS).
 Group B, subgroups 2 and 3 (JAN, JANTX, JANTXV).
 Group C, subgroups 2 and 6.
 Group E, subgroup 1.

TABLE II. Group E inspection (all quality levels) – for qualification and requalification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051		
Hermetic seal Fine leak Gross leak	1071		
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent operation life	1037	$T_A = 25^\circ\text{C}$, $P_T = 300 \text{ mW}$, $V_{CB} = 15 \text{ V dc}$, adjust device current, or power, to achieve a minimum delta T_J of $+100^\circ\text{C}$.	
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See table E-IX, subgroup 4 of MIL-PRF-19500 .	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

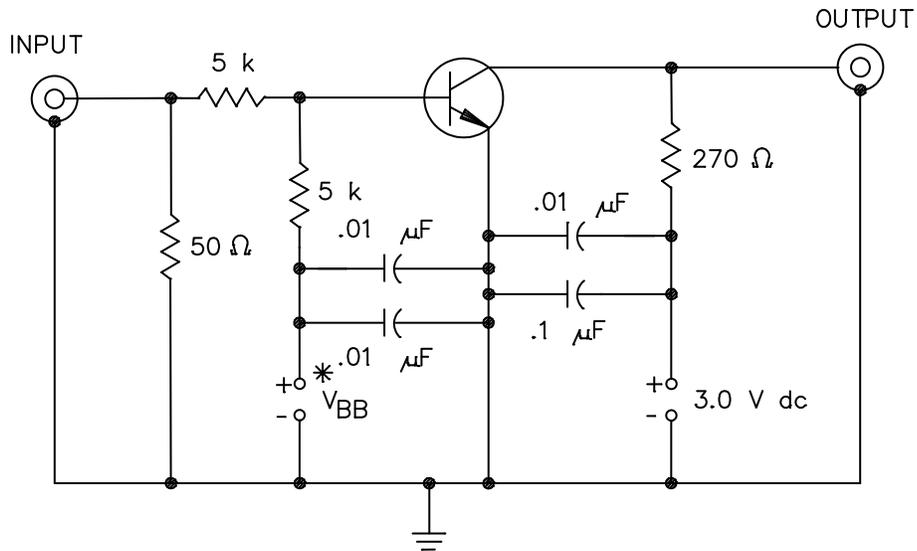


VOLTAGE WAVEFORMS

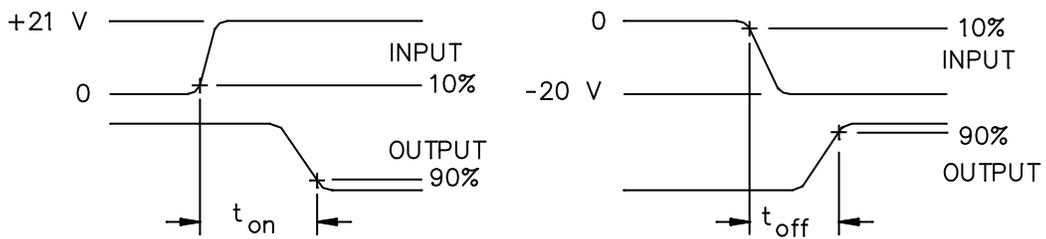
NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics:
 $Z_{out} = 50 \text{ ohm}$, $t_r \leq 1 \text{ nsec}$, $PW \geq 300 \text{ nsec}$, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on a sampling oscilloscope with the following characteristics:
 $Z_{in} \geq 100 \text{ K ohms}$, $t_r \leq 1 \text{ nsec}$.

FIGURE 2. Charge storage time.



* $V_{BB} = -4.0$ V dc FOR t_{ON} , $+17.0$ V dc FOR t_{off}



VOLTAGE WAVEFORMS

NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics:
 $Z_{out} = 50$ ohm, $t_r \leq 1$ nsec, $PW \geq 300$ nsec, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on a sampling oscilloscope with the following characteristics:
 $Z_{in} \geq 100$ K ohms, $t_r \leq 1$ nsec.

FIGURE 3. Turn-on and turn-off time test circuit.

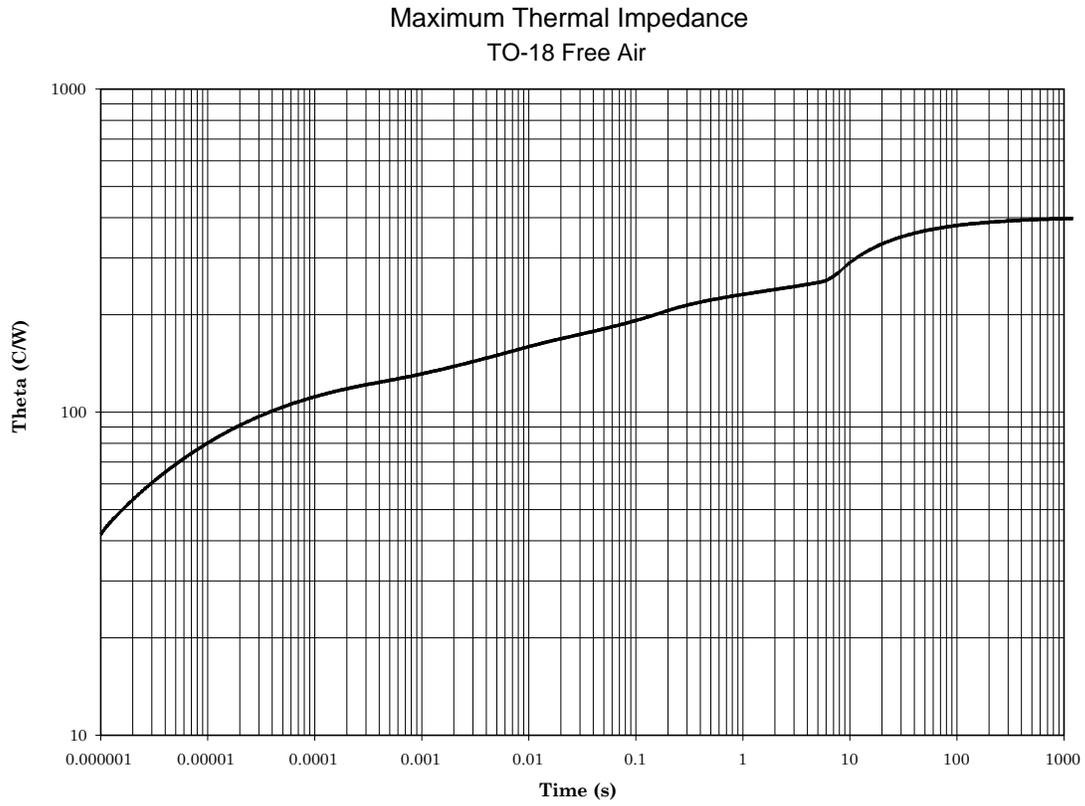


FIGURE 4. Thermal impedance graph (TO-18) ($R_{\theta JA}$).

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.)

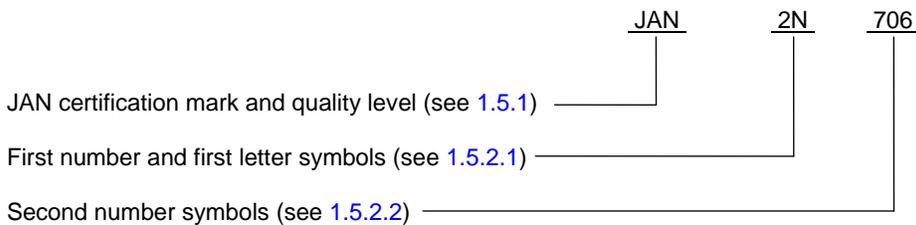
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

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).
- 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.

6.4 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



6.5 List of PINs. There is currently only one possible PIN available on this specification sheet. It is JAN2N706.

6.6 Supersession information and superseded PINs.

6.6.1 Lead finish. The original issue of this specification through MIL-S-19500/120B (26 June 1963) did not specify a lead finish. MIL-S-19500/120C (15 April 1970) specified that the lead finish as "gold (as specified in MIL-STD-1276)". That same revision also allowed for "tin-coated over gold". Tin is no longer acceptable as a lead finish. Later amendments such as MIL-S-19500/120C with amendment 2 (7 August 1974) changed the lead finish to "gold or tin-plated".

6.6.2 Lead material. Because of the performance format of this document, lead material is no longer specified.

6.7 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 5961-2015-042)

Review activities:
Army – AR, AV, MI, SM
Navy – AS, CG, MC, OS, SH
Air Force – 19, 70, 99
NASA – NA

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>.