

The documentation and process conversion measures necessary to comply with this revision shall be completed by 28 January 2015.

INCH-POUND

MIL-PRF-19500/268D
28 October 2015
SUPERSEDING
MIL-S-19500/268C
25 June 1971

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, HIGH-SPEED SWITCHING
THROUGH-HOLE MOUNT, TYPE 2N2481, QUALITY LEVELS 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, high-speed switching transistor. Two levels of product assurance (JAN and JANTX) are provided for all encapsulated devices.

1.2 Package outlines. The device package outlines 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, $T_A = +25^\circ\text{C}$.

Device type	P_T (1) $T_A = +25^\circ\text{C}$	P_T (2) $T_C = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{CES}	V_{EBO}	T_J	T_{STG} and T_{OP}
2N2481	W 0.36	W 1.2	V dc 40	V dc 15	V dc 30	V dc 5.0	$^\circ\text{C}$ +200	$^\circ\text{C}$ -65 to +200

(1) Derate linearly 2.06 mW/ $^\circ\text{C}$ for $T_A > +25^\circ\text{C}$.

(2) Derate linearly 6.85 mW/ $^\circ\text{C}$ for $T_C > +25^\circ\text{C}$.

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. Unless otherwise specified, $T_C = +25^\circ\text{C}$.

Limits	h_{FE} $V_{CE} = 1 \text{ V dc}$ $I_C = 10 \text{ mA dc}$	$ h_{FE} $ $V_{CE} = 10 \text{ V dc}$ $I_C = 10 \text{ mA dc}$ $f = 100 \text{ MHz}$	$V_{CE(SAT)}$ (1) $I_C = 10 \text{ mA dc}$ $I_B = 1 \text{ mA dc}$	t_{on} $I_C = 10 \text{ mA dc}$ $I_{B1} = 1 \text{ mA dc}$ $V_{BE(off)} = 2 \text{ V dc}$	t_{off} $I_C = 10 \text{ mA dc}$ $I_{B1} = 1 \text{ mA dc}$ $I_{B2} = 0.5 \text{ mA dc}$
Minimum	40	3.0	$\frac{V \text{ dc}}$ ---	<u>ns</u> ---	<u>ns</u> ---
Maximum	120	12.0	0.25	75	45

(1) Pulsed (see 4.5.1).

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 and 6.5 for a list of available PINs.

1.5.1 JAN certification mark and quality level. The quality level designators for encapsulated devices that are applicable for this specification sheet are "JAN" and "JANTX".

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 second number symbols for the transistors covered by this specification sheet are "2481".

1.5.3 Suffix symbols. Suffix symbols are not applicable to 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.

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 TO-206AA (formerly TO-18) in accordance with [figure 1](#).

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 or formation is desired, it shall be specified in the acquisition document (see [6.2](#)).

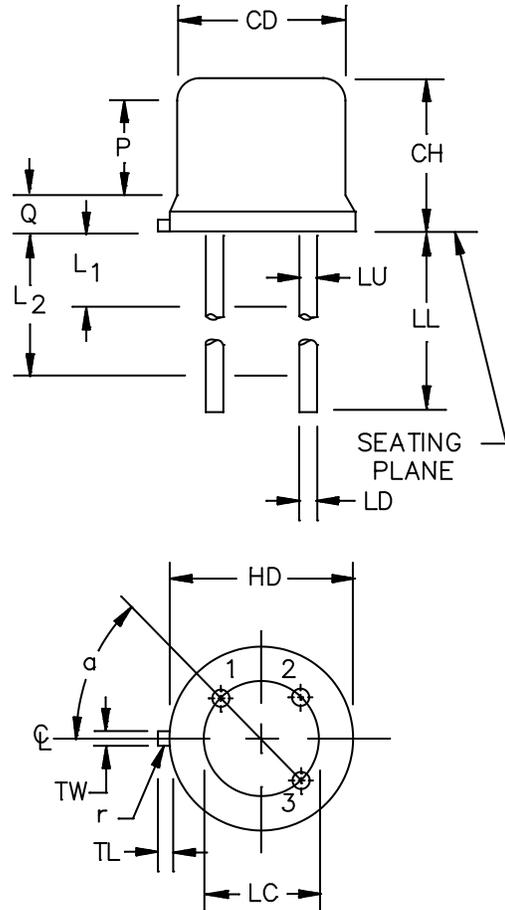
3.4.2 Pin-out. The pin-out of the device shall be as shown on [figure 1](#). Terminal 1 is the emitter, terminal 2 is the base, and terminal 3 is the collector. The collector shall be electrically connected to the case.

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

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

3.7 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	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	
CH	.170	.210	4.32	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		3
LD	.016	.021	0.41	0.53	4, 5
LL	.500	.750	12.70	19.05	5, 6
LU	.016	.019	0.41	0.48	4, 5, 6
L ₁		.050		1.27	6
L ₂	.250		6.35		6
P	.100		2.54		
Q		.030		0.76	7
r					
TL	.028	.048	0.71	1.22	8
TW	.036	.046	0.91	1.17	
α	45° TP		45° TP		



NOTES:

1. Dimensions are in inches. Millimeters equivalents are given for general information only.
2. Terminal 1 is the emitter, terminal 2 is the base, and terminal 3 is the collector. The collector shall be internally connected to the case.
3. When measured in a gauging plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 inch (0.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance.
4. Measured in the zone beyond .250 inch (6.35 mm) from the seating plane.
5. All 3 leads.
6. Symbol LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L₁ and beyond LL minimum.
7. Details of outline in this zone are optional.
8. Measured from the maximum diameter of the actual device.
9. In accordance with ASME Y14.5M, diameters are equivalent to φx symbology.

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

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 (quality level JANTX only). Screening shall be in accordance with table E-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	Measurement
	Quality level JANTX only
9	Not applicable
10	HTRB, method 1039, condition A, $T_A = +150^\circ\text{C}$, $V_{CB} = 15\text{V}$, $I_E = 0$, $t \geq 48$ hours
11	I_{CB01} , h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein. $\Delta I_{CB01} = \pm 100$ percent of initial value or ± 5 nA dc, whichever is greater. $\Delta h_{FE2} = \pm 15$ percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions shall be as follows: $V_{CB} = 12$ V dc; power shall be applied to achieve $T_J = +135^\circ\text{C}$ minimum using a minimum $P_D = 75$ percent of P_T maximum, T_A ambient rated as defined in 1.3.

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. End-point electrical measurements 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 as follows herein.

Subgroup	Method	Conditions
B3	1027	$T_A = +25^{\circ}\text{C}$; $P_T = 360 \text{ mW}$; $V_{CB} = 15 \text{ Vdc}$

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows herein.

Subgroup	Method	Conditions
C2	2036	Test condition E.
C6	1026	$T_A = 25^{\circ}\text{C}$; $P_T = 360 \text{ mW}$; $V_{CB} = 15 \text{ V dc}$.

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 Pulse response measurements. The conditions for pulse response measurement shall be as specified in section 4 of MIL-STD-750.

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> Collector to emitter breakdown voltage	3011	Bias condition D, $I_C = 30 \text{ mA dc}$, pulsed (see 4.5.1)	$V_{(BR)CEO}$	15		V dc
Collector to emitter breakdown voltage	3011	Bias condition C, $I_C = 1.0 \mu\text{A dc}$, pulsed (see 4.5.1)	$V_{(BR)CES}$	30		V dc
Collector to base, breakdown voltage	3001	Bias condition D, $I_C = 10 \mu\text{A dc}$.	$V_{(BR)CBO}$	40		V dc
Emitter to base, breakdown to voltage	3026	Bias condition D, $I_E = 100 \mu\text{A dc}$	$V_{(BR)EBO}$	5.0		V dc
Collector to base, cutoff current	3036	Bias condition D, $V_{CB} = 20 \text{ V dc}$	I_{CB01}		50	nA dc
Emitter to base, cutoff current	3061	Bias condition D, $V_{EB} = 4 \text{ V dc}$	I_{EBO}		100	nA dc

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</u> – continued						
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 1.0$ mA dc, pulsed (see 4.5.1)	h_{FE1}	25		
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 10$ mA dc; pulsed (see 4.5.1)	h_{FE2}	40	120	
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 150$ mA dc; pulsed (see 4.5.1)	h_{FE3}	20		
Collector to emitter voltage (saturated)	3071	$I_C = 10$ mA dc, $I_B = 1.0$ mA dc; pulsed (see 4.5.1).	$V_{CE(sat)1}$	---	0.25	V dc
Collector to emitter voltage (saturated)	3071	$I_C = 100$ mA dc, $I_B = 10$ mA dc; pulsed (see 4.5.1).	$V_{CE(sat)2}$	---	0.4	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 10$ mA dc $I_B = 1.0$ mA dc; pulsed (see 4.5.1).	$V_{BE(sat)1}$	0.7	0.82	V dc
Base to emitter voltage (saturated)	3066	Test condition A; $I_C = 100$ mA dc $I_B = 10$ mA dc; pulsed (see 4.5.1).	$V_{BE(sat)2}$	---	1.25	V dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^\circ\text{C}$				
Collector to base cutoff current	3036	Bias condition D; $V_{CB} = 20$ V dc	I_{CBO}		50	μA dc
Low temperature operation		$T_A = -65^\circ\text{C}$				
Forward-current transfer ratio	3076	$V_{CE} = 1.0$ V dc, $I_C = 10$ mA dc, pulsed (see 4.5.1).	h_{FE}	20		
<u>Subgroup 4</u>						
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} $	3	12	
Open circuit output capacitance	3236	$V_{CB} = 5.0$ V dc, $I_E = 0$, 100 kHz $\leq f \leq 1$ MHz	C_{obo}		5.0	pF
Input capacitance (output open circuited)	3240	$V_{CB} = 5.0$ V dc, $I_E = 0$, 100 kHz $\leq f \leq 1$ MHz	C_{ibo}		7.0	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 4</u> – continued						
Real part of small-signal shorted-circuit input impedance	3266	$V_{CE} = 10 \text{ V dc}$, $I_C = 10 \text{ mA dc}$; $f = 250 \text{ MHz}$	RE_{hie}		60	Ω
Switching parameters:						
Turn-on time:	3251	Test condition A; $V_{CC} = 10 \text{ V dc}$, $I_C = 100 \text{ mA dc}$, $I_{B1} = 10 \text{ mA dc}$, $V_{BE(off)} = 2.0 \text{ V dc}$	t_{on1}		40	ns
Turn-on time:	3251	Test condition A; $V_{CC} = 3.0 \text{ V dc}$, $I_C = 10 \text{ mA dc}$, $I_{B1} = 1.0 \text{ mA dc}$, $V_{BE(off)} = 2.0 \text{ V dc}$	t_{on2}		75	ns
Turn-off time:	3251	Test condition A; $V_{CC} = 10 \text{ V dc}$, $I_C = 100 \text{ mA dc}$, $I_{B1} = 10 \text{ mA dc}$, $I_{B2} = 5.0 \text{ mA dc}$	t_{off1}		55	ns
Turn-off time:	3251	Test condition A; $V_{CC} = 3.0 \text{ V dc}$, $I_C = 10 \text{ mA dc}$, $I_{B1} = 1.0 \text{ mA dc}$, $I_{B2} = 0.5 \text{ mA dc}$	t_{off2}		45	ns
Storage time	3251	Test condition A; $V_{CC} = 10 \text{ V dc}$, $I_C = 10 \text{ mA dc}$, $I_{B1} = 10 \text{ mA dc}$, $I_{B2} = 10 \text{ mA dc}$	t_s		20	ns
<u>Subgroups 5 and 6</u>						
Not applicable						

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

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	Test condition C, 500 cycles.	
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
Steady-state operating life	1026	T _A = +25°C, P _T = 360mW, V _{CE} = 15 V, t = 1000 hours.	
End-point electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B.	

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.)

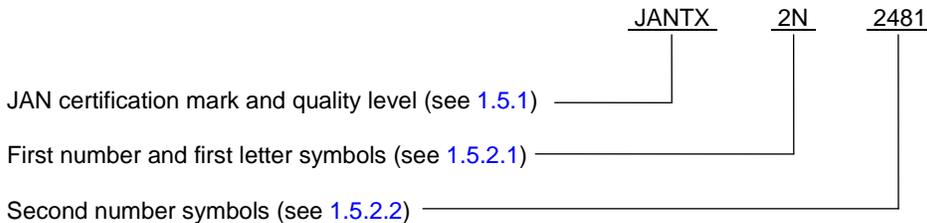
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

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 1.5.4 and 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 (QPDSIS-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. The following are the PINs available on this specification sheet: JAN2N2481 and JANTX2N2481.

6.6 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 5961-2015-069)

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