

The documentation and process conversion measures necessary to comply with this document shall be completed by 27 January 2024.

INCH-POUND

MIL-PRF-19500/522B
w/AMENDMENT 1
27 October 2023
SUPERSEDING
MIL-PRF-19500/522B
9 October 2017

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, NPN, SILICON, HIGH FREQUENCY
TYPES 2N6603 AND 2N6604, JAN, JANTX, AND JANTXV

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 frequency transistors. Three levels of product assurance (JAN, JANTX, and JANTXV) are provided for each device type as specified in [MIL-PRF-19500](#).

1.2 Package outlines. The device package outline for this specification sheet is a 2N6603 and 2N6604 in accordance with [figure 1](#) for all encapsulated device types.

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

	P_T	P_T	P_T	P_T	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_J	T_{STG}
	1/ $T_A =$ $+25^{\circ}\text{C}$	2/ $T_C =$ $+125^{\circ}\text{C}$	3/ $T_A =$ $+25^{\circ}\text{C}$	4/ $T_C =$ $+125^{\circ}\text{C}$						
	<u>mW</u>	<u>mW</u>	<u>mW</u>	<u>mW</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>mA dc</u>	<u>°C</u>	<u>°C</u>
2N6603	300	400			25	15	3.0	30	200	-65 to +200
2N6604			350	500	25	15	3.0	30	200	-65 to +200

1/ Derate at 1.71 mW/°C above $T_A > +25^{\circ}\text{C}$.

2/ Derate at 5.33 mW/°C above $T_C > +125^{\circ}\text{C}$.

3/ Derate at 2.00 mW/°C above $T_A > +25^{\circ}\text{C}$.

4/ Derate at 6.66 mW/°C above $T_C > +125^{\circ}\text{C}$.

1.4 Primary electrical characteristics (common to all types).

Type	h_{FE}		h_{FE}		C_{cb}		NF		G_{pe}		G_{pe}	
	$V_{CE} = 10\text{ V dc}$ $I_C = 15\text{ mA dc}$		$V_{CE} = 10\text{ V dc}$ $I_C = 30\text{ mA dc}$		$V_{CB} = 10\text{ V dc}$ $I_E = 0\text{ mA dc}$ $0.1\text{ MHz} \leq f \leq 1\text{ MHz}$		$V_{CE} = 10\text{ V dc}$ $I_C = 5\text{ mA dc}$ $f = 1\text{ GHz}$		$V_{CE} = 10\text{ V dc}$ $I_C = 15\text{ mA dc}$ $f = 1\text{ GHz}$		$V_{CE} = 10\text{ V dc}$ $I_C = 30\text{ mA dc}$ $f = 1\text{ GHz}$	
	Min	Max	Min	Max	pF	pF	dB	dB	dB	dB	dB	dB
2N6603	30	200			Min	Max	Min	Max	Min	Max	Min	Max
2N6604			30	200	.25	.75	1.0	2.5	15	21	15	21
					.30	.80	1.5	3.0				

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AMSC N/A

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FSC 5961



* 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 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: "JAN", "JANTX", and "JANTXV".

* 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 as follows: "6603" and "6604".

* 1.5.3 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 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

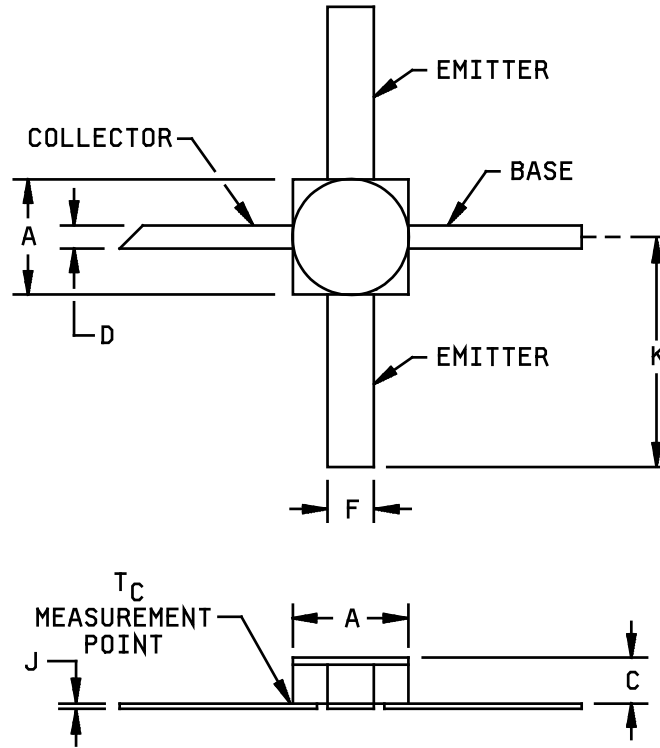
[MIL-PRF-19500](#) - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

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

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

2.4 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.



Ltr	Dimensions			
	in	in	mm	mm
	Min.	Max	Min	Max
A	0.090	0.105	2.29	2.67
C	0.032	0.050	0.81	1.27
D	0.016	0.024	0.41	0.61
F	0.035	0.043	0.89	1.09
J	0.003	0.006	0.08	0.15
K	0.175	0.230	4.45	5.84

*

NOTE: The top of the device body is hermetically sealed by a metallic cap which is electrically connected to the emitter.

FIGURE 1. Physical dimensions

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 manufacturers list 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](#) and as follows.

GNF' ----- Power gain with device tuned for optimum noise figure.

3.4 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in [MIL-PRF-19500](#) and on [figure 1](#).

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](#)).

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

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in [table I](#).

3.8 Marking. Devices shall be marked in accordance with [MIL-PRF-19500](#). At the option of the manufacturer, the marking of the country of origin may be omitted from the body of the transistor.

* 3.9 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](#)).

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 (list applicable JAN levels). 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	Measurements for JANTX and JANTXV levels
3a 3b 3c	Required Not applicable Thermal impedance (transient), method 3131 of MIL-STD-750. See 4.3.2
10	48 hours minimum
11	ICBO and hFE
12	See 4.3.1
13	Subgroup 2 of table I ; $\Delta h_{FE} = \pm 15$ percent of initial value.

4.3.1 Power burn-in. Power burn-in conditions are as follows:

T_A = Room ambient as defined in the general requirements of [MIL-STD-750](#), section 4.5;

2N6603: $V_{CB} \geq 5-15$ V dc; $P_T = 300$ mW.

2N6604: $V_{CB} \geq 5-15$ V dc; $P_T = 350$ mW.

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} (V_C and V_H where appropriate). The thermal impedance limit used in screen 3c and [table I](#), subgroup 2 shall be set statistically by the supplier.

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#) and as specified herein. If alternate screening is being performed in accordance with [MIL-PRF-19500](#), a sample of screened devices shall be submitted to and pass the requirements of subgroup 1 and 2, of [table I](#) herein, inspection only (table E-VIb, group B, subgroup 1 is not required to be performed since solderability and resistance to solvents testing is performed in [table I](#) 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 VIb (JAN, JANTX, and JANTXV) of [MIL-PRF-19500](#) and paragraph [4.4.2.1](#) herein.

4.4.2.1 Group B inspection, table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$V_{CB} = 5 - 15$ V dc. Maximum rated power (see 1.3) shall be applied and ambient temperature shall be adjusted to achieve $T_J \geq +150^\circ\text{C}$.
B6	1032	$T_A = +200^\circ\text{C}$.

4.4.3 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, and as follows.

4.4.3.1 Quality levels JAN, JANTX and JANTXV (see table E-VII of MIL-PRF-19500).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test cond. A, weight = 5 lbs, $t = 15$ seconds each terminal.
C6	1026	$V_{CB} = 5 - 15$ V dc. Maximum rated power (see 1.3) shall be applied and ambient temperature shall be adjusted to achieve $T_J \geq +150^\circ\text{C}$ minimum.

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

4.5.2 Power Gain, Noise Figure and GNF: The device shall be tested in the circuits of figures 2 or 3. The specified conditions shall be applied and the slide screw tuners adjusted to obtain maximum power output for the G_{pe} test and minimum noise figure for NF and GNF tests.

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TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits	Limits	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 4.3.2	$Z_{\theta JX}$			°C/W
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = 1 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{(BR)CEO}$	15		V dc
Breakdown voltage, collector to base	3001	Bias condition D; $I_C = 100 \text{ } \mu\text{A dc}$;	$V_{(BR)CBO}$	25		V dc
Breakdown voltage, emitter to base	3026	Bias condition D; $I_C = 100 \text{ } \mu\text{A dc}$;	$V_{(BR)EBO}$	3		V dc
Collector to base cutoff current	3036	Bias condition D; $I_C = 100 \text{ } \mu\text{A dc}$;	I_{CBO}		50	nA dc
Forward-current transfer ratio 2N6603 2N6604	3076	$V_{CE} = 10 \text{ V dc}$ $I_C = 15 \text{ mA dc}$ $I_C = 30 \text{ mA dc}$	h_{FE}	30	200	
<u>Subgroup 3</u> High-temperature operation:		$T_A = +150^\circ\text{C}$				
Collector to base cutoff current	3036	Bias condition D; $I_C = 100 \text{ } \mu\text{A dc}$;	I_{CBO}		5.0	$\mu\text{A dc}$
Low-temperature operation:		$T_A = -55^\circ\text{C}$				
Forward-current transfer ratio 2N6603 2N6604	3076	$V_{CE} = 10 \text{ V dc}$ $I_C = 15 \text{ mA dc}$ $I_C = 30 \text{ mA dc}$	h_{FE}	15		
<u>Subgroup 4</u> Power gain 2N6603 2N6604		$V_{CE} = 10 \text{ V dc}$; $f = 1 \text{ GHz}$ (see 4.5.2 and figure 2) $I_C = 15 \text{ mA dc}$ $I_C = 30 \text{ mA dc}$	G_{pe}	15	21	dB
Collector to base capacitance 2N6603 2N6604	3236	$V_{CB} = 10 \text{ V dc}$; $I_E = 0$ $.1 \text{ MHz} \leq f \leq 1 \text{ MHz}$	C_{cb}	.25 .30	.75 .80	pF pF

See footnotes at end of table.

TABLE I. Group A inspection. Continued

Inspection 1/ <u>Subgroup 4 - continued</u>	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Conditions		Min	Max	
Noise figure		$V_{CE} = 10 \text{ V dc}; I_C = 5 \text{ mA dc};$ $f = 1 \text{ GHz}$ (see 4.5.2 and figure 3)	NF			
2N6603				1.0	2.5	dB
2N6604				1.5	3.0	dB
<u>Subgroups 5 and 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Input reflection coefficient		$V_{CE} = 10 \text{ V dc}; f = 1 \text{ GHz};$ $Z_O = 50 \Omega;$ $I_C = 15 \text{ mA dc}$	/S11/ LOS11	.5 +165	.8 -165	-- °C
2N6603						
2N6604		$I_C = 30 \text{ mA dc}$	/S11/ LOS11	.45 +155	.75 -175	-- °C
Output reflection coefficient		$V_{CE} = 10 \text{ V dc}; f = 1 \text{ GHz};$ $Z_O = 50 \Omega;$ $I_C = 15 \text{ mA dc}$	/S22/ LOS22	.25 -70	.5 -30	-- °C
2N6603						
2N6604		$I_C = 30 \text{ mA dc}$	/S22/ LOS22	.2 -70	.4 -30	-- °C
Forward transfer coefficient		$V_{CE} = 10 \text{ V dc}; f = 1 \text{ GHz};$ $Z_O = 50 \Omega;$ $I_C = 15 \text{ mA dc}$	/S21/ ²	12	--	dB
2N6603						
2N6604		$I_C = 30 \text{ mA dc}$	/S21/ ²	12	--	dB
Reverse transfer coefficient		$V_{CE} = 10 \text{ V dc}; f = 1 \text{ GHz};$ $Z_O = 50 \Omega;$ $I_C = 15 \text{ mA dc}$	/S12/ ²	--	-22.5	dB
2N6603						
2N6604		$I_C = 30 \text{ mA dc}$	/S12/ ²	--	-22.5	dB
Power gain at optimum noise figure		$V_{CE} = 10 \text{ V dc}; I_C = 5 \text{ mA dc};$ $f = 2 \text{ GHz}$ (see 4.5.2 and figures 2 and 3)	G _{NF}	6	--	dB

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

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

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TABLE II. 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	Intermittent operation life: $V_{CB} = 5 - 15$ V dc, 6,000 cycles. Adjust device current, or power, to achieve a minimum ΔT_J of $+100^\circ\text{C}$	
Electrical measurements		See table I , subgroup 2 herein	
<u>Subgroup 4</u>			
Thermal impedance curves		See MIL-PRF-19500, table E-IX	Sample size N/A
<u>Subgroup 5</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition B	

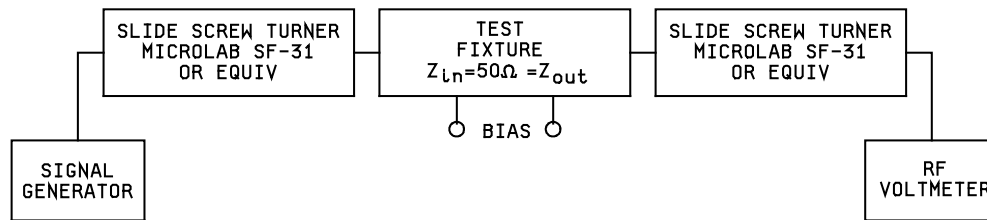


FIGURE 2. Block diagram of Power Gain test circuit at 1 GHz.

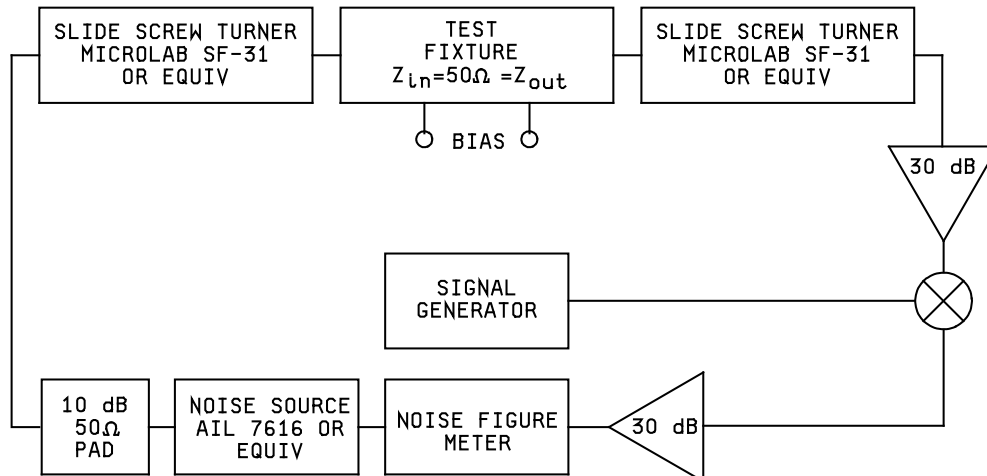


FIGURE 3. Block diagram of Noise Figure test circuit at 1 GHz.

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.

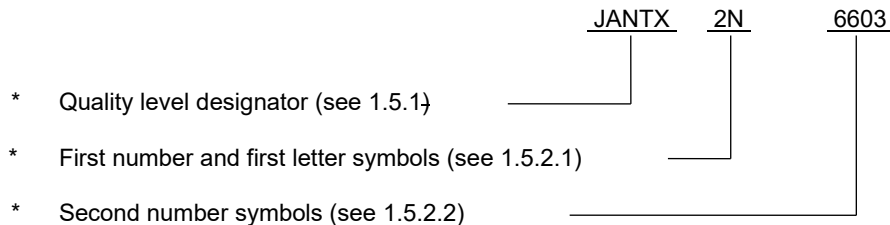
6.2 Acquisition requirements. Acquisition documents should specify the following:

- a Title, number, and date of this specification.
- b Packaging requirements (see 5.1).
- c Lead finish (see 3.4.1).
- d The complete Part or Identifying Number (PIN), see 1.2.

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 PIN construction example.

6.4.1 Encapsulated devices The PINs for encapsulated devices are constructed using the following form.



6.5 List of PINs. The following is a list of possible PINs available on this specification sheet.

PINs for type 2N6603 and 2N6604.		
JAN2N6603	JANTX2N6603	JANTXV2N6603
JAN2N6604	JANTX2N6604	JANTXV2N6604

* 6.6 Amendment notations. The margins of this specification are marked with asterisks to indicate modifications generated by this amendment. 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 previous issue.

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