

The documentation and process conversion measures necessary to comply with this revision shall be completed by 31 October 2001.

INCH-POUND

MIL-PRF-19500/455D
31 July 2001
SUPERSEDING
MIL-PRF-19500/455C
25 January 1998

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER SWITCHING,
TYPES 2N5664, 2N5665, 2N5666, 2N5666S, 2N5666U3, 2N5667, AND 2N5667S,
JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

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

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, power transistors for use in high-speed power-switching applications. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500. Two levels of product assurance are provided for each unencapsulated device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-66), figure 2 (TO-5), figure 3 (surface mount), and figure 4 (JANHC, JANKC).

1.3 Maximum ratings.

Type	P_T $T_A = +25^\circ\text{C}$	P_T $T_C = +100^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_{stg} and T_{op}
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>°C</u>
2N5664	2.5 (1)	30 (2)	250	200	6	5	1	-65 to +200
2N5665	2.5 (1)	30 (2)	400	300	6	5	1	-65 to +200
2N5666, S, U3	1.2 (3)	15 (4)	250	200	6	5	1	-65 to +200
2N5667, S	1.2 (3)	15 (4)	400	300	6	5	1	-65 to +200

- (1) Derate linearly 14.3 mW/°C for $T_A > +25^\circ\text{C}$.
- (2) Derate linearly 300 mW/°C for $T_C > +100^\circ\text{C}$.
- (3) Derate linearly 6.9 mW/°C for $T_A > +25^\circ\text{C}$.
- (4) Derate linearly 150 mW/°C for $T_C > +100^\circ\text{C}$.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.4 Primary electrical characteristics at $T_A = +25^\circ\text{C}$.

Limits	h_{FE} $V_{CE} = 5\text{ V}$ $I_C = 1\text{ A}$		$ h_{FE} $ $V_{CE} = 5\text{ V}$ $I_C = 0.5\text{ A dc}$	$V_{BE(sat)}$ $I_C = 3\text{ A dc}$ (1)	$V_{CE(sat)}$ $I_C = 3\text{ A dc}$ (1)	Pulse response		
			$f = 10\text{ MHz}$			t_{on} $I_C = 1\text{ A dc}$	t_{off} $I_C = 1\text{ A dc}$	
	2N5665 2N5667, S	2N5664 2N5666, S, U3					2N5664 2N5666, S, U3	2N5665 2N5667, S
Min	25	40	2.0	<u>V dc</u>	<u>V dc</u>	<u>$\mu\text{ s}$</u>	<u>$\mu\text{ s}$</u>	<u>$\mu\text{ s}$</u>
Max	75	120	7.0	1.2	0.4	0.25	1.5	2.0

(1) $I_B = 0.3\text{ A dc}$ for 2N5664, 2N5666, 2N5666S, 2N5666U3; $I_B = 0.6\text{ A dc}$ for 2N5665, 2N5667, 2N5667S.

Type	$R_{\theta JC}$
	<u>$^\circ\text{C/W (max)}$</u>
2N5664, 2N5665	3.3
2N5666, 2N5667	6.7
2N5666S, 2N5667S, 2N5666U3	6.7

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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

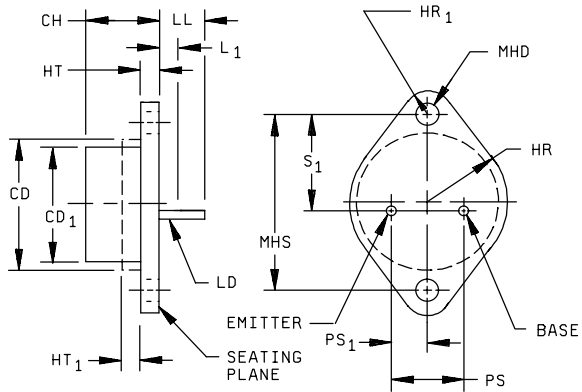
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

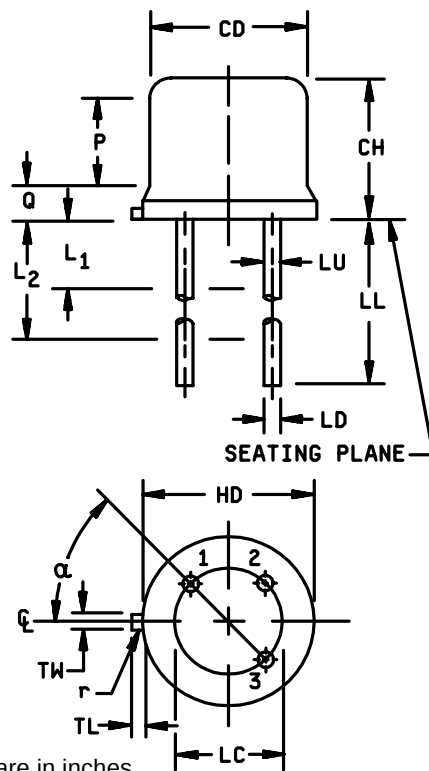


NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Body contour is optional within zone defined by LD and CD.
4. These dimensions should be measured at points .050 inch (1.27 mm) to .055 inch (1.40 mm) below seating plane. When gauge is not used, measurement will be made at seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. The collector shall be electrically connected to the case.
9. LD applies between L₁ and LL. Diameter is uncontrolled in L₁.

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD		.620		15.75	3
CD ₁	.470	.500	11.94	12.70	
CH	.250	.340	6.35	8.64	3
HR		.350		8.89	6
HR ₁	.115	.145	2.92	3.68	
HT	.050	.075	1.27	1.91	3
HT ₁		.050		1.27	3
LD	.028	.034	.711	.863	5, 9
LL	.360	.500	9.14	12.70	5, 9
L ₁		.050		1.27	4
MHD	.142	.152	3.62	3.86	7
MHS	.958	.962	24.33	24.43	
PS	.190	.210	4.83	5.33	4
PS ₁	.093	.107	2.36	2.72	4
S ₁	.570	.590	14.48	14.99	

FIGURE 1. Physical dimensions of transistor types 2N5664 and 2N5665.

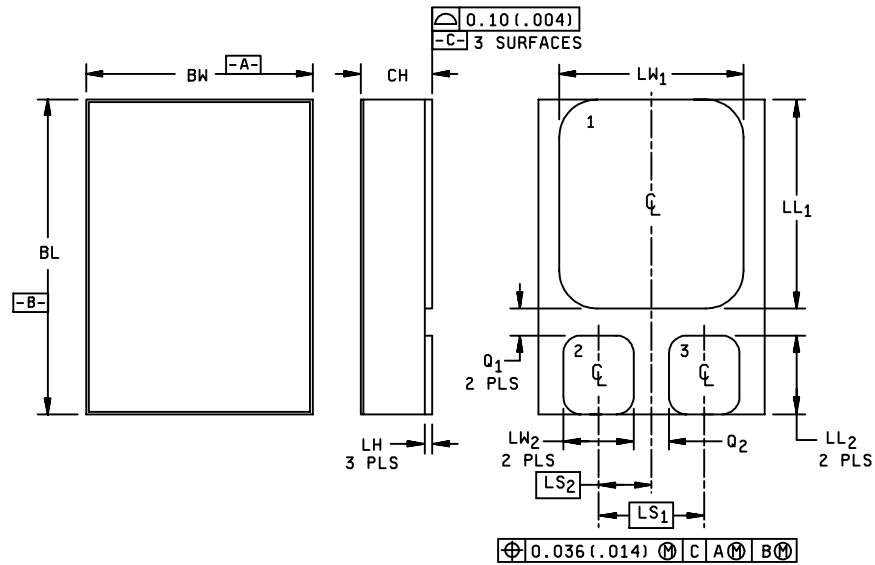


NOTES:

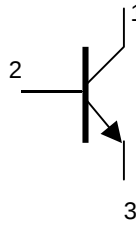
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 inches (6.35 mm) from the seating plane.
4. Measured in the zone .050 inches (1.27 mm) and .250 inches (6.35 mm) from the seating plane.
5. Variations on dimension CD in this zone shall not exceed .010 inches (0.25 mm).
6. Outline in this zone is not controlled.
7. When measured in a gauging plane .054 inches +.001, -.000 (1.37 mm +.03, -.00) below the seating plane of the transistor, maximum diameter leads shall be within .007 inches (.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.
8. The collector shall be electrically connected to the case.
9. Measured from the maximum diameter of the actual device.
10. All three leads
11. Diameter of leads in this zone is not controlled.
12. Lead 1 - Emitter; lead 2 - Base, lead 3 - Collector.
13. For transistor types 2N5666 and 2N5667, LL is 1.500 inches (38.1 mm) minimum and 1.75 inches (44.45 mm) maximum.
14. For transistor types 2N5666S and 2N5667S, LL is .500 inches (12.7 mm) minimum and .75 inches (19.05 mm) maximum.

Ltr	Dimensions				Notes
	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	.1414 Nom		3.59 Nom		6
LD	.016	.021	0.41	0.53	3
LL	See notes 13 and 14				
L ₁		.050		1.27	10
L ₂	.250		6.35		10
LU	.016	.019	0.41	0.48	4
P	.100		2.54		5
Q					6
r		.007		0.18	
TL	.029	.045	0.74	1.14	
TW	0.28	.034	0.71	0.86	

FIGURE 2. Physical dimensions of transistor types 2N5666, 2N5666S, 2N5667 and 2N5667S.



SCHEMATIC

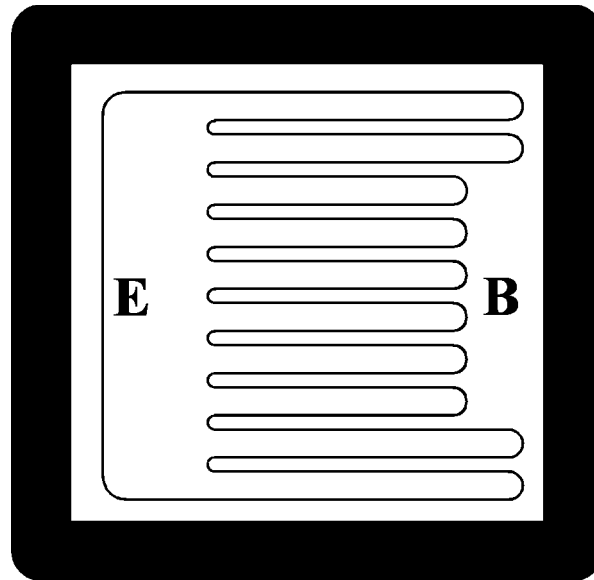


Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.395	.405	10.04	10.28
BW	.291	.301	7.40	7.64
CH	.1085	.1205	2.76	3.06
LH	.010	.020	0.25	0.51
LW1	.281	.291	7.14	7.41
LW2	.090	.100	2.29	2.54
LL1	.220	.230	5.59	5.84
LL2	.115	.125	2.93	3.17
LS1	.150 BSC		3.81 BSC	
LS2	.075 BSC		1.91 BSC	
Q1	.030		0.762	
Q2	.030		0.762	

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Dimensions and tolerances shall be in accordance with ANSI Y14.5M-1982.
4. Terminal 1 - collector, terminal 2 - base, terminal 3 - emitter.

FIGURE 3. Physical dimensions, surface mount (2N5666U3 version).



- | | |
|--------------------|---|
| 1. Chip size: | 120 x 120 mils $\pm$ 2 mils |
| 2. Chip thickness: | 10 $\pm$ 1.5 mils nominal |
| 3. Top metal: | Aluminum 30,000Å minimum, 33,000Å nominal |
| 4. Back metal: | A. Al/Ti/Ni/Ag 12kÅ/3kÅ/7kÅ/7kÅ min. 15kÅ/5kÅ/10kÅ/10kÅ nom.
B. Gold 2,500 minimum, 3,000Å nominal |
| 5. Backside: | Collector |
| 6. Bonding pad: | B = 52 x 12 mils, E = 84 x 12 mils. |

FIGURE 4. JANHC and JANKC (A-version) die dimensions.

2.3 Order of precedence. 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 requirements for acquiring the product described herein shall consist of this document and MIL-PRF-19500.

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.

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (TO-66), figure 2 (TO-5), figure 3 (surface mount), and figure 4 (JANHC, JANKC) herein.

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

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

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3 herein.

3.8 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 JANHC and JANKC qualification. JANHC and JANKC qualification inspection shall be in accordance with MIL-PRF-19500.

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4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table 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 (see table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	I_{CES1} and h_{FE2}	I_{CES1}
11	ΔI_{CES1} and h_{FE2} ; $\Delta I_{CES1} = 100$ percent of initial value or 10 nA dc, whichever is greater; $\Delta h_{FE2} = \pm 15$ percent.	I_{CES1} and h_{FE2} ; $\Delta I_{CES1} = 100$ percent of initial value or 20 nA dc, whichever is greater.
12	See 4.3.1	See 4.3.1
13	Subgroup 2 of table I herein; $\Delta I_{CES1} = +100$ percent of initial value or 10 nA dc, whichever is greater. $\Delta h_{FE2} = \pm 15$ percent.	Subgroup 2 of table I herein; $\Delta I_{CES1} = +100$ percent of initial value or 20 nA dc, whichever is greater. $\Delta h_{FE2} = \pm 25$ percent.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: $T_J = +187.5 \pm 12.5^\circ\text{C}$, $V_{CE} = 100$ V dc, $T_A \leq +100^\circ\text{C}$. Burn-in duration for lot acceptance for the JANKC level follows JANS requirements. Burn-in duration for lot acceptance for the JANHC level follows JANTX requirements.

4.3.2 Screening (JANHC and JANKC). Screening of JANHC and JANKC die shall be in accordance with MIL-PRF-19500. As a minimum, die shall be 100 percent probed to insure the assembled chips will meet the requirements of group A, subgroup 2.

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 E.5.3.1d of MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of group A1 and A2 inspection only (table VIb, group B, subgroup 1 is not required to be performed again if group B has already been satisfied in accordance with 4.4.2).

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table V of MIL-PRF-19500 and table I herein. End-point electrical measurements shall be in accordance with group A, subgroup 2.

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 VIa (JANS) and table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta measurements shall be in accordance with the steps in table II herein as specified in the notes for table II.

4.4.2.1 Group B inspection, table VIa (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
B4	1037	$V_{CB} = 30$ V dc minimum, $P_T = 1.2$ W (TO-5), $P_T = 2.5$ W (TO-66) minimum, $T_A = +25^\circ\text{C} \pm 3^\circ\text{C}$; $t_{on} = t_{off} = 3$ minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	See 4.5.4 herein.
B6	3131	See 4.5.2 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1027	$T_J = +187.5^{\circ}\text{C} \pm 12.5^{\circ}\text{C}$, $V_{CE} = 100 \pm 5 \text{ V dc}$; $T_A = \leq +100^{\circ}\text{C}$.
B5	3131	See 4.5.2 herein.

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 VII of MIL-PRF-19500 and herein. Electrical measurements (end-points) shall be in accordance with group A, subgroup 2. Delta measurements shall be in accordance with the steps in table II herein as specified in the notes for table II.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Terminal strength (tension) 2N5664 and 2N5665 only: Test condition A, weight = 3 pounds, application time = 15 seconds. Terminal strength (lead fatigue) 2N5666, 2N5666S, 2N5667 and 2N5667S only: Test condition E (Not applicable to 2N5666U3).
C6	1027	2N5664, 2N5666, 2N5666S, 2N5666U3: $T_C = +100^{\circ}\text{C}$; $P_T = 30 \text{ W}$; $V_{CE} = 30 \text{ V dc}$. 2N5665, 2N5667 and 2N5667S, $T_A = +25^{\circ}\text{C}$; $P_T = 1.2 \text{ W}$; $V_{CE} = 40 \text{ V}$.

4.5 Methods 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 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following details shall apply:

- a. Collector current magnitude during power application:
 - (1) 2N5664 and 2N5665, 0.833 A dc.
 - (2) 2N5666, 2N5666S, 2N5666U3, 2N5667 and 2N5667S, 0.41 A dc.
- b. Collector to emitter voltage magnitude shall be 20 V dc.
- c. Reference temperature measuring point shall be the case.
- d. Reference temperature measuring point shall be $+25^{\circ}\text{C} \leq T_R \leq +75^{\circ}\text{C}$ and recorded before the test is started.
- e. Mounting arrangement shall be with heat sink to header.
- f. Maximum limit of $R_{\theta JC}$: 2N5664 and 2N5665 shall be 3.3°C/W ; 2N5666, 2N5666S, 2N5666U3, 2N5667 and 2N5667S shall be 6.7°C/W .

4.5.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be conducted at a case temperature (T_C) of +25°C.

4.5.4 Group B accelerated life test. This test shall be conducted using one of the three options listed herein (a, b, or c) with the following conditions applying to all options: $V_{CB} = 30$ V dc, 96 hours minimum, $T_J = +275^\circ\text{C}$.

- a. $T_A = +150^\circ\text{C}$, maximum.
- b. $P_T = 2.5$ W (TO-66); $P_T = 1.2$ W (TO-5, U3 suffix), $T_A = +112^\circ\text{C}$ or P_T adjusted to give a lot average of $T_J = +275^\circ\text{C}$.
- c. $T_A = +25^\circ\text{C} + 3^\circ\text{C}$ with P_T adjusted to give a lot average of $T_J = +275^\circ\text{C}$.

TABLE I. Group A inspection.

Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Breakdown voltage collector to emitter 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3011	Bias condition B; $I_C = 10$ mA dc, pulsed (see 4.5.1), $R_1 = 100 \Omega$	$V_{(BR)CER}$	250 400		V dc V dc
Breakdown voltage emitter to base	3026	Bias condition D, $I_E = 10$ μ A dc, pulsed (see 4.5.1)	$V_{(BR)EBO}$	6		V dc
Collector to emitter cutoff current 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3041	Bias condition C $V_{CE} = 200$ V dc $V_{CE} = 300$ V dc	I_{CES1}		0.2	μ A dc
Collector to base cutoff current 2N5664, 2N5666, 2N5666S 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S 2N5665, 2N5667, 2N5667S	3036	Bias condition D $V_{CB} = 200$ V dc $V_{CB} = 250$ V dc $V_{CB} = 300$ V dc $V_{CE} = 400$ V dc	I_{CBO}		0.1 1.0 0.1 1.0	μ A dc mA dc μ A dc mA dc
Forward-current transfer ratio 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3076	$V_{CE} = 2$ V dc, $I_C = 0.5$ A dc pulsed (see 4.5.1)	h_{FE1}	40 25		
Forward-current transfer ratio 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3076	$V_{CE} = 5$ V dc, $I_C = 1.0$ A dc pulsed (see 4.5.1)	h_{FE2}	40 25	120 75	
Forward-current transfer ratio 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3076	$V_{CE} = 5$ V dc, $I_C = 3.0$ A dc pulsed (see 4.5.1)	h_{FE3}	15 10		

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2</u> - Continued						
Forward-current transfer ratio	3076	V _{CE} = 5 V dc, I _C = 5 A dc, pulsed (see 4.5.1)	h _{FE4}	5		
Collector-emitter saturation voltage 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3071	I _C = 3.0 A dc, I _B = 0.3 A dc, pulsed (see 4.5.1) I _B = 0.6 A dc, pulsed (see 4.5.1)	V _{CE(sat)1}		0.4	V dc
Collector-emitter saturation voltage	3071	I _C = 5 A dc, I _B = 1 A dc, pulsed (see 4.5.1)	V _{CE(sat)2} <u>3/</u>		1.0	V dc
Base-emitter saturation voltage 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3066	Test condition A, I _C = 3.0 A dc, I _B = 0.3 A dc, pulsed (see 4.5.1) I _B = 0.6 A dc, pulsed (see 4.5.1)	V _{BE(sat)1} <u>3/</u>		1.2	V dc
Base-emitter saturation voltage	3066	Test condition A, I _C = 5 A dc, I _B = 1 A dc, pulsed (see 4.5.1)	V _{BE(sat)2}		1.5	V dc
<u>Subgroup 3</u>						
High-temperature operation:		T _A = + 150°C				
Collector to emitter cutoff current 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3041	Bias condition C V _{CE} = 200 V dc V _{CE} = 300 V dc	I _{CES2}		100	µA dc
Low-temperature operation		T _A = -55°C				
Forward-current transfer ratio 2N5664, 2N5666, 2N5666S 2N5665, 2N5667, 2N5667S	3076	V _{CE} = 5 V dc, I _C = 1.0 A dc, pulsed (see 4.5.1)	h _{FE5}		15 10	

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u>						
Magnitude of common-emitter, small-signal short-circuit, forward-current, transfer ratio	3306	V _{CE} = 5 V dc, I _C = 0.5 A dc f = 10 MHz	h _{fe}	2.0	7.0	
Open-circuit output capacitance	3236	V _{CB} = 10 V dc, 100 kHz ≤ f ≤ 1 MHz	C _{obo}		120	pF
Pulse response						
Turn-on time	3251	Test condition A; I _C = 1.0 A dc, V _{CC} = 100 V dc See figure 5 See figure 6	t _{on}		0.25	μs
Turn-off time	3251	Test condition A; I _C = 1.0 A dc, V _{CC} = 100 V dc See figure 5 See figure 6	t _{off}		1.5 2.0	μs μs
<u>Subgroup 5</u>						
Safe operating area (continuous dc) (for types 2N5664 and 2N5665 only)	3051	T _C = + 100°C, t ≥ 1 s, 1 cycle; t _r + t _f = 10 μs (see figure 7)				
Test #1 2N5664 and 2N5665		V _{CE} = 6 V dc, I _C = 5 A dc				
Test #2 2N5664 and 2N5665		V _{CE} = 40 V dc, I _C = 0.75 A dc				
Test #3 2N5664		V _{CE} = 200 V dc, I _C = 43 mA dc				
Test #4 2N5665		V _{CE} = 300 V dc, I _C = 21 mA dc				

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u> - Continued						
Safe operating area (continuous dc) (for types 2N5666, 2N5666S, 2N5667, and 2N5667S)	3051	$T_C = +100^\circ\text{C}$, $t \geq 1$ s, 1 cycle; $t_r + t_f = 10 \mu\text{s}$ (see figure 8)				
Test #1 2N5666, 2N5666S, 2N5667, and 2N5667S		$V_{CE} = 3.0$ V dc, $I_C = 5$ A dc				
Test #2 2N5666, 2N5666S, 2N5667, and 2N5667S		$V_{CE} = 37.5$ V dc, $I_C = 0.4$ A dc				
Test #3 2N5666 and 2N5666S		$V_{CE} = 200$ V dc, $I_C = 27$ mA dc				
Test #4 2N5667 and 2N5667S		$V_{CE} = 300$ V dc, $I_C = 14$ mA dc				
Safe operating area (switching)	3053	Load condition B (clamped inductive load) (see figure 9); $T_C =$ $+100^\circ\text{C}$, $t_r + t_f \leq 10 \mu\text{s}$, duty cycle ≤ 2 percent; $t_p = 4$ ms; $R_S = 0.5 \Omega$, $R_{BB1} = 50 \Omega$, $V_{BB1} = 50$ V dc $R_{BB2} = 50 \Omega$, $V_{BB2} = -4$ V dc $I_C = 5$ A dc, $V_{CC} = 50$ V dc $R_L \leq 2.5 \Omega$, $L = 40$ mH (Triad C- 48U or equivalent)				
2N5664 2N5666 and 2N5666S		Clamp voltage = $200 +0, -5$ V dc				
2N5665 2N5667 and 2N5667S		Clamp voltage = $300 +0, -5$ V dc				
End-point electrical measurements		See table I, group A, subgroup 2 herein				
<u>Subgroups 6 and 7</u>						
Not applicable						

1/ For sampling plan, see MIL-PRF-195002/ Electrical characteristics for 2N5666U3 are identical to 2N5666 unless otherwise noted.3/ Measured at less than 0.125 inch (3.175 mm) from case.

TABLE II. Groups B and C delta measurements. 1/ 2/ 3/

Steps	Inspection <u>4/</u>	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current 2N5664 2N5666, 2N5666S, 2N5666U3 2N5665 2N5667, 2N5667S	3041	Base condition C $V_{CE} = 200 \text{ V dc}$ $V_{CE} = 300 \text{ V dc}$	ΔI_{CES1}	100 percent of initial value or 20 nA dc, whichever is greater.		
2.	Forward-current transfer ratio	3076	$V_{CE} = 5 \text{ V dc}$, $I_C = 1.0 \text{ A dc}$ pulsed (see 4.5.1)	Δh_{FE2} <u>5/</u>	± 25 percent change from initial reading.		

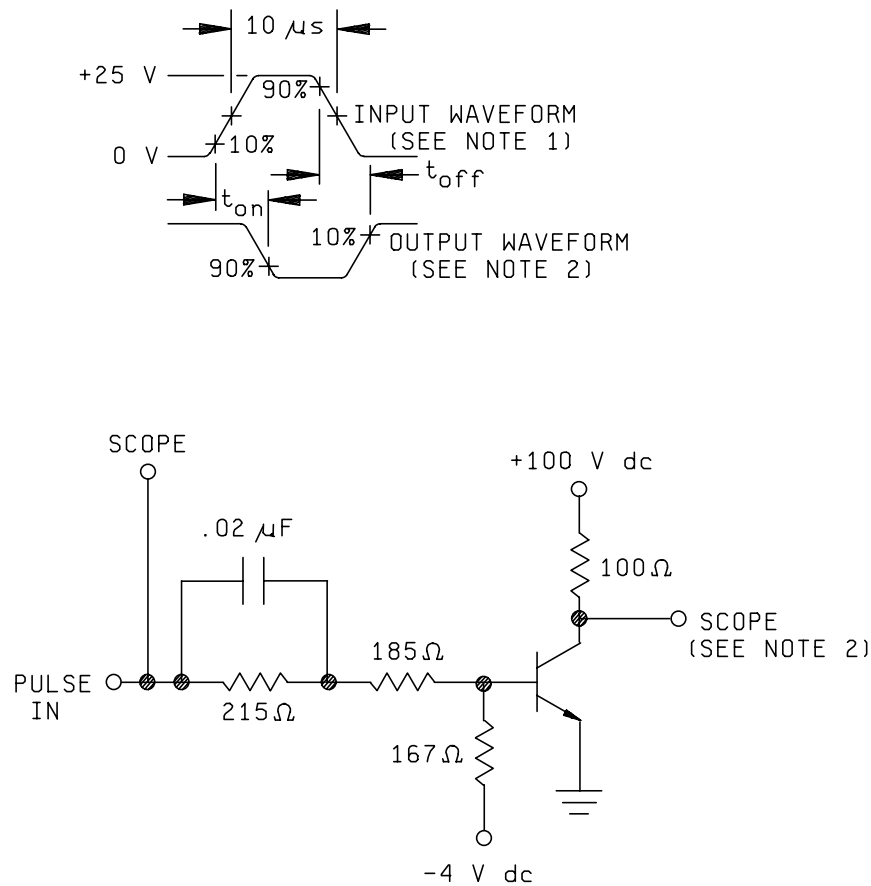
1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are after subgroups 4 and 5, and consist of steps 1 and 2 of table II herein.

2/ The delta measurements for table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are as follows: Subgroups 3 and 6, see table II herein, steps 1 and 2.

3/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, see table II herein, steps 1 and 2.

4/ See MIL-PRF-19500 for sampling plan.

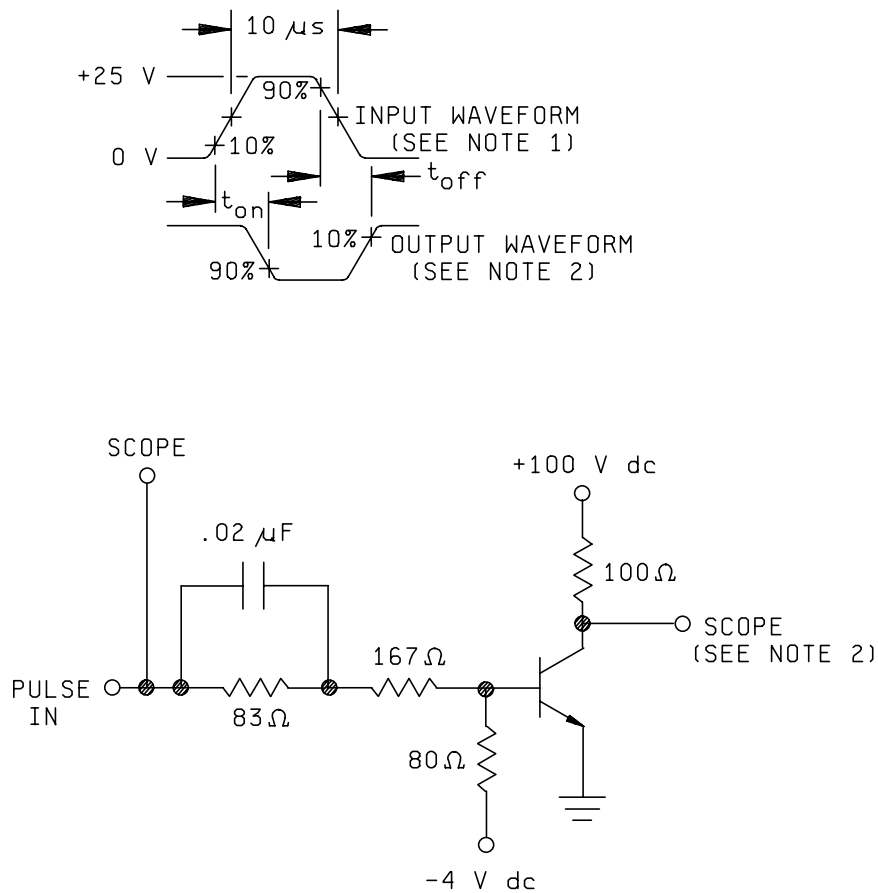
5/ Measured at less than .125 inch (3.175 mm) from case.



NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50$ ohm, $PW = 10$ μ s, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $Z_{in} \geq 10$ M Ω , $C_{in} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional bypassing in order to minimize ringing.
5. The input pulse voltages and supply voltages (-4 V dc and + 100 V dc) are nominal and shall be adjusted to obtain $I_{B1} = -I_{B2} = 30$ mA and $I_C = 1$ A.
6. An equivalent circuit may be used.
7. 0.02 μ F capacitor may be removed during voltage adjustments.

FIGURE 5. Pulse response test circuit for types 2N5664, 2N5666, 2N5666S, and 2N5666U3.



NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50$ ohm, $PW = 10$ μ s, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $Z_{in} \geq 10$ M Ω , $C_{in} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional bypassing in order to minimize ringing.
5. The input pulse voltages and supply voltages (-4 V dc and + 100 V dc) are nominal and shall be adjusted to obtain $I_{B1} = -I_{B2} = 50$ mA and $I_C = 1$ A.
6. An equivalent circuit may be used.
7. 0.02 μ F capacitor may be removed during voltage adjustments.

FIGURE 6. Pulse response test circuit for types 2N5665, 2N5667 and 2N5667S.

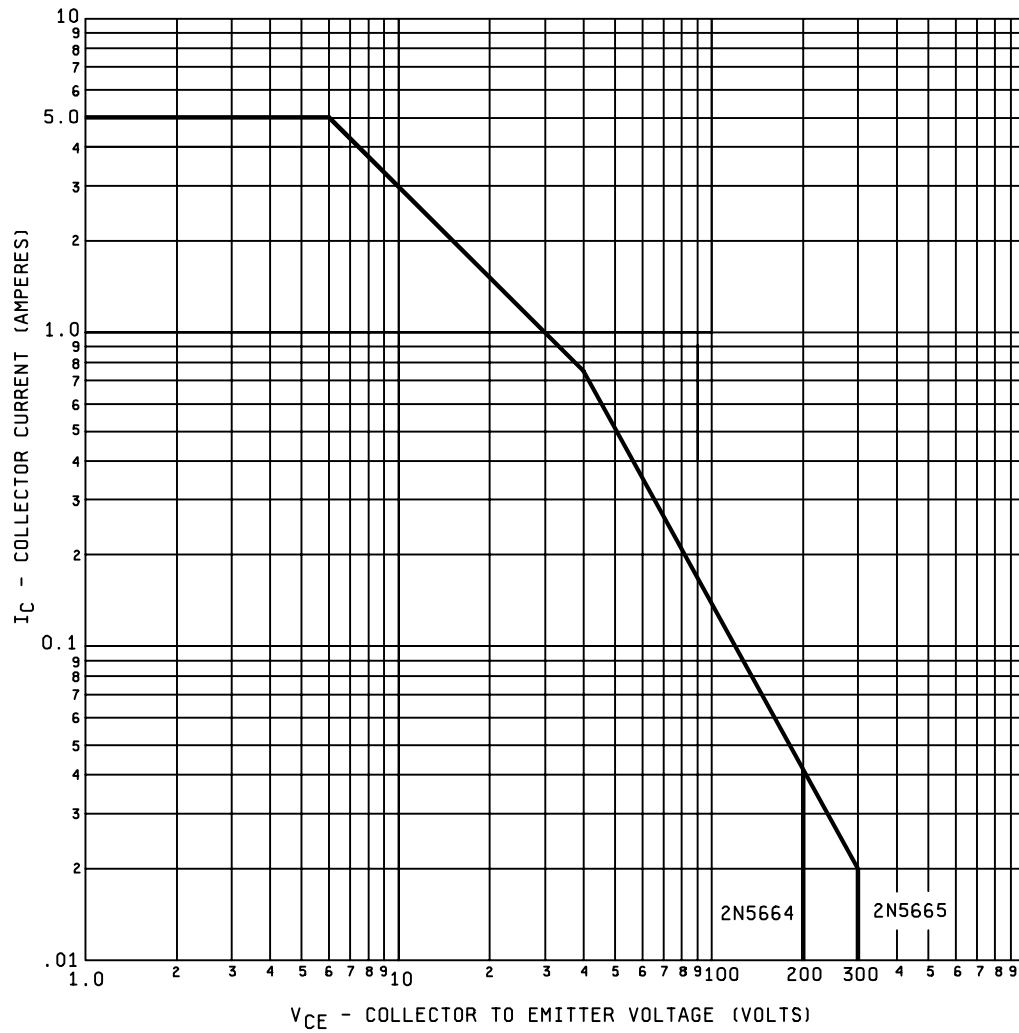
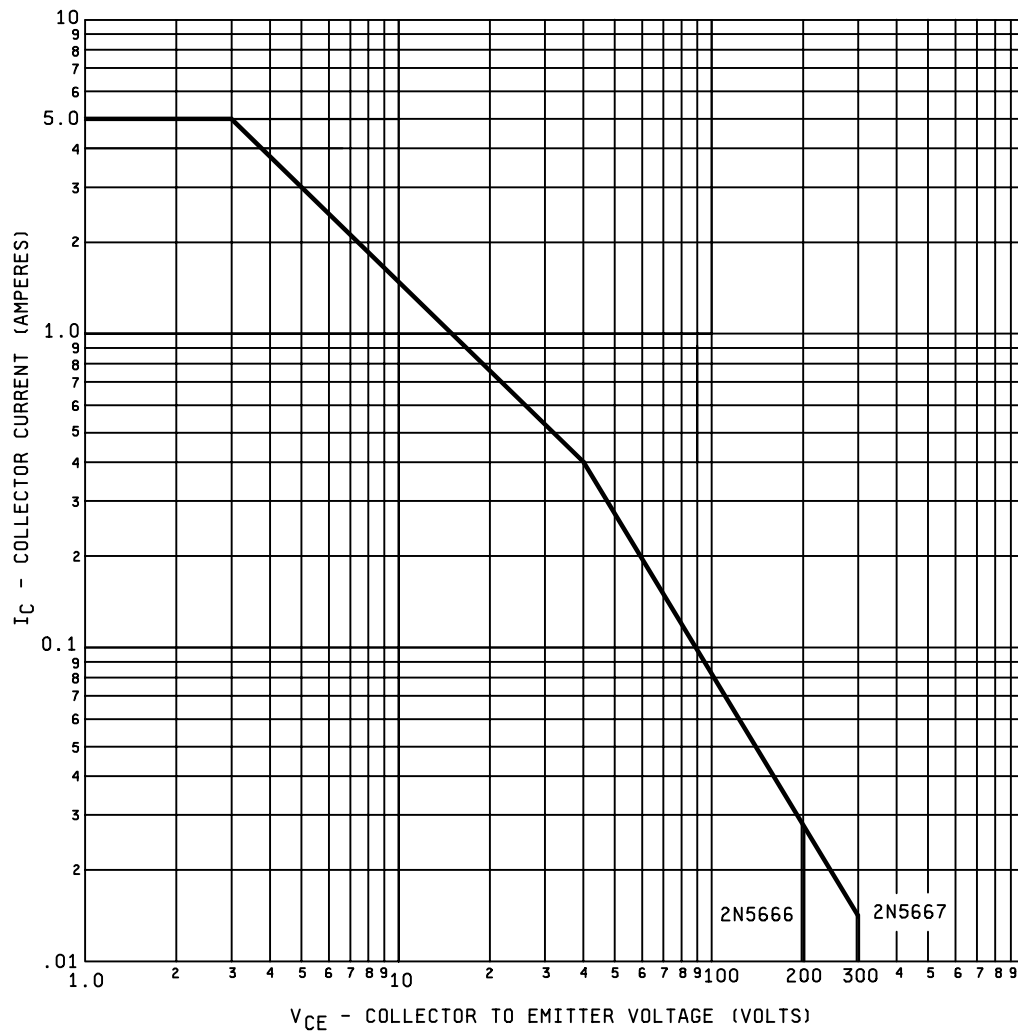
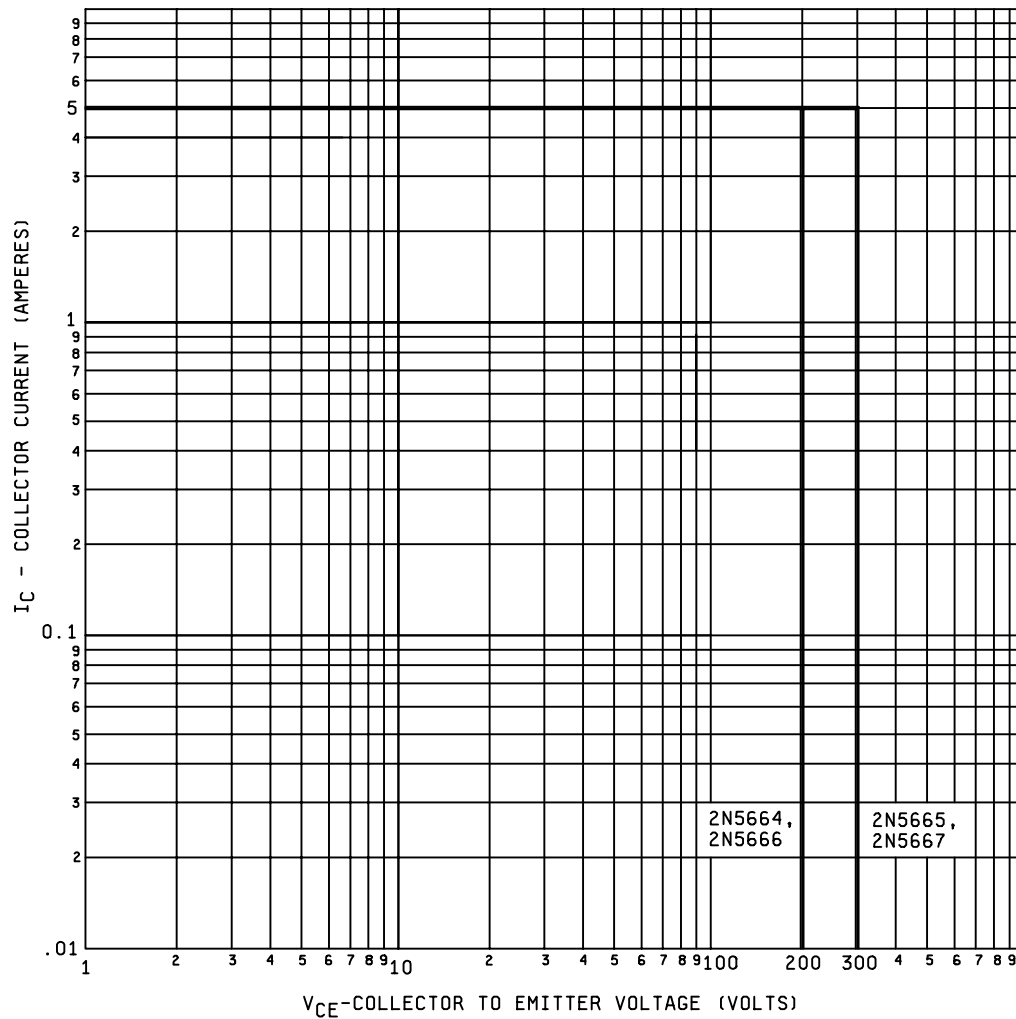


FIGURE 7. Maximum safe operating graph (continuous dc) for types 2N5664 and 2N5665.



NOTE: Electrical characteristics for "S" and "U3" suffix devices are identical to their corresponding devices without the suffix.

FIGURE 8. Maximum safe operating graph (continuous dc) for types 2N5666, 2N5666S, 2N5666U3, 2N5667, and 2N5667S.



NOTE: Electrical characteristics for "S" and "U3" suffix devices are identical to their corresponding devices without the suffix.

FIGURE 9. Safe operating area for switching between saturation and cutoff (clamped inductive load).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. 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.)

6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. The acquisition requirements are as specified in MIL-PRF-19500.

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) 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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000.

6.4 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N5664) will be identified on the QML.

Die ordering information (1)	
PIN	Manufacturer
	43611
2N5664	JANHCA2N5664
2N5665	JANHCA2N5665
2N5666	JANHCA2N5666
2N5667	JANHCA2N5667

(1) For JANKC level, replace JANHC with JANKC.

6.5 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 - NW
Air Force - 11
DLA - CC

Preparing activity:

DLA - CC

(Project 5961-2445)

Review activities:

Army - AR, MI
Navy - AS, MC
Air Force - 19

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER

MIL-PRF-19500/455D

2. DOCUMENT DATE (YYMMDD)

31 July 2001

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER SWITCHING, TYPES 2N5664, 2N5665, 2N5666, 2N5666S, 2N5666U3, 2N5667, AND 2N5667S, JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
Commercial
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EMAIL

7. DATE SUBMITTED
(YYMMDD)

8. PREPARING ACTIVITY

a. Point of contact: Alan Barone

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c. ADDRESS

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DSCC-VAC, P.O. Box 3990, Columbus,
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