The documentation and process conversion measures necessary to comply with this document shall be completed by 25 February 2004.

INCH-POUND

MIL-PRF-19500/455E
25 December 2003
SUPERSEDING
MIL-PRF-19500/455D
31 July 2001

PERFORMANCE SPECIFICATION SHEET

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.

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, 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 un-encapsulated 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°C	P_T T_C = +100°C	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_B	T_{stg} and T_J	$R_{\theta JA}$	$R_{\theta JC}$
	W	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W (max)	°C/W (max)
2N5664	2.5 (1)	30 (2)	250	200	6	5	1		70	2.6
2N5665	2.5 (1)	30 (2)	400	300	6	5	1	-65 to	70	2.6
2N5666, S,	1.2 (3)	15 (4)	250	200	6	5	1	+200	145	2.3
2N5666U3	1.2 (3)	15 (4)	250	200	6	5	1		N/A	2.3
2N5667, S	1.2 (3)	15 (4)	400	300	6	5	1		145	2.3

(1) Derate linearly 14.3 mW/°C for T_A > +25°C.
(2) Derate linearly 300 mW/°C for T_C > +100°C.
(3) Derate linearly 6.9 mW/°C for T_A > +25°C.
(4) Derate linearly 150 mW/°C for T_C > +100°C.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43216-5000, or emailed to alan.barone@.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

1.4 Primary electrical characteristics at T_A = +25°C.

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

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

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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, 4, or 5 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

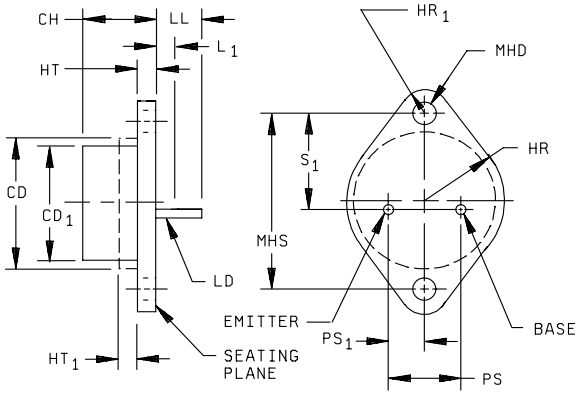
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

* DEPARTMENT OF DEFENSE STANDARDS

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

* (Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or www.dodssp.dap.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

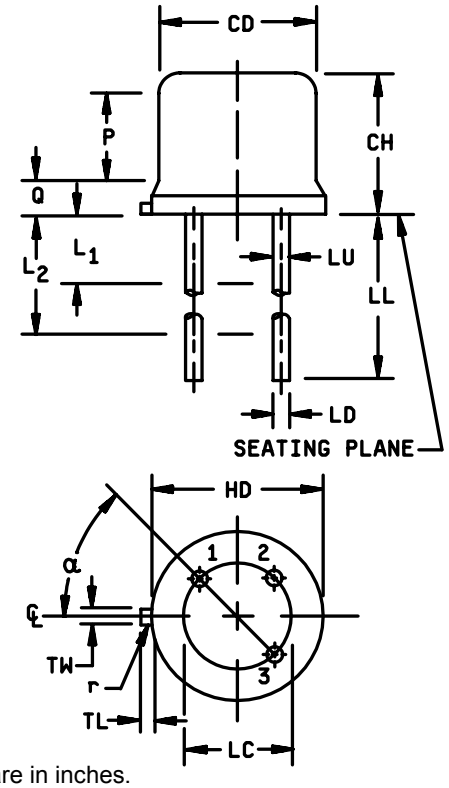
2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.



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	

NOTES:
1. Dimensions are in inches.
2. Millimeters 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 L_1 and LL. Diameter is uncontrolled in L_1.
*10. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

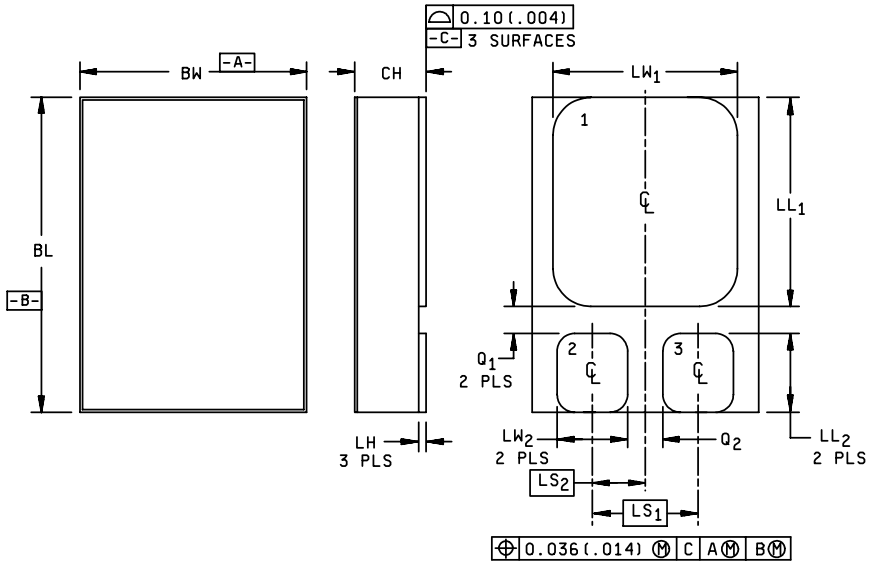
* FIGURE 1. Physical dimensions of transistor types 2N5664 and 2N5665.



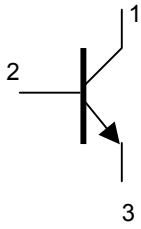
Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.1414 Nom		3.59 Nom		6
LD	.016	.021	0.41	0.53	3
LL	See notes 13 and 14				
L_1		.050		1.27	10
L_2	.250		6.35		10
LU	.016	.019	0.41	0.48	4
P	.100		2.54		5
Q					6
r		.007		0.18	
TL	.029	.045	0.74	1.14	
TW	0.28	.034	0.71	0.86	

NOTES:
1. Dimensions are in inches.
2. Millimeters 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.
*15. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

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



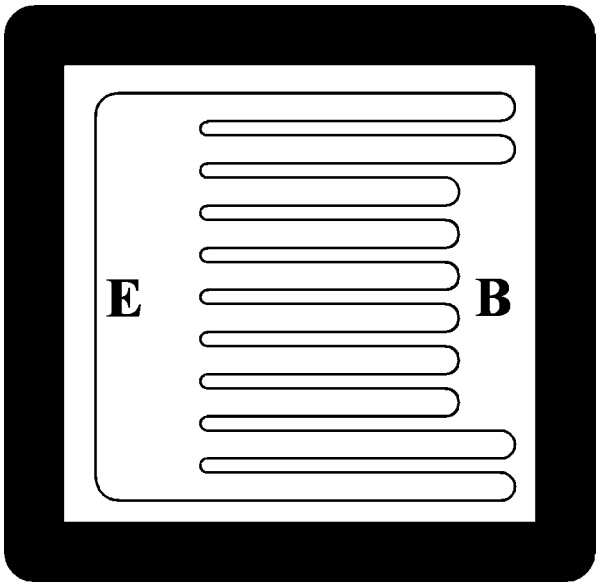
SCHEMATIC



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. Millimeters are given for general information only.
3. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
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 ± 2 mils (3.05 mm x 3.05 mm ±0.051 mm)
2. Chip thickness: 10 ± 1.5 mils nominal, (2.54 mm ±0.038 mm).
3. Top metal: Aluminum 30,000Å minimum, 33,000Å nominal
4. Back metal: A. Al/Ti/Ni/Ag12kÅ/3kÅ/7kÅ/7kÅmin.15kÅ/5kÅ/10kÅ/10kÅ nom.
   B. Gold 2,500 minimum, 3,000Å nominal
5. Backside: Collector
6. Bonding pad: B = 52 x 12 mils (1.32 mm x 0.305 mm), E = 84 x 12 mils (2.13 mm x 0.305 mm).

FIGURE 4. JANHC and JANKC (A-version) die 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 4.3 and 6.2).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and as follows.

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).

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.

3.6 Electrical test requirements. The electrical test requirements shall be as specified in 4.4.2 and 4.4.3, herein.

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

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 Group E qualification. Group E qualification shall be performed herein for qualification or requalification only. In case qualification was awarded to a prior revision of the associated specification that did not request the performance of table III tests, the tests specified in table III herein shall be performed by the first inspection lot to this revision to maintain qualification.

* 4.3 Screening (list applicable JAN levels). 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
3c	Thermal impedance method 3131 of MIL-STD-750, see 4.3.3.	Thermal impedance method 3131 of MIL-STD-750, see 4.3.3.
9	I_{CES1} and h_{FE2}	I_{CES1}
11	ΔI_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 10 nA dc, whichever is greater; Δh_{FE2} = ± 15 percent.	I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 20 nA dc, whichever is greater.
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CES1} = +100 percent of initial value or 10 nA dc, whichever is greater. Δh_{FE2} = ±15 percent.	Subgroup 2 of table I herein; ΔI_{CES1} = +100 percent of initial value or 20 nA dc, whichever is greater. Δh_{FE2} = ±25 percent.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_J = +187.5 ±12.5°C, V_{CE} = 100 V dc, $T_A \leq$ +100°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.

* 4.3.3 Thermal impedance ($Z_{\theta JX}$ measurements). The $Z_{\theta JX}$ 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_{MD} (and V_C where appropriate). The $Z_{\theta JX}$ limit used in Screen 3c shall comply with the thermal impedance graph in figure n (less than or equal to the curve value at the same t_H time) and/or shall be less than the process determined statistical maximum limit as outlined in method 3131.

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, T_A = +25°C ± 3°C; t_{on} = t_{off} = 3 minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on the heating cycle 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.

Subgroup	Method	Condition
B3	1027	T_J = +187.5°C ± 12.5°C, V_{CE} = 100 ± 5 V dc; T_A = ≤ +100°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.

Subgroup	Method	Condition
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, 2N5665, 2N5665S, 2N5665U3: T_C = +100°C; P_T = 30 W; V_{CE} = 30 V dc. 2N5666, 2N5667 and 2N5667S, T_A = +25°C; P_T = 1.2 W; V_{CE} = 40 V.

* 4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IX of MIL-PRF-19500 and as specified in table III herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein; Delta measurements shall be in accordance with the applicable steps of 4.5.3.

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 $+25°C \leq T_R \leq +75°C$ 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 four options listed herein (a, b, or c) with the following conditions applying to all options: V_{CB} = 30 V dc.

a. T_A = +150°C, maximum, t = 96 hours minimum, T_J = +275°C.

b. P_T = 2.5 W (TO-66); P_T = 1.2 W (TO-5, U3 suffix), T_A = +112°C or P_T adjusted to give a lot average of T_J = +275°C, t = 96 hours minimum, T_J = +275°C.

c. T_A = +25°C +3 °C with P_T adjusted to give a lot average of T_J = +275°C, t = 96 hours minimum, T_J = +275°C.

d. Adjust T_a and/or P_d to achieve a T_J = +225°C minimum. t = 216 hours, n = 45, c = 0.

TABLE I. Group A inspection.

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

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

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

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
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	$\lvert h_{fe} \rvert$	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	t_{on}		0.25	µs
2N5664, 2N5666, 2N5666S		See figure 8				
2N5665, 2N5667, 2N5667S		See figure 9				
Turn-off time	3251	Test condition A; I_C = 1.0 A dc, V_{CC} = 100 V dc	t_{off}			
2N5664, 2N5666, 2N5666S		See figure 8			1.5	µs
2N5665, 2N5667, 2N5667S		See figure 9			2.0	µs
Subgroup 5						
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 10)				
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 1/ 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued						
Safe operating area (continuous dc) (for types 2N5666, 2N5666S, 2N5667, and 2N5667S	3051	T_C = +100°C, t ≥ 1 s, 1 cycle; $t_r + t_f$ = 10 μs (see figure 11)				
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 12); T_C = + 100°C, $t_r + t_f \leq 10$ μs, duty cycle ≤ 2 percent; t_p = 4 ms; R_S = 0.5 Ω, R_{BB1} = 50 Ω, V_{BB1} = 50 V dc R_{BB2} = 50 Ω, V_{BB2} = -4 V dc I_C = 5 A dc, V_{CC} = 50 V dc $R_L \leq 2.5$ Ω, 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				
Subgroups 6 and 7						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.
2/ 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/

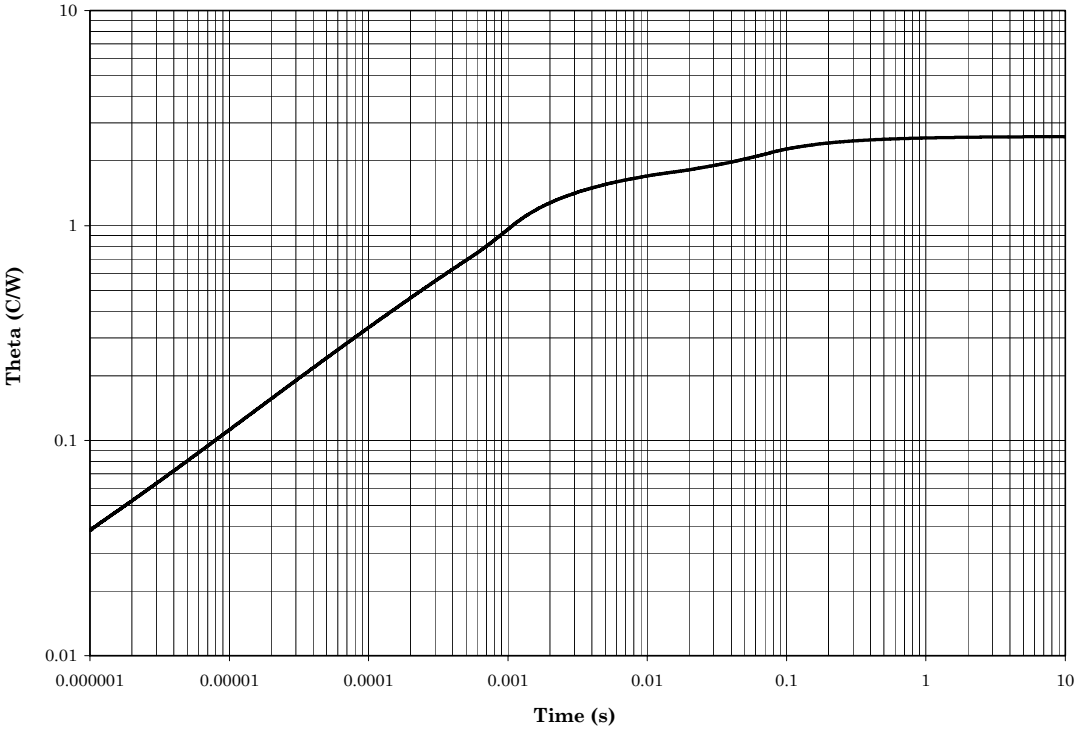
Steps	Inspection 4/	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current	3041	Base condition C	ΔI_{CES1}	100 percent of initial value or 20 nA dc, whichever is greater.		
	2N5664 2N5666, 2N5666S, 2N5666U3		V_{CE} = 200 V dc				
	2N5665 2N5667, 2N5667S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

TABLE III. Group E inspection (all quality levels) - for qualification only.

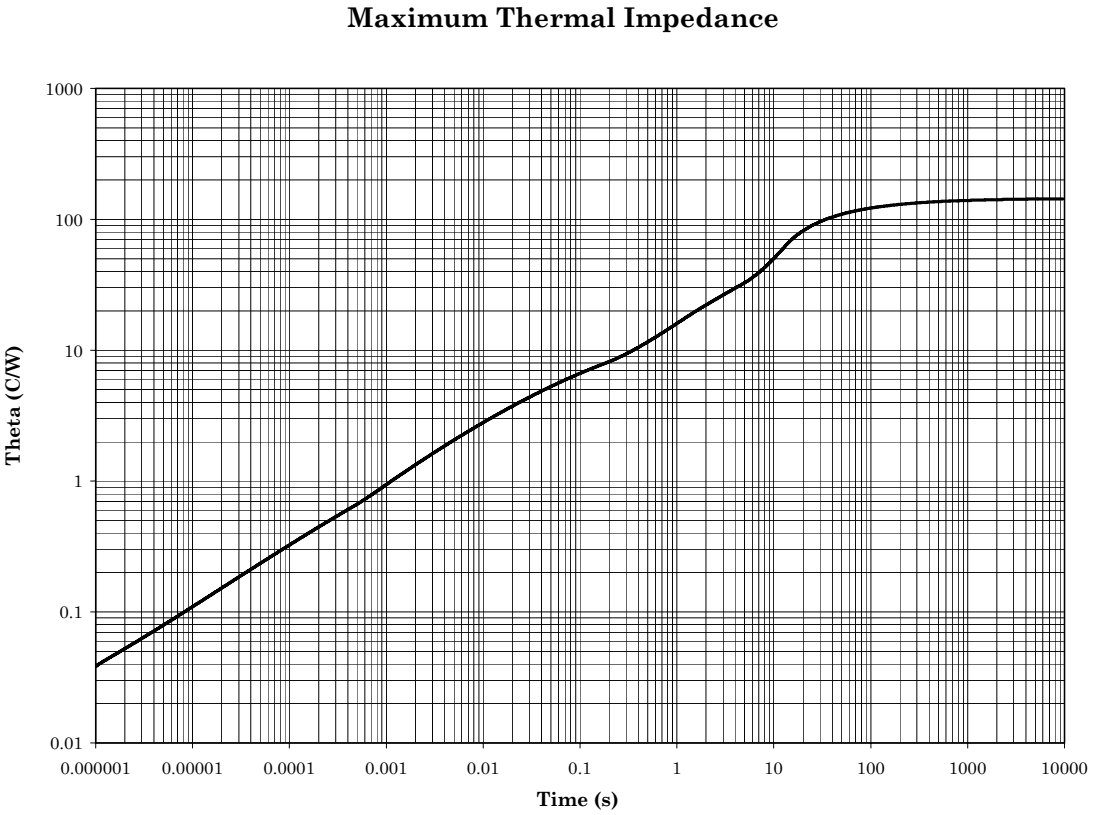
Inspection	MIL-STD-750		Qualification
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2 and table II, step 1 and 2.	
Subgroup 2			45 devices c = 0
Intermittent life	1037	V_{CB} = 10 V dc, 6,000 cycles.	
Electrical measurements		See table I, subgroup 2 and 4.5.3 herein.	
Subgroups 3			
DPA	2102		3 devices c = 0
Subgroups 4			N/A
Thermal impedance curves		Each supplier shall submit their (typical) design maximum thermal impedance curves. In addition, the optimal test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report.	
Subgroup 5,			
Not applicable			
Subgroup 6,			3 devices
ESD (electrocstatic discharge)			
Subgroup 7			
Not applicable			
Subgroup 8			45 devices c = 0
Reverse stability	1033	Condition A for devices $\geq$ 400 V, Condition B for devices < 400 V.	

Maximum Thermal Impedance



Solder mounted to copper heatsink at T_C = +25°C, thermal resistance = 2.6°C/W.

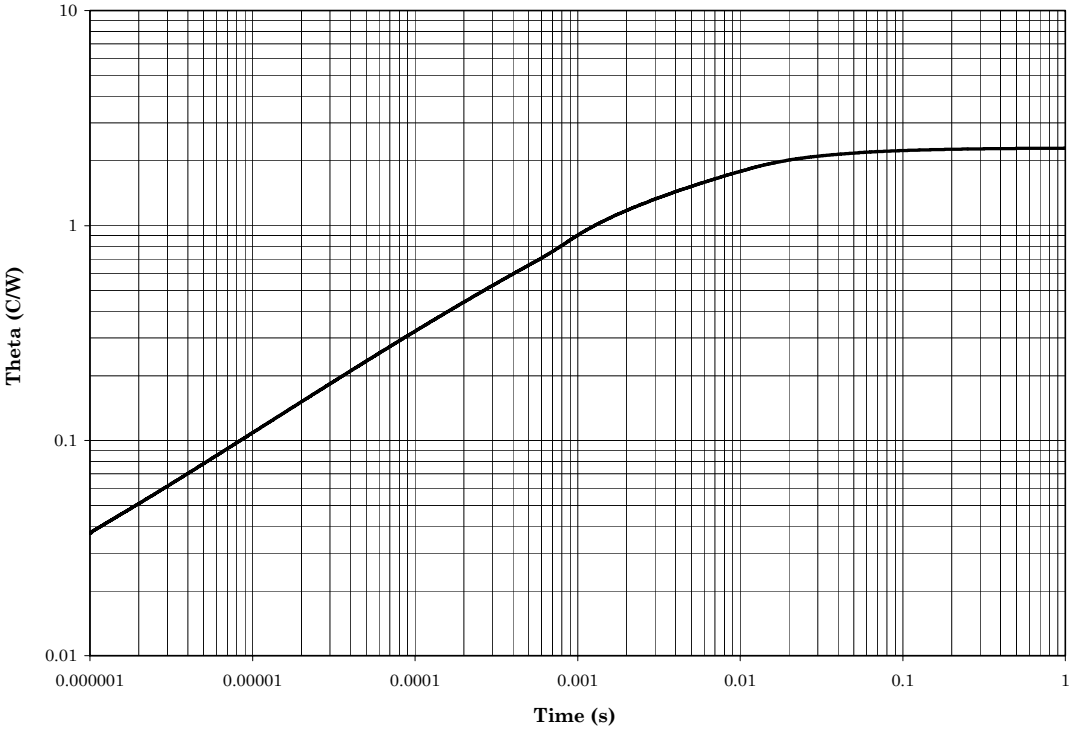
* FIGURE 5. Thermal impedance graph ($R_{\theta JC}$) for 2N5664, and 2N5665 (TO-66).



T_a = +25°C, Pdiss=1W, thermal resistance $R_{\theta JA}$ = 145°C/W (Ambient thermal resistance varies with power).

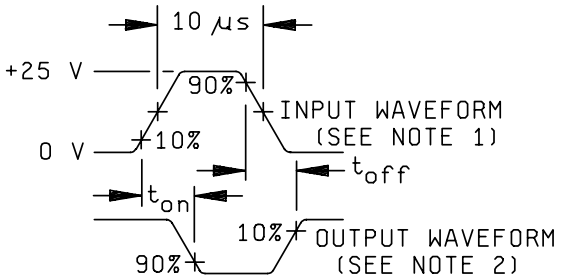
* FIGURE 6. Thermal impedance graph ($R_{\theta JA}$) for 2N5666, 2N5666S, 2N5667, and 2N5667S (TO-5).

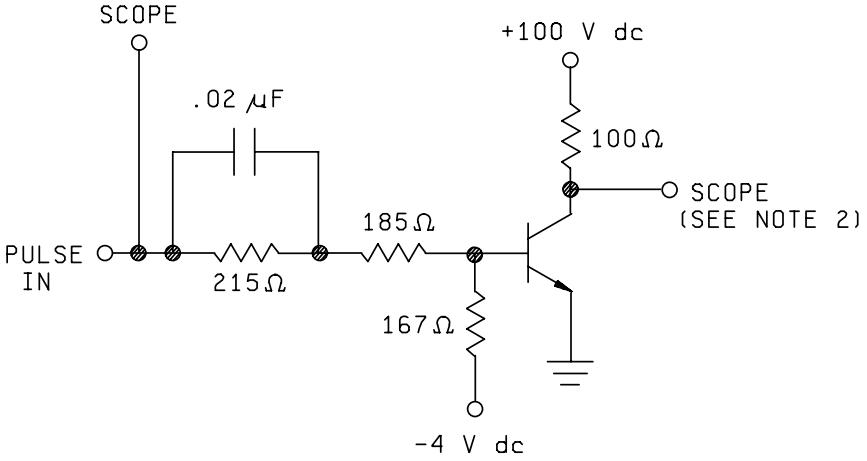
Maximum Thermal Impedance



Solder mounted to copper heatsink at T_C = +25°C, thermal resistance $R_{\theta JC}$ = 2.3°C/W.

* FIGURE 7. Thermal impedance graph ($R_{\theta JC}$) for 2N5666S, 2N5667S, and 2N5666U3.

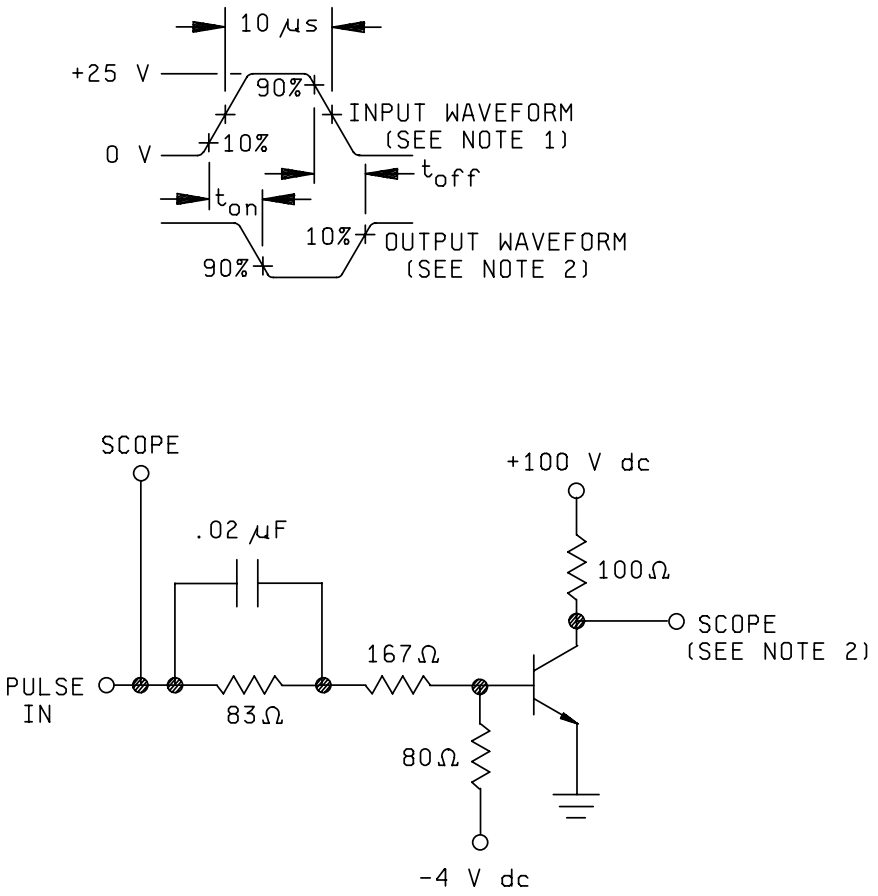




NOTES:

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 µs, 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 µF capacitor may be removed during voltage adjustments.

FIGURE 8. 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 µs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $Z_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ 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 µF capacitor may be removed during voltage adjustments.

FIGURE 9. Pulse response test circuit for types 2N5665, 2N5667 and 2N5667S.

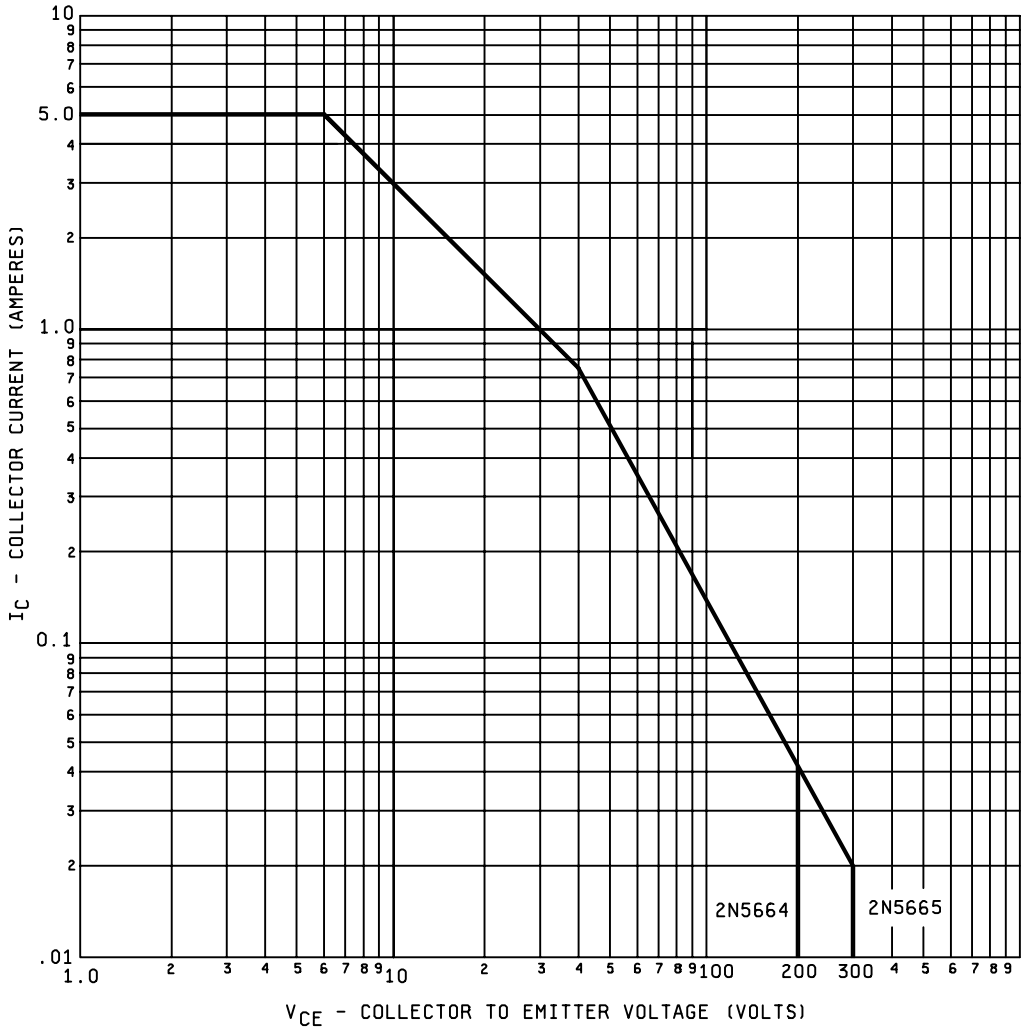
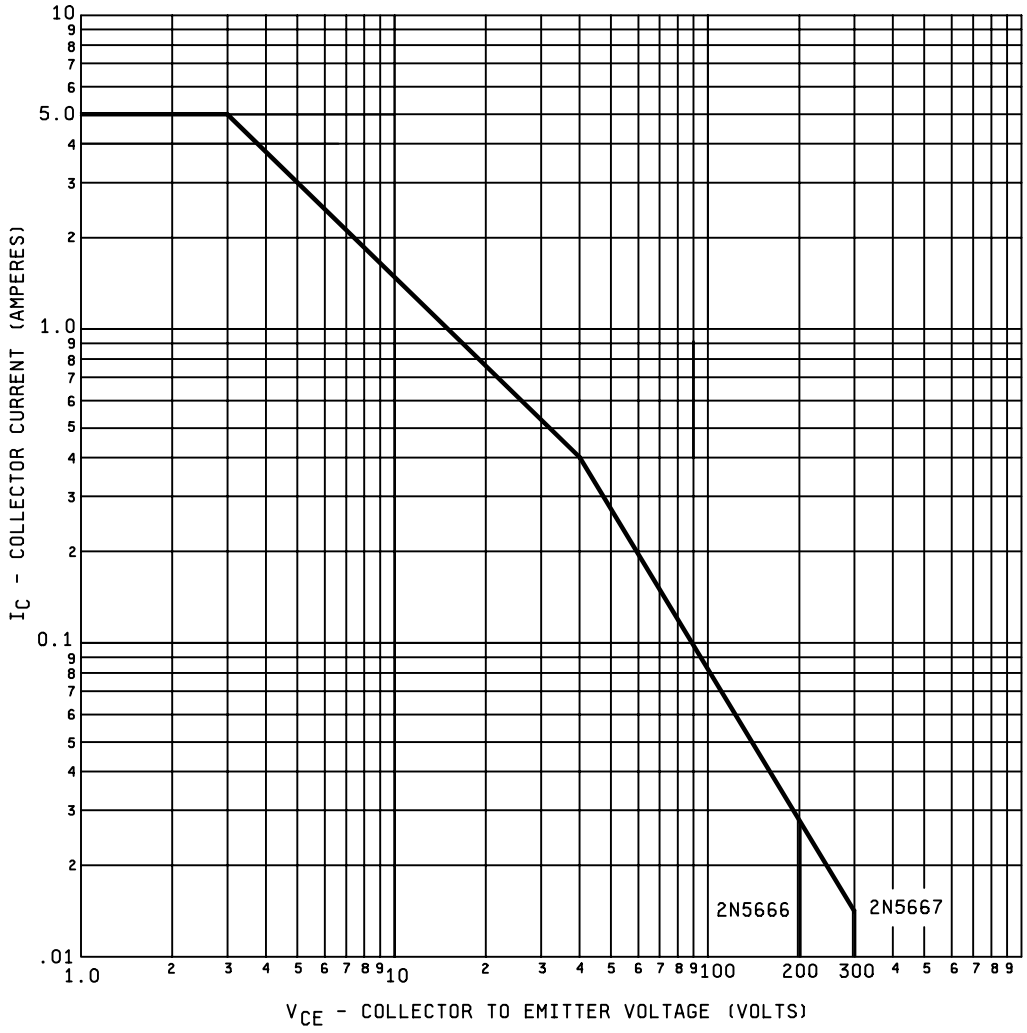
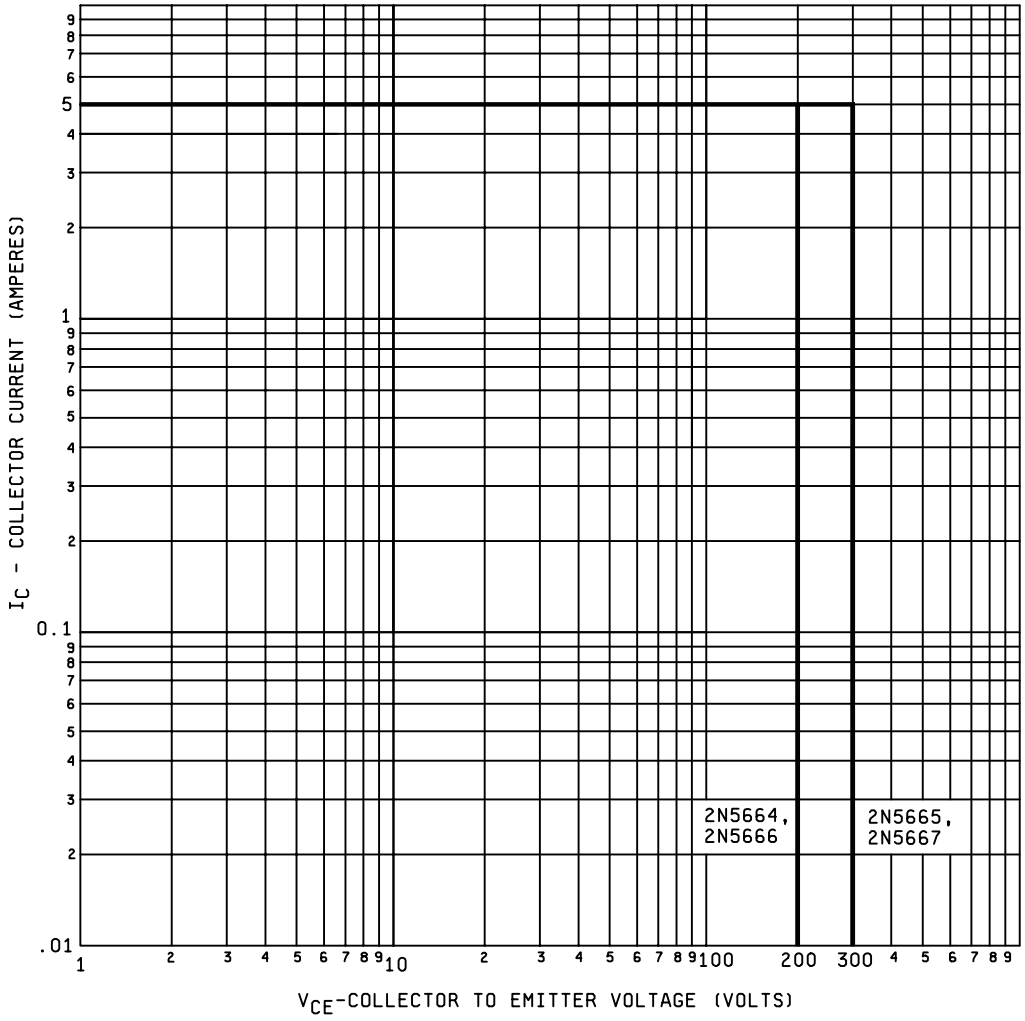


FIGURE 10. Maximum safe operating graph (continuous dc) for types 2N5664 and 2N5665.



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

FIGURE 11. 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 12. 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 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.)

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

* 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. Product assurance level and type designator.

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 No. 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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43216-5000 or e-mail vqe.chief@dla.mil.

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 2N5665 2N5666 2N5667	JANHCA2N5664 JANHCA2N5665 JANHCA2N5666 JANHCA2N5667

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

6.5 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.

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