The documentation and process conversion measures necessary to comply with this revision shall be completed by 12 January 2013.

INCH-POUND

MIL-PRF-19500/454J
12 October 2012
SUPERSEDING
MIL-PRF-19500/454H
20 October 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
TYPES 2N5660, 2N5660U3, 2N5661, 2N5661U3, 2N5662, AND 2N5663, 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, power transistors. Three levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. For types 2N5660 and 2N5661, see figure 1 (similar to TO-66). For types 2N5662 and 2N5663, see figure 2 (similar to TO-5). For types 2N5660U3, and 2N5661U3, see figure 3 (U3).

1.3 Maximum ratings. T_C = +25°C, unless otherwise specified.

Type	P_T T_A = +25°C	P_T T_C = +100°C	$R_{\theta JA}$ (1) (2)	$R_{\theta JC}$ (1) (2)	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	V_{CER}	T_J and T_{STG}
	W	W	°C/W	°C/W	V dc	V dc	V dc	A dc	A dc	V dc	°C
2N5660	2.0	20	87.5	5	250	200	6.0	0.5	2.0	250	-65 to +200
2N5661	2.0	20	87.5	5	400	300	6.0	0.5	2.0	400	-65 to +200
2N5662	1.0	15	175	6.7	250	200	6.0	0.5	2.0	250	-65 to +200
2N5663	1.0	15	175	6.7	400	300	6.0	0.5	2.0	400	-65 to +200
2N5660U3		20		4.5	250	200	6.0	0.5	2.0	250	-65 to +200
2N5661U3		20		4	400	300	6.0	0.5	2.0	400	-65 to +200

(1) For derating, see figures 4 through 8.
(2) For thermal curves, see figures 9 through 16.

* 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.

Limits	h_{FE2} (1) I_C = 0.5 A dc V_{CE} = 5 V dc		$\lvert h_{fe} \rvert$ I_C = 0.1 A dc V_{CE} = 5 V dc f = 10 MHz	$V_{BE(sat)}$ (1) I_C = 1.0 A dc I_B = 0.1 A dc	$V_{CE(sat)}$ (1) I_C = 1 A dc I_B = 0.1 A dc	Pulse response		
						t_{on} I_C = 0.5 A dc	t_{off} I_C = 0.5 A dc	
	2N5660, 2N5660U3, 2N5662	2N5661, 2N5661U3, 2N5663					2N5660, 2N5660U3, 2N5662	2N5661, 2N5661U3, 2N5663
				V dc	V dc	µs	µs	µs
Min	40	25	2					
Max	120	75	7	1.2	0.4	0.25	0.85	1.2

(1) Pulsed (see 4.5.1).

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 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 https://assist.dla.mil/quicksearch/ or https://assist.dla.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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.

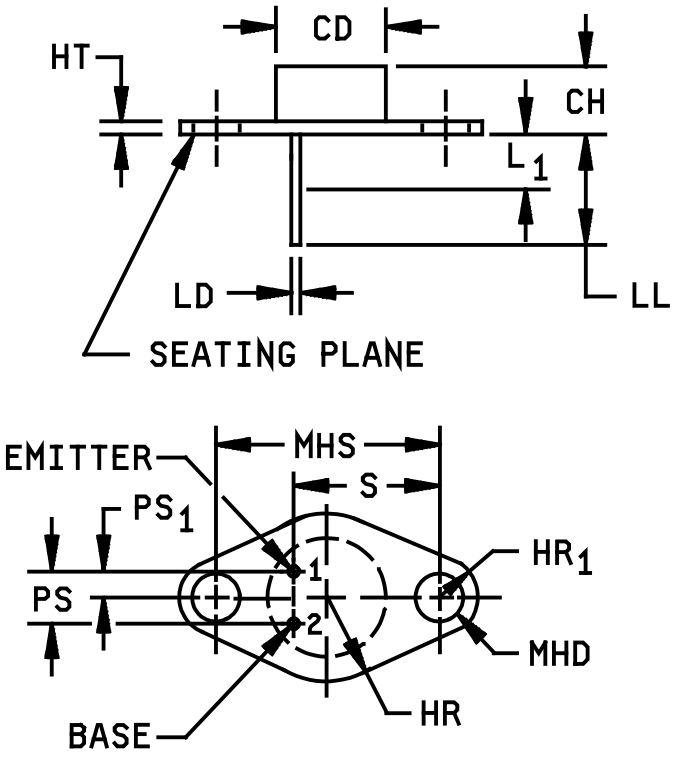


FIGURE 1. Physical dimensions, 2N5660 and 2N5661, (similar to TO-66).

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.470	.500	11.94	12.70	7
CH	.250	.340	6.35	8.64	
HR		.350		8.89	
HR_1	.115	.145	2.92	3.68	4
HT	.050	.075	1.27	1.91	
LD	.028	.034	0.71	0.86	4, 6
LL	.360	.500	9.14	12.70	4
L_1		.050		1.27	4,6
MHD	.142	.152	3.61	3.86	4
MHS	.958	.962	24.33	24.43	
PS	.190	.210	4.83	5.33	3
PS_1	.093	.107	2.36	2.72	3
s	.570	.590	14.48	14.99	3

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. These dimensions should be measured at points .050 inch (1.27 mm) +.005 inch (0.13 mm) -.000 inch (0.00 mm) below seating plane. When gauge is not used, measurement will be made at the seating plane.
4. Two places.
5. The seating plane of the header shall be flat within .001 inch (0.03 mm) concave to .004 inch (0.10 mm) convex inside a .930 inch (23.62 mm) diameter circle on the center of the header and flat within .001 inch (0.03 mm) concave to .006 inch (0.15 mm) convex overall.
6. Lead diameter shall not exceed twice LD within L_1.
7. Body contour is optional within zone defined by CD.
8. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
9. Lead 1 is emitter, lead 2 is base, and case is collector.

FIGURE 1. Physical dimensions, 2N5660 and 2N5661, (similar to TO-66) – Continued.

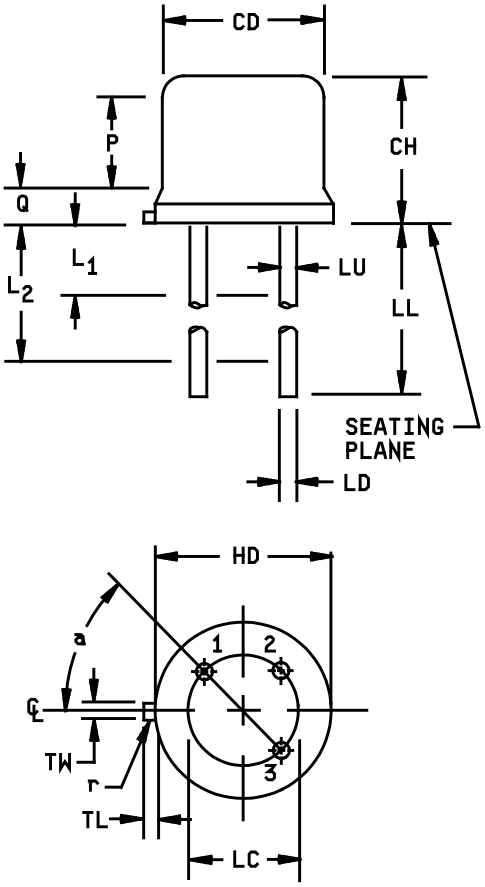
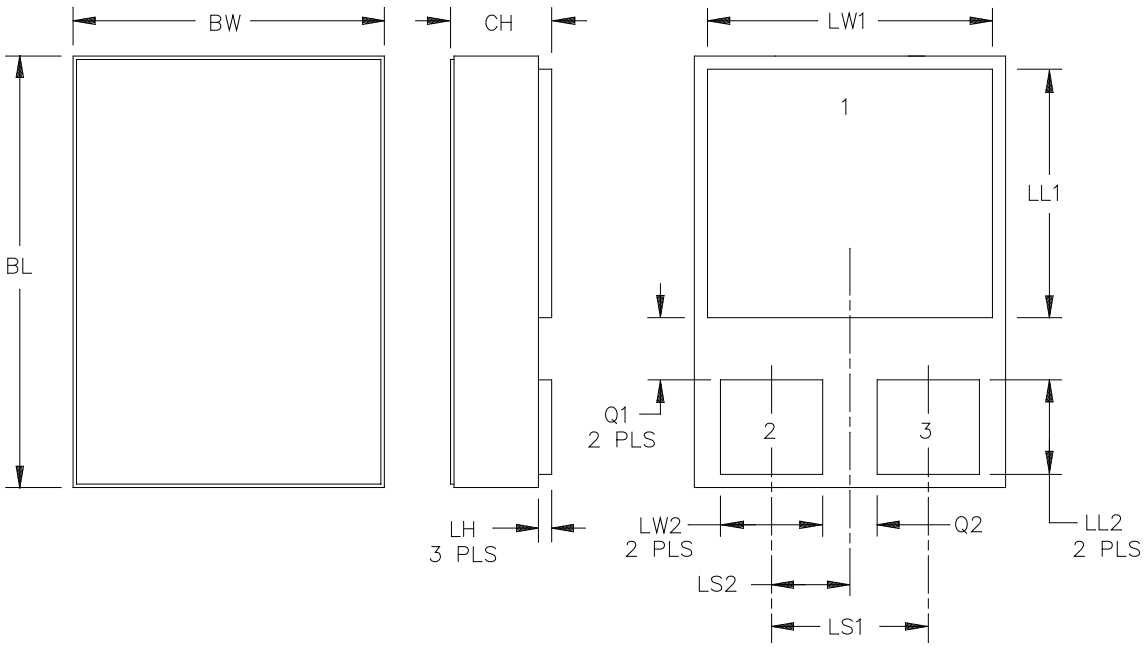


FIGURE 2. Physical dimensions, 2N5662 and 2N5663, (similar to TO-5).

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.355	7.75	9.02	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.021	0.41	0.53	7
LL	1.500	1.750	38.10	44.45	7
LU	.016	.019	0.407	0.482	7
L1		.050		1.27	7
L2	.250		6.35		7
TL	.029	.045	0.74	1.14	3
TW	.028	.034	0.712	0.863	9
P	.100		2.54		
Q		.050		1.27	4
r		.010		0.25	10
α	45°TP		45°TP		6

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Symbol CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) - .000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of TP relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LU applies between L_1 and L_2. Dimension LD applies between L_2 and LL minimum.
8. Lead number three is electrically connected to case.
9. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
* 10. Symbol r is applied to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
12. Lead 1 is emitter, lead 2 is base, and lead 3 is collector.

FIGURE 2. Physical dimensions, 2N5662 and 2N5663, (similar to TO-5) – Continued.



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	7.39
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	
TERM 1	Collector			
TERM 2	Base			
TERM 3	Emitter			

FIGURE 3. Physical dimensions, 2N5660U3 and 2N5661U3 (U3).

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 manufacturer's 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.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (similar to TO-66), figure 2 (similar to TO-5), and figure 3 (U3) 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 finish is desired, it shall be specified in the contract or order (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 paragraph 1.3, 1.4, and table I.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I 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 and table I).

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 (JANTX and JANTXV 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 (see table E-IV of MIL-PRF-19500)	Measurement
	JANTX and JANTXV levels
(1) 3c	Thermal impedance (see 4.3.2)
9	I_{CES1}
10	48 hours minimum
11	I_{CES1} and h_{FE2}; ΔI_{CES1} = 100 percent of initial value or 20 nA, dc whichever is greater.
12	See 4.3.1
13	Subgroup 2 of table I herein; ΔI_{CES1} = 100 percent of initial value or 20 nA dc; Δh_{FE2} = ±25 percent of initial value.

(1) Shall be performed anytime after temperature cycling, screen 3a; and does not need to be repeated in screening requirements.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: V_{CB} = 10 - 30 V dc, T_A = room ambient as defined in 4.5 of MIL-STD-750. Power shall be applied to the device to achieve the required junction temperature, T_J = +135°C minimum and a minimum power dissipation = 75 percent of max P_T as defined in 1.3. With approval of the qualifying activity and preparing activity, alternate burn-in criteria (hours, bias conditions, T_J, and mounting conditions) may be used for JANTX and JANTXV quality levels. A justification demonstrating equivalence is required. In addition, the manufacturing site's burn-in data and performance history will be essential criteria for burn-in modification approval.

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} (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μs max. See table II, group E, subgroup 4 herein.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIC of MIL-PRF-19500, and as specified below. Electrical measurements (end-points) and delta requirements JAN, JANTX, and JANTXV shall be after each step in 4.4.2.1 and shall be in accordance with table I, subgroup 2, and table III herein.

4.4.2.1 Group B inspection, table E-VIC (small die flow, JAN, JANTX, and JANTXV). Separate samples may be used for each step. In the event of a lot failure, the resubmission requirements of MIL-PRF-19500 shall apply. In addition, all catastrophic failures during CI shall be analyzed to the extent possible to identify root cause and corrective action.

Step	Method	Condition
1	1026	V_{CB} = 10 V dc
2	1048	HTRB: Test condition A, 48 hours minimum.
3	1032	High-temperature life (non-operating), t = 340 hours, T_A = +200°C.

4.4.2.2 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

a. For JAN, JANTX, and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. See MIL-PRF-19500.

b. Shall be chosen from an inspection lot that has been submitted to and passed table I, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (group B for JAN, JANTX, and JANTXV) may be pulled prior to the application of final lead finish.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with the applicable of table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable steps of table III herein.

Subgroup	Method	Condition
C2	2036	Test condition A (tension) for 2N5660 and 2N5661; weight = 3 pounds; t = 15s, not applicable for U3 devices.
C2	2036	Test condition E (lead fatigue) for 2N5662 and 2N5663.
C5	3131	See 4.3.2, $R_{\theta JC}$ = 5°C/W for 2N5660 and 2N5661, 4.5°C/W 2N5660U3, 4°C/W 2N5661U3, and 6.7°C/W for 2N5662 and 2N5663.
C6	1026	Not applicable.

4.4.3.2 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes group A tests for conformance inspection. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

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 table II herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2, herein. Delta requirements shall be in accordance with the applicable steps of table III herein.

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.

* TABLE I. Group A inspection.

	Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
	Subgroup 1 2/						
	Visual and mechanical examination	2071					
	Solderability 3/	2026					
	Resistance to solvent 3/ 4/	1022					
	Temp cycling 3/	1051	Test condition C, 25 cycles.				
	Hermetic seal Fine leak Gross leak	1071					
	Electrical measurements		See table I, subgroup 2				
	Bond strength 3/	2037	Precondition T_A = +250°C at t = 24 hrs or T_A = +300°C at t = 2 hrs, n = 11 wires, c = 0				
	Subgroup 2						
	Thermal impedance 5/	3131	See 4.3.2	$Z_{\theta JX}$			°C/W
*	Breakdown voltage, collector to emitter 2N5660, U3, 2N5662 2N5661, U3, 2N5663	3011	Pulsed (see 4.5.1), I_C = 10 mA dc, bias condition B ~~D~~	$V_{(BR)CEO}$	 200 300		V dc
*	Breakdown voltage, collector to base	3011	Bias condition B ~~D~~, I_C = 10 mA dc, pulsed (see 4.5.1), R_{BE} = 100 ohms	$V_{(BR)CER}$			
	2N5660, U3, 2N5662 2N5661, U3, 2N5663				250 400		V dc V dc
	Breakdown voltage, emitter to base	3026	Bias condition D, I_E = 10 µA dc	$V_{(BR)EBO}$	6		V dc
	Collector to emitter cutoff current	3041	Bias condition C	I_{CES1}			
	2N5660, U3, 2N5662 2N5661, U3, 2N5663		V_{CE} = 200 V dc V_{CE} = 300 V dc			0.2 0.2	µA dc µA dc

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Collector to base cutoff current	3036	Bias condition D, V_{CB} = 200 V dc	I_{CBO}			
2N5660, U3, 2N5662		V_{CB} = 200 V dc			0.1	µA dc
		V_{CB} = 250 V dc			1.0	mA dc
2N5661, U3, 2N5663		V_{CB} = 300 V dc			0.1	µA dc
		V_{CB} = 400 V dc			1.0	mA dc
Base emitter voltage (saturated)	3066	Test condition A, pulsed (see 4.5.1), I_C = 1 A dc, I_B = 0.1 A dc	$V_{BE(sat1)}$		1.2	V dc
Base emitter voltage (saturated)	3066	Test condition A, pulsed (see 4.5.1), I_C = 2 A dc, I_B = 0.4 A dc	$V_{BE(sat2)}$		1.5	V dc
Collector to emitter voltage (saturated)	3071	Pulsed (see 4.5.1), I_C = 1 A dc, I_B = 0.1 A dc	$V_{CE(sat)1}$		0.4	V dc
Collector to emitter voltage (saturated)	3071	Pulsed (see 4.5.1), I_C = 2 A dc, I_B = 0.4 A dc	$V_{CE(sat)2}$		0.8	V dc
Forward current transfer ratio	3076	V_{CE} = 2.0 V dc, I_C = 50 mA dc, pulsed (see 4.5.1)	h_{FE1}			
2N5660, U3, 2N5662				40		
2N5661, U3, 2N5663				25		
Forward current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 0.5 A dc, pulsed (see 4.5.1)	h_{FE2}			
2N5660, U3, 2N5662				40	120	
2N5661, U3, 2N5663				25	75	
Forward current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 1 A dc, pulsed (see 4.5.1)	h_{FE3}	15		
Forward current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 2 A dc, pulsed (see 4.5.1)	h_{FE3}	5		

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High temperature operation:		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition C	I_{CES2}			
2N5660, U3, 2N5662		V_{CE} = 200 V dc			9	µA dc
2N5661, U3, 2N5663		V_{CE} = 300 V dc			9	µA dc
Low temperature operation:		T_A = -55°C				
Forward current transfer ratio	3076	V_{CE} = 5.0 V dc, I_C = 0.5 A dc, pulsed (see 4.5.1)	h_{FE5}			
2N5660, U3, 2N5662				15		
2N5661, U3, 2N5663				10		
Subgroup 4						
Small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 5 V dc, I_C = 0.1 A dc, f = 10 MHz	$\|h_{fe}\|$	2	7	
Pulse response						
Turn-on time	3251	Test condition A, V_{CC} = 100 V dc, I_C = 0.5 A dc	t_{on}			
2N5660, U3, 2N5662		See figure 17			0.25	µs
2N5661, U3, 2N5663		See figure 18			0.25	µs
Turn-off time	3251	Test condition A, V_{CC} = 100 V dc, I_C = 0.5 A dc	t_{off}			
2N5660, U3, 2N5662		See figure 17			0.85	µs
2N5661, U3, 2N5663		See figure 18			1.2	µs
Open circuit output capacitance	3236	V_{CB} = 10 V dc, I_E = 0, 100 kHz ≤ f ≤ 1 MHz	C_{obo}		45	pF

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = +100°C, power application time ≥ 1 second, 1 cycle, $t_r + t_f$ = 10 μs, (2N5660 2N5660U3, 2N5661, and 2N5661U3, see figure 19, 2N5662 and 2N5663, see figure 20)				
Test 1						
2N5660, U3, 2N5661, U3		V_{CE} = 10 V dc, I_C = 2 A dc				
2N5662, 2N5663		V_{CE} = 7.5 V dc, I_C = 2 A dc				
Test 2						
2N5660, U3, 2N5661, U3		V_{CE} = 40 V dc, I_C = 500 mA dc				
2N5662, 2N5663		V_{CE} = 25 V dc, I_C = 600 mA dc				
Test 3						
2N5660, U3		V_{CE} = 200 V dc, I_C = 36 mA dc				
2N5662		V_{CE} = 200 V dc, I_C = 27 mA dc				
Test 4						
2N5661, U3		V_{CE} = 300 V dc, I_C = 19 mA dc				
2N5663		V_{CE} = 300 V dc, I_C = 14 mA dc				
Safe operating area (clamped inductive)		T_C = +100°C, $t_r + t_f \leq$ 10 μs duty cycle ≤ 2 percent, I_C = 2 A dc, $t_p \approx$ 4 ms, V_{CE} = 25 V dc (see figures 21 and 22)				
2N5660, U3, 2N5662		Clamp voltage = 200, +0, -5 V dc				
2N5661, U3, 2N5663		Clamp voltage = 300, +0, -5 V dc				
Electrical measurements		See table I, subgroup 2 herein.				

1/ For sampling plan, see MIL-PRF-19500.
2/ For resubmission of failed subgroup 1, double the sample size of the failed test or sequence of tests.
3/ Separate samples may be used.
4/ Not required for laser marked devices.
5/ This test required for the following end-point measurements only:
Group B, steps 2 and 3 (JAN, JANTX, and JANTXV).
Group C, subgroup 2.
Group E, subgroups 1 and 2.

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

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices, c = 0
Temperature cycling	1051	500 cycles, condition D	
Hermetic seal Fine leak Gross leak	1071		
Electrical measurements		See table I, subgroup 2 and table III.	
Subgroup 2			45 devices, c = 0
Steady-state dc blocking life	1039 or 1049	Condition A, 500 hours	
Electrical measurements		See table I, subgroup 2, I_{CBO} test only at V_{CBO} maximum rating (see 1.3) and table III.	
Subgroup 4			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500.	
Subgroup 5			3 devices, c = 0
Barometric pressure (reduced)	1001	Normal mounting pressure = 8 mm Hg ±2 mm Hg for 60 s (minimum)	
Subgroup 8			45 devices, c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V, condition B for devices < 400 V.	

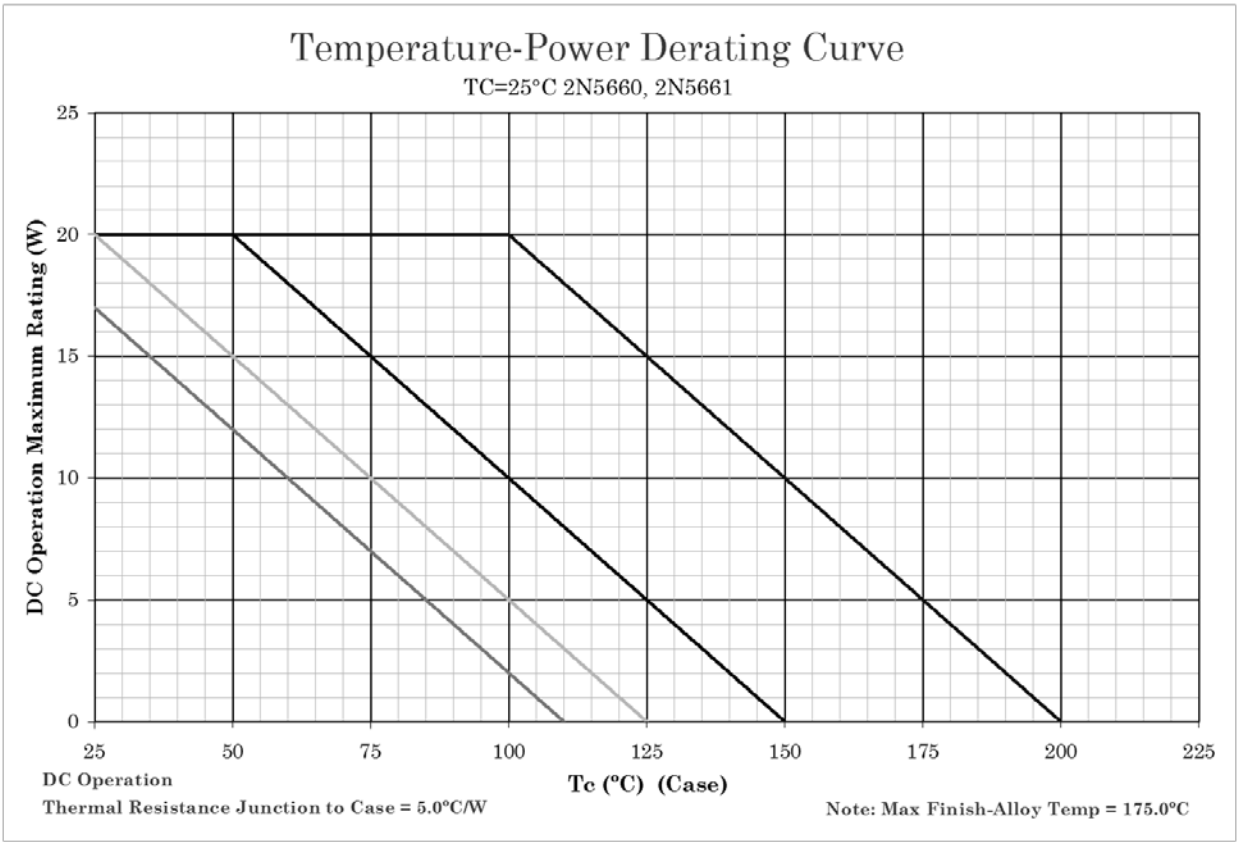
TABLE III. Delta measurements. 1/ 2/ 3/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to emitter cutoff current 2N5660, 2N5662 2N5661, 2N5663	3041	Bias condition C V_{CE} = 200 V dc V_{CE} = 300 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 V dc, I_C = 0.5 A dc, pulsed (see 4.5.1)	Δh_{FE2}	±25 percent change in initial recorded value.		

1/ The delta measurements for 4.4.2 are as follows:
a. Step 1, see table III, steps 1 and 2.
b. Step 2, see table III, steps 1 and 2.
c. Step 3, see table III, steps 1 and 2.

2/ The delta measurements for table E-VII of MIL-PRF-19500 are subgroups 2 and 3, see table III herein, all steps.

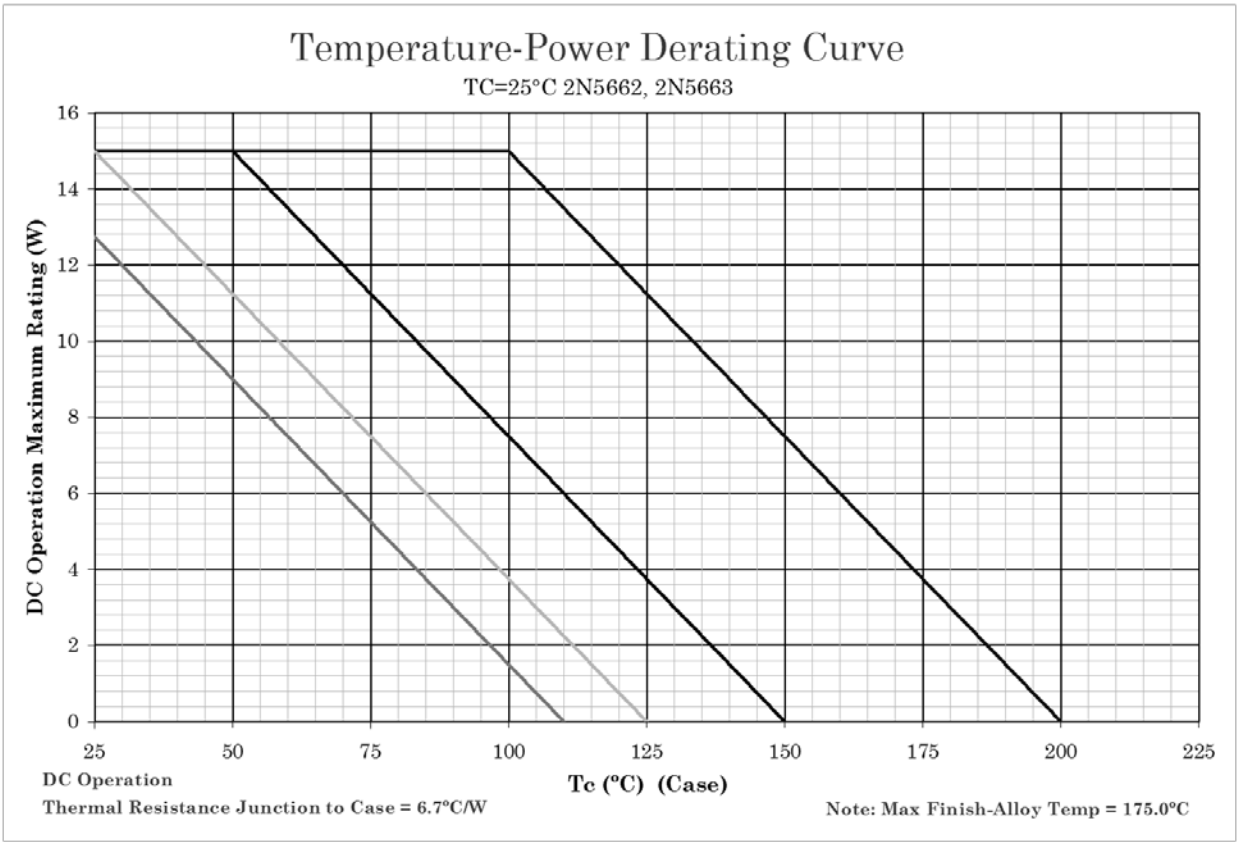
3/ The delta measurements for table E-IX of MIL-PRF-19500 are subgroups 1 and 2, see table III herein, all steps.



NOTES:

1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq +200°C$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq +150°C$ where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq +125°C$ and +110°C to show power rating where most users want to limit T_J in their application.

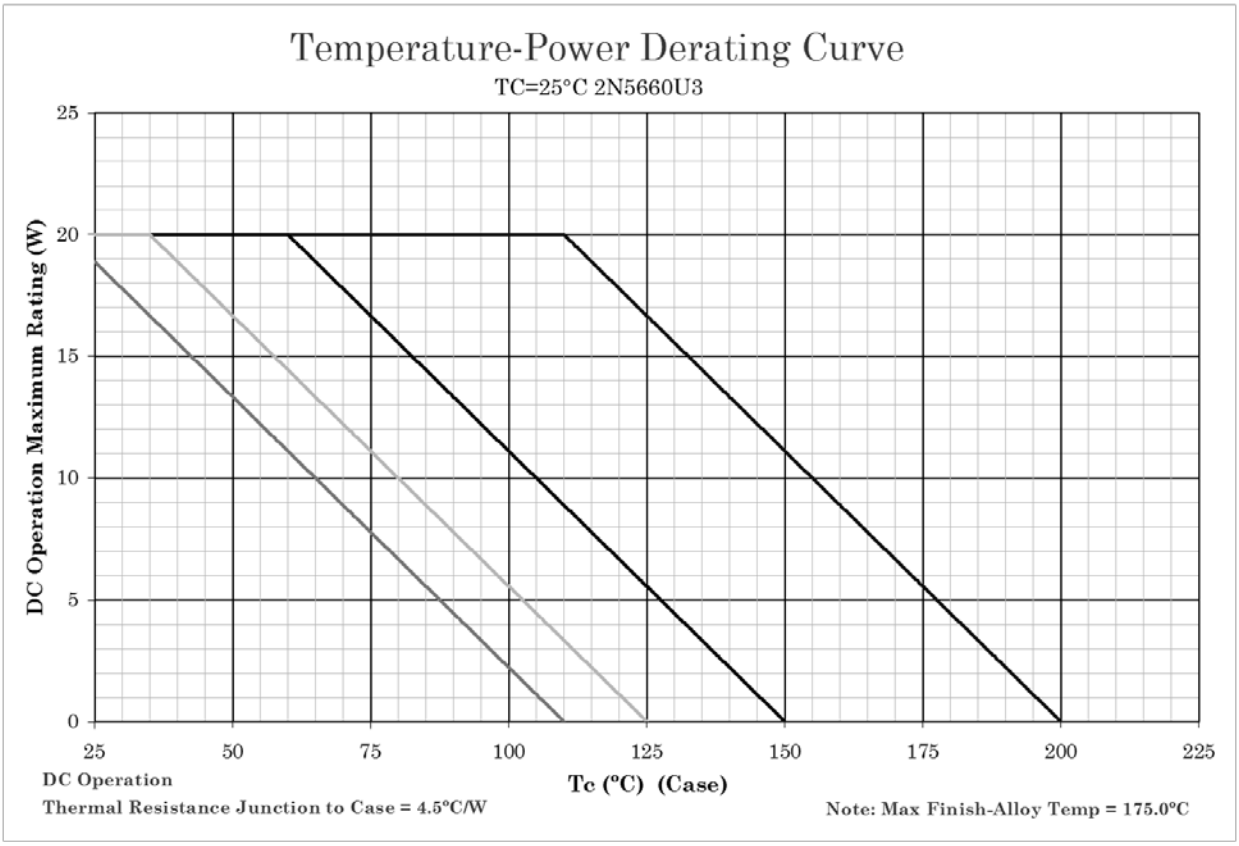
FIGURE 4. Derating for 2N5660 and 2N5661 (similar to TO-66).



NOTES:

1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq +200°C$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq +150°C$ where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq +125°C$ and +110°C to show power rating where most users want to limit T_J in their application.

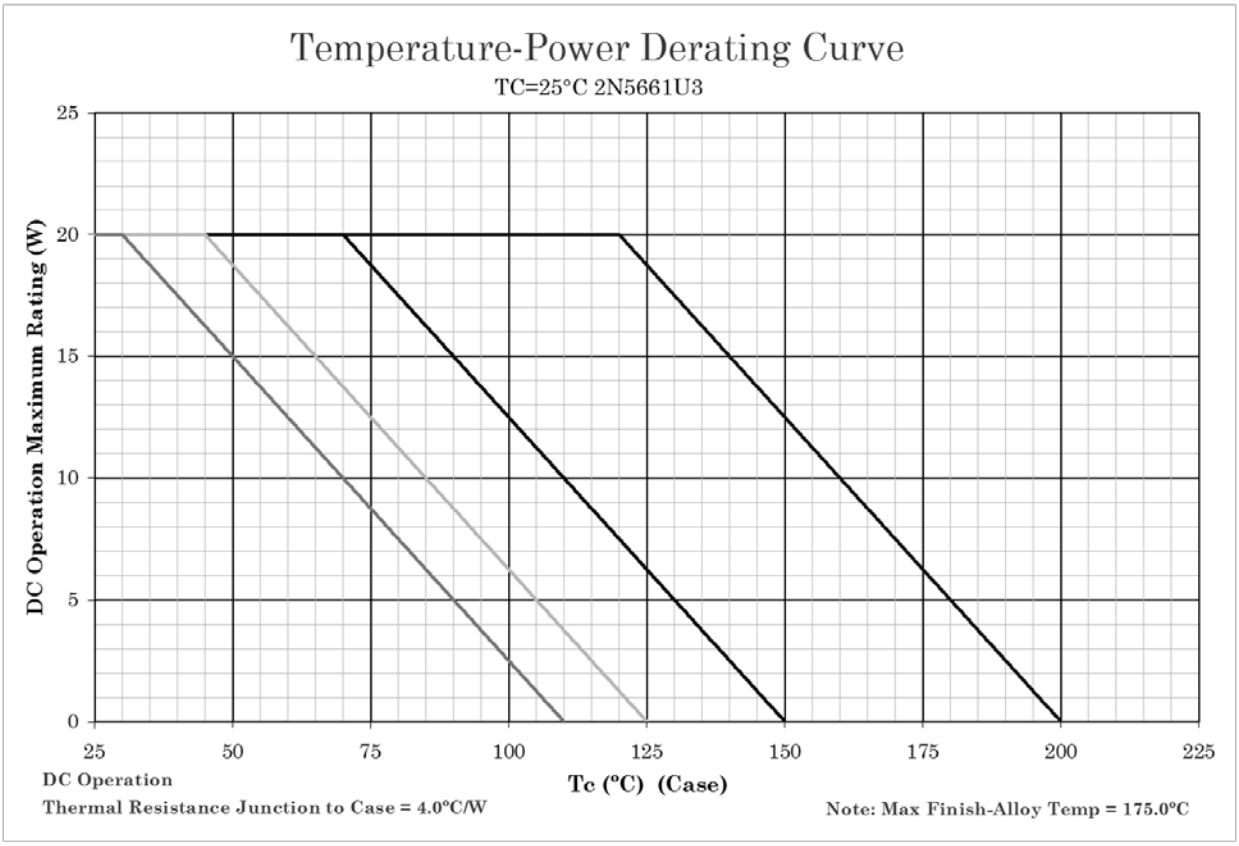
FIGURE 5. Derating for 2N5662 and 2N5663 (similar to TO-5).



NOTES:

1. All devices are capable of operating at ≤ T_J specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature (T_J ≤ +200°C) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at T_J ≤ +150°C where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at T_J ≤ +125°C and +110°C to show power rating where most users want to limit T_J in their application.

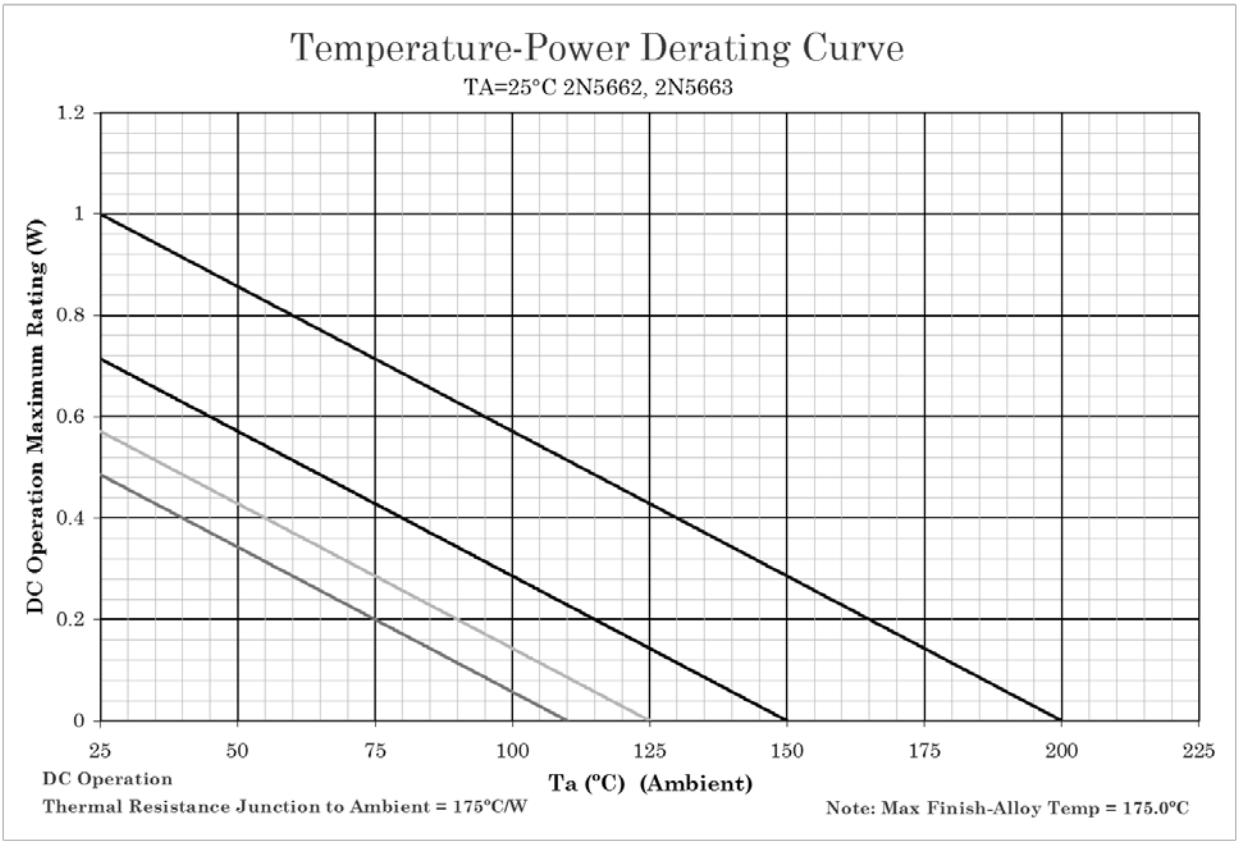
FIGURE 6. Derating for 2N5660U3 (U3).



NOTES:

1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve constrained by the maximum junction temperature ($T_J \leq +200°C$) and power rating specified. (See 1.3 herein.)
3. Derate design curve chosen at $T_J \leq +150°C$ where the maximum temperature of electrical test is performed.
4. Derate design curves chosen at $T_J \leq +125°C$ and +110°C to show power rating where most users want to limit T_J in their application.

FIGURE 7. Derating for 2N5661U3 (U3).



NOTES:

1. All devices are capable of operating at $\leq T_J$ specified on this curve. Any parallel line to this curve will intersect the appropriate power for the desired maximum T_J allowed.
2. Derate design curve chosen at $T_J \leq +150°C$ where the maximum temperature of electrical test is performed.
3. Derate design curves chosen at $T_J \leq +125°C$ and $+110°C$ to show power rating where most users want to limit T_J in their application.

FIGURE 8. Derating for 2N5662, 2N5663 (similar to TO-5).

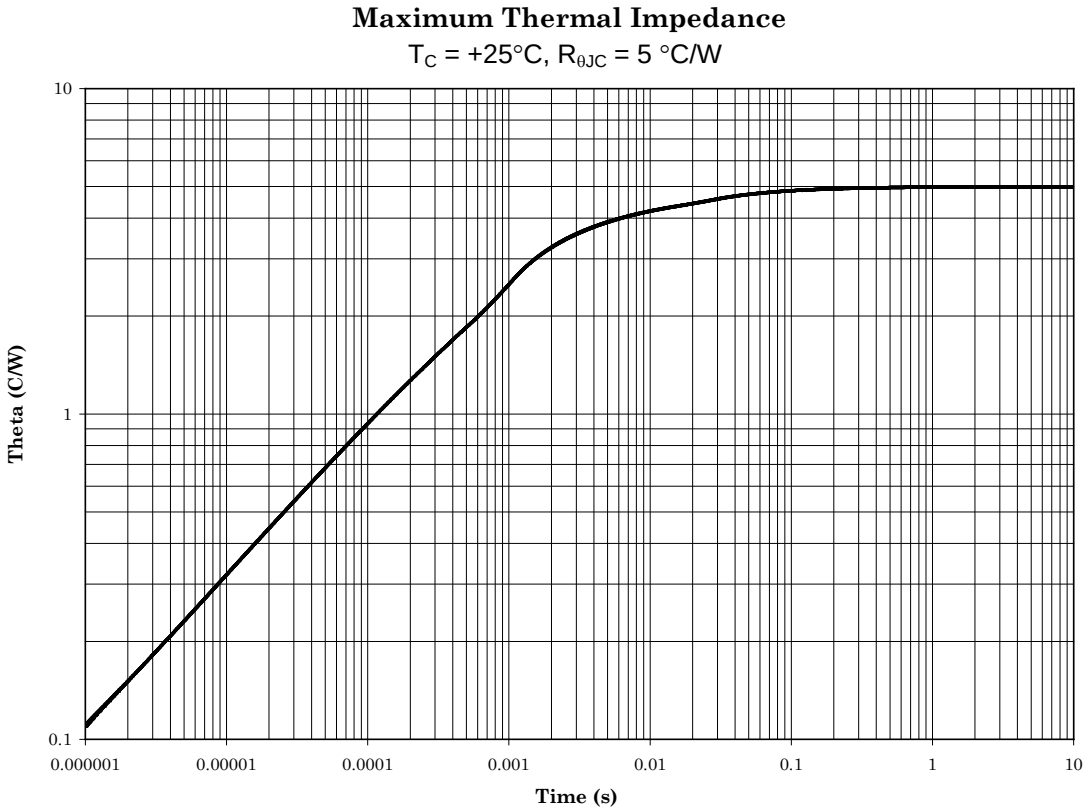


FIGURE 9. Thermal impedance for 2N5660 (similar to TO-66).

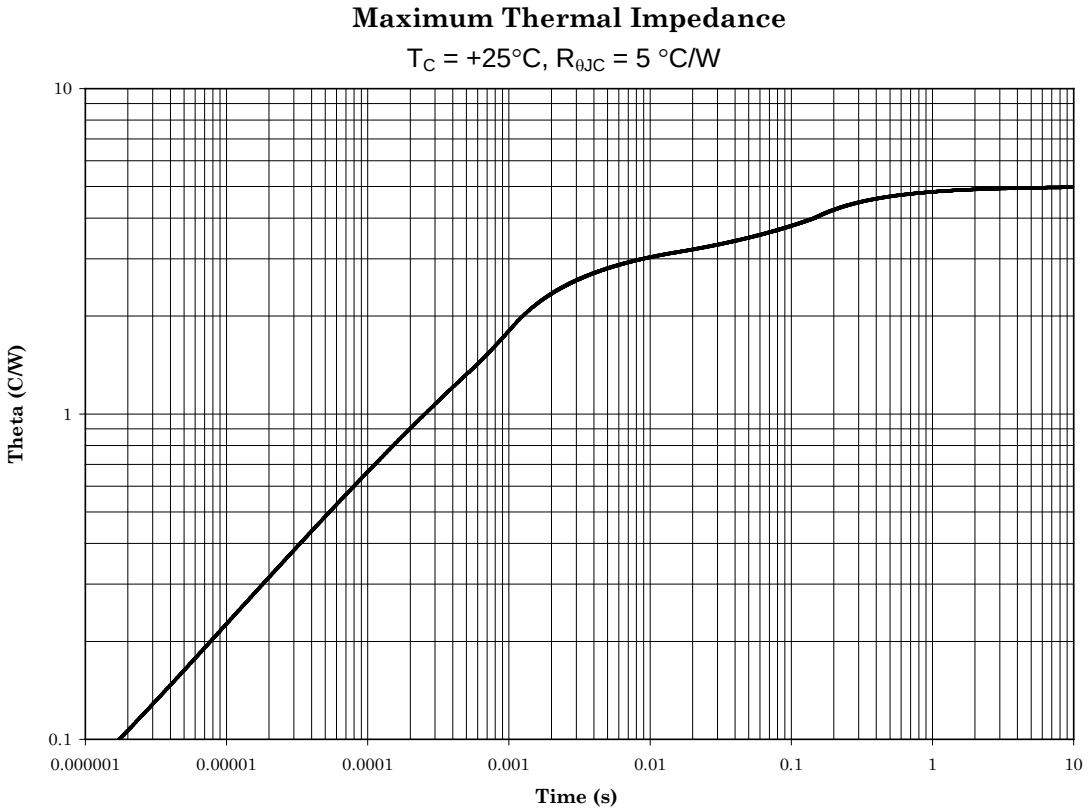


FIGURE 10. Thermal impedance for 2N5661 (similar to TO-66).

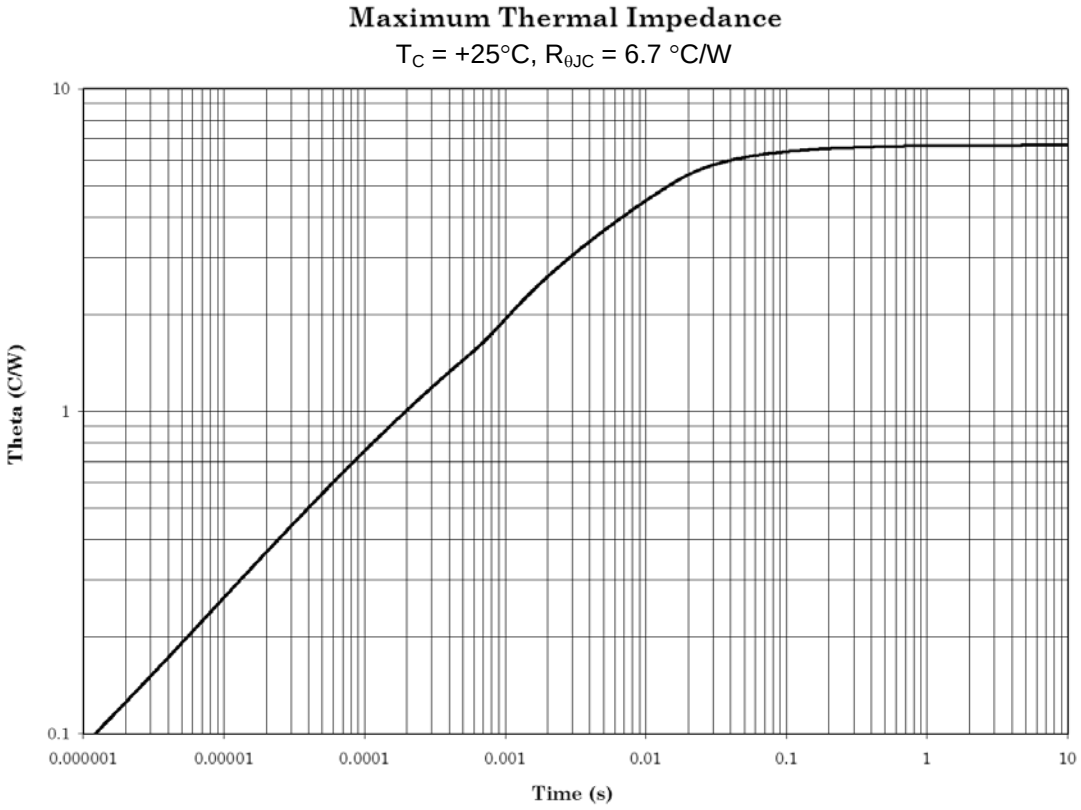


FIGURE 11. Thermal impedance for 2N5662 (similar to TO-5).

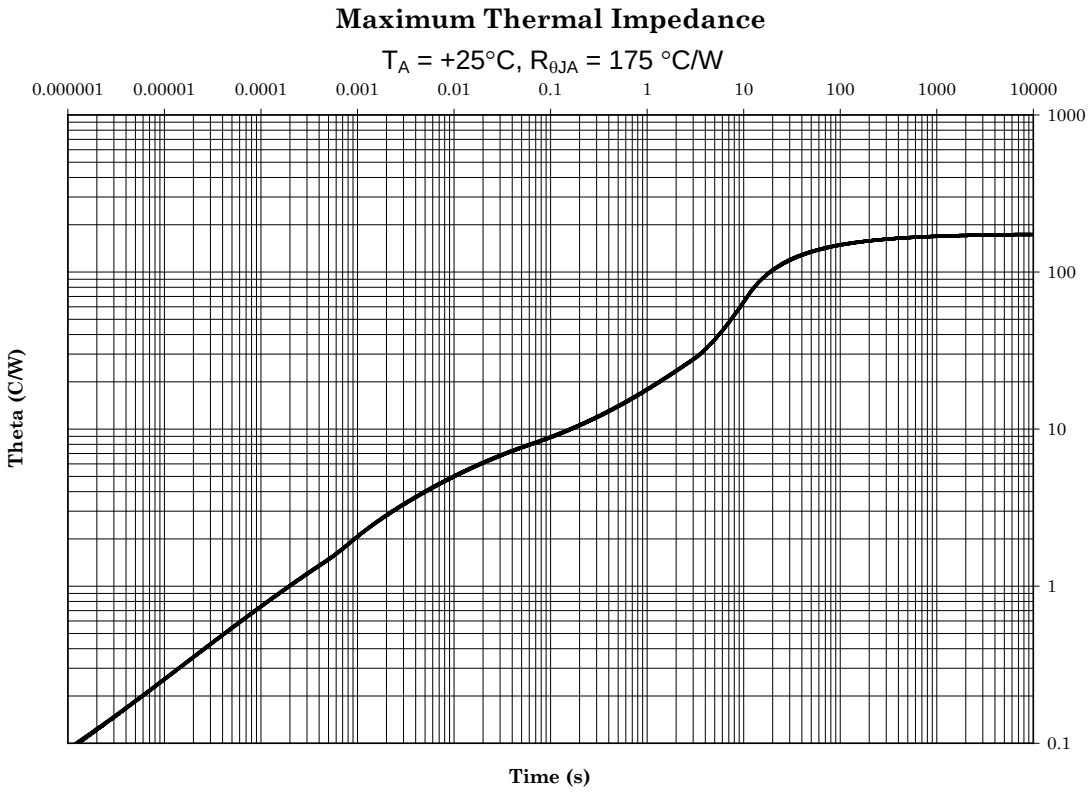


FIGURE 12. Thermal impedance for 2N5662 (similar to TO-5).

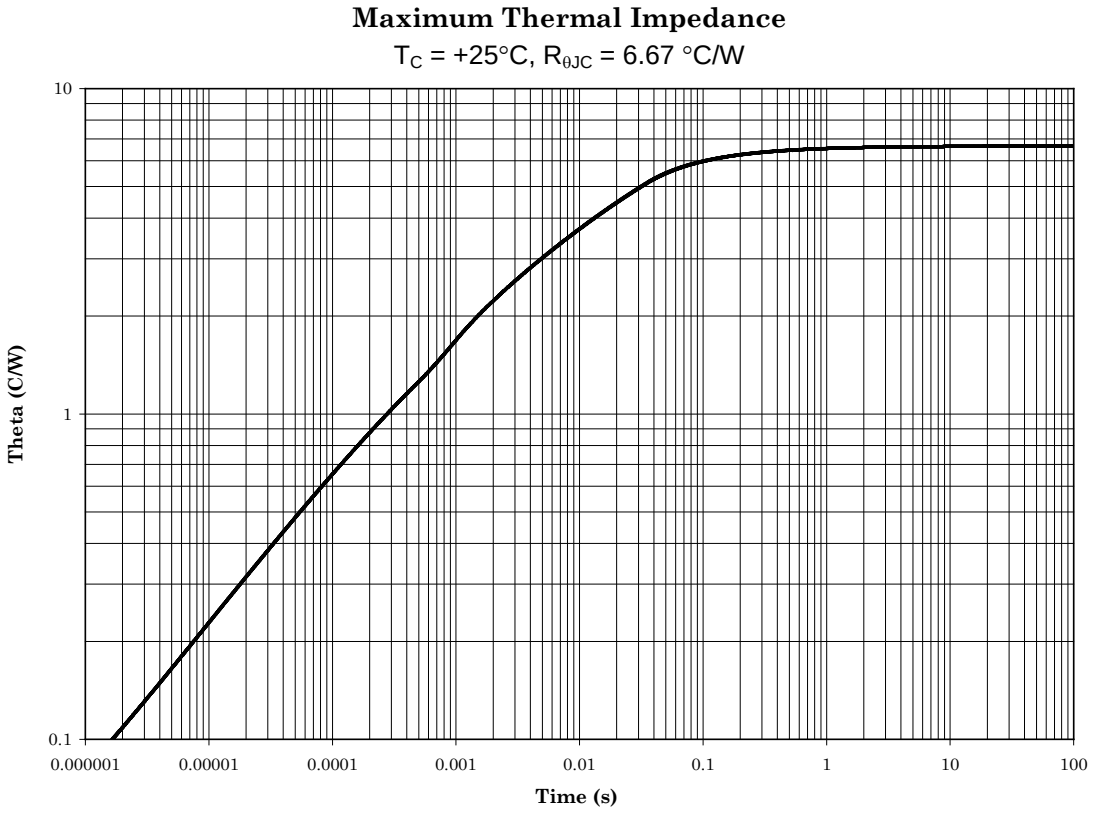


FIGURE 13. Thermal impedance for 2N5663 (similar to TO-5).

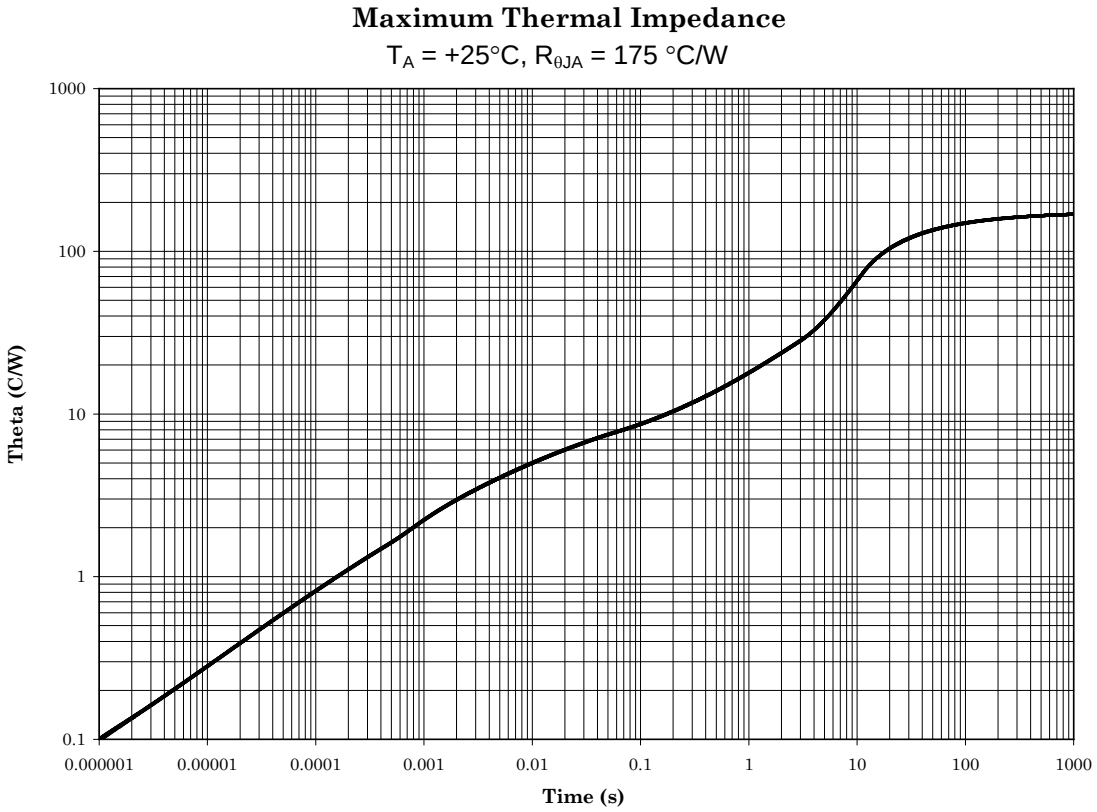


FIGURE 14. Thermal impedance for 2N5663 (similar to TO-5).

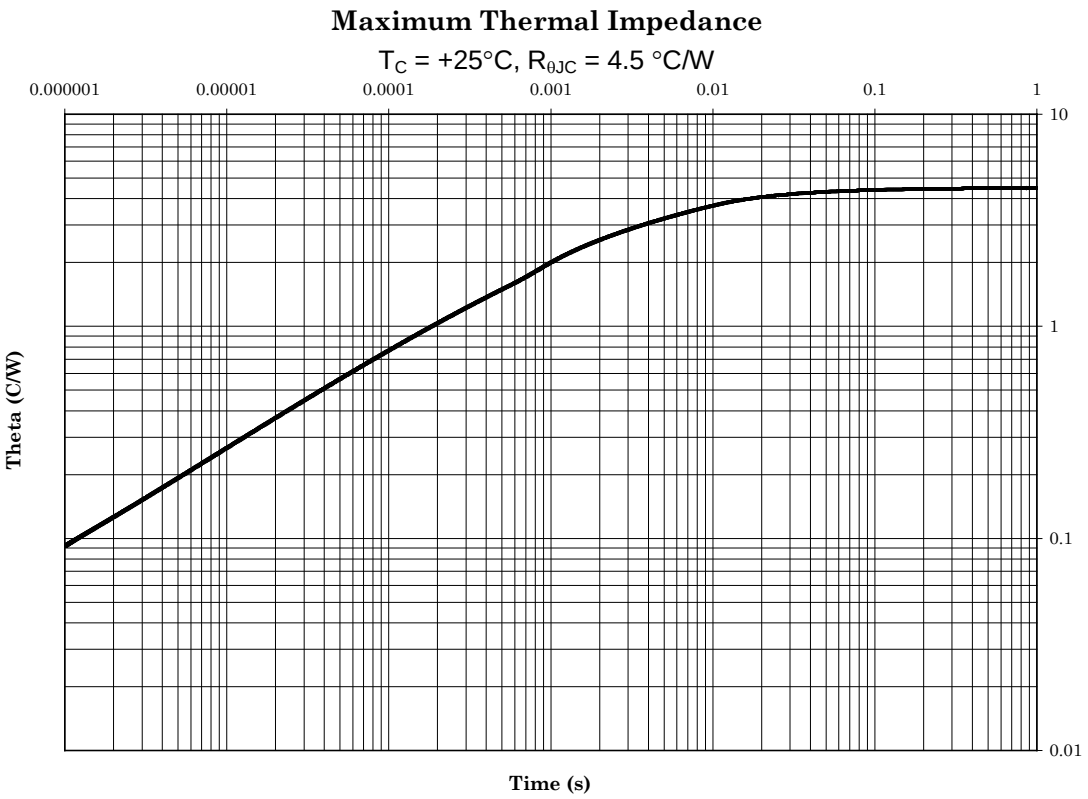


FIGURE 15. Thermal impedance for 2N5660U3 (U3).

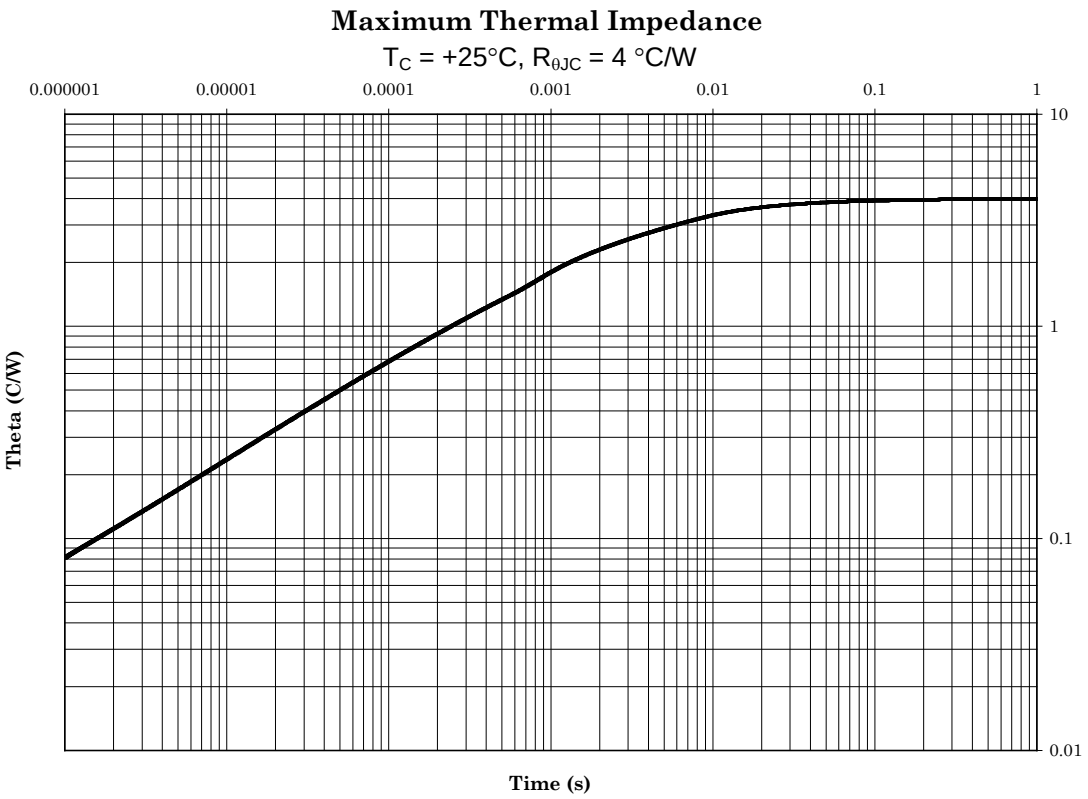
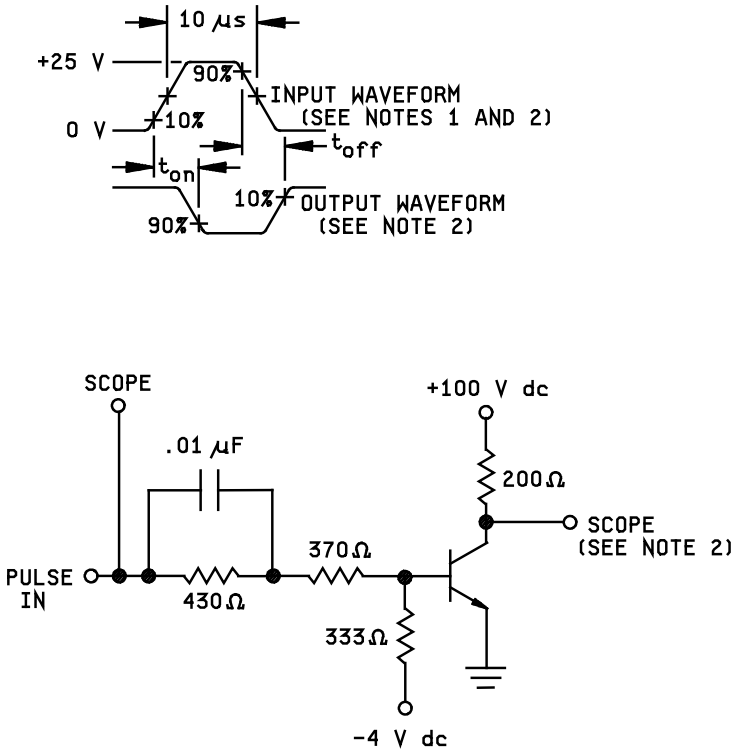


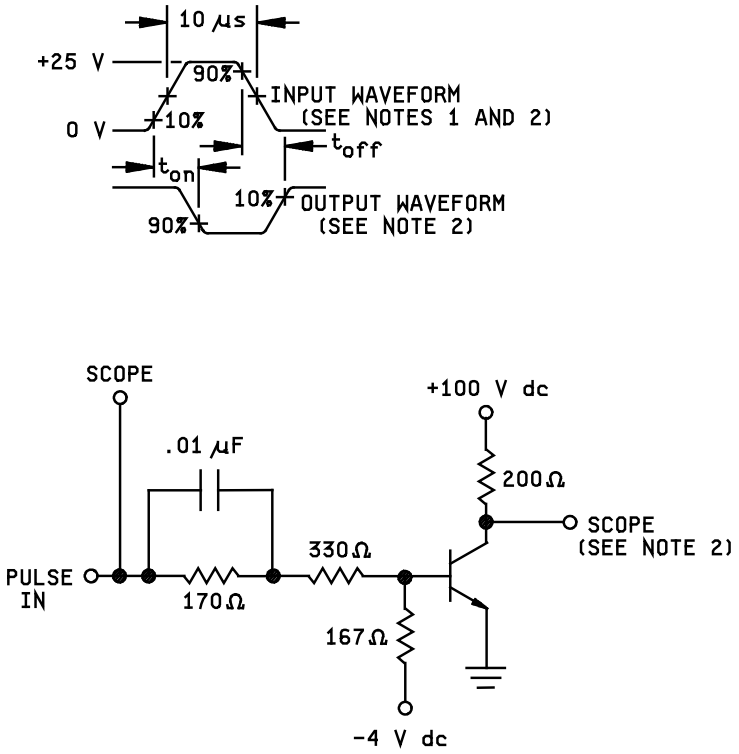
FIGURE 16. Thermal impedance for 2N5661U3 (U3).



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, $Z_{OUT} = 50\ \Omega$, PW = 10 µs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 1$ ns, $Z_{IN} \geq 10\ M\Omega$, $C_{IN} \leq 11.5$ 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, -4 V dc and +100 V dc, are nominal and shall be adjusted to obtain $I_{B1} = -I_{B2} = 15$ mA dc.
6. The 0.01 µF capacitor may be removed for current adjustment only.

FIGURE 17. Pulse response test circuit for types 2N5660 and 2N5662.



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, $Z_{OUT} = 50\ \Omega$, PW = 10 µs, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 1$ ns, $Z_{IN} \geq 10\ M\Omega$, $C_{IN} \leq 11.5$ pF.
3. Resistors shall be noninductive types.
4. The dc power supplies may require additional by = passing in order to minimize ringing.
5. The input pulse voltages, -4 V dc and +100 V dc, are nominal and shall be adjusted to obtain I $I_{B1} = -I_{B2} = 25$ mA dc.
6. The 0.01 µF capacitor may be removed for current adjustment only.

FIGURE 18. Pulse response test circuit for types 2N5661 and 2N5663.

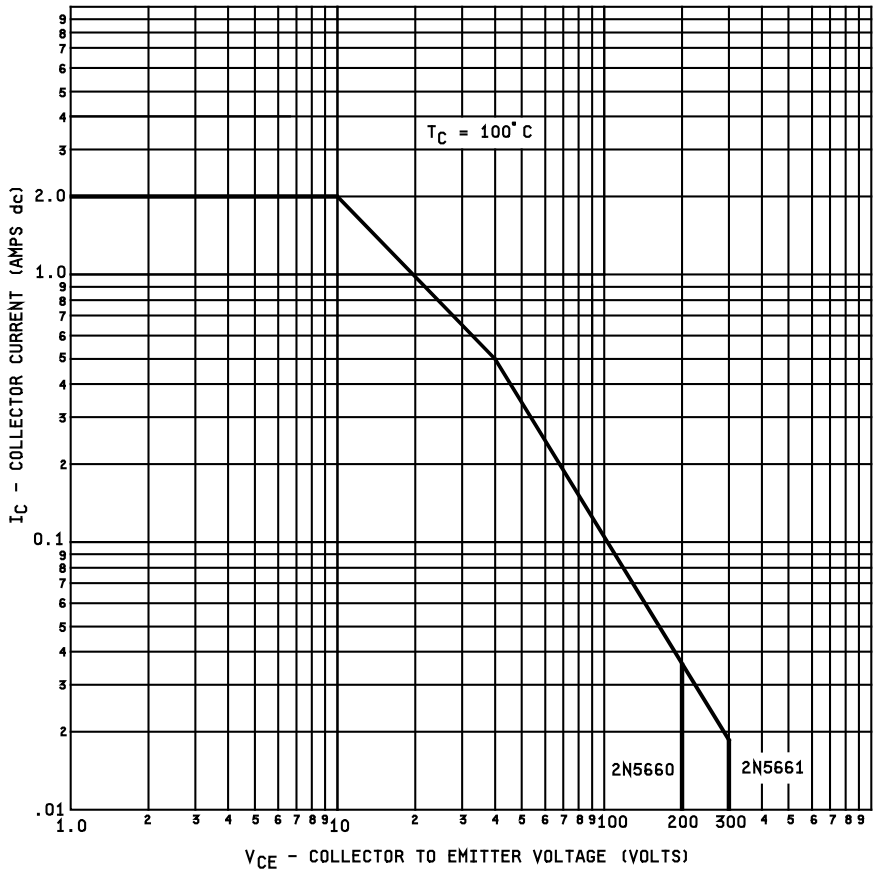


FIGURE 19. Maximum operating area graph (continuous dc) for types 2N5660 and 2N5661.

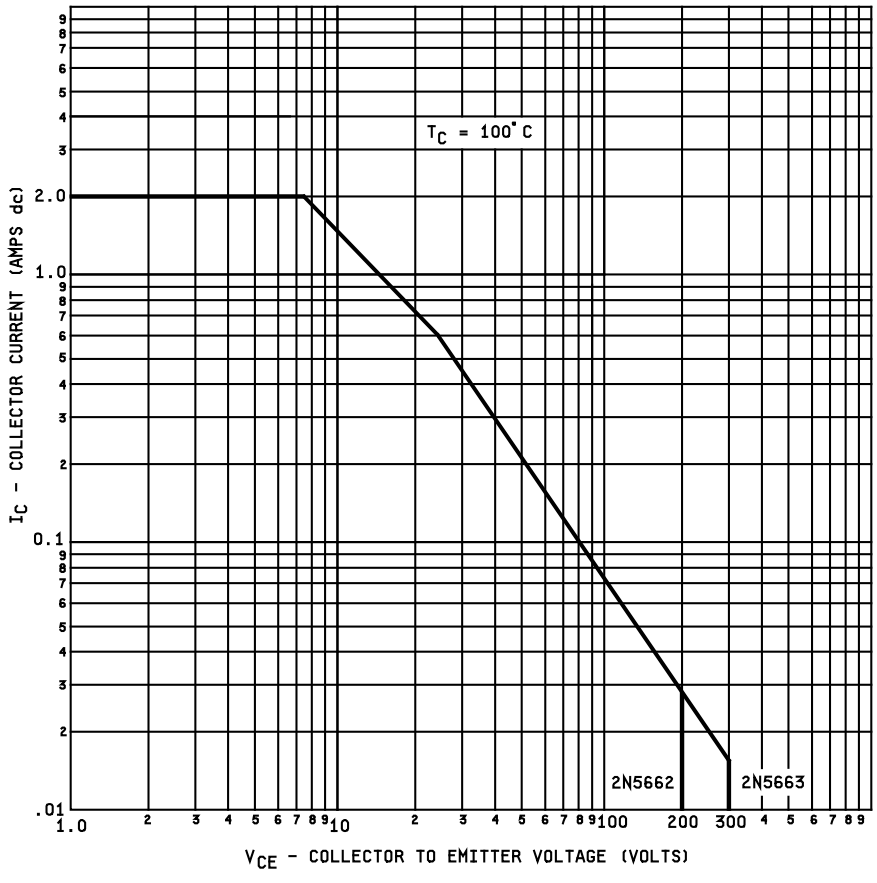


FIGURE 20. Maximum operating area graph (continuous dc) for types 2N5662 and 2N5663.

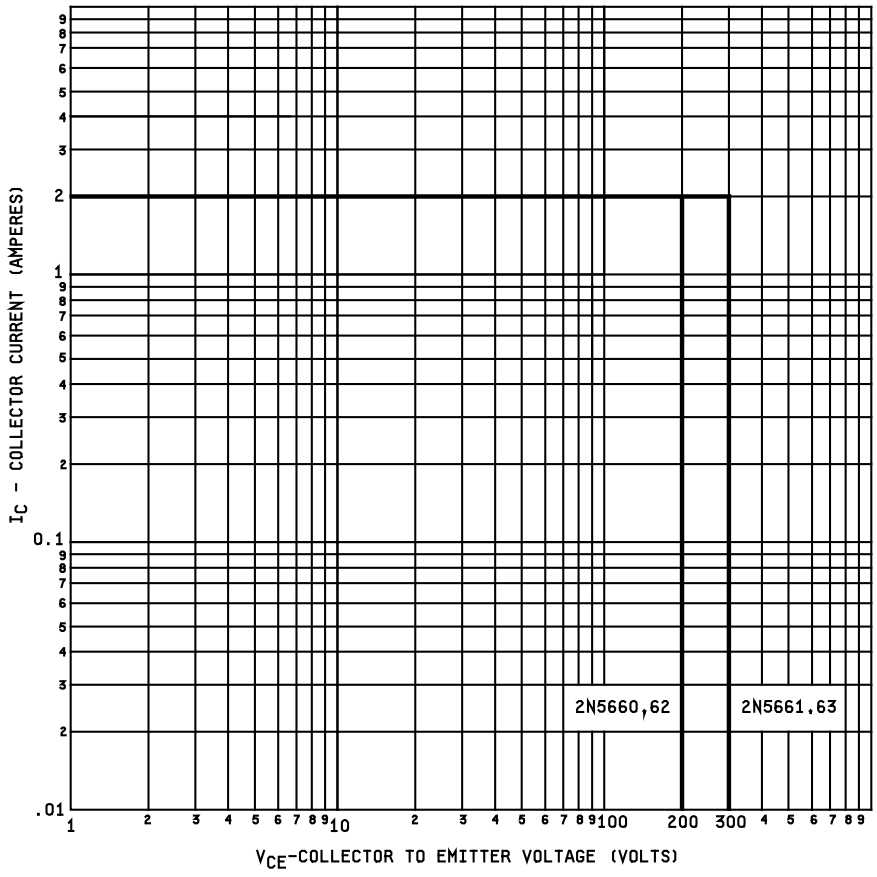
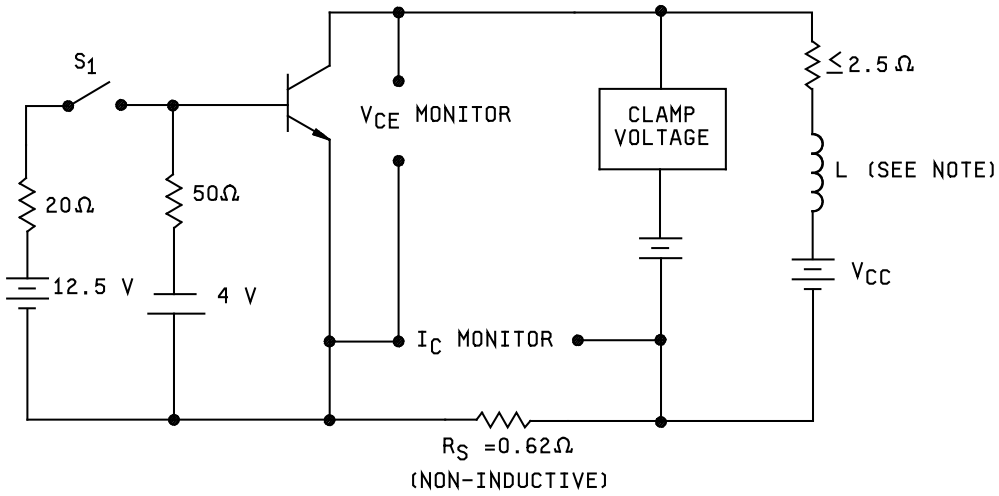


FIGURE 21. Safe operating area for switching between saturation and cutoff - (clamped inductive load).



NOTE: 40 mH (triad C-48U, or equivalent)

Procedure:

1. With switch S_1 closed, set the specified test conditions.
2. Open S_1. Device fails if clamp voltage is not reached.
3. Perform specified end-point tests.

FIGURE 22. Clamped inductive sweep test circuit.

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. 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 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 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.

Custodians:
Army - CR
Navy - EC
Air Force - 85
NASA - NA
DLA - CC

Review activities:
Army - AR, MI, SM
Navy - AS, MC, OS
Air Force - 19

Preparing activity:
DLA - CC

(Project 5961-2012-100)

* 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/ .