The documentation process conversion measures necessary to comply with this revision shall be completed by 10 December 1999

INCH-POUND

MIL-PRF-19500/527B
10 September 1999
SUPERSEDING
MIL-S-19500/527A
1 July 1993

PERFORMANCE SPECIFICATION SHEET
SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER
TYPES 2N6648, 2N6649 and 2N6650 JAN, JANTX AND JANTXV

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 PNP silicon, darlington power transistor. Three levels of product assurance are provided as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO - 3).

1.3 Maximum ratings.

	P_T 1/ T_A = +25°C	P_T 2/ T_C = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_J and T_{STG}	$R_{\theta JC}$
	W	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W
2N6648	5.0	85	-40	-40	-5.0	-0.25	-10	-65 to +175	1.76
2N6649	5.0	85	-60	-60	-5.0	-0.25	-10	-65 to +175	1.76
2N6650	5.0	85	-80	-80	-5.0	-0.25	-10	-65 to +175	1.76

1/ Derate linearly 33.3 mW/°C above T_A > +25°C.

2/ Derate linearly 567 mW/°C above T_C > +25°C.

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

AMSC N/A FSC 5961
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.4 Primary electrical characteristics.

	h_{FE1} 1/	h_{FE2} 1/	$V_{CE(SAT)1}$ 1/	$V_{CE(SAT)2}$ 1/	$V_{BE(ON)1}$ 1/
	V_{CE} = -3 V dc I_C = -1 A dc	V_{CE} = -3 V dc I_C = -5 A dc	I_C = -5.0 A dc I_B = -10 mA dc	I_C = 10 A dc I_B = 0.1 A dc	V_{CE} = -3.0 V dc I_C = -5.0 A dc
			V dc	V dc	V dc
Min	300	1,000			
Max		20,000	-2.0	-3.0	-2.8

C_{obo}	$\|h_{fe}\|$	Pulse response	
V_{CB} = 10 V dc I_E = 0 100 kHz ≤ f ≤1 MHz	V_{CE} = -5.0 V dc I_C = -1.0 A dc f = 1 MHz	t_{on}	t_{off}
pF		µs	µs
300	50 400	2.5	10.0

1/ Pulsed (see 4.5.1).

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

MILITARY

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service, Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

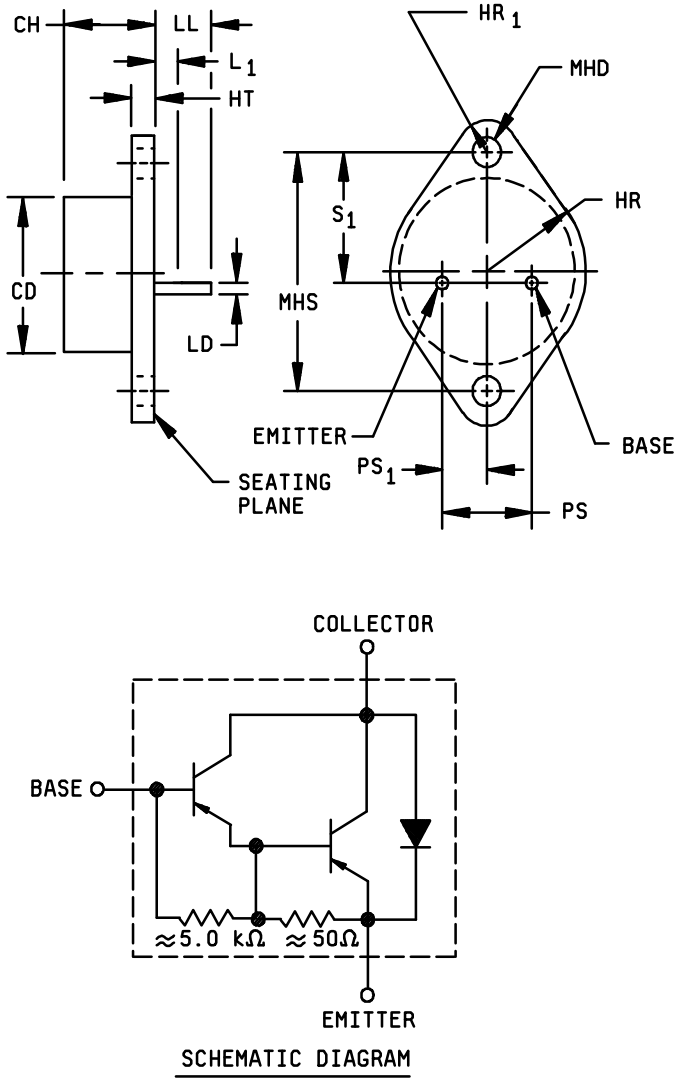


FIGURE 1. Dimensions and configuration (T0-3).

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD		0.875		22.23	
CH	0.250	0.450	6.35	11.43	
HR	0.495	0.525	12.57	13.34	
HR_1	0.131	0.188	3.33	4.78	
HT	0.050	0.135	1.27	3.43	
LD	0.038	0.043	0.97	1.09	
LL	0.312		7.92		
LL_1		0.050		1.27	
MHD	0.151	0.161	3.84	4.09	
MHS	1.177	1.197	29.90	30.40	
PS	0.420	0.440	10.67	11.18	3
PS_1	0.205	0.225	5.21	5.72	3
s_1	0.655	0.675	16.64	17.15	

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. These dimensions should be measured at points 0.050 inch (1.27 mm) and 0.055 inch (1.40 mm) below seating plane. When gauge is not used measurement will be made at the seating plane.
4. The seating plane of the header shall be flat within 0.001 inch (0.03 mm) concave to 0.004 inch (0.10 mm) convex inside a 0.930 inch (23.62 mm) diameter circle on the center of the header and flat within 0.001 inch (0.03 mm) concave to 0.006 inch (0.15 mm) convex overall.
5. Mounting holes shall be deburred on the seating plane side.
6. Collector is electrically connected to the case.

FIGURE 1. Dimensions and configuration (T0-3) - Continued.

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), 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 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturer's list before contract award (see 4.2 and 6.3).

3.2 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500 and as specified herein.

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

3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 herein. The preferred measurements used herein are the metric units. However, this transistor was designed using inch-pound units of measurement. In case of conflicts between the metric and inch-pound units, the inch-pound units shall rule.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-STD-750, MIL-PRF-19500, and herein. Where a choice of lead finish or formation is desired, it shall be specified in the acquisition requirements (see 6.2).

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

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

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

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.

4.3 Screening (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 (table IV) of MIL-PRF-19500)	Measurement JANTX and JANTXV levels
3c 1/	Thermal impedance (see 4.3.2)
11	I_{CEX1} and h_{FE1}
12	See 4.3.1
13	Subgroup 2 of table I herein; ΔI_{CEX1} = 100 percent of initial value or 100 μA dc, whichever is greater. Δh_{FE1} = ± 25 percent of initial value.

1/ May be performed anytime before screen 9.

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

T_J = 162.5 ± 12.5°C, 2N6648 = V_{CB} = -30 V dc, 2N6649 = V_{CB} = -40 V dc,. 2N6650 = V_{CB} = -60 V dc,

4.3.2 Thermal impedance $Z_{\theta JX}$ measurements for screening. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3131. The maximum limit and conditions for $Z_{\theta JX}$ in screening (table IV of MIL-PRF-19500) shall be derived by each vendor by means of process control of actual measurements which characterizes the die attach process. When three lot date codes have exhibited control, the data from these three lots will be used to establish a fixed screening limit (not to exceed the end point limit). Once a fixed limit has been established, monitor all future sealing lots using a sample from each lot to be plotted on the applicable X and R chart.

4.3.2.1 Thermal impedance $Z_{\theta JX}$ measurements for initial qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3131, (read and record data $Z_{\theta JX}$) derived conditions, limits, and thermal response curve shall be supplied to the qualifying activity on the qualification lot prior to qualification approval.

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 table V of MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIb of MIL-PRF-19500 and herein Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

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

Subgroup	Method	Conditions
B3	1027	For solder die attach: V_{CB} ≥ 10 V dc, 2,000 cycles, T_A ≤ 35°C.
B3	1026	For eutectic die attach: V_{CB} ≥ 10 V dc, T_A ≤ 35°C adjust P_T to achieve T_J = 150°C minimum.
B5	3131	See 4.5.2 herein.
B6	1032	T_{STG} = + 175°C

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500 Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.3.1 Group C inspection, appendix E, table VII of MIL-PRF-19500.

Subgroup	Method	Conditions
C2	2036	Test condition A, weight = 10 pounds, t = 15 s.
C6	1027	For solder die attach: V_{CB} ≥ 10 V dc, 6,000 cycles, T_A ≤ 35°C.
C6	1026	For eutectic die attach: V_{CB} ≥ 10 V dc, T_A ≤ 35°C adjust P_T to achieve T_J = 150°C minimum.

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

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

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

a. Collector current magnitude during power application shall be 1.0 A dc.

b. Collector to emitter voltage magnitude shall be ≥ 5 V dc.

c. Reference temperature measuring point shall be the case.

d. Reference point temperature shall be +25°C ≤ T_R ≤ +75°C and recorded before the test is started.

e. Mounting arrangement shall be with heat sink to header.

f. Maximum limit of $R_{\theta JC}$ shall be 1.76°C/W.

4.5.3 Thermal impedance $Z_{\theta JX}$ limit for end point measurements. The following test conditions shall be used for $Z_{\theta JX}$ end point measurements: $Z_{\theta JX}$ = 1.4°C/W.

a. I_M	10 mA.
b. V_{CE} measurement voltage	10 V (same as V_H).
c. I_H collector heating current	4 A (minimum).
d. V_H collector-emitter heating voltage	10 V (minimum).
e. t_H heating time	100 ms.
f. t_{MD} measurement delay time	50 µs to 80 µs.
g. t_{sw} sample window time	10 µs (maximum).

.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical Examination	2071					
Subgroup 2						
Collector – emitter breakdown voltage	3011	Bias condition D; I_C = 200 mA dc pulsed (see 4.5.1)	$V_{(BR)CEO}$			V dc
2N6648				-40		
2N6649				-60		
2N6650				-80		
Collector – emitter breakdown voltage	3011	Bias condition B; I_C = 200 mA dc R_{BB} = 100 ohms, pulsed (see 4.5.1)	$V_{(BR)CER}$			V dc
2N6648				-40		
2N6649				-60		
2N6650				-80		
Collector – emitter cutoff current	3041	Bias condition D;	I_{CEO}		-1	mA dc
2N6648		V_{CE} = -40 V dc				
2N6649		V_{CE} = -60 V dc				
2N6650		V_{CE} = -80 V dc				
Emitter – base cutoff current	3061	Bias condition D; V_{EB} = 5 V dc	I_{EBO}		-10	mA dc
Collector – emitter cutoff current	3041	Bias condition D; V_{BE} =1.5 V dc	I_{CEX1}		-0.3	mA dc
2N6648		V_{CE} = -40 V dc				
2N6649		V_{CE} = -60 V dc				
2N6650		V_{CE} = -80 V dc				
Collector – base cutoff current	3036	Bias condition D;	I_{CBO}		-1	mA dc
2N6648		V_{CE} = -40 V dc				
2N6649		V_{CE} = -60 V dc				
2N6650		V_{CE} = -80 V dc				

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Base - emitter voltage (non saturated)	3066	Test condition B; V_{CE} = -3.0 V dc, I_C = -5.0 A dc; pulsed (see 4.5.1)	$V_{BE(on)1}$		-2.8	V dc
Base - emitter voltage (non saturated)	3066	Test condition B; V_{CE} = -3.0 V dc, I_C = -10 A dc; pulsed (see 4.5.1)	$V_{BE(on)2}$		-4.5	V dc
Collector - emitter saturated voltage	3071	I_C = -5.0 A dc; I_B = -10 mA dc	$V_{CE(sat)1}$		-2.0	V dc
Collector - emitter saturated voltage	3071	I_C = -10 A dc; I_B = -0.1 mA dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		-3.0	V dc
Forward - current transfer ratio	3076	V_{CE} = -3.0 V dc; I_C = -1.0 A dc pulsed (see 4.5.1)	h_{FE1}	300		
Forward - current transfer ratio	3076	V_{CE} = -3.0 V dc; I_C = -5 A dc pulsed (see 4.5.1)	h_{FE2}	1,000	20,000	
Forward - current transfer ratio	3076	V_{CE} = -3.0 V dc; I_C = -10 A dc pulsed (see 4.5.1)	h_{FE3}	100		
Subgroup 3						
High - temperature operation:		T_A = +150°C				
Collector to emitter cutoff current		Bias condition A; V_{BE} = 1.5 V dc	I_{CEX2}		-3.0	MA dc
2N6648		V_{CE} = -40 V dc				
2N6649		V_{CE} = -60 V dc				
2N6650		V_{CE} = -80 V dc				
Low - temperature operation:		T_A = -65°C				
Forward - current transfer ratio	3076	V_{CE} = -3.0 V dc I_C = -5.0 A dc pulsed (see 4.5.1)	h_{FE4}	200		

See footnote at end of table.

TABLE I. Group A inspection - Continued.

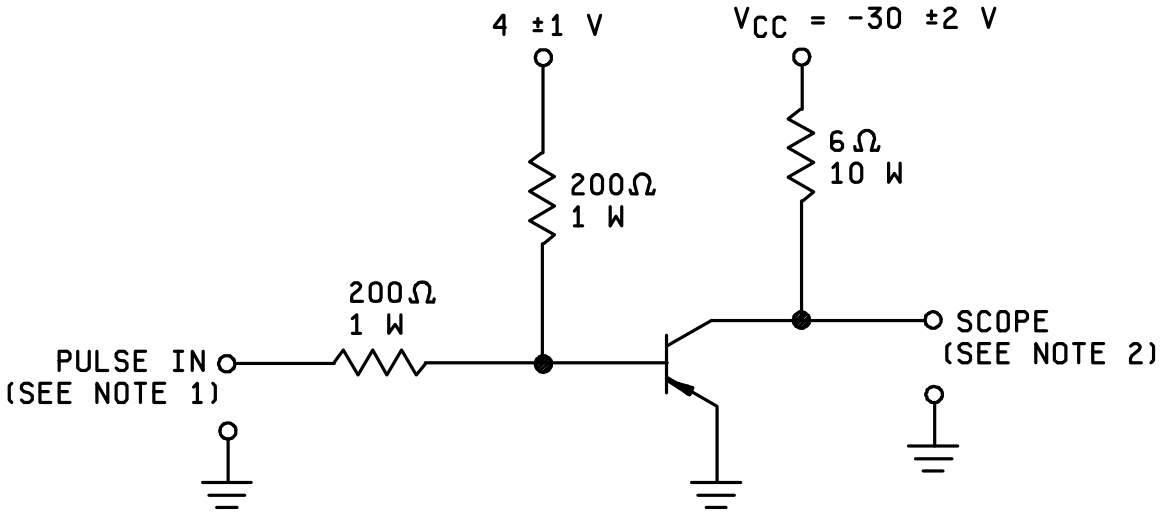
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4						
Pulse response:	3251	Test condition A, except test circuit and pulse requirements in accordance with figure 2.				
Turn-on time		V_{CE} = -30 V dc; I_C = -5.0 A dc; I_{B1} = -20 mA dc	t_{on}		2.5	µs
Turn-off time		V_{CE} = -30 V dc; I_C = -5.0 A dc; I_{B1} = - I_{B2} = 20 mA dc	t_{off}		10.0	µs
Magnitude of small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = -5.0 V dc I_C = -1.0 A dc, f = 1.0 MHz	$\|h_{fe}\|$	50	400	
Open circuit output capacitance	3236	V_{CB} = 10 V dc, I_E = 0, 100 kHZ ≤ f ≤ 1 MHz	C_{obo}		300	pF
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = 25°C; t = 1 s; 1 cycle; (see figure 3)				
Test 1		V_{CE} = 8.5 V dc; I_C = -10 A dc				
Test 2		V_{CE} = 25 V dc; I_C = -3.4 A dc				
Test 3						
2N6648		V_{CE} = -40 V dc; I_C = -0.9 A dc				
2N6649		V_{CE} = -60 V dc; I_C = -0.3 A dc				
2N6650		V_{CE} = -80 V dc; I_C = -0.14 A dc				
Electrical measurements		See table I, subgroup 2				

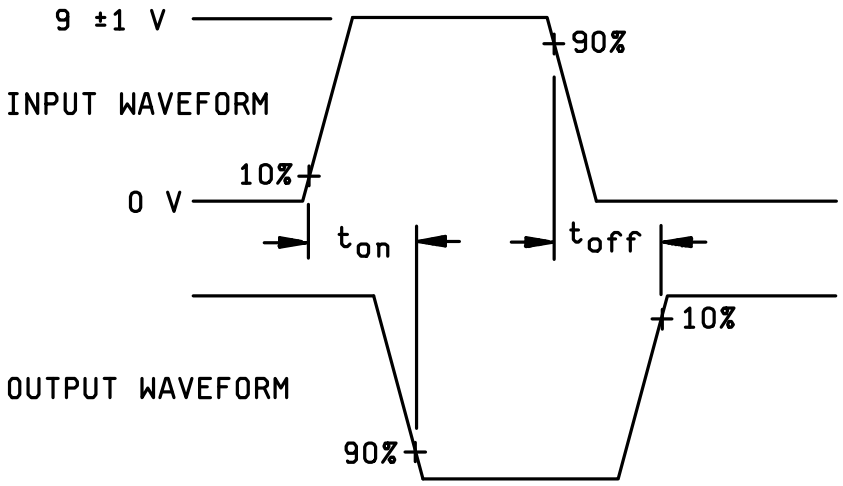
See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued						
Safe operating area (switching)	3053	Load condition C (unclamped inductive load) (see figure 4); T_C = +25°C; duty cycle ≤ 10 percent; R_S ≤ 0.1 ohms.				
Test 1		t_p = 1 ms; (vary to obtain I_C); R_{BB1} = 1 k ohms; V_{BB1} = -10 V dc; R_{BB2} = ∞; V_{BB2} = 0; I_C = -10 A dc; V_{CC} = -30 V dc; R_L = 0.5 ohms; L = 0.25 mH at 10 A dc				
Test 2		t_p = 1 ms; (vary to obtain I_C); R_{BB1} = 10 k ohms; V_{BB1} = -10 V dc; R_{BB2} = ∞; V_{BB2} = 0; I_C = -0.2 A dc; V_{CC} = -30 V dc; R_L = 0.5 ohms; L = 20 mH at 0.2 A dc				
Safe operating area (switching)		Load condition B (clamped inductive load) (see figure 5); T_A = +25°C; $t_r + t_f$ ≤ 1.0 µs; duty cycle ≤ 10 percent; t_p = 5 ms; (vary to obtain I_C); R_S = 0.1 ohms; V_{CC} = -10 V dc; I_C = -10 A dc				
2N6648 2N6649 2N6650		Clamp voltage = -40 V dc Clamp voltage = -60 V dc Clamp voltage = -80 V dc Device fails if clamp voltage not reached.				
Electrical measurements		See table I, subgroup 2				
Subgroups 6 and 7						
Not applicable						

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





NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be each < 20 ns; duty cycle < 2 percent; generator source impedance shall be 50Ω; pulse width = 20 ns.
2. Output sampling oscilloscope: Z_{IN} > 100 kΩ; C_{IN} < 50 pF; rise time < 20 ns.

FIGURE 2. Pulse response test circuit.

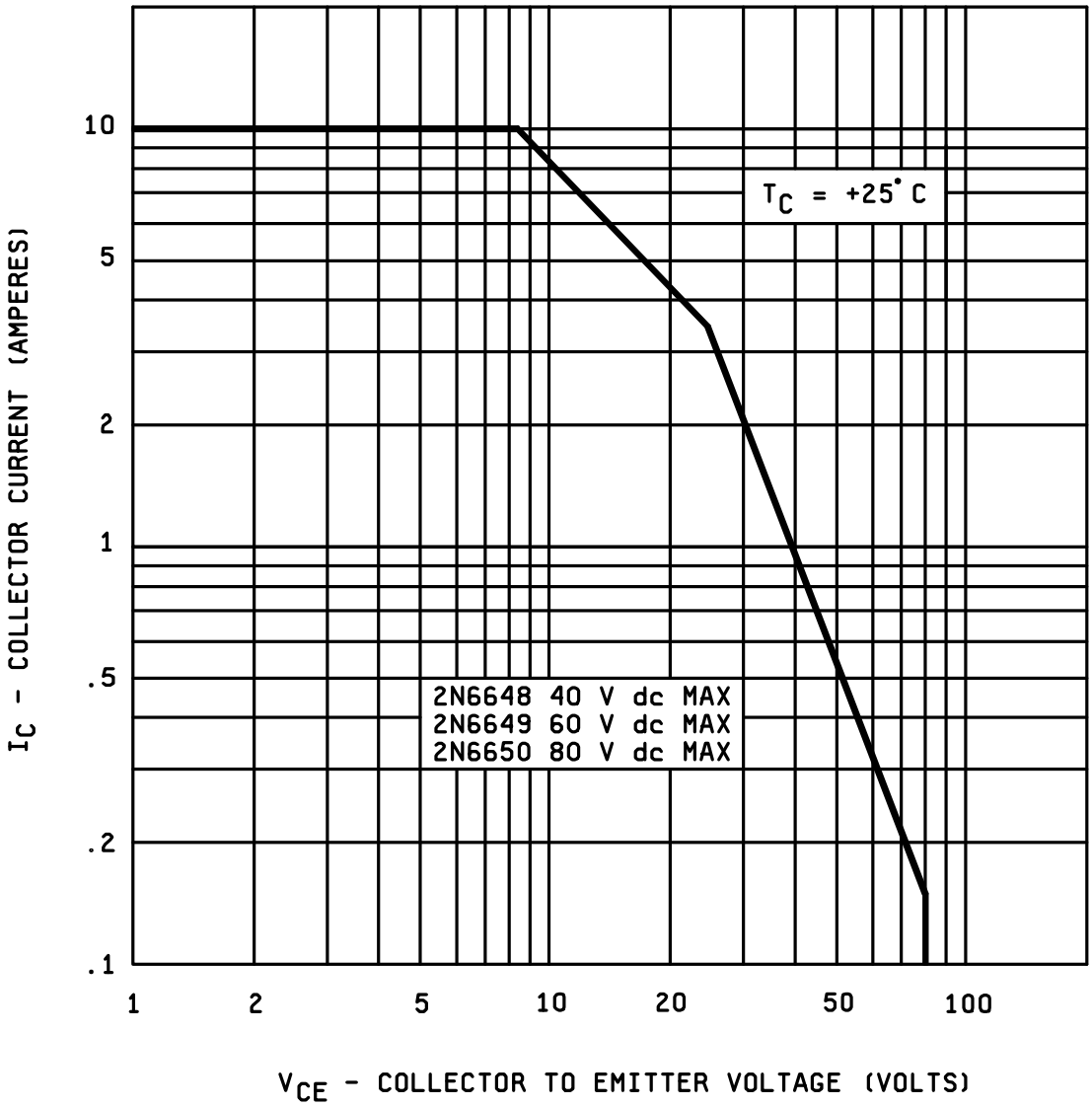


FIGURE 3. Maximum safe operating area graph (continuous dc).

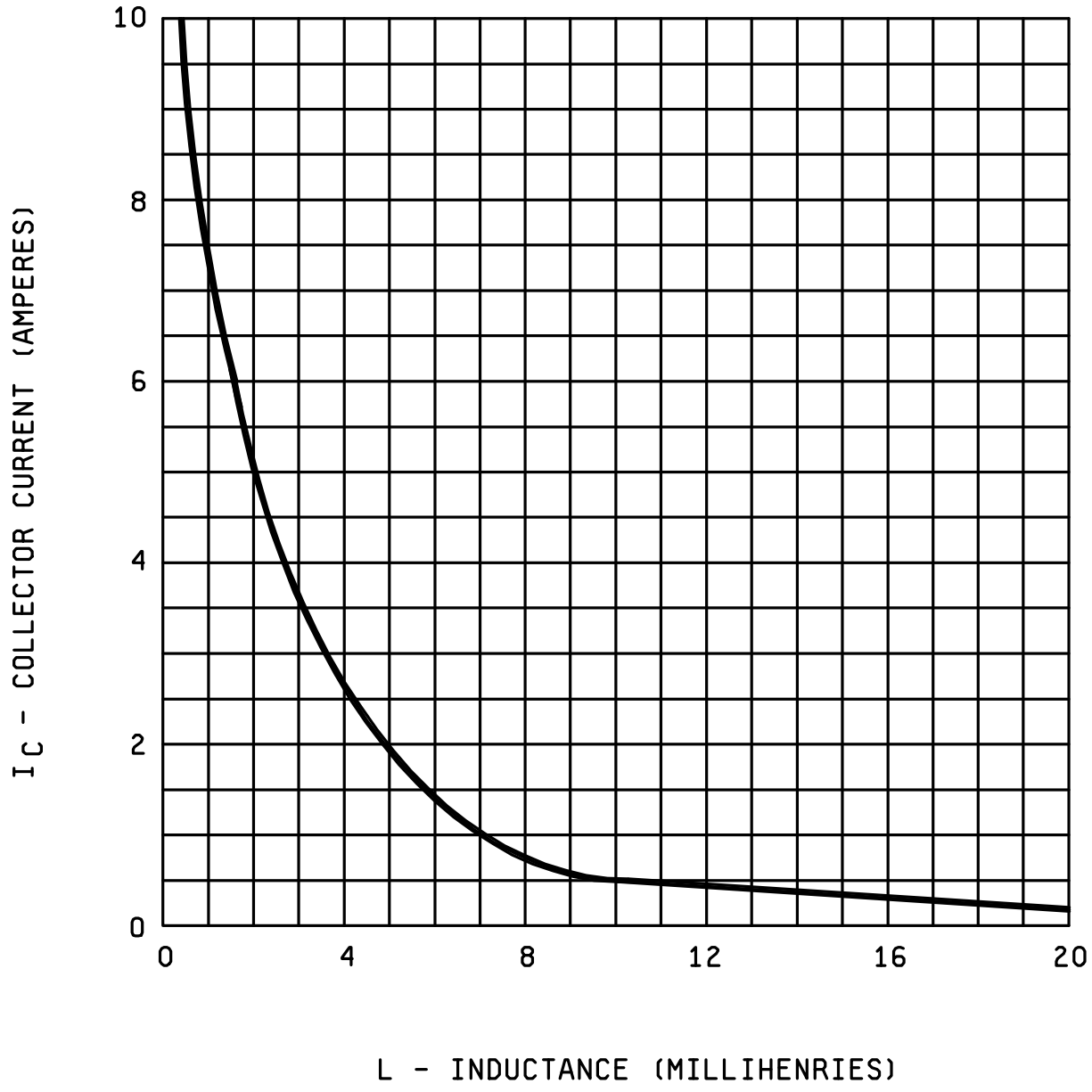
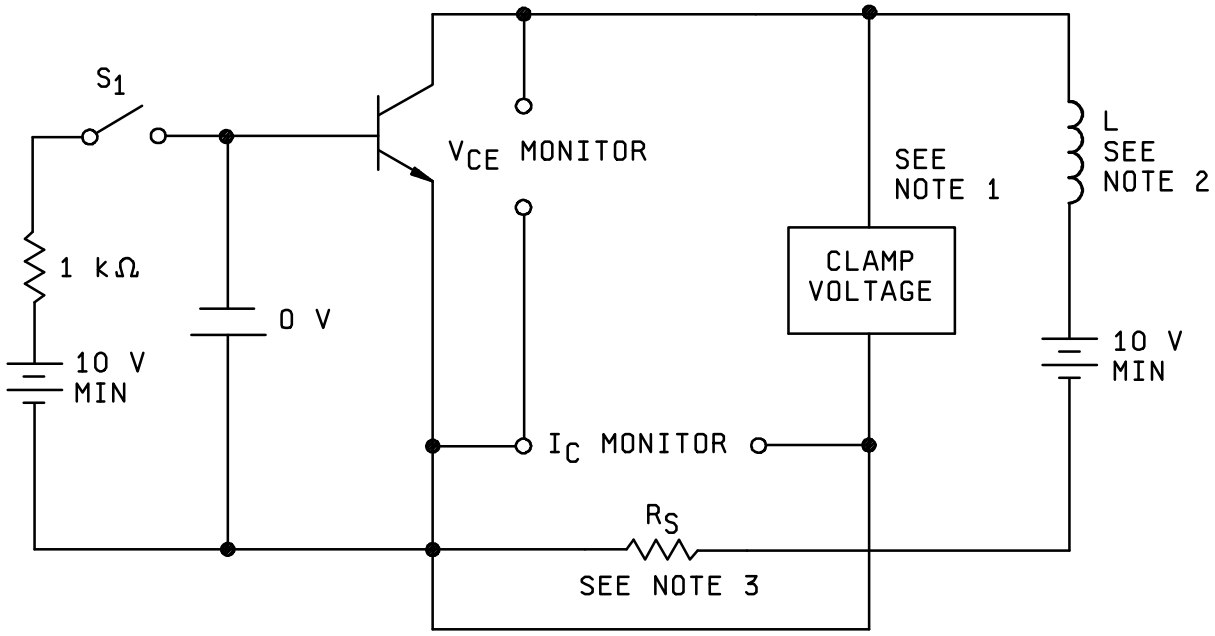


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).



Procedures:

1. With switch S1 closed, set the specified test conditions.
2. Open S1. Device fails if clamp voltage not reached and maintained until the current returns to zero.
3. Perform specified end-point tests.

NOTES:

1. Either a clamping circuit or clamping diode may be used.
2. The coil used shall provide a minimum inductance of 0.25 mH at 10 A with a maximum dc resistance of 0.1Ω.
3. $R_S \leq 0.1\Omega$. 12 W, 1 percent tolerance maximum (noninductive).

FIGURE 5. Clamped inductive sweep test circuit.

5. PACKAGING

5.1 Packaging. Packaging shall prevent mechanical damage of the devices during shipping and handling and shall not be detrimental to the device. When actual packaging of material 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 Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' 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 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Issue of DODISS to be cited in the solicitation (see 2.2.1).

b. The lead finish as specified (see 3.4.1).

c. Type designation and quality assurance level.

d. Packaging requirements (see 5.1).

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 Manufacturer's 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 purchase 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, 3990 East Broad Street, Columbus, OH 43216-5000.

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 11
NASA – NA
DLA - CC

Review activities:
Navy - MC
Air Force – 13, 19

Preparing activity:
DLA - CC

(Project 5961-2077)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/527B	2. DOCUMENT DATE 990910

3. **DOCUMENT TITLE**
SEMICONDUCTOR DEVICE, DARLINGTON TRANSISTOR, PNP, SILICON, POWER TYPES 2N6648, 2N6649 AND 2N6650 JAN, JANTX AND JANTXV

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 DSN FAX EMAIL	7. DATE SUBMITTED

8. PREPARING ACTIVITY

a. Point of Contact Alan Barone	b. TELEPHONE Commercial DSN FAX EMAIL 614-692-0510 850-0510 614-692-6939 alan_barone@dscc.dla.mil
c. ADDRESS Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, Columbus, OH 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman, Suite 2533, Fort Belvoir, VA 22060-6221 Telephone (703) 767-6888 DSN 427-6888