INCH–POUND

MIL–PRF–19500/523D
w/AMENDMENT 1
23 November 2013
SUPERSEDING
MIL–PRF–19500/523C
29 December 2012

The documentation and process conversion measures necessary to comply with this revision shall be completed by 24 February 2014.

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER DARLINGTON
TYPES 2N6383, 2N6384, AND 2N6385, 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 Darlington transistors. Three levels of product assurance are provided for each device type as specified in MIL–PRF–19500.

1.2 Physical dimensions. The device package style is TO–204AA (formerly TO–3) in accordance with figure 1.

1.3 Maximum ratings. Unless otherwise specified, T_A = +25°C.

Types	P_T		$R_{\theta JC}$ max	V_{CBO} and V_{CEO}	V_{EBO}	I_B	I_C	T_J and T_{STG}
	T_A = +25°C (1)	T_C = +25°C (2)						
	W	W	°C/W	V dc	V dc	A dc	A dc	°C
2N6383	6.0	100	1.75	40	5.0	0.25	10	–55 to +175
2N6384	6.0	100	1.75	60	5.0	0.25	10	–55 to +175
2N6385	6.0	100	1.75	80	5.0	0.25	10	–55 to +175

(1) Derate linearly 34.2 mW/°C above T_A > +25°C.
(2) Derate linearly 571 mW/°C above T_C > +25°C.

Comments, suggestions, or questions on this document should be addressed 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. Unless otherwise specified, T_C = +25°C.

Limit	h_{FE1} (1) V_{CE} = 3.0 V dc I_C = 5.0 A dc	$V_{CE(sat)1}$ (1) I_C = 5.0 A dc I_B = 10 mA dc	$V_{CE(sat)2}$ (1) I_C = 10 A dc I_B = 0.1 A dc	$V_{BE(ON)1}$ (1) V_{CE} = 3.0 V dc I_C = 5.0 A dc	C_{obo} V_{CB} = 10 V dc I_E = 0 100 KHz < f < 1 MHz
		V dc	V dc	V dc	pF
Minimum	1,000				
Maximum	20,000	2.0	3.0	2.8	200

Limit	$\|h_{fe}\|$ V_{CE} = 5.0 V dc I_C = 1.0 A dc f = 1 MHz	Pulse response (2) V_{CC} = 30 V dc I_{CC} = 5.0 A dc, I_{B1} = 20 mA dc	
		t_{on}	t_{off}
		µS	µS
Minimum	20		
Maximum	300	2.5	10.0

(1) Pulsed (see 4.5.1).
(2) See figure 2 for pulse response circuits.

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://quicksearch.dla.mil 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.

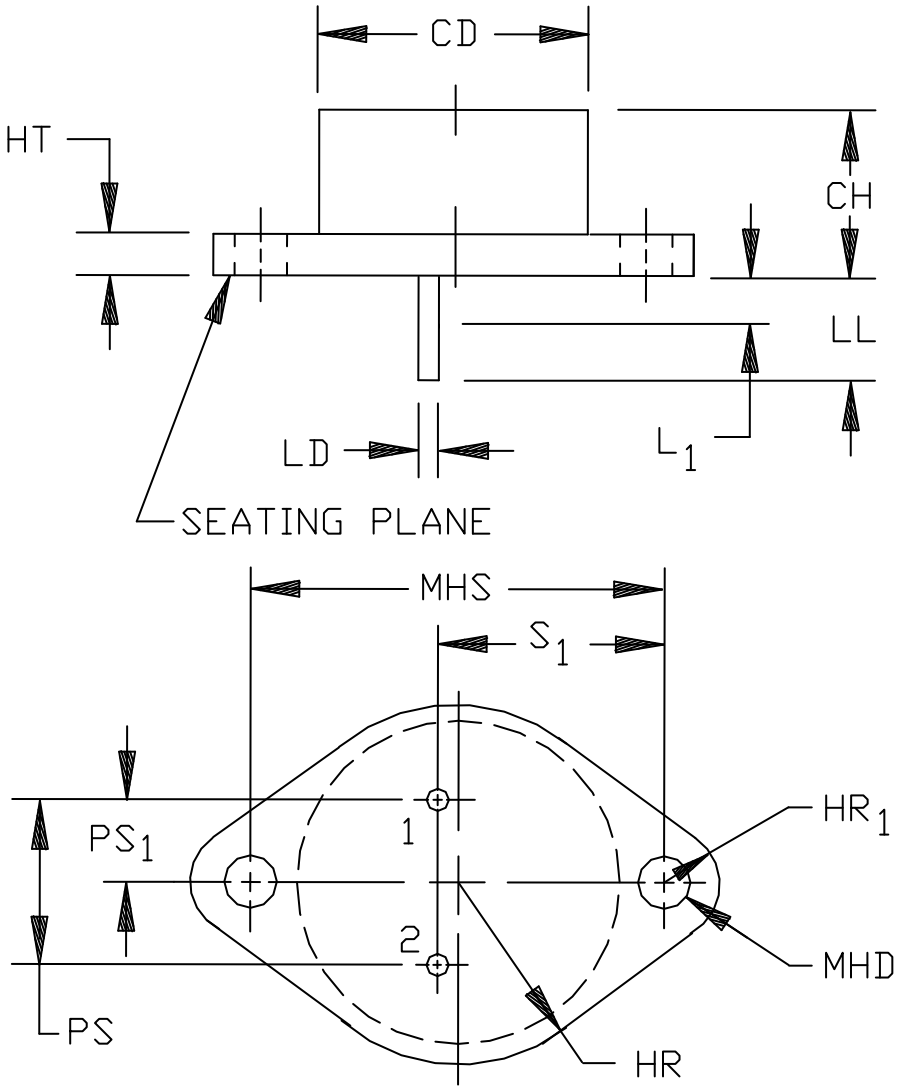


FIGURE 1. Physical dimensions (TO–204AA, formerly TO–3)

Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD		.875		22.23	5
CH	.250	.450	6.35	11.43	
HR	.495	.525	12.57	13.34	6
HR_1	.131	.188	3.33	4.78	6
HT	.050	.135	1.27	3.43	
LD	.038	.043	0.97	1.09	7, 8, 9
LL	.312	.500	7.92	12.7	
L_1		.050		1.27	
MHD	.151	.161	3.84	4.09	10
MHS	1.177	1.197	29.90	30.40	
PS	.420	.440	10.67	11.18	8
PS_1	.205	.225	5.21	5.72	7, 8
S_1	.655	.675	16.64	17.15	7, 8

NOTES:

1. Dimensions are in inches. Millimeters are given for general information only.
2. Terminal 1 is the emitter and terminal 2 is the base. The collector shall be electrically connected to the case.
3. 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.
4. Mounting holes (MHD) shall be deburred on the seating plane side.
5. Body contour is optional within zone defined by dimension CD.
6. Applies to all sides (HR) or both ends (HR_1).
7. Applies to both terminals.
8. Measurement for this dimension shall be taken at points .050 inch (1.27 mm) to .055 inch (1.40 mm) below the seating plane. When gauge is not used, measurement shall be made at seating plane.
9. Lead diameter shall not exceed twice dimension LD within dimension L_1.
10. Applies to both holes.
11. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions (TO–204AA, formerly TO–3) – Continued.

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 (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein shall be as specified in MIL–PRF–19500 and as follows:

I_M – The measurement current applied to forward bias the junction for measurement of V_{BE}.
I_H – The collector current applied to the device under test during the heating period.
t_H – The duration of the applied heating power pulse.
t_{SW} – Sample window time during which final V_{BE} measurement is made.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL–PRF–19500 and on figure 1 herein.

3.4.1 Lead finish. The 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).

3.4.2 Polarity. The identification of terminals of the device package shall be as shown on figure 1. Terminal 1 shall be connected to the emitter, terminal 2 shall be connected to the base, and the collector shall be electrically connected to the case.

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

3.6 Electrical test requirements. The electrical test requirements shall be as specified in table I.

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 and tables I and II).

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 only). 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 only
3c (1)	Thermal impedance, see 4.3.1
11	I_{CEX1} and h_{FE1}
12	See 4.3.2
13	See table I, subgroup 2 herein. ΔI_{CEX1} = 100 percent of initial value or 10 μA dc, whichever is greater. Δh_{FE1} = ±25 percent of initial value.

(1) Thermal impedance shall be performed anytime after temperature cycling (screen 3a) and does not need to be repeated in screening requirements.

4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with test method 3131 of MIL–STD–750 using the guidelines in that method for determining I_M, I_H, t_H, t_{SW}, t_{MD} (and V_H where appropriate). The thermal impedance limit used in screen 3c and table I, subgroup 2 herein shall be set statistically by the supplier. See table II, subgroup 4 (group E) herein.

4.3.2 Power burn-in conditions. The power burn-in conditions shall be as follows: T_J = +162.5°C ±12.5°C. The following details shall apply:

a. V_{CB} = 30 V dc for device type 2N6383.

b. V_{CB} = 40 V dc for device type 2N6384.

c. V_{CB} = 60 V dc for device type 2N6385.

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 E–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 tests and conditions specified for subgroup testing in table E–VIB (JAN, JANTX, and JANTXV) of MIL–PRF–19500 and as follows. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

Subgroup	Method	Conditions
B3	1037	Intermittent operation life, for solder die attach: $V_{CB} \geq 10$ V dc, $T_A \leq +35$°C.
B3	1027	Steady state life, 340 hours, for eutectic die attach: $V_{CB} \geq 10$ V dc, $T_A \leq +35$°C adjust P_T to achieve T_J = +150°C minimum.

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

Subgroup	Method	Conditions
C2	2036	Test condition A; weight = 10 pounds (4.54 Kg); time = 15 s.
C5	3131	Thermal resistance, see 4.3.1, $R_{\theta JC(max)}$ = 1.75°C/W.
C6	1037	Intermittent operation life, for solder die attach: $V_{CB} \geq 10$ V dc, $T_A \leq +35$°C.
C6	1026	Steady state life, for eutectic die attach: $V_{CB} \geq 10$ V dc, $T_A \leq +35$°C adjust P_T to achieve $T_J = +150$°C minimum.

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in appendix E, table E–IX of MIL–PRF–19500 and as specified in table II herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

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

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

TABLE I. Group A inspection.

Inspection 1/	MIL–STD–750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Thermal impedance 2/	3131	See 4.3.1	$Z_{\theta JX}$			°C/W
Breakdown voltage collector to emitter	3011	Bias condition D, I_C = 200 mA dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N6383				40		V dc
2N6384				60		V dc
2N6385				80		V dc
Breakdown voltage collector to emitter	3011	Bias condition B, I_C = 200 mA dc, R_{BB} = 100Ω, pulsed (see 4.5.1)	$V_{(BR)CER}$			
2N6383				40		V dc
2N6384				60		V dc
2N6385				80		V dc
Collector to emitter cutoff current	3041	Bias condition D	I_{CEO}		1.0	mA
2N6383		V_{CE} = 40 V dc				
2N6384		V_{CE} = 60 V dc				
2N6385		V_{CE} = 80 V dc				
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 5.0 V dc	I_{EBO}		5.0	mA
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = 1.5 V dc	I_{CEX1}		100	μA dc
2N6383		V_{CE} = 40 V dc				
2N6384		V_{CE} = 60 V dc				
2N6385		V_{CE} = 80 V dc				
Collector to base cutoff current	3036	Bias condition D	I_{CBO1}		1.0	mA dc
2N6383		V_{CE} = 40 V dc				
2N6384		V_{CE} = 60 V dc				
2N6385		V_{CE} = 80 V dc				
Base emitter voltage (unsaturated)	3066	Test condition B V_{CE} = 3.0 V dc, I_C = 5.0 A dc	$V_{BE(on)1}$		2.8	V dc
Base emitter voltage (unsaturated)	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

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

Inspection 1/	MIL–STD–750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 – Continued.						
Saturation voltage and resistance	3071	I_C = 5.0 A dc, I_B = 10 mA dc, pulsed (see 4.5.1)	$V_{CE(sat)1}$		2.0	V dc
Saturation voltage and resistance	3071	I_C = 10 A dc, I_B = 0.1 A dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$		3.0	V dc
Forward-current transfer ratio	3076	V_{CE} = 3 V dc, I_C = 5 A dc; pulsed (see 4.5.1)	h_{FE1}	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_{FE2}	100		
Subgroup 3						
High temperature operation:		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = 1.5 V dc	I_{CEX2}		3.0	mA dc
2N6383		V_{CE} = 40 V dc				
2N6384		V_{CE} = 60 V dc				
2N6385		V_{CE} = 80 V dc				
Low temperature operation:		T_A = –55°C				
Forward-current transfer ratio	3076	V_{CE} = 3.0 V dc, I_C = 5.0 A dc, pulsed (see 4.5.1)	h_{FE3}	200		
Subgroup 4						
Pulse response	3251	Test condition A, except test circuit and pulse requirements in accordance with figure 2				
Turn-on time		V_{CC} = 30 V dc, I_C = 5.0 A dc, I_{B1} = 20 mA dc	t_{on}		2.5	µs
Turn-off time		V_{CC} = 30 V dc, I_C = 5.0 A dc, I_{B1} = – I_{B2} = 20 mA dc	t_{off}		10	µs
Magnitude of small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 5 V dc; I_C = 1 A dc f = 1.0 MHz	$\|h_{fe}\|$	20	300	
Open-circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0 100 kHz ≤ f ≤ 1 MHz	C_{obo}		200	pF

See footnotes at end of table.

TABLE I. Group A inspection – Continued.

Inspection 1/	MIL–STD–750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = +25°C; t = 1.0 s, 1 cycle See figure 3				
Test 1						
(All device types)		V_{CE} = 10 V dc; I_C = 10 A dc				
Test 2						
(All device types)		V_{CE} = 30 V dc; I_C = 3.33 A dc				
Test 3						
2N6383 2N6384 2N6385		V_{CE} = 40 V dc, I_C = 1.5 A dc V_{CE} = 60 V dc, I_C = 0.4 A dc V_{CE} = 80 V dc, I_C = 0.16 A dc				
Electrical measurements		See of table I, subgroup 2 herein				
Safe operating area (switching)	3053	Load condition C (unclamped inductive load), see figure 4. T_C = 25°C, duty cycle ≤ 10 percent R_S = 0.1Ω				
Test 1		t_p approximately 1 ms (vary to obtain I_C); R_{BB1} = 1 kΩ; V_{BB1} = 10 V dc; R_{BB2} = ∞; V_{BB2} = 0 V; V_{CC} = 30 V dc; I_C = 10 A dc; R_L ≤ 0.5 Ω; L = 1 mH at 10 A dc				
Electrical measurements		See subgroup 2 of this table				
Test 2		t_p approximately 1 ms (vary to obtain I_C); R_{BB1} = 10 KΩ; V_{BB1} = 10 V dc; R_{BB2} = ∞; V_{BB2} = 0 V; V_{CC} = 30 V dc; I_C = 0.2 A dc; L = 100 mH at 0.2 A dc; R_L ≤ 0.5 Ω				
Electrical measurements		See of table I, subgroup 2 herein				

See footnotes at end of table.

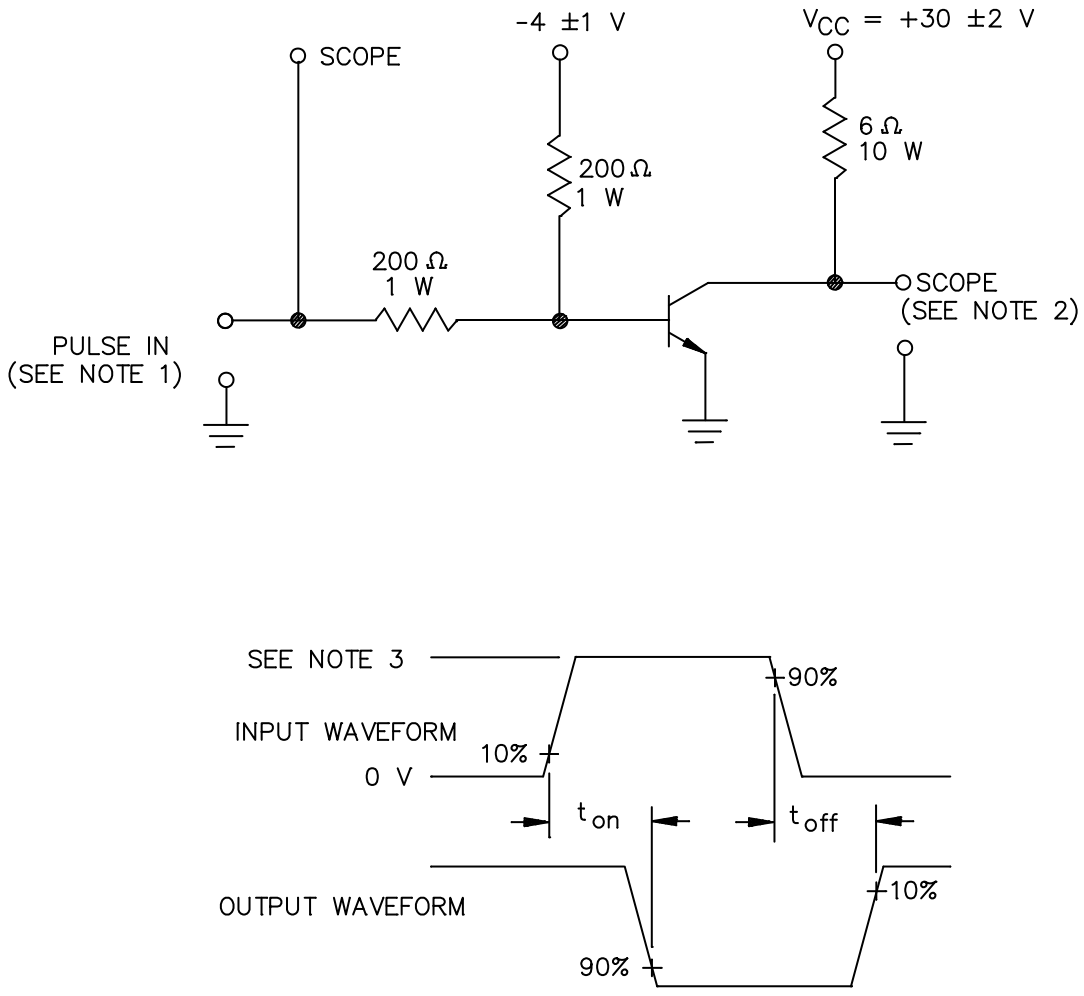
TABLE I. Group A inspection – Continued.

Inspection 1/	MIL–STD–750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5 – Continued.						
Safe operating area (switching)	3053	Load condition B (clamped inductive load) see figure 5 T_A = +25°C, $t_r + t_f \leq 1.0$ µs, duty cycle ≤ 10 percent; t_p = 5 ms (vary to obtain I_C) R_s = 0.1 Ω; V_{CC} = 10 V dc; I_C = 10 A dc				
2N6383 2N6384 2N6385		Clamp voltage = 40 V dc Clamp voltage = 60 V dc Clamp voltage = 80 V dc Device fails if clamp voltage is not reached				
Electrical measurements		See of table I, subgroup 2 herein				

1/ For sampling plan see MIL–PRF–19500.
2/ This test required for the following end-point measurements only:
Group B, subgroups 2 and 3 (JAN, JANTX, and JANTXV).
Group C, subgroups 2 and 6.
Group E, subgroups 1 and 2.

TABLE II. Group E inspection (all quality levels) – for qualification and re-qualification only.

Inspection	MIL–STD–750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices; c = 0
Temperature cycling (air to air)	1051	Test condition G, 500 cycles.	
Hermetic seal Fine leak Gross leak	1071		
Electrical measurements		See of table I, subgroup 2 herein.	
Subgroup 2			45 devices; c = 0
Blocking life	1048	Test temperature = +125°C; V_{CB} = 80 percent of rated voltage; T = 1,000 hours.	
Electrical measurements		See of table I, subgroup 2 herein.	
Subgroup 4			Sample size N/A
Thermal impedance curves		See MIL–PRF–19500.	
Subgroup 8			45 devices; c = 0
Reverse voltage leakage stability	1033	Condition A.	



NOTES:

1. The rise time (t_r) and fall time (t_f) of the applied pulse shall be each < 20 nanoseconds; duty cycle < 2 percent, generator source impedance shall be 50 Ω; pulse width = 20 μs.
2. Output sampling oscilloscope: Z_{IN} > 100 kΩ; C_{IN} < 50 pF; rise time < 2 nanoseconds.
3. Pulse In shall be 10 V maximum.

FIGURE 2. Pulse response test circuit.

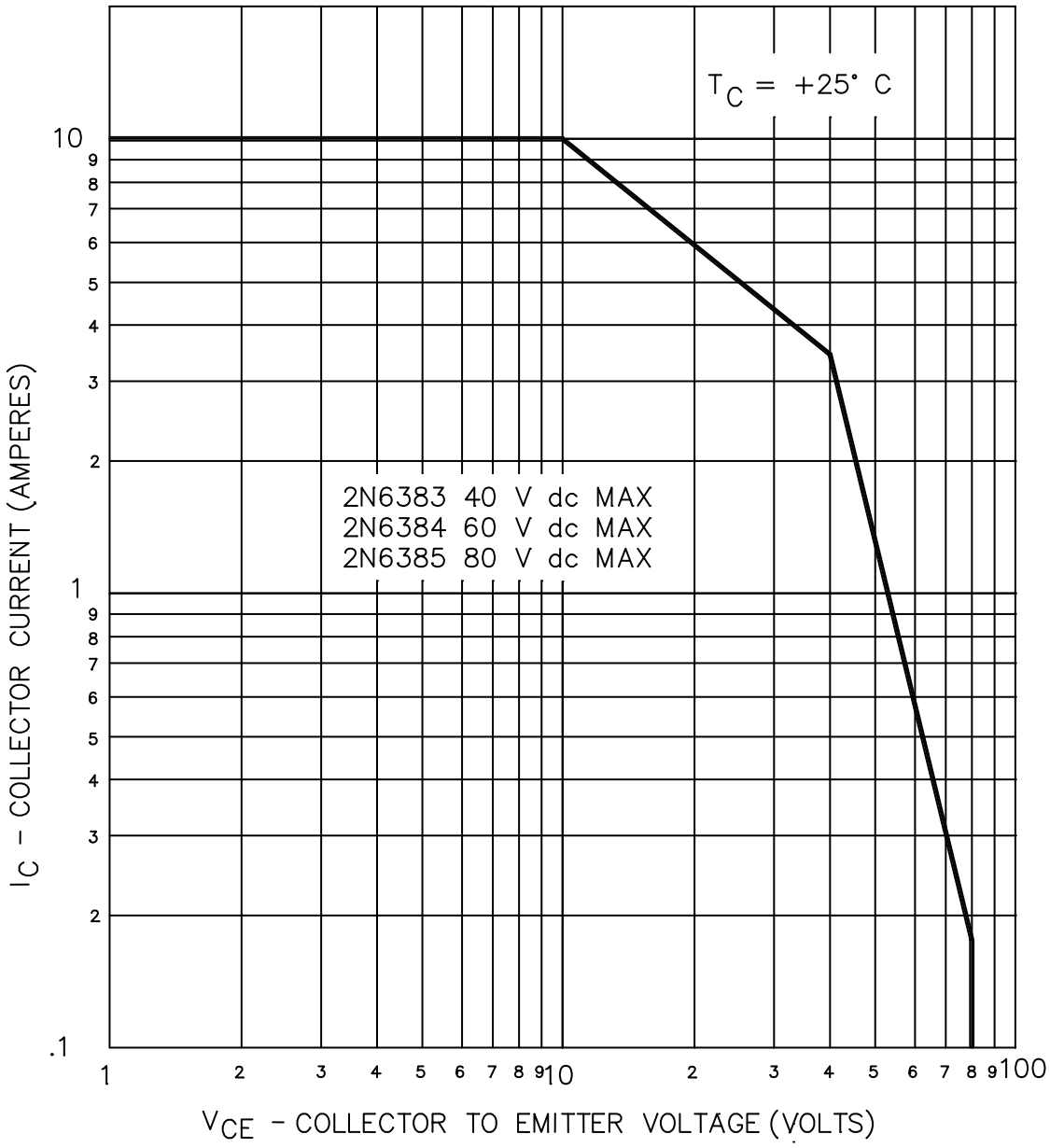


FIGURE 3. Maximum safe operating graph (continuous dc).

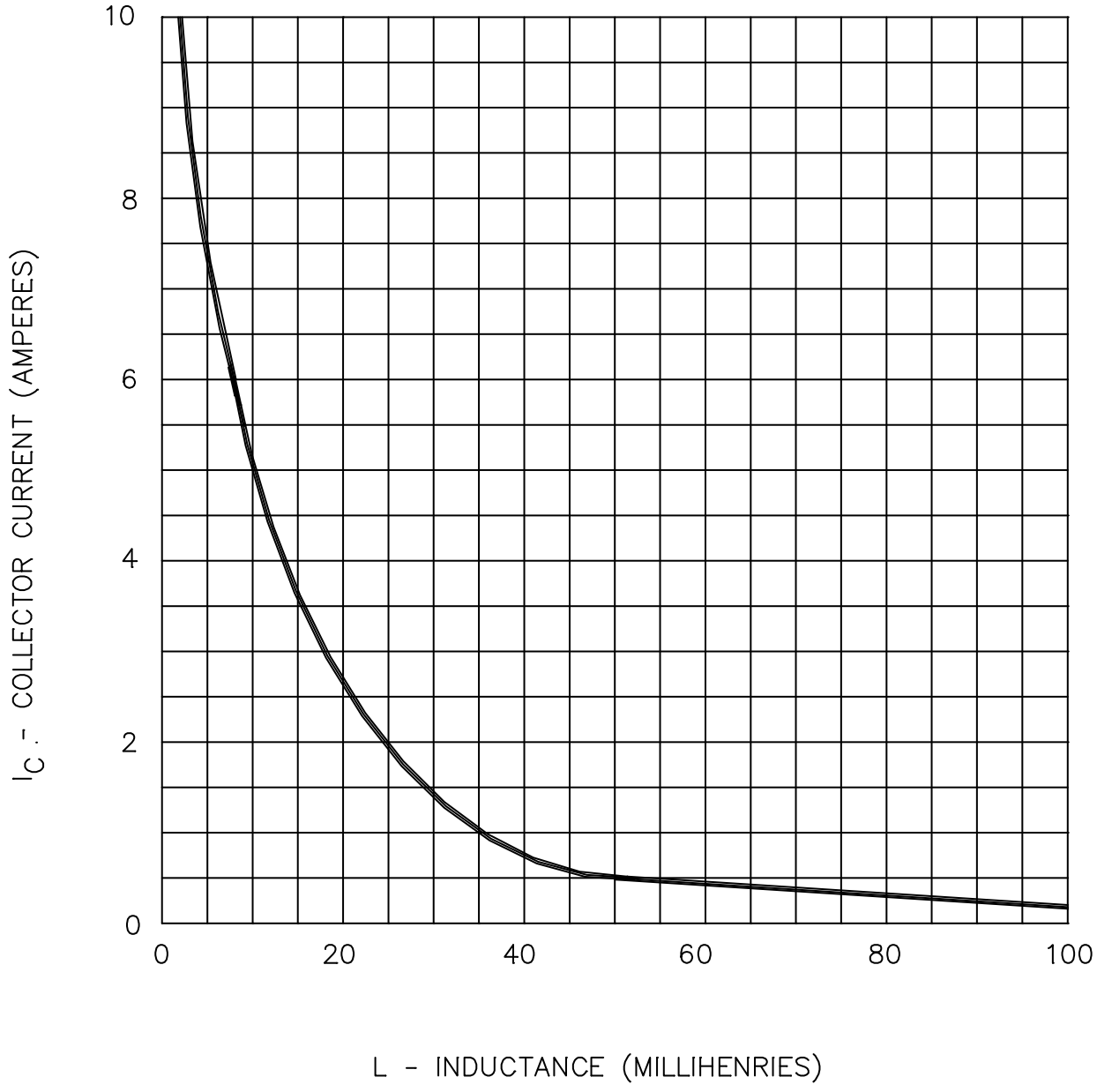
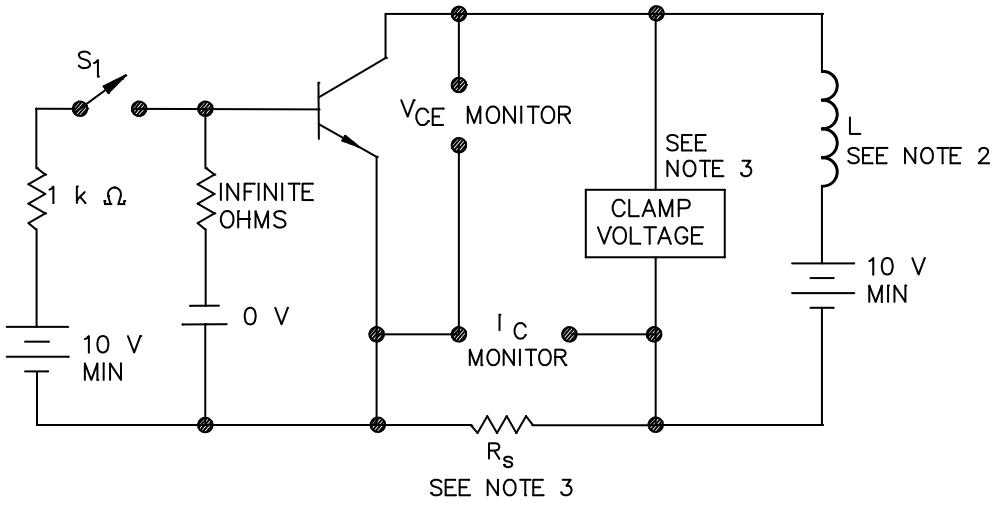


FIGURE 4. Safe operating area for switching between saturation and cutoff (unclamped inductive load).



NOTES:
1. Either a clamping circuit or clamping diode may be used.
2. The coil used shall provide a minimum inductance of 1 mH at 10 A with a max dc resistance of 0.1 ohm.
3. $R_S \leq 0.1$ ohm. 12 W, 1 percent tolerance max (noninductive).
4. With switch S_1 closed, set the specified test conditions.
5. Open S_1. Device fails if clamp voltage is not reached and maintained until the current returns to zero.
6. Perform specified end point tests.

FIGURE 5. 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. The complete Part or Identifying Number (PIN), see section 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 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 vertical lines 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 – AV, MI

Preparing activity:
DLA – CC

(Project 5961–2013–042)

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