The documentation and process conversion measures necessary to comply with this revision shall be completed by 18 March 2009.

INCH-POUND

MIL-PRF-19500/528B
18 December 2008
SUPERSEDING
MIL-PRF-19500/528A
23 July 1999

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER, TYPES 2N6032 AND 2N6033, 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. See figure 1 (similar to TO-3).

* 1.3 Maximum ratings.

Types	P_T (1) T_C = +25°C	$R_{\theta JC}$	V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_J and T_{STG}
	W	°C/W	V dc	V dc	V dc	A dc	A dc	°C
2N6032	140	1.25	120	90	7.0	10	50	-65 to +200
2N6033	140	1.25	150	120	7.0	10	40	-65 to +200

(1) Between T_C = +25°C and T_C = +200°C, linear derating factor (average) = 800 mW/°C.

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

Types	h_{FE1}				C_{obo}		$\|h_{fe}\|$	
	I_C = 50 A dc V_{CE} = 2.6 V dc		I_C = 40 A dc V_{CE} = 2.0 V dc		.1 MHz ≤ f ≤ 1 MHz I_E = 0 A dc V_{CB} = 10 V dc pF		f = 5 MHz I_C = 2.0 A dc V_{CE} = 10 V dc	
	Min	Max	Min	Max	Min	Max	Min	Max
2N6032	10	50				1,000	10	40
2N6033			10	50		1,000	10	40

* Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil/.

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

Type	$V_{BE(sat)}$ I_C = 50 A dc, I_B = 5 A dc (V dc)		$V_{CE(sat)}$ I_C = 50 A dc, I_B = 5 A dc (V dc)		$V_{CE(sat)}$ I_C = 40 A dc, I_B = 4 A dc (V dc)		switching t_{on} (see table I and figure 4) µs		switching t_{off} (see table I and figure 4) µs	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2N6032		2.0		1.3				0.5		2.0
2N6033						1.0		0.5		2.0

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.

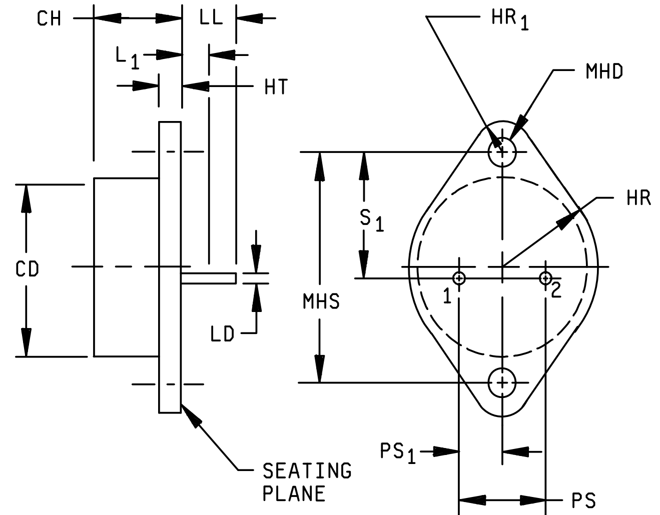
* DEPARTMENT OF DEFENSE STANDARDS

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

* (Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.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		.875		22.22	3
CH	.250	.450	6.35	11.43	
HR	.495	.525	12.57	13.34	
HR_1	.131	.188	3.33	4.78	
HT	.050	.135	1.27	3.43	
L_1		.050		1.27	5, 9
LD	.059	.061	1.50	1.55	5, 9
LL	.312		7.92		5
MHD	.151	.161	3.84	4.09	7
MHS	1.177	1.197	29.90	30.40	
PS	.420	.440	10.67	11.18	4
PS_1	.205	.225	5.21	5.72	4, 5
S_1	.655	.675	16.64	17.14	4



NOTES:
1. Dimensions are in inches.
* 2. Millimeters are given for general information only.
3. Body contour is optional within zone defined by CD.
4. These dimensions shall be measured at points .050 (1.27 mm) to .055 (1.40 mm) below seating plane. When gauge is not
   used, measurement shall be made at seating plane.
5. Both terminals.
6. At both ends.
7. Two holes.
8. Terminal 1 is the emitter, terminal 2 is base. The collector shall be electrically connected to the case.
* 9. LD applies between L_1 and LL. Lead diameter shall not exceed twice LD within L_1.
10. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 1. Physical dimensions (similar to TO-3).

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. 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 figure 1 herein.

3.4.1 Lead finish. Lead finish shall be solderable as defined in MIL-PRF-19500.

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 as specified in table I.

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.

* 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 MIL-PRF-19500 (table E-IV), 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	Not applicable
10	24 hours minimum
11	I_{CEX1} , h_{FE1}
12	See 4.3.1; 168 hours minimum
13	Subgroup 2 of table I herein; ΔI_{CEX1} = ±100% of initial value or 20 μA dc, whichever is greater; Δh_{FE1} = ±25%

(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: T_J = +187.5°C ±12.5°C, $T_A \leq$ +35°C.

JANTX and JANTXV levels
2N6032 ------------------------------------V_{CB} = 60 V dc.
2N6033 ------------------------------------V_{CB} = 100 V dc.

* 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). 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.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

* 4.4.2.1 Group B inspection, table E-VIB (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	1037	For solder die attach: $V_{CB} \geq$ 10 V dc, 2,000 cycles, $T_A \leq$ +35°C. For eutectic die attach: $V_{CB} \geq$ 10 V dc, $T_A \leq$ +35°C, adjust P_T to achieve T_J = +175°C min.

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 table I, subgroup 2 herein.

	Subgroup	Method	Condition
*	C2	2036	Test condition A, weight = 10 pounds, t = 15 s.
*	C5	3131	See 4.3.2.
	C6	1037	For solder die attach: $V_{CB} \geq 10$ V dc, 6,000 cycles, $T_A \leq +35°C$. For eutectic die attach: $V_{CB} \geq 10$ V dc, $T_A \leq +35°C$, adjust P_T to achieve $T_J = +175°C$ min.

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

4.5.2 Input capacitance. This test shall be conducted in accordance with method 3240 of MIL-STD-750, except the output capacitor shall be omitted.

4.5.3 Coil selection for safe operating area tests. In selecting coils for use in clamped and unclamped inductive SOAR tests, prime consideration should be given to the recommended commercially available coil. However, due to the extreme critical nature of the coil in these circuits and wide tolerance of some commercially available coils (+100, -50 percent), it shall be the semiconductor manufacturer's responsibility, to prove upon request, compliance or equivalency of any coil used (commercial or inplant designed) to be within (+20, -10 percent) of the specified inductance at the rated current and dc resistance.

* 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	3131	See 4.3.2	$Z_{\theta JX}$			°C/W
Breakdown voltage, collector to emitter		I_C = 200 mA dc; f = 30 - 60 Hz; L = 15 mH (see figure 2)	$V_{(BR)CEO}$			
2N6032				90		V dc
2N6033				120		V dc
Breakdown voltage, collector to emitter		I_C = 200 mA dc; f = 30 - 60 Hz; L = 15 mH (see figure 2)	$V_{(BR)CER}$			
2N6032				110		V dc
2N6033				140		V dc
Breakdown voltage, collector to emitter		I_C = 200 mA dc; f = 30 - 60 Hz; L = 2 mH (see figure 2)	$V_{(BR)CEX}$			
2N6032				120		V dc
2N6033				150		V dc
Emitter to base cutoff current	3061	Bias condition D V_{EB} = 7 V dc	I_{EBO}		10	mA dc
Collector to emitter cutoff Current	3041	Bias condition D V_{CE} = 80 V dc	I_{CEO}		10	mA dc
* Collector to emitter cutoff Current	3041	Bias condition A; V_{BE} = -1.5 V dc	I_{CEX1}		250	µA dc
2N6032		V_{CE} = 110 V dc				
2N6033		V_{CE} = 135 V dc				
Collector to base cutoff Current	3036	Bias condition D;	I_{CBO}			
2N6032		V_{CB} = 120 V dc			25	mA dc
2N6033		V_{CB} = 150 V dc			25	mA dc
Forward-current transfer ratio	3076	V_{CE} = 2.6 V dc; I_C = 50 A dc (pulsed see 4.5.1)	h_{FE1}			
2N6032				10	50	
Forward-current transfer ratio	3076	V_{CE} = 2.0 V dc; I_C = 40 A dc (pulsed see 4.5.1)	h_{FE1}			
2N6033				10	50	

See footnote 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						
Collector-emitter saturation voltage 2N6032	3071	I_C = 50 A dc; I_B = 5.0 A dc; pulsed (see 4.5.1)	$V_{CE(sat)}$		1.3	V dc
Collector-emitter saturation voltage 2N6033	3071	I_C = 40 A dc; I_B = 4.0 A dc pulsed (see 4.5.1)	$V_{CE(sat)}$		1.0	V dc
Base-emitter saturation voltage 2N6032	3306	Test condition A; I_B = 5.0 A dc; I_C = 50 A dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		2.0	V dc
Base-emitter saturation voltage 2N6033	3306	Test condition A; I_B = 4.0 A dc; I_C = 40 A dc; pulsed (see 4.5.1)	$V_{BE(sat)}$		2.0	V dc
Subgroup 3						
High temperature operation		T_A = +150°C				
Collector to emitter cutoff current	3041	Bias condition D;V_{BE} = 1.5 V dc; V_{CE} = 100 V dc	I_{CEX2}			
2N6032					15	mA dc
2N6033					10	mA dc
Low temperature operation		T_A = -55°C				
Forward-current transfer ratio	3076	Pulsed (see 4.5.1)	h_{FE2}			
2N6032		V_{CE} = 2.6 V dc; I_C = 50 A dc		5		
2N6033		V_{CE} = 2.0 V dc; I_C = 40 A dc		5		
Subgroup 4						
Magnitude of small-signal short- circuit forward current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 2.0 A dc; f = 5.0 MHz	$/h_{fe}/$	10	40	
Open circuit Output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz $\leq$ f $\leq$ 1 MHz	C_{obo}		1,000	pF

See footnote at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued						
Pulse response:	3251	Test condition A except test circuit and pulse requirements in accordance with figure 3.				
Turn-on time			t_{on}		0.5	µs
2N6032		V_{CC} = 30 V dc ±2; I_C = 50 A dc; I_{B1} = 5.0 A dc				
2N6033		V_{CC} = 30 V dc ±2; I_C = 40 A dc; I_{B1} = 4.0 A dc				
Turn-off time			t_{off}		2.0	µs
2N6032		V_{CC} = 30 V dc ±2; I_C = 50 A dc; I_{B2} = 5.0 A dc, I_{B2} = -5.0 A dc				
2N6033		V_{CC} = 30 V dc ±2; I_C = 40 A dc; I_{B1} = 4.0 A dc, I_{B2} = -4.0 A dc				
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = +25°C; t = 1 s; 1 cycle; (see figure 4)				
Test 1 2N6032 only		I_C = 50 A dc; V_{CE} = 2.8 V dc				
Test 2 2N6033 only		I_C = 40 A dc; V_{CE} = 3.5 V dc				
Test 3		I_C = 5.8 A dc; V_{CE} = 24 V dc				
Test 4		I_C = 0.9 A dc; V_{CE} = 40 V dc				
Test 5 2N6032 only		I_C = 0.18 A dc; V_{CE} = 90 V dc				
Test 6 2N6033 only		I_C = 0.1 A dc; V_{CE} = 120 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 5 - Continued						
Safe operating area (switching)	3053	Load condition C; (unclamped inductive load) (see figure 5); T_C = +25°C; Duty cycle ≤ 10 percent; R_S = 0.1 ohm;				
Test 1		$t_p \approx$ 10 ms; R_{BB1} = 1Ω; V_{BB1} = 10 V dc max; R_{BB2} = 20Ω; V_{BB2} = 4 V dc;				
2N6032 2N6033		I_C = 50 A dc; I_C = 40 A dc; V_{CC} = 10 V dc L = 50 μH, 0.1 Ω;				
Test 2		$t_p \approx$ 10 ms; R_{BB1} = 10Ω; V_{BB1} = 10 V dc max; R_{BB2} = 20Ω; V_{BB2} = 4 V dc; I_C = 10 A dc; V_{CC} = 10 V dc L = 500 μH, 0.1 Ω				
Electrical measurements		See table I, subgroup 2				
Safe operating area (switching)		T_A = +25°C; duty cycle ≤ 10 percent. $t_p \approx$ 10 ms (vary to obtain I_C); $R_S \le$ 1 Ω; $V_{CC} \ge$ 50 V dc; L = 50 μH, 0.1 Ω				
2N6032 2N6033		I_C = 50 A dc; I_C = 40 A dc;				

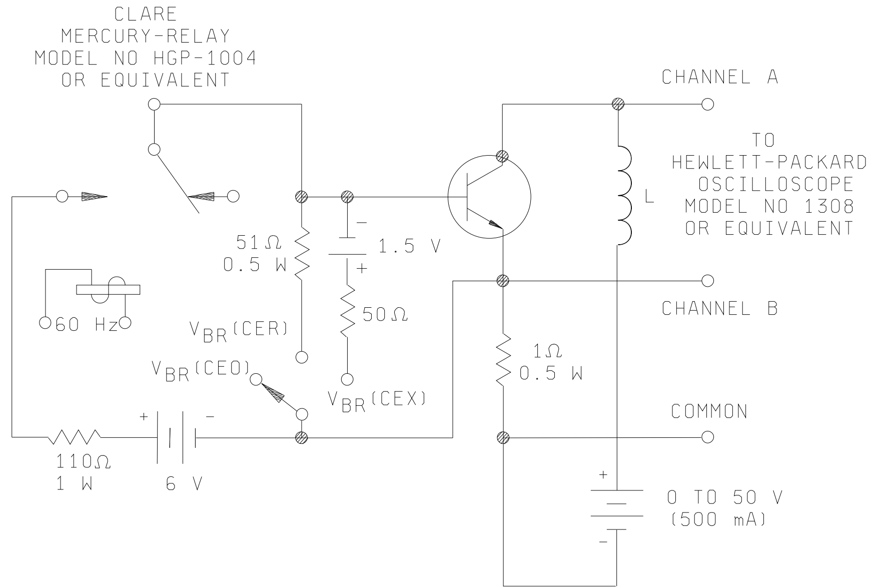
2N6032
2N6033
		clamp voltage = 90 V dc;
		clamp voltage = 120 V dc;
		(see figure 6)				

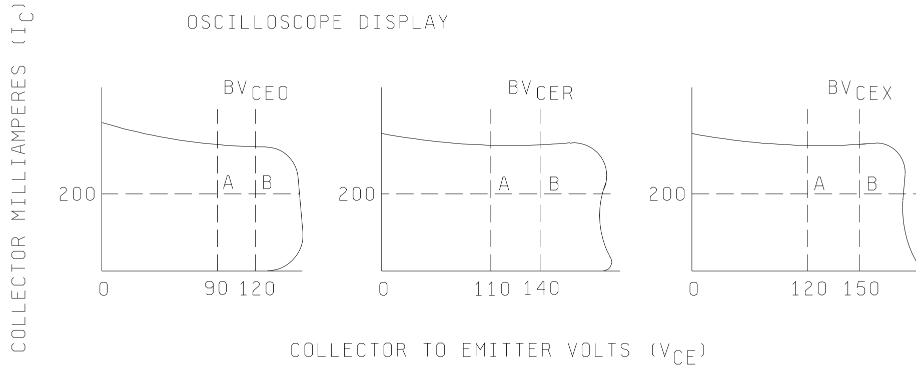
Electrical measurements		See table I, subgroup 2				
Subgroups 6 and 7						
Not applicable						

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

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

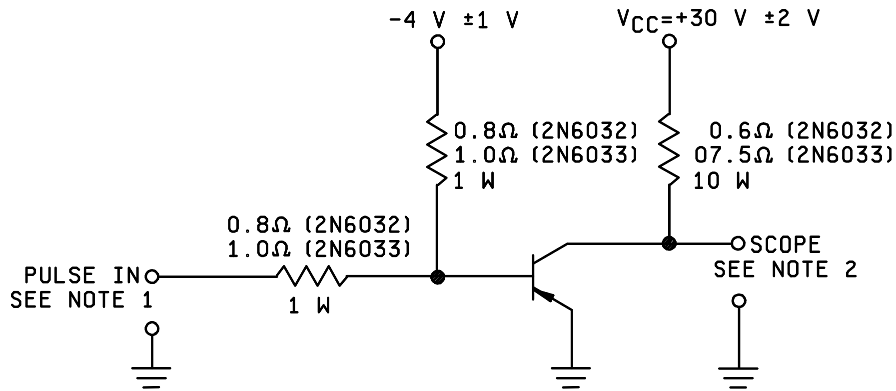
Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	500 cycles minimum	
Hermetic seal Fine leak Gross leak	1071		
Electrical measurements		See table I, subgroup 2 herein.\	
Subgroup 2			45 devices c = 0
Blocking life	1048	Test temperature = +125°C; V_{CB} = 80 percent of rated, without going over the max rate for V_{CEO}; T = 1,000 hours.	
Electrical measurements		See 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 stability	1033	Condition B.	

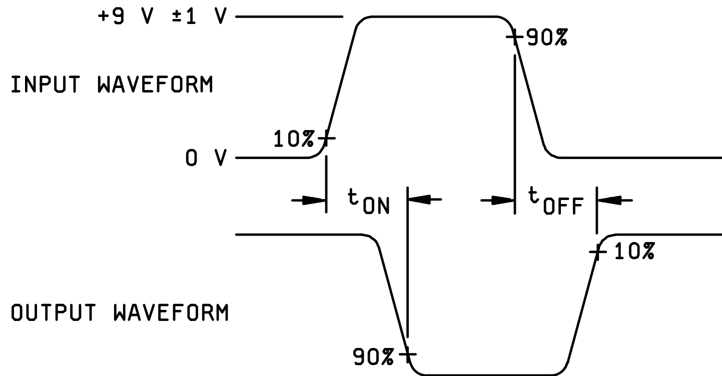




NOTE:
$V_{(BR)CEO}$, $V_{(BR)CER}$, $V_{(BR)CEX}$ is acceptable when the trace falls to the right and above point "A" for type 2N6032.
The trace shall fall to the right and above point "B" for type 2N6033.

FIGURE 2. $V_{(BR)CEO}$, $V_{(BR)CER}$, $V_{(BR)CEX}$ measurement circuit.





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

FIGURE 3. Pulse response test circuit.

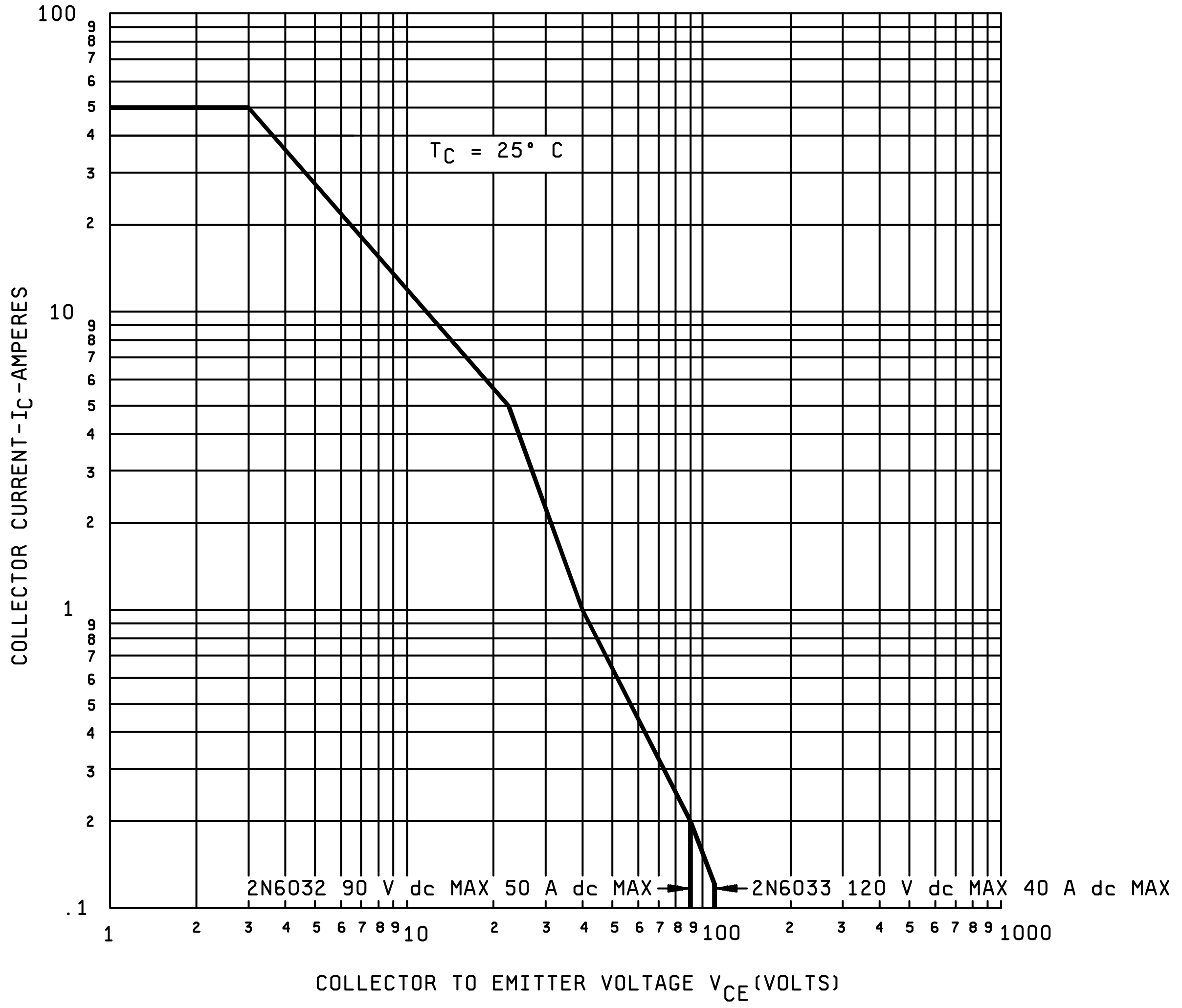


FIGURE 4. Maximum safe operating area graph (continuous dc).

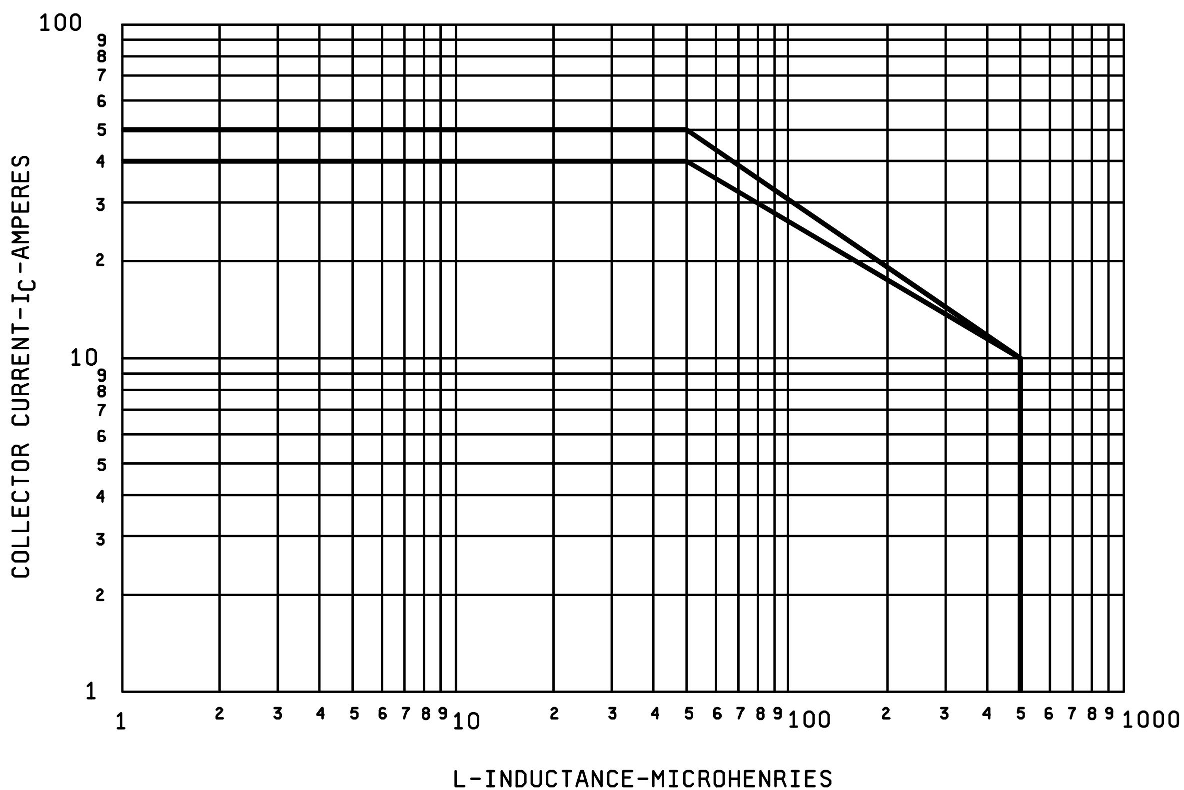
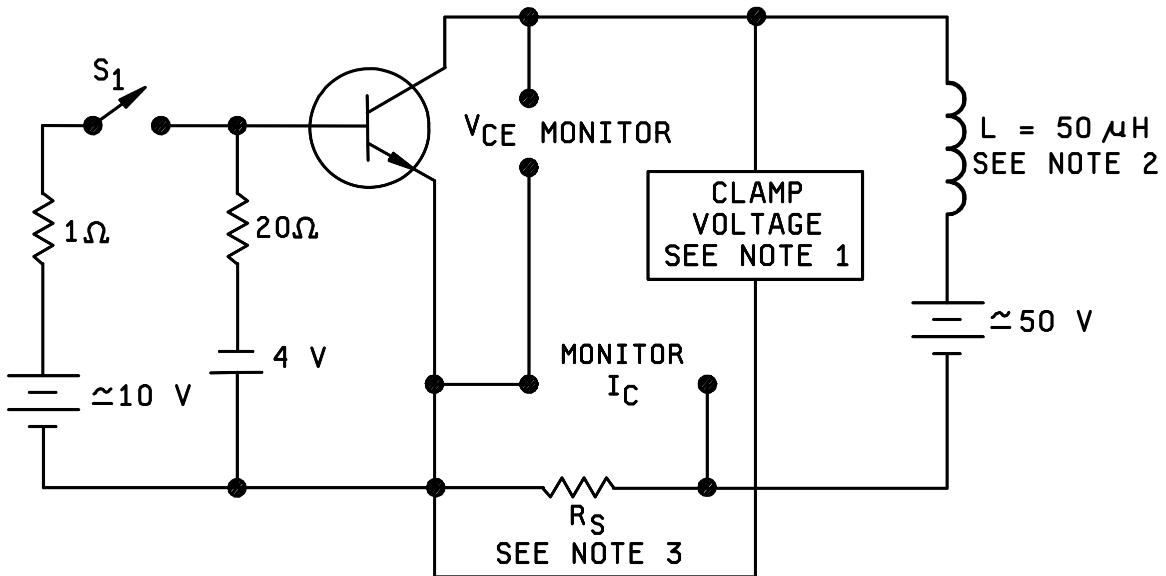


FIGURE 5. Safe operating area for switching between saturation and cutoff (unclamped inductive load).



NOTES:

1. Either a clamping circuit or clamping diode may be used.
2. The coil used shall provide a minimum inductance of 50 µH with a maximum dc resistance of .1 ohm.
3. $R_S \leq .1\ \Omega$, 12 W, 1percent tolerance maximum (non-inductive).

Procedure

1. With switch S_1 closed, set the specified test conditions.
2. Open S_1. Device fails if clamp voltage not reached and maintained until the current returns to zero.
3. Perform specified endpoint tests.

FIGURE 6. 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 Defense Supply Center, Columbus, ATTN: DSCC/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 http://assist.daps.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:
Air Force - 85
DLA - CC

Review activities:
Air Force - 19

Preparing activity:
DLA - CC

(Project 5961-2008-022)

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