The documentation and process conversion measures necessary to comply with this revision shall be completed by 30 September 1994

INCH-POUND

MIL-S-19500/550A
30 June 1994
SUPERSEDING
MIL-S-19500/550(USAF)
21 December 1981

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, FAST-RECOVERY, HIGH CURRENT
TYPES 1N6304, 1N6305, 1N6306, AND R TYPES
JAN, JANTX, JANTXV, JANHC, AND JANKC

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 detail requirements for silicon, high efficiency fast recovery switching power rectifier diodes. Three levels of product assurance are provided for each encapsulated device type as specified in MIL-S-19500, and two levels of product assurance for each unencapsulated device type die.

1.2 Physical dimensions. See figure 1 (DO-203AB) and figure 2 for JANHC and JANKC (die) dimensions.

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

Types	V_R	V_{RWM}	I_O T_C = +100°C 1/ 2/	I_{FSM} T_C = -55°C t_p = 8.3 ms	t_{rr}	V_{FM} I_{FM} = 70 A (pk) duty cycle ≤ 2 percent t_p = 300 µs max	I_R at rated V_R	$R_{\Theta JC}$
	V dc	V dc	A dc	A dc	ns	V (pk)	µA dc	°C/W
1N6304, R	50	50	70	800	50	0.975	25	0.8
1N6305, R	100	100	70	800	50	0.975	25	0.8
1N6306, R	150	150	70	800	50	0.975	25	0.8

1/ Derate linearly, 875 mA/°C from T_C = +100°C to +150°C, and 1,050 mA/°C above T_C > +150°C.

2/ Higher I_O, up to 1.2 times I_O is allowable provided that appropriate heat sinking or forced air cooling maintains the maximum junction temperature at or below +175°C as proven by the junction temperature rise time.
Storage temperature: T_C = -65°C to +175°C.
Operating temperature: T_C = -65°C to +175°C.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defence Electronic Supply Center, DESC-ELDT, 1507 Wilmington Pike, Dayton, OH 45444-5765, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC/NA
FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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

MILITARY

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

STANDARDS

FEDERAL

FED-STD-H28 - Screw-Thread Standards for Federal Services.

MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 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.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500 and as specified herein.

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

JANH	High reliability product assurance level for unencapsulated devices.
JANK	Space reliability product assurance level for unencapsulated devices.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500, and on figure 1 (DO-203AB) and figures 2 and 3 for JANC die herein.

3.3.1 Lead material and finish. Lead material shall be copper (terminal number 1) with a steel cap on a copper stud (terminal number 2). Lead finish shall be solderable as defined in MIL-S-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 Marking. Marking shall be in accordance with MIL-S-19500.

3.4.1 Marking of JANHC and JANKC die. For JANHC and JANKC die, the following marking shall be used (example):

JANHCAM1N6304

↑↑↑↑

- ↑ RHA level (see MIL-S-19500).
- ↑ Source of manufacturer (see figure 2).
- ↑ Unencapsulated.
- ↑ Product assurance level 1/.

1/ Two levels of product assurance levels are provided for unencapsulated devices, H and K (see MIL-S-19500.

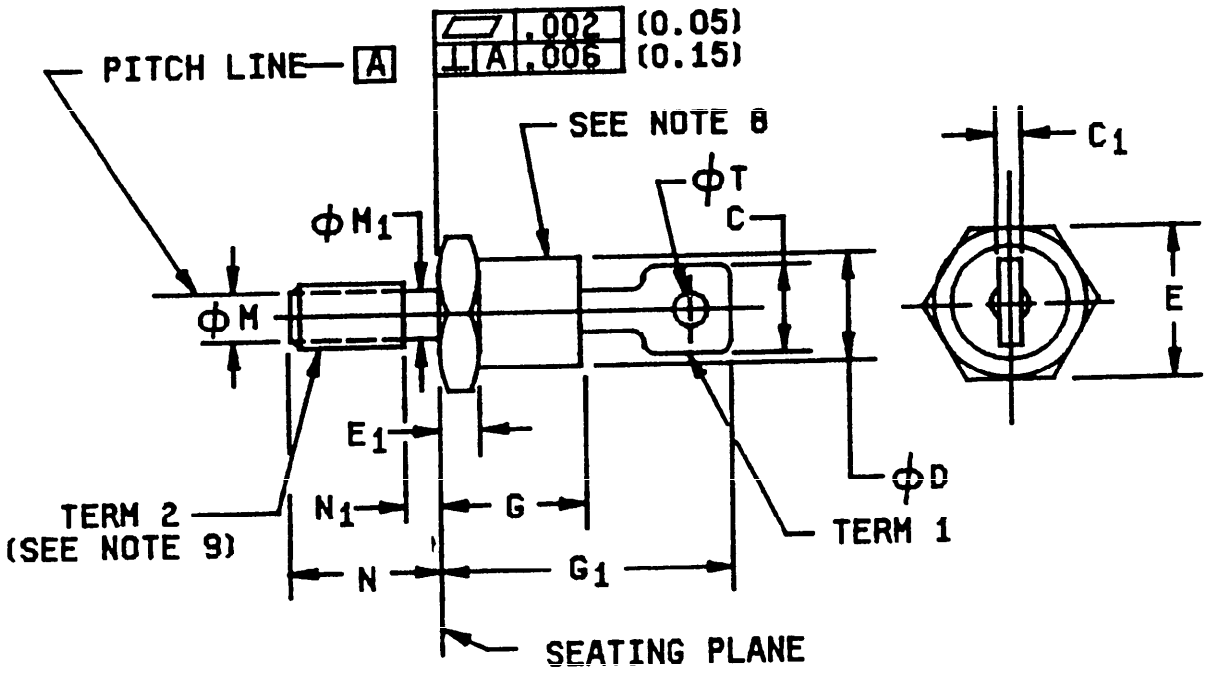
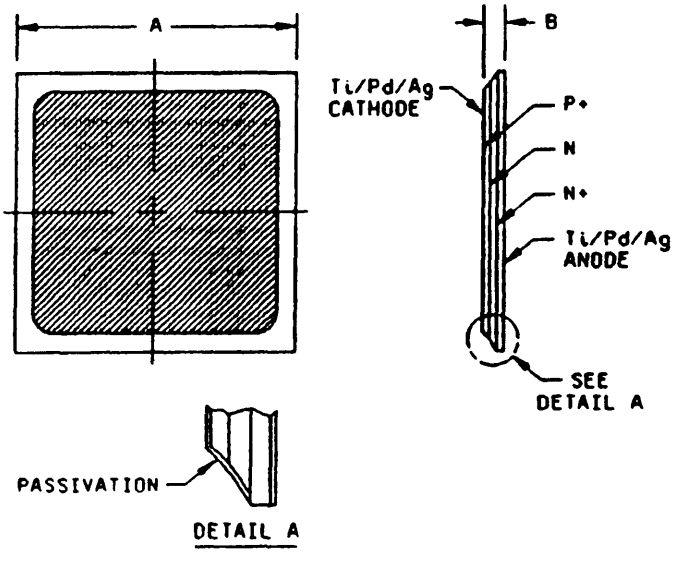


FIGURE 1. Physical dimensions (DO-203AB).

Dimensions					
Ltr	Inches		Millimeters		Notes
	Min	Max	Min	Max	
C		.375		9.53	7
C_1		.080		2.03	
ϕD		.667		16.94	
E	.669	.688	16.99	17.48	
E_1	.115	.200	2.92	5.08	
G		.450		11.43	
G_1	.750	1.000	19.05	25.40	
ϕM					5
ϕM_1	.220	.249	5.59	6.32	
N	.422	.453	10.72	11.51	
N_1		.090		2.29	4
ϕT	.140	.175	3.56	4.45	

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Units must not be damaged by torque of 30 inch-pound applied to .25-28 UNF-2B nut assembled on thread.
4. Length of incomplete or undercut threads of ϕM_1.
5. Maximum pitch diameter of plated threads shall be basic pitch diameter .2268 inch (5.761 mm).
6. A chamfer or undercut on one or both ends of the hex portion is optional; minimum base diameter at seating plane .60 inch (15.2 mm).
7. The angular orientation and peripheral configuration of terminal 1 is undefined.
8. Standard types shall have cathode connected to stud. Reverse types shall have anode connected to stud.
9. Term 2 threads in accordance with FED-STD-H28.

FIGURE 1. Physical dimensions (DO-203AB) - Continued.

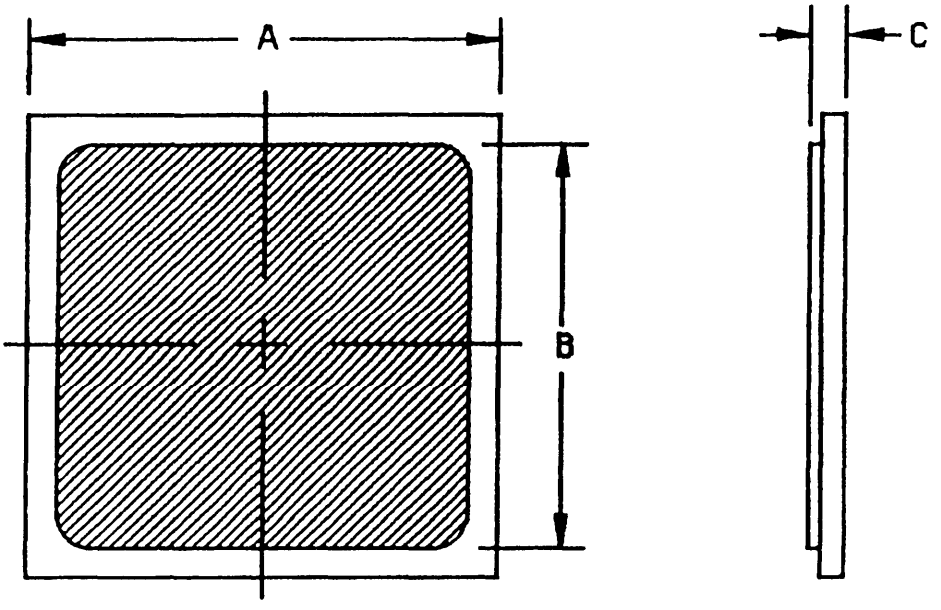


Dimensions					
Ltr	Inches		Millimeters		Notes
	Min	Max	Min	Max	
A	0.199 SQ	0.201 SQ	5.054 SQ	5.105 SQ	
B	0.009	0.011	0.229	0.279	

A version

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Back metal: Ti - Pd - Ag.
4. Top metal: Ti - Pd - Ag.
5. Metalization: Ti = 700 Å; Pd = 700 Å; Ag = 31400 Å.

FIGURE 2. Physical dimensions JANHCA and JANKCA.



Dimensions					
Ltr	Inches		Millimeters		Notes
	Min	Max	Min	Max	
A	0.191 sq	0.201 sq	4.851 sq	5.105 sq	
B	0.173 sq	0.183 sq	4.394 sq	4.648 sq	
C	0.009	0.010	0.229	0.254	

B version

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for information only.
3. Back metal: Cr - Ni - Ag
4. Top metal: Cr - Ni - Ag
5. Metalization: Cr = 800 Å minimum, Ni = 1.5 Å minimum, Ag = 3000 Å minimum.

FIGURE 3. Physical dimensions JANHCB and JANKCB.

3.5 Polarity. The polarity shall be indicated by a graphic symbol with the arrow pointing toward the cathode terminal. The reversed units shall also be marked with an R following the last digit in the type number.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500 and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500. Tests in either polarity shall be sufficient to obtain qualification approval of both polarities.

4.2.1 JANHC and JANKC devices. Qualification shall be in accordance with appendix H of MIL-S-19500.

4.3 Screening (JANTX and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-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 II of MIL-S-19500	Measurement
	JANTX and JANTXV levels
3b 2/	Surge (see 4.3.2)
3c 2/	Thermal response (see 4.3.4)
4	Not applicable
9	Not applicable
10	Not applicable
11	V_{F1} and I_{R1} 1/
12	Burn-in (see 4.3.2)
13 3/	Subgroup 2 of table I herein. V_{F1} and I_{R1}; $\Delta V_{F1} \leq \pm 0.1$ V (pk); $\Delta I_{R1} \leq \pm 5$ µA dc or 100 percent from the initial value, whichever is greater.

1/ I_{R1} measurement shall not be indicative of an open condition.
2/ May be performed at any time after screen 3a. Surge shall precede thermal response.
3/ Thermal response need not be repeated if previously screened.

4.3.1 Screening (JANHC and JANKC). Screening of die shall be in accordance with MIL-S-19500, (appendix H), as a minimum die shall be 100 percent probed in accordance with group A, subgroup 2, except test current shall not exceed 20 A.

4.3.2 Burn-in conditions. Burn-in conditions for all levels are as follows: MIL-STD-750, method 1038, test condition A; T_C = +125°C, V_R = 0.8 to 0.85 rated dc (see 1.3), t = 48 hours.

4.3.2.1 Alternate burn-in conditions. T_C = +150°C, V_R = rated V_R (see 1.3), I_O = 0, f = 50 to 60 Hz, t = 48 hours.

4.3.3 Surge current. Surge current, see MIL-STD-750, method 4066. I_O = 0; V_{RWM} = 0; I_{FSM} = 800 A; six surges; T_A = +25°C; t_p = 8.3 ms.

4.3.4 Thermal response (ΔV_F measurements). The ΔV_F measurements shall be performed in accordance with MIL-STD-750, method 3101. The ΔV_F conditions and maximum ΔV_F limit shall be derived by each vendor. The chosen ΔV_F measurement and conditions for each device in the qualification lot shall be submitted in the qualification report and a thermal response curve shall be plotted. The chosen ΔV_F value shall be considered final after the manufacturer has had the opportunity to test five consecutive lots. t_H = 100 to 250 ms; heating current I_H = 50 A. Measurement current: 50 mA ≤ I_M ≤ 250 mA; t_{MD} = 100 μs to 300 μs.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500 and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-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 IVb (JANTX and JANTXV) of MIL-S-19500 and as follows. Electrical measurements (end-points) shall be in accordance with the applicable steps of table I, group A, subgroup 2 (V_{FM1} and I_{R1} only) herein.

4.4.2.1 Group B inspection, table IVb (JANTX and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B2	4066	T_C = +55°C; V_R = rated V_R (see 1.3); six .083 s surges; 1 surge/minute; I_F (surge) = 800 A dc, I_O = 0.
B3	1037	25 percent rated I_O ≤ I_O applied ≤ rated I_O, 2,000 cycles.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and as follows. Electrical measurements (end-points) shall be in accordance with the applicable steps of table I, group A, subgroup 2 (V_{FM1} and I_{R1} only) herein.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Condition
C2	2036	Tension, test condition A, weight = 10 lbs, t = 15s.
	2036	Bending stress, test condition F, method B; weight = 15 pounds, t = 15 s.
	2036	Seal torque, test condition D1, torque = 3 inch-pound, t = 15 s.
	2036	Stud torque, test condition D2, torque = 30 inch-pound, t = 15 s.
C6	1037	25 percent rated I_O ≤ I_O applied ≤ rated I_O, 6,000 cycles.

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 measurements shall be as specified in section 4 of MIL-STD-750.

4.5.2 DC intermittent operation life. A cycle shall consist of an "on" period, when power is applied suddenly, not gradually, to the device for the time necessary to achieve a delta case temperature of +85°C +15°C -5°C, followed by an "off" period, when the power is suddenly removed, for cooling. Auxiliary (forced) cooling is permitted during the off period only. 30 s ≤ $t_{heating}$ ≤ 180 s. Within the time interval of 5 cycles before to 500 cycles after the termination of the test, the sample units shall be removed from the specified test conditions and allowed to reach room ambient conditions. Specified end-point measurements for qualification and quality conformance inspection shall be complete within 96 hours after removal of sample units from the specified conditions. Additional readings may be taken at the discretion of the manufacturer.

4.5.3 Reverse recovery time. The reverse recovery time shall be measured as shown in the circuit A of figure 4 or equivalent. Care should be exercised to minimize stray inductances in the test circuit and to ensure that the total resistance of the reverse current loop can be adjusted sufficiently low that more than two amperes will flow if not blocked by the diode being tested. Switch SW shall be activated and the regulated voltage source adjusted to achieve the following characteristics of the waveform:

a. The d_i/d_t shall be the specified value between the forward 0.5 ampere point and the reverse 0.2 ampere point.

b. The i_r(rec) shall be the maximum value obtainable, except that if it exceeds 2 amperes, the reverse-recovery time shall then be determined from the current waveform as shown in circuit B on figure 3.

4.5.4 Thermal resistance. Thermal resistance measurements shall be performed in accordance with MIL-STD-750, method 4081 or method 3101. The case reference temperature shall be held to equilibrium within the range of 20°C to 80°C during the power application, and shall be measured at the hex flat. The maximum limit of $R_{\theta JC}$ shall be 0.8°C/W. The following parameter measurements shall be used:

$I_H = I_F \geq 10$ A.

t_H = 50 to 400 ms ($t_H \geq 50$ s for method 4081).

10 mA ≤ I_M ≤ 100 mA.

$t_{MD} \leq 250$ µs.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Forward voltage	4011	I_{FM} = 70 A (pk); duty cycle ≤ 2 percent (pulsed see 4.5.1) t_p = 300 µs maximum	V_{FM1}		.975	V dc(pk)
Forward voltage	4011	I_{FM} = 150 A (pk); duty cycle ≤ 2 percent (pulsed see 4.5.1) t_p = 300 µs maximum	V_{FM2}		1.18	V dc(pk)
Reverse current	4016	DC method; V_R = rated V_R (see 1.3)	I_{R1}		25	µA dc
Subgroup 3						
High temperature operation:		T_C = +150°C				
Reverse current	4016	DC method; V_R = rated V_R (see 1.3)	I_{R2}		30	mA dc
Forward voltage	4011	I_{FM} = 70 A (pk); duty cycle ≤ 2 percent (pulsed see 4.5.1) t_p = 300 µs maximum	V_{FM3}		.84	V dc(pk)
Low temperature operation:		T_C = -55°C				
Breakdown voltage	4021	I_R = 1 mA	$V_{(BR)}$			
1N6304				50		V dc
1N6305				100		V dc
1N6306				150		V dc
Subgroup 4						
Reverse recovery time	4031	Condition B, I_f = 0.5 A dc, I_R = 1 A dc I_{REC} = 0.25 A dc, d_i/d_t = 85 A/µs (minimum), (see 4.5.3 and figure 4)	t_{rr1}		50	ns
Reverse recovery time	4031	Condition C, I_{FM} = 70 A dc, d_i/d_t = 130 A/µs (see 4.5.3 and figure 4)	t_{rr2}		60	ns
Junction capacitance	4001	V_R = 10 V, f = 1 MHz V_{sig} = 50 mV (p-p) maximum	C_J		600	pF

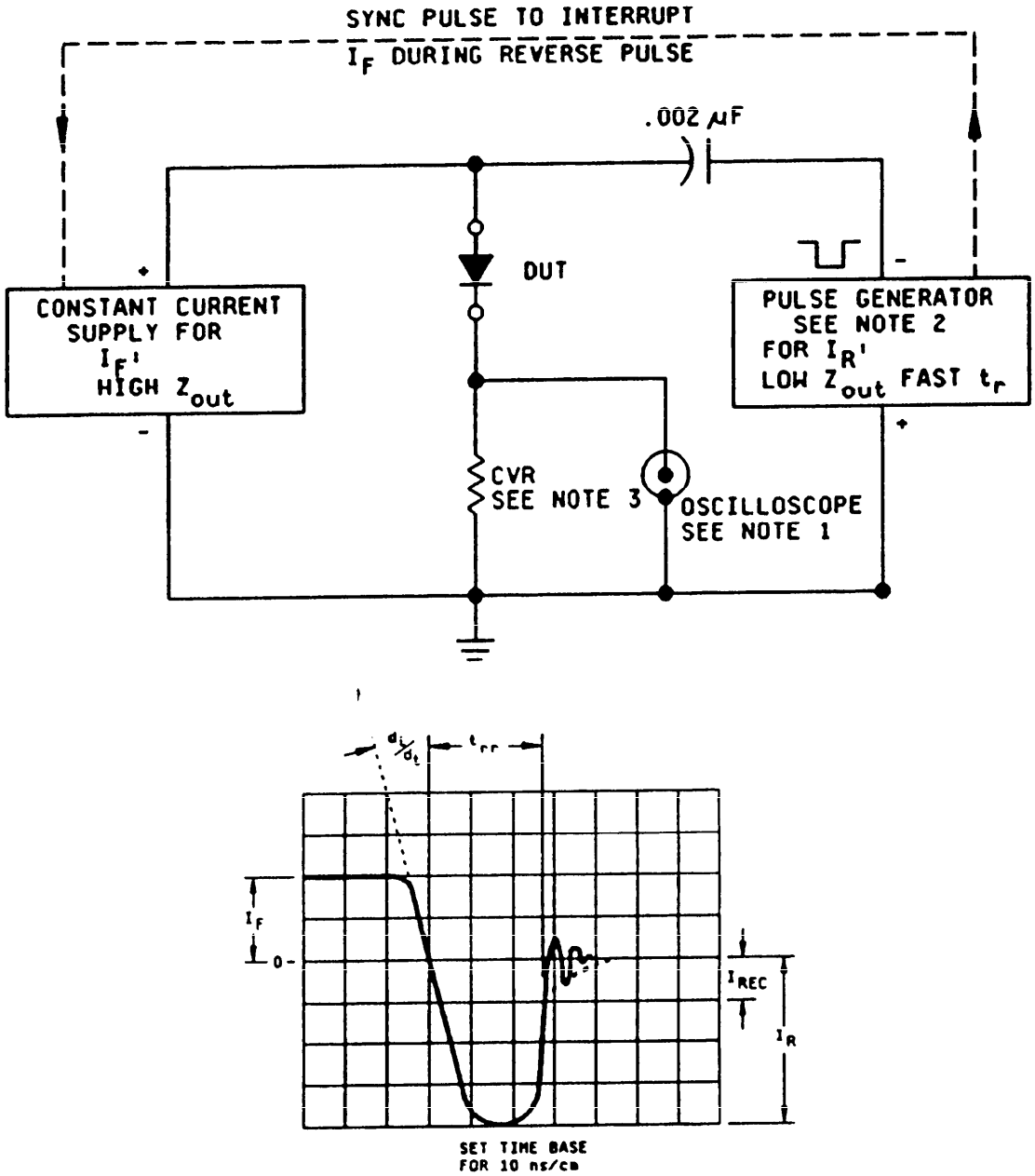
See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroups 5 and 6						
Not applicable						
Subgroup 7						
Forward recovery voltage	4026	I_{FM} = 1 A, $t_p \geq 20$ ns, t_r = 8 ns	$V_{F(Dyn)}$		2.2	V(pk)
Forward recovery time	4026	I_{FM} = 1 A	t_{fr}		15	ns

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

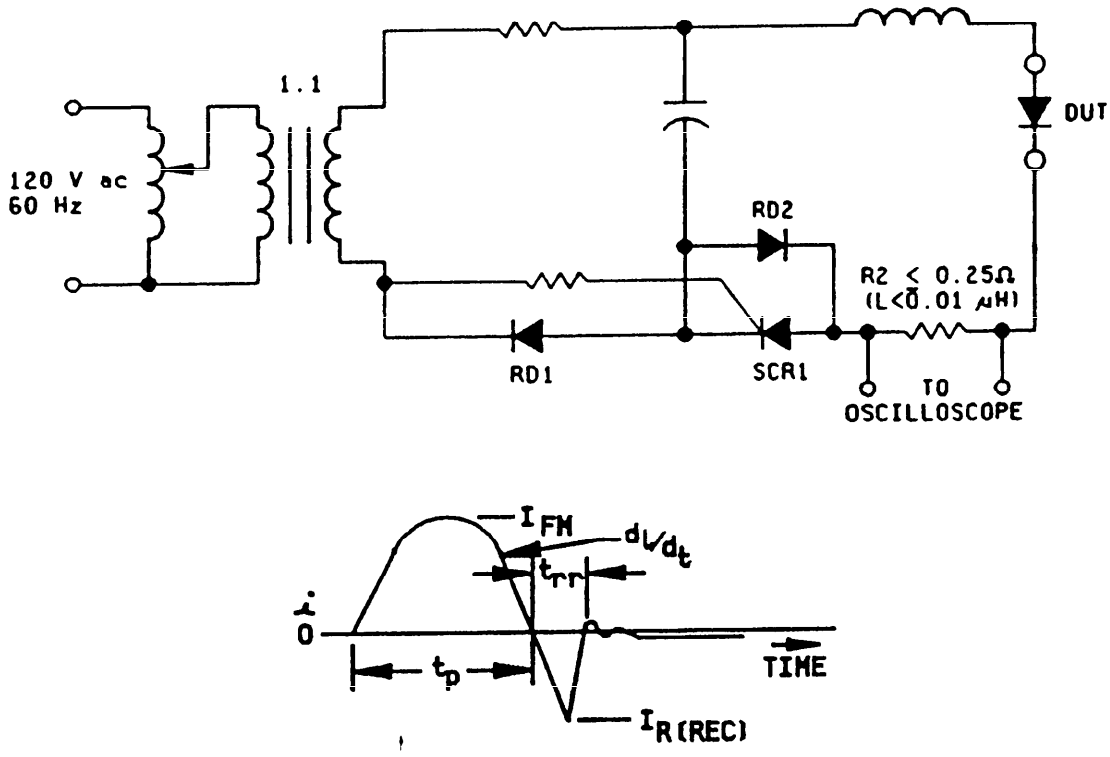
Circuit A



NOTES:
1. Oscilloscope: Rise time ≤ 1 ns; input impedance = 50 ohms maximum.
2. Pulse generator: Rise time ≤ 10 ns; source impedance 50 ohms maximum.
3. Current viewing resistor: Noninductive coaxial type with resistance matched to pulse generator impedance. An appropriate current probe may be used in place of the C.V.R. A 50 ohm, 60 ns, charge line may be used for the Z_{out}.

FIGURE 4. Reverse recovery time circuit and waveform.

Circuit B



NOTE: Select L, C, and input voltage to achieve I_{FM} and d_i/d_t specified.

FIGURE 4. Reverse recovery time circuit and waveform - Continued.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

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-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Lead finish as specified (see 3.3.1).

c. Type designation, product assurance level and for die acquisition, the manufacturer's letter identification should be specified.

6.3 Suppliers of JANC die. The qualified die suppliers will be identified on the QPL (example JANHCA1N6304).

JANC ordering information				
Military PIN	Manufacturer			
	12969	12969	59377	59377
1N6304	JANHCA1N6304	JANKCA1N6304	JANHCB1N6304	JANKCB1N6304
1N6305	JANHCA1N6305	JANKCA1N6305	JANHCB1N6305	JANKCB1N6305
1N6306	JANHCA1N6306	JANKCA1N6306	JANHCB1N6306	JANKCB1N6306

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 extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Army - AR, MI, SM
Navy - AS, CG, MC
Air Force - 13, 15, 19, 80, 85, 99

Preparing activity:
DLA - ES

(Project 5961-1667)

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INSTRUCTIONS

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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-S-19500/550A	2. DOCUMENT DATE (YYMMDD) 940630

3. DOCUMENT TITLE
SEMICONDUCTOR DEVICE, DIODE, SILICON, FAST-RECOVERY, HIGH CURRENT, TYPES 1N6305, 1N6306, AND R TYPES, 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) (1) Commercial (2) AUTOVON (if applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON
c. ADDRESS (Include Zip Code)	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340