MIL-S-19500/217B
17 January 1972
SUPERSEDING
MIL-S-19500/217A
29 September 1965

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTORS, PNP, GERMANIUM, HIGH-POWER

TYPES 2N456B, 2N457B, 2N458B, 2N1021A, 2N1022A

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for a high-power, PNP, germanium transistor (see 6.2).

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

1.3 Maximum ratings.

Type	P_T 1/ $T_C = 25°C$	V_{CBO}	V_{EBO}	V_{CEO}	I_C	T_{stg}	T_J
	W	Vdc	Vdc	Vdc	Adc	°C	°C
2N456B	150	-40	-30	-30	7	-55 to +100	+100
2N457B	150	-60	-35	-40			
2N458B	150	-80	-40	-45			
2N1021A	150	-100	-50	-50			
2N1022A	150	-120	-60	-55			

1/ Derate linearly 2.0 W/°C for $T_C > 25°C$.

1.4 Primary electrical characteristics.

	h_{FE} $I_C = -1.0$ Adc $V_{CE} = -1.5$ Vdc	h_{FE} $I_C = -5.0$ Adc $V_{CE} = -1.5$ Vdc	$\lvert h_{fe} \rvert$ $I_C = -1.0$ Adc $V_{CE} = -2.0$ Vdc f = 100 kHz	$V_{CE}(sat)$ $I_C = -5.0$ Adc $I_B = -0.5$ Adc	V_{BE} $I_C = -5.0$ Adc $V_{CE} = -1.5$ Vdc	θ_{J-C}
				Vdc	Vdc	°C/W
Min.	40	30	2.0	---	---	---
Max.	---	120	8.0	-0.5	-1.5	0.5

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATION

MILITARY

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

STANDARDS

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. Requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500.

3.3 Design and construction. Transistors shall be of the design, construction, and physical dimensions shown on figure 1.

3.4 Performance characteristics. Performance characteristics shall be as specified in tables I, II, and III.

3.5 Marking. Devices shall be marked in accordance with MIL-S-19500.

4. QUALITY ASSURANCE PROVISIONS

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

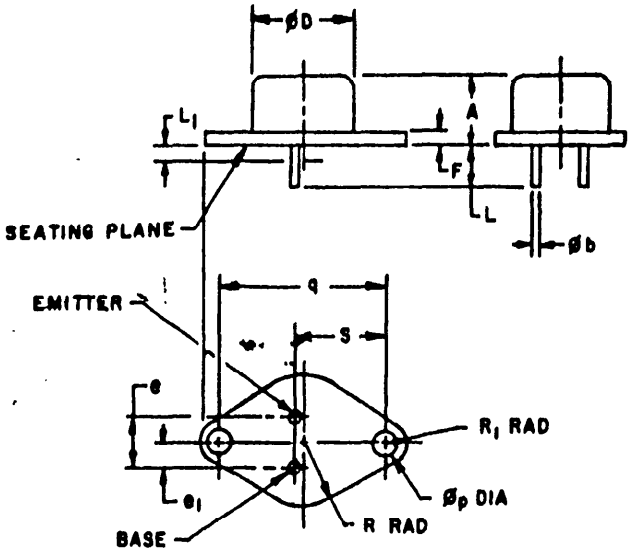
4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III. Subgroups 1, 2, 3 and 4 of group B inspection and subgroup 2 of group C inspection shall be performed on a lot basis in accordance with MIL-S-19500. Subgroups 5 and 6 of group B inspection and subgroups 3 and 4 of group C inspection shall be performed on a sublot basis for the highest and lowest voltage types being qualified to qualify those types and all voltage types between. Subgroup 1 of group C inspection shall be performed on a sublot basis for the highest voltage type being qualified to qualify that type and all lower voltage types.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of groups A, B, and C inspections.

4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I and shall be conducted on a sublot basis.

4.3.2 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table II. Subgroups 5 and 6 of group B shall be performed on a lot basis with the sample being selected from the highest voltage type represented in the lot. Subgroup 6 of group B is not required on those lots which are subjected to group C inspection.

4.3.3 Group C inspection. Group C inspection shall consist of examinations and tests specified in table III. This inspection shall be conducted on the initial lot and thereafter every six months during production. Subgroup 1 of group C shall be performed on a lot basis with the sample being selected from the highest voltage type represented in the lot. Subsequent acceptance of higher voltage types than previously subjected to group C inspection within the current six-month period requires retesting of group C inspection on a lot including the higher voltage types.



LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
ØD		.875		22.23	
A	.250	.450	6.35	11.43	
F	---	.135	---	3.43	
L	.312	.500	7.92	12.70	4
e_1	.205	.225	5.21	5.72	2, 3
e	.420	.440	10.67	11.18	2, 3
q	1.177	1.197	29.90	30.40	
s	.655	.675'	16.64	17.15	2, 3
Øb	.038	.043	.97	1.09	4, 7
R	.495	.525	12.57	13.34	
R_1	.131	.188	3.33	4.78	
Øp	.151	.161	3.84	4.09	
L_1		.050		1.27	6

NOTES:
1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. This dimension should be measured at points .050(1.27 mm) to .055(1.40 mm) below seating plane.
3. When gage is not used, measurement will be made at seating plane.
4. Two leads.
5. Collector shall be electrically connected to the case.
6. Diameter of leads in this zone is not controlled.
7. Øb applies between L_1 and L.

FIGURE 1. Physical dimensions of transistor types 2N456B, 2N457B, 2N458B, 2N1021A, and 2N1022A (TO-3).

TABLE I. Group A inspection.

Examination or test	MIL-STD-750 Method	MIL-STD-750 Details	LTPD	Symbol	Limits Min	Limits Max	Unit
Subgroup 1			10				
Visual and mechanical examination	2071			---	---	---	---
Subgroup 2			5				
Breakdown voltage, collector to emitter	3011	Bias condition D; I_C = -500 mAdc; pulsed (see 4.4.1)		BV_{CEO}			
2N456B					-30	---	Vdc
2N457B					-40	---	Vdc
2N458B					-45	---	Vdc
2N1021A					-50	---	Vdc
2N1022A					-55	---	Vdc
Breakdown voltage, collector to emitter	3011	Bias condition C; I_C = -200 mAdc; pulsed (see 4.4.1)		BV_{CES}			
2N456B					-50	---	Vdc
2N457B					-60	---	Vdc
2N458B					-65	---	Vdc
2N1021A					-70	---	Vdc
2N1022A					-75	---	Vdc
Breakdown voltage, collector to base	3001	Bias condition D; I_C = -2.0 mAdc		BV_{CBO}			
2N456B					-40	---	Vdc
2N457B					-60	---	Vdc
2N458B					-80	---	Vdc
2N1021A					-100	---	Vdc
2N1022A					-120	---	Vdc
Breakdown voltage, emitter to base	3026	Bias condition D; I_E = -2.0 mAdc		BV_{EBO}			
2N456B					-30	---	Vdc
2N457B					-35	---	Vdc
2N458B					-40	---	Vdc
2N1021A					-50	---	Vdc
2N1022A					-60	---	Vdc
Collector to emitter cutoff current	3041	Bias condition A; V_{BE} = +0.2 Vdc		I_{CEX}			
2N456B		V_{CE} = -40 Vdc			---	-2.0	mAdc
2N457B		V_{CE} = -60 Vdc			---	-2.0	mAdc
2N458B		V_{CE} = -80 Vdc			---	-2.0	mAdc
2N1021A		V_{CE} = -100 Vdc			---	-2.0	mAdc
2N1022A		V_{CE} = -120 Vdc			---	-2.0	mAdc

TABLE I. Group A inspection. - Continued

Examination or test	MIL-STD-750 Method	MIL-STD-750 Details	LTPD	Symbol	Limits Min	Limits Max	Unit
Subgroup 2 - Continued							
Collector to emitter cutoff current	3041	Bias condition D:		I_{CEO}			
2N456B		V_{CE} = -20 Vdc			---	-200	mAdc
2N457B		V_{CE} = -25 Vdc			---	-200	mAdc
2N458B		V_{CE} = -30 Vdc			---	-200	mAdc
2N1021A		V_{CE} = -35 Vdc			---	-200	mAdc
2N1022A		V_{CE} = -40 Vdc			---	-200	mAdc
Collector to base cutoff current	3036	Bias condition D:		I_{CBO}			
2N456B		V_{CB} = -20 Vdc			---	-0.5	mAdc
2N457B		V_{CB} = -30 Vdc			---	-0.5	mAdc
2N458B		V_{CB} = -40 Vdc			---	-0.5	mAdc
2N1021A		V_{CB} = -50 Vdc			---	-0.5	mAdc
2N1022A		V_{CB} = -60 Vdc			---	-0.5	mAdc
Emitter to base cutoff current	3061	Bias condition D: V_{EB} = -15 Vdc		I_{EBO}	---	-0.5	mAdc
Subgroup 3			5				
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -1.0 Adc; pulsed (see 4.4.1)		h_{FE}	40	---	---
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -3.0 Adc; pulsed (see 4.4.1)		h_{FE}	35	---	---
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -5.0 Adc; pulsed (see 4.4.1)		h_{FE}	30	120	---
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -7.0 Adc; pulsed (see 4.4.1)		h_{FE}	22	---	---
Collector to emitter voltage (saturated)	3071	I_C = -5.0 Adc; I_B = -0.5 Adc; pulsed (see 4.4.1)		$V_{CE}(sat)$	---	-0.5	Vdc
Base emitter voltage (nonsaturated)	3066	Test condition B: V_{CE} = -1.5 Vdc; I_C = -5.0 Adc; pulsed (see 4.4.1)		V_{BE}	---	-1.5	Vdc
Subgroup 4			10				
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = -2.0 Vdc; I_C = -1.0 Adc; f = 100 kHz		$\lvert h_{fe} \rvert$	2.0	8.0	---

TABLE I. Group A inspection. - Continued

Examination or test	MIL-STD-750 Method	MIL-STD-750 Details	LTPD	Symbol	Limits Min	Limits Max	Unit
Subgroup 4 - Continued							
Pulse response:							
Turn-on time	3251	Test condition A; V_{CC} = -20 Vdc; I_C = -5.0 Adc; I_{B1} = -0.5 Adc (see figure 2)		t_{on}	---	20	μs
Turn-off time	3251	Test condition A; V_{CC} = -20 Vdc; I_C = -5.0 Adc; I_{B1} = -0.5 Adc; I_{B2} = 0.5 Adc (see figure 2)		t_{off}	---	65	μs
Subgroup 5			10				
Safe area test	---	I_C = -4.0 Adc; t_p = 100 μs; f = 200 Hz; time = 10 cycles minimum (see figure 3)		V_{CE}			
2N456B					-25	---	Vdc
2N457B					-35	---	Vdc
2N458B					-40	---	Vdc
2N1021A					-45	---	Vdc
2N1022A					-50	---	Vdc
Subgroup 6			10				
High-temperature operation:		T_C = 70°C					
Collector to base cutoff current	3036	Bias condition D;		I_{CBO}			
2N456B		V_{CB} = -40 Vdc			---	-7.0	mAdc
2N457B		V_{CB} = -60 Vdc			---	-7.0	mAdc
2N458B		V_{CB} = -80 Vdc			---	-7.0	mAdc
2N1021A		V_{CB} = -100 Vdc			---	-7.0	mAdc
2N1022A		V_{CB} = -120 Vdc			---	-7.0	mAdc
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -5.0 Adc; pulsed (see 4.4.1)		h_{FE}	30	150	---
Low-temperature operation:		T_C = -55°C					
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -5.0 Adc; pulsed (see 4.4.1)		h_{FE}	20	---	---

TABLE II. Group B inspection.

Examination or test	MIL-STD-750 Method	MIL-STD-750 Details	LTPD	Limits Symbol	Limits Min	Limits Max	Unit
Subgroup 1			20				
Physical dimensions	2066	(See figure 1)		---	---	---	---
Subgroup 2			15				
Solderability	2026	Dwell time 10 1 sec.		---	---	---	---
Thermal shock (temperature cycling)	1051	Test condition A: 10 cycles: except high temperature 100 $^{+3}_{-0}$ C: time at temperature extremes 15 minutes (minimum)		---	---	---	---
Thermal shock (glass strain)	1056	Test condition B		---	---	---	---
Terminal strength (tension)	2036	Test condition A: weight 10 pounds: time 15 ±3 sec. each lead		---	---	---	---
Hermetic seal	1071	Test condition G or H for fine leaks: test condition A, C, D, or F for gross leaks		---	---	5×10^{-7}	atm cc/s
Moisture resistance	1021	Omit initial conditioning		---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias condition D:		I_{CBO}			
2N456B		V_{CB} = -20 Vdc			---	-0.5	mAdc
2N457B		V_{CB} = -30 Vdc			---	-0.5	mAdc
2N458B		V_{CB} = -40 Vdc			---	-0.5	mAdc
2N1021A		V_{CB} = -50 Vdc			---	-0.5	mAdc
2N1022A		V_{CB} = -60 Vdc			---	-0.5	mAdc
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc: I_C = -5.0 Adc: pulsed (see 4.4.1)		h_{FE}	30	120	---
Subgroup 3			15				
Shock	2016	Nonoperating: 500 G: for 1.0 ms: 5 blows in each orientation: X_1, Y_1, Y_2, and Z_1		---	---	---	---
Vibration, variable frequency	2056	10 G: nonoperating		---	---	---	---
Constant acceleration	2006	5,000 G: in each orientation: X_1, Y_1, Y_2, and Z_1		---	---	---	---
End points:							
(Same as subgroup 2)							

TABLE II. Group B inspection. - Continued

Examination or test	MIL-STD-750 Method	MIL-STD-750 Details	LTPD	Symbol	Limits Min	Limits Max	Unit
Subgroup 4			15				
Salt atmosphere (corrosion)	1041	Electrical rejects maybe used		---	---	---	---
Subgroup 5			7				
High-temperature life (nonoperating)	1032	T_{stg} = +100°C; time = 340 hours (see 4.3.4)		---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias condition D;		I_{CBO}			
2N456B		V_{CB} = -20 Vdc			---	-1.0	mAdc
2N457B		V_{CB} = -30 Vdc			---	-1.0	mAdc
2N458B		V_{CB} = -40 Vdc			---	-1.0	mAdc
2N1021A		V_{CB} = -50 Vdc			---	-1.0	mAdc
2N1022A		V_{CB} = -60 Vdc			---	-1.0	mAdc
Forward-current transfer ratio	3076	V_{CE} = -1.5 Vdc; I_C = -5.0 Adc: pulsed (see 4.4.1)		h_{FE}	24	150	---
Subgroup 6			10				
Steady state operation life	1027	T_C = +75°C; P_T = 20 watts; V_{CB} = -10 to -15 Vdc; time = 340 hours (see 4.3.4)		---	---	---	---
End points:							
(Same as subgroup 5)							

TABLE III. Group C inspection.

Examination or test	MIL-STD-750 Method	MIL-STD-750 Details	LTPD	Symbol	Limits Min	Limits Max	Unit
Subgroup 1			15				
Barometric pressure, reduced (altitude operation)	1001	Normal mounting; Pressure = 8 mm Hg for 60 sec min.		---	---	---	---
Measurement during test:							
Collector to base cutoff current	3036	Bias condition D;		I_{CBO}	---	---	---
2N456B		V_{CB} = -40 Vdc			---	-2.0	mAdc
2N457B		V_{CB} = -60 Vdc			---	-2.0	mAdc
2N458B		V_{CB} = -80 Vdc			---	-2.0	mAdc
2N1021A		V_{CB} = -100 Vdc			---	-2.0	mAdc
2N1022A		V_{CB} = -120 Vdc			---	-2.0	mAdc

TABLE III. Group C inspection. - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 1 - Continued							
Thermal resistance, junction to case	3136	$T_2 = T_J = 90 \pm 10°C$; $T_1 = T_C = 45 \pm 10°C$; I_C (measurement) = +50 mAdc		θ_{J-C}	---	0.5	°C/W
Subgroup 2			10				
Resistance to solvents	---	Method 215 of MIL-STD-202 (see 4.4.2)		---	---	---	---
Subgroup 3			$\lambda = 10$				
High-temperature life (nonoperating)	1031	$T_{stg} = 100°C$ (see 4.3.4)		---	---	---	---
End points:							
(Same as subgroup 5 of group B)							
Subgroup 4			$\lambda = 10$				
Steady-state operation life	1026	$T_C = +90°C$; P_T = 20 watts; V_{CB} = -10 to -15 Vdc (see 4.3.4)		---	---	---	---
End points:							
(Same as subgroup 5 of group B)							

4.3.4 Group B and group C life-test samples. Samples that have been subjected to group B, 340-hours life-test, may be continued on test to 1,000 hours in order to satisfy group C life-test requirements. These samples shall be predesignated, and shall remain subjected to the group C 1,000 hour acceptance evaluation after they have passed the group B, 340-hour acceptance criteria. The cumulative total of failures found during 340-hour test and during the subsequent interval up to 1,000 hours shall be computed for 1,000-hours acceptance criteria, see 4.3.3.

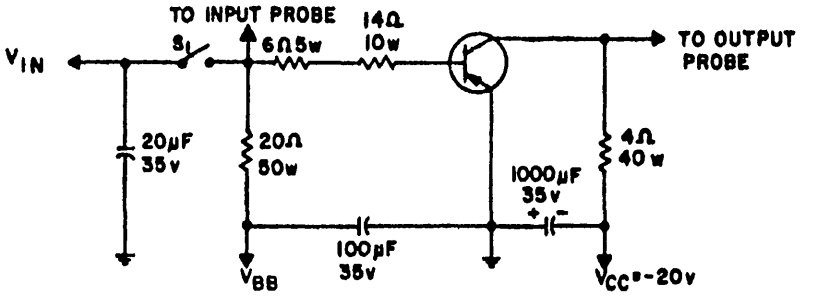
4.4 Methods of examination and test. Methods of examination and test shall be as specified in tables I, II, and III, and as follows:

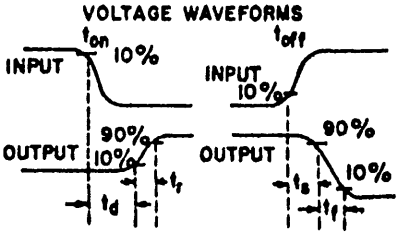
4.4.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.4.2 Resistance to solvents. Transistors shall be subjected to tests in accordance with method 215 of MIL-STD-202. The following details shall apply:

(a) All areas of the transistor body where marking has been applied shall be brushed.
(b) After subjection to the tests there shall be no evidence of mechanical damage to the device and markings shall have remained legible.

4.4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be conducted at a case temperature (T_C) of +25° ±3°C.



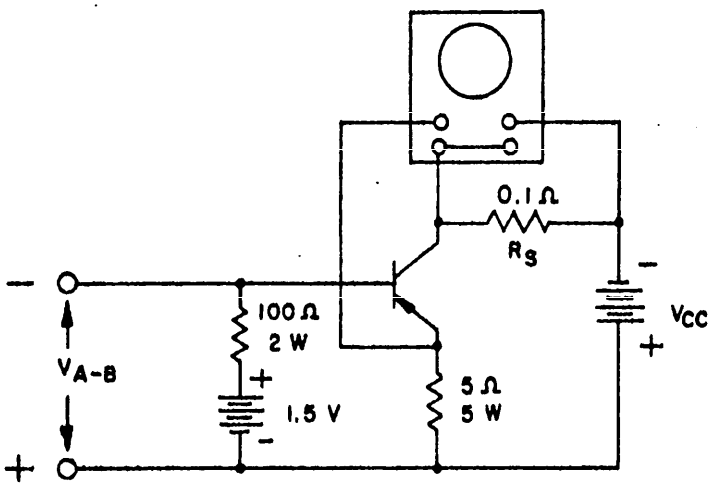


CIRCUIT CONDITIONS

Test	V_{BB}	V_{in}
Turn-On (t_d, t_r)	+9v	-11v
Turn-Off (t_s, t_f)	-21v	+9v

NOTES:
1. Relay S_1 has mecury wetted contacts and provides rise times less than 1/10 of the switching times measured.
2. Duty cycle of S_1 is such that the transistor is ON 4 ms and OFF 12 ms in both turn-on and turn-off tests.
3. Waveforms monitored on scope with following characteristics: (a) Rise time 14 ns max, (b) input capacitance 11.5 pF max, (c) input resistance 10 megohms min.
4. All resistors 5% tolerance, noninductive type.

FIGURE 2. Pulse response test circuit.



Type	V_{CC}	V_{CE}	I_C
	Vdc	Vdc	Adc
2N456B	45.4	25	4.0
2N457B	55.4	35	4.0
2N458B	60.4	40	4.0
2N1021A	65.4	45	4.0
2N1022A	70.4	50	4.0

NOTE: V_{CC} and V_{AB} are regulated power supplies (± 1% both line and load). Adjustment will be necessary to set the exact current and voltage points specified.

FIGURE 3. Safe area test circuit.

5. PREPARATION FOR DELIVERY

5.1 See MIL-S-19500, section 5.

6. NOTES

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Transistor types 2N456B, 2N457B, 2N458B, 2N1021A, and 2N1022A are recommended as electrical and mechaincal replacements for the following transistor types, respectively:

2N456A	2N1021
2N457A	2N1022
2N458A	

Custodians:
Army - EL
Navy - EC
Air Force - 17

Review activities:
Army - EL, MU, MI
Navy - OS
Air Force - 11, 80
DSA - ES

User activities:
Army - EL, SM
Navy - CG, MC, AS, SH
Air Force -

Preparing activity:
Army - EL

Agent:
DSA - ES

(Project 5961-0271)