

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	$\frac{P_T}{T_C} \frac{1}{25^\circ C}$	V_{CBO}	V_{EBO}	V_{CEO}	I_C	T_{stg}	T_J
	<u>W</u>	<u>Vdc</u>	<u>Vdc</u>	<u>Vdc</u>	<u>Adc</u>	<u>°C</u>	<u>°C</u>
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 $T_C > 25^\circ C$.

1.4 Primary electrical characteristics.

	h_{FE} $I_C = -1.0 \text{ Adc}$ $V_{CE} = -1.5 \text{ Vdc}$	h_{FE} $I_C = -5.0 \text{ Adc}$ $V_{CE} = -1.5 \text{ Vdc}$	$ h_{fe} $ $I_C = -1.0 \text{ Adc}$ $V_{CE} = -2.0 \text{ Vdc}$ $f = 100 \text{ kHz}$	$V_{CE(sat)}$ $I_C = -5.0 \text{ Adc}$ $I_B = -0.5 \text{ Adc}$	V_{BE} $I_C = -5.0 \text{ Adc}$ $V_{CE} = -1.5 \text{ Vdc}$	θ_{J-C}
				<u>Vdc</u>	<u>Vdc</u>	<u>°C/W</u>
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.

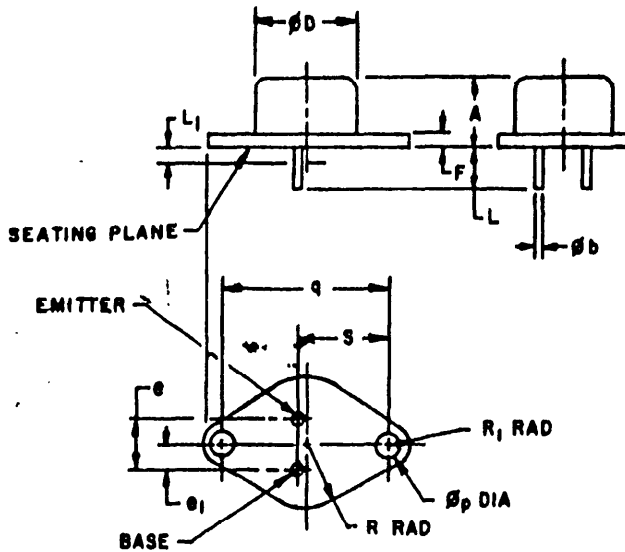
4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III. Subgroups 1, 2, 3 and 4 of group B inspection and subgroup 2 of group C inspection shall be performed on a lot basis in accordance with MIL-S-19500. Subgroups 5 and 6 of group B inspection and subgroups 3 and 4 of group C inspection shall be performed on a subplot 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 subplot 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 subplot 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 L₁ 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		L T P D	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 1</u>			10				
Visual and mechanical examination	2071			---	---	---	---
<u>Subgroup 2</u>			5				
Breakdown voltage, collector to emitter	3011	Bias condition D; $I_C = -500 \text{ mA dc}$; 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; $I_C = -200 \text{ mA dc}$; 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; $I_C = -2.0 \text{ mA dc}$		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; $I_E = -2.0 \text{ mA dc}$		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; $V_{BE} = +0.2 \text{ Vdc}$		I_{CEX}			
2N456B		$V_{CE} = -40 \text{ Vdc}$			---	-2.0	mA dc
2N457B		$V_{CE} = -60 \text{ Vdc}$			---	-2.0	mA dc
2N458B		$V_{CE} = -80 \text{ Vdc}$			---	-2.0	mA dc
2N1021A		$V_{CE} = -100 \text{ Vdc}$			---	-2.0	mA dc
2N1022A		$V_{CE} = -120 \text{ Vdc}$			---	-2.0	mA dc

TABLE I. Group A inspection. - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 2 - Continued</u>							
Collector to emitter cutoff current	3041	Bias condition D: 2N456B $V_{CE} = -20$ Vdc 2N457B $V_{CE} = -25$ Vdc 2N458B $V_{CE} = -30$ Vdc 2N1021A $V_{CE} = -35$ Vdc 2N1022A $V_{CE} = -40$ Vdc		I_{CFO}	---	-200	mAde
					---	-200	mAde
					---	-200	mAde
					---	-200	mAde
					---	-200	mAde
Collector to base cutoff current	3036	Bias condition D: 2N456B $V_{CB} = -20$ Vdc 2N457B $V_{CB} = -30$ Vdc 2N458B $V_{CB} = -40$ Vdc 2N1021A $V_{CB} = -50$ Vdc 2N1022A $V_{CB} = -60$ Vdc		I_{CBO}	---	-0.5	mAde
					---	-0.5	mAde
					---	-0.5	mAde
					---	-0.5	mAde
					---	-0.5	mAde
Emitter to base cutoff current	3061	Bias condition D: $V_{EB} = -15$ Vdc		I_{EBO}	---	-0.5	mAde
<u>Subgroup 3</u>							
Forward-current transfer ratio	3076	$V_{CE} = -1.5$ Vdc; $I_C = -1.0$ Adc; pulsed (see 4.4.1)	5	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
<u>Subgroup 4</u>							
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	10	$ h_{fe} $	2.0	8.0	---

TABLE I. Group A inspection. - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 4 - Continued</u>							
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)	10	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
<u>Subgroup 5</u>							
Safe area test	---	$I_C = -4.0$ Adc; $t_p = 100$ μs; $f = 200$ Hz; time = 10 cycles minimum (see figure 3)	10	V_{CE}	---	---	---
2N456B					-25	---	Vdc
2N457B					-35	---	Vdc
2N458B					-40	---	Vdc
2N1021A					-45	---	Vdc
2N1022A			-50	---	Vdc		
<u>Subgroup 6</u>							
High-temperature operation:							
Collector to base cutoff current	3036	Bias condition D;	10	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:							
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.

MIL-S-19500 217B

Examination or test	MIL-STD-750		I T P D	Limits		
	Method	Details		Symbol	Min.	Max.
<u>Subgroup 1</u>			20			
Physical dimensions	2066	(See figure 1)		---	---	---
<u>Subgroup 2</u>			15			
Solderability	2026	Dwell time 10 ± 1 sec.		---	---	---
Thermal shock (temperature cycling)	1051	Test condition A: 10 cycles; except high temperature 100 ± 3 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		---	5x10 ⁻⁷	atmospheres
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	mAde
2N457B		V _{CB} = -30 Vdc		---	-0.5	mAde
2N458B		V _{CB} = -40 Vdc		---	-0.5	mAde
2N1021A		V _{CB} = -50 Vdc		---	-0.5	mAde
2N1022A		V _{CB} = -60 Vdc		---	-0.5	mAde
Forward-current transfer ratio	3076	V _{CE} = -1.5 Vdc; I _C = -5.0 Ade; pulsed (see 4.4.1)		h _{FE}	30	120
<u>Subgroup 3</u>			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		L T P D	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 4</u>			15				
Salt atmosphere (corrosion)	1041	Electrical rejects maybe used		---	---	---	---
<u>Subgroup 5</u>			7				
High-temperature life (nonoperating)	1032	$T_{stg} = +100^{\circ}C$; 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	---
<u>Subgroup 6</u>			10				
Steady state operation life	1027	$T_C = +75^{\circ}C$; $P_T = 20$ 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		L T P D	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 1</u>			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		L T P D	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 1 - Continued</u>							
Thermal resistance, junction to case	3136	$T_2 = T_J = 90 \pm 10^\circ \text{C};$ $T_1 = T_C = 45 \pm 10^\circ \text{C};$ I_C (measurement) = + 50 mAdc		θ_{J-C}	---	0.5	$^\circ \text{C/W}$
<u>Subgroup 2</u>							
Resistance to solvents	---	Method 215 of MIL-STD-202 (see 4.4.2)	10	---	---	---	---
<u>Subgroup 3</u>							
High-temperature life (nonoperating)	1031	$T_{stg} = 100^\circ \text{C}$ (see 4.3.4)	$\lambda = 10$	---	---	---	---
End points: (Same as subgroup 5 of group B)							
<u>Subgroup 4</u>							
Steady-state operation life	1026	$T_C = +90^\circ \text{C}; P_T = 20$ watts; $V_{CB} = -10$ to -15 Vdc (see 4.3.4)	$\lambda = 10$	---	---	---	---
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.

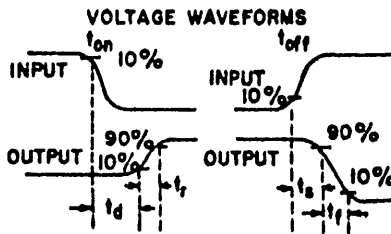
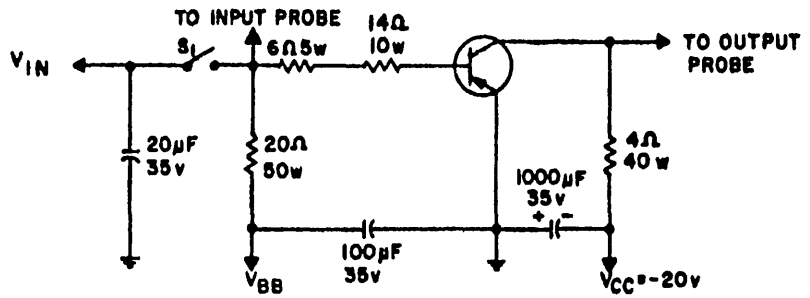
4.4 Methods of examination and test. Methods of examination and test shall be as specified in tables I, II, and III, and as follows:

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 $+25^\circ \pm 3^\circ \text{C}$.



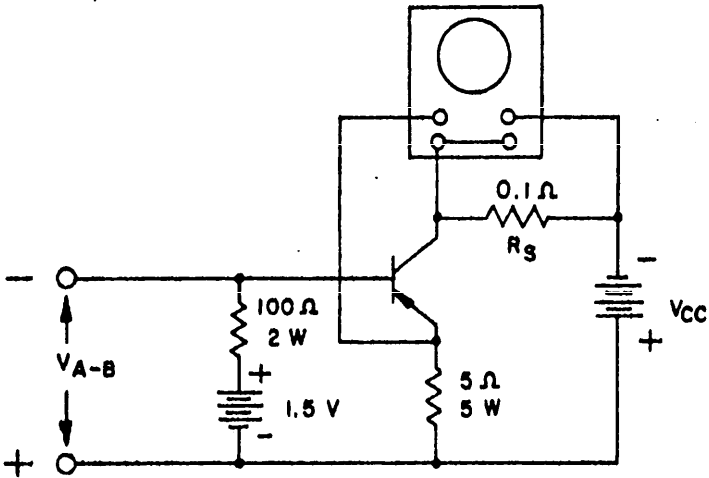
CIRCUIT CONDITIONS

Test	V _{BB}	V _{in}
Turn-On (t _d , t _r)	+9v	-11v
Turn-Off (t _s , t _f)	-21v	+9v

NOTES:

1. Relay S₁ has mercury wetted contacts and provides rise times less than 1/10 of the switching times measured.
2. Duty cycle of S₁ 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
	V _{dc}	V _{dc}	A _{dc}
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 ($\pm 1\%$ 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 mechanical replacements for the following transistor types, respectively:

2N456A	2N1021
2N457A	2N1022
2N458A	

Custodians:

Army - EL
Navy - EC
Air Force - 17

Preparing activity:

Army - EL

Review activities:

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

Agent:

DSA - ES

(Project 5961-0271)

User activities:

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