

MILITARY SPECIFICATION
CV 7440
 SEMICONDUCTOR DEVICE TRANSISTOR
 2N1613

Description:- This specification covers the detail requirements for a NPN Silicon Planar Transistor and is in accordance with K1007, Issue 3, except as otherwise stated.

Mechanical Dimensions and Outlines:- K1007, Section B.
 10.3.2.2 and 10.4.2.2.

Connections:- Lead 1. Emitter
 Lead 2. Base
 Lead 3. Collector, internally connected to case.

Absolute Maximum Ratings:-

Rating	V _{CB}	V _{EB}	V _{CER}	P _{tot}	P _{tot}	P _{tot}	T _{stg}	T _j	Shock	Vib.
Unit	V	V	V	W	W	W	°C	°C	g	g
Min.	-	-	-	-	-	-	-65	-	-	-
Max.	75	7	50	3.0	1.7	0.8	200	200	1500	20
Notes			A	B	C	D			E	

- Note A. $R_{BE} < 10\text{ohms}$ (Pulsed)
 B. Case temperature 25°C
 C. Case temperature 100°C
 D. Ambient temperature 25°C
 E. Duration 0.5 μs.

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Primary Electrical Characteristics

Characteristic	I_{CBO}	I_{CBO}	h_{FE}	h_{FE}	h_{FE}	h_{FE}	h_{FE}	h_{FE}	C_{ob}	C_{ib}
Unit	nA	μ A							pF	pF
Min	-	-	20	35	20	40	20	3.0	-	-
Max.	10	10	-	-		120	-	-	25	80

CONDITIONS	V_{CB}	V	60	60								
	V_{CE}	V			10	10	10	10	10	10	10	
	I_C	mA			0.1	10	10	150	500	50		
	I_E	mA	0	0							0	
	V_{EB}	V									0.5	
	T_{amb}	$^{\circ}$ C	25	150	25	25	-55	25	25	25	25	25
	Freq:	Mc/s	-	-	-	-	-	-	-	20	-	-

Characteristic	h_{fe}	h_{fe}	V_{CE} (sat)	V_{BE} (sat)	F	$T_{on} + T_{off}$
Unit			V	V	dB	nSec
Min	30	35	- -	-	-	-
Max	100	150	1.5	1.3	12	30

CONDITIONS	V_{CE}	V	5	10			10	
	I_C	mA	1	5	150	150	0.3	
	I_B	mA			15	15		
	f	kc/s	1	1			1	
	R_G	ohms					510	
	Notes							See Fig.2 Page 13

Reliability Assurance Provisions: Under discussion

Requirements:-

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Marking The device shall be marked as K1007 Section B. 1.3.4.1(a), (c), (d) and (f) as space permits, any other marking shall be on the packing.

Quality Assurance Provisions:

Destructive Tests The tests listed in Table 2. Group B Inspection, Sub Groups 2, 3 and 4 are considered destructive.

Group C Inspection This inspection shall be conducted on the initial lot, and thereafter every ninety days or every fifth lot, whichever occurs first.

Preparation for Delivery

Packaging The device shall be packed according to K1007, Issue 3. Section A. 1.2.(c).

Joint Service Catalogue Number 5960-99-037-3504

This specification has been prepared by, and the Qualification Approval Authority is:-

Ministry of Aviation, Royal Radar Establishment, Malvern, Worcs. England.

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TABLE 1 GROUP A INSPECTION

Examination or Test	TEST CONDITIONS		AQL %	Insp. Level	Sym-bol	LIMITS		Units
	K1007/NATO Ref.	Specific Conditions				Min.	Max.	
<u>SUB GROUP 1</u> Visual and Mechanical Inspection	5.1	Excluding Physical Dimensions	0.65	I				
<u>SUB GROUP 2</u> Collector-emitter sustaining voltage	7.2.2.2	$R_{BE} = 10 \text{ ohms}$ $I_C = 100 \text{ mA}$ Pulse width $< 300 \mu\text{s}$ $\leq 2\%$ duty cycle	1.0	II	$V_{CER} \text{ (sust)}$	50		V
Collector-emitter sustaining voltage	7.2.2.2.1	$t_p \leq 300 \mu\text{Sec.}$ $\leq 2\%$ duty cycle $I_C = 100 \text{ mA}$			$V_{CEO} \text{ (sust)}$	-30		V
Collector-Base cut-off current	7.2.5.1	$V_{CB} = 60\text{V}$ $I_E = 0$ $V_{EB} = 5\text{V}$			I_{CBO}	-	10	nA
Emitter-Base cut-off current					I_{EBO}	-	10	μA
Static-forward current transfer ratio	7.3.4	$I_C = 150 \text{ mA}$ $V_C = 10\text{V}$ Pulse width $300\mu\text{Sec}$ $\leq 2\%$ duty cycle			h_{FE}	40	120	
Base-emitter saturation voltage	7.3.1	$I_C = 150 \text{ mA}$ $I_B = 15 \text{ mA}$			$V_{BE} \text{ (sat)}$	-	1.3	V

TABLE 1 GROUP A INSPECTION (Cont'd)

Examination or Test	K1007/NATO Ref.	TEST CONDITIONS Specific Conditions	AQL %	Insp. Level	Sym- bol	LIMITS		Units
						Min.	Max.	
Collector-Emitter Saturation Voltage	7.3.5	$I_C = 150 \text{ mA}$			$V_{CE} \text{ (set)}$	-	1.5	V
		$I_B = 15 \text{ mA}$						
		$I_E = 100 \mu\text{A}$						
<u>SUB GROUP 3</u> Small Signal Forward Current Transfer Ratio	7.4.2	$I_C = 1 \text{ mA}$	4.0	I	h_{fe}	30	100	
		$V_C = 5V$						
		$f = 1 \text{ Kc.}$						
		$I_C = 5 \text{ mA}$						
Static forward current transfer ratio	7.4.2	$V_C = 10 \text{ V}$			h_{fe}	35	150	
		$f = 1 \text{ Kc.}$						
		$I_C = 50 \text{ mA}$						
		$V_C = 10 \text{ V}$						
Static forward current transfer ratio	7.3.4	$f = 20 \text{ Mc/s.}$			h_{FE}	20	-	
		$I_C = 500 \text{ mA}$						
		$V_{CE} = 10V$						
		$t_p \leq 300 \mu\text{Sec, } \leq 2\% \text{ duty cycle.}$						
Static forward current transfer ratio	7.3.4	$I_C = 10 \text{ mA}$			h_{FE}	35	-	
		$V_{CE} = 10 \text{ V}$						
		$I_C = 0.1 \text{ mA}$						
		$V_{CE} = 10V$						

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TABLE 1 GROUP A INSPECTION (Cont'd)

Examination or Test	K1007/NATO Ref.	TEST CONDITIONS		AQL %	Insp. Level	Sym-bol	LIMITS		Units
		Specific Conditions					Min.	Max.	
<u>SUB GROUP 4</u> Collector Base Cut-off	7.2.5.1	$T_{amb} = 150^{\circ}C \pm 3^{\circ}C$ $V_{CB} = 60V$ $I_E = 0$		6.5	IA	I_{CBO}	-	10	μA
Static Forward Current Transfer Ratio	7.3.4	$T_{amb} = -55^{\circ}C$ $I_C = 10\text{ mA}$ $V_{CE} = 10V$ See Fig. 2 Page 13				h_{FE}	20		
Total Switching Time						$t_{on} + t_{off}$	-	30	nSec
Noise Figure						NF		12	db
Output Capacitance	7.4.8	$I_C = 0.3\text{ mA}$ $V_C = 10V$ $f = 1\text{ kc/s}$ $R_g = 510\text{ ohms}$ 200 cycle bw $I_C = 0$ $V_{CB} = 10V$ $f = 1\text{ Mc/s}$ $I_C = 0$ $V_{EB} = -0.5V$ $f = 1\text{ Mc/s}$				C_{ob}	-	25	pF
Input Capacitance						C_{ib}	-	80	pF

TABLE 2 GROUP B INSPECTION

See Page 3 Quality Assurance Provisions, Destructive Tests

Examination or Test	K1007/NATO Ref.	TEST CONDITIONS Specific Conditions	AQL %	Insp. Level	Sym- bol	LIMITS		Units
						Min.	Max.	
<u>SUB GROUP 1</u> Physical	5.1	According to drawings 10.3.2.2 and 10.4.2.2	6.5	IE				
<u>SUB GROUP 2</u> Solderability	5.13		4.0	IA				
Temperature Cycling	5.5	3 cycles -55°C to +200°C						
Thermal Shock	5.6.2	100°C to 0°C						
Moisture Resistance	5.3.1							
<u>SUB GROUP 3</u> Vibration Fatigue	5.15	Non operating	4.0	I Note 1				
<u>SUB GROUP 4</u> Lead Fatigue	5.10.2	2 cycles	6.0	IA				
<u>SUB GROUP 5</u> Omitted								
<u>SUB GROUP 6</u> Omitted								

TABLE 2 GROUP B INSPECTION (Cont'd)

Examination or Test	TEST CONDITIONS		AQL %	Insp. Level	Sym- bol	LIMITS		Units
	K1007/NATO Ref.	Specific Conditions				Min.	Max.	
<u>SUB GROUP 7</u>			4.0	I				
High Temperature Life	6.2.1 6.6 6.6.1.2.2.	$T_{stg} = +200^{\circ}C$ $+0^{\circ}C$ $-10^{\circ}C$ Duration 1000 hours		Note 1				
<u>SUB GROUP 8</u>			4.0	IA				
Operating Life	6.3 6.6 6.6.1.2.2.	$T_{amb} = 25^{\circ}C$ $V_{CB} = 40V$ $P_C = 800 mW$ $I_C = 20.0 mA$						
<u>Post test end points for Sub Groups 2 and 2</u>								
Collector-Base Cut-off Current	7.2.5.1	$V_{CB} = 60V$ $I_E = 0$			I_{CBO}	-	0.1	μA
Collector-Emitter Saturation Voltage	7.3.5	$I_C = 150 mA$ $I_B = 15 mA$			$V_{CE (sat)}$	-	1.65	V
Base-Emitter Saturation Voltage	7.3.1	$I_C = 150 mA$ $I_B = 15 mA$			$V_{BE (sat)}$	-	1.45	V

TABLE 2 GROUP B INSPECTION (Cont'd)

Examination or Test	K1007/NATO Ref.	TEST CONDITIONS		AQL %	Insp. Level	Sym-bol	LIMITS		Units
		Specific Conditions					Min.	Max.	
<u>Post Test end points for Sub Groups 7 and 8</u> Collector-Base Cut-off Current Static Forward Current transfer ratio	7.2.5.1 7.3.4	$V_{CB} = 60V$ $I_E = 0$ $I_C = 150 \text{ mA}$ $V_{CE} = 10 V$ $t_p = \leq 300\mu\text{Sec}$ duty cycle $\leq 2\%$				I_{CBO} h_{FE}	- 30 -	/ μA	

TABLE 3 GROUP C INSPECTION
 See Page 3, Quality Assurance Provisions, Group C Inspection

Examination or Test	K1007/NATO Ref.	TEST CONDITIONS		AQL %	Insp. Level	Sym-bol	LIMITS		Units
		Specific Conditions					Min.	Max.	
<u>SUB GROUP 1</u> Input Resistance		$I_C = 1mA$		2.5	II	h_{ie}	1000	4000	ohms
	$V_C = 5V$								
	$f = 1Kc$								
	$I_C = 5mA$								
	$V_C = 10V$								
	$f = 1Kc.$								
	$I_C = 1mA$								
	$V_C = 5V$								
	$f = 1Kc$								
	$I_C = 5mA$								
Voltage Feedback		$I_C = 10V$				h_{re}	-	3×10^{-4}	ohms
	$V_C = 1Kc$								
	$I_C = 5mA$								
	$V_C = 10V$								
	$f = 1Kc$								
	$I_C = 1mA$								
	$V_C = 5V$								
	$f = 1Kc$								
	$I_C = 5mA$								
	$V_C = 10V$								
Output Conductance		$f = 1Kc$				h_{ob}	3.5	25	μmho
	$I_C = 1mA$								
	$V_C = 5V$								
	$f = 1Kc$								
	$I_C = 5mA$								
	$V_C = 10V$								
	$f = 1Kc$								
	$I_C = 1mA$								
	$V_C = 5V$								
	$f = 1Kc$								

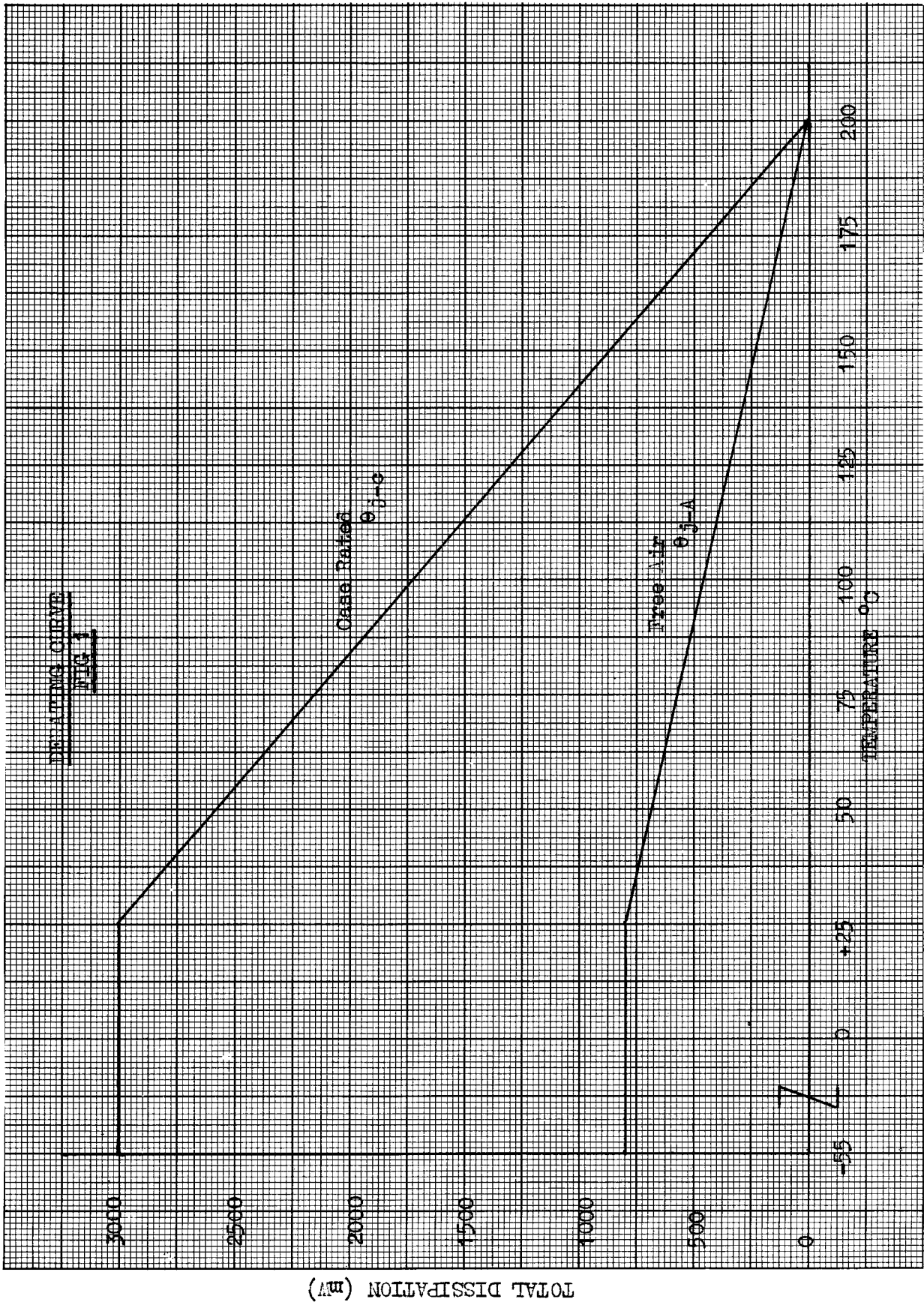
TABLE 3 GROUP C INSPECTION (Cont'd)

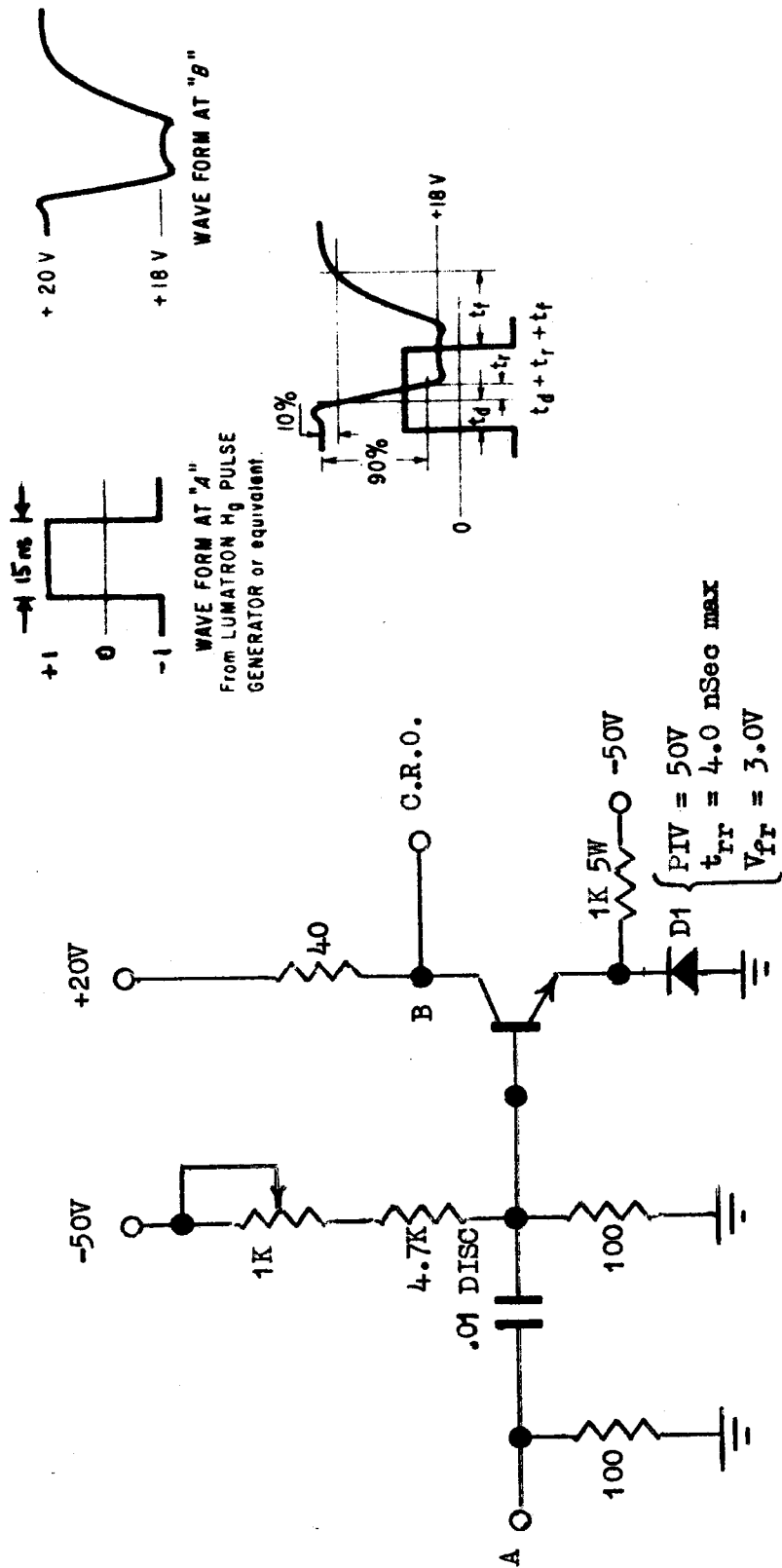
Examination or Test	K1007/NATO Ref.	TEST CONDITIONS		AQL %	Insp. Level	Sym- bol	LIMITS		Units
		Specific Conditions					Min.	Max.	
<u>SUB GROUP 2</u>				6.5	IA				
Shock (non operating)	5.17.1	5 blows in each of three mutually perpendicular directions. $I_E = 0$ $I_C = 100 \mu A$					75		V
Collector Voltage	7.2.1	$I_C = 0$ $I_E = 100 \mu A$							V
Emitter-Base breakdown voltage	7.2.3	$I_C = 0$ $I_E = 100 \mu A$					7	-	V
<u>Post test end points</u>									
As for Group B Inspection, Sub-Groups 2, and 3									

NOTES

1. The maximum sample size is 125.

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SWITCHING TIME MEASUREMENT CIRCUIT