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FINAL REPORT
FOR
JANTX 2N2920

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Prepared
For

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FOREWORD

This report is a summary of the work performed on NASA Contract NAS8-31944. The investigation was conducted for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama. The Contracting Officer's Technical Representative was Mr. F. Villella.

The short-term objective of this preliminary study of transistors, diodes, and FETS is to evaluate the reliability of these discrete devices, from different manufacturers, when subjected to power and temperature step stress tests.

The long-term objective is to gain more knowledge of accelerated stress testing for use in future testing of discrete devices, as well as to determine which type of stress should be applied to a particular device or design.

This report is divided as follows: description of tests, figures, tables, and appendix.



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1.0 INTRODUCTION

DCA Reliability Laboratory, under Contract NAS8-31944 for NASA/Marshall Space Flight Center, has compiled data for the purpose of evaluating the effect of power/temperature step stress when applied to a variety of semiconductor devices. This report covers the dual transistor JANTX2N2920 manufactured by Fairchild and National Semiconductor.

Fifty one (51) samples from Fairchild and 44 from National Semiconductor were submitted to the process outlined in Table 1. In addition, two control sample units were maintained for verification of the electrical parametric testing.

2.0 TEST REQUIREMENTS

2.1 Electrical

All test samples were subjected to the electrical tests outlined in Table 2 after completing the prior power/temperature step stress point. These tests were performed using the Fairchild Model 600 High-Speed Computer-Controlled Tester. Additional bench testing was also required on the devices.

2.2 Stress Circuit

The test circuit shown in Figure 1 was used to power all the test devices during the power/temperature stress conditions. The current was set by I_E and the voltage was varied in order to comply with the specified power rating for this device. At least one of the devices was subjected to Maximum



Rated Power (MRP). All remaining devices were subjected to no less than 90% of MRP. See Figure 1 for load resistance values and voltages.

2.3 Group I - Power Stress

Thirty-two units, 19 from Fairchild and 13 from National Semiconductor, were submitted to the Power Stress Process. The dual transistors were stressed in 500-hour steps at 50, 100, 125, 150 and 175 percent of maximum rated power (MRP) for 2500 hours or until 50% or more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each power step. See Table 1. (*See Notes at end of text.)

2.4 Group II - Temperature Stress I

Thirty-two units, 16 from each manufacturer, were submitted to the Temperature Stress I Process. Group II was subjected to 1600 hours of stress at maximum rated power in increments of 160 hours. The temperature was increased in steps of 25°C, commencing at 75°C and terminating at 300°C or until 50% or more of the devices failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

2.5 Group III - Temperature Stress II

Thirty-one units, 16 from Fairchild and 15 from National Semiconductor, were submitted to the Temperature Stress II Process. Group III was subjected to 112 hours of stress at maximum rated power in increments of 16 hours. The temperature



was increased in steps of 25°C , commencing at 150°C and terminating at 300°C or until 50% or more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

3.0 DISCUSSION OF TEST RESULTS

3.1 Group I - Power Stress

3.1.1 Fairchild. The Fairchild sample lot completed the entire 2500 hours of Group I Testing with a total of one catastrophic failure. The failure occurred 250 hours into the 125% MRP step. Serial number 4039 (Side "A") failed the minimum h_{FE} limit. Typical characteristics of this sample lot's performance (Side "A") were:

- 1) The mean value for I_{CBO} changed 62.9pA from an initial mean of 166.8pA to a final mean of 103.9pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 0.86mV from an initial mean of 50.53mV to a final mean of 49.67mV.
- 3) The mean value for h_{FE} changed 36.0 from an initial mean of 386.0 to a final mean of 422.0.

Typical characteristics of this sample lot's performance (Side "B") were:

- 1) The mean value for I_{CBO} changed 127.3pA from an initial mean of 227.9pA to a final mean of 100.6pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 0.5mV from an initial mean of 50.0mV to



a final mean of 49.50mV.

3) The mean value for h_{FE} changed 46.9 from an initial mean of 385.1 to a final mean of 432.0.

4) The mean value for h_{FE1}/h_{FE2} changed .032 from an initial mean of 1.004 to a final mean of .972.

The control units for this sample lot remained constant throughout the entire Group I Testing.

3.1.2 National Semiconductor. The National Semiconductor sample lot completed the entire 2500 hours of Group I Testing with a total of one catastrophic failure. The failures occurred 500 hours into the 175% MRP step. Serial number 3988 (Sides "A" and "B") failed the minimum h_{FE} limit. Typical characteristics of this sample lot's performance (Side "A") were:

- 1) The mean value for I_{CBO} changed 3.8pA from an initial mean of 146.9pA to a final mean of 143.1pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 0.77mV from an initial mean of 49.09mV to a final mean of 49.85mV.
- 3) The mean value for h_{FE} changed 54.4 from an initial mean of 348.4 to a final mean of 402.8.

Typical characteristics of this sample lot's performance (Side "B") were:

- 1) The mean value for I_{CBO} changed 150.8pA from an initial mean of 266.2pA to a final mean of 115.4pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 1.69mV from an initial mean of 52.54mV to



a final mean of 50.85mV.

3) The mean value for h_{FE} changed 70.9 from an initial mean of 334.1 to a final mean of 405.0.

4) The mean value for h_{FE1}/h_{FE2} changed 0.006 from an initial mean of 1.042 to a final mean of 1.036.

The control units for this sample lot remained constant throughout the entire Group I Testing.

3.1.3 Statistical Summary - Group I. Table 4 outlines the results of Group I - Power Stress Process for each of the electrical parameters and all measurement points for both Fairchild and National Semiconductor.

3.2 Group II - Temperature Stress I

3.2.1 Fairchild. The Fairchild sample lot completed the entire 1600-hour Group II Testing with a total of seven catastrophic failures. The first failure occurred 160 hours into the 225°C-temperature step. Serial number 4046 (Sides "A" and "B") failed the minimum h_{FE} limit. The next failure occurred 160 hours into the 250°C-temperature step. Serial number 4060 (Side "B") failed the minimum h_{FE} limit. The next three failures occurred 160 hours into the 275°C-temperature step. Serial numbers 4052 (Side "B") and 4057 (Side "A") failed the minimum h_{FE} limit. Serial number 4056 failed the maximum h_{FE} matching limit. The last two failures occurred 160 hours into the 300°C-temperature step. Serial numbers 4053 (Sides "A" and "B") and 4059 (Sides "A" and "B") failed



the minimum h_{FE} limit. Serial number 4047 was removed from the Group II Testing 160 hours into the 250°C-temperature step as a MIL-S-19500 limit failure. Serial number 4048 was removed from the Group II Testing 160 hours into the 275°C-temperature step as a MIL-S-19500 limit failure. Typical characteristics of this sample lot's performance (Side "A") were:

- 1) The mean value for I_{CBO} changed 60.6pA from an initial mean of 129.4pA to a final mean of 190.0pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 8.24mV from an initial mean of 48.38mV to a final mean of 56.62mV.
- 3) The mean value for h_{FE} changed 121.2 from an initial mean of 362.7 to a final mean of 241.5.

Typical characteristics of this sample lot's performance (Side "B") were:

- 1) The mean value for I_{CBO} changed 16.7pA from an initial mean of 125.6pA to a final mean of 142.3pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 6.29mV from an initial mean of 48.56mV to a final mean of 54.85mV.
- 3) The mean value for h_{FE} changed 108.8 from an initial mean of 369.7 to a final mean of 260.9.
- 4) The mean value for h_{FE} (matching) changed 0.431 from an initial mean of 0.981 to a final mean of 1.412.

The control units for this sample lot remained constant throughout the entire Group II Testing.



3.2.2 National Semiconductor. The National Semiconductor sample lot completed the entire 1600-hour Group II Testing with a total of eight catastrophic failures. The first failure occurred 160 hours into the 75°C-temperature step. Serial number 4007 (Side "A") failed the minimum h_{FE} limit. The next two failures occurred 160 hours into the 200°C-temperature step. Serial number 3996 (Side "B") failed the minimum h_{FE} limit. Serial number 4005 failed the maximum h_{FE} (matching) limit. The next failure occurred 160 hours into the 225°C-temperature step. Serial number 3994 failed the minimum h_{FE} (matching) limit. The next failure occurred 160 hours into the 275°C-temperature step. Serial number 4008 (Sides "A" and "B") failed the minimum h_{FE} limit. The last three failures occurred 160 hours into the 300°C-temperature step. Serial numbers 3995 (Side "B") and 4000 (Side "B") failed the minimum h_{FE} limit. Serial number 4002 failed the maximum h_{FE} (matching) limit. Typical characteristics of this sample lot's performance (Side "A") were:

- 1) The mean value for I_{CBO} changed 10.9pA from an initial mean of 110.0pA to a final mean of 120.9pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 4.28mV from an initial mean of 45.63mV to a final mean of 49.91mV.
- 3) The mean value for h_{FE} changed 20.2 from an initial mean of 400.6 to a final mean of 420.8.

Typical characteristics of this sample lot's performance (Side "B") were:

- 1) The mean value for I_{CBO} changed



32.0pA from an initial mean of 126.2pA to a final mean of 158.2pA.

2) The mean value for $V_{CE(SAT)}$ changed 907.99mV from an initial mean of 45.81mV to a final mean of 953.8mV.

3) The mean value for h_{FE} changed 128.9 from an initial mean of 428.6 to a final mean of 299.7.

4) The mean value for h_{FE} (matching) changed 21.014 from an initial mean of 0.926 to a final mean of 21.94.

The control units for this sample lot remained constant throughout the entire Group II Testing.

3.2.3 Statistical Summary - Group II. Table 5 of this report outlines the results of Group II - Temperature Stress I Testing, for each of the electrical parameters and all of the measurements pertaining to both Fairchild and National Semiconductor.

3.3 Group III - Temperature Stress II

3.3.1 Fairchild. The Fairchild sample lot completed the entire 112-hour Group III Testing with a total of two catastrophic failures. The two failures occurred 16 hours into the 300°C-temperature step. Serial numbers 4067 (Side "B") and 4074 (Side "B") failed the minimum h_{FE} limit. Typical characteristics of this sample lot's performance (Side "A") were:

1) The mean value for I_{CBO} changed 0.00pA from an initial mean of 11.25pA to a final mean of 11.25pA.



- 2) The mean value for $V_{CE(SAT)}$ changed 0.32mV from an initial mean of 49.06mV to a final mean of 49.38mV.
- 3) The mean value for h_{FE} changed 5.7 from an initial mean of 415.6 to a final mean of 409.9.

Typical characteristics of this sample lot's performance (Side "B") were:

- 1) The mean value for I_{CBO} changed 10.62pA from an initial mean of 6.88pA to a final mean of 17.50pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 2.94mV from an initial mean of 48.31mV to a final mean of 51.25mV.
- 3) The mean value for h_{FE} changed 59.5 from an initial mean of 406.6 to a final mean of 347.1.
- 4) The mean value for h_{FE} (matching) changed 0.669 from an initial mean of 1.02 to a final mean of 1.689.

The control units for this sample lot remained constant throughout the entire Group III Testing.

3.3.2 National Semiconductor. The National Semiconductor sample lot completed the entire 112-hour Group III Testing with a total of four catastrophic failures. The first failure occurred 16 hours into the 150°C-temperature step. Serial number 4010 failed the minimum h_{FE} (matching) limit. The next failure occurred 16 hours into the 275°C-temperature step. Serial number 4022 (Side "A") failed the maximum $V_{CE(SAT)}$ and the minimum h_{FE} limits. The last two failures occurred 16 hours into the 300°C-temperature step. Serial number 4009 (Sides



"A" and "B") failed the minimum h_{FE} limit. Serial number 4023 failed the minimum h_{FE} (matching) limit. Typical characteristics of this sample lot's performance (Side "A") were:

- 1) The mean value for I_{CBO} changed 6.87pA from an initial mean of 4.67pA to a final mean of 11.54pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 0.82mV from an initial mean of 48.80mV to a final mean of 49.62mV.
- 3) The mean value for h_{FE} changed 39.0 from an initial mean of 442.2 to a final mean of 403.2.

Typical characteristics of this sample lot's performance (Side "B") were:

- 1) The mean value for I_{CBO} changed 8.67pA from an initial mean of 1.33pA to a final mean of 10.0pA.
- 2) The mean value for $V_{CE(SAT)}$ changed 2.18mV from an initial mean of 48.13mV to a final mean of 50.31mV.
- 3) The mean value for h_{FE} changed 30.9 from an initial mean of 493.7 to a final mean of 462.8.
- 4) The mean value for h_{FE} (matching) changed 0.011 from an initial mean of 0.925 to a final mean of 0.914.

The control units for this sample lot remained constant throughout the entire Group III Testing.

3.3.3 Statistical Summary - Group III. Table 6 outlines the results of Group III - Temperature Stress II Testing, for each of the electrical parameters and all of the measurement points for both Fairchild



and National Semiconductor.

4.0 FINAL DATA SUMMARY

Table 7 statistically summarizes the change in the mean value from the zero-hour data to the final data. The graphs of Figures 2 and 4 plot the cumulative percent failures versus the temperature stress level for Group II - Temperature Stress I, and Group III - Temperature Stress II. The graphs of Figures 3 and 5 plot the time step for Group II (160 hours) and Group III (16 hours) versus the temperatures T_1 and T_2 calculated from Figures 2 and 4. Tables 8 and 9 summarize the failures encountered for all three stress groups. The failures are separated into two categories: catastrophic failures in Table 8 and parametric failures in Table 9. The data from Table 8 were used as a source for the graphs in Figures 2 and 4. Figures 2 and 4 were used as a source for the graphs in Figures 3 and 5, respectively. Junction temperature is plotted on an inverse hyperbolic scale.

5.0 CONCLUSIONS

The only stress test that did any noticeable damage to both manufacturers was the Group II - Temperature Stress I Test. Many of the failures experienced a marked loss of gain. There was no significant bulk or surface leakage on these parts. This would imply that the h_{FE} fall-off is due only to a loss of emitter efficiency. The loss of injection efficiency in turn is due to the migration of gold and intermetallics under the influence of heat and electrical bias.



The fact that Group I does not reach the high junction temperatures of Group II and that Group III does not reach the long time steps of Group II could be an answer as to why there were not as many failures in the Groups I and II testings.

A plot showing cumulative failure distribution for Groups II and III was drawn for the Fairchild and National Semiconductor sample lots (Figures 2 and 3, and Figures 4 and 5, respectively). Figures 2 and 3 display the data for the Fairchild sample lot used to calculate an activation energy of 1.78eV. Figures 4 and 5 display the data for the National Semiconductor sample lot used to calculate an activation energy of .96eV.

A broken circle around a marked point on the graph indicates a freak failure not calculated as part of the regression line. A solid circle around a marked point indicates an isolated main failure point. The regression line was calculated using the least squares method.

The activation energy was calculated from the formula:

$$E = \left[\ln \left(\frac{t_1}{t_2} \right) \right] \left[\frac{8.63 \times 10^{-5} \text{ eV/}^\circ\text{K}}{\left(\frac{1}{T_1 + 273} \right) - \left(\frac{1}{T_2 + 273} \right)} \right] \text{ eV}$$

Where: t_1 = step of Group II - Temp Stress I = 160 hrs.

t_2 = step of Group III - Temp Stress II = 16 hrs.

T_1 = temperature in $^\circ\text{C}$ of 16% failure for Group II.

T_2 = temperature in $^\circ\text{C}$ of 16% failure for Group III.



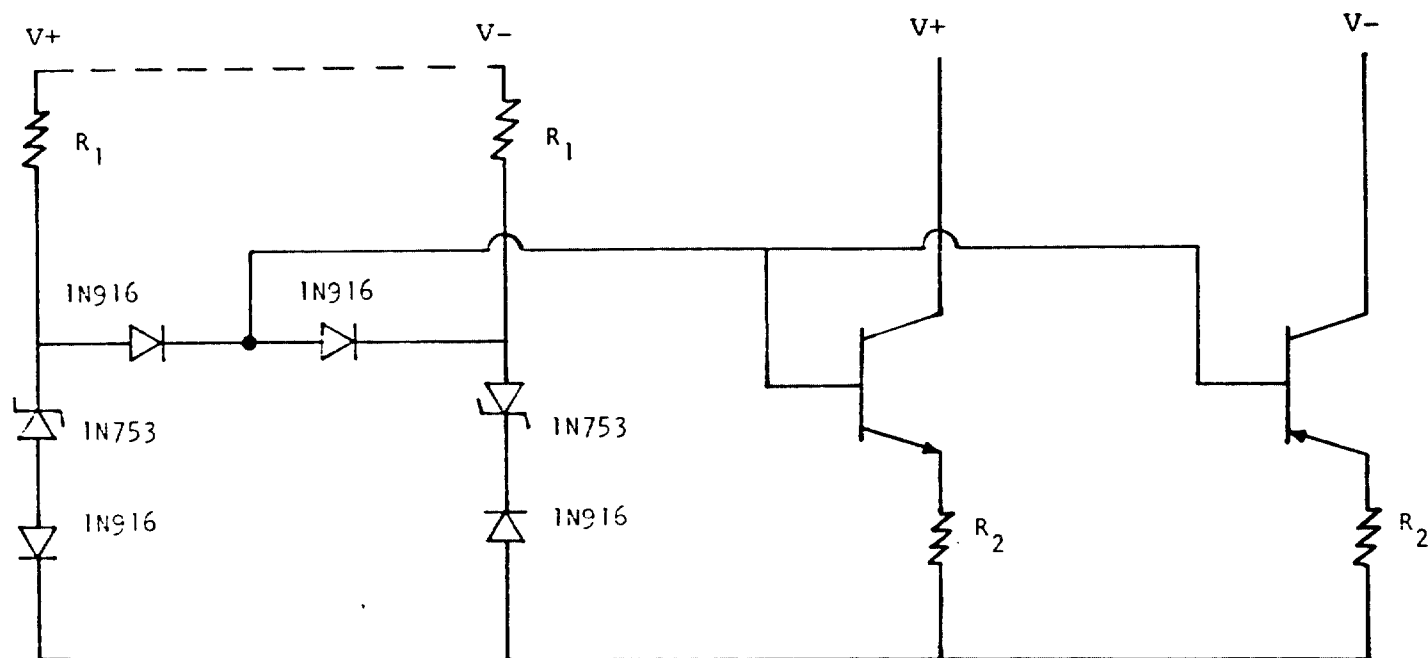
NOTE:

* Conditions for failure:

- A) Open or short
- B) Leakage exceeds the maximum limit by 100 times.
- C) Other parameters exceed MIL limits by 50% or more.



TRANSISTORS



$$R_1 = 800 \pm 5\%, 2W$$

R_2 = Individual Part Type Calculation

$$R_2 = 562 \pm 1\%, 1/2W$$

$V+$ for NPN Transistors

$V-$ for PNP Transistors

FIGURE 1
Power/Temperature Stress Circuit
for JANTX2N2920

JANTX2N2920



FAIRCHILD

JANTX2N2920

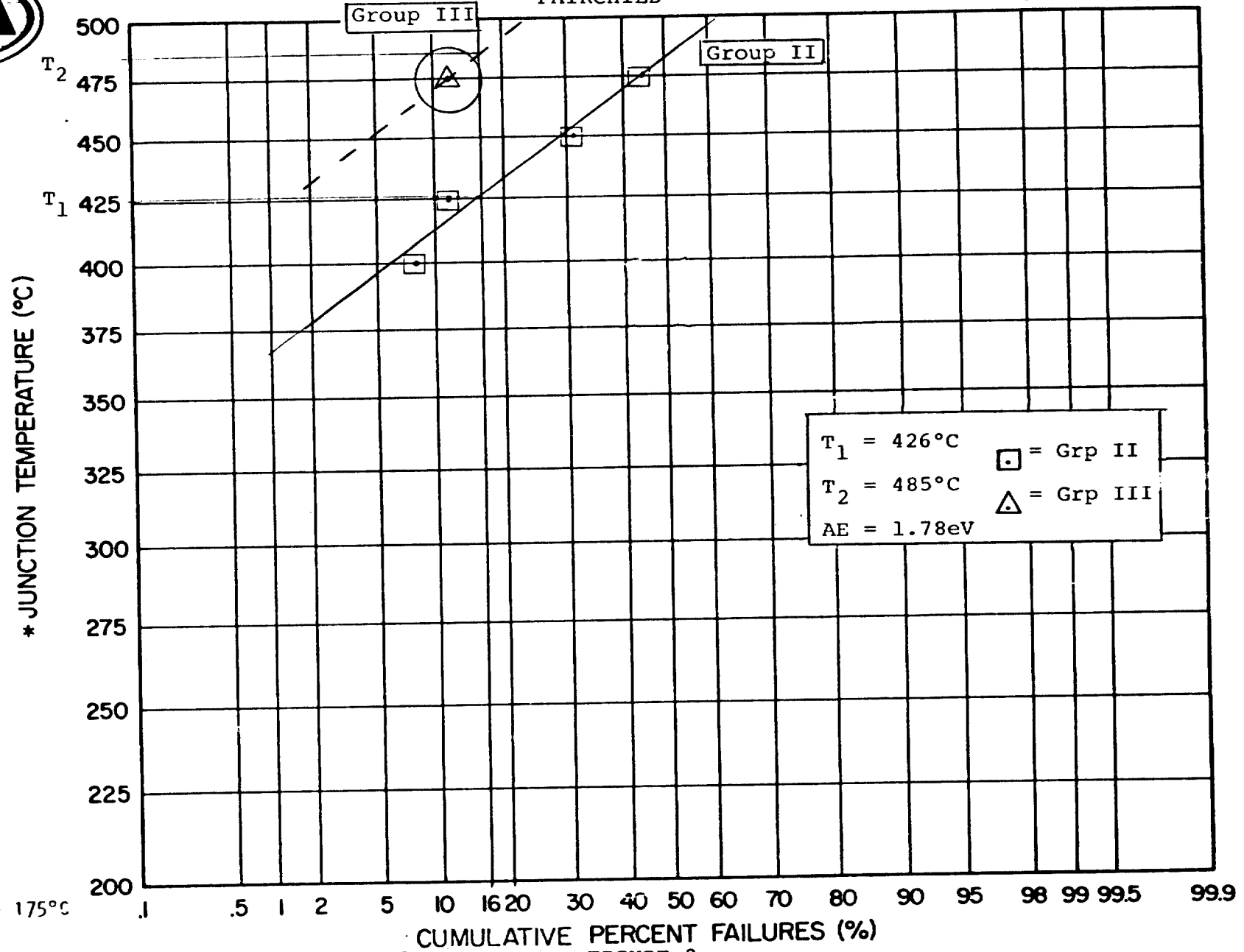


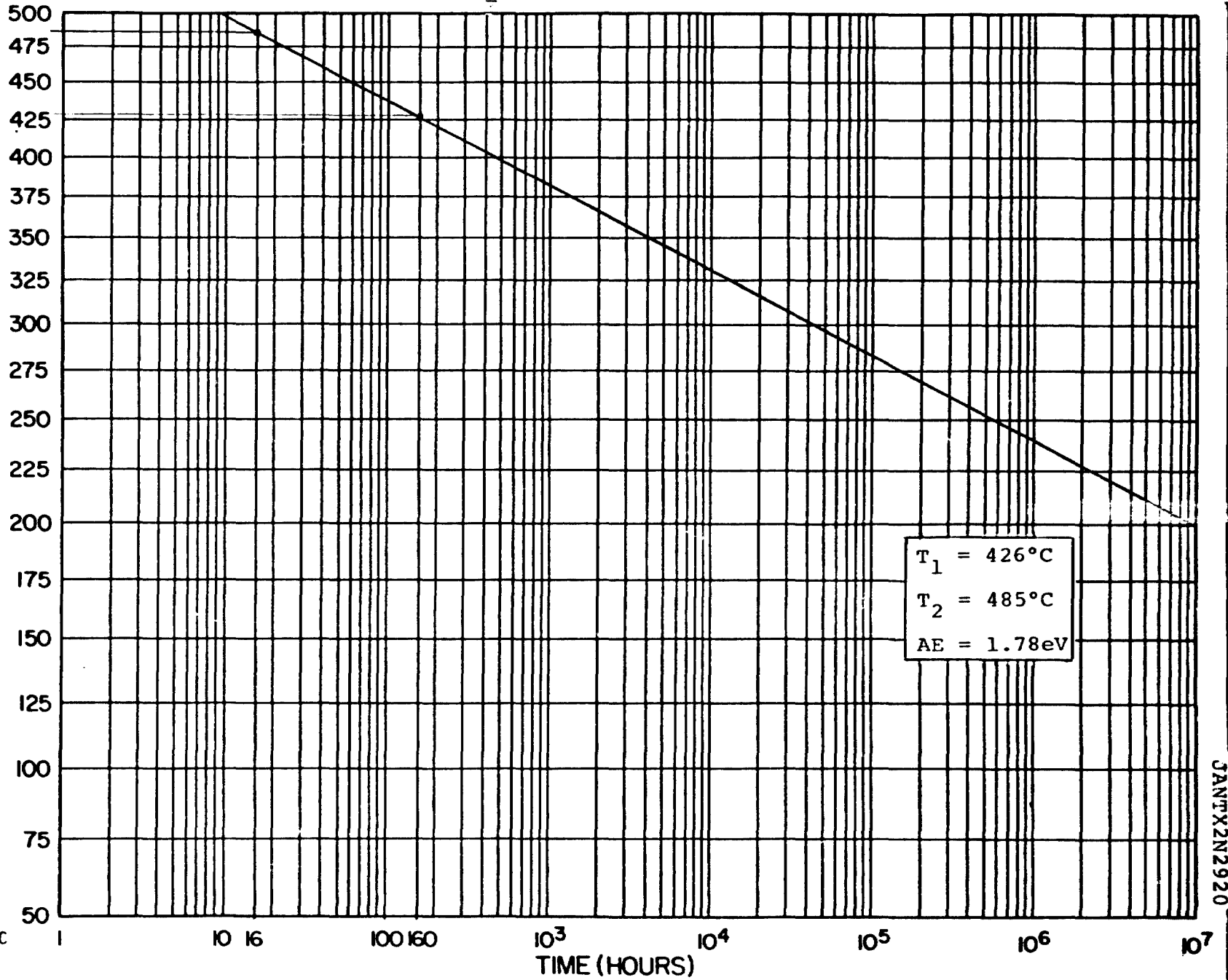
FIGURE 2

Cumulative Percent Failures Versus Junction Temperature, Fairchild

JANTX2N2920



* JUNCTION TEMPERATURE (°C)

 T_2
 T_1 

*NOTE

$$T_J \approx T_A + 175^\circ\text{C}$$

TIME (HOURS)

FIGURE 3

Time Steps Versus Junction Temperature, Fairchild



NATIONAL SEMICONDUCTOR

JANTX2N2920

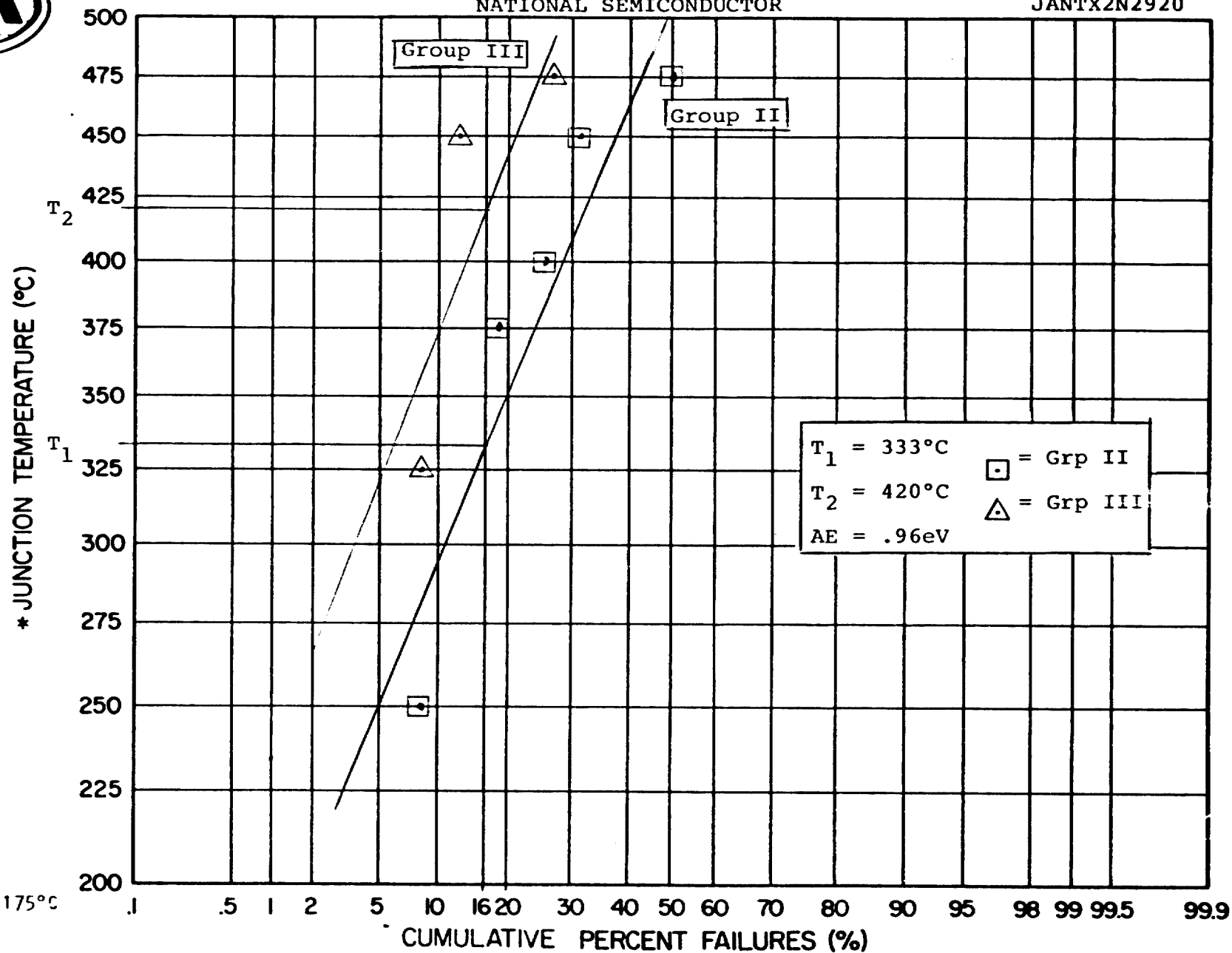


FIGURE 4
Cumulative Percent Failures Versus Junction Temperature, National Semiconductor

JANTX2N2920

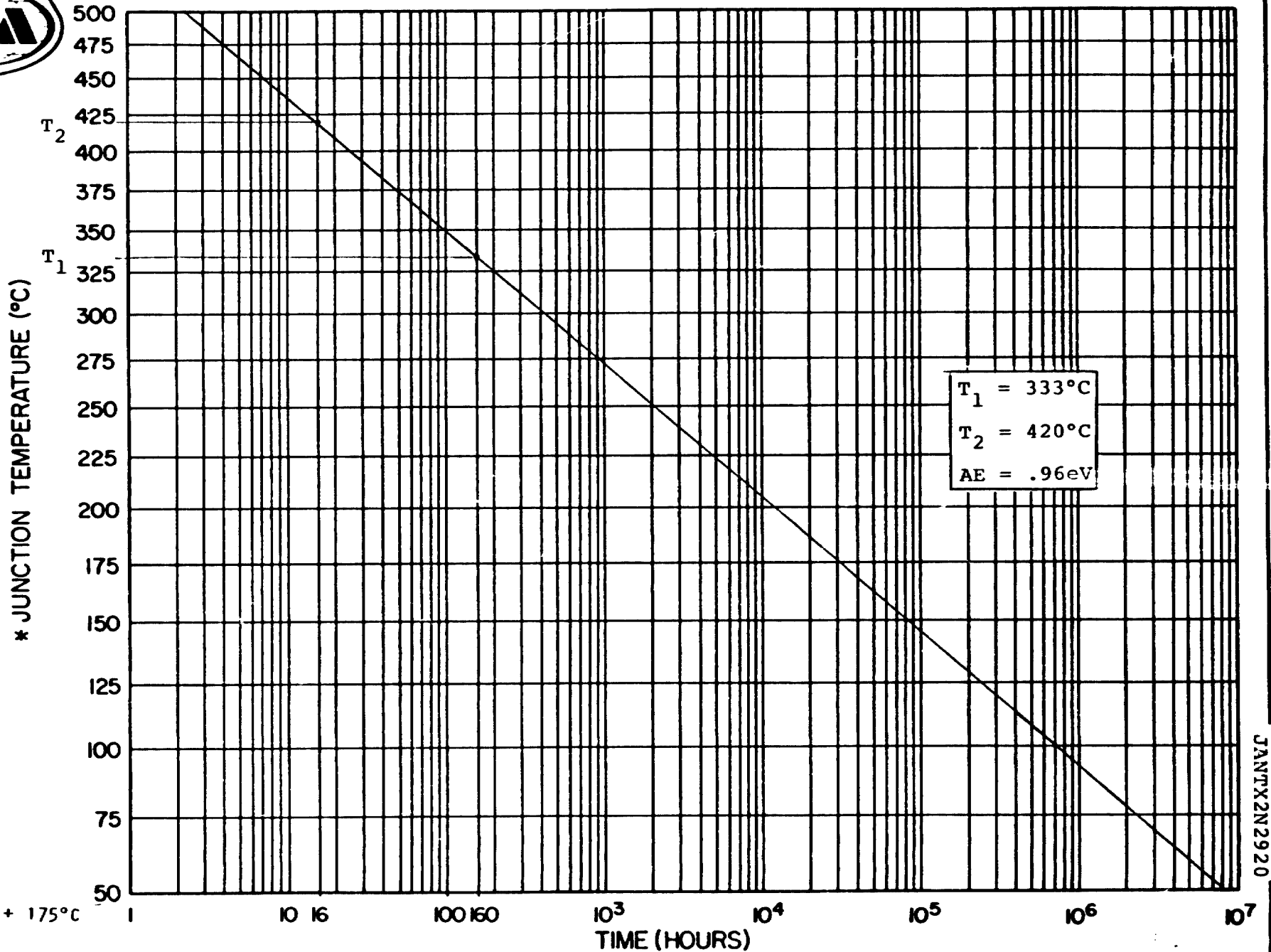
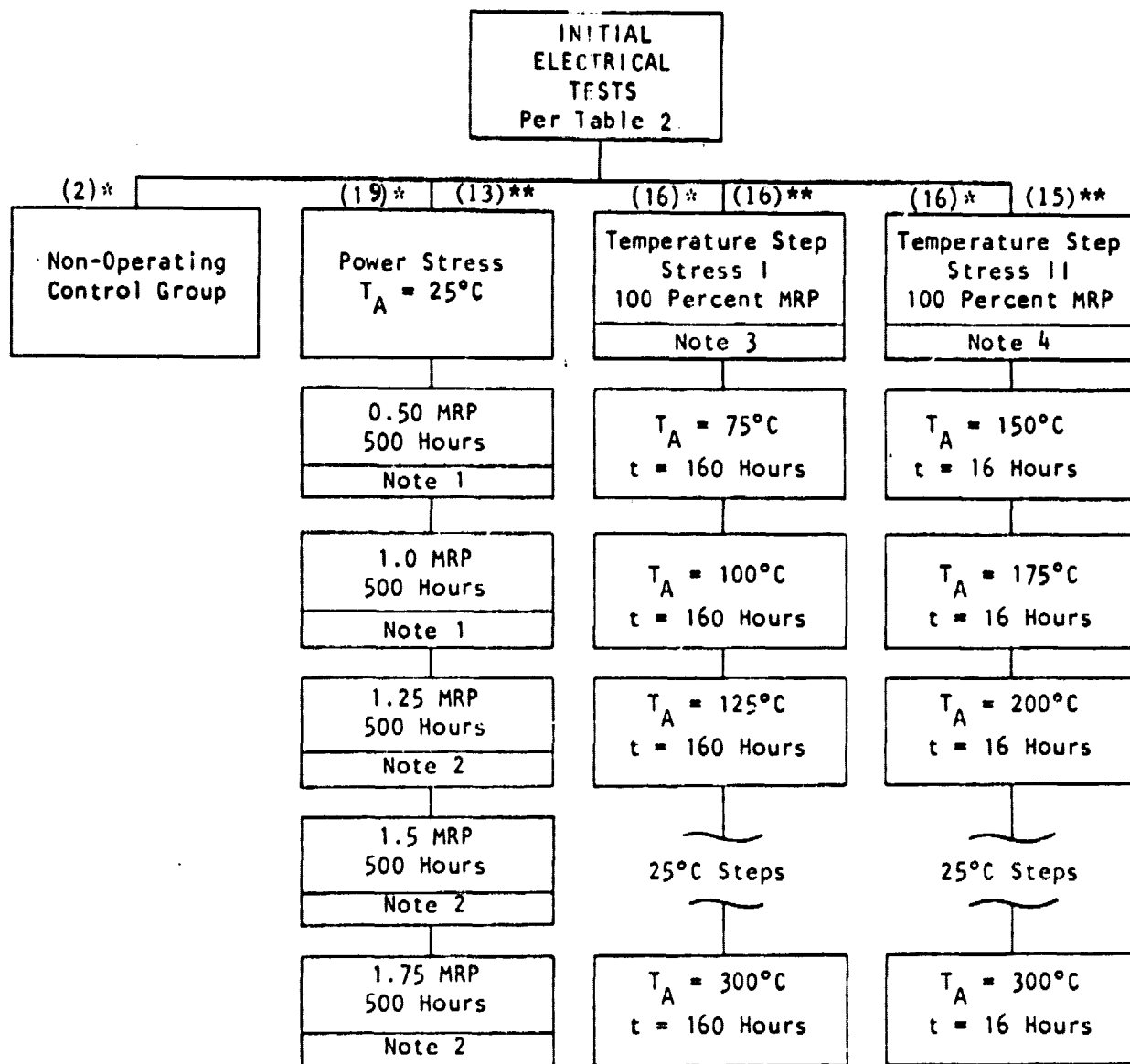


FIGURE 5
Time Steps Versus Junction Temperature, National Semiconductor



JANTX2N2920

TABLES 1 THROUGH 9

TABLE 1
TEST FLOW DIAGRAM

Quantity per manufacturer : *FAIRCHILD
**NATIONAL SEMICONDUCTOR

NOTES:

- 1) Electrical measurements per Table 2 were made at 50, 150, 250 and 500 hours.
- 2) Electrical measurements per Table 2 were made at 10, 25, 50, 150, 250 and 500 hours.
- 3) Electrical measurements per Table 2 were made at the end of each 160 hours.
- 4) Electrical measurements per Table 2 were made at the end of each 16 hours.



TABLE 2
PARAMETERS AND TEST CONDITIONS

PARAMETER	CONDITIONS	SPEC. LIMIT		CAT. LIMIT		UNITS
		MIN	MAX	MIN	MAX	
I_{CBO}	@ $V_{CB} = 45V$		2		200	nA
$V_{CE(SAT)}$	@ $I_C = 1.0mA$ and $I_B = 100\mu A$		.3		.45	V
h_{FE}	@ $V_{CE} = 5V$ and $I_C = 100\mu A$	235		117.5		--
h_{FE1}/h_{FE2} (h_{FE} matching)	@ $V_{CE} = 5V$ and $I_C = 100\mu A$	.9	1.1	.45	1.65	--

NOTES:

1/ In addition, any open or short shall be considered catastrophic

TABLE 3
POWER STRESS BURN-IN CONDITIONS

$I_E = 10.0mA$	
$V_{CE} =$	Percent P_D
12.5V	50
25.0V	100
31.2V	125
37.5V	150
43.7V	175



NOTE
FOR TABLES
4 THROUGH 7

The minimum/maximum initial and final data generally have an absolute accuracy of $\pm 1\%$ of the reading and $\pm$ one digit except for readings greater than 9.99mA which have an absolute accuracy of $\pm 2\%$ of the reading and $\pm$ one digit. The data also have a resolution for four digits. The standard deviations, means, delta means, and average means are, therefore, valid indicators of trends over time and temperature, excepting the minor statistical computer error of supplying a constant number of significant digits.



(continued from first sheet)

GROUP I

TABLE 4 (Cont'd) SIDE "B"
- POWER STRESS DATA SUMMARY

Page 4 of 4

PARAMETER	$I_{CBO} = 2.0\text{nA (MAX)}$		$V_{CE(SAT)} = .3\text{V(MAX)}$		$h_{FE2} = 235 \text{ (MIN)}$		$h_{FE1}/h_{FE2} = .9 \text{ (MIN)}$ 1.1 (MAX)	
CONDITIONS AND LIMITS	@ $V_{CB} = 45\text{V}$		@ $I_C=1.0\text{mA} \ \& \ I_B=100\mu\text{A}$		@ $V_{CE}=5\text{V} \ \& \ I_C=100\mu\text{A}$		@ $V_{CE}=5\text{V} \ \& \ I_C=100\mu\text{A}$	
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL
INITIAL DATA								
MIN VALUE	90.00pA	120.0pA	41.00mV	44.00mV	275.0	212.0	0.900	0.680
MAX VALUE	1.06nA	630.0pA	64.00mV	66.00mV	510.0	495.0	1.110	1.530
MEAN	227.90pA	266.2pA	50.00mV	52.54mV	385.1	334.1	1.004	1.042
STD DEV	227.10pA	145.2pA	4.65mV	5.93mV	56.2	76.5	0.054	0.196
INTERIM DATA								
POWER 150 TO 175% Δ MEAN VALUE								
150% POWER								
1510 HRS	-120.1pA	-165.4pA	-1.39mV	-4.85mV	-5.4	64.4	-0.026	-0.020
1525 HRS	-113.5pA	-161.6pA	-0.83mV	-4.62mV	5.5	75.1	-0.026	-0.016
1550 HRS	-112.9pA	-152.4pA	-1.00mV	-4.62mV	4.6	68.1	-0.027	0.014
1650 HRS	-129.6pA	-150.0pA	-2.39mV	-5.23mV	1.6	58.3	-0.021	-0.004
1750 HRS	-122.9pA	-143.1pA	-1.28mV	-4.46mV	2.8	58.4	-0.023	-0.002
2000 HRS	-111.8pA	-147.7pA	-1.06mV	-4.46mV	12.9	67.5	-0.035	-0.024
175% POWER								
2010 HRS	-119.0pA	-175.4pA	-0.83mV	-4.00mV	14.1	70.6	-0.022	-0.020
2025 HRS	-105.1pA	-155.4pA	-0.83mV	-4.39mV	20.0	72.5	-0.032	-0.010
2050 HRS	-129.6pA	-167.0pA	-1.39mV	-4.77mV	18.0	72.9	-0.025	-0.014
2150 HRS	-127.9pA	-167.0pA	-1.06mV	-4.23mV	33.3	81.8	-0.021	-0.024
2250 HRS	-129.0pA	-173.1pA	-1.17mV	-4.62mV	26.0	77.3	-0.026	-0.026
2500 HRS	-127.3pA	-150.8pA	-0.50mV	-1.69mV	46.9	*70.9	-0.032	-0.006
FINAL DATA								
MIN VALUE	50.00pA	70.0pA	41.00mV	39.00mV	268.0	7.8	0.840	0.530
MAX VALUE	450.0pA	260.0pA	65.00mV	73.00mV	595.0	708.0	1.050	1.470
MEAN	100.6pA	115.4pA	49.50mV	50.85mV	432.0	405.0	.972	1.036
STD DEV	98.2pA	53.2pA	5.50mV	8.39mV	74.6	167.7	.055	0.131

* NOTE: CATASTROPHIC REJECT(S) REMOVED FROM DATA AFTER THIS POINT

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TABLE 4
GROUP I - POWER STRESS DATA SUMMARY
SIDE "A"

Page 1 of 4

PARAMETER	$I_{CBO} = 2.0\text{nA (MAX)}$		$V_{CE(SAT)} = 0.3\text{V (MAX)}$		$h_{FE1} = 235 \text{ (MIN)}$			
CONDITIONS AND LIMIT	@ $V_{CB} = 45\text{V}$		@ $I_C = 1.0\text{mA} \ \& \ I_B = 100\mu\text{A}$		@ $V_{CE} = 5\text{V} \ \& \ I_C = 100\mu\text{A}$			
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL		
INITIAL DATA								
MIN VALUE	100.0pA	110.0pA	42.00mV	40.00mV	285.0	210.0		
MAX VALUE	480.0pA	280.0pA	62.00mV	62.00mV	511.0	580.0		
MEAN	166.8pA	146.9pA	50.53mV	49.08mV	386.0	348.4		
STD DEV	115.1pA	54.0pA	5.20mV	5.78mV	55.5	105.6		
INTERIM DATA								
POWER 50 TO 125% Δ MEAN VALUE								
50% POWER								
50 HRS	19.5pA	-3.1pA	-1.11mV	-1.77mV	2.0	22.8		
150 HRS	-117.3pA	-138.4pA	-1.11mV	-1.54mV	0.4	23.1		
250 HRS	-101.0pA	-139.2pA	-0.58mV	-1.39mV	-3.6	32.7		
500 HRS	-46.8pA	-34.6pA	-1.48mV	-1.54mV	-1.9	47.1		
100% POWER								
550 HRS	-63.1pA	-51.5pA	-1.64mV	-1.62mV	-3.0	53.0		
650 HRS	-60.0pA	-57.7pA	-1.32mV	-1.54mV	-11.1	53.6		
750 HRS	-60.8pA	-67.7pA	-1.21mV	-1.23mV	-12.6	56.6		
1000 HRS	-61.5pA	-60.0pA	-0.95mV	-0.93mV	-7.3	69.2		
125% POWER								
1010 HRS	-63.6pA	-53.8pA	-3.42mV	-2.62mV	-11.6	64.6		
1025 HRS	-51.5pA	-43.1pA	-1.79mV	-2.00mV	-13.9	64.8		
1050 HRS	-36.3pA	-42.3pA	-1.53mV	-1.93mV	-27.4	57.4		
1150 HRS	-63.6pA	-49.2pA	-1.58mV	-1.46mV	-20.8	62.4		
1250 HRS	-53.6pA	-44.6pA	-1.48mV	-1.46mV	-19.9	63.2		
1500 HRS	-61.2pA	-43.8pA	-1.64mV	-1.46mV	-7.3	63.2		

(continued on second sheet)



(continued from first sheet)

GROUP I

TABLE 4 (Cont'd) SIDE "A"
- POWER STRESS DATA SUMMARY

Page 2 of 4

PARAMETER	$I_{CBO} = 2.0nA$ (MAX)		$V_{CE(SAT)} = 0.3V$ (MAX)		$h_{FE1} = 235$ (MIN)			
CONDITIONS AND LIMITS	@ $V_{CB} = 45V$		@ $I_C=1.0mA$ & $I_B=100\mu A$		@ $V_{CE}=5V$ & $I_C=100\mu A$			
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL		
INITIAL DATA								
MIN VALUE	100.0pA	110.0pA	42.00mV	40.00mV	285.0	210.0		
MAX VALUE	480.0pA	280.0pA	62.00mV	62.00mV	511.0	580.0		
MEAN	166.8pA	146.9pA	50.53mV	49.08mV	386.0	348.4		
STD DEV	115.1pA	54.0pA	5.20mV	5.78mV	55.5	105.6		
INTERIM DATA								
POWER 150 TO 175% Δ MEAN VALUE								
150% POWER								
1510 HRS	-65.1pA	-37.7pA	-2.09mV	-1.39mV	-14.3	56.5		
1525 HRS	-64.6pA	-43.1pA	-1.42mV	-1.16mV	-3.1	68.0		
1550 HRS	-55.1pA	-36.9pA	-1.53mV	-1.16mV	-4.9	74.5		
1650 HRS	-64.0pA	-40.0pA	-1.70mV	-1.00mV	-5.4	57.2		
1750 HRS	-62.9pA	-26.9pA	-1.86mV	-0.85mV	-5.3	58.8		
2000 HRS	-34.0pA	-29.2pA	-1.75mV	-1.16mV	0.5	56.8		
175% POWER								
2010 HRS	-33.5pA	-40.0pA	-1.53mV	-0.70mV	6.9	63.9		
2025 HRS	-56.8pA	-30.7pA	-1.64mV	-0.93mV	8.6	70.3		
2050 HRS	-69.6pA	-32.3pA	-2.09mV	-1.23mV	9.8	69.4		
2150 HRS	-72.4pA	-37.7pA	-1.86mV	-0.77mV	25.9	74.0		
2250 HRS	-16.2pA	-49.2pA	-1.92mV	-0.03mV	17.1	67.3		
2500 HRS	-62.9pA	-3.8pA	-0.86mV	-0.77mV	36.0	54.4		
FINAL DATA								
MIN VALUE	60.0pA	80.0pA	42.00mV	40.00mV	226.0	11.5		
MAX VALUE	430.0pA	390.0pA	61.00mV	63.00mV	598.0	713.0		
MEAN	103.9pA	143.1pA	49.67mV	49.85mV	422.0	402.8		
STD DEV	88.5pA	83.0pA	4.92mV	6.56mV	81.9	160.3		

* NOTE: CATASTROPHIC REJECT(S) REMOVED FROM DATA AFTER THIS POINT



TABLE 4 (CONT'D)
GROUP I - POWER STRESS DATA SUMMARY
SIDE "B"

Page 3 of 4

PARAMETER	$I_{CBO} = 2.0nA$ (MAX)		$V_{CE(SAT)} = .3V$ (MAX)		$h_{FE2} = 235$ (MIN)		$h_{FE1}/h_{FE2} = .9$ (MIN) 1.1 (MAX)	
CONDITIONS AND LIMIT	@ $V_{CB} = 45V$		@ $I_C = 1.0mA$ & $I_B = 100\mu A$		@ $V_{CE} = 5V$ & $I_C = 100\mu A$		@ $V_{CE} = 5V$ & $I_C = 100\mu A$	
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL
INITIAL DATA								
MIN VALUE	90.00pA	120.0pA	41.00mV	44.00mV	275.0	212.0	0.900	0.680
MAX VALUE	1.06nA	630.0pA	64.00mV	66.00mV	510.0	495.0	1.110	1.530
MEAN	227.90pA	266.2pA	50.00mV	52.54mV	385.1	334.1	1.004	1.042
STD DEV	227.10pA	145.2pA	4.65mV	5.93mV	56.2	76.5	0.054	0.196
INTERIM DATA								
POWER 50 TO 125% Δ MEAN VALUE								
50% POWER								
50 HRS	-51.1pA	-124.7pA	-0.26mV	-5.23mV	1.2	18.8	0.045	0.020
150 HRS	-192.6pA	-262.4pA	-0.32mV	-5.08mV	-1.4	13.8	0.003	0.035
250 HRS	-191.1pA	-263.1pA	0.32mV	-4.69mV	-1.0	29.4	-0.007	0.010
500 HRS	-105.8pA	-156.2pA	-0.68mV	-5.23mV	1.3	39.1	-0.009	0.019
100% POWER								
550 HRS	-116.3pA	-178.5pA	-0.84mV	-5.16mV	-1.0	50.3	-0.007	0.009
650 HRS	-121.1pA	-181.6pA	-0.79mV	-5.00mV	-1.9	53.4	-0.006	-0.005
750 HRS	-130.0pA	-194.7pA	-0.74mV	-4.85mV	-4.8	58.4	-0.024	-0.010
1000 HRS	-132.1pA	-192.4pA	-0.21mV	-4.31mV	11.0	67.9	-0.047	-0.004
125% POWER								
1010 HRS	-120.5pA	-180.1pA	-1.47mV	-7.00mV	-0.7	49.2	-0.033	0.031
1025 HRS	-113.2pA	-170.8pA	-1.05mV	-5.39mV	-1.1	56.4	-0.040	0.013
1050 HRS	-112.1pA	-169.3pA	-1.00mV	-5.46mV	0.3	62.1	-0.071	-0.015
1150 HRS	-113.7pA	-174.7pA	-1.05-V	-5.31mV	*-5.2	64.0	-0.049	-0.007
1250 HRS	-108.4pA	-161.6pA	-0.68mV	-4.62mV	-0.4	67.9	-0.060	-0.015
1500 HRS	-121.2pA	-170.1pA	-1.00mV	-4.85mV	0.1	69.7	-0.021	-0.019

(continued on second sheet)

TABLE 5 SIDE "A"

JANTX2N2920

GROUP II TEMP STRESS I DATA SUMMARY

PARAMETERS	$I_{CBO} = 2.0nA$		$V_{CE(SAT)} = .3V(MAX)$		$h_{FE} = 235 (MIN)$			
CONDITIONS AND LIMITS	@ $V_{CB} = 45V$		@ $I_C = 1.0mA$ & $I_B = 100\mu A$		@ $V_{CE} = 5V$ & $I_C = 100\mu A$			
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL		
INITIAL DATA	40.0pA	60.0pA	42.00mV	38.00mV	267.0	24.0		
MIN VALUE	510.0pA	270.0pA	59.00mV	55.00mV	490.0	601.0		
MAX VALUE	129.4pA	110.0pA	48.38mV	45.63mV	362.7	400.6		
MEAN	142.8pA	52.8pA	5.21mV	4.94mV	62.7	127.2		
STD DEV								
INTERIM DATA (INITIAL TO POST)								
Δ MEAN VALUE POST 160 HRS.								
TOTAL HRS. TEMP. (T_A)								
160 75°C	-11.3pA	1.2pA	4.31mV	0.43mV	-4.4	-4.0		
320 100°C	1.8pA	5.0pA	0.12mV	0.31mV	-2.0	10.0		
480 125°C	-20.7pA	-20.0pA	-0.13mV	0.43mV	-4.5	9.5		
640 150°C	-3.8pA	5.0pA	0.06mV	0.62mV	27.3	27.9		
800 175°C	-16.9pA	25.0pA	-0.13mV	0.06mV	33.0	36.0		
960 200°C	-19.4pA	-10.0pA	0.43mV	-0.25mV	17.2	*46.8		
1120 225°C	-3.8pA	25.6pA	1.24mV	0.62mV	-11.8	27.5		
1280 250°C	133.1pA	27.1pA	4.00mV	2.23mV	*-33.0	26.9		
1440 275°C	35.3pA	14.2pA	2.55mV	832.37mV	*-89.9	12.2		
1600 300°C	60.6pA	10.9pA	8.24mV	4.28mV	*-121.2	20.2		
FINAL DATA								
LAST STRESS TEMP. (T_A)	300°C	300°C	300°C	300°C	300°C	300°C		
MIN VALUE	60.0pA	70.0pA	44.00mV	41.00mV	17.9	270.0		
MAX VALUE	750.0pA	210.0pA	89.00mV	56.00mV	393.0	555.0		
MEAN	190.0pA	120.9pA	56.62mV	49.91mV	241.5	420.8		
STD DEV	210.6pA	44.8pA	12.63mV	4.56mV	143.4	91.5		

* NOTE: CATASTROPIC REJECT(S) REMOVED FROM DATA AFTER THIS POINT

JANTX2N2920

TABLE 5 SIDE "B"

GROUP II TEMP STRESS I DATA SUMMARY

PARAMETERS	$I_{CBO} = 2.0nA(MAX)$		$V_{CE(SAT)} = .3V(MAX)$		$h_{FE} = 235(MIN)$		$h_{FE1}/h_{FE2} = .9(MIN) 1.1(MAX)$	
CONDITIONS AND LIMITS	@ $V_{CB} = 45V$		@ $I_C = 1.0mA$ & $I_B = 100\mu A$		@ $V_{CE} = 5V$ & $I_C = 100\mu A$		@ $V_{CE} = 5V$ & $I_C = 100\mu A$	
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL
INITIAL DATA								
MIN VALUE	30.0pA	60.0pA	42.00mV	38.00mV	282.0	327.0	0.910	0.060
MAX VALUE	550.0pA	320.0pA	60.00mV	54.00mV	528.0	618.0	1.080	1.190
MEAN	125.6pA	126.2pA	48.56mV	45.81mV	369.7	428.6	0.981	0.926
STD DEV	141.2pA	70.3pA	5.61mV	4.89mV	68.8	86.4	0.046	0.234
INTERIM DATA (INITIAL TO POST)								
Δ MEAN VALUE POST 160 HRS.								
TOTAL HRS. TEMP. (T_A)								
160 75°C	4.4pA	-15.0pA	24.82mV	20.69mV	-1.3	-2.1	-0.010	-0.003
320 100°C	-4.4pA	-1.8pA	0.00mV	0.25mV	-5.7	7.9	0.012	0.005
480 125°C	-18.1pA	-34.9pA	-0.18mV	0.25mV	-3.6	1.3	0.001	0.018
640 150°C	3.1pA	-10.0pA	0.00mV	0.25mV	25.3	19.1	0.015	0.024
800 175°C	1.9pA	-18.1pA	0.00mV	-0.31mV	36.4	22.6	0.004	0.032
960 200°C	-13.1pA	-14.3pA	0.07mV	-0.25mV	38.2	-5.2	-0.049	*0.613
1120 225°C	-0.6pA	13.8pA	1.00mV	0.25mV	-13.3	-21.5	0.133	*0.416
1280 250°C	18.1pA	27.4pA	6.75mV	1.55mV	*-46.4	-2.7	0.178	0.333
1440 275°C	43.0pA	46.3pA	3.58mV	3.61mV	*-97.5	*-38.3	1.923	0.078
1600 300°C	16.7pA	32.0pA	6.29mV	907.99mV	*-108.8	*-128.9	0.431	*21.014
FINAL DATA	300°C	300°C	300°C	300°C	300°C	300°C	300°C	300°C
LAST STRESS TEMP. (T_A)								
MIN VALUE	60.0pA	60.0pA	44.00mV	43.00mV	5.0	1.4	0.070	.94
MAX VALUE	460.0pA	590.0pA	84.00mV	9.99V	469.0	539.0	5.120	193.00
MEAN	142.3pA	158.2pA	54.85mV	953.80mV	260.9	299.7	1.412	21.94
STD DEV	142.2pA	144.6pA	11.10mV	2.86V	134.1	175.8	1.305	55.00

*NOTE: CATASTROPIC REJECT (S) REMOVED FROM DATA AFTER THIS POINT

GROUP III TEMP STRESS II DATA SUMMARY

PARAMETERS	$I_{CBO} = 2.0nA(MAX)$		$V_{CE(SAT)} = 0.3V(MAX)$		$h_{FE} = 235(MIN)$			
CONDITIONS AND LIMITS	@ $V_{CB} = 45V$		@ $I_C = 1.0mA$ & $I_B = 100\mu A$		@ $V_{CE} = 5V$ & $I_C = 100\mu A$			
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL		
INITIAL DATA								
MIN VALUE	0.00pA	0.00pA	40.00mV	38.00mV	257.0	159.0		
MAX VALUE	130.00pA	50.00pA	58.00mV	60.00mV	528.0	702.0		
MEAN	11.25pA	4.67pA	49.06mV	48.80mV	415.6	442.2		
STD DEV	32.95pA	13.10pA	4.96mV	7.49mV	79.3	150.5		
INTERIM DATA (INITIAL TO POST)								
Δ MEAN VALUE								
TOTAL HRS. TEMP. (T_A)								
16 150°C	-6.25pA	0.00pA	0.06mV	0.47mV	0.3	1.0		
32 175°C	-6.25pA	8.66pA	-1.00mV	0.47mV	-4.5	3.4		
48 200°C	4.37pA	16.04pA	0.13mV	0.27mV	5.1	6.4		
64 225°C	-3.13pA	7.47pA	-0.50mV	-0.51mV	3.5	10.9		
30 250°C	-1.88pA	11.76pA	-0.37mV	5.56mV	4.6	10.9		
96 275°C	-5.00pA	1.04pA	0.38mV	*709.3mV	1.5	-*30.4		
112 300°C	0.00pA	6.87pA	0.32mV	0.82mV	-5.7	-*39.0		
FINAL DATA								
LAST STRESS TEMP. (T_A)	300°C	300°C	300°C	300°C	300°C	300°C		
MIN VALUE	0.00pA	0.00pA	39.00mV	37.00mV	234.0	96.0		
MAX VALUE	110.00pA	90.00pA	58.00mV	62.00mV	520.0	733.0		
MEAN	11.25pA	11.54pA	49.38mV	49.62mV	409.9	403.2		
STD DEV	30.59pA	27.69pA	5.27mV	7.28mV	78.9	201.5		

*NOTE: CATASTROPIC REJECT (S) REMOVED FROM DATA AFTER THIS POINT

TABLE 6 SIDE "B"

JANTX2N2920

GROUP III TEMP STRESS II DATA SUMMARY

PARAMETERS	$I_{CBO}=2.0nA(MAX)$		$V_{CE(SAT)}=0.3V(MAX)$		$h_{FE}=235(MIN)$		$h_{FE1}/h_{FE2}=.9(MIN)1.1(MAX)$	
CONDITIONS AND LIMITS	@ $V_{CB}=45V$		@ $I_C=1.0mA$ & $I_B=100\mu A$		@ $V_{CE}=5V$ & $I_C=100\mu A$		@ $V_{CE}=5V$ & $I_C=100\mu A$	
IDENTIFICATION	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL
INITIAL DATA	0.00pA	0.00pA	40.00mV	35.00mV	257.0	344.0	0.904	0.214
MIN VALUE	100.00pA	20.00pA	58.00mV	61.00mV	500.0	743.0	1.109	1.155
MAX VALUE	6.88pA	1.33pA	48.31mV	48.13mV	406.6	493.7	1.020	0.925
MEAN	24.17pA	4.99pA	5.24mV	7.68mV	71.5	150.0	0.053	0.206
STD DEV								
INTERIM DATA (INITIAL TO POST)								
Δ MEAN VALUE								
TOTAL HRS. TEMP. (T_A)								
16 150°C	0.00pA	0.00pA	0.38mV	0.67mV	-2.5	0.5	0.008	0.004
32 175°C	-0.63pA	0.10pA	-0.31mV	-0.06mV	-5.9	9.8	0.006	0.005
48 200°C	3.12pA	2.96pA	0.88mV	1.08mV	0.5	14.3	0.015	-0.016
64 225°C	1.87pA	2.96pA	0.82mV	-0.20mV	0.3	12.1	0.011	-0.001
80 250°C	3.12pA	1.55pA	1.13mV	0.01mV	1.3	13.4	0.009	-0.004
96 275°C	13.12pA	3.67pA	1.13mV	0.01mV	0.7	8.8	0.001	*-0.062
112 300°C	10.62pA	8.67pA	2.94mV	2.18mV	*-59.5	*-30.9	*-0.669	-0.011
FINAL DATA								
LAST STRESS TEMP. (T_A)	300°C	300°C	300°C	300°C	300°C	300°C	300°C	300°C
MIN VALUE	0.00pA	0.00pA	39.00mV	38.00mV	2.6	79.8	0.919	0.229
MAX VALUE	130.00pA	80.00pA	76.00mV	63.00mV	495.0	728.0	10.880	1.203
MEAN	17.50pA	10.00pA	51.25mV	50.31mV	347.1	462.8	1.689	0.914
STD DEV	38.49pA	24.18pA	8.19mV	8.02mV	143.0	189.4	2.381	0.274

* NOTE: CATASTROPIC REJECT (S) REMOVED FROM DATA AFTER THIS POINT

TABLE 7
FINAL DATA SUMMARY

PARAMETER	SPECIFICATIONS LIMIT		U N I T S	MEAN INT. DATA	AVERAGE Δ IN MEAN VALUE					
	MIN	MAX			POWER STRESS		TEMPERATURE STRESS I		TEMPERATURE STRESS II	
					FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL
I _{CBO}		2.0	nA		-.05684	-.04756	+.01549	+.00840	-.00259	+.00741
V _{CE(SAT)}		0.3	V		-.00161	-.00133	+.00207	+.08411	-.00014	*+.10234
h _{FE}	235		-		-2.5462	+57.877	*-18.930	*+21.30	+.68571	-5.2571

* NOTE: CATASTROPIC REJECT (S) REMOVED FROM DATA

TABLE 7 SIDE "B"
FINAL DATA SUMMARY

PARAMETER	SPECIFICATIONS LIMIT		U N I T S	MEAN INT. DATA	AVERAGE Δ IN MEAN VALUE					
	MIN	MAX			POWER STRESS		TEMPERATURE STRESS I		TEMPERATURE STRESS II	
					FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL	FAIRCHILD	NATIONAL
I _{CBO}		2.0	nA		-.12223	-.17266	+.00598	+.00254	+.00446	+.00284
V _{CE(SAT)}		0.3	V		-.00090	-.00477	+.00423	+.09343	+.00010	+.00053
h _{FE}	235		-		*+6.7962	*+59.162	*-17.670	*-14.780	*-9.30	*+4.00
h _{FE1} /h _{FE2}	0.9	1.1	-		-.02469	-.00346	+.26380	*+2.2530	*+.10271	*-.01214

* NOTE: CATASTROPIC REJECT (S) REMOVED FROM DATA



TABLE 8 STEP STRESS CATASTROPHIC FAILURE SUMMARY

JAN TX2N2920

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
100% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
125% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	1	A	0	-
250 hr.	0	-	0	-
150% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
175% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	1	A

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75°C	0	-	1	A
100°C	0	-	0	-
125°C	0	-	0	-
150°C	0	-	0	-
175°C	0	-	0	-
200°C	0	-	1	1 A B
225°C	1	A	1	C
250°C	1	A	0	-
275°C	2	1 A B	1	A
300°C	2	A	2	1 A B

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	-	1	C
175°C	0	-	0	-
200°C	0	-	0	-
225°C	0	-	0	-
250°C	0	-	0	-
275°C	0	-	1	D
300°C	2	A	1	1 A C

MFR "A" - FAIRCHILD

MFR "B" - NATIONAL SEMICONDUCTOR

NOTES: A - $h_{FE} < 117.5$ B - h_{FE} (matching) > 1.65 C - h_{FE} (matching) $< .45$ D - $V_{CE(SAT)} > .45$ V and Note A



TABLE 9 STEP STRESS PARAMETRIC FAILURE SUMMARY

JANTX2N2920

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	-	3 2	A C
100 hr.	1	A	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
100% 50 hr.	1	B	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	1	B	0	-
125% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	1	B	0	-
150% 10 hr.	0	-	0	-
15 hr.	1	B	0	-
25 hr.	0	-	1	A
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	1	A
175% 10 hr.	0	-	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-

GROUP II 160 HR. TEMP. STEPS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75° C	2	B	1 2	A B
100° C	1	B	0	-
125° C	1	B	0	-
150° C	0	-	1	A
175° C	1	A	1 1	A B
200° C	1 1 2	A C B	0	-
225° C	1	A	0	-
250° C	1	C	1	C
275° C	2 1	C D	0	-
300° C	1	E	1	A

GROUP III 16 HR. TEMP. STEPS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150° C	0	-	1 2	A B
175° C	2	A	1 1	B F
200° C	2	A	1	B
225° C	0	-	0	-
250° C	0	-	0	-
275° C	0	-	0	-
300° C	1	C	0	-

MFR "A" = FAIRCHILD
MFR "B" = NATIONAL SEMICONDUCTOR

- NOTES: A - h_{FE} (matching) MAXIMUM LIMIT FAILURE.
B - h_{FE} (matching) MINIMUM LIMIT FAILURE.
C - h_{FE} MINIMUM LIMIT FAILURE.
D - S/N 4047 REMOVED FROM GROUP II TESTING AS A MIL-S-19500 LIMIT FAILURE.
E - S/N 4048 REMOVED FROM GROUP II TESTING AS A MIL-S-19500 LIMIT FAILURE.
F - S/N 4014 REMOVED FROM GROUP III TESTING AS A VISUAL REJECT DUE TO HANDLING.



JANTX2N2920

APPENDIX

FAILURE ANALYSIS



JANTX2N2920

FAILURE ANALYSIS

Date 29 November 1978

J/N 2CN242-39B P/N 2N2920 MFR National Semiconductor

End point:
200nA Max.End point:
117.5 Min.
B₁/B₂ =
0.45-1.65

S/N	BV _{CEO} -volts-	BV _{CBO} -volts-	I _{CBO} -nA- @ V _{CB} = 45 V.	BV _{EBO} -volts-	h _{FE} @ I _C = 100 μ A; V _{CE} = 5 V.	V _{BEO} -volts- @ I _{BEO} = 10 mA	INITIAL REJ. AT TEST SEQUENCE NO.:	INITIAL REJ. FOR:
3995A B	144 85(H)	193 190	<100nA <100nA	7.7 9.6	12 345	0.79 0.81	21 (300°C 1600Hrs.)	h _{FE} match
4005A B	90 76(H)	156 156	<100nA <100nA	11.0 10.8	97 244	0.79 0.78	17 (250°C 1280Hrs.)	h _{FE} match
4007A B	94(H) 120	210 225	<100nA <100nA	10.4 6.7	308 58	0.78 0.77	17 (250°C 1280Hrs.)	h _{FE} match

INTERNAL VISUAL DINSPECTION:

All three samples exhibit dark gold-aluminum intermetallics ("Purple Plague") around all gold ball bonds (see Figure 1).

No other significant defects were seen.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable



JANTX2N2920

FAILURE ANALYSIS

Date 29 November 1978

J/N 2CN242-39B P/N 2N2920 MFR Fairchild

End point: 117.5Min.
200nAmax.
B₁/B₂ = 0.45-1.65

S/N	BV _{CEO} -volts-	BV _{CBO} -volts-	I _{CBO} -nA- @ V _{CB} = 45 V.	BV _{EBO} -volts-	h _{FE} @ I _C = 100μA; V _{CE} = 5.0V.	V _{BEO} -volts- @ I _{BEO} = 10 mA	INITIAL REJ. AT TEST SEQUENCE NO.:	INITIAL REJ. FOR:
4052A B	105 96	240 225	<100nA <100nA	9.2 9.8	152 27	0.80 0.81	21 (300°C 1600Hrs.)	h _{FE} match
4053A B	85 75	105 95	<100nA <100nA	11.6 12.0	4.8 25	0.78 0.82	21 (300°C 1600Hrs.)	h _{FE} match
4057A B	74 125	155 156	<100nA <100nA	10.8 10.8	215 16	0.78 0.78	21 (300°C 1600Hrs.)	h _{FE} match

INTERNAL VISUAL INSPECTION:

All three samples exhibit dark gold-aluminum intermetallics ("Purple Plague") around all gold ball bonds. (See Figure 2.)

No other significant defects were seen.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable

CONCLUSION

One or more transistors on all of the samples have experienced a marked loss of gain. There is no significant bulk or surface leakage on these parts. This implies that the h_{FE} fall-off is due only to a loss of emitter efficiency. The loss of injection efficiency in turn is due to the migration of gold and intermetallics under the influence of heat and electrical bias with a consequent loss of bulk lifetime.

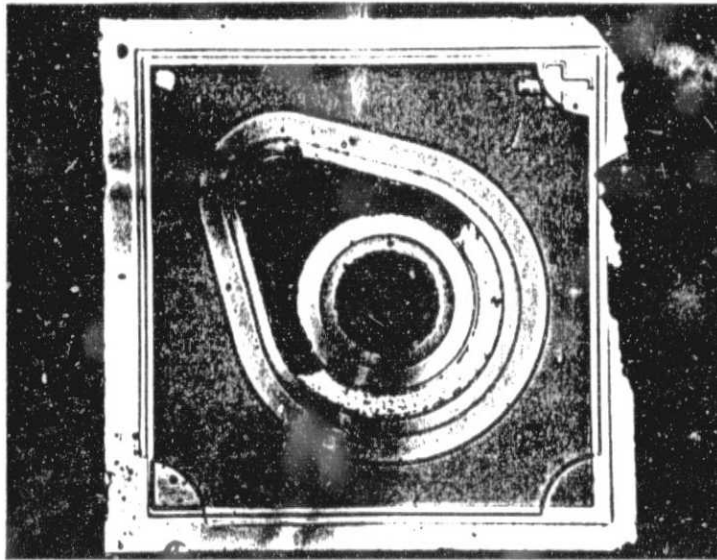


FIGURE A-1

S/N 3995. Magnification 152X.

Typical die geometry of National samples.
The dark areas around the gold ball bonds are
gold-aluminum intermetallics ("Purple Plague").

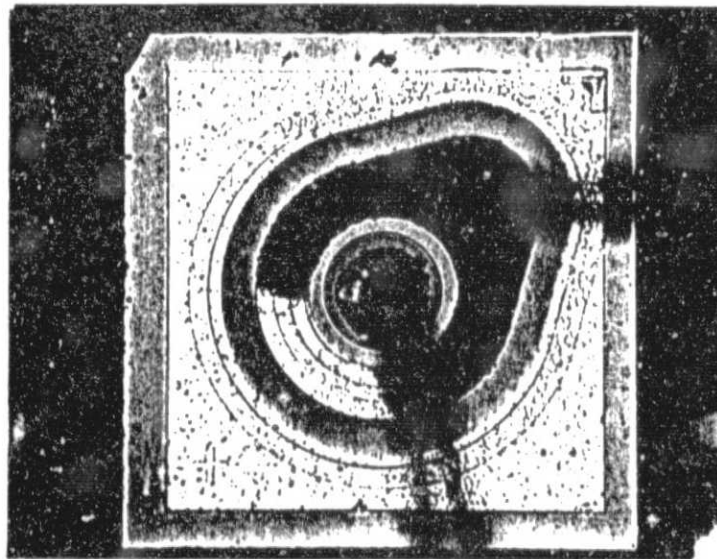


FIGURE A-2

S/N 4025. Magnification 152X.

Typical die geometry of Fairchild samples.
The dark areas around the gold ball bonds are
gold-aluminum intermetallics ("Purple Plague").