



Germanium photodiodes (PIN's and APD's) produced by Teledyne Judson Technologies have demonstrated excellent reliability in life testing programs. This is shown by the fact that no failures have occurred in almost 8000 hours of accelerated testing. The determination of median life is shown to exceed 3000 years and random failure rate is much less than 1 FIT at 25°C. (1 FIT means one failure in 1E9 device-hours.) Since no actual failure distribution nor activation energy for Ge photodiodes have ever been reported in the literature, we use the well-accepted Bellcore Report as a guide to proceed with our reliability analysis. Listed below are pertinent information and a description of the methods and calculations used to determine the median life and random failure rates for Teledyne Judson's Ge photodiodes.

1. Test Conditions

- Test Temperature 130°C
- Bias 25V
- Number of Devices 69

2. Test Results

- Zero failures observed in over 7900 hours.

3. Failure Rate Calculations

Assumptions

- Activation Energy 0.7eV
- Sigma 0.5 & 2.0
- Lognormal Distribution

The assumptions for sigma=0.5 & 2.0 were made to account for both a wide and narrow failure distribution. We believe that this range of sigma values is wide enough to represent the actual failure distribution. If we assume one failure at 7.9E3 hours and a lognormal distribution (Fig. 1), the median life (tm) at 130°C for sigma = 0.5 & 2.0 can be estimated at:

- tm 2.5E4 hours for = 0.5
- tm 5.5E5 hours for = 2.0



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From this estimate, one can extrapolate to the median life at 25°C and 50°C using an Arrhenius plot (Fig. 2) assuming a 0.7eV activation energy. The results are shown as follows:

	tm (hrs.)	
	25°C	50°C
= 0.5	3.0E7	3.8E6
= 2.0	6.0E8	7.8E7

Using these median lives, one can estimate the random failure rate (RFR) at 20 years service at 25°C using Goldthwaite curves (Fig. 3) as follows:

$$\begin{aligned} \text{RFR} &\ll 1.0 \text{ for } = 0.5 \\ \text{RFR} &= 0.3 \text{ for } = 2.0 \end{aligned}$$

As shown by our calculations, Teldyne Judson's Ge photodiodes (both PIN's and APD's) show excellent reliability.

Below is a summary of our reliability analysis.

	= 0.5	= 2.0	
tm @ 50°C	3.8E6	7.8E7	Hours
RFR @ 20 yrs & 25°C	<< 1.0	0.3	FIT's

References

1. Bellcore, 'Reliability Assurance Practices for Optoelectronic Devices' Issue 2 July 1988, pp. 83

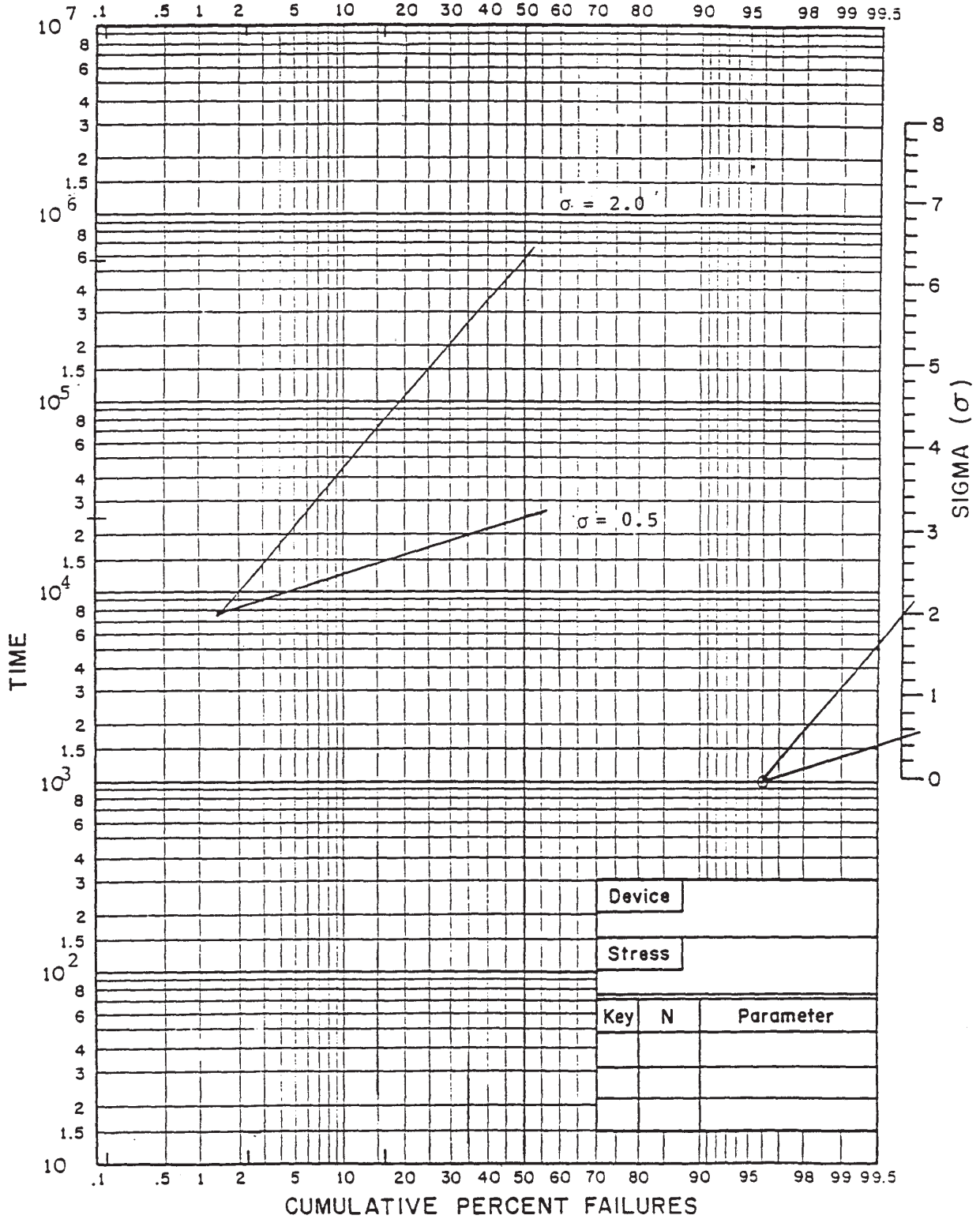


Figure 1: Life Distribution

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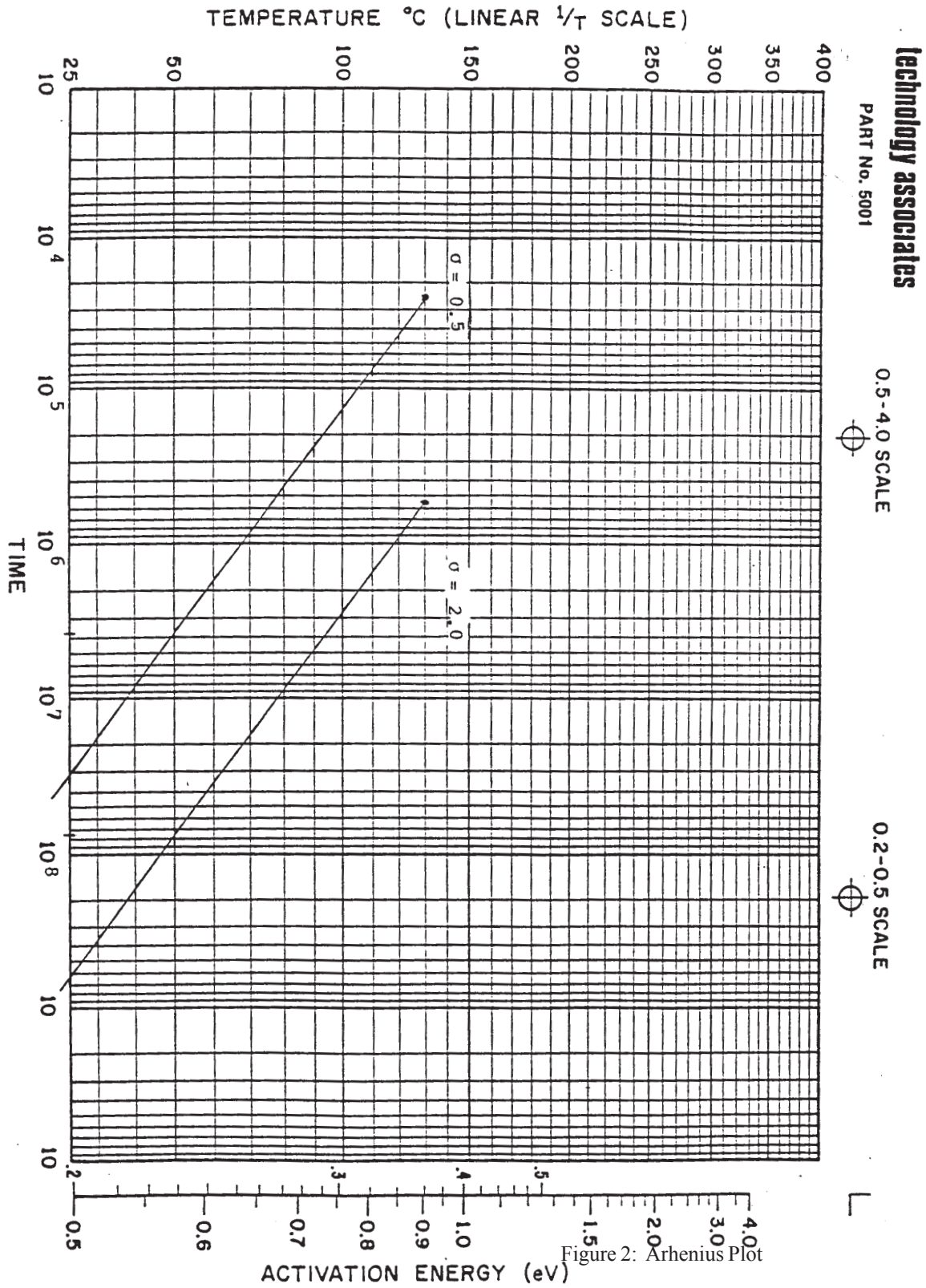


Figure 2: Arrhenius Plot

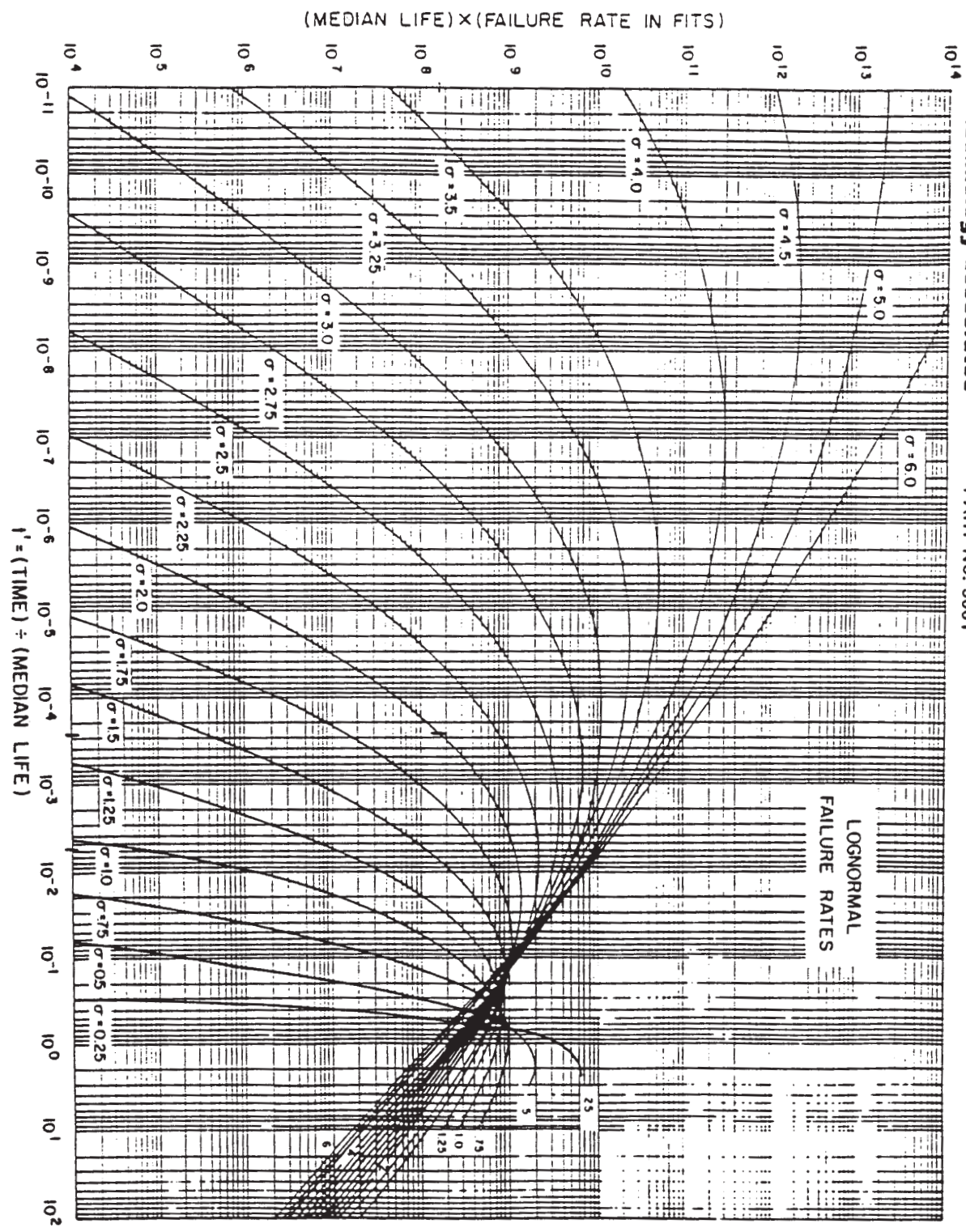


FIGURE 3: GOLDTHWAITE CURVES

Figure 3: Goldthwaite Curves



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