

## AEDR-871x and AEDR-872x

### Three-Channel High-Resolution Reflective Incremental Encoders

#### Description

The following cumulative test results have been obtained from testing performed at Broadcom in accordance with the JEDEC standard. Broadcom tests parts at the absolute maximum rated conditions recommended for the device. The actual performance that you obtain from Broadcom® parts depends on the electrical and environmental characteristics of your application but will probably be better than the performance outlined in [Table 1](#).

**Table 1: Life Tests Demonstrated Performance**

Test Name	Stress Test Conditions	Total Device Hours	Units Tested	Total Failed	Point Typical Performance	
					MTTF	Failure Rate (% / 1K Hours)
High Temperature Operating Life	Vcc = 5.5V, TA = 85°C 1000 hours	460,000	460	0	1,276,781	0.08

#### Failure Rate Prediction

The failure rate of semiconductor devices is determined by the junction temperature of the device. The relationship between the ambient temperature and the actual junction temperature is given by the following equation:

$$T_J(^{\circ}\text{C}) = T_A(^{\circ}\text{C}) + (\theta_{JA} \times P_{AVG})$$

Where:

$T_A$  = Ambient temperature in °C

$\theta_{JA}$  = Thermal resistance of junction-to-ambient in °C/watts

$P_{AVG}$  = Average power dissipated in watts

The estimated MTTF (mean time to failure) and failure rate at temperatures lower than the actual stress temperature can be determined by using an Arrhenius model for temperature acceleration. [Table 2](#) shows the results of such calculations using an activation energy of 0.70 eV (reference MIL-HDBK-217).

**Table 2: Failure Rate Prediction<sup>a</sup>**

Ambient Temperature (°C)	Junction Temperature (°C)	Point Typical Performance <sup>b</sup> in Time (60% Confidence)		Performance in Time <sup>c</sup> (90% Confidence)	
		MTTF <sup>(b)</sup>	Failure Rate (% / 1K Hours)	MTTF <sup>(c)</sup>	Failure Rate (% / 1K Hours)
85	116	1,276,781	0.08	506,835	0.20
75	106	2,333,864	0.04	926,458	0.11
65	96	4,414,872	0.02	1,752,541	0.06
55	86	8,668,614	0.01	3,441,120	0.03
45	76	17,726,903	0.01	7,036,927	0.01
35	66	37,897,648	0.00	15,043,969	0.01
25	56	85,063,482	0.00	33,767,065	0.00

- a. Failures are catastrophic or parametric. Catastrophic failures are open, short, no logic output, no dynamic parameters; whereas parametric failures are failures to meet an electrical characteristic as specified in the product catalog, such as output voltage, duty, or state errors.
- b. The point typical MTTF (which represents a 60% confidence level) is the total device hours divided by the number of failures. In the case of zero failures, one failure is assumed for this calculation.
- c. The 90% confidence MTTF represents the minimum level of reliability performance that is expected from 90% of all samples. This confidence interval is based on the statistics of the distribution of failures. The assumed distribution of failures is chi-square. This particular distribution is commonly used in describing useful life failures.

**Example of Failure Rate Calculation**

Assume a device operating 8 hours/day, 5 days/week. The utilization factor, given 168 hours/week, is:

$$(8 \text{ hours/day}) \times (5 \text{ days/week}) / (168 \text{ hours/week}) = 0.24$$

The point failure rate per year (8760 hours) at a 55°C ambient temperature is:

$$(0.01\% / 1\text{K hours}) \times 0.24 \times (8760 \text{ hours/year}) = 0.02\% \text{ per year}$$

Similarly, the 90% confidence level failure rate per year at 55°C is:

$$(0.03\% / 1\text{K hours}) \times 0.24 \times (8760 \text{ hours/year}) = 0.06\% \text{ per year}$$

**Table 3: Environmental Tests**

Test Name	Test Conditions	Units Tested	Units Failed
Temperature Cycle	–40°C to 85°C, 15-minute dwell time, 5-minute transfer, 1000 cycles	323	0
Wet High Temperature Storage Life	T <sub>A</sub> = 85°C, RH = 85%, 1000 hours	10	0
Low Temperature Storage Life	T <sub>A</sub> = –40°C, 1000 hours	10	0
High Temperature Storage Life	T <sub>A</sub> = 85°C, 1000 hours	10	0
Temperature Humidity Bias	T <sub>A</sub> = 85°C, RH = 85%, V <sub>cc</sub> = 5.5V, 1000 hours	59	0
Low Temperature Operating Life	T <sub>A</sub> = –40°C, V <sub>cc</sub> = 5.5V, 1000 hours	32	0
Sequential Stress Test	Preconditioning => 3x Reflow at 235°C => Temperature Cycle –40°C to 85°C, 15-minute dwell time, 5-minute transfer, 500 cycles	30	0

**Table 4: Electrical Tests**

Test Name	Reference	Test Conditions	Units Tested	Units Failed
ESD – Human Body Model	JESD22-A114D	Up to 2 kV applied to all pins versus ground	9	0
ESD – Machine Model	JESD22-A115A	Up to 200V applied to all pins versus ground	9	0

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