Agilent Technologies
Innovating the HP Way

Motion Sensing Products

Reflective Optical Surface Mount Encoder

Reliability Data

HEDR-8000
HEDR-8100

Description

The following cumulative test results have been obtained from testing performed at Agilent Technologies in accordance with the latest revision of MIL- STD-883 and JIS-C 7021.

Agilent tests parts at the absolute maximum rated conditions recommended for the device. The actual performance you obtain from Agilent 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 Temp. Operating Life	T_A = +85°C V_{CC} = 5.0 V I_{LED} = 15 mA	450,000	450	0	>450,000	<0.22
Low Temp. Operating Life	T_A = -40°C V_{CC} = 5.0 V I_{LED} = 15 mA	45,000	45	0	>45,000	<2.2
High Temp. Storage Life[1]	T_A = 100°C Static State	23,000	23	0	>23,000	<4.35
Low Temp. Storage Life[2]	T_A = -40°C Static State	21,000	21	0	>21,000	<4.76

Failure Rate Definition

For the purpose of this data sheet, a failure is any device which fails data sheet specifications.

Failure Rate Prediction

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

$T_J(°C) = T_A(°C) + \theta_{JA} P_{AVG}$

where

T_A = ambient temperature in °C

θ_{JA} = thermal resistance of junction-to-ambient in °C/watt

P_{AVG} = average power dissipated in watts.

The estimated MTBF and failure rate at temperatures lower than the actual stress temperature can be determined by using an Arrhenius model for temperature acceleration. Results of such calculations are shown in the table below using an activation energy of 0.43 eV (reference MIL-HDBK-217).

Table 2.

		Point Typical Performance[3] in Time		Performance in Time[4] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTBF	Failure Rate (%/1K Hours)	MTBF	Failure Rate (%/1K Hours)
85	94	450,000	0.222	195,000	0.512
75	84	659,000	0.152	286,000	0.350
65	74	985,000	0.101	428,000	0.234
55	64	1,510,000	0.066	656,000	0.153
45	54	2,374,000	0.042	1,031,000	0.097
35	44	3,842,000	0.026	1,669,000	0.060
25	34	6,415,000	0.016	2,786,000	0.036

Example of Failure Rate Calculation

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

(8 hours/day) x (5 days/week) / (168 hours/week) = 0.25.

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

(0.066%/1K hours) x 0.25 x (8760 hours/year) = 0.145% per year.

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

(0.153%/1K hours) x 0.25 x (8760 hours/year) = 0.335% per year.

Table 3. Environmental Tests

Test Name	MIL-STD-883C Reference	JIS-C 7021 Reference	Test Conditions	Units Tested	Units Failed
Temperature Cycle	1010	A-4	-20°C to +85°C, 30 min. dwell, 5 min. transfer, 500 cycles.[5]	405	2
Temperature Cycle Operating Life			-10°C to +60°C, 30 min. dwell, 15 min. transfer, 1,000 cycles. Bias applied[6]	55	0
Solder Heat Resistance			150±10°C pre-heat, 230±5°C for 10±1 sec. (EIAJ Profile)	77	0
Wet High Temperature Operating Life		B-11	T_A = 60°C RH = 90% 1,000 hours, Bias applied	450	1
Wet High Temperature Storage Life		B-11	T_A = 60°C RH = 90% 1,000 hours, non-operating	76	0
Power Temperature Cycle			-45°C to +90°C, 15 min. dwell and transfer, Power 5 min. on/off V_{CC} = 5 volts, $V_{A/B}$ = 3.5 volts	47	0

Table 4. Mechanical Tests

Test Name	MIL-STD-883C Reference	JIS-C 7021 Reference	Test Conditions	Units Tested	Units Failed
Mechanical Shock	2002	A-7-F	3 blows per axis; 1,500 g's; 0.5 msec. half sine.	22	0
Vibration Variable Frequency	2007	A-10-D	3 cycles; 4 min. per sweep each axis, 20 to 2,000 Hz at 20 g's.	22	0

Table 5. Electrical Tests

Test Name	MIL-STD-883C Reference	Test Conditions	Units Tested	Units Failed
ESD Human Body Model	3015	1.5 K Ohms, 100 pF, 5 positive and 5 negative voltage discharges of 2 KV applied to all pins versus ground.	5	0
ESD Machine Model		0 Ohms, 200 pF, 5 positive and 5 negative voltage discharges of 150 V applied to all pins versus ground.	5	0

Notes:
1. Performed in accordance with JIS-C 7021-B-10.
2. Performed in accordance with JIS-C 7021-B-12.
3. The point typical MTBF (which represents a 60% confidence level) is simply the total device hours divided by the number of failures. In the case of zero failures, one failure is assumed for this calculation.
4. The 90% confidence MTBF represents the minimum level of reliability performance which 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 exponential. This particular distribution is commonly used in describing useful life failures. Refer to MIL-STD-690 for details on this methodology.
5. Pre-conditioning included a moisture soak (85°C, 30%RH, 168 hours), a 24 hour 100°C bake and an IR (soldering heat) reflow exposure (Refer to EIAJ-ED4701).
6. Samples were preconditioned per note 5 and soldered on printed wiring boards during the IR reflow.

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