# HRPG Series
Miniature Panel Mount Optical Encoder

# Reliability Data Sheet

## Description

The following cumulative test results have been obtained from testing performed at Avago Technologies Malaysia in accordance with the latest revisions of MIL-STD-883.

Avago tests parts at the absolute maximum rated conditions recommended for the device. The actual performance you obtain from Avago parts depends on the electrical and environmental characteristics of your application but will probably be better than performance outlined in Table 1.

## Failure Rate Prediction

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

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

Where,

$T_A$ = ambient temperature in °C

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

$P_{AVG}$ = average power dissipated in W

The estimated MTTF 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 1. Life Tests - Demonstrated Performance**

| | | | | | Point Typical Performance | |
|---|---|---|---|---|---|---|
| **Test Name** | **Stress Test Conditions** | **Total Device Hours** | **Units Tested** | **Total Failed** | **MTTF** | **Failure Rate (% /1 K Hours)** |
| High Temperature Operating Life | $V_{CC}$= 5.0V<br>Va/Vb = 5.0V<br>$T_A$=85°C<br>1000hours | 598,000 | 598 | 0 | 653,552 | 0.15 |

**Table 2.**

| **Ambient Temperature (°C)** | **Junction Temperature (°C)** | **Point Typical Performance [1] in Time** | | **Performance in Time [2] (90% Confidence)** | |
|---|---|---|---|---|---|
| | | **MTTF (1)** | **Failure Rate (% / 1K Hours)** | **MTTF (2)** | **Failure Rate (% /1K Hours)** |
| 85 | 95 | 653,552 | 0.15 | 259,436 | 0.39 |
| 75 | 85 | 954,186 | 0.11 | 378,777 | 0.26 |
| 65 | 75 | 1,424,743 | 0.07 | 565,570 | 0.18 |
| 55 | 65 | 2,176,328 | 0.05 | 863,922 | 0.12 |
| 45 | 55 | 3,418,077 | 0.03 | 1,356,850 | 0.07 |
| 35 | 45 | 5,509,443 | 0.02 | 2,187,046 | 0.05 |
| 25 | 35 | 9,175,869 | 0.01 | 3,642,482 | 0.03 |

Notes:
1. The point typical MTTF (which represents 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.
2. The 90% Confidence MTTF 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.
3. Failures are catastrophic or parametric. Catastrophic failures are open, short, no logic output, no dynamic parameters while parametric failures are failures to meet an electrical characteristic as specified in product catalog such as output voltage, duty or state errors.

## 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) = 0.24

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

(0.05% / 1K hours) x 0.24 X (8760 hours/year) = 0.11% per year

Similarly, 90% confidence level failure rate per year at 50°C:

(0.012% / 1K hours) X 0.24 X (8760 hours/year) = 0.03% per year

**Table 3. Environmental Tests**

| Test Name | Test Conditions | Units Tested | Unit Failed |
|---|---|---|---|
| Temperature Cycle | -40°C to 100°C,<br>15minutes dwell time, 5 minutes transfer,<br>1000 cycles | 1,208 | 0 |
| Wet High Temperature Operating Life | $T_A$=85°C, RH=85%<br>Vcc=5.0V, Va /Vb = 5.0V<br>1000 hours | 286 | 0 |
| Low Temperature Operating Life | $T_A$=85°C, RH=85%<br>Vcc=5.0 V, Va /Vb = 5.0V<br>1000 hours | 199 | 0 |
| Solderability | Sn 60, Pb 40 Solder at 260°C for 5seconds | 38 | 0 |
| Resistance to Solvents [4] | 3 immersions, 1 minute each, brush after solvent | 90 | 0 |

Note 4. This test is for marking only, not for device functionality

**Table 4. Electrical Tests**

| Test Name | Reference | Test Conditions | Units Tested | Unit Failed |
|---|---|---|---|---|
| Mechanical Shock | Mil-Std-883C 2002 | 30Gs peak, 11msec pulse, 3axes in each direction | 90 | 0 |
| Vibration Test | Mil-Std-883C 2007 | 4 cycles for 4 minutes in each mutually perpendicular axis. 20Gs minimum from 20 to 2000Hz. | 90 | 0 |
| Terminal Strength | Mil-Std-883C 2004 Condition A | 1l. tension, 30seconds, 8 oz, lead bend stress | 77 | 0 |
| Lead Fatigue | Mil-Std-883C 2004 Condition B. | 1lb. tension, 10 seconds,10 x 90° flex | 77 | 0 |
| Moisture Resistance | Mil-Std-883C 1004 | $T_A$=60°C, RH=90%<br>24hours (plus 2 hours at 70°C), unbias. | 154 | 0 |

**Table 5. Mechanical and Vibration shock**

| Test Name | Reference | Test Conditions | Units Tested | Unit Failed |
|---|---|---|---|---|
| ESD | MIL-STD-883C 3015.2 | 10 discharges, 25kV, all pin grounded (machine model) | 131 | 0 |

Avago assures the form, fit, function, quality and reliability of above-mentioned parts as outlined in above-mentioned conditions of this reliability data sheet. If customer runs the parts outside of such specifications, no assurance of form, fit, function, quality and reliability is provided.

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**


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