# 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 in accordance with the latest revision 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 the performance outlined in Table 1.

## Failure Definition:

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

### Table 1. Life Tests

### Demonstrated Performance

| | | | | | Point Typical Performance | |
|---|---|---|---|---|---|---|
| Test Name | Stress Test Conditions | Total Device Hrs. | Units Tested | Total Failed | MTTF | Failure Rate (% /1K Hours) |
| High Temperature Operating Life | $T_A$ = 85°C[1]<br>$V_{CC}$ = 5.0 V<br>$V_A/V_B$ = 5.0 V | 400,000 | 400 | 0 | 400,000 | 0.25 |
| Low Temperature Operating Life | $T_A$ = -40°C<br>$V_{CC}$ = 5.0 V<br>$V_A/V_B$ = 5.0 V | 199,000 | 199 | 0 | >199,000 | <0.500 |

Note:
1. The maximum operating temperature specified for the HRPG Series product is +70°C. The reliability testing was performed at +85°C in order to verify the reliability at +70°C with a guard band of 15°C.

## 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

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

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

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 2.**

| Ambient Temperature (°C) | Junction Temperature (°C) | Point Typical Performance [1] Performance in Time | | Performance In Time [2] (90% Confidence) | |
|---|---|---|---|---|---|
| | | MTTF [1] | Failure Rate (%/ 1K Hours) | MTTF [2] | Failure Rate (%/ 1K Hours) |
| 85 | 95 | 400,000 | 0.250 | 174,000 | 0.575 |
| 75 | 85 | 584,000 | 0.171 | 253,000 | 0.395 |
| 65 | 75 | 872,000 | 0.115 | 378,000 | 0.265 |
| 55 | 65 | 1333,000 | 0.075 | 578,000 | 0.173 |
| 45 | 55 | 2090,000 | 0.048 | 907,000 | 0.110 |
| 35 | 45 | 3373,000 | 0.030 | 1463,000 | 0.068 |
| 25 | 35 | 5614,000 | 0.018 | 2436,000 | 0.041 |

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. Refer to MIL-STD-690B for details on this methodology.
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) = 0.25

The point failure rate per year (8760 hours) at 55°C ambient temperature is:
(0.075% / 1K hours) x (0.25) x (8760 hours/year) = 0.164% per year

Similarly, 90% confidence level failure rate per year at 55°C:
(0.173% / 1K hours) x (0.25) x (8760 hours/year) = 0.38% per year

## Table 3. Environmental Tests

| Test Name | MIL-STD-883C Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|
| Temperature Cycle | 1010 | -40°C to +100°C, 15 minutes dwell, 5 minutes transfer. 1000 cycles | 878 | 0 |
| Solderability | 2003 | Sn 60, Pb 40 Solder at 260°C for 5 seconds | 38 | 0 |
| Resistance to Solvents[4] | 2015 | 3 immersions, 1 minute each, brush after solvent | 90 | 0 |

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

## Table 4. Mechanical Tests

| Test Name | MIL-STD-883C Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|
| Mechanical Shock | 2002 | 30 Gs peak, 11 msec pulse, 3 axes in each direction | 90 | 0 |
| Vibration Variable Frequency | 2007 | 4 cycles for 4 minutes in each mutually perpendicular axis. 20 Gs minimum from 20 to 2000 Hz. | 90 | 0 |
| Terminal Strength | 2004 Condition A | 1 lb. tension, 30 seconds, 8 oz. lead bend stress | 77 | 0 |
| Lead Fatigue | 2004 Condition B | 1 lb. tension, 10 seconds, 10 x 90° flex | 77 | 0 |
| Moisture Resistance | 1004 | $T_A$ = 65°C, RH = 90% 24 hours (plus 2 hours at 70°C), non-operating | 154 | 0 |

## Table 5. Electrical Tests

| Test Name | MIL-STD-883C Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|
| ESD | None | 10 discharges, 25 KV, all pins grounded (machine model) | 131 | 0 |

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