Agilent Technologies
Innovating the HP Way

Fiber-Optic Transmitter and Receiver

Reliability Data

HFBR-0400 Series
Transmitters:
HFBR-1402, -1412, -1404, -1414
Receivers:
HFBR-2402, -2412, -2406, -2416

Introduction

Agilent Technologies' quality system includes an ongoing reliability monitor program to generate a data base from which this reliability data sheet is published.

Transmitter Reliability

The HFBR-0400 Series fiber optic transmitters incorporate AlGaAs emitters and double lens optical systems. This design allows the HFBR-14XX transmitters to be driven at a relatively low current level for a specified amount of coupled power into the fiber. Because transmitter forward currents are proportional to failure rates, a low current translates into excellent transmitter reliability. To further improve reliability, Agilent has implemented a proprietary wafer screening technology that identifies dislocations which can lead to the formation of darkline defects (the primary mechanism for transmitter light output failures).

Transmtter reliability data has been calculated using 100 mA forward current and a 100% duty factor. In many actual use conditions, a 50% duty factor and lower forward currents are highly probable. When this is true, transmitter reliability will be substantially better. The degree of improvement can be projected by examining the footnotes below the HFBR-14XX data.

Reliability Prediction Model

The reliability prediction model used to project failure rate and mean time to failure (MTTF) at various temperatures shown in the second table assumes an exponential cumulative failure function (constant failure rate). The Arrhenius temperature derating equation is used. Agilent Technologies assumes no failure mechanism change between stress and use conditions. A conservative activation energy of 0.43 eV was used and is derived from MIL-HDBD-217 for hybrid devices. Confidence intervals are based upon the chi-squared prediction method associated with exponential distributions.

Fiber-Optic Transmitter

Reliability Data

HFBR-1402
HFBR-1412
HFBR-1404
HFBR-1414

High Temperature Operating Life Test

A. Demonstrated Performance

Test	Equivalent Test Condition	Samples	Device Hours	Failures
HTOL	T_A = 85°C, I_F = 100 mA	880 units	879,500	3

B. Failure Criteria
Failure has occurred when the unit fails catastrophically, or when the light output power decreases 3 dB.

C. Failure Rate Prediction for Random Failures (I_F @ 100 mA, 100% duty cycle)

		Point Typical Performance [1] in Time		Performance in Time [2] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTTF [1] (hours)	FITs [3] ($/10^9$ Hours)	MTTF [2] (hours)	FITs [3] ($/10^9$ Hours)
85	100	293,000	3411	131,000	7596
80	95	352,000	2844	158,000	6334
75	90	424,000	2360	190,000	5255
70	85	514,000	1947	231,000	4337
65	80	626,000	1598	281,000	3560
60	75	766,000	1305	344,000	2905
55	70	945,000	1059	424,000	2357
50	65	1,172,000	854	526,000	1901
45	60	1,462,000	684	657,000	1523
40	55	1,838,000	544	825,000	1212
35	50	2,326,000	430	1,044,000	958
30	45	2,965,000	337	1,331,000	751
25	40	3,810,000	263	1,711,000	585

Notes:
1. The *point* MTTF (representing an estimate of the mean point MTTF) is the total device hours divided by either the number of failures or unity if there are no failures.
2. *90% confident* MTTF and failure rate represent 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 exponential. This particular distribution is commonly used in describing failure rates prior to the onset of wear out. Refer to MIL-STD-690 for details of this methodology.
3. 1 FIT = 1 failure per 10^9 device hours.

Fiber-Optic Link Receiver

Reliability Data

HFBR-2402
HFBR-2412

High Temperature Operating Life Test

A. Demonstrated Performance

Test	Equivalent Test Condition	Samples	Device Hours	Failures
HTOL	T_A = 85°C, V_{CC} = 5.25 V	3,960	2,370,000	1

B. Failure Criteria
Failure has occurred when the unit fails catastrophically. One device failed to switch logic states.

C. Failure Rate Prediction, Receiver (V_{CC} = 5.25 V)

		Point Typical Performance [1] in Time		Performance in Time [2] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTTF [1] (hours)	FITs [3] (/10^9 Hours)	MTTF [2] (hours)	FITs [3] (/10^9 Hours)
85	100	2,370,000	421	609,000	1,640
80	95	2,880,000	346	742,000	1,340
75	90	3,530,000	282	909,000	1,090
70	85	4,350,000	229	1,120,000	892
65	80	5,400,000	184	1,390,000	719
60	75	6,740,000	148	1,730,000	576
55	70	8,480,000	117	2,180,000	458
50	65	10,700,000	93	2,750,000	362
45	60	13,600,000	73	3,510,000	284
40	55	17,500,000	56	4,520,000	221
35	50	22,700,000	43	5,850,000	170
30	45	29,700,000	33	7,650,000	130
25	40	39,200,000	25	10,000,000	99

Notes:
1. The *point* MTTF (representing an estimate of the mean point MTTF) is the total device hours divided by either the number of failures or unity if there are no failures.
2. *90% confident* MTTF and failure rate represent 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 exponential. This particular distribution is commonly used in describing useful life failures. Refer to MIL-STD-690 for details of this methodology.
3. 1 FIT = 1 failure per 10^9 device hours.

Fiber-Optic Link Receiver

Reliability Data

HFBR-2406
HFBR-2416

High Temperature Operating Life Test

A. Demonstrated Performance

Test	Equivalent Test Condition	Samples	Device Hours	Failures
HTOL	T_A = 85°C, V_{CC} = 5.25 V	2,250	2,250,000	0

B. Failure Criteria
Failure has occurred when the unit fails catastrophically.

C. Failure Rate Prediction, Receiver (V_{CC} = 5.25 V)

		Point Typical Performance [1] in Time		Performance in Time [2] (90% Confidence)	
Ambient Temperature (°C)	Junction Temperature (°C)	MTTF [1] (hours)	FITs [3] ($/10^9$ Hours)	MTTF [2] (hours)	FITs [3] ($/10^9$ Hours)
85	100	2,250,000	444	977,164	1023
80	95	2,698,516	371	1,171,953	853
75	90	3,252,687	307	1,412,627	708
70	85	3,941,173	254	1,711,633	584
65	80	4,801,432	208	2,085,240	480
60	75	5,882,744	170	2,554,849	391
55	70	7,250,382	138	3,148,808	318
50	65	8,991,407	111	3,904,927	256
45	60	11,222,799	89	4,874,010	205
40	55	14,102,949	71	6,124,846	163
35	50	17,848,023	56	7,751,315	129
30	45	22,755,516	44	9,882,616	101
25	40	29,238,409	34	12,698,107	79

Notes:
1. The *point* MTTF (representing an estimate of the mean point MTTF) is the total device hours divided by either the number of failures or unity if there are no failures.
2. *90% confident* MTTF and failure rate represent 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 exponential. This particular distribution is commonly used in describing useful life failures. Refer to MIL-STD-690 for details of this methodology.
3. 1 FIT = 1 failure per 10^9 device hours.

HFBR-0400 Mechanical and Environmental Test Data [1]

Test Name	MIL-STD-883D Reference	Test Conditions	Units Tested	Total Failed
Temperature Cycle	1010	500 cycles from -55 to +125°C, 15 minutes at extremes, 5 minutes transfer. [1]	2020 HFBR-1414	1
		500 cycles from -55 to +125°C, 15 minutes at extremes, 5 minutes transfer. [1]	2090 HFBR-2416	0
85/85		T_A = 85°C, 85% relative humidity, No bias, duration = 1,000 hours. [1]	2140 HFBR-1414	7
		T_A = 85°C, 85% relative humidity, V_{CC} = 5 volts, Duration = 1,000 hours [1]	2220 HFBR-2416	6
High Temperature Storage	1008 Condition B	T_A = 125°C 1000 hours	80	0
Resistance to Solvents	2015	Three 1 minute immersions. Brush after solvent immersion.	20	0
Chemical Resistance	—	5 minutes in Acetone, Methanol, Freon TF and Boiling Water	20	0
Vibration Variable Frequency	2007, Condition B	20 G min., 20 to 2000 Hz. 4, 4 minute cycles each X, Y, and Z.	20	0
Thermal Shock	1011 Condition B	-55°C to +125°C, 15 cycles 5 min. dwell / 10 sec. transfer	60	0
Mechanical Shock	2002, Condition B	5 blows each X1, X2, Y1, Y2, Z1, Z2 1500 G, 0.5 msec. pulse.	60	0
Port Wear Test [2]	T_A = 25°C	500 connectorings Less than 1 dBm variation	20	0
Connector Side Load [3]	T_A = 25°C	1 kg side load Less than 1 dBm variation	10	0
Port Strength [4]	T_A = 25°C	6 kg-cm (5.21 inch-lbs), no port damage	10	0
Seal-Dye Penetrant (Zyglo)	1014 Condition D	45 psi, 10 hours No Leakage into microelectronic cavity	20	0
Solderability	2003	245°C	30	0
ESD	Method 3015	Human body model @ 10,000 V	5 HFBR-1414	0
		Human body model @ 2,000 V	5 HFBR-2402	0
		Human body model @ 1000 V	5 HFBR-2416	0

Notes: See following page.

Agilent Technologies
Innovating the HP Way

Notes:
1. Devices were preconditioned with 10 second, 260°C solder dip and 20 cycles, -40°C to 85°C, temperature cycle.

2. Coupled power measurements were maximized before and after stress in determining the 1 dBm variation for SMA HFBR-0400 products. HFBR-0400 ST products do not require this due to the improved coupling design.

3. The Connector Side Load test was only applied to HFBR-0400 SMA products. The Connector Side Load testing required that the housing be held so to prevent the leads from yielding. The load was applied through a SMA connectored fiber optic cable, perpendicular to the port. The product family is designed to limit cable and ferrule damage due to cable loading. The support and active leads should yield before damage to the cable or connector occurs. If extreme mechanical abuse of the cable/ connector is anticipated please contact Agilent's Application Department for suggestions about mechanical strain relief. Due to the spring loaded feature of the ST connector, HFBR-0400 ST products will experience 1 dBm coupled power variation at a side load of less than 1 kg.

4. The Port Strength test was designed to gauge the concerns with hand tightening the connector to the fiber optic port. The limit is set to a level beyond most reasonable hand fastening loading.

5. Package tests are defined as stresses that indicate the environmental strength of the package. Units tested indicate the total number of devices taken from the product family. While not all part numbers have been subjected to each stress, worst case products have been included.

www.semiconductor.agilent.com
Data subject to change.

5968-6620E (11/99)