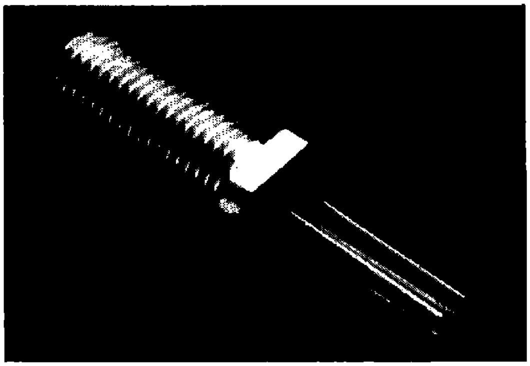
HEWLETT PACKARD

HIGH EFFICIENCY FIBER OPTIC TRANSMITTER

HFBR-1204

Features

- **OPTICAL POWER COUPLED INTO 100/140 μm FIBER CABLE**
  —9.8 dBm Guaranteed at 25° C
  —7.4 dBm Typical
- **FACTORY ALIGNED OPTICS**
- **RUGGED MINIATURE PACKAGE**
- **COMPATIBLE WITH SMA CONNECTORS**



Description

The HFBR-1204 Fiber Optic Transmitter contains an etched-well 820 nm GaAlAs emitter capable of coupling greater than -10 dBm of optical power into HP's 100/140 μm SMA connectored cable assemblies. This high power level is useful for fiber lengths greater than 1 km, or systems where star couplers, taps, or in-line connectors create large fixed losses.

Consistent coupling efficiency is assured by factory alignment of the LED with the mechanical axis of the package connector port. Power coupled into the fiber varies less than 5 dB from part to part at a given drive current and temperature. The benefit of this is reduced dynamic range requirements on the receiver.

High coupling efficiency allows the emitters to be driven at low current levels resulting in low power consumption and increased reliability of the transmitter. Another advantage of the high coupling efficiency is that a significant amount of power can still be launched into smaller fiber such as 50/125 μm (−19.1 dBm typ.).

The HFBR-1204 transmitter is housed in a rugged miniature package. The lens is suspended to avoid mechanical contact with the active devices. This assures improved reliability by eliminating mechanical stress on the die due to the lens. For increased ESD protection and design flexibility, both the anode and cathode are insulated from the case.

HFBR-1204 is compatible with SMA style connectors. The low profile package is designed for direct mounting on printed circuit boards or through panels without additional heat sinking. A complete mounting hardware package (HFBR-4202) is available for horizontal mounting on PCBs, including a snap-on metal shield for harsh EMI/ESD environments.

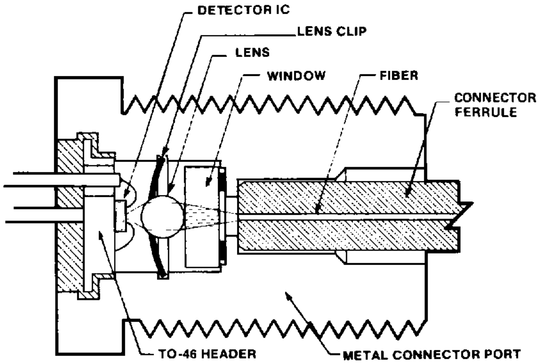
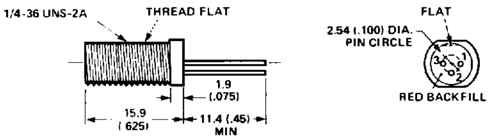


Figure 1. Cross Sectional View

Mechanical Dimensions

HFBR-1204



PIN	FUNCTION
1	ANODE
2	CATHODE
3	CASE

DIMENSIONS IN MILLIMETRES (INCHES)

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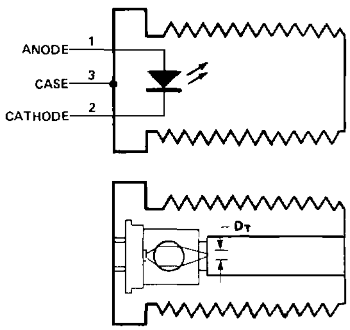
Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Unit	Reference
Storage Temperature		T_S	-55	+85	°C	
Operating Temperature		T_A	-40	+85	°C	Note 4
Lead Soldering Cycle	Temp.			+260	°C	Note 1
	Time			10	sec	
Forward Input Current	Peak	$I_{F,PK}$		100	mA	
	Average	$I_{F,AV}$		100	mA	
Reverse Input Voltage		V_R		1.0	V	
Voltage, Case-to-Junction		V_C		25	V	

HFBR-1204 TRANSMITTER



Electrical/Optical Characteristics -40°C to +85°C unless otherwise specified

Parameter	Symbol	Min.	Typ.[2]	Max.	Units	Conditions	Reference
Forward Voltage	V_F	1.44	1.72	1.94	V	I_F = 100 mA	Figure 2
Forward Voltage Temperature Coefficient	$\Delta V_F/\Delta T$		-0.54		mV/°C	I_F = 100 mA	Figure 2
Reverse Breakdown Voltage	V_{BR}	1.0	3.1		V	I_R = 100 μA	
Numerical Aperture	NA		0.38				
Optical Port Diameter	D_T		250		μm		Note 3
Peak Emission Wavelength	λ_P		820		nm		Figure 5
Peak Output Optical Power Coupled into HP's 100/140 μm SMA Connectored Cable	P_T	-9.8	-7.4	-5.0	dBm	I_F = 100 mA	Figure 3, 4
		105	182	316	μW	T_A = 25°C	Notes 4, 5, 6, 8
		-11.2		-4.2	dBm	I_F = 100 mA	
		76		380	μW	-40°C < T_A < 85°C	
Output Optical Power Coupled into 50/125 μm Fiber	P_T		-19.1		dBm	I_F = 100 mA	Figure 3, 4
			12		μW	T_A = 25°C	Notes 5, 7
Output Optical Power Coupled into Siecor 100/140 μm Fiber Cable or Equivalent	P_T		-9.4		dBm	I_F = 100 mA T_A = 25°C	Figure 3, 4 Notes 5, 11
Optical Power Temperature Coefficient	$\Delta P_T/\Delta T$		-.014		dB/°C	I_F = 100 mA	Figure 3
Case Isolation Resistance (Case to Pins 1 or 2)	R_{CASE}	1			MΩ	V_{CASE} = 25 V	
Thermal Resistance	Θ_{JC}		90		°C/W		Note 9
Rise Time, Fall Time (10 to 90%)	t_r, t_f		11		nsec		Figure 6 Note 10

WARNING: OBSERVING THE TRANSMITTER OUTPUT POWER UNDER MAGNIFICATION MAY CAUSE INJURY TO THE EYE. When viewed with the unaided eye, the infrared output is radiologically safe; however, when viewed under magnification, precaution should be taken to avoid exceeding the limits recommended in ANSI Z136.1-1981.

Notes:
1. 2.0 mm from where leads enter case.
2. Typical data at T_A = 25°C.
3. D_T is measured at the plane of the fiber face and defines a diameter where the optical power density is within 10 dB of the maximum.
4. HP's 100/140 μm fiber cable specified at a narrower temperature range, -20°C to 85°C.
5. Output Optical Power into connectored fiber cable other than HP's Cable/Connector Assemblies may be different than specified because of mechanical tolerances of the connector, quality of the fiber surface and other variables.
6. Measured at the end of 1.0 metre of HP's 100/140 μm Fiber Optic Cable with large area detector and cladding modes stripped, terminated with the appropriate type of connector. This assembly approximates a Standard Test Fiber. The fiber NA is 0.28, measured at the end of greater than 300 metres length of fiber, the NA being defined as the sine of the half angle determined by the 5% intensity points.

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7. Measured at the end of 1.0 metre 50/125 μm fiber with large area detector and cladding modes stripped, approximating a Standard Test Fiber. The fiber NA is 0.21, measured at the end of a 2.0 metre length, the NA being defined as the sine of the half angle determined by the 5% of peak intensity points.
8. When changing microwatts to dBm, the optical power is referenced to 1 milliwatt (1000 μW).
   Optical Power, P (dBm) = 10 log P (μW)/1000 μW
9. Thermal resistance is measured with the transmitter coupled to a connector assembly and mounted on a printed circuit board with the HFBR-4202 mounting hardware.
10. Measured with a 1 mA pre-bias current and terminated into a 50 ohm load.
11. Measured at the end of 1.0 metre Siecor 100/140 μm fiber cable or equivalent, with large area detector and cladding modes stripped, terminated with the appropriate type of connector. This assembly approximates a Standard Test Fiber. The fiber NA is 0.275, measured at the end of a 2.0 metre length, the NA being defined as the sine of the half angle determined by the 5% of peak intensity points.

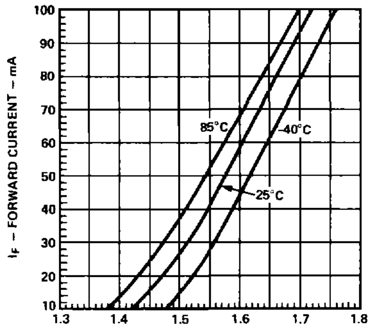

Figure 2. Forward Voltage and Current Characteristics

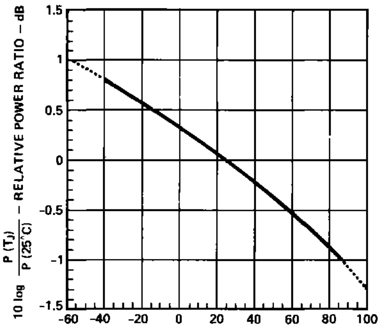

Figure 3. Normalized Thermal Effects in Transmitter Output

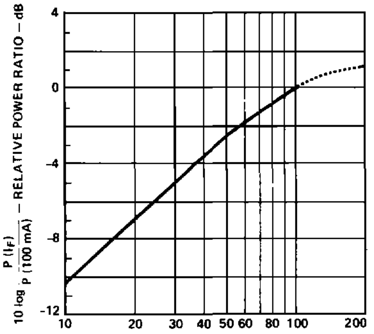

Figure 4. Normalized Transmitter Output vs. DC Forward Current

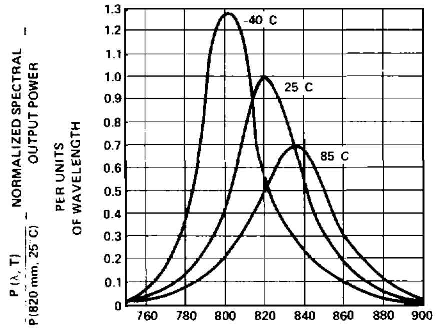

Figure 5. Transmitter Spectrum Normalized to the Peak at 25° C

Ordering Guide

Transmitter: HFBR-1204 (SMA Connector Compatible)

Receiver: HFBR-2202 (5 MBaud, SMA Connector)
HFBR-2204 (40 Mbaud, SMA Connector Compatible)

Mounting Hardware: HFBR-4202 (SMA Connector Compatible)

Fiber Optic Cable — see data sheets

High Speed Operation

Rise and fall times can be improved by using a pre-bias current and "speed-up" capacitor. A 1 mA pre-bias current will significantly reduce the junction capacitance and will couple less than −34 dBm of optical power into the fiber cable. The TTL compatible circuit in Figure 7 using a speed-up capacitor will provide typical rise and fall times of 10 ns.

$$I_{PEAK} = 100\ mA = \frac{V_{CC} - V_F}{34.9\Omega}$$

$$I_{AVG} = 78\ mA = \frac{V_{CC} - V_F}{34.9 + 10\Omega}$$

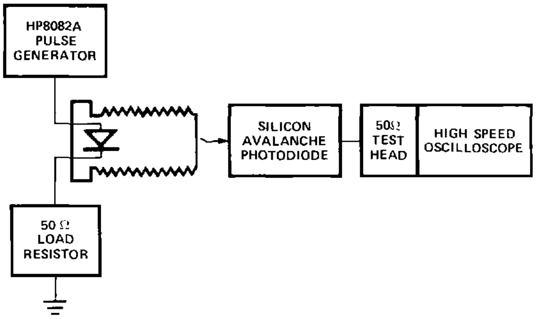

Figure 6. Test Circuit for Measuring t_r, t_f

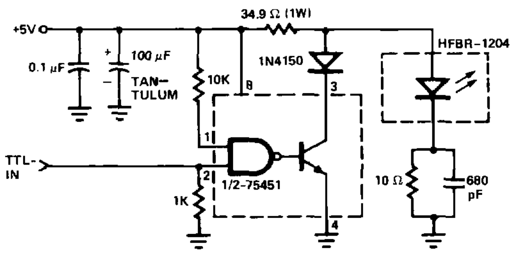

Figure 7. High Speed TTL Circuit

Link Design

With transmitter performance specified as power in dBm into a fiber of particular properties (core size, NA, and index profile), and receiver performance given in terms of the power in dBm radiated from the same kind of fiber, then the link design equation is simply:

(1) $P_T - \ell \cdot \alpha_o = P_R$

where

P_T = transmitter power into fiber (dBm)
ℓ = fiber (cable) length (km)
α_o = fiber attenuation (dB/km)
P_R = receiver power, from fiber, (dBm)

For transmitter input current in the range from 10 to 100 mA, the power varies approximately linearly:

(2) $P_T = P_o + 10 \log (I/I_o)$

where

P_o = transmitter power specification (dBm) at I_o
I_o = specified transmitter current (100 mA)
I = selected transmitter current (mA)

To allow for the dynamic range limits of proper receiver performance, it is necessary that a link with maximum transmitter power and minimum attenuation does not OVERDRIVE the receiver and that minimum transmitter power with maximum attenuation does not UNDERDRIVE it. These limits can be expressed in a combination of the two equations above:

(3) $P_{o\,MAX} + 10 \log (I_{MAX}/I_o) - \ell \cdot \alpha_{oMIN} < P_{R\,MAX}$

(4) $P_{o\,MIN} + 10 \log (I_{MIN}/I_o) - \ell \cdot \alpha_{oMAX} > P_{R\,MIN}$

where

$P_{o\,MAX}$, $P_{o\,MIN}$ = max., min. specified power from transmitter (dBm) at $I = I_o$
I_{MAX}, I_{MIN} = max., min. selected transmitter operating current (mA)
$P_{R\,MAX}$, $P_{R\,MIN}$ = max., min. specified power at receiver (dBm)
α_{oMAX}, α_{oMIN} = max., min. attenuation (dB/km)

A more useful form of these equations comes from solving them for the current ratio, expressed in dB:

(5) $10 \log (I_{MAX}/I_o) < P_{R\,MAX} - P_{o\,MAX} + \ell \cdot \alpha_{oMIN}$

(6) $10 \log (I_{MIN}/I_o) > P_{R\,MIN} - P_{o\,MIN} + \ell \cdot \alpha_{oMAX}$

These are plotted in Figure 8 as the OVERDRIVE LINE, and UNDERDRIVE LINE, respectively for the following components:

HFBR-1204 Transmitter $-11.2 < P_T < -4$ dBm
HFBR-2204 Receiver (25 MHz) $-28.5 < P_R < 12.6$ dBm
HFBR-2204 Receiver (2.5 MHz) $-35.5 < P_R < -12.6$ dBm
HP's 100/140 μm Fiber Cable $4 < \alpha_o < 8$ dB/km

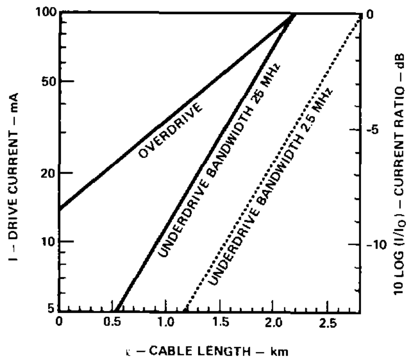

Figure 8. Link Design Limits.

These design equations take account only of the power loss due to attenuation. The specifications for the receiver and transmitter include loss effects in end connectors. If the system has other fixed losses, such as from directional couplers or additional in-line connectors, the effect is to shift both OVERDRIVE and UNDERDRIVE lines upward by the amount of the additional loss ratio.