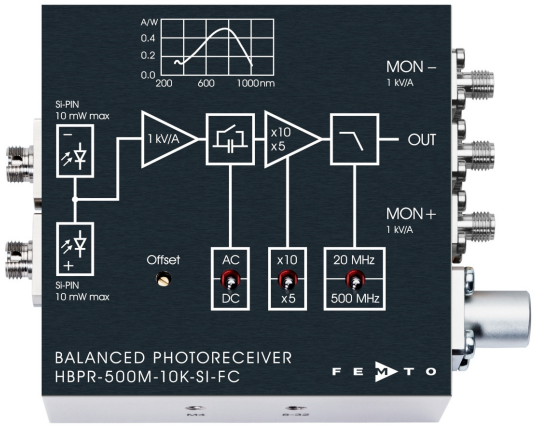
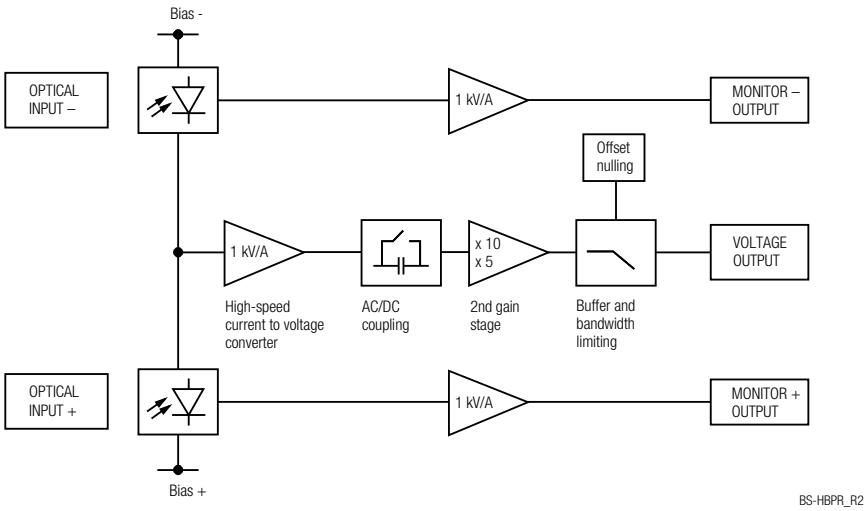
High-Speed Balanced Photoreceiver



Features	• **Bandwidth DC to 500 MHz** • **Common-Mode Rejection Ratio (CMRR) 45 dB typ.** • **Si-PIN photodiodes** • **FC fiber optic inputs** • **Spectral range 320 – 1000 nm** • **Very low NEP, down to 12 pW/√Hz** • **Transimpedance gain switchable 5 × 10^3 V/A, 10 × 10^3 V/A** • **High dynamic input range up to 2 × 10 mW balanced optical power** • **Fast monitor outputs with 10 MHz bandwidth and 1 × 10^3 V/A gain** • **Switchable low pass filter for minimizing wideband noise** • **UNC 8-32 and M4 tapped holes for mounting on standard posts with metric and imperial thread**
Applications	• **Spectroscopy** • **Heterodyne detection** • **Optical coherence tomography (OCT)** • **Optical delay measurement** • **Differential optical front-end for oscilloscopes, spectrum analyzers, A/D converters and RF lock-in amplifiers**
Block Diagram	

High-Speed Balanced Photoreceiver

Intended Use

The HBPR-500M-10K-SI-FC photoreceiver consists of a combination of two anti-parallel connected photodiodes with a subsequent low-noise transimpedance amplifier. It is designed for fast conversion of the tiny difference of two optical signals into an equivalent output voltage. Operation is mostly self-explanatory. If in doubt, consult this document or contact support@femto.de.

For safe operation, please refer to the damage thresholds specified in the "Absolute Maximum Ratings", "Temperature Range" and “Power Supply” sections of this document.

The operating environment must be free of smoke, dust, grease, oil, condensing moisture, and other contaminants that could affect the operation or performance.

Application Notes

The damage threshold of 12 mW for each photodiode mentioned in the “Absolute Maximum Ratings” section applies to reasonably homogeneous illumination of the photodiodes. Extreme focusing of the light beam can lead to damage to the photodiodes, even at significantly lower light power.

To achieve optimum performance, it is recommended that the CW light intensity at both inputs be well balanced. The monitor outputs can be used for continuous balance control. For setups with arbitrarily varying CW offset, the photoreceiver's AC mode can be helpful. Using AC mode increases the CW offset range to 2.5 mW (@ 760 nm), regardless of the gain setting.

Available Version

HBPR-500M-10K-SI-FC

Fix/permanent FC fiber connectors
for high coupling efficiency, excellent conversion gain accuracy and common mode rejection ratio (CMRR)

Related Models

Various free space or fiber coupled HBPR models, with bandwidth up to 500 MHz, in the spectral range from 320 nm to 1700 nm are available.

Si Versions

Fiber-coupled with fix/permanent FC fiber connectors

HBPR-100M-60K-SI-FC	Si-PIN ∅ 0.8 mm, DC – 100 MHz, 320 – 1000 nm, CMRR 50 dB, gain 2.0×10^4 / 6.0×10^4 V/A switchable
HBPR-200M-30K-SI-FC	Si-PIN ∅ 0.8 mm, DC – 200 MHz, 320 – 1000 nm, CMRR 45 dB, gain 1.0×10^4 / 3.0×10^4 V/A switchable
HBPR-500M-10K-SI-FC	Si-PIN ∅ 0.4 mm, DC – 500 MHz, 320 – 1000 nm, CMRR 40 dB, gain 5.0×10^3 / 10.0×10^3 V/A switchable

Free space versions with 1.035"-40 threaded flanges

HBPR-100M-60K-SI-FST	Si-PIN ∅ 0.8 mm, DC – 100 MHz, 320 – 1000 nm, CMRR 50 dB, gain 2.0×10^4 / 6.0×10^4 V/A switchable
HBPR-200M-30K-SI-FST	Si-PIN ∅ 0.8 mm, DC – 200 MHz, 320 – 1000 nm, CMRR 45 dB, gain 1.0×10^4 / 3.0×10^4 V/A switchable
HBPR-500M-10K-SI-FST	Si-PIN ∅ 0.4 mm, DC – 500 MHz, 320 – 1000 nm, CMRR 40 dB, gain 5.0×10^3 / 10.0×10^3 V/A switchable

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Related Models (continued)

InGaAs Versions

Fiber-coupled with fix/permanent FC fiber connectors (ball lense coupled)

HBPR-100M-60K-IN-FC	InGaAs-PIN ∅ 0.08 mm, DC – 100 MHz, 900 – 1700 nm, CMRR 55 dB, gain 2.0×10^4 / 6.0×10^4 V/A switchable
HBPR-200M-30K-IN-FC	InGaAs-PIN ∅ 0.08 mm, DC – 200 MHz, 900 – 1700 nm, CMRR 50 dB, gain 1.0×10^4 / 3.0×10^4 V/A switchable

Free space versions with 1.035"-40 threaded flanges

HBPR-100M-60K-IN-FST	InGaAs-PIN ∅ 0.3 mm, DC – 100 MHz, 800 – 1700 nm, CMRR 50 dB, gain 2.0×10^4 / 6.0×10^4 V/A switchable
HBPR-200M-30K-IN-FST	InGaAs-PIN ∅ 0.3 mm, DC – 200 MHz, 800 – 1700 nm, CMRR 45 dB, gain 1.0×10^4 / 3.0×10^4 V/A switchable
HBPR-450M-10K-IN-FST	InGaAs-PIN ∅ 0.3 mm, DC – 450 MHz, 800 – 1700 nm, CMRR 35 dB, gain 5.0×10^3 / 10.0×10^3 V/A switchable

Available Accessory

PS-15-25-L

Power Supply
Input: 100 – 240 VAC
Output: ±15 VDC

Specifications

Test conditions: $V_S = \pm 15$ V, $T_A = 25$ °C, output load impedance 50 Ω, warm-up 20 minutes (min. 10 minutes recommended), monitor outputs terminated with 1 MΩ

Gain

Transimpedance gain	5×10^3 V/A (@ 2nd gain ×5, 50 Ω load) 10×10^3 V/A (@ 2nd gain ×10, 50 Ω load)
Gain accuracy	±1 % electrical
Conversion gain	2.55×10^3 V/W typ. (@ 2nd gain ×5, 760 nm, 50 Ω load) 5.1×10^3 V/W typ. (@ 2nd gain ×10, 760 nm, 50 Ω load)
Common mode rejection ratio (CMRR)	50 dB typ. (f ≤100 MHz) 40 dB typ. (f ≤500 MHz)

Frequency Response

Lower cut-off frequency	DC / 10 Hz, switchable
Upper cut-off frequency (–3 dB)	500 MHz (@ 2nd gain ×5), 460 MHz (@ 2nd gain ×10), switchable to 20 MHz

Time Response

Rise/fall time (10 % – 90 %)	0.85 ns (@ 2nd gain ×5); 0.95 ns (@ 2nd gain ×10) 17.5 ns (@ bandwidth set to 20 MHz)

Input

Noise equivalent power (NEP)	minimum 12 pW/√Hz (@ 760 nm) 13 pW/√Hz (@ 760 nm, 20 MHz) 29 pW/√Hz (@ 760 nm, 200 MHz) 60 pW/√Hz (@ 760 nm, 500 MHz)
Maximum differential CW power (for linear amplification)	400 µW (@ 2nd gain ×5, DC-coupled, 760 nm) 200 µW (@ 2nd gain ×10, DC-coupled, 760 nm) 2.5 mW (@ AC-coupled, 760 nm)
Max. optical CW balanced power (common mode power)	10 mW (on each photodiode, @ 760 nm)
Monitor optical saturation power (limited by maximum ratings)	12 mW (@ 760 nm)

Detector

Detector type	Si-PIN photodiode in FC fiber connector
Active area	∅ 400 µm, suitable for fibers up to 200 µm core diameter
Spectral range	320 – 1000 nm
Sensitivity	0.51 A/W typ. (@ 760 nm)

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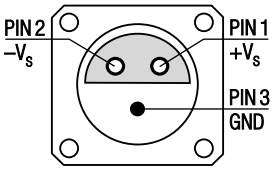
Specifications (continued)		
Output	Output voltage range	±1.0 V (@ 50 Ω load) for linear operation and low harmonic distortion
	Max. output voltage	±2.0 V (@ 50 Ω load)
	Offset voltage compensation	±100 mV typ., adjustable by offset potentiometer
	Output impedance	50 Ω (terminate with 50 Ω load)
	Slew rate	2800 V/µs
	Max. output current	70 mA
	Output reflection S22	–30 dB @ < 100 MHz –20 dB @ < 800 MHz
	Output noise (typ.)	2.3 mV RMS (15 mV peak-peak) (@ 2nd gain ×5) 3.9 mV RMS (26 mV peak-peak) (@ 2nd gain ×10) 0.25 mV RMS (1.7 mV peak-peak) (@ 2nd gain ×5, BW 20 MHz) 0.4 mV RMS (2.5 mV peak-peak) (@ 2nd gain ×10, BW 20 MHz) (@ 50 Ω load, no signal on detectors, measurement bandwidth 2 GHz)
Monitor Outputs	Gain	1×10^3 V/A (@ ≥ 100 kΩ load)
	Voltage range	0 ... +10 V (@ ≥ 100 kΩ load)
	Output impedance	50 Ω (terminate with ≥ 100 kΩ load)
	Max. output current	30 mA typ.
	Bandwidth	DC – 10 MHz
	Output noise	0.6 mV RMS (4 mV peak-peak) (@ 100 kΩ load, no signal on detectors, measurement bandwidth 200 MHz)
Power Supply	Supply voltage	±15 V (±14.5 V ... ±16.5 V)
	Supply current	–90 / +120 mA typ. (depends on operating conditions, recommended power supply capability min. ±200 mA)
Optical Input Connector	Material FC receptacle	nickel silver
Case	Weight	350 g (0.77 lbs)
	Material	AlMg3Mn, nickel-plated
Temperature Range	Storage temperature	–40 °C ... +85 °C
	Operating temperature	0 °C ... +60 °C
Absolute Maximum Ratings	Optical input power (CW)	12 mW (on each photodiode)
	Power supply voltage	±20 V
Connectors	Inputs	FC fiber optic connectors (FC/PC and FC/APC compatible)
	Outputs	SMA jacks (female)
	Power supply	LEMO® series 1S, 3-pin fixed socket (mating plug type: FFA.1S.303.CLAC52)
Scope of Delivery	HBPR-500M-10K-SI-FC, Lemo® 3-pin connector, 3 × adapter SMA (male) to BNC (female), datasheet	
Ordering Information	HBPR-500M-10K-SI-FC	FC fiber optic connectors (FC/PC and FC/APC compatible)



Pin 1: +15 V
Pin 2: –15 V
Pin 3: GND

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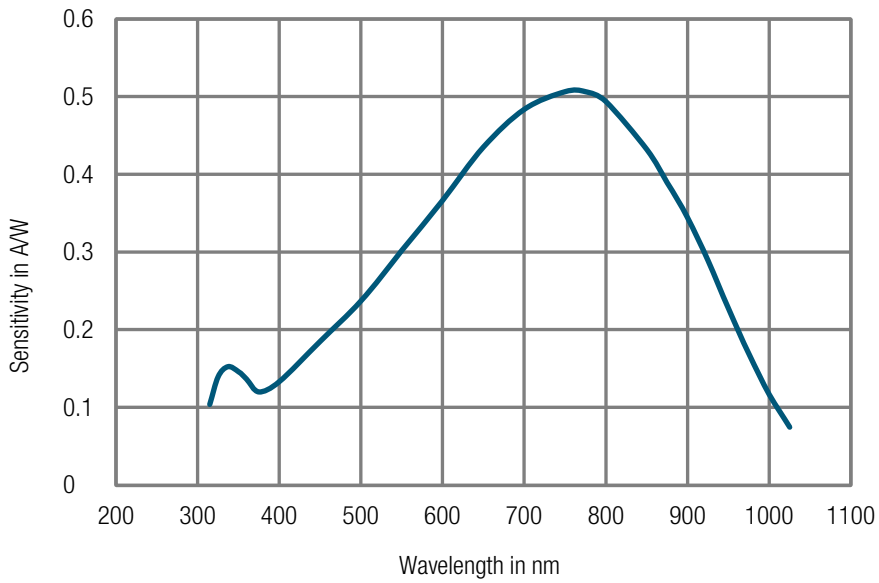
Spectral Response

HBPR-500M-10K-SI-FC (FC fiber optic input)

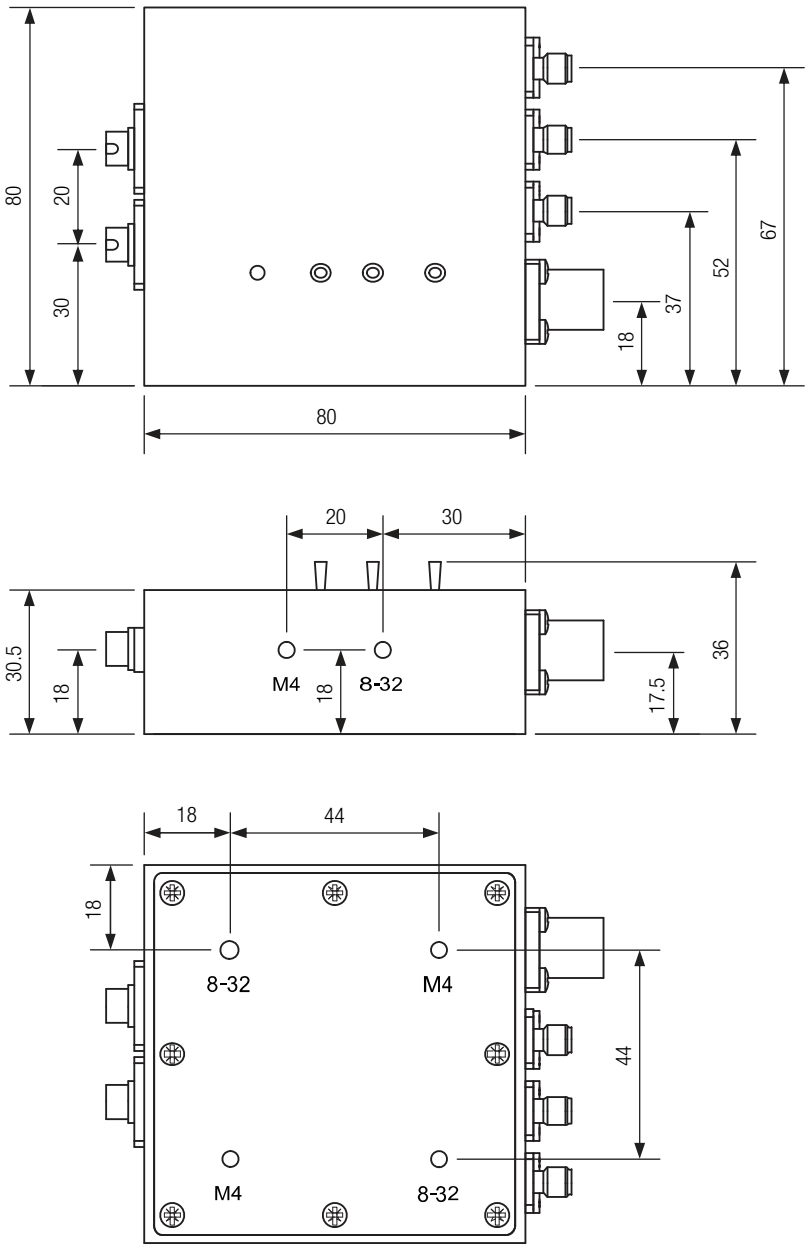


DB-Sens-HBPR-500-SI_R2

High-Speed Balanced Photoreceiver

Dimensions

HBPR-500M-10K-SI-FC



DZ-HBPR_FC_R2

all dimensions in mm unless otherwise noted

The base plate can be rotated if necessary. To do this, loosen the 8 screws.

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