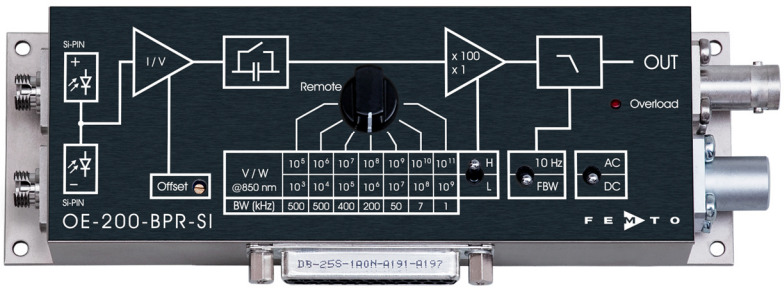
Variable Gain Balanced Photoreceiver



The picture shows model OE-200-BPR-SI-FC

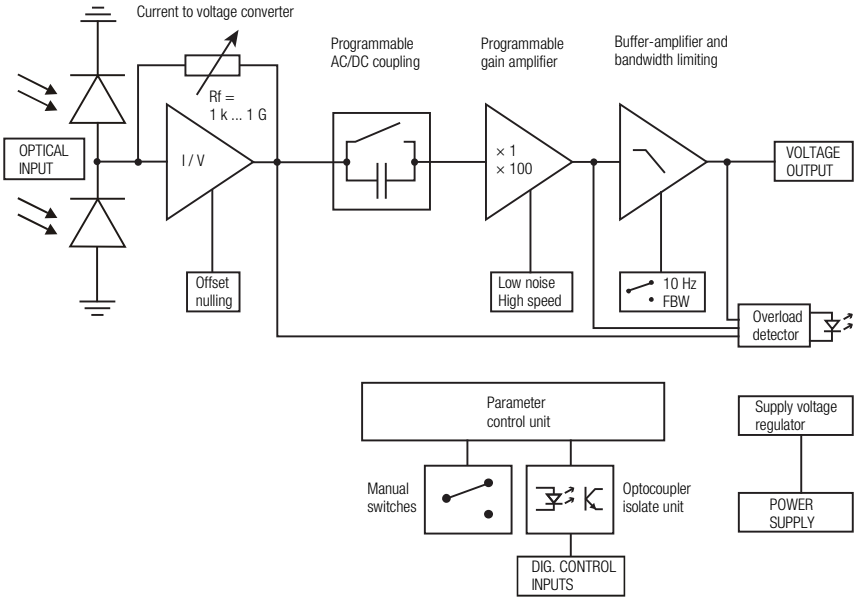
Features

- **Balanced Si-PIN detectors, active diameter 1.2 mm**
- **Common-Mode Rejection Ratio (CMRR) 50 dB typ.**
- **Spectral range 320 - 1060 nm**
- **Very low noise, NEP down to 13 fW/√Hz**
- **Bandwidth up to 500 kHz**
- **Conversion gain adjustable from 1 x 10^3 up to 1 x 10^{11} V/W**
- **FC Fiber optic inputs**
- **Factory calibrated at 850 nm**
- **Full manual and remote control capability**

Applications

- **Heterodyne detection**
- **Spectroscopy**
- **Differential optical front-end for oscilloscopes, spectrum analyzers, A/D converters and lock-in amplifiers**

Block Diagram



Variable Gain Balanced Photoreceiver

Intended Use	The OE-200-BPR-SI is a low-noise, balanced variable gain photoreceiver. It is designed for fast and precise conversion of the difference between optical signals into equivalent output voltages. Operation is largely 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.	
Related balanced Model	OE-200-BPR-IN-FC	Balanced InGaAs-PIN, integrated ball lens, 900 - 1700 nm, conversion gain calibrated at 1550 nm, 2 × FC fiber connectors (fix/permanent)
Related Single Channel Models		
Si Free Space	OE-200-SI-FST	Si-PIN, ∅ 1.2 mm, 320 - 1060 nm, conversion gain adjusted at 850 nm, free space input, 1.035"-40 threaded flange
	OE-200-UV-FST	Si-PIN, 1.1 × 1.1 mm², 190 - 1000 nm conversion gain adjusted at 850 nm, free space input, 1.035"-40 threaded flange
Si Fiber Coupled	OE-200-SI-FC	Si-PIN, ∅ 1.2 mm, 320 - 1060 nm, conversion gain calibrated at 850 nm, FC fiber connector (fix/permanent)
	OE-200-UV-FC	Si-PIN, 1.1 × 1.1 mm², 190 - 1000 nm conversion gain calibrated at 850 nm, FC fiber connector (fix/permanent)
InGaAs Free Space	OE-200-IN1-FST	InGaAs-PIN, ∅ 300 µm, 900 - 1700 nm, conversion gain adjusted at 1310 nm, free space input, 1.035"-40 threaded flange
	OE-200-IN2-FST	InGaAs-PIN, ∅ 300 µm, 900 - 1700 nm, conversion gain adjusted at 1550 nm, free space input, 1.035"-40 threaded flange
InGaAs Fiber Coupled	OE-200-IN1-FC	InGaAs-PIN, integrated ball lens, 900 - 1700 nm, conversion gain calibrated at 1310 nm, FC fiber connector (fix/permanent)
	OE-200-IN2-FC	InGaAs-PIN, integrated ball lens, 900 - 1700 nm, conversion gain calibrated at 1550 nm, FC fiber connector (fix/permanent)
Available Accessories	PRA-PAP 	Alternative mounting option: post adapter plate, easy to mount on FEMTO photoreceiver series OE, FWPR, PWPR, HCA-S and LCA-S
	PS-15-25-L 	Power Supply input: 100 – 240 VAC output: ±15 VDC

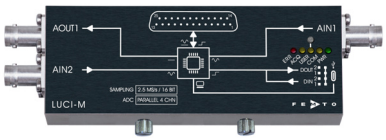
Variable Gain Balanced Photoreceiver

Available Accessories (continued)

LUCI-10

Compact digital I/O interface for USB remote control, supports opto-isolation of amplifier signal path from PC USB port, 16 digital outputs, 3 opto-isolated digital inputs, bus-powered operation

LUCI-M



Compact , universal USB system for data acquisition (DAQ) and control, up to 4 parallel 16 bit ADC channels with 2.5 MS/s, 3 12 bit DAC channels, 24 digital I/O s galvanic isolation from computer,

Specifications

	Test conditions	$V_S = \pm 15$ V, $T_A = 25$ °C, output load impedance 1 MΩ, warm-up 20 minutes (min. 10 minutes recommended)
Gain	Conversion gain	1×10^3 ... 1×10^{11} V/W (@ 850 nm, output load ≥ 100 kΩ)
	Gain accuracy	±1 % electrical, between settings
	Conversion gain accuracy	±5 % (@ $P_{OPT} \leq 1$ mW, 850 nm) guaranteed by factory calibration*
		* factory verified with MM 50/125, FC/APC, NA 0.22 (when using FC/PC fiber connector, coupling efficiency may differ slightly), coupling efficiency depends on fiber type.
	Gain drift	see table below
Frequency Response	Lower cut-off frequency	DC / 1 Hz, switchable
	Upper cut-off frequency (–3 dB)	up to 500 kHz (see table below), switchable to 10 Hz
Input	Input offset current (dark current)	2 pA typ for each photo diode.
	Common mode rejection	50 dB typ.
	Input offset compensation range	±600 pA, adjustable by offset potentiometer or ±400 pA, adjustable by external control voltage
	Input offset drift	see table below
	Noise equivalent power (NEP)	see table below
	Max. differential CW power	see table below
	Max. optical CW balanced power (common mode power)	10 mW (on each photodiode, @ 850 nm)
Detector	Detector type	2 × Si-PIN photodiodes
	Active area	∅ 1.2 mm
	Spectral range	320 - 1060 nm
	Sensitivity	0.61 A/W (@ 850 nm) 0.64 A/W (@ 900 nm)
Output	Output voltage	±10 V (@ ≥100 kΩ output load)
	Output impedance	50 Ω (terminate with ≥10 kΩ load)
	Max. output current	±30 mA (short-circuit proof)

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Specifications (continued)

Performance depending on Gain Setting

Gain setting (low noise) (V/W)**	10^3	10^4	10^5	10^6	10^7	10^8	10^9
Upper cut-off frequency (–3 dB)	500 kHz	500 kHz	400 kHz	200 kHz	50 kHz	7 kHz	1.1 kHz
Rise/fall time (10 % - 90 %)	700 ns	700 ns	900 ns	1.8 µs	7 µs	50 µs	300 µs
NEP (/√Hz)**	40 pW	5.0 pW	1.0 pW	310 fW	97 fW	34 fW	13 fW
Measured at	10 kHz	10 kHz	10 kHz	1 kHz	1 kHz	100 Hz	100 Hz
Integr. input noise (RMS)***	44 nW	5.3 nW	1.4 nW	500 pW	140 pW	18 pW	2.7 pW
Input offset drift (/°C)**	60 nW	6 nW	0.6 nW	51 pW	5.1 pW	0.8 pW	0.6 pW
Gain drift (/°C)	0.008%	0.008%	0.008%	0.01%	0.01%	0.01%	0.02%
Max. differential CW power**	2 mW	1 mW	0.1 mW	10 µW	1 µW	0.1 µW	10 nW

Gain setting (high speed) (V/W)**	10^5	10^6	10^7	10^8	10^9	10^{10}	10^{11}
Upper cut-off frequency (–3 dB)	500 kHz	500 kHz	400 kHz	200 kHz	50 kHz	7 kHz	1.1 kHz
Rise/fall time (10 % - 90 %)	700 ns	700 ns	900 ns	1.8 µs	7 µs	50 µs	300 µs
NEP (/√Hz)**	19 pW	2.4 pW	1.0 pW	210 fW	97 fW	35 fW	16 fW
Measured at	10 kHz	10 kHz	10 kHz	1 kHz	1 kHz	100 Hz	100 Hz
Integr. input noise (RMS)***	19 nW	3.1 nW	1.1 nW	430 pW	130 pW	17 pW	2.5 pW
Input offset drift (/°C)**	60 nW	6 nW	0.6 nW	51 pW	5.1 pW	0.8 pW	0.6 pW
Gain drift (/°C)	0.008%	0.008%	0.008%	0.01%	0.01%	0.01%	0.02%
Max. differential CW power**	0.1 mW	10 µW	1 µW	0.1 µW	10 nW	1 nW	0.1 nW

**referred to 850 nm

*** The integrated input noise is measured with a shaded input in the full bandwidth ("FBW") setting (referred to 850 nm). Measurement bandwidth of the oscilloscope was 20 MHz.

The input referred peak-peak noise can be calculated from the RMS noise as follows:

$$P_{\text{Input noise peak-to-peak}} = P_{\text{Input noise RMS}} \times 6$$

The output noise is given by:

$$U_{\text{Output noise RMS}} = P_{\text{Input noise RMS}} \times \text{gain}$$

$$U_{\text{Output noise peak-to-peak}} = U_{\text{Output noise RMS}} \times 6 = P_{\text{Input noise RMS}} \times \text{gain} \times 6$$

The integrated noise will be reduced considerably by setting the low pass filter to "10 Hz" instead of "FBW".

Indicator LED	Function	overload
Digital Control	Control input voltage range	LOW bit: –0.8 V ... +1.2 V, HIGH bit: +2.3 V ... +12 V
	Control input current	0 mA @ 0 V, 1.5 mA @ +5 V, 4.5 mA @ +12 V
	Overload output	non active: <0.4 V @ 0 ... –1 mA active: typ. 5 ... 5.1 V @ 0 ... 2 mA
Ext. Offset Control	Control voltage range	±10 V
	Offset control input impedance	20 kΩ
	Conversion factor	40 pA/V
Optical Input Connector	Material FC receptacle	nickel silver
Power Supply	Supply voltage	±15 V (±14.75 V ... ±16.5 V)
	Supply current	±110 / –80 mA typ. (depends on operating conditions, recommended power supply capability min. ±200 mA)
Case	Weight	360 g (0.79 lbs)
	Material	AlMg4.5Mn, nickel-plated
Temperature Range	Storage temperature	–40 °C ... +80 °C
	Operating temperature	0 °C ... +60 °C

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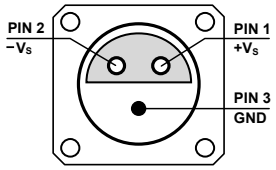
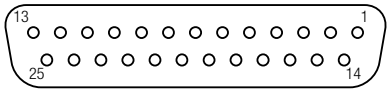
Absolute Maximum Ratings (Damage Threshold)	Optical input power (CW)	20 mW for each photodiode
	Digital control input voltage	–5 V/+16 V relative to digital ground DGND (pin 9)
	Analog control input voltage	±15 V relative to analog ground AGND (pin 3)
	Power supply voltage	±20 V
Connectors	Input	2 × FC fiber optic connectors
	Output	BNC jack (female)
	Power supply	LEMO® series 1S, 3-pin fixed socket (mating plug type: FFA.1S.303.CLAC52)



Pin 1: +15 V
Pin 2: –15 V
Pin 3: GND

Control port: Sub-D 25-pin, female, qual. class 2



Pin 1:	+12 V (stabilized power supply output*)
Pin 2:	–12 V (stabilized power supply output*)
Pin 3:	AGND (analog ground)
Pin 4:	+5 V (stabilized power supply output*)
Pin 5:	digital output: overload (referred to pin 3)
Pin 6:	signal output (connected to BNC)
Pin 7:	NC
Pin 8:	input offset control voltage
Pin 9:	DGND (ground for digital control pins 10 - 14)
Pin 10:	digital control input: gain, LSB
Pin 11:	digital control input: gain
Pin 12:	digital control input: gain, MSB
Pin 13:	digital control input: AC/DC
Pin 14:	digital control input: high speed / low noise
Pin 15 - 25:	NC

*stabilized power supply output current
±12 V: max. ±50 mA, +5V: max. 30 mA

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Remote Control Operation

General

Remote control input bits are opto-isolated and connected by logical OR function to local switch settings. For remote control set the corresponding local switches to “Remote”, “AC” and “H” (High speed) and select the wanted setting via a bit code at the corresponding digital inputs.

Mixed operation, e.g. local gain setting and remote controlled AC/DC setting, is also possible.

Switch setting “FBW / 10 Hz” of the low pass signal filter is not remote controllable.

Gain setting

Low noise	High speed			
Pin 14=HIGH	Pin 14=LOW	Pin 12	Pin 11	Pin 10
Gain (V/W)	Gain (V/W)	MSB		LSB
10^3	10^5	LOW	LOW	LOW
10^4	10^6	LOW	LOW	HIGH
10^5	10^7	LOW	HIGH	LOW
10^6	10^8	LOW	HIGH	HIGH
10^7	10^9	HIGH	LOW	LOW
10^8	10^{10}	HIGH	LOW	HIGH
10^9	10^{11}	HIGH	HIGH	LOW

Gain settling time

<150 ms

AC/DC setting

Coupling	Pin 13
AC	LOW
DC	HIGH

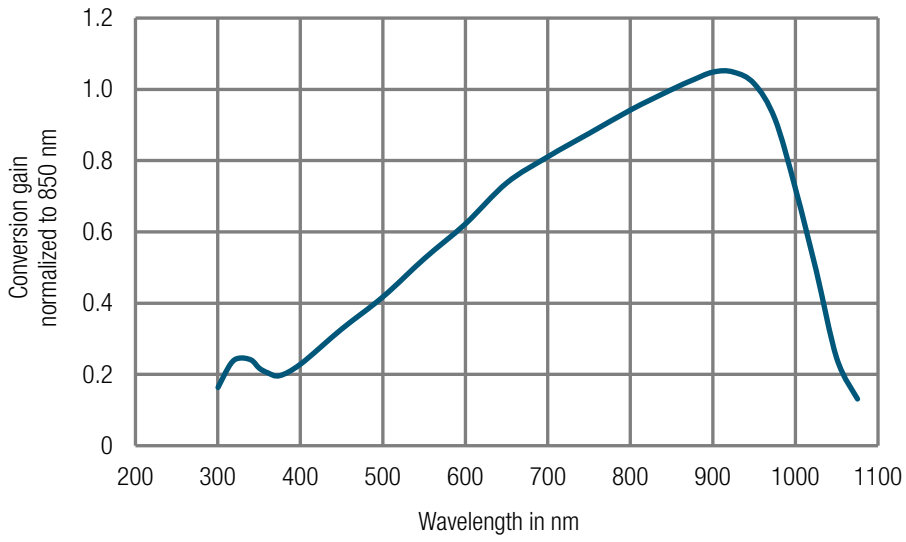
Scope of Delivery

OE-200-BPR-SI-FC, LEMO® 3-pin connector, datasheet, transport package

Ordering Information

OE-200-BPR-SI-FC	Balanced photoreciver, 2 × FC fiber optic connectors (fix/permanent, FC/PC and FC/APC compatible).

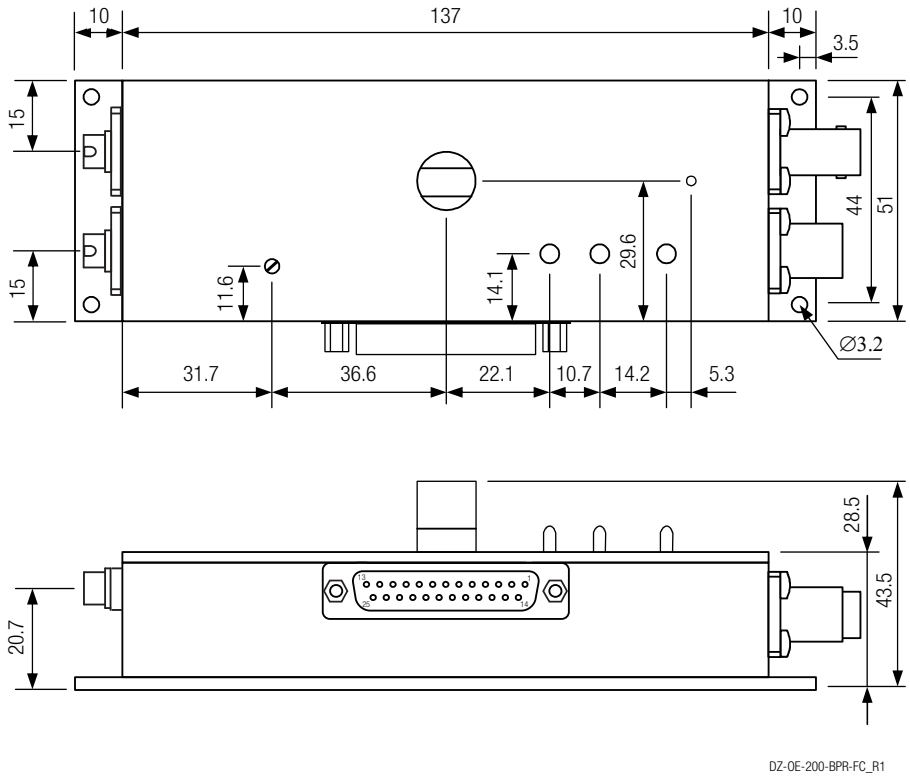
Conversion Gain



Variable Gain Balanced Photoreceiver

Dimensions

OE-200-BPR-SI-FC



all dimensions in mm unless otherwise noted

FEMTO Messtechnik GmbH
Klosterstr. 64
10179 Berlin · Germany
Phone: +49 30 280 4711-0
Fax: +49 30 280 4711-11
Email: info@femto.de
www.femto.de