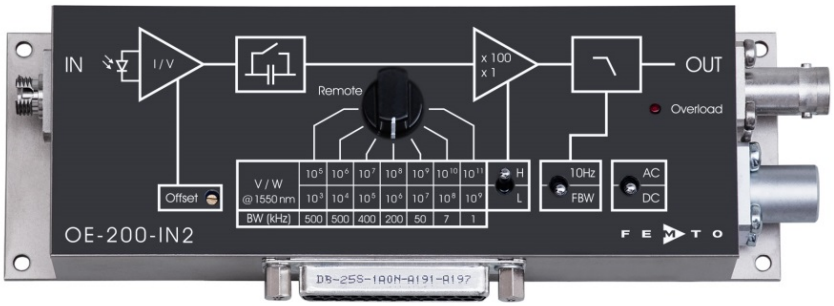
Variable Gain Photoreceiver – Fast Optical Power Meter



The picture shows model OE-200-IN2-FC with fiber optic input.

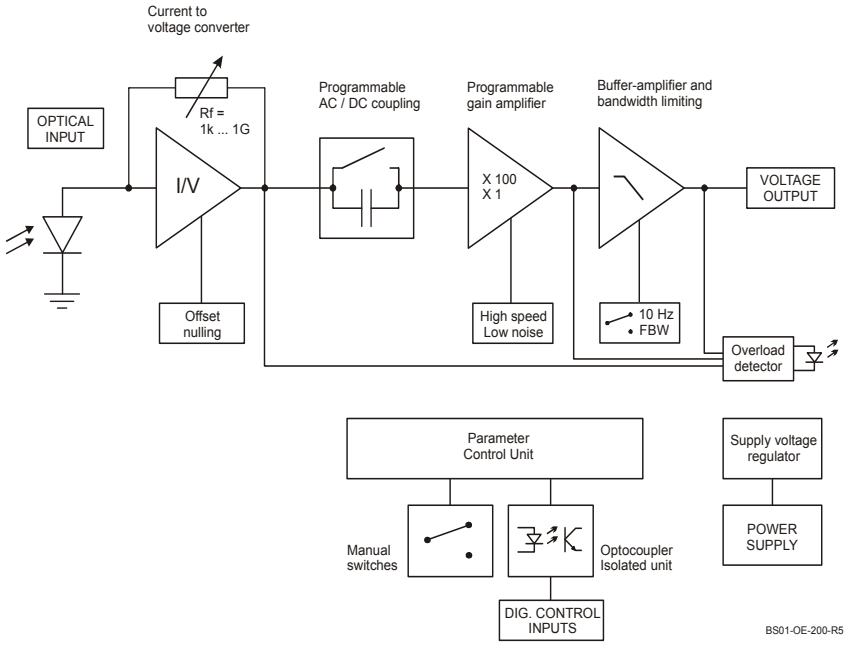
Features

- **InGaAs-PIN detector, active diameter 0.3 mm (free space versions), 80 µm integrated ball lens (FC version)**
- **Spectral range 900 - 1700 nm**
- **Very low noise, NEP down to 6 fW/√Hz**
- **Bandwidth up to 500 kHz**
- **Conversion gain adjustable from 1 x 10^3 up to 1 x 10^{11} V/W**
- **Optical free-space input 1.035"-40 threaded, alternatively 25 mm diameter unthreaded**
- **Fiber optic input available as permanently mounted FC-input (for calibrated precision measurements)**
- **Factory calibrated at 1550 nm (fiber optic FC version only)**
- **Full manual and remote control capability**

Applications

- **All-purpose very low-noise photoreceiver (O/E converter)**
- **Time resolved optical pulse and power measurements**
- **Optical front-end for oscilloscopes, spectrum analyzers, A/D converters and lock-in amplifiers**
- **Fast fiber optic power meter**

Block Diagram



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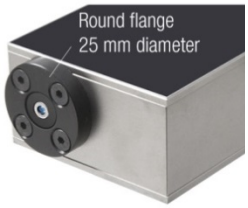
Available Versions

OE-200-IN2-FST

1.035"-40 threaded flange for free space applications compatible with many optical standard accessories.

(Please note: Using the fiber-adapters PRA-FC and PRA-FSMA is not recommended as the small size of the active area can drastically reduce the coupling efficiency.)

OE-200-IN2-FS



25 mm dia. unthreaded flange for free space applications compatible with many optical standard accessories.

OE-200-IN2-FC

fix/permanent FC fiber connector
for highest coupling efficiency and best conversion gain accuracy (±5 %)

Since illumination conditions with the permanently mounted fiber optic connector are well defined, the FC model is delivered with a factory calibrated conversion gain at 1550 nm.

The electro optical conversion gain factors of the FST and FS free space models are set to fit nominally at 1550 nm.

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Related OE-200 Models	See separate datasheets for following models on www.femto.de:	
@ 850 nm	OE-200-SI-FST	Si-PIN, Ø 1.2 mm, 320 - 1060 nm free space input, 1.035"-40 threaded flange
	OE-200-SI-FS	Si-PIN, Ø 1.2 mm, 320 - 1060 nm free space input, 25 mm dia. unthreaded flange
	OE-200-SI-FC	Si-PIN, Ø 1.2 mm, 320 - 1060 nm FC fiber connector (fix/permanent)
	OE-200-UV-FST	Si-PIN, 1.1 x 1.1 mm^2, 190 - 1000 nm free space input, 1.035"-40 threaded flange
	OE-200-UV-FS	Si-PIN, 1.1 x 1.1 mm^2, 190 - 1000 nm free space input, 25 mm dia. unthreaded flange
	OE-200-UV-FC	Si-PIN, 1.1 x 1.1 mm^2, 190 - 1000 nm FC fiber connector (fix/permanent)
@ 1310 nm	OE-200-IN1-FST	InGaAs-PIN, Ø 300 µm, 900 - 1700 nm free space input, 1.035"-40 threaded flange
	OE-200-IN1-FS	InGaAs-PIN, Ø 300 µm, 900 - 1700 nm free space input, 25 mm dia. unthreaded flange
	OE-200-IN1-FC	InGaAs-PIN, integrated ball lens, 900 - 1700 nm FC fiber connector (fix/permanent)
	OE-200-S	customized versions available on request

Available Accessories

PRA-PAP

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

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

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Specifications	Test conditions	$V_S = \pm 15$ V, $T_A = 25$ °C, output load impedance 1 MΩ
Gain	Conversion gain	1×10^3 ... 1×10^{11} V/W (@ 1550 nm, output load ≥ 100 kΩ)
	Gain accuracy	±1 % electrical, between settings
	Conversion gain accuracy	OE-200-IN2-FST/FS (@ $P_{OPT} \leq 2$ mW, 1550 nm) free space ±15 %
		OE-200-IN2-FC (@ $P_{OPT} \leq 1$ mW, 1550 nm) fixed fiber input connector ±5 % guaranteed by factory calibration*
	* Factory verified with SM 9/125, FC/APC, NA 0.13 (when using FC/PC fiber connector, coupling efficiency may differ slightly). In general, coupling efficiency depends on fiber type. Standard SM 9/125 fibers with low numerical aperture (NA) are recommended. Fibers with core diameter larger than 62.5 µm will significantly reduce the coupling efficiency.	
	Gain drift	see table below
Frequency Response	Lower cut-off frequency	DC / 1 Hz, switchable
	Upper cut-off frequency (–3dB)	up to 500 kHz (see table below), switchable to 10 Hz
Detector	Detector type	InGaAs-PIN photodiode
	Active area	Ø 300 µm (free space versions) Ø 80 µm, integrated ball lens (FC version)
	Spectral range	900 - 1700 nm
	Sensitivity	0.95 A/W (@ 1550 nm)
Input	Input offset current (dark current)	2 pA typ.
	Input offset drift	see table below
	Input offset compensation range	±600 pA, adjustable by offset potentiometer or ±400 pA, adjustable by external control voltage
	Optical CW saturation power	see table below
	Noise equivalent power (NEP)	see table below

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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)**	22 pW	2.5 pW	500 fW	150 fW	47 fW	15 fW	6 fW
Measured at	10 kHz	10 kHz	10 kHz	1 kHz	1 kHz	100 Hz	100 Hz
Integr. input noise (RMS)***	23 nW	2.8 nW	650 pW	180 pW	51 pW	7.5 pW	1.1 pW
Input offset drift (/°C)**	40 nW	4 nW	0.4 nW	34 pW	3.4 pW	0.5 pW	0.4 pW
Gain drift (/°C)	0.008%	0.008%	0.008%	0.01%	0.01%	0.01%	0.02%
Optical CW saturation 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)**	15 pW	2.0 pW	520 fW	150 fW	48 fW	15 fW	7 fW
Measured at	10 kHz	10 kHz	10 kHz	1 kHz	1 kHz	100 Hz	100 Hz
Integr. input noise (RMS)***	13 nW	1.9 nW	560 pW	160 pW	48 pW	7.2 pW	1.1 pW
Input offset drift (/°C)**	40 nW	4 nW	0.4 nW	34 pW	3.4 pW	0.5 pW	0.4 pW
Gain drift (/°C)	0.008%	0.008%	0.008%	0.01%	0.01%	0.01%	0.02%
Optical CW saturation power**	0.1 mW	10 µW	1 µW	0.1 µW	10 nW	1 nW	0.1 nW

** referred to 1550 nm

*** The integrated input noise is measured with a shaded input in the full bandwidth ("FBW") setting (referred to 1550 nm).
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". This is especially useful for continuous wave (CW) measurements.

Output	Output voltage range	±10 V (@ ≥100 kΩ output load)
	Max. output current	±30 mA (short-circuit proof)
	Output impedance	50 Ω (terminate with ≥100 kΩ)
Indicator LED	Function	overload
Digital Control	Control input voltage range	LOW bit: –0.8 ... +1.2 V, HIGH bit: +2.3 ... +12 V
	Control input current	0 mA @ 0 V, 1.5 mA @ +5 V, 4.5 mA @ +12 V
	Overload output	nonactive: <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
Power Supply	Supply voltage	±15 V (±14.75 ... ±16.5 V)
	Supply current	+110/–80 mA (depends on operating conditions, recommended power supply capability min. ±200 mA)
	Stabilized power supply output	±12 V, max. 50 mA, +5 V, max. 30 mA
Case	Weight	360 g (0.79 lb)
	Material	AlMg4.5Mn, nickel-plated
Temperature Range	Storage temperature	–40 ... +80 °C
	Operating temperature	0 ... +60 °C

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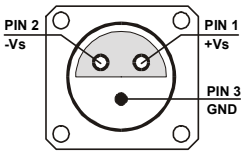
Absolute Maximum Ratings	Optical input power (CW)	20 mW	
	Digital control input voltage	–5 V/+16 V relative to digital ground DGND (pin 9)	
	Analog control input voltage	±15 V relative to analog ground AGND (pin 3)	
	Power supply voltage	±20 V	
Connectors	Input	OE-200-IN2-FST	1.035"-40 threaded flange for free space applications
		OE-200-IN2-FS	25 mm unthreaded flange for free space applications
		OE-200-IN2-FC	FC fiber optic connector
	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 for pins 1 - 8) Pin 4: +5 V (stabilized power supply output) Pin 5: overload output: HIGH = 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	
Scope of Delivery	OE-200-IN2, internally threaded coupler ring (FST version only), Lemo® 3-pin connector, datasheet, transport package		

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Remote Control Operation

General

Remote control input bits are opto-isolated and connected by a logical OR function to the local switch settings. For remote control set the corresponding local switches to "Remote", "AC" and "H" and select the desired setting via a bit code at the corresponding digital inputs.
Mixed operation, e.g. local AC/DC setting and remote controlled gain setting, is also possible.
The switch setting "FBW / 10 Hz" of the low pass signal filter is not remote controllable.

Gain setting

Low noise Gain (V/W) Pin 14=HIGH	High speed Gain (V/W) Pin 14=LOW	Pin 12 MSB	Pin 11	Pin 10 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

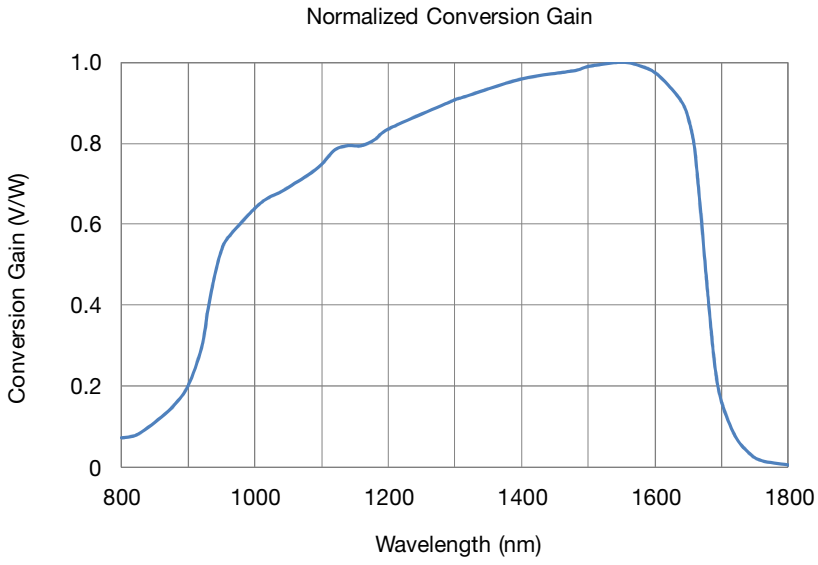
Gain settling time

<150 ms

AC/DC setting

Coupling	Pin 13
AC	LOW
DC	HIGH

Conversion Gain



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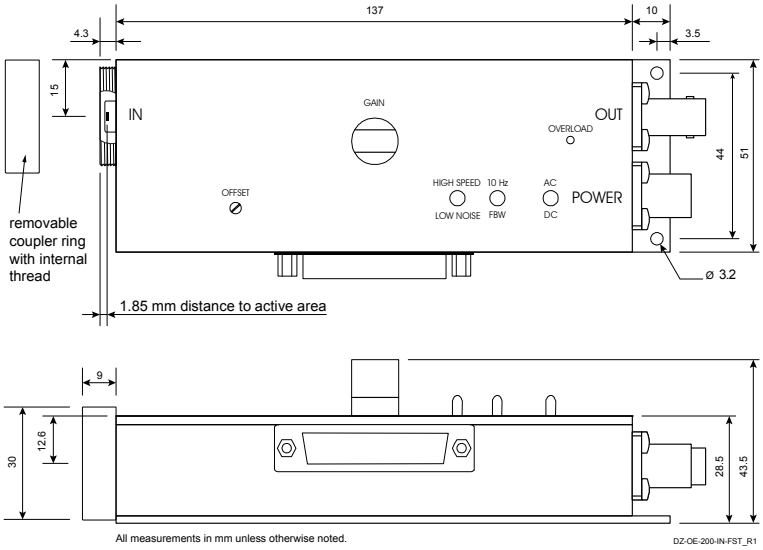
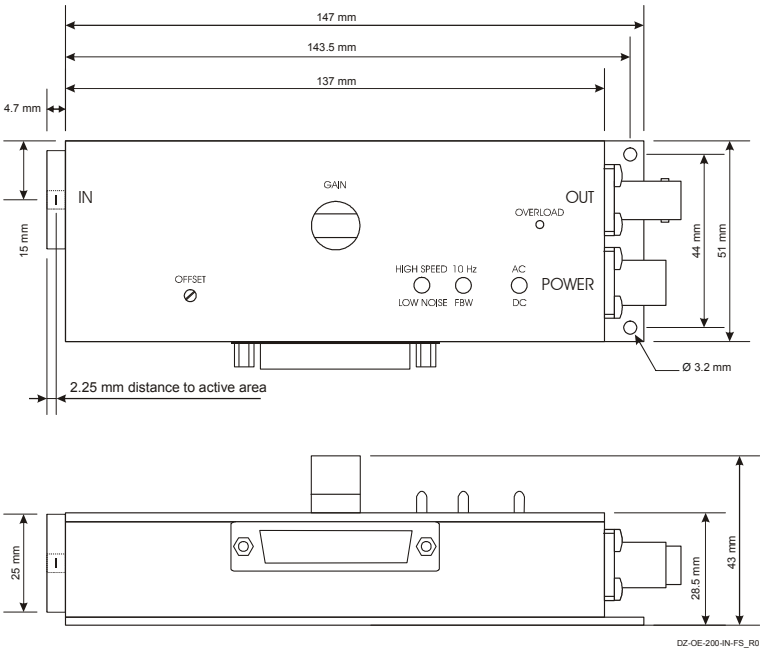
Dimensions

OE-200-IN2-FST (1.035"-40 threaded free space input):



OE-200-IN2-FS (25 mm dia. unthreaded free space input):



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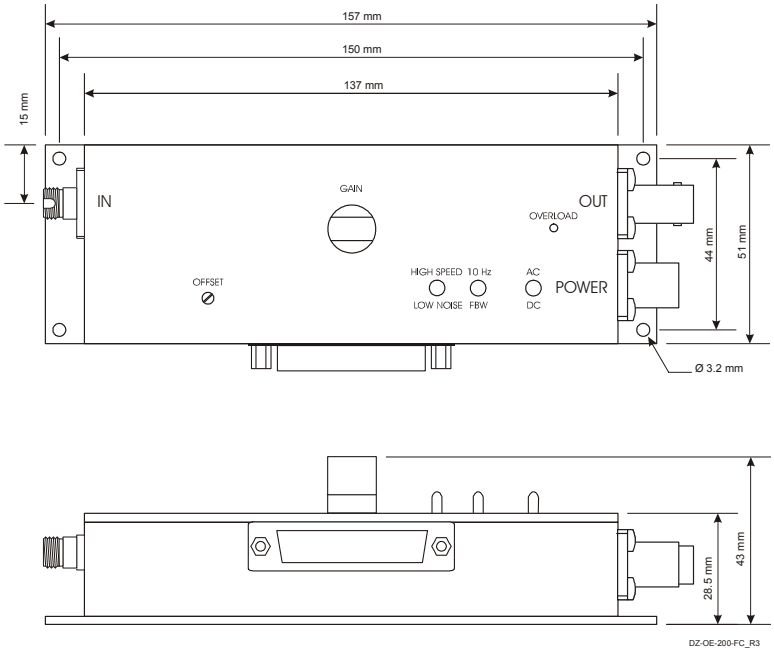
Dimensions (continued)

OE-200-IN2-FC (FC fiber optic input):



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