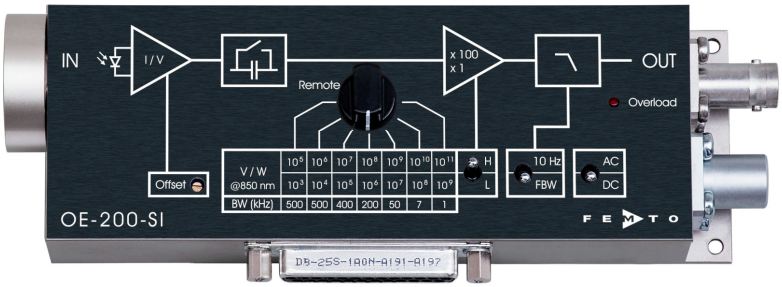
Variable Gain Photoreceiver – Fast Optical Power Meter



The picture shows model OE-200-SI-FST

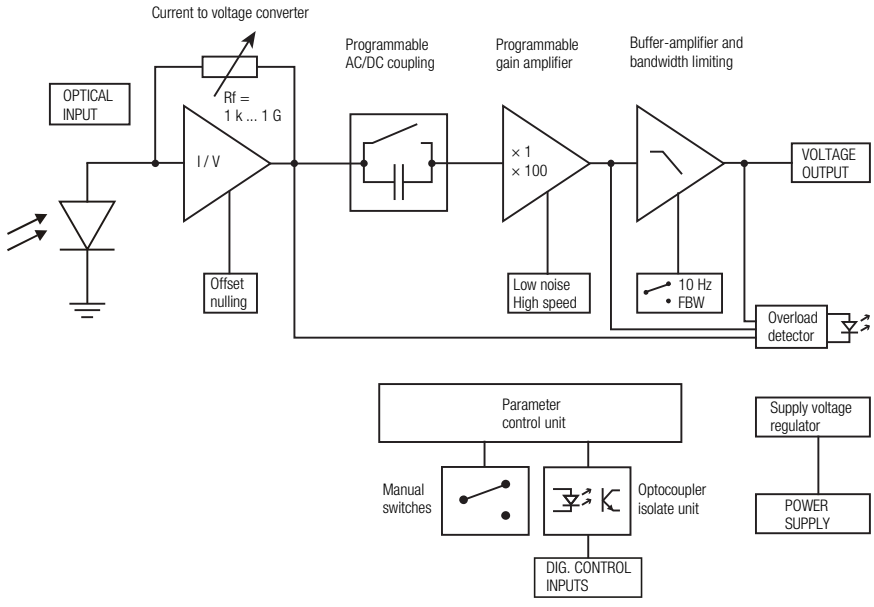
Features

- **Si-PIN detector, active diameter 1.2 mm**
- **Spectral range 320 - 1060 nm**
- **Very low noise, NEP down to 8 fW/√Hz**
- **Bandwidth up to 500 kHz**
- **Conversion gain adjustable from 1 x 10^3 up to 1 x 10^{11} V/W**
- **Free-space input 1.035"-40 threaded, easily convertible to fiber optic input (FC and FSMA) with optionally available screw-on adapters**
- **Fiber optic input also available as permanently mounted FC-input**
- **Factory calibrated at 850 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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Intended Use

The OE-200-SI is a ultra-low noise variable gain photoreceiver. It is designed for fast and precise conversion of small optical signals into equivalent output voltages. 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.

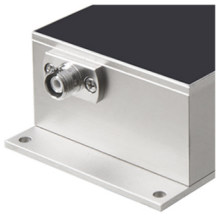
Available Versions

OE-200-SI-FST

1.035"-40 threaded flange with internally threaded coupler ring (outer diameter 30 mm) for free space applications. Compatible with many optical standard accessories and for use with various types of fiber connector adapters.

Optionally available:
Fiber adapters PRA-FC, PRA-FCA and PRA-FSMA.
With the relative large 1.2 mm dia. photodiode installed in the OE-200-SI input coupling is not critical. However, standard SM 9/125 fibers (PC or APC) with low numerical aperture (NA) are recommended for ensuring near 100% coupling efficiency.

OE-200-SI-FC



Fix/permanent FC fiber connector for high coupling efficiency and excellent conversion gain accuracy.

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 850 nm.

The electro optical conversion gain factor of the FST free space model is set to fit nominally at 850 nm.

Related OE-200 Models

See separate datasheets for following models on www.femto.de:

Si Versions

OE-200-UV-FST	Si-PIN, 1.1 × 1.1 mm^2, 190 - 1000 nm conversion gain adjusted at 850 nm, free space input, 1.035"-40 threaded flange
OE-200-UV-FC	Si-PIN, 1.1 × 1.1 mm^2, 190 - 1000 nm conversion gain calibrated at 850 nm, FC fiber connector (fix/permanent)

Variable Gain Photoreceiver – Fast Optical Power Meter

Related OE-200 Models (continued)

InGaAs Versions

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-IN1-FC	InGaAs-PIN, integrated ball lens, 900 - 1700 nm, conversion gain calibrated at 1310 nm, FC fiber connector (fix/permanent)
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
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-FC
PRA-FCA
PRA-FSMA

Fiber-adapter with external 1.035"-40 thread

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

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

Variable Gain Photoreceiver – Fast Optical Power Meter

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	OE-200-SI-FST (@ $P_{OPT} \leq 2$ mW, 850 nm) ±15 % nominal
	OE-200-SI-FC (@ $P_{OPT} \leq 1$ mW, 850 nm) ±5 % 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.
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

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)**	33 pW	3.8 pW	800 fW	240 fW	75 fW	24 fW	8 fW
Measured at	10 kHz	10 kHz	10 kHz	1 kHz	1 kHz	100 Hz	100 Hz
Integr. input noise (RMS)***	39 nW	5 nW	1.3 nW	400 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%
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)**	25 pW	3.5 pW	800 fW	240 fW	76 fW	24 fW	8 fW
Measured at	10 kHz	10 kHz	10 kHz	1 kHz	1 kHz	100 Hz	100 Hz
Integr. input noise (RMS)***	24 nW	3.7 nW	1.1 nW	350 pW	110 pW	16 pW	2.3 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%
Optical CW saturation 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).

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:

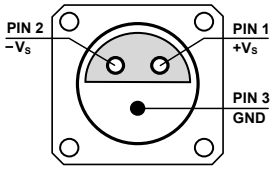
$$U_{\text{Output noise RMS}} = P_{\text{Input noise RMS}} \times \text{gain}$$

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

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.

Variable Gain Photoreceiver – Fast Optical Power Meter

Specifications (continued)		
Detector	Detector type	Si-PIN photodiode
	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 ≥100 kΩ load)
	Max. output current	±30 mA (short-circuit proof)
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 FST flange	1.4305 stainless steel, nickel-plated
	Material FST coupler ring	1.4305 stainless steel, glass bead blasted
	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
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-SI-FST 1.035"-40 threaded flange for free space applications
		OE-200-SI-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)



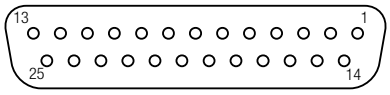
Pin 1: +15 V
Pin 2: –15 V
Pin 3: GND

Variable Gain Photoreceiver – Fast Optical Power Meter

Connectors (continued)

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

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

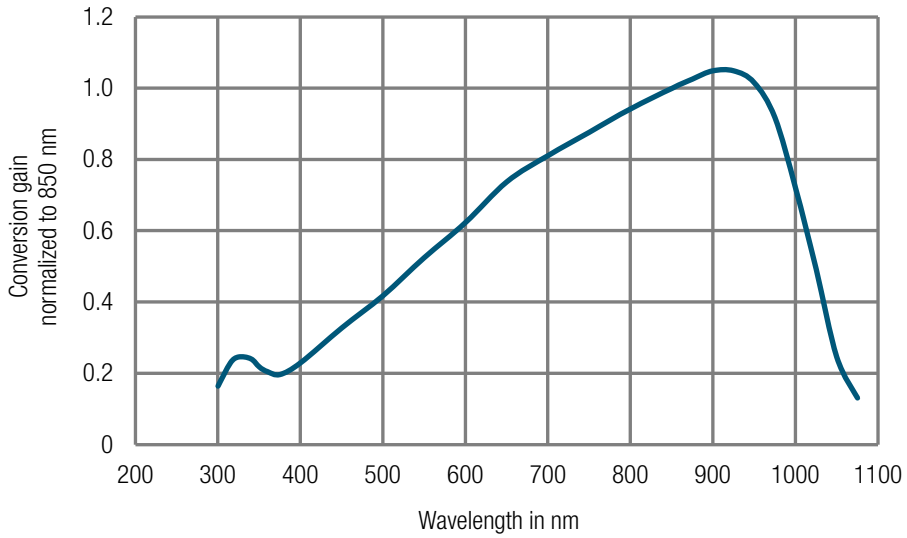
Scope of Delivery

OE-200-SI, internally threaded coupler ring (FST version only), LEMO® 3-pin connector, datasheet, transport package

Variable Gain Photoreceiver – Fast Optical Power Meter

Ordering Information	OE-200-SI-FST	1.035"-40 threaded flange for free space applications and for use with various types of optical standard accessories.
	OE-200-SI-FC	FC fiber optic connector (fix/permanent, FC/PC and FC/APC compatible).

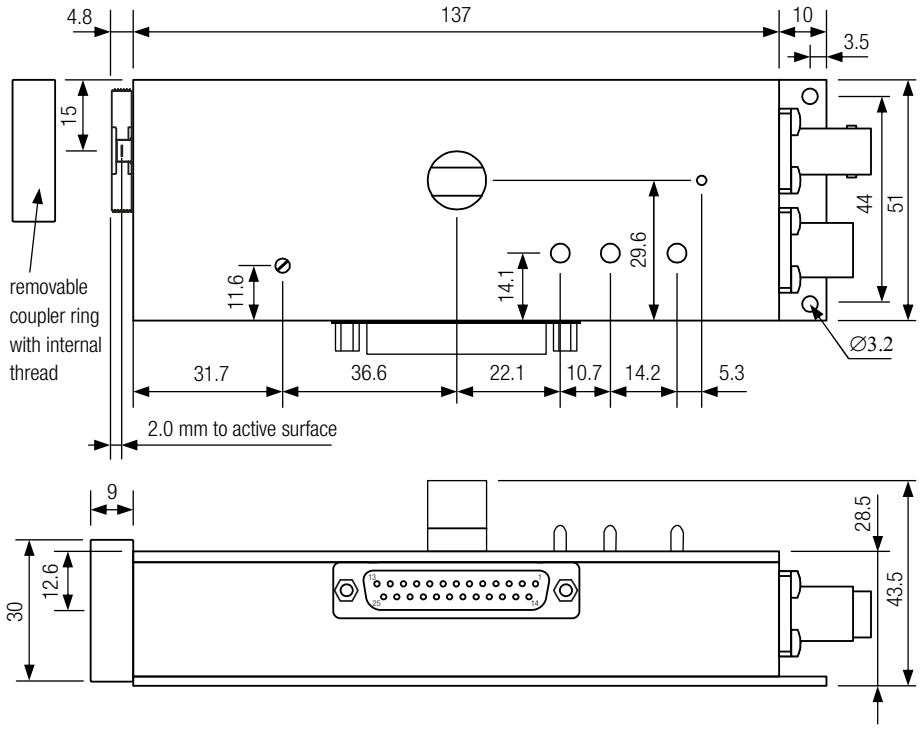
Conversion Gain



DB-Sens-OE-200-SI_R02

Dimensions

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



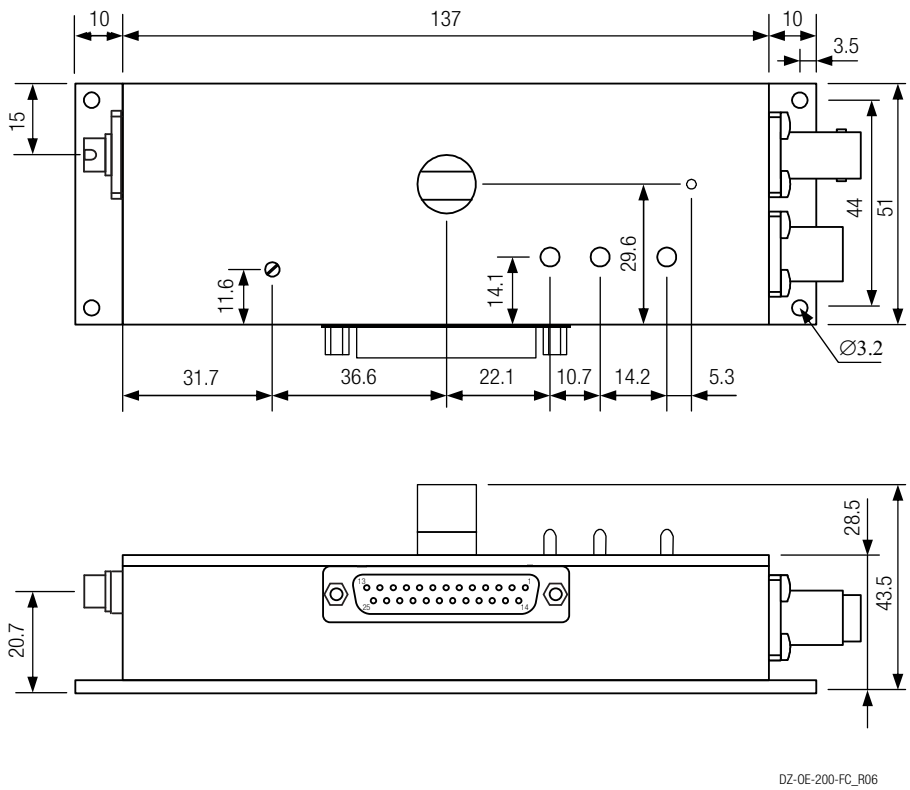
DZ-OE-200-FST_R1

all dimensions in mm unless otherwise noted

Variable Gain Photoreceiver – Fast Optical Power Meter

Dimensions (continued)

OE-200-SI-FC (FC fiber optic input)



all dimensions in mm unless otherwise noted

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