Electro Optical Components, Inc.
5460 Skylane Boulevard, Santa Rosa, CA 95403
Toll Free: 855-EOC-6300
www.eoc-inc.com | info@eoc-inc.com

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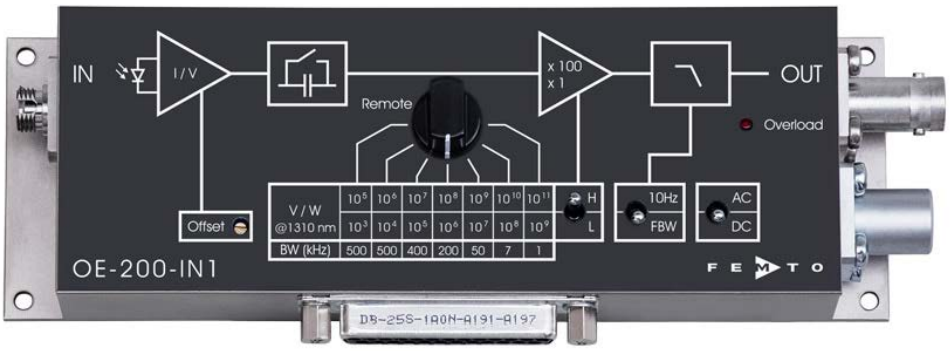
FEMTO®

PHOTORECEIVERS

From Femtowatt Sensitivity to Gigahertz Speed

OE-200 Series Variable Gain Photoreceivers



- Adjustable conversion gain from 10^3 to 10^{11} V/W
- Operating range from fW to mW
- Spectral range from 190 to 1700 nm
- NEP down to 6 fW/√Hz
- Bandwidth up to 500 kHz
- Rise time down to 700 ns
- Calibration for all fiber optic models
- Manual and remote control

APPLICATIONS

All purpose lab photoreceiver | Fiber alignment systems | Fast power monitoring | Test of laser diode to fiber coupling | Linearity measurements over 10 decades | Calibration of optical communication systems | Time-resolved pulse and power measurements | Industrial control and alignment systems

Model	OE-200-SI	OE-200-UV	OE-200-IN1	OE-200-IN2
Detector Type	Si-PIN	Si-PIN	InGaAs-PIN	InGaAs-PIN
Detector Size	Ø 1.2 mm	1.1 x 1.1 mm^2	Ø 0.3 mm (FC: Ø 0.08 mm)	Ø 0.3 mm (FC: Ø 0.08 mm)
Spectral Range	320 - 1060 nm	190 - 1000 nm	900 - 1700 nm	900 - 1700 nm
Calibration Wavelength*	850 nm	850 nm	1310 nm	1550 nm
Input Options	FST, FS, FC	FST, FS, FC	FST, FS, FC	FST, FS, FC
NEP (Dependent on Gain Setting)	8 fW/√Hz - 33 pW/√Hz	17 fW/√Hz - 60 pW/√Hz	7 fW/√Hz - 22 pW/√Hz	6 fW/√Hz - 22 pW/√Hz
Useful Operating Range	ca. 100 fW - 2 mW	ca. 200 fW - 2 mW	ca. 100 fW - 2 mW	ca. 100 fW - 2 mW

The following characteristics are valid for all models:

Performance Range	Low Noise							High Speed						
Conversion Gain [V/W]**	10^3	10^4	10^5	10^6	10^7	10^8	10^9	10^5	10^6	10^7	10^8	10^9	10^{10}	10^{11}
Bandwidth (–3 dB) [kHz]	500	500	400	200	50	7	1.1	500	500	400	200	50	7	1.1
Rise Time (10 % - 90 %)	700 ns	700 ns	900 ns	1.8 µs	7 µs	50 µs	300 µs	700 ns	700 ns	900 ns	1.8 µs	7 µs	50 µs	300 µs
Accuracy Performance	±1 % electrical between settings, ±5 % electro-optical for FC-input, ±15 % electro-optical for FS- and FST-input													
Low Pass Filter	Switchable to 10 Hz													
Output Performance	±10 V (@ ≥100 kΩ load)													
Power Requirements	±15 V, +110 mA/–90 mA typ.													
Control Interface	5 opto-isolated digital inputs, TTL/CMOS compatible, analog offset control voltage input													
Dimensions	170 x 60 x 45 mm (L x W x H), weight 360 g (0.79 lbs)													

* Since illumination conditions with the permanently mounted fiber optic connector are well defined, the FC models are delivered with a factory calibrated conversion gain. The electro optical conversion gain factors of the FST and FS free space models are set to fit nominally at the calibration wavelength.

** @ calibration wavelength

Offset adjustable by trimpot or external control voltage. LED overload indication. Output short-circuit protected. Power supply via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

Input Options

FST-Input

Free space input with 1.035"-40 threaded flange, internal threaded coupler ring included

FS-Input

Free space input with unthreaded flange (25 mm diameter)

FC-Input

Permanent fiber coupled input

OE-300 Series 200 MHz Variable Gain Photoreceivers

- Adjustable transimpedance gain from 10^2 to 10^8 V/A
- Wide bandwidth up to 200 MHz
- Various Si and InGaAs models cover the 320 to 1700 nm wavelength range
- High dynamic input range up to 10 mW optical power
- Large optical detector size up to 3 mm diameter
- Very low noise, NEP down to 47 fW/√Hz
- Switchable low pass filters for minimizing wideband noise
- Full manual and remote control capability

APPLICATIONS

All purpose low-noise photoreceiver (O/E converter) for the MHz range | Time-resolved optical pulse and power measurements | Laser intensity noise measurements (RIN) | Optical front-end for oscilloscopes, spectrum analyzers, A/D converters and RF lock-in amplifiers

Model	OE-300-SI-10	OE-300-SI-30	OE-300-IN-01	OE-300-IN-03
Detector Type	Si-PIN	Si-PIN	InGaAs-PIN	InGaAs-PIN
Detector Size [mm]	1.0 x 1.0	Ø 3.0	Ø 0.08	Ø 0.3
Spectral Range [nm]	400 - 1000	320 - 1000	900 - 1700	800 - 1700
Input Options	FST, FS	FST, FS	FC	FST, FS
NEP (Dependent on Gain Setting)	76 fW/√Hz - 322 pW/√Hz	81 fW/√Hz - 325 pW/√Hz	47 fW/√Hz - 180 pW/√Hz	52 fW/√Hz - 192 pW/√Hz

The following characteristics are valid for all models:

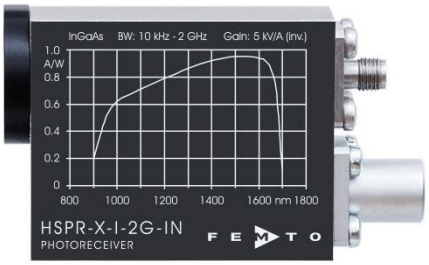
Performance Range	Low Noise						High Speed					
Gain Setting [V/A] (Transimpedance)	10^2	10^3	10^4	10^5	10^6	10^7	10^3	10^4	10^5	10^6	10^7	10^8
Bandwidth (–3 dB) [MHz]	200 (100)[1]	80 (60)[1]	14	3.5	1.8	0.22	175 (80)[1]	80 (60)[1]	14	3.5	1.8	0.22
Accuracy Performance	±1 % (transimpedance)											
Low Pass Filter	switchable to 1 MHz and 10 MHz											
Output Performance	±1 V (@ 50 Ω load), for linear amplification											
Power Requirements	±15 V, +150 mA/–100 mA typ.											
Control Interface	5 opto-isolated digital inputs, TTL/CMOS compatible, analog offset control voltage input											
Dimensions	170 x 60 x 45 mm (L x W x H), weight 320 g (0.74 lbs)											

[1] model OE-300-SI-30

Offset adjustable by trimpot or external control voltage. LED overload indication. Output short-circuit protected. Power supply via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

Please note! FEMTO® offers fiber connectors (e.g. PRA_FC and PRA-FSMA) which allow connecting the most common types of optical fibers to photoreceivers with FST-input without considerable optical losses. Adapters for optical cables with FC connectors (FC/PC, FC/APC, FC/UPC) and FSMA connectors are available. These are recommended for photosensitive areas of 0.4 mm diameter or more (coupling efficiency may be compromised for photodiodes with smaller diameter).

HSPR-X and HSA-X-S Series Ultra-Fast Photoreceivers



- Wavelength range from 320 to 1700 nm
- Ultra-wide bandwidth from 10 kHz up to 2 GHz
- Max. conversion gain 4.75 x 10^3 V/W
- Min. NEP 11 pW/√Hz

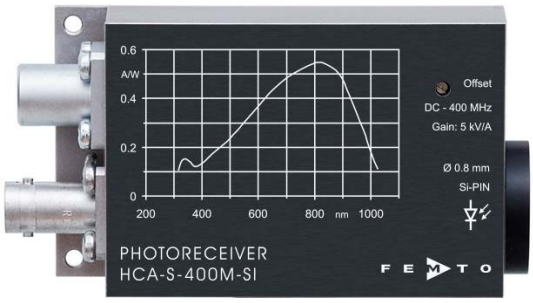
APPLICATIONS

Spectroscopy | Fast pulse and transient measurements | Optical triggering | Optical front-end (O/E converter) for oscilloscopes and A/D converters

Model	HSA-X-S-1G4-SI	HSPR-X-I-1G4-SI (inverting)	HSA-X-S-2G-IN	HSPR-X-I-2G-IN (inverting)
Photodiode	Si-PIN, Ø 0.4 mm (FST, FS), integrated ball lens (FC)		InGaAs-PIN, Ø 0.1 mm (FST, FS), integrated ball lens (FC)	
Spectral Range	320 - 1000 nm	320 - 1000 nm	900 - 1700 nm	900 - 1700 nm
Bandwidth (–3 dB)	10 kHz - 1.4 GHz	10 kHz - 1.4 GHz	10 kHz - 2 GHz	10 kHz - 2 GHz
Rise/Fall Time (10 % - 90 %)	250 ps	250 ps	180 ps	180 ps
Transimpedance Gain	5 x 10^3 V/A	5 x 10^3 V/A (inverting)	5 x 10^3 V/A	5 x 10^3 V/A (inverting)
Conversion Gain	2.55 x 10^3 V/W (@ 760 nm)	2.55 x 10^3 V/W (@ 760 nm)	4.75 x 10^3 V/W (@ 1550 nm)	4.75 x 10^3 V/W (@ 1550 nm)
NEP (@ 100 MHz)	32 pW/√Hz (@ 760 nm)	19 pW/√Hz (@ 760 nm)	16 pW/√Hz (@ 1550 nm)	11 pW/√Hz (@ 1550 nm)
Output VSWR	2.5 : 1	1.4 : 1	2.5 : 1	1.4 : 1
Max. Output Voltage @ 50 Ω	1.9 V_{PP}	2.0 V_{PP}	1.9 V_{PP}	2.0 V_{PP}
Output Noise	3.6 mV_{RMS}	2.5 mV_{RMS}	3.6 mV_{RMS}	2.5 mV_{RMS}
Input Options	FST, FS, FC	FST, FS, FC	FST, FS, FC	FST, FS, FC
Power Requirements	+15 V, 130 mA typ.	+15 V, 150 mA typ.	+15 V, 130 mA typ.	+15 V, 150 mA typ.
Dimensions	80 x 42 x 30 mm (L x W x H), weight 100 g (0.23 lbs)			

Output short-circuit protected. Threaded M4 and 8-32 mounting holes for use with standard mounting posts. Power supply +15 V via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

HCA-S-400M Series 400 MHz Photoreceivers



- Wavelength range from 320 to 1700 nm
- Bandwidth DC to 400 MHz
- Rise time 1 ns
- Max. conversion gain 4.8 x 10^3 V/W

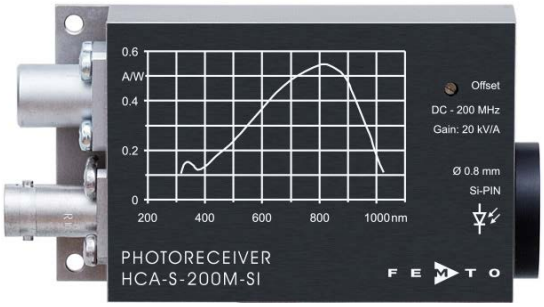
APPLICATIONS

Spectroscopy | Fast pulse and transient measurements | Optical triggering | Test of digital fiber-optic systems | Optical front-end for oscilloscopes and A/D converters

Model	HCA-S-400M-SI	HCA-S-400M-IN
Photodiode	0.8 mm Ø Si-PIN	InGaAs-PIN, Ø 0.3 mm (FST, FS), integrated ball lens (FC)
Spectral Range	320 - 1000 nm	900 - 1700 nm
Bandwidth (–3 dB)	DC - 400 MHz	DC - 400 MHz
Rise/Fall Time (10 % - 90 %)	1 ns	1 ns
Transimpedance Gain	5 x 10^3 V/A	5 x 10^3 V/A
Max. Conversion Gain	2.7 x 10^3 V/W (@ 800 nm)	4.8 x 10^3 V/W (@ 1550 nm)
NEP (@ 100 MHz)	40 pW/√Hz (@ 800 nm)	24 pW/√Hz (@ 1550 nm)
Output Noise	3 mV_{RMS}	3 mV_{RMS}
Input Options	FST, FS, FC, SMA	FST, FS, FC
Power Requirements	±15 V, ±55 mA typ.	
Dimensions	100 x 51 x 28 mm, weight 210 g (0.5 lbs)	

Output voltage ±1.0 V (@ 50 Ω load) for linear amplification. Offset adjustable by potentiometer. Output short-circuit protected. Photoreceivers with free space input come with threaded M4 and 8-32 mounting holes for use with standard mounting posts. Power supply ±15 V via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

HCA-S-200M Series 200 MHz Photoreceivers



- Wavelength range from 320 to 1700 nm
- Bandwidth from DC to 200 MHz
- Max. conversion gain 1.9 x 10^4 V/W
- Min. NEP 5.2 pW/√Hz

APPLICATIONS
Spectroscopy | Fast pulse and transient measurements | Optical triggering | Optical front-end for oscilloscopes, A/D converters and RF lock-in amplifiers

Model	HCA-S-200M-SI	HCA-S-200M-IN
Photodiode	0.8 mm Ø Si-PIN	InGaAs-PIN, Ø 0.3 mm (FST, FS), integrated ball lens (FC)
Spectral Range	320 - 1000 nm	900 - 1700 nm
Bandwidth (–3 dB)	DC - 200 MHz	DC - 200 MHz
Rise/Fall Time (10 % - 90 %)	1.8 ns	1.8 ns
Transimpedance Gain	2 x 10^4 V/A	2 x 10^4 V/A
Max. Conversion Gain	1.1 x 10^4 V/W (@ 800 nm)	1.9 x 10^4 V/W (@ 1550 nm)
NEP (@ 10 MHz)	9.4 pW/√Hz (@ 800 nm)	5.2 pW/√Hz (@ 1550 nm)
Output Noise	3 mV_{RMS}	4.5 mV_{RMS}
Input Options	FST, FS, FC, SMA	FST, FS, FC
Power Requirements	±15 V, ±50 mA typ.	±15 V, ±60 mA typ.
Dimensions	105 x 51 x 28 mm, weight 210 g (0.5 lbs)	

Output voltage ±1.2 V (@ 50 Ω load) for linear amplification. Offset adjustable by potentiometer. Output short-circuit protected. The photoreceivers with free space input come with threaded M4 and 8-32 mounting holes for use with standard mounting posts. Power supply ±15 V via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

LCA-S-400K Series 400 kHz Photoreceivers

- Wavelength range from 400 to 1700 nm
- Bandwidth from DC to 400 kHz
- Max. conversion gain 10^7 V/W
- Min. NEP 75 fW/√Hz

APPLICATIONS
Spectroscopy | General purposes opto-electronic measurements | Optical front-end for oscilloscopes, A/D converters and lock-in amplifiers

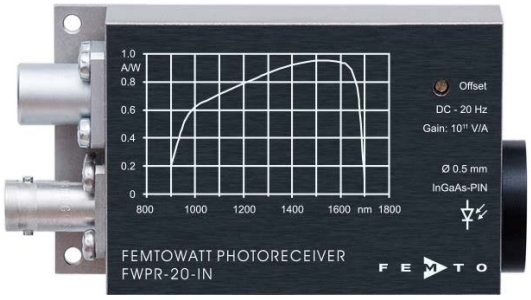
Model	LCA-S-400K-SI	LCA-S-400K-IN
Photodiode	3.0 mm Ø Si-PIN	0.5 mm Ø InGaAs-PIN
Spectral Range	400 - 1100 nm	900 - 1700 nm
Bandwidth (–3 dB)	DC - 400 kHz	DC - 400 kHz
Rise/Fall Time (10 % - 90 %)	1 µs	1 µs
Transimpedance Gain	1 x 10^7 V/A	1 x 10^7 V/A
Max. Conversion Gain	5.9 x 10^6 V/W (@ 920 nm)	9.5 x 10^6 V/W (@ 1550 nm)
NEP (@ 10 kHz)	120 fW/√Hz (@ 920 nm)	75 fW/√Hz (@ 1550 nm)
Output Noise	1.6 mV_{RMS}	2 mV_{RMS}
Input Options	FST, FS	FST, FS
Power Requirements	±15 V, ±40 mA typ.	
Dimensions	100 x 51 x 28 mm, weight 210 g (0.5 lbs)	

Output voltage ±10 V max (@ 100 kΩ load). Offset adjustable by trimpot. Units with fiber optic input are optionally available. Output short-circuit protected. Threaded M4 and 8-32 mounting holes for use with standard mounting posts. Power supply ±15 V via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

Mounting options

- The series HSPR-X/HSA-X-S, HCA-S, LCA-S, FWPR and PWPR feature both UNC 8-32 and M4 tapped holes for mounting on metric and imperial threaded standard posts.
- Optional post adapter plate PRA-PAP adds additional UNC 8-32 and M4 tapped holes to the series OE, HCA-S, LCA-S, FWPR and PWPR.

FWPR-20 Series Femtowatt Photoreceivers



- Ultra-low-noise: NEP 0.7 fW/√Hz
- Wavelength range from 320 nm to 1700 nm
- Bandwidth DC to 20 Hz
- Transimpedance amplifier with high gain up to 10^{12} V/A included

Model	FWPR-20-SI	FWPR-20-IN
Photodiode	1.1 x 1.1 mm² Si	0.5 mm Ø InGaAs-PIN
Spectral Range	320 - 1100 nm	900 - 1700 nm
Bandwidth (–3 dB)	DC - 20 Hz	DC - 20 Hz
Rise/Fall Time (10 % - 90 %)	18 ms	18 ms
Transimpedance Gain	1 x 10^{12} V/A	1 x 10^{11} V/A
Max. Conversion Gain	0.6 x 10^{12} V/W (@ 960 nm)	0.95 x 10^{11} V/W (@ 1550 nm)
NEP (@ 1 Hz)	0.7 fW/√Hz (@ 960 nm)	7.5 fW/√Hz (@ 1550 nm)
Output Noise	6 mV_{RMS}	3 mV_{RMS}
Input Options	FST, FS	FST, FS
Power Requirements	±15 V, ±15 mA typ.	
Dimensions	100 x 51 x 28 mm, weight 190 g (0.42 lbs)	

APPLICATIONS

Fluorescence measurements | Spectroscopy | Electrophoresis | Chromatography | Replacement for photomultiplier tubes (PMTs), avalanche photodiodes (APDs) and liquid nitrogen cooled germanium photodiodes

Output voltage ±10 V max (@ 100 kΩ load). Offset adjustable by potentiometer. Units with fiber optic input are optionally available. Output short-circuit protected. Threaded M4 and 8-32 mounting holes for use with standard mounting posts. Power supply ±15 V via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

PWPR-2K Series Picowatt Photoreceivers

- Ultra-low-noise: NEP ≤ 10 fW/√Hz
- Wavelength range from 320 to 1700 nm
- Bandwidth DC to 2 kHz
- Transimpedance gain switchable 10^9 V/A, 10^{10} V/A

Model	PWPR-2K-SI	PWPR-2K-IN
Photodiode	1.2 mm Ø Si-PIN	0.5 mm Ø InGaAs-PIN
Spectral Range	320 - 1060 nm	900 - 1700 nm
Bandwidth (–3 dB)	DC - 2 kHz	DC - 2 kHz
Rise/Fall Time (10 % - 90 %)	165 µs	165 µs
Transimpedance Gain (switchable)	1 x 10^9 V/A 1 x 10^{10} V/A	1 x 10^9 V/A 1 x 10^{10} V/A
Max. Conversion Gain	0.64 x 10^9 V/W (@ 900 nm, gain 10^9 V/A) 0.64 x 10^{10} V/W (@ 900 nm, gain 10^{10} V/A)	1.1 x 10^9 V/W (@ 1580 nm, gain 10^9 V/A) 1.1 x 10^{10} V/W (@ 1580 nm, gain 10^{10} V/A)
NEP (@ 100 Hz)	9 fW/√Hz (@ 900 nm)	10 fW/√Hz (@ 1580 nm)
Output Noise	0.45 mV_{RMS} @ 10^9 V/A	0.75 mV_{RMS} @ 10^9 V/A
Input Options	FST, FS	FST, FS
Power Requirements	±15 V, +32 mA / –25 mA	
Dimensions	100 x 51 x 33 mm, 220 g (0.49 lbs)	

APPLICATIONS

Spectroscopy, reflection and transmission measurements | Time-resolved optical pulse and power measurements | Characterization of light sources | Highly sensitive applications using chopper modulation | Optical front-end for oscilloscopes, A/D converters and lock-in amplifiers

Output voltage ±10 V max (@ 100 kΩ load). Offset adjustable by potentiometer. Output short-circuit protected. Power supply ±15 V via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.