



**Electro Optical Components, Inc.**

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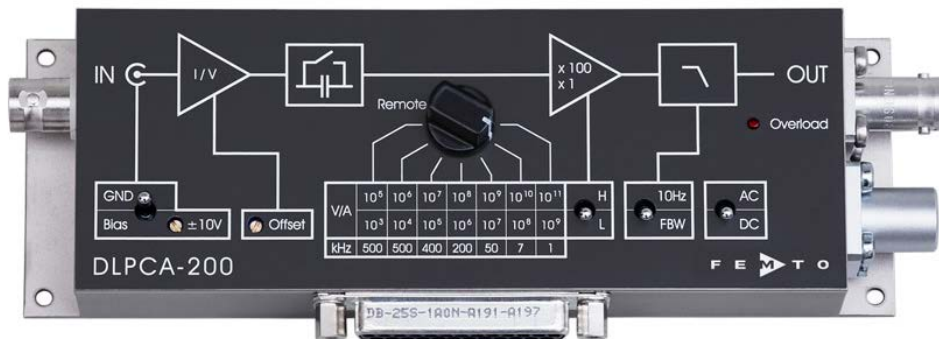
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## CURRENT / TRANSIMPEDANCE AMPLIFIERS

Ultra-Low-Noise Amplifiers  
For High-Speed Precision Measurements



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CURRENT AMPLIFIERS

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VOLTAGE AMPLIFIERS

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GHZ-WIDEBAND  
AMPLIFIERS

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PHOTORECEIVERS

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LOCK-IN AMPLIFIERS

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ACCESSORIES

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## DDPCA-300 Variable Gain Ultra-Low-Noise Current Amplifier

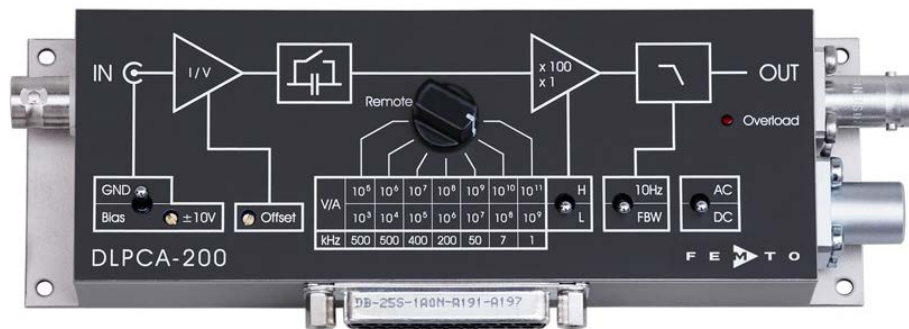


- 0.4 fA peak-to-peak noise
- Variable transimpedance gain from  $10^4$  to  $10^{13}$  V/A
- 240 dB dynamic range for sub-fA to mA measurements
- Adjustable bias voltage
- Compact and highly EMI-shielded case for use close to the signal source
- Manual and remote control

### APPLICATIONS

Photo and ionization detector amplifier | I/V characterization of MOS and JFET structures | measurement of ultra-low currents | Quantum and biotech experiments | Spectroscopy | High resistance measurements | Easy-to-use FEMTO® amplifier add-on to existing digital voltmeter or A/D converter

## DLPCA-200 Variable Gain Low-Noise Current Amplifier



- Variable transimpedance gain from  $10^3$  to  $10^{11}$  V/A
- Input noise down to 4.3 fA/ $\sqrt{\text{Hz}}$
- Bandwidth up to 500 kHz
- Rise time down to 700 ns
- Adjustable bias voltage
- Manual and remote control

### APPLICATIONS

Photodetector amplifier | Scanning tunneling microscopy (STM) | Spectroscopy | Beam monitoring for particle accelerators/synchrotrons | Ionization detectors | Preamplifier for lock-ins, A/D converters, etc.

## DHPCA-100 Variable Gain High-Speed Current Amplifier



- Variable transimpedance gain from  $10^2$  to  $10^8$  V/A
- Bandwidth up to 200 MHz
- Rise time down to 1.8 ns
- Adjustable bias voltage
- Manual and remote control

### APPLICATIONS

Photodetector amplifier | Fast ionization detection | Spectroscopy | Preamplifier for oscilloscopes, A/D converters and RF lock-in amplifiers

## DDPCA-300 Sub-Femto Ampere Sensitivity

Model	DDPCA-300									
Transimpedance [V/A]	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>8</sup>	10 <sup>9</sup>	10 <sup>10</sup>	10 <sup>11</sup>	10 <sup>12</sup>	10 <sup>13</sup>
Bandwidth* (-3 dB) [Hz]	400	400	400	400	150	150	20	20	1	1
Rise Time* (10 % - 90 %) [ms]	0.8	0.8	0.8	0.8	2.3	2.3	17	17	350	350
Equ. Input Noise [ $\sqrt{\text{Hz}}$ ]	45 pA	45 pA	0.45 pA	0.45 pA	15 fA	15 fA	1.3 fA	1.3 fA	0.2 fA	0.2 fA
Accuracy	Transimpedance (Gain) $\pm 1$ %									
Low Pass Filter	3 settings: full bandwidth, 0.7 Hz and 0.1 Hz									
Output Range	$\pm 10$ V, $\pm 30$ mA									
Bias Voltage Range	$\pm 10$ V, max. 10 mA, connected to amplifier input, adjustable by trimpot or remote control voltage									
Power Supply	$\pm 15$ V, +70 mA / -15 mA typ.									
Control Interface	4 opto-isolated digital inputs, TTL/CMOS compatible, analog voltage input for bias control									
Case	170 x 60 x 45 mm (L x W x H), weight 320 g (0.74 lbs)									

\* The values for bandwidth, rise time and integrated input noise stated in the table above are achieved with the low pass filter set to full bandwidth. Lower noise values can be achieved by setting the low pass filter to 0.7 Hz or 0.1 Hz. The minimum of 0.4 fA peak-to-peak noise is achieved in the gain settings 10<sup>12</sup> and 10<sup>13</sup> V/A with the low pass filter set to 0.1 Hz.

Offset adjustable by potentiometer. Overload indication by LED and digital control output. Input protected against  $\pm 2$  kV transients. 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 or contact FEMTO®.

## DLPCA-200 Broad Application Range

Model	DLPCA-200														
Performance Range	Low Noise							High Speed							
Transimpedance [V/A]	10 <sup>3</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>8</sup>	10 <sup>9</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>8</sup>	10 <sup>9</sup>	10 <sup>10</sup>	10 <sup>11</sup>	
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	
Equ. Input Noise [f√Hz]	20 pA	2.3 pA	450 fA	130 fA	43 fA	13 fA	4.3 fA	13 pA	1.8 pA	440 fA	130 fA	43 fA	13 fA	4.3 fA	
Accuracy	Transimpedance (Gain) ± 1 %														
Low Pass Filter	2 settings: full bandwidth and 10 Hz														
Output Range	±10 V, ±30 mA														
Bias Voltage Range	±10 V, max. 22 mA, connected to shield of BNC input socket, switchable to GND														
Power Supply	±15 V, +120 mA / −80 mA typ.														
Control Interface	5 opto-isolated digital inputs, TTL/CMOS compatible, analog voltage input for offset control														
Case	170 x 60 x 45 mm (L x W x H), weight 320 g (0.74 lbs)														

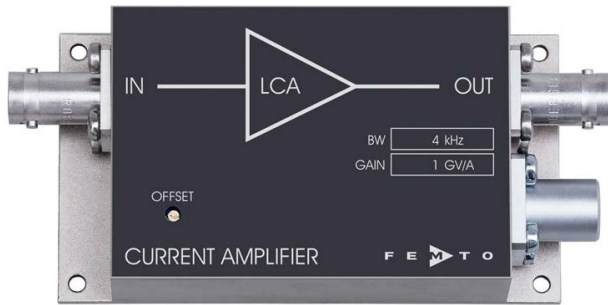
Offset adjustable by potentiometer or external control voltage. LED overload indication. Input protected against  $\pm 3$  kV transients. Output short-circuit protected. Power supply via 3-pin Lemo® socket, a mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet or contact FEMTO®.

## DHPCA-100 MHz Speed

Model	DHPCA-100											
Performance Range	Low Noise						High Speed					
Transimpedance [V/A]	10 <sup>2</sup>	10 <sup>3</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>3</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>8</sup>
Bandwidth (−3 dB) [MHz]	200	80	14	3.5	1.8	0.22	175	80	14	3.5	1.8	0.22
Rise Time (10 % - 90 %)	1.8 ns	4.4 ns	25 ns	0.1 μs	0.2 μs	1.6 μs	2.0 ns	4.4 ns	25 ns	0.1 μs	0.2 μs	1.6 μs
Equ. Input Noise [f√Hz]	220 pA	17 pA	2.2 pA	490 fA	140 fA	51 fA	155 pA	6.1 pA	1.5 pA	440 fA	140 fA	51 fA
Accuracy	Transimpedance (Gain) ± 1 %											
Low Pass Filter	3 settings: full bandwidth, 10 MHz and 1 MHz											
Output Range	±1 V @ 50 Ω load											
Bias Voltage Range	±10 V, max. 22 mA, connected to BNC-shield, switchable to GND											
Power Supply	±15 V, +110 mA / −90 mA											
Control Interface	7 opto-isolated digital inputs, TTL/CMOS compatible, analog voltage input for offset control											
Case	170 x 60 x 45 mm (L x W x H), weight 320 g (0.74 lbs)											

Offset adjustable by potentiometer or external control voltage. LED overload indication. Input protected against  $\pm 3$  kV transients. 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 or contact FEMTO®.

## LCA Series Ultra Low-Noise Current Amplifier



- Input noise down to 180 aA/√Hz
- Bandwidth up to 400 kHz
- Gain up to  $10^{13}$  V/A
- Flat frequency response
- EMI-shielded case

### APPLICATIONS

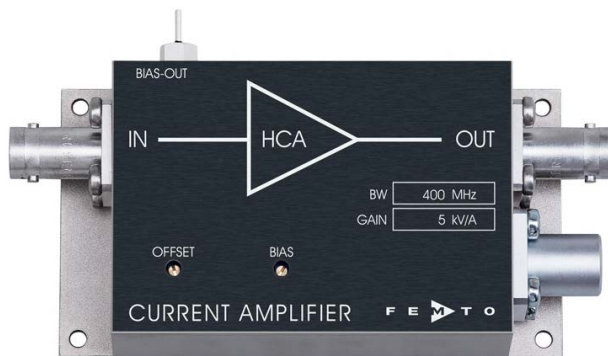
Photodetector amplifier | Spectroscopy | Scanning tunneling microscopy (STM) | Ionization detectors | Pyro- and piezoelectric detectors

Model	-3 dB Bandwidth (DC ...)	Noise Current [ $\sqrt{\text{Hz}}$ ]	Transimpedance (Gain)	Rise/Fall Time
LCA-2-10T	2 Hz	0.18 fA	$10^{12}$ and $10^{13}$ V/A	200 ms
LCA-30-1T	30 Hz	0.5 fA	$1 \times 10^{12}$ V/A	12 ms
LCA-30-200G	30 Hz	0.5 fA	$2 \times 10^{11}$ V/A	12 ms
LCA-200-100G	200 Hz	1.5 fA	$1 \times 10^{11}$ V/A	2 ms
LCA-200-10G	200 Hz	1.5 fA	$1 \times 10^{10}$ V/A	2 ms
LCA-1K-5G	1 kHz	3 fA	$5 \times 10^9$ V/A	400 $\mu$ s
LCA-2K-2G	2 kHz	4.5 fA	$2 \times 10^9$ V/A	200 $\mu$ s
LCA-4K-1G	4 kHz	6.5 fA	$1 \times 10^9$ V/A	100 $\mu$ s
LCA-10K-500M	10 kHz	10 fA	$5 \times 10^8$ V/A	40 $\mu$ s
LCA-20K-200M	20 kHz	14 fA	$2 \times 10^8$ V/A	20 $\mu$ s
LCA-40K-100M	40 kHz	19 fA	$1 \times 10^8$ V/A	10 $\mu$ s
LCA-100K-50M	100 kHz	30 fA	$5 \times 10^7$ V/A	4 $\mu$ s
LCA-200K-20M	200 kHz	40 fA	$2 \times 10^7$ V/A	2 $\mu$ s
LCA-400K-10M	400 kHz	65 fA	$1 \times 10^7$ V/A	1 $\mu$ s

NOTE: Bandwidth and frequency response are independent of detector capacitance. Guaranteed and 100 % tested up to 10 nF for each amplifier (up to 1 nF for LCA-400K-10M).

Output voltage  $\pm 10$  V @  $>10$  k $\Omega$  load. Offset adjustable by trimpot. 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 or contact FEMTO®.

## HCA Series High-Speed Current Amplifier



- Input noise down to 270 fA/√Hz
- Bandwidth up to 400 MHz
- Gain up to  $10^6$  V/A
- Flat frequency response
- Stabilized and adjustable bias voltage output for biasing external photodiodes
- EMI-shielded case

### APPLICATIONS

Fast detection with large area photodiodes | Spectroscopy | Photodetection with PMTs and photodiodes | Ionization detectors | Pyro- and piezoelectric detectors

Model	-3 dB Bandwidth (DC ...)	Noise Current [ $\sqrt{\text{Hz}}$ ]	Transimpedance (Gain)	Rise/Fall Time	Max. Source Capacitance
HCA-1M-1M	1 MHz	270 fA	$1 \times 10^6$ V/A	350 ns	50 pF
HCA-1M-1M-C	1 MHz	3.5 pA	$1 \times 10^6$ V/A	350 ns	2 nF
HCA-2M-1M	2 MHz	340 fA	$1 \times 10^6$ V/A	180 ns	25 pF
HCA-2M-1M-C	2 MHz	3.5 pA	$1 \times 10^6$ V/A	180 ns	1 nF
HCA-4M-500K	4 MHz	490 fA	$5 \times 10^5$ V/A	90 ns	15 pF
HCA-4M-500K-C	4 MHz	3.5 pA	$5 \times 10^5$ V/A	90 ns	500 pF
HCA-10M-100K	10 MHz	1.1 pA	$1 \times 10^5$ V/A	35 ns	15 pF
HCA-10M-100K-C	10 MHz	3.5 pA	$1 \times 10^5$ V/A	35 ns	150 pF
HCA-20M-100K-C	20 MHz	3.5 pA	$1 \times 10^5$ V/A	18 ns	50 pF
HCA-40M-100K-C	40 MHz	3.7 pA	$1 \times 10^5$ V/A	10 ns	30 pF
HCA-100M-50K-C	100 MHz	3.8 pA	$5 \times 10^4$ V/A	3.5 ns	20 pF*
HCA-200M-20K-C	200 MHz	4.9 pA	$2 \times 10^4$ V/A	1.9 ns	8 pF*
HCA-400M-5K-C	400 MHz	21 pA	$5 \times 10^3$ V/A	1 ns	10 pF*

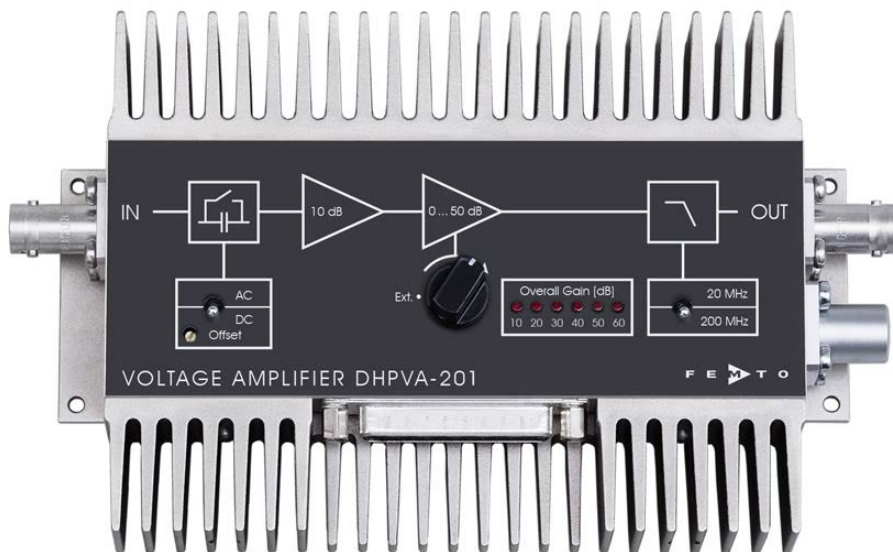
Output voltage  $\pm 1.5$  V, @ 50  $\Omega$  load. Offset adjustable by trimpot. Output short-circuit protected. Adjustable bias-output ( $-12$  V ...  $+12$  V) for biasing photodetectors. Power supply via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

NOTE: The maximum detector capacitance listed above means that up to this value the specified -3dB-bandwidth ( $\pm 15$  %) is guaranteed. Larger capacitances are also possible, but will slightly influence the bandwidth and frequency response.

\* For the ultra fast models HCA-100M-50K-C, HCA-200M-20K-C and HCA-400M-5K-C a reduction in bandwidth up to 25 % of the nominal values might occur if the source capacitance reaches the above noted maximum source capacitance values. Especially for these models short cables at the input and the use of low capacitance sources is of major importance. For further information please view the datasheet or contact FEMTO®.

# VOLTAGE AMPLIFIERS

Variable Gain Wideband Amplifiers



CURRENT AMPLIFIERS

VOLTAGE AMPLIFIERS

GHZ-WIDEBAND  
AMPLIFIERS

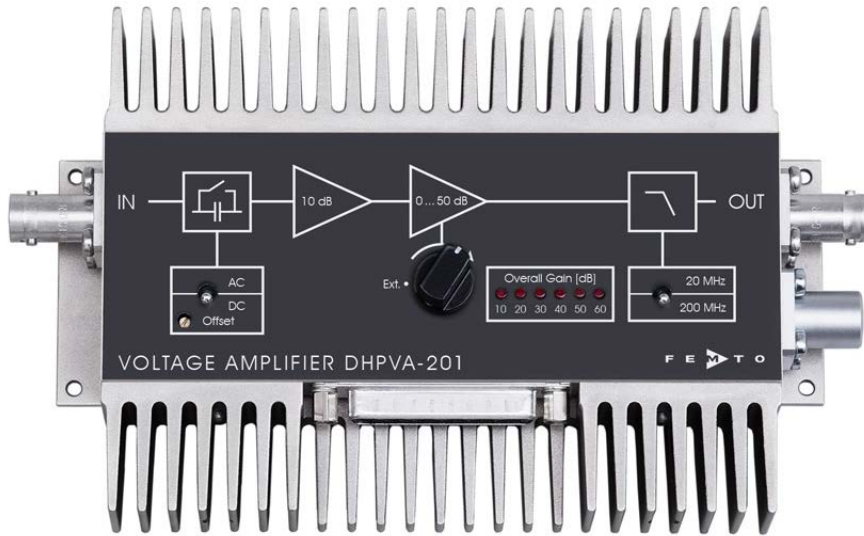
PHOTORECEIVERS

LOCK-IN AMPLIFIERS

ACCESSORIES



## DHPVA Series 100/200 MHz Wideband Voltage Amplifiers



- Bandwidth DC to 100 or 200 MHz independent of chosen gain setting
- Variable gain from 10 to 60 dB ( $\times 3$  to  $\times 1,000$ )
- Input noise 2.3 nV/ $\sqrt{\text{Hz}}$
- DC drift only 0.3  $\mu\text{V}/^\circ\text{C}$
- True DC coupling, switchable to AC
- Switchable 10 or 20 MHz low pass filter for minimizing wide band noise
- Local and remote control

### APPLICATIONS

Oscilloscope and transient recorder preamplifier | Photomultiplier amplifier | Signal booster for optical receivers and current amplifiers | Time-resolved pulse and transient measurements | Automated measurement systems

## HVA Series Wideband Voltage Amplifiers

- Bandwidth DC to 10, 200 or 500 MHz
- Fixed or variable gain up to 60 dB ( $\times 1,000$ )
- Noise down to 0.9 nV/ $\sqrt{\text{Hz}}$
- True DC coupling, switchable to AC
- 50  $\Omega$  bipolar or 1 M $\Omega$  FET input stage

### APPLICATIONS

Oscilloscope and transient recorder preamplifier | Photomultiplier and microchannel plate amplifier | Time-resolved pulse and transient measurements | Amplification of digital signals (no baseline shift at any digital code)



## DLPVA Series Low-Frequency Voltage Amplifiers



- Bandwidth DC to 100 kHz
- Variable gain up to 100 dB ( $\times 100,000$ )
- Input noise down to 0.4 nV/ $\sqrt{\text{Hz}}$
- DC-drift down to 0.5  $\mu\text{V}/^\circ\text{C}$
- True DC coupling, switchable to AC
- Input impedance up to 1 T $\Omega$
- Local and remote control

### APPLICATIONS

Universal low-frequency amplifier | Automated measurements | Industrial sensors | Detector preamplifier | Integrated measurement systems

For detailed information about DHPVA-, HVA-, and DLPVA-series see next page!

## DHPVA Series Reference Class from DC to 200 MHz

Model	DHPVA-101	DHPVA-201
Lower Cut-Off Frequency	DC/10 Hz, switchable	DC/10 Hz, switchable
Upper Cut-Off Frequency	10/100 MHz, switchable	20/200 MHz, switchable
Gain [dB]	10/20/30/40/50/60, switchable	10/20/30/40/50/60, switchable
Input Voltage Noise	2.3 nV/√Hz	2.3 nV/√Hz
Input Voltage Drift	0.3 μV/°C	0.3 μV/°C
Input/Output	50 Ω, BNC	50 Ω, BNC
Input Return Loss S11	−31 dB @ 100 MHz	−22 dB @ 200 MHz
Output Return Loss S22	−35 dB @ 100 MHz	−30 dB @ 200 MHz
Output Voltage	±1 V @ 50 Ω	
Monitor Output	DC - 100 kHz monitor output at D-Sub connector, gain of 1	
Digital Control	5 opto-isolated digital inputs, TTL/CMOS compatible	
Power Requirements	±15 V, ±120 mA typ.	
Dimensions	175 x 105 x 45 mm (L x W x H), weight 560 g (1.24 lbs)	

Offset adjustable by trimpot or external control voltage. Indication of selected gain setting by LEDs. Output short-circuit protected. Power supply via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply series PS-15 available. For further information please see the datasheet.

The new improved models DHPVA-101 and DHPVA-201 replace the previous models DHPVA-100 and DHPVA-200. They are fully compatible delivering at least the same or better electrical performance. The heatsinks may be removed if adequate alternative cooling is provided like mounting the amplifier to a sufficiently large case/rack system.

## HVA Series True DC-Coupling with Zero Output Offset

Model	HVA-10M-60-B	HVA-10M-60-F	HVA-200M-40-B	HVA-200M-40-F	HVA-500M-20-B
Lower Cut-Off Frequency	DC/1 kHz	DC/1 Hz	DC/1 kHz	DC/1 Hz	DC
Upper Cut-Off Frequency	10 MHz	10 MHz	200 MHz	200 MHz	500 MHz
Gain [dB]	40/60	40/60	20/40	20/40	20
Input Voltage Noise	0.9 nV/√Hz	4.7 nV/√Hz	1.2 nV/√Hz	4.5 nV/√Hz	3.0 nV/√Hz
Input Voltage Drift	1 μV/°C	2 μV/°C	1 μV/°C	5 μV/°C	10 μV/°C
Input	50 Ω, BNC	1 MΩ, BNC	50 Ω, BNC	1 MΩ, BNC	50 Ω, BNC
Output	50 Ω, BNC	50 Ω, BNC	50 Ω, BNC	50 Ω, BNC	50 Ω, BNC
Output Voltage	±3.5 V @ 50 Ω	±3.5 V @ 50 Ω	±1 V @ 50 Ω	±1 V @ 50 Ω	±1 V @ 50 Ω
Power Requirements	±15 V, ±70 mA typ.				
Dimensions	112 x 51 x 33 mm (L x W x H), weight 200 g (0.5 lbs)				

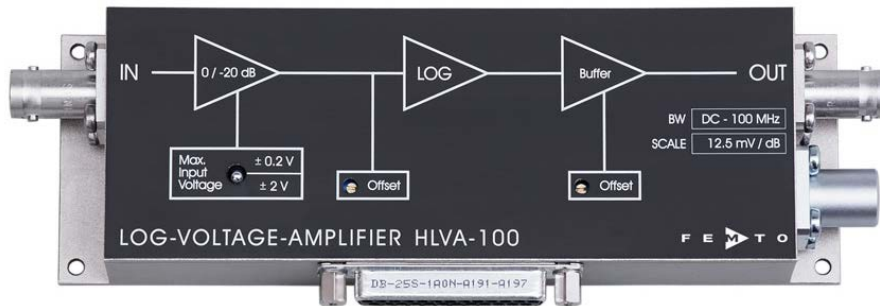
Offset adjustable by trimpot. Output short-circuit protected. Power supply via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

## DLPVA Series High Gain up to 100 dB

Model	DLPVA-100-BUN-S	DLPVA-100-BLN-S	DLPVA-100-B-S	DLPVA-100-B-D	DLPVA-100-F-S	DLPVA-100-F-D
Input stage	Single ended, bipolar	Single ended, bipolar	Single ended, bipolar	True diff., bipolar	Single ended, FET	True diff., FET
Input	1 kΩ, BNC	1 MΩ, BNC	1 MΩ, BNC	1 MΩ, Lemo®	1 TΩ, BNC	1 TΩ, Lemo®
Typical Source Impedance	<50 Ω	<100 Ω	<1 kΩ	<1 kΩ	<1 GΩ	<1 GΩ
Lower Cut-Off Frequency	1.5 Hz (AC only)	DC/1.5 Hz	DC/1.5 Hz	DC/1.5 Hz	DC/1.5 Hz	DC/1.5 Hz
Upper Cut-Off Frequency	1/100 kHz	1/100 kHz	1/100 kHz	1/100 kHz	1/100 kHz	1/100 kHz
Gain [dB]	40/60/80/100	40/60/80/100	20/40/60/80	20/40/60/80	20/40/60/80	20/40/60/80
Input Voltage Noise	0.4 nV/√Hz	0.7 nV/√Hz	2.4 nV/√Hz	3.6 nV/√Hz	5.5 nV/√Hz	6.9 nV/√Hz
Input Voltage Drift	-	0.5 μV/°C	0.7 μV/°C	0.7 μV/°C	1.3 μV/°C	1.3 μV/°C
CMRR	-	-	-	120 dB max.	-	120 dB max.
Output	<100 Ω, BNC (terminate with > 10 kΩ load for best performance)					
Output Voltage	±10 V (@ > 10 kΩ load)					
Digital Control	3 or 4 digital inputs and 1 digital output, opto-isolated, TTL/CMOS compatible					
Power Requirements	±15 V, ±75 mA typ.					
Dimensions	175 x 51 x 34 mm (L x W x H), weight 320 g (0.7 lbs)					

Offset adjustable by trimpot or external control voltage. Indication of selected gain setting by LED. 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.

## HLVA-100 Logarithmic Wideband Voltage Amplifier



- Wide dynamic range up to 80 dB
- DC coupled, rectifying\* input
- Switchable input range from  $\pm 20 \mu\text{V}$  to  $\pm 200 \text{ mV}$  and from  $\pm 200 \mu\text{V}$  to  $\pm 2 \text{ V}$
- Rise/fall time 5 ns
- Input noise  $2 \text{ nV}/\sqrt{\text{Hz}}$
- Local and remote control
- Integrated sample and hold baseline correction

### APPLICATIONS

LIDAR systems | Signal compression | Time-resolved pulse and transient measurements | Mass spectroscopy | Particle detection

Model	HLVA-100	
Input Voltage Range	from $\pm 20 \mu\text{V}$ to $\pm 200 \text{ mV}$ and from $\pm 200 \mu\text{V}$ to $\pm 2 \text{ V}$ , switchable	
Dynamic Range	Typ. 60 dB (for accurate amplitude measurement) Max. 80 dB (for signal detection)	
Scaling	12.5 mV/dB, 250 mV/decade (@ 50 $\Omega$ load)	
Linearity	$\pm 1 \text{ dB}$ (for pulse of min. 20 ns pulse width)	
Input Voltage Noise	2 nV/ $\sqrt{\text{Hz}}$	
Input Voltage Drift	0.6 $\mu\text{V}/^\circ\text{C}$	
Input/Output	50 $\Omega$ , BNC	
Rise/Fall Time	5 ns @ 40 dB step	
Output Voltage Range	+50 to +1075 mV typ. @ 50 $\Omega$ load (if output is adjusted to 1 V at 100 mV input)	
Output Offset Voltage Range	$\pm 500 \text{ mV}$ , adjustable by offset-trimpot	
Baseline Correction	Acquisition time	30 $\mu\text{s}$ (min. sample pulse width)
	Baseline hold droop rate	1 $\mu\text{V/s}$ (typ. @ 25 $^\circ\text{C}$ )
	Loop cut-off frequency	1.5 kHz
Digital Control	2 opto-isolated digital inputs, TTL/CMOS compatible	
Power Requirements	$\pm 15 \text{ V}$ , +90 mA/–120 mA typ.	
Dimensions	171 x 57 x 34 mm (L x W x H), weight 320 g (0.7 lbs)	

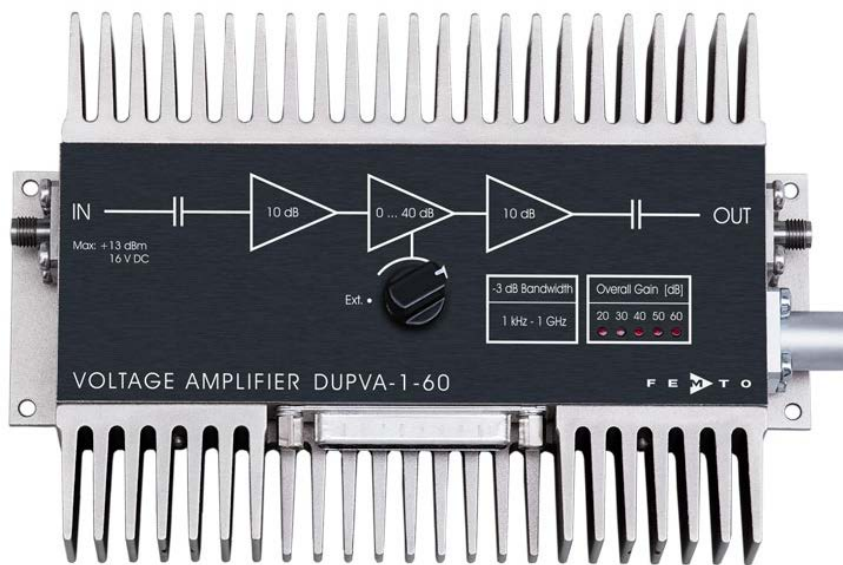
Offset adjustable by trimpot or external control voltage. Power supply via 3-pin Lemo<sup>®</sup> socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

\*The logarithm of a negative number is not defined as real number. Therefore the negative part of an input signal is rectified prior to applying the logarithmic amplification.



# GHZ-WIDEBAND AMPLIFIERS

Suitable as Current and Voltage Amplifiers




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CURRENT AMPLIFIERS

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VOLTAGE AMPLIFIERS

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GHZ-WIDEBAND  
AMPLIFIERS

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PHOTORECEIVERS

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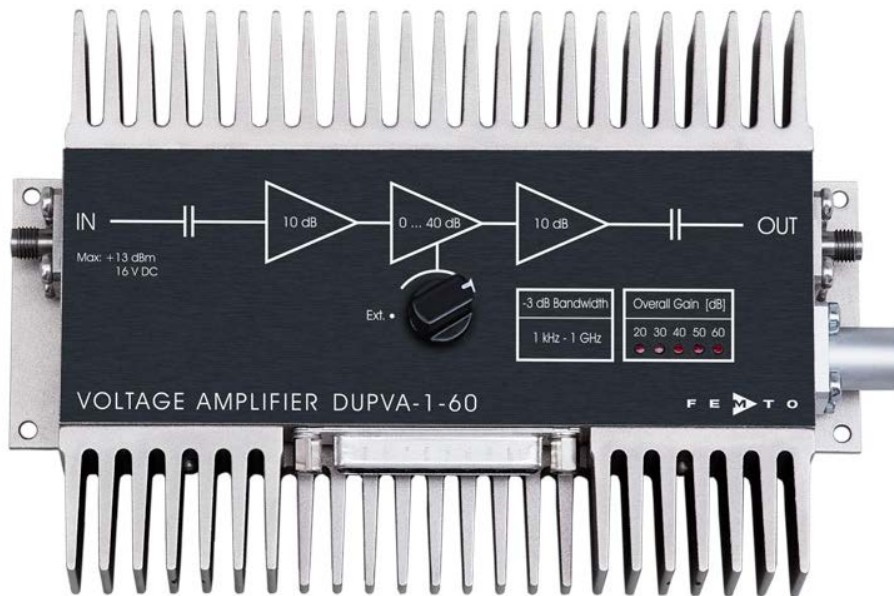
LOCK-IN AMPLIFIERS

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ACCESSORIES

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# DUPVA Series 1 GHz Variable Gain Voltage Amplifiers



- Variable gain up to 70 dB (approx.  $\times 3000$ ), switchable in 10 dB steps
- Bandwidth 1 kHz to 1.2 GHz
- Bandwidth independent of gain setting (guaranteed)
- Noise figure down to 1.9 dB (330 pV/ $\sqrt{\text{Hz}}$ )
- Local and remote gain control

## APPLICATIONS

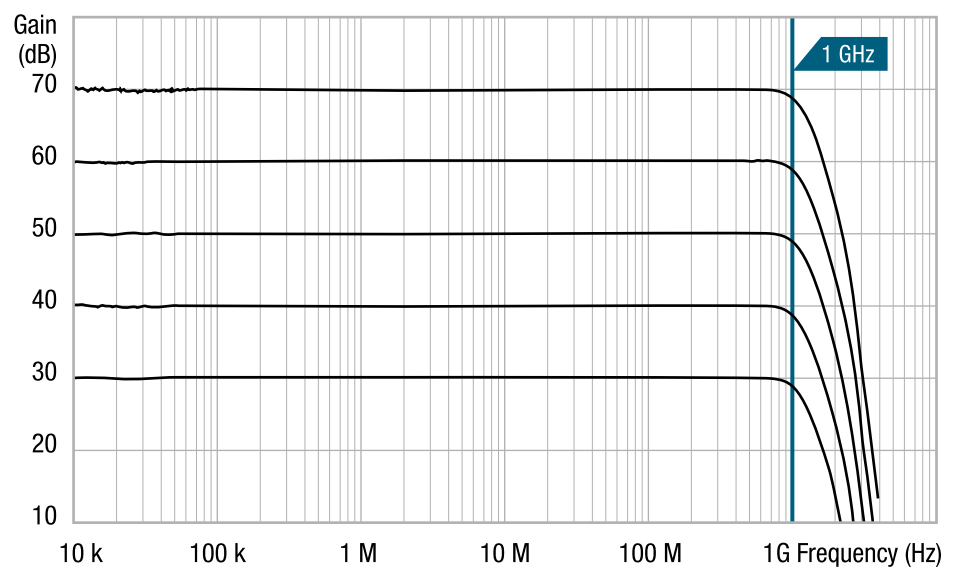
Oscilloscope and transient recorder preamplifier | Photomultiplier and microchannel plate amplifier | Signal booster for optical receivers and current amplifiers | Time-resolved pulse and transient measurements | Automated measurement systems

Model	DUPVA-1-60	DUPVA-1-70
Lower Cut-Off-Frequency	1 kHz	1 kHz
Upper Cut-Off-Frequency	1.2 GHz	1.1 GHz
Rise/Fall Time	380 ps	390 ps
Gain	20/30/40/50/60 dB	30/40/50/60/70 dB
Input Noise	NF 3.0 dB (450 pV/ $\sqrt{\text{Hz}}$ )	NF 1.9 dB (330 pV/ $\sqrt{\text{Hz}}$ )
Output Power	13 dBm (–1 dB compression @ 100 MHz)	12 dBm (–1 dB compression @ 100 MHz)
Power Requirements	$\pm 15 \text{ V}$ , +350 mA / –100 mA, typ.	$\pm 15 \text{ V}$ , +250 mA / –100 mA, typ.
Input/Output	50 $\Omega$ , SMA connector	
Monitor Output	DC - 100 kHz monitor output at D-Sub connector, gain of 1	
Control Interface	3 opto-isolated digital inputs, TTL/CMOS compatible	
Dimensions	165 x 105 x 45 mm (L x W x H), weight 510 g (1.1 lbs)	

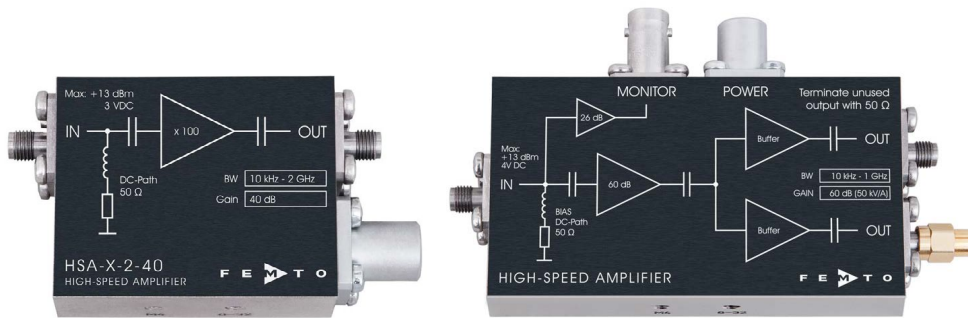
Indication of selected gain setting by LED. Output short-circuit protected. Power supply via 3-pin Lemo® socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

## TYPICAL PERFORMANCE CHARACTERISTICS

- Bandwidth independent of gain setting (guaranteed), see figure: DUPVA-1-70 gain vs. frequency
- Upper cut-off frequency rolloff: 40 dB/oct.



# HSA Series High-Speed GHz Amplifiers



- Ultra-wide bandwidth from 10 kHz up to 2.5 GHz
- Gain up to 60 dB ( $\times 1,000$ )
- Transimpedance gain with photodetectors up to 50,000 V/A
- Very low input noise down to 310 pV/ $\sqrt{\text{Hz}}$  (6.2 pA/ $\sqrt{\text{Hz}}$ )
- Integrated DC-current path for biased photodetector applications

Only HSA-Y series:

- Two identical signal outputs
- DC-monitor output

## APPLICATIONS

Preamplifier for ultra-fast detectors (microchannel plates, photomultipliers, avalanche photodiodes and PIN photodiodes) | Oscilloscope and spectrum/network analyzer preamplifier | Time-resolved pulse and transient measurements | Signal booster in 50  $\Omega$  high-speed systems

HSA-X Models	HSA-X-1-40	HSA-X-2-20	HSA-X-2-40	HSA-X-1-2-40
Lower Cut-Off-Frequency	10 kHz	10 kHz	10 kHz	10 kHz
Upper Cut-Off-Frequency	1.2 GHz	2.5 GHz	2.0 GHz	2.2 GHz
Rise/Fall Time	290 ps	140 ps	180 ps	160 ps
Gain	40 dB ( $\times 100$ )	20 dB ( $\times 10$ )	40 dB ( $\times 100$ )	40 dB ( $\times 100$ ) inverting
Transimpedance*	5,000 V/A	500 V/A	5,000 V/A	5,000 V/A inverting
Input Noise [ $\sqrt{\text{Hz}}$ ]**	310 pV (6.2 pA)	610 pV (12.2 pA)	620 pV (12.4 pA)	430 pV (8.6 pA)
Input VSWR	1.6 : 1	1.23 : 1	1.4 : 1	1.25 : 1
Maximum Output Voltage @ 50 $\Omega$	2 V <sub>pp</sub>	2 V <sub>pp</sub>	1.9 V <sub>pp</sub>	2 V <sub>pp</sub>
Output VSWR	1.35 : 1	1.4 : 1	2.5 : 1	1.4 : 1
Power Requirements	+15 V, +140 mA, typ.	+15 V, +105 mA, typ.	+15 V, +125 mA, typ.	+15 V, +140 mA, typ.
Input/Output	50 $\Omega$ , SMA			
Dimensions	80 x 45 x 25 mm (L x W x H), weight 100 g (0.23 lb)			

HSA-Y Models	HSA-Y-1-40	HSA-Y-1-60	HSA-Y-2-20	HSA-Y-2-40
Lower Cut-Off-Frequency	10 kHz	10 kHz	10 kHz	10 kHz
Upper Cut-Off-Frequency	1.0 GHz	1.1 GHz	2 GHz	1.9 GHz
Rise/Fall Time	330 ps	320 ps	175 ps	185 ps
Gain	40 dB ( $\times 100$ )	60 dB ( $\times 1,000$ )	20 dB ( $\times 10$ )	40 dB ( $\times 100$ )
Transimpedance*	5,000 V/A	50,000 V/A	500 V/A	5,000 V/A
Input Noise [ $\sqrt{\text{Hz}}$ ]**	330 pV (6.6 pA)	330 pV (6.6 pA)	680 pV (13.6 pA)	650 pV (13 pA)
Input VSWR	1.45 : 1	1.4 : 1	1.15 : 1	1.2 : 1
Maximum Output Voltage @ 50 $\Omega$	2.0 V <sub>pp</sub>	2.3 V <sub>pp</sub>	2.5 V <sub>pp</sub>	1.7 V <sub>pp</sub>
Output VSWR	1.6 : 1	1.4 : 1	2.5 : 1	1.8 : 1
Power Requirements	$\pm 15$ V, +200 / -10 mA, typ.	$\pm 15$ V, +180 / -10 mA, typ.	$\pm 15$ V, +160 / -10 mA, typ.	$\pm 15$ V, +185 / -10 mA, typ.
Input	50 $\Omega$ , SMA			
Output	Two identical signal outputs, 50 $\Omega$ , SMA			
Monitor Output	Gain: 26 dB ( $\times 20$ ), transimpedance*: 1 kV/A, output voltage range: $\pm 10$ V ( $R_{\text{load}} > 10$ k $\Omega$ ), bandwidth: DC - 100 kHz			
Dimensions	110 x 70 x 25 mm (L x W x H), weight 180 g (0.41 lb)			

\* Transimpedance = Gain  $\times$  50  $\Omega$  (Input Impedance)

\*\* Input Noise Current = Input Noise Voltage  $\div$  50  $\Omega$  (Input Impedance)

Integrated DC path for use with photodetectors. 8-32 and M4 mounting threads. 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.

# PHOTORECEIVERS

From Femtowatt Sensitivity to Gigahertz Speed




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CURRENT AMPLIFIERS

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VOLTAGE AMPLIFIERS

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GHZ-WIDEBAND  
AMPLIFIERS

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PHOTORECEIVERS

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LOCK-IN AMPLIFIERS

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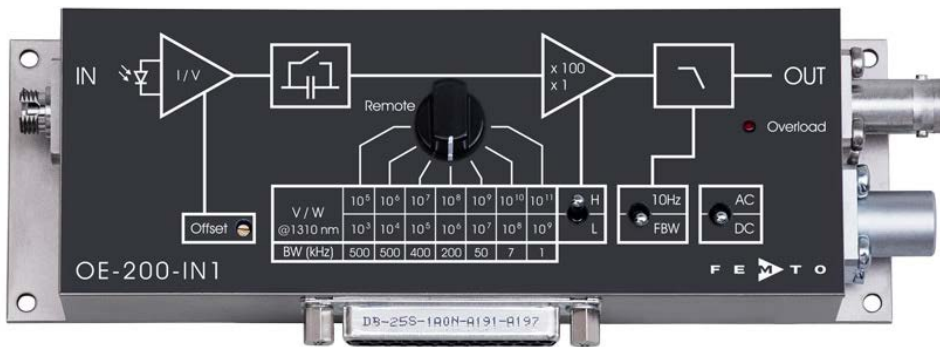


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ACCESSORIES

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## 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  $6 \text{ fW}/\sqrt{\text{Hz}}$
- 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
<b>Detector Type</b>	Si-PIN	Si-PIN	InGaAs-PIN	InGaAs-PIN
<b>Detector Size</b>	Ø 1.2 mm	1.1 x 1.1 mm <sup>2</sup>	Ø 0.3 mm (FC: Ø 0.08 mm)	Ø 0.3 mm (FC: Ø 0.08 mm)
<b>Spectral Range</b>	320 - 1060 nm	190 - 1000 nm	900 - 1700 nm	900 - 1700 nm
<b>Calibration Wavelength*</b>	850 nm	850 nm	1310 nm	1550 nm
<b>Input Options</b>	FST, FS, FC	FST, FS, FC	FST, FS, FC	FST, FS, FC
<b>NEP (Dependent on Gain Setting)</b>	8 fW/√Hz - 33 pW/√Hz	17 fW/√Hz - 60 pW/√Hz	7 fW/√Hz - 22 pW/√Hz	6 fW/√Hz - 22 pW/√Hz
<b>Useful Operating Range</b>	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						
<b>Conversion Gain [V/W]**</b>	10 <sup>3</sup>	10 <sup>4</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>8</sup>	10 <sup>9</sup>	10 <sup>5</sup>	10 <sup>6</sup>	10 <sup>7</sup>	10 <sup>8</sup>	10 <sup>9</sup>	10 <sup>10</sup>	10 <sup>11</sup>
<b>Bandwidth (-3 dB) [kHz]</b>	500	500	400	200	50	7	1.1	500	500	400	200	50	7	1.1
<b>Rise Time (10 % - 90 %)</b>	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
<b>Accuracy Performance</b>	±1 % electrical between settings, ±5 % electro-optical for FC-input, ±15 % electro-optical for FS- and FST-input													
<b>Low Pass Filter</b>	Switchable to 10 Hz													
<b>Output Performance</b>	±10 V (@ ≥100 kΩ load)													
<b>Power Requirements</b>	±15 V, +110 mA/-90 mA typ.													
<b>Control Interface</b>	5 opto-isolated digital inputs, TTL/CMOS compatible, analog offset control voltage input													
<b>Dimensions</b>	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)

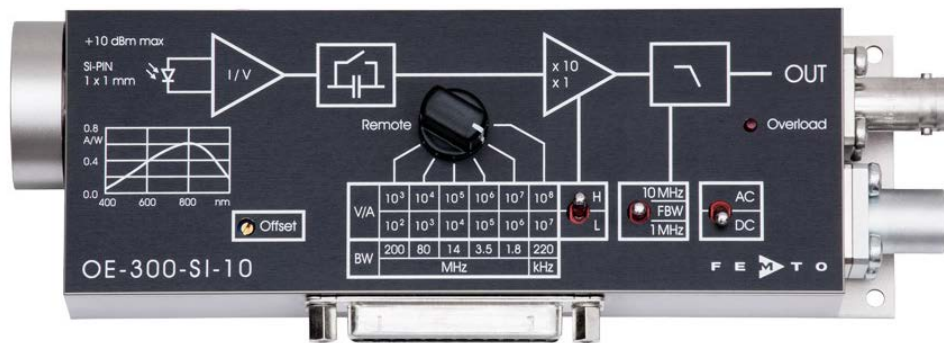


#### FC-Input

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  $47 \text{ fW}/\sqrt{\text{Hz}}$
- 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)	$76 \text{ fW}/\sqrt{\text{Hz}}$ - $322 \text{ pW}/\sqrt{\text{Hz}}$	$81 \text{ fW}/\sqrt{\text{Hz}}$ - $325 \text{ pW}/\sqrt{\text{Hz}}$	$47 \text{ fW}/\sqrt{\text{Hz}}$ - $180 \text{ pW}/\sqrt{\text{Hz}}$	$52 \text{ fW}/\sqrt{\text{Hz}}$ - $192 \text{ pW}/\sqrt{\text{Hz}}$

The following characteristics are valid for all models:

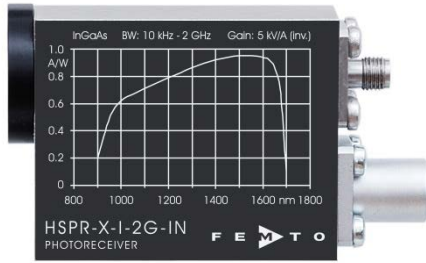
Performance Range	Low Noise							High Speed					
Gain Setting [V/A] (Transimpedance)	$10^2$	$10^3$	$10^4$	$10^5$	$10^6$	$10^7$		$10^3$	$10^4$	$10^5$	$10^6$	$10^7$	$10^8$
Bandwidth (-3 dB) [MHz]	200 (100) <sup>1</sup>	80 (60) <sup>1</sup>	14	3.5	1.8	0.22		175 (80) <sup>1</sup>	80 (60) <sup>1</sup>	14	3.5	1.8	0.22
Accuracy Performance	$\pm 1 \%$ (transimpedance)												
Low Pass Filter	switchable to 1 MHz and 10 MHz												
Output Performance	$\pm 1 \text{ V}$ (@ 50 $\Omega$ load), for linear amplification												
Power Requirements	$\pm 15 \text{ V}$ , +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)												

<sup>1)</sup> 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.



## 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  $4.75 \times 10^3$  V/W
- Min. NEP 11 pW/√Hz

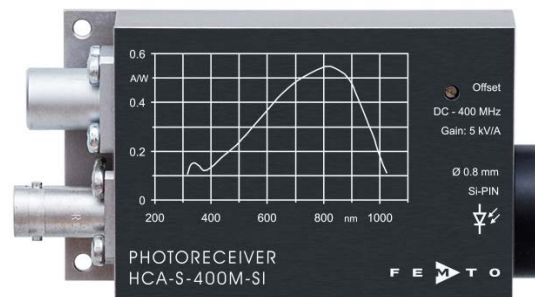
### APPLICATIONS

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	$5 \times 10^3$ V/A	$5 \times 10^3$ V/A (inverting)	$5 \times 10^3$ V/A	$5 \times 10^3$ V/A (inverting)
Conversion Gain	$2.55 \times 10^3$ V/W (@ 760 nm)	$2.55 \times 10^3$ V/W (@ 760 nm)	$4.75 \times 10^3$ V/W (@ 1550 nm)	$4.75 \times 10^3$ 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 <sub>PP</sub>	2.0 V <sub>PP</sub>	1.9 V <sub>PP</sub>	2.0 V <sub>PP</sub>
Output Noise	3.6 mV <sub>RMS</sub>	2.5 mV <sub>RMS</sub>	3.6 mV <sub>RMS</sub>	2.5 mV <sub>RMS</sub>
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<sup>®</sup> 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  $4.8 \times 10^3$  V/W

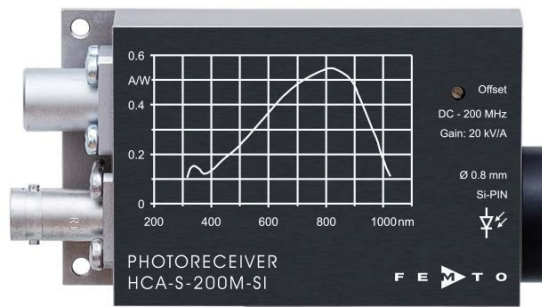
### APPLICATIONS

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	$5 \times 10^3$ V/A	$5 \times 10^3$ V/A
Max. Conversion Gain	$2.7 \times 10^3$ V/W (@ 800 nm)	$4.8 \times 10^3$ V/W (@ 1550 nm)
NEP (@ 100 MHz)	40 pW/√Hz (@ 800 nm)	24 pW/√Hz (@ 1550 nm)
Output Noise	3 mV <sub>RMS</sub>	3 mV <sub>RMS</sub>
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<sup>®</sup> 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  $1.9 \times 10^4$  V/W
- Min. NEP  $5.2 \text{ pW}/\sqrt{\text{Hz}}$

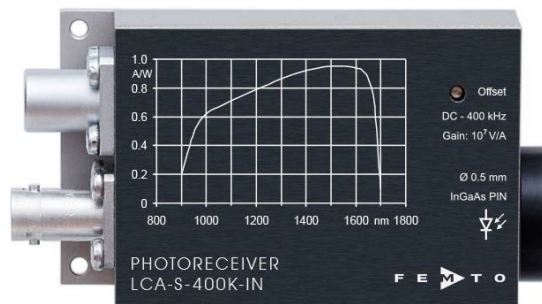
### APPLICATIONS

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	$2 \times 10^4$ V/A	$2 \times 10^4$ V/A
Max. Conversion Gain	$1.1 \times 10^4$ V/W (@ 800 nm)	$1.9 \times 10^4$ V/W (@ 1550 nm)
NEP (@ 10 MHz)	$9.4 \text{ pW}/\sqrt{\text{Hz}}$ (@ 800 nm)	$5.2 \text{ pW}/\sqrt{\text{Hz}}$ (@ 1550 nm)
Output Noise	$3 \text{ mV}_{\text{RMS}}$	$4.5 \text{ mV}_{\text{RMS}}$
Input Options	FST, FS, FC, SMA	FST, FS, FC
Power Requirements	$\pm 15 \text{ V}$ , $\pm 50 \text{ mA}$ typ.	$\pm 15 \text{ V}$ , $\pm 60 \text{ mA}$ typ.
Dimensions	105 x 51 x 28 mm, weight 210 g (0.5 lbs)	

Output voltage  $\pm 1.2 \text{ V}$  (@ 50  $\Omega$  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  $\pm 15 \text{ V}$  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  $75 \text{ fW}/\sqrt{\text{Hz}}$

### 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 $\mu\text{s}$	1 $\mu\text{s}$
Transimpedance Gain	$1 \times 10^7$ V/A	$1 \times 10^7$ V/A
Max. Conversion Gain	$5.9 \times 10^6$ V/W (@ 920 nm)	$9.5 \times 10^6$ V/W (@ 1550 nm)
NEP (@ 10 kHz)	$120 \text{ fW}/\sqrt{\text{Hz}}$ (@ 920 nm)	$75 \text{ fW}/\sqrt{\text{Hz}}$ (@ 1550 nm)
Output Noise	$1.6 \text{ mV}_{\text{RMS}}$	$2 \text{ mV}_{\text{RMS}}$
Input Options	FST, FS	FST, FS
Power Requirements	$\pm 15 \text{ V}$ , $\pm 40 \text{ mA}$ typ.	
Dimensions	100 x 51 x 28 mm, weight 210 g (0.5 lbs)	

Output voltage  $\pm 10 \text{ V}$  max (@ 100 k $\Omega$  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  $\pm 15 \text{ V}$  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



### APPLICATIONS

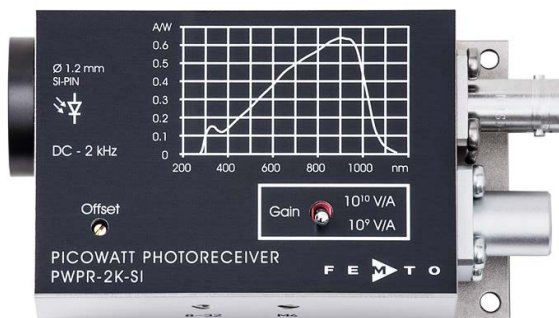
Fluorescence measurements | Spectroscopy | Electrophoresis | Chromatography | Replacement for photomultiplier tubes (PMTs), avalanche photodiodes (APDs) and liquid nitrogen cooled germanium photodiodes

- 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 mm <sup>2</sup> 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 <sub>RMS</sub>	3 mV <sub>RMS</sub>
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)	

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



### 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

- 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 <sub>RMS</sub> @ $10^9$ V/A	0.75 mV <sub>RMS</sub> @ $10^9$ 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)	

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.

# LOCK-IN AMPLIFIERS

Easy-to-Use High-Performance Lock-In Amplifiers  
For Cost-Sensitive Applications



CURRENT AMPLIFIERS

VOLTAGE AMPLIFIERS

GHZ-WIDEBAND  
AMPLIFIERS

PHOTORECEIVERS

LOCK-IN AMPLIFIERS

ACCESSORIES

## LIA-MV-150 Series Lock-In Amplifier Modules



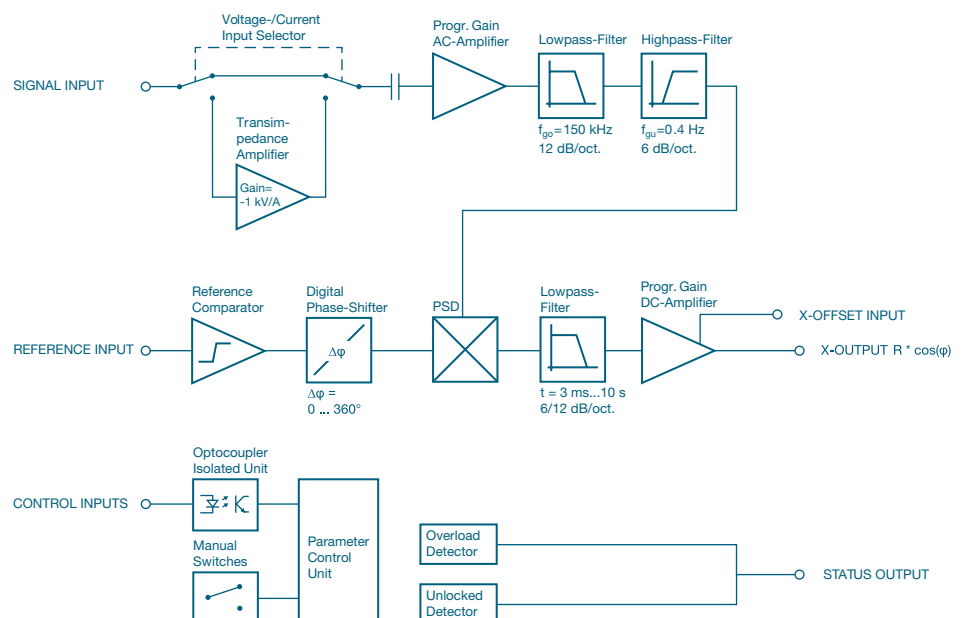
- Current and voltage input
- Working frequency up to 45 kHz
- Adjustable sensitivity, time constant and phase
- Local and remote control
- Compact and EMI-shielded case

Model	LIA-MV-150-S Standard	LIA-MV-150-D True-Differential Input
Voltage Input	BNC connector Single-ended Instrumentation amplifier Noise 12 nV/√Hz	Lemo <sup>®</sup> connector True-differential Instrumentation amplifier Noise 12 nV/√Hz
Current Input	BNC connector Transimpedance amplifier, gain 1 kV/A Noise 13 pA/√Hz	Lemo <sup>®</sup> connector Transimpedance amplifier, gain 1 kV/A Noise 13 pA/√Hz
Sensitivity (Full Scale)	Voltage: 3 μV to 100 mV, switchable in 1-3-10 steps Current: 3 nA to 100 μA, switchable in 1-3-10 steps	
Working Frequency	10 Hz - 45 kHz	
Reference Input	±100 mV to ±5 V, switchable to TTL	
Phase	Adjustable 0° - 360° (8-bit resolution), Temperature drift <0.01°/K	
Demodulator Dynamic Reserve	35 dB @ low drift setting, 55 dB @ high dynamic setting	
Time Constants	3 ms to 10 s, switchable in 1-3-10 steps, slope switchable 6 dB or 12 dB/octave	
Signal Filter	Highpass 0.4 Hz (6 dB/oct.), Lowpass 150 kHz (12 dB/oct.)	
Output	X = in phase, ±10 V full scale, short-circuit protected	
Digital Control	16 TTL, CMOS, opto-isolated 8-bit phase, 4-bit time constant, 4-bit sensitivity	
Power Supply	±15 V, 100 mA typ.	
Dimensions	170 x 60 x 30 mm (L x W x H), weight 370 g (0.82 lbs)	

Power supply via 3-pin Lemo<sup>®</sup> socket. A mating connector is provided with the device. Optional power supply PS-15 available. For further information please view the datasheet.

### APPLICATIONS

Spectroscopy | Laser stabilization |  
Luminescence, fluorescence,  
phosphorescence measurements |  
Light scattering measurements |  
Opto-electronical quality control |  
Integration in industrial and scientific measurement systems | OEM systems



Block diagram LIA-MVD-150



## LIA-MV(D)-200 Series Lock-In Amplifiers



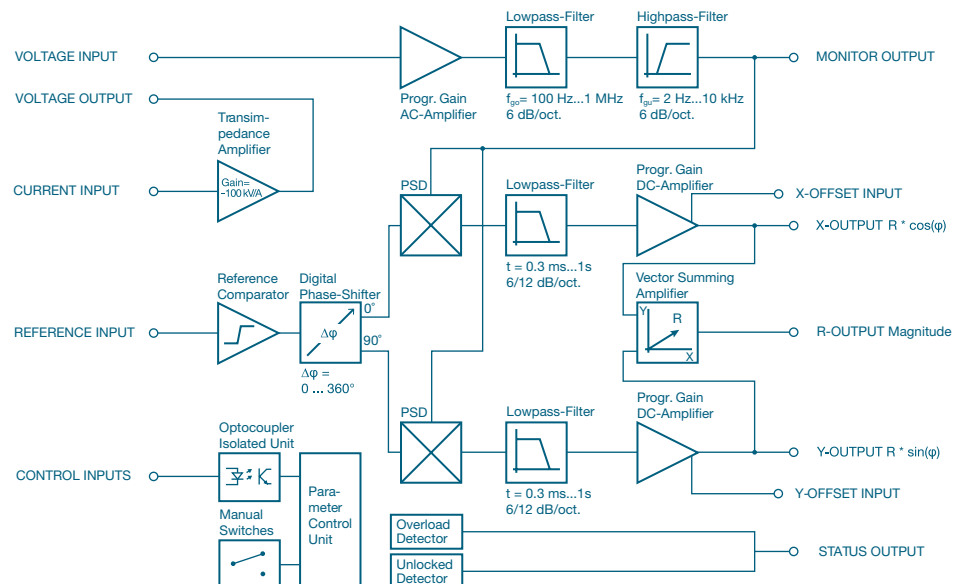
- Single and dual phase
- Rugged aluminum housing
- BNC connectors for input and output signals
- Working frequency 5 Hz up to 120 kHz
- Phase shifter 0° - 360°
- Current and voltage input
- Optional reference oscillator module SOM-1 available

Model	LIA-MV-200-L Single Phase	LIA-MV-200-H Single Phase	LIA-MVD-200-L Dual Phase	LIA-MVD-200-H Dual Phase
Working Frequency	5 Hz - 10 kHz	50 Hz - 120 kHz	5 Hz - 10 kHz	50 Hz - 120 kHz
Time Constants	3 ms - 10 s 6 or 12 dB/oct.	300 μs - 1 s 6 or 12 dB/oct.	3 ms - 10 s 6 or 12 dB/oct.	300 μs - 1 s 6 or 12 dB/oct.
Adjustable Signal Filter (6 dB/oct.)	Highpass 0.2 Hz - 1 kHz Lowpass 100 Hz - 1 MHz	Highpass 2 Hz - 10 kHz Lowpass 100 Hz - 1 MHz	Highpass 0.2 Hz - 1 kHz Lowpass 100 Hz - 1 MHz	Highpass 2 Hz - 10 kHz Lowpass 100 Hz - 1 MHz
Outputs (BNC)	X = in phase, ±10 V full scale, short-circuit protected, Signal monitor output		X = in phase, Y = quadrature, R = magnitude, ±10 V full scale, short-circuit protected, Signal monitor output	
Sensitivity (Full Scale)	Voltage: 3 μV - 1 V in 1-3-10 steps Current: 30 pA - 10 μA in 1-3-10 steps			
Voltage Input (BNC)	Instrumentation amplifier, noise 12 nV/√Hz			
Current Input (BNC)	Transimpedance amplifier, gain 100 kV/A, noise 0.4 pA/√Hz			
Reference Input (BNC)	±100 mV to ±5 V, switchable to TTL			
Phase	Adjustable 0° - 360°; resolution: 8-bit @ f ≤ 60 kHz, 7-bit @ f > 60 kHz Temperature drift <0.01°/K			
Max. Dyn. Reserve	80 dB			
Digital Control	16 TTL/CMOS inputs: 8-bit phase, 4-bit time constant, 4-bit sensitivity			
Power Supply	±15 V, +120 mA / -60 mA			
Dimensions	223 x 105 x 65 mm (L x W x H), weight 1,000 g (2.2 lbs)			

The optional Reference Oscillator SOM-1 can be connected by an extension connector inside the module. 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.

### APPLICATIONS

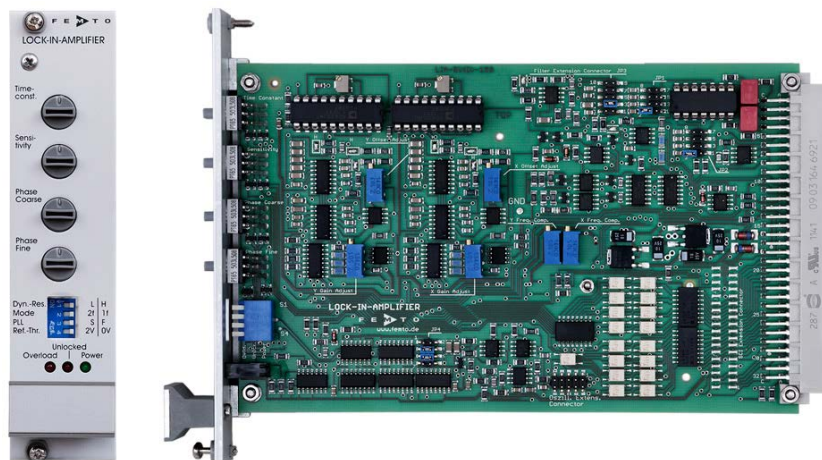
Spectroscopy | Luminescence, fluorescence, phosphorescence measurements | Light scattering measurements | Laser stabilization | Opto-electronical quality control | Integration into industrial and scientific measurement-systems | Alternative to expensive desktop lock-in amplifiers for general lab use



Block diagram LIA-MVD-200-H



## LIA-BV(D)-150 Series Single-Board Lock-In Amplifiers



- Single and dual phase 19" boards
- Working frequency 5 Hz up to 120 kHz
- Phase shifter 0° - 360°
- Current and voltage input
- Parameter control by local switches and opto-isolated digital inputs
- Mounting kit MK-LIA-2 and reference oscillator module SOM-1 available

Model	LIA-BV-150-L	LIA-BV-150-H	LIA-BVD-150-L	LIA-BVD-150-H
	Single Phase	Single Phase	Dual Phase	Dual Phase
Working Frequency	5 Hz - 10 kHz	50 Hz - 120 kHz	5 Hz - 10 kHz	50 Hz - 120 kHz
Time Constants	3 ms - 10 s 6 or 12 dB/oct.	300 μs - 1 s 6 or 12 dB/oct.	3 ms - 10 s 6 or 12 dB/oct.	300 μs - 1 s 6 or 12 dB/oct.
Signal Filter	Highpass 0.2 Hz - 1 kHz Lowpass 100 Hz - 1 MHz	Highpass 2 Hz - 10 kHz lowpass 100 Hz - 1 MHz	Highpass 0.2 Hz - 1 kHz Lowpass 100 Hz - 1 MHz	Highpass 2 Hz - 10 kHz lowpass 100 Hz - 1 MHz
Outputs	X = in phase, ±10 V full scale, short-circuit protected, Signal monitor output		X = in phase, Y = quadrature, R = magnitude ±10 V full scale, short-circuit protected, Signal monitor output	
Sensitivity (Full Scale)	Voltage: 3 μV - 1 V in 1-3-10 steps Current: 30 pA - 10 μA in 1-3-10 steps			
Voltage Input	True-differential instrumentation amplifier, noise 12 nV/√Hz			
Current Input	Transimpedance amplifier, gain 100 kV/A, noise 0.4 pA√/Hz			
Reference Input	±100 mV to ±5 V, switchable to TTL			
Phase	Adjustable 0° - 360°; resolution: 8-bit @ f ≤ 60 kHz, 7-bit @ f > 60 kHz Temperature drift <0.01°/K			
Max. Dyn. Reserve	80 dB			
Digital Control	16 TTL/CMOS inputs: 8-bit phase, 4-bit time constant, 4-bit sensitivity			
Power Supply	±15 V, +120 mA / -60 mA			
Dimensions	160 x 100 x 20 mm (L x W x H), weight 100 g (0.22 lbs)			

### APPLICATIONS

Spectroscopy | Luminescence, fluorescence, phosphorescence measurements | Light scattering measurements | Opto-electronical quality control | Integration in industrial and scientific measurement-systems | Multichannel systems at an attractive price

## ACCESSORIES




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CURRENT AMPLIFIERS

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VOLTAGE AMPLIFIERS

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GHZ-WIDEBAND  
AMPLIFIERS

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PHOTORECEIVERS

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LOCK-IN AMPLIFIERS

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ACCESSORIES

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## LUCI-10 USB Control Interface



- Compact digital I/O interface for USB remote control of FEMTO amplifiers and photoreceivers
- Supports opto-isolation of amplifier signal path from PC USB port
- Bus-powered operation
- System driver, application software and VI's for use with LabVIEW™ included

<b>Model</b>	<b>LUCI-10</b>
<b>Bus Interface</b>	USB 2.0 (full-speed)
<b>Digital I/O Interface</b>	16 output lines, 3 opto-isolated input lines
<b>Supply</b>	PC USB bus powered
<b>Connectors</b>	USB type A and D-Sub, 25 pin, male
<b>Case</b>	Zinc die-cast hood, nickel plated, with jack screws, weight 130 g (0.3 lbs)
<b>Software, Included on CD</b>	Device driver for Microsoft® Windows 32 bit & 64 bit operating system, Dynamic link library (DLL), Graphical user interface (GUI) programs, Sample VI's and FEMTO Library for use in LabVIEW™
<b>System Requirements</b>	Microsoft® Windows XP SP 3 or higher, compatible with Windows 10, Intel Pentium III or AMD Athlon or better, 1 GB RAM or more, 5 GB of hard disk space, USB 1.1 or 2.0 port
<b>Optional Requirements</b>	For development of own application programs a development environment like LabVIEW™ Version 2012 (or higher) or C/C++ is required.

## PS-15-25-L Remote Power Supply

- Input voltage 100 - 240 VAC
- Output  $\pm 15$  V, +500/-400 mA
- Shielded output cord with Lemo® plug
- Floating design to avoid ground loops
- Short-circuit protected
- Ripple typ. 15 mV<sub>RMS</sub>
- Suitable for all FEMTO modules
- Available as European, Australian and US version



## Accessories For Photoreceivers

All FEMTO photoreceivers offered with FS input (round flange with 25 mm diameter) are now also available with 1.035"-40 threaded flange (FST) input – for even more flexibility on the optical bench! For example converting the free-space FST input to an optical fiber input is easily done by screwing on one of the optionally available FEMTO fiber-adapters PRA-FC and PRA-FSMA.

The post adapter plate PRA-PAP expands the optical bread-board mounting options for FEMTO photoreceivers. Even for photoreceivers that are already equipped with post mounting threads the post adapter plate enlarges the mounting position options. Due to the integrated M4 and 8-32 UNC tapped holes, standard posts for breadboard systems can be easily mounted to the photoreceiver via the adapter plate.

The picture shows the PWPR-2K-SI-FST being easily turned into a fiber coupled model.



## PRA-FC / PRA-FSMA Fiber-Adapters And Mounting Tool



- Compatible with all FEMTO photoreceivers with threaded 1.035"-40 free space input (FST)
- Easy mounting option for standard optical fibers
- Recommended for photosensitive areas of 0.4 mm diameter or more (coupling efficiency may be compromised for photodiodes with smaller diameter)
- Machined from solid stainless steel
- Available adapter types: PRA-FC (FC/PC, FC/APC, FC/UPC) and PRA-FSMA
- Additionally available: spanner wrench AT-W1 for convenient mounting of the adapters

## PRA-PAP Post Adapter Plate



- Compatible with FEMTO photoreceiver series FWPR, PWPR, OE, LCA-S and HCA-S
- M4 and 8-32 UNC threads suitable for standard optical mounting posts
- High-tensile material
- Mounting screws included

## CAB-LN1 Series Low Noise Cables



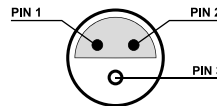
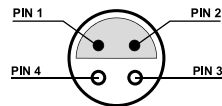
- Minimizes triboelectric and microphonic noise
- Designed for ultra sensitive current and charge measurements
- Noise level reduction by a factor of 1,000
- Highly shielding coaxial design
- Fully assembled with premium quality connectors
- Ultra high insulation resistance  $> 10^{14} \Omega$  – guaranteed
- Variety of lengths available: from 10 cm to 5 m

### APPLICATIONS

Measurements of low currents down to femtoamperes | Photodetectors and ionization detectors | High resistance measurements | Scanning probe microscopy (STM, SPM, STS) | Spectroscopy | Piezo- and pyroelectric transducers

Length	Plug BNC – BNC
0.1 m	CAB-LN1-BB-010
0.2 m	CAB-LN1-BB-020
0.5 m	CAB-LN1-BB-050
1.0 m	CAB-LN1-BB-100
1.5 m	CAB-LN1-BB-150
2.0 m	CAB-LN1-BB-200
3.0 m	CAB-LN1-BB-300
5.0 m	CAB-LN1-BB-500

## Lemo® Connectors



- High quality connector
- 3-pin and 4-pin versions available
- For use with shielded cables
- Suitable for all FEMTO modules