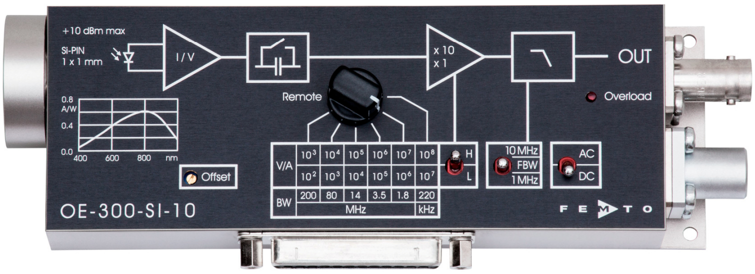
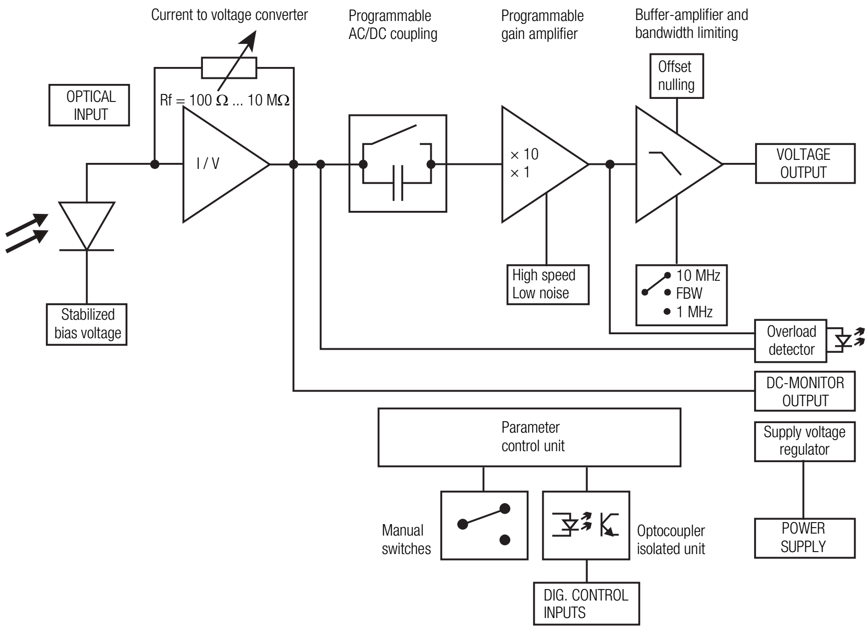
200 MHz Variable Gain Photoreceiver



Features	• **Adjustable transimpedance gain from 10^2 to 10^8 V/A** • **Wide bandwidth up to 200 MHz** • **Si-PIN photodiode covering the 400 to 1000 nm wavelength range** • **Large optical detector size 1 × 1 mm** • **High dynamic input range up to 10 mW optical power** • **Very low noise, NEP down to 76 fW/√Hz** • **Switchable low pass filters for minimizing wideband noise** • **Free-space input 1.035"-40 threaded, easily convertible to fiber optic input (FC and FSMA) with optionally available screw-on adapters** • **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**

Block Diagram



200 MHz Variable Gain Photoreceiver

Intended Use

The OE-300-SI-10 is a high speed 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 Version

OE-300-SI-10-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 × 1 mm photodiode installed in the OE-300-SI-10 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.

Related OE-300 Models

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

OE-300-SI-30-FST	Si-PIN, ∅ 3 mm, 320 - 1000 nm 1.035"-40 threaded flange
OE-300-IN-01-FC	InGaAs-PIN, ∅ 80 µm, 900 - 1700 nm FC fiber receptacle only
OE-300-IN-03-FST	InGaAs-PIN, ∅ 300 µm, 800 - 1700 nm 1.035"-40 threaded flange

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

200 MHz Variable Gain Photoreceiver

Available Accessories (continued)

LUCI-10

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

Specifications

	Test conditions	V_S = ±15 V, T_A = 25 °C, output load impedance 50 Ω, warm-up 20 minutes (min. 10 minutes recommended)
Gain	Transimpedance gain	1×10^2 ... 1×10^8 V/A (output load 50 Ω)
	Gain accuracy	±1 % electrical, between settings
Frequency Response	Lower cut-off frequency	DC / 100 Hz, switchable
	Upper cut-off frequency (–3 dB)	up to 200 MHz (see table below), switchable to 1 MHz or 10 MHz
Input	Optical CW saturation power	see table below
	Noise equivalent power (NEP)	see table below

Performance depending on Gain Setting

Gain setting (low noise) (V/A)	10^2	10^3	10^4	10^5	10^6	10^7
Upper cut-off frequency (–3 dB)	200 MHz	80 MHz	14 MHz	3.5 MHz	1.8 MHz	220 kHz
Rise/fall time (10 % - 90 %)	1.9 ns	3.25 ns	26 ns	92 ns	235 ns	1.6 µs
NEP (/√Hz, @850 nm)	322 pW	25 pW	2.9 pW	740 fW	260 fW	78 fW
Measured at	20 MHz	8 MHz	1.4 MHz	350 kHz	180 kHz	22 kHz
Integr. input noise (RMS)*	7.5 µW	580 nW	35 nW	4.9 nW	1.3 nW	100 pW
CW saturation power (@ 850 nm)	10 mW	1.7 mW	170 µW	17 µW	1.7 µW	170 nW

Gain setting (high speed) (V/A)	10^3	10^4	10^5	10^6	10^7	10^8
Upper cut-off frequency (–3 dB)	175 MHz	80 MHz	14 MHz	3.5 MHz	1.8 MHz	220 kHz
Rise/fall time (10 % - 90 %)	2.3 ns	3.45 ns	26 ns	94 ns	233 ns	1.6 µs
NEP (/√Hz, @ 850 nm)	231 pW	10 pW	2.2 pW	670 fW	228 fW	76 fW
Measured at	18 MHz	8 MHz	1.4 MHz	350 kHz	180 kHz	22 kHz
Integr. input noise (RMS)*	4.5 µW	440 nW	31 nW	4.8 nW	1.3 nW	100 pW
CW saturation power (@ 850 nm)	1.7 mW	170 µW	17 µW	1.7 µW	170 nW	17 nW

* The integrated input noise is measured with a shaded input in the full bandwidth (“FBW”) setting (referred to 850 nm). The measurement bandwidth is 3 × the upper cut-off frequency at the specific gain setting; filter slope is a 1st order roll-off.

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 “1 MHz” or “10 MHz” instead of “FBW”. This is especially useful for continuous wave (CW) measurements.

Detector	Detector type	Si-PIN photodiode
	Active area	1 mm × 1 mm
	Spectral range	400 - 1000 nm
	Sensitivity	0.58 A/W typ. (@ 850 nm)
	Dark current	0.12 nA typ.
Output	Output voltage rang	±1 V (@ 50 Ω output load), for linear amplification
	Output impedance	50 Ω (designed for 50 Ω load)
	Max. output current	±40 mA (short-circuit proof)
	Slew rate	1000 V/µs
	Output offset compensation	adjustable by offset potentiometer and external control voltage, output offset compensation range min. ±100 mV

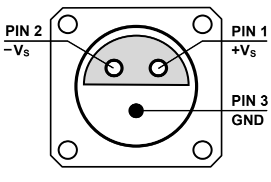
200 MHz Variable Gain Photoreceiver

Specifications (continued)

DC Monitor Output	Monitor output gain	Mode / Monitor gain Low noise: Gain setting divided by –1 High speed: Gain setting divided by –10
	Monitor output polarity	inverting
	Monitor output voltage range	±1 V (@ ≥1 MΩ load)
	Monitor output bandwidth	DC ... 1 kHz
	Monitor output impedance	1 kΩ (designed for ≥1 MΩ load)
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	15 kΩ
Optical Input Connector	Material FST flange	1.4305 stainless steel, nickel-plated
	Material FST coupler ring	1.4305 stainless steel, glass bead blasted
Power Supply	Supply voltage	±15 V (±14.75 V ... ±16.5 V)
	Supply current	±110 / –90 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)	12 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	1.035"-40 threaded flange for free space applications
	Output	BNC jack (female)
	Power supply	LEMO® series 1S, 3-pin fixed socket (mating plug type: FFA.1S.303.CLAC52)



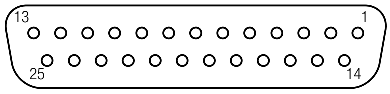
Pin 1: +15 V
Pin 2: −15 V
Pin 3: GND

200 MHz Variable Gain Photoreceiver

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 for pins 1 - 8)
Pin 4:	+5 V (stabilized power supply output*)
Pin 5:	digital output: overload (referred to pin 3)
Pin 6:	DC Monitor output
Pin 7:	NC
Pin 8:	offset control voltage input
Pin 9:	DGND (ground for digital control pins 10 - 16)
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:	upper cut-off frequency limit 10 MHz
Pin 16:	upper cut-off frequency limit 1 MHz
Pin 17 - 25:	NC

*stabilized power supply output current
±12 V: max. ±20 mA, +5V: max. 30 mA

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", "DC", "L" (low noise mode) and "FBW", 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.

Gain setting

Low noise Gain (V/A) Pin 14=LOW	High speed Gain (V/A) Pin 14=HIGH	Pin 12 MSB	Pin 11	Pin 10 LSB
10^2	10^3	LOW	LOW	LOW
10^3	10^4	LOW	LOW	HIGH
10^4	10^5	LOW	HIGH	LOW
10^5	10^6	LOW	HIGH	HIGH
10^6	10^7	HIGH	LOW	LOW
10^7	10^8	HIGH	LOW	HIGH

AC/DC setting

Coupling	Pin 13
DC	LOW
AC	HIGH

Low pass filter setting

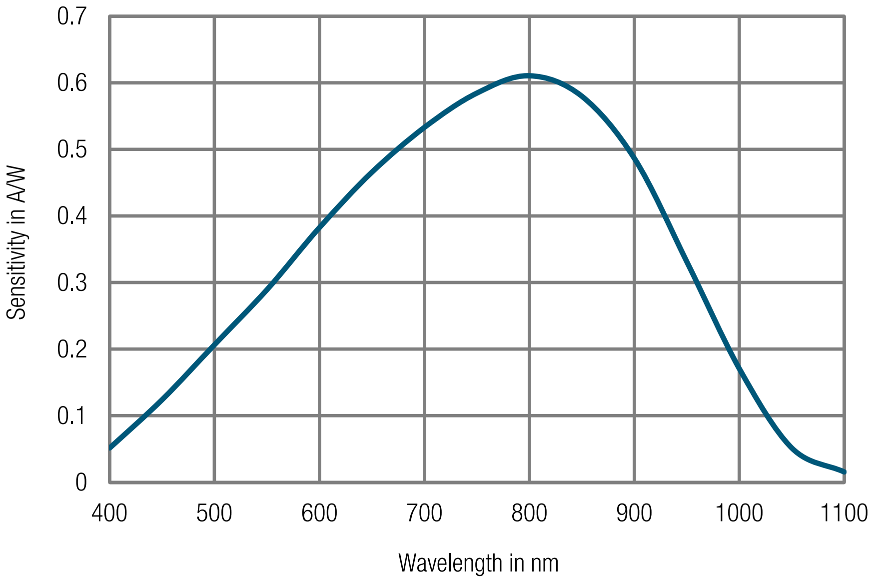
Upper cut-off freq. limit	Pin 15	Pin 16
full bandwidth	LOW	LOW
10 MHz	HIGH	LOW
1 MHz	LOW	HIGH

High speed / low noise setting

Mode	Pin 14
low noise mode	LOW
high speed mode	HIGH

200 MHz Variable Gain Photoreceiver

Scope of Delivery	OE-300-SI-10, internally threaded coupler ring, LEMO® 3-pin connector, datasheet, transport package
Ordering Information	OE-300-SI-10-FST — 1.035"-40 threaded flange for free space applications and for use with various types of optical standard accessories
Spectral Responsivity	



DB-Sens-OE-300-SI-10_R02

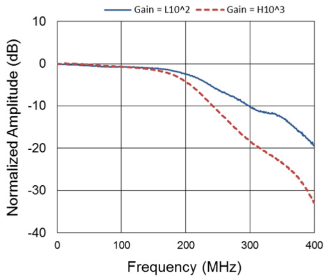
200 MHz Variable Gain Photoreceiver

Typical Performance Characteristic

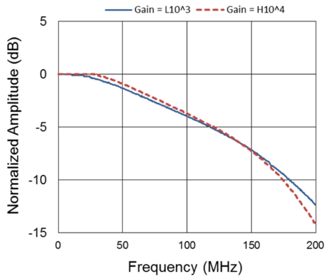
Frequency response

$V_{Supply} = \pm 15\ V_{DC}$; $R_{Load} = 50\ \Omega$

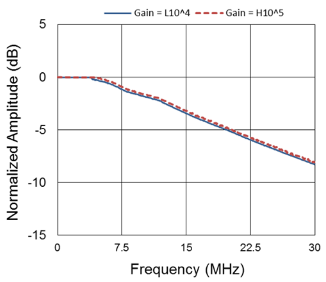
Gain setting: L10^2, H10^3



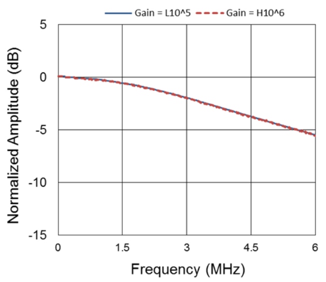
Gain setting: L10^3, H10^4



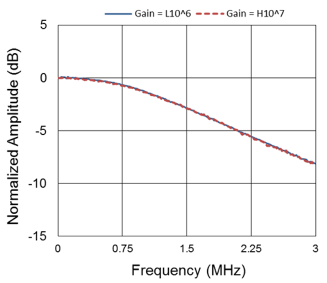
Gain setting: L10^4, H10^5



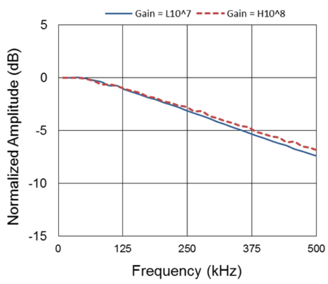
Gain setting: L10^5, H10^6



Gain setting: L10^6, H10^7



Gain setting: L10^7, H10^8

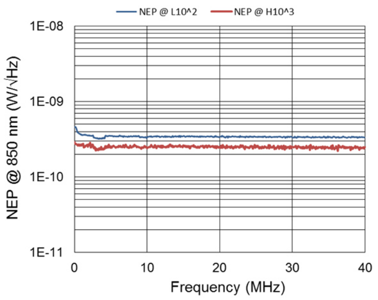


200 MHz Variable Gain Photoreceiver

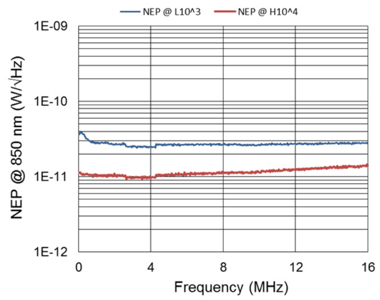
Typical Performance Characteristic (continued)

Input noise equivalent power (NEP)

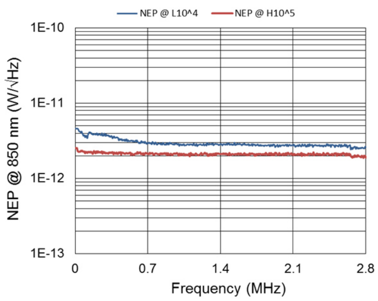
Gain setting L10^2, H10^3



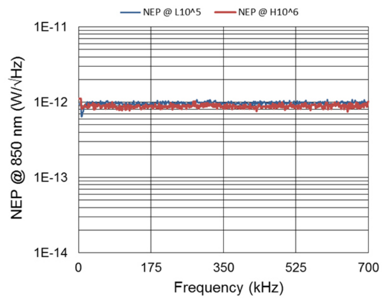
Gain setting L10^3, H10^4



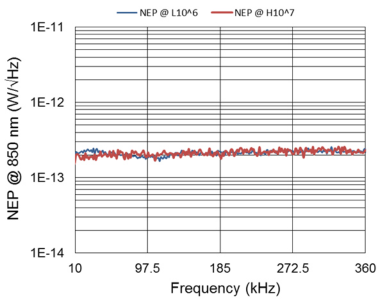
Gain setting: L10^4, H10^5



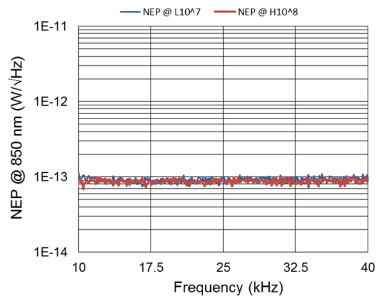
Gain setting: L10^5, H10^6



Gain setting: L10^6, H10^7



Gain setting: L10^7, H10^8

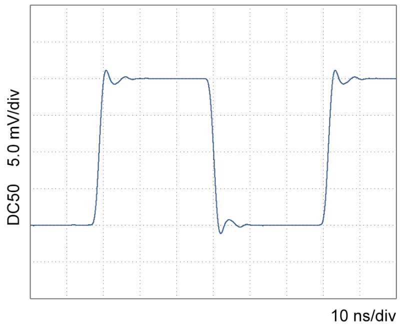


200 MHz Variable Gain Photoreceiver

Typical Performance Characteristic (continued)

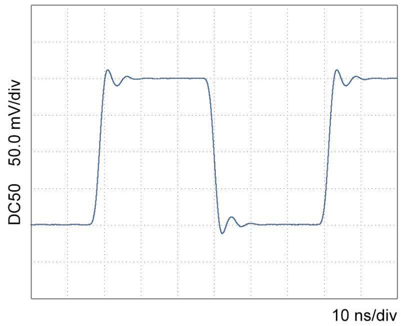
Signal pulse response

Gain setting L10^2



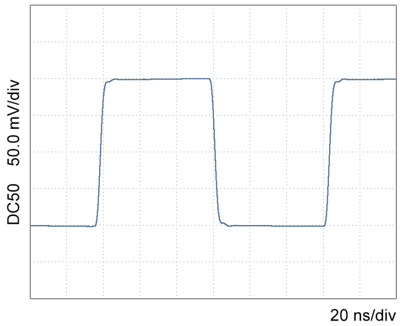
Rise: 1.85 ns Fall: 1.89 ns

Gain setting H10^3



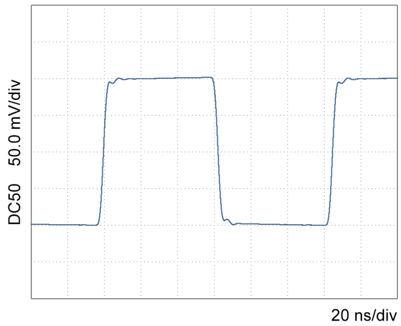
Rise: 2.23 ns Fall: 2.27 ns

Gain setting L10^3



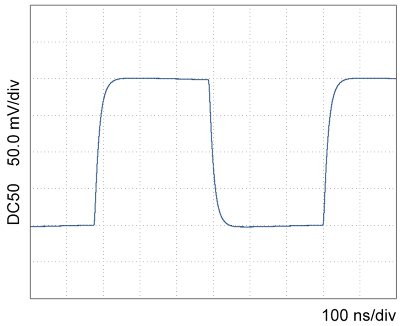
Rise: 3.20 ns Fall: 3.23 ns

Gain setting H10^4



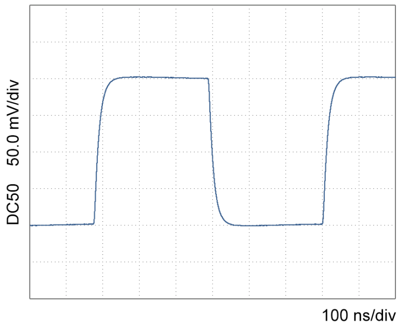
Rise: 3.44 ns Fall: 3.47 ns

Gain setting L10^4



Rise: 26.87 ns Fall: 25.66 ns

Gain setting H10^5

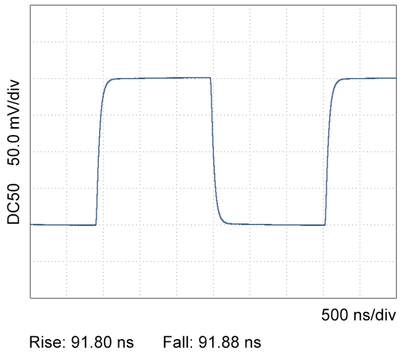


Rise: 27.02 ns Fall: 26.10 ns

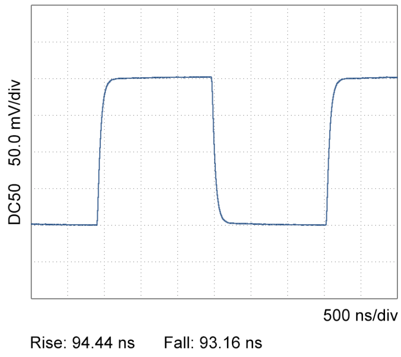
200 MHz Variable Gain Photoreceiver

Typical Performance Characteristic (continued)

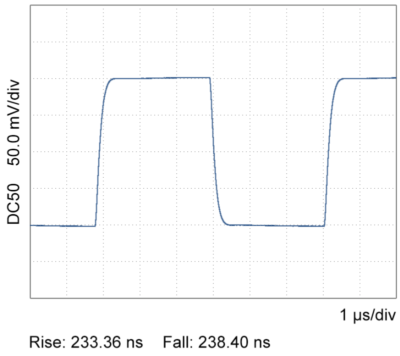
Gain setting L10^{5}



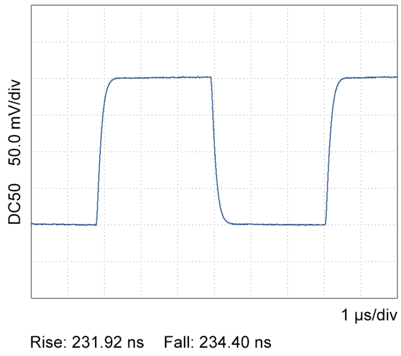
Gain setting H10^{6}



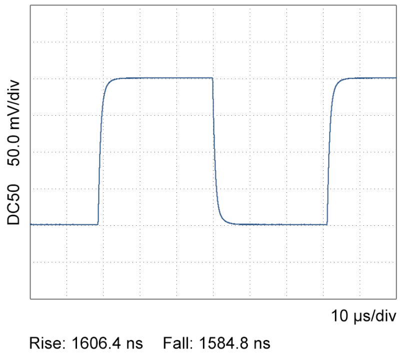
Gain setting L10^{6}



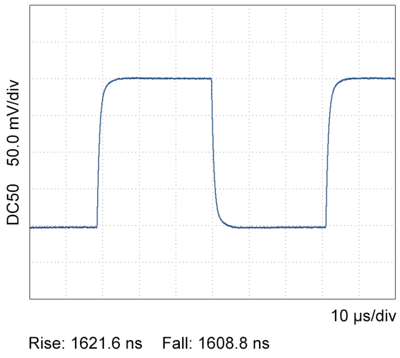
Gain setting H10^{7}



Gain setting L10^{7}



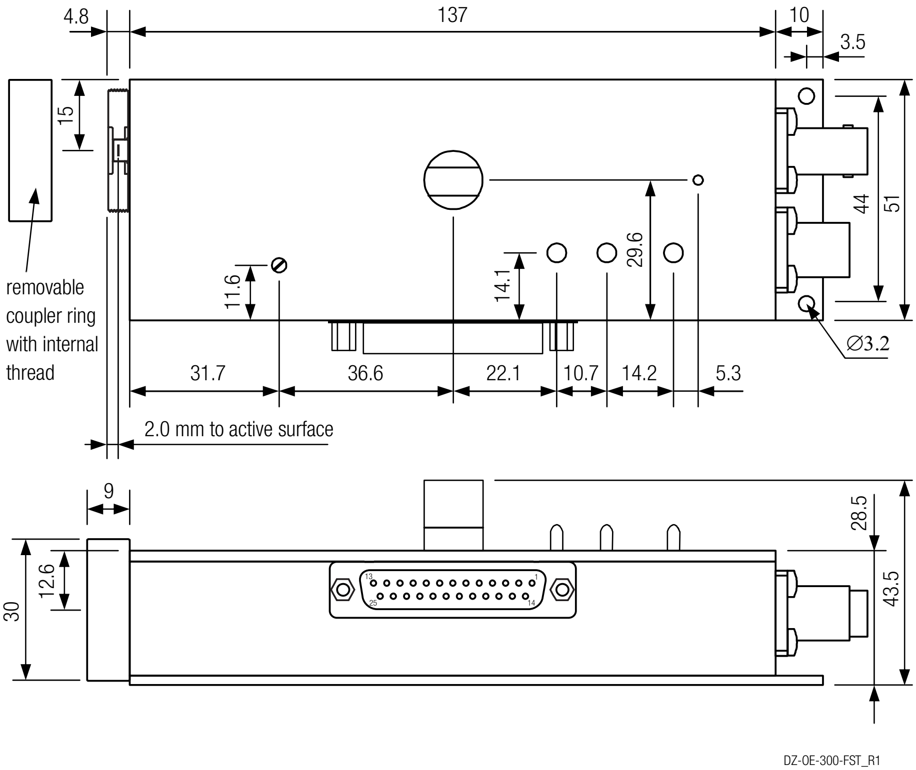
Gain setting H10^{8}



200 MHz Variable Gain Photoreceiver

Dimensions

OE-300-SI-10-FST



all dimensions in mm unless otherwise noted

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