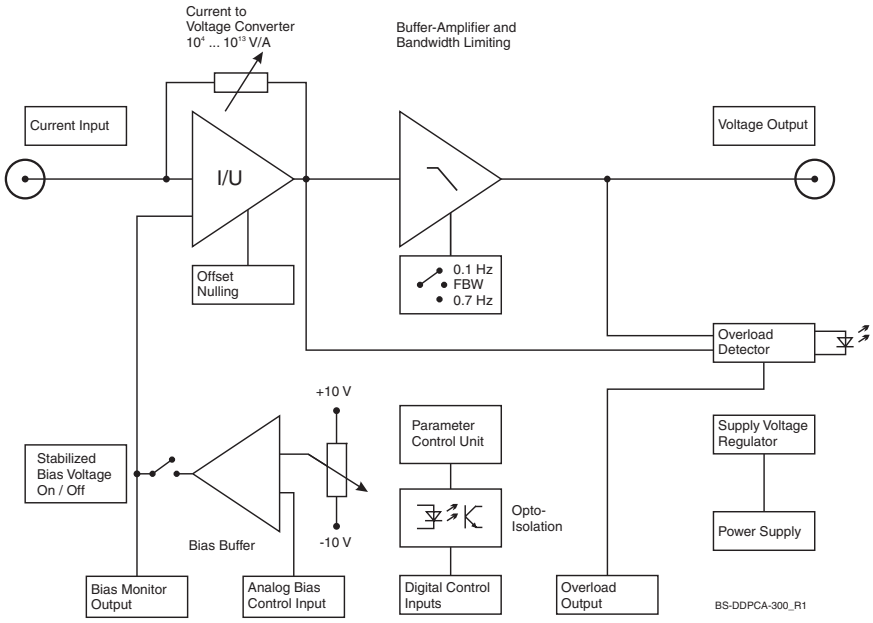
Variable Gain
Ultra Low Noise Current Amplifier

Features	• **0.4 fA Peak-Peak Noise** • **Very High Dynamic Range: Sub-fA to 1 mA (> 240 dB)** • **Transimpedance (Gain) Switchable from 1 x 10^4 to 1 x 10^{13} V/A** • **Bandwidth up to 450 Hz, Rise Time Down to 0.8 ms - Independent of Source Capacitance (up to 10 nF)** • **Adjustable Bias Voltage on Input Relative to Ground** • **Compact Housing for Use Close to the Signal Source** • **Protection against ± 2 kV Transients** • **Local and Remote Control** • **Easy to Use:** **Convert Your Standard Digital Voltmeter or DAQ Board to a High-End Digital Sub-Femtoamperemeter**
Applications	• **Photodetector Amplifier** • **I/V Characterization of Small MOS Structures** • **DC Measurements of Ultra Low Currents** • **Ionization Detectors, Mass Spectrometry, Quantum and Biotech Experiments** • **Spectroscopy** • **High Resistance Measurements**
Block Diagram	

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Specifications	*Test Conditions*	*Vs = ± 15 V, Ta = 25°C*
Gain	Transimpedance	1 x 10^4 ... 1 x 10^{13} V/A
	Gain Accuracy	± 1 %
	Gain Drift	see table below
Frequency Response	Lower Cut-Off Frequency	DC
	Upper Cut-Off Frequency	up to 450 Hz (see table below)
	Low Pass Filter	switchable to 3 settings (full bandwidth, 0.7 Hz and 0.1 Hz)

Upper Cut-Off	Rise Time
Full BW (see table below)	High Speed HS (see table below)
0.7 Hz	0.5 s
0.1 Hz	5 s

Setting the lowpass filter to full bandwidth is recommended for high measurement speed. By setting the low pass filter to 0.7 Hz or 0.1 Hz the noise performance can be improved.

Input	Equ. Input Noise Current	gain setting dependent, min. 0.4 fA peak-peak (gain 10^{12}/10^{13} V/A, low pass filter switched to 0.1 Hz) see table below for noise at full bandwidth and for different gain settings
	Input Bias Current	< 10 fA typ. (max. 25 fA)
	Max. Input Current (Full Scale)	see table below (value for linear amplification)
	Input Offset Compensation	adjustable by offset trimpot, ± 100 fA

Performance Depending on Gain Setting

Gain Setting (V/A)	10^4	10^5	10^6	10^7	10^8
Upper Cut-Off Frequency (- 3 dB)	450 Hz	450 Hz	450 Hz	450 Hz	150 Hz
Rise / Fall Time (10 % - 90 %)	0.8 ms	0.8 ms	0.8 ms	0.8 ms	2.3 ms
Equ. Input Noise Current (Peak-Peak)	10 nA	5 nA	0.1 nA	50 pA	2 pA
Gain Drift (/°C)	0.01 %	0.01 %	0.01 %	0.01 %	0.01 %
Max. Input Current (± Full Scale)	1 mA	0.1 mA	10 µA	1 µA	0.1 µA
DC Input Impedance (// 5 pF)	< 1 Ω	< 1 Ω	< 1 Ω	< 1 Ω	< 100 Ω

Gain Setting (continued) (V/A)	10^9	10^{10}	10^{11}	10^{12}	10^{13}
Upper Cut-Off Frequency (- 3 dB)	150 Hz	20 Hz	20 Hz	1.5 Hz	1.5 Hz
Rise / Fall Time (10 % - 90 %)	2.3 ms	20 ms	20 ms	200 ms	200 ms
Equ. Input Noise Current (Peak-Peak)	1 pA	50 fA	50 fA	1.5 fA	1.5 fA
Gain Drift (/°C)	0.01 %	0.03 %	0.03 %	0.03 %	0.03 %
Max. Input Current (± Full Scale)	10 nA	1 nA	0.1 nA	10 pA	1 pA
DC Input Impedance (// 5 pF)	< 100 Ω	< 10 kΩ	< 10 kΩ	< 1 MΩ	< 1 MΩ

Output	Output Voltage	± 10 V (@ ≥ 1 MΩ load)
	Output Impedance	50 Ω (terminate with ≥ 1 MΩ load for best performance)
	Max. Output Current	± 30 mA

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Specifications (continued)

Adjustable Bias Voltage	Bias Voltage Range	± 10 V at BNC input (at inner conductor, BNC-shield is always connected to analog ground AGND), On/Off switchable
	Bias Current	max. ± 10 mA
	Bias Adjustment (Local)	bias trimpot
	Bias Adjustment (Remote)	by analog control voltage fed to pin 8 of Sub-D connector (200 kΩ impedance, inverting, referred to AGND, max. ± 10 V) Example: feeding + 2 V to pin 8 of Sub-D connector leads to - 2 V bias voltage at inner conductor of BNC input socket referred to BNC shield (analog ground AGND)
Bias Monitor Output	Range	± 10 V, mirrors the adjusted bias voltage at the BNC input (inner conductor referred to AGND)
	Connector	pin 7 of Sub-D connector (referred to AGND pin 3)
	Output Impedance	50 Ω (terminate with ≥ 1 MΩ load for best performance)
Overload Indication	LED	lights when overload is detected
	Digital Output	active when overload is detected (non active: 0 V, max. -1 mA, active: 5.1 V, max. 7 mA; refers to AGND)
Digital Control	Control Input Voltage Range	Low: - 0.8 ...+ 1.2 V, High: 2.3 ... + 12 V (refers to DGND)
	Control Input Current	0 mA @ 0 V, 1.5 mA @ + 5 V, 4.5 mA @ + 12 V
Auxiliary Power Output	Voltage	± 12 VDC, stabilized, max. ± 50 mA (at Sub-D, may be used for supplying external devices up to 50 mA)
Power Supply	Supply Voltage	± 15 V
	Supply Current	+ 70 mA / -15 mA typ. (depends on operating conditions, recommended power supply capability minimum ± 150 mA)
Case	Weight	320 g (0.74 lbs)
	Material	AlMg4.5Mn, nickel-plated
Temperature Range	Storage Temperature	-40 ... +100 °C
	Operating Temperature	0 ... +60 °C

Absolute Maximum Ratings	Signal Input Voltage	± 15 V relative to bias
	Transient Input Voltage	± 2 kV (discharge from 1 nF source)
	Digital Control Input Voltage	- 5 V / + 16 V
	Bias Control Input Voltage	± 12 V
	Power Supply Voltage	± 20 V

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Connectors

Input

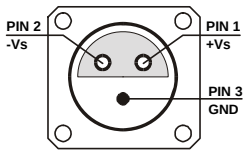
BNC (adjustable/switchable bias on center pin)

Output

BNC

Power Supply

LEMO series 1S, 3-pin fixed socket
Pin 1: + 15V
Pin 2: - 15V
Pin 3: GND



Control Port

Sub-D 25-pin, female, qual. class 2
Pin 1: +12V (stabilized power supply output)
Pin 2: -12V (stabilized power supply output)
Pin 3: AGND (analog ground)
Pin 4: NC
Pin 5: overload output (refers to AGND)
Pin 6: signal output (connected to BNC output connector)
Pin 7: bias voltage monitor output
Pin 8: bias control voltage input
Pin 9: DGND (ground for digital control pins 10 - 13)
Pin 10: digital control input: gain, LSB
Pin 11: digital control input: gain
Pin 12: digital control input: gain
Pin 13: digital control input: gain, MSB
Pin 14 - 25: NC

Remote Control Operation

General

Remote control input bits are opto-isolated. For remote control operation set the rotary gain switch to the "Remote" position and select the wanted gain setting via a bit code at the digital inputs.

Switch settings "Full BW / 0.7 Hz / 0.1 Hz" and "Bias On/Off" are not remote controllable.

Gain Setting

Gain (V/A)	Pin 13 MSB	Pin 12	Pin 11	Pin 10 LSB
10^4	Low	Low	Low	Low
10^5	Low	Low	Low	High
10^6	Low	Low	High	Low
10^7	Low	Low	High	High
10^8	Low	High	Low	Low
10^9	Low	High	Low	High
10^{10}	Low	High	High	Low
10^{11}	Low	High	High	High
10^{12}	High	Low	Low	Low
10^{13}	High	Low	Low	High

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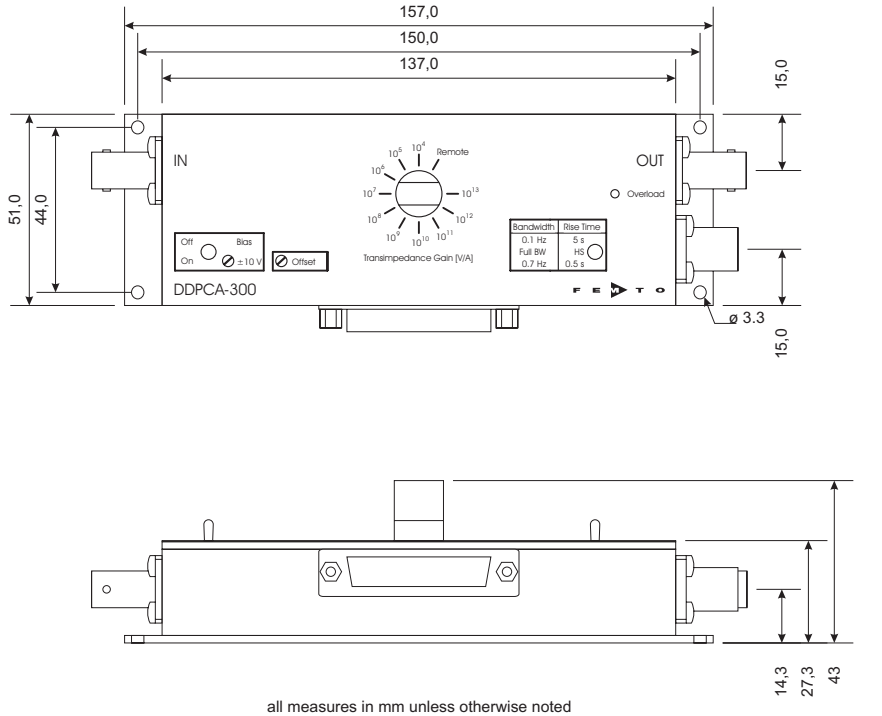
Dimensions



all measures in mm unless otherwise noted

DZ-DDPCA-300_R1

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