**Variable Gain High-Speed Current Amplifier**

**Features**
- Transimpedance (gain) switchable from $1 \times 10^2$ to $1 \times 10^8$ V/A
- Bandwidth from DC up to 200 MHz
- Upper cut-off frequency switchable to 1 MHz, 10 MHz or full bandwidth
- Switchable AC/DC coupling
- Adjustable bias voltage for use with external photo detectors
- Input protection against ±1.5 kV transients
- Local and remote control of all main functions

**Applications**
- Photodiode and photomultiplier amplifier
- Spectroscopy
- Beam monitoring for particle accelerators/synchrotrons
- Ionisation detectors
- Preamplifier for A/D converters, HF lock-ins, etc.

**Block Diagram**

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SOPHISTICATED TOOLS FOR SIGNAL RECOVERY
### Variable Gain
### High-Speed Current Amplifier

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Test conditions</th>
<th>V_s = ±15 V, T_a = 25 °C, load impedance = 50 Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td>Transimpedance</td>
<td>1 x 10^2 ... 1 x 10^8 V/A @ 50 Ω load</td>
</tr>
<tr>
<td></td>
<td>Gain accuracy</td>
<td>±1 %</td>
</tr>
</tbody>
</table>

#### Frequency Response
- **Lower cut-off frequency**: DC / 100 Hz, switchable
- **Upper cut-off frequency**: depending on gain setting up to 200 MHz (see table below), switchable to 10 MHz or 1 MHz

#### Input
- **Equ. input noise current**: see table below
- **Equ. input noise voltage**: typ. 2.8 nV/√Hz
- **Input bias current**: typ. 20 pA

#### Performance depending on Gain Setting

<table>
<thead>
<tr>
<th>Gain setting (low noise) (V/A)</th>
<th>10^2</th>
<th>10^3</th>
<th>10^4</th>
<th>10^5</th>
<th>10^6</th>
<th>10^7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper cut-off frequency (–3 dB)</td>
<td>200 MHz</td>
<td>80 MHz</td>
<td>14 MHz</td>
<td>3.5 MHz</td>
<td>1.8 MHz</td>
<td>220 kHz</td>
</tr>
<tr>
<td>Rise/fall time (10 % - 90 %)</td>
<td>1.8 ns</td>
<td>4.4 ns</td>
<td>25 ns</td>
<td>0.1 µs</td>
<td>0.2 µs</td>
<td>1.6 µs</td>
</tr>
<tr>
<td>Input noise current density (√Hz)</td>
<td>180 pA</td>
<td>11 pA</td>
<td>1.8 pA</td>
<td>480 fA</td>
<td>140 fA</td>
<td>45 fA</td>
</tr>
<tr>
<td>measured at</td>
<td>1 MHz</td>
<td>1 MHz</td>
<td>1 MHz</td>
<td>10 kHz</td>
<td>10 kHz</td>
<td>10 kHz</td>
</tr>
<tr>
<td>Integr. input noise current (RMS)*</td>
<td>2.5 µA</td>
<td>280 nA</td>
<td>25 nA</td>
<td>3.0 nA</td>
<td>0.8 nA</td>
<td>60 pA</td>
</tr>
<tr>
<td>Max. input current (±)</td>
<td>10 mA</td>
<td>1 mA</td>
<td>0.1 mA</td>
<td>10 µA</td>
<td>1 µA</td>
<td>0.1 µA</td>
</tr>
<tr>
<td>DC input impedance</td>
<td>50 Ω</td>
<td>50 Ω</td>
<td>60 Ω</td>
<td>100 Ω</td>
<td>1 kΩ</td>
<td>10 kΩ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gain setting (high speed) (V/A)</th>
<th>10^3</th>
<th>10^4</th>
<th>10^5</th>
<th>10^6</th>
<th>10^7</th>
<th>10^8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper cut-off frequency (–3 dB)</td>
<td>175 MHz</td>
<td>80 MHz</td>
<td>14 MHz</td>
<td>3.5 MHz</td>
<td>1.8 MHz</td>
<td>220 kHz</td>
</tr>
<tr>
<td>Rise/fall time (10 % - 90 %)</td>
<td>2.0 ns</td>
<td>4.4 ns</td>
<td>25 ns</td>
<td>0.1 µs</td>
<td>0.2 µs</td>
<td>1.6 µs</td>
</tr>
<tr>
<td>Input noise current density (√Hz)</td>
<td>155 pA</td>
<td>5.8 pA</td>
<td>1.5 pA</td>
<td>440 fA</td>
<td>140 fA</td>
<td>45 fA</td>
</tr>
<tr>
<td>measured at</td>
<td>1 MHz</td>
<td>1 MHz</td>
<td>1 MHz</td>
<td>10 kHz</td>
<td>10 kHz</td>
<td>10 kHz</td>
</tr>
<tr>
<td>Integr. input noise current (RMS)*</td>
<td>1.9 µA</td>
<td>240 nA</td>
<td>24 nA</td>
<td>3.0 nA</td>
<td>0.8 nA</td>
<td>60 pA</td>
</tr>
<tr>
<td>Max. input current (±)</td>
<td>1 mA</td>
<td>0.1 mA</td>
<td>10 µA</td>
<td>1 µA</td>
<td>0.1 µA</td>
<td>10 nA</td>
</tr>
<tr>
<td>DC input impedance</td>
<td>50 Ω</td>
<td>50 Ω</td>
<td>60 Ω</td>
<td>100 Ω</td>
<td>1 kΩ</td>
<td>10 kΩ</td>
</tr>
</tbody>
</table>

* The integrated input noise is measured with an open but shielded amplifier input in the full bandwidth ("FBW") setting. The measurement bandwidth is 3 x the upper cut-off frequency at the specific gain setting; filter slope is a 1st order roll-off.

The peak-to-peak noise can be calculated from the RMS noise as follows:

- Input referred peak-to-peak noise: \( I_{PP} = I_{RMS} \times 6 \)
- Peak-to-peak output noise: \( U_{PP} = I_{PP} \times \text{gain} \)

Upper cut-off frequencies and equivalent input noise currents given in this table are typical values only which will depend on the source capacitance. Keep the source capacitance as low as possible by using short cables at the input to achieve best possible bandwidth and noise performance. For the dependence of the upper cut-off frequencies on the source capacitance please see the diagrams on the next page.
Variable Gain
High-Speed Current Amplifier

Specifications (continued)

Frequency response plots:

- Plot 1: M2[5] and M1[3]
  - 10^4 V/A Low Noise
  - 10^4 V/A High Speed
  - 10^3 V/A Low Noise
  - 10^3 V/A High Speed

- Plot 2: M1[3] and M2[5]
  - 10^5 V/A Low Noise
  - 10^5 V/A High Speed
  - 10^4 V/A Low Noise
  - 10^4 V/A High Speed

- Plot 3: M2[5] and M1[3]
  - 10^7 V/A Low Noise
  - 10^7 V/A High Speed
  - 10^6 V/A Low Noise
  - 10^6 V/A High Speed

Start 100.0 kHz to Stop 300.0 MHz
Start 100.0 kHz to Stop 30.0 MHz
Start 100.0 kHz to Stop 3.0 MHz
Specifications (continued)

Dependence of upper cut-off frequency on source capacitance

![Graph 1](#)

- $10^2$ V/A Low Noise
- $10^3$ V/A High Speed
- $10^1$ V/A Low Noise
- $10^4$ V/A High Speed

![Graph 2](#)

- $10^4$ V/A Low Noise
- $10^5$ V/A High Speed
- $10^1$ V/A Low Noise
- $10^6$ V/A High Speed

![Graph 3](#)

- $10^6$ V/A Low Noise
- $10^7$ V/A High Speed
- $10^1$ V/A Low Noise
- $10^8$ V/A High Speed

![Graph 4](#)

- $10^7$ V/A Low Noise
- $10^8$ V/A High Speed
- $10^1$ V/A Low Noise
- $10^9$ V/A High Speed

**Variable Gain**

**High-Speed Current Amplifier**

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**SOPHISTICATED TOOLS FOR SIGNAL RECOVERY**
## Specifications (continued)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output</strong></td>
<td></td>
</tr>
<tr>
<td>Output voltage range</td>
<td>±1 V (@ 50 Ω load), for linear amplification</td>
</tr>
<tr>
<td>Output impedance</td>
<td>50 Ω (designed for 50 Ω load)</td>
</tr>
<tr>
<td>Slew rate</td>
<td>1,000 V/µs</td>
</tr>
<tr>
<td>Max. output current</td>
<td>±40 mA</td>
</tr>
<tr>
<td>Output offset</td>
<td>adjustable by offset potentiometer and external control voltage, output offset compensation range min. ±100 mV</td>
</tr>
<tr>
<td><strong>DC Monitor Output</strong></td>
<td></td>
</tr>
<tr>
<td>Monitor output gain</td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>Monitor gain</td>
</tr>
<tr>
<td>low noise</td>
<td>gain setting divided by –1</td>
</tr>
<tr>
<td>high speed</td>
<td>gain setting divided by –10</td>
</tr>
<tr>
<td>Monitor output</td>
<td></td>
</tr>
<tr>
<td>polarity</td>
<td>inverting</td>
</tr>
<tr>
<td>Monitor output voltage range</td>
<td>±1 V (@ ≥1 MΩ load)</td>
</tr>
<tr>
<td>Monitor output</td>
<td></td>
</tr>
<tr>
<td>bandwidth</td>
<td>DC ... 1 kHz</td>
</tr>
<tr>
<td>Monitor output</td>
<td></td>
</tr>
<tr>
<td>impedance</td>
<td>1 kΩ (designed for ≥1 MΩ load)</td>
</tr>
<tr>
<td><strong>Detector Bias</strong></td>
<td></td>
</tr>
<tr>
<td>Bias voltage range</td>
<td>±10 V, max. 22 mA, connected to shield of BNC input socket, adjustable by potentiometer, switchable to GND</td>
</tr>
<tr>
<td><strong>Warning</strong></td>
<td></td>
</tr>
<tr>
<td>A bias current of 20 mA may destroy sensitive detectors. Please pay attention to the correct polarity and careful adjustment of the bias voltage to protect your detector. Put the bias switch to GND (ground) if you do not want to use the internal bias voltage. The positive and negative supply voltage of the amplifier must be switched &quot;on&quot; and &quot;off&quot; simultaneously in order to avoid overvoltage at the bias output.</td>
<td></td>
</tr>
<tr>
<td><strong>Bias Voltage Monitor Output</strong></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>The signal at the bias voltage monitor output (pin 7 of the Sub-D control socket) is identical to the detector bias voltage present on the shield of the input BNC socket. By monitoring the signal on pin 7 the desired bias voltage can be adjusted through the bias potentiometer. Even if the bias switch is set to &quot;GND&quot;, the bias voltage can be monitored and set to the desired value.</td>
</tr>
<tr>
<td>Monitor output</td>
<td></td>
</tr>
<tr>
<td>polarity</td>
<td>non-inverting</td>
</tr>
<tr>
<td>Monitor output voltage range</td>
<td>±10 V (@ ≥1 MΩ load)</td>
</tr>
<tr>
<td>Monitor output</td>
<td></td>
</tr>
<tr>
<td>impedance</td>
<td>1 kΩ (designed for ≥1 MΩ load)</td>
</tr>
<tr>
<td><strong>Indicator LED</strong></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>overload</td>
</tr>
<tr>
<td><strong>Digital Control</strong></td>
<td></td>
</tr>
<tr>
<td>Control input voltage range</td>
<td>LOW bit: −0.8 V ... +1.2 V, HIGH bit: +2.3 V ... +12 V</td>
</tr>
<tr>
<td>Control input current</td>
<td>0 mA @ 0 V, 1.5 mA @ +5 V, 4.5 mA @ +12 V</td>
</tr>
<tr>
<td>Overload output</td>
<td>non active: &lt;0.4 V @ 0 ... −1 mA</td>
</tr>
<tr>
<td></td>
<td>active: typ. 5 ... 5.1 V @ 0 ... 2 mA</td>
</tr>
<tr>
<td><strong>Ext. Offset Control</strong></td>
<td></td>
</tr>
<tr>
<td>Control voltage range</td>
<td>±10 V</td>
</tr>
<tr>
<td>Offset control</td>
<td></td>
</tr>
<tr>
<td>impedance</td>
<td>15 kΩ</td>
</tr>
<tr>
<td><strong>Power Supply</strong></td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>±15 V</td>
</tr>
<tr>
<td>Supply current</td>
<td>typ. 110 / −90 mA (depends on operating conditions, recommended power supply capability min. ±200 mA)</td>
</tr>
<tr>
<td>Stabilized power</td>
<td>±12 V, max. 20 mA, +5 V, max. 50 mA</td>
</tr>
</tbody>
</table>
### Variable Gain

**High-Speed Current Amplifier**

<table>
<thead>
<tr>
<th>Specifications (continued)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case</strong></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>320 g (0.74 lb.)</td>
</tr>
<tr>
<td>Material</td>
<td>AlMg4.5Mn, nickel-plated</td>
</tr>
<tr>
<td><strong>Temperature Range</strong></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>–40 °C ... +100 °C</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 °C ... +60 °C</td>
</tr>
<tr>
<td><strong>Absolute Maximum Ratings</strong></td>
<td></td>
</tr>
<tr>
<td>Signal input voltage</td>
<td>±5 V</td>
</tr>
<tr>
<td>Transient input voltage</td>
<td>±1.5 kV (out of a 1 nF source)</td>
</tr>
<tr>
<td>Control input voltage</td>
<td>–5 V / +16 V</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>±20 V</td>
</tr>
<tr>
<td><strong>Connectors</strong></td>
<td></td>
</tr>
<tr>
<td>Input</td>
<td>BNC, isolated, jack (female)</td>
</tr>
<tr>
<td>Output</td>
<td>BNC, jack (female)</td>
</tr>
<tr>
<td>Detector bias output</td>
<td>shield of input BNC</td>
</tr>
<tr>
<td>Power supply</td>
<td>Lemo® series 1S, 3-pin fixed socket</td>
</tr>
<tr>
<td></td>
<td>(mating plug type: FFA.1S.303.CLAC52)</td>
</tr>
<tr>
<td>Pin 1:</td>
<td>+15V</td>
</tr>
<tr>
<td>Pin 2:</td>
<td>–15V</td>
</tr>
<tr>
<td>Pin 3:</td>
<td>GND</td>
</tr>
<tr>
<td>Control port</td>
<td>Sub-D 25-pin, female, qual. class 2</td>
</tr>
<tr>
<td>Pin 1:</td>
<td>+12 V (stabilized power supply output)</td>
</tr>
<tr>
<td>Pin 2:</td>
<td>–12 V (stabilized power supply output)</td>
</tr>
<tr>
<td>Pin 3:</td>
<td>AGND (analog ground)</td>
</tr>
<tr>
<td>Pin 4:</td>
<td>+5 V (stabilized power supply output)</td>
</tr>
<tr>
<td>Pin 5:</td>
<td>digital output: overload (referred to pin 3)</td>
</tr>
<tr>
<td>Pin 6:</td>
<td>DC monitor output</td>
</tr>
<tr>
<td>Pin 7:</td>
<td>bias monitor output</td>
</tr>
<tr>
<td>Pin 8:</td>
<td>output offset control voltage input</td>
</tr>
<tr>
<td>Pin 9:</td>
<td>DGND (ground for digital control pins 10 - 16)</td>
</tr>
<tr>
<td>Pin 10:</td>
<td>digital control input: gain, LSB</td>
</tr>
<tr>
<td>Pin 11:</td>
<td>digital control input: gain</td>
</tr>
<tr>
<td>Pin 12:</td>
<td>digital control input: gain, MSB</td>
</tr>
<tr>
<td>Pin 13:</td>
<td>digital control input: AC/DC</td>
</tr>
<tr>
<td>Pin 14:</td>
<td>digital control input: high speed / low noise</td>
</tr>
<tr>
<td>Pin 15:</td>
<td>upper cut-off frequency limit 10 MHz</td>
</tr>
<tr>
<td>Pin 16:</td>
<td>upper cut-off frequency limit 1 MHz</td>
</tr>
<tr>
<td>Pin 17 - 25:</td>
<td>NC</td>
</tr>
</tbody>
</table>

---

**SOPHISTICATED TOOLS FOR SIGNAL RECOVERY**

FEMTO
Remote Control Operation

Remote control input pins 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.

Switch setting “Bias / GND” is not remote controllable.

Gain setting

<table>
<thead>
<tr>
<th>Gain setting</th>
<th>low noise gain (V/A)</th>
<th>high speed gain (V/A)</th>
<th>Pin 12</th>
<th>Pin 11</th>
<th>Pin 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>10⁻²</td>
<td>10⁻³</td>
<td>LOW</td>
<td>LOW</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>10⁻³</td>
<td>10⁻⁴</td>
<td>LOW</td>
<td>LOW</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>10⁻⁴</td>
<td>10⁻⁵</td>
<td>LOW</td>
<td>HIGH</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>10⁻⁵</td>
<td>10⁻⁶</td>
<td>LOW</td>
<td>HIGH</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
<tr>
<td>10⁻⁶</td>
<td>10⁻⁷</td>
<td>HIGH</td>
<td>LOW</td>
<td>LOW</td>
<td></td>
</tr>
<tr>
<td>10⁻⁷</td>
<td>10⁻⁸</td>
<td>HIGH</td>
<td>LOW</td>
<td>HIGH</td>
<td>LOW</td>
</tr>
</tbody>
</table>

Gain settling time

<80 ms

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
Photo detector biasing through internal bias voltage source

Set bias switch to "Bias". The photodiode is biased through the amplifier with the bias voltage applied to the shield of the isolated BNC input socket. The photodiode should be mounted in a metal case. For optimum shielding the metal case has to be isolated from the photodiode but connected to the housing of the DHPCA-100.

Photo detector biasing through external voltage source

Set bias switch to "GND". The photodiode is biased through an external voltage source. The shield of the isolated BNC input socket is internally set to amplifier GND. The photodiode should be mounted in a metal case. For optimum shielding the metal case has to be isolated from the photodiode but connected to the housing of the DHPCA-100.
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Dimensions

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