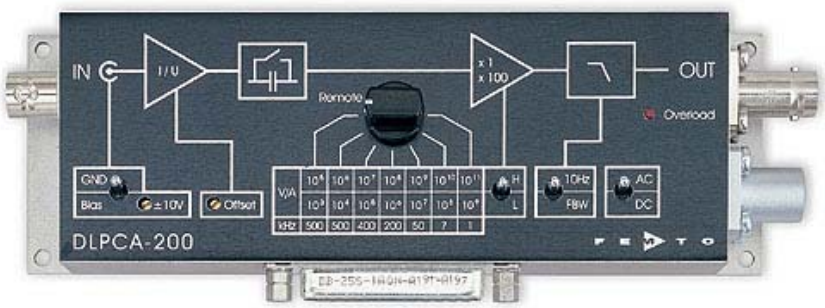
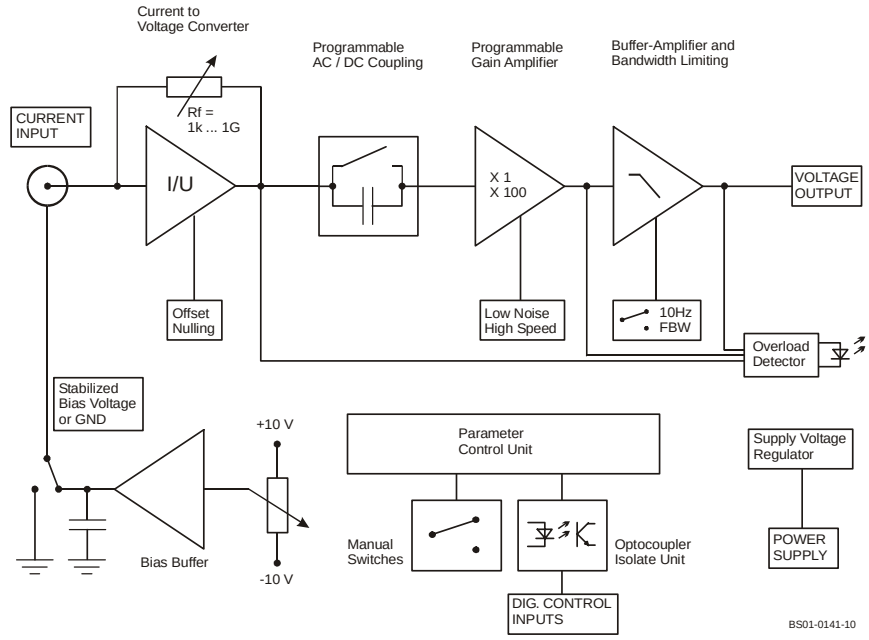
# Variable Gain
# Low Noise Current Amplifier




| | |
|---|---|
| Features | • **Transimpedance (Gain) Switchable from 1 x $10^3$ to 1 x $10^{11}$ V/A**<br>• **Bandwidth DC / 1 Hz ... 500 kHz**<br>• **Bandwidth Switchable to DC ... 10 Hz for Low Noise DC Measurements**<br>• **Bandwidth Independent of Detector Capacitance (up to 1 nF)**<br>• **Adjustable Bias Voltage**<br>• **Protection Against ± 3 kV Transients**<br>• **Local and Remote Control** |
| Applications | • **Photodiode and Photomultiplier Amplifier**<br>• **Scanning Tunneling Microscopy (STM)**<br>• **Spectroscopy**<br>• **Beam Monitoring for Particle Accelerators / Synchrotrons**<br>• **Ionisation Detectors**<br>• **Preamplifier for Lock-Ins, A/D-Converters, etc.** |
| Block Diagram |  |

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## Specifications

*Test Conditions* — *Vs = ± 15 V, Ta = 25°C*

### Gain

| | |
|---|---|
| Transimpedance | 1 x $10^3$ ... 1 x $10^{11}$ V/A |
| Gain Accuracy | ± 1 % |
| Gain Drift | see table below |

### Frequency Response

| | |
|---|---|
| Lower Cut-Off Frequency | DC / 1 Hz |
| Upper Cut-Off Frequency | up to 500 kHz (see table below), switchable to 10 Hz |
| Gain Flatness | ± 0.1 dB |

### Input

| | |
|---|---|
| Equ. Input Noise Current | see table below |
| Equ. Input Noise Voltage | 4 nV/√Hz (@ 1 kHz) |
| Input Offset Current Drift | see table below |
| Input Bias Current | 1 pA typ. (max. 3 pA) |
| Max. Input Current | see table below (value for linear amplification) |
| Input Offset Compensation | adjustable by offset trimpot and external control voltage; max. range see table below |

### Performance depending on Gain Setting

| Gain Setting (Low Noise) (V/A) | $10^3$ | $10^4$ | $10^5$ | $10^6$ | $10^7$ | $10^8$ | $10^9$ |
|---|---|---|---|---|---|---|---|
| Upper Cut-Off Frequency (- 3 dB) | 500 kHz | 500 kHz | 400 kHz | 200 kHz | 50 kHz | 7 kHz | 1.1 kHz |
| Rise / Fall Time (10% - 90%) | 700 ns | 700 ns | 900 ns | 1.8 µs | 7 µs | 50 µs | 300 µs |
| Input Noise Current Density (/√Hz) | 20 pA | 2.3 pA | 450 fA | 130 fA | 43 fA | 13 fA | 4.3 fA |
| measured at | 10 kHz | 10 kHz | 10 kHz | 1 kHz | 1 kHz | 100 Hz | 100 Hz |
| Integr. Input Noise Current (rms)* | 21 nA | 2.4 nA | 500 pA | 130 pA | 41 pA | 5.8 pA | 0.8 pA |
| Offset Current Drift (/°C) | 30 nA | 3 nA | 0.3 nA | 30 pA | 3 pA | 0.3 pA | 0.1 pA |
| Gain Drift (/°C) | 0.008% | 0.008% | 0.008% | 0.01% | 0.01% | 0.01% | 0.02% |
| Max. Input Current (±) | 10 mA | 1 mA | 0.1 mA | 10 µA | 1 µA | 0.1 µA | 10 nA |
| Input Offset Compensat. (±) | 100 µA | 10 µA | 1 µA | 0.1 µA | 10 nA | 1 nA | 0.1 nA |
| DC Input Impedance (// 5 pF) | 50 Ω | 50 Ω | 50 Ω | 60 Ω | 150 Ω | 1 kΩ | 10 kΩ |

| Gain Setting (High Speed) (V/A) | $10^5$ | $10^6$ | $10^7$ | $10^8$ | $10^9$ | $10^{10}$ | $10^{11}$ |
|---|---|---|---|---|---|---|---|
| Upper Cut-Off Frequency (- 3 dB) | 500 kHz | 500 kHz | 400 kHz | 200 kHz | 50 kHz | 7 kHz | 1.1 kHz |
| Rise / Fall Time (10% - 90%) | 700 ns | 700 ns | 900 ns | 1.8 µs | 7 µs | 50 µs | 300 µs |
| Input Noise Current Density (/√Hz) | 13 pA | 1.8 pA | 440 fA | 130 fA | 43 fA | 13 fA | 4.3 fA |
| measured at | 10 kHz | 10 kHz | 10 kHz | 1 kHz | 1 kHz | 100 Hz | 100 Hz |
| Integr. Input Noise Current (rms)* | 12 nA | 1.8 nA | 450 pA | 120 pA | 37 pA | 5.3 pA | 0.8 pA |
| Offset Current Drift (/°C) | 30 nA | 3 nA | 0.3 nA | 30 pA | 3 pA | 0.3 pA | 0.1 pA |
| Gain Drift (/°C) | 0.008% | 0.008% | 0.008% | 0.01% | 0.01% | 0.01% | 0.02% |
| Max. Input Current (±) | 100 µA | 10 µA | 1 µA | 0.1 µA | 10 nA | 1 nA | 0.1 nA |
| Input Offset Compensat. (±) | 100 µA | 10 µA | 1 µA | 0.1 µA | 10 nA | 1 nA | 0.1 nA |
| DC Input Impedance (// 5 pF) | 50 Ω | 50 Ω | 50 Ω | 60 Ω | 150 Ω | 1 kΩ | 10 kΩ |

* The integrated input noise is measured with an open but shielded amplifier input in the full bandwidth („FBW“) setting. The input referred peak-peak noise can be calculated from the rms noise as follows: $I_{peak\text{-}peak} = I_{rms} \times 6$

The output noise is given by: $U_{peak\text{-}peak} = I_{peak\text{-}peak} \times \text{Gain}$

### 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 |

### Detector Bias

| | |
|---|---|
| Bias Voltage Range | ± 10 V, max. 22 mA (bias voltage connected to shield of BNC input socket, adjustable by trimpot, switchable to GND) |

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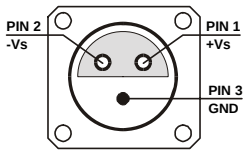
| | | |
|---|---|---|
| Indicator LED | Function | overload |
| Digital Control | Control Input Voltage Range | LOW bit: - 0.8 ...+ 1.2 V, HIGH bit: 2.3 ... + 12 V |
| | Control Input Current | 0 mA @ 0 V, 1.5 mA @ + 5 V, 4.5 mA @ + 12 V |
| | Overload Output | non active: 0 V, max. -1 mA, active: 5.1 V, max. 7 mA |
| Ext. Offset Control | Control Voltage Range | ± 10 V |
| | Offset Control Input Impedance | 20 kΩ |
| Power Supply | Supply Voltage | ± 15 V |
| | Supply Current | + 120 / - 80 mA typ. (depends on operating conditions, recommended power supply capability min. ± 200 mA) |
| | Stabilized Power Supply Output | ± 12 V, max. ± 150 mA, + 5V, max. 50 mA |
| Case | Weight | 320 g (0.74 lb.) |
| | Material | AlMg4.5Mn, nickel-plated |
| Temperature Range | Storage Temperature | -40 ... +100 °C |
| | Operating Temperature | 0 ... +60 °C |
| Absolute Maximum Ratings | Signal Input Voltage | -16 V / + 12 V |
| | Transient Input Voltage | ± 3 kV (out of 200 pF source) |
| | Control Input Voltage | - 5 V / + 16 V |
| | Power Supply Voltage | ± 22 V |
| Connectors | Input | BNC, isolated |
| | Output | BNC |
| | Detector Bias Output | shield of input BNC |
| | Power Supply | LEMO series 1S, 3-pin fixed socket<br>Pin 1: + 15V<br>Pin 2: - 15V<br>Pin 3: GND |
| | Control Port | Sub-D 25-pin, female, qual. class 2<br>Pin 1: + 12 V (stabilized power supply output)<br>Pin 2: - 12 V (stabilized power supply output)<br>Pin 3: AGND (analog ground)<br>Pin 4: + 5 V (stabilized power supply output)<br>Pin 5: digital output: overload<br>Pin 6: signal output (connected to BNC)<br>Pin 7: NC<br>Pin 8: input offset control voltage<br>Pin 9: DGND (ground for digital control pins 10 - 14)<br>Pin 10: digital control input: gain, LSB<br>Pin 11: digital control input: gain<br>Pin 12: digital control input: gain, MSB<br>Pin 13: digital control input: AC/DC<br>Pin 14: digital control input: high speed / low noise<br>Pin 15 - 25: NC |



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## Remote Control Operation

### General

Remote control input bits are opto-isolated and connected by logical OR function to local switch settings. For remote control set the corresponding local switches to “Remote”, "AC" and "H" (High Speed) and select the wanted setting via a bit code at the corresponding digital inputs.
Mixed operation, e.g. local gain setting and remote controlled AC/DC setting, is also possible.

Switch settings “FBW / 10 Hz” and “Bias / GND” are not remote controllable.

### Gain Setting

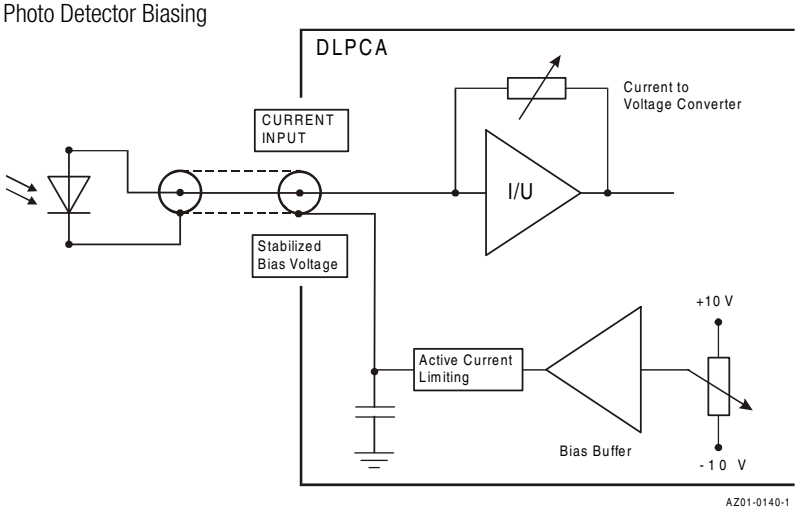
| Low Noise Pin 14=HIGH Gain (V/A) | High Speed Pin 14=LOW Gain (V/A) | Pin 12 MSB | Pin 11 | Pin 10 LSB |
|---|---|---|---|---|
| $10^3$ | $10^5$ | LOW | LOW | LOW |
| $10^4$ | $10^6$ | LOW | LOW | HIGH |
| $10^5$ | $10^7$ | LOW | HIGH | LOW |
| $10^6$ | $10^8$ | LOW | HIGH | HIGH |
| $10^7$ | $10^9$ | HIGH | LOW | LOW |
| $10^8$ | $10^{10}$ | HIGH | LOW | HIGH |
| $10^9$ | $10^{11}$ | HIGH | HIGH | LOW |

### AC/DC Setting

| Coupling | Pin 13 |
|---|---|
| AC | LOW |
| DC | HIGH |

## Application Diagram

Photo Detector Biasing



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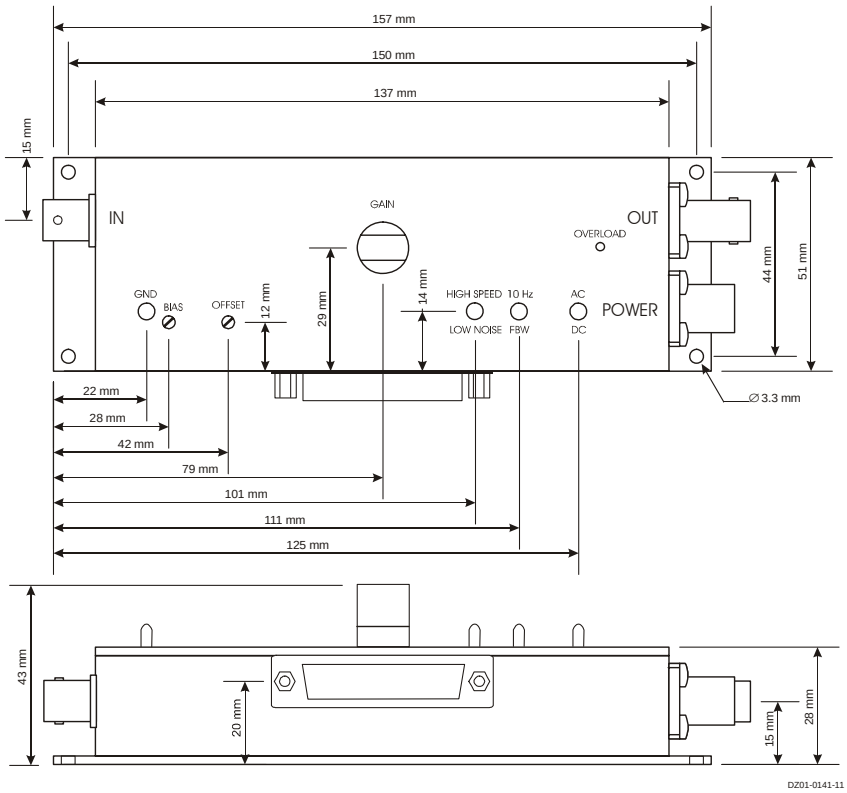
Dimensions

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