CURRENT-TO-VOLTAGE CONVERTER WITH ADJUSTABLE BIAS VOLTAGE

Current-to-Voltage Converter is a precision current-to-voltage converter used to convert weak current signals to voltages between -10 V and 10 V. The gain of the device can be adjusted between 10^3 and 10^{11}. Figure 1 shows the block diagram of the device.

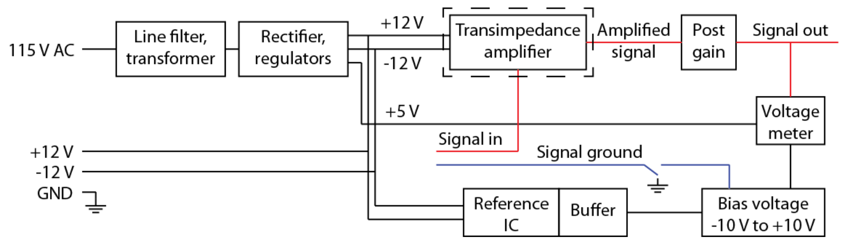

Figure 1: Block diagram of the current-to-voltage converter with adjustable bias voltage.

The device comprises of two separate printed circuit boards. The rectifier, +5 V, +12 V, and -12 V voltage regulators and the filters are on a separate circuit board. The post gain amplifier, amplifying the signal with a gain of -1, 10 or 100, is also on the same circuit board with the voltage regulation circuits.

The high precision transimpedance amplifier is on a separate circuit board, enclosed using a metallic enclosure inside the outer aluminum enclosure. The transimpedance amplifier is capable of amplifying the current signal from 10^3 up to 10^9.

Coupling capacitors of different sizes for the voltage regulators and operational amplifiers are used to minimize the voltage ripple at the power lines. High precision thin film resistors are used to achieve best possible temperature stability and gain accuracy.

CONTROLS

GAIN

The gain of the high precision transimpedance amplifier can be selected between 10^3 and 10^9.

ZERO

The output offset of the transimpedance amplifier can be adjusted using the zero potentiometer. Typically the offset is set to 0 V.

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POST GAIN

The post gain can be selected from three values -1, 10, and 100. When the post gain knob is at -1, the post gain amplifier is not used, but the signal is directed straight from the transimpedance amplifier to the output.

When the post gain is set to 10 or 100, the post gain amplifier is used and the signal from the transimpedance amplifier amplified over again.

BANDWIDTH

The bandwidth knob is used to set the low pass filter cut off frequency. The bandwidth limit is valid only when the post gain is 10 or 100. The following bandwidths are available: 10 Hz, 100 Hz, 1 kHz, and 10 kHz.

DISPLAY

The integrated voltage meter display can show the output voltage or the bias voltage. The display switch is used to select the input signal for the display. The backlight of the voltmeter can also be turned off using the display switch. This is useful to prevent the backlight of the display to disturb the measurement when carrying out measurements in dark.

CONNECTORS

The device has LEMO and BNC connectors for both the input and output signals. A two way LEMO connector of type EGG.0B.302.CLL is used. The LEMO and BNC connectors at the input and output are connected in parallel.

The three pin power connector is of a type IEC C13. Two different device versions with 230 V or 115 V input voltages are available.

PERFORMANCE MEASUREMENTS

LONG-TERM STABILITY

The long term stability of the device was tested by driving the amplifier with a constant current. The current was fed to the amplifier using Keithley Model 263 Calibrator/Source and the output voltage measured with Hewlett Packard 3458A multimeter.

The stability test was carried out at room temperature of 24 ± 1 °C. The tested currents were 10 pA – 100 µA. The driving currents were chosen in such a way that the output voltage was 1 V for all the tested gains.

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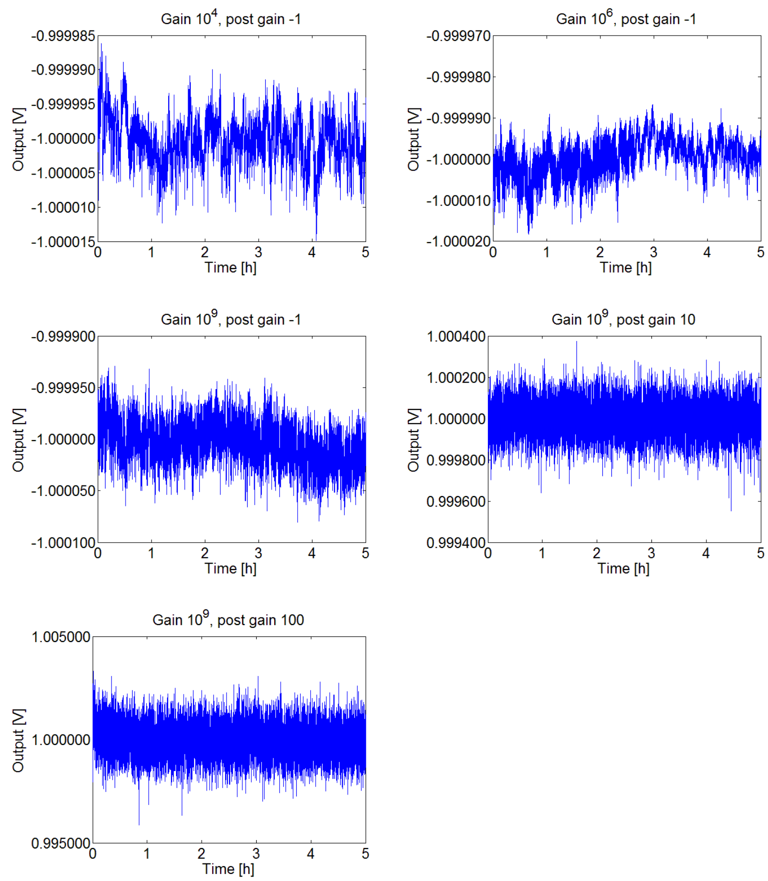

Figure 2: Long-term stability of the device.

TEMPERATURE DEPENDENCE

The effect of ambient temperature on the device gain stability was tested in a weather cabinet. In the measurement the temperature of the ambient air was varied between 285 K and 315 K and the output voltage was measured. The ambient temperature was changed at the rate of 10 °C / h, to allow the temperature of the device components to follow the temperature of the ambient air.

The measurement devices were switched on a day before the measurement to allow them to stabilize well. The current was fed to the amplifier using Keithley Model 263 Calibrator/Source and the output voltage measured with Hewlett Packard 3458A multimeter.

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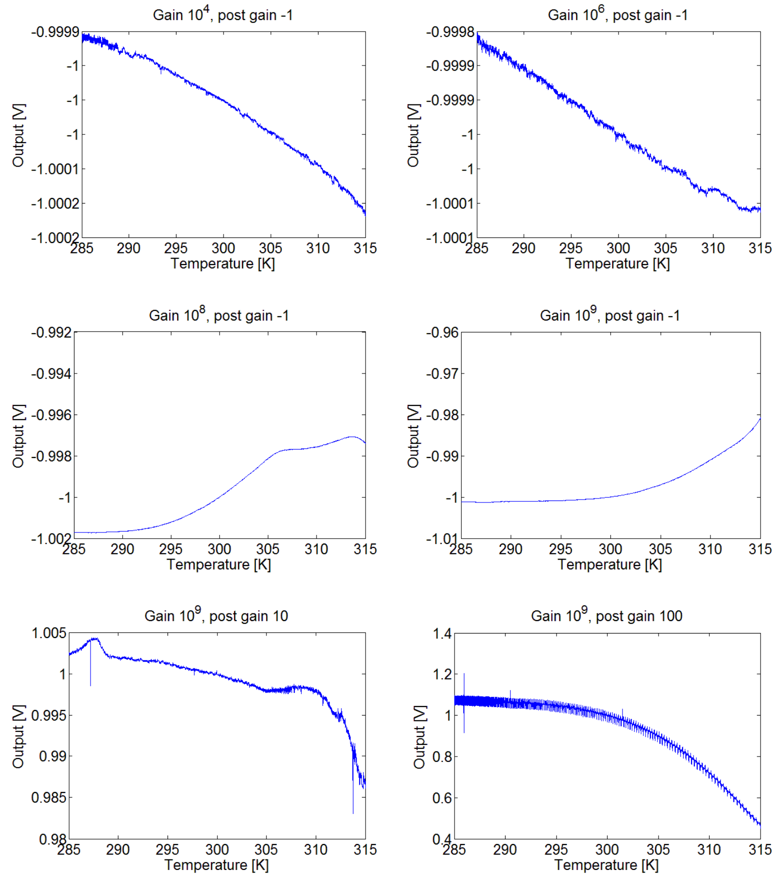

Figure 3: The effect of ambient temperature on the device gain.

NOISE LEVELS

The RMS noise levels for the device were measured using Hewlett Packard 3458A multimeter. The input was floating during the measurements. The noise tests were carried out at room temperature of 24 ± 1 °C.

Gain	RMS [mV]	Gain	RMS [mV]
10^3 -1	0.02825	**10^8 -1**	0.37611
10^4 -1	0.02896	**10^9 -1**	1.61002
10^5 -1	0.02969	**10^9 +10**	3.30081
10^6 -1	0.0309	**10^9 +100**	33.4298
10^7 -1	0.07636		

STABILIZATION TIME

The stabilization time was measured by switching the device on after 24 hours switch off period. The current was fed to the amplifier using Keithley Model 263 Calibrator/Source and the output voltage measured with Hewlett Packard 3458A multimeter. The driving currents were chosen in such a way that the output voltage was 1 V for all the tested gains.

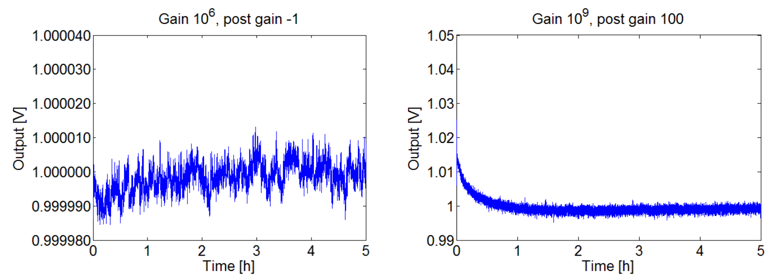

Figure 4: Stability of the device after switch on.

Figure 4 shows that at the moderate gains of less than 10^9, the device is instantly stable after switch on. When using the post gain amplifier, a stabilization time of 90 minutes is required.

Specifications	
Input voltage	230 / 115 VAC
Maximum input current	0.05 A
Recommended operating temperature	23 ± 2 °C
LEMO connector type	EGG.0B.302.CLL
Dimensions	125 mm x 200 mm x 56 mm
Weight	1000 g
IP class	21

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