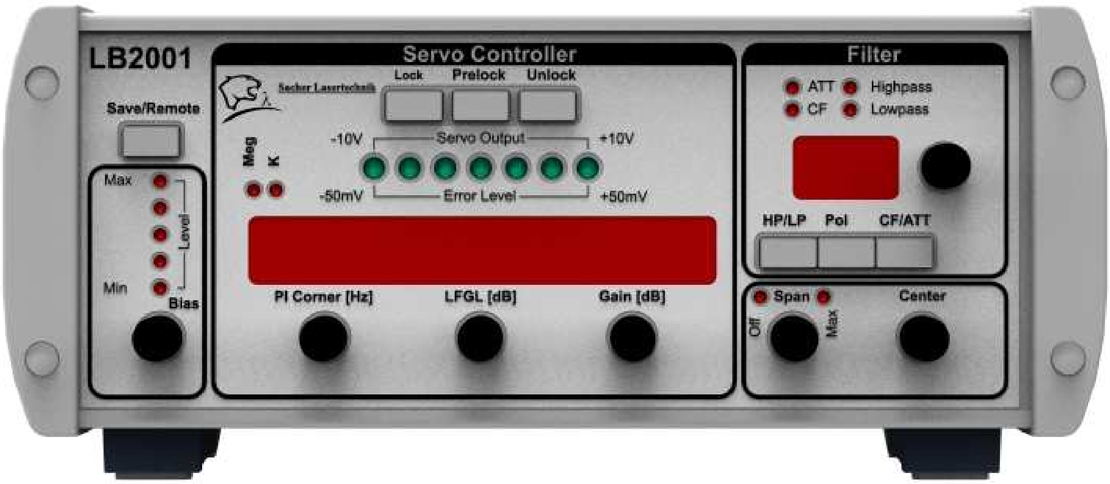
Operating Manual
Servo Controller LB2001



Adress:
Sacher Lasertechnik GmbH
Rudolf-Breitscheid-Str. 1-5
D-35037 Marburg, Germany

Tel.: +49 (6421) 305-0
Fax.: +49 (6421) 305-299
EMail: contact@sacher-laser.com
Web: http://www.sacher-laser.com

Sacher Lasertechnik, LLC
5765 Equador Way
Buena Park, CA 90620, USA

Tel.: 1-714-670-7605
Fax: 1-714-670-7662
Email: sales@sacher-laser.com

Version:
Preliminary 2011-01-01

1. Basic Safety Instructions

The LB2001 is a versatile instrument that can be used in a variety of feedback control applications. However, the LB2001 is not intended for fail-safe operation in hazardous environments or life-threatening situations. The user assumes full responsibility for correct and safe usage of the LB2001 in accordance with any applicable laws, codes, regulations, and standards pertaining to their specific application. Sacher Lasertechnik is not liable for any consequential damage due to misapplication or failure of the LB2001.

Electrical Fuse & Voltage Selection

The LB2001 is pre-configured at the factory to work with the AC mains voltages for your region. Before supplying electrical power to the LB2001, confirm that the power entry module located on the rear panel is installed with the proper fuses and set to the correct wall-plug AC voltage.

AC Mains* V~	Tolerance V~	Fuse Rating**	Module Voltage Switch Settings
115	90-120	250V 0.5 A T	230
230	207-264	250V 0.25 A	115

*50/60 Hz only. ** Module accept only dual metric 5 x 20 mm fuses.

To operate at another AC mains voltage, follow the procedure below:

- With a small screwdriver, pry open fuse cover of the power entry module on rear panel. The AC power cord must be removed from module socket before opening fuse cover.

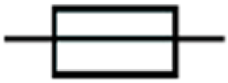
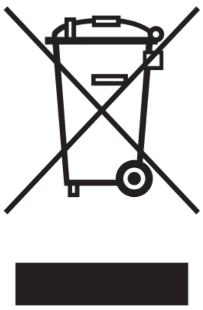
- Carefully pull out the voltage selection wheel from the module. Re-insert so that correct AC voltage setting is facing outwards.

- Pull out the two fuse holders located below voltage selection wheel. Insert correct fuses into each fuse holder and re-insert back into module. Install fuse holders so that arrows on fuse cover and fuse holder align.

- Snap fuse cover back into place. Verify that the correct AC mains voltage can be read through fuse panel before attaching the AC power cord.

Warning: Carefully measure output voltages from the LB2001 before connecting to a device that can be damaged by over-voltage.

Table of Symbols

	Alternating current
	Caution – risk of electrical shock
	Fuse
	It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future. The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

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2. Customer Support

Information and advice about the performance or operation of Sacher Lasertechnik[Group] products is available from our web site and our applications engineers.
For quickest response ask for 'Technical Support' and have your model and serial number available. Support is available by:

Sacher Lasertechnik[Group]
Rudolf-Breitscheid-Str. 1-5
35037 Marburg, Germany
Tel: +49 6421 305 – 0, Fax: +49 6421 305 - 299
Contact@sacher-laser.com
or
5765 Equador Way
Buena Park, CA 90620
USA

The LB2001 is designed to be maintenance free. No user-serviceable parts are inside the unit. No further calibrations are necessary for the LB2001 to meet its accuracy specifications over the lifetime of the product. Opening the instrument case voids the warranty and exposes to user to hazardous voltages that are present inside the instrument case.

Cleaning instructions: Instrument case can be safely cleaned with slightly moistened cloth soaked in water or isopropyl alcohol.

For service or repairs:

Tel.: +1 800 352 3639, Fax: +1 714 670 7662

1. Telephone Sacher Lasertechnik customer service department at (+49) 6421 305290, which will determine if the equipment requires service, repair, calibration, or replacement. Factory office hours are 8:00 am-4:00 pm CET.

2. If the unit must be returned to Sacher Lasertechnik, ask for a Return Merchandise Authorization (RMA) from customer service. Never send any unit back to Sacher Lasertechnik without a Return Merchandise Authorization (RMA).

3. Return the unit, postage prepaid, to Sacher Lasertechnik. Do not forget to write the RMA on the shipping label. Sacher Lasertechnik will refuse and return any package that does not bear an RMA.

4. Pack the unit in its original shipping material (if possible) with at least 1 inch of compressible packing material. Be sure to include an ownership tag and a description fully detailing the defect and the conditions under which it was observed.

5. After repair, the equipment will be returned with a repair report. If the equipment was within specifications, a test set-up fee will be charged to the customer. If the equipment is not under warranty, the customer will be invoiced for the cost appearing on the repair report.

6. Sacher Lasertechnik is responsible for shipping the unit back to the customer if the unit is under warranty. Shipping damage is not covered by this warranty, and shipping insurance, which Sacher Lasertechnik recommends, is at the customer’s expense.

Warranty

Sacher Lasertechnik GmbH warrants its LB2001 to be free of material and workmanship defects for one year from the date of original shipment. This warranty is in lieu of all other guarantees expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. Sacher Lasertechnik shall not be liable for any special, incidental or consequential loss.

During the warranty period, Sacher Lasertechnik will repair or replace the unit, or issue credit, at our option, without charge. Sacher Lasertechnik' liability shall not in any case exceed the cost of correcting defects in the products as explained here, and this service is the sole remedy of the buyer.

This warranty does not apply to defects caused by abuse, accident, modifications, Acts of God, or to use of the product for which it was not intended.

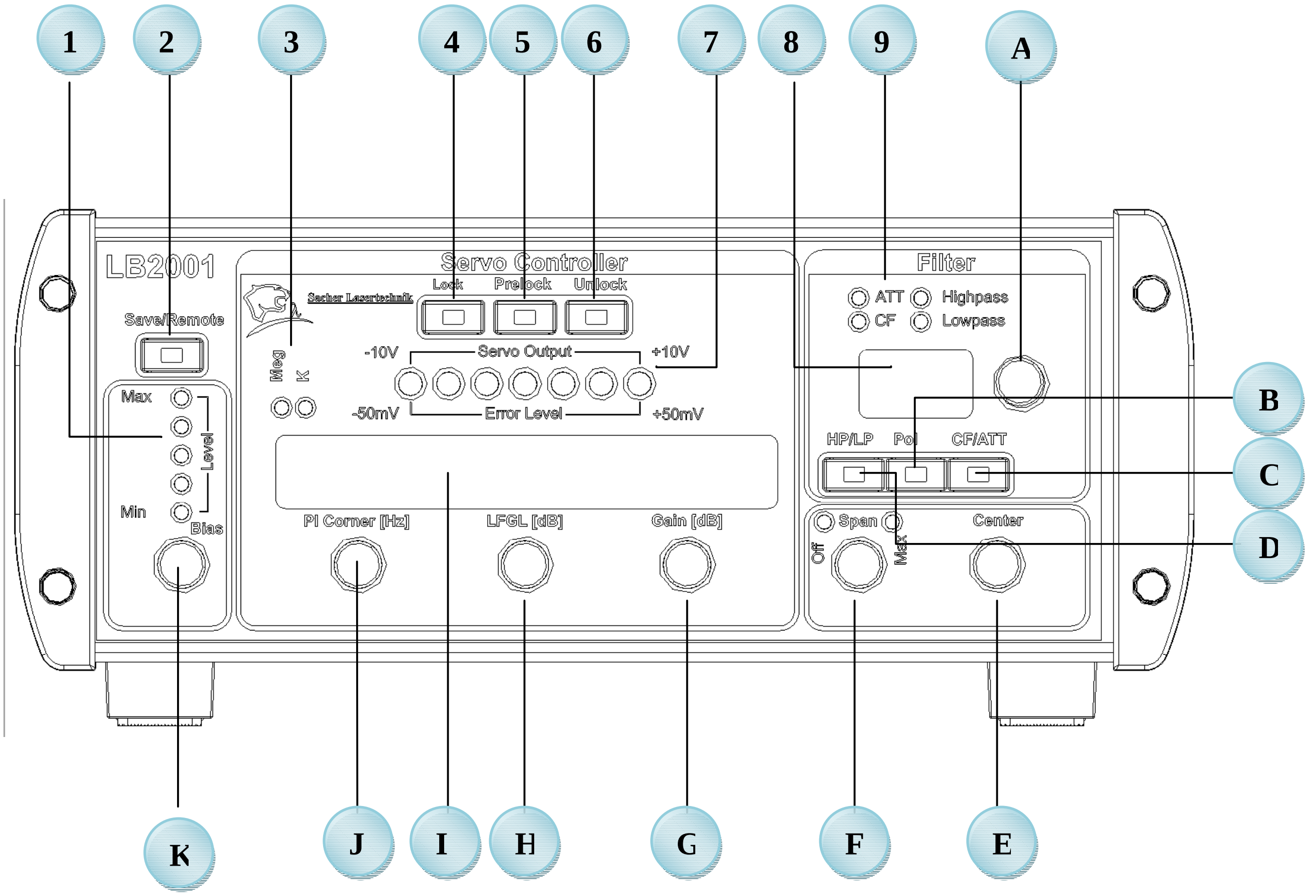
Sacher Lasertechnik shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the purchased product is connected or the operation of any system of which the purchased product may be a part. The LB2001 should not be used in a manner not specified by the manufacturer.

3. Prepare for Use

This chapter gives an overview of the front panel controls and connectors of the LB2005 servo controller and gives all information that is necessary to put the instrument into operation and connect external devices.

3.1. Frontpanel Tour

The front panel of the LB2005 consists of the 7 segment displays hardkeys and the incremental rotation encoders.. Brief explanations on the controls rear panel can be found on the next pages



The detailed functions are:

1 Bias voltage level. The position of the LED signal indicates the position of the bias voltage level relative to the +/-10V operation range of the LB2001

2 Save Switch remote indicator. When "Save" is pressed all settings will be stored in a EEPROM

3 Unit indicator for PI Corner frequency

4 5 6 Acquire Buttons: These buttons are used to acquire lock. Table 2 shows the function for each switch position.

Table 2: Functions for Acquire Switch

Position	Function
Lock Off	Integrator is reset. No control signal is summed into output signal.
LFGL	P-I filter is enabled with a low frequency gain limit determined by LF Gain Limit switch. See the section *Filter Transfer Functions* in Chapter 3.
Lock On	P-I filter is enabled with full integrator. Low frequency gain limit is disabled.

7 The position of the Green LED signal indicates the position of the integrator level relative to the +/-10V operation range of the LB2001.
The position of the Red LED signal indicates the position of the Error level relative to a +/-50mV voltage range. The locked system should always be in the the +/-50mV window.

8 Filter parameter display

9 Display indicators. Shows which parameter could be adjusted with the rotary switch.

A Filter Frequency Adjustment: Depending on the setting of the Low Pass / High Pass Selection Switch, this knob adjusts
The low pass filter frequency of the high pass filter path

B Polarity switch for PT1 and DT1 filter unit

C Corner frequency (CF) / Attenuator selection switch

D Filter selection switch.

E Sweep Center (Output Offset): This knob adjusts the offset voltage of the signal from Output. The offset voltage can be adjusted from the negative voltage limit (fully counter clockwise) to the positive voltage limit (fully clockwise). See the section *Setting Output Voltage Limits* in Chapter 3 for more details on setting the output voltage limits.

F Sweep Span: This knob controls the attenuation of the Sweep In signal. Attenuation is near linear from zero (Off, fully counter-clockwise) to unity gain (fully clockwise). This knob is used to adjust the amplitude of the sweep input signal.

G Gain: This adjustment knob controls the overall feedback gain of the loop filter from -40 dB (fully counter clockwise) to +40 dB (fully clockwise) with a 1dB step resolution. The gain value is displayed above.

H LF Gain Limit: This switch controls the low frequency gain limit (LFGL) of the loop filter. The value of low frequency is displayed above. This knob is only active when the Acquire switch is in LFGL mode. See the section *Filter Transfer Functions* in Chapter 3 for details.

I Display section PI corner frequency (left) , Low Frequency Gain Limit (middle) Gain (right)

J P-I Corner: This switch sets the proportional-integral (P-I) corner frequency of the filter. The corner frequency is displayed above. See the section *Filter Transfer Functions* for details.

K Offset Adjustment (Bias): This adjustment knob controls a stable offset voltage with a 16 bit resolution that can be added to the voltage of input signal. This offset can be adjusted over □10 V with a resolution of <1mV. The offset voltage changes linearly with <1mV per step. The selected offset is displayed above.

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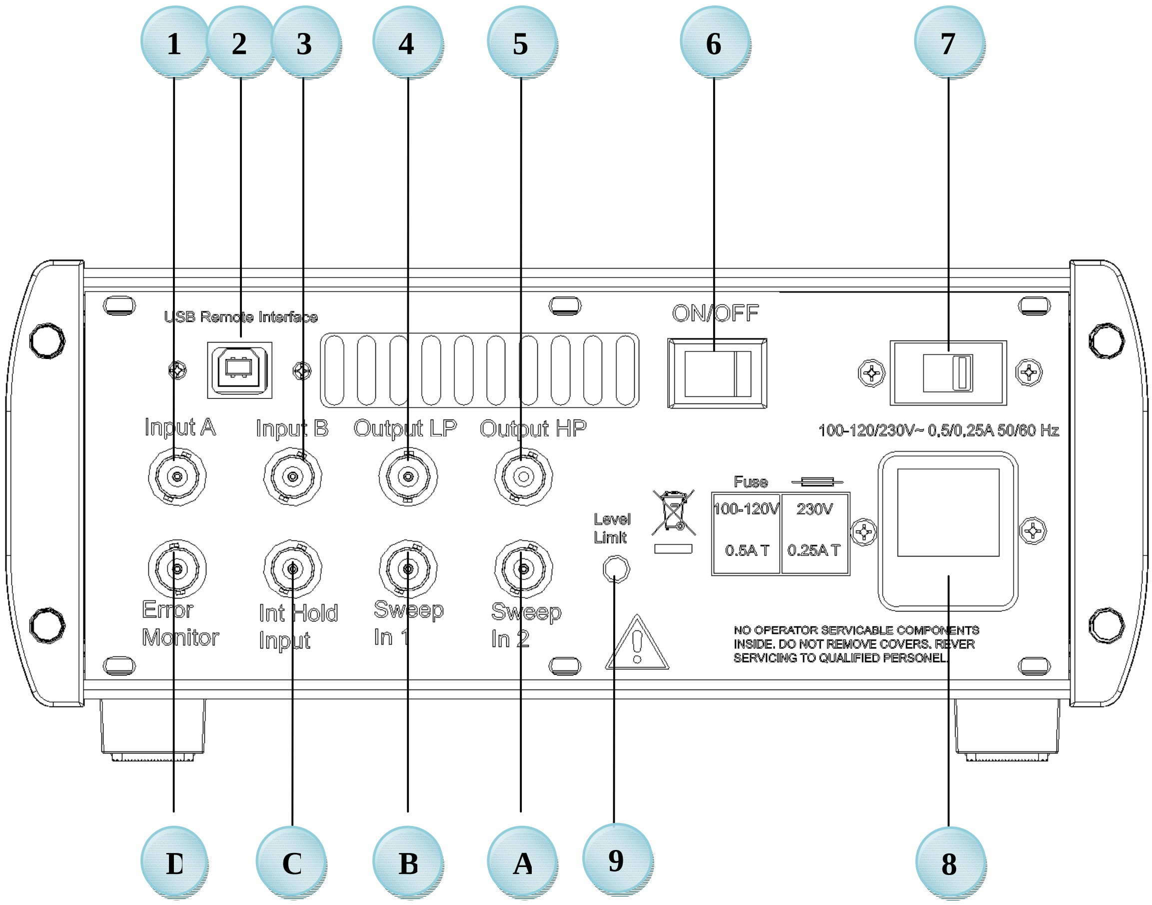
3.2. Rear Panel Tour



1 Input A (non inverting input), The error signal is generated from the voltage (A – B) applied to the BNC input connector

2 USB Remote Interface.

3 Input B (inverting input), The error signal is generated from the voltage applied to the BNC input connector

4 Output (LP): This low pass BNC output is the control signal from the proportional-integral (P-I) filter, going to the filter section and summed with the sweep and modulation signals.

5 Output (HP): This high pass BNC output is the control signal from the proportional-integral (P-I) filter and going to the DT1 filter section.

6 Power switch: This switch is pushed up to | position to turn on AC mains power to LB2001.

7 AC Line Power Voltage Selector

8 Power entry module: The AC power cord must be connected between this instrument receptacle and a properly grounded mains receptacle. The LB2001 can be configured to operate with the following AC mains voltages: 100, 120, 220, and 230-240 VAC. Please carefully read the preceding section *Electrical Fuse & Voltage Selection* for instructions on installing the proper fuses and setting the correct AC supply voltage.

9 PI Filter Output Voltage Limit: This trim-pots determines the integrator voltage rails.

A Sweep In 2: Input signals to this BNC connectors are summed into the Output signal.

B Sweep In 1: This BNC input allows a low frequency periodic sweep signal to be added to the output of the LB2001. The input impedance is 1ķ and the input voltage range is -10V.. +10V. See Sweep Center and Sweep Span controls discussed below for more details.

C Int. Hold Input: This TTL logic input switches off the error signal input to the P-I filter and holds the integrator output voltage at its current value

D Error Monitor: This BNC output connector is a voltage monitor for the error signal generated by the input difference amplifier. The DC-coupled error monitor has unity gain with a nominal output voltage –10V..+10V.

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Content

4. Getting Started

4.1. General

This chapter explains the typical setup and operation of the LB2001 Servo Controller. This chapter should help less experienced users rapidly adapt the LB2001 to their specific servo application. Keep in mind that while the LB2001 has a flexible architecture that lends itself well to many feedback control applications, not all types of operation can be adequately addressed in this manual. The following are general guidelines for operating the LB2001, and some deviation from these procedures may be required to meet specific application needs. Demanding applications will require familiarity with feedback control theory and good characterization of all system components.

The primary function of the LB2001 is to condition an input signal from a detector and to provide an output signal to a transducer that controls a system parameter. The output control signal forces the system parameter to a desired value regardless of external disturbances, such as thermal fluctuations or mechanical noise, which invariably affect the system. The difference between the desired value and the actual value of the controlled parameter is typically called the error signal. For instance, the parameter to be controlled might be the intensity of a diode laser that has its optical output detected by a photodiode. The LB2001 generates an error signal from the photodiode signal and then filters this error signal to provide a control signal that changes the injection current to the diode laser such that a stable optical power is maintained.

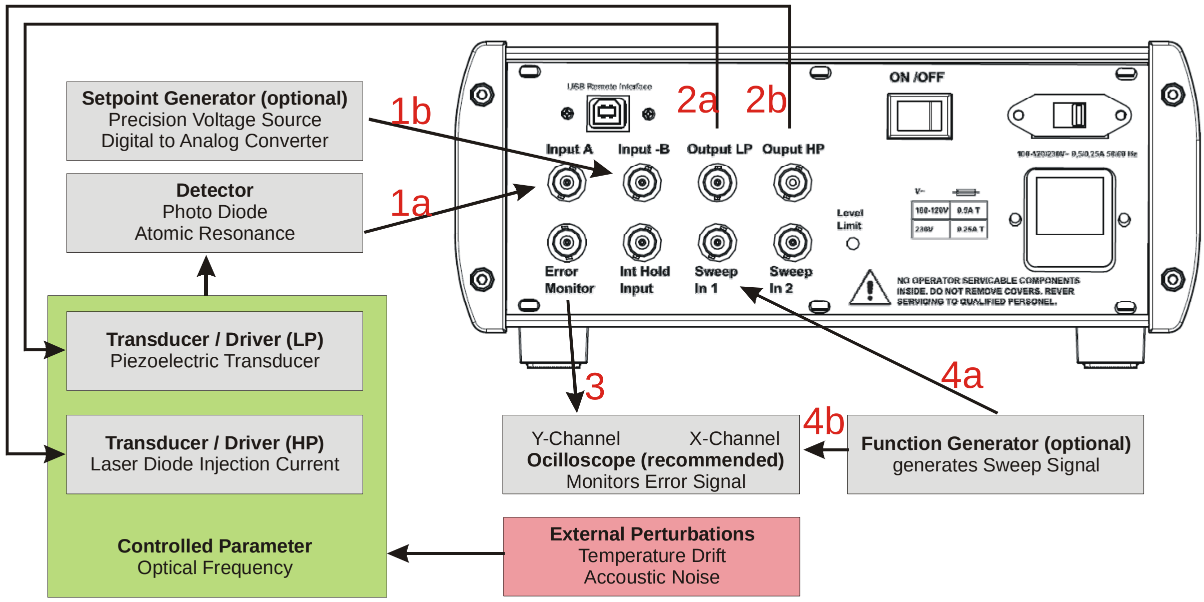
4.2. Typical Setup

The LB2001 is designed to easily integrate with other instruments and devices. This section describes the various electrical signal connections that might be made to and from the LB2001. Some typical signal connections between common instruments are shown in Figure 3. Pay careful attention not to exceed any damage thresholds when making connections between instruments.

NOTE: Before powering the LB2001, make sure that the fuse and voltage settings are correct for your region's wallplug electrical power (see the *Electrical Fuse & Voltage Selection* section of Chapter 1.)

Detector output to LB2001 input: To provide feedback, the parameter to be stabilized must first be detected. For example, a simple photodiode might suffice for detecting optical intensity. For instances where the laser wavelength is stabilized, spectrometers based on atomic/molecular or interferometer resonances are needed to detect optical wavelength shifts. The common characteristic of all detectors is that they produce a nonzero slope that is locally monotonic around the desired lock point. The input section of the LB2001 is a high-impedance, differential amplifier stage that offers flexibility in interfacing to many types of detector outputs.

The A and -B inputs can be used together with differential signals to remove common-mode noise and systematics. Single-ended signals can also be connected, as shown by connection 1a, by simply leaving the unused channel unconnected, or, as depicted by connection 1b, by attaching a stable voltage source that generates an external set-point voltage. Alternatively, the Input Offset knob can provide DC offset to the detector signals. To invert either differential or single-ended signals, use the Polarity button to reverse the connections.



LB2001 Output to transducer input: To close the feedback loop, an electrically tuned transducer is necessary for varying the controlled parameter. (2a) A piezoelectric transducer (PZT) to which a cavity mirror is mounted can tune the wavelength of a laser. Typically, the LP output of the LB2001 does not interface with the transducer directly but instead provides the input to an amplifier system that conditions the control signal to properly drive the transducer. For the PZT discussed above, the control signal from the LB2001 Output will usually feed a high-voltage amplifier that connects to the PZT. Be careful not to exceed any input voltage limits of the transducer. (2b) Variation of the laser diode injection current which tunes the wavelength of a laser. Typically, the HP output is feed to a bias-tee which provides modulation to the laser current. Be careful not to exceed any input voltage limits of the bias-tee.

If necessary, the Output voltage of the LB2001 can be limited by setting the Output Voltage Limit trim pots located on the rear panel. See section *Setting Output Voltage Limits* in Chapter 3 for more details.

LB2001 Error Monitor output to oscilloscope: The Error Monitor allows the user to view the actual error signal that is being processed by the P-I filter. Since integral feedback forces the error signal to zero voltage, the parameter that is being controlled will assume whatever value corresponds to zero error (equal to zero volts). Observing the Error Monitor enables the user to adjust offsets so that the locking point corresponds to the desired value of the controlled parameter. The error signal is also an excellent diagnostic for monitoring the lock condition and optimizing the feedback gain. Because the time domain behavior of the error signal is so important to understanding the feedback control, viewing the Error Monitor output on an oscilloscope is highly recommended.

Function generator output to LB2001 Sweep In: For detector signals that are derived from an optical resonance, it is convenient to sweep the transducer so that the optical frequency scans over the resonance. Observing the resonance on an oscilloscope often makes it easier to offset the error signal so that the locking point (at zero volts) aligns with the desired optical frequency. Furthermore, sweeping the transducer helps to locate the resonance and place the optical frequency within the locking range of the servo system. To add sweep capability, connect a low-frequency (30—60 Hz is usually sufficient) triangle waveform from a function generator to the Sweep In connector, as shown by connection 4a. The sweep signal will then be output to the transducer, with its amplitude controlled by the Sweep Span knob. To synchronize the sweep with the Error Monitor signal, also connect the function generator output to the oscilloscope's timebase trigger

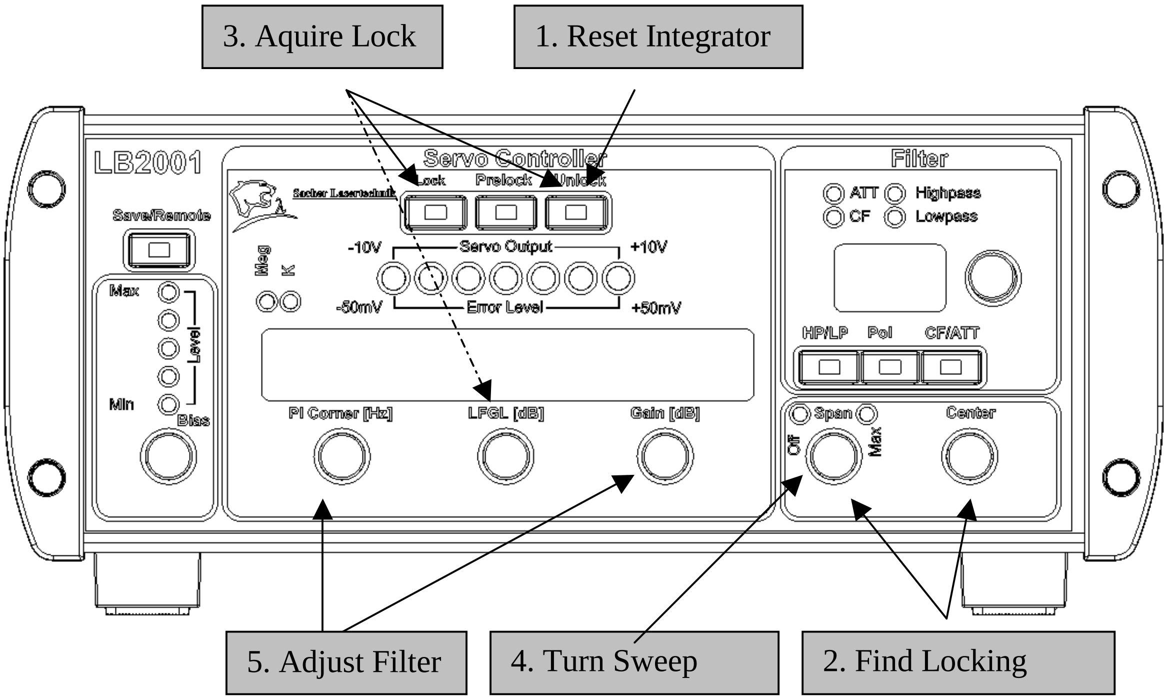
4.3. Typical Operation

The controls of the LB2001 are conveniently arranged for acquiring and optimizing lock. In this section, five steps are suggested that will meet the needs of most applications. Figure 5 shows the controls that are most likely to be adjusted for each step. The solid lines indicate controls that are used most often, while the dashed lines show controls that are less frequently adjusted.

Reset integrator: Before locking, reset the integrator by moving the Acquire switch to the Lock Off position.

Find the locking point: Many applications will require the user to search for the locking point, such as the side or center of an optical resonance. Turn on sweeping by clicking the Sweep Span knob from its Off position, adjusting it for a wide span. Use the Sweep Center knob to adjust the transducer bias so that the lock feature is "centered" within the scan. If needed, the desired lock point can be adjusted to zero voltage with the Input Offset knob while monitoring the error signal. Adjust both the Sweep Center and Sweep Span controls so that the oscilloscope scan shows the discriminator slope of the lock feature. Figure 4 illustrates these concepts for a "side lock" to a resonance.

Acquire lock: The Acquire toggle switch offers two gain settings for turning on the feedback control. When acquiring lock, sometimes it is helpful to limit the DC gain of the integrator. The LFGL position is an intermediate lock mode that applies the P-I filter with a low frequency gain limit. The LF Gain Limit front panel switch determines the setting for this gain limit, and is typically only set once for a specific servo application.



The Lock On position disables the low-frequency gain limit and applies the full integrator gain to the output. Most servo systems should be locked in this position to minimize DC errors. When correctly locked, the Error Monitor signal should be very near zero volts, and the LED indicator light should be green (see Figure 6 for more details.)

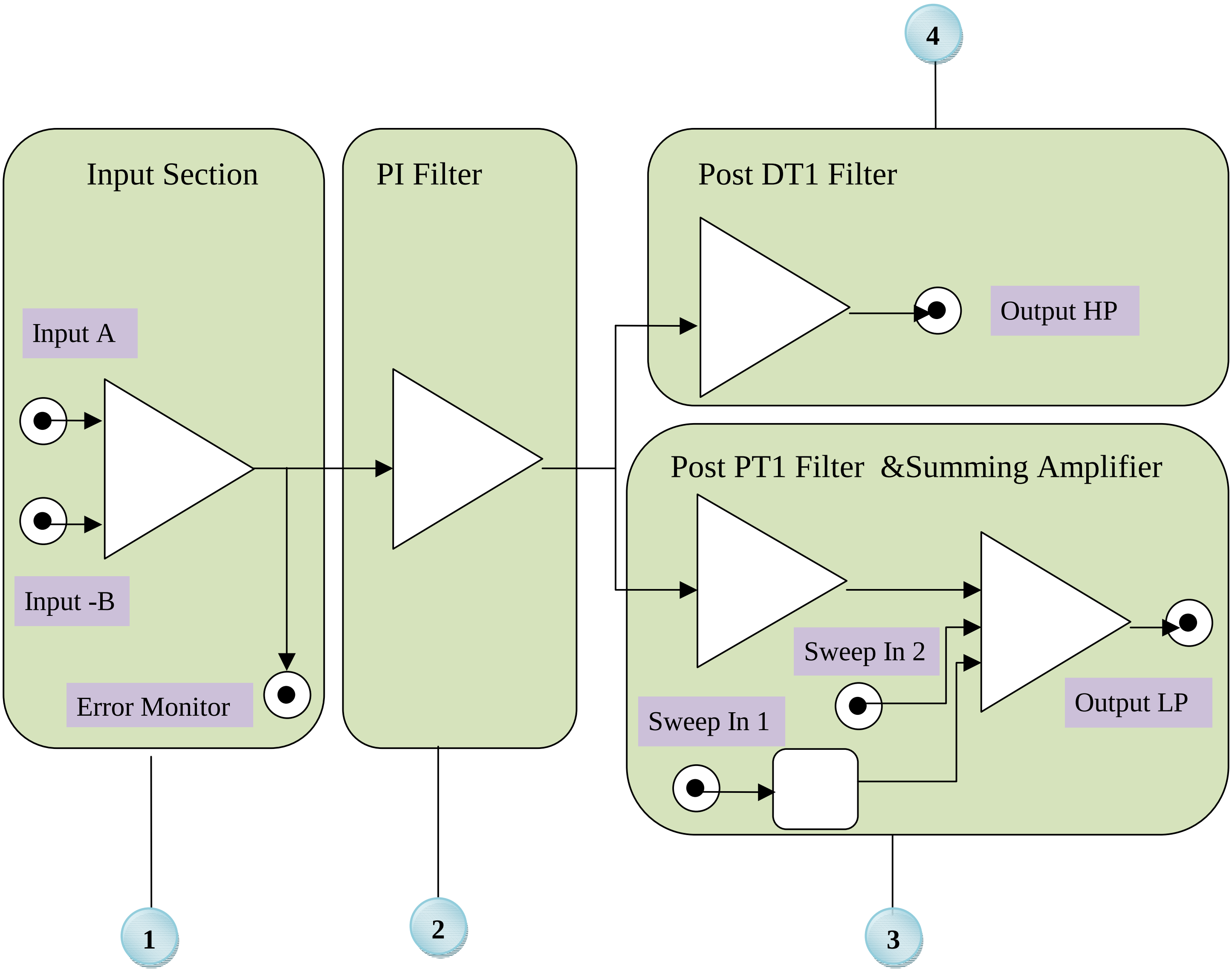
Turn off sweep: If the output was swept to find the lock point, then it is good practice to turn the Sweep Span knob to Off after acquiring lock. This completely disables the sweep signal, and prevents the feedback from working “overtime” to correct the error induced by the sweep signal.

Adjust filter: The P-I Corner frequency can be tuned for optimal performance and stability. Once optimized, it rarely needs to be revisited. However, re-tuning the Gain knob is done fairly often to find the maximum gain setting. A common procedure to is to increase the gain until an oscillation is observed on the Error Monitor, and then reduce the gain until the oscillation just barely stops.

5. System Overview

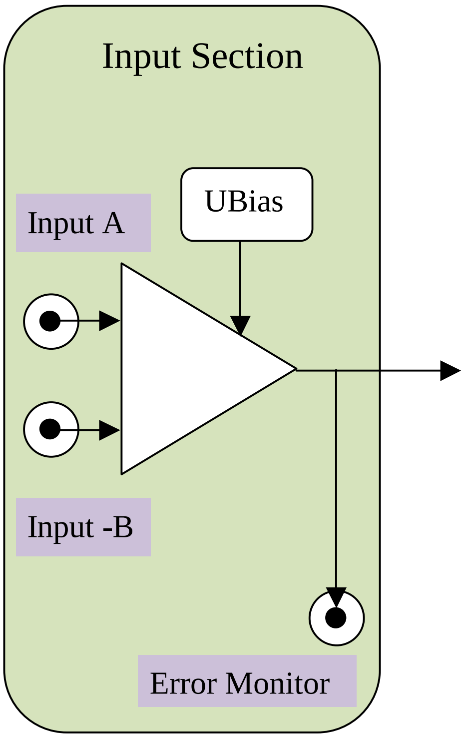
5.1. Signal Architecture

The LB2001 is comprised of 4 stages of analog signal processing. The following picture shows the different sections and how the various input signals are used to derive the output signal. Each section is briefly described below.



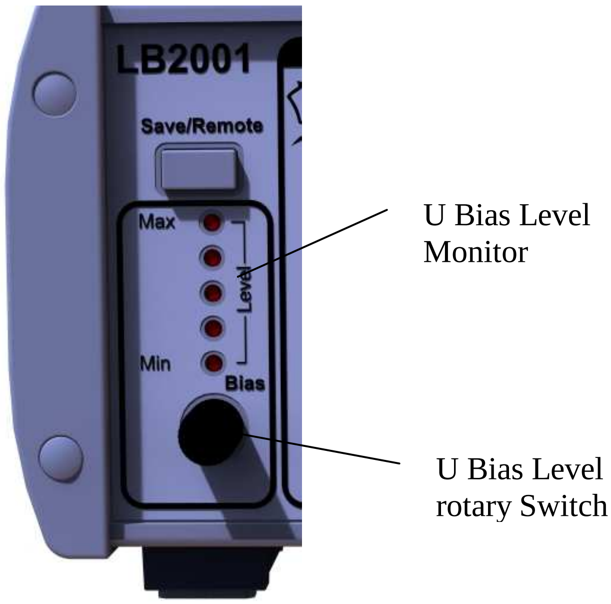
5.2. Input Section

The input section is a difference amplifier with an adjustable voltage offset (U Bias). Common-mode voltages ranging from ±10V can be subtracted. Error signals (observed at the Error Monitor Output) that exceed the voltage range ±330 mV saturate the filter amplifier.
A additional levelbar shows the status of the U Bias Signal.
The U bias signal could be adjusted from -10V to +10V.



The output signal is related to following equation.

$$Output = (InputA - InputB) - UBias$$

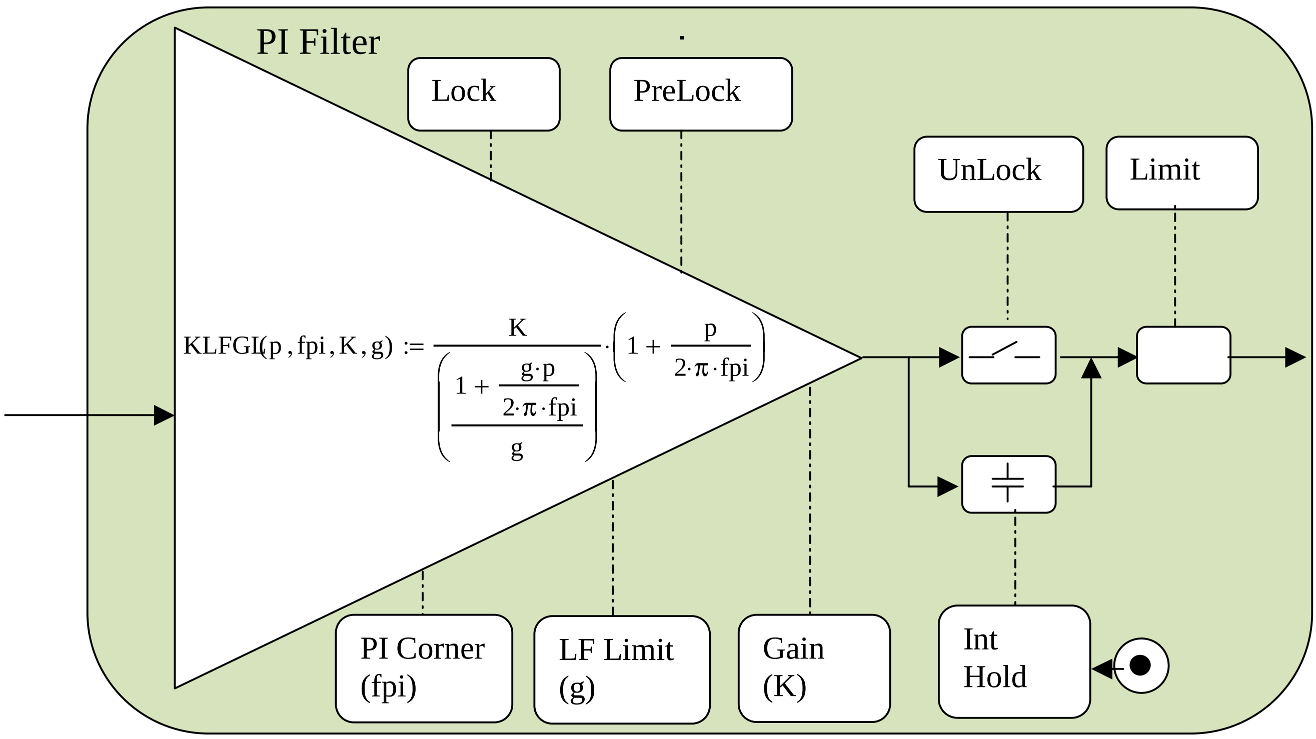


The output level of the input section is displayed on the “Error Level LED Bar”. When the output level exceeds the range of +/- 50mV the LED bar get flashing.

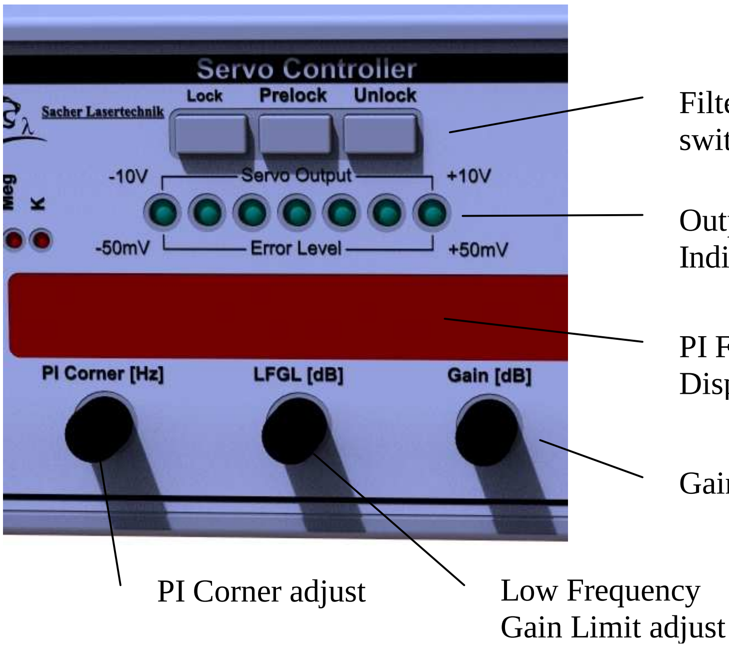
The U Bias level could be adjusted with the U Bias rotary switch. The default incremental step size is 0.3 mV. By pressing the switch the step size is increased to 80 mV

5.3. PI Filter

This section converts the error signal to a control signal with a proportional-integral (P-I) filter. Front panel controls adjust the overall loop gain, the P-I corner frequency, and an optional low-frequency gain limit. A toggle switch is used to disable/enable the output of the P-I filter for acquiring lock. See the next section for more details about the transfer functions available from this filter. An optional TTL input can be used to disable the error signal input and hold the P-I filter output at its current value



The PI Filter is fully configured on the front panel with the following elements



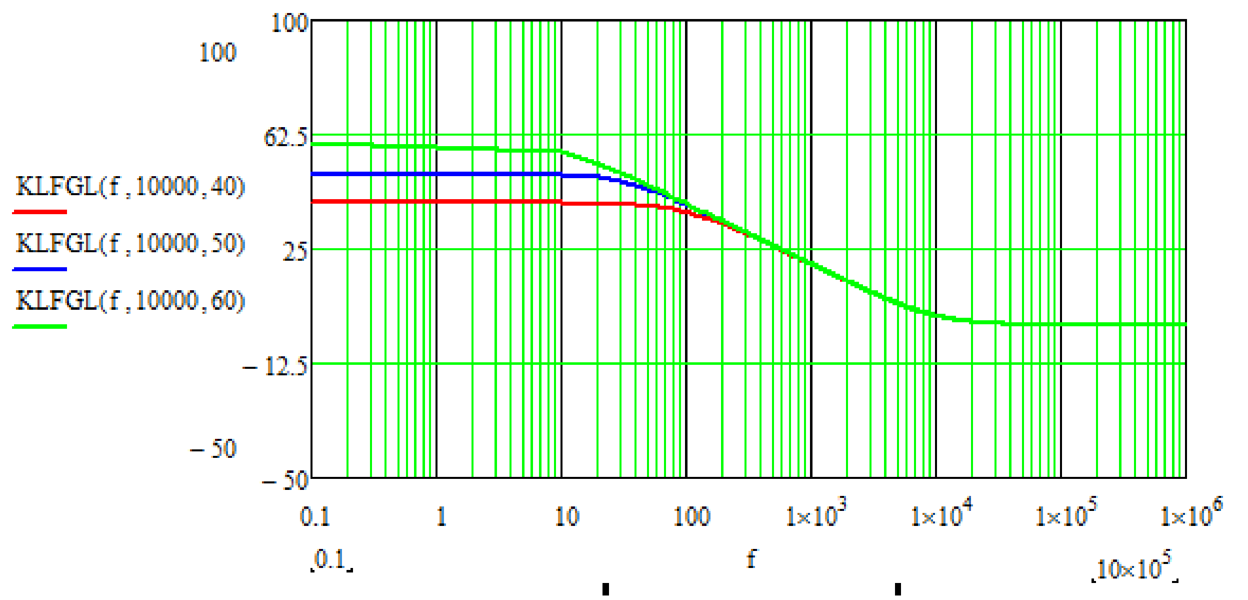
Filter Transfer Functions

The filter is specifically designed to have independent control over the three main parameters that shape the filter frequency response:

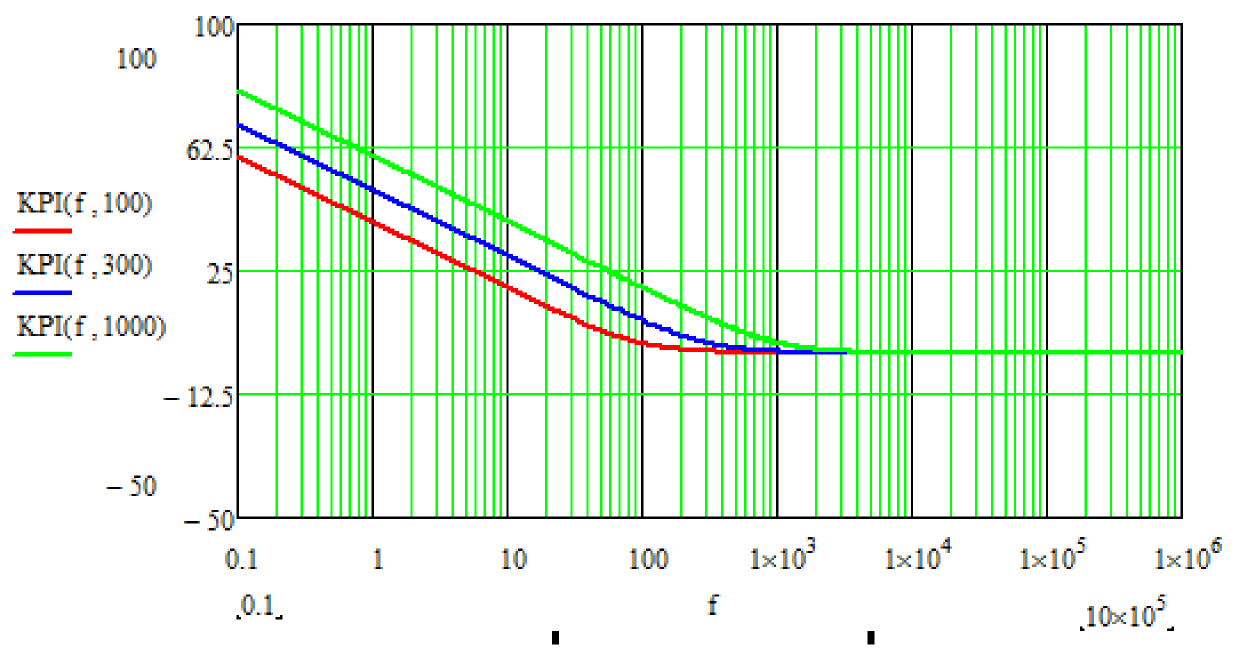
- **P-I Corner (*fPI*):** This is the 3-dB break frequency beyond which proportional gain dominates over integral gain.
- **Gain (*K*):** This is the amount of proportional gain. The gain can be adjusted continuously on a log scale. Changing this gain does not alter any of the corner frequencies of the filter.
- **LF Gain Limit (*g*):** This is the gain limit for low frequencies, as measured from the proportional gain value. The integrator is turned off for frequencies lower than the following 3-dB corner frequency
For the switch LFGL = 0dB the integral gain is completely turned off (g = 0), and the filter operates only in proportional mode.

The following graphs showed the frequency response of the PI Filter in both modes and

Frequency Response Prelock Mode with 3 different LFGL Levels



Frequency Response Lock Mode with 3 different corner frequencies



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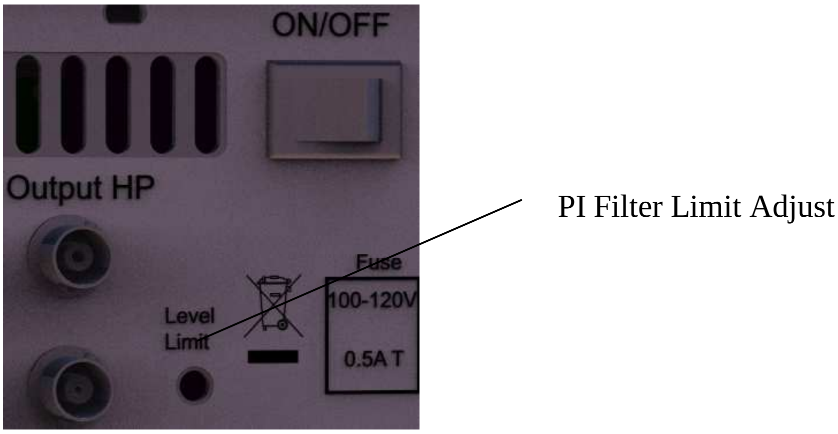
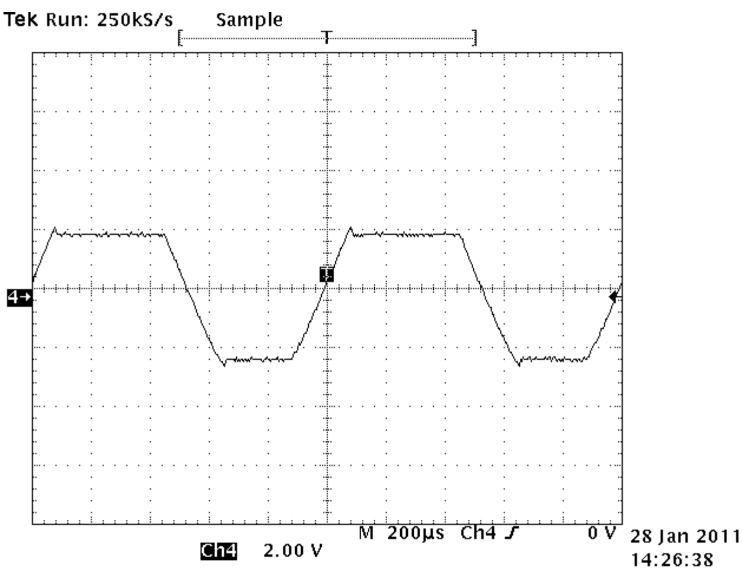
Filter parameters are limited to the values described in the next table.

PI Corner	OFF, 10Hz, 30Hz, 100Hz, 300Hz 1kHz,30kHz,100kHz,300kHz, 1MHz	
Low Frequency Gain Limit	0dB 10dB 20dB 30dB 40dB 50dB,60dB,70dB,80dB	
Gain	-40dB .. +40dB	1db Step Size

For some circumstances the output level of the filter must be limited.
Therefore a hardware limiter is implemented and could be adjusted on rear panel

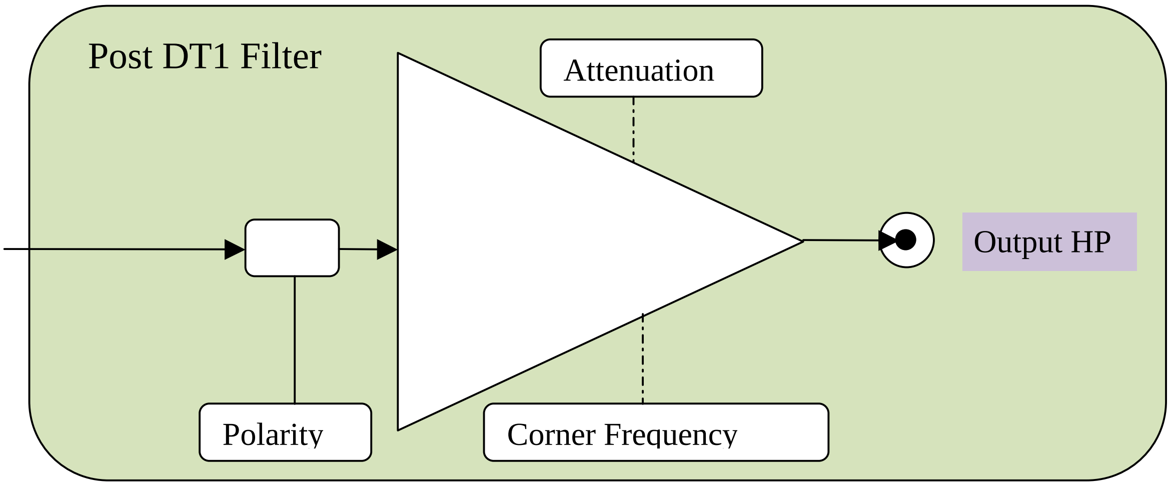


The following diagram shows a limited 1 kHz output signal

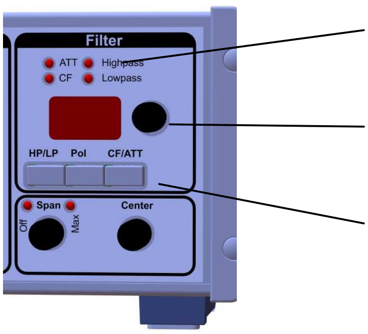


5.4. Post DT1 Filter

This section processed the PI Filter output to a control signal which is given to the Output HP connector on the rear panel. Front panel controls adjust the corner frequency and attenuation. A toggle switch is used to invert the polarity. See the next section for more details about the transfer functions available from this filter.



The DT1 Filter is fully configured on the front panel with the following elements



Filter Focus Indikator

Filter Parameter Adjust rotary Switch

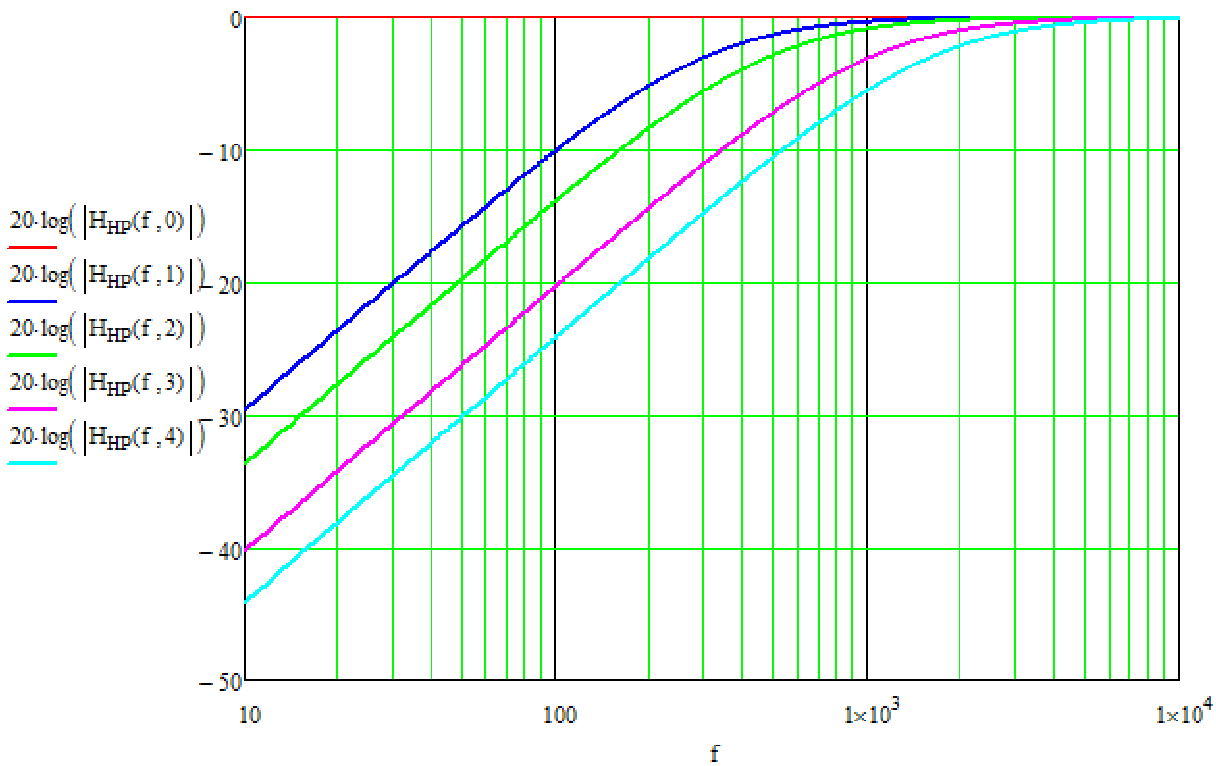
Filter Focus Switch

If one of the parameters needs to be adjusted first the focus switch has to be pressed. The focus indicator displays the parameter which know now could be adjusted.

Abbreviation	Parameter
ATT	Attenuation
CF	Corner Frequency
HP/LP	Highpass /Lowpass
POL	Polarity
CF / ATT	Corner Frequency / Attenuation

The following graphs showed the frequency response of the DT1 Filter

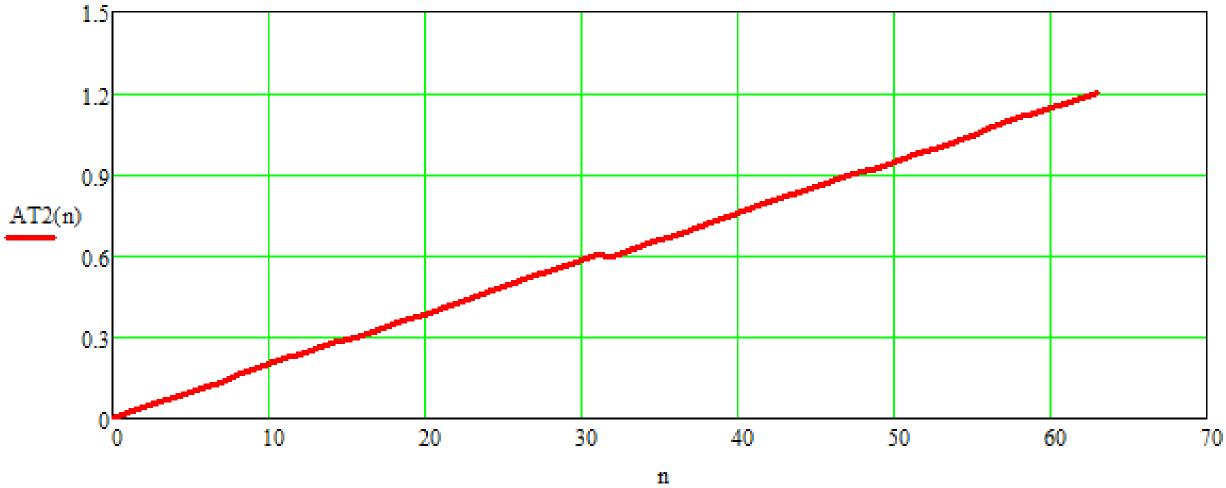
Frequeny Response DT1 Filter with 4 different corner frequencies



Only 4 different corner frequencies are possible to adjust.

Display	**Corner Frequency (fdt1)**
0	0.4 Hz
1	300 Hz
2	490 Hz
3	1100 Hz
4	1700 Hz

The following graphs showed the relationship between attenuation number and real attenuation
The attenuator is controlled by a 6 bit number. The range is 0 to 63

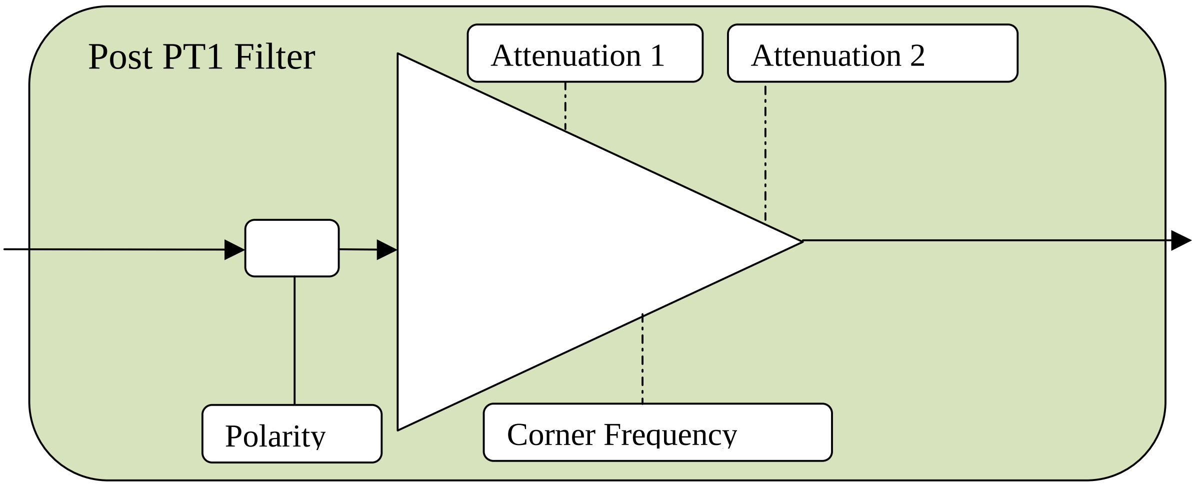


The whole frequency response of the DT1 Post filter could be described by following equation.

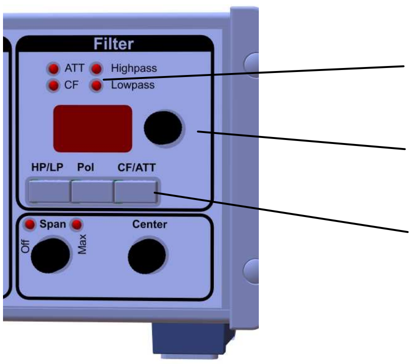
$$KDT1(A1, fdt1, s) := 1 \cdot \left(\frac{A1 + 1}{64} \cdot 1.2 \right) \frac{s}{s + 2 \cdot \pi \cdot fdt1}$$

5.5. Post PT1 Filter

This section processed the PI Filter output to a control which is given to the summing amplifier. Front panel controls adjust the corner frequency and attenuation. A toggle switch is used to invert the polarity. See the next section for more details about the transfer functions available from this filter.



The PT1 Filter is fully configured on the front panel with the following elements



Filter Focus Indikator

Filter Parameter Adjust rotary Switch

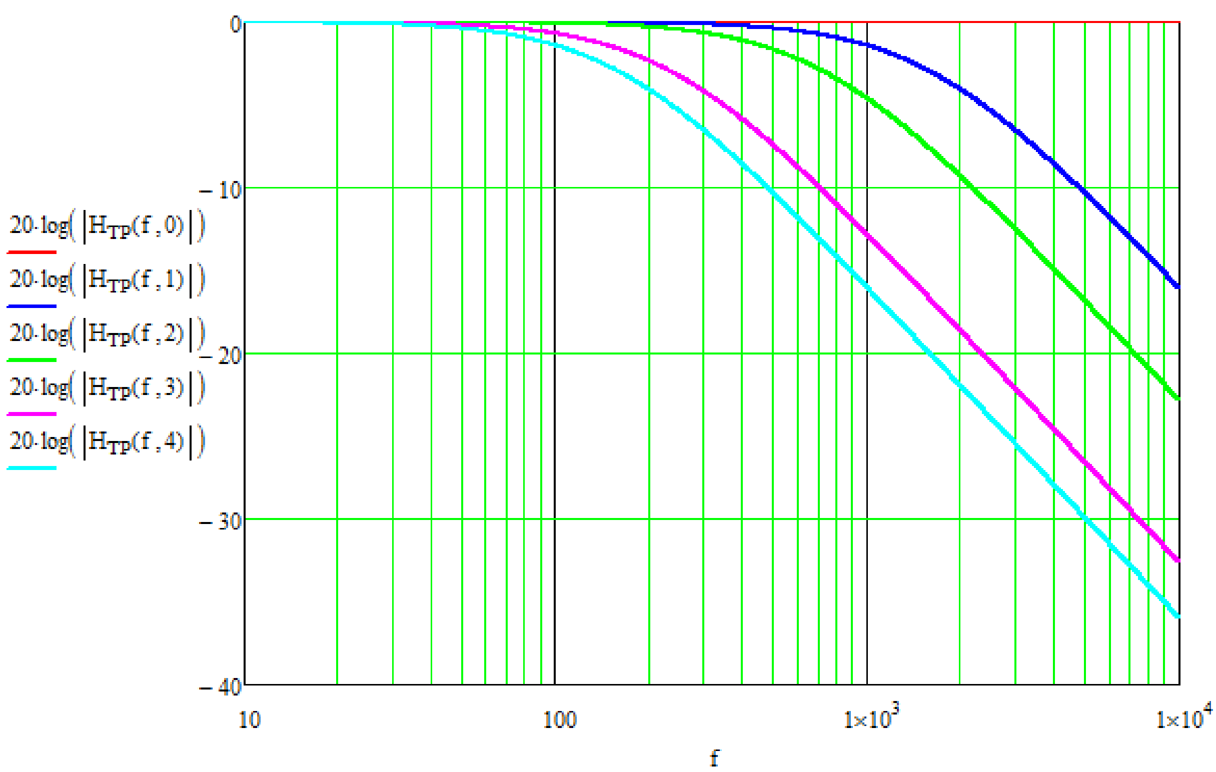
Filter Focus Switches

If one of the parameters needs to be adjusted first the focus switch has to be pressed. The focus indicator displays the parameter which know now could be adjusted.

Abbreviation	Parameter
ATT	Attenuation 1
ATT (flashing)	
CF	Corner Frequency
HP/LP	Highpass /Lowpass
POL	Polarity
CF / ATT	Corner Frequency / Attenuation

The following graphs showed the frequency response of the PT1

Frequeny response PT1 Filter with 4 different corner frequencies



Only 4 different corner frequencies are possible to adjust.

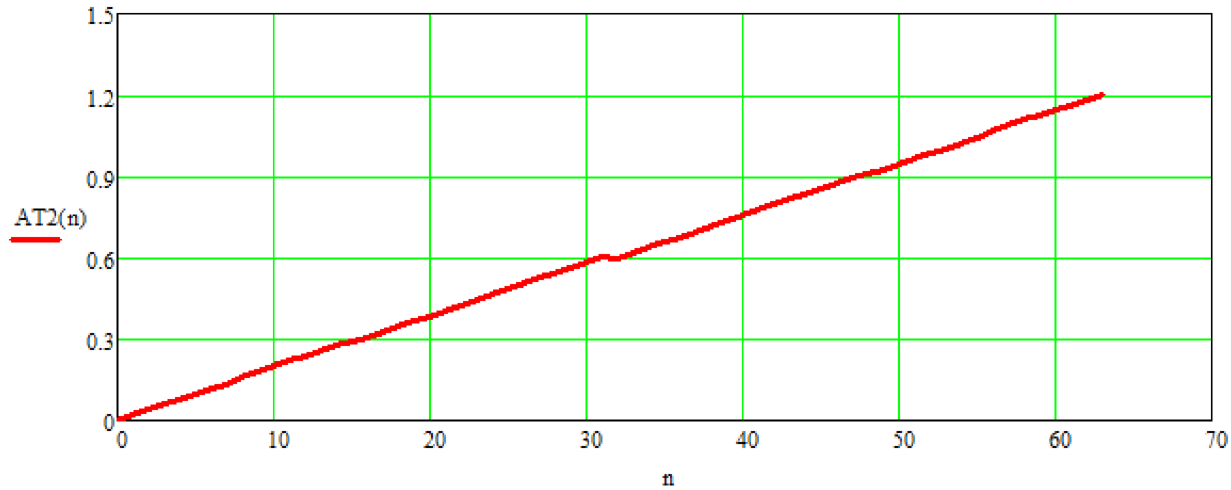
Display	**Corner Frequency (fpt1)**
0	Filter OFF
1	1,6 kHz Hz
2	720 Hz
3	250 Hz
4	160 Hz

Two attenuators are placed after the filter sections.
The first attenuator (ATT1) is controlled by a 2 bit word.
Possible settings are

0	Attenuation = 0 dB
1	Attenuation = -6 dB
2	Attenuation = -9 dB
3	Attenuation = -20 dB

The second attenuator is controlled by a 6 bit number. The range is 0 to 63

The following graphs showed the relationship between attenuation 2 number and real attenuation



The whole frequency response of the PT1 Post filter could be described by following equation.

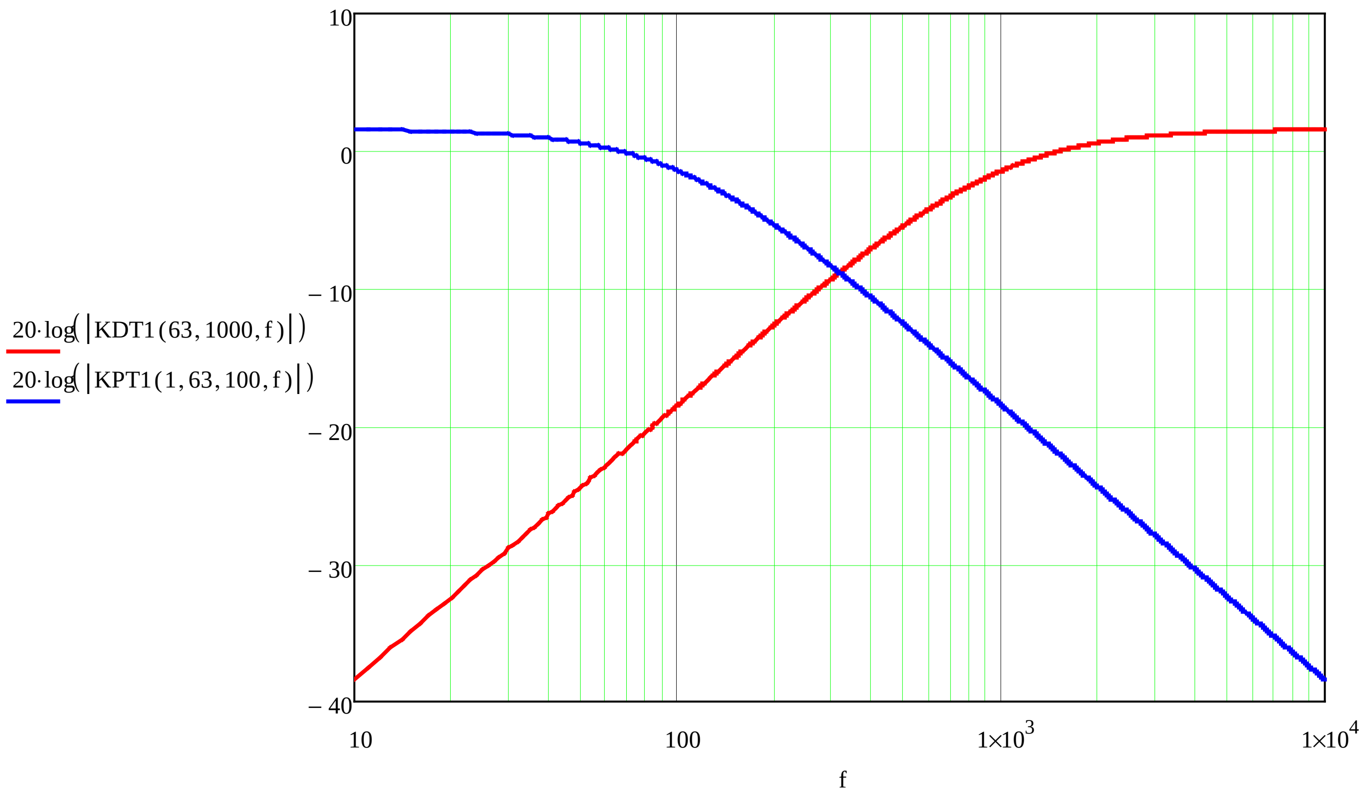
$$KPT1(A1, A2, fpt1, s) := A1 \cdot \frac{A2 + 1}{64} \cdot 1.2 \cdot \frac{2 \cdot \pi \cdot fpt1}{s + 2 \cdot \pi \cdot fpt1}$$

Adress: Sacher Lasertechnik GmbH Rudolf-Breitscheid-Str. 1-5 D-35037 Marburg, Germany
Tel.: +49 (6421) 305-0 Fax.: +49 (6421) 305-299 EMail: contact@sacher-laser.com Web: http://www.sacher-laser.com
Sacher Lasertechnik, LLC 5765 Equador Way Buena Park, CA 90620, USA
Tel.: 1-714-670-7605 Fax: 1-714-670-7662 Email: sales@sacher-laser.com

5.6. Frequency Splitter

DT1 and PT1 Filter should act as frequency splitter.
High frequency response of the error amplifier should be directed to the HP Output.
Low Frequency should go to the summing amplifier and then to the LP Output.

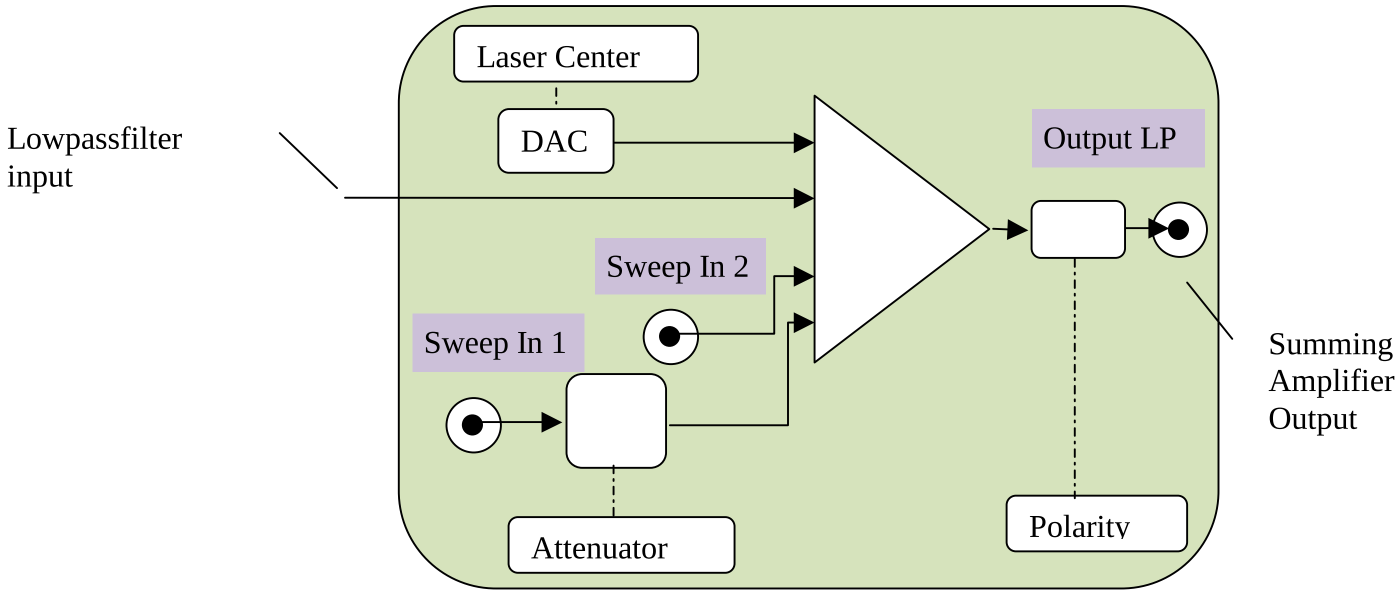
The following graph shows both filters in one picture as good a illustration of the frequency split.



5.7. Summing Amplifier

The LB2001 has two external modulation inputs that are independently available for such applications as adding a modulation frequency to the output for lock-in detection or summing in a feed-forward correction signal for improving the command response of the feedback control. The signals applied to these inputs are summed with the sweep and control signals to form the output signal.

Sweep In1 has a addition attenuator which is useful when laser scan should be successive reduced until the lock point is found.



The Laser Center level could be adjusted with the “Center” rotary switch. The default incremental step size is 0.3 mV. By pressing the switch the step size is increased to 80 mV

The Sweep In 1attenation level could be adjusted with the “Scan” rotary switch from 127 (Min attenuation to 0 (max. attenuation). The default incremental step size is 1. Two LED’s indicate when minimum and maximum rails are reached.

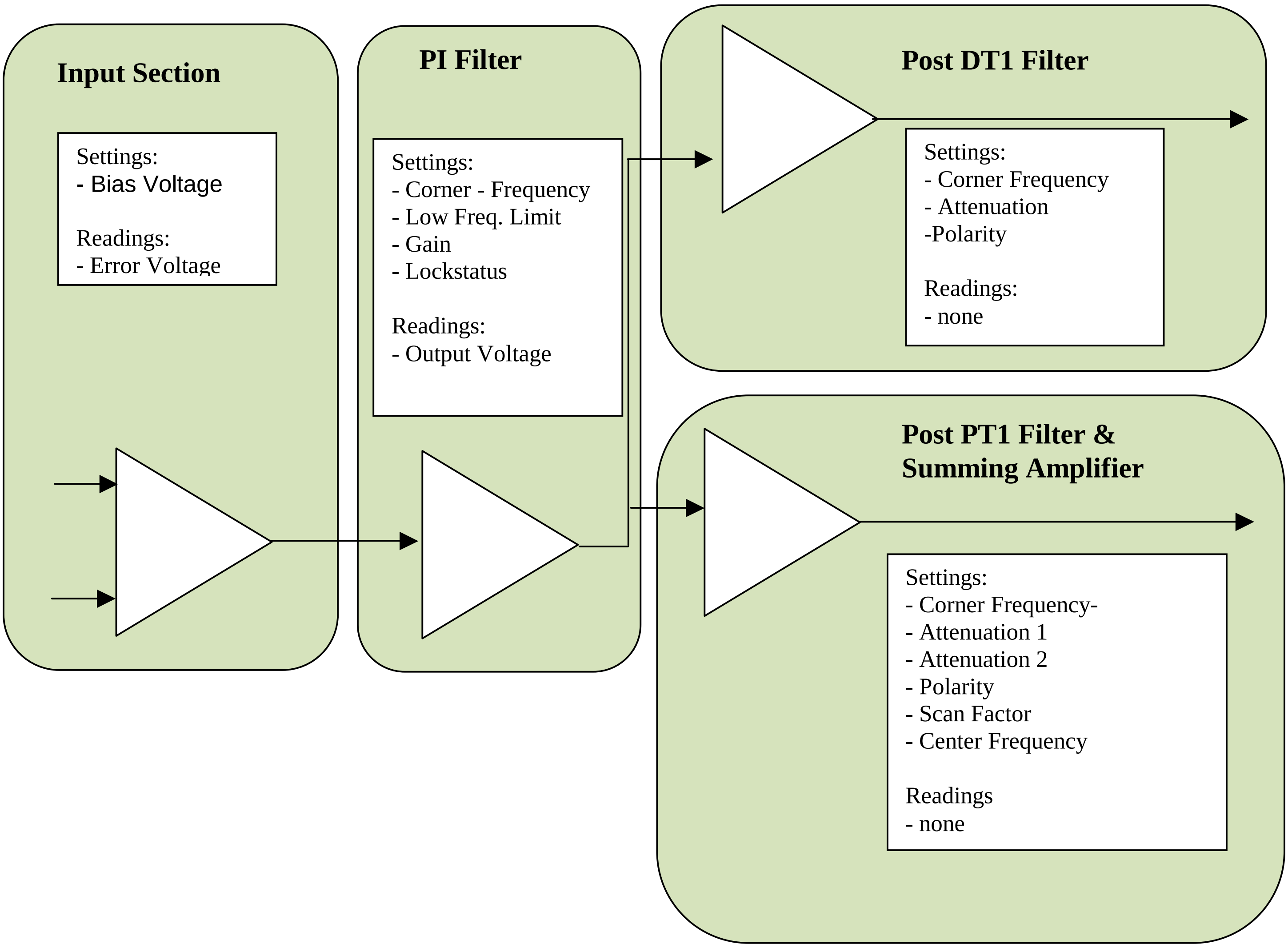
An additional amplifier with polarity control after the summing amplifier gives the user flexibility to adapt the servo controller to the end application.

The Modulation inputs are placed on the rear side of the housing

6. Remote Interface

6.1. Architecture

The LB2001 is equipped with a USB interface. All settings and information which is of shown on the frontpanel could be reached. The following picture shows the different sections and how the remote port are placed.



6.2. Serial Port Emulation

When connecting the LB2001 to the PC a serial port driver will be installed.

The following serial port settings must done.

RS-232 Settings	
baud rate	9600
data bits	8
parity	none
stop bit	1
flow control	none

6.3. Serial Port Commands

The interface accepts 2 ASCII commands. Every command need a fixed number of characters. A valid command will be echoed from the interface.

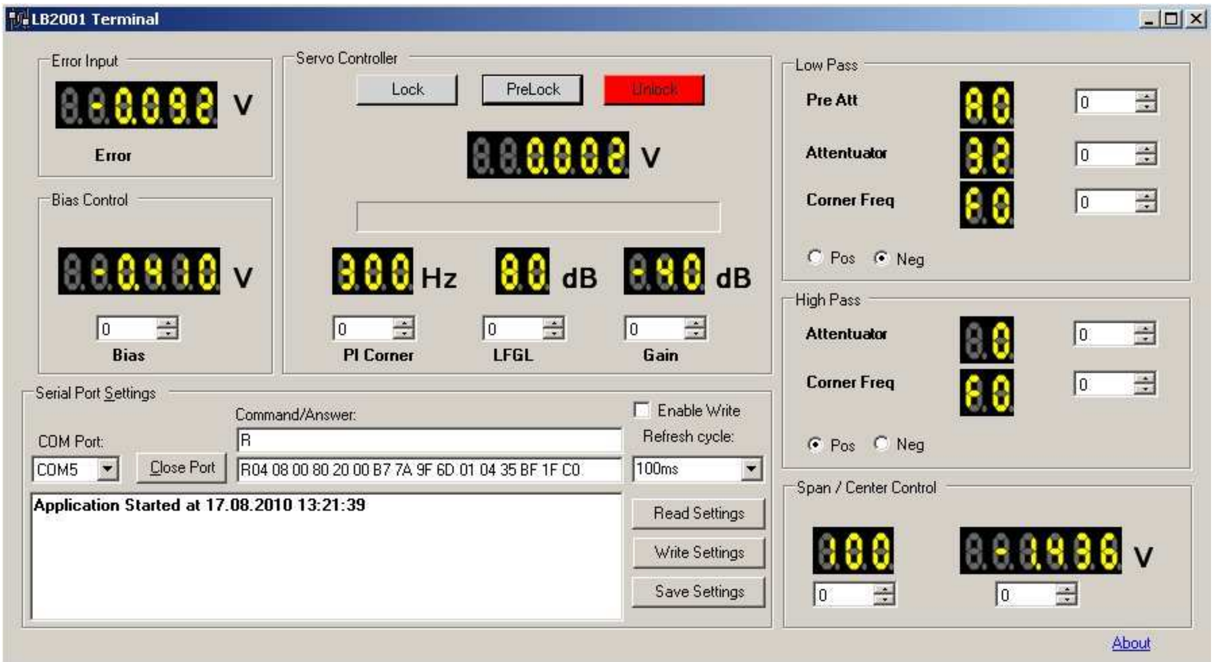
Read Parameter Command	
Syntax	**R**
Response	**Param0 Param2 … Param15**

Description	`Param0  = PI corner Frequency`
	`Param1  = Low frequency gain limit`
	`Param2  = Gain`
	`Param3  = Span`
	`Param4  = Low pass attenuator`
	`Param5  = High pass attenuator`
	`Param6  = Bias voltage high byte`
	`Param7  = Bias voltage low byte`
	`Param8  = Center voltage high byte`
	`Param9  = Center voltage low byte`
	`Param10 = low/high pass Polarity`
	`Param11 = Lockstatus & Preatt.`
	`Param12 = Error voltage high byte`
	`Param13 = Error voltage low byte`
	`Param14 = Integrator lvl high byte`
	`Param15 = Integrator lvl low byte`

Write Parameter Command	
Syntax	**W Param1 Param2 Param2… Param 16**
Response	**W Param1 Param2 Param2… Param 16**
Description	Param0 = 55 Param1 = AA Param2 = PI corner Frequency Param3 = Low frequency gain limit Param4 = Gain Param5 = Span Param6 = Low pass attenuator Param7 = High pass attenuator Param8 = Bias voltage high byte Param9 = Bias voltage low byte Param10 = Center voltage high byte Param11 = Center voltage low byte Param12 = low/high pass Polarity Param13 = Lockstatus & Preatt.

6.4. LB2001 Terminal

For easy use, the LB2001 is supplied with a terminal software shows a screen shot of the terminal software.



7. Specifications

7.1. Performance Specifications

Parameter	Sym	Min	Typ	Max	Unit	Condition
Input section: Difference amplifier						
Input impedance (A, -B)			100		kOhm	
Input Voltage noise density			tbd			
Common mode rejection ratio			tbd			
Input Offset voltage		-10		+10	V	
Error monitor output impedance			50		ohm	
Error monitor bandwidth			2		MHz	
Error monitor gain			1			
Error monitor output voltage		-10		+10		
Filter Section: (P-I controller						
Gain Range		-40		+40	dB	
PI corner frequency range		30		1*10^6	Hz	
Low frequency gain limit range		10		80	dB	
Filter parameter accuracy			10%			
Integrator hold “on” level			1.9		V	
Integrator hold “off” level			0.7		V	
Post DT1 Section						
DT1 corner frequency range		0.4		1700	Hz	
Signal Bandwidth (-3dB)			0.6		MHz	
Attenuation range						
Output Impedance			50		Ohm	
Output voltage range		-10		+10	V	
Max output current						
Post PT1 Section						
PT1 corner frequency range		0		1600	Hz	
Signal Bandwidth (-3dB)			0.25		MHz	
Attenuation range						
Output Impedance			50		Ohm	
Output voltage range		-10		+10	V	
Summing amplifier						
Sweep 1 input impedance			1		kohm	
Sweep 2 input impedance			10		kohm	
Sweep span attenuation		16		100	%	
Sweep center bias voltage		-10		+10	V	
Max output current			5			

7.2. Environmental Specifications

Parameter	Min	Typ	Max	Unit	Condition
Operating temperature	10		40	℃	
Transportation/ staorage temperature	-40		80	℃	
Maximum relative humidity			80	%	
Maximum operating altitude			2000	m	
Instrument weight		4		kg	

7.3. Electrical Specifications

Parameter	Classification
Use type	Indoor use Only
Protection	Ordinary Protection
Equipment class	Calss I (Grounded Type)
Electrical rating	115/230V~ 0.5/0.25A 50/60Hz
Voltage tolerance	+/-15%
Fuse rating	115V 0.5A T or 250C 0.25A T 5mm x 20mm
Ambient pollution	
Transient overvoltage	

7.4. Dimensions

Dimensions in mm