LinearAmp

(Ver.4)

Signal Conditioner Amplifier System

User's Manual

SUPERTECH Instruments

Comparison and general features of the LinearAmp system

In our choice there are three different amplifier systems. This booklet describes the LinearAmp amplifier family. Our other amplifier products are BioAmp and MultiAmp families. All of them are up-to-date, easy to use, highly reliable, microprocessor-controlled constructions. We manufacture three different amplifier families, because the three product lines are optimized for different application fields. Please read through the appropriate descriptions at the website of Supertech for the details.

LinearAmp amplifier is optimized for high-precision signal conditioning tasks in bioelectrical recording.

LinearAmp is a programmable amplifier, but it has (nearly) no sampling circuits in the signal path at all, except the 8-pole switched-capacitor low pass filter. In other words, it is controlled by a built-in microcontroller, or a remote computer, but it has got only high-performance, low noise, low distortion analogue amplifier circuits. This feature is indispensable when you use averaging techniques for processing its output signal. The internal microcontroller and the optional digital port (which offers remote control facility from a PC) are optically isolated from the amplifier stages. In this way we could connect all the advantages of high accuracy analogue amplifier circuits, and easy usage of digital control.

Although LinearAmp is programmable equipment, it does not need a separate computer to work. According to this fact, it can be used as a stand-alone amplifier (while possessing an optional serial port to communicate with a PC). This stand-alone feature is very comfortable, because the computer is always given, but it should be used to collect, and processing the experimental data. LinearAmp's microcontroller on the front panel has got a 3-button keypad, and menu-driven internal software, so it is very friendly to use.

The internal structure of LinearAmp is modular, so the number of the amplifier channels, and the number of the microcontrollers built in one equipment can be decided independently. Only the aspects of the application field should be considered when we decide, how many amplifier channels, and how many microcontrollers will be placed in the cage of the equipment (for example it is comfortable to use only one microcontroller to program all the EEG channels together, but another controller should be used, if there is a single unit channel in the system, and a third controller is necessary, if there are further channels for ECG).

Independently of the number of the microcontrollers, every amplifier channel has got their own DC offset correction circuits, even in a multi-channel system. The voltage range of the offset correction is +/- 200 mV, with 0.1 mV of resolution. In our choice there are two different solutions for the offset correction circuit. One of them is the analogue version with a 10-turn helical potmeter and a digital panelmeter on the front of the equipment. The other version is the digital realization of the same task: a separated microcontroller, dealing with the numerical control of the offset voltage. The actual version should be specified in the order.

Technical data

One of the most sophisticated features of LinearAmp is its Low Pass Filter. This circuit is an 8-pole, Bessel-type filter with linear phase response. This special, high quality Low Pass Filter is necessary to realize the anti-aliasing function, which is indispensable before the analogue to digital conversion.

In the LinearAmp the High Pass Filter, the Low Pass Filter, and the Gain have got 8 possible positions. The actual values, realized during the manufacturing process can be ordered with the default parameters, but they can be requested with special values, to meet any special requirements, as well. The default values for the Filter and Gain sections are listed below. Any combination of the parameters can be selected; even the invalid settings (for instance, if the High Pass Filter is set to higher frequency, than the Low Pass Filter). The invalid settings result no faults in the equipment, only the output voltage will be driven to zero.

High Pass Filter settings:

- DC (0 Hz)
- 0.16 Hz (1 s)
- 0.53 Hz (0.3 s)
- 1.6 Hz (0.1 s)
- 5.3 Hz (0.03 s)
- 10 Hz
- 30 Hz
- 100 Hz

Low Pass Filter settings:

- 100 Hz
- 200 Hz
- 500 Hz
- 1 kHz
- 2 kHz
- 5 kHz
- 10 kHz
- 20 kHz

Gain settings:

- 0.5
- 1
- 2
- 5
- 10
- 20
- 50
- 100

The Notch Filter (hum noise filter) of the LinearAmp is tuned to 50 Hz (or optionally to 60 Hz). The Notch Filter can be switched on and off in the software running on the

microcontrollers. The rejection ratio of the Notch Filter on its central frequency is 40 dB.

There is a possibility to select the full amplifier chain of LinearAmp as Inverting or Noninverting characteristics. This selection is also a menu point of the software running on the microcontrollers.

There is a general Bypass function in LinearAmp. It is also a programmable feature. The Bypass function is not a simple shortcut wire switched between the Input, and the Output connectors of LinearAmp. If the Bypass function is activated, the equipment behaves as a voltage follower, but provides voltage swing limitation for both polarities on the Output. This feature is useful to protect the analogue to digital converter connected to the Output against any faulty input signals appearing on the Input connector of LinearAmp. In extremely worst case LinearAmp behaves as a suicide protector equipment.

If the LinearAmp is used in human experiments, an additional optical isolator circuit should be ordered for every channel with 4 kV of isolation voltage. The optical isolator does not modify any parameter of LinearAmp, because the isolator circuit has got unity gain, with noninverting characteristics.

Noise

The noise level of LinearAmp was measured under the following conditions. The input signal applied to the input of LinearAmp was generated by a battery-powered square wave generator. The output impedance of this generator was 470 Ohms. The measured noise voltages were referred to the input of the LinearAmp (in other words, they were measured at the output, but they were calculated to the input, divided by the actual Gain). The actual settings of the LinearAmp amplifier, except the Low Pass Filter, have negligible effect for the total noise characteristics. The noise level depends mainly on the Low Pass Filter setting. The results of the noise measurement are:

If the bandwidth is 20 kHz (the low pass filter is opened to the widest range), the input noise RMS voltage is less than 12 microVolts (50 microVolts peak-to-peak).

If the bandwidth is limited to 2 kHz with the low pass filter, the input noise RMS voltage is less than 5 microVolts (20 microVolts peak-to- peak).

If the bandwidth is limited to 500 Hz with the low pass filter, the input noise RMS voltage is less than 2.5 microVolts (10 microVolts peak-to- peak).

The difference between amplifier models mostly depends on the quality of the design. Such features as hum noise, square wave transient response, phase response, frequency domain characteristics, ability of parasite oscillations, thermal stability, reliability, etc. are responsibility of the designer. But there is no real difference in the signal to noise ratios of signal conditioner amplifiers manufactured by different firms.

The signal to noise ratio depends on the internal design of the operational (and instrumentational) amplifier integrated circuits. The race of the smaller electronic noise is a race of the semiconductor manufacturers. The designer can only choose from the good amplifiers, from the leader semiconductor factories.

Ground topology

There is a general design method in the high gain amplifiers, what is applied in LinearAmp, as well. Usually in the signal conditioner amplifiers (as in our amplifiers, too, if optical isolators are not used) the Input GND, and Output GND points are connected together internally. The ohmic resistance between them is less than 0.05 Ohms. However they are signed as different points, because in the interior of the amplifier the ground network forms a linear topology, not a single-point GND (as it is advised in the text-books). The suppression of the hum noise is better, if the ground line follows the signal line linearly according to the increasing signal amplitudes from the input to the output. To establish a single-point shielding ground is a good solution at the output end of the signal ground line. Unfortunately the security ground wires are also connected to the metal enclosures of the equipments. The security ground wires are usually hum noise sources for the signal conditioner amplifiers (because they usually drive some mains-frequency fault currents from other equipments, from other rooms), but they must not be disconnected, they are compulsory to be used. If you use a mains isolation transformer with symmetrical secondary coil, you can eliminate the disadvantage of the security ground (if in your lab it is allowed to use, please check the local rules). The Faraday-cage, metal parts in the Faraday-cage, the oscilloscope, the PC, the Output GND of the amplifier, and the real, separated signal ground line (coming from the earth directly, if it is available) should be connected to this single-point shielding ground. But the ground point of the input circuitry should be isolated from the shielding ground point (special care should be taken with the metal parts close to the input in the Faraday-cage). The Input GND point of the amplifier is used to provide a low impedance ground to the input circuitry only.

Connectors

The input and output connectors of LinearAmp amplifiers are standard BNC sockets. Output GND is a 4-mm banana female connector. Output GND point is common to the mains GND, the GND point of the Output BNC sockets and the metal parts of the equipment case. The Input BNC sockets are isolated from the back plate. The Input GND point is the GND point of the Input BNC socket(s).

Warranty

We give you full warranty service, including rest parts for the period of 5 years by default. Longer warranty periods can also be defined and agreed (the actual conditions should be discussed before placing the order). Usually and basically we repair the faulty equipments in our workshop. The expense of the shipment should be covered by our customers.

Further information sources

Technical hotline via email (all of them work):
office@superte.ch
office@supertechinstruments.co.uk
office@super-tech.eu

International technical hotline on the phone: +36 20 9234 386

For further technical information please visit our websites. Supertech Instruments continuously uses four websites with the same content. Please use that one, which is easiest for you to remember:
www.superte.ch
www.supertechinstruments.co.uk
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