Linear Audio Auto-ranging Attenuator

Draft

User Guide

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Introduction

The Linear Audio Auto-ranging Attenuator (AR) is an automatic signal level adjustment unit intended for use with audio soundcard measurements. The AR attenuates or amplifies the signal to be measured to the level expected by the soundcard.

Display and controls

The controls and indicators of the AR are logically grouped according to the signal flow from input to output, see figure 1.

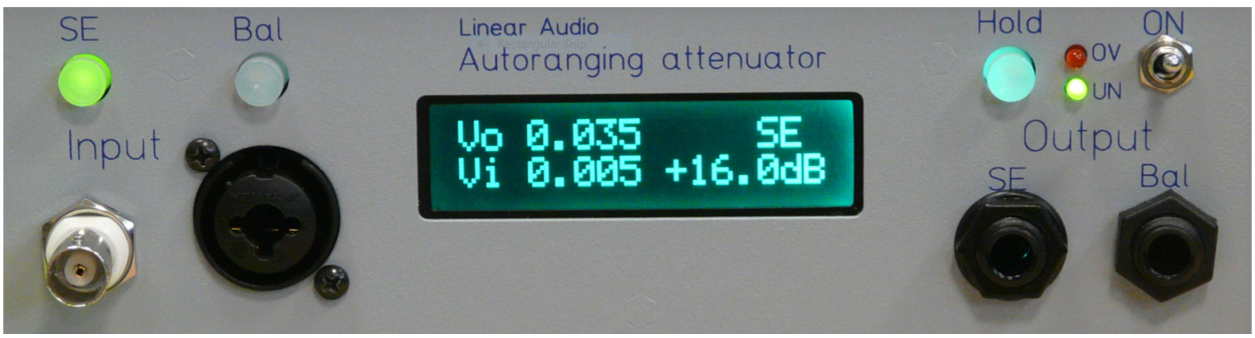

Figure 1 AR front panel layout

At the left side are the signal input jacks; there is a BNC jack for single-ended signals and a combined XLR/TRS jack for balanced signals. Selection of either input is via the two momentary illuminated pushbuttons above the connectors, **SE** and **Bal**.

The display in the middle shows input- and output signal levels in V RMS and the attenuation or gain the input signal is subjected to, as described later. The display color can be set to Green, Red or Blue with an internal jumper (see *Display color*).

At the right side of the front panel are the two simultaneously available single ended and balanced output signals for connection to the soundcard input. Connectors are TRS type.

Above the output connectors are the **Hold** momentarily pushbutton (to be described) as well as the **Over**- and **Under-range** indicators. These will light up when the input signal is too small (Under-range) or too large (Over-range) for the unit to auto-range to the selected output level.

The Under- and Over-range indicators are normally off or will briefly flash when the unit changes the attenuation or gain setting while auto-ranging. When **Hold** (see *Manual Operation*) is activated, the Over- and Under-range indicators may be lit continuously depending in the input signal levels and actual attenuation or gain setting.

The **ON** switch is self-explanatory.

Default settings

At switch-on the unit defaults to single ended input and auto-range mode. The display briefly shows the accuracy calibration setting in force (see *Level meter accuracy adjustment*) as well as the nominal output level the unit will use to auto-range to (see *1 Automatic mode; Range selection).*

Power supply

The AR runs off an internal ‘SilentSwitcher’ which can be powered through a B-type USB connector on the back side. Normally this should be run off a standard 5V USB charger. For extremely sensitive measurements, the AR can be run off a standard 5V PowerBank for full mains isolation.

Display color and contrast

The display has three-color LEDs for backlighting and any one (or several at the same time) can be selected with jumpers. There is also a trim pot to adjust the contrast setting; the optimum setting may be different for different colors. Figure 2 shows the location of the jumpers and the trimpot at the back of the front panel PCB.

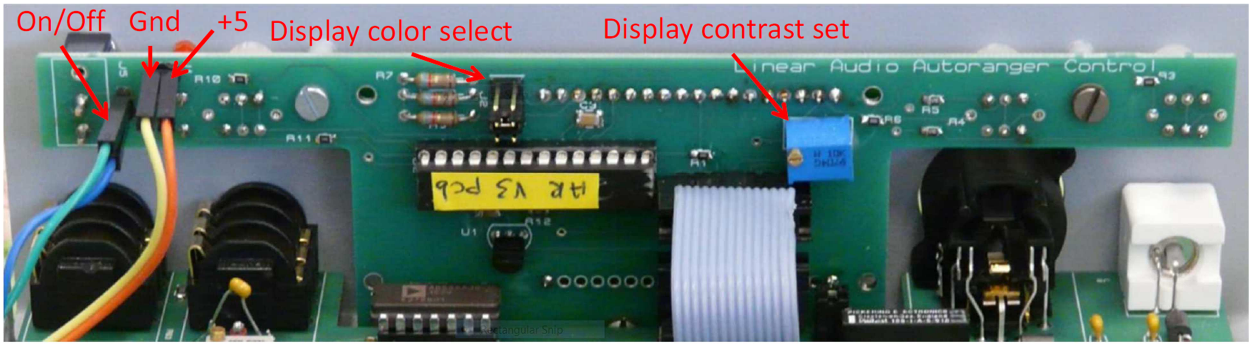

Figure 2 Display color and contrast setting on front panel PCB

Modes of Operation

1 Automatic mode

The AR usually operates, as its name implies, in automatic mode. In this mode, which is default at switch-on, the signal to be measured is input at either the single ended or the balanced input, and the AR provides a single ended and balanced output simultaneously, at a level suitable for a soundcard. This output level remains close to a predetermined nominal level. No further user action is required in this mode of operation.

Range selection

Two nominal output levels (in Vrms) are available as shown in **Table 1**.

Nominal Vout	1.2	1.6
Max Vout	1.5	2.1
Min Vout	0.8	1.0

Table 1 – automatic mode output levels

Selection between the two ranges is done with a jumper at position J1 (see picture 2). This jumper should be changed with the unit switched off; the jumper position is read at switch-on and the selected range will then be set.

2 Manual mode

The AR can also operate in Manual Mode. This mode is initiated by pressing the **Hold** button. When pressed, the specific attenuation or gain setting in force at that moment will be locked in and will be maintained independent of changes in the level of the signal to be measured at the AR input.

When in manual mode, the input selection pushbuttons take on a secondary function. Pressing the **SE** input button will switch the attenuation to -20dB; pressing the **Bal** input button will set the attenuation to -40dB. Again, these settings will then be maintained independent of the input signal level. Pressing either the **SE** or **Bal** input button again will revert the setting to the one that was in force when **Hold** was pressed.

One important use of the manual settings is for level sweeps. For instance, suppose you want to measure your amplifiers' harmonic distortion as a function of signal level. You would then set the maximum level expected and let the AR attenuate it for the soundcard input level. You then press **Hold** to lock in the attenuator setting. You can now sweep the amplifier output level and the input level to the soundcard will vary from zero to the maximum set before. Of course, in the final measurement result you need to correct the signal level for the AR attenuator dB setting shown in the AR display.

Calibration

For the AR to meet its specified performance, a calibration process should be executed. This is set up such that it can be easily performed with a signal generator and an AC RMS voltmeter. To eliminate as much as possible the influence of the voltmeter accuracy, measurements are either minimum adjustments or level ratio adjustments, but the better the voltmeter is in terms of accuracy and RMS frequency range the better.

1 Level meter accuracy adjustment.

The AR has a build-in AC RMS voltmeter to help in assessing the signal level going into the sound card. This indication is not meant to replace the soundcard/software measurement capability but it gives additional confidence that the unit is operating correctly, and it can be calibrated for better than 1% accuracy. The final accuracy depends on the accuracy of the AC voltmeter used.

The AR display also shows the input level it receives. This level is calculated from the measured output level going into the sound card and the attenuator/gain setting. It is shown both as Vin in Vrms and the dB attenuation or gain the input signal is subjected to.

2 Common mode suppression adjustment

This requires a pair of adjustments for maximum common mode suppression, and can be executed with a 1kHz signal generator and a sensitive AC voltmeter.

3 Attenuator frequency response adjustment

For low and medium frequencies, the accuracy of the attenuation and gain steps is +/- 0.1dB by design. This can be extended to 100kHz by executing the frequency response calibration. This can be done with any signal generator that has the required frequency range, and an AC RMS voltmeter. The method followed is first to measure the attenuation at a low frequency to establish the voltmeter ratio accuracy, and then adjusting a capacitive trimmer for the same attenuation at a high frequency.

4 Calibration procedures

A separate spreadsheet contains the calibration procedures. The correct order is first to do the level meter accuracy and common mode adjustments, and then the frequency response adjustments for single ended and balanced inputs. To perform the calibration procedure, the cover of the unit has to be removed and test signals inserted and/or measured at internal test points as indicated in the calibration procedure.

Appendix 1 - Requirements for the calibration equipment.

As noted, the calibration procedures are performed with the aid of a signal generator and an AC RMS voltmeter.

Signal generator

In the calibration procedure the signal generator is called upon to supply output levels up to 10V or more, at frequencies up to 100kHz. Not all signal generators will be able to output 10VRMS. If possible, try to use an external (pre)amplifier; this does not need to be low distortion as signal wave shape is not important.

If you cannot provide 10V levels, you can perform the calibration at lower levels like 5V. In this case, all instances of '10V level' in the calibration procedures should be read as '5V level' or whatever you have selected, but do no change should be made to the procedure to maintain future compatibility.

At one point in the CMRR calibration a 'maximum signal level, but not higher than 100V RMS' is called out. This will normally not be available and the procedure can be done with the maximum level available, if possible via an external amplifier.

AC RMS voltmeter

The AC RMS voltmeter is called upon various tasks:

Level meter accuracy adjustment.

This is an important requirement for the accuracy of the displayed level. The internal A/D converter in the AR has an LSB of 4mV so you would like the AC voltmeter to have a similar or better accuracy at the 1V calibration level. The actual voltmeter accuracy has a direct 1:1 impact on the AR display accuracy.

CMRR measurement

This calibration requires a nulling adjustment measuring signals in the range of around a mV. The AC voltmeter residual should be below this.

Frequency response calibration

The frequency response calibration relies mainly on the ratio accuracy of the AC voltmeter. This means that the voltmeter should indicate two levels that are a factor 10 different in amplitude, as a factor 10 different in level, at better than 1%. Similar for two signals that differ a factor 100 in ratio. If this cannot be guaranteed at 100kHz, the calibration can be done at a lower ‘high frequency’ like 50kHz or even lower, with slightly less response flatness.

If you wish to do this, all instances of ‘100kHz’ in the calibration procedure should be read as ‘50kHz’ or whatever you have selected, but no change should be made to the procedure to maintain future compatibility.

Appendix 2 – Location of test points and adjustment controls as called out in the calibration procedures, as well as the power supply connections, are shown in (**figure 3**).

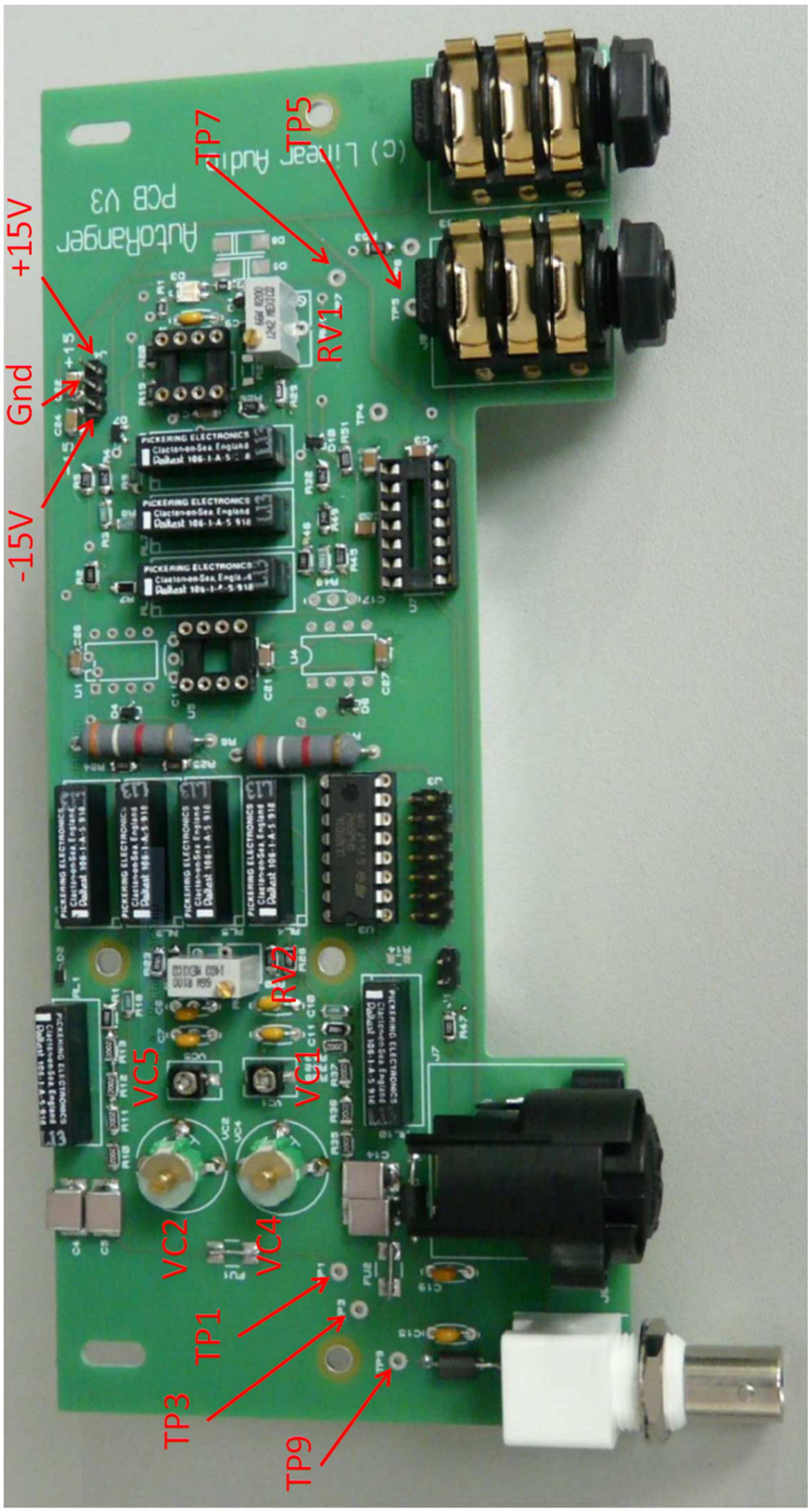

Figure 3 Location of test points and adjustment controls