Keysight Technologies

Maximizing Dynamic Range on the U8903B Audio Analyzer

Application Note

The U8903B Audio Analyzer has 6 input ranges allowing it to directly measure from microvolts up to a maximum of 140 vRMS on the unbalanced BNC input. This wide range covers the vast majority of measurement requirements. When measuring THD+N or signal to noise ratios to the limits of performance however, the user needs to be aware of ranging implications.

This note shows how the U8903-109 BNC accessory kit can be used to make an attenuator that can be used to position a given input signal at the top of a particular range thereby maximising dynamic range.

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Ranging

The U8903B has 6 input ranges spaced at 10 dB intervals. The lowest range is 0.32 vRMS and the highest is 140 vRMS on the unbalanced input or 300 vRMS on the balanced input. This discrete number of ranges is common amongst this type of instrument since each range requires its own switching and calibration.

Potential Measurement Problem

Given the dynamic range of the 24 bit ADC's within the instrument, it's generally ok to let the instruments auto ranging feature choose the appropriate range and carry on with the desired measurement.

When making measurements that concern dynamic range to the limits of performance however the user must take care to position the input signal near the top of the most appropriate range. Positioning the input signal at the bottom of a particular range means the signal is 10 dB nearer the noise floor thereby compromising the dynamic range of the measurement.

Measurement Examples

Figure 1 shows a 1v signal being measured on the analyzers 1v range, this is optimum and the THD+N result is a respectable –112.3 dB. Increasing the input voltage to 1.2 v forces the instrument onto the 3.2 v range. The THD+N result is now nearly 4.5 dB worse!

Figure 2 shows a similar situation where the input signal is increased from 10 v to 12 v. In this case the THD+N result is nearly 10 dB worse! This is because the step from the 10 v range to 32 v range brings in the high impedance attenuators at the very front of the instrument.

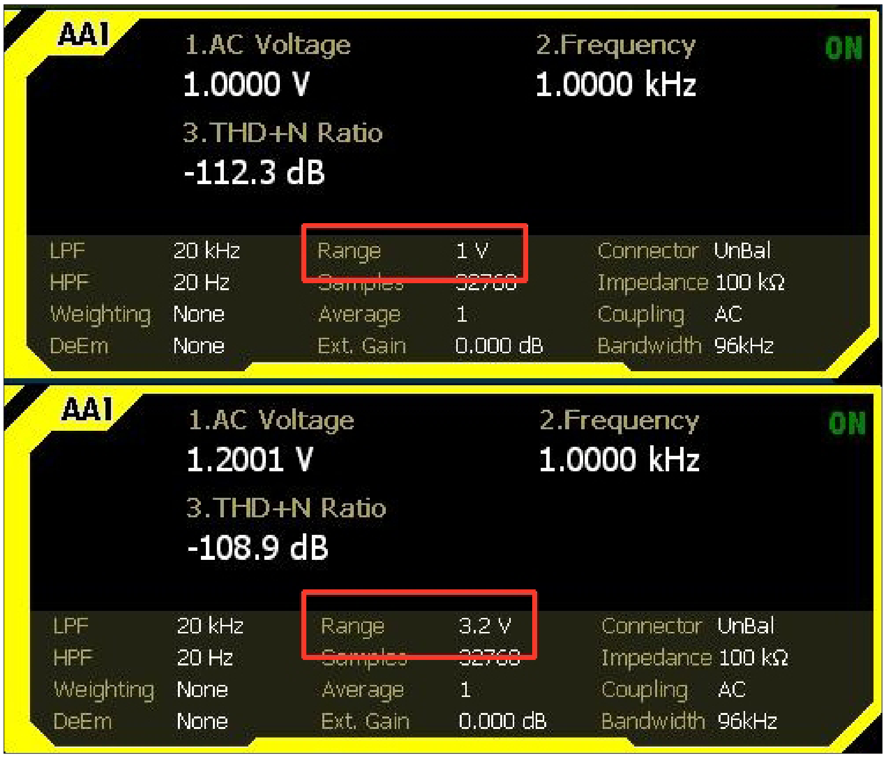

Figure 1 THD+N difference 1v-1.2v input level

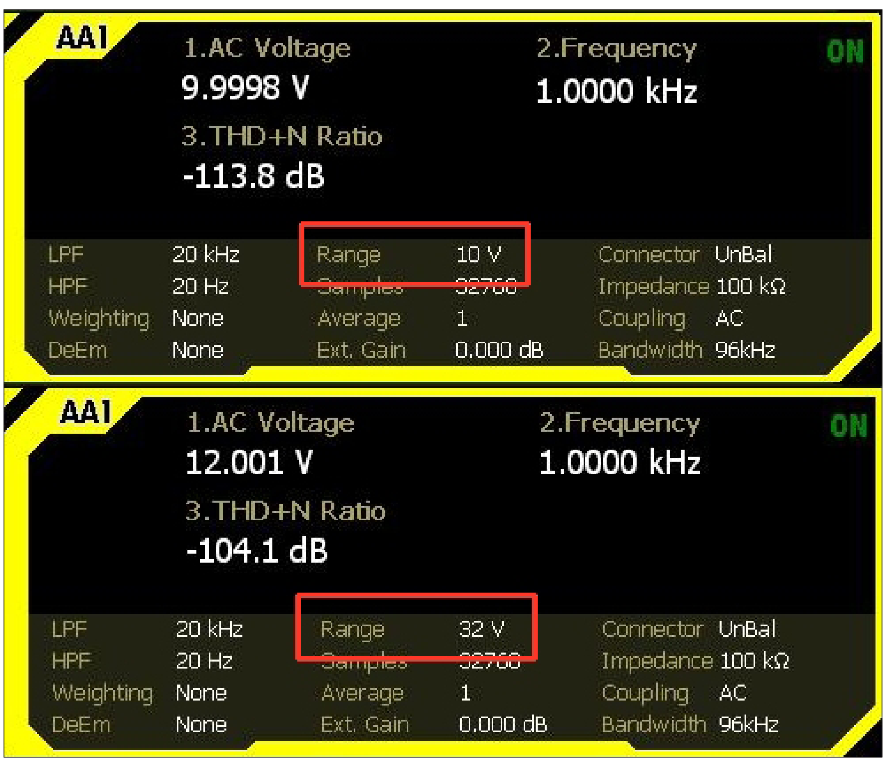

Figure 2 THD+N difference 10v-12v input level

Note that this apparent degradation in THD+N is not unique to the U8903B. This behaviour is consistent with all Audio Analyzers on the market.

Attenuator

If we have a situation where we have a particular device with for example a fixed 12 vRMS output and we want to measure THD+N to the limits of our ability the best direction is to use an attenuator external to the instrument.

The output impedance of most test devices is generally low and will happily drive an attenuator. In order to minimise the effects of the U8903B's input capacitance we also require an attenuator with reasonably low output impedance. Assuming an output impedance of less than 1 kΩ is adequate for most measurements.

The nearest suitable range is the 10 v range so an attenuator offering 0.83 of the input level is appropriate. Using preferred values 0.8196 or –1.727 dB is easily realisable.

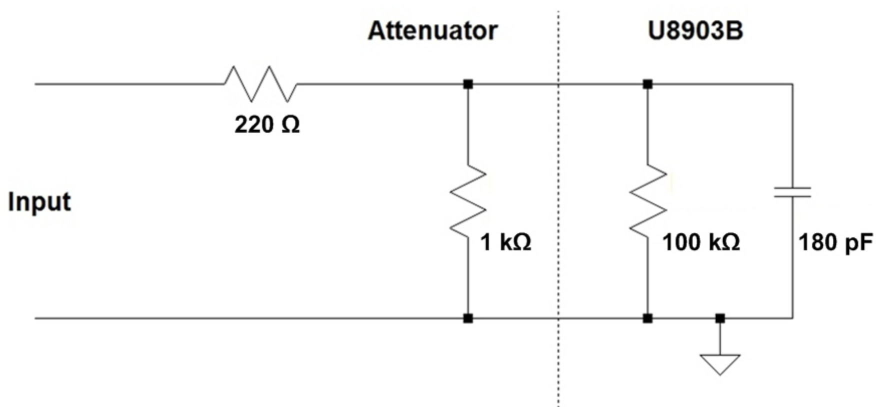

Figure 3 Attenuator Schematic

Component Choice

Metal film resistors should be used to minimise noise and distortion. For this example 0.125 W metal film 1% tolerance parts were chosen from Multicomp – Model number MF 12.

U8903-109 BNC Accessory

The U8903-109 BNC accessory kit is used to house the attenuator components as shown in Figure 4. Details on how to use this kit can be found in the application note with the same title (publication number 5991-1466EN) **http://literature.cdn.keysight.com/litweb/pdf/5991-1466EN.pdf**

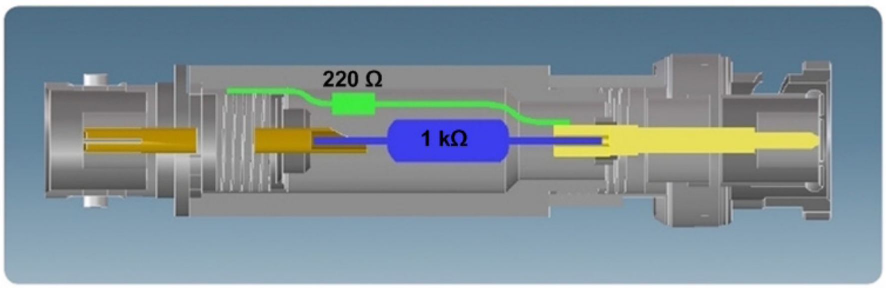

Figure 4 Attenuator employing U8903-109 accessory

Measurement Compensation

Applying an attenuator to any measurement will clearly result in an error in amplitude measurement. This can be corrected with the aid of the External Gain function under the input settings of the analyser.

The value entered here can either be as per the attenuator value calculation or, for best accuracy the attenuator can be measured using the U8903B and the measured value used for compensation. The actual value of the attenuator in this example was 1.88 dB, this also includes the source impedance of the generator being measured.

Measurement Results

Figure 5 below shows the measurement result on the example 12 vRMS waveform with the attenuator on the analyser input. Here we can see the instrument is on the 10 v Range whilst displaying the 12 v result. THD+N is now –111.5 dB, an improvement of 7.4 dB over the standard measurement of Figure 2.

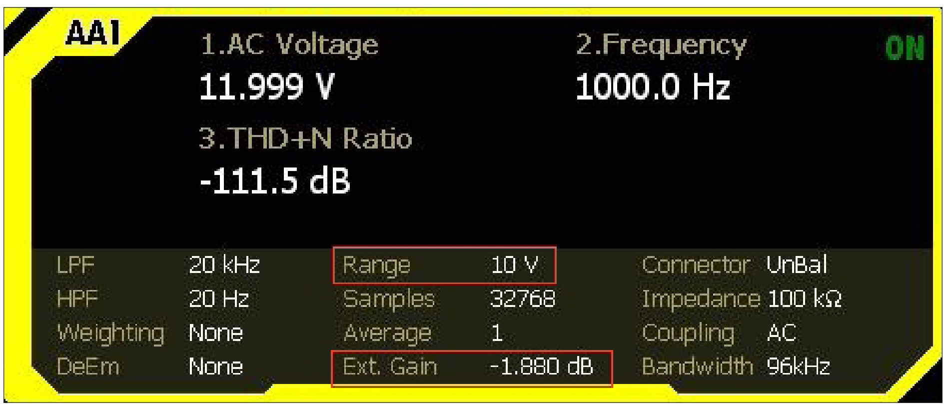

Figure 5 Compensated measurement result

Ranging for Best Residual THD

The whole focus of this note is the maximisation of dynamic range for THD+N measurements. If however the measurement of interest is THD as opposed to THD+N it can sometimes be beneficial to deliberately set the analyser range higher than would be optimal for the input voltage. In this situation the amplifiers within the instrument are being run with a lot more overhead and thus introduce less residual distortion. An example can be seen in Figure 6. Here we can see that the residual THD shows an improvement of nearly 5dB where the THD+N degrades by 4 dB.

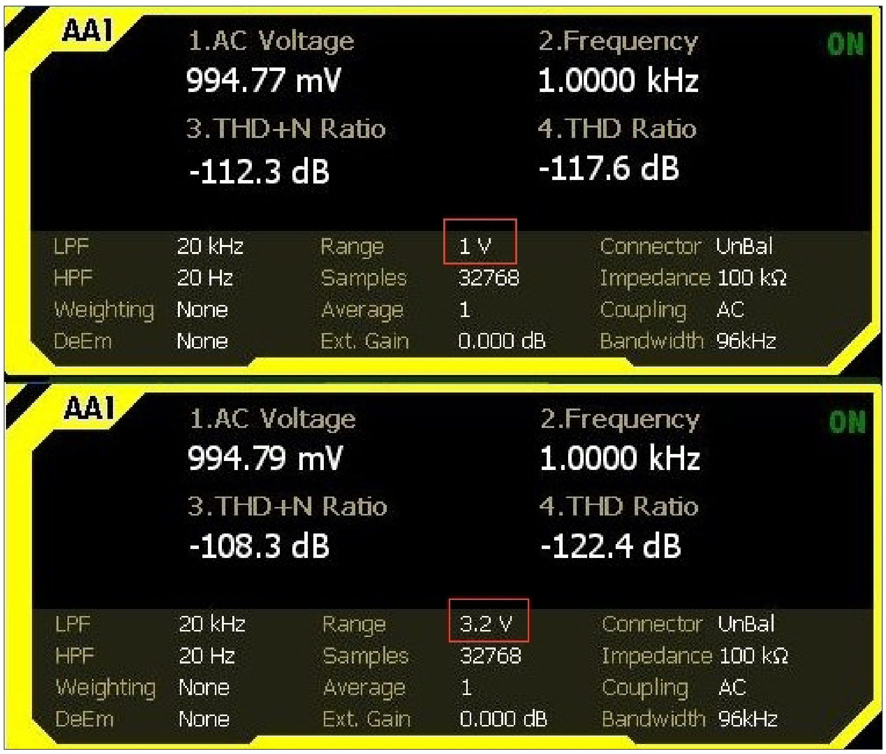

Figure 6 THD improvement by up-ranging

Summary

This note shows how signal position within a measurement range can limit residual THD+N measurements in the audio domain. Also shown is the U8903-109 accessory kit and how this can be used to make simple repeatable attenuators that maximise measurement performance. Measurement compensation via the instrument user interface is demonstrated and the concept of up ranging to give potential THD improvement is introduced.

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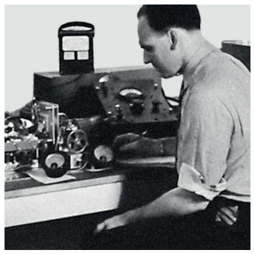

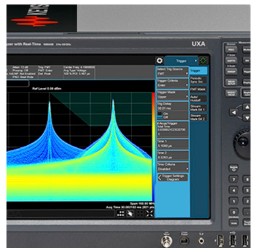

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Published in USA, May 20, 2016
5992-1565EN
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