# Measurement of Clicks on Audio Lines using the Audio Analyzers UPL or UPD

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Subject to change

Products:

**Audio Analyzer UPL**

**Audio Analyzer UPD**

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# 1. Conclusion

Interferences on audio transmissions, which happens only from time to time, are very difficult to be measured. This application note describes a method, used by the audio analyzers UPL and UPD, to monitor test tones without any interruption and detecting even the shortest clicks.

# 2. Sporadically Occurring Interference on Audio Lines

Most of the interference encountered in audio transmissions is continuous and can be easily measured by determining, for instance, distortion, intermodulation suppression, signal-to-noise ratio, etc.
However, some interfering signals are too short to be covered by these measurements. This kind of interference is well known from analog audio measurements as for example clicks heard in analog disc recording. But this type of short interference is also encountered in digital transmissions. The following examples should serve as an illustration:

- Error correction when replaying CDs:
  When defective CDs are played, the original information on the CD can be reconstructed to a certain extent as the recorded information has redundance. It may happen, however, that the error correction circuit does not operate correctly so that brief signal variations are produced and interference in the form of a clicking noise is generated.

- Sample-rate converters, format converters:
  Synchronization faults are a frequent error source in sample-rate or format conversion of digital signals. Errors in sample rate conversion may be caused, for instance, when samples are "forgotten" or available twice. When converting the format of an SDIF2 signal, for instance, care must be taken that the word clock has the correct phase with reference to the data signals. Even different cable lengths may cause interference as a result of faulty synchronization.

- Transmissions from other studios
  When audio signals are received from other studios, eg on DS2 lines, the handover of the external clock at the X21 interface may cause synchronization errors.

- Faulty devices
  When characteristics of digital components vary, eg through heating, clicks may occasionally be produced.

- Harddisk recorders, sound cards in PCs
  Feedbacks via the power supply of PCs may cause voltage peaks to be coupled into the audio path when the hard disk is accessed and thus produce audible interference.

- Insufficiently shielded lines, wrongly laid power supply cables or electrostatic discharges may cause brief signal variations.

All these faults have one thing in common: they occur sporadically - it may happen that only individual signal samples are affected - and that in many cases they are not reproducible. To eliminate such disturbance, the error source has to be found along the transmission chain.

# 3. Measurement Methods

Since the described disturbances occur only sporadically, it is necessary to observe the signal over an extended period of time. Monitoring has to be continuous without interruptions. In many cases this is done through aural monitoring by the measurement engineer, but listening to a sinusoidal tone over an extended period of time is not very pleasant. How can this problem be solved by means of a measurement?

Monitoring over an extended period of time causes normally no problems. A measurement versus time is performed and the result is graphically displayed.

Considering that the clicking noise is very short, measurements have to be performed at very short intervals. Although state-of-the-art measuring instruments like the Audio Analyzers UPL and UPD are able to carry more than 100 measurements per second, level measurements do not yield a satisfactory result. Since the signal level is only impaired by extremely strong clicking noise, a great number of audible clicks cannot be detected with this type of measurement.
However, each interfering noise is shown in the spectrum by additional signal lines. If a 1-kHz test tone is applied, the noise components can be determined in a THD+N measurement. If a sufficiently high measurement rate is used, the chance of being able to detect a clicking noise is relatively high. But however high the measurement rate may be, the measurement is not continuous - not even when a peak detector is used. Brief signal variations cause voltage variations at the detector which are "retained" for a certain period of time as a result of the clearly longer discharge time.

Measurements of this kind during an ongoing program require a considerable outlay for comparing the original signal to the disturbed one and are not described in this application note.

# 4. Measurements with Audio Analyzer UPL or UPD

The Audio Analyzers UPL and UPD permit uninterrupted monitoring of any audio line without the above problems.
A 1-kHz sinewave may be used as a test signal. The level of the DUT is measured after a notch filter, ie all spectral components except the test signal are measured (THD+N measurement). The result is displayed versus time.
The UPL/UPD samples all test signals and performs an analysis at the digital level. The PEAK function is used to ensure that all unwanted noise components are detected. With this measurement all digital values, ie 48000 samples per second (also for analog measurements), are analyzed in the 22-kHz analyzer of the UPL/UPD. With the aid of the notch filter, a quasi-distortion measurement is performed in the course of which the peak value of each audio sample is measured. An interval time can be specified for the peak measurements. During this time the highest peak value is retained - similar to the procedure with the max. hold function. For instance, when an interval time of 1 s is selected, the highest peak value detected within this period is output every second. The advantage of this compression technique is that measurements can be carried on for long periods of time without too many values being displayed on the time axis. With a suitable combination of the interval time and the number of values shown, also short periods can be monitored with an extremely fine resolution, for instance 10 seconds with a 10-ms resolution. The measurement can be continued for hours without any interference being overlooked.

# 5. Instrument Setup for Practical Measurements

For a display versus time select the TIME CHART mode under the START COND menu item. In this mode continuous measurements are performed without a restart of the analyzer, and results are graphically displayed.

The peak detector is selected in the FUNCTION line with PEAK & S/N. With "PK abs" selected, the magnitude of the higher of the two peaks (positive and negative peak) is determined. To eliminate the test signal, activate the notch filter in the FILTER line, which has previously been selected in the filter panel. A highpass filter (eg 400 Hz) may also be connected into the circuit to suppress any DC components that might impair the measurement results.

The interval time for the peak function has to be matched to the value set for "Time Tick" under TIME CHART to avoid pauses occurring in the measurements. For this reason the interval time should be equal to or longer than the value entered for "Time Tick". To obtain a good time resolution, it is advisable to make full use of the 1024 testpoints that can be displayed for the period to be monitored. The use of 1000 testpoints seems to be appropriate.

The autorange function of the analyzer should be switched off to avoid time being lost for the switchover of the measurement range during which measured values cannot be made. Thanks to the wide dynamic range of the UPL/UPD the range required for full-scale deflection can be retained and all clicking noises with an S/N ratio better than 70 dB can be detected.

The generator produces a test signal of eg 997 Hz.

The panel below shows a possible setup:

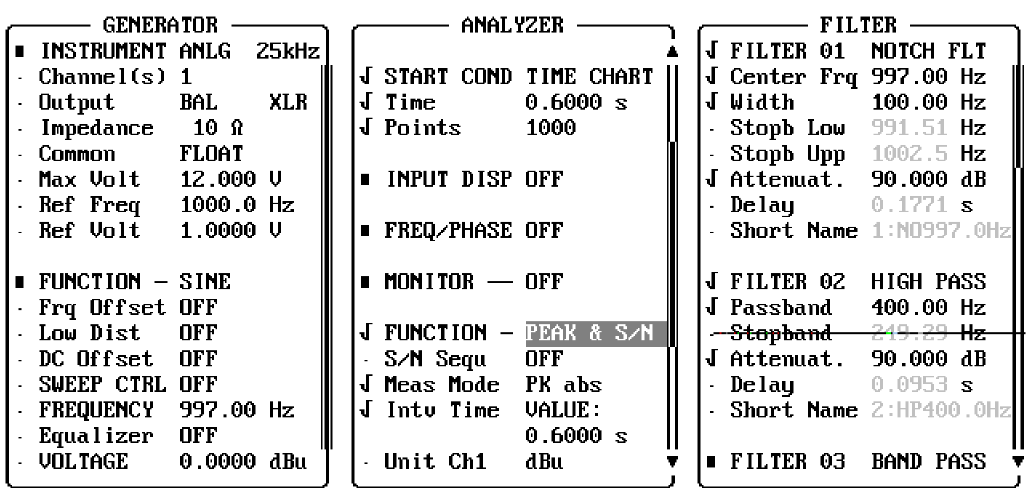


Fig. 1: Possible instrument setup for measurements with a 997-Hz signal

With 1000 points and a time interval of 0.6 s, a recording period of 10 minutes is obtained. With other values set recording may be continued for hours.

The 997-Hz notch filter suppresses the fundamental of the test signal and, since all other signal components are measured, this has the effect of a THD+N measurement. Of course, any other frequency may be set for the notch filter; UPL/UPD offers unlimited possibilities on its filter panel.

The highpass filter in the analyzer is required for suppressing any DC components of the signal which would reduce the display resolution. Since the noise spectrum is displayed at higher frequencies, the measurement of the clicking noise will not be affected.

With the aid of the above UPL/UPD measurement, practically any clicking noise and similar interference can be detected.
In the enclosed printout (Fig. 2) the measurement was carried out at 997 Hz and a level of 0 dBu. Every 60 seconds a noise signal in the form of a $\sin^2$ pulse of 50 µs and a level of -40 dBu was simulated. All the applied signals were detected and displayed with the correct level. Pulses shorter than 50 µs (corresponding to 20 kHz) practically never occur in the audio bandwidth.

Although such signals cannot even be heard with a headphone, they can be measured without problems. Thus the described measurement is not only less tiring for the ears of the measurement engineer but also considerably better - at least in this example.

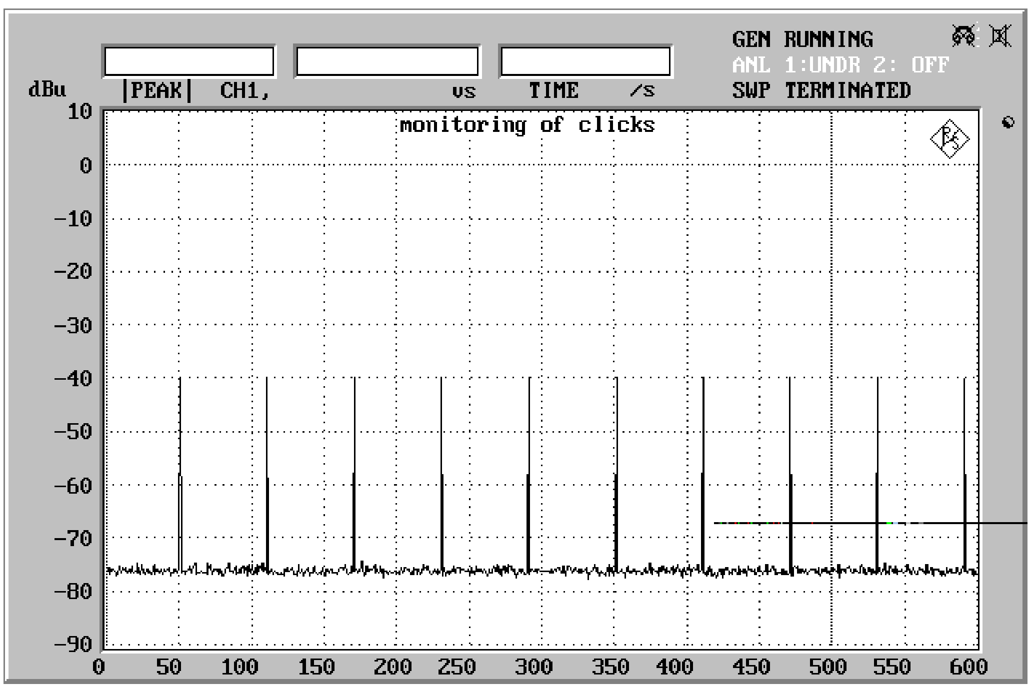


Fig. 2: Clicking noise simulated with the aid of sin² pulses