Audio Analyzer UPL

The solution for the budget-conscious

- For all interfaces: analog, digital and combined
- Real dual-channel measurements
- Maximum dynamic range
- FFT analysis
- Jitter analysis
- Interface tester
- Freely programmable filters
- Versatile functions
- Compact unit with integrated PC
- Automatic test sequences
- Extensive online help

ROHDE & SCHWARZ
Audio analysis today and tomorrow

Analog and digital

Audio signal processing is nowadays no longer conceivable without the use of digital techniques. Yet, analog technology continues to exist and undergoes constant improvement. State-of-the-art measuring instruments must therefore be able to handle both analog and digital signal processing.

The generator is every bit as versatile: it supplies any conceivable signal from sinewave and noise signals through to multisine-wave signals comprising up to 7400 frequencies.

In addition to all this, UPL features excellent technical data: analog sine-wave generation with harmonics of up to 15 harmonics, with a noise floor below -120 dB, spectrum displays with a noise floor below -140 dB for analog and -160 dB for digital interfaces, FFT with a maximum frequency resolution of 0.05 Hz, etc.

UPL performs all measurements using digital signal processing. Analog signals to be tested undergo elaborate pre-processing before they are digitized and measured by means of digital routines. For example, in THD measurements, the fundamental wave is attenuated by means of a notch filter and the residual signal amplified by 30 dB before it is digitized. In this way, the dynamic range can be extended beyond that offered by the internal 20-bit converter. This provides the scope required for measuring future converters, which will be technically more advanced than present-day devices (see graph on the right). This concept guarantees a performance and flexibility far superior to instruments providing purely analog or digital measurements.

Audio Analyzer UPL performs practically all types of analog measurement, from frequency response measurements through to externally controlled sweeps with reference traces, determination of 3rd-order difference frequency distortion, spectral display of demodulated wow and flutter signals, etc. In contrast to many other audio analyzers, UPL is capable of performing real dual-channel measurements in the audio-frequency range, i.e. there is no need for switchover between two inputs and this facility is not limited to a few special cases.
The above measurement concept offers many more advantages over merely analog concepts:

- The test routines performed on analog and digital interfaces are identical. This allows, for instance, the direct comparison of IMD measurements made ahead of and after a converter.

- In intermodulation measurements, spurious components are measured selectively for all frequencies in accordance with the mathematical formula of the relevant test standards. This procedure avoids the measurement of adjacent components along with the spurious, which is usually inevitable with analog test methods.

- The intelligent combination of analog and digital measurement techniques paves the way for future applications.

- All test functions are available both on the analog and the digital interfaces. This makes it possible to measure at any point of a common analog and digital transmission path. Only this ensures efficient and complete testing.

- The filters, too, were implemented digitally, resulting in an infinite number of filters as it were, and this also for measurements on analog interfaces. Just choose the type of filter (eg highpass), cutoff frequency and attenuation: that's all you have to do to loop a new filter into the test path.

- Measurement speed is as a rule higher than with analog techniques since digital test routines can adapt their speed to the input frequency. And - last but not least:
- Operation is the same for the analog and the digital interfaces. A feature that should not be underestimated.

A future-proof investment

Nobody can accurately predict today what effects future developments in digital technology will have on the audio world and what will be the resulting test requirements. This is however no problem for Audio Analyzer UPL, since all test functions are implemented digitally, UPL can be adapted to changing requirements by simply loading the necessary software - and this also for the analog interfaces.

And one more thing: Rohde & Schwarz is the only manufacturer to equip its audio analyzers with 32-bit floating-point signal processors throughout, thus offering plenty of reserves beyond the limits of today's common 24-bit technology.

A competent partner

The name of Rohde & Schwarz stands for excellent quality - thousands of audio analyzers have proven records at satisfied customers and have been in operation successfully for many years. After the purely analog UPA and UPD, which still holds the top position in today's audio measurement technology, Audio Analyzer UPL has been developed to complete the program.

As a competent partner we shall be pleased to advise you on the optimum use of our instruments. Our representatives are available for you all over the world, and our customer support center and application engineers in Munich are there to help you find the right solution to your measurement tasks. In addition, you will find a wealth of proposals and solutions in our application notes and software.

Naturally, Rohde & Schwarz instruments are certified in compliance with ISO 9001.

Audio Analyzer UPL
Versatile test functions

UPL offers a wealth of measurement functions both for analog and – with option UPL-B2 – digital interfaces.

- **Level or S/N** with rms, peak or quasi-peak weighting.
- **Selective level**
The center frequency of the band-pass filter can be swept or coupled to the generator frequency, to the frequencies of a multitone signal (e.g., for fast frequency response measurements) or to the input signal.
- **SINAD or (THD+N)**
The sum of all harmonics and noise is measured (Fig. 1).
- **Total harmonic distortion (THD)**
  Single harmonics, all the harmonics or any combination of harmonics can be measured (Fig. 2).
- **Modulation distortion**
  to DIN-IEC 268-3. 2nd and 3rd order intermodulation is measured.
- **Intermodulation**
  using the difference tone method. 2nd and 3rd order intermodulation is measured.
- **Wow and flutter**
  to DIN IEC, NAB, JIS or the 2-sigma method to DIN IEC where the demodulated signal spectrum is also displayed.
- **Polarity test**
  for checking signal paths for reversed polarity.
- **Crosstalk**
- **Waveform function**
  for representing the test signal in the time domain (Fig. 3). Waveforms can be smoothed by interpolation. Slow sequences can be displayed compressed, e.g., for analyzing the transient response of compander or AGC circuits (Fig. 4).

Test signals – as you like it

The generators of UPL supply an extremely wide variety of analog and – with option UPL-B2 – digital test signals:

- **Sinewaves**
  for level and harmonic distortion measurements. The signal can be applied to an equalizer with user-selectable nominal frequency response, e.g., for compensating the frequency response of the test assembly.
- **Two-tone signal**
  for modulation distortion analysis. Various amplitude ratios can be selected and the frequencies are continuously adjustable.
• Difference tone signal for intermodulation measurements with continuous setting of both frequencies.

• Special multitone signal comprising up to 7400 frequencies with selectable amplitude distribution. The frequency spacing can be linked to the resolution used for the Fast Fourier Transform, thus enabling rapid and precise single-shot measurements of the frequency response of a DUT.

• Multitone signal comprising up to 17 sinewaves of any frequency and with the same or different levels; setting of phase with UPL-B6.

• Sine burst signal with adjustable interval and on-time and programmable low level, eg for testing AGCs.

• Sine^2 burst also with adjustable interval and on-time, eg for testing rms rectifier circuits.

• Noise with a variety of probability distributions, eg for acoustic measurements; setting of crest factor with UPL-B6

• Arbitrary waveforms for generating any voltage curve of up to 16k points.

Signals can be measured with an offset, digital audio signals can be dithered with adjustable level, and selectable amplitude distribution can be added to digital audio signals.

A variety of sweep functions

For continuous variation of the test signals, UPL offers amplitude and frequency sweeps and for bursts additionally sweeps of the interval and the on-time. Sweeps are defined either by means of a table or via parameters such as start value, number of steps, linear/log stepping or time interval. It is also possible to sweep two variables simultaneously.

In measurements of external signals, these can be used for analyzer sweeps (external sweeps). Many different start conditions can be set, allowing measurements to be triggered by a variety of events. Results will be stable even for DUTs with unknown or unstable transient response thanks to the settling function.

Tests on hi-fi components call for increasingly complex measurement techniques. Results obtained in the test lab must be verified in production, where as a rule not the whole range of test functions is needed but economical solutions to cater for large batches. UPL is an ideal choice for this task, and it optimally complements its "bigger brother", Audio Analyzer UPD, which is mainly employed in development. The operating concept of the two units based on the same IEC/IEEE-bus commands is identical, so there is no problem using them jointly.
Spectral analysis

With its FFT analyzer, UPL is also capable of spectrum analysis. The number of samples for Fast Fourier Transform can be selected between 256 and 16k in binary steps (Fig. 5). A special feature is zoom FFT. The signal to be measured is digitally preprocessed to increase the frequency resolution by a factor of 2 to 128 over a selectable range. In this way, a maximum resolution of 0.05 Hz is attained. It should be emphasized that this is not just a scale expansion but the measurement is really made at a higher resolution (Fig. 6).

Programmable filters

The filters of UPL are software-implemented so that the user can define any number of filters. The most common weighting filters are provided as standard. Further filters can be programmed in a few seconds by entering the type (lowpass, highpass, bandpass, bandstop, notch, third octave or octave), frequency and attenuation (Fig. 7). The instrument’s open architecture shows its strength in particular where special requirements have to be met: special filters can be implemented using commercial filter design programs. The data are transferred to UPL and the designed filter looped into the signal path.

High measurement speed

In designing Audio Analyzer UPL, particular emphasis was placed on optimizing the measurement speed of the test system as a whole:

- All operations involving elaborate computing are carried out by digital signal processors. The PC is merely used for control of the unit and display of results.
- UPL can perform even complex test functions simultaneously on both channels. This feature alone reduces the time for stereo measurements by 50% compared with most analyzers available on the market.
- The digital test routines adapt their speed optimally to the input frequency. This enhances measurement speed especially in the case of frequency sweeps.
- UPL performs harmonic distortion and IMD measurements using patented, digital test procedures that combine high accuracy with high measurement speed.
- Digital signal processing even reduces settling and transient times achievable with purely analog instruments. These times are also taken into account in the test routines, yielding stable measurements without the need for activating settling functions (these are understood to be repeated measurements until results are within a tolerance band).
- The user interface was tailored to the requirements of a test, not of an office environment.
Any display panels not needed can be switched off, which also cuts down the processing time. When all displays are switched off and results are output via the IEC/IEEE bus, more than 100 level measurements per second can be made.

Use in Production:

Instruments to be used in production tests must satisfy a variety of requirements:

- High measurement speed is vital for achieving a high production throughput. By making appropriate use of the instrument functions, go/no-go decisions can be made already in the audio analyzer, thus reducing the run time of a DUT (Fig. 8).
- Two-channel measurements allow the simultaneous and thus time-saving determination of input and output characteristics.
- The use of FFT analysis provides a decisive advantage especially in the case of frequency response measurements, which are particularly time-critical. Example: 900 frequency values in 150 ms.
- Long calibration intervals, resulting from the extensive use of digital circuits, make for high availability of the instrument.
- Model UPL66 is specially tailored to the requirements of production. UPL66 comes without a display and keypad, thus saving purchasing costs. Yet the unit can be operated manually by connecting a PC keyboard and a VGA monitor, enabling fast fault localization in the event of production problems.
- Remote-control capability via the IEC/IEEE bus is a must in large-scale production systems. In the design of Audio Analyzer UPL, special importance was attached to data transfer via the IEC/IEEE bus. The logging mode can be used to speed up the generation of control programs for the IEC/IEEE bus. With the program generator provided in UPL-B10, it is no longer necessary to look up IEC/IEEE-bus commands.

High measurement speed, two-channel measurements and remote-control capability via the IEC/IEEE bus are a must in production systems. The long calibration intervals of UPL make for high availability and reduce running costs.

UPL66 - special model for use in test systems, with the full flexibility of the standard model!
Interfaces, protocol analysis, jitter

Analog interfaces
- Balanced inputs with high common-mode rejection and various impedances commonly used in the studio. Measurements can be made on lines with phantom feed.
- Balanced outputs, floating (to prevent hum loops).
- The generator outputs can be internally connected to the analyzer inputs so that different types of measurement can be made without the need for changing the cabling.

Digital audio interfaces (option UPL-B2)
- Balanced (XLR), unbalanced (BNC) and optical (TOSLINK) inputs and outputs for connecting consumer electronics and professional studio equipment.
- The levels of the balanced and unbalanced outputs are adjustable so that the sensitivity of digital audio inputs can be determined.
- The format of the generated channel status data may be professional or consumer independent of the selected interface.
- A reference (XLR) and a synchronization (BNC) input provided on the rear panel allow both the analyzer and the generator to be synchronized to the digital audio reference signal (DARS) to AES 11, and the generator in addition to wordclock, video sync signals (PAL/SECAM/NTSC) and to 1024-kHz reference clocks.
- The generator as well as the analyzer can be driven with clock rates of 27 to 55 kHz. The clock signals can also be produced internally by the generator.
- The clock rates of the analyzer and generator are independent of each other. This allows measurements on sample converters.
- The word length can be selected between 8 and 24 bits independently for generator and analyzer.

Digital protocol analysis and generation (option UPL-B2)
This software option extends the functions of option UPL-B2 by an in-depth analysis and generation of additional digital data:
- Analysis of channel status and user data. The data are output in binary form, as hexadecimal numbers, as ASCII characters or, in the case of channel status data, evaluated in the professional or consumer format to AES 3 or IEC 958 (Fig. 12).

Improvement of audio quality of sound cards and multimedia equipment - a task for UPL.
• Generation of channel status data, user data and validity bits. Channel status data can be entered in binary form or via panel to AES 3 or IEC 958 in the professional or consumer format.
• Any bits can be combined under a symbolic name. In this way, data input and representation can easily be adapted to customer's requirements.
• Simultaneous measurement of clock rate and display of interface errors (such as parity error).

Jitter and interface tests (option UPL-B22)
With this option, the physical parameters of digital audio interfaces can be examined. UPL-B22 extends the functions of option UPL-B2.

Signal analysis:
• Measurement of jitter amplitude and display of jitter signal in the frequency and time domain (Figs 9 and 10).
• UPL generates bit or word-synchronous sync signals that allow the accurate display of digital audio signals on an oscilloscope (preamble, eye pattern, signal symmetry, superimposed noise, etc).
• Measurement of input pulse amplitude and sampling frequency.
• Measurement of phase difference between audio and reference input signal.
• Measurement of time difference between output and input signal. This allows delay times of equalizers, audio mixers etc. to be measured.
• Analysis of common-mode signal of balanced input (frequency, amplitude, spectrum).

Signal generation:
• The clock of the output signal can be "jittered" by superimposing a sinewave or noise signal of variable amplitude.
• A common-mode signal can be superimposed on the balanced output signal.
• Long cables can be simulated by means of a switchable cable simulator.
• The phase shift between the digital audio and the reference output can be varied.

Test assemblies for electroacoustic converters frequently consist of microphones and loudspeakers, whose frequency response must be compensated. The equalizer function of UPL furnishes tailor-made solutions for such tests. Comprehensive test routines can be implemented with the aid of the universal sequence controller (page 13).
Efficient online help

UPL offers a variety of help functions to provide optimum support for the user:

HELP function
HELP information can be called for each input field.

SHOW I/O key
If no results are displayed, eg because no input signal or an incorrect input signal is present, information on possible causes will appear upon pressing SHOW I/O. Moreover, the input and output configuration will be displayed.

Info boxes
These highlighted boxes inform the user of any incorrect settings.

Online help
The permissible range of values is indicated for each menu item requiring the entry of a numerical value. This range takes into account any limitations resulting from higher-order parameters, eg the sample rate in the case of measurements on digital interfaces.

Protection against illegal entries
UPL will not accept entries outside the permissible range. An alarm tone will be issued, and the value changed to the permissible minimum or maximum value.

A wealth of functions - yet easy to operate

- Related functions and settings are combined in panels that can be called at a keystroke. Up to three panels can be displayed at a time.
- The operator is not burdened with unnecessary information. Only the parameters and settings needed for a given application are displayed – the others are available in the background. For example, the sweep parameters are transferred to the generator panel and displayed only when the sweep function is activated.
- Uncomplicated entries: the user simply needs to open a menu and make entry or selection.
- Continuous status information on generator, analyzer and sweep.

Designed for convenience
**Results at a glance**

- Real-time display of results for one or both channels and several test functions.
- Simultaneous display of frequency and phase.
- With graphics, results can be read off with vertical and horizontal cursors. Tolerance curves or stored results can be added for comparison.
- Sets of traces can be displayed, stored and evaluated for both channels.
- Graphics modes range from traces and bargraphs through spectrum display to three-dimensional waterfalls.

It is often the case that only a few parameters need to be modified after a measurement sequence has been started. Therefore, entry lines can be selected from the input panels for the generator, analyzer, etc by marking them with a tick and transferred to a status panel. The status panel thus provides a summary of parameters for a measurement routine which offers the following advantages:

- Instrument settings can be displayed together with graphical and numerical results.
- All important information can be printed on a single hardcopy.
- Instrument settings can be modified quickly without changing panels as UPL can also be operated from the status panel.
Audio Analyzer UPL is a compact unit with an integrated controller. It avoids the disadvantages of external PC control, which is found in other audio analyzers.

UPL features elaborate screening which will not be found in any conventional PC, including magnetically shielded power transformers and coated filter pane in front of the display.

The strengths of UPL show up especially in mobile use. The unit is compact and lightweight and requires no additional equipment. Results are stored in the built-in PC and thus available for later use. Routine measurements can be repeated easily using stored instrument settings.

The instrument is easy to transport as it requires no external equipment such as keyboard, monitor or other PC peripherals.

UPL is supplied all ready to the customer. Installation is reduced to unpacking the unit and switching it on for starting the measurement. The user can forget about problems that cropped up in the past with the installation of interface cards or PC software.

With audio analyzers controlled from an external PC, interference may be radiated from the PC, monitor or interface connections, which distorts measurement results. Not so with UPL: the instrument has specified EMC characteristics which also include the internal PC.

And a real boon: the price of UPL includes the internal PC.

All-in package

- Built-in hard disk and disk drive.
- Connectors for keyboard, mouse, monitor, printer and plotter.
- Centronics interface for connecting printer or network.
- Drivers for all commercial printers supplied as standard.
- Postprocessing of results directly in UPL using standard software.
- All results available in the common data formats, making it easy to import graphics into documents, for example.
- Easy loading of function and software extensions via floppy disk.
- Automatic test sequences and measurement programs with universal sequence controller. Easy generation of programs with built-in program generator.

Block diagram of UPL
The options

Low Distortion Generator UPL-B1
The low distortion generator is essential for all applications requiring extremely pure analog signals or an extended frequency range up to 110 kHz. Its inherent distortion is well below that of the built-in universal generator which already has excellent specifications.

Digital Interface UPL-B2
contains the digital audio interfaces (balanced, unbalanced and optical). This option is described in detail on pages 8 and 9, including software extensions (protocol analysis and generation, UPL-B21, and jitter and interface test, UPL-B22).

Remote Control UPL-B4
enables remote control of UPL via the RS-232-C interface or the IEC/IEEE-bus interface to IEC625/IEEE 488. The commands implemented largely correspond to SCPI guidelines.

Audio Monitor UPL-B5
adds a headphones output and built-in loudspeaker to UPL. The input signal of the analog and digital interfaces and with level and THD+N measurements – the filtered or weighted signal can be monitored.

Extended Analysis Functions UPL-B6
In modern audio systems, the transfer characteristics are dynamically adapted to the input signals. With conventional, static test signals as input signals, the dynamic processes are not activated and can thus not be analyzed. Coherence and transfer functions are the solution to this problem: speech, music, noise, etc are used as test signals, and the transfer characteristics are represented by analyzing the output spectrum referred to the input spectrum.

With the rub & buzz measurement, manufacturing defects of loudspeakers are detected in next to no time by measuring the unwanted signals in the frequency range above that of typical distortion products.

In multitone signal generation, UPL-B6 allows the phase and crest factor to be set.

Further functional extensions of UPL-B6 are under preparation.

Hearing Aids Test Accessories UPL-B7
This option includes an acoustic test chamber as well as all accessories required for measurements on hearing aids such as battery adapters, connecting cables and an acoustic coupler. The associated software enables the complete measurements to EN 60118 and ANSI 3 22 (for this, options UPL-B5 and -B10 must be fitted).

Universal Sequence Controller UPL-B10
enables measurement sequences to be generated and executed, thus turning UPL into an automatic test system. Programming of measurement sequences is greatly facilitated by the built-in program generator:

Each manual control step is recorded in the logging mode and translated into a complete line of the sequence program with correct syntax, ie test sequences can be programmed without a single line to be typed by the user. The program thus generated does not just give the sequence of keys to be pressed but contains the instructions in easy-to-read IEC/IEEE-bus syntax according to SCPI. BASIC commands can then be used to modify the program, eg for branching or graphic outputs.

Complete application programs based on the universal sequence controller are available for measurements on CD players, tuners, etc.

The universal sequence controller can also be used for remote control of external equipment via the IEC/IEEE-bus or the RS-232-C interface. On the other hand, programs generated on UPL can after slight modifications be transferred to an external controller for the remote control of UPL. This greatly facilitates the generation of remote-control programs.

150 Ω Modification UPL-U3
changes the source impedance of the analog generator from 200 Ω to 150 Ω.
Specifications
Data without tolerances are typical values

Analog analyzers

For analog measurements two analyzers with different bandwidths, specifications and measurement functions are provided:

Analyzer ANLG 22 kHz

- Frequency range: DC/10 Hz to 21.90 kHz
- Level measurement (ms)
  - Error limit at 1 kHz: ±0.05 dB
  - Frequency response ref. to 1 kHz:
    - 20 Hz to 22 kHz: ±0.03 dB
    - 10 to 20 kHz: ±0.1 dB
    - 20 Hz to 50 kHz: ±0.1 dB
    - 50 to 110 kHz: ±0.2 dB

*DC/AC coupling

Analyzer ANLG 110 kHz

- Frequency range: DC/20 Hz to 110 kHz
- Level measurement (ms)
  - Error limit at 1 kHz: ±0.05 dB
- Frequency response ref. to 1 kHz:
  - 20 Hz to 22 kHz: ±0.03 dB
- Generator output

Inputs

XLR connectors: 2 channels, balanced (unbalanced measurements possible with XLR/KNC Adapter UPL-Z1). Floating/grounded and AC/DC coupling switchable

Input impedance:
- 0.1 V to 110 mV, (balanced)
- 0.1 V to 110 V, at each pin against ground

Cross talk attenuation:
- >120 dB, frequency <22 kHz
- >100 dB at 50 Hz
- >80 dB at 1 kHz
- >60 dB at 15 kHz

Generator output

Each channel switchable to the other output channel, input impedance: balanced 200 kHz, unbalanced 100 kHz

Measurement functions

RMS value, wideband
- Measurement speed: AUTO
- Error limits: ±0.05 dB at 1 kHz, ±0.1 dB additional error
- AUTO FAST: ±0.2 dB, 4.2 ms/42 ms, at least 1 cycle
- Input impedance: 1 m Ohm to 10 x
- GEN TRACK: ±1 V
- Noise (600 Ohm): ±2 V, ±1.6 V typ. (ANGK 22 kHz), weighting filters and user-definable filters, up to 3 filters can be combined, analog notch filter in addition

Spectrum

RMS value, selective
- Bandwidth (3-dB): ±0.1 dB
- Selectivity: 1%, 3%, 1/12 octave, 1/3 octave and user-selectable fixed bandwidth, minimum bandwidth 10 kHz
- Frequency setting
  - Automatic: to input signal
  - Fixed through input value: sweep through selectable range ±0.2 dB ± ripple of filters
- Error limit: ±0.2 dB ± ripple of filters

Measurement

- Peak value
  - with analyzer ANLG 22 kHz only: peak max., peak min., peak-to-peak, peak absolute
  - with analyzer ANLG 110 kHz: peak max., peak min., peak-to-peak, peak absolute

- Error limit
  - Frequency response
  - Filters: weighting filters and user-definable filters, up to 3 filters can be combined, analog notch filter in addition

Quasi-peak

- with analyzer ANLG 22 kHz only
- to CCR 468-d
- ±8 µV with CCR weighting filter, weighting filters and user-definable filters, up to 3 filters can be combined, analog notch filter in addition

DC voltage

- Voltage range:
  - 0 to ±10 V
- Error limit:
  - ±1 % of measured voltage ± 0.1 % of measurement range
- Measurement range:
  - 100 mV to 100 V, in steps of 10 dB
- S/N measurement routine
  - available for measurement functions - rms, wideband - peak - quasi-peak

FFT analysis

Total harmonic distortion (THD)
- Frequency tuning

Weighted harmonics
- Error limits
  - harmonics: ±0.5 dB
  - ±0.7 dB

Inherent distortion

Analyzer ANLG 22 kHz
- Fundamental: ±0.1 dB additional error
- Frequency tuning automatic or fixed through entered value
- Spectrum: chart showing signal and distortion

Analyzer ANLG 110 kHz
- Fundamental: ±0.2 dB, ±0.5 dB, ±0.7 dB

Inherent distortion

- Total inherent distortion of analyzer and generator (with option UPL-5), analyzer with dynamic mode precision
- >3.5 V typ. reduced by 3 dB, ±0.5 V sensitivity reduced by input noise

THD+N and SINAD

- Frequency tuning

Input voltage

- Bandwidth
  - Measurement
  - Error limits
    - <100 kHz
    - ±0.5 dB
    - ±0.7 dB

- Spectrum

- Pseudo-FFT of filtered signal

- Total inherent distortion of analyzer and generator (with option UPL-5), analyzer with dynamic mode precision

- For full measurement range (-100 dB + 2 pV with auto range function)
  - ±0.5 dB at ±100 V

- Frequency range lower frequency

- Spectrum

- Measurement routine available for measurement function

- THD+N and SINAD

- Measurement method

- Frequency range lower frequency

- Upper frequency

- Error limit
  - Inherent distortion
  - Fundamental: ±0.1 dB additional error
  - Frequency tuning automatic or fixed through entered value
  - Spectrum: chart showing signal and distortion
  - Measurement range

- MOD DIST

- Measurement range

- Error limit

- Error limits
  - Frequency range, upper frequency

- Spectrum

- Measurement range

- Error limit

- Error limits
  - Frequency range, upper frequency

- Spectrum

- Measurement range

- Error limit

- Error limits
  - Frequency range, upper frequency

- Spectrum

- Measurement range

- Error limit

- Error limits
  - Frequency range, upper frequency
**analog generators**

An 18-bit AD/DA converter is used for analog signal generation. The characteristics of the basic generator can be improved and extended with a low-distortion RC oscillator (Low Distortion Generator UPL-B6): sine with reduced distortion, frequency range up to 110 kHz, level error ±0.5%, 600 Hz to 20 kHz, ±0.75% at 30°C.

**Outputs**
- XLR connectors, 2 channels, floating, balanced/unbalanced switchable, short-circuit-proof, max current <120 mA, with external lead

**Balanced**
- Voltage: ±0.5 V rms, 20 Vrms (sine, open-circuit)
- Crosstalk attenuation: >115 dB
- Source impedance: <500 Ohm (source impedance), 25 Ohm (load impedance)
- Load impedance: ±200 Ohm

**Unbalanced**
- Voltage: ±0.5 V rms, 20 Vrms (sine, open-circuit)
- Crosstalk attenuation: >115 dB
- Source impedance: 5 Ohm
- Load impedance: ±200 Ohm

**Multi-sine**
-Frequency range: 2 Hz to 30 Hz
- Frequency spacing: adjustable from 2 Hz
- Frequency resolution: 0.01 Hz
- Dynamic range: 110 dB
- Waveforms: sine, pink noise, defined by file
- Mode 1: sine burst
- Mode 2: sine burst

**Signals**
- **Sine**
  - Frequency range: 2 Hz to 21.75 kHz
  - Frequency error: ±50 ppm
  - Level error: ±0.1 dB at 1 kHz
  - Frequency response (referred to 1 kHz)
  - 20 Hz to 20 kHz: ±0.05 dB
- **Sine (with low-distortion generator option)**
  - Frequency range: 10 Hz to 110 kHz
  - Frequency error: ±0.5% at 15 to 30°C
  - Level error: ±0.1 dB at 1 kHz
  - Frequency response (ref. to 1 kHz)
  - 10 Hz to 110 kHz: ±0.05 dB
  - Harmonics: typ. <1.5 dB (<120 dB at 1 kHz), measurement bandwidth 20 Hz to 20 kHz, voltage 1 to 5 V

**Difference frequency distortion (DFD)**
- Measurement method: selective to DIN IEC 268-3 or 118
- Frequency range: 80 Hz to 2 kHz, center frequency 200 Hz to 100 kHz
- Error limit: ±0.5 dB, center frequency <20 kHz
- Inherent distortion: ±0.5 dB, 125 dB, ±0.1 dB, ±0.05 dB
- Spectrum: bar chart showing signal and distortion

**Wow and flutter**
- Measurement method: with analyzer ANG 22 kHz only
- Weighting filter: OFF
- Error limit: ±0.005% weighted, ±0.01% unweighted
- Phase: postFFT of demodulated signal
- Time domain display (WAVFORM)
  - Trigger: rising/falling edge
  - Trigger level: -200 to +200 V, interpolated between samples
  - Trace length: max. 742 points
  - Standard mode: 1: 1; 0.5: 1; 2: 1,024: 1, 0.8: 1,024: 1
  - Compressed mode: 0.8: 1,024: 1, 0.8: 1,024: 1, 0.8: 1,024: 1
- Frequency range
  - Frequency range: 20 Hz to 110 kHz, ±0.5 ppm
  - Phase: ±0.5°

**Group delay**
- Frequency range: 20 Hz to 20 kHz
- Measurement error in seconds:
  - with analyzer ANG 22 kHz only

**Polarity test**
- Measurement: polarity of unsymmetrical input signal
- Display: +P0, -P0

**Analog Analyzer UPl 5**

<table>
<thead>
<tr>
<th>Measurement Method</th>
<th>20 Hz to 110 kHz</th>
<th>±0.5 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error limit</td>
<td>±0.5°</td>
<td></td>
</tr>
<tr>
<td>Frequency range</td>
<td>20 Hz to 20 kHz</td>
<td>±0.5°</td>
</tr>
<tr>
<td>Group delay</td>
<td>20 Hz to 20 kHz</td>
<td>±0.5°</td>
</tr>
<tr>
<td>Frequency range</td>
<td>±0.5°</td>
<td></td>
</tr>
<tr>
<td>Measurement error</td>
<td>±0.5°</td>
<td></td>
</tr>
</tbody>
</table>

- *Only for measurement functions RMS, FFT and THD+N, error limits apply to BL-FIT with zoom factor 2, 4:1, 2 kHz, 21.75 kHz, 2 kHz, 2 kHz.
- **) Δf: phase measurement error in °, Δf: frequency step.
- * Only for measurement functions RMS, FFT and THD+N, error limits apply to BL-FIT with zoom factor 2, 4:1, 2 kHz, 21.75 kHz, 2 kHz.
Digital analyzer (with option UPL-B2)

Inputs

Balanced input: XLR connector, transformer coupling
Unbalanced input: BNC, grounded

Impedance:
- Balanced input: 110 Ω
- Unbalanced input: 75 Ω

Optical input: TOSLINK

Audio bits: up to 8
Clock rate: 8 Hz to 24 Hz
Format: 27.65 MHz, synchronous to DAI or DARS

Measurement functions

(RMS measurements at 24 bits, full scale)

<table>
<thead>
<tr>
<th>RMS value, wideband</th>
<th>Error limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement bandwidth</td>
<td>±0.1 dB</td>
</tr>
<tr>
<td>AUTO FAST</td>
<td>±0.01 dB</td>
</tr>
<tr>
<td>AUTO</td>
<td>±0.001 dB</td>
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</tbody>
</table>

Integration time:
- AUTO FAST/AUTO VALUE: 4.2 ms/42 ms, at least 1 cycle
- GEN TRACK: 1 ms to 10 s
- Filters: up to 3 filters can be combined post-FFT of filtered signal

Spectrum:

<table>
<thead>
<tr>
<th>RMS value, selective</th>
</tr>
</thead>
</table>
| Bandwidth: (0 - 1 dB) | ±1 %, 3%, 1/12 octave, 1/3 octave and user-selectable fixed bandwidth, min. bandwidth 10 Hz 100 dB, bandpass or bandstop filter, Elliptical or Butterworth filter - automatic input filter - fixed to generator
| Selectivity | ±0.2 dB = ripple of filters |
| Frequency setting | ±0.2 dB = ripple of filters |
| Error limit | ±0.2 dB |

Peak value:

<table>
<thead>
<tr>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error limit: peak max., peak min., peak-to-peak, peak absolute</td>
</tr>
<tr>
<td>Error limit: 20 ms to 1 s</td>
</tr>
</tbody>
</table>

Quasi-peak Measurement:

<table>
<thead>
<tr>
<th>Measurement, error limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filters</td>
</tr>
</tbody>
</table>

DC voltage:

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>Error limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>±0.5 %</td>
<td></td>
</tr>
</tbody>
</table>

S/N measurement routine:

<table>
<thead>
<tr>
<th>Error limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1 %</td>
</tr>
</tbody>
</table>

FFT analysis:

<table>
<thead>
<tr>
<th>Total harmonic distortion (THD)</th>
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</thead>
<tbody>
<tr>
<td>Fundamental</td>
</tr>
<tr>
<td>Frequency tuning</td>
</tr>
<tr>
<td>Bandwidth</td>
</tr>
<tr>
<td>Error limit</td>
</tr>
<tr>
<td>Inherent distortion</td>
</tr>
<tr>
<td>Spectrum</td>
</tr>
<tr>
<td>THD+N and SINAD</td>
</tr>
<tr>
<td>Fundamental</td>
</tr>
<tr>
<td>Frequency tuning</td>
</tr>
<tr>
<td>Bandwidth</td>
</tr>
<tr>
<td>Error limit</td>
</tr>
<tr>
<td>Inherent distortion</td>
</tr>
<tr>
<td>Spectrum</td>
</tr>
<tr>
<td>Modulation distortion (MOD DIST)</td>
</tr>
<tr>
<td>Measurement method</td>
</tr>
<tr>
<td>Frequency range</td>
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<tr>
<td>Lower frequency</td>
</tr>
<tr>
<td>Upper frequency</td>
</tr>
<tr>
<td>Error limit</td>
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<tr>
<td>Inherent distortion</td>
</tr>
<tr>
<td>Spectrum</td>
</tr>
<tr>
<td>Wow and flutter</td>
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<tr>
<td>Measurement method</td>
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<tr>
<td>Frequency range</td>
</tr>
<tr>
<td>Difference frequency</td>
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<tr>
<td>Error limit</td>
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<tr>
<td>Inherent distortion</td>
</tr>
<tr>
<td>Spectrum</td>
</tr>
<tr>
<td>Error limit</td>
</tr>
<tr>
<td>Inherent noise</td>
</tr>
<tr>
<td>Spectrum</td>
</tr>
</tbody>
</table>

1) Total inherent distortion of analyzer and generator
2) Fixed frequency independent of sampling rate.

Audio Analyzer UPL
<table>
<thead>
<tr>
<th><strong>Channels</strong></th>
<th><strong>Optical output</strong></th>
<th><strong>Audio bits</strong></th>
<th><strong>Format</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Frequency limits specified far the signals apply to a sampling rate of 48 kHz.** For other sampling rates limits are calculated according to the formula: \( f_{\text{lim}} = \frac{f_{\text{sample}}}{48} \) sampling rate/48 kHz.

### Outputs

<table>
<thead>
<tr>
<th>Balanced output</th>
<th>Unbalanced output</th>
<th>Audio bits</th>
<th>Clock rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>XIR connector, transformer coupling</td>
<td>BNC, transformer coupling</td>
<td>8 to 24</td>
<td>2 kHz</td>
</tr>
<tr>
<td>110Ω, short-circuit proof, level (Vpp into 110 Ω)</td>
<td>75Ω, short-circuit proof, level (Vpp into 75 Ω)</td>
<td>internal: 27 to 55 kHz or synchroniza­tion to analyzer; external: synchronization to wordclock input, video sync, DARS, IEC 958, professional and consumer format to IEC 958 as well as user-definable formats at all outputs</td>
<td></td>
</tr>
<tr>
<td>±1 dB</td>
<td>±1 dB</td>
<td>±1 ppm relative to clock rate</td>
<td></td>
</tr>
<tr>
<td>XIR connector, transformer coupling</td>
<td>BNC, transformer coupling</td>
<td>1 cycle</td>
<td>2 cycles</td>
</tr>
</tbody>
</table>

### Signals

<table>
<thead>
<tr>
<th>(all signals with 24 bits, full scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General characteristics</td>
</tr>
<tr>
<td>level resolution</td>
</tr>
<tr>
<td>Audio bits</td>
</tr>
<tr>
<td>frequency error</td>
</tr>
<tr>
<td>Frequency offset</td>
</tr>
</tbody>
</table>

**Digital audio protocol (option UPL-B21).**

**Generator**
- Validity bit
- Channel status data

**Data user**
- Data user

**Analyzer**
- Display
- Error indication
- Clock rate measurement
- Channel status display

**User bit display**
- User bit display

**MOD DIST**
- Frequency range
- Lower frequency
- Upper frequency
- Level (dBF, level ratio (LF:UF))
- Inherent distortion
- Level (LF:UF)
- 1:1
- Sweep parameters

**DFD**
- Frequency range
- Center frequency
- Inherent distortion
- DFD d, DFD d2
- Sweep parameters

**Multi sine**
- Frequency range
- Frequency spacing
- Frequency resolution
- Dynamic range
- Characteristics

**Sine burst, sine burst**
- Burst time
- Low level
- Sweep parameters

**Noise**
- Distribution

**Arbitrary waveform**
- Memory size
- Clock rate
- Polarity test signal
- Sine burst with the following characteristics
- Frequency
- On-time
- Interval

**Digital Analyzer UPL** 17
**Jitter and interface test (option UPL-B22)**

### Generator
- **Signal shape**
  - sin, noise
- **Frequency range**
  - 10 Hz to 21.75 kHz (sin to 110 kHz with option UPL-B1)
- **Amplitude (peak-to-peak)**
  - 0 to 5 V (correct to 0 to 800 mV at 48 kHz sampling rate)
- **Common mode signal**
  - for balanced output
- **Waveform**
  - sine
- **Frequency range**
  - 20 Hz to 21.75 kHz (110 kHz with option UPL-B1)
- **Amplitude (Y_u)**
  - 0 to 20 V
- **Phase (output to reference)**
  - adjustable between -64 and +64.6.4 [correct to ±50% of frame]
- **Cable simulator**
  - 100 m typical audio cable

### FFT analyzer
- **Specifications**
  - apply to analyzer ANLG 22 kHz or digital analyzer; values in () apply to analyzer ANLG 110 kHz.
- **Frequency range**
  - Dynamic range
    - Digital: >135 dB
    - Analog: 115.5 dB (without analog notch filter)
- **Noise floor**
  - Digital: -160 dB
  - Analog: -140 dB (with/without analog notch filter)
- **FFT size**
  - 256, 512, 1 k, 2 k, 4 k, 8 points
- **Window functions**
  - rectangular, Hann, Blackman-Harris, Rife-Vincent 1 to 3, Hamming, flat top, Kaiser (β = 1 to 20)
- **Resolution**
  - from 0.05 Hz with zoom
  - from 0.86 Hz without zoom
- **Zoom**
  - 2 to 128 (2 to 16)
- **Averaging**
  - 1 to 256, exponential and normal

### Filters
- **For all analog and digital analyzers. Up to 3 filters can be combined as required. All filters are digital filters with a coefficient accuracy of 32 bit floating point (exception: analog notch filter).**
- **Weighting filters**
  - A weighting
  - C weighting
  - CCIT
  - CCIR weighted, unweighted
  - CCIR ARM
  - deepphase 50/15, 50, 75, 17
  - rumble weighted, unweighted
  - DC noise highpass filter
  - IEC/IEEE tuner
  - jitter weighted
- **User-definable filters**
  - Design parameters:
    - 8th order elliptical, type C (for highpass and lowpass filters also 4th order)
    - passband ripple ±0.1 dB, stopband attenuation approx. 20 to 120 dB (highpass and lowpass filters: stopband attenuation 40 to 120 dB)
    - Highpass, lowpass filters
      - limit frequencies ±0.1 dB selectable, stopband indicated
    - Bandpass, bandstop filters
      - passband ±0.1 dB selectable, stopband indicated
    - Notch filter
      - center frequency and bandwidth ±0.1 dB selectable, stopband indicated
    - One-third and octave filters
      - center frequency selectable, bandwidth ±0.1 dB indicated
    - File defined filters
      - any 8th-order filter cascaded from 4 bands, defined in the z plane by poles/zeros or coefficients

### Jitter injeetion
- **Generator sweep**
  - **Parameters**
    - frequency, level
    - with bursts also interval and duration, one or two-dimensional
    - linear, logarithmic, tabular, single, continuous, manual
    - automatic after end of measurement
    - time delay (fixed or loaded table)
- **Stepping**
  - automatic after end of measurement
- **Analyzer sweep**
  - **Parameters**
    - frequency or level of input signal
    - single, continuous
    - frequency, level, phase, distortion
  - **Trigger**
    - delayed (0.5 s) after input level or input frequency variation, settling function selectable
    - time-controlled
  - **Setting**
    - for level, frequency, phase, distortion measurements, settling function: exponential, flat or averaging

### Sweep speed
- **Two-channel rms measurement 20 Hz to 20 kHz, 30 points generator sweep, logarithmic (frequency measurement switched off, low Dist off)**
  - with GEN TRACK
    - AUTO FAST 1 s
    - AUTO 2.5 s

---

**Audio Analyzer UPL**
Display of results

Units
- Level (analog): V, dBu, dBV; W, dBm, difference (Δ), deviation (Δ%) and ratio (without dimension, %, dB), to reference value
- Level (digital): FS, %FS, dBFS, LSBs, deviation (Δ%) or ratio (Δ fsk), to reference value

Distortion
- % or dB, referred to signal amplitude, THD and THD+N in all available level units (absolute or relative to selectable reference value)

Frequency
- Hz, difference (Δ), deviation (Δ%) and ratio (to quiescent Vpp, 1/3 octave, octave or decade), to reference value (entered or stored, current generator frequency)

Phase
- rad, difference (Δ), to reference value (entered or stored)

Reference value (level)
- Fixed value (entered or stored), Current value of a channel or generator signal, permits direct measurement of gain, linearity, channel difference, crosstalk. In sweep mode, traces (other trace or loaded from file) can be used as a reference too.

Graphical display of results
- Monitor (UPL model 06)
  - Display modes: 9", LCD TFT, colour
    - display of any sweep
    - display of trace groups
    - bargraph display with min./max. values
    - spectrum, also as waterfall display
    - lists of results
    - bar charts for THD and intermodulation measurements
    - autoscale
    - X-axis zoom
    - full-screen and part-screen mode
- 2 vertical, 1 horizontal cursor line
- search function for max. values
- marker for harmonics (spectrum)
- user-labelling for graphs
- change of unit and scale also possible for loaded traces

Display functions
- - screen copy to printer, plotter or file (PCX, HPGL, Postscript)
- - sweep lists
- - list of results
- - list of autoscale, tolerance values
- - equalizer traces

Printer driver
- HP GL

Platter language
- Interfaces: 2 x RS-232-C, Centronics, IEC 625 (option UPL-B4)

Storage functions
- instrument settings, optionally with measured values and curves
- - spectra, - sweep results, - tolerance curves, - equalizer traces

Remote control
- via IEC 625-2 (IEEE 488) and RS-232-C, commands largely to SCPI

Audio monitor (option UPL-B5)
- Headphone connector: 6.3-mm-jack socket
- Output voltage: max. 8 Vp
- Source impedance: 10 Ohm, short-circuit-proof
- Recommended headphone impedance: 600 Ω

Extended analysis functions (option UPL-B6)
- Coherence and transfer functions
- Frequency range: 10 Hz to 110 kHz
- Frequency resolution
- Averaging
- FFT length
- Rub & buzz measurement
- Tracking highpass filter: lower: 10 Hz
- Measurement time: 20 s to 20 points

Multisine generator function
- Mode 1
- Mode 2

Further functions
- being developed

Hearing aids test accessories (option UPL-B7)
- Consisting of: acoustic test chamber, acoustic 2 cm³ coupler, various battery adapters, connecting cables, software for measurements to ANSI S2.22 and UPL 85 and UPL 810

150 Ω modification (option UPL-U3)
- Change of source impedance of analog generator to 150 Ω (instead of 200 Ω set as standard) at the factory

General data
- Operating temperature range: 0 to +45 °C
- Storage temperature range: -20 to +60 °C
- Humidity: max. 85% for max. 60 days, below 65% on average/year, no condensation

EMI
- EN 55011-1
- EN 55011-2
- DIN EN 61000-3-2
- UL 61000-3-2
- CAN/CSA C22.2 No. 1010-1

Safety standards
- VDE-0851, UL 61010-1
- IEC 1010-1
- UL 3111-1
- CAN/CSA C22.2 No. 1010-1

Conformity marks
- Dimensions (W x H x D): 435 mm x 192 mm x 475 mm
- Weight: 12.6 kg

Audio Analyzer UPL
## Ordering Information

<table>
<thead>
<tr>
<th>Order designation</th>
<th>Accessory supplied</th>
<th>Options</th>
<th>Recommended extras</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio Analyzer</td>
<td>UPL</td>
<td>UPL, B1</td>
<td>19&quot; Rack Adapter</td>
</tr>
<tr>
<td>with colour LCD</td>
<td></td>
<td>UPL, B2</td>
<td>Service manual</td>
</tr>
<tr>
<td>Audio Analyzer</td>
<td>UPL66</td>
<td>UPL, B2</td>
<td></td>
</tr>
<tr>
<td>without display and keyboard</td>
<td></td>
<td>UPL, B2</td>
<td></td>
</tr>
<tr>
<td>Accessories supplied</td>
<td>power cable, operating manual, backup disks with MS-DOS operating system and user manual, backup program disk with operating and measurement software</td>
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<tr>
<td>Low Distortion Generator</td>
<td>UPL, B81</td>
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<tr>
<td>Digital Audio I/O</td>
<td>UPL, B82</td>
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<td>Digital Audio Protocol</td>
<td>UPL, B83</td>
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<td>Jitter and Interface Test</td>
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<td>Audio Monitor</td>
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<tr>
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<tr>
<td>Universal Sequence Controller</td>
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<td>XLR/BNC Adapter Set</td>
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<tr>
<td>Low Distortion Generator</td>
<td>UPL, B1</td>
<td>19&quot; Rack Adapter</td>
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<td>Digital Audio I/O</td>
<td>UPL, B2</td>
<td>Service manual</td>
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</tbody>
</table>

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