Audio Analyzer UPD

Tomorrow's digital world today

- For all interfaces: analog, digital and combined
- Programmable digital interfaces
- Real dual-channel measurements
- Maximum dynamic range
- Wide bandwidth
- 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.

Audio Analyzer UPD performs practically all types of audio 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, UPD is capable of performing real dual-channel measurements in the audio-frequency range, ie there is no need for switchover between two inputs and this type of measurement is not limited to a few special cases.

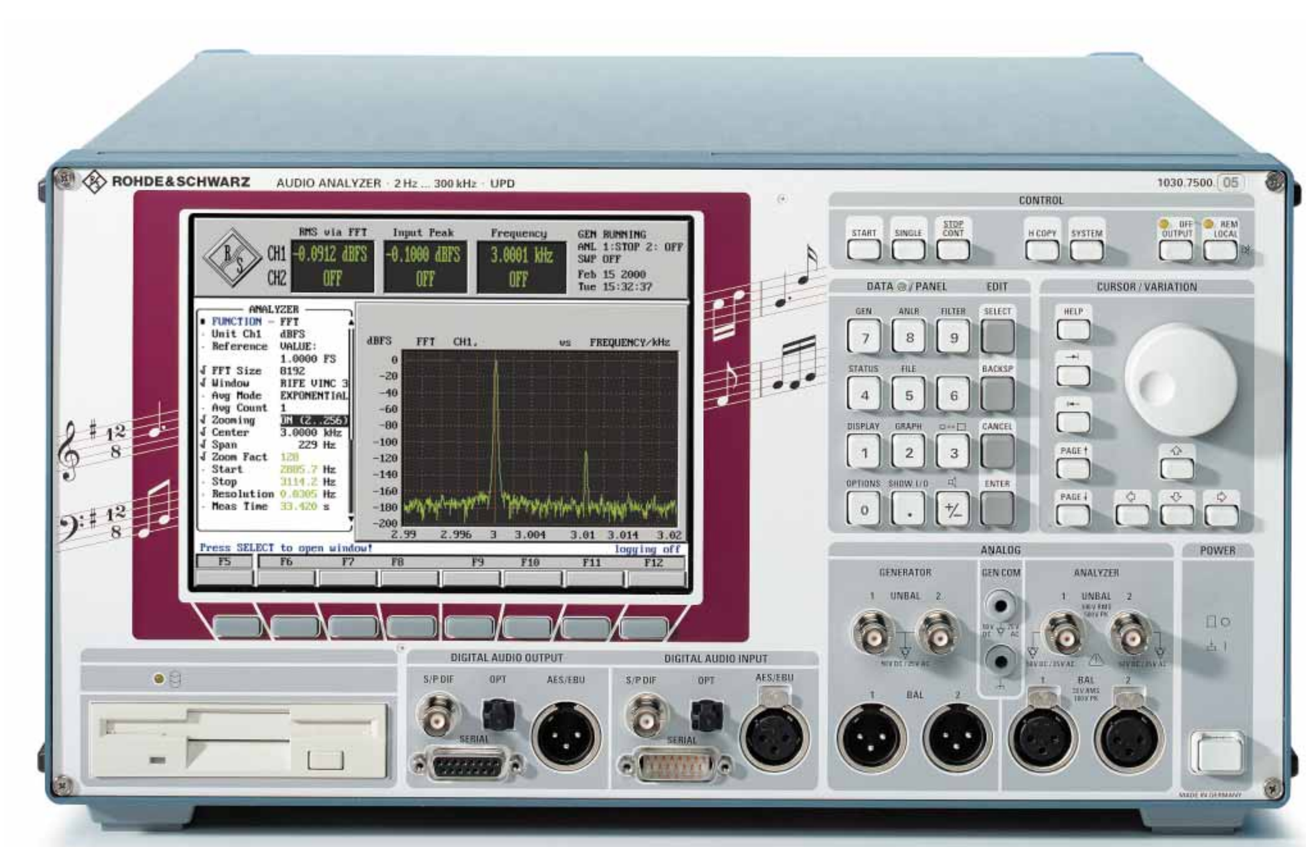
The generator is every bit as versatile: it supplies any conceivable signal from sinewave and noise signals through to multi-sinewave signals comprising up to 7400 frequencies.

In addition to all this, UPD features excellent technical data: analog sinewave generation with harmonics of typ. –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 0.02 Hz, etc.

UPD provides signal monitoring via loudspeaker, jitter measurements on digital audio signals, resynchronization of jittered digital audio signals by means of a jitter-free clock signal, and many more features.

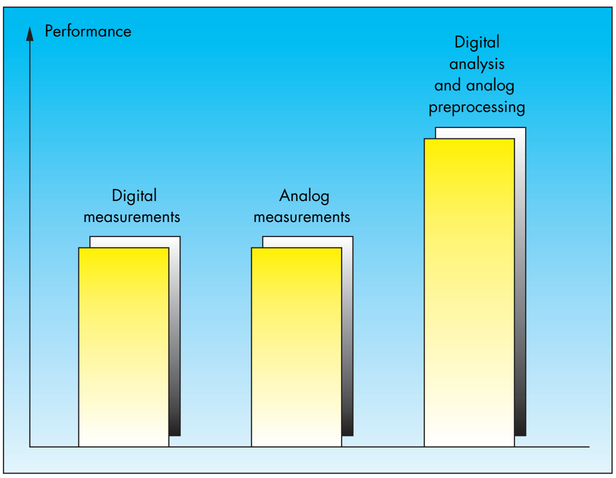
Superior analysis concept

UPD performs all measurements using digital signal processing. Analog signals to be tested undergo elaborate preprocessing before they are digitized and measured by means of digital routines. For example, in THD measurements, the fundamental 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 converter. This provides sufficient margin for measuring converters of the future, which will be technically more advanced than those of present-day technology (see graph on the right). This concept guarantees performance and flexibility by far superior to instruments providing purely analog or digital measurements.



The above measurement concept offers many other advantages over merely analog concepts:

- The test routines for 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 spuria, 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, are implemented digitally, resulting in an infinite number of filters as it were, and this also for measurements on analog interfaces. Simply 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

Certified Quality System
ISO 9001
DQS REG. NO 1954-04

Certified Environmental System
ISO 14001
REG. NO 1954

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 UPD. Since all test functions are implemented digitally, UPD 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.

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 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 and ISO 14001.

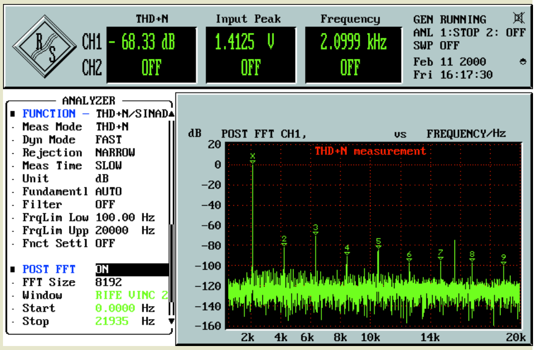


Fig. 1: Automatic marking of harmonics in THD+N measurements makes nonharmonics visible at a glance

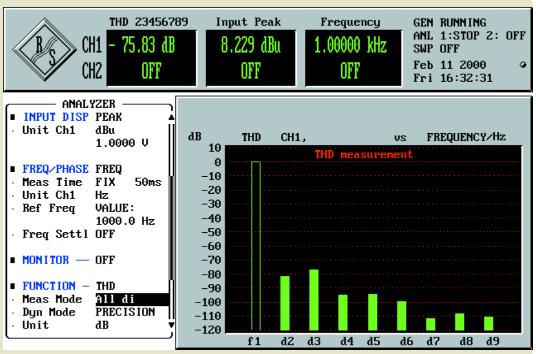


Fig. 2: In THD measurements, single harmonics, all harmonics or any combination of harmonics can be measured

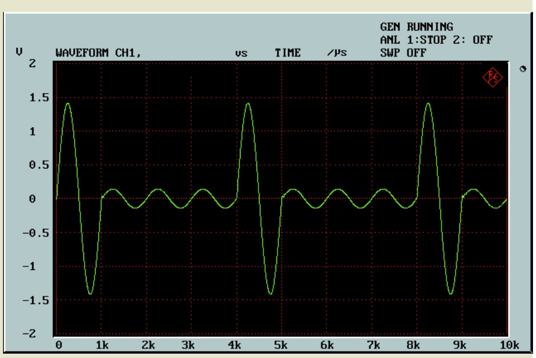


Fig. 3: The waveform function displays the test signal in the time domain. The example shows a sinewave burst

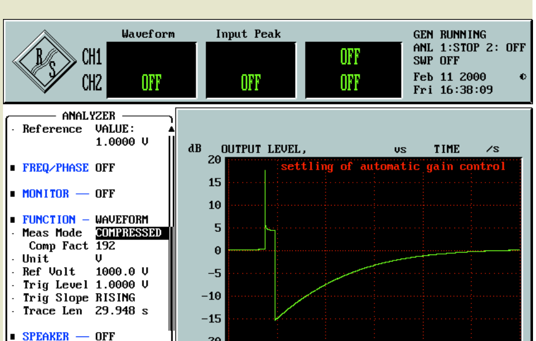


Fig. 4: The transient characteristics of an AGC play an important role in testing hearing aids or automatic volume control on tape recorders

An allrounder

Test signals – as you like it

The generators of UPD supply an extremely wide variety of analog and digital test signals:

- **Sinewaves**
  for level and harmonic distortion measurements. The signal can be applied to an equalizer with user-selectable nominal frequency response, eg 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
- **Multitone signal**
  comprising up to 17 sinewaves of any frequency and with the same or different amplitude; setting the phase is also possible
- **Sine burst signal**
  with adjustable interval and on-time as well as programmable low level, eg for testing AGCs
- **Sine² burst**
  also with adjustable interval and on-time, eg for testing rms rectifier circuits
- **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
- **Squarewave**
  as an ideal signal for measuring the transient response of a DUT
- **Signal for dynamic intermodulation measurement (DIM)**
  consisting of a squarewave and a sinewave signal with a level ratio of 4:1
- **Noise**
  with a variety of amplitude probability distributions, eg for acoustic measurements; crest factor can be set
- **Arbitrary waveforms**
  for generating any voltage curve of up to 16k points
- **AM and FM**
  for sinewave signals
- **DC**
  also with sweep function

Signals can be generated with an offset. Moreover, digital audio signals can be dithered with adjustable level and selectable amplitude distribution.

Versatile measurement functions

UPD offers a wealth of measurement functions both for analog and digital interfaces.

- **Level or S/N**
  with rms, peak or quasi-peak weighting; high measurement speeds due to automatic adaptation of integration times to input signal
- **Selective level**
  The center frequency of the bandpass filter can be swept or coupled to the generator frequency, to the frequencies of a multitone signal (eg 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)**
  Individual 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
- **Dynamic intermodulation measurement**
  on the products specified by DIN-IEC
- **Wow and flutter**
  to DIN-IEC, NAB, JIS or the 2-sigma method to DIN-IEC where the demodulated-signal spectrum is also displayed
- **DC voltage**
- **Frequency, phase and group delay**
- **Polarity**
  signal paths are checked 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, eg for analyzing the transient response of compander or AGC circuits (Fig. 4)
- **Coherence and transfer functions**
  for determining the transfer characteristics of complex test signals

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. Audio Analyzer UPD and its „little brother" UPL complement each other. 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

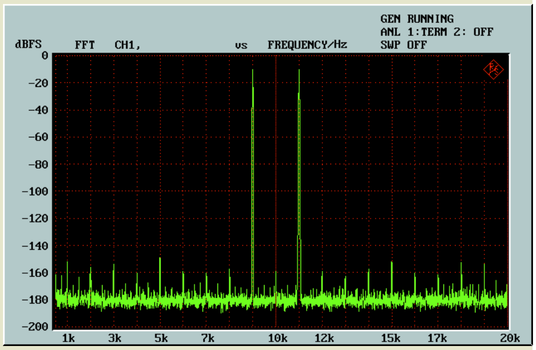


Fig. 5: FFT spectrum of two-tone signal shown on full screen

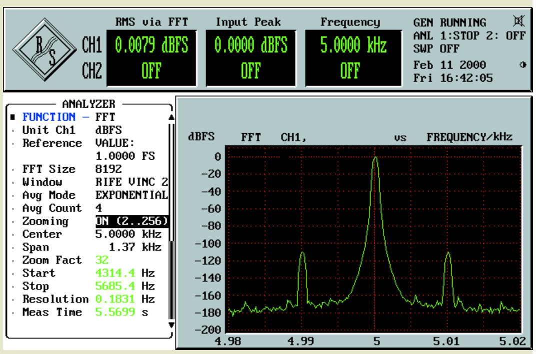


Fig. 6: With the zoom FFT function, sidebands spaced only a few hertz from the signal can be displayed

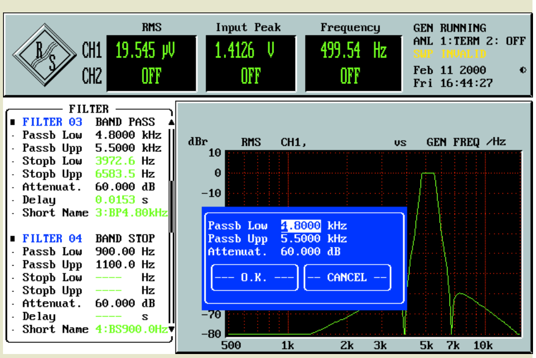


Fig. 7: Filters can be defined by entering just a few parameters

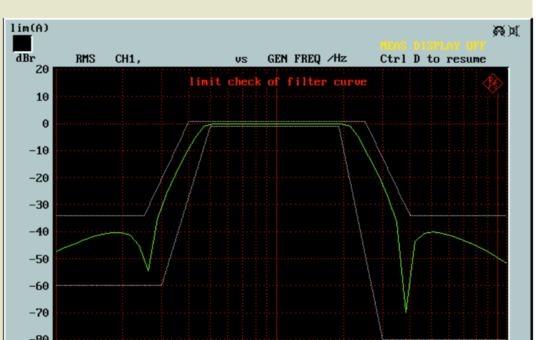


Fig. 8: Tolerance curves enable fast go/nogo tests

Spectrum analysis

With its FFT analyzer, UPD 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 256 over a selectable range. In this way, a maximum resolution of 0.02 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 UPD 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 UPD and the created filter is looped into the signal path.

A variety of sweep functions

For continuous variation of the test signals, UPD offers amplitude and frequency sweeps and for bursts additionally sweeps of interval and 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.

All-in package

Audio Analyzer UPD is a compact unit with an integrated controller. It avoids the disadvantages of external PC control, which is found in other audio analyzers.

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

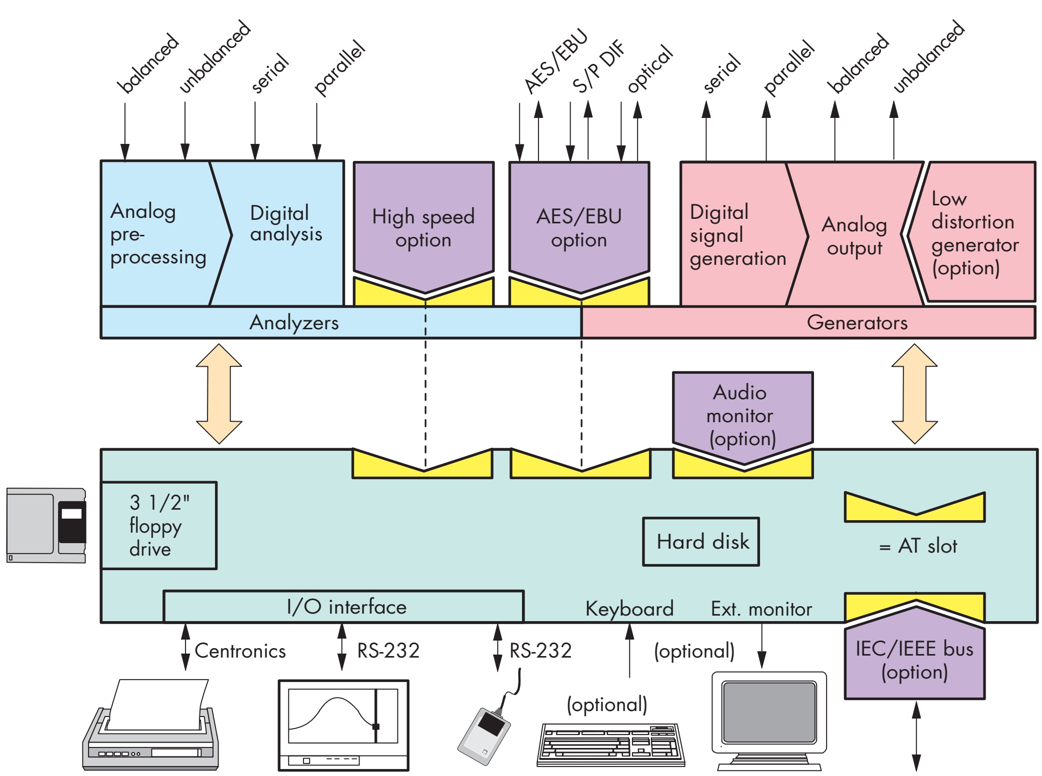
UPD is supplied ready for use. Installation is nothing more than unpacking the unit and switching it on for starting the measurement. The user is not burdened with problems that cropped up in the past with the installation of interface cards or PC software.

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 UPD: the instrument has specified EMC characteristics which also include the internal PC. In contrast to conventional PCs, UPD features elaborate screening such as magnetically shielded power transformers and coated filter pane in front of the display.

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

- Built-in hard disk and disk drive
- Connectors for keyboard, mouse, monitor, printer and plotter
- Centronics interface for connecting printer or network
- Drivers for commercial printers are supplied as standard
- Remote control via IEC/IEEE bus
- Postprocessing of results directly in UPD 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 UPD



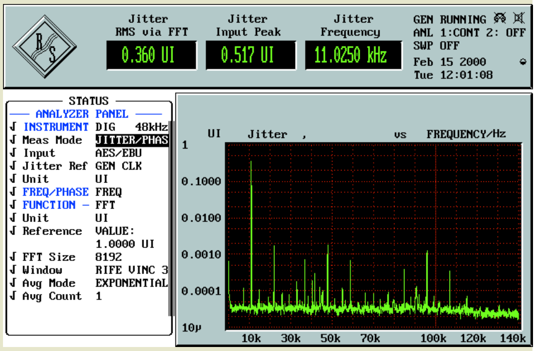


Fig. 9: Individual interference components can easily be found with the aid of the jitter spectrum

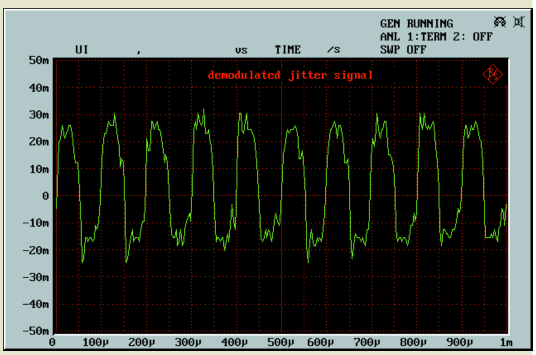


Fig. 10: Display of jitter signal in time domain

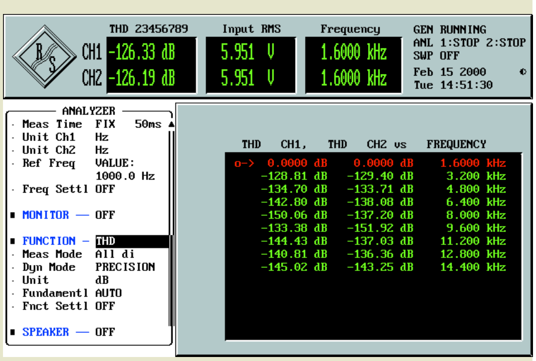


Fig. 11: Complete measured-value tables can be output for all functions

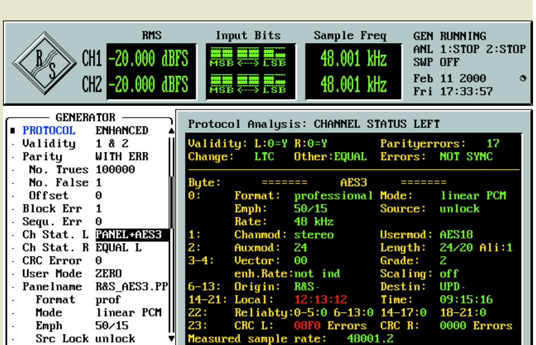


Fig. 12: UPD generates and analyzes additional data in digital data streams in line with all common standards. The data are represented in binary form, as hexadecimal numbers, as ASCII characters or evaluated in consumer or professional format

Interfaces, protocol analysis, jitter

Analog interfaces

- Balanced inputs and outputs with high common-mode rejection and various impedances commonly used in the studio. Measurements can be made on lines with phantom feed
- Unbalanced inputs and outputs, floating (eg 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

Programmable digital audio interfaces

- Parallel inputs and outputs for connecting modules or converters with parallel interface
- Serial inputs and outputs for adapting modules with a non-standard serial interface or audio chips. This interface is user-programmable, ie by selecting the word length, clock polarity, position of sync pulse, etc, it can be matched to almost any serial format, eg also to I²S bus
- Word lengths up to 32 bits with max. 28 audio bits open up a wide application range. Clock rates up to 1 MHz (word clock) can be processed

Standardized digital audio interfaces (option UPD-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 irrespective of the selected interface
- The clock rates of the analyzer and generator are independent of each other. This allows measurements on sample rate converters
- The word length can be selected between 8 and 24 bits independently for generator and analyzer

- 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)

- 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 requirements
- Simultaneous measurement of clock rate and display of interface errors (such as parity error)
- Generation of parity and CRC errors, etc, for testing input circuits
- An additional high-impedance input permits measurements to be performed without opening the signal path

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

Signal analysis:
- Measurement of jitter amplitude and display of jitter signal in the frequency and time domain (Figs 9 and 10)
- UPD 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
- Analysis of common-mode signal of balanced input (frequency, amplitude, spectrum, etc.)

Digital components of various data formats and clock rates are the stock-in-trade of professional users. They call for a measuring instrument offering top performance at all interfaces at high accuracy and over a wide dynamic range. Operation is identical for analog and digital interfaces, which enhances operator convenience. Fast fault diagnosis is possible by means of stored test routines, allowing the elimination of problems immediately before transmission

Signal generation:
- The clock of the output signal can be "jittered" by superimposing a sinewave or noise signal of variable amplitude
- An input signal with jitter can be output jitter-free
- 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 output and the reference output can be varied
- A reference (XLR) input and a synchronization (BNC) input provided on the rear panel allow the generator to be synchronized to the digital audio reference signal to AES 11, word clock, video sync signals (PAL, SECAM, NTSC) and to 1024 kHz reference clocks
- Generation of variable clock signals from 30 kHz to 52.5 kHz, also for operating UPD-B2
- Adjustable pulse amplitude

Designed for convenience

Efficient online help

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

HELP function

HELP information in German or English can be called for each input field.

SHOW I/O key

If no results can be 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

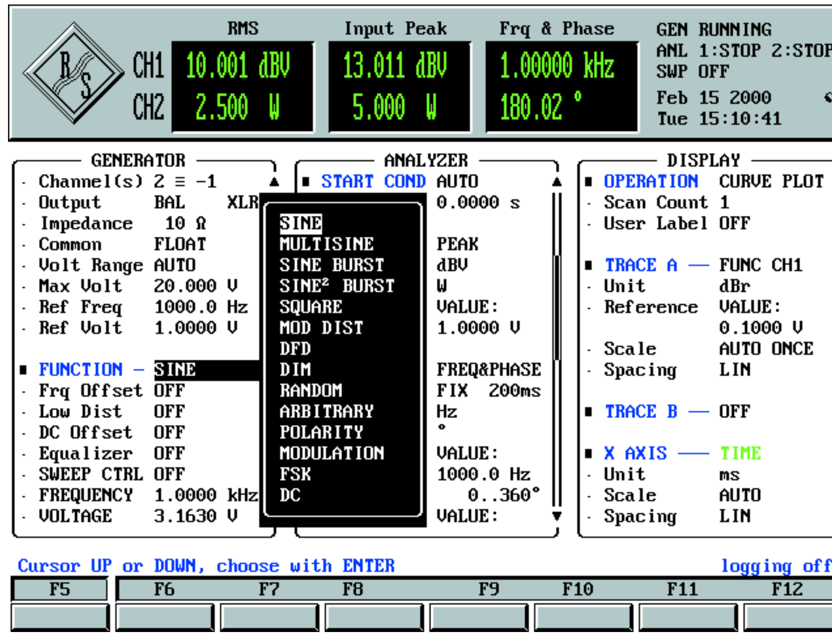
These highlighted boxes inform the user of any incorrect settings.

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 related parameters, eg the sample rate in the case of measurements on digital interfaces.

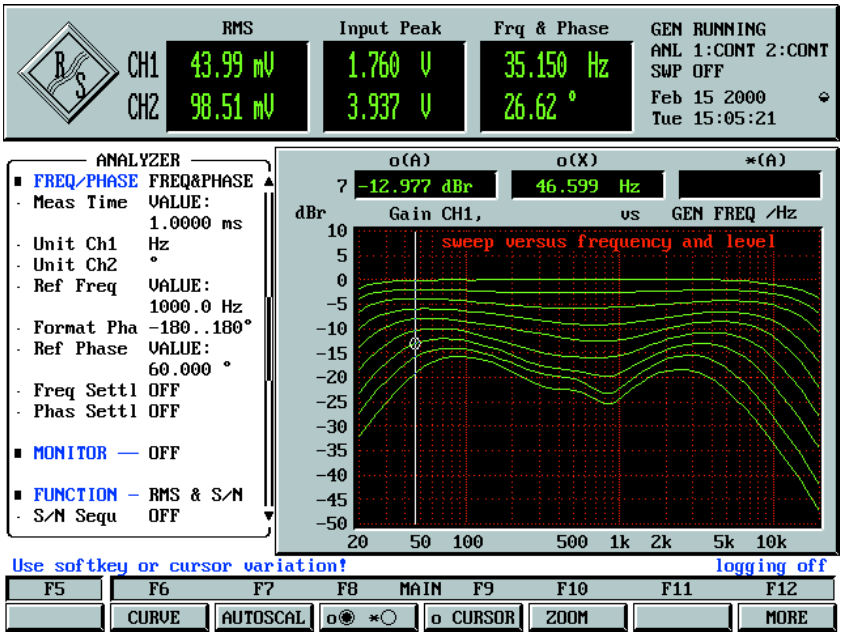
Protection against illegal entries

UPD 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.



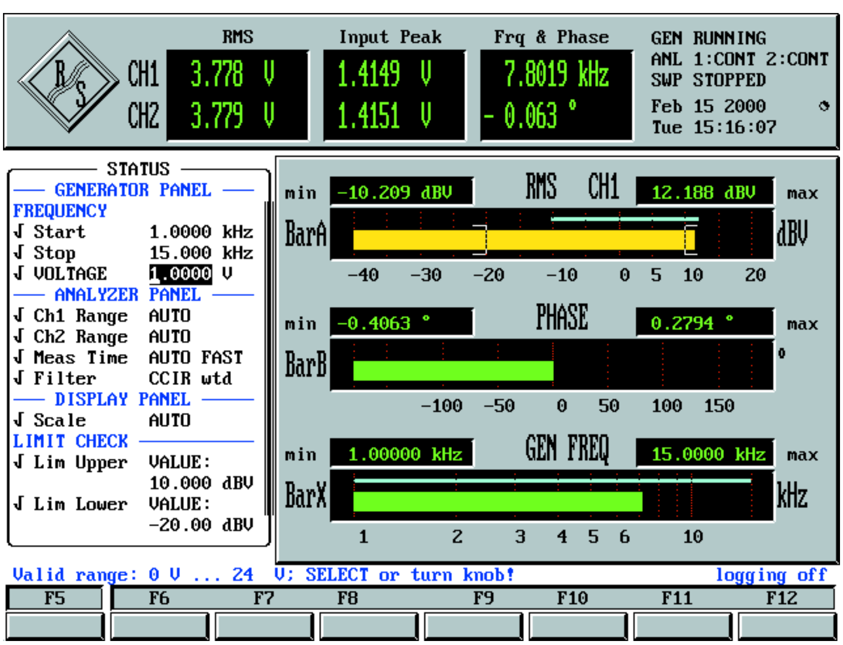
A wealth of functions – yet easy to operate

- 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
- Fast access to frequently used instrument setups and a comprehensive library of standard measurements simplify familiarization with the instrument
- Uncomplicated entries: the user simply needs to open a menu and make an entry or selection
- Continuous status information on generator, analyzer and sweep
- Rapid operating sequences through the use of softkeys, eg for graphical representations
- The user can choose between operation via mouse, external keyboard or front panel. This choice makes sense since the working space required by a mouse is not always available
- Short learning time thanks to an easy-to-understand operating concept treating analog and digital measurements in the same way



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. They are then transferred to a status panel. The status panel thus gives 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 UPD can also be operated from the status panel

Fast and efficient

High measurement speed

In designing Audio Analyzer UPD, 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
- UPD can perform even complex test functions simultaneously on both channels with the built-in high-speed option UPD-B3. This feature alone reduces the time for stereo measurements by 50% compared with most analyzers available on the market
- The digital test routine adapts its speed optimally to the input frequency. This enhances measurement speed especially in the case of frequency sweeps
- UPD performs harmonic distortion and IMD measurements using patented, digital test procedures that combine high accuracy with high measurement speed
- Digital signal processing reduces setting 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)
- User interface tailored to the requirements of a test, not of an office environment
- Display windows not needed can be switched off, which also cuts down the processing time

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/nogo 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
- Long calibration intervals, resulting from the extensive use of digital circuits, make for high availability of the instrument
- Remote-control capability via the IEC/IEEE bus is a must in large-scale production systems. In the design of Audio Analyzer UPD, 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 UPD-K1, it is no longer necessary to look up IEC/IEEE-bus commands

Options for further applications

Low distortion generator

The low distortion generator is essential for all applications requiring extremely pure analog signals or generation of an analog DIM signal. Its inherent distortion is well below that of the built-in universal generator which already has excellent specifications.

AES/EBU interface

This interface option (UPD-B2) contains the AES/EBU, the S/P DIF and the optical interfaces. An additional signal processor on the PCB permits also user bits, status bits, parity and CRC errors, etc, to be generated and analyzed in addition to audio data. Input and display masks can be user-defined with the aid of configuration files for adapting the interface to any protocol. Ready-made masks are available for protocols to AES3 or consumer format. The output level of the interface can be programmed. An additional high-impedance input enables measurements without opening the signal path.

Option UPD-B22 permits also the physical parameters of the serial bit stream of the digital audio interface to be investigated (for details refer to page 9).

High-speed option

UPD was designed for high measurement speed. For this reason all analog switching circuits are provided with two channels. Operations for the two measurement channels are calculated in time multiplex. If higher measurement speed is needed – eg in production – the optional High speed Extension UPD-B3 can be used. With the aid of this option digital processing too is performed in parallel for the two channels.

Audio monitor

The optional Audio Monitor UPD-B5 adds a headphones output and a built-in loudspeaker to UPD. During rms measurements in the frequency range up to 20 kHz, the input signal and the filtered signal can be monitored at the interfaces of the analog analyzer and the AES/EBU option.

UPD-B5 is also provided with four TTL inputs and eight TTL outputs which can be used for instance for switching checkpoint selectors.

IEC/IEEE-bus option

IEC-625/IEEE-488 bus Interface UPD-B4 enables remote control of UPD to IEC 625/IEEE 488. The employed commands largely meet SCPI standards.

Universal sequence controller

This option (UPD-K1) allows measurement sequences to be generated and executed, thus turning UPD 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 to the user for measurements on CD players, tuners, etc.

With the IEC/IEEE-bus option (UPD-B4) fitted, the universal sequence controller can also be used for remote control of external IEC/IEEE-bus equipment. Moreover, programs generated on UPD can be transferred after slight modifications to an external controller for the remote control of UPD. This greatly facilitates the generation of remote-control programs.

Automatic line measurement

Option UPD-K33 serves for automatic measurements of all relevant parameters of broadcast links according to ITU-T O.33. Generator and analyzer are normally located at different sites. They are synchronized with the aid of FSK signals. The operator may utilize the standard sequences defined by ITU-T O.33 or prepare his own.

Option UPD-K1 is needed for the use of UPD-K33.

Specifications

Data without tolerances are typical values

Analog analyzers

Three analyzers differing in bandwidth, specifications and measurement functions are available for analog measurements.

Analyzer	Frequency range
ANLG 22 kHz	2 Hz/10 Hz to 21.90 kHz
ANLG 100 kHz	20 Hz to 100 kHz
ANLG 300 kHz	50 Hz to 300 kHz
Voltage measurement ranges	5 dB steps for V_{in} >300 mV, 10 dB steps for V_{in} <300 mV
Measurement accuracy	±0.05 dB at 1 kHz (sine, rms)
Frequency response[1]	
20 Hz to 22 kHz	±0.03 dB
10 Hz to 20Hz	±0.15 dB
22 kHz to 50 kHz	±0.1 dB
50 kHz to 100 kHz	±0.2 dB
100 kHz to 300 kHz	±1.0 dB

Inputs

Balanced	2 independent channels XLR connectors (female), floating
Voltage range	0.1 µV to 35 V (rms, sine)
Input impedance	300 Ω, 600 Ω, 20 kΩ ±0.5% each, one value <20 kΩ specified by user (ready for installation), parallel 200 pF
Crosstalk attenuation	>120 dB, frequency <22 kHz
Common mode rejection (V_{in} <3 V)	>110 dB at 50 Hz, >86 dB at 1 kHz, >60 dB at 16 kHz
Common mode voltage (V_P)	max. 50 V (safety regulation), protected by surge protector
Unbalanced	2 independent channels BNC connectors (female), floating/ grounded switchable
Voltage range	0.1 µV to 300 V (rms, sine)
Input impedance	1 MΩ || 200pF
Crosstalk attenuation	>120 dB, frequency <22 kHz
Common mode rejection (V_{in} <3 V)	>110 dB at 50 Hz, >86 dB at 1 kHz, >60 dB at 16 kHz
Common mode voltage (V_P)	max. 50 V (safety regulation), protected by surge protector
Generator output	each input switchable to any output, input impedance: balanced 200 kΩ, unbalanced 100 kΩ

Measurement functions

RMS value, wideband	
Measurement accuracy	
Measurement speed	
AUTO	±0.05 dB at 1 kHz, sine
AUTO FAST	±0.1 dB additional error
Integration time	
AUTO FAST	4.2 ms, at least 1 cycle
AUTO	42 ms, at least 1 cycle
VALUE	1 ms to 10 s
Noise (600 Ω)	
with A weighting filter	1 µV
with CCIR unweighting filter	<2 µV (typ. 1.6 µV)
Filter	weighting and user-definable filters, up to 4 filters combinable additional analog notch filter (dynamic range expanded by up to 30 dB)
Spectrum	post-FFT of filtered signal
RMS value, selective	
Bandwidth (–0.1 dB)	1%, 3%, 1/12 octave, 1/3 octave and user-selectable fixed bandwidth, minimum bandwidth 20 Hz
Selectivity	100 dB, bandpass or bandstop filter, 8th order filter, elliptical
Frequency setting	– automatic to input signal – coupled to generator – fixed through entered value – sweep in user-selectable range
Measurement accuracy	±0.2 dB + ripple of filters
Peak value	with analyzer ANLG 22 kHz only
Measurement	peak max, peak min, peak-to-peak, peak absolute
Measurement accuracy	±0.2 dB at 1 kHz
Interval	20 ms to 10 s
Filters	weighting filters and user-definable filters, up to 3 filters combinable
Quasi-peak	with analyzer ANLG 22 kHz only
Measurement, accuracy	to CCIR 468-4
Noise (600 Ω)	<8 µV with CCIR weighting filter
Filter	weighting and user-definable filters, up to 3 filters combinable, analog notch filter in addition
DC voltage	
Voltage range	0 to ±300 V unbalanced 0 to ±35 V balanced
Measurement accuracy	±(1.5% + 2 mV)
Measurement range	100 mV to 300 V (balanced 30 V), 10 dB steps
S/N measurement routine	available for measurement functions – rms, wideband – peak – quasi-peak indication of S/N ratio in dB, no post-FFT
FFT analysis	see FFT analyzer section
Total harmonic distortion (THD)	
Fundamental	6 Hz to 110 kHz
Frequency tuning	– automatic to input signal – coupled to generator – fixed through entered value
Weighted harmonics	any combination of d_2 to d_9, up to max. 300 kHz
Measurement accuracy, harmonics <50 kHz	±0.5 dB
<100 kHz	±0.7 dB
<300 kHz	±1.5 dB

[1] Relative to 1 kHz, sine, rms.
Additional error ±0.1 dB for voltages >60 V unbalanced (>10 V balanced) and frequencies >50 kHz.
For analyzer ANLG 22 kHz with lower measurement limit 2 Hz (min. freq. 2 Hz): ±0.03 dB from 10 Hz to 22 kHz, ±0.05 dB from 2 Hz to 10 Hz.

Inherent distortion[1]			
Analyzer ANLG 22 kHz			
Fundamental	>100 Hz		<–110 dB, typ. –115 dB
	20 Hz to 100 Hz		<–100 dB
	10 Hz to 20 Hz		<–96 dB
Analyzer ANLG 100 kHz			
Fundamental	50 Hz to 20 kHz		<–97 dB, typ. –105 dB
	20 kHz to 50 kHz		<–92 dB
Analyzer ANLG 300 kHz			
Fundamental	130 Hz to 20 kHz		<–97 dB, typ. –105 dB
	20 kHz to 50 kHz		<–92 dB
	50 kHz to 110 kHz		<–86 dB
Spectrum			bar chart showing signal and distortion

THD+N and SINAD

Fundamental	20 Hz to 110 kHz
Frequency tuning	– automatic to input signal – coupled to generator – fixed through entered value
Input voltage	>100 µV typ. with automatic tuning
Bandwidth	upper and lower frequency limit selectable, one additional weighting filter
Measurement accuracy	
Bandwidth <50 kHz	±0.5 dB
<100 kHz	±0.7 dB
<300 kHz	±1.5 dB

Inherent distortion[2]		
Analyzer ANLG 22 kHz		
Bandwidth	20 Hz to 21.90 kHz	typ. –110 dB at 1 kHz, 2.5 V <–105 dB +2 µV typ. –108 dB +1.5 µV [3]
Analyzer ANLG 100 kHz		
Bandwidth	142 Hz to 22 kHz	<–95 dB + 2.5 µV, typ. –100 dB +1.75 µV
	142 Hz to 100 kHz	<–88 dB + 5 µV, typ. –95 dB + 3.5 µV
Analyzer ANLG 300 kHz		
Bandwidth	427 Hz to 22 kHz	<–97 dB + 2.5 µV, typ. –100 dB +1.75 µV
	427 Hz to 100 kHz	<–90 dB + 5 µV, typ. –95 dB + 3.5 µV
	427 Hz to 300 kHz	<–85 dB + 10 µV, typ. –92 dB + 7 µV
Spectrum		post-FFT of filtered signal

Modulation factor (MOD DIST)

Measurement method		selective to DIN-IEC 268-3
Frequency range	lower frequency	30 to 1200 Hz
	upper frequency	8xLF to 100 kHz[4]
Measurement accuracy		±0.50 dB
Inherent distortion[5]		
Upper frequency	4 to 15 kHz	<–96 dB (–90 dB), typ. –103 dB
	15 to 20 kHz	<–96 dB (–85 dB)
Spectrum		bar chart showing signal and distortion

Difference frequency distortion (DFD)

Measurement method		selective to DIN-IEC 268-3 or 118
Frequency range	difference frequency	80 Hz to 1 kHz
	center frequency	200 Hz to 100 kHz[6]
Measurement accuracy		±0.50 dB, center frequency <20 kHz
Inherent distortion[7]	DFD d_2	<–115 dB, typ. –125 dB
	DFD d_3	<–96 dB, typ. –105 dB
Spectrum		bar chart showing signal and distortion

Dynamic intermodulation distortion (DIM) with analyzer ANLG 22 kHz only

Measurement method	selective weighting of all 9 interference lines to DIN-IEC 268-3
Test signal	square/sine 3.15 kHz/15 kHz or 2.96 kHz/14 kHz, frequency tolerance ±3%, any square/sine amplitude ratio (standard 4:1)
Measurement accuracy	±1 dB
Inherent distortion[8]	<–80 dB, typ. –90 dB
Spectrum	bar chart showing signal and distortion

Wow and flutter with analyzer ANLG 22 kHz only

Measurement method		DIN-IEC, NAB, JIS, 2-sigma to IEC-386
Weighting filter	OFF	highpass 0.5 Hz, bandwidth 600 Hz
	ON	bandpass 4 Hz to IEC-386
Measurement accuracy		±3%
Inherent noise		<0.0005% weighted <0.001% unweighted
Spectrum		post-FFT of demodulated signal

Time domain display (WAVEFORM)

Trigger	rising/falling edge
Trigger level	–300 V to +300 V, interpolated between samples
Standard mode	
Trace length	max. 7424 points
Interpolation	1, 2, 4, 8, 16, 32
Enhanced mode	single channel
Trace length	max. 65530 points
Compressed mode	2- to 1024-fold compression (envelope for AGC measurement), with analyzer ANLG 22 kHz only

Coherence and transfer function with analyzer ANLG 22 kHz only

Frequency range	DC to 21.9 kHz
Frequency resolution	from 5.86 Hz
Averaging	2 to 2048
FFT length	256, 512, 1 k, 2 k, 4 k, 8 k points

Frequency

Frequency range	2 Hz to 300 kHz
Accuracy	±50 ppm
Input voltage	>5mV

1) Total inherent distortion of analyzer and generator (with option UPD-B1), analyzer with dynamic mode precision >10 V: typ. 3 dB lower;
<0.5 V: sensitivity reduced by inherent noise
(typ. 0.25/1.25/2.5 µV with analyzers ANLG 22/100/300 kHz).

2) Total inherent distortion of analyzer and generator (with option UPD-B1), analyzer with dynamic mode precision, fundamental <100 kHz.

3) At full-scale measurement range (<–100 dB + 2 µV with auto range).
<–100 dB +2 µV for fundamental<100 Hz.
<–100 dB for input voltage >5 V.

4) For upper frequency >20 kHz the bottom limit of the lower frequency is reduced.

5) Input voltage >200 mV, typical values apply between 0.5 and 5 V.
Lower frequency >200 Hz, values in ( ) for lower frequency <200 Hz.
Dynamic mode precision; level ratio LF:UF = 4:1.

6) For center frequency >20 kHz the bottom limit of the difference frequency is reduced.

7) Input voltage >200 mV, typical values apply between 0.5 V and 5 V, dynamic mode precision (at DFD d_2), center frequeny 5 kHz to 20 kHz.

8) Input voltage >200 mV, typical values apply between 0.5 V and 5 V. Total inherent distortion of analyzer and generator at full-scale measurement range.

Phase

Accuracy	
at 1 kHz	±0.1° typ.
20 Hz to 25 kHz[1]	±0.4°
10 Hz to 20 Hz	±1.0°
25 kHz to 100 kHz	±1.75°
Input voltage	> 15 mV, both signals of almost identical level
Display range	±180° or 0 to 360°

Group delay

Frequency range	20 Hz to 100 kHz
Accuracy in seconds	Δφ/(Δf x 360), where Δφ = phase accuracy in °, Δf = frequency step

Polarity test

Measurement	polarity of unsymmetrical input signal
Display	+POL, –POL

Analog generators

A 20-bit D/A converter is used for analog signal generation. Two generators differing in frequency ranges, specifications and test signals are available:

Generator	Frequency range	Sample Rate
ANLG 25 kHz	2 Hz to 25 kHz	96 kHz
ANLG110 kHz	2 Hz to 110 kHz	384 kHz

The characteristics of the basic generator can be improved and extended with a low-distortion RC oscillator (Low Distortion Generator UPD-B1):

— sine with reduced distortion
— improved intermodulation signals DFD and MODDIST
— signal generation for dynamic intermodulation measurement DIM

Outputs

Balanced	XLR connectors (male), 2 channels, floating/grounded switchable, short-circuit-proof; external feed <120 mA
Voltage	0.1 mV to 24 V (rms, sine, open-circuit)
Crosstalk attenuation	>117 dB, frequency <20 kHz
Source impedance	10 Ω 30 Ω ± 0.5Ω, 200 Ω, 600 Ω, ± 0.5% in each case, one user-selectable value >30 Ω , ready for installation
Load impedance	>400 Ω (incl. source impedance)
Output balance	>80 dB at 1 kHz,
(output floating)	>60 dB at 20 kHz

Unbalanced	BNC connectors (female), 2 channels, floating/grounded switchable, short-circuit-proof; external feed <120 mA
Voltage	0.1 mV to 12 V (rms, sine, open-circuit)
Crosstalk attenuation	>117 dB, frequency <20 kHz
Source impedance	5 Ω 15 Ω ± 0.5Ω, one user-selectable value > 15 Ω, ready for installation
Load impedance	>200 Ω

Signals

Sine

Frequency range	
Generator ANLG 25 kHz	2 Hz to 25 kHz
Generator ANLG 110 kHz	2 Hz to 110 kHz
Frequency accuracy	±50 ppm
Level accuracy	±0.1 dB at 1 kHz
Frequency response (ref. to1 kHz)	
20 Hz to 20 kHz	±0.05 dB
2 Hz to 110 kHz	±0.1 dB
Inherent distortion THD+N	
Generator ANLG 25 kHz, fundamental 20 Hz to 25 kHz	
Measurement bandwidth	
20 Hz to 22 kHz	<–92 dB, typ. –96 dB
20 Hz to 100 kHz	<–87 dB
Generator ANLG 110 kHz, fundamental 20 Hz to 100 kHz	
Measurement bandwidth	
20 Hz to 22 kHz	<–94 dB, typ. –98 dB
20 Hz to 100 kHz	<–80 dB
Sweep parameters	frequency, level

Sine (with low distortion generator option)

Frequency range	2 Hz to 110 kHz
Frequency accuracy	
PRECISION	±0.1%
FAST	±0.5% at 15 °C to 30 °C ±0.75% at 5 °C to 45 °C
Level accuracy	±0.1 dB at 1 kHz
Frequency response (ref. to 1 kHz)	
20 Hz to 20 kHz	±0.05 dB
10 Hz to 110 kHz	±0.1 dB
Harmonics	typ. <–120 dB (<–130 dB at 1 kHz), measurement bandwidth 20 Hz to 20 kHz, voltage 1 V to 5 V

Inherent distortion		THD	
Fundamental	1 kHz, 1 V to 10 V	<–125 dB typ.	
	20 Hz to 2 kHz	<–113 dB	
	2 kHz to 7 kHz	<–110 dB	
	7 kHz to 20 kHz	<–105 dB	
	20 kHz to 50 kHz	<–92 dB	
	50 kHz to 100 kHz	<–86 dB	
		THD+N[2]	Meas. bandw.
Fundamental	1 kHz, 2.5 V	–110 dB typ.	22 kHz
	100 Hz to 20 kHz	<–105 dB +2 µV	22 kHz
	20 Hz to 100 Hz	<–100 dB +2 µV	22 kHz
	<100 kHz	<–90 dB +5 µV	100 kHz
	<20 kHz	<–88 dB +10 µV	300 kHz
	<100 kHz	<–85 dB +10 µV	300 kHz
Sweep parameters		frequency, level	

MOD DIST		for measuring the modulation distortion
Frequency range	lower frequency	30 Hz to 2.5 kHz
	upper frequency	8xLF to 110 kHz (max. 25 kHz with ANLG 25 kHz)
Level ratio (LF:UF)		selectable from 10:1 to 1:1
Level accuracy		±0.5 dB
Inherent distortion		<–80 dB (typ. –90 dB) upper frequency 4 kHz to 25 kHz, level ratio LF:UF = 4:1
Sweep parameters		upper frequency, level

MOD DIST (with low distortion generator option)

Frequency range	lower frequency	30 Hz to 500 Hz
	upper frequency	4 kHz to 110 kHz
Level ratio (LF:UF)		selectable from 10:1 to 1:1
Level accuracy		±0.5 dB

1) ±0.4° above 2 Hz, with analyzer ANLG 22 kHz and lower measurement limit 2 Hz (min. freq. 2 Hz).

2) Total inherent distortion of analyzer and generator, analyzer using dynamic mode precision. When the low-impedance source resistors are used (unbalanced 5 Ω, balanced 10 Ω), the THD+N value in level range 0.6 V to 2.5 V balanced (0.3 V to 1.25 V unbalanced) is reduced by typ. 3 dB because of noise.

Inherent distortion[1)]		
Upper frequency	4 kHz to 15 kHz	<–96 dB (– 90 dB), typ. –103 dB
	15 kHz to 20 kHz	<–96 dB (– 85 dB)
Sweep parameters		upper frequency, level

DFD		for measuring the difference tone
Frequency range	difference freq.	80 Hz to 1 kHz
	center frequency	200 Hz to 109 kHz (max. 24 kHz with ANLG 25 kHz)
Level accuracy		±0.5 dB
Inherent distortion[2)]	DFD d_2	< –114 dB, typ.–120 dB
	DFD d_3	< –85 dB, typ. –95 dB
Sweep parameters		center frequency, level

DFD (with low distortion generator option)		
Frequency range		
Difference frequeny		80 Hz to 1 kHz
Center frequency		200 Hz to 109 kHz
Level accuracy		±0.5 dB
Inherent distortion[3)]	DFD d_2	< –120 dB, typ.–125 dB
	DFD d_3	< –96 dB, typ. –105 dB
Sweep parameters		center frequency, level

DIM (only with option UPD-B1)	for DIM measurements to DIN-IEC 268-3 (dynamic intermodulation distortion)
Waveform	square/sine 3.15 kHz/15 kHz or 2.96 kHz/14 kHz, square/sine amplitude ratio 4:1. bandwidth (3 dB) 30 kHz/100 kHz, selectable
Max. level (V_{PP})	50 V (25 V unbalanced)
Level accuracy	±0.5 dB
Inherent distortion[4)]	< –80 dB, typ.–90 dB
Sweep parameters	level

Multi-sine	
Characteristics	– 1 to 17 spectral lines – level, frequency and phase selectable for each line – crest factor optimized to minimum or selectable
Generator ANLG 25 kHz	
Frequency range	5.86 Hz to 25 kHz
Frequency spacing	adjustable from 5.86 Hz with <0.01% resolution or matching to FFT frequency spacing
Dynamic range	100 dB referred to total peak value
Generator ANLG 110 kHz	
Frequency range	23.44 Hz to 110 kHz
Frequency spacing	adjustable from 23.44 Hz with <0.01% resolution or matching to FFT frequency spacing
Dynamic range	80 dB referred to total peak value

Squarewave	with generator ANLG 25 kHz only
Frequency range	2 Hz to 10 kHz
Max. level (V_{PP})	40 V (20 V unbalanced)
Level accuracy	±0.2 dB (rms)
Rise time	1.5 µs
Sweep parameters	frequency, level

Sine burst, sine² burst	
Burst time	1 sample up to 60 s, 1-sample resolution
Interval	burst time up to 60 s, 1-sample res.
Low level	0 to burst level, absolute or relative to burst level (0 with sine² burst)
Bandwidth	25 kHz/110 kHz with generator ANLG 25 kHz/110 kHz (elliptical filter)
Sweep parameters	burst frequency, level, time, interval

Noise	
Noise in time domain	
Distribution	Gaussian, triangular, rectangular
Noise in frequency domain	
Frequency range	
Generator ANLG 110 kHz	5.86 Hz to 25 kHz
Generator ANLG 110 kHz	23.44 Hz to 110 kHz
Frequency spacing	adjustable from 5.86 Hz (above 23.44 Hz with ANLG 110 kHz) with <0.01% resolution or matching to FFT frequency spacing
Distribution	white, pink, 1/3 octave, defined by file
Crest factor	optimized to minimum or selectable

Arbitrary waveform	loaded from file
Memory depth	max. 16384
Clock rate	96 kHz/384 kHz with generator ANLG 25 kHz/110 kHz
Bandwidth	25 kHz/110 kHz with generator ANLG 25 kHz/110 kHz (elliptical filter)

Polarity test signal	with generator ANLG 25 kHz only
Sine² burst with following characteristics:	
Frequency	1.2 kHz
On-time	1 cycle (0.8333 ms)
Interval	2 cycles (1.6667 ms)

FM signal	with generator ANLG 25 kHz only
Carrier frequency	2 Hz to 25 kHz
Modulation frequency	1 mHz to 25 kHz
Modulation	0 to 100%

AM signal	with generator ANLG 25 kHz only
Carrier frequency	2 Hz to 25 kHz
Modulation frequency	1 mHz to 25 kHz
Modulation	0 to 100%

DC voltage	with generator ANLG 25 kHz only
Level range	0 to ±10 V (±5 V unsymmetrical), can be swept
Accuracy	±2%

DC offset[5)]	0 to ±10.0 V (±5 V unsymmetrical) 18-bit resolution
Accuracy	±2%
Residual offset	<1% of rms value of AC signal (typ. <0.1%)

1) Output voltage >200 mV, typ. values apply from 0.5 V to 5 V. Lower frequency >100 Hz, value in () for lower frequency <100 Hz. Level ratio LF:UF = 4:1.

2) Center frequency 5 kHz to 20 kHz, DFD d_2 –95 dB (typ.) with DC offset.

3) Output voltage >200 mV, typ. values apply from 0.5 V to 5 V. DFD d_3: total inherent distortion of analyzer and generator; center frequency 5 kHz to 20 kHz.

4) Input voltage >200 mV, typ. values apply from 0.5 to 5 V. Total inherent distortion of analyzer and generator at full-scale measurement range.

5) For all signals except squarewave and DIM, no DC offset for signal generation with Low Dist ON. With DC offset the AC voltage swing will be reduced, specified inherent distortion values apply to DC offset = 0.

Digital analyzers

Three analyzers differing in bandwidth, specifications and measurement functions are available for digital measurements.

Analyzer	Frequency range
DIG 48 kHz	2 Hz/10 Hz to 21.90 kHz
DIG 192 kHz	10 Hz/100 Hz to 87 kHz
DIG 768 kHz	10 Hz/100 Hz to 350 kHz

With analyzers DIG 192 kHz and DIG 768 kHz the number of samples is limited to 96000. This reduces the lower limit frequency and the maximum filter settling time. Frequency limits specified for the individual measurement functions apply to a sampling frequency of 48 kHz. Limits for other sampling frequencies are calculated according to the formula: $f_{new} = f_{48\,kHz} \times$ sampling rate/ 48 kHz.
Maximum values for analyzer DIG 768 kHz are specified in [ ].

Inputs

Serial (audio)	with option UPD-B2
Channels	1, 2 or both
Audio bits	8 to 24
Clock rate	32/44.1/48 kHz
Format	professional and consumer format to AES3 or IEC-958 as well as user-definable formats at all inputs
Balanced input	XLR connector (female), transformer coupling
Impedance	110 Ω, 10 kΩ, switchable
Level (V_{PP})	min. 200 mV, max. 12 V into 110 Ω (24 V into 10 kΩ)
Unbalanced input	BNC, grounded
Impedance	75 Ω
Level (V_{PP})	min. 100 mV, max. 5 V
Optical input	TOSLINK

Serial (universal)	15-contact DSUB connector (male)
Channels	1 and/or 2 separate or multiplexed
Word length	8/16/24/32 bits
Audio bits	8 to 28 bit
Data format	MSB/LSB first
Synchronization	pos./neg. edge of bit clock and word clock selectable, position of word clock within word user-selectable, word select (MUX) low/high
Clock rate	100 Hz to 1 MHz (word clock)

Parallel	37-contact DSUB connector (male)
Channel 1/MUX	channel 1 or channels 1 and 2 multiplexed
Channel 2	contained in option UPD-B3 (high-speed extension)
Word length	28 bits
Audio bits	8 to 28
Synchronization	word clock with pos./neg. edge, word select (MUX) low/high
Clock rate	100 Hz to 1 MHz

Measurement functions

(all measurements at 24 bits, full scale)

RMS value, wideband	
Measurement bandwidth	up to 0.5 times the clock rate
Measurement accuracy	
AUTO FAST	±0.1 dB
AUTO	±0.01 dB
FIX	±0.001 dB
Integration time	
AUTO FAST	4.2 ms, at least 1 cycle
AUTO	42 ms, at least 1 cycle
VALUE	1 ms to 10 s
Filter	weighting and user-definable filters, up to 4 filters combinable
Spectrum	post-FFT of filtered signal

RMS value, selective	
Bandwidth (–0.1 dB)	1%, 3%, 1/12 octave, 1/3 octave and user-selectable fixed bandwidth, min. bandwidth 20 Hz
Selectivity	100 dB, bandpass or bandstop filter, 8th order filter, elliptical
Frequency setting	– automatic to input signal – coupled to generator – fixed through entered value – sweep in user-selectable range
Measurement accuracy	±0.2 dB + ripple of filters

Peak value	with analyzer DIG 48 kHz only
Measurement	peak max, peak min, peak-to-peak, peak absolute
Measurement accuracy	±0.2 dB at 1 kHz
Interval	20 ms to 10 s
Filter	weighting and user-definable filters, up to 3 filters combinable

Quasi-peak	with analyzer DIG 48 kHz only
Measurement, accuracy	to CCIR 468-4
Filter	weighting and user-definable filters, up to 3 filters combinable

S/N measurement routine	available for measurement functions: – rms, wideband – peak – quasi-peak indication of S/N ratio in dB, no post-FFT

FFT analysis	see FFT analyzer section

Total harmonic distortion (THD)	
Fundamental	6 Hz to 21.90 kHz [100 Hz to 350 kHz]
Frequency tuning	– automatic to input signal – coupled to generator – fixed through entered value
Weighted harmonics	any combination of d_2 to d_9, up to 21.90 kHz [350 kHz]
Measurement accuracy	±0.1 dB
Inherent distortion[1]	
Fundamental	
42 Hz to 21.90 kHz	<–130 dB
24 Hz to 42 Hz	<–112 dB
12 Hz to 24 Hz	<–88 dB
Spectrum	bar chart showing signal and distortion

THD+N and SINAD	
Fundamental	20 Hz to 21.90 kHz [320 Hz to 350 kHz]
Frequency tuning	– automatic to input signal – coupled to generator – fixed through entered value
Stopband range	fundamental ±28 Hz, but max. up to 1st harmonic
Bandwidth	upper and lower frequency limit selectable, one additional weighting filter
Measurement accuracy	±0.3 dB
Inherent distortion[1]	
Bandwidth 20 Hz to 21.90 kHz	
Fundamental	
28 Hz to 21.90 kHz	<–126 dB
24 Hz to 28 Hz	<–109 dB
20 Hz to 24 Hz	<–96 dB
Spectrum	post-FFT of filtered signal

1) Total inherent distortion of analyzer and generator.

Modulation distortion (MOD DIST)

Measurement method		selective to DIN-IEC 268-3
Frequency range	lower frequency	30[400] Hz to 500 Hz[1]
	upper frequency	4 kHz[1] to 21.25 kHz [348 kHz]
Measurement accuracy		±0.2 dB
Inherent distortion[2]		
Level LF:UF	1:1	<–133 dB
	4:1	<–123 dB
	10:1	<–115 dB
Spectrum		bar chart showing signal and distortion

Difference frequency distortion (DFD)

Measurement method		selective to DIN-IEC 268-3 or 118
Frequency range		
Difference frequency		80 Hz [500 Hz] to 2 kHz[1]
Center frequency		200 Hz to 20.90 kHz [348 kHz]
Measurement accuracy		±0.2 dB
Inherent distortion[2]	DFD d_2	<–130 dB
	DFD d_3	<–130 dB
Spectrum		bar chart showing signal and distortion

Dynamic intermodulation distortion (DIM)

	with analyzer DIG 48 kHz only
Measurement method	selective weighting of all 9 interference lines to DIN-IEC 268-3
Test signal	square/sine 3.15 kHz/15 kHz or 2.96 kHz/14 kHz, frequency tolerance ±3%, any square/sine amplitude ratio (standard 4:1)
Measurement accuracy	±0.2 dB
Inherent distortion[2]	<–125 dB
Spectrum	bar chart showing signal and distortion

Wow and flutter

		with analyzer DIG 48 kHz only
Measurement method		DIN-IEC, NAB, JIS, 2-sigma to IEC-386
Weighting filter	OFF	highpass 0.5 Hz, bandwidth 600 Hz
	ON	bandpass 4 Hz to IEC-386
Measurement accuracy		±3%
Inherent noise		<0.0003% weighted
		<0.0008% unweighted
Spectrum		post-FFT of demodulated signal

Time domain display (WAVEFORM)

Trigger	rising/falling edge
Trigger level	–1 FS to +1 FS, interpolated between samples
Standard mode	
Trace length	max. 7424 points
Interpolation	1, 2, 4, 8, 16, 32
Enhanced mode	single channel
Word length	max. 65530 points
Compressed mode	2- to 1024-fold compression (envelope for AGC measurement), with analyzer DIG 48 kHz only

Frequency[3]

Frequency range	
with rms value	2 Hz to 21.90 kHz
with THD	6 Hz to 21.90 kHz
with FFT, THD+N	20 Hz to 20 kHz
Accuracy	typ. ±5 ppm THD+N <–70 dB
Input signal	>–80 dBFS

[1] Fixed frequency independent of sampling rate.
[2] Total inherent distortion of analyzer and generator.
[3] Only with measurement functions RMS, THD, THD+N and FFT analysis.

Phase[4]

Accuracy	±0.1°, 20 Hz to 20 kHz
Display range	±180° or 0 to 360°

Group delay[4]

Frequency range	20 Hz to 20 kHz
Accuracy in seconds	$\Delta\varphi/(\Delta f \times 360)$, where $\Delta\varphi$ = phase accuracy in °, Δf = frequency step

Polarity test

Measurement	polarity of unsymmetrical input signal
Display	+POL, –POL

Digital generators

Three generators differing in frequency and test signals are available for digital signal generation.

Generator	Frequency range
DIG 48 kHz	2 Hz to 21.90 kHz
DIG 192 kHz	2 Hz to 87 kHz
DIG 768 kHz	2 Hz to 350 kHz

Frequency limits indicated for the signals apply to a sampling rate of 48 kHz. Frequency limits for other sampling rates are calculated according to the formula: $f_{new} = f_{48\,kHz} \times$ sampling rate/48 kHz.

Max. values for generator DIG 768 kHz are specified in [ ].

Outputs

Serial (audio)	with option UPD-B2
Channels	1, 2 or both
Audio bits	8 to 24
Clock rate	internal: 32 kHz, 44.1 kHz, 48 kHz or synchronization to analyzer external: synchronization to word clock input (27 kHz to 55 kHz)
Format	professional and consumer format to AES 3 or IEC-958 as well as user-definable formats at all outputs
Balanced output	XLR connector (male), transformer coupling
Impedance	110 Ω, short-circuit-proof
Level (V_{PP} into 110 Ω)	20 mV to 5.1 V, in steps of 20 mV
Accuracy	±1 dB (rms)
Unbalanced output	BNC connector (female), transformer coupling
Impedance	75 Ω, short-circuit-proof
Level (V_{PP} into 75 Ω)	10 mV to 1.5 V, in steps of 10 mV
Accuracy	±1 dB (rms)
Optical output	TOSLINK
Serial (universal)	15-contact DSUB connector (female)
Channels	1 and/or 2 separate or multiplexed
Word length	8/16/24/32 bits
Audio bits	8 to 28
Data format	MSB/LSB first
Synchronization	pos./neg. edge of bit clock and word clock selectable, position of word clock within word user-selectable, word select (MUX) low/high
Clock rate (word clock)	internal: 32 kHz, 44.1 kHz, 48 kHz and multiples thereof up to max. 768 kHz external: 100 Hz to 768 kHz
Parallel	37-contact DSUB connector (female)
Channel 1/MUX	channel 1 or channels 1 and 2 multiplexed
Word length	28 bits
Synchronization	word clock with pos./neg. edge, word select (MUX) low/high
Clock rate	internal: 32 kHz, 44.1 kHz, 48 kHz and multiples thereof up to max. 768 kHz external: 100 Hz to 768 kHz

[4] Only with FFT analysis at serial audio inputs (AES/EBU, S/P DIF or optical).

Signals

(All signals with 24 bits, full scale)

General characteristics

Level resolution	2^{-24}
Audio bits	8 to 28 (8 to 24 at AES), LSB rounded off
Dither[1]	
Distribution	Gaussian, triangular, rectangular
Level	2^{-24} FS to 1 FS
Frequeny accuracy	±50 ppm (internal clock), ±1 ppm ref. to clock rate
Frequency offset[1]	0 or +1000 ppm
DC offset	0 to ±1 FS adjustable

Sine

Frequency range	2 Hz[2] to 21.90 kHz [350 kHz]
Total harmonic distortion (THD)	<–133 dB
Sweep parameters	frequency, level

MOD DIST — for measuring the modulation distortion

Frequency range	lower frequency	30[50] Hz to 500 Hz[2]
	upper frequency	4 kHz[2] to 21.90 kHz [350 kHz]
Level ratio (LF:UF)		selectable from 10:1 to 1:1
Inherent distortion		
Level LF:UF	1:1	<–133 dB
	4:1	<–123 dB
	10:1	<–115 dB
Sweep parameters		upper frequency, level

DFD — for measuring the difference tone

Frequency range	
Difference frequency	80 Hz [100 Hz] to 1 kHz[2]
Center frequency	200 Hz[2] to 20.90 kHz [350 kHz]
Inherent distortion[3]	
DFD d_2	<–130 dB
DFD d_3	<–130 dB
Sweep parameters	center frequency, level

DIM — for DIM measurement to DIN-IEC 268-3 (dynamic modulation distortion)

Waveform	square/sine 3.15 kHz/15 kHz or 2.96 kHz/14 kHz, square/sine amplitude ratio 4:1
Inherent distortion[3]	< –125 dB
Sweep parameters	level

Multi-sine

Characteristics	– 1 to 17 spectral lines – level, frequency and phase selectable for each line – crest factor optimized to minimum or selectable
Frequency range	2.93 Hz to 21.90 kHz [46.88 Hz to 350 kHz]
Frequency spacing	adjustable from 2.93 Hz [46.88 Hz] with <0.01% resolution or matching to FFT frequency spacing
Dynamic range	>133 dBFS

Squarewave

Frequency	2 Hz[2] to 12 kHz [50 Hz to 192 kHz], 2-sample resolution
Sweep parameters	frequency, level

Sine burst, sine^2 burst

Burst time[4]	1 sample up to 60 s
Interval[4]	burst time up to 60 s
Low level	0 to burst level, absolute or relative to burst level (0 with sine^2 burst)
Sweep parameters	burst frequency, level, time, interval

Noise

Noise in time domain	not with generator DIG 768 kHz
Distribution	Gaussian, triangular, rectangular
Noise in frequency domain	
Frequency range	2.93 Hz to 21.90 kHz [46.88 Hz to 350 kHz]
Frequency spacing	adjustable from 2.93 Hz [46.88 Hz] with <0.01% resolution or matching to FFT frequency spacing
Distribution	white, pink, 1/3 octave, defined by file
Crest factor	optimized to minimum or selectable

Arbitrary waveform — loaded from file

Memory depth	max. 16384
Clock rate	sample rate of generator

Polarity test signal — with generator DIG 48 kHz only

Sine^2 burst with following characteristics:	
Frequency	1.2 kHz[2]
On-time	1 cycle
Interval	2 cycles

FM signal — with generator DIG 48 kHz only

Carrier frequency	2 Hz[2] to 21.90 kHz
Modulation frequency	1 mHz[2] to 21.90 kHz
Modulation	0 to 100%

AM signal — with generator DIG 48 kHz only

Carrier frequency	2 Hz[2] to 21.9 kHz
Modulation frequency	1 mHz[2] to 21.9 kHz
Modulation	0 to 100%

DC voltage — with generator DIG 48 kHz only

Level range	0 to ±1 FS, can be swept

Digital audio protocol (with option UPD-B2)

Generator

Validity bit	NONE, L, R, L+R
Error simulation	parity/block error/sequence error/ CRC error, correctly or with adjustable error rate
Channel status data	mnemonic entry with user-definable masks, predefined masks for professional and consumer format to AES3 or IEC-958
Local time code	automatic generation selectable
CRC	automatic generation selectable
User data	loaded from file (max. 16384 byte) or set to zero

Analyzer

Display	– validity bit L and R – change of status bits – differences between L and R
Error indication	block errors, sequence errors, clock-rate errors, preamble errors
Error counter	parity, CRC
Clock-rate measurement	50 ppm

1) With signals sine, DFD and MOD DIST. Dither not with generator DIG 768 kHz.
2) Fixed frequency independent of sampling rate.
3) Total inherent distortion of analyzer and generator.

4) 1-sample resolution, duration max. 20 ms with generator DIG 768 kHz.

Channel status display	user-definable mnemonic display of data fields, predefined settings for professional and consumer format to AES3 or IEC-958. binary and hexadecimal format
User bit display	user-definable mnemonic display, block-synchronized

Jitter and interface tester (option UPD-B22)

For non-specified characteristics the data of UPD-B2 apply

Generator

Level (V_{pp} into 110 Ω)	0 to 8 V, in 240 steps, balanced, 0 to 2 V, unbalanced
Clock rate	
Internal	continuously adjustable between 30 kHz and 52.5 kHz and synchronization to analyzer
External	30 kHz to 52.5 kHz, synchronization to word clock input, video sync, DARS, 1024 kHz
Jitter injection	
Waveform	sine, noise
Frequency range	10 Hz to 110 kHz
Amplitude (peak-to-peak)	0 to 10 UI
Common mode signal	for balanced output
Waveform	sine
Frequency range	20 Hz to 110 kHz
Amplitude (V_{pp})	0 to 20 V
Phase (output to reference)	adjustable between –64 and +64 UI (corresp. to ±50% of frame)
Cable simulator	
Long cable	100 m typical audio cable
Short cable	typ. 30 ns rise time

Analyzer

Impedance	110 Ω (bal.), 75 Ω (unbal.)
Amplitude (V_{pp})	200 mV to 12 V (balanced) 100 mV to 5 V (unbalanced)
Sampling rate	30 kHz to 52.5 kHz (phase, jitter and common-mode measurement)
Jitter measurement	amplitude, frequency, spectrum 0 to 5 UI typ. for f<500 Hz, decreasing to 0.5 UI for up to 50 kHz (at 48 kHz)
Reclocking	input signal available at reference output (rear of instrument) after removal of jitter
Common mode test	at balanced input
Amplitude (V_{pp})	0 to 30 V
Frequency	20 Hz to 110 kHz
Spectrum	20 Hz to 110 kHz
Phase (input to reference)	–64 to +64 UI (corresp. to ±50% of frame)
Sync output	switchable to generator, REF generator, audio input, REF input or reference PLL; word clock or biphase clock selectable

FFT analyzer

Frequency range, digital	2 Hz to 350 kHz
analog	2 Hz to 300 kHz
Dynamic range	
Digital	>135 dB
Analyzer ANLG 22 kHz	120 dB/105 dB[1]
Analyzer ANLG 100/300 kHz	115 dB/85 dB[1]
Noise floor	
Digital	–160 dB
Analyzer ANLG 22 kHz	–140 dB/110 dB[1]
Analyzer ANLG 100/300 kHz	–120 dB/90 dB[1]

[1] With / without analog notch filter.

FFT size	256, 512, 1 k, 2 k, 4 k, 8 k points (16 k with zoom factor 2)
Window functions	rectangular, Hann, Blackman-Harris, Rife-Vincent 1to 3, Hamming, flat top, Kaiser (ß = 1 to 20)
Resolution	from 0.023 Hz with zoom, from 5.86 Hz without zoom
Zoom	– 2 to 256 with ANLG 22 kHz and DIG 48 kHz – 2 to 16 with ANLG 100/300 kHz – 2 to 8 with DIG 192/768 kHz
Averaging	1 to 256, exponential and normal

Filter

For all analog and digital analyzers. Up to 4 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 filter	– A weighting – C message – CCITT – CCIR weighted, unweighted – CCIR ARM – deemphasis 50/15, 50, 75, J.17 – rumble weighted, unweighted – DC noise highpass – IEC tuner – jitter weighted

User-definable filters

Design parameters:
8th order elliptical, type C (for highpass and lowpass filters also 4th order selectable), passband ripple +0/–0.1 dB, stopband attenuation approx. 20 dB to 120 dB selectable in steps of approx. 10 dB (highpass and lowpass filters: stopband attenuation 40 dB 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 width (–0.1 dB) selectable, stopband indicated
Third octave and octave filters	center frequency selectable, bandwidth (–0.1 dB) indicated
File-defined filters	any 8th order filter cascaded from 4 biquads, defined in the z plane by poles/zeroes or coefficients

Analog notch filter

For measurements on signals with high S/N ratio, this filter improves the dynamic range of the analyzer by up to 30 dB to 140 dB for analyzer 22 kHz, or 120 dB for analyzer 110 kHz/300 kHz (typical noise floor for FFT). The filter is also used for measuring THD, THD+N and MOD DIST with dynamic mode precision.

Characteristics	available in analog analyzers with measurement functions: – rms, wideband – rms, selective – quasi-peak – FFT analysis
Frequency range	10 Hz to 100 kHz center frequency (f_c)
Frequency tuning	– automatic to input signal – coupled to generator – fixed through entered value
Stopband	typ.>30 dB, f_c ±0.5%
Passband	typ. –3 dB at 0.77 x f_c and 1.3 x f_c , typ. ±0.5 dB outside 0.5 x f_c to 2 x f_c

Audio monitor/parallel I/O interface (option UPD-B5)

Headphones connector	6.3 mm jack
Output voltage (V_P)	max. 8 V
Output current (I_P)	max. 50 mA
Source impedance	10 Ω, short-circuit-proof
Recommended headphones impedance	600 Ω
Parallel I/O interface	for driving signal routing switchers
Connector	25-contact DSUB, female

Sweep

Generator sweep

Parameters	frequency, level, with bursts also interval and duration, one- or two-dimensional
Sweep	linear, logarithmic, tabular, single, continuous, manual
Stepping	– automatic after end of measurement – time delay, fixed or loaded table

Analyzer sweep

Parameters	frequency or level of input signal
Sweep	single, continuous
Trigger	– delayed (0 to 10 s) after input level or input frequency variation, settling function selectable – time-controlled
Settling	for level, frequency, phase, distortion measurements, settling function: exponential, flat or averaging

Sweep speed

RMS measurement 20 Hz to 20 kHz, 30-point generator sweep, logarithmic (frequency measurement switched off, Low Dist off).

with	AUTO FAST	1 s
	AUTO	2.5 s

Display of results

Units

Level (analog)	V, dBu, dBV, W, dBm, difference (Δ), deviation (Δ%) and ratio (without dimension, %, dBr) to reference value
Level (digital)	FS, %FS, dBFS, LSBs deviation (Δ%) or ratio (dBr) to reference value
Distortion	% or dB, referred to signal amplitude, THD and THD+N in all variable level units (absolute or relative to selectable reference value)
Frequency	Hz, difference (Δ), deviation (Δ%) and ratio (as quotient f/f_{ref}, 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	8.4" LCD, colour
Display modes	– display of any sweep trace – display of trace groups – bargraph display with min./max.values – spectrum, also as waterfall display – list of results – bar charts for THD and intermodulation measurements
Display functions	– 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

Test reports

Functions	– screen copy to printer, plotter or file (PCX, HPGL, Postscript) – lists of results – sweep lists – tolerance curves – list of out-of-tolerance values – equalizer curves
Printer driver	supplied for approx. 130 printers
Plotter language	HP-GL
Interfaces	2 x RS-232, Centronics, IEC 625 (option UPD-B4)
Storage function	– instrument settings – spectra – sweep results – sweep lists – tolerance curves – equalizer traces
Remote control	via IEC 625-2 (IEEE 488), commands largely to SCPI (option UPD-B4)

General data

Operating temperature range	0 to +45 °C
Storage temperature range	–20 °C to +60 °C
Humidity	max. 85% for max. 60 days, below 65% on average/year, no condensation
EMI	EN 50081-1
EMS	EN 50082-1
Power supply	100/120/220/230 V ±10%, 47 Hz to 63 Hz, 290 VA
Dimensions (W x H x D)	435 mm x 236 mm x 475 mm
Weight	22 kg

Ordering information

Order designation	Audio Analyzer UPD	1030.7500.05
Accessories supplied	power cable, operating manual, backup system disks with MS-DOS operating system and user manual, backup program disk with operating and measurement software	
Options		
Low Distortion Generator	UPD-B1	1078.2601.02
AES/EBU Interface	UPD-B2	1031.2301.02
Jitter and Interface Tester	UPD-B22	1078.6503.02
High-Speed Extension	UPD-B3	1031.2001.02
IEC-625/IEEE-488 Bus Interface	UPD-B4	1031.2901.02
Audio Monitor	UPD-B5	1031.5300.02
Universal Sequence Controller	UPD-K1	1031.4204.02
Arbitrary Waveform Designer	UPD-K2	1031.4404.02
Automatic Line Measurement to ITU-T O.33	UPD-K33	1031.5500.02
Recommended extras		
19" Adapter	ZZA-95	0396.4911.00
Service manual		1030.7551.24
Service Kit	UPD-Z2	1031.3208.02

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