2.6 Analyzers (ANALYZER Panel)

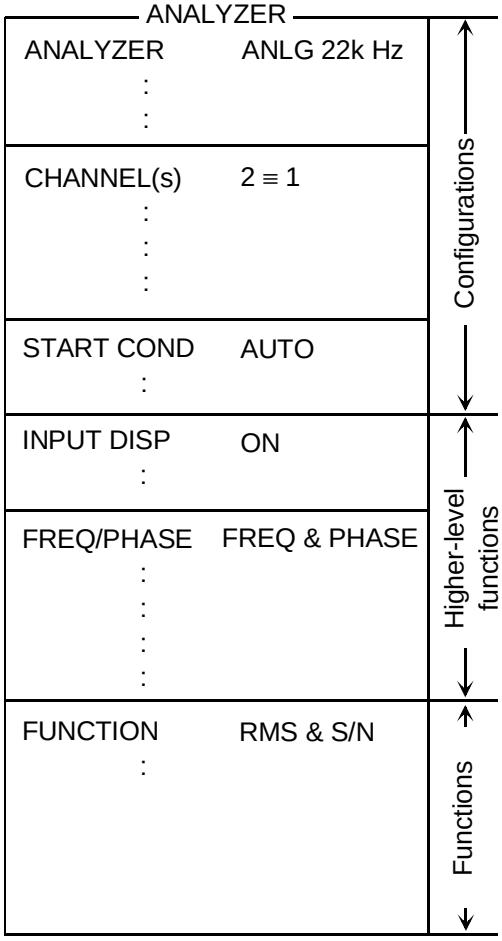
Activate the ANALYZER panel:
UPL front panel: ANLR key
External keyboard: ALT + A
Mouse: (repeated) click on the panel name, until the ANALYZER panel is displayed

If the ANALYZER panel is already visible on the screen, it can be activated also by actuating one of the TAB keys (repeatedly) or by mouse-click.
Advantage: The panel need not be established again.

2.6.1 Selecting the Analyzer

The ANALYZER panel makes the settings for 2 analog and 1 digital analyzer instrument available.

The ANALYZER panel consists of the following segments:



Selection of the analog or digital instrument, reference impedance for power units, configuration segment for setting the test inputs.

(Input connectors, channel selection, input impedance)
see 2.6.3 Configuration of the Digital Analyzer
see 2.6.2 Configuration of the Analog Analyzers

Ways of starting the analyzer, see 2.6.4

Input signal, see 2.6.5.18 INPUT

Combined frequency / phase measurement, see 2.6.5.19

Analyzer functions, see 2.6.5.2 to 2.6.5.19

When switching from the analyzer instrument to the other, the data of all segments are stored for the current instrument, the data of the new instrument are loaded and the panel contents can be entered anew. When changing to the analyzer function, the settings in the configuration range are retained.

Note: *The "parameter link" function which can be selected in the OPTION panel may be used to influence the UPL with changes of function and instrument. As requested, existing settings in the function and/or configuration segment of the GENERATOR panel are accepted for the new function or instrument - if physically possible.*

.-Measurement range limits of the ANALYZER instruments:

Table 2-27

Instrument	Lower limit	Upper limit	Sample rate
ANLG 22 kHz[1)]	DC/10 Hz	21.9 kHz	48 kHz
ANLG 110 kHz[1)]	DC/20 Hz	110 kHz	307.2 kHz
DIGITAL with UPL-B2	10 Hz	2)	27 ... 55 kHz
DIGITAL with UPL-B29	10 Hz	2)	35 ... 106 kHz

1) The frequency value refers to the upper limit of the analog analyzers

2) Limit depends on sampling rate (see below)

Lower limit:

DC: Setting the DC function in one of the two analog analyzer instruments results in DC coupling of the input unit

10 Hz: The menu item ”Min Freq” in the analyzer instruments ANLG 22 kHz and DIGITAL indicates the lower limit.

20 Hz: The menu item ”Min Freq” in the “fast“ analyzer instruments (ANLG 110 kHz) indicates the lower limit.

Upper limit:

Signals can be measured up to this limit.

Measurement range limits of the digital ANALYZER instrument:

The maximum measurement frequency is given by

f_{max} = *sample frequency x 0.5 for RMS, otherwise sample frequency x 117 / 256*

Set the sample frequency in the configuration segment of the ANALYZER panel using menu item Sample-Frq.

For more details, refer to 2.6.3 Configuration of the Digital Analyzer.

Table 2-28 Availability of functions depending on the ANALYZER instrument:

Instrument	Measurement functions																
	RMS	RMS sel	PEAK	QPEAK	DC	THD	THD+N	MOD DIST	DFD	Wow &FL	FFT	Polarity	Filter-Sim	Coher	Rub& Buzz	1/3-Octave	Wave-form
ANLG 22 kHz	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes[1)]	yes	yes
ANLG 110 kHz	yes	yes	-	-	yes	yes	yes	yes	yes	-	yes	yes	yes	-	yes[1)]	-	yes
DIGITAL	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	-	yes[1)]	yes

[1)] with built-in option UPL-B29 (digital audio 96 kHz) in the base rate mode only

Higher-level functions:

The selected function can be complemented by higher-level supplementary functions.

INPUT-DISP measurement:

see 2.6.5.18

- PEAK Display of the peak value of the two input signals
- RMS Display of the rms value for the measurement functions THD, THD+N, FFT, MOD DIST and DFD
- PHAS TO REF (with Jitter option UPL-B22 only in the analyzer mode JITTER/PHAS)
  Display of phase between selected digital input and reference input
- DIG INP AMP (with Jitter option UPL-B22 only in the analyzer mode COMMON/INP)
  Display digital signal amplitude

If INPUT DISP RMS is set and a measurement function is selected which does not allow for RMS display or where it does not make sense, "-----" is displayed in the Input RMS window. INPUT PEAK measurements can still be performed.
The availability of the INPUT RMS measurement related to the selected measurement function can be looked up in the subsequent table.

Frequency and phase measurement

see 2.6.5.19

- FREQuency display on all channels switched on

Additionally, in the analyzers ANLG 22 kHz and DIGITAL

- FREQuency display on channel 1, PHASE display on channel 2; selectable only with two-channel measurement
- FREQuency display on channel 1, GRPDEL group delay) display on channel 2, selectable only with two-channel measurement

Additionally, in the analyzer DIGITAL

- SAMPLE FREQuency display on all channels switched on

If a measurement function has been selected which does not allow frequency or phase measurement or where it does not make sense (such as DFD), "-----" is displayed in the "Freq & Phase“ window. Refer to the table below for the availability of the frequency and phase measurement in dependence of the selected measurement function.

Table 2-29 Availability of frequency and phase measurement depending on measurement functions

Measurement function	**INPUT DISP**		**FREQ/PHASE**		
	PEAK	**RMS**	**FREQ**	**PHASE**	**GRP DELAY**
OFF	yes	yes	yes	ANLG 22kHz/DIGITAL	ANLG 22kHz/DIGITAL
RMS & S/N	yes	ANLG 110 kHz	yes	ANLG 22kHz/ DIGITAL[3)]	ANLG 22kHz/ DIGITAL[3)]
RMS select	yes	yes	yes	no	no
PEAK & S/N	yes	no	no	no	no
Q PK & S/N	yes	no	no	no	no
DC	yes	no	no	no	no
THD	yes	yes	yes	no	no
THD+N	yes	yes	yes	ANLG 22kHz/ DIGITAL2)	ANLG 22kHz/ DIGITAL2)
MOD DIST	yes	yes	no [1)]	no	no
DFD	yes	yes	no[1)]	no	no
WOW & FL	yes	no	no	no	no
POLARITY	yes	no	no	no	no
FFT	yes	yes	yes	ANLG 22kHz/ DIGITAL	ANLG 22kHz/ DIGITAL
FILTSIM	no	no	no	no	no
WAVEFORM	yes	no	no	no	no
Coherence	yes	no	no	no	no
1/3-OCTAVE	yes	no	no	no	no
Rub & Buzz	yes	ANLG 110 kHz	yes	no	no

1) However, the individual frequencies of signal and interference are displayed in a histogram or spectrum list.

2) with built-in option UPL-B29 (digital audio 96 kHz) in the base rate mode only

3) with built-in option UPL-B29 (digital audio 96 kHz) in the high rate mode only; in the high rate mode with filter switched off and 'Meas Time' GEN TRACK or VALUE.

2.6.2 Configuration of Analog Analyzers

The two-channel analog analyzer features balanced XLR test inputs; unbalanced BNC cables can be connected via an *adapter* plug UPL-Z1 which can be supplied separately. Both channels can be configured individually. The configuration is explained by way of the below ANALYZER panel and its menu items.

Min Freq

Display of the lower frequency range limit.

10 Hz

lower limit frequency 10 Hz with ANLG 22 kHz

20 Hz

lower limit frequency 20 Hz with ANLG 110 kHz

Ref Imped

(Reference Impedance)

Reference impedance as reference for computing the units dBm, W, ∆%W, ∆W, P/Pr and %P/Pr (see **2.4 Units**).

Specified range: 1 mΩ to 100 kΩ

Channel(s)

Select the input channels.

1
2

The selected channel only is active, the other one is switched off.
The input impedance is retained at the XLR female connectors when the channel is switched off (see ”Input” BAL XLR, ”Impedance”).

1 & 2

Both channels are active and can be configured individually.

2 ≡ 1

Both channels are active and equally configured. When *switching over* to this selection causes channel 2 to be set using the parameters of channel 1.

1 ≡ 2

Both channels are active and equally configured. When *switching over* to this selection causes channel 1 to be set using the parameters of channel 2.

Coupling

Selection of input coupling.
AC or DC coupling may be selected to make use of the full frequency range of the UPL (DC to 22/110 kHz) and to suppress the undesired DC of the DUT. This selection can be made (with setting "1&2") independently for both channels.

AC

AC coupling: a DC offset of the DUT will not be transmitted and does not therefore affect the DUT.
The specifications of the UPL analyzer are with reference to this type of coupling.

When the DC measurement function is selected, the setting "AC coupling" is ignored, i.e. the measurement is always performed with DC coupling. The input impedances with 300 Ω and 600 Ω are generally DC-coupled (see Impedance).

***Note**:* *A procedure similar to AC coupling can be selected in the digital analyzer for specific measurement functions. Selection is made with menu item "DC Suppress ON" under the specific measurement function.*

DC

DC coupling: test signals up to 0 Hz are picked up and considered in the results of RMS, RMS selective, peak, quasi peak, DC, FFT and waveform measurements.

***Note**:* *Irrespective of the selection made here, "Min Freq" is used as the limit frequency for automatic algorithms (e.g. "Range AUTO", "Meas Time AUTO"). Signals below the specified "Min Freq" can be detected but not reliably interpreted with these automatic functions. In the event that very low-frequency signals are to be measured (with DC coupling), it is recommended to use the settings FIX or VALUE.*

Input

Select the input mode.

The current setting is displayed. (See also 2.12 Display of Selected Inputs / Outputs). The input mode can be reset after having opened the selection window.

BAL

Balanced to ground test inputs via XLR female connectors (see Fig. 2-18). Deactivated inputs are floating, set input impedances 300 Ω or 600 Ω are retained.
Unbalanced measurements can be performed via BNC/XLR *adapter* (UPL-Z1 option).

GEN1
GEN2
GEN CROSSED

Internal connection of the analyzer input or both analyzer inputs to the generator output of the other channel, respectively. Allows the device-internal measurement of the voltages at the generator connectors as well as crosstalk and two-port measurements. The generator output is loaded by each analyzer channel by 2 x 100 kΩ (see Figures 2-17, 2-18 and 2-19). The input connectors (female) of the appertaining analyzer channels are inactive.

***Note**: If both channels are configured equally (channels 2≡1 or 1≡2), GEN CROSSED is displayed instead of GEN CH1 or GEN CH2. Physically, this conjunction is identical.*

Impedance

Select the input impedance, only selectable in BAL mode.

300 Ω

Impedance 300 Ω, input impedance is DC-coupled.

600 Ω

Impedance 600 Ω, input impedance is DC-coupled.

200 kΩ

Impedance 200 kΩ

With impedances 300 Ω and 600 Ω, only voltages of up to 25 V may be applied. With voltages > 25 V the input is protected against overloading. The input impedance is temporarily switched to 200 kΩ and the generator output switched off, see 2.13 Fast Switch-off of Outputs. The overload protection of the analyzer inputs is valid for analog board versions ≥ 4.00 and software version ≥ 1.0.

Common

Common reference of potential of the XLR inputs, selectable in the BAL mode only.

FLOAT

XLR pin floating against chassis ground.
Permissible voltage ≤ 30 V AC or 50 V DC against chassis ground.

GROUND

XLR pin 1 connected to frame ground (PE conductor).
Switchover to GEN mode at a later date or switching off the set balanced channel renders the reference to ground ineffective.



Important:

Reference to measurement potential only, no safety connection to VDE 0411!
When connecting a measurement source, a current of 2 A via the device-internal ground connection should not be exceeded, otherwise the device may be damaged.

Note:

When using a BNC/XLR adapter (UPL-Z1), the XLR pins 1 and 3 are connected via the adapter. The FLOT/GROUND switchover then allows selection of the reference of potential of the BNC external conductor.

Range

Select the measurement range.

Allows the optimum voltage range to be set depending on the measurement sphere. After having opened the selection window, 3 modes are offered for selection.

AUTO Automatic selection of the range.

FIX The set range is retained in any case.

Note: *When switching from AUTO → FIX, the currently valid channel range is used. In the configuration Channels →2≡1 or 1≡2, the less sensitive of the two ranges of channel 1 and 2 is transferred.*

LOWER The set range is kept as the lowest range. Overloads cause higher ranges to be automatically switched over to.

After having chosen the FIX and LOWER modes, the rated value set for the range is displayed in the subsequent line where a new range can be set after having opened the selection window.

Table 2-30 Voltage measurement ranges of analog analyzers

Measurement range	**Measurement function**		**Remarks**
(Nominal value)	**DC**	**Others**	
18 mV	1)	yes	
30 mV	1)	yes	
60 mV	1)	yes	
100 mV	yes	yes	
180 mV	1)	yes	
300 mV	yes	yes	
600 mV	1)	yes	
1.0 V	yes	yes	
1.8 V	1)	yes	
3.0 V	yes	yes	
6.0 V	1)	yes	
10.0 V	yes	yes	
18.0 V	1)	yes	
30.0 V	yes	yes	
60.0 V	1)	yes	Ranges 60.0 V and 100.0 V are available for analog board versions ≥ 4.00 and software versions ≥ 1.0.
100.0V	yes	yes	

1) With the DC function, the next insensitive and valid range is internally set when selecting the range. (see 2.6.5.5 DC)

An optimum dynamic range for the measurement of non-linear distortions is guaranteed by spacing the range in 5-dB steps. Overranges or underranges in the current measurement range causes the switchover to the next possible range provided that RANGE AUTO is selected. The same is true for RANGE LOWER, however switchover to the next lower range is performed only when the range limit selected in the menu is not violated.

The range values are rms values for sine or other waveforms with a crest factor of $\sqrt{2}$ or less.

Equivalent circuit diagrams of test inputs:

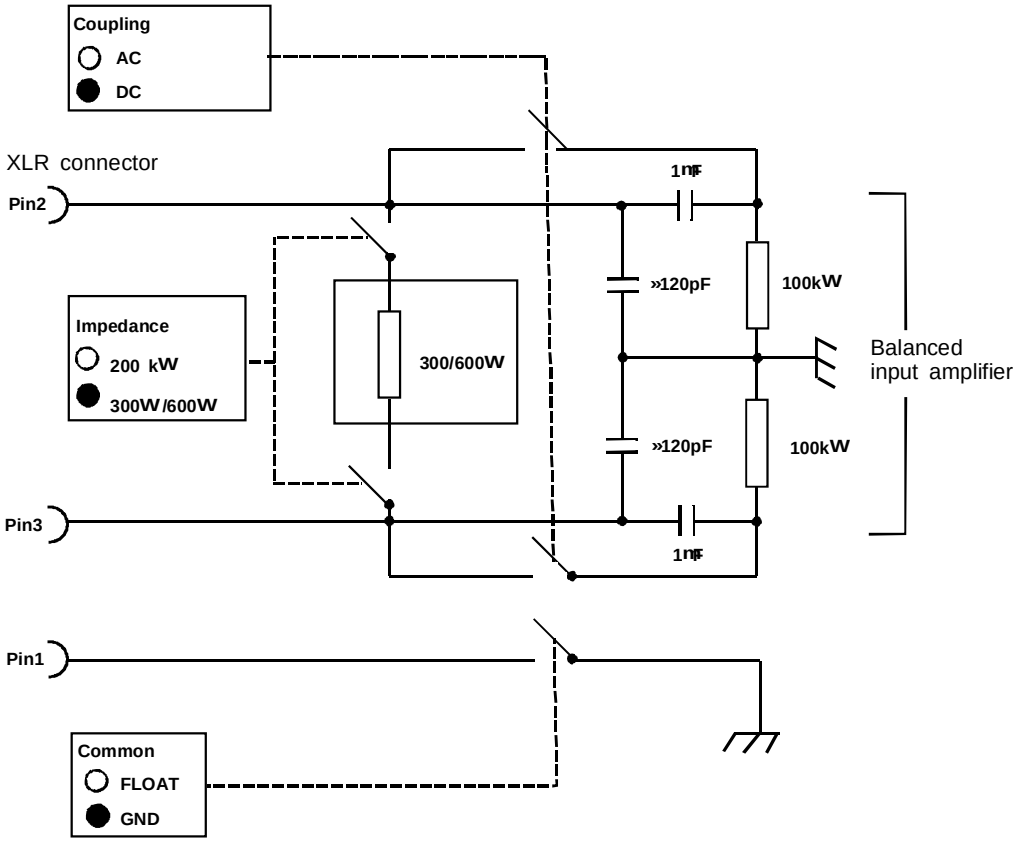


Fig. 2-16 Balanced input (Input BAL, channel 1 or 2)

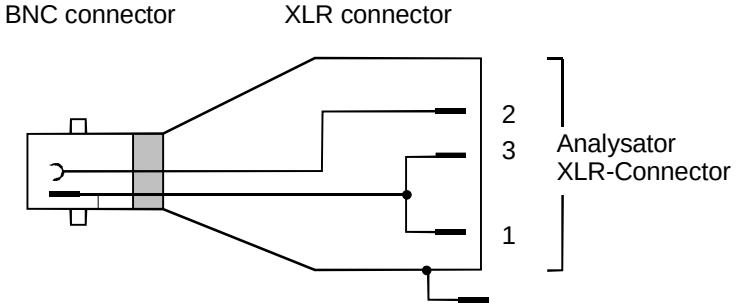


Fig. 2-17 Unbalanced measurement via BNC/XLR adapter

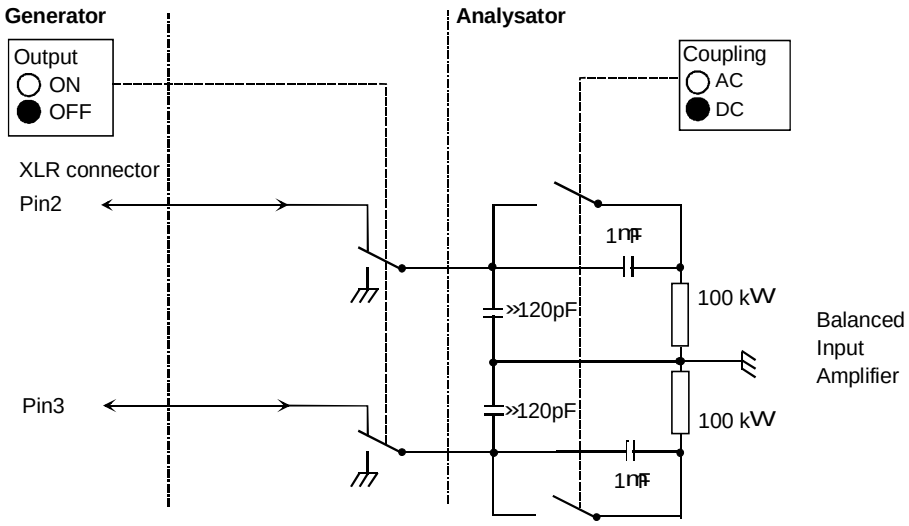


Fig. 2-18 Internal connection to generator output

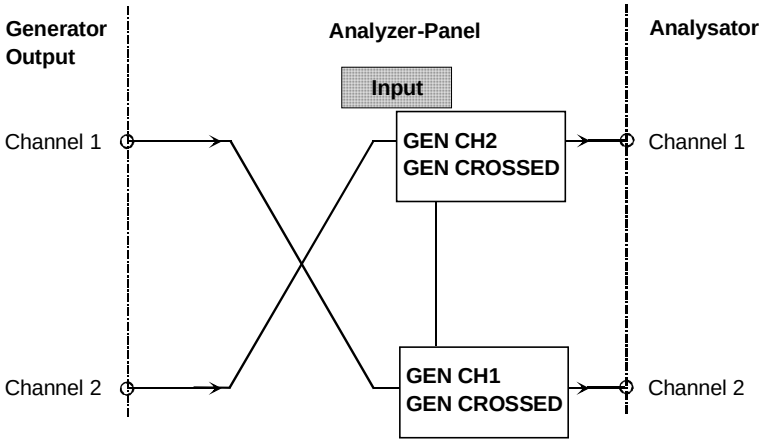


Fig. 2-19 Internal signal paths

2.6.3 Configuration of Digital Analyzer

***Notes**:*

- *Prior to making the analyzer settings, the generator should be configured usefully. Otherwise, undesired generator settings could cause superfluous restrictions in the analyzer panel.*
- *If the generator is not used as a signal source, it is advisable to switch over to analog mode in order to avoid any interference of the generator settings.*

Meas Mode (measurement mode)

indicates what is to be measured at the digital interfaces.

AUDIO DATA	Measurement of digital audio data
JITTER/PHAS	Measurement of jitter at the selected digital audio input and of the phase offset to the reference signal (REF IN at the rear of the instrument).
COMMON/INP	Measurement of COMMON signal (at XLR female connector) and digital input amplitude.

Note: *A COMMON measurement is not possible at the unbalanced digital input (BNC connector). Therefore, irrespective of the selected input, the COMMON MODE measurement is always performed at the balanced input (CLR connector). Consequently, selection of the digital input only affects the measurements of DIG INP AMP and SAMPLE FREQ.*

Note: *Functions producing a level measurement result are the only appropriate with Jitter/Phas Common/Inp modes which is why function selection is restricted to the level measurements (RMS and PEAK) as well as the FFT and waveform display. With FFT selected, RMS values are displayed.*

Min Freq

Is displayed only if AUDIO DATA has been selected as Meas Mode.

10 Hz	Display of the lower frequency range limit for measurement of the digital audio data.

Channel(s)

Is displayed only if AUDIO DATA has been selected for Meas Mode.
All other analyzer modes refer to the digital data *stream* and not to the data *content* so that specifying a channel would be meaningless.

1	Measurement on channel 1, only; data of channel 2 are ignored.
2	Measurement on channel 2, only; data of channel 1 are ignored.
BOTH	Measurement on both channels

Input

Selection of input interface:

BAL XLR	Balanced digital input (XLR)
UNBAL BNC	Unbalanced digital input (BNC)
	***Note**: In the measurement mode COMMON/INP (with Jitter option UPL-B22 only) a warning is displayed that a COMMON measurement is not possible at the unbalanced digital input. The measurement of the COMMON MODE signal is always performed at the BAL XLR connector, irrespective of the selected digital input. Only the DIG INP AMP and SAMPLE FREQ measurements are carried out at the UNBAL BNC connector.*
OPTICAL	Optical digital input (TOSLINK)
INTERN	Digital input for test and demonstration purposes



To avoid EMC problems the user should take care of proper shielding of the XLR connector cables.

Jitter Ref

(Jitter Reference)

Is displayed only, if JITTER/PHASE has been selected for Meas Mode. Indicates the signal to which the jitter measurement is referred.

***Note**: The phase measurement is always referred to the REF input.*

VARI (PLL)

The reference signal is the sampling signal obtained from the input signal via the internal sync PLL. Synchronization is performed via the VCO in the maximum capture range. The capture range is:

- with option UPL-B2 (digital audio I/O) 27 kHz to 55 kHz
- with option UPL-B29 in the base rate mode 40 kHz to 55 kHz
- with option UPL-B29 in the high rate mode 40 kHz to 106 kHz

Not possible if the source mode JITTER/PHASE has been selected in the generator, since the internal PLL is already required for phase generation in this mode.

32.0 (PLL)
44.1 (PLL)
48.0 (PLL)

Only with option UPL-B2 (digital audio I/O)

88.2 (PLL)
96.0 (PLL)

Only with option UPL-B29 (digital audio 96 kHz) in the high rate mode
Only with option UPL-B29 (digital audio 96 kHz) in the high rate mode

The sample signal derived from the input signal via the internal synchronization PLL is used as reference signal. Synchronization is made via the fixed-frequency VCXO.
Not possible if the source mode JITTER/PHASE has been selected in the generator, since the internal PLL is already required for phase generation in this mode.

***Note:** Synchronization to the input signal by means of the internal PLL should be selected only, if the jitter signal is generated by an external device.*

GEN CLK

The generator clock serves as reference signal.
Possible *only,* if the generator is also synchronized to the internal generator clock (menu item Sync To GEN CLK in the GENERATOR panel)

***Note:** GEN CLK is only meaningful, if the jitter signal is generated by an own generator.*

Sync To

(Analyzer synchronized to)

Is displayed only, if AUDIO DATA has been selected for Meas Mode; with JITTER/PHASE, *fixed settings* are obtained (depending on "Jitter Ref" and the synchronization of the generator).
Indicates the input signal to which the analyzer is synchronized.

AUDIO IN Synchronization to the digital AUDIO input signal (front panel).

REF IN Synchronization to the REF IN input signal (XLR female on the rear panel).

***Note**: In Meas Mode JITTER/PHAS the analyzer automatically synchronizes to the clock selected as "Jitter Ref"*

Sample Freq

Is displayed only if AUDIO DATA has been selected as Meas Mode.

Setting the signal clock rate.
The clock rate can be selected as desired only, if the analyzer does not synchronize to the generator clock, otherwise - if in the JITTER/PHAS Meas Mode the generator has been selected as Jitter Ref - Sample Freq is automatically set (invisible to the user) to the generator clock rate.

32 kHz
44.1 kHz
48 kHz
88.2 kHz
96 kHz

with option UPL-B2 (digital audio I/O) only

only with option UPL-B29 (digital audio 96 kHz) in the high rate mode
only with option UPL-B29 (digital audio 96 kHz) in the high rate mode

VALUE:

Range for numerical input:
- with option UPL-B2 (digital audio I/O) 27 kHz to 55 kHz
- with option UPL-B29 in the base rate mode 35 kHz to 55 kHz
- with option UPL-B29 in the high rate mode 35 kHz to 106 kHz

The analyzer is informed on the sample frequency *applied* by means of the (numerical or predefined) selection of the sample frequency in order to enable correct measurement of the audio signal frequencies. This information does not influence the synchronization of the analyzer.

AUTO

For Sample Freq, the actually measured sampling rate is entered. The sampling rate is updated once per second provided it has changed by at least 0.01 %.
If no signal (clock) is applied, the previous sampling rate is retained in the panel until a clock is applied again. No measurement can be performed then; all measured-value displays indicate "Input? – press show I/O"

CHAN STATUS

For determining the sample rate the corresponding channel status bits in the AES/IBU protocol of the test signal are decoded. Depending on the format (consumer or professional) different bits are interpreted (24 to 27 or 6 to 7 and 35 to 38). The sample rate is updated as soon as a different sample rate is indicated by the channel status bits.
If the channel status bits do not forward any information ("not indicated"), or if protocol analysis is switched off, the most recently set sampling rate remains active.

Note: *If the frequency entered does not correspond to the frequency applied, all filter and frequency measurements vary accordingly in frequency! The frequency applied to the UPL (sample rate) must not exceed **55 kHz** (UPL-B2) and **106 kHz** (UPL-B29). Otherwise, incorrect measurements or abortion of the measurement may occur.*

The maximum measurement frequency of the digital analyzer is obtained from the sample frequency and the (modified) "Nyquist" factor:

f_{max} = sample rate x 117 / 256

Audio Bits

8 to 24
Reducing the word length causes the audio sample values to be cut to the specified word length.

2.6.3.1 Measurement of Jitter, Phase and Common Mode

With digital audio interfaces, there are two types of signals to be measured, e.g., within a quality check. One is the digitally coded analog signal, and the other the digital signal. The latter toohas analog parameters such as peak-to-peak voltage, frequency etc. It may be subject to interference like an analog signal. Noise or AC voltage may be superimposed, which may cause the signal slopes to be shifted. This effect is called jitter and, if it is strong enough, the audio signal can no longer be decoded or regenerated correctly. The conventional decoders fail often even before reaching the theoretical limit which is why information on the practically reached jitter in a facility is quite important.

The signal lines can be designed as balanced lines which is quite usual in analog technology. Thus, injected interferences, e.g. from grounded (hum) loops would be ineffective. However, in practice, this attenuation is not always sufficient so that a common-mode voltage of sufficiently high magnitude may also prevent decoding and regeneration. The UPL can measure this common-mode voltage on the digital signal. Of course, a common-mode signal cannot be generated at the unbalanced and the optical output.

The UPL can thus measure two different types of interference of the digital audio signals: shifting of the signal slopes (jitter) and a common-mode voltage superimposed on the digital lines. The analog generator is available for measurement of the interference voltages. The RMS (&S/N) and peak functions as well as the FFT analysis and the oscilloscope display (WAVEFORM) are particularly suited for the practice. The spectrum analysis allows first conclusions to be made on the cause of the interference (e.g., superimposed AC hum or switching power supply). The interference caused by the common-mode voltage can be read off directly as voltage.

Jitter and delay are usually stated in UI (unit interval). UI is defined as the smallest pulse width of the digital audio signal (eye width) and is independent of the selected sample frequency. One UI corresponds to the clock period of the digital signal (biphase clock). With digital audio signals, one UI corresponds to the 128th of the sample period; at 48 kHz one UI is approx. 163 ns.

For measuring the jitter, a reference clock must be available. For this purpose a high-stability internal oscillator can be used or a PLL (phase locked loop), if the UPL is externally synchronized (via the "Sync In" connector on the rear panel). The PLL integrates phase deviations as a function of time. Both the internal oscillator and the PLL are also used for the digital generator, so that analyzer and generator cannot be set completely independent of each other in this case.

If several, digitally-coded signals have to be interconnected, as commonly done in the studio, the signal synchronization is also of importance. Associated frames, which contain the respective instantaneous values (samples) of the left and right channels, must not be delayed such that the timing tolerances of the receiver are exceeded. This can be noticed as omission or doubling of individual samples. The UPL can measure this shift as phase between the digital input on the front panel and the reference channel (‘Ref In’ connector on the rear panel).

In addition to the method described above which uses an external clock frequency (Sync PLL), the analyzer as a decoder and measuring instrument for the data contents itself (i.e. not as a jitter/phase meter or common-mode analyzer) can also be synchronized directly to the digital signal at the analyzer input via the menu item "Sync To". A difference has to be made between the input on the front panel (AUDIO IN) and the input of the reference receiver (REF IN) on the rear panel. Moreover, the analyzer can be synchronized also to the internal digital generator (GEN CLK).

2.6.4 Ways of Starting the Analyzer, Ext. Sweep

Available for

all three ANALYZER instruments. No external sweeps are however possible in ANLG 110 kHz, i.e. in addition to the AUTO measurement mode only the time-triggered measurements (TIME TICK and TIME CHART) can be selected.

Theory of operation

"START COND" determines when, how often or the conditions which must prevail to trace measured values.

Depending on the selection of START COND, the measured value is - when the conditions required for tracing of measured values are met - triggered, displayed in a UPL trace buffer. The trace buffer may contain up to 17 K (17408) measurement data depending on the application.

The measured value list can be displayed or represented in the form of graphics (see 2.10). If the options UPL-B10 or UPL-B4 are fitted, it can also be read in via a self-controlled program or external controller.
Depending on the selection of START COND, the measurement either starts immediately (AUTO) or only when the desired trigger condition is fulfilled.
With START COND not AUTO, an external sweep (START COND → FREQ CH1/2, FRQ FST CH1/2, VOLT CH1/2) or periodic measured value tracing (START COND → TIME TICK, TIME CHART) or armed single (START COND → LEV TRG CH1/2, EDG TRG CH1/2) is started using the START or SINGLE keys (see 2.11 Starting and Stopping of Measurements or Sweeps).

START COND

(Start Condition) specifies an event triggering off a measurement.

AUTO

Continuous measurement mode without trigger condition. The measured values are stored in the trace buffer only, if the frequency sweep of the selective RMS measurement or any generator sweep is active, simultaneously.
The SINGLE or START keys allow you to switch between single and continuous measurement when no sweep is active.
The AUTO mode must be activated to enable the sweep of the frequency of the selective rms measurement (see 2.6.5.3 RMS SELECT) or of the generator parameters (see 2.5.4.2). Several sweeps at the same time are not permissible and can therefore not be set.

START COND

The measured values are triggered at regular intervals. The intervals for starting measurements are determined by the distance between the timeticks. The measured values are entered in the buffer and displayed in the measurement result window.

TIME TICK

The START key is used to start a sequence of periodic tracings of measured values, which is restarted from the beginning when the number of sweep points specified under ”Points” is reached.
If the timetick is greater than the measuring time, the next timetick is waited for after each single measurement; no measurement is performed during this period.
If the timetick is smaller than the measuring time, the next timetick is only triggered after completion of the measurement. The sweep is then indicated with corrected x-axis, i. e. the single measured values are entered with correct timing.
The SINGLE key allows you to start a single sequence of periodic tracings of measured values. The sweep enters the SWP TERMINATED state when the number of sweep points specified under ”Points” is reached. The analyzer state is then ”TERMINATED”.

TIME cannot be simultaneously active with the frequency sweep of the selective rms measurement or any generator sweep!

TIME CHART

Measured values (of the running continuous measurement) are entered in a time chart in the time pattern that can be entered under "Time". Contrary to TIME TICK, where a new (single) measurement is started with each tick and the result is only entered after completion of the measurement, TIME CHART also permits to display intermediate results. This is useful in particular in the case of quasi-peak measurements.

FREQ CH1
FREQ CH2
FRQ FST CH1
FRQ FST CH

Tracing of measured values because a change in frequency was noted at ANALYZER input channel 1 or channel 2.
With the START or SINGLE key, an external frequency sweep is started, which in turn starts a single measurement on the occurrence of a trigger event or, as the case may be, after a delay to be entered. The measurement result is entered in the measured value buffer.
Starting a continuous sweep using the START key causes the sweep to be restarted after any change in frequency in the direction from stop to start frequency (see 2.11).
A single sweep started by the SINGLE key is stopped by a measured value beyond the stop frequency.
Changes of the frequency of STOP and START are ignored.

Note: *FRQ FST CH1/2 can be selected for especially fast frequency sweeps with clean signals (e.g. from the CD). If however the signal has a large noise component, the slower measurement procedure FREQ CH1/2 must be used.*

FREQ CH1|FREQ CH2-|FRQ FST CH1|FRQ FST CH2 cannot be simultaneously active with the frequency sweep in the RMS Select measurement or any generator sweep!

Note: *By activating the associated* ***settling,*** *unwanted interfering signals like voice can be made ineffective. It must be switched off with floating sweep.*

START COND

VOLT CH1
VOLT CH2

A measurement result is recorded because a voltage change is detected at the analyzer input channel 1 or 2.
With the START or SINGLE key an external voltage sweep is started, which in turn starts a single measurement upon a trigger event (or after a delay to be entered). The measurement result is stored in the buffer.
When a continuous sweep is started with the START key, the sweep is restarted every time the voltage changes in the direction from the stop to the start level.
If a single sweep is started with the SINGLE key, the sweep is stopped by a measured value beyond the stop level. Changes of the STOP and START voltages are ignored.

VOLT CH1 | VOLT CH2 cannot be simultaneously active with the frequency sweep of the selective RMS measurement or with any generator sweep.

***Note**: In most cases (e.g. sliding sweep) it is advisable to perform an external voltage sweep with Settling switched on to prevent individual test points to be triggered too early by voltage transients. Two samples are sufficient for the settling parameters; the resolution should be set to minimum.*

LEV TRG CH1
LEV TRG CH2

Triggering (single shot) because of a *level* detected at analyzer input channel 1 or 2. Measured values are not stored in the trace buffers and, consequently, there is no graphical display via the X axis.
Using the START or SINGLE key, level monitoring is enabled. It waits for the level to enter the range between Start and Stop for the first time. Then a single measurement is started - possibly after the entered delay.
If the continuous trigger has been started with the START key, new triggering in the specified range takes place only if the level had been out of this range at the upper or lower end. Hence, level monitoring is only reactivated when a level is detected outside the specified range.

EDG TRG CH1
EDG TRG CH2

Triggering (single shot) caused by a voltage *edge* detected at the analyzer input channel 1 and 2. The measured value is neither stored in the buffers nor graphically displayed via the X axis.
Level monitoring is started with the START or SINGLE key but it is only activated when a level outside the start-stop interval is measured. Triggering is performed when a level occurs for the first time in the range between Start and Stop (edge trigger). A single measurement is then started - possibly after the specified delay.
If continuous trigger has been started using the START key, new triggering in the specified range only takes place when the level had been out of the range at the upper or lower end. Hence, level monitoring is only reactivated when a level is detected outside the specified range.

By pressing the STOP key, an external sweep is finished. By pressing the CONT key, the continuous measurement mode is started again.

Delay

The menu items START COND →

AUTO | FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2
LEV TRG CH1 | LEV TRG CH2
EDG TRG CH1 | EDG TRG CH2

allows the user to enter a delay time, which is useful for:

- Signal modifications at the generator (entry of values, variations via rotary knob)
- Sweeps
- Actuation of STOP/CONT or START keys (continuous measurement)
- SINGLE key actuation (single measurement)
- Modifications in the ANALYZER panel
- Modifications in the GENERATOR panel
- Modifications in the FILTER panel

Delay determines the waiting time required from the events stated above to the restart of a measurement in order to allow the device under test to settle.

Specified range: 50 ms to 10 s

Units: s | ms | µs | min

Note: *Delay is considered in single measurements only, i.e. in single measurements triggered by the SINGLE key or sweep sequencing in the START COND → AUTO mode or on the occurrence of a trigger event in the START COND → FREQ CH1/2, VOLT CH1/2 modes.*
During continuous measurements, delay is considered in the first measurement only. The following measurements are made without delay.

Time

In the menu item START COND → TIME TICK | TIME CHART the intervals between the single tracings of measured values can be specified.

A single measurement is started after every time **tick**. A new measurement is only triggered when the last measurement has been completed. If a time tick is selected which is smaller than the measuring time, the time tick is adapted internally to the measuring time; i.e., it is extended to be identical.

With the start condition TIME ***CHART,*** the current measured value is entered upon expiry of the time entered, independent of the number of measured values obtained in the meantime, if any. If a time is selected which is smaller than the measuring time, the same result is traced several times (with different x-values). If this effect is to be avoided, “Time“ must be increased.

Specified range: 10 ms to 2000 s

Units: s | ms | µs | min

Resolution: 1 ms

Points

The menu item START COND → TIME TICK | TIME CHART allows the number of entries in the measured value buffer to be entered.

Specified range: 2 to 1024

Note: *A time-tick scan is terminated after (points x time tick) seconds. If the individual measurements cannot be performed at the selected time-tick rate - due to an exceeded time-tick set - the trace buffer contains less than "points" measured values.*

Min VOLT

The menu items START COND →

FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2

allow the entry of a minimum voltage to be applied to the ANALYZER input in order to trigger a measurement.

Specified range:
digital (audio data mode): 0.00001 to 1.0 FS
analog: 0.00001 to 30 V

Units:
digital (audio data mode):
FS | %FS | dBFS | LSBs | bits
analog:
V | mV | µV | dBu | dBV | dBm | W | mW | µW

Start

Stop

The menu items START COND →

FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2
LEV TRG CH1 | LEV TRG CH2
EDG TRG CH1 | EDG TRG CH2

allow the entry of the start and stop values. The frequency or level applied to the ANALYZER input must not exceed the start/stop limits in order to trigger the measurement.
By single sweeps, the STOP value is used to recognize the end of the sweep. The STOP value should therefore be somewhat smaller than the expected signal range.

Specified range
- FREQ CH1 | FREQ CH2 FRQ FST CH1 | FRQ FST CH2:
total range permitted (see 2.6.1)

- VOLT CH1 | VOLT CH2:
  analog: 10 µV to 30 V
  V | mV | µV | dBu | dBV | dBm | W | mW | µW
  digital: LL to 1.0 FS
  FS | %FS | dBFS | LSBs | bits
  LL: The lower limit for the level start/stop values depends on the number of audio bits (see 2.6.3), however must not be less than 1µFS. It can be calculated as follows:
  $LL = 2^{-Audio\ Bits}$

Variation

The menu items START COND →

FREQ CH1 | FREQ CH2
FRQ FST CH1 | FRQ FST CH2
VOLT CH1 | VOLT CH2

allow the entry of a value in percent - or in dB (for high power ramping) – by which the input frequency or input voltage must be varied at least in order to trigger a measurement.
Changing the frequency or voltage in the direction from stop to start by this numeric value causes a restart of the sweep if continuous sweep has been set.

Note: *Select the variation 5 % to 10 % smaller than the expected change in order to guarantee reliable triggering on the one hand and to prevent triggering on intermediate values on the other hand.*

Specified range:
for frequency sweeps: LL to 50%
for level sweeps: LL to 900 % (= 20 dB)

Unit: % (for level sweeps also dB)

LL: The lower limit for the entry of variation is not less than 0.1% and is output such that not more than 1024 measured values are generated (depending on the spacing between start and stop values).

Settling

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5 Functions

FUNCTION	
	Note: *The addition "&S/N" indicates that this function allows S/N measurements.*
OFF	No measurement function, measurement of Input RMS/PEAK and frequency/phase, however, enabled
RMS & S/N	True RMS measurement of AC voltages see 2.6.5.2
RMS SELECT	Selective RMS measurement with narrow bandpass see 2.6.5.32
PEAK & S/N	Maximum peak value within a monitoring interval, see 2.6.5.4
Q PK & S/N	Peak value detection with subsequent defined rising and falling times, see 2.6.5.4
DC	DC measurement, see 2.6.5.5
THD	Distortion measurement (without consideration of broadband noise), see 2.6.5.6
THD+N/SINAD	Distortion or SINAD measurement (including broadband noise), see 2.6.5.7
MOD DIST	Intermodulation measurement with high-frequency useful sinewave signal and a low-frequency interfering sinewave signal, see 2.6.5.8
DFD	Difference Frequency Distortion measurement by two adjacent tones with relatively high frequencies, see 2.6.5.9
WOW & FL	Wow and flutter measurement see 2.6.5.10
POLARITY	Polarity measurement to check for polarity reversal in a device under test, see 2.6.5.11
FFT	Graphical display of spectrum, see 2.6.5.12
FILTER SIM.	Filter simulation see 2.6.5.13
WAVEFORM	Waveform display; see 2.6.5.14.
PROTOCOL	evaluation and display of AES protocol data Only in the digital analyzer with measurement mode AUDIO DATA.
COHERENCE	Measurement of transfer function and coherence of two signals; with installed option UPL-B6 only, see 2.6.5.22
RUB & BUZZ	Loudspeaker measurements (rub&buzz, frequency response, polarity); with installed option UPL-B6 in the analog analyzers only, not available in the high rate mode (with option UPL-B29 installed), see 2.6.5.23
1/3-OCTAVE	1/3-Octave measurement, with installed option UPL-B6 only, not available in 110 kHz analyzer and in digital analyzer in the high rate mode (with option UPL-B29 installed), see 2.6.5.24

Note: *The addition "&S/N" indicates that this function allows S/N measurements.*

FUNCTION

(*continued*)

DIG INP AMP

Only with Jitter option (UPL-B22). This measurement function is selected under menu item INPUT DISP; see 2.6.5.16.

PHAS TO REF

Only with Jitter option (UPL-B22) This measurement function is selected under menu item INPUT/PHAS; see 2.6.5.17.

2.6.5.1 Common Parameters of Analyzer Functions

DC Suppress

(DC Suppress)

With the **digital** measurement functions RMS & S/N, RMS SEL, FFT and Waveform, a DC component in the test signal can be suppressed so that it is present neither in the measurement result nor in the graphics display. To do so the actual DC value is determined for each measurement and then considered in the measured value by calculation. This preliminary measurement performed for FFT and Waveform requires additional measurement time (approx. 200 ms), but because of the relatively slow measurements this is in most cases not important. With RMS and RMS SEL measurements, the DC component is measured in parallel with the main measurement and does not therefore affect the measurement time.

***Note**: This menu item is not offered with* **analog** *measurements, as in this case the function is assumed by the selection of the input coupling (which is superordinate to the functions).*

ON

The DC component of the signal to be measured is suppressed (AC coupling); only the AC component is considered in the measurement result.

OFF

The DC content of the signal to be measured is *not* suppressed (DC coupling) and contained in the measurement result.

S/N Sequ

(S/N sequence)

The functions RMS & S/N, PEAK & S/N, Q-PK & S/N offer the possibility of S/N measurements (signal-to-noise). The generator signal at the device under test is alternately switched on (signal) and off (noise) and a measurement is performed in each case. During signal-on-phase the selected filters are turned off in order to exclusively weight the noise signal. The ratio of the two measured values in dB expresses the S/N ratio of the device under test.
Any desired generator setting is permissible.
A deactivated generator means:

- with analog generator instruments, the output voltage is switched off with the output resistance being constant
- with digital generator instruments, a level value of 0.0 full scale is output with the clock rate being unvaried (all bits to 0)

ON

S/N measurement on

Notes:

- *A filter with high-pass characteristic should be switched on in order to avoid measurement errors due to superimposed dc in the analog range. If this is not the case, a corresponding error message is displayed when switching on S/N mode.*
- *Measurement at low frequencies where a highpass is not usable should be performed using a file defined delay filter with about 1.5 s delay. By this means the DC-level that appears when switching off the generator can decay before noise measurement. is started.*
- *The selectable filters only affect the noise measurement. If they are to affect the signal measurement, too, this can be achieved by using the command line parameter "-o2".*

OFF

S/N measurement off

Measurement function	**selectable analog units:**	**selectable digital units:**
Intermodulation measurements MOD DIST | DFD	% | dB	% | dB
Distortion measurements THD Meas Mode: SELECT di ALL even d ALL odd di ALL di	% | dB	% | dB
Meas Mode: SEL di LEV even di LEV odd di LEV di	V|dBV|dBu|dBm|W|Δ %V|ΔV|V/V_r|%V/V_r|Δ %W|ΔW|P/P_r|%P/P_r|dB	FS|%FS|dBFS|Δ %|dB_r|LSBs

Measurement function	**selectable analog units:**	**selectable digital units:**
Distortion measurements THD+N Meas Mode: THD+N | NOISE | SINAD	% | dB	% | dB
Meas Mode: LEVEL THDN | LEVEL NOISE	V|dBV|dBu|dBm|W|Δ %V|ΔV|V/V_r|%V/V_r|Δ %W|ΔW|P/P_r|%P/P_r|dB	FS|%FS|dBFS|Δ %|dB_r|LSBs
Wow and flutter measurements WOF&FL	%	%
Transfer function (COHERENCE Trace A, Ch1/Ch2)	% | dB	% | dB
Coherence measurement (COHERENCE Trace B)	γ^2	γ^2

Unit Ch1

Selection of the units of measurement results for channel 1.

Unit Ch2

Selection of units of measurement results for channel 2.

With all level measurements, the (display) units for the two channels can be selected independent of each other, e.g., in order to constitute one channel as absolute quantity and the other channel with any reference.

Selectable analog units (also valid for Meas Mode COMMON/INP in DIGITAL instrument):

V | dBV | dBu | dBm | W | Δ%V | ΔV | V/V_r | %V/V_r | Δ%W | ΔW | P/P_r | %P/P_r | dB_r

Selectable digital units (Meas Mode AUDIO DATA):

FS | %FS | dBFS | Δ% | dB_r | LSBs | bits

The measurement functions PEAK and QPEAK as well as the INPUT DISP displays also allow the selection of the HEX unit.

Selectable jitter units (Meas Mode JITTER/PHAS):

UI | %UI | dBUI | ppm | ns | UI_r | dB_r (for jitter)

UI | %FRM | ºFRM | ns (for phase)

For conversion formulae and notation of the measured value display units for IEC bus control, see 2.4 Units

Unit

Selection of units for measurement results for both channels. Measurements which usually have both channels with the same unit, provide a common menu item for both channels for selection of the (display) unit.
Basis of calculation see relevant measurement function.
Conversion formulas see 2.4 Units.

Reference

Reference values for the analyzer measurement function and the Input Disp measurement.

All measurements which obtain dimensional results, can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the addition “r“ or the prefix "Δ") is selected, the displayed result takes into consideration the reference entered here.
Each measurement function and each of the superior functions provide their own reference, which applies for both channels, respectively.
The selection made here is entered into the display panel per default, if an appropriate trace (FUNC CH1/2 or IMP RMS CH1/2) and the selected display reference is *not* FILE, HOLD or OTHER TRACE.

Value

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FUNC CH1/2 or IMP RMS CH1/2) has been selected and the display reference has been set to VALUE.
The specified range depends on the measurement function and the instrument function (analog or digital):

Units:

digital (audio data mode):
FS | %FS | dBFS | LSBs | bits | Δ% | dBr
digital (jitter mode):
UI | %UI | dBUI | ppm | ns | UIr | dBr
analog and digital common mode:
V | mV | µV | dBu | dBV | dBm | W | mW | µW

Specified range for

- DC measurement function:
  - digital (audio data mode): -100 to 100 FS
  - analog: -1000 to 1000 V
- other (level) measurement functions and INPUT DISP:
  - digital (audio data mode): 100 pFS to 100 FS
  - digital (jitter mode): 100 pUI to 100 UI
  - analog (and common mode): 100 pV to 1000 V

STORE CH1
STORE CH2

The level measurement result of channel 1 or channel 2 is stored on pressing the ENTER key and displayed as new reference value. The reference value does not change during the measurement. These selection items are displayed with two-channel measurement, only.

STORE

The result of a one-channel measurement is stored on pressing the ENTER key. The reference value does not change during the measurement. This selection item is displayed with one-channel measurement.

Reference

MEAS CH1
MEAS CH2

Each level measurement result of channel 1 or channel 2 is immediately stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case. These selection items are only available with 2-channel measurements.

DIG OUT AMP

Only for the display of the digital input amplitude (INPUT DISP: DIG INP AMP). The measured value is referenced to the digital signal level set in the digital generator (see 2.6.5.18, INPUT).

GEN TRACK

The current generator voltage and each newly set voltage *of the function generator* are stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case.

***Exception**: When the jitter is measured in the digital analyzer, the generator of the jitter signal is used as a reference. So, if the audio data come from the function generator and the jitter signal from the auxiliary generator, the jitter amplitude of the auxiliary generator is used as a reference.*

If the measured value is RMS-weighted, the RMS value of the generator voltage is used. If it is a peak value (INPUT DISP PEAK, PEAK function), the peak value of the generator voltage is used.

If the instrument functions of generator and analyzer are different (analog or digital), a ***conversion factor*** of

$$\frac{1\ \text{FS}}{1\ \text{V}}$$

is calculated.

Note: *The generator voltage selected in the panel is always used as reference instead of the actually output generator voltage. This applies, in particular, if equalization is switched on (cf. 2.5.4.3 SINE). If reference is to be made to the actually output voltage, the latter must be measured (internally) (CH1 Input GEN CH2) and the measurement result (of channel 2) must be referred to the measured voltage (Reference MEAS CH1).*

Ref Freq

Reference Frequency
Reference value for the frequency measurement.
Results of frequency measurements can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the addition “r“ or the prefix "Δ") is selected, the displayed result takes into consideration the reference entered here; it applies for both channels or (with combined frequency/phase measurement or frequency/group-delay measurement) for the frequency of channel 1.
The selection made here is entered into the display panel per default, if an appropriate trace (FREQ CH1/2) and the selected display reference is *not* FILE, HOLD or OTHER TRACE.

Value

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FREQ CH1/2) has been selected and the display reference is set to VALUE.

Specified range: 1 mHz to 1 MHz
Units: Hz | kHz

STORE CH1
STORE CH2

The frequency measurement result of channel 1 and/or channel 2 is stored on pressing the ENTER key and displayed as new reference value. The reference value does not change during the measurement. This selection is provided with two-channel measurement, only.

STORE

The result of a one-channel frequency measurement or a combined FREQ&PHASE measurement or FREQ&GRPDEL measurement is stored on pressing the ENTER key. The reference value does not change during the measurement. This selection is provided with one-channel measurement, only.

MEAS CH1
MEAS CH2

Each frequency measurement result of channel 1 or channel 2 is immediately stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case. *Not* available for 1-channel or combined frequency-phase measurements or frequency/group delay measurements.

GEN TRACK

The presently valid generator frequency and each newly set generator frequency are stored as the reference value and can then be used (by both channels) for a referenced display. A referenced unit must be selected in this case.

Note: *The generator voltage selected in the panel is always used as reference instead of the actually output generator voltage. This applies, in particular, if equalization is switched on (cf. 2.5.4.3 SINE). If reference is to be made to the actually output voltage, the latter must be measured (internally) (CH1 Input GEN CH2) and the measurement result (of channel 2) must be referred to the measured voltage (Reference MEAS CH1).*

Ref Phase

(Reference Phase)
Reference value for the phase measurement.
This menu line is displayed only, if two-channel measurement and the phase or group-delay measurement have been selected.
Results of phase and group-delay measurement can be displayed either absolutely or referred to a reference. If a reference-related unit (to be recognized by the prefix "Δ") the result is displayed taking into consideration the reference entered here.

VALUE

Display and entry of a fixed reference value.
Per default, this entry is entered into the display panel if an appropriate trace (FREQ CH1/2) has been selected and the display reference is set to VALUE.

Specified range and units for:

- phase measurement:
  Specified range: - 360° to +360° or -2π to +2π
  Units: ° | RAD
- group-delay measurement:
  Specified range: - 10 s to +10 s
  Units: s | ms | µs | min.

STORE

The results of phase or group-delay measurement are stored on depression of the ENTER key and displayed as new reference value. The reference value does not change during the measurement.

FILTER

For the functions in the ANALYZER panel

- RMS & S/N (RMS measurement), 3 filters
- PEAK & S/N (peak measurement), 3 filters (*****)
- QPK & S/N (quasi-peak measurement), 3 filters (*****)
- THD+N/SINAD (distortion measurement) 1 filter
- RMSSEL (selective RMS measurement) 1 filter
- FILTSIM (filter simulation) 3 filters
- RUB & BUZZ (loudspeaker measurement) 2 filter
- WAVEFORM (DIGITAL or ANLG22kHz) 1 filter (*****)
- 1/3-OCTAVE 1 filter (*****)
- FFT 3 filter (*****)

can be selected and assigned to the ANALYZER function (see 2.7 Analyzer Filters (FILTER Panel)).

Note: *Apart from these filters of digital design, an analog notch filter can be switched on additionally with the analog measurement functions RMS, RMS SELECT, QPK and FFT for elimination of individual frequency lines (see menu item Notch (Gain) in this section).*

UPL-B29*: The functions marked (*****) can be operated without filter only in the high rate mode as well as in ANLG 110 kHz analyzer.*

POST FFT

POST FFT is an FFT subsequent to the functions

- RMS & S/N
- THD+N/SINAD
- WOW & FL.

The input signal is sampled, the sampled values are stored and analyzed according to the selected measurement function. Subsequent to determination of the measurement result, an FFT is calculated and graphically displayed. Then, the measurement of the selected function is restarted and the activated filters, if any, begin to settle again.

For more details on the FFT including all its parameters, refer to Section 2.6.5.12.

ON

POST-FFT is calculated; however, it is displayed only, if the operation SPECTRUM has been selected in the DISPLAY panel.
With generator sweep, the end of the POST FFT algorithm determines the sweep stepping, thus reducing the sweep rate!
POST-FFT is switched on *coercively*, if the phase measurement is selected for the measurement function RMS (with two-channel measurement).

OFF

POST-FFT is not calculated.
This selection is made to achieve a maximum measurement speed.
POST-FFT is switched off *coercively*, if

- the S/N measurement or
- the special mode TRIGGERED FIX

is used for the RMS function.

FFT Size

Enter the FFT size (256 to 8192), see 2.6.5.12 FFT.

Start

Only display (no entries possible) of the frequency limits of the generated spectrum.

Stop

Resolution

Only display (no entries possible) of frequency resolution.

Window

Select the window function. Possible windows and their applications, see 2.6.5.12 FFT.

Notch (Gain)

For the functions RMS & S/N, RMS SELECT, Q PK & S/N and FFT, the three analog analyzers offer an analog notch filter of 2nd order to be activated for narrow-band suppression of interfering frequency lines. With notch switched on, one of 3 gain factors can be selected:

OFF	Analog notch filter off
0 dB	Analog notch filter on; no gain effective
12 dB Auto	Analog notch filter on; gain 12 dB
30 dB Auto	Analog notch filter on; gain 30 dB

Note: *If frequency components occur outside the analyzer frequency range, the notch gain may cause the analyzer to be overdriven. In this case, the notch gain is reduced step by step, which is to be indicated by adding "Auto" in the items 12 dB and 30 dB.*

Notch Freq

Selection of the notch-filter center frequency.

AUTO	Center frequency of the notch filter tracks the measured frequency.
VALUE	Numerical entry of the notch filter center frequency Specified range: 10 Hz to 22,5 kHz Units: Hz, kHz Switching on VALUE causes the latest valid notch frequency to be displayed. When switching over from AUTO to VALUE, e.g., and the (external) test signal having a frequency of 117 kHz, the frequency displayed is 110 kHz.
GEN TRACK	With the generator signal function set to SINE, BURST, SINE2 PULSE or SQUARE, the current generator frequency specified under generator menu item FREQUENCY is used as notch filter center frequency. Any other signal function leads to an error message.

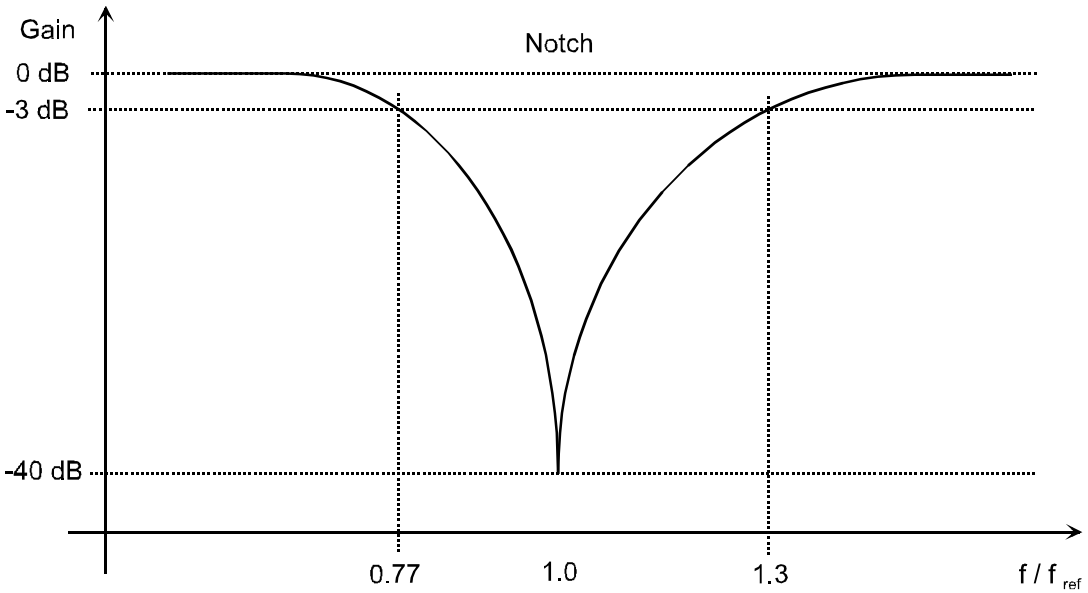


Fig. 2-20 Characteristic of analog notch filter

Application example: quantising noise measurement

The notch filter being subsequent to the input level stage, the fundamental wave level determines the dynamic range of the input circuit. The measurement range in which the fundamental wave is measured therefore determines the dynamic range of the quantising noise measurement.

Settling
Freq Settl
Phas Settl
Fnct Settl

Most measurements can be subceded by a settling or averaging procedure in order to obtain settled measured values even with settling DUTs.

Exceptions and special features:

- Settling cannot be realized with *group-delay measurement*, since the measured value is defined with varying frequency, only.
- From the physical point of view, settling is not required with the measuring functions *POLARITY* and *FILTSIM*
- The *WAVEFORM* function does not allow for selection of settling, but averaging (menu item Interpol).
- The *FFT* function does not allow for selection of settling, but it provides two different averaging modes (menu item Avg Mode NORMAL or EXPONENTIAL).
- The *1/3-OCTAVE* function does not allow for selection of settling; averaging is provided by setting of the measurement time.
- In the measurement modes *JITTER/PHAS* and *COMMON/INP* Settling cannot be selected, but with measurement functions *FFT* and *WAVEFORM* the averaging modes described above.

OFF

Settling process switched off; measurement result available in the shortest possible time. This setting should always be selected if maximum measuring speed is required.

EXPONENTIAL

Settling with exponential course of the tolerance and resolution.

FLAT

Settling with horizontal course of tolerance and resolution.

AVERAGE

Arithmetic averaging of the results

For further information, cf. 2.3.4 Settling Process

Samples

To menu item Settling → EXPONENTIAL | FLAT:
Number of subsequent measured values compared in the settling proces
If value 6 is entered here, this means that the latest measured value compared to 5 preceding measured values.
Specified range: 2 to 6

To menu item Settling → AVERAGE
Number of measured values used for arithmetic averaging.
Specified range: 2 to 100

Tolerance

To menu items Settling → EXPONENTIAL | FLAT:
The tolerance value denotes the maximally permissible deviation from the preceding measured value a settled measured value may have in order to be classed as valid by the UPL.
The value of the maximally permissible deviation of the current measured value compared to the 2nd/3rd/4th and 5th last measured value is determined by the setting EXPONENTIAL | FLAT .

For further information, cf. 2.3.3 "Settling Process"

Unit: % or dB (not WOW & FL and frequency measurement)
Specified range: 0.001 % to 10 % or
0.000087 dB to 0.828 dB

% and dB values can be converted into one another:

$$\%\ \text{value} = \left(10^{\frac{\text{dB-value}}{20}} - 1\right) \times 100$$

$$\text{dB value} = 20 * \lg\left(\frac{\%\text{-value}}{100} + 1\right)$$

Resolution

To menu items Settling → EXPONENTIAL | FLAT:
Measured value resolution considered if the measured value does not satisfy the tolerance limits.

For further information, cf. 2.3.4 Settling Process

Specified range and units depend on instrument and measurement function:

- RMS & S/N | RMS SELECT | PEAK & S/N | Q PK & S/N | DC / external level sweep:
  analog: 0.1 µV to 10 V; V|mV|µV|dBV|dBu|W|mW|µW|dBm
  digital: Min. FS to 0.1 FS; FS |% FS |dBFS |LSBs | bits | Δ% | dBr
- THD+N/SINAD | THD | MOD DIST | DFD | WOW & FL:
  0.000001 % to 10 %; % | dB
- Frequency measurement / external frequency sweep:
  100 µHz to 10 Hz; Hz | kHz
- Phase measurement:
  0.0001 ° to 10 ° ° | RAD

Min. FS: $2^{(-1 * \text{audio bits})}$ however, not less than 1 µFS

Exception: a resolution of down to 1 nFS can be entered for the external level sweep so that the setting procedure can also be used for very small levels.

Time-out

If the settling mechanism does not recognize a stabilization of the measured value within the time stated under ”time-out”, the test loop is aborted and "Input - Press SHOW I/O" output instead of a measured value. A gap points to the missing value in the graphical curve display of a sweep.
For further information, cf. 2.3.4 Settling Process

Specified range: 0.001 to 10 s
Unit: s

Recommended Values:

For the majority of measurements on AF instruments, the following settings are suitable:

- Settling EXPONENTIAL
- Tolerance 1% (approx. 0.1 dB)
- Resolution:value of the last but one digit displayed in the result window, e.g., with a displayed value of 10.0000 Hz, this is 1 MHz
- Time-out 1 s

SPEAKER

cf. 2.6.6 Headphone/Speaker Output

Pre Gain

cf. 2.6.6 Headphone/Speaker Output

Spk Volume

cf. 2.6.6 Headphone/Speaker Output

Phone Out

cf. 2.6.6 Headphone/Speaker Output

2.6.5.2 RMS (incl. S/N)

Available in all analyzers.

Analog mode:

True rms measurements of AC voltages (frequency ranges of the analog ANALYZER instruments, see 2.6.1 Selecting the Analyzer) of any desired waveform up to 100 V. Depending on the selected coupling, a superimposed dc is either measured (dc coupling) or not measured (ac coupling)

Digital mode:

The signal contents is indicated as true rms full-scale value from 0.0 to 1.0. A superimposed dc is either measured or suppressed depending on the selection "DC Suppress":(OFF) or (ON).

Note: *If all converter bits are set, 1.0 FS (= 0.0 dBFS) is displayed.*

Frequency measurement:

Particularly fast frequency measurement is enabled with RMS (and RMS SELECT). To this end, the frequency measurement must be switched on "Meas Time" must be set to FAST. Although this frequency measurement only negligibly increases the total measuring time, it should be renounced for extremely fast measurements, (GEN TRACK or very short VALUE) in particular with very weak signals.

S/N Sequ

(see 2.6.5.1 Common Parameters of Analyzer Functions)

DC Suppres

Selectable in the digital analyzer only;
corresponding setting required for analog analyzers: AC/DC coupling,
see 2.6.2 Configuration of the Analog Analyzers

Note: *DC suppression is only effective for the measured RMS value. With post-FFT a DC component is displayed even if DC suppression is switched on. A DC-free FFT display can only be obtained with the FFT measurement function.*

Meas Time

AUTO FAST
AUTO

(Measure Time)

The rms measurement time serves to match the measurement rate to the signal frequency. It depends on the measurement requirements whether a short measuring time or high accuracy will have priority.

Automatic matching of the measuring time to the signal frequency with consideration of the signal period. The measuring time is matched as far as possible to the input signal; with AUTO FAST, a maximum algorithmic error of 1% (with AUTO: 1‰) may arise. With very weak signals, the measuring time is limited to 1 period according to Min Freq.

***Notes**:*

. *In the case of very noisy or distorted signals or multitone signals, the automatic measurement modes - particularly AUTO FAST - may not be able to detect the signal period. To avoid measurement errors, these signals should preferably be measured with GEN TRACK or - if an external generator is used - with the measurement mode VALUE.*

. *To allow automatic-mode measurement of the signals described under 1 with the advantage of high measurement speed, the minimum measurement is optimized automatically. Only the first measurement – without post-FFT – is performed using the high measurement speed. For all other measurements the measurement time is increased to 100 ms or the measurement time of post-FFT, respectively, which enables higher accuracy. This means that the first triggered measurement result (eg. when sweeping) is obtained very fast, while the subsequent results are more accurate.*

Meas Time (Measure Time)

VALUE

Numeric entry of desired measuring time. Since measurement errors may occur when the measuring time is not matched to the period, this mode should be selected only if the period of the signal is exactly known or no other measuring mode can be used. The measurement time should be an integral multiple of the period (to *avoid* errors due to termination of measurements) or at least much longer than the period time (to *minimize* such errors).

Specified range:

ANLG 22 kHz:	100 µs to 10 s
ANLG 110 kHz:	100 µs to 0.3 ms
DIGITAL:	100 µs to 10 s

Units: s | ms | µs | min

TRIGGERED

Special measurement mode; a single measurement (with selectable measuring time) is performed, as soon as the signal first exceeds a trigger threshold (also selectable). This measurement mode, in conjunction with a bursted generator signal, allows for measurement of the *first period* of a signal.

Application: *Anechoic measurements on loudspeakers, measurement of short signal pulses.*

Notes:

1. *Only single-channel measurements should be performed.*
2. *A fixed voltage range should be set in the analog analyzer. Activation of the auto ranger would delay the beginning of the measurement.*
3. *No filters and no settling can be selected.*
4. *Triggering on level thresholds can also be selected using "START CONDition LEV TRG CH1/2". **Any** measurement function (e.g. "WAVEFORM") can be selected. The measurement mode described here can, however, be used for RMS measurements only. Advantage: the measurement starts **without delay**.*

GEN TRACK

Measurement over (at least) one whole period of the generator signal. If required, the generator frequency is matched to the analyzer sampling rate. In the case of high frequencies the measurement time is extended to several periods to increase the measurement accuracy.
Particularly suitable for measuring very noisy or distorted signals and for extremely fast sweeps.

The period length is calculated from the signal frequency entered in the generator panel which is why this measuring mode should only be used with use of the UPL *function* generator.

Notes:

1. *If the MODDIST signal is used as generator signal, the measurement time is referred to the LOWER Frequency, which normally dominates.*

2. *If CODED AUDIO is used as the generator signal, the generator frequency cannot be adjusted due to the coarse frequency spacing. Slight*

inaccuracies might occur which is why the measurement speed AUTO is recommended.

3. *If ARBITRARY is used as the generator signal, the measurement time is synchronized to the number of samples in the file loaded. Thus, the measurement always involves a full period of the ARB signal (which is output repetitively).*

When using the low-distortion generator, small frequency offsets may occur which may lead to a reduction of the measuring accuracy if the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases.

The fixed integration time specified with VALUE (without consideration of the signal period) leads to the following consequences depending on the meas. time/signal period ratio:

- Meas Time is integer multiple of signal period:
  Optimum integration effect. Steady display!
- Meas Time larger than, yet no integer multiple of signal period:
  Integration effect, however beats occur in the display.
- Meas Time smaller than signal period:
  No integration effect. AC measurement result follows the signal waveform.

Unit Ch1/2 (see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference (see 2.6.5.1 Common Parameters of Analyzer Functions)

Sweep Mode

Displayed only in ANLG 22 kHz and DIG 48 kHz analyzers.

This menu item is provided to increase the speed of frequency sweeps with the universal generator of the UPL.

UPL-B29: *In the high rate mode, the sweep can be operated at normal speed only; the menu item **Sweep Mode** is therefore not offered.*

To increase the sweep speed the following ***conditions*** have to be fulfilled by the ***generator***:

NORMAL

- Function SINE
- Low distortion OFF
- Sweep control AUTO ...
- X axis FREQ
- Z axis OFF

BLOCK

Normal sweep trigger without additional speed optimization; may be used for any kind of sweep.
This setting is used internally whenever one of the conditions for optimized sweep synchronization is not met, e.g. in the "learn mode" (see below).

Speed-optimized sweep:
The 1st sweep is always performed with the speed set under NORMAL. During this sweep the generator parameters for the subsequent sweeps are learned and stored (learn mode).
As long as no settings are done in the instrument, the BLOCK mode can use the learned parameters as from the 2nd sweep (play mode) so that setting times for the individual sweep points are considerable shortened. For reasons of speed, measured values are not indicated. Traces are displayed when the sweep is completed.
During a sweep the instrument cannot be operated. If one or several keys are pressed during the sweep, the current sweep is terminated and the unit returns to the learn mode where the functions of the pressed keys are performed.

Note: *Settling cannot be switched on in the block mode.*

Notch (Gain)

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Filter

(see 2.7 Analyzer Filters (FILTER Panel))
Maximum 3 filters can be selected.

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Post FFT

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Switching on the POST FFT improves the digital frequency-measurement result for frequencies above 4 times the FFT resolution. This can be noticed in particular with high frequencies and/or noisy signals.

POST FFT is switched on coercively, if phase or group-delay measurement is switched on - with two-channel measurement. Since these measurements cannot be performed unless (POST) FFT is selected, the latter cannot be switched off until frequency measurement is set OFF or to FREQ again.

The POST FFT is switched off automatically with selecting TRIGGERED measuring time or switching on S/N measurement.

Note: *With active Post-FFT a DC part that might exist is always displayed in the FFT spectrum, e.g. even when DC suppressing is switched off. A DC free FFT display can be achieved via measurement function FFT.*

Trig Level

(Trigger level); is displayed with Meas Time TRIGGERED, only.

Sets the trigger threshold which determines the start of the RMS measurement. The trigger level applies in relation to the full-scale value selected under menu item Ch1/2 Range as fixed voltage range.

Specified range: -240 to 0 dB
Unit: % or dB

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.3 RMS SELECT (Selective RMS Value)

Available in all analyzers. Selective RMS measurement with narrow bandpass or bandstop.

DC Suppres

Selectable in the digital analyzer only;

corresponding setting for analog analyzers:
"Coupling AC/DC", see 2.6.2 Configuration of the Analog Analyzers

Meas Time

(Measure Time) serves to match the measurement rate to the signal frequency. It depends on the measurement requirements whether a short measuring time or high accuracy will have priority.

AUTO FAST
AUTO

Automatic matching of the measuring time to the signal frequency with consideration of the signal period. The measuring time is matched as far as possible to the input signal; with AUTO FAST, a maximum algorithmic error of 1% (with AUTO: 1‰) may arise. With very weak signals, the measuring time is limited to 1 period according to Min Freq.

***Notes**:*

1. *In the case of very noisy or distorted signals or multitone signals, the automatic measurement modes - particularly AUTO FAST - may not be able to detect the signal period. To avoid measurement errors, these signals should preferably be measured with GEN TRACK or - if an external generator is used - with the measurement mode VALUE.*
2. *To allow automatic-mode measurement of the signals described under 1 with the advantage of high measurement speed, the minimum measurement is optimized automatically. Only the first measurement is performed using the high measurement speed. For the following measurements the measurement time is increased to 100 ms, which enables higher accuracy. This means that the first triggered measurement result (eg. when sweeping) is obtained very fast, while the subsequent results are more accurate.*

VALUE

Numeric entry of desired measuring time. Since measurement errors may occur when the measuring time is not matched to the signal period, this mode should only be used if the signal period is exactly known or the other measurement modes cannot be used. The measuring time should be an integral multiple of the period (to *avoid* errors due to termination of measurement) or be at least much longer than the period (to *minimize* such errors).

Specified range:

ANLG 22 kHz: 100 µs to 10 s
ANLG 110 kHz: 100 µs to 0.3 ms
DIGITAL: 100 µs to 10 s

Units: s | ms | µs| min

GEN TRACK

Measurement over (at least) one whole period of the generator signal. If required, the generator frequency is matched to the analyzer sampling rate. In the case of high frequencies the measuring time is extended to several periods to increase the measurement accuracy. Particularly suitable for measuring noisy or distorted signals and for very fast sweeps.

The period length is calculated from the signal frequency entered in the generator panel which is why this measuring mode should only be used with use of the UPL *function* generator.

Notes:

1. *If the MODDIST signal is used as generator signal, the measurement time is referred to the LOWER Frequency, which normally dominate*
2. *When using the low-distortion generator, small frequency offsets may occur which may lead to a reduction of the measuring accuracy ift the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases*

offsets may occur which can lead to a reduction of the measuring accuracy if the measuring time is coupled to the rated frequency. The measurement rate AUTO should be used in these cases.

Unit Ch1/2 (see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference (see 2.6.5.1 Common Parameters of Analyzer Functions)

Bandwidth Bandwidth of bandpass (BP) or bandstop (BS)

BP 1%
BS 1% Geometrically symmetrical bandwidth 1%

BP 3%
BS 3% Geometrically symmetrical bandwidth 3%

BP 1/3 OCT
BS 1/3 OCT Geometrically symmetrical bandwidth ≈ 23%

(obtained from $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}} = 0.2315 = 23.15\%$)

BP 1/12 OCT
BS 1/12 OCT Geometrically symmetrical bandwidth ≈ 6%

(obtained from $\sqrt[24]{2} - \frac{1}{\sqrt[24]{2}} = 0.0577 = 5.77\%$)

BP FAST
BS FAST same as BP/BS 1/3 OCT, for 40 dB attenuation only but with considerably shorter settling time.

BP FIX:
BS FIX: Arithmetically symmetrical bandwidth using numerical entry

Analyzer	Range for bandwidth
ANLG 22 kHz	9.9 Hz to 16 kHz
ANLG 110 kHz	70.4 Hz to 113.8 kHz
DIGITAL	$f_{cmin} * 0.99 ... \frac{\text{sample freq.}}{3}$

$f_{cmin} = \frac{\text{sample freq.}}{4800}$ (minimum center freq.)

Units: Hz, kHz

Note: *For Third Octave filters the 0,1dB-bandwidth is reduced in order to obtain an attenuation of 3 dB at the cut-off frequencies. Hence the effective bandwidth is lower than the theoretical value.*

Note: *It may occur in the analog analyzer 110 kHz that the selection filter cannot settle - due to low frequencies and narrow passband or stopband. If this is the case,*

- *increase the passband or stopband, or*
- *increase the filter center frequency, or*
- *use the analyzer 22 kHz.*

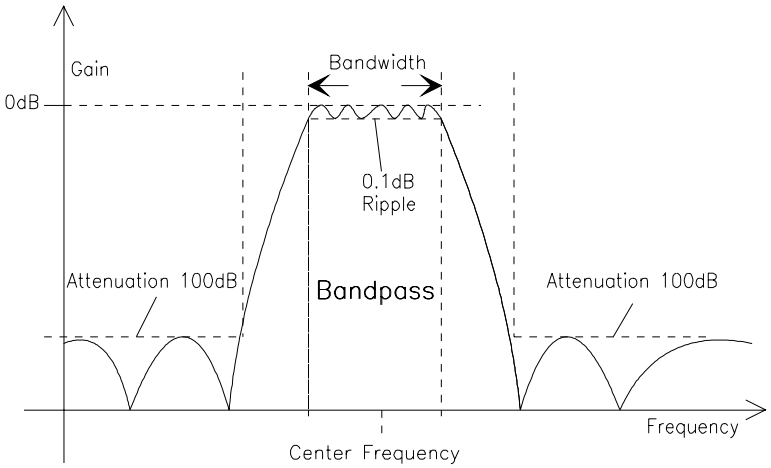


Fig. 2-21 Bandpass used for selective rms measurement

Frequency Sweep of Selective RMS Measurement

The band center frequency of the selective rms measurement can be swept using various procedures. A table with a maximum of 1024 frequency entries is generated. As desired, the individual frequency points can be

- calculated from user specifications (SWEEP CTRL → AUTO SWEEP | MANU SWEEP)
- loaded from file as list sweep (SWEEP CTRL → AUTO LIST | MANU LIST)
- derived from the individual frequencies of generator MULTISINE (SWEEP CTRL → GEN MLTSINE).

SWEEP CTRL

(Sweep Control)

is used to select whether and how to sweep the band center frequency. The notch frequency of the switch-selectable analog notch filter is swept additionally, with analog analyzers.

OFF

The sweep system is switched off. The band center frequency can be selected via menu item FREQ MODE (see below).

***Note**: With this setting, the sweep system is available for generator or analyzer sweeps. By selection of FREQ MODE and switching on a generator frequency sweep or external frequency sweep the band center frequency can be swept over the generator frequency or over the frequency of an external generator.*

AUTO SWEEP

Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11 Starting and Stopping of Measurements or Sweeps).
The sweep parameter data are calculated from the user specifications (start/stop values and step size or number of points); “normal“ sweep

SWEEP CTRL

AUTO LIST	Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11 Starting and Stopping of Measurements or Sweeps). The sweep parameter data are read from a file (list sweep);
MANU SWEEP	The sweep is controlled by means of the rotary knob and/or cursor keys. After pressing the START key, only the first frequency of the selective rms measurement is set. Any further frequency is requested using the rotary knob or by pressing a cursor key (see 2.11 Starting and Stopping of Measurements or Sweeps). When sequencing the manual sweep, the result of the current measurement is not waited for, i.e., the current RMS SELECT measurement and an analyzer delay, if set, are aborted. As with AUTO SWEEP, the sweep parameter data are calculated from the user specifications (start/stop values and step size or number of points); “normal“ sweep
MANU LIST	The sweep sequence is similar to MANU SWEEP; the sweep parameter data are, however, read from a file (similar to AUTO LIST); (List Sweep).
GEN MLTSINE	(Generator multisine) The band center frequency of selective RMS measurement is subsequently set to the multisine frequencies entered in the generator panel (see 2.5.4.4 MULTISINE). The generator signal function is assumed to be set to MULTISINE. This setting is used for fast measurement of the frequency response. The sweep runs automatically upon depression of the START or SINGLE key (see 2.11 Starting and Stopping of Measurements or Sweeps).

Notes on manual sweep:

In order to control manual sweeps using the rotary knob or the cursor keys, the graphics panel must be active (full-screen or part-screen mode). When the sweep is started, the switchover to the graphics panel occurs automatically. The feature ”manual sweep” can be used to vary the band center frequency with a user-definable increment. The increment is defined by a fixed STEP (with MANU SWEEP) or by a variable step size defined in a file (with MANU LIST). With remote control, the command ”INIT:NEXT<n>” is used to continue.
Subsequent to setting a new sweep point, a continuous measurement is performed on this point. All measured values thus obtained can be read off from the display or from the curve plot (in the form of crosses). With sweep sequencing, the value *last* measured is stored.
By turning the rotary knob fast, individual sweep points can be skipped (to be recognized as gaps in the graphical curve display), or repeated by turning the rotary knob back.
The measured values are indicated by crosses in the Curve Plot mode. If Scan count >1 has been selected in the display panel, the crosses are not deleted prior to a new character, but remain on the screen. With strongly fluctuating measured values, the representation approximately takes the shape of a bar. If sweep steps are skipped or advanced too fast, a NAN value (Not A Number) is entered. When reaching the end of the sweep, the complete trace (with the last measured values, respectively) is obtained.

Spacing

Spacing of the sweep ranges for menu items

SWEEP CTRL → AUTO SWEEP | MANU SWEEP

LIN POINTS

The sweep range between Start and Stop is linearly spaced by a number of points which is to be entered under menu item "Points".
The step size in Hz can be derived from the number of linear points:

$$Step[Hz] = \frac{|Stop[Hz] - Start[Hz]|}{Points - 1}$$

LIN STEPS

The sweep range between Start and Stop is spaced in frequency intervals determined by the linear step size in Hz which is to be entered under menu item "Step".
The number of points can be calculated from the linear step size in Hz:

$$Points = \frac{|Stop[Hz] - Start[Hz]|}{Step[Hz]} + 1$$

LOG POINTS

The sweep range between Start and Stop is logarithmically spaced by a number of points to be specified under menu item ”Step”.
The multiplier for the step size can be derived from the number of logarithmic points:

$$Step = \left(\frac{Stop[Hz]}{Start[Hz]}\right)^{\frac{1}{Points-1}}$$

LOG STEPS

The sweep range between Start and Stop is spaced using a logarithmic step size which is to be entered under menu item ”Step” as multiplier without unit.

Note: *When switching from ...POINTS to ...STEPS, no conversion is performed. The set values are retained in the background. When switching between LIN STEPS and LOG STEPS, the numerical value specified for ”Steps” remains the same.*

Start

Displayed with normal sweep only (SWEEP CTRL → AUTO SWEEP | MANU SWEEP).

Stop

Entry of the start and stop value for the sweep of the band center frequency.
For the specified range and units, see FREQ MODE → FIX.

Points

Displayed with normal sweeps (SWEEP CTRL → AUTO SWEEP | MANU SWEEP) if the spacing LIN POINTS or LOG POINTS has been selected.

Enter the number of points for the frequency sweep of the band center frequency.

Specified range: 2 to 1024
Units: integer value without unit

Step

Displayed with normal sweeps (SWEEP CTRL → AUTO SWEEP | MANU SWEEP) if LIN STEPS or LOG STEPS has been selected with Spacing.

Enter the step size for the frequency sweep of the band center frequency.
Specified range:
The step size must be selected such that max. 1023 single steps (= 1024 sweep points) result. The step size must not be larger than the absolute difference between Stop and Start.
For the valid specified range, see operator guidance line.

Units with	Spacing → LIN STEPS:	Hz | kHz
	spacing → LOG STEPS:	no unit, because of multiplier

Filename

Displayed with list sweeps only (SWEEP CTRL → AUTO LIST | MANU LIST) if LIN POINTS or LOG POINTS has been selected.

File containing the frequency values for the frequency sweep of the band center frequency. (For the format of the sweep lists, see Appendix).

FREQ MODE

Displayed with bandpass center frequency switched off, only (SWEEP CTRL → OFF).

Specification of the band center frequency.
With analog analyzers, this implies specification of the notch frequency of the switch-selectable analog notch filter.

FIX

Numerical entry of a fixed bandpass center frequency, i.e., also notch frequency, if notch switched on (menu line NOTCH (Gain) in the analog analyzers).
The minimum and maximum possible center frequency is determined by the instrument selected and the bandwidth specified and displayed in the operator guidance line. (For table with values, see below.)

For other measurement spheres, the generator can be swept, however does not cause any change in frequency of the selective rms measurement.

GEN TRACK

(Generator tracking)
The bandpass center frequency - and also the notch frequency (menu line Notch(Gain) in the analog analyzers), if switched on - tracks the generator frequency. This can be varied by the user (entry of value, rotary knob in menu item “FREQUENCY“ of the generator) or by a generator frequency sweep.
By means of the factor entered in the next menu line it can be determined whether the center frequency should directly track the generator frequency (factor = 1) or be a multiple thereof. If the factor is an integral multiple, it may be used for measuring single harmonics.
The bandpass center frequency can be tracked to the generator signal functions SINE, MULTISINE, BURST or SINE2 PULSE“, only; any other signal function causes an error message.

Note: *When using the low-distortion generator, small frequency offsets may occur which may lead to incorrect measurements if the band center frequency is coupled to the rated frequency and the actual frequency is out of the selected passband or stopband. The measured frequency should be used in these cases (FREQ MODE MEAS CH1/2).*

FREQ CH1
FREQ CH2

The bandpass center frequency - and also the notch frequency (menu line Notch(Gain) in the analog analyzers), if switched on, tracks the frequency measured on channel 1 or 2.

Note*:* *Switching over the input channels 1↔2 causes the frequency mode FRQ CH1 ↔ FRQ CH2 to be switched over, too.*

Factor

Displayed only with FREQ MODE → GEN TRACK.

Specifies the factor by which the center frequency of the bandpass or bandstop filter is higher than the generator frequency. An integral factor >1 allows a single harmonic to be measured. With the factor 1 the fundamental can be selected.

Specified range: 1 to 20

***Note**: The factor does not affect the notch filter frequency. With GEN TRACK selected, the notch filter is set exactly to the generator frequency without considering the "factor" so that a wider dynamic range can be obtained through the suppression of the fundamental irrespective of the measurement task.*

Sweep Mode

Displayed only with FREQ MODE → GEN TRACK in the ANLG 22 kHz and DIG 48 kHz analyzers.

This menu item is used to increase the speed of frequency sweeps using the built-in universal generator.

***UPL-B29**: In the high rate mode, the sweep can be operated at normal speed only; the menu item Sweep Mode is therefore not offered.*

To increase the sweep speed the following ***generator conditions*** must be fulfilled:

- Function SINE
- Low distortion OFF
- Sweep control AUTO to
- X axis FREQ
- Z axis OFF

In addition, the following settings have to be made in the ***ANALYZER panel***:

- Freq Mode GEN TRACK
- Notch (Gain) OFF (recommended)

Description:
The 1st sweep is always performed with the speed set under NORMAL. During this sweep the filter and generator parameters for the subsequent sweeps are learned and stored (learn mode).
As long as no new settings are made in the instrument, the FAST and BLOCK mode can use the learned parameters as from the 2nd sweep (play mode) so that setting times for the individual sweep points are considerable shortened.
If the start key is pressed or a instrument setting made, the (slower) learn mode is selected.

***Note**: In the play mode, measured values are not indicated in the result display for reasons of speed.*

NORMAL Normal sweep without additional speed optimization; may be used for any kind of sweep. This setting is used internally whenever one of the conditions for optimized sweep synchronization is not met, e.g. in the learn mode (see below).

FAST Speed-optimized sweep without any operational restrictions. Measured values are not indicated for reason of speed.

BLOCK Further speed optimization of sweep but in this case the instrument cannot be operated during the sweep. If one or several keys are pressed, the sweep is terminated and the FAST mode is selected where the functions of the pressed keys are executed. Measured values are not indicated for reasons of speed; traces are displayed upon completion of the sweep.

Notch (Gain)

(see 2.6.5.1 Common Parameters of Analyzer Functions)
An analog notch can be switched on additionally in the analog analyzers to improve the stopband attenuation.

The notch frequency is coupled directly to the band center frequency of the selective filter, i.e., it is selected via the menu FREQ MODE.

Filter

(see 2.7 Analyzer Filters (FILTER Panel))
In addition to the selective filter and the analog notch, another (digital) filter can be selected.

***Application**: Highpass filter for DC suppression.*

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

Specified range for the bandpass center frequency:

The minimum and maximum possible center frequency is determined by the instrument selected and the bandwidth specified and is displayed in the operator guidance line.

Analyzer	f with bandwidth 1%	f with bandwidth 3%	f_c with bandwidth 1/3 OCT	f with bandwidth 1/12 OCT	f_c with bandwidth FIX:
ANLG 22 kHz	10 Hz to 21.83 kHz	10 Hz to 21.61 kHz	10 Hz to 19.54 kHz	10 Hz to 21.31 kHz	$5{,}05\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N1} - \frac{bw_{fix}}{2}$
ANLG 110 kHz	64 Hz to 119.4 kHz	64 Hz to 118.2 kHz	64 Hz to 106.2 kHz	64 Hz to 116.6 kHz	$35{,}91\,\text{Hz} + \frac{bw_{fix}}{2} \ldots f_{N2} - \frac{bw_{fix}}{2}$
DIGITAL	$f_{cmin} \ldots \frac{f_N}{1{,}005}$	$f_{cmin} \ldots \frac{f_N}{1{,}015}$	$f_{cmin} \ldots \frac{f_N}{1{,}12246}$	$f_{cmin} \ldots \frac{f_N}{1{,}0293}$	Sample freq. 0.1052E-3 + $\frac{bw_{fix}}{2} \ldots f_{N-} \frac{bw_{fix}}{2}$

f_c = Bandpass center frequency

f_{cmin} = $\frac{\text{Int. sample freq.}}{4800}$ (minimum center frequency)

f_N = Int. sample freq.* $\frac{117}{256}$ (useful frequency)

bw_{fix} = bandwidth entered in numerical form

f_{N1}=21.94 kHz

f_{N2}=125 kHz

Notes on aural monitoring of residual signal:
Aural monitoring of the residual signal with the RMS selective measurement switched on is possible with the frequency-controlled universal generator (`Low Dist = OFF`*), with setting* `FREQ MODE = GEN TRACK` *and the narrow bandstop filter* `Bandwidth = BS 1%`*. When the generator frequency is varied, the fundamental is suppressed by the bandstop filter.*
If the low-distortion generator is used (`Low Dist = ON`*), which offers a purer spectrum but not quite the frequency accuracy of the universal generator, the generator frequency may be slightly outside the range of the BS 1% bandstop filter. Thus the fundamental is not completely suppressed.*

Remedy:
Select a wide bandstop filter (`BS 3%, BS 1/3 OCT, 1/12 OCT`*) or set* `FREQ MODE = FIX` *with the desired center frequency for the RMS selective measurement and vary the frequency of the low-distortion generator in the GENERATOR panel by a few Hz to adjust the generator frequency exactly to the bandwidth of the bandstop filter.*
To be able to continuously monitor the residual signal, a frequency measurement must not be selected in the ANALYZER panel, as for a frequency measurement all filters in the UPL have to be switched off for a brief period of time, i.e. also the RMS-selective bandpass or bandstop filter:
`FREQ/PHASE = OFF`,

`FREQ MODE` *not* `FREQ CH1|FREQ CH2`.

2.6.5.4 PEAK, Q-PEAK (Peak and Quasi-peak Weighting incl. S/N)

Available in the analyzers ANLG 22 kHz and DIGITAL.

PEAK measurement

Peak value detector follows the waveform without delay.

Quasi-PEAK measurement

Peak value detection with subsequent and defined rising and falling times. This measurement is used for interference voltage measurements to CCIR 468-4 and DIN 45405.

In the peak and quasi-peak measurement, the maximum peak value of the input signal is determined and displayed within the monitoring interval selected under menu time "Intv Time". Subsequently, the peak value memory is cleared and the next peak value is searched for. The principle of operation is comparable to that of a maximum pointer instrument.

As to the measurement:

- *With the use of the analog analyzer an internal DC offset is also part of the measured value. The DC offset can be minimized using the CALIBRAT function in the OPTION panel.*
- *When applying a squarewave signal, it is bandlimited by the upper limit of the selected analyzer, leading to overshoots at the edges (Gibb's phenomenon). The overshoots are also measured during peak weighting, which may lead to a measured value exceeding the input peak. Particularly in the digital range, full-scale values > 1 may be measured (see 2.4 Units).*

S/N Sequ	(S/N Sequence) (see 2.6.5.1 Common Parameters of Analyzer Functions)
Meas Mode	(Measurement Mode) of PEAK measurement (see 2.4 Units).
PK +	The peak positive voltage is measured
PK -	The (absolute) peak negative voltage is measured
PK to PK	The peak-to-peak voltage is measured
PK abs	The absolute peak voltage (positive or negative) is measured

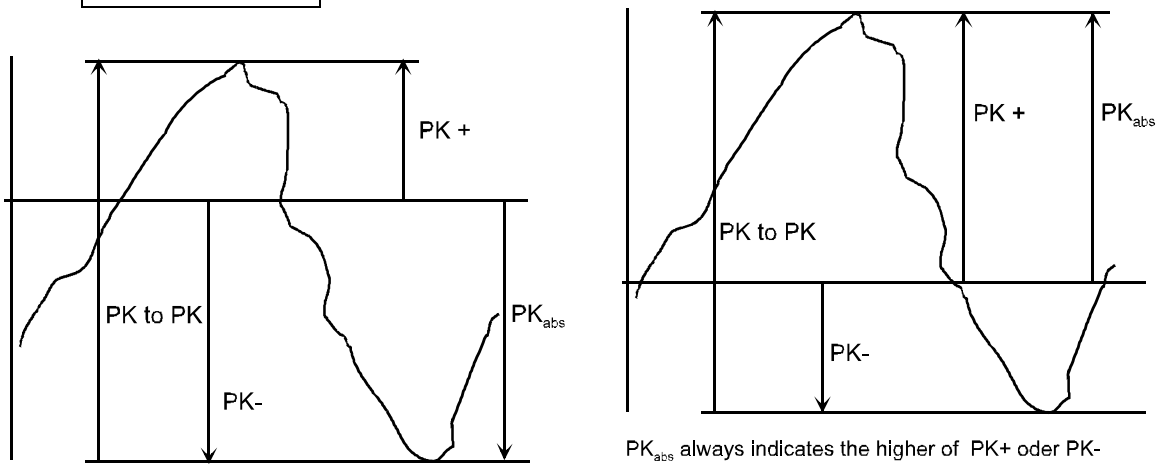


Fig. 2-22 Signal with the measurement modes

Intv Time

(Interval Time)
Monitoring interval for peak value detection
Selection depends on the type of input signal and measurement sphere. Universal specifications cannot be made.

FIX 50 MS	50 ms PEAK only
FIX 200 MS	200 ms PEAK only
FIX 1000 MS	1000 ms PEAK only
FIX 3 SEC	3000 ms PEAK only
VALUE	Numerical entry. Range of value: 20 ms to 100 s, Units: s | ms | µs | min

***Notes on quasi-peak measurement**:*

In order to obtain settled measured values, the measuring time should not drop below 3 s with triggered measurements and sweeps.

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Notch (Gain)

quasi peak only
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Filter

(see 2.7 Analyzer Filters (FILTER Panel)
Maximum 3 filters can be selected.

***UPL-B29**: No filters can be switched on in the high rate mode.*

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

2.6.5.5 DC

Principle of measurement

DC voltages can be measured from 0 to ±30 V. The DC reference point is the connecting point 3 of the XLR female connectors (see 2.6.2). For selecting the measurement range for DC measurements, see 2.6.2, Range Table.

During a DC measurement, overloading of the measurement path caused by a superposed AC voltage causes a less sensitive range to be automatically set, which however means less measuring accuracy.

Meas Time

If the DC voltage is superposed by an AC voltage, specifying the Meas Time as integration time relative to the signal period of the AC voltage has different effects:

Meas Time is an integer multiple of signal period:
An integration effect results. The AC voltage is ***not*** included as part of the DC measurement result. Steady display!

Meas Time larger than, yet no integer multiple of signal period:
As above, yet beats occur in the display

Meas Time smaller than signal period:
No integration effect. The AC voltage is included as part of the DC measurement result. The DC measurement result follows the course of the AC voltage.

FIX 200 MS

Measuring time 200 ms

VALUE

Numerical entry.
Specified range: 100 µs to 1.5 s
Units: s | ms | µs | min

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

2.6.5.6 THD Measurement

Available in all analyzers.

For distortion measurements, apply an extremely pure sinewave signal to the device under test. Select the signal frequency such that the significant components of the distortion spectrum are still below the upper range limit (see 2.6.1, 2.6.2, 2.6.3) of the selected ANALYZER instrument.

A signal not meeting the requirements leads to a SHOW I/O message (see 2.3.5):

The signal has no zero crossings and is not suitable for distortion measurements:
"Can't find zero crossing in Signal"

With the signal function SINE (see 2.5.4.3) in combination with the low-distortion generator (UPL-B1 option), the generator in the UPL offers a sinewave signal meeting the high demands on its spectral purity.

Principle of measurement

The UPL offers the possibility of distortion measurements over single harmonics or combinations thereof (d2 to d9), the amplitudes of the single harmonics being selectively measured and their square sum put in relation to the total rms value. As against the THD+N measurement (see 2.6.5.7 THD+N/SINAD measurement), broadband noise is not considered in the THD measurement due to the selective harmonics measurement.

$$U_{THD}[dB] = 20 \times \log \frac{\sqrt{Ud2^2 + \ldots + Ud9^2}}{\text{total rms value}}$$

$\sqrt{Ud2^2 + \ldots + Ud9^2}$: square sum of selected harmonics

Display of the measurement result:

Apart from displaying the THD in the result display, an additional graphical (histogram) or numerical display of the fundamental and the individual harmonics can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel. All harmonics in the frequency range are indicated in the histogram. The selected harmonics which are contained in the result are marked by wide bars, the other ones by narrow bars, so that they can be distinguished.

***Note**: If the fundamentals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Meas Mode

(Measurement Mode)
Select the harmonics to be measured and the way of display. The harmonics are then displayed above the measured value window. "THD 2–4–6–8", for example, means that the 2nd, 4th, 6th and 8th harmonics are measured.

SELECT di	Any combination of harmonic distortions d2 to d9. The measurement result is the root from the square sum of the selected harmonic distortion ***referred to the total RMS value***. Display in % or dB.
All even di	Like SELECT di, all ***even*** harmonics distortions (d2, d4, d6, d8) being selected.
All odd di	Like SELECT di, all ***odd*** harmonic distortions (d3, d5, d7, d9) being selected.
All di	Like SELECT di, ***all*** harmonic distortions (d2 to d9) being selected.
LEV SEL di	Any combination of harmonic distortions d2 to d9. The measurement result is the root from the square sum of the selected harmonic distortion, display as ***RMS value*** (with any level unit).
LEV even di	Like LEV SEL di, all ***even*** harmonics distortions (d2, d4, d6, d8) being selected.
LEV odd di	Like LEV SEL di, all ***odd*** harmonic distortions (d3, d5, d7, d9) being selected.
LEV all di	Like LEV SEL di, ***all*** harmonic distortions (d2 to d9) being selected.

di 2 4 6 8

is displayed only, if either SELECT di or LEV SEL di has been selected with Meas Mode.

√	**d2**
	d3
√	**d4**
	d5
√	**d6**
	d7
√	**d8**
	d9

Upon selection of the desired harmonic distortions using the ↑ and ↓keys, the harmonic distortion measurement can be selected (√) or disabled by pressing the SELECT key.

Dyn Mode

(Dynamic Mode) only with analog analyzers,
determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

The measurement is performed with higher dynamic and with the analog notch filter cut in. The notch filter is suitable for measurements up to 22.5 kHz - i.e. there are no restrictions in the ANLG 22-kHz instrument. Signals with a fundamental ≤ 22.5 kHz can be measured in the ANLG 110-kHz instrument. Signals with a fundamental > 22.5 kHz cause the error message "Frequency exceeds notch range" to be output.

The measuring time is longer in the PRECISION mode.

Unit

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Analyzer Functions)
only available in level measurement modes (LEV...).

This value may be entered manually if desired. Otherwise, the current RMS value will be automatically entered, if the reference value of INPUT DISP RMS is stored with the STORE (or STORE CH1 or STORE CH2) function.

Fundamental

Specifies how the fundamental is to be determined.

AUTO

UPL automatically determines the fundamental (during a THD measurement).

AUTO should always be used when the signal is derived from a low-distortion generator or an external generator and the signal has not an extremely high harmonic content.

VALUE

Numerical entry of fundamental
Specified range:
ANLG 22 kHz: 6 Hz to 21.9 kHz
ANLG 110 kHz: 38 Hz to 125 kHz
DIGITAL: sample frequency/8192 to useful bandwidth

Useful bandwidth = sample frequency * 117/256

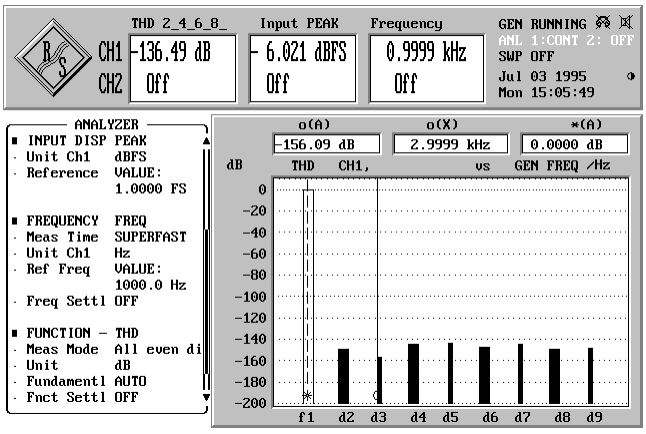
VALUE should be preferred for signals with a high harmonic content derived from an external generator.

GEN TRACK

UPL takes the fundamental from the frequency setting of the generator. This improves the setting accuracy for signals with a high harmonic content.

GEN TRACK should be used when the signal is derived from the internal universal generator.

Note: *When the internal low-distortion generator is used, the generator frequency is accurately measured and the fundamental corrected, if required. Thus the measurement result is not influenced by the frequency inaccuracy of the generator (e.g. temperature drift).*



Graphical presentation of THD measurement results
in the form of a histogram see 2.10.1 and 2.10.2

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

2.6.5.7 THD+N/SINAD Measurement (Total Harmonic Distortion+ Noise)

Available in all analyzers.

For THD or SINAD measurements, apply a highly pure sinewave signal to the device under test. Select the signal frequency such that the significant components of the THD spectrum are still below the upper measurement limit (see 2.6.1, 2.6.2, 2.6.3) of the used ANALYZER instrument.

If the signal offered does not meet the requirements, a SHOW I/O message is output (see 2.3.5):

- In the frequency range, the fundamental wave cannot be found:

"Can't find fundamental"

- The frequency of the found fundamental wave is less than the lower limit value (for its calculation, see below, Fundamental VALUE):

"Fundamental too low"

With the signal function SINE (see 2.5.4.3) in combination with the low-distortion generator (UPL-B1 option), the generator in the UPL offers a sinewave signal meeting the high demands on its spectral purity.

Principle of measurement

The fundamental is filtered out and the remaining energy consisting of harmonics and broadband noise within the band limits specified under "FrqLim Low" and "FrqLim Upp" is calculated in one or several FFT procedures. The user can select the size of the *first* FFT for starting the calculation,

- implicitly by selecting measurement time (with post FFT switched off)
- explicitly by selecting FFT size (with post FFT switched on).

A compromise has to be made between measurement speed and measurement accuracy. If the FFT size is not sufficient to measure the fundamental of the measurement signal, the FFT size and if required the zoom factor can be increased in steps.
The energy of the noise and harmonics can either be displayed as an rms value or related to the total rms value, the total rms value being bandlimited to "FrqLim Upp". The selection is made under the menu item "Meas Mode". Depending on the selected measurement mode, different units are used:

- V or FS for rms display
- % or dB for the ratio display

In the measurement modes NOISE and LEVEL NOISE, all harmonics are filtered out in addition to the fundamental. With every harmonic also the noise energy of the respective sideband is filtered out. In the case of very low frequencies - and theoretically a great number of harmonics - a considerable amount of the noise energy is thus lost. These measurement modes should therefore only be used for higher frequencies (> 100 ∗ FFT resolution) and large FFT size.

Measurement limits

The lower frequency limit for the signal is 10 Hz (or 20 Hz in the ANLG 110 kHz). The frequency of the fundamental must be limited at the upper end so that the harmonic to be measured is still below the limit frequency of the analyzer used or below the selected "FrqLim Upp". For measurements in the dynamic mode PRECISION, the fundamental (in the ANLG 110 kHz analyzer) should not be higher than 22.5 kHz (upper frequency limit of built-in analog notch filter).
For noise measurements (in the measurement modes NOISE and LEVEL NOISE, with harmonics not being taken into account) the fundamental must be at least 36 times the minimum resolution (displayed under Post FFT). In the ANLG 22-kHz analyzer and at a sampling rate of 48 kHz in the digital analyzer, a lower limit of 105.6875 Hz is obtained, in the ANLG 110 kHz analyzer 675 Hz.
THDN Post FFT is only possible if the fundamental of the measurement signal is by a multiple (depending on the selected analyzer) above the resolution selected under Post FFT (see FFT size). To reduce the resolution and thus the lower frequency limit, the FFT size may have to be increased.

Measurement speed

The measurement speed depends on the (selected) FFT size and the required dynamic measurement range.
The required FFT size is obtained from the frequency of the signal to be measured and the desired accuracy. The wider the FFT, the finer the frequency resolution and the lower the lower frequency limit. Consequently, a wide FFT has to be used for low frequencies or high accuracy requirements so that a longer measurement time has to be accepted.
For measuring particularly low-distortion signals, the measurement range can be extended by selecting the Precision mode with the result that the measurement time is doubled.
To obtain the highest possible measurement speed, two parameters can be optimized:

- Select smallest FFT size or adapt the FFT size to the fundamental of the measurement signal. The FFT size should be large enough so that the fundamental to be measured is at least 10 times greater (8.5 times in the ANLG 110, 12 times in the digital analyzer) as the resolution displayed under Post FFT. Only then can be total signal be measured with one single FFT. If the UPL generator is used as a signal source, *Fundamental GEN TRACK* and *FFT Size 512 ("Meas Time SUPERFAST".)* should be selected.
- Select *Dynamic Mode FAST* if the signal does not require the full dynamic measurement range.

Display of measurement result:

In addition to the total harmonic distortion (in the result display), its frequency spectrum can also be represented graphically or numerically as POST FFT. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

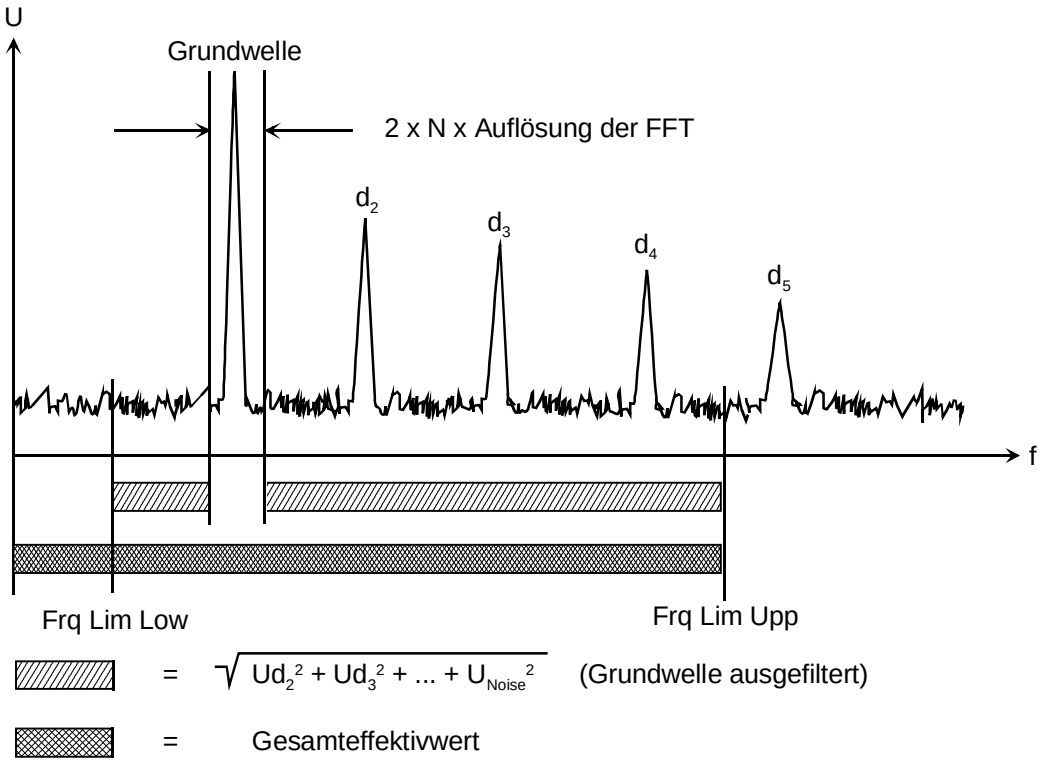


Fig. 2-23

N = 12 for digital analyzer
10 for ANLG 22 kHz
8.5 for ANLG 110 kHz

$$U_{THD+N}[dB] = 20 * \log \frac{\sqrt{U_{d2}{}^2 + U_{d3}{}^2 + ... + U_{noise}{}^2}}{\text{total rms value}}$$

THD+N measurements provide negative dB-values, SINAD measurements result in positive dB-values. The magnitudes of the values are identical.

$\sqrt{U_{d2}{}^2 + U_{d3}{}^2 + ... + U_{noise}{}^2}$ = Square sum of all harmonic distortions+ noise within the frequency range specified under FrqLim Low and FrqLim Upp.

Meas Mode

(Measurement mode)
Selection of the measurement and display modes. The measurement mode selected is displayed above the measured value window.

THD+N

The THD including noise is measured, the result is the root from the square sum of the selected harmonic and the noise voltage, ***referred to the total RMS value***, display in % or dB.

SINAD

Like THD+N, however, displayed as reciprocal value; display only (positive) dB.

NOISE

The noise is measured, only; the noise voltage ***referred to the total RMS value*** is obtained as result, display in % or dB.

LEVEL THDN

The THD including noise is measured, the result is the root from the square sum of the selected harmonic and the noise voltage, display of the rms value (in any level unit).

LEVEL NOISE

The noise is measured, only; the noise is obtained as result, display of the rms value in % or dB.

Dyn Mode

(Dynamic Mode) only in the analog analyzers
Determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with low dynamic is performed.

PRECISION

The measurement is performed with higher dynamic and with the analog notch filter cut in; the measuring time increases, correspondingly.
The notch filter is laid out for measurements up to 22.5 kHz - i.e. there are no restrictions in the ANLG 22-kHz instrument. Signals with a fundamental ≤ 22.5 kHz can be measured in the ANLG 110-kHz instrument. Signals with a fundamental > 22.5 kHz cause the error message "Frequency exceeds notch range" to be output.

The measuring time is longer in the PRECISION mode.

Rejection

Displayed only in the analog instruments with the Dyn Mode FAST.

NARROW

The fundamental is suppressed extremely narrowband. Thus, interference components can be recognized which are very close to the carrier.

WIDE

To suppress the fundamental, a notch filter is used with a characteristic which was in the past commonly used in analog measuring instruments. The measured values are improved due to the broadband filtering, since harmonic components close to the carrier are also suppressed.
This mode should be used if the measurement results are to be comparable to those of analog instruments.

Meas Time

(Measurement time)
The measurement time is used to adapt the measurement speed to the required accuracy. To obtain a higher measurement speed the (initial) FFT size is reduced.

SLOW

Measurements are performed with the greatest FFT size (8k zoom FFT). Additional FFTs (with a higher zoom factor) are only required for extremely low frequencies. This setting should be selected in particular when only the noise (NOISE or LEVEL NOISE) is measured so that harmonics are suppressed with a bandwidth as narrow as possible.

FAST

The initial FFT is measured with reduced FFT size (2 k). With low frequencies, additional FFTs (with more points and a higher zoom factor) are required.

SUPERFAST

The initial FFT is measured with the smallest FFT size (0.5 k). Additional FFTs (with more points and a higher zoom factor) may be required. This setting should only be selected if the measurement result need not be too accurate and the frequency of the signal to be measured is not very low.

***Note**: With post-FFT switched on, the FFT size can be set as required irrespective of the settings made here, i.e. the selected measurement speed is ignored.*

Unit

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Analyzer Functions)
only available in level measurement modes (LEV...).

This value may be entered manually if desired. Otherwise, the current RMS value will be automatically entered, if the reference value of INPUT DISP RMS is stored with the STORE (or STORE CH1 or STORE CH2) function.

Fundamental

Determines how to obtain the fundamental frequency.

AUTO

UPL determines the fundamental frequency automatically (while the THD+N measurement is being performed)

VALUE

Numerical entry of fundamental frequency.
Specified range:

ANLG 22 kHz:	10.0 Hz	to	21.9 kHz
ANLG 110 kHz:	20 Hz	to	120 kHz
DIGITAL:	12 * sample freq. /8 * 8192 to sample freq. * 117/256		

The setting VALUE should preferably be used for signals with a high harmonic content when an external generator is used as a signal source.

GEN TRACK

UPL takes the fundamental from the frequency setting of the generator. This increases the setting accuracy for signals with high harmonic content and increases the measurement speed.

If the frequency of a fundamental cannot be measured with the set FFT size, the FFT size is increased such that the measurement can be performed with a single FFT (or 2 FFTs in the precision mode). Thus the highest possible measurement speed can be obtained for any generator frequency with the setting FFT Size 512.

Setting GEN TRACK is to be used when the signal is derived from the internal generator.

***Note**: When the internal low-distortion generator is used, the generator frequency is accurately measured in the measurement modes NOISE or LEVEL NOISE and the dynamic mode PRECISION and the fundamental is corrected, if required. Thus the measurement result is not influenced by the frequency inaccuracy of the generator (e.g. temperature drift). This does not affect the measurement speed, however.*

Filter

OFF
A weighting
C MESSAGE
CCITT
CCIR wtd
CCIR unwtd
DEEM 50/15
DEEMPH 50
DEEMPH 75
DEEMPH J.17
RUMBLE WTD
RUMBLE UNW
DC NOISE HP
CCIR ARM
IEC TUNER

The THD+N measurement result can be weighted using one of 14 filters (see 2.7.1). User definable filters are available, too.

CCIR unwtd is not available in the ANLG 110-kHz instrument.

FrqLim Low

Lower band limit of THD+N / SINAD measurement function. This limit does *not* influence calculation of the total RMS value.
Specified range:

ANLG 22 kHz:	10.0 Hz to 21.93 kHz
ANLG 110 kHz:	20.0 Hz to (120 kHz - 62.5 Hz)
DIGITAL:	sample freq./ (2 * 8192) to (sample freq. * 0.45294)

FrqLim Upp

Upper band limit of THD+N / SINAD measurement function
Specified range:

ANLG 22 kHz:	(FrqLim Low + 8.79 Hz) to 21.94 kHz
ANLG 110 kHz:	(FrqLim Low + 62.5 Hz) to 120 kHz
DIGITAL:	(FrqLim Low + sample freq. / 5461.3) to sample freq. * 117/256

Note: *If the fundamental of the measurement signal is above "FrqLim Upp", relative measurements (THDN, SINAD and NOISE) are not useful because the energy of the fundamental has been filtered out in the reference signal. In this case an error message is output.*

Only harmonic distortions and noise components within the band limits are used in the calculation.

Only frequencies *below FrqLim Upp* are considered in the calculation of the total RMS value.

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

POST FFT

OFF

ON

(see 2.6.5.1 Common Parameters of Analyzer Functions)

There is ***no*** post-processing of measuring data for POST FFT, the measurement can thus be terminated faster.

After obtaining the result of the THD+N measurement, the measured data are prepared for ***POST FFT display***. The display can be selected in the DISPLAY panel. Only FFT Size of the following five FFT setting parameters can be modified, all others are displayed.

Note: *If the selected FFT size is too small, the POST FFT cannot be displayed.*

FFT Size

512
1024
2048
4096
8192

FFT size used for THDN calculation and post-FFT display, adjustable between 512 and 8192 in steps of 2.

A larger FFT size (i.e. more calculated points) yields a finer frequency resolution and thus a lower frequency limit and higher accuracy but longer measurement times.

The FFT size selected determines the display of the post FFT and the original zoom FFT used for THDN calculation. If the FFT size is not sufficient to resolve the fundamental, the following results are obtained has the following consequences:

- The post FFT cannot be displayed; an error message is indicated in the graphics display.
- Additional FFTs with an increased number of points are automatically calculated; the measurement time is extended accordingly.

To be able to perform a *Post* FFT, the fundamental must be above the displayed resolution (see below) by a defined factor. This factor is as follows:

- 12 for (LEVEL) THDN and SINAD in the digital analyzer,
- 10 for (LEVEL) THDN and SINAD in the ANLG 22 kHz analyzer,
- 8,5 for (LEVEL) THDN and SINAD in the ANLG 110 kHz analyzer,
- 36 for all (LEVEL) NOISE measurements.

If required, the FFT size has to be increased or the ANLG 22 kHz instrument has to be selected.

To avoid additional FFTs (because the FFT size is too small) without having to switch to a larger and thus slower FFT, "Fundamental GEN TRACK" should be selected when the internal generator is used. With this setting the fundamental is known before the 1st FFT so that the calculation can be started with the smallest possible FFT (≥ FFT size).

Window

Always RIFE VINC 2 (analog) or RIFE VINC 3 (digital)

***Note**:* *For special applications the FFT window may be selected arbitrarily with the THD+N measurment using the command line parameter "-tthdnwin" ; the "-tthdn" parameter which can be used up to software version 2.02 has no function any more with 2.03.*

Start

Display value, not identical with FrqLim Low

Stop

Display value, (useful bandwidth), not identical with FrqLim High

Resolution

The display value determines the lower limit frequency for the measurement.

Equalizer

Activation/deactivation of an equalizer table consisting of frequency information and associated voltage gain factors.
The frequency response of a transmission link can be equalized, for example, and the measurement point can be transformed to a different reference point.
The FFT bins of the spectrum recorded are multiplied by a frequency-dependent equalizer factor which may be calculated by interpolating the two adjacent frequency reference points of the equalizer table. The FFT spectrum thus equalized can be used as a basis for the calculation of the THD+N or level value and can be displayed.

The equalization of the FFT spectrum is an interesting alternative to filtering the input signal since the equalizer file can be easily generated from the frequency response to be equalized (see 2.9.1.2) and does not have to be available as coefficient or pole/zero file.

Typical application for acoustic measurements (e.g. mobile phones):
compensation of transfer function ERP (ear reference point) to DRP (drum reference point) for measurements on artificial ears of type 3.2 or higher. The THD+N measurement of the sound waves by the microphone applied to the "eardrum" can thus be referred to the required measurement point (at the auricle).

ON

The equalizer is switched on. The menu item 'Equal. file' is activated, i.e. the indicated file is loaded. The THD+N value is calculated from the equalized FFT spectrum.

OFF

The equalizer is switched off. The THD+N value is calculated from the original FFT spectrum.

Equal. file

(Equalizer file) only if equalizer → ON

Menu item for entering the name of the equalizer file. The file is opened and loaded into an internal buffer.

If the name entered is not valid (drive not ready, file not found, invalid format etc), an error message is displayed and "not found" is entered into the menu line.

For entering file names see 2.3.2.5
For generating an equalizer file see 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data ("Store → EQUALIZATN").

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Aural monitoring of the residual THD+N signal is described in section 2.6.6 Headphone/Speaker Output; Example of application: Monitoring the distortion component of a signal.

UPL-B29: Aural monitoring of the residual signal is not possible in the high rate mode.

2.6.5.8 MOD DIST (Modulation Distortion)

Available in all analyzers.

For modulation distortion measurements, apply a frequency mixture consisting of a low-frequency interfering sinewave signal (e.g. 60 Hz) and a high-frequency useful sinewave signal (e.g. 7 kHz) to the device under test. The amplitude of the interfering signal should be equal or higher than that of the useful signal. According to DIN IEC 268 Part 3, a peak amplitude ratio of interfering : useful signal = 4 : 1 should preferably be selected.

When the signal offered does not meet the requirements, a SHOW I/O message (see 2.5.3) is output:

- Useful signal is not in the frequency range from 2 kHz to 110 kHz:

"Cannot find high tone in the range from 2 to 110 kHz."

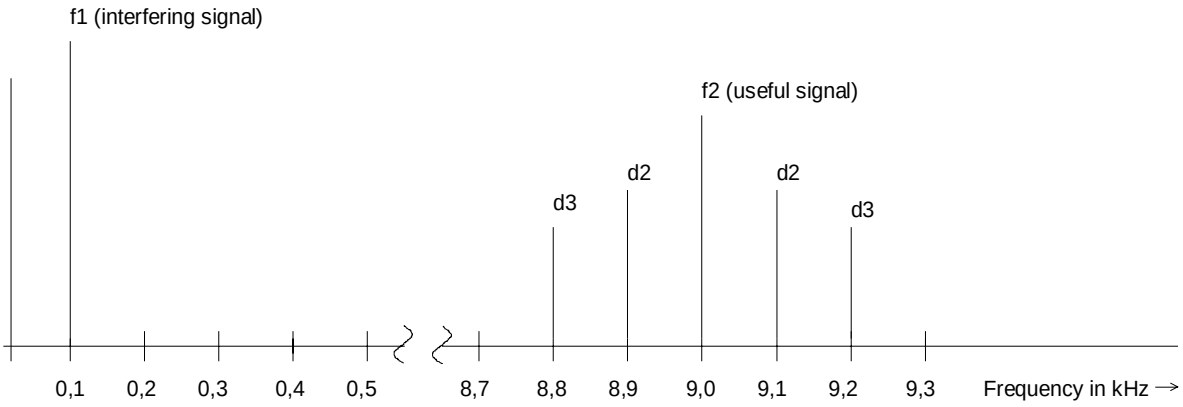
- Interfering signal is not in the frequency range from 0 Hz to 1100 Hz:

"Cannot find low tone in the range from 0 to 1100 Hz."

With the signal function MOD DIST (see 2.5.4.7), the UPL generator offers by the above frequency mixture, allowing the frequencies and amplitude ratio of interfering and useful signal as well as the level to be specified. Total level and useful frequency can be swept.

Principle of measurement

Unaffected by noise due to selective measurement, the UPL measures the intermodulation products of 2nd and 3rd order in line with DIN IEC 268 Part 3 and does the square sum of the intermodulation products. (Contrary to the DIN IEC 268 Part 3 Recommendation, the total modulation distortion is measured to permit comparisons with the hitherto commonly used SMPTE measurement procedures).



d2 = Intermodulation product of 2nd order
d3 = Intermodulation product of 3rd order

Fig. 2-24

Modulation distortion of 2nd order

$$dm2 = \frac{|U_{(f1+f2)}| + |U_{(f2-f1)}|}{U_{(f2)}}$$

Modulation distortion of 3rd order

$$dm3 = \frac{|U_{(f2-2f1)}| + |U_{(f2+2f1)}|}{U_{(f2)}}$$

Square sum:

$$dm(2+3) = \sqrt{dm2^2 + dm3^2}$$

MOD DIST [dB] = 20 * lg (dm(2+3))

Display of the measurement result:

In addition to displaying the total intermodulation distortion in the result display, an additional graphical (histogram) or numerical display of the useful frequency and the signal frequency and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Dyn Mode

(Dynamic Mode), with analog analyzers, only.
Determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

If the measured value is better than 55 dB (analog 22 kHz) or 40 dB (analog 110 kHz), the measurement is performed with higher dynamic range and analog notch filter cut in. The measuring time increases, correspondingly. If the intermodulation value of the signal drops below 50 to 55 dB, the measurement is performed in FAST mode.

Unit

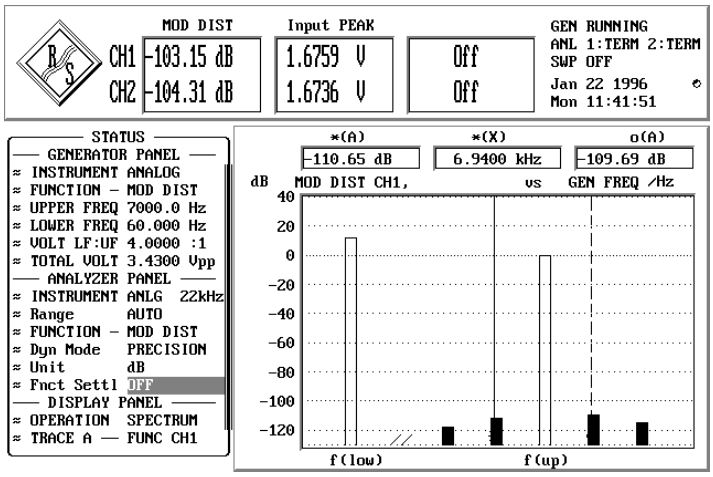
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)



Graphical presentation of MOD DIST measurement results in the form of a histogram see 2.10.1 and 2.10.2

2.6.5.9 DFD (Difference Frequency Distortion)

Available in all analyzers.

To measure the difference frequency distortion of 2nd or 3rd order, apply a frequency mixture to the device under test. The frequency mixture is to consist of two sinewave signals of the same amplitude with, to DIN IEC 268 part 3, an arithmetic mean frequency out of the one-third octave band (5, 6.3, 8, 10, 12.5, 16, 20 kHz). A frequency offset of 80 Hz is to be selected, preferably.

Frequency limits for d_2- and d_3-measurements:
$2f_2$-f_1 must still be within the frequency range of the instrument set (see 2.6.1).
When the signal offered does not meet the requirements, a SHOW I/O message is output (see 2.3.5):

- The frequency difference is higher than 1100 Hz:
  "Frequency difference of IMD tones seems to be too large; (> 2100.0 Hz)"
- The frequency difference is less than 70 Hz:
  "Frequency difference of IMD tones seems to be too small; (<70.0 Hz)"
- The levels of the two sinewave signals differ by more than 20 %:
  "Level of IMD tones seems to be too different; (more than 20 %)"

***Note**: A level check of IMD tones is **not** performed in the measurement modes to **IEC 118**. A DFD measurement can therefore be carried out even in the case of strongly distorted IMD signals (e.g. because of the frequency response of the DUT or the transmission path).*

With the signal function DFD (see 2.5.4.8), the UPL generator offers the above frequency mixture. The mean frequency, frequency difference and total amplitude can be specified by the user.

Principle of measurement

With the Meas Mode d_2 or d_3 selected, the UPL measures selectively. Thus being unaffected by noise, the intermodulation products of 2nd or 3rd order are measured in accordance with DIN IEC 268 part 3.

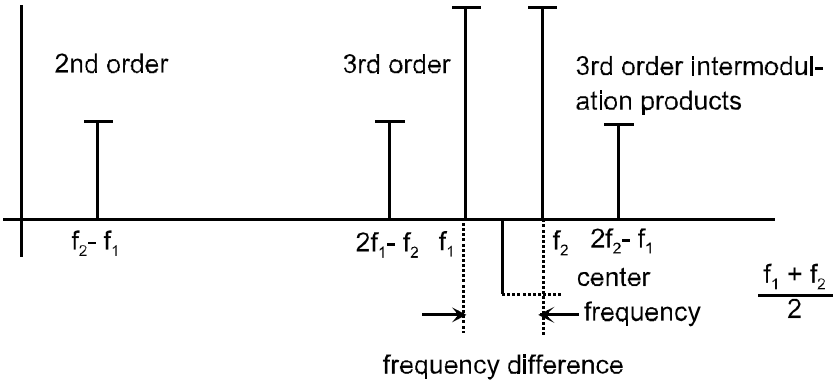


Fig. 2-25

Difference frequency distortion of 2nd order:

$$d_2\,[\mathrm{dB}] = 20 \times \lg \frac{\left|U_{(f_2 - f_1)}\right|}{2 \times U_{(f_2)}}$$

$$d_2\,[dB] = 20x\lg \frac{\left|U_{(f_2 - f_1)}\right|}{U_{(f_2)}}$$

Difference frequency distortion of 3rd order:

$$d_3\,[\mathrm{dB}] = 20 \times \lg \frac{\left|U_{(2f_2 - f_1)}\right| + \left|U_{(2f_1 - f_2)}\right|}{2 \times U_{(f_2)}}$$ to IEC 268

$$d_3\,[dB] = 20x\lg \frac{\left|U_{(2f_1 - f_2)}\right|}{U_{(f_2)}}$$ to IEC 118

Display of measurement result:

In addition to displaying the difference frequency distortion (d2 or d3) in the result display, an additional graphical (histogram) or numerical display of the center frequency and the difference frequency (according to the meas. mode selected) and of the individual intermodulation products can be switched on. This is effected by selection of OPERATION SPECTRUM or SPECTR LIST in the DISPLAY panel.

Note: *If the intermodulation signals applied to the two measuring inputs have different frequencies, the frequencies indicated in the graphics refer to the channel which is displayed in trace A.*

Meas Mode

Measurement mode for selecting the order of the intermodulation product and the measurement standard used.

d2 (IEC 268)

Measurement and display of 2nd order intermodulation products referred to *twice* the "upper frequency" (to IEC 268).

d3 (IEC 268)

Measurement and display of 3rd order intermodulation products referred to *twice* the "upper frequency" (to IEC 268).

d2 (IEC 118)

Measurement and display of 2nd order intermodulation products referred to the "upper frequency" (to IEC 118).

d3 (IEC 118)

Measurement and display of 3rd order intermodulation products referred to the "upper frequency" (to IEC 118).

Note: *Measurements to IEC 118 are mainly used for hearing aids. Due to the different formulae, the d2 measurement to IEC 268 yields a result better by 6 dB.*

Dyn Mode

Dynamic Mode, only for analog Meas Mode → d2;
determines the possible dynamic of the measurement result and thus the measurement rate.

FAST

A fast measurement with less dynamic is performed.

PRECISION

If the measured value is better than 50 dB, the measurement is made with higher dynamic. The measuring time increases, correspondingly. If the intermodulation value of the signal is below 50 dB, the measurement is performed in FAST mode.

Unit

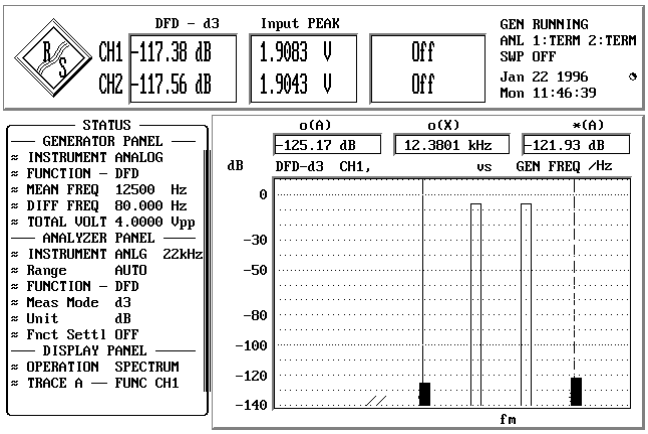
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)


DFD - d3
Input PEAK
CH1 -117.38 dB
CH2 -117.56 dB
1.9083 V
1.9043 V
Off
Off
GEN RUNNING
ANL 1:TERM 2:TERM
SWP OFF
Jan 22 1996
Mon 11:46:39
STATUS
GENERATOR PANEL
INSTRUMENT ANALOG
FUNCTION - DFD
MEAN FREQ 12500 Hz
DIFF FREQ 80.000 Hz
TOTAL VOLT 4.0000 Vpp
ANALYZER PANEL
INSTRUMENT ANLG 22kHz
Range AUTO
FUNCTION - DFD
Meas Mode d3
Unit dB
Fnct Settl OFF
DISPLAY PANEL
OPERATION SPECTRUM
TRACE A — FUNC CH1
σ(A)
σ(X)
*(A)
-125.17 dB
12.3801 kHz
-121.93 dB
dB
DFD-d3 CH1,
vs
GEN FREQ /Hz
0
-30
-50
-80
-100
-120
-140
fm

2.6.5.10 Wow & Flutter

Available only in the instruments ANLG 22 kHz and DIGITAL.
Measurement of the frequency deviation of a recording device (wow & flutter). To this end, a sine tone with fixed frequency (usually 3.15 kHz or 3.00 kHz) is reproduced by a reference sound carrier. During its reproduction, frequency errors occur because of cyclic variations. Frequency distortion is specified in percent of the carrier frequency. These deviations are determined using different weighting filters and methods depending on which standard is applied.

Principle of measurement

The input signal is limited symmetrically to the test frequency (3 kHz to NAB and JIS, 3.15 kHz to DIN) using a bandpass filter (passband width 1000 Hz, attenuation 80 dB, Bessel characteristic), and is subsequently subjected to FM demodulation. The demodulator output is sampled at 1/16 of the original sampling frequency and stored for POST FFT. A higher sampling rate is not useful because the signal is band-limited. Following a bandpass which can be cut in, the respective weighting is selected depending on the standard.

Standard

Set the standard applying to the measurement:

DIN/IEC

Standards:	DIN 45507 / IEC 386 / CCIR 409-2	
Reference frequency:	3150 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	quasi-peak,	
	time constants: rising time:	30.8 ms,
	falling time:	606 ms

NAB

Standards:	NAB Rec.	
Reference frequency:	3000 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	averaging the detected frequency error signal, time constant: 300 ms	

JIS

Standards:	Japan Industry Standard	
Reference frequency:	3000 Hz	
Weighting filters:	weighted:	bandpass, center frequency 4 Hz
	unweighted:	highpass, 0.5 Hz
Weighting method:	rms weighting, integration time 2 sec	

2 Sigma 5 s
2 Sigma 10 s

The 2-sigma weighting to IEC 386/1988 is implemented in the UPL. Its purpose is to determine a threshold for the wow and flutter value at which 5 % of the measured values have a magnitude that is higher than this threshold, ensuring that sporadically occurring outliers do not affect the measurement result.
The integration time is selectable: 5 or 10 seconds.

Weighting

ON

The measurement is weighted using a weighting filter, bandpass 4 Hz.

OFF

Weighting filter off, highpass 0.5 Hz.
Maximum weighting bandwidth in both cases: 200 Hz

Frequency response of weighting filter (to DIN 45507, IEC 386, CCIR Rec. 409-2):

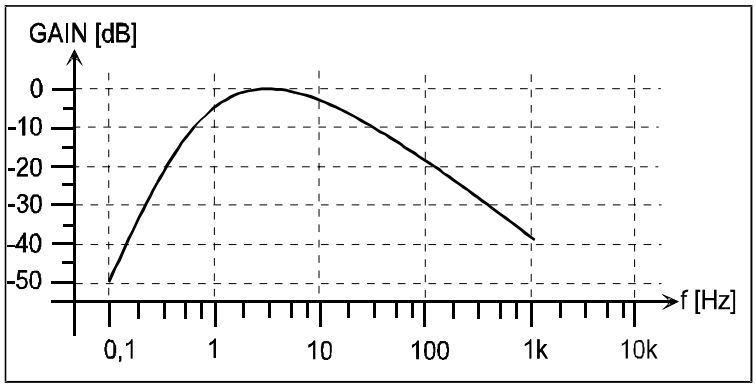


Fig. 2-26 Frequency response of weighting filter

Unit

(cf. 2.6.5.1 Common Parameters of Analyzer Functions)
The W&F measurement result can be indicated in %, only.

Fnct Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Post FFT

(see 2.6.5.1 Common Parameters of Analyzer Functions)

ON

Display of the frequency spectrum of the data which have been FM-demodulated and weighted with the weighting filter. The wow and flutter measurement is aborted after about 2 seconds with POST FFT selected. The demodulated data are subsequently used for calculation of an FFT.

OFF

No POST FFT (thus no interruption of the measurement).

FFT Size

Enter FFT size (256 to 8192). (see 2.6.5.12 FFT).

Window

Select the window function; possible windows and their applications, see 2.6.5.12 FFT.

Start

Display of the frequency limits of the generated spectrum (no entry). Since the demodulator stage samples by the factor 16, the upper limit of the spectrum is

127/256 * sampling rate / 16

(For sampling rate, cf. 2.6.1 Selecting the Analyzer).

Stop

Resolution

Display of frequency resolution (no editing).

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.11 POLARITY (Polarity Test)

Available in all analyzers.

The POLARITY measurement serves to check whether a device under test passes on an applied signal with the same polarity or with reversed polarity. To this end, set the POLARITY function on the generator (see 2.5.4.11) and apply the generator test signal (SINE^2 BURST signal) to the DUT.

Principle of measurement:

The analyzer weights and displays the polarity of the DUT output signal. In order for the convention

without polarity reversal = "+1 Pol" is displayed
with polarity reversal = " -1 Pol " is displayed

to be true, a ***positive*** SINE^2 BURST signal must be applied to the DUT. The UPL generator provides a suitable signal function (POLARITY) for this purpose.

An external signal can also be applied to the DUT provided that a suitable SINE^2 BURST signal is used.

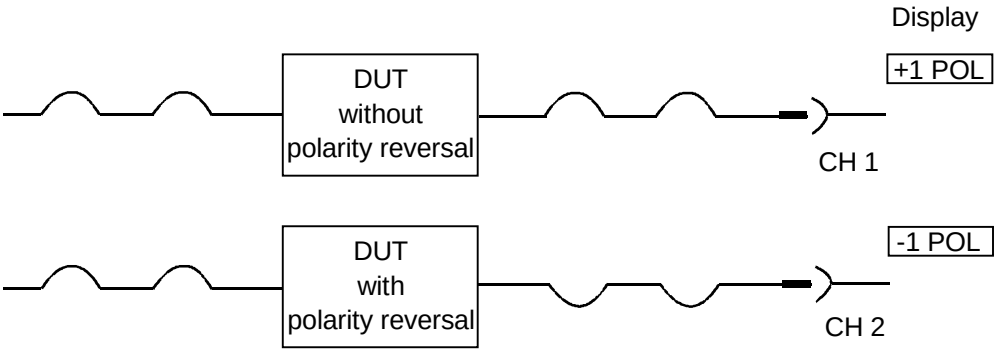


Fig. 2-27

SPEAKER (see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.12 FFT (Spectrum)

Available in all analyzers.

Spectrum display of the input signal, transforming into the frequency range being effected by way of the so-called fast Fourier transform (FFT). The graphical or numerical display of the FFT can be selected in the DISPLAY panel (menu item OPERATION). The graphical display is in line with the parameters set in the DISPLAY panel. The section to be displayed (in the x and y directions) can be selected independent of the frequency range and zoomed zone selected in the ANALYZER panel. If, due to inappropriate settings in both panels, a result is outside the visible screen , this can be remedied quickly by selection of the AUTO scaling for the X and the Y-axis (see also 2.10 Graphical Data Presentation (DISPLAY and GRAPHICS Panels)).

Note: *In the ANLG 22 kHz and DIGITAL analyzers the input signal can be filtered with up to 3 filters. Filters cannot be used in the ANLG 110 kHz analyzer but spectrum display of a* ***filtered*** *input signal is possible by means of menu item Post-FFT of the RSM & S/N function.*

DC Suppres

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Selectable in the digital analyzer only; corresponding setting for analog analyzers:
"Coupling AC/DC", see 2.6.2 Configuration of the Analog Analyzers

Note: *With DC suppression switched on, the measurement time for FFT is approx. 200 ms longer.*

Unit Ch1/2

Selection of the unit for the display of the RMS value for channel 1 or 2, respectively.
(cf. 2.6.5.1 Common Parameters of Functions)

The selection **entered** here is referred to for display of the spectrum in the DISPLAY panel, as standard. However, it may be overwritten in the DISPLAY panel (by entry under menu item Unit of TRACE A or B).

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Chan Delay

(Interchannel delay)
Delay compensation of the DUT by entering the time by which channel 1 is to be delayed with respect to channel 2. If channel 2 has a shorter delay than channel 1, this can be compensated for by entering a negative value. Delay compensation is of relevance to phase measurements, as time discrepancies between the two test signals result in a phase shift dependent on the current frequency, which may corrupt the phase-measurement result.

Specified range: -10 s to +10 s

Note: *If zoom FFT is switched on, interchannel delay cannot be selected; it is set to 0 internally.*

Filter

(See 2.7 Analyzer Filters (FILTER Panel))
In analyzers ANLG 22 kHz and DIGITAL, up to three filters can be selected in Meas Mode AUDIO DATA.

***Option UPL-B29**: No filter can be switched on in the high rate mode.*

Notch (Gain)

(see 2.6.5.1 Common Parameters of Analyzer Functions)

FFT Size

FFT size, settable from 256 to 8192 in binary steps.

256
512
1024
2048
4096
8192

The larger the FFT size (more calculated points), the better the frequency resolution, however the longer the measuring time. The number of displayable lines as a function of FFT Size and ZOOMing is given below:

Zooming ON:	maximum	FFT Size x 117/256 x 2
Zooming OFF:	analog:	FFT Size x 117/256
	digital:	FFT Size x 127/256

Note: *The number of displayable lines may be reduced with the "Zooming ON" setting - part of the frequency lines may fall within the negative frequency range due to eccentric "Center" setting.*

Window

Selection of the window function:

In system theory, the FFT treats a block of data (finite-length signal sequence) as though it were an infinite periodic sequence. In practice, however, discontinuities usually occur at the ends of the block. The discontinuities would be weighted as pulses (with white spectrum). This pulse spectrum masks the actual (useful) signal spectrum (leakage).
Remedy: The ends of the finite-length signal sequence for the FFT are smoothly tapered to zero by windowing the data. The FFT then treats the signal as a continuous periodic sequence. Window functions thus help to minimize the leakage (at the expense of selectivity).

Range of applications of the windows:

HANN
The HANN window combines selectivity with good leakage suppression for distant interferences, yet has a relatively wide bell-shaped curve around the signal lines.

RECTANGULAR
Window function switched off. When the signal fits exactly with an integer number of periods into the block windowed for the FFT, there will be no discontinuities at the block ends. In this case, a window is not necessary and maximum frequency resolution can be obtained. This characteristic is advantageous for fast and frequency-precise measurements of frequency responses in the case of the generator signals RANDOM / Domain: FRQ (so-called FFT noise, see 2.5.4.9 RANDOM, Domain = Frequency) and MULTISINE (see 2.5.4.4).
(See 2.6.7.3 Fast Frequency Response Measurement)

BLACKMAN-H
The bell-shaped curve falls off very steeply to about 80 dB; however below this point, this window has considerable leakage.

RIFE-VINC 1
RIFE-VINC 2
RIFE-VINC 3
Suppression of distant interferences is excellent with all 3 windows. With increasing order of the windows, the width of the bell-shaped curve decreases at the bottom of the single lines and increases at the top.
Various trade-offs between frequency resolution and suppression of close interferences can thus be made.

HAMMING
Offers no significant advantages, has been implemented for the sake of completeness.

FLAT_TOP
The top of the bell-shaped curve (which is caused only by a single sine line) is as flat as to include always two adjacent lines with approximately the same height.
Advantage: The amplitude can be precisely read from the graphs as against with other window functions.
Disadvantage: Poor frequency selectivity.

KAISER
The trade-off between selectivity, close interference suppression and distant interference suppression determines the selection of parameter ß (from 1.5 to 20). With ß = 8, selectivity is good but distant interference suppression is only about 90 dB. With ß = 16, distant interference suppression is excellent, however the bell is relatively wide.
(see 2.6.5.1 Common Parameters of Analyzer Functions)

Avg Mode

Selection of the averaging method in the FFT

NORMAL

The entered number of FFTs is executed, the partial results added and then divided by this number.
With swept waterfall (OPERATION mode WATERFALL), the waterfall is displayed with respect to all sweeps points.

EXPONENTIAL

Averaging is executed continuously. The current result is calculated to:

$$AVG(n) = \frac{1}{k} \cdot FFT(n) + \frac{k-1}{k} \cdot AVG(n-1)$$

With swept waterfall (OPERATION mode WATERFALL), a waterfall of the intermediate results is displayed for every sweep point; then the waterfall is cleared (for the next sweep point).

Notes: *After a restart of the measurement (e.g. caused by SWEEP, calibration or cursor movement), averaging is started anew. Average is not executed if the display mode is set to MAX HOLD.*

Avg Count

Number of averagings (with Avg Mode NORMAL) or k (Avg Mode EXPONENTIAL, see AVG(n) formula.

Zooming

Determines, whether the FFT is calculated from the entire frequency range or from a section only.

OFF

"Normal" FFT, frequency range from 0 to range limit.
Range limit:

- analog: 117/256 * (internal) sampling rate
- digital: 127/256 * sampling rate.

(For the sampling rates of the individual instruments, refer to 2.6.1 Selecting the Analyzer.)

ON (2...128)

Zoom the frequency range about the center frequency (Center) by processing the signal in the time domain before the FFT (see notes below). Zooming is effected with a factor of 2, 4, 8, ... up to 128 (16 in ANLG 110 kHz). The factor is determined by the span. The measuring time is doubled with each zoom step. The maximum zoom factor depends on the selected instrument (see below).

Zoom Fact

(Read only, can't be changed)
Display of the zoom factor.

Start

(Read only, can't be changed)
Display of the lower measurement limit:
with normal FFT: 0 Hz
with ZOOM-FFT: frequency of the 1st line which lies in *the positive frequency range*

Stop

(Read only, can't be changed)
Display of the upper measurement limit in Hz or kHz
See table 20.

Center

This menu item is displayed only with Zooming ON. Center of the zoomed zone, continuously variable within the useful range of the respective instrument.

With the center frequency set closer to the ***lower*** range limits (0 Hz) than span /2, part of the frequency lines are allotted to the negative frequency range. These lines are ***not*** calculated, they are, however, not available for the frequency resolution.

If the center frequency is set closer to the ***upper*** range limits than span /2, part of the frequency lines exceed the frequency range. These lines contribute to the calculation and are displayed in order to enable evaluation of the behaviours at the range limits. For normal applications, this setting should be avoided, since the measured rms value may become incorrect due to aliasing components.

Span

This menu item is displayed only with Zooming ON. You can select out of 7 (with DIGITAL and ANLG 25) or 4 (with ANLG 110) possible zooming zones. SPAN is the entire range displayed, except for the event that Center was selected such that part of the FFT is below 0 Hz (see Center). The selection list for span is calculated depending on the current sampling rate and labeled.

Resolution

(Read only, can't be changed)
Spacings between the FFT lines in Hz or kHz. Line spacings down to the mHz range can be obtained by selecting a high zoom factor (very small span) and a long FFT (large FFT size).

Specified range:
normal FFT

ANLG	22 kHz	5.8598 x 8192 / FFT Size
ANLG	110 kHz	37.5 x 8192 / FFT Size
DIGITAL		sample frq / FFT Size

Zoom FFT:
Value of the normal FFT /zoom factor

Meas Time

(Measurement Time)
(Read only, can't be changed)
Time required by the analyzer for signal

Equalizer

Activation/deactivation of an equalizer table consisting of frequency information and associated voltage gain factors.
The frequency response of a transmission link can be equalized, for example, and the measurement point can be transformed to a different reference point.
The calculated FFT bins are multiplied by a frequency-dependent equalizer factor which may be calculated by interpolating the two adjacent frequency reference points of the equalizer table. The FFT spectrum thus equalized is then displayed and used as a basis for calculating the total RMS value.

The equalization of the FFT spectrum is an interesting alternative to filtering the input signal since the equalizer file can easily be generated from the frequency response to be equalized (see 2.9.1.2) and does not have to be available as coefficient or pole/zero file.

Typical application for acoustic measurements (e.g. mobile phones):
compensation of transfer function ERP (ear reference point) to DRP (drum reference point) for measurements on artificial ears of type 3.2 or higher. The measurement of the sound waves by the microphone applied to the "eardrum" can thus be referred to the required measurement point (at the auricle).

ON

The equalizer is switched on. The menu item 'Equal. file' is activated, i.e. the indicated file is loaded.

OFF

The equalizer is switched off; the FFT spectrum remains unchanged.

Equal. file

(Equalizer file) only if equalizer → ON

Menu item for entering the name of the equalizer file. The file is opened and loaded into an internal buffer.

If the name entered is not valid (drive not ready, file not found, invalid format etc), an error message is displayed and "not found" is entered into the menu line.

For entering file names see 2.3.2.5;
For generating an equalizer file see 2.9.1.2 Loading and Storing of Series of Measured Values and Block/List Data ("Store → EQUALIZATN").

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Table 2-31: Upper range limit for the FFT as a function of the analyzer instrument and zooming

Instrument	**upper range limit for FFT**	
	with normal FFT	**with Zoom-FFT (depending on "Center"; maximum)**
ANLG 22 kHz	21.938 kHz	21.938 kHz
ANLG 110 kHz	12o kHz	120 kHz
DIGITAL	127/256 * Sample Frq	117/256 * Sample Frq

***Note**: The antialiasing filter in the analyzer ANLG 110 kHz is effective before reaching the upper range limit, already*

Additional information on FFT:
Width of bell-shaped curve (worst case) in lines:

Table 2-32 FFT window

Window	**-20 dB**	**-40 dB**	**-60 dB**	**-80 dB**	**-100 dB**
Hann	4	7	14.5	29	64
Rectangular	6.7	68	∞	∞	∞
Blackman-Harris	4.5	6	7	8	21.5
Rife-Vinc 1	4	6	9	14	21
Rife-Vinc 2	5.5	7	9	11	16
Rife-Vinc 3	6.5	8.2	10	12	14,5
Hamming	3	4	29	∞	∞
Flat_Top	7.5	9	11	14	19
Kaiser (ß=8)	3.5	4.2	6	11.5	
Kaiser (ß=16)	4.5	6	8	11	15

∞ this suppression will never be attained or far off only.

Frequency measurement with FFT: With FFT, the spectral line with the highest signal amplitude in the with FFT: spectrum is entered as frequency value in the respective display field. With the exception of the Kaiser window, the adjacent lines are included as part of the frequency calculation, thus increasing the accuracy (on the assumption of single sine lines). In particular with the windows HANN, RIFE VINC 1 to 3, high accuracies can be obtained.

*Amplitude accuracy***:** Depending on the window and position of the single signal lines relative to the FFT lines, system-related display read errors of up to -3 dB occur. The error is worst when the selected window is narrow at its top, the input signal falling on the center between two FFT lines (e.g. in rectangular windows).
Using the cursor function IMAX (interpolated maximum) for reading the peak values in the display causes the interpolation to be made on the actual peak value, the windows HANN, RIFE-VINC 1-3 providing accuracies of more than 1 % (on the assumption of single sine lines, only).

Implementing the FFT: The FFT has been implemented as decimation-in-frequency-FFT in complex presentation with 32-bit floating numbers. For coding, in particular the rounding noise has been optimized, reducing the errors due to FFT processing to less than -130 dB. The data are input to the analyzer at a time, the FFT being computed subsequently. Thus, the measurement is not continuous, which does however not adversely affect the measurement (with usually stationary signals).
With ZOOM-FFT, the input signal is shifted by way of convolution with a Dirac pulse at the center frequency so that the selected range falls on frequency values around zero. After lowpass filtering and subsequent undersampling, the range can be displayed with a better resolution.
A ZOOM is always implemented in three stages (up to the factor of 8). Zooming up to the factor 256 is feasible when using the ”slow” instruments ANLG 22 kHz and DIGITAL. The input signal for the FFT will be complex when shifting the input signal using a single Dirac pulse. For this reason, 7488 (analog) or 4064 (digital, without zoom) points are displayable with an FFT of 8192 points! With ZOOM, the center frequency is visible in the display at about -140 dB (on technical grounds).

Resolution, measurement time and span

Example: ANLG 22 kHz and DIGITAL: (sampling rate = 48 kHz, 8192 FFT points)

Table 2-33 Resolution, measurement time and span with FFT

	max. SPAN [Hz]	max. resolution [Hz]	Measurement time [ms]
FFT	23807	5.8593	170.71
ZOOM 2:1	21938	2.9296	348.12
ZOOM 4:1	10969	1.4648	696.25
ZOOM 8:1	5485	0.7324	1392.5
ZOOM 16:1	2742	0.3662	2785
ZOOM 32:1	1371	0.1831	5570
ZOOM 64:1	686	0.0915	11140
ZOOM 128:1	343	0.0457	22280

SPAN and resolution are proportional to, measuring time is reciprocal to the sampling rate.

Window functions:

All window functions (except for Kaiser) are computed according to the following formula:

$$\text{Window(i)} = \sum \text{A(n) x } \cos \frac{2\pi ni}{\text{FFT}-\text{Size}}$$

where A(n) is the respective amplitude factor of line n.

Table 2-34 Window functions with FFT, Coefficients A(n)

	A(0)	A(1)	A(2)	A(3)	A(4)
HANN	0.50000	-0.50000	0.0	0.0	0.0
RIFE-VINC 1	0.37500	-0.50000	0.12500	0.0	0.0
RIFE-VINC 2	0.31250	-0.46875	0.18750	-0.03125	0.0
RIFE-VINC 3	0.2734375	-0.43750	0.21875	-0.06250	0.0078125
BLACKMAN-H	0.35875	-0.48829	0.14128	-0.01168	0.0
HAMMING	0.54000	-0.46000	0.0	0.0	0.0
FLAT–TOP	0.18810	-0.36923	0.28702	-0.13077	0.02488
RECT	1.00000	0.0	0.0	0.0	0.0

The KAISER window is given by:

$$Window(i) = \frac{BESSEL\,(ß * \sqrt{1-\frac{4n^2}{N^2}})}{BESSEL\,(ß)}$$

where BESSEL (i) is the modified Bessel function of 1st order.

2.6.5.13 FILTER SIM

Available in all analyzers.
The function FILTER SIM. is not used for measurements, but serves to check a selectable combination of filters or user-defined filters for their sum frequency response. For this purpose, filters can be selected as with the functions RMS, PEAK and QUASI-PEAK.

The filter simulation takes place with a fixed pattern in the frequency domain. This pattern results in system clock /8192; (e.g. a sampling rate of 48 kHz results in 5.86 Hz). The range from 0 Hz to half the sampling rate is simulated, producing 4096 output points in the graphics.

Functioning of the simulation:

The filters used in the UPL are IIR (infinite impulse response) filters. These filters are defined by poles and zeroes in the complex Z-level, conjugated complex poles and zeroes being combined to a real biquad.

These biquads feature the following transfer function:

$$H(z) = b0 \times \frac{z^2 + b_1 z + b_2}{z^2 - a_1 z - a_2}$$

4 biquads constitute an UPL filter, the coefficients b0 of the single biquads being multiplied so that a common gain is obtained. Up to 4 of such 8-pole UPL filters can be used in measurement functions.

This sum transfer function (sum of all single transfer functions) is evaluated for

z = exp(jw) with w = (0 toi * π/ 4096) and i = 0 to 4096

the denominator and numerator polynomials and the filter gain being calculated at the simulation points. Hence, the filter simulation features only a fixed resolution, extremely sharp filters (e.g. very narrow-band notch filters) cannot be simulated in this way. Actually, such filters should not be used at all, because, in the case of pole and zero positions near the unit circle, numerical accuracy problems occur or these filters have a tendency to show so-called limit cycles (i.e. signals at the filter output without a corresponding signal at the filter input).

The above frequency pattern does not apply to the use of the filters in measurements (RMS, PEAK, QUASI-PEAK), since the filters are calculated in the time domain in this case.

Filter	(see **2.7 Analyzer Filters (FILTER Panel)**) Up to 3 filters can be simulated.
SPEAKER	(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.14 Waveform (Display in the Time Domain)

Available in all analyzers.
This function is used to display the input signal in the time domain. The trigger state being displayed in the result window, the signal in the graphics window. Level values can be read from the graphics window using the cursors. A filter selection can be made similar to the functions RMS, PEAK and QUASI PEAK.

Two-channel measurement:
- In the slow instruments (ANLG 22 kHz and DIGITAL), the two input channels are measured simultaneously. One of them may be selected as trigger channel; as soon as it has exceeded the trigger level, the two channels are triggered such that they are graphically displayed with correct time.
- In the 110-kHz analyzer, the two channels are measured sequentially, which is why no time reference between the two channels is specified. With continuous measurement (CONTINUOUS, see below) the switchover to the other channel is initiated even without a trigger event occurring upon reaching 10 times the memory depth at the latest. Trigger events may thus get lost. One-channel measurement is therefore required to guarantee continuous monitoring.

Triggering:
The UPL waits for the specified slope at the defined level.
The user may select between 2 trigger modes in order to provide for continuous monitoring on the one hand and also obtain a display even with non-triggering signals (which are too weak) on the other hand:
- CONTINUOUS (by pressing the START key) starts a continuous measurement which initiates a trigger automatically upon reaching 10 times the memory depth (trace length) at the latest. 'not triggered' is indicated in the result display. Signal monitoring is continued.
- SINGLE (by pressing the SINGLE key) starts a single measurement. The signal is only monitored until the trigger threshold is exceeded or the STOP key is actuated. The measured signal is displayed only, if a trigger event occurs. Monitoring is not interrupted in this mode. This applies also for remote or sequence control.

Representation:
- In the slow analyzers (ANLG 22 kHz and DIGITAL), both channels have the same time axis which applies in relation to the trigger point of the selected trigger channel.
- In the 110-kHz analyzer, the time axis of each (individual) channel applies in relation to the trigger point of the respective channel.

Settings:
In the analyzer panel, the mode, the trigger condition and the memory depth are set, only; in the slow analyzers, the trigger channel is set, too. Scaling of the picture (X and Y axis) is set in the display panel (see Section 2.10).

DC Suppres

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Selectable in the digital analyzer only;
corresponding setting for analog analyzers:
"Coupling AC/DC", see 2.6.2 Configuration of the Analog Analyzers

Note: *With DC suppression switched on, the time required for each measurement is approx. 200 ms longer.*

Meas Mode

Determines the memory depth and processing mode

STANDARD

Usual display of the samples, max. TRACE length is 7488 samples.
For smoothing of the curve display (with periodic signals), the "Interpol" measurement mode can be switched on.
Recommended for short recording and with periodic signals.

COMPRESSED

Only for the analyzers ANLG 22 kHz and DIGITAL.
In the COMPRESSED mode, the input signal is first fed to a peak-value detector (absolute value generation). Following this, the number of samples set under Comp Fact are combined. This peak value is then used as the input signal of the waveform function. Thus the x-axis is so to speak compressed, which allows long times to be acquired.
Interpol can't be switched on.
Recommended if ***long*** recording times are required and only the ***peak value characteristic*** is of interest.

***Note**: When settings are made in the display panel, the compressed WAVEFORM can also be logarithmically displayed. This can be either directly specified (Spacing LOG) or indirectly by selecting a logarithmic unit. Power units (e.g. W, %P/P_r) may also be used.*

***Application**: Investigation of switch-on/off transients, e.g. of AGC circuits (automatic gain control)*

UNDERSAMPLE

For ANLG 22 kHz and DIGITAL analyzers only.
The input signal is "undersampled", i.e. the samples specified under Comp Fact are arithmetically averaged and then used as input sample for the waveform function. As a result the X axis is compressed similar to the compressed mode and long periods can be recorded.
"Interpol" cannot be switched on.
Recommended if ***long*** recording times are required and the ***time template of the signal*** is of interest.

Comp Fact

(Only for Meas Mode COMPRESSED or UNDERSAMPLE)

Selection of the compression ratio for the compressed waveform display. Number of samples which are comprised to one sample for the waveform.

Specified range 2 to 1024

Unit

Selecting the unit for waveform display.
(see 2.6.5.1 Common Parameters of Analyzer Functions)

The unit ***entered*** here is also used as standard for the waveform display in the DISPLAY panel. However, it can be overwritten in the DISPLAY panel (by an entry made under the menu item Unit of TRACE A or B).

Note: *Contrary to an entry in the DISPLAY panel, the unit entered here is stored when the function or instrument is changed making it available again when the function is switched back to waveform display.*

Selectable analog units (applies also to Meas Mode COMMON/INP in the DIGITAL instrument):

V | dBV | dBu | dBm | W | Δ%V| ΔV | V/V_r | %V/V_r | Δ%W |ΔW | P/P_r | %P | P_r | dB_r

Selectable digital units (Meas Mode AUDIO DATA):

FS | %FS | dBFS | Δ% | dB_r | LSBs | bits

Selectable jitter units (Meas Mode JITTER/PHAS):

UI | %UI | dBUI | ppm | ns | UI_r | dB_r

Note: *Logarithmic units are only possible in the Meas Mode COMPRESSED.*

Ref Volt

(see 2.6.5.1 Common Parameters of Analyzer Functions)
In the case of waveform display the reference value can only be entered as a numeric value; this menu item corresponds to the value entered under „Reference VALUE“.

Filter

One filter each can be selected in the ANLG 22 kHz and DIGITAL analyzers under Meas Mode AUDIO DATA.

UPL-B29: *No filter can be switched on in the high rate mode.*

Trig Level

Set the trigger threshold. The threshold is entered as a fixed voltage, i.e. independent of the measurement range (which is set either fixed or using AUTO RANGE).

Specified range:

digital (audio data mode):	± 1 FS
digital (jitter mode):	± 10 UI
analog and digital common mode:	± 200 V

Trig Slope

Specifies the edge to which should be triggered.

RISING

Rising edge

FALLING

Falling edge

Interpol

1
2
4
8
16
32

(Only Meas Mode STANDARD)
Selects the number of interpolation steps used for the display of the traced waveform.

No interpolation

Interpol > 1 causes switch-on of the interpolation algorithm
This setting can be used to obtain a smoothed display in the case of few samples per period of the input signal. The maximum permissible trace length is however reduced with this setting.
Recommended with high frequencies, which allow for recording of few samples per period, only.

Trace Len

The maximum settable Trace Len is a function of the sampling rate, the interpolation value and the selected measurement mode.

Specified range: 1 µs to max. Trace Len

The following is true:

$$\text{max. Trace Len} = \frac{\text{sampling rate x Comp Fact}}{\text{sampling rate x Interpol}}$$

The memory depth is 7488 samples.

Trig Src

CHAN 1

CHAN 2

GEN BURST

(Trigger channel);
only provided in analyzers ANLG 22 kHz and DIGITAL.

Selects the source which has to trigger recording when the trigger level is exceeded. Both measurement channels - designated “coupled“ in the result window - are started synchronously so that the graphical display of the two channels is made with correct time reference.

Channel 1 triggers the measurement; if channel 2 is also measured, "coupled" is displayed in the result window.

Channel 2 triggers the measurement; if channel 1 is also measured, "coupled" is displayed in the result window.

The generator signal triggers the measurement at the beginning of the "Burst On" phase, if an appropriate generator function has been selected. (If not, no waveform is generated, the graphical display is deleted and a corresponding "press show I/O" message is displayed,
This setting ensures that the measurement starts time-synchronously with the generator burst; internal group delays are considered automatically. Thus, the selection of GEN BURST allows for determining group delays of DUTs from the graphical representation of the waveform.

Note: *Switching over from one-channel to two-channel measurement causes the channel which has been* ***measured last*** *to become the trigger channel.*

SPEAKER

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.15 Protocol Analysis

This measurement function is only available with option UPL-B21 (Digital Audio Protocol) installed.

The protocol function is no conventional measurement function but allows for display of the channel status and user data for the AES/EBU interface. The setting is made in the DISPLAY panel (cf. 2.10.8).

2.6.5.16 Measurement of Digital Input Amplitude

In the UPL the measurement of the digital input amplitude is not selected as a measurement function but as an input display (INPUT DISP). To do so the measurement mode COMMON/INP has to be set (see 2.6.5.18 INPUT).
This has the advantage that the input amplitude can be indicated *simultaneously* with the display of the common measurement function.

2.6.5.17 Measurement of Phase between Digital Input and Reference Signal

In the UPL the phase measurement between DIG IN and REF IN is not selected as a measurement function but as an input display (INPUT/PHAS). To do so the measurement mode JITTER/PHASE has to be set (see 2.6.5.18 INPUT).
This has the advantage that the phase is displayed *simultaneously* with the measured jitter value.

2.6.5.18 INPUT Display

Available in all three analyzers.

INPUT DISP

Not provided in the digital analyzer in Meas Mode JITTER/PHAS.

OFF

Input display switched off

PEAK

Display of the input peak value as a numeric value
In the **digital analyzer,** the input signal is sampled with the rate specified by the user (see 2.6.3).
In the **analog analyzers,** the input signal is, after the input level stage, sampled with the following sample rates:

- ANLG 22 kHz with 48 kHz
- ANLG 110 kHz with 307.2 kHz

The input peak measurements mainly serve for checking the maximum input, indicating the peak values of the AC-coupled input signal before the filters.

Exception: *With the analog notch filter switched on in the analog measurement functions RMS, RMS SELECT, QPEAK or FFT, the input peak value is detected after the notch filter.*

RMS

Display of the analog RMS value. Only provided in the analog analyzers and only effective with the measurement functions THD, TDH+N/SINAD, MODDIST, DFD and FFT; can also be displayed as sweep curve (DISPLAY – TRACE A → INP RMS CH1/2).

DIG INP AMP

Provided *only* with Jitter option (UPL-B22) in Meas Mode COMMON/INP.
Display of digital input amplitude at selected digital input (XLR or BNC) This measurement can be performed simultaneously with any measurement function of the COMMON signal.

INPUT/PHAS

Provided *only* with Jitter option (UPL-B22) in Meas Mode JITTER/PHAS.

OFF

Input display switched off.

PEAK

Display of input peak value (see INPUT DISP).

PHAS TO REF

Display of the frame phase of the jittered signal between AUDIO and REF input. This measurement can be performed simultaneously with any measurement function of the JITTER signal.

INPUT DISP → PEAK or RMS

Unit Ch1/2 (see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference (see 2.6.5.1 Common Parameters of Analyzer Functions)

INPUT DISP → DIG INP AMP

Unit Ch1/2 (see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference (see 2.6.5.1 Common Parameters of Analyzer Functions)

DIG OUT AMP

The measured value is referenced to the digital signal level set in the digital generator, i.e. to
- Unbal Vpp, if the UNBAL input is selected,
- Bal Vpp, if the BAL input is selected.

INPUT/PHAS → PHAS TO REF

Unit Ch1/2 Units: UI | %FRM | ºFRM | ns

Since no relative units are used, a reference command is not offered.

2.6.5.19 Frequency Measurement

With the menu item FREQ/PHASE, which is part of the superordinate functions of the ANALYZER panel, five measurement modes can be selected:

OFF	No frequency measurement, therefore faster function measurement
FREQ	Frequency measurement on both channels
FREQ&PHASE	Frequency measurement on channel 1, phase measurement between channel 2 and 1
FREQ&GRPDEL	Frequency measurement on channel 2, measurement of group-delay or continuous phase between channel 2 and 1
SAMPLE FREQ	Display of input sampling frequency (on both channels)

Table 2-35 Frequency measurement

Instrument	Functions in combination with frequency measurement																
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD +N	MOD DIST	DFD	Wow &FL	FFT	Polarity	Filter simul	Coher	Rub& Buzz	1/3-Octave	WAVE - FORM
ANLG 22 kHz	√	√	n	n	n	√	√	n	n	n	√	n	n	n	√	n	n
ANLG 110 kHz	√	√	-	-	n	√	√	n-	n	-	√	n	n	-	√	-	n
DIGITAL	√	√	n	n	n	√	√	n	n	n	√	n	n	n	-	n	n

√ valid frequency-measurement result
- function measurement not possible (function not available in this instrument)
n no frequency measurement result possible or useful (Display "-----")

The measuring time cannot be selected for the frequency measurement; if possible, the frequency information is obtained by the selected function measurement using various methods:

1. With the two RMS measurements (without POST FFT), it is derived from the number of zero crossings.
2. With other measurements (even OFF function) it is derived from the FFT.

The 1st procedure offers the advantage of high measuring speed, while the 2nd method supplies accurate measured values even with very poor signal-to-noise ratio and/or high frequencies. Thus, the user may optimize frequency measurement for his test signal by selecting the appropriate function - unless a specified function has to be measured, simultaneously:

1. RMS function (without POST FFT) for signals with high signal-to-noise ratio with low to medium frequencies.
2. FFT function or RMS with POST FFT or Function OFF for signals with low signal-to-noise ratio and without low frequencies.

The RMS function allows for increasing the accuracy of frequency measurement by switching on the POST FFT. With POST FFT switched on the frequency measurement result is derived from the FFT if the frequency drops below a lower cut-off frequency - irrespective of an optional spectrum display (menu item "OPERATION" in the DISPLAY panel). This lower cut-off frequency of the FFT is 4 times the FFT resolution and can thus be modified by the user via the FFT size (see 2.6.5.2 RMS).

The measuring accuracy of ***the FFT-based frequency measurement*** depends on the following parameters

- *Window function:* The RIFE VINCent windows 1 or 2 are suited best.
- *FFT-Size*: as high as possible, best 8192

- *Zoom-FFT*: although switching on Zoom-FFT increases the measuring time (just like a big FFT size), the resolution and accuracy are improved (particularly with low frequencies).
- *Zoom factor*: set by selection of "Span". The smaller the span, the larger the zoom factor and the better the frequency resolution and accuracy.
  Note: "Span" and "Center" must be selected such that the desired measurement range from Start to Stop is covered.
  Recommendation: Excellent measurement accuracy can already be obtained with a zoom factor of 2 without the need for limiting the frequency range of the instrument. To this end, "Center" must be set to "Span / 2".

Example: Configure the FFT as indicated below in the measuring range ANLG 22 kHz:

FFT Size	8192
Window	RIFE VINC 2
Avg Count	1
Zooming	ON (2 to 128)
Center	11.975 kHz
Span	21.94 kHz

Thus, measurement range and resolution are obtained:

Zoom Factor	2
Start	6.25 Hz
Stop	21.938 kHz
Resolution	2.9297 Hz

Note: *With Function OFF, the frequency measurement is performed according to the FFT settings described in the example.*

Meas Time

Definition of measurement time and precision of the frequency measurement for the measurement functions OFF and RMS. Does not influence the other measurement functions.

FAST

The frequency measurement (for the measurement function OFF also the phase measurement) is set to attain optimum speed:

RMS: The measurement may be performed without post FFT; the frequency is determined on the basis of the number of zero crossings, unless the user actually switches on post FFT.

OFF: The measurement is performed at reduced FFT size (4 k FFT) and without zooming, which makes it around four times faster than the PRECISION measurement.

PRECISION

The frequency measurement (for the measurement function OFF also the phase measurement) is set to attain optimum precision:

RMS: Post FFT (8 k FFT, without zoom) is switched on automatically to obtain a more precise measurement result.

OFF: The measurement is performed at maximum FFT size and with zoom (factor 2) switched on. For low frequencies an additional measurement is performed using an increased zom factor.

Unit Ch1/2

Selection of the result units for channel 1/2.

With frequency measurement, the (display) units for both channels can be selected individually, in order to display one channel as absolute quantity and the other one with any reference, by way of example.

Selectable units:

Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Refer to Section 2.4 Units, for conversion formulae and the notation of the measurement result display for IEC/IEEE-bus control.

Ref Freq

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Freq Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.20 Combined Frequency, Phase and Group Delay Measurement

Only for the analyzers ANLG 22 kHz and DIGITAL in two-channel mode
(Channel(s) 1&2 | 1≡2 | 2≡1 | BOTH)

Table 2-36 Availability of phase/group-delay measurement

Instrument	Functions in combination with phase measurement																
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD +N	MOD DIST	DFD	Wow &FL	FFT	Polarity	Filter simul	Coher	Rub& Buzz	1/3-Octave	WAVE - FORM
ANLG 22 kHz	√	n	n	n	n	n	√	n	n	n	√	n	n	n	n	n	n
ANLG 110 kHz	n	n	-	-	n	n	n	n	n	-	n	n	n	-	n	-	n
DIGITAL	√	n	n	n	n	n	√	n	n	n	√	n	n	n	-	n	n

√ valid result of phase and group-delay measurement
- function measurement not possible (function not available in this instrument
n no result of phase or group-delay measurement possible or useful (display "-----")
(BRM) base rate mode: standard in option UPL-B2, selectable in option UPL-B29 (digital audio 96 kHz)
(HRM) high rate mode selectable in option UPL-B29 (digital audio 96 kHz) only
(1) only possible if no filters are selected and 'Meas Time' is set to VALUE or GEN TRACK
(2) only with zooming switched off

The phase difference is obtained in the phase measurement from the signals of channels 1 and 2. The phase-measurement results are in the 0 to 360° and -180 to +180° ranges. With frequency sweep running, however, the phase may be continuously measured, ie outside the 360° and -180° limits (continuous phase measurement), provided certain conditions are fulfilled (see group-delay measurement).
For continuous phase measurement select GROUP DELAY and a phase unit.

The signal of channel 1 is used as reference signal.

Note: *The result of the phase measurement is derived from the FFT or POST FFT. If phase or group-delay measurements are performed in conjunction with RMS function, switch-on of the POST FFT is forced, therefore; the frequency-measurement result is derived from the POST FFT, also, provided that the frequency is above the lower cut-off frequency of the FFT (4-fold resolution due to bell-shaped DC offset). The POST FFT may be displayed as spectrum but this is not a must (menu item OPERATION in the DISPLAY panel).*

For ***group delay measurements,*** the phase is differentiated with respect to the frequency, ie the differential quotient is evaluated:

$$\tau_2 = \Delta\varphi / (2\pi \times \Delta f) \qquad \Delta\varphi = \varphi_{2meas} - \varphi_{1meas}$$

For ***continuous phase measurements,*** the difference of two consecutive phase-measurement results is added to the first phase-measurement result:

$$\varphi_2 = \Delta\varphi + \varphi_1 \qquad \Delta\varphi = \varphi_{2meas} - \varphi_{1meas}$$

Both measurements are available in the GROUP DELAY menu item. They are only defined for *changes* in the frequency and therefore only make sense in conjunction with frequency sweeping. If they are attempted at a constant frequency, an error message will be issued.

If a frequency sweep is to be set for measuring group delay or continuous phase, the following should be noted:

- Select the frequency step size and/or the number of sweep points such that phase shifts exceeding 180° between 2 subsequent sweep points cannot occur.
- Spacing should be linear, since, with logarithmic spacing, the frequency increments could be too small with low frequencies and the phase shift could be too large with high frequencies.

When measuring the group-delay versus frequency (e.g., by means of a generator frequency sweep), the first sweep point is not defined, respectively, since a reference point for calculation of the delta values of frequency and phase is not available before obtaining the 2nd frequency value.

Unit Ch1/2

Selection of units for the measurement for channel 1 and 2.

Selectable units for the frequency measurement (channel 1):
Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Selectable units for the phase measurement (channel 2):
° | RAD | Δ° | ΔRAD

Selectable units for group-delay measurement (channel 2):
s | Δs

***Note**: Continuous phase is obtained by selecting* ° *or* RAD *under GROUP DELAY.*

Refer to section 2.4, Units, for conversion formulae and notation of the measurement result display units for IEC/IEEE-bus control

Ref Freq

(See 2.6.5.1 Common Parameters of Analyzer Functions)

Format Pha

(Format phase) Displayed range of phase values:

0 ... 360°	from 0 to 360°; selectable, if UNIT CH2 ° | Δ°
-180 ... + 180°	from -180° to +180°; selectable, if UNIT CH2 ° | Δ°
-360 ... 0°	from -360 to 0°; selectable, if UNIT CH2 °|Δ°
0 ... 2 Π	from 0 to 2π; selectable, if UNIT CH2 RAD | ΔRAD
-Π ... +Π	-π to +π ; selectable, if UNIT CH2 RAD | ΔRAD
-2 Π ... 0	from -2π to 0; selectable, if UNIT CH2 RAD | ΔRAD

***Note**: Continuous phase representation (-∞ to +∞) is possible under GROUP DELAY if a phase unit is selected instead of the usual time unit.*

Ref Phase	(See 2.6.5.1 Common Parameters of Analyzer Functions)
Freq Settl	(See 2.6.5.1 Common Parameters of Analyzer Functions)
Phas Settl	(See 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.21 Measurement and display of analyzer sampling frequency

Only available in the digital analyzer.

When selecting SAMPLE FREQ, the measured sampling frequency is displayed on the channels switched on (or in the frequency window of the JITTER/PHAS or COMMON MODE measurement). Irrespective of the selection of menu item FREQ/PHASE, the sampling frequency is always measured internally and can also be displayed in the PROTOCOL panel (provided that option UPL-B21 is fitted).

Unit Ch1/2

Selection of the result units for channel 1 and 2.

Selectable units for the sampling rate:
Hz | ΔHz | Δ%Hz | Toct | Oct | Dec | f/f_r

Refer to Section 2.4 Units for conversion formulae and notation of the measurement result display units for the IEC/IEEE-bus control.

Ref Freq

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Freq Settl

(see 2.6.5.1 Common Parameters of Analyzer Functions)

2.6.5.22 Coherence Measurement and Transfer Function

This function can only be selected with built-in option UPL-B6 (Extended Analysis Functions).
It is limited to the DIGITAL and ANLG 22 kHz instruments.

The analyzer calculates the transfer function CH1/CH2 (Trace A) and the coherence function (similarity, Trace B) of two signals. In the DISPLAY panel graphical or numerical display of the coherence can be switched on (under menu item OPERATION). The graphics display is in accordance with the parameters set in the DISPLAY panel. The section to be displayed (X and Y direction) can be selected independent of the frequency range selected in the ANALYZER panel.

Measurement method:

The complex FFT is calculated for each channel, the two channels being measured at exactly the same time. The cross-correlation between the two FFTs is formed and averaged. The square of the cross-correlation is divided by the averaged size of the individual FFTs; the coherence result is thus independent of the selected measurement ranges.

$$\gamma^2 = \frac{\left|\sum \text{Kanal1} \otimes \text{Kanal2}\right|}{\sum\left|\text{FFT(Kanal1)}\right| \cdot \sum\left|\text{FFT(Kanal2)}\right|} \qquad \text{where} \quad 0 \le \gamma^2 \le 1$$

$\gamma^2 = 1$ means that at this frequency channel 2 is linearly dependent on channel 1. The accuracy of the measurement increases with the number of averaging performed.

The transfer function is calculated as follows:

$$H(z) = \frac{\sum \left|FFT(Kanal1)\right|}{\sum\left|FFT(Kanal2)\right|}$$ relevant standard: ANSI S3.42-1992

Application:

The coherence measurement function uses test signals which cover the entire audio spectrum; it is therefore recommended to set the generator to noise (both in terms of time and frequency).
The generator signal should be applied simultaneously to the input of the DUT and the analyzer channel 2 (reference channel). The output of the DUT is connected to analyzer channel 1 (measurement channel).

Note: *The coherence measurement performs complex calculations and requires synchronous two-channel input signals. This brings about some limitations:*

- *The coherence function is only available for the instruments DIGITAL and ANLG 22kHz.*
- *Since the coherence measurement is a comparative measurement between channel 1 and channel 2, both channels must be active.*

In contrast to other measurements, no test result is computed in this case but two permanently assigned curves are drawn which can only be stored and loaded together (as "DUAL FILE" in the DISPLAY panel.

- Trace A (menu item FUNC CH1): transfer function CH1/CH2
- Trace B (menu item FUNC CH2): coherence result γ^2

The number of averagings performed *n* is displayed in relation to the number of averagings desired *m*.

averaging *n of m*

Unit

Selects the display unit for the transfer function; % or dB can be selected.

The selected unit is also used as standard for the spectrum in the DISPLAY panel, but it can be overwritten by an entry in the menu item "Unit" of TRACE A in the DISPLAY panel.

Chan Delay

(Interchannel delay)
Delay compensation of the DUT by entering the time by which channel 1 is to be delayed with respect to channel 2. If channel 2 has a shorter delay than channel 1, this can be compensated for by entering a negative value.

Specified range: -10 s to +10 s

FFT Size

Size of FFT, settable in steps of 2 between 256 and 8192.

256
512
1024
2048
4096
8192

A larger FFT size (i.e. more calculated points) implies a finer frequency resolution but also correspondingly longer measurement times.

Window

Selects the window function

HANN
RECTANGULAR
BLACKMAN-H
RIFE-VINC 1
RIFE-VINC 2
RIFE-VINC 3
HAMMING
FLAT TOP
KAISER

Same as with FFT

Avg Count

Number of averaging operations; the coherence function requires a great number of averaging procedures to obtain accurate results. Averaging numbers above 30 are recommended.

Start

(Display only, no changes possible)
Display of lower measurement limit in Hz or kHz; since no zoom FFT is to be performed here, the lower limit is always 0 Hz.

Stop

(Display only; no changes possible)
Display of upper measurement limit in Hz or kHz.

Resolution

(Display only; no changes possible)
Display of spacing between FFT lines in Hz or kHz.
Specified range: 5.8598 $\times$ 8192 / FFT Size

Note: *A normalization factor can be entered for Trace A (transfer function) in the DISPLAY panel (or transferred from the cursor position). Thus the transfer function can be set to 0 dB at any position.*

2.6.5.23 Loudspeaker Measurements (RUB & BUZZ)

This item can only be selected with built-in option UPL-B6 (extended analysis functions) and is offered in the analog analyzers only.

***UPL-B29**: In the high rate mode, the RUB&BUZZ measurement is not available.*

Loudspeaker measurements can only be performed with the internal universal sinewave generator. When the RUB & BUZZ item is selected, suitable ***generator*** setting is automatically performed, if applicable.

INSTRUMENT	ANALOG
FUNCTION	SINE
Low Dist	OFF

Loudspeaker measurements are made up of different measurements some of which can be performed simultaneously. Measurements performed:

- **RUB & BUZZ measurement** with fixed or tracking highpass filter or a combination of the two,
- *simultaneous* **frequency response measurement,**
- **polarity measurement** of the loudspeaker at the end of a sweep or single measurement.

Connecting the test equipment:

The UPL generator is connected to the loudspeaker or - in the case of high signal levels - to a power amplifier.
The precision microphone is connected to one or both test inputs of the UPL analyzer - possibly via an amplifier - depending on the measurement range (see below).

The RUB & BUZZ measurement is always performed in channel 1, the measurement result is available as the result of channel 1 (SENS1:DATA1)
The (unfiltered) frequency response measurement result is available

- in the 22 kHz analyzer as measurement result in channel 2 (SENS1:DATA2)
- in the 110 kHz analyzer as input RMS value in channel 1 (SENS2:DATA1).

The polarity measurement result is displayed as a phase value (SENS4:DATA).

The mentioned measurements can be performed in both analog analyzers, but there are certain differences with a view to operation and connections:

	ANLG 22 kHz	**ANLG 110 kHz**
Connection of precision microphone:	To both measurement channels in parallel	to measurement channel 1
Channel selection	One or two channels; any selection is possible	single-channel only CH1 only
Activation of **RUB&BUZZ measurement:**	Activation of channel 1: Channel(s) 1, 1&2, 1≡2 or 2≡1	Permanently active
Activation of **frequency response measurement:**	Activation of channel 2: Channel(s) 2, 1&2, 1≡2 or 2≡1	Activation of Input Disp RMS
Activation of **polarity measurement:**	FREQ/PHASE → FREQ&PHASE FREQ/PHASE → FREQ&GRPDEL	FREQ/PHASE → FREQ
Deactivation of **polarity measurement:**	FREQ/PHASE → OFF FREQ/PHASE → FREQ	FREQ/PHASE → OFF

RUB & BUZZ measurement

This measurement is used to detect manufacturing faults in loudspeakers, which are audible as non-harmonic noise or high harmonics. Since even a properly functioning loudspeaker produces k2 and K3 harmonics, THD+N measurements are not suitable in this case. A measurement function is required instead, which not only suppresses the fundamental but also the next higher harmonics and measures only the residual signal.

The method used here measures the RMS value after a highpass which filters out all "legal" harmonics. Depending on the application, the passband frequency

- is set to a fixed frequency,
- tracks the n-fold generator frequency,
- fulfills a combination of both.

Frequency response measurement:

The frequency response measurement corresponds to an RMS measurement without filter. In the ANLG 110 kHz instrument the accuracy of the RMS measurement is however not fully attained because the measurement time of the input RMS result is not matched to the signal period.

Polarity measurement:

This polarity measurement is tailored to measurements of the loudspeaker *chassis*. It is *not* suitable for measuring loudspeaker *systems* and should not be confused with the POLARITY function for measuring electrical systems such as frequency filters.

The polarity measurement is switched on via the FREQ/PHASE menu item, which is at a higher level than the measurement function (see table further up).

Same as with the POLARITY measurement function, the measured value is indicated with "+ Pol" for correct polarity and "- Pol" for incorrect polarity. In the case of remote or automatic sequence control, a positive numeral is read out for correct polarity and a negative one for incorrect polarity. This numeral also yields a measure for the reliability of the measurement result. The higher the magnitude of the measured value, the more reliable the correct/incorrect polarity criterion. With values between -1.5 and +1.5 the test setup and device settings (e.g. delay) should be checked.

Optimizing the measurement speed:

This measurement function was implemented especially for production tests, i.e. for the purpose of high measurement speed. To ensure the full use of all capabilities the following should be observed:

ANALYZER panel:		
Range	FIX	
FREQ/PHASE	OFF	(if a polarity measurement is *not* required)
Meas Time	GENTRACK	
Sweep Mode	FAST or BLOCK	(if a generator sweep is performed)
OPTIONS panel:		
Beeper	OFF	
Meas Disp	OFF	
Switch off graphics cursor		
Switch off graphics display (3-panel display)		(if only results are required)

The settling time of the filters can also be shortened, but this reduces the measurement accuracy. This is done via the call parameter when the UPL is started:

-tfilxx.yy

xx and yy are factors for modifying the settling time
11 to 99: Settling time shortened to 0.9 to 0.1

1 to 9 Settling time extended by 10 to 1.1
xx: reduces the settling time of an optional lowpass filter
yy: reduces the settling time of the standard highpass filter

Example: if UPL is started with

UPL -tfil99.30,

(standard value), the settling time of the optional lowpass filter is reduced to 10% and that of the standard highpass filters to 25% of the theoretical value.

Meas Time

(Measurement time)

The measurement time of the RUB & BUZZ measurement is used to adapt the measurement speed to the signal frequency. In most cases - particularly in the case of sweeps - the selection of GEN TRACK is recommended since RUB & BUZZ assumes the use of the internal function generator.

AUTO FAST
AUTO

Automatic matching of the measurement time to the signal frequency taking into account the signal period. This is only useful when an unknown signal frequency is used or the generator frequency modification cannot be accepted, which is unavoidable in the case of GEN TRACK. (see 2.6.5.2 RMS)

VALUE

Numerical entry of desired measurement time. This is only useful when an unknown signal frequency is used or a very weak signal is to be measured. (see 2.6.5.2 RMS)

GEN TRACK

Measurement taking up (at least) one whole generator signal period. If required, the generator frequency can be adapted to the analyzer sample rate. To increase the measurement accuracy in the case of high frequencies, the measurement time is extended to several periods.
This mode guarantees maximum accuracy at a minimum measurement time and should be given preference. (see 2.6.5.2 RMS)

Unit Ch1/2

Selects the units for the RUB & BUZZ measurement results in channel 1 and channel 2.

Reference

Reference values for the RUB & BUZZ measurement.

FREQ MODE

Determines the highpass filter type

FIX

A fixed highpass filter is used; the numeric value of the passband frequency is entered in the menu line below.

GEN TRACK

(Generator tracking)
A tracking highpass filter is used which should preferably be tuned to about the 5th harmonic of the generator frequency. The multiple by which the passband frequency should be higher than the generator frequency can be entered under "Factor" in the next menu line.
The frequency limits, within which tracking of the filter frequency should be performed, can be selected in addition. When a limit is reached (FrqLim Low or Upp) the filter frequency is held at this frequency. Thus a tracking highpass filter can be produced which becomes a fixed-frequency highpass filter below FrqLim Low and/or above FrqLim Upp.
If tracking should be performed over the entire frequency range, the frequency limits should be set to the minimum and maximum value.

Factor

Specifies the factor by which the passband frequency should be higher than the generator frequency. For the Rub & Buzz measurement a factor of approx. 5 would be appropriate.

Specified range: 2 to 20

When the product of generator frequency and factor reaches
- the FrqLim Upp value, the highpass filter is held at this frequency
- the upper frequency limit of the analyzer, Rub & Buzz is not carried out and an error message ("Input? Press Show IO") is displayed instead. The remaining measurement (transfer function in the other channel or below Input Disp) is performed at a higher speed.

Sweep Mode

This menu item is used to increase the speed of frequency sweeps performed with the built-in universal generator.
To increase the sweep speed the following ***conditions*** have to be met by the ***Generator:***

- Function SINE
- Low Distortion OFF
- Sweep control AUTO ...
- X axis FREQ
- Z axis OFF

Operation:
The 1st sweep is performed at the speed of the NORMAL setting. During this sweep the filter and generator parameters to be used for the subsequent sweeps are learned and stored (learn mode).
As long as no new settings are made on the instrument, the FAST and BLOCK mode selected as from the 2nd sweep (play mode) can use the learned parameters. This considerably shortens the setting times for the individual sweep points.
If the start key is pressed or a setting is made on the instrument, the (slower) learn mode is selected again.

***Note**: In the play mode, measured values are not indicated on the result display for reasons of speed. Exception: polarity measured at the sweep end.*

NORMAL

Normal sweep trigger without additional speed optimization; can be used for any kind of sweep.
This setting is used internally whenever one of the conditions for optimized sweep synchronization is not met, likewise in the learn mode (see below).

FAST

In 22 kHz analyzer only; speed optimization of sweep without operational restrictions. Measured values are not displayed for reasons of speed.

BLOCK

The sweep sequence is further optimized, however, the instrument cannot be operated with sweeping. Pressing one or more keys stops the current sweep run; the key reactions are then made up for.
If no setting was made on the instrument, a stopped sweep may be continued without being switched to the LEARN mode anew by means of pressing the START or the CONT key (continuous sweep) or SINGLE (single sweep).
The measured values are not displayed in order not to reduce speed; the traces are not displayed until the end of sweep.

***Note**: Settling cannot be switched on in the block mode.*

Filter

(See **2.7 Analyzer Filters (FILTER Panel)**)
Two (digital) filters can be selected in addition to the standard highpass filter.

Use: *Lowpass filter for band limiting (particularly in the ANLG 110 kHz instrument), delay filter for extending the settling time, bandstop filter for eliminating interfering lines, etc.*

Note: *Same as the standard highpass filter, the filters selected here are only active for measurement channel 1. Channel 2 (in 22 kHz analyzer) and the input RMS of channel 1 (in 110 kHz analyzer) are measured without filter.*

FrqLim Low

With FREQ MODE → GEN TRACK only; lower band limit for tracking the frequency of the highpass filter.

If the product of generator frequency and factor drops below the value specified here, the passband frequency of the highpass filter is held at this value.

Specified range:
ANLG 22 kHz: 10.0 Hz to 21.938 kHz
ANLG 110 kHz: 20.0 Hz to 120 kHz

FrqLim Upp

With FREQ MODE → GEN TRACK only; upper band limit for tracking the highpass filter frequency.

If the product of generator and factor exceeds the value specified here, the passband frequency of the highpass filter is held at this value.

Specified range:
ANLG 22 kHz: FrqLim Low to 21.938 kHz
ANLG 110 kHz: FrqLim Low to 120 kHz

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

In the 22 kHz analyzer, the (residual) Rub & Buzz signal in channel 1 and the unfiltered signal in channel 2 can be monitored. This is done by selecting FUNCT CH1 or CH2 provided the selected channel is also active as a measurement channel.

If the Rub & Buzz signal exceeds the bandwidth of the employed analyzer, the monitoring output FUNCT CH1 is muted to avoid noise during sweeps, which would degrade the measurement of Rub & Buzz.

2.6.5.24 Third Analysis (1/3 OCTAVE)

This selection is only available in combination with Option UPL-B6 (Extended Analysis Functions). It is generally not available with the 110 kHz analyzer.

***UPL-B29**: In the high rate mode (see 2.15.9 Selecting the Sampling Mode), 1/3-octave analysis is available in the analog analyzer only.*

With the third analysis, the levels in up to 32 third-octave bands are measured simultaneously. The analysis is performed according to standard IEC 1260 of 1995 with level accuracy of class 0 (± 1,0 dB).

The bandwidth of a third-octave band relative to the band center is $\sqrt[6]{2} - \frac{1}{\sqrt[6]{2}}$ (= 1/3 octave). The third-octave filters are designed as 4th-order Chebychev filters. The reference frequency of 1 kHz is used as a basis for calculating all the other center frequencies of the band.

The third-octave bands to be measured are selected by entering lower and upper frequency limits. A separate RMS value is determined for each third-octave band and displayed either graphically or numerically. The total RMS value for all the selected third-octave bands is displayed. If necessary, it can also be displayed as a bar graph or (for specialist applications with frequency sweep) a curve plot.

The precisely calculated third-octave bands are used as a basis for the *measurement*. The nominal band center frequencies are rounded to two or three significant digits and used for the *numeric representation* of the thirds (operation SPECTR LIST). With the *graphic representation* (operation SPECTRUM), only the octaves are labelled as space is limited.

The measurement range of the third analysis begins at the nominal band center frequency of 16 Hz (15.87 Hz) and ends at 20 kHz. The total bandwidth ranges from 14.1 to 22449.2 Hz, that is the total audible range.

Third analysis in UPL is performed for one channel only. Dual-channel measurements should normally be avoided, as the multiplexing that is required makes continuous measurement of both channels impossible and the channels therefore have to settle to steady state each time a single measurement has been performed. However this measurement mode may be suitable for single measurements with long measurement times. Of course both traces may also be used also for single-channel measurements, eg trace B for displaying a comparison spectrum. If two traces are used, the thirds are superimposed, which gives a very clear picture on a colour display: the overlaying portions of the two traces are displayed, as in other measurements, a mix of the colours used.

Pink noise, which can also be generated by the UPL, is recommended as *trigger signal* for the third analysis. Unlike white noise, its level roll-off of $\sqrt{1/f}$ compensates for the apparent level increase encountered with third analysis, which results from the absolute bandwidth increasing as the frequency increases.

Line Count

Determines the number of thirds which can be measured and displayed. The number was 30 up to software 2.02. A (continuous) reduction of thirds is also possible without this menu item by simply entering "FrqLimLow" and "FrqLimUpp". This menu item is prinicipally provided to maintain compatibility.
Maximum 30 thirds can be calculated and displayed. The lowest third which can be measured has a nominal center frequency of 25 Hz

30

"30" is mainly required to maintain compatibility with earlier written remote and sequence control programs.

32

In addition, 2 low-frequency thirds, i.e., maximum 32 thirds, can be calculated and displayed. The lowest third which can be measured has a nominal center frequency of 16 Hz.
"32" should be set with writing any new remote and sequence control programs and setups.

Meas Time

(Measurement Time)

VALUE

The only parameter determining the measurement speed is the measurement time, which is entered as a numeric value. To minimize measurement uncertainties, the selected measurement time is rounded to integer multiples of 512 samples, which corresponds to a step width of approx. 10.6 ms for the analog analyzer (internal sampling rate 48 kHz). For long-time measurements, measurement times of up to 12 hours can be selected.

The measurement time also determines the update rate of the third analysis. Shorter measurement times lead to results being displayed faster but for shorter times. Each time the selected measurement time elapses, the *third* results are updated. No intermediate results are displayed. The update rate of the measurement result can be reduced by entering the "reading rate" in the OPTIONS panel. If the selected measurement time is too short, the lower third measurement results become inaccurate ("noisy"). If the measurement results are of considerably more interest than the graphic representation, the selected measurement time should be long enough to yield sufficiently accurate measurement results for even the lowest third that is required.

Specified range:

ANLG 22 kHz: 10.67 ms to 720 min (12 h)
DIGITAL: 512 / f_{sample} to 720 min

Units: s | ms | µs | min

Note: *The measurement time of the first measurement is increased by the settling time of the slowest third octave filter. To reduce this delay the "frequency limit low" can be raised. Thus the calculation, delay and display of the lower tird octaves are obmitted.*

Max Hold

Hold function for the maximum result of each third. The function can be turned off. Reset by pressing the START key. Just like the measurement results of the thirds, the max-hold values can be displayed either graphically as horizontal markers in the spectrum or numerically in a spectrum list. They are available via auto and remote control. To present numerical results, switch on Scan #2 (PgUp or PgDn key). Graphically the maximum values are indicated by narrow horizontal lines at the top of the associated third bars.

OFF Max-hold function switched off; only the third bars are displayed.

FOREVER Max-hold function switched on; the markers lie on the maximum values; reset only by starting the measurement (START key).

SLOW DECAY Max-hold function switched on; the markers lie on the maximum values for the "hold time" to be set in the following line and then decay exponentially (time constant 0.5 s).

FAST DECAY Max-hold function switched on; the markers remain on the maximum values for the "hold time" to be set in the following line and then go back to the current measurement value for the third.

***Note**: The counter for the hold time is reset and restarted whenever a new maximum value occurs. Each third has its own counter, so each marker can move independently.*

Hold Time

Only for Max Hold --> SLOW / FAST DECAY

Setting of the time for which the maximum value of a third is held before the marker returns to the measured value. The selected hold time does not influence the decay time.

Unit Ch1/2

(See 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(See 2.6.5.1 Common Parameters of Analyzer Functions)

GEN TRACK is not available for third analysis, as this analysis is usually triggered by noise signals (eg pink noise), for which generator tracking is not defined.

Filter

(See 2.7 Analyzer Filters (FILTER Panel))

One standard or user-defineable filter can be selected.

***UPL-B29**: No filter can be switched on in the high rate mode.*

FrqLim Low

Lower band limit for third analysis. The representation and calculation of the third bands start with the band containing the lower limit frequency. Any signals below the lowest third band will not be included in the calculation of the total RMS value. The higher the lower limit frequency, the faster the signal will settle and the shorter the time for first measurement.

Specified range: depends on "Line Count" (values in brackets apply for 30 lines)

ANLG 22 kHz: 14.254 Hz (22.627 Hz) to 21.938 kHz
DIGITAL: 14.254 Hz (22.627 Hz) to f_{max}
f_{max} depends on the sampling rate and does not exceed 22 449 Hz

Note**:* *In single measurement mode (e.g. frequency sweep), all third octave filters must have settled prior to starting the measurement. Thus the measurement time for **each** single measurement is increased by the the filter delay. In order to reduce filter delay only as many low-frequency thirds should be measured as required by the measuring task. FrqLim Low should be set **as high as possible

FrqLim Upp

Upper band limit for third analysis. The representation and calculation of the third bands ends with the band containing the upper limit frequency. Any signals above the top third band will not be included in the calculation of the total RMS value. Frequency limit upper does not affect the measurement time.
Specified range:

ANLG 22 kHz: FrqLim Low to 21.938 kHz
ANLG 110 kHz: FrqLim Low to f_{max} f_{max} depends on the sampling rate and does not exceed 22 449 Hz

SPEAKER

(See 2.6.6 Headphone/Speaker Output)

The input signals of channel 1 or channel 2 (without filter) can be monitored.

2.6.5.25 12th OCTAVE Analysis (12th OCTAVE)

This selection is only available in combination with Option UPL-B6 (Extended Analysis Functions). It is generally not available with the 110 kHz analyzer.

***UPL-B29**: In the high rate mode (see 2.15.9 Selecting the Sampling Mode, 12th octave analysis is available in the analog analyzer (ANLG 22 kHz),only.*

With the 12th octave analysis, the levels in up to 125 frequency bands can be measured simultaneously. In contrast to the third analysis, the levels of the individual frequency bands are not measured using narrow-band bandpass filters but by means of a special zoom FFT integrating the FFT bins in the individual bands (frequency lines).

The **advantages compared to the third analysis** are a higher resolution and the dual-channel measurement which allows for considering a reference signal in addition to the measurement signal at the same time.

The **disadvantage compared to the third analysis** is the rough stepped measurement time which is an integer multiple of the FFT measurement time. Moreover, monitoring without gaps cannot be guaranteed. However the monitoring gaps are not critical with most applications, in particular, if a reference signal is determined simultaneously on the 2nd channel.

The bandwidth of a 12th octave band relative to the band center is $\sqrt[24]{2} - \frac{1}{\sqrt[24]{2}}$ (= 5.77%).

The reference frequency of 1 kHz is used as basis for calculating all the other center frequencies of the band by multiplication or division $\sqrt[12]{2}$. The nominal band center frequencies are derived from standard DIN 323.

The frequency bands to be measured are selected by entering lower and upper frequency limits. A separate RMS value is determined for each selected frequency band by integrating all FFT bins of this band and is then displayed either graphically or numerically. The total RMS value for all the selected frequency bands is displayed. If necessary, it can also be displayed as a BAR GRAPH or (for specialist applications with frequency sweep) a CURVE PLOT.

The measurement range of the third analysis begins at the nominal band center frequency of 16 Hz (15.87 Hz) and ends at 20 kHz. The total bandwidth ranges from 15.4 to 20586 Hz, that is the total audible range.

The precisely calculated frequency bands are used as a basis for the *measurement*. The nominal band center frequencies are used for the *numeric representation* of the 12th octaves (operation SPECTR LIST). With the *graphic representation* (operation SPECTRUM), only the octaves are labelled as space is limited.

As an alternative to the spectrum representation of the discrete frequency bands (operation SPEKTRUM) the 12th octave analysis may also be represented as curve plot (operation CURVE PLOT), if no sweep is activated. This representation provides the advantage of scaling the graphics into both directions as desired such that even small sections of the frequency range can be clearly arranged. With remote or sequence control the first measured frequency line may preferably assume the index 0 in the trace data set, whereas index 0 always refers to the frequency line 16 Hz with the spectrum representation independent of being measured or not.

Pink noise, which can also be generated by the UPL, is recommended as *trigger signal* for the third analysis. Unlike white noise, its level roll-off of $\sqrt{1/f}$ compensates for the apparent level increase encountered with 12th octave analysis, which results from the absolute bandwidth increasing as the frequency increases.

Meas Time

(Measure Time)

VALUE

The only parameter determining the measurement speed is the measurement time, which is entered as a numeric value. It is always rounded to an integer multiple of the measurement time of the used zoom FFT.

The minimum measurement time depends on the lower frequency limit selected. The lower it is set, the longer the measurement will take.

If a measurement time is entered which is longer than the minimum measurement time, several FFTs are averaged internally. Measurement inaccuracies are thus determined, on the other hand, short-time monitoring gaps occur which are usually not critical.

For long-time measurements, measurement times of up to 12 hours can be selected.

The measurement time also determines the update rate of the12th octave analysis. Each time the selected measurement time elapses, the results are updated; no intermediate results are displayed.

Specified range:

ANLG 22 kHz: $tmeas_{FFT}$ ... 720 min (12 h)
DIGITAL: $tmeas_{FFT}$ ... 720 min
$tmeas_{FFT}$ = measurement time for a zoom FFT, depending on the lower frequency limit

Units: s | ms | µs | min

Max Hold

Hold function for the maximum result of each 12th octave. The function can be turned off. Reset by pressing the START key. Just like the measurement results of the individual frequency bands, the max-hold values can be displayed either graphically as horizontal markers in the spectrum or numerically in a spectrum list. They are available via auto and remote control. To present numerical results, switch on Scan #2 (PgUp or PgDn key). Graphically the maximum values are indicated by narrow horizontal lines at the top of the associated bars of the frequency bands.

OFF

Max-hold function switched off; only the bars of the bands are displayed.

ON

Max-hold function switched on; the markers lie on the maximum values; corresponds to the "FOREVER" setting with third analysis. Reset only by starting the measurement (START key).

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Analyzer Functions)

Reference

(see 2.6.5.1 Common Parameters of Analyzer Functions)

GEN TRACK cannot be selected with 12th octave analysis, since triggering is usually initiated by noise signals (e.g., pink noise), which generator tracking is not defined for.

Filter

(see 2.7 Analyzer Filters (FILTER Panel))

Any standard or user-defined filter may be selected.

UPL-B29: *No filter may be switched on in high rate (see 2.15.9 Selecting the Sampling Mode.*

FrqLim Low

Lower band limit for 12th octave analysis. The representation and calculation of the frequency bands start with the band containing the lower limit frequency. Any signals below the lowest frequency band will not be included in the calculation of the total rms value.

The lower the lower limit frequency, the narrower the frequency bands which will have to be measured. In order not to fall below a minimum amount of bins per band, the FFT resolution and thus the zoom factor of the FFT will have to be increased with narrower frequency bands

A zoom factor higher than 2 means on the other hand, that a single measurement will not be sufficient to cover the complete frequency range. In this case, 2 measurements are performed internally for the lower and the upper frequency range and the measured values of the single measurements are combined.

The lower limit frequency thus considerably influences the measurement speed which is why it should not be selected lower than required for the measurement task.

Optimum settings for the frequency range are, e.g (analog analyzer or DIGITAL 48 kHz)

- 410 Hz to any frequency
- 205 Hz to 11172 Hz

Specified range:

ANLG 22 kHz: 15.4 Hz to 20586 Hz
DIG 48 kHz: 15.4 Hz to f_{max}
f_{max} depends on the sampling rate and does not exceed 20586 Hz

FrqLim Upp

Upper band limit for 12^{th} octave analysis. The representation and calculation of the frequency bands end with the band containing the upper limit frequency. Any signals above the top frequency band will not be included in the calculation of the total rms value.

FrqLim Upp conditionally affects the measurement speed (analog or DIGITAL 48 kHz):

- If the *lower limit frequency is above* 409 Hz, FrqLim Upp does not affect the measurement speed.
- If the *lower limit frequency is below* 409 Hz, the measurement speed is lower, if FrqLim Upp is higher than
  FrqLim Low + 10.97 kHz

Specified range:

ANLG 22 kHz: FrqLim Low to 20586 Hz
DIGITAL: FrqLim Low to f_{max}
f_{max} depends on the sampling rate and does not exceed 20586 Hz

SPEAKER

(see 2.6.6 Headphone/Speaker Output)

The input signals of channel 1 and/or channel 2 (without filter) can be monitored.

2.6.6 Headphone/Speaker Output

The Headphone/Speaker Output UPL-B5 permits to monitor both analog and digital measuring and test signals during the measurement. For this purpose, the built-in loudspeaker or the externally connected headphones are used. The impedance of the headphones should be 600 Ω so that a distortion-free operation is guaranteed even with full volume. When connecting headphones with lower impedance, distortions have to be taken into account depending on the power level. The maximum peak voltage at the headphones is 8 volts.

Principle of operation:

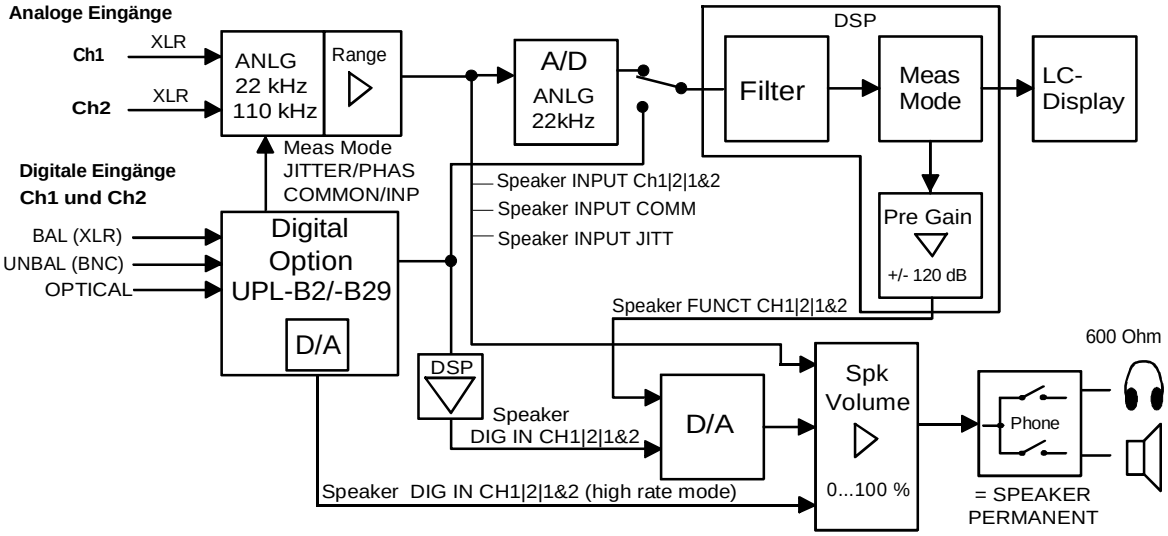


Fig. 2-28 Principle of operation of the headphones/speaker output

The input signals of all analog analyzers (INPUT) and the output signals of all analyzer level functions may serve as signal sources for the monitor output, in addition monitoring of THDN and Rub&Buzz residual signal can be switched on.

UPL-B29: Aural monitoring of residual signals is possible in the base rate mode only In the case of option UPL-B29 in high rate mode, UPL-B5 variant 03 is necessary for aural monitoring. If high rate mode is active, aural monitoring is fundamentally possible at inputs, also with Analog Analyzer 22 kHz.

Table 2-37 Monitoring realized for the analyzer functions

Functions	Monitoring possible	Output signal =
RMS, RMS Sel, PEAK, Quasi PEAK	yes (not in the high rate mode)	Filtered or unfiltered input signal
THD+N, RUB&BUZZ	yes (not in the high rate mode)	Residual signal or unfiltered input signal
DC, THD, MOD DIST, DFD, WOW & FL, FILTER SIM, COHER FFT, POLARITY, WAVEFORM, 1/3-Octave	no	Input signal

Pre Gain permits a signal variation of +/- 120 dB. This permits to boost even weak residual signals such that they can be monitored. If the AES/ EBU option is installed, the AES/EBU signal can also be monitored at the input (AES).
A level control (volume) permits setting of the volume. In the case of Phone SPEAKER, the internal loudspeaker is automatically switched off by connecting the headphones. In the case of Phone PERMANENT, only the loudspeaker is switched on and off using the Speaker-off key.

The Speaker menu is located at the end of the ANALYZER panel and linked to the measurement function, i.e. it is stored and loaded together with the function. Thus the monitoring output can be configured separately for each measurement function. For instance, a high preamplification is required for monitoring residual signals (THD+N, Rub&Buzz, RMS SEL with tracking bandstop filter) while a considerably lower preamplification is sufficient for (filtered or unfiltered) RMS measurements to avoid overdriving and excessive volumes.

To protect the user against excessive volumes (particularly when headphones are connected), the monitoring output is automatically switched off when SETUP settings are loaded, the analyzer instrument or a function is changed or the Speaker command is given. In this case the monitoring output has to be switched on again with the Speaker-off key (LOCAL key). If headphones are used, the Speaker menu should be checked prior to switching on to avoid excessive volumes increased through inadvertent gain setting ("Spk Volume", "Pre Gain").

Note: *The monitor output is designed as*

- *control output for monitoring the input signal by means of headphones or loudspeaker or for*
- *monitoring the signal using an oscilloscope, since analog signals from 20 Hz to 110 kHz can be monitored with a frequency response of ±0.2 dB and digital output signals. Due to noise sidebands of the internal PLL of option UPL-B5, a THD + N measurement does not provide the excellent data usually supplied by the measuring path of the UPL (distortion ≤-60 dB above the frequency range from 20 Hz to 110 kHz). However, these non-harmonic interfering signals are inaudible due to the psychoacoustic masking effect of the human ear.*

ANALYZER panel

SPEAKER Monitor output

OFF	Monitor output is switched off
INPUT Ch1	Monitoring the input signals of the analog analyzers ANLG 22 kHz and ANLG 110 kHz on channel 1. The signal is applied to both output channels.
INPUT Ch2	... on channel 2
INPUT Ch1&2	Monitoring the input signals of the analog analyzers ANLG 22 kHz and ANLG 110 kHz on channel 1 and channel 2 (stereo operation). If channel 1 or channel 2 are selected as analyzer input, only the left-hand or right-hand phones output can be monitored correspondingly.
DIG IN Ch1	Monitoring of the left channel of the digital audio interface of the digital analyzer DIGITAL (Digital Audio I/O Option UPL-B2 or UPL-B29)
DIG IN Ch2	... of the right channel.
DIG Ch1&2	... of both channels. ***Note:*** *Monitoring of the digital audio signals is only possible if the Digital Audio I/O Option UPL-B2 or UPL-B29 is installed.* *Bei eingebauter UPL-B29 ist zum Mithören im High Rate Mode (siehe 2.15.9 Selecting the Sampling Mode) die Mithöroption UPL-B5 Variante 03 notwendig.* ***If the high rate mode is switched on, monitoring is possible via the inputs only. This also applies to the 22 kHz analog analyzer.***
FUNCT Ch1 **FUNCT Ch2**	Monitoring of the measurement function output of the analog analyzer ANLG 22 kHz for channel 1. If filters are switched on for the measurement function, the filtered signal (or the residual signal for THD+N, Rub&Buzz or RMS SEL) can also be monitored here.
FUNCT Ch1&2	... channel 2.
INPUT JITT	... both channels (stereo operation).
INPUT COMM	Available only in the DIGITAL analyzer with Digital Audio I/O option (UPL-B2 + UPL-B22) in Meas Mode JITTER/PHAS. The demodulated jitter signal is applied to the ANLG 110 kHz analyzer and can be listened to. Available only in the DIGITAL analyzer with Digital Audio I/O option (UPL-B2 + UPL-B22) in Meas Mode COMMON/INP. The superimposed common-mode signal at the digital inputs is applied to the ANLG 110 kHz analyzer and can be listened to.

Pre Gain

For the menu items SPEAKER FUNCT CH1/2/1&2 a gain or attenuation of the function output can be set in the range ± 120 dB. If the gain is set too high, the signal is limited at the monitor output.

Spk Volume

Volume for the monitor output, settable from 0 to 100%

Phone

Configuration of the monitor output at the phones connector.

= SPEAKER

When connecting the headphones, the internal loudspeaker is automatically switched off.
Phones output is operated in conformance with the loudspeaker, i.e. the Speaker-off key (LOCAL key) switches off the internal loudspeaker or phones output. The monitor signal sounds either from the built-in loudspeaker or from the connected headphones.

PERMANENT

Phones output is permanently switched on. Speaker-off key only acts on the internal loudspeaker irrespective of whether the headphones are connected up. In this case, the internal loudspeaker also remains active with the headphones inserted.

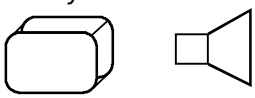
Keys for speaker control:

LOCAL key



This key is used to switch on/off the internal loudspeaker in local mode of the UPL (Speaker-off key). In remote mode, the first keystroke switches to the local mode.

+ / key



This key opens a box for faster setting of the monitoring volume (Spk Volume).

Example of application: Monitoring the distortion of a signal

In the UPL, the signal distortion can be monitored either directly when a THD+N measurement is performed or by switching on a narrow bandstop filter in the case of an RMS SELECT measurement.

When a **THD+N measurement** is performed, the signal to be monitored is routed via a digital filter or a second (analog) notch filter. The frequency of the signal is permanently monitored and the notch filter immediately fine-tuned, if required. In this case the monitoring output is briefly muted.

Depending on the selected generator and the quality of the test signal, a different setting is required for menu items "Fundamental" and "Dyn Mode":

- Internal universal generator (Low Dist → OFF)

  Select Fundamental → GEN TRACK; the dynamic mode is arbitrary. When the generator frequency is changed, the internal notch filters are automatically tuned to the new fundamental.

- Internal low-distortion generator (Low Dist → ON)

  Select Fundamental → AUTO. (When the low-distortion generator is switched on, GEN TRACK is ignored and handled internally in the same way as AUTO.) This is to avoid the generator frequency being slightly outside the stopband range of the two notch filters. The dynamic mode PRECISION may be selected if the signals to be measured are only slightly distorted or noisy.

- External generator:
  Select Fundamental → AUTO. The signal frequency is permanently monitored and the internal notch filter fine-tuned, if required. Select the dynamic mode PRECISION or FAST depending on the signal quality.

***Note** on monitoring the residual signal during the THD+N measurement:*

- *The monitoring output is muted for approx. 1 s every time a change is made in the GENERATOR or ANALYZER panel before the THD+N measurement is (re)started or when the notch filter is internally tuned. This is not a malfunction but should protect the listener against clicks and noise while the settings are made, which would be very disturbing because of the high gain of the residual signal.*
- *If external signal sources are used, it cannot be avoided for the fundamental to go outside the stopband range of the notch filter and being applied with high level to the monitoring output whenever the frequency is changed. As soon as the THD+N measurement routine identifies a new fundamental, the monitoring output is muted and the notch filter adjusted.*

Remedy:

- *This effect can be avoided through the use of an internal generator.*
- *If an external generator has to be used, the following procedure is recommended:*
  Stop or abort the current (permanent) measurement using the STOP or SINGLE key, then set the external generator and restart the measurement with the START key.
- *If the time of the generator switchover cannot be predicted, a short measurement time should be selected to minimize the period before the signal is muted.*
  1. *Reduce Meas Time SUPERFAST or the FFT size (with post-FFT switched on).*
  2. *Switch post-FFT OFF.*
  3. *Switch result display off.*

- *If the loudspeaker is not switched on again after muting although Speaker was neither switched off by means of the PHONE OFF key nor via the Speaker menu, it could be that the measurement routine cannot find a reliable and sufficiently strong signal.*

Remedy:

- *Switch off the analog notch filter by selecting the dynamic mode FAST or*
- *Fundamental GEN TRACK, provided the internal universal generator is used.*

- *If the signal to be measured contains considerable noise or strong harmonics, it could happen that the fundamental after the analog notch filter cannot be detected.*

Remedy: as above

- *Any kind of DC (DUT, DC offset of notch filter) may cause the monitoring output to be overdriven and muted.*

***Remedy**:*

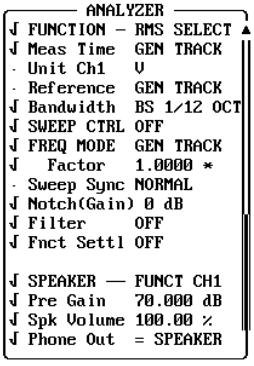
- *Perform or switch on a DC offset calibration in the OPTIONS panel.*
- *Switch on the highpass filter (Filter →HP...),*
- *Switch on AC coupling (Couple CHx→ AC).*

If an **RMS SELECT measurement** is performed, the distortion can be monitored by cutting in a narrow bandstop filter. The frequency of the bandstop filter can be permanently set or automatically adjusted when the frequency is changed in the GENERATOR panel.

The DUT is connected, for instance, between analog generator input 1 and analog analyzer input 1. Settings on the UPL:

Load the UPL default setting in the FILE panel.
`LOAD INSTRUMENT STATE`
`Mode DEF SETUP`

Settings in the UPL ANALYZER panel:



With FREQ MODE GEN TRACK, the bandstop center frequency follows the frequency setting in the GENERATOR panel.
FREQ MODE FIX holds the bandstop frequency irrespective of the generator frequency.

With NOTCH(Gain) 0 dB, an analog notch filter is switched on which increases the stopband attenuation by another 40 dB (in addition to the 100 dB attenuation of the bandstop filter).

Switch on loudspeaker: press Speaker off key (LOCAL key) or open volume box (+/- key) and adjust the desired volume.

By setting Pre Gain, the residual signal can now be boosted above the audible level.

Depending on the distortion of the DUT, the harmonics of the test frequency can be clearly distinguished from the noise.
Depending on the selected generator, menu items Bandwidth and FREQ MODE can be set in different ways:

- Internal universal generator (Low Dist→ OFF)

  Select FREQ MODE → GEN TRACK; the set bandwidth may be as narrow as desired (Bandwidth → BS 1%) because the universal generator features a very high frequency stability. When the generator frequency is varied, the fundamental is automatically suppressed by the tracking bandstop filter.

- Internal low-distortion generator (Low Dist → ON)

  When the low-distortion generator is used, which features a high spectral purity but a slightly reduced frequency stability, it may happen that the generator frequency is slightly outside the bandstop filter range BS 1% and the fundamental is not completely suppressed. *Remedy*: Select

  – a wider bandstop filter (bandwidth → BS 3%, BS 1/3 OCT, BS 1/12 OCT) *or*

  – FREQ MODE → FIX and tune the center frequency manually to the generator frequency or, the other way round, vary the generator frequency by a few Hz so that the fundamental is optimally suppressed.

- External generator:

  Select FREQ MODE → FIX and tune the center frequency as accurately as possible to the generator frequency. For generators with a non-stabilized frequency, a wideband bandstop filter should be selected in addition (bandwidth → BS 3%, BS 1/3 OCT, BS 1/12 OCT).

Note *on monitoring the residual signal during the RMS selective measurement:*

Any kind of DC (DUT, DC offset of notch filter) may cause the monitoring output to be overdriven and muted.

Possible remedies*:*

– *Perform or switch on a DC offset calibration in the OPTIONS panel.*
– *Switch on highpass filter (Filter →HP...),*
– *Switch on AC coupling (Couple CHx → AC).*

2.6.7 Applications

2.6.7.1 Crosstalk Measurement

Crosstalk means the -undesired- coupling of signals of one channel to another communication channel. It is usually indicated as a function of the frequency. It is measured by modulating one channel by means of measuring the amplitude in the unmodulated channel. Since the coupled signals are normally low and may correspond to the signal-to-noise ratio, the full dynamic range should be used. The values are indicated in dB, the output amplitude of the modulated channel being used as reference.

- Basic setting

The generator is set to SINE and a frequency sweep is activated. Since crosstalk normally does not reveal steep variations over the frequency, approx. 20 to 30 test points with logarithmic spacing are sufficient in the range from 20 Hz to 20 kHz. VOLTAGE is set such that the maximum voltage is reached at the DUT output.

The RMS & S/N (with S/N Seq OFF) function is used in the analyzer to measure the level with AUTO or AUTOFAST mode. This is a two-channel measurement, i.e., Channels(s) is set to 2=1. Range AUTO matches the different levels automatically. INPUT DISP and FREQ/PHASE measurements should be switched OFF to increase the measurement speed.

Since the measurement is to be displayed as CURVE PLOT, operation is set accordingly in the DISPLAY panel. Scan count is set 1. Scale B is selected NOT EQUAL A. Unit should be set to dBr in both channels and the normalize value to 1.0 * or 0 dB.

- Measuring crosstalk from CH2 to CH1

The generator setting is "Channel(s) 2“ in order to switch on channel 2.
In the DISPLAY panel, Trace A is set to FUNC CH1 and reference to MEAS CH2.
Trace B is OFF. -Pressing the SINGLE key starts the first measurement sequence.

- Holding the measurement

Since the same display shall contain crosstalk of the other channel, the first measurement must be “held“ by selection of the setting Trace A HOLD. If AUTO ONCE has not yet been selected for Scale, the automatic scaling can now be initiated.

- Measuring crosstalk from CH1 to CH2

In the GENERATOR panel, Channel(s) 1 is selected in order to switch on the other channel.
Trace B is set to FUNC CH2 and MEAS CH1 is selected as reference.
Pressing the SINGLE key starts the 2nd sweep.

- Post-processing/storage

Since the crosstalk values of the individual channels do normally not deviate considerably from each other, the scaling of TRACE A can be copied using Scale B EQUAL A.

The complete measurement can then be stored in a file by entering Store TRACE A+B and a file name in the FILE panel. Besides, a screen hard copy can be selected for documentation purposes and output by pressing the HCOPY key in the OPTIONS panel.

- Copying the functions to be executed in the STATUS panel

This measurement is a typical application for the STATUS panel. The few command lines to be executed can be copied into the common STATUS panel by marking them in order to avoid manifold switchover between GENERATOR and DISPLAY panels (cf. 2.8 STATUS panel). Assuming that nothing

has been marked, the Channel(s) command is ticked off in the GENERATOR panel and the lines TRACE A, Reference (A), TRACE B, Reference (B) and Scale B, if required, are ticked off in the DISPLAY panel.

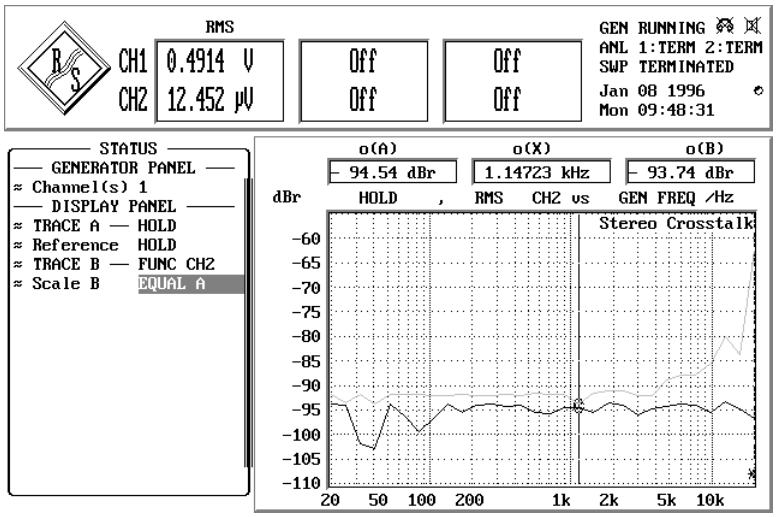


Fig. 2-29 STATUS and GRAPHICS panels with crosstalk measurement

2.6.7.2 Linearity Measurements

In linearity measurements the output level is plotted versus the input level. The unit normally used is dBr but V/Vr can also be selected. If a fixed reference value is used, a straight rising line is obtained. To accentuate departures from linearity, a straight horizontal line would be desirable. This line is obtained when the measured values are not referenced to a fixed value but to the input frequency.

The UPL does not offer a separate function for linearity measurements. Such measurements are defined as a special reference of the level measurement. This offers the following **advantages**:

1. Linearity measurement not confined to one single measurement function. *All level measurements* (RMS, RMS select, quasi-peak and all peak measurements) can be used for linearity measurements.
2. Switchover between linearity measurement and (absolute) level measurement is effected by selecting the unit (menu line "Unit 1" or "Unit 2"). It is thus possible to display the linearity measurement in one channel and the absolute level in the other.
3. By selecting the reference (menu line "Reference"), a switchover is made between a fixed or a floating reference (linearity measurement). Thus the linearity measurement can be displayed in one channel and the level referenced to a fixed value in the other.

***Note**: The reference used for linearity measurements is defined as "**floating reference value**" in this manual. In contrast to the commonly used fixed reference, each measured value has a reference value of its own.*

The linearity measurement can be performed by means of a sweep. Measured values can be numerically or graphically displayed in the GRAPHICS panel and normalized. Moreover, the nonlinearity of each measured (level) value can be directly read from the result window without a sweep being set and performed.

Either the internal generator (GEN TRACK) or - when both channels are switched on - one of the two measurement channels (MEAS CH 1/2) can be selected as a reference for the linearity measurement. A measurement channel has to be selected as a reference when an external generator is used or if reference is to be made to a specific point in the test setup.

***Note**: A two-channel linearity measurement assumes that neither of the measurement channels is needed as a reference. With MEAS CH1 or MEAS CH2 selected as a reference, the linearity measurement can be performed in one channel only. Being referenced to itself, the other channel yields 0 dBr.*

More possibilities are available when the measurement is carried out in the form of a sweep with the result displayed in a graphics window:

1. When stored as a trace file, the level curve of a reference item (golden unit) can be selected as a reference under FILE in the DISPLAY panel. Thus departures from linearity can be displayed with a reference to this golden unit without the latter being available for the measurement.
2. The level curve measured in the other trace (or loaded from a file) can be directly selected as a reference in the DISPLAY panel (OTHER TRACE). Thus it is possible to subsequently reference the absolute level curves of the two channels to each other.
3. The sweep shows the linearity deviation (e.g. in dBr) from the selected reference curve. This deviation is not necessarily around 0 dBr. If the DUT has a gain or loss, the deviation may be above or below this value. The gain factor of the DUT can be compensated for by a scaling factor which can be entered either numerically or by means of an automatic 0-dB scaling to the current cursor position.

Note: *When measuring D/A or A/D converters using the internal UPL generator, the linearity measurement (with GEN TRACK) leads to the physical problem of referencing an analog voltage to a digital one (or vice versa). UPL internally calculates with a* ***conversion factor*** *of*

1V / 1FS or 1FS / 1V

Same as the gain factor, this conversion factor can also be compensated for by the scaling factor.

1-channel linearity measurement referenced to measurement channel 1:

1. Select analyzer (ANLG 22 kHz or ANLG 110 kHz) according to the required frequency.
2. Select a level measurement (RMS, RMS select, quasi-peak or peak) and, if necessary, the measurement mode suitable for the measurement task.
3. If a curve is to be swept, further settings have to be made in the DISPLAY panel: Operation must be set to Curve Plot, FUNCT CH2 should be selected for trace A and trace B should be OFF.
4. Select dBr or V/Vr for channel 2 and trace A (in the ANALYZER and, if required, the DISPLAY panel).
5. Select MEAS CH1 as a reference (menu line REFERENCE in the ANALYZER and, if required, in the DISPLAY panel). The measurement result of channel 2 is then referenced to the input of channel 1.
6. The linearity deviation is displayed in the result display of channel 2 with the selected unit. On triggering a (SINGLE) sweep, the linearity characteristic is graphically displayed versus the input level.

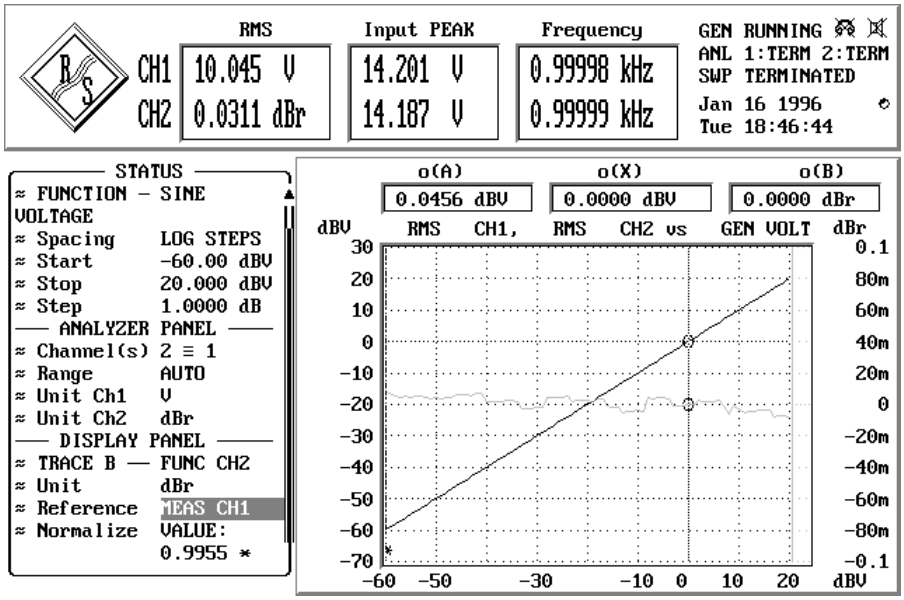


Fig. 2-30 Configuration of UPL for linearity measurement referenced to channel 1, the linearity characteristic being displayed on trace B, the absolute reference channel on trace A.

2-channel linearity measurement referenced to internal generator:

1. First configure and set the internal generator (sinewave signal, level sweep, signal frequency, etc.).
2. Select analyzer (ANLG 22 kHz or ANLG 110 kHz) according to the required frequency.
3. Select a level measurement (RMS, RMS select, quasi-peak or peak) and, if necessary, the measurement mode suitable for the measurement task.
4. Further settings are to be made in the DISPLAY panel: Operation must be set to "Curve Plot", FUNCT CH1 should be selected for trace A and FUNCT CH2 for trace B.
5. Select the unit dBr or V/Vr for both channels and both traces (in the ANALYZER and DISPLAY panels).
6. Select GEN TRACK as a reference (menu line REFERENCE in the ANALYZER and DISPLAY panel). Both measurement inputs are now referenced to the set generator level.
7. The linearity deviation is shown in the result displays with the selected unit. On triggering a (SINGLE) sweep, the linearity characteristics of both channels are displayed versus the generator level.

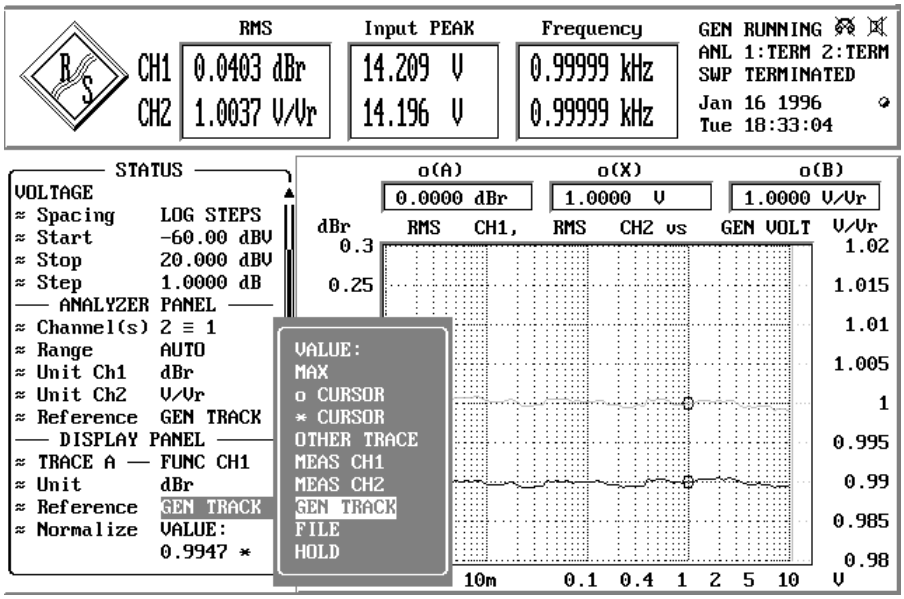


Fig. 2-31 Configuration of UPL for 2-channel linearity measurement referenced to the internal generator; display of linearity curve of both channels

After termination of the sweep, the swept curves can be normalized to one (or two different) points (e.g. 1 V). In this case the curve is vertically shifted so that it crosses the 0-dBr line at the selected reference points:

1. Switch over to the GRAPHICS panel (GRAPH key or ALT+R). Activate one or both graphics cursors, if required.
2. Move the cursor(s) to the desired reference point(s).
3. Return to the DISPLAY panel (DISP key or ALT+D).
4. Open the menu item Normalize of Trace A, select O-Cursor or ✷- cursor, depending on which one was used for marking the reference point.
5. If required, repeat step 4 for Trace B.

Note: *If the linearity characteristic is to be determined at various frequencies, this can be realized by means of the two-dimensional sweep (with frequency on the Z axis). The individual curves overlap in the display and yield a set of curves.*

2.6.7.3 Fast Frequency-Response Measurements

Usually, frequency-response measurements are performed using (generator) frequency sweeps and RMS measurement. Although the UPL offers a very high RMS measurement speed (approx. 15 ms per measured value), such a sweep may lead to a total measuring time, which is unacceptable due to the large number of sweep steps to be performed. In other words faster modes are called for.

A combination of the FFT function and the generator signal RANDOM, Domain FREQ would be an alternative. The generator can be synchronized to the spacing of the analyzer, i.e. each generated frequency line of the (pseudo) random signal is assigned exactly one line of the FFT. Thus FFT windowing can be omitted and a maximum frequency and level accuracy is obtained.

After outputting the generator random signal, all measurements can be performed at the speed of a single FFT. Thus, the measurement speed only depends on the FFT size, which should be selected so that the desired (linear) frequency resolution is just obtained.

Note: *Logarithmic spacing is not possible with FFT; irrespective of this, logarithmic scaling of the X axis can be selected in the DISPLAY panel.*

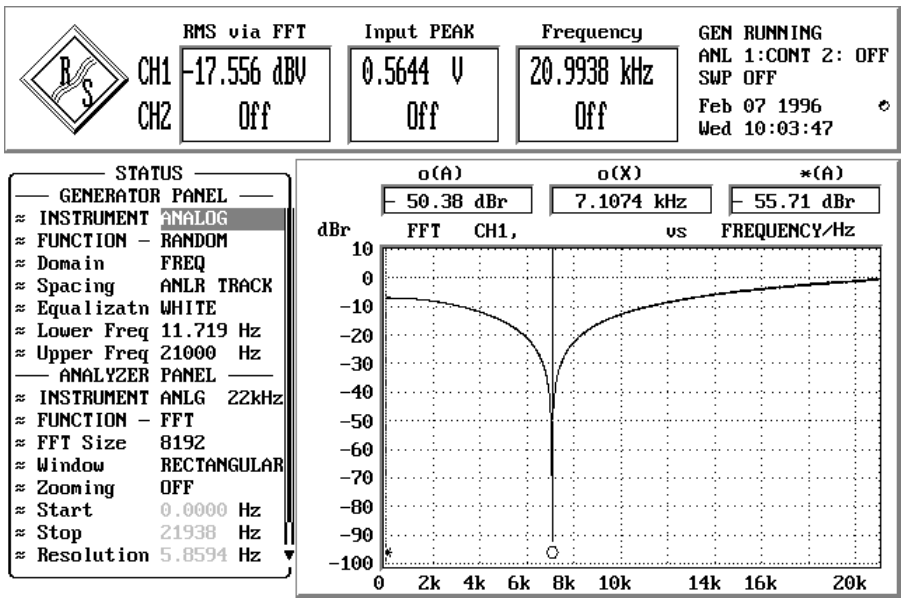


Fig. 2-32 Configuration and result of fast frequency-response measurement

2.6.8 Optimizing the Measurement Speed

A high measurement speed is of particular importance for remote control as the measurement time directly influences the program run time. For this reason program sequences are given in Section 3.15.10 Tuning - Setup for Maximum Measurement Speed, to optimize the measurement speed in the case of remote control.

Short measurement times are also desirable in manual operation, particularly for sweeps and FFT, in order to obtain a real-time characteristic (e.g. for tuning procedures). For this reason a few general hints will be given below on how to cut down on the available measurement time. Optimization measures can be classified in 4 groups:

1. Speed optimization *without affecting* the measurement accuracy
2. *Compromise* between measurement time and accuracy or dynamic
3. Speed optimization through use of *internal* generator,
4. Optimizing the sweep speed
5. Optimales Ausnutzen der DSP-Performance abhängig von der Taktrate

A brief form of these hints is available in the UPL online help functions (see 2.3.7 Help Function) under the item "Optimization".

1. Speed Optimization without Affecting Measurement Results

- Selecting a suitable analyzer instrument (analog measurement signals only)

  In the ANLG 22-kHz instrument, the two channels can be measured in parallel (synchronously) already during sampling. This analyzer also offers a wider conversion range and a lower frequency limit and should therefore be used in all cases where an upper measurement limit of 22 kHz is sufficient.

- Switching off unused measurement inputs

  An unused measurement input may considerably extend the measurement time as a measurement is only terminated when a measured value is available for the unused input too. Some measurement functions (e.g. RMS with automatic measurement time, THD+N) require a much longer time for measuring low signal levels (noise) but even if a signal is present on channel 2, the measurement time is certainly longer than in the case of 1-channel operation, as also the 2nd channel has to be completely evaluated and displayed. In the ANLG 110-kHz instrument the two channels are measured sequentially so that the measurement time is at least twice as long.

- Switching off the "Beeper"

  In the setting "Beeper ON" there is a short sound of several 100 ms duration after each (single) sweep which indicates the sweep ending. During this time no device activities are possible. Especially with short sweeps this dead time is disturbing. Therefore the Beeper function should be switched off while sweeps are running - especially under remote/automatic control - if no acoustic reply of sweep end is required.

- Switching off unused result displays

  If the result displays for FREQUENCY and INPUT DISP are not required they should be switched off. In addition to saving the time required for evaluation and display of these values, some measurement functions (e.g. RMS) can be terminated more quickly.

- Switching off settling functions

  For most signals the settling function is not required. If the DUT provides a stable signal, the UPL yields settled values even without the settling function. Settling (or averaging) multiplies the measurement time by at least the number of the set samples (see 2.3.4 Settling Process).

- Switching off filters that are not required

  Each (digital) filter increases the total measuring time because of its settling time. Unused filters should therefore be switched off in the ANALYZER panel.

- Switching off the measurement delay function ("Delay" under START CONDITION)

  With the aid of this function DUT delays can be corrected. The start of the 1st measurement and consequently of each sweep point are delayed for a defined period each time the generator or analyzer setting is changed. If a start delay is not required, this time should be set to 0.0 (see 2.6.4 Ways of Starting the Analyzer, Ext. Sweep).

- Manual selection of analyzer level range (analog measurement signals only)

  If the level of the signal to be measured is known and a limited measurement range can be accepted, the analyzer level range should be manually selected (Range FIX). A range corresponding to the highest expected level should be set, an UNDERRANGE being taken into account. This prevents a new measurement with a corrected range setting to be performed. To ensure that the measurement will not be falsified by a higher signal level, "Range LOWER" may be selected. With this mode selected the measurement function is able to correct the measurement range in the case of OVERRANGE (see 2.6.2 Configuration of the Analog Analyzers).

2. Compromise between Measurement Time and Accuracy or Dynamic

The methods below can only be used with certain measurement functions.

- Selection of low measurement dynamic (dynamic mode FAST, for analog measurement functions THD, THD+N/SINAD, DFD, MODDIST only).

  If signals not making full use of the UPL dynamic range are to be measured, e.g. distortion above 0.1%, precision measurements are not required. Consequently, the measurement time can be reduced by about a factor of 2 without any loss in accuracy.

- Reducing the FFT size for FFT and THD+N

  Halving the FFT size also halves the measurement time required for FFT. This also applies to FFT-supported measurement functions like THD+N and SINAD.

  In the case of THD+N/SINAD measurements, reducing the FFT size does not only reduce the time required for (post)-FFT but also the THD+N/SINAD measurement time, irrespective of whether post-FFT is activate or not. This however is at the expense of the measurement accuracy. (see 2.6.5.7 THD+N/SINAD).

- Reducing the numeric value of "Measure Time" for RMS, RMSSEL, PEAK, QPEAK and DC

  If a fixed measurement time is used, the desired time can be directly entered as a numeric value. Entering a shorter measurement time reduces the measurement accuracy. The measurement time is defined for each single measurement. With AUTO ranging selected, a new measurement performed because of an unfavorable (UNDERRANGE) or incorrect (OVERRANGE) level range leads to a total measurement time which exceeds the desired one.

- Selecting AUTO FAST for RMS and RMSSEL

  Automatic selection of the measurement time in the case of RMS measurements ensures that the shortest possible measurement time is selected for the desired accuracy (AUTO or AUTO FAST) in the case of unknown signals irrespective of the test frequency. If an accuracy of 1% is sufficient, AUTO FAST should be used (see 2.6.5.2 RMS).

- Extending the span for zoomed FFT

  The span for zoomed FFT should not be smaller than that required by the necessary frequency resolution. Doubling the span halves the frequency resolution and the measurement time (see 2.6.5.12 FFT).

- Increasing the bandwidth for RMSSEL

  The larger the band of the digital bandpass or bandstop filter, the shorter the measurement time. The measurement can be speeded up if a reduced selectivity is sufficient for the signal frequency (see 2.6.5.3 RMS SELECT).

- Reducing the attenuation and/or the edge steepness of user-defined filters

  Both measures reduce the settling time of the filters and thus the measurement time (see 2.7.2 Creating the User-definable Filters).

- Reducing the order of user defined high and low passes

  By this measurement too the response time of the filter and consequently the measurement time is reduced (see 2.7.2 Creating the User-definable Filters).

- Deactivating the analyzer frequency response calibration with frequency response measurements

  When using the measurement function rms ("Meas Time" *not* GEN TRACK) the frequency response calibration can be switched off thus reducing the linearity accuracy. This is implied when switching off the frequency measurement

- Deactivating the generator frequency response measurement

  The generator frequency response calibration can be switched off by means of deleting and renaming the "C:\UPL\REF\FLAT_GEN.CAL" file and restarting the UPL, subsequently. This procedure is more convenient if UPL-B10 option is installed by means of calling the BASIC macro FLAT_GEN.BAS (in C:\UPL\USER.

3. Speed Optimization Through Use of Internal Generator

- Selection of GEN TRACK modes, if available (RSM, RMSSEL, THD, THD+N/SINAD).

  With "Meas Time GEN TRACK" selected for RMS and RMSSEL, the measurement time can be exactly set to integral periods of the set generator frequency. The generator frequency can then be slightly modified (see 2.6.5.2 RMS).

  With "Fundamental GEN TRACK" selected for RMSSEL, a preliminary measurement for determining the frequency is not required. (see 2.6.5.3 RMS SELECT).

  With "Fundamental GEN TRACK" selected for THD+N/SINAD, the 1st FFT is performed with the correct resolution even if the selected FFT size is too small. In the case of low frequencies and a small FFT size, the measurement speed is almost doubled (see 2.6.5.7 THD+N/SINAD).

  Selecting "Fundamental GEN TRACK" for a pure THD measurement does not noticeably increase the measurement speed. Since an accurately defined fundamental is required for the THD measurement, "Fundamental AUTO" should be used.

- Fast frequency-response measurement possible

  If the harmonics generator ("Domain FREQ", "Shape FILE") is synchronized to the FFT analyzer, a highly accurate real-time frequency analysis can be performed. (see 2.6.7.3 Fast Frequency Response Measurement).

4. Optimizing the Speed of Generator Sweeps

- To perform a frequency sweep 'Sweep Mode' (in analyzer panel) should be set to FAST or BLOCK - if available.

On certain conditions sweep velocity can be considerably increased:

- Selection of generator function SINE
- Use of universal generator, that is Low Dist OFF
- automatic frequency sweep without Z-sweep, that is X-Axis FREQ, Z-Axis OFF

- Selecting the universal generator instead of the low-distortion or analog auxiliary generator

  Since the universal generator is superior regarding frequency setting time and frequency accuracy than the low-distortion generator it should preferably be used as a sweep generator. The low-distortion generator should only be used if its wide frequency range and excellent distortion and S/N ratio are required.

- Deactivating equalization of generator signal (SINE and DFD)

  With activated signal equalization the level has to be reset each time the frequency is changed. This extends the total setting time and thus the sweep time. For this reason equalization should be switched OFF in the case of very fast sweeps (see 2.5.4.1.3 Equalization of SINE, SINE BURST, DFD, MULTISINE, RANDOM).

- Synchronizing the generator to the analyzer (next step ANLR SYNC)

  When the UPL generator and analyzer are used together, a generator sweep should always be synchronized to the analyzer. Thus it is ensured that the generator is switched exactly at the time when all measurement results are available (i.e. also frequency and input on the active channels, if required).

  DWELL should only be used together with an external analyzer (see 2.5.4.2 Sweeps).

- Manual selection of generator level range (only for analog level sweeps using the universal generator)

  When a reduced dynamic range can be accepted for the generator, selection of the fixed generator level range and generator setting time as well as the settling time can be shortened (see 2.5.2 Configuration of the Analog Generator).

- Reducing the measurements at low frequencies (particularly for RMS, RMSSEL and THD+N)

  ==> linear instead of logarithmic spacing,

  ==> increasing the start or (in the case of a sweep "from top to bottom") the stop frequency.

  Low frequencies require longer measurement times. For this reason too many unnecessary sweep points should be avoided in the lower frequency range.

- Reducing the sweep points or increasing the spacing, list sweep

  The time required for a sweep increases linearly with the number of sweep points. Unnecessary sweep points should be avoided. In the case of a list sweep the individual sweep points can be spaced as required and sweep points may be concentrated at positions of interest without substantially increasing the total number of sweep points (see 2.5.4.2 Sweeps).

- Switching off the result display and the status information

  In the case of sweeps, the output of individual results in the result display is mostly unnecessary or even useless particularly when the results are indicated with a high update rate. The same applies to the status information. For this reason the two displays can be switched off (together). This elimination of the output time - irrespective of the required measurement time - is particularly noticeable in the case of very fast sweeps (see 2.15.5 Display Settings). The measurements can still be followed by means of the sweep curve or the bargraph display. The complete sweep list can be displayed in the graphics panel whenever required. (see 2.10.4 Display of Lists).

- Switching off the graphic cursor

  For most applications display and update of the cursor values are not required while running sweep. Only the terminated sweep is analyzed by means of graphic cursors. Therefore the graphic cursors can be switched off during the sweep run and so the sweep time can be reduced (see 2.10.2 Trace and Spectrum Display).

5. Optimized Utilization of DSP Performance with the Clock Rate

The higher the clock rate of the test signal or the signal to be generated, the smaller is the performance margin of the DSPs in UPL. This may have three different effects:

1. The DSP cannot cope with the high clock rate and samples are lost.
2. The DSP cannot complete all its jobs in realtime, so subsequent processing becomes necessary.
3. The DSP cannot process the two measurement channels in parallel, so multiplex operation becomes necessary.

The effect under 1 must be avoided under all circumstances. The UPL analyzer and generator ensure clock rates up to 55 kHz in the BRM (base rate mode) and clock rates up to 106 kHz in the HRM (high rate mode). If an external digital signal is applied, the user must ensure the signal clock frequency to be within the specifications of the sample mode used.

The selection of HRM leads to a higher performance margin allowing the processing of higher clock rates. In HRM, measurement functions involving high computation effort therefore have to be performed offline (as under 2) or sequentially (as under 3).

Multiplexing reduces the measurement speed of the following functions (group 1) for two-channel measurements:

- Selective RMS
- RMS with filter with AUTO/AUTO FAST as measurement time
- Peak
- Quasi peak

The following measurement functions (group 2) require longer time for the subsequent processing in two-channel operation:

- Zoom FFT
- THD+N/SINAD
- MDIST
- DFD

All other measurement functions (group 3) are performed with the same speed in HRM as in BRM.

From the above, the following **guidelines for using base rate mode and high rate mode** may be derived:

- For exclusively analog measurements (AA), BRM should be used.
- For measuring / generating digital signals with clock rates above 55 kHz, HRM must be activated.
- Digital signal above 55 kHz or with an unknown clock rate should only be applied with HRM switched on.
- If HRM is switched on, longer measurement times are needed for two-channel measurements in group 2 and especially in group 1. Two-channel operation should therefore be switched on only if both channels actually have to be measured.

2.6.9 Improving the Frequency Response

The analyzer of the UPL is generally equipped with a frequency response calibration for rms measurements which compensates for the systematic frequency response errors of the internal components. To activate the calibration it is required that the frequency measurement is switched on with rms measurements or "Meas Time" set to GEN TRACK.

If – for measurements with built-in universal generator - the frequency response is to be further improved, the remaining frequency response of the analyzer in conjunction with the generator frequency response can be smoothed additionally by means of an instrument-specific equalization file.

To create this equalization file ("FLAT_GEN.CAL" under C:\UPL\REF), a BASIC program FLAT_GEN.BAS is supplied on the "SETUP/EXAMPLES" disk and loaded into the directory "C:\UPL\USER" with installation. It may be started as a macro, if the UPL-B10 option is installed. The equalization file can also be created manually using the "FLAT_GEN.SAC" setup.

The generator frequency response correction should *not* be used in the following situations:

- whenever a maximum setting speed of the generator is required. The correction increases the time for setting a new generator frequency since the frequency and the level, in addition, have to be set. The time for a frequency response measurement with generator sweep increases with correction switched on by less than 10 %.
- if the generator is to be operated together with an external analyzer. Since the created equalization file also contains the inverted residual frequency response of the analyzer, the generator frequency response could be limited in the worst case. Verschlechterung des reinen Generatorfrequenzgang kommen.

The generator frequency response correction can be switched off again for the reasons described above. This is effected by the macro FLAT_GEN.BAS or manually by deleting or renaming "C:\UPL\REF\FLAT_GEN.CAL" file and subsequently restarting the UPL.