ROHDE&SCHWARZ
Instruments
Division

Operating Manual

AUDIO ANALYZER
UPD

2 Hz to 300 kHz

1030.7500.02/04

Printed in the Federal
Republic of Germany

Safety Instructions

This unit has been designed and tested according to the standards outlined overleaf and has left the manufacturer's premises in a state fully complying with the safety standards.

In order to maintain this state and to ensure safe operation, observe the following instructions, symbols and precautions.

1) When the unit is to be permanently cabled, first connect protective ground conductor before making any other connections.

2) Built-in units should only be operated when properly fitted into the system.

3) For permanently cabled units without built-in fuses, automatic switches or similar protective facilities, the AC supply line shall be fitted with fuses rated to the units.

4) Before switching on the unit ensure that the operating voltage set at the unit matches the line voltage.

   If a different operating voltage is to be set, use a fuse with appropriate rating.

5) Units of protection class I with disconnectible AC supply cable and plug may only be operated from a power socket with protective ground contact.

   The protective ground connection should not be made ineffective by an extension cable.

   Any breaking of the protective ground conductor within or outside of the unit or loosening of the protective ground connection may cause the unit to become electrically hazardous.

   The protective ground conductor shall not be interrupted intentionally.

6) Before opening the unit, isolate it from the AC supply.

   Adjustment and replacement of parts as well as maintenance and repair should be carried out only by specialists approved by R & S.

   Observe safety regulations and rules for the prevention of accidents.

   Use only original parts for replacing parts relevant to safety (e.g. power on/off switches, power transformers or fuses).

7) Also observe the additional safety instructions specified in this manual.

   For measurements on dangerous contact voltages > 25 V AC or 50 V DC, observe the protective measures to VDE and the rules for the prevention of accidents to ensure special operator safety.
   Danger from contact with live parts or metal connector systems should be prevented by adhering to the **limits to VDE 0411, Part 1.**

   According to VDE 0411:
   Limit the peak current values from a measuring voltage source to the following maximum values.
   For DC: ... 2 mA
   For AC $\leq$ 1kHz: ... 0.7 mA
   For AC > 1kHz: ... 0.7 mA $\cdot$ f/kHz, max. 70 mA.

   Further protective measures to increase operator safety:
   - Use coaxial cables with insulated connector parts.
   - Ensure the reliable connection to ground of the reference point of the measurement source as well as of the unit.
   - For measurements on line current circuits, use a ground-fault circuit interrupter (g.f.c.i.). Disconnection at a leakage current of 10 mA, max. 30 mA.
   - Isolate the measuring voltage source.

Explanation of Symbols Used

 - Read operating manual, observe the safety symbols used

 - Caution, shock hazard

 - Protective ground connection

 - Unit ground

 -Equipotentiality

 - Ground

EMC Recommendations

The electromagnetic compatibility of the UPD complies with the relevant standards specified in the data sheet.
Please observe the following to obtain accurate measurements in the presence of electromagnetic disturbances:

- Use shielded cables to all connectors of the UPD (both measurement inputs/outputs and computer links to eg the printer).
- The balanced inputs/outputs are much less susceptible to interference fields than the unbalanced ones and should therefore be used in the relevant cases.
- For connection of an external monitor, we recommend the use of a low-radiation model.
- When operating the UPD with an external keyboard, the Rohde & Schwarz keyboard which is protected against radiated noise should be employed.
- Protection against electrostatic charge:
  Although the connectors of the UPD are largely protected against static charge, avoid touching the connector pins with your fingers.

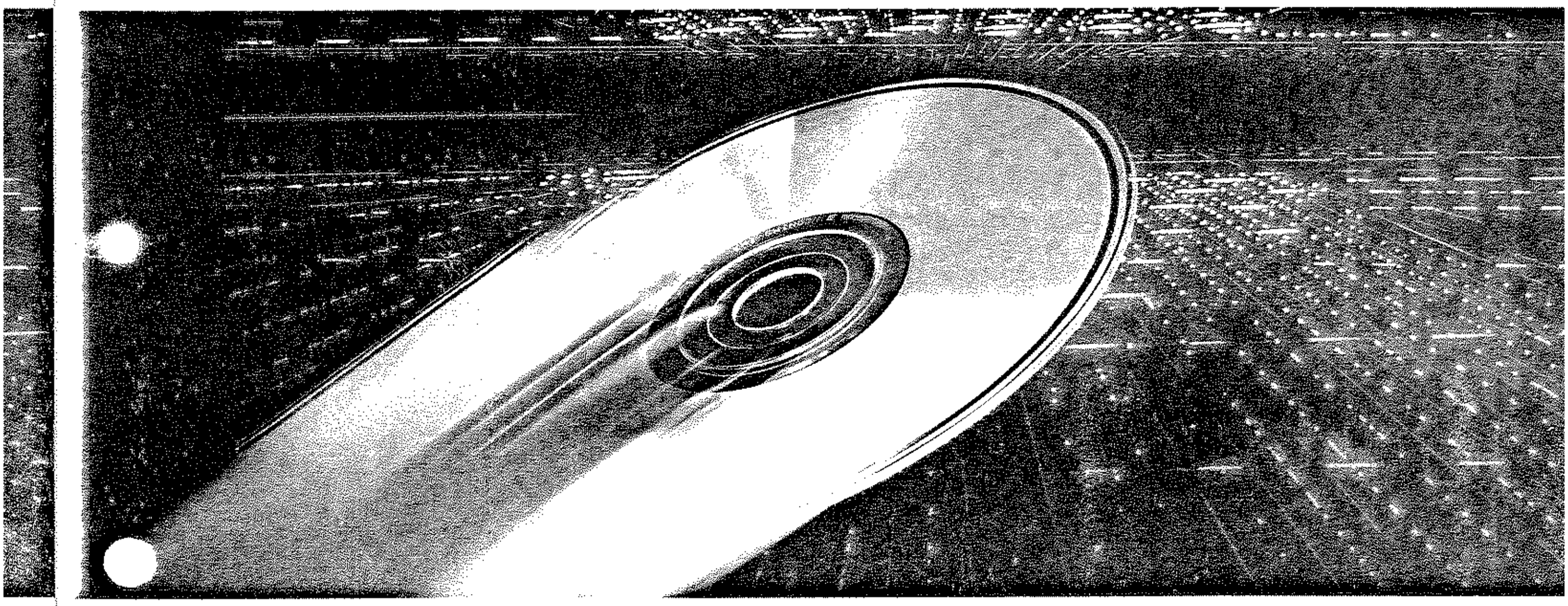
This is to certify that the unit below

Audio Analyzer UPD (1030.7500.02)

complies with the following standard:

DIN 57411 Part 1/VDE 0411 Part 1

"Safety Requirements for Electronic Measuring Apparatus"
(almost fully adapted to IEC 348)

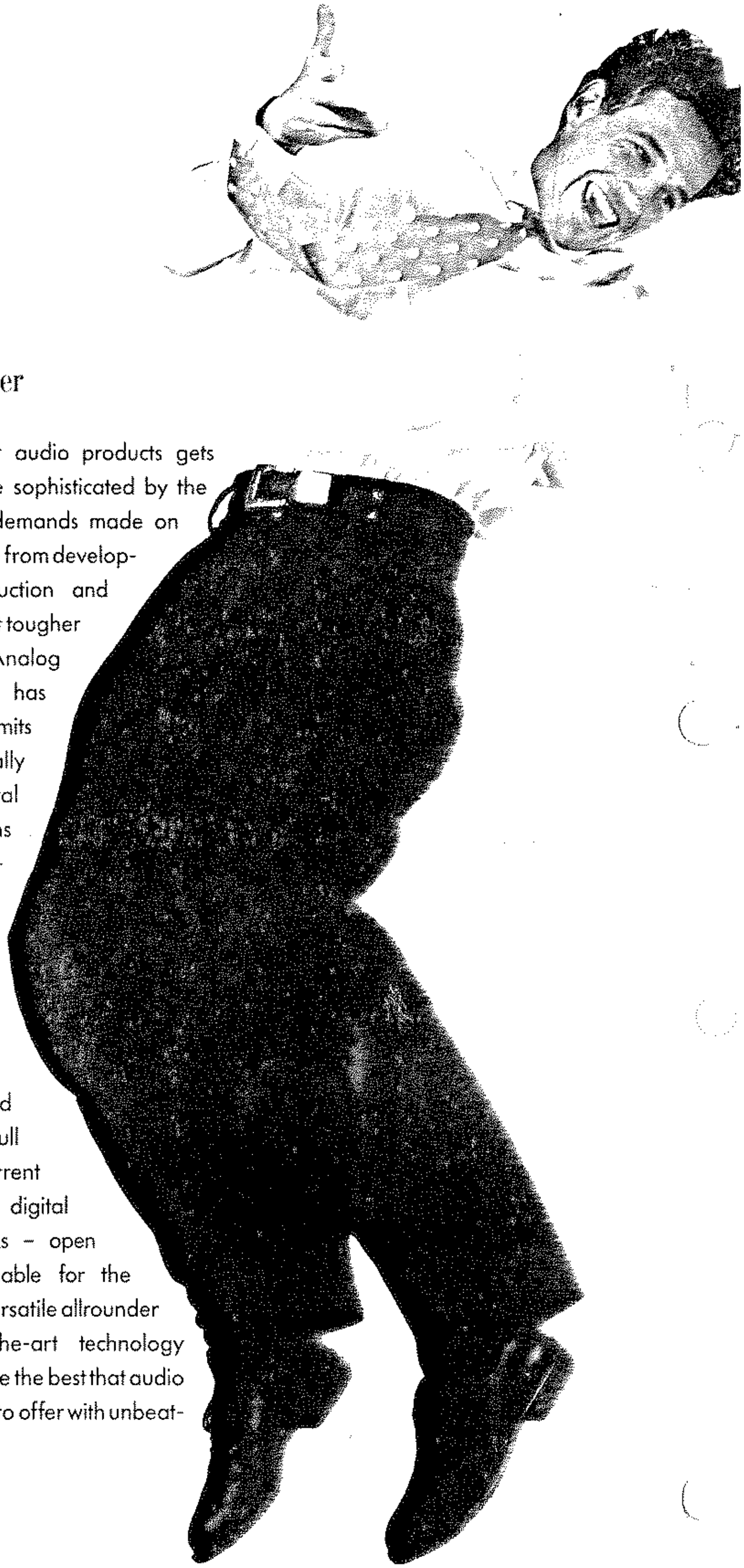


Tomorrow's digital world today

Audio Analyzer UPD

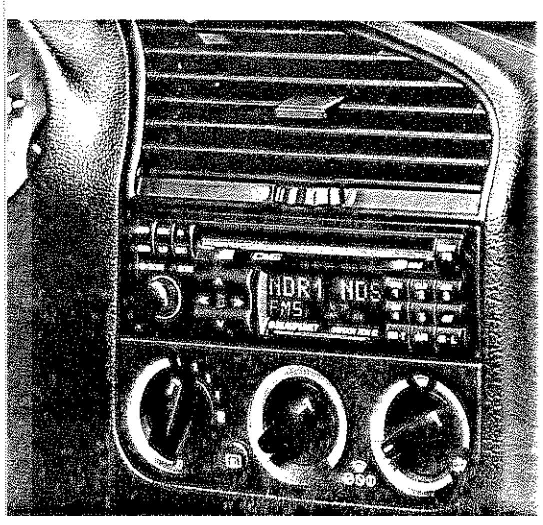
ROHDE & SCHWARZ

Pacemaker for progress



The allrounder

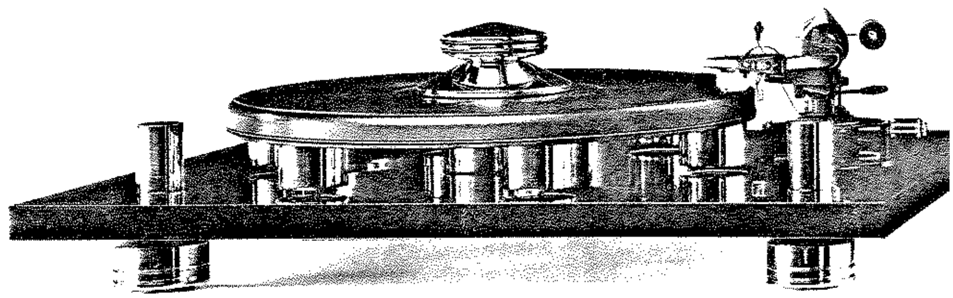
The market for audio products gets more and more sophisticated by the day. And the demands made on measurements – from development to production and monitoring – get tougher and tougher. Analog technology has reached the limits of the physically possible – digital technology opens a totally new dimension. What is needed is a first-class audio analyzer. With digital technology. Equipped to meet the full range of current analog and digital measuring tasks – open and programmable for the future. A truly versatile allrounder with state-of-the-art technology that can measure the best that audio technology has to offer with unbeatable accuracy.



A complete solution

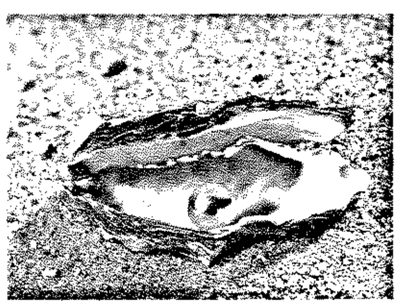
The Audio Analyzer UPD is a compact, universal measuring instrument with built-in generators for measuring the full range of audio parameters at analog and digital interfaces. The UPD measures fast and is equipped with all commonly used interfaces. Windowing and user prompting make the UPD easy to use despite the large number of measuring and signal generating possibilities.

Latest digital signal processing, an extensive range of analysis modes and Fast Fourier Transform (FFT) give you peace of mind for the future – for this technology allows the implementation of new measuring functions simply by loading the required software.

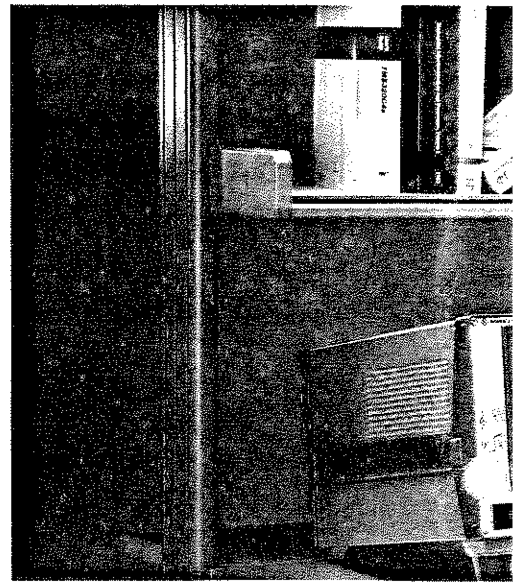


Analog testers are almost two a penny

The market for analog audio analyzers is full of suppliers with a very wide range of quality aspirations. But in the digital area there is only one device – the UPD from Rohde & Schwarz. Not an analog device with a digital add-on – but a fully digital measuring instrument that can



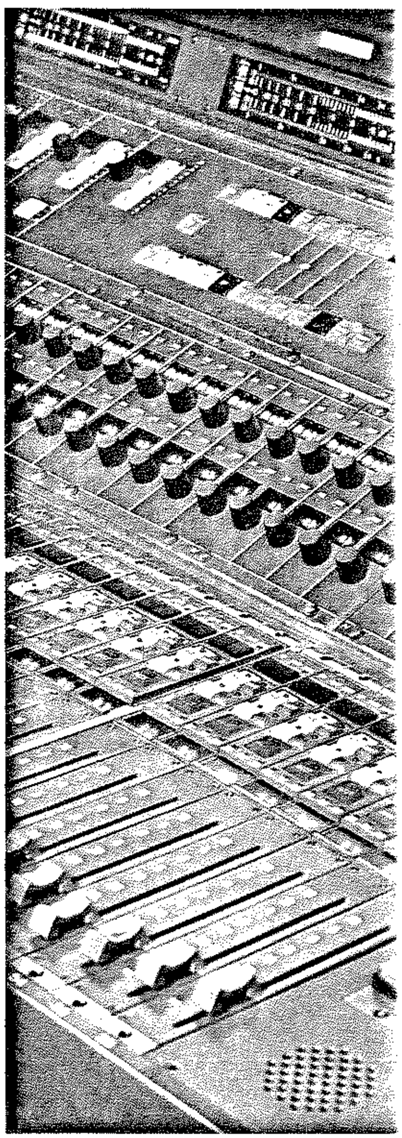
also handle everything the analog world has to offer. The pearl among the audio analyzers that already masters the requirements of tomorrow's digital world.



Versatile in application

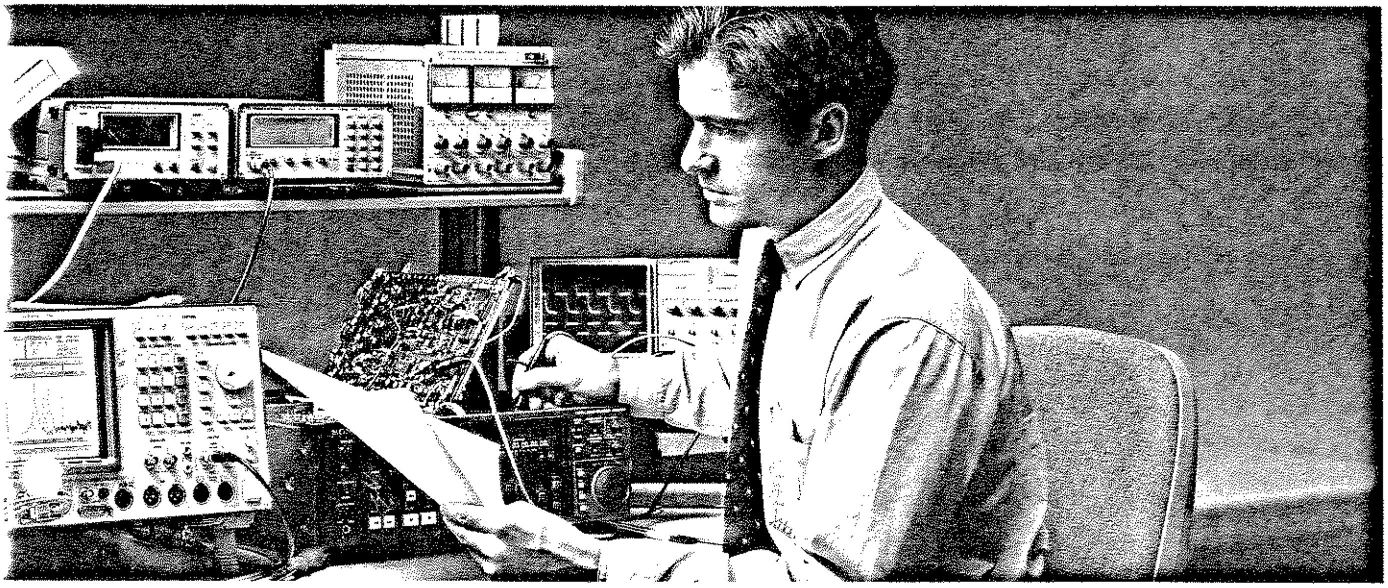
The UPD is the right analyzer for measurements on high-end audio equipment – whether an individual component or an audio mixer in a sound studio. And because it is so compact, the UPD can also be taken along for measurements on site. The UPD demonstrates its strengths in a wide range of applications:

- Entertainment electronics
  - DCC
  - Minidisc
  - CD player
  - Cassette decks
  - Amplifiers
  - Tape decks
  - Car hifi



"Your decision for the UPD is a decision for the future."

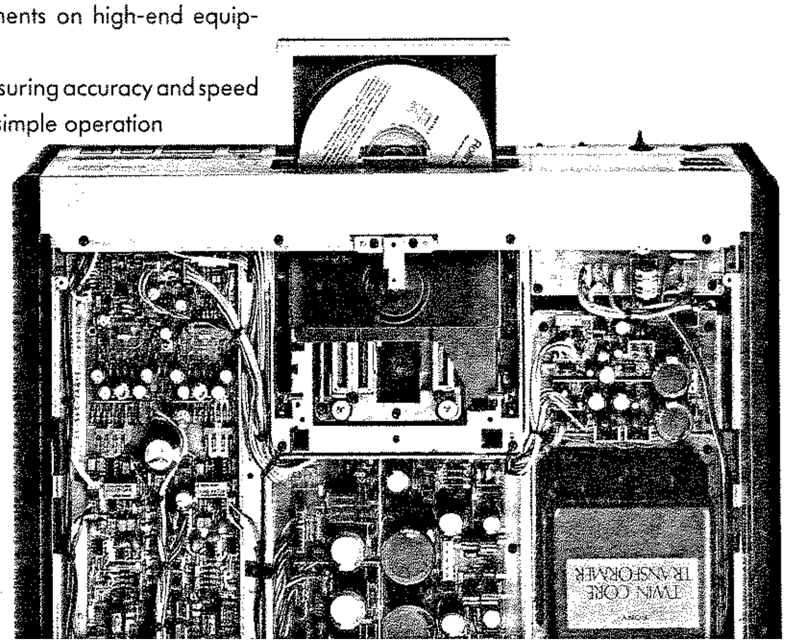
UPD measures where performance is critical



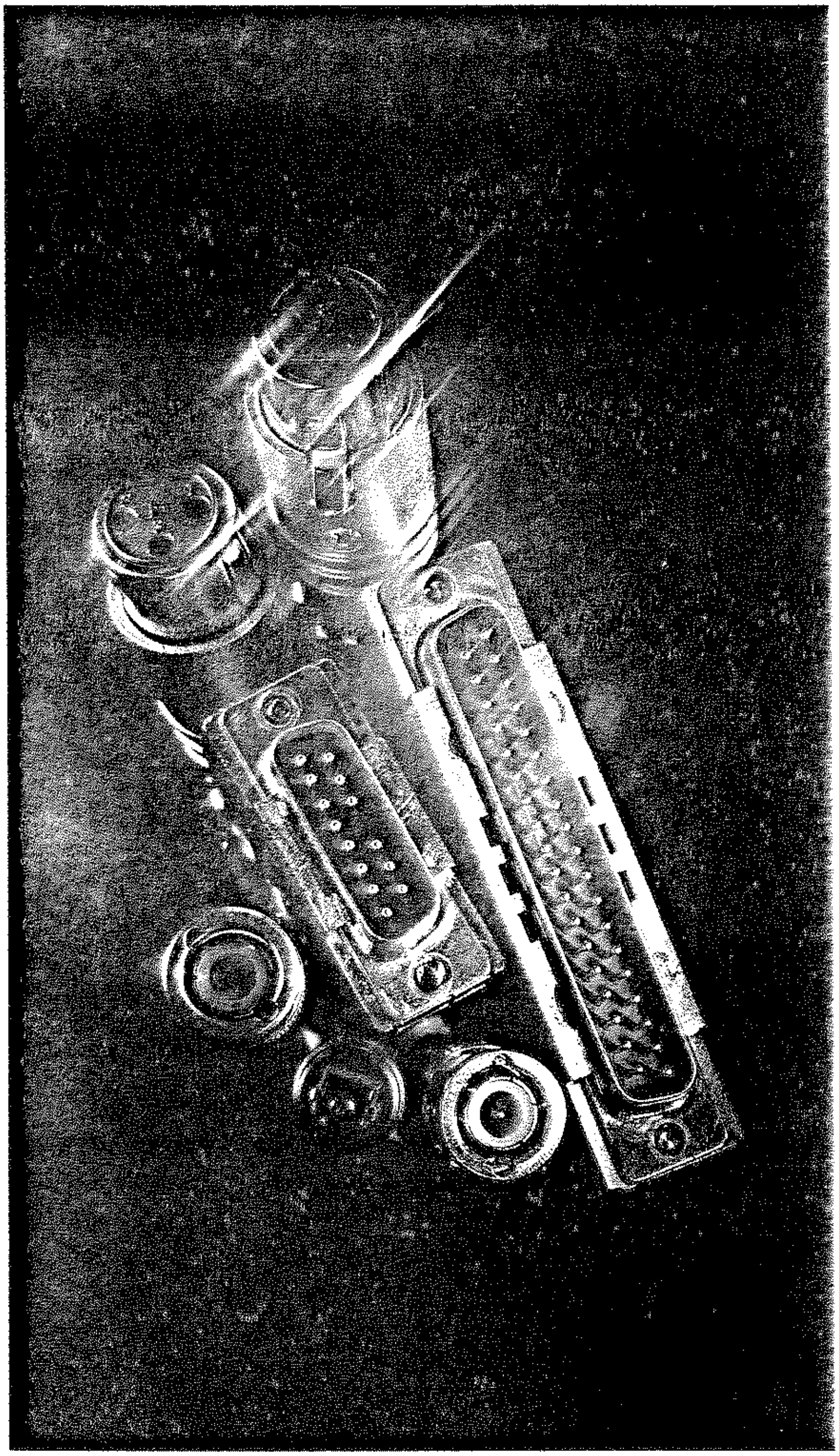
- Professional studio technology
  - Audio mixers
  - Tape machines
  - DAT recorders
  - Sampling rate converter
  - Sound processors etc.
- Transmission links
- Modules and components
  - ADC, DAC
  - Equalizers

The advantages at a glance

- Compact unit with integrated PC
- Two-channel measurement for fast and effective stereo measurements
- Comprehensive range of analysis modes through built-in FFT analyzer
- Quick and easy implementation of new measuring functions with 3½" diskette
- All measurements with any combination of input and output (AA, AD, DA and DD)
- Flexible application through almost unlimited range of filters
- Extremely high dynamic range for measurements on high-end equipment
- High measuring accuracy and speed
- Fast and simple operation



The benefits are measurable in dollars and cents



Measure anything at any interface

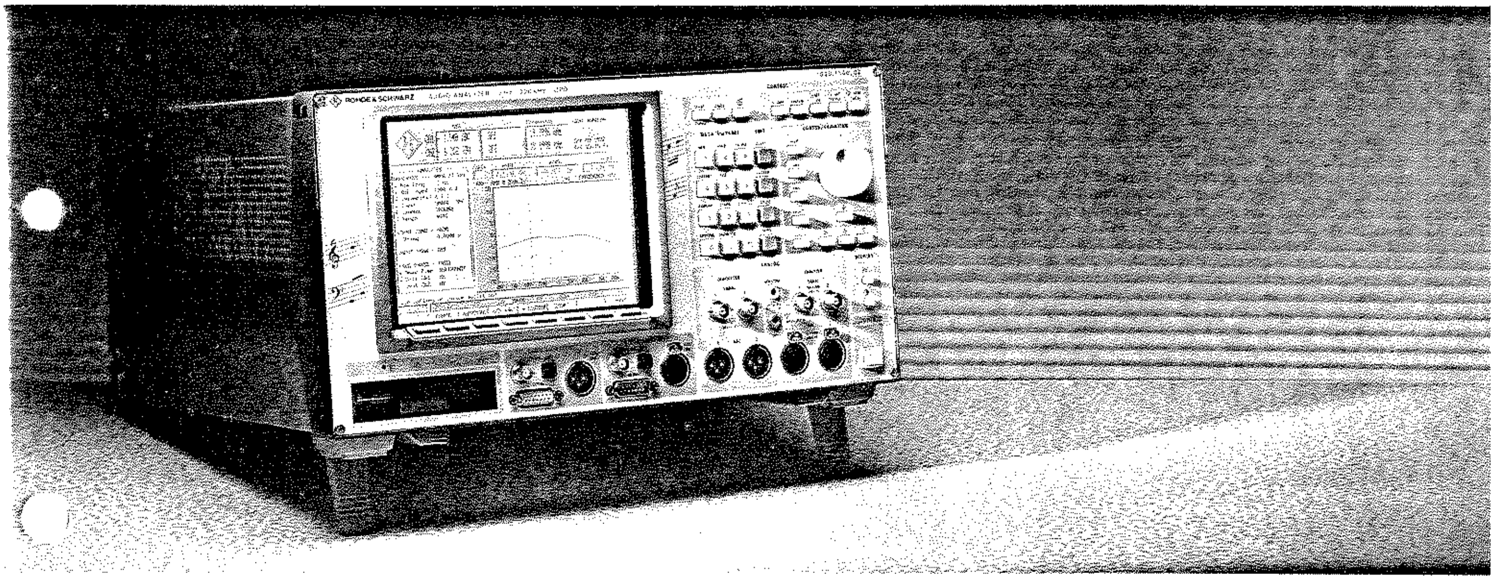
Equipped with all common interfaces, the UPD can measure just about anything. In future you won't need three measuring instruments – but just one. The UPD Audio Analyzer. No matter what interface you have – we'll make the connection.

Programmed for the future

Digital filters and signal processing mean superb accuracy and great flexibility. As filters and signal processing are software-implemented, new features can be added with little effort. Formerly, changed testing requirements often called for the purchase of new equipment. Not with the UPD. A software update is all the is needed.

Pacemaker for measurement

Fast signal setting and high measuring speed are features of the UPD that ensure a high throughput in production and help to reduce costs.



Easy to operate

Despite the wide range of functions offered, intelligent user prompting and context-sensitive help keep the UPD remarkably simple to operate.

Routine measurements become truly routine: call up settings, carry out measurement and generate the protocol at the press of a key. And because familiarization is fast, you save both time and costs.

A sound investment

Many reasons speak for the UPD. Alone the name Rohde & Schwarz holds the promise of superb quality – and of a secure future for servicing and spares. Ensuring that you will be more than happy with your UPD way into the future. And that your investment remains sound for years to come.

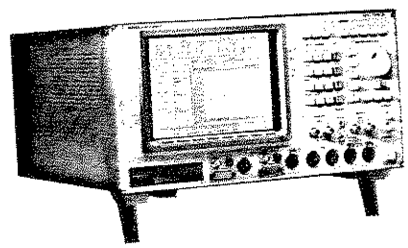
Technical description

The Audio Analyzer UPD contains analyzers and generators for dual-channel measurements and for generating a wide variety of analog and digital audio signals.

Measurement functions

Thanks to the wide range of built-in analysis functions, practically any audio measurement problem can be solved:

- Level or S/N measurements, rms, peak or quasi-peak measurements can be made.
- Selective level measurements. The centre frequency of the bandpass can be swept or can be coupled to the generator frequency, to the frequencies of a multi-tone signal (eg for fast frequency response measurements) or to the input signal.
- SINAD or THD+N measurements. The sum of all harmonics and noise is measured.
- Harmonic distortion measurements. All the harmonics, single harmonics or any combination of harmonics can be measured (Fig. 1).
- Modulation distortion analysis to DIN-IEC 268-3. 2nd and 3rd order intermodulation is measured.
- Intermodulation measurements using the difference tone method. 2nd and 3rd order intermodulation is measured.
- Dynamic intermodulation distortion measurements on the products stipulated in the DIN-IEC standard.
- Wow and flutter measurements to DIN-IEC, NAB, JIS or the 2σ method to DIN-IEC where the demodulated-signal spectrum is also displayed.
- DC voltage measurements
- Frequency and phase measurements
- Polarity test



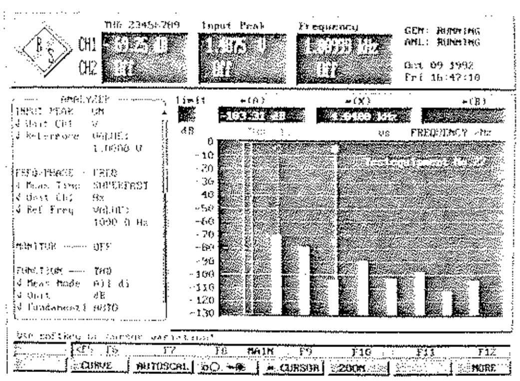


Fig. 1 Values obtained from harmonic distortion and intermodulation measurements can also be displayed as a histogram diagram

FFT analysis

As it contains an FFT analyzer, the UPD can also carry out spectrum analysis (Fig. 2). The number of samples for the fast Fourier transform can be selected from 256 to 8192 in binary steps.

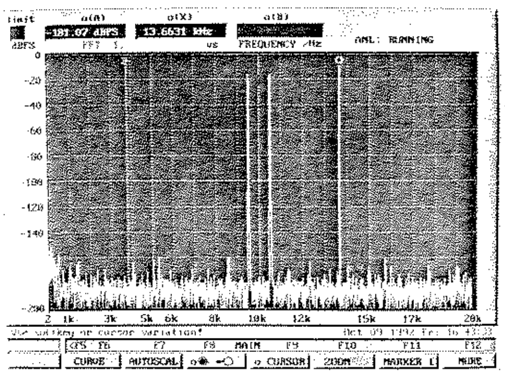


Fig. 2 FFT spectrum of a two-tone signal produced by UPD generator shown in full-screen mode

A special feature is the zoom FFT (Fig. 3). The signal to be measured is digitally processed and the frequency resolution can be increased by a factor of 2 to 256 over a selectable range. In this way, a maximum resolution of 0.02 Hz can be obtained. It must be emphasized that this is not just a scale expansion, the measurement is really made at this higher resolution.

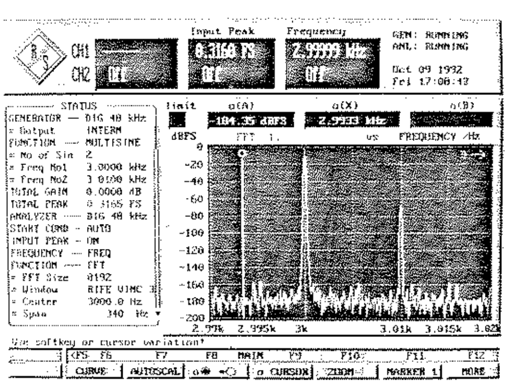


Fig. 3 Zoom FFT of a sinewave signal with a non-harmonic spaced 10 Hz away

Test signals at a glance

The generators in the UPD produce an extremely wide range of analog and digital test signals:

- Sinewaves, for example for level and harmonic distortion measurements. The signal can be connected to an equalizer with a user-selectable nominal frequency response.
- Two-tone signal for modulation distortion analysis (or for intermodulation measurements using the SMPTE method). Various amplitude ratios can be selected and the frequency is continuously adjustable.
- Difference tone signal for intermodulation measurements with continuous setting of the centre frequency and frequency difference.
- Signal for dynamic intermodulation distortion measurements (DIM). It comprises a rectangular signal and a sine signal with an amplitude ratio of 4:1.
- Multi-tone signal comprising up to 17 sinewaves with any frequency and with the same or different levels.
- Sine burst signal with adjustable interval and on-time as well as programmable LOW level, eg for psophometric voltage measurements.
- Sine^2 burst, also with adjustable interval and on-time, eg for testing rms rectifier circuits.
- Squarewave, the ideal signal for measuring the transient response of DUTs.
- Noise with a variety of probability distributions, eg for investigating the DUT's response.
- Special noise signals which are defined by a selectable number of frequencies and their amplitude distributions. The frequency raster can be linked to the analysis raster used for fast Fourier transforms making it possible to rapidly and precisely determine the frequency response of a DUT at one go.
- Arbitrary waveforms – any voltage curve with 16000 points or less can be generated.
- Polarity test signal to check for reversed polarity on the signal path.
- FM signal for simulating impaired audio signals.

These test signals can be continuously varied by means of the variety of sweep modes available. The amplitude and frequency can be swept and in the case of bursts, the interval and the on-time. The sweep is either defined by means of a table or parameters such as start values, number of steps, linear/log stepping or time interval. Two variables can also be swept simultaneously.

Interfaces

All UPD interfaces are dual-channel. All interfaces with the exception of the parallel interface are on the front panel:

Analog interfaces

- Balanced inputs and outputs with a particularly high common mode rejection. A variety of impedances which are commonly used in the studio are provided. They are floating so that measurements can be made on lines which are also used to carry supply voltages (phantom feeds).

- Unbalanced inputs and outputs, also floating (eg to prevent hum loops).

The generator outputs can be internally connected to the analyzer inputs so that different types of measurements can be made without having to change the cabling.

Digital interfaces

- Parallel inputs and outputs for connecting boards or converters with parallel interfaces.

- Serial inputs and outputs for boards with non-standard serial interfaces or audio chips. This interface is user-programmable, ie it can be adapted to practically all serial formats by selecting the appropriate word length, clock polarity, the timing of the sync pulse etc.

- AES/EBU interface for connecting professional studio equipment (option).

- S/P DIF and optical interface for measurements on consumer electronics (option).

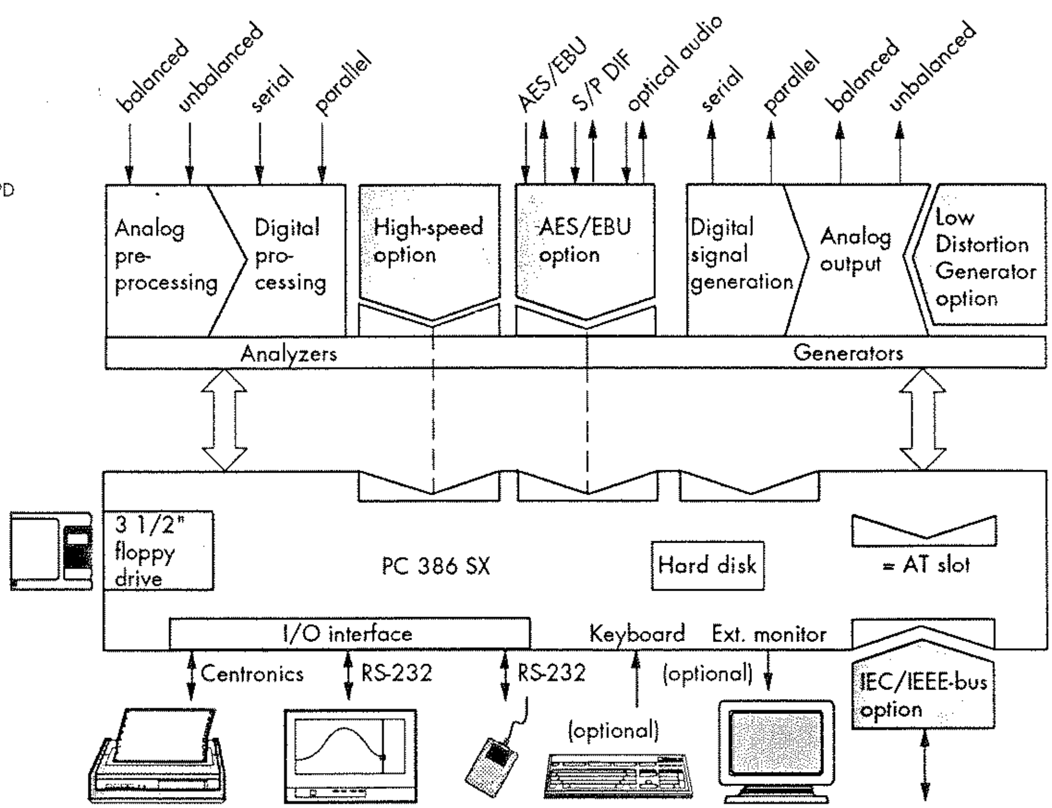
Instrument architecture – leaves way open for extensions

The UPD comprises a generator, analyzer and processor section, the latter being built around a 386 SX-PC (Fig. 4) operating under MS-DOS.

Standard interfaces (2 × RS-232, Centronics, VGA) are provided for a keyboard, mouse, monitor, printer and plotter. A hard disk and a 3.5" disk drive are built in.

This processor concept has distinct advantages:

Fig. 4: Block diagram of UPD



- Test data can be processed further at the MS-DOS level with standard software.
- Free slots for measurement and data processing expansions (eg network board).
- Future-proof – application programs and measurement functions that will be developed in the future can be easily and rapidly loaded using the disk drive.

Signal processing in the generator and analyzer is all-digital. Signals fed in via the analog inputs are also converted to digital signals (after complex analog-signal conditioning) inside the instrument.

All-digital signal processing provides the following:

1. All measurements at all interfaces are carried out in the same way. Results from different interfaces are therefore directly comparable.
2. All measurement signals are available at all outputs, ie measurements with every input/output combination are possible (A/A, A/D, D/A, D/D).
3. The UPD can easily accommodate modifications in test procedures and functions that will be introduced in the future. The user only needs to load the new software.

Digital signal processing also has other advantages. For example, multi-frequency signals can be generated elegantly.

Even the built-in filters are software-implemented. This means that the user essentially has an infinite number of filters at his disposal. The twelve most common weighting filters are available as standard. Other filters can be programmed in a matter of seconds by entering the type (lowpass, highpass, bandpass, bandstop, notch, third octave or octave), frequency and attenuation. The instrument's open architecture really pays off when special requirements have to be met. Special filters can be implemented using commercially available filter design programs. The data is transferred to the UPD and the designed filter is looped into the signal path.

Lots of functions but easy to operate

Attempts to create an easy-to-use universal measuring instrument with a wide range of measurement and generator facilities often do not produce the desired result. The UPD, however, has succeeded where others have failed. The following are the salient features:

- Short learning time thanks to an easy-to-understand operating concept and treating analog and digital measurements in the same way.
- Operator is not bombarded with unnecessary information. Only essential parameters and settings are displayed – the others are available in the background. For example, the sweep parameters are only transferred to the generator panel and displayed when the sweep function is selected.
- Operation is safe from incorrect entries. The UPD will only accept entries that make sense in the context of the measurement being performed. The range of the parameter to be entered for any menu item is also displayed. Incorrect entries are ignored.
- Self-documentation. A comprehensive help system with information on all current menu items explains the application or function in question in Englisch or German.

The LCD screen has a principle role to play in the operation of the UPD. All setting parameters and results are displayed on it in a clear and logical way. Related functions and settings are displayed together in panels which can be selected with one keystroke. A maximum of three panels can be displayed simultaneously (Fig. 5).

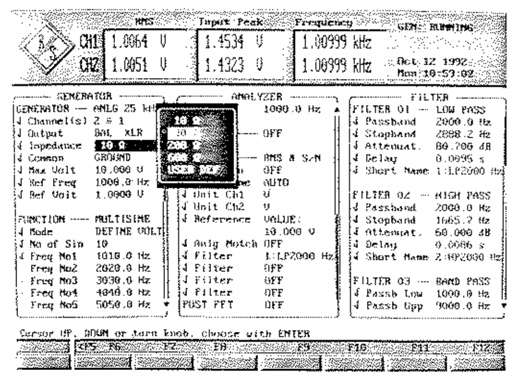


Fig. 5 Related functions and settings are combined in panels

The operator can choose to make entries either from the instrument front panel, from an external keyboard or with a mouse.

Results at a glance

The way results can be displayed on the UPD is really unique. The results for both channels can be displayed simultaneously on the screen in numerical and graphical form. The peak values of the input signals and the frequency and/or phase can also be displayed. The graphics modes range from the bargraph (Fig. 6) through the spectrum display to the three-dimensional waterfall display (Fig. 7). Results can be read off from the graphics with vertical and horizontal cursors. Tolerance masks or stored results can also be added to the screen and compared with the graphics. A full-screen display is also possible (Fig. 2). Hardcopy can, of course, be printed out on a printer or plotter. Over 200 printer drivers are supplied with the UPD.

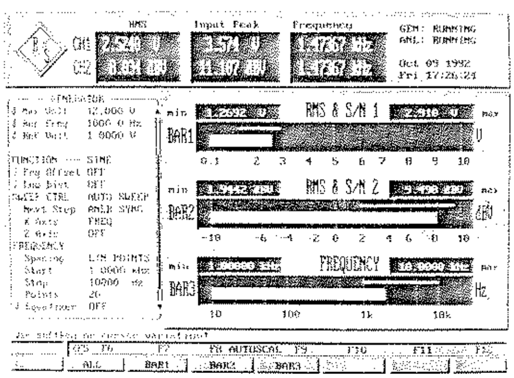


Fig. 6 Bargraph display of rms value for both channels and of frequency with maximum and minimum indications superimposed

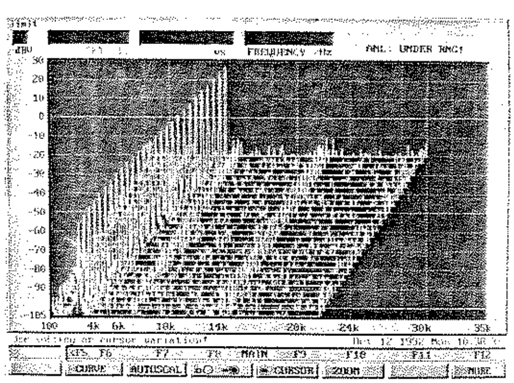


Fig. 7 Three-dimensional spectral display (waterfall)

The status panel – a useful special feature

It is often the case that only a few parameters have to be modified after a measurement sequence has been started. The UPD takes this requirement fully into account. Entry lines can be taken from the entry panels for the generator, the analyzer etc. and transferred to the status panel. This clear summary of the measurement routine has the following advantages:

- Instrument settings can be displayed together with graphical and numerical results (Fig. 3).
- All important information can be printed on a single hardcopy.
- Instrument settings can be modified quickly without changing panels as the UPD can also be operated from the status panel.

Options for more advanced applications

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

AES/EBU interface
This interface option (UPD-B2) contains the AES/EBU interface, the S/P DIF interface and the optical interfaces. Thanks to the extra signal processor on the plug-in card, user bits, status bits etc. can be generated and analyzed as well as audio bits. The output level is programmable. An additional high-impedance input makes it possible to make measurements without disconnecting the signal path.

High-speed option
In the design of the UPD, obtaining high measurement speed was one of the priorities. A dual-channel design was therefore adopted for all analog circuits. The processor operations for the two measurement channels are time-multiplexed. If extremely high speeds are required, say in a production environment, the High-speed Option UPD-B3 can be used. With this option, even the digital processing for the two channels is performed in parallel.

IEC/IEEE-bus option

The IEC/IEEE-bus Option UPD-B4 makes it possible to remote control the UPD to IEC 625 or IEEE 488. The commands implemented correspond for the most part to SCPI guidelines.

With the exception of the UPD-B3, all options are cards and software packages which the user can slot in and load himself.

Condensed Specifications

All inherent spurious for the frequency range 20 Hz to 22 kHz with option UPD-B1 (Low Distortion Generator) fitted.

Analyzers

Analog inputs	
Balanced	2 independent channels, each floating, XLR connectors (female)
Level measurement range	0.1 µV to 35 V_{rms}
Common mode rejection	>110 dB (50 Hz)
Crosstalk attenuation	>120 dB (<22 kHz)
Input impedance	300 Ω/600 Ω/20 kΩ/1 value as specified by customer
Unbalanced	2 independent channels, BNC connectors, each floating (optionally to ground)
Level measurement range	0.1 µV to 300 V_{rms}
Crosstalk attenuation	>120 dB (<22 kHz)
Input impedance	1 MΩ
Generator output	each output switchable to any input
Frequency range	2 Hz to 300 kHz
Frequency response flatness	±0.03 dB (20 Hz to 22 kHz, referred to 1 kHz)

Digital inputs	
Parallel, channel 1/MUX	28 bit parallel, either channel 1 or channels 1 and 2 multiplexed
Parallel, channel 2	provided by option UPD-B3
Word clock	pos./neg. edge
Word select (MUX mode)	low/high
Serial	channel 1 or 2 or channels 1 and 2 multiplexed
Word length	8/16/24/32 bits
Word offset	max. ± half word length relative to word select
Bit clock	pos./neg. edge
Word clock	pos./neg. edge
Word select (MUX mode)	low/high
Data format	MSB/LSB first
Clock rates	32/44.1/48 kHz/integral multiples to 768 kHz max. and user-definable external clock rates
AES/EBU option	
AES/EBU input	XLR connector (female), 110 Ω and high impedance (10 kΩ)
S/P DIF input	BNC connector, 75 Ω
Optical input	Toslink system
Clock rates	32/44.1/48 kHz
Frequency range	2 Hz to 45.3% of clock rate
Frequency response deviation	none

Measurement functions	**Analog analyzers ←**	**Digital analyzers →**
AF level		
Inherent noise (600 Ω)	1.0 µV (A weighting) ← 1.6 µV (CCIR unweighted) ←	−180 dBFS →
Error limit	±0.05 dB (V_{rms}, 1 kHz)	
Weighting	RMS, peak[2], quasi-peak (CCIR 468)[2]	
Filters	CCIR weighted and unweighted, CCITT, A-weighting, C-message, 75-µs deemphasis, 50-µs deemphasis, J.17 deemphasis, DC noise highpass, rumble filter weighted and unweighted; highpass, lowpass, bandpass, band-stop, notch, third-octave and octave filters freely configurable by user in terms of cutoff frequencies and attenuation; max. of four filters can be combined	
S/N measurement	integrated	
Selective level		
Centre frequency	input value/swept/coupled to generator or input frequency	
Bandwidth (0.1 dB)	1%/3%	

Total harmonic distortion (THD)		
Fundamental	10 Hz to 110 kHz	
Inherent distortion (Σ 2nd to 9th order)	−115 dB[1] ←	−130 dB[1] →
Weighted harmonics	all (2nd to 9th)/all even/all odd/any sum of harmonics	
SINAD or THD+N		
Fundamental	25 Hz to 110 kHz	
Inherent distortion	−110 dB[1] ←	−120 dB[1] →
Filters	highpass and lowpass with selectable cutoff frequency	
Modulation distortion	2nd and 3rd order	
Measurement procedure	selective to DIN-IEC 268-3, 1991	
Inherent distortion	−108 dB ←	−130 dB →
Difference tone	2nd or 3rd order	
Measurement procedure	selective to DIN-IEC 268-3, 1991	
Inherent distortion d2	−125 dB ←	−130 dB →
Inherent distortion d3	−107 dB[1] ←	−130 dB →
Dynamic intermodulation distortion (DIM)[2]		
Measurement procedure	selective to DIN-IEC 268-3, 1991	
Inherent distortion	−90 dB[1] ←	−100 dB →
Wow and flutter[2]		
Measurement procedure	DIN-IEC/NAB/JIS/2σ (IEC 386, 1988)	
Frequency	2 Hz to 300 kHz	
Measurement error (S/N >80 dB)	±0.005%	
Phase	2 Hz to 110 kHz ←	not possible →
Measurement error	0.1° (1 kHz)	
DC voltage	0 to ±35 V balanced ← 0 to ±500 V unbalanced ←	not possible →
Polarity test		
FFT analyzer		
Frequency range	2 Hz to 300 kHz ←	2 Hz to 45.3% of clock rate →
FFT size	256/512/1k/2k/4k/8k points	
Window functions	rectangular/Hann/Blackman-Harris/Rife-Vincent 1 to 3/Hamming/flat-top/Kaiser	
Averaging	max. 32-fold	
Max. resolution	0.023 Hz (for zoom factor of 256 and 48-kHz clock rate)	
Dynamic range	140 dB	

Generators

Analog outputs	
Balanced	2 channels, XLR connectors (male), floating (optionally to ground)
Output voltage	0.1 mV to 24 V_{rms} (unloaded)
Common mode rejection	>85 dB (at 1 kHz, open output)
Crosstalk attenuation	120 dB (<22 kHz)
Output impedance	10/30/200/600 Ω/1 user-selectable value
Unbalanced	2 channels, BNC connectors, floating
Output voltage	0.1 mV to 12 V_{rms} (unloaded)
Crosstalk attenuation	>110 dB (<22 kHz)
Output impedance	5 Ω/15 Ω/1 user-selectable value
Universal generator	
Frequency range	2 Hz to 110 kHz
Frequency response flatness	±0.05 dB (20 Hz to 22 kHz, referred to 1 kHz)
Inherent distortion	−96 dB
Option UPD-B1 (Low Distortion Generator)	
Frequency range	10 Hz to 110 kHz
Frequency response	±0.05 dB (20 Hz to 25 kHz, referred to 1 kHz)
Inherent distortion	−115 dB

Digital outputs	
Parallel, channel 1/MUX	28 bit parallel, either channel 1 or channels 1 and 2 multiplexed
Word clock	pos./neg. edge
Word select (MUX mode)	low/high
Serial	channel 1 or channel 2 or channels 1 and 2 multiplexed
Word length	8/16/24/32 bits
Word offset	max. ± half word length relative to word select
Bit clock	pos./neg. edge
Word clock	pos./neg. edge
Word select (MUX mode)	low/high
Data format	MSB/LSB first
Clock rates	32/44.1/48 kHz/integral multiples to 768 kHz max. and user-definable external clock rates
AES/EBU option	
AES/EBU output	XLR connector (male), 110 Ω
S/P DIF output	BNC connector, 75 Ω
Optical output	Toslink system
Clock rates	32/44.1/48 kHz and synchronization to input signal or external word clock
Frequency range	2 Hz to 45.3% of clock rate
Frequency response deviation	none
Inherent distortion	−130 dB

Generator functions	**Analog generators ←**	**Digital generators →**
Sine		
Inherent distortion	−115 dB[3]) (20 Hz to 22 kHz) ←	−130 dB →
Inherent THD+N	−110 dB[3])[1]) (20 Hz to 22 kHz) ←	−130 dB →
Intermodulation signal for modulation distortion analysis	selectable signal frequency, interfering frequency and amplitude ratio	
Inherent distortion	−110 dB[3]) ←	−130 dB →
Two-tone signal for DFD analysis	selectable centre frequency and frequency offset	
Inherent distortion d2	−125 dB[3]) ←	−130 dB →
Inherent distortion d3	−107 dB[3])[1]) ←	−130 dB →
Intermodulation signal for DIM analysis[2])[3])		
Inherent distortion	−90 dB[1])	
Multi-sine	amplitude and frequency individually selectable	
Max. number of frequencies	17	
Sine burst	level ratio and duty cycle selectable	
Sine² burst	duty cycle selectable	
Rectangular wave	max. 10 kHz	
Noise	flat/normal/triangular distribution	
Multi-frequency noise	band-limited, white/pink/user-specific	
Arbitrary waveform	any waveform from file	
Max. number of points	16000	
Polarity test signal[2])		
FM signal[2])	modulation deviation, modulation frequency and carrier frequency selectable	
Sweeps	frequency/amplitude/burst interval/burst duration/time	
Sweep modes	linear/log/from table, one/two dimensional, single-shot/repetitive, automatic/manual	

I/O interfaces

Screen	9", LCD, monochrome
Display modes	– bargraph for instantaneous results with min/max indication – curve plot for any sweep – list of measurement curves – spectra, also waterfall display mode – result histogram for THD and intermodulation measurements
Display functions	– autoscaling – X-axis zoom – full-screen and part-screen mode – 2 vertical cursors – 1 horizontal cursor – find peak – markers for harmonics (with spectra) – graphics labelling – change of units and scaling possible, even for loaded curves
Result logging	
Interfaces	2 × RS-232, Centronics, IEC 625/IEEE 488 (option UPD-B4)
Printer driver	200 supplied
Plotter language	HP-GL
Functions	– screen copy, also as PCX and HP-GL file – measurement data in table form – sweep tables – tolerance masks – list of values exceeding limits – equalizer curves
Memory functions	instrument settings, spectra, sweep results, sweep tables, tolerance masks, equalizer curves
Remote control	to IEC 625-2/IEEE 488, commands mostly in conformity with SCPI (option UPD-B4)

General data

Rated temperature range	0 to +45 °C (no condensation)
RFI/EMI	to EN 50081-1
EMS	to EN 50082-1
Power supply	100/120/220/230/240 V ± 10% 290 VA, 47 to 63 Hz
Dimensions (W × H × D)	435 mm × 236 mm × 475 mm
Weight	22 kg

Ordering information

Order designation	Audio Analyzer UPD	1030.7500.02
Accessories supplied	power cord, operating manual, backup disk with MS-DOS operating system, backup program disk with operating and measurement software	
Options		
Low Distortion Generator	UPD-B1	1031.2601.02
AES/EBU Interface	UPD-B2	1031.2301.02
High-speed Extension	UPD-B3	1031.2001.02
IEC-625/IEEE-488-bus Interface	UPD-B4	1031.2901.02
Recommended extras		
19" Adapter (incl. front handles)	ZZA-95	0396.4911.00

[1]) Total inherent spurious from generator and analyzer
[2]) Not over whole frequency range
[3]) Only with low distortion generator option fitted

PD 757 · 0006.21 · Subject to change · Data without tolerances: order of magnitude only · Printed on chlorine-free paper as a contribution to environmental conservation.

ROHDE&SCHWARZ

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ROHDE&SCHWARZ

EC Certificate of Conformity

(to EMC Directive 89/336/EEC)

CE

This is to certify that

Audio Analyzer
UPD
1030.7500.02

(equipment, type, designation)

complies with the provisions of the Directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 89/336/EEC).

This declaration of conformity of the European Communities is the result of an examination carried out by the quality assurance of **ROHDE & SCHWARZ** in accordance with European Standards EN 50081-1 and EN 50082-1, as laid down in Article 10 of the Directive.

ROHDE & SCHWARZ
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DIN ISO 9001

ZERTIFIZIERTES QUALITÄTSSICHERUNGSSYSTEM

REG. NR. 1954-02

Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätssicherungssystems entwickelt, gefertigt und geprüft. Das Rohde&Schwarz-Qualitätssicherungssystem ist nach ISO 9001 zertifiziert.

Sollten Sie trotzdem bei der Erst-Inbetriebnahme Anlaß zu einer Beanstandung haben, senden Sie bitte das rückseitige Fax-Formular ausgefüllt zurück. Beauftragen Sie bei Bedarf die nächstliegende Rohde&Schwarz-Servicestelle mit der Reparatur.

Certificate of quality

Dear Customer,

You have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality assurance standards. The Rohde& Schwarz quality assurance system is certified according to ISO 9001.

Should you nevertheless have cause for a complaint after putting your product into operation for the first time, please fill in the Fax form on the back and return it to us. If the need arises, request your nearest Rohde&Schwarz service center to carry out the repair.

Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes d'assurance-qualité. Le système d'assurance-qualité de Rohde&Schwarz a été homologué conformément à la norme ISO 9001.

Si, malgré cela, vous avez des réclamations lors de sa première mise en marche, nous vous prions de bien vouloir remplir le formulaire de télécopie au verso et de nous le retourner. Le cas échéant, contacter le point de service après-vente Rohde&Schwarz le plus proche pour qu'il effectue la réparation.

ROHDE&SCHWARZ

095 1000 810-0394

ROHDE&SCHWARZ

Empfänger
Addressee
Destinataire

ROHDE & SCHWARZ GmbH & Co. KG
Zentrales Qualitätswesen
Mühldorfstraße 15

D-81671 München

Telefax-Nr. des Empfängers
Telefax number of addressee
N° de téléfax du destinataire

(*49) 89 4129 3325

Betreff Subject Sujet	Anlieferfehler Dead on Arrival Défaut constaté a l'arrivée

Absender
Sender
Expéditeur

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Telefon
Telephone
Téléphone

Telefax
Téléfax

Anzahl der Seiten inkl. dieser Seite
Number of pages incl. this page
Nombre de pages incluant cette page

Beanstandung / Shortcomings / Défauts

Gerätetype:
Type:
Type d'appareil: ______________________________

Sach-Nr.:
Stock No.:
N° de référence: ______________________________

Serien-Nr.:
Serial No.:
N° de série: ______________________________

R&S-Auftrags-Nr.:
R&S Order No.:
N° de commande R&S: ______________________________

Kurze Beschreibung der Beanstandung / Short description of shortcoming / Description de défaut:

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Datum / Date / Date Unterschrift / Signature / Signature

Supplement to UPD Operating Manual

Contrary to the present manual, the following functions which are described in this manual have not yet been implemented in software version 2.0:

- Screen hardcopy to plotter and HPGL file.
- Analyzer function Filter Sim (filter simulation).

Important!

The C: \UPD\READ.ME file gives essential information which is still to be considered in the manual as well as information on alterations.

Every new function is individually described in the help function of the UPD. A help for special applications of the UPD is also to be found there.

1 Preparations for Use

1.1 Start-up Procedure

1.1.1 Setting up the Audio Analyzer

The UPD can be operated in the following positions:

- Horizontal position: fold out the front feet provided on the instrument bottom in order to obtain an enhanced view to the LC display.

- Vertical position tilted on its rear panel. Fold out the feet provided on the rear panel and use a 90% offset power connector (included in the accessories supplied).

Note:
To ensure optimum performance of the audio analyzer observe the following:
- Do not cover the lateral ventilation openings.
- Adhere to the permissible ambient temperature specified in the data sheet.
- Avoid moisture condensation. If it has already occured, dry out the instrument before switching it on.

1.1.2 Rackmounting

Mounting into 19"-racks is possible using the 19"-adapter ZZA-95 (order no. 0369.4911.00).

Note:
To ensure optimum performance of the audio analyzer observe the following:
- Be sure sufficient air is supplied within the rack.
- There must be adequate space between ventilation openings and rack housing.
- Make sure air convection for the heat sink at the instrument rear is not impeded.

1.1.3 Power Supply

The UPD is powered by AC voltages of 100 V, 115 V, 120 V, 220 V, 230 V and 240 V, each with a tolerance of ± 10 % and frequencies between 47 Hz and 63 Hz.

Before initial power-up, check that the correct supply voltage is set. If it is not correct, it must be reset as follows:

- Remove the power cord.

- Open cap of voltage selector using a slotted screwdriver.

- Remove both fuse holders and insert fuses with the appropriate value (included in the accessories supplied):
  Rated voltages 100 to 120 V,
  2 fuses T 3.15 L (IEC 127-2/III)
  Rated voltages 220 to 240 V,
  2 fuses T 1.6 L (IEC 127-2/III)

- Insert the fuse holder.

  Remove the cylinder labelled with the rated voltages and re-insert it such that the value visible in the cap window when fitted corresponds to the desired rated voltage. If there is no suitable imprint, select the value closest to the desired one.

- Close the cap.

1.1.4 Switching-on

Note:
Make sure no diskette is available in the disk drive when turning the audio analyzer ON (press ON/OFF switch on the front panel).

Switch-on of the UPD is followed by the system start-up, self-test of the controller and loading of the MS-DOS operating system as well as of the measurement and operating software from the hard disk. While the UPD switch-on logo is being displayed, the self-test of the measurement hardware is executed (see Section 4.2, Function Test). The last UPD setup which has been automatically stored is subsequently loaded from the CMOS-RAM, setting the UPD to the status valid before switch-off.

Note:
If no characters are displayed on the screen after switch-on, the contrast control may be misadjusted. Set the contrast for the desired angle of view.

For operation of an external monitor, refer to Section 2.16, Connecting External Devices.

Note:

- The system self-test also includes checking the availability of an external keyboard (see 2.16, Connecting External Devices). If an external keyboard is connected, it can be used for operating the UPD.
- Connecting the external keyboard after having turned on the UPD may involve that the software does not recognize the keyboard i.e. it is without function.
- With the use of an external keyboard, the storage test of the system can be aborted - while the storage addresses are being counted up - using the ESC key.
- The message

  PRESS <DEL> IF YOU WANT TO RUN SETUP/EXTD-SET

  is displayed during system start-up. Pressing this key allows you to enter the SETUP program where system configuration, date and time can be defined. We advise against calling this program as changing its settings, though inadvertently, may cause the UPD to work incorrectly or not work at all.

  Calling this program is required only after battery replacement. (Section 4.3, Troubleshooting, deals with battery replacement and setups and, in addition, how to correct a misadjusted SETUP.) If required, date or time should be changed using the DOS commands DATE and TIME (see 2.15.8 or DOS manual).

1.1.5 Switching-off

- Wait until there are no accesses to the hard disk or disk drive anymore (LED OFF).
- Remove the diskette from the drive.
- Press the ON/OFF key on the front panel. (All UPD setups are maintained.)

1.2 Fitting Options and Plug-in User Cards

Important!
All options are sensitive to electrostatic charge. Handle them in line with ESD-regulations.

Assembly (applies to all options):

- Turn the UPD off, disconnect the power cable.
- Unscrew the feet from instrument rear (four Phillipps screws).
- Slide the upper panelling slightly to the rear and withdraw.
- After having fitted the option remount all covers, brackets and clamps in reverse order to that of removal. Fit the panelling and the instrument feet.
- Turn the UPD on. Install supplementary software supplied, if any, according to instructions. The software automatically recognizes the fitted option.

1.2.1 Fitting the Low-distortion Generator Option (UPD-B1)

- Remove the cover plate from the analog unit (on the right when seen from the front).
- Unscrew the board holding device from the center panel.
- Insert the board into the short slot X26 of the analog motherboard.

After installation of the board, level and frequency accuracy must be calibrated. No external measuring equipment is required for this purpose as the generator signal is measured via an internal connection by the analyzer. However, be sure the other two boards of the analog generator and of the analog analyzer have been adjusted and calibrated.

The frequency is measured using the frequency counter in the UPD.

The voltage is calibrated relative to the universal generator: the reference is not the measuring accuracy of the analyzer but the signal of the universal generator ANLG 110 kHz. The LOW DISTORTION GENERATOR thus provides the same level accuracy as the factory-calibrated universal generator.

Caution:
During calibration, any cables must not be connected to the outputs of the generator or to the inputs of the analyzer.
Ambient temperature 23 ± 5 °C.
Warm-up time of UPD at least 2 hours

Calibration:
- Turn UPD on.
- Wait until the instrument has warmed up.
- Invoke the calibration routine in the OPTIONS panel under CALIBRATION GEN by selecting ONCE in line LDG Auto. The calibration is executed automatically.

1.2.2 Fitting the AES/EBU-S/P DIF Option (UPD-B2)

- Fit the option into AT slot no. 5 (identification SLOT 5, see top side of rear panel).
- Remove the clamp over the large plug-in cards.
- Remove the mounting bracket of the second four plug-in cards (2 screws on instrument rear panel) and withdraw rear-panel section.
- Insert the option into AT slot no. 5.
- The UPD basic unit already contains the cables (one ribbon cable, three shielded cables) connecting the front-panel connectors to the option board.

  Ribbon cable → X51
  Coax cable W510 → X510
  Coax cable W512 → X512
  Balanced cable W511 → X511

- Connect jumper wire W50 to connector X50 of option and connector X50 (3rd from behind) of plug-in card A 12.

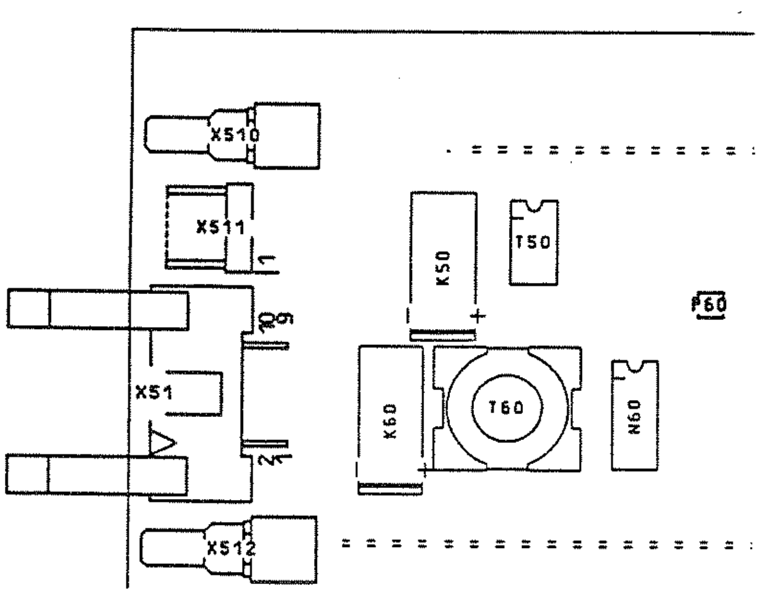


Fig. 1-1 Connector assignment on option board

1.2.3 Fitting the High-speed Option (UPD-B3).

Note:
This option can be fitted only in a Rohde & Schwarz service station because of the calibration required after its installation.

- The larger one of the two option boards is fitted into the last AT slot (identified by SLOT 8 on top side of rear panel).
- Remove the clamp from the large plug-in cards.
- Detach the mounting bracket from the second four plug-in cards (2 screws on instrument rear panel) and remove rear-panel section.
- Disconnect the following cables:

Cable	Plug-in card	Connector
W93	A12 (SLOT 6)	X90 (first from behind)
W32	A12 (SLOT 6)	X30 (second from behind)
W31	A11 (SLOT 7)	X30 (first from behind)

- Insert the option into the AT slot stated above.
- Connect the following cables in the order given below:

Cable	Plug-in card	Connector
W35	A15 (SLOT 8)	X30 (first from behind)
W31	A11 (SLOT 7)	X30 (first from behind)
W32	A12 (SLOT 6)	X30 (second from behind)
W93	A12 (SLOT 6)	X90 (first from behind)
Brücke W71	A11 (SLOT 7)	X71 (second from behind)
Brücke W71	A15 (SLOT 8)	X71 (second from behind)

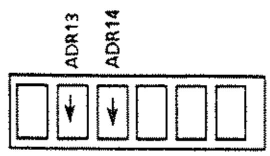
- Remove the cover from the chamber for the analog hardware (to the right when seen from the front).
- Tilt the UPD on its side, remove the lower panelling.
- Remove SMB connector from the bottom of the analyzer board for channel 2 (directly next to the side panel). Withdraw the board from the UPD.
- Remove the smaller one of the two shielding covers on component side.
- Insert the second option board into the open chamber: fix the hooks on the shielding panel and insert the board fixing it from the rear of the main board with the two screws supplied.
- Mark with a cross the field "ADC-Board included" on the adhesive label on the shielding panel of the analyzer board using a felt-tip pencil.

Note:
When reassembling the UPD do not forget to plug in the coax connector.

1.2.4 Fitting the IEC-625/IEEE-488 Option (UPD-B4)

- Fit the option into AT slot no. 1 (identified by SLOT 1, see top side of rear panel).
- Remove the bracket of the first four plug-in cards (2 screws on instrument rear panel) and withdraw rear-panel section.
- Unplug cable W145 of the adjacent controller card.
- Check on correct selection of address range, DMA channel and interrupt line.

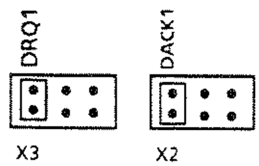
Address range:
Switch S1
(Top view)



Used addresses:

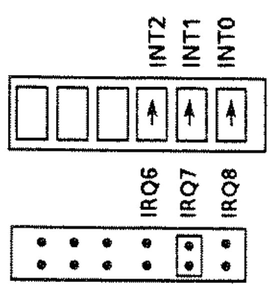
02E1	06E1	0AE1	0EE1
12E1	16E1	1AE1	1EE1
82E1	86E1	8AE1	8EE1
92E1	96E1	9AE1	9EE1

DMA channel:



Select DMA channel 1 using the plug-in jumpers.

Interrupt line:
Switch S1
(Top view)



Select Interrupt 7 using switch and jumper.
- Insert the option into AT slot no. 1.
- Reconnect cable W145.
- Install the software in line with the supplied instructions.

1.2.5 Fitting User Plug-in Cards

Any free AT slot can be used for fitting the cards. Install them in the same way as the IEC-625 option described above.

Note:
Interrupts 10 and 11 out of the free interrupts of an AT are already used in the UPD. The I/O addresses 390H-393H and the DMA channels 5 and 6 are assigned.

With the IEC-625/IEEE-488 option (UPD-B4) fitted, the addresses, DMA- and interrupt lines stated above are also assigned.

1.3 Software Re-installation

Two diskettes are supplied together with your UPD:

- UPD System Disk, containing all programs associated with MS-DOS.
- UPD Program Disk, including the complete UPD operating and measurement software.

The UPD is supplied with the operating system and the UPD software already installed on the built-in hard disk. The supplied diskettes are needed only when the complete software or sections thereof have been deleted inadvertently by the user. The MS-DOS and UPD software can also be installed separately.

Note:
The UPD software is supplied in packed format and unpacked only during installation (the software then considerably exceeds the capacity available on the diskette). The unpacking program may output messages such as "Exploding...", "Unpacking" etc. These messages are correct and do not mean faulty installation.

Installing the MS-DOS operating system:

- Connect the external keyboard.
- Turn the UPD on.
- Press the CTRL, ALT, DEL keys.
- The installation program is started.

Continue the installation following the notes on the screen.

Installing the UPD operating and measurement software:

- Connect the external keyboard.
- Turn the UPD on.
- Exit the UPD operating software by pressing ESC key while the switch-on logo is being displayed on the screen, or, with the UPD operating software loaded, by pressing the SYSTEM key and Enter (corresponds to "Normal Exit to DOS" in the selection box).
- Insert the UPD program diskette.
- Key in A :, press Enter.
- Key in UPDINST, press Enter.

The UPD software is now copied to the hard disk.
Continue the installation following the notes on the screen.

The UPD operator surface will then be displayed on the LCD screen.

Note:
If an updated version of MS-DOS or of the UPD software is to be installed, also proceed as described above.

The files copied to the hard disk during installation are stored in the following directory structure:

```
C:\ ──┬── DOS
      ├── UTIL
      ├── TEMP
      ├── MOUSE
      │
      └── UPD ──────┬── REF
                    ├── SETUP
                    ├── USER
                    ├── DSP
                    └── DRIVER
```

The READ.ME file in the C:\ directory refers to the contents of the individual directories and files.

After installation, the \DOS, \UTIL and \UPD paths are defined.

Note:
To ensure correct functioning of the UPD measurement and operating software, do not modify the directory structure stated above nor the paths.

Installing the Mouse:

For operation of the UPD via a mouse, the mouse driver used must be stored under the name mouse.com in the UPD path C:\MOUSE.
The desired mouse driver must be available on a 3.5"-diskette.

Proceed as follows:
In the following example, the name of the mouse driver to be installed is msmouse.com and is available in the root directory on the diskette.

- Insert the diskette into the 3.5"-drive.
- Execute the following DOS-command:
  copy a:msmouse.com c:\mouse\mouse.com

For connection of the mouse, see 2.16 Connecting External Devices.

Operation of the UPD using DOSSHELL
Setting of the keypad:

DOSSHELL is a program of operating system MS-DOS which permits the fast change between different applications.
Whether UPD is to be executed together with DOSSHELL is set using command BOOTSET. This command also permits the selection of the keypad between German and English key assignment.

Advantages in using DOSSHELL:

- easy changeover between UPD and other programs (e.g. editor and user programs)

Disadvantages in using DOSSHELL:

- UPD absolutely requires an external keypad to be operated.
- UPD becomes slower because the space available for the UPD becomes smaller.
- Operation using the mouse can lead to the breakdown of DOSSHELL.

Further notes on DOSSHELL: cf. MS-DOS manual

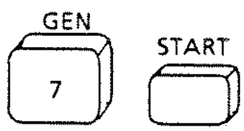
2 Manual Operation

Note:
You do not need any specific knowledge as to the MS-DOS operating system for use of the UPD.

We assume that you know what is meant by eg a file, a directory or a path and do not provide any further explanations on that.

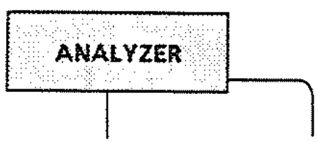
If you do not have this knowledge or, if the UPD is to be used as a computer (see Section 2.17) for eg data reprocessing, please refer to the MS-DOS manual. It is included in the accessories and can be ordered under the order designation given in the data sheet.

Legend of graphic symbols used in this manual:

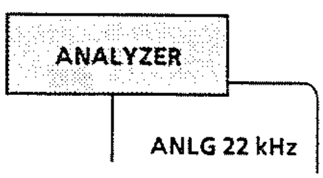


Front-panel keys

Softkey



Menu item of a panel



Parameter of a menu item

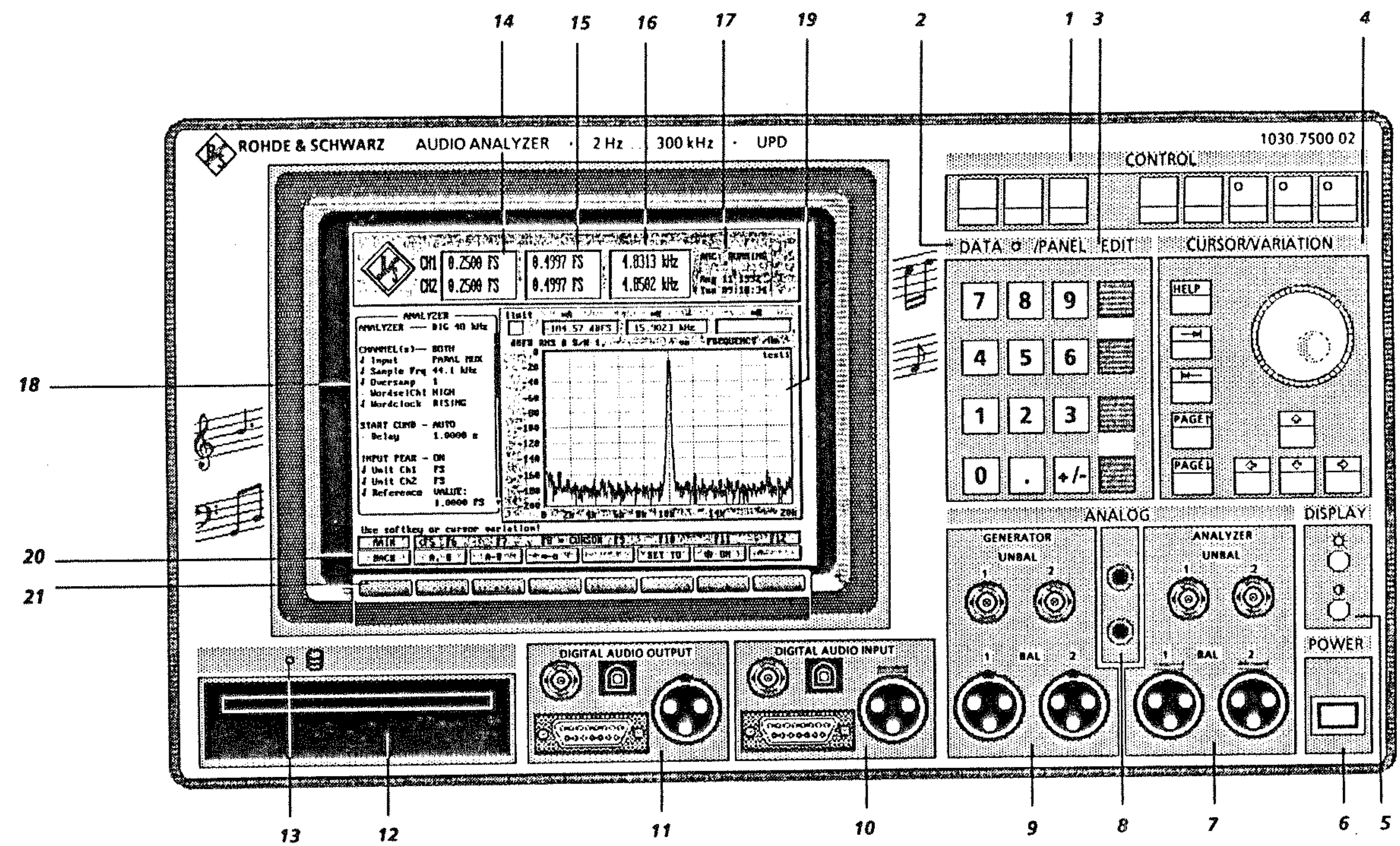


Fig. 2-1 Front-panel view

2.1 Explanations of Front- and Rear-panel Views incl. Key Combinations on the External Keyboard

2.1.1 Front-panel View

1 CONTROL keypad

Front-panel key	Key combination External keyboard (English/German)	Function
START	Ctrl F5/ Strg F5	Start continuous measurement or sweep, reset min. and max. values of bargraph display, average values and average traces (see 2.11 Starting and Stopping a Measurement)
SINGLE	Ctrl F6/ Strg F6	Start a single measurement or single sweep (see 2.11 Starting and Stopping a Measurement)
STOP/CONT	Ctrl F7/ Strg F7	Stop or continue measurement or sweep (toggle function) (see 2.11 Starting and Stopping a Measurement)
H COPY	Ctrl F8/ Strg F8	Print a hard copy of screen (see 2.14.1 Hard Copy of Screen)
SYSTEM	Ctrl F9/ Strg F9	Return to MS-DOS (see 2.17 UPD used as Computer)
LCD	Ctrl F10/ Strg F10	Switch LC display ON/OFF (OFF: LED lights up) (2.15.5 Setting, Switching off the Displays)
OUTPUT	Ctrl F11/ Strg F11	Switch all outputs ON/OFF (OFF: LED lights up) (see 2.13 Fast Switch-off of Outputs)
LOCAL	Ctrl F12/ Strg F12	Switch from remote to local mode (Remote control: LED is ON)

2 DATAIPANEL keypad

Keypad with dual assignment:

DATA-LED ON:	Keys serve as numeric keypad (± key switches the sign over)
DATA-LED OFF:	Keys are used to call a panel (see 2.3.1 Panels); the labelling above the keys is valid:

Front-panel key	Key combination External keyboard (English/German)	Function
GEN	Alt G	Settings of all five generators (see 2.5 Generators)
ANLR	Alt A	Settings of all six analyzers (see 2.6 Analyzers)
FILTER	Alt T	Filter definitions of analyzers (see 2.7 Analyzer Filters)
Status	Alt S	Sum up user-definable menu items of any panel (see 2.8 STATUS Panel)
FILE	Alt F	Loading and storing traces and lists (see 2.9.1), editing files and directories (see 2.9.2)

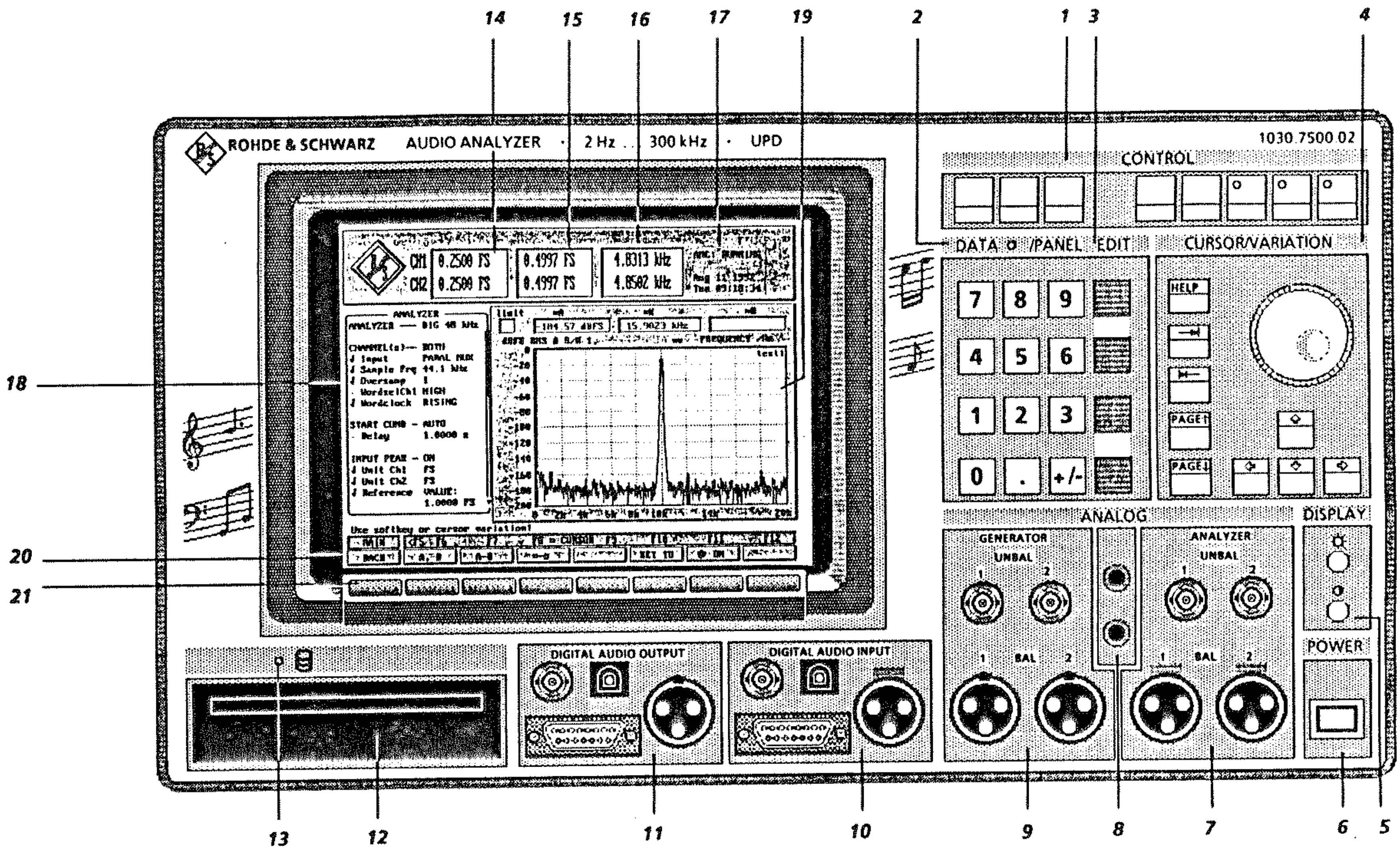


Fig. 2-1 Front-panel view

2 DATA / PANEL keypad

Front-panel key	Key combination External keyboard (English/German)	Function
Display	Alt D	Parameters for graphical display of results (see 2.10 Graphical Data Presentation)
Graph	Alt R	Activate panel or graphical display (toggle function)
▫ ↔ □	Alt Z	Switch between full-screen and part-screen mode (toggle function) (see 2.10.9)
Options	Alt O	Parameters for printout (see 2.14 Printing/ Plotting) and auxiliary settings (see 2.15 Setting and Displaying Auxiliary Parameters)
Show I/O	Alt I	Front-panel display with the selected inputs/ outputs marked; explanations in the case of indistinct input signals

3 EDIT keypad

(see 2.3.2 Data Entry)

SELECT	Space	Open a selection, input or dialog window, select characters when entering text
BACKSP	←	Delete the character before the cursor
CANCEL	Esc	Close open window, the old value or parameter will remain effective
ENTER	Enter	Close open window, the new value or parameter will be accepted

4 CURSOR / VARIATION keypad

(see 2.3.2 Data Entry, 2.3.1 Panels)

HELP	F1	Open a help window
→|,|←	→|,|←	Tabulator right/left; change to the next input field to the right or to the left
PAGE ↑, PAGE ↓	Page ↑, Page ↓ / Picture ↑, Picture ↓	Turn pages in a panel or move windows back and forth
↑, ↓	↑, ↓	Move the cursor up/down
→, ←	→, ←	Move the cursor to the left, right; only effective in an open input window
Rotary knob	Cntrl←/Strg ←, Cntrl →/Strg →	Increment or decrement the number on the cursor position, open a selection window and scroll its items

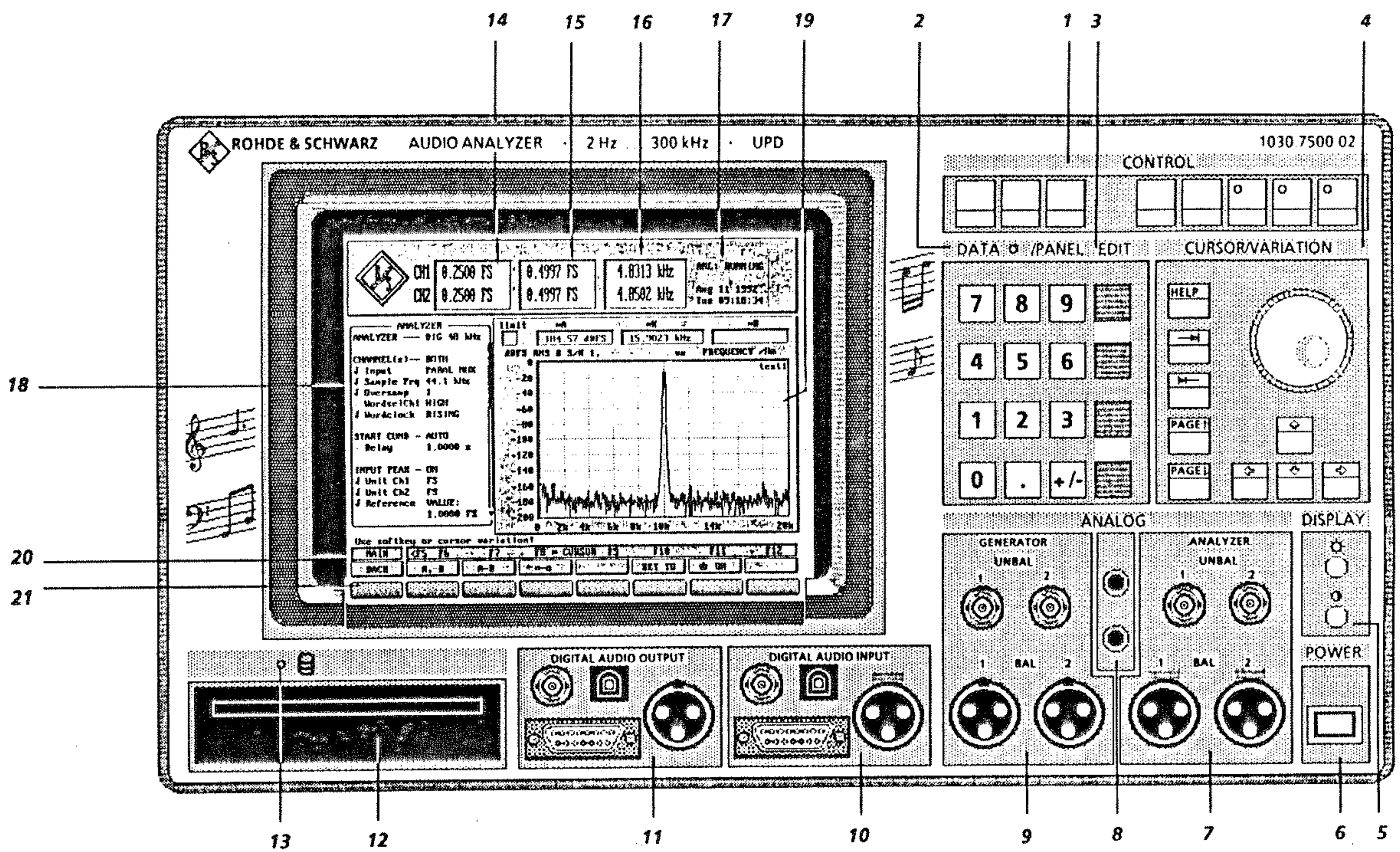


Fig. 2-1 Front-panel view

5 Display

Top knob	Brightness control
Bottom knob	Contrast control

6 Power switch

7

Input connectors of the analyzers for the analog interfaces (see 2.6.2 Configuration of the Analog Analyzers)

Unbalanced inputs:	BNC female connectors
Balanced inputs:	XLR female connectors

8

Upper female connector (GEN COM):
common connection to ground of the floating generator outputs,
4-mm banana plug

Lower female connector: (⏚)
frame ground of UPD
4-mm banana plug

9

Output connectors of generators for the analog interfaces (see 2.5.2 Configuration of Analog Generators)

Unbalanced inputs:	BNC female connectors
Balanced inputs:	XLR female connectors

10

Input connectors of the analyzers for the digital audio interfaces (see 2.6.3 Configuration of Digital Analyzers)

Serial	serial interface, two-channel, 15-pole D-SUB connector

The following three female connectors have only a function when the AES\EBU S\P DIF option (UPD-B2, for the order number see data sheet) is fitted.

S/P DIF :	BNC female connector
Opt	optical interface acc. to EIAJ CP-340, TOSLINK system
AES/EBU	XLR female connector

11

Output connectors of the generators for the digital audio interfaces (see 2.5.3 Configuration of Digital Generators)

Serial	serial interface, two-channel, 15-pole D-SUB connector

The following three connectors have only a function when the AES\EBU S\P DIF option (UPD-B2, see data sheet for the order number) is fitted.

S/P DIF :	BNC female connector
Opt	optical interface approved to EIAJ CP-340, TOSLINK system
AES/EBU	XLR connector

12

3.5"disk drive
LED indicating read or write access

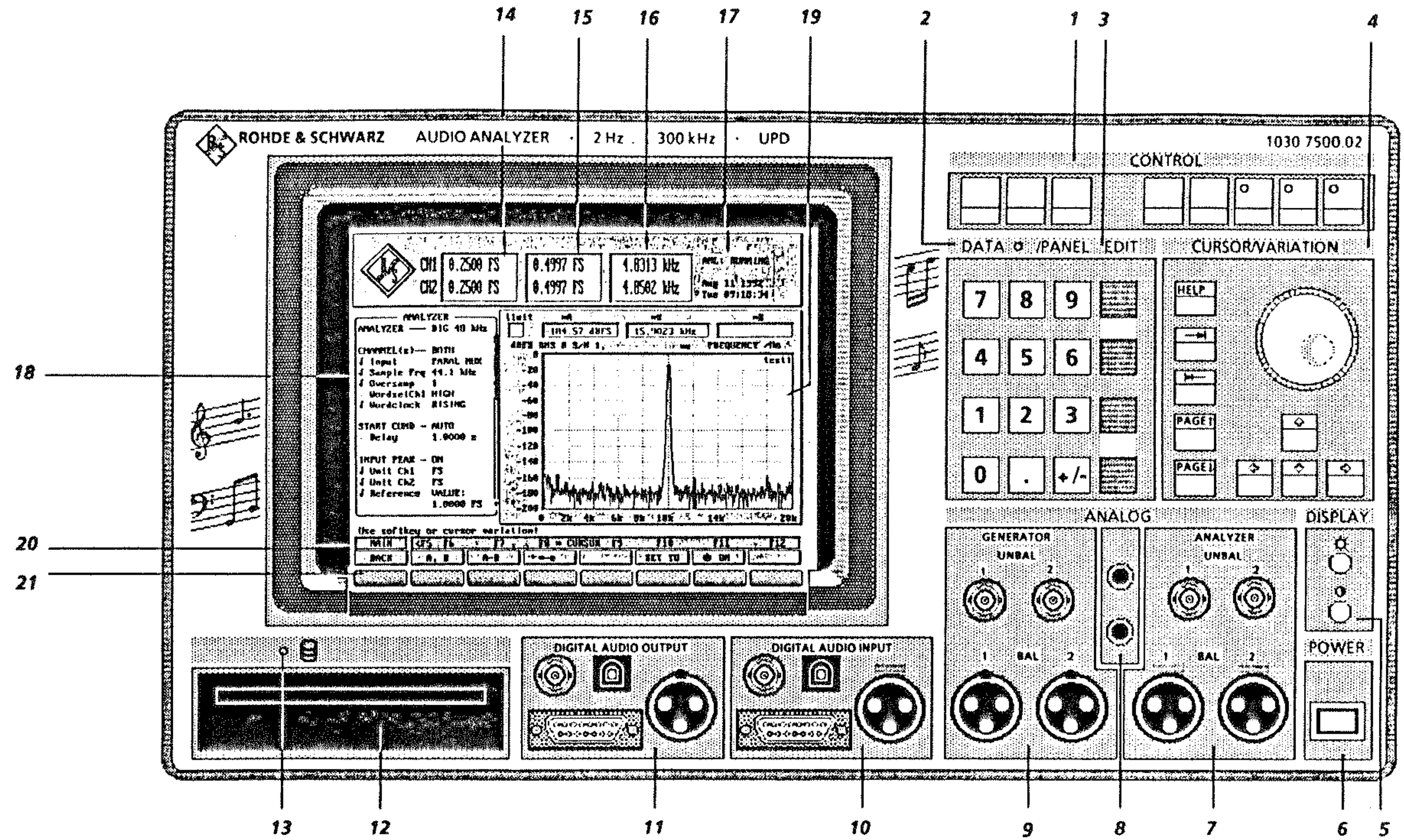


Fig. 2-1 Front-panel view

13

LED indicating a read or write access to the built-in hard disk

14

Display of the result of a selected measurement function, simultaneously for channel 1 and 2

15

Display of peak level of input signal, simultaneously for channel 1 and 2

16

Display of frequency for both input signals or of frequency and phase between both input signals

17

Current mode of generator, analyzer and sweep system. Date and time.

18

One of altogether 7 panels, each containing all the appertaining settings

19

Graphical presentation of results, the measured values at the cursor positions being used

20

Operator guidance line, also indicating the permissible range of values during data entry.

21

Softkeys. Entry of units and operation of the graphical display; can also be activated via mouse or function keys of external keyboard.

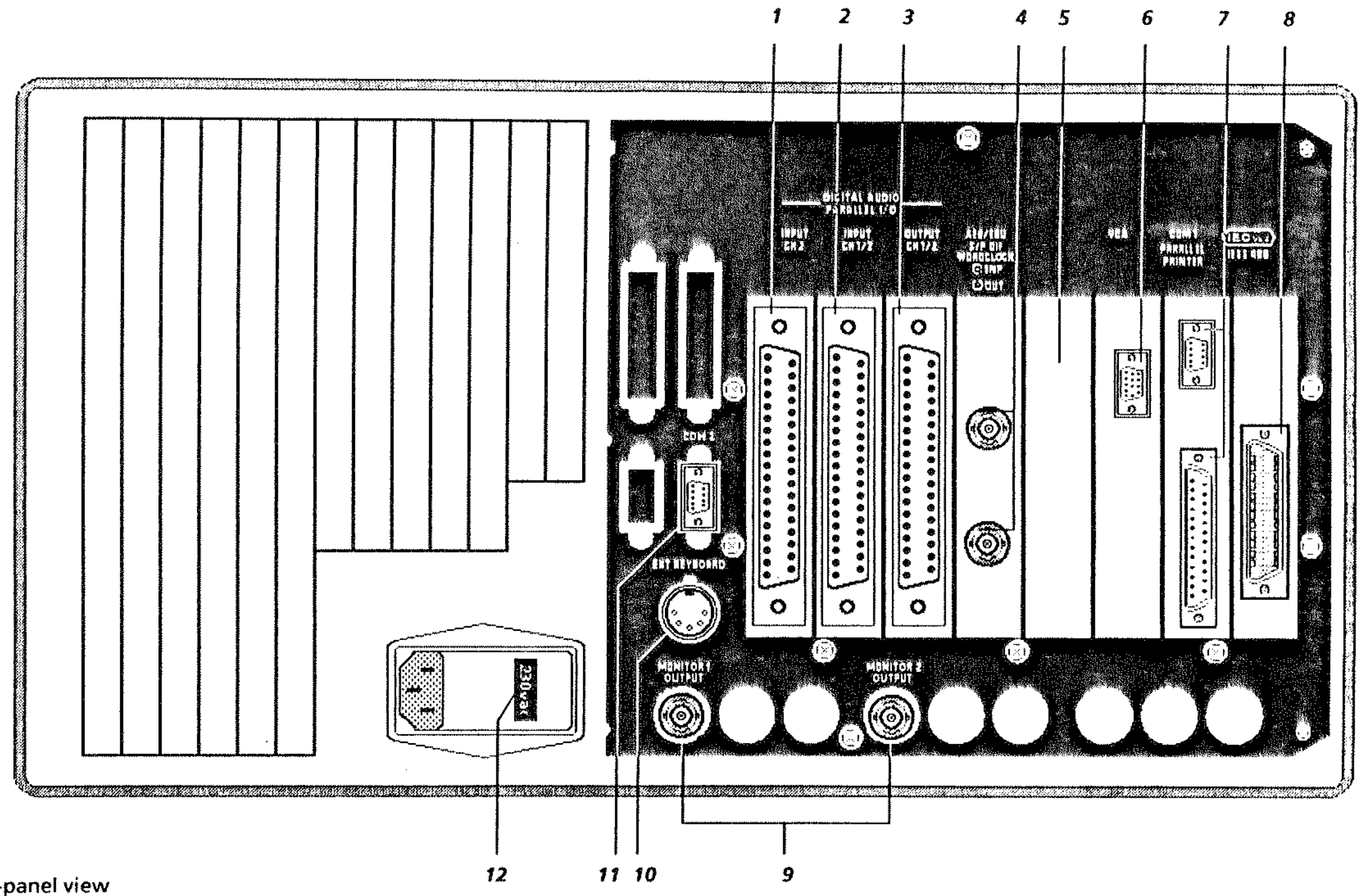


Fig. 2-2 Rear-panel view

2.1.2 Rear-panel View

1

Second parallel input of the analyzers for the digital audio interfaces; provided only with the High-speed option fitted (UPD-B3, for the order number see data sheet), 37-pole D-SUB connector (see 2.6.3, Configuration of the Digital Analyzers).

2

Parallel input of the analyzers for the digital audio interfaces, for one-channel or multiplexed two-channel signals, 37-pole D-SUB connector (see 2.6.3 Configuration of the Digital Analyzers).

3

Parallel output of the generators for the digital audio interfaces, for one-channel or multiplexed two-channel signals, 37-pole D-SUB connector (see 2.5.3 Configuration of the Digital Generators)

4

Word clock input (upper BNC female connector) and Word clock output (lower BNC female connector) of the AES\EBU S\P DIF option (UPD-B2, for the order number see data sheet); provided only with the option fitted (see 2.6.3, Configuration of the Digital Analyzers / 2.5.3 Configuration of the Digital Generators)

5

Free AT slot even with all options fitted

6

Connector for an external VGA monitor, 15-pole D-SUB female connector, triple-row

7

Upper connector:
first serial RS 232-C interface, 9-pole D-SUB connector
Lower connector:
parallel printer interface, 25-pole D-SUB female connector

8

IEC/IEEE BUS female connector, provided only with the IEC-625/IEEE-488 option (UPD-B4) fitted (for order number see data sheet)
(see Section 3, Remote Control)

9

Monitor outputs for channel 1 and 2 of analog analyzer (see 2.6.6 Monitor)

10

Female connector for an external keyboard (see 2.16 Connecting External Devices)

11

Second serial RS 232-C interface, 9-pole D-SUB connector

12

Display of the rated supply voltage set

2.2 Introductory Examples

This section provides an introduction to the operation of the UPD via the front-panel keyboard by way of examples which base on each other (operation via external keyboard or mouse, see 2.3 General Instructions for Use).

The examples are:

- Loading the default setup
- Frequency response measurement of the analog UPD generator from 15 Hz through 20 kHz using the sweep function
- Cutting in a filter
- Ways of presentation of measurement results
- FFT of a two-tone signal, measured at digital interface
- Hard copy of screen

General information

After switch-on, the instrument status matches that before switch-off. This is true for all setting parameters of the UPD ie also for those currently not displayed on the screen.

Use the cursor (field in inverse display) and the SELECT, BACKSP, CANCEL and ENTER keys to operate the UPD. The cursor indicates for which input field an entry is expected. With the ↑, ↓, PAGE ↑, PAGE ↓, Tab → and Tab ← keys, the cursor can be moved from one input field to the next one. The cursor cannot be placed on fields with indicating function only. They are displayed in a different grey or another color.

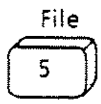
With the SELECT key, you can open a selection, input or dialog window where you can enter either a numerical value or select a parameter using the cursor keys. ENTER or CANCEL allow you to close the window again. The varied value is accepted with ENTER, the old value being retained with CANCEL. Numerical values can be varied further just by using the rotary knob without opening an input window. The digital cursor (underscore) indicating the position which is incremented or decremented can be moved using the →, ← keys.

The operator guidance line (between panels and softkeys) states the permissible range of values for the currently selected field.

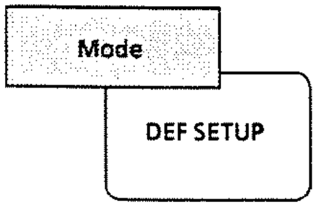
The softkeys allow you to enter units and use the graphics display.

Example 1: Loading the Default Setup

(Only required to ensure that equal conditions prevail in the examples given below)



Press the figures key 5 on the front panel. As the instrument is currently not expecting a numerical input (LED above the figures keys does not light up) the secondary function indicated above the keys is automatically executed. In this example, it is the FILE function.
Causes the appertaining panel (= input window) to be displayed on the screen. The panel contains the menu items dealing with file management.



Using the keys above, place the cursor to the input field in the second line of the panel (= right-hand column of menu item "Mode" under the heading LOAD INSTRUMENT STATE), press SELECT, select DEFAULT with the cursor, close the window using ENTER. The UPD default setup is loaded.

Note: *The operator sequence "SELECT, selection with the cursor, ENTER" is always necessary to select a parameter, is however not explicitly stated in the following explanations.*

Example 2: Frequency Response Measurement of the UPD Generator in the Range from 15 Hz to 20 kHz using the Sweep Function

Analyzer settings:

GEN **7**

ANLR **8**

FILTER **9**

Cause the panels for setting the generator, analyzer filters and the analyzer to be successively displayed on the screen. The cursor is always in the panel most recently selected, which is here the ANALYZER panel.

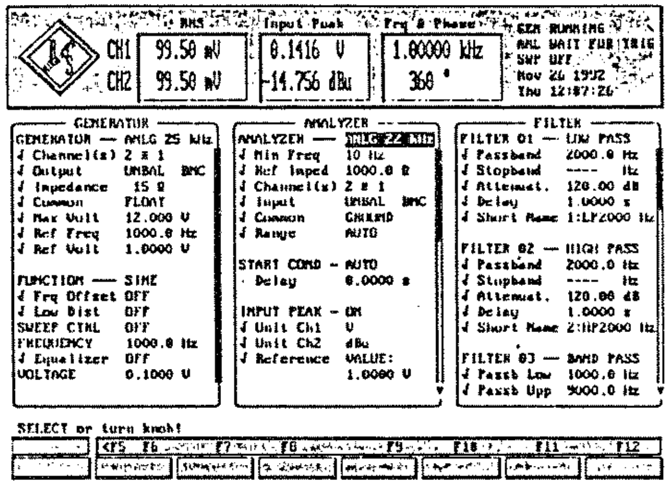


Fig. 2-3

ANALYZER → **ANLG 22 kHz**

Define which one of the six analyzers is to be used. The preset parameter is ANLG 22 kHz, which is designed for the analog interfaces and the frequency range up to 22 kHz. The panel displayed on the screen indicates all possible ways of setting this analyzer; the settings of the other analyzers, eg the analyzer DIG 48 kHz are suppressed, however retained.

Channel(s) → **1&2**

Define which channel is to be measured. Select two-channel measurement.

FREQ / PHASE → **Freq &Phase**

Switch to simultaneous frequency and phase measurement

CH1 Input → **GEN 1**

Select the input on which the measurement is to be carried out. Switch channel 1 to GEN 1 and channel 2 to GEN 2. The generator outputs are now connected internally to the analyzer inputs.

CH2 Input

GEN 2

FUNCTION

RMS&S/N

Define the measurement function. All measurement capabilities are listed in the selection window (SELECT key). Keep the preset rms measurement (CANCEL key).

The UPD measures continuously, which is why the measurement results of the signal currently output by the generator are already displayed on the upper range of the screen:

- the first window shows the results for both channels of the selected measurement function, which is here the rms measurement (the heading of the window reflects the selected function)
- the second window gives the peak level of the input signal, also for both channels
- the third window outputs the frequency of the input signal and the phase between both channels

Generator settings:

Switch to the next input field (to the left); in this case, when pressing the key no more than twice, to the GENERATOR panel and to the position the cursor was placed when the panel was left, in this example the first line.

GENERATOR — **ANLG 25 kHz**

Specify which one of the five generators is to be used. The preset parameter is ANLG 25 kHz, which is the generator for the analog interfaces and the frequency range up to 25 kHz.

FUNCTION — **SINE**

Specify the type of signal to be output. The selection window lists all possible types of signals. Keep the presetting, which is sine-wave.

SWEEP CTRL — **AUTO SWEEP**

Define whether a sweep is to be carried out, whether the sweep is specified by parameters or a list and whether the sweep is to be continued automatically or manually via rotary knob. Switch to AUTO SWEEP. The panel shows some additional lines in which the sweep parameters are to be specified:

X Axis — **FREQ**

Define which parameter is to be swept, here the frequency.

Start — **20 kHz**

Specify the start and stop values of the sweep. With a frequency sweep selected, frequency values are expected:
Enter the start value of 20 kHz: place the cursor to the input field, press SELECT (the LED DATA above the entry block for digits lights up indicating that these keys have now the function of figures keys and cannot be used to select panels), key in 20, press softkey kHz (= F6), thus closing the input window. Select the input field for the stop value using the cursor key.

Stop — **15 Hz**

Place the digital cursor to the second position using the ← key, set 15 Hz using the rotary knob.

VOLTAGE — **1.0 V**

Specify the output voltage. Set to 1.0 V.
The permissible range of values is output in the operator guidance line (above the softkeys).

Note: *The maximum level which is still permitted to be output can be defined in the menu item "Max volt" (protects custom circuits against destruction in case of a keying error). The upper range limit permissible for inputs is thus limited to this value and accordingly varied in the operator guidance line.*

Setting the Display Parameters:

DISPLAY 1

Causes the DISPLAY panel to be displayed on the screen (at the former position of the FILTER panel) and the cursor to be placed in this panel. Contains all parameters concerning the graphical presentation.

OPERATION – **CURVE PLOT**

The standard setting CURVE PLOT is used to display the measurement results in the form of a curve.

Trace A – **FUNC CH1**

Define which data are to be collected in the measured value memory A. Here, the parameter FUNC CH1 specifies the results of the function currently active for channel 1. With rms measurement selected in the analyzer, the results of this measurement are collected.

Unit – **dBr**

Specify the unit with which the Y axis is to be scaled. (It is possible to select a different unit from that selected in the ANALYZER panel for numerical display of the measurement result. A different unit can be selected even at a later date in order to rescale an already available trace.)

Scale – **MANUAL**

The standard setting AUTO ONCE causes the scaling to be effected automatically whenever a measurement function is changed. At the beginning of the sweep, the full-scale values are set to a useful start value. After the sweep has been completed, the measured full-scale values are taken as the basis for rescaling.
Switch to Manual. Scaling can now be specified in the lines TOP and Bottom.

TOP – **0,2 dBr**

Enter the full-scale values +0.2 dBr and -0.2 dBr. (The dBr softkey appears after having activated the MORE softkey twice.)
The full-scale values can be entered in units other than specified for scaling of the axis. (Renders conversion of the full-scale values when changing the scaling unit unnecessary.)

Bottom – **-0,2 dBr**

Trace B – **PHASE**

The phase measurement values are collected in the measured value memory B.

Scale / **MANUAL**	Switch to manual scaling. The scale for trace B is displayed in the right-hand margin of the graphics window.
TOP / **+ 1°**	Enter full-scale values of ± 1°.
Bottom / **-1°**	
X AXIS / **FREQ**	Indication value only. Is autamatically set to the sweep control variable.
Scale / **Auto**	Automatically scale the X axis with the start and stop values of the sweep.
SPACING / **LOG**	Select between linear and logarithmic scaling of the X-axis (= sweep parameter). Keep the presetting LOG.
GRAPH [2]	Toggle key switching from the selected input panel to the window for graphical presentation of traces, bargraphs or trace lists and vice versa. Press the key. The graphics window will appear in full display (because the key was pressed when the panels were shown in full display, ie 3 panels simultaneously).
□↔□ [3]	Switches from full-screen to part-screen mode and vice versa. The panel most recently selected (here: DISPLAY panel) is shifted to the left on the screen, the GRAPH window being displayed next to it on the right side instead of the other two panels (part-screen mode).
SINGLE	Start a single sweep. The current measured values are output in the measurement result window and, at the same time, both traces are displayed. The sweep starts at the high frequencies (because of start value = 20 kHz). The graph window is now active, ie the → and ← keys, the rotary knob and the softkeys refer to the graphical display.

The measurement of the sum frequency response of generator and analyzer is thus complete.

Example 3: Cutting in a Filter

DISPLAY 1

Select the DISPLAY panel.

TRACE B — OFF

Switch off trace B.

TOP — 10 dBr

Bottom — - 60 dBr

Reset the top full-scale value to 10 dBr and the bottom full-scale value of trace A to -60 dBr.
You can select Scale Auto Once instead, causing the scaling to be automatically matched at the end of the sweep.

□◄►□ 3

Switch from part-screen to full-screen mode (here: 3-panel display as the cursor was in a panel).

FILTER 9

Select the FILTER panel. Up to 9 filters can be defined by the user at the same time: Enter the type of filter (lowpass, highpass...), attenuation, passband or center frequency and bandwidth you wish to use in the menu item "FILTER XX", finished. To make the entry more convenient for you, some filters are predefined.

Filter 05

Scroll to the first notch filter.
The parameters displayed in green or grey are values which have been determined by the internal filter design program. These values are for your information and cannot be changed.

Help

If you need help, press the Help key to open the help window, which provides you with brief information on the current menu item, here the filters. You may select key words highlighted in the help text and obtain further information on these items by pressing SELECT.

Cancel

Cancel closes the help window (also ENTER).

Center Frq — 4 kHz

Set the center frequency to 4 kHz, the (band)Width to 500 Hz and Atten(uation) to 50 dB. The filter is now defined and is automatically designated "5:NO4000 Hz".

Select the ANALYZER panel using eg the tabulator key (depress twice) and scroll to its end using eg the Page ↓ key.

Filter — 5:N04000 Hz

Define the filters activated in the selected rms measurement. Scroll to the first menu item "Filter" under the heading FUNCTION, open the selection window containing a list with the nine filters defined in the FILTER panel together with their short designations and all weighting filters. All settable filters can be made visible by scrolling with the ↓ and ↓ cursor keys.
Place the cursor on Filter 5:NO4000 Hz and select using Enter.
The filter is now being calculated. The displayed filter parameters are updated in the FILTER panel.

GEN 7

Select the GENERATOR panel.

Frequency:

Spacing — LIN Points

Select linear spacing between sweep variables.

Start — 3500 Hz

Change the start and stop values of the sweep to 3500 Hz or 4500 Hz in order to facilitate analysis of the stopband of the notch filter.

Stop — 4500 Hz

3

Switch from full-screen (3 panels) to part-screen mode.

SINGLE

Start a new sweep. The frequency response for channel 1 with the notch filter activated is displayed. Scaling of the X-axis is automatically matched to the new sweep values.

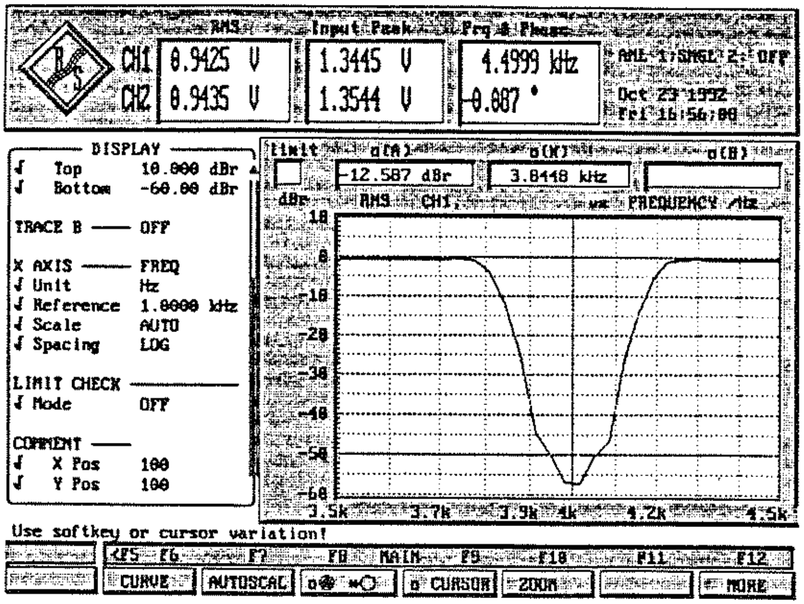

RMS
Input Peak
Frq & Phase
CH1 0.9425 V
CH2 0.9435 V
1.3445 V
1.3544 V
4.4999 kHz
-0.087 °
DISPLAY
Top 10.000 dBr
Bottom -60.00 dBr
TRACE B —— OFF
X AXIS —— FREQ
Unit Hz
Reference 1.0000 kHz
Scale AUTO
Spacing LOG
LIMIT CHECK
Mode OFF
COMMENT
X Pos 100
Y Pos 100
12.587 dBr
3.8448 kHz
FREQUENCY
Use softkey or cursor variation!
CURVE
AUTOSCAL
CURSOR
ZOOM
MORE

Fig. 2-4

Example 4: Ways of Presentation of Measurement Data

GRAPH 2

The graphical display window is activated, ie all entries (eg via rotary knob, softkeys) are relevant for graphical display.

o ◉ •○

The softkey indicates by the filled circle which cursor is active, ie can be moved using the cursor keys or the rotary knob (in the example 0-cursor). Select the 0-cursor by pressing the softkey.

CURSOR – SET TO – MIN A

Graphical display and the cursor function can be altered using these softkeys. The key sequence CURSOR, SET TO, MIN A, for example, sets the (active) cursor to the minimum value of the sweep.

BACK – BACK

The Back softkey allows you to return to the next higher menu level. Press twice.

ZOOM – AT o UP

The X-axis is zoomed symmetrically around the 0-cursor by the factor of 2 with each key depression.

DISPLAY 1

Select the DISPLAY panel.

OPERATION – TRACE LIST

Display of measured value list for the most recent sweep. This list can be stored eg for further processing (FILE panel, "STORE TRACE/LIST": "STORE" → "TRACE A", select a file name).

START

Start a continuous sweep.

OPERATION – Bargraph

Select bargraph display. The function to be displayed and the other parameters can be selected independently for each bargraph. The minimum and maximum values indicated are reset whenever the START key is pressed.

START

Start a continuous sweep. The current rms values and frequency are indicated in bargraph display.

SINGLE

Ends the continuous sweep at the end of the last sweep.

Example 5: FFT of a Two-tone Signal, Measured at Digital Interface

□ ◀▶ ☐ **3**	Select full-screen mode for the panels.
GEN **7**	Select the GENERATOR panel.
GENERATOR / **DIG 48 kHz**	Select the generator for the digital interfaces with a sample rate of 48 kHz or less.
Channel / **1**	Set single-channel output.
Output / **Intern**	Switch to the internal digital interface to the analyzer. (This mode has been implemented for testing purposes. It allows the digital outputs/inputs to be connected to each other without any external cable connections required.)
FUNCTION / **DFD**	A difference tone signal with a selectable mean frequency (enter in menu item "Mean Freq") and a selectable difference frequency (menu item "Diff freq") is generated. The total level is 100 % FS (full scale), ie the peak value of the level matches the maximum number that can still be displayed ("all bits set").
MEAN FREQ / **5 kHz**	Enter mean and difference frequency.
DIFF FREQ / **1 kHz**	

ANLR

8

Select the ANALYZER panel.

ANALYZER

DIG 48 kHz

Select the analyzer for the digital interfaces with a sample rate of 48 kHz or less.

Input

Intern

Switch to the internal digital interface to the generator. The generator is connected internally to the analyzer. (The internal sample rate is fixedly set to about 43 kHz.)

Function

FFT

Select FFT analysis

FFT-Size

8192

Specify the size of the calculated FFT in number of points. The higher the FFT, the higher the frequency resolution (see DISPLAY menu item "Resolution"), however the more the measuring time (see DISPLAY menu item "Meas Time").

DISPLAY

1

Trace A:

Unit

dBFS

Top

0 dBFS

Set the full-scale values.

Bottom

-200 dBFS

3

Switch to part-screen mode.
The spectrum of the difference tone signal is displayed.

Zooming

ON

Increases the frequency resolution by one center frequency (menu item "Center") through digital preprocessing of the signal by the zoom factor (DISPLAY menu item "Zoom-Fact"). The frequency range displayed is thus decreased by the same factor (menu item "Span").

Note: *Not to be confused with the Zoom in Graph where the measured data are only displayed in zoomed form. Here, the measurement is really made at this higher resolution!*

Center

5 kHz

Set to 5 kHz (= center frequency of difference tone signal)

Span

4.94 kHz

Select 4.94 kHz. This results in an expansion by a factor of 8 (zoom factor). In the graphics window, the zoomed spectrum is displayed (see Fig. 2-5).I

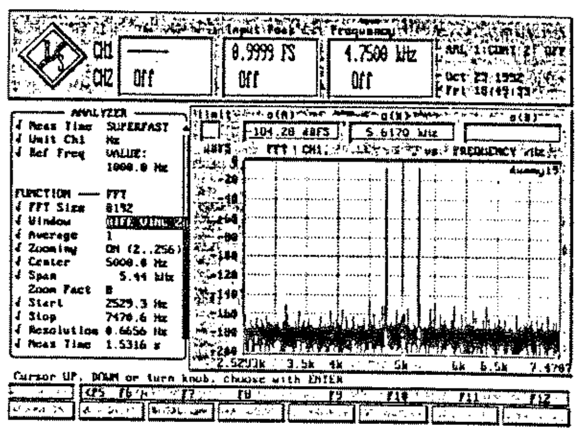


Fig. 2-5

ANLR

8

Change to the ANALYZER panel.

Average

4

Averaging of several subsequent FFTs. Select 4. The noise portion of the signal is slowly decreasing.

Example 6: Hard Copy of Screen

STATUS 4

Activate the STATUS panel. As a standard feature, a copy of the most significant menu items of all panels is displayed in this panel. Furthermore, all lines which have been marked by the user in one of the panels are listed. It is thus possible to sum up all particularly important parameters in one panel and to print them out together with the measurement results.

For generation of a hard copy, just connect a printer to the parallel interface and configure the UPD appropriately:

OPTIONS 0

Select the OPTIONS panel.
Select the printer driver suitable for the connected printer in the field "SCREEN HARD COPY" of menu item"Printname" (selection is the same as for entering a file name, see 2.3.2.5).

H COPY

Starts the printout. Printing is a background process, allowing you to further operate the UPD.
With very fast printers, we recommend stopping the measurements by pressing the Stop key. Printing itself will then be made more rapidly.

2.3 General Instructions for Use

The UPD is very easy to operate, especially when you observe the following helpful tips:

- Always proceed from "top to bottom" in the panels.
  Reason: Variations in parameters of individual menu items may affect the selection or the range of values of menu items further down, however not of menu items above.

- Edit the DISPLAY panel only after the generator and the analyzer have been set.
  Reason: Everything which can be displayed graphically also depends on the selected measurement function.
  Many setting parameters of the DISPLAY panel are automatically adopted from other panels, if desired, eliminating the need for setting display parameters.

General Hints as to Mouse Operation

If a mouse is connected to the UPD (see 2.16, Connecting External Devices), an arrow the position of which can be changed by moving the mouse appears on the screen. The arrow can be moved across the entire screen. If the cursor is on the desired position, the action (see the following Section) is always triggered by pressing a mouse key (= clicking on a field).

Further, the mouse can be used to

- select between the three different display modes:
  3-panel display, part display and full display, with the left and right mouse key being pressed simultaneously in the shaded area (cf. Fig. 2-5, 1 a and c). The mouse click to change the display modes must be at a position in the panel which is not assigned by an operable field.
- change between panel and graphics in the part display, with the left mouse key being pressed in the shaded area (cf. Fig. 2-5.1 b).
- change the panel by clicking the panel heading using the left mouse key (cf. Fig. 2-5.1 d).

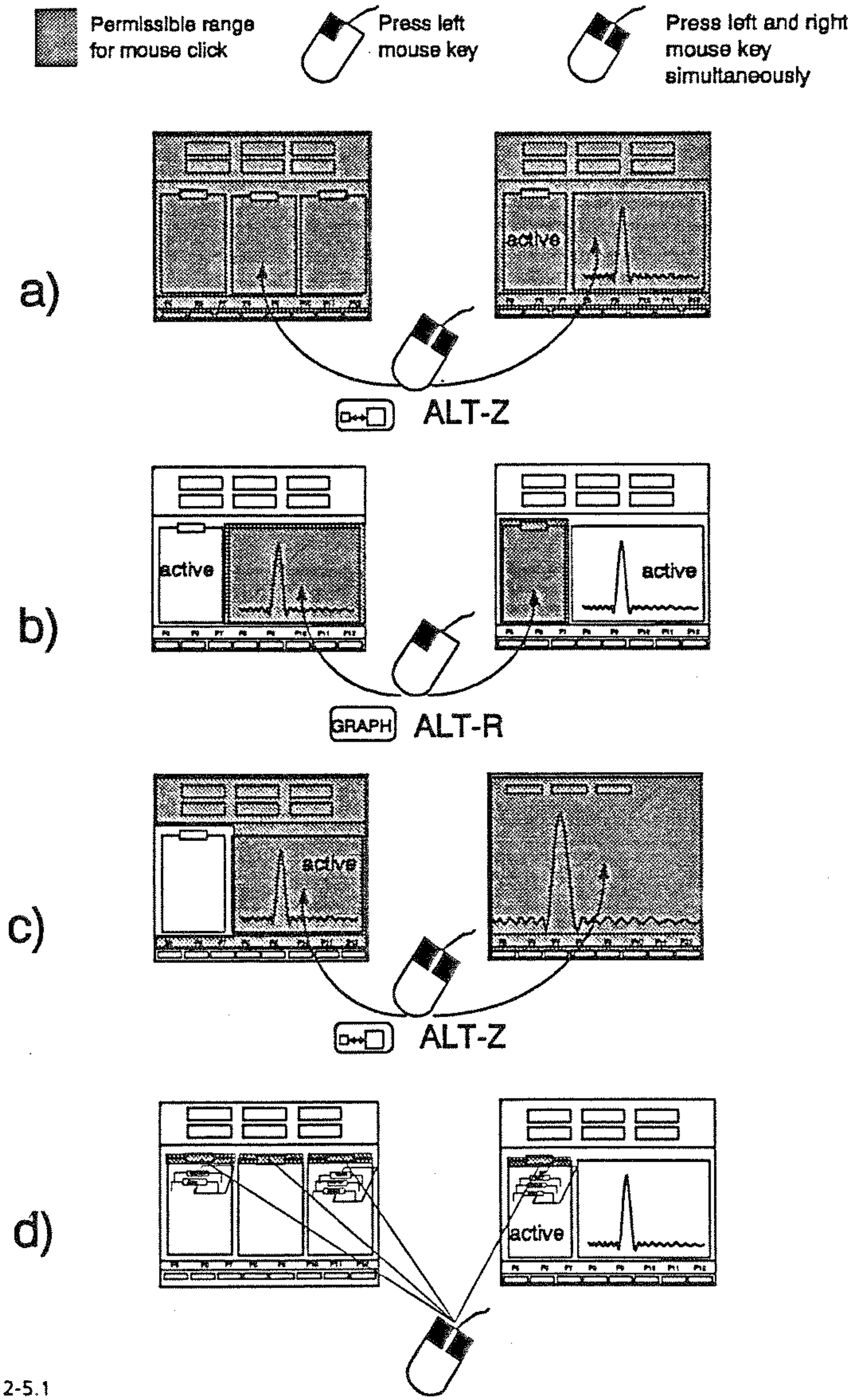

Permissible range for mouse click
Press left mouse key
Press left and right mouse key simultaneously
a)
active
ALT-Z
b)
active
active
GRAPH
ALT-R
c)
active
ALT-Z
d)
active

Fig 2-5.1

2.3.1 Panels

Related settings and functions are always combined to form a so-called panel in the UPD. Each panel has a name (= heading in the upper margin of the panel), which is used to call the panel.

In addition to the panels, there is another window in which the measurement results are displayed graphically. Selection and activation of this graphics window matches that of a panel, which is just larger than the panel.

Only one panel can be active at one time. An active panel is characterized by the cursor (field in inverse display) being placed in it, ie entries can be made only in this panel. On the whole, there are eight panels (incl. graphics window), a maximum of 3 panels being displayable on the screen at one time.
A panel is selected and, if required, displayed on the screen using

- the panel keys on the front panel
- the short-key combinations of the external keyboard (option)

Switchover between visible panels is also possible by:

- the tab →, tab ← keys.
- moving the mouse cursor (arrow) to the desired panel and clicking on a field
- the short-key combination of the external keyboard (option).

When a panel is called, the position of the cursor matches that at the time when the panel was left (exception: changing the panel using the mouse; in this case the position of the mouse cursor is relevant). Thus, you can quickly switch between constantly recurring input points.

The keys on the front-panel keypad named DATA/PANEL are assigned two functions. The first is the fast selection of the panels (see Table 2-1), the second function is that of a input block for numbers. Switchover from first to second function and vice versa is made automatically. If the UPD expects the entry of figures (after having pressed the SELECT key with the cursor placed on a field for the entry of numerical values, see Section 2.3.2, Data Entry), the keys serve as figures keys, otherwise as keys for panel selection. If the entry of data is expected, the LED above the designation DATA lights up.

Table 2-1 Panels and their functions

Panel name	Front-panel key	Key combination ext. keyboard	Function
Analyzer	ANLR	Alt-A	Settings of all six analyzers
Generator	GEN	Alt-G	Settings of all five generators
Filter	FILTER	Alt-T	Filter definitions of the analyzers
File	FILE	Alt-F	Loading and storing of traces and lists, editing of files and directories
Display	DISPLAY	Alt-D	Parameters for graphical presentation of measurement results
Status	STATUS	Alt-S	Summary of user-definable menu items of any panel
Options	OPTIONS	Alt-O	Parameters for printout, auxiliary settings
Graphics	GRAPH	Alt-G	Activates panel or graphical display (toggle function)
Full-screen/part-screen	□ ↔ □	Alt-Z	Switching from full-screen to part-screen mode (toggle function)

Note: *For a complete list of short-key combinations for operation via an external keyboard, refer to Section 2.1.1, Front-panel View.*

Every panel has a fixed position on the screen (except when part-screen mode is simultaneously selected, see the following Section):

Position on the screen

left	center	right
Generator	Analyzer	Filter
File		Display
		Options
Status		
	—— Part-screen ——	
	—— Full-screen ——	

The GRAPH key allows you to switch from the active panel to graphical display and vice versa.

The ◻ ⟷ □ key is used to change from full-screen mode (graphics over the entire screen or 3-panel display, depending on whether graphics or a panel is active) to part-screen mode (a panel by the side of graphics) and vice versa.

In part-screen mode, the panel used most recently moves to the left side of the screen. Any subsequently called panel is placed on this position, too, allowing the user to display and print any panel (especially the → STATUS panel) together with the graphical presentation of results at one time.

After the part-screen mode has been switched off, the current panel is reshifted to its normal position.

Scrolling in the Panel

If a panel has more lines than can be displayed on the screen section, the ↑, ↓, Page ↑ and Page ↓ keys (or the corresponding keys on the external keyboard) can be used for scrolling in the panel. The bar in the right-hand margin of each panel stands for its complete size, the dark section representing the section currently visible on the screen. Arrows show you in which direction to scroll to cause the lines not visible to be displayed in the window.

With the mouse connected, the panel contents is scrolled by one line whenever the respective arrow is selected. Pressing and holding down the mouse key causes the contents to be scrolled until the key is released. Any desired panel section can be made visible by selecting the dark part of the bar and positioning it appropriately by moving the mouse with the key held down.

STATUS Panel

This special panel can be called only in part-screen mode. Any line in any panel can be marked with a tick in the first column (select the position using the Tab ←, ↑ and ↓ keys, press SELECT, the tick is switched on or off (toggle function)). Each marked line is taken over into the so-called STATUS panel, thus allowing the user to sum up all important parameters in one panel. It can be simultaneously displayed with the measurement results and their graphical representation, which is of particular interest for the documentation of results (see 2.8 STATUS panel).

The UPD can be operated from the STATUS panel as well as from all other panels, thus allowing you to execute any repetitively used control sequence from one panel only.

Changing an Instrument

The UPD has six analyzers (one in each of the measurement ranges 22 kHz, 100 kHz and 300 kHz for the measurement on analog interfaces, three for the measurement on digital audio interfaces with sample rates of up to 48 kHz, 192 kHz and 768 kHz). All analyzers are set in the ANALYZER panel. The generators are set correspondingly in the GENERATOR panel.

Each of these instruments has its own data set, each with a different structure. The data sets are different with respect to

- the selection of the displayed menu items (= lines of the panel). All settings possible for the selected instrument are displayed (eg of the analyzer for analog interfaces in the frequency range up to 22 kHz), the settings of the other instruments (eg of the analyzer for the digital interfaces with a sample rate of up to 768 kHz) are suppressed, however retained in the background. This ensures fast and convenient operation of the UPD despite the wide variety of possible settings.

- the permissible range of values for the parameters. It is not possible, for example, to set a sample rate of 96 kHz in the analyzer "DIG 48 kHz", however it is feasible in the analyzer "DIG 192 kHz".

- the selection of the functions. To give an example, the analyzer for the frequency range up to 22 kHz is provided with more measurement capabilities than the analyzer for the frequency range up to 300 kHz.

For switching between the instruments, follow the instructions below:

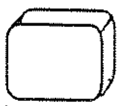
- ▸ Place the cursor on the input field of the first panel line (= right-hand column of the line named ANALYZER or GENERATOR) using the mouse or the ↑, Page ↑ and Tab → keys. Then press

SELECT

(or any mouse key or space on the external keyboard). A selection window with a list of all available analyzers or generators will be displayed.

- ▸ Select an instrument using the ↑ and ↓ keys, rotary knob or mouse and press

ENTER



(or any mouse key or Enter on the external keyboard). The selection window is closed and the settings of the "former" instrument are saved. The panel with the menu items and all settings appertaining to the instrument most recently selected is built up anew.

Changing Functions or Parameters

Changing a function (eg from RMS to THD measurement or, from sinewave to multi-sinewave generation) is performed analogously to changing an instrument, which is explained above: all menu items including the parameters appertaining to the function are retained. (The frequencies and amplitudes of all multi-sinewaves are still present, even when the frequency and amplitude of the single sinewave have been changed in the meantime).

Also when changing parameters, the menu items not required are suppressed, their parameters are however retained and are available again when they are activated.

Example 1:
Select: balanced input, impedance 600 Ω, change to unbalanced output and an impedance of 5 Ω for an intermediate measurement. When switching back to the balanced output, an impedance of 600 Ω is automatically set.

Example 2:
Changing from "Off" to, for example, "AUTO SWEEP" in the menu item "Sweep CTRL" causes the menu items (= lines) required in this mode "Start", "Stop", "Points" etc. to be displayed together with the parameters set for the most recent sweep. These lines are canceled again, when the sweep is switched off.

Note: *The order of the menu items in the panel is selected such that varying a parameter may induce changes in the lines further down, however never in lines further up in the panel. We advise you to proceed in the given order from top to bottom.*

2.3.2 Data Entry

The cursor (field in inverse display) indicates for which input field an entry is currently expected. The cursor can be moved from one input field to the other using the front-panel keys ↑, ↓, Page ↑, Page ↓, Tab → and Tab ← or the corresponding keys on the external keyboard. Some fields in the column with the input fields have display function only, the cursor cannot be placed into them. They are displayed in a different color or in a different grey shade. Menu items without input field serve as headings.

Note: *The same menu item may have an input field or just serve as heading depending on the parameters selected in other menu items.*
Note Section 2.3.2.6 Data Input or Output during Measurements

2.3.2.1 Selecting a Parameter

Place the cursor on the desired input field. Press the SELECT key (or the space bar on the external keyboard) or any mouse key or slightly turn the rotary knob to open a selection window containing all parameters appertaining to this menu item. The rotary knob, Cursor ↑ and Cursor ↓ keys or the mouse are used to select the parameters. The window is closed again using ENTER (also with external keyboard), CANCEL (or ESC on external keyboard) or by pressing a mouse key. The parameter of the selection window is taken over with ENTER whereas the former setting is retained with CANCEL. Also, the parameter is accepted when selected with the mouse or, the window is closed while the former setting is retained when any point outside the selection window is selected using the mouse.

Note: *The contents of the selection windows are not constant but vary depending on the other settings selected.*
For a list of all key combinations assigned to the front-panel keys of the external keyboard, refer to Section 2.1, Front- and Rear-panel Views. The key combinations are therefore not explicitly specified in the following description.

2.3.2.2 Entry of Numerical Data

Entry using the rotary knob

Place the cursor on the desired input field and the numerical cursor (= underscore) to the position to be incremented or decremented. Change the figure using the rotary knob.

The digits can be varied only within the range of values specified in the operator guidance line. A warning is audible when the limit values are reached (can be deactivated, see 2.15.2 Beeper On / Off)

Note: *Some settings require other settings in the panel to be varied (example: when changing the reference voltage, all settings referring to this value must be converted). In this case, the complete panel must be rewritten whenever a value is changed, thus slowing down the rotary knob function.*

Entry using the numeric keypad

Position the cursor to the desired input field, press SELECT or any mouse key causing a small input window with the current value to be displayed. (The number of digits available in the input window may be higher than that of the input field allowing the user to enter values with a higher accuracy than can be displayed in the panel, if required. After having closed the window the rounded value appears in the panel.)

If the value is to be re-entered completely, simply enter the figure using the numeric keypad. The first key depression automatically deletes the old value. The BACKSP key is used to delete the figure to the left of the cursor during input.

If you wish to change only individual figures, place the numerical cursor on the respective position using the → or ← key and enter the desired figure (changing the position of the numerical cursor before the entry of the first figure or deleting a character causes the former value to be retained).

Close the window using

- ENTER: the value entered anew is accepted
- CANCEL: the old value is retained
- Softkeys: the selected unit is set and the value entered anew is accepted
- Clicking with the mouse inside the input window: the value entered anew is accepted
- Clicking with the mouse outside the input window: the value entered anew is not accepted

Entries outside the specified range of values are not accepted, a warning is audible (can be switched off, see 2.15.2 Beeper On / Off) and the entry is changed to the appropriate minimum or maximum value.

Changing the unit at a later date

Place the cursor on the unit field (using Tab → in the numeric input field) causing a softkey line with the units permissible for this menu item to be displayed. The current numeric value is converted for the selected unit by pressing the respective softkey (see also next Section).

2.3.2.3 Using the Softkeys

The softkeys (eight keys at the bottom screen margin) are used for the entry of units and operation of graphical display. The MORE softkey switches to further softkeys available to this operating point, the BACK softkey returns to the next higher softkey level.

The softkeys can be activated

- using the front-panel keys
- using the function keys on the external keyboard specified in the softkey labelling
- by clicking by means of the mouse.

2.3.2.4 Help Line

The help line is between the panels and the softkeys and always refers to the input field marked by the cursor. It provides you with information on which keys to use for further operation and the permissible range of values. Entries outside the specified range are not accepted, a warning is audible and the entry is replaced by the appropriate minimum or maximum value.

Note: *The maximum permissible range of values may depend on other settings, ie is not constant. For further information on the current menu item, press the HELP key.*

2.3.2.5 Entry of File Names

Position the cursor on the input field of the menu item the file name of which is to be changed and press the SELECT key. A dialog window consisting of three more windows will be displayed.

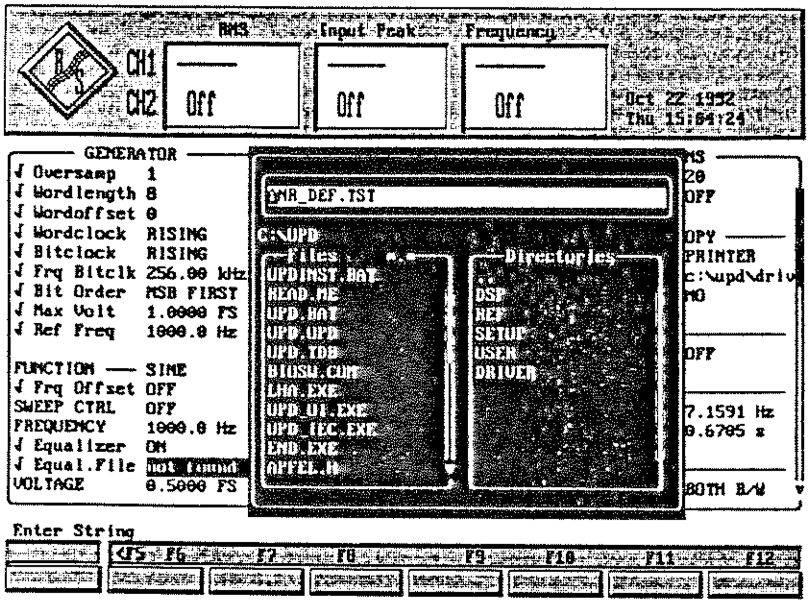


Fig. 2-6

- The top window serves for editing the file name (incl. path name, if required). When selecting the dialog window, it is preassigned with the current file name of the selected menu item. The line below indicates the currently used path (disk drive and directory, see also paragraph "Working Directory").

- The "Files" window allows you to select an already available file. This window lists all files contained in the current path of the file type provided as standard for this menu item. (The type of file is identifiable by the three letters after the point. Different types of files are used for the different tasks of a file (eg limit file, sweep list file etc.) to facilitate file management. For a list of all types and their meanings, see Section 2.9.1, Loading and Storing).

- The "Directories" window allows the user to change the directory. It contains the subdirectories (if any) of the current path. The directory name "..." represents the higher-order directory with respect to the current directory.

The Tab ← and Tab → keys can be used to switch between the above windows.

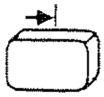
Working Directory

Files can be summed up in a working directory for certain projects or instrument users (see Section 2.9.1, Loading and Storing). The path specified in the menu item WORKING DIRECTORY of the FILE panel (eg C:\PROJECT1) precedes all file names used in the UPD at the time of loading or storing, provided they do not begin with "\" oder "Drive:\".
Example:

Entering the file name MEAS5\MYFILE.XYZ results in the path C:\PROJECT1\MEAS5\MYFILE.XYZ, to use the above example again.

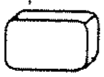
Selecting an already available file

→|



Change to the Directories window using the tab key in the open dialog window.

↑ ↓

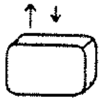


Select the desired directory. Scrolling is possible as in a panel, also with the help of Page ↓ (see Section 2.3.1, Panels: Scrolling in the Panel).

ENTER

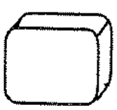
The newly selected, current path is displayed, the window contents are updated, *.xxx is entered as file name, where xxx stands for the type of file provided as standard for the selected menu item.

↑ ↓



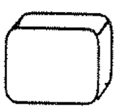
Change to the Files window and select the desired file.

ENTER



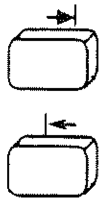
The selected file name is taken over into the input window where it can still be modified (see below "Entering a new file name"). Entering an already available file name is to be preferred, in particular when no keyboard is used as entering a completely new name is then time-consuming.

ENTER



Close the dialog window, storing or loading is effected with the name stated in the input window. CANCEL closes the window without any operation carried out, the old file name being retained.

Entering a new file name



- Change to the uppermost window.
  The file name to be entered must comply with the MS-DOS conventions: a maximum of eight characters followed by a point and the data type consisting of a maximum of three characters. The **< >** = , ; : . * ? [] () ∧ + ! characters must not be used.

There are three ways of entering the file name:

- via the front-panel keyboard
- with the help of the mouse (also with no external keyboard connected)
- using an external keyboard.

For entries without using an external keyboard, place the input cursor ("∧" character) on the position where characters are to be entered using the → or ← key. Press the mouse key or the SELECT key. A selection window with all characters which can be entered will be displayed. Select a character (using the mouse or →, ← keys), which is then inserted into the file name at the cursor position whenever a mouse key or the SELECT key is pressed. An entry at the first postion causes the former file name to be automatically deleted. BACKSP is used to delete the character to the left of the input cursor. Close the selection window using the ENTER key, by selecting <ok> in the selection window or by selecting one of the three windows in the dialog window with the help of the mouse.

When using an external keyboard, editing is made directly in the input window, the above selection window with the alphabet is not displayed. On **power-up**, the UPD checks whether an external keyboard is connected. (Being not initialized when connected after power-up of the UPD, the keyboard does not function properly.)

The following can be entered in the input window (see also previous section "Working Directory"):

- File name without path specification: The path specified in the next line is used. Storing and loading is initiated using ENTER.
- File names with wild cards (don't care characters * and ?). ENTER serves to display the respective files in the FILES window, eg *.LUP is used to list all files of this type. The search for file types other than the standard files is thus possible.
- Only a path. The path and window contents are correspondingly updated.
- File name incl. the complete path specification. Storing and loading is initiated using ENTER.

2.3.2.6 Data Input or Output during Measurements

No internal or external sweep switched on

(External sweep: The parameter AUTO is not selected for menu item START COND of analyzer)
All entries are permissible at any time. After having terminated an entry (ENTER), the present measurement or output is aborted, the newly selected parameters are set and the measurement or output is restarted.

Note that with graphical display (eg continuous FFT, bargraph, histogram of intermodulation measurement), the graphics output is interrrupted when a selection window is opened, however the measurement continues. After having closed the window, the graphics is restored, or, when display parameters were changed, the graphics is deleted and built up again with the new settings (in the case of continuous FFT, this is performed only at the end of the present FFT).

Internal or external sweep switched on

(External sweep: The parameter AUTO is not selected for menu item START COND of analyzer)

Any entry causes the sweep to be stopped (ie it is stopped after conclusion of the current sweep) and then the action initiated by the activated key to be executed because modifications to parameters during a sweep may affect the measurement, thus rendering the measurement results displayed on the screen questionable.

Exceptions:

The following keys can be activated or the following actions can be made without aborting a sweep:

- Entries in the DISPLAY panel
- Display of any panel without varying parameters
- Rotary knob (enables a manual sweep, (see 2.5.4.2 Sweeps)
- Softkeys of graphical display of results
- "LCD ON/OFF"

Changes in the GENERATOR, ANALYZER, FILTER or STATUS panels cause the internal instrument status to be set to "measurement invalid" because the measurement results do not match the setting parameters. The attempt to save or print these measurement results is prompted by an appropriate warning (see Section 2.9.1 "Loading and Storing" and Section 2.14 "Printing"). It is no longer possible to continue the sweep using the CONT key, a restart with the START or SINGLE key is required.

Modifications to parameters in the DISPLAY, FILE and OPTIONS panels do not affect the measurement results; the internal instrument status is "measurement valid". Entries are immediately processed. (Exception: With continuous FFT, modifictions to the display parameters are considered only in the next spectrum to be output). The measurement can be continued with the CONT key.

Note: *See also 2.11 Starting and Stopping a Measurement.*

2.3.3 Display of Measured Values and Settling Process

The display windows for a maximum of 6 measurement results are in the upper section of the screen except for in full-screen mode.

To the right of the windows, there are status information on the current instrument state, see 2.3.4 Status Display.

The output of measurement results is stopped when windows are opened during operation. Measurement results are never covered by any window.

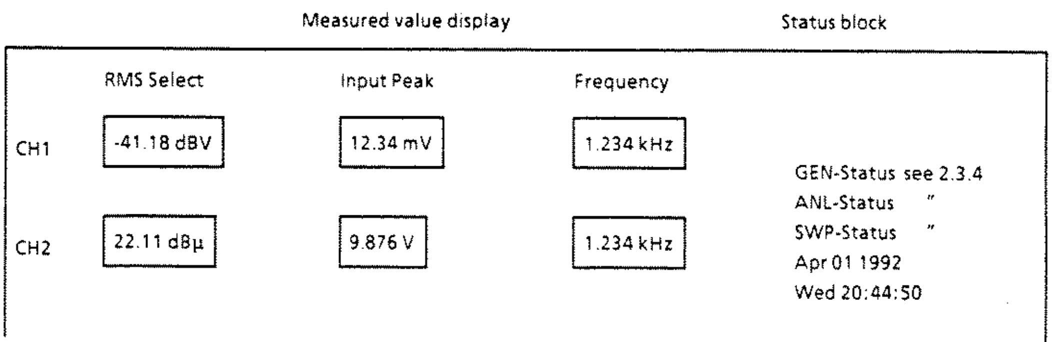


Fig. 2-7

1st column: Measurement results of the selected measurement functions ...

2nd column: Peak value display of input levels ...

3rd column: Frequency and phase measurement results ...

... each for both channels at one time.

Display of measured values:

1.234 V	Valid measurement result Depending on the selected unit, the measurement results are shown in 3 $^1/_2$-, 4 $^1/_2$- or 5 $^1/_2$-digit display ie the decimal point jumps at the transition 2.999 <--> 3.00, 29.99 <--> 30.0, 299.9 <--> 300 etc. If a measured value happens to be in the transition range, hysteresis prevents an unsteady display. The individual measurement results are displayed as soon as they are available. The measurement rate corresponds to that settable for the measurement function (see 2.6.5 Functions).
Off	The measurement channel or function is OFF, for example, Input Peak = OFF
- - - -	There is no measurement result related to the selected function available, eg, there are no frequency measurement results during DC measurements.
- INPUT ? - Press SHOW I/O	The measurement result cannot be displayed because of an inappropriate input signal. A hint about how to eliminate the error appears when pressing the SHOW I/O key (see 2.3.5).

Settling Process

Why settling is necessary:

If a modification is made at the generator of the UPD and if the settling time of a test item is known, it can be considered using the delay indication in the analyzer panel (cf. 2.6.4). Settling processes within the UPD are automatically considered so that the user does not need to take these times into account. The analyzer supplies settled, valid measurement results.

If there is a test item with an unknown transient response between the generator and the analyzer of the UPD or if a test item is fed by an external generator, a transient response will usually be observed at the measurement result after a change of the signal or a manipulation at the test item (in the case of a high measurement rate compared to the settling time) until the display has stabilized. The steadied readout is then accepted to be valid.

The settling process in the UPD has the aim of imitating and automating this procedure. A measured value is only output if it satisfies a certain accuracy the user can enter freely (maximal deviation from the settled final value, later the expression "tolerance" is used). The settling process is preferably used in cases where measurements are to be made at test items with an unknown or changing settling time. The settling process can be combined with a delay so that an undesired signal characteristic can be ignored before the settling process begins as of the starting time of the measurement (change of generator or of signal with external sweep). The settling process can also be used to steady the readout by rejecting values which do not comply with the accuracy entered.

How the settling process is realized:
The value measured by the UPD is permanently compared with up to 5 measured values stored immediately before. A measured value is only accepted as valid if it is within the tolerance limits entered by the user with regard to the previous measured values. Otherwise it is rejected and included in the series of comparison values for the next measured value.

Where settling can be set:
The settling process can be applied to:

- External sweep	(START COND → FREQ CH1 | FREQ CH2 | VOLT CH1 | VOLT CH2)
- Frequency results	(FREQ/PHASE → FREQ)
- Phase results	(FREQ/PHASE → FREQ&PHASE)
- Function results	for all functions except for FFT, POLARITY and WAVEFORM (START COND → AUTO)

The settling process for the external sweep and the settling process for the frequency, phase or function measurement can be combined.

Exception:
Settling process in combination with external sweep with a change of the frequency as trigger condition (setting START COND → FREQ CH1 | FREQ CH2) cannot be combined with a settling of the frequency results. Reason: There are already settled frequency results which do not have to be weighted using a settling process again!

All settling settings can be activated in the ANALYZER panel in the corresponding panel sections under menu item "Settling".

The settling parameters:
The appropriate settling parameters are stored for every measurement function so that the settling settings once selected and well tested are effective in a change of the function.

Settling → EXPONENTIAL
sets a result comparison window with an exponential characteristic whose lock-in range is determined by the setting "tolerance". This setting is ideal for measurements on test items with a normal exponential transient response and usually covers most applications (cf. Fig. 2-7.1).

Settling → FLAT
sets a result comparison window with a fully flat characteristic (tolerance band) whose lock-in range is determined by the setting "tolerance". With a very small tolerance entered, this setting only supplies a measurement result if the test item has quasi completely settled. Due to this stricter settling condition, the time until a valid measured value is recognized is usually longer than with the EXPONENTIAL setting (cf. Fig. 2-7.1).

Settling → AVERAGE
causes an arithmetic averaging for the number of measured values set in samples. After a restart of the measurement by pressing the Single key at the UPD or a parameter entry which must result in a restart of the measurement such as modifications of the generator signal or of the settling parameters themselves, the average is only output when the number of measurements set by means of "samples" has been made. If the memory is full of measurement results, the most previous result is dismissed and the average output with every new result. In this phase, an abrupt change of the signal results in a creeping change of the average (low-pass properties).

Tolerance:
The tolerance value denotes the maximally permissible deviation from the previous measured value a settled measured value may have in order to be classed as valid by the UPD. 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 EXPONENTIAL | FLAT setting.

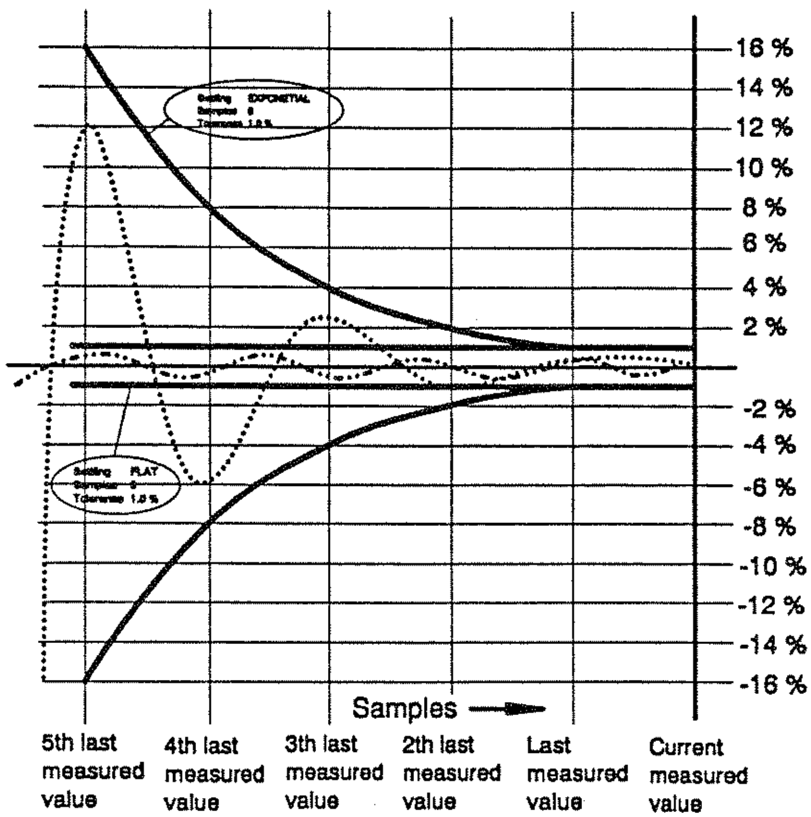


Fig. 2-7.1 Tolerance characteristic

If, e.g., samples = 6 is selected, the latest measured value at a time is compared with the 5 previous measured values. If for the tolerance = 1% (or 0.086 dB) has been entered, this means that the current measured value must be identical to

- the previous result to an accuracy of ± 1% (or ± 0.086 dB)
- the 2nd previous result to an accuracy of ± 2% (or ± 0.172 dB)
- the 3rd previous result to an accuracy of ± 4% (or ± 0.340 dB)
- the 4th previous result to an accuracy of ± 8% (or ± 0.668 dB)
- the 5th previous result to an accuracy of ± 16% (or ± 1.289 dB).

If the current measured value is 1 V in a level measurement, e.g., the previous measured values must be in the following range to have the value accepted as being valid:

- the previous result between 0.99 and 1.01 V
- the 2nd previous result between 0.98 and 1.02 V
- the 3rd previous result between 0.96 and 1.04 V
- the 4th previous result between 0.92 and 1.08 V
- the 5th previous result between 0.84 and 1.16 V

When for the tolerance = 0.1 dB has been entered, this means that the current measured value must be identical to

- the previous result to an accuracy of ± 0.1 dB
- the 2nd previous result to an accuracy of ± 0.2 dB
- the 3rd previous result to an accuracy of ± 0.4 dB
- the 4th previous result to an accuracy of ± 0.8 dB
- the 5th previous result to an accuracy of ± 1.6 dB.

Resolution:

With very small measured values, especially at the lower measurement limit of the UPD, or in the case of signals with superimposed noise, a relatively large measuring error is felt so that the measured value often is no longer within the exponential tolerance characteristic. In this case, a minimum value of the result resolution is considered, the "resolution" value, which serves as the starting value for an exponential resolution characteristic and which has exactly the same curve (EXPONENTIAL or FLAT) as the exponential tolerance characteristic.

A value outside the exponential tolerance characteristic which has been caused by superimposed noise is not expressive with regard to the transient response of the test item. If the measured value satisfies the resolution entered by the user, however, it is accepted as being valid nevertheless.

If, e.g., the current measured value is not within the tolerance limit required compared to the 4th last result, the amount of the difference between the current measured value and the 4th last value is found and compared to the resolution value no. 4. If this difference value is better than the resolution value, the measurement result is considered to be valid.

Example by means of the followwing panel setting:

Settling	EXPONENTIAL
Samples	5
Tolerance	1.0 %
Resolution	0.5 mV

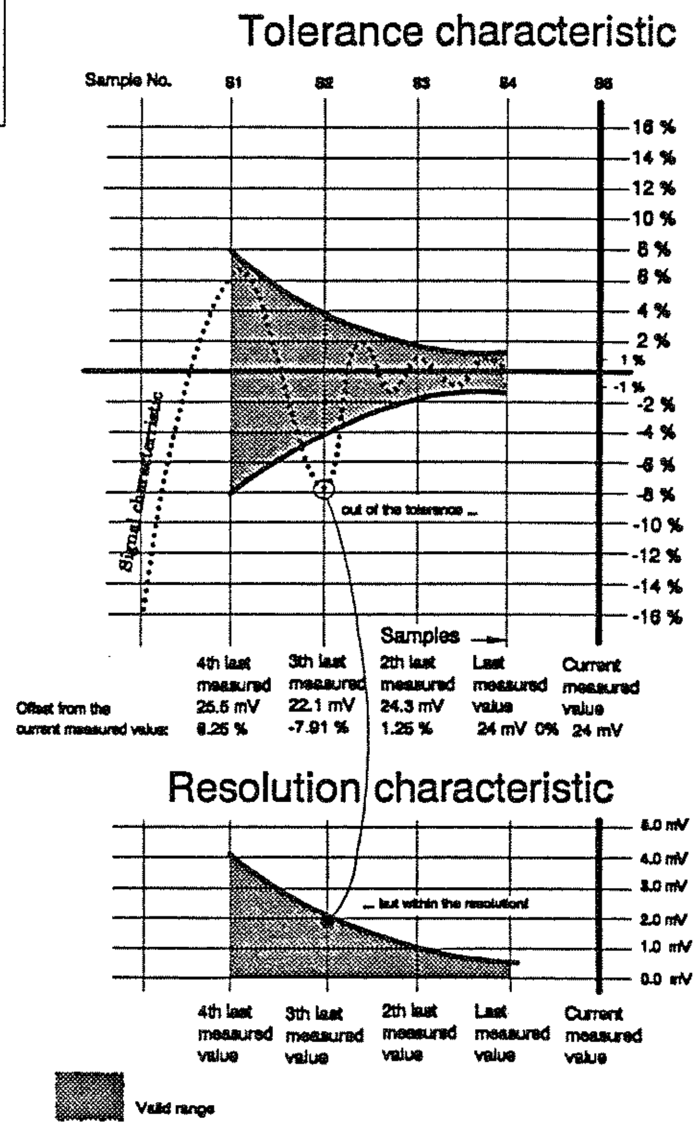


Fig. 2-7.2 Connection between tolerance and resolution

The EXPONENTIAL curves are always calculated to the basis 2. The sampling points of the exponential tolerance characteristic, e.g. starting from tolerance 1%, are calculated to: 1%, 2%, 4% and 8%. The sampling points of the resolution curve, e.g. starting from a resolution of 0.5 mV, are calculated to: 0.5 mV, 1 mV, 2 mV and 4 mV. The offset of the current measured value compared to the 3rd last measured value is -7.91% and is therefore not within the desired tolerance. When the amount of the difference between the current measured value (24 mV) and the 3rd last measured value (22.1 mV) is smaller than or equal to the resolution value [S2] (2 mV), the current measured value is accepted as being valid nevertheless.

$|24\ mV - 22.1\ mV| = 1.9\ mV$
Since $1.9\ mV < 2\ mV$, the current measured value is valid.

Timeout:

Timeout denotes the time which may elapse from the start of a measurement until the settling mechanism has recognized a settled measurement result. If the measured value does not stabilize within this time, the measuring loop is aborted and the note "Input - Press SHOW I/O" output instead of a measured value. During a sweep with a graphical curve display, a gap indicates that a value is missing. In the case of settling with an external sweep (cf. next paragraph) a timeout is not considered. If option Highspeed (UPD-B3) is fitted, the timeout period begins simultaneously for both channels after "delay" has elapsed. If option Highspeed is not fitted, channels Ch1 and Ch2 are measured sequentially and the timeout period reset with every change of the channel after "delay" has elapsed.

Settling process with external sweep:

For better understanding the following explanations, please read menu items
- "Min VOLT"
- "Start"
- "Stop"
- "Variation"

in Section 2.6.4, Ways of Starting the Analyzer, Ext. Sweep

When the external sweep (START COND → FREQ CH1 | FREQ CH2 | VOLT CH1 | VOLT CH2) is used together with the settling process, the following measurement procedure results:

1. Check whether a level of at least the value indicated in "Min VOLT"is present at the measurement input. (Only true of an external sweep with triggering on frequency changes (START COND → FREQ CH1 | FREQ CH2)
   No: Execute step 1.

2. Wait for the stabilization of the frequency with setting
   START COND → FREQ CH1 | FREQ CH2,
   the stabilization of the level with setting
   START COND → VOLT CH1 | VOLT CH2
   by means of the settling process.

3. Check whether the level or the frequency are in the range indicated by "Start" and "Stop".
   No: Execute step 1.
   Yes:- Wait the time indicated under delay to permit a test item to settle.
   - Execute function measurement (possibly including function settling)
   - Proceed function result to the display

4. Check whether a change in level or frequency by at least the value indicated in "Variation" has occurred.
   No: Execute step 4
   Yes: Execute step 1

Note on the delay:
A delay with an external sweep with settling process is useful when measurement is carried out on test items showing a slow transient response of the level due to a change in frequency (e.g. hearing aids with sound-level limiter or compander/expander circuits with fast level rise times and slow decay times). A frequency change has to be set as a trigger condition (START COND → FREQ CH1 | FREQ CH2). If the settling mechanism supplies quickly steadied values for the frequency results but the level is far from having stabilized, the lapse of the level settling time can be waited for using delay.

Example by means of the folllowing level setting:

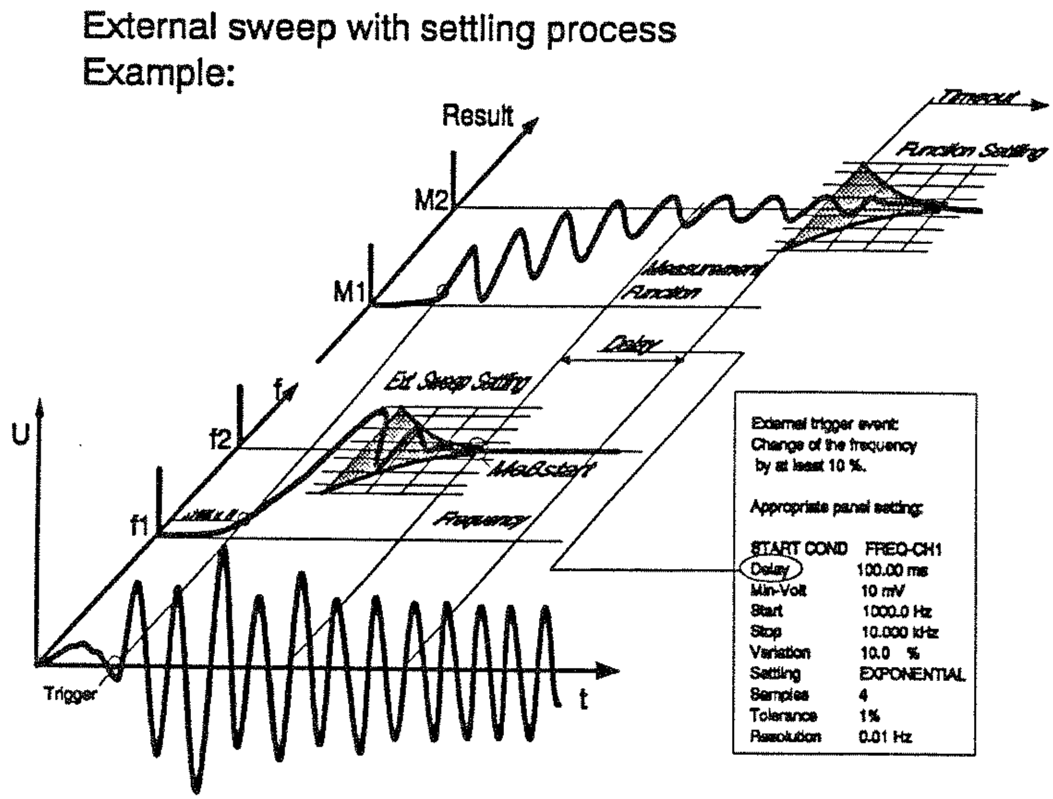


Fig. 2-7.3 External sweep with settling process

Optimizing the settling parameters:
In order to obtain maximal measurement rates in connection with the settling mechanism, the DELAY time under START COND → AUTO (cf. 2.6.4) is to be observed. This is the time elapsing from the setting of the generator until the restart of a measurement (and thus the start of the settling process) (cf. 2.6.4) in order to take into account possible dead times of a test item. The UPD automatically considers the settling time of the generator and the analyzer. If the value 0.0 s is entered for DELAY, no additional delay is effective and a maximum measurement rate is achieved.

As the settling process in the UPD can be used for individual measurements, the suitable settling parameters can be easily determined by observing the measurement results and by trying.

Determination of suitable settling parameters

Delay value if the UPD generator is used
Measurement using Timetick (START COND → TIME) and graphical display. After a generator modification, determine the time until the sudden signal change.
Delay time = (number of measured values - 1) * timetick spacing.

Delay value with external sweep
In the case of unknown signals, short dead times of the test item up to approx. 100 ms can be determined using function WAVEFORM, for longer dead times we recommend to use a storage oscilloscope. If test bands, test CDs etc. are used, possible manufacturer's instructions can be used. Trying delay values for the external sweep is usually not successful since settled measured values might occur, but possibly at an undesired point of time.

Sample value
A high value makes high demands on the transient response of the test item. No general statements possible.

Tolerance value
Select bar display until the min/max values are within the desired limits. A tolerance indication of 1% is suitable for most AF applications. In the case of noisy test bands with considerable level fluctuations, e.g., the tolerance value must not be selected too small as otherwise settled measured values would never be obtained. Tolerance values of approx. 5% with 3 samples can be useful.

Resolution value
Observe value displayed. The resolution value should always remain near the UPD resolution. If, e.g., the level result fluctuates by 2 mV, a value which is approx. 5 times higher, i.e. 10 mV, would be suitable as resolution value.

Caution!
Two high a resolution value would permanently signal settled measured values although the tolerance conditions would permanently be violated.

The longest time the UPD takes to measure the test item can be determined by experimenting. If this time is slightly increased, it can be used as timeout period and guarantees a maximal rate of the test run in the case of timeout being exceeded.

If noisy signals are weighted via the settling process, a steadied readout can be achieved by suitably setting "tolerance". However, the measurement rate decreases as possibly very many measured values have to be rejected until the settling condition is satisfied. The settling process offers the possibility of averaging (cf. AVERAGE).

2.3.4 Status Display

The status information is always displayed in the top right section of the screen and contains information on the current status of the generator, analyzer and sweep system as well as date and time.

Exception: In full-screen mode (see 2.10.9 Switching between Full-screen and Part-screen Mode), date and time are displayed right-flush in the operator guidance line.

Status display GEN Status

GEN OFF:	Both generator channels are off.
GEN RUNNING:	Generator outputs signal.
GEN BUSY:	Generator-DSP is temporarily processing the waveform.
GEN HALTED:	No generator output signal because of the setting not yet concluded or invalid.
GEN OVERRUN:	The sample rate applied to the external input (see 2.5.3) is too high for the selected digital generator. Remedy: • Select a lower external sample rate. Recall the function. • Select a faster digital generator

Status display ANL Status

ANL WAIT FOR TRIG: The analyzer waits for the trigger condition set under START COND (see 2.6.4).

ANL 1: ⌴ 2 : ⌴

Separate status information for analyzer channels 1 | 2:

OFF:	Channel OFF, no status messages
OVER:	Overranges may occur when • a measurement range has been fixed using FIX (see 2.6.2 Range) • a signal with a level featuring a crest factor > 2 is applied to the range limit • a DC portion is superposed on the signal with a lower range limit of 2 Hz • DC control is applied to the input configuration BAL.
UNDR:	Unterranges may occur when a measurement range has been fixed using FIX or LOWER (see 2.6.2 Range)
RANG:	Ranging. No measurements possible!
SNGL:	Single measurement running — see 2.11 Starting and Stopping a Measurement
CONT:	Continuous measurement running — see 2.11 Starting and Stopping a Measurement
TERM:	Single measurement terminated — see 2.11 Starting and Stopping a Measurement
STOP:	Measurement stopped — see 2.11 Starting and Stopping a Measurement
CAL:	Cyclic internal DC offset calibration of A/D converter in the analog analyzers or DC offset calibration of input levels in measurement function DC. Calibration, see 2.15.6
ORUN:	The sample rate applied to the external input (see 2.6.3) is too high for the selected digital instrument. Remedy: • Select a lower external sample rate Recall the function. • Select a faster digital instrument

Status display SWP Status after modifications to the settings

SWP OFF:	No sweep	
SWP INVALID:	Sweep invalid because not yet started	
SWP TERMINATED:	Single sweep terminated	
SWP STOPPED:	Sweep was stopped and can be continued	see 2.11 Starting and Stopping a Measurement
SWP CONT RUNNING:	Continuous sweep running	
SWP SNGL RUNNING:	Single sweep running	
SWP MANU RUNNING:	Manual sweep running	

SWP UNDERRANGE: On account of an underrange, valid, yet inaccurate measured values occurred during a sweep.

Other status displays:

In the section where date and time is displayed, the following status messages are displayed. Data and time are displayed again when the cause for the error has been removed.

PRINTER NOT READY

- After the H COPY key has been pressed, the UPD recognizes that no printer is connected.
- The connection to the printer has been interrupted while files or lists (see 2.14.1 and 2.14.2) are being printed.

CONVERTING SETUP: The setup of a previous UPD program version is being converted to be loadable by the latest UPD program version.

WAIT FOR CAL: ANA OFFSET: The analyzer requires an offset calibration. It is currently not feasible because cyclic DC-offset calibration has been switched off (see 2.15.6) or, due to a running sweep, has been disabled. The UPD is measuring without being calibrated.

The operator guidance line shows the following status message:

DUMP SCREEN TO TEMPORARY FILE: Pressing the H COPY key causes the screen contents to be copied to a temporary file. While this status message is being displayed, operation of the UPD is not possible.

2.3.5 Error Messages

All error messages in manual mode are displayed in a window in the center of the screen until ENTER is pressed.

The error message contains a hint about its recovery, if possible.

Error messages in measurement mode

In measurement mode, error messages may occur on account of inappropriate input signals or settings, thus disabling the display of measured values. Instead, the following hint is displayed in the window:

```
- INPUT? -
Press SHOW I/O
```

Fulfilling this request by pressing the SHOW I/O key on the UPD front panel (or ALT + I on the keyboard) sets a graphics to show the currently active inputs/outputs (see 2.12) and a text giving information about why the display of measured values is not possible. If there are more than one message, the messages can be called one after the other by repeatedly pressing the SHOW I/O key. Messages issued more than 30 seconds ago are not displayed.
The UPD front-panel graphics is removed and the measurement mode is entered again when

- all messages have been read out and the SHOW I/O key is pressed again.
- CANCEL or ESC is pressed.

Fatal errors with error messages

Just in case an internal software error making it impossible for the UPD program to run should occur, which is never to happen, the DOS operating system is branched to. The following error message will be displayed.
"Save setup to C:\UPD\SETUP\UPD.SET and Exit to DOS!"
"Internal Error No. xxx -- press any key!" where xxx is the error number.

Before returning to the DOS operating system, the current setup and a fault diagnostics buffer including the error number xxx is stored from the battery-backed RAM of the UPD to the hard disk under the name C:\UPD\SETUP\UPD.SET.

You can facilitate troubleshooting for the R&S service personnel by including the UPD.SET file.

To this end, connect a keyboard to the UPD (see 2.16 Connecting External Devices), insert a 3 $^1/_2$ "-disk into the disk drive and enter the DOS command:

```
COPY C:\UPD\SETUP\UPD.SET A:
```

When the UPD is put into operation again after a fatal error, the power-up picture includes the hint

"Error in prev. run! CANCEL → default setting, ENTER → previous setting"
offering you the following possibilities

- CANCEL: ... booting the UPD with its default setting
- ENTER: ... booting the UPD with the previous setting which might be faulty.

Fatal errors without error message

In the case of a fatal error without errror message, the UPD was no longer capable of storing the information which provides the above selection box when the UPD is put into operation again. Analogous to the above selection box, you can select between two ways of starting the UPD.

<u>Booting the UPD with the setup most recently stored in the CMOS-RAM</u>

This setup may be correct despite the faulty response of the UPD. To avoid having to re-enter the settings most recently input, try to start the UPD with this setup.

- Switch power switch off and on (no further action necessary).

In case the above attempt fails,

<u>boot the UPD</u>

```
UPD  -d                 -c   -r  -bd<n>    <ENTER or  <--'  >
     -sa:mysetup.set    -m       -bp<n>
                        -i
```

-bd<n> Size of data memory for automatic control of the UPD using R&S-Basic, cf. 3.6.5.1 "UPD/Basic memory management"

-bp<n> Size of program memory for the automatic control of the UPD using R&S-Basic, cf. 3.6.5.1 "UPD/Basic memory management"

-r: This setting is recommended for remote control!
When starting the UPD, error messages need not be acknowledged by the press of a key.
If messages requiring a decision by the user by pressing the CANCEL or ENTER key occur, the UPD is started with a useful setting.

-c: LCD and ext. monitor in colour mode
-m: LCD and ext. monitor in monochrome mode
-i: Only LCD in monochrome mode

-d: Setup "DEFAULT.SET" in the directory c:\upd\setup supplied together with the UPD is loaded.
-s: The UPD is started with the setup indicated without a space after -s.
The file name should be combined with a path name, e.g.:
-sa:\setup\mysetup.set or
-sc:\upd\user\mysetup.set
(The name mysetup.set only serves as an example here).

The parameters can be specified in any number or order, however must be separated by at least one space.

2.3.6 Help Function

Calling the HELP function:

Help

UPD front panel

External keyboard

A HELP information can be called for any input field in the panels (context-sensitive). It is displayed in a window in the center of the screen. Depending on the size of the HELP information, waiting times of several seconds may occasionally occur, which is indicated by the note

Just a moment please!

If the HELP information extends the range provided in the window, paging is possible by way of the Page ↑ and Page ↓ keys. A scroll bar at the right margin of the window indicates the position of the visible text section with respect to the complete HELP information. Highlighted fields within the HELP information serve as crossreferences for a more detailed description. Crossreference information is selected using the ↑, ↓, →, ← keys and displayed using SELECT. The HELP window is used and scrolled in the same way as is a panel (see 2.3.1 Panels).

Requesting a HELP information stops the output of graphics.
Measurement results can still be output.

2.4 Units

There are two types of units available in the UPD:

- Units for the output of measurement results:
  Select a display unit for every measurement function in the ANALYZER panel. The measurement result will be displayed with this unit in the measured value window (see 2.3.3 Display of Measured Values).
- Units for the input of values via all 6 panels (eg reference values, frequencies, level etc.). The units are selected using the units softkey line.

Units for analog level measurement results:
Functions: RMS & S/N, RMS Select, PEAK, QPEAK, DC and Input Peak display.
Basic unit: Volt (V[V])

Table 2-2

Value in	IEC/IEEE-bus notation	Conversion formula
V	V	$V[V]$
dBV	DBV	$20 * lg (V[V])$
dBu	DBU	$20 * lg (V[V]/0.7745967$
dBm	DBM	$10 * lg (V[V]^2 * 1000/R_{REF})$
W	W	$V[V]^2/R_{REF}$
Δ%V	CPCTV	$(V[V]/V_{REF}-1)*100$
ΔV	DV	$V[V]-V_{REF}$
V/Vr	V/VR	$V[V]/V_{REF}$
%V/Vr	PCTV/VR	$100 * V[V]/V_{REF}$
Δ%W	DPCTW	$(((V[V]^2/R_{REF})-P_{REF}) * 100)/P_{REF}$
ΔW	DW	$(V[V]^2/R_{REF}) - P_{REF}$
P/Pr	PIPR	$(V[V]^2/R_{REF})/P_{REF}$
%P/Pr	PCTPIPR	$V[V]^2/R_{REF}/P_{REF} * 100$
dB	DBR	$20 * lg (V[V]/V_{REF})$

R_{REF} = Value of reference impedance from ANALYZER panel

V_{REF} = Reference value from ANALYZER panel of functions RMS & S/N, RMS-Select, PEAK, QPEAK, DC or Input Peak measurement

P_{REF} = $V_{REF}{}^2/R_{REF}$

Units for digital level measurement results:

Functions: RMS & S/N, RMS-Select, PEAK, QPEAK and Input Peak display.

Basic unit: Full Scale V[FS] 0 ... 1

Table 2-3

Value in	IEC/IEEE bus notation	Conversion formula
FS	FS	$V_{[FS]}$
%FS	PCTFS	$V_{[FS]} \cdot 100$
dBFS	DBFS	$20 \lg (V_{[FS]})$
Hex *)	HEX	$V_{[FS]}$ * 65535
Δ%	DPCT	$(V_{[FS]}/V_{REF}-1)$ * 100
dBr	DBR	$20 \lg (V_{[FS]}/V_{REF})$

*) Level measurement result in hex
The full-scale value measured at the digital interface as the result of a digital analyzer function is displayed as a 6-digit hexadecimal number (6 digits = 24 bit = 23 bit mantissa + 1 sign bit) in the measured value window, for example:

Table 2- 3a

FS value	Hex display
1.0	7FFFFF Hex
0.9	733333 Hex
0.5	400000 Hex
0.0001	000347 Hex
0.0	000000 Hex
-0.0001	FFFCB9 Hex
-0.5	C00000 Hex
-0.9	8CCCCD Hex
-1.0	800000 Hex

All digital analyzer functions provide FS values in the range from 0 to 1. The peak measurement functions PEAK & S/N and Q-PK & S/N may provide FS values < 0 or > 1, irrespective of the PEAK mode selected. All values < -1 and > 1 are displayed as 80000 Hex and 7FFFFF Hex, respectively.

FS values > 1 may occur

- with the function PEAK & S/N together with Meas Mode PK +, when applying a square signal. Being band-limited, overshoots at the edges (Gibb's phenomenon) occur, which, with peak evaluation, are included as part of the measurement result.
- with the measurement function PEAK & S/N together with Meas Mode PK to PK or PKabs.

FS values < 0 may occur

- with the function PEAK & S/N together with Meas Mode PK-.

V_{REF} = Reference value from the ANALYZER panel of functions RMS & S/N, RMS Select, PEAK, QPEAK or Input Peak measurement.

Units for analog and digital interference level measurement results:

Functions: THD, THD + N/SINAD, MOD DIST, DIM, DFD
Basic unit: % (re[%])

Table 2-4

Value in	IEC/IEEE bus notation	Conversion formula
%	PCT	rel[%]
dB	DB	20 * lg (rel[%] /100)

Unit for analog and digital S/N measurement results:

Functions: RMS, PEAK, QPEAK with S/N measurement on

Table 2-5

Value in	IEC/IEEE bus notation	Conversion formula
dB	DB	20 * lg(S/N)

S: Measured level with generator on
N: Measured level with generator off

Units for analog and digital frequency measurement results:

Basic unit: Hz (F[Hz])

Table 2-6

Value in	IEC/IEEE bus notation	Conversion formula
Hz	HZ	$F_{[Hz]}$
ΔHz	DHZ	$F_{[Hz]}-F_{REF}$
Δ%Hz	DPCTHZ	$100 * (F_{[Hz]} - F_{REF})/F_{REF}$
Toct *	TOCT	$lg (F_{[Hz]}/F_{REF}) \cdot 9.96578$
Oct	OCT	$lg (F_{[Hz]}/F_{REF})/0.30103$
Dec	DEC	$lg (F_{[Hz]}/F_{REF})$
f/fr	F/FR	$F_{[Hz]}/F_{REF}$

*) Toct = Third Octave

F_{REF} = Reference parameter from ANALYZER panel of frequency measurement

Units for analog phase measurement results:

Basic unit: degree (P[°])

Table 2-7

D_{REF} = Reference parameter from ANALYZER panel of phase measurement

Value in	IEC/IEEE-bus notation	Conversion formula
°	DEG	P[°]
RAD	RAD	P[°] * (PI/180)
Δ°	DDEG	$P_{[°]} - D_{REF}$
ΔRAD	DRAD	$(P[°] - D_{REF})$ * (PI/180);

Unit for analog and digital wow & flutter measurement results:

Basic unit: % (rel[%])

Table 2-8

Value in	IEC/IEEE-bus notation	Conversion formula
%	PCT	rel[%]

Units for the entry of values in the panels (softkeys) or via IEC bus:

To simplify the matter

- the input values are designated only by the unit in the following conversion formulae. Example: "dBu" actually means "value in dBu".
- the conversions into µ, m, k, M have been left out.

Absolute analog level units (without reference)

Conversion formulae		IEC/IEEE bus notation
Vpp = depending on the generator function (see 2.5.4 for respective signal function)		VPP
dBu = 20 * lg (V/0,7746)	$V = 0.7746 * 10^{(dBu/20)}$	DBU
dBV = 20 * lg (V)	$V = 10^{(dBV/20)}$	DBV
$dBm = 10 * lg (V^2 * 1000/R_{REF})$	$V = \sqrt{10^{(dBm/10)} * R_{REF}/1000}$	DBM
$W = V^2/R_{REF}$	$V = \sqrt{(W * R_{REF})}$	W

Relative analog level units (with reference)

Conversion formulae		IEC/IEEE bus notation
$\Delta V = V - U_{REF}$	$V = \Delta V + U_{REF}$	DV
$\Delta\%V = (V/U_{REF} - 1) * 100$	$V = U_{REF} * (1 + \Delta\%V/100)$	DPCTV
$V/Vr = V/U_{REF}$	$V = V/V_r * U_{REF}$	V/VR
$\%V/Vr = V/U_{REF} * 100$	$V = \%V/Vr * U_{REF}/100$	PCTV/VR
$\Delta W = (V^2 - U_{REF}^2)/R_{REF}$	$V = \sqrt{(dW * R_{REF}) + U_{REF}^2}$	DW
$\Delta\%W = (V^2 - U_{REF}^2) * 100/U_{REF}^2$	$V = \sqrt{U_{REF}^2 * (\Delta\%W/100 + 1)}$	DPCTW
$P/Pr = V^2/U_{REF}^2$	$V = \sqrt{P/Pr * U_{REF}^2}$	P/PR
$\%P/Pr = V^2/U_{REF}^2) * 100$	$V = \sqrt{\%P/Pr * U_{REF}^2/100}$	PCTP/PR
$dBr = 20 * lg(V/U_{REF})$	$V = 10^{(dBr/20)} * U_{REF}$	
V/on = V/Burstamp[V]	V = V/on * Burstamp[V]	V/VON
%on = 100 * V/Burstamp[V]	V = %on * Burstamp[V]/100	PCTON
dBon = 20 * lg (V/Burstamp[V])	$V = 10^{(dBon.20)}$ * Burstamp[V]	DBON

Absolute digital level units (without reference)

Conversion formulae		IEC/IEEE bus notation
BtFS = - 3.322 * lg (FS)	FS = 10 - (BtFS /3.322)	FSBIT
%FS = 100 * FS	FS = %FS/100	PCTFS
dBFS = 20 * lg (FS)	$FS = 10^{(dBFS/20)}$	DBFS

Relative digital level units (with reference)

Conversion formulae		IEC/IEEE bus notation
$dBr = 20 * lg(FS/U_{REF})$	$FS = 10^{(dBr/20)} * U_{REF}$	DBR
%on = 100 * V/Burstamp[FS]	FS = %on * Burstamp[FS]/100	PCTON
dBon = 20 * lg (FS/Burstamp[FS])	$FS = 10^{(dBon/20)}$ * Burstamp[FS]	DBON

Absolute time units

Conversion formulae		IEC/IEEE bus notation
cyc = s * Signalfrequenz	s = cyc / Signalfrequenz	CYC

Absolute frequency units

Conversion formulae	IEC/IEEE bus notation
Hz	HZ

Relative frequency units (with reference)

Conversion formulae		IEC/IEEE bus notation
$\Delta Hz = Hz - F_{REF}$	$Hz = \Delta Hz + F_{REF}$	DHZ
$f/fr = Hz/F_{REF}$	$Hz = f/fr * F_{REF}$	F/FR
$\Delta\%Hz = 100 * (Hz - F_{REF})/F_{REF}$	$Hz = \Delta\%Hz * F_{REF}/100 + F_{REF}$	DPCTHZ
Toct*) $= lg(Hz/F_{REF}) * 9.96578$	$Hz = 2^{(Toct/3)} * F_{REF}$	TOCT
$Oct = lg(Hz/F_{REF}) * 3.32193$	$Hz = 2^{(Oct)} * F_{REF}$	OCT
$Dec = lg(Hz/F_{REF})$	$Hz = 10^{(Dec)} * F_{REF}$	DEC
*) Toct = Third Octave		

Absolute phase units

Conversion formulae		IEC/IEEE bus notation
rad = ° * (PI/180)	° = rad * (180/PI)	RAD

Absolute resistance units

Conversion formulae	IEC/IEEE bus notation
Ω	OHM

Legend:

FS:	Abbreviation for Full Scale = ratio 0...1
UREF:	Level reference value in V or FS → *)
RREF:	"Ref Imped" parameter from ANALYZER panel
FREF:	Frequency reference value in Hz
Burstamp:	High level of generator burst signal, see 2.5.4.5, BURST
Signal frequency:	Frequency of generator burst signal or pulse signal, see 2.5.4.5 BURST, 2.5.4.6 SINE2BURST

2.5 Generators (GENERATOR Panel)

The GENERATOR panel is activated by means of the GEN key (UPD front panel) or the key combination "ALT G" (external keyboard). The panel is always displayed on the left side of the screen and consists of two segments: configuration and function.

GENERATOR		
GENERATOR	DIG 48 kHz	Select the analog or digital instrument.
CHANNEL(s)	CH1	Configuration segment for setting the outputs. (output connectors, channel select, output impedance / sample frequency, oversampling factor, etc.) see 2.5.3 Configuration of the Digital Generators see 2.5.2 Configuration of the Analog Generators
FUNKTION	SINE	Functions (waveforms) of the Generator, see 2.5.4

When changing the function (generator signal)

- the current function is stored to the hard disk;
- the desired function is loaded from the hard disk, initialized and, if possible, started.

When changing the generator (eg DIG48 instead of ANLG25)

- the current generator with all settings and functions is stored to the hard disk;
- the desired generator with the currently active function is loaded from the hard disk, initialized and, if possible, started.

2.5.1 Selecting the Generator

GENERATOR

The GENERATOR panel contains the settings for 2 analog and 3 digital generators. The instruments differ from each other in their frequency ranges and the possible functions (waveforms).

ANLG 25kHz	Two-channel analog generator 2 (10) Hz to 25 kHz
ANLG 110kHz	Two-channel analog generator 2 (10) Hz to 110 kHz
DIG 48kHz	Two-channel digital generator 2 Hz to 21.75 kHz
DIG 192kHz	Two-channel digital generator 2 Hz to 87 kHz
DIG 768kHz	Single-channel digital generator 2 Hz to 348 kHz

The standard universal generator can be supplemented by the Low-distortion Generator option (UPD-B1) for sinewave generation in the analog ranges. The option has the lower frequency limit of 10 Hz. The LOW DIST GEN can be used for sinewave signals (SINE) and for two-tone signals (DFD, DIM, MOD DIST).

Advantages:

- Low distortion (SINE)
- Enhanced signal quality for intermodulation signals (DFD, MOD DIST);
- Enables signal generation for analog dynamic intermodulation measurements DIM; (without Low-dist. Gen. possible in the digital range only).

The generator you select affects the following features in the instrument (apart from analog / digital switchover):

- maximum clock rate of generator in the digital range; with a fixed sample frequency (32 kHz, 44.1 kHz or 48 kHz), different oversampling factors are thus possible.
- single-channel / two-channel mode (see above)
- functions that can be generated (see Table 2-10)
- frequency resolution
- lengths of intervals with burst signals (see 2.5.4.5 SINE BURST and 2.5.4.6 SINE² BURST)

Frequency ranges of digital generator instruments:

The maximum generator output frequency is given by:

$$f_{max} = sample\ frequency \times oversampling\ factor \times 29/64$$

Set the sample frequency and oversampling factor in the configuration segment of the GENERATOR panel using the menu items Sample-Frq and Oversamp, respectively.

Depending on the digital instrument selected, the following oversampling factors or external clock rates can be selected in the GENERATOR panel.

Table 2-9 Possible oversampling factors

Instrument	Oversampling factors	Max. external clock rates	Multiplex possible
DIG 48 kHz:	1	48 kHz	yes
DIG 192 kHz:	1, 2, 4	192 kHz	yes
DIG 768 kHz:	1, 2, 4, 8, 16	768 kHz	no

No oversampling factor can be selected for a sample frequency applied externally (see Section 2.5.3 Configuration of the Digital Generators).

Clock rates of digital GENERATOR instruments in single-channel mode and multiplex mode:

The internal clock rate is given by

$$f_{ab} = sample\ frequency \times oversampling\ factor$$

External clock rate (per channel)

$$f_{abex} = sample\ frequency$$

Table 2-10 Availability of the generator functions depending on the generator selected

Function/Generator	Analog		Digital		
	25 kHz	110 kHz	48 kHz	192 kHz	768 kHz
SINE	yes	yes	yes	yes	yes
MULTISINE	yes	yes	yes	yes	yes
SINE BURST	yes	yes	yes	yes	yes
SINE² BURST	yes	yes	yes	yes	yes
SQUARE	yes	no	yes	yes	yes
MOD DIST	yes	yes	yes	yes	yes
DFD	yes	yes	yes	yes	yes
DIM	only with UPD-B1	no	yes	yes	no
RANDOM	yes	yes	yes	yes	yes
ARBITRARY	yes	yes	yes	yes	yes
POLARITY	yes	no	yes	no	no
FM	yes	no	yes	no	no

There are 3 states the active generator (visible in the panel) can assume (see Status Display, Section 2.3.4):

- RUNNING: Set function (generator signal) is output via the specified interface.
- BUSY: Generator output signal is calculated.
- HALTED: Generator is halted; the outputs are terminated.

RUNNING, ie a signal is constantly output, is the normal status of the generator. It is automatically restarted after having (re)set the generator.

The generator can be manually restarted at all times by recalling the generator or the function (open the respective selection window and confirm using ENTER).

The setting of some signals (eg specific noise signals) involves a lot of computations. During this time, the generator does not produce any signal and is in the BUSY state. After having successfully concluded the computations, the generator automatically re-enters the RUNNING state. To allow you to perform further settings without having to wait for the computations to be concluded, the generator automatically enters the HALTED state at the press of a key. The calculation is continued (→ "BUSY") when the next setting is concluded.

Other reasons for halting the generator (HALTED):

- Faulty setting (eg wrong file name).
  Remedy: eliminate the cause of error; restart, if required.

- Applying a too high external frequency (generator is "overrun").
  Remedy: reduce the clock frequency and restart.

2.5.2 Configuration of the Analog Generators

The generator can be used as balanced or unbalanced source with one or two output channels. Various internal resistors are selectable - there is even the possibility of fitting an additional resistor in each output.

The complete generator is designed to be floating to frame potential. The banana jack plug GEN COM is connected to generator ground.

The below overview of possible settings is followed by substitute circuit diagrams showing the three different output circuits (unbalanced signal, balanced signal, or common-mode test signal).

Channel(s)	The deactivated channel is internally terminated with the set internal impedance. Crosstalk attenuation does not depend on the internal impedance set.
OFF	both channels off
1	channel 1 on, channel 2 off
2	channel 2 on, channel 1 off
2≡1	identical signal on both channels
2≡-1	channel 2 inverted against channel 1

Output	With the use of BNC connectors, the XLR connectors are deactivated with high impedance and vice versa.	
UNBAL	unbalanced signal	BNC connector(s)
BAL	balanced signal	XLR connector(s)
COMTST	common-mode test signal	XLR connector(s)

Impedance — With Output UNBAL selected

- 5 Ω
- 15 Ω
- USER DEF

or

Impedance — With Output BAL or Output COMTST selected

- 10 Ω
- 30 Ω
- 200 Ω
- 600 Ω
- USER DEF

Common

FLOAT	Floating generator ground
GROUND	Generator ground connected to frame

Max Volt — Limit value for input of output voltage prevents the inadvertent entry of too high voltage values.

Ref Freq — Reference value for the relative frequency units.
A change of the reference frequency causes all reference-related frequency inputs to be recomputed.
The absolute frequency of the generator signal is retained.

Ref Volt — Reference value for the relative voltage units.
A change of the reference level causes all reference-related voltage inputs to be recomputed.
The absolute voltage of the generator signal is retained.

2.5.2.1 Unbalanced Output (Output UNBAL)

The output signal is applied between internal and external conductor of the BNC female connector. The external conductors of both BNC female connectors are connected to generator ground GEN COM.

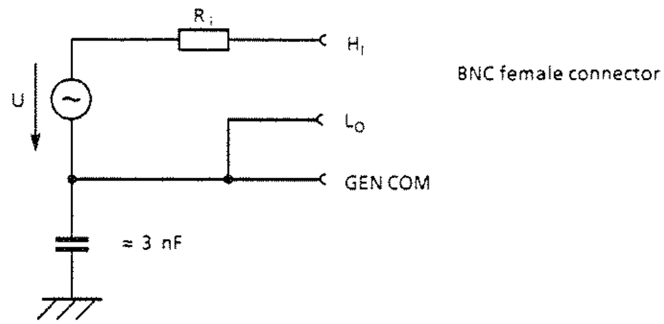


Fig. 2-8

Depending on the channel and impedance, the following output circuits are possible (capacitances are omitted):

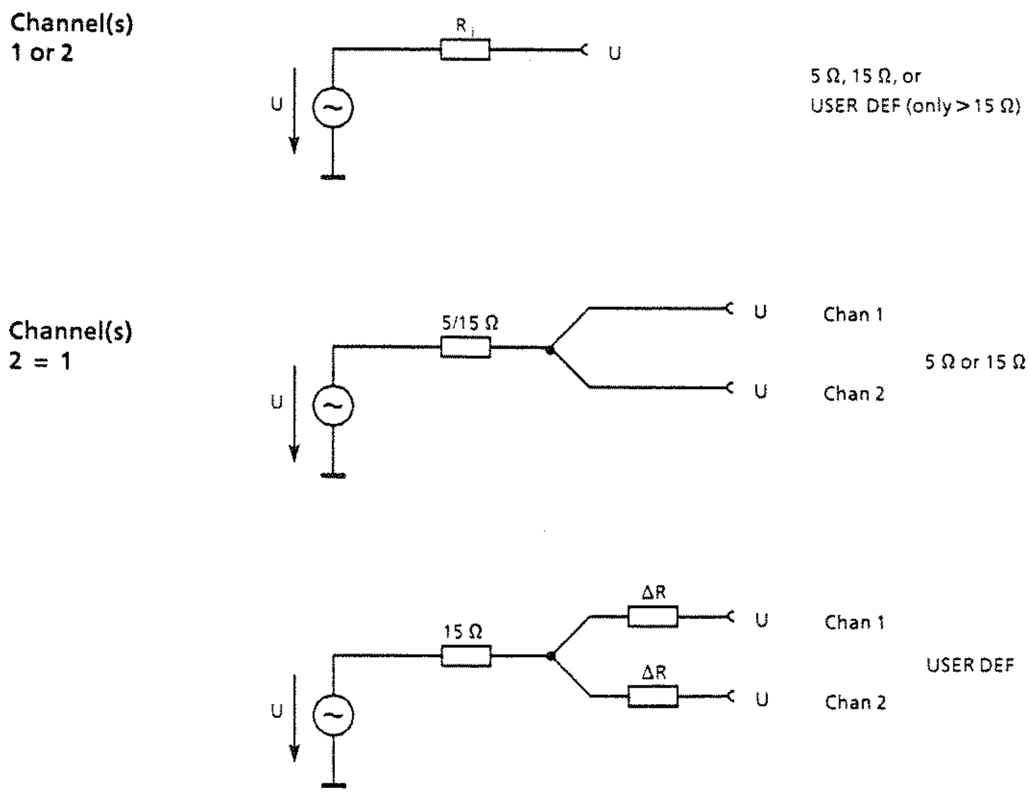


Fig. 2-9 Unbalanced output

Channel(s)
2 = -1

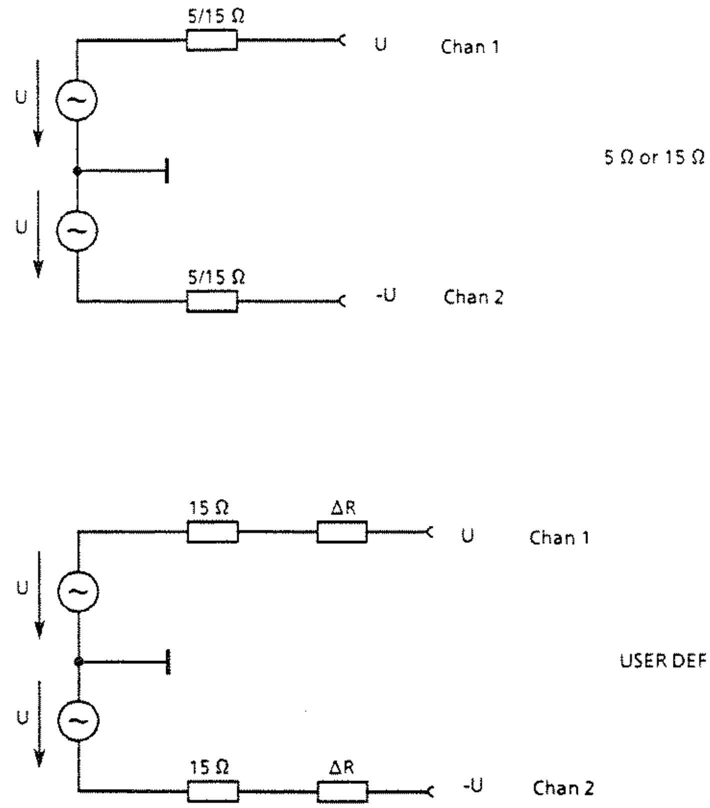


Fig. 2-10 Unbalanced output

2.5.2.2 Balanced Output (Output BAL)

The output signal is applied between contacts 2 and 3 of the XLR female connector. The source impedance is presented by two equal resistors, one in each signal line.

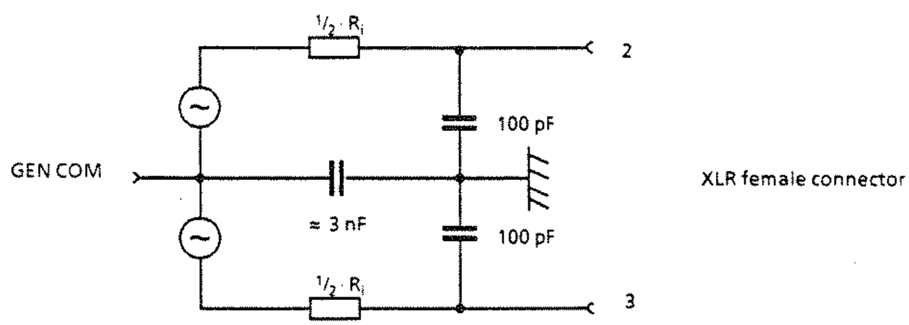
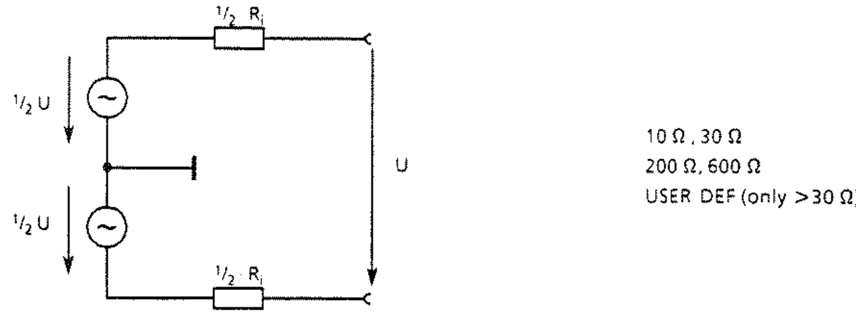


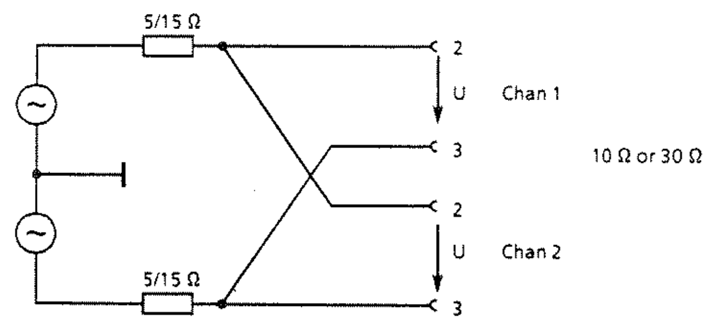
Fig. 2-11 Balanced output

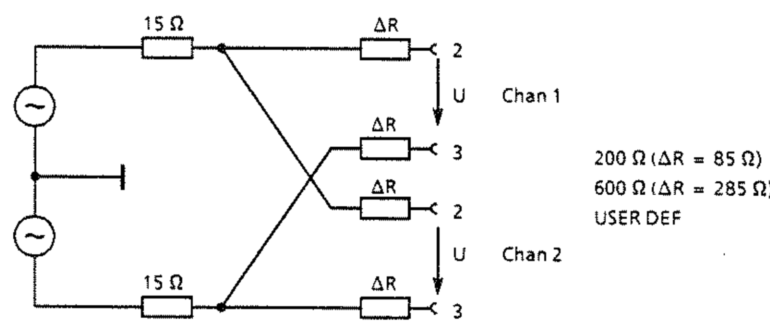
Depending on channel and impedance, the following output circuits are obtained. (Capacitances are not included in the figure):

Channel(s)
1 or 2



Channel (s)
2 = 1





Channel(s)
2 = -1

With channel 2, pins 2 and 3 of the XLR female connector are exchanged. The signal of channel 2 is inverted compared to channel 1, otherwise as with channel(s) 2 = 1

Fig. 2-12 Balanced output

2.5.2.3 Balanced Output with Common-mode Test Signal (Output COMTST)

The same output signal is applied to contacts 2 and 3 of the XLR female connector. The reference is the generator ground GEN COM. The source impedance is made up of 2 equal resistors, one in each signal line. This configuration of the generator output is suitable for testing the common-mode rejection of balanced devices under test.

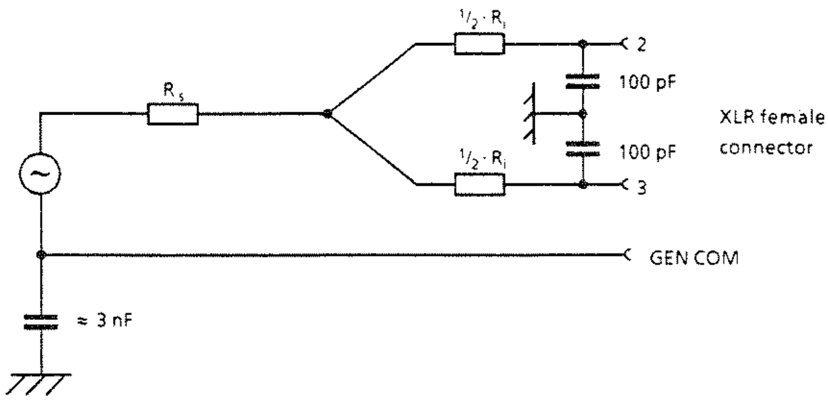
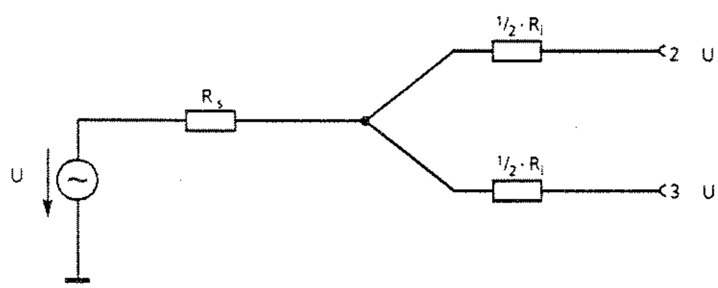


Fig. 2-13 Output with common-mode signal

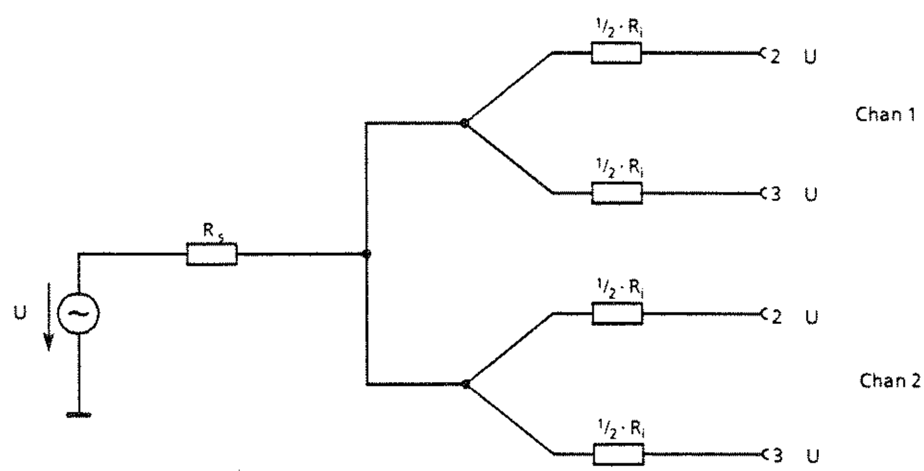
Depending on the channel and impedance, the following output circuits are obtained (capacitances are omitted):

The common source resistance R_s is:
5 Ω with R_i = 10Ω
15 Ω with R_i = 30 Ω, 200 Ω, 600 Ω, USER DEF

Channel(s)
1 or 2



Channel(s)
2 = 1



Channel(s)
2 = -1

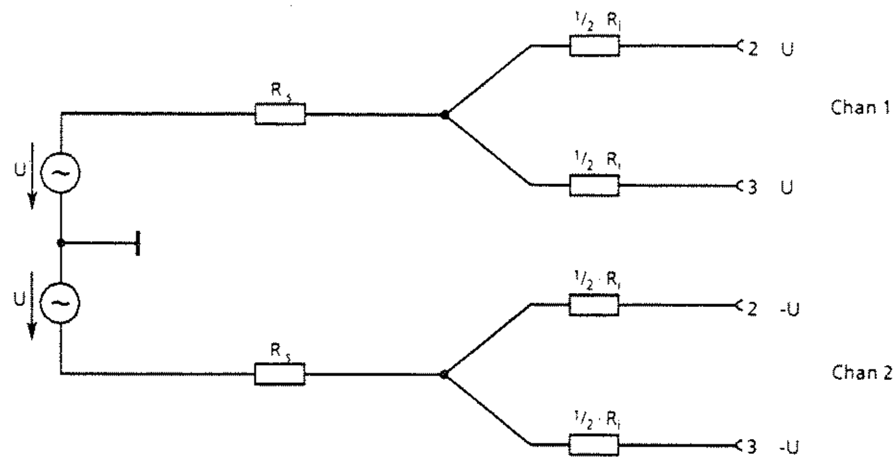


Fig. 2-14

2.5.2.4 User-definable Resistors (USER DEF)

Special measurement spheres often require specific internal resistors.

Any additional internal resistance R_{user} can be implemented in both channels for both the balanced and the unbalanced output by fitting several resistors (ΔR) on the OUTPUT CIRCUIT board of the analog generator.

Equations: UNBAL: $\Delta R = R_{user} - 15\Omega$
BAL: $\Delta R = 0.5 \times R_{user} - 15\Omega$

Note: *All options are electrostatic sensitive devices. Handle them in line with ESD regulations.*

Mounting:

- Switch off the UPD.
- Remove the top panelling and cover of the analog unit (to the right when seen from the front).
- Withdraw the OUTPUT CIRCUIT board (second next board to the center panel).
- Unscrew the cover from component side.
- Solder tags for fitting additional resistors (ΔR) are available on the board for both channels of the balanced and unbalanced output:

UNBAL:	channel 1: ΔR	between	X807, X808
	channel 2: ΔR	between	X907, X908
BAL:	channel 1: ΔR	between	X803, X804, and X805, X806
	channel 2: ΔR	between	X903, X904, and X905, X906

These special resistors can be different for the balanced and unbalanced outputs, they can even have different values in both channels.
Switch the user-definable resistors on by selecting USER DEF in the dialog box for impedance.

2.5.2.5 Output Power

The output amplifier, attenuator and all internal resistors are short-circuit proof. The peak current is limited to about 200 mA. With a maximum rms value of the output voltage of 24 V balanced and 12 V unbalanced, the maximum power loss in the load resistor (with a short-circuit in the internal resistor) is 3.4 W or 1.7 W.

Take this into account when dimensioning the user-definable resistors.

Delicate devices under test might be damaged or even destroyed by an output voltage inadvertently selected too high. For this reason, the maximum settable voltage can be limited (Max Volt).

2.5.3 Configuration of the Digital Generators

2.5.3.1 Common settings:

Channel(s)

- OFF
- 1
- 2
- 2≡ 1
- 2≡ −1

Set the currently active output channel:

The exact meaning depends, among others, on the interface used, see Table 2-11, Interfaces.

Note: When using the PARALLEL output (not multiplexed), selection of channel 2 is not possible; PARALLEL MUX is automatically switched to.

Output

The output interface can be selected from:
(For their meaning, see also Table 2-4)

SERIAL MUX	Serial universal output, multiplex mode
SERIAL	Serial universal output
PARAL MUX	Parallel output, multiplexed
PARALLEL	Parallel output
AES/EBU	Digital interface, XLR
S/P DIF	Digital interface, BNC
OPTICAL	Optical interface
INTERN	Interface to anlyzer

Available interfaces depending on the instrument used:

- DIG48kHz: all interfaces in all modes
- DIG192kHz: AES, S/P DIF, OPTICAL, INTERN no longer selectable
- DIG768kHz: only SERIAL and PARALLEL in single-channel mode

Max Volt

Limit for the input of the output voltage; prevents too high voltage values from being entered inadvertently.

Ref Freq

Reference value for the relative frequency units.
All frequency inputs related to the reference value are converted if the reference frequency changes.
The absolute frequency of the generator signal remains unchanged.

Table 2-11 Interfaces

Output	Channel	Explanation
SERIAL	OFF	No output
	1	Output on channel 1
	2	Output on channel 2
	2 ≡ 1	Same output on both channels
	2 ≡ -1	Normal output on channel 1, inverted on channel 2
SERIAL MUX	OFF	No output
	1	Multiplexed output on channel 1 Only samples with wordselect = setting of WordselCh1 include audio data, samples on second channel: 0.
	2	Multiplexed output on channel 2 Only samples with wordselect unequal to setting of WordselCh1 include audio data, samples on second channel: 0.
	2 ≡ 1	Multiplexed output Both channels include (equivalent) audio data.
	2 ≡ -1	Multiplexed output Samples with Wordselect = setting of WordselCh1 include non-inverted audio data, samples of second channel include inverted audio data.
PARALLEL	OFF	No output
	1	Output to parallel interface
	2	Not possible
	2 ≡ 1	Not possible
	2 ≡ -1	Not possible
PARAL MUX	OFF	No output
	1	Multiplexed output Only samples with wordselect = setting of WordselCh1 include audio data, samples on second channel: 0.
	2	Multiplexed output Only samples with wordselect unequal to setting of WordselCh1 include audio data, samples on second channel: 0.
	2 ≡ 1	Multiplexed output Both channels include (equivalent) audio data.
	2 ≡ -1	Multiplexed output Samples with Wordselect = setting of WordselCh1 include non-inverted audio data, samples of second channel include inverted audio data.
INTERN	OFF	No output
	1	Output via internal connection to analyzer
	2	Not possible
	2 ≡ 1	Not possible
	2 ≡ -1	Not possible

Sample Frq
32 kHz 44,1 kHz 48 kHz EXTERN SYNCHRON

Set the output clock rate:
With 32 kHz, 44.1 kHz, 48 kHz the clock is generated internally;

If you have selected EXTERN, the audio clock from the interface is applied externally (PARALLEL: EXSTRBIN, pin 36, see Table 2-14; SERIAL: SCLKIN, pin 4, see Table 2-13; AES EBU, S/P DIF and OPTICAL: BNC female connector on rear panel); the frequency applied must appear in the next field to be displayed.

Important:
If the frequency entered does not match the frequency applied, all signals generated are correspondingly shifted in frequency! The frequency applied must not exceed the respective maximum sample clock rate of the selected instrument (48,000Hz x max. permissible oversampling rate) by more than 5 % (2 % in the case of DIG768kHz), as otherwise faulty signals occur or output is aborted.

The minimum sample rate is 100 kHz.

Status display: GEN: OVERRUN;

Remedy:
Restart the respective generator instrument by reselecting the generator.
Selecting SYNCHRON (only with AES/EBU, S/P DIF and OPTICAL) causes the clock to be adopted from the selected digital input signal of the analyzer.

Oversamp
1 2 4 8 16

(Oversampling)
Set a clock multiplier; depending on the instrument, 1 to 16 are selectable, see Table 2-12.

Note: *The oversampling factor refers to the full word length. Higher oversampling factors (eg 64) are often used with bit stream converters (1-bit-sigma-delta converters). They are usually controlled with an oversampling factor of 1. In this case oversampling is effected with, for example, the considerably higher bit clock (sample clock rate x word length).*

The internal sample clock rate is given by:

$$\textit{Sample clock rate} = \textit{basic clock rate} \times \textit{oversampling factor} \times \textit{muliplex factor}$$

The multiplex factor is 1 and 2 for normal signals and multiplex signals, respectively.

The system clock rate (also referred to as sample rate) is obtained by:

$$\textit{System clock rate} = \textit{basic clock rate} \times \textit{oversampling factor}$$

Table 2-12

Instrument	Basic clock rate [kHz]	Multiplex posible	Oversampling possible factors
DIG48	32, 44,1, 48	yes	no
DIG192	32, 44,1, 48	yes	*2, *4,
DIG768	32, 44,1, 48	no	*2, *4, *8, *16

The maximum signal frequency is 29/64 x system clock rate.

An externally applied sample frequency does not permit selection of any oversampling factor, the internal sample clock rate matches the external sample clock rate.

The two's complement is used as the data format (signed integer).

Examples:	MSB,	... LSB:	0010000...0 =	+ 0.25	×	full scale
	MSB,	... LSB:	0111111...1 =	+ 1.00	×	full scale
	MSB,	... LSB:	1000000...1 =	-1.00	×	full scale
	MSB,	... LSB:	1100000...0 =	-0.50	×	full scale

(MSB = Most Significant Bit)

Audio Bits

Word length in bits of the generated audio samples

Range of values depends on the output:

- Output → SERIAL MUX | SERIAL:

with word length		
	= 8:	8
	= 16:	8 to 16
	= 24:	8 to 24
	= 32:	8 to 28

- Output → PARAL MUX | PARALLEL: 8 to 28
- Output → AES/EBU | S/P DIF | OPTICAL: 16 to 24
- Output → INTernal: 8 to 28

Reducing the word length causes the values of the audio samples to be rounded to the specified word length.

2.5.3.2 Serial universal interface

Wordlength

- 8
- 16
- 24
- 32

Set the data bits per output sample:

Wordoffset

(Word offset)
Set the position of the synchronizing pulse (= word clock) or Word-select line (= Word Sel CH1) relative to the beginning of the sample data. Range: -Word length/2 to +Word length/2-1 (see Fig. 2-15). This setting changes the significance of the audio bits. Shifting the synchronizing pulse by one bit position in the direction of the MSB causes the signal amplitude to be "doubled". With a signal amplitude between 0.5 and 1.0 FS (full scale), a misadjusted word offset causes jumps in the signal!

Audio Bits

see "Common Settings"

Word clock

- RISING
- FALLING

Only with SERIAL
Set the polarity of the synchronizing pulse.
The active edge of the word clock signal (which refers to the beginning of the data) is either rising or falling.

Bit clock

- RISING
- FALLING

Set the polarity of the clock used for output of the individual bits.

Note: *Faults in transmission (sporadic errors) may occur due to crosstalk.*
Remedy: ▶ *Terminating the lines*
▶ *Inverting the bit clock*

WordselCh1

WordselCh1:
With SERIAL MUX only.
The SWSOUT line includes a square signal of a frequency equal to the sample rate.

LOW — When outputting data of channel 1, SWSOUT = LOW

HIGH — When outputting data of channel 1, SWSOUT = HIGH

Frq Bitclock

(Frequency bit clock)
(Only display field, cannot be varied). Display of bit clock.
Equation:
Bit clock = word length × sample clock rate (see above)

Bit Order

Set the bit order:

LSB FIRST — The least significant bit is output first.

MSB FIRST — The most significant bit is output first.

Terminal conditions:

All outputs are operated by modules of the 74AC-family via a protective resistor of 22 Ω and are thus temporarily short-circuit proof. A short-circuit too long causes the driver module to be excessively heated, which may then fail.

Fast switch-off:

Pressing the OUTPUT OFF key causes all outputs (except for OUT5V) to be switched to high-impedance states (TRI-STATE). Clock signals are applied again when depressing the OUTPUT OFF key once more.

Table 2-13 Pin assignment and signals (serial universal interface)

Signal name	Pin	Remark
GND OUT5V GND	7.8 12 1.2	 5V, 50 mA
Channel 1: SCLK SDATAA SWSA	 9 10 11	Channel 1: (with SERIAL MUX: 1&2) Output, bit clock Output, audio data Output, sync pulse (word clock) by MUX: Wordselect
Channel 2: SCLK SDATAB SWSB	 15 14 13	Channel 2: Output, bit clock Output, audio data Output, sync pulse (word clock)
SCLKIN SWSOUT	4 6	Input, external bit clock Output, wordselect with SERIAL MUX (Frequency = audio clock)

Setup + Hold times:

Serial data are stable >5ns before the clock edge and >10 ns after the clock edge.

Timing:

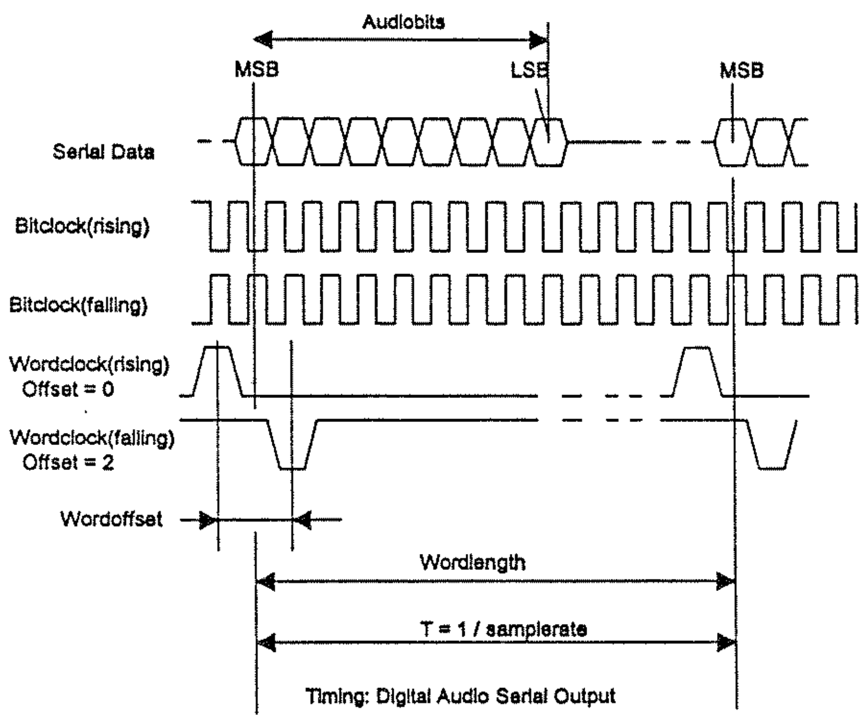


Fig. 2-15 Timing: Digital Audio Serial Output

2.5.3.3 Parallel Interface:

Located on the Digital Generator board at the UPD rear panel, labelled with DIGITAL AUDIO OUTPUT, 37-contact D-SUB female connector.

Settings:

Audio Bits

see "Common Settings"

WordselCh1

LOW

HIGH

(Word Select Channel 1)
(This setting appears with PARAL MUX only). Set the assignment of channel 1 with PARAL MUX:

LOW: Channel 1 is assigned low-level on the LR line.

HIGH: Channel 1 is assigned high-level on the LR line.

Word clock

RISING

FALLING

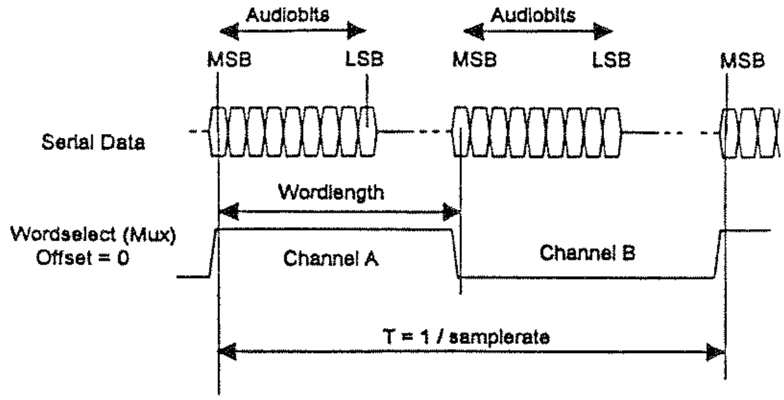
Set the polarity of the strobe signal; for more details, refer to Timing (see Fig. 2-15).

Table 2-14   Pin assignment and signals (parallel interface)

Signal name	Pin	Remark
GND	16	
OUT5V	17	5V, 50 mA
GND	19	
GND	18	
Digital Audio Bit 27 (MSB)	2	Output
Digital Audio Bit 26	3	
Digital Audio Bit 25	4	
Digital Audio Bit 24	5	
Digital Audio Bit 23	6	
Digital Audio Bit 22	7	
Digital Audio Bit 21	8	
Digital Audio Bit 20	9	
Digital Audio Bit 19	10	
Digital Audio Bit 18	11	
Digital Audio Bit 17	12	
Digital Audio Bit 16	13	
Digital Audio Bit 15	14	
Digital Audio Bit 14	15	
Digital Audio Bit 13	20	
Digital Audio Bit 12	21	
Digital Audio Bit 11	22	
Digital Audio Bit 10	23	
Digital Audio Bit 09	24	
Digital Audio Bit 08	25	
Digital Audio Bit 07	26	
Digital Audio Bit 06	27	
Digital Audio Bit 05	28	
Digital Audio Bit 04	29	
Digital Audio Bit 03	30	
Digital Audio Bit 02	31	
Digital Audio Bit 01	32	
Digital Audio Bit 00 (LSB)	33	Output
LR (Wordselect)	34	Output, with PARA MUX only
PSTROBE	35	Output, clock, selectable polarity
EXSTRBIN	36	Input, external strobe (audio clock)
not connected	37	

Important! *Always connect external devices adjusting to the MSB, as otherwise the most significant bits are extended with incorrect signs.*

Timing:



Timing: Digital Audio Serial Mux Input/Output

Fig. 2-16

Data format:
Terminal conditions: as with serial interface
Fast switch-off:

2.5.3.4 Digital Interface AES / SPDIF / OPTICAL

Audio data generated by the digital generator are transferred to the UPD-B2 option (AES/EBU), where the required extra bits (validity, parity, user bits, ...; see also Section 2.5.4, AES/EBU Protocol Definition) are added.

Outputs via these interfaces are possible only with the generator instrument DIG48kHz selected.

Audio Bits

see "Common settings"

Level V_{pp}

Set the output voltage of the digital signal.
(Peak-to-peak voltage when terminated with the rated impedance: 110 Ω with AES/EBU, 75 Ω with S/P DIF). No-load output voltage is twice as high.

Setting range:	AES/EBU:	20 mV to 5.1 V
	S/P DIF:	10 mV to 1.5 V

2.5.3.4.1 AES/EBU Protocol Definition

Selection of the generator output AES/EBU, S/P DIF or OPTICAL causes the additional section PROTOCOL to be displayed in the GENERATOR panel. This section sums up the commands for definition of the protocol information (channel status data, user data, validity, parity).

Note: On the rear panel, there is BNC female connector "Wordclock OUT" to which a TTL signal with the sample frequency is applied. The left channel (1) is identified with Low, the right channel (2) with High.

Valid Chan — Set the validity identification within the AES/EBU data stream.

NONE	No validity bit set
1	Validity bit set only in channel 1 (= left, A)
2	Validity bit set only in channel 2 (= right, B)
1&2	Validity bit set in both channels

Parity — Specify whether the protocol is to be generated with parity errors.

TRUE	All samples are generated with the correct parity.
WITH ERR	Setting the error rate using the commands No. Trues, No. Falses and Offset.

No True — Specify the number of samples with correct parity bit.

Numerical entry from 100 to 1,000,000

Information on the definition of parity errors:

A number of samples with correct parity bit (Offset) is output first. Then a cyclical sequence consisting of a number of samples with false parity bit (No. False), which is followed by a number of samples with correct parity bit (No. True) is output. "True" alternates with "False"

The numbers refer to the sum of L and R samples.

Applications:

- If the sum of No. True and No. False is equal to 384, the positions of the parity errors within a block can be determined using Offset.
- A very large Offset can be used for reliable settling of the test hardware.

No False

Specify the number of samples with false parity bit.

Numerical entry from 0 to 1000

With the setting 0, only the correct parity bits are output.

Offset

Specify the number of samples with correct parity bit until the first parity error occurs.

Numerical entry from 0 to 1,000,000

For more details, see under No. True.

Block Err

Specify the interval (in blocks) in which the errors in the start-of-block-preamble sequences are generated.

Numerical entry from 0 to 100000

0: no error, all start-of-block-preambles are correct.
1 to 100000: After the specified number of samples, a start-of-block-preamble sequence is, in each case, replaced by a normal "left" preamble (missing start of block).

Sequ. Err

Specify the interval (in blocks) in which the errors in the preamble sequence are generated.

Numerical entry from 0 to 10000

0: no error, all preambles are correct.
1 to 10000: A block with sequence error is generated every specified interval of blocks. For this reason, each 48th left preamble within this block is replaced by a right one. The sequence " L R R R L" is generated instead of the sequence " L R L R L". This inverted sample, however, has the status information of the associated left channel, the only difference is the inverted preamble.

Ch Stat. L	Define how the channel status data LEFT are generated.
ZERO	All channel status data bits are 0. (The operating mode (AES3, CRC, RAW) is defined with the command Ch Stat. R).
FILE + AES3	UPD generates local timecode and CRC, other channel status data are defined using the following file.
PANEL + AES3	UPD generates local timecode and CRC, other channel data are set using the panel defined by the "Panelfile" file.
FILE + CRC **PANEL + CRC**	As FILE + AES3 or PANEL + AES3, however UPD does not generate local timecode, which is a fixed setting instead.
FILE **PANEL**	As FILE + AES3 or PANEL + AES3, however UPD generates neither local timecode nor CRC (RAW mode).

The setting that can be made under this menu item affects Ch Stat. R. Any settings under Ch Stat. R. that are incompatible with the selection made here causes a corresponding error message to be output and the setting to be rejected. The PANEL can be assigned only once. The operating mode (AES, CRC, RAW) must be the same for both channels.

Filename

Specify a file containing channel status data for LEFT.

preset type of file: *.pgc

The data are each defined in a line. Keywords in the file specify for which bits and side (left, right or both) the data are defined.
When using this command, only those definitions containing data for the left or for both sides are considered. This allows you to use the same file for both sides.

Syntax:

Side: AES_CHAN_STAT or AES_CHAN_STAT_BOTH are used to indicate the beginning of data for both sides. Analogously, AES_CHAN_STAT_RIGHT and AES_CHAN_STAT_LEFT indicate the beginning of data for one side.

These keywords may be used in any order and as often as desired.

Data: In the file, values are entered with the following line:

Keyword BIT followed by a destination range and the respective value.

Example: BIT:12-15, 1
(BITs 12-15 are assigned "0001")

It is also possible to use the generator status data from the analyzer. In this case, enter the keyword "TRACK" instead of a value.

Example: BIT:12-15, TRACK

The time can be entered into the UPD using the keyword "TIME" instead of a value. The time is multiplied by the currently selected sample rate (see Section 2.5.3) in order to obtain the number of samples made since midnight.

Example: BIT:112-143, TIME

Example file: R&S_AES3.PGC

Ch Stat. R

Specify how to generate the Channel Status data RIGHT.

The setting that can be made here is a function of Ch Stat. L. The PANEL can be assigned only once. The operating mode (AES3, CRC, RAW) must be the same for both channels.
For more details on the individual commands, refer to Ch. Stat L.

ZERO

All channel status data bits are 0. (Operating Mode (AES, CRC, RAW) is defined by Ch. Stat L. When Left is also set to ZERO, the operating mode is RAW).

EQUAL L

Both sides are the same. All definitions made for the left side are copied to the right. The operating mode is defined by Ch. Stat L.

FILE + AES3

This selection is displayed only when ZERO, FILE + AES3 or PANEL + AES3 have been selected for Ch.Stat L.

PANEL + AES3

This selection is displayed only when ZERO, FILE + AES3 have been selected for Ch.Stat L.

FILE + CRC

This selection is displayed only when ZERO, FILE + CRC or PANEL + CRC have been selected for Ch.Stat L.

PANEL + CRC

This selection is displayed only when ZERO or FILE + CRC have been selected for Ch.Stat L.

FILE

This selection is displayed only when ZERO, PANEL or FILE have been selected for Ch.Stat L.

PANEL

This selection is displayed only when ZERO or FILE have been selected for Ch.Stat L.

Filename

Specify a file containing Channel Status data for RIGHT.

preset type of file: *.pgc

The data are each defined in a line. Keywords in the file specify for which bits and side (left, right or both) the data are defined (see also specifications for the left side).
When using this command, only those definitions containing data for the right or for both sides are considered. This allows you to use the same file for both sides.

Format: see Ch. Stat. L

CRC Error

Define the interval (in blocks) used for the generation of errors in the CRC of the status data.

Numerical entry from 0 to 100,000

0: no error, all CRCs are correct.
1 to 100000: After the specified number of blocks one CRC error is generated simultaneously in both channels. (CRC error: the correct CRC is replaced by the inverted bit pattern).

This command is displayed only when the operating mode of the channel status data is CRC or AES3.

User Mode

Specify how to generate the user data.

ZERO

All user bits are initialized to be 0.

FILE DEF

User bits are output according to the definitions in the subsequent file.

Note:
Changing the user bits stops both the generator and the analyzer for a short time.

Filename

Specify a file containing user data.

Preset type of file: *.pgu

The file contains both user data for the left and the right side. The keyword AES _ USER _ DATA _ LEFT is used to indicate the beginning of data for the left side. Analogously, AES _ USER _ DATA _ RIGHT is used for the right side.

In the following lines, values must be entered as hexadecimal numbers without any further designations . Each line contains 32 bits.

The UPD repeats cyclically the user bits read in, the length of each cycle being equal for both sides. Reading in less bits on one side than on the other causes zeros to be inserted. 6 (or a multiple thereof) result in corrected user data from the beginning of the block.
The maximum permissible number of user bits is 4096 words = 16384 bytes = 131072 bits per side.

Example: AES _ USER _ DATA _ RIGHT
0 x 55504420 # = 'UPD '

Panelfile

Specify a file which contains the definitions of the freely programmable panel. This menu item is displayed only when a panel has been specified for Ch.Stat L or Ch.Stat R.

Preset type of file: *.prp

This file allows you to define an input field tailored to meet the current requirements. To this end, enter the respective command designations, the permissible range of values and the destination of the setting into the file. 4 types of commands are permissible:

• Selection commands

Entering the keyword SELECTION or EXTSELECT followed by parameters defines a selection command.

Examples:

- SELECTION " Use", BIT:0, 0 = "CONS", 1 = "PROF"

  (Bit 0 of the channel status data can be switched between ANLR TRACK, CONS and PROF using the menu line 'Use'.)

- SELECTION " Usermod", BIT:12-15, 0 = "not ind", 3 = "USER"

  (The four bits 12 to 15 can be switched between ANLR TRACK, not ind and USER using the menu line 'Usermod'.)

Note :

- Max. 12 normal selection commands and 3 extended ones are permissible.
- The UPD inserts automatically the selection ANLR TRACK, which causes the corresponding bits of the analyzer to be copied.
- The BIT interval must not be larger than 32.
- Max. 8 selections per command (SELECTION) are permissible. Any value within the specified range of bits can be assigned to the selections.
- In the case of overlapping bit ranges, the most recent setting overwrites the bits defined before.
- Up to 24 selection possibilities are permissible with EXTSELECT.

• Text commands

Entering the keyword TEXT followed by parameters defines a text command.

Example:

- TEXT " Origin", BIT:48-79

  (The 32 bits 48 to 79 of the channel status data are filled with the text characters to be entered here.)

Note:

- Max. 4 selection commands are permissible.
- The BIT interval must not be larger than 32, ie max. 4 text characters (ASCII) per command are permissible.
- When no text is entered, the UPD copies the corresponding analyzer contents.

- **Value commands (normal)**

Entering the keyword VALUE followed by parameters defines a value command, which allows the specification of status bits as numbers. These numbers can even be multiplied by a multiplier specified in the file.

Example:

- VALUE " Abs.Hour", BIT:144-175, MULT:SET_RATE MULT:3600
  (The value defined here is entered into the 32 bits 144 to 175, the number after MULT (3600 * and SET_RATE = set sample rate) being multiplied by the value before it is entered.)

Note:

- Max. 12 value commands are permissible.
- The BIT interval must not be larger than 32, the entry is limited to 31 bits.
- When entering -1 into the panel, the corresponding analyzer bit range is copied.
- The keywords MULT are optional. The keyword SET_RATE can also be used as multiplier.

- **Value commands (additive)**

The entry of the keyword ADDVALUE followed by parameters defines a value command, the value being added to already available values.

Example:

- ADDVALUE " Abs.Min", BIT:144-175, MULT:2880000
  (The value entered here is added to the 32 bits 144 to 175 of the channel status data. Prior to the addition, the number after MULT (288000 = 60 * 48000) is multiplied by the value.)

Note:

- See under value command (normal).

Examples: R&S_AES3.PPC for panel acc. to AES3 format
R&S_CONS.PPC for panel acc. to consumer format

In the panel, the UPD displays the commands in the order
1. SELECTION/EXTSELECT
2. VALUE / ADD VALUE
3.TEXT
In the file, any desired order is permissible.

2.5.3.5 Digital Interface INTERN

Internal digital connection between generator and analyzer. The sample rate is fixedly set to 43619.7917 Hz (only possible with DIG 48 kHz, single-channel).

Audio Bits	see "Common Settings"

2.5.5 Functions

Function	
SINE	Single sine, dither may be included (with all generators)
MULTISINE	up to 17 sines (with all generators)
SINE BURST	Sine burst signal (with all generators)
$SINE^2$ BURST	Asymmetrical sine burst (with all generators)
SQUARE	Square signal (with DIG 48 kHz, DIG 192 kHz, DIG 768 kHz, ANLG 25 kHz)
MOD DIST	Test signal for modulation distortions (with all generators)
DFD	Test signal for intermodulation measurements (with all generators)
DIM	Test signal for dynamic intermodulation measurements (with DIG 48 kHz, DIG 192 kHz; analog only with ANLG 25 kHz together with LDG option)
RANDOM	Random noise (with all generators)
ARBITRARY	For waveforms to be specified (with all generators)
POLARITY	Test signal for polarity measurements (with DIG 48 kHz and ANLG 25 kHz)
FM	Frequency-modulated sine (with DIG 48 kHz and ANLG 25 kHz)

2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Frq Offset	Frequency offsets when entering frequencies.
+ 1000 ppm	Set the frequency with an offset of + 0.1%
OFF	Set the frequency without offset
Dither	For digital generators only.
ON	A noise component is superposed on the signals. The amplitude of the noise component can be entered in the next menu line (unit: FS %FS dBFS BtFS). The power density function (PDF) can be entered further down.
OFF	No superposed noise As to the unit: In addition to the general digital amplitude units, the unit btFS (bit full scale) is available. The number specifies the number of MSBs not dithered.
PDF	Only for digital generators, with activated dither Select the amplitude distribution (probability distribution function) of the superposed noise signal.
GAUSS	Gaussian distribution
TRIANGLE	Triangular distribution from -peak to + peak
RECTANGLE	Equivalent distribution from -peak to + peak
Low Dist	(Low Distortion Generator) For analog generators only. Activate/deactivate the low-distortion generator (see 2.5.1 Selecting the Generator).
ON	(Only with UPD-B1 option, 1031.2601.02); a sinewave is produced by the low distortion generator: with double sine, the other signal is generated by the universal generator.
OFF	All signals are produced by the universal generator.
Settling	Only for analog generators and with the low distortion generator switched on.
FAST	Fast settling of the low-distortion sine
PRECISION	High frequency accuracy of the low-distortion sine by readjusting the frequency once, yet longer settling time.

2.5.5.1.1 Common Parameters for All Functions

DC Offset	permits the superposition of a settable direct voltage on the generator output
ON	The signals are superimposed a d.c. voltage content. The amplitude of the d.c. voltage content can be entered in the next menu line. This selection is not possible for function DIM as well as for the analog square-wave signal. Effects on the AC signal: • the settable total AC voltage is smaller • the DFD signal has an S/N ratio which is poorer by 30 dB
OFF	no d.c. voltage signal active

Note: for the analog generators, offset is on ± 5 V (UNBAL) or ± 10 V (BAL, COMTST)

2.5.5.2 Sweeps

With many generator functions, it is useful to output signal parameters (level, frequency, in the case of burst signals also switch-on time and length of intervals) not only statically but to vary them with respect to time. A sweep system allowing 2 parameters to be varied simultaneously (two-dimensional sweep) is available for these signals.

- One-dimensional sweep: the parameter specified under X-axis is varied from start to stop or according to the LIST file.
- Two-dimensional sweep: the parameter specified under Z-axis is set to the start value or the first entry in the 1st LIST file. The parameter defined under X-axis is varied from start to stop or in accordance with the 2nd LIST file. The Z-parameter is then set to the next value and the sweep of the X-parameter starts again from the beginning. The two-dimensional sweep is concluded when the Z-parameter has assumed its final value.

The so-called "LIST buffers", with a length of 1024 entries each, serve as data source for the sweep parameters. The total length of the LIST buffers is obtained by multiplying the lengths of X- and Z-buffer; with one-dimensional sweeps, the length of the Z-buffer is to be defined as 1. If you specify too many items, the last ones, ie those exceeding 1024 are ignored. Each buffer contains a table, which can either be derived from user specifications (normal sweep) or is loaded from a file (list sweep; see Sweep→Ctrl). With normal sweeps, tables with rising or falling values are generated depending on whether the start value is lower or higher than the stop value. Sweeping from high to low frequencies allows the beginning of the sweep curve to be displayed faster than its end because high frequencies require less measuring time. In the case of list sweeps, the values for the sweep parameter can be listed in any order.

For starting and stopping the sweep, see 2.11.

Table 2-15 List of sweepable function parameters depending on the function selected:

Function	VOLTAGE	FREQUENCY	ON-TIME	INTERVAL
SINE	yes	yes	---	---
MULTISINE	no	no	---	---
SINE BURST	yes	yes	yes	yes
$SINE^2$ BURST	yes	yes	yes	yes
SQUARE	yes	yes	---	---
MOD DIST	yes (Total Volt)	yes (user frequency)	---	---
DFD	yes (Total Volt)	MEAN yes (mean frequency)	---	---
DIM	yes (Total Volt)	fixed no (standardized frequency pause)	---	---
RANDOM	no	---	---	---
ARBITRARY	no	---	---	---
POLARITY	no	---	---	---
FM	no	no	---	---

Remark:

In addition to the above generator sweeps, several analyzer sweeps can be performed:

- Time-controlled analyzer sweeps are selected under menu item START COND in the ANALYZER panel (for all measurement functions)
- The bandpass mean frequency can be swept in the RMS SELECTIV measurement.

Only one of these sweeps can be active at one time. The attempt to select a 2nd sweep is acknowledged by an error message and the selection is rejected.

If you wish to select a generator sweep while a sweep is currently being active in the analyzer, first deactivate the sweep in the ANALYZER panel.

Setting:
- START COND→AUTO
- SWEEP CTRL→OFF

Sweep Ctrl

Activate/Deactivate the sweep system and specify the data source and sweep run.

OFF

The sweep system is switched off; all parameters are entered directly into the panel by the user.

AUTO SWEEP

The sweep runs automatically after having pressed the START or SINGLE key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are obtained from user specifications (start/stop value and step size or number of points); normal sweep
Sweep stepping can be synchronized with the analyzer in menu item Next Step.

AUTO LIST

The sweep runs automatically after having pressed the START or SINGLE key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are read from the file; (list sweep) for generation of lists, see 2.9.1.2, menu item STORE TRACE/LIST, Store→X AXIS, Store→Z AXIS
Sweep stepping can be synchronized with the analyzer in menu item Next Step.

MANU SWEEP

The sweep is controlled by means of the rotary knob and/or the SINGLE key. When you press the START key, the 1st measured value only is recorded. Any further sweep point must be explicitly requested using the rotary knob or by pressing the SINGLE key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are obtained from user specifications (start/stop values and step size or number of points); normal sweep.
When sequencing the manual sweep, the result of the current measurement is not waited for, i.e. the current measurement and possibly a set analyzer delay are aborted.

MANU LIST

The sweep is controlled by means of the rotary knob and/or the SINGLE key. When you press the START key, the 1st measured value only is recorded. Any further sweep point must be explicitly requested using the rotary knob or by pressing the SINGLE key (see 2.11, Starting and Stopping a Measurement).
The data of the sweep parameters are read from a file; list sweep.
For generation of lists, refer to 2.9.1.2, menu item STORE TRACE/LIST, Store→X AXIS, Store→Z AXIS
When sequencing the manual sweep, the result of the current measurement is not waited for, i.e. the current measurement and possibly a set analyzer delay are aborted.

Remark:
The feature "manual sweep" can be used to vary generator parameters with a user-definable increment (Step) in the interval "Start" ... "Stop".
Fast rotation of the rotary knob allows you to leave out individual sweep points. Sweep points can be repeated by turning the rotary knob back.

Next step

With automatic sweep system and automatic sweep stepping ("Sweep Ctrl→AUTO SWEEP" or "Sweep Ctrl→AUTO LIST"). Select the sweep synchronization.

ANLR SYNC

Analyzer synchronization:
The sweep continues after a valid measured value has been obtained; recommended in generator/analyzer mode.

DWELL VALUE

Time synchronization with fixed time:
The sweep continues after a specified time has elapsed. The time is defined in menu item "Dwell". Required for sweeps with external analyzer.

DWELL FILE

Time synchronization using times specified in a list
The sweep continues after specified times which are read out of a list and interpolated on the basis of the existing X-axis.

Dwell File

With automatic file sweep ("Sweep Ctrl→AUTO LIST") and time synchronization ("Next step→DWELL FILE") only.
Specify a file containing the dwell times

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 output and the reason for the fault is entered into the menu line.
For entry of file names, see 2.3.2.5; for generation of the list, see 2.9.1.2 Loading and Storing of Traces and Lists.

Dwell

Only with automatic sweep and time synchronization ("Next step→ DWELL VALUE").

Enter a dwell time for all sweep points.

Range of values:	0 to 1000 s.
Unit:	s ms µs
Resolution:	≈ 50 ms

X Axis

With an active sweep system only.
Select the sweep parameter (one-dimensional sweep) or the 1st sweep parameter (two-dimensional sweep).

VOLT

Signal voltage (SINE, SINE BURST, $SINE^2$ BURST , SQUARE) or total voltage (MOD DIST, DFD, DIM) is swept.

FREQ

Signal frequency (SINE, SINE BURST, $SINE^2$ BURST, SQUARE), useful frequency (MOD DIST) or center frequency (DFD) is swept.

ON TIME

Time of high level with burst signals is swept.

INTERVAL

Interval time with burst signals is swept.

Z Axis	With active automatic sweep only ("Sweep Ctrl→AUTO SWEEP" or "Sweep Ctrl→AUTO LIST") Select the 2nd sweep parameter for a two-dimensional sweep.
OFF	Sweep is one-dimensional
VOLT	as under X Axis
FREQ	as under X Axis
ON TIME	as under X Axis
INTERVAL	as under X Axis

Spacing	With normal sweep only ("Sweep Ctrl→AUTO SWEEP" or "Sweep Ctrl→MANU SWEEP"); Determine the sweep range spacing.
LIN POINTS	The sweep range is linearly divided by a number of points to be specified. The number is entered under menu item "Points".
LIN STEPS	Beginning from "Start", the sweep range is divided into intervals using a linear step size to be specified under menu item "Step".
LOG POINTS	The sweep range is logarithmically divided by a number of points to be specified. The number is entered under menu item "Points".
LOG STEPS	Beginning from "Start", the sweep range is divided into intervals using a logarithmic step size to be specified under menu item "Step" (multiplier without unit)

Remark:
No conversion is performed when switching from ... POINTS to ...STEPS and vice versa; the set values are retained in the background. The numeric value for "STEP" remains the same when switching between LIN STEPS and LOG STEPS.

Start

With normal sweep only (Sweep Ctrl→AUTO SWEEP or Sweep Ctrl→MANU SWEEP)
Enter the start value for the (above) sweep parameter.
Range of values, unit and resolution: as for the appertaining sweep parameter.

Stop

With normal sweep only (Sweep Ctrl→AUTO SWEEP or Sweep Ctrl→MANU SWEEP)
Enter the stop value for the (above) sweep parameter
Range of values, unit and resolution: as for the appertaining sweep parameter.

Points

With normal sweep only ("Sweep Ctrl→AUTO SWEEP" or "Sweep Ctrl→MANU SWEEP") and "Spacing→LIN POINTS" or "Spacing→LOG POINTS" selected.

Range of values:	2 to 1024.
Units:	None (integer)

Enter the number of sweep points for the (above) sweep parameter. The sweep range is divided into (points - 1) steps. 2 points at least (start and stop value) are required.

Note: *With two-dimensional sweeps, the product of the points of the X-axis and those of the Z-axis must not exceed 1024.*

Step

With normal sweep only ("Sweep Ctrl→AUTO SWEEP" or Sweep Ctrl→MANU SWEEP") and "Spacing→LIN STEPS" or "Spacing→LOG STEPS" selected.

Enter the step size for the (above) sweep parameter.

Valid range of values: see operator guidance line. The step size is to be selected as high as to result in not more than 1023 individual steps.

Unit and resolution: as for the appertaining sweep parameter. With logarithmic spacing, no unit can be entered (factor without unit).

Note: *With two-dimensional sweeps, the product of the points of the X-axis and those of the Z-axis must not exceed 1024.*

2.5.5.3 SINE

Sinewave signal which is generated in the analog range by the universal generator or, optionally, by the low-distortion generator, when fitted.

Frq Offset

See 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

Dither

For digital generators only;
See 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

PDF

For digital generators only;
See 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

Low Dist

For analog generators only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

ON Signals are generated by the low-distortion generator

OFF Signals are generated by the universal generator

FREQUENCY

- Enter the sine frequency
- Enter a file name for the frequency list (list sweep)
  For entering a file name, see 2.3.2.5

Range of values: f_{min} to f_{max} (depending on generator used, see 2.5.1 Selecting the Generator)
Unit: Hz kHz ΔHz ΔkHz f/fr Δ%Hz Toct Oct Dec
Resolution: 1 mHz

Settling

For low-distortion generator only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST.

Equalizer

Activate/Deactivate an equalizer table including frequency specifications and the appertaining voltage amplification factors. Depending on the frequency, the set voltage can be multiplied by an equalizing factor (after interpolation between the adjacent frequency points, if required) before they are switched to the outputs. The equalized voltage can be measured internally by means of the analyzer. Setting: ANALYZER panel "Chx Input GENy", x = measurement channel (1 or 2), y = generator channel (1 or 2); indicated as measurement result. Application: Pre-/Deemphasis; frequency-independent power output by equalizing with inverted frequency response.

ON

Equalizer is switched on. Menu item "Equal. file" is activated, ie the file listed under this menu item is loaded.
Typical application: Simulating the effects of a preemphasis; measurement with constant power on units under test with frequency response.

OFF

Output voltage is not affected.

Equal. file

(Equalizer file)
with Equalizer→ON only;
Menu item for entry of the equalizer file name. The file is opened and saved in an internal buffer.

Entering an invalid name (disk drive not ready, file not found, invalid format, etc.) leads to the output of an error message and the entry "not found" in the menu line.

For entering a file name, see 2.3.2.5;
For generation of an equalizer file, see 2.9.1.2 Loading and Storing of Traces and Lists ("Store→EQUALIZATN").

Voltage

- Enter the sinewave amplitude
- Enter a file name for the amplitude list (list sweep). For entering file names, see 2.3.2 Data Entry

Range of values: digital: 0 to 1 FS
analog: 0 to 12 V_{rms} for UNBAL (BNC) or COMTST (XLR)
0 to 24 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max Volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units digital FS %FS dBFS
analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/V_r dBr
Δ%V ΔV ΔmV ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$

2.5.5.4 MULTISINE

Up to 17 single sine voltages can be superposed on each other.

They are generated exclusively by the universal generator.

The phase angles of the single sine voltages are automatically optimized such that the maximum total peak value is as low as possible. The resulting total peak value thus being frequency-dependent, the voltage may increase when varying individual frequencies. The set maximum voltage ("Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators) is however never exceeded since the worst case is taken as the basis for linear superposition when entering the single voltages.

Further specific multi-tone signals are selected using the functions

- MOD DIST (2 sinewave amplitudes with the ratios 1:1 to 10:1)
- DFD (2 equivalent sinewave amplitudes)
- SINE (1 sinewave with any amplitude)

With these 3 functions, "Dither" with "PDF" (only digital) or "Frq Offset" can be set. The low-distortion generator can additionally be used in the analog range if the LDG option is fitted.

Mode

Select the input mode for the individual sine lines:

EQUAL VOLT A frequency can be defined for each single sine; the amplitude is however the same for all sinewaves

DEFINE VOLT Frequency and amplitude can be defined for each single sine.

No of sin

Range of values: 1 to 17
Units: none

Enter the number of desired tones, ie how many sines can be edited. In EQUAL VOLT mode, the entry also influences the maximum amplitude that can be entered for a single sine tone (see "Volt No (i) ").

Freq No (i)

Enter the sinewave frequency i (i = 1 to 17)

Range of values: f_{min} to f_{max} (depending on generator)
f_{min}: 10 Hz (ANLG 25kHz and DIG 48kHz)
25 Hz (ANLG 110kHz and DIG 192kHz)
50 Hz (DIG 768kHz)
f_{max}: see 2.5.1 Selecting the Generator

Units: Hz kHz ΔHz ΔkHz f/f_r Δ%Hz Toct Oct Dec
Resolution = f_{min};

The single frequencies may lie as close to each other as desired or may even be superposed on each other (taking the resolution into account).

Volt No (i)

Enter the sinewave amplitude i (i = 1 to 17)

Range of values: the total voltage of V_{max} is available for all n single sines (n = "No of sin", 1 to 17) :
digital: V_{max} = 1 FS
analog: V_{max} = 12 V_{rms} for UNBAL (BNC) or COMTST (XLR)
V_{max} = 24 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by menu item "Max volt", see 2.5.2, Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators.*

V_{max} is split up into the single sine voltages as follows:

- in EQUAL VOLT mode, any sine may be as large as $V_{max/n}$.
- in DEFINE VOLT mode, any sine may be as large as the difference between V_{max} and the sum of all other active single sines

Units: digital FS %FS dBFS
analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/V_r dBr Δ%V ΔV ΔmV ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

Total Gain

Enter an amplification factor (in dB), which allows the rms value resulting from the superimposition of the single voltages to be increased or decreased.

Unit: dB

Total Peak

Read only

Indicates total peak value of multi-tone signal. The value is usually below the sum of the single peak values due to internal phase optimization. V, mV or µV can be selected as the unit.

Units:	digital	FS %FS dBFS
	analog	V mV µV

Total RMS

Read only

Indicates total rms value of multi-tone signal.

Units:	digital	FS %FS dBFS
	analog	V mV µV dBu dBV V/V_r dBr Δ%V ΔV ΔmV ΔµV

As to the unit: RMS units can be used only.

2.5.5.5 SINE BURST

Sine periodically varying between high and low level.

Frequency

- Enter the sine frequency.
- Enter a file name for the frequency list (list sweep)
  For entering the file name, see 2.3.2.5.

Range of values:	2 Hz to f_{max} (50 Hz to f_{max} für DIG 768 kHz) f_{max} depending on generator; see 2.5.1 Selecting the Generator
Resolution:	1 mHz (50 Hz für DIG 768 kHz)
Unit:	Hz kHz ΔHz ΔkHz f/fr Δ%Hz Toct Oct Dec
Side-effect:	ON TIME is adjusted, if required.

Voltage

- Enter the high-level sine amplitude, ie the amplitude during burst time
- Enter a file name for the high-level amplitude list (list sweep)
  For entering the file name, see 2.3.2.5

Range of values:	digital: 0 to 1 FS analog: 0 to 12 V_{rms} for UNBAL (BNC) or COMTST (XLR) to 24 V_{rms} for BAL (XLR)
Caution:	Voltage limitation of the rms value by menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators
Units:	digital FS %FS dBFS analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/V_r dBr Δ%V ΔV ΔmV ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;
Side-effect: Low Level is adjusted, if required.

Low Level

Enter the low-level sine amplitude, ie the amplitude during OFF time.

Range of values: 0 to high level (VOLTAGE)
Units: analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/V_r dBr Δ%V ΔV ΔmV ΔµV V/on %on dBon
digital FS %FS dBFS %on dBon

As to the unit:
In addition to the standard voltage specifications (absolute or relative to the reference value), further relative units referring to high level can be used. They are

%on, dBon; in the analog range also V/on

If a unit of this kind is selected, the ratio

low level : high level

is always kept constant when the high level is varied. This means that changing VOLTAGE (also during a sweep) changes the low level, too. With all other units, varying VOLTAGE affects the low level only when VOLTAGE becomes smaller than the low level.

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times \sqrt{2}$;

ON-TIME

- Enter the burst duration, ie the time during which the sine has its high level
- Enter a file name for the time list of the high level (list sweep)
  For entering a file name, see 2.3.2.5.

Range of values: lower limit:
ANLG 25 kHz: t_{min} = 10.417 µs
ANLG 110 kHz: t_{min} = 2.604 µs
DIG 48 kHz: t_{min} = 1 / $sample_{Frq}$
DIG 192 kHz,
DIG 768 kHz: t_{min} = 1 / ($sample_{Frq}$ × oversampling factor)
upper limit:
60 s (DIG 768 kHz: 20 ms)

Unit: s, ms, µs, cyc, kcyc, Mcyc

Side-effect:
Entering a burst duration exceeding the length of an interval causes the interval length to be increased to burst duration.

As to the unit: Apart from standard time specifications, the burst duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the burst time - remaining constant when the frequency is changed, ie increasing the frequency decreases the burst duration of the burst signal, thus decreasing the ratio ON_TIME : INTERVAL.

INTERVAL

- Enter the burst interval length
- Enter a file name for the time list of INTERVAL (list sweep)
  For entering a file name, see 2.3.2.5.

Range of values: lower limit: set burst duration.
upper limit: 60 s (DIG 768 kHz: 20 ms)

Units: s, ms, µs

Modifications to the parameters ON-TIME or INTERVAL have effects only at the end of the interval. The current interval can be aborted by restarting the function (open the selection window "FUNCTION" and confirm using ENTER) in order to avoid waiting times, especially with long intervals.

2.5.5.6 SINE2 BURST

Sine2-wave signal which is periodically switched on and off. Either positive or negative pulses (also partial pulses) can be generated (by entering a negative voltage). Typically, the signal is not dc-free.

FREQUENCY

- Enter the sine2-wave frequency
- Enter a file name for the frequency list (list sweep)
  For entering file names, see 2.3.2.5

Range of values: 2 Hz to f_{max} (50 Hz to f_{max} for DIG 768 kHz)
f_{max} depending on generator; see 2.5.1 Selecting the Generator
Units: Hz kHz ΔHz ΔkHz f/f_r Δ%Hz Terz Oct Dec
Resolution: 1 mHz (50 Hz für DIG 768 kHz)

The period of this signal is defined as the time required for a pulse.
Side-effect: "ON TIME" is adjusted, if required.

VOLTAGE

- Enter the sine2-wave amplitude
- Enter a file name for the amplitude list of the pulse (list sweep)
  For entering file names, see 2.3.2.5

Range of values: digital: 0 to 1 FS
analog: 0 to 12 V_{rms} for UNBAL (BNC) or COMTST (XLR)
to 24 V_{rms} for BAL (XLR)

Units: digital FS %FS dBFS
analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/Vr dBr Δ%V ΔV ΔmV ΔµV

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

As to the unit:
When entering negative voltages, the pulse is inverted. Conversion into logarithmic units (dBFS, dBu, dBr, dBV) is not possible in this case.
peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times 2 / \sqrt{1.5}$;
V_{rms} is the rms value during pulse time, the level during OFF time is not considered when calculating the rms value.

ON-TIME

- Enter the pulse duration, ie the time the sine2 is switched on
- Enter a file name for the list of pulse time (list sweep)
  For entering file names, see 2.3.2.5

Range of values: lower limit:
1 sample; depending on generator; in the digital range, also on the clock rate (or oversampling factor),
digital: $t_{min} = 1 / (sample_{Frq} \times oversamp)$
analog: $t_{min} =$ 10.417 µs (ANLG 25 kHz)
= 2.604 µs (ANLG 110 kHz)
upper limit:
depending on generator, 60 s (DIG 768 kHz: 20 ms)

Units: s, ms, µs, cyc, kcyc, Mcyc

Side-effect:
Specifying a burst duration longer than the interval length causes the latter to be increased to burst duration.

As to the unit: Apart from standard time specifications, the pulse duration can also be specified in cycles. The selection of this unit, which is relative to frequency, results in the number of cycles - and not the pulse time - remaining constant when the frequency is changed, ie increasing the frequency decreases the pulse duration, thus decreasing the ratio ON_TIME : INTERVAL.

INTERVAL

- Enter the interval length
- Enter a file name for the time list of the "INTERVAL" (list sweep)
  For entering file names, see 2.3.2.5

Range of values: lower limit: set burst duration
upper limit: 60 s (DIG 768 kHz: 20 ms)

Unit: s, ms, µs

Changes in the parameters ON-TIME or INTERVAL have effects only at the end of the interval. The current interval can be aborted by restarting the function (open the selection window "FUNCTION" and confirm using ENTER) in order to avoid waiting times, especially with long intervals.

2.5.5.7 SQUARE

Square signal (dc-free); not available for ANLG 110kHz

FREQUENCY

- Enter the square-wave frequency
- Enter a file name for the frequency list (list sweep)
  For entering file names, see 2.3.2.5

Range of values: depending on generator; in the digital range, also on the clock rate (or oversampling factor)

ANLG 25 kHz: 2 Hz to 10 kHz
DIG 48 kHz,
DIG 192 kHz: 2 Hz to $\text{sample}_{Frq} \times$ oversamp / 4
DIG 768 kHz: 50 Hz to $\text{sample}_{Frq} \times$ oversamp / 4

Units: Hz kHz ΔHz ΔkHz f/f_r Δ%Hz Toct Oct Dec
Resolution: non-linear

VOLTAGE

- Enter the square-wave amplitude
- Enter a file name for the amplitude list (list sweep)
  For entering file names, see 2.3.2.5

Range of values: digital: 0 to 1 FS
analog: 0 to 10 V_{rms} for UNBAL (BNC) or COMTST (XLR)
0 to 20 V_{rms} for BAL (XLR)

Caution: Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators

Units: digital FS %FS dBFS
analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/V_r dB_r Δ%V ΔV ΔmV ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2$

2.5.5.8 MOD DIST (Two-tone Signal to SMPTE)

Superposing 2 sinewave signals: low-frequency interfering signal and high-frequency useful signal; interfering signal is 1 to 10 times stronger than useful signal.

For intermodulation measurements to SMPTE (Society of Motion Picture and Television Engineers) and modulation distortion analysis to DIN-IEC 268-3.

Frequencies

Recommendation DIN 45403, sheet 4 or DIN-IEC 268-3:
interfering signal: $f1 <= 1.4 \times$ lower limit frequency of DUT
$f1 >= 31.5$ Hz
useful signal: $f2 >= 0.7 \times$ upper limit frequency of DUT
$f2 >= 8 \times f1$

SMPTE standard:
interfering signal: f1 = 60 Hz
useful signal: f2 = 7 kHz

Amplitude ratio interfering signal : useful signal:
4:1 (SMPTE); to DIN, 10:1 is also possible

With the LDG option fitted, the useful signal in the analog range can be generated by the universal generator or, alternatively, by the low-distortion generator.

Note: *For intermodulation measurements to MOD DIST, an appropriate measurement function is to be set in the ANALYZER panel (see 2.6.5.8).*

Frq Offset

See 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Dither

For digital generators only;
See 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

PDF

For digital generators only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Low Dist

For low-distortion generator only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

ON The useful signal is generated by the low-distortion generator, the interfering signal by the universal generator (less inherent intermodulation).

OFF Both signals are produced by the universal generator.

UPPER FREQ

- Enter the useful frequency
- Enter a file name for the useful frequency list (list sweep)
  For entering file names, see 2.3.2.5

Range of values:	4 kHz to f_{max} f_{max} depending on generator; see 2.5.1
Units:	Hz kHz ΔHz ΔkHz f/f_r Δ%Hz Toct Oct Dec
Resolution:	1 mHz (50 Hz for DIG 768 kHz)

LOWER FREQ

Enter the interfering frequency

Range of values:	30 Hz (50 Hz für DIG 768 kHz) .. 500 Hz
Units:	Hz kHz ΔHz ΔkHz f/fr Δ%Hz Terz Oct Dec
Resolution:	1 mHz (50 Hz for DIG 768 kHz)

Settling

For low-distortion generator only: see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

TOTAL VOLT

- Enter the total amplitude of both sinewave signals
- Enter a file name for the amplitude list (list sweep)
  For entering file names, see 2.3.2.5

Range of values: digital: 0 to 1 FS
analog: 0 to 10.964 V_{rms} for UNBAL (BNC) or COMTST (XLR)
to 21.927 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units: digital FS %FS dBFS
analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV V/V_r dB_r Δ%V ΔV ΔmV ΔµV

In the analog range, the maximum peak voltage is $\sqrt{2} \times 12$ V (UNBAL) or $\sqrt{2} \times 24$ V (BAL). Hence, the following restriction applies

$V_{pp} \leq 33.941\ V_{pp}$ (UNBAL) or
$V_{pp} \leq 67.883\ V_{pp}$ (BAL)

$V_{pp} = V1_{pp} + V2_{pp}$

The total voltage is divided into useful signal and interfering signal in a (selectable) ratio. The maximum total rms voltage, which is obtained from the square sum of the single rms values, thus depends on the level ratio interfering signal : useful signal. The specifications for the range of values stated above are relative to the ratio 10 : 1. The closer the ratio comes to the value 1 : 1, the lower the maximum obtainable total rms voltage. With 1 : 1, it is 8.485 V_{rms} (UNBAL) or 16.97 V_{rms} (BAL).

As a rule, the relationship between total peak-to-peak voltage and total rms voltage can be expressed as follows:

$$V_{pp} = V_{rms} \times 2 \times \sqrt{2} \times (k+1) / \sqrt{(k \times k + 1)}; \quad k = \text{"VOLT LF:UF"}$$

If the total voltage is specified in a peak-to-peak unit, the ratio k = VOLT LF:UF can be freely selected in the range of 1 to 10.

With the total voltage specified in an rms unit, the resulting total peak voltage must not exceed the maximum permissible value of 33.941 V_{pp} (UNBAL) or 67.883 V_{pp} (BAL). For this reason, for voltages of 8.485 V_{rms} or higher (UNBAL) or, respectively, 16.97 V_{rms} or higher (BAL) the lower limit for VOLT LF:UF is higher than 1.

Side-effect:
When entering the total voltage as rms value, the menu item VOLT LF:UF is corrected upward, if required.

VOLT LF:UF

Enter the ratio interfering level : useful level as a real number.

Range of values: 1.0 to 10.0

In the analog range, the lower limit (with higher rms voltage specifications) depends on the required total rms voltage (see TOTAL VOLT).

Unit: none

2.5.5.9 DFD (Difference Frequency Distortion)

Two closely spaced sinewave signals of the same amplitude; for intermodulation measurements (DFD method to DIN-IEC 268-3, former DIN 45403, Sheet 3).

With the LDG option fitted, the low-frequency sinewave in the analog range can be produced by the function generator or, alternatively, the low-distortion generator.

Note: *For intermodulation measurements to DFD, an appropriate measurement function is to be set in the ANALYZER panel (see 2.6.5.10).*

Frq Offset

see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Dither

For digital generators only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

PDF

For digital generators only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

Low Dist

For analog generators only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

ON — The high-frequency sinewave is generated by the low-distortion generator, the low-frequency sinewave by the universal generator.

OFF — Both signals are produced by the universal generator.

MEAN FREQ

- Enter the mean frequency
- Enter a file name for the mean frequency list (list sweep)
  For entering file names, see 2.3.2.5.

Range of values:	5 kHz to (f_{max} - 1 kHz) f_{max} depending on generator; see 2.5.1 Selecting the Generator
Units:	Hz kHz ΔHz ΔkHz f/fr Δ%Hz Toct Oct Dec
Resolution:	1 mHz; (DIG 768 kHz: 100 Hz)

DIFF FREQ

Enter the frequency difference between both sines

Range of values:	80 Hz to 1 kHz (DIG 768 kHz: 100 Hz to 1 kHz) f_{min} depending on generator; see 2.5.1 Selecting the Generator
Units:	Hz kHz ΔHz ΔkHz f/f_r Δ%Hz Toct Oct Dec
Resolution:	1 mHz (DIG 768 kHz: 100 Hz).

Rec. to DIN-IEC 268-3: 80 Hz

Settling

For low-distortion generator only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

TOTAL VOLT

- Enter the total amplitude of both sinewave signals
- Enter a file name for the amplitude list (list sweep)
  For entering file names, see 2.3.2.5

Range of values: digital: 0 to 1 FS
analog: 0 to 8.485 V_{rms} for UNBAL (BNC) or COMTST (XLR)
0 to 16.971 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units: digital FS %FS dBFS
analog V mV µV V_{pp} mV_{pp} μV_{pp} dBu dBV
V/V_r dBr Δ%V ΔV ΔmV ΔµV

The maximum peak-to-peak voltage in the analog range is $\sqrt{2} \times 12$ V (UNBAL) or $\sqrt{2} \times 24$ V (BAL). Hence the following limitation applies:

$V_{pp} \leq 33.941\ V_{pp}$ (UNBAL) or
$V_{pp} \leq 67.883\ V_{pp}$ (BAL)

$V_{pp} = V_{1pp} + V_{2pp}$

With two equivalent single voltages $V_{1pp} = V_{2pp}$, the maximum permissible total rms voltage is:

$$V_{(rms)} = \sqrt{(2\times(V1pp/(2\times\sqrt{2}))\hat{}2)} = \sqrt{2} \times V_{1pp} / (2\times\sqrt{2}) = V_{1pp}/2 = Vpp / 4$$

The relationship between total peak-to-peak voltage and total rms voltage can therefore be described by:
$V_{pp} = V_{rms} \times 4$

2.5.5.10 DIM (Signal for DIM Measurements)

Dynamic Intermodulation Distortion (DIM); for intermodulation measurements (DIN-IEC 268-3, as of 1991).
A sinewave of higher frequency is superposed on a low-frequency squarewave.

The total amplitude only can be defined by the user. The square has the quadruple (peak) amplitude of the sinewave signal.

In the analog range, DIM is possible only with the LDG option and "ANLG 25 kHz" selected; the sinewave is generated by the low-distortion generator.

With "ANLG 110 kHz" and "DIG 768 kHz", DIM is not possible.

Note: *An appropriate measurement function (only "ANLG 22 kHz") is to be set in the ANALYZER panel for intermodulation measurements to DIM (see 2.6.5.9).*

Square/Sin

There are 2 fixed frequency pairs available for sine and square:

2,96/14 kHz	Square signal 2.96 kHz, sinewave signal: 14.0 kHz
3,15/15 kHz	Square signal 3.15 kHz, sinewave signal: 15.0 kHz

Bandwidth

For analog generators only
In the analog range, the square signal is limited to 30 kHz or, optionally, 100 kHz.

30 kHz	Band limitation at 30 kHz
100 kHz	Band limitation at 100 kHz

Settling

For low-distortion generator only;
see 2.5.5.1 Common Parameters for the Signals SINE, DFD, MOD DIST

TOTAL VOLT

- Enter the total amplitude of square and sinewave signal
- Enter a file name for the amplitude list (list sweep)
  For entering file names, see 2.3.2.5

Range of values: digital: 0 to 1 FS
analog: 0 to 10.60 V_{rms} for UNBAL (BNC) or COMTST (XLR)
0 to 21.21 V_{rms} for BAL (XLR)

Caution: *Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators*

Units: digital FS, %FS, dBFS
analog V, mV, µV, V_{pp}, mV_{pp}, μV_{pp}, dBu, dBV, V/V_r, dBr, Δ%V, ΔV, ΔmV, ΔµV

2.5.5.11 Random (Pseudo Noise)

FUNCTION

Random

Set generator signals which have the same or similar characteristics as noise (eg closely spaced sine lines in the frequency domain). There are two ways of defining these signals:

- Specify the amplitude density distribution in the time domain (Domain: TIME)
- Specify the amplitude frequency distribution in the frequency domain (Domain: FREQ)

This function is available in all generators.

Domain

FREQ

DOMAIN: FREQ
Sine lines with settable amplitudes are generated and superposed on each other using defined frequency spacings to produce the output signal. In order to minimize the resulting peak value of the signal, each line is phase-optimized relative to the other lines. Minimum form factors (= peak/rms) can thus be obtained. Depending on the selectivity of the analyzer, the output signal is not displayed as a sequence of single lines, but as a noise signal with continuous level above the frequency.

TIME

DOMAIN: TIME
In this mode, noise signal generation is effected by nested random functions which have been optimized to produce evenly distributed noise. Periodicity is the case only after a runtime of at least 1 day.

Special application:
When the frequency spacing of the sine lines generated here **exactly** matches the analysis spacing used for the FFT, an FFT analysis is feasible without leakage. A selectivity of one line can thus be obtained with the square window. The setup consisting of this generator and analyzer allows you to precisely determine the frequency response of a device under test at one go.

Note: *As the optimization is very compute-bound, a few seconds of computing time before the output is started may be required by the generator, especially with small frequency spacings and wide noise band. →Status display: "GEN: BUSY".*
Entering data while GEN: BUSY is being displayed aborts the computations and the generator enters the GEN:HALTED state. Selecting again the generator or the output function restarts the generator.

Spacing

Set the frequency spacing:
(displayed with Domain = Freq only)

USER DEF

The frequency spacing can be set manually from 10 Hz to the upper limit frequency of the generator currently used. The value entered is corrected to the next settable value. The limits and settable frequency values depend on the sample rate (see 2.5.1 Selecting the Generator).
The range of values depends on the sample frequency and the generator (f_{max})

Units: Hz, kHz

ANLR-TRACK

The value specified for the FFT analysis spacing is automatically adopted. The value is also displayed in the ANALYZER panel under "FFT:Resolution" (see 2.6.5.13 FFT). This setting is ideal for an analysis using the rectangular window.
With no FFT selected in the analyzer, the setting is rejected (error message!).

Equalizatn

(displayed with Domain = FREQ only)
Specify the function which is used to determine the amplitudes of the single sine lines.

WHITE

All the sine lines between start value (see below) and stop value have the same amplitude.

PINK

The amplitude of the sine lines between start and stop value is proportional to $\sqrt{1/f}$

THIRD OCT

As PINK, however band-limited to 1/3 octave = TOCT with settable mean frequency.

FILE

The amplitudes of the single lines are set using floating numbers which are read from a file.

File format:

The file is a pure ASCII file where the amplitudes of the single frequency lines starting from 0 Hz are entered as floating numbers; the space between the lines is determined by "Spacing". The numbers specify only the amplitude ratio between the lines and not the output amplitude (which is determined after phase optimization using "VOLTAGE PEAK"). The file must have a line with the keyword 'FREQUENCY_FILE' before the numbers. Comment lines begin with '#' and are allowed anywhere. No difference is made between upper-case and lower-case letters. The preset type of file is '.FTF' (= frequency table file).

Example: `'example.ftf' in the C:\UPD\USER directory.`

Lower Freq

Upper Freq

Set the lower / upper limit of the range for generated noise (with WHITE and PINK). The limits for this setting are 1 x spacing (lower limit) and 29/64 x sample rate (upper limit). The values entered are rounded to integer multiples of "spacing".

MEAN FREQ

(displayed with Domain = Freq)
Set the mean frequency at 1/3 octave. The output starts at the line next to the mean frequency/ 1.12246 and ends with the line next to the mean frequency x 1.12246.

VOLTAGE PEAK

Set the peak output level.

VOLTAGE RMS

Display of the rms output voltage (with ANLG25 and ANLG100 only)

PDF

(displayed with Domain = TIME)
(PDF = Probability Density Function) Select the amplitude distribution function of the output signal:

Gauss

Normal (gaussian) distribution which is cut off at triple the σ-value of the gaussian distribution curve.

Triangle

Triangle distribution from -peak to + peak.

Equivalent

Equivalent distribution from -peak to + peak.

The gaussian and triangle distributions are obtained by calculation on the basis of equivalent distribution.

2.5.5.12 Arbitrary (User-programmable Signal)

FUNCTION

ARBITRARY

Output of any arbitrary waveform, which may consist of up to 16,383 points (= samples). The waveform is read from a file, 2 different formats being supported.

a) **AWD format:** Output file of the arbitrary waveform designer. The Arbitrary Waveform Designer (AWD-K1) is a software package for generation of any waveform which can be run on compatible PCs (eg on UPD).

b) **ASCII format:** The individual samples are entered as a sequence of numbers (FLOAT format) into the file. During output, a numeric value of 1.0 corresponds to the peak voltage specified in the VOLTAGE PEAK field. The file must contain a line with the keyword 'TIMETAB_FILE' before the numbers. Comment lines begin with '#' and are allowed anywhere. No difference is made between upper-case and lower-case letters. The preset type of file is '.ttf' (= time table file).

Example: `'example.ttf' in the C:\UPD\USER directory.`

The loaded waveform is continuously repeated (without gaps) during output.

The number of samples automatically results from the number of curve samples included in the file.

VOLTAGE PEAK

Set the peak output level.

2.5.5.13 POLARITY (Polarity Test Signal)

Specific SINE² BURST signal with the following characteristics:

FREQUENCY:	sample rate/80 (DIG 48 kHz) 1.2 kHz (ANLG 25 kHz)
ON-TIME:	1 cyc
INTERVAL:	2 cyc

The amplitude of the signal only can be selected by the user. The signal is not DC-free.

With ANLG 25 kHz and DIG 48 kHz only

VOLTAGE

Enter the SINE² amplitude;

Range of values	digital: 0 to 1 FS analog: 0 to 12 V_{rms} for UNBAL (BNC) or COMTST (XLR) to 24 V_{rms} for BAL (XLR)
Caution:	Voltage limitation of the rms value by means of menu item "Max volt", see 2.5.2 Configuration of the Analog Generators / 2.5.3 Configuration of the Digital Generators.
Units:	digital FS %FS dBFS analog V mV µV Vpp mVpp µVpp dBu dBV V/Vr dBr Δ%V ΔV ΔmV ΔµV

peak-to-peak amplitude (analog): $V_{pp} = V_{rms} \times 2 \times 2 / \sqrt{1.5}$;

V_{rms} is the rms value during pulse time, the level during OFF time is not allowed for in rms value calculation.

2.6 Analyzers (→ ANALYZER Panel)

Activate the ANALYZER panel:
UPD front panel: ANLR
External keyboard: ALT + A

2.6.1 Selecting the Analyzer

The ANALYZER panel makes the settings for 3 analog and 3 digital analyzer instruments available. The instruments are distinguished by their frequency measurement ranges and implemented functions.

The ANALYZER panel consists of the following segments:

ANALYZER			
ANALYZER : :	ANLG 22 kHz	Configurations	Selection of the analog or digital instrument, lower measurement limit, reference impedance for power units, configuration segment for setting the test inputs.
CHANNEL(s) : : : :	BOTH		(Input connectors, channel selection, input impedance, sample frequency, oversampling factor, etc.) see 2.6.3 Configuration of the Digital Analyzers see 2.6.2 Configuration of the Analog Analyzers
START COND :	Auto		Ways of starting the analyzer, see 2.6.4
INPUT PEAK :	ON	Higher-level functions	Peak value of input signal, see 2.6.5.15 Input Peak
FREQ/PHASE :	FREQ&PHASE		Combined frequency / phase measurement, see 2.6.5.16
MONITOR :	ON		Connector for headphones, see 2.6.6 Monitor.
FUNCTION :	RMS & S/N	Functions	Functions, see 2.6.5.2 to 2.6.5.13

When switching from one 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 a different analyzer function, the settings in the configuration range are retained.

Measurement range limits of the analog ANALYZER instruments:

Table 2-16

	Lower limit	Upper limit
ANLG 22 kHz [1]	DC/2 Hz/10 Hz	21.75 kHz
ANLG 100 kHz	DC/20 Hz	100 kHz
ANLG 300 kHz	DC/50 Hz	300 kHz

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

Lower limit:

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

2 Hz/10 Hz: The menu item "Min Freq" in the analyzer instrument ANLG 22 kHz offers selection of the lower limit.

2 Hz: Input unit is DC-coupled.
The input unit is controlled by DC signals. Limit check responds to both AC and DC signals. A superposed DC signal may cause the switchover to a less sensitive range, thus possibly reducing the accuracy of AC measurements.

10 Hz: Input unit is AC-coupled.

20 Hz:
50 Hz: Input unit is AC-coupled.

Upper limit:

Signals can be measured up to this limit.

Measurement range limits of the digital ANALYZER instruments:

The maximum measurement frequency is given by

$$f_{max} = \textit{sample frequency} \times \textit{oversampling factor} \times 29.0 / 64.0$$

Set the sample frequency and the oversampling factor in the configuration segment of the ANALYZER panel using menu items Sample-Frq and Oversamp, respectively.

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

The internal sample frequency is given by:

$$f_{ab} = sample\,frequency \times oversampling\,factor$$

External sample frequency (per channel)
(no oversampling factor selectable)

$$f_{abext} = sample\,frequency$$

Availability of functions depending on the ANALYZER instrument:

Table 2-17

Instrument	Functions													
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD + N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simulation
ANLG 22 kHz	x	x	x	x	x	x	x	x	x	x	x	x	x	x
ANLG 100 kHz	x	x	-	-	x	x	x	x	-	x	-	x	x	x
ANLG 300 kHz	x	x	-	-	x	x	x	x	-	x	-	x	x	x
DIG 48 kHz	x	x	x	x	-	x	x	x	x	x	x	x	x	x
DIG 192 kHz	x	x	-	-	-	x	x	x	-	x	-	x	x	x
DIG 768 kHz	x	x	-	-	-	x	x	x	-	x	-	x	x	x

Higher-level functions:

The selected function can be complemented by higher-level supplementary functions, which can be selected in the configuration range:

INPUT-PEAK measurement:
Display of peak value of input signal, see 2.6.5.15 INPUT PEAK

Sample frequencies of the digital ANALYZER instruments for single-channel and multiplex mode

(see 2.6.3 Configuration of the Digital Analyzers)

FREQUENCY-PHASE measurement:

The menu item FREQ/PHASE in the range with the higher-level functions of the ANALYZER panel allows you to select two measurement modes:

- FREQ (frequency measurement on both channels)
- FREQ & PHASE (frequency measurement on channel 1, at the same time, phase measurement between channel 2 and 1)

For more details, refer to 2.6.5.16.

Availability of frequency measurement:

Table 2-18

Instrument	Functions simultaneously available with frequency measurement													
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD + N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simulation
ANLG 22 kHz	√	√	√	√	-	√	√	≈	≈	≈	√	√	-	√
ANLG 100 kHz	√	√	-	-	-	√	√	≈	≈	≈	-	√	-	√
ANLG 300 kHz	√	√	-	-	-	√	√	≈	≈	≈	-	√	-	√
DIG 48 kHz	√	√	-	-	-	√	√	-	-	-	-	√	-	-
DIG 192 kHz	√	√	-	-	-	√	√	-	-	-	-	√	-	-
DIG 768 kHz	√	√	-	-	-	√	√	-	-	-	-	√	-	-

Availability of phase measurement:

For analog instruments in two-channel measurement mode only (Channel(s): 1&2¦2 ≡ 1¦1 ≡ 2).
Otherwise this item is not offered for selection.

Tabelle 2-19

Instrument	Functions simultaneously available with phase measurement													
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD + N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simulation
ANLG 22 kHz	√	√	√	√	-	√	√	≈	≈	≈	√	√	-	√
ANLG 100 kHz	√	√	-	-	-	√	√	≈	≈	≈	-	√	-	√
ANLG 300 kHz	√	√	-	-	-	√	√	≈	≈	≈	-	√	-	√

√ valid measurement result
\- no measurement result ("-----" displayed)
≈ the input signal being a frequency mixture, the measurement result is only conditionally true

2.6.2 Configuration of the Analog Analyzers

The two-channel analog analyzer features unbalanced, balanced and floating test inputs. Both channels can be configured individually, their measurement inputs are DC-decoupled from each other and from frame potential. The configuration is explained by way of the below ANALYZER panel and its menu items.

ANALYZER Panel

Min Freq	Selection and display of the lower frequency range limit. *Settable only with ANALYZER ANLG 22 kHz.* *For ANALYZER ANLG 100 kHz and ANLG 300 kHz, mere display function.*
2Hz	DC coupling of the inputs with AC and DC measurements Even with AC measurements, DC parts in the measurement signal control the input amplifier, which might reduce the resolution and accuracy of the display.
10Hz	AC coupling of the inputs. In balanced mode, however, the input resistors are always DC coupled (see "Impedance").The DC function renders selection of this parameter ineffective (see 2.6.5.5, DC).
Ref Imped	Reference impedance as reference for computing the units dBm, W, Δ%W, ΔW, P/Pr and %P/Pr (see 2.4, Common Parameters of All Functions). The current setting is displayed. The reference impedance can be reset after having opened the selection window.
<Value>	Setting range 1 mΩ to 100 kΩ
Channel(s)	Select the input channels.
1	The selected channel only is active, the other one is switched off.
2	In balanced mode, 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. Initial selection causes channel 2 to be set using the parameters of channel 1 (CH 1 or 2 may already be active or still be deactivated).
1 ≡ 2	As above, however 1 and 2 interchanged.

Input	Select the input mode. The current setting is displayed. (See also 2.12, Display of Selected Inputs and Outputs). The input mode can be reset after having opened the selection window.
UNBAL BNC	**Unb**alanced, floating inputs via BNC female connectors (see Fig. 2-17) Deactivated inputs are floating and open.
BAL XLR	**Bal**anced to ground, floating inputs via XLR female connectors (see Fig. 2-18). Deactivated inputs are floating, set input impedances are retained.
GEN1 GEN2	Internal connection of a **Gen**erator channel to the analyzer channels. Allows the device-internal measurement of the voltages at the generator connectors. The generator output is loaded by each analyzer channel by 2 x 100 kΩ in balanced mode and 100 kΩ in unbalanced mode (see Figures 2-19, 2-20 and 2-21). The input connectors (female) of the appertaining analyzer channels are inactive.

Impedance

Select the input impedance.

1M Ω	In unbalanced mode, UNBAL BNC only; no further selection possible.
300 Ω	With balanced input, BAL XLR, balanced to ground, floating design.
600 Ω	As with impedance 300 Ω
20k Ω	As with impedance 300 Ω
USER DEF	Allows the setting of a resistor in balanced mode, which you can fit into each of the channels (see "User-definable Resistors" - at the end of this section).

Common

Common reference of potential of BNC input female connector, selectable in the UNBAL mode only.

FLOAT	BNC external conductor floating against frame ground. Permissible voltage ≤ 25V AC or 50V DC against frame ground.
GROUND	BNC external conductor connected to frame ground (PE conductor). Switchover to BAL-, GEN mode at a later date or switching off the set unbalanced 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.**

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.
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, which can be reset after having opened the selection window.

Table 2-20 Ranges

Rated values RMS or DC	Input Unbal	Input Bal	Analyzer ANLG 22 KHz	Analyzer ANLG 100/300 kHz
1 mV	X	X	-[1]	X[2]
3 mV	X	X	-[1]	X[2]
10 mV	X	X	-[1]	X[2]
30 mV[1]	X	X	X	X[2]
100 mV	X	X	X	X
300 mV	X	X	X	X
1 V	X	X	X	X
1.8 V	X	X	X	X[2]
3 V	X	X	X	X
6 V	X	X	X	X[2]
10 V	X	X	X	X
18 V	X	X	X	X[2]
30 V	X	X	X	X
60 V	X	-	X	X[2]
100 V	X	-	X	X
180 V	X	-	X	X[2]
300 V	X	-	X	X

x ... possible

- ... not possible

1) With analyzer instrument "ANLG 22 kHz", the most sensitive measurement range is limited to 30 mV.
The great dynamic range of the audio A/D converter however allows measurements down to a few µV to be performed with a high measured value resolution (lower limit → 0 V).

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

3) For the analyzer instruments ANLG 100/300 kHz, the three most sensitive ranges (1 mV, 3 mV and 10 mV) can be used when the signals to be measured have no frequencies higher than the upper limit (100 / 300 kHz) of the selected instrument and their levels are within the selected range.
Otherwise, the use of 'Range LOWER 30 mV' is recommended to block the three ranges in order to avoid measurement errors due to overloads.

An optimum dynamic range for the measurement of non-linear distortions is guaranteed by spacing the range below 1 V in 10-dB steps while using 5-dB steps in the range above 1 V. 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.

Caution: *For measurements on dangerous contact voltages > 25 V AC or 50 V DC, observe the limit values to VDE 0411, Part 1.*
We recommend that the peak currents from a test voltage source be limited to the following maximum values:
for DC: to 2.0 mA
for AC to 1 kHz: to 0.7 mA
for AC > 1 kHz: to 0.7 mA x f/kHz, maximum 70 mA.
Furthermore, the reference point of the test source and the instrument frame should be grounded.

Equivalent circuit diagrams of test inputs:

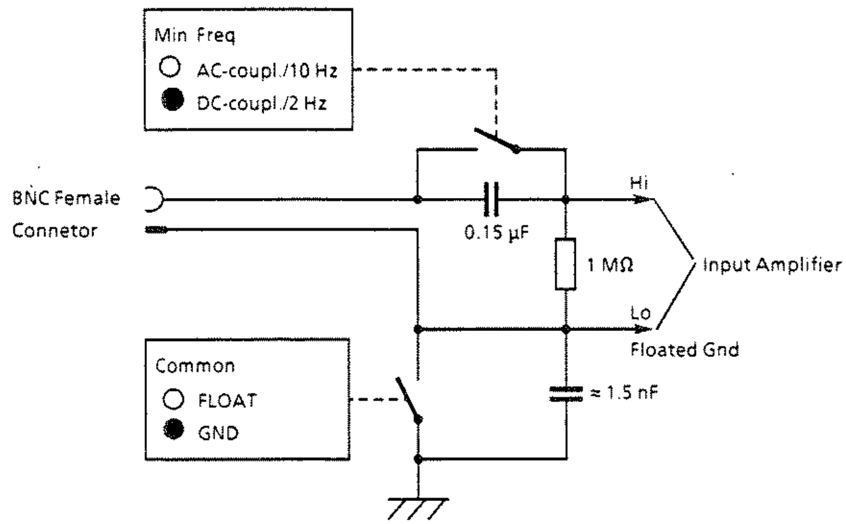


Fig. 2-17 Unbalanced input, Input UNBAL BNC (channel 1 or 2)

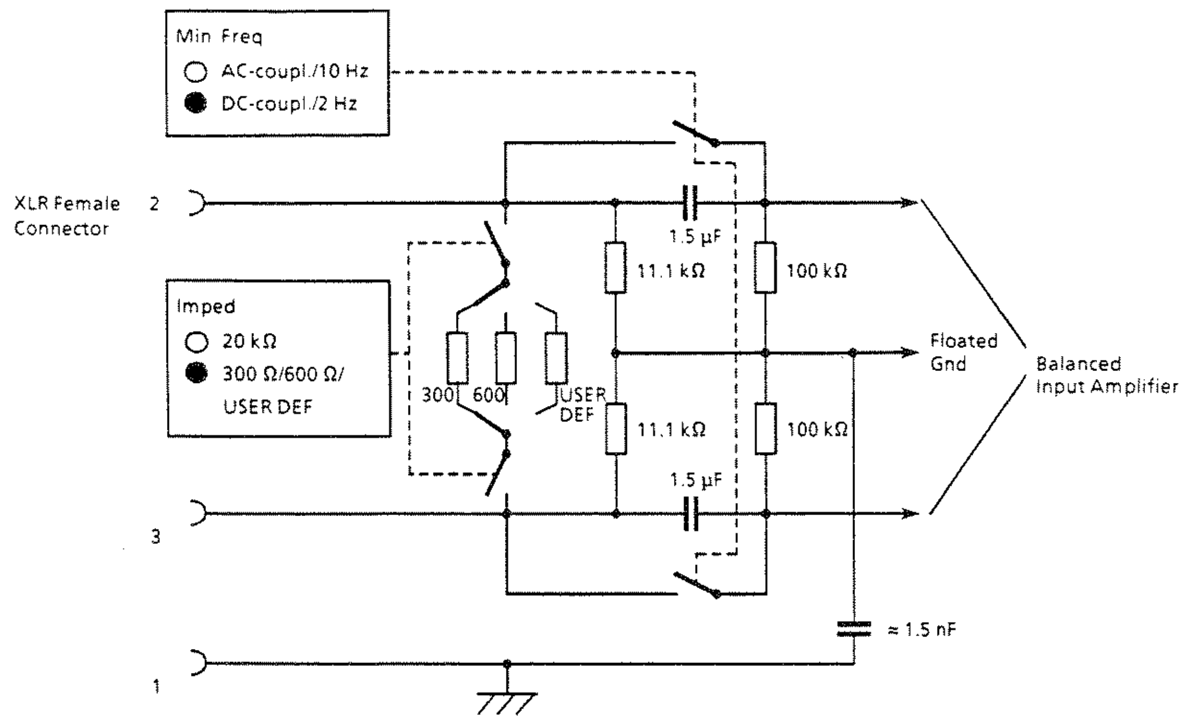


Fig. 2-18 Balanced input, (Input BAL XLR, channel 1or 2)

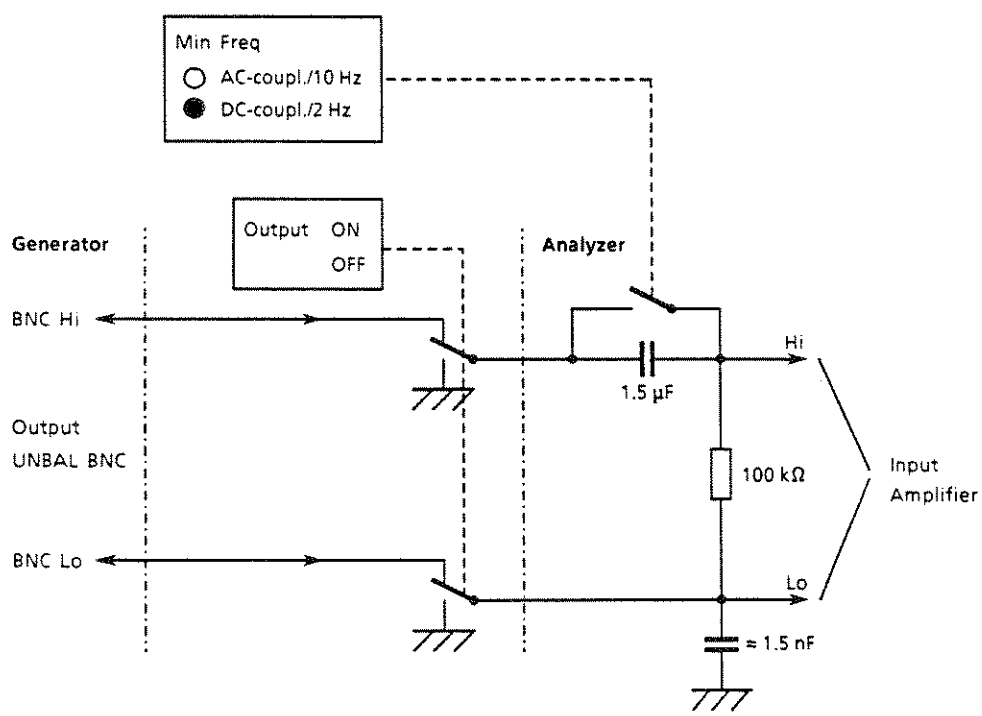


Fig. 2-19 Internal connection to generator output UNBAL BNC

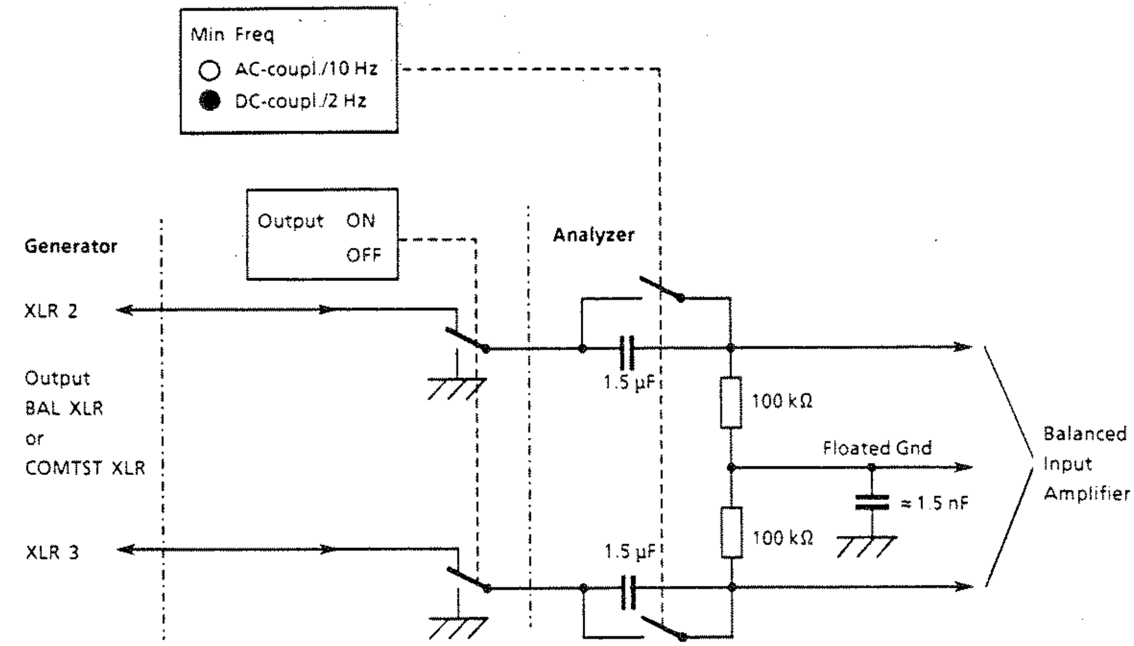


Fig. 2-20 Internal connection to generator output BAL XLR

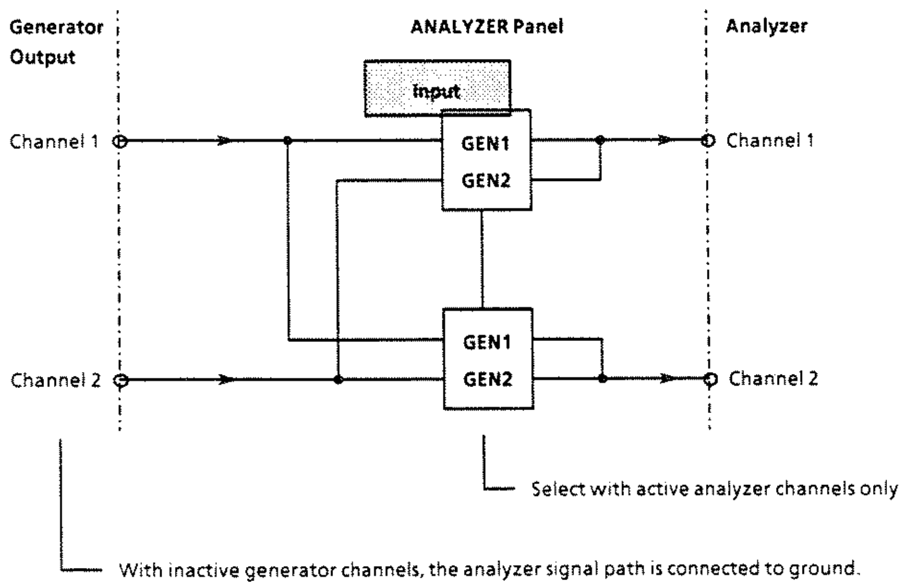


Fig. 2-21 Internal signal paths

User-definable Input Impedances (USER DEF)

For specific measurement spheres, the input impedance of the balanced measurement input can be configured separately for each channel. Both analyzer channels in the UPD can each be retrofitted with one additional resistor.
Calculation and specification:

- R_{USER}, desired input resistance in the range about 1 Ω to max. 20 kΩ at the XLR female connector, resulting from paralleling the 20-kΩ input and the additional input resistor R.

  - $$\textit{Fitted resistor } R = \frac{1}{\frac{1}{R_{USER}} - \frac{1}{20\,k\Omega}}$$

- Max. loading capability: 1W

- With the USER DEF setting, limited maximum measurement voltage at the XLR female connector : $V = \sqrt{(1\,W \times R_{user})}$ or max. 35 V

Installation (by authorized service personnel only):

Note: *All boards are electrostatic sensitive devices. Handle them in line with ESD regulations.*

- Remove the power plug from the UPD.
- Withdraw the upper panelling and shielding cover (front-panel, right-hand).
- Withdraw the boards Analog Analyzer CH1 or, as the case may be, CH2 using the detent levers and disconnect the coaxial connections at the bottom side.
- Unscrew left-hand cover on component side.
- Solder the additional resistor to the soldering tags P250, P251.

Switch-on:
Select the parameter USER DEF in the dialog window of menu item "Impedance".

State as delivered:
No resistor is factory-fitted, leading to the effective input impedance of 20 kΩ when selecting the menu parameter USER DEF.

MONITOR:
Connector for headphones, see 2.6.6 - Monitor
Available for:
- all analog analyzer instruments

2.6.3 Configuration of the Digital Analyzers

Common Settings:

Min Freq

- 2 Hz
- 10 Hz
- 100 Hz

Select the lower frequency range limit.

DIG 48kHz	Selection between 2 Hz/10 Hz
DIG 192kHz	Selection between 10 Hz/100 Hz
DIG 768 kHz	Selection between 10 Hz/100 Hz

All functions offering AUTO for selection (eg Meas Time AUTO) get faster with hight frequency range limit, ie the measurement rate increases!

Channels

- 1
- 2
- BOTH

Set the currently active channel:

The meaning depends on the interface used, see the below overview of interfaces.

Input

Select the input interface:

SERIAL MUX	serial universal input, multiplexed
SERIAL	serial universal input
PARAL MUX	parallel input, multiplexed
PARALLEL	parallel input
AES/EBU	digital input, XLR
S/P DIF	digital input, BNC
OPTICAL	digital input, optical
INTERN	digital input, from internal generator

Available interfaces depending on the instrument used:

- DIG 48kHz: all interfaces in all modes
- DIG 192kHz: AES/EBU, S/P DIF, OPTICAL, INTERN no longer possible
- DIG 768kHz: AES/EBU, S/P DIF, OPTICAL, INTERN no longer possible

Note: *AES/EBU, S/P DIF and OPTICAL can be used only together with UPD-B2 option (AES/EBU S/P DIF).*

Table 2-21 Overview of interfaces

Input	Channel	Explanation
SERIAL	1	Measurement on channel 1
	2	Measurement on channel 2
	BOTH	Measurement on both channels
SERIAL MUX	1	Multiplexed input on channel 1 Only samples with a Wordselect line status identical to the Wordselect setting are measured.
	2	Multiplexed input on channel 1 Only samples with Wordselect different from Wordselect setting are measured.
	BOTH	Multiplexed input on channel 1. Both channels are measured.
PARALLEL	1	Measurement on parallel interface
	2	Measurement on second parallel interface, with UPD-B3 (Highspeed) option only.
	BOTH	Simultaneous measurement on both interfaces, with UPD-B3 option only.
PARA MUX	1	Multiplexed input Only samples with Wordselect identical to WordselCh1 setting are measured.
	2	Multiplexed input Only samples with Wordselect different from WordselCh1 are measured.
	1 ≡ 2	Multiplexed input Both samples with Wordselect = HIGH and = LOW are measured.
INTERN	1	Only 1 channel possible.

Sample Frq

32 kHz

44,1 kHz

48 kHz

VALUE

Set the signal clock rate; with 32 kHz, 44.1 kHz and 48 kHz, an appropriate internal clock is generated, which is available at the interfaces for control of an external circuit; otherwise the (generated) clock is insignificant for the measurement!

When selecting VALUE, the frequency applied can be entered in the next field to be displayed; clocks at the interface are not generated in this case.

Important: *If the frequency set does not match the frequency applied, all filters and frequency measurements are correspondingly shifted in frequency! The frequency applied to the UPD (sample rate) must not exceed the respective maximum sample clock rate (48000 Hz x maximum permissible oversampling rate) of the selected instrument by more than 10 %. Otherwise faulty measurements may occur or the measurement is aborted.*

Status display:

ANL: ORUN; Restart the measurement by selecting the function again.

Oversamp

1
2
4
8
16

(Oversampling)
Set a clock multiplier; depending on the instrument, 1 to 16 are selectable, see Overview.

Note: *This oversampling factor refers to the full word length. Higher oversampling factors (eg 64) are often used with bit stream converters (1-bit-sigma-delta converters). They are usually controlled with an oversampling factor of 1.*

The internal system clock rate (also referred to as sample rate) is given by:

System clock rate = basic clock rate × oversampling

Specifying the frequency by selecting VALUE does not permit selection of an oversampling factor; the internal sample frequency matches the external one.

Table 2-22

Instrument	Basic clock rate [kHz]	Multiplex possible	Oversampling possible factors
DIG48	32, 44.1, 48	yes	no
DIG192	32, 44.1, 48	yes	• 2, • 4,
DIG768	32, 44.1, 48	no	• 2, • 4, • 8, • 16

Hence, the following frequency ranges of the digital ANALYZER instruments result:

f_{max} = sample rate × 29/64

Maximum measurement frequency in kHz

Table 2-23

	Sample frequency	Oversampling factors 1	2	4	8	16
DIG 48 kHz	32 kHz	14.50	----	----	----	----
	44.1 kHz	19.98	----	----	----	----
	48 kHz	21.75	----	----	----	----
	VALUE 100 Hz to 48 kHz	direct entry of frequency without oversampling factor 29/64 x clock rate				
DIG 192 kHz	32 kHz	14.50	29.00	58.00	----	----
	44,1 kHz	19.98	39.96	79.93	----	----
	48 kHz	21.75	43.50	87.00	----	----
	VALUE 100 Hz to 300 kHz	direct entry of frequency without oversampling factor 29/64 x clock rate				
DIG 768 kHz	32 kHz	14.50	29.00	58.00	116.00	232.00
	44.1 kHz	19.98	39.96	79.93	159.86	319.72
	48 kHz	21.75	43.50	87.00	174.00	348.00
	VALUE 100 Hz to 1000 kHz	direct entry of frequency without oversampling factor 29/64 x clock rate				

Audio Bits

Word length of analysed audio samples in bit.

Range of values depends on output:

- Output → SERIAL MUX | SERIAL:

With word length	= 8:	8
	= 16:	8 to 16
	= 24:	8 to 24
	= 32:	8 to 28

- Output → PARAL MUX | PARALLEL: 8 to 28
- Output → AES/EBU | S/P DIF | OPTICAL: 16 to 24
- Output → INTernal: 8 to 28

Reducing the word length causes the audio sample values to be rounded to the specified word length.

Serial Interface: (Universal)

Located on the UPD front panel, labelled with DIGITAL AUDIO INPUT, 15-contact D-SUB connector.

The two's complement is used as **data format** (signed integer).

Examples: MSB, ... LSB: 0010000...0 = +0.25 * full scale
MSB, ... LSB: 0111111...1 = +1.00 * full scale
MSB, ... LSB: 1000000...0 = -1.00 * full scale
MSB, ... LSB: 1100000...0 = -0.50 * full scale
(MSB = Most Significant Bit)

WordLength

- **8**
- **16**
- **24**
- **32**

Set the data bits per input sample: 8, 16, 24 or 32 bits.

Wordoffset

Set the position of the synchronizing pulse or wordselect signal (see Fig. 2-22) relative to the beginning of the sample data.
Range: -WordLength/2 ... +WordLength/2-1. The softkey allows the significance of the audio bits to be altered. Shifting the synchronizing pulse by one bit position towards the MSB (= smaller word offset) 'doubles' the signal amplitude. With the signal amplitude being between 0.5 and 1.0 FS (full scale) (and therefore doubling being not possible), a misadjusted word offset causes incorrect measurements because any less significant bit is always interpreted as MSB, except when the setting is correct. With the word offset of the converter being unknown, the proper position must be determined using the trial-and-error method.

Audio Bits

see "Common Settings"

Word clock

- **RISING**
- **FALLING**

Set the polarity of the synchronizing pulse: RISING or FALLING (active edge).

Bit clock

- **RISING**
- **FALLING**

Set the polarity of the bit clock: RISING or FALLING.

Note: *Faults in transmission (sporadic errors) may be remedied by inverting the bit clock. The reasons for errors of this type may be crosstalk of the clock line on the data or violation of the setup- and / or holdtime request of the receiver.*

Bit Order	
	Set the bit order:
LSB FIRST	The less significant bit is the first to be received.
MSB FIRST	The most significant bit is the first to be received

WordselCH1	
	(This setting appears with SERIAL MUX only). Set the assignment of channel 1 with SERIAL MUX:
LOW	Channel 1 is assigned low-level on the WORDSEL A line.
HIGH	Channel 1 is assigned high-level on the WORDSEL A line.

Terminal conditions:

All outputs (clock lines) are operated by modules of the 74AC-family via a protective resistor of 22 Ω and are thus temporarily short-circuit proof. A short-circuit too long causes the driver module to be excessively heated, which may then fail. All inputs feature TTL switching thresholds and are applied via a protective resistor of 220 Ω to modules of the 74ACT-family.

Setup time: (the time during which, before a clock pulse, data must not change): 15 ns
Hold time: (the time during which, after a clock pulse, data must not change): 5 ns

Fast switch-off:

Pressing the OUTPUT OFF key causes all outputs (except for OUT5V) to be switched to high-impedance states (TRI-STATE). Clock signals are applied again when depressing the OUTPUT OFF key once more.

Table 2-24 Pin assignent and signals (serial interface):

Signal name	Pin	Remark
GND	7,8	
OUT5V	12	5V, 50 mA
GND	2	
Kanal 1:		With SERIAL MUX: channel 1&2
SCLKA	9	Input, bit clock
SDATAA	10	Input, audio data
WORDSELA	11	Input, synchronizing pulse or wordselect
Kanal 2:		
SCLKB	15	Input, bit clock
SDATAB	14	Input, audio data
WORDSELB	13	Input, synchronizing pulse
ACLKOUT	5	Output, bit clock output (8 to 32-fold audio clock)
SWSOUT	4	Output, audio clock

Timing:

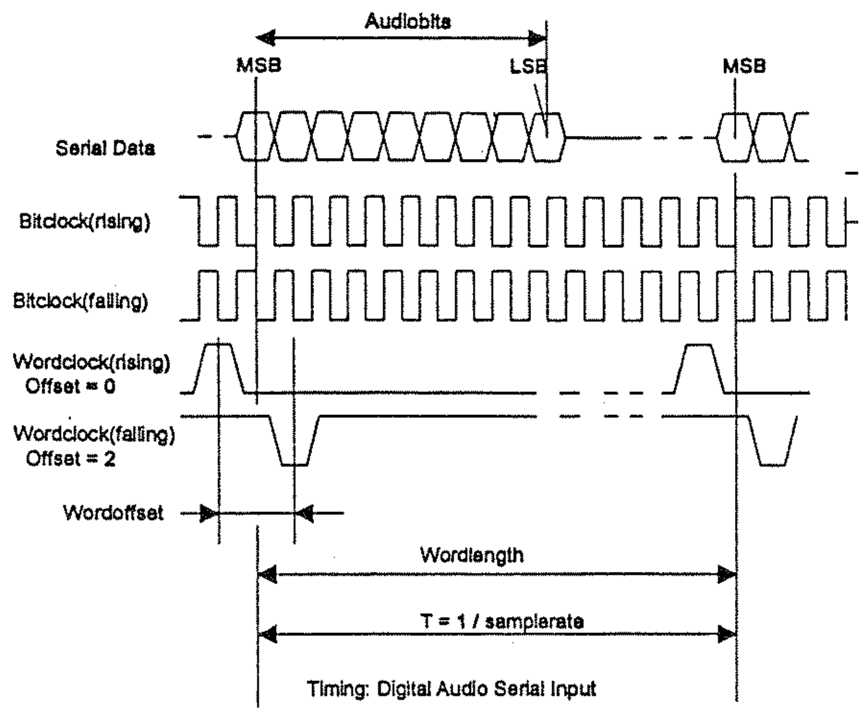


Fig. 2-22 Timing: Digital Audio Serial Input

Parallel Interface:

Located on the UPD rear panel, labelled with DIGITAL AUDIO INPUT, 37-contact D-SUB connector. The interface is located on the Digital Analyzer board or on the UPD-B3 option (Highspeed).

Note:

- *with PARALLEL input (not multiplexed), channel 2 can be selected only when the High-speed option is fitted.*
- *with PARALLEL input (multiplexed), the female connector labelled with 'Channel 1/2' can only be used.*

Settings:

WordselCH1

(This setting appears with PARAL MUX only). Set the assignment of channel 1 with PARAL MUX:

LOW — Channel 1 is assigned low-level on the LR line.

HIGH — Channel 1 is assigned high-level on the LR line.

Word clock

Set the polarity of the strobe signal (RISING or FALLING). For more details, refer to Timing.

RISING

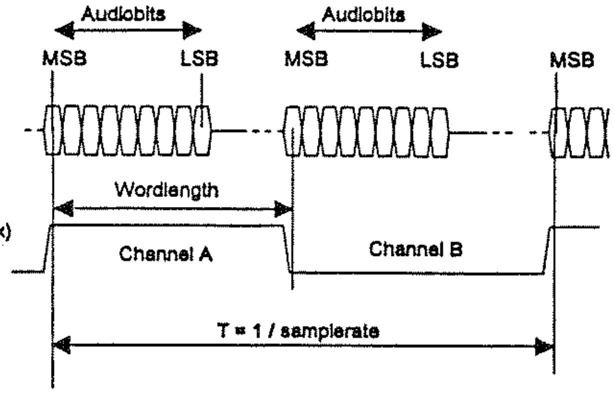
FALLING

Table 2-25 Pin assignment and signals (parallel interface):

Signal name	Pin	Remark
GND	16	
OUT5V	17	5V, 50 mA
GND	19	
GND	18	
Digital Audio Bit 27 (MSB)	2	
Digital Audio Bit 26	3	
Digital Audio Bit 25	4	
Digital Audio Bit 24	5	
Digital Audio Bit 23	6	
Digital Audio Bit 22	7	
Digital Audio Bit 21	8	
Digital Audio Bit 20	9	
Digital Audio Bit 19	10	
Digital Audio Bit 18	11	
Digital Audio Bit 17	12	
Digital Audio Bit 16	13	
Digital Audio Bit 15	14	
Digital Audio Bit 14	15	
Digital Audio Bit 13	20	
Digital Audio Bit 12	21	
Digital Audio Bit 11	22	
Digital Audio Bit 10	23	
Digital Audio Bit 09	24	
Digital Audio Bit 08	25	
Digital Audio Bit 07	26	
Digital Audio Bit 06	27	
Digital Audio Bit 05	28	
Digital Audio Bit 04	29	
Digital Audio Bit 03	30	
Digital Audio Bit 02	31	
Digital Audio Bit 01	32	
Digital Audio Bit 00 (LSB)	33	
LR (Wordselect)	34	Evaluated with PARAL MUX only
PSTROBE	35	Read clock (audio clock)
PCLKOUT	36	Output, bit clock output (32 • set clock rate)
PWSOUT	37	Output, set audio clock

Important: *Always connect external devices adjusting to the MSB, as otherwise the most significant bits are read with incorrect signs (leading to faulty measurements).*

Timing:



Timing: Digital Audio Serial Mux Input/Output

Fig. 2-23

Data format:	⌉
Terminal conditions:	as with serial interface
Fast switch-off:	⌋

AES/EBU, S/P DIF , OPTICAL Interfaces

The input data are read by the UPD-B2 option (AES/EBU S/P DIF). After the extra bits (validity, parity, user bits, ...) have been removed, the audio data are transferred to the analyzer.

Measurements on this interface are possible only with the analyzer instrument DIG48kHz selected.

Ch1 Imped	Select the input impedance (possible with AES/EBU only)
110 Ω	Terminate the balanced AES/EBU line with the rated impedance.
10 kΩ	High-impedance monitoring of UPD on existing connection
Sample Frq	See 2.6.3 Common Settings.
Audio Bits	See 2.6.3 Common Settings.

Interface INTERN:

Internal digital connection between generator and analyzer. The sample rate has a fixed setting of 43619.7917 Hz.

Measurements on this interface are possible only single-channel and with the analyzer instrument DIG48Hz selected.

Caution: *Also, the generator must be set to INTERN!*

Audio Bits	See 2.6.3 Common Settings.

2.6.4 Ways of Starting the Analyzer, Ext. Sweep

Available for

all six ANALYZER instruments.

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 the measurement result window and saved in an UPD-internal, 1024-digit measured value buffer.

The measured value list can be displayed or represented in the form of graphics (see 2.10).
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 → AUTO, FREQ CH1/2, VOLT CH1/2) or periodic measured value tracing (START COND → TIME) is started using the START or SINGL keys (see 2.11 Starting and Stopping a Measurement).

START COND (Start Condition) Specifies an event triggering off a measurement.

AUTO Continuous measurement mode **without** trigger condition.

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.

TIME The measured values are traced at regular intervals determined by the distance between the timeticks. The measured values are entered in the buffer and displayed in the measurement result window.

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.
Between the individual sweep points, the analyzer is in continuous measurement mode.
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 selected with frequency sweep of the selective rms measurement or any generator sweep being set at the same time!

START COND

FREQ CH1
FREQ CH2

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 occurence 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. A new trigger event occurring before this single measurement is terminated causes the immediate start of the new single measurement.
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: *Before changing the value to be measured, a time not less than the sum of delay and measuring time must elapse; otherwise it is not possible to conclude the measurement. This would mean that no measured values are displayed or stored in the buffer.*

FREQ CH1 | FREQ CH2 cannot be selected when the frequency sweep in the RMS Select measurement or any generator sweep is simultaneously set!

VOLT CH1
VOLT CH2

Tracing of measured values because a change in voltage was noted at ANALYZER input channel 1 or channel 2.

With the START or SINGLE key, an external voltage sweep is started, which in turn starts a single measurement on the occurence 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. A new trigger event occurring before this single measurement is terminated causes the immediate start of the new single measurement.
Starting a continuous sweep using the START key causes the sweep to be restarted after any change in voltage 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 level.
Changes of the voltage of STOP and START are ignored.

Note: *Before changing the value to be measured, a time not less than the sum of delay and measuring time must elapse; otherwise it is not possible to conclude the measurement. This would mean that no measured values are displayed or stored in the buffer.*

VOLT CH1 | VOLT CH2 cannot be selected when the frequency sweep in the RMS Select measurement or any generator sweep is simultaneously set!

Pressing the STOP key ends an external sweep. By pressing the CONT key, continuous measurement mode is returned to.

Delay

The menu item START COND → AUTO, FREQ CH1/2, VOLT CH1/2 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
- STOP/CONT key depression (continuous measurement)
- SINGLE key depression (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.

Range of values: 50 ms to 10 s
Units: s, ms, µs

Note:
Delay is considered in single measurements only, ie in single measurements triggered by the SINGLE key 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.

Timetick

In the menu item START COND→TIME the intervals between the single tracings of measured values can be specified. A single measurement is started after every tick.A new measurement is only triggered when the last measurement has been completed. I.e., if a timetick is selected which is smaller than the measuring time, the timetick is adapted internally to the measuring time; i.e., it is extended to be identical.

Range of values: 10 ms to 10 s
Units: s, ms, µs

Points

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

Range of values: 1 to 1023

Min VOLT

The menu items START COND → FREQ CH1 | FREQ CH2 allow the entry of a minimum voltage to be applied to the ANALYZER input in order to trigger a measurement.

Range of values:

Analog instrument:	10 µV to 1000 V Units: V, mV, µV dBV, dBu, W, mW, dBm
Digital instrument:	0.0001 to 1.0 FS Units: FS, %FS, dBFS

Start

Stop

The menu items START COND → FREQ CH1 | FREQ CH2
VOLT CH1 | VOLT 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.

Range of values FREQ CH1 | FREQ CH2:

Analog instrument:	2 Hz | 10 Hz to range limits, see 2.6.1
Digital instrument:	0 Hz to range limits, see 2.6.1 Units: Hz, kHz

Range of values VOLT CH1 | VOLT CH2:

Analog instrument:	10 µV to 1000 V Units: V, mV, µV dBV, dBu, W, mW, dBm
Digital instrument:	LL to 1.0 FS Units: FS, %FS, dBFS

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:
$LL = 2^{-\text{Audio Bits}}$

Variation

The menu items START COND → FREQ CH1 | FREQ CH2
VOLT CH1 | VOLT CH2
allow the entry of a value in percent 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 causes a restart of the sweep.

Note:	Select the variation 10 % to 50 % smaller than the variations to be expected in order to guarantee reliable triggering.
Range of values:	LL to 50% Unit: %

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).

2.6.5 Functions

FUNCTION

OFF	No measurement function
RMS & S/N	True rms measurement of ac voltages see 2.6.5.2
RMS SELECT	Selective rms measurement with narrow bandpass see 2.6.5.3
PEAK & S/N	Determining the 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 (with consideration of 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
DIM	Dynamic intermodulation measurement with low-frequency square signal and high-frequency sinewave signal, see 2.6.5.9
DFD	Intermodulation measurement to DFD method by two adjacent tones with relatively high frequencies, see 2.6.5.10
WOW & FL	Wow and flutter measurement see 2.6.5.11
POLARITY	Polarity measurement to check for polarity reversal in a device under test, see 2.6.5.12
FFT	Graphical display of spectrum, see 2.6.5.13
WAVEFORM	Display of waveform see 2.6.5.14

2.6.5.1 Common Parameters of Functions

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. 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

OFF S/N measurement off

Unit

Units for measured values of both channels for

- intermodulation measurements THD¦MOD DIST¦DIM¦DFD: %¦dB
- intermodulation measurements THD + N/SINAD: dB
- wow& flutter measurements WAF: %

For fundamentals of calculation, see corresponding function.
For conversion formulae, see 2.4 Units.

Unit Ch1

Units of measurement results of channel 1 .....

Unit Ch2

Units of measurement results of channel 2 .....
...for
level measurement functions RMS¦RMS SEL¦DC:
analog units:
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
digital units:
FS¦% FS¦dBFS¦Δ%¦dB_r

level measurement functions PEAK¦QPEAK and Input-Peak measurement:
analog units:
as with RMS
digital units:
FS¦% FS¦dBFS¦Δ%¦dB_r¦HEX

frequency measurement:
Hz¦ΔHz¦Δ% Hz¦Toct¦Oct¦Dec¦f/f_r

phase measurement:
°¦RAD¦Δ°¦ΔRAD

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

Reference

Reference values for the analyzer measurement function

VALUE
1,2345mV

Functions:
RMS, RMS SELECT, PEAK&S/N, QPK&S/N, Input Peak
Range of values for:
analog instruments = 1 µV to 1000 V
digital instruments = 0.0 to 1.0 FS
Units:
analog instruments: V¦mV¦µVdBV¦dBu¦W¦mW¦µW¦dBm
digital instruments: FS¦%F¦SdBFS

DC:
Range of values for:
analog instruments = -1000 V to 1000 V
(DC function not available for digital instruments)
Units:
V¦mV¦µV¦dBV¦dBu¦W¦mW¦µW¦dBm

STORE CH1

The level measurement result of channel 1 is stored on depression of the ENTER key. The reference value does not change during the measurement.

STORE CH2

The level measurement result of channel 2 is stored on depression of the ENTER key. The reference value does not change during the measurement.

STORE

The result of a single-channel measurement is stored on depression of the ENTER key. The reference value does not change during the measurement.

Ref Freq

(Reference Frequency)

VALUE
1,2345 kHz

Range of values: 1 mHz to 1 MHz
Units: Hz¦kHz

STORE CH1

The frequency measurement result of channel 1 is stored on depression of the ENTER key. The reference value does not change during the measurement.

STORE CH2

The frequency measurement result of channel 2 is stored on depression of the ENTER key. The reference value does not change during the measurement.

STORE

The result of a single-channel frequency measurement or a combined FREQ&PHASE measurement is stored on depression of the ENTER key. The reference value does not change during the measurement.

Ref Phase

(Reference Phase)

VALUE
1,2345 °

STORE

Range of values: - 360° to + 360° or -2π to + 2π
Units: °¦RAD

The measurement result is stored as reference phase on depression of the ENTER key.
The reference value does not change during the measurement.

FILTER

For the functions in the ANALYZER panel

- RMS & S/N (RMS measurement), 4 filters
- PEAK & S/N (peak measurement), 3 filters
- QPK & S/N (quasi-peak measurement), 3 filters

can be selected out of the 21 filters offered in the filter selection window and assigned the ANALYZER function. (see 2.7 Analyzer Filters)

POST FFT

POST FFT is an FFT subsequent to the functions

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

After having sampled the input signal and stored the sampled values, the function is aborted and, using the sampled values, 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.

Note: *Carrying out a generator sweep in conjunction with one of the above functions with POST FFT → ON causes the end of the POST FFT algorithm to determine the sweep intervals!*

For more detais on the FFT including all its parameters, refer to Section 2.6.5.13.

ON — POST FFT ON

OFF — POST FFT OFF

Softkey	Description
FFT-Size	Enter the FFT size (256 to 8192), see 2.6.5.13 FFT.
Start / **Stop**	Only display (no entries possible) of the frequency limits of the generated spectrum. As the demodulator stage undersamples with the factor of 8, the upper limit of the spectrum is already reached with 0.125 × 29/64 of the sample rate (sample rate, see 2.6.1 Selecting the Analyzer).
Resolution	Only display (no entries possible) of frequency resolution.
Window	Select the window function. Possible windows and their applications, see 2.6.5.13 FFT.
Anlg Notch	For the functions RMS & S/N, Q PK & S/N und 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	Analog notch filter on; gain 12 dB
30 dB	Analog notch filter on; gain 30 dB
Notch Freq	
AUTO	Center frequency of the notch filter tracks the measured frequency.
VALUE 1.2345 kHz	Numerical entry of the notch filter center frequency Range of values: 10 Hz to 110 kHz Units: Hz, kHz
GEN TRACK	With the generator signal function set to SINE, BURST, SINE^2 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 a SHOW I/O message (see 2.3.5).

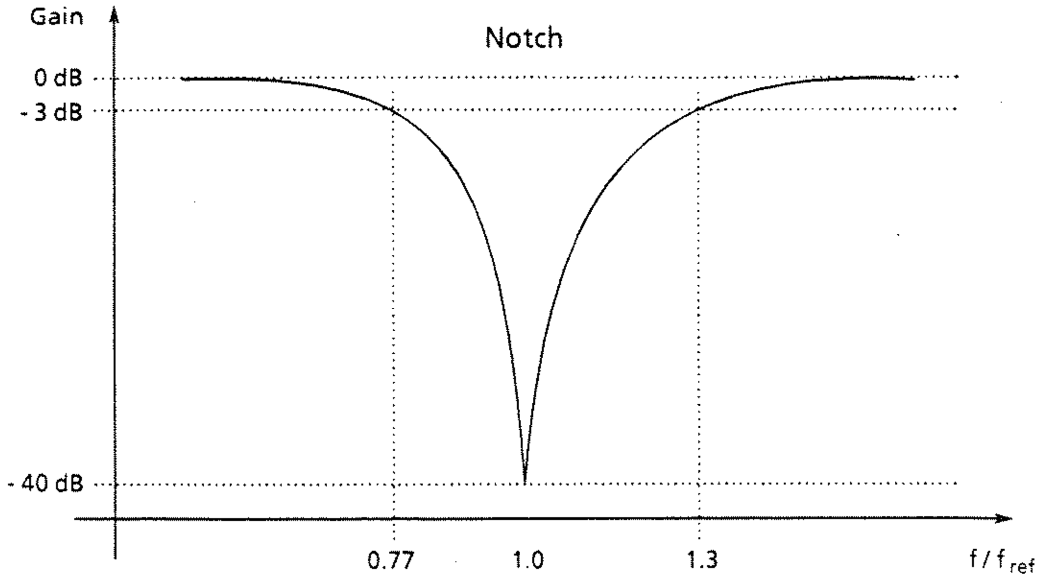


Fig. 2-24 Characteristic of analog notch filter

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

OFF	Switch off settling process
EXPONENTIAL	Exponential course of the tolerance and resolution.
FLAT	Horizontal course of tolerance and resolution.
AVERAGE	Arithmetic averaging of the results

For further information, cf. 2.3.3 "Settling Process"

Samples

To menu item Settling → EXPONENTIAL | FLAT:
Number of subsequent measured values compared in the settling process. If value 6 is entered here, this means that the latest measured value is 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 UPD.
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
SINAD measurement, only dB permissible
WOW flutter and frequency measurement, only % permissible
Specified range: 0.001 % to 10 % or
0.000087 dB to 0.828 dB

% and dB values can be converted into one another:

% value = (pow10 (dB value / 20)) - 1) * 100
dB value = 20 * lg (% value / 100 + 1)

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. 2.3.3 "Settling Process"

Specified range:
Analog instruments with functions:

RMS & S/N | RMS SELECT | PEAK & S/N | Q PK & S/N | DC:	10 µV to 10 V
THD + N/SINAD in mode SINAD:	20 to 120 dB
THD + N/SINAD in mode THD + N | NOISE:	0.0001 % to 10 %
THD | MOD DIST | DFD | DIM | WOW & FL:	0.0001 % to 10 %

Digital instruments with functions:

RMS & S/N | RMS SELECT | PEAK & S/N | Q PK & S/N | DC:	MinFS to 0.1 FS
THD + N/SINAD in mode SINAD:	20 to 120 dB
THD + N/SINAD in mode THD + N | NOISE:	0.0001 % to 10 %
THD | MOD DIST | DFD | DIM | WOW & FL:	0.0001 % to 10 %

Frequency measurement:	
FREQ/PHASE → FREQ:	100 µHz to 10 Hz
External sweep	
START COND → FREQ CH1 | FREQ CH2	100 µHz to 10 Hz
External sweep	
START COND → VOLT CH1 | VOLT CH2	10 µV to 10 V MinFS to 0.1 FS
Phase measurement:	
FREQ/PHASE → FREQ&PHASE:	0.01 ° to 10 °

MinFS: $2^{(-1 \cdot \text{audio bits})}$ however, not smaller than 1 µFS

Units:	
Analog instruments with functions:	
RMS & S/N | RMS SELECT | PEAK & S/N |	
Q PK & S/N | DC:	V | dBV | dBu | W | dBm
THD + N/SINAD in mode SINAD:	dB
THD + N/SINAD in mode THD + N | NOISE:	% | dB
THD | MOD DIST | DFD | DIM | WOW & FL:	% | dB
External sweep	
START COND → FREQ CH1 | FREQ CH2	Hz
External sweep	
START COND → VOLT CH1 | VOLT CH2	V | dBV | dBu | W | dBm
Digital instruments with functions:	
RMS & S/N | RMS SELECT | PEAK & S/N |	
Q PK & S/N | DC:	FS | %FS | dBFS
THD + N/SINAD in mode SINAD:	dB
THD + N/SINAD in mode THD + N | NOISE:	% | dB
THD | MOD DIST | DFD | DIM | WOW & FL:	% | dB
External sweep	
START COND → FREQ CH1 | FREQ CH2	Hz
External sweep	
START COND → VOLT CH1 | VOLT CH2	FS | %FS | dBFS
Frequency measurement:	Hz
Phase measurement:	°

Timeout

If the settling mechanism does not recognize a stabilization of the measured value within the time stated under "timeout", 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. 2.3.3 "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 is for the majority of measurement on AF instruments
- 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 kHz, this is 1 mHz
- Timeout 1 s

2.6.5.2 RMS (incl. S/N)

Available for all six 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 in the range of 1 µV to 300 V with a resolution of 0.1 µV in the most sensitive measurement range.

With a lower measurement limit of

- 2 Hz, a superposed dc signal controls the input unit and may adversely affect the measurement accuracy (see 2.6.1 Selecting the Analyzer, Range Limits)!
- 10 Hz, there is ac coupling

Digital mode:

The signal contents is indicated as true rms full-scale value (all converter bits are set = FS 1.0) from 0.0 to 1.0.

S/N Sequ (see 2.6.5.1 Common Parameters of Functions)

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

Meas Time (Measurement Time)
The rms measurement time serves to match the measurement rate to the signal frequency.

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.
SUPERFAST	50 ms
FAST	200 ms
SLOW	1000 ms
VALUE 1.2345 s	Numerical entry. Range of values: 1 ms to 10 s Units: s, ms, µs

SUPERFAST, FAST, SLOW and VALUE are fixed integration times without consideration of the signal period.

Meas Time is integer multiple of signal period:
Optimum integration effect. Steady display!

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

Meas Time smaller than signal period:
No integration effect. AC measurement result follows the signal waveform.

Reference	(see 2.6.5.1 Common Parameters of Functions)
Anlg Notch	(see 2.6.5.1 Common Parameters of Functions)
Filter	(see 2.7. Selecting the Analyzer Filters)
Post FFT	(see 2.6.5.1 Common Parameters of Functions)

2.6.5.3 RMS SELECTIV

Available for all six analyzers.

Selective rms measurement with narrow bandpass.

Meas Time (Measurement Time)
(identical to Meas Time in 2.6.5.2)

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

Reference (see 2.6.5.1 Common Parameters of Functions)

Bandwidth Bandwidth of bandpass

- **1%** Geometrically symmetrical bandwidth 1%
- **3%** Geometrically symmetrical bandwidth 3%
- **1/3 OCT** Geometrically symmetrical bandwidth (obtained from $\sqrt[3]{2}$ = 1.25992 = 25.992%)
- **1/12 OCT** Geometrically symmetrical bandwidth ≈ 6% (obtained from $\sqrt[12]{2}$ = 1.05946 = 5.946%)
- **FIX 1.234 kHz** Arithmetically symmetrical bandwidth using numerical entry

Range of values: Range of values for the numerical entry of the bandwidth(FIX:):

Analyzer	Range for bandwidth bw_{fix}
ANLG 22 kHz	9.9 Hz to 16 kHz
ANLG 100 kHz	70.4 Hz to 113.8 kHz
ANLG 300 kHz	211.2 Hz to 341.3 kHz
DIG 48 kHz DIG 192 kHz DIG 768 kHz	$f_{cmin} * 0.99 \cdots \frac{\text{sample freq.}}{3}$

Units: Hz, kHz

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

Int. sample freq. = Sampl Freq. * Oversamp

Irrespective of the selected bandwidth, the bandwidth does not fall below the following minimum bandwidth:

Analyzer	Minimum bandwidth
ANLG 22 kHz	9.9 Hz
ANLG 100 kHz	70.4 Hz
ANLG 300 kHz	211.2 Hz
DIG 48 kHz DIG 192 kHz DIG 768 kHz	$\frac{\text{Int. sample freq.}}{4800} * 0.99$

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

Int. sample freq. = Sampl Freq. * Oversamp

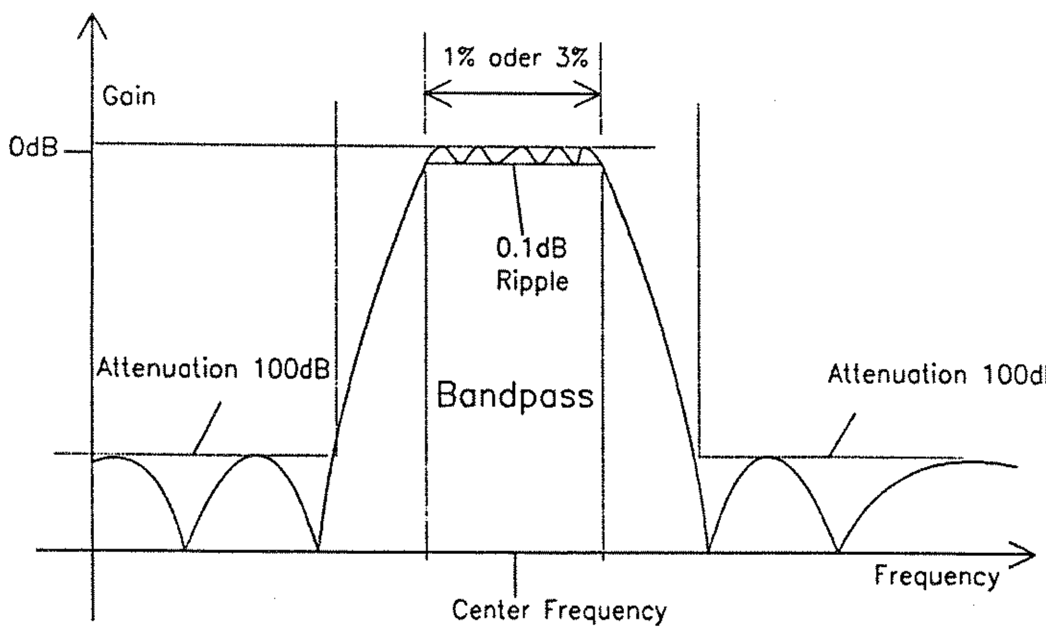


Fig. 2-25 Bandpass used for selective rms measurement

Frequency Sweep of Selective RMS Measurement

The frequency of the selective rms measurement can be swept using the following menu items. 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)
- taken from the single frequencies of the generator setting MULTISINE (SWEEP CTRL → GEN MLTSINE).

SWEEP CTRL

(Sweep Control)
is used to select whether and how to sweep. A sweep can be activated only when continuous measurement is switched ON (START COND → AUTO see 2.6.4) and generator sweep OFF (Sweep Ctrl → OFF see 2.5.4.2) in the analyzer.

OFF

The sweep system is switched off.

GEN MLTSINE

(Generator Multisine)
The bandpass center frequency of selective rms measurement is successively set to the multisine frequencies in the GENERATOR panel (see 2.5.4.4 Multisine), requiring the generator signal function to be set to MULTISINE. Otherwise the SHOW I/O message is displayed (see 2.3.5).

This setting is primarily used for fast frequency response measurements and is operated in the same way as the AUTO LIST sweep.

AUTO SWEEP

Pressing the START or SINGLE key causes the sweep to run automatically (see 2.11 Starting and Stopping a Measurement).
The sweep parameter data are calculated from the user specifications for "Spacing", "Start", "Stop", "Points" or "Steps".

MANU SWEEP

The sweep is controlled by means of the rotary knob and/or SINGLE key. After pressing the START key, the first frequency of the selective rms measurement only is set. Any further frequency is requested using the rotary knob or by pressing the SINGLE key (see 2.11 Starting and Stopping a Measurement).
As with AUTO SWEEP, the sweep parameter data are calculated from the user specifications for "Spacing", "Start", "Stop", "Points" or "Steps".

SWEEP CTRL

AUTO LIST

The list sweep runs automatically after having pressed the START or SINGLE key (see 2.11 Starting and Stopping a Measurement).
The sweep parameter data are read from the file specified under "Filename". For format and generation of the sweep lists, refer to the **Appendix**.

MANU LIST

As with MANU SWEEP, the sweep is controlled by means of the rotary knob in the GRAPH panel and/or SINGLE key. After pressing the START key, only the first frequency of the selective rms measurement out of the sweep list is set. Any further frequency must be specifically requested using the rotary knob or by pressing the SINGLE key (see 2.11 Starting and Stopping a Measurement).
The sweep parameter data are read from the file specified under "Filename". For format and generation of the sweep lists, refer to the Appendix.

As to MANU SWEEP and MANU LIST:
Fast rotation of the rotary knob allows single sweep points or relatively large sweep ranges to be left out, which is indicated by gaps in the graphical representation of the curve. Reverse rotation allows preceding points to be repeated or the interrupted curves to be completed.

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 to be specified under menu item "Points".
The step size in Hz can be derived from the number of linear points:

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

LIN STEPS

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

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

Spacing

LOG POINTS

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

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

LOG STEPS

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

As to POINTS and STEPS:
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 number specified for "Steps" remains the same.

Start

Stop

Enter the start or stop value for the frequency sweep of the selective rms measurement.
Displayed for SWEEP CTRL →AUTO SWEEP | MANU SWEEP only.
For the range of values and units, see FREQ MODE →FIX.

Points

Enter the number of points for the frequency sweep of the selective rms measurement.
Displayed only for SWEEP CTRL→AUTO SWEEP | MANU SWEEP when Spacing →LIN POINTS | LOG POINTS.

Range of values:	2 to 1024
Units:	Integer value without unit

Step

Enter the step size for the frequency sweep of the selective rms measurement.
Displayed only for SWEEP CTRL → AUTO SWEEP | MANU SWEEP when Spacing →LIN STEPS | LOG STEPS.
Range of values:
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 range of values, see operator guidance line.

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

Filename

File containing the frequency values for the frequency sweep of the selective rms measurement (For the format of the sweep lists, see Appendix). Displayed for SWEEP CTRL → AUTO LIST | MANU LIST only.

FREQ MODE

Specify the bandpass center frequency when there is no sweep. Displayed for SWEEP CTRL → OFF only.

FIX
1234,5 Hz

Numerical entry of a fixed bandpass center frequency
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 affect any change in frequency of the selective rms measurement.

GEN TRACK

(Generator Tracking)
Any modification of the generator setting either by the user (entry of values, rotary knob) or due to a generator sweep causes the bandpass center frequency to track the generator frequency currently specified under generator menu item FREQUENCY provided that the generator signal function is set to SINE, BURST, SINE² PULSE or SQUARE.
Any other signal function causes a SHOW I/O message (see 2.3.5).

FREQ CH1
FREQ CH2

Frequency of the selective rms measurement follows the frequency measured on channel 1|2.

Range of values 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_c with bandwidth 1%	f_c with bandwidth 3%	f_c with bandwidth 1/3 OCT	f_c with bandwidth 1/12 OCT	f_c with bandwidth FIX:
ANLG 22 kHz	10 Hz...21.64 kHz	10 Hz...21.43kHz	10 Hz...19.38 kHz	10 Hz...21.13 kHz	$5.05\text{ Hz} + \frac{bw_{fix}}{2} \ldots f_N - \frac{bw_{fix}}{2}$
ANLG 100 kHz	71 Hz...153.8 kHz	71 Hz...152.3 kHz	71 Hz...137.8 kHz	71 Hz...150.2 kHz	$35.91\text{ Hz} + \frac{bw_{fix}}{2} \ldots f_N - \frac{bw_{fix}}{2}$
ANLG 300 kHz	213 Hz...461.7 kHz	213 Hz...457.1k Hz	213 Hz...413.4 kHz	213 Hz...450.8 kHz	$107.7\text{ Hz} + \frac{bw_{fix}}{2} \ldots f_N - \frac{bw_{fix}}{2}$
DIG 48 kHZ DIG 192 kHZ DIG 768 kHz	$f_{cmin} \ldots \frac{f_N}{1.005}$	$f_{cmin} \ldots \frac{f_N}{1.005}$	$f_{cmin} \ldots \frac{f_N}{1.12246}$	$f_{cmin} \ldots \frac{f_N}{1.0293}$	Int. sample freq. * 0.1052E-3 $\frac{bw_{fix}}{2} \ldots f_N - \frac{bw_{fix}}{2}$

fc = Bandpass center frequency

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

$f_N = \text{Int. sample freq.} * \frac{29}{64}$ (useful frequency)

Int. sample freq. = Sampl Freq * Oversamp

bw_{fix} = bandwidth entered in numerical form

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

Available in the analyzers ANLG 22 kHz and DIG 48 kHz.

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.

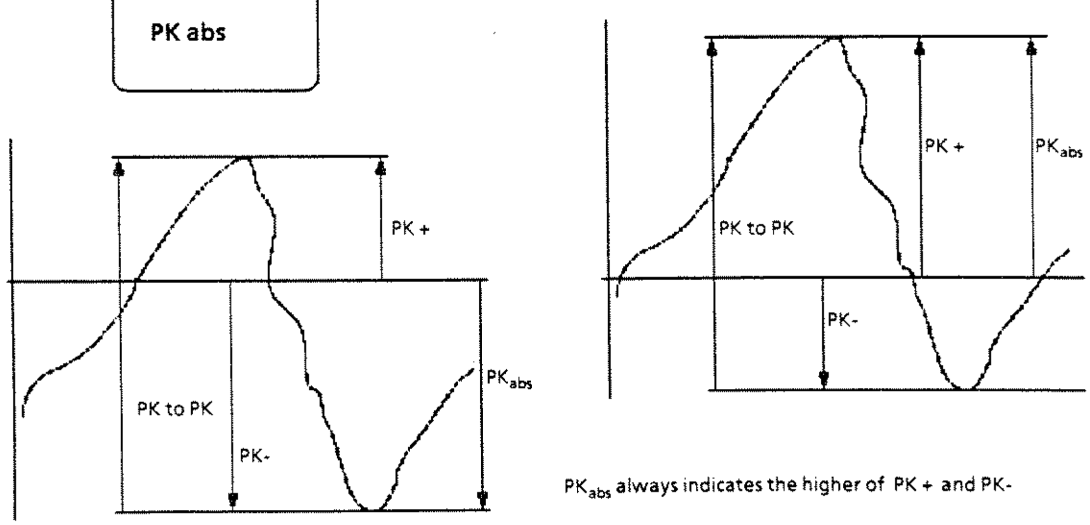
As to the measurement:

- *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 square 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 (see footnote 2.4 Units - Hex).*

S/N Sequ — (S/N Sequence)
(see 2.6.5.1 Common Parameters of Functions)

Meas Mode — (Measurement Mode)
of PEAK measurement (see footnote 2.4 Units - Hex).

- **PK +**
- **PK -**
- **PK to PK**
- **PK abs**



PK$_{abs}$ always indicates the higher of PK + and PK-

Fig. 2-26 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.

SUPERFAST	50 ms
FAST	200 ms
SLOW	1000 ms
VALUE 1.0000 s	Numerical entry. Range of value: 1 ms to 10 s, Units: s, ms, µs

Unit Ch1 / 2

(see 2.6.5.1 Common Parameters of Functions)

Reference

(see 2.6.5.1 Common Parameters of Functions)

Anlg Notch

(see 2.6.5.1 Common Parameters of Functions)

Filter

(see 2.7 Analyzer Filters)

2.6.5.5 DC

Available for the three analog analyzers only.

Principle of measurement
DC voltages can be measured at the Unbal input from 0 to ± 300 V, at the Bal input from 0 to ± 35 V. The DC reference point is the external conductor of the BNC female connector and connecting point 3 of the XLR female connectors for the unbalanced input (UNBAL BNC) and balanced input (BAL XLR), respectively (see 2.6.2). For selecting the measurement range for DC measurements, see 2.6.2, Table 2-20.

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.

FAST	200 ms	
VALUE 1.0000 s	Numerical entry. Range of values: Units:	 1 ms to 10 s, s, ms, µs

Unit Ch1/2

(see 2.6.5.1 Common Parameters of Functions)

Reference

(see 2.6.5.1 Common Parameters of Functions)

2.6.5.6 THD Measurement

Available for all six 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 setting Fundamentl GEN TRACK (fundamental frequency of THD + N measurement is coupled to the current generator frequency), an unsuitable signal function is selected in the GENERATOR:
"No valid GEN-Function (SINE, BURST, S2PULS or SQUARE)"

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

Principle of measurement

The UPD 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 sqare 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.

$$\boxed{V_{THD}\,[\mathrm{dB}] = 20 \times \log \frac{\sqrt{Vd2^2 + \ldots + Vd9^2}}{\text{total rms value}}}$$

$\sqrt{Vd2^2 + \ldots + Vd9^2}$: square sum of selected harmonics

Meas Mode	(Measurement Mode) Select the harmonics to be measured, which are then displayed above the measured value window. "THD 2_4_6_8", for example, means: The 2nd, 4th, 6th and 8th harmonic distortions are measured.
SELECT di	Any combination of harmonic distortions d2 to d9 See next command
All even di	All even harmonic distortions: d2, d4, d6, d8
All odd di	Alle uneven harmonic distortions: d3, d5, d7, d9
All di	All harmonic distortions: d2 ... d9

di 2468

√ d2
d3
√ d4
d5
√ d6
d7
√ d8
d9

Select any combination of harmonic distortions.

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.

Unit

(see 2.6.5.1 Common Parameters of Functions)

Fundament

Specify how the fundamental frequency is to be determined.

AUTO

UPD automatically determines the fundamental frequency.

VALUE
1000,0 Hz

Numerical entry of fundamental frequency
Range of values:

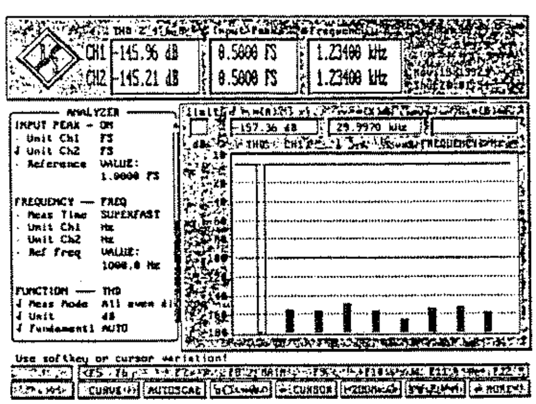
ANLG	22 kHz:	10 Hz	to	21.75 kHz
ANLG	100 kHz:	100 Hz	to	100 kHz
ANLG	300 kHz:	250 Hz	to	300 kHz
DIG	48 kHz:	10 Hz	to	useful bandwidth
DIG	192 kHz:	100 Hz	to	useful bandwidth
DIG	768 kHz:	1000 Hz	to	useful bandwidth

Useful bandwidth = int. sample freq. * 29/64
Int. sample freq. = Sampl Frq * Oversamp

GEN TRACK

With the generator signal function set to "SINE" "BURST" "SINE² PULSE" or "SQUARE", the generator frequency currently specified under generator menu item FREQUENCY is used as fundamental frequency.
Selecting any other signal function results in a SHOW I/O message (see 2.3.5).

The settings VALUE and GEN TRACK are preferably used for signals with high harmonic content to increase the setting accuracy.



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

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

Available for all six 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 up to 300 kHz, 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, Fundamentl VALUE):

"Fundamental too low"

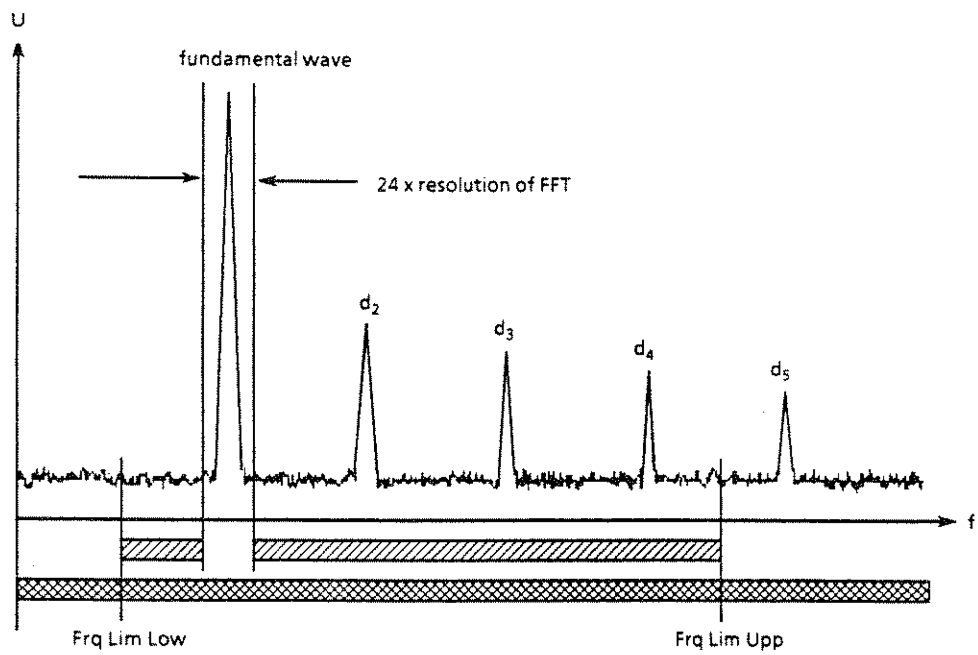
For the setting Fundamentl GEN TRACK (fundamental frequency of THD + N measurement is coupled to the current generator frequency), an unsuitable signal function is selected in the GENERATOR:

"No valid GEN-Function (SINE, BURST, S2PULS or SQUARE)"

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

Principle of measurement

The fundamental wave is filtered out, the total remaining energy consisting of harmonic distortions and broadband noise within the band limits specified under FrqLimLow and FrqLimUpp being put in relation to the total rms value.



(hatched) = $\sqrt{Vd_2^2 + Vd_3^2 + ... + V_{Noise}^2}$ (fundamental filtered out)

(cross-hatched) = total rms value

Fig. 2-27

$$V_{THD+N}\,[dB] = 20 \cdot \log \frac{\sqrt{V_{d2}^2 + V_{d3}^2 + \ldots + V_{noise}^2}}{\text{total rms value}}$$

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

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

Meas Mode — THD + N or SINAD measurement result display

THD + N	(negative dB-values)
SINAD	(positive dB-values)
NOISE	as THD + N, however, the harmonic lines are not weighted

UNIT — (see 2.6.5.1 Common Parameters of Functions)

Fundamentl — Determines the fundamental frequency for THD + N measurements

AUTO	UPD automatically measures the fundamental frequency.
VALUE 1000.0 Hz	Numerical entry of fundamental frequency. Range of values: ANLG 22 kHz: 23.438 Hz to 21.75 kHz ANLG 100 kHz: 166.67 Hz to 100 kHz ANLG 300 kHz: 500 Hz to 300 kHz DIG 48 kHz: DIG 192 kHz: LL to useful bandwidth DIG 768 kHz: LL = sample frq / 2048 Useful bandwidth = sample frq * 29/64 Int. sample freq. = Sampl Frq * Oversamp (For the sample frequency of the digital analyzer instruments, see 2.6.1).
GEN TRACK	With the generator signal function set to "SINE" "BURST" "SINE2 PULSE" or "SQUARE", the generator frequency currently specified in the generator menu item FREQUENCY is used as fundamental frequency. Any of the 5 generator instruments is permissible. Selecting an inappropriate signal function causes a corresponding error message to be output.

The settings VALUE and GEN TRACK are preferably used for signals with high harmonic content to increase the setting accuracy.

POST FFT (see 3.2.5.5.1 Common Parameters of Functions)

- **OFF** The FFT setting parameters are not displayed.
- **ON** The following five FFT setting parameters are displayed. They cannot be modified.

FFT Size fixed to 8192

Window fixed to RIFE VINC 3

Start Display value

Stop Display value

Resolution Sample freq [Hz] / 16384 (see Fundamentl VALUE)

Frq Lim Low

Lower range limit of THD + N / SINAD measurement function.
Range of values:
ANLG 22 kHz: (8 * resolution) to (21.75 kHz - 3 * resolution)
ANLG 100 kHz: (8 * resolution) to (100 kHz - 3 * resolution)
ANLG 300 kHz: (8 * resolution) to (300 kHz - 3 * resolution)
DIG 48 kHz:
DIG 192 kHz: (8 * resolution) ... (useful bandwidth- 3 * resolution)
DIG 768 kHz:

Useful bandwidth = int. sample freq. * 29/64
Int. sample freq. = Sampl Frq * Oversamp

Frq Lim Upp

Upper band limit of THD + N / SINAD measurement function
Range of values:
ANLG 22 kHz: (Freq Lim Low + 3 * resolution) to 21.75 kHz
ANLG 100 kHz: (Freq Lim Low + 3 * resolution) to 100 kHz
ANLG 300 kHz: (Freq Lim Low + 3 * resolution) to 300 kHz
DIG 48 kHz:
DIG 192 kHz: (Frq Lim Low + 3 * resolution) to useful bandwidth
DIG 768 kHz:

Useful bandwidth = int. sample frq * 29/64
Int. sample frq. = Sampl Frq * Oversamp

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

2.6.5.8 MOD DIST

Available for all six analyzers.

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

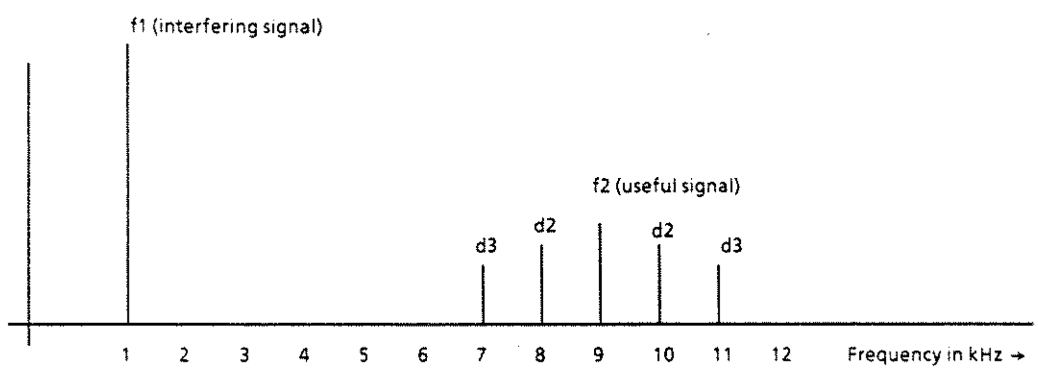
When the signal offered does not meet the requirements, a SHOW I/O message (see 2.3.5) is output:

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 2.5.4.8), the UPD 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.

Principle of measurement

Unaffected by noise due to selective measurement, the UPD 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. (As against 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. 2-28

$$\boxed{\text{MOD DIST [dB]} = 20 \cdot \lg(\text{dm}(2+3))}$$

Modulation distortion of 2nd order:

$$\boxed{\text{dm2} = \frac{|V_{(f1+f2)}| + |V_{(f2-f1)}|}{V_{(f2)}}}$$

Modulation distortion of 3rd order:

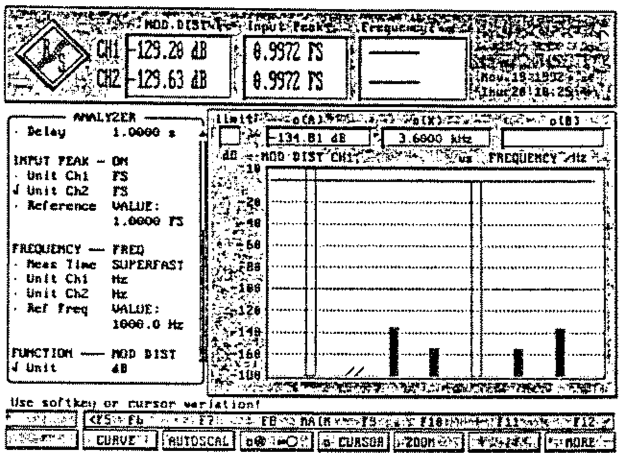
$$\boxed{\text{dm3} = \frac{|V_{(f2-2f1)}| + |V_{(f2+2f1)}|}{V_{(f2)}}}$$

Square sum:

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

Unit

(see 2.6.5.1 Common Parameters of 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 DIM (Dynamic Intermodulation Distortion)

DIM is available in the ANALYZER instruments ANLG 22 kHz and DIG 48 kHz.

For the dynamic intermodulation distortion measurement (DIM), apply a frequency mixture, consisting of a low-frequency squarewave superposed by a high-frequency sinewave with a peak-amplitude-ratio of square : sine = 4 : 1, to the device under test. To DIN IEC 268 Part 3, the squarewave is to be spectrally limited to 30 kHz or 100 kHz using a one-pole lowpass.

The UPD is able to weight two squarewave/sinewave frequency mixtures:

To DIN IEC 268 Part 3:
    square 3.15 kHz / sine 15 kHz
as against DIN for applications in the RF range:
    square 2.96 kHz / sine 14 kHz

For deviations exceeding

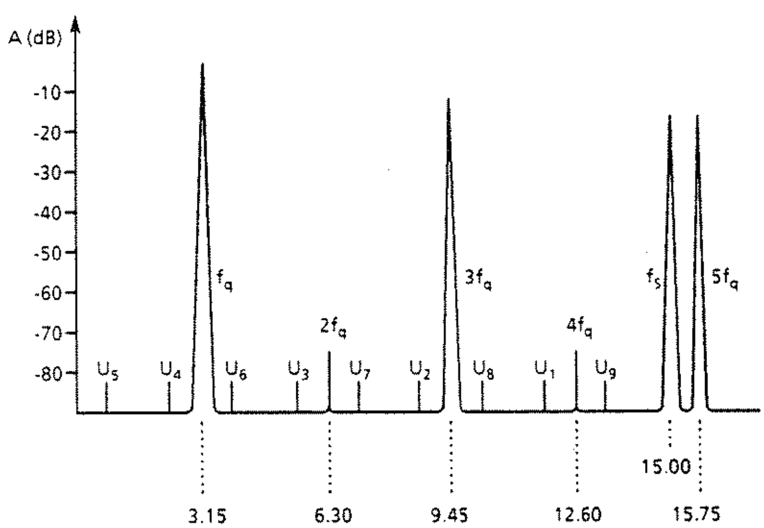
- ± 2 % of the specified squarewave frequency or
- ± 5 % of the specified sinewave frequency

the following SHOW I/O messages (see 2.3.5) are output.
"No squarewave at defined frequency." or
"No sinewave at defined frequency."

With the signal function DIM (see 2.5.4.10), the UPD generator offers the two frequency mixtures stated above, band limitation of the squarewave to 30 kHz or 100 kHz and amplitude setting.

Principle of measurement

The UPD selectively measures the nine components of dynamic intermodulation, which are caused by the device under test and are within the AF range. As against the obsolete principle of measurement, which is to filter out only two or three interfering lines in the lower frequency range using a lowpass and obtain a measurement result impaired by noise, the UPD now provides a measurement result unaffected by noise due to the selective measurement of each individual interfering line. The intermodulation distortions provided by the new method may be higher than with the former method, yet conforming to standards.



Intermodulation components		Frequency kHz
Frequency	Voltage	
$5f_q - f_s$	U_5	0.75
$f_s - 4f_q$	U_4	2.40
$6f_q - f_s$	U_6	3.90
$f_s - 3f_q$	U_3	5.55
$7f_q - f_s$	U_7	7.05
$f_s - 2f_q$	U_2	8.70
$8f_q - f_s$	U_8	10.20
$f_s - f_q$	U_1	11.85
$9f_q - f_s$	U_9	13.35

Fig. 2-29 Frequency spectrum of signal for DIM measurements illustrated by the example of a frequency mixture of square 3.15 kHz / sine 15 kHz

$$\boxed{\text{DIM value [dB]} = 20 \cdot \lg(d)}$$

$$d = \frac{\sqrt{V_1^2 + V_2^2 + V_3^2 \ldots + V_9^2}}{V_s}$$

fq	=	squarewave frequency
fs	=	sinewave frequency
V1...V9	=	rms value of spectral components
Vs	=	rms value of sinewave signal
d	=	dynamic intermodulation distortion

Unit

(see 2.6.5.1 Common Parameters of Functions)

FREQ MODE

Select reference frequencies.

FIX

Two fixed reference frequency pairs can be selected in the command line Square/Sin (see next command).

GEN TRACK

With the generator signal function set to DIM, the reference frequency pair specified under generator menu item Square/Sin (see 2.5.4.10) is used as reference frequency pair in DIM measurements.
If, by mistake, any other generator signal function is set, the SHOW I/O message (see 2.3.5) *"No valid GEN-Function* (SINE, BURST, S2PULS or SQUARE required)." is output.

Square/Sin

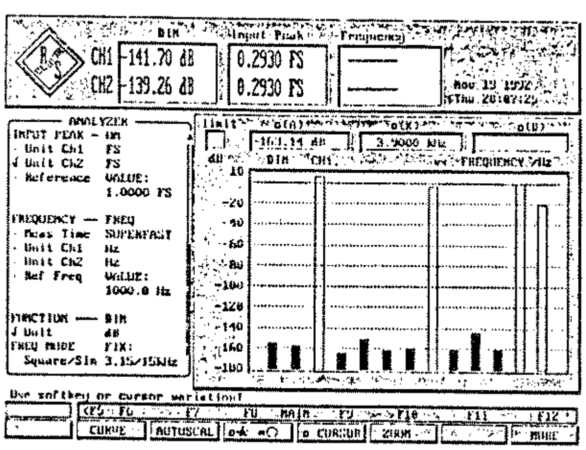
Two reference frequency pairs

2,96/14 kHz

Squarewave frequency 2.96 kHz, sinewave frequency 14 kHz

3,15/15 kHz

Squarewave frequency 3.15 kHz, sinewave frequency 15 kHz acc. to the above standard



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

2.6.5.10 DFD (Difference Frequency Distortion)

Available for all six 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 terz band (5, 6.3, 8, 10, 12.5, 16, 20 kHz). According to the standard, 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; (> 1100.0 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 %)"

With the signal function DFD (see 2.5.4.9), the UPD generator offers the above frequency mixture allowing the mean frequency, frequency difference and amplitude to be specified by the user.

Principle of measurement

With the DFD function in the ANALYZER panel set to Meas Mode d_2 or d_3, the UPD 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.

d_3-measurements make higher demands on the selectivity of the evaluation than d_2-measurements because the intermodulation products are very close to the two tones.

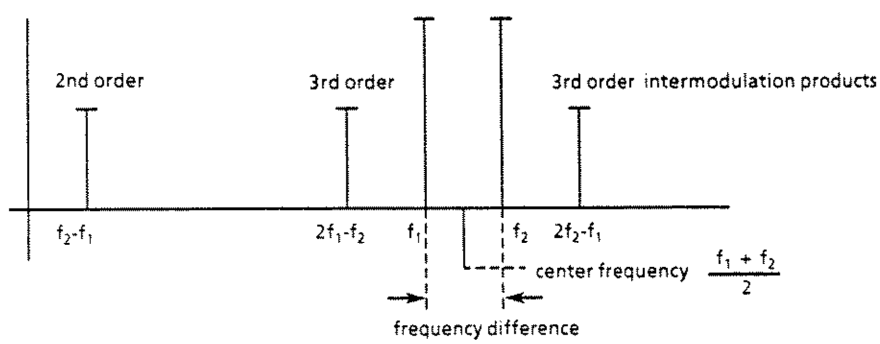


Fig. 2-30

Difference frequency distortion of 2nd order:

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

Difference frequency distortion of 3rd order:

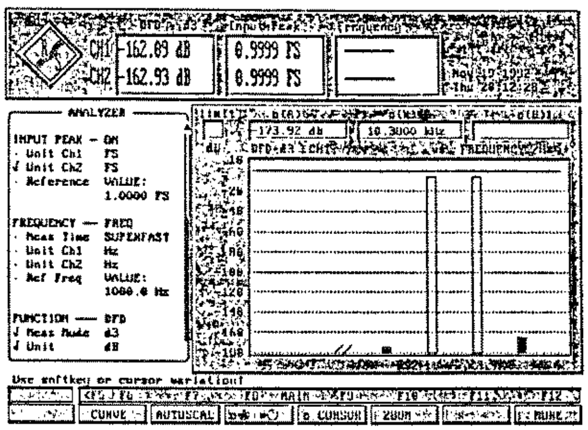
$$d_3\,[\mathrm{dB}] = 20 \times \lg \frac{|V_{(2f_2-f_1)}| + |V_{(2f_1-f_2)}|}{2 \times V_{(f_2)}}$$

Meas Mode Measurement Mode
Measurement of intermodulation products

d2 2nd order

d3 3rd order

Unit (see 2.6.5.1 Common Parameters of Functions)



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

2.6.5.11 Wow & Flutter

Function

W&F

Measurement of frequency distortion of sound recording and reproducing equipment (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.

This measurement is available in the instruments DIG 48 kHz and ANLG25 kHz, only.

Standard

Set the standard applying to the measurement:

DIN/IEC

Standards:	DIN 45507 / IEC 386 / CCIR 409-J
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 4Hz unweighted: highpass, 0.5 Hz
Weighting method:	rms weighting, integration time 2 sec

2 Sigma 5 s

2 Sigma 10 s

The 2-σ weighting to IEC 386/1988 is implemented in the UPD. Its purpose is to determine a threshold v for the wow and flutter value such that 5 % of the magnitudes of the measured values are higher than threshold v, ensuring that sporadically occurring outliers do not affect the measurement result.
The integration time is selectable: 5 or 10 seconds.

Weight

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: 500 Hz

Frequency response of weighting filter (to DIN 45507, IEC P386, CCIR Rec. 409-1):

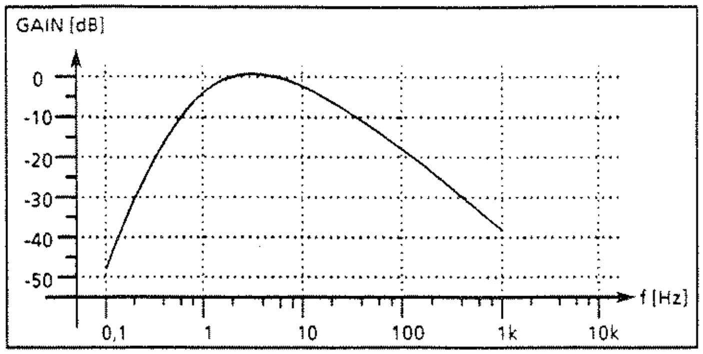


Fig. 2-31 Frequency response of weighting filter

Unit

Set the display unit (here: % only), see also 2.6.5.1 Common Parameters of Functions.

Post-FFT

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 available, 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 2.6.5.13, FFT).

Start

Stop

Display of the frequency limits of the generated spectrum. As the demodulator stage undersamples with the factor of 16, the upper limit of the spectrum is already reached with 0.0625 x 29/64 of the sample rate. Yet, resolution is enhanced by the factor of 16 (sample rate, see 2.6.1 Selecting the Analyzer).

Resolution

Display of frequency resolution.

Window

Select the window function; possible windows and their applications, see 2.6.5.13 FFT.

Theory of operation:

Test procedure:
The input signal is limited symmetrically with respect to the test frequency (= 3 kHz with NAB and JIS, = 3.15 kHz with DIN) using a bandpass (pass-band width 1000 Hz, attenuation 80 dB, Bessel-characteristics) and is subsequently FM-demodulated. The demodulator output is sampled with 1/16th of the original sample rate and stored for a Post-FFT. A higher sample 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.

2.6.5.12 POLARITY (Reversed Polarity Test)

Available for all six 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 2.5.4.13) and apply the generator test signal ($SINE^2$ BURST signal) to the DUT. The analyzer weights the polarity of the DUT output signal:

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

The signal can also be applied externally to the DUT, provided that a suitable $SINE^2$ BURST signal is used.

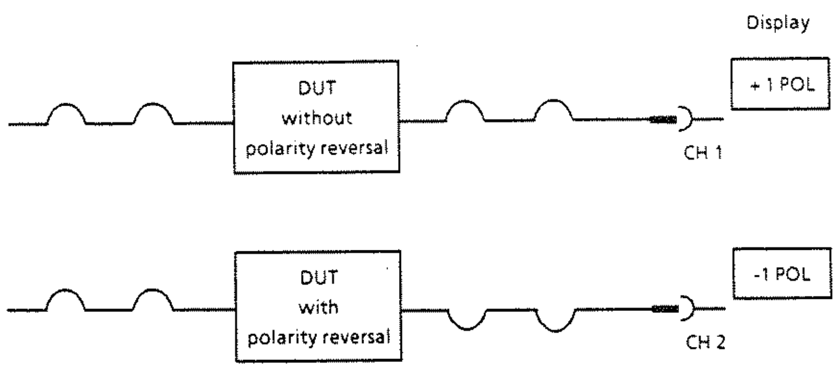


Fig. 2-32

2.6.5.13 FFT (Spectrum)

FUNCTION

FFT

Spectrum display of the unfiltered input signal, transforming into the frequency range being effected by way of the so-called fast Fourier transform (= FFT). With the GRAPH panel switched on, the graphical display is in line with the parameters set in the DISPLAY panel.

Important:

The spectrum display is absolutely independent of the set measurement range and the zoomed zone. With ill-suited settings in both panels, a result may be outside the visible range on the screen (see also 2.10 Graphical Data Presentation).

Note: *Spectrum display of a filtered input signal is possible by way of menu item POST FFT of the function RMS & S/N.*

ANLG Notch

(see 2.6.5.1 Common Parameters of Functions)

FFT Size

256
512
1024
2048
4096
8192

FFT size, settable from 256 to 8192 in binary steps. 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 SIZE and ZOOM is given in the following table:

Table 2-26

	Displayable lines with	
FFT size	ZOOM OFF	ZOOM ON
256	116	232
512	232	464
1024	464	928
2048	928	1856
4096	1856	3712
8192	3712	7424

Note: *With ANLG 100kHZ, 300kHz and DIG 192kHz as well as DIG 768kHz with (→Zooming) ON, 8192 is possible only.*

Zooming

OFF

"Normal" FFT, frequency range from 0 to range limit, which is 29/64 x sample rate. For the sample rates of the individual instruments, refer to 2.6.1 Selecting the Analyzer.
Example: with ANLG25 and DIG48: 0 Hz to 21750 Hz.

ON (2...256)

Zoom the frequency range by one 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 256. 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)
Display of the zoom factor.

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.

Exponential

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

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

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 or k.

Start

(Read only)
Display of the lower measurement limit:
with normal FFT: 0 Hz
with ZOOM-FFT: 0 Hz or CENTER - SPAN / 2 (the higher of)

Stop

(Read only)
Display of the upper measurement limit
with normal FFT: 29 / 64 of the sample rate
with ZOOM-FFT: 29 / 64 of the sample rate or CENTER + SPAN / 2 (the lower of)

Note: With the analyzers ANLG 100 and ANLG 300, the antialiasing filters are already effective before the upper measurement limit is reached.

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 range limits 0 or, as the case may be, 29 / 64 of the sample rate (eg 21750 Hz with ANLG25) than span / 2, FFT points exceeding the displayable zone are calculated. A setting of this kind is not useful.

Span

This menu item is displayed only with Zooming ON. You can select out of 8 (with DIG 48 and ANLG 25), 4 (with ANLG 100 and ANLG 300) or 3 (with DIG 192 and DIG 768) possible zooming zones. SPAN is the entire range displayed, except for the event that Center was selected such that part of the FFT is outside the measurement range (see Center). The selection list for span is calculated depending on the current sample rate.

Resolution

(Read only)
Spacings between the FFT lines in Hz. 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).

Meas Time

(Measurement Time)
(Read only)
Time required by the analyzer for signal recording.

Window

Settable window functions:
HANN, RECTANGULAR, BLACKMAN-H, RIFE-VINC 1, RIFE-VINC 2, RIFE-VINC 3, HAMMING, FLAT_TOP, KAISER

In system theory, the FFT treats a block of data (finite-length signal sequence) as though it is one period of a 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 one period of a periodic sequence. Window functions thus help to minimize the leakage (at the expense of resolution).

Range of applications of the windows:

HANN

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

RECTANGULAR

No window function. 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 2.5.4.11 Random, Domain = Frequency) and multi-tone (see 2.5.4.4) MULTISINE.

BLACKMAN-H

The mainlobe 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 mainlobe 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 mainlobe (which is caused only by a single sine line) is as wide as to include always two adjacent lines with approximately the same height.
Advantage: The amplitude can be precisely read from the graphics as against with other window functions.
Disadvantage: Bad frequency resolution.

KAISER

The trade-off between resolution, close interference suppression and distant interference suppression determines the selection of parameter β (from 1.5 to 20). With $\beta = 8$, selectivity is good but distant interference suppression is only about -90 dB. With $\beta = 16$, distant interference suppression is excellent, however the mainlobe is relatively wide.

Additional information on FFT:

Width of bell-shaped curve (worst case) in lines:

Table 2-27

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 is (hardly) never obtained.

Frequency measurement with FFT:

With FFT, the spectral line with the highest signal amplitude in the spectrum is entered as frequency value in the respective display field. With the exception of window = Kaiser, 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 - 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 (eg 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), an additional stage being possible with the analog instruments ANLG100 and ANLG300. Zooming up to the factor 256 is feasible when using the "slow" instruments ANLG25 and DIG48. The input signal for the FFT will be complex when shifting the input signal using a single dirac pulse. For this reason, 7424 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: DIG 48 and ANLG25: (sample rate = 48 kHz, 8192 FFT points)

Table 2-28

	max. SPAN [Hz]	max. Resolution [Hz]	Measurement time [ms]
FFT	21750	5.8593	170.67
ZOOM 2:1	21750	2.9296	341.33
ZOOM 4:1	10875	1.4648	682.67
ZOOM 8:1	5437	0.7324	1136.53
ZOOM 16:1	2718	0.3662	2273.1
ZOOM 32:1	1359	0.1831	5546.1
ZOOM 64:1	679	0.0915	10109.2
ZOOM 128:1	339	0.0457	21218.5
ZOOM 256:1	169	0.0228	43436.9

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

- Window functions:

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

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

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

Coefficients A(n):

Table 2-29

	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:

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

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

2.6.5.14 Waveform (Display in the Time Domain)

Funktion

WAVEFORM

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.

As is the case with all other functions, this function, too, is executed separately in the two channels, ie each channel triggers individually. In the graphical display, no relation with respect to time between the two channels is defined.

Triggering:

The UPD waits for the specified slope at the defined level. In case this condition does not occur within double the memory depth, automatic triggering is set off. This is indicated by "not triggered".
The trigger point is always at the beginning of the memory. The time axis of each channel is relative to the trigger point of the respective channel.

Settings:

In the ANALYZER panel only the trigger condition and the memory depth are set. Scaling of the picture (X and Y axis) is set in the DISPLAY panel (see Section 2.10).

Trig Level

Set the voltage of the trigger level.

The trigger level is a fixed setting, irrespective of the current range (which is set either fixed or using AUTO RANGE).

Range of values:	Analog instruments:	-300 V to 300 V
	Digital instruments:	-1 FS to 1 FS

Trig Slope

Set the triggering slope.

RISING

Triggering is effected when the signal crosses the trigger slope from bottom to top.

FALLING

Triggering is effected when the signal crosses the trigger slope from top to bottom.

Interpol

1
2
4
8
16
32

Selects the interpolation steps used for the display of the traced waveform.

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.

Trace Len

Specify how long the signal is to be traced.

The maximum settable Trace Len is a function of the sample rate and of the interpolation value.

Range of values: 1µs to max. Trace Len

The following is true:

$$\text{max. Trace Len} = \frac{7424}{\text{sample rate} * \text{Interpol}}$$

Examples: Sample rate = 48 kHz, Interpol = 1:
Trace Len = 150 ms
Sample rate = 44.1 kHz, Interpol = 4:
Trace Len = 42 ms

2.6.5.15 INPUT

Available for all six analyzers.

INPUT

OFF	Input display switched off
PEAK	Display of the input peak value as a numeric value
BITS	For the digital instruments, a bit activity display of the input peak value can be set as a bit pattern in the result window. This display is suitable for troubleshooting at digital interfaces.

INput → PEAK

In the **digital analyzers,** 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 100 kHz	with	341.3 kHz
ANLG 300 kHz	with	1024 kHz

Input peak measurements mainly serve for checking the maximum input, indicating the peak values of the input signal before the filters.

Exception: With the analog notch filter set in the analog functions RMS, QPEAK or FFT, the input peak value is detected after the notch filter.

The maximum value of these sampled signals is indicated within a monitoring time, which depends on the measurement rate, the selected function and the lower measurement frequency of the selected analyzer.

Note: *In the case of an AC measurement with DC coupling carried out in the analyzer ANLG 22 kHz (Min Freq 2 Hz), the highest AC voltage peak is always indicated. DC control is not considered.*

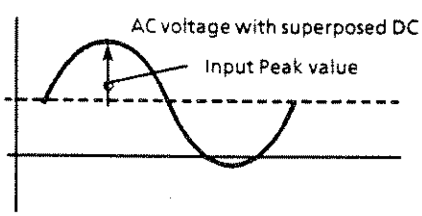


Fig. 2-33

Unit Ch1/2

Reference

(see 2.6.5.1 Common Parameters of Functions)

Input → BITS:

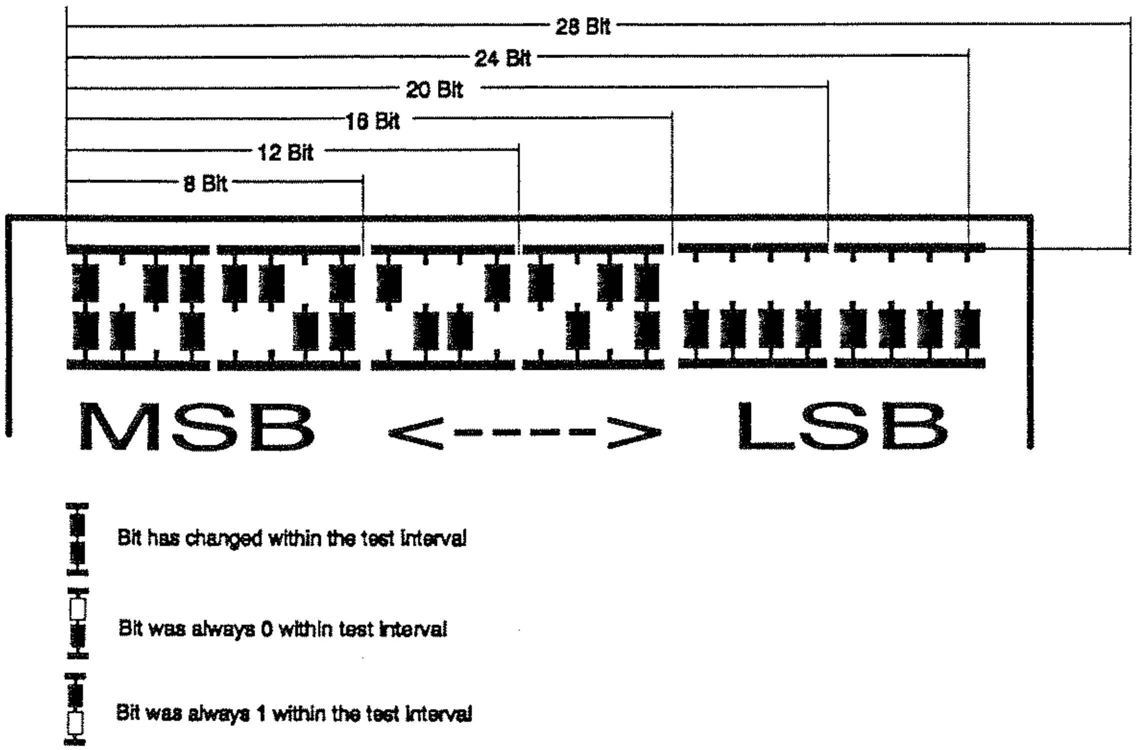


Fig. 2-32.1 Bit activity display

The bit sequence whose bit width can be set using parameter "Audio Bits" in the analyzer panel is always displayed left-justified. In the case of a display of more than 24 bits, the least significant bits are not displayed. In the case of a display of less than 24 bits, the bits right of the bit limit are always displayed as 0. The above example shows the display for setting Audio Bits 16".
Bits not changing due to a hardware error can be easily determined.
The bit activity display is not available for IEC bus operation.

2.6.5.16 Frequency and Phase Measurement

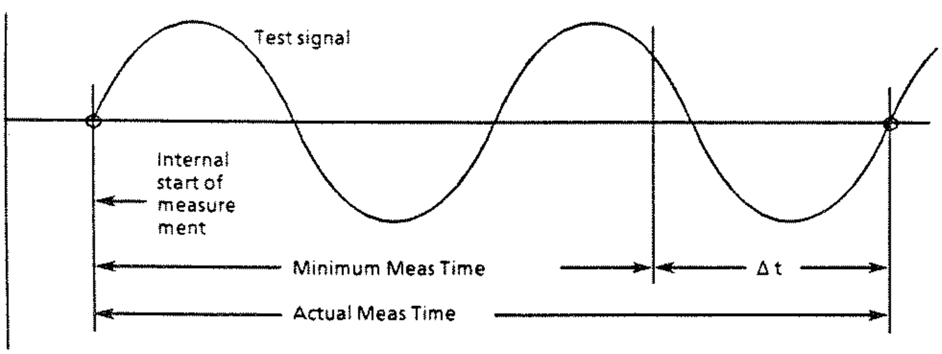
Frequency measurement

Table 2-30 Frequency measurement

Instrument	Functions in combination with frequency measurement													
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD + N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simulation
ANLG 22 kHz	√	√	√	√	-	√	√	≈	≈	≈	√	√	-	√
ANLG 100 kHz	√	√	√	-	-	√	√	≈	≈	≈	-	√	-	√
ANLG 300 kHz	√	√	√	-	-	√	√	≈	≈	≈	-	√	-	√
DIG 48 kHz	√	-	-	-	-	√	√	-	-	-	-	√	-	-
DIG 192 kHz	√	-	-	-	-	√	√	-	-	-	-	√	-	-
DIG 768 kHz	√	-	-	-	-	√	√	-	-	-	-	√	-	-

√ valid measurement result
- no measurement result (Display "-----")
≈ measurement result is only conditionally true since the input signal is a frequency mixture.

For frequency measurements, a minimum measuring time can be selected using the "Meas Time" command. The measurement begins with a rising zero crossing of the signal and ends after a time resulting from the minimum measuring time and the time until the next rising zero crossing of the signal occurs. Thus, only integer multiples of the signal period are measured.
After having processed the control signal levels, frequency and phase measurements are, with the analog analyzers, always performed as broadband measurements without filtering (3-dB measuring bandwidth about 500 kHz).



Δ t = time until the next rising zero crossing occurs

Fig. 2-34

Meas Time	Minimum measurement time for frequency measurement
SUPERFAST	50 ms
FAST	200 ms
SLOW	1000 ms
VALUE 1.0000 s	Numerical entry. Range of values: 1 ms to 1.6 s Units: s, ms, µs

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

Ref Freq (see 2.6.5.1 Common Parameters of Functions)

Combined frequency/phase measurement

For analog instruments in two-channel mode only (channel(s): 1 & 2 ¦ 2 ≡ 1 ¦1 ≡ 2, see 2.6.1)

Table 2-31 Availability of phase measurement

Instrument	Functions in combination with phase measurement													
	RMS	RMSsel	PEAK	QPEAK	DC	THD	THD + N	MOD DIST	DIM	DFD	Wow&F	FFT	Polarity	Filter simulation
ANLG 22 kHz	√	√	√	√	-	√	√	≈	≈	≈	√	√	-	√
ANLG 100 kHz	√	√	√	-	-	√	√	≈	-	≈	-	√	-	√
ANLG 300 kHz	√	√	√	-	-	√	√	≈	-	≈	-	√	-	√

√ valid measurement result
- no measurement result (Display "-----")
≈ measurement result is only conditionally true since the input signal is a frequency mixture.

In phase measurements, the phase difference between the signals of channel 2 and 1 is determined.

The signal of channel 1 serves as reference signal.

The phase can be measured between

- equally configured inputs, eg
  Channel 2 UNBAL (BNC) → Channel 1 UNBAL (BNC) or
  Channel 2 BAL (XLR) → Channel 1 BAL (XLR)
- Differently configured inputs, eg
  Channel 2 UNBAL (BNC) → Channel 1 BAL (XLR)
  Channel 2 BAL (XLR) → Channel 1 UNBAL (BNC)

Important:
In phase measurements with

- unbalanced input (BNC), the phase reference point is the external conductor of the BNC female.
- balanced input (XLR), the phase reference point is the XLR connecting point 3.

(See 2.6.2 Configuration of the Analog Analyzers)

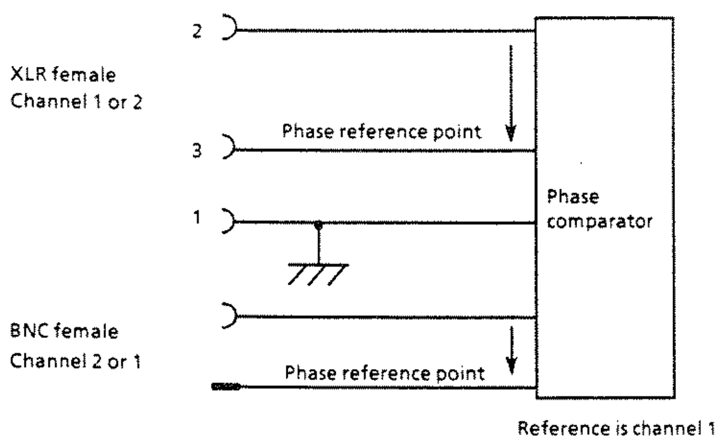


Fig. 2-35

Meas Time (See Frequency Measurement)

Unit Ch1/2 (See 2.6.5.1 Common Parameters of Functions)

Ref Freq (See 2.6.5.1 Common Parameters of Functions)

Format Pha Format phase

0 ... 360 °
-180 ... + 180 °
0 ... 2 π
-π.... + π

Displayed range of phase

Ref Phase (See 2.6.5.1 Common Parameters of Functions)

2.6.6 Monitor Output

Available for the three analog analyzers, only.

Theory of operation

The input signal is applied from the input level stage via a low-distortion level attenuator to the monitor outputs (UPD rear panel, see Fig. 2-2, No. 9), which are primarily provided for the connection of headphones.

The monitor outputs are AC coupled.
When the channel(s) are switched off, 0 V is applied to the corresponding monitor output(s).

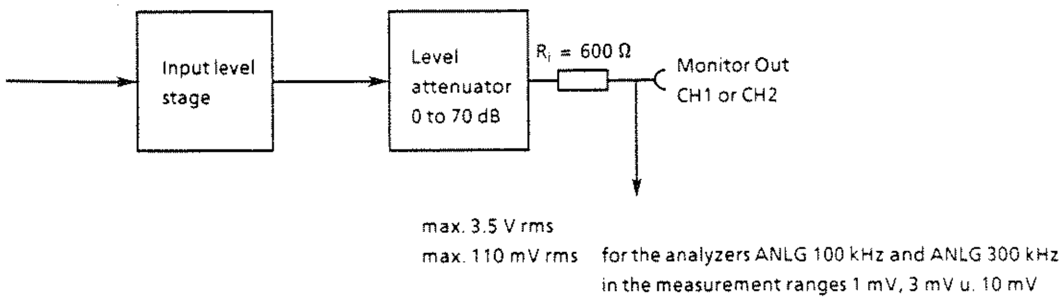


Fig. 2-36

ANALYZER Panel

Monitor — Monitor output

ON

OFF

Attenuation — Level attenuation from 0 to 70 dB (highest attenuation = 70 dB).
Unit in dB only.

2.7 Analyzer Filters (FILTER Panel)

The FILTER panel has been devised for definition of the filters which can then be used in the ANALYZER panel. Before you can select a user-definable filter in the analyzer, you must, of course, create it in the FILTER panel.

Activating the FILTER panel:	UPD front-panel:	Press the FILTER key
	Keyboard:	ALT + T

Filter

For the functions

- RMS & S/N (rms measurement) → 4 filters possible
- PEAK & S/N (peak measurement), → 3 filters possible
- Q-PK & S/N (quasi-peak meas.) → 3 filters possible
- FILTSIM (filter simulation) → 4 filters possible

any desired filters from the filter selection window can be set in the ANALYZER panel. This window contains user-definable filters (the first 9) and weighting filters, which are referred to by their short names in the FILTER panel or by a name complying to the standard. You can select any desired filter (also several times) and assign to the ANALYZER measurement function.

The sum frequency response of all selected filters can be graphically displayed using the analyzer function FILTSIM (see 2.6.5.16).

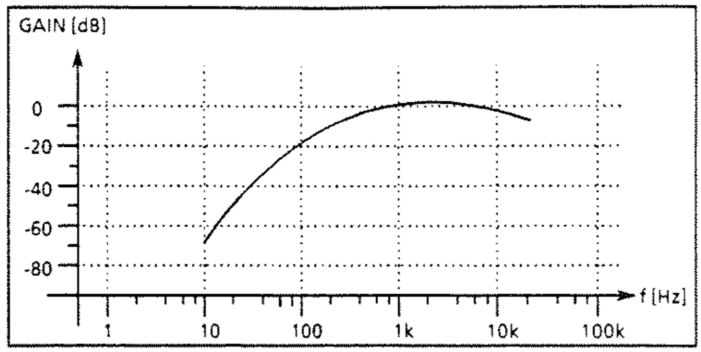
2.7.1 Weighting Filters

The user-definable filters in the UPD (see 2.7.2 Creating User-definable Filters) are complemented by 12 pre-defined weighting filters, which are automatically matched to the current sample rate. Due to the digital realization, the frequency response absolutely complies with the standard. With a very small sample rate (eg 32 kHz in the DIG48 instrument), some sections of the filter functions are close to the measurement range limit, resulting in distortions in these sections (with eg a sample rate of 32 kHz, distortions may occur in the range over 13.5 kHz). Yet, the filter is still within the permissible tolerances. For this reason, it is not possible to set weighting filters in combination with sample rates smaller than 30 kHz.

Filter: A Weighting

Standard(s): DIN 45412

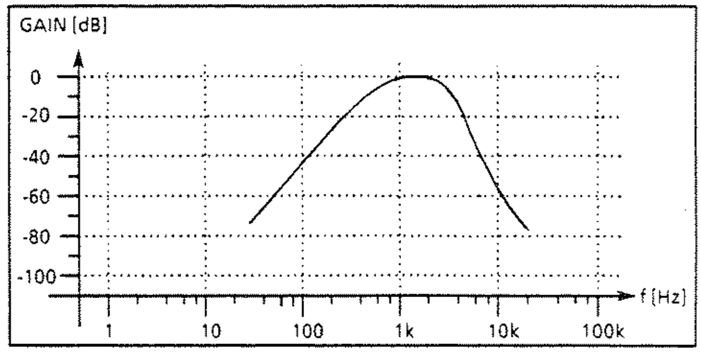
Application: Weighting for disturbing voltage measurements



Filter: C Message

Standard(s): IEEE 743-84

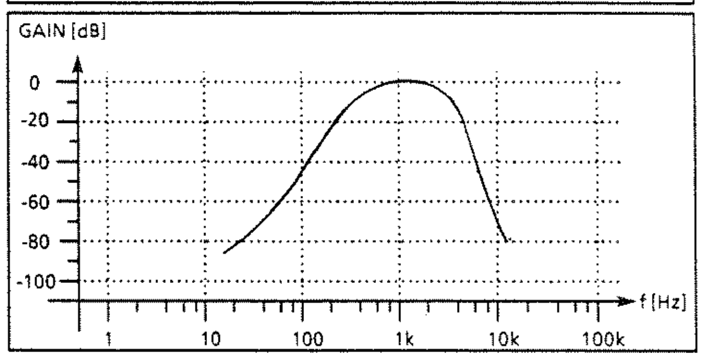
Application: Transmission measurements



Filter: Filter: CCITT 0.41

Standard(s): CCITT 0.41
IEEE Rec. 743-84
CISPR 6-76
CCITT Rec. P.53

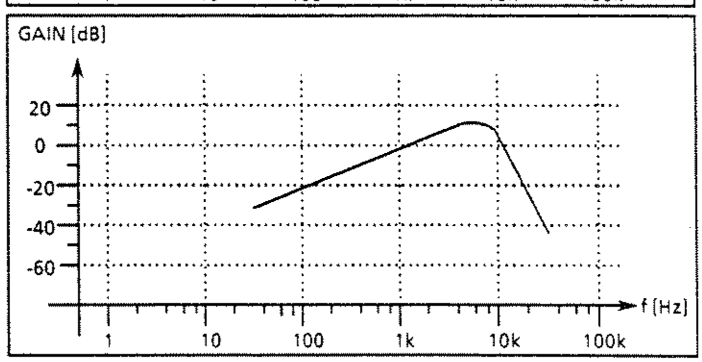
Application: Psophometric measurements



Filter: CCIR 468-4

Standard(s): CCIR Rec. 468-4
DIN 45405
CCITT Rec. N21
CISPR 6-76

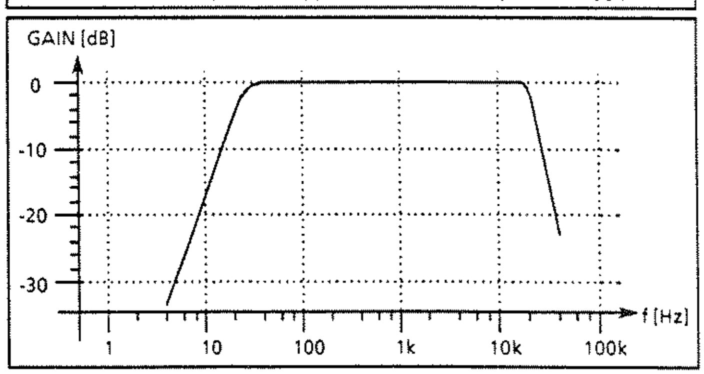
Application: Weighting for disturbing voltage measurements



Filter: CCIR unwtg

Standard(s): CCIR Rec. 468-4

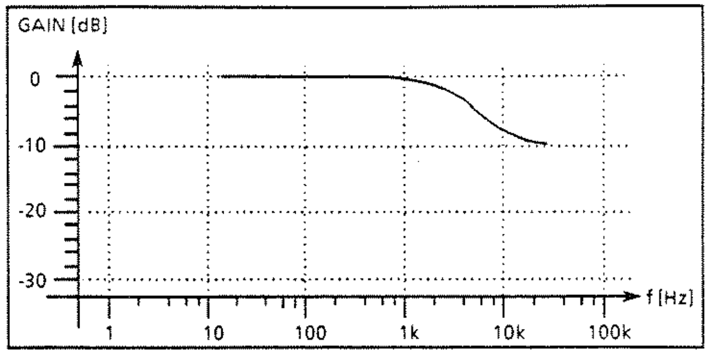
Application: Bandpass from 20 Hz to 20 kHz for band-limited, unweighted measurements to CCIR



Filter: DEEM 50/15

Standard(s): CCIR Rec. 651

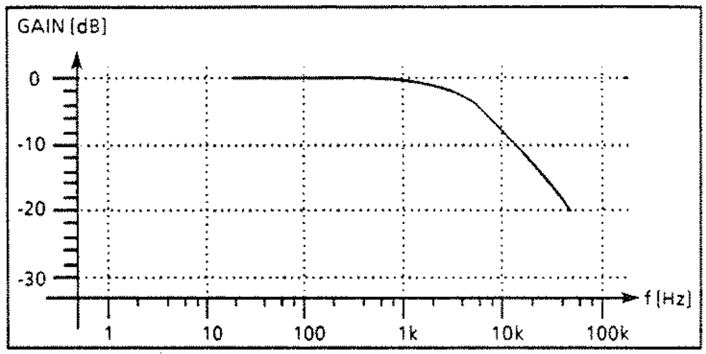
Application: Compact discs



Filter: Deemph 50

Standard(s): ARD Spec. 5/3.1

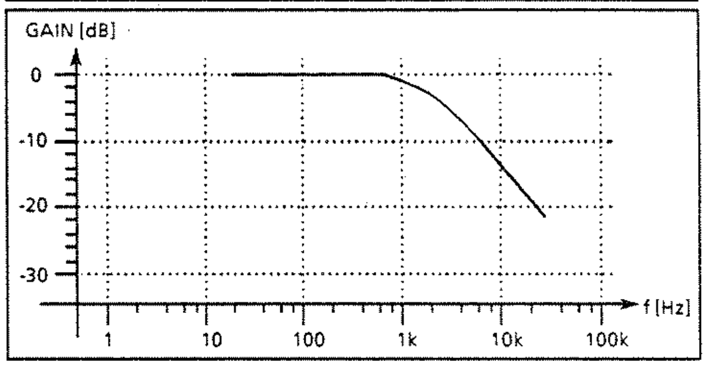
Application: Interference and noise voltage measurements to DIN 45405



Filter: Deemph 75

Standard(s): ARD Spec. 5/3.1

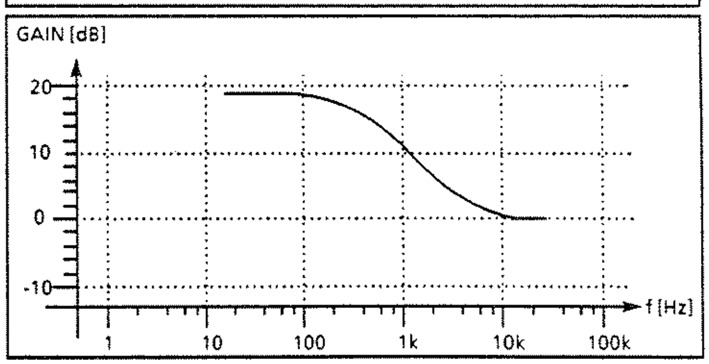
Application: Interference and noise voltage measurements to DIN 45405



Filter: Deemph J.17

Standard(s): CCITT J.17

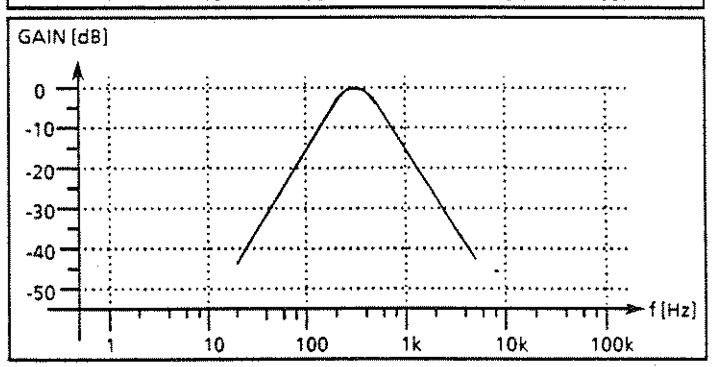
Application: Interference and noise voltage measurements to DIN 45405



Filter: Rumble wtg

Standard(s): DIN 45539

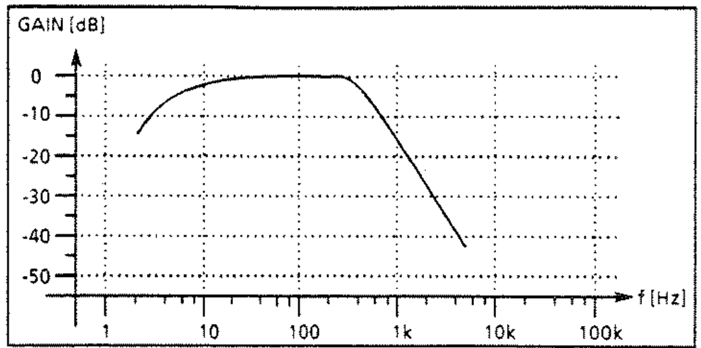
Application: Testing of record players
Noise voltage measurements



Filter: Rumble unwtg

Standard(s): DIN 368.3
DIN 45539

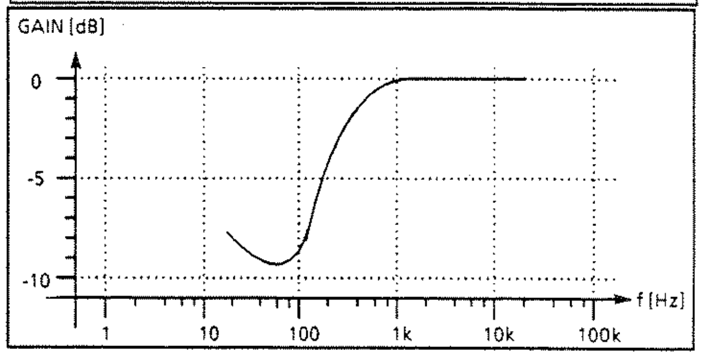
Application: Testing of record players
Interference voltage measurements



Filter: DC noise HP

Standard(s): ARD Spec. 3/4
ARD Spec. 12/2

Application: Highpass for DC noise measurements



2.7.2 Creating the User-definable Filters

The FILTER panel is made up of 9 filter items designated as FILTER 01 ... FILTER 09. Each filter item can be assigned a filter type LOW-PASS, HIGH-PASS, BAND-PASS, BAND-STOP, NOTCH, 1/3 OCT FLT, OCTAVE FLT, FILE-DEF, which are referred to below. Each filter type is predefined by its cutoff frequencies and the desired filter attenuation. After the filter has been calculated, further filter data (settling time, actual attenuation, stopband range, which are displayed in a different color) are available in the FILTER panel.

There is also the possibility of reading in any desired filter by selecting "FILE DEF".

Any filter defined in the FILTER panel is provided with a short name, which is then used to call the filter in the ANALYZER panel. The short name refers to type and cutoff frequency of the filter.

The filters have been implemented as recursive filters (= IIR filters) with 8 poles.

The filters are defined in terms of their frequency limits, which is why the contents of the FILTER panel is independent of the selected ANALYZER instrument ANLG 25 kHz to DIG 768 kHz. Filter parameters which used to make sense for a certain instrument may be futile in combination with another instrument.

Example:
A lowpass with a cutoff frequency of 50 kHz is a commonly used filter with the ANALYZER instrument DIG 768kHz, however ineffective in the instrument DIG 48kHz.

For this reason, proceed in the following order when setting the filters:

1. Switch all filters in the ANALYZER panel off:
   Enter any desired filter parameters in the FILTER panel. The filter parameters are neither checked nor updated.

2. In the ANALYZER panel, select a filter from the FILTER panel: now, the parameters of the filters are checked:
   a) Valid filter parameters: filter is set
   b) Invalid filter parameters: error message on the screen, filter remains OFF

3. Try to modify in the FILTER panel filter parameters of a filter selected in the ANALYZER panel:
   A dialog window appears where you can enter the new filter parameters. When you press the O.K. key in the dialog window the filter parameters are checked.
   a) Valid filter parameters: filter is set
   b) Invalid filter parameters: error message on the screen, the dialog window remains open for further entry of filter parameters.

Exiting the filter dialog window using CANCEL or ESC causes

- the filter in the ANALYZER panel to be switched OFF.
- the most recently valid filter parameters to remain unchanged in the FILTER panel.

Note: *A type of filter can be repeatedly assigned with the same or different filter parameters to the 9 filter items!*
The sum frequency response of the set filters can be displayed with the help of the simulation (see FILTSIM function).
You can select the filters in the ANALYZER panel in any desired order. For reasons of stability, it is however useful to select the filter with the "hardest" characteristics (eg very narrow bandstop filters) as the last one (below in the panel).
It is possible to superpose several filters of the same type and with equal filter parameters for one measurement function. To give an example, a very steep 80-dB lowpass (in this case, with 16 poles, yet double ripple in the passband range) can be realized by superposing two 40-dB lowpasses.

2.7.2.1 Common Parameters of All Filters

Atten

(= Attenuation). Specify the desired filter attenuation in dB (example: 40 dB). After the filter has been checked and set, the actually realized attenuation (usually higher) is entered. Filter attenuations can be implemented about every 10 dB.
Exception: The filter calculation file (see 2.7.2.6, Internal Calculation of Filters) has been modified.

Delay

(Read only)
Enter the estimated settling time of the filter in seconds.
This value is updated only when the filter is checked.

Shortname

(Read only)
Specify a short name later used to call the filter in the ANALYZER panel. The short name is made up of an abbreviation (2 letters) for the filter type and the frequency (LP = lowpass, HP = highpass, BP = bandpass, BS = bandstop, TZ = terz filter, OC = octave filter, NO = notch filter). The frequency value is updated only when the filter is checked.

2.7.2.2 Lowpass / Highpass

Filter

LOW PASS

HIGH PASS

Select a lowpass or highpass.

Passband

Specify the cutoff frequency of the passband range.

Stopband

(Read only). Display of the cutoff frequency of the stopband range, which is determined by the selected attenuation and passband range. This value is updated only when the filter is checked.

The base filters used have eight poles, 'elliptic C'-type to /SAAL 88/ with a ripple of 0.1 dB in the passband range.

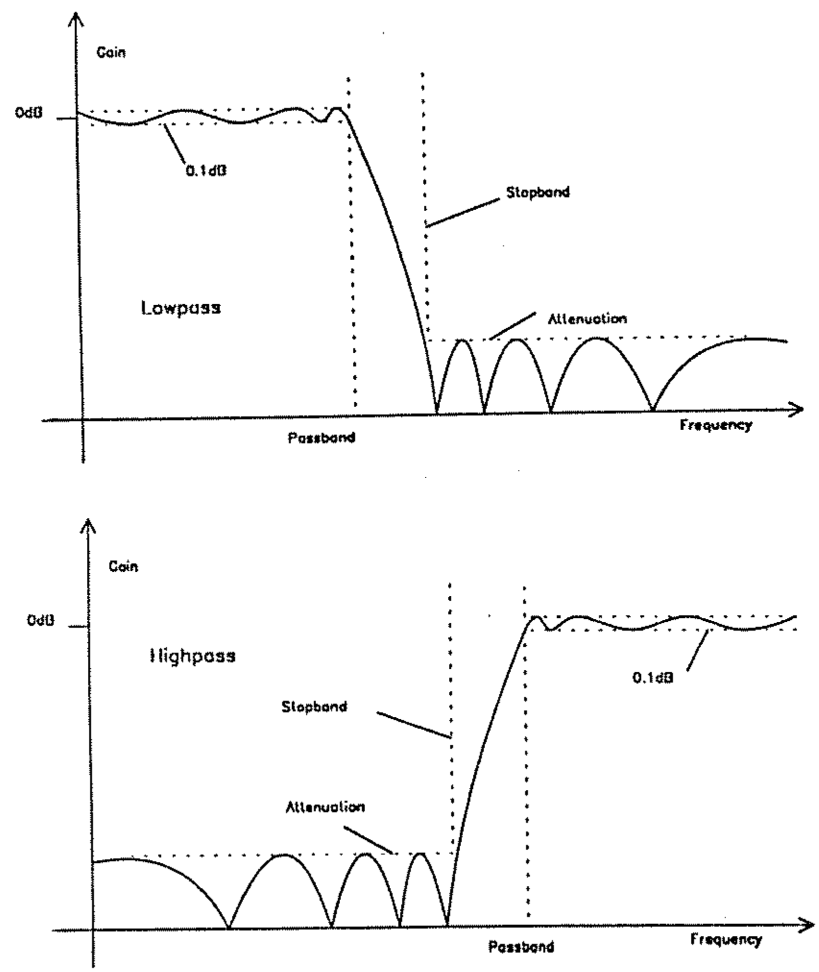


Fig. 2-37 LOW-PASS and HIGH-PASS frequency response together with filter parameters

2.7.2.3 Bandpass / Bandstop

Filter

- BAND-PASS
- BAND-STOP

Passbd low	Enter the lower cutoff frequency of the passband range.
Passbd upp	Enter the upper cutoff frequency of the passband range.
Stopbd low	(Read only) Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.
Stopbd upp	(Read only) Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

The base filters used have 4 poles, 'elliptic C'-type to /SAAL 88/ where one base filter is used for the upper and one for the lower filter edge. As 'elliptic C' has a pole at infinity, a bandstop of this type features a pole in the center between the two passband frequencies.

Values for Passbd low and Passbd upp which are close to each other cause long settling times during realization and the danger of limit cycles (oscillations of the filter on account of self-excitation induced by rounding noise). In this case, it is useful to simulate the filters before the measurement (see analyzer function FILTSIM).

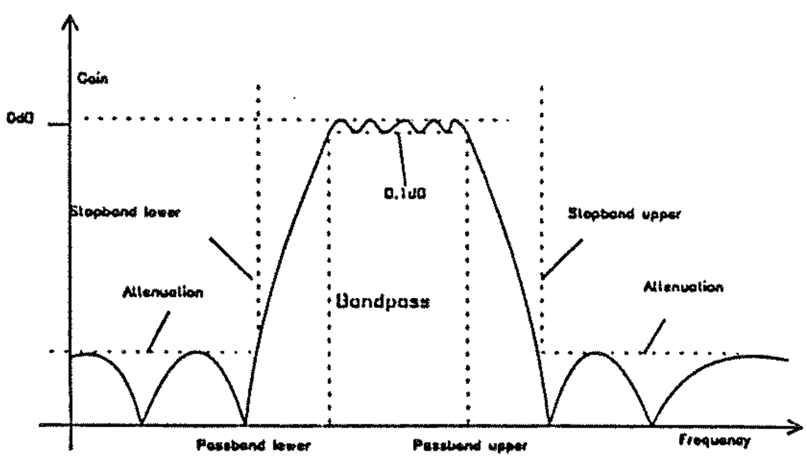


Fig. 2-38 BAND-PASS and BAND-STOP frequency response together with filter parameters

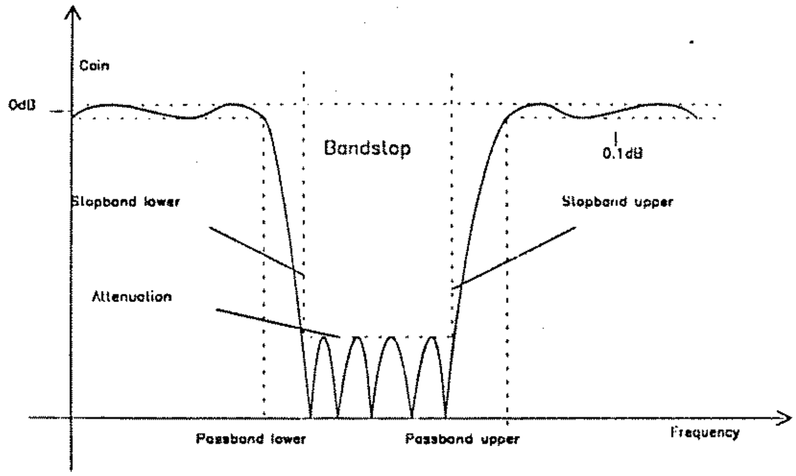


Fig. 2-39 BAND-STOP frequency response together with filter parameters

2.7.2.4 Notch

Filter

NOTCH

Center Freq — Enter the center frequency of the bandstop.

Width — Enter the difference between upper and lower cutoff frequency of the passband range.

Stopbd low — (Read only)
Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

Stopbd upp — (Read only)
Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

The base filters used have 4 poles, 'elliptic C'-type to /SAAL 88/ where one base filter is used for the upper and one for the lower filter edge. As 'elliptic C' has a pole at infinity, a bandstop of this type features an attenuation pole at the center frequency.
Use:
Attenuation of single frequencies in the signal.

Small values for "width" cause long settling times during realization and the danger of limit cycles (oscillations of the filter on account of self-excitation induced by rounding noise). In this case, it is useful to simulate the filters before the measurement (see analyzer function FILTSIM).

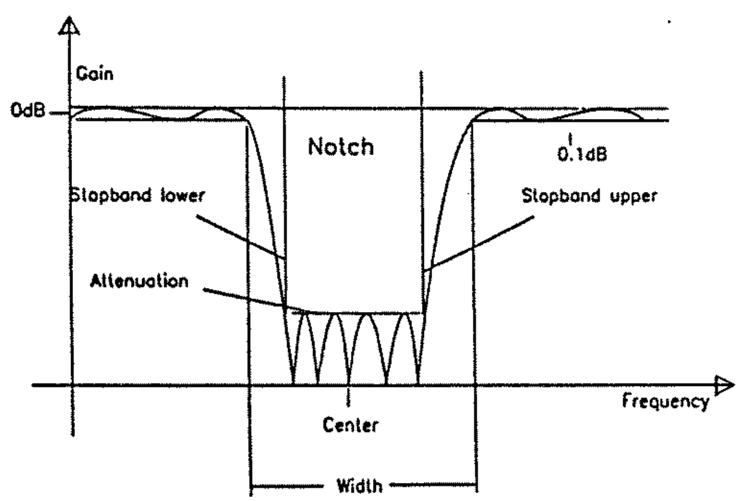


Fig. 2-40 Notch filter frequency response together with filter parameters

2.7.2.5 Third-octave / Octave

FILTER	
1/3 OCT FLT	(1/3 OCT FLT = 1/3 Octave)
OCTAVE FLT	
Center-Freq	Enter the center frequency of the bandstop.
Width	(Read only) Enter the difference between upper and lower cutoff frequency of the passband range.
Stopbd. low	(Read only) Display of the lower cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.
Stopbd. upp	(Read only) Display of the upper cutoff frequency of the stopband range, which is determined by the selection of attenuation and passband range. This value is updated only when the filter is checked.

These filters have been implemented as bandpasses (see 2.7.2.3 Bandpass / Bandstop) which are geometrically symmetrical to the center frequency, thus allowing the passband cutoff frequencies to be calculated from the center frequency::

$^1/_3$ octave filter:	Passbd low	= Center Freq	/	1.12246
	Passbd upp	= Center Freq	×	1.12246
Octave filter:	Passbd low	= Center Freq	/	1.41421
	Passbd upp	= Center Freq	×	1.41421

2.7.2.6 Internal Calculation of Filters

All filter parameters are transformed from the Z range (digital, sampled) to the S range (analog, continuous) using the sample rate valid for the respective instrument. In the S range, the filter parameters are normalized to a passband limit of 1.0. The filter suitable for this transformed filter with respect to the type and minimum desired attenuation is searched for in the filter data base. This filter is then denormalized and retransformed while the actual stopband and actual attenuation are being calculated.
This transformation is performed with the currently effective sample rate. The predefined cutoff frequencies are maintained, however different stopband frequencies will be obtained (depending on the selected sample rate). When the sample rate on which the calculation is based does not match the actual clock rate (e.g. in the case of a wrong entry), both passband frequency and stopband frequency are shifted.
After the start of the measurement (e.g. through a new setting, pressing of the START key or in the case of SWEEP), UPD waits for a certain settling time per filter before the actual signal integration. This settling time is calculated on the basis of the desired attenuation and the filter coefficients. If (in exceptional cases) the time calculated is too small, the filters have not completely settled at the start of the measurement. To remedy this, the following trick is possible:
If the FILE_DEF filter "DELAY.COE" is selected, a settling time can be entered there which is considered in addition to the normal settling time in the measurement. Filter DELAY.COE has no function otherwise.

The filter data base is filled with the filters in the 'ref_lp.rlp' file in the C:\UPD\REF directory on start of the system software.

The filters contained in this file are derived from /SAAL 88/. Their ripple in the passband range is 0.1 dB.

2.7.2.7 File-defined Filter ("FILE-DEF")

For applications requiring additional filters which are not offered by the instrument, any desired filter can be read in from a file. The filter in the file must be an IIR filter with 8 poles/zeros. The filter must be designed (in the Z range, ie digital, sampled) with reference to the sample rate used in the respective ANALYZER instrument. Two data formats are supported:

a) Coefficient output file of FDAS, version 2.1 and 2.2. FDAS is a filter design program from the company of Momentum Data Systems. Select a cascade of biquads with 32-bit float number representation as implementation for generation of the filter with the help of FDAS.

   Example: see R&S_EXAM.COE file in the C:\UPD\USER directory

b) ASCII file where the poles and zeros (in the Z level) must be entered as floating numbers. 8 poles and zero positions (4 pairs) only are permissible. Unused poles and zeros must be shifted to the origin of the Z level.

   File format:

1st line:	Identification: 'pole zero file'
2nd line:	Key word 'gain' followed by a float number: specification of filter gain
following lines:	Key word 'pole' or 'zero' followed by real and imaginary part. Complex conjugate pairs must be consecutive and be at the 1st, 3rd, 5th or 7th position, respectively.

The transfer function is given by:

$$S(z) = gain * \frac{\Pi\,(z - z_0(i)) * (z - z_0(i+1))}{\Pi\,(z - z_p(i)) * (z - z_p(i+1))}$$

where S(z) is the normalized transfer function, z_0 are zeros and z_p are poles.

The filter should be checked using the simulation.

Comment lines are to begin with '#' and are permissible anywhere; no difference is made between upper-case and lower-case letters.

Example: see EXAMPLE.ZPZ file in the C:\UPD\USER directory

Literature:
/SAAL88/: Rudolf Saal, Handbook of Filter Design, 2nd edition, Hüthig 1988

2.8 STATUS Panel

Activating the STATUS panel:

UPD front panel: STATUS
External keyboard: ALT + S

The STATUS panel can be activated only in part-screen graphics mode (see 2.10.8 Switching between Full-screen and Part-screen Mode) and is always on the left side of the screen.

The STATUS panel displays only those command lines of a panel which have been ticked (select the position before the line using the tab ← keys, press SELECT, the tick is switched on and off (toggle function). The UPD thus offers the possibility of displaying a clearly structured excerpt from all settings on the left side of the screen.

Instead of using the other panels, the UPD can also be operated from the STATUS panel, allowing you to carry out constantly recurring operator sequences from one panel only. Use of the STATUS panel is especially advantageous for display and, if required, printout (see 2.14) of graphics on the right side together with the essential UPD settings on the left side of the screen.

Empty STATUS panel.
No command lines have
been ticked off.

```
STATUS
No commands selected!

Only commands which are
ticked off appear in
the STATUS-Panel.


For further information
press HELP!
```

Command lines in the GENERATOR,
ANALYZER und DISPLAY panel
have been ticked off.

```
STATUS
— GENERATOR PANEL —
√Channel (s)   1
√Output        UNBAL BNC
√FUNCTION  -   SINE
√FREQUENCY     10.000 Hz
√VOLTAGE       3.0000 V
— ANALYZER PANEL —
√Channel (s)   1
√CH1 Input     UNBAL BNC
√FUNCTION  -   RMS & S/N
√Meas Time     AUTO  FAST

— DISPLAY PANEL —
√ OPERATION    BARGRAPH
√ Unit         V
√ Spacing      LIN
```

Fig. 2-41

2.9 FILE Panel

The FILE panel is activated by pressing the FILE key (UPD front panel) or the key combination "ALT F" (external keyboard). The FILE panel is always displayed on the left side of the screen.

2.9.1 Loading and Storing

Files can be stored to hard disk (drive "C:") or diskette (drive "A:", can also be addressed as "B:"). All system files, and per default the user files too, are available on hard disk. The user files can also be written to or read from diskette.

UPD system software updates are also loaded from diskette (see 1.3, Software Re-installation). For storing files on diskette, DOS- formatted 3.5" diskettes are required. Unformatted diskettes can be formatted on operating system level using the command

FORMAT A:

An external keyboard is required for this purpose.

Insert the diskettes with the metal slider pointing to the front and the label facing you. The diskette is ejected by pressing the eject key.

On the left side of the diskette, there is a lockable write protection; the disk is write-protected when the hole is free.

The individual types of files are characterized by reserved file types (file extensions), which are listed in the table below. It also provides information on where, ie in which panel, the file is loaded.

Table 2-32

Extension	Meaning
.AES	Report information AES/EBU + S/P DIF
.BAT	Batch file for automatic execution of several programs; reserved (DOS)
.BPZ	Binary file with poles-zeros
.CAL	Calibration file; reserved for calibration factors
.COE	Coefficient file for filters (see 2.7.2.7)
.COM	Executable programs; (eg BIOSW.COM); reserved (DOS)
.DWL	Dwell time for automatic generator sweeps: loaded in the GENERATOR panel, menu item "Dwell List"
.ERR	Error file for exceedings of the limits loaded in the DISPLAY panel by selecting Trace A/B→FILE; OPERATION→LIM REPORT;

Extension	Meaning
.EXE	Executable programs; (eg UPD__UI.EXE); reserved (DOS)
.FTF	Amplitude/Frequency table for generation of noise in the frequency domain (see 2.5.4.11)
.GL	Screen Copy (HPGL format) is generated in the UPD for subsequent output to a HPGL printer
.HLP	Help file
.LLW	Limit curve (LOWER) loaded in the DISPLAY panel under the heading LIMIT CHECK, "Lim, Lower" menu item "File name"
.LUP	Limit curve (UPPER) loaded in the DISPLAY panel under the heading LIMIT CHECK, "Lim, Upper" menu item "File name"
.NPZ	reserved for filters
.NRM	Normalization file reserved for filters
.OUT	DSP files reserved for programs to be down-loaded to the DSPs
.PAC	Report analysis (AES/EBU, SP DIF), screen control file for channel status data
.PAU	Report analysis (AES/EBU, SP DIF), screen control file for channel status data
.PCX	Screen Copy (pixel format) generated in the UPD for later editing and output to a printer
.PGC	Report generation (AES/EBU, SP DIF), user data, file for channel status data
.PGU	Report generation (AES/EBU, SP DIF), user data, file for channel status data
.PPC	Report generation (AES/EBU, SP DIF), user data, file for definable report panel
.RLP	Reference lowpass (reserved for filters, see 2.7.2.7)
.SCO	Setup; loaded in the FILE panel under the heading LOAD INSTRUMENT, menu item Mode→ACT SETUP
.SPV	Sweep list for generator voltage loaded in the GENERATOR panel, menu item "VOLTAGE" or "TOTAL VOLT" (depending on the function) for X- or Z-axis sweep
.SPF	Sweep list for frequency of the generator or selective rms measurement; loaded in the GENERATOR panel, menu item "FREQUENCY", "MEAN FREQ" or in the ANALYZER panel, menu item "File name" for X- or Z-axis sweep
.SPO	Sweep list for burst duration loaded in the GENERATOR panel, menu item "ON-TIME" for X- or Z-axis sweep
.SPI	Sweep list for burst interval loaded in the GENERATOR panel, menu item "INTERVAL" for X- or Z-axis sweep
.TRC	Trace lists for recording of measured values loaded in the DISPLAY panel by selecting Trace A/B→FILE; OPERATION→CURVE PLOT;
.TTF	Time table for generation of arbitrary signals (see 2.5.4.12)
.VEQ	Equalizer file loaded in the GENERATOR panel, menu item "Equal File"
.ZPZ	Pole-zero file reserved for filters

Note: *Reserved files must not be changed or renamed.*

2.9.1.1 Loading and Storing of Default Setups and Complete Setups

Setups are loaded and stored by entering a file name in menu item "File name". If the desired file name is already in the menu line, you simply have to open and close the appertaining selection box. (see 2.3.2 Data Entry).

LOAD INSTR	(Load Instrument) Load an instrument setup
STORE INST	(Store Instrument) Store an instrument setup
Mode	Select what is to be loaded or stored.
COMPL SETUP	(Complete Setup) Complete instrument setup is to be loaded / stored. It includes all latent (ie currently not active) functions and instruments. A file occupies about 60 Kbytes of mass storage.
DEF SETUP	(Default setup) For loading only; Rohde&Schwarz default setup is to be loaded. It includes all latent (ie currently not active) functions and instruments. We advise against modifying this setup, however it is possible to do so: overwrite the "UPDDEF.SCO" file by a setup stored in the "COMPL SETUP" mode.

When loading a new instrument setup, the former setting is overwritten. All lists (equalizer, limits, etc.) are filled with files the names of which are contained in the new setup. If a file cannot be loaded (eg the specified equalizer file has been cleared in the meantime), an error message is generated and the cause of trouble is entered into the menu line as file name.

On loading of the new setup, generator and analyzer are started.

Note: *When loading setups, their file names may not exist (eg because they have been deleted in the meantime or the setup has been adopted from another UPD). In such cases, the cause of error (usually "not found") is stated below the respective entry (eg "File name").*

Attrib

(Attributes)
For storing only.

READ ONLY

The stored file is write-protected.

READ/WRITE

The stored file can be deleted or overwritten.

Deleting a write-protected file requires the R-attribute to be deleted using the DOS command ATTRIB on operating system level.
Syntax: `ATTRIB -R file name`

The use of an external keyboard is necessary for this purpose. We therefore recommend that the write protection be used only when a setup is not to be changed anymore.

Filename

Causes a file with the specified file name to be loaded or stored.

If the file cannot be opened, an error message and "not found" is entered in the menu line.

For entering file names, see 2.3.2.5.

2.9.1.2 Loading and Storing of Traces and Lists

All files (contents of the trace buffers, lists of sweep parameters, dwell lists of a freely running sweep, equalization files and limit reports) are stored in the FILE panel; the files are loaded into the panels in which they are useful.
The data stored to file can be read in and further processed by other programs. In most cases, ASCII format is preferred for numerals. In the R&S example files (R&S_EXAM.nnn), the file format is described in the form of comments.

The following can be recalled into the GENERATOR panel:

- equalization files for generator function SINE (see 2.5.4.3 SINE)
- Traces and lists as sweep parameters for the list sweep (see 2.5.4.2 Sweeps)
- Dwell lists for the list sweep (see 2.5.4.2 Sweeps)

In the DISPLAY panel, traces can be loaded from files into the trace buffers (TRACE A→FILE or TRACE B→FILE; see 2.10.1 Parameters for Display of Traces and Spectra). The files may include:

- Traces, sweep lists and FFT spectra (OPERATION→TRACE LIST, OPERATION→CURVE PLOT or OPERATION→BARGRAPH, OPERATION→SPECTRUM))
- Limit reports (OPERATION→LIM REPORT)

The files are stored by entering a file name under menu item "File name". If the desired file name is already available in the menu line, open and close the appertaining selection box (see 2.3.2.5).

STORE TRACE/LIST

Store traces and sweep lists

STORE

During a sweep, various buffers are created for sweep parameters, measured values, limit exceedings and waiting times, if any. This menu item serves to select which one of these buffers is to be stored.

TRACE A
TRACE B

Store the TRACE A or the TRACE B buffer; (specify in the DISPLAY panel which measured values are to be collected in which trace buffer) (see 2.10.1, Parameters for Display of Traces and Spectra). In addition to the trace data, the values of the appropriate X-axis as well as the following settings from the display panel are stored to permit the curve to be displayed as it was scaled in storing.

TRACE A/B

Unit	
Reference Value	
Spacing	LIN/LOG
Top	
Bottom	

X AXIS

Unit	
Reference Value	
Spacing	LIN/LOG
Left	
Right	

X AXIS

Store the list with the sweep points for the sweep parameter lying on the X-axis (for generation of lists used in the list sweep).

For the generation of a sweep list, proceed as follows:

GENERATOR panel

- Activate the sweep system ("Sweep Ctrl → AUTO SWEEP")
- Set the 1st sweep parameter to the desired parameter (eg FREQ for the frequency sweep list)
- Select the start and stop values as well as spacing of the desired parameter (recommended: LIN POINTS or LOG POINTS)
- Enter the number of sweep points, which determine the number of entries in the sweep list generated later.
- To avoid the generator waiting for the synchronization with the analyzer, select "Next stop → DWELL" and a short "Dwell".

Start the sweep (see 2.11. Starting and Stopping a Measurement). When the sweep enters the SWP ... RUNNING state, the sweep list is available; the sweep can be aborted.

Generating or modifying sweep lists is also possible using a text editor (eg EDIT from DOS).

STORE

Z AXIS

Store the list with the sweep points for the sweep parameter lying on the Z-axis (with two-dimensional sweep only, for generation of lists used in the list sweep).

For the generation of a sweep list, proceed as follows:

Generator panel

- Activate the sweep system ("Sweep Ctrl → AUTO SWEEP")
- Set the 2nd sweep parameter to the desired parameter (eg FREQ for the frequency sweep list)
- Select the start and stop values as well as spacing of the desired parameter (recommended: LIN POINTS or LOG POINTS)
- Enter the number of sweep points, which determine the number of entries in the sweep list generated later.
- To avoid the generator waiting for the synchronization with the analyzer, select "Next stop → DWELL" and a short "Dwell".

Start the sweep (see 2.11. Starting and Stopping a Measurement). When the sweep enters the SWP ... RUNNING state, the sweep list is available; the sweep can be aborted.

Generating or modifying sweep lists is also possible using a text editor (eg EDIT from DOS).

DWELL

For sweeps with time synchronization only; store the buffer for the dwell time. The time data are obtained either from a file (with list sweep) or they are all equal (with Next Step Dwell). The dwell time or the file name for the active dwell list is entered in menu item "Dwell" or "Dwell List" in the GENERATOR panel (see 2.5.4.2 Sweeps).

LIM UPPER
LIM LOWER

The upper or lower limit curve (tolerance mask) is stored to file.

When a limit curve is loaded as described in Section 2.10.7 Limit Check, a list including all interpolated X-Y-pairs is output.

EQUALIZATN

(Equalization)
Special case: store the frequency response of a device under test as equalization file, which can then be read in for compensation purposes in a sweep with a generator sinewave signal under menu item "Equal. file" in the GENERATOR panel. Also, the inverse or the frequency response normalized at any frequency can be stored (see menu item Norm Freq or Invert 1/n). The measurement data (voltage curve) are provided in one of the trace buffers, which can be selected under menu item "Volt sourc".
Requirements: analyzer is not set to FFT, Z-axis buffer is OFF, X-axis buffer contains a frequency list, the trace buffer selected under "Volt sourc" contains a voltage list of the same length. If these requirements are not fulfilled, an error message is output during storage of the data.
For generation of a equalization file, proceed as follows:

GENERATOR panel:
- Select output channel 1; Configure the generator (see 2.5.2 Configuration of the Analog Generators or 2.5.3 Configuration of the Digital Generators)
- Switch on the sinewave generator (FUNCTION→SINE)
- Activate the sweep system (Sweep Ctrl→SWEEP, or LIST)
- Switch the 1st sweep parameter to frequency (X Axis→FREQ)
- Switch the 2nd sweep parameter off (Z Axis→OFF)
- Configure the sweep (see 2.5.4.2 Sweeps)

ANALYZER panel:
- Select input channel 1; configure the analyzer (see 2.6.2 Configuration of the Analog Analyzers or 2.6.3 Configuration of the Digital Analyzers)
- Set the measurement function of the analyzer to RMS (see 2.6.5 Functions)
- Configure the measurement: Unit Ch1→V, Meas-Time→AUTO

DISPLAY panel:
- Assign the trace buffer A to the measurement function (TRACE A→FUNC CH1)
- Switch of the trace buffer B (TRACE B→OFF)
- Configure the display: Scale AUTO→ ONCE (see 2.10.1 Parameters for Display of Traces and Spectra (DISPLAY Panel)

Connect the device under test (output and input channel 1) and start the single sweep (see 2.11 Starting and Stopping a Measurement); store the frequency response after completion of the sweep.

FILE panel:
- Specify the measurement data buffer: Volt sourc→TRACE A
- Specifications for the normalization of the frequency response: see menu items "Norm freq" and "Invert 1/n".

LIM REPORT

(Limit Report)
The list containing the limit exceedings is to be stored. Enter the limit values or limit curves in the DISPLAY panel under menu items "Lim upper" and " Lim lower" (see 2.10.7 Limit Check).

Notes:
- *With the FFT active, the selection points "TRACE A" and TRACE B" are possible only; the traces then contain the FFT data.*
- *The X-axis and (with 2-dimensional sweep) Z-axis are also stored when storing the traces; For assignment of the sweep parameters, see GENERATOR panel "X-Axis" and "Z-Axis" (see 2.5.4.2 Sweeps).*
- *For the list formats (file types), refer to the table in Section 2.9.1.*

Appendmode

For traces and limit report only.

ON — New data are appended to the existing file; if it does not yet exist, it is created.

OFF — New data overwrite the already existing file (if any).

Format

Select the file format.

BIN — Data are stored in binary format; rapid access.

ASCII — Data are stored in ASCII format, can be further processed using any text editor or other programs.

Voltsource

For Store → EQUALIZATN only.
The trace buffer specified here must be the one containing the measurement data; the ANALYZER and DISPLAY panels must be appropriately configured (see "Store → EQUALIZATN").

TRACE A
TRACE B — The voltage data are read from the trace buffer A/B.

Normfreq

For Store → EQUALIZATN only.

Specify the frequency on the voltage value of which is normalized. Selecting the frequency at which the frequency response curve has its maximum means that the equalization file contains values from 0 to 1 only. If any other frequency is selected, factors higher than 1 occur.

Invert1/n

For Store → EQUALIZATN only.

Inverting the frequency response causes, with the equalizer switched on, the device under test to get an equalized frequency response. Application: constant (frequency-independent) outgoing power, pre-/deemphasis

ON — The equalization curve is stored in inverted form.
OFF — The equalization file is not inverted.

Filename

Causes the trace or list to be stored under the specified file name.

If the file cannot be opened, an error message and "not found" is displayed in the menu line.

For entering file names, see 2.3.2.5.

2.9.2 Editing Files and Directories

The following files are available under the heading UTILS in the FILE panel, which is called by pressing the FILE key.

The UPD software is supported by the MS-DOS operating system and uses its file manager, which is normally not of importance for the user. It however provides extended capabilities, which you can make use of, if desired. For reasons of internal management, the UPD software assigns a fixed data type (extension) to each file type depending on its function, allowing the identification of the file type. The extension consists of up to three letters after the point in the file name and is usually not available to the user in other menu items (the extension used is specified in the menu items concerning files as well as in the list given in Section 2.9.1).

DELETE

A file can be deleted using this command. All menu commands used to store files overwrite an existing file with the same name or create a new file.

WORK DIR

(Working directory)
Files can be arranged in directories allowing classification depending on, for example, the user or the project. The working directory, which precedes all file names and path names (unless they begin with a "\" in the main directory) is thus selected. Independent of the working directory, there are also directories which are used by the UPD-internal software.

Example: Work Dir C:\UPD\DUT04

No.	Data input	Data access to
1	SWEEP.SCO	C:\UPD\DUT04\SWEEP.SCO
2	\SWEEP.SCO	C:\SWEEP.SCO
3	\UPD\DUT05\SWEEP.SCO	C:\UPD\DUT05\SWEEP.SCO

Storing files in the main directory (example 2) or in the UPD system directories (\UPD,\UPD\REF,\UPD\DRIVER, etc.) should be avoided.

COPY

Select the file to be copied. The file name may consist of the complete path name and specification of the disk drive. The write protection attribute is transferred to the generated file.

TO

Specifies the TO file name (together with drive and directory, if required) to which the file selected by COPY is to be copied.

SYSTEM

The UPD software runs as a program under MS-DOS. Aborting the program with the SYSTEM key allows you to use the UPD as a conventional ISA (IBM-compatible) PC, provided that an external keyboard is connected (see 2.17, UPD used as Computer).

2.10 Graphical Data Presentation (DISPLAY and GRAPHICS Panels)

The DISPLAY panel is used to set how the measurement results are graphically presented. Important: what (and how) is measured is set in the ANALYZER panel, or, with sweeps, in the GENERATOR panel. How the measurement is displayed can be changed at a later date, too. Also, curves can be retrieved from files and redrawn.

The DISPLAY panel is built up using the front-panel key DISPLAY or key combination Alt-D on the external keyboard. The menu items in the DISPLAY panel affect the GRAPHICS panel which occupies either 2/3 of the screen (part-screen graphics mode) or the complete screen (full-screen graphics) (selectable by the o ↔ O key or key combination ALT-Z).

OPERATION

CURVE PLOT

The results of a sweep, function of time (waveform) or FFT are entered as line diagram in the Cartesian coordinate system. As a rule, two dependent variables (TRACE A and TRACE B) can be displayed above an independent variable (X AXIS). With LIMIT check activated, the tolerance masks are also included.The extensive command menu provided on the softkeys allows you to scale and zoom the display and to dimension the display using the CURSORs (see 2.10.1 and 2.10.2).

TRACE LIST

The measurement results are output in the form of digits. The three columns (TRACE A, TRACE B and X AXIS) are complemented by a fourth column where exceedings of the UPPER or LOWER LIMIT curve are marked. In full-screen graphics mode, two additional columns indicate the LIMITS (interpolated between intermediate values!) (see 2.10.3 and 2.10.4) if LIMIT CHECK has been activated (see 2.10.7).

LIM REPORT

As opposed to TRACE LIST, the digit lines with measured values exceeding the tolerances only are displayed (see 2.10.3 and 2.10.4), which is possible only with LIMIT CHECK activated (see 2.10.7).

BARGRAPH

The current measured values are displayed analogously in the form of bars ('signal level meter'). This type of indication is ideally suited for measurements where the relative size or change in size - and not the exact value - is desired. Max. 3 BARGRAPHS are displayed. The extreme values are marked by trailing pointers (see 2.10.5 and 2.10.6).

SPECTRUM

With FUNCTION FFT selected in the ANALYZER panel, the frequency spectrum calculated by the DSP is displayed (SPECTRUM is automatically set with FFT selected in the ANALYZER panel).

With FUNCTION DIM, MOD DIST, DFD or THD selected in the ANALYZER panel, the spectrum components of the stimulae and interference products can be displayed in the form of a histogram (see 2.10.1 and 2.10.2).

PROTOCOL

In the GRAPH window, the protocol data of the digital interface are displayed. Evaluation of the protocol is made simultaneously with the respective function (see 2.10.8).

2.10.1 Parameters for Display of Traces and Spectra (DISPLAY Panel)

MODE

DEL BEF WR

DELete BEFore WRite gradually deletes the traces of the most recent measurement before the new trace is (further) drawn. With FFT, the complete spectrum is replaced. As, in a manual sweep, the direction may be arbitrary, making it impossible to delete the former trace in a useful way, OVERLay mode is automatically switched to in this case.

OVERL/MAX H

(OVERLay/MAX Hold)
The sweep curves on the screen are not deleted but any new sweep overlays the current display. (However, everything is deleted when the coordinate system is to be created anew, eg in the case of a new scaling.) See also softkey function KEEP LAST. With FFT, this key is used to switch on the MAXimum Hold function. FFT AVERAGE cannot be set unequal to 1 in the ANALYZER panel with OVERL/MAX H selected, see 2.6.5.13.

WATERFALL

(With FFT only). Shifts the single curves in the Z axis to obtain a spatial impression. One channel only can be traced at a time, which is why 1 or 2 must be selected under "Channel(s)" in the ANALYZER panel. To obtain a useful display, scaling is to be set as follows:

1. TRACE Top is to be set such that the upper half (or 3/5) of the coordinate system is empty (ie is not occupied by the first trace).
2. X-AXIS Right such that about half of the coordinate system is free.
3. TRACE Bottom is to be set above the noise limit, making noise invisible by clipping and emphasizing significant spectral components.

TRACE A

Is used to select which measurement results are to be collected and graphically represented as TRACE A (or TRACE B) eg in the case of a sweep.

Caution: Display of the trace can be switched OFF (invisible) by means of a softkey.

TRACE B

FUNC CH1

(Function Channel 1)
The results of the measurement of channel 1 currently selected in the ANALYZER panel by way of FUNCTION are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.

FUNC CH2

As above, however for channel 2.

FREQ CH1

(Frequency Channel 1)
Frequency meter channel 1. Possible only with FREQ/PHASE in the ANALYZER panel not OFF and OPERATION not SPECTRUM.

FREQ CH2

Frequency meter channel 2. Possible only with FREQ/PHASE in the ANALYZER panel set to FREQ and OPERATION not SPECTRUM.

PHASE

Phase meter between channel 1 and 2. Possible only with FREQ/PHASE in the ANALYZER panel set to FREQ&PHASE and OPERATION not SPECTRUM.

HOLD

Does not collect new values but continues to display the old trace.

OFF

No measured values are collected and hence, nothing can be displayed under this TRACE.

FILE

A sweep stored in a file in the FILE panel (TRACE LIST) can be recalled and displayed, eg for comparison purposes, using this option.

Sweep lists and FFT files can be loaded. The following basic conditions must be satisfied to load a sweep list.

- The measuring function must not be set to FFT and the display OPERATION must not be set to SPECTRUM .
- All sweeps must be switched to OFF (or START COND to AUTO) or the sweep parameter (FREQ, VOLT, TIME) must be identical to the X-axis of the trace file to be loaded.

The following conditions must be satisfied to load an FFT file.

- The measuring function must be set to FFT or display OPERATION to SPECTRUM.

When loading the trace file, TRACE A has the function of a "master" trace; trace B is the "slave" trace:

- The "master" trace can always be loaded as soon as the above basic conditions are satisfied. In addition to the trace data, the stored display settings including the complete X-axis are also loaded (cf. Section 2.9.1.2, menu item STORE → TRACE A/B). If a sweep has been selected, the loaded trace is interpolated on the X list specified by the sweep.
- When trace A is switched off, TRACE B becomes the "master" trace.
- Being the "slave" trace, TRACE B must conform to the X-scale of the "master" trace; i.e., only the trace data and the appropriate Y-scale are loaded. The curve is interpolated on the X-axis already specified. If this X-axis is incompatible, the "slave" trace is switched.

FILENAME

(Displayed with TRACE A/B FILE only)
The name of the file with a sweep or FFT to be displayed is entered. If an error occurs during loading, "NOT FOUND" is output in this line.

SCALE B

EQUAL A

The second (dependent) measured value is displayed using the same scaling as for Trace A. Any values for UNIT, REFERENCE, SCALE, SPACING, TOP and BOTTOM need not be entered for the second axis.
This requires however that the same function is selected for TRACE A and B (only the channel may be different).

NOT EQUAL A

Different scaling for the second sweep.

UNIT

Is used to specify the unit with which the results are to be displayed (see 2.4 Units). Recorded sweeps can be redisplayed with other units at any time. Traces loaded using TRACE A/B FILE therefore need not be drawn in the same way as they have been stored.

REFERENCE

The reference value is needed for the relative units.

MAX

The maximum value of the sweep is adopted once as reference value.

CURSOR

The value on which the cursor is placed is adopted once.

VALUE:

A numeric value with unit serving as reference value for the relative units is entered.

SCALE

AUTO ONCE

Uses the minimum and maximum values of the current sweep for scaling of TRACE A and B (once) and rescales after changing the function using FUNCTION in the ANALYZER panel or TRACE A/B in the DISPLAY panel. The sweep or FFT start/stop values of the GENERATOR or ANALYZER panel are adopted for the X axis. The following menu items TOP and BOTTOM or LEFT and RIGHT are no longer displayed because they have been set in doing so.
If there are not yet any measured values available, preset range limits are used for the time being and rescaled after the end of the sweep. When changing the measurement function (using TRACE A/B or FUNCTION in the ANALYZER panel with FUNC CH1/2 or GRAPH ON/OFF with SMPTE, THD and DFD) an automatic rescaling is performed after the first measurement in the SCALE AUTO ONCE state. (Re-)START does not initiate a new scaling.
The full-scale values of the new scaling are determined about 5 % lower or higher than the exact values. Using an intelligent algorithm, 'even' values appropriate for the scale are selected.

SCALE

MANUAL

Leaves the scaling to the user.

With a new scaling the image is deleted and redrawn after the rescaling. This applies also to an FFT started by the Single key. With FFT in Continous mode (started by Start key), however, the running FFT is still drawn, the new scaling being considered only in the next FFT.

Spacing

LIN

Divides the Y-axis linearly.

LOG

Divides the Y-axis logarithmically. With logarithmic units (dB) selected, LIN only can be selected.

TOP

The menu item is displayed only with TRACE A/B SCALE MANUAL. The item serves to set the upper value of the Y-axis (of the scale for the measured values). Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB-) units.

BOTTOM

(With TRACE A/B SCALE MANUAL), the menu item serves to set the lower value of the y-axis (of the scale for the measured values). The value must be smaller than that of TOP. Negative or 0-values are not permissible with SPACING LOG and logarithmic (dB-) units.

LEFT

(With X AXIS SCALE MANUAL), the menu item sets the left value of the X-axis (of the independent value). Negative or 0 values are not permissible with SPACING LOG and logarithmic (dB-) units.

RIGHT

(With X AXIS SCALE MANUAL), the menu item sets the right value of the X-axis (of the independent value). The value must be selected higher than that for LEFT. Negative or 0-values are not permissible with SPACING LOG and logarithmic (dB-) units.

COMMENT

Allows the entry of a comment with a length of max. 27 characters, which is output together with the curve in the case of OPERATION CURVE PLOT.

X Pos

(X Position)
Defines the X-position of the comment. X is the relative distance to the 0-point (bottom, left) in % (0 to 100) of the coordinate system.

Y Pos

(Y Position)
Defines the Y-position of the comment. Y is the relative distance to the 0-point in % (0 to 100) of the coordinate system. 0-point is on the left side at the bottom. The reference point for the text is the first letter (bottom, left).

2.10.2 Trace and Spectrum Display

Basically, two dependent values (TRACE A and TRACE B) can be displayed above an independent value (X AXIS), the scales for TRACE A and TRACE B being displayed on the left-hand and right-hand margin, respectively (unless the same scaling has been selected by way of TRACE B, SCALE B: EQUAL A). The measurement functions selected for display are faded in on the upper margin in the form of letters.

Overrange values are not displayed (the curve is interrupted). Underrange values are indicated in the status line SWEEP INFO in the top, right corner. Measured values not fitting into the selected coordinate system are displayed as horizontal line at the top or bottom.

With THD, MOD DIST, DIM and DFD measurements, the measured values can be displayed in the form of a histogram above the frequency axis (with OPERATION SPECTRUM), the frequency axis being not true to scale and invariable.

There are two cursors (→ see page 2.196!) marked by * and o, respectively. They can be moved across the display using the rotary knob or the direction keys. The measured values below the cursor positions are displayed in three windows (depending on the function set, also difference values). The cursor jumps from measured value to measured value. If there are more measured values than can be displayed as points (eg with FFT), the maximum out of the measured values displayed on one point is displayed. Here, the cursor jumps from line to line.

Also, the cursor can be moved outside the coordinate system and indicate the appertaining values. In this case, its symbol is placed in the top corners.

With LIMIT check switched on (see 2.10.7, Limit Check), the tolerance masks are displayed, too.

An extensive command menu on the softkeys allows you to scale, zoom the display, select the cursor functions and to set markers on the single frequency lines or the harmonics of the FFT.

The cursor can be moved and the softkeys can be operated only after the GRAPHICS panel has been selected using the front-panel key GRAPH or the key combination ALT-R.

The softkey menus have max. 3 levels. The extremely left key (labelled with "BACK") always returns to the preceding menu level. Its designation is indicated above the BACK softkey and constitutes together with the text displayed in center above the remaining 7 softkeys the heading of the current menu.

Some softkeys indicate ON or OFF states, where ○ is the symbol for OFF and ◉ for ON.

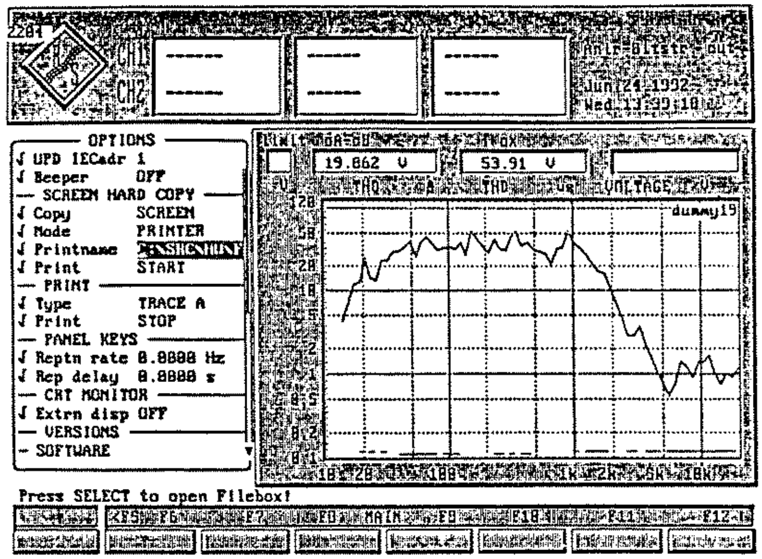


Fig. 2-41

The first two levels of the softkey menu tree are dealt with below. A third level, if any, is explained subsequently.

CURVE

A ◉

B ○

switches the display of curves or lines on or off (toggle key). Display only is affected. (With TRACE A/B in the DISPLAY panel OFF, nothing can be displayed. Changing a function (using TRACE A/B in the DISPLAY panel) switches A and B to ON.)

AUTOSCAL

ALL

Rescales the X- and Y-axes using the present measured values of a sweep or the FFT. If there are no measured values, the preset range limits are used and scaled after the end of the sweep. The present display including the axes are deleted and subsequently redrawn (see also AUTOSCALE).

A

The left-hand A-axis only is rescaled, the A curve is redrawn.

B

The right-hand B-axis only is rescaled, the B curve is redrawn. Is ignored with SCALE B set to EQUAL A.

X

The X-axis only is rescaled (not with SPECTRUM and Analyzer FUNCTION THD, MOD DIST, DIM or DFD).

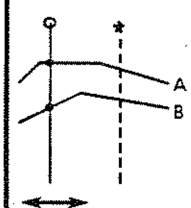
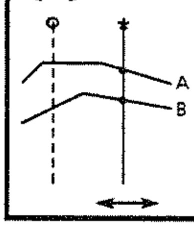
Switches alternately the *-cursor or the o-cursor active. The active cursor only can be moved using the rotary knob or the direction keys and can display the measured values. The softkeys pressed subsequently (HLINE, SET TO and ON/OFF) refer to the active cursor. The inactive cursor is displayed in short dashes.
The o-cursor is used for the ZOOM function and as reference for the *-cursor and horizontal cursor. The *-cursor can be switched over to horizontal line (not with SPECTRUM).

*** CURSOR**

The subsequent softkeys serve to select the various cursor functions. The units of the numerical values are determined by the axis scaling.

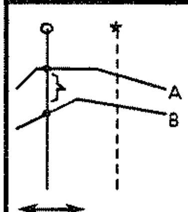
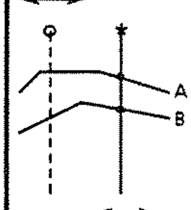
A,B

Display of the measured values of curves A and B at the cursor position as well as the appertaining X value.

Graphics	Labelling of display field	Selected softkey
	oA oB oX	oCURSOR A,B
	*A *B *X	*CURSOR A,B

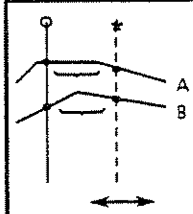
A-B

Display of the difference value between curves A and B at the position of the cursor and of the X-value (useful only with identical phys. variables).

Graphics	Labelling of display field	Selected softkey
	oA-oB (unit of A !) oX	oCURSOR A-B
	*A-*B (unit of A !) *X	*CURSOR A-B

*** - o**

(With active *-cursor only). Display of the difference between the values at the positions of the *- and o-cursor on curve A (or curve B) and the difference between the X values.

Graphics	Labelling of display field	Selected Softkey
	*A-oA *B-oB *X-oX	*- o

HLINE →

(With active *-cursor and Operation Curve Plot only). Switchover of *-cursor to horizontal cursor. This subsequent command level is explained below.

SET TO →

Sets the active cursor to specific values. This subsequent softkey command level is referred to below.

ON/OFF

Switches alternately the cursor on and off. A deactivated cursor is no longer displayed.

ZOOM

Zooms the display in X-direction. The ZOOM function is not active with histogram indication (OPERATION SPECTRUM and simultaneously Analyzer FUNCTION THD, MODDIST, DIM or DFD).

AT o UP

Zooms the display on the X-axis by the factor 2 (repeated activation is possible). The center used is the o-cursor which is then also placed in the center. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

AT o DOWN

Compresses the display on the X-axis to half the size (can be pressed repeatedly). The o-cursor is the center, which afterwards is in the middle. Changes the LEFT and RIGHT parameters of the x-axis in the display panel.

CEN TO o

Sets the center of the X-axis of the new coordinate system to the value of the o-cursor without zooming. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

o TO *

The end values of the new (zoomed) X-axis are predefined by the X-values of the two cursors which will subsequently be placed on these cursor values. Changes the LEFT and RIGHT parameters of the X-axis in the DISPLAY panel. In order to obtain a scrolling effect, the cursors can be shifted to X-values outside the displayed range; the values continue to be displayed.

UNZOOM

Restores the original X-axis, defined by X AXIS LEFT and RIGHT. UNZOOM is also performed internally when modifying and setting a parameter which changes the X-axis. Restores the original LEFT and RIGHT parameters of the X-axis in the DISPLAY panel.

UNDO

Cancels the last ZOOM action (one-time).

MARKER

TRACEA→

TRACEB→

(With FFT only). Switches the display of markers in the form of triangulars above the marked measured value on trace A (or B) ON. The functions are on the next softkey level and described below.

MORE

KEEP

(Keep Last Trace). The present trace (pair of traces) is not deleted for the next sweep but is retained. This trace is lost only when the display has to be deleted, eg due to a new scaling (as against function TRACE A/B HOLD storing the trace).

SETREF

Sets reference values for the conversion of relative units in the softkey level described below.

The functions of the third (and last) level of the softkey menu is referred to in the following:

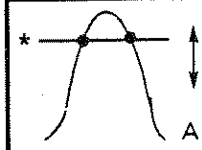
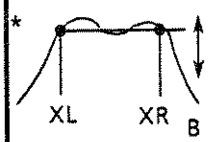
* CURSOR

HLINE

A

B

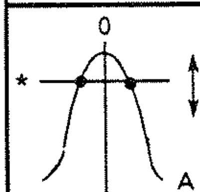
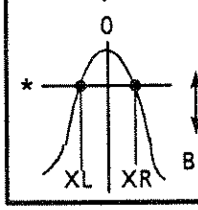
(With Operation Curve Plot (not with FFT) only)
The *-cursor is switched over to horizontal line. Its Y-value and the X-values of its intersections with trace A (or B) are displayed, if available. If there are several intersections, the extreme, right-hand and the extreme, left-hand intersections are used. When changing its position via rotary knob or direction keys the cursor jumps from measured value to measured value, usually meeting exactly only 1 intersection (left or right). The, in each case, other (last) intersection is no longer valid and therefore displayed in brackets. With softkey B, the intersections with trace B are displayed.

Graphics	Labelling of display field	Selected softkey
	*Y *XAL *XAR	HLINE A
	*Y *XBL *XBR	HLINE B

Δ A

Δ B

The *-cursor is switched over to horizontal line. The difference between its Y-value and that of the o-cursor is displayed. The intersections with trace A or, as the case may be, trace B are displayed (see above). Use: simple measurement of the -3-dB points.

Graphics	Labelling of display field	Selected softkey
	oA-*Y *XAL *XAR	Δ HLINE A
	oB-*Y *XBL *XBR	Δ HLINE B

MARKER

A

B

MAX

With FFT only; sets the first marker (triangle marked by "X") to the maximum value of trace A (or B).

o-CURSOR

With FFT only; sets the first marker to the value defined by the o-cursor. Trace A (or B) is used.

VIEW OFF

With FFT only; deletes the first marker on trace A (or B).

HARM ◉

(Harmonics) with FFT only; sets or deletes alternately the markers 2 to 9 of the harmonics (frequency multiples) of the first marker. The values of trace A (or B) are marked. With the first marker (triangle marked by "X") being on the fundamental wave, K2 to K9, for example, are marked.

CURSOR

SET TO

MIN A

MIN B

(Not with FFT). The active cursor is set to the minimum value of the sweep (in the displayed section). It is also displayed as the cursor value. The measured values of trace A (or trace B) are used.

IMAX A

IMAX B

(With FFT only). The active cursor is placed on the interpolated maximum, which may be higher than the values displayed (see 2.6.5.13 FFT). This value is displayed as cursor value, too.

MAX A

MAX B

The active cursor is placed on the maximum value of the sweep (in the displayed section). It is also displayed as the cursor value. The Y-values of trace A (or trace B) are used.

MARKER1

(With FFT only). The active cursor is placed on marker 1 of the FFT. Its value is then displayed as cursor value.

NEXT MAR

(With FFT only). The active cursor is placed on the next marker of the FFT. Its value is then displayed as cursor value.

MORE

SETREF

(Set Reference)
Sets the reference value TRACE A REFERENCE in the DISPLAY panel to the current value of the *-cursor. In this case, the cursor must not have HLINE function. Effective only with relative scaling units and causes trace A to be redrawn. Applies analogously to TRACE B, where SCALE B must not be set to EQUAL A.

A WITH *

B WITH *

A WITH o

B WITH o

Sets the reference value TRACE A REFERENCE to the current value of the o-cursor. In this case, the cursor must not have HLINE function. Effective only with relative scaling units and causes trace A to be redrawn. Applies analogously to TRACE B, where SCALE B must not be set to EQUAL A.

2.10.3 Parameters for the Display of Lists (DISPLAY Panel) (TRACE LIST, LIMIT REPORT)

TRACE A

TRACE B

Used to select which measurement results are to be collected during a sweep as TRACE A (or TRACE B), which are then displayed as a list of numbers in the GRAPHICS panel (graphics window).

FUNC CH1 — (Function Channel 1) The results of the current measurement of channel 1, which has been selected in the ANALYZER panel by way of FUNCTION, are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.

FUNC CH2 — As above, however of channel 2.

FREQ CH1 — (Frequency Channel 1) Frequency meter channel 1. Possible only when FREQ/PHASE in the ANALYZER panel is not set to OFF.

FREQ CH2 — Frequency meter channel 2. Possible only when FREQ/PHASE in the ANALYZER panel is set to FREQ.

PHASE — Phase meter between channel 1 and 2. Possible only when FREQ/PHASE in the ANALYZER is set to FREQ&PHASE.

HOLD — Does not collect any new values but holds the old ones.

OFF — Switches the display in the form of a list off.

FILE — A sweep stored to file in the FILE panel (TRACE STORE LIST) can be recalled and displayed, eg for comparison purposes, using this option. The subsequent menu line is required for this purpose.

FILE NAME

(Displayed with TRACE A/B FILE only). Enter the name of the file with a sweep or FFT to be displayed. If any error occurs during loading, "NOT FOUND" is output in this line.

UNIT

Determines the unit with which the results are to be displayed (see also Section 2.4 Units). Recorded sweeps can be reprinted at any time using any other unit.
When, after selection of a new function or a new instrument, the present unit can no longer be used, the units set for the measurement in the ANALYZER or GENERATOR panels are automatically adopted for the new function.

REFERENCE	The reference value is required for the relative units and the limit curves.
MAX	The maximum value of the sweep is adopted once as reference value.
O CURSOR	The value the cursor is placed on is adopted once.
VALUE:	A numeric value with unit is entered.

2.10.4 Display (GRAPHICS Panel) of Lists (TRACE LIST, ERROR REPORT)

The results of a sweep are output as numbers using TRACE A (or B) LIST. TRACE A, TRACE B and X AXIS are displayed in 3 columns which are complemented by a fourth column in which exceedings of the UPPER or LOWER LIMIT curve by the measurement result are indicated by way of arrows (triangles) pointing upward or downward. To this end, limit check must be activated in the FILE panel. In full-screen graphics mode, the LIMITS, if active (LIMIT CHECK not OFF), are indicated in additional two columns (interpolated in the case of intermediate values).

The symbol for the o-cursor is displayed in the left edge of the screen in the line with the value on which the cursor is placed (also with trace presentation). After a new picture has been set up the cursor is placed in the center and can be moved using the rotary knob or the direction keys. When the cursor reaches the edge of the picture, the display is scrolled line for line. Any new sweep deletes an old line replacing it by a new line.

As opposed to **TRACE LIST, LIM REPORT** displays only those measured values exceeding the upper tolerance mask (LIMIT UP) or the lower tolerance mask (LIMIT LOW). Limit check must be activated in the FILE panel for this purpose. Any new sweep deletes the old display completely and sets it up anew from top to bottom. If there are more lines than can be displayed on the screen, the picture segment can be shifted using the rotary knob or the direction keys.

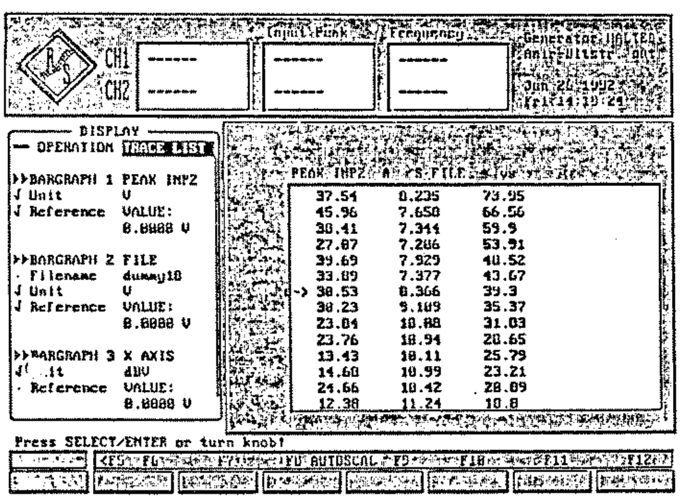


Fig. 2-42

2.10.5 Parameters for BARGRAPH Display (DISPLAY Panel)

BARGRAPH1		Used to select which measurement results are to be indicated as bargraph.
BARGRAPH2		
	FUNC CH1	(Function Channel 1) The results of the current measurement of channel 1, which has been selected in the ANALYZER panel by way of FUNCTION, are used. Possible only when FUNCTION in the ANALYZER panel is not OFF.
	FUNC CH2	As above, however of channel 2.
	FREQ CH1	Frequency meter channel 1. Possible only when FREQ/PHASE in the ANALYZER panel is not set to OFF.
	FREQ CH2	Frequency meter channel 2. Possible only when FREQ/PHASE in the ANALYZER panel is set to FREQ.
	PHASE	Phase meter between channel 1 and 2. Possible only when FREQ/PHASE in the ANALYZER is set to FREQ&PHASE.
	OFF	Switches the display in the form of a list off.
UNIT		Determines the unit with which the results are to be displayed (see also Section 2.4 Units).
REFERENCE		The reference value is required for the relative units.
	MAX	The maximum value is adopted once as reference value.
	VALUE	A numeric value with unit is entered.

Scale

AUTO ONCE Uses the minimum and maximum values for scaling (once) and rescales after changing the function using FUNCTION in the ANALYZER panel or TRACE A/B in the DISPLAY panel. The menu items LEFT and RIGHT are no longer displayed because they have been set in doing so. For BAR 3, the sweep start/stop values are adopted from the GENERATOR or ANALYZER panel.

MANUAL Leaves the subsequent scaling to the user.

SPACING

LIN Linear spacing of the display axis.

LOG Logarithmic spacing of the display axis. With logarithmic units (dB) selected in UNIT, LIN only can be selected.

LEFT/BOTTOM (With SCALE MANUAL,) sets the bottom left value of the display. Negative or 0-values are not permissible in combination with SPACING LOG or logarithmic (dB-) units.

RIGHT/TOP (With SCALE MANUAL,) sets the top right value of the display. The value must be higher than that of LEFT. Negative or 0-values are not permissible in combination with SPACING LOG or logarithmic (dB-) units.

AUTOSCAL

ALL Rescales the axes of BAR1 and BAR2 using the current maximum values of the measurement and BAR3 using the sweep start/stop values. If there are no measured values, the range limits are used.

BAR1 BAR1 only is rescaled (otherwise as ALL).

BAR2 BAR2 only is rescaled (otherwise as ALL).

BAR3 BAR3 only is rescaled (otherwise as ALL).

2.10.6 BARGRAPH Display (GRAPHICS Panel)

BARGRAPH indication is used to display the current measured values analogously in the form of bars. Bargraph display is suited for applications in which the relative magnitude or changes in magnitude are significant and not the exact value. A maximum of 3 bargraphs can be displayed. Values exceeding the displayable range are indicated by a triangular arrow on the left or right side.

The peak values measured in the monitoring interval (after Start) are marked by a pointer, identifiable by the thin line, its left end marking the minimum value, the right end the maximum value. The pointer can be reset using the Start key.

With limit check activated in the FILE panel (LIMIT not OFF), also the limit values (interpolated in the case of intermediate values) are displayed in the form of brackets. When changing the independent axis (eg the frequency with sweeps), the brackets are automatically set to the appropriate values. The bargraph changes its color when exceedings of the limits occur.

The minimum and maximum values during the monitoring interval are displayed as numbers above the bargraphs. In full-screen mode, the difference between maximum and minimum value is indicated, too.

BARGRAPH3 represents the current X-value of the set sweep. The field remains empty when no sweep is started.

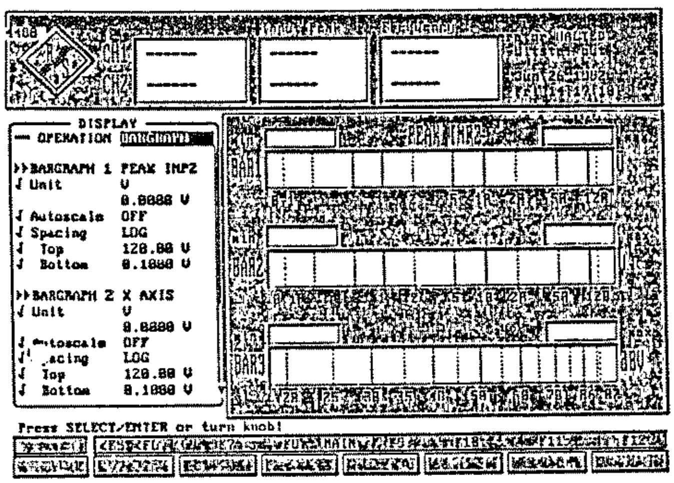


Fig. 2-43

2.10.7 Limit Check

The following commands are available under the heading LIMIT CHECK in the DISPLAY panel which is called by pressing the DISPLAY key or the key combination Alt-D on the external keyboard.

A lower and an upper limit or, as the case may be, a limit curve can be defined for the measurement, each measured value of a sweep or an FFT being compared with the limits. With trace display, they are included in the coordinate system; with bargraph indication, they are marked by lines (varying in position). With TRACE LIST, lines containing measured values out of tolerance are marked by a triangle. With LIM REPORT active, measured values violating the limits are indicated or stored. (See also OPERATION command in the DISPLAY panel in Section 2.10 and STORE TRACE/LIST in the FILE panel in Section 2.9.1.2.)

With CURVE PLOT, limit exceedings are marked in the top, left edge by an arrow pointing downwards (lower limit is violated) or by an arrow pointing upwards (upper limit or limit line is exceeded). A single exceeded limit marks the whole sweep as out of the tolerance. Overrange values are exceedings of the tolerances as opposed to underrange values. When relative units are used, the limits are converted using the reference value in the DISPLAY panel.

CHECK

TRACE A	Trace A (or BARGRAPH 1) or, optionally Trace B (or BARGRAPH 2) can be checked.
TRACE B	
TRACE A + B	Both curves are checked commonly for an exceeding of the limits. As there is only one tolerance band, this is only useful if the physical measured quantity is the same. The reference value of trace A is used.

MODE

LIM LOWER	The lower limit is checked.
LIM UPPER	The upper limit is checked.
LIM LOW&UP	The lower and upper limits are checked.
OFF	Limit check is OFF.

LIM LOWER

LIM UPPER

VALUE	A value with unit is entered for the upper/lower limit. With a relative unit, the appertaining reference value is taken over from the DISPLAY panel (TRACE A/B REFERENCE).
OFF	

FILE NAME

This serves to load the file with the limit curve. If mode LIM LOWER or LIM LOW&UP is switched on, the curve for the lower limit can be loaded which obtains the extension .LLW to the file name. In mode UPPER or LIM LOW&UP, this is the file with extension .LUP.
These files contain x-y pairs, with the y-value being a factor which is multiplied with the set reference value (TRACE A (orB) REFERENCE VALUE from the display panel) to obtain an absolute value. By changing the reference value, the tolerance band on the y-scale can be offset.
Only a few sampling points are necessary. The intermediate values necessary for the tolerance monitoring of a sweep or an FFT are interpolated at the start of a sweep. This requires the indication whether the axes for x and y are divided linearly or log., so as to ensure that correct values are calculated in the case of segments not running horizontally or vertically. These lines become ellipse segments in the other division, respectively. If points are required before or after the last sampling point, the last slopes to the interpolation are continued..
In the case of full-screen mode, the interpolated limit values are also indicated for every measured value in the graphics window with OPERATION TRACE LIST or LIMIT Report.

Caution: Up to version 1.15, the limit curves with OPERATION CURVEPLOT are also drawn as a curve in this interpolated form and thus have been coupled to the sweep set in their resolution, with the entered sampling values generally only being exact with many sweep points. In later versions, the sampling points are always drawn independently of the sweep set.
The file format is described in the example data (R&S_EXAM.LLW and R&S_EXAM.LUP) in the form of comments.

2.10.8 PROTOCOL Analysis

Screen display:

The screen (consisting of 16 lines, each with 50 characters) is divided into two sections:

TOP: Invariable elements in the protocol:

- Validity: shows the state of the validity bit in the respective channel.
- Parityerrors: indicates the sum of parity errors that have occured up to this point in time. This number is reset to zero on selection of a new analyzer or when pressing the start key.
- Change: indicates any changes in the channel status data
  - NO: no changes
  - LTC: changes only in the fields 'local time code' (bits 112 to 143) and CRC (bits 184 to 191).
  - YES: changes in any other bit position.
- Other: shows whether the, in each case, other channel is the same or different.
- Errors: indicates the errors that have occurred:
  - UNEXP BB: unexpected preample for beginning of block (too early)
  - SQ BLOCK: missing (gap) preamble for beginning of block
  - NOT LOCK: missing preamble for beginning of block
  - PREAMBLE: invalid preamble
  - SQ L/R: error in channel sequence (L/R)
  - RATE ERR: measured clock rate and set rate deviate from each other by more than 200 ppm
  - NONE: no error

BOTTOM: These 13 lines can be matched to the currently used protocol with the help of a protocol control file.

The error counters Parityerror, CRC _ left and CRC _ right can be reset by pressing the start key or reselecting the analyzer.
Changing status bits are displayed and output in red.
Bits that have not changed since the latest output are displayed in green.
Comments (PRINT command) are displayed in yellow.

Example:

Protocol Analysis: Channel Status Left

```
Validity:  R:0       L:1          Parityerrors: ______
Change:    YES       Other:EQUAL  Errors: NONE
-----------------------------------------------------------
Byte:         = = = = = = =  AES3  = = = = = = =
0:     Format:   prof           Mode:      audio
       Emph:     J.17           Source:    locked
       Rate:     48kHz
1:     Chanmod:  stereo         Usermod:   AES18
2:     Auxmod:   20 no          Length:    23      R:0
3-5:   Vector:   12             Grade:     2       R:0
6-13:  Origin:   UPD_           Destin:    R&S_
14-21: Local:    01234567       Time:      12:45:00
22:    Relia:    0-5:1   6-13:0 14-17:0    18-21:0
23:    CRC L:    ________       CRC R:     ________
Measured sample rate: 48000.2
```

↑ text entered by UPD

↓ from here: user defined

This example is generated using protocol file R&S_aes3.pac.

Source	Select the data to be displayed.
CHAN STAT L	Channel status data left are displayed.
CHAN STAT R	Channel status data right are displayed.
USER L	User data left are displayed.
USER R	User data right are displayed.

With CHAN STAT L or R, the following line is read out on the screen:

Proto File

Proto File selects the interpretation file for channel status data.
Selection from: file name, preset type of file: *.pac

Description:

The protocol information is displayed in two sections; the two upper lines are displayed in a fixed format and contain information on validity, parity, other errors and differences between the two channels. The other lines are formatted using the specifications in the file, the individual bits being assigned any output text you desire. This file can be modified to suit any protocol you desire.

Example: see R&S __ AES3.PAC

File format: same as with USER DAT, see below

With USER DAT, the following lines are displayed:

FORMAT

Format selects the interpretation mode.

Selection from: BINARY, HEX, ASCII, AES18

BINARY

User data are represented in a 01010 sequence.
Representation is block aligned.

HEX

User data are represented as a hexadecimal, numerical sequence.
Representation is block aligned.

ASCII

User data are represented as text.
Representation is block aligned.

FILE

Interpretation, block aligned

With FILE, the following line is added:

Proto File

Proto File selects the interpretation file for user data.

Selection from: file name, preset type of file: *.PAU

File format:

The protocol file has the following structure:

One line for each operation, followed by parameters which are separated by commas. The parameters allow the representation of any bits (1 to 32) from the selected data, the output position being freely selectable. Each line must not contain more than 255 characters.

Operations:

PRINT: Text output (independent of data)

Example:

PRINT 26, 5, "Usermod:"

(in column 26, line 5 the text "Usermod:" is entered)

VALUE: Output of values, either as hex number (default) or as text provided that an assignment is present.

Example:

VALUE 17, 3, BIT:2-4, 0 = "not ind", 4 = "no empf", 6 = "50/15 "

(in column17, line 3, the contents of the three bits (2,3,4) are represented as hex (or text, in case the value is 0, 4 or 6)

VALUE 17,11, CRC_L_ERR

(in column 17, line 11, the contents of the CRC left frequency counter is represented)

As to the output width:
If there are text assignments, the largest text determines the output width; In case there are no text assignments, the number of bits to be represented determines the output width.

As data source, the following specifications are permissible:

- 'BIT' followed by ':' and definition of the bits:
  - a number from 0 to 191: single bit
  - an interval (eg 4-9): combined sequence of bits, max. 32 bits permissible
- 'CRC _ L _ ERR': Internal error counter of CRC _ error left.
- 'CRC _ R _ ERR': Internal error counter of CRC _ error right.
- 'MEASURED _ RATE': measured sample rate (represented as 5.1-digit floating number (eg '48001.2')

BINARY: same as VALUE, however default output as bit pattern

TEXT: Text output (in ASCII) using a number of letters determined by the number of selected bits; Each TEXT operation allows only 32 bits to be represented; for longer text outputs, several subsequent text lines are to be used.

Example:

TEXT 17, 8, BIT:48-79
(in column 17, line 8, the contents of the 32 bits is represented as text)
Characters that cannot be printed are replaced by '?' or, if '0', by '.' .

TIME: Time output (in the form of 12:45:56) of the selected number divided by the specified rate. Number/rate are interpreted as seconds since midnight.

Examples:

TIME35, 9, BIT:144-175, RATE:48000.0
TIME35, 9, BIT:144-175, RATE:SET _ RATE

(in column 35, line 9, the contents of the 32 bits are represented as time (eg 12:34:45)

'RATE:' Should correspond to the sample rate, can be specified as floating number.
As an alternative, the following specifications are also possible:

MEASURED _ RATE: measured clock rate
SET _ RATE: clock rate set in the panel

2.10.9 Switching between Full-screen and Part-screen Mode

Part-screen graphics mode offers you the possibility of complementing the graphical representation with a panel. The large measured value display on the upper screen edge is maintained, too. In full-screen graphics mode, the graphics has been scaled up to occupy the complete screen. The only differences between part-screen and full-screen mode are the two additional columns with the limits for the output of lists (TRACE LIST and LIM REPORT) and the display of the difference between minimum and maximum value with BARGRAPH, which are offered in full-screen mode only.

After having selected the GRAPHICS panel using the GRAPH key (or key combination Alt-R), you can choose between full-screen and part-screen mode using the front-panel key □↔□ (or key combination Alt-Z) or by clicking the mouse (see also 2.3, G. Instructions for Use and 2.3.1, Panels).

Fig. 2-44

2.11 Starting and Stopping a Measurement

Basically, you have to differentiate between measurements and sweeps.

- Measurements refer to frequency, phase and input peak measurements and the functions (also S/N measurements). Likewise, the FFT is handled as a single measurement while being a graphical presentation. Measurements can run as continuous or single measurements.
- Sweeps are generator and analyzer sweeps. They can run as continuous, single or manual sweeps. Part of the analyzer sweeps are also the time-controlled and the external sweeps which are set under menu item "START COND". Every sweep has to be started explicitly (key "START" or "SINGLE").

Measurements are controlled with the START, SINGLE and STOP/CONT keys and so-called "Abort" events. When no key is pressed, the analyzer is in the "CONT RUNNING" status, ie is continuously measuring. The UPD always enters this state when sweeps have been aborted.

Abort event: Any event rendering the running measurement or the running sweep invalid, which are among others:

- User entries in the GENERATOR, ANALYZER or FILTER panel or in the corresponding sections in the STATUS panel.
- Switching the outputs off (OUTPUT OFF key, see 2.13).

Upon an abort event, the measurement or sweep is restarted. This ensures that an indicated measured value or displayed sweep is based on the current setting only.

UPD measures simultaneously the selected function, input peak and the frequency on the selected input channels (without Highspeed option, channels 1 and 2 are measured sequentially). In the case of two-channel analog measurements, the phase between channnel 1 and channel 2 can be displayed as an alternative to the frequency on channel 2.

Single measurements can be masked out by the following actions:

- Any measurement can be switched off in the ANALYZER panel. OFF is displayed in the measured value display.
- Measurements which, although being switched on in the ANALYZER panel, are physically not possible with the selected function (eg frequency measurement with DC) are marked by "____" in the measured value display.

The Status display (top, right) indicates, among others, the states of the analyzer and sweep system:

CONT	continuous measurement running
SNGL	single measurement running
TERM	single measurement terminated
STOP	measurement stopped

Further messages about sweeps (see 2.3.4):

SWP OFF	sweep system switched off
SWP INVALID	sweep invalid due to changes of parameters or because sweep is not yet started
SWP CONT RUNNING	continuous sweep running
SWP SNGL RUNNING	single sweep running
SWP MANU RUNNING	manual sweep running
SWP TERMINATED	single sweep terminated
SWP STOPPED	sweep was stopped, can be continued.

Sweep points causing an OVERRANGE when measured are invalid (shown by a gap in the sweep curve, NAN (not a number) in the sweep list). An UNDERRANGE occurring during the sweep causes the message

SWP UNDERRANGE

to be entered in the sweep status line after termination or abortion of the sweep. The sweep status line is overwritten with the new sweep status only when the sweep is deactivated or restarted.

Continuous and single measurements

Continuous measurements:
In this mode, UPD measures continuously until one of the following actions is performed:

- With the SINGLE key, you can switch a running continuous measurement into single measurement mode. The analyzer enters the "TERM" state after completion of the single measurement. With the START or STOP/CONT key, you can reactivate the continuous measurement.
- Using the STOP/CONT key, a running measurement can be aborted immediately: the analyzer enters the "STOP" state. Pressing the STOP/CONT key again or, alternatively, the START key causes the continuous measurement to be reactivated.
- With the START key, you can restart a running measurement at any time to continue as continuous measurement, causing the averaging (see FFT), no-return pointers and min/max values to be reset.

Single measurements run just once; the analyzer then enters the "TERM" state. A single measurement is considered to be terminated when all the selected measurements on the selected channels have been concluded. If a measurement fails (eg because no signal is applied to one of the selected channels), the message *"Input? Press Show-IO"* will be displayed in the appertaining measured value display. Any completed single measurement must be re-initiated using the SINGLE key or by an abort event.

Switchover continuous measurement → single measurement: SINGLE key
Switchover single measurement → continuous measurement: START key

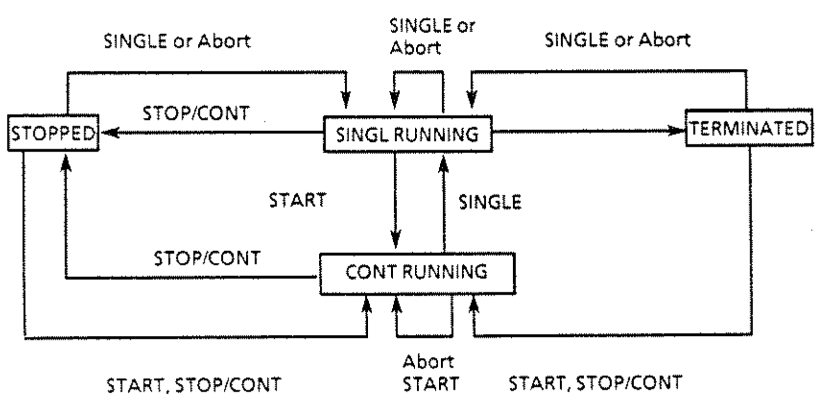


Fig. 2-45 State diagram of measurement (no sweep active)

Sweeps:

Continuous sweeps are started using the START key (sweep state "CONT RUNNING") and run until one of the following events occurs:

- STOP/CONT key is pressed → running measurement is terminated, sweep is stopped (sweep state "STOPPED"); analyzer is switched to "wait for trigger".
- SINGLE key is pressed → sweep continues as single sweep (sweep state "SNGL RUNNING").

▸ Abort event (see above) → running measurement and sweep are aborted; the sweep is restarted.

With the START key, you can restart the continuous sweep at any time. This causes all sweep curves traced until now to be deleted, averaging (see FFT), the non-return pointers and min/max values to be reset.

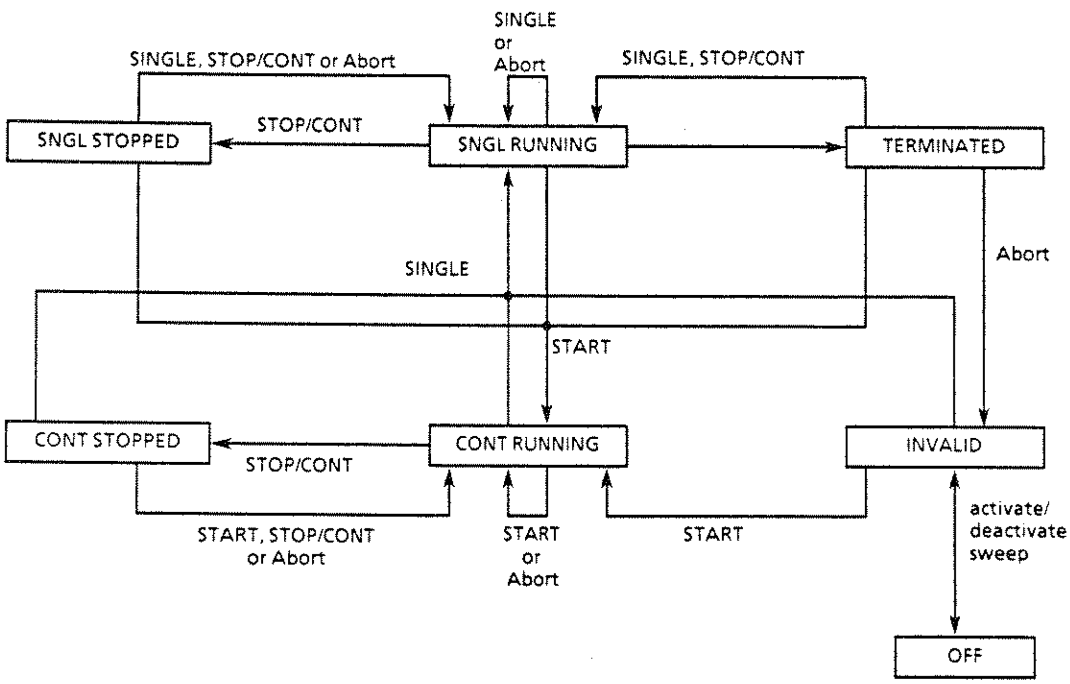
Single sweeps are started using the SINGLE key (sweep state "SNGL RUNNING") and run only once, ie until the sweep parameter (with 2-dimensional sweep, the parameter of the Z-axis) has reached its stop value. Single sweeps subsequently enter the "TERM" state. They are interrupted or aborted by the following events:

▸ STOP/CONT key is pressed → running measurement is terminated, sweep and analyzer are stopped (sweep state "STOPPED").

▸ Abort event → running measurement and sweep are aborted (sweep state "INVALID"); the sweep is restarted.

After the single sweep has been concluded, the analyzer enters the "TERM" state, ie no further measurements will be performed. With the STOP/CONT key, the analyzer can be switched to continuous measurement.

With the SINGLE key, you can restart the single sweep at any time.



Note:
The states "SNGL STOPPED" and "CONT STOPPED" are briefly indicated in the status display with "STOPPED".

Fig. 2-46 State diagram of sweep

Manual sweeps ("Sweep Ctrl→MANU...") are started using either the START or SINGLE key. However, they do not run automatically; each sweep point must be explicitly requested with the SINGLE key or the rotary knob (sweep state "MANU RUNNING"). When graphics is active (GRAPH key), the rotary knob can be used for sweep parameter variation.

With the START key, you can restart the manual sweep at any time, causing all sweep curves traced until now to be deleted, averaging (see FFT), non-return pointers and min/max values to be reset.

External single sweeps are started using the SINGLE key and run only once. They are stopped by the following events:

- Pressing the STOP/CONT key. Pressing the key again causes continuous measurement mode to be entered again.
- A measured value beyond the selected stop value.

Measured values opposite to the direction of the sweep are ignored.

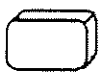
External continuous sweeps are started with the 'START' key and run until one of the following events occurs:

- Pressing the STOP/CONT key. Running measurements are finished, sweep is stopped and is regarded as finished.
- Pressing the SINGLE key. Sweep continues as external single sweep.
- Abort event (see above): running measurement and external sweep are aborted, the external sweep is restarted.

A measured value opposite to the direction of the sweep starts a new measurement curve which starts with this value.

Note: Sweeps cannot be started with the sweep state being OFF, but must be activated in the GENERATOR or ANALYZER panel before ("Sweep Ctrl" not OFF or "START COND" not AUTO). In the sweep state "OFF", start the continuous measurement and the single measurement using the START key (and STOP/CONT) and SINGLE key, respectively.

START



Start continuous or manual sweep (only with active sweep system, see 2.5.5.2 Sweeps) and active measurements.

Sweep system active:
Resets sweeps (peak-, average values and non-return pointers are reset and graphical representation deleted) and starts sweeps; new state: RUNNING
With manual sweep selected, any new sweep setting must be triggered using the rotary knob.
While the sweep is running, any entries in the GENERATOR, ANALYZER or FILTER panel or in the corresponding sections in the STATUS panel cause the sweep to be aborted. Permissible keys (not changing the state):

- LCD off
- softkeys
- rotary knob

Sweep system inactive (sweep state "OFF"):
Resets measurements (averaging, peak-, average values and non-return pointers are reset) and (re)starts continuous measurement.

SINGLE

Sweep system active:
In the sweep states "SNGL RUNNING", "STOPPED", "TERMINATED" or "INVALID":

- Starts a single or manual sweep

In the sweep state "MANU RUNNING":

- Switches the manual sweep one step further

In the sweep state "CONT RUNNING":

- Switches from continuous to single sweep

Sweep system inactive (sweep state "OFF"):
Key refers to single/continuous measurement:

- Analyzer state "SNGL RUNNING", "STOPPED" or "TERMINATED": starts a single measurement
- Analyzer state "CONT RUNNING": switches from continuous to single measurement.

STOP
CONT

Sweep system active:
In the sweep state "CONT RUNNING" or "SNGL RUNNING":
- Aborts the sweep; new state: STOPPED
- Analyzer is switched to "wait for trigger".

In the sweep state "STOPPED":
- Continues the sweep without reset; new state: SNGL RUNNING or CONT RUNNING

In the sweep state "INVALID" or "TERMINATED":
- Continuous measurement is started.

Sweep system inactive (sweep state "OFF"):
Key refers to single /continuous measurement
- Analyzer state "...RUNNING": aborts the measurement immediately
- Analyzer state "STOPPED" or "TERMINATED": starts continuous measurement.

2.12 Display of Selected Inputs / Outputs

SHOW I/O

Shows a picture of the UPD front panel; the active inputs and outputs are marked by arrows.

The LC display shown indicates which inputs and outputs have been selected on the UPD rear panel.

Pressing the key while the message "Input? Press SHOW I/O" is being output in (at least) one of the measured value displays causes the messages on measurement errors, which may have occured, to be displayed, too (see Section 2.3.5 Error Messages).

2.13 Fast Switch-off of Outputs

OUTPUT
OFF

Switches all outputs off (incl. the clock lines of the digital interfaces).

States:
- Digital outputs are of high resistance; no clock.
- Analog outputs are terminated (impedance is retained); output level = 0 V.
- Digital inputs supply no clock.

When switched off, the lines can be reactivated only by pressing the OUTPUT OFF key again.

An LED indicates the state of the key. LED on signifies OUTPUT OFF.

2.14 Printing / Plotting / Storing the Screen Contents (OPTIONS Panel)

2.14.1 Printing, Plotting and Storing Screen Copies

Use the H COPY (hard copy) key on the front panel to initiate printing, plotting or storing to file of the screen contents **displayed at the instant the key is pressed.**

Specify the type of device used for printout of the hard copy in the OPTIONS panel. Activate this panel by pressing the OPTIONS key or key combination ALT O on the external keyboard.

Basically, there are four types of outputs:

1. Pixel-oriented data on printer via printer driver for eg a hard copy of screen
2. Vector-oriented outputs in HP-GL format using PLOTTER. These data are usually output to plotters, however some laser printers also support the HP-GL format, eg for plotting measurement traces.
3. HP-GL data stored to file.
4. Outputs in PCX format to file for further processing in other programs.

The following menu items are available in the OPTIONS panel under the heading SCREEN HARD COPY.

DESTIN	(Destination)
PRINTER	Graphics are output in the form of pixel data to a printer. Printing is performed in the background while the UPD is accomplishing other tasks.
PLOTTER	Control characters are output in HP-GL format, a language specifically defined for plotters, yet also supported by some laser printers. HP-GL format offers the advantage of the resolution being determined by the output unit instead of by the UPD screen (slashes without disturbing stages). The size of the output is defined by the configuration of eg the plotter as all vectors are plotted relative to the configuration (see under P1, P2 "point" and "size/rotate" in the plotter manual).
PCX FILE	The PCX format (pixel format) was defined by the ZSoft company for PC Paintbrush and is accepted by most programs capable of loading graphics (MS WINDOWS programs and others).
HPGL FILE	Apart from most plotters (eg R&S DOP 2), some laser printers and some programs with graphics import capabilities also understand the HP-GL format. It is vector-oriented and offers the advantage of the resolution being determined by the output unit instead of by the UPD screen (slashes without disturbing stages). In addition, the size of the output is defined by the configuration of eg the plotter as all vectors are drawn relative to the configuration (see also plotter manual).

The following table lists the colors used in the screen hard copy and assignment of the plotter pens:

Function/Font	UPD LCD	UPD color screen	Plott Pen	Rec. color
Panel	black	black	1	black
Trace A	black	green	2	green
Trace B	grey	yellow	3	blue
Axes B	grey	yellow	3	blue
Scales	grey	red	4	light-red (thin line)

COPY

With DESTINATION PLOTTER and HPGL FILE only.

SCREEN

The complete screen contents is output, including all labellings and cursor displays as well as the curves/bargraphs with scales. In part-screen graphics mode, the display of the current measured values and a panel are additionally included. The softkeys and operator guidance line are masked out and replaced by date, time and R&S logo.

CURVE/GRID

The curves/bargraphs including the scales and scale labellings are output, however not the cursors and other labellings.

CURVE

The curve(s) displayed on the screen are transmitted only, thus reducing the time required for output.

PRINT NAME

drivername

(With DESTIN PRINTER only). For most matrix printers with 9 or 24 wires, a printer driver can be selected from the following list. The driver serves to convert the internal graphics (pixel) format into control characters for the connected printer with graphics capabilities.

Note: Printing is performed in the background while the UPD is already carrying out further measurements. To speed up the output, stop the measured value output using the STOP/CONT key.

To make your selection from the list of about 300 supported printers as easy as possible, the most important printer drivers only are offered in the selection box, the following printer types being assigned to the driver names (many other printers can emulate one of these types):

R&SPDN.PDT	Rohde & Schwarz PDN/Fujistu DL-2400 C
EPFX80.PDT	Epson FX-80
EPLQ1000.PDT	Epson LQ-1000
HPDJET.PDT	HP Desk Jet
HPLJET.PDT	HP Laser Jet
HPLJET3.PDT	HP Laser Jet Series III
HPTJET.PDT	HP Think Jet
IBMGRAPH.PDT	IBM PC Graphics Printer
IBMPRO.PDT	IBM Proprinter
KY1000.PDT	IBM Kyocera F-1000A
NECP6.PDT	NEC Pinwriter P5/P6/P7 60 dpi
NECP6180.PDT	NEC Pinwriter P5/P6/P7 180 dpi

If you want to select other printer drivers from the list of about 300 printers summed up in the BDRV.PDT file, call the SELECTP program. To this end, you require an external keyboard. Start the operating system using the front-panel key SYSTEM or CTRL - F9 and change the directory by entering CD/UPD/DRIVER (see 2.17 UPD used as Computer).

After you have started SELECTP a list of printer types will be displayed, in which the direction keys can be positioned. Select a highlighted name by means of the Enter key. End the SELECTP program by pressing the Esc key. A printer driver designated APPL.PDT is generated with the selection. Use the MS-DOS command RENAME to chose a different name. The extension .PDT should be maintained.

PLOT ON	(With DESTINATION PLOTTER only) Select the interface for HP-GL output.
COM1 COM2	The plotter/printer is connected to one of the two serial interfaces (RS232). The parameters of data transmission for transmitter (UPD) and receiver (plotter) must match each other. Wiper switches on the plotter/printer and the MS-DOS MODE program on the UPD are normally used for setting the parameters. The MODE program can be invoked in the AUTOEXEC.BAT or, on DOS-level, using MODE COM1:. See 2.16, Connecting External Devices.
LPT1	Some plotters can also be operated using the (parallel) printer interface. This setting is required especially for laser printers with HP-GL interpreter.
IEC BUS	Output of pixel data or vector data is effected via the IEC bus interface.
IEC Adr	(With PLOT ON IEC BUS only). Determines the listener address of the IEC bus output device for output of graphics.
Abort	
NO	The H COPY key starts the output.
YES	Output is aborted prematurely. Subsequently, the parameter changes to NO again.

2.14.2 Printing Traces and Lists

The following menu item is available in the OPTIONS panel under the heading PRINT.

The measured values and other block data are output to printer as numbers (in ASCII code) using this key (immediately executed, the H COPY key need not be pressed).

Type	The first column contains the data selected in the following. The values which would be on the X-axis with Curve Plot, usually the swept values, are contained in the second column.
OFF	Function is off.
TRACE A TRACE B	Prints the measured values selected for TRACE A (or TRACE B) in the DISPLAY panel. Also, units (and reference values, if any) are taken over from the DISPLAY panel.
EQUALIZATN	Prints the values of the equalization table.
LIM REPORT	Prints only values exceeding the limits. Limit check must be activated.
DWELL	Prints the values for the sweep dwell time.
LIM UP	Prints the upper limit curve.
LIM LOW	Prints the lower limit curve.
X AXIS	Prints the values of the X-axis only.
Z AXIS	Prints the values of the Z-axis only.
TRACE A + B	Prints both traces next to one another. The X-axis is output in the 3rd column.

2.15 Setting and Displaying Auxiliary Parameters (OPTIONS Panel)

Activate the OPTIONS panel by pressing the OPTIONS key (UPD front panel) or key combination "ALT O" (external keyboard). The panel is displayed on the right side of the screen.

2.15.1 IEC/IEEE-bus Address

UPD IEC adr

Defining the UPD IEC-bus address when connecting it to an IEC/IEEE-bus.
Application: see 2.16, Connecting External Devices

Range of values 0 to 31
Default: 20

2.15.2 Beeper On/Off

Beeper

ON A brief audible warning is output in the case of error messages, exceedings of the range of values or of limits and at the end of sweeps.

OFF Beeper is switched off.

2.15.3 Keyboard Settings

The settings refer to both the UPD front panel and the external keyboard (if available).

Rep rate

(Repetition rate)
Number of generated key codes per second (unit: Hz) with repetitive triggering.

Range of values: 0 (no repetitive triggering) to 20
Default: 10

Rep delay

(Repetition delay)
Time delay until repetitive triggering responds (Unit: s).

Range of values: 0.25 to 1.0
Default: 0.5 s

2.15.4 Language of Help Texts

Language	Set the language used in the help texts and key assignment of the external keyboard.
ENGLISH	Help texts are read out in English; the keyboard is set to UK (English key assignment)
GERMAN	Help texts are read out in German; the keyboard is set to GR (German key assignment)

Assignment of the external keyboard is set using various autoexec.bat files.
For UK, autoex_e.bat (autoex _d.bat for GR) is copied to c:\autoexec.bat. For this reason, the keyboard is reset not before the UPD is switched on again or after a warm start.
The environment variable UPD_LANG is set correspondingly either to E or D by the autoexec.bat file. When checking the language commands or switching to another language, c:\autoexec.bat is not overwritten provided that the environment variable has already the correct value.

2.15.5 Setting, Switching Off the Displays

Extern disp	(External Display)
INTERN ONLY	Display on the built-in LCD screen only.
BOTH COLOR	Display on the external VGA monitor, too (see 2.16 Connecting External Devices); use a color monitor for color output. The display has been optimized for color display, thus leading to reduced contrast quality on the built-in LCD screen.
BOTH BW	The data are additionally displayed on the external VGA monitor (see 2.16 Connecting External Devices), however only black-and-white. The contrast quality on the built-in LCD screen is not reduced in this mode.

OFF LCD

Switches the internal LCD screen off in order to increase the life of the screen and to minimize disturbing influences (eg with remote control or with the use of an external monitor).

An LED indicates the state of the key. When the LED is on, the LCD is off. When the LED is off, yet the LC display is still off, the reason might be the contrast control being misadjusted.

2.15.6 Calibration

Calibration ANL

Zero Auto	Dynamic offset calibration
OFF	DC offset calibration of the ADC board is OFF; the calibration factors most recently valid are used. *Note: Calibration should be switched off for short periods only (eg for execution of a sweep), as otherwise relatively significant measurement errors may occur.*
ON	Cyclic calibration of the DC offset of the ADC board and, if necessary, of the zero offset of analog DC measurements. A calibration is also made whenever an instrument is changed. *Note: A cyclic calibration is not performed while a sweep is running; it is delayed until the sweep is terminated or stopped.*
ONCE	Immediate offset calibration of the ADC board and (with DC selected as function) of all DC measurement ranges. Then the setting changes to ON.

Calibration GEN

LDG Auto

OFF Calibration of low-distortion generator inactive.

ONCE Automatic calibration of low-distortion generator. Allowed only after an operating time of at least one hour. Then the setting changes to OFF.

2.15.7 Version Display and Service Functions

The version numbers of software, analog and digital hardware and of options are displayed in the OPTIONS panel. As these menu items cannot be edited, they cannot be selected by the cursor.

SOFTWARE

UI	<version number>
HW	<version number>
IEC	<version number>

HARDWARE ANALOG

Analy Ch1	<version number>
Analy Ch2	<version number>
Motherbrd	<version number>
Generator	<version number>
DAC	<version number>

HARDWARE DIGITAL

Analyzer	<version number>
Generator	<version number>

OPTIONS

Highspeed	<version number>
LDG	<version number>
IEC board	<version number>
AES/EBU	<version number>

Any software, hardware or option which is not installed is marked by the letters -NA- (Not Available). They are displayed instead of the version number.

Also the service functions are in the OPTIONS panel. They are given under menu item SERVICE PSWD, protected by a password and thus not available to the user.

2.15.8 Setting the Real-time Clock

If time or date displayed on the UPD is not correct, set the AT real-time clock. Use the DOS commands "TIME" and "DATE" on operating system level for this purpose. Enter the operating system using the SYSTEM key (see 2.17, UPD Used as Computer).

2.16 Connecting External Devices

Important:
Using shielded cables for connection of external devices is recommended!
Otherwise spurious emissions may slightly increase, adversely affecting a very sensitive device under test.

All connectors below are located on the UPD rear panel (see 2.1.2 Rear-panel View).

IEC/IEEE-bus
Option: UPD-B4 (IEC-625/IEEE-488 interface)
Applications:
- Remote control of UPD from a host computer; select the address in the OPTIONS panel: "UPD IECadr" (see 2.15.1 IEC bus address).
- SCREEN HARD COPY on a plotter connected to the IEC-bus; settings in the OPTIONS panel: "Destin→PLOTTER", "Plot on→IEC BUS", "IEC-Adr" (see 2.14.1 Hard Copy of Screen).

For IEC-bus operation, see Section 3.3.

RS 232 (COM1, COM2)
2 serial interfaces
Applications:
- Connecting a mouse or a roll key; offers you another way of operating the panels and softkeys. The mouse driver supplied with the mouse is to be copied to the hard disk in accordance with the instructions given in Section 1.3, Mouse Installation. For more details, refer to the mouse manual.
- SCREEN HARD COPY on a plotter connected to COM1 or COM2; settings in the OPTIONS panel "Destin→PLOTTER", "Plot on→COM1/2" (see 2.14.1 Hard Copy of Screen).
  Standard configuration of the serial interfaces COM1: and COM2:
- parity even
- 7 data bits
- 1 stop bit
- none retry

The interfaces can be reconfigured on operating system level using the "MODE" command (see SYSTEM key).
mode com1: **baud = b parity = p data = d stop = s retry = r**

Centronics
Parallel interface for connection of a printer (see 2.14.2 Printing Traces and Lists)

External keyboard
Keyboard interface for connection of an AT keyboard
Applications:
- Offers you another way of operating the panels and softkeys; facilitates the entry of letters (for file names, comments on curve charts).
- Required for the editing of files (eg for generation of equalization files), in particular the "AUTOEXEC.BAT" and "CONFIG.SYS" system files.
- Required for operation on operating system level (entry of DOS commands).

VGA (external VGA monitor)
CRT interface for connection of a (color or black-and-white) VGA monitor
Advantages:
- Increased screen size
- Color trace representation possible

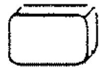
Switchover to external monitor in the OPTIONS panel using the menu item "Extrn disp→BOTH..." (see 2.15.5 Setting, Switching Off the Displays)

Monitor 1/2
Monitoring outputs channel 1 and 2 for the unfiltered (analog) input signal; active for analog analyzers only; switching on and level attenuation in the ANALYZER panel ("MONITOR→ON" and "Atten", see 2.6.6 Monitor (Attenuation).

2.17 UPD Used as Computer

The UPD software is created on the basis of the MS-DOS operating system from Microsoft. MS-DOS commands and programs are available when exiting the UPD software. A user manual for MS-DOS is included in the accessories.

SYSTEM



This key (or key combination CTRL-F9 on the external keyboard) is used to exit the UPD software. A dialog box is then displayed in which the command must be confirmed in order to avoid the inadvertent entry of the MS-DOS operating system.

On operating system level, the user is responsible for not changing or deleting the files required by the UPD. Also, the directory structure used should be maintained (see 1.3, Software Re-installation). The CONFIG.SYS and AUTOEXEC.BAT files required for starting the UPD should be modified by experienced users only.

The following three ways are possible for restarting the UPD software:

1. Change to UPD directory by entering >CD \UPD and call the UPD.BAT batch file by way of >UPD (where ">" is the input request by MS-DOS and need not be entered).
2. Press the CTRL, ALT and DEL keys simultaneously in order to trigger a warm start.
3. Switch the UPD off and (after a few seconds) on again.

3 Remote Control

3.1 Introduction

The instrument can be equipped with an IEC-bus interface according to standard IEC 625/IEEE 488/.1 and .2 (UPD-B4 option). The connector is located at the rear of the instrument and permits a controller to be connected for remote control. The instrument supports the SCPI version 1991.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on the IEEE 488.2 standard and aims at the standardization of device-specific commands, error handling and status registers.

This section assumes basic knowledge of IEC-bus programming and operation of the controller. The requirements of the SCPI standard placed on command syntax, error handling and configuration of the status registers are explained in detail in the respective sections.

3.2 IEC-bus Control

3.2.1 Brief Instructions

The short and simple operating sequence given below (written in R&S-BASIC) permits fast putting into operation of the instrument and setting of its basic functions. As a prerequisite, the IEC-bus address, which is factory-set to 20, must not have been changed.

- Connect instrument to controller using IEC-bus cable.
- Write and start the following program on the controller:

`100 IEC TERM 10 : IEC TIME 5000`	Terminator of controller = <LF>
`120 IEC OUT 20, "*RST; *CLS"`	Reset instrument
`130 IEC OUT 20, "SOURce:FUNCtion SIN"`	Output signal = sine
`140 IEC OUT 20, "SOURce:FREQuency 1 kHz"`	Frequency = 1 kHz
`150 IEC OUT 20, "SOURce:VOLTage 1V"`	Output voltage level = 1 Volt
`160 END`	End program

A sine-wave signal with a frequency of 1 kHz and a level of 1 V is now applied to the output of the instrument

- To return to manual control, press the LOCAL key at the front panel.

3.2.2 Setting the Device Address

The IEC-bus address of the audio analyzer is set in the OPTIONS panel (see Section 2). The address can be entered in the range from 0 to 30 and is retained in the non-volatile memory when the UPD is switched off. The address is factory-set to 20 (upon delivery or firmware update).

The controller uses the IEC-bus address to address the UPD as IEC-bus talker or -listener. Talk Only mode is not provided in the UPD.

3.2.3 LOCAL - REMOTE Switchover

On power-on, the UPD is always in the LOCAL state (manual control). It is switched to REMOTE (remote control) as soon as it receives a setting command from the controller. The UPD remains in this state after data transfer has been completed. This is indicated by the "REMOTE" LED on the front panel.

In this mode, manual control via the front panel is not possible. Rotary knob and keys (except for the LOCAL key) are disabled, the menus remain unchanged. There are two ways to return to the LOCAL state:

- by the addressed command "Go To Local" (GTL) from the controller.
- by pressing the LOCAL key on the front panel of the UPD. Data output from the controller to the UPD should be stopped before pressing the LOCAL key, as otherwise the UPD will immediately enter the REMOTE state again. The LOCAL key can be disabled by the universal command "Local Lockout" (LLO) sent by the controller in order to prevent undesired switchover to the "Local" state. Returning from the disabled state to manual operation is possible with the GTL command. However, the Local Lockout function is effective again when reentering the REMOTE state. Triggered by the controller, the Remote Enable line (REN) renders the LLO function definitely ineffective. In R&S-BASIC, for example, the combination of the commands IECNREN and IECREN is used for this purpose.

3.2.4 Device Messages

Device messages (acc. to IEC 625-1) are transferred on the data lines of the IEC-bus, the ATN control line not being active, ie High. ASCII code (ISO 7-bit code) is used. A distinction is made between:

- Common Commands (acc. to IEC 625, see Section 3.2.8)
- Device-specific commands (see Section 3.3)

Commands with a "?", such as FREQUENCY?, are referred to as "query messages" and request the UPD to output the respective value. Device responses use the same format as commands. The data and values read in by the controller can thus be directly returned to the UPD. In this example, the output of the analyzer may be "FREQ 9000". If the unit is missing, the basic unit (here: Hz) is applied.

3.2.5 Commands Received by the UPD in Listener Mode (Controller to Device Messages)

Input buffer:

All the commands and data sent to the UPD are stored temporarily in the 4096-byte input buffer. Longer command lines can also be processed. The, in each case, previously received part of the command is processed internally in the receiver.

Terminators:

Any command line must be ended by a terminator (except for continued command lines). Permissible terminators are:

- <New Line> (ASCII code 10 decimal)
- <End> (EOI line active) together with the last character of the command line or the character <New Line>.

As the character <Carriage Return> (ASCII code 13 decimal) is permissible as a filler without effect before the terminator, the combination of <Carriage Return> and <New Line> is also permissible.

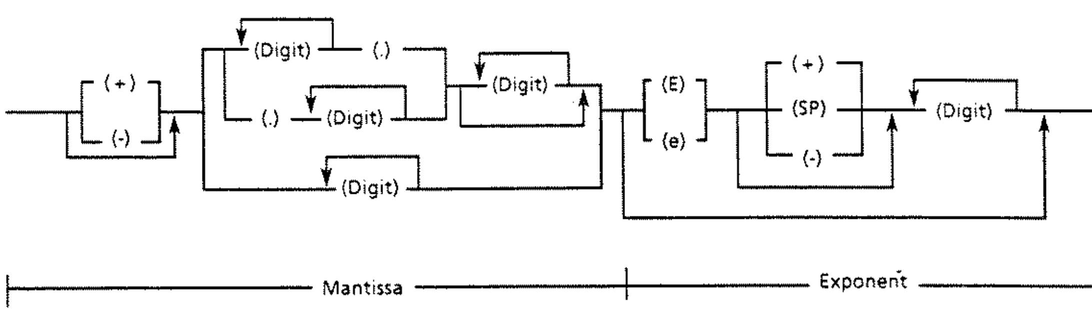
All IEC-bus controllers from Rohde & Schwarz send terminators accepted by the UPD as standard. A command line may require more than one line on the controller screen since the end of a command line is only limited by the terminator.

Separators:

A command line may contain several commands (program message units) when separated from each other by a semicolon (;).

- With or without exponent to base 10, "E" or "e" can be used as the exponent character.
  Example: `451` `451E-3` `+4.51e-2`
- The exponent is permissible with or without a sign, a space is also permissible instead of the sign.
  Example: `1.5E+3` `1.5e-3` `1.5E 3`
- Specification of the exponent only (eg E-3) is not permissible, 1E-3 is correct.
- Leading zeros are permissible in the mantissa and exponent.
  Example: `+0001.5` `-03.7E-03`
- The length of the numeric value, including the exponent, may be up to 20 characters. The number of digits for the mantissa and exponent is only limited by this condition. Digits that exceed the resolution of the device are rounded up or down; they are, however, always considered for the order of magnitude.

Numeric value



SP: Any character with ASCII code 0 to 9 and 11 to 32 decimal, especially space

3.2.6 Messages Sent by the UPD in Talker Mode (Device to Controller Messages)

The UPD sends messages via the IEC-bus, if it

- has been requested to make data available in its output buffer by one or more query messages with a question mark within one command line,
- indicates by setting bit 4 in the status byte (Message Available) that the requested data are now available in the output buffer,
- has been addressed as a talker (e.g. by the R&S-BASIC command "IECIN").

It is necessary for the command line with the data requests to be transmitted directly before talker addressing; if another command line is present in between, the output buffer is cleared and bit 2 in the event status register is set (query error; cf. Section 3.3.5).

The output buffer has a capacity of 8 kbyte.

A query message is formed by adding a question mark to the respective header, e.g. FREQUENCY?.

If the UPD is addressed as a talker directly after the query message, the bus handshake is disabled until the requested data are available. This may take several seconds since e.g. with CALibrate:ZERO:AUTO a calibration is performed before addressing. In this case it is more useful to wait for the MAV-bit (cf. Section 3.3.5).

The syntax for data output is exactly the same as for commands received by the UPD. <New Line> together with END (EOI active) is always used as terminator. The transmission of header and numeric value enables the messages sent by the UPD as a talker to be returned unchanged from the controller to the test receiver. Thus a setting performed via the front panel can be read, stored in the controller and returned later to the receiver via the IEC-bus.

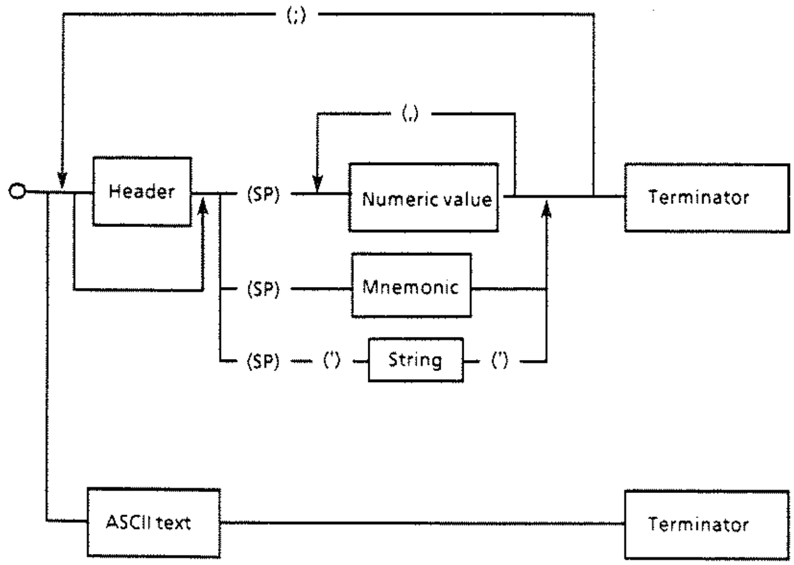
Notes: *If the UPD receives several query messages, it also returns several messages within one line separated by semicolons (;).*

Several numeric values (day, month and year) can be sent as a reply to certain query messages (e.g. SYSTEM:DATE?). They are separated by commas (,).

Header and numeric values are always separated by spaces. Headers only consist of upper-case letters and the characters ":" "_" and "".*

The messages sent by the UPD do not contain units. In the case of physical variables, the numeric values are referred to the basic unit (cf. Section 3.3.4).

Output message line



Numeric value

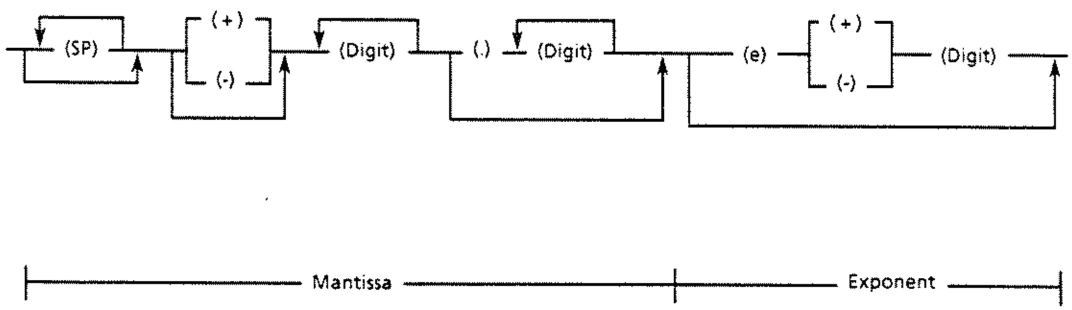


Fig. 3-1 Syntax diagram of messages sent by the UPD

3.2.7 Brief Introduction to SCPI

SCPI (Standard Commands for Programmable Instruments) defines the communication between controller and device. It is based on standards IEC 625-1 and -2 (IEEE 488) and standardizes syntax and commands. The command system is of a hierarchical structure consisting of defined key words followed by one or several parameters.

SCPI key words

All key words feature a long form and a short form (often four letters). Either the short form or the long form can be entered, other abbreviations are not permissible. There is no difference between upper-case and lower-case letters. Numbers used as suffixes can be added to all key words to allow the differentiation between several functions or features of the same kind.

The short form is always used in responses to queries.

SCPI syntax elements

The **colon** ":" separates the key words of a command. It has to be inserted before a new command when more than one command separated by semicolon are in one line (ie the colon can be omitted at the beginning of a new line).

The **semicolon** ";" separates two commands of a command line. It does not alter the path, ie key words of a lower level can be added and the words of the upper level need not be repeated.

The **comma** separates several parameters of a command.

A **space** separates command sequence and parameter(s). Otherwise it is ignored.

The **question mark** at the end of a command (instead of the parameter) causes the device to respond (query). Only commands with a "?" cause the UPD to respond.

Commands beginning with "*" are common commands. In compliance with IEC 625 (IEEE 488) they are used for resetting, self-test and status operations.

All lines must be ended by a "newline" character. According to IEC 625, either the EOI signal or a sequence of carriage returns and line feed characters.

SCPI data types

Numerical parameters can be entered in any form, ie with sign, decimal point and exponent. They can also contain multipliers (M, k or u). According to IEC 625-2, no unit may be appended to numerical values output by the UPD. Special numeric parameters are the discrete parameters MINimum, MAXimum, UP, DOWN, INF and NAN (DEFault is not used in the UPD).

Discrete parameters are words with a limited number of selections (in the form of 1 out of n). They are subject to the same rules as the key words in commands.

Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. 0 or 1 is provided in a query.

Strings may contain any ASCII characters and must always be entered in quotation marks (' or ").

3.2.7.1 Syntax of Commands Used by the UPD

In this manual, the following conventions for the notation of the command system to SCPI are adhered to:

Square brackets "[]" denote optional key words, suffixes or parameters (which can be omitted).

Pointed brackets "< >" embrace parameters (or descriptions thereof) to be replaced by the user.

The vertical stroke "|" separates a number of discrete parameters, only one of which is to be used.

Braces "{}" mean that the parameter in braces can be repeated as often as desired (in most cases).

In the following sections, the **short form** of the key words is given in upper-case letters. Lower-case letters are appended to indicate the **long form**.

Many of the commands used by the UPD are not (yet) standardized in line with SCPI (because they are too specific for general-purpose instruments or innovations). They are given in **italics**, their structure and syntax being defined in compliance with SCPI.

Numerical data as parameters without unit are denoted by <n>. Data for which the specification of a unit may make sense are marked by <nu>. Entering these units is accepted by the UPD (not part of SCPI). If not otherwise specified, the basic unit appertaining to the command is assumed. During output, the number is converted with the unit last used (except for measured values and block numbers), the unit itself being not output (acc. to IEC 625-2). In the UPD, the unit can be queried using the command UNIT:LAST? (not in line with SCPI).

To provide for differentiation between several functions or features of the same kind numerical suffixes are added to the key words. The UPD has, for example, 2 input channels with 4 simultaneously active sensors (SENSE1...4). 6 (instead of 8) measurement results can be indicated simultaneously. Only two of them can be displayed in the form of a curve. There are, for example, commands affecting all measured value sensors (eg INPut2 for channel 2). This is why in some commands entries without suffix are valid for eg both channels or all sensors. This is however contradictory to SCPI where entries without suffix are interpreted like entries with the suffix 1. In the UPD syntax (which is unambiguous), the suffix in commands which are valid for several functions or features of the same kind is ignored (without any error message).

Example:
- TRACe[1] means: TRACe and TRACe1 are both permissible and equal;
- TRACe[1|2] means: a distinction between TRACe (or TRACe1) and TRACe2 is to be made;
- TRACe[] means: the suffix is ignored (all permissible) because this command affects both TRACe1 and TRACe2.

3.2.8 Common Commands

The common, device-independent commands are grouped as follows:

- Commands referring to the Service Request function with the associated status and mask registers
- Commands for device identification
- Commands referring to the Parallel Poll function
- Commands for triggering sequences
- Commands for device-internal sequences (reset, calibrate, self-test) and for synchronizing sequences.

Table 3-24 Device-independent commands (common commands)

Command	Numeric value/ Range	Meaning
*RST	---	**Reset** (no query) Sets the audio analyzer to a defined default status as it is possible with LOAD INSTRUMENT STATE DEF SETUP on the front panel. This command does not affect the status of the IEC-bus interface, the set IEC-bus address, the mask registers of the Service Request function and the output buffer.
*PSC	0 to 65535	**Power On Status Clear** (reset on power-up) A numeric value higher than 0 causes the Service Request Enable mask register (SRE) and the Event Status Enable mask register (ESE) to be cleared during power-up. A value equal to 0 causes the registers mentioned above to retain their contents when the device is switched on and off. Switching the UPD on sets bit 7 in the Event Status register. Thus a service request can be triggered on power-up when the Event Status and Service Request Enable register have been configured appropriately (cf. Section 3.3.5).
*OPC	---	**Operation Complete** (ready message) Sets bit 0 (Operation Complete) in the Event Status register (ESR) when all previous commands have been executed.
*CLS	---	**Clear Status.** Sets the status registers ESR and STB to zero. The mask registers of the Service Request function (ESE and SRE) are not affected. This command does not alter the status of the IEC-bus interface, the set IEC-bus address, the mask registers of the Service Request function and the output buffer
*ESE	0 to 255	**Event Status Enable** Sets the Event Status Enable mask register to the specified value which is interpreted as a decimal number (see Section 3.3.5)

Command	Numeric value /Range	Meaning
*SRE	0 to 255	**Service Request Enable** Sets the Service Request Enable mask register to the specified value which is interpreted as a decimal number (cf. Section 3.3.5).
*PRE	0 to 65535	**Parallel Poll Enable** Sets the Parallel Poll Enable mask register to the specified value which is interpreted as a decimal number.
*WAI	---	**Wait To Continue** (no query) Permits the servicing of the subsequent commands only after all preceding commands have been executed (cf. Section 3.3.1.5).
*ESR?	0 to 255	**Event Status Register** Event status register query
*IDN?	?	**Identification** Identification query
*STB	0 to 255	**Status Byte** Status byte query
*TST?	0 to 255?	**Test** Self test query
*IST?	?	**Parallel Poll** Individual status query

3.2.9 Service Request and SCPI Status Reporting System

In line with standard SCPI, the registers to standard IEC488-2 already described are complemented by another two registers: the questionable status (problem) register and the operation status register (see overview of registers). As is the case with the other registers, the bits of these two registers are set by events and reset when queried (ie with STAT:QUES:EVEN?).

Each of these registers features an enable register allowing each of the bits to be masked. The enable registers can be set and read. They are however not automatically reset by the readout. These masks allow the user to specify which events in the individual levels are ORed to form a sum message.

The status byte contains the sum or the result of these events. A mask, which is the standard event enable register (ESE), is used to specify which bits, ie which (sum) events send a service request (SRQ) to the controller.

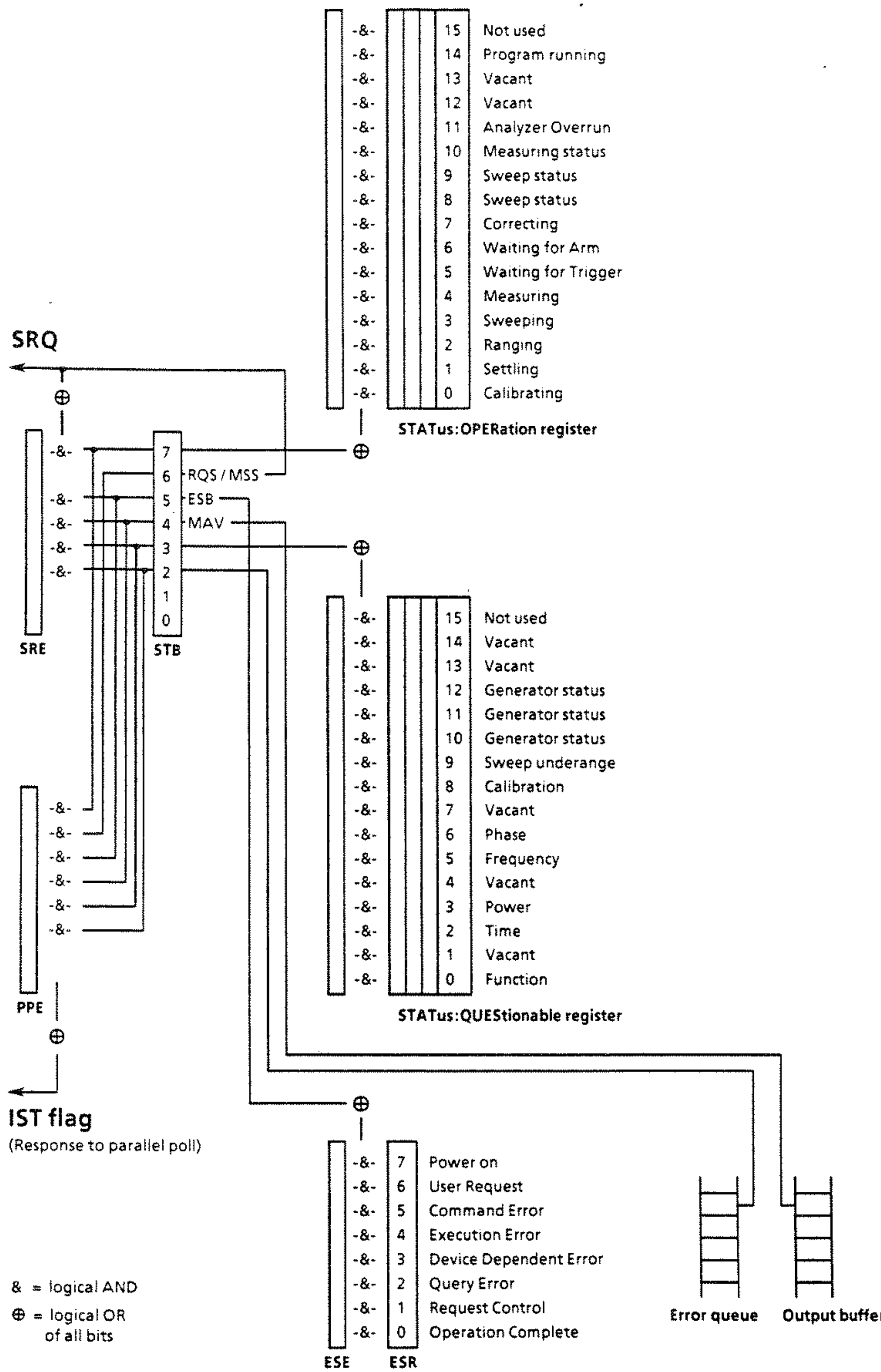


Fig. 3-3 Overview of status registers

a) Event Status (ESR):

The Event Status register is an extended version of the status byte used in earlier IEC-bus programmable measuring instruments. In this register the UPD specifies special events that can be queried by the controller. The respective bit associated with the event or status is set to 1. This bit remains set until it is cleared by reading out the Event Status register (command *ESR?) or by one of the following conditions:

- the commands *RST or *CLS
- switching on the power supply voltage (the power-on bit is then however set).

Table 3-36 Meaning of the individual bits in the Event Status register (ESR)

Bit No.	Meaning
7	**Power On** Is set when the device is switched on or the power returns following a power failure.
6	**User Request** This bit is set in the ESR by activating the LOCAL key. If the mask register is set appropriately, the UPD can trigger a Service Request in the controller.
5	**Command Error** Is set, if one of the following errors is detected during analysis of the received commands: • syntax error • illegal unit • illegal header • a numeric value was combined with a header that requires no subsequent numeric value.
4	**Execution Error** Is set, if one of the following errors was detected during execution of the received commands: • A numeric value is out of the permissible range (for the respective parameter) • A received command is incompatible with a currently active device setting.
3	**Device-dependent Error** Is set, if function errors occur.
2	**Query Error** Is set, if: • an attempt is being made by the controller to read data from the UPD when no query command has been issued before • the data prepared in the output buffer are not read and instead a new command is sent to the UPD. The output buffer is cleared in this case.
1	**Request Control** Is set, if the UPD requires the IEC-bus for control purposes (e.g. plotter).
0	**Operation Complete** Is set in response to the commands *OPC and *OPC? when all the pending commands have been processed and executed.

b) Event Status Enable (ESE):

This register is set by the controller and forms the mask for the Event Status register. The user can select which bits in the Event Status register also effect the setting of the sum bit ESR (bit 5 in the status byte) thus enabling a service request. The sum bit can only be set when at least one bit in the ESR and the appropriate bit in the ESE are set to 1. The sum bit is automatically cleared, when the condition stated above no longer prevails, e.g. when the bits in the ESR have been cleared by reading out the ESR or, when the ESE register has been changed. The ESE register is set to zero on power on when the power-on-status-clear flag is 1 (*PSC 1). The command "*ESE value"serves to set the Event Status Enable mask register where "value" is the contents of the register in decimal form. The current value of the register can be read out again using *ESE? (see Fig. 3-4).

c) **Status byte (STB):**

The status byte can be read using

- command *STB?
  The contents is output in decimal form. The status byte is not changed by the readout and the Service Request is not cleared.
- a serial poll
  The contents is transmitted in binary form. The RQS-bit is set to zero and the Service Request inactive, the remaining bits of the status byte are not changed.

The status byte is cleared by

- command *CLS, provided that the output buffer is empty.
  This command clears the Event Status register (ESR) and the output buffer, thus setting the bit ESR in the status byte to zero. This in turn brings about the clearing of the RQS-bit and of the Service Request message.
- reading the ESR using *ESR? or by setting the ESE to zero using *ESE 0 or by reading the contents of the output buffer.

Table 3-3 Meaning of the individual bits of the status byte (STB)

Bit	Bus line	Designation	Meaning
0	DIO 0		not used
1	DIO 1		not used
2	DIO 2		not used
3	DIO 3	QUEST	Sum bit of questionable status register A informing on questionable instrument states.
4	DIO 4	MAV	Message available, ie output buffer is not empty, pending message, eg a measured value, can be read.
5	DIO 5	ESR	Sum bit of event status register
6	DIO 6	RQS	Request Service
7	DIO 7	OPER	Sum bit of operation status register informing on instrument operations

d) **Service Request Enable (SRE)**

The controller can set this mask register for the status byte. The conditions that enable a Service Request can thus be selected. The command SRE 32, for example, sets the mask register such that a Service Request is generated only when the ESR-bit (bit no. 5) is set. The SRE-register is reset (= 0) on power-on provided that the Power On Clear flag is "1". The SRE-register is not changed by DCL and SDC.

e) Parallel Poll Enable Register

The Parallel Poll Enable register has a capacity of 16 bit. Each bit in this register has a corresponding bit in the status byte or in a device-specific register. If the bit-for-bit operation of the Parallel Poll Enable register with the two ones stated above does not result in 0, the IST-bit (Individual Status) is set to 1. The IST-bit is sent as a reply to a parallel poll of the process controller, thus allowing the identification of the reason for the service request. (The IST-bit can also be read using "*IST?"). Figure 3-3 illustrates the relations.

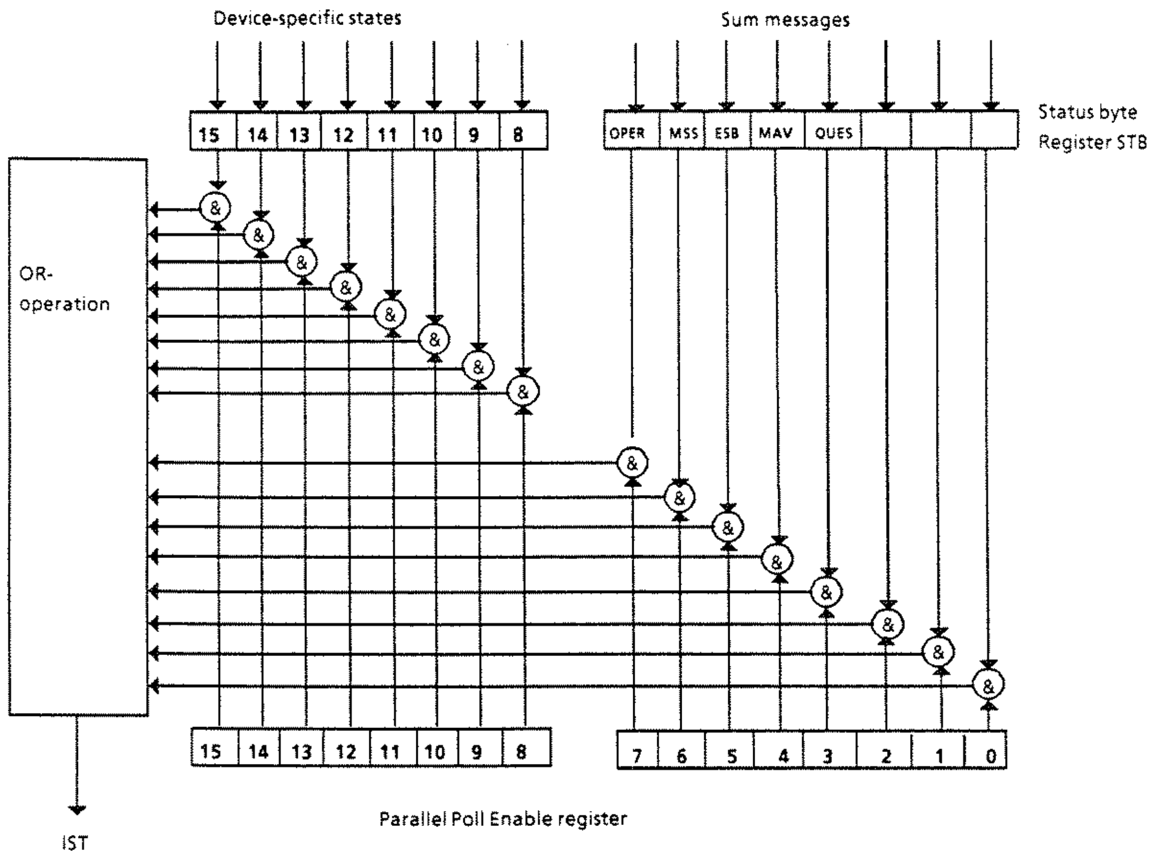


Fig. 3-3 Parallel Poll Enable register PRE

f) **Assignment and relation of the individual registers**

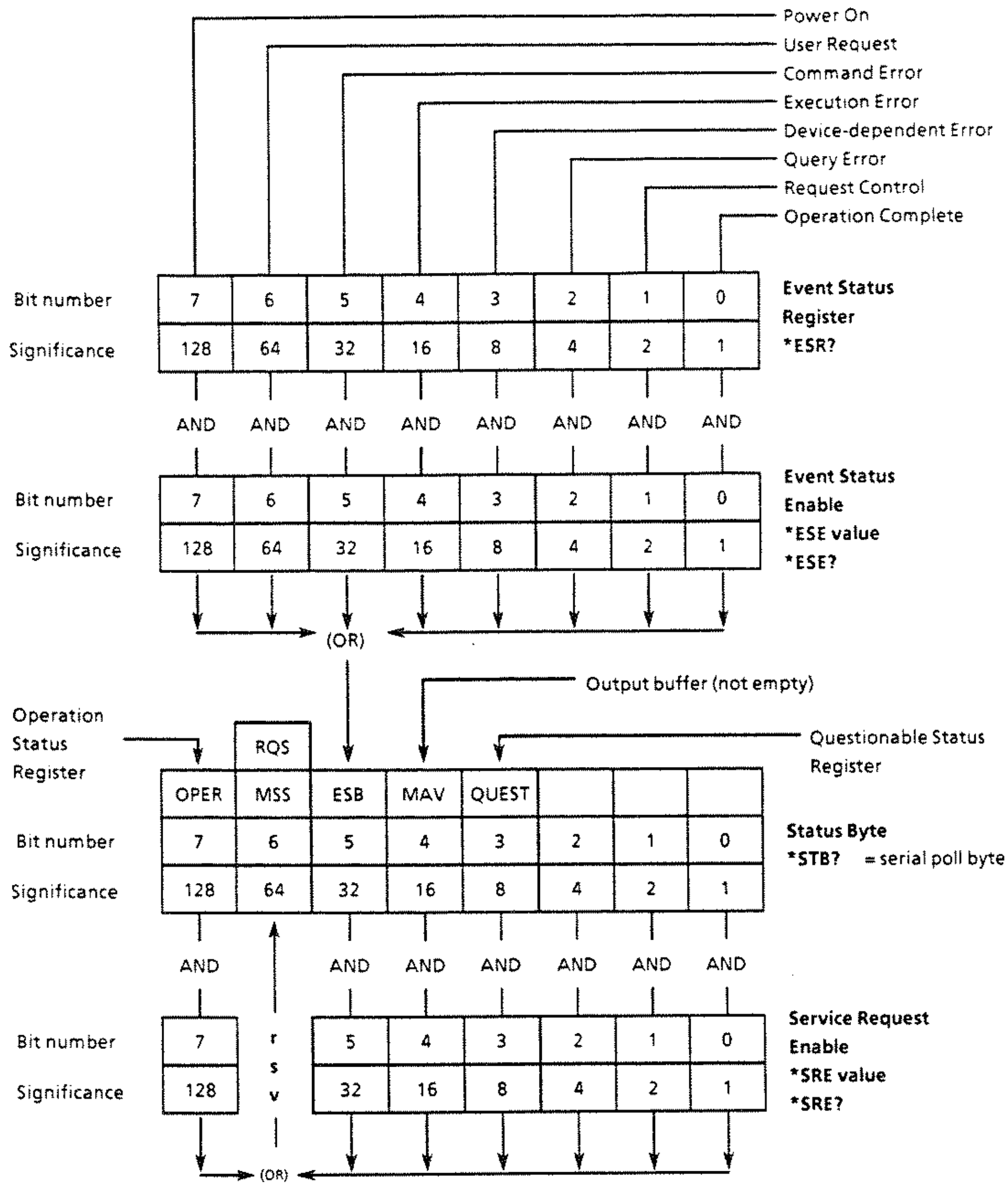


Fig. 3-4 Status registers

3.2.10 Resetting Device Functions

Table 3-4 gives various commands and events causing individual device functions to be reset:

Table 3-4 Resetting device functions

Event	Switching on the operating voltage		DCL, SDC (Device Clear, Selected Device Clear)	Commands		
	Power On Clear Flag			*RST	*CLS	
	0	1				
Device default setting	--	--	--	yes	--	--
ESR, STB	yes	yes	--	---	clear	---
ESE and SRE	--	clear	--	--	--	--
Clear output buffer	yes	yes	yes	--	yes	--
Clear service request	yes	1)	2)	--	3)	--
Reset command processing and input buffer	yes	yes	yes	--	--	--
OPER and QUES Enable register	--	clear	--	--	--	clear
OPER and QUES Event register	--	clear	--	--	clear	--

1) Yes, but "Service Request on Power On" is possible.
2) Yes, if only triggered by a message in the output buffer.
3) Yes, if not triggered by a message in the output buffer.

3.2.11 Command Processing Sequence and Synchronization

The commands received by the UPD are first stored in an input buffer which can accommodate up to 4096 characters. Once the terminator has been received, the commands are processed in the sequence in which they were sent. During this time, the IEC-bus can be used for communication with other devices. Command lines which exceed the capacity of the input buffer are processed in several sections. The bus is occupied during this time.

The commands *OPC and *OPC? (operation complete) are used as feedback information on when processing of the received commands was terminated and a scan (if any) has been completely executed.

*OPC sets bit 0 in the Event Status register triggering a service request when all pending commands have been executed.

*OPC? provides an additional message in the output buffer and sets bit 4 (MAV, Message Available) in the status byte.

This synchronization can be established within a command line by the command *WAI, i.e. all subsequent commands are only executed when the pending commands have been completely executed.

3.2.12 Programming Examples

The IEC/IEEE-bus option UPD-B4 includes a diskette containing files with examples. The file names end with the extension .BAS. The files provide information on programming the instrument and may contribute to the solution of more complex programming tasks. The files are based on each other and are provided with explanations.

Rohde & Schwarz-BASIC, version 2.00 or later has been used as programming language. However, the programs can be translated into other languages.

3.2.13 General Information on Remote Control of the UPD

In Section 3.3, the IEC-bus commands are grouped according to their functions. The commands are listed in the same order as in the description of manual operation (Section 2.5 to 2.15). For further information or for comparison purposes, reference is made to the sections on manual operation. Each remote control command usually has a corresponding command provided in the panels or by the softkeys.

Another list (Section 3.4) gives the IEC-bus commands in alphabetical order as well as possible error messages and their causes when related to the commands.

Section 3.5 describes the instrument default status, which the instrument assumes eg after command *RST.

What has been said in Section 2.3, General Instructions for Use, also applies to IEC-bus control. With many parameters making sense only in combination with others or changing the values or limit values of other parameters, it is of particular importance to stick to the order applying to the IEC-bus commands. If in doubt, set the commands in the same order as in the panels (from top to bottom) and send the commands concerning the DISPLAY panel after generator and analyzer commands.

In the UPD, INSTrument 1 refers to a generator which, depending on the selection, is either a analog or digital generator with 2 or 3 different frequency limits. Each of these altogether 5 generators has its own data protection system which, after selection of the respective generator, becomes active , ie overwrites the current settings and adopts the values most recently set with this generator. Each of these data sets in turn contains data sets of all functions (both active and inactive functions). On selection of a new function, the appertaining data set becomes active and resets the generator with the new data.

INSTrument 2 addresses the analyzer in the UPD. It offers 3 analog and 2 digital instruments to be selected alternatively. The appertaining data set becomes active, the one used before being stored to the hard disk. As explained above with the generator, the settings are changed in this case, too.

Generator commands usually begin with the key words SOURce or OUTPut. The generator can be switched to the different functions (eg sine, burst, square, DIM, etc.) using command SOURce:FUNCtion. Each of the functions has its own data set in order to avoid inconsistencies. As only commands and parameters suitable for the function can be selected, the ones most recently set for the function are fetched (and the ones used before are stored). In the panels, the commands and parameters set when changing the function are listed after the function command.

To allow a distinction to be made between functions and features of the same kind which are active at the same time a number (suffix) is appended to the key words. With the multi-sine function selected in the generator, this means that eg the third frequency is set using SOURce:FREQuency3 and the appertaining voltages are set by way of SOURce:VOLTage3.

Analyzer commands tend to begin with the key words SENSe or INPut. Several analyzers can be active at one time, thus supplying measured values at the same time. SENSe 1 is the main analyzer. Its function can be switched over as described below. SENSe 2 measures the input peak, SENSe 3 the frequency and SENSe 4 the phase. Measuring both channels simultaneously is possible. It is therefore necessary to select the desired channel using DATA1 or DATA2. To give an example, SENSe2:DATA1? is used to query the input peak voltage of the first channel and SENSe3:DATA2? serves to query the frequency of the second channel.

The main analyzer SENSe1 can be switched to different functions (eg rms voltage, modulation distortion, wow & flutter, etc.). Some commands or parameters make sense only in combination with particular functions. Therefore each function has its own data set. Changing the function causes the commands (following in the panel) to be reset to the values most recently used together with this function.

Commands referring to the analyzer ***Filter***s begin with the key words SENSe:FILTer. The numerals 1 to 4 appended to the word filter (filter suffix) serve to address the desired filter. It is also possible to address more than one filter at one time.

The key words CALCulate: TRANsform mark the commands for the ***FFT and Post-FFT:***

Commands for graphical representation (in the DISPLAY panel) generally begin with the words DISPlay[:WINDow]:TRACe1 (or :TRACe2). The key word WINDow can also be omitted. TRACe1 and TRACe2 refer to the first and second curve, respectively.

Commands concerning the loading or storing to the hard disk or diskette begin with the key word MEMory.

3.2.14 Reading Blocks of Measured Values (Lists)

If an entire block of measured values is available after a sweep or an FFT (spectral analysis), this list can be transmitted to the controller by means of a single query by the UPD. (See 3.3.9, Commands for Input/Output of (Block) Data).
The following example reads the measured values of the 1st row on the Y1-scale:

```
IEC OUT 20,"TRAC:DATA? TRAC1"
IEC IN 20,A$
```

with short-form notation being selected.
The values displayed on the Y2-axis can be fetched using parameter TRAC2 in the same way.

```
IEC OUT 20,"TRAC:DATA? LIST1"
```

is used correspondingly as a query for the X-axis.

FFT

The number of values that can be transmitted is limited to 1023, which has to be observed when reading in an FFT > = 2 k. However, there is a mode to limit the data quantity by only accepting the values above a selectable limit. This limit is selected using the UPPER LIMIT curve in the display panel and can also be a single value. Only the peaks exceeding this limit have to be transmitted in order to fade out noise, e.g. If, on the other hand, all values are to be transmitted, the limit must be selected sufficiently small (e.g. -200 dB). The list of the X-values only contains the frequencies belonging to the Y-values in this FFT mode as well.

Sweep

In contrast, all measured values are always stored in the blocks in the case of the sweeps. The three blocks described in the following always contain as many numbers as the sweep set specifies with its number of points.

The sweep values can be compared with a lower and an upper limit curve. If a measured value is out of these tolerances, a 1 is entered in the error block, otherwise 0 as specified according to the SCPI standard. The position at which this 0 or 1 is (the index) corresponds to the index of the Y and X-blocks.
Example:

```
IEC OUT 20,"CALC:LIM:REP?"
IECI IN 20,A$
IEC OUT 20,"TRAC:POIN? TRAC1"
IEC IN 20,A$
A=VAL(A$)
```

reads the error report block and the number of values.

3.2.14 SCPI Conformance

The commands are based on SCPI version 1991.0.

The commands confirmed or approved by the SCPI committee are given in normal letters in the following list.

The commands which are too specific for general-purpose instruments or specifically designed for innovations are listed in italics. They are not part of the SCPI definition.

3.3 IEC-bus Commands

3.3.1 Generators

3.3.1.1 Selecting the Generator

Command	Parameter	Basic unit	Meaning	Section
INSTrument[1][:SELect]	A25		Generator Analog 25 kHz	2.5.1 GENERATOR
	A110		Generator Analog 110 kHz	
equivalent to	D48		Generator Digital 48 kHz	
	D192		Generator Digital 192 Hz	
	D768		Generator Digital 768 kHz	
INSTrument[1] :NSELect	1		Generator Analog 25 kHz	2.5.1 GENERATOR
	2		Generator Analog 110 kHz	
	3		Generator Digital 48 kHz	
	4		Generator Digital 192 Hz	
	5		Generator Digital 768 kHz	

3.3.1.2 Configuration of Analog Generators

Command	Parameter	Basic unit	Meaning	Section
OUTPut:*SELect*	*OFF* *CH1* *CH2* *CH2Is1* *CH2Phas180*		Generator channels switched off Only generator channel1 active Only generator channel2 active Both generator channels active Both generator channels active, channel 2 in phase opposition to channel 1	2.5.2 Channel(s)
OUTPut:*TYPE*	*BALanced* *UNBalanced* *CTESt*		Balanced output (XLR connector) Unbalanced output (BNC connector) Common mode test output	2.5.2 Output
OUTPut:IMPedance	*R5* *R10* *R15* *R30* *R200* *R600* *USERdefined*		Output impedance 5 Ω (UNB only) Output impedance 10 Ω (BAL only) Output impedance 15 Ω (UNB only) Output impedance 30 Ω (BAL only) Output impedance 200 Ω (BAL only) Output impedance 600 Ω (BAL only) Output impedance user defined	2.5.2 Impedance
OUTPut:LOW	FLOat GROund		Common floating Common grounded	2.5.2 Common
SOURce:VOLTage:LIMit[:AMPLitude]	<nu> 0 to 1 FS 0 to 24 V	 V V	 Voltage limitation (INST D48 | D192 | D768) Voltage limitation (INST A25|A110)	2.5.2 Max Volt
SOURce:FREQuency:*REFerence*	<nu> 1 mHz to 1 MHz	 Hz	 Reference frequency	2.5.2 Ref.Freq
SOURce:VOLTage:REFerence	<nu> 1µV to 1 MV	 V	 Reference voltage	2.5.2 Ref.Volt

3.3.1.3 Configuration of Digital Generators

Command	Parameter	Basic unit	Meaning	Section
OUTPut:*SELect*	*OFF* *CH1* *CH2* *CH2Is1* *CH2Phas180*		Generator channels switched off Only generator channel1 active Only generator channel2 active Both generator channels active and in phase Both generator channels active, channel 2 in phase opposition to channel 1	2.5.3 Channel(s)
OUTPut:*TYPE*	*PARallel* *MPARallel* *SERial* *MSERial* *AESebu* *SPDif* *OPTical* *INTernal*		Parallel digital output active Parallel digital output active; multiplex mode Serial digital output active Serial digital output active; multiplex mode AES/EBU output active S/P DIF output active Optical digital output active Digital outputs inactive, generator signal is internally applied to analyzer	2.5.3 Output
OUTPut:*SAMPle:MODE*	*F32* *F44* *F48* *EXTern* *SYNChron*		Sample frequency 32 kHz Sample frequency 44.1 kHz Sample frequency 48 kHz Sample frequency external Sample frequency synchronized with analyzer	2.5.3 Sample Freq
OUTPut:*SAMPle:FREQuency*	<nu> 100 Hz to 48 kHz 100 Hz to 192 kHz 100 Hz to 768 kHz	 Hz Hz Hz	 External sample frequency (for INST:SEL:D48) External sample frequency (for INST:SEL:D192) External sample frequency (for INST:SEL:D768)	2.5.3
OUTPut:*OSAMpling*	*N1* *N2* *N4* *N8* *N16*		Generator oversampling factor 1 Generator oversampling factor 2 Generator oversampling factor 4 Generator oversampling factor 8 Generator oversampling factor 16	2.5.3 Oversamp
SOURce:VOLTage:LIMit[:AMPLitude]	<nu> 0 to 1 FS	 FS	 Voltage limitation	2.5.3 Max Volt
SOURce:*FREQuency:REFerence*	<nu> 1 mHz to 1 MHz	 Hz	 Reference frequency	2.5.3 Ref.Freq
OUTPut:*AUDiobits*	<n>		Word length of audio samples in bits	

3.3.1.4 Further Commands Relating to the Interfaces to the Generators

3.3.1.4.1 Serial Interfaces (Serial, Serial Mux)

Command	Parameter	Basic unit	Meaning	Section
OUTPut:*WLENgth*	*L8* *L16* *L24* *L32*		Word length 8 bit Word length 16 bit Word length 24 bit Word length 32 bit	2.5.3 Word length
OUTPut:*WOFFset*	<*n*> -N/2 to + N/2; N = OUTP:WLEN		Word offset	2.5.3 Word offset
OUTPut:*WSELect* (only for Serial Mux)	*LOW* *HIGH*		Word Select Ch1 has LOW level Word Select Ch1 has HIGH level	2.5.3 WordselCh1
OUTPut:*WCLock* (only for Serial)	*RISing* *FALLing*		Data word is accepted with rising or falling edge	2.5.3 Word clock
OUTPut:*BCLock*	*RISing* *FALLing*		Bits are output with rising or falling edge	2.5.3 Bit clock
OUTPut:*BCLock:FREQuency?*		Hz	Frequency of bit clock, query only	2.5.3 Frq Bit clk
OUTPut:*BITOrder*	*MSBFirst* *LSBFirst*		Data word is sent with MSB first Data word is sent with LSB first	2.5.3 Bit order

3.3.1.4.2 Parallel Interfaces (Parallel, Parallel Mux)

Command	Parameter	Unit	Meaning	Section
OUTPut:*WSELect* (only for Parallel Mux)	*LOW* *HIGH*		Word Select CH1 has LOW level Word Select CH1 has HIGH level	2.5.3 Wordsel CH1
OUTPut:*WCLock*	*RISing* *FALLing*		Data word is accepted with rising or falling edge	2.5.3 Word clock

3.3.1.4.3 AES / EBU-, S / P DIF and Optical Interfaces

Command	Parameter	Basic Unit	Meaning	Section
OUTPut:*SIGNal*:LEVel	<nu> 20 mV to 5.1 V 10 mV to 1.5 V	V	Signal level of digital data stream OUTP:CONF AES OUTP:CONF SPD	2.5.3
OUTPut:*VALidity*	 *N1ANd2* *N1* *N2* *NONE*		Sets the validity identification within the AES/EBU data stream. Validity bit is set for both channels Validity bit is set for channel 1 only Validity bit is set for channel 2 only Validity bit is set for no channel at all	2.5.3 Validity

3.3.1.4.4 AES / EBU PROTOCOL Definition

Command	Parameter	Basic unit	Meaning	Section
SOURce: *PROTocol: PARity*	 ON FAIL		Specifies whether the protocol is to be generated with parity errors. All samples with correct parity. Setting the error rate with the commands described below: ...NFCount, ... FCOunt and ... FOFFset	see 2.5.4 Parity
SOURce: *PROTocol: PARity: NFCount*	<n> 100 to 10 000 000		Specifies the number of samples with correct parity bit.	see 2.5.4 No. Trues
SOURce: *PROTocol: PARity: FCOunt*	<n> 0 to 1000		Specifies the number of samples with false parity bit.	see 2.5.4 No. False
SOURce: *PROTocol: PARity: FOFFset*	<n> 0 to 100 000 000		Specifies the number of samples with correct parity bit up to the first parity error.	see 2.5.4 Offset
SOURce: *PROTocol: FBLock*	<n> 0 to 100 000		Defines the interval (in blocks) in which errors in the beginning-of-block preamble sequence are generated.	see 2.5.4 Block Err
SOURce: *PROTocol: FCRC*	<n> 0 to 100 000		Defines the interval (in blocks) in which errors in the CRC of the status data are generated.	see 2.5.4 CRC Error
SOURce: *PROTocol: OBLock*	<n> 0 to 100 000		Defines the interval (in blocks) in which errors in the preamble sequence are generated.	see 2.5.4 Seq Err

Command	Parameter	Basic unit	Meaning	Section
SOURce: ***PROTocol: LCHanelstatus***			Specifies how the channel status data LEFT are to be generated.	see 2.5.4 Ch Sta. L
	ZERO		All channel status data bits are 0.	→ ZERO
	AES3		UPD generates local timecode and CRC. The other channel status data are defined by the file that is loaded using command MMEMory: LOAD: LPGC "filename".	→ FILE + AES3
	CRC		Same as AES3-..., however local timecode is not generated by UPD, but is set as a fixed value from the file.	→ FILE + CRC
	RAW		Same as AES3-..., however neither local timecode nor CRC are generated by UPD, but are set as fixed value from the file.	→ FILE
MMEMory: LOAD: ***LPGC***	**"filename"**		Specifying a file containing channel status data for LEFT. Preset type of file: *.prd	see 2.5.4 Filename
SOURce: ***PROTocol: RCHanelstatus***			Specifies how the channel status data RIGHT are to be generated	see 2.5.4 Ch Stat. R
	ZERO		All channel status data bits are 0.	→ ZERO
	LEQual		Both sides are equal. All definitions made for LEFT are copied to the right side. The operating mode is defined by Ch. Stat L.	→ EQUAL L
	AES3		UPD generates local timecode and CRC. The other channel status data are defined by the file that is loaded using command MMEMory: LOAD: RPGC "filename".	→ FILE + AES3
	CRC		Same as AES3-..., however local timecode is not generated by UPD, but is set as a fixed value from the file.	→ FILE + CRC
	RWA		Same as AES3-..., however neither local timecode nor CRC are generated by UPD, but are set as fixed values from the file.	→ FILE
MMEMory: LOAD: ***RPGC***	**"filename"**		Specifying a file containing channel status data for RIGHT. Preset type of file: *.prd	see 2.5.4 Filename
SOURce: ***PROTocol: UMODe***			Specifies how user data are to be generated.	see 2.5.4 User Mode
	ZERO		All user bits are initialized to be 0.	
	FILE		User bits are output according to the definitions in the file that is loaded using command MMEMory: LOAD: PGU "filename".	

Command	Parameter	Basic Unit	Meaning	Section
MMEMory: LOAD *PGU*	"filname"		Stating a file containing USER data Preset data type: *.prd	see 2.5.4 Filname
DISPlay: *PROTocol: ERRor: GENeral?*			Only query command Indicates the errors having occurred. Response via IEC bus: "UBB" : Unexpected preamble for start of block (too early) "SQB" : Missing preamble (gap) for start of block "NSYN": Missing preamble for start of block "PRMB": Invalid preamble "SQLR" : Error in the channel sequence (L/R) "RERR" : Measured clock rate and set rate deviate by more than 200 ppm from one another. "NONE": No error	see 2.10 OPERATION → PROTOCOL
DISPlay: *PROTocol: ERRor: PARity?*			Only query error Indicates the sum of the preceding parity errors; this number is reset to zero when the analyzer is reselected or the start key is pressed.	see 2.10 OPERATION → PROTOCOL
DISPlay: *PROTocol: ERRor: LCRC?*			Only query error Internal error counter of the CRC errors at the left	see 2.10 OPERATION → PROTOCOL
DISPlay: *PROTocol: ERRor: RCRC?*			Only query error Internal error counter of the CRC errors at the right	see 2.10 OPERATION → PROTOCOL
DISPlay: *PROTocol: ERRor: CHSTatus?*			Only query error Indicates whether there is a change in the channel status data. Response via IEC bus: "NO" : No change "LTC" : Only changes in the fields local time code (bits 112 to 143) and CRC (bits 184 to 191). "YES" : Changes in another bit position	see 2.10 OPERATION → PROTOCOL

Command	Parameter	Basic Unit	Meaning	Section
DISPlay: *PROTocol: ERRor: LR?*			Only query error Channel status data between left and right channel are ... Response via IEC bus: "EQUAL" : equal "DIFF" : different	see 2.10 OPERATION → PROTOCOL
DISPlay: *PROTocol: ERRor: LVALbit?*			Only query error Indicates how the validity bit is placed in the left channel. Response via IEC bus: "Y0" "N1"	see 2.10 OPERATION → PROTOCOL
DISPlay: *PROTocol: ERRor: RVALbit?*			Only query error Indicates how the validity bit is placed in the right channel. Response via IEC bus: "Y0" "N1"	see 2.10 OPERATION → PROTOCOL

3.3.1.5 Generator Sweeps

Command	Parameter	Basic unit	Meaning	Section
SOURce:SWEep:MODE	MANual AUTO		Manual sweep Automatic sweep	2.5.4.2 Sweep Ctrl
SOURce:SWEep:*NEXTstep*	*DWELl* *ASYNc* *LIST*		Sweep continues after a certaom (fixed) time has elapsed. Sweep continues after a valid measured value has been obtained. Sweep continues after a certain time defined by interpolated list value.	2.5.4.2 Next Step
SOURce:SWEep:DWELl	<nu> 0 to 1000 s	s	Dwell time per sweep step	2.5.4.2 Dwell
MMEMory:*LOAD:LIST DWELl*	*"filename"*		Specified file contains the dwell times	2.5.4.2
SOURce:FREQuency:MODE	CW FIXed SWEep1 SWEep2 LIST1 LIST2		Frequency setting via entry Frequency setting via normal sweep Frequency as X-axis Frequency setting via normal sweep Frequency as Z-axis Frequency setting via list sweep Frequency as X-axis Frequency setting via list sweep Frequency as Z-axis	2.5.4.2
SOURce:VOLTage:MODE	CW FIXed SWEep1 SWEep2 LIST1 LIST2		Amplitude setting via entry Amplitude setting via normal sweep Amplitude as X-axis Amplitude setting via normal sweep Amplitude as Z-axis Amplitude setting via list sweep Amplitude as X-axis Amplitude setting via list sweep Amplitude as Z-axis	2.5.4.2

Command	Parameter	Basic unit	Meaning	Section
SOURce:*ONTime*:MODE	CW FIXed		Burst time setting via entry	2.5.4.2
	SWEep1		Burst time setting via normal sweep Burst time as 1st parameter	
	SWEep2		Burst time setting via normal sweep Burst time as 2nd parameter	
	LIST1		Burst time setting via list sweep Burst time as 1st parameter	
	LIST2		Burst time setting via list sweep Burst time as 2nd parameter	
SOURce:*INTerval*:MODE	CW FIXed		Interval setting via entry	2.5.4.2
	SWEep1		Interval setting via normal sweep Interval as 1st parameter	
	SWEep2		Interval setting via normal sweep Interval as 2nd parameter	
	LIST1		Interval setting via list sweep Interval as 1st parameter	
	LIST2		Interval setting via list sweep Interval as 2nd parameter	

Note: Max. 2 sweep parameters can be selected to be not CW (= FIXed). Combining SWEep and LIST is not permissible. Likewise, assignment of the same selection point (eg SWEep1) to different sweep parameters is not permissible; the selection made most recently is valid, the other sweep parameters are set to FIXed.

A normal sweep (or list sweep) is possible only when exactly 1 sweep parameter is set to SWEep1 (or LIST1).
The sweep system is switched off when all sweep parameters are set to CW (= FIXed).

Sweep settings for SOUR:FUNCT:SINusoid|BURSt|SQRBurst|SQUare|MDISt|DFD|DIM only (see 2.5.4.2)

Command	Parameter	Basic unit	Meaning	Section
SOURce:FREQuency:STARt	<nu> function-specific	Hz	Start value for frequency sweep	2.5.4.2/3/5/6/ 7/8/9/10
SOURce:FREQuency:STOP	<nu> function-specific	Hz	Stop value for frequency sweep	2.5.4.2/3/5/6/ 7/8/9/10
SOURce:SWEep:*FREQuency*:POINts	<n> 2 to 1024		Number of sweep points for frequency sweep	2.5.4.2 Points
SOURce:SWEep:*FREQuency*:SPACing	**LIN**ear **LOG**arithmic		Frequency sweep range spacing -linear -logarithmic	2.5.4.2 Spacing
SOURce:SWEep:*FREQuency*:STEP	<nu>	Hz	Step size for frequency sweep	2.5.4.2 Step

Sweep settings for SOUR:FUNC:SINusoid|BURSt|SQRBurst|SQUare|MDISt|DFD only (see 2.5.4.2)

Command	Parameter	Basic unit	Meaning	Section
SOURce:VOLTage:STARt	<nu> generator-specific function-specific 0 to 1 FS	 V FS	Start value for amplitude sweep Analog range Digital range	2.5.4.2/3/5/6/ 7/8/9/10
SOURce:VOLTage:STOP	<nu> generator-specific function-specific 0 to 1 FS	 V FS	Stop value for amplitude sweep Analog range Digital range	2.5.4.2/3/5/6/ 7/8/9/10
SOURce:SWEep:*VOLTage*:POINts	<n> 2 to 1024		Number of sweep points for amplitude sweep	2.5.4.2 Points
SOURce:SWEep:*VOLTage*:SPACing	**LIN**ear **LOG**arithmic		Amplitude sweep range spacing -linear -logarithmic	2.5.4.2 Spacing
SOURce:SWEep:*VOLTage*:STEP	<nu> generator-specific function-specific 0 to 1 FS	 V FS	Step size for amplitude sweep Analog range Digital range	2.5.4.2 Step

Sweep settings for SOUR:FUNCT:BURST|SQRBurst only

Command	Parameter	Basic unit	Meaning	Section
SOURce:*ONTime*:STARt	<nu> generator-specific	s, cyc	Start value for burst time sweep	2.5.4.2/5/6
SOURce:*ONTime*:STOP	<nu> generator-specific	s, cyc	Stop value for burst time sweep	2.5.4.2/5/6
SOURce:SWEep:*ONTime*:POINts	<n> 2 to 1024		Number of sweep points for burst time sweep	2.5.4.2 Points
SOURce:SWEep:*ONTime*:SPACing	LINear LOGarithmic		Burst time sweep range spacing -linear -logarithmic	2.5.4.2 Spacing
SOURce:SWEep:*ONTime*:STEP	<nu>	s, cyc	Step size for burst time sweep	2.5.4.2 Step
SOURce:*INTerval*:STARt	<nu> generator-specific	s	Start value for interval sweep	2.5.4.2 2.5.4.5/6
SOURce:*INTerval*:STOP	<nu> generator-specific	s	Stop value for interval sweep	2.5.4.5/6
SOURce:SWEep:*INTerval*:POINts	<n> 2 to 1024		Number of sweep points for interval sweep	2.5.4.2 Points
SOURce:SWEep:*INTerval*:SPACing	LINear LOGarithmic		Interval sweep range spacing -linear -logarithmic	2.5.4.2 Spacing
SOURce:SWEep:*INTerval*:STEP	<nu>	s	Step size for interval sweep	2.5.4.2 Step

Note: Range of values for "START", "STOP": The range of values are specified in the sections on the functions.
Range of values for "STEP": The permissible step size is determined by "START" and "STOP".

3.3.1.6 Generator Functions

Command	Parameter	Basic unit	Meaning	Section
SOURce:FUNCtion [:SHAPe]			Generator signal:	3.2.4.4 FUNCTION
	SINusoid		Sinusoidal tone	
	MULTisine		Multi-tone (up to 17 sine lines)	
	BURSt		Sine burst	
	SQRBurst		Sine^2 burst	
	SQUare		Square	
	MDISt		Double sine (similar to SMPTE)	
	DFD		Double sine (difference frequency distortion method)	
	DIM		Sine and square (DIM standards)	
	RANDom		Noise	
	USER		User-defined signals	
	POLarity		Polarity test signal	
	FM		Frequency modulation	

3.3.1.6.1 Common Parameters for Sine, DFD und MOD DIST

Command	Parameter	Basic unit	Meaning	Section
SOURce:FREQuency:*OFFSet:STATe*	*ON* *OFF*		Frequency offset 0.1 % No frequency offset	2. Frq. Offset
SOURce:*SINusoid:DITHer:STATe* SOURce:*SINusoid:DITHer*	*ON* *OFF* *<nu>* 0 to 1 FS	FS	Signal is superposed by noise Noise superposition off Noise amplitude	2. Dither
SOURce:*RANDom:PDF*	GAUSsian TRIangle RECTangle		Gaussian noise distribution Triangular noise distribution Equivalent noise distribution	2. PDF
SOURce:*LOWDistortion*	*ON* *OFF*		1st sine is generated by low-distortion generator (LDG) All signals are generated by the function generator	2. Low Dist
SOURce:FREQuency:*QUALity*	*PRECision* *FAST*		Frequency of LDG is fine-adjusted (maximum precision) Frequency of LDG is roughly adjusted (maximum speed)	2.5.4.1 Settling

Command	Parameter	Basic Unit	Meaning	Section
SOURce:VOLTage[:LEVel] [:AMPLitudel]:OFFSet:STATe	ON OFF		Settable d.c. voltage content effective The set d.c. voltage content is ineffective	see 2.5.4.1.1
SOURce:VOLTage[:LEVel] [:AMPLitudel]:OFFSet	 -5 V to 5 V -10 V to 10 V -1 V to 1FS	 V V FS	Amplitude of the d.c. voltage content Analog range (OUTP:CONF UNB[CTES) Analog range (OUTP:CONF BAL) Digital range	see 2.5.4.1.1

3.3.1.6.1.1 Common Parameters For Sine, DFD And MOD DIST

Command	Parameter	Basic Unit	Meaning	Section
SOURce:FREQuency:*OFFSet:STATe*	*ON* *OFF*		Frequency offset 0.1 % No frequency offset	2nd Frq Offset
SOURce:*SINusoid:DITHer:STATe* SOURce:*SINusoid:DITHer*	*ON* *OFF* *<nu>* 0 to 1 FS	 FS	Noise is superimposed on the signal Noise superimposition off Amplitude of noise	2nd Dither
SOURce:*RANDom:PDF*	GAUSsian TRIangle RECTangle		Gaussian noise distribution Triangular noise distribution Equivalent noise distribution	2nd PDF
SOURce:*LOWDistortion*	*ON* *OFF*		1st sine is generated using LDG All signals are generated using the function generator	2nd Low Dist
SOURce:FREQuency:*QUALity*	*PRECision* *FAST*		Frequency of the LDG is reset (maximal accuracy) Frequency of the LDG is coarsely set (maximal rate)	2.5.4.1 Settling

3.3.1.6.2 SINE

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SOURce:LOWDistortion</td><td>ON
OFF</td><td></td><td>Sine signal is generated by LDG
Sine signal is generated by function generator</td><td>2.5.4.1/
2.5.4.3</td></tr>
<tr><td>SOURce:FREQuency[:CW | FIXed]</td><td><nu>
f_{min} to f_{max}</td><td>
Hz</td><td>
Sine frequency</td><td>2.5.4.3</td></tr>
<tr><td>SOURce:FREQuency:STARt</td><td><nu>
f_{min} to f_{max}</td><td>
Hz</td><td>
Start value for frequency sweep</td><td>2.5.4.2</td></tr>
<tr><td>SOURce:FREQuency:STOP</td><td><nu>
f_{min} to f_{max}</td><td>
Hz</td><td>
Stop value for frequency sweep</td><td>2.5.4.2</td></tr>
<tr><td>MMEMory:LOAD:LIST FREQuency</td><td>"filename"</td><td></td><td>File with frequency sweeps</td><td>2.5.4.3</td></tr>
<tr><td>SOURce:VOLTage:EQUalize:STATe</td><td>ON
OFF</td><td></td><td>Sine signal is equalized
Sine signal not dependent on frequency</td><td>2.5.4.3</td></tr>
<tr><td>MMEMory:LOAD:LIST EQUalize</td><td>"filename"</td><td></td><td>File with equalizer data</td><td>2.5.4.3</td></tr>
<tr><td>SOURce:VOLTage[:LEVel][:AMPLitude]</td><td><nu>
0 to 12 V
0 to 24 V
0 to 1 FS</td><td>
V
V
FS</td><td>Sine amplitude
Analog range (OUTP:CONF:UNB|CTES)
Analog range (OUTP:CONF:BAL)
Digital range</td><td>2.5.4.3</td></tr>
<tr><td>SOURce:VOLTage:STARt</td><td><nu>
0 to 12 V
0 to 24 V
0 to 1 FS</td><td>
V
V
F</td><td>Start value for amplitude sweep
Analog range (OUTP:CONF:UNB|CTES)
Analog range (OUTP:CONF:BAL)
Digital range</td><td>2.5.4.2</td></tr>
<tr><td>SOURce:VOLTage:STOP</td><td><nu>
0 to 12 V
0 to 24 V
0 to 1 FS</td><td>
V
V
FS</td><td>Stop value for amplitude sweep
Analog range (OUTP:CONF:UNB|CTES)
Analog range (OUTP:CONF:BAL)
Digital range</td><td>2.5.4.2</td></tr>
<tr><td>MMEMory:LOAD:LIST VOLTage</td><td>"filename"</td><td></td><td>File with amplitude values</td><td>2.5.4.3</td></tr>
</table>

Note: f_{min}, f_{max} depend on the generator (s. 2.5.1)

Caution: "SOUR:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.3 MULTISINE

Command	Parameter	Basic unit	Meaning	Section
SOURce:*MULTisine:MODE*	*EQUal*voltage *DEFined*voltage		1 to 17 frequencies of equal voltage 1 to 17 frequencies and voltages	2.5.4.4
SOURce:*MULTisine:COUNt*	<n> 1 to 17		Number of settable frequencies	2.5.4.4
SOURce:FREQuency[<i>][:CW | FIXed]	<nu> 10 to f_{max} 25 to f_{max} 50 to f_{max}	Hz	i^{th} sine frequency; i = 2 to 17, no index for i = 1 for INST A25|D48 for INST A110|D192 for INST D768	
SOURce:VOLTage[<i>][:LEVel][:AMPLitude]	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	i^{th} sine voltage; i = 2 to 17, no index for i = 1 Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.4
SOURce:VOLTage:*TOTal:GAIN*	<nu>	dB	Subsequent amplification of all sine lines (<0 → attenuation); upper range limit depends on individual rules as to sine and sine frequencies as well as SOURCE:VOLT:LIM	2.5.4.4
SOURce:VOLTage:*TOTal*[:LEVel][:AMPLitude]?	<nu>	 V FS	Total peak amplitude; query only (for analog generators) (for digital generators)	2.5.4.4
SOURce:VOLTage:*TOTal:RMS?*	<nu>	 V FS	Total rms amplitude; query only (for analog generators) (for digital generators)	2.5.4.4

Note: f_{max} depends on generator (s. 2.5.4.1)
The maximum amplitude can be set for SOUR<i>:VOLT only when all other sinewaves have an amplitude of 0. Otherwise, V_{max} must be reduced by the sum of the remaining single voltages.

Caution: SOUR:VOLT:TOT is voltage-limited by SCPI command "SOUR:VOLT:LIM"
With the single amplitudes being unknown, all sinewaves should be set explicitly to 0 before setting the maximum amplitude.
1. SOUR:MULT:MODE EQU
2. SOUR1:VOLT 0

3.3.1.6.4 SINE BURST

Command	Parameter	Basic unit	Meaning	Section
SOURce:FREQuency[:CW | FIXed]	<nu> 2 to f_{max} 50 to f_{max}	Hz	Sine frequency for INST A25|A110|D48|D192 for INST D768	2.5.4.5
SOURce:FREQuency:STARt	<nu> 2 to f_{max} 50 to f_{max}	Hz	Start value for frequency sweep for INST A25|A110|D48|D192 for INST D768	2.5.4.2
SOURce:FREQuency:STOP	<nu> 2 to f_{max} 50 to f_{max}	Hz	Stop value for frequency sweep for INST A25|A110|D48|D192 for INST D768	2.5.4.2
MMEMory:LOAD:*LIST FREQuency*	"filename"		File with frequency values	2.5.4.5
SOURce:VOLTage[:LEVel][:AMPLitude]	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Burst amplitude (amplitude during High phase of signal) Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.5
SOURce:VOLTage:STARt	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Start value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
SOURce:VOLTage:STOP	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Stop value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
MMEMory:*LOAD:LIST VOLTage*	"filename"		File with amplitude values	2.5.4.5
SOURce:VOLTage:*LOWLevel*	<nu> 0 to SOUR:VOLT	 V %on FS %on	 Amplitude during LOW phase of signal Analog range Digital range	2.5.4.5
SOURce:*ONTime*[:CW | FIXed]	<nu> 10.417 µs to 60 s 2.604 µs to 60 s 1/clock rate to 60 s 1/clock rate to 20 ms	s, cyc	Burst time for INST A25 for INST A110 for INST D48|D192 for INST D768	2.5.4.5

Command	Parameter	Basic unit	Meaning	Section
SOURce:*ONTime*:STARt	<nu> 10.417 µs to 60 s 2.604 µs to 60 s 1/clock rate to 60 s 1/clock rate to 20 ms	s, cyc	Start value for burst time sweep for INST A25 for INST A110 for INST D48|D192 for INST D768	2.5.4.2
SOURce:*ONTime*:STOP	<nu> 10.417 µs to 60 s 2.604 µs to 60 s 1/clock rate to 60 s 1/clock rate to 20 ms	s, cyc	Stop value for burst time sweep for INST A25 for INST A110 for INST D48|D192 for INST D768	2.5.4.2
MMEMory:LOAD:LIST ONTime	"filename"		File with burst time values	2.5.4.5
SOURce:INTerval[[:CW | FIXed]	<nu> SOUR:ONT to 60 s SOUR:ONT to 20 ms	s	Interval time for INST A25|A110|D48|D192 for INST D768	2.5.4.5
SOURce:INTerval:STARt	<nu> SOUR:ONT to 60 s SOUR:ONT to 20 ms	s	Start value for interval sweep for INST A25|A110|D48|D192 for INST D768	2.5.4.2
SOURce:INTerval:STOP	<nu> SOUR:ONT to 60 s SOUR:ONT to 20 ms	s	Stop value for interval sweep for INST A25|A110|D48|D192 for INST D768	2.5.4.2
MMEMory:LOAD:*LIST INTerval*	"filename"		File with interval time values	2.5.4.5

Note: Clock rate, f_{max} depends on generator (s. 2.5.1).
Caution: "SOUR:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.5 SINE^2 BURST

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SOURce:FREQuency[:CW|FIXed]</td><td><nu>
2 to f_{max}
50 to f_{max}</td><td>Hz</td><td>Burst frequency
for INST A25|A110|D48|D192
for INST D768</td><td>2.5.4.6</td></tr>
<tr><td>SOURce:FREQuency:STARt</td><td><nu>
2 to f_{max}
50 to f_{max}</td><td>Hz</td><td>Start value for frequency sweep
for INST A25|A110|D48|D192
for INST D768</td><td>2.5.4.2</td></tr>
<tr><td>SOURce:FREQuency:STOP</td><td><nu>
2 to f_{max}
50 to f_{max}</td><td>Hz</td><td>Stop value for frequency sweep
for INST A25|A110|D48|D192
for INST D768</td><td>2.5.4.2</td></tr>
<tr><td>MMEMory:LOAD:LIST FREQuency</td><td>"filename"</td><td></td><td>File with frequency values</td><td>2.5.4.6</td></tr>
<tr><td>SOURce:VOLTage[:LEVel][:AMPLitude]</td><td><nu>
0 to 12 V
0 to 24 V
0 to 1 FS</td><td>
V
V
FS</td><td>Burst amplitude
Analog range (OUTP:CONF:UNB|CTES)
Analog range (OUTP:CONF:BAL)
Digital range</td><td></td></tr>
<tr><td>SOURce:VOLTage:STARt</td><td><nu>
0 to 12 V
0 to 24 V
0 to 1 FS</td><td>
V
V
FS</td><td>Start value for amplitude sweep
Analog range (OUTP:CONF:UNB|CTES)
Analog range (OUTP:CONF:BAL)
Digital range</td><td>2.5.4.2</td></tr>
<tr><td>SOURce:VOLTage:STOP</td><td><nu>
0 to 12 V
0 to 24 V
0 to 1 FS</td><td>
V
V
FS</td><td>Stop value for amplitude sweep
Analog range (OUTP:CONF:UNB|CTES)
Analog range (OUTP:CONF:BAL)
Digital range</td><td>2.5.4.2</td></tr>
<tr><td>MMEMory:LOAD:LIST VOLTage</td><td>"filename"</td><td></td><td>File with amplitude values</td><td>2.5.4.6</td></tr>
<tr><td>SOURce:ONTime[:CW|FIXed]</td><td><nu>
10.417 µs to 60 s
2.604 µs to 60 s
1/clock rate to 60 s
1/clock rate to 20 ms</td><td>s ,cyc</td><td>Burst time
for INST A25
for INST A110
for INST D48|D192
for INST D768</td><td>2.5.4.6</td></tr>
<tr><td>SOURce:ONTime:STARt</td><td><nu>
10.417 µs to 60 s
2.604 µs to 60 s
1/clock rate to 60 s
1/clock rate to 20 ms</td><td>s, cyc</td><td>Start value for burst time sweep
for INST A25
for INST A110
for INST D48|D192
for INST D768</td><td>2.5.4.2</td></tr>
<tr><td>SOURce:ONTime:STOP</td><td><nu>
10.417 µs to 60 s
2.604 µs to 60 s
1/clock rate to 60 s
1/clock rate to 20 ms</td><td>s ,cyc</td><td>Stop value for burst time sweep
for INST A25
for INST A110
for INST D48|D192
for INST D768</td><td>2.5.4.2</td></tr>
</table>

Command	Parameter	Basic unit	Bemerkung	Section
MMEMory:LOAD:*LIST ONTime*	"filename"		File with burst time values	2.5.4.6
SOURce:*INTerval*[:CW | FIXed]	<nu> SOUR:ONT to 60 s SOUR:ONT to 20 ms	s	Interval time for INST A25|A110|D48|D192 for INST D768	2.5.4.6
SOURce:*INTerval*:STARt	<nu> SOUR:ONT to 60 s SOUR:ONT to 20 ms	s	Start value for interval sweep for INST A25|A110|D48|D192 for INST D768	2.5.4.2
SOURce:*INTerval*:STOP	<nu> SOUR:ONT to 60 s SOUR:ONT to 20 ms	s	Stop value for interval sweep for INST A25|A110|D48|D192 for INST D768	2.5.4.2
MMEMory:LOAD:LIST INTerval	"filename"		File with interval values	2.5.4.6

Note: f_{max} depends on generator (s. 2.5.1)
Caution: "SOURC:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"
When entering negative amplitude values, the pulse is inverted.

3.3.1.6.6 SQUARE

Command	Parameter	Basic unit	Meaning	Section
SOURce:FREQuency[:CW | FIXed]	<n>u 2 Hz to 10 kHz 2 Hz to clock rate/4 50 Hz to clock rate/4	Hz	Square frequency for INST A25 for INST D48, INST D192 for INST D768	2.5.4.7
SOURce:FREQuency:STARt	<nu> 2 Hz to 10 kHz 2 Hz to clock rate/4 50 Hz to clock rate/4	Hz	Start value for frequency sweep for INST A25 for INST D48, INST D192 for INST D768	2.5.4.2
SOURce:FREQuency:STOP	<nu> 2 Hz to 10 kHz 2 Hz to clock rate/4 50 Hz to clock rate/4	Hz	Stop value for frequency sweep for INST A25 for INST D48, INST D192 for INST D768	2.5.4.2
MMEMory:LOAD:*LIST FREQuency*	"filename"		File with frequency values	2.5.4.7
SOURce:VOLTage[:LEVel][:AMPLitude]	<nu> 0 to 10 V 0 to 20 V 0 to 1 FS	 V V FS	Square amplitude Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.7
SOURce:VOLTage:STARt	<nu> 0 to 10 V 0 to 20 V 0 to 1 FS	 V V FS	Start value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
SOURce:VOLTage:STOP	<nu> 0 to 10 V 0 to 20 V 0 to 1 FS	 V V FS	Stop value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
MMEMory:LOAD:*LIST VOLTage*	"filename"		File with amplitude values	2.5.4.7

Note: f_{max} depends on generator (s. 2.5.1)
Caution: "SOUR:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.7 MOD DIST

Command	Parameter	Basic unit	Meaning	Section
SOURce:LOWDistortion	ON OFF		Useful signal is generated by LDG Both sines are generated by function generator	2.5.4.1/ 2.5.4.8
SOURce:FREQuency[1][:CW | FIXed]	<nu> 4 kHz to f_{max}	Hz	Useful frequency	2.5.4.8
SOURce:FREQuency:STARt	<nu> 4 kHz to f_{max}	Hz	Start value for useful frequency sweep	2.5.4.2
SOURce:FREQuency:STOP	<nu> 4 kHz to f_{max}	Hz	Stop value for useful frequency sweep	2.5.4.2
MMEMory:LOAD:*LIST FREQuency*	"filename"		File with frequency values	2.5.4.8
SOURce:FREQuency[2] [:CW | FIXed]	<nu> 30 to 500 Hz	Hz	Interfering frequency	2.5.4.8
SOURce:VOLTage:*TOTal*[:LEVel][:AMPLitude]	<nu> 0 to 10.964 V 0 to 21.927 V 0 to 1 FS	 V V FS	Total amplitude Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.8
SOURce:VOLTage:STARt	<nu> 0 to 10.964 V 0 to 21.927 V 0 to 1 FS	 V V FS	Start value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
SOURce:VOLTage:STOP	<nu> 0 to 10.964 V 0 to 21.927 V 0 to 1 FS	 V V FS	Stop value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
MMEMory:LOAD:*LIST VOLTage*	"filename"		File with amplitude values	2.5.4.8
SOURce:VOLTage:*RATio*	<n> 1 to 10		Ratio of interfering to useful signal	2.5.4.8

Note: f_{max} depends on generator (s. 2.5.1)

Caution: "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"
In the analog range, the lower limit SOUR:VOLT:RAT (in the case of relatively high specifications for rms voltage) depends on the required total rms voltage SOUR:VOLT:RAT (see TOTAL VOLT).

3.3.1.6.8 DFD

Command	Parameter	Basic unit	Bemerkung	Section
SOURce:LOWDistortion	**ON** **OFF**		1st sine is generated by LDG Both sines are generated by function generator	2.5.4.1/ 2.5.4.9
SOURce:FREQuency:*MEAN*	<nu> 5 to 24 kHz 5 to 109 kHz 5 kHz to (clock rate*29/64-1 kHz)	Hz	Mean frequency for INST A25 for INST A110 for INST D48|D192|D768	2.5.4.9
SOURce:FREQuency:STARt	<nu> 5 to 24 kHz 5 to 109 kHz 5 kHz to (clock rate*29/64-1 kHz)	Hz	Start value for mean frequency sweep for INST A25 for INST A110 for INST D48|D192|D768	2.5.4.2
SOURce:FREQuency:STOP	<nu> 5 to 24 kHz 5 to 109 kHz 5 kHz to (clock rate*29/64-1 kHz)	Hz	Stop value for mean frequency sweep for INST A25 for INST A110 for INST D48|D192|D768	2.5.4.2
MMEMory:LOAD:*LIST FREQuency*	"filename"		File with frequency values	2.5.4.9
SOURce:FREQuency:*DIFFerence*	<nu> 80 Hz to1 kHz 100 Hz to1 kHz	Hz	Difference frequency for INST A25|A110|D48|D192 for INST D768	2.5.4.9
SOURce:VOLTage:*TOTal*[:LEVel][:AMPLitude]	<nu> 0 to 8.485 V 0 to 16.971 V 0 to 1 FS	 V V FS	Total amplitude Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.9
SOURce:VOLTage:STARt	<nu> 0 to 8.485 V 0 to 16.971 V 0 to 1 FS	 V V FS	Start value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
SOURce:VOLTage:STOP	<nu> 0 to 8.485 V 0 to 16.971 V 0 to 1 FS	 V V FS	Stop value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
MMEMory:LOAD:*LIST VOLTage*	"filename"		File with amplitude values	2.5.4.9

Note: Clock rate, f_{min}, f_{max} depend on generator (s. 2.5.1)
Caution: "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.9 DIM

Command	Parameter	Basic unit	Meaning	Section
SOURce:*DIM*	*DIMA* *DIMB*		Frequency square/sine 3.15/15 kHz Frequency square/sine 2.96/14	2.5.4.10
SOURce:*BANDwidth* SOURce:*BWIDth*	 *F30* *F100*		Band limitation of analog square ... to 30 kHz ... to100 kHz	2.5.4.10
SOURce:VOLTage:*TOTal*[:LEVel] [:AMPLitude]	<nu> 0 to 21,2 V 0 to 10,6 V 0 to 1 FS	 V V FS	Total amplitude Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.10
SOURce:VOLTage:STARt	<nu> 0 to 21,2 V 0 to 10,6 V 0 to 1 FS	 V V FS	Start value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
SOURce:VOLTage:STOP	<nu> 0 to 21,2 V 0 to 10.6 V 0 to 1 FS	 V V FS	Stop value for amplitude sweep Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.2
MMEMory:LOAD:*LIST VOLTage*	"filename"		File with amplitude values	2.5.4.10

Caution: "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.10 Random

Command	Parameter	Basic unit	Meaning	Section
SOURce:*RANDom:DOMain*	***FREQuency*** ***TIME***		Frequency domain Time domain	2.5.4.11
SOURce:VOLTage:*TOTal*[:LEVel] [:AMPlitude]	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Noise peak amplitude Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.11
SOURce:VOLTage:*TOTal:RMS?*		 V FS	Noise rms amplitude: query only Analog range Digital range	2.5.4.11

Further commands for frequency domain only:

Command	Parameter	Basic unit	Meaning	Section
SOURce:*RANDom:SPACing:MODE*	***ATRack*** ***USERdefined***		Analyzer frequency spacing synchronous Frequency spacing acc. to user entry	2.5.4.11
SOURce:*RANDom:SPACing:FREQuency*	<nu> 10 Hz to 25 kHz 25 Hz to 110 kHz 10 Hz to clock rate *29/64 25 Hz to clock rate *29/64 50 Hz to clock rate *29/64	Hz	Entry of frequency spacing for INST A25 for INST A110 for INST D48 for INST D192 for INST D768	2.5.4.11
SOURce:*RANDom:SHAPe*	***WHITe*** ***PINK*** ***TOCTave*** ***ARBitrary***		White noise Pink noise $^1/_3$-octave noise File-defined noise	2.5.4.11

Command	Parameter	Basic unit	Meaning	Section
SOURce:*RANDom:FREQuency:LOWer* SOURce:*RANDom:FREQuency:UPPer*	<*nu*> <*nu*> 10 Hz to 25 kHz 25 Hz to 110 kHz 10 Hz to clock rate *29/64 25 Hz to clock rate *29/64 50 Hz to clock rate *29/64	Hz Hz	Upper/lower frequency limit for white and pink noise for INST A25 for INST A110 for INST D48 for INST D192 for INST D768	2.5.4.11
SOURce:FREQuency:*MEAN*	<*nu*> 11.225 Hz 28.062 Hz 11.225 Hz to clock rate 29/64/1.12246 28.062 Hz to clock rate 29/64/1.12246 56.123 Hz to clock rate 29/64/1.12246	Hz	Mean frequency for $^1/_3$-octave noise INST A25 INST A110 INST D48 INST D192 INST D768	2.5.4.11
MMEMory:LOAD:*LIST ARBitrary*	*"filename"*		File with data for file-defined noise	2.5.4.11

Further commands for time domain only:

Command	Parameter	Basic unit	Meaning	Section
SOURce:*RANDom:PDF*	*GAUSsian* *TRIangle* *RECTangle*		Gaussian noise distribution function Triangular noise distribution function Equivalent noise distribution function	2.5.4.11

Note: Clock rate depends on generator (s. 2.5.1)
Caution: · "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.11 Arbitrary

Command	Parameter	Basic unit	Meaning	Section
MMEMory:LOAD:*LIST ARBitrary*	"filename"		File with data for signal shape	2.5.4.12
SOURce:VOLTage:*TOTal*[:LEVel] [:AMPLitude]	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Peak amplitude of signal Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.12
SOURce:VOLTage:*TOTal:RMS?*		 V FS	RMS amplitude of signal: query only Analog range Digital range	2.5.4.12

Caution: "SOUR:VOLT:TOT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.1.6.12 POLARITY

Command	Parameter	Basic unit	Meaning	Section
SOURce:VOLTage[:LEVel][:AMPLitude]	<nu> 0 to 12 V 0 to 24 V 0 to 1 FS	 V V FS	Pulse amplitude Analog range (OUTP:CONF:UNB|CTES) Analog range (OUTP:CONF:BAL) Digital range	2.5.4.13

Caution: "SOURC:VOLT" is voltage-limited by SCPI command "SOUR:VOLT:LIM"

3.3.2 IEC-bus Commands for Analyzers

3.3.2.1 Selecting the Analyzer

Command	Parameter	Basic unit	Meaning	Section
INSTrument2 [:SELect] equivalent to	A22 A100 A300 D48 D192 D768		Analog analyzer 22 kHz Analog analyzer 100 kHz Analog analyzer 300 kHz Digital analyzer 48 kHz Digital analyzer 192 kHz Digital analyzer 768 kHz	see 2.6.1
INSTrument2 :NSELect	1 2 3 4 5 6		Analog analyzer 22 kHz Analog analyzer 100 kHz Analog analyzer 300 kHz Digital analyzer 48 kHz Digital analyzer 192 kHz Digital analyzer 768 kHz	see 2.6.1

3.3.2.2 Configuration Commands

Command	Parameter	Basic unit	Meaning	Section
INPut[] :FILTer[:LPASs] :FREQuency	<nu> 2 Hz, 10 Hz, 100 Hz	Hz	Lower limit frequency for analyzer instruments A22 and D48.	2.6.2 Min Freq
SENSe[] :POWer :REFerence :*RESistance*	<nu> 1 mΩ to 100 kΩ	Ohm	Reference resistance for power unit	RREF in 2.4, s. 2.6.2 Ref Resist
INPut[] :*SELect*				s2.6.2 and 2.6.3 CHANNEL(s)
	CH1		Only channel 1 active (analog and digital mode)	→1
	CH2		Only channel 2 active (analog and digital mode)	→2
	CH1And2		Both channel 1 and 2 active, settings may be different (only analog mode)	→1 & 2
	CH1Is2		Both channel 1 and 2 active, identical settings (only analog mode). Data of channel 1 are adopted for channel 2.	→1 ≡ 2
	CH2Is1		Both channel 1 and 2 active, identical settings (only analog mode). Data of channel 2 are adopted for channel 1.	→2 ≡ 1
	BOTH		Both channel 1 and 2 active, identical settings (only digital mode).	→BOTH
INPut[1|2] :*TYPE*				s. 2.6.2 Input
	BALanced		Balanced input (XLR connector), see Fig. 2-1/7. For analog instruments only.	→BAL XLR
	UNBalanced		Unbalanced input (BNC connector), see Fig. 2-1/7. For analog instruments only.	→UNBAL BNC
	GEN1		Internal connection to generator channel 1. For analog instruments only.	→GEN 1
	GEN2		Internal connection to generator channel 2. For analog instruments only.	→GEN 2
	PARallel		Parallel input. For connector, see Fig. 2-2/1 and 2. For digital instruments only.	→PARALLEL
	MPARallel		Parallel input for multiplexed signals. For connector, see Fig. 2-2/2. For digital instruments only.	→PARAL MUX
	SERial		Serial input, for connector, see Fig. 2-1/10. For digital instruments only.	→SERIAL
	MSERial		Serial input for multiplexed signals. For connector, see Fig. 2-1/10. For digital instruments only.	→SERIAL MUX
	AESEbu		AES/EBU interface, for connector, see Fig. 2-1/10. For digital instruments only.	→AES/EBU
	SPDif		S/P DIFF interface, for connector, see Fig. 2-1/10. For digital instruments only.	→S/P DIF
	OPTical		Optical interface, for connector, see Fig. 2-1/10. For digital instruments only.	→OPTICAL
	INTern		Internal interface to digital generator	→INTERN

Command	Parameter	Basic unit	Meaning	Section
INPut[1|2] :IMPedance				s. 2.6.2 Imped
	R300		Input impedance for unbalanced input = 300 Ω	→300 Ω
	R600		Input impedance for unbalanced input = 600 Ω	→600 Ω
	R20K		Input impedance for unbalanced input = 20 kΩ	→20 kΩ
	USERdefined		Input impedance for unbalanced input is specified by user	→USER DEF
	R110 *R10K*		Input impedance of digital AES-EBU interface 110 Ω: correction termination with rated impedance. 10 kΩ: high-impedance termination enabling the UPD the monitoring.	see 2.6.3 CH1 Imped
INPut[1|2] :LOW				s. 2.6.2 Common
	FLOat		External conductor of unbalanced input not connected to instrument ground (PE conductor).	→FLOAT
	GROund		External conductor of unbalanced input connected to instrument ground (PE conductor).	→GROUND
SENSe[] :VOLTage :RANGe[1|2] :LOWer	<nu> The range values must be equivalent to the values in the measurement range table, see 2.6.2.	V	The values should never fall below this range. Select a higher range.	s. 2.6.2 Range →LOWER
SENSe[] :VOLTage :RANGe[1|2] :AUTO				s. 2.6.2 Range
	ON		Autoranging	→Auto
	OFF		The current range is accepted and retained as :UPPer. Corresponds to SENSe[] :VOLTage :RANGe[1|2] [:UPPer] <current range>	No equivalent in manual operation.
SENSe[] :VOLTage :RANGe[1|2] [:UPPer]	<nu> The range values must be equivalent to the values in the measurement range table, see 2.6.2.	V	Maintain this range without any provisions.	s. 2.6.2 Range →FIX

Command	Parameter	Basic unit	Meaning	Section
INPut[] :*SAMPle :FREQuency :MODE*	*F32* *F44* *F48* *VALue*		Sample frequency for digital instruments 32 kHz Sample frequency for digital instruments 44,1 kHz Sample frequency for digital instruments 48 kHz Sample frequency is applied externally. For entry of values, see next command.	s. 2.6.3 Sample Frq →32 kHz →44.1 kHz →48 kHz →VALUE:
INPut[] :*SAMPle :FREQuency*	<*nu*> for instrument D48 = 100 Hz to 48 kHz D192 = 100 Hz to 300 kHz D768 = 100 Hz to 1000 kHz	Hz	Value of applied sample frequency	see 2.6.3 Sample Frq →VALUE:
INPut[] :*OSAMpling*	*N1* *N2* *N4* *N8* *N16*		Clock multiplier depends on instrument, see 2.6.1	see 2.6.3 Oversamp
INPut[] :*WLENgth*	*L8* *L16* *L24* *L32*		Data bits per input sample with serial interface	see 2.6.3 Word length
INPut[] :*WOFFSet*	<n> = -16 to 16		Position of synchronizing pulse with serial interface	see 2.6.3 Word offst
INPut[] :*WSELect*	*LOW* *HIGH*		Identifies CH1 on LR line with parallel MUX	see 2.6.3 WordselCh1
INPut[] :*WCLock*	*RISing* *FALLing*		Polarity of synchronizing pulse with serial interface	see 2.6.3 Word clock
INPut[] :*BCLock*	*RISing* *FALLing*		Polarity of bit clock with serial interface	see 2.6.3 Bit clock
INPut[] :*BITOrder*	*MSBFirst* *LSBFirst*		Bit order with serial interface	see 2.6.3 Bit order
INPut[] :*AUDiobits*	<n> range of values s. 2.3.6 Audio Bits		Word length of audio samples to be analyzed in bits	see 2.6.3 Audio Bits

3.3.2.3 Ways of Starting the Analyzer, Ext. Sweep

Command	Parameter	Basic unit	Meaning	Section
TRIGger :SOURce IMMediate |TIMer| CH1Freq|CH2Freq|CH1Level|CH2Level				see 2.6.4 START COND
	IMMediate		Continuous measurement mode w i t h o u t trigger condition	→AUTO
	TIMer		Storing of measured values to the buffer at regular intervals.	→TIME
	CH1Freq|CH2Freq		Tracing of measured values due to a variation in frequency noted at the ANALYZER input, channel 1 or channel 2.	→CH1Freq| CH2Freq
	CH1Level |CH2Level		Tracing of measured values due to a variation in level noted at the ANALYZER input, channel 1 or channel 2.	→CH1Level| CH2Level
TRIGger :DELay <nu>	<nu> = 50 ms to 10 s	s	Waiting time after measurement (settling time for device under test).	see 2.6.4 Delay
TRIGger :TIMer <nu>	<nu> = 50 ms to 10 s	s	Intervals between tracings of measured values.	see 2.6.4 Timetick
TRIGger :COUNt <nu>	<nu> = 1 to 1023		Number of measured values entered into the buffer.	see 2.6.4 Points

Command	Parameter	Basic unit	Meaning	Section
ARM :LEVel **:MIN** <nu>	<nu>analog instruments 10 µV to 1000 V <nu> digital instruments 0.0001 to 1.0 FS	V FS	Minimum voltage required for triggering a measurement with external frequency sweep. Minimum voltage required for triggering a measurement with external frequency sweep.	see 2.6.4 Min VOLT
ARM :FREQuency **:STAR**t <nu> **ARM :FREQ**uency **:STOP** <nu>	<nu> analog instruments 2 Hz | 10 Hz to range limits (see 2.6.1) <nu>digital instruments 0 Hz to range limits (see 2.6.1)	Hz	Input frequency must be within the range between start and stop frequency in order to trigger the measurement.	see 2.6.4 Start | Stop
ARM :VOLTage **:STAR**t <nu> **ARM :VOLT**age **:STOP** <nu>	<nu> analog instruments 10 µV to 1000 V <nu> digital instruments >1 µFS to 1.0 FS	V FS	Input level must be within the start/stop voltage limits in order to trigger the measurement. Input level must be within the start/stop voltage limits in order to trigger the measurement.	see 2.6.4 Start | Stop
TRIGger **:FREQ**uency **:VAR**iation <nu>	<nu> > 0.1 to 50%	PTC	Percentage by which the input frequency must vary at least in order to trigger a measurement.	see 2.6.4 Variation
TRIGger **:VOLT**age **:VAR**iation <nu>	<nu> > 0.1 to 50%	PTC	Percentage by which the input voltage must vary at least in order to trigger a measurement.	see 2.6.4 Variation

3.3.2.4 Analyzer Functions

3.3.2.4.1 Common Parameters for Analyzer Functions

Common	Parameter	Basic Unit	Meaning	Section
SENSe[1]:TRIGger:SETTling:MODE SENSe[1]:FUNCtion:SETTling:MODE SENSe3:FREQuency:SETTling:MODE SENSe3:PHASe:SETTling:MODE	OFF EXPonential FLAT AVERage		Settling process for external triggering: OFF Settling with exponential tolerance and resolution characteristic Settling with tolerance and resolution band Arithmetic averaging	see 2.6.5.1 Settling→OFF OFF EXPonential FLAT AVERage
SENSe[1]:TRIGger:SETTling:COUNt SENSe[1]:FUNCtion:SETTling:COUNt SENSe3:FREQuency:SETTling:COUNt SENSe3:PHASe:SETTling:COUNt	<n> EXP|FLAT: 2 to 6 AVER: 2 to 100		Number of test points considered in settling. 3 means that the instantaneous measured value is compared with the 2 preceding results	see 2.6.5.1 Samples
SENSe[1]:TRIGger:SETTling:TOLerance SENSe[1]:FUNCtion:SETTling:TOLerance SENSe3:FREQuency:SETTling:TOLerance	<n>	%	Starting value of the exponential tolerance characteristic or tolerance band	see 2.6.5 Tolerance
SENSe[1]:TRIGger:SETTling:RESolution SENSe[1]:FUNCtion:SETTling:RESolution SENSe3:FREQuency:SETTling:RESolution SENSe3:PHASe:SETTling:RESolution	<nu> Specified range and units depend on instrument and functions see 2.6.5.1	V FS % dB Hz DEG(°)	Starting value of the exponential resolution characteristic or tolerance band.	see 2.6.5 Resolution
SENSe[1]:FUNCtion:SETTling:TOUT SENSe3:FREQuency:SETTling:TOUT SENSe3:PHASe:SETTling:TOUT	<nu> 0.001 to 10 s	s	Maximal settling time If no settled measurement result is achieved within this time, the measurement is aborted and an invalid measured value signalled.	see 2.6.5 Timeout

3.3.2.4.2 RMS Measurement incl. S/N

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FUNCtion "*RMS*"			RMS measurement	see 2.6.5 FUNCTION →RMS & S/N
SENSe[1] :FUNCtion :*SNSequenz*	*ON* *OFF*		S/N (Signal to Noise) measurement on S/N (Signal to Noise) measurement off	see 2.6.5.1 S/N Sequ
SENSe[1] [:VOLTage] :UNIT[1|2] SENSe[1] [:POWer] :UNIT[1|2] SENSe[1] :UNIT[1|2]	V|DBV|*DBU|FS|* DBM|W *DPCTV|DV|V|VR|* *PCTV|VR|DPCTW|* *DW|P|PR|PCTP|PR* *PCTFS|DBFS|DPCT|* *DBR*		Display units for RMS measurement results	see 2.4 Units
SENSe[1] :VOLTage :APERture :*MODE*	*AFAST* *AUTO* *SFAST* *FAST* *SLOW* *VALue*		Automatic matching of the measurement time to the signal frequency, taking the signal period into account. The measurement time is matched as far as possible to the input signal. With AFAST, a maximum algorithmic error of 1 %, with AUTO of 1 ‰ may occur. 50 ms 200 ms fixed integration times 1000 ms Numerical entry of measurement time. For entry of values, see next command.	see 2.6.5.2 Meas Time
SENSe[1] :VOLTage :APERture	<nu> = 1 ms to 10s	s	Numerical input of measurement time. Measuring time allowing the display to become steady.	see 2.6.5.2 Meas Time
SENSe[1] [:VOLTage|POWer] :REFerence :*MODE*	*CH1store* *CH2store* *STORe* *VALue*		With two-channel measurements, storing the current measurement result from channel 1 as reference value. With two-channel measurements, storing the current measurement result from channel 2 as reference value. With single-channel measurements, storing the current measured value as reference. Reference value is entered using the following command.	see 2.6.5.1 Reference
SENSE[1] [:VOLTage|POWer] :REFerence	<nu> Analog = 1 µV to 1000 V Digital = 0.0 to 1.0 FS	Analog: V Digital: FS	Numerical entry of reference values	see 2.6.5.1 Reference

Command	Parameter	Basic Unit	Meaning	Section
SENSe[1] :*NOTCh[:STATe]*	**DB 12** **DB 30** **DB 0** **OFF**		Analog notch filter on; gain 12 dB Analog notch filter on; gain 30 dB Analog notch filter on; no gain Analog notch filter off;	see 2.6.5.1 Analog Notch →OFF
SENSe[1]:*NOTCh: FREQuency:MODE*	*AUTO* *FIXed* *SOURce*		Notch filter center frequency tracks the measured frequency. For numerical entry of notch filter center frequency, see next command. Notch filter center frequency tracks the generator frequency.	see 2.6.5.1 Notch Freq →AUTO →VALUE: →GEN TRACK
SENSe[1]:*NOTCh: FREQuency:FIXed*	<*nu*> for analog instruments 10 Hz to 110 kHz	HZ	Numerical center frequency of notch filter	see 2.6.5.1 Notch Freq →VALUE:
SENSe[1] :FILTer<i>:.....	<i> = 1 to 4		See 3.3.4 Selecting the Analyzer Filters	see 2.7.1
CALCulate:TRANsform:FREQuency:STATe	**OFF** **ON**		No POST-FFT with selected measurement function POST-FFT with selected measurement function, see 3.3.3.16 FFT CALCulate:TRANsform:FREQuency:FFT S256 to S8K CALCulate:TRANsform:FREQuency:WINDow RECT to KAIs CALCulate:TRANsform:FREQuency:STARt ? CALCulate:TRANsform:FREQuency:STOP ? CALCulate:TRANsform:FREQuency:RESolution?	see 2.6.5.1 POST FFT
SENSe[1]:TRIGger: SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.3 Selective RMS Measurement incl. Sweep

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SENSe[1] :FUNCtion "RMSSelectiv"</td><td></td><td></td><td>Selective rms measurement</td><td>see 2.6.5.3 FUNCTION →RMS SELECT</td></tr>
<tr><td>SENSe[1] [:VOLTage] :UNIT[1|2]
SENSe[1] [:POWer] :UNIT[1|2]
SENSe[1] :UNIT[1|2]</td><td>V|DBV|DBU|FS
DBM|W
DPCTV|DV|VIVR|
PCTVIVR|DPCTW|
DW|PIPR|PCTPIPR|D
BR|
PCTFS|DBFS|DPCT</td><td></td><td>Display units for results of selective rms measurement</td><td>see 2.4 Units</td></tr>
<tr><td>SENSe[1] :VOLTage :APERture :MODE</td><td>AFAST
AUTO

SFAST
FAST
SLOW
VALue</td><td></td><td>Automatic matching of the measurement time to the signal frequency, taking the signal period into account. The measurement time is matched as far as possible to the input signal. With AFAST, a maximum algorithmic error of 1 %, with AUTO of 1 ‰ may occur.
50 ms
200 ms fixed integration times
1000 ms
Numerical entry of measurement time. For entry of values, see next command.</td><td>see 2.6.5.3 Meas Time</td></tr>
<tr><td>SENSe[1] :VOLTage :APERture</td><td><nu>
= 1 ms to 10 s</td><td>s</td><td>Numerical entry of measurement time.
Measurement time allowing the display to become steady.</td><td>see 2.6.5.3 Meas Time</td></tr>
<tr><td>SENSe[1] :BWIDth [:RESolution]:MODE
SENSe[1] :BANDwidth [:RESolution]: MODE</td><td>
PCT1
PCT3
TOCT
OCT12
FIX</td><td></td><td>Bandwidth of bandpass
Geom. symm.: 1%
Geom. symm.: 3%
Geom. symm.: 1/3 Octav = 26%
Geom. symm.: 1/12 Octav = 6%
Arithm. symm.: For numerical entry, see next command.</td><td>siehe 2.6.5.3 Bandwidth</td></tr>
<tr><td>SENSe[1] :BWIDth[:RESolution]
SENSe[1] :BANDwith[:RESolution]</td><td><nu></td><td>Hz</td><td>Numerical entry of arithm. symmetrical bandwidth</td><td>siehe 2.6.5.3 Bandwidth</td></tr>
<tr><td>SENSe[1] [:VOLTage|POWer] :REFerence :MODE</td><td>CH1store

CH2store

STORe
VALue</td><td></td><td>With two-channel measurements, storing the current measurement result from channel 1 as reference value.
With two-channel measurements, storing the current measurement result from channel 2 as reference value.
With single-channel measurements, storing the current meas. result as reference value.
Entering the reference value using the following command.</td><td>see 2.6.5.1 Reference</td></tr>
<tr><td>SENSE[1] [:VOLTage|POWer] :REFerence</td><td><nu>
Analog =
1 µV to 1000 V
Digital =
0.0 to 1.0 FS</td><td>Analog: V
Digital: FS</td><td>Numerical entry of reference value.</td><td>siehe 2.6.5.1 Reference</td></tr>
</table>

Sweep for selective RMS measurement

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SENSe[1] :FREQuency :MODE</td><td>FIXed | CW
(equal)
SWEep

LIST

SOURce
CH1
CH2
MULTisine</td><td></td><td>Presetting for fixed frequency of selective rms measurement. Numerical entry using SENSe[1] :FREQuency [:FIXed|:CW] <nu>
Frequency sweep of selective rms measurement.
The sweep parameter data are determined by the following user specifications:
SENSe[1] :FREQuency :STARt|STOP <nu>
SENSe[1] :SWEep :SPACing LINear|LOGarithmic
SENSe[1] :SWEep :STEP <nu>
SENSe[1] :SWEep :POINts <n>
Frequency list sweep of selective rms measurement.
The sweep parameter data are read from the file specified under MMEMory :LOAD :LIST FREQuency, "filename". For format of sweep lists, see annex.
Frequency of selective rms measurement tracks current generator frequency
Frequency of selective rms measurement tracks the frequency measured on channel 1|2.

Frequency of selective rms measurement is set consecutively to the multisine frequencies specified in the Generator panel (see 2.5.4.4 Multisine). The sweep is similar to a LIST sweep.</td><td>see 2.6.5.3
SWEEP CTRL

→GEN MLTSINE</td></tr>
<tr><td>SENSe[1] :FREQuency [:FIXed|:CW]</td><td><nu>
Range of values, see 2.6.5.3 FREQ MODE → FIX</td><td>Hz</td><td>Numerical entry of frequency for selective rms measurement.</td><td>see 2.6.5.3 FREQ MODE →FIX</td></tr>
<tr><td>SENSe[1] :SWEep :MODE</td><td>
AUTO

MANual</td><td></td><td>
Automatic sweep run.
This command together with command SENSe[1] :FREQuency :MODe SWEep sets the AUTO SWEEP mode.
After pressing the LOCAL key, the rotary knob is effective.
This command together with command SENSe[1] :FREQuency :MODe SWEep sets the MANU SWEEP mode.</td><td>see → 2.6.5.3
SWEEP CTRL
→AUTO SWEEP

→MANU SWEEP</td></tr>
</table>

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FREQuency :STARt **SENSe[1] :FREQuency :STOP**	<nu> Range of values see 2.6.5.3 SWEEP CTRL → Start/Stop	Hz	Start and stop frequency for frequency sweep of selective rms measurement.	see 2.6.5.3 SWEEP CTRL →Start | Stop
SENSe[1] :SWEep :SPACing	**LIN**ear **LOG**arithmic		Linear or logarithmic sweep spacing	see 2.6.5.3 Spacing
SENSe[1] :SWEep :POINts	<n> = 2 to 1024		Number of sweep spacings. Depending on the selected SPACing (SENSe[1] :SWEep :SPACing LINear|LOGarithmic) the sweep frequency range between "START" and "STOP" is divided by <n> linear or logarithmic points.	see 2.6.5.3 Points
SENSe[1] :SWEep :STEP	<nu> | <n> The step size must be selected such that max. 1023 single steps (= 1024 sweep points) result. The step size must not be higher than the absolute difference between STOP and STARt.	SENSe[1] :SWEep :SPACing LINear: Hz SENSe[1] :SWEep :SPACing LOGarithmic: no unit, no multiplier	Sweep step size Depending on the selected SPACing SENSe[1] :SWEep :SPACing LINear|LOGarithmic the sweep frequency range between "START" and "STOP" is divided by a linear step size in Hz or a logarithmic step size in the form of a multiplier.	see 2.6.5.3 Steps
SENSe[1] :LIST :*MODE*				see 2.6.5.3 SWEEP CTRL
	AUTO		Automatic list sweep This command together with command SENSe[1] :FREQuency :MODe LIST sets the AUTO LIST mode. After pressing the LOCAL key, the rotary knob is effective.	→ AUTO LIST
	MANual		This command together with command SENSe[1] :FREQuency :MODe LIST sets the MANU LIST mode.	→ MANU LIST

Command	Parameter	Basic Unit	Meaning	Section
MMEMory :LOAD :*LIST FREQuency*, "filename"	"filename" = path and file name of a frequency list for the LIST sweep in a selective rms measurement, e.g. "c:\upd\ref\swpflst.lst"		Loading a frequency list for the list sweep.	see 2.6.5.3 SWEEP CTRL → Filename For format of list sweeps, see annex.
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.4 Peak and Quasi-peak Measurement incl. S/N

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SENSe[1] :FUNCtion "PEAK"</td><td></td><td></td><td>Peak value measurement</td><td>see 2.6.5.4
FUNCTION
→PEAK & S/N</td></tr>
<tr><td>SENSe[1] :FUNCtion "QPEak"</td><td></td><td></td><td>Quasi-peak value measurement</td><td>see 2.6.5.4
FUNCTION
→QPK & S/N</td></tr>
<tr><td>SENSe[1] [:VOLTage] :UNIT[1|2]
SENSe[1] [:POWer] :UNIT[1|2]
SENSe[1] :UNIT[1|2]</td><td>V|DBV|DBU|FS|HEX
DBM|W
DPCTV|DV|V/VR|
PCTV|VR|DPCTW|
DW|P|PR|PCTP|PR|
DBR
PCTFS|DBFS|DPCT</td><td></td><td>Display units of peak and quasi-peak measurement results</td><td>see →2.4 Units</td></tr>
<tr><td>SENSe[1] :FUNCtion :SNSequenz</td><td>ON
OFF</td><td></td><td>S/N- (signal-to-noise) measurement on.
S/N- (signal-to-noise) measurement off.</td><td>see 2.6.5.1
S/N Sequ</td></tr>
<tr><td>SENSe[1] :FUNCtion :MMODe</td><td>PPEak
NPEak
PTOPeak
PABSolut</td><td></td><td>PK + -value
PK- -value
PK to PK-value
Absolute PK-value</td><td>see 2.6.5.4 Meas Mode</td></tr>
<tr><td>SENSe[1] :VOLTage :INTVtime :MODE</td><td>SFAST
FAST
SLOW
VALue</td><td></td><td>50 ms
200 ms Monitoring interval for peak search
1000 ms
Numerical entry of interval time.
Entry of values, see next command.</td><td>see 2.6.5.4
Intv Time</td></tr>
<tr><td>SENSe[1] :VOLTage :INTVtime</td><td><nu>
= 1 ms to 10s</td><td>s</td><td>Numerical entry of interval time.
Monitoring interval for peak search</td><td>see 2.6.5.4
Intv Time</td></tr>
<tr><td>SENSe[1] [:VOLTage|POWer] :REFerence :MODE</td><td>CH1store

CH2store

STORe
VALue</td><td></td><td>With two-channel measurements, storing the current measurement result from channel 1 as reference value.
With two-channel measurements, storing the current measurement result from channel 2 as reference value.
With single-channel measurements, storing the current measurement result as reference value.
Entering the reference value using the following command.</td><td>see 2.6.5.1
Reference</td></tr>
<tr><td>SENSE[1] [:VOLTage|POWer] :REFerence</td><td><nu>
Analog =
1 µV to 1000 V
Digital =
0.0 to 1.0 FS</td><td>Analog: V
Digital: FS</td><td>Numerical entry of reference values</td><td>see 2.6.5.1
Reference</td></tr>
</table>

Command	Parameter	Basic Unit	Meaning	Section
SENSe[1] :*NOTCh[:STATe]*	**DB 12** **DB 30** **DB 0** **OFF**		Analog notch filter on; gain 12 dB Analog notch filter on; gain 30 dB Analog notch filter on; no gain Analog notch filter off;	see 2.6.5.1 Analog Notch →OFF
SENSe[1]:*NOTCh: FREQuency:MODE*	*AUTO* *FIXed* *SOURce*		Notch filter center frequency tracks the measured frequency For numerical entry of notch filter center frequency, see next command Notch filter center frequency tracks generator frequency	see 2.6.5.1 Notch Freq →AUTO →VALUE: →GEN TRACK
SENSe[1]:*NOTCh: FREQuency:FIXed*	<*nu*> for analog instruments 10 Hz to 110 kHz	HZ	Numerical entry of notch filter center frequency	see 2.6.5.1 Notch Freq →VALUE:
SENSe[1] :FILTer<i>:.....			see 3.3.3 Selecting the Analyzer Filters	see 2.7.1
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.5 DC Measurement

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic Unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SENSe[1] :FUNCtion "DC"</td><td></td><td></td><td>DC measurement</td><td>see 2.6.5
FUNCTION → DC</td></tr>
<tr><td>SENSe[1] [:VOLTage] :UNIT[1|2]
SENSe[1] [:POWer] :UNIT[1|2]
SENSe[1] :UNIT[1|2]</td><td>V|DBV|DBU
DBM|W
DPCTV|DV|VIVR|
PCTVIVR|DPCTW|
DW|PIPR|PCTPIPR|
DBR</td><td></td><td>Display units for DC measurement results</td><td>see 2.4
Units</td></tr>
<tr><td>SENSe[1] :VOLTage :APERture :MODE</td><td>FAST
VALue</td><td></td><td>200 ms integration time allowing the display to become steady.
Numerical entry of integration time; for entry of values, see next command.</td><td>see 2.6.5.5
Meas Time</td></tr>
<tr><td>SENSe[1] :VOLTage :APERture</td><td><nu>
= 1 ms to 10 s</td><td>s</td><td>Numerical entry of integration time.
Integration time allowing the display to become steady</td><td>see 2.6.5.5
Meas Time</td></tr>
<tr><td>SENSe[1] [:VOLTage|POWer] :REFerence :MODE</td><td>CH1store

CH2store

STORe
VALue</td><td></td><td>With two-channel measurements, the current measurement result from channel 1 is stored as reference value.
With two-channel measurements, the current measurement result from channel 2 is stored as reference value.
With single-channel measurements, the current result is stored as reference value.
The reference value is specified using the following command.</td><td>see 2.6.5.1
Reference</td></tr>
<tr><td>SENSE[1] [:VOLTage|POWer] :REFerence</td><td><nu>
Analog =
1 µV to 1000 V
Digital =
0.0 to 1.0 FS</td><td>Analog: V
Digital: FS</td><td>Numerical entry of reference values.</td><td>see 2.6.5.1
Reference</td></tr>
<tr><td>SENSe[1]:FUNCtion:SETTling:xxxx</td><td></td><td></td><td>Settling commands cf.
3.3.2.4.1 Common Parameters for Analyzer Functions</td><td>see 3.3.2.4.1</td></tr>
</table>

3.3.2.4.6 THD Measurement

Command	Parameter	Basic Unit	Meaning	Section
SENSe[1] :FUNCtion "*THD*"			THD measurement	see 2.6.5 FUNCTION →THD
SENSe[1] :UNIT	**PCT|DB**		Display units for results of THD measurements	see 2.4 Units
SENSe[1] :FUNCtion :*MMODe*	***SELectdi*** ***DALL*** ***DODD*** ***DEVen***		Any combination of harmonic distortions out of d2 to d9 is to be set with the following command. Selection of harmonic distortions to be measured: All harmonic distortions: d2 to d9. All odd harmonic distortions: d3, d5, d7, d9. All even harmonic distortions: d2, d4, d6, d8.	see 2.6.5.6 Meas Mode →SELECT di →All di →All odd di →All even di
SENSe[1] :FUNCtion :*DISTortion*	<n> *)		Decimal equivalent of integer value <n> for any combination of harmonics, eg d2, d4, d6, d9, is desired; binary: 0000000010010101 decimal equivalent: <n> = 149	see 2.6.5.6 →di2468
SENSe[1] :VOLTage :*FUNDamental* :*MODE*	***AUTO*** ***SOURce*** ***VALue***		Determining the fundamental frequency: Automatically by way of a frequency measurement. Depending on generator frequency. Numerical entry of fundamental frequency. Range of values, see next command.	see 2.6.5.6 Fundamental
SENSe[1] :VOLTage :*FUNDamental*	*<nu>* Specified range see 2.6.5.6 Fundamental	Hz	Numerical entry	see 2.6.5.6 Fundamental
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

*)

d15	d14	d13	d12	d11	d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0	
-	-	-	-	-	-	-	-	di9	di8	di7	di6	di5	di4	di3	di2	Harmonics
x	x	x	x	x	x	x	x	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	

x = without meaning
0 = Harmonic distortions not selected
1 = Harmonic distortions selected

3.3.2.4.7 THD + N/ Sinad Measurement

Command	Parameter	Basic Unit	Meaning	Section
SENSe[1] :FUNCtion "*THDNsndr*"			THD + N measurement	see 2.6.5 FUNCTION →THD + N/SINAD
SENSe[1] :FUNCtion :*MMODe*	 *THDN* *SNDRatio* *NOISe*		Display of measured value in the form of a THD + N value SINAD value As THD + N, but without weighting the harmonics	see 2.6.5.7 Meas Mode →THD + N →SINAD → NOISE
SENSe[1] :UNIT	PCT|DB		Display units for results of THD + N measurement	see 2.4 Units
SENSe[1] :VOLTage :*FUNDamental*	 *AUTO* *SOURce* *VALue*		Determining the fundamental frequency: Automatically by frequency measurement Depending on generator frequency Numerical entry of fundamental frequency. For entry of values, see next command.	see 2.6.5.7 Fundamental
SENSe[1] :VOLTage : *FUNDamental*	<nu> Specified range see 2.6.5.7 Fundamental	Hz	Numerical entry of fundamental frequency	see 2.6.5.7 Fundamental
CALCulate:TRANsform:FREQuency :STATe	OFF ON		No POST-FFT with selected function POST-FFT with selected function (see 3.3.3.116 FFT) CALCulate:TRANsform:FREQuency:FT S256 to S8K CALCulate:TRANsform:FREQuency:WINDow RECT to KAIS CALCulate:TRANsform:FREQuency:STARt? CALCulate:TRANsform:FREQuency:STOP? CALCulate:TRANsform:FREQuency:RESolution?	see 2.6.5.1 POST FFT
SENSe[1] :FREQuency:*LIMit:UPPer*	<nu> Specified range see 2.6.5.7 →Frq Lim Upp	Hz	Lower band limit of THD + N function	see 2.6.5.7 →Frq Lim Upp
SENSe[1] :FREQuency:*LIMit:LOWer*	<nu> Specified range see 2.6.5.7 →Frq Lim Low	Hz	Upper band limit of THD + N function	see 2.6.5.7 →Frq Lim Low
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.8 MOD DIST

Command	Parameter	Basic Unit	Meaning	Section
SENSe[1] :FUNCtion "*MDISt*"			MODDIST measurement	see 2.6.5. FUNCTION →MODDIST
SENSe[1] :UNIT	**PCT|DB**		Display units for results of MODDIST measurement	see 2.4 Units
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.9 DIM

Command	Parameter	Basic Unit	Meaning	Section
SENSe[1] :FUNCtion "*DIM*"			DIM measurement	see 2.6.5. FUNCTION →DIM
SENSe[1] :UNIT	**PCT|DB**		Display units for results of DIM measurement	see 2.4 Units
SENSe[1] :FREQuency :MODE	**FIXed|CW** equivalent to **SOURCe**		Setting the reference frequency pair using the following command. Setting the reference frequency pair using the signal function DIM in the generator.	see 2.6.5.9 FREQ MODE →FIX → GEN TRACK
SENSe[1] :FREQuency :*SQRSin*	***DIMA*** ***DIMB***		Square = 2.96 kHz, sine = 14 kHz Square = 3.15 kHz, sine = 15 kHz	see 2.6.5.9 FREQ MODE →FIX→2.96/14kHz →FIX→3.15/15kHz
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.10 DFD

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FUNCtion "*DFD*"			Difference frequency distortion measurement	see 2.6.5. FUNCTION →DFD
SENSe[1] :UNIT	**PCT|DB**		Display units for results of DFD measurement	see 2.4 Units
SENSe[1] :FUNCtion :*MMODe*	***D2*** ***D3***		Intermodulation distortion d2 Intermodulation distortion d3	see 2.6.5.10 Meas Mode
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands see 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.11 Wow & Flutter

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FUNCtion "*WAF*"			Wow & Flutter measurement	see 2.6.5. FUNCTION →WOW & FL
SENSe[1] :FUNCtion :*STANdard*	***NAB*** ***JIS*** ***DINiec*** ***SI05*** ***SI10***		W&F to NAB W&F to JIS W&F to DIN/IEC W&F 2 Sigma 5 s. W&F 2 Sigma 10s	see 2.6.5.11 Rule
SENSe[1] :FUNCtion :*WEIGhting*	***ON*** ***OFF***		W&F weighting filter on W&F weighting filter off	see 2.6.5.11 Weight
SENSe[1] :UNIT	**PCT**		No further display unit selectable!	see 2.4 Units
CALCulate:TRANsform:FREQuency **:STATe**	**OFF** **ON**		No POST-FFT with selected function POST-FFT with selected function (see 3.3.3.16 FFT) CALCulate:TRANsform:FREQuency:FFT S256 to S8K CALCulate:TRANsform:FREQuency:WINDow RECT to KAIS CALCulate:TRANsform:FREQuency:STARt? CALCulate:TRANsform:FREQuency:STOP? CALCulate:TRANsform:FREQuency:RESolution?	see 2.6.5.1 POST FFT
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands see 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.12 POLARITY

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FUNCtion "*POLarity*"			Polarity measurement to check for reverse polarity in a device under test.	see 2.6.5. FUNCTION →POLARITY

3.3.2.4.13 FFT

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FUNCtion "*FFT*"			FFT measurement function	see 2.6.5.13 POST FFT
SENSe[1]: *NOTCh[:STATe]*	**DB 12** **DB 30** **DB 0** **OFF**		Analog notch filter on; gain 12 dB Analog notch filter on; gain 30 dB Analog notch filter on; no gain Analog notch filter off;	see 2.6.5.1 Anlg. Notch →ON →OFF
SENSe[1]:*NOTCh: FREQuency:MODE*	***AUTO*** ***FIXed*** ***SOURce***		Notch filter center frequency tracks the measured frequency For numerical entry of notch filter center frequency, see next command Notch filter center frequency tracks the generator frequency	see 2.6.5.1 Notch Freq →AUTO →VALUE: →GEN TRACK
SENSe[1]:*NOTCh: FREQuency:FIXed*	<*nu*> for analog instruments 10 Hz to110 kHz	HZ	Numerical entry of notch filter center frequency	see 2.6.5.1 Notch Freq →VALUE:
CALCulate :TRANsform :FREQuency :*FFT*	***S256*** ***S512*** ***S1K*** ***S2K*** ***S4K*** ***S8K***		FFT size 256 lines 512 lines 1024 lines 2048 lines 4096 lines 8192 lines	see 2.6.5.13 FFT Size
CALCulate :TRANsform :FREQuency :*AVERage*	<n> = 1 to 16		Number of averaging processes for optimum noise suppression	see 2.6.5.13 Average

Command	Parameter	Basic unit	Meaning	Section
CALCulate :TRANsform :FREQuency :STARt? CALCulate :TRANsform :FREQuency :STOP?			Query commands for beginning and end of FFT, depending on CENTer and SPAN. <nu> in Hz is returned.	see 2.6.5.13 Start / Stop
CALCulate :TRANsform :FREQuency :CENTer	<nu> 0 to meas. range limits, see 2.6.1	Hz	Center frequency for FFT calculation	see 2.6.5.13 Center
CALCulate :TRANsform :FREQuency *:ZOOM*	<n> = 1 <n> for instrum. A22 u. D48 = 2,4,8to256 A100 u. A300 = 2,4,8,16 D192 u. D768 = 2,4,8		Zoom FFT off (standard FFT) Zoom factor of Zoom-FFT. As against in manual mode, the zoom factor instead of SPAN is entered in IEC-bus mode. SPAN, which depends on the zoom factor, is determined by the following query command.	see 2.6.5.13 Zoom FFT
CALCulate :TRANsform :FREQuency :SPAN?			Query command for frequency range around center frequency; depending on zoom factor. <nu> in Hz is returned. As against in manual mode, the value for SPAN can only be read but not entered in IEC-bus mode. SPAN can be altered by changing the zoom factor as well as by modifying the sample frequency and oversampling factor.	see 2.6.5.13 Span
CALCulate :TRANsform :FREQuency *:RESolution?*			Query command for frequency resolution of FFT, depending on CENTer and SPAN. <nu> in Hz is returned.	see 2.6.5.13 Resolution
CALCulate :TRANsform :FREQuency *:MTIMe?*			Query command for FFT measuring time, depending on FFT size. <nu> in s is returned.	see 2.6.5.13 Meas Time
CALCulate :TRANsform :FREQuency :WINDow	RECTangular HANNing *BLACkman__harris* *RIF1* *RIF2* *RIF3* HAMMing FLATtop *KAISer*		Fast and frequency-precise High spectral resolution, wide bell-shaped curve Mainlobe falls off very steeply Excellent suppression of distant interferences Excellent suppression of distant interferences Excellent suppression of distant interferences Implemented for the sake of completeness Amplitude can be read from graphics Selection of parameter ß determines characteristics	see 2.6.5.13 Window
CALCulate :TRANsform :FREQuency :WINDow *:BETAfactor*	<n> = 1 to 20	no unit	ß-factor for KAISer window	see 2.6.5.13 ß-Factor

3.3.2.4.14 WAVEFORM

Command	Parameter	Basic unit	Meaning	Section
SENSe[1]: FUNCtion "WAVeform"			Display of the waveform of the applied signal	see 2.6.5 Function
TRIGger:LEVel	**<nu>** analog instruments: -300V to 300V digital instruments: -1FS to 1 FS	V	Sets the voltage of the trigger level.	see 2.6.5.14 Trig Level
TRIGger: SLOPe	**POSitive** **NEGative**		Sets the trigger slope.	see 2.6.5.14 Trig Slope
SENSe[1]: SMOothing: APERture	**N1** **N2** **N4** **N8** **N16** **N32**		Selects the interpolation stages to smooth the display of the traced waveform. N1 to N32 = Factor 1 to 32	see 2.6.5.14 Interpol
SENSe[1]: *WAVeform:DURation*	**<nu>** 1 µs ... see 2.6.5.14	s	Sets the period of time the signal is traced. The max. settable Trace Len is a function of the sample rate and interpolation value.	see 2.6.5.14 Trace Len

3.3.2.4.15 Input Peak

<table>
<tr><th>Command</th><th>Parameter</th><th>Basic unit</th><th>Meaning</th><th>Section</th></tr>
<tr><td>SENSe2 :FUNCtion</td><td>"OFF"
"PEAKvoltage"</td><td></td><td>Input peak measurement off
Input peak measurement on</td><td>see 2.6.5.15
INPUT PEAK</td></tr>
<tr><td>SENSe2 [:VOLTage] :UNIT[1|2]

SENSe2 [:POWer] :UNIT[1|2]
SENSe2 :UNIT[1|2]</td><td>V|DBV|DBU|FS|
HEX
DBM|W
DPCTV|DV|V/VR|
PCTV/VR|DPCTW|
DW|P/PR|PCTP/PR|
DBR
PCTFS|DBFS|DPCT</td><td></td><td>Display units for results of input peak measurement</td><td>see 2.4 Units</td></tr>
<tr><td>SENSe2 :VOLTage :REFerence :MODE</td><td>CH1store

CH2store

STORe
VALue</td><td></td><td>With two-channel measurements, the current measurement result from channel 1 is stored as reference value.
With two-channel measurements, the current measurement result from channel 2 is stored as reference value.
With single-channel measurements, the current result is stored as reference value.
The reference value is specified using the following command.</td><td>see 2.6.5.1
Reference</td></tr>
<tr><td>SENSe2 :VOLTage :REFerence</td><td><nu>
Analog =
1 µV to 1000 V
Digital =
0.0 to 1.0 FS</td><td>Analog: V
Digital: FS</td><td>Numerical entry of reference value.</td><td>see 2.6.5.1
Reference</td></tr>
</table>

3.3.2.4.16 Frequency Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3 :FUNCtion	"OFF" "FREQuency"		Frequency measurement off Frequency measurement on	see 2.6.5.16 FREQUENCY
SENSe3 :FREQuency :UNIT[1|2]	HZ|DHZ|DPCTHZ| TOCT|OCT|DEC| F/FR		Display units for results of frequency measurement	see →2.4 Units
SENSe3 :FREQuency :APERture :*MODE*	*SFASt* *FAST* *SLOW* *VALue*		50 ms 200 ms Minimum measurement time for frequency measurement 1000 ms Numerical entry of measurement time; for entry of values, see next command	see 2.6.5.16 Meas Time
SENSe3 :FREQuency :APERture	<nu> = 1 ms to 10 s	s	Numerical entry of measurement time	
SENSe3 :FREQuency :REFerence :*MODE*	*CH1store* *CH2store* *STORe* *VALue*		With two-channel measurements, the current measurement result from channel 1 is stored as reference value. With two-channel measurements, the current measurement result from channel 2 is stored as reference value. With single-channel measurements, the current result is stored as reference value. The reference value is specified using the following command.	see 2.6.5.1 Reference
SENSe3 :FREQuency :REFerence	<nu> 0.001 Hz to 1000 kHz	Hz	Numerical entry of reference value	see 2.6.5.1 Reference
SENSe[1]:FUNCtion:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.17 Frequency and Phase Measurement

Command	Parameter	Basic unit	Meaning	Section
SENSe3 :FUNCtion	"OFF" "FQPHase"		Combined frequency and phase measurement off Combined frequency and phase measurement on	see 2.6.5.16 PHASE
SENSe3 :FREQuency :UNIT[1]	HZ|DHZ|DPCTHZ| TOCT|OCT|DEC| F/FR		Display units for results of frequency measurement	see 2.4 Units
SENSe3 :PHASe :UNIT2	DEG|RAD|DDEG| DRAD|		Display units for results of phase measurement	see 2.4 Units
SENSe3 :FREQuency :APERture :MODE	*SFASt* *FAST* *SLOW* *VALue*		50 ms 200 ms Min. measuring time for frequency measurement 1000 ms Numerical entry of measurement time. For entry of values, see next command.	see 2.6.5.16 Meas Time
SENSe3 :FREQuency :APERture	<nU> = 1 ms to 10 s	s	Numerical entry of measurement time.	
SENSe3 :FREQuency :REFerence :*MODE*	*STORe* *VALue*		The current frequency measurement result is stored as reference value. The reference value is entered using the following command.	see 2.6.5.1 Reference
SENSe3 FREQuency :REFerence	<nU> 0.001 Hz to 1000 kHz	Hz	Numerical entry of reference value.	see 2.6.5.1 Reference
SENSe3:FREQuency:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1
SENSe3 :*PHASe* :REFerence :*MODE*	*STORe* *VALue*		The current phase measurement result is stored as reference value. The reference value is entered using the following command.	see 2.6.5.1 Reference
SENSe3 :*PHASe* :REFerence	<nU> -360° to +360°	DEG	Numerical entry of reference value.	see 2.6.5.1 Reference
SENSe3 :*PHASe* :*FORMAT*	*POSitive* *POSNegative*		0 to 360° or 0 to 2π -180 to -180° or -π to +π	see 2.6.5.16
SENSe3:*PHASe*:SETTling:xxxx			Settling commands cf. 3.3.2.4.1 Common Parameters for Analyzer Functions	see 3.3.2.4.1

3.3.2.4.18 Monitor

Command	Parameter	Basic unit	Meaning	Section
SYSTem:*MONItor*:STATe	ON OFF		Analog headphones input on Analog headphones input off	see 2.6.6 Monitor
SYSTem:*MONitor:ATTenuation*	<nu> = 0 to 70 dB	dB	Attenuation for analog headphones input 70 dB = max. attenuation	see 2.6.6 Monitor

3.3.3 Selecting the Analyzer Filters

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :FILTer<i> :*UFILter1*to: *UFILter9* [:STATe]	<i> = 1 to 4, **ON|OFF**		Each of the 9 user filters (UFILter) can be assigned a HPASs, LPASs, BPASs, BSTOp, NOTCh, TERZ, OCTav or FILE filter, their parameters being freely definable (see SENSe :FILTer<n> :HPASs|:LPASs ... and the following commands). Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter
SENSe[1] :FILTer<i> :CCITt [:STATe]	<i> = 1 to 4, **ON|OFF**		For psophometric measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →CCITT
SENSe[1] :FILTer<i> :*CCIUnweight* [:STATe]	<i> = 1 to 4, **ON|OFF**		Bandpass 20 Hz to 20 kHz Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →CCIR unwtd
SENSe[1] :FILTer<i> :CCIR [:STATe]	<i> = 1 to 4, **ON|OFF**		For disturbing voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →CCIR wtd
SENSe[1] :FILTer<i> :AWEighting [:STATe]	<i> = 1 to 4, **ON|OFF**		For disturbing voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →A Weighting
SENSe[1] :FILTer<i> :CMESsage [:STATe]	<i> = 1 to 4, **ON|OFF**		For transmission measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →C MESSAGE
SENSe[1] :FILTer<i> :*DEMPhasis50* [:STATe]	<i> = 1 to 4, **ON|OFF**		For interference and noise voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →DEEMPH 50
SENSe[1] :FILTer<i> :*DEMPhasis75* [:STATe]	<i> = 1 to 4, **ON|OFF**		For interference and noise voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →DEEMPH 75
SENSe[1] :FILTer<i> :*DEMPhasis17* [:STATe]	<i> = 1 to 4, **ON|OFF**		For interference and noise voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →DEEMPH J.17
SENSe[1] :FILTer<i> :*DEMPhasis5015* [:STATe]	<i> = 1 to 4, **ON|OFF**		For interference and noise voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →DEEM 50/15
SENSe[1] :FILTer<i> :*WRUMble* [:STATe]	<i> = 1 to 4, **ON|OFF**		Testing of record players, noise voltage measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →RUMBLE wtd
SENSe[1] :FILTer<i> :*URUMble* [:STATe]	<i> = 1 to 4, **ON|OFF**		Testing of record players, interference voltage measureements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →RUMBLE unw
SENSe[1] :FILTer<i> :*DCNoise* [:STATe]	<i> = 1 to 4, **ON|OFF**		Highpass for DC noise measurements Switching a filter ON automatically switches the filter used before OFF.	see 2.7.1 Filter →DC NOISE HP

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :*UFILTer*<i> :HPASs [:STATe]	<i> = 1 to 9, **ON|OFF**		Highpass Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :LPASs [:STATe]	<i> = 1 to 9, **ON|OFF**		Lowpass Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :UFILTer<i> :*BPASs* [:STATe]	<i> = 1 to 9, **ON|OFF**		Bandpass Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :*BSTOp* [:STATe]	<i> = 1 to 9, **ON|OFF**		Bandpass Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :*NOTCh* [:STATe]	<i> = 1 to 9, **ON|OFF**		Notch filter Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :*TOCTave* [:STATe]	<i> = 1 to 9, **ON|OFF**		Third octave filter (Third Octave) Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :*OCTav* [:STATe]	<i> = 1 to 9, **ON|OFF**		Oktave filter Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :*FILE* [:STATe]	<i> = 1 to 9, **ON|OFF**		User-defined filter Switching a filter ON automatically switches the filter used before OFF.	see 2.7.2 FILTER 01 to 09
SENSe[1] :*UFILTer*<i> :*PASSb*	<i> = 1 to 9 **<nu>** = LL*) Meas. range limit, see 2.6.1	Hz	Passband for HPASs and LPASs	see 2.7.2.2 FILTER 0x →Passband
SENSe[1] :*UFILTer*<i> :*STOPb?*	<i> = 1 to 9		Query command for stopband of HPASs and LPASs	see 2.7.2.2 FILTER 0x →Stopband
SENSe[1] :*UFILTer*<i> :*PASSb* :*LOWer*	<i> = 1 to 9 **<nu>** = LL*) Meas. range limit, see 2.6.1	Hz	Lower passband for BPASs and BSTOp	see 2.7.2.3 FILTER 0x →Passb low

*) LL = Lower limit for the instruments
A22: 24 Hz
A100: 179 Hz
A300: 512 Hz
D48, D192, D768: sample freq*oversamp/2000
see 2.6.3

Command	Parameter	Basic unit	Meaning	Section
SENSe[1] :*UFILTer*<i> :*PASSb* :*UPPer*	<i> = 1 to 9 <nu> = LL*) Meas. range limit, see 2.6.1	Hz	Upper passband for BPASs and BSTOp	see 2.7.2.3 FILTER 0x →Passb upp
SENSe[1] :*UFILTer*<i> :*STOPb* :*LOWer?*	<i> = 1 to 9		Query command for lower stopband of BPASs and BSTOp	see 2.7.2.3 FILTER 0x →Stopb low
SENSe[1] :*UFILTer*<i> :*STOPb* :*UPPer?*	<i> = 1 to 9		Query command for upper stopband of BPASs and BSTOp	see 2.7.2.3 FILTER 0x →Stopb upp
SENSe[1] :*UFILTer*<i> :*CENTer*	<i> = 1 to 9 <nu> = LL*) Meas. range limit, see 2.6.1	Hz	Center frequency for NOTCh, TOCT OCTAv	see 2.7.2.4 und 2.7.2.5 FILTER 0x →Center Frq
SENSe[1] :*UFILTer*<i> :*WIDTh*	<i> = 1 to 9 <nu> = LL*) Meas. range limit, see 2.6.1	Hz	Center fequency for NOTCh, TOCT OCTAv	see 2.7.2.4 und 2.7.2.5 FILTER 0x →Width
SENSe[1] :*UFILTer*<i> :*ATTenuation*	<i> = 1 to 9 <nu> = 3 to 120 dB	dB	Attenuation for all filters, except for FILE Def. The value may be corrected in the UPD. It can be queried using a query command.	see 2.7.2.1 FILTER 0x →Atten
SENSe[1] :*UFILTer*<i> :*DELay*	<i> = 1 to 9 <nu> = 0 to 1 s	s	Settling time for the file-defined filters	see 2.7.2.7 FILTER 0x →Delay
SENSe[1] :*UFILTer*<i> :*DELay?*	<i> = 1 to 9 no entry of values!		Query command for settling time of filters HPASs, LPASs, BPASs, BSTOp, NOTCh, TOCT OCTav	see 2.7.2.1 FILTER 0x →Delay
SENSe[1] :*UFILTer*<i> :*FILE*	<i> = 1 to 9 "*filename*"		Path and file name of file-defined filter data eg "C:\UPD\USER\MYFILT.ZPZ"	see 2.7.2.7 FILTER 0x →Filename

*) LL = Lower limit for instruments
A22: 24 Hz
A100: 179 Hz
A300: 512 Hz
D48, D192, D768: sample freq*oversamp/2000
see 2.6.3

3.3.4 Units for IEC Measurement Results

Command	Parameter	Basic unit	Meaning	Section
SENSe[1|2] [:VOLTage] :UNIT[1|2]	V DBV *DBU* *FS* *HEX*		V dBV dBu FS Hex Display units for absolute results of voltage measurements	see 2.4 Units
SENSe[1|2] [:POWer] :UNIT[1|2]	DBM W		dBm W Display units for absolute results of power measurements	see 2.4 Units
SENSe[1|2] :UNIT[1|2]	*DPCTV* *DV* *VIVR* *PCTVIVR* *DPCTW* *DW* *PIPR* *PCTPIPR* *DBR* *PCTFS* *DBFS* *DPCT* PCT DB		Δ%V ΔV V/VR $\%V/V_r$ Δ%W ΔW P/P_r $\%P/P_r$ ΔdB %Fs dBFS Δ% % dB Display units for relative measurement results	see 2.4 Units
SENSe3 :FREQuency :UNIT[1|2]	HZ *DHZ* *DPCTHZ* *TERZ* *OCT* *DEC* *FIFR*		Hz ΔHz Δ%Hz Terz Oct Dec f/fr Display units for absolute and relative frequency measurement results	see 2.4 Units
SENSe3 :PHASe :UNIT	DEG RAD *DDEG* *DRAD*		° RAD Δ° ΔRAD Display units for absolute and relative phase measurement results	see 2.4 Units

3.3.5 Loading and Storing

3.3.5.1 Loading and Storing of Instrument Setups

Command	Parameter	Basic unit	Remark	Section
MMEMory:LOAD:STATe	2|3, "filename" 2 3		Loading setup "filename" filename Complete instrument setup R&S default setup	2.9.1.1
MMEMory:STORe:STATe	"filename" 2		Store Setup "filename" Complete instrument setup	2.9.1.1
MMEMory:STORe:STATe:*RONLy*	ON OFF		File is write-protected	2.9.1.1

3.3.5.1.1 Loading and Storing of Traces and Lists

Command	Parameter	Basic unit	Meaning	Section
MMEMory:STORe:*APPend*:STATe	ON OFF		Data are appended to existing file Data overwrite existing file	2.9.1.2
MMEMory:STORe:*FORMat*	*BIN* *ASCii*		Data are stored in binary format Data are stored in ASCII format	2.9.1.2
MMEMory:STORe:TRACe	TRACe1,"filename" TRACe2,"filename"		Store trace A buffer under "filename" Store trace B buffer under "filename"	2.9.1.2
MMEMory:STORe:*LIST*	*LIST1*,"filename" *LIST2*,"filename" DWELi,"filename"		Store X-axis list under "filename" Store Z-axis list under "filename" Store dwell time list under "filename"	2.9.1.2

3.3.5.1.2 Storing of Limit Exceedings (Error Reports)

Command	Parameter	Basic unit	Meaning	Section
MMEMory:STORe:*APPend*:STATe	ON OFF		Data are appended to existing file Data overwrite existing file	2.9.1.2
MMEMory:STORe:*FORMat*	*BIN* *ASCii*		Data are stored in binary format Data are stored in ASCII format	2.9.1.2
MMEMory:STORe:LIST	*ERRors*, "filename"		Store limit error under "filename"	2.9.1.2

3.3.5.1.3 Storing of Equalization Files

Command	Parameter	Basic unit	Meaning	Section
MMEMory:STORe:*FORMat*	*BIN* *ASCii*		Data are stored in binary format Data are stored in ASCII format	2.9.1.2
CALCulate:*EQUalize:FEED*	*TRACe1* *TRACe2*		Amplitude data are read from trace buffer A/B	2.9.1.2
CALCulate:*EQUalize:NORMfreq*	<nu> f_{min} to f_{max}	Hz	Frequency on the level of which is normalized	2.9.1.2
CALCulate:*EQUalize:INVert*	ON OFF		Frequency response is stored in inverted form	2.9.1.2
MMEMory:STORe:*LIST*	*EQUalize*,"filename"		Store equalization file under "filename"	2.9.1.2

3.3.5.2 Commands for Editing Files and Directories

Command	Parameter	Basic unit	Meaning	Section
MMEMory:DELete	"filename"		With this command, a file is deleted.	2.9.2
MMEMory:CDIRectory	"pathname"		Selects a directory for file operations.	2.9.2
MMEMory:COPY "filename1,"filename2"	<filename1> <filename2>		Selects the file to be copied. Specifies the name of the file (with drive and directory, if required) to which sthg. is to be copied.	2.9.2

3.3.6 Commands for Graphical Representation of Results

In the following, TRACe1 and TRACe2 serve to differentiate between the two displayable curves (Trace A and Trace B) or bargraphs and measured value lists.

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow][:TRACe]:*OPERation*			This command serves to specify how the measurement results are to be presented graphically using the following parameters.	2.10
	OFF		Graphical output switched off.	
	CURVeplot		Line chart in the Cartesian coordinate system.	2.10.2
	LIST		List of numbers.	2.10.4
	ERRors		Only lists of measured values out of tolerance. Limit check must be switched on.	2.10.4
	BARGraph		Bargraph display in analog form	
	SPECtrum		Display of FFT or, with THD, DFD, DIM or MODDIST, in the form of a schematic spectrum display	2.10.6 2.10.2
	PROTOcol		In the GRAPH window, the protocol data of the AES / EBU digital interface are displayed.	2.10.8
DISPlay[:WINDow]:TRACe[]:MODE	*DELete__bef__wr* *OVERlay__maxh* *WATerfall*		Deletes the traces of the preceding measurement by gradually overwriting them. The traces on the screen overlay each other. With FFT, the Max. Hold function is switched on. (Staggered) display in the Z-axis (only with FFT).	2.10.1
DISPlay[:WINDow]:TRACe[1|2]:FEED			Selects which measurement result is to be displayed as TRACe1 (or TRACe2).	2.10.1
	"SENSe1:DATA1"		The function is specified by SENSe1:FUNCtion " < > ". Value from channel 1(CH1).	
	"SENSe1:DATA2"		The function is specified by SENSe1:FUNCtion " < >2. Value from channel 2 (CH2).	
	"SENSe3:DATA1"		Measured value from frequency meter, channel 1 (CH1).	
	"SENSe3:DATA2"		Measured value from frequency meter, channel 2 (CH2).	
	"SENSe4"		Measured value from phase meter.	
	"HOLD"		Holds the old values for display (collects no new measured values).	
	"FILE"		Serves to display the measured value from the file using the following command.	
	"OFF"		Switched off	
MMEMory:LOAD:TRACeTRACe[1|2],	"filename"		Loads a trace stored to file.	2.10.1
TRACe:DATA? TRACe[1|2]			Query only. Subsequently, the trace (block data!) can be read from the UPD to the controller.	2.10.1
DISPlay:[WINDow]:TRACe[1|2]:Y [:SCALe]:UNIT	<u>	[1])	Specifies the unit with which the results are to be displayed.	2.10.1
DISPlay:[WINDow]:TRACe[1|2]:Y [:SCALe]:RLEVel:*MODE*			This reference value is required for the relative units of TRACe1 or TRACe2.	2.10.1
	VALue		The value entered subsequently is used as reference.	
	MAXimum		Adopts the max. value of the trace once.	
	CURSor[1|2]		Adopts the value on which the cursor is placed once (1for +- and 2 for 0-cursor).	
DISPlay:[WINDow]:TRACe[1|2]:Y [:SCALe]:RLEVel	<nu>	[1])	Entering the reference value for relative units.	2.10.1

[1]) Depending on DISPLAY:TRACe:FEED and (with SENSe1:) on SENSe1:FUNCtion

Command	Parameter	Basic unit	Meaning	Section
DISPlay:[WINDow]:TRACe2:Y [:SCALe]:*EQUal*	*ON* *OFF*		TRACe2 can be displayed on the same axis as TRACe1. In this case no values can be entered for:UNIT, :RLEVel, :SCALe :AUTO, :TOP, :BOTTom and :SPACing concerning the second axis. Independent of Trace1.	2.10.1
DISPlay:[WINDow]:TRACe[1|2]:Y [:SCALe]:AUTO	*EXECute* OFF ONCE		Uses the minimum and maximum values of the present sweep for scaling of the selected Y-axis (once). Leaves the scaling to the user.	2.10.1
DISPlay:[WINDow]:TRACe[1|2]:Y [:SCALe]:TOP	<nu>	1)	(With TRACe1/2 AUTO OFF) sets the upper value of the Y-axis (of the dependent value).	2.10.1
DISPlay:[WINDow]:TRACe[1|2]:Y [:SCALe]:BOTTom	<nu>	1)	(With TRACe1/2 AUTO OFF) sets the lower value of the Y-axis (of the dependent value).	2.10.1
DISPlay[:WINDow]:TRACe[1|2]:Y :SPACing	LINear LOGarithmic		Linear spacing of the Y-axis Logarithmic	2.10.1
DISPlay[:WINDow]:TRACe[1|2]:X :[SCALe]:*UNIT*	<u>		Determines the units with which the results are to be displayed on the X-axis.	2.10.1
DISPlay[:WINDow]:TRACe[1|2]:X :[SCALe]:RLEVel	<nu>	2)	Entering the reference value for relative units.	2.10.1
DISPlay[:WINDow]:TRACe[]:X :[SCALe]:AUTO	ON OFF		Uses the minimum and maximum values of the present sweep for scaling of the X-axis (once). Leaves the scaling to the user.	2.10.1
DISPlay[:WINDow]:TRACe[]:X :[SCALe]:LEFT	<nu>	2)	(With:X:[SCALe]:AUTO OFF) sets the left-hand value of the X-axis (of the independent value).	2.10.1
DISPlay[:WINDow]:TRACe[]:X :[SCALe]:RIGHT	<nu>	2)	(With:X:[SCALe]:AUTO OFF) sets the right-hand value of the X-axis (of the independent value). The lower value of LEFT and RIGHT is used for the left side.	2.10.1
DISPlay[:WINDow]:TRACe[]:X:SPACing	LINear LOGarithmic		Linear spacing of the X-axis. Logarithmic	
DISPlay[:WINDow]:TEXT[:DATA]	"string"		Allows the entry of text which is output in the trace display in the case of :OPERation CURVeplot.	2.10.1
DISPlay[:WINDow]:TEXT:LOCate	<ny>[,<nx>]		Specifies the X- and Y-position of the text. X and Y are the relative distance from the 0-point of the coordinate system in % (0 to 100)	2.10.1
DISPlay[:WINDow]:TRACe[]:*CURSor* *[1|2]*	ACTive		Toggles the display of the cursors ON or OFF. Affects the display only. CURSor1 is identified by o. CURSor2 by *.	2.10.2

2) Depending on the sweep selected for the analyzer or generator

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:TRACe[]:*CURSor[1]:MODE*			The parameters serve to select the function of the cursor and the type of numerical values displayed with the cursor.	2.10.2
	N12		Display of measured values A and B and the appertaining X-value.	
	D12		Display of the difference value of A and B at the position of the cursor and of the X-value.	
	OFF		The deactivated cursor is not displayed.	
DISPlay[:WINDow]:TRACe[]:*CURSor2:MODE*	***N12***		Display of measured values A and B and the appertaining X-value.	2.10.2
	D12		Display of the difference value of A and B at the position of the cursor and of the X-value.	
	HL1		The *-cursor is switched to horizontal line. Its Y-value and the intersections with TRACe1 (if any) are displayed.	
	HL2		The intersections with TRACe2 are displayed.	
	HLD1		The *-cursor is switched to horizontal line. The difference between its y-value and that of the o-cursor is displayed. Also, the intersections with TRACe1 are displayed.	
	HLD2		As for HLD1, however the intersections with TRACe2 are displayed.	
	OFF		The deactivated cursor is not displayed.	
DISPlay[:WINDow]:TRACe[]:*CURSor[1|2]:POSition:MODE*			Changes the position of the specified cursor.	2.10.2
	MIN1		Sets the cursor to the minimum value of TRACe1.	
	MAX1		Sets the cursor to the maximum value of TRACe1.	
	MIN2		Sets the cursor to the minimum value of TRACe2.	
	MAX2		Sets the cursor to the maximum value of TRACe2.	
	MARKer1		Sets the cursor to the value of the 1st marker (FFT only).	
	NEXTmarker		Sets the cursor to the next marker value (FFT only).	
	VALue		Sets the cursor to the value specified (using the subsequent command).	
	IMAX1		Sets the cursor to the max. calculated value of TRACe1 (with FFT only).	
	IMAX2		Sets the cursor to the max. calculated value of TRACe2 (with FFT only).	
DISPlay[:WINDow]:TRACe[]:CURSor*[1|2]:POSition*	<nu>	3)	Sets the specified cursor to the value on the X-axis.	2.10.2
DISPlay[:WINDow]:TRACe[]:*CURSor[]:DATA1?* DISPlay[:WINDow]:TRACe[]:*CURSor[]:DATA2?* DISPlay[:WINDow]:TRACe[]:*CURSor[]:DATA3?*			Return the values of the cursor position. Depending on the DISPlay [:WINDOW]:TRACe[]:CURSor[1|2]:MODE N12|D12|OFF-HL1|HL2|HLD1|HLD2 and DISPlay[:WINDow]:TRACe:CURSor[1|2]ACTive, the following values are available: DATA1 DATA2 DATA3 N12 A X B D12 A-B X - OFF - - - only with CURSor2ACTive: HL1 XAL y XAR HL2 XBL y XBR HLD1 XAL A-Y XAR HLD2 XBL B-Y XBR	2.10.2

3) The same units as with DISPLay:TRACe:X are permissible

Command	Parameter	Basic unit	Meaning	Section
DISPlay[:WINDow]:TRACe[]:*ZOOM*	*ATCUrsor*		Specifies the center of the X-axis in the new coordinate system to the value of the o-cursor (CURSor1) without magnification.	2.10.2
	BETWeen		The end values of the new (magnified) X-axis are defined by the X-values of the two cursor(s)	
DISPlay[:WINDow]:TRACe[]:*ZOOM*	0		Restores the original X-axis, which is defined by X AXIS LEFT and RIGHT.	2.10.2
	1		Magnifies the trace on the X-axis by the factor of 2 (repeated activation is possible).	
	-1		Reduces the trace on the X-axis by the factor of 2 (repeated activation is possible).	
DISPlay[:WINDow]:TRACe[1|2]:*MARKer*			Markers can be set only with FFT selected.	2.10.2
	MAXimum		Sets the first marker to the maximum value of TRACe1 or TRACe2.	
	CURSor		Sets the first marker to the values defined by the o-cursor. TRACe1 or TRACe2 are used.	
	OFF		No markers.	
DISPlay[:WINDow]:TRACe[1|2]:*MARKer:HARMonics*	ON		The harmonics (frequency multiples) are marked by MARKER1 (FFT only). The values of TRACe1 or TRACe2 are marked.	2.10.2
	OFF		The harmonics are not marked.	
DISPlay[:WINDow]:TRACe[]:*AUToscale*			Rescales the X- and TRACe1-axes. TRACe2 axis, if active, is also rescaled.	2.10.2
DISPlay[:WINDow]:TRACe[]:*KEEPlast*			The present trace (or, as the case may be, pair of traces) is not deleted but retained for the next sweep or FFT.	2.10.2
DISPlay:*CONFiguration*			Configuration of the screen as is shown after switchover to LOCAL:	2.10.7
	P		Full-screen graphics (Plot)	
	SP		Status panel and part-screen graphics	
	AP		Analyzer panel and part-screen graphics	
	GP		Generator panel and part-screen graphics	
	FP		File panel and part-screen graphics	
	DP		Display panel and part-screen graphics	
	OP		Option panel and part-screen graphics	
	GAT		Generator-, Analyzer- and Filter panel	
	GAO		Generator-, Analyzer- and Options panel	
	GAD		Generator-, Analyzer- and Display panel	
	FAT		File-, Analyzer- and Filter panel	
	FAO		File-, Analyzer- and Options panel	
	FAD		File-, Analyzer- and Display panel	
	SHON		Show IO graphics on	
	SHOFF		Show IO graphics off	
DISPLAY :*ANNotation [:STATe]*	*ON*		In the Remote state, measurement results and status are displayed.	
	Off		The display remains unchanged in the Remote state. (IEC-bus operation becomes faster!)	

3.3.6.1 Commands for Limit Check

See also Section 2.10.7 Limit Check and 3.3.11 IEC-Bus Commands for Input/Output of Block Data, for the transfer of limit curves and limit check results in the form of block data.

Command	Parameter	Basic unit	Meaning	Section
CALCulate:LIMit:*ON*	*TRACe1* *TRACe2* *TR1And2*		Trace1 or bargraph 1 is monitored. Trace2 or bargraph 2 is monitored. Both traces (bargraphs) are monitored in common.	2.10.7
CALCulate:LIMit:UPPer:STATe	ON OFF		Checking of the upper limit on. Checking of the upper limit off.	2.10.7
CALCulate:LIMit:UPPer:VALue	<nu>	*)	Specifies a single upper limit value.	2.10.7
MMEMory:LOAD:*LIST LIMUpper*, "filename"			Defines a file with the upper limit curve.	2.10.7
CALCulate:LIMit:LOWer:STATe	ON OFF		Checking of the lower limit on. Checking of the lower limit off.	2.10.7
CALCulate:LIMit:LOWer:VALue	<nu>	*)	Specifies a single lower limit value.	2.10.7
MMEMory:LOAD:*LIST LIMLower*, "filename"			Defines a file with the lower limit curve.	2.10.7
CALCulate:LIMit:FAIL?			Returns 1, if any limit is exceeded, otherwise 0.	2.10.7

*) The same units as with DISPLAY:TRACe:Y are permissible.

3.3.6.2 PROTOCOL Analysis

Command	Parameter	Basic unit	Meaning	Section
DISPlay: *PROTocol: SELect*			Selects the report data of the AES/EBU interface to be displayed.	see 2.10.8 →Source
	LCHanelstatus		Left channel: Status data	
	RCHanelstatus		Right channel: Status data	
	LUSerdata		Left channel: User data	
	RUSerdata		Right channel: User data	
DISPlay: *PROTocol: FORMat*			Format selects the interpretation mode for the USER data.	see 2.10.8 Format
	BINary			
	HEXadecimal			
	ASCii			
	FILE		Interpretation file for user data loaded by means of MMEMory: LOAD: PAU "filename".	
MMEMory: LOAD: *PAU*	**"filename"**		selects the interpretation file if DISPlay: PROTocol: FORMat: FILE has been set.	see 2.10.8 Proto File
MMEMory: LOAD: *PAC*	**"filename"**		selects the interpretation file for Channel Status Data.	see 2.10.8 Proto File

*) The same units as with DISPLAY:TRACe:Y are permissible.

3.3.7 Commands for Printing/Plotting of the Screen Contents and for Storing to File

Command	Parameter	Basic unit	Meaning	Section
HCOPy :DESTination	*PRINter* *PLOTer* *PCXFile*, "filename" *HPGLfile*, "filename" <filename>		Start of output to printer via printer driver selected subsequently. Output to plotter using HP-GL language. Entering the file name for storing of the screen contents. The extension is .pcx and is fixed. Storing in the PCX (pixel) format. Store using the HP-GL plotter language. Entering the file name for storing of the screen contents. The extension is .gl and is fixed.	2.14.1
HCOPy :ITEM	 *ALL* *GRATicule* *TRACe*		Effective with HCOPy :DESTination PLOTter|HPGLfile only. The entire screen contents is output, ie all labellings and cursors, indications and traces/bargraphs including scales. With part-screen mode, indication of measured values and a panel are additional features. Stores the picture of the traces/bargraphs incl. the scales and scale labellings, however not the cursors and other labellings. The trace(s) displayed on the screen is (are) transferred.	2.14.1
HCOPy:*PRName*	"drivername"		Effective with HCOPy :DESTlination PRINter only Selects a printer driver for conversion of the pixel information into the control characters of the printer.	2.14.1
HCOPy :*PLPort*	 **IEC** **COM1** **COM2** **LPT1**		Effective with HCOPy :DESTINATION PLOTter only. Hardcopy via IEC-bus interface. Hardcopy via serial interface 1. Hardcopy via serial interface 2. Hardcopy via parallel printer interface.	2.14.1

Command	Parameter	Basic unit	Meaning	Section
HCOPy:*PLADdress*	<n>		Effective with HCOPy :PLPort IEC only Selects the IEC-bus address of the plotter/printer for the hard copy.	see 2.14.1
HCOPy:IMMediate HCOPy:ABORt			Starts the hard copy. Aborts the hard copy before its normal end.	see 2.14.1
SYSTem:*PRINt*			Output to printer in the form of numerals in ASCII-code (incl. X-axis).	see 2.14.2
	TRACe1		Output of TRACe1.	
	TRACe2		Output of TRACe2.	
	EQUalize		Output of equalization values.	
	ERRors		Output of values with limit exceedings.	
	DWELi		Output of dwell time values	
	LIMLower		Output of lower limits.	
	LIMUpper		Output of upper limits.	
	OFF		Output is switched off.	
	LIST1		X-axis (eg sweep)	
	LIST2		Z-axis (eg sweep)	
	TR1And2		Output of both traces	

3.3.8 Setting and Display of Auxiliary Parameters

3.3.8.1 IEC-bus Address

Command	Parameter	Basic unit	Meaning	Section
SYSTem:COMMunicate:GPIB:ADDRess	<n> 0 to 31		IEC-bus address of UPD	2.15.1

3.3.8.2 Switching the Beeper On/Off

Command	Parameter	Basic unit	Meaning	Section
SYSTem:BEEPer:STATe	ON OFF		Beeper on	2.15.2

3.3.8.3 Keyboard Settings

Command	Parameter	Basic unit	Meaning	Section
SYSTem:KEY:*RRATe*	<nu> 0 to 20 Hz	Hz	Repetition rate of UPD and AT-keyboard	2.15.3
SYSTem:KEY:*RDELay*	<nu> 0.25 to 1.0 s	s	Delay time until UPD and AT-keyboard respond	

3.3.8.4 Setting, Switching off the Displays

Command	Parameter	Basic unit	Meaning	Section
DISPlay:*MODE*	*INTern* *COLBoth* *BWBoth*		Indication on internal LCD-display only Indication also on the external color monitor Indication also on the external monochrome monitor	2.15.5
DISPlay:*ENABle*	*ON* *OFF*		Indication on LCD-display LCD-display is switched off.	2.15.5

3.3.8.5 Version Display

Command	Parameter	Basic unit	Meaning	Section
SYSTem:*SOFTware:VERSion?*	***UI*** ***HW*** ***IEC***		Version number of software user interface Version number of software hardware module Version number of software IEC-bus module	2.15.7
SYSTem:*AHARdware:VERSion?*	***ACH1*** ***ACH2*** ***MBOard*** ***GENerator*** ***DAC***		Version number of analog analyzer channel 1, with ADC-board only Version number of analog analyzer channel 2, with or without ADC-board Version number of analog analyzer motherboard Version number of analog generator output circuit Version number of analog generator DAC-board	2.15.7
SYSTem:*DHARdware:VERSion?*	***ANALysator*** ***GENerator***		Version number of digital analyzer Version number of digital generator	2.15.7
SYSTem:*OPTions:VERSion?*	***LDG*** ***IECBoard*** ***AESebu*** ***AHSPeed*** ***DHSPeed*** ***GNON*** ***ANON***		Version number of LDG option Version number of IEC-board option Version number of AES-EBU-board option Version number of Highspeed option analog Version number of Highspeed option digital Version number of generator reserve board Version number of analyzer reserve board	2.15.7

3.3.8.6 Calibration

Command	Parameter	Basic unit	Meaning	Section
CALibrate:LDG:AUTO	**OFF**		No calibration of the low distortion generator.	see 2.15.6
	ONCE		Triggers the automatic calibration of the low distortion generator. May only occur after an operating time of one hour.	
CALibrate:ZERO:AUTO	**OFF**		No offset calibration	
	ON		Offset calibration cyclically and in the case of a change analyzer/instrument.	
	ONCE		Manual triggering of the offset calibration; then return to ON.	
CALibrate	**OFF**		No offset calibration. Equivalent to CALibrate:ZERO:AUTO OFF.	see 2.15.6 Calibrate
	AUTO		Offset calibration cyclically and in the case of a change analyzer/instrument. Equivalent to CALibrate:ZERO:AUTO ON.	
	DCC		Manual triggering of the offset calibration; then return to AUTO. Equivalent to CALibrate:ZERO:AUTO ONCE.	
	LDG		Automatic calibration of the low distortion generator. May only occur after an operating time of one hour. Equivalent to CALibrate LDG:ZERO:AUTO ONCE.	

3.3.9 Commands for Input/Output of (Block) Data

Command	Parameter	Basic unit	Meaning	Section
FORMat[:DATA]	ASCii REAL		Specifies, for block data only, the number format: output in the form of numbers with sign, point and exponent, if any (default). Specifies, for block data only, the number format: output in binary format	
SENSe[1]:LIST:FREQency SOURce[1]:LIST:FREQency	<n>{,<n>} <n>{,<n>}	Hz	These two commands are equivalent, specifying the block data concerning a frequency sweep or frequencies for a number of measurements. When limit or equalization curves are specified, the frequencies must be arranged in increasing or decreasing order.	
SENSe[1]:LIST:FREQency:POINts? SOURce[1]:LIST:FREQency:POINts?	0 to 1023 0 to 1023		These two commands are equivalent, specifying the number of currently available block data values concerning the frequency axis.	
SOURce[1]:LIST:VOLTage	<n>{,<n>}	V	Specifies the block data concerning a voltage sweep or the output voltage for a sequence of measurements.	
SOURce[1]:LIST:VOLTage:POINts?	0 to 1023		Specifies the number of currently available block data values concerning the voltage axis.	
SOURce[1]:LIST:*ONTime*	<n>{,<n>}	s	Specifies the block data concerning a sweep of the ratio of on-time to off-time of the burst signal or for a sequence of measurements.	
SOURce[1]:LIST:*ONTime*:POINts?	0 to 1023		Returns the number of currently available block data values concerning the on-time axis.	
SOURce[1]:LIST:*INTerval*	<n>{,<n>}		Specifies the block data concerning a sweep of the ratio of on-time to off-time of the burst signal or for a sequence of measurements.	
SOURce[1]:LIST:*INTerval*:POINts?	0 to 1023		Returns the number of currently available block data values concerning the interval axis	
SOURce[1]:LIST:DWELl	<n>{,<n>}	s	Specifies the block data concerning the dwell time of a sweep or of a sequence of measurements.	
SOURce[1]:LIST:DWELl:POINts?	0 to 1023		Returns the number of currently available block data values concerning the dwell time.	
SOURce[1]:VOLTage:EQUalize:DATA	<n>{,<n>}		Specifies the block data concerning the voltage axis of the equalization curve.	
SOURce[1]:VOLTage:EQUalize:POINts?	0 to 1023		Returns the number of currently available block data values concerning the voltage-equalization list.	
SOURce[1]:EQUalize:CONTrol[:DATA]	<n>{,<n>}		Specifies the block data concerning the frequency axis of the equalization curve.	
SOURce[1]:EQUalize:CONTrol:POINts?	0 to 1023		Returns the number of currently available block data values concerning the frequency axis of the equalization curve.	
CALCulate:LIMit:UPPer[:DATA]	<n>{,<n>}	*1	Returns the block data values concerning the Y-axis of the upper limit curve.	
CALCulate:LIMit:UPPer:POINts?	0 to 1023		Returns the number of currently available block data values concerning the Y-axis of the upper limit curve.	
CALCulate:LIMit:LOWer[:DATA]	<n>{,<n>}	*1	Returns the block data values concerning the Y-axis of the lower limit curve.	
CALCulate:LIMit:LOWer:POINts?	0 to 1023		Returns the number of currently available block data values concerning the Y-axis of the lower limit curve.	
CALCulate:*LIMit:UPPer:CONTrol [:DATA]*	<n>{,<n>}		Returns the block data values concerning the X-axis of the limit curves.	

Command	Parameter	Basic unit	Meaning	Section
CALCulate:LIMit:UPPer:CONTrol :POINts?	0 to 1023		Returns the number of currently available block data values concerning the X-axis of the limit curves.	
CALCulate:LIMit:LOWer:CONTrol [:DATA]			Returns the block data values concerning the Y-axis of the limit curves.	
CALCulate:LIMit:LOWerCONTrol :POINts?			Returns the number of currently available block data values concerning the X-axis of the limit curves.	
CALCulate:LIMit:FAIL?	Query only		Returns "1" in the case of limit exceedings, otherwise 0.	
CALCulate:LIMit:REPort[:DATA]	Query only		Returns the block data values concerning limit exceedings.	
CALCulate:LIMit:REPort:POINts?	0 to 1023		Returns the number of currently available block data values concerning limit exceedings.	
SENSe[1]:DATA1|2?	Query only	Depending on FUNCTION	Returns the measured value of the 1st analyzer (RMS, RMS selectiv, PEAK, Qpeak, DC, THD, SNDRatio, SMPTE, DIM, DFD, WAF weight and WAF unweight). DATA1 refers to input channel 1 und DATA2 selects the second input.	
SENSe[2]:DATA1|2?	Query only	V/FS	Returns the measured value of the 2nd analyzer (peak voltage meter). DATA1 refers to input channel 1, DATA2 selects the second input.	
SENSe[3]:DATA1|2?	Query only	Hz	Returns the measured value of the 3rd analyzer (frequency counter). DATA1 refers to input channel 1, DATA2 selects the second input.	
SENSe[4]:DATA?	Query only	GRAD	Returns the measured value of the 4th analyzer (phase meter). DATA1 refers to input channel 1, DATA2 selects the second input.	
TRACe[:DATA] TRACe1,	<n>{,<n>} Query form: TRACe[:DATA]? TRACe1	[1]	Returns the block data values concerning the measurement data of the 1st trace (Y1-axis).	
TRACe:POINts? TRACe1	0 to 1023		Returns the number of currently available block data values concerning the measurement data of the 1st trace (Y1-axis).	
TRACe[:DATA] TRACe2	<n>{,<n>} Query form: TRACe[:DATA]? TRACe2	[1]	Returns the block data values concerning the measurement data of the 2nd trace (Y2-axis).	
TRACe:POINts? TRACe2,	0 to 1023		Returns the number of currently available block data values concerning the measurement data of the second trace (Y2-axis).	
TRACe[:DATA] LIST1,	<n>{,<n>}	[2]	Returns the block data values concerning the 1st sweep list (X-axis).	
TRACe:POINts? LIST1	0 to 1023		Returns the number of currently available block data values concerning the 1st sweep list (X-axis).	
TRACe[:DATA] LIST2,	<n>{,<n>}	[2]	Returns the block data values concerning the 2nd (nested) sweep list (Z-axis).	
TRACe:POINts? LIST2	0 to 1023		Returns the number of currently available block data values concerning the 2nd (nested) sweep list (Z-axis).	

[1] Depending on DISPLay:TRACe:FEED and (with SENSe1e:DATA) on SENSe1:FUNCtion
[2] Depending on the sweep selected in the analyzer or generator

3.3.10 Commands for Status and Error Queries

Command	Parameter	Basic unit	Meaning	Section
STATus :OPERation [:EVENt]			Query only : Returns the status of the operation register. Querying the register clears it.	
STATus :OPERation :ENABle	<n>		Sets the mask enabling the related event to be transferred to the sum bit. A "1" in the byte with the appropriate significance enables the transfer.	
STATus :QUEStionable [:EVENt]			Query only : Returns the status of the questionable register. Querying the register clears it.	
STATus :QUEStionable :ENABle	<n>		Sets the mask enabling the related event to be transferred to the sum bit. A "1" in the byte with the appropriate significance enables the transfer.	
STATus :PRESet			Resets the Enable registers to QUEStionable and OPERation registers (to 0). See also 3.3.6 Resetting of Device Functions. For general administration purposes, each device, acc. to SCPI, additionally knows the following commands:	
SYSTem: VERSion?			Query only : Returns the number of the SCPI version used by specifying the year with point and one digit after the point.	
SYSTem: ERRor?			Query only : Returns the last error message out of the error message queue. The error messages consist of a number followed by text. Negative error numbers are SCPI-defined, the positive numbers being device-specific. If there is no error, the output is **0, " No error"** If the queue gets too long, the error message: **-350, "Queue overflow"** is output. With *CLS and on power-on of the device, all error messages are cleared.	

3.3.11 Commands for Synchronization

Command	Parameter	Basic unit	Bemerkung	Section
INITiate :CONTinuous	ON OFF		Presetting of continuous measurement. Presetting of a single measurement, which is triggered using INITiate. [:IMMediate] (see next command)!	see 2.11 Starting and Stopping a Measure-ment
INITiate [:IMMediate]			Starting a single measurement. Command INITiate :CONTinuous ON|OFF determines whether it is to be a continuous or single measurement (see preceding command). The two INITiate ... commands simulate START or SINGLE key depression. The following commands must be entered: START key: INITiate :CONTinuous ON INITiate [:IMMediate] SINGLE key: INITiate :CONTinuous OFF INITiate [:IMMediate]	see 2.11 Starting and Stopping a Measure-ment
ABORt			Simulation of STOP/CONT key	see 2.11 Starting and Stopping a Measure-ment

3.3.12 Service Commands (not standardized by SCPI)

Command	Parameter	Basic unit	Meaning	Section
DIAGnostic:STATe	OFF ON		Activate service mode; save instrument state Deactivate service mode, restore instrument state	
DIAGnostic:AGEN:DACVoltage:AC DIAGnostic:AGEN:DACVoltage:DC	<n> 0 to 1 <n>-1 to 1		Control of DAC sine voltage DC offset of DAC	
DIAGnostic:AGEN:BOARd	 DAC LDG OUT		Selecting the generator board: DAC board Low-distortion generator board Output circuit Spare board (no-name)	
DIAGnostic:AGEN:NUMBer	<n>0 ...		Position of the first bit to be altered in the bit stream of the selected generator board.	
DIAGnostic:AGEN:COUNt	<n>0 ...		Number of bits to be altered (consecutively)	
DIAGnostic:AGEN:VALue	<n>0 ...		Date which is written from the position NUMBer onward into the bits following COUNt of the generator board selected by BOARd. This command triggers the setting of the bits in the bit stream and must therefore be performed at last (after presetting of BOARd, NUMBer and COUNt).	
DIAGnostic:AGEN:EXECute			Shifting the generator bit stream to the analog hardware. This command triggers the setting of the relays and should be performed after all desired bit positions have been defined.	
DIAGnostic:AGEN:ENABle	ON OFF		Set generator enable bit Reset generator enable bit	
DIAGnostic:AANL:BOARd	 MOT ANA1 ANA2		Selecting the analyzer board: Motherboard Analyzer board channel 1 Analyzer board channel 2 Spare board (no-name)	
DIAGnostic:AANL:NUMBer	0 ...		Position of the first bit to be altered in the bit stream of the selected analyzer board	
DIAGnostic:AANL:COUNt	0 ...		Number of bits to be altered (consecutively)	
DIAGnostic:AANL:VALue	0 ...		Date which is written from the position NUMBer onward into the bits following COUNt of the analyzer board selected by BOARd. This command triggers the setting of the bits in the bit stream and must therefore be performed at last (after presetting of BOARd, NUMBer and COUNt).	
DIAGnostic:AANL:EXECute			Shifting the analyzer bit stream to the analog hardware. This command triggers the setting of the relays and should be performed after all desired bit positions have been defined.	

3.4 Alphabetical List of IEC-bus Commands with Error Description

The UPD software allows the specification of a unit for numbers marked by <nu>. When no unit is entered for these numbers, they assume the basic unit appertaining to the command. In accordance with SCPI, we advise using the basic units. Alternative units are conditioned by other settings, thus making the programming of IEC-bus sequences considerably more complex. If you are confronted with "Error: Unit not allowed", refer to Section 2.4, Units.

Note as to the alphabetical order:
In the case of key words with subsequent square brackets, the characters in brackets are ignored. The letters after the brackets are relevant to the alphabetical order, for example:

Input [] : FILTer ...
Input [1|2] : TYPE BALanced ...
:
:
SENSe [1] : FILTer<i> ...
SENSe [1|2] [:POWer]:UNIT ...
SENSe [] : VOLTage:RANGe ...

Decisive criteria are the letters after]
Contents in brackets is ignored

ARM :*FREQuency :STARt*<nu> **ARM :*FREQuency :STOP*<nu>**	
Error: Value out of Range	Valid range of values:
	<nu> analog instruments = 2 Hz | 10 Hz to range limit (see 2.6.1) digital instruments = 0 Hz to range limit (see 2.6.1)
Error: Unit not allowed	Allowed:
	Hz | kHz
Error: Command not allowed	Allowed only when:
	TRIGger :SOURce TIMer CH1Freq |CH2Freq

ARM :LEVel *:MIN* <nu>	
Error: Value out of Range	Valid range of values:
	<nu> analog instruments = 10 µs to 1000 V digital instruments = 0.0001 to 1.0 FS
Error: Unit not allowed	Allowed:
	Analog instruments = V | mV | uV (= µV) | dBV | dBu | W | mW | uW (= µW) | dBm Digital instruments = FS | PCTFS | dBFS
Error: Command not allowed	Allowed only when:
	TRIGger :SOURce CH1Freq | CH2Freq

ARM :*VOLTage :STARt*<nu> **ARM :*VOLTage :STOP*<nu>**	
Error: Value out of Range	Valid range of values:
	<nu> analog instruments = 10 µs to 1000 V digital instruments = 1 µFS to 1.0 FS (see 2.4.6)
Error: Unit not allowed	Allowed:
	Analog instruments = V | mV | uV (= µV) | dBV | dBu | W | mW | uW (= µW) | dBm Digital instruments = FS | PCTFS | dBFS
Error: Command not allowed	Allowed only when:
	TRIGger :SOURce CH1Level | CH2Level

CALCulate :EQUalize :FEED TRACe1|TRACe2

CALCulate :EQUalize :INVert ON|OFF

CALCulate :EQUalize :NORMfreq <nu>

CALCulate :LIMit :FAIL?	
Error: Command not allowed	Allowed only when:
	CALCulate :LIMit :UPPer :STATe ON or CALCulate :LIMit :LOWer :STATe ON

CALCulate :LIMit :LOWer [:DATA] <n> {,<n>}

CALCulate :LIMit :LOWer :CONTrol :POINts?

CALCulate :LIMit :LOWer :CONTrol [:DATA] <n> {,<n>}	
Error: Command not allowed	Allowed only when:
	CALCulate :LIMit :UPPer :STATe ON or CALCulate :LIMit :LOWer :STATe ON

CALCulate :LIMit :LOWer :POINts?

CALCulate :LIMit :LOWer :STATe ON | OFF

CALCulate :LIMit :ON TRACe1 | TRACe2| TR1And2	
Error: Command not allowed	Allowed only when:
	CALCulate :LIMit :UPPer :STATe ON or CALCulate :LIMit :LOWer :STATe ON

CALCulate :LIMit :REPort [:POINts]?	
Errorr: Command not allowed	Allowed only when:
	CALCulate :LIMit :UPPer :STATe ON or CALCulate :LIMit :LOWer :STATe ON

CALCulate :LIMit :REPort [:DATA]?	
Errorr: Command not allowed	Allowed only when:
	CALCulate :LIMit :UPPer :STATe ON or CALCulate :LIMit :LOWer :STATe ON

CALCulate :LIMit :UPPer [:DATA] <n> {,<n>}	
Errorr: Command not allowed	Allowed only when:
	CALCulate :LIMit :UPPer :STATe ON or CALCulate :LIMit :LOWer :STATe ON

CALCulate :LIMit :UPPer :CONTrol :POINts?

CALCulate :LIMit :UPPer :CONTrol [:DATA] <n> {,<n>}

CALCulate :LIMit :UPPer :POINts?

CALCulate :LIMit :UPPer :STATe ON | OFF

CALCulate :TRANSform :FREQuency :AVERage <n>	
Error: Value out of Range	Valid range of values:
	<n> = 1 to 16
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT"

CALCulate :TRANsform :FREQuency :FFT |S256|S512|S1K|S2K|S4K|S8K	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT" or SENSe[1] :FUNCtion "RMS|WAF" with POST-FFT: CALCulate :TRANsform :FREQuency :STATE ON

CALCulate :TRANsform :FREQuency :MTIMe?	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT"

CALCulate :TRANsform :FREQuency :RESolution?	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT" or SENSe[1] :FUNCtion "RMS|THDNsndr|WAF" with POST-FFT: CALCulate :TRANsform :FREQuency :STATE ON

CALCulate :TRANsform :FREQuency :SPAN?	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT" and CALCulate :TRANsform :FREQuency :ZOOM ON

CALCulate :TRANsform :FREQuency :STARt?	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT" or SENSe[1] :FUNCtion "RMS|THDNsndr|WAF" with POST-FFT: CALCulate :TRANsform :FREQuency :STATE ON

CALCulate :TRANsform :FREQuency :STATE ON|OFF	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|THDNsndr|WAF"

CALCulate :TRANsform :FREQuency :STOP?	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT" or SENSe[1] :FUNCtion "RMS|THDNsndr|WAF" with POST-FFT: CALCulate :TRANsform :FREQuency :STATE ON

CALCulate :TRANsform :FREQuency :WINDow :BETAfactor <n>	
Error: Command not allowed	Valid range of values:
	<n> = 1 to 20
Error: Command not allowed	Allowed only when:
	CALCulate :TRANsform :FREQuency :WINDow KAISer

CALCulate :TRANsform :FREQuency :WINDow RECTangular|HANN|BLACkman__harris|/RIF1|RIF2|RIF3|KAISer|HAMMing |FLATtop	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "FFT" or SENSe[1] :FUNCtion "RMS|WAF" with POST-FFT: CALCulate :TRANsform :FREQuency :STATE ON

CALCulate :TRANsform :FREQuency :ZOOM N1|N2|N4|N8|N16|N32|N64|N128|N256	
Error: Parameter not allowed	Allowed only when:
N16 N32|N64|N128|N256	INSTrument2 [:SELect] A22|A100|A300|D48 INSTrument2 [:SELect] A22|D48
Error: Command not allowed	Allowed only when: SENSe[1] :FUNCtion "FFT"

CALibrate :LDG : AUTO OFF|ONCE	
Error: Command not allowed	Allowed only when: Option UPD-B1 must be installed.

CALibrate :OFF|AUTO|DCC|LDG

CALibrate :ZERO :OFF|ON|ONCE|AUTO

DIAGnostic :AANL :BOARd MOT|ANA1|ANA2|ANON	
Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AANL :COUNt <n>	
Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AANL :EXECute	
Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AANL :NUMBer <n>	
Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AANL :VALue <n>	
Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AGEN :BOARd DAC|LDG|OUT|GNON	
Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AGEN :COUNt <n>

Error: Command not allowed	DIAG:STAT ON

DIAGnostic :AGEN :DACVoltage :AC <n>

Error: Value out of Range	Allowed only when: 0.0 < = n < = 1.0
Error: Command not allowed	DIAG:STAT ON

DIAGnostic :AGEN :DACVoltage :DC <n>

Error: Value out of Range	Allowed only when: 1.0 < = n < = 1.0
Error: Command not allowed	DIAG:STAT ON

DIAGnostic :AGEN :EXECute

Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AGEN :ENABle ON|OFF

Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AGEN :NUMBer <n>

Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :AGEN :VALue <n>

Error: Command not allowed	Allowed only when: DIAG:STAT ON

DIAGnostic :STATe ON|OFF

DISPlay :ENABle ON|OFF

DISPlay :MODE INTern|COLBoth|BWBoth

DISPlay: PROTocol: ERRor: CHSTatus?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: GENeral?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: LCRC?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: LVALbit?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: LR?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: PARity?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: RCRC?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: ERRor: RVALbit?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay: PROTocol: FORMat BINary | HEXadecimal | ASCii | AES18 | FILE	
Error: Command not allowed	Allowed only when:
	DISPlay: PROTocol: SELect LUSerdata | RUSerdata

DISPlay: PROTocol: SELect LCHanelstatus|RCHanelstatus|LUSerdata|RUSerdata	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2]: OPERation PROTocol

DISPlay [:WINDow] :TEXT [:DATA] "string"	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum

DISPlay [:WINDow] :TEXT :LOCate <ny> [,<nx>]	
Error: Value out of range	Valid range of values:
	0 to 100
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum

DISPlay [:WINDow] :TRACe[] :AUToscale	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor[1|2] ACTive	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor[] :DATA1?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor[] :DATA2?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :CURSor[1|2] ACTive and DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor[] :DATA3?	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :CURSor[1|2] ACTive and DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor[1|2] :POSition :MODE MIN1 | MAX1 | MIN2 | MAX2 | MARKer1 | NEXTmarker | VALue | IMAX1 | IMAX2	
Error: Parameter not allowed	Allowed only when:
MARKer1 or NEXTmarker or IMAX1 or IMAX2	SENSe[1]Function "FFT"
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor[1|2] :POSition <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor1 :MODE N12 | D12 | OFF	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[] :CURSor2 :MODE N12 | D12 | HL1 | HL2 | HLD1 | HLD2 | OFF	
Error: Parameter not allowed	Allowed only when:
HL1 | HL2 | HLD1 | HLD2	DISPlay [:WINDow] :TRACe[] :FEED "SENSe[1]:DATA[1|2]" and SENSe[1] :Function "FFT" or function with Post-FFT switched on
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[] :OPERation not OFF or not BARGraph

DISPlay [:WINDow] :TRACe[1|2] :FEED "SENSe[1|3|4]:DATA[1|2] | HOLD | FILE | OFF"	
Error: Parameter not allowed	Allowed only when:
"SENSe1 :DATA1"	SENSe1 :FUNCtion not set to "OFF" or "FFT" and INPut :SELect CH1 or CH1And2 or CH1Is2 or CH2Is1 or BOTH
"SENSe1 :DATA2"	SENSe1 :FUNCtion not set to "OFF" or "FFT" and INPut :SELect CH2 or CH1And2 or CH1Is2 or CH2Is1 or BOTH
"SENSe3 :DATA1"	SENSe3 :FUNCtion FREQuency and INPut :SELect CH1 or CH1And2 or CH1Is2 or CH2Is1 or BOTH
"SENSe3 :DATA2"	SENSe3 :FUNCtion FREQuency and INPut :SELect CH2 or CH1And2 or CH1Is2 or CH2Is1 or BOTH
"SENSe4"	SENSe3 :FUNCtion FQPHase INPut :SELect CH1And2 or CH1Is2 or CH2Is1 or

DISPlay [:WINDow] :TRACe[] :KEEPlast	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum (FFT spectrum or Post-FFT)

DISPlay [:WINDow] :TRACe[1|2] :MARKer MAXimum | CURSor | OFF	
Error: Command not allowed	Allowed only when:
	SENSe[1]:Function "FFT"

DISPlay [:WINDow] :TRACe[1|2] :MARKer :HARMonics ON | OFF	
Error: Command not allowed	Allowed only when:
	SENSe[1]:Function "FFT"

DISPlay [:WINDow] :TRACe[] :MODE DELete__bef__wr | OVERlay__maxh | CASCade	
Error: Parameter not allowed	Allowed only when:
CASCade	SENSe[1]:FUNCtion "FFT"
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum

DISPlay [:WINDow] :TRACe[1|2] :OPERation OFF | CURVeplot | LIST | ERRors | BARGraph | SPECtrum| PROTocol	
Error: Parameter not allowed	Allowed only when:
SPECtrum PROTocol	SENSe[1]:FUNCtion "FFT" | "THD" | "DIM" | "DFD" | "MODDIST" INSTrument2 [:SELect] D48 und INPut [1|2] :TYPE AESEbu | SPDif | OPTical

DISPlay [:WINDow] :TRACe[1|2] :RLEVel CURSor1 | CURSor2

DISPlay [:WINDow] :TRACe[1|2] :VIEW IMMediate | DELayed

DISPlay [:WINDow] :TRACe[] :X [:SCALe] :AUTO ONCE | OFF	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph

DISPlay [:WINDow] :TRACe[] :X [:SCALe] :LEFT <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe[] :X [:SCALe] :AUTO OFF

DISPlay [:WINDow] :TRACe[] :X [:SCALe] :RIGHT <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe[] :X [:SCALe] :AUTO OFF

DISPlay [:WINDow] :TRACe[] :X [:SCALe] :RLEVel <nu>

DISPlay [:WINDow] :TRACe[] :X :SPACing LINear | LOGarithmic	
Error: Parameter not allowed	Allowed only when:
LOGarithmic	DISPlay [:WINDow] :TRACe[] :X [:SCALe] :UNIT not set to log unit (eg. dB)
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph

DISPlay [:WINDow] :TRACe[] :X [:SCALe] :UNIT ....

DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :AUTO ONCE | OFF | EXECute	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe[1] :FEED not "OFF"

DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :BOTTom <nu>	
Error: Value out of range	Valid range of values
	< (DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :TOP <nu>)
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe[1] :FEED not "OFF" and DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :AUTO OFF

DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :RLEVel <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1] :FEED not "OFF"

DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :RLEVel :MODE MAXimum | CURSor	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1] :FEED not "OFF"

DISPlay [:WINDow] :TRACe[1] :Y :SPACing LINear | LOGarithmic	
Error: Parameter not allowed	Allowed only when:
LOGarithmic	DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :UNIT not set to log unit (eg dB)
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe[1] :FEED not "OFF"

DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :TOP <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARgraph and DISPlay [:WINDow] :TRACe[1] :FEED not "OFF" and DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :AUTO OFF

DISPlay [:WINDow] :TRACe[1] :Y [:SCALe] :UNIT	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1] :FEED not "OFF"

DISPlay [:WINDow] :TRACe[] :ZOOM ATCUrsor | BETWeen	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum (FFT spectrum or Post-FFT)

DISPlay [:WINDow] :TRACe[] :ZOOM 0 | 1 | -1	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum (FFT spectrum or Post-FFT)

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :AUTO ONCE | OFF | EXECute	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :BOTTom <nu>	
Error: Value out of range	Valid range of values:
	< (DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :TOP <nu>)
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF and DISPlay [:WINDow] :TRACe2 :Y [SCALe] :AUTO OFF

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal ON | OFF	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe2 :FEED not "OFF"

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :RLEVel <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :RLEVel :MODE MAXimum | CURSor	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF

DISPlay [:WINDow] :TRACe2 :Y :SPACing LINear | LOGarithmic	
Error: Parameter not allowed	Allowed only when:
LOGarithmic	DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :UNIT not set to log unit (eg dB)
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :TOP <nu>	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1|2] :OPERation CURVeplot | SPECtrum | BARGraph and DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :AUTO OFF

DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :UNIT	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe2 :FEED not "OFF" and DISPlay [:WINDow] :TRACe2 :Y [:SCALe] :EQUal OFF

FORMat [:DATA] ASCii | REAL

HCOPy [:WINDow] :COPY :EXECute STARt | ABORt

HCOPy :DESTination PRINter | PLOTer | PCXFile, "name" | HPGLfile, "name"

HCOPy [:WINDow] :ITEM ALL | GRATicule | TRACe	
Error: Command not allowed	Allowed only when:
	HCOPy :DESTination PLOTter or HPGL file

HCOPy :PLADdress <n>	
Error: Command not allowed	Allowed only when:
	HCOPy :PLPort IEC

HCOPy :PLPort IEC | COM1 | COM2 | LPT1	
Error: Command not allowed	Allowed only when:
	HCOPy :DESTination PLOTter

HCOPy :PRName "drivername"	
Error: Command not allowed	Allowed only when:
	HCOPy :DESTination PRINter

INPut[] :AUDiobits <n>		
Error: Value out of Range	Valid range of values	
	Range of values depends on INPut[1|2] :TYPE ... and INPut[] :WORD ...	
	• INPut[1|2] :TYPE SERial|MSERial INPut[] :WORD	L8 : n = 8 L16 : n = 8 to 16 L24 : n = 8 to 24 L32 : n = 8 to 28
	• INPut[1|2] :TYPE PARallel|MPARallel:	n = 8 to 28
	• INPut[1|2] :TYPE AESEbu|SPDif|OPTical:	n = 16 to 24
	• INPut[1|2] :TYPE INTernal:	n = 8 to 28
Error: Command not allowed	Allowed only when:	
	INSTrument 2[:SELect] D48|D192|D768	

INPut[] :BCLock RISing|FALLing	
Error: Command not allowed	Allowed only when:
	INPut[1|2] :TYPE SERial|MSERial

INPut[] :BITOrder MSBFirst|LSBFirst	
Error: Command not allowed	Allowed only when:
	INPut[1|2] :TYPE SERial|MSERial

INPut[] :FILTer [:LPASs] :FREQuency <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = Instrum. A22 and D48: 2 Hz | 10 Hz Instrum. D192 and D768: 10 Hz | 100 Hz
Error: Command not allowed	Allowed only when:
	INSTrument2 [:SELect] A22

<table>
<tr><th colspan="2">INPut[1|2] :IMPedance R300|R600|R20K|USERdefined|R110|R10K</th></tr>
<tr><td>Error:
Parameter not allowed</td><td>Allowed only when:</td></tr>
<tr><td>R300|R600|R20K|
USERdefined</td><td>INPut[1|2] :TYPE BALanced</td></tr>
<tr><td>R110|R10K</td><td>INPut[1|2] :TYPE AESEbu</td></tr>
<tr><td>Error
Command not allowed</td><td>Allowed only when:
INSTrument2 [:SELect] A22|A100|A300 and
INPut[1|2] :TYPE BALanced
or
INSTrument 2[:SELect] D48 and
INPut[1|2] :TYPE AESbu</td></tr>
</table>

<table>
<tr><th colspan="2">INPut[1|2] :LOW FLOat|GROund</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>INPut[1|2] :TYPE UNBalanced</td></tr>
</table>

<table>
<tr><th colspan="2">INPut[] :OSAMpling N1|N2|N4|N8|N16</th></tr>
<tr><td>Error:
Parameter not allowed</td><td>Allowed only when:</td></tr>
<tr><td>N2|N4
N8|N16</td><td>INSTrument2 [:SELect] D192|D768
INSTrument2 [:SELect] D768</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>INPut[] :SAMPle :FREQuency :MODE F32|F44|F48</td></tr>
</table>

<table>
<tr><th colspan="2">INPut[] :SAMPle :FREQuency:MODE F32|F44|F48|VALUE</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>INPut[1|2] :TYPE PARallel|MPARallel|SERial|MSERial|AESEbu|SPDif|OPTical</td></tr>
</table>

INPut[] :SAMPle :FREQuency <nu>	
Error: Value out of Range	Valid range of values:
	<nu> for instrum. D48 = 100 Hz to 48 kHz D192 = 100 Hz to 300 kHz D768 = 100 Hz to 1000 kHz
Error: Command not allowed	Allowed only when:
	INPut[] :SAMPle :FREQuency :MODE VALue

INPut[1|2] :SELect CH1|CH2|CH1And2|CH1Is2|CH2Is1|BOTH	
Error: Param not allowed	Allowed only when:
CH1And2|CH1Is2|CH2Is1 BOTH	INSTrument2 [:SELect] A22|A100|A300 INSTrument2 [:SELect] D48|D192

INPut[1|2] :TYPE BALanced|UNBalanced|GEN1|GEN2|PARallel|MPARallel|SERial|MSERial|AESEbu|SPDif|OPTical|INTern	
Error: Parameter not allowed	Allowed only when:
BALanced|UNBalanced| GEN1|GEN2 PARallel MPARallel SERial MSERial AESEbu|SPDif|OPTical	 INSTrument2 [:SELect] A22|A100|A300 INSTrument2 [:SELect] D48|D192|D768 and INPut[] :SELect CH1 without High-speed option or INPut[] :SELect CH2|BOTH with High-speed option INSTrument2 [:SELect] D48|D192 INSTrument2 [:SELect] D48|D192|D768 INSTrument2 [:SELect] D48|D192 INSTrument2 [:SELect] D48 and AES option
INTern	INSTrument2 [:SELect] D48

INPut[] :WCLock RISing|FALLing	
Error: Command not allowed	Allowed only when:
	INPut[1|2] :TYPE PARallel|MPARallel|SERial

INPut[] :WOFFSet <n>

Error: Value out of Range	Valid range of values:
	<n> = -16 to 16
Error: Command not allowed	

<table><tr><td></td><td>INPut[1|2] :TYPE SERial|MSERial</td></tr></table>

INPut[] :WORD L8|L16|L24|L32

<table>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>INPut[1|2] :TYPE SERial|MSERial</td></tr>
</table>

INPut[] :WSELect LOW|HIGH

<table>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>INPut[1|2] :TYPE MPARallel|MSERial</td></tr>
</table>

INSTrument2 [:SELect] A22|A100|A300|D48|D192|D768 equivalent to
INSTrument2 [:NSELect] <n>

Error: Value out of Range	Valid range of values
	<n> = 1 to 6 1 = A22 2 = A100 3 = A300 4 = D48 5 = D192 6 = D768

INSTrument[1] [:SELect] A25|A110|D48|D192|D768

INSTrument[1] :NSELect <n>

Error: Value out of Range	1 < = n < = 5

MMEMory :CDIRectory "pathname"

MMEMory :COPY "filename1","filename2"

MMEMory :DELete "filename"

MMEMory :LOAD :LIST ARBitrary, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".ARB"-type.
Error: Command not allowed	SOUR:FUNC USER or SOUR:FUNC RAND and SOUR:RAND:DOM FREQ and SOUR:RAND:SHAP ARB

MMEMory :LOAD :LIST DWELl, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".DWL"-type.
Error: Command not allowed	SOUR:FUNC must be set to a sweepable function (SIN, BURS, SQRB, SQU, MDIS, DFD oder DIM) and a list sweep must be active (one of the commands SOUR:FREQ:MODE, SOUR:VOLT:MODE, SOUR:ONT:MODE or SOUR:INT:MODE must be set to LIST1) and a time-triggered generator sweep must be active (SOUR:SWE:MODE AUTO and SOUR:SWE:NEXT DWEL)

MMEMory :LOAD :LIST EQUalize, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".VEQ"-type.
Error: Command not allowed	SOUR:FUNC SIN

MMEMory :LOAD :LIST FREQuency, "filename"	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe LIST and SENSe[1] :LIST :MODE AUTO|MANual

MMEMory :LOAD :LIST FREQuency, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".SPF"-type.
Error: Command not allowed	SOUR:FUNC must be set to a function allowing a frequency sweep (SIN, BURS, SQRB, SQU, MDIS or DFD) and the frequency list sweep must be active (SOUR:FREQ:MODE LIST1 or LIST2)

MMEMory :LOAD :LIST INTerval, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".SPI"-type.
Error: Command not allowed	SOUR:FUNC must be set to a burst function (BURS or SQRB) and the interval list sweep must be active (SOUR:INT:MODE LIST1 or LIST2)

MMEMory :LOAD :LIST LIMLower, "filename"

MMEMory :LOAD :LIST LIMUpper, "filename"

MMEMory :LOAD :LIST ONTime, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".SPO"-type.
Error: Command not allowed	SOUR:FUNC must be set to a burst function (BURS or SQRB) and the burst time list sweep must be active (SOUR:ONT:MODE LIST1 or LIST2)

MMEMory :LOAD :LIST VOLTage, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or in the working directory and be of the ".SPV"-type.
Error: Command not allowed	SOUR:FUNC must be set to a function allowing a level sweep (SIN, BURS, SQRB, SQU, MDIS, DFD or DIM) and the level list sweep must be active (SOUR:VOLT:MODE LIST1 or LIST2)

MMEMory: LOAD: LPGC "filename"	
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol: LCHanelstatus AES3 | CRC | RAW

MMEMory: LOAD: PAC "filename"	
Error: Command not allowed	Allowed only when:
	DISPlay: PROTocol: SELect LCHanelstatus | RCHanelstatus

MMEMory: LOAD: PAU "filename"	
Error: Command not allowed	Allowed only when:
	DISPlay: PROTocol: FORMat FILE

MMEMory: LOAD: PGU "filename"	
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol: UMODe FILE

MMEMory: LOAD: RPGC "filename"	
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol: RCHanelstatus AES3 | CRC | RAW

MMEMory :LOAD :STATe <n>, "filename"	
Error: Value out of Range	2 < = n < = 3
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must exist in the specified directory or working directory and be of the ".SCO"-type.

MMEMory :LOAD :TRACe TRACe[1|2], "filename"	
Error: Command not allowed	Allowed only when:
	DISPlay [:WINDow] :TRACe[1] :FEED "FILE"

MMEMory:STORe:APPend:STATE ON|OFF"	
	Note that it is ignored with MMEM:STOR:LIST EQU "filename"

MMEMory:STORe:FORMat BIN|ASCii	
	Note that it is ignored with MMEM:STOR:LIST ERR"filename"

MMEMory :STORe :LIST DWELl, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must be of the ".DWL"-type.
	A time-triggered generator sweep must be active (SOUR:SWE:MODE AUTO and SOUR:SWE:NEXT DWEL)

MMEMory :STORe :LIST EQUalize, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and a valid directory; the file must be of the ".VEQ"-type. A generator level sweep across the frequency must be set and concluded (SOUR:FREQ:MODE SWE1). The trace buffer selected under CALC:EQU:FEED (TRAC1 or TRAC2) must contain a voltage list of the same length as the sweep.

MMEMory :STORe :LIST ERRors, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and specify a valid directory; the file must have the type designation ".ERR". A sweep with limit check must be set and executed completely (CALC:LIM:UPP:STAT ON and/or CALC:LIM:LOW:STAT ON); the respective limit curves must be defined (either by way of CALC:LIM:UPP/LOW:VALue <n> or by reading the limit curve)

MMEMory :STORe :LIST LIST1, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and specify a valid directory; the file must have, according to the sweep parameter of the X-axis, one of the type designations ".SPF", ".SPV", ".SPO" or ".SPI". The sweep the X-parameter of which matches the type designation must be set.

MMEMory :STORe :LIST LIST2, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and specify a valid directory; the file must have, according to the sweep parameter of the Z-axis, one of the type designations ".SPF", ".SPV", ".SPO" or ".SPI". The two-dimensional sweep the Z-parameter of which matches the type designation must be set.

MMEMory :STORe :STATe <n>, "filename"	
Error: Value out of Range	n = 2
Error: Param not allowed	(The (optional) drive-/path designation must refer to a valid drive (A: or C:) and specify a valid directory; the file must have the type designation ".SCO".

MMEMory :STORe :STATe :RONLy ON|OFF

MMEMory :STORe :TRACe TRACe1, "filename"	
Error: Param not allowed	The (optional) drive-/path designation must refer to a valid drive (A: or C:) and specify a valid directory; the file must have the type designation ".TRC". Trace buffer #1 must contain measurement data of a sweep or FFT.

<table>
<tr><th colspan="2">MMEMory :STORe :TRACe TRACe2, "filename"</th></tr>
<tr><td>Error:
Param not allowed</td><td>The (optional) drive-/path designation must refer to a valid drive (A: or C:) and specify a valid directory;
the file must have the type designation ".TRC".
Trace buffer #2 must contain measurement data of a sweep or FFT.</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :AUDiobits <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>Valid range of values
Range of values depends on
OUTPut :TYPE ... and
OUTPut :WLENgth ...
- OUTPut :TYPE SERial|MSERial
OUTPut :WLENgth L8 : 8
L16 : 8 to 16
L24 : 8 to 24
L32 : 8 to 28
- OUTPut :TYPE PARallel|MPARallel: 8 to 28
- OUTPut :TYPE AESEbu|SPDif|OPTical: 16 to 24
- OUTPut :TYPE INTernal: 8 to 28</td></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :BCLock RISing|FALLing</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF SER|MSER</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :BCLock :FREQuency?</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF SER|MSER</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :BITOrder MSBFirst|LSBFirst</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF SER|MSER</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :IMPedance R10|R30|R200|R600|R5|R15|USERdefined</th></tr>
<tr><td>Error:
Param not allowed</td><td>1. Selected: R5 or R15:
OUTP:CONF UNBAL
2. Selected: R10, R30, R200 or R600:
OUTP:CONF BAL|CTES</td></tr>
<tr><td>Error:
Command not allowed</td><td>INST A25|A110</td></tr>
</table>

OUTPut :LOW FLOat|GROund	
Error: Command not allowed	INST A25|A110

OUTPut :OSAMpling N1|N2|N4|N8|N16	
Error: Param not allowed	1. Selected: N8 or N16: INST D768 2. Selected: N2 or N4: INST D192|D768
Error: Command not allowed	INST D48|D192|D768 and OUTP:CONF PAR|MPAR|SER|MSER and OUTP:SAMP:MODE F32|F44|F48

OUTPut :SAMPle :FREQuency <nu>	
Error: Value out of Range	Range of values depends on clock rate (s. 2.5.3)
Error: Command not allowed	INST D48|D192|D768 and OUTP:CONF PAR|MPAR|SER|MSER|AES|SPD|OPT and OUTP:SAMP:MODE EXT

OUTPut :SAMPle :MODE F32|F44|F48|EXTern|SYNChron	
Error: Param not allowed	1. Selected SYNC: INST D48 and OUTP:CONF AES|SPD|OPT and AES/EBU-S/P DIF option must be fitted.
Error: Command not allowed	INST D48|D192|D768 and OUTP:CONF PAR|MPAR|SER|MSER|AES|SPD|OPT

OUTPut :SELect CH1|CH2|CH2Is1|CH2Phase180|OFF

OUTPut :SIGNal:LEVel <nu>	
Error: Value out of Range	OUTP:CONF AES: 20 mV to 5.1 V OUTP:CONF SPD: 10 mV to 1.5 V
Error: Command not allowed	INST D48 and OUTP:CONF AES|SPD and AES|EBU-SPDIF option must be fitted.

<table>
<tr><th colspan="2">OUTPut :TYPE BALanced|UNBalanced|PARallel|MPARallel|SERial|MSERial|AESebu|SPDif|OPTical|CTESt|INTern</th></tr>
<tr><td>Error:
Command not allowed</td><td>1. Selected: BAL, UNB or CTST:
INST A25|A110
2. Selected: SER:
INST D48|D192|D768
3. Selected: PAR:
INST D48|D192|D768 and
OUTP:SEL OFF|CH1
4. Selected: MSER or MPAR:
INST D48|D192
5. Selected: AES, SPD or OPT:
INST D48 and
AES/EBU-S/P DIF option must be fitted.
6 Selected INT
INST D48 and
OUTP:SEL OFF|CH1</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :VALidity N1ANd2|N1|N2|NONE</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48 and
OUTP:CONF AES|SPD|OPT and
AES/EBU-S/P DIF option must be fitted.</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :WCLock RISing|FALLing</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF PAR|SER|MPAR|</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :WLENgth L8|L16|L24|L32</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF SER|MSER</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :WOFFset <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>OUTP:WLEN/2 < n < +OUTP:WLEN/2</td></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF SER|MSER</td></tr>
</table>

<table>
<tr><th colspan="2">OUTPut :WSELect LOW|HIGH</th></tr>
<tr><td>Error:
Command not allowed</td><td>INST D48|D192|D768 and
OUTP:CONF MPAR|MSER</td></tr>
</table>

SENSe[1]: BWIDth [:RESolution] :MODE PCT1 | PCT3 | TOCT | OCT12 | FIX **SENSe[1]: BANDwidth [:RESolution] : ...**	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMSSelectiv"

SENSe[1] :BWIDth[:RESolution] <nu> **SENSe[1] :BANDwidth[:RESolution] <nu>**	
Error: Value out of Range	Valid range of values:
	For range of values, see 2.6.5.2 Bandwidth
Error: Command not allowed	Allowed only when:
	SENSe[1]:BANDwidth[:RESolution]: MODE FIX

SENSe[1] :DATA1|2?	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion not set to "OFF" or "FFT"

SENSe[1] :FILTer<i> :AWEighting [:STATe] ON|OFF	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :CCIRweight [:STATe] ON|OFF	
Error Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :CCITt [:STATe] ON|OFF

Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :CCIUnweight [:STATe] ON|OFF

Error Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILter<i> :CMESsage [:STATe] ON|OFF

Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILter<i> :DCNoise [:STATe] ON|OFF

Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :DEMPhasis17 : STATe ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILter<i> :DEMPhasis50 : STATe ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :DEMPhasis75 : STATe ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :DEMPhasis5015 : STATe ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :UFILter1 to :UFILter9 [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 4
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :URUMble [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FILTer<i> :WRUMble [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FREQuency [:FIXed|:CW] <nu>	
Error: Value out of Range	Valid range of values:
	<nu> for instrument ANLG 22 kHz: 10 Hz to 21.74 kHz ANLG 1000 kHz: 71.11 Hz to 100 kHz ANLG 300 kHz: 213.3 Hz to 300 kHz DIG 48 kHz: Lower limit to max. measurement frequency DIG 192 kHz: Lower limit to max. measurement frequency DIG 768 kHz: Lower limit to max. measurement frequency Lower limit = sample frq/4800 Int. sample freq. = Sampl Frq • Oversamp Max. measurement frequency = sample freq • 29/64
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe CW|FIXed

SENSe[1] :FREQuency :LIMit:LOWer <nu>	
Error: Value out of Range	Valid range of values:
	<nu>
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "THDNsndr"

SENSe[1] :FREQuency :LIMit:UPPer <nu>	
Error: Value out of Range	Valid range of values:
	<nu>
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "THDNsndr"

SENSe[1] :FREQuency :MODe CW|FIXed|SWEep|LIST|SOURce|CH1|CH2|MULTisine	
Error: Parameter mot allowed	Allowed only when:
SWEep|LIST	TRIGger: SOURce IMMediate and SOURce:FREQuency :MODE CW|FIXed (no generator sweep)
SOURce	SENSe[1] :FUNCtion "RMSSelectiv" and SOURce: FUNCtion [:SHAPe] SINusoid|BURSt|SQUare|S2PULse or SENSe[1] :FUNCtion "DIM" and SOURce:FUNCtion[:SHAPe] DIM
CH1 CH2 MULTisine	INPut[1|2] :SELect CH1|CH1And2|CH1Is2|CH2Is1|BOTH INPut[1|2] :SELect CH1|CH1And2|CH1Is2|CH2Is1|BOTH TRIGger:SOURce IMMediate and SOURce:FREQuency :MODE CW|FIXed (no generator sweep)
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMSSelectiv|DIM"

SENSe[1] :FREQuency :SQRSin DIMA|DIMB	
Error: Parameter not allowed	Allowed only when:
DIMA|DIMB	SENSe[1] :FREQuency:MODE CW|FIXed
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "DIM"

SENSe[1] :FREQuency :STARt <nu> **SENSe[1] :FREQuency :STOP <nu>**	
Error: Value out of Range	Valid range of values:
	<nu> for instrument ANLG 22 kHz: 10 Hz to 21.75 kHz ANLG 100 kHz: 71.11 Hz to 100 kHz ANLG 300 kHz: 213.3 Hz to 300 kHz DIG 48 kHz: Lower limit to max. measurement frequency DIG 192 kHz: Lower limit to max. measurement frequency DIG 768 kHz Lower limit to max. measurement frequency Lower limit = sample freq/4800 Int. sample freq. = Sampl Freq • Oversamp Max. measurement freq. = sample freq • 29/64
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe SWEep and SENSe[1] :SWEep :MODE AUTO|MANual

SENSe[1] :FUNCtion "DC|DFD|DIM|FFT|PEAK|QPEak|RMS|RMSSelectiv|MDISt|THD|THDNsndr|WAF|POLarity|OFF"	
Error: Parameter not allowed	Allowed only when:
DC DIM PEAK|QPEAK WAF	INSTrument2 [:SELect] A22|A100|A300 INSTrument2 [:SELect] A22|D48 INSTrument2 [:SELect] A22|D48 INSTrument2 [:SELect] A22|D48

SENSe[1] :FUNCtion :DISTortion <n>	
Error: Parameter not allowed	Allowed only when:
	<n> = Decimal equivalent of bit combination used for harmonics, see *)
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "THD"

*)

d15	d14	d13	d12	d11	d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0	
-	-	-	-	-	-	-	-	di9	di8	di7	di6	di5	di4	di3	di2	Harmonics
x	x	x	x	x	x	x	x	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	

SENSe[1] :FUNCtion :MMODe D2|D3	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "DFD"

SENSe[1] :FUNCtion :MMODe THDN|SNDRatio|NOISe|D2|D3|SELectdi|DALL|DODD|DEVen|PPEak|NPEak|PTOPeak|PABSolut	
Error: Parameter not allowed	Allowed only when:
THDN|SNDratio|NOISe D2|D3 SELectdi|DALL| DODD|DEVen PPEak|NPEak|PTOPeak| PABSolut	SENSe[1] :FUNCtion "THDNsndr" SENSe[1] :FUNCtion "DFD" SENSe[1] :FUNCtion "THD" SENSe[1] :FUNCtion "PEAK"
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "DFD|PEAK|THD|THDNsndr"

SENSe[1]:FUNCtion:SETTling:COUNt <n>	
Error: Value out of Range	Valid range of values:
	EXPonential | FLAT: 2 to 6 AVERage: 2 to 100
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion:SETTling:MODE EXPonential | FLAT | AVERage

SENSe[1]:FUNCtion:SETTling:MODE OFF | EXPonential | FLAT | AVERage	
Error: Command not allowed	Allowed only when:
	SENSe[1]: FUNCtion "RMS|RMSSelectiv|PEAK|QPEak|DC|THD|THDNsndr|DFD|DIM|MDIST|WAF"

SENSe[1]:FUNCtion:SETTling:RESolution <nu>	
Error: Value out of Range	Valid range of values:
	Analog instruments: SENSe[1]: FUNCtion "RMS|RMSSelectiv|PEAK|QPEak|DC": 10 µV to 10 V **Digital instruments:** SENSe[1]: FUNCtion "RMS|RMSSelectiv|PEAK|QPEak|DC": MinFS to 0.5 FS **Together:** SENSe[1]: FUNCtion "THDNsndr"; MMODe SNDRatio: 20 to 120 dB SENSe[1]: FUNCtion "THDNsndr"; MMODe NOISe: 0.0001 % to 10 % SENSe[1]: FUNCtion "THD|DFD|DIM|MDIST|WAF": 0.0001 % to 10 %
Error: Unit not allowed	Allowed
	Analog instruments: SENSe[1]: FUNCtion "RMS|RMSSelectiv|PEAK|QPEak|DC": V | dBV | dBu | W | dBm **Digital instruments:** SENSe[1]: FUNCtion "RMS|RMSSelectiv|PEAK|QPEak|DC": FS | PCTFS (%FS) | dBFS **Together:** SENSe[1]: FUNCtion "THDNsndr"; MMODe SNDRatio: dB SENSe[1]: FUNCtion "THDNsndr"; MMODe NOISe: PCT (%) | dB SENSe[1]: FUNCtion "THD|DFD|DIM|MDIST|WAF": PCT (%) | dB
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion:SETTling:MODE EXPonential | FLAT | AVERage MinFS: $2^{(-1 * \text{audio bits})}$ but not smaller than 1 µFS

SENSe[1]:FUNCtion:SETTling:TOLerance <nu>	
Error: Value out of Range	Valid range of values:
	0.001 % to 10 %
Error: Unit not allowed	Allowed
	PCT (%) | dB Exception: in SINAD measurement, only dB allowed (SENSe[1]: FUNCtion "THDNsndr" and SENSe[1]: FUNCtion: MMODe SNDRatio) in Wow/Flutter measurement, only PCT (%) allowed (SENSe[1]: FUNCtion "WAF")
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion:SETTling:MODE EXPonential | FLAT | AVERage

SENSe[1]:FUNCtion:SETTling:TOUT <nu>	
Error: Value out of Range	Valid range of values:
	0.001 to 10 s
Error: Unit not allowed	Allowed
	s
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion:SETTling:MODE EXPonential | FLAT | AVERage

SENSe[1] :FUNCtion :SNSequence ON|OFF	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|PEAK|QPEAK"

SENSe[1] :FUNCtion :STANdard NAB|JIS|DINiec|SI05|SI10	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "WAF"

SENSe[1] :FUNCtion :WEIGhting ON|OFF	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "WAF"

SENSe[1] :LIST :MODE AUTO|MANual	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMSSelectiv" and SENSe[1] :FREQuency :MODe LIST

SENSe[1] :LIST :FREQuency :POINts?

SENSe[1] :LIST :FREQuency <n> {,<n>}

SENSe[1] :LIST :MODE AUTO|MANual	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe LIST

SENSe[1] :NOTCh [:STATe] OFF|DB0|DB12|DB30	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|FFT" and INSTrument2 [:SELect] A22|A100|A300 or SENSe[1]: FUNCtion "QPEak" and INSTrument2 [:SELect] A22

SENSe[1] :NOTCh FREQuency :FIXed <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 10 Hz to 110 kHz
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe[1] :NOTCh FREQuency :MODE FIXed

SENSe[1] :NOTCh FREQuency :MODE AUTO|FIXed|SOURce	
Error: Parameter not allowed	Allowed only when:
SOURce	SOURce:FUNCtion[:SHAPe] SINusoid|BURSt|SQUare|S2PUlse
Error: Command not allowed	Allowed only when:
	SENSe[1] :NOTCh [:STATe] ON

SENSe[] :POWer :REFerence :RESistance <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 1 mΩ to 100 kΩ
Error: Unit not allowed	Allowed only when:
	Ohm|kOhm
Error: Command not allowed	Allowed:
	INSTrument2 [:SELect] A22|A100|A300

SENSe[1] : SMOothing: APERture N1 | N2 | N4 | N8 | N16 | N32	
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion "WAVeform"

SENSe[1] :SWEep :MODE AUTO|MANual	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe SWEep

SENSe[1] :SWEep :POINts <n>	
Error: Value out of Range	Valid range of values:
	<n> = 2 to 1024
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe SWEep and SENSe[1] :SWEep :MODE AUTO|MANual and SENSe[1] :SWEep :SPACing LINear|LOGarithmic

SENSe[1] :SWEep :SPACing LINear|LOGarithmic	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe SWEep and SENSe[1] :SWEep :MODE AUTO|MANual

SENSe[1] :SWEep :STEP <n>	
Error: Value out of Range	Valid range of values:
	<n> = The step size must be selected such that a maximum of 1023 single steps (= 1024 sweep points) result. It must not be higher than the absolute difference between SENSe[1] :FREQuency :STOP <n> and SENSe[1] :FREQuency :STARt <n>
Error: Unit not allowed	Allowed:
	for SENSe[1] :SWEep :SPACing LINear: Hz|kHz SENSe[1] :SWEep :SPACing LOGarithmic: no unit as it is a multiplier.
Error: Command not allowed	Allowed only when:
	SENSe[1] :FREQuency :MODe SWEep and SENSe[1] :SWEep :MODE AUTO|MANual and SENSe[1] :SWEep :SPACing LINear|LOGarithmic

<table>
<tr><th colspan="2">SENSe[1]:TRIGger:SETTling:COUNt <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>Valid range of values:</td></tr>
<tr><td></td><td>EXPonential | FLAT: 2 to 6
AVERage: 2 to 100</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>SENSe[1]:TRIGger:SETTling:MODE EXPonential | FLAT | AVERage</td></tr>
</table>

<table>
<tr><th colspan="2">SENSe[1]:TRIGger:SETTling:MODE OFF | EXPonential | FLAT | AVERage</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>TRIGger:SOURce CH1Freq | CH2Freq | CH1Level | CH2Level</td></tr>
</table>

<table>
<tr><th colspan="2">SENSe[1]:TRIGger:SETTling:RESolution <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Valid range of values:</td></tr>
<tr><td></td><td>Analog instruments:
TRIGger:SOURce CH1Freq | CH2Freq: 100 µHz to 10 Hz
TRIGger:SOURce CH1Level | CH2Level: 10 µV to 10 V
Digital instruments:
TRIGger:SOURce CH1Freq | CH2Freq: 100 µHz to 10 Hz
TRIGger:SOURce CH1Level | CH2Level: MinFS to 0.1 FS</td></tr>
<tr><td>Error:
Unit not allowed</td><td>Allowed</td></tr>
<tr><td></td><td>Analog instruments:
TRIGger:SOURce CH1Freq | CH2Freq: Hz
TRIGger:SOURce CH1Level | CH2Level: V | dBV | dBu | W | dBm
Digital instruments:
TRIGger:SOURce CH1Freq | CH2Freq: Hz
TRIGger:SOURce CH1Level | CH2Level: FS | PCTFS (%FS) | dBFS</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>SENSe[1]:TRIGger:SETTling:MODE EXPonential | FLAT | AVERage

MinFS: $2^{(-1 * \text{audio bits})}$ but not smaller than 1 µFS</td></tr>
</table>

SENSe[1]:TRIGger:SETTling:TOLerance <nu>	
Error: Value out of Range	Valid range of values:
	0.001 % to 10 %
Error: Unit not allowed	Allowed
	TRIGger:SOURce CH1Freq | CH2Freq: PCT (%) TRIGger:SOURce CH1Level | CH2Level: PCT (%) | dB
Error: Command not allowed	Allowed only when:
	SENSe[1]:TRIGger:SETTling:MODE EXPonential | FLAT | AVERage

SENSe[1] :UFILter<i> :ATTenuation <nu>	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9 <nu> = 3 to 120 dB
Error: Unit not allowed	Allowed:
	dB
Error: Command not allowed	
	SENSe :FILTer<i> :LPASs|HPASs|BPASs|BSTOp|NOTCh|TOCTave|OCTave [:STATe] ON

SENSe[1] :UFILter<i> :BPASs [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :BSTOp [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

*) lower limit for the instruments
A22: 24 Hz
A100: 179 Hz
A300: 512 Hz
D48, D192, D768: Sample Freq*Oversamp/2000 (see 2.6.3)

SENSe[1] :UFILter<i> :CENTer <nu>	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9 <nu> = lower limit*) to measurement range limits, see 2.6.1
Error Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :NOTCh|TOCTave|OCTave [:STATe] ON

SENSe[1] :UFILter<i> :DELay <nu>	
Error Value out of Range	Valid range of values
	<i> = 1 to 9 <nu> = 0 to 1 s
Error: Unit not allowed	Allowed:
	us(= µs)|ms|s
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :FILE [:STATe] ON

SENSe[1] :UFILter<i> :FILE "filename"	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :FILE [:STATe] ON

SENSe[1] :UFILter<i> :FILE [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :HPASs [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :LPASs [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :NOTCh [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :OCTave [:STATe] ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :PASSb :LOWer <nu>	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9 <nu> = lower limit *) to measurement range limits, see 2.6.1
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :BPASs|BSTOp [:STATe] ON

SENSe[1] :UFILter<i> :PASSb :UPPer <nu>	
Error: Value out of Range	Valid range of values
	<i> = 1 to 9 <nu> = lower limit *) to measurement range limits, see 2.6.1
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :BPASs|BSTOp [:STATe] ON

*) LL = Lower limit for the instruments
A22: 24 Hz
A100: 179 Hz
A300: 512Hz
D48, D192, D768: Sample Freq * Oversamp/2000 (see 2.6.3)

SENSe[1] :UFILter<i> :PASSb <nu>	
Error: Value out of Range	Valid range of values
	<i> = 1 to 9 <nu> = lower limit *) to measurement range limits, see 2.6.1
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :LPASs|HPASs [:STATe] ON

SENSe[1] :UFILter<i> :STOPb:?	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9
Error: Command not allowed	Allowed only when:
	SENSe :FILTer<i> :LPASs|HPASs[:STATe]ON

SENSe[1] :UFILter<i> :STOPb:LOWer?	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :BPASs|BSTOp[:STATe]ON

SENSe[1] :UFILter<i> :STOPb:UPPer?	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :BPASs|BSTOp[:STATe]ON

SENSe[1] :UFILter<i> :TOCTave[:STATe]ON|OFF	
Error: Value out of Range	Valid range of values:
	<i> = 1 to 9

SENSe[1] :UFILter<i> :WIDTh <nu>	
Error: Value out of Range	Valid range of values
	<i> = 1 to 9 <nu> = lower limit *) to measurement range limit, see 2.6.1
Error: Unit not allowed	Allowed only when:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe :UFILTer<i> :NOTCh|TOCTave|OCTave [:STATe] ON

SENSe[1|2] [:POWer] :UNIT[1|2] DBM|W	
Error: Parameter not allowed	Allowed only when:
	The units allowed for the respective instruments and functions are given in Section 2.4, Units.
Error: Command not allowed	Allowed only when:
	INSTrument2 [:SELect] A22|A100|A300

SENSe[1|2] :UNIT[1|2] DPCTV|DV|V/VR|PCTV/VR|DPCTW|DW|P/PR|PCTP/PR|DBR|PCTFS|DBFS|DPCT|PCT|DB	
Error: Parameter not allowed	Allowed only when:
	The units allowed for the respective instruments and functions are given in Section 2.4, Units.

<table>
<tr><th colspan="2">SENSe[1] :UNIT[] PCT|DB</th></tr>
<tr><td>Error:
Parameter not allowed</td><td>Allowed only when:</td></tr>
<tr><td>PCT
DB</td><td>SENSe[1] :FUNCtion "THD|MDISt|DIM|DFD|WAF"
SENSe[1] :FUNCtion "THD|THDNsndr|MDISt|DIM|DFD"</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>SENSe[1] :FUNCtion "THD|THDNsndr|MDISt|DIM|DFD|WAF"</td></tr>
</table>

<table>
<tr><th colspan="2">SENSe[1] [:VOLTage|POWer] :REFerence :MODE |CH1store|CH2store|STORe|VALue</th></tr>
<tr><td>Error:
Parameter not allowed</td><td>Allowed only when:</td></tr>
<tr><td>CH1store|CH2store
STORE</td><td>INPut[] :SELect CH1And2|CH1Is2|CH2Is1|CHBOTH
INPut[] :SELect CH1|CH2</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>SENSe[1] :FUNCtion "RMS|RMSSelectiv|PEAK|QPEak|DC"</td></tr>
</table>

<table>
<tr><th colspan="2">SENSe[1] [:VOLTage|POWer] :REFerence <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Valid range of values:</td></tr>
<tr><td></td><td><nu> = 1 µV to 1000 V for the analog instruments and functions RMS|RMSSelectiv|PEAK|QPEAK
= -1000 V to 1000 V for the analog instrument A22 and the function DC

= 0.0 to 1.0 FS : for the digital instruments and functions RMS|RMSSelectiv|PEAK|QPEAK</td></tr>
<tr><td>Error:
Unit not allowed</td><td>Allowed:</td></tr>
<tr><td></td><td>Analog: V|mV|uV(= µV)|dBV|dBu|W|mW|uW(= µW)|dBm
Digital: FS|PCTFS|dBFS</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>SENSe[1] [:VOLTage|POWer] :REFerence :MODE VALue</td></tr>
</table>

<table>
<tr><th colspan="2">SENSe[1|2] [:VOLTage] :UNIT[1|2] V|DBV|DBU|FS|HEX</th></tr>
<tr><td>Error:
Parameter not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>The units allowed for the respective instruments and functions are given in Section 2.4, Units.</td></tr>
</table>

SENSe[1] :VOLTage :APERture <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 1 ms to 10s
Error: Unit not allowed	Allowed:
	us(= µs)|ms|s
Error: Command not allowed	Allowed only when:
	SENSe[1] :VOLTage :APERture:MODE VALue

SENSe[1] :VOLTage :APERture :MODE AFAST|AUTO|SFASt|FAST|SLOW|VALue	
Error: Parameter not allowed	Allowed only when:
AFAST AUTO SFAST FAST SLOW	SENSe[1] :FUNCtion "RMS|RMSSelectiv" SENSe[1] :FUNCtion "RMS|RMSSelectiv" SENSe[1] :FUNCtion "RMS|RMSSelectiv" SENSe[1] :FUNCtion "RMS|RMSSelectiv|DC" SENSe[1] :FUNCtion "RMS|RMSSelectiv"
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "RMS|RMSSelectiv|DC"

SENSe[1] :VOLTage :FUNDamental <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = The range of values depends on the function selected SENSe[1]:FUNCtion "THD": <nu> — SENSe[1]:FUNCtion "THDNsndr": <nu> ANLG 22 kHz: 10 kHz: 10 Hz to 21.75 kHz — 23.438 Hz to 21.75 kHz ANLG 100 kHz: 100 Hz to 100 kHz — 166.67 Hz to 100 kHz ANLG 300 kHz: 250 Hz to 300 kHz — 500 Hz to 300 kHz DIG 48 kHz: 10 Hz to max. meas. freq. — lower limit Hz to max. meas. freq. DIG 192 kHz: 100 Hz to max. meas. freq. — lower limit Hz to max. meas. freq. DIG 768 kHz: 1000 Hz to max. meas. freq. — lower limit Hz to max. meas. freq. Lower limit = Sample freq/2048 Int. sample frequency = Sampl Frq • Oversamp Max. meas. freq. = sample frequency • 29/64
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe[1] :VOLTage :FUNDamental VALue

SENSe[1] :VOLTage :FUNDamental :MODE AUTO|SOURce|VALue	
Error: Parameter not allowed	Allowed only when:
SOURce	SOURce :FUNCtion [:SHAPe] SINusoid|BURSt|SQUare|S2PUlse
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "THD|THDNsndr"

SENSe[1] :VOLTage :INTVtime :MODE SFASt|FAST|SLOW|VALue	
Error: Command not allowed	Allowed only when:
	SENSe[1] :FUNCtion "PEAK|QPEAK"

SENSe[1] :VOLTage :INTVtime <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 1 ms to 10s
Error: Unit not allowed	Allowed:
	us(= µs)|ms|s
Error: Command not allowed	Allowed only when:
	SENSe[1] :VOLTage :INTVtime VALue

SENSe[] :VOLTage :RANGe[1|2] :AUTO ON|OFF	
Error: Command not allowed	Allowed only when:
	INPut[1|2] :TYPE BALanced|UNBalanced|GEN1|GEN2

SENSe[] :VOLTage :RANGe[1|2] :LOWer <nu>	
Error: Value out of Range	Valid range of values:
	<nu> The range values must match the values given in the "Ranges" table (see 2.6.2).
Error: Unit not allowed	Allowed:
	mV|V
Error: Command not allowed	Allowed only when:
	INPut[1|2] :TYPE BALanced|UNBalanced|GEN1|GEN2

SENSe[] :VOLTage :RANGe[1|2] [:UPPer] <nu>	
Error: Value out of Range	Valid range of values:
	<nu> The range values must match the values given in the "Ranges" table (see 2.6.2).
Error: Unit not allowed	Allowed:
	mV|V
Error: Command not allowed	Allowed only when:
	INPut[1|2] :TYPE BALanced|UNBalanced|GEN1|GEN2

SENSe[1] :WAVeform:DURation <nu>	
Error: Value out of Range	Valid range of values:
	The upper range limit depends on SENSe: SMOothing: APERture N1 | N2 | N4 | N8 | N16 | N32: Interpol = 1|2|4|8|16|32 $\text{max. Trace Len} = \frac{7424}{\text{Abtastfrequenz} * \text{Interpol}}$ Range of values = 1.0 µs to max. Trace Len
Error: Unit not allowed	Allowed:
	s|ms|us
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion "WAVeform"

SENSe2 :DATA1|2?	
Error: Command not allowed	Allowed only when:
	SENSe2 :FUNCtion "PEAKvoltage"

SENSe2 [:POWer] :UNIT[1|2] DBM|W	
Error: Parameter not allowed	Allowed only when:
	The units suitable for the respective instruments and functions are given in Section 2.4, Units
Error: Command not allowed	Allowed only when:
	SENSe2 :FUNCtion "PEAKvoltage"

SENSe2 :UNIT[1|2] DPCTV|DV|V/VR|PCTV/VR|DPCTW|DW|P/PR|PCTP/PR|DBR|PCTFS|DBFS|DPCT	
Error: Parameter not allowed	Allowed only when:
	The units suitable for the respective instruments and functions are given in Section 2.4, Units.
Error: Command not allowed	Allowed only when:
	SENSe2 :FUNCtion "PEAKvoltage"

SENSe2 [:VOLTage] :UNIT[1|2] V|DBV|DBU|FS|HEX	
Error: Parameter not allowed	Allowed only when:
	The units suitable for the respective instruments and functions are given in Section 2.4, Units.
Error: Command not allowed	Allowed only when:
	SENSe2 :FUNCtion "PEAKvoltage"

SENSe2 :VOLTage :REFerence :MODE |CH1Store|CH2Store|STORe|VALue	
Error: Parameter not allowed	Allowed only when:
CH1store|CH2store STORE	INPut[] :SELect CH1And2|CH1Is2|CH2Is1|CHBOTH INPut[] :SELect CH1|CH2
Error: Command not allowed	Allowed only when:
	SENSe2 :FUNCtion "PEAKvoltage"

SENSe2 :VOLTage :REFerence <nu>	
Error: Value out of Range	Valid range of values:
	<nu> for A22|A100|A300 = 1 µV to 1000 V D48|D192|D768 = 0.0 to 1.0 FS
Error: Unit not allowed	Allowed:
	Analog: V|mV|uV(=µV)|dBV|dBu|W|mW|uW(=µW)|dBm Digital: FS|PCTFS|dBFS
Error: Command not allowed	Allowed only when:
	SENSe2 :VOLTage :REFerence :MODE VALue

SENSe3 :DATA1|2?	
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FREQ" or "FQPHase"

SENSe3 :FREQuency :APERture <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 1 ms to 10 s
Error: Unit not allowed	Allowed:
	us(=µs)|ms|s
Error: Command not allowed	Allowed only when:
	SENSe3 :FREQuency :APERture :MODE VALue

SENSe3 :FREQuency :APERture :MODE SFASt|FAST|SLOW|VALue	
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FREQuency|FQPHase"

SENSe3 :FREQuency :REFerence <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 1 mHz to 1 MHz
Error: Unit not allowed	Allowed:
	Hz|kHz
Error: Command not allowed	Allowed only when:
	SENSe3 :FREQuency :REFerence :MODE VALue

SENSe3 :FREQuency :REFerence :MODE CH1store|CH2store|STORe|VALue	
Error: Parameter not allowed	Allowed only when:
CH1store|CH2store	INPut[] :SELect CH1And2|CH1Is2|CH2Is1|CHBOTH and SENSe3 :FUNCtion "FREQuency"
STORE	INPut[] :SELect CH1And2|CH1Is2|CH2Is1|CHBOTH and SENSe3 :FUNCtion "FQPHase|FQPOlarity" or INPut[] :SELect CH1|CH2 and SENSe3 :FUNCtion "FREQuency"
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FREQuency|FQPHase|FQPOlarity"

SENSe3:FREQuency:SETTling:COUNt <n>	
Error: Value out of Range	Valid range of values:
	EXPonential | FLAT: 2 to 6 AVERage: 2 to 100
Error: Command not allowed	Allowed only when:
	SENSe3:FREQuency:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3:FREQuency:SETTling:MODE OFF | EXPonential | FLAT | AVERage	
Error: Command not allowed	Allowed only when:
	SENSe3:FUNCtion FREQuency or SENSe3:FUNCtion FQPHase

SENSe3:FREQuency:SETTling:RESolution <nu>	
Error: Value out of Range	Valid range of values:
	100 µHz to 10 Hz
Error: Unit not allowed	Allowed
	Hz
Error: Command not allowed	Allowed only when:
	SENSe3:FREQuency:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3:FREQuency:SETTling:TOLerance <nu>	
Error: Value out of Range	Valid range of values:
	0.001 % to 10 %
Error: Unit not allowed	Allowed only when:
	PCT (%)
Error: Command not allowed	Allowed only when:
	SENSe3:FREQuency:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3:FREQuency:SETTling:TOUT <nu>	
Error: Value out of Range	Valid range of values:
	0.001 to 10 s
Error: Unit not allowed	Allowed
	s
Error: Command not allowed	Allowed only when:
	SENSe3:FREQuency:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3 :FREQuency :UNIT[1|2] HZ|DHZ|DPCTHZ|TOCT|OCT|DEC|F/FR	
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FREQuency"

SENSe3 :FUNCtion "OFF|FREQuency|FQPHase	
Error: Parameter not allowed	Allowed only when:
FQPHase	INSTrument2 [:SELect] A22|A100|A300 and INPut[] :SELect CH1And2|CH1Is2|CH2Is1

SENSe3 :PHASe :FORMAT POSitive|POSNegative	
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FQPHase"

SENSe3 :PHASe :REFerence :MODE STORe|VALue	
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FQPHase"

SENSe3 :PHASe :REFerence <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = -360 ° to + 360 ° or -2 π to + 2 π
Error: Unit not allowed	Allowed:
	DEG|RAD
Error: Command not allowed	Allowed only when:
	SENSe3 :PHASe :REFerence :MODE VALue

SENSe3:PHASe:SETTling:COUNt <n>	
Error: Value out of Range	Valid range of values:
	EXPonential | FLAT: 2 to 6 AVERage: 2 to 100
Error: Command not allowed	Allowed only when:
	SENSe3:PHASe:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3:PHASe:SETTling:MODE OFF | EXPonential | FLAT | AVERage	
Error: Command not allowed	Allowed only when:
	SENSe3:FUNCtion FQPHase

SENSe3:PHASe:SETTling:RESolution <nu>	
Error: Value out of Range	Valid range of values:
	0.01 ° to 10 °
Error: Unit not allowed	Allowed
	DEG (°) | RAD
Error: Command not allowed	Allowed only when:
	SENSe3:PHASe:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3:PHASe:SETTling:TOUT <nu>	
Error: Value out of Range	Valid range of values:
	0.001 to 10 s
Error: Unit not allowed	Allowed
	s
Error: Command not allowed	Allowed only when:
	SENSe3:PHASe:SETTling:MODE EXPonential | FLAT | AVERage

SENSe3 :PHASe :UNIT2 DEG|RAD|DDEG|DRAD	
Error: Parameter not allowed	Allowed only when:
DEG|RAD|DDEG|DRAD	SENSe3 :FUNCtion "FQPHase"
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FQPHase"

SENSe4 :DATA?	
Error: Command not allowed	Allowed only when:
	SENSe3 :FUNCtion "FQPHase"

SOURce :BANDwidth F30|F100 SOURce :BWIDth F30|F100	
Error: Command not allowed	Allowed only when: INST A25 and SOUR:FUNC DIM.

SOURce:DIM DIMA|DIMB	
Error: Command not allowed	Allowed only when: INST A25|D48|D192 and SOUR:FUNC DIM.

SOURce[1] :EQUalize :CONTrol :POINts?

SOURce[1] :EQUalize :CONTrol [:DATA] <n> {,<n>}

SOURce :FREQuency[1] [:CW|:FIXed] <nu>	
Error: Value out of Range	Range of values depends on generator and function.
Error: Command not allowed	SOUR:FUNC SIN|MULT|BURS|SQRB|SQU|MDIS|FM and SOUR:FREQ:MODE CW|FIX

SOURce :FREQuency<i> [:CW|:FIXed] <nu>;i = 3 to 17	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC MULT

SOURce :FREQuency :DIFFerence <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC DFD

SOURce :FREQuency :MEAN <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC DFD and SOUR:FREQ:MODE CW|FIX or SOUR:FUNC RAND and SOUR:RAND:DOM FREQ and SOUR:RAND:SHAP TOCT

SOURce :FREQuency :MODE CW|FIXed|SWEep1|SWEep2|LIST1|LIST2	
Error: Command not allowed	SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD

SOURce :FREQuency :OFFSet :STATe ON|OFF	
Error: Command not allowed	SOUR:FUNC SIN|MDIS|DFD

SOURce :FREQuency :QUALity FAST|PRECision	
Error: Command not allowed	INST A25|A110 and SOUR:FUNC SIN|MDIS|DFD and SOUR:LOWD ON

SOURce :FREQuency :REFerence <nu>	
Error: Value out of Range	1 mHz < n < 1 MHz

SOURce :FREQuency :STARt <nu>	
Error: Value out of Range	Range of values depends on generator and function.
Error: Command not allowed	SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD and SOUR:FREQ:MODE SWE1|SWE2

SOURce :FREQuency :STOP <nu>	
Error: Value out of Range	Range of values depends on generator and function.
Error: Command not allowed	SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD and SOUR:FREQ:MODE SWE1|SWE2

SOURce :FREQuency2 [:CW|:FIXed] <nu>	
Error: Value out of Range	Range of values depends on generator and function.
Error: Command not allowed	SOUR:FUNC MULT|MDIS|FM.

SOURce :FUNCtion [:SHAPe] SINusoid|MULTisine|BURSt|SQUare|SQRBurst|MDISt|DFD|DIM|RANDom|USER|POLarity|FM	
Error: Param not allowed	1. Selected SQU: INST A25|D48|D192|D768 2. Selected DIM: INST A25|D48|D192 and (with INST A25:) LDG option must be fitted. 3. Selected POL INST A25|D48 4. Selected FM INST A25|D48

SOURce :INTerval [:CW|:FIXed] <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC BURS|SQRB and SOUR:INT:MODE CW|FIX

SOURce :INTerval :MODE CW|FIXed|SWEep1|SWEep2|LIST1|LIST2	
Error: Command not allowed	SOUR:FUNC BURS|SQRB

SOURce :INTerval :STARt <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC BURS|SQRB and SOUR:INT:MODE SWE1|SWE2

SOURce :INTerval :STOP <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC BURS|SQRB and SOUR:INT:MODE SWE1|SWE2

`SOURce[1] :LIST :DWELl :POINts?`

`SOURce[1] :LIST :DWELl <n> {,<n>}`

`SOURce[1] :LIST :FREQuency :POINts?`

`SOURce[1] :LIST :FREQuency <n> {,<n>}`

`SOURce[1] :LIST :INTerval :POINts?`

`SOURce[1] :LIST :INTerval <n> {,<n>}`

`SOURce[1] :LIST :ONTime :POINts?`

`SOURce[1] :LIST :ONTime <n> {,<n>}`

`SOURce[1] :LIST :VOLTage :POINts?`

`SOURce[1] :LIST :VOLTage <n> {,<n>}`

SOURce :LOWDistortion ON|OFF	
Error: Param not allowed	1. Selected ON: Option UPD-B1 must be fitted.
Error: Command not allowed	Allowed only when: INST A25|A110 and SOUR:FUNC SIN|MDIS|DFD

SOURce :MULTisine :COUNt <n>	
Error: Value out of Range	1 < = n < = 17
Error: Command not allowed	Allowed only when: SOUR:FUNC MULT

SOURce :MULTisine :MODE EQUalvoltage|DEFinedvoltage	
Error: Command not allowed	Allowed only when: SOUR:FUNC MULT

SOURce :ONTime [:CW|:FIXed] <nu>	
Error: Command not allowed	Allowed only when: SOUR:FUNC BURS|QRB and SOUR:ONT:MODE CW|FIX

SOURce :ONTime :MODE CW|FIXed|SWEep1|SWEep2|LIST1|LIST2	
Error: Command not allowed	Allowed only when: SOUR:FUNC BURS|SQRB

SOURce :ONTime :STARt <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	Allowed only when: SOUR:FUNC (BURS|SQRB) and SOUR:ONT:MODE SWE1|SWE2

SOURce :ONTime :STOP <nu>	
Error: Value out of Range	Range of values depends on generator.
Error: Command not allowed	SOUR:FUNC BURS|SQRB and SOUR:ONT:MODE SWE1|SWE2

SOURce: PROTocol: FBLock <n>	
Error: Value out of Range	Valid range of values:
	0 to 100·000
Error: Command not allowed	Allowed only when:
	OUTPut:TYPE AESebu | SPDif | OPTical

SOURce: PROTocol: FCRC <n>	
Error: Value out of Range	Valid range of values:
	0 to 100·000
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol: LCHanelstatus ZERO and SOURce: PROTocol: RCHanelstatus AES3 | CRC or SOURce: PROTocol: LCHanelstatus AES3 | CRC or SOURce: PROTocol: RCHanelstatus AES3 | CRC

SOURce: PROTocol: LCHanelstatus ZERO | AES3 | CRC | RAW	
Error: Command not allowed	Allowed only when:
	OUTPut:TYPE AESebu | SPDif | OPTical

SOURce: PROTocol: OBLock <n>	
Error: Value out of Range	Valid range of values:
	0 to 100·000
Error: Command not allowed	Allowed only when:
	OUTPut:TYPE AESebu | SPDif | OPTical

SOURce: PROTocol:PARity ON | FAIL	
Error: Command not allowed	Allowed only when:
	OUTPut:TYPE AESebu | SPDif | OPTical

SOURce: PROTocol: PARity: FCOunt <n>	
	Valid range of values:
	0 to 1000
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol:PARity FAIL

SOURce: PROTocol: PARity: FOFFset <n>	
Error: Value out of Range	Valid range of values:
	0 to 100·000·000
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol:PARity FAIL

SOURce: PROTocol: PARity: NFCount <n>	
Error: Value out of Range	Valid range of values:
	0 to 100·000·000
Error: Command not allowed	Allowed only when:
	SOURce: PROTocol:PARity FAIL

SOURce: PROTocol: RCHanelstatus ZERO|LEQual|AES3|CRC|RAW	
Error: Parameter not allowed	Allowed only when:
AES3	SOURce: PROTocol: LCHanelstatus ZERO | AES3
CRC	SOURce: PROTocol: LCHanelstatus ZERO | CRC
RAW	SOURce: PROTocol: LCHanelstatus ZERO | RAW
Error: Command not allowed	Allowed only when:
	OUTPut:TYPE AESebu | SPDif | OPTical

SOURce: PROTocol: UMODe ZERO | FILE	
Error: Command not allowed	Allowed only when:
	OUTPut:TYPE AESebu | SPDif | OPTical

SOURce:RANDom :DOMain FREQuency|TIME	
Error: Command not allowed	SOUR:FUNC RAND

SOURce:RANDom :FREQuency :LOWer <nu>	
Error: Value out of Range	Range of values depends on generator
Error: Command not allowed	Allowed only when: SOUR:FUNC RAND and SOUR:RAND:DOM FREQ and SOUR:RAND:SHAP WHIT|PINK

SOURce:RANDom :FREQuency :UPPer <nu>	
Error: Value out of Range	Range of values depends on generator, see 3.2.4.4.11
Error: Command not allowed	Allowed only when: SOUR:FUNC RAND and SOUR:RAND:DOM FREQ and SOUR:RAND:SHAP WHIT|PINK

SOURce:RANDom :PDF GAUSsian|TRIangle|RECTangle	
Error: Command not allowed	Allowed only when: SOUR:FUNC RAND and SOUR:RAND:DOM TIME or SOUR:FUNC SIN|MDIS|DFD and INST D48|D192|D768 and SOUR:SIN:DITH:STATe ON

SOURce:RANDom :SHAPe WHITe|PINK|TOCTave|ARBitrary	
Error: Command not allowed	Allowed only when: SOUR:FUNC RAND and SOUR:RAND:DOM FREQ

SOURce:RANDom :SPACing :FREQuency <nu>	
Error: Value out of Range	Range of values depends on generator
Error: Command not allowed	Allowed only when: SOUR:FUNC RAND and SOUR:RAND:DOM FREQ and SOUR:RAND:SPAC:MODE USER

SOURce:RANDom :SPACing :MODE ATRack|USERdefined	
Error: Command not allowed	Allowed only when: SOUR:FUNC RAND and SOUR:RAND:DOM FREQ

SOURce:SINusoid :DITHer :STATe ON|OFF	
Error: Command not allowed	Allowed only when: INST D48|D192|D768 and SOUR:FUNC SIN|MDIS|DFD

<table>
<tr><th colspan="2">SOURce:SINusoid :DITHer <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>0.0 < = n < = 1.0</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
INST D48|D192|D768 and
SOUR:FUNC SIN|MDIS|DFD and
SOUR:SIN:DITH:STATe ON</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :DWELl <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>0.0 s < n < 1000.0 s</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC must be set to a function allowing a sweep (SIN|BURS|SQRB|SQU|MDIS|DFD|DIM)
and
a normal sweep must be active (one of the commands SOUR:FREQ:MODE, SOUR:VOLT:MODE, SOUR:ONT:MODE or SOUR:INT:MODE must be set to SWE1) and
a time-triggered generator sweep must be active (SOUR:SWE:MODE AUTO and
SOUR:SWE:NEXT DWEL)</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :FREQuency :POINts <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>2 < = n < = 1024</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD
SOUR:FREQ:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :FREQuency :SPACing LINear|LOGarithmic</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD
SOUR:FREQ:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :FREQuency :STEP <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Range of values depends on SOUR:FREQ:STAR and SOUR:FREQ:STOP</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD
SOUR:FREQ:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :INTerval :POINts <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>2 < = n < = 1024</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC BURS|SQRB and
SOUR:INT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :INTerval :SPACing LINear|LOGarithmic</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC BURS|SQRB and
SOUR:INT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :INTerval :STEP <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Range of values depends on SOUR:INT:STAR and SOUR:INT:STOP</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC BURS|SQRB and
SOUR:INT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :MODE MANual|AUTO</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM and
a normal sweep must be active (one of the commands SOUR:FREQ:MODE, SOUR:VOLT:MODE, SOUR:ONT:MODE or SOUR:INT:MODE must be set to SWE1)</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :NEXTstep DWELl|ASYNc</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM) and
a normal automatic sweep must be active (one of the commands SOUR:FREQ:MODE, SOUR:VOLT:MODE, SOUR:ONT:MODE or SOUR:INT:MODE must be set to SWE1 and SOUR:SWE:MODE AUTO)</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :ONTime :POINts <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>2 < = n < = 1024</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC BURS|SQRB and
SOUR:ONT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :ONTime :SPACing LINear|LOGarithmic</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC BURS|SQRB and
SOUR:ONT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :ONTime :STEP <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Range of values depends on SOUR:ONT:STAR and SOUR:ONT:STOP, see 3.2.4.4.2</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC BURS|SQRB and
SOUR:ONT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce:SWEep :VOLTage :POINts <n></th></tr>
<tr><td>Error:
Value out of Range</td><td>2 < = n < = 1024</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM and
SOUR:VOLT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :VOLTage :SPACing LINear|LOGarithmic</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM and
SOUR:VOLT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :SWEep :VOLTage :STEP <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Range of values depends on SOUR:VOLT:STAR und SOUR:VOLT:STOP</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM and
SOUR:VOLT:MODE SWE1|SWE2</td></tr>
</table>

<table>
<tr><th colspan="2">SOURce :VOLTage[1][:LEVel] [:AMPLitude] <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Range of values depends on generator and function</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:
SOUR:FUNC SIN|MULT|BURS|SQRB|SQU|POL|FM and
SOUR:VOLT:MODE CW|FIX</td></tr>
</table>

SOURce :VOLTage<i> [:LEVel] [:AMPLitude] <nu> ;i = 3to17	
Error: Value out of Range	Range of values depends on generator, see 3.2.4.4.4.
Error: Command not allowed	Allowed only when: SOUR:FUNC MULT and SOUR:MULT:MODE DEF

SOURce[1] :VOLTage :EQUalize :POINts?

SOURce[1] :VOLTage :EQUalize [:DATA] <n> {,<n>}

SOURce :VOLTage :EQUalize :STATe ON|OFF	
Error: Command not allowed	Allowed only when SOUR:FUNC SIN

SOURce :VOLTage :LIMit [:AMPLitude] <nu>	
Error: Value out of Range	0 to 24 V INST A25|A110 0 to 1 FS INST D48|D192|D768

SOURce :VOLTage :LOWLevel <nu>	
Error: Value out of Range	0.0 < n < SOUR:VOLT
Error: Command not allowed	Allowed only when SOUR:FUNC BURS

SOURce :VOLTage :MODE CW|FIXed|SWEep1|SWEep2|LIST1|LIST2	
Error: Command not allowed	Allowed only when SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM

SOURce:VOLTage[:LEVel] [:AMPLitude]:OFFSet:STATe ON|OFF	
Error: Param.not allowed	
	1st selected ON: INST A25|A110 and SOUR:FUNC SIN|MULT|BURS|SQRB|MDIST|DFD|RAND|USER|POL|FM or INST D48|D192|D768 and SOUR:FUNC SIN|MULT|BURS|SQU|SQRB|MDIST|DFD|RAND|USER|POL|FM

SOURce :VOLTage[:LEVel] [:AMPLitude]:OFFSet <nu>	
Error: Param.not allowed	
	-5 to 5 for OUTP:CONF UNB|CTES -10 to 10 for OUTP:CONF BAL -1 to 1 for INST D48|D192|D768

SOURce :VOLTage :RATio <n>	
Error: Value out of Range	ratmin* < = n < = 10 ratmin* = 1 (for INST D48, D192 and D768) ratmin* depends on SOUR:VOLT:TOT (for INST A25 and A110)
Error: Command not allowed	Allowed only when: SOUR:FUNC MDIS

* see 2.5.5.8 TOTAL VOLT

SOURce :VOLTage :REFerence <nu>	
Error: Value out of Range	1 µV < = n < = 1 MV
Error: Command not allowed	Allowed only when: INST A25|A110

SOURce :VOLTage :STARt <nu>	
Error: Value out of Range	see SOUR:VOLT
Error: Command not allowed	Allowed only when: SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM

SOURce:VOLTage :STOP <nu>	
Error: Value out of Range	see SOUR:VOLT
Error: Command not allowed	Allowed only when: SOUR:FUNC SIN|BURS|SQRB|SQU|MDIS|DFD|DIM

SOURce :VOLTage:TOTal :RMS?	
Error: Command not allowed	Allowed only when: INST A25|A110 and SOUR:FUNC MULT|RAND|USER

SOURce :VOLTage :TOTal [:LEVel] [:AMPLitude]?	
Error: Command not allowed	Allowed only when: SOUR:FUNC MULT|MDIS|DFD|DIM|RAND|USER

SOURce :VOLTage :TOTal [:LEVel] [:AMPLitude] <nu>	
Error: Value out of Range	Range of values depends on generator and function
Error: Command not allowed	Allowed only when: SOUR:FUNC MDIS|DFD|DIM|RAND|USER and SOUR:VOLT:MODE CW|FIX

SOURce :VOLTage2 [:LEVel] [:AMPLitude] <nu>	
Error: Value out of Range	Range of values depends on generator and function
Error: Command not allowed	Allowed only when: SOUR:FUNC FM or SOUR:FUNC MULT and SOUR:MULT:MODE DEF

SYSTem :AHARDware :VERSion? ACH1|ACH2|MBOard|GENerator|DAC

SYSTem :BEEPer :STATe ON|OFF

SYSTem :COMMunicate :GPIB :ADDRess <n>	
Error: Value out of Range	0 < = n < = 31

SYSTem :DHARDware :VERSion? ANALyzer|GENerator

SYSTem :KEY :RDELay <nu>	
Error: Value out of Range	0.25 < = n < = 1.00

SYSTem :KEY :RRATe <nu>	
Error: Value out of Range	0 < = n < = 20

SYSTem :MONitor :ATTenuation <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 0 to 70 dB
Error: Unit not allowed	Allowed:
	dB
Error: Command not allowed	Allowed only when:
	SYSTem :MONitor :STATe ON

SYSTem :MONitor :STATe ON|OFF	
Error: Command not allowed	Allowed only when:
	INSTrument2 [:SELect] A22|A100|A300

SYSTem :OPTions :VERSion? LDG|IECBoard|AESebu|AHSPeed|DHSPeed|ANON|GNON

SYSTem :PRINt TRACe1 | TRACe2 | EQUalize | ERRors | DWELl | LIMLower | LIMUpper | OFF | LIST1 | LIST2 | TR1And2

SYSTem :SOFTware :VERSion? UI|HW|IEC

TRACe :DATA? TRACe[1|2]

TRACe [:DATA] LIST1 <n> {,<n>}

TRACe [:DATA] LIST2 <n> {,<n>}

TRACe :POINts? LIST1

TRACe :POINts? LIST2

TRACe :POINts? TRACe1

TRACe :POINts? TRACe2

TRACe [:DATA] TRACe1 <n> {,<n>}

TRACe [:DATA] TRACe2 <n> {,<n>}

TRIGger :COUNt <n>	
Error: Value out of Range	Valid range of values:
	<n> = 1 to 1023
Error: Command not allowed	Allowed only when:
	TRIGger :SOURce IMMediate | CH1Freq | CH2Freq | CH1Level | CH2Level

TRIGger :DELay <nu>	
Error: Value out of Range	Valid range of values:
	<nu> = 1 ms to 10s
Error: Unit not allowed	Allowed:
	us(= µs)|ms|s
Error: Command not allowed	Allowed only when:
	TRIGger :SOURce IMMediate|CH1Freq|CH2Freq|CH1Level|CH2Level

TRIGger : *FREQuency :VARiation*<n>	
Error: Value out of Range	Valid range of values:
	<nu> = > 0.1 to 50% (see 2.6.4)
Error: Unit not allowed	Allowed:
	PCT
Error: Command not allowed	Allowed only when:
	TRIGger :SOURce CH1Freq | CH2Freq

TRIGger:LEVel <nu>	
Error: Value out of Range	Valid range of values:
	Analog instruments: -300 V to 300 V Digital instruments: - 1 FS to 1 FS
Error: Unit not allowed	Allowed:
	Analog instruments: V|mV|uV|dBV|dBu|W|mW|uW|dBm Digital instruments: FS|PCTFS|dBFS
Error: Command not allowed	Allowed only when:
	SENSe[1]:FUNCtion "WAVeform"

<table>
<tr><th colspan="2">TRIGger: SLOPe POSitive | NEGative</th></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>SENSe[1]:FUNCtion "WAVeform"</td></tr>
</table>

<table>
<tr><th colspan="2">TRIGger :SOURce IMMediate |TIMer|CH1Freq | CH2Freq | CH1Level |CH2Level</th></tr>
<tr><td>Error:
Parameter not allowed</td><td>Allowed only when:</td></tr>
<tr><td>CH1Freq | CH1Level
CH2Freq | CH2Level</td><td>INPut[ ] :SELect | CH1 | CH1And2 | CH1Is2 | CHBOTH
INPut[ ] :SELect | CH1 | CH1And2 | CH1Is2 | CHBOTH</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>Always allowed!</td></tr>
</table>

<table>
<tr><th colspan="2">TRIGger :TIMer <nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Valid range of values:</td></tr>
<tr><td></td><td><nu> = 50 ms to 10 s</td></tr>
<tr><td>Error:
Unit not allowed</td><td>Allowed:</td></tr>
<tr><td></td><td>us (= µs) | ms | s</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>TRIGger :SOURce TIMer</td></tr>
</table>

<table>
<tr><th colspan="2">TRIGger : VOLTage :VARiation<nu></th></tr>
<tr><td>Error:
Value out of Range</td><td>Valid range of values:</td></tr>
<tr><td></td><td><nu> = > 0.1 to 50% (see 2.4.6)</td></tr>
<tr><td>Error:
Unit not allowed</td><td>Allowed:</td></tr>
<tr><td></td><td>PCT</td></tr>
<tr><td>Error:
Command not allowed</td><td>Allowed only when:</td></tr>
<tr><td></td><td>TRIGger :SOURce CH1Level | CH2Level</td></tr>
</table>

3.5 UPD Default Setup

3.5.1 Generator Default Settings

- **INSTRUMENT — ANLG 25 kHz**

· Channel(s) 2 = 1

With setting GENERATOR → ANLG 25 kHz (default setting) or ANLG 110 kHz, the following is true:

· Output	UNBAL BNC	
· Impedance	15 Ω	(600 Ω with setting of output → BAL XLR)
· Common	FLOAT	
· Max Volt	12.000 V	
· Ref Freq	1000.0 Hz	
· Ref Volt	1.0000 V	

The following is true with setting GENERATOR → DIG 48 kHz, DIG 192 kHz or DIG 768 kHz:

· Channel(s)	2 = 1	
· Output	SERIAL	
· Sample Frq	48 kHz	
· Oversamp	1	(2 with DIG 192 kHz, 8 with DIG 768 kHz)
· Wordlength	24	(not with PARAL MUX)
· Wordoffset	0	(not with PARAL MUX)
· Audio Bits	20	
· Wordclock	RISING	not with SERIAL MUX and PARAL MUX)
· WordselCh1	HIGH	(with SERIAL MUX and PARAL MUX)
· Bitclock	RISING	(not with PARAL MUX)
· Bit Order	MSB FIRST	(not with PARAL MUX)
· Max Volt	1.0000 FS	
· Ref Freq	1000.0 Hz	

The following is true with setting Output AES/EBU | S/P DIF | OPTICAL:

AES PROTOCOL ———

· Valid Chan	NONE
· Parity	TRUE
· Block Err	0
· Sequ. Err	0
· Ch Stat. L	ZERO
· Ch Stat. R	ZERO
· User Mode	ZERO

The following is true with setting Parity WITH ERR:

· No Trues	100
· No False	0
· Offset	0

• Functions of all Generators

- **FUNCTION — SINE**

· Frq Offset OFF

· Low Dist ON (Generators ANLG 25 kHz, ANLG 110 kHz. If option low dist. generator not installed: OFF)

· DC Offset OFF — with ON: 0.0000 FS

. Dither OFF (Generators DIG 48KHz, DIG 192 kHz, DIG 768 kHz)

With setting Dither ON
0.0000 FS

· PDF GAUSS

· SWEEP CTRL	OFF	
· FREQUENCY	1000.0 Hz	
· Settling	FAST	(If option low dist. generator installed, generators ANLG 25 kHz, ANLG 110 kHz)
· Equalizer	OFF	
· Equal.File	R&S_EXAM.VEQ	(If equalizer ON)
· VOLTAGE	0.5000 V [FS]	

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
FREQUENCY
· Spacing    LOG POINT
· Start      20000. Hz
· Stop       20.000 Hz        if X or Z-Axis → FREQ selected
· Points     30
· Equalizer  OFF
VOLTAGE
· Spacing    LIN POINTS
· Start      0.0100 V [FS]    if X or Z-Axis → VOLT selected
· Stop       0.5000 V [FS]
· Points     30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
· FREQ.FILE  R&S_EXAM.SPF    if X or Z-Axis → FREQ selected
· VOLT.FILE  R&S_EXAM.SPV    if X or Z-Axis → VOLT selected
```

■ FUNCTION — MULTISINE

· DC Offset	OFF	with ON: 0.0000 FS
· Mode	DEFINE VOLT	
· No of Sin	2	
· Freq No1	1000.0 Hz	
· Freq No2	40.000 Hz	
· Volt No1	0.5000 V [FS]	
· Volt No2	0.5000 V [FS]	
· TOTAL GAIN	0.0000 dB	
· TOTAL PEAK	1.4086 V [FS]	
· TOTAL RMS	0.7071 V [FS]	

The following is true with setting "No of Sin 17":

· Freq No1	1000.0 Hz
· Freq No2	40.000 Hz
· Freq No3	60.000 Hz
· Freq No4	120.00 Hz
· Freq No5	250.00 Hz
· Freq No6	310.00 Hz
· Freq No7	500.00 Hz
· Freq No8	1000.0 Hz
· Freq No9	2000.0 Hz
· Freq No10	4000.0 Hz
· Freq No11	6290.0 Hz
· Freq No12	8000.0 Hz
· Freq No13	10000. Hz
· Freq No14	12500. Hz
· Freq No15	14000. Hz
· Freq No16	16000. Hz
· Freq No17	18000. Hz
· Volt No1	0.5000 V [FS]
· Volt No2	0.5000 V [FS]
· Volt No3	0.0000 V [FS]
· Volt No4	0.0000 V [FS]
· Volt No5	0.0000 V [FS]
· Volt No6	0.0000 V [FS]
· Volt No7	0.0000 V [FS]
· Volt No8	0.0000 V [FS]
· Volt No9	0.0000 V [FS]
· Volt No10	0.0000 V [FS]
· Volt No11	0.0000 V [FS]
· Volt No12	0.0000 V [FS]
· Volt No13	0.0000 V [FS]
· Volt No14	0.0000 V [FS]
· Volt No15	0.0000 V [FS]
· Volt No16	0.0000 V [FS]
· Volt No17	0.0000 V [FS]
· TOTAL GAIN	0.0000 dB

■ FUNCTION — SINE BURST

· DC Offset	OFF	with ON: 0.0000 FS
· SWEEP CTRL	OFF	
· FREQUENCY	1000.0 Hz	
· VOLTAGE	0.5000 V [FS]	
· Low Level	0.0000 V [FS]	
· ON TIME	0.0100 s	
· INTERVAL	1.0000 s	

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
FREQUENCY
· Spacing    LOG POINT
· Start      20000. Hz        if X or Z Axis → FREQ selected
· Stop       20.000 Hz
· Points     30
VOLTAGE
· Spacing    LIN POINTS
· Start      0.0100 V [FS]    if X or Z Axis → VOLT selected
· Stop       0.5000 V [FS]
· Points     30
INTERVAL
· Spacing    LIN POINTS
· Start      1.0000 s         if X or Z Axis → INTERVAL selected
· Stop       0.0200 s
· Points     30
ON TIME
· Spacing    LIN POINTS
· Start      0.0010 s         if X or Z Axis → ON TIME selected
· Stop       0.2000 s
· Points     30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step    ANLR SYNC
· X Axis       FREQ
· Z Axis       OFF
· FREQ FILE    C:\UPD\USER\R&S_EXAM.SPF  if X or Z-Axis FREQ selected
· VOLT FILE    C:\UPD\USER\R&S_EXAM.SPV  if X or Z-Axis VOLT selected
· ONTIME FILE  C:\UPD\USER\R&S_EXAM.SPO  if X or Z-Axis ON TIME selected
· INTV FILE    C:\UPD\USER\R&S_EXAM.SPI  if X or Z-Axis INTERVAL selected
```

■ FUNCTION — SINE² BURST

```
· DC Offset    OFF          with ON: 0.0000 FS
· SWEEP CTRL   OFF
· FREQUENCY    1000.0 Hz
· VOLTAGE      0.5000 V  [FS]
· ON TIME      0.0100 s
· INTERVAL     1.0000 s
```

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
FREQUENCY
· Spacing    LIN POINTS
· Start      20000. Hz        if X or Z-Axis → FREQ selected
· Stop       20.000 Hz
· Points     2
VOLTAGE
· Spacing    LIN POINTS
· Start      0.0100 V [FS]    if X or Z-Axis → VOLT selected
· Stop       0.5000 V [FS]
· Points     30
INTERVAL
· Spacing    LIN POINTS
· Start      1.0000 s         if X or Z-Axis → INTERVAL selected
· Stop       0.0200 s
· Points     2
ON TIME
· Spacing    LIN POINTS
· Start      0.0010 s         if X or Z-Axis → ON TIME selected
· Stop       0.2000 s
· Points     30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step   ANLR SYNC
· X Axis      FREQ
· Z Axis      OFF
· FREQ FILE   C:\UPD\USER\R&S_EXAM.SPF   if X or Z Axis → FREQ selected
· VOLT FILE   C:\UPD\USER\R&S_EXAM.SPV   if X or Z Axis → VOLT selected
· ONTIME FILE C:\UPD\USER\R&S_EXAM.SPO   if X or Z Axis → ON TIME selected
· INTV FILE   C:\UPD\USER\R&S_EXAM.SPI   if X or Z Axis → INTERVAL selected
```

■ FUNCTION — SQUARE

```
· DC Offset    OFF        with ON: 0.0000 FS
· SWEEP CTRL   OFF
· FREQUENCY    1000.0 Hz
· VOLTAGE      0.5000 V  [FS]
```

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step   ANLR SYNC
· X Axis      FREQ
· Z Axis      OFF
FREQUENCY
· Spacing     LIN POINTS
· Start       12000. Hz        if X or Z Axis → FREQ selected
· Stop        20.000 Hz
· Points      30
VOLTAGE
· Spacing     LIN POINTS
· Start       0.0100 V [FS]    if X or Z Axis → VOLT selected
· Stop        0.5000 V [FS]
· Points      30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step   ANLR SYNC
· X Axis      FREQ
· Z Axis      OFF
· FREQ FILE   C:\UPD\USER\R&S_EXAM.SPF   if X or Z Axis → FREQ selected
· VOLT FILE   C:\UPD\USER\R&S_EXAM.SPV   if X or Z Axis → VOLT selected
```

■ FUNCTION — MOD DIST

```
· Frq Offset   OFF
· DC Offset    OFF          with ON: 0.0000 FS
· Low Dist     ON           (Generators ANLG 25 kHz, ANLG 110 kHz. If option low dist. generator not
                            installed: OFF)
· SWEEP CTRL   OFF
· UPPER FREQ   4000.0 Hz
· LOWER FREQ   40.000 Hz
· Settling     PRECISION    (If option low dist. generator installed, generators ANLG 25 kHz,
                            ANLG 110 kHz)
· TOTAL VOLT   1.0000 V
· Volt LF:UF   4.0000 :1
```

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step   ANLR SYNC
· X Axis      FREQ
· Z Axis      OFF
UPPER FREQUENCY
· Spacing     LOG POINTS
· Start       20000. Hz        if X or Z Axis → FREQ selected
· Stop        4000.0 Hz
· Points      30
TOTAL VOLTAGE
· Spacing     LIN POINTS
· Start       0.0100 V [FS]    if X or Z Axis VOLT selected
· Stop        0.5000 V [FS]
· Points      30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
· UPP F.FILE C:\UPD\USER\R&S_EXAM.SPF     if X or Z Axis → FREQ selected
· TOT V.FILE C:\UPD\USER\R&S_EXAM.SPV     if X or Z Axis → VOLT selected
```

■ FUNCTION — DFD

```
· Frq Offset OFF
. DC Offset  OFF                 with ON: 0.0000 FS
· Low Dist   ON                  (Generators ANLG 25 kHz, ANLG 110 kHz. If option low dist. generator not
                                 installed: OFF)
· SWEEP CTRL   OFF
· MEAN FREQ    12500. Hz
· DIFF FREQ    80.000 Hz
· Settling     FAST              (If option low dist. generator installed (generators ANLG 25 kHz,
                                 ANLG 110 kHz))
·TOTAL VOLT    1.0000 V
```

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
MEAN FREQUENCY
· Spacing    LIN POINTS
· Start      20000. Hz         if X or Z Axis → FREQ selected
· Stop       5000.0 Hz
· Points     30
TOTAL VOLTAGE
· Spacing    LIN POINTS
· Start      0.0100 V [FS]     if X or Z Axis → VOLT selected
· Stop       0.5000 V [FS]
· Points     30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step  ANLR SYNC
· X Axis     FREQ
· Z Axis     OFF
· MEANF.FILE C:\UPD\USER\R&S_EXAM.SPF     if X or Z Axis FREQ selected
· TOT V.FILE C:\UPD\USER\R&S_EXAM.SPV     if X or Z Axis VOLT selected
```

■ FUNCTION — DIM

```
· DC Offset   OFF                with ON: 0.0000 FS
· Square/Sin  3.15/15 kHz
· Bandwith    30 kHz             (only generators ANLG 25 kHz, ANLG 110 kHz)
· SWEEP CTRL  OFF
· Settling    FAST               (only generators ANLG 25 kHz, ANLG 110 kHz)
· TOTAL VOLT  1.0000 V  [FS]
```

The following is true with setting SWEEP CTRL → AUTO SWEEP or MANU SWEEP:

```
· Next Step  ANLR SYNC
· X Axis     VOLT              only volt possible
· Z Axis     OFF
TOTAL VOLTAGE
· Spacing    LIN POINTS
· Start      0.0100 V [FS]
· Stop       0.5000 V [FS]
· Points     30
```

The following is true with setting SWEEP CTRL → AUTO LIST or MANU LIST:

```
· Next Step  ANLR SYNC
· X Axis     VOLT
· Z Axis     OFF
· TOT V.FILE C:\UPD\USER\R&S_EXAM.SPV
```

- **FUNCTION — RANDOM**

```
· DC Offset  OFF              with ON: 0.0000 FS
· Domain     TIME
· PDF        GAUSS
· VOLT PEAK  1.0000 V [FS]
· VOLT RMS   0.2550 V         only in analog generators
```

The following is true with setting "Domain FREQ":

```
· Spacing     USER DEF
              10.000 Hz
· Equalizatn  WHITE
· Lower Freq  10.000 Hz
· Upper Freq  20000. Hz
· VOLT PEAK   1.0000 V [FS]
```

- **FUNCTION — ARBITRARY**

```
· DC Offset  OFF              with ON: 0.0000 FS
· Filename   C:\UPD\USER\R&S_EXAM.TTF
· VOLT PEAK  1.0000 V [FS]
· VOLT RMS   1.0000 V         only in the analog generators
```

- **FUNCTION — POLARITY**

```
· DC Offset  OFF              with ON: 0.0000 FS
· VOLTAGE    0.5000 V [FS]
```

- **FUNCTION — FM**

```
· DC Offset  OFF              with ON: 0.0000 FS
· Mod Freq   1000.0 Hz
· Carr Freq  40.000 Hz
· Mod Volt   0.5000 %
· Carr Volt  0.5000 V [FS]
```

3.5.2 Analyzer Default Settings

- **INSTRUMENT ANLG 22kHz**

The following is true with setting ANALYZER ANLG 22 kz ANLG 100 kHz, ANLG 300 Hz:

```
· Min Freq    10 Hz           (only for ANLG 22kHz)
· Ref Imped   600.00 Ω
· Channel(s)  1
· Ch1 Input   UNBAL  BNC
```

The foll. is true with setting Ch1 Input → BAL XLR:

```
· Ch1 Imped   600 Ω           The same settings are true for channel 2 (if selected)
· Ch1 Common  FLOAT
· Ch1 Range   AUTO
```

The following is true with setting ANALYZER DIG 48 kHz, DIG 192 kHz, DIG 768 kHz:

· Min Freq	2 Hz	(10 Hz with DIG 192 kHz and DIG 768 kHz)
· Channel(s)	1	
· Input	SERIAL MUX	
· Sample Frq	48 kHz	
· Oversamp	1	(2 with DIG 192 kHz, 8 with DIG 768 kHz)
· Wordlength	24	(not with PARAL and PARAL MUX)
· Wordoffset	0	(not with PARAL and PARAL MUX)
· Audio Bits	20	
· Wordclock	RISING	(not with SERIAL MUX and PARAL MUX)
· WordselCh1	HIGH	(with SERIAL MUX and PARAL MUX)
· Bitclock	RISING	(not with PARAL and PARAL MUX)
· Bit Order	MSB FIRST	(not with PARAL and PARAL MUX)

■ START COND — AUTO

· Delay 0.0000 s

The following is true with setting START COND TIME:

· Timetick 1.000 s
· Points 30

The following is true with setting START COND FREQ CH1 | FREQ CH2:

· Delay 0.0000 s
· Min Volt 0.0100 V
· Start 1000.0 Hz
· Stop 10000. Hz
· Variation 10.000 %
· Settling OFF

The following is true with setting Settling EXPONENTIAL | FLAT:

· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 Hz

The following is true with setting Settling AVERAGE:

. Samples 3

The following is true with setting START COND VOLT CH1 | VOLT CH2:

· Delay 0.0000 s
· Start 0.0100 V
· Stop 1.0000 V
· Variation 10.000 %
· Settling OFF

The following is true with setting Settling EXPONENTIAL | FLAT:

· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 V

The following is true with setting Settling AVERAGE:

· Samples 3

• Functions of All Analyzers

■ INPUT — PEAK
- Unit Ch1   V [FS]
- Reference   VALUE:
  1.0000 V [FS]

■ FREQ/PHASE — FREQ
- Meas Time   FAST
- Unit Ch1   Hz
  Unit Ch2   °   (if phase selected)
- Ref Freq   VALUE:
  1000.0 Hz
- Format Pha   -180..+180°   (if phase selected)
- Ref Phase   VALUE: (if phase selected)
  10.000 °
- Freq Settl   OFF
- Phas Settl   OFF   (if phase selected)

The following is true with setting Freq Settl EXPONENTIAL | FLAT:
- Samples   3
- Tolerance   1.0000 %
- Resolution   0.1000 Hz
- Timeout   5.0000 s

The following is true with setting Freq Settl AVERAGE:
- Samples   3

The following is true with setting Phas Settl EXPONENTIAL | FLAT:
- Samples   3
- Resolution   0.1000 °
- Timeout   5.0000 s

The following is true with setting Phas Settl AVERAGE:
- Samples   3

■ MONITOR — OFF
- Attenuat.   0.0 dB   (if MONITOR ON)

• Default Settings of the Different Measurement Functions:

■ FUNCTION — RMS & S/N
- S/N Sequ   OFF
- Meas Time   AUTO FAST
- Unit Ch1   V [FS]
- Unit Ch2   V [FS]   (if channel 2 activated)
- Reference   VALUE:
  1.0000 V [FS]
- Notch (Gain)   OFF
- Filter   OFF
- Filter   OFF
- Filter   OFF
- Filter   OFF
- Fnct Settl   OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:
- Samples   3
- Tolerance   1.0000 %
- Resolution   0.0010 V

The following is true with setting Fnct Settl AVERAGE:
- Samples   3

■ POST FFT —OFF
· FFT Size 4096 (if POST FFT ON)
· Window RIFE VINC 2 (if POST FFT ON)

■ **FUNCTION — RMS SELECT**
· Meas Time AUTO FAST
· Unit Ch1 V [FS]
· Unit Ch2 V [FS] (if channel 2 activated)
· Reference VALUE:
1.0000 V [FS]

· Bandwidth 1 % with bandwidth FIX: 100.00 Hz
■ SWEEP CTRL —OFF

The following is true with setting SWEEP CTRL AUTO SWEEP, MANU SWEEP:

· Spacing LOG POINTS
· Start 100.00 Hz
· Stop 20000. Hz
· Points 30

The following is true with setting SWEEP CTRL AUTO LIST, MANU LIST:

· Filename C:\UPD\USER\R&S_EXAM.SPF
■ FREQ MODE — GEN TRACK with FREQ MODE FIX: 1000.0 Hz
· Fnct Settl OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:
· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 V

The following is true with setting Fnct Settl AVERAGE:
· Samples 3

■ **FUNCTION — PEAK & S/N** (only in analyzers ANLG 22 kHz and DIG 48 kHz)
· S/N Sequ OFF
· Meas Mode PK+
· Intv Time FAST
· Unit Ch1 V [FS]
· Unit Ch2 V [FS] (if channel 2 selected)
· Reference VALUE:
1.0000 V [FS]
· Filter OFF
· Filter OFF
· Filter OFF
· Fnct Settl OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:
· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 V

The following is true with setting Fnct Settl AVERAGE:
· Samples 3

■ **FUNCTION — Q PK & S/N** (only in analyzer ANLG 22 kHz and DIG 48 kHz)

```
· S/N Sequ    OFF
· Intv Time   SLOW
· Unit Ch1    V   [FS]
· Unit Ch2    V   [FS]
· Reference   VALUE:
              1.0000 V  [FS]
· Notch (Gain) OFF
· Filter      OFF
· Filter      OFF
· Filter      OFF
· Fnct Settl  OFF
```

(if channel 2 activated)

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

```
· Samples     3
· Tolerance   1.0000 %
· Resolution  0.0010 V
```

The following is true with setting Fnct Settl AVERAGE:

```
· Samples     3
```

■ **FUNCTION — DC** (only in analyzers ANLG 22 kHz, ANLG 100 kHz, ANLG 300kHz)

```
· Meas Time   FAST
· Unit Ch1    V   [FS]
· Unit Ch2    V   [FS]
· Reference   VALUE:
              1.0000 V  [FS]
· Fnct Settl  OFF
```

(if channel 2 selected)

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

```
· Samples     3
· Tolerance   1.0000 %
· Resolution  0.0010 V
```

The following is true with setting Fnct Settl AVERAGE:

```
· Samples     3
```

■ **FUNCTION — THD**

```
· Meas Mode   All di
· Unit        dB
· Fundamentl  AUTO
· Fnct Settl  OFF
```

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

```
· Samples     3
· Tolerance   1.0000 %
· Resolution  0.0010 %
· Timeout     5.0000 s
```

The following is true with setting Fnct Settl AVERAGE:

```
· Samples     3
```

■ **FUNCTION — THD + N/SINAD**

```
· Meas Mode   THD+N
· Unit        dB
· Fundamentl  AUTO
· FrqLim Low  100.00 Hz
· FrqLim Upp  20000. Hz
· Fnct Settl  OFF
```

The following is true with setting Fnct Settl EXPONENTIAL | FLAT if Meas Mode THD + N | NOISE has been selected:

- Samples 3
- Tolerance 1.0000 %
- Resolution 0.0010 %
- Timeout 5.0000 s

The following is true with setting Fnct Settl EXPONENTIAL | FLAT if Meas Mode SINAD has been selected:

- Samples 3
- Tolerance 0.0864 dB
- Resolution 20.000 dB
- Timeout 5.0000 s

The following is true with setting Fnct Settl AVERAGE:

- Samples 3

- POST FFT OFF

The following is true with setting POST FFT ON:

- FFT Size 8192
- Window RIFE VINC 3

■ FUNCTION — MOD DIST

· Unit dB
· Fnct Settl OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 %
· Timeout 5.0000 s

The following is true with setting Fnct Settl AVERAGE:

· Samples 3

■ FUNCTION — DFD

· Meas Mode d2
· Unit dB
· Fnct Settl OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 %
· Timeout 5.0000 s

The following is true with setting Fnct Settl AVERAGE:

· Samples 3

■ FUNCTION — DIM (only in analyzers ANLG 22 kHz and DIG 48 kHz)

· Unit dB
· FREQ MODE FIX:
Square/Sin 3.15/15kHz
· Fnct Settl OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 %
· Timeout 5.0000 s

The following is true with setting Fnct Settl AVERAGE:

· Samples 3

■ FUNCTION — WOW & FL (only in analyzers ANLG 22 kHz and DIG 48 kHz)

· Standard DIN/IEC
· Weighting ON
· Unit %
· Fnct Settl OFF

The following is true with setting Fnct Settl EXPONENTIAL | FLAT:

· Samples 3
· Tolerance 1.0000 %
· Resolution 0.0010 %
· Timeout 5.0000 s

The following is true with setting Fnct Settl AVERAGE:

· Samples 3

· POST FFT   OFF

The following is true with setting POST FFT:

· FFT Size   8192
· Window   RIFE VINC 1

■ **FUNCTION — FFT**

· Notch(Gain) OFF
· FFT Size   4096
· Window   RIFE VINC 2
· Average   1
· Zooming   OFF

The following is true with setting ZOOMING ON:

· Zooming   ON (2...256)
· Center   10000 Hz
· Span   21.75 kHz (ANLG 22 kHz)
    154.67 kHz (ANLG 100 kHz)
    464.00 kHz (ANLG 300 kHz)

With the digital analyzers, the value depends on the sample rate selected

· Zoom Fact   2

■ **FUNCTION — POLARITY**   (there are no further parameters)

■ **FUNCTION — WAVEFORM**

· Trig Level   0.0000 V
· Trig Slope   RISING
· Interpol   1
· Trace Len   0.0100 s

3.5.3 Filter Panel Default Settings

● Basic Parameters of the Individual Types of Filters:

Lowpass filter:

· Passband   20000. Hz
· Attenuat.   60.000 dB
· Short Name   1:LP20.0kHz

Highpass filter:

· Passband   400.00 Hz
· Attenuat.   60.000 dB
· Short Name   2:HP400.0Hz

Bandpass filter:

· Passb Low   900.00 Hz
· Passb Upp   1100.0 Hz
· Attenuat.   60.000 dB
· Short Name   3:BP900.0Hz

Bandstop filter:

· Passb Low   900.00 Hz
· Passb Upp   1100.0 Hz
· Attenuat.   60.000 dB
· Short Name   4:BS900.0Hz

Notch filter:

- Center Frq 16000. Hz
- Width 500.00 Hz
- Attenuat. 60.000 dB
- Short Name 5:N016.0kHz

Octave filter:

- Center Frq 12500. Hz
- Attenuat. 60.000 dB
- Short Name 7:OC12.5kHz

File-defined filter (FILE DEF):

- File name C:\UPD\USER\R&S_EXAM.COE
- Delay 0.3866 s
- Short Name 8:R&S_EXAM

- **Standard Types of Filters of the Individual Filters:**

FILTER 01	LOW PASS
FILTER 02	HIGH PASS
FILTER 03	BAND PASS
FILTER 04	BAND STOP
FILTER 05	NOTCH FLT
FILTER 06	1/3 OCT FLT
FILTER 07	OCTAVE FLT
FILTER 08	FILE DEF.
FILTER 09	FILE DEF.

3.5.4 Display Panel Default Settings

- **OPERATION — BARGRAPH**
- **BARGRAPH 1 — FUNC CH1**
  - Unit V [FS, Hz, dB, %] (Basic unit of the selected analyzer or bargraph function (cf. Section 2.4))
  - Reference VALUE:
    1.0000 V [FS, Hz, dB, %] (Basic unit of the selected analyzer or bargraph function (cf. Section 2.4))
  - Scale AUTO ONCE
  - Spacing LIN
- **BARGRAPH 2 — OFF**

If the same function has been selected for BARGRAPH 2 and BARGRAPH 1:

Scale B EQUAL A

If → NOT EQUAL A has been selected for Scale B:

- Unit V [FS, Hz, dB, %] (Basic unit of the selected analyzer or bargraph function (cf. Section 2.4))
- Reference VALUE:
  1.0000 V [FS, Hz, dB, %] (Basic unit of the selected analyzer or bargraph function (cf. Section 2.4))
- Scale AUTO ONCE
- Spacing LIN

VOLT, FREQ, ON TIME and INTERVAL are values displayed depending on the setting under "X Axis" with a generator sweep.

With a sweep of the center frequency of the rms selective bandpass filter in the analyzer with measurement function RMS SELECT, FREQ is displayed.

■ **BARGRAPH 3 VOLT**

· Unit	V [FS]
· Reference	1000.0 V [1.0000 FS]
· Scale	AUTO
· Spacing	LIN

■ **BARGRAPH 3 FREQ**

· Unit	Hz
· Reference	1000.0 Hz
· Scale	AUTO
· Spacing	LIN

■ **BARGRAPH 3 ON TIME | INTERVAL**

· Unit	S
· Scale	AUTO
· Spacing	LIN
LIMIT CHECK	
· Mode	OFF

The following is true with setting "Mode LIM LOWER, LIM UPPER, LIM LOW&UP ":

· Check	TRACE A	
· Lim Upper	VALUE: 0.5000 V	(not with LIM LOWER)
· Lim Lower	VALUE: 0.0500 V	(not with LIM UPPER)

3.5.5 Standard Settings of the Option Panel

· UPD IECadr	20
· Beeper	ON
SCREEN HARD COPY	
· Destin	PRINTER
Printname	R&SPDN
· Abort	NO

If Destin → PLOTTER, PCX FILE or HPGL FILE is selected, the following is true:

· Copy	SCREEN	(with HPGL FILE and PLOTTER)
· Filename	SCREEN	(with HPGL- and PCX-FILE)
· Plot on	IEC BUS	(with PLOTTER)
· IEC Adr	4	(with PLOTTER)

PRINT	
· Type	OFF
PANEL KEYS	
· Reptn Rate	10.000 Hz
· Rep Delay	0.5000 s
DISPLAY	
· Extrn Disp	BOTH B/W
HELP LANGUAGE	
· Language	GERMAN
CALIBRATion	ANL
· Zero Auto	ON
CALIBRATion	GEN
· LDG Auto	OFF

3.5.6 Standard Setting of the File Panel

```
LOAD INSTRUMENT STATE ———
· Mode        COMPL SETUP
. Filename    LASTSAVE
STORE INSTRUMENT STATE ———
' Mode        COMPL SETUP
· Attrib      READ/WRITE
· Filename    LASTSAVE
STORE TRACE/LIST ——————————
· Store       OFF
UTILS ————————————————————
· Delete      TO_DELET
· Work Dir    C:\UPD\USER
. COPY        SOURCE
· To          DEST
```

3.6 Automatic Control of the UPD with R&S-Basic

Important note: The software described below can be obtained as an accessory for the UPD with the designation UPD-K1 and is not supplied with the UPD.

3.6.1 Use

Executing frequent test sequences in a fast and repeatable way, summing up the results and creating a valuable documentation, these are the applications of the automatic UPD control with R&S Basic. These automatic complete measurements, consisting of generator and analyzer functions of the UPD, are used for entire characterization of instruments and components in production or in the test shop and for ensuring and monitoring the characteristics of operating and transmission devices.

A universal automatic control for the automatic complete measurement does not only have to control the instrument functions, but must also be able to evaluate the measurement results and branch in the program. Besides, operator prompting with confirmations and indications is expected. Furthermore, synchronization with a time base or external events may be required. Thus, some programming is sometimes required, but it should be as easy as possible. Therefore, a complete BASIC interpreter with optimally integrated commands is used for operation of the measuring instrument. A simple keystroke permits to change between normal operation of the measuring instrument and BASIC. The command extensions for the instrument control feature the same structure as the IEC-bus commands, which in turn comply with the international SCPI standard. For reasons of speed, however, the SCPI short form is always used.

3.6.2 Scope of Functions

The UPD provides about 600 elements of operation (ie functions in the programming language) and almost that much key words as parameters. Therefore, not only the users who actually do not want to be involved with programming, but also the experts will appreciate the integrated program generator. Every input via front panel or keyboard for setting the UPD is recorded in logging mode and added to the program as a complete program line! Simple test sequences are thus completely programmed without having typed a single line. There is no need to check the correct syntax, the created program can be easily read due to the standard SCPI notation and can thus be easily modified and supplemented.

R&S Basic with easy to handle IEC-bus commands that are optimally incorporated into the syntax can also control further IEC-bus devices without the need for an external controller (This requires option IEC-bus interface UPD-B4). Likewise, it is easily possible to operate the serial interface and write and read files for connection with peripheral devices or other programs.

For graphical output, BASIC can fully make use of the UPD software: Graphs with sophisticated scaling and labelling, bargraphs, bargraphs with trailing pointers, all of them also with automatic scaling depending on the measured value, are still available. In addition, the graphics commands belonging to Basic can also be used.

If the UPD is to be controlled by an external controller in a test system, two REPLACE commands can be used to convert all UPD IN/OUT instructions into IEC commands (IEC IN/OUT). This constitutes the basical program for controlling the UPD.

3.6.3 Preparation for Use

Tbsequently, a memory model for Basic can be selected by calling UPDSET. The user indicates how much memory he wants to reserve for the Basic program and Basic data (variables). Since the UPD cannot simultaneously be remote-controlled via the IEC bus and the automatic control, the user must choose between the two possiblilities by means of UPDSET. The files CONFIG.SYS and UPD.BAT are thus changed. -UPDSET contains a menu through which the user is guided.
• Enter "UPDSET" and "↵" after the prompt c:>.
The operating mode selected is maintained even after the instrument has been switched off.

To estimate the required memory, the following rough values are given: A typical Basic line requires about 25 bytes. 13k program memory is thus sufficient for about 500 lines or 10 pages of program. The remaining empty memory can be polled in Basic with FRE(1). -A variable in Basic requires about 15 bytes (depending on the length of the name), and a field with floating-point numbers requires 8 bytes for each index. FRE(o) indicates the remaining storage area.

The memory should not be oversized, since the program may be limited in its speed from a certain size onwards (see also Appendix UPD/Basic memory management). If the preselected values are not exceeded, the floppy disk supplied permits to install the automatic control with R&S Basic on the UPD. For this purpose
• Switch off UPD.
• Connect external keyboard (compatible with AT) to the UPD.
• Switch on UPD.
• Quit the UPD program by pressing the keys "SYSTEM" and "ENTER" (front panel) or "Strg F9" and "↵" (external keyboard)
• Insert UPD CONTROL floppy (Automatic Control).
• Enter "A:" and "↵" to change to drive A.
• Enter "ACINST" and "↵" after the prompt A:>.
• After the installation, take the UPD CONTROL floppy disk out of the drive.
• Enter "C:" and "↵" to change to drive C.

Important note: The Automatic Control UPD-K1 assumes the UPD software version 2.0 or greater. If an earlier version is installed, ACINST will output an appropriate error message and request reinstallation (see UPD Manual 1.3 Reinstallation of the UPD Software).

Suhe UPD operates at full speed.

In the case of first installation, the UPD must boot anew; otherwise this is only necessary when the memory model is changed. UPDSET can also be called in order to inquire about the currently active memory allocation. If the UPD is to operate again as a measuring instrument controlled externally via IEC bus, UPDSET can also be used to return to this mode.

3.6.4 Operation

In the following, a distinction is made between Basic and the UPD program, the latter including all routines except Basic (i.e. the test, readout, graphics output and input routines).

3.6.4.1 Connection Basic-UPD

The function key F3 switches between the UPD and the Basic input mode. If Basic is in the input mode, the fields for output of measured values appear at the upper edge, irrespective of whether picture graphics is selected in the UPD or not. The field below down to the softkeys is available to Basic. When returning to UPD operation, the panels are first completely built up again in order to exactly indicate the instantaneous settings, since they may have been changed from Basic. Basic becomes inactive, but its last status is maintained.

While Basic is waiting for a line entry (as after pressing of the "↵"-key), the UPD program continuous to run in the background, and the measurement results are indicated. The effects produced by the settings made by Basic can thus be observed immediately.

Possible error messages after pressing of the F3 key: In the case of the message "stringx.sys device driver not loaded", Basic has not been installed correctly, with "memory not available" a memory size has been selected with UPDSETfor which the available space is not sufficient.

3.6.4.2 Logging Mode

The function key F2 switches the "logging mode" on and off. The respective mode is indicated in the bottom right corner above the softkeys. In the case of "on", all entries used for setting the UPD are appended to the Basic program as command line. After switching to the Basic mode, these new lines are displayed automatically and can be modified, if necessary.

The Basic commands for automatic control of the UPD differ only slightly from the commands for remote control via the IEC bus. The program can easily be converted into the other commands using the Basic command REPLACE (e.g. for controlling the UPD using an external controller). See also UPD-specific modifications of the Basic manual, paragraph REPLACE.

3.6.4.3 Basic Extensions

R&S Basic for the UPD is extended by the following commands (they are described in detail in the following). For comparison, equivalent IEC-bus commands are indicated in parentheses.

UPD OUT <string>	(IEC OUT <adr>, <string>)
UPD IN <string variable>	(IEC IN <adr>, <string variable)
UPD GTL	(IEC LAD<adr>:IEC GTL)
UPD BLOCKIN <array variable>	
UPD BLOCKOUT <array variable>, <count>	

UPD OUT <string>

transfers a string (constant in quotation marks, variable marked by $ or string expression) to the UPD program.
Example:

```
100 UPD OUT "SOUR:FREQ 1000HZ"
```

sets the frequency of the generator.

The syntax of the strings is summed up further below.

UPD IN <v>$

accepts a string from the UPD program. This may be a measured value, a block of measured values or a polled setting. What is to be read in must be indicated before by means of a query provided with a question mark.
Example:

```
100 UPD OUT "SENS:DATA2?"
110 UPD IN A$
```

applies the measured value of the 2nd channel to variable A$ for further processing.

UPD GTL [B | U| G]

Switches back to UPD mode under program control.

Without parameters given, the UPD input mode is selected again (as with the F3 key in Basic mode or the EXIT instruction). Pressing of the F3 key permits to return to Basic again. However, Basic remains in the RUN mode (contrary to first pressing of the F3 key or EXIT) and continues the user program with the line following UPD GTL after pressing the F3 key.

The appended "U" temporarily switches to the UPD mode in order to build up all displays, in particular the graphics window set and the trace(s) or FFT. However, no entries can be made in the panels. Basic also remains in the RUN mode, only waiting for entries if intended in the program. This is illustrated in the following example, where the Basic program is only continued after the user has pressed a key:

```
100 UPD GTL U :' Update graphics
110 PRINT "Press any key to continue..."
120 INKEY A$
130 IF A$="" THEN 120
...
...
970 UPD GTL B :' Restore Basic screen
980 END
```

The "B" as parameter permits to restore the Basic display to the status visible before calling of UPD GTL U.
The "G" parameter is used to switch over to UPD mode in order to build up all panels and immediately back to the Basic mode. Especially the graphics panel is drawn (if it has been made active using DISP:CONF) so that the data transmitted by Basic can be displayed, for example.

If the Basic program is stopped or aborted by means of a STOP instruction or by pressing the Untbr. key (together with the Strg key), the F3 key acts differently when switching back to Basic mode, depending on the GTL parameter: After "B", the Basic display is restored, "U" restores the display built up after RUN (e.g. with UPD graphics output).

UPD BLOCKIN <array(i)>

Loads block data (ie lists or series of measurements) from the UPD program into a data field (indexed variable) for further processing. As with UPD IN, a query must indicate before what to read in. The number i indicates the index starting from which the first value of the block is stored. The length of the complete list is always used, which is why the data field must have been defined large enough before with DIM.

Examples of block_commands:

```
90 DIM A(200)
100 UPD OUT "sour:list:freq?"
110 UPD BLOCKIN A(0)
120 UPD OUT "sour:list:freq:poin?"
130 UPDIN A$: Count = VAL(A$)
```

for transferring the data from the UPD to Basic into the field A( ) and the current length to Count.

UPD BLOCKOUT <array(i)> [,n]

Stores block data (like UPD BLOCKIN) in a reserved communication area of the UPD so that they can subsequently be transferred from Basic to the UPD program using a UPD OUT "...." command. Possible applications are the transfer of lists or values for subsequent graphical representation.
The index i indicates the value starting from which the data field is transferred. n determines the number of values; without this value, the size defined by DIM is used.

Example (note the sequence):

```
100 UPD BLOCKOUT a(0),20
100 UPD OUT "trace trac1"
```

for transferring the data from Basic to the UPD, e.g. for graphical display.

3.6.4.4 Differences from the IEC-bus Syntax

The syntax of the SCPI commands (strings) is basically the same as the one used for IEC bus control(see UPD IEC-bus description), except for a few differences:

1. Only the short form is always accepted (in general 4 letters indicated in upper-case notation in the description).

2. The suffix 1 (equivalent with the case without suffix) must be omitted with the headers, but not with the parameters.
Example:

```
10 UPD OUT "inp:type bal"
   not
   (10 UPD OUT "inp1:type bal")
   but
20 UPD OUT "inp2:type bal"

30 UPD OUT "inp:sel ch1"
   not
   (10 UPD OUT "inp:sel ch")
```

3. Optional key words (in square brackets [] in the description) must not be used.

3.6. Only the following "*" commands are currently available: *RST and *WAI.

3.6.4.5 UPD specific Modifications to the Basic Manual

There are only little modifications to the supplied standard Basic manual resulting from different conditions. In the part of the manual depending on the computer, the Basic manual of the version for the controllers PSA and PAT is valid.

Softkey labelling and function keys

Compared with the standard Basic manual, the function keys are shifted by 4 keys, because F1 to F4 are assigned different functions in the UPD. The softkey labelling has been adapted accordingly for the UPD. Switchover between alphanumeric and graphics mode (F8) is not provided in the UPD.

BYE

is a synonym for EXIT; description see under EXIT.

COLOR

should not be modified in order in order not to affect the UPD graphics output. The colors are assigned as follows:

Pen	UPD color mode	UPD b/w mode	
0	white	white	(background)
1	black	dark grey	(preselected color)
2	white	grey	
3	red	black	
4	grey	grey	
5	yellow	light grey	
6	black	dark grey	
7	yellow	dark grey	
8	grey	black	
9	green	black	
10	blue	black	
11	green	black	
12	yellow	dark grey	
13	dark green	dark grey	
14	black	black	
15	black	black	

COPYOUT

is not supported. See GSAVE "LPT1".

EXIT (synonym for BYE)

leaves the Basic mode and returns to the UPD input mode and not to MS-DOS.

GRAPHIC

The interface name for putting out graphics on the screen is no longer GRAPH but GRAPX with the UPD.

GSAVE on LPT

is not supported. Instead, the HCOP:DEST <> remote-control command should be used for printed output of the display.

HELP

is not supported as a command; instead, the F1 key permits to ask for context-related help if the cursor is positioned on a key word (not yet in UPD Version 2.0).

HOLD

Note: During the wait time, the routines are not continued; therefore, with long times, it is better implemented with a loop with TIME.

REPLACE

In order to allow for the comma to be also contained in the REPLACE command as part of the string (and not as separator between the new and the old string), it can be used with preceding backslash (\,) within the string. Example1:

old program: `100 UPD OUT A$`

`REPLACE UPD OUT, IEC OUT 20,`

new program: `100 IEC OUT 20,A$`

Example2:

old program: `100 IEC IN 20, A$`

`REPLACE IEC IN 20\,, UPD IN`

new program: `100 UPD IN A$`

SCREEN

is not supported; SCREEN 18 (VGA mode with 16 colors/grey shades) is always set.

SET

The color of the pen is selected from the colors described above under COLOR.

SHELL

is only supported with restrictions, since the remaining memory of approx. 60 bytes is too small; the MS-DOS command interpreter together with the program called must not exceed this memory size. However, this is the case with the internal and a few external MS-DOS commands (dir, del, md, cd etc, see MS-DOS manual).

VIEWPORT

The upper limit for y2 should be 294 so that the upper field remains vacant for readout of the measured values. In principal, there are no restrictions to the Basic graphics commands, it is up to the user whether the area used by the UPD graphics is overwritten.

WINDOW

The preselected values are 0,639,0,**293.**

ZOOM

is not supported

3.6.5 Appendix

3.6.5.1UPD/Basic Memory Management

Since the memoy available to MS-DOS programs is limited, the overlay technique is used in the UPD program. Furthermore, Basic requires memory for the user program and its data (variables). These memoryareas are assigned the parameters
  -bp<n> for the program memory and
  -bd<n> for the data memory.

Example:
```
upd_ui -bp16 -bd8
```

reserves 16k main memory for the program and 8k for the data, Basic itself needing about 3k for its own management.

The minimum values are about 8k program and 4k data. Basic can manage a maximum of 64k. However, with a size of about 2 times 32 k, the overlay memory for the UPD program is decreased, reducing the program speed. More detailed specifications are not possible, since the available total memory, which may be occupied by resident programs and device drivers, may vary to a great extent.

The memory management of the UPD program is to be briefly explained in the following so that an expertized user can optimize his own configuration. The program and data memory used for Basic is first reserved in the UMB area. If this is not possible (because the line DOS=HIGH,UMB is missing in the CONFIG.SYS, or too may other programs have been loaded into this area by LOADHIGH or DEVICEHIGH), the space in the conventional memory (below 640k) is used. If the remaining memory for the UPD program becomes too small then, no memory is reserved for Basic at all. The attempt to switch to Basic then produces the error message "not enough memory for BASIC".

If space in the conventional memory is to be used, the overlay memory is decreased. The UPD program may be restricted in its speed from a certain size onwards, which also depends on the memory required by other resident programs.

When executing Basic, other instruments can also be controlled via the IEC-bus interface. In this case, the UPD is the system controller via Basic, ie it can no longer be remote-controlled by an external controller. The parser program UPD_IEC.EXE is no longer needed and must not be loaded any more when starting the UPD. Instead, Basic requires the following device drivers:
  STRINX.SYS as Basic editor
  IECX.SYS as IEC-bus controller
  GRAPHX.SYS for the Basic commands for graphics output
  BEEPX.SYS for audio outputs.
The user need not be familiar with the details, because, with the program UPDSET described in 3.6.3, he is automatically supplied with the CONFIG.SYS to be used and the associated batch files.

Annex A IEC/IEEE-bus Interface

The UPD can be equipped with an IEC/IEEE-bus interface according to standard IEC 625.1/IEEE 488. The mating connector is at the rear of the instrument. A controller for remote control can be connected via the interface. Interconnection is made via a shielded cable.

A.1 Characteristics of the Interface

- 8-bit parallel data transfer
- bidirectional data transfer
- three line handshake
- high data transfer rate of max. 350 kByte/s
- up to 15 devices can be connected
- maximum length of interconnecting cable 15 m (single connection 2m)
- wired OR if several instruments are interconnected in parallel

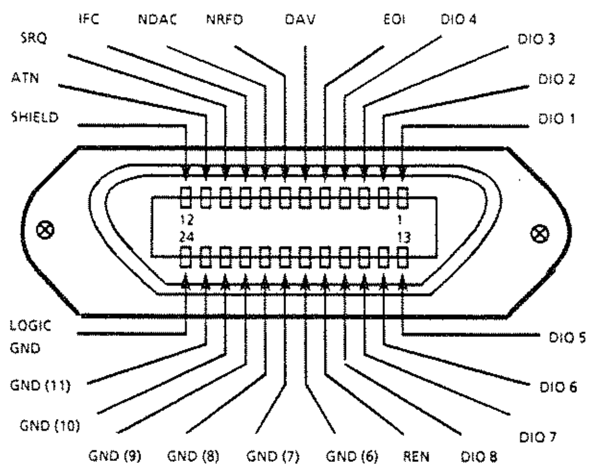


Fig. A-1 Contact Assignment of IEC-bus connector

A.2 Bus Lines

1. **Data bus with 8 lines DIO 1 to DIO 8.**
   The transmission is bit-parallel and byte-serial in the ASCII/ISO code. DIO1 is the bit of lowest order, DIO8 the bit of highest order.

2. **Control bus with 5 lines.**
   IFC (Interface Clear),
   active low resets the interfaces of all connected instruments to the default setting.

   ATN (Attention),
   active low signals the transmission of interface messages
   inactive high signals the transmission of device-dependent messages.

SRQ (Service Request),
active low enables a device connected to send a service request to the controller.

REN (Remote Enable),
active low permits the switchover to remote control.

EOI (End or Identify),
has two functions in connection with ATN:
active low marks the end of data transmission with ATN = HIGH
active low triggers a parallel poll with ATN = LOW.

3. **Handshake bus with three lines.**
DAV (Data Valid),
active low signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active low signals that one of the devices connected is not ready for data transfer.

NDAC (Not Data Accepted),
active low as long as the instrument connected is accepting the data present on the data bus.

A.3 Interface Functions

Instruments which can be remote-controlled via IEC-bus can be equipped with different interface functions. Table A-2 lists the interface functions appropriate for the UPD.

Table A-2 Interface functions (max. for module NEC 7210)

Control character	Interface function
SH1	Handshake source function (source handshake)
AH1	Handshake drain function (acceptor handshake)
L3/LE3	Listener function.
T5/TE5	Talker function, ability to respond to serial poll
SR1	Service request function (Service Request)
PP1	Parallel poll function
RL1	Remote/Local switchover function
DC1	Resetting function (Device Clear)
DT1	Trigger function (Device Trigger)
C1...5	Controller function (with optional software only)

A.4 Interface Messages

Interface messages are transmitted to the UPD on the data lines, with the attention line being active (LOW). They enable the communication between instrument and controller.

Common Commands

The common commands are encoded in the range 10 through 1F hex. They are effective for all instruments connected to the bus without addressing them before.

Command	BASIC command for R&S controllers	Effect on UPD
DCL (Device Clear)	IECDCL	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Inferface Clear)	IECIFC	Resets the interfaces to the default setting.
LLO (Local Lockout)	IECLLO	The LOC/IEC ADDR key is disabled.
SPE (Serial Poll Enable)	IECSPE	Ready for serial poll
SPD (Serial Poll Disable)	IECSPD	End of serial poll
PPU (Parallel Poll Unconfigure)	IECPPU	End of the parallel-poll state

Addressed Commands

The addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Command	BASIC command for R&S controllers	Effect on UPD
SDC (Selected Device Clear)	IECSDC	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GTL (Go to Local)	IECGTL	Transition to the "Local" state (manual control)
PPC (Parallel Poll Configure)	IECPPC	Configure instrument for parallel poll (requires follow-up command)

Table 3-3 ASCII/ISO- and IEC character data set

Control characters						Numbers and special characters				Upper-case letters				Lower-case letters			
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	`	112	p
1	SOH	GTL	17	DC1	LLO	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	´	55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	|
13	CR		29	GS		45	-	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	? / UNL	79	O	95	_	111	o	127	DEL
Addressed commands			Universal commands			Listener addresses				Talker addresses				Secondary addresses and commands			

Control character code:

eg

9	HT	TCT

- TCT — Interface message ("Take Control")
- HT — ASCII character ("Horizontal Tab")
- 9 — Decimal

Annex B List of Error Messages

The following list contains error messages which can be obtained via IEC-bus or in manual operation. Negative error numbers are SCPI-defined and are given in full length although the UPD does not use all of them. Positive error numbers mark device-specific errors.

The table contains the error number in the left-hand column. In the right-hand column, the error text being entered into the error/event queue or being displayed is printed in bold face. Below the error text, there is an explanation as to the respective error.

B.1 SCPI-specific Error Messages

No Error

Error number	**Error query response** Explanation
0	**No error** This message is output if the error queue is completely empty.

Command Error — sets bit 5 in the ESR register.

Error number	**Error query response** Explanation
-100	**Command Error** The command is faulty or invalid.
-101	**Invalid Character** A syntactic element contains a character which is invalid for that type. Example: A header containing an ampersand, "SOURCE&"
-102	**Syntax error** An unrecognized command or data type was received. Example: A string was received when the device does not accept strings.
-103	**Invalid separator** The device was expecting a separator and received an illegal character. Example: The semicolon was omitted after a program message unit.
-104	**Data type error** The device recognized a data element different than one allowed. Example: Numeric or string data are expected but block data was received.

Error number	**Error query response** Explanation
-105	**GET not allowed** A Group Execute Trigger (GET) was received within a program message.
-108	**Parameter not allowed** More parameters were received than allowed in this command.
-108	**Missing parameter** Fewer parameters were received than required for this command.
-110	**Command header error** Faulty header.
-111	**Header separator error** A character which is not a legal header separator was encountered. Example: No white space followed the header, "*ESE255"
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is syntactically correct, but it is undefined for the UPD. Example: E*XYZ is not defined for any device.
-114	**Header suffix out of range** A nonheader character has been encountered in the header element parsed by the device.
-120	**Numeric data error** Faulty numeric data.
-121	**Invalid character in number** A number contains an illegal character. Example: An "A" in a decimal numeric or a "9" in octal data.
-123	**Exponent too large** The magnitude of the exponent is larger than 37.
-124	**Too many digits** The mantissa of a decimal numeric data element contains more than 255 digits (excluding leading zeros).
-128	**Numeric data not allowed** A legal numeric data element was received, but the device does not accept one in this position for the header.
-130	**Suffix error** Faulty suffix.
-131	**Invalid suffix** The suffix is inappropriate for this device.
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix was received after a numeric element which does not allow suffixes.

Fortsetzung: Command Error

Error number	Error query response Explanation
-140	**Character data error** Faulty character data.
-141	**Invalid character data** Either the character data element contains an invalid character or the particular element received is not valid for the header.
-144	**Character data too long** The character data element contains more than twelve characters.
-148	**Character data not allowed** A legal character data element was encountered where prohibited by the device.
-150	**String data error** Faulty string data.
-151	**Invalid string data** A string data element was expected, but was invalid for some reason. Example: An END message was received before the terminal quote character.
-158	**String data not allowed** A legal string data element was encountered where prohibited by the device.
-160	**Block data error** Faulty block data.
-161	**Invalid block data** A block data element was expected, but was invalid for some reason. Example: An END message was received before the length was satisfied.
-168	**Block data not allowed** A legal block data element was encountered where prohibited by the device.
-170	**Expression error** Faulty expression data.
-171	**Invalid expression** Invalid expression data element, for example, unmatched parentheses or an illegal character.
-178	**Expression data not allowed** A legal expression data element was encountered where prohibited by the device.
-180	**Macro error** A faulty macro was defined, or an error occured when executing a macro.
-181	**Invalid outside macro definition** A macro parameter placeholder ($<number) is outside the macro definition.
-183	**Invalid inside macro definition** The program message unit sequence, sent with a *DDT or *DMC command, is syntactically invalid.
-184	**Macro parameter error** A command inside the macro definition had the wrong number or type of parameter.

Execution Error — sets bit 4 in the ESR register

Error number	**Error query response** Explanation
-200	**Execution error** An error occurred when executing a received command.
-201	**Invalid while in local** A command is not executable while the device is in local due to a hard local control; for example, a device with a rotary switch receives a message which would change the switches state, but the device is in local so the message cannot be executed.
-202	**Settings lost due to rtl** A setting associated with a hard local control was lost when the device changed to LOCS from REMS or to LWLS from RWLS.
-210	**Trigger error**
-211	**Trigger ignored** Get, *TRG or triggering signal was received and recognized by the device but was ignored because of device timing considerations; for example, the device was not ready to respond. Note: A DT0 device always ignores GET and treats *TRG as a command error.
-212	**Arm ignored** An arming signal was received and recognized by the device but was ignored.
-213	**Init ignored** A request for a measurement initiation was ignored as another measurement was already in progress.
-214	**Trigger deadlock** The trigger source for the initiation of a measurement is set to GET and subsequent measurement query is received. The measurement cannot be started until a GET is received, but the GET would cause an interrupted error.
-215	**Arm deadlock** The arm source for the initiation of a measurement is set to GET and subsequent measurement query is received. The measurement cannot be started until a GET is received, but the GET would cause an interrupted error.
-220	**Parameter error** A program data element related error occurred.
-221	**Settings conflict** A legal program data element was parsed but could not be executed due to the current device state.
-222	**Data out of range** The received data element was syntactically correct but could not be executed because the value was outside the legal range as defined by the device.
-223	**Too much data** A legal program data element of block, expression, or string type was received that contained more data than the device could handle due to memory or related device-specific requirements.
-224	**Illegal parameter value**
-230	**Data corrupt or stale** Possibly invalid data; new reading started but not completed since last access.
-231	**Data questionable** Measurement accuracy is suspect.

Error number	Error query response Explanation
-240	**Hardware error** A legal program command or query could not be executed because of a hardware problem in the device.
-241	**Hardware missing** A legal program command or query could not be executed because of missing device hardware; for example, an option was not installed.
-250	**Mass storage error** A mass storage error occurred.
-251	**Missing mass storage** A legal program command or query could not be executed because of missing mass storage; for example, an option was not installed.
-252	**Missing media** A legal program command or query could not be executed because of a missing media; for example, no disk.
-253	**Corrupt media** A legal program command or query could not be executed because of currupt media; for example, bad disk or wrong format.
-254	**Media full** A legal program command or query could not be executed because the media was full; for example, there is no room on the disk.
-255	**Directory full** A legal program command or query could not be executed because the media directory was full.
-256	**File name not found** A legal program command or query could not be executed because the file name on the device media was not found; for example, an attempt was made to read or copy a nonexistent file.
-257	**File name errror** A legal program command or query could not be executed because the file name on the device media was incorrect; for example, an attempt was made to copy to a duplicate file name.
-258	**Media protected** A legal program command or query could not be executed because the media was protected; for example, the write-protect tab on a disk was present.
-260	**Expression error** An expression program data element related error occurred.
-261	**Math error in expression** A syntactically legal expression program data element could not be executed due to a math error; for example, a divide-by-zero was attempted.

Error number	Error query response Explanation
-270	**Macro error** A macro-related execution error occurred.
-271	**Macro syntax error** A syntactically legal macro program data sequence could not be executed due to a syntax error within the macro definition.
-272	**Macro execution error** A syntactically legal macro program data sequence could not be executed due to some error in the macro definition.
-273	**Illegal macro label** The macro label defined in the *DMC command was a legal string syntax, but could not be accepted by the device; for example, the label was too long, the same as a common command header, or contained invalid header syntax.
-274	**Macro parameter error** The macro definition improperly used a macro parameter placeholder.
-275	**Macro definition too long** A syntactically legal macro program data sequence could not be executed because the string or block contents were too long for the device to handle.
-276	**Macro recursion error** A syntactically legal macro program data sequence could not be executed because the device found it to be recursive.
-277	**Macro redefinition not allowed** A syntactically legal macro label in the *DMC command could not be executed because the macro label was already defined.
-278	**Macro header not found** A syntactically legal macro label in the *GMC query could not be executed because the header was not previously defined.
-280	**Program error** A downloaded program-related execution error occurred..
-281	**Cannot create program** An attempt to create a program was unsuccessful.
-282	**Illegal program name** The name used to reference a program was invalid; for example, redefinig an existing program, deleting a nonexistent program, or in general, referencing a nonexistent program.
-283	**Illegal variable name** An attempt was made to reference a nonexistent variable in a program.
-284	**Program currently running** Certain operations dealing with programs may be illegal while the program is running; for example, deleting a running program might not be possible.
-285	**Program syntax error** Syntax error in a downloaded program.
-286	**Program runtime error**

Device-specific Error — sets bit 3 in the ESR register.

Error number	**Error query response** Explanation
-300	**Device-specific error** Generic device-dependent error for devices that cannot detect more specific errors.
-310	**System error** An error termed "system error" by the device has occurred.
-311	**Memory error** An error was detected in the memory of the device.
-312	**PUD memory lost** The protected user data saved by the *PUD command has been lost.
-313	**Calibration memory lost** Non-volatile calibration data used by the *CAL? command has been lost.
-314	**Save/recall memory lost** Non-volatile calibration data saved by the *SAV command has been lost.
-315	**Configuration memory lost** Non-volatile configuration data saved by the device has been lost.
-330	**Self-test failed**
-350	**Queue overflow** This error code is entered into the queue instead of the code that caused the error. This code indicates that there is no room in the queue and an error occurred but was not recorded. The queue can contain 5 entries.

Query Error — sets bit 2 in the ESR register.

Error number	**Error query response** Explanation
-400	**Query error** Generic device-dependent query error for devices that cannot detect more specific errors.
-410	**Query INTERRUPTED** A condition causing an INTERRUPTED query error occured. Example: The device received data after a query before a response was completely sent.
-420	**Query UNTERMINATED** A condition causing an UNTERMINATED query error occured. Example: The device was addressed to talk and an incomplete program message was received.
-430	**Query DEADLOCKED** A condition causing an DEADLOCKED query error occured. Example: Both input buffer and output buffer are full and the device cannot continue.
-440	**Query UNTERMINATED after indefinite response** A query was received in the same program message after a query requesting an indefinite response was executed.

B.2 UPD-specific Error Messages

Device-dependent Error — sets bit 3 in the ESR register.

Error number	**Error query response** Explanation
301	Error while saving SETUP!
302	Data format offset binary not implemented!
304	Not enough XMM memory for spooler
305	No printer driver for spooler
306	Printer not ready
307	Cannot open arbitrary waveform file! Check file name and directory. Default path and extension = C:\UPD\USER*.AWD
308	ile format error in arbitrary waveform File! (Empty!) Check file name and directory. Default path and extension = C:\UPD\USER*.AWD
309	File format error in arbitrary waveform file! (No header!) Check file name and directory. Default path and extension = C:\UPD\USER*.AWD
317	Error while reading measurement data with hw__query!
319	Cannot load default-ISO C:\UPD\SETUP\DEFAULT.SET!
320	Cannot create file C:\UPD\SETUP\UPD.SET!
321	File C:\UPD\SETUP\UPD.SET does not exist: creating...!
322	Can't find suitable Ref.LP! No filter designed! Possible reasons: - filter specification too hard. - C:\UPD\REF\REF__LP.RLP modified.
323	Cannot find filter coefficient file (e.g. C:\UPD\USER\xxx.COE! No filter designed!
324	Error in file format of filter coefficient file or pole zero file (e.g. C:\UPD\USER\xxx.COE or xxx.ZPZ)! No filter designed!
325	Sample frequency smaller than 30 kHz selected! No filter designed!
326	Error in filter specification: Passband out of frequency measuring range! Choose a faster analyzer!
360	Device error reported from DOS!
361	Write protect on drive x! (x: 0 ≡ A,1 ≡ B,...)
362	Unknown unit on drive x! (x: 0 ≡ A,1 ≡ B,...)
363	Drive x not ready! (x: 0 ≡ A,1 ≡ B,...)

Error number	Error query response Explanation
364	Unknown command on drive x! (x: 0 ≡ A,1 ≡ B,...)
365	Data error (CRC) on drive x! (x: 0 ≡ A,1 ≡ B,...)
366	Bad request on drive x! (x: 0 ≡ A,1 ≡ B,...)
367	Seek error on drive x! (x: 0 ≡ A,1 ≡ B,...)
368	Unknown media type on drive x! (x: 0 ≡ A,1 ≡ B,...)
369	Sector not found on drive x! (x: 0 ≡ A,1 ≡ B,...)
370	Printer out of paper
371	Write fault on drive x! (x: 0 ≡ A,1 ≡ B,...)
372	Read fault on drive x! (x: 0 ≡ A,1 ≡ B,...)
373	General failure on drive x! (x: 0 ≡ A,1 ≡ B,...)
376	Invalid disk change on drive x! (x: 0 ≡ A,1 ≡ B,...)
377	Notch frequency too high
378	Sweep already selected in generator panel (SWEEP CTRL) or analyzer panel (SWEEP CTRL or START COND). Turn OFF active sweep before selecting another!
379	Trace selection in display panel is forced to HOLD!
380	Low distortion generator not installed!
381	Can not track on Analyzer; Function FFT must be selected
382	Cannot open calibration file for generator
383	Cannot open calibration file for LDG
384	Cannot open calibration file for analyzer
385	Function FILT SIM. not yet implemented!
386	Generator function invalid! For FREQ MODE -> GEN TRACK, either SINE, SINE BURST, SINE ≡ BURST or SQUARE must be used, or switch back to FREQ MODE -> FIX!
387	Cannot open file!
388	Generator function invalid! For FREQ MODE -> GEN TRACK, DIM must be used or switch back to FREQ MODE -> FIX!
390	Cannot delete file! File ist write protected!
391	Cannot copy source file to destination!
392	Directory, declared in "Work Dir", does not exist!

Error number	Error query response Explanation
393	Wrong SETUP-Versionsnumber! The current setup will not be changed!
394	Error while reading file!
395	Illegal command while reading file!
396	Cannot open declared SETUP-.File!
397	Error while reading file. It does not contain a valid header!
398	File not compatible with current store mode!
399	DAC Board: Error in board ID.
400	Output Circuit: Error in board ID
401	No analog generator boards detected.
402	ADC-board: Error in board ID.
403	Analog motherboard: Error in board ID.
404	No analog analyzer boards detected.
406	Incompatible IEC version no. x.y! Version no. x.y required!
407	No heap memory left; cannot load file.
408	No heap memory left; cannot store file.
409	Incompatible file format
410	Requested File has no SWEEP trace format. To load this file, please select FUNCTION FFT and OPERATION SPECTRUM
411	Requested File has no FFT trace format. To load this file, please select OPERATION CURVE PLOT
413	Analog notch AUTO mode only valid with frequency measurement active! Please select FREQ or FREQ&PHASE.
414	Cannot open disp. TRACE A file.
415	Cannot open disp. TRACE B file.
416	Cannot open gen. EQUALIZATION file.
417	Cannot open disp. UPPER LIMIT file.
418	Cannot open disp. LOWER LIMIT file.
419	Cannot open gen. sweep FREQ file.

Error number	Error Query Response Explanation
420	Cannot open anlr. sweep FREQ file.
421	Cannot open gen. sweep VOLTAGE file.
422	Cannot open gen. sweep ONTIME file.
423	Cannot open gen. sweep INTERVALL file.
424	Cannot open gen. sweep DWELL file.
425	FFT average is limited to 1 because OVERL/MAX H is selected in DISPLAY panel!
426	Wrong keyword in line x in AES Protocol File.
427	Wrong parameter in line x in AES Protocol File.
428	Missing colon after BIT in line x in AES Protocol File.
429	Too many bits defined for value in line x in AES Protocol File.
430	File too long in line x in AES Protocol File.
431	Line too long in line x in AES Protocol File.
432	X coordinate out of valid range in line x in AES Protocol File.
433	Y coordinate out of valid range in line x in AES Protocol File.
434	Last bit is greater then first bit in line x in AES Protocol File.
435	Parameter RATE is zero in line x in AES Protocol File.
436	Parameter RATE missing in line x in AES Protocol File.
437	Cannot open AES Protocol File! Check filename, directory and Work Dir.
442	Syntax error (wrong keyword) in Generator AES User File
443	Cannot open Generator AES User File.

Error number	**Error Query Response** Explanation
444	Cannot create destination setup file (UPD.???).
445	Cannot open default setup file (DEFAULT.???).
446	Cannot open converter file (*.CNV).
447	Error while reading converter file.
448	Error while reading setup file.
451	Auto conversion failed; please use manual converter.
453	Calibration setup not found, calibration data unchanged.
454	Tolerance file not found or data invalid; calibration data unchanged.
455	Calibration Measurement failed, calibration data unchanged.
456	Calibration data out of tolerance; calibration data unchanged. See file LDG__ER.CAL in directory REF
457	Error in CMOS calibration data; all CF are set to 1.0.
458	Stringlength out of valid range! 0 ... 4 characters allowed.
459	Missing key AES__CHAN__STAT in line x in AES Protocol File.
460	Cannot open AES Panel File! Check filename, directory and Work Dir.
461	Wrong keyword in line x in AES Panel File.
462	Max. count of SELECTION commands exceeded in line x in AES Panel File.
463	Max. count of VALUE commands exceeded in line x in AES Panel File.
464	Max. count of TEXT commands exceeded in line x in AES Panel File.
465	Missing colon after BIT in line x in AES Panel File.
466	Last bit is greater than first bit in line x in AES Panel File.

Error number	**Error query response** Explanation
467	Too many bits defined for value in line x in AES Panel File.
468	Code out of valid range in line x in AES Panel File.
469	MULT factor < 0 in line x in AES Panel File.
470	Sweep already selected in generator panel. Look at SWEEP CTRL. Turn OFF active sweep before selecting another!
471	Sweep already selected in analyzer panel. Look at START COND. Turn OFF active sweep before selecting another!
472	Sweep already selected in analyzer panel. Look at SWEEP CTRL in RMS selectiv function. Turn OFF active sweep before selecting another!
474	Requested File has incompatible X axis. To load this file, please turn OFF active sweep
2000	No DSP Board found! Turn Power off, wait a few seconds, turn power on to retry!
2001	Cannot open file C:\UPD\DSP\GENOUT.OUT! Check installation!
2002	Cannot boot DSP x! Turn Power off, wait a few seconds, turn power on to retry!
2003	Generator DSP not available! Turn Power off, wait a few seconds, turn power on to retry!
2004	Analyzer DSP not available! Turn Power off, wait a few seconds, turn power on to retry!
2006	XMM not found or not enough memory
2007	Error while initialising Filter! Filterror = x. Check installation!
2008	Panel x not defined or cannot open file C:\UPD\SETUP\UPD.SET!
2009	Suspicious value for Ref.TP-Pole! Check installation C:\UPD\REF\REF__LP.RLP!
2010	Suspicious value for Ref.TP-Zero count! Check installation C:\UPD\REF\REF__LP.RLP!

Error number	**Error query response** Explanation
2011	Cannot find file C:\UPD\REF*.BPZ! Check installation!
2012	Cannot find file C:\UPD\REF\REF__LP.RLP! Check installation!
2013	Cannot read file C:\UPD\REF\REF__LP.RLP! Check installation!
2014	Cannot open file C:\UPD\REF*.BPZ! Check installation!
2015	Cannot open file C:\UPD\DSP\AES__OUT! Check installation!
2016	Cannot open file C:\UPD\DSP\ANAIN__OUT! Check installation!
2017	Filter not implemented! Check installation!
2018	Cannot find file C:\UPD\REF*.BPZ! Check installation!
2019	GEN-Digital-Board not installed!
2020	ANL-Digital-Board not installed!
2021	Cannot load DSP overlay (x)! Check installation!
2141	Noname Board (Generator) not present; hardware setting impossible
2144	Noname Board (Analyzer) not present; hardware setting impossible
2280	Insufficient disk space! Cannot write file!
2327	Not enough memory for malloc!
2328	Makefilt not initialised!
2330	Undefined Filter type!
2333	Not enough memory to allocate copy__buffer!
2235	Cannot open destination file!
2236	Cannot open source file!
2272	Source file: Path or file not found!
2273	Source File: Too many open files!

Error number	**Error query response** Explanation
2274	Source File: Permission denied! File is write protected!
2275	Source File: Invalid access code!
2276	Destination file: Path or file not found!
2277	Destination file: Too many open files!
2278	Destination file: Permission denied! File is write protected!
2279	Destination file: Invalid access code!
2332	Cannot make WOW__FL-Filter. Check C:\UPD\REF\REF__LP.RLP!

4 Maintenance and Troubleshooting

4.1 Maintenance

4.1.1 Mechanical Maintenance

- Clean the front panel and keys using a soft, damp cloth soaked with a liquid detergent, if required.
- Cleaning the LC display: do not use any acid solutions or abrasive cleaners (otherwise the anti-reflecting coat is damaged)! We recommend that standard cleaners as are used for optical devices such as glasses, objectives and the like or water mixed with some rinsing liquid be used for cleaning.

4.1.2 Electrical Maintenance

The UPD requires no electrical maintenance.

4.2 Function Test

Upon switch-on of the UPD the following self-tests are performed:

- Self-test on the computer. On the detection of any error the AT warning tone codes (see Table 4-1) will be audible. The system start is aborted, the UPD cannot be operated. With an external keyboard connected, the subsequent memory test can be aborted by pressing the "ESC" key.

Table 4-1 AT warning tone codes

AT warning tone	Meaning
1	DRAM refresh failure
2	parity circuit failure
3	base 64KB RAM failure
4	system timer failure
5	processor failure
6	keyboard controller - gate A20 error
7	virtual mode exception error
8	display memory R/W test failure *)
9	ROM-BIOS checksum failure

*) non-fatal error

- Self-test on all boards of the measurement hardware including all options installed (recognized by the UPD itself). The self-test is carried out while the switch-on picture is being displayed on the screen and also during normal measurement procedures - however to a limited extent. On the detection of an error a message is displayed, which specifies the type of error, the name of the defective board and, if possible, a hint for the user how to eliminate the defect.

4.3 Troubleshooting

Error messages displayed after the self-tests or during a measurement usually contain a hint as to the cause of trouble and its elimination (see Section 2.3.5 Error Messages). If the cause is a defective board, it should be replaced (see 4.4, Replacing the Boards). For more details on the theory of operation of the measurement hardware boards and instructions on further fault locating, please refer to the Service Manual (order designation 1030.7551.24).

Other possible causes of trouble:

Fault symptoms:

- The real-time clock or the data are incorrect upon switch-on of the UPD.

- The UPD does not run up.

Cause:
Lost setup, flat PC lithium battery

The UPD contains a lithium battery for backing up the CMOS memory containing the computer setups when the UPD is switched off. The setups include operating parameters such as disk drives, memory organization etc. which the computer requires during system start. The instrument may fail completely when this setup or parts thereof are missing. Battery life is about 6 years.

Error recovery:
Replace the battery and reset the setup:

Replacing the battery
- Remove the Digital Generator board (designation A12, see identification on rear panel), see Section 4.4 Replacing the Boards.

- Unplug the battery cable from connector J6 (on the main board directly in front of the rear panel at the position of the replaced board).

- Remove the battery (mounted to side panel of the analog power supply unit chamber)
  The following type can be fitted instead:
  * TADIRAN TL-5742/W, lithium 3.4 Volt (R&S order no. 0632.7893.00)

- Fix the new battery using a cable tie and connect it.

- Refit the board, close the instrument.

SETUP Setting (for UPD 1030.7500.02, 80386 CPU)

- Connect external keyboard.
- Turn UPD on, press "DEL" key; when the message "PRESS <DEL> IF YOU WANT TO RUN SETUP/EXTD-SET"is displayed, hold down the key until the selection menu "EXIT FOR BOOT, RUN CMOS SETUP, RUN XMOS SETUP" is displayed.
- Select "RUN CMOS SETUP"using the ↓ key, press ENTER, the menu shown in Fig. 4-1 will be displayed.

Note: *The drive parameters in Fig. 4-1 are valid for 41 MB hard disk; parameters for further hard disks, see the following table 4-1.*

- Change all parameters to the value given in the figure (date and time to the current value, however) using the keys specified in the menu (see last line), exit the menu using ESC and Y (YES).

SETUP Setting (for UPD 1030.7500.04, 80486 CPU)

- Select setup (as with 80386 CPU) and set according to Figures 4-6, 4-7, 4-8.
- Store setup again (as with 80386 CPU)

Note: *Perform the following settings correctly, otherwise the instrument may fail completely! If so, switch the UPD off, press and hold the INS key, turn the UPD on, release the key as soon as the memory test starts. The setup thus assumes its default settings.*

- Select "RUN XMOS SETUP"using the ↓ key, press ENTER, Fig. 4-2 will be displayed, select the first line, a page with hints will be displayed, press ENTER, Fig. 4-3 will be displayed.
- Change all parameters to the value given in the figure using the keys specified in the menu, exit the menu using ESC.
- Proceed with the next two lines of Fig. 4-2 in the same manner, the appertaining parameters being given in Figures 4-4 and 4-5.
- Select the line "WRITE CMOS REGISTERS AND EXIT", press ENTER. The new setup is stored, which is followed by a system start. Now, the operator environment is displayed again on the UPD.

```
        CMOS SETUP (C) Copyright 1985-1990, American Megatrends Inc.,

Date (mn/date/year): Tue, Aug 11 1992   Base memory size   : 640 KB
Time (hour/min/sec): 14 : 44 : 36       Ext. memory size   : 3072 KB
Floppy drive A:    : 1.44 MB, 3½"       Numeric processor  : Not Installed
Floppy drive B:    : Not Installed
                                        Cyln  Head  WPcom  LZone  Sect  Size
Hard disk C: type  : 47 = USER TYPE     980   5     65535  982    17    41 MB
Hard disk D: type  : Not Installed
Primary display    : VGA or EGA
Keyboard           : Not Installed

Scratch RAM option : 1

Month : Jan, Feb,.....Dec
Date  : 01, 02, 03,...31
Year  : 1901, 1902,...2099

ESC = Exit, ↓ → ↑ = Select, PgUp/PgDn = Modify
```

Sun	Mon	Tue	Wed	Thu	Fri	Sat
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

Fig. 4-1

```
EXTENDED CMOS SETUP PROGRAM Ver - 1.51 ,(C)1988, American Megatrends Inc.

              NEAT CHIPSET SETUP PROGRAM
                      MAIN MENU
        ------------------------------------------
           EASY NEAT CHIPSET REGISTER SETUP
         ADVANCED NEAT CHIPSET REGISTER SETUP
       ENABLE/DISABLE VIDEO AND MAIN BIOS SHADOW
            WRITE CMOS REGISTERS AND EXIT
         DO NOT WRITE CMOS REGISTERS AND EXIT
```

Fig. 4-2

```
EXTENDED CMOS SETUP PROGRAM Ver - 1.51 ,(C)1988, American Megatrends Inc.

                   Memory Configuration
Bank      Enabled/Disabled      DRAM Type      Waitstate
----      ----------------      ---------      ---------
0         ENABLED               1MEG           0 WAIT STATE
1         ENABLED               1MEG           0 WAIT STATE
2         DISABLED                             0 WAIT STATE
3         DISABLED                             0 WAIT STATE

                  Clock Sources Selected
Processor Clock        Bus Clock        DMA Clock
---------------        ---------        ---------
CLK2IN                 CLK2IN/2         SCLK

               Shadow RAM/Interleave
BIOS Shadow          Video Shadow             Memory
F0000H,64K     C0000H,16K  C4000H,16K     Interleave
-----------    ----------  ----------     ----------
ENABLED        ENABLED     ENABLED        ENABLED

                                      ZERO WAIT STATE
                                      ONE WAIT STATE
                                      -----------------------
                                      MOVE BAR-<PgUp/PgDn>
                                      CHANGE WINDOWS ↑↓→
                                      EXIT-<ESC>
```

Fig. 4-3

Table 4-1

Drive parameter (to be entered in BIOS)						
Drive	Cyln	Head	WPcom	LZone	Sect	Size
CP 3044	980	5	65535	982	17	41 MB
CP 30104	762	8	0	0	39	116 MB
CP 30254	895	10	0	0	55	240 MB

```
EXTENDED CMOS SETUP PROGRAM Ver - 1.51 ,(C)1988, American Megatrends Inc.

         BITS   7 - 0
82C811   60H -> 00   0 0 R 0 R 0
         61H -> 1 R  00  01  01
         62H -> RR   10  01  00

82C812   64H -> 0     00    RRRRR
         65H -> 0 0 0 0 1 1 1 0
         66H -> 1 0 0       RRRRR
         67H -> 0 0 0 0 0 0 0 0
         68H -> 1 1 1 1 1 1 0 0
         69H -> 0 0 0 0 1 1 1 1
         6AH -> 11  1       RRRRR
         6BH -> 1 0 0 0 0 0  11
         6CH -> 00     0    RRRRR
         6DH -> 0100          0000
         6EH -> 00    00  00  00
         6FH -> 000   0 R  0 0 R

82C206   01H -> 01  00  00  0 1

 Go to Prev/Next Register -↑↓
  Go to  Prev/Next Entry   - →
         Scroll Bit value - PgUp/PgDn
      Return to MAIN MENU - <ESC>

PROCCLK Register RA0
82C811 Revision number
```

Fig. 4-4

```
EXTENDED CMOS SETUP PROGRAM Ver - 1.51 ,(C)1988, American Megatrends Inc.

   SETUP SHADOW RAM FOR 812
 MAIN  BIOS SHADOW AT F0000H,64K ->1
 VIDEO BIOS SHADOW AT C0000H,16K ->1
 VIDEO BIOS SHADOW AT C4000H,16K ->1

 Go to Prev/Next Register -↑↓
  Go to  Prev/Next Entry   - →
         Scroll Bit value - PgUp/PgDn
      Return to MAIN MENU - <ESC>

 MAIN  BIOS SHADOW AT F0000H,64K
   1=SHADOW ENABLE
   0=SHADOW DISABLE
```

Fig. 4-5

BIOS SETUP PROGRAM - STANDARD CMOS SETUP


```
Date (mn/date/year): Wed, Nov 10 1993              Base memory : 640 KB
Time (hour/min/sec): 14 : 52 : 23                  Ext. memory : 3072 KB
                                        Cyln  Head  WPcom LZone Sect  Size
Hard disk C: type   : 47 = USER TYPE    895   10    0     0     55    240 MB
Hard disk D: type   : Not Installed
Floppy drive A:     : 1.44 MB, 3½"
Floppy drive B:     : Not Installed
Primary display     : VGA/PGA/EGA
Keyboard            : Not Installed
```

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	1	2	3	4
5	6	7	8	9	10	11

```
Month : Jan, Feb,.....Dec
Date  : 01, 02, 03,...31
Year  : 1901, 1902,...2099
```

ESC:Exit Select F2/F3:Color PU/PD:Modify

Fig. 4-6

BIOS SETUP PROGRAM - ADVANCED CMOS SETUP


```
Above 1 MB Memory Test      : Disabled
Hard Disk Type 47 RAM Area  : 0:300
System Boot Up Num Lock     : Off
Cache Memory                : Both
Password Checking Option    : Setup
Video   ROM Shadow C000,16K: Enabled
Video   ROM Shadow C400,16K: Enabled
System  ROM Shadow F000,64K: Enabled
```

ESC:Exit Sel (Ctrl)Pu/Pd:Modify F1:Help F2/F3:Color
F5:Old Values F6:BIOS Setup Defaults F7:Power-On Defaults

Fig. 4-7

```
                BIOS SETUP PROGRAM - ADVANCED CHIPSET SETUP
           (C)1991 American Megatrends Inc., All Rights Reserved

Auto-Configuration          : Enabled     Non-Cacheable Block-2 Base : 0KB
DMA Address/Data Hold Time  : 1-2 T       Local Bus Ready# Delay     : Disabled
AT BUS Clock Select         : CPUCLK/6
I/O Recovery Time Delay     : 8BCLK
Cache Read Hit Burst        : 2-1-1-1
Cache Write Hit Wait State  : 1WS
DRAM Read Wait State        : 1WS
DRAM Write Wait State       : 1WS
Memory Remapping            : Enabled
Memory above 16MB Cacheable: No
C0000-C3FFF,16K  Cacheable : No
C4000-C7FFF,16K  Cacheable : No
F0000-FFFFF,64K  Cacheable : No
Non-Cacheable Block1 Enable: Disabled
Non-Cacheable Block-1 Size : 1MB
Non-Cacheable Block-1 Base : 0KB
Non-Cacheable Block2 Enable: Disabled
Non-Cacheable Block-2 Size : 16MB

   ESC:Exit  Sel  (Ctrl)Pu/Pd:Modify  F1:Help  F2/F3:Color
   F5:Old Values  F6:BIOS Setup Defaults  F7:Power-On Defaults
```

Fig. 4-8

Fault symptom:

- After switch-on, the UPD is not in the same state as it was before switch-off. The last entries have been omitted.

- The following error message is displayed:

  "CMOS CHECKSUM ERROR. CHECK BATTERY"

Cause:
Flat lithium battery of measurement hardware

The UPD contains a CMOS memory where all settings of all active panels and the data of the measurement traces are stored. The settings of the other panels and the previous states of the active panels are additionally stored to the hard disk, ensuring that these data will be available when the battery fails. A lithium battery is used for backing up the CMOS memory when the instrument is switched off. Battery life is approximately 10 years.

Error recovery:
- Withdraw the Digital Generator board (designation A12, see identification on rear panel), see Section 4.4, Replacing the Boards).
- Solder out the flat battery.

  The following battery types can be fitted instead:
  * Saft LS3 CNA, lithium 3.4 V, 1 AH (R&S order no. 0565.1687.00)
  * Electroche QFC85 1/2 AM 3B960-AX

- Fit the new battery by way of soldering, check for correct polarity (see battery labellings), fix the battery using a cable tie.

- Refit the board, close the instrument.

- Turn the UPD on. It automatically loads the complete setup most recently stored to the hard disk (see above).

Fault symptom:

- The UPD does not respond in a sensible way or not at all on key depressions or IEC bus commands.

Cause:
The combination of previous settings resulted in an inadvertent program run causing the software to "crash".

Error recovery:
Restart the UPD!

Depending on the desired instrument setup take the following steps:

Restart the UPD with the instrument setup most recently stored in the CMOS-RAM.
This setup may be correct despite the faulty response of the UPD. To avoid having to enter again the settings most recently made, have a try at starting the UPD with this setup.

- Turn power switch off and on. (No further action possible).

In case the procedure stated above fails, restart the UPD with its default setup.

- Connect external keyboard (see 2.16 Connecting External Devices).
- Turn power switch off and on.
- When the UPD switch-on logo is displayed, abort the UPD program by pressing ESC and enter the DOS operating system level, where you can restart the UPD with its default setting by entering the command

UPD -d -c <ENTER or ↵ >

-d: The setup "DEFAULT.SET" in the "c:\upd\setup" directory supplied together with the UPD is loaded.

LOAD INSTRUMENT STATE in the FILE panel allows the loading of a setup which was stored by the user (see 2.9.1.1).

4.4 Replacing the Boards

Important!
All boards are sensitive to electrostatic charge. Handle them in line with the ESD-regulations!

The following applies to the replacement of all boards:

- Disconnect the power connector the from UPD.
- Unscrew the feet from instrument rear (four Phillipps screws).
- Slide the upper panelling slightly to the rear and withdraw.
- After having fitted the new board remount all covers, brackets and clamps in reverse order to that of removal. Fit the panelling and the instrument feet.
- Turn the UPD on.

4.4.1 Plug-in Cards of AT Computer Board

Applies to the following boards:

Digital Generator		1030.8706.02
Digital Analyzer		1030.8506.02
AES/EBU-S/P DIF Option	(UPD-B2)	1030.2001.02
Highspeed Option	(UPD-B3)	1030.2301.02
IEC 625/IEEE 488 Option	(UPD-B4)	1030.2901.02

- Remove the clamp from the board to be replaced.
- Remove the appertaining bracket (2 screws on instrument rear) and withdraw the rear-panel section.
- Disconnect all cables of this board or led via this board.
- Withdraw the old board, fit the new board at the same position.
- Reconnect all cables which have been removed.

A label with the designations of the board (eg A12) and of the connector is adhered to each cable connector. The board designation is on the instrument frame, the connector designation on the board.
To provide for proper laying of the cables insert the cables in the following order (slots are counted from left to right, when seen from the front):

Cable	Plug-in card	Connector
W35	A15 (into slot no. 8)	X30 (first from rear)
W31	A11 (into slot no. 7)	X30 (first from rear)
W32	A12 (into slot no. 6)	X30 (second from rear)
W93	A12 (into slot no. 6)	X90 (first from rear)
Jumper W71	A11 (into slot no. 7)	X71 (second from rear)
Jumper W71	A15 (into slot no. 8)	X71 (second from rear)

4.4.2 Analog Generator

The analog generator consists of the following boards:

DAC BOARD	1030.9460.02
OUTPUT CIRCUIT	1030.9290.02
LOW DIST GEN (UPD-B1 option)	1031.2601.02

These boards are located behind the output connectors in the analog unit of the UPD and are inserted into the analog motherboard.

- Remove the cover plate from the analog unit (to the right, when seen from the front).

Caution:
None of the three boards of the analog generator can be replaced independently of the other boards without any adjustment or calibration required. Frequency response and DC offset is to be adjusted, level accuracy and DC offset to be calibrated.

For adjustment and calibration of the analog generator, refer to the Service Manual (R&S order no. 1030.7551.24).

4.4.2.1 Replacing the DAC BOARD

- Remove the cover plate from the analog unit (to the right, when seen from the front).
- Unscrew the board holding device from the center panel.
- Tilt the lever to the top and withdraw the board.
- Insert the new board.
- Turn the UPD on.

Adjustment and calibration:
Generators ANLG 25kHz and ANLG 110kHz:
Adjust frequency response and DC offset. Calibrate level accuracy and DC offset. For adjustment and calibration of the DAC board refer to the Service Manual (R&S order no. 1030.7551.24).

4.4.2.2 Replacing the LOW DISTORTION GENERATOR (UPD-B1 Option)

- Remove the cover plate from the analog unit (to the right when seen from the front).
- Unscrew the board holding device from the center panel.
- Tilt the lever to the top and withdraw the board.
- Insert the new board.
- Turn the UPD on.

Adjustment and calibration:
See Section 1.2.1 Fitting the LOW-DISTORTION GENERATOR Option (UPD-B1)

No external measuring equipment is required for this purpose. However, be sure the other two boards of the analog generator and of the analog analyzer have been adjusted and calibrated, too.

4.4.2.3 Replacing the OUTPUT CIRCUIT

- Remove the cover plate from the analog unit (to the right when seen from the front).
- Tilt both levers to the top and withdraw the board.
- Insert the new board.

Adjustment and calibration:
The OUTPUT CIRCUIT board influences the signals of the other two boards.

Therefore, after replacement
- first adjust and calibrate the DAC BOARD and
- then adjust and calibrate the LOW DISTORTION GENERATOR.

Stick to the above order!

4.4.3 Analog Analyzer

The analog analyzer consists of the following boards:

Channel 1		
ANALOG ANALYZER	1030.9102.02	
ADC BOARD	1030.9260.02	
Channel 2		
ANALOG ANALYZER	1030.9102.02	
ADC-BOARD	1030.9260.02	(Part of UPD-B3 option)

The boards of the analog analyzer are located behind the input female connectors in the analog unit of the UPD and inserted in the analog motherboard.

With the UPD-B3 option fitted, the ADC BOARD is included in each of the ANALOG ANALYZERs.

4.4.3.1 Replacing the ANALOG ANALYZER CH1 or CH2

- Remove the upper panelling and shielding cover (to the right when seen from the front).
- Withdraw the Analog Analyzer CH1 or CH2 board using the levers and remove the coaxial connectors from the bottom.
- Complete the new analog analyzer with the ADC BOARD, if required (see 4.4.3.2) and fit into the instrument.
- Start up the UPD.

Adjustment and calibration:
Proceed in line with Service Manual, R&S order no. 1030.7551.24

4.4.3.2 Replacing the ADC BOARD

- Remove the ANALOG ANALYZER.
- Withdraw the smaller one of the two shielding covers on component side.
- Unscrew the two screws on rear side.
- Withdraw the ADC board to the top holding it as straight as possible in order to avoid bending the connector pins.
- Insert the new board.

Adjustment and calibration:
Proceed in line with Service Manual, R&S order no. 1030.7551.24.
When retrofitting the ADC BOARD into the ANALOG ANALYZER CH2 to complete the UPD-B3 option, calibration and adjustment can be performed in line with Section 1.2.1, Fitting the Options without any further measuring equipment being required. Be sure the other boards of the analog analyzer have already been adjusted and calibrated.