2.3 General Instructions for Use

The UPL is very easy to operate, especially when you observe the following recommendations:

- **First select the instrument (both generator and analyzer)**

  Reason: An individual set of parameters is provided for each instrument. This parameter set is saved when changing the instrument and restored when returning to the instrument. It must be loaded first before beginning to make new entries. When changing an instrument, the current choice of functions may change also (e.g., analog instruments do not offer selection of the sampling rate..).

- **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 UPL (see Section 1.1.7 Connecting a Mouse), 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. 2-6, 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. 2-6 b).
- change the panel by clicking the panel heading using the left mouse key (cf. Fig. 2-6 d).

- entry of file names, comments etc. is easier than via the front-panel keypad. If no external keyboard is connected, a "screen keyboard" is displayed. Its keys can be actuated by selecting them using the mouse.

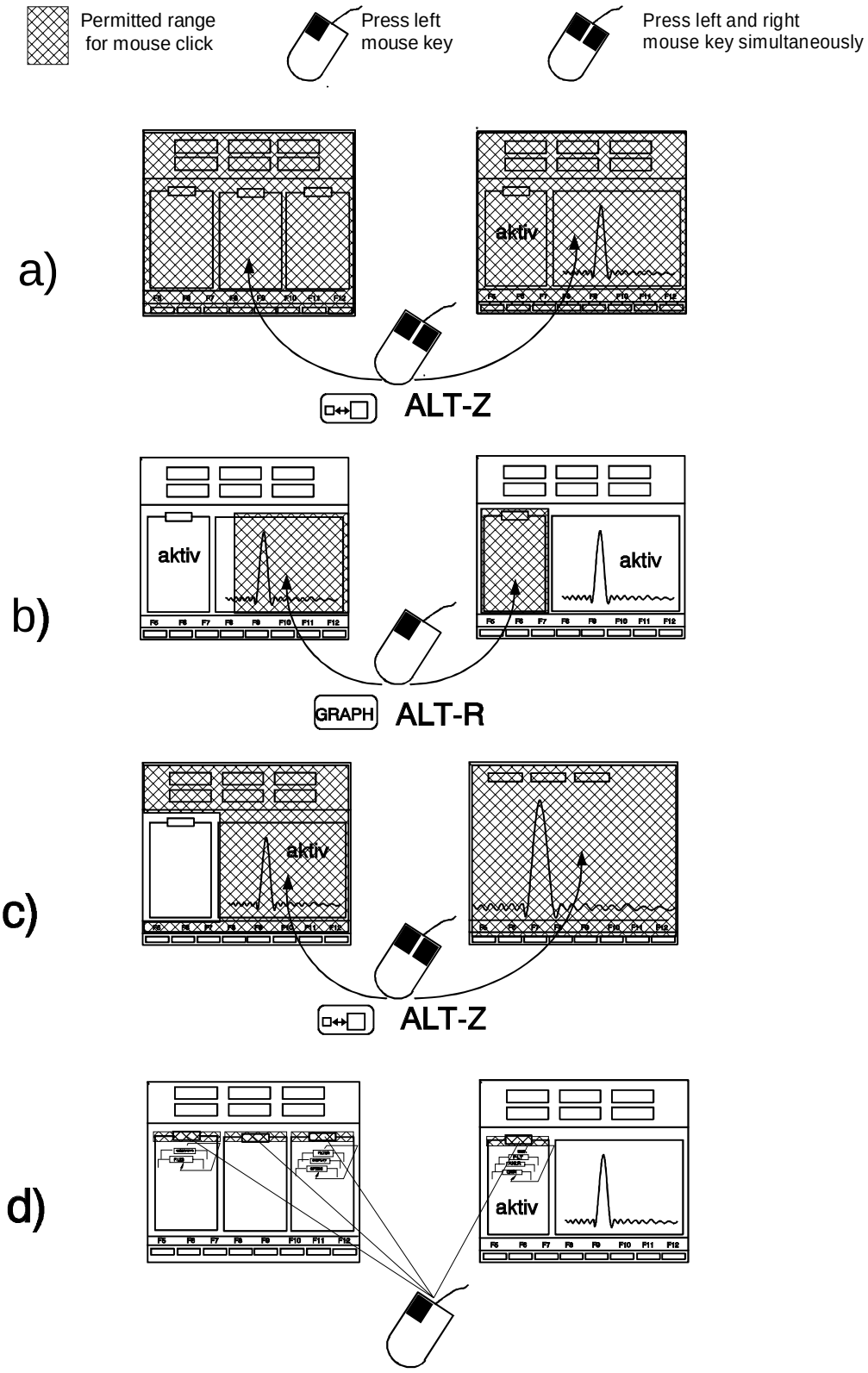

Permitted range
for mouse click
Press left
mouse key
Press left and right
mouse key simultaneously
a)
aktiv
ALT-Z
b)
aktiv
aktiv
GRAPH
ALT-R
c)
aktiv
ALT-Z
d)
aktiv

Fig. 2-6

2.3.1 Panels

Related settings and functions are always combined to form a so-called panel in the UPL. 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, i.e. 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) (see table 2-1).

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.

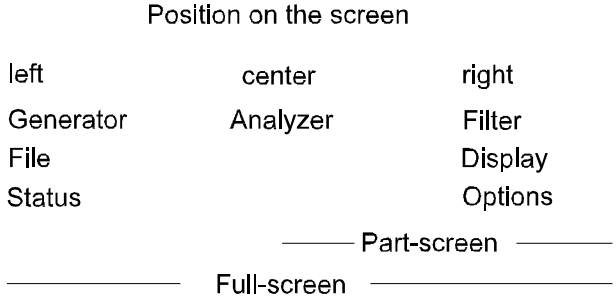
The keys on the front-panel keypad named DATA/PANEL are assigned two functions. The first is the fast selection of the panels (see Table 2-1), the second function is that of a input block for numbers. Switchover from first to second function and vice versa is made automatically. If the UPL expects the 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	Settings for printer/plotter, ext. keyboard, ext. monitor, information on options fitted, calling of calibration routines
Graphics	GRAPH	Alt-R	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 or to the HELP menu under UPL (HELP key or F1 of the external keyboard).*

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



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 UPL 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 UPL has three analyzers (one in each of the measurement ranges 22 kHz and 110 kHz for the measurement on analog interfaces, three for the measurement on digital audio interfaces). 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 (e.g., of the analyzer for analog interfaces and the frequency range up to 22 kHz), the settings of the other instruments (e.g.. of the analyzer for the digital interfaces) are suppressed, however retained in the background. This ensures fast and convenient operation of the UPL 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 in the analyzer ”ANLG 22 kHz”, however it is feasible in the analyzer ”DIGITAL”.
- 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 110 kHz.

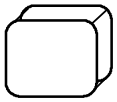
Parameter Link

It may sometimes be required with changing the instrument that the set of parameters which had been set last time is not set, but that the one of the currently used instrument is set instead. This is, e.g., the case when checking converters, if the same measurements are to be performed at the digital interfaces as have been performed at the analog interfaces. The option panel allows for selection, if any parameters of the current instrument are to be set and which ones, i.e., which are not to be overwritten by the loaded data set (see 2.15.8 Parameter Link). If this so-called parameter link is activated, a query box is displayed with changing the instrument where the user can select once again, whether the parameter link is to be carried out or not.

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

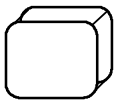


press

(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



press

(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 (e.g. 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:
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.*

Parameter Link

It may sometimes be required with changing a function that the set of parameters which had been set last time is not set, but that the one of the currently used function is set instead. This parameter link can be selected in the option panel (see 2.15.8 Parameter Link). If this so-called parameter link is activated, a query box is displayed with changing the function where the user can select once again, whether the parameter link is to be carried out or not.

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 gray 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 to open a selection window containing all parameters appertaining to this menu item. The 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 Numeric Data

Entry using the rotary knob

- Place the cursor on the desired input field using the rotary knob or the cursor keys ↓ or ↑
- press ENTER or move the numerical cursor (= underscore) to the position to be incremented or decremented.
- the color of the current field changes and the rotary knob can be used to scroll the figure.

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

After having left the field by one of the keys ↓ , ↑ , PgUp, PgDn, TAB, SHIFT TAB or CANCEL the rotary knob is used to move the cursor up and down the panel.

Sweep parameters (e.g. generator frequency or level) may be incremented or decremented by a user-defined value which is set by specifying the step width of the manual sweep.

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 or a number key on the external keyboard 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 pressing of the key 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 ← 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 labeling
- by mouse click.

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 or 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, i.e. 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.

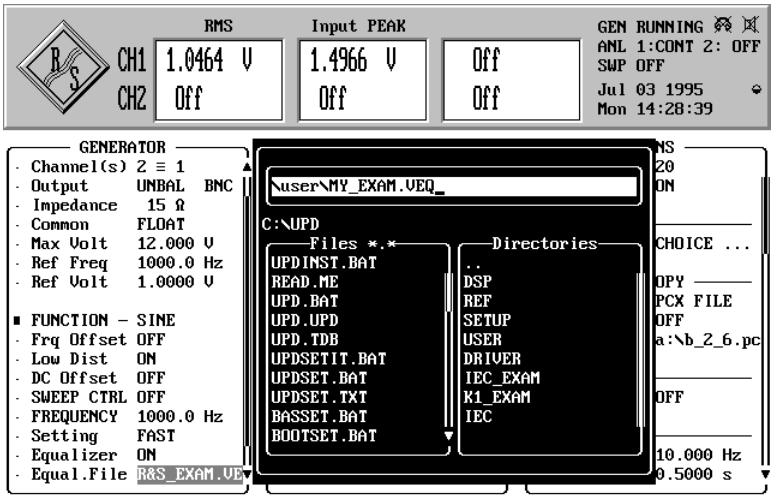


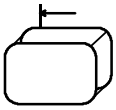
Fig. 2-7

- 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 (e.g. limit file, sweep list file etc.) to facilitate file management. For a list of all types and their meanings, 2.9.1 Loading and Storing).

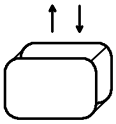
- The ”Directories” window allows the user to change the directory. It contains the subdirectories (if any) of the current path. The directory name ”...” represents the higher-order directory with respect to the current directory.

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

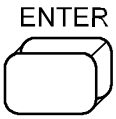
Selecting an already available file



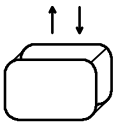
Change to the Directories window using the tab key in the open dialog window.



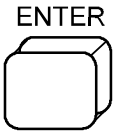
Select the desired directory. Scrolling is possible as in a panel, also with the help of Page ¬ (see Section 2.3.1 Panels)



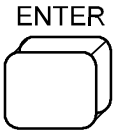
The newly selected, current path is displayed, the window contents are UPLated, *.xxx is entered as file name, where xxx stands for the type of file provided as standard for the selected menu item.



Change to the Files window and select the desired file.

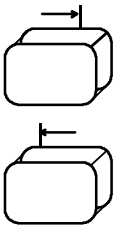


The selected file name is taken over into the input window where it can still be modified (see below ”Entering a new file name”). Entering an already available file name is to be preferred, in particular when no keyboard is used as entering a completely new name is then time-consuming.



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:

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

For entries without using an external keyboard, place the input cursor (" /\" character) on the position there 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 position 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 UPL checks whether an external keyboard is connected. (Being not initialized when connected after power-up of the UPL, the key-board 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, e.g. *.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.

Using the 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 (e.g. C:\PROJECT1) precedes all file names used in the UPL at the time of loading or storing, provided they do not begin with ”\” or ”Drive:\”.

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

2.3.2.6 Data Input or Output during Measurements

Internal or external sweep switched off

(**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 (e.g. continuous FFT, bargraph, histogram of intermodulation measurement), the graphics output is interrupted 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 (i.e. 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

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/Plotting/Storing the Screen Contents (OPTIONS Panel)). 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, modifications 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 of Measurements or Sweeps*

2.3.3 Display of Measured Values

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 2.3.5 Status Display.

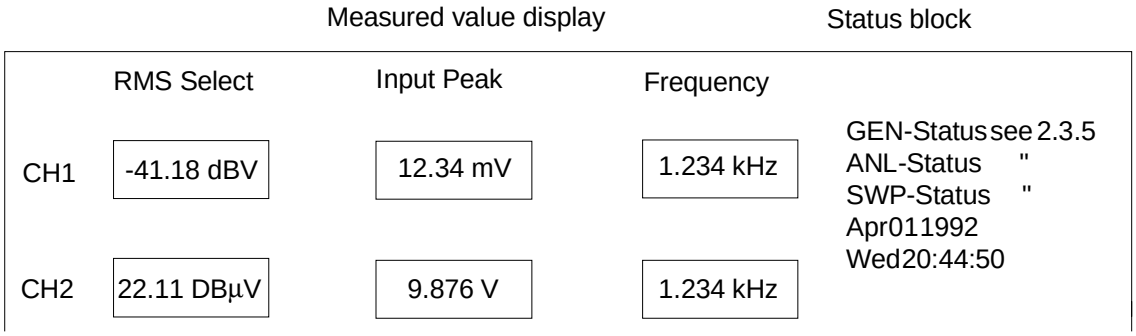


Fig. 2-8

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

2nd column: Measurement results of the measuring function selected in menu item „Input Disp“ (in the example, 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	The measurement results are shown in 3 ½-, 4 ½- or 5 ½-digit display i.e. 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 number of digits and the rate of updating the displayed measurement results can be selected in the option panel - depending on the measurement function (see 2.6.5 Functions). Independent of this reading rate, the measurement rate can be selected for the individual functions (see 2.6.5 Functions). Only the function influences the measurement accuracy. With fluctuating measurement results it is advisable to reduce the number of digits to be displayed (reading resolution) in order to obtain a steady display. The measurement results can be displayed with various units individually for each channel. The unit is selected in the analyzer panel with the measurement function.
OFF	The measurement channel or function is OFF, for example, Input Peak = OFF
– – – –	There is no measurement result related to the selected function available, e.g., 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 2.6.3).

2.3.4 Settling Process

2.3.4.1 Introduction

Why settling is necessary:

If a modification is made at the generator of the UPL 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 Ways of Starting the Analyzer, Ext. Sweep). Settling processes within the UPL 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 UPL 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 UPL 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 UPL 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”.

2.3.4.2 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:

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. 2-9).

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. 2-9).

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 UPL 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).

Samples:

This value indicates the number of measured values used for tolerance and resolution comparison. Samples = 6 means that the latest measured value is compared with the 5 last measured values.

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 UPL. The value of the maximally permissible deviation of the current measured value compared to the 2nd/3rd/4th and 5th last measured value is determined by the EXPONENTIAL | FLAT setting.

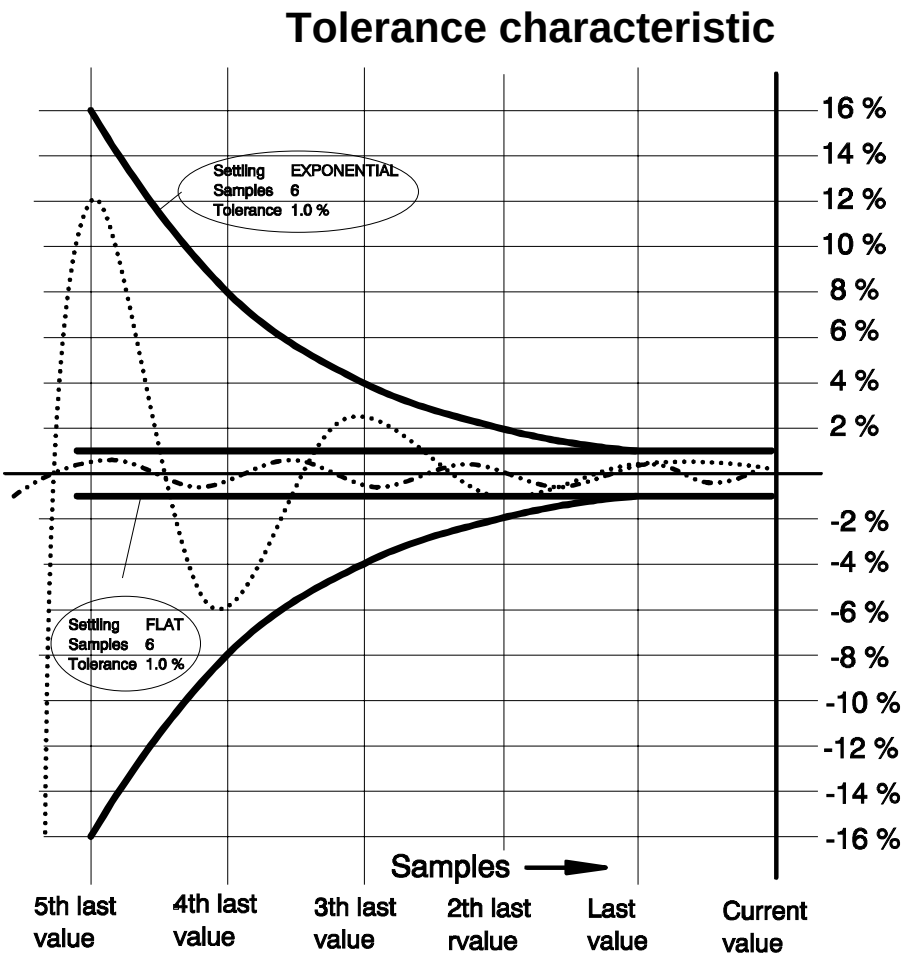


Fig. 2-9 Tolerance characteristic

When the measured values are checked as to whether they satisfy the tolerance condition,

- volt is always used as a basis for the measurement result for level measurements RMS & S/N, RMS SELECT, PEAK & S/N, Q PK & S/N and DC,
- % is used as a basis for the measurement result for intermodulation measurements THD, THD+N/SINAD MOD DIST, DFD and WOW & FL, and
- Hz is used as a basis for the measurement result for frequency measurements, irrespective of the unit in which the measurement result is displayed.
  For a phase measurement, it is only possible to set the resolution (see resolution).

Examples:

In the following examples, Settling → EXPONENTIAL and samples = 6. If the tolerance is 1%, this means that the current measured value must be identical to

- the last measured value ±1% (or ±0.086 dB)
- the 2nd to the last measured value ±2% (or ±0.172 dB)
- the 3rdto the last measured value ±4% (or ±0.340 dB)
- the 4th to the last measured value ±8% (or ±0.668 dB)
- the 5th to the last measured value ±16% (or ±1.289 dB).

Level measurement, tolerance 1 %:

A measured value of 1 V is displayed as settled, when

- the	last measured value is between	0.99 and 1.01 V (±1%)
- the 2nd	to the last measured value is between	0.98 and 1.02 V (±2%)
- the 3rd	to the last measured value is between	0.96 and 1.04 V (±4%)
- the 4th	to the last measured value is between	0.92 and 1.08 V (±8%)
- the 5th	to the last measured value is between	0.84 and 1.16 V (±16%)

Intermodulation measurement, tolerance 1%:
A measured value of 0.01 % is displayed as settled, when

- the	last measured value is between	0.0099 and 0.0101 % (±1%)
- the 2nd	to the last measured value is between	0.0098 and 0.0102 % (±2%)
- the 3rd	to the last measured value is between	0.0096 and 0.0104 % (±4%)
- the 4th	to the last measured value is between	0.0092 and 0.0108 % (±8%)
- the 5th	to the last measured value is between	0.0084 and 0.0116 % (±16%)

Intermodulation measurement, tolerance 0.1 dB (1.16 %):
A measured value of -80 dB (0.01%) is displayed as settled, when

- the	last measured value is between	-80.1 and -79.9 dB (±1.16%)
- the 2nd	to the last measured value is between	-80.2 and -79.8 dB (±2.32%)
- the 3rd	to the last measured value is between	-80.4 and -79.6 dB (±4.63%)
- the 4th	to the last measured value is between	-80.8 and -79.2 dB (±9.26%)
- the 5th	to the last measured value is between	-81.7 and -78.5 dB (±18.53%)

Frequency measurement, tolerance 1 %:
A measured value of 1000 Hz is displayed as settled, when

- the	last measured value is between	990 and 1010 Hz (±1%)
- the 2nd	to the last measured value is between	980 and 1020 Hz (±2%)
- the 3rd	to the last measured value is between	960 and 1040 Hz (±4%)
- the 4th	to the last measured value is between	920 and 1080 Hz (±8%)
- the 5th	to the last measured value is between	840 and 1160 Hz (±16%)

Resolution:

With very small measured values, especially at the lower measurement limit of the UPL, or in the case of signals with superimposed noise, relatively large measuring errors may occur 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 (see fig. 2-10).

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 smaller than the resolution value, the measurement result is considered to be valid.

The accuracy of the phase measurement results is the same throughout the entire range from 0 to 360°. Observing the tolerance for phase measurement results would not be very useful, because the slightest phase fluctuations about 0° would cause large tolerance jumps and thus continuously violate the tolerance conditions. Therefore, only specification of the resolution is possible for the phase measurement, i.e. the absolute offset of the current phase measurement result compared to the previous phase measurement results in ·°.

Example:
Phase measurement with resolution 1°·:
A phase result is indicated to be valid if the magnitude of the difference between the current measured value and
- the last measured value < = 1°
- the 2nd last measured value < = 2°
- the 3rd last measured value < = 4°
- the 4th last measured value < = 8°
- the 5th last measured value < = 16°

Example by means of the following panel setting:

Settling	EXPONENTIAL
Samples	5
Tolerance	1.0 %
Resolution	0.5 mV

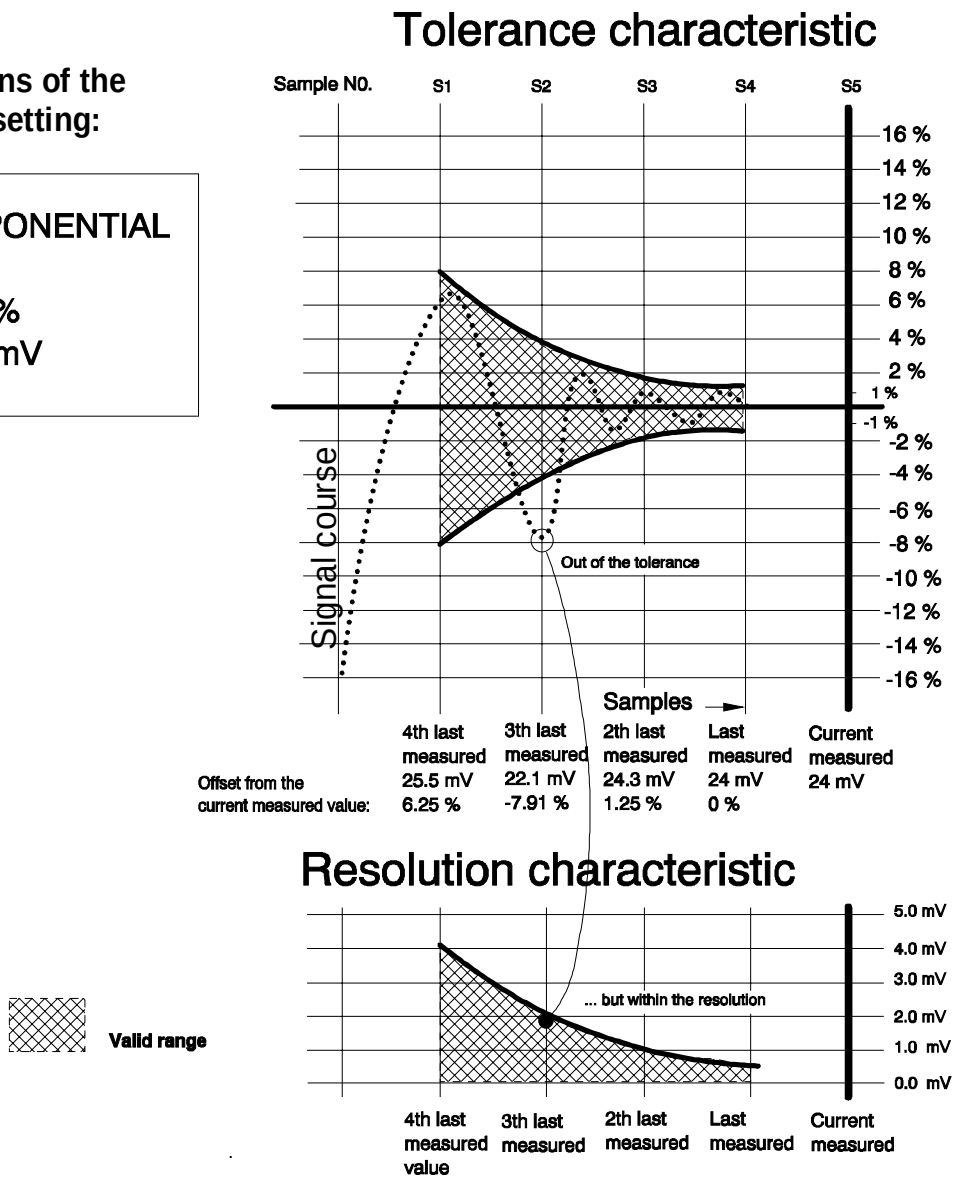


Fig. 2-10 Connection between tolerance and resolution

The EXPONENTIAL traces 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 trace, 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.

Time-out:

Time-out 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 in the curve trace indicates that a measured value is missing. In the case of settling with an external sweep (cf. next paragraph) a time-out is not considered.

2.3.4.3 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 (see fig. 2-11):

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, or
   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.

External sweep with settling process example:

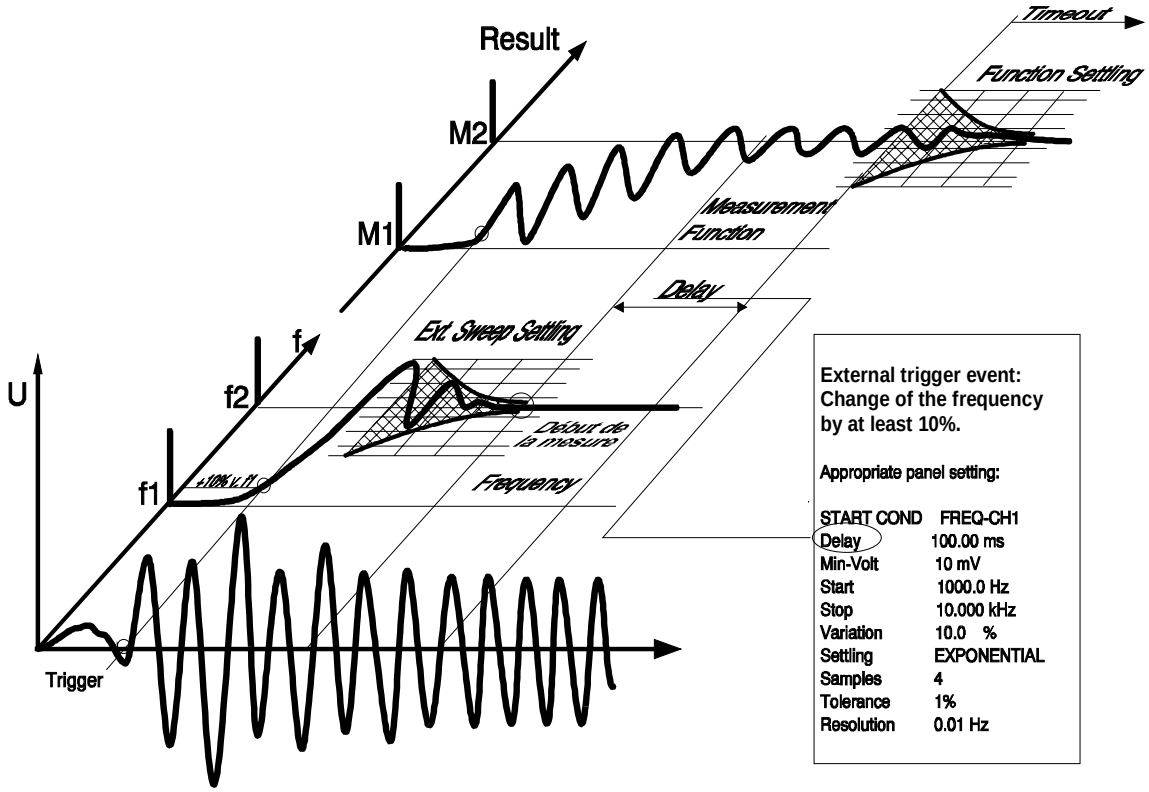


Fig. 2-11 External sweep with settling process

2.3.4.4 SETTLING Check and Optimization

Settling check

If the SHOW I/O key is pressed during a fault-free measurement run with activated settling process, the settling control characters "r", "t" or "-" appear in a suggested result window or after the text "Ext. Sweep", indicating whether the result display or the trigger event were possible because of a fulfilled tolerance or resolution condition. According to this display, the tolerance or resolution value can be varied until the desired transient response is achieved.

Example of an indication in SHOW I/O display:

	Func		Freq
CH1	rtttr		rrt
CH2	ttttr		ttt

Ext. Sweep: trt

Explanation:

"**t**": tolerance condition fulfilled
e.g., “t“ at the third position: tolerance condition of the current measurement result compared to the 3rd last measurement result was fulfilled.
"**r**": resolution condition fulfilled, only
e.g., “r“ at the fifth position: the tolerance condition of the current measurement result compared to the 5th last measurement result was

n o t fulfilled, the resolution condition was fulfilled instead.

Exception:
Since no tolerance condition can be specified for the phase measurement, a settled phase measurement result is always characterized by "r".

"**-----**": No settled measurement result.
Remedy:
- Increase tolerance and resolution value
- Reduce the number of samples
- Switch from FLAT to EXPONENTIAL.

"rrrrr" The measurement result is too unsteady or noisy for the selected tolerance condition.
Remedy:
Select greater tolerance value.
If a still smaller resolution value was selected, "-----" would be displayed.

"rttrt" The measurement result is still too unsteady or noisy for the selected tolerance value.
Remedy:
The more unsteady this display, the greater the tolerance value to be selected.

"ttttt" The measurement results lie all inside the specified tolerance range.
The tolerance condition can be tightened by using a smaller tolerance value or the setting Settling → FLAT until an "r" appears sporadically.

Note: *If varying or fluctuating measurement results are to be observed although the tolerance condition is fulfilled, this may be due to the following reasons:*
- Slowly rising or falling measured values (compared to the measurement rate)
- Sudden, but rare variation of the measured values compared to the measurement rate.

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) in order to take into account possible dead times of a test item. The UPL 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 UPL can be used for individual measurements, the suitable settling parameters can be easily determined by observing the measurement results and by trying.

Delay value if the UPL generator is used

Measurement of the DUT delay using the time-controlled measurement functions Timetick or Timechart (START COND → TIME TICK or TIME CHART, cf. 2.6.4 Ways of Starting the Analyzer, Ext. Sweep) and graphical display. After a generator modification, determine the time until the sudden signal change.

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.

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).

Resolution value
Observe value displayed. The resolution value should always remain near the UPL 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.*

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

Note*:* *For explanation of how to enter settling commands see 2.6.5.1 Common Parameters of Analyzer Functions.*

2.3.5 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: • Set a lower external sample rate. Recall the function.

Status display ANL Status

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

ANL1: 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 Configuration of the Analog Analyzers) • a signal with a level featuring a crest factor > 2 is applied to the range limit • 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 Configuration of the Analog Analyzers)
RANG:	Ranging. No measurements possible!
SNGL:	Single measurement running
CONT:	Continuous measurement running
TERM:	Single measurement terminated
STOP:	Measurement stopped
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: • Set a lower external sample rate Recall the function.

(SNGL, CONT, TERM, STOP: see 2.11 Starting and Stopping Measurements or Sweeps)

Status display SWP Status after modifications to the settings

SWP OFF:	No sweep	see 2.11 Starting and Stopping of Measurements or Sweeps
SWP INVALID:	Sweep invalid because not yet started or parameter varied	
SWP TERMINATED:	Single sweep terminated	
SWP STOPPED:	Sweep was stopped and can be continued	
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 UPL recognizes that no printer is connected.
- The connection to the printer has been interrupted while files or lists (see 2.14.1 and 2.14.5) are being printed.

CONVERTING SETUP — The setup of a previous UPL program version is being converted to be loadable by the latest UPL 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 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 UPL is not possible.

2.3.6 Error Messages

Each error message in manual mode is displayed in a window in the center of the screen until it is confirmed by the user. This can be done in three different ways:

1. By pressing the ENTER key of the UPL keyboard. This is recommended if the entry causing the error message was made via the UPL keyboard.
2. By operating the rollkey of the UPL. This is recommended if the entry causing the error message was also made via the rollkey. It is therefore not necessary to press the ENTER key while using the rollkey.
3. By pressing the RETURN key of the external keyboard connected. This is recommended if the entry causing the error message was made via the external keyboard.

The error message contains information about troubleshooting, 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 UPL 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 UPL 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 UPL 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:\UPL\SETUP\UPL.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 UPL to the hard disk under the name C:\UPL\SETUP\UPL.SET.

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

To this end, connect a keyboard to the UPL (see 1.1.6 Connecting an External Keyboard), insert a 3½"-disk into the disk drive and enter the DOS command:

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

When the UPL 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 UPL with its default setting
- ENTER: ... booting the UPL with the previous setting which might be faulty.

Fatal errors without error message

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

Booting the UPL with the setup most recently stored in the CMOS-RAM

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

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

In case the above attempt fails,

boot the UPL

Enter the following and terminate with ENTER:

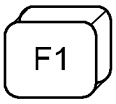
UPL -d	The setup ”DEFAULT.SET” supplied with the UPL in the directory C:\UPL\SETUP is loaded.
UPL -s	The UPL is started with the setup given without space character following "-s". The file name should be combined with a path name, e.g.: -sA:\SETUP\MYSETUP.SET ODER -sC:\UPL\USER\MYSETUP.SET (The file names are given by way of example.)

2.3.7 Help Function

Calling the HELP function:



UPL 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 cross-references for a more detailed description. Cross-reference 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.

Selection of the language

The help text can either be displayed in German or English language. The languages can be selected in the OPTION panel under the menu item Language (cf. 2.15.4)

Help information on the graphics softkeys:

By calling the help function with active part or full display, the user obtains the help information on the graphics softkeys.

2.3.8 Simplification of Panels

The UPL and UPD menu lines are arranged in the same way in all the panels. This means the UPL or UPD user works in a familiar environment with any unit and in any setup.

However, this also has the effect that some menu lines – which are important for certain applications – are located down at the bottom outside the visible window. Vice versa, menu lines that may not be needed for the application on hand are located further up, taking up all the space in the visible range.

For this reason, the panels for particular UPL/UPD applications can be simplified by clearing the visible range from menu lines that are momentarily not required. Every panel can be modified such that the 18 most important menu lines are arranged in the upper range which is visible in the panel window.

When a menu line is eliminated, a new section labelled "Hidden Commands" appears at the end of the panel, which now contains the eliminated menu line. If several menu lines are eliminated, they will be arranged in this section in the same order as in the upper range of the panel. Of course, the hidden menu lines can still be used and may also be restored to their original positions whenever desired.

Each menu line can be hidden and restored via the associated check box.

Action	Key on UPL keyboard	Key on external keyboard	UPL response
Hiding	BACKSPACE	BACKSPACE or DEL	Menu line is moved to "Hidden Commands" section
Restoring	BACKSPACE	BACKSPACE or INS	Menu line is moved back to original position

Note: *If all menu lines of a panel have been restored, the empty "Hidden Commands" section will disappear.*

If an external keyboard is connected, the "Hidden Commands" sections of the panels can be temporarily "hidden" by pressing CTRL H. This is not stored in the device setup, ie when the unit is started anew, the "Hidden Commands" are again visible. While the unit is on, the "Hidden Commands" are made visible again by pressing CTRL H a second time.

Note: *The status panel does not contain a "Hidden Commands" section. By pressing the BACKSPACE key, the menu lines in the original panel are hidden or restored. The status panel is reduced by switching off the tick for the menu lines that are currently not needed.*

2.4 Units

There are two types of units available in the UPL:

- Units for the display 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). The unit is selected under the menu item “UNIT“ of the respective measurement function subsequent to opening the window.
- Units for the input of values (e.g. reference values, frequencies, level etc.). While data are entered, all appropriate units are offered on the softkeys thus enabling termination of the value entry by selection of the unit. Opening of the selection window is not required (cf. 2.3.2.2 Entry of Numerical Data).

2.4.1 Units for the Display of Measurement Results

To simplify the matter

- the data to be entered are designated in the conversion formulae below with their unit, only.
  Example: "dBu" means: value in dBu.
- the conversions into µ, m, k, M are omitted

Units for analog level measurement results:

Functions: RMS & S/N, RMS Select, PEAK, QPEAK, DC, Input-Disp: PEAK, Input Disp: RMS
Basic unit: Volt (V[V])

Table 2-2 Units for analog level measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
V	V	
dBV	DBV	20 * lg (V)
dBu	DBU	20 * lg (V/0.7745967)
dBm	DBM	10 * lg (V^2*1000/R_{REF})
W	W	V^2/R_{REF}
Δ%V	CPCTV	(V/U_{REF}-1)*100
ΔV	DV	$V-U_{REF}$
V/Vr	VVR	V/U_{REF}
%V/Vr	PCTVVR	100 * V/U_{REF}
Δ%W	DPCTW	(((V^2/R_{REF})-P_{REF}) * 100)/P_{REF}
ΔW	DW	(V^2/R_{REF}) - P_{REF}
P/Pr	PPR	(V^2/R_{REF})/P_{REF}
%P/Pr	PCTPPR	(V^2/R_{REF})/P_{REF} * 100
dB	DBR	20 * lg (V/U_{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/RMS measurement
P_{Ref} = (U_{REF})^2/R_{REF}

Units for digital level measurement results:

Functions: RMS & S/N, RMS-Select, PEAK, QPEAK Input-Disp: PEAK, Input Disp: RMS

Basic unit: Full Scale FS 0 to 1

Table 2-3 Units for digital level measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
FS	FS	
%FS	PCTFS	FS×100
dBFS	DBFS	20 × log (FS)
Hex *)	HEX	FS×65535
Δ%	DPCT	$(FS/U_{REF}-1) \times 100$
dBr	DBR	$20 \times \log (FS/U_{REF})$
LSBs	LSBS	$FS \times 2^{\text{audio bits-1}}$
bits	BITS	$\text{ld} (FS \times 2^{\text{audio bits-1}} + 1)$

V_{Ref} = Reference from the ANALYZER panel of the functions RMS & S/N, RMS-SELECT, PEAK, QPEAK, DC or Input-PEAK/RMS measurement

*) Level measurement result in hex
The full-scale (FS) 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 2-4 Level measurement results FS/Hex

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. Exception: the peak measurement functions PEAK & S/N and Q-PK & S/N may provide FS values < 0 or >1, depending on 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-.

Units for analog and digital interference level measurement results:

Functions: THD, THD+N/SINAD, MOD DIST, DIM, DFD
Basic unit: %

Table 2-5 Units for analog and digital interference level measurement results

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

Unit for analog and digital S/N measurement results:

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

Table 2-6 Unit for analog and digital S/N measurement result

Value in	IEC/IEEE-bus notation	Conversion formula
dB	DB	20 * log(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

Table 2-7 Units for analog and digital frequency measurement results

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

*) Toct = Third Octave
F_{Ref} = Reference parameter from ANALYZER panel of frequency measurement

Units for phase measurement results:

Basic unit: degree

Table 2-8 Units for phase measurement results

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

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

Units for group-delay measurement results:

Basics unit: s

Table 2-9 Units for group-delay measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
s	S	
Δs	DS	τ[s] - D_{REF}

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

Unit for analog and digital wow & flutter measurement results:

Basic unit: %

Table 2-10 Units for analog and digital wow & flutter measurement results

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

Unit for digital jitter measurement results:

Basic unit:UI

Table 2-11 Unit for digital jitter measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
UI	UI	
%UI	PCTUI	$100 \times UI$
dBUI	DBUI	$20 \times \log (UI)$
ppm	PPMUI	$10^6 \times UI$
ns	NS	$10^9 \times UI / (128 \times \text{sample frequency})$
dBr	DBR	$20 \times \log (UI/U_{REF})$

Unit for digital phase measurement results (PhaseToRef):

Basic unit: UI

Table 2-12 Unit for digital phase measurement results

Value in	IEC/IEEE-bus notation	Conversion formula
UI	UI	
%FRM	PCTFRM	$100 \times UI / 128$
°FRM	DEGFRM	$360 \times UI / 128$
ns	NS	$10^9 \times UI / (128 \times \text{sample frequency})$

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

2.4.2 Units for the Entry of Values

To simplify the matter

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

Table 2-13 Absolute analog level units (without reference voltage)

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

*) For the generator, the reference impedance is fixed to R_{REF} = 600 ohm.

Table 2-14 Relative analog level units (with reference voltage)

Conversion formulae		IEC/IEEE-bus notation
$\Delta V = V-U_{REF}$	$V = \Delta V+U_{REF}$	DV, Dm,V, DuV
$\Delta\%V = (V/U_{REF}-1) * 100$	$V = U_{REF} * (1+\Delta\%V/100)$	DPCTV
$V/Vr = V/U_{REF}$	$V = V/V_r * U_{REF}$	VVR
$\%V/Vr = V/U_{REF} * 100$	$V = \%V/Vr * U_{REF}/100$	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
$P/Pr = V^2/UREF^2$	$V = \sqrt{P / Pr * U_{REF}^2}$	P/PR
$\%P/Pr = V^2/U_{REF}^2) * 100$	$V = \sqrt{\%P / Pr * U_{REF}^2 / 100}$	PCTPPR
dBr = $20 * \log (V/U_{REF})$	$V = 10^{(dBr/20)} * U_{REF}$	DBR
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 * log (V/Burstamp[V])	V = $10^{(dBon/20)}$ * Burstamp[V]	DBON

Table 2-15 Absolute digital level units (without reference)

Conversion formulae		IEC/IEEE-bus notation
bits = - 3.322 * log (FS)	$FS = \frac{2^{bits}-1}{2^{Audiobits-1}}$	BITs
%FS = 100 * FS	FS = %FS/100	PCTFS
dBFS = 20 * log (FS)	FS = $10^{(dBFS/20)}$	DBFS
LSBS =FS * $2^{Audio\ bits-1}$	$FS = \frac{LSBS}{2^{Audiobits-1}}$	LSBS

Table 2-16 Relative digital-level units (with reference)

Conversion formulae		IEC/IEEE-bus notation
$dBr = 20 \times \log (FS/U_{REF})$	$FS = 10^{(dBr/20)} \times U_{REF}$	DBR
$\Delta\% = 100 \times (FS/U_{REF} - 1)$	$FS = (\Delta\% / 100 + 1) \times U_{REF}$	DPCT
%on = 100 × FS/Burstamp[FS]	FS = %on × Burstamp[FS]/100	PCTON
dBon= 20 × log (FS/Burstamp[FS])	$FS = 10^{(dBon/20)} \times$ Burstamp[FS]	DBON

Table 2-17 Absolute time units

Conversion formula		IEC/IEEE-bus notation
s		S, MS, US
min = 60 s	s = min / 60	MIN
cyc = s * signal frequency	s = cyc / signal frequency	CYC, KCYC, MCYC

Table 2-18 Relative time units

Conversion formula		IEC/IEEE-bus notation
$\Delta s = s - T_{REF}$	$s = \Delta s + T_{REF}$	DS, DMS, DUS
min = 60 s	s = min / 60	MIN
cyc = s * signal frequency	s = cyc / signal frequency	CYC, KCYC, MCYC

Table 2-19 Absolute frequency units

Conversion formula	IEC/IEEE-bus notation
Hz	HZ KHZ

Table 2-20 Relative frequency units (with reference)

Conversion formulae		IEC/IEEE-bus notation
$\Delta Hz = Hz - F_{REF}$	$Hz = \Delta Hz + F_{REF}$	DHZ, DKHZ
$f/fr = Hz/F_{REF}$	$Hz = f/fr * F_{REF}$	FFR
$\Delta\%Hz = 100 * (Hz - F_{REF})/F_{REF}$	$Hz = \Delta\%Hz * F_{REF}/100 + F_{REF}$	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 = Terz		

Table 2-21 Absolute phase unit

Conversion formula		IEC/IEEE-bus notation
rad = °· * (PI/180)·	° = rad * (180/PI)	RAD

Table 2-22 Relative phase unit

Conversion formula		IEC/IEEE-bus notation
$\Delta° = ° - D_{REF}$	$° = \Delta° + D_{REF}$	DDEG
Δ RAD = $(° - D_{REF}) * (\pi / 180)$·	$° = (\Delta \text{ RAD} * 180 / \pi) + D_{REF}$	DRAD

Table 2-23 Deviations (tolerance) compared to the previous measured values in the settling function (see 2.3.4 and 2.6.5.1)

Conversion formula		IEC/IEEE-bus notation
% = $(10^{dB/20} - 1) * 100$	dB = 20 * lg (%/100 -1)	DB, PCT

Table 2-24 Step size of a logarithmic level sweep

Conversion formula		IEC/IEEE-bus notation
MLT = $10^{dB/20}$	dB = 20 * log (MLT)	MLT, DB

Table 2-25 Absolute resistance unit

Conversion formula	IEC/IEEE-bus notation
Ω	OHM, KOHM

Legend:

FS:	Abbreviation for Full Scale = ratio 0 to 1
U_{REF}:	Level reference value in V or FS → *)
R_{REF}:	"Ref Imped" parameter from ANALYZER panel
F_{REF}:	Frequency reference value in Hz
Burstamp:	High level of generator burst signal, see 2.5.4.5 SINE BURST
Signal frequency:	Frequency of generator burst signal or pulse signal, see 2.5.4.5 BURST, 2.5.4.6 SINE2 BURST
D_{REF}:	Phase reference value in ×
MLT:	Multiplication factor (marked by "*" in the panel)