ROHDE&SCHWARZ

Test and Measurement
Division

Supplement to R&S FSQ Manual
Analog Baseband Input FSQ-B71

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Dear Customer,

The pages that follow will supplement the operating manual for your equipment.

Please insert these pages at the end of Chapter 4 or Chapter 6.1 in your operating manual.

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Contents

Optional I/Q Baseband Input R&S FSQ-B71

The baseband input is used for direct measurement of complex baseband signals (normally modulation signals).

In the FFT Analyzer mode, measurements are performed by the FSQ. The results are shown on the FSQ display. Measurements in both the time domain and frequency domain are possible. Wherever possible, operation is the same as that for the *Spectrum Analysis* mode.

Alternatively you can also extract data: To do so, the R&S FSQ digitizes the analog input signals at a user-selectable sampling rate.
The samples can be transferred via IEC/IEEE bus or LAN interface to an external computer for analysis. They are not displayed (Baseband IQ Data Grabbing).

Note: *Baseband IQ data grabbing denotes the following:*
The TRACE:IQ subsystem (see chapter 6.1) is used by an external computer via IEC/IEE bus or LAN interface. That is, the FSQ digitizes the signals applied at the baseband input, then filters, decimates and transfers them to the external computer, where they are further processed by a program (e.g. Matlab) to be written by the customer. No results are displayed by the FSQ.
The user must explicitly select the sampling rate (thereby automatically selecting the filter bandwidth) and the data length.
The center frequency is always 0 Hz.

From firmware version 1.8x and higher, the baseband input can also be used with the options FS-K5, FS-K70, FS-K72, FS-K73, FS-K82 and FS-K84. For baseband functions of options not listed here, refer to the respective manual.

Functional description

(Refer to the block diagram on page 4.24-3)

The device under test, e.g. a complex modulation source, is connected to inputs I INPUT, UNBAL and Q INPUT UNBAL. By definition, I is the real part (**i**n phase) and Q the imaginary part (**q**uadrature phase).

Differential sources are connected to BAL HIGH and BAL LOW, the inverted signal being connected to BAL LOW.

There is an attenuator to –15 dB at the input. This means that higher input voltages are attenuated to <1 V so that the A/D converter is not overloaded. Voltages of ±1 V can be measured at the 0 dB position. In sensitive measurement ranges, a preamplifier to +30 dB ensures adequate modulation of the A/D converter and thus a low noise figure.
The attenuator and preamplifier settings are permanently coupled to the setting of the ***measurement range***.

RANGE	5.62 V	3.16 V	1.78 V	1 V	562 mV	316 mV	178 mV	100 mV	56.2 mV	31.6 mV
Attenuator	-15 dB	-10 dB	-5 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
Preamplifier	0 dB	0 dB	0 dB	0 dB	+5 dB	+10 dB	+15 dB	+20 dB	+25 dB	+30 dB

The attenuator and preamplifier have an impedance of 50 Ω. The switchable ***1 MΩ input (or 1 KΩ depending on the B71 module version)*** is reached by inserting a high-impedance 1:1 amplifier directly behind the input sockets. In this instance the maximum measurement range is 1.78 V.

At the ***BALANCED OFF*** position only the high input is through-connected and at the ***BALANCED ON*** position the difference between the high and the low inputs is through-connected for further processing.

The anti-aliasing lowpass filter follows. If required, it can be switched off (measurement bandwidth >30 MHz): ***LOWPASS ON/OFF***.

If required, a dither signal can be added to the test signal, ***DITHER ON/OFF***. This improves the linearity of the A/D converter at low modulation. For further details, refer to *page 4.24-10.*

The test signal (with dither signal if necessary) is sampled by a 14 bit A/D converter with 81.6 MHz.
The anti-aliasing filter is optimized for this fixed sampling rate.

The user must specify the sampling rate when data is extracted. It is user-definable but must be between 10 kHz and 81.6 MHz.
With the FFT Analyzer, the user never selects the sampling rate directly but always indirectly using other parameters (span, RBW, etc). The firmware always selects the appropriate output sampling rate.
In both cases, the sampling rate is not reduced at the A/D converter but by means of digital signal processing using a resampler and subsequent integer decimation. Digital filters limit the signal before decimation to the bandwidth which can still be displayed without aliasing at the output sampling rate.

If the sampling rate is set too low for the test signal, the bandwidth of the signal is limited; but this does not result in aliasing (folding back of high frequencies to the useful band).

The bandwidths available for the given sampling rate are specified in the following table. Reference is made to the useful bandwidth, without limitation of the data (flat response of the digital filters).
This table is only relevant if data is extracted (Baseband IQ Data Grabbing).
With the FFT Analyzer, the sampling rate is calculated by the firmware. In this case, the interdependencies from Chapter “Using the I/Q baseband input in the FFT Analyzer” must be observed.

Table 4.24-1 Available bandwiths

Sampling rate from	to	**Max. bandwidth I and Q in each case**
81,6 MHz	>40,8 MHz	0.441 sample rate *)
40.8 MHz	>20.4 MHz	0.34 sample rate
20.4 MHz	>10.2 MHz	0.4 sample rate
10.2 MHz	>5.1 MHz	0.4 sample rate
5.1 MHz	>2.55 MHz	0.4 sample rate
2.55 MHz	>1.275 MHz	0.4 sample rate
1.275 MHz	>0.6375 MHz	0.4 sample rate
0.6375 MHz	>318.75 kHz	0.4 sample rate
318.75 kHz	>159.375 kHz	0.4 sample rate
159.375 kHz	>79.6875 kHz	0.4 sample rate
79.6875 kHz	>39.84375 kHz	0.4 sample rate
39.84375 kHz	>19.921875 kHz	0.4 sample rate
19.921875 kHz	10 kHz	0.4 sample rate

*) 36 MHz with LOWPASS ON

These bandwidths apply to I and Q, and are therefore the equivalent lowpass filter bandwidths.

The complex signal formed by I and Q is a bandpass signal having a center frequency of zero.
The bandpass filter bandwidth is twice the size of the lowpass filter bandwidth shown in the table.

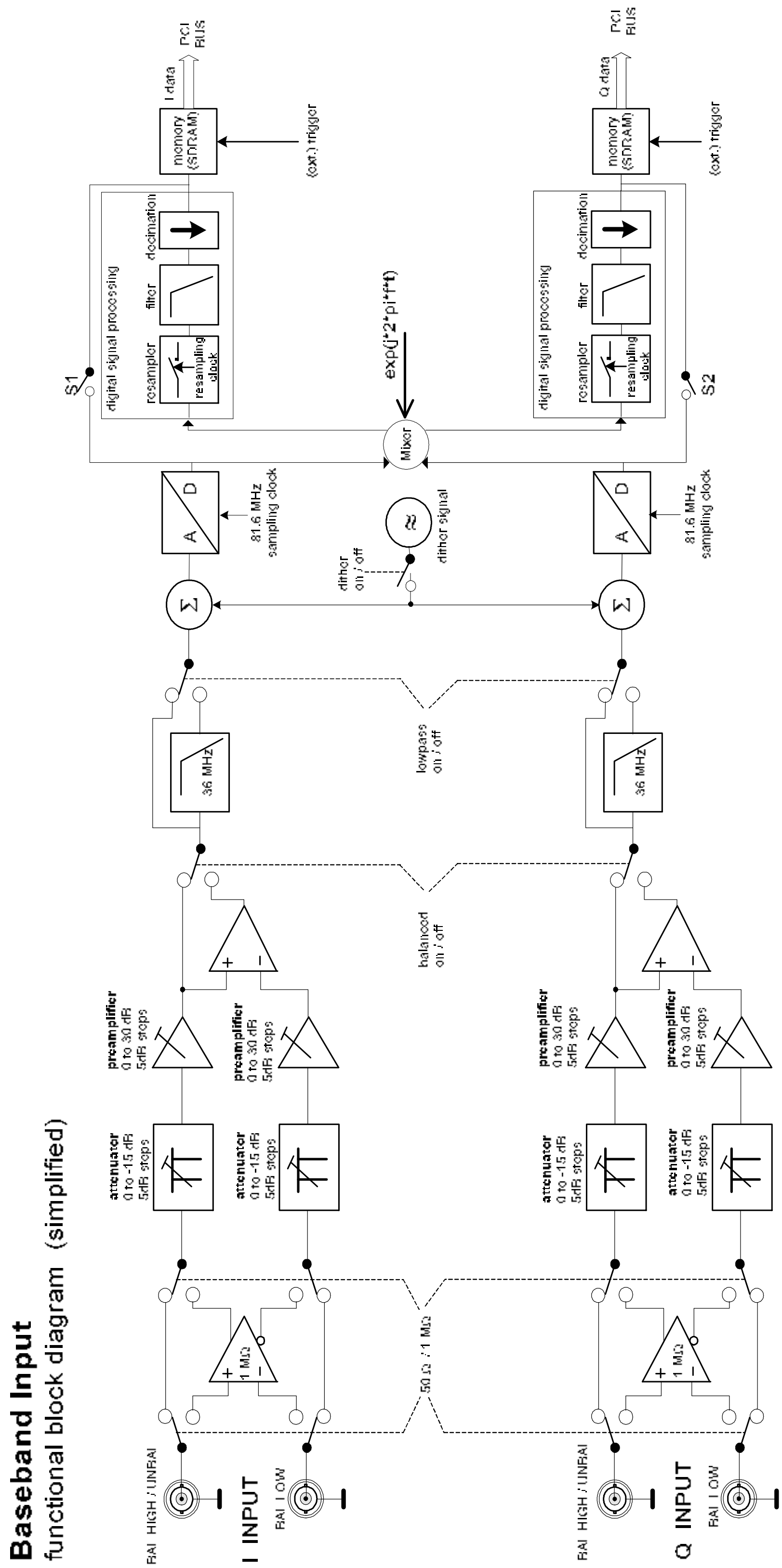
The **maximum bandpass filter bandwidth** is therefore **72 MHz**.

When data is extracted, the samples (I/Q data) are written with the selected sampling rate to a 16 Mword memory (16 Mword for both I and Q). The number of measurement values (samples) to be acquired is user-selectable.
The FFT Analyzer, however, selects the data volume automatically such that the data volume is always just large enough for the requirements of the user-selected measurement task. The "Capture both domains" mode is an exception; here the complete memory volume of 16 Mwords is filled.

With the **trigger** setting ***IMMEDIATE*** (corresponds to *FREE RUN*), sample acquisition begins directly following the request.
The **trigger** setting ***EXTERNAL*** supports synchronization of sample acquisition with an external trigger signal. The number of test points to be acquired before the trigger instant can be set.
With the **trigger** setting ***IFPOWER*** (corresponds to *I/Q LEVEL*), sample acquisition begins as soon as the magnitude of the I/Q signal exceeds or falls below a selectable threshold. The number of test points to be acquired before the trigger instant can be set.

If data is extracted, the acquisition and output of I/Q samples are controlled using the commands of the **TRACe:IQ subsystem**.
In this case the measurement results are output in list form, with the list of I data and the list of Q data immediately following each other in the output buffer. You can use the FORMAT command to choose between binary output (32 bit IEEE 754 floating-point numbers) and output in ASCII format
For further details, refer to chapter 6 onwards.

Functional block diagram



Error correction

The block diagram does not show the calibration sources and operator action for error correction.

The R&S FSQ automatically corrects all important parameters of the baseband input provided that a valid total calibration has been performed (total calibration status passed).

Baseband input parameters corrected after total calibration

Offset: Compensated for by means of a D/A converter before the A/D converters. This ensures that the modulation range of the A/D converters is retained even at high offset voltages (at high gain).

Gain: Digitally corrected by a RAM with a correction table (lookup table) downstream of the A/D converters.

Frequency response: Constant amplitude and group delay (linear phase) over the frequency are achieved by means of digital compensation filters.

Phase difference: The delay difference (and thus the phase difference) between I and Q is compensated for by means of digital filters.

Trigger offset: The different propagation delays (depending on the sampling rate and filters in the signal path) are automatically corrected so that the time reference between the test signal and an external trigger signal is retained.

Level display

The I/Q data specifies the voltages at the I/Q inputs at the sampling instants in volts.

Generally speaking, the I/Q value pairs are regarded as complex numbers:
I = in phase = real part
Q = quadrature phase = imaginary part

The complex pointer represents a real signal in terms of magnitude and phase.

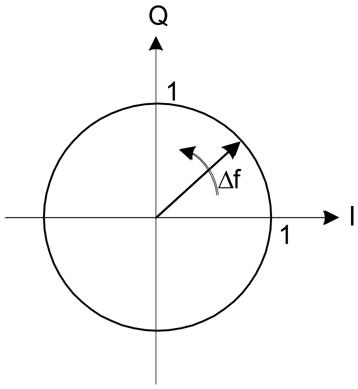
$$Magnitude = \sqrt{I^2 + Q^2} \qquad Phase = \arctan\left(\frac{Q}{I}\right)$$

Relationship between RF and baseband

Example:
An unmodulated carrier (sinewave signal) is applied to the RF input and its frequency is Δf higher than the set receive frequency. The carrier has an **rms voltage of 1 V**.

Following mixing into the complex baseband, a **vector with a length of 1**, which rotates with Δf, is obtained.

The following then applies to the I/Q data: Magnitude = $\sqrt{I^2 + Q^2} = 1$.
The magnitude represents the rms value of the RF signal.



The same signal represented in the baseband:

$$Q = 1V * \sin(2\pi\Delta f t)$$
$$I = 1V * \cos(2\pi\Delta f t)$$

They are two sinewave signals in phase quadrature with an rms voltage of 0.707 V and a peak voltage of 1 V.

In the 1 V measurement range, a peak voltage of 1 V can be measured in each instance at the I/Q inputs, which corresponds to an rms value of 0.707 V with sinewave signals.
This means that a real signal with an rms value of 1 V can be displayed.

In the case of an identical RefLevel setting, the measurement range at the baseband input conforms to the measurement range of the RF input. The Ref Level at the RF input corresponds to the measurable rms value; the Ref Level at the baseband input corresponds to the peak value for both I and Q.

General operation

The following diagrams explain which settings must be made to allow the hardware to process the input signals correctly. The operating principle is the same for all operating modes; configuration, however, takes place at different locations.

The configurations for the baseband inputs are kept separate for the following operating modes:

- Baseband IQ Data Grabbing (extraction of data by means of IEC/IEEE bus or LAN interface, TRACE:IQ)
- FFT Analyzer
- every option which can use the baseband inputs

For configuration, the **FFT Analyzer** provides:

- a separate submenu (see chapter „*SIGNAL SOURCE* submenu of the FFT Analyzer")
- or, alternatively, the submenu which can be called up using the SIGNAL SOURCE softkey in the SETUP menu (see chapter "*SIGNAL SOURCE* submenu of the FFT Analyzer")

All **options** which can use the baseband inputs provide the following for configuration:

- the submenu, which can be called up using the SIGNAL SOURCE softkey in the SETUP menu (see chapter "Switching on and configuring the I/Q baseband input")

Please also refer to the operating manual for the respective option.

Note: *Both paths are always taken into consideration when data is extracted. The possibility of ignoring a path is only available in the FFT Analyzer (IQ PATH softkey).*

Activation

IEC/IEEE bus command: `INP:SEL AIQ | RF`

Used to toggle the signal input on the R&S FSQ between RF and baseband (**A**nalog **I**/**Q**).

Settings of the baseband inputs

Input impedance

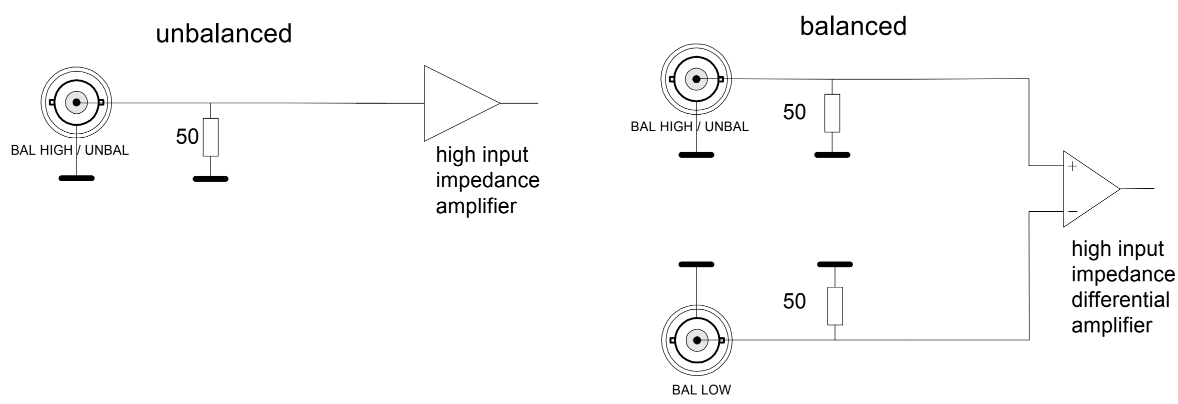
IEC/IEEE bus command: `INP:IQ:IMP LOW | HIGH`

LOW corresponds to 50 Ω; HIGH corresponds to 1 MΩ or 1 KΩ (depending on the B71 module version).

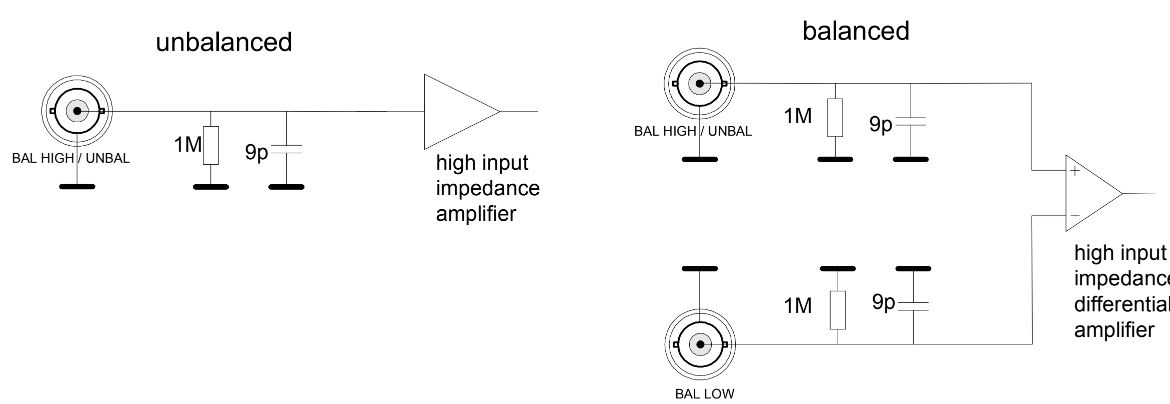
The default setting is LOW.

Equivalent input circuit

50 Ω



1 MΩ



Differential input impedance for a floating source: 2 MΩ +4.5 pF

Note: *It should be remembered that at the 50 Ω setting there is always a 50 Ω DC path to ground, even when the input is switched to BALANCED.*

Measurement mode

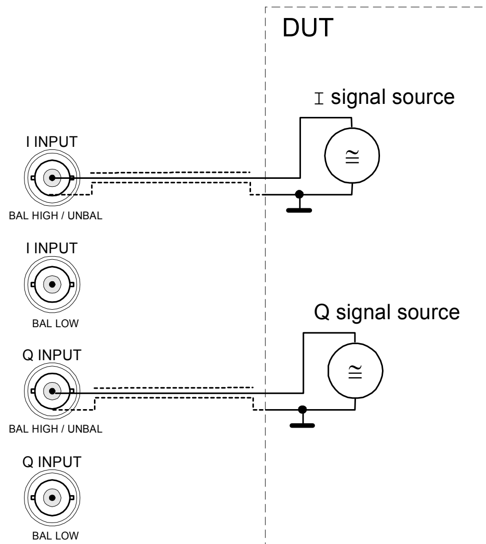
IEC/IEEE bus command: `INP:IQ:BAL ON |OFF`

Used to toggle the measurement mode between balanced (BALANCED ON) and referenced to ground (BALANCED OFF).

The default setting is ON.

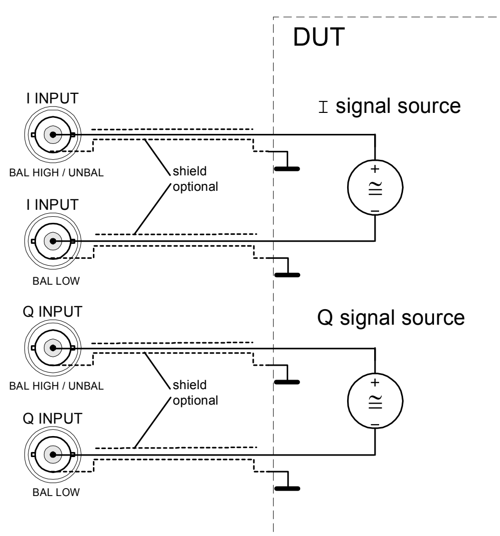
Connecting the signal sources (device under test)

BALANCED OFF



The connection to ground is run via the shield of the coaxial cable.

BALANCED ON



A connection to ground is not necessary.

Lowpass filter

IEC/IEEE bus command: `IQ:LPAS ON|OFF`

Used to switch the anti-aliasing filters upstream of the A/D converters on and off (cutoff frequency 36 MHz).

The default setting is ON.

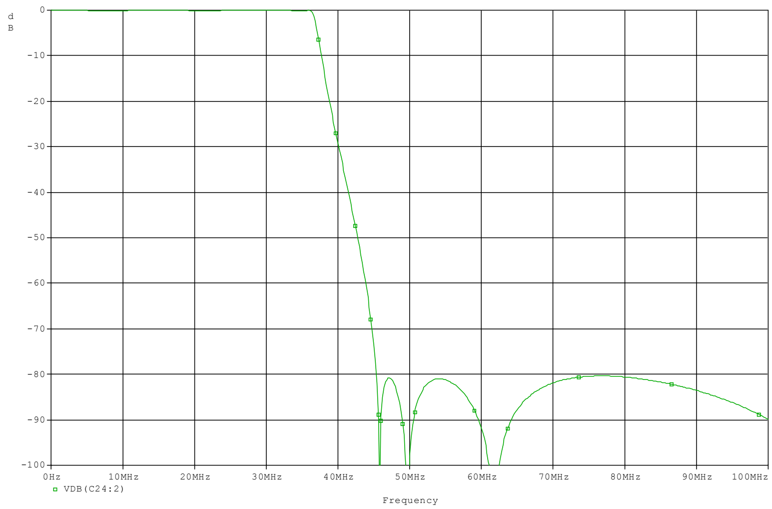


Fig. 4.24-1 Anti-aliasing lowpass filter, typical frequency response

Note:

- The filter prevents frequencies above the usable frequency range (>36 MHz) from being mixed into the usable frequency range (DC to 36 MHz) as a result of sampling (sampling frequency 81.6 MHz). It should therefore always be switched on. It should be remembered that, for example, harmonics and other spurious emissions of the device under test might be in the disallowed frequency range.
- Amplitude response and phase response (or group delay) of the filter are compensated for up to 30 MHz.
- With the filter switched off, amplitude response and phase response (or group delay) of the filter are compensated for up to 36 MHz. This setting is recommended only if the higher bandwidth is required. In this case, it is important to ensure that the spectrum of the device under test >45.6 MHz has adequately decayed since these spectral components appear in the useful band > 36 MHz.

Dithering

IEC/IEEE bus command: `IQ:DITH ON|OFF`

Used to switch the dither signal on and off. The dither signal is added to the useful signal by the A/D converter before sampling.

The default setting is OFF.

The dither signal distinctly improves the linearity of the A/D converter at low signal levels (low modulation at the A/D converter) and thus the accuracy of the level displayed.

Note: *The dither signal is necessary only if the total AC voltage applied to the input (up to 36 MHz) is more than 46 dB less than the measurement range. The DC component is not taken into account.*

The dither signal has no effect at a modulation higher than measurement range –46 dB. A disadvantage, however, is that it might have to be removed from the spectrum as a result of post-processing (filters).

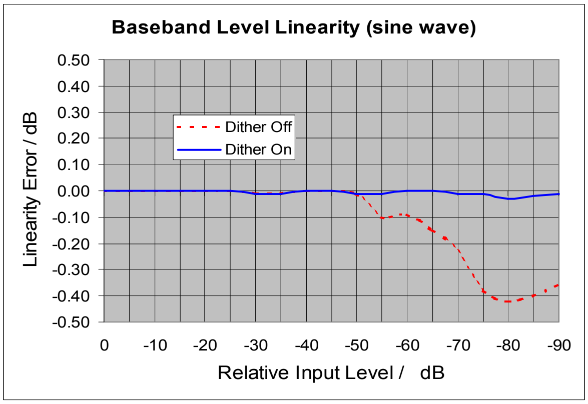


Fig. 4.24-2 Typical linearity error with and without dither signal

Characteristics of the dither signal:

Band-limited noise, center frequency 38.93 MHz (in the I/Q spectrum), 3 dB bandwidth approx. 2 MHz, peak voltage 7 %, rms 1 % of modulation range of A/D converter.

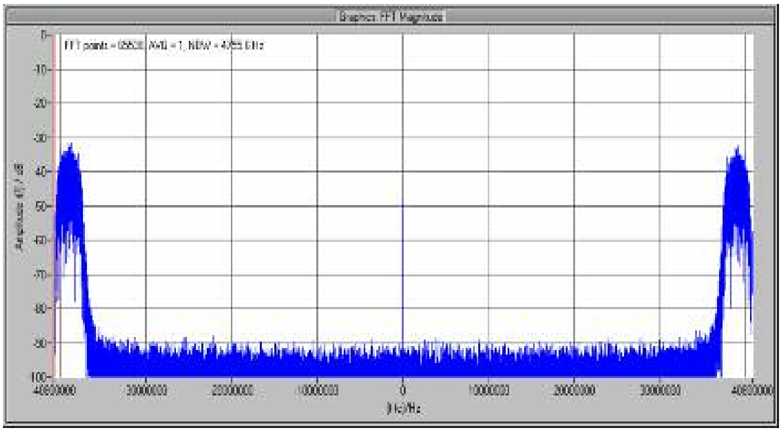


Fig. 4.24-3 Dither signal, spectrum (complex FFT of I/Q data)

The entire spectrum is outside the usable frequency range (>36 MHz) and can therefore be removed by means of digital filters without affecting the useful signal. If data is extracted by means of IEC/IEEE bus or LAN interface, at lower sampling rates (<40.8 MHz) the dither signal will already have been removed by the internal digital filters and therefore no longer appears in the I/Q data.

In the FFT Analyzer the dither signal is almost completely removed by the internal digital filters.

Measurement range

IEC/IEEE bus command: `VOLT:IQ:RANG 5.62|3.16|1.78|1|0.562|0.316 ...`

The unit for input is volts.

The default setting is 1 V.

The measurement range specifies the measurable peak voltage, at the I and Q inputs in each case.
For example, voltages between –1 V and +1 V can be measured with a setting of 1 V.

With the BALANCED ON setting, the measurement range defines the measurable differential voltage.

The measurement range can be changed in steps of 5 dB.
Permissible settings:

0.0316 V
0.0562 V
0.1 V
0.178 V
0.316 V
0.562 V
1 V
1.78 V
3.16 V only with IMPEDANCE LOW (50 Ω)
5.62 V only with IMPEDANCE LOW (50 Ω)

Headroom: Typically 3 dB (with dither 2 dB); higher voltages can still be measured. The A/D converter is overloaded when the headroom is exceeded. After the I/Q data has been read out, the overload display appears: *IFOVL*.

Triggering sample acquisition

Selecting the trigger source

IEC/IEEE bus command: `TRIG:SOUR IMM|EXT|IFP`

IMMEDIATE Activates cyclic data acquisition, i.e. there is no explicit triggering of the start of measurement. Sample acquisition starts immediately with the request for I/Q data.

EXTERNAL Activates triggering by means of a TTL signal at the *EXT TRIGGER/GATE* input socket on the rear panel of the instrument. Sample acquisition starts with the slope (see polarity) of the external trigger signal.

IFPOWER Activates triggering to the magnitude $\sqrt{(I^2+Q^2)}$ of the I/Q signal. The trigger threshold can be set in V (see trigger threshold).

Selecting the polarity (trigger slope)

IEC/IEEE bus command: `TRIG:SLOP POS|NEG`

Used to set the polarity of the trigger slope.

Sample acquisition starts after a positive or a negative slope of the trigger signal.

Selecting the trigger threshold

IEC/IEEE bus command: `TRIG:LEV:IFP 0.7 [V]`

Used to determine the threshold in volts for the IFPOWER trigger (triggering to the magnitude of the I/Q signal). Sample acquisition starts when the value exceeds (positive polarity) or drops below (negative polarity) the selected threshold.

Using the I/Q baseband input in the FFT Analyzer

The FFT Analyzer provides a convenient way of analyzing the signals at the analog baseband input in both the time domain and the frequency domain. This does not require an external computer. The FSQ is used to process the data and to display the results.
Many of the functions belonging to the *Spectrum Analysis* mode are also available in the FFT Analyzer. Operation is largely based on that of the *Spectrum Analysis* mode.

In contrast to the *Spectrum Analysis* mode, the FFT Analyzer does not determine the spectrum using the sweep principle but instead by performing a FFT (Fast Fourier Transform) on the input data. For this reason, some parameter interdependencies are completely different. There are also a number of new setting options, such as the window functions.

In the FFT Analyzer, a distinction is made between the two operating modes *Time Domain* and *Frequency Domain* (corresponding to the operating modes Zero Span and Span > 0 of the basic unit). They differ with respect to signal processing and the internal parameter interdependencies.

Operating principle of the FFT Analyzer

This chapter contains a brief description of the signal processing steps for the two operating modes of the FFT Analyzer.

The processing sequence depends on several parameters which are only relevant for the FFT Analyzer:

- Is the Time Domain or Frequency Domain mode active?
- Which input signal am I expecting (IQ-PATH parameter, see page 4.24-40)?
  - I+jQ mode: Signals at the I and Q input are regarded as components of a complex signal.
  - I ONLY mode: A signal at the I input is regarded as a single, real signal. A signal at the Q input is ignored.
  - Q ONLY mode: A signal at the Q input is regarded as a single, real signal. A signal at the I input is ignored.
- Is the *CAPTURE BOTH DOMAINS* mode active?
  This mode allows measurements with completely different configurations to be performed repeatedly using data which needs to be acquired once only. Initial acquisition of the data must, however, be performed directly to the memory. In the first step, the samples of both the I and Q input are always recorded regardless of the input signal setting.
- How large is the span in the *Frequency Domain* mode?
  If the span is larger than 27.5 MHz, initial acquisition of the data must once again be performed directly to the memory.

The input signals are processed in the following sequence corresponding to the functional block diagram on page 4.24-3:

1. Provision of the appropriate input impedance (50 Ω or 1 MΩ / 1 KΩ).
2. Different attenuation of signal depending on the REFERENCE LEVEL. Both inputs do, however, always experience the same level of attenuation.
3. Different amplification of signal depending on the REFERENCE LEVEL. Both inputs do, however, always experience the same level of gain.
4. Adaptation of the measurement mode (balanced / referenced to ground). Has the same effect on both inputs.
5. Activation of analog anti-aliasing filter or not. Has the same effect on both inputs.

6. Possible addition of shaped dither signal.
7. Sampling of both paths at constant 81.6 MHz.
8. The I and Q samples are then written directly to the memory, but only if this is necessary. Bypassing of switch S1 and S2 using the signal processing block.
9. The samples from both the I and Q input are passed on to the mixer. They either come from the current data acquisition process (i.e. directly from the two A/D converters) or are read out of the two memories if the samples were written directly to these memories beforehand, e.g. because the CAPTURE BOTH DOMAINS mode is active.
   Reading out of the raw data and all subsequent signal processing steps can also be triggered by a manual or automatic RECALC process (see page 4.24-56). Signal processing starts here for every RECALC process.
10. The samples pass through the complex mixer. The mixer has a complex input and output. Depending on the IQ PATH setting, the mixer performs the following internal processes:
    - *I + J*Q* mode: The samples from the I input are passed on to the real part of the mixer input and the samples from the Q input to the imaginary part.
    - *I ONLY* mode: The samples from the I input are passed on to the real part of the mixer input. The samples from the Q input are discarded. The imaginary part of the mixer input is instead set to zero.
    - *Q ONLY* mode: The samples from the Q input are passed on to the real part of the mixer input. The samples from the I input are discarded. The imaginary part of the mixer input is instead set to zero.
11. The resulting real or complex signal at the mixer input is multiplied in the mixer by a complex rotating phasor. This causes a shift in the frequency domain which is directly proportional to the rotational frequency of the rotating phasor. The rotational frequency can also be 0 Hz; there is then no shift. The rotational frequency is calculated automatically by the firmware on the basis of the measurement settings. The output signal of the mixer is normally complex. If the input signal was real and has not been mixed, it remains real.

The next processing steps are different for the two operating modes *Time Domain* and *Frequency Domain*.

Operating principle in the *Time Domain* mode

The resampler processing block is not active in the *Time Domain* mode.

An identical digital lowpass filter in both signal paths allows only low-frequency signal components to pass. However, these signal components had a completely different frequency position prior to mixing. The mixing process should have shifted the frequency domain of interest to the range around 0 Hz. It is not attenuated by the filter.
In the *Time Domain* mode, the filter always has a Gaussian characteristic. Its bandpass filter bandwidth (twice the cutoff frequency) corresponds to the *RESOLUTION BANDWIDTH* (*RBW*) selected by the user.
The filter also performs integer decimation. With small filter bandwidths, the effect of decimation may be greater than with large filter bandwidths. The output sampling rate for small and medium *RBWs* is always approx. 20 times that of the selected *RBW*; with very large *RBWs* the output sampling rate drops to approx. twice that of the selected *RBW*.

The two filtered signals are then stored in the memory The output sampling rate of the signal processing block determines the period during which the memory is completely full. As a result, the maximum observation time in the *Time Domain* mode usually depends on the selected *RBW*. If, however, *CAPTURE BOTH DOMAINS* and *SINGLE SWEEP* are active, the acquisition time is always max. 0.16 seconds (16 Mwords / 81.6 MHz minus settling time) irrespective of the RBW since the data is initially recorded in the memory without decimation. See Chapter “Setting the bandwidths and sweep time – *BW* key, softkey *SWT MANUAL”.*

The data is then read out of the memory for analysis. This cannot be performed until data acquisition and processing has been completed. Unlike the zero-span mode in the *Spectrum Analysis* mode, the result trace is therefore not continuously plotted on the display in the case of long observation times. Instead, the trace only appears after the observation time has elapsed. With very large data volumes (i.e. large *RBW* and/or long observation time), the data is read out in blocks and, as a result, the trace is plotted bit by bit.

The read-out measurement data can be analyzed in a number of different ways:

- *MAGNITUDE* diagram: The magnitude of the measurement data is plotted over time. This roughly corresponds to the zero-span mode in the *Spectrum Analysis* mode.
- *VOLTAGE* diagram: The real and imaginary part of the read-out measurement data is plotted. If the mixer was not active, this corresponds to the operating principle of a digital single-channel or dual-channel storage oscilloscope. If, however, the mixer was active, the information contained in this diagram will not be conclusive.

Note: *The upper and lower diagram display the real part and the imaginary part of the selected complex or real input signal AFTER the input signal has passed through the signal processing modules. The two diagrams DO NOT normally represent the I and Q inputs.*

A Gaussian filter is always used for Time Domain measurements. The user-definable window functions from the Frequency Domain mode are completely irrelevant here.

Operating principle in the *Frequency Domain* mode

The resampler processing block is active in the *Frequency Domain* mode. It performs fractional resampling of the sampling rate. Combined with the subsequent integer decimation in the digital filters, this allows the output sampling rate to be varied steplessly over a very broad range.

An identical digital lowpass filter (approximately rectangular in form) in both signal paths removes high-frequency signal components. Only slightly more than the span selected by the user is allowed through unchanged. The mixing process should have shifted the center of the selected span to the frequency 0 Hz.
This permits the largest possible decimation (here integer decimation) to be performed following filtering, i.e. the sampling rate is reduced.

The two filtered signals are then stored in the memory. The output sampling rate of the signal processing block determines the period during which the memory is completely full. This gives rise to the interdependencies and minimum/maximum values described in chapter "Setting the bandwidths and sweep time – *BW* key". Other values apply in the *CAPTURE BOTH DOMAINS* mode since the acquisition time is max. 0.16 seconds (16 Mwords / 81.6 MHz minus settling time). In this mode, data is always initially recorded in the memory without decimation.

The samples are then read out of the memory. They are multiplied using the selected window function. A complex FFT transforms the data from the time domain to the frequency domain.

The FFT results can be analyzed in a number of different ways:

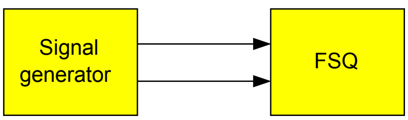
- *MAGNITUDE* diagram: Only the magnitude of the FFT results is displayed. This is therefore similar to the *Spectrum Analysis* mode of the FSQ.
- *MAGNITUDE PHASE* diagram: The upper diagram corresponds to the upper *MAGNITUDE* diagram. The phase information is, however, also displayed in the lower diagram. The phase trace only provides conclusive information if a single measurement (*SINGLE SWEEP*) was performed, or if a periodic signal is analyzed in the CONTINUOUS SWEEP using a trigger.
- *REAL IMAG* diagram: The real and imaginary parts of the FFT results are displayed on a linear scale. These can also be negative. This diagram is generally of little relevance. As with the *MAGNITUDE PHASE* diagram, a single measurement should be performed or, alternatively, a trigger should be used.

Measurement examples for the FFT Analyzer

This chapter explains operation of the FFT Analyzer using typical measurements as examples. Chapter "Instrument functions of the FFT Analyzer" contains a detailed explanation of the basic operating steps, e.g. selecting menus and setting parameters. The layout of the screen and the information displayed on the screen are also described.
The following examples start with the FFT Analyzer in its default state. The default state is set by pressing the *PRESET* key or the *PRESET FFT* key. The full default setup is described in Chapter "Default settings of the FFT Analyzer – *PRESET FFT* key".

Measurement example 1 – Spectrum of a GSM signal in the complex baseband

Test setup:



Settings on the signal generator (e.g. R&S SMIQ or R&S SMU)

Frequency:	not relevant, because the baseband output is used
Level:	not relevant, because the baseband output is used
Modulation:	GSM standard; PRBS data is used

The I baseband output of the signal generator is connected to the I baseband input of the FSQ. The Q baseband output of the signal generator is connected to the Q baseband input of the FSQ. With asymmetrical cabling, the "unbalanced" inputs of the FSQ must be used.

Measurements with the FFT analyzer

1. Set the FSQ to its default state:
   - Press the PRESET key.
2. Change to the FFT Analyzer:
   - Press the *FFT* hotkey.
3. Configure the baseband input:
   - Press the *SIGNAL SOURCE* softkey.
   - Select the appropriate input impedance using the *IQ INPUT* softkey (the input impedance depends on the signal generator).
   - Use the *BALANCED* softkey to set the measurement mode (balanced / referenced to ground) (depends on the signal generator).
4. Set the span to 1 MHz:
   - Press the *SPAN* key and enter 1 MHz.
5. Set the resolution bandwidth to 10 kHz:
   - Press the *FREQ* key, then the *RES BW MANUAL* softkey and enter 10 kHz.
6. Switch on averaging:
   - Press the *TRACE* key and then the *AVERAGE* softkey.

You can see the typical spectrum of a GSM signal (see Fig. 4.24-4). The center frequency is 0 Hz. Positive and also negative frequencies are shown. This is meaningful, because the spectrum of a complex input signal is in most cases not symmetrical to 0 Hz.

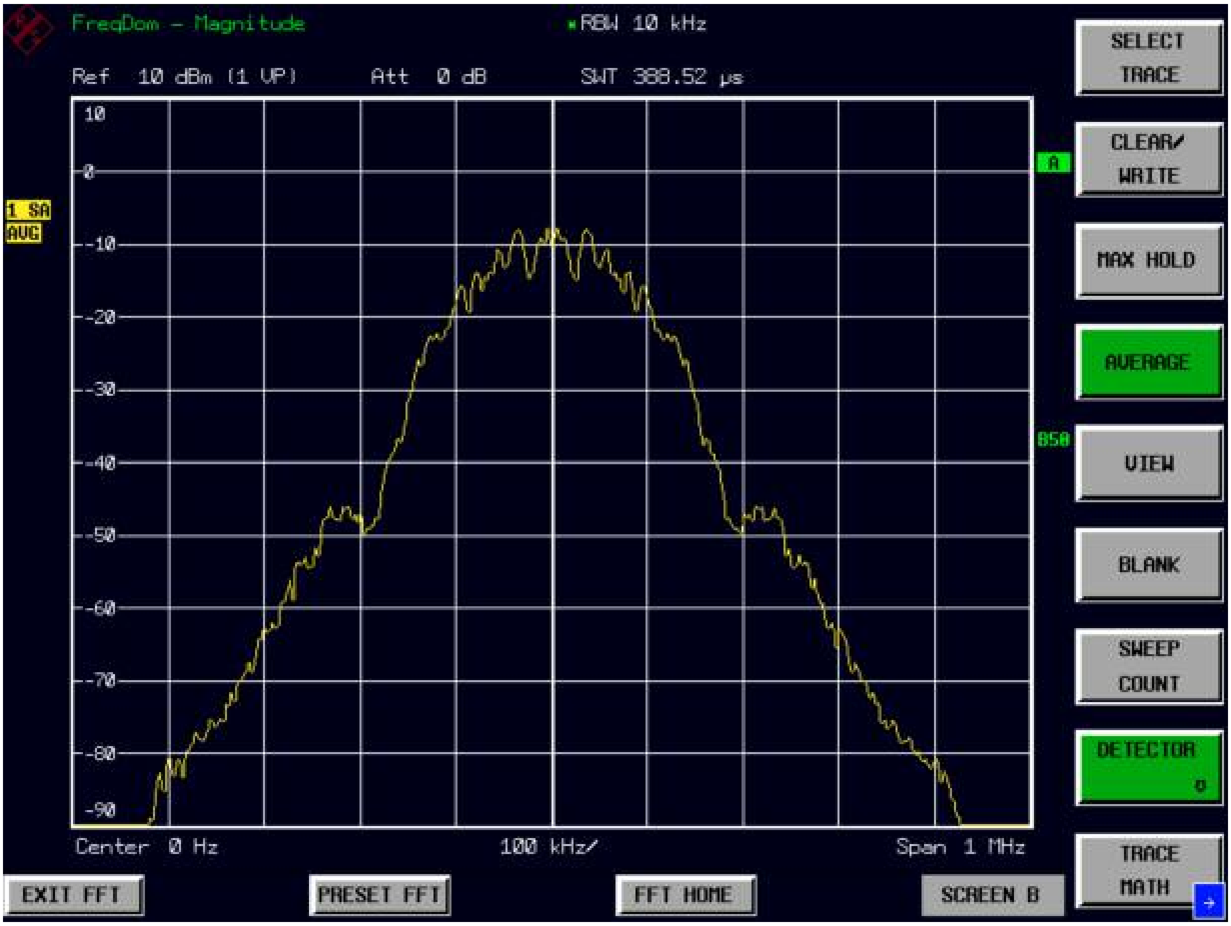


Fig. 4.24-4 Typical spectrum of a GSM signal (PRBS data is used)

We want to generate a complex rotating phasor now.

7. Switch the signal generator to bit pattern "11111..." or "00000....":
   - ➢ Operator interactions depend on the signal generator used.
     Important: Differential coding must be used.
8. Use the marker to measure the frequency and the level of the rotating phasor:
   - ➢ Press the *MKR* ⇒ key, then the *PEAK* softkey.

You can see (Fig. 4.24-5) the spectrum of a complex rotating phasor. Its frequency is a quarter of the GSM symbol frequency of 270.833 kHz (=67.708 kHz). You can read the frequency and the level of the rotating phasor in the marker information field.

A complex rotating phasor is defined as:

$$s(t) = e^{j \cdot \varpi \cdot t} = \cos(\varpi \cdot t) + j \cdot \sin(\varpi \cdot t)$$

with a positive or negative ω, which determines the direction of rotation and the frequency.
The above formula can be rewritten as:

$$\sin(\varpi \cdot t) = \tfrac{1}{2 \cdot j} \cdot (e^{j \cdot \varpi \cdot t} - e^{-j \cdot \varpi \cdot t})$$

and

$$\cos(\varpi \cdot t) = \tfrac{1}{2} \cdot (e^{j \cdot \varpi \cdot t} + e^{-j \cdot \varpi \cdot t})$$

A sine or cosine can be split into two complex rotating phasors. We will need this fact later.

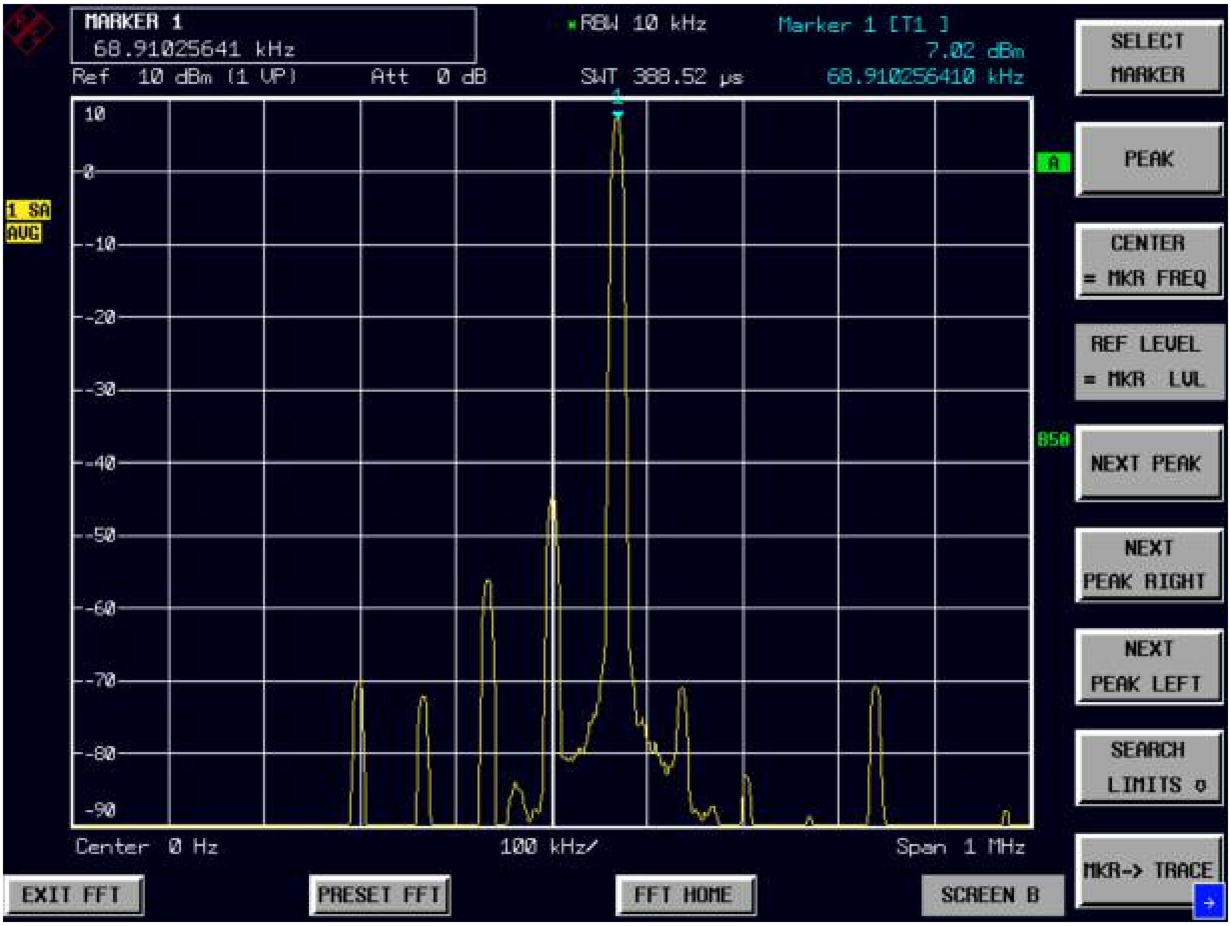


Fig. 4.24-5 Spectrum with pattern "11111..." or "00000..." used.

Note: In the spectrum you can see a small DC offset around 0 Hz and a few harmonics at multiples of 67.708 kHz.

We now want to generate a complex rotating phasor with the opposite direction of rotation:

9. Switch the signal generator to alternating bit pattern "10101..."
   - Operator interactions depend on the signal generator used.
     Important: Differential coding must be used.
10. Use the marker to measure the frequency and the level of the rotating phasor:
    - Press the *MKR ⇒* key, then the *PEAK* softkey.

Now you can see (Fig. 4.24-6) the spectrum of the same complex rotating phasor, but with the opposite direction of rotation. The level measured by the marker stays the same.

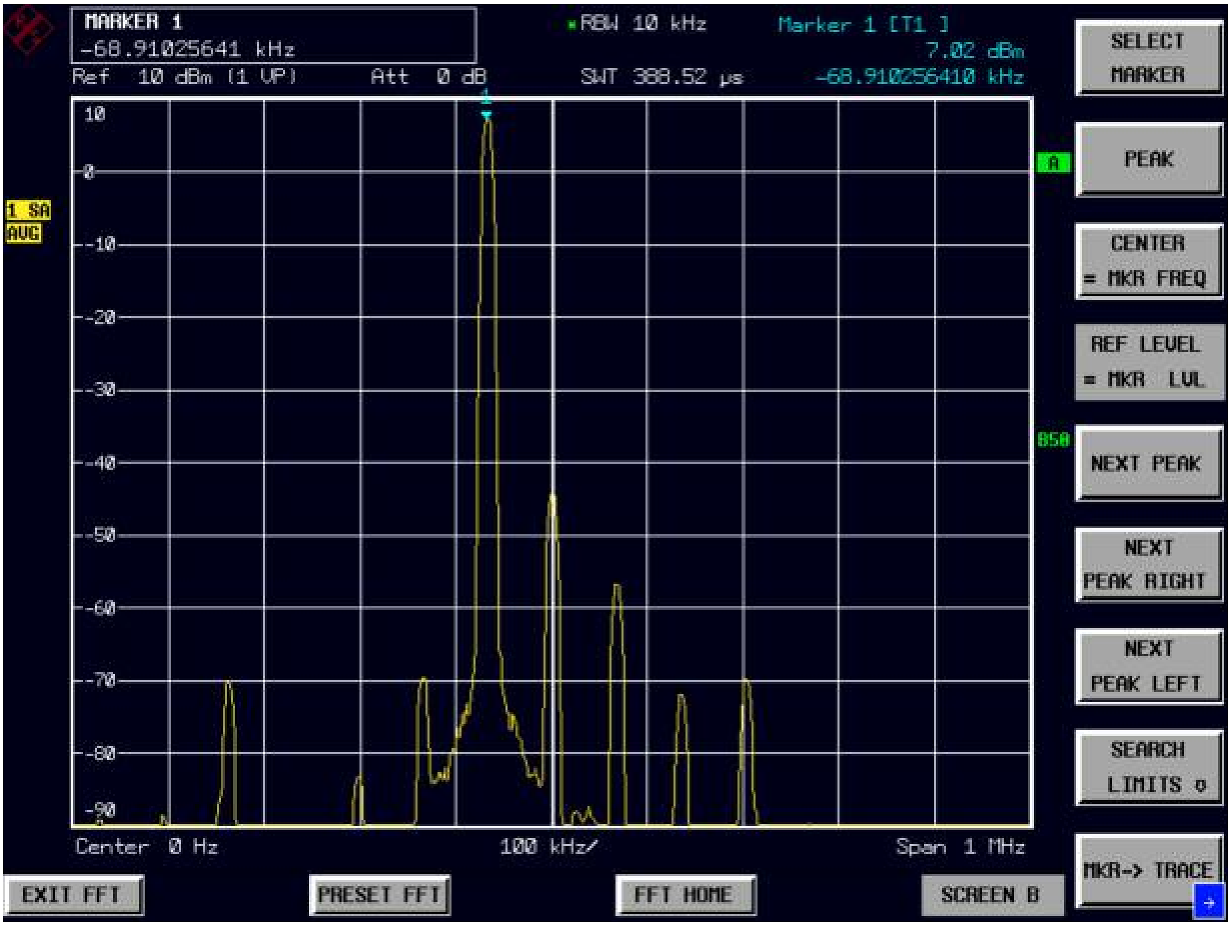


Fig. 4.24-6 Spectrum with pattern "101010..." used.

11. Switch from a complex to a real input signal:
    - Disconnect the cable from the Q input of the FSQ.

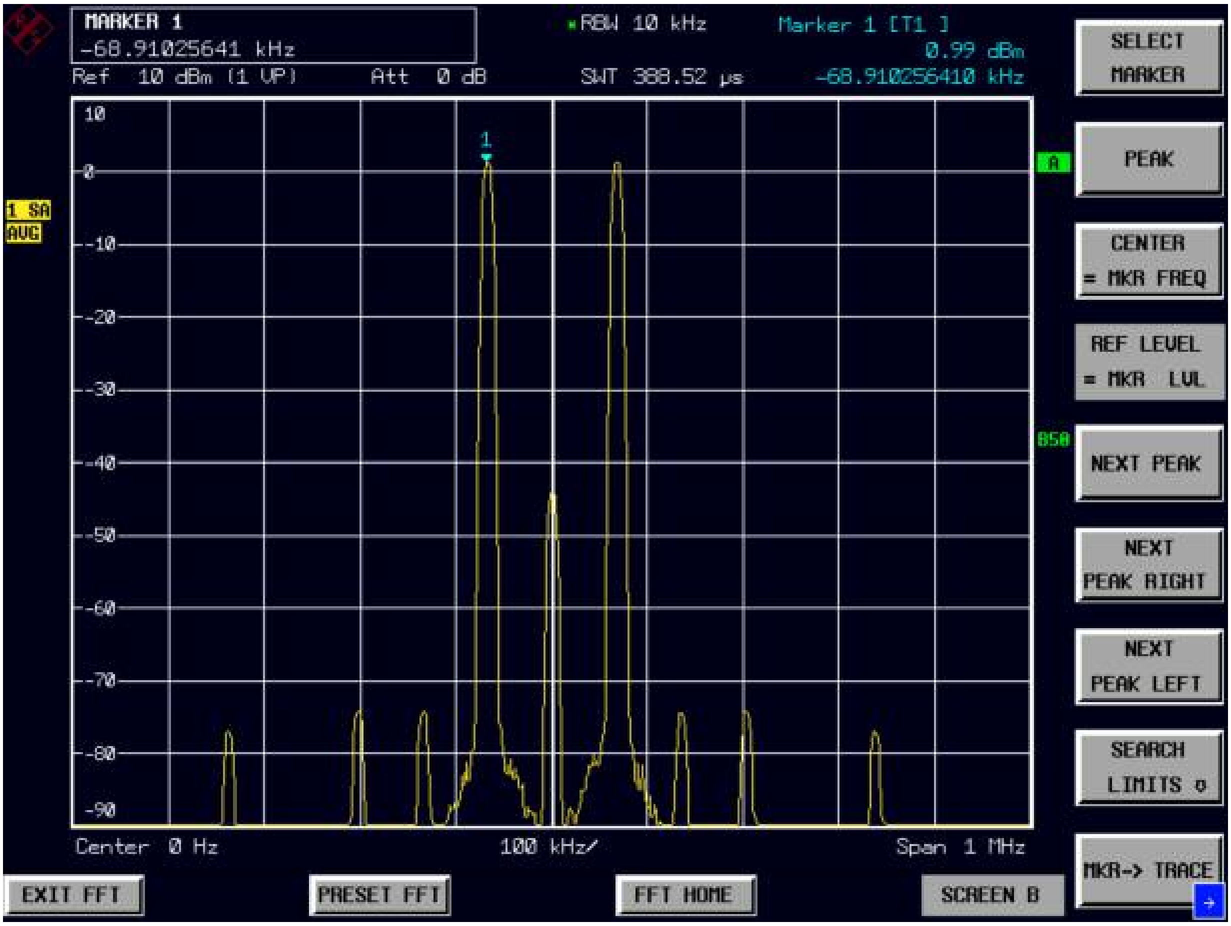


Fig. 4.24-7 Spectrum after disconnecting the Q signal. Misconfiguration of the FFT analyzer!

You can see (Fig. 4.24-7) the complex spectrum of a real carrier. The level of the carrier measured by the marker is 6 dB smaller now. This is because half of the input power is now missing (one cable disconnected). Due to the complex FFT, the remaining power is additionally split into equal shares on a rotating phasor with a negative frequency and another one with a positive frequency.

Expressed mathematically: $\cos(\varpi \cdot t) = \frac{1}{2} \cdot (e^{j \cdot \varpi \cdot t} + e^{-j \cdot \varpi \cdot t})$

Conclusion: When measuring real signals, you should not use the configuration *I+j*Q*.

We remove the current misadjustment to get the correct spectrum of the signal applied to the I input:

12.Switch to real input signals:

- ➢ Press the *HOME FFT* hotkey, then *SIGNAL SOURCE*, then *IQ PATH*, then *I ONLY*

13.Use the marker to measure the frequency and the level of the rotating phasor:

- ➢ Press the *MKR* ⇒ key, then the *PEAK* softkey.

The FFT analyzer omits the range of negative frequencies due to the selection of real input signals. The spectrum of a real signal is symmetrical to 0 Hz.
The correct level is now shown in the range of positive frequencies (see Fig. 4.24-8). The level is now half of the level in Fig. 4.24-5.

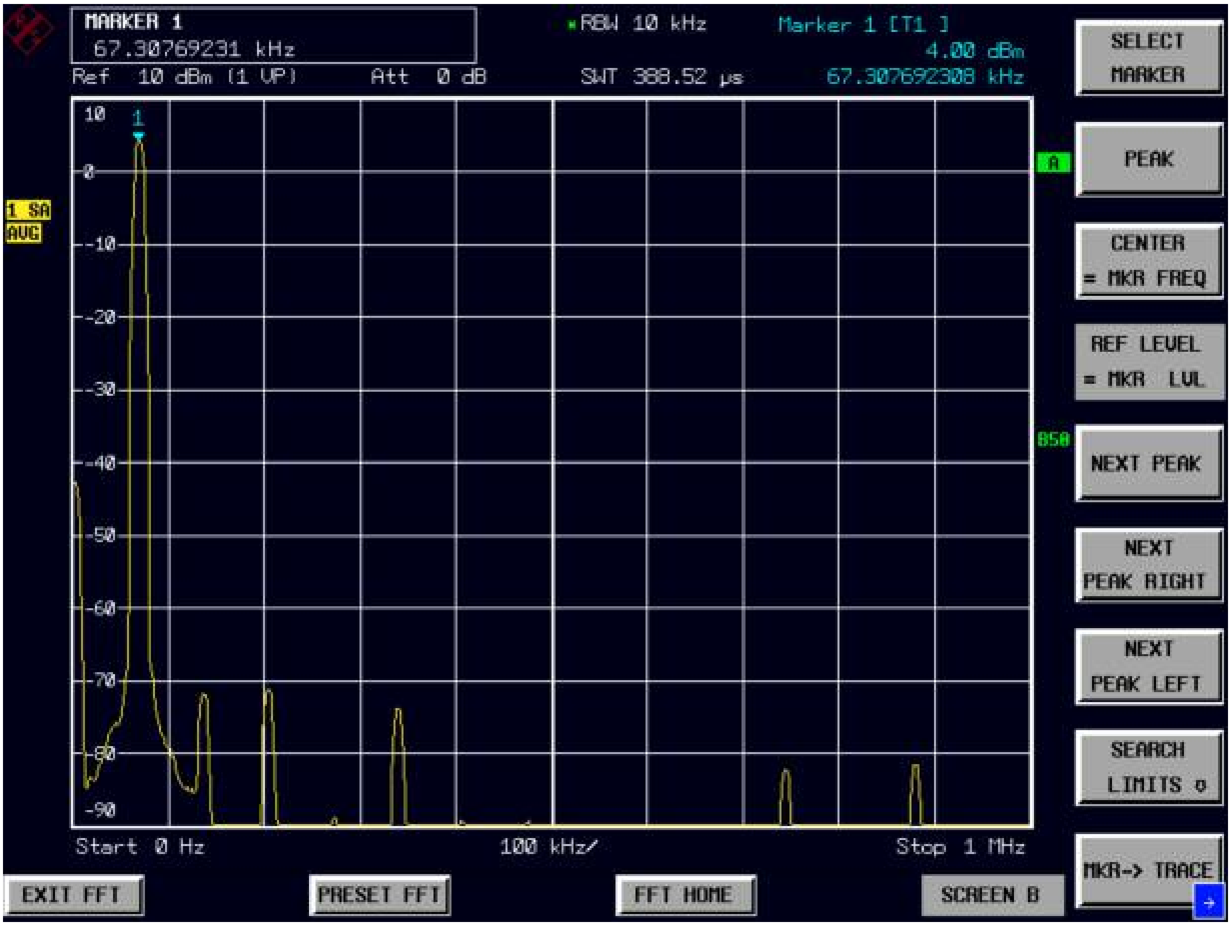
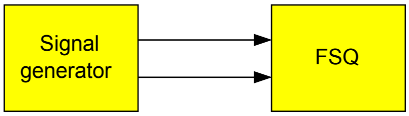


Fig. 4.24-8 Spectrum after switching to real input signals.

Measurement example 2 – Function of the RECALC softkey

This measurement example shall demonstrate the application possibilities of the RECALC function. We are using it in this example to measure the phase difference between the sine oscillations at the I and Q input. As in the previous example, a complex phasor is used as the input signal.

Test setup:



Settings on the signal generator (e.g. R&S SMIQ or R&S SMU)

Frequency:	not relevant, because the baseband output is used
Level:	not relevant, because the baseband output is used
Modulation:	GSM standard; "1111..." or "0000...." pattern is used

The I baseband output of the signal generator is connected to the I baseband input of the FSQ. The Q baseband output of the signal generator is connected to the Q baseband input of the FSQ. With asymmetrical cabling, the "unbalanced" inputs of the FSQ must be used.

Measurements with the FFT analyzer

1. Set the FSQ to its default state:
   - ➢ Press the *PRESET* key.
2. Change to the FFT analyzer:
   - ➢ Press the *FFT* hotkey.
3. Configure the baseband input:
   - ➢ Press the *SIGNAL SOURCE* softkey.
   - ➢ Select the appropriate input impedance using the *IQ INPUT* softkey (the input impedance depends on the signal generator).
   - ➢ Use the *BALANCED* softkey to set the measurement mode (balanced / referenced to ground) (depends on the signal generator).
4. Initiate capturing of data:
   - ➢ Press the *SWEEP* key, then the *SINGLE SWEEP* softkey.

The memory was now filled completely with sampled data of the signals applied to the I and Q inputs (because the CAPTURE BOTH DOMAINS softkey was active).
All following measurements of this measurement example are completely based on this data, since the *RECALC* or the *RECALC AUTO* softkeys will be used each time. You could already disconnect both cables now or connect a new device under test.

5. Switch on the automatic RECALC:
   - ➢ Press the *SWEEP* key, then the *NEXT* hardkey, then the *RECALC AUTO* softkey.

We already know the frequency of the rotating phasor from the previous measurement example. It is 270.8333 kHz / 4 = 67.708 kHz.

6. Set the span to 200 Hz and the center frequency to 67.708 kHz:
   - ➢ Press the *SPAN* key and enter 200 Hz.
   - ➢ Press the *FREQ* key and enter 67.708 kHz.
7. Switch on the phase information:

- Press the *HOME FFT* hotkey, then *FREQUENCY DOMAIN*, then the *MAGNITUDE PHASE* softkey.

.

8. Measure the phase of the signal applied to the I input:
   - Press the *HOME FFT* hotkey, then *SIGNAL SOURCE*, then the *I-ONLY* softkey.
   - Press the *MKR* key. Then enter 67.708 kHz.

In the marker information field you can read the phase of the sine wave applied to the I input (see Fig. 4.24-9).

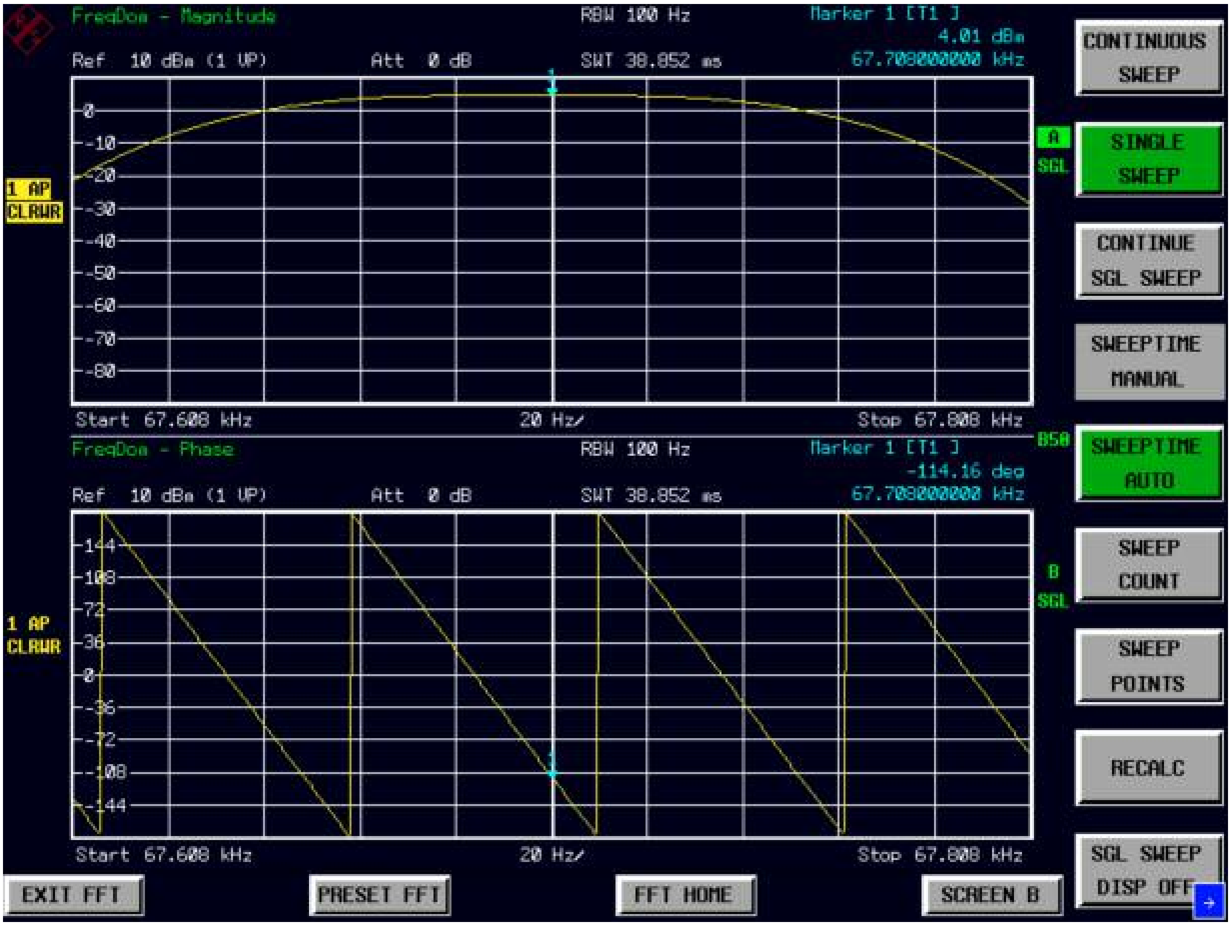


Fig. 4.24-9 Example of the measurement of the phase of the sine wave applied to the I input.

9. Measure the phase of the signal applied to the Q input:
   - Press the *HOME FFT* hotkey, then *SIGNAL SOURCE*, then the *Q-ONLY* softkey.

Fig. 4.24-10 Example of the measurement of the phase of the sine wave applied to the Q input.

In the marker information field you can read the phase of the sine wave applied to the Q input (see Fig. 4.24-10).

The phase difference between the I and the Q input is 155.89˚ - (-114.16˚) = 270.05˚ = -89.95˚.

Now we want to observe both signals in the time domain:

10. Switch to time domain. Show both signals simultaneously:
    - ➢ Press the *HOME FFT* hotkey, then *SIGNAL SOURCE*, then the *I+j*Q* softkey.
    - ➢ Press the *HOME FFT* hotkey, then *TIME DOMAIN*, then the *VOLTAGE* softkey.
11. Switch off the mixer and set up the sweep time:
    - ➢ Press the *FREQ* key, then enter 0 Hz.
    - ➢ Press the *SWEEP* key, then enter 20 µs.
12. Search for the maximum of the signal applied to the I input:
    - ➢ Press the *MKR* key. The marker searches for the maximum of the trace of the I input automatically. The other marker is automatically moved synchronously on the trace of the Q input.

At the found maximum, you can see (Fig. 4.24-11) a zero crossing of the sine wave applied to the Q input. The phase difference is therefore again about -90°.

Note: *This measurement in the time domain does not reach the accuracy of the previous one in the frequency domain. It should only show that you can also switch between time domain and frequency domain when using CAPTURE BOTH DOMAINS and RECALC.*

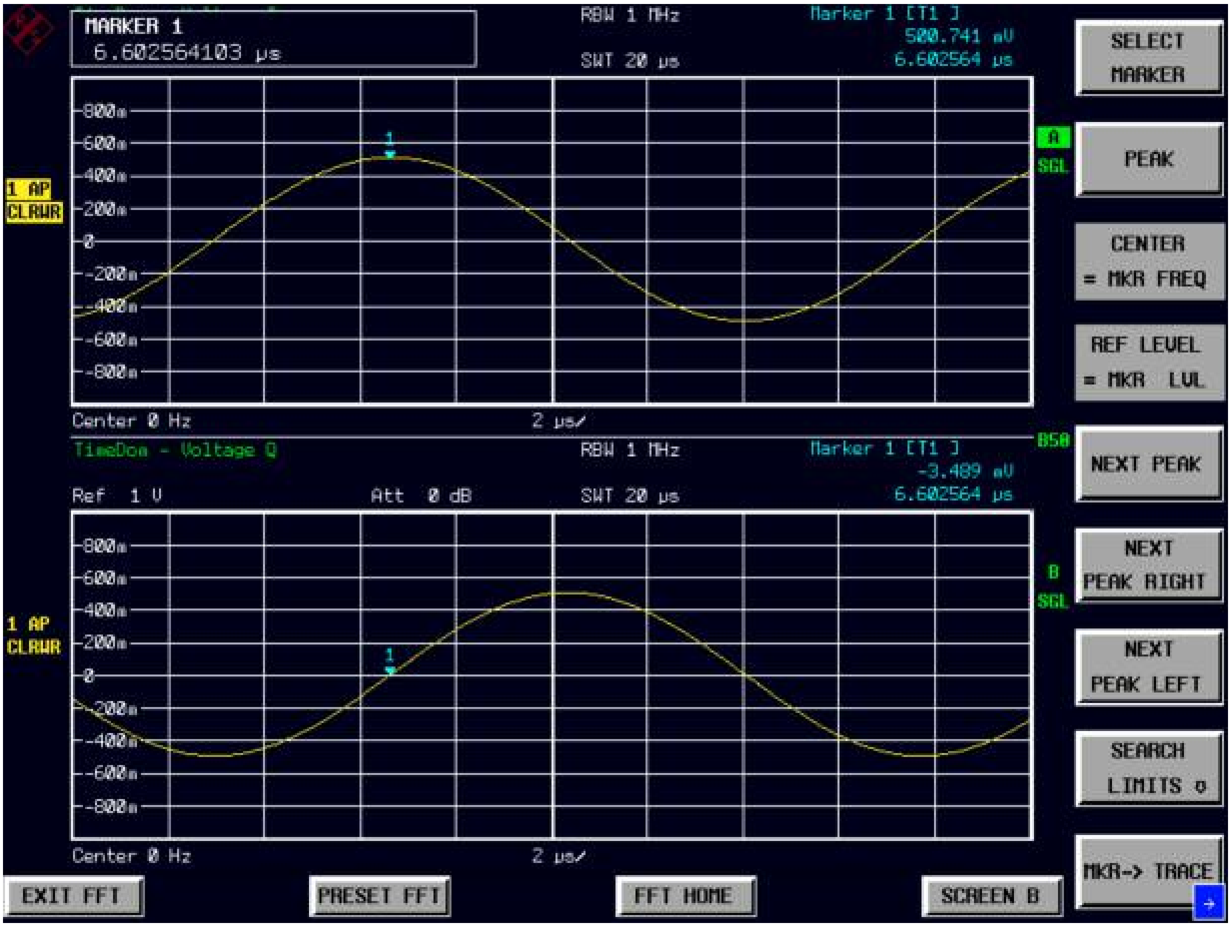


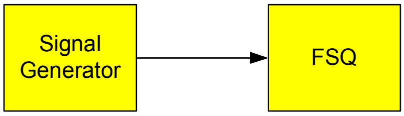
Fig. 4.24-11: Both signals shown simultaneously in the time domain.

Measurements on AM signals

This measurement example is based on the corresponding measurement example given in the FSQ operating manual. Refer to chapter 2 onwards for details on the technical background.
In this example, an AM signal with a frequency of 100 MHz has been measured. If, however, the signal has a very low intermediate frequency, it will not be possible to measure this signal using the RF input (insufficient LO suppression). The analog baseband input in combination with the FFT Analyzer provides almost exactly the same possibilities for analyzing this low IF signal.

Measurement example 1 – Displaying the AF of an AM signal in the time domain

Test setup:



Settings at the signal generator (e.g. R&S SMIQ or SMU)

Frequency:	10 MHz
Level:	0 dBm
Modulation:	50 % AM, 1 kHz AF

The RF output of the signal generator is connected to the I baseband input of the FSQ. With asymmetrical cabling, the "unbalanced" I input must be used.

Measurements with the FFT Analyzer

1. Set the FSQ to its default state:
   - Press the PRESET key.
2. Change to the FFT Analyzer:
   - Press the *FFT* hotkey.
3. Configure the baseband input:
   - Press the *SIGNAL SOURCE* softkey.
   - Select the appropriate input impedance using the *IQ INPUT* softkey (the input impedance depends on the signal generator).
   - Use the *BALANCED* softkey to set the measurement mode (balanced / referenced to ground) (depends on the signal generator).
   - Press the *IQ PATH* softkey and then the *I ONLY* softkey to select the I input only.
4. Set the center frequency and then set the span to 0 Hz:
   - Press the *FREQ* key and enter 10 MHz.
   - Press the *SPAN* key and enter 0 Hz.
5. Set the reference level to a peak voltage of 0.562 V and the display range to linear.
   - Press the *AMPT* key and enter 0.562 V.
   - Press the *RANGE LINEAR* softkey.
6. Switch to *SINGLE SWEEP* to obtain a static image:
   - Press the *SWEEP* key and then the *SINGLE SWEEP* key.

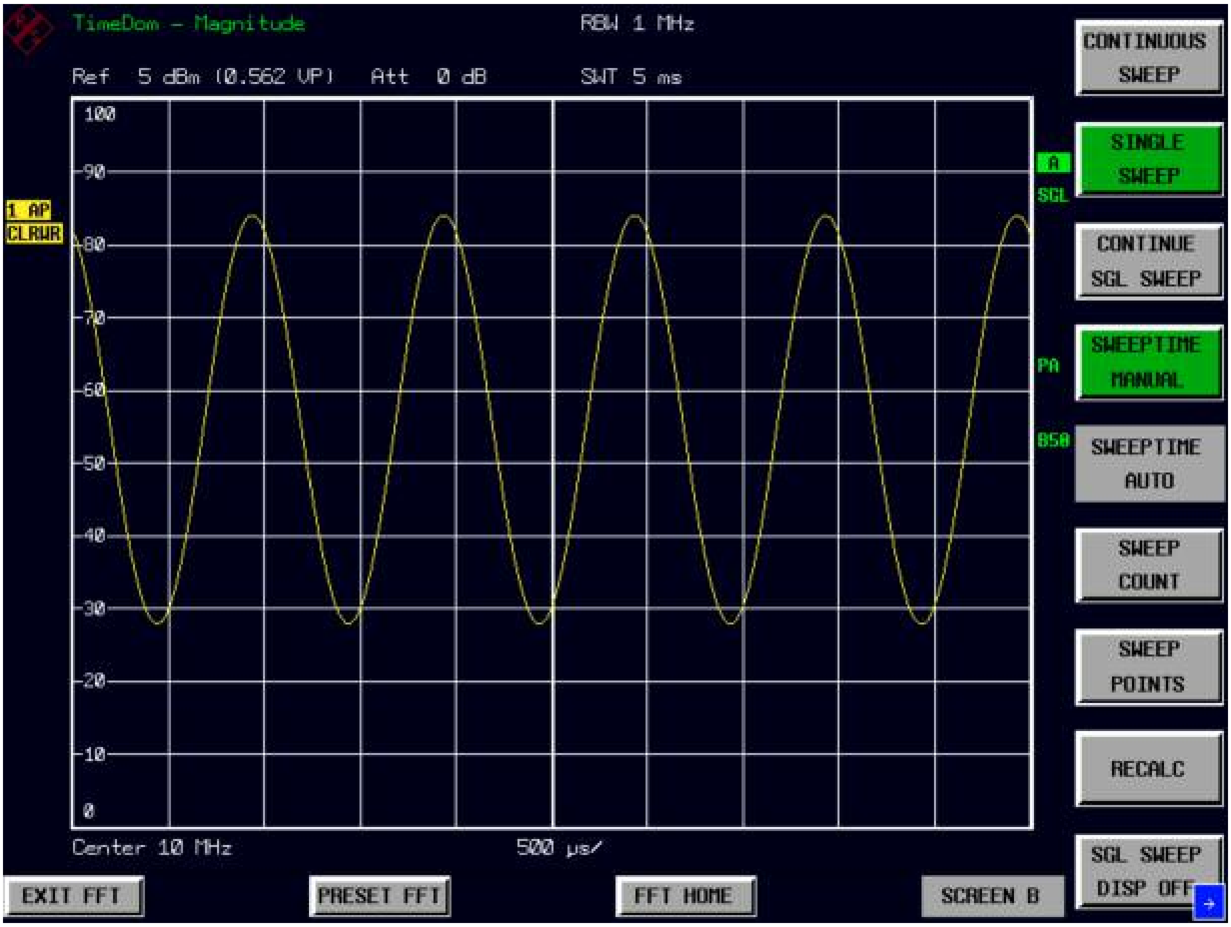
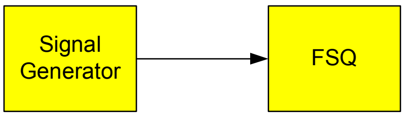


Fig.4.24-12: Measuring the 1 KHz AF-signal, which modulated the carrier

The display shows the demodulated AF signal. In the FFT Analyzer, however, there is no means of triggering the video signal or monitoring the modulated signal (because signal processing is done off-line).

Measurement example 2 – Measuring the modulation depth of an AM carrier in the frequency domain



Settings at the signal generator (e.g. R&S SMIQ or SMU)

Frequency:	10 MHz
Level:	-30 dBm
Modulation:	50% AM, 1 kHz AF

The RF output of the signal generator is connected to the I baseband input of the FSQ. With asymmetrical cabling, the "unbalanced" I input must be used.

Measurements with the FFT Analyzer:

1. Set the FSQ to its default state:
   - Press the *PRESET* key.
2. Change to the FFT Analyzer:
   - Press the *FFT* hotkey.
3. Configure the baseband input:
   - Press the *SIGNAL SOURCE* softkey.
   - Select the appropriate input impedance using the *IQ INPUT* softkey.
   - Use the *BALANCED* softkey to set the measurement mode (balanced / referenced to ground).
   - Press the *IQ PATH* softkey and then the *I ONLY* softkey to select the I input only.
4. Set the center frequency and then set the span to 5 kHz:
   - Press the *FREQ* key and enter 10 MHz.
   - Press the *SPAN* key and enter 5 kHz.
5. Set the reference level to a peak voltage of 0.178 V.
   - Press the *AMPT* key and enter 0.178 V.
6. Activate the marker function for measuring the AM modulation depth.
   - Press the *MEAS* key.
   - Press the *MODULATION DEPTH* softkey.
     The FSQ automatically sets a marker on the carrier signal in the center of the diagram and one delta marker each on the upper and lower AM sidebands. The FFT Analyzer calculates the AM modulation depth from the level differences of the delta markers relative to the main marker and outputs the numeric value in the marker information field („MDEPTH 50.158%“).

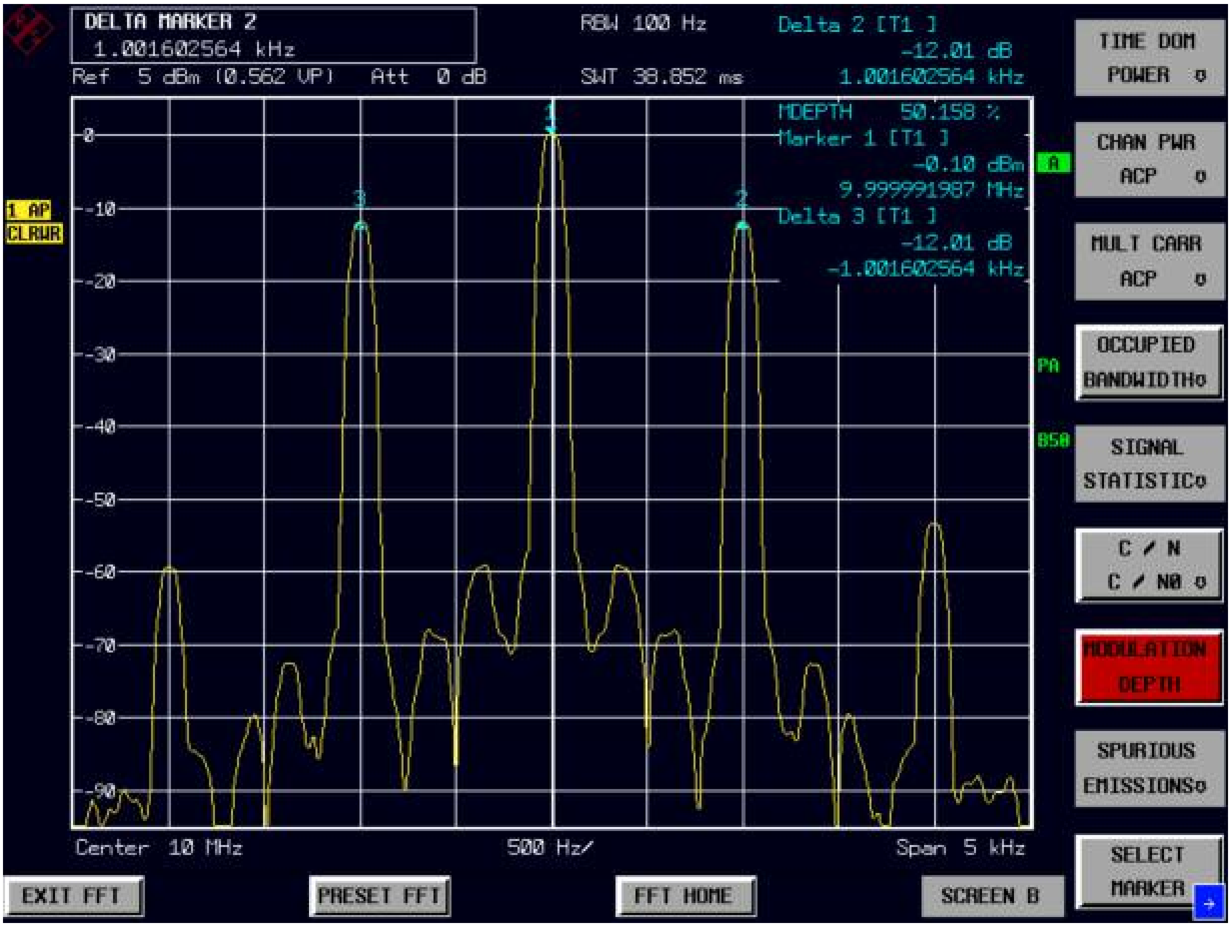


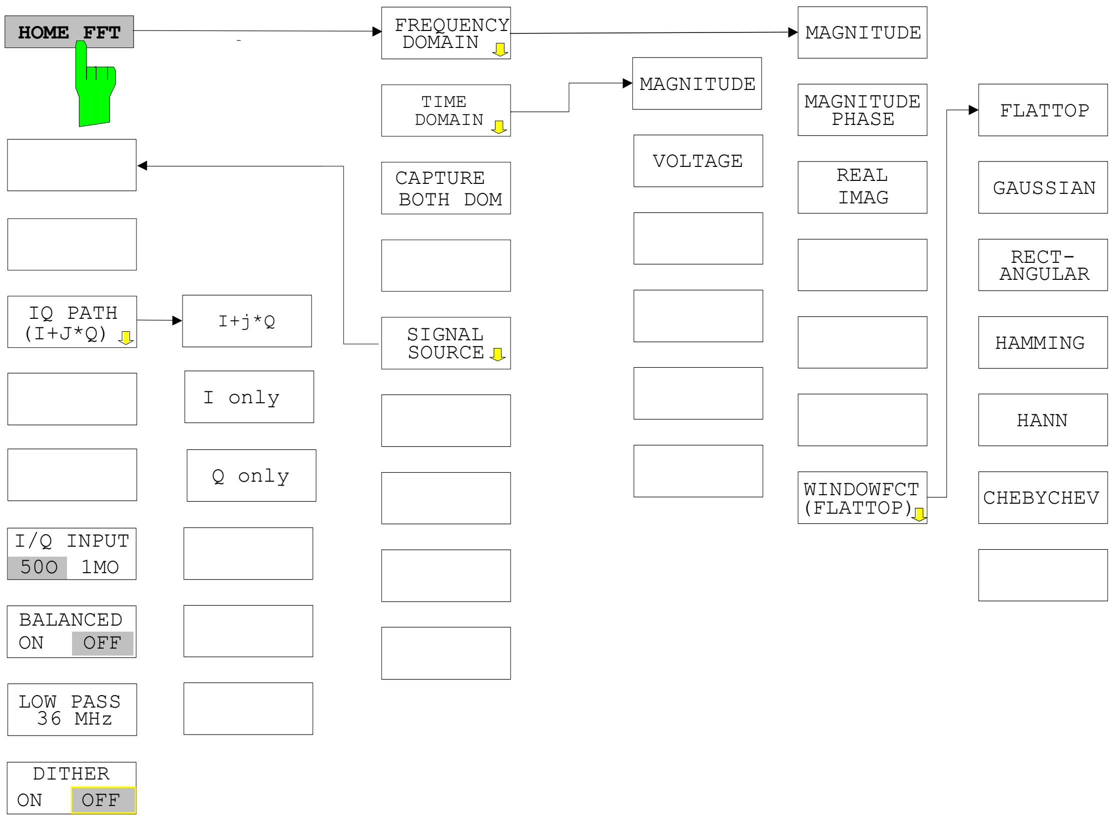
Fig.4.24-13: Measuring the AM modulation depth in the frequency domain

Manual operation of the FFT Analyzer

The FFT Analyzer is operated in largely the same way as the FSQ.
The most significant differences are as follows:

- Negative frequencies can now also be set for certain parameters (Center Frequency, Start Frequency, etc).
- Other interdependencies exist between frequency resolution, measurement time and frequency span.

Overview of menus



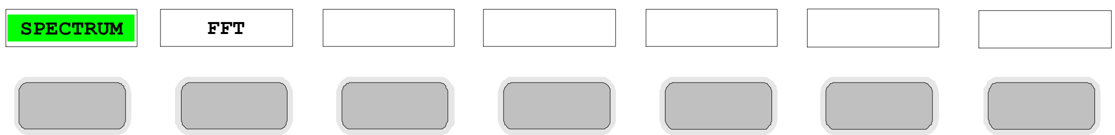
Instrument functions of the FFT Analyzer

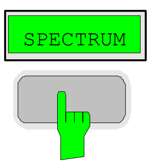
All the FFT analyzer functions and their uses are described in this chapter. The order in which the menu groups are described follows that of the procedures for configuring and starting measurements:

1. Resetting the instrument – PRESET key
2. Setting the operating mode – hotkey bar
3. Setting the measurement parameters – FREQ, SPAN, AMPT, BW, SWEEP, TRIG, TRACE and CAL keys
4. Selection and configuration of the measurement function – MKR, MKR->, MKR FCTN, MEAS and LINES keys

Selecting the operating mode – HOTKEY bar

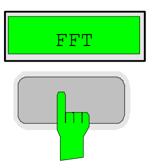
The FSQ has seven keys ("hotkeys") below the display to allow fast selection of the various operating modes. These keys may have different functions depending on the available instrument options.
The illustration below shows how the hotkey bar may look if the instrument is in the *Spectrum Analysis* mode and not yet in the *FFT Analyzer* mode.





The *SPECTRUM* hotkey switches the FSQ to the *Spectrum Analysis* mode.

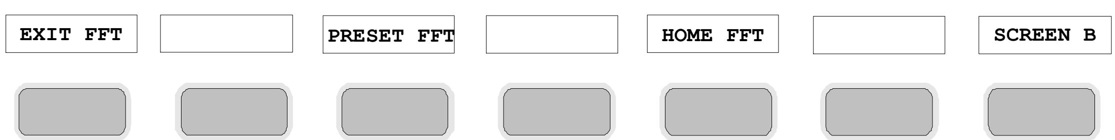
IEC/IEEE bus command: `INST:SEL SAN`

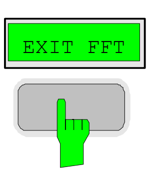


The *FFT* hotkey switches the FSQ to the FFT Analyzer mode.

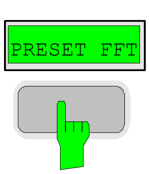
IEC/IEEE bus command: `INST:SEL FAN`

Pressing the *FFT* key activates the *FFT Analyzer* mode and the hotkey bar has the following appearance:



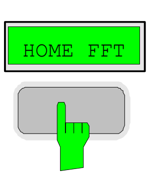


The *EXIT FFT* hotkey switches the FSQ back to the *Spectrum Analysis* mode. There is no IEC/IEEE bus command for this function. Every IEC/IEEE bus command which is used to switch to a different operating mode has the same effect.

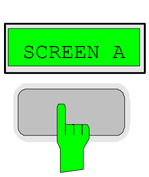


The *PRESET FFT* hotkey sets the FFT Analyzer to a predefined state. See Chapter “Default settings of the FFT Analyzer – *PRESET FFT* key”.

IEC/IEEE bus command: SENS:FFT:PRES

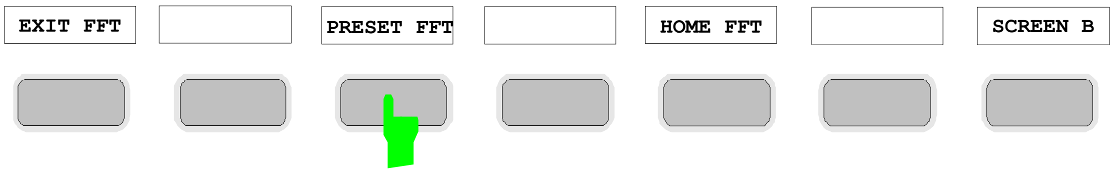


The *HOME FFT* hotkey opens the main menu of the FFT Analyzer.



Real split-screen mode is not possible in the FFT Analyzer. Although in the FFT Analyzer there are measurements with a split screen, these measurements cannot display the results of two completely independent measurements. The SCREEN A / SCREEN B hotkey can only be used in measurements that automatically display split-screen diagrams. Marker operations and the configuration of the diagram axes can be switched between the upper diagram (SCREEN A) and the lower one (SCREEN B) with this hotkey.

Default settings of the FFT Analyzer – *PRESET FFT* key



The *PRESET FFT* key sets the FFT Analyzer to a predefined default state.

IEC/IEEE bus command: SENS:FFT:PRES

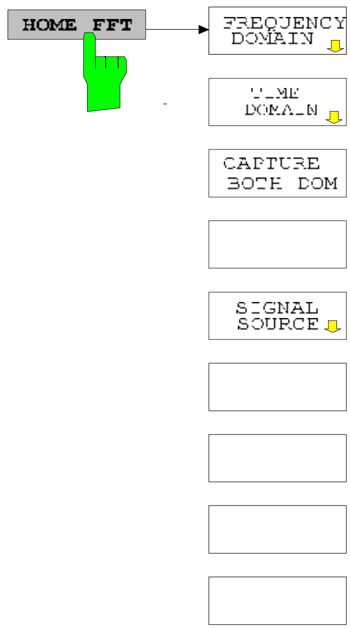
Pressing the *PRESET FFT* key sets the default settings in the FFT Analyzer as shown in Table 4.24-2.

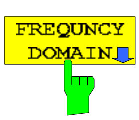
Table 4.24-2 Default settings of the FFT Analyzer

Parameter	**Setting**
Operating mode (Mode)	FFT Analyzer
FFT Analyzer mode	Frequency Domain, *Magnitude* diagram
Capture Both Domains	On
Window function	Flattop
Center frequency	0 Hz
Center frequency step	0.1 * span
Frequency span (Span)	72 MHz
Reference level (Ref Level)	1.0 V Peak
Level range	100 dB log
Level unit	dBm
Resolution bandwidth (Res BW)	auto
Span / RBW	50
Sweep	cont
Sweep count	0
Sweep points	625
Trigger	free run
Trace 1	clr write
Trace 2/3	blank
Detector	auto peak
Trace Math	off
Freq Offset	0 Hz
Ref Level Offset	0 dB
Ref Level Position	100 %
Grid	abs
Cal Correction	on
Measurement mode I/Q balanced / unbalanced	balanced
Input impedance HIGH / LOW	Low (50 Ω)
Type of signal at baseband input (*IQ Path*)	I+jQ
Baseband input dither signal ON / OFF	Off
Baseband input analog lowpass filter 36 MHz On / Off	On

Main menu of the FFT Analyzer

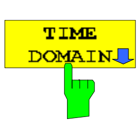
This softkey main menu appears on the right-hand side of the display immediately after the *FFT Analyzer* mode is started or whenever the *HOME FFT* hotkey is pressed.





The *FREQUENCY DOMAIN* softkey opens a submenu in which various types of spectrum measurements can be selected. The softkey activates the *Frequency Domain* mode and deactivates the *Time Domain* mode.
Note: The *Frequency Domain* mode can also be activated by entering a *SPAN* larger than 0 Hz (see chapter “Setting the frequency span – SPAN key.

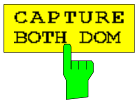
IEC/IEEE bus command: `SENS:FREQ:SPAN 10MHz`



The *TIME DOMAIN* softkey opens a submenu in which various types of time-domain measurements can be selected.
The softkey activates the *Time Domain* mode and deactivates the *Frequency Domain* mode.

Note: *The Time Domain mode can also be activated by entering a SPAN of 0 Hz (see Chapter “Setting the frequency span – SPAN key”).*

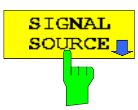
IEC/IEEE bus command: `SENS:FREQ:SPAN 0Hz`



The *CAPTURE BOTH DOM* softkey (short for "capture both domains") has a toggle function. Function active: In single sweep mode, the entire I/Q data memory is always filled with unfiltered raw data first. By using the *RECALC* and *RECALC AUTO* softkeys in the *SWEEP* menu, this data can then be analyzed as often as required using different instrument settings. This is possible in both the time and frequency domain, hence the name of the softkey.

Function not active: Data acquisition is optimized for the currently selected measurement task. This means that the observation time is only as long as necessary. As a result, measurements are generally performed more quickly, unless the measurement settings force data to be written directly to the memory. If the function is not active and the data rate can be reduced prior to writing the data to the memory, this will permit a longer observation time and a better frequency resolution.

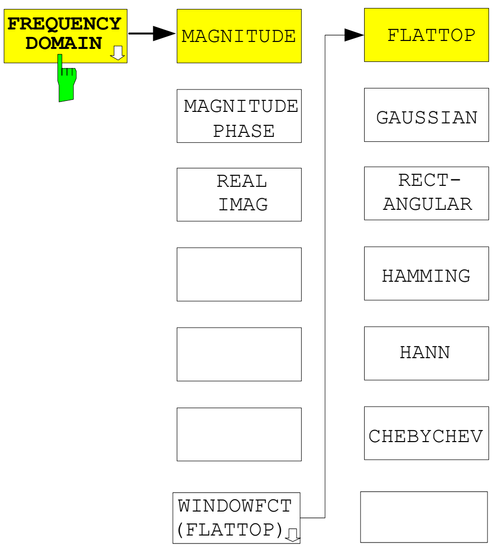
IEC/IEEE bus command: `SENS:FFT:CAPT ON`



The *SIGNAL SOURCE* softkey opens a submenu in which the properties of the input signal and the way in which the signal is to be processed can be defined.
IEC/IEEE bus command: -

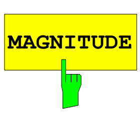
Frequency Domain submenu of the FFT Analyzer

This submenu appears when the *FREQUENCY DOMAIN* softkey in the main menu of the FFT Analyzer is pressed.



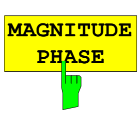
The first three softkeys are used to select the display mode for the measured spectrum. The softkey changes color when selected. Pressing a different softkey toggles the selection.

The displayed spectrum range depends primarily on the parameters *SPAN / CENTER FREQUENCY* and *START FREQUENCY / STOP FREQUENCY*. The frequency resolution is determined using the parameter *RESOLUTION BANDWIDTH* (*RBW*). The selected window function determines the filter shape and the shape factor. The window function and the RBW together determine the data acquisition time (i.e. *SWEEP TIME*) which is automatically selected internally.



If the *MAGNITUDE* softkey is selected, only the magnitude of the spectrum is displayed as the result. The functions which are also used in the spectrum analysis mode (e.g. in the *MEAS* menu) and which require a level trace can be applied to this trace.

IEC/IEEE bus command: `CALC:FORM MAGN`

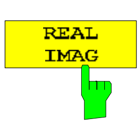


If the *MAGNITUDE PHASE* softkey is selected, the magnitude of the spectrum and its phase information are displayed as the result.

Note: *This option should only be selected for single measurements or when using a trigger with periodic signals.*

It should be noted that scaling of the phase information can be controlled using a special submenu (*PHASE SETTINGS*) opened with the *AMPT* key.

IEC/IEEE bus command: `CALC:FORM MPH`

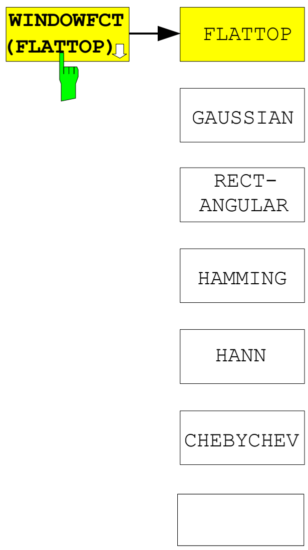


If the *REAL IMAG* softkey is selected, the real and imaginary parts of the spectrum are displayed as the result. The results are displayed on a linear scale.

Note: *This option should only be selected for single measurements or when using a trigger with periodic signals.*

A number of measurements (e.g. from the menu opened with the *MEAS* key) are not permitted in this display mode.

IEC/IEEE bus command: `CALC:FORM RIM`



The *WINDOWFCT* softkey (short for "window function") opens a submenu in which the window function for the FFT input data can be selected. The input data for the FFT is multiplied by the selected window function. This suppresses leakage effects (but not in the case of the rectangular window).

The softkey also indicates the type of window function currently active.

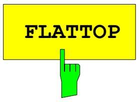
Note: *The window function is completely irrelevant in the Time Domain mode.*

Selecting a different window function changes the filter shape of the resolution filter, e.g.:

- shape factor: ratio of –60 dB bandwidth to –3 dB bandwidth
- sidelobe fall-off
- attenuation of highest sidelobe

The equivalent noise bandwidth remains constant when the window function is changed. This is achieved by adapting the acquisition time (referred to as *SWEEPTIME* in the *Spectrum Analysis* mode of the FFT Analyzer).

Important: *In the FFT Analyzer, the equivalent noise bandwidth is used as the entry for RESOLUTION BANDWIDTH.*

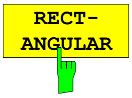


The *FLATTOP* softkey selects a "flattop" window function. It provides optimum amplitude accuracy. It is therefore the default setting. It is also suitable for measurements with a wide dynamic range because the sidelobes are attenuated very effectively.

IEC/IEEE bus command: `SENS:WIND:TYPE FLAT`

The *GAUSSIAN* softkey selects a "Gaussian" window function.
It is also suitable for measurements with a wide dynamic range because the sidelobes are attenuated very effectively.

IEC/IEEE bus command: `SENS:WIND:TYPE EXP`



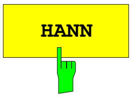
The *RECTANGULAR* softkey selects a "rectangular" window function. The input data is then not weighted differently but instead remains unchanged. This type of window function is also referred to as "boxcar window" or "transient window".
It should be used for brief transient signals (no data is lost).
It should be used in cases where only frequency resolution is an important factor.
It is otherwise unsuitable since leakage is not suppressed.

IEC/IEEE bus command: `SENS:WIND:TYPE RECT`

The *HAMMING* softkey selects a "Hamming" window function.

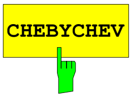
Note: *It is not suitable for measurements with a wide dynamic range.*

IEC/IEEE bus command: `SENS:WIND:TYPE HAMM`



The *HANN* softkey selects a "Hann" window function (sometimes also referred to as "Hanning").
It is sometimes used for measurements on noise-like signals.

IEC/IEEE bus command: `SENS:WIND:TYPE HANN`



The *CHEBYCHEV* softkey selects a "Chebychev" window function. It is also suitable for measurements with a wide dynamic range because the sidelobes are attenuated very effectively.

IEC/IEEE bus command: `SENS:WIND:TYPE CHEB`

Table 4.24-3 Window function data

	ENBW (bins)	BW_{3dB} (bins)	BW_{3dB} / ENBW	BW_{6dB} (bins)	BW_{6dB} / ENBW	Shape factor $=BW_{60dB}/BW_{3dB}$	Highest sidelobe (dB)	sidelobe fall off (dB / decade)
Flattop	3.89	3.85	0.99	4.73	1.22	2.4	-90	0
Hann	1.50	1.45	0.97	2.02	1.35	9.1	-31.5	60
Hamming	1.36	1.32	0.97	1.83	1.35	70.7	-42.6	20
Rectangular	1.00	0.89	0.89	1.21	1.21	707	-13.3	20
Gaussian	2.26	2.13	0.94	3.00	1.32	4.4	-87.6	20
Chebychev	2.03	1.95	0.96	2.72	1.34	3.84	-110	0

Explanation of the table values:

- The equivalent noise bandwidth of a filter is the bandwidth which an ideal, rectangular filter would need to have to allow the same power to pass if white noise is applied at the input.
- The value BW_{3dB} / *ENBW* indicates the factor by which the measured 3 dB bandwidth is smaller than the selected RBW (which is defined by the equivalent noise bandwidth).
  If, for example, a Hann window and an RBW of 10 kHz are used, a 3 dB bandwidth of approx. 9.7 kHz will be measured with the *N DB DOWN* measurement.
- The values of the highest sidelobe and of the sidelobe fall-off are important if measurements are to be performed with the widest possible dynamic range. The flattop, Gaussian and Chebychev windows are ideal for such measurements. The flattop and Chebychev windows have sidelobes with more or less constant attenuation.
- The shape factor is a measure of the shape of a window or filter. It is defined as the ratio of 60 dB bandwidth to 3 dB bandwidth. Small values are to be aimed for. The rectangular window and Hamming window do not perform well here.

Interdependency between observation time and window function:

In the FFT Analyzer, the equivalent noise bandwidth is used as the entry for *RESOLUTION BANDWIDTH (RBW)*. This is because the FFT has an equivalent noise bandwidth of exactly one bin if the rectangular window function is used. The frequency resolution of the FFT for this window is 1 Hz if the observation time is 1 second. RBW and observation time (here referred to as *SWEEPTIME SWT*, although no sweep principle is actually applied) are reciprocal.

The equation $\Delta f = RBW = \frac{1}{SWT}$ applies in the case of a rectangular window.

However, leakage effects occur which make the rectangular window unusable for the majority of applications. If a window function is then used to reduce these leakage effects, the data is slowly attenuated toward zero at the beginning and end of the observation time. The effective observation time drops as a result and the frequency resolution in turn becomes poorer. The *FFT* then has a noise bandwidth which is one relative equivalent noise bandwidth larger than if a rectangular window of the same length is used (see the Table 4.24-3).

$$ENBW_{rel}(window) = \frac{ENBW(window)}{ENBW(rectangular)}$$

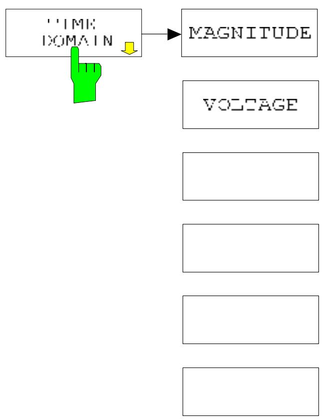
This problem can be solved by increasing the observation time by multiplying it by the relative equivalent noise bandwidth $ENBW_{rel}$ of the window function:

The equations $SWT = \frac{ENBW_{rel}}{RBW}$ and $RBW = \frac{ENBW_{rel}}{SWT}$ apply for all windows.

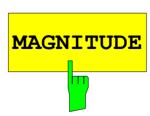
Changing the window function therefore changes the observation time. However, changing the SPAN does not change the observation time, which is in complete contrast to the Spectrum Analysis mode.

Time Domain submenu of the FFT Analyzer

This submenu appears when the *TIME DOMAIN* softkey in the main menu of the FFT Analyzer is pressed.

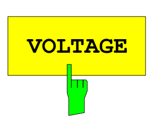


The observation time is determined by the parameter *SWEEP TIME* (*SWT*). The parameter *RESOLUTION BANDWIDTH* (*RBW*) determines the filter bandwidth. The parameter *CENTER FREQUENCY* determines the frequency which is to be exactly at the center of the filter and is not attenuated. This is achieved internally by means of frequency conversion (multiplication by a complex rotating phasor).



If the *MAGNITUDE* softkey is selected, the magnitude of the input signal (which may be offset with respect to frequency and then filtered by lowpass filters) over time is displayed as the result.
Using the *IQ PATH* softkey (in the *SIGNAL SOURCE* menu), it is possible to decide whether both paths or just one path of the baseband input is to be through-connected.

IEC/IEEE bus command: `CALC:FORM MAGN`



If the *VOLTAGE* softkey is selected, the real and imaginary parts of the input signal (which may be offset with respect to frequency and then filtered by lowpass filters) over time are displayed as the result. The diagram is split into two parts and shows the real and imaginary part on a linear scale.

If no mixing takes place *(CENTER FREQUENCY* = 0 Hz), the following applies:

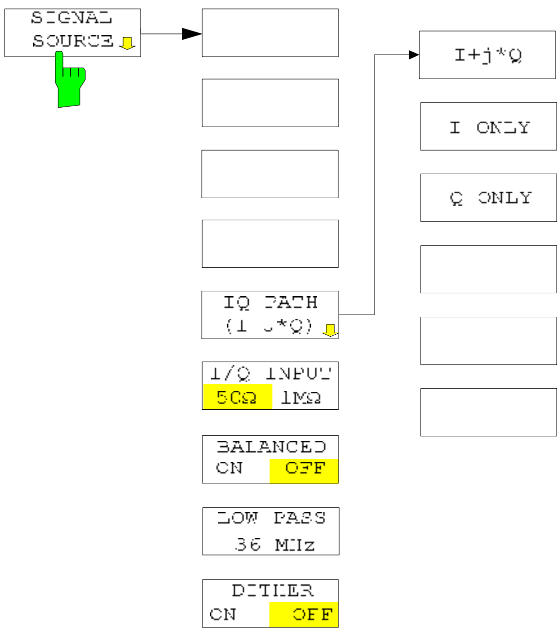
- With *IQ PATH* = *I* + *j***Q*: The real part and imaginary part of the result corresponds to the voltage characteristic at the I input and Q input.
- With *IQ PATH* = *I ONLY*: The real part of the result corresponds to the voltage characteristic at the I input. The imaginary part is zero.
- With *IQ PATH* = *Q ONLY*: The real part of the result corresponds to the voltage characteristic at the Q input. The imaginary part is zero.

A number of measurements (e.g. from the menu opened with the *MEAS* key) are not permitted in this display mode.

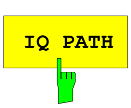
IEC/IEEE bus command: `CALC:FORM VOLT`

SIGNAL SOURCE submenu of the FFT Analyzer

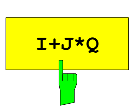
This submenu appears when the *SIGNAL SOURCE* softkey in the main menu of the FFT Analyzer is pressed.



The way in which the FFT Analyzer is to process the input signals can be defined in this menu.
A similar menu for configuring the baseband input can also be opened by pressing the *SETUP* hardkey.

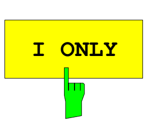


The *IQ PATH* softkey opens a submenu. The way in which the two input paths are to be interpreted can be defined in this submenu.
Only one state can be active at a time in the submenu. The color of one of the three softkeys in the submenu changes to indicate which one is active. The *IQ PATH* softkey also indicates the selected function.



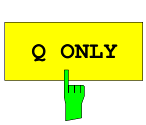
The *I+J*Q* softkey causes the FFT Analyzer to regard the signals at the I and Q input as components of a complex signal. This is the standard setting for the analysis of signals with complex modulation.

IEC/IEEE bus command: `INP:IQ:TYPE IJQ`



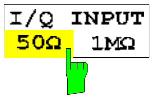
The *I ONLY* softkey causes the FFT Analyzer to regard the signal at the I input as a single, real signal. The signal at the Q input is ignored.
This setting should be selected if, for example, a signal at a low intermediate frequency is connected to the I input.

IEC/IEEE bus command: `INP:IQ:TYPE I`



The *Q ONLY* softkey causes the FFT Analyzer to regard the signal at the Q input as a single, real signal. The signal at the I input is ignored.
This setting should be selected if, for example, a signal at a low intermediate frequency is connected to the Q input.

IEC/IEEE bus command: `INP:IQ:TYPE Q`



The *IQ INPUT* 50Ω */ IQ INPUT 1MΩ* softkey is used to toggle the input impedance of the baseband inputs. The setting has the same effect on both inputs.
See also page 4.24-8.

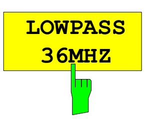
Depending on which version of the B71 module you are using, the softkey label may also be *IQ INPUT* 50Ω */ IQ INPUT 1KΩ* since the high input impedance can also be 1 kΩ.
However, the IEC/IEEE bus command uses the same keywords (*LOW / HIGH*) for both versions.

Caution: Toggling the input impedance has no effect on the power level indicated in the FFT Analyzer. It is always assumed that the measured voltage is applied to a 50 Ω resistor.

IEC/IEEE bus command: `INP:IQ:IMP LOW`

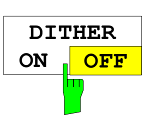
The *BALANCED ON / BALANCED OFF* softkey is used to toggle the measurement mode of the baseband inputs.
ON switches to balanced inputs; *OFF* switches to ground-referenced inputs. The setting has the same effect on both inputs.
See also page 4.24-9.

IEC/IEEE bus command: `INP:IQ:BAL:STAT ON`



The *LOWPASS 36MHZ ON / LOWPASS 36MHZ OFF* softkey is used to toggle the analog anti-aliasing lowpass filters of the baseband inputs. The setting has the same effect on both inputs.
See also page 4.24-9.

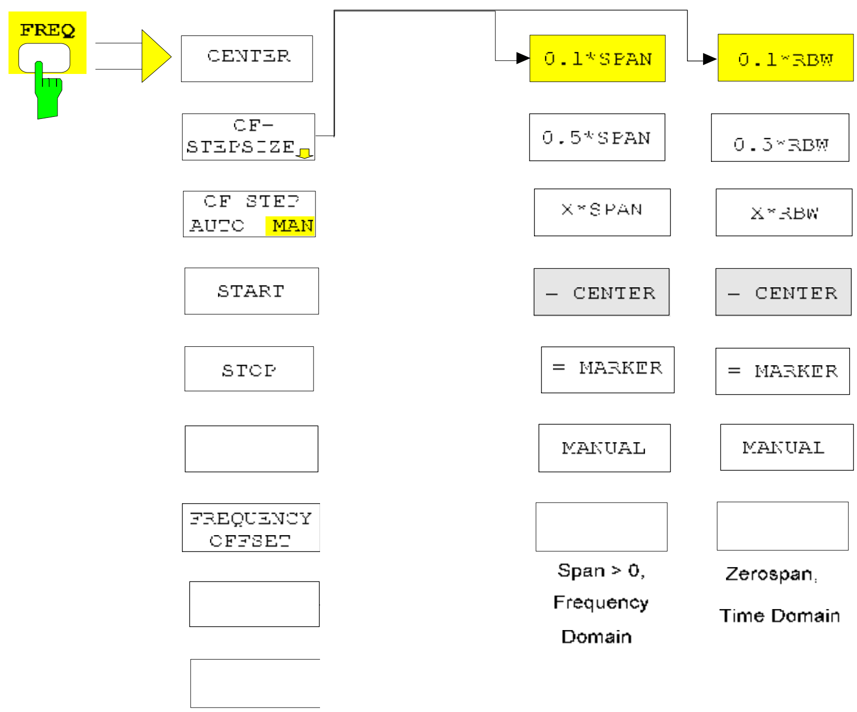
IEC/IEEE bus command: SENS:IQ:LPAS:STAT ON



The *DITHER ON / DITHER OFF* softkey is used to add a shaped dither signal to both inputs.
See page 4.24-10 in cases where this is advisable.

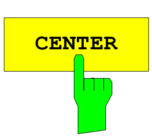
IEC/IEEE bus command: SENS:IQ:DITH:STAT ON

Selecting the frequency and frequency span – *FREQ* key



The functionality and structure of the menu tree which is opened by pressing the *FREQ* hardkey are largely the same as that for the *Spectrum Analysis* mode.
One significant difference is that the FFT Analyzer also allows negative frequencies to be entered in the case of complex input signals. However, only positive frequencies are possible for real input signals.

The functionalities *CF-STEPSIZE = CENTER* and *CF-STEPSIZE = MARKER* are disabled for the FFT Analyzer.



The *CENTER* softkey opens a window in which the center frequency can be entered.

The permissible entry ranges for the center frequency are as follows:

For the frequency domain (Frequency Domain, Span > 0):

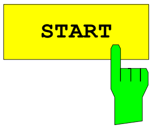
- For *IQ PATH = I + jQ* (complex signal):
  $-36\text{ MHz} + \text{Minspan}/2 \le f_{center} \le +36\text{ MHz} - \text{Minspan}/2$
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal)
  $\text{Minspan}/2 \le f_{center} \le +36\text{ MHz} - \text{Minspan}/2$

For the time domain (Time Domain, Span = 0):

- For *IQ PATH = I + jQ* (complex signal):
  $-36\text{ MHz} \le f_{center} \le 36\text{ MHz}$
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal)
  $0\text{ Hz} \le f_{center} \le 36\text{ MHz}$

f_{center} Center frequency
Minspan Smallest selectable span > 0 Hz (10 Hz)

IEC/IEEE bus command: `FREQ:CENT 10MHz`



The *START* softkey activates manual entry of the start frequency.
The permissible entry ranges for the start frequency are as follows:

For the frequency domain (Frequency Domain, Span > 0):

- For *IQ PATH = I + jQ* (complex signal):
  -36 MHz $\leq f_{start} \leq$ +36 MHz - Minspan
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal)
  0 $\leq f_{start} \leq$ +36 MHz - Minspan

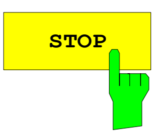
For the time domain (Time Domain, Span = 0):

- For *IQ PATH = I + jQ* (complex signal):
  -36 MHz $\leq f_{start} \leq$ 36 MHz
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal)
  0 Hz $\leq f_{start} \leq$ 36 MHz

If the entered start frequency is greater than the stop frequency, the stop frequency is set to start frequency + minspan.

f_{start}	Start frequency
Minspan	Smallest selectable span > 0 Hz (10 Hz)

IEC/IEEE bus command: `FREQ:STAR 2MHz`



The *STOP* softkey activates entry of the stop frequency.

The permissible entry ranges for the stop frequency are as follows:

For the frequency domain (Frequency Domain, Span > 0):

- For *IQ PATH = I + jQ* (complex signal):
  -36 MHz + Minspan $\leq f_{stop} \leq$ +36 MHz
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal) Minspan $\leq f_{stop} \leq$ +36 MHz

For the time domain (Time Domain, Span = 0):

- For *IQ PATH = I + jQ* (complex signal):
  -36 MHz $\leq f_{stop} \leq$ 36 MHz
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal)
  0 Hz $\leq f_{stop} \leq$ 36 MHz

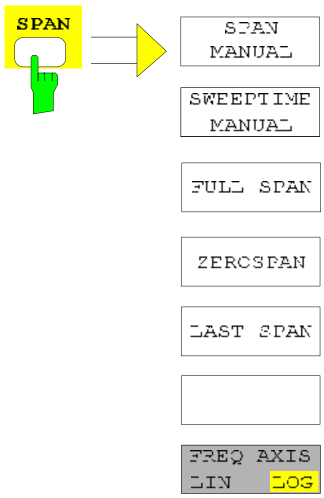
If the entered stop frequency is less than the start frequency, the start frequency is set to stop frequency - minspan.

f_{stop}	Stop frequency
Minspan	Smallest selectable span > 0 Hz (10 Hz)

IEC/IEEE bus command: `FREQ:STOP 20MHz`

The other softkeys are not explained here. Their functionality in the FFT Analyzer is the same as in the FSQ. An explanation is given from chapter 4 onwards of the FSQ operating manual.

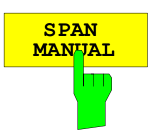
Setting the frequency span – SPAN key



The *SPAN* key opens a menu which contains the various options for setting the frequency span (Frequency Domain mode).
In the frequency domain (Span > 0), entry of the span (*SPAN MANUAL* softkey) is activated automatically. In the time domain (Span = 0), entry of the sweep time (*SWEEPTIME MANUAL* softkey) is activated automatically.

The functionality and structure of the menu tree is largely the same as that for the *Spectrum Analysis* mode.

The FREQ AXIS LIN / FREQ AXIS LOG functionality is, however, not available for the FFT Analyzer. A linear frequency axis is always selected.



The *SPAN MANUAL* softkey activates manual entry of the frequency span, whereby the center frequency is kept constant wherever possible. *CENTER FREQUENCY* is adapted automatically only if the new span projects beyond the permissible ranges. This is indicated on the display.

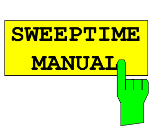
For the frequency domain (Frequency Domain, Span > 0), the permissible entry range for the frequency span is:

- For *IQ PATH = I + jQ* (complex signal):
  Minspan < f_{span} ≤ 72 MHz
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal)
  Minspan < f_{span} ≤ 36 MHz

Entering a span of 0 Hz activates the *Time Domain* mode. In this mode, 0 Hz is the only permissible value for *SPAN.*
Entering a span > 0 Hz activates the *Frequency Domain* mode.

f_{span}	Frequency span (Span)
Minspan	Smallest selectable span (10 Hz)

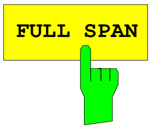
IEC/IEEE bus command: `FREQ:SPAN 2MHz`



The *SWEEPTIME MANUAL* softkey activates manual entry of the sweep time in the *Time Domain* mode (Span = 0). If the span is greater than 0, the softkey is not available as the observation time is selected internally by the firmware.

The softkey with the same label in the submenu opened by pressing the SWEEP hardkey has the same functionality. See Table 4.24-4 for the permissible values of the SWEEPTIME parameter.

IEC/IEEE bus command: `SWE:TIME 1ms`

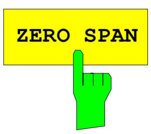


The *FULL SPAN* softkey sets the frequency span to the largest possible span in the FFT Analyzer. If the *Time Domain* mode is currently active, the mode also switches over to *Frequency Domain*.

The span and center frequency are then as follows:

- For *IQ PATH = I + jQ* (complex signal):
  SPAN = 72 MHz, i.e. –36 MHz to +36 MHz.
  CENTER FREQUENCY = 0 Hz
- For *IQ PATH = I ONLY* or *IQ PATH = Q ONLY* (real signal):
  SPAN = 36 MHz, i.e. from 0 Hz to +36 MHz
  CENTER FREQUENCY = 18 MHz

IEC/IEEE bus command: `FREQ:SPAN:FULL`



The *ZERO SPAN* softkey sets the frequency span to 0 Hz. As a result, the mode of the FFT Analyzer changes to *Time Domain*.
The x-axis becomes the time axis, whereby the gridlines each correspond to 1/10 of the current sweep time (*SWT*).

IEC/IEEE bus command: `FREQ:SPAN 0Hz`

If the frequency span has been changed, pressing the *LAST SPAN* softkey restores the previous setting on the instrument. In this way, it is possible to switch between an overview measurement (*FULL SPAN*) and a detailed measurement (manually selected center frequency and span).

Note: *The last span value is restored if and only if the span is > 0, i.e. the time domain is not selected automatically.*

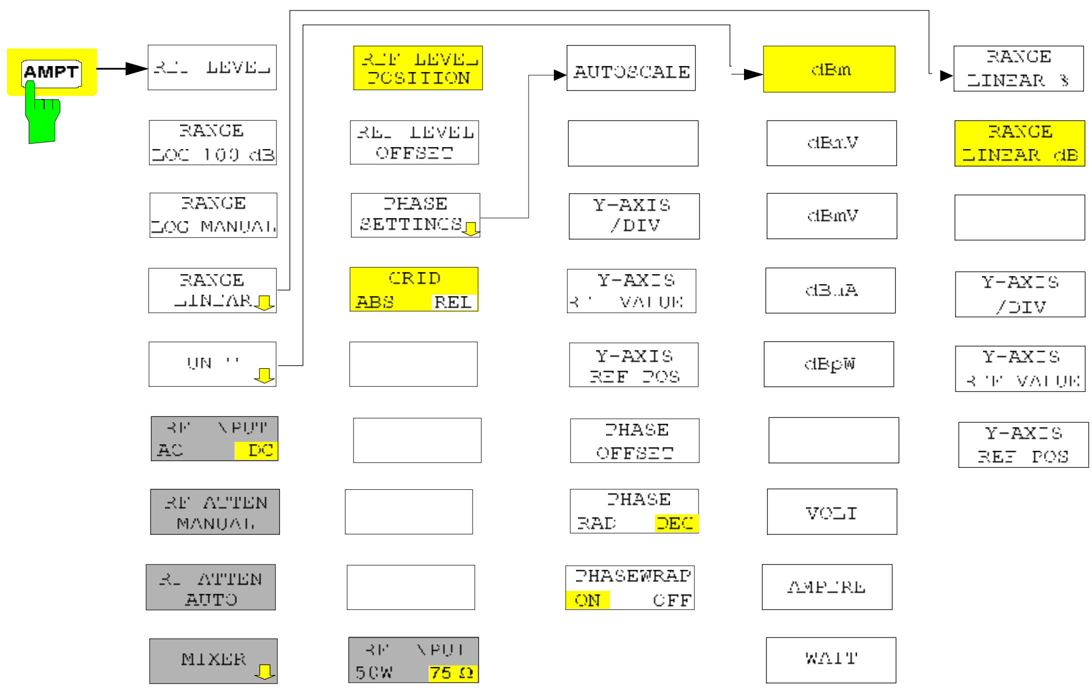
IEC/IEEE bus command: –

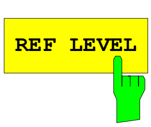
Setting the level display and configuring the diagrams – *AMPT* key

The *AMPT* key opens a submenu in which the reference level (*REF LEVEL*) and various properties of the result diagrams can be configured. *REF LEVEL* can be entered immediately since the entry dialog is opened automatically as soon as the *AMPT* key is pressed.

The menu tree is largely based on that of the *Spectrum Analysis* mode. Only a few functions are deactivated for the FFT Analyzer. The submenu for configuring the phase diagram is, however, new.

Note. *If the analog baseband input is used, the reference level should not be specified as the RMS power but rather as the applied peak voltages. See also Chapter "Switching on and configuring the I/Q baseband input" (REF LEVEL softkey) and Chapter "Level display".*



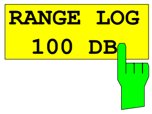


The *REF LEVEL* softkey activates entry of the reference level. If the baseband input is used, this level is expected at the input as the maximum voltage and not as the RMS input power (this is intended to avoid overloading of the A/D converter). The value is therefore entered in "volt peak". The level in the diagram label is specified in dBm, however, since the limit values in the mobile radio standards are also specified in dBm. 1 volt peak corresponds to 10 dBm.

The following values are permissible:
0.0316 V
0.0562 V
0.1 V
0.178 V
0.316 V
0.562 V
1 V
1.78 V
3.16 V only with IMPEDANCE LOW (50 Ω)
5.62 V only with IMPEDANCE LOW (50 Ω)

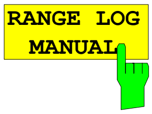
See also Chapter "Switching on and configuring the I/Q baseband input" (REF LEVEL softkey) and Chapter "Level display".

IEC/IEEE bus command: `SENS:VOLT:IQ:RANGE 1` or `DISP:WIND:TRAC:Y:RLEV 1`



The *RANGE LOG 100 dB* softkey sets the level display range to 100 dB.

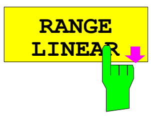
IEC/IEEE bus command: `DISP:WIND:TRAC:Y:SPAC LOG`
`DISP:WIND:TRAC:Y 100DB`



The *RANGE LOG MANUAL* softkey activates manual entry of the level display range. Display ranges from 10 to 200 dB in 10 dB steps are permitted. Invalid entries are rounded to the nearest permissible value.

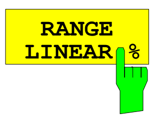
The default setting is 100 dB.

IEC/IEEE bus command: `DISP:WIND:TRAC:Y:SPAC LOG`
`DISP:WIND:TRAC:Y 120DB`



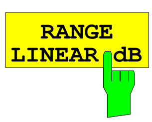
The *RANGE LINEAR* softkey switches the display range of the analyzer over to linear scaling and opens the submenu for selecting % or dB as the diagram labeling. The display in % is selected the first time the display range is switched over to linear scaling (see *RANGE LINEAR dB* softkey).

IEC/IEEE bus command: `DISP:WIND:TRAC:Y:SPAC LIN`



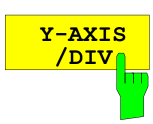
The *RANGE LINEAR %* softkey switches the display range of the analyzer to linear scaling. The horizontal gridlines are labeled in %. The grid has decadic division. Markers are displayed in the selected unit and delta markers in % referred to the voltage value at the position of marker 1.

IEC/IEEE bus command: `DISP:WIND:TRAC:Y:SPAC LIN`



The *RANGE LINEAR dB* softkey switches the display range of the analyzer to linear scaling. The horizontal gridlines are labeled in dB.
Markers are displayed in the selected unit and delta markers in dB referred to the power at the position of marker 1.

IEC/IEEE bus command: `DISP:WIND:TRAC:Y:SPAC LDB`



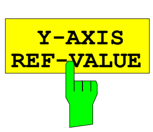
With linear scaling, the *Y-AXIS/DIV* softkey is used to determine the value range which is to correspond to the distance between two horizontal gridlines. The entire displayed value range is therefore equivalent to 10 times the selected value.

The softkey is only available in the following display modes:

- REAL IMAG in the Frequency Domain mode
- VOLTAGE in the Time Domain mode

The setting always affects both subdiagrams in the same way.

IEC/IEEE bus command: `DISP:WIND:TRAC:Y:PDIV 10`



The *Y-AXIS REF-VALUE* softkey determines the reference value of the diagram at the reference position. The gridlines are arranged on the basis of this reference value.

The softkey is only available in the following display modes:

- REAL IMAG in the Frequency Domain mode
- VOLTAGE in the Time Domain mode

The setting always affects both subdiagrams in the same way.

IEC/IEEE bus command: `DISP:WIND:TRAC:T:RVAL 1`

The *Y-AXIS REF-POS* softkey is used to control the location of the reference position within the grid from 0% to 100%. The default value is 50%.

The softkey is only available in the following display modes:

- REAL IMAG in the Frequency Domain mode
- VOLTAGE in the Time Domain mode

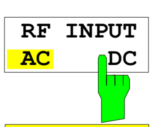
The setting always affects both subdiagrams in the same way.

IEC/IEEE bus command: `DISP:WIND:TRAC:Y:POS`

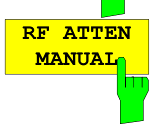
The *UNIT* softkey opens a submenu in which the desired unit for the level axis can be selected.

In the default setting, the level is displayed over 1 milliwatt (= dBm). The input impedance, which is ALWAYS assumed to be 50 Ω, can be used for conversion to other units. As a result, it is possible to convert the units dBm, dBmV, dBµV, dBµA, dBpW, V, A and W directly.

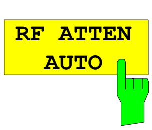
IEC/IEEE bus command: `CALC:UNIT:POW DBM`



The *RF INPUT AC/DC* softkey is deactivated if the baseband input is used.

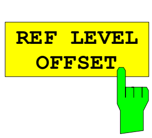


The *RF ATTEN MANUAL* softkey is deactivated if the baseband input is used.



The *RF ATTEN AUTO* softkey is deactivated if the baseband input is used.

AMPT side menu:



The *REF LEVEL OFFSET* softkey activates entry of an arithmetic level offset. This is added to the measured level irrespective of the selected unit. The y-axis scaling is changed accordingly.
The setting range is ±200 dB in 0.1 dB steps.

IEC/IEEE bus command:
`DISP:WIND:TRAC:RLEV:OFFS -10dB`

PHASE SETTINGS

The *PHASE SETTINGS* softkey opens a submenu in which the scaling of the phase diagram can be configured. The softkey and the submenu are therefore only available for the *MAGNITUDE PHASE* measurement in the *Frequency Domain* mode.

Note: *The AUTOSCALE, PHASE OFFSET, PHASE RAD/DEG and PHASEWRAP ON/OFF softkeys always affect the phase diagram. The other softkeys of this submenu can have an effect on either the upper or lower diagram, depending on the position of the SCREEN A/B hotkey.*

AUTOSCALE

The *AUTOSCALE* softkey performs one-off scaling of the phase diagram so that the current trace fully utilizes the value range.

IEC/IEEE bus command:
`DISP:WIND2:TRAC:Y:SCAL:AUTO ONCE`

Y-AXIS /DIV

The *Y-AXIS/DIV* softkey is used to determine the value range which is to correspond to the distance between two horizontal gridlines. The entire displayed value range is therefore equivalent to 10 times the selected value. With manual entry, the unit selected using the *PHASE RAD / PHASE DEG* softkey applies (only for the phase diagram).

IEC/IEEE bus command:
`DISP:WIND2:TRAC:Y:PDIV 10DEG`

Y-AXIS REF-VALUE

The *Y-AXIS REF-VALUE* softkey determines the reference value of the diagram at the reference position. The gridlines are arranged on the basis of this reference value. The unit selected using the *PHASE RAD / PHASE DEG* softkey applies (only for the phase diagram).

IEC/IEEE bus command:
`DISP:WIND2:TRAC:Y:RVAL 20DEG`

Y-AXIS REF-POS

The *Y-AXIS REF-POS* softkey is used to control the location of the reference position within the grid from 0% to 100%. The default value is 50%.

IEC/IEEE bus command:
`DISP:WIND2:TRAC:Y:RPOS 50`

PHASE OFFSET

The *PHASE OFFSET* softkey determines a constant phase value which is added to the overall phase trace. This allows a test point to be assigned to a desired phase value.
The unit selected using the *PHASE RAD / PHASE DEG* softkey applies.

IEC/IEEE bus command: `SENS:CORR:OFFS:PHAS 10DEG`

PHASE RAD DEG

The *PHASE RAD / PHASE DEG* softkey switches the unit of the phase trace between radians and degrees.

IEC/IEEE bus command: `CALC:UNIT:ANGL RAD`

PHASEWRAP ON OFF

The *PHASEWRAP ON* / *PHASEWRAP OFF* softkey activates/deactivates the phase trace limitation to the value range between –180º and +180º / -pi to +pi.

IEC/IEEE bus command: `CALC2:FORM PHAS`
`CALC2:FORM UPHAS`

GRID ABS REL

The *GRID ABS/REL LEVEL* softkey is deactivated if the baseband input is used.

Setting the bandwidths and sweep time – *BW* key

The *BW* key opens a menu in which the resolution bandwidth (*RBW*) and sweep time (*SWT*) which determine the measurement are set. The *RBW* can be coupled to the span (stop frequency minus start frequency, *SPAN*) or can be freely defined by the user. The automatic coupling is set by pressing the *RES BW AUTO* softkey. The coupling ratio is selected using the *COUPLING RATIO* softkey.

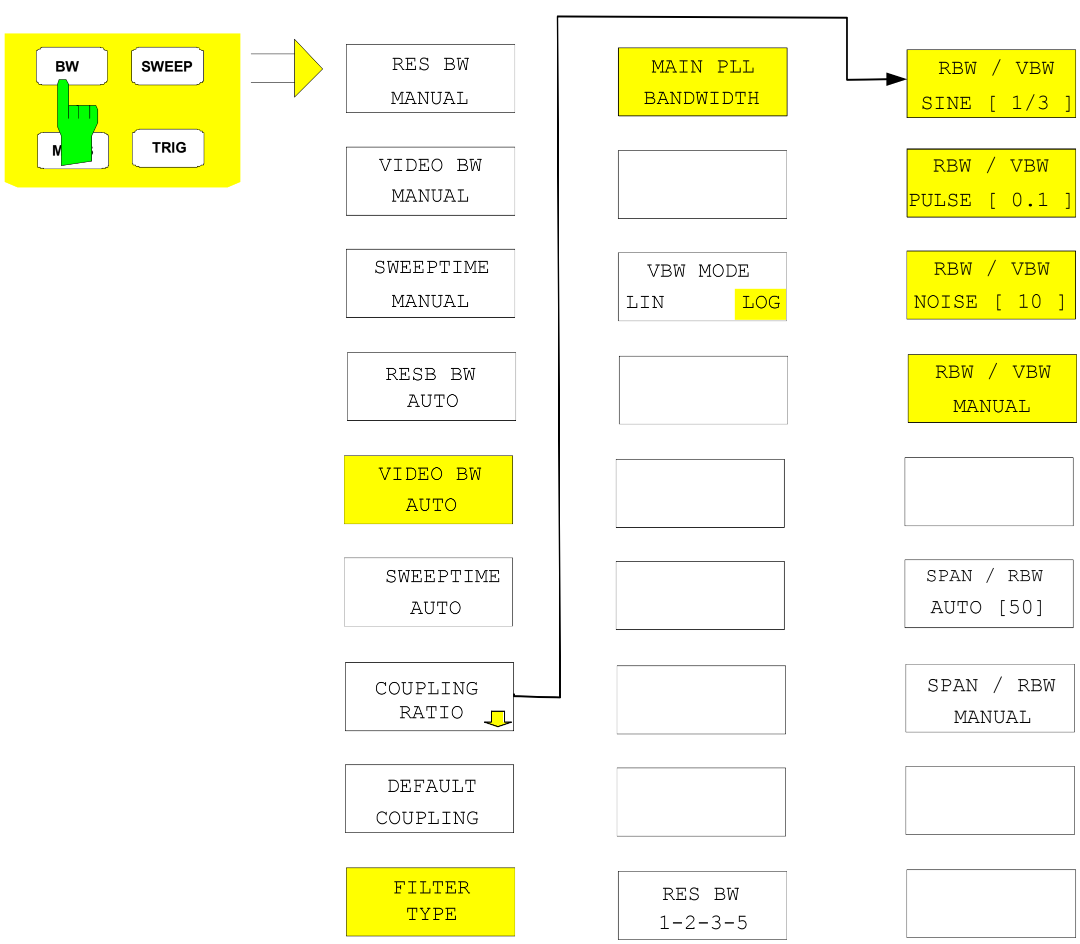
The *RES BW MANUAL* softkey activates direct entry of the RBW. There is then no coupling to the SPAN.

In the FFT Analyzer, digital filters are used as the resolution filters only in the *Time Domain* mode. In this mode, the FFT Analyzer therefore provides the same resolution bandwidths as in the *Spectrum Analysis* mode.

An FFT with preselectable windowing of the data is used in the *Frequency Domain* mode. The resolution bandwidths can be selected both in the usual steps and in fine intermediate steps (*RES BW 1-2-3-5* softkey).

The FFT Analyzer does not support video filters (*VBW*). The averaging of consecutive traces can be used instead.

Note: *The FFT filters, which can be selected in the Spectrum Analysis mode using the FILTER TYPE softkey, should not be confused with the FFT Analyzer. This softkey is deactivated in the FFT Analyzer.*



RES BW MANUAL

The *RES BW MANUAL* softkey activates manual entry of the resolution bandwidth.

The following applies in the *Frequency Domain* mode:

- The resolution bandwidth can be set in steps of 1, 2, 3, 5 and 10 or in steps of 0.1 Hz, depending on the setting of the *RBW 1-2-3-5* softkey. The nominal values for the resolution bandwidths are the equivalent noise bandwidths of the resolution filters and NOT the 3 dB bandwidths.
- The largest possible RBW is always 20 MHz.
- For *CAPTURE BOTH DOMAINS* active and/or a span greater than 27.5 MHz, the smallest possible RBW is 25 Hz, or rounded up to 30 Hz.
- Otherwise the smallest attainable RBW is equal to 0.1 Hz times the relative ENBW of the set window function, depending on the position of *RES BW 1-2-3-5,* rounded up or not. For the relative ENBW, see Table 4.24-4.
- Also applicable, however, is a maximum ratio of the span to RBW, which cannot be exceeded. Ratios that are too extreme can be rejected by the firmware.

The following applies in the *Time Domain* mode:

- The resolution bandwidth can always be selected in steps of 1, 2, 3, 5 and 10 between 10 Hz and 20 MHz (s. Table 4.24-4). The nominal values for the resolution bandwidths are the 3 dB bandwidths which are familiar from the *Spectrum Analysis* mode.

If necessary, the *RBW* is rounded to the nearest possible value when the *Frequency Domain* mode is switched over to the *Time Domain* mode.

When bandwidths are entered manually, the value is always rounded to the nearest possible bandwidth; if bandwidths are entered using the rotary knob or the UP/DOWN keys, the value is scrolled up and down in steps.

A green asterisk (*) appears on the display field to indicate that the resolution bandwidth has been entered manually.

IEC/IEEE bus command: `BAND 1MHz`

VIDEO BW MANUAL

The *VIDEO BW MANUAL* softkey is deactivated in the *FFT Analyzer* mode. Use the *TRACE AVERAGE* function instead.

SWEEPTIME MANUAL

The *SWEEPTIME MANUAL* softkey activates manual entry of the sweep time. It is only available in the *Time Domain* mode.
In the *Frequency Domain* mode, the sweep time is preset by selecting the window function and frequency resolution. It is therefore not possible to change the sweep time.

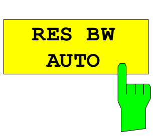
In time domain mode (Span = 0 Hz), the sweep times (which may range from 1 µs to max. 16000 s) can be selected in steps of max. 5% of the sweep time. When sweep times are entered manually, the FFT Analyzer always rounds to the nearest possible sweep time; if sweep times are entered using the rotary knob or the UP/DOWN keys, the FFT Analyzer scrolls the sweep time up and down in steps.
Refer also to Table 4.24-4 for the sweep times. In the FFT Analyzer, the maximum sweep time depends on the selected *RESOLUTION BANDWIDTH* and the *CAPTURE BOTH DOMAINS* function.

IEC/IEEE bus command: `SWE:TIME 10ms`

Table 4.24-4 Maximum sweep times for the Time Domain mode

Maximum SWEEPTIME for *Time Domain*	***CAPTURE BOTH DOMAIN S* = OFF**	***CAPTURE BOTH DOMAINS* = ON**
RBW = 10Hz	16000.0000 s	Not available
RBW = 20Hz	16000.0000 s	
RBW = 30Hz	16000.0000 s	0.1600s
RBW = 50Hz	16000.0000 s	
RBW = 100Hz	8000.0000 s	
RBW = 200Hz	4000.0000 s	
RBW = 300Hz	2500.0000 s	
RBW = 500Hz	1600.0000 s	
RBW = 1KHz	800.0000 s	
RBW = 2KHz	400.0000 s	
RBW = 3KHz	250.0000 s	
RBW = 5KHz	160.0000 s	
RBW = 10KHz	80.0000 s	
RBW = 20KHz	40.0000 s	
RBW = 30KHz	25.0000 s	
RBW = 50KHz	16.0000 s	
RBW = 100KHz	8.6000 s	
RBW = 200KHz	4.5000 s	
RBW = 300KHz	2.8000 s	
RBW = 500KHz	1.6000 s	
RBW = 1MHz	0.8000 s	
RBW = 2MHz	0.6000 s	
RBW = 3MHz	0.6000 s	
RBW = 5MHz	0.4000 s	
RBW = 10MHz	0.4000 s	
RBW = 20MHz	0.4000 s	

Caution: *Very large volumes of data will be recorded if the values for both RBW and SWEEPTIME are large. The trace will then be plotted block by block.*



The *RES BW AUTO* softkey is only available in the frequency domain (Span > 0 Hz). The softkey is not visible in the time domain.

It couples the resolution bandwidth to the selected frequency span (*SPAN*). If the frequency span is changed, the resolution bandwidth is adjusted automatically.

Automatic coupling of the resolution bandwidth to the frequency span is always recommended if a resolution bandwidth setting is desired which is suitable for the measurement task and in proportion to the selected span.

The coupling ratio is set in the *COUPLING RATIO* submenu.

IEC/IEEE bus command: `BAND:AUTO ON`

VIDEO BW AUTO

The *VIDEO BW AUTO* softkey is not available in the FFT Analyzer mode because a video filter is not supported.

SWEEPTIME AUTO

The *SWEEPTIME AUTO* softkey is only available in the frequency domain (*SPAN* > 0 Hz) and is always selected there because it is not possible to select the *SWEEPTIME* manually.
The softkey is not visible in the time domain because the *SWEEPTIME* can only be selected manually.

COUPLING RATIO →

RBW / VBW SINE [1/3]
RBW / VBW PULSE [0.1]
RBW / VBW NOISE [10]
RBW / VBW MANUAL
SPAN / RBW AUTO [50]
SPAN / RBW MANUAL

The *COUPLING RATIO* softkey opens a submenu in which the coupling ratio can be selected. In the FFT Analyzer this is only the ratio of *SPAN* and *RBW.*

In the default state, i.e. when the *COUPLING RATIO* softkey is not active (not highlighted), the ratio of span to resolution bandwidth (SPAN/RBW) is 50 (corresponds to *SPAN / RBW AUTO [50]*).

It is only possible to select one of the *SPAN / RBW* softkeys if *RBW AUTO* is selected.

RBW / VBW SINE [1/3]

The *RBW/VBW SINE* softkey is deactivated in the FFT Analyzer mode.

RBW / VBW PULSE [.1]

The *RBW/VBW PULSE* softkey is deactivated in the FFT Analyzer mode.

RBW / VBW NOISE [10]

The *RBW/VBW NOISE* softkey is deactivated in the FFT Analyzer mode.

RBW / VBW MANUAL

The *RBW/VBW MANUAL* softkey is deactivated in the FFT Analyzer mode.

SPAN /RBW AUTO [50]

The *SPAN/RBW AUTO* softkey sets the following coupling ratio:
Resolution bandwidth = Frequency span/50

This coupling ratio corresponds to the default setting.

IEC/IEEE bus command: `BAND:RAT 0.02`

It is only possible to select this softkey if *RBW AUTO* is active.

SPAN /RBW MANUAL

The *SPAN/RBW* softkey activates entry of the coupling ratio of frequency span and resolution bandwidth.

The ratio of frequency span to resolution bandwidth can be set between 1 and 10000.

IEC/IEEE bus command: `BAND:RAT 0.1`

It is only possible to select this softkey if *RBW AUTO* is active.

DEFAULT COUPLING

The *DEFAULT COUPLING* softkey sets all coupling functions to their default state (*AUTO*); in the FFT Analyzer this only applies to *SPAN/RBW*. In addition, the *SPAN/RBW* ratio in the *COUPLING RATIO* submenu is set to 50.

IEC/IEEE bus command: `BAND:AUTO ON`

FILTER TYPE

The *FILTER TYPE* softkey is deactivated in the FFT Analyzer mode. Only filters which have a Gaussian characteristic and the selected 3 dB bandwidth are available for time domain measurements. An FFT with user-selectable window function is always used for frequency domain measurements.

BW – NEXT menu:

MAIN PLL BANDWIDTH

The *MAIN PLL BANDWIDTH* softkey is deactivated in the FFT Analyzer mode.

VBW MODE LIN LOG

The *VBW MODE LIN/LOG* softkey is deactivated in the FFT Analyzer mode because no video filter is supported.

RES BW 1-2-3-5

The *RES BW 1-2-3-5* softkey is only available in the *Frequency Domain* mode. When activated, the *RESOLUTION BANDWIDTH* can only be changed in steps of 1, 2, 3, 5 and 10 (which is also always the case in the *Time Domain* mode).
However, this softkey is also used to activate manual entry of freely selected bandwidths in the *Frequency Domain* mode. The values must then be entered by means of the *RES BW MANUAL* softkey, or are derived from the SPAN if the automatic coupling function is activated. If the values are in the permissible range, they are rounded to 0.1 Hz and accepted.

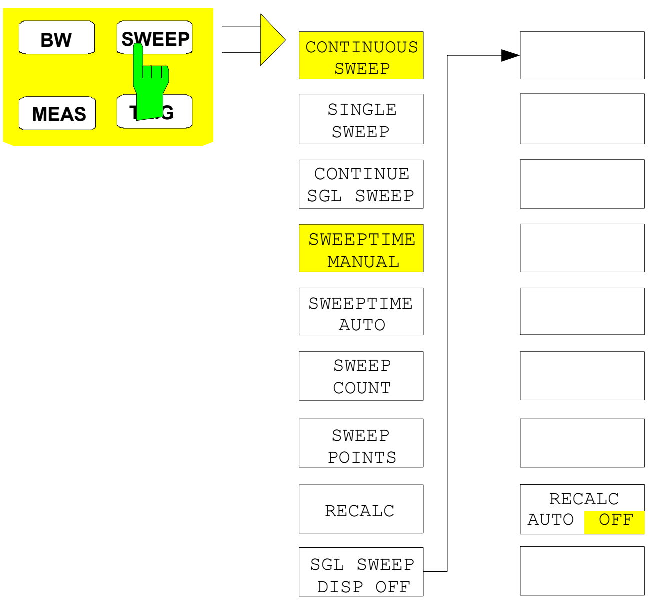
If the system is switched back to the mode with the bandwidth steps or to the *Time Domain* mode, the *RESOLUTION BANDWIDTH* is rounded to the nearest permissible value.

IEC/IEEE bus command: `SENS:BWID:RESO:STEP:MODE LIN`
`SENS:BAND:RESO:STEP:MODE L1235`

Setting the sweep – *SWEEP* key

The SWEEP key is used to select the frequency sweep type.
Note: The term "sweep" is used here (and also at other points in the description of the FFT Analyzer) although no "sweep" principle is performed in a frequency analysis. The term is based on the *Spectrum Analysis* mode of the FSQ and the softkey labels used in this mode.
The sweep time used for the FFT is also shown at the top of the screen in the middle of the display (e.g. as "SWT = 10 ms"). This is, however, not the time required for a complete measurement process. If *CAPTURE BOTH DOMAINS* is active, data acquisition is initially performed for 0.16 seconds for a SINGLE SWEEP and then only a small proportion of the data is usually used for calculating the FFT. The overall measurement process is made up of the times for data acquisition, for filtering and decimation of the data, for calculation of the FFT and for displaying the results.
However, the displayed *SWEEPTIME* only indicates which time domain is covered by the input data of the FFT.

SWEEP menu



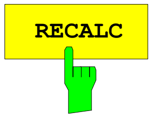
The *SWEEP* key opens a menu in which the frequency sweep (sweep mode) is configured.

The *CONTINUOUS SWEEP, SINGLE SWEEP* and *SGL SWEEP DISP OFF* softkeys are selection switches. Only one of these switches can be active at any one time.

Most of the softkeys do not need to be explained in this chapter because their functionality is identical to that in the *Spectrum Analysis* mode. Please refer to chapter 4 of the FSQ operating manual.

The *SWEEPTIME MANUAL* and *SWEEPTIME AUTO* softkeys behave in a different way. The two softkeys are also in the menu which is opened by pressing the BW key. Their function is explained in Chapter “Setting the bandwidths and sweep time – *BW* key”.

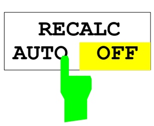
The two softkeys *RECALC* and *RECALC AUTO / RECALC OFF* are specially intended for the FFT Analyzer:



The *RECALC* softkey is deactivated and cannot be used if the *CAPTURE BOTH DOMAINS* measurement mode is not active.
The *RECALC* softkey can only be operated if the *CAPTURE BOTH DOMAINS* measurement mode is active, the FFT Analyzer is in the *SINGLE SWEEP* mode and measurement data has already been acquired.
The data stored in the memory (always sampled for 0.16 s at 81.6 MHz) is reanalyzed according to the current instrument settings each time the *RECALC* softkey is pressed. Data acquisition is not performed again. Any trigger settings, e.g. *EXTERN* or *I/Q LEVEL*, are ignored, i.e. reanalysis is performed immediately.

The instrument settings which can be adjusted are, for example:

- Time Domain / Frequency Domain
- measurement display mode (MAGNITUDE, VOLTAGE, etc)
- RBW, SPAN, WINDOWFCT, CENTER FREQUENCY, SWEEPTIME
- type of detector
- IQ PATH: I + jQ, I ONLY, Q ONLY



The *RECALC AUTO* / *RECALC OFF* softkey is deactivated and cannot be used if the *CAPTURE BOTH DOMAINS* measurement mode is not active.

If the softkey is set to *OFF*, the *RECALC* softkey must be pressed each time recorded data is to be analyzed using modified measurement settings.

If, however, the softkey is set to *AUTO*, the firmware automatically triggers a *RECALC* whenever the adjustable parameters are changed manually.

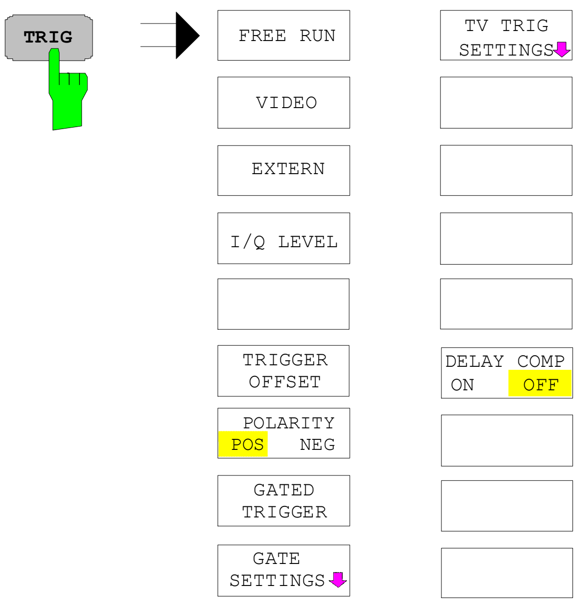
However, as soon as one of the critical parameters has been changed (see the description of the *RECALC* softkey), the automatic *RECALC* is not performed and, like the *RECALC* softkey, the *RECALC AUTO / OFF* softkey is also temporarily deactivated.

Triggering the sweep – *TRIG* key

The *TRIG* key opens a menu for setting the various trigger sources and selecting the polarity of the trigger. The associated softkeys are highlighted to indicate that the trigger mode is active.

The enhancement label **TRG** is displayed on the screen to indicate that a trigger mode other than *FREE RUN* is set.

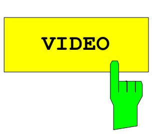
TRIGGER menu



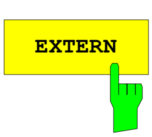
The *FREE RUN* softkey activates the free-running measurement, i.e. there is no explicit triggering of the start of measurements. When one measurement has been completed, another is started immediately.

FREE RUN is the default setting of the FFT Analyzer.

IEC/IEEE bus command: `TRIG:SOUR IMM`

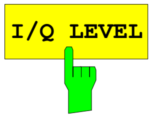


The *VIDEO* softkey is deactivated in the FFT Analyzer mode.



The *EXTERN* softkey activates triggering by means of a TTL signal at the *EXT TRIGGER/GATE* input socket on the rear panel of the instrument. It has the same functionality as in the *Spectrum Analysis* mode.

IEC/IEEE bus command: `TRIG:SOUR EXT`



The *I/Q LEVEL* softkey activates triggering to the magnitude of the I/Q signal and determines the trigger threshold in volts. Sample acquisition starts when the value exceeds (positive polarity) or drops below (negative polarity) the selected threshold.

Here too, the *IQ PATH* setting is taken into account, which means the I or Q input may be ignored.
The following applies to the bandwidth within which the magnitude of the I/Q signal is measured:

- *With CAPTURE BOTH DOMAINS* inactive:
  - Frequency domain measurement: the bandwidth is slightly smaller than the set span, but no more than about 19 MHz
  - Time domain measurement: the bandwidth is the set RBW
- *With CAPTURE BOTH DOMAINS* active:
  - Frequency domain measurement*:* the bandwidth is always about 19 MHz
  - Time domain measurement: the bandwidth is the set RBW

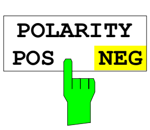
Only in FFT Analyzer mode is the bandwidth symmetric around the set center frequency.

IEC/IEEE bus command: `TRIG:LEV:IFP 0.7`

The *TRIGGER OFFSET* softkey activates entry of a time offset between the trigger signal and the start of the sweep.

Triggering is delayed (entry > 0) or advanced (entry < 0) by the entered time relative to the trigger signal. The time can be entered in the value range –100 ms to 50 s (default: 0 s).

IEC/IEEE bus command: `TRIG:HOLD 10US`

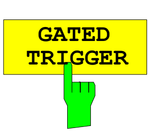


The *POLARITY POS/NEG* softkey determines the polarity of the trigger slope.

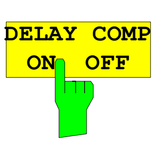
Measurement starts after a positive or a negative slope of the trigger signal. The selected setting is highlighted accordingly.
The setting applies to all trigger types except *FREE RUN*.

The default setting is *POLARITY POS*.

IEC/IEEE bus command: `TRIG:SLOP POS`

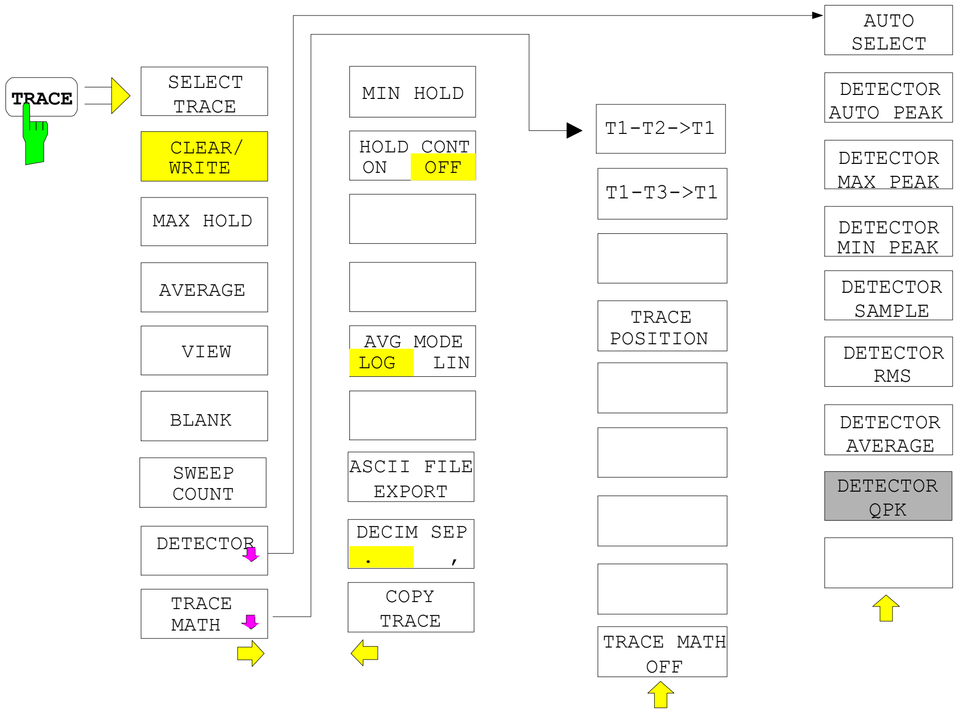


The *GATED TRIGGER* softkey and the functions of the associated submenu and of the *GATE SETTINGS* softkey are not available in the FFT Analyzer mode.



The *DELAY COMP ON/OFF* softkey is not available in the FFT Analyzer mode. Group delay compensation for the resolution filters with active external trigger is always active.

Selecting and setting the traces – TRACE key

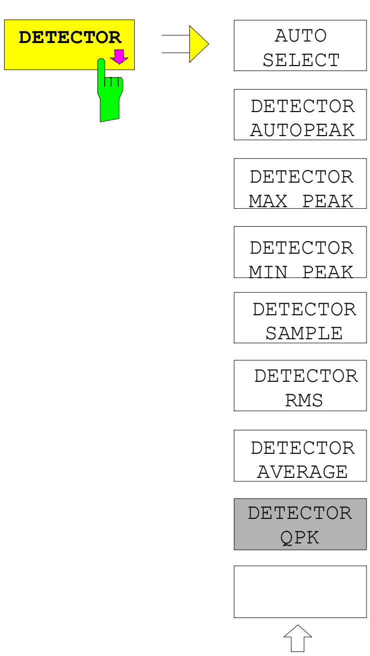


Many of the softkeys in this menu do not need to be described in detail here because their functionality is identical to that in the *Spectrum Analysis* mode. Please refer to chapter 4 of the FSQ operating manual.

Only those softkeys whose functions differ in the *FFT Analyzer* and *Spectrum Analysis* modes are described below:

The *ASCII FILE EXPORT* softkey saves the active trace to a disk in ASCII format.

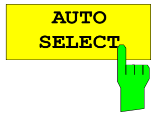
IEC/IEEE bus command: `FORM ASC;` `MMEM:STOR:TRAC 1,'TRACE.DAT'`



The *DETECTOR* softkey opens a submenu for selecting the detector for the selected trace. The softkey is highlighted if the detector is not selected using *AUTO SELECT*.

The detector can be selected separately for each trace. The *AUTO SELECT* mode sets the appropriate detector for each trace display type (Clear Write, Max Hold or Min Hold).
With split-screen FFT Analyzer diagrams, the selected detector always applies to both diagrams.

The softkeys for the detectors are selection switches; only one of these switches can be active at any one time.



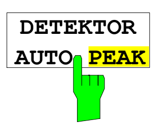
The *AUTO SELECT* softkey (= default setting) selects the most suitable detector according to the selected trace display type (Clear Write, Max Hold and Min Hold).

Display type	**Detector**
Clear/Write	Auto Peak
Average	Sample
Max Hold	Max Peak
Min Hold	Min Peak

The detector which is active for the trace in question is identified in the respective trace display field by means of the following designations:

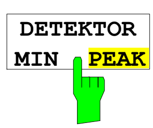
Detector	
Auto Peak	AP
Max Peak	PK
Min Peak	MI
Average	AV
RMS	RM
Sample	SA

IEC/IEEE bus command: `DET:AUTO ON`



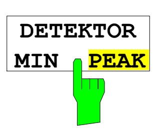
The *DETECTOR AUTOPEAK* softkey activates the autopeak detector. This is possible irrespective of the SWEEPPOINTS parameter.

IEC/IEEE bus command: `DET APE`



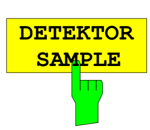
The *DETECTOR MAX PEAK* softkey activates the maximum peak detector. It is recommended if pulse-like signals are to be measured.

IEC/IEEE bus command: `DET POS`



The *DETECTOR MIN PEAK* softkey activates the minimum peak detector. The minimum peak detector makes weak sinewave signals clearly visible in noise. The pulse signals are suppressed in composite signals consisting of sinewave and pulse signals.

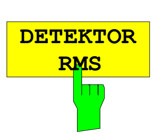
IEC/IEEE bus command: `DET NEG`



The *DETECTOR SAMPLE* softkey activates the sample detector.

It is used if uncorrelated signals such as noise are to be measured. The power can be determined for weighting and for the log amplifier by means of fixed correction factors.

IEC/IEEE bus command: `DET SAMP`



The *DETECTOR RMS* softkey activates the RMS detector.
It is not available in the *Frequency Domain* mode in the FFT Analyzer.

The RMS detector always supplies the signal power irrespective of the signal shape. To do so, the mean square of all sampled level values is formed during the sweep of a pixel. The sweep time thus determines the number of averaged values and with increasing sweep time better averaging is obtained. The RMS detector is therefore an alternative means of averaging over several sweeps (see *TRACE AVERAGE*).

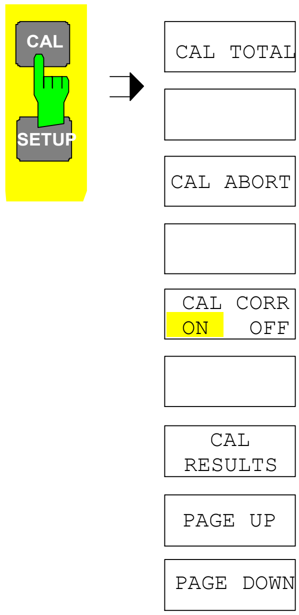
IEC/IEEE bus command: `DET RMS`

The *DETECTOR AVERAGE* softkey activates the average detector.
It is not available in the *Frequency Domain* mode.
Unlike the RMS detector, the average detector supplies the linear average of all level values during the sweep of a pixel.

IEC/IEEE bus command: `DET AVER`

The *DETECTOR QPK* softkey is not available in the FFT Analyzer mode.

Correction data acquisition – *CAL* key



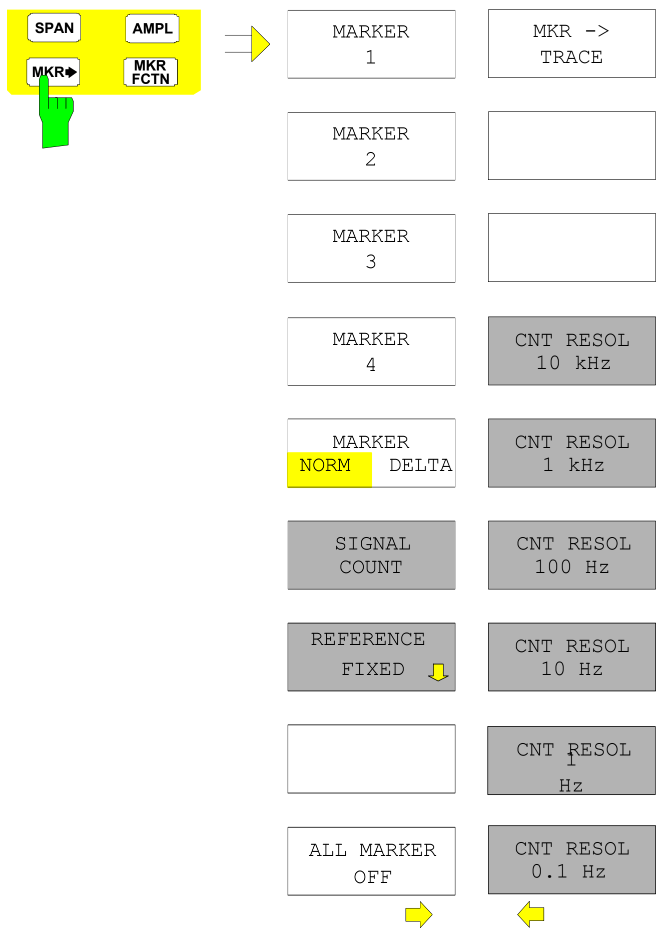
The *CAL* key opens a menu containing the available functions for the acquisition, display and activation of data used for system error correction.

The *CAL TOTAL* key starts correction data acquisition for the entire instrument. Correction data will also be calculated for the B71 module (if this module is installed in the instrument). This improves the accuracy of the FFT Analyzer. When correction data acquisition has been completed, press the *PRESET FFT* softkey, for example, and then the *CAL CORR ON / OFF* softkey to view the effects of the DC offset.

The softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the *Spectrum Analysis* mode. Please refer to chapter “Recording the Correction Data of FSQ – CAL Key” of the FSQ operating manual.

Technical details regarding correction data can also be found in Chapter ”Error correction”.

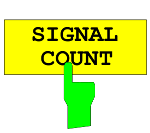
Markers and delta markers – *MKR* key



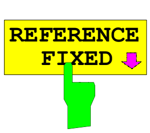
Many of the softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the *Spectrum Analysis* mode. Please refer to chapter “Change of Settings via Markers – MKR -> Key” of the FSQ operating manual.

Only those softkeys whose functions differ in the *FFT Analyzer* and *Spectrum Analysis* modes are described below:

Special features are the new split-screen diagrams *REAL IMAG*, *VOLTAGE* and *MAGNITUDE PHASE*. On these diagrams, it is not possible to move markers separately on each trace; these markers are in fact marker pairs which are coupled to each other. The values of both markers are displayed, however.

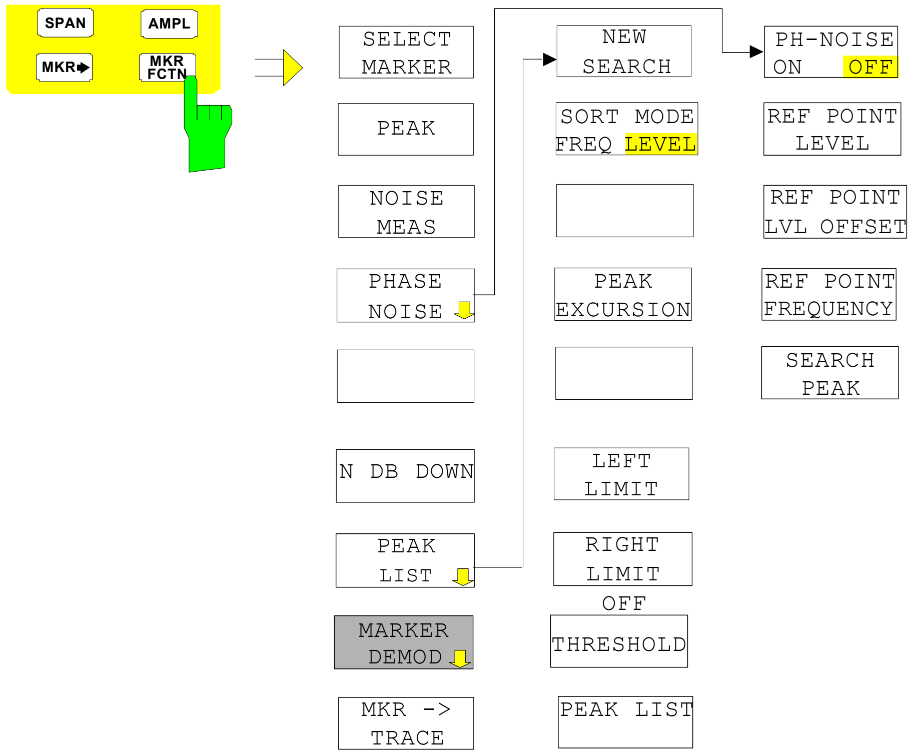


The *SIGNAL COUNT* softkey is deactivated in the FFT Analyzer mode. The softkeys for setting the counter accuracy in the side menu are therefore also unnecessary and are deactivated.



The *REFERENCE FIXED* softkey is deactivated in the FFT Analyzer mode, except for Frequency Domain *MAGNITUDE* .

Marker functions – *MKR FCTN* key



Many of the softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the *Spectrum Analysis* mode. Please refer to chapter “Marker Functions – MKR FCTN Key” of the FSQ operating manual.

Only those softkeys whose functions differ in the *FFT Analyzer* and *Spectrum Analysis* modes are described below:

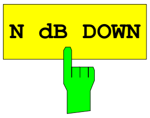
Please note that, similar to other functions, negative frequencies (both as entries and as results) are also possible in the FFT Analyzer.

The following should be noted with regard to the *NOISE MEAS* and *PHASE NOISE* softkeys:
The measurements are also possible in the FFT Analyzer. However, various restrictions apply. For example:

- not all detectors are available
- no video filter is available
- no split screen is available

Special features are the new split-screen diagrams *REAL IMAG*, *VOLTAGE* and *MAGNITUDE PHASE*. On these diagrams, it is not possible to move markers separately on each trace; these markers are in fact marker pairs which are coupled to each other. The values of both markers are displayed, however.

In split-screen diagrams, the marker always operates (search for peak, etc) in the diagram currently selected by the *SCREEN A / SCREEN B* hotkey; the other marker automatically moves in sync.



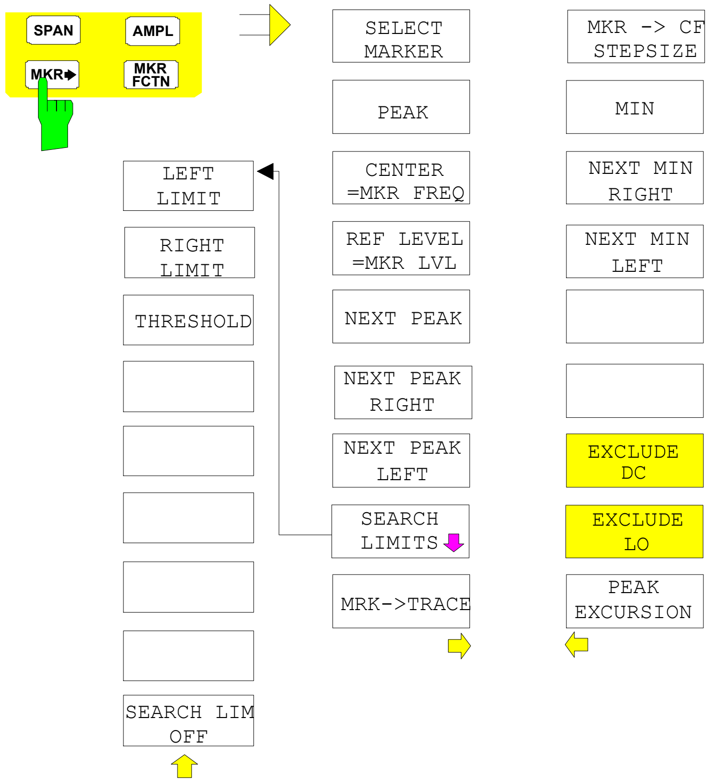
The function is identical to that in the *Spectrum Analysis* mode. When the 3 dB bandwidths of the FFT-analyzer's resolution filters are measured in the *Frequency Domain* mode, the value that is returned is not exactly the same as the value that was set as the *RESOLUTION BANDWIDTH*. This is due to the fact that the equivalent noise bandwidths are entered as the *RBW* in the Frequency Domain mode in the FFT Analyzer. See also the explanations of the window functions in Chapter " *Frequency Domain* submenu of the FFT Analyzer".

The function is disabled in the following display modes:

- time domain – *VOLTAGE*
- frequency domain – *REAL IMAG*
- frequency Domain *MAG PHASE*

The *MARKER DEMOD* softkey is deactivated in the FFT Analyzer mode. It is not possible to demodulate and monitor AM or FM signals.

Changing instrument settings with markers – *MKR* ⇒ key



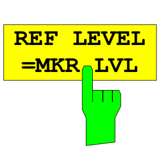
Many of the softkeys in this menu do not need to be explained in detail here because their functionality is identical to that in the *Spectrum Analysis* mode. Please refer to (see chapter „Change of Settings via Markers – MKR -> Key") of the FSQ operating manual.

Only those softkeys whose functions differ in the *FFT Analyzer* and *Spectrum Analysis* modes are described below:

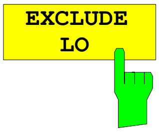
Please note that, similar to other functions, negative frequencies (both as entries – e.g. search limits – and as results) are also possible in the FFT Analyzer.

Functions which are available in the *Spectrum Analysis* mode only when *SPAN* is > 0, are also available only in Frequency Domain mode in the FFT Analyzer.

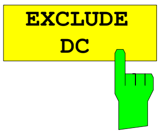
The restriction that applies to the *PEAK* softkey in the *MKR FCTN* menu also applies to all marker search functions (*MIN*, *NEXT MIN RIGHT, NEXT MIN LEFT, NEXT PEAK RIGHT, NEXT PEAK LEFT, NEXT PEAK, PEAK*):
With split-screen diagrams, you can use the *SCREEN A / SCREEN B* hotkey to select between the two diagrams.



The *REF LEVEL = MKR LVL* softkey is deactivated in the FFT Analyzer mode.



The *EXCLUDE LO* softkey is deactivated in the FFT Analyzer mode. The *EXCLUDE DC* softkey performs a similar function.



In the FTT Analyzer, the *EXCLUDE DC* softkey performs the function of the *EXCLUDE LO* softkey. The function can only be activated in the *Frequency Domain* mode.

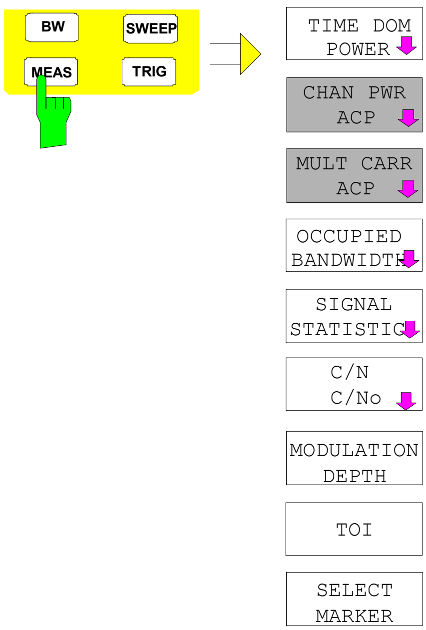
The following therefore applies if the function is active:
The frequency 0 Hz is excluded from the search to ensure that, e.g. with the peak function, the marker does not move to the DC component at 0 Hz in the case of span settings which include this frequency. The minimum frequency to which the marker moves is $\geq 2 \times$ resolution bandwidth (*RBW*). The largest negative frequency with a complex input signal is -2 * resolution bandwidth.

If the function is deactivated, the search is not restricted to a specific range. The frequency 0 Hz is included in the marker search functions.

IEC/IEEE bus command: `CALC:MARK:LOEX ON`

Power measurements – MEAS key

MEAS menu:

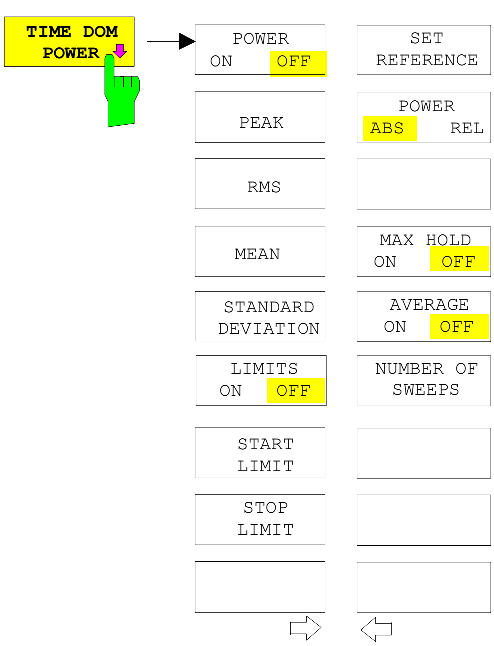


The *MEAS* key opens the menu for setting up the power measurements.

The following measurements are possible:

- power in the time domain (*TIME DOM POWER*)
- occupied bandwidth (*OCCUPIED BANDWIDTH*)
- signal/noise power (*C/N, C/No*)
- amplitude distribution (*SIGNAL STATISTIC*)
- modulation depth (*MODULATION DEPTH*)
- third-order intercept (*TOI*)

The above-mentioned measurements are performed alternately.



The *TIME DOM POWER* softkey activates measurement of the power in the time domain and opens the submenu for configuring the power measurement.
The submenu allows selection of the type of power measurement (rms or mean power), the settings for max hold and averaging as well as the definition of limits.

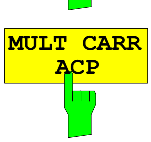
The range of the power measurement can be restricted by defining limits.

Note: *The measurement is only available in the MAGNITUDE measurement in the time domain (span = 0).*

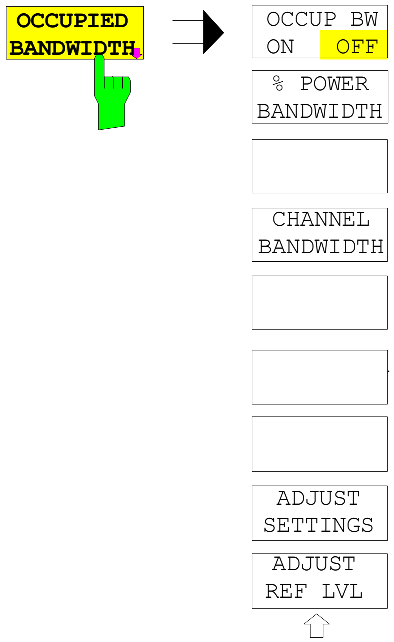
The FFT Analyzer does not provide any channel filters other than filters with Gaussian characteristic.

Please refer to chapter "Power Measurement in Time Domain" of the FSQ operating manual for detailed explanations of the individual softkeys in the submenus.

The *CHAN PWR ACP* softkey and the functionalities of the associated submenu are not available in the FFT Analyzer mode.



The *MULT CARR ACP* softkey and the functionalities of the associated submenu are not available in the FFT Analyzer mode.



The *OCCUPIED BANDWIDTH* softkey activates measurement of the occupied bandwidth on the basis of the current configuration and opens the submenu for configuring the measurement. The softkey is only available for the frequency domain (span > 0); it changes color when the measurement is activated.

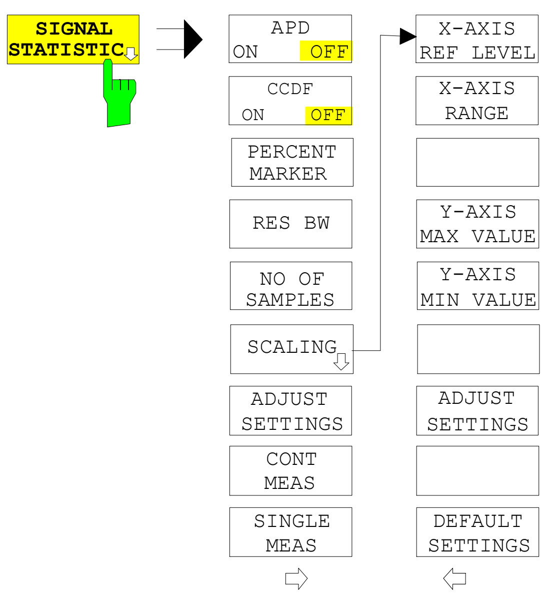
In the spectrum display mode, the "Occupied Bandwidth" measurement determines the bandwidth that contains a predefined percentage of power of the displayed frequency range (*% POWER BANDWIDTH* softkey).
The FFT Analyzer does not provide all detectors or any video filter.

The occupied bandwidth is output on the marker display field and indicated in the trace by means of temporary markers.

Note: *The function is only available on a level trace in the frequency domain (span > 0). It is disabled in the REAL IMAG display mode.*

The measurement is performed on the trace on which marker 1 is located. In order to analyze a different trace, marker 1 must be moved to a different trace using *SELECT TRACE* in the *MKR* menu.

Please refer to chapter „submenu MEAS OCCUPIED BANDWIDTH“ of the FSQ operating manual for detailed explanations of the individual softkeys in the submenus.



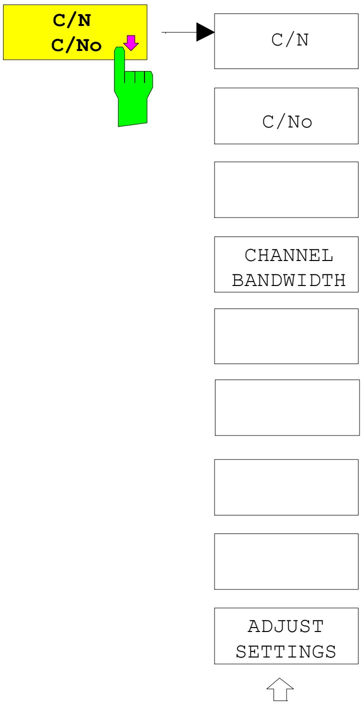
The *SIGNAL STATISTIC* softkey opens a submenu for measuring the amplitude distribution. The softkey is only available for the time domain.

Special features of this measurement:

- The I and the Q input are sampled. The settings *I ONLY* and *Q ONLY* are not allowed!
- The set center frequency is ignored. The center frequency is always 0 Hz for this measurement.
- The RBW can be set between 10 kHz and 60 MHz.
- Rectangular filters are used instead of filters with a Gaussian characteristic.

Measurement of either the amplitude probability distribution (*APD*) or the complementary distribution (*CCDF*) can be selected in this submenu. Only one of the amplitude distribution functions can be selected at any one time.

Please refer to Please refer to chapter „submenu MEAS SIGNAL STATISTIC“ of the FSQ operating manual for detailed explanations of the individual softkeys in the submenus.



The *C/N, C/No* softkey opens the submenu for configuring measurement of the signal/noise ratio.
Measurement either without bandwidth reference (C/N) or with bandwidth reference (C/No) can then be selected in the submenu. It is also possible to select the bandwidth of the measurement channel and to adapt the frequency span (SPAN) accordingly.

Note: *The measurements are only available in the frequency domain (span > 0). The MAGNITUDE display mode must be active.*

In the FFT Analyzer, the function is identical to that in the *Spectrum Analysis* mode.

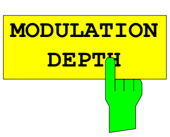
Note: *Not all detectors are available; there is no video filter.*

Please refer to chapter “Measurement of Carrier/Noise Ratio C/N and C/No“ of the FSQ operating manual for detailed explanations of the individual softkeys in the submenus.

The measurement can be performed with every window function. However, a warning is output if the measurement is started when a window function other than the flattop window is active. This is because the measurement result for the carrier might be too low if the flattop window function is not selected.

IEC/IEEE bus command:

```
CALC:MARK:FUNC:POW:SEL CN
CALC:MARK:FUNC:POWer:RES? CN
CALC:MARK:FUNC:POWer:SE CN0
CALC:MARK:FUNC:POWer:RES? CN0
CALC:MARK:FUNC:POWer OFF
```



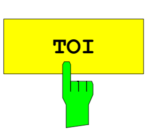
The *MODULATION DEPTH* softkey activates measurement of the AM modulation depth. An AM carrier is required on the screen for this function to operate correctly.

Note: *The measurements are only available in the frequency domain (span > 0). The MAGNITUDE or MAGNITUDE PHASE display mode must be active.*

In the FFT Analyzer, the function is identical to that in the *Spectrum Analysis* mode. Please refer to chapter “Measurement of Carrier/Noise Ratio C/N and C/N_0” of the FSQ operating manual.
The measurement can be performed with every window function. However, a warning is output if the measurement is started when a window function other than the flattop window is active. This is because the measurement result for the carriers might be too low if the flattop window function is not selected.

IEC/IEEE bus command:

```
CALC:MARK:FUNC:MDEP ON | OFF
CALC:MARK:FUNC:MDEP:RESult?
```



The *TOI* softkey is used to trigger measurement of the third-order intercept.
The measurements are only available in the frequency domain (span > 0). The *MAGNITUDE* or *MAGNITUDE PHASE* display mode must be active.

In the FFT Analyzer, the function is identical to that in the *Spectrum Analysis* mode.
Please refer to (s. chapter “Measurement of Carrier/Noise Ratio C/N and C/N_0”).
The measurement can be performed with every window function. However, a warning is output if the measurement is started when a window function other than the flattop window is active. This is because the measurement result for the carriers might be too low if the flattop window function is not selected.

IEC/IEEE bus command:

```
CALC:MARK:FUNC:TOI ON;
CALC:MARK:FUNC:TOI:RES?
```

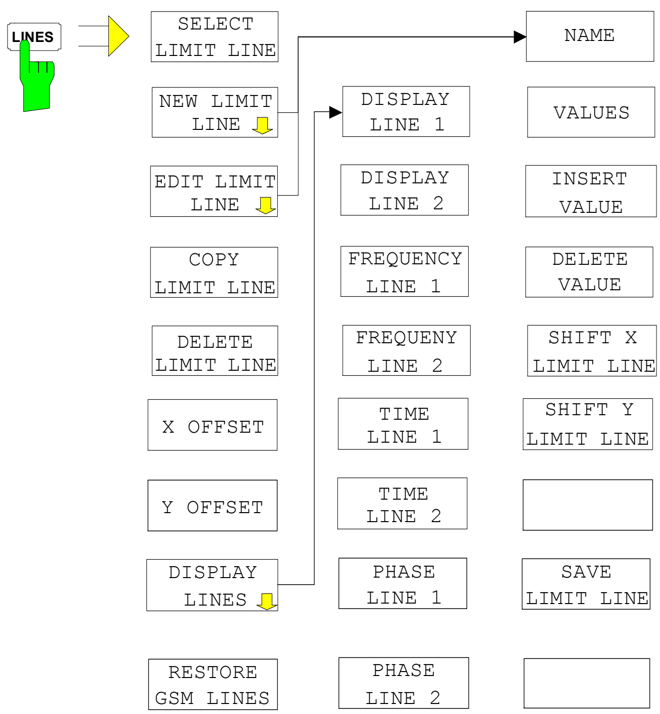
Setting limit lines and display lines – *LINES* key

The function of the limit lines and display lines is identical to that in the *Spectrum Analysis* mode. Please refer to chapter „Setting limit lines and display lines – *LINES* key“ for a detailed description of each softkey.

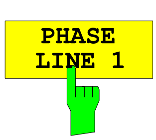
Special features of the FFT Analyzer are:
Limit lines are not available for the *REAL IMAG* frequency domain measurement or the *VOLTAGE* time domain measurement. With the *MAGNITUDE PHASE* frequency domain measurement, limit lines can only be applied to the magnitude.
The state and position of the lines are stored separately for the *Time Domain* and *Frequency Domain* modes. This means that the previous lines are restored when the mode is changed.

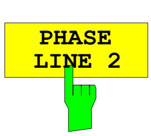
As in the *Spectrum Analysis* mode, the display lines are not always available:

- frequency lines only available in frequency domain
- time lines only available in time domain
- phase lines only available for measurements with phase display



New softkeys are:





The *PHASE LINE 1/2* softkeys activate/deactivate phase lines 1/2 and activate entry of the line position.
The phase lines mark the selected phases in the measurement window.
Entries are made in the currently selected phase unit.
The line is adapted automatically if the unit is changed using the *PHASE RAD/DEG* softkey in the *AMPT* menu.
The line will, however, not be adapted automatically if the phase offset is changed using the *PHASE OFFSET* softkey in the *AMPT* menu.

Note: *The softkeys are only available in the frequency domain for the MAGNITUDE PHASE measurement.*

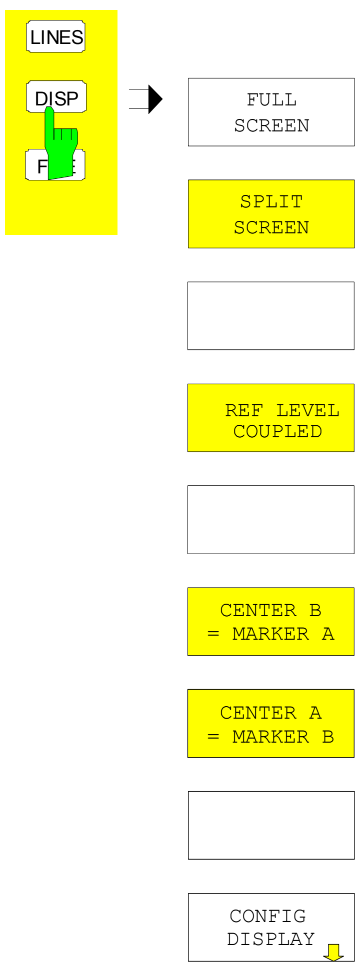
IEC/IEEE bus command:
```
CALC:PLIN1:STAT ON
CALC:PLIN1 120DEG
CALC:PLIN2:STAT ON
CALC:PLIN2 140deg
```

Configuring the screen display – *DISP* key

The *DISPLAY* menu is used both to configure the diagram display on the screen and to select the desired display elements and colors.

In the FFT Analyzer, two measurement windows are not designed to be completely decoupled from each other, i.e. they are not intended to behave like two completely independent instruments (*SPLIT SCREEN* operation).
Although there are measurements with a split screen, they draw their data from the same measurement.

For this reason, all softkeys which are required for *SPLIT SCREEN* are disabled.
The submenu of the *CONFIG DISPLAY* softkey behaves in the same way as in the *Spectrum Analysis* mode. Please refer chapter “Setting limit lines and display lines – *LINES* key“ for details.



Using the I/Q baseband input in the options

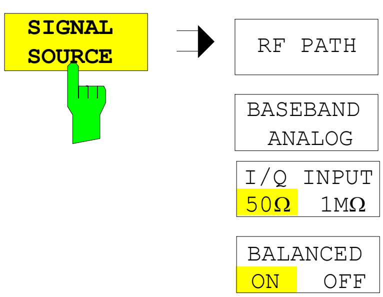
Note: *The functions described in this chapter are available from firmware version 1.8 or higher or the first firmware version of the option listed below.*

The baseband input is also available in the options FS-K5, FS-K7, FS-K8, FS-K70, FS-K72, FS-K73, FS-K76, FS-K77, FS-K82, FS-K83 and FS-K84. The following section describes those softkeys used to control the baseband input which are identical in all of the named options, as well as any other characteristics which are common to all options. Baseband functions of options not listed here can be found in the respective manual.
This chapter does NOT refer to the FFT Analyzer. The FFT Analyzer is dealt with in chapter “Using the I/Q baseband input in the FFT Analyzer”.

The individual application measurements that can be performed with the baseband input are described separately for each application.

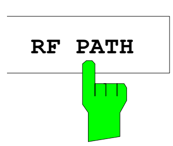
The applications themselves are described in the respective manuals.

Switching on and configuring the I/Q baseband input



The *SIGNAL SOURCE* softkey in the *SETUP* menu opens the menu for switching on and configuring the baseband inputs.

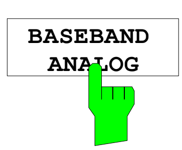
Note: *Both the I and Q path are always taken into consideration in the options. The possibility of ignoring a path is only available in the FFT Analyzer (IQ PATH softkey).*



The *RF PATH* softkey switches off the baseband input.

The default setting is *RF PATH ON* (i.e. baseband input OFF).

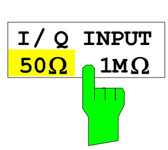
IEC/IEEE bus command: `INP:SEL RF`



The *BASEBAND ANALOG* softkey switches on the baseband input.

The default setting is *baseband input OFF.*

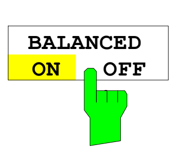
IEC/IEEE bus command: `INP:SEL AIQ`



The *I/Q INPUT 50Ω - 1MΩ* softkey toggles the input impedance of the baseband inputs.

The default setting is *50 Ω*.

IEC/IEEE bus command: `INP:IQ:IMP LOW | HIGH`



The *BALANCED ON - OFF* softkey switches the inputs to balanced (BALANCED ON) or referenced to ground (BALANCED OFF).
The default setting is *ON.*

IEC/IEEE bus command: `INP:IQ:BAL ON |OFF`

If the baseband input is active, the enhancement label **B50** (input impedance 50 Ω) or **B1M** (input impedance 1 MΩ) is displayed at the right of the diagram.

The lowpass filter of the baseband input cannot be switched off and dithering cannot be switched on within the applications.

When the baseband input is active, it is also not possible to make the following settings in the named options (unlike in the *FFT Analyzer* mode):

- center frequency (irrelevant)
- RF attenuation (automatically derived from reference level)
- resolution and video bandwidth (irrelevant)

REF LEVEL

In the baseband, the reference level is entered in volt peak. The level in the diagram label is specified in dBm, however, since the limit values in the mobile radio standards are also specified in dBm. 1 volt peak corresponds to 10 dBm.

The following values are permissible:
0.0316 V
0.0562 V
0.1 V
0.178 V
0.316 V
0.562 V
1 V
1.78 V
3.16 V only with IMPEDANCE LOW (50 Ω)
5.62 V only with IMPEDANCE LOW (50 Ω)

IEC/IEEE bus command: `SENS:VOLT:IQ:RANGE 1`

REF LEVEL OFFSET

By entering an adequate reference level offset (to compensate for the output amplifier of a base station or mobile phone not available in the measurement path), the values can be shifted to the appropriate range.
The y-axis scaling is changed accordingly.

The setting range is ±200 dB in 0.1 dB steps.

IEC/IEEE bus command: `DISP:WIND:TRAC:RLEV:OFFS -10dB`

Application FS-K5

When the baseband input is active, the following measurements can be performed with application FS-K5 (GSM and EDGE):

PHASE/FREQ ERROR (GSM)
MODULATION ACCURACY (EDGE)
POWER VS TIME
and
AUTO LEVEL&TIME

The following measurements are disabled:

CARRIER POWER
MODULATION SPECTRUM
TRANSIENT SPECTRUM
SPURIOUS

Application FS-K7

When the baseband is active, all measurements can be performed with application FS-K7 (FM demodulator).

Application FS-K8

When the baseband input is active, the following measurements can be performed with application FS-K8 (Bluetooth):

OUTPUT POWER
MODULATION CHAR
INIT CARR FREQ TOL
CARR FREQ DRIFT

The following measurements are disabled:

TX SPEC ACP

Application FS-K70

When the baseband is active, all measurements can be performed with application FS-K70 (vector signal analysis).

Applications FS-K72 and FS-K73

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K72/K74 (3G FDD BS) and FS-K73 (3G FDD MS).

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
STATISTICS

Applications FS-K76 and FS-K77

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K76 (TD-SCDMA BTS) and FS-K77 (TD-SCDMA MS).

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
POWER VS TIME
STATISTICS

Applications FS-K82 and FS-K83

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K82 (CDMA 2k BS) and FS-K83 (CDMA 2k MS).

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
SIGNAL STATISTIC

Applications FS-K84 and FS-K85

All code domain power measurements and the ADJUST REF LEVEL function are available in applications FS-K84 (1xEVDO BS) and FS-K85.

The following measurements are disabled:

POWER
ACLR
SPECTRUM EM MASK
OCCUPIED BANDWIDTH
SIGNAL STATISTIC

Remote control commands

For remote control, the FFT Analyzer mode mainly uses the commands of the Spectrum Analyzer mode (frequency and time domain). For limitations on the availability of commands, see section "Manual Operation". All specific expansions of the IQ Baseband FSQ-B71 option are described in the following section.

Option identification

***OPT?**

OPTION IDENTIFICATION QUERY queries the options contained in the instrument and returns a list of installed options. The individual options are separated by commas.

Position	Option	
1		Reserved
2	B4	OCXO
3		Reserved
4	B6	TV and RF Trigger Reserved
5		FSE: Vector analysis Reserved
6		Reserved
7	B9	Tracking Generator 3.6 GHz / can be I/Q-modulated
8		Reserved
9		Reserved
10	B12	Tracking Generator Attenuator 0 to 70 dB
11 to 13		Reserved
14		Reserved
15 to 18		Reserved
19	B21	Ext. Mixer Reserved
20 to 22		Reserved
23	B25	Electronic Attenuator
24 to 46		Reserved
47	FSQ-B71	Baseband Input

CALCulate:FORMat subsystem

The CALCulate:FORMat subsystem determines the postprocessing and conversion of measured data. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2>			
:FORMat	MAGNitude | PHASe | UPHase | RIMag | MPHase | VOLTage		

:CALCulate<1|2>:FORMat MAGNitude | PHASe | UPHase | RIMag | MPHase | VOLTage

This command defines the display of traces.

Example: `":CALC:FORM MPH"` Display of magnitude/phase diagram

Characteristics: *RST value: MAGNitude
SCPI: conforms to standard

Operating mode: FFT

The availability of the parameters depends on the FREQUENCY DOMAIN/TIME DOMAIN setting

MAGNitude Display of magnitude.
This parameter is available in both the frequency and time domains.

RIMag Display of real and imaginary component of spectrum.
This parameter is available only in the frequency domain.

MPHase Display of magnitude and phase of spectrum.
This parameter is available only in the frequency domain.

VOLTage Display of voltage.
This parameter is available only in the time domain.

PHASe Display of phase with limitation to ±180 deg or . ± π (PHASE WRAP).
This parameter is available only in the phase diagram.

UPHASe Display of phase without limitation to ±180 deg or . ± π (PHASE UNWRAP).

This parameter is available only in the phase diagram.

CALCulate:MARKer subsystem

The CALCulate:MARKer subsystem controls the marker functions in the instrument. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2> :MARKer<1...4> :LOEXclude	<Boolean>		

CALCulate<1|2>:MARKer<1...4>:LOEXclude ON | OFF

This command switches the suppression of the DC component on or off during maximum search. This function is available only in the FFT Analyzer mode in the frequency domain display.

This setting is valid for all markers and delta markers in all measurement windows.

Example: "`CALC:MARK:LOEX OFF`"

Characteristics: *RST value: ON
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix under CALCulate`<1|2>` and the numeric suffix under MARKer`<1...4>` are irrelevant.

CALCulate:PLINe subsystem

The CALCulate:PLINe subsystem controls the display lines in the phase diagram in the FFT Analyzer mode. The measurement window is selected via CALCulate1 (SCREEN A) or CALCulate2 (SCREEN B).

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2>			
:PLINe<1|2>	<numeric_value>	DEG | RAD	
:STATe	<Boolean>		

CALCulate<1|2>:PLINe<1|2> -36000 to 36000s

This command defines the position of the display lines in the phase diagram (phase line).

The lines mark the specified phases in the measurement window. Phase lines are available only in the frequency domain of the magnitude/phase display when the FFT Analyzer mode is active.

Example: "`CALC2:PLIN2 10ms`"

Characteristics: *RST value: - (STATe to OFF)
SCPI: instrument-specific

Operating mode: FFT

CALCulate<1|2>:PLINe<1|2>:STATe ON | OFF

This command switches the display lines in the phase diagram on or off. Phase lines are available only in the frequency domain of the magnitude/phase display when the FFT Analyzer mode is active.

Example: "`CALC2:PLIN2:STAT ON`"

Characteristics: *RST value: OFF
SCPI: instrument-specific

Operating mode: FFT

CALCulate:UNIT subsystem

The CALCulate:UNIT subsystem defines the units of the phase in the FFT Analyzer mode.

COMMAND	PARAMETER	UNIT	COMMENT
CALCulate<1|2> :UNIT :ANGLe	 DEG | RAD		

CALCulate<1|2>: UNIT:ANGLe DEG | RAD

This command selects the unit of the phase in the magnitude/phase diagram.

Example: "`CALC2:UNIT:ANGL RAD`"

Characteristics: *RST value: DEG
SCPI: instrument-specific

Operating mode: FFT

DIAGnostic subsystem

The DIAGnostic subsystem contains the commands that support instrument diagnostics for service, maintenance and repair. According to the SCPI standard, these commands are all instrument-specific.

COMMAND	PARAMETER	UNIT	COMMENT
DIAGnostic<1|2>			
:SERVice			
:IQ			
:CALibration			
:DESTination	IHIGh | ILOW | QHIGh | QLOW		
:DC	<numeric_value>	V	
:PULSe			
:PRATe	<numeric_value>	Hz	
:INPut	IQ | GND | CALDc | CALPulse		

DIAGnostic<1|2>:SERVice:IQ:CALibration:DESTination IHIGh | ILOW | QHIGh | QLOW

The calibration signals (DC Cal signal and Pulse Cal signal) can be switched to only one input at a time. This command switches the calibration signal to the I or Q path.

HIGh selects the positive and LOW the negative input. The negative input is through-connected only in the Balanced setting. The calibration signals are always positive. An inverted signal therefore appears in the output data when a signal is being fed to the negative input (LOW).

The DC Cal signal voltage is set using the command diag:serv:iq:cal:dc, and the frequency of the Pulse Cal signal is set using the command diag:serv:iq:cal:puls:prat.

IHIGh	Feed calibration signal to positive I path.
ILOW	Feed calibration signal to negative I path.
QHIGh	Feed calibration signal to positive Q path.
QLOW	Feed calibration signal to negative Q path.

Example: "DIAG:SERV:IQ:CAL:DEST QHIG"

Characteristics: *RST value: IHIGh
SCPI: instrument-specific

Operating mode: IQBB

The numeric suffix <1|2> is irrelevant with this command.

DIAGnostic<1|2>:SERVice:IQ:CALibration:DC 0 | 0.1 | 0.178 | 0.316 | 0.562 | 1.0

This command selects the voltage for the DC Cal signal in volts.

Example: "DIAG:SERV:IQ:CAL:DC 0.316"

Characteristics: *RST value: 0
SCPI: instrument-specific

Operating mode: IQBB

The numeric suffix <1|2> is irrelevant with this command.

DIAGnostic<1|2>:SERVice:IQ:CALibration:PULSe:PRATe 10 kHz | 62.5 kHz | 80 kHz | 100 kHz | 102.4 kHz | 200 kHz | 500 kHz | 1 MHz | 2 MHz | 4 MHz

This command sets the frequency of the Pulse Cal signal.

Example: `"DIAG:SERV:IQ:CAL:PULS:PRAT 80KHZ"`

Characteristics: *RST value: 62.5 kHz
SCPI: instrument-specific

Operating mode: IQBB

The numeric suffix <1|2> is irrelevant with this command.

DIAGnostic<1|2>:SERVice:IQ:INPut IQ | GND | CALDc | CALPulse

This command selects the baseband signal source.

IQ	The female I and Q connectors of the FSQ are the baseband signal sources.
GND	The baseband inputs are internally connected to ground.
CALDc	The baseband signal source is the DC Cal signal. The voltage of this signal can be set with diag:serv:iq:cal:dc.
CALPulse	The baseband signal source is the Pulse Cal signal. The frequency of this signal can be set with diag:serv:iq:prat.

Example: `"DIAG:SERV:IQ:INP CALD"`

Characteristics: *RST value: IQ
SCPI: instrument-specific

Operating mode: IQBB

The numeric suffix <1|2> is irrelevant with this command.

DISPlay subsystem

The DISPLay subsystem controls the scaling of measurement data on the screen.
The measurement window is selected via WINDow1 (SCREEN A) or WINDow2 (SCREEN B).

<table>
<tr><th>COMMAND</th><th>PARAMETER</th><th>UNIT</th><th>COMMENT</th></tr>
<tr><td>DISPlay</td><td></td><td></td><td></td></tr>
<tr><td>[:WINDow<1|2>]</td><td></td><td></td><td></td></tr>
<tr><td>:TRACe<1...3></td><td></td><td></td><td></td></tr>
<tr><td>:Y</td><td></td><td></td><td></td></tr>
<tr><td>[:SCALe]</td><td></td><td></td><td></td></tr>
<tr><td>:RLEVel</td><td><numeric_value></td><td>DB</td><td></td></tr>
<tr><td></td><td><numeric_value></td><td>DBM | V</td><td></td></tr>
<tr><td>:RVALue</td><td><numeric_value></td><td>DBM | DB |
DEG | RAD |
HZ | PCT</td><td></td></tr>
<tr><td>:RPOSition</td><td><numeric_value></td><td>PCT</td><td></td></tr>
<tr><td>:PDIVision</td><td><numeric_value></td><td>DB |
DEG | RAD |
HZ | PCT</td><td></td></tr>
</table>

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel –130 dBm to 30 dBm

This command defines the reference level or the measurement range of the baseband input.

If the reference level offset is <> 0, the specified value range of the reference level is changed by the offset.

I/Q data acquisition (TRAC:IQ:STAT ON):
RF input: The limits, units and dependencies specified in the FSQ manual apply. The unit and value range depends on the setting made with `CALCulate:UNIT`.

Baseband input: Use the command SENS:VOLT:IQ:RANG:UPP to set the gain.

FFT Analyzer:

In the FFT Analyzer mode, volt peak is generally used as the unit. The setting can also be made with SENS:VOLT:IQ:RANG:UPP in this case. The value range of the baseband input depends on the input impedance. The measurement range is defined as the measurable peak voltage (positive and negative).

Input impedance	**Value range / Volt (5 dB steps)**
Low (50 Ω)	0.0316; 0.0562; 0.1; 0.178 ; 0.316; 0.562; 1; 1.78; 3.16; 5.62
High (1 MΩ or 1KΩ)	0.0316; 0.0562; 0.1; 0.178 ; 0.316; 0.562; 1; 1.78

Example: "`INST:SEL FANAL`" 'FFT Analyzer mode
"`DISP:WIND1:TRAC:Y:RLEV 0.1`" 'sets the reference level to 0.1 volt peak

Characteristics: *RST value: -20 dBm for TRAC:IQ
1 V peak for FFT Analyzer mode
SCPI: conforms to standard

Operating mode: IQ BB, FFT

The numeric suffix under WINDow`<1...2>` and the numeric suffix under `TRACe<1...3>` are irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RLEVel:OFFSet –200 dB to 200 dB

This command defines the reference level offset.

Example: "`DISP:WIND1:TRAC:Y:RLEV:OFFS -10dB`"

Characteristics: *RST value: 0 dB
SCPI: conforms to standard

Operating mode: IQ BB, FFT

The numeric suffix under WINDow`<1...2>` and the numeric suffix under `TRACe<1...3>` are irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:PDIVision <numeric_value>

This command defines the scaling of the y-axis.

Example: "`:DISP:WIND2:TRAC:Y:PDIV 20deg`" 'Sets the scaling of the y-axis to 20 deg/ DIV

Characteristics: *RST value: --
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix under TRACe <1...3> is irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RPOSition 0 to 100 PCT

This command defines the position of the reference value for the y-axis.

Example: "`:DISP:WIND2:TRAC:Y:RPOS 30PCT`" 'shifts the reference value to 30 %

Characteristics: *RST value: --
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix under TRACe <1...3> is irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:RVALue <numeric_value>

This command defines the reference value for the y-axis of the measurement diagram.

Example: "`:DISP:WIND2:TRAC:Y:RVAL 10deg`" 'sets the reference value to 10 deg

Characteristics: *RST value: 0
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix under TRACe <1...3> is irrelevant.

DISPlay[:WINDow<1|2>]:TRACe<1...3>:Y[:SCALe]:AUTO ONCE

This command adapts the diagram limits to the current measurement results. The value range depends on the selected display.

Example: "`:DISP:WIND2:TRAC:Y:SCAL:AUTO ONCE`"

Characteristics: *RST value: ---
SCPI: instrument-specific

Operating mode: FFT

This command is an event, so it has neither an *RST value nor a query.

INPut subsystem

The INPut subsystem controls the characteristics of the instrument inputs. The numeric suffix is irrelevant for the FFT Analyzer mode.

COMMAND	PARAMETER	UNIT	COMMENT
INPut<1|2>			
:IQ			
:BALanced			
[:STATe]	<Boolean>		
:IMPedance	LOW | HIGH		
:TYPE	I | Q | IQ		

INPut<1|2>:IQ:BALanced[:STATe] ON | OFF

This command toggles the baseband inputs between balanced and unbalanced.

ON	Inputs balanced
OFF	Inputs unbalanced

Example: `"INP:IQ:BAL ON"`

Characteristics: *RST value: OFF
SCPI: instrument-specific

Operating mode: IQBB, FFT

The numeric suffix <1|2> is irrelevant with this command.

INPut<1|2>:IQ:IMPedance LOW | HIGH

This command selects the impedance of the baseband inputs.

LOW	Input impedance 50 Ω
HIGH	Input impedance 1 MΩ or 1 KΩ, depending on the version of the B71 module

Example: `"INP:IQ:IMP HIGH"`

Characteristics: *RST value: LOW
SCPI: instrument-specific

Operating mode: IQBB, FFT

The numeric suffix <1|2> is irrelevant with this command.

INPut<1|2>:IQ:TYPE I | Q | IQ

This command defines the input signal path used. It is available only in the FFT Analyzer mode.

I	Real signal	I only
Q	Reall signal	Q only
IQ	Complex signal	I+j*Q

Example: `"INP:IQ:TYPE IQ"` 'Selection of 'I+j*Q'

Characteristics: *RST value: IQ
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix <1|2> is irrelevant with this command.

INPut<1|2>:SELect AIQ | RF

This command switches the baseband inputs on (AIQ) or off (RF). *This command is not available in the FFT Analyzer mode.*

Example: `"INP:SEL AIQ"`

Characteristics: *RST value: RF
SCPI: instrument-specific

Operating mode: IQBB

The numeric suffix <1|2> is irrelevant with this command.

INSTrument subsystem

The INSTrument subsystem selects the instrument operating mode either by means of text parameters or by means of permanently assigned numbers.

COMMAND	PARAMETER	UNIT	COMMENT
INSTrument			
[:SELect]	SANalyzer | FANalyzer		
	<numeric_value>		
:NSELect			

INSTrument[:SELect] SANalyzer | FANalyzer

This command enables you to switch between operating modes by entering the name of the preferred mode.

Parameter: SANalyzer: Spectrum Analysis mode
FANalyzer FFT Analyzer mode

INSTrument:NSELect <numeric value.

This command enables you to switch between operating modes by entering numeric values.

Parameter: 1: Spectrum Analysis mode
22: FFT Analyzer mode

SENSe:BANDwidth subsystem

This subsystem controls the setting of the analyzer filter bandwidths. The two commands BANDwidth and BWIDth are identical. The numeric suffix is irrelevant for the FFT Analyzer mode.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe<1|2>]			
:BANDwidth			
[:RESolution]	<numeric_value>	HZ	
:STEP			
:MODE	LIN | L1235	--	
:BWIDth			
[:RESolution]	<numeric_value>	HZ	
:STEP			
:MODE	LIN | L1235	--	

[SENSe<1|2>:]BANDwidth|BWIDth[:RESolution]:STEP:MODE LIN | L1235.

This command controls the rounding of the settable bandwidth in the FFT Analyzer mode (in the frequency domain). With L1235, it is limited to steps of 1/2/3/5/10; with LIN, it is rounded to 0.1 Hz.

Example: "BAND:STEP:MODE L1235"

Characteristics: *RST value: L1235
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix <1|2> is irrelevant with this command.

SENSe:CORRection subsystem

The SENSe:CORRection subsystem controls how correction factors are calculated into the measurement results.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe<1|2>] :CORRection :OFFSet :PHASe	<numeric_value>,	DEG, RAD	

[SENSe<1|2>:]CORRection:OFFSet:PHASe <numeric_value.

This command sets a reference value for the phase display in the FFT analyzer mode.

Example: `"CORR:OFFS:PHAS 10deg"` includes a phase offset of 10 deg

Characteristics: *RST value: 0 dB
SCPI: instrument-specific

Operating mode: FFT

SENSe:FFT subsystem

The SENSe:FFT subsystem controls the FFT analyzer.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe<1|2>]			
:FFT			
:CAPTure	<Boolean>	--	
:AUTO	<Boolean>		
:CALCulate			No query
:PRESet			No query
[:Instrument]			No query

[SENSe<1|2>:]FFT:CAPTure ON | OFF

This command controls how data is captured in the FFT Analyzer mode. While the highest measurement speed is attained with OFF, ON and Single Sweep allow switching between the time and frequency domains even after the measurement without further data capture being necessary.

Example: `"FFT:CAPT ON"`

Characteristics: *RST value: ON
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]FFT:CAPTure:AUTO ON | OFF

This command controls the automatic recalculation of measurement results after changing the instruments parameter. This function is only available for BOTH DOMAIN OFF and SINGLE SWEEP.

Example: `"FFT:CAPT:AUTO ON"`

Characteristics: *RST value: OFF
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]FFT:CAPTure:CALCulate

This command restarts the analysis of captured data with new parameter settings, e.g. resolution bandwidth, window function or domain. This function is only available for BOTH DOMAIN OFF and SINGLE SWEEP.

This recalculation is automatically done, if FFT:CAPT:AUTO is switched ON.

Example: `"FFT:CAPT:CALC"`

Characteristics: *RST value: -
SCPI: instrument-specific

Operating mode: FFT

This command is an event and therefore has no *RST value and no query.
The numeric suffix <1|2> is irrelevant with this command.

SENSe<1|2>:]FFT:PRESet[:DEVice]

This command sets the FFT Analyzer mode to the default state. This default state is identical with the setting in effect after PRESET.

Example:	"SENS:FFT:PRES"	'sets the FFT Analyzer mode to the default state

Characteristics:	*RST value:	--
	SCPI:	instrument-specific

Operating mode: FFT

This command is an event, so it has neither an *RST value nor a query.

The numeric suffix <1|2> is irrelevant with this command.

SENSe:IQ subsystem

This subsystem controls settings for the baseband input.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe<1|2>]			
:IQ			
:DITHer			
[:STATe]	<Boolean>		
:LPASs			
[:STATe]	<Boolean>		

[SENSe<1|2>:]IQ:DITHer[:STATe] ON | OFF

This command inserts a 2 MHz-wide noise signal at 42.67 MHz into the signal path of the baseband input.When measuring data with TRAC:IQ subsystem it appears in the spectrum at 38.92 MHz.

Example: `"IQ:DITH ON"`

Characteristics: *RST value: OFF
SCPI: instrument-specific

Operating mode: IQBB, FFT

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>:]IQ:LPASs[:STATe] ON | OFF

This command inserts a 36 MHz filter into the I and Q paths of the baseband input.

Example: `"IQ:LPAS OFF"`

Characteristics: *RST value: ON
SCPI: instrument-specific

Operating mode: IQBB, FFT

The numeric suffix <1|2> is irrelevant with this command.

SENSe:VOLTage subsystem

This subsystem controls the amplitude settings of the baseband input.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe<1|2>] :VOLTage :IQ :RANGe [:UPPer]	<numeric_value>	V	

[SENSe<1|2>]:VOLTage:IQ:RANGe[:UPPer] <numeric_value>

This command defines the measurement range of the baseband input. The value range depends on the input impedance. The measurement range defines the measurable peak voltage (positive and negative).

Input impedance	Range of values / Volt (5 dB steps)
Low (50 Ω)	0.0316; 0.0562; 0.1; 0.178 ; 0.316; 0.562; 1; 1.78; 3.16; 5.62
High (1 MΩ or 1 kΩ)	0.0316; 0.0562; 0.1; 0.178 ; 0.316; 0.562; 1; 1.78

Example: ":VOLT:IQ:RANGE 0.1"

Characteristics: *RST value: 1
SCPI: instrument-specific

Operating mode: IQBB, FFT

The numeric suffix <1|2> is irrelevant with this command.

[SENSe<1|2>]:VOLTage:IQ:RANGe:OFFSet –200 dB to 200 dB

This command defines the reference level offset for the baseband input. In the FFT Analyzer mode, the command DISP:WIND:TRAC:Y:SCAL:RLEV:OFFS can also be used.

Example: ":VOLT:IQ:RANG:OFFS -20dB" 'sets the reference level offset for the baseband input to –20 dB

Characteristics: *RST value: 0 dB
SCPI: instrument-specific

Operating mode: IQBB, FFT

The numeric suffix <1|2> is irrelevant with this command.

SENSe:WINDow subsystem

This subsystem controls the evaluation in the FFT Analyzer mode.

COMMAND	PARAMETER	UNIT	COMMENT
[SENSe<1|2>]			
:WINDow			FFT Analyzer only
:TYPE	FLATtop | EXPonential | HAMMing | HANNing | RECTangular | CHEBychev		

SENSe<1|2>:WINDow:TYPE

This command selects the type of the window function for the FFT input data in the spectrum display (span > 0).

Parameter:	FLATtop	"Flattop" type
	EXPonential	"Gaußian" type
	HAMMing	"Hamming" type
	HANNing	"Hann" type
	RECTangular	"Rectangular" type
	CHEBychev	"Chebychev" type

Example: `"WIND:TYPE HAMM"`

Characteristics: *RST value:
SCPI: instrument-specific

Operating mode: FFT

The numeric suffix <1|2> is irrelevant with this command.

TRACe:IQ subsystem

The commands of this subsystem are used to measure and output I/Q data. For this purpose, a measurement memory is provided with a capacity of 16 Mword each for I and Q data. The number of samples to be acquired can be set. The sample rate can be selected in the range from 10 kHz to 81.6 MHz.
All trigger sources except VIDeo are available for triggering. The number of test points captured prior to triggering can be set for all available sources except FREE RUN (for FREE RUN, this value can always be assigned with 0).
The measurement results are output in list form, with the list of I data and the list of Q data immediately following each other in the output buffer. You can use the FORMAT command to choose between binary output (32-bit IEEE 754 floating-point numbers) and output in ASCII format.
The subsystem commands can be used in two ways:

1. Measurement and result retrieval in one command:

   This method causes the shortest delay between measurement and sample output, but requires that the control computer be actively waiting for the instrument to respond.

2. Setting of the instrument, starting of the measurement with "`INIT`" and querying of the result list at the end of the measurement:

   With this method, the control computer can be used during the measurement for other activities, which is at the expense of the additional time required for synchronization by means of a service request.

TRACe<1|2>:IQ:DATA?

This command starts a measurement with the setting specified by `TRACe:IQ:SET` and immediately returns the list of frequency-response corrected measurement results. The number of measurement results depends on specifications for the `TRACe:IQ:SET` command; the output format depends on the setting made via the `FORMat` subsystem and via TRACe:IQ:DATA:FORMat.

Note: This command requires that all requested measurement data be completely retrieved before the instrument accepts any further commands.

Parameter: none

Example: "TRAC:IQ:STAT ON" 'switches on I/Q data capturing

"INP:IQ:SEL AIQ" 'selects baseband input

"TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,0,4096" 'configures the measurement:

'filter type:	Normal
'RBW:	10 MHz
'sample rate:	32 MHz
'trigger source:	External
'trigger slope:	Positive
'pretrigger samples:	0
'# of samples:	4096

`"FORMat REAL,32"'` 'defines the format of the response data

`"TRAC:IQ:DATA?"` 'starts the measurement and outputs the results

Returned values:

Irrespective of the output format selected, the data is scaled linearly with *Volt* as the unit and corresponds to the voltage at the RF input of the instrument.

ASCII format (FORMat ASCII):

In this case, the command returns a comma-separated list (comma separated values or CSV) of the measured voltage values in floating-point format. The number of returned data here is 2 * the number of samples, the first half containing the I values and the second half the Q values.

Note: *If the volume of sampled values is >512 k ≡ 524288 sampled values, the data is transferred in logical blocks of 512 k. See below.*

Binary format (FORMat REAL,32):

In this case, the command returns binary data (definite length block data as defined in IEEE 488.2), in which the samples are arranged in sequential lists of I and Q data in 32-bit IEEE 754 floating-point numbers. The return string has the following structured:

#44096<I-value1><I-value2>...<I-value512k><Q-value1><Q-value2>...<Q-value512k>

where

#4	number of places occupied by the following number of data bytes (here: 4)
4096	number of following data bytes (*# of DataBytes*, here: 4096)
<I-value x>	4-byte floating-point I value; maximum number: 512 k
<Q-value y>	4-byte floating-point Q value; maximum number: 512 k

The number of I and Q values can be calculated as follows:

$$\# of\ I - Data \quad = \quad \# of\ Q - Data \quad = \quad \frac{\# of\ DataBytes}{8}$$

The offset of the Q data in the output buffer can thus be calculated as follows:

$$Q - Data - Offset \quad = \quad \frac{(\# of\ DataBytes)}{2} + LengthIndicatorDigits$$

where LengthIndicatorDigits is the number of characters of the length specification (including '#'). The preceding example (#41024...) thus yields a value of 6 for LengthIndicatorDigits and an offset of 512 + 6 = 518 for the Q data in the output buffer

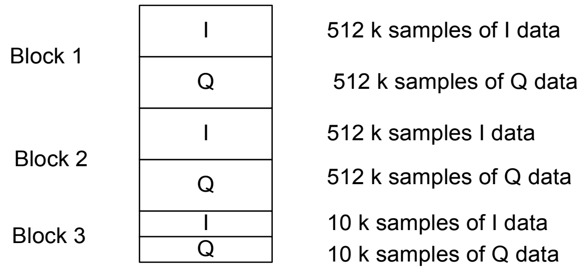
where LengthIndicatorDigits is the number of characters of the length specification (including '#'). The preceding example (#44096...) thus yields a value of 6 for LengthIndicatorDigits and an offset of 2048 + 6 = 2054 for the Q data in the output buffer.

Blockwise transfer if the amount of data exceeds 512 k words:

If the volume of sampled values is >512 k ≡ 524288 sampled values, the data is transferred in logical blocks of 512 k. All transferred blocks except the last one have a data length of exactly 512 k words.

The following example shows the data structure for 1058816 I data and 1058816 Q data of the sampled values. Since the block length is limited to 512 k, three blocks are required for data transfer:

512 k	(=524288) samples of I data of **Block 1**
512 k	(=524288) samples of Q data of **Block 1**
512 k	(=524288) samples of I data of **Block 2**
512 k	(=524288) samples of Q data of **Block 2**
10 k	(=10240) samples of I data of **Block 3**
10 k	(=10240) samples of Q data of **Block 3**



Block transfer structure for 1034 k samples = 1058816 samples

Characteristics: *RST value: --

Note:
The following minimum buffer sizes are recommended for the response string when querying I/Q data with TRAC:IQ:SET set to *RST.
ASCII format: 10 kbyte
Binary format: 2 kbyte

SCPI: instrument-specific

Operating mode: IQBB

TRACe<1|2>:IQ:DATA:FORMat COMPatible | IQBLock | IQPair>

This command controls the I/Q data output format (for command TRAC:IQ:DATA?):

COMPatible alternately transfering 512k I data and 512k Q data
IQBLock transfering all I data first and then all Q data
IQPair transfering I/Q data in pairs

Example: `"TRAC:IQ:DATA:FORM IQP"`

Characteristics: *RST value: COMP
SCPI: device specific

Mode: A

TRACe<1|2>:IQ:DATA:MEMory? <offset samples>,<# of samples>

This command allows you to read previously captured (and frequency-response-corrected) I/Q data from memory by specifying the offset of the beginning of the capture and the number of samples. Thus, a data record can be read in smaller portions after being initially captured. The maximum number of measurement results available depends on specifications for the `TRACe:IQ:SET` command; the output format depends on the setting made via the `FORMat` subsystem.

Note: *This command requires that all requested measurement data be completely retrieved before the instrument accepts any further commands.*

If no I/Q data is available in the memory because the associated measurement has not yet been started, the command generates a query error.

Parameter:	<offset samples>	Offset of the values to be output relative to the beginning of the captured data. Value range: 0 to <# of samples> - 1, where <# of samples> is the value specified for the TRACe:IQ:SET command.
	<# of samples>	Number of samples to be output. Value range: 1 to <# of samples> - <offset samples> where <# of samples> is the value specified for the TRACe:IQ:SET command.

Example:

`"TRAC:IQ:STAT ON"` 'switches on I/Q data capture

`"TRAC:IQ:SET NORM,10MHz,32MHz,EXT,POS,100,4096"`

'configures the measurement:

'filter type:	Normal
'RBW:	10 MHz
'sample rate:	32 MHz
'trigger source:	External
'trigger slope:	Positive
'pretrigger samples:	100
'# of samples:	4096

`"INIT;*WAI"` 'Starts the measurement and waits for the operation to be completed

`"FORMat REAL,32"` 'Defines the format of response data

'Read out results:

`"TRAC:IQ:DATA:MEM? 0,2048"`	'reads in 2048 I/Q values starting from 'beginning of capture
`"TRAC:IQ:DATA:MEM? 2048,1024"`	'reads in 1024 I/Q values starting from half the 'captured data
`"TRAC:IQ:DATA:MEM? 100,512"`	'reads in 512 I/Q values starting from trigger time' (<pretrigger samples> was 100)

Returned values:

Irrespective of the output format selected, the data is scaled linearly with V as the unit and corresponds to the voltage at the RF input of the instrument. The structure of the return buffer matches that of the `TRACe:IQ:DATA?` command.

Characteristics: *RST value: --
SCPI: instrument-specific

Operating mode: A-Z

TRACe<1|2>:IQ:SET <filter type>,<rbw>,<sample rate>,<trigger source>,<trigger slope>, <pretrigger samples>,<# of samples>

This command defines the default settings of the hardware for I/Q data capture. The sample rate, trigger setting and the capture length are thus set.

Parameters:

<filter type>:	NORMAL	not relevant for baseband input
<rbw>:	3MHz	not relevant for baseband input
<sample rate>:	Sampling rate of data capture	
	Value range:	10 kHz to 81.6 MHz
<trigger mode>:	Selection of the trigger source used for I/Q measurement.	
	Permissible values:	IMMediate | EXTernal | IFPower
<trigger slope>:	Trigger slope used.	
	Permissible values:	POSitive | NEGative |
<pretrigger samples>:	Number of samples captured prior to trigger time.	
	Value range:	-16744447 (= $-2^{24}+513$) to 65023 (= 64*1024 – 513); where negative values correspond to trigger delay.
	Note: Always enter the value 0 if <trigger mode> = IMMediate.	
<# of samples>:	Number of samples to be output.	
	Value range:	1 to 16 776 704 (16*1024*1024 –512)

Examples:

`"TRAC:IQ:SET NORM,3MHz,32MHz,EXT,POS,0,2048"` 'reads 2048 I/Q values starting from the trigger time.
sample rate: 32 MHz
trigger: external
slope: positive

`"TRAC:IQ:SET NORM,3MHz,4MHz,EXT,POS,1024,512"` 'reads 512 I/Q values starting from 1024 measurement points prior to the trigger time.
sample rate: 4 MHz
trigger: external
slope: positive

Characteristics: *RST values: `NORM,3MHz,32MHz,IMM,POS,0,128`

Note: *For this setting, the following minimum buffer sizes are recommended for the response string when using the TRAC:IQ:DATA? command:*

ASCII format: 10 kbyte
binary format: 2 kbyte

SCPI: instrument-specific

Operating mode: A-Z, IQBB

TRACe<1|2>:IQ:SRATe 10.0kHz to 81.6MHz

This command sets the sample rate for I/Q data capture. This means that the sampling rate can also be changed later on without affecting the other settings.

Value range: 10.0 kHz to 81.6 MHz

Example: `"TRAC:IQ:SRAT 4MHZ"`

Characteristics: *RST value: 32 MHz
SCPI: instrument-specific

Operating mode: A-Z, IQBB

TRACe<1|2>:IQ[:STATe] ON|OFF

This command enables or disables I/Q data capture.

Note: *I/Q data capture is not compatible with other measurement functions. Therefore, all other measurement functions are disabled when I/Q data capture is enabled.*
Likewise, traces cannot be displayed in this mode. All traces are therefore set to "BLANK".
Finally, the split-screen mode is automatically disabled when the function is enabled.

Example: `TRAC:IQ ON` 'enables I/Q data capture

Characteristics: *RST value: OFF
SCPI: instrument-specific

Operating mode: A-Z, IQBB