ROHDE&SCHWARZ

Test and Measurement
Division

Supplement

Tracking Generator

FSE-B8

1066.4469.02

FSE-B9

1066.4617.02

FSE-B10

1066.4769.02

FSE-B11

1066.4917.02

Dear FSE Customer,

The following collection of pages is intended to supplement your manuals for the instruments FSEA, FSEB, FSEM, FSEK, FSIQ and ESIB.

Please file the pages into your folder at the end of chapter 2 (tabbed divider 2).

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Republic of Germany

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Chapter 2.13

2.13 Tracking Generator Option

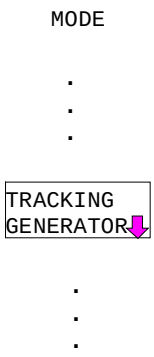
In the normal mode, the tracking generator sends a signal exactly at the input frequency of the instrument without a frequency offset.

For frequency-converting measurements it is possible to set a constant frequency offset of ±200 MHz between the output signal of the tracking generator and the receive frequency of the instrument.
Moreover, an I/Q modulation or AM and BB-FM modulation of the output signal can be carried out by using two analog input signals.

The output level is level-controlled and can be set in 0.1-dB steps in the range from -20 to 0 dBm, the level control can also be operated with external detectors. When the tracking generator is equipped with the optional attenuator, the setting range is extended from -90 dBm to 0 dBm.

The tracking generator can be used in all operating modes. The recording of test setup calibration values (SOURCE CAL) and the normalization with this correction values (*NORMALIZE*) is only possible in operating mode *ANALYZER MODE.*

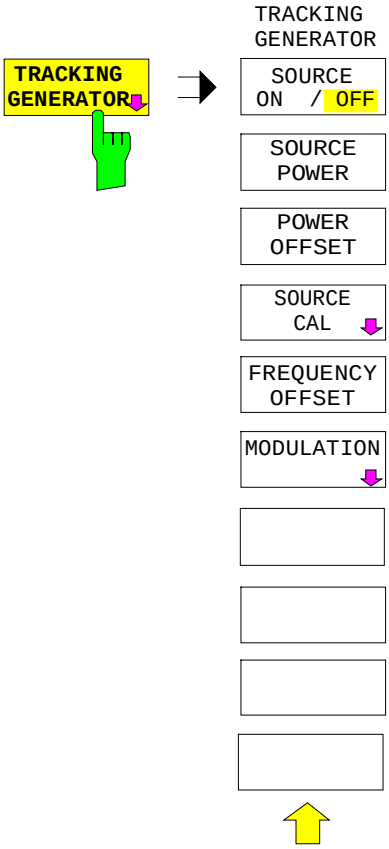
SYSTEM MODE menu:



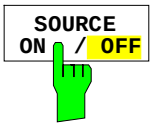
The *MODE* key activates the menu in which the submenu for setting the tracking generator can be selected in addition to different operating modes.

2.13.1 Tracking Generator Settings

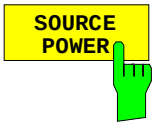
SYSTEM MODE menu:



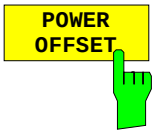
The *TRACKING GEN* softkey opens a menu for setting the functions of the tracking generator.



The *SOURCE ON/OFF* softkey switches the tracking generator on or off.
Default setting is *OFF*



The *SOURCE POWER* softkey activates the input of the tracking generator output level.
The output level can be set in 0.1-dB steps from 0 dBm to -20 dBm. The setting range is extended to -90 dBm when the tracking generator is equipped with the optional attenuator FSE-B12.
If the tracking generator is off, it is automatically switched on by the *SOURCE PWR* softkey.
Default setting is -20 dBm.



The *POWER OFFSET* softkey activates the input of a constant level offset of the tracking generator.
With this offset it is possible to consider attenuators or amplifiers at the output connector of the tracking generator during the input or output of output levels, for example.
The permissible setting range is -200 dB to +200 dB in 0.1-dB steps. Positive offsets apply to a subsequent amplifier and negative offsets to an attenuator.
Default setting is 0 dB.

2.13.2 Transmission Measurement

In this measurement, the transmission characteristic of a two-port network is measured. The built-in tracking generator serves as a signal source. The tracking generator is connected to the input connector of the DUT. The input of the instrument is fed from the output of the DUT.

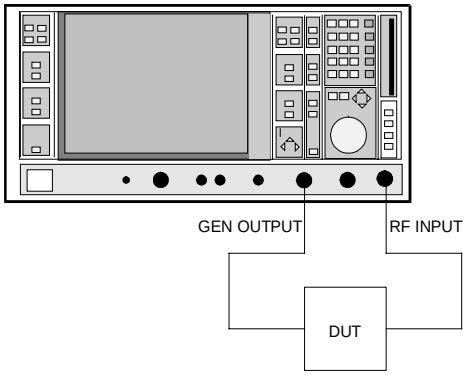
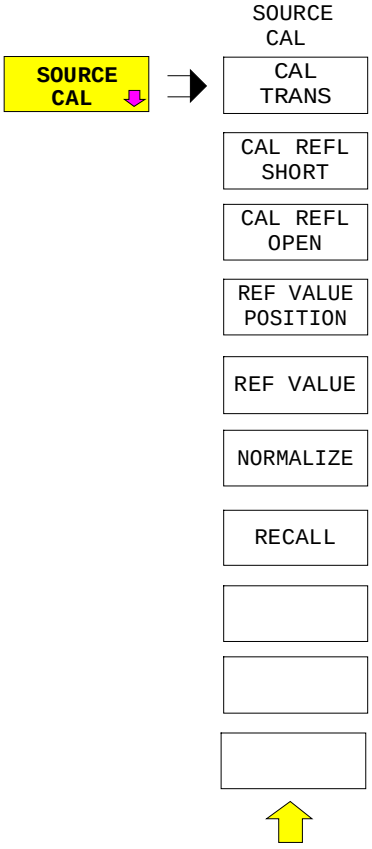


Fig. 2.13-1 Test setup for reflection measurements

A calibration can be carried out to compensate for the effects from the test setup (eg. frequency response of connecting cables).

2.13.2.1 Calibration of Transmission Measurement

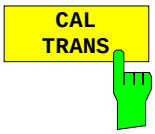
SYSTEM MODE-TRACKING GENERATOR menu:



The *SOURCE CAL softkey* opens a submenu comprising the calibration functions for the transmission and reflection measurement.

The calibration of the reflection measurement is described in section 2.13.3, its functioning in section 2.13.4 .

To carrry out a calibration for transmission measurements the whole test setup is through-connected (THRU).



The *CAL TRANS* softkey triggers the calibration of the transmission measurement.

It starts a sweep that records a reference curve. This trace is then used to obtain the differences to the normalized values.

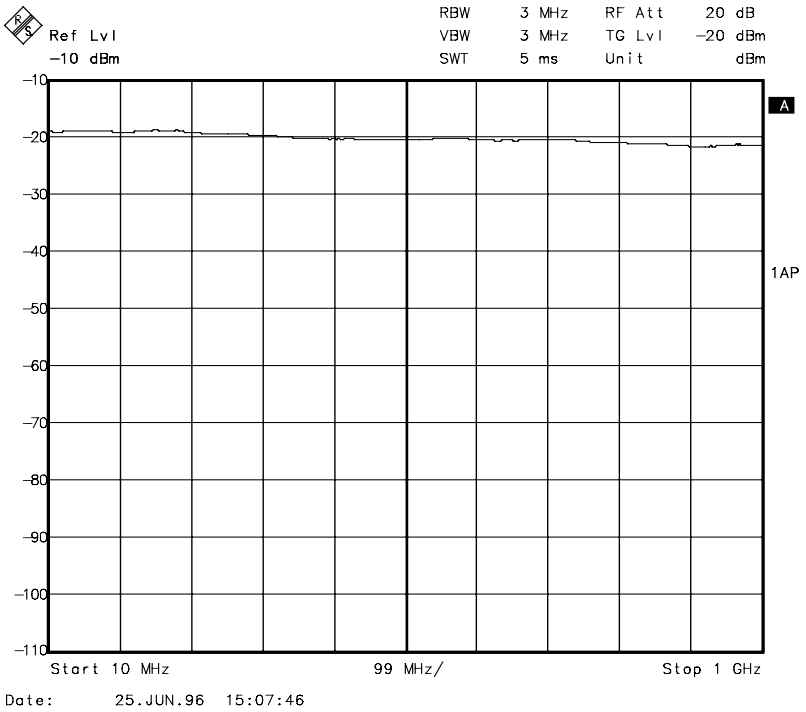
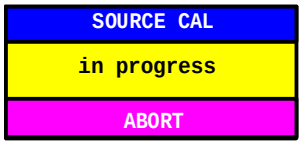
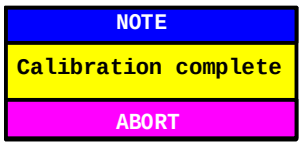


Fig. 2.13-2 Trace of a transmission calibration procedure

During the calibration sweep the following message is displayed:



After the calibration sweep the following message is displayed:

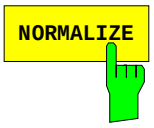


This message is cleared after approx. 3 seconds.

By storing and reloading the reference data set using the *SAVE* and *RECALL* softkeys in the key array *MEMORY* it is possible to store several calibration data sets and to switch between them without having to carry out a new calibration.

2.13.2.2 Normalization

SYSTEM MODE-TRACKING GENERATOR -SOURCE CAL menu:



The *NORMALIZE* softkey switches the normalization on or off. The softkey is only offered if the memory contains a correction trace.

If no reference line is switched on when activating the normalization, all measured values are with reference to the top grid line. The effects of the test setup is corrected in such a way that the measured values are displayed at the top grid margin.

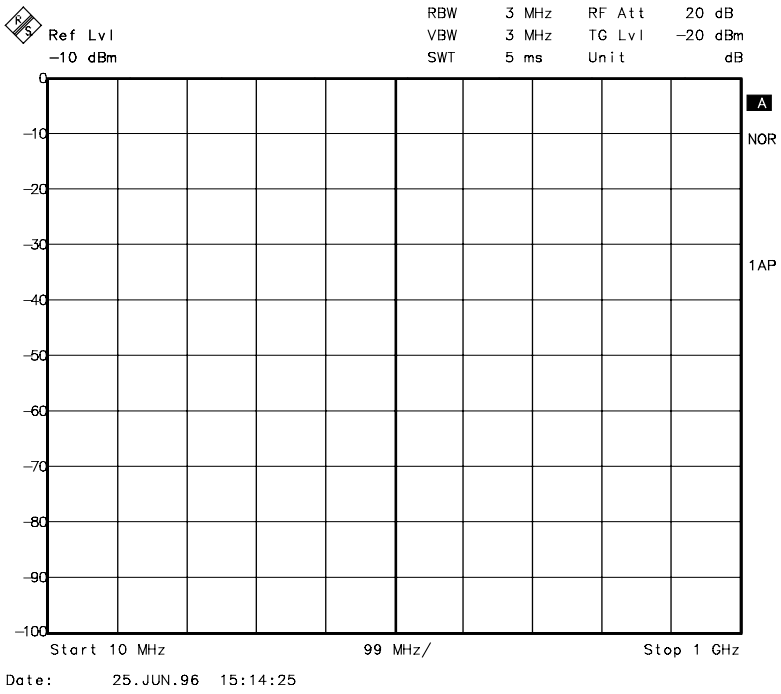
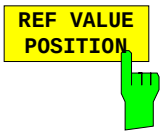


Fig. 2.13-3 Normalized display

In the *SPLIT SCREEN* setting, the normalization is switched on in the current window. Different normalizations can be active in the two measurement windows.

Normalization is aborted as soon as the operating mode *ANALYZER* is quit but can be switched on again as long as the reference trace stored in the memory has not been overwritten.

It is now possible to shift the relative reference point within the grid by using the *REF VALUE POSITION* softkey. Thus, the trace can be shifted from the top grid margin to the middle of the grid:



The *REF VALUE POSITION* softkey (reference position) marks a reference position in the active measurement window on which the normalization (difference formation with a reference curve) is performed.

If no reference line is switched on, the softkey switches on a reference line and activates the input of its position. The line can be moved within the grid limits.
The reference line is switched off by pressing the softkey again.

The function of the reference line is explained in section 2.12.4 Functioning of Calibration.

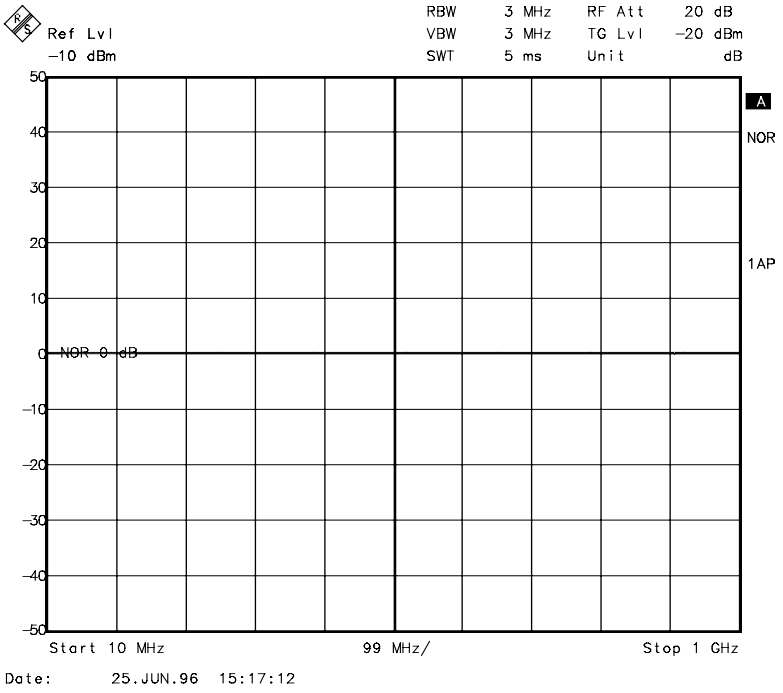


Fig. 2.13-4 Normalized measurement, shifted with *REF POSITION* 50 %

The *REF VALUE* softkey activates the input of a level value which is assigned to the reference line.

With normalization switched on, all measured values are displayed relative to the reference line, or if the latter is switched off relative to the top grid line which corresponds to 0 dB with default setting.

The value of *REF VALUE* is with reference to the actually active measurement window.

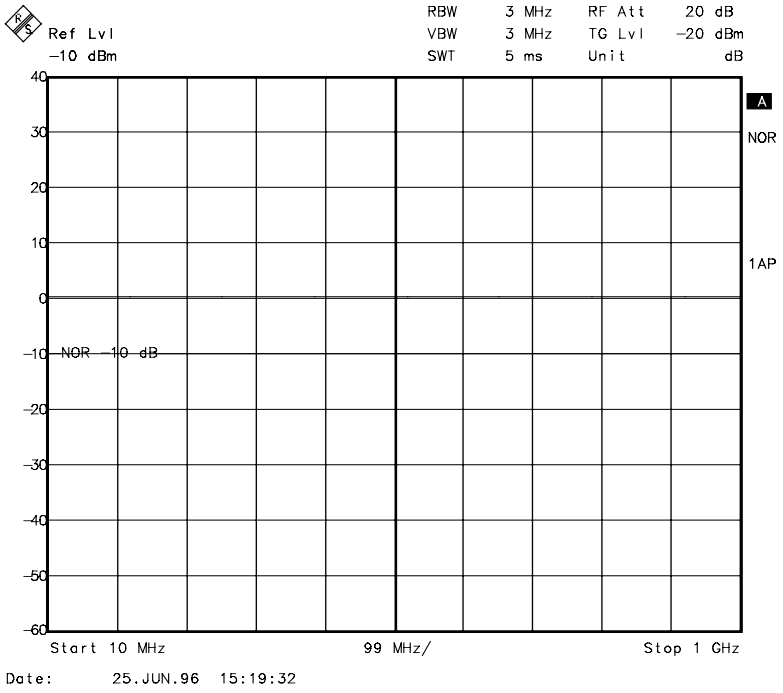


Fig. 2.13-5 Measurement with REF VALUE 20 dB and REF VALUE POSITION 50%

If a 10dB-attenuator pad is measured, the reference line can be displayed with a nominal attenuation after calibration by entering *REF VALUE* -10 dB. Departures from this nominal value are then displayed with high resolution (eg 1dB/Div) and with the absolute attenuation (eg 1 dB below nominal value = 11 dB attenuation).

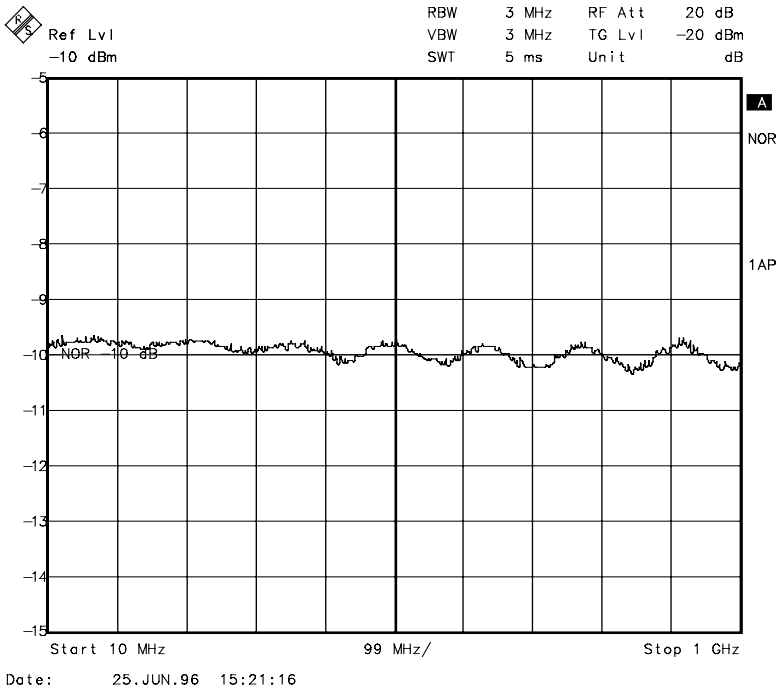
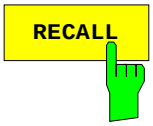


Fig. 2.13-1 Measurement of a 10dB attenuator pad with 1 dB / Div



The *RECALL* softkey restores the instrument setting with which the calibration was carried out.
This can be useful if the device setting was changed after calibration (eg center frequency setting, frequency deviation, reference level, etc.).

The softkey is only offered if:

- the analyzer mode has been selected
- the memory contains a calibration data set.

2.13.3 Reflection Measurement

Scalar reflection measurements can be carried out by means of a reflection-coefficient bridge.

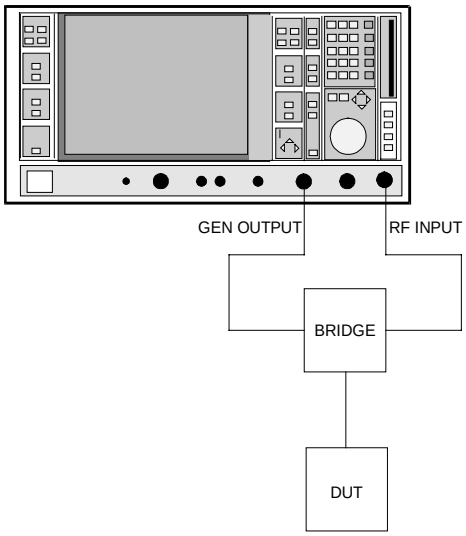


Fig. 2.13-6 Test setup for reflection measurements

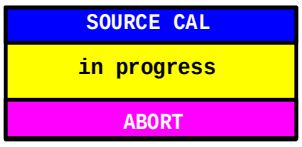
2.13.3.1 Calibration of Reflection Measurement

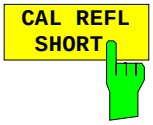
This calibration essentially corresponds to that of the transmission measurement.

SYSTEM MODE-TRACKING-SOURCE CAL submenu

The *CAL REFL OPEN* softkey starts the open-circuit calibration.

During calibration the following message is displayed

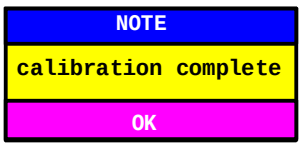




The *CAL REFL SHORT* softkey starts the short-circuit calibration.

If both calibrations (open circuit, short circuit) are carried out, the calibration curve is formed by averaging the two measurements and stored in the memory. The order of measurements is optional.

The completion of the calibration is indicated by



The display is cleared after 3 seconds.

2.13.4 Functioning of Calibration

Independent of the selected measurement (transmission/reflection) the calibration performs a difference calculation of the current measured values to a reference curve. The hardware settings used for measuring the reference curve is also assigned to the reference data set.

With the normalization switched on, the device stetting can largely be changed without stopping the normalization, ie the necessity to carry out a new normalization is reduced to a minimum.

To this effect, the reference data set (trace with 500 measured values) is also available as a table with 500 points (frequency/level).
Differences in level settings between the reference curve and the current device setting are calculated automatically. For small spans, a linear interpolation of the intermediate values is carried out. If the span is increased, the values at the left or right end of the reference data set are frozen until the set start or stop frequency is reached, ie the reference data set is extended by constant values.
An enhancement label is used to mark the different levels of measurement accuracy. This enhancement label is displayed at the right display margin when normalization is switched on and in case of an error from the reference setting. Three accuracy levels are defined:

Table 2.13-1 Measurement accuracy levels

Accuracy	**Enhancement label**	**Reason/Limitation**
High	NOR	No difference between reference setting and measurement
Medium	APP (approximation)	Change of the following settings: • coupling (RBW, VBW, SWT) • reference level, RF attenuation • start or stop frequency • output level of tracking generator • frequency offset of tracking generator • detector (max peak, min peak, sample...) Change of frequency: • 500 frozen points at maximum within the set sweep limits (corresponds to a doubling of the span)
-	Abortion of calibration	• more than 500 frozen points within the set sweep limits (in case of span doubling)

Note: *At a reference level (REF LEVEL) of -10 dBm and at a tracking generator output level of the same value the instrument operates without a headroom. ie the instrument is in danger of being overloaded if a signal is applied whose amplitude is higher than the reference line. In this case, either the message "OVLD" for overload is displayed in the status line or the display range is exceeded (upper limitation of trace = Overrange).*

This overload can be avoided by two actions:

- *Reducing the output level of the tracking generator (SOURCE POWER, SYSTEM-MODE-TRACKING GENERATOR menu)*
- *Increasing the reference level (REF LEVEL, LEVEL-REF menu)*

2.13.5 Frequency-Converting Measurements

For frequency-converting measurements (eg on converters) the tracking generator is able to set a constant frequency offset between the output frequency of the tracking generator and the receive frequency of the instrument. Up to an output frequency of 200 MHz the measurement can be carried out in inverted and normal position.

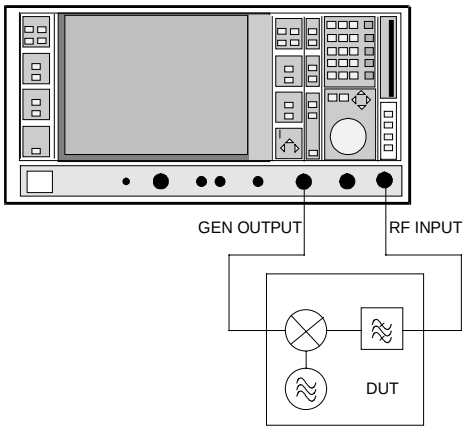
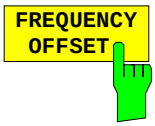


Fig. 2.13-7 Test setup for frequency-converting measurements

SYSTEM MODE-TRACKING GENERATOR menu:



The *FREQUENCY OFFSET* softkey activates the input of the frequency offset between the output signal of the tracking generator and the input frequency of the instrument. The permissible setting range is ±200 MHz in 1-Hz steps.
The default setting is 0 Hz.

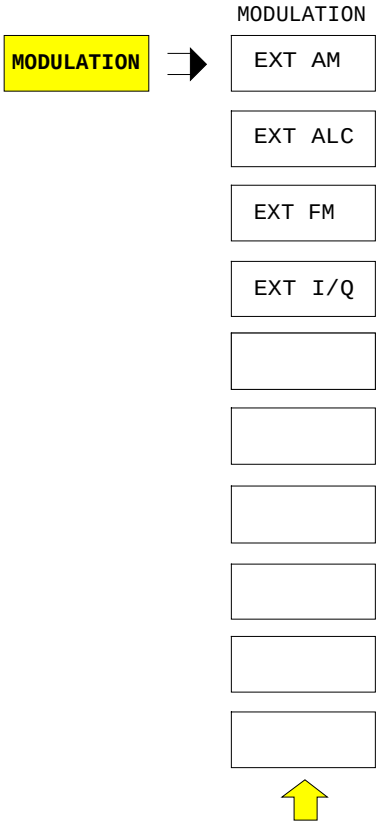
If a positive frequency offset is entered, the tracking generator generates an output signal above the receive frequency of the instrument. In case of a negative frequency offset it generates a signal below the receive frequency of the instrument. The output frequency of the tracking generator is calculated as follows:

Tracking generator frequency = receive frequency + frequency offset.

A frequency offset cannot be entered if an external I/Q or FM modulation is switched on. In this case, the *FREQUENCY OFFSET* softkey is blocked.

2.13.6 External Modulation of Tracking Generator

SYSTEM MODE-TRACKING GENERATOR menu:



The *MODULATION* softkey opens a submenu for selecting the different modulation types.

The time characteristic of the output signal of the tracking generator can be influenced by means of externally fed-in signals (input voltage range -1 V to +1 V).

The functions for amplitude and frequency modulation and for external level control are always available.

The function IQ modulation is only available in models of tracking generators that are equipped with the IQ modulator (FSE-B9 and FSE-B11).

Two BNC connectors at the rear panel are available as signal inputs. Their function can be changed according to the modulation selected:

TG-INPUT I / AM / ALC and

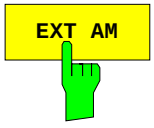
TG-INPUT Q / FM

The types of modulation can partly be combined with each other and with the frequency offset function. The following table shows which types of modulation are possible at the same time and which can be combined with the frequency offset function.

Table 2.13-2 Simultaneous modes of modulation (tracking generator)

Modulation	**Frequency offset**	**EXT AM**	**EXT ALC**	**EXT FM**	**EXT I/Q**
Frequency offset		•	•	•	
EXT AM	•			•	
EXT ALC	•				
EXT FM	•	•			
EXT I/Q					

• modulations can be combined



The *EXT AM* softkey activates an AM modulation of the tracking generator output signal.

The modulation signal is connected to the *TG-INPUT AM* connector. An input voltage of 1 V corresponds to 100% amplitude modulation. The maximum possible modulation depth is 80%.

Switching on an external AM deactivates the following functions:

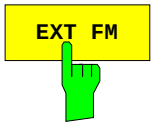
– active external level control
– active I/Q modulation.

The *EXT ALC* softkey activates the external level control.

In case of external level control the output level of the tracking generator is determined from the signal of an external detector. The external detector has to supply a negative voltage in the range of -0.1 to -1 V which is applied to the *TG-INPUT ALC* connector. The setting of the output level is the same as that of the internal level control but the output level depends on the external detector.

Switching on an external level control deactivates the following functions:

– active external AM
– active I/Q modulation.

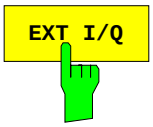


The *EXT FM* softkey activates the FM modulation of the tracking generator output signal.

The modulation frequency range is 1 kHz to 100 kHz, the deviation is approx. 1 MHz at an input voltage of 1 V.
The modulation signal is connected to the TG-INPUT FM connector.

Switching on an external FM deactivates the following function:

– active I/Q modulation.



The *EXT I/Q* softkey is only offered with I/Q modulator option built-in. It activates the external I/Q modulation of the tracking generator (FSE-B9 and FSE B-11).

The signals for modulation are connected to the two input connectors *TG-INPUT IN* and *TG-INPUT Q* at the rear of the unit. The input voltage range is ±1 V into 50 Ω.

Switching on an external I/Q modulation deactivates the following functions:

– active external AM
– active external level control
– active external FM or
– a level offset.

Functional description of quadrature modulator:

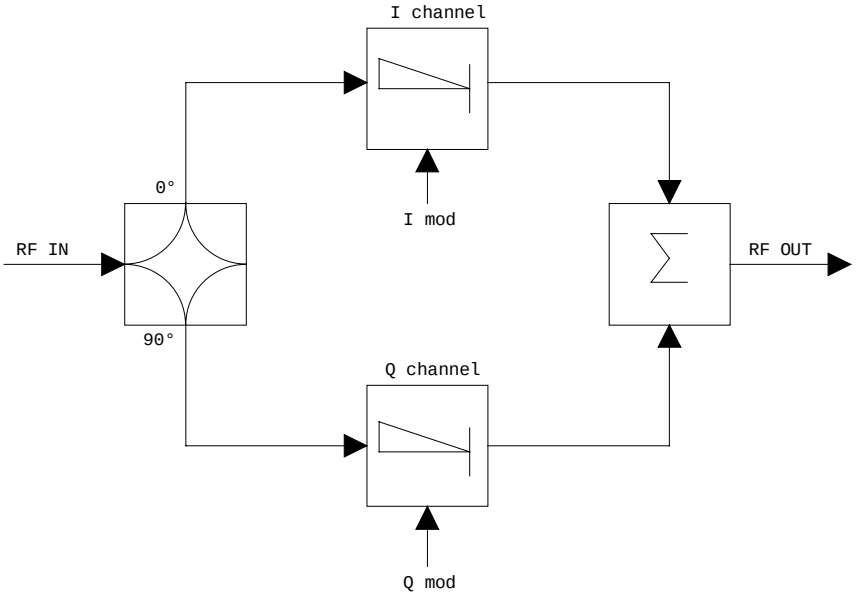


Fig. 2.13-8 I/Q modulation

I/Q modulation is performed by means of the built-in quadrature modulator. The RF signal is divided into the two orthogonal I and Q components (inphase and quadrature phase). Amplitude and phase are controlled in each path by the I and Q modulation signal. A RF output signal controllable in amplitude and phase is obtained by adding the two components.