R&S®FSV-K10x (LTE Uplink)
LTE Uplink Measurement Application
User Manual

ROHDE & SCHWARZ

This manual describes the following firmware applications:

- R&S®FSV-K101 EUTRA / LTE FDD Uplink Measurement Application (1310.9100.02)
- R&S®FSV-K105 EUTRA / LTE TDD Uplink Measurement Application (1310.9780.02)

The contents of this manual correspond to the following R&S®FSVR models with firmware version 2.23 or higher:

- R&S®FSVR7 (1311.0006K7)
- R&S®FSVR13 (1311.0006K13)
- R&S®FSVR30 (1311.0006K30)
- R&S®FSVR40 (1311.0006K40)

The software contained in this product makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgement" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

The following abbreviations are used throughout this manual: R&S®FSV is abbreviated as R&S FSV.

Contents

1 Introduction

Currently, UMTS networks worldwide are being upgraded to high speed downlink packet access (HSDPA) in order to increase data rate and capacity for downlink packet data. In the next step, high speed uplink packet access (HSUPA) will boost uplink performance in UMTS networks. While HSDPA was introduced as a 3GPP Release 5 feature, HSUPA is an important feature of 3GPP Release 6. The combination of HSDPA and HSUPA is often referred to as HSPA.

However, even with the introduction of HSPA, the evolution of UMTS has not reached its end. HSPA+ will bring significant enhancements in 3GPP Release 7. The objective is to enhance the performance of HSPA-based radio networks in terms of spectrum efficiency, peak data rate and latency, and to exploit the full potential of WCDMAbased 5 MHz operation. Important features of HSPA+ are downlink multiple input multiple output (MIMO), higher order modulation for uplink and downlink, improvements of layer 2 protocols, and continuous packet connectivity.

In order to ensure the competitiveness of UMTS for the next 10 years and beyond, concepts for UMTS long term evolution (LTE) have been investigated. The objective is a high-data-rate, low-latency and packet-optimized radio access technology. Therefore, a study item was launched in 3GPP Release 7 on evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). LTE/ EUTRA will then form part of 3GPP Release 8 core specifications.

This introduction focuses on LTE/EUTRA technology. In the following, the terms LTE or EUTRA are used interchangeably.

In the context of the LTE study item, 3GPP work first focused on the definition of requirements, e.g. targets for data rate, capacity, spectrum efficiency, and latency. Also commercial aspects such as costs for installing and operating the network were considered. Based on these requirements, technical concepts for the air interface transmission schemes and protocols were studied. Notably, LTE uses new multiple access schemes on the air interface: orthogonal frequency division multiple access (OFDMA) in downlink and single carrier frequency division multiple access (SC-FDMA) in uplink. Furthermore, MIMO antenna schemes form an essential part of LTE. In an attempt to simplify protocol architecture, LTE brings some major changes to the existing UMTS protocol concepts. Impact on the overall network architecture including the core network is being investigated in the context of 3GPP system architecture evolution (SAE).

1.1 Requirements for UMTS Long-Term Evolution

LTE is focusing on optimum support of packet switched (PS) services. Main requirements for the design of an LTE system are documented in 3GPP TR 25.913 [1] and can be summarized as follows:

- Data Rate: Peak data rates target 100 Mbps (downlink) and 50 Mbps (uplink) for 20 MHz spectrum allocation, assuming two receive antennas and one transmit antenna are at the terminal.

- Throughput: The target for downlink average user throughput per MHz is three to four times better than Release 6. The target for uplink average user throughput per MHz is two to three times better than Release 6.

- Spectrum efficiency: The downlink target is three to four times better than Release 6. The uplink target is two to three times better than Release 6.

- Latency: The one-way transit time between a packet being available at the IP layer in either the UE or radio access network and the availability of this packet at IP layer in the radio access network/UE shall be less than 5 ms. Also C-plane latency shall be reduced, e.g. to allow fast transition times of less than 100 ms from camped state to active state.

- Bandwidth: Scaleable bandwidths of 5 MHz, 10 MHz, 15 MHz, and 20 MHz shall be supported. Also bandwidths smaller than 5 MHz shall be supported for more flexibility.

- Interworking: Interworking with existing UTRAN/GERAN systems and non-3GPP systems shall be ensured. Multimode terminals shall support handover to and from UTRAN and GERAN as well as inter-RAT measurements. Interruption time for handover between EUTRAN and UTRAN/GERAN shall be less than 300 ms for realtime services and less than 500 ms for non-realtime services.

- Multimedia broadcast multicast services (MBMS): MBMS shall be further enhanced and is then referred to as E-MBMS.

- Costs: Reduced CAPEX and OPEX including backhaul shall be achieved. Costeffective migration from Release 6 UTRA radio interface and architecture shall be possible. Reasonable system and terminal complexity, cost, and power consumption shall be ensured. All the interfaces specified shall be open for multivendor equipment interoperability.

- Mobility: The system should be optimized for low mobile speed (0 to 15 km/h), but higher mobile speeds shall be supported as well, including high speed train environment as a special case.

- Spectrum allocation: Operation in paired (frequency division duplex / FDD mode) and unpaired spectrum (time division duplex / TDD mode) is possible.

- Co-existence: Co-existence in the same geographical area and co-location with GERAN/UTRAN shall be ensured. Also, co-existence between operators in adjacent bands as well as cross-border co-existence is a requirement.

- Quality of Service: End-to-end quality of service (QoS) shall be supported. VoIP should be supported with at least as good radio and backhaul efficiency and latency as voice traffic over the UMTS circuit switched networks.

- Network synchronization: Time synchronization of different network sites shall not be mandated.

1.2 Long-Term Evolution Uplink Transmission Scheme

1.2.1 SC-FDMA

During the study item phase of LTE, alternatives for the optimum uplink transmission scheme were investigated. While OFDMA is seen optimum to fulfil the LTE requirements in downlink, OFDMA properties are less favourable for the uplink. This is mainly due to weaker peak-to-average power ratio (PAPR) properties of an OFDMA signal, resulting in worse uplink coverage.

Thus, the LTE uplink transmission scheme for FDD and TDD mode is based on SCFDMA with a cyclic prefix. SC-FDMA signals have better PAPR properties compared to an OFDMA signal. This was one of the main reasons for selecting SC-FDMA as LTE uplink access scheme. The PAPR characteristics are important for cost-effective design of UE power amplifiers. Still, SC-FDMA signal processing has some similarities with OFDMA signal processing, so parameterization of downlink and uplink can be harmonized.

There are different possibilities how to generate an SC-FDMA signal. DFT-spread-OFDM (DFT-s-OFDM) has been selected for EUTRA. The principle is illustrated in figure 1-1.

For DFT-s-OFDM, a size-M DFT is first applied to a block of M modulation symbols. QPSK, 16QAM and 64 QAM are used as uplink EUTRA modulation schemes, the latter being optional for the UE. The DFT transforms the modulation symbols into the frequency domain. The result is mapped onto the available sub-carriers. In EUTRA uplink, only localized transmission on consecutive sub-carriers is allowed. An N point IFFT where N>M is then performed as in OFDM, followed by addition of the cyclic prefix and parallel to serial conversion.
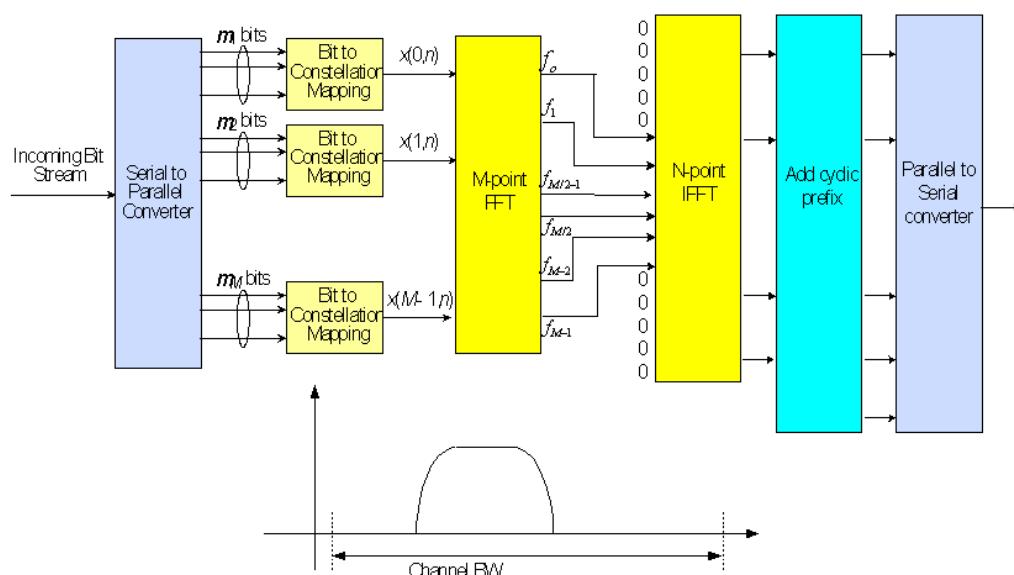
Fig. 1-1: Block Diagram of DFT-s-OFDM (Localized Transmission)

The DFT processing is therefore the fundamental difference between SC-FDMA and OFDMA signal generation. This is indicated by the term DFT-spread-OFDM. In an SCFDMA signal, each sub-carrier used for transmission contains information of all transmitted modulation symbols, since the input data stream has been spread by the DFT transform over the available sub-carriers. In contrast to this, each sub-carrier of an OFDMA signal only carries information related to specific modulation symbols.

1.2.2 SC-FDMA Parameterization

The EUTRA uplink structure is similar to the downlink. An uplink radio frame consists of 20 slots of 0.5 ms each, and 1 subframe consists of 2 slots. The slot structure is shown in figure 1-2.

Each slot carries N_{symb}^{UL} SC-FDMA symbols, where N_{symb}^{UL} = 7 for the normal cyclic prefix and N_{symb}^{UL} = 6 for the extended cyclic prefix. SC-FDMA symbol number 3 (i.e. the 4th symbol in a slot) carries the reference signal for channel demodulation.
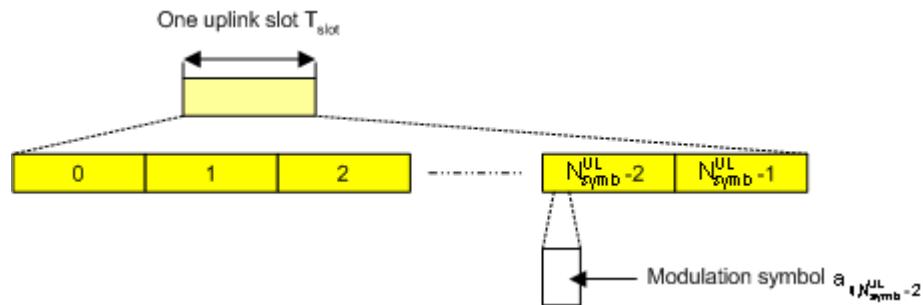
Fig. 1-2: Uplink Slot Structure

Also for the uplink, a bandwidth agnostic layer 1 specification has been selected. The table below shows the configuration parameters in an overview table.

Configuration	Number of symbols N_{symb}^{UL}	Cyclic prefix length in samples	Cyclic prefix length in µs
Normal cyclic prefix Δf=15kHz	7	160 for first symbol 144 for other symbols	5.2 µs for first symbol 4.7 µs for other symbols
Extended cyclic prefix Δf=15kHz	6	512	16.7 µs

1.2.3 Uplink Data Transmission

In uplink, data is allocated in multiples of one resource block. Uplink resource block size in the frequency domain is 12 sub-carriers, i.e. the same as in downlink. However, not all integer multiples are allowed in order to simplify the DFT design in uplink signal processing. Only factors 2, 3, and 5 are allowed.

The uplink transmission time interval (TTI) is 1 ms (same as downlink).

User data is carried on the Physical Uplink Shared Channel (**PUSCH**) that is determined by the transmission bandwidth NTx and the frequency hopping pattern k0.

The Physical Uplink Control Channel (**PUCCH**) carries uplink control information, e.g. CQI reports and ACK/NACK information related to data packets received in the downlink. The PUCCH is transmitted on a reserved frequency region in the uplink.

1.2.4 Uplink Reference Signal Structure

Uplink reference signals are used for two different purposes: on the one hand, they are used for channel estimation in the eNodeB receiver in order to demodulate control and data channels. On the other hand, the reference signals provide channel quality information as a basis for scheduling decisions in the base station. The latter purpose is also called channel sounding.

The uplink reference signals are based on CAZAC (Constant Amplitude Zero Auto-Correlation) sequences.

1.2.5 Uplink Physical Layer Procedures

For EUTRA, the following uplink physical layer procedures are especially important:

Non-synchronized random access

Random access may be used to request initial access, as part of handover, when transiting from idle to connected, or to re-establish uplink synchronization. The structure is shown in figure 1-3.
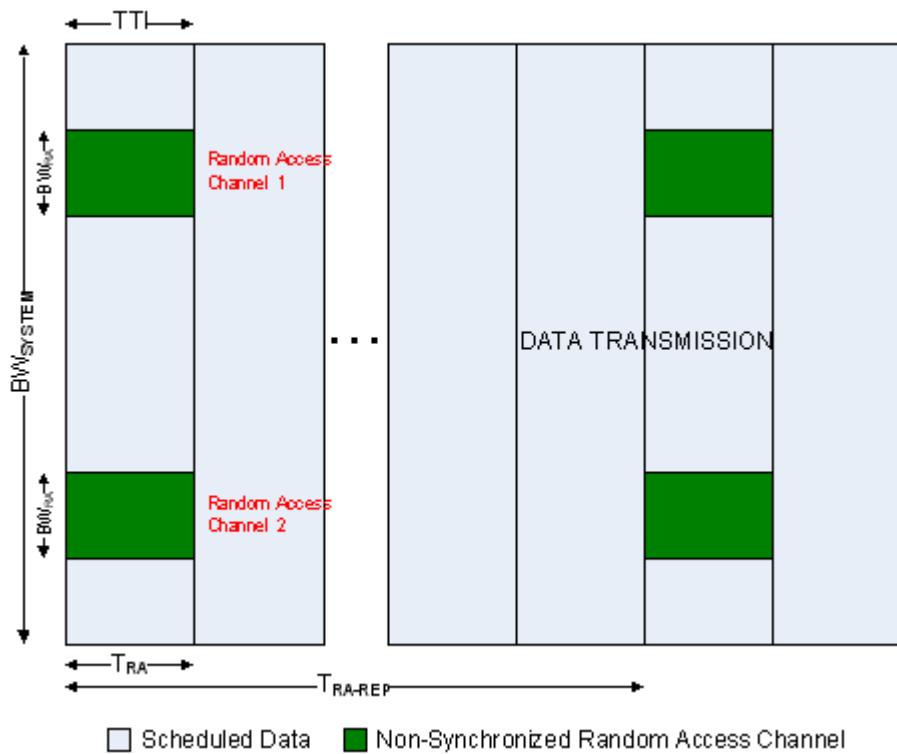
Fig. 1-3: Random Access Structure, principle

Multiple random access channels may be defined in the frequency domain within one access period T_{RA} in order to provide a sufficient number of random access opportunities.

For random access, a preamble is defined as shown in figure 1-4. The preamble sequence occupies T_{PRE} = 0.8 ms and the cyclic prefix occupies T_{CP} = 0.1 ms within one subframe of 1 ms. During the guard time T_{GT}, nothing is transmitted. The preamble bandwidth is 1.08 MHz (72 sub-carriers). Higher layer signalling controls in which subframes the preamble transmission is allowed, and the location in the frequency domain. Per cell, there are 64 random access preambles. They are generated from Zadoff-Chu sequences.
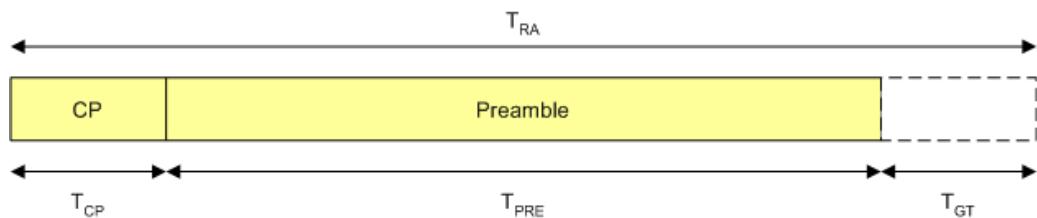
Fig. 1-4: Random Access Preamble

The random access procedure uses open loop power control with power ramping similar to WCDMA. After sending the preamble on a selected random access channel, the UE waits for the random access response message. If no response is detected then another random access channel is selected and a preamble is sent again.

Uplink scheduling

Scheduling of uplink resources is done by eNodeB. The eNodeB assigns certain time/frequency resources to the UEs and informs UEs about transmission formats to use. Scheduling decisions affecting the uplink are communicated to the UEs via the Physical Downlink Control Channel (PDCCH) in the downlink. The scheduling decisions may be based on QoS parameters, UE buffer status, uplink channel quality measurements, UE capabilities, UE measurement gaps, etc.

Uplink link adaptation

As uplink link adaptation methods, transmission power control, adaptive modulation and channel coding rate, as well as adaptive transmission bandwidth can be used.

Uplink timing control

Uplink timing control is needed to time align the transmissions from different UEs with the receiver window of the eNodeB. The eNodeB sends the appropriate timing-control commands to the UEs in the downlink, commanding them to adapt their respective transmit timing.

Hybrid automatic repeat request (ARQ)

The Uplink Hybrid ARQ protocol is already known from HSUPA. The eNodeB has the capability to request retransmissions of incorrectly received data packets.

1.3 References

[1] 3GPP TS 25.913: Requirements for E-UTRA and E-UTRAN (Release 7)

[2] 3GPP TR 25.892: Feasibility Study for Orthogonal Frequency Division Multiplexing (OFDM) for UTRAN enhancement (Release 6)

[3] 3GPP TS 36.211 v8.3.0: Physical Channels and Modulation (Release 8)

[4] 3GPP TS 36.300: E-UTRA and E-UTRAN; Overall Description; Stage 2 (Release 8)

[5] 3GPP TS 22.978: All-IP Network (AIPN) feasibility study (Release 7)

[6] 3GPP TS 25.213: Spreading and modulation (FDD)

[7] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for Wireless Broad-Band Systems Using OFDM – Part I. IEEE Trans. on Commun. Vol. 47 (1999) No. 11, pp. 1668-1677.

[8] Speth, M., Fechtel, S., Fock, G., and Meyr, H.: Optimum Receiver Design for OFDM-Based Broadband Transmission – Part II: A Case Study. IEEE Trans. on Commun. Vol. 49 (2001) No. 4, pp. 571-578.

2   Welcome

The EUTRA/LTE measurement application makes use of the I/Q capture functionality of the following spectrum and signal analyzers to enable EUTRA/LTE TX measurements conforming to the EUTRA specification.

● R&S FSVR

This manual contains all information necessary to configure, perform and analyze such measurements.

2.1   Installing the Software

For information on the installation procedure see the release notes of the R&S FSVR.

2.2   Application Overview

Starting the application

Access the application via the "Mode" menu.

► Press the MODE key and select "LTE".
Note that you may have to browse through the "Mode" menu with the "More" softkey to find the LTE entry.

Second LTE channel

The application provides a second LTE channel that you can access via the Mode menu with the softkey labeled "LTE2".

This second channel has the same functionality as the LTE channel. You can use it to perform measurements on two LTE channels with a different configuration, for example to test carrier aggregation.

Presetting the software

When you first start the software, all settings are in their default state. After you have changed any parameter, you can restore the default state with the PRESET key.

CONFigure:PRESet on page 147

Elements and layout of the user interface

The user interface of the LTE measurement application is made up of several elements.
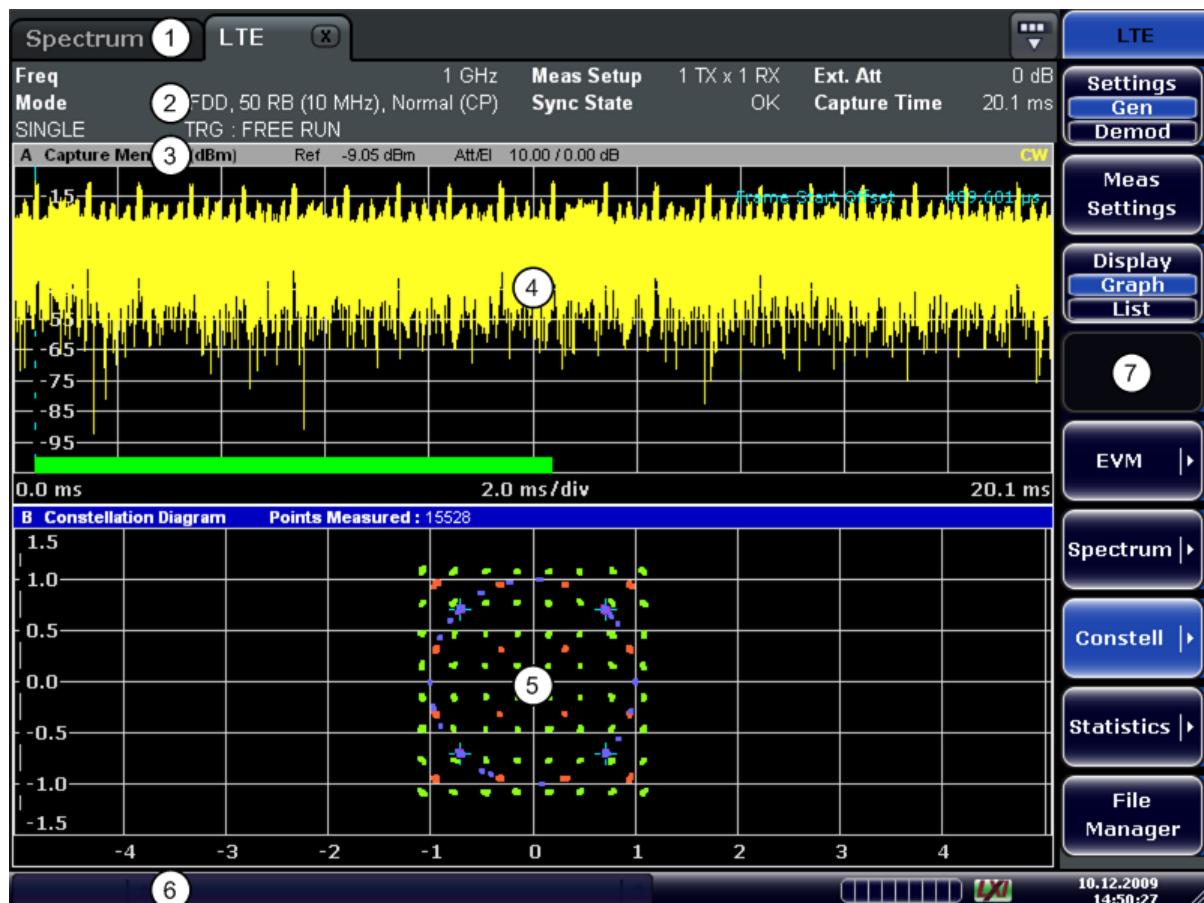
1 = Channel Bar: contains all currently active measurement applications
2 = Table Header: shows basic measurement information, e.g. the frequency
3 = Result Display Header: shows information about the trace
4 = Result Display Screen A: shows the measurement results
5 = Result Display Screen B: shows the measurement results
6 = Status Bar: shows the measurement progress, software messages and errors
7 = Softkeys: open settings dialogs and select result displays

The status bar

The status bar is located at the bottom of the display. It shows the current measurement status and its progress in a running measurement. The status bar also shows warning and error messages. Error messages are generally highlighted.

Display of measurement settings

The header table above the result displays shows information on hardware and measurement settings.

The header table includes the following information

- **Freq**
  The analyzer RF frequency.

- **Mode**
  Link direction, duplexing, cyclic prefix and maximum number of physical resource blocks (PRBs) / signal bandwidth.

- **Meas Setup**
  Shows number of transmitting and receiving antennas.

- **Sync State**
  The following synchronization states may occur:
  - **OK** The synchronization was successful.
  - **FAIL** The synchronization has failed.

  SCPI Command:
  [SENSe]:SYNC[:STATe]? on page 89

- **Ext. Att**
  Shows the external attenuation in dB.

- **Capture Time**
  Shows the capture length in ms.

2.3 Support

If you encounter any problems when using the application, you can contact the Rohde & Schwarz support to get help for the problem.

To make the solution easier, use the "R&S Support" softkey to export useful information for troubleshooting. The R&S FSVR stores the information in a number of files that are located in the R&S FSVR directory C:\R_S\Instr\user\LTE\Support. If you contact Rohde & Schwarz to get help on a certain problem, send these files to the support in order to identify and solve the problem faster.

3   Measurement Basics

3.1   Symbols and Variables

The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k} \hat{a}_{l,k}$	data symbol (actual, decided)
$A_{l,k}$	data symbol after DFT-precoding
Δf, $\Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}$, $\hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}$, $\hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	SC-FDMA symbol index
N_{DS}	number of SC-FDMA data symbols
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{TX}	number of allocated subcarriers
$N_{k,l}$	noise sample
n	index of modulated QAM symbol before DFT pre-coding
Φ_l	common phase error
r_i	received sample in the time domain
$R'_{k,l}$	uncompensated received sample in the frequency domain

$r_{n,l}$	equalized received symbols of measurement path after IDFT
T	duration of the useful part of an SC-FDMA symbol
T_g	duration of the guard interval
T_s	total duration of SC-FDMA symbol

3.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.

The contents of this chapter are structered like the DSP.

3.3 The LTE Uplink Analysis Measurement Application

The block diagram in figure 3-1 shows the general structure of the LTE uplink measurement application from the capture buffer containing the I/Q data up to the actual analysis block.

After synchronization a fully compensated signal is produced in the reference path (purple) which is subsequently passed to the equalizer. An IDFT of the equalized symbols yields observations for the QAM transmit symbols $a_{n,l}$ from which the data estimates $â_{n,l}$ are obtained via hard decision. Likewise a user defined compensation as well as equalization is carried out in the measurement path (cyan) and after an IDFT the observations of the QAM transmit symbols are provided. Accordingly, the measurement path might still contain impairments which are compensated in the reference path. The symbols of both signal processing paths form the basis for the analysis.
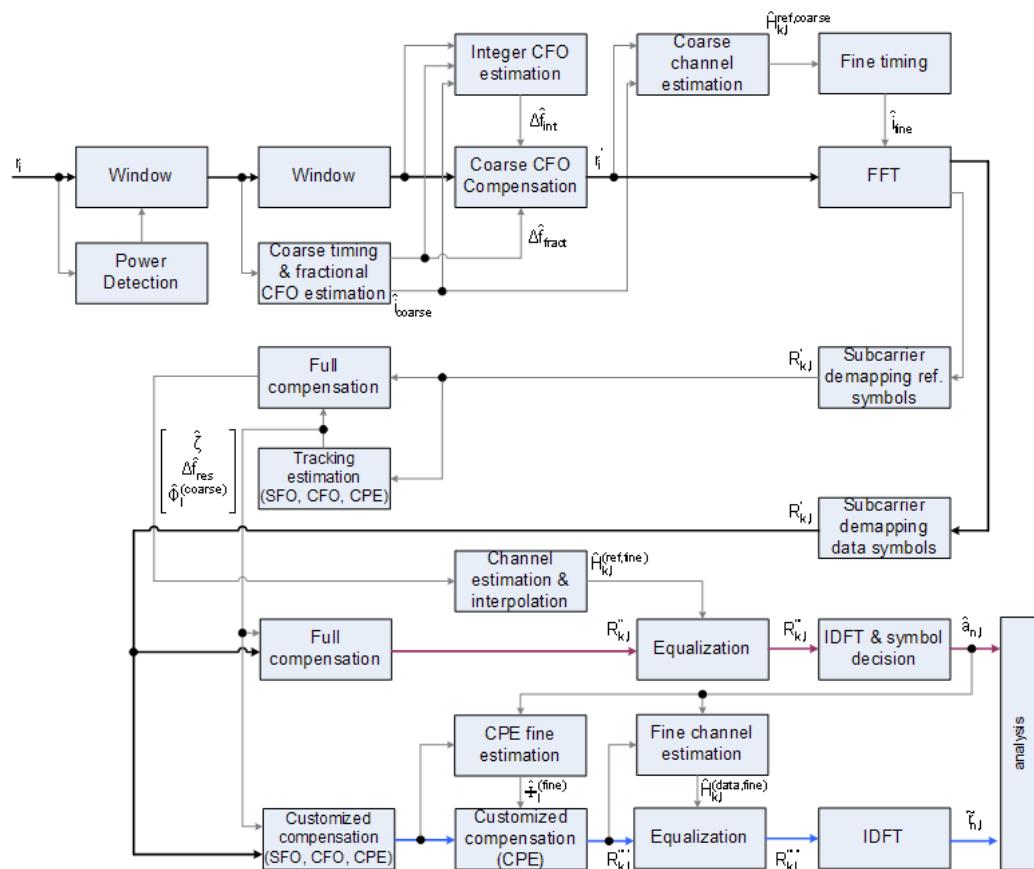
Fig. 3-1: Block diagram for the LTE UL measurement application

3.3.1 Synchronization

In a first step the areas of sufficient power are identified within the captured I/Q data stream which consists of the receive samples r_i. For each area of sufficient power, the analyzer synchronizes on subframes of the uplink generic frame structure [3]. After this coarse timing estimation, the fractional part as well as the integer part of the carrier frequency offset (CFO) are estimated and compensated. In order to obtain an OFDM demodulation via FFT of length N_{FFT} that is not corrupted by ISI, a fine timing is established which refines the coarse timing estimate.

A phase tracking based on the reference SC-FDMA symbols is performed in the frequency domain. The corresponding tracking estimation block provides estimates for

- the relative sampling frequency offset ζ
- the residual carrier frequency offset Δf_{res}
- the common phase error Φ_l

According to references [7] and [8], the uncompensated samples $R'_{k,l}$ in the DFT-pre-coded domain can be stated as

$$R'_{k,l} = A_{k,l} \cdot H_{k,l} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{k,l}$$

(3 - 1)

with

- the DFT precoded data symbol $A_{k,l}$ on subcarrier k at SC-FDMA symbol l,
- the channel transfer function $H_{k,l}$,
- the number of Nyquist samples N_S within the total duration T_S,
- the duration of the useful part of the SC-FDMA symbol $T=T_S-T_g$
- the independent and Gaussian distributed noise sample $N_{k,l}$

Within one SC-FDMA symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $R'_{k,l}$ completely in the reference path and according to the user settings in the measurement path. Thus the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decoded the data symbols in the reference path, an additional data-aided phase tracking can be utilized to refine the common phase error estimation.

3.3.2 Analysis

The analysis block of the EUTRA/LTE uplink measurement application allows to compute a variety of measurement variables.

EVM

The most important variable is the error vector magnitude which is defined as

$$EVM_{l,k} = \frac{\left| \tilde{r}_{n,l} - \hat{a}_{n,l} \right|}{\sqrt{E\left\{ \left| a_{n,l} \right|^2 \right\}}}$$

(3 - 2)

for QAM symbol n before precoding and SC-FDMA symbol l. Since the normalized average power of all possible constellations is 1, the equation can be simplified to

$$EVM_{n,l} = \left| \tilde{r}_{n,l} - \hat{a}_{n,l} \right|$$

(3 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{DS}N_{TX}} \sum_{l=0}^{N_{LB}-1} \sum_{n=0}^{N_{TX}-1} EVM_{n,l}^2}$$

(3 - 4)

for N_{DS} SC-FDMA data symbols and the N_{TX} allocated subcarriers.

I/Q imbalance

The I/Q imbalance contained in the continuous received signal r(t) can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(3 - 5)

where s(t) is the transmit signal and I and Q are the weighting factors describing the I/Q imbalance. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(3 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(3 - 7)

based on the complex-valued estimate $\Delta\hat{Q}$.

Basic in-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The relative in-band emissions are given by

$$Emissions_{relative}(\Delta_{RB}) = \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_S| \cdot N_{RB}} \sum_{t \in T_S} \sum_{c}^{c+12 \cdot N_{RB}-1} |Y(t,f)|^2}$$

(3 - 8)

where T_S is a set $|T_S|$ of SC-FDMA symbols with the considered modulation scheme being active within the measurement period, Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. Δ_{RB}=1 or Δ_{RB}=-1 for the first adjacent RB), c is the lower edge of the allocated BW, and Y(t,f) is the frequency domain signal evaluated for in-band emissions. N_{RB} is the number of allocated RBs .

The basic in-band emissions measurement interval is defined over one slot in the time domain.

Other measurement variables

Without going into detail, the EUTRA/LTE uplink measurement application additionally provides the following results:

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

3.4 SRS EVM Calculation

In order to calculate an accurate EVM, a channel estimation needs to be done prior to the EVM calculation. However, the channel estimation requires a minimum of two resource elements containing reference symbols on a subcarrier. Depending on the current Channel Estimation Range setting, this means that either at least two reference symbols ("Pilot Only") or one reference symbol and at least one data symbol ("Pilot and Payload") need to be available on the subcarrier the EVM is to be measured.

For PUSCH, PUCCH and PRACH regions, these conditions are normally fulfilled because the DMRS (= Demodulation Reference Signal) is already included. However, the SRS may also be located on subcarriers which do not occupy any other reference symbols (see figure 3-2).
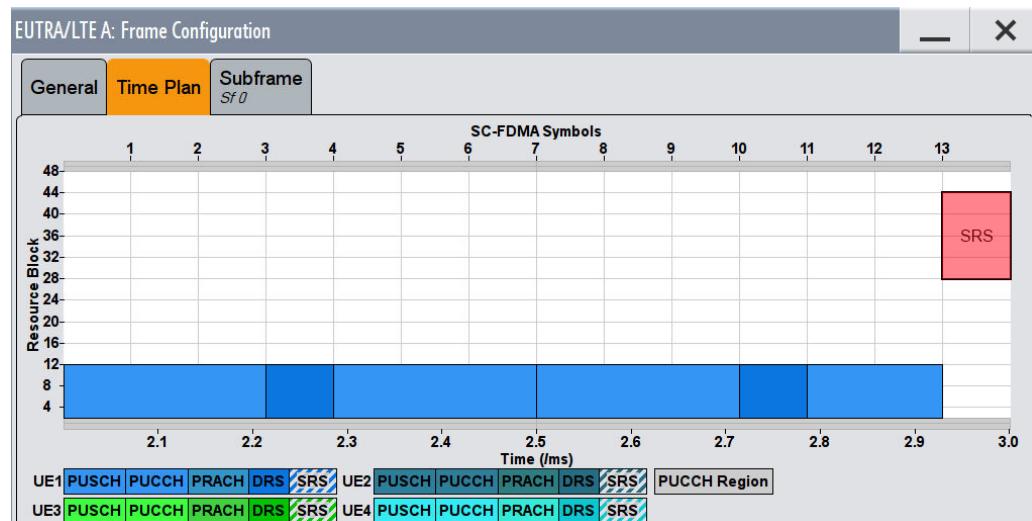
Fig. 3-2: No EVM can be measured for the SRS

In this case it is not reasonable to calculate an EVM and no SRS EVM value will be displayed for the corresponding subframe.

If the SRS subcarriers contain two DMRS symbols (or one DMRS and one PUSCH for "Pilot and Payload" channel estimation range) the SRS EVM can be measured (see figure 3-3).
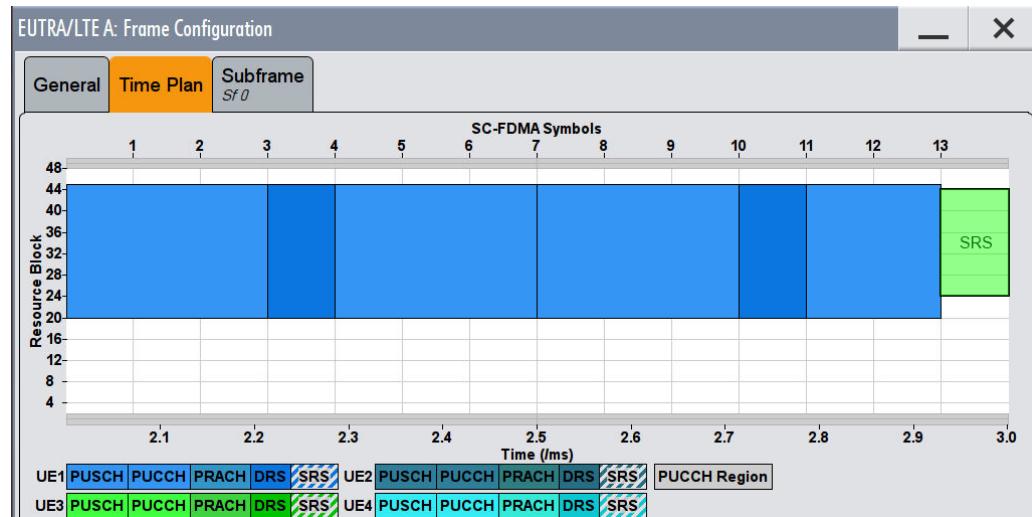
Fig. 3-3: The EVM of the complete SRS can be measured

The SRS allocation might cover subcarriers which partly fulfill the conditions mentioned above and partly do not. In this case the EVM value given in the Allocation Summary will be calculated based only on the subcarriers which fulfill the above requirements (see figure 3-4).
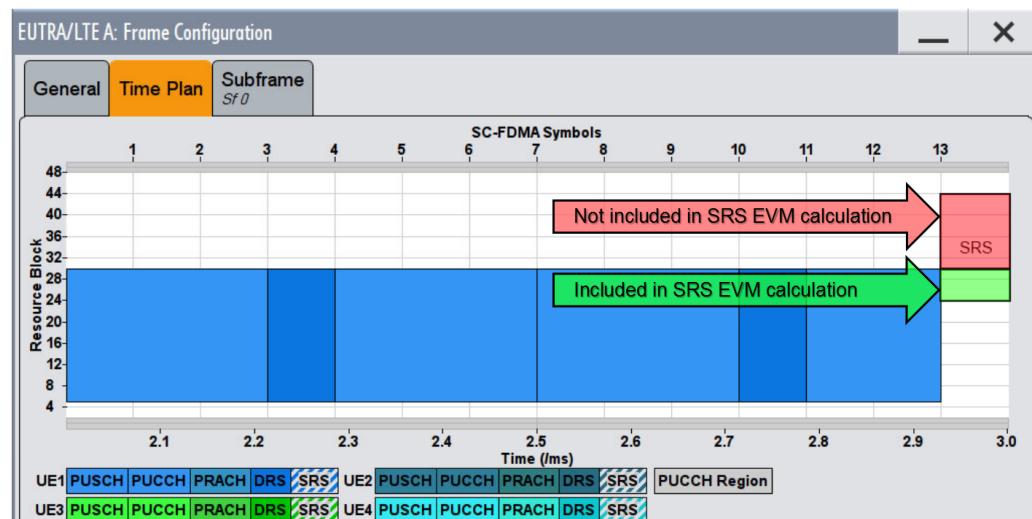
Fig. 3-4: The EVM for parts of the SRS can be measured

4 Measurements and Result Displays

The LTE measurement application features several measurements to examine and analyze different aspects of an LTE signal.

The source of the data that is processed is either a live signal or a previously recorded signal whose characteristics have been saved to a file. For more information see "Selecting the Input Source" on page 53.

For more information on the functionality to actually perform the measurement see chapter 5.1, "Performing Measurements", on page 42.

4.1 Numerical Results

Result Summary
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

▶ Press the "Display (List Graph)" softkey so that the "List" element turns blue to view the Result Summary.

Remote command:

`DISPlay[:WINDow<n>]:TABLe` on page 88

Contents of the result summary

Result Summary						
Frame Result 2/60	Min	Mean	Limit	Max	Limit	Unit
EVM PUSCH QPSK		0.43			18.50	%
EVM PUSCH 16QAM		0.00			13.50	%
EVM DMRS PUSCH QPSK		0.22	18.50			%
EVM DMRS PUSCH 16QAM		0.00	13.50			%
EVM PUCCH		0.00	18.50			%
EVM DMRS PUCCH		0.00	18.50			%
EVM PRACH						%
Results for Selection	Subframe(s) ALL	Slot(s) ALL		Frame Result 2/60		
EVM All	0.39	0.40		0.41		%
EVM Phys. Channel	0.42	0.42		0.43		%
EVM Phys. Signal	0.19	0.22		0.27		%
Frequency Error	587.25	587.76		588.41	680.00	Hz
Sampling Error	7.59	7.68		7.78		ppm
IQ Offset	- 62.49	- 62.32		- 61.95		dB
IQ Gain Imbalance						dB
IQ Quadrature Error						°
Power	- 30.71	- 30.71		- 30.71		dBm
Crest Factor	5.55	5.80		6.03		dB

The table is split in two parts. The first part shows results that refer to the complete frame. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

In addition to the red font, the application also puts a red star (* 25.60) in front of failed results.

Note: The EVM results on a frame level (first part of the table) are calculated as defined by 3GPP at the edges of the cyclic prefix.
The other EVM results (lower part of the table) are calculated at the optimal timing position in the middle of the cyclic prefix.

Because of inter-symbol interference, the EVM calculated at the edges of the cyclic prefix is higher than the EVM calculated in the middle of the cyclic prefix.

EVM PUSCH QPSK	Shows the EVM for all QPSK-modulated resource elements of the PUSCH channel in the analyzed frame.
	FETCh:SUMMary:EVM:USQP[:AVERage]? on page 93
EVM PUSCH 16QAM	Shows the EVM for all 16QAM-modulated resource elements of the PUSCH channel in the analyzed frame.
	FETCh:SUMMary:EVM:USST[:AVERage]? on page 94
EVM DRMS PUSCH QPSK	Shows the EVM of all DMRS resource elements with QPSK modulation of the PUSCH in the analyzed frame.
	FETCh:SUMMary:EVM:SDQP[:AVERage]? on page 92
EVM DRMS PUSCH 16QAM	Shows the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH in the analyzed frame.
	FETCh:SUMMary:EVM:SDST[:AVERage]? on page 93

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the slots.

The header row of the table contains information about the selection you have made (like the subframe).

EVM All	Shows the EVM for all resource elements in the analyzed frame.
	`FETCh:SUMMary:EVM[:ALL][:AVERage]?` on page 91
EVM Phys Channel	Shows the EVM for all physical channel resource elements in the analyzed frame.
	A physical channel corresponds to a set of resource elements carrying information from higher layers. PUSCH, PUCCH and PRACH are physical channels. For more information see 3GPP 36.211.
	`FETCh:SUMMary:EVM:PCHannel[:AVERage]?` on page 92
EVM Phys Signal	Shows the EVM for all physical signal resource elements in the analyzed frame.
	The reference signal is a physical signal. For more information see 3GPP 36.211.
	`FETCh:SUMMary:EVM:PSIGnal[:AVERage]?` on page 92
Frequency Error	Shows the difference in the measured center frequency and the reference center frequency.
	`FETCh:SUMMary:FERRor[:AVERage]?` on page 94
Sampling Error	Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.
	`FETCh:SUMMary:SERRor[:AVERage]?` on page 96
I/Q Offset	Shows the power at spectral line 0 normalized to the total transmitted power.
	`FETCh:SUMMary:IQOFfset[:AVERage]?` on page 95
I/Q Gain Imbalance	Shows the logarithm of the gain ratio of the Q-channel to the I-channel.
	`FETCh:SUMMary:GIMBalance[:AVERage]?` on page 94
I/Q Quadrature Error	Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.
	`FETCh:SUMMary:QUADerror[:AVERage]?` on page 95
Power	Shows the average time domain power of the allocated resource blocks of the analyzed signal.
	`FETCh:SUMMary:POWer[:AVERage]?` on page 95
Crest Factor	Shows the peak-to-average power ratio of captured signal.
	`FETCh:SUMMary:CRESt[:AVERage]?` on page 91

4.2 Measuring the Power Over Time

This chapter contains information on all measurements that show the power of a signal over time.

Capture Buffer

The Capture Buffer result display shows the complete range of captured data for the last data capture. The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).
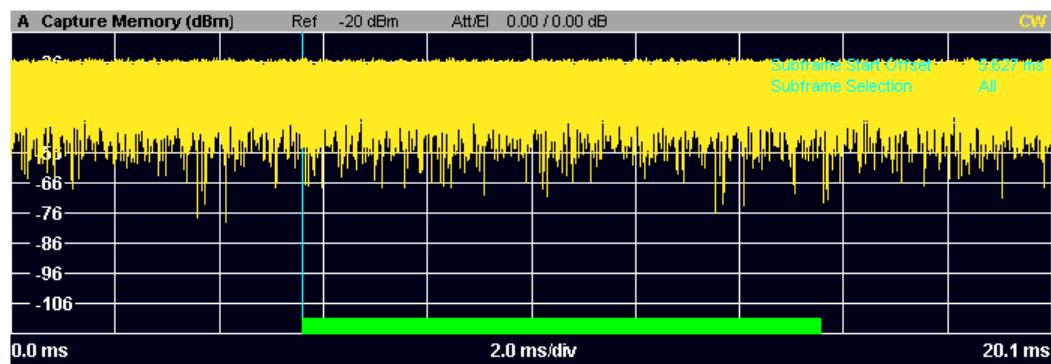
Fig. 4-1: Capture buffer without zoom

The header of the diagram shows the reference level, the mechanical and electrical attenuation and the trace mode.

The green bar at the bottom of the diagram represents the frame that is currently analyzed.

A blue vertical line at the beginning of the green bar in the Capture Buffer display represents the subframe start. Additionally, the diagram contains the "Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.
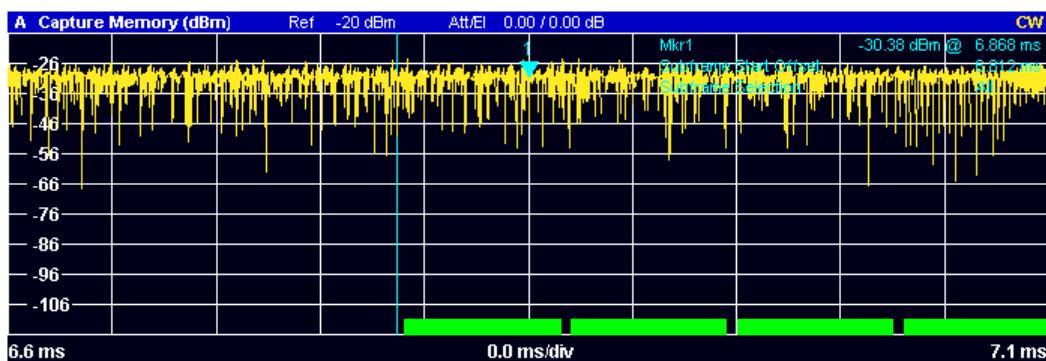
Fig. 4-2: Capture buffer after a zoom has been applied

Remote command:
Selecting the result display: CALCulate<n>:FEED 'PVT:CBUF'
Querying results: TRACe:DATA?
Querying the subframe start offset: `FETCh:SUMMary:TFRame?` on page 96

4.3 Measuring the Error Vector Magnitude (EVM)

This chapter contains information on all measurements that show the error vector magnitude (EVM) of a signal.

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed slot in the capture buffer.

If you analyze all slots, the result display contains three traces.
- Average EVM
  This trace shows the subcarrier EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed slots.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the subcarrier EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 73

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.
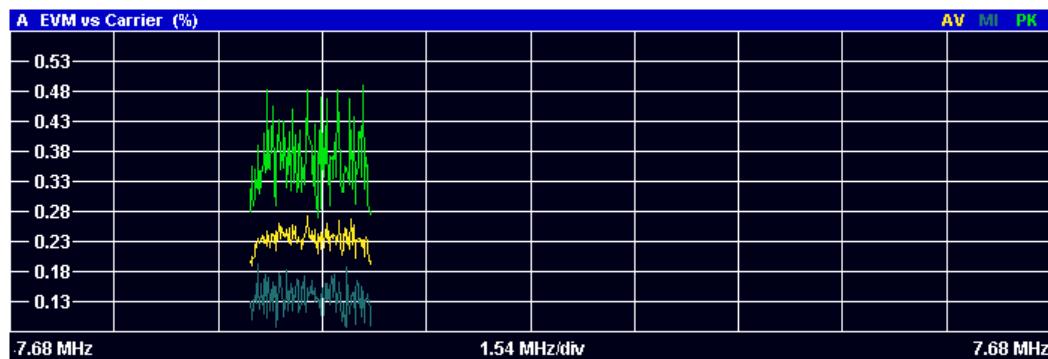
Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:EVCA'
Querying results: TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed slot.

If you analyze all subframes, the result display contains three traces.
● Average EVM
  This trace shows the OFDM symbol EVM averaged over all slots.
● Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed slots.
● Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the OFDM symbol EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 73

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSVR could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.
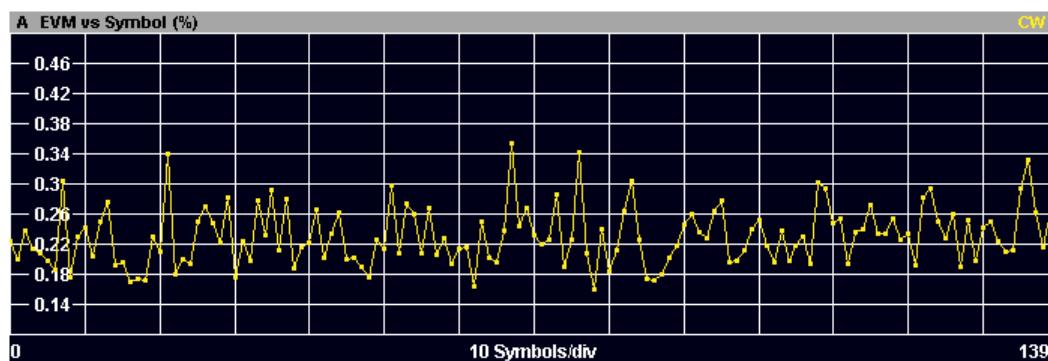
Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:EVSY'
Querying results: TRACe:DATA?

EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.
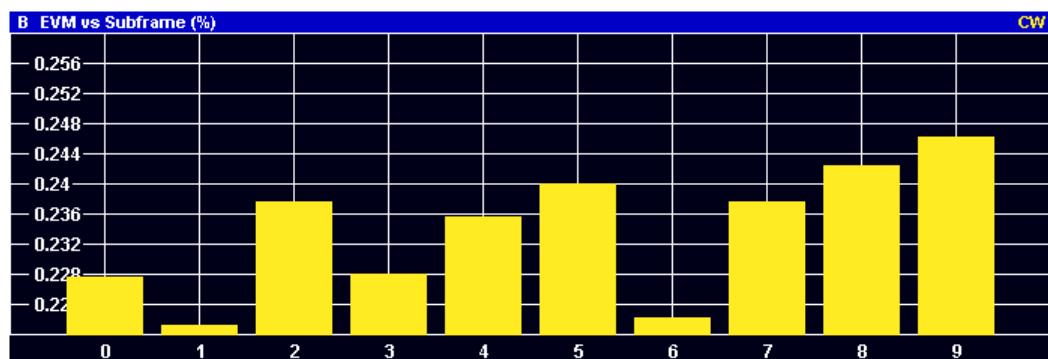
Remote command:
Selecting the result display: CALCulate<n>:FEED 'EVM:EVSU'
Querying results: TRACe:DATA?

4.4 Measuring the Spectrum

This chapter contains information on all measurements that show the power of a signal in the frequency domain.

In addition to the I/Q measurements, spectrum measurements also include two frequency sweep measurements, the Spectrum Emission Mask and the Adjacent Channel Leakage Ratio.

4.4.1 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

4.4.1.1 Available Measurements

Spectrum Mask
Starts the Spectrum Emission Mask (SEM) result display.

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The application labels the limit line to indicate whether the limit check has passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.
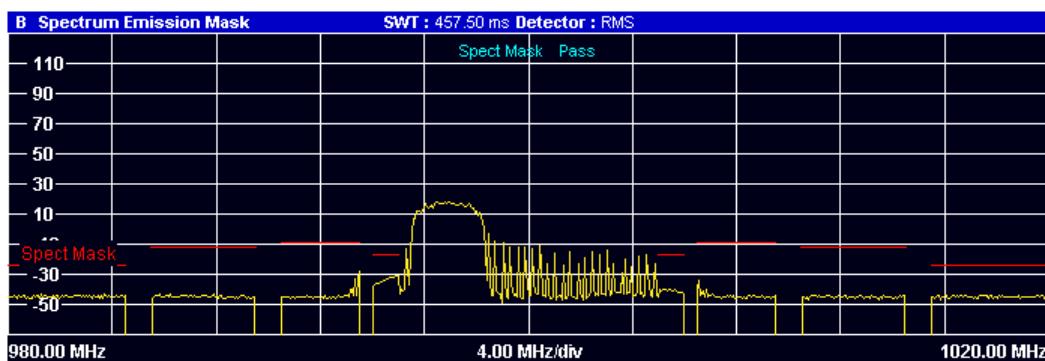
A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

A Spectrum Emission Mask List　　Ref　-26.2 dBm　　Att/El　0.00 / 0.00 dB

Start Freq. Rel.	Stop Freq. Rel.	RBW	Freq. at Δ to Limit	Power Abs.	Power Rel.	Δ to Limit
-17.50 MHz	-15.50 MHz	1.00 MHz	983.453504000 MHz	-92.05 dBm	-61.65 dB	-79.05 dB
-15.05 MHz	-10.05 MHz	100.00 kHz	989.399040000 MHz	-93.46 dBm	-63.05 dB	-80.96 dB
-10.05 MHz	-5.05 MHz	100.00 kHz	994.950016000 MHz	-75.77 dBm	-45.37 dB	-70.27 dB
5.05 MHz	10.05 MHz	100.00 kHz	1.005665088 GHz	-75.44 dBm	-45.03 dB	-69.08 dB
10.05 MHz	15.05 MHz	100.00 kHz	1.010937472 GHz	-94.43 dBm	-64.03 dB	-81.93 dB
15.50 MHz	17.50 MHz	1.00 MHz	1.016883008 GHz	-92.15 dBm	-61.74 dB	-79.15 dB

Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:SEM'
Querying results: TRACe:DATA?

ACLR
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The ACLR measurement analyzes the power of one or two transmission channels and the power of the two neighboring channels (adjacent channels) to the left and right of the TX channels. If you analyze two TX channels, these have to be next to each other. The distance between the two TX channels is variable and is defined as a TX offset. The TX channels are labeled C0 and Cu0 in the diagram.

In case of two TX channels, the lower adjacent channels (cl1 and cl2) are to the left of the first TX channel. The upper adjacent channels (cu1 and cu2) are to the right of the second TX channel.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent channel bandwidths. On the y-axis, the power is plotted in dBm.

By default the ACLR settings are based on the selected LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and the Noise Correction.
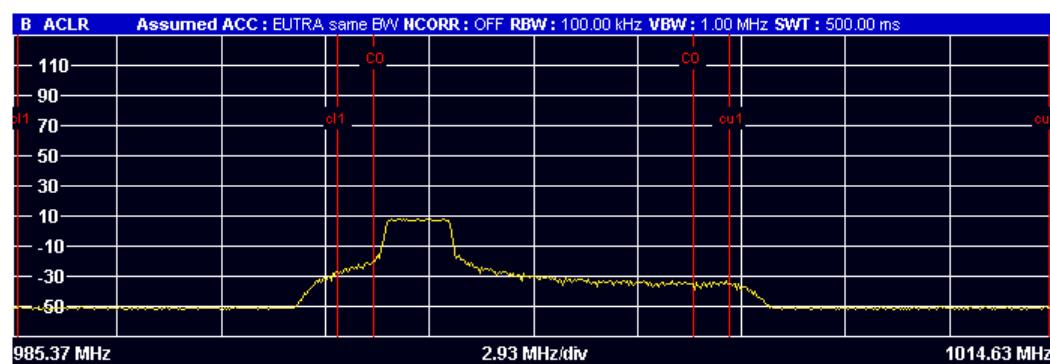
The power for the TX channel is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel.

In case of two TX channels, the power of the adjacent channels to the left of the TX channels are values relative to the power of the left TX channel. The power of the adjacent channels on the right of the TX channels are values relative to the power of the right TX channel.

In addition, the ACLR measurement results are also tested against the limits defined by 3GPP. In the diagram, the limits are represented by horizontal red lines.

ACLR table

A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
  Note that if you perform a measurement on two TX channels, each TX channel only has one set of adjacent channels. The first TX channel (C0) those to its left, the second TX channel (Cu0) those to its right.
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**

Shows the relative power of the lower and upper adjacent and alternate channels
● **Limit**
Shows the limit of that channel, if one is defined.

A ACLR List				Ref 26.2 dBm	Att/El 0.00 / 0.00 dB
Channel	Bandwidth	Spacing	Lower	Upper	Limit
TX	9.000 MHz	...		19.73 dBm	...
Adjacent	9.000 MHz	10.00 MHz	-41.85 dB	-46.74 dB	-29.20 dB
	...	...	...	...	...

Remote command:
Selecting the result display:
CALCulate<n>:FEED 'SPEC:ACP'
Querying results:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?
TRACe:DATA?

4.4.2 I/Q Measurements

4.4.2.1 Inband Emissions

Inband Emission
Starts the Inband Emission result display.

This result display shows the relative power of the unused resource blocks (yellow trace) and the inband emission limit lines (red trace) specified by the LTE standard document 3GPP TS36.101.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection.

Note that you have to select a specific subframe and slot to get valid measurement results.
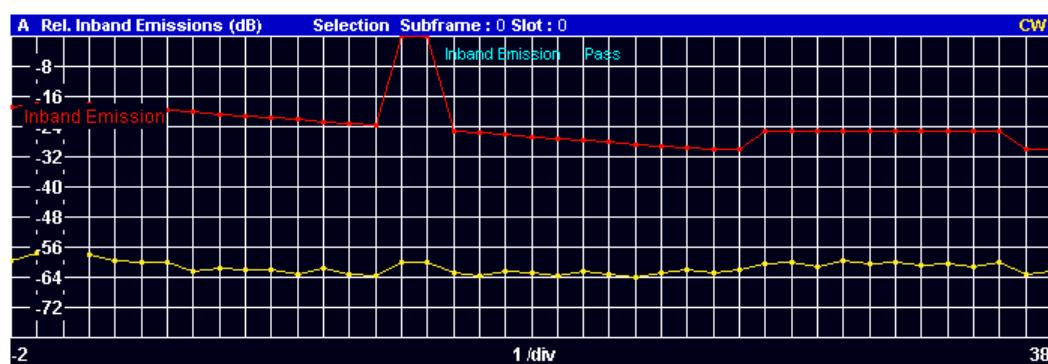
Remote command:
Selecting the result display: CALCulate<screenid>:FEED 'SPEC:IE'
Qurying results: TRACe:DATA?

4.4.2.2   Flatness (Flat | Grdel | Diff)

Channel Flatness

Starts the Channel Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.

Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:FLAT'
Querying results: TRACe:DATA?

Channel Group Delay

Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.
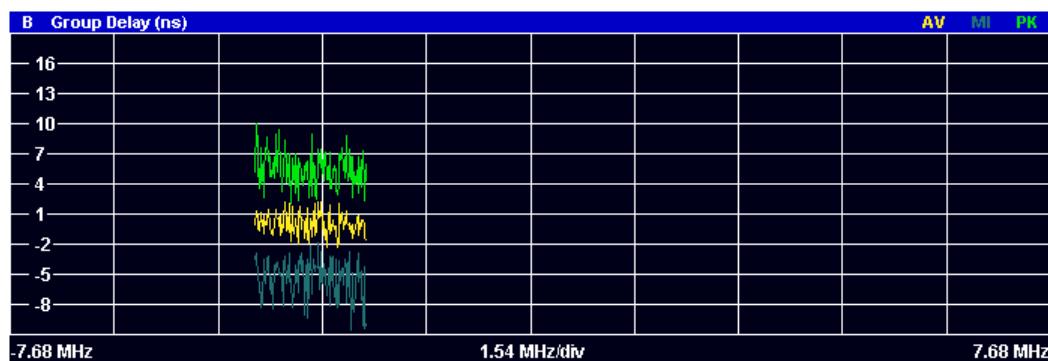
Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:GDEL'
Querying results: TRACe:DATA?

Channel Flatness Difference
Starts the Channel Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.
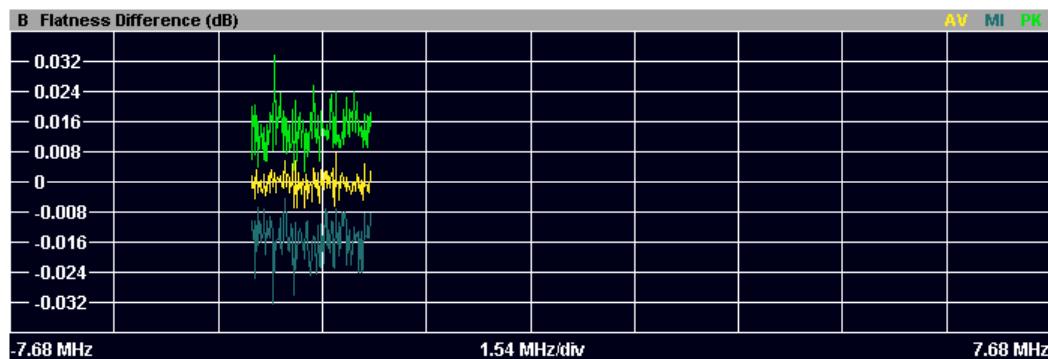
Remote command:
Selecting the result display: CALCulate<n>:FEED 'SPEC:FDIF'
Querying results: TRACe:DATA?

4.5 Measuring the Symbol Constellation

This chapter contains information on all measurements that show the constellation of a signal.

Constellation Diagram

Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

In the default state, the result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.

The ideal points for the selected modulation scheme are displayed for reference purposes.
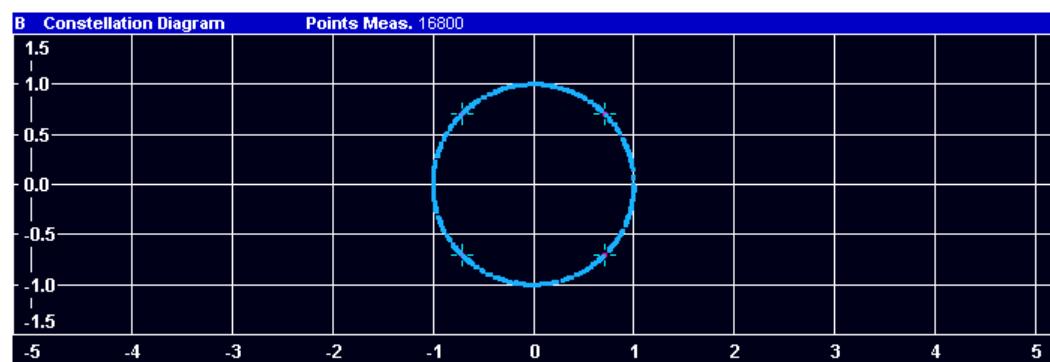
The constellation diagram also contains information about the current evaluation range. In addition, it shows the number of points that are displayed in the diagram.

Remote command:
Selecting the result display: CALCulate<n>:FEED 'CONS:CONS'
Querying results: TRACe:DATA?

DFT Precod Constellation

Starts the DFT Precod Constellation result display.

This result display shows the inphase and quadrature phase results. It shows the data without the DFT precoding. The result display evaluates the full range of the measured input data. You can filter the results in the Constellation Selection dialog box.
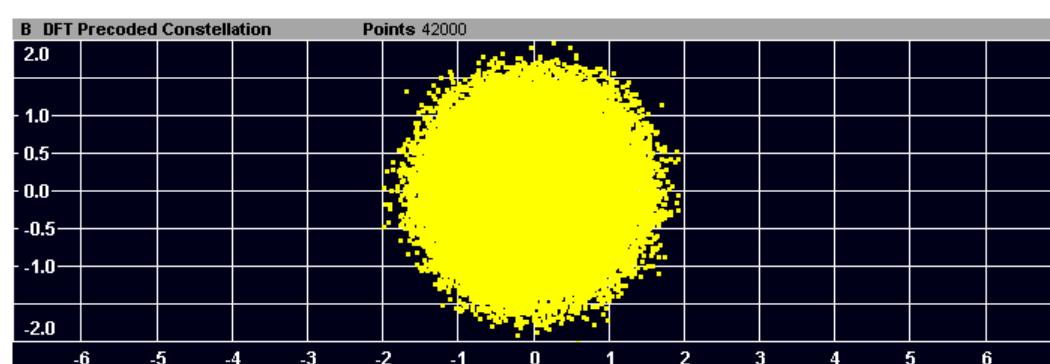
Remote command:
Selecting the result display: CALCulate<screenid>:FEED 'CONS:DFTC'

4.6 Measuring Statistics

This chapter contains information on all measurements that show the statistics of a signal.

CCDF

Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.
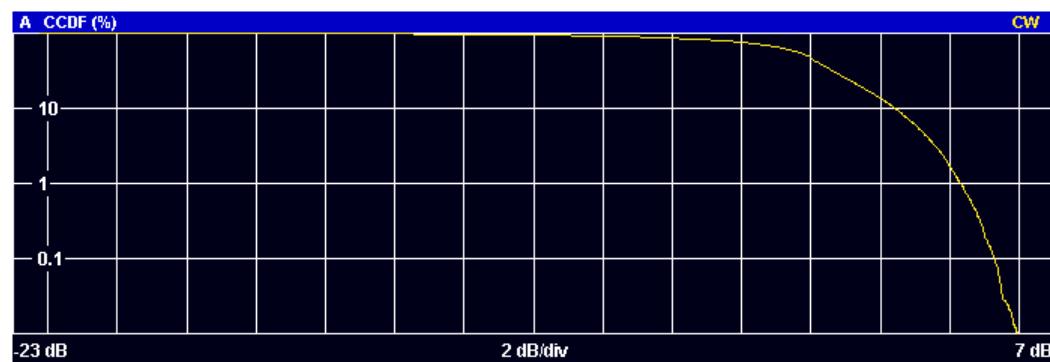
Remote command:
Selecting the result display: CALCulate<n>:FEED 'STAT:CCDF'
Querying results: TRACe:DATA?

Allocation Summary

Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the follwing information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the current PDSCH allocation.
- **Offset RB**
  Shows the resource block offset of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power**
  Shows the power of the allocation in dBm.
- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Remote command:
Selecting the result display: CALCulate<n>:FEED 'STAT:ASUM'
Querying results: TRACe:DATA?

Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.

The table contains the following information:

- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.

- **Modulation**
  Modulation type of the channels.
- **Symbol Index** or **Bit Index**
  Shows the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

Remote command:
Selecting the result display: CALCulate<n>:FEED 'STAT:BSTR'
Querying results: TRACe:DATA?

4.7 3GPP Test Scenarios

3GPP defines several test scenarios for measuring user equipment. These test scenarios are described in detail in 3GPP TS 36.521-1.

The following table provides an overview which measurements available in the LTE application are suited to use for the test scenarios in the 3GPP documents.

Table 4-1: Test scenarios for E-TMs as defined by 3GPP (3GPP TS 36.521-1)

Test scenario	Test described in	Measurement
UE Maximum Output Power	chapter 6.2.2	Power (➜ Result Summary)
Maximum Power Reduction	chapter 6.2.3	Power (➜ Result Summary)
Additional Maximum Power Reduction	chapter 6.2.4	Power (➜ Result Summary)
Configured UE-transmitted Output Power	chapter 6.2.5	Power (➜ Result Summary)
Minimum Output Power	chapter 6.3.2	Power (➜ Result Summary)
Transmit Off Power	chapter 6.3.3	n/a
On/Off Time Mask	chapter 6.3.4	n/a
Power Control	chapter 6.3.5	n/a
Frequency Error	chapter 6.5.1	Frequency Error (➜ Result Summary)
Transmit Modulation	chapter 6.5.2.1	EVM results
	chapter 6.5.2.2	I/Q Offset (➜ Result Summary)
	chapter 6.5.2.3	Inband Emission
	chapter 6.5.2.4	Spectrum Flatness
Occupied Bandwidth	chapter 6.6.1	Occupied Bandwidth[1]
Out of Band Emission	chapter 6.6.2.1	Spectrum Emission Mask
	chapter 6.6.2.2	Spectrum Emission Mask
	chapter 6.6.2.3	ACLR
Spurious Emissions	chapter 6.6.3.1	Spurious Emissions[1]

Test scenario	Test described in	Measurement
	chapter 6.6.3.2	Spurious Emissions[1]
	chapter 6.6.3.3	Spurious Emissions[1]
Transmit Intermodulation	chapter 6.7	ACLR
Time Alignment	chapter 6.8	Time Alignment

[1]these measurements are available in the Spectrum application of the Rohde & Schwarz signal and spectrum analyzers (for example the R&S FSW)

5 Configuring and Performing the Measurement

Before you can start a measurement, you have to configure the R&S FSVR in order to get valid measurement results. This chapter contains detailed information on all settings available in the application.

You can access the two main settings dialog boxes via the "Settings (Gen Demod)" softkey. Pressing the softkey once opens the "General Settings" dialog box. The "Gen" label in the softkey turns orange to indicate an active "General Settings" dialog box. Pressing the softkey again opens the "Demod Settings" dialog box. When the "Demod Settings" dialog box is active, the "Demod" label in the softkey turns orange.

In the "General Settings" dialog box, you can set all parameters that are related to the overall measurement. The dialog box is made up of three tabs, one for general settings, one for MIMO settings and one for advanced settings. By default, the "General" tab is the active one.

In the "Demod Settings" dialog box you can set up the measurement in detail, e.g. the demodulation configuration. The dialog box is made up of three tabs, one for configuring the signal configuration, one for setting up the frame configuration and one for configuring the control channels and miscellaneous settings. By default, the "DL Demod" tab is the active one.

You can switch between the tabs by touching the tab on the touchscreen or with the cursor keys.

5.1 Performing Measurements

The sweep menu contains functions that control the way the R&S FSVR performs a measurement.

Single Sweep and Continuous Sweep
In continuous sweep mode, the R&S FSVR continuously captures data, performs measurements and updates the result display according to the trigger settings.

To activate single sweep mode, press the "Run Single" softkey. In single sweep mode, the R&S FSVR captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSVR interrupts the measurement.

You can always switch back to continuous sweep mode with the "Run Cont" softkey.

Remote command:
INITiate:CONTinuous on page 88

Auto Level

The "Auto Level" softkey initiates a process that sets an ideal reference level for the current measurement.

For more information see "Defining a Reference Level" on page 45.

Remote command:
[SENSe]:POWer:AUTO<instrument>[:STATe] on page 111

Refresh

Updates the current result display in single sweep mode without capturing I/Q data again.

If you have changed any settings after a single sweep and use the Refresh function, the R&S FSVR updates the current measurement results with respect to the new settings. It does not capture I/Q data again but uses the data captured last.

Remote command:
INITiate:REFResh on page 89

5.2 Defining General Measurement Characteristics

The "General Settings" contain settings to describe the basic measurement configuration.

5.2.1 Defining Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal.

The signal characteristics are part of the "General" tab of the "General Settings" dialog box.
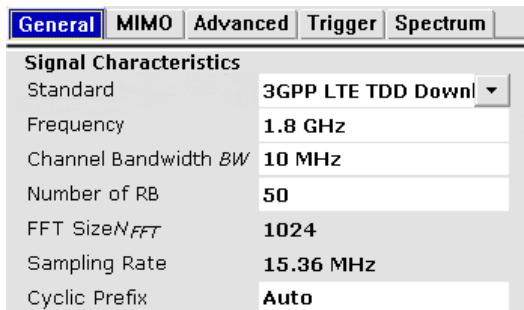
General	MIMO	Advanced	Trigger	Spectrum	

Signal Characteristics

Standard	3GPP LTE TDD Downl ▼
Frequency	1.8 GHz
Channel Bandwidth BW	10 MHz
Number of RB	50
FFT Size N_{FFT}	1024
Sampling Rate	15.36 MHz
Cyclic Prefix	Auto

Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the set of options you have installed.

- option FSx-K100(PC) enables testing of 3GPP LTE FDD signals on the downlink
- option FSx-K101(PC) enables testing of 3GPP LTE FDD signals on the uplink
- option FSx-K102(PC) enables testing of 3GPP LTE MIMO signals on the downlink
- option FSx-K104(PC) enables testing of 3GPP LTE TDD signals on the downlink
- option FSx-K105(PC) enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.
- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.
- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

Remote command:
Link direction: CONFigure[:LTE]:LDIRection on page 107
Duplexing mode: CONFigure[:LTE]:DUPLexing on page 107

Defining the Signal Frequency

For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

Remote command:
Center frequency: [SENSe]:FREQuency:CENTer on page 108

Channel Bandwidth / Number of Resource Blocks

Specifies the channel bandwidth and number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. Currently, the LTE standard recommends six bandwidths (see table below).

The application also calculates the FFT size and sampling rate from the channel band-width. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	30.72	30.72
FFT Size	128	256	512	1024	2048	2048

Remote command:
CONFigure[:LTE]:UL:BW on page 107

Cyclic Prefix
The cyclic prefix serves as a guard interval between OFDM symbols to avoid interfer-ences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.
  The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.
- Auto
  The application automatically detects the cyclic prefix mode in use.

Remote command:
CONFigure[:LTE]:UL:CYCPrefix on page 108

5.2.2 Configuring the Input Level

The level settings contain settings that control the input level of the analyzer.

The level settings are part of the "General" tab of the "General Settings" dialog box.
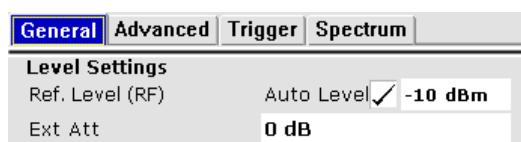
Defining a Reference Level
The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can either specify the **RF Reference Level** (in dBm) or **Baseband Reference Level** (in V), depending on the input source.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value before each sweep. This process slightly increases the measurement time. You can define the measurement time of that measurement with the **Auto Level Track Time** (➜ "Advanced" tab).

Automatic level detection also optimizes RF attenuation.

Remote command:
Manual (RF): `CONFigure:POWer:EXPected:RF<instrument>` on page 109
Manual (BB): `CONFigure:POWer:EXPected:IQ<instrument>` on page 109
Automatic: `[SENSe]:POWer:AUTO<instrument>[:STATe]` on page 111
Auto Level Track Time: `[SENSe]:POWer:AUTO<instrument>:TIME` on page 111

Attenuating the Signal
Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE measurement application provides several attenuation modes.

- **External** attenuation is always available. It controls an external attenuator if you are using one.
- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.
  Mechanical attenuation is available in the "Advanced" tab of the "General Settings" dialog box.

Positive values correspond to an attenuation and negative values correspond to an amplification.

RF attenuation is independent of the reference level. It is available if automatic reference level detection is inactive. The range is from 0 dB to 75 dB.

Remote command:
RF attenuation: `INPut<n>:ATTenuation<instrument>` on page 110
External attenuation: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 109

5.2.3 Configuring the Data Capture

The data capture settings contain settings that control the amount of data and the way that the application records the LTE signal.

The data capture settings are part of the "General" tab of the "General Settings" dialog box.
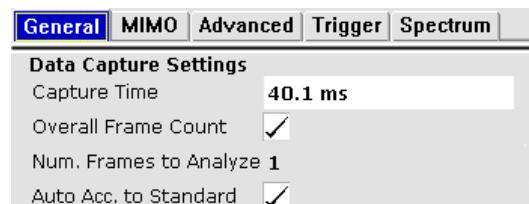
| General | MIMO | Advanced | Trigger | Spectrum |

Data Capture Settings
Capture Time   40.1 ms
Overall Frame Count   ✓
Num. Frames to Analyze 1
Auto Acc. to Standard ✓

Capture Time
Defines the capture time.

The capture time corresponds to the time of one sweep. Hence, it defines the amount of data the application captures during one sweep.

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in one sweep.

Remote command:
[SENSe]:SWEep:TIME on page 113

Overall Frame Count
Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the R&S FSVR analyzes all complete LTE frames currently in the capture buffer.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:STATe on page 112

Number of Frames to Analyze
Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single sweep, the R&S FSVR continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,

- the data is captured according to the standard.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt on page 112

Auto According to Standard

Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the R&S FSVR evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

This parameter is not available if the overall frame count is inactive.

Remote command:
[SENSe][:LTE]:FRAMe:COUNt:AUTO on page 112

5.2.4   Triggering Measurements

The trigger settings contain settings that control triggered measurements.

The trigger settings are part of the "Trigger" tab of the "General Settings" dialog box.
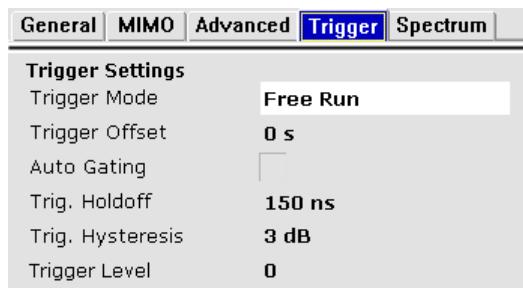
For more information also see Auto Gating in the "Spectrum" tab of the "General Settings" dialog box.

Configuring the Trigger

A trigger allows you to capture those parts of the signal that you are really interested in.

While the application runs freely and analyzes all signal data in its default state, no matter if the signal contains information or not, a trigger initiates a measurement only under certain circumstances (the trigger event).

The application supports several **trigger modes** or sources.

- Free Run
  Starts the measurement immediately and measures continuously.
- External
  The trigger event is the level of an external trigger signal. The measurement starts when this signal meets or exceeds a specified trigger level at the "Ext Trigger/ Gate" input.
- IF Power

The trigger event is the IF power level. The measurement starts when the IF power meets or exceeds a specified power trigger level.

- RF Power
  The trigger event is the RF power level. The measurement starts when a signal outside of the measured channel meets or exceeds a certain level at the first intermediate frequency.
  The level range is from -50 dBm to -10 dBm. The corresponding trigger level at the RF input is:
  The RF Power trigger is available with detector board 1307.9554.02 Rev. 05.00 or higher. It is not available for measurements with the digital I/Q interface (R&S FSVR-B17).
- Power Sensor
  The trigger event is a specified level measured by a power sensor. The measurement starts when a power sensor measurement meets certain conditions.
  The power sensor as a trigger source is available with option R&S FSV-K9 and a connected power sensor.

You can define a **power level** for an external, IF power, RF power or power sensor trigger.

The name and contents of the Power Level field depend on the selected trigger mode. It is available only in combination with the corresponding trigger mode.

The measurement starts as soon as the trigger event happens. It may become necessary to start the measurement some time after the trigger event. In that case, define a **trigger offset** (or trigger delay). The trigger offset is the time that should pass between the trigger event and the start of the measurement.

The trigger offset may be a negative time. The trigger offset is then called a **pretrigger**.

The trigger offset is available for all trigger modes, except free run.

A trigger event usually is a certain level value. The **trigger hysteresis** defines a distance to the trigger level that the input signal must stay below in order to fulfill the trigger condition.

If you want to have a minimum time between indivudual measurements, set a **trigger holdoff**. A trigger holdoff defines a waiting period that must at least pass between one trigger event and the next.

Remote command:
For a comprehensive list of commands to define trigger characteristics see chapter 8.9, "Trigger Configuration", on page 115.

5.3 Configuring Spectrum Measurements

The Spectrum settings contain parameters to configure spectrum measurements (ACLR and SEM) in particular.

5.3.1 General ACLR and SEM Configuration

The gate settings settings are part of the "Spectrum" tab of the "General Settings" dialog box.

| General | Advanced | Trigger | **Spectrum** |

SEM/ACLR Settings
Num. of Tx Channels	1
Car. Agg. Channel BW	User
Tx2 Bandwidth	**10 MHz**
Tx2 Offset	**10 MHz**
Auto Gating	
Span	Auto Span ✓ **50 MHz**
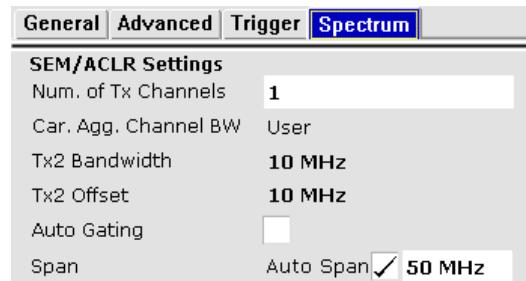
Auto Gating

Turns gating for SEM and ACLR measurements on and off.

If on, the application evaluates the on-periods of an LTE TDD signal only. The application determines the location and length of the on-period from the "TDD UL/DL Allocations" and the "Configuration of the Special Subframe".

Note that the automatic cyclic prefix mode detection is not supported if you have turned on Auto Gating. In that case, you have to select the cyclic prefix mode manually.

Auto gating is available for TDD measurements in combination with an external or IF power trigger.

If you are using an external trigger, the DUT has to send an LTE frame trigger.

Remote command:
[SENSe]:SWEep:EGATe:AUTO on page 119

Span

Defines the frequency span that is displayed in the frequency sweep result displays (SEM and ACLR).

When the "Auto Span" is on, the application automatically calculates the ideal span for the measured signal. The ideal span for the signal depends on the channel bandwidth that you have selected.

Alternatively, you can define the span manually when you turn the "Auto Span" off. When you define the span manually, you can enter any number that is greater than the span that would be calculated automatically. This mechanism makes sure that the span is not too small for the signal bandwidth and the complete signal is displayed.

Note that changing the span only takes effect when you start a new measurement after you have changed the span.

Remote command:
[SENSe]:FREQuency:SPAN on page 117

5.3.2 Configuring SEM Measurements

The SEM settings are part of the "Spectrum" tab of the "General Settings" dialog box.
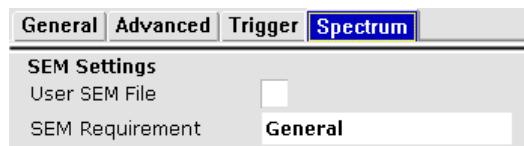
SEM Requirement
Selects the type of spectrum emission mask used for the Out of Band emission measurement.

The software supports general and specific (additional) spectrum emission masks. The specific spectrum emission masks contain additional SEM requirements. The additional requirements masks to use for the measurement depend on the network signalled value "NS_03", "NS_04", "NS_06" or "NS_07".

If "NS_06" or "NS_07" is indicated in the cell, use SEM requirement "NS_06_07".

Remote command:
[SENSe]:POWer:SEM:UL:REQuirement on page 119

5.3.3 Configuring ACLR Measurements

The ACLR settings are part of the "Spectrum" tab of the "General Settings" dialog box.
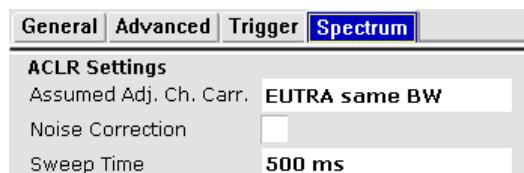
Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

Remote command:
[SENSe]:POWer:ACHannel:AACHannel on page 117

Number of TX Channels

The application allows you to perform ACLR and SEM measurements on systems that support carrier aggregation.

The number of TX channels defines the number of transmission (TX) channels to include in ACLR or SEM measurements.

Measurements on one or two TX channels are supported.

For measurements on two TX channels, you can additionally define the bandwidth of the second TX channel and the distance between the two TX channels.

For the second TX channel, you can select the bandwidths as defined by 3GPP. For more information see "Channel Bandwidth / Number of Resource Blocks" on page 44.

Remote command:

[SENSe]:POWer:ACHannel:BANDwidth:CHANnel2 on page 118

[SENSe]:POWer:ACHannel:SPACing:CHANnel on page 118

[SENSe]:POWer:ACHannel:TXCHannels:COUNt on page 118

Noise Correction

Turns noise correction on and off.

Note that the input attenuator makes a clicking noise after each sweep if you are using the noise correction in combination with the auto leveling process.

Remote command:

[SENSe]:POWer:NCORrection on page 119

Sweep Time

Defines a sweep time for ACLR measurements.

A longer sweep time may increase the probability that the measured value converges to the true value of the adjacent channel power, but obviously increases measurement time.

Remote command:

[SENSe]:SWEep:TIME on page 113

5.4 Defining Advanced Measurement Characteristics

The "Advanced" settings contain parameters to configure more complex measurement setups.

5.4.1 Controlling I/Q Data

The I/Q settings contain settings that control the I/Q data flow.

The I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.

Swap I/Q

Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
[SENSe]:SWAPiq on page 113

5.4.2 Controlling the Input

The input settings contain settings that control the input source.

The input settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.
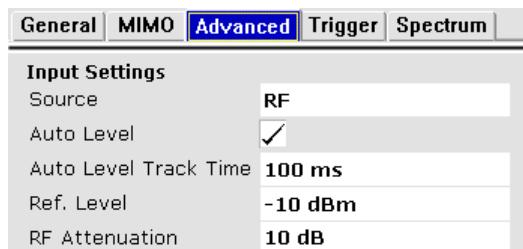
For more information on reference level see "Defining a Reference Level" on page 45.

For more information on signal attenuation see "Attenuating the Signal" on page 46.

Selecting the Input Source
The input source selects the source of the data you'd like to analyze. You can either analyze a live signal or a signal that has been recorded previously and whose characteristics have been saved to a file.

You can select the input source from the "Source" dropdown menu.

- RF
  Captures and analyzes the data from the RF input of the spectrum analyzer in use.
- Baseband (BB)
  Captures and analyzes the data from the baseband input of the spectrum analyzer in use.
- Digital I/Q
  Captures and analyzes the data from the digital baseband input of the spectrum analyzer in use.
  The digital baseband input is available with option R&S FSVR-B17.

For more information on using hardware option R&S FSVR-B17 see the manual of the R&S FSVR.

Remote command:
INPut:SELect on page 114

5.4.3 Configuring the Digital I/Q Input

The digital I/Q settings contain settings that configure the digital I/Q input.

The digital I/Q settings are part of the "Advanced Settings" tab of the "General Settings" dialog box.
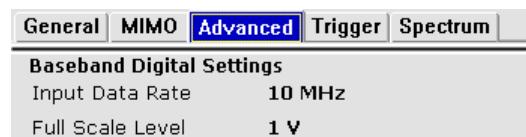
Sampling Rate (Input Data Rate)
Defines the data sample rate at the digital baseband input.

The sample rate is available for a digital baseband input source.

Remote command:
INPut<n>:DIQ:SRATe on page 114

Full Scale Level
Defines the voltage corresponding to the maximum input value of the digital baseband input.

Remote command:
INPut<n>:DIQ:RANGe[:UPPer] on page 115

5.5 Configuring the Signal Demodulation

The uplink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

You can find the demodulation settings in the "Demod Settings" dialog box.

5.5.1 Configuring the Data Analysis

The data analysis settings contain setting that control the data analysis.

The data analysis settings are part of the "Uplink Demodulation Settings" tab of the "Demodulation Settings" dialog box.

UL Demod	UL Frame Config	UL Adv Sig Config	UL PRACH Config

Data Analysis

Analysis Mode	**PUSCH/PUCCH**
Channel Est. Range	**Pilot and Payload**
Compensate DC Offset	✓
Coded Bits Scrambling	✓
Auto Demodulation	**Subframe Config**
SubFr. Conf. Detection	
Supprssd. Interf. Sync	
Multicarrier Filter	
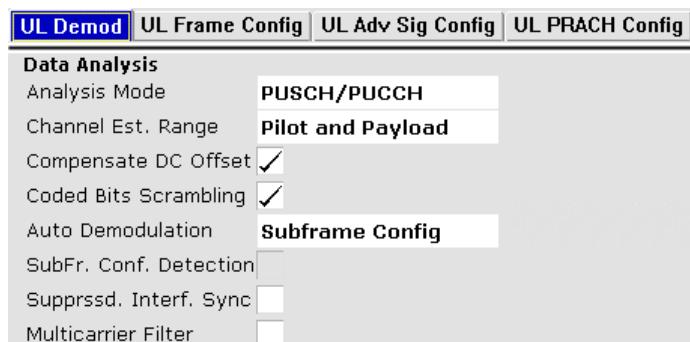
Analysis Mode

Selects the channel analysis mode.

You can select from "PUSCH/PUCCH" mode and "PRACH" mode.

PUSCH/PUCCH mode analyzes the PUSCH and PUCCH. This is the default.

PRACH mode analyzes the PRACH only. In PRACH analysis mode no subframe or slot selection is available. Instead you can select a particular preamble that the results are shown for. Note that PRACH analysis mode does not support all result displays.

Remote command:
[SENSe][:LTE]:UL:DEMod:MODE on page 121

Channel Estimation Range

Selects the method for channel estimation.

You can select if only the pilot symbols are used to perform channel estimation or if both pilot and payload carriers are used.

Remote command:
[SENSe][:LTE]:UL:DEMod:CESTimation on page 121

Compensate DC Offset

Turns DC offset compensation when calculating measurement results on and off.

According to 3GPP TS 36.101 (Annex F.4), the R&S FSVR removes the carrier leakage (I/Q origin offset) from the evaluated signal before it calculates the EVM and in-band emissions.

Remote command:
[SENSe][:LTE]:UL:DEMod:CDCoffset on page 120

Scrambling of Coded Bits

Turns the scrambling of coded bits for the PUSCH on and off.

The scrambling of coded bits affects the bitstream results.
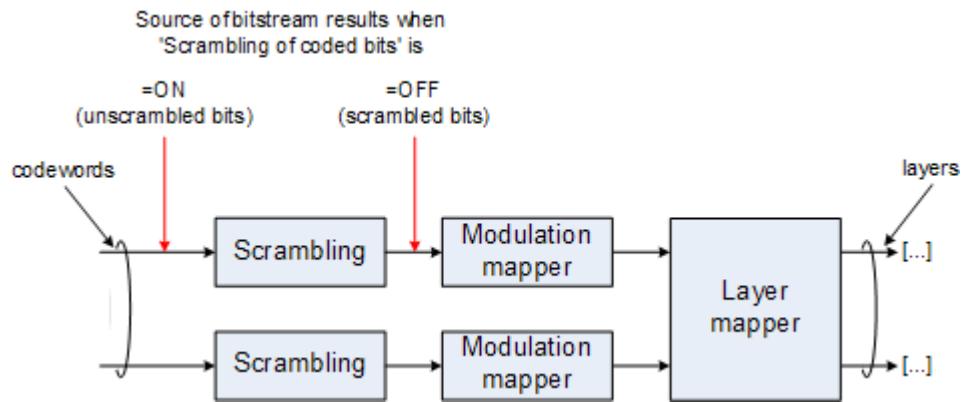
Fig. 5-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
[SENSe][:LTE]:UL:DEMod:CBSCrambling on page 120

Auto Demodulation

Turns automatic demodulation on and off.

If active, the R&S FSVR automatically detects the characteristics of each subframe in the signal (resource allocation of the signal).

Two methods of detection are supported:

● Subframe Configuration
  This method automatically determines the characteristics for each subframe as shown in the Subframe Configuration Table.
  The table is populated accordingly.
● Subframe Configuration & DMRS
  Auto Demodulation, **DMRS Auto Detection (On)**
  This method automatically detects the PUSCH and SRS (i.e. no PUCCH can be detected).
  To determine these characteristics, the software detects the CAZAC base parameters. Thus, the DMRS configuration parameters are not required for the synchronization and therefore are not available using this method.
  Note however that it is not possible to derive the DMRS configuration parameters from the CAZAC base parameters so that the disabled DMRS configuration parameters do not reflect the current parameters used for the synchronization. Also note that it can happen that the software successfully synchronizes on non-3GPP signals without a warning.

Automatic demodulation is not available if the Suppressed Interference Synchronization is active.

Remote command:
[SENSe][:LTE]:UL:DEMod:ACON on page 120

Subframe Configuration Detection

Turns the detection of the subframe configuration on and off.

Upon activation, the software compares the current demodulated LTE frame to the subframe configuration you have set. Only if the signal is consistent with the configuration, the software will further analyze the LTE frame.

If inactive, the software analyzes the signal even if it is not consistent with the current subframe configuration.

Subframe configuration detection is available if you are using a Predefined subframe configuration.

Remote command:
[SENSe][:LTE]:UL:FORMat:SCD on page 122

Suppressed Interference Synchronization
Turns suppressed interference synchronization on and off.

If active, the synchronization on signals containing more than one user equipment (UE) is more robust. Additionally, the EVM is lower in case the UEs have different frequency offsets. Note that Auto Demodulation is not supported in this synchronization mode and the EVM may be higher in case only one UE is present in the signal.

Remote command:
[SENSe][:LTE]:UL:DEMod:SISYnc on page 122

Multicarrier Filter
Turns the suppression of interference of neighboring carriers on and off.

Remote command:
[SENSe][:LTE]:UL:DEMod:MCFilter on page 121

5.5.2 Compensating Measurement Errors

The tracking settings contain settings that compensate for various common measurement errors that may occur.

The tracking settings are part of the "Uplink Demodulation Settings" tab of the "Demodulation Settings" dialog box.
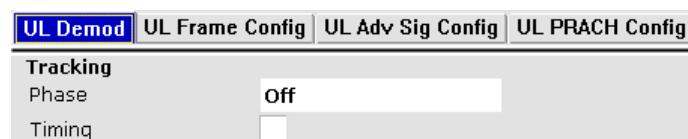
Phase
Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

"Off"   Phase tracking is not applied.

"Pilot Only"   Only the reference signal is used for the estimation of the phase error.

"Pilot and Pay-   Both reference signal and payload resource elements are used for
load"   the estimation of the phase error.

Remote command:
[SENSe][:LTE]:UL:TRACking:PHASe on page 122

Timing
Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

Remote command:
[SENSe][:LTE]:UL:TRACking:TIME on page 123

5.6 Configuring Uplink Frames

The frame configuration contains settings that define the structure of the uplink LTE signal.

You can find the frame structure in the "Demod Settings" dialog box.

5.6.1 Configuring TDD Signals

The TDD settings define the characteristics of an LTE TDD signal.

The TDD settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.

Configuring TDD Frames
TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations
Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Conf. of Special Subframe

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 10 different configurations for the special subframe. However, configurations 8 and 9 only work for a normal cyclic prefix.

If you select configurations 8 or 9 using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

Remote command:
Subframe: `CONFigure[:LTE]:UL:TDD:UDConf` on page 123
Special subframe: `CONFigure[:LTE]:UL:TDD:SPSC` on page 123

5.6.2 Configuring the Physical Layer Cell Identity

The physical signal characteristics contain settings to describe the phyiscal attributes of an LTE signal.

The physical settings are part of the "Frame Configuration" tab of the "Demodulation Settings" dialog box.

UL Demod	**UL Frame Config**	UL Adv Sig Config	UL PRACH Config

Physical Layer Cell Identity
Cell ID	0
Cell Identity Group	0
Identity	0

Configuring the Physical Layer Cell Identity

The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the application automatically updates the other two.

The Cell ID determines

- the reference signal grouping hopping pattern
- the reference signal sequence hopping
- the PUSCH demodulation reference signal pseudo-random sequence
- the cyclic shifts for PUCCH formats 1/1a/1b and sequences for PUCCH formats 2/2a/2b
- the pseudo-random sequence used for scrambling
- the pseudo-random sequence used for type 2 PUSCH frequency hopping

Remote command:
Cell ID: `CONFigure[:LTE]:UL:PLC:CID` on page 124
Cell Identity Group: `CONFigure[:LTE]:UL:PLC:CIDGroup` on page 124
Identity: `CONFigure[:LTE]:UL:PLC:PLID` on page 124

5.6.3 Configuring Subframes

An LTE frame consists of 10 subframes. Each individual subframe may have a different resource block configuration. This configuration is shown in the "Subframe Configuration Table".

The application supports two ways to determine the characteristics of each subframe.

- Automatic demodulation of the channel configuration and detection of the subframe characteristics.
  In case of automatic demodulation, the contents of the table are determined according to the signal currently evaluated.
  For more information see "Auto Demodulation" on page 56.

- Custom configuration of the configuration of each subframe.
  Remote command:
  Conf. subframes: `CONFigure[:LTE]:UL:CSUBframes` on page 125

Frame number offset

A frame number offset is also available. The frame number offset assigns a number to the demodulated frame in order to identify it in a series of transmitted (and captured) frames.

Remote command:

`CONFigure[:LTE]:UL:SFNO` on page 125

5.6.3.1 Individual Subframe Configuration

The "Subframe Configuration Table" contains the characteristics for each subframe. The software supports a maximum uplink LTE frame size of 10 subframes. The subframe number in the table depends on the number of "Configurable Subframes" that you have defined or that have been detected in case of automatic demodulation.

Each row of the table represents one subframe.

Subframe Number

Shows the number of a subframe.

Note that, depending on the TDD configuration, some subframes may not be available for editing. The R&S FSVR labels those subframes "(not used)".

Enable PUCCH

Turns the PUCCH in the corresponding subframe on and off.

If you enable PUCCH, the application automatically turns PUSCH off. "Modulation", "Number of RBs" and "Offset RB" are unavailable for that subframe. If you disable PUCCH, the application automatically turns PUSCH on. "Modulation", "Number of RBs" and "Offset RB" become available

Remote command:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT` on page 126

Modulation

Selects the modulation scheme for the corresponding PUSCH allocation.

The modulation scheme is either QPSK, 16QAM or 64QAM.

Remote command:
`CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation` on page 126

Number of RB

Sets the number of resource blocks the PUSCH allocation covers. The number of resource blocks defines the size or bandwidth of the PUSCH allocation.

Remote command:
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount on page 125

Offset RB

Sets the resource block at which the PUSCH allocation begins.

Make sure not to allocate PUSCH allocations into regions reserved for PUCCH allocations.

Remote command:
CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset on page 126

5.7 Defining Advanced Signal Characteristics

The uplink advanced signal characteristics contain settings that describe the detailed structure of a uplink LTE signal.

You can find the advanced signal characteristics in the "Demod Settings" dialog box.

5.7.1 Configuring the Demodulation Reference Signal

The demodulation reference signal settings contain settings that define the physical attributes and structure of the demodulation reference signal. This reference signal helps to demodulate the PUSCH.

The demodulation reference signal settings are part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

UL Demod	UL Frame Config	UL Adv Sig Config	UL PRACH Config
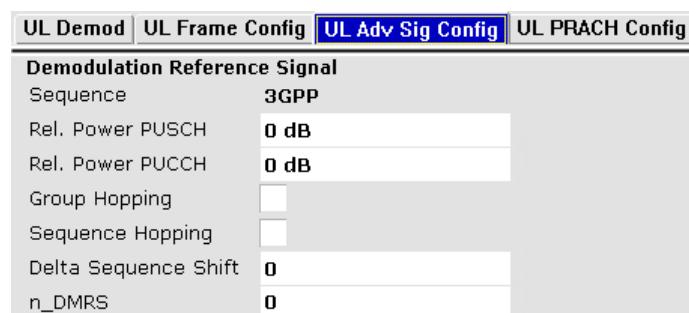
Demodulation Reference Signal

Sequence	3GPP
Rel. Power PUSCH	0 dB
Rel. Power PUCCH	0 dB
Group Hopping	
Sequence Hopping	
Delta Sequence Shift	0
n_DMRS	0

Sequence

Selects the definition the demodulation reference signal is based on.

"3GPP" The structure of the DRS is based on the 3GPP standard.
If you are using a DRS based on 3GPP, you have to set all parameters in the "Demodulation Reference Signal" settings group. They have to be the same as those of the signal generator.

Relative Power PUSCH

Defines the power of the DMRS relative to the power level of the PUSCH allocation in the corresponding subframe (P_{DMRS_Offset}).

The effective power level of the DMRS depends on the allocation of the subframe and is calculated as follows.

$P_{DMRS} = P_{UE} + P_{PUSCH} + P_{DMRS\_Offset}$

The relative power of the DMRS is applied to all subframes.

The power of the PUSCH (P_{PUSCH}) may be different in each subframe.

Remote command:
CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer on page 128

Relative Power PUCCH

Defines the power of the DMRS relative to the power level of the PUCCH allocation in the corresponding subframe (P_{DMRS_Offset}).

The effective power level of the DMRS depends on the allocation of the subframe and is calculated as follows.

$P_{DMRS} = P_{UE} + P_{PUCCH} + P_{DMRS\_Offset}$

The relative power of the DMRS is applied to all subframes.

The power of the PUCCH (P_{PUCCH}) may be different in each subframe.

Remote command:
CONFigure[:LTE]:UL:DRS:PUCCh:POWer on page 128

Group Hopping

Turns group hopping for the demodulation reference signal on and off.

The group hopping pattern is based on 17 hopping patterns and 30 sequence shift patterns. It is generated by a pseudo-random sequence generator.

If on, PUSCH and PUCCH use the same group hopping pattern.

Remote command:
CONFigure[:LTE]:UL:DRS:GRPHopping on page 127

Sequence Hopping

Turns sequence hopping for the uplink demodulation reference signal on and off.

Sequence hopping is generated by a pseudo-random sequence generator.

Remote command:
CONFigure[:LTE]:UL:DRS:SEQHopping on page 128

Delta Sequence Shift

Defines the delta sequence shift Δ_{SS}.

The standard defines a sequence shift pattern f_{ss} for the PUCCH. The corresponding sequence shift pattern for the PUSCH is a function of f_{ss}^{PUCCH} and the delta sequence shift.

For more information refer to 3GPP TS 36.211, chapter 5.5.1.3 "Group Hopping".

Remote command:
CONFigure[:LTE]:UL:DRS:DSSHift on page 127

n(1)_DMRS

The n_DMRS parameter can be found in 3GPP TS36.211 V8.5.0, 5.5.2.1.1 Reference signal sequence.

Currently, n_DMRS is defined as n_DMRS = $n_{DMRS}^{(1)}$+$n_{DMRS}^{(2)}$.

Remote command:
CONFigure[:LTE]:UL:DRS:NDMRs on page 128

5.7.2　Configuring the Sounding Reference Signal

The sounding reference signal settings contain settings that define the physical attributes and structure of the sounding reference signal.

The sounding reference signal settings are part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

UL Demod	UL Frame Config	**UL Adv Sig Config**	UL PRACH Config

Sounding Reference Signal

Present	
Sequence	**3GPP**
Rel. Power	**0 dB**
SRS Subframe Conf.	**0**
SRS BW B_SRS	**0**
Freq. Dmn. Pos. n_RRC	**0**
SRS BW Conf. C_SRS	**0**
Transm. Comb. k_TC	**0**
SRS Cyclic Shift N_CS	**0**
Conf. Index I_SRS	**0**
Hopping BW b_hop	**0**

Present

Includes or excludes the sounding reference signal (SRS) from the test setup.

Remote command:
CONFigure[:LTE]:UL:SRS:STAT on page 131

SRS Rel Power

Defines the power of the SRS relative to the power of the corresponding UE (P_{SRS_Offset}).

The effective power level of the SRS is calculated as follows.

$P_{SRS} = P_{UE} + P_{SRS\_Offset}$

The relative power of the SRS is applied to all subframes.

Remote command:
CONFigure[:LTE]:UL:SRS:POWer on page 130

SRS Subframe Conf.

Defines the subframe configuration of the SRS.

The subframe configuration of the SRS is specific to a cell. The UE sends a shortened PUCCH/PUSCH in these subframes, regardless of whether the UE is configured to send an SRS in the corresponding subframe or not.

Remote command:
CONFigure[:LTE]:UL:SRS:SUConfig on page 131

SRS Bandwidth B_SRS

Defines the parameter B_{SRS}.

B_{SRS} is a UE specific parameter that defines the bandwith of the SRS. The SRS either spans the entire frequency bandwith or uses frequency hopping when several narrowband SRS cover the same total bandwidth.

The standard defines up to four bandwidths for the SRS. The most narrow SRS bandwidth (B_{SRS} = 3) spans four resource blocks and is available for all channel bandwidths. The other three values of B_{SRS} define more wideband SRS bandwidths. Their availability depends on the channel bandwidth.

The availability of SRS bandwidths additionally depends on the bandwidth configuration of the SRS (C_{SRS}).

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
CONFigure[:LTE]:UL:SRS:BSRS on page 129

Freq. Domain Pos. n_RRC

Defines the parameter n_{RRC}.

n_{RRC} is a UE specific parameter and determines the starting physical resource block of the SRS transmission.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
CONFigure[:LTE]:UL:SRS:NRRC on page 130

SRS BW Conf. C_SRS

Defines the bandwidth configuration of the SRS.

The bandwidth configuration is a cell specific parameter that, in combination with the SRS bandwidth and the channel bandwidth, defines the length of the souunding reference signal sequence. For more information on the calculation refer to 3GPP TS 36.211 chapter 5.5.3 "Sounding Reference Signal".

Remote command:
CONFigure[:LTE]:UL:SRS:CSRS on page 129

Transm. Comb. k_TC

Defines the transmission comb k_{TC}.

The transmission comb. is a UE specific parameter. For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
CONFigure[:LTE]:UL:SRS:TRComb on page 131

SRS Cyclic Shift N_CS

Defines the cyclic shift (n_{CS}) used for the generation of the SRS CAZAC sequence.

Because the different shifts of the same Zadoff-Chu sequence are orthogonal to each other, applying different SRS cyclic shifts can be used to schedule different UE to simultaneously transmit their SRS.

Remote command:
CONFigure[:LTE]:UL:SRS:CYCS on page 130

Conf. Index I_SRS

Defines the configuration index of the SRS.

The configuration index I_{SRS} is a cell specific parameter that determines the SRS periodicity (T_{SRS}) and the SRS subframe offset (T_{offset}). The effects of the configuration index on T_{SRS} and T_{offset} depends on the duplexing mode.

For more information refer to 3GPP TS 36.213, Table 8.2-1 (FDD) and 8.2-2 (TDD).

Remote command:
CONFigure[:LTE]:UL:SRS:ISRS on page 130

Hopping BW b_hop

Defines the parameter b_{hop}.

b_{hop} is a UE specific parameter that defines the frequency hopping bandwidth. SRS frequency hopping is active if $b_{hop} < B_{SRS}$.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
CONFigure[:LTE]:UL:SRS:BHOP on page 129

5.7.3 Defining the PUSCH Structure

The PUSCH structure settings contain settings that describe the physical attributes and structure of the PUSCH.

The PUSCH structure is part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

UL Demod	UL Frame Config	UL Adv Sig Config	UL PRACH Config
PUSCH Structure			
Freq. Hopping Mode	Off		
PUSCH Hopping Offset	4		
Number of Subbands	4		
Info. in Hopping Bits	0		

Frequency Hopping Mode
Selects the frequency hopping mode of the PUSCH.

Several hopping modes are supported.
- None
  No frequency hopping.
- Inter Subframe Hopping
  PUSCH changes the frequency from one subframe to another.
- Intra Subframe Hopping
  PUSCH also changes the frequency within a subframe.

Remote command:
CONFigure[:LTE]:UL:PUSCh:FHMode on page 131

PUSCH Hopping Offset
Defines the PUSCH Hopping Offset N_{RB}^{HO}.

The PUSCH Hopping Offset determines the first physical resource block and the maximum number of physical resource blocks available for PUSCH transmission if PUSCH frequency hopping is active.

Remote command:
CONFigure[:LTE]:UL:PUSCh:FHOFfset on page 132

Number of Subbands
Defines the number of subbands reserved for PUSCH.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
CONFigure[:LTE]:UL:PUSCh:NOSM on page 132

Info. in Hopping Bits
Defines the information available in the hopping bits according to the PDCCH DCI format 0 hopping bit definition.

The information in the hopping bits determines whether type 1 or type 2 hopping is used in the subframe and, in case of type 1, additionally determines the exact hopping function to use.

For more information on PUSCH frequency hopping refer to 3GPP TS36.213.

Remote command:
CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB on page 132

5.7.4 Defining the PUCCH Structure

The PUCCH structure settings contain settings that describe the physical attributes and structure of the PUCCH.

The PUCCH structure is part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

UL Demod	UL Frame Config	**UL Adv Sig Config**	UL PRACH Config

PUCCH Structure	
Num. of RB for PUCCH	0
Delta Shift	2
N(1)_cs	6
N(2)_RB	1
Format	F1 normal
N_PUCCH	0

No. of RBs for PUCCH
Defines the number of resource blocks reserved for PUCCH.

The resource blocks for PUCCH are always allocated at the edges of the LTE spectrum.

In case of an even number of PUCCH resource blocks, half of the available PUCCH resource blocks is allocated on the lower, the other half on the upper edge of the LTE spectrum (outermost resource blocks).

In case of an odd number of PUCCH resource blocks, the number of resource blocks on the lower edge is one resource block larger than the number of resource blocks on the upper edge of the LTE spectrum.

Remote command:
CONFigure[:LTE]:UL:PUCCh:NORB on page 134

Delta Shift

Defines the delta shift parameter.

The delta shift is the difference between two adjacent PUCCH resource indices with the same orthogonal cover sequence (OC).

It determines the number of available sequences in a resource block that can be used for PUCCH formats 1/1a/1b.

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
CONFigure[:LTE]:UL:PUCCh:DESHift on page 133

N(1)_cs

Defines the number of cyclic shifts used for PUCCH format 1/1a/1b in a resource block used for a combination of the formats 1/1a/1b and 2/2a/2b.

Only one resource block per slot can support a combination of the PUCCH formats 1/1a/1b and 2/2a/2b.

The number of cyclic shifts available for PUCCH format 2/2a/2b N(2)_cs in a block with combination of PUCCH formats is calculated as follows.

N(2)_cs = 12 - N(1)_cs - 2

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
CONFigure[:LTE]:UL:PUCCh:N1CS on page 134

N(2)_RB

Defines bandwidth in terms of resource blocks that are reserved for PUCCH formats 2/2a/2b transmission in each subframe.

Since there can be only one resource block per slot that supports a combination of the PUCCH formats 1/1a/1b and 2/2a/2b, the number of resource block(s) per slot available for PUCCH format 1/1a/1b is determined by N(2)_RB.

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
CONFigure[:LTE]:UL:PUCCh:N2RB on page 134

Format

Selects the format of the PUCCH.

You can define the PUCCH format for all subframes or define the PUCCH format for each subframe individually.

- F1, F1a, F1b, F2, F2a, F2b, F3
  Selects the PUCCH format globally for every subframe.

Note that formats F2a and F2b are only supported for normal cyclic prefix length.

For more information refer to 3GPP TS36.211, table 5.4-1 "Supported PUCCH Formats".

Remote command:
CONFigure[:LTE]:UL:PUCCh:FORMat on page 133

N_PUCCH
Defines the resource index for PUCCH format 1/1a/1b respectively 2/2a/2b.

It is also possible to define N_{PUCCH} on a subframe level by selecting the "Per Subframe" menu item. For more information see chapter 5.6.3, "Configuring Subframes", on page 60.

Remote command:
CONFigure[:LTE]:UL:PUCCh:NPAR on page 135

5.7.5 Defining Global Signal Characteristics

The global settings contain settings that apply to the complete signal.

The global settings are part of the "Uplink Adv Sig Config" tab of the "Demodulation Settings" dialog box.

UE ID/n_RNTI
Sets the radio network temporary identifier (RNTI) of the UE.

Remote command:
CONFigure[:LTE]:UL:UEID on page 135

5.8 Defining the PRACH Structure

The PRACH structure settings contain settings that describe the physical attributes and structure of the PRACH.

The PRACH structure setup is part of the "Uplink PRACH Config" tab of the "Demodulation Settings" dialog box.

UL Demod	UL Frame Config	UL Adv Sig Config	UL PRACH Config

PRACH Structure

PRACH Configuration	0
Restricted Set	☐
Frequency Offset	0
Ncs Conf	0
Logical Root Seq. Indx	0
Sequence Index(v) Auto	✓
Sequence Index(v)	0
Auto Preamble Mapping	✓
Freq. Res. Index	0
Half Frame Ind. t1_RA	0

PRACH Configuration

Sets the PRACH configuration index as defined in the 3GPP TS 36.211, i.e. defines the subframes in which random access preamble transmission is allowed.

The preamble format is automatically derived form the PRACH Configuration.

Remote command:
CONFigure[:LTE]:UL:PRACh:CONF on page 136

Restricted Set

Selects whether a restricted preamble set (high speed mode) or the unrestricted preamble set (normal mode) will be used.

Remote command:
CONFigure[:LTE]:UL:PRACh:RSET on page 137

Frequency Offset

For preamble formats 0-3, sets the PRACH Frequency Offset as defined in the 3GPP TS 36.211, i.e. determines the first physical resource block available for PRACH expressed as a physical resource block number.

Remote command:
CONFigure[:LTE]:UL:PRACh:FOFFset on page 136

Ncs Conf

Selects the Ncs configuration, i.e. determines the Ncs value set according to TS 36.211, table 5.7.2.-2 and 5.7.2-3.

Remote command:
CONFigure[:LTE]:UL:PRACh:NCSC on page 137

Logical Root Sequ. Idx

Selects the logical root sequence index.

The logical root sequence index is used to generate preamble sequences. It is provided by higher layers.

Remote command:
CONFigure[:LTE]:UL:PRACh:RSEQ on page 137

Sequence Index (v)

Defines the sequence index (v).

The sequence index controls which of the 64 preambles available in a cell is used.

If you select the "Auto" menu item, the software automatically selects the required sequence index.

Remote command:
CONFigure[:LTE]:UL:PRACh:SINDex on page 138

PRACH Preamble Mapping

The frequency resource index f_{RA} and the half frame indicator $t1_{RA}$ are neccessary to clearly specify the physical resource mapping of the PRACH in case a PRACH configuration index has more than one mapping alternative.

If you turn on the "Auto Preamble Mapping", the software automatically detects f_{RA} and $t1_{RA}$.

The values for both parameters are defined in table '5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency' (3GPP TS 36.211 v10.2.0).

The frequency resource index and half frame indicator are available in TDD mode.

Remote command:
CONFigure[:LTE]:UL:PRACh:APM on page 136
CONFigure[:LTE]:UL:PRACh:FRINdex on page 136
CONFigure[:LTE]:UL:PRACh:HFINdicator on page 137

6 Analyzing Measurement Results

The "Measurement Settings" contain settings that configure various result displays. These settings are independent of the signal, they adjust the display of the results. You can open the dialog box with the "Meas Settings" softkey. The corresponding dialog box is made up of three tabs. By default, the "Selection" tab is the active one.

6.1 Selecting a Particular Signal Aspect

In the "Selection" tab of the "Measurement Settings" dialog box you can select specific parts of the signal you want to analyze.

Subframe Selection
Selects a particular subframe whose results the application displays.

You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, EVM vs. Symbol x Carrier, Inband Emission, Channel Flatness, Spectrum Flatness SRS, Channel Group Delay, Spectrum Flatness Difference, Power vs Symbol x Carrier, Constellation Diagram, DFT Precoded Constellation, Allocation Summary, Bit Stream and Time Alignment. If ---All--- is selected, either the results from all subframes are displayed at once or a statistic is calculated over all analyzed subframes.

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

Example: Subframe selection

If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.

with **AV MI PK**

- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.
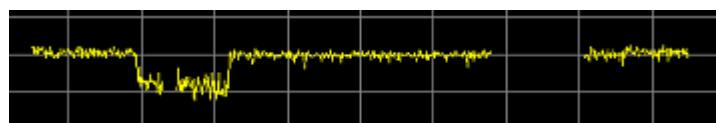
Remote command:
[SENSe][:LTE]:SUBFrame:SELect on page 139

6.2 Defining Measurement Units

In the "Units" tab of the "Measurement Settings" dialog box you can select the unit for various measurement results.

EVM Unit
Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
UNIT:EVM on page 141

6.3 Defining Various Measurement Parameters

In the "Misc" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.

Bit Stream Format
Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

Fig. 6-1: Bit stream display in uplink application if the bit stream format is set to "symbols"

Fig. 6-2: Bit stream display in uplink application if the bit stream format is set to "bits"

Remote command:
UNIT:BSTR on page 140

6.4 Selecting the Contents of a Constellation Diagram

The "Evaluation Filter" dialog box contains settings to configure the contents of a constellation diagram.

You can access the dialog box with the "Constellation Selection" softkey in the "Measurement" menu.

Evaluation Range for the Constellation Diagram
The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the Constellation Diagram.

By default the application displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.

- Modulation
  Filters the results to include only the selected type of modulation.
- Allocation
  Filters the results to include only a particular type of allocation.
- Symbol
  Filters the results to include only a particular OFDM symbol.
- Carrier
  Filters the results to include only a particular subcarrier.

The result display is updated as soon as you make the changes.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

Remote command:
Modulation: `[SENSe][:LTE]:MODulation:SELect` on page 139
Allocation: `[SENSe][:LTE]:ALLocation:SELect` on page 138
Symbol: `[SENSe][:LTE]:SYMBol:SELect` on page 140
Carrier: `[SENSe][:LTE]:CARRier:SELect` on page 139

6.5 Scaling the Y-Axis

In the "Y-Axis" tab of the "Measurement Settings" dialog box you can set various parameters that affect some result displays.
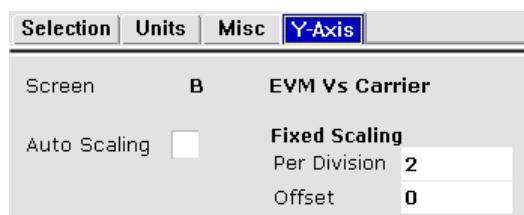
Y-Axis Scale
The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you have turned on **automatic scaling**.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis. **Fixed scaling** becomes available when you turn off automatic scaling. For a fixed scaling, define the distance between two grid lines (scaling **per division**) and the point of origin of the y-axis (the **offset**).

Remote command:
Automatic scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO` on page 146
Manual scaling:
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet` on page 146
`DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv` on page 146

6.6 Using Markers

The firmware application provides marker functionality to work with. You can use a marker to mark specific points on traces or to read out measurement results.
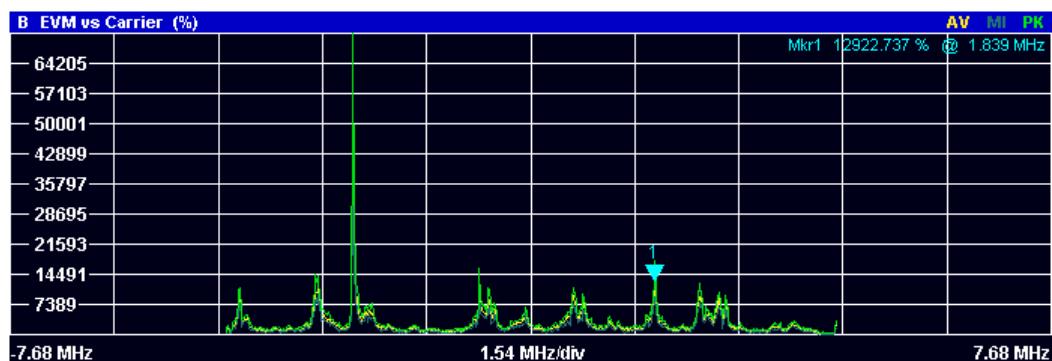
Fig. 6-3: Example: Marker

The MKR key opens the corresponding submenu. You can activate up to four markers with the "Marker <x>" softkeys. The first marker is always a normal marker. Markers 2 to 4 are delta marker by default. The reference marker for the delta marker is marker 1. You can turn all delta markers into normal markers with the "Marker (Norm Delta)" softkey.

After pressing the "Marker <x>" softkey, you can set the position of the marker in several ways.

● Enter a frequency value in the marker input field.

● Move the marker with the rotary knob.

● Position the marker to the trace minimum or trace maximum with the "Marker Max" or "Marker Min" softkeys.

The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.
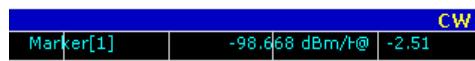
The "Marker <x>" softkey have three possible states:

● If the "Marker <x>" softkey is black, the marker is off.

● After pressing the "Marker <x>" softkey it turns orange to indicate an open dialog box and the the marker is active. The dialog box to specify the marker position on the frequency axis opens.

● After closing the dialog box, the "Marker <x>" softkey turns blue. The marker stays active.

Marker 1

Pressing the "Marker <x>" softkey again deactivates the marker. You can also turn off the marker by pressing the "All Marker Off" softkey.

If you'd like to see the area of the spectrum around the marker in more detail, you can use the Marker Zoom function. Press the "Marker Zoom" softkey to open a dialog box in which you can specify the zoom factor. The maximum possible zoom factor depends on the result display. The "Unzoom" softkey cancels the marker zoom.

Marker Zoom
Zoom Factor   1
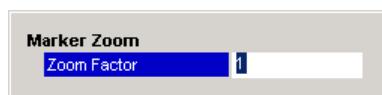
Note that the zoom function is not available for all result displays.

If you have more than one active trace, it is possible to assign the marker to a specific trace. Press the "Marker ➜ Trace" softkey in the marker to menu and specify the trace in the corresponding dialog box.

SCPI commands:

See chapter 8.15.4, "Using Delta Markers", on page 143.

7 File Management

7.1 File Manager

The root menu of the application includes a File Manager with limited functions for quick access to file management functionality.

Loading a Frame Setup

The frame setup or frame description describes the complete modulation structure of the signal, such as bandwidth, modulation, etc.

The frame setup is stored as an XML file. XML files are very commonly used to describe hierarchical structures in an easy-to-read format for both humans and PC.

A typical frame setup file would look like this:

```
<FrameDefinition LinkDirection="uplink" TDDULDLAllocationConfiguration="0"
RessourceBlocks="50" CP="auto" PhysLayCellIDGrp="Group 0" PhysLayID="ID 0"
N_RNTI="0" N_f="0" NOfSubbands="4" N_RB_HO="4" NOfRB_PUCCH="4"
DeltaShift="2" N1_cs="6" N2_RB="1" NPUCCH="0" DeltaOffset="0"
PUCCHStructureFormat="F1 normal" N_c_fastforward="1600"
HoppingBitInformation="0" FrequencyHopping="None" DemRefSeq="3GPP"
DemPilBoostdBPUSCH="0" DemPilBoostdBPUCCH="0" GroupHop="0" SequenceHop="0"
EnableN_PRS="1" Delta_ss="0" N_DMRS1="0" N_DMRS2="0" SoundRefSeq="3GPP"
SoundRefBoostdB="0" SoundRefPresent="0" SoundRefSymOffs="13" SoundRefCAZAC_u="2"
SoundRefCAZAC_q="0" SoundRefCAZAC_alpha="0" SoundRefCAZAC_mode="2" SoundRefB="0"
SoundRefC="0" SRSSubframeConfiguration="0" SoundRefN_CS="0" SoundRefK_TC="0"
SoundRefN_RRC="0" SoundRefb_hop="0" SoundRefI_SRS="0" SoundRefk0="24"
SoundRefNumSubcarrier="132">
  <Frame>
    <Subframe>
      <PRBs>
        <PRB Start="2" Length="10" Modulation="QPSK" PUCCHOn="0" BoostingdB="0"></PRB>
      </PRBs>
    </Subframe>
  </Frame>
  <stControl PhaseTracking="1" TimingTracking="0" CompensateDCOffset="1"
    UseBitStreamScrambling="1" ChannelEstimationRange="2" AutoDemodulation="1">
  </stControl>
</FrameDefinition>
```

All settings that are available in the "Demod Settings" dialog box are also in the frame setup file. You can enter additional allocations by adding additional PRB entries in the PRBs list.

To load a frame setup, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load Demod Setup" button.

Loading an I/Q File

The R&S FSVR is able to process I/Q data that has been captured with a R&S FSVR directly as well as data stored in a file. You can store I/Q data in various file formats in order to be able to process it with other external tools or for support purposes.

I/Q data can be formatted either in binary form or as ASCII files. The data is linearly scaled using the unit Volt (e.g. if a correct display of Capture Buffer power is required). For **binary** format, data is expected as 32-bit floating point data, Little Endian format (also known as LSB Order or Intel format). An example for binary data would be: 0x1D86E7BB in hexadecimal notation is decoded to -7.0655481E-3. The order of the data is either IQIQIQ or II...IQQ...Q.

For ASCII format, data is expected as I and Q values in alternating rows, separated by new lines: <I value 1>, <Q value 1>, <I value 2>, <Q value 2>, ...

To use data that has been stored externally, press the "File Manager" softkey in the root menu of the application. Select the file you want to load and activate it with the "Load IQ Data" button.

7.2 SAVE/RECALL Key

Besides the file manager in the root menu, you can also manage the data via the SAVE/RECALL key.

The corresponding menu offers full functionality for saving, restoring and managing the files on the R&S FSVR. The save/recall menu is the same as that of the spectrum mode. For details on the softkeys and handling of this file manager, refer to the operating manual of the R&S FSVR.

8 Remote Commands

8.1 Overview of Remote Command Suffixes

This chapter provides an overview of all suffixes used for remote commands in the LTE application.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.
<m>	Selects a marker. Irrelevant for the LTE application.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

8.2   Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSVR.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

8.2.1   Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.

- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSVR follow the SCPI syntax rules.

- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.

- **Reset values (*RST)**

Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.

- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.

- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

8.2.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

8.2.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

8.2.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

8.2.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

8.2.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

8.2.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

8.2.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

8.2.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 8.2.2, "Long and Short Form", on page 83.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

8.2.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELete 'Spectrum'`

8.2.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

8.3 Measurement Selection

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType>   String containing the short form of the result display. See table below for details.

Example: CALC2:FEED 'PVT:CBUF'
                    Select Capture Buffer to be displayed on screen B.

Manual operation: See "Capture Buffer" on page 27
                        See "EVM vs Carrier" on page 28
                        See "EVM vs Symbol" on page 29
                        See "EVM vs Subframe" on page 30
                        See "Spectrum Mask" on page 31
                        See "ACLR" on page 32
                        See "Inband Emission" on page 34
                        See "Channel Flatness" on page 35
                        See "Channel Group Delay" on page 35
                        See "Channel Flatness Difference" on page 36
                        See "Constellation Diagram" on page 37
                        See "DFT Precod Constellation" on page 37
                        See "CCDF" on page 38
                        See "Allocation Summary" on page 38
                        See "Bit Stream" on page 39

Result display	Parameter
ACLR	'SPEC:ACP'
Allocation Summary	'STAT:ASUM'
Bitstream	'STAT:BSTR'
Capture Buffer	'PVT:CBUF'
CCDF	'STAT:CCDF'
Constellation Diagram	'CONS:CONS'
CSI RS Weights (Magnitude)	'BEAM:IRWM'
CSI RS Weights (Phase)	'BEAM:IRWP'
DFT Precoded Constellation	'CONS:DFTC'
EVM vs Carrier	'EVM:EVCA'
EVM vs Subframe	'EVM:EVSU'
EVM vs Symbol	'EVM:EVSY'
Flatness Difference	'SPEC:FLAT'
Group Delay	'SPEC:GDEL'
Inband Emission	'SPEC:IE'
Power Spectrum	'SPEC:PSPE'
Spectrum Flatness	'SPEC:FLAT'
Spectrum Emission Mask	'SPEC:SEM'
Time Alignment Error	'PVT:TAER'

DISPlay[:WINDow<n>]:TABLe <State>

This command turns the result summary on and off.

Parameters:

<State>   **ON**

                           Turns the result summary on and removes all graphical results
                           from the screen.

                           OFF

                           Turns the result summary off and restores the graphical results
                           that were previously set.

Example: DISP:TABL OFF
                           Turns the result summary off.

Manual operation: See "Result Summary" on page 24

8.4 Measurement Execution

INITiate:CONTinuous <State>

This command controls the sweep mode.

Parameters:

<State>   ON | OFF

                           ON
                           Continuous sweep

                           OFF
                           Single sweep

                           *RST: OFF

Example: INIT:CONT OFF
                           Switches the sequence to single sweep.
                           INIT:CONT ON
                           Switches the sequence to continuous sweep.

Manual operation: See "Single Sweep and Continuous Sweep" on page 42

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measure-
ments.

In single sweep mode, you can synchronize to the end of the measurement with `*OPC`. In continuous sweep mode, synchronization to the end of the sweep is not possible.

Example:	`INIT` Initiates a new measurement.
Usage:	Event

INITiate:REFResh

This command updates the current I/Q measurement results to reflect the current measurement settings.

No new I/Q data is captured. Thus, measurement settings apply to the I/Q data currently in the capture buffer.

The command applies exclusively to I/Q measurements. It requires I/Q data.

Example:	`INIT:REFR` The application updates the IQ results
Usage:	Event
Manual operation:	See "Refresh" on page 43

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State>	The string contains the following information. A zero represents a failure and a one represents a successful synchronization.
Example:	`SYNC:STAT?` Would return, e.g. '1' for successful synchronization.
Usage:	Query only

8.5 Numeric Result Query

FETCh:CYCPrefix?

This command queries the cyclic prefix type that has been detected.

Return values:

<PrefixType>   The command returns -1 if no valid result has been detected yet.

NORM
Normal cyclic prefix length detected

EXT
Extended cyclic prefix length detected

Example: FETC:CYCP?
Returns the current cyclic prefix length type.

Usage: Query only

FETCh:PLC:CIDGroup?

This command queries the cell identity group that has been detected.

Return values:

<CidGroup>   The command returns -1 if no valid result has been detected yet.

Range: 0 to 167

Example: FETC:PLC:CIDG?

Returns the current cell identity group.

Usage: Query only

FETCh:PLC:PLID?

This command queries the cell identity that has been detected.

Return values:

<Identity>   The command returns -1 if no valid result has been detected yet.

Range: 0 to 2

Example: FETC:PLC:PLID?

Returns the current cell identity.

Usage: Query only

FETCh:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Return values:

<CrestFactor>   <numeric value>

Crest Factor in dB.

Example: FETC:SUMM:CRES?

Returns the current crest factor in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM[:ALL]:MAXimum?
FETCh:SUMMary:EVM[:ALL]:MINimum?
FETCh:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Return values:

<EVM>   <numeric value>

Minimum, maximum or average EVM, depending on the last
command syntax element.
The unit is % or dB, depending on your selection.

Example: FETC:SUMM:EVM?

Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM:PCHannel:MAXimum?
FETCh:SUMMary:EVM:PCHannel:MINimum?
FETCh:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Return values:

<EVM>   <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: FETC:SUMM:EVM:PCH?
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM:PSIGnal:MAXimum?
FETCh:SUMMary:EVM:PSIGnal:MINimum?
FETCh:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Return values:

<EVM>   <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: FETC:SUMM:EVM:PSIG?
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM:SDQP[:AVERage]?

This command queries the EVM of all DMRS resource elements with QPSK modulation of the PUSCH.

Return values:

<EVM>   <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:SDQP?
Returns the EVM of all DMRS resource elements with QPSK modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM:SDST[:AVERage]?

This command queries the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:SDST?

Returns the EVM of all DMRS resource elements with 16QAM modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM:UCCD[:AVERage]?

This command queries the EVM of all DMRS resource elements of the PUCCH as shown in the result summary.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:UCCD?

Returns the average EVM of all DMRS resource elements.

Usage: Query only

FETCh:SUMMary:EVM:UCCH[:AVERage]?

This command queries the EVM of all resource elements of the PUCCH as shown in the result summary.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:UCCH?

Returns the average EVM of all resource elements.

Usage: Query only

FETCh:SUMMary:EVM:USQP[:AVERage]?

This query returns the EVM for all QPSK-modulated resource elements of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:USQP?

Queries the PUSCH QPSK EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:EVM:USST[:AVERage]?

This query returns the the EVM for all 16QAM-modulated resource elements of the PUSCH.

Return values:

\<EVM\>   EVM in % or dB, depending on the unit you have set.

Example: FETC:SUMM:EVM:USST?
                     Queries the PUSCH 16QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:FERRor:MAXimum?
FETCh:SUMMary:FERRor:MINimum?
FETCh:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Return values:

\<FreqError\>   \<numeric value\>

                     Minimum, maximum or average frequency error, depending on the last command syntax element.

                     Default unit: Hz

Example: FETC:SUMM:FERR?
                     Returns the average frequency error in Hz.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:GIMBalance:MAXimum?
FETCh:SUMMary:GIMBalance:MINimum?
FETCh:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Return values:

\<GainImbalance\>   \<numeric value\>

                     Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

                     Default unit: dB

Example: FETC:SUMM:GIMB?
                     Returns the current gain imbalance in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:IQOFfset:MAXimum?
FETCh:SUMMary:IQOFfset:MINimum?
FETCh:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Return values:

<IQOffset>   <numeric value>

Minimum, maximum or average I/Q offset, depending on the last command syntax element.

Default unit: dB

Example: FETC:SUMM:IQOF?
Returns the current IQ-offset in dB

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:POWer:MAXimum?
FETCh:SUMMary:POWer:MINimum?
FETCh:SUMMary:POWer[:AVERage]?

This command queries the total power.

Return values:

<Power>   <numeric value>

Minimum, maximum or average power, depending on the last command syntax element.

Default unit: dBm

Example: FETC:SUMM:POW?
Returns the total power in dBm

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:QUADerror:MAXimum?
FETCh:SUMMary:QUADerror:MINimum?
FETCh:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Return values:

<QuadError>   <numeric value>

Minimum, maximum or average quadrature error, depending on the last command syntax element.

Default unit: deg

Example: FETC:SUMM:QUAD?
Returns the current mean quadrature error in degrees.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:SERRor:MAXimum?
FETCh:SUMMary:SERRor:MINimum?
FETCh:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Return values:
<SamplingError>   <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: FETC:SUMM:SERR?
Returns the current mean sampling error in ppm.

Usage: Query only

Manual operation: See "Result Summary" on page 24

FETCh:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the Capture Buffer result display.

Note that you have to select a particular subframe; otherwise the command returns an error.

Return values:
<Offset>   Time difference between the (sub)frame start and capture buffer start.

Default unit: s

Example: FETC:SUMM:TFR?
Returns the (sub)frame start offset.

Usage: Query only

Manual operation: See "Capture Buffer" on page 27

8.6 Measurement Result Query

8.6.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

`TRAC2:DATA? TRACE1`

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe[:DATA]?`).

8.6.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
- LIST
  Returns the contents of the ACLR table.
  For each channel, it returns six values.

<channel type>, <bandwidth>, <spacing offset>, <power of
lower channel>, <power of upper channel>, <limit>, ...
The unit of the <bandwidth> and <spacing offset> is Hz.
The unit of the power values is either dBm for the TX channel or dB for the neighboring channels.
The unit of the limit is dB.
The <channel type> is encoded. For the code assignment see chapter 8.6.1.17, "Return Value Codes", on page 104.
Note that the TX channel does not have a <spacing offset>, <power of
lower channel> and <limit>. NaN is returned instead.

8.6.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

<subframe>, <allocation ID>, <number of RB>, <offset RB>,
<modulation>, <absolute power>, <EVM>, ...

The unit for <absolute power> is always dBm. The unit for <EVM> depends on
UNIT:EVM. All other values have no unit.

The <allocation ID> and <modulation> are encoded. For the code assignment
see chapter 8.6.1.17, "Return Value Codes", on page 104.

Note that the data format of the return values is always ASCII.

Example:

Allocation Summary						
Sub-frame	Alloc. ID	Number of RB	Offset RB	Modulation	Power/ dBm	EVM/%
0	PUSCH	10	2	QPSK	-84,743	0,002
	DMRS PUSCH			CAZAC	-84,743	0,002
	SRS			CAZAC	-80,940	0,003

TRAC:DATA? TRACE1 would return:

```
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
0, -42, 0, 0, 6, -80.9404231343884, 3.97834623871343E-06,
...
```

8.6.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream
for each line of the table.

<subframe>, <modulation>, <# of symbols/bits>,
<hexadecimal/binary numbers>,...

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The `<modulation>` is encoded. For the code assignment see chapter 8.6.1.17, "Return Value Codes", on page 104.

For symbols or bits that are not transmitted, the command returns

- "FF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:

`TRAC:DATA? TRACE1` would return:

```
0, -40, 0, 2, 0, 03, 01, 02, 03, 03, 00, 00, 00, 01, 02, 02, ...
<continues like this until the next data block starts or the end of data is reached>
0, -40, 0, 2, 32, 03, 03, 00, 00, 03, 01, 02, 00, 01, 00, ...
```

8.6.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

`<absolute power>, ...`

The unit is always dBm.

The following parameters are supported.

- TRACE1

8.6.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2

Returns the corresponding power levels (x-axis).

```
<# of values>, <relative power>, ...
```

The unit is always dB.

The first value that is returned is the number of the following values.

8.6.1.6 Channel and Spectrum Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.7 Channel and Spectrum Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average power over all subframes.
- TRACE2
  Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.8 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

```
<group delay>, ...
```

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average group delay over all subframes.
- TRACE2
  Returns the minimum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.9 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Sym0][Carrier1]>, <Q[SF0][Sym0][Carrier1]>, ..., <I[SF0][Sym0][Carrier(n)]>, <Q[SF0][Sym0][Carrier(n)]>,

<I[SF0][Sym1][Carrier1]>, <Q[SF0][Sym1][Carrier1]>, ..., <I[SF0][Sym1][Carrier(n)]>, <Q[SF0][Sym1][Carrier(n)]>,

<I[SF0][Sym(n)][Carrier1]>, <Q[SF0][Sym(n)][Carrier1]>, ..., <I[SF0][Sym(n)][Carrier(n)]>, <Q[SF0][Sym(n)][Carrier(n)]>,

<I[SF1][Sym0][Carrier1]>, <Q[SF1][Sym0][Carrier1]>, ..., <I[SF1][Sym0][Carrier(n)]>, <Q[SF1][Sym0][Carrier(n)]>,

<I[SF1][Sym1][Carrier1]>, <Q[SF1][Sym1][Carrier1]>, ..., <I[SF1][Sym1][Carrier(n)]>, <Q[SF1][Sym1][Carrier(n)]>,

<I[SF(n)][Sym(n)][Carrier1]>, <Q[SF(n)][Sym(n)][Carrier1]>, ..., <I[SF(n)][Sym(n)][Carrier(n)]>, <Q[SF(n)][Sym(n)][Carrier(n)]>

With SF = subframe and Sym = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.
- TRACE2
  Returns the constellation points of the reference symbols included in the selection.
- TRACE3
  Returns the constellation points of the SRS included in the selection.

8.6.1.10 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

<EVM>, ...

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

8.6.1.11 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

8.6.1.12 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<EVM>, ...`

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

8.6.1.13 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<frequency error>,...`

The unit is always Hz.

The following parameters are supported.

- TRACE1

8.6.1.14   Inband Emission

For the Inband Emission result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns the relative resource block indices (x-axis values).
  `<RB index>, ...`
  The resource block index has no unit.
- TRACE2
  Returns one value for each resource block index.
  `<relative power>, ...`
  The unit of the relative inband emission is dB.
- TRACE3
  Returns the data points of the upper limit line.
  `<limit>, ...`
  The unit is always dB.

Note that you have to select a particular subframe to get results.

8.6.1.15   Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

8.6.1.16   Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns 11 values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, <reserved>, <reserved>...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

8.6.1.17   Return Value Codes

This chapter contains a list for encoded return values.

<allocation ID>

Represents the allocation ID. The value is a number in the range {1...-70}.

- **1** = Reference symbol
- **0** = Data symbol
- **-1** = Invalid
- **-40** = PUSCH
- **-41** = DMRS PUSCH
- **-42** = SRS PUSCH
- **-50** = PUCCH
- **-51** = DMRS PUCCH
- **-70** = PRACH

<channel type>

- **0** = TX channel
- **1** = adjacent channel
- **2** = alternate channel

<modulation>

Represents the modulation scheme. The range is {0...14}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

TRACe[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 8.6.1, "Using the TRACe[:DATA] Command", on page 96.

Query parameters:
TRACE1 | TRACE2 |
TRACE3

LIST

Usage:	Query only

8.6.2 Reading Results

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Return values:

<LimitCheck>	Returns two values, one for the upper and one for the lower adjacent channel.
	PASSED
	Limit check has passed.
	FAILED
	Limit check has failed.
Example:	CALC:LIM:ACP:ACH:RES? ALL
	Queries the results of the adjacent channel limit check.
Usage:	Query only

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Return values:

<LimitCheck>	Returns two values, one for the upper and one for the lower alternate channel.
	PASSED
	Limit check has passed.
	FAILED
	Limit check has failed.
Example:	CALC:LIM:ACP:ALT:RES? ALL
	Queries the results of the alternate channel limit check.
Usage:	Query only

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]? <ResultType>

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m>	1

Query parameters:

<ResultType>	**CPOW**
	This parameter queries the channel power of the reference range.

Return values:

<Result>	**Results for the Spectrum Emission Mask measurement:**
	Power level in dBm.
	Results for the ACLR measurements:
	Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
	• <TXChannelPower> is the power of the transmission channel in dBm
	• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
	• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
	• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
	• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
	(...)
	• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
	• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example:	CALC1:MARK:FUNC:POW:RES?
	Returns the current ACLR measurement results.

Usage:	Query only

Manual operation:	See "ACLR" on page 32

8.7 General Settings

8.7.1 Defining Signal Characteristics

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>	**TDD**
	Time division duplex
	FDD
	Frequency division duplex
	*RST: FDD

Example:	CONF:DUPL TDD
	Activates time division duplex.

Manual operation:	See "Selecting the LTE Mode" on page 44

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>	**DL**
	Downlink
	UL
	Uplink

Example:	CONF:LDIR DL
	EUTRA/LTE option is configured to analyze downlink signals.

Manual operation:	See "Selecting the LTE Mode" on page 44

CONFigure[:LTE]:UL:BW <Bandwidth>

This command selects the uplink bandwidth.

Parameters:

<Bandwidth>	BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00
Example:	CONF:UL:BW BW1_40 Sets a signal bandwidth of 1.4 MHz in uplink.
Manual operation:	See "Channel Bandwidth / Number of Resource Blocks" on page 44

CONFigure[:LTE]:UL:CYCPrefix <PrefixLength>

This command selects the cyclic prefix for uplink signals.

Parameters:

<PrefixLength>	**NORM** Normal cyclic prefix length **EXT** Extended cyclic prefix length **AUTO** Automatic cyclic prefix length detection *RST: AUTO
Example:	CONF:UL:CYCP EXT Sets cyclic prefix type to extended.
Manual operation:	See "Cyclic Prefix" on page 45

CONFigure[:LTE]:UL:NORB <ResourceBlocks>

This command selects the number of resource blocks for uplink signals.

Parameters:

<ResourceBlocks>	<numeric value> *RST: 50
Example:	CONF:UL:NORB 25 Sets the number of resource blocks to 25.

[SENSe]:FREQuency:CENTer <Frequency>

This command sets the center frequency for RF measurements.

Parameters:

<Frequency>	<numeric value> Range: fmin to fmax *RST: 1 GHz Default unit: Hz
Example:	FREQ:CENT 2GHZ Set the center frequency to 2 GHz.

Manual operation: See "Defining the Signal Frequency" on page 44

8.7.2 Configuring the Input Level

CONFigure:POWer:EXPected:IQ<instrument> <RefLevel>

This command defines the reference level when the input source is baseband.

Parameters:

<RefLevel>   <numeric value>

                   Range: 31.6 mV to 5.62 V
                   *RST: 1 V
                   Default unit: V

Example: CONF:POW:EXP:IQ2 3.61
                   Sets the baseband-reference level used by analyzer 2 to 3.61 V.

Manual operation: See "Defining a Reference Level" on page 45

CONFigure:POWer:EXPected:RF<instrument> <RefLevel>

This command defines the reference level when the input source is RF.

Parameters:

<RefLevel>   *RST: -30 dBm
                   Default unit: DBM

Example: CONF:POW:EXP:RF3 -20
                   Sets the radio frequency reference level used by analyzer 3 to
                   -20 dBm.

Manual operation: See "Defining a Reference Level" on page 45

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Attenuation>

This command selects the external attenuation or gain applied to the RF signal.

Parameters:

<Attenuation>   <numeric value>

                   *RST: 0
                   Default unit: dB

Example:	DISP:TRAC:Y:RLEV:OFFS 10
	Sets an external attenuation of 10 dB.

Manual operation: See "Attenuating the Signal" on page 46

INPut<n>:ATTenuation<instrument> <Attenuation>

This command sets the RF attenuation level.

Parameters:

<Attenuation>	<numeric value>
	*RST: 5 dB
	Default unit: dB

Example:	INP:ATT 10
	Defines an RF attenuation of 10 dB.

Manual operation: See "Attenuating the Signal" on page 46

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:

<Attenuation>	Attenuation level in dB.
	Default unit: dB

Example:	INP:EATT 10
	Defines an attenuation level of 10 dB.

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:

<State>	ON	OFF
	*RST: OFF

Example:	INP:EATT:STAT ON
	Turns the electronic attenuator on.

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with option R&S FSV-B25, but not if R&S FSV-B17 is active.

Parameters:

<State>	ON | OFF
	*RST: OFF

Example:	INP:EATT:AUTO ON
	Turns automatic selection of electronic attenuation level on.

[SENSe]:POWer:AUTO<instrument>[:STATe] <State>

This command initiates a measurement that determines the ideal reference level.

Parameters:

<State>	**OFF**
	Performs no automatic reference level detection.
	ON
	Performs an automatic reference level detection before each measurement.
	ONCE
	Performs an automatic reference level once.
	*RST: ON

Example:	POW:AUTO2 ON
	Activate auto level for analyzer number 2.

Manual operation:	See "Auto Level" on page 43
	See "Defining a Reference Level" on page 45

[SENSe]:POWer:AUTO<instrument>:TIME <Time>

This command defines the track time for the auto level process.

Parameters:

<Time>	<numeric value>
	*RST: 100 ms
	Default unit: s

Example:	POW:AUTO:TIME 200ms
	An auto level track time of 200 ms gets set.

Manual operation:	See "Defining a Reference Level" on page 45

8.7.3 Configuring the Data Capture

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes>	<numeric value>
	*RST: 1

Example: FRAM:COUN:STAT ON
FRAM:COUN:AUTO OFF
Activates manual input of frames to be analyzed.
FRAM:COUN 20
Analyzes 20 frames.

Manual operation: See "Number of Frames to Analyze" on page 47

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:

<State>   **ON**
Selects the number of frames to analyze according to the LTE standard.
OFF
Turns manual selection of the frame number on.

Example: FRAM:COUN:AUTO ON
Turns automatic selection of the analyzed frames on.

Manual operation: See "Auto According to Standard" on page 48

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:

<State>   **ON**
You can set the number of frames to analyze.
OFF
The R&S FSVR analyzes a single sweep.
*RST: ON

Example: FRAM:COUN:STAT ON
                     Turns manual setting of number of frames to analyze on.

Manual operation: See "Overall Frame Count" on page 47

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

When you are performing an ACLR measurement, the command defines the sweep time.

Parameters:
<CaptLength>   Numeric value in seconds.

                     Default unit: s

Example: SWE:TIME 40ms
                     Defines a capture time of 40 milliseconds.

Manual operation: See "Capture Time" on page 47
                     See "Sweep Time" on page 52

8.8 Advanced Settings

8.8.1 Controlling I/Q Data

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:
<State>   ON | OFF

                     *RST: OFF

Example: SWAP ON
                     Turns a swap of the I and Q branches on.

Manual operation: See "Swap I/Q" on page 53

8.8.2 Controlling the Input

For information on the remote commands for reference level and attenuation settings see chapter 8.7.2, "Configuring the Input Level", on page 109.

INPut:SELect <Source>

This command selects the signal source.

Parameters:

<Source>   **RF**
                            Selects the RF input as the signal source.

                            AIQ
                            Selects the analog baseband input as the data source. This source is available only with option R&S FSVR-B71.

                            DIQ
                            Selects the digital baseband input as the data source. This source is available only with option R&S FSVR-B17.

Example: INP DIQ
                            Selects the digital baseband input.

Manual operation: See "Selecting the Input Source" on page 53

TRACe:IQ:FILTer:FLATness <FilterType>

This command turns the wideband filter on and off.

Parameters:

<FilterType>   **NORMal**
                            Uses the normal filter.

                            WIDE
                            Turns the wideband filter on.

                            *RST: NORMal

Example: TRAC:IQ:FILT:FLAT WIDE
                            Turns the wideband filter on.

8.8.3 Configuring the Digital I/Q Input

INPut<n>:DIQ:SRATe <SampleRate>

This command defines the sampling rate for a digital I/Q signal source.

Parameters:

<SampleRate>	*RST: 10 MHz
	Default unit: Hz

Example:	INP:DIQ:SRAT 10MHZ
	Defines a sampling rate of 10 MHz.

Manual operation:	See "Sampling Rate (Input Data Rate)" on page 54

INPut<n>:DIQ:RANGe[:UPPer] <ScaleLevel>

This command defines the full scale level for a digital I/Q signal source.

Parameters:

<ScaleLevel>	*RST: 1 V
	Default unit: V

Example:	INP:DIQ:RANG 0.7
	Sets the full scale level to 0.7 V.

Manual operation:	See "Full Scale Level" on page 54

8.9 Trigger Configuration

TRIGger[:SEQuence]:HOLDoff<instrument> <Offset>

This command defines the trigger offset.

Parameters:

<Offset>	<numeric value>
	*RST: 0 s
	Default unit: s

Example:	TRIG:HOLD 5MS
	Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:IFPower:HOLDoff <Offset>

This command defines the holding time before the next trigger event.

Note that this command is available for **any trigger source**, not just IF Power.

Parameters:

<Offset>   Range: 150 ns to 10 s
                         *RST: 150 ns
                         Default unit: s

Example: `TRIG:IFP:HOLD 1`
                         Defines a holdoff of 1 second.

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis.

Parameters:

<Hysteresis>   Range: 3 to 50
                         *RST: 3
                         Default unit: dB

Example: `TRIG:IFP:HYST 10`
                         Defines a trigger hysteresis of 10 dB.

TRIGger[:SEQuence]:LEVel<instrument>:POWer <Level>

This command defines the trigger level for an IF power trigger.

Parameters:

<Level>   Default unit: DBM

Example: `TRIG:LEV:POW 10`
                         Defines a trigger level of 10 dBm.

TRIGger[:SEQuence]:MODE <Source>

This command selects the trigger source.

Parameters:

<Source>   **EXTernal**
                         Selects external trigger source.
                         IFPower
                         Selects the IF power trigger source.
                         IMMediate
                         Selects free run trigger source.
                         PSEN
                         Selects power sensor trigger source.
                         RFPower
                         Selects RF power trigger source.
                         *RST: IMMediate

Example: `TRIG:MODE EXT`
                         Selects an external trigger source.

8.10 Spectrum Measurements

[SENSe]:FREQuency:SPAN <Span>

This command defines the frequency span.

Available for ACLR and SEM measurements.

Parameters:

<Span>   Frequency span in Hz.

Example: FREQ:SPAN 20MHZ
                          Defines a span of 20 MHz.

Manual operation: See "Span" on page 50

[SENSe]:POWer:ACHannel:AACHannel <Channel>

This command selects the assumed adjacent channel carrier for ACLR measurements.

Parameters:

<Channel>   **EUTRA**
                          Selects an EUTRA signal of the same bandwidth like the TX
                          channel as assumed adjacent channel carrier.

                          UTRA128
                          Selects an UTRA signal with a bandwidth of 1.28MHz as
                          assumed adjacent channel carrier.

                          UTRA384
                          Selects an UTRA signal with a bandwidth of 3.84MHz as
                          assumed adjacent channel carrier.

                          UTRA768
                          Selects an UTRA signal with a bandwidth of 7.68MHz as
                          assumed adjacent channel carrier.

                          *RST: EUTRA

Example: POW:ACH:AACH UTRA384
                          Selects an UTRA signal with a bandwidth of 3.84MHz as
                          assumed adjacent channel carrier.

Manual operation: See "Assumed Adjacent Channel Carrier" on page 51

[SENSe]:POWer:ACHannel:BANDwidth:CHANnel2 <Bandwidth>

This command defines the channel bandwidth of the second TX channel in ACLR measurements.

Before you can use the command, you have to select two TX channels for the ACLR measurement with [SENSe]:POWer:ACHannel:TXCHannels:COUNt on page 118.

Note that you have to add a suffix with the value "2" at the CHANnel syntax element.

Parameters:

<Bandwidth>   Bandwidth of the second TX channel in Hz.
Supported LTE bandwidths are listed in the description of
CONFigure[:LTE]:UL:BW on page 107.

Example: POW:ACH:TXCH:COUN 2
POW:ACH:BAND:CHAN2 BW15_00
Defines a bandwidth of 15 MHz for the second TX channel.

Manual operation: See "Number of TX Channels" on page 52

[SENSe]:POWer:ACHannel:SPACing:CHANnel <Distance>

This command defines the distance between the first and the second TX channel for ACLR measurements.

Before you can use the command, you have to select two TX channels for the ACLR measurement with [SENSe]:POWer:ACHannel:TXCHannels:COUNt on page 118.

Parameters:

<Distance>   Distance from the center of the first TX channel to the center of the second TX channel in Hz.

Example: POW:ACH:TXCH:COUN 2
POW:ACH:SPAC:CHAN 10MHZ
Defines a channel spacing of 10 MHz.

Manual operation: See "Number of TX Channels" on page 52

[SENSe]:POWer:ACHannel:TXCHannels:COUNt <TXChannels>

This command selects the number of transmission (TX) channels in ACLR measurements.

Parameters:

<TXChannels>   Number of transmission channels.

1
One TX channel is analyzed in ACLR measurements.
2
Two TX channels are analyzed in ACLR measurements.

Example: POW:ACH:TXCH:COUN 2
Selects two TX channels for the ACLR measurement.

Manual operation: See "Number of TX Channels" on page 52

[SENSe]:POWer:NCORrection <State>

This command turns noise correction for ACLR measurements on and off.

Parameters:

<State>   ON | OFF

                   *RST: OFF

Example: POW:NCOR ON
                   Activates noise correction.

Manual operation: See "Noise Correction" on page 52

[SENSe]:POWer:SEM:UL:REQuirement <Requirement>

This command selects the requirements for a spectrum emission mask.

Parameters:

<Requirement>   GEN | NS3 | NS4 | NS67

                   GEN
                   General spectrum emission mask.

                   NS3 | NS4 | NS67
                   Spectrum emission masks with additional requirements.

Example: POW:SEM:UL:REQ NS3
                   Selects a spectrum emission mask with requirement for network
                   signalled value NS3.

Manual operation: See "SEM Requirement" on page 51

[SENSe]:SWEep:EGATe:AUTO <State>

This command turns auto gating for SEM and ACLR measurements on and off.

This command is available for TDD measurements in combination with an external or
IF power trigger.

Parameters:

<State>   **ON**
                   Evaluates the on-period of the LTE signal only.

                   OFF
                   Evaluates the complete signal.

Example: SWE:EGAT:AUTO ON
                   Turns auto gating on.

Manual operation: See "Auto Gating" on page 50

8.11 Signal Demodulation

8.11.1 Configuring the Data Analysis

[SENSe][:LTE]:UL:DEMod:ACON <Type>

This command selects the method of automatic demodulation for uplink signals.

Parameters:

<Type>   **ALL**
                           Automatically detects and demodulates the PUSCH and SRS.
                           OFF
                           Automatic demodulation is off.
                           SCON
                           Automatically detects and demodulates the values available in
                           the subframe configuration table.

Example: UL:DEM:ACON OFF
                           Turns automatic demodulation off.

Manual operation: See "Auto Demodulation" on page 56

[SENSe][:LTE]:UL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for uplink signals on and off.

Parameters:

<State>   ON | OFF

                           *RST: ON

Example: UL:DEM:CBSC OFF
                           Deactivates the scrambling.

Manual operation: See "Scrambling of Coded Bits" on page 56

[SENSe][:LTE]:UL:DEMod:CDCoffset <State>

This command turns DC offset compensation for uplink signals on and off.

Parameters:

<State>	ON | OFF
	*RST: ON

Example:	`UL:DEM:CDC OFF`
	Deactivates DC offset compensation.

Manual operation:	See "Compensate DC Offset" on page 55

[SENSe][:LTE]:UL:DEMod:CESTimation <Type>

This command selects the channel estimation type for uplink signals.

Parameters:

<Type>	PIL | PILPAY
	PIL
	Pilot only
	PILP
	Pilot and payload
	*RST: PILP

Example:	`UL:DEM:CEST PIL`
	Uses only the pilot signal for channel estimation.

Manual operation:	See "Channel Estimation Range" on page 55

[SENSe][:LTE]:UL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State>	ON | OFF
	*RST: OFF

Example:	`UL:DEM:MCF ON`
	Turns suppression on of neighboring carriers on.

Manual operation:	See "Multicarrier Filter" on page 57

[SENSe][:LTE]:UL:DEMod:MODE <Reference>

This command selects the uplink analysis mode.

Parameters:

<Reference>	**PUSCh**
	Analyzes the PUSCH and PUCCH.
	PRACh
	Analyzes the PRACH.
	*RST: PUSCh

Example: UL:DEM:MODE PRAC
                     Selects PRACH analysis mode.

Manual operation: See "Analysis Mode" on page 55

[SENSe][:LTE]:UL:DEMod:SISYnc <State>

This command turns suppressed interference synchronization on and off.

Parameters:
<State>   ON | OFF
                     *RST: OFF

Example: UL:DEM:SISY ON
                     Turns suppressed interference synchronization on.

Manual operation: See "Suppressed Interference Synchronization" on page 57

[SENSe][:LTE]:UL:FORMat:SCD <State>

This command turns detection of the subframe configuration on and off.

The command is available if "Auto Demodulation" is turned off.

Parameters:
<State>   ON | OFF
                     *RST: OFF

Example: UL:FORM:SCD ON
                     Turns detection of the subframe configuration on.

Manual operation: See "Subframe Configuration Detection" on page 56

8.11.2 Compensating Measurement Errors

[SENSe][:LTE]:UL:TRACking:PHASe <Type>

This command selects the phase tracking type for uplink signals.

Parameters:
<Type>   **OFF**
                     Deactivate phase tracking
                     PIL
                     Pilot only
                     PILP
                     Pilot and payload
                     *RST: OFF

Example: SENS:UL:TRAC:PHAS PILP
                       Use pilots and payload for channel estimation.

Manual operation: See "Phase" on page 57

[SENSe][:LTE]:UL:TRACking:TIME <State>

This command turns timing tracking for uplink signals on and off.

Parameters:
<State>   ON | OFF
                       *RST: OFF

Example: UL:TRAC:TIME ON
                       Activates timing tracking.

Manual operation: See "Timing" on page 58

8.12 Frame Configuration

8.12.1 Configuring TDD Signals

CONFigure[:LTE]:UL:TDD:SPSC <Configuration>

This command selects the special subframe configuration for LTE uplink signals.

Parameters:
<Configuration>   <numeric value>

Example: CONF:UL:TDD:SPSC 2
                       Selects special subframe configuration 2.

Manual operation: See "Configuring TDD Frames" on page 58

CONFigure[:LTE]:UL:TDD:UDConf <Configuration>

This command selects the UL/DL TDD subframe configuration for uplink signals.

Parameters:
<Configuration>   Range: 0 to 6
                       *RST: 0

Example: `CONF:UL:TDD:UDC 4`
                     Selects allocation configuration number 4.

Manual operation: See "Configuring TDD Frames" on page 58

8.12.2   Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:UL:PLC:CID <CellId>

This command defines the cell ID.

Parameters:
<CellId>   **AUTO**
                     Automatically defines the cell ID.
                     <numeric value>
                     Number of the cell ID.
                     Range: 0 to 503

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 60

CONFigure[:LTE]:UL:PLC:CIDGroup <GroupNumber>

This command selects the cell identity group for uplink signals.

Parameters:
<GroupNumber>   Range: 1 to 167
                     *RST: 0

Example: `CONF:UL:PLCI:CIDG 12`
                     Selects cell identity group 12.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 60

CONFigure[:LTE]:UL:PLC:PLID <Identity>

This command selects the physical layer identity for uplink signals.

Parameters:
<Identity>   **AUTO**
                     Automatic selection
                     0...2
                     Manual selection
                     *RST: AUTO

Example: `CONF:DL:PLC:PLID 2`
                     Sets the physical layer identity to 2.
                     `CONF:DL:PLC:PLID AUTO`
                     Physical layer ID is selected automatically.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 60

8.12.3 Configuring Subframes

CONFigure[:LTE]:UL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the uplink signal.

Parameters:

<NofSubframes>   Range: 1 to 10
                     *RST: 1

Example: `CONF:UL:CSUB 5`
                     Sets the number of configurable subframes to 5.

CONFigure[:LTE]:UL:SFNO <Offset>

This command defines the system frame number offset.

The application uses the offset to demodulate the frame.

Parameters:

<Offset>   <numeric value>
                     *RST: 0

Example: `CONF:UL:SFNO 2`
                     Selects frame number offset 2.

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBCount <NofRBs>

This command selects the number of resource blocks in an uplink subframe.

Parameters:

<NofRBs>   <numeric value>
                     *RST: 11

Example: `CONF:UL:SUBF8:ALL:RBC 8`
                     Subframe 8 consists of 8 resource blocks.

Manual operation: See "Number of RB" on page 62

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:RBOFfset <RBOffset>

This command defines the resource block offset in an uplink subframe.

Parameters:

<RBOffset>   <numeric value>

                       *RST: 2

Example: CONF:UL:SUBF8:ALL:RBOF 5

                       Subframe 8 has a resource block offset of 5.

Manual operation: See "Offset RB" on page 62

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:POWer <Power>

This command defines the (relative) power of an uplink allocation.

Parameters:

<Power>   <numeric value>

                       *RST: 0
                       Default unit: DB

Example: CONF:UL:SUBF8:ALL:POW -1.3

                       Sets the power of the allocation in subframe 8 to -1.3 dB.

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:CONT <Content>

This command allocates a PUCCH to an uplink allocation.

Parameters:

<Content>   **NONE**
                       Turns off the PUSCH and the PUCCH.

                       PUCCh
                       Turns on the PUCCH.

                       *RST: PUSC

Example: CONF:UL:SUBF8:ALL:CONT PUCC

                       Subframe 8 contains a PUCCH.

Manual operation: See "Enable PUCCH" on page 61

CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation <Modulation>

This command selects the modulation of an uplink allocation.

Parameters:

<Modulation>   QPSK | QAM16 | QAM64

                       *RST: QPSK

Example: CONF:UL:SUBF8:ALL:MOD QPSK

The modulation of the allocation in subframe 8 is QPSK.

Manual operation: See "Modulation" on page 61

8.13 Advanced Signal Characteristics

8.13.1 Configuring the Demodulation Reference Signal

CONFigure[:LTE]:UL:DRS:DSSHift <Shift>

This command selects the delta sequence shift of the uplink signal.

Parameters:

<Shift>   <numeric value>

*RST: 0

Example: CONF:UL:DRS:DSSH 3

Sets the delta sequence shift to 3.

Manual operation: See " Delta Sequence Shift" on page 64

CONFigure[:LTE]:UL:DRS:GRPHopping <State>

This command turns group hopping for uplink signals on and off.

Parameters:

<State>   ON | OFF

*RST: OFF

Example: CONF:UL:DRS:GRPHopping ON

Activates group hopping.

Manual operation: See " Group Hopping" on page 63

CONFigure[:LTE]:UL:DRS:NDMRs <nDMRS>

This command defines the n_{DMRS}.

Parameters:

<nDMRS>   <numeric value>

Example: CONF:UL:DRS:NDMR 0
                               Selects n_{DMRS} 0.

Manual operation: See " n(1)_DMRS" on page 64

CONFigure[:LTE]:UL:DRS:PUCCh:POWer <Power>

This command sets the relative power of the PUCCH.

Parameters:

<Power>   *RST: 0
                               Default unit: DB

Example: CONF:UL:DRS:PUCC:POW 2
                               Sets the power of the PUCCH to 2 dB.

Manual operation: See " Relative Power PUCCH" on page 63

CONFigure[:LTE]:UL:DRS[:PUSCh]:POWer <Power>

This command sets the relative power of the PUSCH.

Parameters:

<Power>   *RST: 0
                               Default unit: DB

Example: CONF:UL:DRS:POW 2
                               Sets the relative power of the PUSCH to 2 dB.

Manual operation: See " Relative Power PUSCH" on page 63

CONFigure[:LTE]:UL:DRS:SEQHopping <State>

This command turns sequence hopping for uplink signals on and off.

Parameters:

<State>   ON | OFF
                               *RST: OFF

Example: CONF:UL:DRS:SEQH ON
                               Activates sequence hopping.

Manual operation: See " Sequence Hopping" on page 63

8.13.2 Configuring the Sounding Reference Signal

CONFigure[:LTE]:UL:SRS:BHOP \<Bandwidth>

This command defines the frequency hopping bandwidth b_{hop}.

Parameters:

\<Bandwidth>	\<numeric value>
	*RST: 0

Example: CONF:UL:SRS:BHOP 1

Sets the frequency hopping bandwidth to 1.

Manual operation: See " Hopping BW b_hop" on page 66

CONFigure[:LTE]:UL:SRS:BSRS \<Bandwidth>

This command defines the bandwidth of the SRS (B_{SRS}).

Parameters:

\<Bandwidth>	\<numeric value>
	*RST: 0

Example: CONF:UL:SRS:BSRS 1

Sets the SRS bandwidth to 1.

Manual operation: See " SRS Bandwidth B_SRS" on page 65

CONFigure[:LTE]:UL:SRS:CSRS \<Configuration>

This command defines the SRS bandwidth configuration (C_{SRS}).

Parameters:

\<Configuration>	\<numeric value>
	*RST: 0

Example: CONF:UL:SRS:CSRS 2

Sets the SRS bandwidth configuration to 2.

Manual operation: See " SRS BW Conf. C_SRS" on page 66

CONFigure[:LTE]:UL:SRS:CYCS <CyclicShift>

Sets the cyclic shift n_CS used for the generation of the sounding reference signal CAZAC sequence.

Parameters:

<CyclicShift>	<numeric value>
	*RST: 0

Example: CONF:UL:SRS:CYCS 2

Sets the cyclic shift to 2.

Manual operation: See " SRS Cyclic Shift N_CS" on page 66

CONFigure[:LTE]:UL:SRS:ISRS <ConfIndex>

This command defines the SRS configuration index (I_{SRS}).

Parameters:

<ConfIndex>	<numeric value>
	*RST: 0

Example: CONF:UL:SRS:ISRS 1

Sets the configuration index to 1.

Manual operation: See " Conf. Index I_SRS" on page 66

CONFigure[:LTE]:UL:SRS:NRRC <FreqDomPos>

Sets the UE specific parameter Freq. Domain Position n_{RRC}.

Parameters:

<FreqDomPos>	<numeric value>
	*RST: 0

Example: CONF:UL:SRS:NRRC 1

Sets n_{RRC} to 1.

Manual operation: See " Freq. Domain Pos. n_RRC" on page 65

CONFigure[:LTE]:UL:SRS:POWer <Power>

Defines the relative power of the sounding reference signal.

Parameters:

<Power>	<numeric value>
	*RST: 0
	Default unit: DB

Example: CONF:UL:SRS:POW -1.2

Sets the power to -1.2 dB.

Manual operation: See " SRS Rel Power" on page 65

CONFigure[:LTE]:UL:SRS:STAT <State>

Activates or deactivates the sounding reference signal.

Parameters:

<State>   ON | OFF

                     *RST: OFF

Example: CONF:UL:SRS:STAT ON

                     Activates the sounding reference signal.

Manual operation: See " Present" on page 65

CONFigure[:LTE]:UL:SRS:SUConfig <Configuration>

This command defines the SRS subframe configuration.

Parameters:

<Configuration>   <numeric value>

                     *RST: 0

Example: CONF:UL:SRS:SUC 4

                     Sets SRS subframe configuration to 4.

Manual operation: See " SRS Subframe Conf." on page 65

CONFigure[:LTE]:UL:SRS:TRComb <TransComb>

This command defines the transmission comb (k_{TC}).

Parameters:

<TransComb>   <numeric value>

                     *RST: 0

Example: CONF:UL:SRS:TRC 1

                     Sets transmission comb to 1.

Manual operation: See " Transm. Comb. k_TC" on page 66

8.13.3 Defining the PUSCH Structure

CONFigure[:LTE]:UL:PUSCh:FHMode <HoppingMode>

This command selects the frequency hopping mode in the PUSCH structure.

Parameters:

<HoppingMode>	**NONE**	
	No hopping	
	INTer	
	Inter subframe hopping	
	INTRa	
	Intra subframe hopping	
	*RST:	NONE

Example:	CONF:UL:PUSC:FHM NONE
	Deactivates frequency hopping for the PUSCH.

Manual operation:	See " Frequency Hopping Mode" on page 67

CONFigure[:LTE]:UL:PUSCh:FHOFfset <Offset>

This command defines the frequency hopping offset for the PUSCH.

Parameters:

<Offset>	<numeric value>	
	*RST:	4

Example:	CONF:UL:PUSC:FHOF 5
	Sets the hopping offset to 5.

Manual operation:	See " PUSCH Hopping Offset" on page 67

CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB <HBInfo>

This command defines the information in hopping bits of the PUSCH.

Parameters:

<HBInfo>	<numeric value>	
	Range:	0 to 3
	*RST:	0

Example:	CONF:UL:PUSC:FHOP:IIHB 1
	Defines type 1 as the information in hopping bits.

Manual operation:	See " Info. in Hopping Bits" on page 68

CONFigure[:LTE]:UL:PUSCh:NOSM <NofSubbands>

This command defines the number of subbands/M of the PUSCH.

Parameters:

<NofSubbands>	<numeric value>	
	*RST:	4

Example:	CONF:UL:PUSC:NOSM 2
	Sets the number of subbands to 2.

Manual operation: See " Number of Subbands" on page 67

8.13.4 Defining the PUCCH Structure

CONFigure[:LTE]:UL:PUCCh:DEOFfset <Offset>

This command defines the delta offset of the PUCCH.

Parameters:

<Offset>   <numeric value>

                            Range: 0 to 2
                            *RST: 0

Example: CONF:UL:PUCC:DEOF 2
                            Sets the delta offset to 2.

CONFigure[:LTE]:UL:PUCCh:DESHift <Shift>

This command defines the delta shift of the PUCCH.

Parameters:

<Shift>   <numeric value>

                            Range: 1 to 3
                            *RST: 2

Example: CONF:UL:PUCC:DESH 3
                            Sets the delta shift of the PUCCH to 3.

Manual operation: See " Delta Shift" on page 69

CONFigure[:LTE]:UL:PUCCh:FORMat <Format>

This command selects the PUCCH format.

Note that formats 2a and 2b are available for normal cyclic prefix length only.

Parameters:

<Format>	**F1 (F1)**
	F1A (F1a)
	F1B (F1b)
	F2 (F2)
	F2A (F2a)
	F2B (F2b)
	F3 (F3)
	*RST: F1

Example:	CONF:UL:PUCC:FORM F1B
	Sets the PUCCH format to F1B.

Manual operation: See " Format" on page 69

CONFigure[:LTE]:UL:PUCCh:N1CS <N1cs>

This command defines the N(1)_cs of the PUCCH.

Parameters:

<N1cs>	<numeric value>
	*RST: 6

Example:	CONF:UL:PUCC:N1CS 4
	Sets N(1)_cs to 4.

Manual operation: See " N(1)_cs" on page 69

CONFigure[:LTE]:UL:PUCCh:N2RB <N2RB>

This command defines the N(2)_RB of the PUCCH.

Parameters:

<N2RB>	<numeric value>
	*RST: 1

Example:	CONF:UL:PUCC:N2RB 2
	Sets N2_RB to 2.

Manual operation: See " N(2)_RB" on page 69

CONFigure[:LTE]:UL:PUCCh:NORB <ResourceBlocks>

This command selects the number of resource blocks for the PUCCH.

Parameters:

<ResourceBlocks> **<numeric value>**
Selects the number of RBs.

AUTO
Detects the number of RBs automatically.

*RST: 0

Example: CONF:UL:PUCC:NORB 6
Sets the number of resource blocks to 6.

Manual operation: See " No. of RBs for PUCCH" on page 68

CONFigure[:LTE]:UL:PUCCh:NPAR <Format>

This command defines the N_PUCCH parameter in the PUCCH structure settings.

Parameters:

<Format> <numeric value>

<numeric value>

SUBF
Selects the definition of N_PUCCH on subframe level.

*RST: 0

Example: CONF:UL:PUCC:NPAR 2
Sets N_PUCCH to 2.

Manual operation: See " N_PUCCH" on page 70

8.13.5 Defining Global Signal Characteristics

CONFigure[:LTE]:UL:UEID <ID>

Sets the radio network temporary identifier (RNTI) of the UE.

Parameters:

<ID> <numeric value>

*RST: 0

Example: CONF:UL:UEID 2
Sets the UE ID to 2.

Manual operation: See "UE ID/n_RNTI" on page 70

8.14 PRACH Structure

CONFigure[:LTE]:UL:PRACh:APM <State>

This command turns automatic preamble mapping for the PRACH on and off.

Parameters:

<State>   ON | OFF

Example: CONF:UL:PRAC:APM ON
                       Turns automatic preamble mapping on.

Manual operation: See "PRACH Preamble Mapping" on page 72

CONFigure[:LTE]:UL:PRACh:CONF <Configuration>

This command selects the PRACH preamble format.

Parameters:

<Configuration>   <numeric value>

Example: CONF:UL:PRAC:CONF 2
                       Selects PRACH configuration 2.

Manual operation: See "PRACH Configuration" on page 71

CONFigure[:LTE]:UL:PRACh:FOFFset <Offset>

This command defines the PRACH frequency offset.

The command is available for preamble formats 0 to 3.

Parameters:

<Offset>   Resource block offset.

Example: CONF:UL:PRAC:FOFF 5
                       Defines a frequency offset of 5 resource blocks.

Manual operation: See "Frequency Offset" on page 71

CONFigure[:LTE]:UL:PRACh:FRINdex <FRINdex>

This command selects the PRACH frequency index.

Parameters:

<FRINdex>   <numeric value>

Example: CONF:UL:PRAC:FRIN 10
                         Selects the frequency index 10.

Manual operation: See "PRACH Preamble Mapping" on page 72

CONFigure[:LTE]:UL:PRACh:HFINdicator <HFINdicator>

This command defines the PRACH half frame indicator.

Parameters:

<HFINdicator>   <numeric value>

Example: CONF:UL:PRAC:HFIN 5
                         Selects half frame indicator 5.

Manual operation: See "PRACH Preamble Mapping" on page 72

CONFigure[:LTE]:UL:PRACh:NCSC <Configuration>

This command defines the Ncs configuration for the PRACH.

Parameters:

<Configuration>   <numeric value>

Example: CONF:UL:PRAC:NCSC 1
                         Selects Ncs configuration 1.

Manual operation: See "Ncs Conf" on page 71

CONFigure[:LTE]:UL:PRACh:RSEQ <RootSeqIdx>

This command defines the PRACH logical root sequence index.

Parameters:

<RootSeqIdx>   <numeric value>

Example: CONF:UL:PRAC:RSEQ 2
                         Selects logical root sequence index 2.

Manual operation: See "Logical Root Sequ. Idx" on page 72

CONFigure[:LTE]:UL:PRACh:RSET <State>

This command turns the restricted preamble set for PRACH on and off.

Parameters:

<State>   ON | OFF
                         *RST: OFF

Example: CONF:UL:PRAC:RSET ON
                         Turns the restricted set on.

Manual operation: See "Restricted Set" on page 71

CONFigure[:LTE]:UL:PRACh:SINDex <Index>

This command selects the PRACH sequence index.

Parameters:

<Index>   **<IndexValue>**
                       Number that defines the index manually.

                       AUTO
                       Automatcailly determines the index.

Example: CONF:UL:PRAC:SIND 2
                       Selects sequence index 2.

Manual operation: See "Sequence Index (v)" on page 72

8.15 Measurement Result Analysis

8.15.1 Selecting Displayed Data

[SENSe][:LTE]:ALLocation:SELect <Allocation>

This command filters the displayed results in the constellation diagram by a particular type of allocation.

Parameters:

<Allocation>   **ALL**
                       Shows the results for all allocations.

                       <numeric_value>
                       Shows the results for a particular allocation type.
                       Allocation types are mapped to numeric values. For the code
                       assignment see chapter 8.6.1.17, "Return Value Codes",
                       on page 104.

                       *RST: ALL

Example:	`ALL:SEL 2` Shows the results for PDSCH allocation 2.
Manual operation:	See "Evaluation Range for the Constellation Diagram" on page 75

[SENSe][:LTE]:CARRier:SELect <Carrier>

This command filters the displayed results in the constellation diagram by a particular subcarrier.

Parameters:

<Carrier>	**ALL** Shows the results for all subcarriers. **<numeric_value>** Shows the results for a particular subcarrier. *RST: ALL
Example:	`CARR:SEL 1` Shows the results for subcarrier 1.
Manual operation:	See "Evaluation Range for the Constellation Diagram" on page 75

[SENSe][:LTE]:MODulation:SELect <Modulation>

This command filters the displayed results in the constellation diagram by a particular type of modulation.

Parameters:

<Modulation>	**ALL** Shows the results for all modulation types. **<numeric_value>** Shows the results for a particular modulation type. Modulation types are mapped to numeric values. For the code assignment see chapter 8.6.1.17, "Return Value Codes", on page 104. *RST: ALL
Example:	`MOD:SEL 3` Shows the results for all elements with a 16QAM modulation
Manual operation:	See "Evaluation Range for the Constellation Diagram" on page 75

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:

<Subframe>	ALL | <numeric value>
	ALL
	Select all subframes
	0...39
	Select a single subframe
	*RST: ALL
Example:	SUBF:SEL ALL
	Select all subframes for analysis.
Manual operation:	See "Subframe Selection" on page 73

[SENSe][:LTE]:SYMBol:SELect <Symbol>

This command filters the displayed results in the constellation diagram by a particular OFDM symbol.

Parameters:

<Symbol>	**ALL**
	Shows the results for all subcarriers.
	<numeric_value>
	Shows the results for a particular OFDM symbol.
	*RST: ALL
Example:	SYMB:SEL 2
	Shows the results for the second OFDM symbol.
Manual operation:	See "Evaluation Range for the Constellation Diagram" on page 75

8.15.2 Selecting Units

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>	**SYMbols**
	Displays the bit stream using symbols
	BITs
	Displays the bit stream using bits
	*RST: SYMbols
Example:	UNIT:BSTR BIT
	Bit stream gets displayed using Bits.
Manual operation:	See "Bit Stream Format" on page 74

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>   **DB**
                          EVM results returned in dB
                          PCT
                          EVM results returned in %
                          *RST: PCT

Example: UNIT:EVM PCT
                          EVM results to be returned in %.

Manual operation: See "EVM Unit" on page 74

8.15.3 Using Markers

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Suffix:

<m>   1

Example: CALC:MARK:AOFF
                          Turns off all markers.

Usage: Event

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command positions a marker on the peak value of the trace.

Suffix:

<m>   1..n

Example: CALC:MARK2:MAX
                          Positions marker 2 on the trace peak.

Usage: Event

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command positions a marker on the minimum value of the trace.

Suffix:

<m>   1..n

Example: `CALC:MARK:MIN`

Positions marker 1 on the trace minimum.

Usage: Event

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off.

Suffix:

<m>   1

Parameters:

<State>   ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`

Turns on marker 3.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command positions the marker on a particular trace.

If necessary, the command turns on the marker first.

Suffix:

<m>   1

Parameters:

<Trace>   1 | 2 | 3

Number of the trace you want the marker positioned on.

CALCulate<n>:MARKer<m>:X <Position>

This command positions a marker on a particular coordinate on the x-axis.

If necessary, the command first turns on the marker.

Suffix:

<m>   1

Parameters:

<Position>   Numeric value that defines the marker position on the x-axis.

Default unit: The unit depends on the result display.

Example: `CALC:MARK:X 1GHZ`

Moves the marker to the frequency of 1 GHz.

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m>   1

Example: `INIT:CONT OFF`
                    Switches to single measurement mode.
                    `CALC:MARK2 ON`
                    Switches marker 2.
                    `INIT;*WAI`
                    Starts a measurement and waits for the end.
                    `CALC:MARK2:Y?`
                    Outputs the measured value of marker 2.

Usage: Query only

8.15.4 Using Delta Markers

CALCulate<n>:DELTamarker<m>:AOFF

This command turns all delta markers off.

Suffix:

<m>   1

Example: `CALC:DELT:AOFF`
                    Turns off all delta markers.

Usage: Event

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command positions a marker on the peak value of the trace.

Suffix:

<m>   1..n

Example: CALC:DELT2:MAX
                      Positions delta marker 2 on the trace peak.

Usage: Event

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command positions a delta marker on the minimum value of the trace.

Suffix:
<m>   1..n

Example: CALC:DELT2:MIN
                      Positions delta marker 2 on the trace minimum.

Usage: Event

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

Suffix:
<m>   1

Parameters:
<State>   ON | OFF
                      *RST: OFF

Example: CALC:DELT3 ON
                      Turns on delta marker 3.

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command positions a delta marker on a particular trace.

Suffix:
<m>   1

Parameters:
<Trace>   1 | 2 | 3
                      Number of the trace you want the delta marker positioned on.

CALCulate<n>:DELTamarker<m>:X <Position>

This command positions a delta marker on a particular coordinate on the x-axis.

If necessary, the command first turns on the delta marker.

Suffix:
<m>   1

Parameters:

<Position>   Numeric value that defines the delta marker position on the x-axis.

                       Default unit: The unit depends on the result display.

Example: CALC:DELT2:X 1GHZ

                       Positions delta marker 2 on the frequency of 1 GHz.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:
<m>   1

Example: INIT:CONT OFF

                       Switches to single measurement mode.

                       CALC:DELT2 ON

                       Turns on delta marker 2.

                       INIT;*WAI

                       Starts a measurement and waits for the end.

                       CALC:MARK2:Y?

                       Queries the measurement result at the position of delta marker 2.

Usage: Query only

8.15.5 Scaling the Vertical Diagram Axis

Programming example to scale the y-axis

```
//Start EVM vs Symbol result display in screen B.
CALC2:FEED 'EVM:EVSY'
//Refresh the measurement results based on the contents of the capture buffer
INIT:IMM
//Select screen B.
DISP:WIND2:SEL
//Select dB as the EVM unit.
UNIT:EVM DB
//Define the point of origin of 5 dB on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:OFFS 5
//Define the distance of 10 dB between two grid lines on the y-axis.
DISP:TRAC:Y:SCAL:FIXS:PERD 10
```

DISPlay[:WINDow]:TRACe:Y:SCALe:AUTO

This command automatically adjusts the scale of the y-axis to the current measurement results.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Example:	`DISP:TRAC:Y:SCAL:AUTO`
	Scales the y-axis of the selected result display.
Usage:	Event
Manual operation:	See "Y-Axis Scale" on page 76

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet <Origin>

This command defines the point of origin of the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:

<Origin>	Point of origin of the y-axis.
	The unit depends on the result display you want to scale.
Example:	See chapter 8.15, "Measurement Result Analysis", on page 138.
Manual operation:	See "Y-Axis Scale" on page 76

DISPlay[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv <Distance>

This command defines the distance between two grid lines on the y-axis and thus has an effect on the scale of the y-axis.

Note that the command only affects the result display selected with `DISPlay[:WINDow<n>]:SELect`.

Parameters:

<Distance>	The unit depends on the result display you want to scale.
Example:	See chapter 8.15, "Measurement Result Analysis", on page 138.
Manual operation:	See "Y-Axis Scale" on page 76

8.16 Software Configuration

CONFigure:PRESet

Initiates a preset to the default state of the software, and, if connected to an analyzer, also presets the analyzer.

Example:	CONF:PRES Presets the software.
Usage:	Event

DISPlay[:WINDow<n>]:SELect

This command selects the measurement window.

Example:	DISP:WIND2:SEL Selects screen B.
Usage:	Event

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format>	ASCii	REAL *RST: ASCii
Example:	FORM REAL The software will send binary data in Real32 data format.

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:

<Path>	String containing the path and name of the file.
Example:	MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'
Usage:	Setting only

List of Commands

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